3.0 SUPPLEMENTAL INFORMATION REQUESTS

NEEDS, ALTERNATIVES, ALTERNATIVES TO

SIR 1

Project Description Volume 2: Section 1.1, Pages 1-9. Shell states that it had a responsibility to its shareholders and Alberta to define and advance the development of its lease holdings in economically viable ways to realize the value from the investment. Shell further states that the continued development of oil sands would serve to supplement diminishing sources of conventional crude oil and contribute to the overall domestic output of crude oil, thereby reducing Canada's import and dependence on foreign oil.

a) Provide information regarding the contribution of the Pierre River Mine Project (PRM) to the overall Canadian and North American demand for liquid fuels.

b) Provide information regarding the role of liquid hydrocarbon fuels to the global energy supply matrix in the short and medium term in relation to the role of alternative energy sources.

Response:

a) Projected crude oil supply/demand information obtained from the Canadian National Energy Board and the United States Energy Information Administration is presented in Table 1-1. Bitumen production from oil sands mining in the Athabasca region is expected to grow from 0.9 million barrels per day in 2010 to nearly 1.9 million barrels per day by 2030. The Pierre River Mine (PRM) would contribute almost 10% to this total. Assuming that all mined oil sand is processed within Canada and the United States, its contribution towards meeting the total crude oil demand in Canada and the United States could grow from 4.5% in 2010 to approximately 9% in 2030.

Table 1-1 North American Crude Oil Supply and Demand

Supply and Demand	2010	2020	2030
	(Millions of Barrels Crude Oil per Day)		
US Crude Oil Production	9.7	13.1	11.7
US Imports	9.5	6.8	7.3
US Demand	**19.2**	**19.8**	**19.0**
Mined Bitumen	*0.9*	*1.4*	*1.9*
In-situ Bitumen	*0.8*	*1.8*	*2.7*
Total Canadian Crude Oil Production	**2.9**	**4.7**	**6.1**
Net Light Oil Exports	*0.9*	*1.3*	*1.3*
Net Heavy Oil Exports	*1.0*	*2.2*	*3.3*
Net Canadian Exports/Imports	**1.9**	**3.5**	**4.7**
Canadian Demand	**1.0**	**1.3**	**1.4**

Sources: US Energy Information Administration, "Annual Energy Outlook 2013 with Projections to 2040", Early Release, December 5, 2012.

National Energy Board, "Canada's Energy Future: Energy Supply and Demand Projections to 2035", Chapter 4: Crude Oil Outlook, November 2011.

b) For a number of years Shell has provided information and potential scenarios of how the world energy supply and demand may evolve over time.

A breakdown for one possible global energy demand forecast taken from Shell's "Signals and Signposts" publication is presented in Table 1-2. Shell has recently provided two new scenarios entitled "Mountains and Oceans"; however, the data is very similar and for the purposes of responding to this information request, Shell believes the information in Table 1-2 is illustrative and provides the requested information. It should be noted that these forecasts are necessarily based on many assumptions and therefore subject to change and interpretation.

Table 1-2 Projected Primary Energy Demand – 2000 to 2030

Energy Type	2000	2010	2020	2030
Crude oil, Exajoules per Year (EJ/yr)	155	168	195	197
Natural gas, EJ/yr	87	114	146	169
Coal, EJ/yr	96	149	184	193
Nuclear, EJ/yr	28	32	41	56
Biomass, EJ/yr	42	55	59	61
Solar, EJ/yr	0	1	6	20
Wind, EJ/yr	0	1	4	10
Other renewable sources [a] EJ/yr	13	17	23	28
Total Primary Energy Demand[b]	**422**	**536**	**659**	**734**

(a) Other renewable sources include hydro-electric, geothermal, tidal, and waste.

(b) Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Source: Shell Energy Scenarios to 2050: Signals & Signposts, Appendix 2, page 76, Shell International, projections under current and expected policies;
http://www.shell.com/home/content/aboutshell/our_strategy/shell_global_scenarios/

In the short term (2020), crude oil is anticipated to supply nearly 30% of the world's energy demand versus 14% for alternative sources as demonstrated in Table 1-2.

Medium term total energy demand is projected to continue to increase. Both alternative and liquid hydrocarbon fuels will be needed to meet this demand.

SIR 2

Project Description Volume 2: Section 1.1, Page 1-10. Shell states that it considered alternatives to the Project including the 'no development' option as well as certain timings for development. Shell concluded that the Project, as proposed, would be the most practical, economic, and sustainable means of extracting the resource. The 'no development' option was stated to be incompatible with fulfilling the need for the Project. Shell determined that other methods of bitumen recovery, such as in situ recovery, were technically infeasible for these leases.

a) Provide a list and description of the alternatives to PRM it evaluated.

b) Describe the criteria that were used to illustrate the broad environmental effects and the costs and benefits of alternatives considered and how the criteria were used to identify the preferred alternative.

Response:

The following is Shell's response to parts (a) and (b) of this information request.

Consistent with the Canadian Environmental Assessment Agency's Operational Policy Statement for Addressing "Need for", "Purpose of", "Alternatives to" and "Alternative Means" under the *Canadian Environmental Assessment Act*, *2012,* Shell considered alternatives to Pierre River Mine (PRM) in relation to the need and purpose of PRM from the perspective of Shell.

As described in the EIA, Pierre River Mine, Volume 2, Section 1.1, Shell has an obligation to its shareholders to define and advance development of the PRM lease holdings in economically viable ways. Shell also has a responsibility to the people of Alberta to develop the resource in a timely and efficient manner. Further, continued development of the Athabasca oil sands will provide a secure, domestic source of crude oil, which can replace diminishing conventional supplies and offset a growing demand. The Pierre River Mine is required to meet these needs. The Pierre River Mine will achieve the purpose of maximizing the value of the resource and providing a supply of bitumen as a source of energy products, for the benefit of Shell's shareholders, Albertans and the broader public.

There are no alternatives (or functionally different ways) to meet the PRM need and achieve the PRM purpose. A ‘no development’ option is inconsistent with the need for and purpose of PRM and therefore cannot be considered an alternative. The use of in situ methods of bitumen recovery, such as Steam Assisted Gravity Drainage (SAGD), fireflood and in situ upgrading are not technically feasible. The PRM resource is too shallow and not amenable to SAGD. Other in situ technologies are too immature and carry a high risk. In Shell’s assessment, the use of in situ methods is not an alternative to PRM because it does not represent a timely, efficient, and economically viable way of developing the resource, nor would it maximize the value of the resource. No other potential alternatives to the PRM were identified.

In addition to alternatives to PRM, Shell considered a variety of alternative means of carrying out the PRM. The alternative means considered, as well as the assessment methods and criteria used to assess these alternative means are described in the EIA, Pierre River Mine, Volume 2, Section 13, as well as the response to JRP SIR 4.

The PRM as currently described represents the preferred project that meets the need and achieves the purpose discussed above, taking into account a variety of factors, including technical, economic and environmental considerations.

SIR 3

Jackpine Mine Expansion and Pierre River Mine - Submission of Information to the Joint Review Panel, Section 2.3, Page 20. Shell makes a commitment to eliminate mature fine tailings (MFT) from Jackpine Mine pit lakes through the employment of densification technology such as centrifuges. It did not, however, specify whether this commitment also applied to the PRM site.

a) Clarify whether Shell has also committed to eliminating MFT from Pierre River Mine pit lakes through the employment of densification technology such as centrifuges.

Response:

a) Shell is not committing to have MFT-free end pit lakes for PRM. Justification for not committing to MFT-free end pit lakes is discussed in JRP SIR 20.

SIR 4

4) Project Description Volume 2: Section 13.1, Page 13.2. Shell states that a number of process methods were identified as having possible alternative means. These included: mining method (including equipment), tailings management, ore preparation, conditioning and extraction, primary bitumen extraction, froth treatment, process water sourcing, basal aquifer disposal, electrical power and heat supply, and waste handling.

a) Provide a description of the alternative means considered for ore preparation, ore conditioning and extraction, primary bitumen extraction, and froth treatment.

b) Develop criteria to determine the technical and economic feasibility of each alternative means proposed in (a).

c) Identify the preferred means based on the relative consideration of environmental effects, and of technical and economic feasibility.

d) Determine and apply criteria that identify alternative means as unacceptable on the basis of significant adverse environmental effects.

e) Determine criteria to examine the environmental effects of each remaining alternative means to identify a preferred alternative.

Response:

a) The alternative means considered for ore preparation, ore conditioning and extraction, primary bitumen extraction, and froth treatment are listed and described in the first column of the following tables (Tables 4-1 to 4-4; column titled ‘Technology’).

b) The technical and economic criteria utilized for evaluating the alternative means for PRM are included in Shell’s project assessment framework. Specifically, Shell’s project assessment framework consists of five broad categories: Technical, Economic, Commercial, Operational, and Regulatory. Criteria that were deemed to be relevant to the PRM were chosen from within these broader categories. These project-specific considerations form the remainder of the columns in the following tables. Their connections to the five broad categories are shown in parentheses beneath the column title.

To develop a ‘short list’ of alternative means from what could be an extensive list of process methods, two overriding screening-level criteria were applied. These are:

- Commercialization - The process must either have been operated commercially, or have completed sufficient piloting under field conditions such that there is confidence in the operating performance under commercial conditions and scale. Given the scale of investment and the impact on project economics, large green field projects are not the appropriate context for commercializing unproven prototype processes.
- Environmental Performance - The technology after mitigation must not result in significant adverse environmental impacts. In some instances the required mitigation can render the PRM unacceptable based on other criteria such as operating cost or operability. For example, at the current state of development, solvent extraction processes that have been piloted to date have not achieved sufficiently low levels of solvent in tailings to be considered for selection and/or the cost to mitigate these emissions is too high.

The list of technology options in Tables 4-1 to 4-4 includes only those processes that meet the above screening criteria.

c) The preferred means chosen are identified in the Tables 4-1 to 4-4 by pale yellow highlighting. The final selection of technology was based on the combined influence of all the listed criteria.

In regards to environmental criteria, the environmental effects of various technologies used in commercial oil sands mining generally consist of water consumption rates, quality of effluent, and energy consumption (which relates to greenhouse gas emissions). Water consumption and effluent quality are related primarily to the extraction process. The energy efficiency components are incorporated into both the Economics (i.e., the cost of energy required to operate the process) and the Environmental Effects (amount of greenhouse gases and/or NO_x) columns.

The impacts and relationships between the five broad categories, including Technical and Economic, are complex and constantly under review through an iterative evaluation process up until the time of final investment decision. There is no set formula or prescriptive process employed by Shell, but rather the systematic application of knowledge by experienced professionals working on the PRM development. Specific factors such as the influence of environmental effects are not considered in isolation, rather they are incorporated into the broader project assessment framework under the premise that any viable technology choice must meet applicable regulatory requirements, must not produce significant adverse environmental effects after mitigation, and must be efficient with respect to the use of resources. Technologies that inherently produce higher emissions typically require more abatement and thus result in higher operating costs and/or poorer operability. Isolating the costs associated with abatement and/or mitigation measures separately can be onerous and lead to inappropriate comparisons.

d) As noted in response (b) above, there are no specific criteria for elimination of alternatives based solely on environmental effects, apart from the initial screening. The environmental effects of any technology must be mitigated to comply with the applicable regulations and any requirements arising from an approval. Industry experience and technical familiarity are often applied in the evaluation process to identify impractical alternatives or alternatives that may result in prohibitively expensive mitigation efforts. Details of the relevant environmental effects which were considered in the selection process are presented in Tables 4-1 to 4-4.

e) See response (d) above.

Introduction to the Tables of Alternative Technology or Assessment Methods

A brief description of each of the technology areas requested are outlined as follows:

Ore Preparation

This area includes mining of the oil sand ore, crushing the ore and transport to the site of continuous processing (i.e., the extraction plant). With hydro-transport, ore delivery to extraction follows slurry preparation and is combined with the slurry conditioning step in a slurry pipeline.

Ore Conditioning

Ore conditioning is the process of slurrying oil sand with water to release the bitumen from the sand matrix. Further size reduction of the ore occurs within the slurry preparation process via mechanical mixing. The initial design of tumbler conditioning drums used vibrating screens on the discharge resulting in rejected lumps greater than 20 mm. Recent systems employed in the industry have increased the reject size to 50 or 100 mm or in the case of wet crushing, the ability to eliminate reject screening. Typically, caustic (NaOH) is used as a dispersant and pH control to assist in the release of bitumen.

Bitumen Extraction

Bitumen extraction is the process of recovering bitumen from the conditioned ore slurry. In the water-based extraction processes this typically occurs in two stages. The first stage (primary recovery) takes advantage of spontaneous flotation using the air bubble-bitumen attachment occurring during slurry preparation. The second stage (flotation) uses induced aeration to recover more bitumen from the tailings from the primary stage.

Froth Treatment

Froth treatment is the process of removing water and fine mineral particles from the bitumen froth recovered in extraction. The froth is typically about 60% bitumen, 30% water and 10% fine solids. Generally, the water and solids are removed by diluting the bitumen with a solvent to reduce its viscosity and density. The solids and water are then settled out using gravity (settlers and inclined plate separators) or with mechanically increased G-force (centrifuges, cyclones). The naphtha-based froth treatment process typically reduces solids and water to about 1% and 4% respectively of bitumen mass.

The paraffinic froth treatment process employs the insolubility of asphaltenes in light, alkane hydrocarbons to reject a portion of the asphaltene in the bitumen. Asphaltenes are high molecular weight components of crude oils consisting of connected aromatic ring structures containing higher concentrations of sulphur and nitrogen embedded in the ring structures than are contained in lighter crude fractions. They account for the majority of coke production in a coker and the majority of catalyst contamination in catalytic hydro-conversion processes, primarily due to vanadium and nickel compounds which are also concentrated in the asphaltene fraction. A prerequisite of any froth treatment process is that it must produce a marketable bitumen product.

The technical and economic criteria used to evaluate the above technology options are set out in Tables 4-1 to 4-4. The preferred means (selected options) are highlighted and summarized at the bottom of each table.

Table 4-1 Ore Preparation: Includes Oil Sand Excavation, Primary Sizing and Transport to the Ore Processing Surge (Storage) Pile or Bin

Technology (Shell assessment framework)	Capital and Operating Expenses (Economics)	Equipment Reliability and Flexibility (Operational)	Ore Selectivity (Technical and Economics)	Resource Recovery (Regulatory and Economics)	Technical Maturity (Technical)	Environmental Effects (Technical and Economics)	Shell Corporate Knowledge (Operational)	Access to Technology (Technical and Commercial)	Integration with Existing Assets (Operational)
Bucket wheel excavator & long conveyors. Excavators operate on multiple benches cutting ore from the mine face, discharging it to conveyors which deliver the oil sand to a surge pile or bin at the extraction plant.	High	Poor reliability requires large standby capacity. Cyclical output requires over-sized conveyors. Ore size control is a function of bucket design and grizzly spacing over conveyor loading point.	Very limited. Long, wide operating benches constrain pit geometry.	Limited access to irregular pit geometry.	Fully commercial for oil sands but all systems abandoned in favour of truck-shovel/hydro-transport.	Not a critical factor. Conveyors use grid power while trucks localize emissions.	No experience	Accessible from vendors	Requires new support infrastructure and organization
Dragline & bucket wheel reclaimer & long conveyors. Draglines operate on top of the oil sand and caste the ore to windrows on the top bench. Bucketwheels then reclaim the ore and discharge it to conveyors which in turn deliver the oil sand to a surge pile or bin at the extraction plant.	High	Requires wide operating benches. Sinusoidal output not suitable for direct slurry to hydro-transport.	Some ability for centre rejects on mine face. Provides good ore blending capability.	Limited access to irregular pit geometry.	Fully commercial for oil sands but all systems abandoned in favour of truck-shovel/ hydro-transport.	Not a critical factor. Conveyors use grid power (coal fired power) while trucks localize emissions from diesel combustion.	No experience	Accessible from vendors	Requires new support infrastructure and organization
Electric cable shovel & ore trucks haul to a primary crusher or sizer. Shovels operate on multiple benches filling ore haul trucks. A cable shovel performs a single sweep through the full bench.	Low (Compared to above systems)	Steady crusher/sizer output for integration with hydro-transport.	Limited within bench. Blending through multiple bench delivery.	Better access to smaller or irregular ore bodies.	Fully commercial in oil sands.	Trucks localize diesel combustion emissions, conveyors use grid power derived from coal fired power generation.	Now operating	Accessible from vendors	Incremental to existing support
Hydraulic shovel & ore trucks haul to a primary crusher or sizer. As above. A hydraulic shovel is also capable of mid-bench excavation and diesel power provides easier mobility than an electric powered shovel.	Low	Constant crusher/sizer output for integration with hydro-transport. Diesel-hydraulic shovels are easier to relocate than electric cables.	Best selectivity within bench. Blending through multiple bench delivery	Better access to smaller or irregular ore bodies.	Fully commercial in oil sands.	Shovels & trucks localize diesel combustion emissions. Electric shovels use grid power derived from coal fired power generation.	Now operating	Accessible from vendors	Incremental to existing support
High speed double roll crusher. Two large cylindrical drums with impact lugs spaced at the nominal dimension spin inwardly crushing large rock, frozen slabs and lumps to 400 to 600 mm nominal size.	Part of the above two systems	Good availability. Ability to quickly change out worn components during operations.	n/a	n/a	Fully commercial in oil sands.	n/a	Now operating	Accessible from vendors	Incremental to existing support
Sizer. Compared to a double-roll crusher, a sizer rotates more slowly and provides 3-dimensional size control rather than one-dimensional.	Similar to above Selection is based on technical-commercial assessment	Good availability.	n/a	n/a	Fully commercial in oil sands.	n/a	No experience, but similar to double roll crushers	Accessible from vendors	Incremental to existing support
Natural gas fueled haul trucks. Natural gas used in a modified diesel engine.	Low fuel cost at current natural gas prices	High-pressure gas does not provide the fuel capacity and refuelling flexibility of liquid fuels.	n/a	n/a	Not yet commercial. Fuelling infrastructure and impacts on haul capacity need evaluation.	Lower emissions than diesel fuel.	No current experience but under investigation.	Unknown, Shell is currently working with vendors	Could be implemented into an operating mine with some new infrastructure & little impact on existing infrastructure
Electric trolley on pit haul roads. Diesel-electric trucks have an on-board diesel generator to power electric wheel motors. Trucks are equipped with an overhead trolley that engages electric wires shifting power supply from the diesel generator to the electrical supply system.	High capital cost for trolley & periodic relocation	When electrical power shifts to trolley, the power load on the truck on-board diesel generator is reduced.	n/a	n/a	Commercial.	Shifts emissions from electric power generation from mine site to electric grid. Coal-fired generation and gas fired peak generation may increase GHGs.	No experience	Accessible from vendors	Could be implemented into an operating mine with some new infrastructure & little impact on existing infrastructure

Note: Based on the factors of capital cost and mine flexibility, Shell has selected shovel-truck mining delivering to a primary crusher (or sizer) feeding a surge pile or surge bin. Generally a mix of cable and hydraulic shovels is used with the balance optimised based on mine plan requirements. Natural gas-fuel for ore (and overburden) haul trucks will be considered in the future as further experience and information is gained.

n/a= Not applicable.

Table 4-2 Ore Conditioning: Includes Slurry Preparation and Secondary Sizing for Delivery to Bitumen Recovery

Technology (Shell assessment framework)	Capital and Operating Expenses (Economics)	Equipment Reliability and Flexibility (Operational)	Resource Recovery (Regulatory and Economics)	Technical Maturity (Operational and Technical)	Environmental Effects (Technical and Economics)	Corporate Knowledge (Operational)	Access to Technology (Technical and Commercial)	Integration with Existing Assets (Operational)
Tumblers. Large rotating cylinders with internal steam-sparger pipes. Slurry is discharged over vibrating screens.	High	High maintenance requirements contribute to significant down time.	Acceptable. Rejects were high in winter (Screening to < 20 mm).	Commercial	Higher energy intensity than current processes therefore higher GHG's are produced.	No experience.	Available	Not an important consideration for this technology.
Cyclo-feeder & rejects crushing feeding Hydro-Transport. The cyclo-feeder is a silo-shaped vessel with a conical bottom outlet. Oil sand and slurry water enter the top, midway screens reject oversize lumps & rock.	Medium	Unwieldy rejects crushing & recycle needed for winter rejects. Conical wear surface.	Good. Shift from 20 mm to 50 mm reduced reject oil losses.	Commercial (1st Hydro-Transport slurry prep system)	Lower energy usage derived in the shift from an 80°C to 50°C process. This results in lower GHG's.	No experience.	Available	Not an important consideration for this technology.
Mix box with integral hammer-mill feeding Hydro-Transport. Similar to a cyclo-feeder but with rectangular surfaces. The hammer-mill between two vibrating screens reduces rejects to a low level.	Medium	Use of a hammer mill substantially reduced rejects. Hammer mill has high wear requiring more maintenance.	Good. Sizing was increased to 100 mm maximum to reduce rejects and improve oil recovery.	Commercial (2nd Hydro-Transport slurry prep system)	Lower energy and therefore lower GHG's by confining 50°C to slurry preparation Hydro-Transport with lower temperature in recovery sections.	No experience.	Available	Not an important consideration for this technology.
Wet crushing (sizing) feeding Hydro-Transport. Sizers within the slurry mix box reduce all lumps and rock to less than 100 mm.	Medium	Expected to have lower wear.	Best. The rejects oil losses and rejects handling system are eliminated.	Commercial in 2015	Lower energy and therefore lower GHG's by confining 50°C to slurry preparation- Hydro-Transport with lower temperature in recovery sections.	No experience but work planned due to recovery & material handling benefits.	Not currently available	Not an important consideration for this technology.
Rotary breaker feeding Hydro-Transport. A rotating cylinder with holes to release slurry but hold lumps greater than e.g., 50 mm.	Medium	Not amenable to design for periodic relocation.	Acceptable. High rejects unless reprocessing is included.	Commercial	Generally operated at 50°C and therefore marginally higher GHG's.	Current operations.	Available	Not an important consideration for this technology.

Note: Based on current corporate knowledge and recent improvements in recovery, Shell has provisionally selected the rotary breaker slurry preparation system followed by Hydro-Transport. Wet crushing feeding Hydro-transport will be considered should this technology be commercialized and available.

Table 4-3 Bitumen Extraction: Includes Primary Recovery and Secondary Flotation Recovery

Technology (Shell assessment framework)	Capital and Operating Expenses (Economics)	Equipment Reliability and Flexibility (Operational)	Resource Recovery (Regulatory and Economics)	Technical Maturity (Operational and Technical)	Environmental Effects (Technical and Economics)	Corporate Knowledge (Operational)	Access to Technology (Technical and Commercial)	Integration with Tailings (Technical and Economics)
Primary separator								
Raked bottom vessel. Oil sand slurry is fed to a large round vessel with a shallow-sloped conical bottom outlet. Rotating rakes plow the settled sand to a central outlet. Bitumen froth overflows from the water surface. A "middlings" stream, made up of water, fines and bitumen that did not spontaneously float, is withdrawn and fed to flotation cells for secondary recovery.)	Not a significant consideration.	Poor. Rakes are a mechanical system requiring maintenance with potential for unplanned outages.	No significant difference.	Commercial	No distinguishing factors.	No experience with primary separator. Some experience with raked thickeners.	Available	Primary and secondary tailings can be disposed of as combined slurry, or a portion of secondary tailings may be discharged separately for density control of the sand tailings. Sand tailings are used for cell and beach construction of the tailings settling pond for water recycle.
Steep cone primary recovery cell. Similar to the above but with a ≈ 55^0 conical vessel bottom requiring no rakes.	Not a significant consideration.	More reliable - avoids mechanical rakes.	No significant difference.	Commercial	No distinguishing factors.	Existing.	Available	As above.
Secondary Recovery								
Flotation cells. Primary separator middlings are fed to vessels where air is injected through rotating impellors generating small bubbles which attach to bitumen particles. Bitumen froth overflows the cells for direct recovery or recycle to the primary separator.	Low	Some wear on flotation cells	Lowest recovery.	Commercial	No distinguishing factors.	No operating experience.	Available	As above.
Flotation cells on the cyclones overflow of primary tailings. Similar to above except primary separator tailings are cycloned to remove sand with the desanded tailings sent to flotation cells.	High	Less wear on flotation cells	Intermediate recovery.	Commercial	No distinguishing factors.	Existing.	Available	Flotation tailings can be fed to a thickener for recovery of warm water and disposal of thickened tailings.
Flotation cells on primary cycloned middlings and sand tailings.	High	Very high wear on sand flotation cells	Highest recovery.	Commercial	No distinguishing factors.	Existing	Available	Flotation tailings can be fed to a thickener for recovery of warm water and disposal of thickened tailings.
Jameson downcomers installed in deep-cone secondary recovery vessel. Primary separator tailings are sent to a large vessel designed for mass-flow of densified sand out the steep conical bottom outlet. Vertical pipes called Jameson downcomers are installed in the upper portion of the vessel. A re-circulating flow of middlings through the downcomers induces aeration for flotation of the bitumen.	Unknown	Reduced steps and wear components: No cyclones, no flotation cells, fewer pumps.	Highest recovery.	Commercial	May provide better integration with tailings management and therefore less terrestrial impacts.	No operating experience.	Not currently Available. Patents held by Syncrude & Xstrata.	Mass flow bin can provide dense sand tailings without cyclones.

Note: Based on current corporate knowledge, reliability and recent improvements in recovery, Shell has provisionally selected the steep cone cell for primary recovery followed by cycloning of flotation cells on cyclone overflow from primary tailings.

Table 4-4 Froth Treatment: Includes Removal of Water (Containing Dissolved Salts), Mineral Solids and Where Applicable, Rejection of Asphaltene

Technology (Shell assessment framework)	Capital and Operating Expenses (Economics)	Equipment Reliability and Flexibility (Operational)	Resource Recovery (Regulatory and Economics)	Product Quality (Operational and Commercial)	Technical Maturity (Operational and Technical)	Environmental Effects (Technical and Economics)	Corporate Knowledge (Operational)	Access to Technology (Technical and Commercial)	Integration with Existing Assets (Operational)
Naphtha-based treatment. Bitumen froth is diluted with naphtha to reduce the viscosity and density of the bitumen. Centrifuges, cyclones or gravitational settlers are used to remove the water and solids impurities.	Lowest[(a)]	Originally used all rotating equipment. Newer capacity can employ static equipment.	Asphaltenes all remain in product (Asphaltenes may have negligible to negative value in refinery feedstock).	Ultrafine solids and water soluble salts (chlorides) remain in product. Precludes conventional transportation through common carrier pipelines and processing through conventional refinery de-salting equipment. Residue or coke products contain the ultrafine solids. Downstream upgraders must be designed for higher chloride content.	Commercial	The volatile organics released from the solvent losses are a function of naphtha composition.	No commercial experience.	Available	Would require separate diluent and transportation system and specialized market.
Paraffinic froth treatment at atmospheric pressure. A paraffinic solvent such as pentane or hexane is used to dilute the bitumen. In addition to viscosity and density reduction, a portion of the highest molecular weight bitumen fraction is rejected acting as a collector of the fine solids and water droplets. Gravity settlers remove the water-solids-asphaltene contaminants.	Highest	Uses large settlers with rotating rake withdrawal system.	About half of asphaltene rejected.	Fungible product. Produces a higher hydrocarbon yield in cokers. Produces a preferred feedstock for catalytic hydro-conversion due to reduced asphaltenes and metal contaminants.	Commercial	Volatile organics emitted from the solvent losses have lower aromatic content.	Commercial design and operating experience.	Available	Integrates well. Use of common diluent supply and transportation system.
High-temp/high-pressure paraffinic. As above, but temperature is increased effecting much faster settling and use of smaller, pressurized settlers.	Intermediate	Reliable process system. All static separation equipment.	About half of asphaltene content is rejected. Better control over solvent loss.	As above with better control over asphaltene rejection and product quality.	Commercial	As above. Improved volatile organic emissions control. Better integration with heat recovery.	Commercial design and operating experience.	Available	Integrates well. Use of common diluent supply and transportation system.

(a) For a new system taking advantage of static equipment design.

Note: Based on the requirement for a fungible product (market-grade bitumen), integration with current assets, capital cost and improved process performance, Shell has selected high-temperature paraffinic froth treatment.

METHODS

DETERMINATION OF PIERRE RIVER MINE PROJECT EFFECTS

SIR 5

The Panel notes that many of the sections of the Environmental Impact Assessment (EIA) have not presented the effects of the Pierre River Mine Project separately from the Jackpine Mine Expansion Project. In order to determine the significance of effects from the Pierre River Mine Project, the Panel requires information on effects of the Pierre River Mine Project only, without inclusion of the effects of the Jackpine Mine Expansion Project. Shell determined the environmental consequences for some components of the EIS from the effects of both the Jackpine and Pierre River Projects combined. To determine the effects of only the Pierre River Mine Project, the environmental consequences must be calculated for each KIR using the effects within the Pierre River Mine LSA or some such reasonable spatial area as determined and rationalized by the proponent.

a) Assess the Pierre River Mine Project's effects for all KIRs where this was not previously done.

b) Provide the environmental consequences for each KIR of the Pierre River Mine Project.

Response:

The following is a brief summary of the requested information for JRP SIR 5(a) and (b). Additional information is filed in Appendix 1.

Shell has assessed the effects of PRM, in isolation from JME, on all Key Indicator Resources (KIRs) identified for the PRM where this was not previously done, along with the environmental consequences for each KIR. To provide this information, an updated assessment was completed for the following components:

- Air Quality and the Effects of Air Emissions on Human and Wildlife Health, and Ecological Receptors;
- Hydrology;
- Water Quality;
- Aquatic Health;

- Fish and Fish Habitat;
- Soils and Terrain;
- Terrestrial Vegetation, Wetlands and Forest Resources;
- Wildlife and Wildlife Habitat; and
- Biodiversity.

This update removes JME from the assessment and represents Shell's current plans for the PRM. The assessment case for PRM is referred to as the 2013 PRM Application Case throughout the SIR submission.

The response to JRP SIR 5 was developed with consideration of the other JRP information requests, items raised by regulators and stakeholders during the regulatory process, and commitments made previously by Shell for supporting assessment work. Accounting for these items provides a more robust assessment and maintains consistency between this response and the other information presented in the submission. Key assessment approach updates that are included in this submission include:

- Updated Base Case and Planned Development (PDC) cases: the JRP SIRs requested, among other things, an updated EIA PDC current as of June 2012. To allow a reasonable comparison between assessment case information within this submission, EIA Base Case information was also updated with a project inclusion list current to June 2012.
- Updated approach to assessing forest fire and timber harvest: A key change in approach involves use of A Landscape Cumulative Effects Simulator (ALCES®) model to simulate forest fire and forest harvest information. The revised model of burns and cutblocks was applied to the Terrestrial Resources assessment for the Pre-Industrial Case, 2013 Base Case, 2013 PRM Application Case and 2013 PDC in this submission.

The following sections provide conclusions by component for the 2013 PRM Application Case. Details of the assessment are provided in Appendix 1.

Air Quality

Of the 130 ambient air quality parameters assessed in the 2013 PRM Application Case, 120 are classified as negligible environmental consequence and eight were classified as having a low environmental consequence. The regional annual NO_2 prediction was rated as moderate environmental consequence and the community 24-hour particular matter up to 2.5 micrometres in size ($PM_{2.5}$) prediction was rated as high environmental consequence at Cabin J. The PRM air emissions have little to no incremental effect on air quality at the regional community receptors, and there are no predicted occurrences above the Alberta Ambient Air Quality Objectives (AAAQOs) or other applicable criteria for sulphur dioxide (SO_2), carbon monoxide (CO), hydrogen sulphide (H_2S), carbon disulphide (CS_2), select volatile organic compounds (VOCs), select polycyclic aromatic hydrocarbons (PAHs) and metals. There are AAAQO exceedances of nitrogen dioxide ($NO_{2)}$ at the Regional Study Area (RSA) scale, and $PM_{2.5}$, at five receptor locations; however, these exceedances are mainly due to existing and approved projects in the region and there are minimal increases in predicted concentrations due to the PRM.

Environmental Health

Overall, air emissions from PRM alone, and in combination with air emissions from other sources, are not expected to result in adverse human health effects in the area. The changes between the 2013 Base Case and the 2013 PRM Application Case for human health risks are generally small, suggesting that PRM is not expected to contribute appreciably to health risks in the region. Based on this, the exclusion of the JME does not alter the assessment results or the conclusions originally presented in the Human Health Risk Assessment (HHRA) of the EIA.

The results of the Screening Level Wildlife Health Risk Assessment (SLWHRA) indicate that the overall risks posed to wildlife health will be low. Therefore, no impacts to wildlife populations are expected based on estimated wildlife exposures to predicted maximum acute and chronic air concentrations or predicted soil and surface water concentrations. These conclusions are consistent with those presented in the WHRA of the EIA.

The air emissions effects assessment for the 2013 PRM Application Case considered the results of Potential Acid Input (PAI) on aquatic and soil receptors, ground-level concentrations of SO_2 and NO_2 on vegetation, and terrestrial eutrophication from increased nitrogen deposition. The environmental consequences for all parameters were predicted to be negligible, the same as in the EIA.

Hydrology

The 2013 PRM Application Case Hydrology assessment for the Athabasca River includes an updated list of existing and approved developments and focuses on PRM, without the effects of JME. The assessment shows that flows and water levels in the 2013 PRM Application Case are similar to those described in the EIA.

Water Quality

Within the LSA, acute and chronic toxicity and tainting potential levels are predicted to be lower than guideline values, and labile naphthenic acids are predicted to be less than 1 mg/L under the 2013 PRM Application Case at all assessment nodes. In general, concentrations of most substances are changed relative to the EIA because the model was recalibrated using the most up-to-date observed data, but those changes did not alter the conclusions of the EIA.

The assessment of water quality for the 2013 PRM Application Case for the Athabasca River was based on the re-calibrated Athabasca River Model (ARM) and included updated input sources. The conclusion of negligible changes to water quality concentrations in the Athabasca River in the 2013 PRM Application Case is consistent with the EIA conclusions.

Changes to water quality are further assessed for potential effects to aquatic health in Section 3.4 of Appendix 1, and to human and wildlife health in Sections 2.3 and 2.4 of Appendix 1, respectively.

Aquatic Health

Activities associated with the 2013 PRM Application Case are predicted to influence water quality in receiving watercourses and waterbodies and in pit lakes. Potential effects on aquatic health were evaluated in consideration of two potential effects pathways:

- direct effects occurring as a result of predicted changes to water quality; and
- indirect effects related to dietary consumption and possible accumulation of substances in fish tissue.

Concentrations of individual substances received negligible to low ratings for environmental consequence. When all lines of evidence are considered together, including predicted acute and chronic toxicity levels, as well as predicted changes to sediment quality, water quality and fish tissue metal concentrations, PRM pit lakes are expected to be able to support viable aquatic ecosystems, and discharged waters are not anticipated to impair aquatic health in receiving streams.

Fish and Fish Habitat

Based on the mitigations in place in the form of the Water Management Framework to manage cumulative water withdrawals from the Athabasca River and the updated assessment on water quality for the 2013 PRM Application Case, the effects to Fish and Fish Habitat due to PRM are negligible and remain unchanged from the conclusions presented in the EIA. All other fish and fish habitat effects for PRM are unchanged from the EIA Application Case and are offset through the planned development of compensation habitat in South Redclay Lake as described in the Draft No Net Loss Plan (Golder 2012).

Soils and Terrain

Before reclamation, soil loss or alteration is classified as having a high environmental consequence in the Local Study Area (LSA) and a negligible environmental consequence in the RSA. After reclamation, it is predicted that there will be a permanent decrease of soils mostly due to the construction of South Redclay Lake which results in a moderate environmental consequence in the LSA and a negligible consequence in the RSA. The residual forestry capability impact is rated as a positive direction, low environmental consequence in the LSA, and a negligible environmental consequence in the RSA. These environmental consequences are unchanged from the EIA.

Terrestrial Vegetation, Wetlands and Forest Resources

Ten KIRS and vegetation resources were assessed in the 2013 PRM Application Case. Nine KIRs and vegetation resources are predicted to have negative effects during construction and operations, while neutral effects are predicted for the remaining KIR, rare and special plant communities in the LSA. In the LSA, high negative environmental consequences are associated with riparian communities, old growth forests, loss/alteration to wetlands (including peatlands and patterned fens), and high rare plant potential.

At Closure, six KIRs and vegetation resources will experience a net positive change (terrestrial vegetation, productive forests, high traditional use plants and effects of dust), negative and negligible change (lichen jack pine communities), or neutral and negligible change (rare and special plant communities) as a result of direct effects due to PRM in the LSA. Direct effects due to PRM will result in negative effects for the remaining four KIRs and vegetation resources with environmental consequences that are low or high. Additional indirect effects of PRM due to groundwater drawdown at Closure will not cause changes to the predicted environmental consequences for KIRs within the LSA and RSA.

A brief summary of the conclusions for each KIR and vegetation resource and a comparison with EIA conclusions follows.

The environmental consequence for uplands is moderate in the LSA and negligible in the RSA during construction and operations. At Closure, PRM is expected to have a high, positive environmental consequence at the LSA scale and a negligible, positive environmental consequence at the RSA scale. Assessing PRM effects alone results in a high positive (% of resource) environmental consequence for terrestrial upland communities instead of a low positive (% LSA) environmental consequence as reported in the EIA.

The PRM is predicted to have a negative and moderate environmental consequence on lichen jack pine communities in the LSA during construction and operations. The environmental consequence is negligible in the RSA during construction and operations. At Closure, the PRM is expected to have a negative, negligible environmental consequence at the LSA scale (based on % of resource) instead of a positive and negligible environmental consequence as reported in the EIA (based on % LSA). At the RSA scale at Closure, assessing the effects of PRM alone results in a negative and negligible environmental consequence for lichen jack pine communities, the same as in the EIA.

The environmental consequence for riparian communities during PRM construction and operations is predicted to be negative and high within the LSA. The PRM is predicted to have a negative low environmental consequence for riparian communities in the LSA at Closure, which differs from the positive negligible environmental consequence predicted for riparian communities in the EIA due to changes in the Closure and Reclamation Plan. Riparian communities are not mapped at the RSA scale for the predicted reclamation landscape, as explained in Section 4.3 of Appendix 1; therefore, Closure riparian communities are not identified at the RSA scale.

During construction and operations and at Closure, PRM is expected to have a negative, high environmental consequence for old growth forests in the LSA. This prediction differs from the negative and low environmental consequence predicted for old growth forests in the LSA in the EIA, which included JME and was based on % of LSA rather than % of resource. Within the RSA, the environmental consequence is negative and negligible, both during construction and operations and at Closure. This assessment will not change the environmental consequences for old growth in the RSA as compared to the EIA.

During construction and operations, PRM is expected to have a negative, high environmental consequence in the LSA for wetlands (including peatlands and patterned fens). At Closure, direct effects of the PRM on wetlands (including peatlands and patterned fens) are expected to have a negative and high environmental consequence at the LSA scale. As discussed in the response to JRP SIR 46, peatlands and patterned fens are not differentiated at the RSA level. Both during construction and operations and at Closure, a negligible environmental consequence at the RSA scale is predicted for PRM, and will not change the environmental consequence assessed for wetlands (including peatlands and patterned fens) in the EIA.

Environmental consequences on economic forests are negative and moderate in the LSA, and negative and negligible in the RSA during construction and operations and at Closure. This assessment will not change the environmental consequence for productive forests in the LSA compared to the EIA. Within the RSA, overall changes in economic forest result in the same positive and negligible environmental consequence as in the EIA.

Due to direct and indirect effects combined, during construction and operations PRM will have a negative, high environmental consequence on high rare plant potential within the LSA, and a negative, negligible environmental consequence for this KIR in the RSA. At Closure, the effects of PRM on high rare plant potential are predicted to result in a negative and high environmental consequence at the LSA scale and a negative, negligible environmental consequence at the RSA scale. These environmental consequences are unchanged from the EIA.

During construction and operations, the PRM will result in a negative and moderate environmental consequence to high traditional use plant potential areas in the LSA and a negative and negligible environmental consequence in the RSA. At Closure, the PRM is predicted to have a positive and low environmental consequence for high traditional use plant potential at the LSA scale. A positive and negligible environmental consequence was assigned for high traditional use plant potential at the RSA scale at Closure, which does not change the environmental consequence as assessed in the EIA.

The effects of dust on vegetation are expected to be negative and low within the LSA. At Closure, there will be no effects of dust due to the PRM, because mining operations will be complete and, overall, dust effects to vegetation will be positive (i.e., there are fewer dust sources), and low at Closure.

Wildlife and Wildlife Habitat

The environmental consequences of PRM on wildlife abundance at the LSA and RSA scales are similar to those previously assessed in the EIA and for Species at Risk (SAR) in the *May 2011, Submission of Information to the Joint Review Panel*, Appendix 2. After reclamation, the environmental consequences of the PRM on wildlife abundance will be negligible in magnitude and environmental consequence at the RSA and LSA scales for all affected species.

Although it is probable that the abundances of horned grebe, olive-sided flycatcher, rusty blackbird, short-eared owl, wolverine and yellow rail are not limited by habitat within the RSA, enough uncertainty exists that the potential effects of habitat loss on abundance were considered. To be conservative, the magnitude of effects to regional populations of these species were estimated as equivalent to the magnitude of the habitat loss effects within the RSA for the 2013 PRM Application Case prior to reclamation. As a result, the RSA scale environmental consequence of the 2013 PRM Application Case before Closure on the abundance of horned grebe, rusty blackbird and yellow rail increase from negligible in the *May 2011, Submission of Information to the Joint Review Panel* to low in this submission.

The environmental consequences of habitat loss during operations are high for all affected species during operations and before Closure at the LSA scale, as stated in the EIA and the *May 2011, Submission of Information to the Joint Review Panel*, Appendix 2, Species at Risk Assessment. The removal of the effects of JME and other updates, as discussed above, results in changes to the environmental consequences for the indirect effects of habitat before Closure for some species at risk. Specifically, the predicted decline of high suitability habitat due to the indirect effects of sensory disturbance and surficial aquifer drawdown during operations changes:

- from a low environmental consequence in the Species at Risk Assessment to high for common nighthawk, horned grebe, short-eared owl, wood bison and yellow rail in the 2013 PRM Application Case; and
- from a moderate environmental consequence in the Species at Risk Assessment to high for olive-sided flycatcher in the 2013 PRM Application Case.

The net environmental consequence of PRM during operations was previously assessed for wolverine and wood bison habitat as low at the RSA scale (*May 2011, Submission of Information to the Joint Review Panel*). However, the removal of the effects of JME reduced the environmental consequence of potential habitat loss to negligible for both KIRs.

The effects of PRM on potential wood bison and woodland caribou habitat are assessed as having a negative high environmental consequence prior to reclamation at the LSA scale, and a negligible environmental consequence at the RSA scale.

The removal of the effects of JME results in changes to the environmental consequences for the effects of the PRM on habitat at Closure for some KIRs. Specifically, the effects of the PRM at Closure were assessed as follows:

- from a positive and high environmental consequence in the EIA (Volume 5, Section 7.5.3) to a negative and high for black-throated green warbler after Closure for the 2013 PRM Application Case;
- from a negative and low environmental consequence in the Species at Risk Assessment (*May 2011 Submission of Information to the Joint Review Panel*, Appendix 2) to negative and high for common nighthawk after Closure for the 2013 PRM Application Case;
- from a negative and high environmental consequence in the Species at Risk Assessment (*May 2011 Submission of Information to the Joint Review Panel*) to positive and high for horned grebe after Closure for the 2013 PRM Application Case; and
- from a positive and high environmental consequence in the EIA (Volume 5, Section 7.5.3) to negative and low for moose and moderate for fisher after Closure for the 2013 PRM Application Case.

At the RSA scale, the environmental consequences of the effects of PRM on habitat at Closure are unchanged from the EIA and the *May 2011, Submission of Information to the Joint Review Panel*, Appendix 2, Species at Risk Assessment, and remain negligible to low for all assessed species. After reclamation, the environmental consequence of PRM on woodland caribou habitat is predicted to be positive and high.

During operations, the assessed environmental consequences for wildlife movement are negative and negligible at the LSA and RSA scales for Canadian toad, barred owl and black-throated green warbler. Environmental consequences of the PRM on movement for little brown myotis and northern myotis are also negative and negligible at the LSA and RSA scales. For all other wildlife KIRs and species at risk that may be affected, the assessed environmental consequences before reclamation are unchanged from those previously assessed, and range from negligible for all avian species and western toad to low for terrestrial mammals.

At Closure, the assessed environmental consequences of PRM on movement of Canadian toad, barred owl, black-throated green warbler and western toad are positive and negligible at the LSA and RSA scales. For all other wildlife KIRs and SAR that may be affected, the assessed environmental consequences at Closure range from positive and negligible for little brown myotis, northern myotis, and avian species to negative and low for terrestrial mammals. The negative and low environmental consequences at Closure for terrestrial mammals (i.e., moose, black bear, Canada lynx, fisher and wolverine) at the LSA scale are due to the creation of South Redclay Lake at the north end of the LSA and large pit lakes at the south end of the LSA. This results in a change to the environmental consequence of PRM on wolverine movement from positive and low (*May 2011, Submission of Information to* *the Joint Review Panel*), to negative and low at the LSA scale (Table 4.4 4). The negligible effects at the RSA scale in the EIA remain unchanged in this assessment.

Biodiversity

During construction and operations, the environmental consequences for all levels of biodiversity in the LSA are predicted to be high, the same as the EIA. After reclamation, the environmental consequences for all levels of biodiversity in the LSA are predicted to be moderate, whereas the EIA was rated high. Negligible environmental consequences to biodiversity are predicted in the RSA both during construction and operations and after reclamation, the same as the EIA.

References:

Golder (Golder Associates Ltd.). 2012. *Draft No Net Loss Plan: Jackpine Mine Expansion and Pierre River Mine Project*. Submitted to Shell Canada Energy, September 2012. 105 pp. + 9 Appendices.

SIGNIFICANCE OF EFFECTS

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EIA Volume 5: Terrestrial Resources and Human Environment, Section 1.3, Tables 1.3-4 and 1.3-5, Pages 1-33 to 1-37. Shell determines environmental consequences for different resources. The system identifies a numerical score for each of the criteria used to evaluate an impact and the score is then used to assign environmental consequence to residual impacts. In the Jackpine Mine Expansion and Pierre River Mine - Submission of Information to the Joint Review Panel, Appendix 2: Federally Listed Species at Risk Assessment, Section 1.3.3.2, Page 7, Shell states, " A significant adverse effect is defined as: an adverse Project-related effect resulting in a sustained, irreversible effect with unacceptable environmental consequences on a regional resource, population or community; or an adverse Project-related effect resulting in a sustained, irreversible effect with unacceptable environmental consequences on a unique localized resource, population or community; or an adverse Project-related effect resulting in an unacceptable health risk."

a) **Explain and quantify the numerical ranking system Shell used and explain how and why it weighted specific components (e.g., magnitude, reversibility, frequency, etc.) in the manner in which it did. Provide information such as peer reviewed literature or other scientific basis that supports the use of the weighting methodology in question. Provide the thresholds and scale used for determining the environmental significance of the Project's effects for each key indicator**

resource (KIR) (for example, provide the threshold of habitat loss for each wildlife KIR above which the effect would be considered significant).

b) Provide the rationale Shell employed to conclude that the methods, including scale, criteria, definitions, and thresholds are reasonable.

c) If Shell used professional judgment in determining significance and environmental consequence, provide details of how and where it was applied and what judgements Shell considered.

Response:

a) The environmental consequence ranking system was originally developed as part of the assessment of Suncor's Project Millennium (Suncor 1998), which was reviewed as part of a federal Comprehensive Study (DFO 1998). The assessment methods for impact analyses and classification, including an explanation and quantification of the numerical ranking system, are detailed in the EIA, Volume 3, Section 1.3.6.

The numbers used in the numerical ranking system were chosen based on Golder Associates Ltd.'s professional judgement regarding the relative importance of each criterion for the evaluation of environmental effects, and ultimately the determination of significance using ecological thresholds. Professional judgement was also applied to evaluate the weighting of criteria scores to ensure that resultant environmental consequence ratings are appropriate for potential sets of circumstances. For example, the large values represented by high magnitude effects indicate that they are likely to result in a high environmental consequence, unless the effect is reversible and of limited geographic extent, duration and frequency. Similarly, a low magnitude effect may result in an environmental consequence that could range from negligible to moderate depending on the reversibility, geographic extent, duration and frequency of the effect. Details on the weightings for impact description criteria, by environmental component, are provided in the EIA, Volume 3, Section 1.3.6.1, Table 1.3-4.

The numeric scores for reversible effects (-3 or +3), in particular, indicate the potential for recovery of the ecological endpoint (December 2009 Jackpine Mine Expansion, Supplemental Information, Volume 1, SIR 374a, page 23-8). These scores reflect the concept that the significance of an effect should be reduced if the effect can be reversed (CEAA 2010, internet site). In contrast, greater geographic extent, duration and frequency may further compound environmental effects, but more limited extent, duration and frequency would not reduce the effect when and where it occurs. The size of scores for reversibility, geographic extent, duration and frequency, reflect that these criteria are judged to have similar influence over the determination of significance.

Assessment Methods for the determination of environmental consequences were developed and reviewed by environmental assessment professionals using guidance from the Canadian Environmental Assessment Agency (CEAA) documentation, peer-reviewed literature, other available data and professional judgment. The criteria used (i.e., magnitude, geographic extent, duration, frequency and reversibility) have been identified as those that “should be taken into account in deciding whether adverse environmental effects are significant” (CEAA 2010, internet site). Definitions of these criteria are consistent with those provided in the CEAA document “*Determining whether a project is likely to cause significant adverse environmental effects*” (CEAA 2010, internet site). The numerical scores used to estimate the environmental consequence of magnitude, geographic extent, duration, reversibility and frequency were detailed in the EIA, Volume 3, Section 1.3.6.2, Table 1.3-5.

Project effects are considered after appropriate mitigation measures have been implemented. This approach follows the Government of Canada’s guidance, which states that “*The determination of whether an environmental impact is significant will be considered only after taking into account any mitigation measures.”* (CEAA 2010, internet site), an approach re-stated in Hegmann et al. (1999). Therefore, significance was determined only after protection or mitigation measures were proposed. Mitigation measures are defined as measures for *“the elimination, reduction or control of the adverse environmental effects of the project, and includes restitution for any damage to the environment caused by such effects through replacement, restoration, compensation or any other means."* (*Canadian Environmental Assessment Act* 1992, as amended) (Government of Canada 1992).

The ranking system is a guide and was used to ensure consistent results. This system has been used for numerous oil sands Environmental Impact Assessments (EIAs) in Alberta, including the following projects that underwent federal review processes: Suncor Energy Inc. (Suncor) Millennium, Canadian Natural Resources Limited (Canadian Natural) Horizon, Albian Sands Muskeg River Mine Expansion and Shell’s Canada Jackpine Mine – Phase 1 and Jackpine Mine Expansion. The system has also been applied to numerous oil sands EIAs that have undergone reviews by the Government of Alberta, including Albian Sands Muskeg River Mine, Suncor Firebag, Canadian Natural Primrose and Wolf Lake Expansion, OPTI Canada Inc. Long Lake, Suncor Voyageur Project, MEG Energy Corp. Christina Lake, Cenovus FCCL Ltd. Narrows Lake, Canadian Natural Kirby and Kirby Expansion, and the Brion Energy Corp. Dover Commercial Project.

The approach continues to be appropriate for application to the Pierre River Mine because it is transparent and allows reviewers to independently analyze and interpret the criteria used, either individually or as a sum by the environmental consequence score.

Environmental significance of PRM’s effects was determined at the Regional Study Area (RSA) scale using the assessment methods described in Appendix 3.1, Section 2.11 of this submission. The environmental consequence ranking system was incorporated into the determination of significance, such that Adverse effects with moderate or high environmental consequence ratings could result in effects that are either Significant or Not Significant and require careful consideration prior to making a final determination. Adverse effects with negligible or low environmental consequence ratings were unlikely to produce significant effects.

Using the concepts of magnitude, geographic extent, duration, reversibility, frequency and ecological context, the significance of adverse effects was determined for each KIR using appropriate ecological thresholds or resource management criteria. Ecological thresholds are exceeded when ecosystem function is seriously impaired or when plant or animal populations are no longer viable. An example of an ecological threshold is the point at which a wildlife population is no longer self-sustaining or ecologically effective. Resource management criteria are acceptable levels of change set by regulators to protect the environment or human health. Examples of resource management criteria are air and water quality limits.

Where uncertainty was present with respect to whether an ecological threshold or resource management criterion has been exceeded, the source(s) of uncertainty were described and significance was determined using a weight of evidence approach. That is, significance was determined by carefully evaluating the scientific evidence indicating that an effect exceeds an ecological threshold or resource management criterion compared with the scientific evidence indicating the effect does not exceed the threshold or limit, using a reasoned narrative where data, assumptions, and interpretations are clearly stated. A precautionary approach was applied when determining significance in the face of uncertainty. Where a weight of evidence analysis presented equivocal results, effects were considered significant. For those effects identified as being adverse and significant, effect likelihood is based on the probability of the activities actually resulting in the predicted effect. Significant adverse effects were identified as either Likely or Unlikely.

For air quality, the environmental consequence for the cumulative effect of individual compounds is based on comparison with available Alberta Ambient Air Quality Objectives (ESRD 2013) and the Texas Commission on Environmental Quality Effects Screening Levels (TCEQ 2013). Any compounds that are classified as having a moderate or high environmental consequence would be considered significant. This classification is for ambient air quality only and does not necessarily reflect the potential impacts to environmental health.

Environmental consequences for cumulative effects to Aquatic Resources are significant if they represent sustained, irreversible effects to the abundance of resources and populations in the RSA such that ecological resilience and integrity is compromised. Ecological resilience may be compromised when ecological thresholds are exceeded. An ecological threshold is defined as a level of environmental change where an ecosystem or ecosystem component requires protection (CEAA 2010, internet site). Any landscape change that exceeds an ecological threshold is likely a significant environmental effect (Hegmann et al. 1999).

For Terrestrial Resources (i.e., Soils and Terrain, Terrestrial Vegetation, Wetlands and Forest Resources, Wildlife and Biodiversity), significance is determined using ecological thresholds and resource management criteria, as described in greater detail in Appendix 3.1, Section 2.11.2 of this submission. Cumulative effects were considered significant in terms of exceeding ecological thresholds if:

- an animal or plant population is no longer self-sustaining;
- an animal or plant population is no longer ecologically effective; or
- ecosystem function has been lost at the community, ecosystem, or landscape scales.

Ecosystem function can be lost due to changes in the population of a highly interactive species but can also be lost due to changes in the amount and composition of habitats representing communities, ecosystems and landscapes. Loss of ecosystem function or ecosystem shifts due to changes in vegetation community SIRs such as wetlands or old growth forests are also considered significant.

The determination of whether or not self-sustaining and ecologically effective populations or ecological function of each terrestrial KIR were maintained at the RSA scale was based on available data from the regional population considered in light of ecological context, specifically using the concepts of adaptability and resilience. Part of the ecological context applied in this evaluation includes an analysis of existing trends (e.g., in populations) to facilitate predictions of future trends. This is consistent with the *Cumulative Effects Assessment Practitioner's Guide*, which states that "when an actual capacity level cannot be determined, analysis of trends can assist in determining whether goals are likely to be achieved or patterns of degradation are likely to persist" (Hegmann et al. 1999).

In cases where a population may no longer be self-sustaining or ecologically effective but the ultimate cause of decline is not related to PRM or other developments in the oil sands region, the cumulative effect of those developments for that KIR may not be significant. For example, if a species is declining in Alberta or across its North American range, but the cause of the decline is not associated with the PRM or cumulative effects of other projects in the region, then the contribution of PRM and other associated developments at the scale of the regional cumulative effects assessment would not be considered significant. Significance in terms of ecological thresholds was determined for cumulative effects at the RSA scale only, as the assessment of ecological significance must be conducted at scales that encapsulate key ecological processes (e.g., sufficient time for the landscape changes to result in measurable population trends, and sufficient space for annual movement patterns and home ranges) for terrestrial KIRs. The RSA was determined as described in the EIA, Volume 5, Section 7.2.4, using biological rationale such as the home ranges of wide-ranging species and natural subregion boundaries, as well as geographic features and the furthest potential measurable effect in combination with approved and planned projects in the region.

The following resource management criteria have been identified by recent JRP decision reports for oil sands mines (Joint Review Panel for the Joslyn North Mine Project 2011, Joint Review Panel for the Shell Canada Energy Jackpine Mine Expansion Project 2013), and were used in parallel to ecological thresholds to determine the significance of effects:

- an adverse effect that exceeds 20% of a resource at the Local Study Area (LSA) and RSA scales is determined to be significant; and
- any adverse effect to federally listed species at risk is determined to be significant.

The significance of impacts to the exercise of Aboriginal Rights and Interests cannot be determined in the same manner as other biological or environmental KIRs. The environmental consequences to a particular Aboriginal Right or Interest will be closely tied, and in most cases directly related to the environmental consequences to the supporting environmental or biological KIR, within the boundaries of the appropriate study area. However, a determination of significance of impact to the exercise of Aboriginal Rights and Interests requires a broader context and involves consideration of:

- which affected KIRs are relied upon for the exercise of an Aboriginal Right;
- the degree of use of or access to those KIRs;
- the extent to which those KIRs may be preferentially used or accessed by an Aboriginal group both within that group’s traditional area, as well as within the LSA and RSA; and
- complex cultural effects for which there are no agreed-upon thresholds.

The effects to the exercise of Aboriginal rights and interests may be considered significant if they represent sustained, long-term adverse effects to KIRs that are relied upon, are regularly and preferentially used, and are readily accessible. Furthermore, changes to the ability or desire to exercise particular Aboriginal rights related to the KIRs may contribute to the significance of an effect on Aboriginal rights and interests.

b) Shell is confident that the method applied to evaluate impacts is reasonable, as it has been developed through consideration of guiding principles from the Canadian Environmental Assessment Agency and application of professional judgement, it has been applied and tested repeatedly in circumstances similar to those for this Project, and has the benefits of consistency and transparency.

c) See response (a).

References:

CEAA (Canadian Environmental Assessment Agency). 2010. *Reference guide: determining whether a project is likely to cause significant adverse environmental effects*. Available at: https://www.ceaa-acee.gc.ca/default.asp?lang=En&n=D213D286-1. Updated October 10, 2010. Accessed September 3, 2013.

DFO (Department of Fisheries and Oceans Canada). 1998. *Comprehensive Study Report*. Suncor Energy Inc. Project Millennium. Habitat Management Division, Freshwater Institute. Winnipeg, MN. Submitted October 1998. 102 pp. + Appendices.

ESRD (Alberta Environment and Sustainable Resource Development). 2013. *Alberta Ambient Air Quality Objectives*. Alberta Environment Air Policy Branch. Issued February 2013. Edmonton, AB. ISBN: 978-1-1406-0757-7 (printed); 978-1-4601-0758-4 (on-line).

Government of Canada. 1992. *Canadian Environmental Assessment Act*. S.C. 1992, c.37. Minister of Justice. 81 pp.

Hegmann, G., C. Cocklin, R. Creasey, S. Dupuis, A. Kennedy, L. Kingsley, W. Ross, H. Spaling, D. Stalker and AXYS Environmental Consulting Ltd. 1999. *Cumulative Effects Assessment Practitioners Guide*. Prepared by AXYS Environmental Consulting Ltd. and The CEA Working Group for the Canadian Environmental Assessment Agency. Hull, PQ. 134 pp. Available online at: http://www.ceaa.gc.ca/43952694-0363-4B1E-B2B3-47365FAF1ED7/Cumulative_Effects_Assessment_Practitioners_Guide.pdf

Joint Review Panel for the Joslyn North Mine Project. 2011. *Report of the Joint Review Panel: Joslyn North Mine Project*. Total E&P Joslyn Ltd. Alberta.

Joint Review Panel for the Shell Canada Energy Jackpine Mine Expansion Project. 2013. *Report of the Joint Review Panel: Shell Canada Energy Jackpine Mine Expansion Project, application to amend approval 9756*. Fort McMurray Area. July 9, 2013. 413 pp.

Suncor (Suncor Energy Inc.). 1998. *Project Millennium Application*. Volumes 1, 2A, 2B, 2C and 2D. Submitted to Alberta Energy and Utilities Board and Alberta Environmental Protection. Prepared by Suncor Energy Inc., Oil Sands in association with Golder Associates Ltd., Nichols Applied Management and Klohn-Crippen Consultants Ltd. April 1998. Fort McMurray, AB.

TCEQ (Texas Commission on Environmental Quality). 2013. *Listing of Effects Screening Levels (ESLs) for use in Texas*. Available at http://www.tceq.texas.gov/toxicology/esl/list_main.html. Accessed April 2013.

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The information for environmental consequences of effects prior to reclamation for some KIRs would be important for the Panel when assessing the effects of the Project, cumulative effects, and determining significance.

a) Provide the environmental consequences for each KIR for wildlife abundance, wildlife movement, wildlife habitat, vegetation, and Aboriginal rights and interests, prior to reclamation, where this has not already been done.

Response:

a) The environmental consequences for the 2013 PRM Application Case and the 2013 Planned Development Case (PDC) for terrestrial Key Indicator Resources (KIRs) prior to reclamation are provided in Appendices 1 and 2 and are also presented in the tables below.

Environmental consequences in the Local Study Area (LSA) and Regional Study Area (RSA) for the 2013 PRM Application Case prior to reclamation (i.e., during construction and operations) for vegetation are presented in Table 7-1 and also discussed in Appendix 1, Section 4.3 and summarized in Table 4.3-17. Environmental consequences in the LSA and RSA for the 2013 PRM Application Case prior to reclamation for wildlife abundance, wildlife habitat and wildlife movement are presented in Tables 7-2, 7-3 and 7-4, and also discussed in Appendix 1, Section 4.4 and summarized in Tables 4.4-1, 4.4-2 and 4.4-4, respectively.

The environmental consequences of development in the RSA from the 2013 Base Case to the 2013 PDC prior to reclamation are presented in Tables 7-5 and 7-8, and also discussed in Appendix 2, Section 3.4 and summarized in Table 3.4-8 for vegetation, and Table 3.4-10 for wildlife abundance, habitat and movement.

The environmental consequences of development in the RSA from the Pre-Industrial Case (PIC) to the 2013 PRM Application Case prior to reclamation are presented in Tables 7-6 and 7-9, and also discussed in Appendix 2, Section 4.3, and summarized in Table 4.3-11 for vegetation and Tables 4.3-13 to 4.3-36 for wildlife abundance, habitat and movement, respectively. The environmental consequences of development in the RSA from the PIC to the 2013 PDC prior to reclamation are presented in Tables 7-7 and 7-9, and also discussed in Appendix 2, Section 5.2, and summarized in Table 5.2-9 for vegetation and Tables 5.3-11 to 5.3-34 for wildlife abundance, habitat and movement, respectively.

Table 7-1 Residual Impact Classification for the Pierre River Mine Effects on Terrestrial Vegetation, Wetlands and Forest Resources in the Local Study Area: 2013 PRM Application Case - During Construction and Operations

Component Criteria	Direction	Magnitude[a]	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence (LSA)	Environmental Consequence (RSA)[b]
terrestrial vegetation (uplands)[c]	negative	high (+15)	local (0)	long-term (+2)	reversible (-3)	low (0)	moderate (+14)	negligible
lichen jack pine communities[c]	negative	high (+15)	local (0)	long-term (+2)	reversible (-3)	low (0)	moderate (+14)	negligible
riparian communities[d]	negative	high (+15)	local (0)	long-term (+2)	reversible/ irreversible (0)	low (0)	high (+17)	n/a
old growth forests[c]	negative	high (+15)	local (0)	long-term (+2)	reversible/ irreversible (0)	low (0)	high (+17)	negligible
wetlands (including peatlands and patterned fens)[d]	negative	high (+15)	local (0)	long-term (+2)	reversible/ irreversible (0)	low (0)	high (+17)	negligible
high rare plant potential[d]	negative	high (+15)	local (0)	long-term (+2)	irreversible (+3)	low (0)	high (+20)	low
rare and special plant communities[d]	neutral	n/a (0)	n/a (0)	n/a (0)	n/a (0)	low (0)	n/a (0)	n/a
productive forests[c]	negative	high (+15)	local (0)	long-term (+2)	reversible (-3)	low (0)	moderate (+14)	negligible
high traditional use plants potential[d]	negative	high (+15)	local (0)	long-term (+2)	reversible (-3)	low (0)	moderate (+14)	negligible
dust[c]	negative	low (+5)	local (0)	medium-term (+1)	n/a	moderate (+1)	low (+7)	n/a

(a) The magnitude of the residual impact is based on percent of resource at 2013 Base Case.

(b) RSA Environmental Consequence magnitude is based on percent of RSA resource.

(c) Assessed based on direct effects.

(d) Assessed based on direct and indirect effects.

Notes Numerical scores for ranking of environmental consequence are explained in EIA, Volume 3, Section 1.3.6.
Table 7-1 from SIR 7 is the same as Table 4.3-17 of Appendix 1 of this submission.

n/a = Not applicable.

Table 7-2 Residual Impact Classification for the Pierre River Mine on Wildlife Abundance: 2013 PRM Application Case - During Construction and Operations

Potential Effects and Key Indicator Resources	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence (LSA)	Environmental Consequence (RSA)
Interactions of Wildlife with Infrastructure								
Canadian toad, barred owl	negative	low (+5)	local (0)	medium-term (+1)	reversible (-3)	moderate (+1)	negligible (+4)	negligible
moose, Canada lynx, fisher, beaver, black bear	negative	low (+5)	regional (+1)	medium-term (+1)	reversible (-3)	moderate (+1)	negligible (+5)	negligible
black-throated green warbler	negative	low (+5)	beyond regional (+2)	medium-term (+1)	reversible (-3)	high (+2)	low (+7)	negligible
western toad	negative	low (+5)	local (0)	medium-term (+1)	reversible (-3)	moderate (+1)	negligible (+4)	negligible
wolverine	negative	low (+5)	regional (+1)	medium-term (+1)	reversible (-3)	moderate (+1)	negligible (+5)	negligible
Canada warbler, common nighthawk, horned grebe, olive-sided flycatcher, rusty blackbird, short-eared owl, yellow rail	negative	low (+5)	beyond regional (+2)	medium-term (+1)	reversible (-3)	high (+2)	low (+7)	negligible
peregrine falcon, red knot, whooping crane	negative	low (+5)	beyond regional (+2)	medium-term (+1)	reversible (-3)	moderate (+1)	low (+6)	negligible
Increased Predation, Hunting and Trapping								
beaver, black bear, Canada lynx, fisher, moose, wolverine	negative	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	negligible
wood bison	negative	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low
woodland caribou	negative	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	low (0)	negligible (0)	high[(a)]
Direct Mortality due to Site Clearing								
moose, black bear, Canada lynx, fisher, beaver	negative	negligible (0)	regional (+1)	medium-term (+1)	reversible (-3)	low (0)	negligible (-1)	negligible
Canadian toad, barred owl	negative	low (+5)	local (0)	medium-term (+1)	reversible (-3)	low (0)	negligible (+3)	negligible
western toad	negative	low (+5)	local (0)	medium-term (+1)	reversible (-3)	low (0)	negligible (+3)	negligible
wolverine	negative	negligible (0)	regional (+1)	medium-term (+1)	reversible (-3)	low (0)	negligible (0)	negligible

Table 7-2 Residual Impact Classification for the Pierre River Mine on Wildlife Abundance: 2013 PRM Application Case - During Construction and Operations (continued)

Potential Effects and Key Indicator Resources	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence (LSA)	Environmental Consequence (RSA)
Removal of Nuisance Wildlife								
black bear, beaver	negative	low (+5)	regional (+1)	medium-term (+1)	reversible (-3)	moderate (+1)	negligible (+5)	negligible
Increased Vehicle-Wildlife Collisions								
Canadian toad, moose, black bear, Canada lynx, barred owl, fisher, beaver	negative	low (+5)	local to regional (0 to +1)	long term (+2)	reversible (-3)	low (0)	negligible (+4 to +5)	negligible
black-throated green warbler	negative	low (+5)	beyond regional (+2)	long term (+2)	reversible (-3)	low (0)	low (+6)	negligible
western toad	negative	low (+5)	local (0)	long term (+2)	reversible (-3)	low (0)	negligible (+4)	negligible
wolverine	negative	low (+5)	regional (+1)	long term (+2)	reversible (-3)	low (0)	negligible (+5)	negligible
Canada warbler, common nighthawk, horned grebe, olive-sided flycatcher, peregrine falcon, red knot, rusty blackbird, short-eared owl, whooping crane, yellow rail	negative	low (+5)	beyond regional (+2)	long term (+2)	reversible (-3)	low (0)	low (+6)	negligible
Sensory Disturbance								
barred owl	negative	negligible (0)	local (0)	medium-term (+1)	reversible (-3)	high (+2)	negligible (0)	negligible
moose, Canada lynx, fisher	negative	negligible (0)	regional (+1)	short-term (0)	reversible (-3)	high (+2)	negligible (0)	negligible
black bear	negative	low (+5)	regional (+1)	short-term (0)	reversible (-3)	high (+2)	negligible (+5)	negligible
black-throated green warbler	negative	low (+5)	beyond regional (+2)	medium-term (+1)	reversible (-3)	high (+2)	low (+7)	negligible
peregrine falcon, red knot, whooping crane	neutral	n/a	n/a	n/a	n/a	n/a	negligible (0)	negligible
western toad	negative	low (+5)	local (0)	long-term (+2)	reversible (-3)	low (0)	negligible (+4)	negligible
wolverine	negative	low (+5)	regional (+1)	medium-term (+1)	reversible (-3)	high (+2)	low (+6)	negligible

Table 7-2 Residual Impact Classification for the Pierre River Mine on Wildlife Abundance: 2013 PRM Application Case - During Construction and Operations (continued)

Potential Effects and Key Indicator Resources	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence (LSA)	Environmental Consequence (RSA)
Canada warbler, common nighthawk, horned grebe, little brown myotis, northern myotis, olive-sided flycatcher, rusty blackbird, short-eared owl, yellow rail	negative	low (+5)	beyond regional (+2)	medium-term (+1)	reversible (-3)	high (+2)	low (+7)	negligible
Net Change due to Pierre River Mine								
Canadian toad, barred owl	negative	low (+5)	local (0)	long-term (+2)	reversible (-3)	moderate (+1)	negligible (+5)	negligible
moose, Canada lynx, fisher, beaver, black bear	negative	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	negligible
black-throated green warbler	negative	low (+5)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	low (+8)	negligible
western toad	negative	low (+5)	local (0)	long-term (+2)	reversible (-3)	low (0)	negligible (+4)	negligible
little brown myotis, northern myotis, olive-sided flycatcher, peregrine falcon, red knot, short-eared owl, whooping crane	negative	low (+5)	beyond regional (+2)	long term (+2)	reversible (-3)	low (0)	low (+6)	negligible
wolverine	negative	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	negligible
wood bison	negative	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	moderate (+1)	low (+6)	low
woodland caribou	negative	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	low (0)	negligible (0)	high[a]
Canada warbler, common nighthawk, horned grebe, rusty blackbird, yellow rail	negative	low (+5)	beyond regional (+2)	long term (+2)	reversible (-3)	low (0)	low (+6)	low

[a] As a result of the potential effects associated with the displacement of wolves from the LSA into surrounding habitat and taking into account that woodland caribou are currently declining in the RSA. See Appendix 2, Section 3.4.3.1.1.

Notes: Numerical scores for the ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

Table 7-2 from SIR 7 is the same as Table 4.4-1 of Appendix 1 of this submission.

n/a = Not applicable because these are migratory species and although their use of habitat during migration may be affected by sensory disturbance, there are no predicted effects on abundance as a result of sensory disturbance.

Table 7-3 Residual Impact Classification for the Pierre River Mine on Wildlife Habitat: 2013 PRM Application Case - During Construction and Operations

Potential Effects and Key Indicator Resources	Direction	Magnitude[a]	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence (LSA)	Environmental Consequence (RSA)
Direct Effects (Site Clearing)								
barred owl	negative	high (+15)	local (0)	long-term (+2)	reversible (-3)	high (+2)	high (+16)	low
Canadian toad	negative	high (+15)	local (0)	long-term (+2)	reversible (-3)	high (+2)	high (+16)	low
beaver, black bear	negative	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	negligible
Canada lynx, fisher, moose	negative	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	low
black-throated green warbler	negative	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	high[b]
western toad	negative	high (+15)	local (0)	long-term (+2)	reversible (-3)	high (+2)	high (+16)	negligible
wolverine, wood bison	negative	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	negligible
woodland caribou	negative	high (+15)	regional (+1)	long-term (+2)	reversible/irreversible (0)	high (+2)	high (+20)	negligible
Canada warbler, common nighthawk, horned grebe, little brown myotis, northern myotis, olive-sided flycatcher, short-eared owl, yellow rail	negative	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	negligible
rusty blackbird	negative	high (+15)	beyond regional (+2)	long-term (+2)	reversible/irreversible (0)	high (+2)	high (+21)	low
Indirect Effects (Sensory Disturbance and Surficial Aquifer Drawdown)								
fisher	negative	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible
barred owl	negative	low (+5)	local (0)	long-term (+2)	reversible (-3)	high (+2)	low (+6)	negligible
beaver	neutral	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)	negligible
Canadian toad	negative	low (+5)	local (0)	long-term (+2)	reversible (-3)	high (+2)	low (+6)	negligible

Table 7-3 Residual Impact Classification for the Pierre River Mine on Wildlife Habitat: 2013 PRM Application Case - During Construction and Operations (continued)

Potential Effects and Key Indicator Resources	Direction	Magnitude[a]	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence (LSA)	Environmental Consequence (RSA)
Canada lynx, moose	negative	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)	negligible
black bear	negative	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	negligible
black-throated green warbler	negative	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	high [b]
western toad	negative	high (+15)	local (0)	long-term (+2)	reversible (-3)	high (+2)	high (+16)	negligible
wolverine, wood bison, woodland caribou	negative	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	negligible
Canada warbler, common nighthawk, horned grebe, little brown myotis, northern myotis, olive-sided flycatcher, rusty blackbird, short-eared owl, yellow rail	negative	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	negligible
Net Change from Project								
barred owl, Canadian toad	negative	high (+15)	local (0)	long-term (+2)	reversible (-3)	high (+2)	high (+16)	low
beaver, black bear	negative	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	negligible
Canada lynx, fisher, moose	negative	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	low
black-throated green warbler	negative	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	high [b]
western toad	negative	high (+15)	local (0)	long-term (+2)	reversible (-3)	high (+2)	high (+16)	low
wolverine, wood bison	negative	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	negligible
Canada warbler, common nighthawk, little brown myotis, northern myotis, olive-sided flycatcher, short-eared owl	negative	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	negligible

Table 7-3 Residual Impact Classification for the Pierre River Mine on Wildlife Habitat: 2013 PRM Application Case - During Construction and Operations (continued)

Potential Effects and Key Indicator Resources	Direction	Magnitude[a]	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence (LSA)	Environmental Consequence (RSA)
horned grebe	negative	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	low
woodland caribou	negative	high (+15)	regional (+1)	long-term (+2)	reversible/irreversible (0)	high (+2)	high (+20)	negligible
rusty blackbird, yellow rail	negative	high (+15)	beyond regional (+2)	long-term (+2)	reversible/irreversible (0)	high (+2)	high (+21)	low

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7).

(b) Additional habitat losses in the RSA may result in a high environmental consequence at the RSA scale, taking into account that black-throated green warblers may be currently declining to extirpation in the RSA and the decline may be the result of breeding habitat loss. See Appendix 2, Section 4.3.4.2.4.2.

Notes: Numerical scores for the ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

Table 7-3 from SIR 7 is the same as Table 4.4-2 of Appendix 1 of this submission.

Table 7-4 Residual Impact Classification of the Pierre River Mine on Wildlife Movement: 2013 PRM Application Case - During Construction and Operations

Potential Effects and Key Indicator Resources	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence (LSA)	Environmental Consequence (RSA)
Wildlife Movement During Operations								
Canadian toad, barred owl	negative	negligible (0)	local (0)	long-term (+2)	reversible (-3)	high (+2)	negligible (+1)	negligible
black-throated green warbler	negative	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible
beaver	negative	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)	low
moose, black bear, Canada lynx, fisher	negative	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)	low
western toad	negative	negligible (0)	local (0)	long-term (+2)	reversible (-3)	high (+2)	negligible (+1)	negligible
Canada warbler, common nighthawk, horned grebe, little brown myotis, northern myotis, olive-sided flycatcher, rusty blackbird, short-eared owl, yellow rail	negative	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible
wolverine, wood bison	negative	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)	low
Wildlife Movement After Closure								
Canadian toad, barred owl	positive	negligible (0)	local (0)	long-term (+2)	reversible (-3)	high (+2)	negligible (+1)	negligible
beaver	positive	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible
black-throated green warbler	positive	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible
moose, black bear, Canada lynx, fisher	negative	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)	negligible
western toad	positive	negligible (0)	local (0)	long-term (+2)	reversible (-3)	high (+2)	negligible (+1)	negligible
Canada warbler, common nighthawk, horned grebe, little brown myotis, northern myotis, olive-sided flycatcher, rusty blackbird, short-eared owl, yellow rail	positive	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible
wolverine, wood bison	negative	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)	negligible

Notes: Numerical scores for the ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.

Table 7-4 from SIR 7 is the same as Table 4.4-4 of Appendix 1 of this submission.

Table 7-5 Residual Impact Classification for Terrestrial Vegetation, Wetlands and Forest Resources in the Regional Study Area: 2013 Base Case to 2013 Planned Development Case - During Construction and Operations

Component Criteria	Planned Development Case Assessment Criteria						
	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence
wetlands (including peatlands and patterned fens)	negative	low (+5)	regional (+1)	long term (+2)	irreversible/reversible (0)	high (+2)	low (+10)
old growth forests	negative	low (+5)	regional (+1)	long term (+2)	irreversible/reversible (0)	high (+2)	low (+10)
high rare plant potential	negative	moderate (+10)	regional (+1)	long term (+2)	irreversible/reversible (0)	high (+2)	moderate (+15)

[(a)] Residual impact magnitude is based on percent of resource.

Notes: Numerical scores for ranking of environmental consequence are explained in EIA Volume 3, Section 1.3.6.

Table 7-5 from SIR 7 is the same as Table 3.4-8 of Appendix 2 of this submission.

Table 7-6 Residual Impact Classification for the Effects on Terrestrial Vegetation, Wetlands and Forest Resources in the Regional Study Area: Pre-Industrial Case to 2013 PRM Application Case - During Construction and Operations

Component Criteria	Direction	Magnitude		Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence (RSA)[c]	
		2013 Base Case	2013 PRM Application Case					2013 Base Case	2013 PRM Application Case
terrestrial vegetation (uplands)[a]	negative	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	high (+17)
lichen jack pine communities[a]	negative	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)
old growth forests[a]	negative	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	irreversible/reversible (0)	high (+2)	moderate (+15)	moderate (+15)
wetlands (including peatlands and patterned fens)[b]	negative	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	irreversible/reversible (0)	high (+2)	moderate (+15)	moderate (+15)
high rare plant potential[b]	negative	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	irreversible/reversible (0)	high (+2)	moderate (+15)	moderate (+15)
productive forests[a]	negative	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)	low (+7)
high traditional use plant potential[a]	negative	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	high (+17)

(a) Assessed based on direct effects.

(b) Assessed based on direct and indirect effects.

(c) RSA Environmental Consequence magnitude is based on percent of resource in the RSA at PIC.

Note: Numerical scores for ranking of environmental consequence are explained in EIA, Volume 3, Section 1.3.6.
Table 7-6 from SIR 7 is the same as Table 4.3-11 of Appendix 2 of this submission.

Table 7-7 Residual Impact Classification for Terrestrial Vegetation, Wetlands and Forest Resources in the Regional Study Area: Pre-Industrial Case to the 2013 Planned Development Case - During Construction and Operations

Component Criteria	Planned Development Case Assessment Criteria						
	Direction	Magnitude[a]	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence
wetlands (including peatlands and patterned fens)	negative	moderate (+10)	regional (+1)	long term (+2)	irreversible/reversible (0)	high (+2)	moderate (+15)
old growth forests	negative	high (+15)	regional (+1)	long term (+2)	irreversible/reversible (0)	high (+2)	high (+20)
high rare plant potential	negative	high (+15)	regional (+1)	long term (+2)	irreversible/reversible (0)	high (+2)	high (+20)

(a) Residual impact magnitude is based on percent of resource.

Note: Numerical scores for ranking of environmental consequence are explained in EIA Volume 3, Section 1.3.6.
Table 7-7 from SIR 7 is the same as Table 5.3-9 of Appendix 2 of this submission.

Table 7-8 Residual Impact Classification for Effects on Wildlife in the Regional Study Area: 2013 Base Case to 2013 Planned Development Case - During Construction and Operations

Potential Effects and Key Indicator Resources	Direction	Magnitude[a]	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence
Wildlife Abundance							
Canadian toad, barred owl	negative	low (+5)	local (0)	long-term (+2)	reversible (-3)	high (+2)	low (+6)
beaver, black bear, moose	negative	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)
Canada lynx, fisher	negative	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)
black-throated green warbler	negative	moderate (+10)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	moderate (+13)
little brown myotis, northern myotis, peregrine falcon, red knot, western toad, whooping crane,	negative	negligible (0)	local to beyond regional (0 to +2)	long-term (+2)	reversible (-3)	high (+2)	negligible (1 to +3)
common nighthawk, horned grebe, olive-sided flycatcher, short-eared owl, wolverine, wood bison	negative	low (+5)	regional to beyond regional (+1 to +2)	long-term (+2)	reversible (-3)	high (+2)	low (+7 to +8)
rusty blackbird, yellow rail	negative	moderate (+10)	beyond regional (+2)	long-term (+2)	reversible/ irreversible (0)	high (+2)	high (+16)
Canada warbler	negative	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)
woodland caribou	negative	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)
Wildlife Habitat (Including Fragmentation)							
Canadian toad	negative	low (+5)	local (0)	long-term (+2)	reversible (-3)	high (+2)	low (+6)
beaver, black bear	negative	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)
barred owl	negative	moderate (+10)	local (0)	long-term (+2)	reversible (-3)	high (+2)	moderate (+11)
Canada lynx, fisher, moose	negative	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)
black-throated green warbler	negative	moderate (+10)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	moderate (+13)
common nighthawk, little brown myotis, northern myotis, olive-sided flycatcher, short-eared owl	negative	low (+5)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	low (+8)

Table 7-8 Residual Impact Classification for Effects on Wildlife in the Regional Study Area: 2013 Base Case to 2013 Planned Development Case During - Construction and Operations (continued)

Potential Effects and Key Indicator Resources	Direction	Magnitude[a]	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence
wolverine	negative	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)
horned grebe	negative	low (+5)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	low (+8)
western toad	negative	moderate (+10)	local (0)	long-term (+2)	reversible (-3)	high (+2)	moderate (+11)
woodland caribou	negative	low (+5)	regional (+1)	long-term (+2)	reversible/ irreversible (0)	high (+2)	low (+10)
wood bison	negative	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)
rusty blackbird, yellow rail	negative	moderate (+10)	beyond regional (+2)	long-term (+2)	reversible/ irreversible (0)	high (+2)	high (+16)
Canada warbler	negative	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)
Wildlife Movement							
Canadian toad	negative	low (+5)	local (0)	long-term (+2)	reversible (-3)	high (+2)	low (+6)
barred owl	negative	negligible (0)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)
black-throated green warbler	negative	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)
beaver, black bear, Canada lynx, fisher, moose	negative	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)
western toad	negative	low (+5)	local (0)	long-term (+2)	reversible (-3)	high (+2)	low (+6)
Canada warbler, common nighthawk, horned grebe, little brown myotis, northern myotis, olive-sided flycatcher, rusty blackbird, short-eared owl, yellow rail	negative	negligible (0)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)
wolverine, wood bison	negative	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	low (+7)

[a] Magnitude for wildlife habitat is defined through habitat suitability modelling (Appendix 3.7).

Notes: Numerical scores for ranking of environmental consequence are explained in Volume 3, Section 1.3.6.

Table 7-8 from SIR 7 is the same as Table 3.4-10 of Appendix 2 of this submission.

Table 7-9 Residual Impact Classification for Effects on all Key Indicator Resources in the Regional Study Area: Pre-Industrial Case to 2013 Base Case, 2013 PRM Application Case and 2013 Planned Development Case - During Construction and Operations

Potential Effects and Key Indicator Resources	Direction	Magnitude[a]			Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence		
		2013 Base Case	2013 PRM Application Case	2013 PDC					2013 Base Case	2013 PRM Application Case	2013 PDC
Barred Owl											
Abundance	negative	high (+15)	high (+15)	high (+15)	local 0	long-term (+2)	reversible (-3)	high (+2)	high (+16)	high (+16)	high (+16)
Habitat	negative	high (+15)	high (+15)	high (+15)	local 0	long-term (+2)	reversible (-3)	high (+2)	high (+16)	high (+16)	high (+16)
Movement	negative	negligible 0	negligible 0	negligible 0	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	negligible (+2)	negligible (+2)
Net Effects	negative	high (+15)	high (+15)	high (+15)	local 0	long-term (+2)	reversible (-3)	high (+2)	high (+16)	high (+16)	high (+16)
Beaver											
Abundance	negative	moderate (+10)	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)	moderate (+12)
Habitat	negative	moderate (+10)	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)	moderate (+12)
Movement	negative	high (+15)	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	high (+17)	high (+17)
Net Effects	negative	moderate (+10)	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)	moderate (+12)
Black Bear											
Abundance	negative	moderate (+10)	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)	moderate (+12)
Habitat	negative	moderate (+10)	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)	moderate (+12)
Movement	negative	high (+15)	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	high (+17)	high (+17)
Net Effects	negative	moderate (+10)	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)	moderate (+12)
Black-throated Green Warbler											
Abundance	negative	high (+15)	high (+15)	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	high (+18)	high (+18)
Habitat	negative	high (+15)	high (+15)	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	high (+18)	high (+18)
Movement	negative	negligible 0	negligible 0	negligible 0	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Net Effects	negative	high (+15)	high (+15)	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	high (+18)	high (+18)
Canada Lynx											
Abundance	negative	moderate (+10)	moderate (+10)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)	high (+17)
Habitat	negative	moderate (+10)	moderate (+10)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)	high (+17)
Movement	negative	high (+15)	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	high (+17)	high (+17)
Net Effects	negative	moderate (+10)	moderate (+10)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)	high (+17)

Table 7-9 Residual Impact Classification for Effects on all Key Indicator Resources in the Regional Study Area: Pre-Industrial Case to 2013 Base Case, 2013 PRM Application Case and 2013 Planned Development Case - During Construction and Operations (continued)

Potential Effects and Key Indicator Resources	Direction	Magnitude[a]			Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence		
		2013 Base Case	2013 PRM Application Case	2013 PDC					2013 Base Case	2013 PRM Application Case	2013 PDC
Canadian Toad											
Abundance	negative	moderate (+10)	moderate (+10)	moderate (+10)	local 0	long-term (+2)	reversible (-3)	high (+2)	moderate (+11)	moderate (+11)	moderate (+11)
Habitat	negative	moderate (+10)	moderate (+10)	moderate (+10)	local 0	long-term (+2)	reversible (-3)	high (+2)	moderate (+11)	moderate (+11)	moderate (+11)
Movement	negative	moderate (+10)	moderate (+10)	moderate (+10)	local 0	long-term (+2)	reversible (-3)	high (+2)	moderate (+11)	moderate (+11)	moderate (+11)
Net Effects	negative	moderate (+10)	moderate (+10)	moderate (+10)	local 0	long-term (+2)	reversible (-3)	high (+2)	moderate (+11)	moderate (+11)	moderate (+11)
Fisher											
Abundance	negative	moderate (+10)	moderate (+10)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)	high (+17)
Habitat	negative	moderate (+10)	moderate (+10)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)	high (+17)
Movement	negative	high (+15)	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	high (+17)	high (+17)
Net Effects	negative	moderate (+10)	moderate (+10)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)	high (+17)
Moose											
Abundance	negative	moderate (+10)	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)	moderate (+12)
Habitat	negative	moderate (+10)	moderate (+10)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)	high (+17)
Movement	negative	high (+15)	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	high (+17)	high (+17)
Net Effects	negative	moderate (+10)	moderate (+10)	moderate (+10)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	moderate (+12)	moderate (+12)	moderate (+12)
Canada Warbler											
Abundance	negative	high (+15)	high (+15)	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	high (+18)	high (+18)
Habitat	negative	high (+15)	high (+15)	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	high (+18)	high (+18)
Movement	negative	negligible 0	negligible 0	negligible 0	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Net Effects	negative	high (+15)	high (+15)	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	high (+18)	high (+18)
Common Nighthawk											
Abundance	negative	low (+5)	low (+5)	moderate (+10)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	low (+8)	low (+8)	moderate (+13)
Habitat	negative	low (+5)	low (+5)	moderate (+10)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	low (+8)	low (+8)	moderate (+13)
Movement	negative	negligible 0	negligible 0	negligible 0	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Net Effects	negative	low (+5)	low (+5)	moderate (+10)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	low (+8)	low (+8)	moderate (+13)

Table 7-9 Residual Impact Classification for Effects on all Key Indicator Resources in the Regional Study Area: Pre-Industrial Case to 2013 Base Case, 2013 PRM Application Case and 2013 Planned Development Case - During Construction and Operations (continued)

Potential Effects and Key Indicator Resources	Direction	Magnitude[a]			Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence		
		2013 Base Case	2013 PRM Application Case	2013 PDC					2013 Base Case	2013 PRM Application Case	2013 PDC
Horned Grebe											
Abundance	negative	moderate (+10)	moderate (+10)	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	moderate (+13)	moderate (+13)	high (+18)
Habitat	negative	moderate (+10)	moderate (+10)	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	moderate (+13)	moderate (+13)	high (+18)
Movement	negative	negligible 0	negligible 0	negligible 0	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Net Effects	negative	moderate (+10)	moderate (+10)	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	moderate (+13)	moderate (+13)	high (+18)
Little Brown Myotis											
Abundance	negative	negligible 0	negligible 0	negligible 0	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Habitat	negative	moderate (+10)	moderate (+10)	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	moderate (+13)	moderate (+13)	high (+18)
Movement	negative	negligible 0	negligible 0	negligible 0	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Net Effects	negative	negligible 0	negligible 0	negligible 0	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Northern Myotis											
Abundance	negative	negligible 0	negligible 0	negligible 0	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Habitat	negative	moderate (+10)	moderate (+10)	high (+15)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	moderate (+13)	moderate (+13)	high (+18)
Movement	negative	negligible 0	negligible 0	negligible 0	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Net Effects	negative	negligible 0	negligible 0	negligible 0	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Olive-sided Flycatcher											
Abundance	negative	moderate (+10)	moderate (+10)	moderate (+10)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	moderate (+13)	moderate (+13)	moderate (+13)
Habitat	negative	moderate (+10)	moderate (+10)	moderate (+10)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	moderate (+13)	moderate (+13)	moderate (+13)
Movement	negative	negligible 0	negligible 0	negligible 0	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Net Effects	negative	moderate (+10)	moderate (+10)	moderate (+10)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	moderate (+13)	moderate (+13)	moderate (+13)
Peregrine Falcon											
Abundance	negative	negligible 0	negligible 0	negligible 0	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Habitat	negative	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Movement	negative	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Net Effects	negative	negligible 0	negligible 0	negligible 0	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Red Knot											
Abundance	negative	negligible 0	negligible 0	negligible 0	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Habitat	negative	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Movement	negative	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Net Effects	negative	negligible 0	negligible 0	negligible 0	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)

Table 7-9 Residual Impact Classification for Effects on all Key Indicator Resources in the Regional Study Area: Pre-Industrial Case to 2013 Base Case, 2013 PRM Application Case and 2013 Planned Development Case - During Construction and Operations (continued)

Potential Effects and Key Indicator Resources	Direction	Magnitude[a]			Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence		
		2013 Base Case	2013 PRM Application Case	2013 PDC					2013 Base Case	2013 PRM Application Case	2013 PDC
Rusty Blackbird											
Abundance	negative	moderate (+10)	high (+15)	high (+15)	beyond regional (+2)	long-term (+2)	reversible/irreversible 0	high (+2)	high (+16)	high (+21)	high (+21)
Habitat	negative	moderate (+10)	high (+15)	high (+15)	beyond regional (+2)	long-term (+2)	reversible/irreversible 0	high (+2)	high (+16)	high (+21)	high (+21)
Movement	negative	negligible 0	negligible 0	negligible 0	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Net Effects	negative	moderate (+10)	high (+15)	high (+15)	beyond regional (+2)	long-term (+2)	reversible/irreversible 0	high (+2)	high (+16)	high (+21)	high (+21)
Short-eared Owl											
Abundance	negative	negligible 0	negligible 0	low (+5)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	low (+8)
Habitat	positive/negative	positive low (+5)	positive low +5)	negative low (+5)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	positive low (+8)	positive low (+8)	negative low (+8)
Movement	negative	negligible 0	negligible 0	negligible 0	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Net Effects	negative	negligible 0	negligible 0	low (+5)	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	low (+8)
Western Toad											
Abundance	negative	low (+5)	low (+5)	low (+5)	local 0	long-term (+2)	reversible (-3)	high (+2)	low (+6)	low (+6)	low (+6)
Habitat	negative	high (+15)	high (+15)	high (+15)	local 0	long-term (+2)	reversible (-3)	high (+2)	high (+16)	high (+16)	high (+16)
Movement	negative	moderate (+10)	moderate (+10)	moderate (+10)	local 0	long-term (+2)	reversible (-3)	high (+2)	moderate (+11)	moderate (+11)	moderate (+11)
Net Effects	negative	low (+5)	low (+5)	low (+5)	local (0)	long-term (+2)	reversible (-3)	high (+2)	low (+6)	low (+6)	low (+6)
Whooping Crane											
Abundance	negative	negligible 0	negligible 0	negligible 0	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Habitat	negative	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Movement	negative	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Net Effects	negative	negligible 0	negligible 0	negligible 0	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Wolverine											
Abundance	negative	high (+15)	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	high (+17)	high (+17)
Habitat	negative	high (+15)	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	high (+17)	high (+17)
Movement	negative	high (+15)	high (+15)	high (+15)	regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	high (+18)	high (+18)
Net Effects	negative	high (+15)	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	high (+17)	high (+17)
Wood Bison											
Abundance	negative	negligible 0	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	low (+7)	low (+7)
Habitat	negative	high (+15)	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	high (+17)	high (+17)	high (+17)
Movement	negative	high (+15)	high (+15)	high (+15)	regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	high (+18)	high (+18)
Net Effects	negative	negligible 0	low (+5)	low (+5)	regional (+1)	long-term (+2)	reversible (-3)	high (+2)	negligible (+2)	low (+7)	low (+7)

Table 7-9 Residual Impact Classification for Effects on all Key Indicator Resources in the Regional Study Area: Pre-Industrial Case to 2013 Base Case, 2013 PRM Application Case and 2013 Planned Development Case - During Construction and Operations (continued)

Potential Effects and Key Indicator Resources	Direction	Magnitude[a]			Geographic Extent	Duration	Reversibility[b]	Frequency	Environmental Consequence		
		2013 Base Case	2013 PRM Application Case	2013 PDC					2013 Base Case	2013 PRM Application Case	2013 PDC
Woodland Caribou											
Abundance	negative	high (+15)	high (+15)	high (+15)	regional (+1)	long-term (+2)	irreversible (+3)	high (+2)	high (+23)	high (+23)	high (+23)
Habitat	negative	high (+15)	high (+15)	high (+15)	regional (+1)	long-term (+2)	reversible/irreversible 0	high (+2)	high (+20)	high (+20)	high (+20)
Movement	negative	high (+15)	high (+15)	high (+15)	regional (+2)	long-term (+2)	reversible (-3)	high (+2)	high (+18)	high (+18)	high (+18)
Net Effects	negative	high (+15)	high (+15)	high (+15)	regional (+1)	long-term (+2)	irreversible (+3)	high (+2)	high (+23)	high (+23)	high (+23)
Yellow Rail											
Abundance	negative	high (+15)	high (+15)	high (+15)	beyond regional (+2)	long-term (+2)	reversible/irreversible 0	high (+2)	high (+21)	high (+21)	high (+21)
Habitat	negative	moderate (+10)	high (+15)	high (+15)	beyond regional (+2)	long-term (+2)	reversible/irreversible 0	high (+2)	high (+16)	high (+21)	high (+21)
Movement	negative	negligible 0	negligible 0	negligible 0	beyond regional (+2)	long-term (+2)	reversible (-3)	high (+2)	negligible (+3)	negligible (+3)	negligible (+3)
Net Effects	negative	high (+15)	high (+15)	high (+15)	beyond regional (+2)	long-term (+2)	reversible/irreversible 0	high (+2)	high (+21)	high (+21)	high (+21)

(a) Magnitude is defined through habitat suitability modelling (Appendix 3.7, Section 1).

(b) For wildlife species that are dependent upon wetlands, including peatlands, but are also associated with non-peatland wetlands types, the partial reversibility of the effects of habitat change for these species is classified as “reversible/irreversible”.

Note: Numerical scores for impact criteria and ranking of environmental consequence are explained in the EIA, Volume 3, Section 1.3.6.
Table 7-9 from SIR 7 is the same as Table 3.4-10, Tables 4.3-13 to 4.3-36 and Tables 5.3-11 to 5.3-34 of Appendix 2 of this submission.

The environmental consequences for Aboriginal Rights and Interests cannot be determined in the same manner as the other biological or environmental KIRs contained in the preamble, and thus are not outlined in the tables above. To determine the environmental consequences to Aboriginal Rights and Interests as a KIR, it is necessary to consider the environmental consequences for the rest of the aforementioned biological or environmental KIRs. This is because the vast majority of Aboriginal Rights and Interests are based on access to and use of those biological and environmental KIRs at the LSA level, and throughout and beyond the RSA level. Accordingly, Shell's view is that the environmental consequences to a particular Aboriginal Right or Interest will be closely tied or directly related to the environmental consequences of the supporting environmental or biological KIR. For example, to the extent particular Aboriginal Rights and Interests are dependent on the use of or access to areas of High Traditional Plant Use Potential, the consequence for High Traditional Plant Use Potential provides an analogue for the consequence for the Aboriginal Rights and Interests that is reliant on that KIR. In the case of this example, the consequence is moderate at the LSA scale, and negligible at the RSA scale.

CUMULATIVE EFFECTS

SIR 8

The Terms of Reference for the Joint Review Panel indicates that the cumulative effects assessment should include a Pre-industrial Case to allow the Panel to take into account the effects that may have already been experienced prior to the Project and future foreseeable projects or activities as of the issuance of the Joint Review Panel's Terms of Reference. At present, Shell's assessment does not include a pre-industrial baseline. Shell did include some future foreseeable projects and activities, however additional projects and activities have been disclosed and/or occurred since Shell completed the cumulative effects assessment, and thus an update is required to account for these projects.

The Panel also requests that Shell include forest harvesting plans for the period of time up until the closure and reclamation of the Project. Shell has included timber harvesting plans only up until 2011, as stated in EIA Volume 5: Terrestrial Resources and Human Environment, Section 7.6.2.1, Page 7-140. The Panel also requires Shell to include the effects of past and future forest fires within the regional study area (RSA) when updating the cumulative effects assessment.

Shell provided a cumulative effects assessment for both the Jackpine Mine Expansion and Pierre River Mine Projects combined. The Panel requires information on any KIR that is affected by the Pierre River Mine Project and not by the Jackpine Mine

Expansion Project and the outcome of any change to the cumulative effects assessment resulting from this distinction.

The Panel requests a comparison of the information from the Pre-industrial Case to the Application Case and to the Planned Development Case. The Panel notes that this information would provide a more complete picture of cumulative effects for PRM.

a) Update the cumulative effects assessments to take into account the above provisions and

(i) Provide an assessment of the Application Case to the Pre-industrial Case for all appropriate KIRs providing all necessary tables, figures, and interpretation.

(ii) Provide an assessment of the Planned Development Case to the Pre-industrial Case for all appropriate KIRs providing all necessary tables, figures and interpretation.

(iii) Provide the significance of the cumulative effects for all appropriate KIRs after reclamation, for each of the above assessments.

Response:

The following is a brief summary of the requested information for JRP SIR 8. Additional information is filed in Appendix 2.

As requested Shell has provided a Pre-Industrial Case (PIC), plus an updated 2013 Planned Development Case (PDC), and 2013 Application Case current to June 2012, to account for foreseeable projects and activities publicly disclosed since the EIA for PRM was completed. The PIC is intended to represent conditions before substantial industrial development occurred in the region. Since information for some components is lacking, the PIC is based on the oldest data available, or on the most representative data available, for each component rather than on a consistent year basis.

The response to JRP SIR 8 was developed with consideration of the other JRP SIRs, items raised by regulators and stakeholders during the regulatory process (including the JME regulatory process), and commitments made previously by Shell for supporting assessment work. The updated assessment accounts for these items and maintains consistency between this response and the other information presented in the submission. Key updates that were made to the assessment approach in this submission include:

- Updated Base Case: The EIA Base Case information was updated similar to the 2013 PDC with a project inclusion list current to June 2012. This update was done to allow a reasonable comparison between assessment case information within this submission. For example, Total E&P Canada Ltd. Joslyn North Mine has been added to the updated Base Case, given that regulatory approval has been granted for this project. A detailed list of the projects included in the updated Base Case is provided in Appendix 3.1 (Section 2.4). This updated assessment case is referred to as the 2013 Base Case in this submission.

- Updated Application Case: JRP SIR 5 requested that Shell present the effects of PRM alone, in isolation from JME, for specific sections of the EIA. This updated assessment case for PRM is referred to as the 2013 PRM Application Case throughout the SIR submission and is presented in Appendix 1. The 2013 PRM Application Case results are also discussed in the 2013 PDC assessment presented in Section 3.0 of Appendix 2, and in the 2013 PRM Application Case to PIC assessment presented in Section 4.0 of Appendix 2.
- Updated approach to assessing forest fire and forest harvest: A key change in approach involves use of A Landscape Cumulative Effects Simulator (ALCES®) model to simulate forest fire and forest harvest information. Landscape simulations were conducted using the ALCES® and ALCES Mapper® computer programs. The ALCES® program was used to simulate the effects of forest fire and forest harvest in the Regional Study Area (RSA) over a 60-year period. The ALCES Mapper® program was used to simulate the potential spatial configuration of forest fire and forest harvest. The revised model of burns and cutblocks was applied to the Terrestrial Resources assessment for the PIC, 2013 Base Case, 2013 PRM Application Case and 2013 PDC in this submission.

Appendix 3.1 details the approach used to determine environmental significance.

a) **Pre-Industrial Case Summary**

The PIC is intended to represent conditions prior to substantial industrial development in the region. Since information for some components is lacking, the PIC is based on the oldest data available, or on the most representative, for each component rather than on a consistent year basis. In the EIA and previous regulatory submissions, pre-industrial conditions have been referred to as “Pre-Development” or the “Pre-Development Case”. To avoid confusion with the Planned Development Case (PDC) all references to pre-development have been re-titled “Pre-Industrial Case” for this submission.

Components discussed in the PIC are air quality, health risk, air emissions effects on ecological receptors, aquatic resources (hydrogeology, hydrology, water quality, and fish and fish habitat), terrestrial resources (soils and terrain; terrestrial vegetation, wetlands and forest resources; wildlife; and biodiversity), and human environment (traditional knowledge and land use, and socio-economics).

Where possible, the PIC information is compared with 2013 Base Case information. This comparison will allow the JRP to “take into account the effects that may have already been experienced prior to the Project”.

Air Quality and Environmental Health

The level of anthropogenic emissions in the region would generally be lower in the PIC than in the 2013 Base Case, as discussed in Appendices 1 and 3.2. Accordingly, while human health risks could not be adequately characterized for the PIC owing to the overall quality of the database of measured air, soil and vegetation data prior to 1965 for the compounds relevant to the Human Health Risk Assessment, there would be lower human health risks via exposure pathways that were dependent on these datasets. The air emissions effects on ecological receptors could also not be assessed for the PIC, as much of the essential environmental data for the air emissions effect analyses are not available from the PIC period. As already stated, the level of anthropogenic emissions in the region would generally be lower in the PIC than in the 2013 Base Case predictions.

Aquatic Resources

Hydrogeology

In general, within the PRM Local Study Area (LSA), PIC groundwater flow in the Basal Aquifer is in an easterly to southeasterly direction towards the Athabasca River, which is the major regional groundwater discharge feature in the RSA. In the surficial deposits within the PRM LSA, groundwater flow is generally from the topographic high of the Birch Mountains to the east and southeast toward the Athabasca River valley.

Hydrology

No existing and approved oil sands projects are present in the tributary streams to the Athabasca River in the PRM LSA. Hence, the 2013 Base Case hydrologic conditions are the same as the PIC flow conditions. For Athabasca River, the net annual water allocation to all existing and approved oil sands developments represents a reduction in the mean annual Athabasca River flow of about 2.1% based on the recorded river flows at Fort McMurray from PIC to 2013 Base Case. The combined reductions in seasonal flows in Reach 4 are less than 13.2% for an average year. The predicted combined changes in flow depths at Node S24 are less than 4 cm.

Surface Water Quality

Pre-Industrial Case data were used as the basis of the water quality assessment in the EIA. These data were used to calibrate water quality models. Under PIC conditions, total metals and nutrients frequently exceeded guidelines in the small streams and the Athabasca River. The high background levels are generally associated with high total suspended solids from upstream of Fort McMurray and occur mostly during the spring season, consistent with the findings of Glozier et al. (2009).

It is well established that the Athabasca River and its tributaries are subject to natural oil sands inputs that affect water quality. Several studies have examined longitudinal trends in metals and Polycyclic Aromatic Hydrocarbon (PAH) concentrations in the region. While these studies were done after oil sands development began in 1967, many of the studies were completed in undisturbed tributaries, which represent PIC conditions.

Fish and Fish Habitat

Because industrial development had not occurred within the small streams of the PRM LSA when the baseline field studies were conducted, it can be assumed that the species distribution and fish habitat conditions presented in the EIA Base Case and Draft No Net Loss Plan are also representative of PIC fish habitat conditions. Therefore, a fish and fish habitat assessment for the PIC is not required.

Terrestrial Resources

The increased development activities from the PIC to the 2013 Base Case in the RSA has resulted in a decrease in mineral and organic soils and a corresponding increase in disturbed landscapes.

Changes in natural Regional Land Cover Classes (RLCCs) from the PIC to 2013 Base Case range from 3% to 27% of the resource. The largest percent change occurs in the terrestrial vegetation category, where mixedwood aspen-white spruce was reduced by 27% of the resource or 52,635 ha. Total disturbances, including 100,095 ha of cutblocks, increased by 311,139 ha due to the loss or alteration of other RLCCs. Approximately 119,936 ha (12% of the resource) of wetlands were lost or altered. Terrestrial vegetation was also reduced by 164,927 ha (21% of the resource). The amount of burn decreased by 24,044 ha (6% of the resource).

The increase in human disturbances from the PIC to the 2013 Base Case result in an increase in the amount of high suitability habitat in the RSA for short-eared owl, due primarily to the increased prevalence of cutblocks in the RSA at the 2013 Base Case. There is a decrease in the amount of high suitability habitat for all remaining KIRs for which effects on habitat were assessed. The decline in high and moderate-high suitability habitat combined is of low magnitude (i.e., a less than 10% change) for common nighthawk, of high magnitude (i.e., a greater than 20% change) for barred owl, black-throated green warbler, Canada warbler, western toad, wolverine, wood bison and woodland caribou, and of moderate magnitude (i.e., greater than 10% change, but less than or equal to 20%) for all other wildlife Key Indicator Resources (KIRs) for which changes in habitat were quantified using Habitat Suitability (HS) models.

For little brown myotis and northern myotis foraging and roosting habitat, mixedwood and coniferous forests show a less than 20% decline from the PIC to the 2013 Base Case prior to reclamation. This decline would result in a moderate magnitude effect of development in the RSA on little brown myotis and northern myotis foraging and roosting habitat.

Landscape changes should be assessed in the broader context of the overall availability of habitat. The amount of human disturbance in the RSA has been estimated to increase from less than 0.1% at the PIC to 14% of the RSA at the 2013 Base Case. Therefore, at the 2013 Base Case, 86% of the RSA remains undisturbed by humans.

From the PIC to the 2013 Base Case, areas ranked high for biodiversity potential will decrease by 72,042 ha (13% of the resource). This decrease is nearly equally distributed between the high-ranked RLCCs, with non-treed wetlands and treed fen declining by 12% and 14% in the RSA, respectively. Moderate biodiversity potential areas will decrease by 129,573 ha (15% of the resource). Reductions to the terrestrial RLCCs characterize the majority (62%) of this change. Low biodiversity potential areas will increase by 202,334 ha (23% of the resource). All of the low-ranked RLCCs experience losses, with the exception of cutblocks and other disturbances, which increase from the PIC to the 2013 Base Case.

Human Environment

The cumulative effects of development between the PIC and the 2013 Base Case have disturbed between 8% and 15% of the Community of Fort McKay's Culturally Significant Ecosystems (CSEs). The cumulative effects of development between PIC and the 2013 Base Case have disturbed 14% of the area of Fort McKay First Nation's traditional territory within the RSA, 17% of the area of the Mikisew Cree First Nation (MCFN) and Athabasca Chipewyan First Nation (ACFN) traditional territories within the RSA and 18% of the area of the Fort McMurray #468 First Nation (FM468) traditional territory within the RSA.

Without oil sands development, the regional population would be much smaller than it is today and communities in the region would not have experienced many of the socio-economic challenges precipitated by development. At the same time, neither would the region or its residents have realized many of the benefits of development, including jobs, income, and increased service offerings and amenities. Although growth is a pathway by which many socio-economic effects occur, the level of that growth alone is not a sufficient indicator of the nature and magnitude of these effects. Consideration must be given to the availing processes and systems in place to handle and address these effects. In the Wood Buffalo region, these processes and systems have expanded considerably over time, especially in recent years as a response to rapid growth in the late 1990s to 2008 period.

2013 Planned Development Case Summary

Air Quality

For the 2013 PDC, NO_2, $PM_{2.5}$, H_2S, benzene and acrolein were assessed because other air quality parameters were predicted to be negligible in the 2013 PRM Application Case. The regional annual NO_2 predictions were above the AAAQO outside developed areas; however, the predicted annual NO_2 concentrations in the communities were below the AAAQO. The H_2S predictions at the regional communities remain below the AAAQOs. The 24-hour $PM_{2.5}$ predictions were above the AAAQO at some communities. The 2013 PDC predicted 1-hour and annual benzene exceedances at Fort McMurray, and annual acrolein exceedances at Fort McMurray and the Oil Sands Lodge. The benzene and acrolein predictions at all other communities were within applicable AAAQOs and other applicable criteria. The exceedances at Fort McMurray are primarily due to the estimated increase in emissions from future population growth in Fort McMurray. Of the 10 ambient air quality parameters assessed for the 2013 PDC, four are rated as having a low environmental consequence, two are rated as moderate, and four are rated as having a high environmental consequence.

Environmental Health

Overall, the changes between the 2013 Base Case and 2013 PDC risks are generally small. Cumulative environmental risks associated with the additional projects and activities planned for the region are not expected to result in adverse health effects. Based on the re-analysis, the 2013 PDC does not alter the assessment results or the conclusions originally presented in the HHRA of the EIA.

The results of the 2013 WHRA indicate that the overall risks posed to wildlife health will be low. Therefore, no impacts to wildlife populations are expected based on estimated wildlife exposures to predicted maximum acute and chronic air concentrations or predicted soil and surface water concentrations. These conclusions are consistent with those presented in the EIA WHRA.

Since the 2013 PRM Application Case assessment of air emissions effects on ecological receptors resulted in negligible environmental consequences, a classification of 2013 PDC effects was not completed.

Hydrogeology

The results of the 2013 PDC show that the effects of dewatering and depressurization from the portion of the proposed Teck Frontier Mine that is immediately adjacent to PRM will overlap with the effects from PRM. This dewatering and depressurization will lead to a 17% reduction in surface water outflows within the PRM LSA as compared to the 2007 PDC. Minimal additional effects on groundwater discharge rates (5% reduction) are expected for the Athabasca River reaches between Nodes A1 and A3 from planned developments. This result is consistent with the limited additional drawdown predicted in the Basal Aquifer in the immediate vicinity of the Athabasca River.

Hydrology

The planned development activities within the PRM LSA will result in decreased flows to Athabasca River from tributary creeks. The decreases in flows are due to closed-circuit operations during mine operation and due to increased evaporation from pit lakes in the Far Future.

The total annual net water requirement from the Athabasca River for the regional developments excluding the oil sands projects is 188.7 million m^3 (5.98 m^3/s). The total projected annual net water allocations to existing, approved and planned oil sands mining projects are about 611 million m^3. This represents about 76% of the total annual net water allocation of 799 million m^3 (25.4 m^3/s) in the Athabasca River basin.

Effects of the 2013 PDC on the Athabasca River flows and water levels were quantified for Reach 4 and Node S24, respectively. The total peak water withdrawal for the 2013 PDC is about 34.6 m^3/s, compared to 27.1 m^3/s for the 2013 PRM Application Case.

The predicted reduction in mean seasonal Athabasca River flows for the 2013 PDC range from 0% in winter under 10-year dry hydrologic conditions to 1.7% in winter under 10-year wet hydrologic conditions. The incremental water level reductions due to planned developments in the Athabasca River are less than 2 cm of the mean seasonal flow depths.

Water Quality

Water quality was assessed for the PRM LSA and the Athabasca River under the 2013 PDC. Increases in constituent concentrations in LSA watercourses were predicted due to the Teck Frontier Mine, which is the only other planned project in the LSA. Negligible changes were predicted to pit lakes or to the Athabasca River under the 2013 PDC.

Terrestrial Resources

Soils and Terrain

The 2013 PDC assessment shows an increase in planned development disturbances. After reclamation, there will be a net increase of mineral soils (172,805 ha or 17% of Resource) at Closure, compared to the 2013 Base Case. A net loss of 28,080 ha (3% of the resource) of organic soils is predicted after reclamation based on the conceptualized landscape. The environmental consequence rating for permanent loss of organic soils for the 2013 PDC in the RSA is increased from low to moderate compared to the EIA.

Terrestrial Vegetation, Wetlands and Forest Resources

The 2013 PDC assessed effects to the following KIRs that were assessed to have negative and greater than negligible environmental consequences predicted in the LSA for the 2013 PRM Application Case at Closure: wetlands (including peatlands and patterned fens), old growth forests and high rare plant potential.

During construction and operations in the 2013 PDC, negative and low environmental consequence were predicted for wetlands (including peatlands and patterned fens) and old growth forests. A negative and moderate environmental consequence is predicted for high rare plant potential due to the loss of non-treed wetlands.

The results of the 2013 PDC assessment indicate that there has been no change to environmental consequence rankings from the EIA PDC at Far Future for wetlands (including peatlands and patterned fens) and old growth forest. The environmental consequence ranking at Far Future for wetlands (including peatlands and patterned fens) and old growth forest remained negative and low as in the EIA PDC (Volume 5, Section 7.6). The high rare plant potential environmental consequence ranking at Far Future is positive and low, and is the same as the EIA (Volume 5, Section 7.6).

Wildlife and Wildlife Habitat

The effects of PRM and other planned developments on wildlife abundance, habitat and movement were previously assessed in the EIA and the Species at Risk Assessment (*May 2011, Submission of Information to the Joint Review Panel,* Appendix 2).

Impacts affecting the abundance of Eskimo curlew and northern leopard frog are not predicted because these species have not been recorded in the RSA. Woodland caribou are declining to extirpation in the RSA with or without additional industrial developments and the combined effects of displaced alternate prey populations during construction and increased forage for moose and deer in vegetated clearings as well as in young reclaimed habitats are likely to result in increased alternate prey and wolf population densities in the absence of management intervention. Therefore, the cumulative effects of development in the RSA due to the 2013 PDC on woodland caribou may result in a high magnitude effect on abundance.

Where sufficient information is not available to assess the effects of landscape change on wildlife abundance, the results of habitat modelling (Appendix 3.7, Section 1) predictions regarding effects to high suitability habitat are used as a proxy, under the conservative assumption that abundance is directly related to the availability of habitat. However, as many wildlife KIRs are not likely to be directly limited by habitat in the RSA, this conservative assumption is likely to result in overestimations of actual effects to abundance. Of the wildlife KIRs that may be sensitive to the availability of habitat in the RSA (Section 4.2.3.1.1), habitat suitability modelling results suggest declines in abundance from the 2013 Base Case to the 2013 PDC that are high in environmental consequence for Canada warbler, rusty blackbird and yellow rail; moderate for Canada lynx, fisher, black-throated green warbler; and low for barred owl, beaver, black bear, Canadian toad, moose, common nighthawk, horned grebe, olive-sided flycatcher, short-eared owl and wolverine (Appendix 3.7, Section 1).

The combined effects of interactions with infrastructure and vehicle collisions are likely to have a negligible magnitude effect on the abundance of peregrine falcon, red knot and whooping crane, which seasonally migrate through the RSA.

Little brown myotis and northern myotis abundance is unlikely to be affected by habitat loss in the RSA, because no hibernacula are likely to occur in the RSA, these species are opportunistic in their selection of summer foraging and roosting habitat, and the fungal disease WNS is the primary limitation on abundance across their range. Effects to abundance may be assessed qualitatively by taking into consideration the small risks of mortality due to development in the RSA, which are predicted to be of negligible environmental consequence in the 2013 PDC.

The abundance of wood bison may be limited by disease, and potentially unregulated hunting. The combined effects of incidental sources of mortality associated with changes in the RSA between the 2013 Base Case and the 2013 PDC are predicted to result in a low magnitude effect on wood bison abundance.

Although western toad population declines in the RSA appear to be due to disease rather than habitat loss, soil disturbance in the RSA in the 2013 PDC may result in a negligible magnitude effect on western toad abundance.

The predicted effects of the 2013 PDC represent a reasonable worst-case scenario, because habitat suitability modelling in the 2013 PDC assumes that disturbances from construction occur simultaneously and no reclamation will occur. The actual loss of habitat at any point in time will be less, due to the phased nature of developments and reclamation. Reclamation is not represented because the precise locations and size of some planned projects and the associated reclamation and revegetation plans are unknown. However, there is a regulatory requirement to reclaim wildlife habitat. Therefore, predicted environmental consequences are likely greater than what may actually take place. There will be a reduction in environmental consequence as wildlife habitat redevelops and wildlife populations return into the reclaimed landscape from neighbouring source populations.

Biodiversity

The 2013 PDC assessment predicted an overall negative low environmental consequence in the RSA for all levels of biodiversity during construction and operations and in the Far Future. This result is the same as what was predicted in the EIA PDC assessment (EIA, Volume 5, Section 7.6, Table 7.6-11).

Traditional Knowledge and Land Use

Under the 2013 PDC, disturbances to the combined moderate and intense use portions of the Fort McKay CSEs will represent 16% of the Large Game Harvesting CSE, 24% of the Bird Harvesting CSE, 12% of the Furbearer Harvesting CSE, 24% of the Fish Harvesting CSE and 40% of the Traditional Plant (Berry) Harvesting CSE. Under the 2013 PDC, disturbances are calculated to represent 24% of the area of MCFN's traditional territory within the RSA, 10% of the area of ACFN's Homeland Zone within the RSA, 35% of the area of ACFN's Proximate Zone within the RSA and 24% of the area of FM468's traditional territory within the RSA.

The results of the assessment indicate that the 2013 PDC has significant effects on traditional harvesting in the RSA for the Community of Fort McKay, MCFN, ACFN, FM468 and Fort McMurray Métis. The effects of the 2013 PDC are assessed as not significant for Fort Chipewyan Métis Local #125.

2013 PRM Application Case to Pre-Industrial Case Assessment

Air Quality

Of the 130 ambient air quality parameters assessed for the 2013 PRM Application Case, 82 are rated as having a negligible environmental consequence and 45 are rated as having a low environmental consequence when compared to the PIC. The annual nitrogen dioxide (NO_2) predicted concentration in the RSA was rated as having a moderate environmental consequence because the maximum prediction outside disturbed areas is above the Alberta Ambient Air Quality Objective (AAAQO). Elevated NO_2 concentrations are near approved projects in the region and a model performance evaluation completed as part of the air quality assessment (EIA Volume 3, Appendix 3-8) indicates that NO_2 predictions near open-pit mine sites are over-predicted.

Two parameters (community 24-hour particulate matter with a mean aerodynamic diameter of 2.5 microns or small [$PM_{2.5}$] and annual acrolein) were rated with a high environmental consequence. The 24-hour $PM_{2.5}$ predictions at several communities are above the AAAQO due to existing and approved projects in the 2013 Base Case. There is no increase in predicted concentrations from 2013 Base Case to the 2013 PRM Application Case. The maximum annual acrolein prediction at Oil Sands Lodge is slightly above the Texas Commission on Environmental Quality Effects Screening Level (TCEQ ESL); however, the change due to PRM is less than 1%.

After reclamation, there will be few sources of air emissions compared to operations and air quality levels are expected to return to near-PIC levels in the region. Therefore, the potential effects from the PIC to the 2013 PRM Application Case on air quality after reclamation are not considered a likely significant adverse environmental effect.

Surface Water Quality and Aquatic Health

The 2013 PRM Application Case environmental consequence rankings for aquatic health parameters are negligible or low. Therefore, they are not likely significant adverse environmental effects.

Terrestrial Resources

Overall, the assessment of cumulative effects to terrestrial resources indicates substantial changes in the RSA from PIC to the 2013 PRM Application Case. Most of these changes are negative and result primarily from the cumulative effects of existing and approved developments (i.e., the 2013 Base Case). For example, on average about 98% of wildlife habitat effects from the PIC to the 2013 PRM Application Case are due to disturbances that are present in the 2013 Base Case. The PRM makes an incremental contribution to the large existing cumulative effects identified at 2013 Base Case.

An assessment to determine whether these changes constituted significant adverse effects was conducted using both ecological threshold and resource management criteria approaches for each terrestrial KIR, including biodiversity overall, for which PRM effects were assessed to be greater than negligible at the LSA scale. A detailed explanation for the both ecological threshold and resource management criteria is presented in Appendix 3.1. Prior to reclamation, the ecological threshold approach identified significant effects for three KIRs, whereas resource management criteria identified significant effects for 24 KIRs, or 69% of all KIRs (Table 8-1). The PRM contribution to significant adverse cumulative effects is small relative to the effect already present at 2013 Base Case. Using both ecological thresholds and resource management criteria, most Significant effects identified for terrestrial resources were already present in the 2013 Base Case.

The distinction between significance approaches is important when evaluating the results presented in Table 8-1. As noted in Appendix 3.1, ecological thresholds produce a more appropriate and meaningful assessment of significance for conservation of terrestrial resources because they indicate whether or not populations or ecosystems have lost, or are expected to lose, the ability to sustain themselves or maintain ecological function. A significant result identified using ecological thresholds represents a critical conservation concern. Significant adverse effects identified using ecological thresholds should be addressed to avoid contributing to the loss of healthy plant or animal populations or ecological function within the RSA.

Table 8-1 Summary of Key Indicator Resource Significance Determinations for Cumulative Effects to Terrestrial Resources From the Pre-Industrial Case to the 2013 PRM Application Case

KIR	Before Reclamation		After Reclamation	
	RSA – Ecological Thresholds	RSA – Resource Management Criteria	RSA – Ecological Thresholds	RSA – Resource Management Criteria
Soils				
soil	-	-	n/a	Not Significant
Vegetation				
terrestrial vegetation	Not Significant	Significant	Not Significant	Significant
lichen jack pine community	-	Significant	-	Significant
wetlands	Not Significant	Not Significant	Not Significant	Not Significant
old growth forests	Not Significant	Not Significant	Not Significant	Not Significant
productive forests	-	Not Significant	Not Significant	Not Significant
high rare plant potential areas	Not Significant	Not Significant	Not Significant	Not Significant
high traditional use plant potential areas	-	Significant	-	Significant
Wildlife				
barred owl	Not Significant	Significant	-	-
beaver	Not Significant	Not Significant	-	-
black bear	Not Significant	Not Significant	-	-
black-throated green warbler	Significant	Significant	-	-
Canada lynx	Not Significant	Significant	-	-
Canadian toad	Not Significant	Not Significant	-	-
fisher	Not Significant	Significant	-	-
moose	Not Significant	Significant	-	-
Canada warbler	Significant	Significant	-	-
common nighthawk	Not Significant	Significant	-	-
horned grebe	Not Significant	Significant	-	-
little brown myotis	Not Significant	Significant	-	-
northern myotis	Not Significant	Significant	-	-
olive-sided flycatcher	Not Significant	Significant	-	-
peregrine falcon	Not Significant	Significant	-	-
red knot	Not Significant	Significant	-	-
rusty blackbird	Not Significant	Significant	-	-
short-eared owl	Not Significant	Significant	-	-
western toad	Not Significant	Significant	-	-
whooping crane	Not Significant	Significant	-	-
wolverine	Not Significant	Significant	-	-
wood bison	Not Significant	Significant	-	-
woodland caribou	Significant	Significant	-	-
yellow rail	Not Significant	Significant	-	-
Biodiversity				
species-level	Significant	Not Significant	Significant	Not Significant
ecosystem-level	Not Significant	Not Significant	Not Significant	Not Significant
landscape-level	Not Significant	Not Significant	Not Significant	Not Significant

n/a = Not applicable; - = Significance not assessed because of linkages with other components (i.e., soils indicators are directly reflected in changes to terrestrial vegetation, wetlands and forest resources), limited data (i.e., lichen jack pine community) or lack of meaningful ecological application of the indicator (i.e., productive forest and areas of high traditional use plant potential). To be conservative, and due to uncertainty in future population trends, significance for wildlife is assessed during construction and operations only.

Note: Cumulative effects from the PIC to the 2013 PRM Application Case include and are predominantly due to existing and approved developments in the 2013 Base Case.

The resource management criteria approach used for this assessment, in contrast, is ecologically arbitrary for many KIRs. There is no evidence that the loss of 20% of a resource is an appropriate ecological threshold for most species, and many studies identify much higher losses (i.e., between 40% and 90%) before abrupt and non-linear, negative changes in ecological or population function occur (Andren 1994; Monkkonen and Reunanen 1999; Rompre et al. 2010; Swift and Hannon 2010). Similarly, it is generally not reasonable to assume that any adverse effect to a species at risk, no matter how small, will meaningfully alter the sustainability of the population in the RSA. However, resource management criteria do identify limits identified by resource managers or regulators beyond which losses are considered unacceptable. Significant effects identified using resource management criteria therefore represent adverse effects, but not effects that necessarily require immediate management action to achieve long-term conservation of the resource.

After reclamation, the number of Significant adverse cumulative effects decrease for vegetation KIRs, Effects to soils and ecosystem and landscape level biodiversity are Not Significant before and after reclamation. Adverse cumulative effects would also likely decline for most wildlife KIRs after reclamation, and this would likely result in a reduction of the number of Significant adverse effects, especially those detected using the 20% resource management criterion. However, spatially explicit reclamation data to evaluate the amount of high quality habitat reclaimed at the RSA scale are unavailable and significance after reclamation was not determined for wildlife KIRs, resulting in an overall conservative assessment of predicted impacts based on effects during construction and operations.

Traditional Land Use

The effects to traditional land use under the 2013 PRM Application Case were determined for each of the potentially affected Aboriginal groups. The effects of the 2013 PRM Application Case were determined for hunting, trapping, fishing, and plant and berry harvesting opportunities. Harvesting opportunities were considered to be a combination of the availability of each underlying resource (e.g., wildlife, fish) and access to the resource. The assessment also considered the effects on traditional harvesting activities from odour, noise, visual effects, human health effects and socio-economic effects. A summary of the effects classification for each of the potentially affected Aboriginal groups is found in Table 8-2.

Table 8-2 Effects Classification and Significance for Traditional Land Use Under the 2013 PRM Application Case

Aboriginal Group	Effects Classification for Traditional Land Use	Significance Prior to Reclamation
Community of Fort McKay	High	Significant
Mikisew Cree First Nation	Moderate to High	Significant
Athabasca Chipewyan First Nation	High	Significant
Fort McMurray #468 First Nation	Moderate to High	Significant
Fort Chipewyan Métis Local #125	Low to High (Effects mostly limited to use of RFMA #1275)	Not Significant
Fort McMurray Métis Local #1935	High (Trapping not assessed)	Significant

[a] All effects classifications were assessed as negative in direction, regional in extent, long term in duration and irreversible, therefore only the magnitude has been provided within the table.

Significance Post-Reclamation

While it is not possible to determine the RSA closure landscape in detail because detailed reclamation plans are not available for all projects in the 2013 PRM Application Case, the assessment assumes that project-related disturbances will generally be reclaimed to allow wildlife re-population in preferred harvesting areas throughout RSA, and access to resources and preferred harvesting areas by traditional harvesters. Although the 2013 PRM Application Case was not expected to have a significant effect on fish abundance, the closure landscape is expected to facilitate access to preferred fishing areas. As a result, the opportunities for traditional wildlife harvesting (trapping, hunting and fishing) are expected to increase as a result of the closure landscape.

The effects to traditional plant harvesting opportunities within the RSA are also generally expected to increase. While the combined high and moderate traditional plant potential is expected to remain much the same at Closure as under the 2013 PRM Application Case, the decrease in land disturbance is expected to provide easier access to preferred harvesting areas. As a result of the closure landscape, the effects of the 2013 PRM Application Case post-reclamation on traditional harvesting opportunities are assessed as Not Significant.

Socio-economic factors can also influence the undertaking of traditional harvesting. These include a variety of socio-economic factors, such as desire to continue with traditional land use activities, engagement in wage employment, and perceptions of contamination relating to water, wildlife, or vegetation. While these factors have been identified as present for Aboriginal groups assessed in the 2013 PRM Application Case, it is not possible to determine the degree to which they will affect Aboriginal populations at the time of reclamation or closure.

2013 Planned Development Case to Pre-Industrial Case Assessment

Air Quality

For the comparison of the 2013 PDC to the PIC, NO_2, $PM_{2.5}$, hydrogen sulphide (H_2S), benzene and acrolein were assessed because other air quality parameters were predicted to be negligible in the 2013 PRM Application Case. The regional annual NO_2 predictions were above the AAAQO outside developed areas; however, the predicted annual NO_2 concentrations in the communities were below the AAAQO. The H_2S predictions at the regional communities remain below the AAAQOs. The 24-hour $PM_{2.5}$ predictions were above the AAAQO at some communities. The 2013 PDC predicted 1-hour and annual benzene exceedances at Fort McMurray, and annual acrolein exceedances at Fort McMurray. The benzene and acrolein predictions at all other communities were within applicable AAAQOs and other applicable criteria. The exceedances at Fort McMurray are primarily due to the estimated increase in emissions from future population growth in Fort McMurray. Of the 10 ambient air quality parameters assessed for the 2013 PDC, four are rated as having a low environmental consequence, two are rated as moderate, and four are rated as having a high environmental consequence.

After reclamation, there will be few sources of air emissions compared to operations and air quality levels are expected to return to near-PIC levels in the region. Therefore, the potential effects from the PIC to the 2013 PDC on air quality after reclamation are not considered a likely significant adverse environmental effect.

Water Quality and Aquatic Health

The 2013 PDC to PIC environmental consequence rankings for aquatic health parameters are negligible or low. Therefore, they are not likely significant adverse environmental effects.

Terrestrial Resources

Overall, the assessment of cumulative effects to terrestrial resources indicates substantial changes in the RSA from PIC to the 2013 PDC. Most of these changes are negative and result primarily from the cumulative effects of existing and approved developments (i.e., the 2013 Base Case). The incremental change from the 2013 Base Case to the 2013 PDC is larger for some KIRs, accounting for many of the differences between the assessed effects of development in the RSA from the PIC to 2013 PRM Application Case (Section 4) and the effects of development in the RSA from the PIC to the 2013 PDC that are assessed in this section.

An assessment to determine whether these changes constituted significant adverse effects was conducted for each terrestrial KIR and for biodiversity at the species, ecosystem, and landscape levels for which PRM effects were assessed to be greater than negligible at the LSA scale using both ecological threshold and resource management criteria approaches. Prior to reclamation, the ecological threshold approach identified significant effects for three KIRs, whereas resource management criteria identified significant effects for 25 KIRs, or 71% of all KIRs (Table 8-3). The addition of all planned developments, including PRM, for the PIC to 2013 PDC assessment resulted in a much larger incremental effect than observed in the PIC to 2013 PRM Application Case (Section 4). However, using ecological thresholds and resource management criteria, most Significant effects identified for terrestrial resources were already present in the 2013 Base Case. Additional KIRs identified as significant in the PIC to 2013 PDC using resource management criteria are black bears, beaver, old growth forests, and high rare plant potential. No additional KIRs were identified as significant using ecological thresholds.

The distinction between significance approaches is important when evaluating the results presented in Table 8-3. As noted in Appendix 3.1, ecological thresholds produce a more appropriate and meaningful assessment of significance for conservation of terrestrial resources because they indicate whether or not populations or ecosystems have lost, or are expected to lose, the ability to sustain themselves or maintain ecological function. A significant result identified using ecological thresholds represents an important conservation concern.

The resource management criteria approach used for this assessment, in contrast, is ecologically arbitrary for many KIRs. There is no evidence that the loss of 20% of a resource is an appropriate ecological threshold for most species, and many studies identify much higher losses (i.e., between 40% and 90%) before abrupt and non-linear, negative changes in ecological or population function occur (Andren 1994; Monkkonen and Reunanen 1999; Rompre et al. 2010; Swift and Hannon 2010). Similarly, it is generally not reasonable to assume that any adverse effect to a species at risk, no matter how small, will meaningfully alter the sustainability of the population in the RSA. However, resource management criteria do identify limits identified by resource managers or regulators beyond which losses are considered unacceptable. Significant effects identified using resource management criteria therefore represent adverse effects, but not effects that necessarily require immediate management action to achieve long-term conservation of the resource.

After reclamation the number of Significant adverse cumulative effects decreased for vegetation KIRs and effects to soils and ecosystem and landscape level biodiversity remained Not Significant. Adverse cumulative effects also would likely decline for most wildlife KIRs after reclamation, and this likely would result in a reduction of the number of Significant adverse effects, especially those detected using the 20% resource management criterion. However, spatially explicit reclamation data to evaluate the amount of high quality habitat reclaimed at the RSA scale were unavailable and significance after reclamation was not determined for wildlife KIRs, resulting in a conservative assessment.

Table 8-3 Summary of Key Indicator Resource Significance Determinations for Cumulative Effects to Terrestrial Resources From the Pre-Industrial Case to the 2013 Planned Development Case

Key Indicator Resource	Before Reclamation		After Reclamation	
	RSA – Ecological Thresholds	RSA – Resource Management Criteria	RSA – Ecological Thresholds	RSA – Resource Management Criteria
Soils				
soil	-	-	n/a	Not Significant
Vegetation				
terrestrial vegetation	-	-	-	-
lichen jack pine community	-	-	-	-
wetlands	Not Significant	Not Significant	Not Significant	Not Significant
old growth forests	Not Significant	Significant	Not Significant	Significant
productive forests	-	-	-	-
high rare plant potential areas	Not Significant	Significant	Not Significant	Not Significant
high traditional use plant potential areas	-	-	-	-
Wildlife				
barred owl	Not Significant	Significant	-	-
beaver	Not Significant	Significant	-	-
black bear	Not Significant	Significant	-	-
black-throated green warbler	Significant	Significant	-	-
Canada lynx	Not Significant	Significant	-	-
Canadian toad	Not Significant	Not Significant	-	-
fisher	Not Significant	Significant	-	-
moose	Not Significant	Significant	-	-
Canada warbler	Significant	Significant	-	-
common nighthawk	Not Significant	Significant	-	-
horned grebe	Not Significant	Significant	-	-
little brown myotis	Not Significant	Significant	-	-
northern myotis	Not Significant	Significant	-	-
olive-sided flycatcher	Not Significant	Significant	-	-
peregrine falcon	Not Significant	Significant	-	-
red knot	Not Significant	Significant	-	-
rusty blackbird	Not Significant	Significant	-	-
short-eared owl	Not Significant	Significant	-	-
western toad	Not Significant	Significant	-	-
whooping crane	Not Significant	Significant	-	-
wolverine	Not Significant	Significant	-	-
wood bison	Not Significant	Significant	-	-
woodland caribou	Significant	Significant	-	-
yellow rail	Not Significant	Significant	-	-
Biodiversity				
species-level	Significant	Significant	Significant	Significant
ecosystem-level	Not Significant	Significant	Not Significant	Not Significant
landscape-level	Not Significant	Significant	Not Significant	Significant

n/a = Not applicable; - = Significance not assessed for terrestrial vegetation, wetlands and forest resources because the 2013 PDC was completed for those components that had a low, moderate or high negative environmental consequence in the LSA in the 2013 PRM Application Case assessment at Closure, and were applicable at the RSA scale (Appendix 1). Significance was not assessed some cases because terrain and soils indicators are directly reflected in changes to terrestrial vegetation, wetlands and forest resources). To be conservative, and due to uncertainty in future population trends, significance for wildlife is assessed during construction and operations only.

Note: Cumulative effects from the PIC to the 2013 PRM Application Case include and are predominantly due to existing and approved developments in the 2013 Base Case.

Traditional Land Use

The effects to traditional land use activities under the 2013 PDC were determined for each of the potentially affected Aboriginal groups. The effects of the 2013 PDC were determined for hunting, trapping, fishing, and plant and berry harvesting opportunities. Land use opportunities were considered to be a combination of the availability of each underlying resource (e.g., wildlife, fish) and access to the resource. The assessment also considered the effects on traditional harvesting activities from odour, noise, visual effects, human health effects and socio-economic effects. The following discusses the effects classification and significance of the 2013 PDC to PIC on traditional land use for the potentially affected Aboriginal groups. A summary of the effects classification and significance for each of the potentially affected Aboriginal groups is found in Table 8-4.

Table 8-4 Effects Classification and Significance for Traditional Land Use Under the 2013 Planned Development Case

Aboriginal Group	Effects Classification for Traditional Land Use	Significance Prior to Reclamation
Community of Fort McKay	High	Significant
Mikisew Cree First Nation	Moderate to High	Significant
Athabasca Chipewyan First Nation	High	Significant
Fort McMurray #468 First Nation	Moderate to High	Significant
Fort Chipewyan Métis Local #125	Low to High (Effects mostly limited to use of RFMA #1275)	Not Significant
Fort McMurray Métis Local #1935	High (Trapping not assessed)	Significant

[a] All effects classifications were assessed as negative in direction, regional in extent, long term in duration and irreversible, therefore only the magnitude has been provided within the table.

Community of Fort McKay

The effects to traditional hunting, trapping, fishing, and traditional plant and berry harvesting were each assessed as high magnitude under the 2013 PDC. Due to the location of PDC land and access disturbances in relation to the community of Fort McKay, the resulting impacts are likely to be experienced by the community as a whole and affect the community of Fort McKay's ability to undertake traditional land use activities. The effects of the 2013 PDC on Fort McKay's traditional land use are therefore considered significant.

Mikisew Cree First Nation

The assessment determined that the effects to MCFN traditional hunting, and plant and berry harvesting within the RSA are adverse and high in magnitude. The effects to MCFN traditional fishing within the RSA were assessed as adverse and high in magnitude for MCFN members living in Fort McMurray or communities further south, and moderate in magnitude for MCFN members living in Fort Chipewyan. The effects on MCFN traditional trapping in the RSA were assessed as moderate to high in magnitude for the individual(s) trapping on RFMA #2892. As a result of the high magnitude impacts on traditional hunting, and plant harvesting, traditional fishing, and on traditional trapping for MCFN members living in Fort McMurray, the effects of the 2013 PDC are considered significant for MCFN harvesting within the RSA.

Athabasca Chipewyan First Nation

The assessment determined that the effects of the 2013 PDC on traditional hunting, fishing, and plant and berry harvesting within the RSA are adverse and high in magnitude. The effects to traditional trapping were assessed as adverse and high for the individuals trapping on Registered Fur Management Area (RFMA) #1714. As a result of the high magnitude impacts to traditional hunting, fishing, and plant and berry harvesting, the effects of the 2013 PDC are considered to have a substantial effect on ACFN traditional land use in the RSA, and are therefore considered significant.

Fort McMurray #468 First Nation

The assessment determined that the 2013 PDC effects to FM468 traditional hunting, fishing, and plant and berry harvesting within the RSA are adverse and high in magnitude. The 2013 PDC effects to FM468 trapping in the RSA are assessed as adverse and moderate to high in magnitude. As a result of the high magnitude effects to FM468 traditional harvesting within the RSA, the effects are considered significant.

Fort Chipewyan Métis Local #135

The effects classification determined that the effects to traditional hunting, trapping and plant harvesting by members of Fort Chipewyan Métis Local #125 within the RSA were adverse and high in magnitude. The effects to traditional fishing were assessed as low. The high impacts are mostly the result of impacts to the use of RFMA #1275 by the Métis RFMA holders. The available information further indicated that the large majority of traditional land use by members of Fort Chipewyan Métis Local #125 occurs north of the RSA in the larger area around Fort Chipewyan. Because the impacts within the RSA are limited to a few individuals and that the large majority of traditional land use occurs north of the RSA, the impacts of the 2013 PDC are not expected to substantially alter the ability of Fort Chipewyan Métis Local #125 members to practice traditional activities. As a result, the effects of the 2013 PDC on traditional land use by Fort Chipewyan Métis within the RSA are considered not significant.

Fort McMurray Métis Local #1935

The effects classification determined that the effects of the 2013 PDC on Fort McMurray Métis Local #135 on traditional hunting, fishing, and plant and berry harvesting within the RSA were adverse and high in magnitude. There is not enough information to assess the effects of the 2013 PDC on trapping by Fort McMurray Métis. As a result of the high magnitude and long duration effects to traditional hunting, fishing, and plant and berry harvesting, the effects of the 2013 PDC on Fort McMurray Métis harvesting in the PDC are considered significant.

The effects classification for traditional uses of the land under the 2013 PDC are summarized in Table 8-4.

References:

Andren, H. 1994. *Effects of Habitat Fragmentation on Birds and Mammals in Landscape With Different Proportions of Suitable Habitats: a Review*. Oikos. 71. p. 655-366.

Glozier, N.E., D.B. Donald, R.W. Crosley and D.H. Halliwell. 2009. *Wood Buffalo National Park Water Quality: Status and Trend From 1989 - 2006 in Three Major Rivers; Athabasca, Peace and Slave*. Prairie and Northern Office. Water Quality Monitoring and Surveillance Division/Water Science and Technology Directorate/Environment Canada.

Monkkonen, M. and P. Reunanen. 1999. *On critical thresholds in landscape connectivity: a management perspective*. Oikos. 84: 302-305.

Rompre, G., Y. Boucher, L. Belanger, S. Cote and W.D. Robinson. 2010. *Conserving Biodiversity in Managed Forest Landscapes: the Use of Critical Thresholds for Habitat*. The Forestry Chronicle. 86. 5. p. 589-596.

Swift, T.L. and S.J. Hannon. 2010. *Critical Thresholds Associated With Habitat Loss: a Review of the Concepts, Evidence, and Applications*. Biological Reviews. 85. 1. p. 35-53.

SIR 9

Provide the significance of the cumulative effects for each KIR for wildlife abundance, wildlife movement, wildlife habitat, vegetation, and Aboriginal traditional land use as well as rights and interests prior to reclamation, for each of the above assessments. Athabasca Chipewyan First Nation (ACFN) Technical Review, Appendix D-1, Section 1.2, Page 1. ACFN states that Shell did not fully incorporate adequate pre-industrial scenarios in its cumulative effects assessments and considered the Planned Development Case scenarios a methodological failure since projects disclosed since June 2007 were not included in the assessment. ACFN also disputed Shell only assessing a Planned Development Case when individual impacts for the Application Case were rated greater than negligible.

a) **Discuss any risks for not completing a Planned Development Case where Application case results were considered negligible but measurable at a local or regional scale.**

Response:

a) The significance of the cumulative effects for each Key Indicator Resource (KIR) for wildlife abundance, wildlife movement, wildlife habitat, vegetation, and Aboriginal traditional land use as well as rights and interests prior to reclamation have been provided in Appendix 2, Section 3 and Section 4. The assessment of the significance of cumulative effects in the Regional Study Area (RSA) incorporates a PIC, as described in Appendix 2, Section 2. The 2013 PDC has been updated to include projects that were disclosed as of June 2012 (i.e., the 2013 PDC). The Terms of Reference issued by Alberta Environment in 2007 for the EIA provide detailed requirements for the 2013 PDC. Shell has complied with those EIA Terms of Reference requirements.

A 2013 PDC assessment is completed for residual impacts as long as they are rated greater than negligible at the Local Study Area (LSA) scale (EIA, Volume 3, Section 1.3.3). A negligible environmental consequence may be defined as an environmental change that is small enough to be virtually un-measureable and of little or no importance or consequence within the LSA; that is, the Project is not predicted to have a measureable effect on that resource. For terrestrial resources, the LSA boundary is determined by adding a 500 m buffer to the project footprint (EIA, Volume 5, Section 7.2.4), and this focused Project-scale approach increases the likelihood that an adverse effect to a terrestrial resource within the LSA will be greater than negligible.

All wildlife and many vegetation KIRs have been assessed in the 2013 PDC because 2013 PRM Application Case effects were predicted to be greater than negligible. The 2013 PDC assessment is intended to focus on the primary cumulative effects associated with the Project in relation to other planned projects (EIA, Volume 3, Section 1.3.5). The cumulative effects of all indicators may be interesting from a broad regional planning perspective; however, indicators that are negligibly affected by the Project at a local scale do not warrant a regional cumulative effects assessment within a project-specific EIA. Focusing on those project effects that are predicted to be greater than negligible ensures that assessment effort is focused on effects measurably influenced by the Project. In Shell's view, the risk that the above approach under predicts significant cumulative effects is very low.

MINING AND GEOLOGY

SIR 10

Jackpine Mine Expansion and Pierre River Mine - Submission of Information to the Joint Review Panel, Section 2.1.1, Page 6. Shell states, "Updated geology and associated geology models using additional information obtained from recent operational drilling."

a) Provide the core hole data, in csv format, from the recent operational drilling, as well as the data from any other drilling programs conducted since the last submission of core hole data in 2007.

Response:

a) The geology information that is referred to in the above reference is from the Jackpine Mine operational drilling program, and would not be relevant to the Pierre River Mine. Therefore, Shell has not provided it in this submission.

The most recent drilling program by Shell at the Pierre River Mine was conducted in the winter of 2008/2009. This information was provided as part of the April 2010 Pierre River Mine Supplemental Information, Round 2 submission, SIR 6.

SIR 11

PRM Supplemental Information Response Round 2, Section 3.1, Response 2a, Page 3-1. Shell states, "Shell is currently in discussion with its adjacent lease holders to ensure that resource recovery is maximized for both parties, and fully expects lease boundary agreements to be in place before operations start."

a) Provide an update of the discussion with the adjacent leaseholders around the optimization of resource recovery at the common lease boundary.

Response:

a) Since 2007, Shell and Teck Resources Limited (Teck) have been engaged in discussions to optimize lease boundaries and resolve common development concerns. These discussions recently culminated in an agreement to swap lease holdings, allowing both companies to more efficiently develop the bituminous resource in the region. Specifically, former Shell leases 309, 310, 351, 475, 476, 607, 608, 609 and the northeastern portion of 352 have been exchanged for Teck's lease 14 which is located between Shell's lease 9 and 17 immediately adjacent to the Pierre River Mine area.

None of the bituminous resource involved in this exchange was to be mined as part of the Pierre River Mine application. The impact of the newly acquired lease 14 on any future Pierre River Mine is not known at this time and would be the subject of future regulatory applications. This lease exchange will have no impact on the Pierre River Mine Application currently before the Panel and Shell has no plans at this time to modify the Pierre River Mine application as a result of this announcement.

The lease swap eliminates mining along lease boundaries between the current Pierre River Mine and Teck. Therefore, for current projects there will no longer be any potential for ore sterilization due to mining along lease boundaries between Shell and Teck.

For future projects, by consolidating holdings into contiguous areas, the number of boundaries between Shell and Teck is minimized. The potential for ore sterilization for future projects along lease boundaries for future projects has therefore been greatly reduced.

Shell has also entered into a Projects Agreement with Teck that allows for the Pierre River Mine to proceed as filed with no modifications. While Teck may now own the mineral rights to certain areas that Shell proposed be used for mine infrastructure such as external tailings facilities and fish compensation areas, the construction, operation and abandonment of these facilities is facilitated under this Agreement and is unaffected by the lease swap.

Longer term, this Agreement will facilitate efficient development of the regional resource base by minimizing ore sterilization along remaining common lease boundaries and improving the utilization of infrastructure.

This agreement will also eliminate Shell's specific concerns associated with the development of Teck's Frontier Project.

PROCESS

SIR 12

PRM Supplemental Information Response Round 1, Volume 1, Section 10.1, Page 10-103. Shell provided the bitumen recovery data for Muskeg River Mine from 2003 to 2008 in various tables.

a) Update the tables to include 2009-2011 data.

b) Update the tables to include Jackpine Mine 2011 data.

Response:

a) Table 12-1 provides the Annual Muskeg River Mine and Jackpine Mine bitumen recovery, to date, and Alberta Energy Regulatory (AER) Directive 082 requirement.

Table 12-1 Annual Bitumen Recovery

Year	Average Grade	Extraction Recovery [%]	Overall Bitumen Recovery [%]	AER Requirement [%]
Annual Muskeg River Mine Recovery				
2003	12.4	90.8	88.0	90.0
2004	12.2	91.1	88.9	90.0
2005	11.9	90.5	88.7	90.0
2006	12.1	87.8	86.5	90.0
2007	11.3	88.3	87.3	90.0
2008	10.1	87.9	85.3	88.7
2009	10.9	84.9	87.2	90.0
2010	10.8	87.4	87.4	89.9
2011	10.6	88.3	88.7	89.9
2012	10.4	87.3	89.4	90.0
Annual Jackpine Mine Bitumen Recovery				
2011	11.4	88.1	88.2	90.0
2012	11.4	86.5	92.5	90.0

b) Table 12-1 provides up to date Jackpine Mine bitumen recovery data and AER Directive 082 requirement.

SIR 13

PRM Supplemental Information Response Round 2, Section 4.1, Page 4-20. Shell states, "As stated in the May 2009 Pierre River Mine, Supplemental Information, Volume 1, SIR 166f: Shell has taken several initiatives at the Muskeg River Mine regarding the initial design, with the objective of improving bitumen recovery…".

a) Describe the modifications/changes made at the Muskeg River Mine to improve bitumen recovery, since 2009.

b) Discuss the impact of these modifications/changes on bitumen recovery.

c) Describe any additional modifications/changes that Shell is planning at either Muskeg River Mine or Jackpine Mine to improve bitumen recovery.

d) Describe the design improvements being incorporated into the PRM design to help improve bitumen recovery.

e) Discuss whether these design changes will result in other potential impacts at PRM. For example, the need for additional plant space, change in water quality, change in mine plan etc.

f) Discuss Shell's understanding of the relationship between accurate control of the ore blend and bitumen recovery.

g) Discuss if Shell has sufficient geological data to develop and execute a mine plan to provide and supply an acceptable plant feed.

Response:

a) The Muskeg River Mine (MRM) has implemented numerous modifications to improve bitumen recovery since 2009. These improvements have included both process and equipment related modifications, such as adjusting the pH of the slurry, improved measurement of the conditioning slurry line material, a new feed well, and improved reliability of screening and secondary separation. Near the end of 2011, a new ore blending management program began, and in July 2012, stockpiling of ore was added to the blend protocol to ensure consistent feed is provided to the plant. This consistent feed allows the plant to operate more reliably, with reduced outages. The ore that is not feasible for processing at the time of mining, but is above the Alberta Energy Regulatory (AER) Directive 082 minimum ore grade of 7% (ERCB 2013), is sent to a temporary stockpile. Plant adjustments are currently being assessed or implemented which will allow increased feed variation and the reduction of this stockpile when feasible over time.

In addition, Shell is in the process of implementing a conditioning slurry line extension at the MRM which will improve ore conditioning and bitumen recovery.

b) MRM has achieved monthly bitumen plant recovery targets in compliance with AER Directive 082 since the implementation of the ore blend and stockpiling protocol in July 2012, with the exception of November and December 2012.

c) In addition to the changes discussed in (a), Shell is committed to further improvements to bitumen recovery at MRM and JPM. Projects have been approved and are being executed to increase the temperature of the conditioning slurry line which will increase bitumen recovery. Shell has implemented a dedicated recovery advisory panel, as well as a dedicated project team assigned to ensure bitumen recovery success. Options assessed and implemented to improve bitumen recovery are discussed with the AER on an ongoing basis.

d) All improvements identified at MRM through the current initiatives that have potential to improve bitumen recovery at PRM will be further assessed. As discussed above, this includes optimization of slurry conditioning (e.g., slurry line length), separation efficiency (e.g., feed well design, flotation reliability) and extraction chemistry (e.g., pH adjustment). The plant design will be balanced with consideration for mine planning and ore blending needs. Understanding the ore body of PRM in more detail will allow Shell to improve the plant design, given the learning from MRM and JPM on the importance of balancing robustness of plant design with ore body feed variations.

e) At this stage of planning, any foreseen design changes to the plant would not result in material impacts to the current regulatory application. During detailed plant design any changes resulting from further drilling information will be incorporated and any material changes discussed with the AER as they become available.

f) Shell has implemented a blend and stockpiling protocol procedure since July 2012. The success of this blend protocol has shown that consistent feed to the plant, as well as understanding the limits of the plant, improves bitumen recovery and substantially reduces plant downtime. Improvements to the plant are still required to ensure that all bitumen is processed, as stockpiling is required at this time to meet bitumen recovery requirements. As discussed in (c), plant improvements are being addressed through the dedicated recovery project team.

g) Shell will require further delineation of the ore body and analysis of the feed blend prior to detailed design. The process for detailed plant and mine design is an iterative process and will be optimized throughout the design phase. The plant design will be capable of accommodating variations in the feed consistent with the ore body characteristics and the final mine plan. These typically change from the conceptual application layout within the project design boundaries identified.

References:

AER (Alberta Energy Regulator). 2013. *Directive 082: Operating Criteria: Resource Recovery Requirements for Oil Sands Mine and Processing Plant Operations*. February 13, 2013. Calgary, AB. 6 pp.

SIR 14

PRM Supplemental Information Response Round 2, Section 4.1, Page 4-15. Shell states, "Shell is applying to build one asphaltene-fired cogeneration unit and one natural- gas fired cogeneration unit. However asphaltene energy recovery (AER) technology is still under development and must meet Shell's investment criteria…before proceeding to design and construction."

a) Provide an update on the cogeneration system that Shell is applying for as part of PRM.

Response:

a) In its January 18, 2012 letter filed with the Jackpine Mine Expansion Joint Review Panel, Shell advised that it is no longer seeking approval for AER as part of its Jackpine Mine Expansion Project, and that it would replace AER cogeneration with auxiliary, natural gas-fired equipment.

Shell is also confirming that it does not intend to seek the use of AER to generate steam and power at PRM. Instead, Shell is seeking approval to build two, 85-MW natural gas cogeneration units. As noted in the April 2010, Pierre River Mine Supplemental Information Response Round 2, ERCB SIR 17, Section 4.1, page 4-15, an assessment of two natural gas cogeneration units was included in the EIA.

SIR 15

PRM Supplemental Information Response Round 2, Section 4.1, Page 4-19. Shell states, "The current design basis for the high temperature froth treatment process is to reject less than 10 wt% asphaltene based on bitumen production. The asphaltene rejection level is a balance between upstream bitumen recovery and final bitumen quality. Lower asphaltene rejection rates favour higher bitumen recoveries but lower bitumen quality, whereas increased asphaltene rejection rates favour the application of technologies for AER and further upgrading at the AOSP Scotford Upgrader. This balance of adding value to the bitumen resource can and does shift over time, so that Shell cannot make a firm commitment on the level of asphaltene rejection."

a) Does Shell consider asphaltene to be a potentially usable resource?

b) If the AER is not proceeding, provide the storage location for the rejected asphaltene.

c) Shell indicated that lower rejection rates favour higher bitumen recoveries and higher rejection rates favour the application of technologies for AER. If AER is not proceeding, explain why Shell would favour higher rejection rates instead of minimizing asphaltene rejection.

d) Is Shell committed to limiting asphaltene rejection to 10 weight percent based on bitumen production?

Response:

a) Hydrogen addition technologies such as those employed at the Shell Scotford Upgrader have no ability to convert the heavier, clay containing asphaltene compounds that are currently rejected in the Tailings Solvent Recovery Unit (TSRU) tailings at Shell's current Muskeg River Mine operations. The inclusion of these asphaltenes in upgrader feedstock is detrimental to the catalytic processes employed and renders the catalyst ineffective. In downstream processing facilities where hydroprocessing is not employed as a residual upgrading technology, but rather processed through a conventional non-coking refinery, they would remain unconverted and ultimately be disposed of as road asphalt and/or heavy fuel oil with no value uplift. In the case of a coking refinery they would be converted entirely to petroleum coke and render few valuable hydrocarbons.

On this basis, Shell does not believe that the heavy asphaltenes rejected from the froth treatment process are a valuable resource at this time. Should the economics of asphaltene gasification improve significantly, and a viable carbon capture and storage scheme be developed, asphaltenes could potentially be a future energy source.

b) The rejected asphaltenes would be co-mingled with the TSRU tailings and deposited in the external tailings facility similar to the current operations at Muskeg River Mine. The rejected asphaltenes would be co-mingled with the TSRU tailings and deposited in the external tailings facility similar to the current operations at Muskeg River Mine.

c) The above statement was intended to illustrate the relationship between bitumen recovery (as defined by Directive 082) and asphaltene energy recovery and did not include the economics associated with downstream processing. For example, the economic penalty associated with lower bitumen recovery is partially compensated by the energy recovered from the asphaltenes and the improved light oil conversion of the higher quality bitumen.

d) Yes.

TAILINGS

SIR 16

Jackpine Mine Expansion and Pierre River Mine - Submission of Information to the Joint Review Panel. Shell provided updated tailings management plan for the Jackpine Mine Expansion (JPME) project. Provide an updated tailings management plan that indicates compliance with Directive 074, including, but not limited to, the following:

a) The objectives that Shell commits to achieve.

b) The targets and timelines that Shell commits to achieve.

c) Other technologies that have been or will be considered by Shell, besides thickened tailings (TT) and non-segregating tailings (NST) technology.

d) A description of how the technologies will be demonstrated and accepted as appropriate by Shell.

e) The timeframe Shell will require between choosing a technology and implementing it commercially.

f) A description of the systems and resources Shell will deploy to successfully implement the technologies.

Response:

a) Shell is committed to meeting the objectives of AER Directive 074 that are in place at the start up of operations and will continue to work with the AER to ensure that the appropriate technology is successfully implemented to achieve the required targets and timelines. Shell will implement the knowledge acquired from the Muskeg River Mine (MRM) and the Jackpine Mine – Phase 1 (JPM-1) for fines capture, and continue to improve on technology options as results are available.

b) Shell is committed to meeting AER Directive 074 targets and timelines. The fines balance to achieve this commitment is summarized in Table 16-1. Shell will be required to process 6.6 Mt of fines in the initial operating years to achieve the 50% fines capture target. The technology that will be employed for this incremental fines treatment, noted as “Other” in Table 16-1, will be based on results of ongoing pilot testing, as well as continued assessment of current field operational results. As new information is developed it will be brought forward to the AER for discussion and consideration through face to face sessions, as well as the reports required in support of AER Directive 074.

c) Technologies that are being considered by Shell, besides TT and NST, are:

   i) Atmospheric Fines Drying (AFD) which has been successfully applied at the MRM.

   ii) Centrifugation, which has been proposed at Jackpine Mine for fines capture.

   iii) Many additional technologies are being developed within Canada’s Oil Sands Innovation Alliance’s (COSIA) Tailings Environmental Priority Area (EPA) that might prove to complement the overall tailings management suite. A sampling of these are listed below:

      – enhanced or engineered fines capture in beaches;
      – thickening of froth treatment tailings;
      – water-capped tailings;

- filter pressed tailings;
- in-line filtration;
- sand raining of soft tailings;
- electrokinetic agglomeration;
- dewatering screens; and
- overburden co-mixing.

In addition, the Tailings EPA is able to continually evaluate emerging technologies that are very early in the development cycle. These technologies will be advanced based on their technical merit and ability to address known gaps in tailings technology development.

Table 16-1 Directive 074 Compliance Estimation for the Pierre River Mine

Year	Ore Fines to Extraction [Mt]	PRM Fines Sequestered						D074 Fines Sequestered Targets and Performance			
		NST [Mt]	TT [Mt]	TSRU [Mt]	Other[(a)] [Mt]	Total Fines Sequestered [Mt]	Cumulative Fines Sequestered [Mt]	Annual D074 Fines Sequestered Target [Mt]	Annual D074 Fines Sequestered Target [%]	Annual Fines Sequestered [%]	Cumulative % of Fines Sequestered Target [%]
2021	0.9	0.0	0.4	0.1	0.0	0.4	0.4	0.4	50	50	100
2022	2.7	0.0	1.0	0.2	0.2	1.3	1.8	1.3	50	50	100
2023	7.7	0.0	3.0	0.4	0.5	3.9	5.6	3.9	50	50	100
2024	9.5	0.0	3.7	0.5	0.5	4.7	10.4	4.7	50	50	100
2025	10.8	0.0	4.2	0.6	0.6	5.4	15.8	5.4	50	50	100
2026	16.2	0.0	6.4	0.9	0.8	8.1	23.9	8.1	50	50	100
2027	16.7	0.0	6.6	0.9	0.9	8.4	32.3	8.4	50	50	100
2028	15.5	0.0	6.1	0.8	0.8	7.8	40.0	7.8	50	50	100
2029	16.6	0.0	6.5	0.9	0.9	8.3	48.3	8.3	50	50	100
2030	16.5	0.0	6.4	0.9	1.0	8.3	56.6	8.3	50	50	100
2031	15.4	0.0	6.5	0.8	0.4	7.7	64.3	7.7	50	50	100
2032	16.5	12.8	0.0	0.9	0.0	13.7	78.0	8.3	50	83	108
2033	17.0	13.2	0.0	0.9	0.0	14.1	92.0	8.5	50	83	114
2034	17.1	13.2	0.0	0.9	0.0	14.1	106.2	8.5	50	83	119
2035	15.6	12.2	0.0	0.8	0.0	13.0	119.2	7.8	50	84	122
2036	17.9	13.8	0.0	1.0	0.0	14.8	133.9	9.0	50	82	126
2037	16.5	6.6	2.0	0.9	0.0	9.5	143.4	8.3	50	57	125
2038	19.0	2.0	4.2	1.0	0.0	7.2	150.6	9.5	50	38	121
2039	20.4	15.5	0.0	1.1	0.0	16.6	167.1	10.2	50	81	124
2040	18.9	4.9	3.1	1.0	0.0	9.0	176.1	9.5	50	48	123
2041	18.4	5.6	2.7	1.0	0.0	9.3	185.4	9.2	50	51	121
2042	16.9	6.3	2.2	0.9	0.0	9.4	194.8	8.4	50	56	121
Total	**322.7**	**105.9**	**64.9**	**17.4**	**6.6**	**194.8**	**194.8**				

(a) "Other" fines sequestered is to be determined upon review of TT performance improvement, AFD and centrifuge projects.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

d) The AFD technology has been implemented at MRM, and centrifugation is proposed for the JPM-1 and JME operations. These technologies are discussed within Shell's annual Directive 074 submissions and demonstrations of their performance will be reviewed by Shell and adjusted accordingly prior to PRM operations. Continued review of the operating and proposed technologies for fines capture will inform the decision on implementation of the most technical and cost-effective technology for PRM. A description of the technologies, and how they will be demonstrated and accepted are;

i) Atmospheric Fines Drying: Muskeg River Mine continues to develop its AFD program. AFD involves the transfer of Mature Fine Tailings (MFT) from the tailings pond to the drying area. They are then mixed with flocculants – chemical agents which help bring the fine clay particles in the MFT together – and placed on a sloped surface to help speed up the release of water from the clay. What remains are deposits that are further dried to meet strength requirements. In 2012, the AFD program exceeded the annual target of 1Mt of fines capture by utilizing the opportunity areas in front of the mine advance, as well on available beach space on top of the External Tailings Facility (ETF). The pace at which this large-scale trial of a new technology was delivered is evidence of the significant focus and effort Shell has placed on meeting Directive 074 targets. The measured strength of this material is noted to be above the required targets. Undrained shear strength was measured to be above 50 kPa in the crust and 3 kPa in the remainder. The average undrained strength of the capped deposit is estimated to be at least 8 to 10 kPa. Both TT and AFD technologies are currently being applied at MRM. Once the first in-pit Dedicated Disposal Area (DDA) is available, Composite Tailings (CT) will be utilized until NST or alternative technologies are commercialized.

ii) Centrifugation: The Jackpine Mine continues to propose centrifugation to meet the 50% fines capture requirement. Current plans indicate that a trial plant could be commissioned and started up by the end of 2013, with the target date of first fines feed in Q2 of 2014, with full-scale centrifugation planned to be in operation in 2015. Shell's confidence in this technology is based upon extensive research and development shared through COSIA.

iii) Thickener Design Improvements: Shell is currently reviewing existing thickener performance improvement options. The intent of these design improvements is to increase the density of the thickened product, thereby increasing fines capture. The results of this review will be applied to the PRM thickener design, where applicable.

iv) Alternative/COSIA Technologies: Technology demonstration will be primarily based on suitability towards closure and reclamation. The site-wide tailings plan will dictate the necessary specifications for a reclamation substrate and technologies will be evaluated based upon their ability to reliably produce to those specifications. As with any new technology option, a series of steps through viability, proof of concept, small-scale piloting and eventual field trials is required. If able to contribute towards a viable closure and reclamation plan, additional factors such as cost of implementation, commercial readiness, ease of operation and amenability to progressive reclamation will also be factors in determining an acceptable technology.

e) Shell will continue to review the results of the current operating tailings technologies, namely TT and AFD. Shell will also continue to study and assess the NST and centrifugation technologies, through internal evaluation and COSIA participation. An investment decision on the PRM tailings technology is not required until post 2016, which will allow sufficient time for concept selection, detailed design and construction for 2021 operation. The PRM Fines Measurement Plan will be submitted in conjunction with the Annual Compliance Report by September 30 of the year before tailings deposition commences, as outlined in AER Directive 074, Section 4.4 (ERCB 2009).

f) Shell employs a thorough process defined as Opportunity Realization which sets out a rigorous approach to the management of opportunities to ensure that they are appropriately defined, evaluated and executed. The process is founded on:

- A decision-driven Opportunity Realisation Process (ORP) that promotes good preparation, planning and appropriate assurance in the delivery and execution of an opportunity.
- Competent people with clear roles and responsibilities leading, staffing and governing opportunities.
- A clear governance structure.

All future tailings technology opportunities will follow this process from identify and assess phases, through to the execution and operation phase.

Shell participates and funds COSIA for tailings technology studies. Shell also has invested substantially in tailings technologies, such as AFD and centrifugation, which demonstrates Shell's commitment to improve on current operations.

References:

ERCB (Energy Resources Conservation Board). 2009. *Directive 074: Tailings Performance Criteria and Requirements for Oil Sands Mining Schemes*. February 3, 2009. Calgary, AB. 14 pp.

SIR 17

PRM Supplemental Information Response Round 2, Section 4.1, Response 31a, Page 4-31. Shell states, "Shell intends to meet the objectives of ERCB Directive 074 by enhancing the tailings plan outlined in the application with one, or a combination of, the following:

- **Applying the appropriate thickener design**
- **Using coagulants**
- **Potentially recycling thin fine tailings (TFT) to a supplemental thickening**
- **process"**

a) Identify Shell's challenges with thickener design and thickener operations at the Muskeg River Mine and Jackpine Mine Phase 1?

b) Specify the potential changes to the thickener design and thickener operations considered for PRM compared to that of the MRM and JPME design.

c) The proposed TT technology, non-segregating tailings technology (NST) and the applications proposed above are all based on the success of a thickener. Describe Shell's contingency plan in the event the proposed tailings management plan does not meet the requirements of Directive 074.

Response:

a) Challenges with the MRM and JPM-1 thickener operation can be attributed to a coarser than design ore grade, which has resulted in frequent off-design operation of the thickener and lower fines solids loading. Shell is currently reviewing existing thickener performance improvement options to mitigate the lower than projected fines content in the ore body. These options include cyclone modification and dilution mixing to the existing thickeners. The purpose of the proposed modifications is to increase fines loading and increase the density of the thickened product with subsequent higher fines capture.

b) Shell will continue to review the thickener performance improvement options proposed and include any potential modifications to the PRM thickener during detailed design. Also, continued assessment of thickener opportunities, such as paste thickening and higher density NST will be completed. Also, Shell's continued involvement in COSIA EPA will help identify further improvements to the thickener design. Improved ore characterization during delineation of the PRM ore body will also provide better input to the final thickener design.

c) Shell is committed to reducing fluid tailings and improving the rate of reclamation following mine disturbance. Shell continues to work within COSIA to evaluate a suite of tailings technologies and optimize the application of those technologies to meet Directive 074 criteria.

The tailings technologies that Shell has committed to for MRM and JPM operations, and will continue to progress for PRM as a contingency plan are Atmospheric Fines Drying (AFD) or Centrifugation. Shell has effectively demonstrated AFD at the MRM operation. Data evaluation from AFD indicates the material will comply with Directive 074 requirements. Centrifugation, although not currently directly demonstrated by Shell, is scheduled to be demonstrated in the near future. Also, centrifugation experience gained from others and shared through COSIA will be employed. Continued participation in COSIA and the subsequent tailings technology opportunities will be assessed for implementation at PRM.

The NST technology has been demonstrated through large scale pilot, which indicate that the NST process is technically viable and that the resultant deposits will comply with AER Directive 074 requirements. Additional NST investigation is planned to minimize the risks associated with operability.

SIR 18

PRM Supplemental Information Response Round 2, Section 4.1, Response 38a, Page 4-40. Shell states, "The Pierre River Mine will produce 196 Mm^3 of recovered bitumen product. The estimated production of MFT is 251.1 Mm^3."

a) Provide rationale for Shell's proposed MFT volume at closure.

b) Provide a comparison of the proposed MFT volume at closure of PRM as per barrel of bitumen production with existing and approved oil sands mining projects, including but not limited to Suncor, Kearl, Fort Hills and Joslyn North Mine.

Response:

a) Shell has chosen the Thickened Tailings (TT) and Non-Segregating Tailings (NST) technology for the Pierre River Mine. The Mature Fine Tailings (MFT) at closure for the PRM submission is based upon predicted pilot and actual performances of the NST and TT products respectively. The TT performance directly affects MFT at closure volumes. Shell's design assumptions for the thickener are considered conservative, based on past operating data and are anticipated to be improved from the planned assumptions through initiatives discussed in SIR 16. Also, applications of alternative technologies discussed in SIR 16, such as centrifugation or Atmospheric Fines Drying (AFD) are likely to be applied to PRM, with project decisions anticipated during the detailed design phase. The quantity of MFT reduction anticipated at closure with these proposed initiatives, as well as the implementation of MFT treatment technologies is not quantified at this time, however will be provided to the AER, as required prior to operations.

b) The result of MFT at closure is a function of the technology chosen, specific area geology, and operational performance. For this reason, Shell is not able to comment on the validity of other operator projections, or how their MFT volume at closure will be achieved.

As requested in this SIR however, a comparison of the proposed MFT volume at closure of other projects is provided. The reference for this information is based on information taken directly from the AER website, 2013 Directive 074 submissions.

The tailings management plan submissions used for this requested comparison are forward looking for existing operations, and therefore do not account for previous production results, or past MFT treatment.

Source data: AER Directive 074 Submission website:

- Kearl (2013): 66 Mm^3 of MFT at closure for ~4,900 Mbbls, for a ratio of 0.01;
- Suncor (2013): 75 Mm^3 of MFT at closure for ~2,300 Mbbls, for a ratio of 0.03;
- CNRL (2013): 178 Mm^3 of MFT at closure for ~3,600 Mbbls, for a ratio of 0.05;
- Aurora North (2013): 220 Mm^3 of MFT at closure for ~1,800 Mbbls, for a ratio of 0.12; and
- Fort Hills (2009): 0 Mm^3 of MFT at closure for ~2,330 Mbbls, for a ratio of 0.00.

Source data: Public Applications:

- Pierre River (2013): 251 Mm^3 of MFT at closure for ~1,300 Mbbls, for a ratio of 0.16; and
- Joslyn Mine (2010): 0 Mm^3 of MFT at closure for ~759 Mbbls, for a ratio of 0.00.

ENVIRONMENT

AIR

SIR 19

In 2011, Alberta Environment and Sustainable Resource Development updated the Alberta Ambient Air Quality Objectives (AAAQOs) for sulphur dioxide (SO2) and nitrogen dioxide (NO2).

a) Provide an updated air quality assessment for PRM, including an analysis of the compliance with the new AAAQOs for SO_2 and NO_2.

b) Discuss any anticipated environmental and health impacts from (a).

Response:

a) The updated air quality assessment for PRM is provided in this submission as part of Appendix 1, Appendix 2 and Appendix 3.2. Table 19-1 provides a summary of the regional SO_2 and NO_2 predictions outside disturbed areas in the Air Quality Local Study Area (LSA) and the Regional Study Area (RSA) in comparison with AAAQO (ESRD 2013). All SO_2 predictions and the 1-hour NO_2 predictions are below the applicable AAAQOs. The 2013 PDC (2013 PDC) annual NO_2 prediction outside developed areas in the LSA is slightly above the AAAQO of 45 µg/m³. The annual NO_2 predictions in the RSA are above the AAAQO for all three assessment cases (2013 Base Case, 2013 PRM Application Case, and 2013 PDC). The annual NO_2 predicted exceedances are due to existing, approved and planned projects in the region and are considered conservative. For modelling purposes, it was assumed that all developments were operating at their maximum capacity at the same time; however, the operational life of each development will actually be staggered over time. The model evaluation (EIA Volume 3, Appendix 3-8) also indicates that NO_2 predictions near open-pit mine sites are over-predicted.

Table 19-1 Summary of Regional SO_2 and NO_2 Predictions

Parameter[(a)]	AAAQO	2013 Base Case	2013 PRM Application Case	2013 PDC
Local Study Area				
maximum 1-hour SO_2 concentration [µg/m³]	450	82.2	82.2	86.1
maximum 24-hour SO_2 concentration [µg/m³]	125	39.5	39.5	26.7
maximum 30-day SO_2 concentration [µg/m³]	30	11.2	11.2	8.3
maximum annual SO_2 concentration [µg/m³]	20	4.6	4.6	4.1
maximum 1-hour NO_2 concentration [µg/m³]	300	150.9	150.9	139.4
maximum annual NO_2 concentration [µg/m³]	45	26.2	43.3	**45.5**
Regional Study Area				
maximum 1-hour SO_2 concentration [µg/m³]	450	276.4	276.4	329.1
maximum 24-hour SO_2 concentration [µg/m³]	125	70.6	70.6	72.3
maximum 30-day SO_2 concentration [µg/m³]	30	15.5	15.5	24.5
maximum annual SO_2 concentration [µg/m³]	20	10.4	10.4	18.8
maximum 1-hour NO_2 concentration [µg/m³]	300	214.2	214.2	212.0
maximum annual NO_2 concentration [µg/m³]	45	**51.6**	**52.4**	**57.6**

(a) All predictions are outside developed areas.

Note: Bold numbers indicate an exceedance above the Alberta Ambient Air Quality Objective (AAAQO) (ESRD 2013).

b) The environmental health risk assessment is provided in Appendix 3.3. In the acute inhalation assessment of the updated Human Health Risk Assessment (HHRA), the peak (1st highest) 10-minute SO_2 concentration is predicted to exceed the 10-minute Air Quality Guideline (AQG) established by the World Health Organization (WHO) at one of the industrial camp sites (Oil Sands Lodge) only. Peak 10-minute SO_2 air concentrations are predicted to be below the 10-minute AQG of 500 µg/m³ at all other locations assessed in the updated HHRA (WHO 2000). On an hourly basis, peak SO_2 concentrations are predicted to be below the AAAQO of 450 µg/m³ at all locations assessed in the HHRA for PRM, including the Oil Sands Lodge (ESRD 2013).

Frequency analysis of the predicted air concentrations at the Oil Sands Lodge indicates that 10-minute SO_2 concentrations could exceed the 10-minute AQG of 500 µg/m³ about 0.03% of the time. This suggests that these exceedances are unlikely to occur.

At the Oil Sands Lodge, the peak 10-minute SO_2 concentrations are predicted to be 647 µg/m³ for the 2013 Base Case and 2013 PRM Application Case and 663 µg/m³ for the 2013 PDC. Because there is no difference between the 2013 Base Case and the 2013 PRM Application Case air concentrations, the PRM is not expected to increase the acute SO_2-related health risks at this location.

A detailed discussion of the potential health effects at varying concentrations of SO_2 was presented in the EIA, Volume 3, pages 5-98 to 5-100 (Table 5.3-28). The peak predicted 10-minute SO_2 concentration of 663 µg/m³ at Oil Sands Lodge is at the low end of the range of air concentrations where increased airway resistance and potential bronchoconstriction resulting coughing, wheezing and shortness of breath in asthmatic or sensitive individuals engaged in moderate exercise (depending on the severity of asthmatic condition) has been reported. No effects on lung function in normal individuals are typically reported at these SO_2 concentrations.

Use of the peak predicted air concentrations is likely conservative, as these concentrations result from rare meteorological conditions of a short-lived nature. Alberta ESRD recommends that the eight highest predicted 1-hour concentrations for each location in a single year be disregarded, because they are considered to be outliers (AENV 2009). The 9th highest value may therefore be a more reasonable concentration to consider for the purposes of the updated HHRA, because the SO_2 concentration is expected to be equal to or lower than this value 99.9% of the time. The predicted 9th highest 10-minute SO_2 concentration of 257 µg/m^3 at Oil Sands Lodge is well below the 10-minute AQG of 500 µg/m^3, and is at the low end of the range of air concentrations where possible modest, transient changes in lung function indices (detectable by spirometry) among asthmatics during moderate to strenuous exercise might occur. All changes in airway resistance at this concentration would be fully reversible and subclinical in nature, with no evidence of wheezing, shortness of breath or other clinical signs.

Sulphur dioxide was not evaluated in the chronic inhalation assessment because a chronic health-based exposure limit could not be identified. The ESRD annual AAAQO for SO_2 is based on ecosystem effects rather than human health, and no supporting documentation is available. The maximum annual SO_2 concentration outside developed areas is below the AAAQO of 20 µg/m^3.

Overall, the anticipated health risks associated with SO_2 are expected to be low, and adverse health effects are therefore not expected.

Peak hourly and annual NO_2 air concentrations are predicted to be below the 1-hour AAAQO of 300 µg/m^3 and US EPA RfC of 100 µg/m^3, respectively, at all locations assessed in the updated HHRA (ESRD 2013; US EPA 2010). Adverse health effects are therefore not expected to result from the inhalation of NO_2. The ESRD annual AAAQO for NO_2 of 45 µg/m^3, which was used in the air quality assessment, was not used in the HHRA because it is based on vegetation effects rather than human health.

The overall conclusions of the updated HHRA, based on the updated air quality assessment for PRM, are consistent with those presented in the EIA HHRA.

References:

AENV (Alberta Environment). 2009. *Air Quality Model Guideline*. Government of Alberta, Alberta Environment. Revised May 2009.

ESRD (Alberta Environment and Sustainable Resource Development). 2013. *Alberta Ambient Air Quality Objectives and Guidelines Summary*. Issued February 2013.

US EPA (United States Environmental Protection Agency). 2010. *40 CFR Parts 50 and 58*. Primary National Ambient Air Quality Standards for Nitrogen Dioxide. Final Rule.

WHO (World Health Organization). 2000. *Air Quality Guidelines for Europe, Second Edition*. World Health Organization, Regional Office for Europe, Copenhagen. WHO Regional Publications, European Series, No. 91.

WATER QUALITY/QUANTITY AND NAVIGATION

SIR 20

Jackpine Mine Expansion and Pierre River Mine - Submission of Information to the Joint Review Panel, Appendix A – Muskeg River Diversion Alternative Assessment, Section 3.1, Page 7. Shell states, "The changes in the MRDA Mine Plan potentially affect the results of the Aquatic Resources Assessment in ten ways: removing MFT from pit lakes." Table 3.4-1, Page 16, provides characteristics of pit lakes proposed for the Jackpine Mine area.

a) Justify Shell's plan to develop pit lakes containing MFT for PRM considering JPME will have no MFT in its end pit lakes (EPLs).

Response:

a) The Jackpine Mine Expansion (JME) commitment for Mature Fine Tailings (MFT)-free pit lakes was a project-specific commitment. The JME project was originally conceived and designed to sequester MFT within the pit lakes at closure, and required routing of the Muskeg River via a pipeline during operations. Technical reviews were undertaken by Shell with First Nations in 2010 and 2011, where the pipeline and the routing of the river at closure through an MFT-containing pit lakes were identified as unacceptable. First Nations viewed the diversion of the river, and the MFT in the pit lakes as undesirable given its spiritual significance. For these reasons, Shell made the project-specific commitment to eliminate MFT from the JME pit lakes.

The *May 2011, Submission of Information to the Joint Review Panel*, Appendix 1 (as referenced), included the removal of MFT from the pit lakes for JME. The conclusions for hydrology, and fish and fish habitat showed the predicted effects were essentially the same as those presented in the EIA which assumed sequestration of MFT in the JME pit lakes.

Accordingly, Shell believes that pit lakes containing MFT at PRM will be sustainable and have no significant adverse environmental impacts. Shell also believes that pit lakes containing MFT will provide for a more economical project, given the substantial cost associated with treating MFT during operations. The PRM pit lakes containing MFT do not connect to a major watercourse such as the Muskeg River and were assessed in the EIA, as amended in *October 2013, Pierre River Mine, Joint Review Panel Supplemental Information Requests,* Appendix 1, Section 3.3. This assessment concluded that PRM would have negligible to low effects on aquatic health. Shell is confident in the results from the assessment completed on the effects of tailings on pit lakes water quality. Water quality modelling predicted that concentrations of key constituents such as naphthenic acids, Total Dissolved Solids (TDS), chronic and acute toxicity and tainting potential would all be below aquatic threshold values.

In addition, Shell is participating in the Syncrude Base Mine Lake research program. The results of this program, combined with ongoing research from Canada's Oil Sands Innovation Alliance (COSIA), will confirm whether MFT within the pit lakes is a viable option for closure purposes at PRM. Shell believes that MFT sequestration in pit lakes is a viable technology, which is anticipated to be validated decades in advance of pit lakes development at PRM.

Shell also believes adequate time exists to progressively apply and incorporate findings from continuing research and demonstration lakes into PRM closure plans. If further MFT treatment is required for closure purposes, Shell believes that fines treatment options such as Shell's currently operated Atmospheric Fines Drying technology, or the proposed JME centrifugation technologies can be employed.

SIR 21

Five oil sands companies, currently operating and withdrawing water from the Athabasca River, signed an agreement to meet the terms of the Water Management Framework (WMF): Instream Flow Needs and Water Management System for the Lower Athabasca River (AESRD, DFO; 2007) for the 2011-2012 winter period.

a) Is Shell committed to signing future agreements to meet the terms of the current water management framework, including all its projects?

Response:

a) Yes.

SIR 22

Project Description Volume 2: Section 10.5, Page 10-18. Shell states, "A raw water storage facility will be required by 2018. This facility will be located in a valley adjacent to the Athabasca River Valley, and will be contained and partitioned by five dykes to create two separate waterbodies… The raw water storage facility used during operations will be converted during decommissioning and closure to a treatment lake." Further in Section 20.4, Page 20-37, Figure 20-12, the dykes are shown to contain the water in the Redclay Compensation Lake and the Raw Water Storage Facility.

a) Provide safety measures and management plans to guarantee geotechnical stability of the dykes proposed for both compensation lake and treatment lake after reclamation and in perpetuity.

Response:

a) The Pierre River Mine permanent water storage dams will be operated, maintained and monitored according to standards outlined in the Canadian Dam Association (CDA) - Dam Safety Guidelines. During mine operation or post mining any active dam has to have a current Operation, Maintenance and Surveillance Manual. The CDA guideline is used by dam safety regulators and dam operators in all provinces of Canada and provides the standard of practice for the thousands of small to large water storage dams (hydroelectric, irrigation, flood control and recreational) in Canada.

Shell will maintain the dams until they are no longer required after which time they would be decommissioned (breached, drained and reclaimed); or dealt with in accordance with direction from the Province.

SIR 23

EIA Volume 4A: Aquatic Resources, Section 6.3.6.2, Page 6-212. Shell states, "…some downward seepage migration towards the Basal Aquifer. However, due to the low hydraulic conductivity of the McMurray Formation oil sands deposits, this seepage is not expected to reach the Basal Aquifer during operations." However, Project Description Volume 2: Section 4.1, Figure 4-4, Page 4-11, indicates there is less than 3m of "minable ore thickness" in the vicinity of the External Tailings Disposal Area (ETDA), and Section 13.3, Page 13-11 states, the ETDA location was selected because, among other reasons, this site "did not sterilize potential ore".

a) Discuss what effect the absence (or limited thickness) of minable oil sands in the McMurray Formation under the ETDA will have on estimates of vertical seepage from the ETDA to the Basal Aquifer.

b) Provide an update on groundwater monitoring investigation including, plans for determining the actual hydraulic properties of the deposits in this area, and the vertical hydraulic gradient between various surficial aquifers and between surficial aquifers and the Basal Aquifer. If additional monitoring wells have been installed near the proposed ETDA, provide their location and a summary of hydraulic properties and water quality from those wells.

c) Provide a revised estimate of vertical seepage from the ETDA into the Basal Aquifer considering that low-permeability oil sands deposits are not present (or are of limited thickness) to limit vertical seepage.

d) Discuss the rationale for installing ETDA seepage mitigation wells to the base of Quaternary deposits, when it appears that seepage may enter the Basal Aquifer in greater than predicted volumes.

Response:

a) The limited thickness, or absence, of mineable oil sands in the McMurray Formation in the area of the ETDA was represented in the groundwater model and the estimates of vertical seepage to the Basal Aquifer have accounted for the limited thickness, or absence, of mineable oil sands, as described below. The results of the groundwater model discussed in the EIA, Volume 4A, Section 6.3.6.2, Figure 6.3-102 indicated that a plume of process-affected water will eventually reach the Basal Aquifer in the Far Future, but it will be contained by the proposed mitigation measures (a system of recovery wells).

The following three subsections provide additional information on the data that was available and incorporated into the groundwater model; the results of the seepage analysis, and the uncertainty associated with the vertical seepage estimates.

Available Data for Basal Aquifer and McMurray Formation Oil Sands Thickness

Data from the Oil Sands Groundwater Database (Oil Sands Groundwater Association [OSGA]; v1.6), Shell boreholes, and Special Report 006 (SPE006: Wynne et al. 2006) were used to develop the Devonian and McMurray Top Structure maps, which were imported into the groundwater model. The isopach of the Basal Aquifer was generated by using the cumulative thickness of the water sands data from the OSGA database supplemented with data from Shell boreholes. The top of the Basal Aquifer surface in the model was generated by adding the Basal Aquifer isopach to the Devonian top structure. This surface forms the bottom of the McMurray oil sands in the model (EIA, Volume 4A, Appendix 4.1, Section 1.2.2.1).

Shell data are represented in Figures 3-2, 3-3, 3-4, 3-5 and 3-6 of EIA Volume 2. In particular, Figure 3-4 shows the isopach of the Lower McMurray 2 (LM2) member, which overlies the Basal Aquifer. The LM2 member generally consists of lagoonal mud, silt and fine sand and it is barren of oil sand ore. The LM2 member acts as an effective aquitard due to its low hydraulic conductivity. Where present, the LM2 aquitard overlies the Basal Aquifer in the area of the ETDA. The LM2 aquitard provides an additional hydraulic barrier to ETDA seepage, complementing the low hydraulic conductivity oil sands in the McMurray Formation in the area of the ETDA.

Vertical Seepage from the ETDA to the Basal Aquifer

The groundwater model estimated seepage from the ETDA and the results indicated that a plume of process-affected water would eventually reach the Basal Aquifer in the Far Future. The results of the simulations are described in detail in the EIA, Volume 4A, page 6-222, under the sub-heading “External Tailings Disposal Area”. Two scenarios were considered:

- Without mitigation measures: Figures 6.3-94 and 6.3-95 of EIA Volume 4A show the estimated extent of the process-affected plume that would eventually develop in the Basal Aquifer in the Far Future.
- With mitigation measures: Figures 6.3-101 and 6.3-102 of EIA Volume 4A show the estimated extent of the process-affected plume that would eventually develop in the Basal Aquifer in the Far Future. This scenario demonstrates that Shell’s proposed mitigation measures (system of recovery wells) are effective in containing seepage in both the Quaternary deposits and the Basal Aquifer.

Uncertainty on Vertical Seepage from the ETDA to the Basal Aquifer

Vertical seepage from the ETDA to the Basal Aquifer may increase or decrease, from the EIA estimated values, depending on the actual thickness of the mineable oil sands present underneath the ETDA. However, any plume of process-affected seepage that develops in the Basal Aquifer will be contained by the proposed mitigation measures (system of recovery wells), effectively removing the uncertainty in the seepage to the Basal Aquifer.

b) Additional groundwater investigations were conducted in 2009 in the area of the ETDA and included:

- installation of 19 monitoring wells (10 in the Upper Quaternary deposits, 6 in the Lower Quaternary deposits, 1 in the Basal Aquifer and 2 in the Devonian);
- response testing of the monitoring wells in the Quaternary deposits to determine the hydraulic conductivity of the surrounding geologic materials;
- measuring groundwater levels at the monitoring wells; and
- sampling all monitoring wells for groundwater quality.

The locations of the monitoring wells in the general area of the ETDA, including the previous monitoring wells installed in 2006 and 2007, are shown in Figure 23-1.

A summary of the 2009 water level measurements is presented in Table 23-1.

A summary of the hydraulic properties (i.e., hydraulic conductivity) for the 2009 monitoring wells completed in the Quaternary deposits is presented in Table 23-2. No response tests or pumping tests were conducted on the Basal or Devonian wells.

A summary of vertical hydraulic gradients for nests of piezometers is presented in Table 23-3.

A summary of the groundwater quality is presented in Tables 23-4 to 23-9.

Additional investigations will be conducted as part of the detailed design for the ETDA and might include the following:

- installation of nests of monitoring wells in Quaternary deposits and Basal Aquifer to determine the vertical hydraulic gradients between the surficial aquifer and the Basal Aquifer, where applicable; and
- installation of production wells and accompanying observation wells in both surficial aquifers and the Basal Aquifer to conduct pumping tests to determine the hydraulic properties of both the surficial aquifers and the Basal Aquifer.

The results of the additional field investigations will then be used to refine the local groundwater flow model, which will be used for the detailed design of the proposed mitigation measures (system of recovery wells).

Figure 23-1 Location of Monitoring Wells in the Area of the Pierre River Mine External Tailings Disposal Area

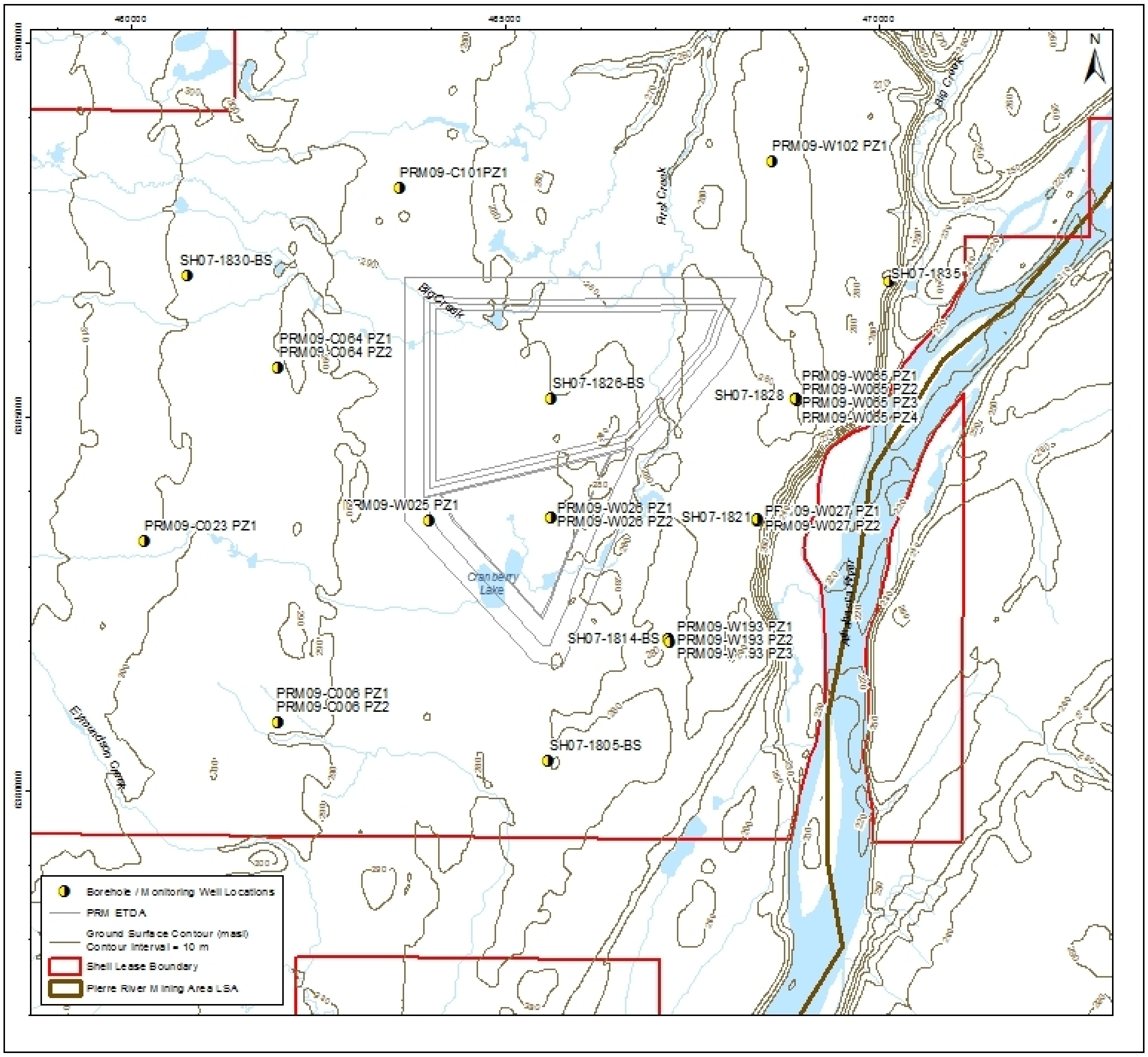

Table 23-1 Summary of Water Level Measurements – March 2009

Completion Formation	Monitoring Well	Surface Elevation [masl]	Top of Casing [masl]	Depth to Groundwater [mbtoc][a]	Groundwater Elevation [masl]	Measurement Date (2009)
Upper Quaternary	PRM09-C006 PZ1	290.35	291.16	2.96	288.21	March 18
	PRM09-C023 PZ1	303.20	304.00	2.98	301.03	March 16
	PRM09-C064 PZ1	291.86	292.92	4.84	288.09	March 18
	PRM09-C101PZ1	285.62	286.50	4.38	282.12	March 18
	PRM09-W025 PZ1	283.59	284.58	2.39	282.19	March 16
	PRM09-W026 PZ1	284.85	285.64	4.40	281.24	March 16
	PRM09-W027 PZ1	285.71	286.53	Dry	<277.40	March 17
	PRM09-W065 PZ1	278.37	279.38	8.72	270.66	March 13
	PRM09-W102 PZ1	283.91	284.70	12.79	271.91	March 16
	PRM09-W193 PZ1	282.76	283.61	5.52	278.09	March 16
Lower Quaternary	PRM09-C006 PZ2	290.44	291.21	17.28	273.93[b]	March 18
	PRM09-C064 PZ2	291.95	292.88	23.70	269.18[b]	March 18
	PRM09-W026 PZ2	284.85	285.66	4.40	281.26	March 16
	PRM09-W027 PZ2	285.78	286.46	14.33	272.13	March 17
	PRM09-W065 PZ2	279.85	280.79	9.23	271.56	March 13
	PRM09-W193 PZ2	282.66	283.51	5.41	278.11	March 16
Basal Aquifer	PRM09-W065 PZ3	279.75	280.74	30.00	250.74	March 13
Devonian	PRM09-W065 PZ4	279.75	280.86	15.15	265.71	March 13
	PRM09-W193 PZ3	282.68	283.41	N/M	N/M	N/M

[a] mbtoc = metres below top of casing.

[b] Groundwater elevation may not have stabilized and may not represent static conditions.

N/M = Not measured.

Table 23-2 Summary of Quaternary Deposit Hydraulic Conductivity from Single Well Response Tests and One Pumping Test – Pierre River Mine ETDA Area

Monitoring Well	Lithology	Quaternary Deposit Hydraulic Conductivity [m/s]			
		Clay, Silt	Lower Till	Upper Sand	Lower Sand
PRM09-C006 PZ1	Clay	3.0E-06	-	-	-
PRM09-C023 PZ1	Clay, silt	1.2E-06	-	-	-
PRM09-C064 PZ1	Sand layer within silty till	-	-	8.7E-05	-
PRM09-C101 PZ1	Sand, clay and silt	6.4E-06	-	-	-
PRM09-W025 PZ1	Sand, some silt and clay	2.4E-06	-	-	-
PRM09-W026 PZ1	Sand	-	-	1.0E-04	-
PRM09-W065 PZ1	Sand	-	-	9.3E-05	-
PRM09-W102 PZ1	Sand	-	-	3.1E-04	-
PRM09-W193 PZ1	Sand	-	-	1.0E-03	-
PRM09-C006 PZ2	Silt, clay till	-	-	-	-
PRM09-C064 PZ2	Sandy, clayey till	-	5.2E-05	-	-
PRM09-W026 PZ2	Sand	-	-	-	6.5E-04
PRM09-W027 PZ2	Sand, gravelly	-	-	-	5.3E-04
PRM09-W065 PZ2	Sand (pumping test)	-	-	-	2.7E-05
	Min	1.2E-06	-	8.7E-05	2.7E-05
	Max	6.4E-06	-	1.0E-03	6.5E-04
	Geometric Average	2.7E-06	-	1.9E-04	2.1E-04

Table 23-3 Vertical Hydraulic Gradients – March 2009 – Pierre River Mine ETDA Area

Monitoring Well Nest	Distance Between Mid-Points of Screened Intervals [m]	Difference in Hydraulic Head [m]	Vertical Hydraulic Gradient [m/m]
PRM09-W026 – PZ1 & PZ2 (upper Quaternary sand and lower Quaternary sand)	18.1	-0.02	0.001 (neutral)
PRM09-W065 – PZ1 & PZ2 (upper Quaternary sand and lower Quaternary sand)	13.2	-0.90	0.07 (upward)
PRM09-W193 – PZ1 & PZ2 (upper Quaternary sand and lower Quaternary sand)	18.2	0.00	0.000 (neutral)
PRM09-W065 – PZ2 & PZ3 (lower Quaternary sand and Basal Aquifer)	69.8	20.82	0.3 (downward)
PRM09-W065 – PZ3 & PZ4 (Basal Aquifer and Devonian)	26.7	-14.97	0.6 (upward)

Table 23-4 Groundwater Quality Results - Field Measured Parameters

Sample Point	Sample Date	Matrix Sample Number	Field Temp [°C]	Field [pH]	Field EC [µS/cm]
PRM09-C101-PZ1	18-Mar-09	08280090318200	1.3	**6.1**	510
PRM09-C023-PZ1	18-Mar-09	08280090318201	0.3	6.6	990
PRM09-W025-PZ1	18-Mar-09	08280090318202	1.9	7.6	410
PRM09-W026-PZ1	18-Mar-09	08280090318203	1.5	7.0	340
PRM09-W026-PZ2	18-Mar-09	08280090318204	2.1	7.0	760
PRM09-W193-PZ1	18-Mar-09	08280090318205	2.1	7.8	450
PRM09-W193-PZ2	18-Mar-09	08280090318206	2.6	7.4	590
PRM09-W193-PZ3	18-Mar-09	08280090318207	2.2	**9.2**	600
PRM09-W027-PZ1	18-Mar-09	dry @ 9.18	---	---	---
PRM09-W027-PZ2	18-Mar-09	08280090318208	2.4	8.3	620
PRM09-W065-PZ1	18-Mar-09	08280090318209	0.8	7.6	410
PRM09-W065-PZ1 dup	18-Mar-09	08280090318211	2.1	7.5	410
PRM09-W065-PZ2	18-Mar-09	08280090318210	2.0	7.5	460
PRM09-W065-PZ3	19-Mar-09	08280090319215	4.4	7.2	83400
PRM09-W065-PZ3 dup	19-Mar-09	08280090319217	4.5	7.2	83300
PRM09-W065-PZ4	19-Mar-09	08280090319216	3.9	**8.9**	890
PRM09-W102-PZ1	19-Mar-09	08280090319212	3.4	8.2	390
PRM09-C006-PZ1	19-Mar-09	08280090319213	2.5	7.6	720
PRM09-C006-PZ2	19-Mar-09	08280090319214	1.4	7.8	1190
PRM09-C064-PZ1	19-Mar-09	08280090319219	3.0	7.3	1300
PRM09-C064-PZ2	19-Mar-09	08280090319220	2.6	7.6	2720
Minimal Detection Limit			0.1	0.1	0.2
Alberta Tier 1 - Natural Areas*			NS	6.5-8.5[P(AO)]	NS

Notes: --- - not analyzed.

NS - not specified.

[AO] - aesthetic objective from Guidelines for Canadian Drinking Water Quality (Health Canada 2008).

[P] - indicates guideline for Potable Groundwater exposure pathway.

* - Alberta Tier 1 Soil and Groundwater Remediation Guidelines (AENV 2009).

Bold indicates values do not meet applicable guidelines.

Table 23-5 Groundwater Quality Results - General and Inorganic Parameters

Monitoring Well	Sample Date	MSI Sample Number	Lab [pH]	Lab EC [mS/cm]	Ca [mg/L]	Mg [mg/L]	Na [mg/L]	K [mg/L]	Cl [mg/L]	HCO_3 [mg/L]	CO_3 [mg/L]	SO_4 [mg/L]	NO_2-N [mg/L]	NO_3-N [mg/L]	NO_2/NO_3-N [mg/L]	Hardness^ [mg/L]	Total Alkalinity^ [mg/L]	TDS [mg/L]	Sulphide [mg/L]	Phenol [mg/L]
PRM09-C101-PZ1	18-Mar-09	08280090318200	7.2	523	64.5	15.6	18	3.5	3	165	<5	126	<0.05	1	1	225	135	316	**0.041**	<0.001
PRM09-C023-PZ1	18-Mar-09	08280090318201	7.2	936	108	33.6	70	4.8	13	623	<5	27	<0.05	<0.1	<0.1	408	511	**563**	**0.019**	**0.020**
PRM09-W025-PZ1	18-Mar-09	08280090318202	6.8	371	37.4	9.7	17	5.4	5	102	<5	83.2	<0.05	<0.1	<0.1	133	83	208	**0.03**	**0.005**
PRM09-W026-PZ1	18-Mar-09	08280090318203	7.7	351	50.7	6.8	10	3	3	230	<5	1.9	<0.05	<0.1	<0.1	155	188	188	**0.043**	**0.007**
PRM09-W026-PZ2	18-Mar-09	08280090318204	7.8	779	81.2	19.1	58	5	7	476	<5	44.5	<0.05	1	1	281	390	453	**0.033**	**0.008**
PRM09-W193-PZ1	18-Mar-09	08280090318205	8	464	79.5	13.4	4	1.9	3	285	<5	28.1	<0.05	0.2	0.2	254	234	271	**0.014**	0.001
PRM09-W193-PZ2	18-Mar-09	08280090318206	7.8	589	64	16.2	34	4.8	6	323	<5	52.3	<0.05	<0.1	<0.1	227	265	336	**0.146**	**0.011**
PRM09-W193-PZ3	18-Mar-09	08280090318207	**9.2**	561	36.1	9.1	72	33.9	39	181	26	68.7	<0.05	0.7	0.7	128	192	377	**0.09**	**0.021**
PRM09-W027-PZ2	18-Mar-09	08280090318208	7.9	616	92.8	17.6	18	3.3	4	428	<5	2.5	<0.05	<0.1	<0.1	304	351	349	**0.011**	0.004
PRM09-W065-PZ1	18-Mar-09	08280090318209	8	432	68.1	12.4	4	1.2	2	276	<5	11.4	<0.05	0.3	0.3	221	227	237	**0.094**	0.002
PRM09-W065-PZ1 dup	18-Mar-09	08280090318211	8	432	71.5	13.3	4	1.8	2	278	<5	12.8	<0.05	0.2	0.2	233	227	242	**0.058**	0.003
PRM09-W065-PZ2	18-Mar-09	08280090318210	8.1	471	60.7	12.5	24	1.7	2	327	<5	0.5	<0.05	1.6	1.6	203	268	269	**0.004**	**0.015**
PRM09-W065-PZ3	19-Mar-09	08280090319215	7.8	78,900	1,440	312	**19,800**	<5	**29,100**	594	<5	**4,550**	<0.05	0.2	0.2	4,880	486	**55,500**	**45.7**	**0.162**
PRM09-W065-PZ3 dup	19-Mar-09	08280090319217	7.8	78,900	1,480	319	**20,400**	<50	**29,500**	595	<5	**5,080**	<0.05	0.2	0.2	5,010	488	**57,100**	**40.1**	**0.09**
PRM09-W065-PZ4	19-Mar-09	08280090319216	8.5	882	28.4	7.9	134	13.2	106	231	<5	96.6	<0.05	0.6	0.6	103	196	**506**	**0.131**	**0.02**
PRM09-W102-PZ1	19-Mar-09	08280090319212	8	395	66.8	13.1	2	1	2	262	<5	5.8	<0.05	1.1	1.1	221	215	225	**0.042**	<0.001
PRM09-C006-PZ1	19-Mar-09	08280090319213	7.5	745	101	20.9	21	3.3	2	255	<5	170	<0.05	2.5	2.5	338	209	455	<0.002	0.002
PRM09-C006-PZ2	19-Mar-09	08280090319214	8.3	1,250	40.4	12	**217**	11.5	43	559	<5	176	**0.32**	1.1	1.4	150	458	**781**	**0.194**	**0.021**
PRM09-C064-PZ1	19-Mar-09	08280090319219	7.8	1,360	182	43.6	77	5.3	11	524	<5	351	<0.05	<0.1	<0.1	634	429	**927**	**0.011**	0.003
PRM09-C064-PZ2	19-Mar-09	08280090319220	8.1	2,690	46.2	11.5	**623**	8	92	1,780	<5	62.2	<0.05	0.2	0.2	163	1,460	**1,720**	**0.033**	**0.016**
Minimal Detection Limit			0.1	0.2	0.5	0.1	1	0.5	1	5	5	0.5	0.05	0.1	0.1	1	5	1	0.002	0.001
Parameter Maximum			9.2	78,900	1,480	319	20,400	33.9	29,500	1,780	26	5,080	0.32	2.5	2.5	5,010	1,460	57,100	45.7	0.162
Parameter Minimum			6.8	351	28.4	6.8	2	ND	2	102	ND	0.5	ND	ND	ND	103	83	188	ND	ND
Alberta Tier 1 - Natural Areas*			6.5-8.5$^{P(AO)}$	NS	NS	NS	200$^{P(AO)}$	NS	230^{A}	NS	NS	500$^{P(AO)}$	0.06^{A}	2.9^{A}	NS	NS	NS	500$^{P(AO)}$	0.002^{A}	0.004^{A}

Notes: NS - not specified.
ND - not detected.
^{A} - indicates guideline for Aquatic Life exposure pathway.
^{P} - indicates guideline for Potable Groundwater exposure pathway.
^{AO} - aesthetic objective from Guidelines for Canadian Drinking Water Quality (Health Canada 2008).
^ - expressed as $CaCO_3$.
* - Alberta Tier 1 Soil and Groundwater Remediation Guidelines (AENV 2009).
Bold indicates values do not meet applicable guidelines.

Table 23-6 Groundwater Quality Results - Dissolved Metals

Monitoring Well	Sample Date	MSI Sample Number	Al [mg/L]	Sb [mg/L]	As [mg/L]	Ba [mg/L]	Be [mg/L]	Bi [mg/L]	B [mg/L]	Cd [mg/L]	Cr [mg/L]	Co [mg/L]	Cu [mg/L]	Fe [mg/L]	Pb [mg/L]
PRM09-C101-PZ1	18-Mar-09	08280090318200	<0.01	<0.0004	0.0034	0.0432	<0.0005	<0.00005	0.194	<0.0001	<0.0004	0.0037	0.0017	**2.52**	<0.0001
PRM09-C023-PZ1	18-Mar-09	08280090318201	0.03	0.0006	**0.0129**	0.185	<0.0005	<0.00005	0.307	**0.0002**	**0.002**	0.0436	0.0031	**24.6**	0.0001
PRM09-W025-PZ1	18-Mar-09	08280090318202	**0.4**	0.0008	**0.0126**	0.153	<0.0005	<0.00005	0.163	**0.0002**	0.0008	0.0064	**0.0066**	**11.2**	**0.0046**
PRM09-W026-PZ1	18-Mar-09	08280090318203	<0.01	<0.0004	0.0006	0.0775	<0.0005	<0.00005	0.033	<0.0001	<0.0004	0.0024	0.0016	**3.15**	<0.0001
PRM09-W026-PZ2	18-Mar-09	08280090318204	<0.01	<0.0004	0.0019	0.0891	<0.0005	<0.00005	0.261	<0.0001	0.0005	0.0010	0.0014	**0.76**	<0.0001
PRM09-W193-PZ1	18-Mar-09	08280090318205	**0.78**	<0.0004	0.0009	0.158	<0.0005	<0.00005	0.021	<0.0001	**0.0023**	0.0033	**0.0042**	**6.79**	0.0046
PRM09-W193-PZ2	18-Mar-09	08280090318206	<0.01	<0.0004	0.0008	0.0705	<0.0005	<0.00005	0.101	<0.0001	<0.0004	0.0006	0.0018	**0.33**	<0.0001
PRM09-W193-PZ3	18-Mar-09	08280090318207	0.1	<0.0004	0.0014	0.105	<0.0005	<0.00005	0.215	<0.0001	**0.0048**	0.0006	0.002	**3.07**	0.0011
PRM09-W027-PZ2	18-Mar-09	08280090318208	<0.01	<0.0004	<0.0004	0.189	<0.0005	<0.00005	0.076	<0.0001	<0.0004	0.0005	0.0008	**1.61**	<0.0001
PRM09-W065-PZ1	18-Mar-09	08280090318209	**0.12**	<0.0004	<0.0004	0.0907	<0.0005	<0.00005	0.024	<0.0001	<0.0004	0.0005	<0.0006	0.132	0.0002
PRM09-W065-PZ1 dup	18-Mar-09	08280090318211	0.03	<0.0004	<0.0004	0.0925	<0.0005	<0.00005	0.023	<0.0001	<0.0004	0.0005	<0.0006	0.101	0.0002
PRM09-W065-PZ2	18-Mar-09	08280090318210	<0.01	<0.0004	<0.0004	0.180	<0.0005	<0.00005	0.072	<0.0001	<0.0004	0.0002	<0.0006	0.024	0.0002
PRM09-W065-PZ3	19-Mar-09	08280090319215	<0.2	<0.008	**0.0310**	0.060	<0.01	<0.001	1.55	<0.002	<0.04	<0.002	**0.020**	<0.5	<0.002
PRM09-W065-PZ3 dup	19-Mar-09	08280090319217	<0.2	<0.008	**0.0420**	0.065	<0.01	<0.001	1.47	<0.002	<0.04	<0.002	**0.020**	<0.5	<0.002
PRM09-W065-PZ4	19-Mar-09	08280090319216	0.06	0.0008	0.0020	0.0338	<0.0005	<0.00005	0.173	<0.0001	**0.0065**	0.0010	**0.0031**	**0.97**	0.0006
PRM09-W102-PZ1	19-Mar-09	08280090319212	<0.01	<0.0004	<0.0004	0.183	<0.0005	<0.00005	0.010	<0.0001	<0.0004	0.0002	0.0014	<0.005	<0.0001
PRM09-C006-PZ1	19-Mar-09	08280090319213	<0.01	<0.0004	0.0004	0.0679	<0.0005	<0.00005	0.458	**0.0002**	<0.0004	0.0016	0.0023	<0.005	<0.0001
PRM09-C006-PZ2	19-Mar-09	08280090319214	<0.01	0.0011	0.0019	0.139	<0.0005	<0.00005	0.673	<0.0001	0.0005	0.0020	**0.006**	0.032	<0.0001
PRM09-C064-PZ1	19-Mar-09	08280090319219	<0.01	<0.0004	0.0009	0.115	<0.0005	<0.00005	0.409	<0.0001	<0.0004	0.0023	0.0022	0.010	<0.0001
PRM09-C064-PZ2	19-Mar-09	08280090319220	<0.01	0.0024	0.0030	0.250	<0.0005	<0.00005	1.86	<0.0001	**0.0012**	0.0018	**0.0035**	<0.01	<0.0001
Minimal Detection Limit			0.01	0.0004	0.0004	0.0001	0.0005	0.00005	0.002	0.0001	0.0004	0.0001	0.0006	0.005	0.0001
Parameter Maximum			0.78	0.0024	0.0420	0.250	ND	ND	1.86	0.0002	0.0065	0.0436	0.020	24.6	0.0046
Parameter Minimum			ND	ND	ND	0.0338	ND	ND	0.010	ND	ND	ND	ND	ND	ND
Alberta Tier 1 - Natural Areas*			0.005[a]-0.1[b,A**]	0.006[P(MAC)]	0.005[A]	1[P(MAC)]	NS	NS	5[P(MAC)]	H[A^]	0.001[Ad^]	NS	H[A**]	0.3[P(AO),A]	H[A^]

Table 23-6 Groundwater Quality Results - Dissolved Metals (continued)

Monitoring Well	Sample Date	MSI Sample Number	Mn [mg/L]	Hg [mg/L]	Mo [mg/L]	Ni [mg/L]	Se [mg/L]	Ag [mg/L]	Sr [mg/L]	Tl [mg/L]	Sn [mg/L]	Ti [mg/L]	U [mg/L]	V [mg/L]	Zn [mg/L]
PRM09-C101-PZ1	18-Mar-09	08280090318200	**0.778**	<0.0001	0.0015	0.0200	0.0006	<0.0002	0.23	<0.00005	<0.0002	0.0016	0.0015	0.0004	0.009
PRM09-C023-PZ1	18-Mar-09	08280090318201	**4.58**	<0.0001	0.0091	0.0656	**0.0048**	<0.0002	0.394	<0.00005	<0.0002	0.0016	0.0097	<0.001	**0.649**
PRM09-W025-PZ1	18-Mar-09	08280090318202	**0.738**	<0.0001	0.0031	0.0184	0.0006	<0.0002	0.214	0.00006	<0.0002	0.0063	0.0012	0.0042	**0.120**
PRM09-W026-PZ1	18-Mar-09	08280090318203	**0.805**	<0.0001	0.0002	0.0046	<0.0004	<0.0002	0.0755	<0.00005	<0.0002	0.0014	0.0002	0.0012	0.005
PRM09-W026-PZ2	18-Mar-09	08280090318204	**0.488**	<0.0001	0.0004	0.0031	0.0004	<0.0002	0.419	<0.00005	0.0004	0.0025	0.0003	0.0013	0.028
PRM09-W193-PZ1	18-Mar-09	08280090318205	**0.573**	<0.0001	0.0002	0.0086	0.0004	<0.0002	0.127	0.00009	<0.0002	0.0362	0.001	0.0054	0.013
PRM09-W193-PZ2	18-Mar-09	08280090318206	**1.07**	<0.0001	0.0007	0.0039	0.0004	<0.0002	0.28	<0.00005	0.0007	0.0014	<0.0001	0.0003	0.010
PRM09-W193-PZ3	18-Mar-09	08280090318207	**0.138**	<0.0001	0.0050	0.0081	0.0005	<0.0002	0.213	<0.00005	0.0007	0.0031	0.0005	0.0013	**0.035**
PRM09-W027-PZ2	18-Mar-09	08280090318208	**0.632**	<0.0001	0.0003	0.0027	<0.0004	<0.0002	0.229	<0.00005	0.0007	0.0009	<0.0001	0.0001	**0.353**
PRM09-W065-PZ1	18-Mar-09	08280090318209	**0.095**	<0.0001	0.0006	0.0018	<0.0004	<0.0002	0.102	<0.00005	<0.0002	0.0067	0.0008	0.0005	0.002
PRM09-W065-PZ1 dup	18-Mar-09	08280090318211	**0.091**	<0.0001	0.0005	0.0018	<0.0004	<0.0002	0.102	<0.00005	<0.0002	0.0021	0.0008	0.0002	0.007
PRM09-W065-PZ2	18-Mar-09	08280090318210	**0.153**	<0.0001	0.0001	0.0011	<0.0004	<0.0002	0.188	<0.00005	0.0004	0.0013	0.0003	0.0007	**0.109**
PRM09-W065-PZ3	19-Mar-09	08280090319215	**0.20**	<0.0001	<0.002	0.0330	**0.021**	<0.004	23.1	<0.001	<0.004	<0.006	<0.002	<0.01	0.020
PRM09-W065-PZ3 dup	19-Mar-09	08280090319217	**0.20**	<0.0001	<0.002	0.0330	**0.021**	<0.004	22.5	<0.001	<0.004	<0.006	<0.002	0.020	0.020
PRM09-W065-PZ4	19-Mar-09	08280090319216	**0.056**	<0.0001	0.0096	0.0139	**0.0011**	<0.0002	0.237	<0.00005	0.0003	0.0025	0.0022	0.001	0.015
PRM09-W102-PZ1	19-Mar-09	08280090319212	**0.058**	<0.0001	0.0006	0.0012	<0.0004	<0.0002	0.067	<0.00005	<0.0002	0.0005	0.0006	<0.001	0.006
PRM09-C006-PZ1	19-Mar-09	08280090319213	**0.282**	<0.0001	0.0005	0.0455	0.0008	<0.0002	0.314	<0.00005	<0.0002	0.0014	0.0014	0.0001	0.025
PRM09-C006-PZ2	19-Mar-09	08280090319214	**0.299**	<0.0001	0.0161	0.0060	0.0009	<0.0002	0.598	<0.00005	<0.0002	0.001	0.0018	0.0007	**0.058**
PRM09-C064-PZ1	19-Mar-09	08280090319219	**1.05**	<0.0001	0.0009	0.0065	0.0007	<0.0002	0.605	0.00008	<0.0002	0.001	0.0061	<0.001	**0.042**
PRM09-C064-PZ2	19-Mar-09	08280090319220	**0.124**	<0.0001	0.0111	0.0085	**0.003**	<0.0002	0.437	<0.00005	<0.0002	0.0013	0.0088	0.0013	**0.846**
Minimal Detection Limit			0.01	0.0001	0.0001	0.0008	0.0004	0.0002	0.0001	0.00005	0.0002	0.0003	0.0001	0.0001	0.001
Parameter Maximum			4.58	ND	0.0161	0.0656	0.021	ND	23.1	0.00009	0.0007	0.0362	0.0097	0.020	0.846
Parameter Minimum			0.056	ND	ND	0.0011	ND	ND	0.067	ND	ND	ND	ND	ND	0.002
Alberta Tier 1 - Natural Areas*			0.05[P(AO)]	0.000005[Ac]	NS	H[A^]	0.001[A]	0.0001[A^]	NS	NS	NS	NS	0.02[P(MAC)]	NS	0.03[A]

Notes: NS - guideline not specified.
ND - not detected.
[a] - value if pH <6.5, Ca <4.0, DOC <2.
[b] - value if pH >6.5, Ca >4.0, DOC >2.
[c] - Chronic aquatic life guideline from Alberta Environment Surface Water Quality Guidelines for Use in Alberta (AENV 1999).
[d] - indicates guideline level for Cr(VI); guideline level for Cr(III) = 0.0089 mg/L.
[A] - indicates guideline for Aquatic Life exposure pathway.
[P] - indicates guideline for Potable Groundwater exposure pathway.
H - dependent on hardness value.
[AO] - aesthetic objective from Guidelines for Canadian Drinking Water Quality (Health Canada 2008).
[MAC] - maximum acceptable concentration based on health effects from Guidelines for Canadian Drinking Water Quality (Health Canada 2008).
* - Alberta Tier 1 Soil and Groundwater Remediation Guidelines (AENV 2009).
** - Alberta Environment Surface Water Quality Guidelines for Use in Alberta (AENV 1999).
^ - Canadian Water Quality Guidelines for the Protection of Aquatic Life (CCME 2007).
Bold indicates values do not meet applicable guidelines.

Table 23-7 Groundwater Quality Results - Dissolved Hydrocarbons and Naphthenic Acid

Sample Point	Sample Date	MSI Sample Number	Benzene [mg/L]	Toluene [mg/L]	Ethylbenzene [mg/L]	Xylenes [mg/L]	Total BTEX [mg/L]	F1†† C –C [mg/L]	>10 16 [mg/L]	Naphthenic Acid [mg/L]
PRM09-C101-PZ1	18-Mar-09	08280090318200	<0.0005	<0.0005	<0.0005	<0.0005	ND	<0.1	**1.4**	<1
PRM09-C023-PZ1	18-Mar-09	08280090318201	<0.0005	<0.0005	<0.0005	<0.0005	ND	<0.1	<0.05	5
PRM09-W025-PZ1	18-Mar-09	08280090318202	<0.0005	<0.0005	<0.0005	<0.0005	ND	<0.1	<0.05	<1
PRM09-W026-PZ1	18-Mar-09	08280090318203	<0.0005	<0.0005	<0.0005	<0.0005	ND	<0.1	**1.2**	<1
PRM09-W026-PZ2	18-Mar-09	08280090318204	<0.0005	<0.0005	<0.0005	<0.0005	ND	<0.1	<0.05	<1
PRM09-W193-PZ1	18-Mar-09	08280090318205	<0.0005	<0.0005	<0.0005	<0.0005	ND	<0.1	**2.8**	<1
PRM09-W193-PZ2	18-Mar-09	08280090318206	<0.0005	<0.0005	<0.0005	<0.0005	ND	<0.1	<0.05	<1
PRM09-W193-PZ3	18-Mar-09	08280090318207	<0.0005	0.00158	<0.0005	<0.0005	0.0016	<0.1	<0.05	<1
PRM09-W027-PZ2	18-Mar-09	08280090318208	<0.0005	<0.0005	<0.0005	<0.0005	ND	<0.1	<0.05	<1
PRM09-W065-PZ1	18-Mar-09	08280090318209	<0.0005	<0.0005	<0.0005	<0.0005	ND	<0.1	**1.8**	<1
PRM09-W065-PZ1 dup	18-Mar-09	08280090318211	<0.0005	<0.0005	<0.0005	<0.0005	ND	<0.1	**1.8**	<1
PRM09-W065-PZ2	18-Mar-09	08280090318210	<0.0005	<0.0005	<0.0005	<0.0005	ND	<0.1	<0.05	<1
PRM09-W065-PZ3	19-Mar-09	08280090319215	<0.0005	<0.0005	<0.0005	<0.0005	ND	<0.1	<0.05	2
PRM09-W065-PZ3 dup	19-Mar-09	08280090319217	<0.0005	<0.0005	<0.0005	<0.0005	ND	<0.1	<0.05	2
PRM09-W065-PZ4	19-Mar-09	08280090319216	<0.0005	0.00106	<0.0005	<0.0005	0.0011	<0.1	<0.05	<1
PRM09-W102-PZ1	19-Mar-09	08280090319212	<0.0005	<0.0005	<0.0005	<0.0005	ND	<0.1	1.1	<1
PRM09-C006-PZ1	19-Mar-09	08280090319213	<0.0005	<0.0005	<0.0005	<0.0005	ND	<0.1	<0.05	<1
PRM09-C006-PZ2	19-Mar-09	08280090319214	**0.0255**	0.0147	0.00123	0.00452	0.0460	<0.1	**3.6**	3
PRM09-C064-PZ1	19-Mar-09	08280090319219	<0.0005	<0.0005	<0.0005	<0.0005	ND	<0.1	<0.2	<1
PRM09-C064-PZ2	19-Mar-09	08280090319220	<0.0005	<0.0005	<0.0005	<0.0005	ND	<0.1	0.54	7
Minimal Detection Limit			0.0005	0.0005	0.0005	0.0005	-	0.1	0.05	1
Alberta Tier 1 - Coarse Grained Soils - Natural Areas*			0.005 P(MAC)	0.024 P(AO)	0.0024 P(AO)	0.3 P(AO)	NS	2.2 P	1.1 P	NS

Notes: NS - guideline not specified.

AO - aesthetic objective from Guidelines for Canadian Drinking Water Quality (Health Canada 2008).

MAC - maximum acceptable concentration based on health effects from Guidelines for Canadian Drinking Water Quality (Health Canada 2008).

P - indicates guideline for Potable Groundwater exposure pathway.

* - Alberta Tier 1 Soil and Groundwater Remediation Guidelines (AENV 2009).

†† - F1 excludes BTEX.

Bold indicates values do not meet applicable guidelines.

Table 23-8 Groundwater Quality Results - Polycyclic Aromatic Hydrocarbons

Sample Point	Sample Date	MSI Sample Number	Acenaphthene [mg/L]	Acenaphthylene [mg/L]	Acridine [mg/L]	Anthracene [mg/L]	Benz[a]anthracene [mg/L]	Benzo[b+j]fluoranthene [mg/L]	Benzo[k]fluoranthene [mg/L]	Benzo[a]pyrene [mg/L]	Benzo[g,h,i]perylene [mg/L]	Biphenyl [mg/L]	Chrysene [mg/L]	Dibenz[a,h]anthracene [mg/L]
PRM09-C101-PZ1	18-Mar-09	08280090318200	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.00015	<0.0001	<0.0001	<0.0001	<0.0001	0.00048	<0.0001
PRM09-C023-PZ1	18-Mar-09	08280090318201	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.000015	<0.00001
PRM09-W025-PZ1	18-Mar-09	08280090318202	0.000017	0.000016	<0.00001	**0.000015**	0.00001	0.00004	0.000011	**0.000017**	0.000024	<0.00001	0.000072	<0.00001
PRM09-W026-PZ1	18-Mar-09	08280090318203	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.00052	<0.0002
PRM09-W026-PZ2	18-Mar-09	08280090318204	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
PRM09-W193-PZ1	18-Mar-09	08280090318205	<0.00008	<0.00008	0.000218	**0.000208**	**0.000109**	**0.000544**	<0.00008	**0.000286**	**0.00135**	0.000114	0.000501	<0.00008
PRM09-W193-PZ2	18-Mar-09	08280090318206	<0.00001	0.000013	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
PRM09-W193-PZ3	18-Mar-09	08280090318207	<0.00001	<0.00001	0.000046	<0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	0.000013	0.000026	<0.00001
PRM09-W027-PZ2	18-Mar-09	08280090318208	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
PRM09-W065-PZ1	18-Mar-09	08280090318209	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.000019	<0.00001	<0.00001	0.000071	<0.00001	0.000051	<0.00001
PRM09-W065-PZ1 dup	18-Mar-09	08280090318211	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.000014	0.000025	<0.00001	0.000043	<0.00001	0.000045	<0.00001
PRM09-W065-PZ2	18-Mar-09	08280090318210	<0.00001	0.000031	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001	<0.00001
PRM09-W065-PZ3	19-Mar-09	08280090319215	<0.00001	<0.00001	<0.00001	**0.000026**	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.000032	<0.00001	<0.00001
PRM09-W065-PZ3 dup	19-Mar-09	08280090319217	<0.00001	<0.00001	0.000017	**0.000044**	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.000016	<0.00001	<0.00001
PRM09-W065-PZ4	19-Mar-09	08280090319216	0.000018	<0.00001	0.000035	**0.000056**	<0.00001	0.000018	0.000014	<0.00001	<0.00001	<0.00001	0.000041	<0.00001
PRM09-W102-PZ1	19-Mar-09	08280090319212	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	0.000017	0.000019	0.00001	0.000015	<0.00001	0.000065	<0.00001
PRM09-C006-PZ1	19-Mar-09	08280090319213	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
PRM09-C006-PZ2	19-Mar-09	08280090319214	0.00064	0.00023	0.00043	**0.00059**	**0.00044**	**0.00087**	0.00029	**0.00051**	**0.00046**	<0.0002	**0.00359**	<0.0002
PRM09-C064-PZ1	19-Mar-09	08280090319219	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
PRM09-C064-PZ2	19-Mar-09	08280090319220	0.00027	<0.0001	<0.0001	**0.00011**	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.000547	<0.0001
Minimal Detection Limit			0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
Parameter Maximum			0.00064	0.00023	0.00043	0.00059	0.00044	0.00087	0.00029	0.00051	0.00135	0.000114	0.00359	ND
Parameter Minimum			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
AB Tier 1 - Coarse Grained Soils - Natural Areas*			0.0058[A]	0.046[A]	NS	0.000012[A]	0.000018[A]	0.00048[A]	0.00048[A]	0.000015[A]	0.00017[A]	NS	0.0014[A]	0.00026[A]

Table 23-8 Groundwater Quality Results - Polycyclic Aromatic Hydrocarbons (continued)

Sample Point	Sample Date	MSI Sample Number	Dibenzothiophene [mg/L]	Fluoranthene [mg/L]	Fluorene [mg/L]	Indeno[1,2,3-c,d]pyrene [mg/L]	1-Methylnaphthalene [mg/L]	2-Methylnaphthalene [mg/L]	Naphthalene [mg/L]	Phenanthrene [mg/L]	Pyrene [mg/L]	Quinoline [mg/L]	Retene [mg/L]	Benzo[a]pyrene TPE** [mg/L]
PRM09-C101-PZ1	18-Mar-09	08280090318200	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	**0.000020**
PRM09-C023-PZ1	18-Mar-09	08280090318201	<0.00001	0.000012	<0.00001	<0.00001	<0.00001	0.000014	0.00002	0.00002	**0.000028**	<0.00001	0.000014	0.000001
PRM09-W025-PZ1	18-Mar-09	08280090318202	0.00001	0.000029	0.000013	0.000012	0.000011	0.000015	0.00004	0.00005	**0.000055**	<0.00001	0.000051	**0.000025**
PRM09-W026-PZ1	18-Mar-09	08280090318203	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.00027	0.000005
PRM09-W026-PZ2	18-Mar-09	08280090318204	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00003	0.00002	0.000011	<0.00001	<0.00001	ND
PRM09-W193-PZ1	18-Mar-09	08280090318205	<0.00008	<0.00008	<0.00008	**0.000405**	0.000114	<0.00008	0.00011	0.00014	**0.000129**	<0.00008	0.000615	**0.000410**
PRM09-W193-PZ2	18-Mar-09	08280090318206	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00004	0.00001	0.000018	<0.00001	<0.00001	ND
PRM09-W193-PZ3	18-Mar-09	08280090318207	0.000018	**0.000075**	0.00002	<0.00001	0.000014	0.000018	0.00010	0.00014	**0.000218**	<0.00001	0.00002	0.000001
PRM09-W027-PZ2	18-Mar-09	08280090318208	<0.00001	0.000013	<0.00001	<0.00001	0.000051	0.000071	0.00021	0.00002	0.000014	0.000037	<0.00001	ND
PRM09-W065-PZ1	18-Mar-09	08280090318209	<0.00001	<0.00001	<0.00001	<0.00001	0.000013	0.000017	0.00005	0.00001	**0.000029**	<0.00001	0.00002	0.000003
PRM09-W065-PZ1 dup	18-Mar-09	08280090318211	<0.00001	0.000011	<0.00001	<0.00001	0.000011	0.000015	0.00005	0.00001	0.000025	<0.00001	0.000016	0.000005
PRM09-W065-PZ2	18-Mar-09	08280090318210	<0.00001	<0.00001	0.000013	<0.00001	0.000069	0.000094	0.00029	0.00002	0.000011	0.000015	<0.00001	ND
PRM09-W065-PZ3	19-Mar-09	08280090319215	<0.00001	0.000022	<0.00001	<0.00001	<0.00001	<0.00001	0.00003	0.00002	**0.000063**	0.00002	<0.00001	ND
PRM09-W065-PZ3 dup	19-Mar-09	08280090319217	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00003	0.00002	**0.000044**	0.00002	0.000013	ND
PRM09-W065-PZ4	19-Mar-09	08280090319216	0.000016	**0.000138**	0.000014	<0.00001	<0.00001	<0.00001	<0.00001	0.00006	**0.000373**	0.000027	0.000075	0.000004
PRM09-W102-PZ1	19-Mar-09	08280090319212	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00002	0.00001	0.000019	0.000014	0.000045	**0.000015**
PRM09-C006-PZ1	19-Mar-09	08280090319213	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00002	0.00001	<0.00001	0.00001	<0.00001	ND
PRM09-C006-PZ2	19-Mar-09	08280090319214	<0.0002	**0.00052**	<0.0002	<0.0002	0.00034	0.00026	0.00059	**0.00069**	**0.00144**	<0.0002	0.00433	**0.000711**
PRM09-C064-PZ1	19-Mar-09	08280090319219	<0.00001	0.00001	<0.00001	<0.00001	0.00001	0.00002	0.00003	0.00002	0.00001	<0.00001	<0.00001	ND
PRM09-C064-PZ2	19-Mar-09	08280090319220	<0.0001	<0.0001	0.00012	<0.0001	<0.0001	<0.0001	<0.0001	0.00020	**0.00023**	<0.0001	0.00079	0.000005
Minimal Detection Limit			0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
Parameter Maximum			0.00002	0.00052	0.00012	0.000405	0.00034	0.00026	0.00059	0.00069	0.00144	0.000037	0.00433	0.000711
Parameter Minimum			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
AB Tier 1 - Coarse Grained Soils - Natural Areas*			NS	0.00004[A]	0.003[A]	0.00021[A]	NS	NS	0.0011[A]	0.0004[A]	0.000025[A]	NS	NS	0.00001[P]

Notes: NS - guideline not specified.
ND - not detected.
A - indicates guideline for Aquatic Life exposure pathway.
P - indicates guideline for Potable Groundwater exposure pathway.
* - Alberta Tier 1 Soil and Groundwater Remediation Guidelines (AENV 2009)
** - Equivalent Benzo[a]pyrene concentrations based on relative carcinogenic potency.
Bold indicates values do not meet applicable guidelines.

Table 23-9 Groundwater Quality Results - Alkylated Polycyclic Aromatic Hydrocarbons

Sample Point	Date	MSI Sample Number	C1 Acenaphthenes [mg/L]	C1 Benz(a)Anthracenes/Chrysenes [mg/L]	C1 Benzofluoranthenes/Benzopyrenes [mg/L]	C1 Biphenyls [mg/L]	C1 Dibenzothiophenes-1 [mg/L]	C1 Fluoranthenes/Pyrenes [mg/L]	C1 Fluorenes [mg/L]	C1 Phenanthrenes/Anthracene [mg/L]	C2 Benz(a)Anthracenes/Chrysenes [mg/L]	C2 Benzofluoranthenes/Benzopyrenes [mg/L]	C2 Biphenyls [mg/L]	C2 Dibenzothiophenes [mg/L]
PRM09-C101-PZ1	18-Mar-09	08280090318200	<0.4	1.72	0.9	<0.4	<0.4	0.63	<0.4	<0.4	2.65	0.7	<0.4	<0.4
PRM09-C023-PZ1	18-Mar-09	08280090318201	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.05	<0.04	<0.04	<0.04	0.044
PRM09-W025-PZ1	18-Mar-09	08280090318202	0.047	0.196	0.177	<0.04	0.073	0.135	0.044	0.109	0.282	0.057	<0.04	0.239
PRM09-W026-PZ1	18-Mar-09	08280090318203	<0.8	1.46	1.06	<0.8	<0.8	1.08	<0.8	0.97	2.58	1.08	<0.8	1.66
PRM09-W026-PZ2	18-Mar-09	08280090318204	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.131	<0.04	<0.04	<0.04	<0.04
PRM09-W193-PZ1	18-Mar-09	08280090318205	<0.32	1.62	3.90	<0.32	0.92	1.00	<0.32	1.68	2.56	2.48	<0.32	3.14
PRM09-W193-PZ2	18-Mar-09	08280090318206	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.066	<0.04	<0.04	<0.04	<0.04
PRM09-W193-PZ3	18-Mar-09	08280090318207	0.078	<0.04	<0.04	<0.04	0.101	<0.04	0.06	0.176	<0.04	<0.04	<0.04	0.224
PRM09-W027-PZ2	18-Mar-09	08280090318208	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
PRM09-W065-PZ1	18-Mar-09	08280090318209	<0.04	0.086	0.156	<0.04	<0.04	0.05	<0.04	0.056	0.126	0.101	<0.04	0.042
PRM09-W065-PZ1 dup	18-Mar-09	08280090318211	<0.04	0.065	<0.04	<0.04	<0.04	0.05	<0.04	0.062	0.102	<0.04	<0.04	0.053
PRM09-W065-PZ2	18-Mar-09	08280090318210	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
PRM09-W065-PZ3	19-Mar-09	08280090319215	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.05	<0.04	<0.04	<0.04	0.047
PRM09-W065-PZ3 dup	19-Mar-09	08280090319217	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.069	<0.04
PRM09-W065-PZ4	19-Mar-09	08280090319216	0.079	0.793	<0.04	<0.04	0.109	0.085	<0.04	0.261	0.084	<0.04	<0.04	0.33
PRM09-W102-PZ1	19-Mar-09	08280090319212	<0.04	0.181	<0.04	<0.04	<0.04	0.12	<0.04	0.071	0.244	0.04	<0.04	0.086
PRM09-C006-PZ1	19-Mar-09	08280090319213	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
PRM09-C006-PZ2	19-Mar-09	08280090319214	0.83	11.9	3.63	<0.8	5.29	7.00	2.61	5.11	19.2	1.86	1.56	23.7
PRM09-C064-PZ1	19-Mar-09	08280090319219	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
PRM09-C064-PZ2	19-Mar-09	08280090319220	<0.4	1.33	<0.4	<0.4	1.22	0.90	1.09	1.21	2.19	<0.4	0.55	5.55
Minimal Detection Limit			0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
AB Tier 1 - Coarse Grained Soils - Natural Areas*			NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 23-9 Groundwater Quality Results - Alkylated Polycyclic Aromatic Hydrocarbons (continued)

Sample Point	Date	MSI Sample Number	C2 Fluoranthenes/Pyrenes [mg/L]	C2 Fluorenes [mg/L]	C2 Naphthalenes [mg/L]	C2 Phenanthrenes/Anthracenes [mg/L]	C3 Dibenzothiophenes [mg/L]	C3 Fluoranthenes/Pyrenes [mg/L]	C3 Fluorenes [mg/L]	C3 Naphthalenes [mg/L]	C3 Phenanthrenes/Anthracenes [mg/L]	C4 Dibenzothiophenes [mg/L]	C4 Naphthalenes [mg/L]	C4 Phenanthrenes/Anthracenes [mg/L]
PRM09-C101-PZ1	18-Mar-09	08280090318200	1.86	<0.4	<0.4	<0.4	1.01	3.19	<0.4	<0.4	0.71	3.56	<0.4	4.73
PRM09-C023-PZ1	18-Mar-09	08280090318201	<0.04	<0.04	0.041	0.042	0.061	<0.04	<0.04	0.056	<0.04	<0.04	0.102	<0.04
PRM09-W025-PZ1	18-Mar-09	08280090318202	0.205	0.174	0.076	0.236	0.361	0.222	0.238	0.122	0.257	0.547	0.295	0.873
PRM09-W026-PZ1	18-Mar-09	08280090318203	1.69	0.85	<0.8	1.47	3.05	2.77	1.14	<0.8	2.60	6.34	0.99	5.59
PRM09-W026-PZ2	18-Mar-09	08280090318204	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
PRM09-W193-PZ1	18-Mar-09	08280090318205	1.89	1.27	0.47	2.03	5.08	1.99	1.49	0.78	4.59	5.65	2.12	6.68
PRM09-W193-PZ2	18-Mar-09	08280090318206	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.085	<0.04
PRM09-W193-PZ3	18-Mar-09	08280090318207	0.053	0.193	0.069	0.194	0.222	<0.04	0.224	0.234	0.196	0.272	0.316	0.387
PRM09-W027-PZ2	18-Mar-09	08280090318208	<0.04	<0.04	0.054	<0.04	<0.04	<0.04	<0.04	0.076	<0.04	<0.04	<0.04	<0.04
PRM09-W065-PZ1	18-Mar-09	08280090318209	0.084	<0.04	<0.04	0.075	0.148	0.081	<0.04	0.052	0.163	0.245	<0.04	0.286
PRM09-W065-PZ1 dup	18-Mar-09	08280090318211	0.048	<0.04	<0.04	0.064	0.096	0.059	<0.04	<0.04	0.11	0.215	<0.04	0.295
PRM09-W065-PZ2	18-Mar-09	08280090318210	<0.04	<0.04	0.081	<0.04	<0.04	<0.04	<0.04	0.083	<0.04	<0.04	0.157	<0.04
PRM09-W065-PZ3	19-Mar-09	08280090319215	<0.04	<0.04	0.063	0.045	<0.04	<0.04	<0.04	<0.04	0.061	<0.04	0.073	0.105
PRM09-W065-PZ3 dup	19-Mar-09	08280090319217	<0.04	<0.04	0.066	0.07	<0.04	<0.04	<0.04	0.064	<0.04	<0.04	0.051	<0.04
PRM09-W065-PZ4	19-Mar-09	08280090319216	0.106	0.104	0.082	0.431	0.447	0.097	0.247	0.403	0.413	0.309	0.437	0.82
PRM09-W102-PZ1	19-Mar-09	08280090319212	0.219	<0.04	<0.04	0.084	0.375	0.282	0.059	0.061	0.257	0.67	0.084	2.02
PRM09-C006-PZ1	19-Mar-09	08280090319213	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.063	<0.04	<0.04	<0.04	<0.04
PRM09-C006-PZ2	19-Mar-09	08280090319214	11.4	10.2	1.95	17.4	44.5	14.6	17.8	4.45	40.8	40.2	14.2	97.3
PRM09-C064-PZ1	19-Mar-09	08280090319219	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.05	<0.04	<0.04	<0.04	<0.04
PRM09-C064-PZ2	19-Mar-09	08280090319220	1.64	2.39	<0.4	3.63	8.65	2.08	4.14	1.01	6.04	7.55	3.18	15.4
Minimal Detection Limit			0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
AB Tier 1 - Coarse Grained Soils - Natural Areas*			NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Notes: NS - not specified.

* - Alberta Tier 1 Soil and Groundwater Remediation Guidelines (AENV 2009).

c) As discussed in JRP SIR 23(a), the results of the groundwater model discussed in the EIA, Volume 4A, Section 6.3.6.2 are based on the McMurray Formation isopachs that accounted for the thin or absent low-permeability oil sands. These results indicated that a plume of process-affected water will eventually reach the Basal Aquifer, but it will be contained by the proposed mitigation measures (system of recovery wells).

d) The ETDA seepage mitigation wells are designed to be installed to the base of Quaternary deposits, because the Quaternary deposits directly underlie the ETDA, and any seepage from the ETDA will first go into the Quaternary deposits. The Basal Aquifer is generally separated from the Quaternary deposits by an aquitard, the low-permeability oil sand deposits, and seepage from the ETDA will take time to reach the Basal Aquifer, even in areas of thin oil sand deposits, because of the corresponding thicker Quaternary deposits in these areas.

Groundwater modelling (EIA, Volume 4, Figures 6.3-101 and 6.3-102) of the proposed mitigation measures (system of recovery wells) indicated that installing the wells to the base of the Quaternary deposits would contain the plume of process-affected water that may enter the Basal Aquifer. In the detailed design phase, the number, spacing, depth and completion details of the recovery wells will be defined and, if required, the recovery wells could be extended to the base of the Basal Aquifer.

References:

AENV. 1999. *Surface water quality guidelines for use in Alberta Edmonton*, AB, Science and Standards Branch.

AENV. 2009. *Alberta Tier 1 Soil and Groundwater Remediation Guidelines.* Edmonton, AB.

CCME. 2007. *Canadian Water Quality Guidelines for the Protection of Aquatic Life.* Winnipeg, MB, Updated December 2007.

Health Canada. 2008. *Guidelines for Canadian drinking water quality - Summary technical documents.* Water Quality and Science Bureau.

Wynne, D.A., M. Attalla, T. Berezniuk, M. Brulotte, D. Cotterill, R. Strobl and D. Wightman. 2006. *Athabasca Oil Sands Data McMurray/Wabiskaw Oil Sands Deposit – Electronic Data*. Special Report 006. Alberta Geological Survey. June 19, 2006. Edmonton, AB.

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Project Description Volume 2: Section 3.2, Figure 3-5, Page 3-14. Shell displays a Basal Aquifer isopach map showing that the Basal Aquifer unit is not present under most of the proposed mine pit footprint. EIA Volume 4A: Aquatic Resources, Section 6.3.6.2. Shell discusses predicted and modeled changes to the groundwater levels and flow directions Basal Aquifer which are displayed in Fig. 6.3-72, pg. 6-187 (and others). These figures appear to show substantial drawdown in the Basal Aquifer where the unit is not present.

a) Discuss the impacts of the overall predictions of water level drawdown considering that drawdown will not occur where the Basal Aquifer unit is not present and discuss how this would affect:

i. Vertical seepage potential from the ETDA

ii. Distribution of impacts to the basal aquifer from ETDA seepage

iii. Distribution of impacts to the basal aquifer from mine pit backfill seepage

b) The mine process includes the use of water from Basal Aquifer depressurization. Explain how the absence of the Basal Aquifer unit under the majority of the proposed mine pit footprint will affect the predicted depressurization water volumes. How does this affect the water balance?

Response:

a) Although the Basal Aquifer is not present under most of the proposed mine footprint, the numerical model (MODFLOW) used to simulate Basal Aquifer depressurization requires that each model layer be continuous across the entire model domain. This is a technical requirement of the numerical code for three-dimensional model representation. Therefore, a small layer thickness was required within the model even where the Basal Aquifer was mapped as absent (EIA, Volume 4, Appendix 4-1, Section 1.2.2.2).

In areas of the model domain where the Basal Aquifer was mapped as absent, Layer 9 of the numerical model (the Basal Aquifer layer) was assigned a nominal thickness of 1 m and the hydraulic properties of the overlying oil sands layer (EIA, Volume 4, Appendix 4-1, Section 1.2.2.3, Figure 13; Table 1). Consistent with the modelling approach to assess depressurization effects, drain boundary conditions were assigned to the top of the Basal Aquifer layer within the mine pit limits.

Drawdown will occur primarily within the Basal Aquifer unit, but some drawdown will propagate into the lower permeability oil sands.

The drawdowns shown in EIA, Volume 4A, Section 6.3, Figure 6.3-72, where the Basal Aquifer is not present, represent the change in the hydraulic head that would be observed at the bottom of the oil sand deposits due to mining. That is, the change from high hydraulic head prior to mining to near atmospheric pressure when active mining is complete. Although the drawdowns are technically correct, they are not attributable to the Basal Aquifer.

i. The Basal Aquifer is present only in the northeast portion of the PRM mine pit (EIA, Volume 2, Section 3.0, Figure 3-5; EIA, Volume 4, Appendix 4-1, Section 1.2.2.1, Figure 5). Modelling indicated that depressurization of the Basal Aquifer in the northeast portion of the mine pit area would not extend to the ETDA, which is located about 4.9 km to the north of the mine pit area. Therefore, depressurization of the Basal Aquifer in the mine pit area is not expected to cause drawdown in the Basal Aquifer beneath the ETDA and would affect neither the vertical gradient nor the rate of vertical seepage from the ETDA.

ii. Depressurization of the Basal Aquifer in the northeast portion of the mine pit area will not affect the distribution of impacts to the Basal Aquifer from ETDA seepage. For predicted effects of ETDA seepage to the Basal Aquifer refer to EIA, Volume 4A, Section 6.3.2.3, Figures 6.3-101 and 6.3-102.

iii. The presence and absence of the Basal Aquifer was properly represented in the groundwater model through Model Layer 9 – Basal Aquifer Layer (EIA Volume 4A, Appendix 4.1, Section 1.2.2.1, Figure 5; and Figure 13). Predicted impacts from the mine pit backfill seepage to the Basal Aquifer are presented in Figures 6.3-101, 6.3-104 and 6.3-105 (EIA Volume 4A, Section 6.3).

b) As discussed above, the absence or presence of the Basal Aquifer within the mine pit area was considered in the groundwater model. Therefore, even though drawdown is shown where the Basal Aquifer is absent, the associated seepages are very small due to the presence of low permeability oil sands material represented in the nominal 1 m thick interval. The impact of these small seepages on the mine water balance is negligible. The water balance for Pierre River Mine is presented in EIA Volume 2, Section 10, Table 10-2 including the inflows from the Basal Aquifer (due to depressurization). The Basal Aquifer inflows represent 0.3% to 1.9% of the total inflows.

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EIA Volume 5: Terrestrial Resources and Human Environment, Section 8.4.6.2, Page 8-94. Shell discusses the Eymundson Sinkholes and up to 60 other sinkholes in a 15 km2 around the Eymundson Sinkholes, indicating that karst processes have or are occurring in the proposed project area.

a) Discuss the potential implications of the presence of units affected by karst processes below the proposed mine footprint and associated facilities including the ETDA.

b) Discuss the potential for small and large volume water inflows to the mine pit from underlying units, including the Devonian, as a result of karst or other geological processes/features.

c) Discuss how Shell plans to prevent water inflows from underlying units, including the Devonian?

d) Discuss how Shell plans to manage inflow water should it occur.

Response:

a) Karst may be broadly described as the presence of voids in carbonate rocks due to rock dissolution. Karst features include sinkholes, sinking streams, closed depressions, subterranean drainage, and caves, among others. Karst is a common feature where carbonate rocks are present and exposed to infiltrating rain water.

The surface expression of sinkholes in the PRM area, as identified through air-photo interpretation, suggests that karst processes were at least active in the geological past, primarily when the Devonian limestone was at surface. Karst processes from that era are referred to as paleokarst. Since then, there have been multiple erosive events and deposition periods leading to infilling of various materials. Previous karst systems, where they existed, would not be active anymore and surface features potentially associated with paleokarst would not be indicative of present hydrogeological conditions. Nevertheless, it is recognized that karst processes that were at play in the geological past may also have been in play in recent geological times, particularly where significant erosion of overlying deposits occurred,

If karst, or remnants of paleokarst, existed in the geological units beneath the mine footprint area or beneath the ETDA area, the primary concerns would be (1) the presence of large voids and the potential collapse of such voids; and (2) the potential existence of an underground network of conduits.

If undetected, unexpected collapse of underground voids could lead to potential loss of equipment, safety risks and subsequent delays and increased costs to mining activities.

If undetected, unexpected exposure to an underground network of conduits could lead to potential inflows of water to the mine, or to enhanced migration pathways for mine tailings backfill or ETDA seepage outflows.

The occurrence of these events is not in the best interest of the miners and Shell will implement pro-active measures to identify and mitigate potential karst occurrences as discussed further in the response (c).

b) Based on drilling conducted to date (197 total holes tagging Devonian of which 87 were drilled by Shell in 2006 and 2007), no evidence of karst features, fractures, or loss of circulation have been observed in core holes completed into the upper 15 m of the Devonian Waterways Formation within Shell Lease 9 and 17 areas. This result indicates that the Upper Waterways Formation is likely of low permeability and that it could be considered an aquitard, with near zero flows.

In 2011, Shell conducted a geophysical airborne survey (frequency and time domain electromagnetics) over Lease 9, as a proactive measure to map the occurrence of potential saline anomalies related to karsts/sinkholes. Several features that could indicate sinkholes have been identified and mapped.

Shell recognizes that karst, fractures and fault occurrences are unpredictable but with the data mentioned above Shell has enough data to apply the geohazard protocol described in response (c).

c) Based on Shell's experience with Cell 2A ingress event at Muskeg River Mine, and prior to the start of the PRM, Shell will implement a geohazard protocol to identify and characterize potential hydraulic pathways in the Devonian rock layers beneath the bitumen-bearing McMurray Formation. This protocol builds on Shell's existing geological knowledge of the Devonian units beneath its leases and specifically helps to inform mine and tailings planning departments to:

- avoid exchanges of Devonian aquifer waters with other aquifers via pathways to and from Devonian saline aquifers;
- identify areas affected by the Devonian that may have potential to contribute to mine wall or floor instability; and
- identify areas affected by the Devonian that may have potential to contribute to fracture instabilities related to in-pit dyke structures.

The geohazard protocol is based on a pro-active geological, geophysical, geotechnical and hydrogeological investigation using a combination of investigative assessment methods. These assessment methods include: the review of existing data, airborne geophysics, drilling, seismic and other techniques to acquire the following: stratigraphy, structure(s), history of disturbance (structural and karst-induced), hydrostratigraphy, hydrochemistry data, and geomechanical characteristics, all of which may affect the Devonian.

The features that could lead to an upward vertical flow from the Devonian units into the mine may include any one or combination of possible vertical pathways through the cap rock, including sinkholes, collapse chimneys, fractures or faults (of tectonic or solution origin). The focus of the program would be to identify and characterize potential vertical pathways in parallel with developing an improved understanding of their origin and distribution.

A site-specific risk assessment will be carried out at the PRM through the application of geohazard protocols to identify high, medium and low risk areas. The risk management process will focus on four areas:

- absolute elevation of pit floor (a lower elevation limit has been imposed on mine pit depths);
- changes in elevation of the Devonian surface, determined as gradient;
- thickness of cover between the Devonian surface and lowest mine surface; and
- any anomalies observed while mining in the area.

A combination of these factors contributes to the overall mine plan that is to be selected for a particular area. Other oil sands companies have also agreed to share data on regional aquifer flows and the geology of rock structures underlying oil sands deposits. Coordination now exists amongst operating companies to expand and develop the knowledge of regional subsurface conditions of the Devonian succession which includes its aquifers.

Shell’s protocols manage risk by identifying the elevation below which no mining is allowed without detailed study and approval from the Chief Geologist and Chief Tailings Geotechnical Engineer. This elevation will be selected considering the hydraulic head in pertinent Devonian saline aquifers and the subcrop elevation of the Devonian limestone.

Above this elevation, areas of elevated risk can be properly addressed through the protocol utilizing geohazard maps for the mine. Currently, the protocol followed when medium risk areas are mined include sampling of any observed water flows, observation of anomalies by pit-geologists and increased awareness of the risk area by shovel operators. Identified areas of high risk are not immediately mined, but rather the base of feed is adjusted to leave sufficient material in place to ensure a buffer remains on top of any potential vertical pathway. A risk assessment is then conducted on this area to determine whether mining at a later date is possible.

d) Several engineering techniques are available to mitigate karst issues (Milanović 2004). For example, if water is not an issue, existing voids could be infilled, conduits plugged, and crack grouted. Where water is present, there is a need to control the flux of water. In low flow situations, injection of cement grout may be adequate; in moderate flow situations pre-injection of acrylamide/polyurethane foam may be required to control the groundwater flow such that injection of cement grout can be accomplished; in high flow situations, hot bitumen can be used as a quenching agent to block flow.

For very small releases, such as seeps, the water will be sampled and directly analyzed to understand its origin. If there is a possibility that it originated from the deeper saline aquifers, mining will immediately cease, a cap will be placed over the inflow location, and a more detailed investigation will be initiated.

For larger volume releases, mining will immediately be redirected to other areas and water samples will be taken. Depending on the size and volume of the release, the water will either be contained by placing material on top of the ingress or by building dykes. Following containment of a release, a field investigation will be initiated and an execution plan will be developed to seal uncontrolled flows, based on the methodology developed for Cell 2A at Muskeg River Mine.

References:

Milanović, P.T. 2004. *Water Resources Engineering in Karst*. CRC Press. 328 p.

SIR 26

Submission on the Adequacy of the Environmental Impact Statement for Shell's Pierre River Mine Project- ACFN Industry Relation Corporation September 14, 2012, Section IX, Pages 32 to 35. ACFN state concern about cumulative impacts of proposed water withdrawals on river flow during ice-free, low-flow periods with perceived impacts resulting in reductions in drinking water quality and site access, overall water quality and access to traditional sites. They also state their concern that Shell had not incorporated the latest climate information from AENV and Fisheries and Oceans Canada (DFO) and from the Athabasca River WMF Phase 2 committee. Fort McKay First Nation (FMFN) specifically requested in Shell Proposed Jack Mine Expansion and Pierre River Mine Projects Environmental Impact Assessment and Application Review prepared for Fort McKay Industry Relations Corporation, February 2010, Section 5.1, Page 72, that the latest version of the WMF be made available for comment.

a) Provide an updated status of the Phase 2 Athabasca River WMF as it pertains to proposed PRM specific water use allocations.

b) Reassess the effect of changes in water level in the Athabasca River and availability of water caused by climate change for PRM using the most up-to-date data to identify potential trends.

c) Specify contingency options if Shell or another operator has mined out or dewatered an area on which the other party is relying.

Response:

a) The Committee for the Water Management Framework for the Lower Athabasca River, of which Shell actively participated in developing, provided recommendations to the Canadian and Alberta governments in January 2010. The Committee's recommendations have not yet been adopted by government, and water withdrawal management at Shell's current operations has been accomplished using Phase I recommendations.

   Notwithstanding, it is recognized that withdrawals below an Ecological Base Flow are not ideal in the long term, and Shell has undertaken measures to reduce reliance on water from the Athabasca River including greater use of recovery water and groundwater to continue to reduce reliance on freshwater. Shell will continue to commit to operating under the current framework and any future frameworks that define limits to water withdrawals on the Athabasca River.

b) The potential effects of climate change on the Athabasca River flows and water levels were assessed in the EIA (Volume 3, Appendix 3-4). The assessment was based on trend analysis of past records, and scenarios developed using forecasted changes by Global Climate Models (GCMs) from the Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report (TAR) (IPCC 2001).

   The potential effects of climate change on the Athabasca River flows, water levels and water quality were re-assessed using outputs from climate change scenarios projected based on GCMs outputs from IPCC Fourth Assessment Report (AR4) (IPCC 2007) which is the most up-to-date data source available from the IPCC. Forecasts of future climate conditions were analyzed using a calibrated and re-validated hydrologic model, (i.e., the Hydrologic Simulation Program-Fortran [HSPF] model) developed for the Athabasca River Basin and its tributaries. The results of the assessment of the effects of potential climate change scenarios on the Athabasca River flows and water levels and flows of tributaries to the Athabasca River located within the Local Study Area (LSA), as well as effects on water quality, are provided in Appendix 4.

   For the Athabasca River, under predicted future climate change scenarios, more frequent restrictions on water withdrawals would be imposed, consequently, the percentage reductions in seasonal flows due to water withdrawal are less compared to those without the effects of climate change. For Athabasca River tributaries within the LSA, flows will increase under future warmer and wetter conditions and median conditions, while flows tend to decrease for warmer and drier conditions. These results are comparable to results presented in Volume 3, Appendix 3-4, and hence the EIA conclusions would remain unchanged under the updated climate change analysis scenarios.

c) As part of the mining operations, Shell will monitor the aquifers underneath its mine lease in respect of aquifer response to dewatering (water levels as well as water quality changes). The hydrogeological monitoring would include analyzing for potential aquifer responses respecting dewatering activities at neighboring operations. This analysis would provide aquifer information (water volumes/levels and quality) which will be incorporated in mining and extraction plans. Additionally, hydrogeological data sharing agreements exist between Shell and neighboring operators; an example is the Basal McMurray Formation Aquifer data sharing under the framework of the Oil Sands Groundwater Association. Given the above prior measures for the purpose of contingency planning, Shell does not anticipate competing mining needs in respect of the use of groundwater resources. Based on hydrogeological monitoring data, an appropriate contingency option would be assessed if a competing groundwater need arises.

References:

IPCC (Intergovernmental Panel on Climate Change). 2001. *The Science Basis. Contribution of Working Group I to the third Assessment Report of the Intergovernmental Panel on Climate Change* [J.T. Houghton, Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, K. Maskell, C.A. Johnson (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 877 pp.

IPCC. 2007. *The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 996 pp.

SIR 27

Shell JPME Terrestrial Review – Implications of Lower Athabasca Regional Plan (LARP) - August 28 2012. Schedule B, Page 2. Schedule B provides specific thresholds for surface water quality as part of LARP's outcome #4 (Air and water are managed to support human and ecosystem needs).

a) Describe any implications related to implementation of the Lower Athabasca Surface Water Quality Framework thresholds on PRM water quality monitoring including potential required changes to Shell's proposed monitoring program.

b) Explain how these thresholds might affect Shell's current results and predictions of water quality impacts from the Project.

Response:

a) Water quality monitoring for the Lower Athabasca Regional Plan (LARP) will be completed by Alberta Environment and Sustainable Resource Development (ESRD) as part of the *Environmental Protection and Enhancement Act* (EPEA) permitting and will reflect the requirements of the Provincial and Federal authorities at the time. Shell will comply with these requirements.

b) The water quality limits prescribed by LARP were compared to water quality predictions in Appendix 2, Section 3. The predictions indicated that no limits would be exceeded under any assessment scenario, at any snapshot. The LARP limits are designed to be protective of all end uses in the river. Therefore, water quality in the Athabasca River is predicted to be maintained throughout the operational and closure period of the PRM.

SIR 28

Pierre River Mine Additional Information and Clarification for Federal Departments August 2010, Pages 82 to 89. Shell provides a PRM Navigability Assessment Technical Memorandum that identifies specific activities potentially affecting navigability which included water withdrawals, stream diversion and instream works.

a) Assess cumulative effects, using a Pre-industrial Case to Application and Pre-industrial to Planned Development Case (as of the issuance of the JRP's Terms of Reference) of Athabasca River navigation. Take into consideration influences such as: overall water withdrawals, climate trends, water diversion, natural river fluctuation fish habitat compensation measures (e.g., North and South Redclay Lakes) sand movement, and dredging. Ensure that this assessment includes specific predictive methodology used (e.g., annual flows, peak flows, 7Q10 low flow) to derive these conclusions.

Response:

a) Cumulative effects on navigability on the Athabasca River were assessed using a PIC to 2013 Base Case, PIC to 2013 PRM Application Case, and PIC to 2013 PDC. The assessment methods and results of the assessment are outlined below.

Recorded flows for Athabasca River below Fort McMurray, water withdrawal information obtained from ESRD and potential effect of climate change on flows obtained from general circulation models were used to assess the hydrological impact of the Pierre River Mine (PRM) on the Athabasca River (EIA, Volume 4A, Section 6.4.2). The flows and water levels generated for this assessment account for all of the influences mentioned including: overall water withdrawals, climate trends, water diversion, natural river fluctuations, fish habitat compensation measures, sand movement, and dredging. The fish habitat compensation measures proposed for the PRM are not located in the Athabasca River and therefore, will not directly interfere with navigation on the Athabasca River. The change in flow in the Athabasca River due to the development of habitat compensation for the PRM (i.e., South Redclay Lake) have been accounted for in the flow and water level assessment. A commercial navigation channel has not been maintained by dredging on the Athabasca River since the mid-1990s. Shell is unaware of plans for Athabasca River navigation channel dredging in the foreseeable future.

Cumulative Effects: Pre-Industrial Case to 2013 Base Case

The changes to water levels in the Athabasca River that are predicted for the winter, spring, summer, and fall seasons under the hydrologic conditions of average year, 10-year dry, and 10-year wet between the PIC and the 2013 Base Case are summarized in Table 28-1. The maximum change in water level from the PIC to the 2013 Base Case is a decrease of 4 cm. Under the PIC and 2013 Base Case conditions the change in water levels over the seasons in an average year is about 1.7 m (summer to winter season). Hence, a decrease of 4 cm is not expected to affect navigability of the Athabasca River.

Table 28-1 Athabasca River Flow Depths at Node S24 (located within Reach 4) for the Pre-Industrial Case and 2013 Base Case

Hydrologic Condition	Season	Pre-Industrial Case	2013 Base Case	Change from Pre-Industrial Case
		Water Level [m amsl]	Water Level [m amsl]	[m]
Average year	winter	225.94	225.90	-0.04
	spring	226.56	226.52	-0.04
	summer	227.64	227.61	-0.03
	fall	226.62	226.58	-0.04
10-year dry	winter	225.83	225.81	-0.02
	spring	226.07	226.04	-0.03
	summer	227.32	227.29	-0.03
	fall	226.38	226.34	-0.04
10-year wet	winter	225.97	225.93	-0.04
	spring	226.65	226.61	-0.04
	summer	228.32	228.29	-0.03
	fall	227.00	226.96	-0.04

Note: amsl = above mean sea level.

Cumulative Effects: Pre-Industrial Case to 2013 PRM Application Case

The changes to water levels in the Athabasca River that are predicted for the winter, spring, summer, and fall under the hydrologic conditions of average year, 10-year dry, and 10-year wet between the PIC and the 2013 PRM Application Case are summarized in Table 28-2. The maximum change in water level from the PIC to the 2013 PRM Application Case is a decrease of 5 cm. The maximum change in water level from the 2013 Base Case to the 2013 PRM Application Case is a decrease of 1 cm. Under the Pre-Industrial Case and 2013 PRM Application Case conditions the change in water levels over the seasons in an average year is about 1.7 m (summer to winter season). Hence, a decrease of 5 cm is not expected to affect navigability of the Athabasca River.

Table 28-2 Changes to the Athabasca River Flow Depths at Node S24 for the 2013 PRM Application Case

Hydrologic Condition	Season	Pre-Industrial Case	2013 Base Case	2013 PRM Application Case		
		Water Level	Water Level	Water Level	Change Due to Pierre River Mine	Change from Pre-Industrial Case
		[m amsl]	[m amsl]	[m amsl]	[m]	[m]
Average Year	Winter	225.94	225.90	225.90	0.00	-0.04
	Spring	226.56	226.52	226.52	0.00	-0.04
	Summer	227.64	227.61	227.60	-0.01	-0.04
	Fall	226.62	226.58	226.57	-0.01	-0.05
10-Year Dry	Winter	225.83	225.81	225.81	0.00	-0.02
	Spring	226.07	226.04	226.04	0.00	-0.03
	Summer	227.32	227.29	227.28	-0.01	-0.04
	Fall	226.38	226.34	226.34	0.00	-0.04
10-Year Wet	Winter	225.97	225.93	225.93	0.00	-0.04
	Spring	226.65	226.61	226.60	-0.01	-0.05
	Summer	228.32	228.29	228.28	-0.01	-0.04
	Fall	227.00	226.96	226.96	0.00	-0.04

Note: amsl = above mean sea level.

Cumulative Effects: Pre-Industrial Case to 2013 Planned Development Case

The changes to water levels in the Athabasca River that are expected for the winter, spring, summer, and fall under the hydrologic conditions of average year, 10-year dry, and 10-year wet between the PIC and the 2013 PDC are summarized in Table 28-3. The maximum change in water level from the PIC to the 2013 PDC is a decrease of 6 cm. Under the Pre-Industrial Case and 2013 PDC conditions the change in water levels over the seasons in an average year is about 1.7 m (summer to winter season). Hence, a decrease of 6 cm is not expected to affect navigability of the Athabasca River.

Table 28-3 Changes to the Athabasca River Flow Depths in Reach 4 for the 2013 Planned Development Case

Hydrologic Condition	Season	Pre-Industrial Case	2013 Base Case	2013 PRM Application Case	2013 Planned Development Case		
		Water Level	Water Level	Water Level	Water Level	Change Due to Planned Development	Change from Pre-Industrial Case
		[m amsl]	[m amsl]	[m amsl]	[m amsl]	[m]	[m]
Average Year	Winter	225.94	225.90	225.90	225.89	-0.01	-0.05
	Spring	226.56	226.52	226.52	226.51	-0.01	-0.05
	Summer	227.64	227.61	227.60	227.59	-0.01	-0.05
	Fall	226.62	226.58	226.57	226.56	-0.01	-0.06
10-Year Dry	Winter	225.83	225.81	225.81	225.81	0.00	-0.02
	Spring	226.07	226.04	226.04	226.04	0.00	-0.03
	Summer	227.32	227.29	227.28	227.27	-0.01	-0.05
	Fall	226.38	226.34	226.34	226.33	-0.01	-0.05
10-Year Wet	Winter	225.97	225.93	225.93	225.92	-0.01	-0.05
	Spring	226.65	226.61	226.60	226.60	0.00	-0.05
	Summer	228.32	228.29	228.28	228.27	-0.01	-0.05
	Fall	227.00	226.96	226.96	226.94	-0.02	-0.06

Note: amsl = above mean sea level.

The cumulative changes to water levels in the Athabasca River that are predicted for the winter, spring, summer and fall seasons as a result of the total allowable withdrawals under Water Management Framework restrictions, including the effect of reduced Athabasca River flows due to climate change, are provided in Table 28-4. The model scenario presented is CGCM3T47 (median scenario) – SR-B1 (further information is provided in Appendix 4 of this submission). The additional decrease in the Athabasca River water levels due to potential climate change effect is about 14 cm and the combined change is about 19 cm. These changes are not expected to affect navigability of the Athabasca River.

Table 28-4 Change to Athabasca River Water Level in Reach 4 Considering Climate Change Effects in 2050s

Model Scenario	Season	Baseline Water Level (1961 to 1990)	Water Level – with Climate Change (no-Water Withdrawal)		Climate Change Plus Water Withdrawal					
					2013 Base Case		2013 PRM Application Case		2013 Planned Development Case	
		Stream Flow Discharge	Water Level	Change due to Climate Change Only	Water Level	Change From Baseline Water Level	Water Level	Change From Baseline Water Level	Water Level	Change From Baseline Water Level
		[m]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[m]
CGCM3T47 (Mean) - SR-B1	winter	225.98	225.99	0.01	225.95	-0.03	225.94	-0.03	225.93	-0.04
	spring	226.68	226.78	0.10	226.74	0.06	226.73	0.05	226.72	0.04
	summer	227.96	227.82	-0.14	227.79	-0.17	227.78	-0.18	227.77	-0.19
	fall	226.71	226.62	-0.09	226.59	-0.12	226.58	-0.13	226.57	-0.14

In summary, the water level decreases predicted between the Baseline and 2013 PDC are up to 19 cm (14 cm of which is attributed to climate change), which, when compared to a variation in water level between the winter and summer seasons (during an average year) of about 1.7 m, is not expected to affect navigability of the Athabasca River. The effect of PRM is predicted to be up to a 1 cm decrease (difference between the 2013 Base Case and 2013 PRM Application Case) in water levels in the Athabasca River which is not expected to affect navigability.

SIR 29

29) ACFN Integrated Knowledge and Land Use Report- April 20, 2011 (Section 6.2, page 87), MCFN Indigenous Knowledge and Use Report- February 15, 2012 Section 6.2.1, pages 83-84, Section 6.3.1.4, page 94. ACFN and Mikisew Cree First Nation (MCFN) state that portions of Redclay Creek and Big Creek are reported to be navigable at adequate flow levels, and are used currently by ACFN members and in the past by MCFN members as water transportation routes to access resources. Both waterways are reported to have become too low to travel on at low flow levels. Transport Canada (TC) states that, based in its 2009 navigability assessment of PRM waterways within the Project RSA only the Athabasca River is navigable (Pierre River Mine Additional Information and Clarification for Federal Departments, August 2010, Section 4, Question 4, Page 13).

a) Address ACFN/MCFN concerns regarding reported loss of navigability on PRM LSA waterways with emphasis on Big Creek and Redclay Creek. Include potential cumulative effects impeding current and future use of PRM watersheds in the analysis.

b) Provide your comments respecting the 2010 TC assessment (concluding only Athabasca River is navigable) in relation to reported recent, current and potential ACFN/MCFN usage of PRM Local Study Area (LSA) waterways. Include incorporation of past TC reports or other historical information to get a complete pre-industrial comparison with current conditions and use of waterways.

c) Address Aboriginal concerns of possible effects to navigation from proposed installation of the Redclay compensation works including the ‘flow splitting structure’ on Redclay Creek outlet.

d) Identify sections of the Athabasca River that would experience changes in stream flow/depth and the influence of fluctuations on navigability to important Aboriginal sites within the RSA.

Response:

a) Transport Canada (TC) issued their assessment on February 23, 2010 that concluded that the only navigable stream affected by the PRM was the Athabasca River. The TC assessment was filed by Shell in the April 2010 Pierre River Mine Project, Supplemental Information, Round 2, Section 1.2. Shell also provided additional information in its August 2010 Pierre River Mine, Additional Information and Clarification for Federal Departments, Section 4 to TC assessing the navigational effects of the proposed bridge, water intake and the outlet of South Redclay Lake. The South Redclay Lake Outlet assessment was updated to include the PIC with the methodology and results outlined below.

Outlet of North and South Redclay Lake

The head watershed of Unnamed Creek 19, Redclay Creek and Big Creek will be diverted to North and South Redclay Lake in 2018. The outlet from the South Redclay Lake will be a new outlet channel. Flow statistics from this new outlet channel were compared to combined PIC flow statistics for Unnamed Creek 19, Redclay Creek and Big Creek near the mouth to determine changes in flows due to PRM and planned developments in the LSA. The predicted water depth changes to the combined flow parameters are provided in Table 29-1, which is adapted from Appendix 2, Table 3.3.2-1 of this submission.

Mean annual, mean open-water and mean ice-cover water levels due to the development of the PRM are predicted to increase for the 2018 snapshot.

Changes to the expected values of mean annual and mean open-water levels due to development of PRM are less than 1 cm for 2034 and 2042 snapshots, and after the closure period (after 2052). The 10-year peak water depth will reduce during the operational period and after the closure period due to significant attenuation of flood flows by the North and South Redclay Lake. The mean ice-cover flow water depth is expected to decrease by up to 1 cm during the operational period and not change after the closure period. The 7Q10 low flow water depth will not change over the life of the mine.

For the 2013 PDC, closed-circuit operations from the Frontier Project will slightly decrease the expected combined flows at the outlet of the North and South Redclay Lake compared to the 2013 PRM Application Case values. The expected values of the mean annual and mean open-water water depths will decrease by less than 1 cm, and the expected value of the mean ice-cover will remain unchanged in 2018. Changes to the expected values of mean annual and mean open-water levels are less than 3 cm for 2034, 2042 and 2052 snapshots, and after the closure period. The 10-year peak flow water level will reduce during the operation period and also after the closure period. The mean ice-cover flow water depth is expected to increase slightly during the operational period and after the closure period.

Table 29-1 Changes to the South Redclay Lake Outflow Channel Water Levels

Year	Expected Value of Parameter Under Conditions for Given Snapshot	Pre-Industrial Case	2013 PRM Application Case		2013 Planned Development Case	
			2013 PRM Application Case	Change from Pre-Industrial Case	2013 Planned Development Case	Change from 2013 PRM Application Case
		[m]	[m]	[m]	[m]	[m]
2018[b]	mean annual discharge	0.15	0.16	0.00	0.15	-0.01
	mean open-water discharge[a]	0.20	0.21	0.00	0.20	-0.01
	mean ice-cover discharge[a]	0.05	0.06	0.01	0.05	0.00
	7Q10 low flow discharge	0.00	0.00	0.00	0.00	0.00
	10-year flood peak discharge	0.87	0.84	-0.03	0.83	-0.01
2034	mean annual discharge	0.15	0.15	-0.01	0.14	-0.01
	mean open-water discharge[a]	0.20	0.20	-0.01	0.18	-0.02
	mean ice-cover discharge[a]	0.05	0.05	0.00	0.06	0.01
	7Q10 low flow discharge	0.00	0.00	0.00	0.00	0.00
	10-year flood peak discharge	0.87	0.69	-0.18	0.55	-0.14
2042	mean annual discharge	0.15	0.15	-0.01	0.13	-0.01
	mean open-water discharge[a]	0.20	0.20	-0.01	0.18	-0.02
	mean ice-cover discharge[a]	0.05	0.05	0.00	0.05	0.01
	7Q10 low flow discharge	0.00	0.00	0.00	0.00	0.00
	10-year flood peak discharge	0.87	0.69	-0.18	0.54	-0.15
2052	mean annual discharge	0.15	0.15	-0.01	0.13	-0.02
	mean open-water discharge[a]	0.20	0.19	-0.01	0.17	-0.03
	mean ice-cover discharge[a]	0.05	0.05	0.00	0.05	0.00
	7Q10 low flow discharge	0.00	0.00	0.00	0.00	0.00
	10-year flood peak discharge	0.87	0.69	-0.19	0.52	-0.16
Far-future	mean annual discharge	0.15	0.15	-0.01	0.14	-0.01
	mean open-water discharge[a]	0.20	0.19	-0.01	0.17	-0.03
	mean ice-cover discharge[a]	0.05	0.05	0.00	0.09	0.04
	7Q10 low flow discharge	0.00	0.00	0.00	0.00	0.00
	10-year flood peak discharge	0.87	0.69	-0.19	0.45	-0.23

[a] The "open-water" season is the period from mid-April to mid-November; "ice cover" season is the period from mid-November to mid-April.

[b] 2013 PRM Application Case flow represents outflow from South Redclay Lake. Hence, a portion of the pre-industrial watershed contributing runoff to Big Creek at the mouth during pre-development is directed to the pit lakes in the Far Future.

Notes: 2013 Update data reproduced from Appendix 2, Table 3.3.2-1 of this submission.

PIC data represent the combined flows from Big Creek at mouth, Redclay Creek at the mouth and unnamed Creek 19 at the mouth.

2013 Base Case is the same as PIC.

The design philosophy adopted for the outlet channel from the North and South Redclay Lake is to create a channel with similar characteristics to existing streams in the area which TC does not consider meet their navigability criteria. The TC assessment concluded that the only navigable stream affected by the PRM was the Athabasca River. This was filed by Shell in the April 2010 Pierre River Mine Project, Supplemental Information, Round 2, Section 1.2. However, it is recognized that the ACFN and MCFN state that Big Creek and Redclay Creek are reported to be navigable at adequate flow levels so it is likely that North and South Redclay Lake outlet channel will meet ACFN and MCFN's navigability requirements since the predicted changes in water depth are about 1 cm for mean annual flow and about 20 cm for 10-year flood flow.

b) In 2010, Transport Canada filed in its federal SIR 4 a footnote stating that the only waterway associated with PRM in the RSA considered to be navigable was the Athabasca River (August 2010 Pierre River Mine, Additional Information and Clarification for Federal Departments, Section 4). The ACFN and MCFN state that Big Creek and Redclay Creek are reported to be navigable at adequate flow levels. These groups differ in their assessment of navigability.

c) The flow splitting structure is part of the Teck Resources Limited Frontier Oil Sands Mine Project (the Frontier Project). Shell has no comment.

d) The Athabasca River downstream of Fort McMurray is divided into 5 reaches (Figure 1, AENV 2007). Each of these reaches has a different instream flow requirement that is determined based on hydrology, biology, geomorphology, water quality, and connectivity. Instream flow needs is a scientifically defensible amount of water necessary to maintain and protect an aquatic ecosystem, in this case, the Athabasca River (AENV 2007).

   Pierre River Mine has the potential to affect stream flows and depths from approximately the midpoint of Segment 3 to Lake Athabasca (Figure 1, AENV 2007). As stated in SIR 28(a), the maximum water level decreases of 5 cm, predicted between the PIC and the 2013 PRM Application Case, and of 6 cm, predicted between the PIC and 2013 PDC, are not expected to affect navigability of the Athabasca River.

References:

AENV (Alberta Environment). 2007. *Alberta Environment & Fisheries and Oceans Canada Water Management Framework: Instream Flow Needs and Water Management System for the Lower Athabasca River*. February 2007.

Candler, Craig, Rachel Olson, Steven DeRoy and the Firelight Group Research Cooperative with the Athabasca Chipewyan First Nation and the Mikisew Cree First Nation. 2010. *As Long as the Rivers Flow: Athabasca River Knowledge, Use and Change*. November 26, 2010.Transport Canada. 2010 Minor Waters User Guide, TP 14838. Available at: http://www.tc.gc.ca/eng/marinesafety/tp-tp14838-3092.htm.

FISH AND FISH HABITAT

SIR 30

EIA Volume 4B: Aquatic Resources Appendices, Appendix 4-6 Section 5.1, Page 63. Shell states that, of eight proposed fish habitat compensation options, it selected the creation of a compensation lake in the lower Big Creek and lower Redclay Creek watersheds (Option 1) based on select criteria. Shell provides general observations as to its rationale for selecting its preferred option. The Option 1 fish habitat compensation works are located entirely on the PRM lease area and are intended to address both proposed JPME and PRM fish habitat compensation requirements.

a) Provide the specific criteria used and how Shell weighted these criteria (e.g., impacts on wildlife, vs. fish vs. commercial interests) in its determination that Option 1 was the most feasible option. Include a summary of who was consulted and the results of these discussions.

b) Provide a detailed description of any anticipated changes to the existing compensation plan to address PRM specific project effects assuming Option 1 remains the preferred fish habitat compensation strategy.

c) Provide a rationale for any proposed changes to the original compensation plan and any long term effects to fish and fish habitat from these changes.

Response:

a) Shell has been evaluating, consulting on, and developing fish habitat compensation options related to its oil sands operations for over a decade. During that period, Shell has received direct feedback from regulators, First Nations and Métis stakeholders and has learned from the challenges encountered in developing habitat compensation for the Muskeg River Mine Expansion and Jackpine Mine – Phase 1 projects. The lessons learned and feedback that have been gained from past projects have been incorporated into the decision-making process when evaluating options for the Pierre River Mine.

For the Muskeg River Mine Expansion, challenges were identified with the primary option for compensation that was originally proposed in 2006 (Golder 2006) due to the site being located off of a Shell lease, which resulted in incompatibility with an adjacent development that would have made the option unsustainable and the eventual requirement to identify an alternate option. The fish habitat compensation lake built for Jackpine Mine – Phase 1 was located above a mineable bitumen deposit and required a lengthy regulatory process to obtain approval for ore sterilization. Based on these experiences, Shell prioritized options that were located on a Shell lease and options that would not require sterilization of mineable bitumen.

For the Pierre River Mine, several preliminary decision criteria were used to screen the potential suitability of each compensation option, including the potential for sterilization of mineable bitumen, conflict with adjacent developments, watershed size, fish access and colonization, previous stakeholder comments, and long-term sustainability. The key factors related to each option considered which made those options less favourable than the South Redclay Lake option are provided in Section 4.2 of the Draft No Net Loss Plan (Golder 2012).

The preliminary screening process for each option was conducted by Shell and the results were shared during consultation sessions held in early 2009 with Fisheries and Oceans Canada (DFO), First Nations and Métis stakeholders, where additional feedback was gathered. Aboriginal groups that were consulted on Shell's No Net Loss Plan included Fort McKay First Nation & Métis Local 63 (together FMFN), Athabasca Chipewyan First Nation (ACFN), Mikisew Cree First Nation (MCFN), Métis Local 125 and Métis Local 1935. During consultation, a preference was stated to provide compensation habitat within traditional territories if habitat losses were occurring within traditional territories. An alternative option was also identified that involved enhancement in the Richardson Lake area, and although this option was not part of the original list, the merits of this option were presented in the Draft No Net Loss Plan (Golder 2012). The consultation sessions were also used to identify species distribution within the PRM footprint as well as to identify the preferred target fish community for the compensation lake.

The ACFN, MCFN and FMFN were also provided an opportunity to review and provide written comments on an early draft of the No Net Loss Plan, with comments from each group received in late 2011. Responses to each comment were provided to each group with a number of the recommendations incorporated into the revised Draft No Net Loss Plan submitted in 2012.

b) Shell undertook a process following the submission of the EIA in 2007 to continue with the advancement of the compensation plan. The conceptual plan identified in Appendix 4-6 was followed by the submission of the Draft No Net Loss Plan (Golder 2012), which was developed through consultation with DFO, First Nations and Métis stakeholders. The Draft No Net Loss Plan (Golder 2012) directly incorporates and compensates for Pierre River Mine's specific project effects and no additional modifications to the Draft No Net Loss Plan are being proposed at this time.

c) See response to (b). No changes to the Draft No Net Loss Plan (Golder 2012) are currently being proposed for the Pierre River Mine, and therefore, the conclusions on the effects to fish and fish habitat remain unchanged from the EIA.

References:

Golder (Golder Associates Ltd.). 2006. *Draft No Net Loss Plan for Muskeg River Mine Expansion Project*. Submitted to Shell Canada Energy, August 2006. 90 pp. + 4 Appendices.

Golder. 2012. *Draft No Net Loss Plan: Jackpine Mine Expansion and Pierre River Mine Project*. Submitted to Shell Canada Energy, September 2012. 105 pp. + 9 Appendices.

SIR 31

DFO's reply to the Joint Review Panel's June 18, 2012 request for public comments on additional information for Shell's proposed Pierre River Mine Project- September 12, 2012, Pages 3, 5. DFO expressed uncertainty about how the No Net Loss Plan (NNLP) would compensate for indirect and cumulative impacts to fisheries and whether surrounding habitats would remain productive. DFO was not sure whether this assessment could be carried out at the single project level or should instead be a regional initiative. DFO noted that Shell would provide an updated NNLP to the Panel in the future providing additional information on the Athabasca River Bridge and water intake as well as information on effects related to constructing fish habitat.

a) **Explain how it proposes that the NNLP will compensate for indirect and cumulative impacts to fisheries and if surrounding habitats will remain productive including the Lower Athabasca River and Delta.**

b) **Describe how it will assess whether a) is feasible within the PRM project specific scope or whether a collaborative regional effort is required. If so, describe how it proposes to act in concert with other industry interests to conduct this regional cumulative impacts assessment.**

Response:

a) Shell developed a Draft No Net Loss Plan (Golder 2012) to compensate for losses to fish habitat resulting from the development of the Pierre River Mine and the Jackpine Mine Expansion. This Plan was filed with the JRP in September 2012. The proposed habitat compensation has been designed to offset the direct and indirect impacts to fish and fish habitat due to the PRM and to sustain the regional fish populations, including fish populations in the Athabasca River. Upon completion of the South Redclay Lake fish habitat compensation project for PRM, including the construction of an outlet channel to connect South Redclay Lake to the Athabasca River, it is expected that the habitat in South Redclay Lake and the outlet channel will provide for both local fisheries opportunities within South Redclay Lake, as well as to continue to support fisheries from the Athabasca River. The Draft No Net Loss Plan also includes the construction of geomorphically designed channels that connect to the Athabasca River that will provide spawning habitat for Athabasca River fish and will support Athabasca River fisheries to a similar level that is currently provided by the tributary streams affected by the PRM.

Similar to the PRM, all oil sands mine operations that have been approved since the late 1990s have a requirement to develop fish habitat compensation to protect regional fisheries as part of their project approvals. Shell believes the cumulative impacts of projects on regional fisheries resources within the lower Athabasca River are being addressed through the implementation of project-specific fish habitat compensation plans. As stated previously in our October 15, 2012 reply letter to JPME intervener submissions, Shell disagrees that additional assessment of cumulative impacts to downstream fisheries and fish habitats is required. Shell has provided the cumulative effects assessment as part of the PRM's environmental impact assessment (EIA) and has included an update to that assessment in Appendix 2 of this submission. These documents provide the necessary information to inform a public interest determination. In addition to the development of compensation habitats, other mitigation and management measures, as prescribed within project-specific approvals and defined in the Water Management Framework for the Lower Athabasca River and the Lower Athabasca Regional Plan, are required of each operator to protect water quality and quantity in the lower Athabasca River and the Athabasca River delta to protect the aquatic ecosystem. The Lower Athabasca Regional Plan is a regional initiative designed to manage the cumulative effects of all operators.

b) Shell believes that the cumulative impacts for PRM have been adequately assessed in the context of the EIA. However, Shell would suggest that the best approach to monitor and assess the effectiveness of compensation implementation and cumulative interaction amongst each of the individual operator's fish habitat compensation projects within the mineable oil sands region on a regional scale is through a collaborative effort amongst industry partners. The Fisheries Sustainable Habitat (FiSH) committee, which is a joint industry-DFO committee that has been established to coordinate regional compensation and monitoring efforts, would be one possible avenue for completing such an assessment. Shell is an active participant of the FiSH committee and Shell would support identifying the completion of a cumulative assessment of fish compensation habitat development on the regional fishery as a future priority for the FiSH committee.

References:

Golder (Golder Associates Ltd.). 2012. *Draft No Net Loss Plan: Jackpine Mine Expansion and Pierre River Mine Project*. Submitted to Shell Canada Energy, September 2012. 105 pp. + 9 Appendices.

SIR 32

Shell Jackpine Mine Expansion and Pierre River Mine Project Draft No Net Loss Plan-Golder and Associates Ltd. 2012, Section 6.3.4, Pages 68 to 73. Shell states that mercury concentrations commonly increase in fish tissue after impoundment in reservoirs in northern temperate regions. This often results in fish tissue mercury concentrations that exceed the Canadian human consumption guideline of 0.5 µg/g (Health Canada (HC) 2007) for some species and sizes of fish for a time. This effect is typically greatest in fish species that are top predators. Shell's NNLP listed studies showing that predicted mercury concentrations are greater than the Canadian human consumption guideline of 0.5 µg/g for Northern pike and walleye for South Redclay Lake without mitigation. Shell provided a list of potential mitigation options to address possible increases in mercury levels in South Redclay Lake.

a) Provide evidence of the success of the proposed mitigation options in reducing methyl mercury levels below HC guideline levels.

b) Describe contingencies in the event that mercury levels remain high for an extended period beyond the 1-2 years peak Shell had indicated.

c) Assess cumulative effects of high mercury levels on fish health in association with other water quality constituent increases through the life of the Project.

Response:

a) A review of techniques for managing increases in methyl mercury concentrations in reservoirs and lakes (Mailman et al. 2006) was the basis for identifying a strategy that would best suit the circumstances of South Redclay Lake. Shell has proposed to use selective intensive harvesting to manage methyl mercury concentrations in the fish population of the South Redclay Lake. This technique is supported by experimental studies that have demonstrated reductions in methyl mercury after intensive fishing events (Surette et al. 2006; Verta 1990). This approach to mitigating methyl mercury serves multiple functions:

- it will reduce the methyl mercury concentration of fish after the intensive harvest sessions through the mechanism of growth dilution;
- it will reduce the number of years for the system to return to background methyl mercury concentrations by removing long-lived fish that were present during the period of elevated methyl mercury uptake after lake flooding; and
- it will serve to manage the risk of exposure to humans and wildlife during the period of elevated mercury uptake through the direct removal and disposal of fish from the

food chain that have the highest risk of elevated methyl mercury above background levels.

Since the 2006 review paper (Mailman et al. 2006), recent studies have provided further evidence that growth dilution serves as a mechanism for reducing methyl mercury concentrations in fish tissue (Lepak et al. 2012; Ward et al. 2010) and that selective harvest of the largest predatory fish in the population both increased growth rates and reduced methyl mercury concentrations in the remaining fish population (Sharma et al. 2008, 2011). The work by Sharma et al. (2008, 2011) had a specific focus of using selective harvest techniques to reduce methyl mercury concentrations in the remaining fish population through growth dilution and concluded that it can be an effective tool to manage methyl mercury concentrations.

b) The data review provided in Section 6.3.4 of the Draft No Net Loss Plan (Golder 2012) indicated elevated methyl mercury levels in fish tissue in a newly formed reservoir, without mitigation, are likely to be sustained for a period of between 20 to 30 years before returning to background concentrations. Based on a review and analysis by Bodaly et al. (2007), reservoirs within northern boreal landscapes will typically experience peak methyl mercury concentrations in fish tissues within the first 10 years post-impoundment without mitigation followed by a decline to background conditions. The intensive fishing program is predicted to reduce the duration and the magnitude of peak methyl mercury concentrations post-impoundment and would continue until such a time as monitoring results indicate methyl mercury concentrations have returned to background levels. The contingencies around extended durations of elevated methyl mercury beyond what has been predicted in the Draft No Net Loss Plan (Golder 2012) include public signage and notices to warn against fish consumption from South Redclay Lake, increasing the frequency of intensive harvest events, and installation of a drop structure at the outlet of South Redclay Lake to prevent large-bodied species from entering South Redclay Lake from the Athabasca River in the event that the intensive fishing efforts become a concern for Athabasca River fish populations.

c) Potential aquatic effects due to concentrations of mercury and other water quality constituents were assessed for the Local Study Area in Appendix 1, Section 3, and for the Regional Study Area in Appendix 2, Section 3. The assessment concluded that there would be negligible to low effects on aquatic health due to mercury and other water quality constituents in water and in fish tissue concentrations. The assessment considered water concentrations from cumulative developments in the Athabasca Oil Sands Region. However, fish tissue concentrations that may be elevated due to methyl mercury production in the newly flooded South Redclay Lake were not included in the assessment because these fish will be managed through Shell’s intensive harvest events. Likewise, increased concentrations of mercury in water from South Redclay Lake were shown in a modelling study completed for the Draft No Net Loss Plan (Golder 2012) to result in negligible changes in mercury concentrations in water in the Athabasca River.

References:

Bodaly, R.A., W.A. Jansen, A.R. Majewski, R.J.P. Fudge, N.E. Strange, A.J. Derksen and D.J. Green. 2007. *Postimpoundment time course of increased mercury concentrations in fish in hydroelectric reservoirs of Northern Manitoba, Canada*. Archives of Environmental Contamination and Toxicology. 53: 379-389.

Golder (Golder Associates Ltd.). 2012. *Draft No Net Loss Plan: Jackpine Mine Expansion and Pierre River Mine Project*. Submitted to Shell Canada Energy, September 2012. 105 pp. + 9 Appendices.

Lepak, J.M., K-D. Kinzli, E.R. Fetherman, W.M. Pate, A.G. Hansen, E.I. Gardunio, C.N. Cathcart, W.L. Stacy, Z.E. Underwood, M.M. Brandt, C.A. Myrick and B.M. Johnson. 2012. *Manipulation of growth to reduce mercury concentrations in sport fish on a whole-system scale*. Can. J. Fish. Aquat. Sci. 69: 122-135.

Mailman, M., L. Stepnuk, N. Cicek and R.A. Bodaly. 2006. *Strategies to lower methyl mercury concentrations in hydroelectric reservoirs and lakes: A review*. Science of the Total Environment 368: 224–235.

Sharma, C.M, R. Borgstrom, J.S. Huitfeldt and B.O. Rosseland. 2008. *Selective exploitation of lake pike Esox lucius – effects on mercury concentrations in fish populations*. Sci. Tot. Environ. 399: 33-40.

Sharma, C.M., R. Borgstrom and B.O. Rosseland. 2011. *Biomanipulation in Lake Arungen, Norway: a tool for biological control*. In A.A. Ansari et al. [eds], Eutrophication: Causes, Consequences and Control. Springer Science+Business Media B.V., Netherlands. 394 pg.

Surette, C., M. Lucotte and A. Tremblay. 2006. *Influence of intensive fishing on the partitioning of mercury and methyl-mercury in three lakes of Northern Quebec*. Sci. Tot. Environ. 368(1): 248-261.

Verta, M. 1990. *Changes in fish mercury concentrations in an extensively fished lake*. Can. J. Fish. Aquat. Sci. 47:1888–1897.

Ward, D.M., K.H Nislow, C.Y. Chen and C.L. Folt. 2010. *Rapid, efficient growth reduces mercury concentrations in stream-dwelling Atlantic salmon*. Trans. Am. Fish. Soc. 139:1-10.

Aquatic Health

SIR 33

Shell Canada Energy's responses to the Joint Review Panel's (JRP) January 12, 2012 Supplemental Information Requests (SIRs) - May 15, 2012, Appendix 3.6 Supporting Information for Aquatic Resources, Section 2, Page 1 and Section 2.8.2, Pages 66 to 67. Shell states that Appendix 3.6 represents Chronic Effects Benchmark (CEB) derivations for both JPME and PRM. In its assessment Shell did not elaborate on possible effects of predicted increases of naphthenic acid levels despite stating that data to develop site specific CEBs for refractory naphthenic acids was "inadequate" thus no CEBs had been developed, and that "additional studies would be necessary to assess the hazard of naphthenic acids." Shell referenced authors who concluded that ambient levels of naphthenic acids in the Athabasca Oil Sands watersheds range from non-detectable to 2,000 µg/L and that acute toxicity from naphthenic acids occurred at 1-5 mg/L levels for some fish species and at LC50 levels of 4-78 mg/L for other species.

a) **Comment on potential impacts to health of aquatic and other potentially affected species from Project related naphthenic acid levels as well as impacts to human health from consumption of these organisms in light of no site specific CEBs for refractory naphthenic acids being available.**

b) **Provide the specific methodology Shell used to draw its conclusions regarding effects to aquatic and other species and in measuring effects on human health from consumption of these organisms.**

Response:

a) Potential impacts to the health of aquatic organisms from naphthenic acids are assessed in Appendix 1, Section 3.5.1. As stated in that section, in the absence of a CEB, Shell has conservatively applied the results of the most applicable peer-reviewed literature in assessing Project effects.

   In their recent review of the health effects of naphthenic acids, Kindzierski et al. (2012) stated that the "properties of aged OSPW [oil sands process water]-derived [naphthenic acids] (i.e., low octanol water partition values and apparent rapid depuration) offer no meaningful scientific evidence to support the fish ingestion pathway as being important for potential human exposure to these compounds." As such, naphthenic acids are not expected to increase human health risks through fish consumption.

b) Concentrations of naphthenic acids in watercourses and waterbodies were predicted using the models and assessment methods presented in the EIA, Volume 4B, Appendix 4-2. These prediction methods have been followed in this submission, except that assumptions regarding naphthenic acid degradation and speciation have been updated to align with the End Pit Lake Guidance Document (CEMA 2012). Predicted concentrations were then assessed for potential effects on aquatic organisms by comparing to effects thresholds from literature, as described in Appendix 1, Section 3.5.1.

Because naphthenic acids are not expected to travel up the food chain and affect fish tissue concentrations (Kindzierski et al. 2012), exposure to naphthenic acids through the fish ingestion pathway was not considered relevant to the human health risk assessment.

References:

CEMA (Cumulative Environmental Management Association). 2012. *End Pit Lake Guidance Document.* D. Wylynko and J. Hyrnyshyn (Eds.). September 2012. Fort McMurray, Ab.

Kindzierski, W., J. Jin and M. Gamal El-Din. 2012. *Review of Health Effects of Naphthenic Acids: Data Gaps and Implications for Understanding Human Health Risk*. Oil Sands Research and Information Network, University of Alberta, School of Energy and the Environment, Edmonton, Alberta. OSRIN Report No. TR-20. 43 pp.

WILDLIFE

SIR 34

Although Shell conducted baseline surveys for waterfowl (ducks and geese), Shell did not include waterfowl as a KIR in its EIA. Waterfowl are a culturally important group of species for aboriginal peoples and are an important group of migratory birds. Shell stated in Environmental Setting Report – Terrestrial, Terrestrial Environmental Setting Report, Section 5.4.2.3, Page 5-103 that some participants to the CEMA-sponsored Wildlife Movement Traditional Environmental Knowledge Workshop were of the opinion that waterfowl and large flocks of snow geese no longer stop in the Athabasca delta during migration. In their technical review, the ACFN had concerns regarding the absence of a waterfowl KIR, as they are harvested by First Nations peoples. In the Athabasca Chipewyan First Nation Integrated Knowledge and Land Use Report and Assessment for Shell Canada's Proposed Jackpine Mine Expansion and Pierre River Mine, April 20, 2011, Section 5.2.5, Page 61 ACFN members have reported changes in migratory bird patterns, including ducks and geese, concurrent with oil sands development impacting the quantity of birds available for the ACFN spring bird hunt, particularly in the area of the Athabasca delta. Environment Canada

also recommended that waterfowl be included as a KIR to gain further understanding of their distribution, abundance and habitat use in the LSA.

a) Clarify and provide Shell's rationale as to why it did not use a waterfowl KIR in the EIA.

b) Provide rationale and ecological criteria for the use of another species as a waterfowl surrogate in the EIA, if one was used by Shell.

c) Explain how Shell incorporated Traditional Ecological Knowledge (TEK) about the decline in the population of geese and other waterfowl species in the Peace-Athabasca Delta into its EIA.

d) Assess the cumulative impacts of the project on waterfowl species in the Peace-Athabasca Delta.

Response:

a) Shell assessed the effects of Pierre River Mine (PRM) on horned grebe, which is a waterfowl Key Indicator Resource (KIR), in the Species at Risk (SAR) Assessment in the May 2011*, Submission of Information to the Joint Review Panel*, Appendix 2. The effects of the PRM on horned grebe and other wildlife KIRs before and after reclamation are reassessed in this current submission based on updated landscape data and information on population status, trends and threats (Appendix 1, Section 4.4). The cumulative effects of development in the Regional Study Area (RSA) were also assessed for horned grebe in the RSA from the 2013 Base Case to the 2013 PDC (Appendix 2, Section 2.4.3), and from the PIC to the 2013 Base Case, 2013 PRM Application Case, and the 2013 PDC (Appendix 2, Sections 2.3.3, 3.3.3 and 4.3.3).

A focused list of KIRs was developed for the Environmental Impact Assessment (EIA). The KIRs for the EIA were selected based on discussions with regulators at the time to ensure that the assessment of impacts of PRM on wildlife was comprehensive (EIA, Volume 5, Section 7.2.6.2). The predicted effects of PRM on KIRs were applied to other wildlife species with similar life histories and ecological requirements. As such, the KIRs used in the EIA acted as surrogates for inferring effects to other species and species groups, such as waterfowl. The use of wildlife indicators or surrogate species for assessing impacts on wildlife, including endangered species and species at risk, is an acceptable protocol that has been used for assessing the impacts of development on wildlife in the Athabasca Oil Sands Region for more than a decade, and was accepted by the Joint Review Panel for the Mackenzie Gas Project application (Joint Review Panel 2010) and the Joint Review Panel for the Jackpine Mine Expansion (AER and CEAA 2013). On this basis, horned grebe was considered a surrogate species for waterfowl in general. Horned grebe shares a substantial number of ecological requirements and has a similar life-history as many ducks and geese (see part ‘b’ below for more information). Accordingly, the assessed effects of interactions with tailings ponds, collisions with infrastructure and vehicles on horned grebe abundance also apply to waterfowl.

The potential risks posed to waterfowl health were assessed in the Wildlife Health Risk Assessment (WHRA) (EIA, Volume 3, Section 5.4).

b) Horned grebe is an effective surrogate for waterfowl in the assessment (see response to part ‘a’). Like many species of waterfowl, horned grebe preferentially select semi-permanent and permanent freshwater ponds and shallow bays or marshes containing open water and emergent vegetation such as sedges, rushes and cattails for breeding and raising young (i.e., brooding). Nests are usually floating in emergent vegetation within a few metres of open water (Stedman 2000). Horned grebes use ponds of a wide range of sizes for breeding (COSEWIC 2009; Fournier and Hines 1999; Heglund et al. 1994).

A brief description of the habitat associations for each of the 11 waterfowl species identified within the PRM Local Study Area (LSA) (Golder 2007) during baseline waterfowl surveys conducted in fall 2005 and spring 2006 are listed in Table 34-1. All waterfowl species generally nest on or near water and feed and brood their young on, or adjacent to, aquatic habitat features (e.g., wetlands, lakes, ponds, rivers). There are differences between the habitat associations and behaviours of different waterfowl species. For example, while horned grebe nests are generally floating in emergent vegetation, blue-winged teal, Canada goose, and green-winged teal nest on the ground in vegetation near water, while common goldeneye and common merganser are cavity nesters. However, a requirement for open water is a trait common among all waterfowl, making horned grebe an effective surrogate.

c) Effects to wildlife in the Peace-Athabasca Delta (PAD) were not assessed in the EIA because the PAD is approximately 70 km north of the northern boundary of the RSA, will likely not be affected by PRM, and was therefore not subject to a comprehensive wildlife cumulative effects assessment. However, a discussion on the effects to waterfowl in the PAD is provided in part “d” of this response.

d) The RSA is approximately 70 km south of the PAD. Cumulative effects to waterfowl in the PAD are assessed by considering the effects of development in the context of available information on historical population trends and the factors that are known or suspected to limit populations of KIRs and SAR in the PAD.

Available TEK regarding waterfowl populations in the PAD is summarized in a report prepared by The Firelight Group for the Athabasca Chipewyan First Nations Industry Relations Corporation (Firelight Group 2012). The report, which states that the study is incomplete and that data collection is ongoing, is based on anecdotal information. All traditional harvesting and habitation sites discussed by the Firelight Group are beyond the RSA boundary. The Firelight Group (2012) also reported:

- a reduction in water level resulting in areas no longer used by waterfowl;
- an observed reduction in waterfowl weight;
- estimates that a large waterfowl population reduction occurred in 1970s and 1980s due to development in the Athabasca Oil Sands Region as well as due to the W.A.C. Bennett Dam; and
- an observed change in migratory patterns, such that migratory birds avoid the Athabasca River.

Table 34-1 Breeding Habitat Requisites for the Waterfowl Species Observed within the Local Study Area During the Waterfowl Aerial Surveys, 2005 and 2006[(a)]

Species	Breeding Habitat Comments	Reference
American wigeon	Breeds near shallow freshwater wetlands, small lakes, ponds, and rivers. Broods frequent open water of marshy ponds, lake bays, or marshy river edges.	Mowbray 1999
blue-winged teal	Generally select temporary and seasonal wetlands in early spring then shift to semi-permanent wetlands later in the season. Large permanent wetlands are more often used during drought years. Apparent preference for areas with good interspersion of water and emergent vegetation. Prefers to nests in grass or herbaceous cover within 150 m of water. Broods show preference for seasonal and semi-permanent wetlands with emergent vegetation.	Rohwer et al. 2002
bufflehead	Permanent ponds and small lakes. Generally avoids ponds with extensive emergent or submergent vegetation. Obligate cavity nester, uses woodpecker cavities predominantly in poplar or aspen trees with un-obscured entrance. Readily uses nest boxes. May nest up to 500 m from water. Brood on small ponds, usually close to the nest.	Gauthier 1993
Canada goose	Highly variable, but generally nests on drier, slightly elevated terrain near permanent water including lakes, ponds, large streams, muskegs, marshes, and wet hummocky areas. Often selects islands with good visibility. May use beaver and muskrat lodges. Broods frequent, wet, gradually sloping shorelines with easy access to water as well as shallow ponds, mud barrens, and areas of short grasses and sedges.	Mowbray et al. 2002
common goldeneye	Typically nests near wetlands, lakes, and rivers bordered by forests mature enough to provide suitable tree cavities. Generally an arboreal cavity nester but may use rock crevasses. Nest sites may be up to 1.3 km from water. Availability of invertebrates appear to influence habitat selection (i.e., typically select waterbodies without fish). Broods often move from a nesting lake to a rearing lake which appears to be initiated by food availability.	Eadie et al. 1995
common merganser	Generally nests in tree cavities in mature forests bordering lakes and rivers, though rock cavities, tree root hollows, and holes in banks may be used. Often reuses nest sites and readily uses suitably sized nest boxes. Nests may be located relatively far from water (i.e., >500 m). Broods often move from smaller stream and ponds near nest site to larger lakes, rivers and bays. On rivers, broods usually frequent near-shore areas.	Mallory and Metz 1999
green-winged teal	Nests on the ground in sedge meadows, grasslands, brush thickets or woods, usually within 200 m of a pond. In Alberta, majority of nests (86%) are under the cover of sedges. Beaver ponds in wooded areas are commonly selected. Typically feeds in shallow water, near shorelines, and on mudflats.	Johnson 1995
lesser scaup	Breeding pairs and broods are typically associated with seasonal and semi-permanent wetlands and lakes with emergent vegetation. May also use shallow river impoundments with deep marsh emergents. Usually nests on bare soil at wetland margins. Broods generally use shallow semi-permanent or permanent wetlands or bays with abundant aquatic invertebrates, emergent vegetation, and at least some submergent vegetation.	Austin et al. 1998
mallard	Highly variable habitat selection throughout range, In northern Alberta preference for more vegetated and fertile wetlands with areas of open water. Usually nests in uplands with dense cover within 150 m of water but occasionally nests in wetlands and in emergent vegetation over water. Will nest in high densities on islands. Generally brood on seasonal, semi-permanent or permanent ponds, lakes, lagoons, rivers, and streams. Tend to brood within shallow water areas and wetlands with both emergent and open water. Broods frequently switch ponds.	Drilling et al. 2002
ring-necked duck	Generally shallow freshwater wetlands (especially marshes, fens, and bogs) with fringes of flooded or floating emergent vegetation interspersed with herbaceous species and shrubs. Will also use open water zones with abundant submerged or floating aquatic plants. In northern Alberta, found to be significantly concordant with fishless lakes. Nests over water in flooded or emergent vegetation within 200 m of open water. Adults and young feed in open water.	Roy et al. 2012

(a) Tundra swan was also observed, but breeds in the Arctic and not in the LSA or RSA.

The United States Fish and Wildlife Service (USFWS) conducts annual waterfowl population estimates in partnership with Canadian Wildlife Service (CWS), various provincial agencies, and private conservation organizations over northern Alberta (i.e., Strata 77; Zimpfer et al. 2012). The available USFWS data suggest that there was a decline in waterfowl populations in the 1960s (USFWS 2013). However, although population fluctuations are apparent, waterfowl populations do not appear to have declined from the early 1970s to 2012 (USFWS 2013). This finding suggests that waterfowl populations in northern Alberta have been resilient to Oil Sands development, which has occurred largely after the 1970s.

The USFWS data do not necessarily contradict the available TEK regarding waterfowl populations in the PAD. The waterfowl population reduction reported by First Nations groups within the PAD may be at too fine a scale to be detected within the USFWS data set, which is at the scale of much of northern Alberta (i.e., Strata 77). In addition, the USFWS data do not include geese, which are hunted by First Nations.

Sources of mortality such as interactions with infrastructure (e.g., collisions with powerlines, structures, and tailings ponds), collisions with vehicles, sensory disturbance, and vegetation clearing by existing, approved, and planned developments in the RSA are predicted to have a negligible effect on the abundance of horned grebe and other waterfowl in the PAD because the PAD is 70 km north of the northern boundary of the RSA and waterfowl therefore come into contact with PRM only during migration. Waterfowl mortality data collected at Shell's tailings ponds to date (see response to JRP SIR 75) suggest that mortality associated with PRM infrastructure on waterfowl will have a negligible effect on migrating waterfowl populations.

An assessment of cumulative effects in the PAD was conducted on hydrology and surface water quality (Appendix 3.4). The assessment concluded that although there have been changes in the water regimes of the PAD, these are predominately due to the operations of the W.A.C. Bennett Dam on the Peace River. The effects of the PRM in conjunction with existing, approved and planned developments (i.e., 2013 PDC) in the Athabasca Oil Sands Region on water level changes and flooding, as well as surface water and sediment quality changes in the PAD are negligible (Appendix 3.4). Development in the RSA would likely result in a negligible effect on the movement of waterfowl in the PAD, because the PAD is located 70 km north of the northern boundary of the RSA and therefore waterfowl from the PAD may come into contact with the RSA only during migration. The PRM will not impede migration because birds are able to fly around or over the development. Therefore, the effects of existing, approved and planned developments in the RSA on the abundance, habitat, and movement of waterfowl in the PAD are predicted to be negligible.

References:

AER and CEAA (Alberta Energy Regulator); (Canadian Environmental Assessment Agency). 2013. *Report of the Joint Review Panel Established by the Federal Minister of the Environment and the Energy Resources Conservation Board. Decision 2013 ABAER 011: Shell Canada Energy, Jackpine Mine Expansion Project, Application to Amend Approval 9756, Fort McMurray Area*. July 9, 2013. AER Application No. 1554388. CEAA Reference No. 59540. Published by Alberta Energy Regulator and Canadian Environmental Assessment Agency. Calgary, AB. 413 pp. ISBN: 978-1-100-22455-8.

Austin, J.E., C.M. Custer, and A.D. Afton. 1998. *Lesser Scaup (Aythya affinis)*, The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/338. Accessed May 9, 2013.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2009. *COSEWIC assessment and status report on the horned grebe (Podiceps auritus), western population and Magdalen Islands population, in Canada*. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 42 pp.

Drilling, N., R. Titman and F. Mckinney. 2002. *Mallard (Anas platyrhynchos)*, The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/658. Accessed May 9, 2013.

Eadie, J.M., M.L. Mallory and H.G. Lumsden. 1995. *Common Goldeneye (Bucephala clangula)*, The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/170. Accessed May 9, 2013.

Firelight Group, The. 2012. *Preliminary Data on ACFN Knowledge and Use: Migratory Birds and Aquatic Fur, with reference to the proposed Jackpine Mine Expansion (JPME) proposed by Shell Canada*. Technical Memorandum prepared for the Athabasca Chipewyan First Nations, Industry Relations Corporations. 19 pp.

Fournier, M.A. and J.E. Hines. 1999. *Breeding ecology of the horned grebe (Podiceps auritus) in subarctic wetlands*. Canadian Wildlife Service Occasional Paper Number 99. 34 pp.

Gauthier, G. 1993. *Bufflehead (Bucephala albeola)*, The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/067. Accessed May 9, 2013.

Golder (Golder Associates Ltd.). 2007. *Wildlife and Wildlife Habitat Environmental Setting Report for the Jackpine Mine Expansion & Pierre River Mine Project*. Prepared for Shell Canada Limited. Calgary, AB. Submitted December 2007. 185 pp.

Heglund, P.J., J.R. Jones, L.H. Frederickson and M.S. Kaiser. 1994. *Use of boreal forested wetlands by Pacific Loons (Gavia pacifica Lawrence) and Horned Grebes (Podiceps auritus L.): relations with limnological characteristics*. Hydrobiologia 279/280:171-183.

Johnson, K. 1995. *Green-winged Teal (Anas crecca)*, The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/193. Accessed May 9, 2013.

Joint Review Panel (Joint Review Panel for the Mackenzie Gas Project). 2010. *Foundation for a Sustainable Northern Future: Report of the Joint Review Panel for the Mackenzie Gas Project*. Published under the Authority of the Minister of Environment, Government of Canada, December 2009.

Mallory, M. and K. Metz. 1999. *Common Merganser (Mergus merganser)*, The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/442. Accessed May 9, 2013.

Mowbray, T. 1999. *American Wigeon (Anas americana)*, The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/401. Accessed May 9, 2013.

Mowbray, T.B., C.R. Ely, J.S. Sedinger and R.E. Trost. 2002. *Canada Goose (Branta canadensis)*, The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/682. Accessed May 9, 2013.

Rohwer, F.C., W.P. Johnson and E.R. Loos. 2002. *Blue-winged Teal (Anas discors)*, The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/625. Accessed May 9, 2013.

Roy, C.L., C.M. Herwig, W.L. Hohman and R.T. Eberhardt. 2012. *Ring-necked Duck (Aythya collaris)*, The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/329. Accessed May 9, 2013.

Stedman, S.J. 2000. *Horned Grebe (Podiceps auritus)*, The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/505. Accessed May 9, 2013.

USFWS (U.S. Fish and Wildlife Service). 2013. *Migratory bird data center*. Available online: http://mbdcapps.fws.gov/. Accessed February 24, 2013.

Zimpfer, N.L, W.E. Rhodes, E.D. Silverman, G.S. Zimmerman and K.D. Richkus. 2012. *Trends in Duck Breeding Populations: 1955-2012*. US Fish and Wildlife Service, Division of Migratory Bird Management. MD. 20 pp. + appendix.

SIR 35

EIA Volume 5: Terrestrial Resources and Human Environment, Table 7.6-8, Page 7-145. Shell provided the reduction in habitat for each wildlife KIR for the Planned Development Case. In Shell's updated cumulative effects assessment:

a) Provide maps for each wildlife KIR in the RSA indicating the various habitat suitability classes that occurred during the pre-industrial baseline, at present and which would occur in the future (prior to reclamation and after reclamation and closure). Include habitat (for any wildlife KIRs that occurred in the LSA in the pre-industrial baseline) that is found in the LSA at present, even if the wildlife KIR does not occur in the LSA presently.

Response:

a) The requested information is provided in Appendix 5 as Figures 1 to 16. The maps depict habitat suitability for each wildlife Key Indicator Resource (KIR) in the Pierre River Mine Regional Study Area (RSA) during the PIC, 2013 Base Case and 2013 PDC.

Habitat suitability in the future can only be represented prior to reclamation at the RSA scale because spatial data describing the reclamation plans of planned developments are not available.

Figures 1 to 16 show habitat suitability for the following wildlife KIRs:

- barred owl;
- beaver;
- black bear;
- black-throated green warbler;
- Canadian toad;
- fisher/marten;
- Canada lynx; and
- moose.

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EIA Volume 5: Terrestrial Resources and Human Environment, Table 7.5-35, Page 7-105. Shell's residual impact analysis for LSA wildlife abundance in the Application Case indicates low local environmental consequences for black-throated green warbler as a result of interaction with infrastructure, increased vehicle-wildlife collisions, and sensory disturbance. In EIA Volume 5: Terrestrial Resources and Human Environment, Table 7.6-9, Page 7-149. Shell provides pre-mitigation impact classification of effects on wildlife abundance, habitat, fragmentation and wildlife movement corridors for the PDC, however effects to the abundance of black-throated green warbler are not included.

a) Explain why abundance of black-throated green warbler is not included as a KIR in the PDC (Table 7.6-9).

Response:

a) Shell has assessed the effects of the 2013 PDC on the abundance of all wildlife Key Indicator Resources (KIRs), including black-throated green warbler. From the 2013 Base Case to the 2013 PDC prior to reclamation, the effects of Pierre River Mine and other existing and planned developments on black-throated green warbler abundance are predicted to be of moderate environmental consequence in the Regional Study Area (RSA) (Appendix 2, Section 3.4.3). From the PIC to the 2013 PDC, the effects of Pierre River Mine and other existing and planned developments on black-throated green warbler abundance are predicted to be of high environmental consequence in the RSA (Appendix 2, Section 5.3.3).

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EIA Volume 5: Terrestrial Resources and Human Environment, Appendix 5.2 Closure, Conservation and Reclamation Plan for the Pierre River Mining Area, Page 75. Shell provided the same values for moderate and moderate high-quality moose habitat for both JPME and PRM: a decrease of 1,704 ha (56%) and 1,585 ha (24%) relative to pre-development conditions.

a) Clarify and correct, if required, the values of moderate and moderate-high quality moose habitat after reclamation for PRM.

Response:

a) The change in suitable habitat from the EIA Base Case to Closure reported in the EIA, Appendix 5.2 erroneously reported changes for both the PRM Local Study Area (LSA) and the JME LSA. The moose Resource Selection Function (RSF) model has been re-run to estimate the change in suitable moose habitat from the 2013 Base Case to Closure for PRM. The corrected information is discussed in Section 2, Table 2-1. From the 2013 Base Case to after Closure, moderate and moderate-high suitability moose habitat in the PRM LSA is predicted to decline by 1,744 ha (22%) and 2,331 ha (48%), respectively (Appendix 3.7, Section 1.3). From the 2013 Base Case to after Closure, high suitability moose habitat is predicted to decline by 763 ha (31%) (Appendix 3.7, Section 1.3).

The predicted decline in moderate, moderate-high and high suitability moose habitat is because forest stands at Closure are assumed to be 80 years of age (Appendix 1, Section 4.4.1.2). Eighty years represents the estimated time required for the development of mature forest on the reclaimed landscape, and is therefore an appropriate time frame upon which to compare vegetation, wildlife and biodiversity values in the reclaimed landscape against the 2013 Base Case values. For moose, which prefer young forest stands (Serrouya and D'Eon 2002), the 80-year-old stands at Closure result in habitat suitability modelling suggesting a negative high magnitude effect at Closure. However, this overestimates the long-term effects of Pierre River Mine on moose in the reclaimed landscape, where natural disturbance and succession processes will occur. Stand ages will cycle naturally over time and patches of young forest will re-occur over time. Habitat suitability model predictions are based on a moment in time, and do not represent long-term stand dynamics or changes to site capability. Therefore, professional judgement was applied to reduce the environmental consequences for changes to habitat after Closure for moose to negative and low at the LSA scale (Appendix 1, Section 4.4.1.2).

References:

Serrouya, R. and R. D'Eon. 2002. *Moose habitat selection in relation to forest harvesting in a deep snow zone in British Columbia*. Prepared for Downie Timber Ltd., Revelstoke, BC.

SIR 38

EIA Volume 3: Air Quality, Noise and Environmental Health, Appendix 3-2, Section 2.5, Page 10. Shell provides information on reports and other products produced from the various CEMA groups up to 2007.

a) Provide an updated list of reports or studies conducted by CEMA or other multi-stakeholder committees since 2007 in regards to wildlife or species at risk.

Response:

a) Publicly available reports or studies conducted in Alberta by multi-stakeholder committees are those by the Cumulative Environmental Management Association (CEMA), the Alberta Biodiversity Monitoring Institute (ABMI), the Ecological Monitoring Committee for the Lower Athabasca (EMCLA), the WHEC (Wildlife Habitat Effectiveness and Connectivity) Committee and the Regional Bird Monitoring Program for the Oil Sands Region. These reports have been used to provide additional ecological knowledge regarding wildlife and species at risk in Alberta, and have therefore informed the assessment of cumulative effects and the determination of significance (Appendix 2, Sections 4.3.3 and 5.3.3). The reports since 2007 that contain information related to wildlife or species at risk are:

- ABMI. 2007. *Olive-sided Flycatcher [Contopus cooperi] Distribution & Habitat Associations in Alberta*. Alberta Biodiversity Monitoring Institute. Alberta, Canada.
- ABMI. 2007. *Rethinking Rarity*. Alberta Biodiversity Monitoring Institute. Alberta, Canada.
- ABMI. 2009. *The Status of Birds and Vascular Plants in Alberta's Lower Athabasca Planning Region: Preliminary Assessment 2009*. Alberta Biodiversity Monitoring Institute. Alberta, Canada.
- ABMI. 2009. *The Status of Biodiversity in Alberta Pacific Industries' Forest Management Agreement Area: Preliminary Assessment*. Alberta Biodiversity Monitoring Institute. Alberta, Canada.

- ABMI. 2009. *The Status of Biodiversity in the Alberta-Pacific Forest Industries' Forest Management Agreement Area: Supplementary Report 2009*. Alberta Biodiversity Monitoring Institute. Alberta, Canada.
- ABMI. 2009. *Q & A: The Status of Biodiversity in the Alberta-Pacific Forest Industries' Forest Management Agreement Area*. Alberta Biodiversity Monitoring Institute. Alberta, Canada.
- ABMI. 2009. *Processing Terrestrial Bird Recordings (10006), Version 2009-11-23*. Alberta Biodiversity Monitoring Institute. Alberta, Canada.
- ABMI. 2009. *ABMI Species Pyramid: Guild Definitions and Species Lists*. Version 2009-12-12. Alberta Biodiversity Monitoring Institute. Alberta, Canada.
- ABMI. 2010. *Terrestrial Field Data Collection Protocols (10001), Version 2010-04-20*. Alberta Biodiversity Monitoring Institute. Alberta, Canada.
- ABMI. 2011. *Monitoring activity report: Lower Athabasca Planning Region, 2010 Season*. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Report available at www.abmi.ca. 58 pp.
- ABMI. 2011. *Status Report for the South Saskatchewan Planning Region: Preliminary Assessment 2011*. Alberta Biodiversity Monitoring Institute. Alberta, Canada.
- ABMI. 2012. *Status Report on Landbirds in Alberta's Boreal Plains Ecozone - Preliminary Assessment 2012*. Alberta Biodiversity Monitoring Institute. Alberta, Canada.
- ABMI. 2012. *Predictive Mapping of Species Abundance: Reducing Guesswork in Land Use Management*. Alberta Biodiversity Monitoring Institute. Alberta, Canada.
- ABMI. 2012. *Terrestrial Field Data Collection Protocols (Abridged Version) 2012-06-27*. Alberta Biodiversity Monitoring Institute. Alberta, Canada.
- ABMI, Alberta Innovates – Technology Futures and Salmo Consulting. 2011. *Assessing the influence of industrial development on caribou (Rangifer tarandus) in the Lower Athabasca Planning Region of Alberta*. Prepared for the Ecological Monitoring Committee of the Lower Athabasca. Available online: http://emcla.ca/wp-content/uploads/2012/05/EMCLA-Caribou-Project-2011SummaryReport-Only.pdf. 27 pp. Accessed May 28, 2013.
- CEMA. 2007. *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region: 5.0 - Design Elements for Wildlife Habitat*. Prepared by Megan Harris for the Cumulative Environmental Management Association - Biodiversity & Wildlife Subgroup of the Reclamation Working Group. Lorax Environmental. CEMA Contract No. 2006-0033 RWG.
- CEMA. 2007. *Guideline for wetland established on reclaimed oil sands leases (revised second edition)*. Prepared by Lorax Environmental for CEMA Wetlands and Aquatics Subgroup of the Reclamation Working Group, Fort McMurray, AB.

- CEMA. 2007. *Evaluation of the Alberta Biodiversity Monitoring Institute for monitoring reclaimed oil sands sites*. Prepared by Golder Associates Ltd. for Biodiversity and Wildlife Subgroup of the Reclamation Working Group of the Cumulative Environmental Management Association, Fort McMurray, AB. CEMA Contract No.2006-0018 RWG.
- CEMA. 2007. *Oil Sands end pit lakes: a review to 2007*. Prepared by Clearwater Environmental Consultants for the Cumulative Environmental Management Association. CEMA Contract No. 2006-0024 RWG.
- CEMA. 2007. *Reach-specific water quality objectives for the Lower Athabasca River*. Prepared by Golder Associates for the Cumulative Environmental Management Association. 06-1336-009; CEMA Contract No. 2006-0034 SWWG. Calgary, AB.
- CEMA. 2007. *Reclamation certification process review phase 2: draft*. Prepared by Millennium EMS Solutions Ltd. for Cumulative Environmental Management Association RCSG.
- CEMA. 2007. *Simulated Changes in Landuse and Biological and Landscape Indicators on CEMA LMAs 3c, 4 and 5*. Prepared by Alberta Research Council for the Cumulative Environmental Management Association (CEMA). CEMA Contract No. 2003-0033 SEWG.
- CEMA. 2008. *Terrestrial ecosystem management framework for the Regional Municipality of Wood Buffalo, prepared by sustainable ecosystem working group of the Cumulative Environmental Management Association, final version-June 5, 2008*. 57 pp.
- CEMA. 2008. *Wildlife Literature Review with Specific Reference to Wildlife Species and Chemicals of Potential Concern to the Oil Sands Region*. Commissioned by the TMACWG. Prepared by Intrinsik Environmental Sciences Inc. for the Cumulative Environmental Management Association, Fort McMurray, AB - Trace Metals and Air Contaminants Working Group. CEMA Contract No. 2007-0020 TMAC.
- CEMA. 2009. *Post-Mining Habitats and Breeding Birds in the Athabasca Oil Sands Region*. Prepared by Lynette Yvonne Dagenais for the Cumulative Environmental Management Association (CEMA). CEMA Contract No. 2006-0010 RWG. Master of Science. University of Alberta.
- CEMA. 2009. *Effects of Oil Sands Process-Affected Water and Substrates on Wood Frog (Rana Sylvatica) Eggs and Tadpoles*. Prepared by N. Gupta for the Cumulative Environmental Management Association. University of Saskatchewan. Saskatoon, SK.
- CEMA. 2009. *Management Scenario Combination Modeling (supplement to the Terrestrial Ecosystem Management Framework) Group*. Prepared by Silvatech Consulting Ltd. for the Cumulative Environmental Management Association - Sustainable Ecosystem Working Group. CEMA Contract No. 2008-0022 SEWG.

- CEMA. 2009. *Traditional use mapping of the Lower Athabasca River: phase 1 study*. Prepared by WRG Westland Resource Group Inc. to Cumulative Environment Management Association, Fort McMurray, AB. CEMA Contract No. 2009-0010 SWWG. Victoria, BC.
- CEMA. 2009. *Guidelines for reclamation to forest vegetation in the Athabasca Oil Sands - 2nd edition: a technical review*. Prepared by The Forestry Corp. for Cumulative Environment Management Association, Fort McMurray, AB. CEMA Contract No. 2009-0025 RWG.
- CEMA. 2009. *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region*. Prepared by the Terrestrial Subgroup. CEMA Contract No. 2008-0029 RWG.
- CEMA. 2009. *Traditional land use mapping study of the Lower Athabasca River - Phase 2*. Prepared by TERA Environmental Consultants for Cumulative Environmental Management Association. CEMA Contract No. 2009-0026 SWWG.
- CEMA. 2009. *Estimating effects of water withdrawals from the Lower Athabasca River*. Prepared by Laughing Water Arts & Science, Inc. for the Cumulative Environmental Management Association, Fort McMurray, AB. 06-2009; CEMA Contract No. 2007-0033 SWWG.
- CEMA. 2009. *Review and assessment of deposition and potential bioaccumulation of trace metals in the Athabasca Oil Sands region*. Prepared by ENVIRON International Corporation for the Trace Metal and Air Contaminant Working Group of the Cumulative Environmental Management Association. CEMA Contract No. 2007-0055 TMAC.
- CEMA. 2009. *Dialogue on Ecosystem Response Management System and Coordinated Access Management Strategies: Perspectives on a Further Refinement of the Terrestrial Ecosystems Management Framework*. Prepared by Cumulative Environmental Management Association - Sustainable Ecosystem Working Group. CEMA Contract No. SEWG 2009-0006.
- CEMA. 2010. *Wildlife Movement and Habitat Connectivity Monitoring Guidelines for the Regional Municipality of Wood Buffalo - Task 1: Literature Review*. Prepared by Jacques Whitford AXYS Ltd. for the Cumulative Environmental Management Association (CEMA) - Wildlife Movement Task Group. CEMA Contract No. 2007-0026A SEWG.
- CEMA. 2010. *Guide to the landscape design checklist in the Athabasca Oil Sands region*. Prepared by Millennium EMS Solutions Ltd. for Cumulative Environmental Management Association, Fort McMurray, AB. CEMA Contract No. 2007-0054 RWG.
- CEMA. 2009. *Review of Critique by The Forestry Corp of Guidelines for Reclamation of Forest Vegetation in the Athabasca Oil Sands Region*. Prepared by Michael Newton, PhD for the Cumulative Environmental Management Association, Fort McMurray, AB. CEMA Contract No. 2009-0025 RWG.

- CEMA. 2011. *Synthesis of Habitat Models used in the Oil Sands Region*. Prepared by LGL Limited environmental research associates for the Cumulative Environmental Management Association - The Reclamation Working Group (RWG), Fort McMurray, AB. CEMA Contract No. 2010-0034 RWG. Fort McMurray, AB. 30 p.
- CEMA. 2011. *The state of existing empirical data and scientific knowledge on habitat-species relationships for wildlife that occupy aquatic habitats, with a focus on the Boreal region of Alberta*. Prepared by Alberta Innovates - Technology Futures Sustainable Ecosystems Unit for the Cumulative Environmental Management Association - Aquatics Sub Group (ASG) of the Reclamation Working Group (RWG). Contract Number: 2009-0049 RWG.
- CEMA. 2011. *Early Successional Wildlife Monitoring Program on Reclaimed Plots in the Oil Sands Region: Year 1 2010-2011 Annual Report*. Prepared by LGL Limited Environmental Research Associates for the Cumulative Environmental Management Association - Reclamation Working Group (RWG). CEMA Contract No. RWG 2010-0023.
- CEMA. 2012. *Validation Procedures for Habitat Models in the Oil Sands Region*. LGL Report EA3354. Prepared by LGL Limited Environmental Research Associates for the Cumulative Environmental Management Association - Reclamation Working Group (RWG). CEMA Contract No. 2011-0034. Fort McMurray, AB. -95 + pp.
- CEMA. 2012. *Early Successional Wildlife Monitoring Program on Reclaimed Plots in the Oil Sands Region: Year 2 2011-2012 Annual Report*. Prepared by LGL Limited Environmental Research Associates for the Cumulative Environmental Management Association - Reclamation Working Group (RWG). CEMA Contract No. RWG 2010-0023.
- CEMA. 2012. *Development of a Regional Monitoring Program to Assess the Effects of Oil Sands Development on Wetland Communities*. Prepared by Ciborowski, J.H., Grgicak-Mannion, A., Kang, M., Rooney, R., Zeng, H., Kovalenko, K., Bayley, S., Foote, A. Lee and submitted to the Cumulative Environmental Management Association (CEMA). CEMA Contract No. RWG 2010-0029.
- CEMA. 2009. *A Review of Existing Models and Potential Effects of Water Withdrawals on Semi-aquatic Mammals in the Lower Athabasca River Final Report*. Prepared by Hood, G., C. Bromley and N. Tiitmamer Kur for the Cumulative Environmental Management Association (CEMA) - Surface Water Working Group.
- Eaton, B., C. Paszkowski, K. Kendell, A. Whiting, E. Bayne, D. Huggard and S. Nielsen. 2011. *Recommendations for an amphibian monitoring pilot study in the Lower Athabasca Region of Alberta*. Report to the Ecological Monitoring Committee for the Lower Athabasca, Alberta. 59 pp. Available online: http://emcla.ca/wp-content/uploads/2012/05/EMCLA_Amphibians_2011_FINAL.pdf. Accessed May 28, 2013.

- EMCLA (Ecological Monitoring Committee for the Lower Athabasca). 2011. *3-year vision and 2012 work plan*. Available online: http://emcla.ca/wp-content/uploads/2012/04/EMCLA-2012-Vision-and-Workplan_FINAL.pdf. 8 pp. Accessed May 28, 2013.
- EMCLA. 2012. *Annual report 2011*. Available online: http://emcla.ca/wp-content/uploads/2012/05/EMCLA-2011-Annual-Report_FINAL.pdf. 15 pp. Accessed May 28, 2011.
- Fisher, J.T., L.T. Priestly, T. Muhly, D. haggard, E. Bayne and S. Nielsen. 2011. *Recommendations for an owl monitoring pilot study in northeast Alberta. Ecological Monitoring Committee for the Lower Athabasca, Alberta*. 75 pp. Available online: http://emcla.ca/wp-content/uploads/2012/05/EMCLA-Owl-Report-2011_FINAL.pdf. Accessed May 28, 2013.
- Muhly, T., E. Bayne, K. Drake, D. Huggard and S. Nielsen. 2011. *Recommendations for a yellow rail monitoring pilot study in the Lower Athabasca Region of Alberta*. Report to the Ecological Monitoring Committee for the Lower Athabasca, Alberta. 37 pp. Available online: http://emcla.ca/wp-content/uploads/2012/05/YERA-2011-Report_Final_16Jan2012.pdf. Accessed May 28, 2013.
- Spaedtke, H., S. Boutin and C. De La Mare. 2012. *WHEC (Wildlife Habitat Effectiveness and Connectivity) annual report 2011*. 30 pp.
- WHEC (Wildlife Habitat Effectiveness and Connectivity (WHEC) Committee. 2011. *WHEC 2010 Annual Field Research Update*. Submitted to Alberta Environment and Sustainable Resource Development. 18 pp.
- St. Clair, C.C., T. Habib, S. Loots, J. Ball and C McCallum. 2012. *2011 annual report of the Regional Bird Monitoring Program for the Oil Sands Region*. 28 pp.

Wildlife Health

SIR 39

EIA Volume 3: Air Quality, Noise and Environmental Health, Section 5.5.2.8, Page 5-208. Shell states that air emissions can result in direct effects (e.g., through inhalation) and indirect effects via potential effects to wildlife habitat. As lichens are of high food value to caribou and are sensitive to air emissions, they are good indicators of potential effects of air emissions on wildlife habitat. Boreal woodland caribou was not included in Shell's Wildlife Health Risk assessment (WHRA).

a) Given the potential for direct and indirect impacts from sulfur dioxide on sensitive lichen species and that lichens are a high food value to caribou, update the WHRA to include boreal caribou as a wildlife receptor.

Response:

a) The sulphur dioxide (SO_2) emissions from PRM are very low due to the use of natural gas and due to the exclusion of the Asphaltene Energy Reduction (AER), as outlined in the January 18, 2012 letter to the JRP. With these changes, the estimated PRM SO_2 emission rate assessed for the *October 2013, Pierre River Mine, Joint Review Panel Supplemental Information Requests* is 0.06 t/d, which is much lower than the SO_2 emission rate of 4.10 t/d assessed in the EIA.

The primary objective of the Wildlife Health Risk Assessment (WHRA) was to describe the potential adverse population-level effects of Chemicals of Potential Concern (COPC), potentially released by the Project, on mammalian and avian wildlife. To address this objective, the WHRA examined both primary (direct) and secondary (indirect) pathways of exposure.

Since emissions will be released to the air from various sources, an obvious pathway by which wildlife could be exposed is via inhalation; less obvious pathways could also exist and are explored as part of the WHRA. For example, chemicals emitted to air will be deposited onto soils surrounding PRM. Depending on the volatility of the chemical, deposition could affect local soil chemical concentrations. Exposure through dust inhalation, inadvertent ingestion of soil and dermal contact with soil were included in the WHRA.

Concentrations of some chemicals in local plants could be affected by direct deposition of atmospheric emissions onto plant surfaces and plant uptake from soils. As a result, potential exposure through ingestion of vegetation was included in the WHRA. The terms “direct” and “indirect”, in the context of the WHRA, refer to the primary and secondary pathways of exposure to the COPC, and not to the potential effects on wildlife habitat, such as food availability. For example, the WHRA examined the potential risks to wildlife health as a result of the direct inhalation of SO_2, but did not examine the potential indirect risks to wildlife health as a result of predicted SO_2 effects on lichen abundance and/or diversity. This qualitative evaluation of indirect effects was provided in the EIA, Appendix 3-13, Section 5.2.2. In Section 5.2.2, the impact analysis for terrestrial vegetation and wetlands under the EIA PDC concluded that 324 ha of woodland caribou habitat with high lichen food value could potentially be affected by SO_2 emissions. However, the potential impact areas were primarily identified in close proximity to the oil sands projects located south of PRM, along the Athabasca River and not within defined woodland caribou habitat areas (e.g., Audet, Firebag and Steepbank caribou areas) (see Appendix 3-13, Section 5.2.2, Figure 16 of the EIA).

For potential wildlife health risks associated with SO_2, the acute (short-term) and chronic (long-term) inhalation health risk estimates were provided for mammalian wildlife in the EIA, Volume 3, Section 5.4.3. These inhalation health risk estimates were not species specific, and could be considered representative of the potential health risks posed to local woodland caribou. In acute and chronic assessments, the inhalation health risk estimates for SO_2 were less than 1.0 for mammalian wildlife, indicating that the predicted 1-hour and annual SO_2 air concentrations were less than the acute and chronic Toxicological Reference Values (TRVs, i.e., "safe" levels of exposure) for mammalian wildlife, respectively. Sulphur dioxide was not included in the indirect (or multiple) pathway assessment of the WHRA because:

- it is a gaseous compound that would be unlikely to contribute to wildlife exposures via indirect pathways; and
- the health effects of SO_2 are strictly related to inhalation (i.e., act at the point of contact, which in this case is respiratory tissue).

In addition to potential health effects, effects to lichen abundance could potentially affect woodland caribou by decreasing the availability of an important source of forage. However, habitat loss is not believed to be a limiting factor for woodland caribou, and caribou populations likely remain below the carrying capacity set by forage availability, even in fragmented landscapes (Wittmer et al. 2005). Instead, most evidence indicates that the primary effect of development on caribou derives from the changes in large mammal predator-prey systems that accompany the creation of early seral vegetation communities by large-scale clearing (e.g., forest harvesting, seismic lines; James and Stuart-Smith 2000; Latham et al. 2011; Wittmer et al. 2005). Therefore, any effect to lichen abundance due to development in the Regional Study Area is unlikely to affect the abundance of woodland caribou.

References

James, A.R.C. and A.K. Stuart-Smith. 2000. *Distribution of Caribou and Wolves in Relation to Linear Corridors*. Journal of Wildlife Management. 64:154-159.

Latham, A.D.M., M.C. Latham, N.A. McCutchen and S. Boutin. 2011. *Invading white-tailed deer change wolf-caribou dynamics in northeastern Alberta*. Journal of Wildlife Management 75(1): 204-212.

Wittmer, H.U., A.R.E. Sinclair, B.N. McLellan. 2005. *The role of predation in the decline and extirpation of woodland caribou*. Oecologia 144:257-267.

Species at Risk

SIR 40

Shell stated in the Federally Listed Species at Risk Surveys November 2011 Report, Section 4, Page 18, "…the best available information suggests that the abundance of these species is not limited by habitat in northeastern Alberta. Therefore, it is likely that species at risk that use the LSAs will have available high quality habitat elsewhere in the region that they can relocate to, and that the loss of high quality habitat within the LSAs will not have a significant effect on regional populations." EIA Volume 5: Terrestrial Resources and Human Environment, Appendix 5-4 Wildlife Monitoring, Pages 41-67. Shell provided habitat suitability for the wildlife KIRs in map format.

a) Provide maps for the PRM LSA indicating habitat suitability for all species at risk assessed in the EIA.

b) Provide maps for each species at risk KIR occurring within the RSA indicating the various habitat suitability classes that occurred during the pre-industrial baseline, at present, and that would occur in the future (prior to reclamation and after reclamation and closure). Include habitat (for any species at risk KIRs that occurred in the LSA during the pre-industrial baseline) that is found in the LSA at present even if the wildlife KIR does not occur in the LSA presently.

Response:

a) In conjunction with the requested information in JRP SIR 35, the requested information is provided in Appendix 5 as Figures 17 to 27. The maps depict habitat suitability (or, in the case of wolverine, core security) at the 2013 Base Case and at Closure for all Species at Risk (SAR) assessed in the EIA for the Pierre River Mine Local Study Area (LSA). Core security habitat refers to areas where the probability of contact with humans, and the associated risk of mortality, is minimized (*May 2011, Submission of Information to the Joint Review Panel, Appendix 2*).

Figures 17 to 27 show habitat suitability (or core security) for the following wildlife SAR:

- Canada warbler;
- common nighthawk;
- horned grebe;
- olive-sided flycatcher;
- rusty blackbird;
- short-eared owl;

- western toad;
- wolverine core security;
- wood bison;
- woodland caribou; and
- yellow rail.

b) The requested information is provided in Appendix 5 as Figures 28 to 49. The maps show habitat suitability for all SAR assessed in the Pierre River Mine Regional Study Area (RSA) during the PIC, 2013 Base Case and 2013 PDC. Habitat suitability in the future can only be represented prior to reclamation at the RSA scale because spatial data describing the reclamation plans of planned developments are not available. See part a) of this response for the list of wildlife SAR represented.

SIR 41

Wood bison are a culturally important species to aboriginal groups. TEK indicates that core bison range is currently restricted to the west side of the Athabasca River, north of and including the PRM LSA, as well as the lower Firebag corridor on the east side of the Athabasca River. It is important that the direct and indirect effects of PRM and cumulative effects on wood bison be assessed in their current core range.

a) Quantify the effects of the Project and other cumulative effects on wood bison within their current core range as identified through TEK.

Response:

a) Wood bison is listed federally as “Threatened” by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and “Schedule 1: Threatened” under the *Species at Risk Act, SC 2002, c. 29* (SARA) (Species at Risk Public Registry 2013). Wood bison are listed as “At Risk” in Alberta (ASRD 2012). Bison are protected from hunting by non-aboriginals in Wood Buffalo National Park (WBNP) located in northeast Alberta and within a special wildlife management area in northwest Alberta. The special management area protects the Hay-Zama herd, which is geographically distinct from the seven distinct herds that occur in Alberta in and around WBNP (Government of Alberta 2012). Wood bison occurring on provincial lands outside of the designated management area are not protected by legislation unless they are owned as livestock. Wood bison in and around WBNP are infected by the cattle diseases bovine tuberculosis and bovine brucellosis, as well as anthrax (Mitchell and Gates 2002). These diseases are believed to be the primary limitation on wood bison populations in Alberta (Mitchell and Gates 2002). Unregulated hunting is allowed outside of the protected areas (e.g., Ronald Lake herd) to reduce the transmission of diseases from herds in and around WBNP to the uninfected Hay-Zama herd within the special wildlife management area. The effects of unregulated hunting on the herd are not known.

First Nations in Alberta consider wood bison to be a culturally significant species that has been harvested for generations in the area south of WBNP (ACFN 2010). The proposed PRM Local Study Area (LSA) is located on the west side of the Athabasca River and overlaps both “known” and “observed” core bison habitat, as identified by Traditional Ecological Knowledge (TEK; Candler 2011). The terms “known” and “observed” describing bison core ranges are not defined by the ACFN (2010). The bison herd located in this area is the Ronald Lake herd, which is estimated to number between 167 and 186 bison (Government of Alberta 2013). Based on TEK, the range of this herd extends south and west from Ronald Lake towards the Birch Mountains, and also east of the Athabasca River up the Firebag River valley (Candler 2011). The bison herds found in and around WBNP are located approximately 30 km north of the PRM LSA and within the wildlife management area approximately 350 km northwest of the PRM LSA. An examination of telemetry collar data collected between March and July 2013 shows that the home range of the Ronald Lake herd overlaps with WBNP (Government of Alberta 2013), and therefore bison of the Ronald Lake herd are likely to interact with diseased bison herds that occur in and around the park. However, although the Ronald Lake herd may be diseased, a recent analysis of blood and tissue samples have led to an estimated rate of disease in the herd that is between 0% and 12% for tuberculosis and brucellosis (Government of Alberta 2013). Therefore, the herd appears to be either free of these diseases or infected at a rate that is lower than the sampling strategy was capable of detecting, and lower than the 30% to 50% rate of disease present in herds in and around Wood Buffalo National Park (Government of Alberta 2013).

Unregulated harvest likely affects the abundance of the Ronald Lake herd. Harvest pressure is associated with winter access across the Athabasca River by ice bridge (Powell and Morgan 2010). However, even with the combined effects of disease and unregulated hunting there is no evidence that the Ronald Lake herd is decreasing, and it may be increasing (Government of Alberta 2013).

Historical bison range occurs throughout the Regional Study Area (RSA; Roe 1951). Bison require early seral vegetation and select meadow and willow grassland habitats for foraging (Lartner and Gates 1991). The Richardson fire and vegetation clearing for oil and gas exploration, pipeline and transmission line right-of-ways, and forest harvest are likely to increase suitable foraging habitat for bison through the creation of early seral vegetation. In the 2013 Planned Development Case (PDC), soil disturbances due to industrial development take up only 14% of the RSA. Based on habitat suitability modelling in the RSA, 88% of high suitability habitat for bison present in the Pre-Industrial Case (PIC) is still present in the 2013 PDC. Much of this habitat is currently not utilized by the Ronald Lake herd.

The Ronald Lake herd is unlikely to be limited by the availability of habitat, but rather by the effects of unregulated hunting, predation and disease (e.g., bovine tuberculosis, bovine brucellosis, anthrax). Therefore, effects to abundance may be assessed qualitatively by taking into consideration the risks of interactions with infrastructure, mortality due to clearing, increased hunting as a result of increased access, vehicle collisions and sensory disturbance on population abundance. Given that the Ronald Lake herd is not likely habitat limited and that they are likely to be displaced to alternate suitable habitat outside of the PRM footprint, road access outside of the LSA but associated with PRM, combined with unregulated hunting, could have a detrimental effect on the herd. Although risks of interactions with infrastructure, mortality due to clearing, vehicle collisions and sensory disturbance are unlikely to have a greater than negligible effect on population abundance, increased access as described above could potentially result in a decline in wood bison abundance within “known” and “observed” core bison habitat, as described by TEK. However, increases in existing access due to the presence of an ice bridge across the Athabasca River in winter and Teck Resources Limited Frontier Oil Sands Mine Project (the Frontier Project) winter drilling programs does not seem to have resulted in a decline in the herd (Government of Alberta 2013).

As a result of the potential effects of increased access to the PRM area, access restrictions limiting traffic to project personnel should be instituted on the access road to PRM. When implemented properly, restricting access has been proven to be an effective way to dramatically reduce incidents of hunting mortality (Crichton et al. 2004). The location and form of access restrictions should be discussed in consultation with stakeholders and the regulators to maximize the likelihood that the restrictions will result in the desired results, that is, the protection of the herd from increased unregulated hunting as a result of project-related increased vehicular access. Restricting access to project personnel along with a prohibition of firearms should effectively reduce the potential for increased hunting mortality on the Ronald Lake herd.

Therefore, environmental consequences of development in the RSA on bison abundance from the PIC to the 2013 Base Case are predicted to be negligible. Environmental consequences from the PIC to the 2013 PRM Application Case and the 2013 PDC are predicted to be low.

High suitability wood bison habitat is predicted to have declined and to continue to decline due to development in the RSA, based on habitat suitability modelling (Appendix 3.7 of this submission). The magnitude and environmental consequence of the decline of high suitability bison habitat within the “known” core range are predicted to be low from the PIC to the 2013 Base Case, moderate from the PIC to the 2013 PRM Application Case, and high from the PIC to the 2013 PDC (Table 41-1). The magnitude and environmental consequence of the decline of high suitability bison habitat within the “known” core range are predicted to be low from the 2013 Base Case to the 2013 PRM Application Case (Table 41-1).

Table 41-1 Wood Bison Habitat Change Within "Known" Core Range from the Pre-Industrial Case and the 2013 Base Case in the Regional Study Area

Key Indicator Resource	Habitat Suitability Class	Pre-Industrial Case		Change from the Pre-Industrial Case to the 2013 Base Case		Change from the Pre-Industrial Case to the 2013 PRM Application Case		Change from the Pre-Industrial Case to the 2013 Planned Development Case		Change from the 2013 Base Case to the 2013 PRM Application Case	
		Habitat Area [ha]	% of Total Area	Area [ha]	%	Area [ha]	%	Area [ha]	%	Area [ha]	%
wood bison	high	11,311	10	-843	-7	-1,484	-13	-6,673	-59	-641	-6
	moderate	45,174	38	-997	-2	-1,293	-3	-11,222	-25	-296	>-1
	low	28,980	25	1,969	7	1,337	5	-5,758	-20	-632	-2
	nil	27,791	24	-129	>-1	1,439	5	23,653	85	1,569	6
	outside model area	4,670	4	0	<1	0	<1	0	<1	0	0

Within the "observed" core range, the magnitude and environmental consequence of the decline of high suitability bison habitat are predicted to be moderate from the PIC to the 2013 Base Case and the 2013 PRM Application Case, and high from the PIC to the 2013 PDC (Table 41-2). From the 2013 Base Case to the 2013 PRM Application Case, the magnitude and environmental consequence of the decline of high suitability bison habitat within the "known" core range are predicted to be low (Table 41-2).

Bison movement in the RSA may be adversely affected by development in a manner similar to the effects of development on the movement of moose in the RSA as described in Appendix 3.7. As a result, the environmental consequence of development on wood bison movement within both "known" and "observed" core ranges is predicted to be high from the PIC to the 2013 Base Case, the 2013 PRM Application Case, and the 2013 PDC.

High suitability habitat within "known" and "observed" core wood bison ranges has declined over time, and is predicted to continue to decline in the 2013 PDC. Development in the core ranges has also increased impediments to movement. The wood bison population in the RSA is unlikely to be limited by the availability of habitat, but rather the effects of unregulated hunting, predation and disease (e.g., bovine tuberculosis, bovine brucellosis, anthrax) within "known" and "observed" core ranges. Therefore, it is unlikely that development in the RSA from the PIC to 2013 Base Case has contributed to the decline of this species. The following discusses the effects of changes in the RSA to wood bison in terms of adverse, significant and likely effects from the PIC to the 2013 PRM Application Case and the 2013 PDC:

- Effects on wood bison populations in the RSA are considered Adverse effects.
- The environmental consequence ratings for these effects on wood bison populations are low. The cumulative effects of development in the RSA are not likely to exceed ecological thresholds and compromise resilience and adaptability of the Ronald Lake herd such that it would no longer be a self-sustaining and ecologically effective population. Therefore, this is considered an Insignificant effect.
- The predicted effect is considered Likely.

Therefore, the effects on wood bison within "known" and "observed" core ranges are not considered a likely significant adverse environmental effect.

Table 41-2 Wood Bison Habitat Change Within "Observed" Core Range from the Pre-Industrial Case and the 2013 Base Case in the Regional Study Area

Key Indicator Resource	Habitat Suitability Class	Pre-Industrial Case		Change from the Pre-Industrial Case to the 2013 Base Case		Change from the Pre-Industrial Case to the 2013 PRM Application Case		Change from the Pre-Industrial Case to the 2013 Planned Development Case		Change from the 2013 Base Case to the 2013 PRM Application Case	
		Habitat Area [ha]	% of Total Area	Area [ha]	%	Area [ha]	%	Area [ha]	%	Area [ha]	%
wood bison	high	4,175	8	-580	-14	-693	-17	-1,012	-24	-113	-3
	moderate	7,198	13	708	10	412	6	82	1	-295	-4
	low	10,219	18	391	4	56	<1	283	3	-335	-3
	nil	9,776	18	-519	-5	225	2	648	7	743	8
	outside model area	24,243	44	0	>-1	0	>-1	0	>-1	0	0

References:

ACFN (Athabasca Chipewyan First Nation). 2010. *Supplementary Submission of Athabasca Chipewyan First Nation to the Federal Statutory Review of the Species at Risk*. Available online: http://www.ceaa.gc.ca/050/documents_staticpost/cearref_37519/44815/A27.pdf. Accessed May 5, 2013.

ASRD. 2012. *The General Status of Alberta Wild Species 2010*. Alberta Sustainable Resource Development, Fish and Wildlife Service Division. http://srd.alberta.ca/FishWildlife/SpeciesAtRisk/GeneralStatusOfAlbertaWildSpecies/GeneralStatusOfAlbertaWildSpecies2010/SearchForWildSpeciesStatus.aspx. Accessed May 13, 2013.

Candler, C. 2011. *Athabasca Chipewyan First Nation Knowledge and Use Report and Assessment for Shell Canada's Proposed Redclay Compensation Lake*. Prepared by Firelight Group Research Cooperative. 121 pp.

Chrichton, V., T. Barjer and D. Schindler. 2004. *Response of a wintering moose population to access management and no hunting – a Manitoba experiment*. Alces 40: 87-94.

Government of Alberta. 2012. *Managing Disease Risk in Alberta's Wood Bison with Special Focus on Bison to the West of Wood Buffalo National Park*. 2011-2012 Progress Report. 22 pp. Available online: http://srd.alberta.ca/fishwildlife/WildlifeDiseases/documents/ManagingDisease-WoodBison-ProgressReport-Aug2012.pdf. Accessed May 6, 2013.

Government of Alberta. 2013. *Ronald Lake bison (Bison bison): winter 2012-1013 activities*. Progress report (final). 39 pp.

Lartner, N.C. and C.C. Gates. 1991. *Diet and habitat selection of wood bison in relation to seasonal changes in forage quantity and quality*. Canadian Journal of Zoology 69:2677-2685.

Mitchell, J.A. and C.C. Gates. 2002. *Status of the wood bison (Bison bison athabascae) in Alberta*. Alberta Sustainable Resource Development, Fish and Wildlife Division, and Alberta Conservation Association, Wildlife Status Report No. 38, Edmonton, AB. 32 pp.

Powell, T. and T. Morgan. 2010. *Ronald Lake bison (Bison bison) survey: February 2010*. Alberta Sustainable Resource Development, Wildlife Division. Fort McMurray, Alberta. 14 pp.

Roe, F.G. 1951. *The North American Buffalo: A Critical Study of the Species in its Wildlife State*. University of Toronto Press, Toronto. Page 303-304.

Species at Risk Public Registry. 2013. http://www.sararegistry.gc.ca. Accessed May 13, 2013.

SIR 42

EIA Volume 4b: Aquatic Resources Appendices, Appendix 4 Closure Drainage Plan for the Jackpine Expansion Mining Area, Section 4.6, Page 41. Shell describes the proposed 4 km^2 Redclay Compensation lake to be constructed as part of the Project.

a) Qualify the effects of the Redclay Compensation Lake on species at risk and describe measures to mitigate these effects.

b) Provide a comparison of species at risk habitat and biodiversity potential at the Redclay Compensation lake location and at alternative compensation lake locations to evaluate their relative suitability for species at risk.

Response:

a) Since submission of the EIA, the size and location of the compensation lake, referred to as South Redclay Lake, has evolved with additional analysis; South Redclay Lake is the current proposal for compensation of fish habitat for the Pierre River Mine as described in the Draft No Net Loss Plan (Golder 2012). There are 16 federally listed Species at Risk (SAR) that could potentially occur in the Local Study Area (LSA) and the proposed South Redclay Lake footprint (Table 42-1). However, many of these SAR are unlikely to be affected by construction of the South Redclay Lake. Red knot do not breed in northeastern Alberta and no historical data on this species within the Oil Sands Region are available. Peregrine falcons are likely migratory in the Oil Sands Region because typical nesting habitat, high cliffs over waterbodies, is not present in the Regional Study Area (RSA) and no eyries have been documented to date. Whooping cranes in the Oil Sands Region breed exclusively in the northern portion of Wood Buffalo National Park in the Northwest Territories. None of these species are likely to be sensitive to the availability of migratory staging habitat within the RSA. In addition, woodland caribou are virtually absent from the LSA, and are therefore unlikely to be affected by construction of the South Redclay Lake.

A detailed list of mitigation measures in relation to potential PRM affects and affected SAR is presented in the response to JRP SIR 43 of this submission. Clearing activities required for construction of the South Redclay Lake may affect the abundance of some wildlife SAR. Specifically, some mortality may occur to western toad, which may be hibernating in the soil during clearing. However, most wildlife species are sufficiently mobile to vacate the area before clearing. In addition, clearing will occur outside of the migratory bird nesting season (see JRP SIR 43), so migratory bird SAR (i.e., Canada warbler, common nighthawk, horned grebe, olive-sided flycatcher, rusty blackbird, short-eared owl and yellow rail) will not be present. In addition, vehicle-wildlife collisions may occur for some SAR during construction. However, speed limits on site will be posted and strictly enforced, thereby reducing the risk of collisions (JRP SIR 43). Overall, wildlife mortality occurring due to construction of South Redclay Lake is predicted to result in a negligible environmental consequence for the abundance of regional populations for each wildlife SAR.

Table 42-1 Federally Listed Species At Risk that Could Occur in the Local Study Area

Common Name	Latin Name	COSEWIC[(a)]	SARA[(a)]
Canada warbler	*Wilsonia canadensis*	Threatened	Schedule 1: Threatened
common nighthawk	*Chordeiles minor*	Threatened	Schedule 1, Threatened
horned grebe	*Podiceps auritus*	Special Concern	No Schedule, No Status
little brown myotis	*Myotis lucifugus*	Endangered	No Schedule, No Status
northern myotis	*Myotis septentrionalis*	Endangered	No Schedule, No Status
olive-sided flycatcher	*Contopus cooperi*	Threatened	Schedule 1: Threatened
peregrine falcon (*anatum/tundrius* subspecies)	*Falco peregrinus*	Special Concern	No Schedule, No Status
red knot (*rufa* subspecies)	*Calidris canutus rufa*	Endangered	No Schedule, No Status
rusty blackbird	*Eughagus caroinus*	Special Concern	Schedule 1: Special Concern
short-eared owl	*Asio flammeus*	Special Concern	Schedule 1: Special Concern
western toad	*Bufo boreas*	Special Concern	Schedule 1: Special Concern
whooping crane	*Grus americana*	Endangered	Schedule 1: Endangered
wolverine (western population)	*Gulo gulo*	Special Concern	No Schedule: No Status
wood bison	*Bison bison athabascae*	Threatened	Schedule 1: Threatened
woodland caribou	*Rangifer tarandus*	Threatened	Schedule 1: Threatened
yellow rail	*Coturnicops noveboracensis*	Special Concern	Schedule 1: Special Concern

(a) Species at Risk Public Registry 2013, internet site.

Most habitat for wildlife SAR within the LSA will be lost or effectively unavailable during construction of the South Redclay Lake and the PRM. However, because the South Redclay Lake footprint represents 0.03% of the RSA, habitat loss due to construction of the compensation lake will result in a negligible environmental consequence for regional populations of wildlife SAR. At closure, the South Redclay Lake and associated waterbodies (i.e., fresh water storage and channels) will be functional wildlife habitat, representing a 323 ha increase in the areal extent of lakes as well as a 23 ha increase in the Canada buffalo-berry-green alder aspen (b2) ecosite phase due to reclamation of the dam faces, borrow pits for the dams and spoil piles for material excavated from the dam footprints. All other ecosite phases and wetland types present in the South Redclay Lake footprint in the 2013 Base Case will be lost during construction.

Changes to high suitability habitat for wildlife SAR were predicted using habitat suitability models (*May 2011, Submission of Information to the Joint Review Panel*, Appendix 2, Federally Listed Species at Risk Assessment, Appendix B; Appendix 3.7). As outlined in Table 42-2, changes due to the South Redclay Lake are predicted to result in the following:

- A Net increase in high suitability habitat in the LSA following reclamation for Canada warbler, horned grebe and wolverine. High suitability horned grebe habitat increases due to the increase in lake area, while high suitability habitat for Canada warbler and wolverine increases due to the removal of disturbances present in the 2013 Base Case, as well as the creation of upland habitat.
- Net decrease in high suitability habitat in the LSA, following reclamation, for common nighthawk, olive-sided flycatcher, rusty blackbird, yellow rail, short-eared owl, western toad and wood bison because of the conversion of terrestrial habitat to the South Redclay Lake.

Table 42-2 Change in High Suitability Habitat for Wildlife Species at Risk Due to the South Redclay Lake

Key Indicator Resource	2013 Base Case Habitat		Change From 2013 Base Case to Construction/Operations		Change From 2013 Base Case to Reclamation	
	High Suitability Habitat Area [ha]	% of High Suitability Habitat in the LSA	Change in High Suitability Habitat Area [ha]	% of High Suitability Habitat Available in the LSA in the 2013 Base Case	Change in High Suitability Habitat Area [ha]	% of High Suitability Habitat Available in the LSA in the 2013 Base Case
Canada warbler	<1	<1	>-1	>-1	31	2
common nighthawk	233	3	-233	-3	-233	-3
horned grebe	3	2	-3	-2	80	36
olive-sided flycatcher	121	6	-121	-6	-78	-4
rusty blackbird	162	5	-162	-5	-149	-5
short-eared owl	101	1	-101	-1	-101	-1
western (boreal) toad	114	4	-114	-4	-35	-1
wolverine	448	3	-448	-3	57	<1
wood bison	23	<1	-23	>-1	-23	>-1
yellow rail	50	3	-50	-3	-50	-3

Little brown myotis and northern myotis were listed as “Endangered” by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in February of 2012 due to the rapidly spreading White-Nose Syndrome (WNS), which is a fungal infection that interferes with hibernation (COSEWIC 2012a,b). Prior to the arrival of WNS in Alberta, the availability of hibernacula may have been limiting regional abundance. However, winter hibernacula in the Alberta Oil Sands Region are only known outside the RSA in Cadomin Cave and Wood Buffalo National Park (ASRD and ACA 2009; Barclay 2012, pers. com.), and will not be affected by construction of the South Redclay Lake. Little brown myotis and northern myotis are considered to be habitat generalists with respect to their summer roosting and foraging habitat, typically using a range of mixedwood and coniferous forests (ASRD and ACA 2009; Crampton and Barclay 1998). Therefore, habitat change for little brown and northern myotis may be generalized from changes to the areal extent of mixedwood and coniferous forests in the RSA. Mixedwood and coniferous forests will decline by about 1% of that available in the LSA in the 2013 Base Case due to construction of the South Redclay Lake.

The environmental consequences of adverse effects of construction of the compensation lake on wildlife SAR habitat will range from negligible to low at the LSA scale, and will be negligible at the RSA scale. Positive effects to habitat due to construction of the compensation lake are predicted for Canada warbler, horned grebe and wolverine.

The South Redclay Lake will present a barrier to the movement of wolverine and wood bison during construction. This barrier will be reduced but not entirely removed at Closure due to the partial barrier presented by the introduction of the lake. Movements of both species will not be affected in winter when the lake is frozen. Bison are capable swimmers and as such, although the lake will likely affect bison movement patterns, the lake is not predicted to be a barrier to summer movement. For wood bison and wolverine movement, the environmental consequences of the South Redclay Lake will be low at the LSA scale and negligible at the RSA scale. For all remaining wildlife SAR, environmental consequences of the South Redclay Lake on movement will be adverse and negligible at the LSA and RSA scale during construction, and positive and negligible at closure.

b) A number of alternative compensation lake location options were considered before selecting the South Redclay Lake location. However, for various reasons, alternative lake locations were deemed to be less appropriate (JRP SIR 30). Because alternative locations were less appropriate, planning for these options did not proceed to a level of design detail that would allow a detailed comparison of wildlife SAR habitat and biodiversity potential between alternative sites.

A discussion of the rationale for selecting the location of South Redclay Lake is discussed as part of the response to JRP SIR 30.

References:

ASRD and ACA (Alberta Sustainable Resources Development and Alberta Conservation Association). 2009. *Status of the Northern Myotis (Myotis sepentrionalis) in Alberta: Update 2009.* Alberta Sustainable Resource Development. Wildlife Status Report No. 3 (Update 2009). Edmonton, AB. 34 pp.

Barclay, R.M.R. 2012. Professor and Department Head, Department of Biological Science, University of Calgary. Email communication with Richard Novy on June 25, 2012.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2012a. *Technical Summary and Supporting Information for an Emergency Assessment of the Little Brown Myotis Myotis lucifugus.* Committee on the Status of Endangered Wildlife in Canada. Ottawa. 25pp.

COSEWIC. 2012b. *Technical Summary and Supporting Information for an Emergency Assessment of the Northern Myotis Myotis septentrionalis.* Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. 24 pp.

Crampton, L.H. and R.M. Barclay. 1998. *Selection of Roosting and Foraging Habitats by Bats in Different-Aged Aspen Mixedwood Stands.* Conservation Biology 12: 1347-1358.

Golder (Golder Associates Ltd.). 2012. *Shell Jackpine Mine Expansion and Pierre River Mine Project Draft No Net Loss Plan.* Submitted to Shell Canada Energy, September 2012, Calgary, AB.

Species at Risk Public Registry. 2013. Available at: http://www.sararegistry.gc.ca. Accessed April 24, 2013.

SIR 43

In the May 2011 Submission of Information to the JRP, Response to Federal Information Requests – Round 2, Page 80 on species at risk, Shell concluded that there are not likely to be any significant adverse environmental effects on any species at risk after the application of appropriate mitigation measures. In its August 2011 letter to the Canadian Environmental Assessment Agency in response to Shell's May 2011 submission on species at risk, Environment Canada indicates that insufficient information is presented to determine the adequacy of the mitigation measures for species at risk. It states that the *Species at Risk Act* (SARA), Section 79(2) states that, "The person must identify the adverse effects of the Project on the listed wildlife species and its critical habitat and, if the Project is carried out, must ensure that measures are taken to avoid or lessen those effects and to monitor them…"

a) Provide a detailed description of on-site and offsite mitigation measures for species at risk that will be used to meet the requirements of the SARA, including all effects on species at risk, regardless of significance. Mitigation measures should be clearly linked to specific project impacts (habitat loss, increased mortality and altered movements) and should address mitigation to i) avoid, minimize or otherwise compensate for loss of habitat for species at risk, ii)

prevent direct or indirect mortality of species at risk, including (but not limited to) whooping cranes, which migrate over the oil sands region, and iii) avoid or minimize effects on species at risk movement.

Response:

a) Federally listed Species at Risk (SAR) that may occur in the Local Study Area (LSA) are listed in Table 43-1. The mitigations that apply to each SAR, as well as the ways in which those mitigations will eliminate, reduce, control or avoid the effects of the Project are described in Table 43-2. Shell's monitoring and adaptive measures are described in Table 43-3.

Table 43-1 Potential and Observed Federally Listed Species in the Local Study Area

Common Name	Latin Name	COSEWIC[(a)]	SARA[(a)]
Canada warbler	*Wilsonia canadensis*	Threatened	Schedule 1: Threatened
common nighthawk	*Chordeiles minor*	Threatened	Schedule 1: Threatened
horned grebe	*Podiceps auritus*	Special Concern	No Schedule, No Status
little brown myotis	*Myotis lucifugus*	Endangered	No Schedule, No Status
northern myotis	*Myotis septentrionalis*	Endangered	No Schedule, No Status
olive-sided flycatcher	*Contopus cooperi*	Threatened	Schedule 1: Threatened
peregrine falcon (*anatum/tundrius* subspecies)	*Falco peregrinus*	Special Concern	No Schedule, No Status
red knot (*rufa* subspecies)	*Calidris canutus rufa*	Endangered	No Schedule, No Status
rusty blackbird	*Eughagus caroinus*	Special Concern	Schedule 1: Special Concern
short-eared owl	*Asio flammeus*	Special Concern	Schedule 3: Special Concern
western toad	*Bufo boreas*	Special Concern	Schedule 1: Special Concern
whooping crane	*Grus americana*	Endangered	Schedule 1: Endangered
wolverine (western population)	*Gulo gulo*	Special Concern	No Schedule, No Status
wood bison	*Bison bison athabascae*	Threatened	Schedule 1: Threatened
woodland caribou	*Rangifer tarandus*	Threatened	Schedule 1: Threatened
yellow rail	*Coturnicops noveboracensis*	Special Concern	Schedule 1: Special Concern

(a) Species at Risk Public Registry 2013.

Table 43-2 Mitigation and their Mechanisms for Minimizing the Effects of the Project on Federally Listed Species at Risk

Potential Effect	Species	Mitigation	Mechanisms for Eliminating or Minimizing Project Effects
Interactions with Infrastructure	Canada warbler, common nighthawk, horned grebe, olive-sided flycatcher, peregrine falcon red knot, rusty blackbird, short-eared owl, whooping crane, yellow rail	Designing lighting to reduce light pollution in the adjacent wildlife corridor (EIA, Volume 5, Section 7.1.3, page 7-11).	Proper lighting will reduce the collisions of avian SAR with infrastructure.
		Using markers, such as aviation spheres, to mark transmission lines, in particular those located above tree line or in clearings (EIA, Volume 5, Section 7.1.3, page 7-11).	Using aviation markers will increase power line visibility and thereby reduce avian mortality due to collisions with infrastructure.
	whooping crane, horned grebe, red knot, yellow rail	Deploying and maintaining bird deterrent systems (EIA, Volume 5, Section 7.1.3, page 7-11).	The use of bird deterrents (e.g., human effigies, scare cannons) are proven effective at deterring waterfowl and shore birds from coming into contact with tailings ponds, thus reducing migratory bird mortality.
Direct Mortality due to Site Clearing	Canada warbler, common nighthawk, horned grebe, little brown myotis, northern myotis, olive sided flycatcher, red knot, rusty blackbird, short-eared owl, western toad whooping crane, yellow rail	Avoiding clearing between April 20 and August 25 (need new reference) to avoid the main breeding bird and ungulate calving seasons (EIA Volume 5, Section 7.1.3, Page 7-11).	Vegetation clearing outside of the main breeding season will eliminate mortality of nesting migratory birds which will not be present in the LSA at that time and will reduce impacts on neonatal ungulates.
Vehicle-wildlife Collisions	All species	Reducing traffic volumes by continuing to transport staff to site using buses (EIA, Volume5, Section 7.1.3, page 7-10 and 7-11).	Minimizing the volume and frequency of traffic along access roads will reduce vehicle-wildlife collisions, as well as reduce indirect effects such as habitat alienation caused from sensory disturbance.
		Planning and sharing access with other industrial partners (EIA, Volume 5, Section 7.1.3, page 7-11).	Fewer roads throughout the LSA will reduce vehicle-wildlife collisions.
		Enforcing traffic speed limits (EIA Volume 5, Section 7.1.3, page 7-10 and 7-11).	Complying with traffic speed limits on site will reduce the risk of vehicle-wildlife collisions, thus minimizing direct mortality of federally listed species at risk occurring in the LSA.
	wolverine, wood bison, woodland caribou	Constructing straight roads with long sight lines where feasible (EIA, Volume 5, Section 7.1.3, page 7-10).	Straight roads with a long line-of-sight will reduce the potential for vehicle-wildlife collisions on the lease, thereby minimizing the effects of the Project on wildlife abundance.
		Fencing the approaches to the Athabasca River bridge (EIA, Volume 5, Section 7.1.3, page 7-10 and 7-11).	Reduce the risk of vehicle collision with wildlife by directing wildlife to crossing structures and deterring wildlife from entering the bridge.
		Posting wildlife crossing signage where key wildlife crossing areas are identified (EIA, Volume 5, Section 7.1.3, page 7-10 and 7-11).	Alerting construction and operations traffic of areas with higher wildlife activity will reduce wildlife mortality events by minimizing vehicle-wildlife collisions.
		Undertaking dust control on roads (EIA, Volume 5, Section 7.1.3, pages 7-11).	Dust control will increase visibility along roads, reducing the potential for wildlife-vehicle collisions and resulting effects on the abundance of federally listed species.
	wolverine	Storing all food wastes in bear-proof containers followed by transport off site (EIA, Volume 5, Section 7.1.3, page 7-11).	Minimize the attraction of wildlife to project facilities and the associated risk of vehicle collisions.
Increased Hunting and Trapping	horned grebe whooping crane, woodland caribou, wolverine, wood bison	Prohibiting staff and contractors from hunting and trapping on site (EIA, Volume 5, Section 7.1.3, pages 7-10 and 7-11; PRM Round 2 SIRs, AENV 74a).	On site hunting and trapping prohibitions will minimize the indirect effects of the Project on the abundance of federally listed species that may be intentionally or unintentionally harvested.
		Controlling access along the access road to the Project.	Increased access may lead to increased hunting and trapping for some wildlife species. Controlling access with reduce the risk of increased hunting and trapping.

Table 43-2 Mitigation and their Mechanisms for Minimizing the Effects of the Project on Federally Listed Species at Risk (continued)

Potential Effect	Species	Mitigation	Mechanisms for Eliminating or Minimizing Project Effects
Sensory Disturbance	All species	Planning and sharing access with other industrial partners (EIA, Volume 5, Section 7.1.3, page 7-11).	Minimizing the total number of roads will reduce the extent of vehicle noise through the LSA thereby reducing sensory disturbance.
		Designing lighting to reduce light pollution in the adjacent wildlife corridor (EIA, Volume 5, Section 7.1.3, page 7-11).	Proper use of lighting (e.g., shielded lighting, directing spotlights away from wildlife corridors) will reduce indirect habitat loss due to sensory disturbance.
	Canada warbler, Common nighthawk, horned grebe, little brown myotis, northern myotis, olive-sided flycatcher, rusty blackbird, short-eared owl, whooping crane, wolverine, wood bison, woodland caribou, yellow rail	Installation of sound attenuation walls if monitoring results suggest sensory disturbance is an issue in the corridors (PRM Round 2 SIRs, AENV 49c).	Reduce the range of noise suspected of creating sensory disturbance in travel corridors.
		Avoiding clearing between April 1 and August 30 to avoid the main breeding bird and ungulate calving seasons (EIA Volume 5, Section 7.1.3, Page 7-11).	Vegetation clearing outside of the main breeding season will eliminate sensory disturbance to breeding birds and bats which will not be present in the LSA at that time and will reduce impacts on neonatal ungulates.
Net Change in Habitat	All species	Reclamation (EIA, Volume 5, Section 7.1.3, page 7-12).	The reclamation of areas disturbed by the Project will reduce the effects of the Project for all species at risk as habitats are reclaimed and wildlife movement is improved. The benefits to each species will vary with the quantity and quality of the reclaimed habitats.
		Implementing regulatory standard soil handling, management and storage practices. (EIA, Volume 5, Section 7.1.3, page 7-11).	Improve the effectiveness of wildlife habitat reclamation for all SAR.
		Leaving remnant forested areas undisturbed where practical (EIA, Volume 5, Section 7.1.3, page 7-10).	Keeping remnant forested areas undisturbed and intact will: - Maintain breeding and foraging habitat. - Maintain potential travel corridors for those remnant areas that are contiguous with large forested areas outside the LSA, thereby maintaining genetic connectivity for species moving throughout the RSA (i.e., wolverine, woodland caribou, bison). - Maintaining dispersal routes for western toads between potential metapopulations thus maintaining genetic connectivity.
		Maintaining a 250-m wildlife corridor along the Athabasca River from the wetted edge in the 100-year flood event. (EIA, Volume 5, Section 7.1.3, page 7-11).	Provides landscape connectivity for ungulates and other mobile species thereby maintaining genetic connectivity for species moving throughout the RSA. Maintains important riparian habitat with high value for nesting birds as well as foraging habitat for a wide array of species.
		Retaining treed buffers around or near watercourses (EIA, Volume 5, Section 7.1.3, page 7-11).	Riparian areas are recognized for their significant role in supporting wildlife and biodiversity. Avoiding these areas during construction and operations will: - Maintain breeding and foraging habitat for a number of listed bird species utilizing these areas during the breeding season. - Maintain potential foraging and travel routes for species such as wolverine, woodland caribou and bison moving throughout the RSA, thus maintaining genetic connectivity. - Maintaining dispersal routes for western toads between potential metapopulations, thus maintaining genetic connectivity. - Create resting opportunities for species migrating through the RSA.
		Planning and sharing access with other industrial partners (EIA, Volume 5, Section 7.1.3, page 7-11).	Sharing access with other industrial partners will reduce habitat loss due to excessive site clearing.
		Undertaking dust control on roads (EIA, Volume 5, Section 7.1.3, pages 7-11).	This measure will minimize dust pollution of roadside habitats that may deter federally listed species from using these areas.
		Expanding and implementing the existing weed control system for the Project area (EIA, Volume 5, Section 7.1.3, page 7-11).	Help maintain the integrity and productivity of natural vegetation communities important to species at risk.
Barriers to Movement	wolverine, wood bison, woodland caribou	Providing for wildlife passage under the Athabasca River bridge on both the east and west banks of the river.	Maintain landscape connectivity and therefore genetic connectivity for species moving throughout the RSA.
		Planning and sharing access with other industrial partners (EIA, Volume 5, Section 7.1.3, page 7-11).	Fewer roads throughout the LSA will reduce linear disturbance on the landscape and potential barriers to movement.

Table 43-3 Monitoring and Adaptive Measures

Mitigation	Species Affected	Mechanisms for Eliminating or Minimizing Project Effects
Shell will structure its monitoring program at Pierre River Mine to align with the monitoring programs at its existing operations. The program will: • monitor soil and vegetation on the reclaimed sites; • assess tree and woody-stemmed plants on the reclaimed sites; and • assess wildlife use of areas reclaimed within and areas adjacent to the mine (EIA, Volume 1, Section 20.3, page 20-28).	All species	Reclamation monitoring will help assess the success of re-vegetation and wildlife re-colonization. The results of monitoring will inform decisions of whether existing re-vegetation trajectories require active intervention within an adaptive management framework. Monitoring and adaptive management of vegetation on reclaimed sites will assist in the development of productive vegetation communities and the wildlife species at risk that depend upon them.
The Wildlife Monitoring Program will be developed collaboratively with government, industry and other stakeholders, should the project be approved. Shell will continue to work closely with these stakeholders to identify target species to be monitored (PRM Round 1 SIRs, AENV 498a).	All species	Wildlife monitoring will help inform the site-specific implementation of wildlife mitigation measures in an adaptive management framework. The combination of monitoring and adaptive management maximizes the effectiveness of mitigation measures for minimizing effects to wildlife and wildlife habitat.
Project specific wildlife monitoring will involve remote cameras to record wildlife use of the movement corridors (JME Round 2 SIRs, AENV 41c). Shell will use adaptive management to determine appropriate strategies to increase the functionality of the corridors for selected target wildlife species if wildlife monitoring program indicates that the river corridors are not facilitating wildlife movement and habitat use as expected (JME Round 2 SIRs, AENV 41d and 43aii).	wolverine wood bison	The use of remote cameras will help monitor the effectiveness of corridors for maintaining landscape connectivity. Results can be compared with remote camera monitoring data collected during baseline surveys. Local corridor monitoring results will be used in an adaptive management framework to adjust mitigation measures that may improve the functionality of the corridor.
Shell will continue its active participation in the Cumulative Environmental Management Association (CEMA) Reclamation Working Group (RWG) that develops reclamation guidelines for the Oil Sands Region. (JME Round 1 SIRs, AENV 429a/ PRM Round 1 SIRs, AENV 448a).	All species	Re-vegetating disturbed lands according to the reclamation guidelines prepared by the CEMA RWG will promote the restoration of productive vegetation communities, including wetlands. Productive vegetation communities are more likely to provide high quality habitat for wildlife species at risk.
Shell is committed to regional research initiatives between industry and government, which will examine the effectiveness of wildlife corridors and link wildlife corridor use with population demographics at the regional scale. Data regarding population demographics may be collected using GPS collars or DNA sampling techniques (JME Round 1 SIRs, AENV 439a; JME Round 2 SIRs, AENV 41c). Shell is participating in the Regional Wildlife Habitat Effectiveness and Corridor Program Technical Committee under CONRAD designed to inform decisions regarding appropriate setback distance and corridor widths for wildlife along project boundaries and adjacent rivers (JME Round1 SIRs, AENV 439cv).	wolverine wood bison	Local monitoring, in combination with regional monitoring, will help evaluate the effectiveness of wildlife corridors at facilitating wildlife movement and maintaining genetic connectivity. Determining appropriate setback distances will assist in adaptive management of corridors to maximize their effectiveness.

References:

Species at Risk Public Registry. 2013. Available at: http://www.sararegistry.gc.ca. Accessed April 24, 2013.

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Environment Canada questioned the adequacy of species at risk baseline data used to conduct analyses for the EIA. In response to these concerns, Shell agreed in its May 2011 Submission of Information to the JRP, Section 4.2 Response to Environment Canada – Wildlife, Page 75 to commence additional baseline surveys in 2011 following protocols as agreed to with Environment Canada. However, Shell stated in the November 2011 Federally Listed Species at Risk Report, Page i, that fires in the PRM LSA in 2011 prevented surveys from being conducted safely due to danger related to smoke and helicopter use.

a) Provide an update of species at risk surveys (including yellow rail) conducted in the PRM LSA in 2012 or planned for future years.

Response:

a) Appendix 6 presents the methods and results of focused field surveys within the Pierre River Mine (PRM) Local Study Area (LSA) for wildlife species listed under the S*pecies at Risk Act* (SARA) and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) that breed within the PRM LSA. Surveys were conducted in June and July 2012.

The list of target species for focused surveys was determined by Golder Associates Ltd. and Shell Canada Limited in co-operation with Environment Canada. Focused surveys were conducted for common nighthawk, horned grebe, Canada warbler, olive-sided flycatcher and rusty blackbird in the PRM LSA. Focused surveys for yellow rails in the LSA were conducted in 2009 (Golder 2009). General survey approaches used for baseline surveys in the PRM LSA (Golder 2007) were sufficient for surveying the remaining federally listed SARs that may potentially breed in the LSA.

The common nighthawk, Canada warbler and olive-sided flycatcher are currently listed federally as 'Threatened' and are on Schedule 1 under the SARA. The western population of horned grebe and rusty blackbird are designated as 'Special Concern' by COSEWIC. Provincially, common nighthawk, horned grebe, Canada warbler and rusty blackbird are designated as 'Sensitive', while olive-sided flycatcher is listed as 'Secure'.

Common nighthawk surveys were conducted at 66 plots on July 6 and 7, 2012. Forty-seven individual common nighthawks were recorded within survey plots in and around the PRM LSA. Mean relative abundance and density were highest in the lichen jack pine (a1) ecosite phase, followed by burned upland (BUu), blueberry jack pine-aspen (b1), and in cutblocks (CC). Twenty-one incidental observations of common nighthawks were recorded in seven different vegetation types.

Seven survey plots were surveyed for horned grebe between June 17 and 20, 2012. No detections of horned grebe were recorded in the LSA.

A total of 103 point counts were conducted during breeding bird SAR surveys from June 17 to 20, 2012. Forty-seven survey plots were surveyed specifically for Canada warbler, 31 for olive-sided flycatcher, 4 for rusty blackbird, and 25 for both olive-sided flycatcher and rusty blackbird due to their overlapping use of some wooded wetlands types. In all, one Canada warbler was observed in the dogwood white spruce (e3) ecosite phase, representing less than 0.02 individuals per hectare of high quality habitat sampled. No observations were made for olive-sided flycatcher or rusty blackbird within the survey plots. During species at risk surveys in 2012 in and around the PRM LSA, five Canada warblers were recorded incidentally; four in the dogwood white spruce (e3) ecosite phase and one in the dogwood balsam poplar-white spruce (e2) ecosite phase. Three incidental observations of olive-sided flycatcher were recorded in a cutblock (CC), as well as in wooded swamp (STNN), and shallow open water (WONN) wetlands types. One incidental observation of a rusty blackbird was recorded near a large shallow open water (WONN) wetlands type during the horned grebe surveys.

Avian SAR were observed where they were expected to be found, thus supporting assumptions related to habitat associations for these species. Those same habitat associations were used to predict the effects of the Project on habitat for federally-listed SAR. Data from SAR surveys form a baseline against which future monitoring data may be compared. However, for these species there is no linkage between the results of the baseline surveys and the Environmental Impact Assessment. Data from focused SAR surveys are not available elsewhere in the Oil Sands Region for comparison. However, even if such data were available, knowing whether abundances were relatively high or low in high quality habitats in the LSAs would not influence Environmental Impact Assessment predictions due to the beyond-regional scale at which populations of these rare species fluctuate. Observations of these SAR would be expected to exhibit high variability at any given location over time.

References:

Golder (Golder Associates Ltd.). 2007. *Wildlife and Wildlife Habitat Environmental Setting Report for the Jackpine Mine Expansion & Pierre River Mine Project*. Prepared for Shell Canada Limited. Calgary, AB. Submitted December 2007.

Golder. 2009. J*ackpine Mine Expansion & Pierre River Mine Project Environmental Impact Assessment Follow-up 2009 Yellow Rail Surveys.* Prepared for Shell Canada Limited. Calgary, AB. Submitted October 2009.

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The Alberta Environment Final Terms of Reference Environmental Impact Assessment Report for the Shell Canada Limited Jackpine Mine Expansion & Pierre River Mine, November 28, 2007, Section 5.6.4 requested that Shell assess the effects of the Project on wildlife indicators and species at risk. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) recently classified the little brown myotis (Myotis lucifugus) and northern myotis (Myotis septentrionalis) as Endangered. Project and cumulative effects should be evaluated for COSEWIC-listed species because they may be listed on Schedule 1 of the SARA prior to Project approval.

a) **Include any new species recently listed by COSEWIC or SARA (e.g., little brown myotis and northern myotis) in its updated assessment for PRM as a separate key indicator species in the EIA**

b) **Using quantitative modelling, where appropriate, identify and discuss direct and indirect Project and cumulative effects on both bat species in the LSA and RSA, including effects on habitat, movement and mortality; and**

c) **Identify mitigation measures to avoid or lessen Project effects on little brown myotis and northern myotis.**

Response:

a) The little brown myotis and the northern myotis were recently listed as “Endangered” by COSEWIC due to White-Nose Syndrome (WNS) which is causing population declines in the eastern portion of their range (COSEWIC 2012a,b). These species are not currently on any schedule of the *Species at Risk Act* (SARA). The little brown myotis and northern myotis are listed as “Secure” and “May Be at Risk” in Alberta, respectively (ASRD 2010).

Little brown myotis and northern myotis were included as Key Indicator Resources (KIRs) in the 2013 assessment for the effects of PRM and other planned developments. Residual and cumulative effects from the 2013 Base Case to the 2013 PRM Application Case during the construction, operation, and closure phases at the Local Study Area (LSA) and Regional Study Area (RSA) scales are assessed in Appendix 1, Section 4.4. Cumulative effects are assessed from the 2013 Base Case to the 2013 Planned Development Case in Appendix 2, Section 3.4.3, from the Pre-Industrial Case to the

2013 Base Case and 2013 PRM Application Case in Appendix 2, Section 4.3.3, and from the PIC to the 2013 PDC in Appendix 2, Section 5.3.3.

b) The direct and indirect effects of the Pierre River Mine and cumulative regional effects on little brown myotis and northern myotis habitat, movement and mortality have been assessed in Appendix 1, Section 4.4 and Appendix 2, Sections 3.4.3, 4.3.3 and 5.3.3.

c) Mitigation measures that will avoid or minimize Pierre River Mine effects on the little brown myotis and the northern myotis are outlined in the response to JRP SIR 43 and are briefly summarized as follows:

- Mortality and sensory disturbance associated with clearing will be avoided or reduced by clearing primarily in winter, when little brown myotis and northern myotis are in hibernacula, which are unlikely to occur in the RSA.
- Planning and sharing access with other industrial partners will reduce habitat loss and sensory disturbance.
- Leaving remnant forested areas undisturbed, where practical, will maintain foraging and roosting habitat.
- Reclamation of areas disturbed by PRM will reduce the effects of habitat loss.

References:

ASRD (Alberta Sustainable Resource Development). 2010. *The General Status of Alberta Wild Species 2010*. Alberta Sustainable Resource Development, Fish and Wildlife Service Division. Available online at: http://srd.alberta.ca/FishWildlife/SpeciesAtRisk/GeneralStatusOfAlbertaWildSpecies/GeneralStatusOfAlbertaWildSpecies2010/SearchForWildSpeciesStatus.aspx. Accessed April 24, 2013.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2012a. *Technical Summary and Supporting Information for an Emergency Assessment of the Northern Myotis Myotis septentrionalis*. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. 24 pp.

COSEWIC. 2012b. *Technical Summary and Supporting Information for an Emergency Assessment of the Little Brown Myotis Myotis lucifugus*. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. 25 pp.

VEGETATION, WETLANDS AND FOREST RESOURCES

SIR 46

EIA Volume 5: Terrestrial Resources and Human Environment, Section 7.6.2.1, Page 7-138. Shell's assessment for terrestrial vegetation, wetlands and forest resources focused on the following KIRs: Lichen Jack Pine Communities, Riparian Communities, Old growth forests, Peatlands, Patterned fens, Rare and special plant communities, Productive forests, Rare plant potential, and Traditional plant potential. Change in wetlands as a whole, including peatlands is provided in The KIRs peatlands and patterned fens were not separated out for the environmental consequence assessments for project effects and for cumulative effects.

a) Provide the environmental consequences for all cases, for the peatland and patterned fen KIRs separately instead of combining them under the heading "wetlands".

Response:

a) Wetlands (including peatlands and patterned fens) are examined as a Key Indicator Resource (KIR) in JRP SIR 5, Appendix 1, Section 4.3. Peatlands and patterned fens are not separated from wetlands in the EIA Planned Development Case (PDC) (EIA Volume 5, Section 7.6.2.1) because the Regional Study Area (RSA) mapping data (LANDSAT) used for the Geographic Information System (GIS) analysis does not differentiate these wetland types, as discussed further below. Although mapping data cannot be used to delineate peatlands and patterned fens at the RSA scale, an estimate is used to develop environmental consequence ratings discussed below. The loss of soil-disturbed peatlands is considered to be irreversible due to the current inability to completely recover peatland systems after soils disturbance (Rooney et al. 2011) using current reclamation standards.

Local Study Area

The results of the 2013 PRM Application Case are provided in JRP Appendix 1, Section 4.3, Table 4.3-2 of this submission. To summarize, there are 5,592 ha of peatlands (including burned wetlands) in the PRM Local Study Area (LSA) for the 2013 Base Case (Table 46-1). Clearing (i.e., direct effects) and water table drawdown (i.e., indirect effects) due to PRM will reduce peatlands by 4,704 ha to 888 ha, a loss of 84% of the resource in the LSA. At Closure, some of this loss will be recovered due to the natural recovery of some peatlands from effects of water table drawdown; a total of 1,808 ha of peatlands or 32% of the resource at 2013 Base Case are predicted to be present at Closure. The net change of peatland in the LSA is a loss of 3,784 ha or 68% of the resource from 2013 Base Case. There are 67 ha of patterned fens (i.e., FOPN) in the PRM LSA for the 2013 Base Case. Clearing (i.e., direct effect) and water table drawdown (i.e., indirect effect) due to PRM will result in a 100% loss within the LSA and therefore a 100% loss of the patterned fens (FOPN) resource in the 2013 PRM Application Case. As a result of recovery from water table drawdown, not all patterned fens are permanently lost. At Closure (i.e., after reclamation), there remains a 54 ha loss of patterned fen (81% of resource) due to the direct effects of PRM. In the LSA, the loss of peatlands and patterned fens results in a high environmental consequence for this resource during construction and operations (JRP SIR 5, Appendix 1, Section 4.6, Table 4.6-17) and at Closure (JRP SIR 5, Appendix 1, Section 4.6, Table 4.6-18).

Table 46-1 Peatlands and Patterned Fens to be Cleared and Reclaimed in the Local Study Area

Map Code	Description	2013 Base Case[a]		Direct Loss/Alteration due to PRM		Indirect Loss/Alteration due to Drawdown from PRM		Loss/Alteration due to PRM Direct and Indirect Effects[b]		Closure[c]		Net Change due to PRM[d]	
		Area [ha]	% of LSA[a]	Area [ha]	% of Resource[e]	Area [ha]	% of Resource[e]	Area [ha]	% of Resource[e]	Area [ha]	% of Resource[e]	Area [ha]	% of Resource[e]
Wetlands Types													
BFNN	forested bog	17	<1	-16	-92	-1	-6	-17	-97	1	8	-16	-92
BONS	shrubby bog	1	0	-1	-100	0	0	-1	-100	0	0	-1	-100
BTNN	wooded bog	347	1	-186	-54	-128	-37	-314	-91	172	50	-175	-50
BUw	burn wetlands[f]	2,345	10	-1,616	-69	-294	-13	-1,910	-81	728	31	-1,616	-69
FONG	graminoid fen	810	4	-661	-82	-86	-11	-746	-92	149	18	-661	-82
FONS	shrubby fen	963	4	-513	-53	-210	-22	-724	-75	450	47	-513	-53
FOPN	open patterned fen	67	<1	-54	-81	-13	-19	-67	-100	13	19	-54	-81
FTNN	wooded fen	1,042	5	-748	-72	-178	-17	-926	-89	295	28	-748	-72
Peatlands and Patterned Fens Total		**5,592**	**24**	**-3,795**	**-68**	**-909**	**-16**	**-4,704**	**-84**	**1,808**	**32**	**-3,784**	**-68**

(a) For the purposes of this assessment, each land cover type is assumed to be 100% of Resource at 2013 Base Case.

(b) Loss/alteration due to the PRM combines direct effects due to site clearing (Project footprint) and indirect effects due to groundwater drawdown within the LSA, and at 2013 PRM Application Case is the value upon which the environmental consequence is assessed.

(c) Closure scenario includes reclamation of the PRM development areas. Values presented in this table do not include indirect effects due to groundwater drawdown, as drawdown will occur primarily during the life of PRM. Drawdown effects on wetlands types and the compensation lake may extend to Closure. At Closure combined direct and indirect effects are predicted to cause a loss of 899 ha (16% of resource) of peatlands and 67 ha (100% of resource) of patterned fens.

(d) Net change due to the PRM is calculated as the difference between 2013 Base Case and Closure. Net change is a value upon which the environmental consequence is assessed at Closure.

(e) % of Resource is calculated as a percentage of 2013 Base Case area.

(f) The burn wetlands (BUw) type is also considered to be a peatlands wetlands type.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

n/a = Not applicable.

Regional Study Area

Peatlands and patterned fens are not separated from wetlands in the EIA PDC (EIA Volume 5, Section 7.6.2.1) because the RSA LANDSAT mapping data used for the GIS analysis does not differentiate these wetland types. Because the environmental consequence ratings are based on data from the GIS analysis, the ratings were not provided for peatlands and patterned fens in the EIA. Shell's January 18, 2012 letter to the JPME Joint Review Panel provides a discussion on why the more detailed Alberta Vegetation Inventory (AVI) mapping data cannot be used for RSA scale analysis. First, AVI data are not available over the entire RSA. Second, even if these data were available, there are computational limits on the number of data polygons that the GIS, used in the assessment, can process without failing, and the number of polygons in the RSA exceeds that limit.

Although mapping data cannot be used to delineate peatlands and patterned fens at the RSA scale, an estimate of the areal extent of peatlands and patterned fens in the RSA can be used to develop environmental consequence ratings.

Based on a review of nine oil sands projects within the RSA, peatlands are estimated to represent 67% of all wetlands mapped at the regional scale (EIA, Volume 5, Section 7.6.2.1). AVI data are not available for patterned fens across the whole RSA and therefore has to be estimated. Vitt et al. (2001) determined that roughly 11% of wetlands within the Boreal ecoregion are comprised of patterned fens. The peatland and patterned fen proportions (i.e., 0.67 and 0.11, respectively) can be used to estimate 2013 Base Case and loss/alteration of peatlands and patterned fens within the RSA. These proportions are calculated using the total amount of wetlands lost or altered during construction and operations, and after reclamation (2013 PRM Application Case and 2013 PDC).

Peatland Results in the Regional Study Area

For the PIC, there were 1,015,270 ha of wetlands in the RSA. Considering that 67% of this wetland area is estimated to be peatlands, then a total of 680,231 ha of the RSA can be considered peatlands for the PIC.

Using the 0.67 proportion, it is estimated that there are 599,874 ha (26% of the RSA) of peatlands in the 2013 Base Case.

In the 2013 Application Case, the PRM's environmental consequences in the RSA for peatlands are as follows, using the 0.67 proportion:

- During Construction and Operations, 6,637 ha (1% of resource) of peatlands are predicted to be lost, resulting in a negative and low environmental consequence.
- After reclamation, 4,550 ha (less than 1% of resource) of peatlands are predicted to be lost resulting in a negative and low environmental consequence.

In the 2013 PDC, PRM and planned developments result in environmental consequences in the RSA for peatlands as follows, based on the 0.67 proportion:

- During 2013 PDC Construction and Operations, 47,384 ha of peatlands (8% of resource) are predicted to be lost, resulting in a negative and moderate environmental consequence.
- After reclamation, 6,661 ha of peatlands (1% of resource) are predicted to be lost, resulting in a negative and moderate environmental consequence.
- The amount of peatlands estimated at 2013 PDC after reclamation is 593,213 ha (99% of resource).

Patterned Fen Results in the Regional Study Area

For the PIC, there are 1,015,270 ha of wetlands. Under the assumption that 11% of this wetland area is patterned fens, a total of 111,680 ha of the PIC RSA would be considered to be patterned fens.

Using the 0.11 proportion, it is estimated that there are 98,487 ha (4% of the RSA) of patterned fens in the 2013 Base Case.

In the 2013 Application Case, using the 0.11 proportion, the PRM's environmental consequences in the RSA for patterned fens are as follows:

- During Construction and Operations, 1,090 ha (1% of resource) of patterned fens are predicted to be lost, resulting in a negative, low environmental consequence.
- After reclamation, 883 ha (less than 1% of resource) of patterned fens are predicted to be lost, resulting in a negative and negligible environmental consequence.

In the 2013 PDC, using the 0.11 proportion, the Project and planned developments result in environmental consequences in the RSA for patterned fens as follows:

- During 2013 PDC Construction and Operations, 7,779 ha of patterned fens (8% of resource) are predicted to be lost, resulting in a negative and moderate environmental consequence.
- After reclamation, 1,094 ha (1% of resource) of patterned fens are predicted to be lost, resulting in a negative and moderate environmental consequence.
- The amount of patterned fens estimated at 2013 PDC after reclamation is 97,393 ha (99% of resource).

References:

Rooney, R.C., S.E. Bayley and D.W. Schindler. *Oil sands mining and reclamation cause massive loss of peatland and stored carbon*. http://www.pnas.org/content/109/13/4933 Accessed March 23, 2012.

Vitt, D.H., L.A. Halsey, C. Campbell, S.E. Bayley and M.N. Thormann. *2001 Spatial patterning of net primary production in wetlands of continental Canada*. Ecoscience 8: 499-505.

SIR 47

With respect to the EIA Update Report 2008, Section 2, Table 2.7-4, Page 69, indicate for this table which ecosite phases are associated with which Vegetation, Wetlands and Forestry KIRs.

Response:

Shell used the following vegetation-related Key Indicator Resources (KIRs) in its terrestrial assessment.

- riparian communities (1);
- rare plant potential – high (2);
- traditional plant potential – high (3);
- lichen jack pine communities (4);
- old growth forest (5);
- peatlands (6);
- patterned fens (7);
- rare and special plant communities (8); and
- productive forest (9).

These KIRs each map to single or multiple ecosite phases or wetlands types. Table 47-1 is an update to the 2008 EIA Update, Section 2, Table 2.7-4. Table 47-1 includes a column titled “Terrestrial Vegetation, Wetlands and Forest Resources KIRs” which lists the relevant KIRs for a given ecosite phase or wetlands type. The cells in column “Terrestrial Vegetation, Wetlands and Forest Resources KIRs” contain numbers that correspond to the associated KIRs listed above (see footnote ‘a’).

Table 47-1 Ecosite Phases and Wetlands Types to be Cleared and Reclaimed in the Local Study Area

Terrestrial Vegetation, Wetlands and Forest Resources KIRs[a]	Map Code	Description	2013 Base Case[b]		Direct Loss/Alteration due to Pierre River Mine		Indirect Loss/Alteration due to Drawdown from Pierre River Mine		Loss/Alteration due to Pierre River Mine Direct and Indirect Effects[b]		Closure[c]		Net Change due to Pierre River Mine[d]	
			Area [ha]	% of LSA[b]	Area [ha]	% of Resource[f]	Area [ha]	% of Resource[f]	Area [ha]	% of Resource[f]	Area [ha]	% of Resource[f]	Area [ha]	% of Resource[f]
Central Mixedwood Natural Subregion Ecosite Phases														
4,9	a1	lichen jack pine	7	<1	-7	-100	n/a	n/a	-7	-100	56	818	49	718
3,5,8,9	b1	blueberry jack pine-aspen	125	<1	-83	-67	n/a	n/a	-83	-67	151	121	26	21
3,9	b2	blueberry aspen (white birch)	37	<1	-14	-39	n/a	n/a	-14	-39	143	386	106	286
3,5,9	b3	blueberry aspen-white spruce	115	<1	-51	-45	n/a	n/a	-51	-45	332	289	217	189
3,5,9	b4	blueberry white spruce-jack pine	101	<1	-72	-71	n/a	n/a	-72	-71	29	29	-72	-71
9	c1	Labrador tea-mesic jack pine-black spruce	5	<1	-5	-99	n/a	n/a	-5	-99	958	20,404	953	20,304
3,5,9	d1	low-bush cranberry aspen	873	4	-363	-42	n/a	n/a	-363	-42	1,405	161	532	61
3,5,9	d2	low-bush cranberry aspen-white spruce	468	2	-247	-53	n/a	n/a	-247	-53	425	91	-42	-9
3,5,9	d3	low-bush cranberry white spruce	208	<1	-71	-34	n/a	n/a	-71	-34	137	66	-71	-34
1,3,5,9	e1	dogwood balsam poplar-aspen	7	<1	-6	-88	n/a	n/a	-6	-88	48	660	41	560
1,3,5,9	e2	dogwood balsam poplar-white spruce	97	<1	-30	-31	n/a	n/a	-30	-31	113	117	17	17
1,3,5,9	e3	dogwood white spruce	74	<1	-51	-69	n/a	n/a	-51	-69	179	243	106	143
1	f1	horsetail balsam poplar-aspen	2	<1	-2	-100	n/a	n/a	-2	-100	0	0	-2	-100
3,9	f2	horsetail balsam poplar-white spruce	<1	<1	-<1	-100	n/a	n/a	-<1	-100	0	0	-<1	-100
9	f3	horsetail white spruce	4	<1	-2	-62	n/a	n/a	-2	-62	1	38	-2	-62
9	g1	Labrador tea-subhygric black spruce-jack pine	11	<1	-<1	-4	n/a	n/a	-<1	-4	10	96	-<1	-4
1,5,9	h1	Labrador tea/horsetail white spruce-black spruce	107	<1	-58	-54	n/a	n/a	-58	-54	49	46	-58	-54
		central mixedwood ecosite phases subtotal	*2,240*	*10*	*-1,065*	*-48*	*n/a*	*n/a*	*-1,065*	*-48*	*4,037*	*180*	*1,798*	*80*
Athabasca Plain Natural Subregion Ecosite Phases														
4,5,9	a1	bearberry jack pine	772	3	-294	-38	n/a	n/a	-294	-38	689	89	-83	-11
3,5,9	b1	Canada buffalo-berry-green alder jack pine-aspen-white birch	1,654	7	-595	-36	n/a	n/a	-595	-36	1,065	64	-590	-36
3,5,9	b2	Canada buffalo-berry-green alder aspen	1,939	8	-676	-35	n/a	n/a	-676	-35	2,055	106	117	6
3,5,9	b3	Canada buffalo-berry-green alder aspen-white spruce-black spruce	1,227	5	-634	-52	n/a	n/a	-634	-52	1,258	102	30	2
3,5,9	b4	Canada buffalo-berry-green alder white spruce-black spruce-jack pine	451	2	-206	-46	n/a	n/a	-206	-46	248	55	-203	-45
9	c1	Labrador tea-mesic jack pine-black spruce	23	<1	-8	-36	n/a	n/a	-8	-36	1,133	4,905	1,110	4,805
n/a	d1	Labrador tea-subhygric black spruce-jack pine	34	<1	-23	-69	n/a	n/a	-23	-69	2,105	6,265	2,072	6,165
1,3,5,9	e1	willow/horsetail aspen-white birch-balsam poplar	319	1	-29	-9	n/a	n/a	-29	-9	292	92	-27	-8
1,3,5,9	e2	willow/horsetail aspen-white spruce-black spruce	224	<1	-126	-56	n/a	n/a	-126	-56	209	93	-15	-7
1,3,5,9	e3	willow/horsetail white spruce-black spruce	159	<1	-61	-38	n/a	n/a	-61	-38	480	302	321	202
9	Pj-Lt Complex	jack pine-tamarack complex	4	<1	-4	-100	n/a	n/a	-4	-100	0	0	-4	-100
		Athabasca plain ecosite phases subtotal	*6,805*	*29*	*-2,655*	*-39*	*n/a*	*n/a*	*-2,655*	*-39*	*9,533*	*140*	*2,728*	*40*
Wetlands Types														
6	BFNN	forested bog	17	<1	-16	-92	-1	-6	-17	-97	1	8	-16	-92
2,6	BONS	shrubby bog	1	<1	-<1	-100	0	0	-<1	-100	0	0	-<1	-100
6	BTNN	wooded bog	347	1	-186	-54	-128	-37	-314	-91	172	50	-175	-50
1,2,6	FONG	graminoid fen	810	4	-661	-82	-86	-11	-746	-92	149	18	-661	-82
1,2,6	FONS	shrubby fen	963	4	-513	-53	-210	-22	-724	-75	450	47	-513	-53
1,2,6,7,9	FOPN	open patterned fen	67	<1	-54	-81	-13	-19	-67	-100	13	19	-54	-81
1,2,6,8	FTNN	wooded fen	1,042	5	-748	-72	-178	-17	-926	-89	295	28	-748	-72
1,2	MONG	marsh	140	<1	-104	-74	-36	-26	-140	-100	146	104	6	4
1,2,8	SONS	shrubby swamp	495	2	-221	-45	-37	-8	-258	-52	275	55	-221	-45
1,5,9	STNN	wooded swamp	590	3	-239	-41	-210	-36	-449	-76	351	59	-239	-41
2	WONN	shallow open water	69	<1	-42	-62	-<1	-<1	-43	-62	27	38	-42	-62
		wetlands types subtotal	*4,541*	*20*	*-2,785*	*-61*	*-900*	*-20*	*-3,684*	*-81*	*1,878*	*41*	*-2,663*	*-59*

Table 47-1 Ecosite Phases and Wetlands Types to be Cleared and Reclaimed in the Local Study Area (continued)

Terrestrial Vegetation, Wetlands and Forest Resources KIRs[a]	Map Code	Description	2013 Base Case[b]		Direct Loss/Alteration due to Pierre River Mine		Indirect Loss/Alteration due to Drawdown from Pierre River Mine		Loss/Alteration due to Pierre River Mine Direct and Indirect Effects[b]		Closure[c]		Net Change due to Pierre River Mine[d]	
			Area [ha]	% of LSA[b]	Area [ha]	% of Resource[f]	Area [ha]	% of Resource[f]	Area [ha]	% of Resource[f]	Area [ha]	% of Resource[f]	Area [ha]	% of Resource[f]
Miscellaneous Vegetation Types														
1,9	BUu	burn upland	5,065	22	-2,533	-50	n/a	n/a	-2,533	-50	2,533	50	-2,533	-50
1,6	BUw	burn wetlands[g]	2,345	10	-1,616	-69	-294	-13	-1,910	-81	728	31	-1,616	-69
1	Me	meadow	9	<1	-2	-20	n/a	n/a	-2	-20	7	80	-2	-20
1,2	Sh	shrubland	110	<1	-3	-3	n/a	n/a	-3	-3	108	97	-3	-3
n/a	Sh1	reclaimed shrubland type 1	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	413	n/a	413	n/a
n/a	Sh2	reclaimed shrubland type 2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	699	n/a	699	n/a
		miscellaneous vegetation types subtotal	*7,530*	*33*	*-4,154*	*-55*	*-294*	*-4*	*-4,448*	*1,513*	*4,488*	*60*	*-3,042*	*-201*
Non-Vegetation Types														
n/a	lake	lake[h]	83	<1	-51	-61	n/a	n/a	-51	-61	2,041	2,447	1,957	2,347
n/a	littoral zone	littoral zone	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	254	n/a	254	n/a
n/a	river	river	180	<1	-2	-1	n/a	n/a	-2	-1	178	99	-2	-1
1	sand	sand	48	<1	-5	-10	n/a	n/a	-5	-10	43	90	-5	-10
		non-vegetation types subtotal	*312*	*1*	*-58*	*-19*	*n/a*	*n/a*	*-58*	*-19*	*2,516*	*807*	*2,205*	*707*
Disturbances														
9	CC	cutblock	931	4	-606	-65	n/a	n/a	-606	-65	325	35	-606	-65
1[i]	DIS	disturbance	771	3	-420	-54	n/a	n/a	-420	-54	351	46	-420	-54
		disturbances subtotal	*1,702*	*7*	*-1,026*	*-60*	*n/a*	*n/a*	*-1,026*	*-60*	*676*	*40*	*-1,026*	*-60*
Total			**23,129**	**100**	**-11,742**	**-51**	**-1,193**	**-5**	**-12,935**	**-56**	**23,129**	**100**	**n/a**	**n/a**

(a) Numbers in each row indicate that the ecosite phases and wetlands types have the potential to contain the following Key Indicator Resources (KIRs): 1) riparian communities (if within 100m of water), 2) high rare plant potential, 3) high traditional plant potential, 4) lichen jack pine communities, 5) old growth, 6) peatlands, 7) patterned fens, 8) rare and special plants communities and 9) productive forest.

(b) For the purposes of this assessment, each land cover type is assumed to be 100% of Resource at 2013 Base Case.

(c) Loss/alteration due to the Pierre River Mine (PRM) combines direct effects due to site clearing (Project footprint) and indirect effects due to groundwater drawdown within the LSA, and at 2013 PRM Application Case is the value upon which the environmental consequence is assessed.

(d) Closure scenario includes reclamation of the PRM development areas. Values presented in this table do not include indirect effects due to groundwater drawdown, as drawdown will occur primarily during the life of PRM. Drawdown effects on wetlands types surrounding pit lakes may extend to Closure. At Closure combined direct and indirect effects are predicted to cause a loss of 978 ha (22% of resource) of wetlands, 899 ha (16% of resource) of peatlands and 67 ha (100% of resource) of patterned fens.

(e) Net change due to the PRM is calculated as the difference between 2013 Base Case and Closure. Net change is a value upon which the environmental consequence is assessed at Closure.

(f) Percent of Resource is calculated as a percentage of 2013 Base Case area.

(g) The burn wetlands (BUw) type is also considered to be a peatlands wetlands type.

(h) Includes a planned compensation lake and planned littoral zones bordering pit lakes at Closure.

(i) Disturbed riparian communities include cutline/trail and inactive wellsites.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

n/a = Not applicable.

SIR 48

In EIA Volume 5: Terrestrial Resources and Human Environment, Section 7.6.2, Table 7.6-4, Page 7-138:

a) clarify what is meant by "Far Future."

b) clarify whether the net change due to planned developments presented in Table 7.6-4 is after reclamation. If it is before reclamation, provide the values for the Regional Land Cover Classes after reclamation.

c) under "wetlands", provide the area and percentages for peatlands and patterned fens individually.

Response:

a) Far Future is defined as 80 years following final reclamation.

b) The values presented for net change due to planned developments (EIA, Volume 5, Section 7.6.2, Table 7.6-4) are after reclamation. Net change is calculated as the difference between the 2013 Base Case and Far Future. EIA, Volume 5, Section 7.6.2, Table 7.6-4 has been updated in Appendix 2, Section 3.4.2, Table 3.4-5 for the revised 2013 PDC.

c) As detailed in the response to JRP SIR 46, the Regional Study Area (RSA) scale area and percentages for peatlands and patterned fens are not assessed individually using Geographic Information System (GIS) because wetlands classification at the RSA scale is too coarse to differentiate peatlands and patterned fens separately from other wetlands. However, applying the assessment methods discussed in the response to JRP SIR 46 to the information in Appendix 2, Section 3.4.2, Table 3.4-5 of this submission, a high level estimate of changes in peatlands due to the 2013 PDC are provided as follows:

- 2013 Base Case – 599,874 ha of peatlands comprising approximately 26% of the RSA area.
- Losses due to PRM (i.e., 2013 PRM Application Case) during construction and operations – 6,637 ha, 1% of resource.
- Losses due to the PRM and planned developments in the 2013 PDC during construction and operations – 47,384 ha, 8% of resource.
- Net loss to peatlands in 2013 PDC at Closure after reclamation – 6,661 ha, 1% of resource.
- Resultant closure condition in the 2013 PDC after reclamation – 593,213 ha comprising 99% resource of peatlands in the 2013 Base Case.

Similar data as was used to estimate peatlands are not available for patterned fens within the RSA. However, Vitt et al. (2001) determined that roughly 11% of wetlands within the Boreal ecoregion are comprised of patterned fens.

Applying the assessment methods discussed in the response to JRP SIR 46 to the information in Table 3.4-5 of JRP Appendix 2 (updated version of EIA's Table 7.6-4), a high level estimate of changes in patterned fens due in the 2013 PDC are provided as follows:

- 2013 Base Case – 98,487 ha patterned fens comprising approximately 4% of the RSA area.
- Losses due to PRM (i.e., 2013 PRM Application Case) during construction and operations – 1,090 ha, 1% of resource.
- Losses due to the PRM and planned developments in 2013 PDC during construction and operations –7,779 ha, 8% of resource.
- Net loss to patterned fens in the 2013 PDC at Closure after reclamation – 1,094 ha, 1% of resource.
- Resultant closure condition in the 2013 PDC after reclamation – 97,393 ha comprising 99% resource of patterned fens in the 2013 Base Case.

References:

Vitt, D.H., L.A. Halsey, C. Campbell, S.E. Bayley and M.N. Thormann. 2001. *Spatial Patterning of Net Primary Production in Wetlands of Continental Canada*. Ecoscience 8: 499-505.

SIR 49

EIA Volume 5: Terrestrial Resources and Human Environment, Section 7.6.2.1, Table 7.6-5, Page 7-140 is unclear with respect to impacts to old growth forest.

a) Clarify whether this table reflects the project and planned development effects before or after closure and reclamation.

b) Provide total values for loss of old growth forest for the PRM LSA.

c) Clarify if the increase in old growth forest in the column titled "Loss/Alteration Due to the Project and Jackpine Mine – Phase 1" indicates old growth before reclamation, after reclamation, or in the Far Future.

d) **Clarify if the columns representing hectares are hectares of each land cover class or of approximate old growth within each land cover class.**

Response:

a) Table 7.6-5 (EIA, Volume 5, Section 7) provides the EIA Application Case and EIA PDC impacts to old growth forest before Closure and reclamation in the RSA. The table values also represent impacts after reclamation and Closure. While Shell expects re-establishment of old growth forest in the reclaimed project areas, for the purposes of the assessment, reclamation and Closure measures for terrestrial resources consider conditions 80 years following the end of operations. Development of old growth forest is expected to take 100 or more years, depending on the tree species (Andison 2003; Schneider 2002), such that effects after Closure and reclamation are conservatively estimated to be the same as effects before Closure and reclamation. Table 7.6-5 is updated in Appendix 2 of this submission as Table 5.3-6 for the 2013 PDC.

b) Total old growth forest lost for the PRM Local Study Area (LSA) is 448 ha (less than 1% of resource) (Table 49-1). Further details on impacts to old growth forest in the 2013 PDC are discussed in the response to JRP SIR 8 in Appendix 2, Section 5.3.2 of this submission.

c) The values presented under the column titled “Loss/Alteration Due to the Project and Jackpine Mine – Phase 1” within Table 7.6-5 (EIA, Volume 5, Section 7) are incorrect. The corrected information is discussed in Section 2.0, Table 2-1. Because PRM and Jackpine Mine Expansion result in a decrease in old growth forest, the values in the column should have been negative. As discussed above, this decrease in old growth forest applies to conditions both before and after Closure and reclamation.

   A revised table is presented below for clarification (Table 49-1), and is also included in the Errors and Omissions, Section 2.0. The revised table reflects the updated loss/alteration due to the PRM as presented in the response to JRP SIR 5 (Appendix 2, Section 4.3.2); the effects of the Jackpine Mine Expansion are excluded. The loss/alteration due to planned developments has also been updated in accordance with the response to JRP SIR 8 (Appendix 2, Section 5.3.2).

Table 49-1 Old Growth Forest in the Regional Study Area: 2013 Base Case to 2013 Planned Development Case

Regional Land Cover Classes	Forest Type (Old Growth Range)[(a)]	Mid-Point Estimated Occurrence of Old Growth in the RSA[(b)]	Estimated 2013 Base Case Old Growth in the RSA[(c)(d)]		Estimated Loss/Alteration of 2013 Base Case Old Growth Due to the Pierre River Mine[(e)]		Estimated Loss/Alteration of 2013 Base Case Old Growth Due to Planned Developments[(c)(d)]	
		[% of Land Cover] Class	Area [ha]	% of RSA[(f)]	Area [ha]	% of Resource[(g)]	Area [ha]	% of Resource[(g)]
Terrestrial Vegetation								
coniferous jack pine	pine dominant (16-36%)	26	43,246	2	-<1	-<1	-1,337	-3
coniferous jack pine-black spruce	pine dominant (16-36%)	26	10,414	<1	-88	-<1	-421	-4
coniferous white spruce	white spruce dominant (10-34%)	22	11,525	<1	-72	-<1	-1,134	-10
deciduous aspen-balsam poplar	hardwood dominant (14-42%)	28	49,859	2	-95	-<1	-6,526	-13
mixedwood aspen-jack pine	mixedwood dominant (16-38%)	27	10,539	<1	-19	-<1	-632	-6
mixedwood aspen-white spruce	mixedwood dominant (16-38%)	27	39,085	2	-173	-<1	-4,336	-11
treed bog/poor fen	black spruce dominant (12-28%)	20	84,771	4	0	0	-4,868	-6
treed fen	black spruce dominant (12-28%)	20	46,074	2	-<1	-<1	-5,206	-11
Total		**n/a**	**295,513**	**13**	**-448**	**-<1**	**-24,460**	**-8**

(a) Based on percent ranges of overmature dominant tree species derived from computer modeling of historic patterns in seral stage variation over time (Andison 2003).

(b) Based on mid-point of the overmature age class range values in Andison (2003).

(c) Burns and cutblocks as modelled by ALCES are accounted for within each Regional Land Cover Class (RLCC).

(d) Estimations are calculated by multiplying the total area of each land cover class by the mid-point estimated occurrence of old growth.

(e) Values generated by correlating the amount of loss/alteration of old growth in each LSA vegetation type to the corresponding regional land cover class.

(f) For the purposes of this assessment, each RLCC is assumed to be 100% of resource at 2013 Base Case.

(g) % of Resource is calculated as a percentage of 2013 Base Case area; the areas of this column are not additive.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

n/a = Not applicable, PRM - Pierre River Mine.

d) Each column in Table 7.6-5 (EIA, Volume 5, Section 7) and in the revised Table 49-1 with the units of “hectares” refers to hectares of old growth forest and are estimated as outlined below.

The number of hectares of old growth presented in the column titled “Loss/Alteration Due to the Project and Jackpine Mine – Phase 1” were derived using Alberta Vegetation Inventory (AVI) data for the LSA. Values were generated by correlating the amount of loss/alteration of old growth in each LSA vegetation type to the corresponding regional land cover class. Section 3.3.3, Table 3.3-2 of the Terrestrial Vegetation Wetlands and Forest Resources Environmental Setting for the Jackpine Mine Expansion & Pierre River Mine Project provides a correlation between the regional land cover classes used in the RSA map and the vegetation types and disturbances mapped within the LSA. As discussed in the response to JRP SIR 5, regional mapping data does not include AVI data.

The number of hectares of old growth presented in the columns titled “Estimated 2013 Base Case Old Growth in the Regional Study Area (RSA)” and “Loss/Alteration Due to Planned Developments” were estimated from the relationships between the regional land cover classes and predicted levels of old growth for each class in the region. The amount of old growth forest in the RSA was determined based on the midpoint values for age class variability (Andison 2003), as listed in the column titled “Estimated Occurrence of Old Growth in the RSA [%].”

References:

Andison, D. 2003. *Natural Levels of Forest Age-Class Variability on the Alberta-Pacific FMA*. Bandaloop Landscape-Ecosystem Services. November, 2003. Belcarra, BC.

Schneider, R.R. 2002. *Old Growth Forests in Alberta: Ecology and Management*. Alberta Centre for Boreal Research. Edmonton, AB.

SIR 50

EIA Volume 5: Terrestrial Resources and Human Environment, Appendix 5-3, Table 6, Page 8. Shell states that terrestrial upland vegetation will increase by 17% and wetlands will decrease by 67% in the LSA during the Application Case, resulting in a more homogeneous landscape at closure that will replace wetland types with more uniform terrestrial habitat types.

a) Assess the future loss of peatlands throughout the RSA and its long-term impact on the regional component of the Boreal Forest ecosystem.

b) Explain the effects of peatland loss on surface water storage, surficial groundwater levels, water quality, and surrounding vegetation.

c) Identify potential impacts of peatland loss on vegetation communities and on biodiversity. Include listed species at risk and migratory birds.

Response:

a) The Geographic Information System (GIS) dataset used for Regional Study Area (RSA) analysis does not differentiate peatlands from other wetlands; however, a conceptual estimate is available in JRP SIR 46. The future loss of wetlands throughout the RSA is 6,792 ha and is discussed in the response to JRP SIR 5 (Appendix 1, Tables 4.3-1 and 4.3-2). The PRM will result in a loss of peatlands in the Local Study Area (LSA) and a shift to more areas of drier upland ecosites and open water at Closure (JRP SIR 46). This shift will occur because it is not currently possible to completely recover the loss of peatland systems after disturbance (Rooney et al. 2011). Wetland loss due to the PRM is predicted to be less than 1% of the resource in the RSA and therefore a negligible regional impact which is unlikely to have a long-term impact to the Boreal Forest Ecosystem. However, there may be local effects on surface water storage, surficial groundwater levels, water quality and surrounding vegetation.

b) The PRM will result in a loss of peatlands in the LSA and a shift to more areas of drier upland ecosites and open water at Closure. This shift will occur because it is not currently possible to completely recover the loss of peatland systems after disturbance (Rooney et al. 2011) as reclamation techniques have not been established. Although peatland loss due to the PRM is predicted to be less than 1% of the resource in the RSA and therefore a negligible regional impact, there may be local effects on surface water storage, surficial groundwater levels, water quality and surrounding vegetation.

While peatlands will be lost in the LSA at Closure, water storage on-site will continue to be provided through a combination of pit lakes, a compensation lake, vegetated waterways and constructed wetlands. Wetlands incorporated as part of the reclaimed landscape are expected to transition into marsh wetlands types and function similarly to the natural analogues of peatlands in terms of providing surface water storage and flood attenuation. The anticipated effects to the receiving streams from changes in flow rates, including the effects related to changes in water storage capacity in the PRM area at Closure, are discussed in Section 6.4.6.3 of the EIA (Volume 4A).

Surficial groundwater levels are expected to return to pre-disturbance levels after dewatering activities for each pit are completed and the pit backfilled (EIA, Volume 4A, Section 6.3.6.2, page 6-208). It is not expected that the loss of peatlands will affect this process. The closure wetlands will naturally adjust to the changes in groundwater levels as they return to pre-disturbance levels.

Peatlands are rich in fulvic and humic acids (i.e., organic acids) and are known to act as a filtrate system. The loss of peatlands and other wetlands is likely to alter the water quality by decreasing the quantity of these acids and system filtration capacity. However, areas that will be recovered to a wetland capacity at Closure will be constructed to have similar capacity for organic acid production and filtration (Kadlec and Wallace 2009). While there will be a reduction in water treatment capacity due to loss of peatlands in the mine footprint, adequate water quality to the receiving environment will be maintained through a combination of constructed wetlands, the South Redclay Lake, and pit lakes. The anticipated effects to the quality of water in receiving streams at Closure, including the effects of loss of filtration capacity from peatlands, is discussed in Section 6.5.6.3 of the EIA (Volume 4A).

The potential effects due to drawdown on wetlands include reductions in water levels and alterations to moisture regimes that may lead to a shift in species composition (e.g., more shrubs and trees) and succession towards more terrestrial vegetation communities (LaChance and Lavoie 2004; Strack et al. 2006). With the exception of areas adjacent to pit lakes, it is expected that with proper operational and closure drainage management, effects to vegetation surrounding the mine site will be temporary and reversible. As groundwater levels in areas surrounding pit lakes equalize to that of the lakes, a shift in species composition is anticipated for wetland vegetation in surrounding areas as water levels stabilize. The recovery of vegetation, at Closure, due to changes in groundwater levels are discussed in the EIA, Volume 5; Appendix 5-2, Section 2.3.2 and Section 2.5.

c) Peatland removal within the mine footprint and dewatering of adjacent peatlands will result in the loss or alteration of some wetlands types, (e.g., open patterned fens [FOPN], treed patterned fens [FTPN], and marshes [MONG]) (EIA, Volume 5, Section 7.5.6.4, page 7-133). These wetlands types are ranked high for biodiversity potential. At Closure, high and low biodiversity potential areas are predicted to decline in the LSA, while moderate biodiversity potential areas are predicted to increase (Appendix 1, Section 4.5, Figure 4.5-1). With the shift at Closure from areas with peatlands to upland habitats, changes in habitat availability for wildlife species are anticipated in the LSA. Increases in high suitability habitats in the LSA are predicted for the following wildlife KIRs, including some Species at Risk (SAR) and migratory birds (Appendix 1, Section 4.4, Table 4.4-3):

- beaver;
- Canada lynx;
- Canadian toad;
- Canada warbler;
- horned grebe;
- little brown myotis;

- northern myotis;
- olive-sided flycatcher;
- wolverine; and
- woodland caribou (due to the predicted increase in ecosite phases rich in lichen, such as lichen jack pine and bearberry jack pine [a1], Labrador tea-mesic jack pine-black spruce [c1] and Labrador tea-subhygric black spruce-jack pine [Athabasca Plain d1]).

The shift from wetlands to upland habitats is also predicted to have a negative environmental consequence in the LSA at Closure for some wildlife species. High magnitude decreases in high suitability habitat are predicted for the following species (Appendix 1, Section 4.4, Table 4.4-3):

- western toad;
- wood bison;
- short-eared owl; and
- yellow rail.

These changes are due to a net decrease in wetlands types (including peatlands) which are preferred by these species. However, at the RSA scale, at which effects to populations of these wide-ranging species are properly assessed, environmental consequences are predicted to be negligible (Appendix 1, Section 4.4, Table 4.4-3), and unlikely to represent significant effects for these species (*May 2011, Submission of Information to the Joint Review Panel*, Appendix 2, Federally Listed Species at Risk Assessment, Appendix B).

References:

LaChance, D. and C. Lavoie. 2004. *Vegetation of Sphagnum bogs in highly disturbed landscapes: relative influence of abiotic and anthropogenic factors*. Applied Vegetation Science 7(2): 183-192.

Kadlec, R. H. and S. D. Wallace. 2009. *Treatment Wetlands*. Second Edition. CRC Press LLC, Boca Raton, FL, USA. 1016 pp.

Strack, M., J.M. Waddington, L. Rochefort and E.-S. Tuittila. 2006. *Response of vegetation and net ecosystem carbon dioxide exchange at different peatland microforms following water table drawdown*. Journal of Geophysical Research 111: G02006, 1-10.

Rooney, R.C., S.E. Bayley and D.W. Schindler. 2011. *Oil sands mining and reclamation cause massive loss of peatland and stored carbon*. http://www.pnas.org/content/109/13/4933 Accessed March 23, 2012.

EFFECTS OF THE ENVIRONMENT ON THE PROJECT

SIR 51

The Alberta Environment Terms of Reference Environmental Impact Assessment Report for the Shell Canada Limited Jackpine Mine Expansion & Pierre River Mine, November 28, 2007, Section 5.1, Page 13 requires the environmental assessment to include information about ecological processes and natural forces that are expected to produce changes in environmental conditions (e.g., forest fires, flood or drought conditions). Consistent with the *Canadian Environmental Assessment Act 2012*, the Panel will also consider any change to the Project that may be caused by the environment. The Panel finds that information related to these environmental changes is not provided in the EIA and that additional information is required. Discuss how the Project would be affected by stochastic large scale disturbances and projected human disturbances as described below and how the Project is equipped to handle such events.

a) Describe how the predicted decrease in wetland vegetation and increase in upland vegetation as a result of the Project could increase fire spread. Provide an assessment on how the Project may be sensitive to forest fires and how Shell has prepared for such incidences.

b) Provide an assessment of potential effects to the Project from possible flooding in the region. Include a flood analysis for the Pierre and Lower Athabasca Rivers.

c) Provide your comments as to whether or not the project may be sensitive to drought. If Shell's view is that the project may be sensitive to drought, provide an assessment of the potential for drought in the area. Explain how Shell used the trends in air temperature and precipitation to estimate the expected range of future streamflows in the Athabasca River that will be used for the water requirements of the Project. Include a discussion of long-term, cumulative implications for water management of the Athabasca River.

Response:

a) The Pierre River Mine is located in the boreal forest (Central Mixedwood and the Athabasca Plain Subregions). Published records (ESRD 2012) show that since 1935 there has only been one fire within the Local Study Area (LSA), which occurred in the spring of 2011.

A decrease in wetland vegetation and an increase in upland vegetation could mean a potential for an increase in fire spread. Generally, as treed ecosite types mature towards old growth, there is an increase in coarse woody debris and increased potential for fire and fire spread. Fire spread rates will be dependent on relative abundance of fire-resistance fuels (e.g., green vegetation) and the range of soil moisture regimes within the upland ecosite phases. Slow spread rates are associated with fresh to moist, herb (i.e., forbs) and shrub-dominated mixedwood upland sites, and with wet, herb and shrub dominated sites or rich lowland sites, while fast spread rates are associated with dry to fresh, herb and shrub poor upland conifer sites (Wiltshire and Archibald 1998; Luke et al. 2000).

Shell prepares for these infrequent events as part of their emergency response planning (EIA Volume 2, Section 12.3). The impact of forest fires on plant and mine operations is dependent on wind direction and the proximity of the fire, but typically are short term in duration. Potential forest fires effects may include:

- fire exclusion zones (i.e., areas with restricted activities due to the health and safety risk posed by fire), which could affect access to some areas; especially if an exclusion zone includes a roadway;
- visibility due to smoke could impact operational safety at the mine site and on access routes;
- potential impacts to regional infrastructure such as power lines; and
- workers health due to poor air quality resulting from smoke.

b) The flood risk limits for the 2-, 10-, and 100-year flood events have been delineated for the Athabasca River and provided in Figure 2.3-10 of the Hydrology Environmental Setting Report for the PRM.

The Pierre River will be diverted south around the PRM site. The valley of the diversion channel will be designed to contain flood levels up to 1:100 year to avoid potential effects to PRM from possible flooding from the Pierre River diversion.

Shell facilities were designed to consider flood events in accordance with regulatory requirements and professional design guidelines. Several water management structures were designed to contain and convey flows for all hydrologic conditions up to the one-in-one-hundred year flood level (EIA, Volume 2, Section 10) without uncontrolled spillage that might cause failure of the facilities. Moderate and high consequence facilities (as per dam classification by Canadian Dam Association's 2007 *Dam Safety Guidelines* [CDA 2007]), such as the External Tailings Disposal Area, are designed to withstand the probable maximum flood (EIA, Volume 2, Section 10); with the necessary freeboard for wind set-up and wave run-up. In addition, as described in the EIA, Volume 2, Section 12, emergency response plans will be in place to execute responses appropriate to potential flood emergency scenarios. Given these mitigations, minimal effects to the PRM are anticipated.

c) The PRM is designed to meet its water needs through prudent use and recycling of water collected from site surface runoff, groundwater diverted through pit dewatering, and raw water withdrawn from the Athabasca River. Should a drought occur, availability of water from each of these sources would be naturally reduced and, if unmitigated, there would be more reliance on the Athabasca River to meet PRM's needs. Depending on the duration and magnitude of a drought, the Water Management Framework for the Lower Athabasca River could impose restrictions on water availability thus affecting the ability of the PRM to maintain full production. Shell recognized this sensitivity to drought and designed the PRM with three primary mitigations.

The first mitigation was to develop a water balance for the PRM that considered dry hydrologic conditions by assuming reduced availability of surface runoff and groundwater, based on an anticipated annual precipitation under a one-in-one-hundred year dry scenario. Flow statistics representative of one-in-one-hundred year dry hydrologic conditions were derived for closed-circuited areas using a hydrologic model to simulate long term runoff. These flow statistics were applied to the water balance to predict the range of future anticipated water requirements for the PRM.

The second mitigation was to design on-site water storage to temporarily supplement water needs when there are periods of restricted Athabasca River water withdrawal. A final raw water storage needs assessment will be completed after Phase 2 of the Water Management Framework for the Lower Athabasca River has been approved.

The third mitigation was to design for an instantaneous raw water withdrawal rate that would allow Shell to replenish its water storage during times of high flow (e.g., spring run off). This ensures water withdrawal rates during times of low flow (e.g., winter) can be managed in accordance with the Water Management Framework for the Lower Athabasca River and that any impact to operations is minimized.

Given these above mitigations, drought conditions are predicted to have minimal effects to the PRM.

References:

CDA (Canadian Dam Association). 2007. *Dam Safety Guidelines.* http://www.imis100ca1.ca/cda/CDA/Publications_Pages/Dam_Safety_Guidelines.aspx. Accessed on March 2013.

ESRD (Alberta Environment and Sustainable Resource Development). 2012. *Historical Wildfire Database*. http://srd.alberta.ca/Wildfire/WildfireStatus/HistoricalWildfireInformation/HistoricalWildfireDatabase.aspx. Accessed on March 2013.

Luke, A.B., D.J. Archibald, R.W. Arnup and N.L. Wood. 2000. *Prescribed Fire as a Vegetation Management Tool*. Northwest Sci.& Technol. Technical Note TN-45, in Bell, F.W., M. McLaughlan and J. Kerley (compilers). Vegetation Management Alternatives - A Guide to Opportunities. Ont. Min. Natur. Resour. Thunder Bay, Ont. 12 pp.

Wiltshire, R. and D.J. Archibald. 1998. *Boreal Mixedwood Management and Prescribed Fire.* Boreal Mixedwood, 1998. Number 16. 309 pp.

SOCIO-ECONOMIC

SIR 52

PRM Supplemental Information Response Round 1, Volume 1, Section 6.2, Page 6- 8. Shell states, "Estimates of direct on and off-site employment associated with the normal execution scenario for project construction have increased more than 50% from estimates presented in the EIA Update of May 2008, Section 5.4.1. In particular:

- **on-site employment has increased from about 11,730 to 17,800 person-years**
- **off-site employment has increased from about 3,910 to 5,560 person-years"**

a) Clarify if the estimates for on-site and off-site workers will remain the same as those provided in the 2009 PRM SIR, for construction.

Response:

a) The workforce estimates for construction have been reviewed and remain the same as those provided in the May 2009 Pierre River Mine, Supplemental Information Requests, Volume 1, Section 6.2.

SIR 53

PRM Supplemental Information Response Round 1, Volume 1, Section 6.2 Page 6- 13. Shell states, "Table 6-3 compares the updated Base Case and Planned Development Case population projections (December 2008) to those contained in the May 2008 EIA Update."

a) Clarify if the new population models from Regional Municipality of Wood Buffalo (RMWB) will change the population impacts for PRM.

Response:

a) Updated 2013 Base Case and 2013 PDC population projections have been derived from the RMWB Municipal Development Plan (MDP) forecast, and the most recent forecast available from the RMWB Population and Employment Projection Model. The MDP forecast has been adjusted, taking into consideration: a 2013 PDC bitumen production curve that is below the forecast used for the MDP; the recent 2012 Municipal Census results; and current industry practices and plans regarding project accommodations.

Under 2013 PDC assumptions, the population of Fort McMurray is expected to reach nearly 137,870 in 2030, approximately 32,355 above 2013 Base Case estimates (105,515). The population growth rate under 2013 PDC assumptions is anticipated to vary over the 2013 to 2030 period in response to oil sands project activity.

The long-term population impact of the PRM (i.e., 2013 PRM Application Case) is expected to be about 1% above the 2013 Base Case. Much of the Project's population impact will be mitigated by the PRM's:

- remote location;
- use of a camp-based model for housing workers during both construction and operations; and
- use of a fly-in/fly-out approach to transporting workers in and out of the region.

For further information on updated population projections, see Appendix 2, Section 3.5.2.

SIR 54

EIA Update Report 2008, Section 5.3, Page 135. Shell states, "The three levels of government and the oil sands industry are responding to the pressures, including a suite of funding announcement in February 2007 to address health pressures, assist with replacement and upgrade of water and waste water facilities, build affordable housing units, improve access to child care, and provide planning support for the RMWB (GOA 2008d)."

a) Provide an update on federal and provincial government economic response to RMWB needs.

Response:

a) An overview of current socio-economic issues in the region, along with responses from both government and industry to these issues, can be found in Appendix 2, Section 3.5.2, Attachment A.

SIR 55

PRM Supplemental Information Response Round 1, Volume 1, Section 6.2 Page 6- 12. Shell states, "Shell's current view, given this long timeframe for development, is that the Pierre River Mine will proceed according to the schedule outlined in the application."

a) Provide an update on timelines.

b) Based on the updated timelines, is Shell still able to accommodate the required workforce.

Response:

a) The date for first oil from Pierre River Mine (PRM) has been updated from 2018 to 2021, to allow for a reasonable timeline for design and construction to occur after regulatory approvals are anticipated. Under the updated timeline, PRM construction is expected to begin in mid-2018 and run until the end of 2024.

b) Shell remains committed to ensuring the PRM workforce is properly accommodated and is confident in its ability to use a camp-based model during both PRM construction and operations. A primary objective of the PRM's camp-based model is to eliminate the health and safety concerns associated with workers commuting daily from Fort McMurray to a remote facility.

SIR 56

EIA Update Report 2008, Section 5.9, Page 153. Shell states, "The corresponding estimates of school-aged children, assuming PRM only, are 145 in 2015 and 900 in 2021."

a) Clarify whether the 900 school-aged children are the result of construction and operations workforce families moving to the region.

b) Discuss if there will be capacity in the community to absorb the additional 900 school-aged children?

Response:

a) The estimate of 900 school-aged children is a peak effect that results from an overlap in the construction and operations phases of the PRM. The estimate of school-aged children is derived from the estimated population effect associated with direct, indirect and induced project-related employment.

b) Due to updated project timelines (see response to JRP SIR 55a), the estimate of 900 school aged children has shifted from 2021 to 2024. Also, because the estimate is a peak effect largely associated with project construction, the effect is temporary and may not fully materialize. The estimate of school-aged children is intended to illustrate generally the potential demands on education services in the region. The long-term Project effect is about 180 school-aged children, once construction is complete and operation is fully underway.

The capacity of the education system to address forecasted demand will depend upon current planning initiatives being properly resourced and carried out in a timely manner. Although the capacity of the education system has improved in recent years (e.g., new schools, expanded course offerings and student services), several challenges remain, including:

- the need for further new school infrastructure to meet increasing demand, particularly in fast-growing neighbourhoods, and
- difficulties in recruiting and retaining teachers and other support staff.

For further discussion of current education delivery issues in the region and public and private sector responses to those issues, see Appendix 2, Section 3.5, Attachment B.

For its part, Shell will continue to assess and support education and training initiatives in the region. In addition Shell will continue to communicate regularly with government, public service agencies, and other industry partners about the effects of its operations on regional infrastructure and services. This includes ongoing support of population forecasting initiatives in the region via Shell's involvement with the Oil Sands Developers Group (OSDG). Population forecasts provide regional service providers, including educational authorities with estimates that can be used to inform planning exercises.

SIR 57

PRM Supplemental Information Response Round 1, Volume 1, SIR 46, Page 9-11. Shell states, "Project-related traffic on Highway 63 north of the current Muskeg River Mine and Aurora Mine turnoffs is expected to average between 490 and 595 AADT over the entire construction period (2015-2021)."

a) Update the Average Annual Daily Traffic (AADT) numbers to reflect the updated schedule.

Response:

a) Project-related AADT numbers presented in December 2009, Pierre River Mine Supplemental Information Response, Volume 1, SIR 46, have been reviewed and remain the same. The updated schedule will shift project-related traffic further out in time, occurring during the 2018 to 2024 period. Project-related traffic is now expected to peak in 2023.

SIR 58

Pierre River Mine Project Volume 2, Section 2.5, Page 2-11. Shell states, "Access to the Pierre River Mine will be provided by a 4 to 5 km road linking Lease No. 9 to the RMWB's Fort Chipewyan winter road, which is about 16 km north of the end of highway 63. This will require the construction of a bridge over the Athabasca River"

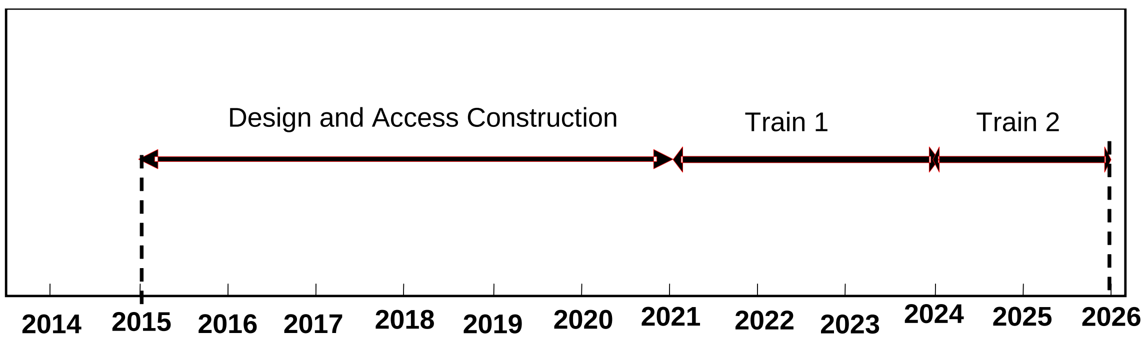
a) Does Shell propose to have the bridge in place before construction starts? If so, discuss the schedule. If not, comment on how Shell plans to access the site.

Response:

a) A bridge over the Athabasca River is required to be in place before construction of the Pierre River Mine begins.

The anticipated schedule for design and construction activities for PRM is shown below in Figure 58-1. It is expected that bridge work would start 5 years before first oil.

Figure 58-1 Anticipated Schedule for all Design and Construction Activities for Pierre River Mine



HEALTH

SIR 59

EIA Volume 3, Air Quality, Noise and Environmental Health Section 5.3, Pages 5-94 and 5-111. Shell describes changes in chemical of potential concern (COPC) levels as "minimal", "moderate" and "high". In some analyses, "moderate" is referenced as a 6-9% change in concentration, and in other analyses "moderate" is referenced as an 8-22% change.

a) **Provide the definition for "minimal", "moderate" and "high" in Shell's analysis. Describe at what concentration Shell would consider the impact to be significant and justify that threshold.**

b) **If these levels are dependent on the COPC in the analysis, provide the rationale for why the definition may change.**

Response:

a) The terms negligible, minimal, moderate and high, in the context of the Human Health Risk Assessment (HHRA), refer to the predicted changes in the potential health risk estimates, and not air concentrations. The predicted changes in potential health risk estimates – expressed as Risk Quotients (RQs) for the non-carcinogenic chemicals and Incremental Lifetime Cancer Risks (ILCRs) for the carcinogenic chemicals – were described as:

- "negligible" if there was no predicted change from the potential 2013 Base Case health risk estimates;
- "minimal" if the predicted change from the potential 2013 Base Case health risk estimates did not exceed 5%;
- "moderate" if the predicted change from the potential 2013 Base Case health risk estimates was greater than 5%, but did not exceed 25%; and
- "high" if the predicted change from the potential 2013 Base Case health risk estimates was greater than 25%.

In the HHRA, there is no single "threshold" above which risk estimates would be considered significant. The interpretation of each health risk estimate and its associated significance must proceed on a "chemical-by-chemical" or individual chemical basis. A health risk estimate value or "threshold" of 1.0 is commonly used in health risk assessments to distinguish between low health risks, where the health risk estimates are predicted to be less than or equal to 1.0, and potentially elevated health risks, where the health risk estimates are predicted to be greater than 1.0. The significance of these potentially elevated health risks, that is whether or not the elevated health risks would be associated with adverse health effects in humans, generally involves the consideration of other factors such as the degree of conservatism incorporated in the HHRA, the likelihood of an "exceedance" occurring, and the project's contribution to the risks. The discussion of significance is continued in part b of the response, below.

b) As described in part (a), the definitions of "negligible", "minimal", "moderate" and "high" were consistent throughout the HHRA because these all relate to the magnitude of the predicted changes in the risk estimates. These ratings do not address whether or not the changes are expected to be associated with adverse health effects (i.e., whether or not these changes are significant). The likelihood of an adverse health effect occurring was addressed on a case-by-case and chemical-by-chemical basis.

The primary objective of the HHRA was to describe the nature and significance of the potential health risks posed to people who might be exposed to the chemicals released to the environment by the PRM. Uncertainty can surround the prediction of any potential health risks, regardless of type or source. This uncertainty can take several forms, including: uncertainty due to lack of information; uncertainty due to the variability intrinsic to living systems; and, uncertainty due to experimental and measurement error. These and other forms of uncertainty can confound the interpretation of any potential health risks. By convention, the uncertainty in the HHRA was accommodated, in part, through the use of assumptions which embraced a certain degree of conservatism. These assumptions were described in EIA, Volume 3, Table 5.3-14. Using this approach, any potential health risks identified in the assessment are unlikely to be understated, but may be considerably overstated.

Given the conservatism incorporated in the HHRA, health risk estimates predicted to be less than or equal 1.0, indicating that the estimated exposure was less than or equal to the exposure limit, are associated with a low level of risk and the potential for adverse health effects, even in sensitive individuals, was determined to be negligible. Health risk estimates predicted to be greater than 1.0 are associated with an elevated level of risk, the significance of which was necessarily balanced against:

- the predicted change from the potential 2013 Base Case health risk estimate as result of the PRM;
- the likelihood of an exceedance; and
- the degree of conservatism incorporated in the potential health risk estimate.

Due to the exceedance of the selected exposure limit, the potential for adverse health effects is no longer negligible, but may still be considered low based on the weight-of-evidence. Whether the potential for adverse health effects is determined to be negligible or low, the overall conclusion of the HHRA is that adverse health effects would not be expected and that the potential health risks are not significant. However, the role of the risk assessor is to inform the reviewer, whether it is a member of the general public or a regulatory agency, of the potential health risks, but not to make a determination as to the acceptability of those risks. The conclusions of the HHRA are only one of the many factors that the reviewer may consider in determining the acceptability of the risks.

Use of the terms “significant” and “non-significant” in HHRA may suggest to the reviewer that a judgment of the acceptability of the potential health risks has been made. For example, the term significant may suggest to the reviewer that the potential health risks are not acceptable, whereas the term non-significant may imply an acceptability of the potential health risks. It should be made clear that the use of the terms “significant” and “non-significant” in this response carry no such judgment, and are strictly used in an attempt to address the reviewer’s request.

With this approach, a potential health risk would typically have been considered significant in the HHRA if:

- the health risk estimate was predicted to exceed 1.0;
- the predicted change from the potential 2013 Base Case health risk estimate as result of the PRM was considered moderate to high;
- the likelihood of an exceedance was considered high; and
- the degree of conservatism incorporated in the predicted risk estimate was considered low.

To put this concept into its proper perspective, it is helpful to consider the example of the estimated acute health risk estimates for acrolein in the HHRA. Although the acute health risk estimates for acrolein exceeded 1.0 (i.e., 1.1 to 18), the potential for adverse health effects as a result of the PRM was determined to be low (and the potential health risks not significant) because:

- the predicted change from the potential 2013 Base Case health risk estimates was considered low to moderate, depending upon the location under consideration;
- the likelihood of an exceedance was considered low to moderate, depending upon the location under consideration; and
- the degree of conservatism incorporated in the predicted health risk estimates was considered high.

Based on the weight-of-evidence, the primary driver of the “not significant” ranking would be the high degree of conservatism incorporated in the predicted health risk estimates.

SIR 60

PRM Supplemental Information Round 1, Volume 2, Part 4, Appendix A, Fort McKay First Nation Traditional Knowledge Report, Page 43. Shell notes that participants in the study reported concerns that traditional foods and water supplies are no longer safe to consume. Although Shell provided a multiple pathways assessment and included an Aboriginal receptor group in the EIA, Shell is directed by the Alberta Environment Final Terms of Reference Environmental Impact Assessment Report for the Shell Canada Limited Jackpine Mine Expansion & Pierre River Mine, November 28, 2007, Section 7, Page 25, to determine the impact of the Project on the health of Aboriginal people, to identify possible mitigation strategies and to assess cumulative effects of the Project on the health of First Nation receptors.

a) Describe how traditional practices of Aboriginal groups in the area may be impacted by changes or perceived changes in the levels of toxic substances in traditional food items, including fish, wild game and other country foods. In addition, describe how any avoidance of such food items may affect Aboriginal health.

b) Assess the effects on the health of the Aboriginal peoples due to the cumulative impacts on their traditional lifestyle caused by the proposed project in combination with past, existing and future development using a pre-industrial baseline.

c) Identify possible monitoring and mitigation strategies for the direct and cumulative impacts of the Project on the health of Aboriginal peoples.

Response:

a) Traditional foods are an important component of good health among Aboriginal peoples. The social, cultural, spiritual, nutritional and economic benefits of these foods and their preparation, procurement and consumption are important in the maintenance of Aboriginal culture as indigenous relationships to the land are based on such traditional practices (Fediuk 2003). Country foods can also contribute significantly more protein, iron and zinc to the diets of Aboriginal consumers than southern/market foods and the increase in obesity, diabetes and cardiovascular disease has been linked to a shift away from a country food diet and a less active lifestyle (Van Oostdam et al. 2005).

Canada's Aboriginal communities in general have been moving from a country food diet to one that more closely resembles that of the general population. While there is limited data available on the health impacts of reduced wild meat consumption specific to Northern Alberta Aboriginal communities, studies conducted in other jurisdictions indicate how a move away from traditional country foods towards a market diet that is high in energy, saturated fats and simple sugars, coupled with reduced physical activity, causes a rise in the prevalence of obesity and subsequently diabetes (Gittelson et al. 1998; Receveur et al. 1998; Thouez et al. 1989; Wein 1986; Young 1988).

This suggests that changes in community-specific patterns of traditional food consumption, namely through reduced reliance on wild foods, such as moose and fish, could affect the health of members of Aboriginal communities in the Oil Sands Region. Alterations in dietary patterns could result from: (i) reduced access to traditional areas used for harvesting wild game, plants and fish; (ii) a decline in wildlife abundance (and other country foods) in the region; and (iii) perceived and/or real changes in the quality (or safety) of the country foods due to environmental contamination.

Aboriginal groups in the region have raised concerns about the general quality and safety of their traditional foods. Concerns about the safety of traditional foods may be contributing to the overall shift away from the traditional Aboriginal diet in the Oil Sands Region. However, Pierre River Mine (PRM) is not expected to adversely affect the quality of the foods traditionally consumed by the Aboriginal communities in the area. This is based on the findings of the Human Health Risk Assessment (HHRA) for the PRM which considered the health risks associated with multiple routes of exposure, including those related to water, fish, wild game, plants, berries and soil (Appendix 3.3). The HHRA was based on a combination of measured data and predictive models. The results of the HHRA indicated that the potential for adverse health effects associated with PRM activities on traditional land use is low because predicted concentrations of chemicals of potential concern in dietary media (i.e., traditional plants and game meat) were predicted to be below levels that would be associated with adverse health effects.

b) Please see the response to JRP SIR 60a.

c) For risks associated with environmental exposure to chemical emissions in the region, Shell has made a number of commitments to reduce the Pierre River Mine’s potential impacts on air quality and water quality. These commitments were described in EIA, Volume 3, Section 3.2.2 for air quality and EIA, Volume 4A, Section 6.1.4.3 for water quality.

To mitigate the impacts associated with a potential shift away from traditional foods, Shell will continue to consult with the Fort McKay First Nation and Métis, Athabasca Chipewyan First Nation, Mikisew Cree First Nation, Fort McMurray #468 First Nation, Fort Chipewyan Métis Local #125 and Fort McMurray Métis to address issues and concerns about traditional use of the areas adjacent to and outside of the PRM area and the perceived changes in the levels of toxic substances in traditional food items. Shell will further minimize the risk of potential health impacts from a reduction in hunting opportunities by maintaining, whenever possible, traditional user access to the area encompassed by the PRM, maintaining active wildlife movement corridors, and maintaining to the extent practical access to traditional trails.

Shell will continue to actively participate in regional multi-stakeholder planning and research initiatives that consider the long-term sustainability of effective traditional land use, including the Reclamation Working Group of the Cumulative Environmental Management Association (CEMA) and Sustainable Ecosystems Working Group of CEMA.

References:

Fediuk, K. 2003. *Contemporary and Desired Use of Traditional Resources in a Coast Salish Community: Implications for Food Security and Aboriginal Rights in British Columbia*. 26th Annual Meeting of the Society for Ethnobiology, Seattle, WA.

Gittelson, J., T. Wolever, T. Harris, R. Harris-Giraldo, A. Hanley and B. Zinman. 1998. *Specific patterns of food consumption and preparation are associated with diabetes and obesity in a Native Canadian community*. The Journal of Nutrition Vol. 128(3): 541-547.

Receveur, O., N. Kassi, H.M. Chan, P.R. Berti and H.V. Kuhnlein. 1998. *Yukon First Nations' Assessment of Dietary Benefit/Risk*. Centre for Indigenous Peoples' Nutrition and Environment.

Thouez, J.P., A. Rannou and P. Foggin. 1989. *The other face of development: Native population, health status and indicators of malnutrition – the case of the Cree and Inuit in northern Quebec*. Soc Sci Med. 29: 965-974.

Van Oostdam J., S.G. Donaldson, M. Feeley, D. Arnold, P. Ayotte, G. Bandy, L. Chaff, E. Dewaily, C.M. Furgal, H. Kuhnlein, E. Loring, G. Muckle, E. Myles, O. Receveur, B. Tracy, U. Gill and S. Kalhok. 2005. *Human health implications of environmental contaminants in Arctic Canada: A review*. Science of the Total Environment. 2005, vol. 351-52.

Wein, E. 1986. *Nutrition of Northern Native Canadians*. Canadian Home Economics Journal 36(1): 25-29.

Young, T.K. 1998. *Are Subarctic Indians Undergoing the Epidemiological Transition?* Soc. Sci. Med 26: 659-671.

SIR 61

EIA Volume 3: Air Quality, Noise and Environmental Health, Section 5.3, Page 5-57. Shell noted that "residents were assumed to spend 1.5 hour per day outside". It is not clear how Shell used the Heath Canada (2004a) guidance referenced for the exposure assessment of the Aboriginal receptor category, particularly with respect to the time spent indoors.

a) **Clarify whether the EIA assumptions for residents of 22.5 hours per day spent indoors is applicable for the Aboriginal receptor group. If so, provide rationale that this assumption is relevant for people engaged in a subsistence lifestyle.**

Response:

a) The EIA Human Health Risk Assessment (HHRA) assumed that people would spend most of their time indoors (EIA, Volume 3, Section 5.3). This assumption was questioned by Alberta Environment and Sustainable Resource Development through the supplemental information request process (December 2009 Pierre River Mine, Supplemental Information, Volume 2: SIR 78). As a result, the current assessment assumed that the Aboriginal receptor group would spend all of their time outdoors as they engaged in their subsistence lifestyles (Appendix 3.3).

SIR 62

The Panel is aware that a working group had been established to provide recommendations for a community health study to address the health concerns of the community of Fort Chipewyan.

a) Provide the results of any municipal, provincial or federal health studies that have been conducted in the region and document if and how it integrated these studies in its EIA.

Response:

a) Municipal, provincial or federal health studies that had been conducted in the region and made publicly available before the submission of the Environmental Impact Assessment (EIA) were described in the EIA Volume 3, Sections 5.2.9.1 and 5.2.9.2. Information from these studies was incorporated into the Human Health Risk Assessment (HHRA). These studies included:

- The 2000 Alberta Health and Wellness (AHW) report: *The Alberta Oil Sands Community Exposure and Health Effects Assessment Program.*
- The 2006 Alberta Cancer Board (ACB) report: *Cancer in Alberta: A Regional Picture 2006.*
- The 2007 AHW report: *Health Trends in Alberta: A Working Document*.
- The 2007 Wood Buffalo Environmental Association report: *Wood Buffalo Environmental Association Human Exposure Monitoring Program: Part I – Methods Report, Part II – 2005 Monitoring Year Results*.

The following studies were also considered and described as part of the current submission (Appendix 3.3):

- The 2006 Canadian Population Health Initiative report: *How Healthy are Rural Canadians? An Assessment of their Health Status and Health Determinants*.

- The 2009 ACB report: C*ancer Incidence in Fort Chipewyan, Alberta 1995-2006*.
- The 2009 AHW report: *Human Health Risk Assessment – Mercury in Fish*.
- The 2010 Royal Society of Canada Expert Panel study: *Environmental and health impacts of Canada's oil sands industry*.
- The 2011 AHW report: *Guidance on Human Health Risk Assessment for Environmental Impact Assessment in Alberta*.
- The AHW Interactive Health Data Application.
- The summary of the 2012 Kindzierski et al. study: *Wood Buffalo Environmental Association Ambient Air Quality Data Summary and Trend Analysis*.

The information from such reports and studies can be useful for "identifying critical receptors as well as in interpreting the HHRA in the context of population baseline, project and cumulative risks" (AHW 2011).

As such, the baseline information contained in the health studies listed above was considered as part of the problem formulation, or planning stage, of the updated HHRA presented in Appendix 3.3. In this initial step of the HHRA, the overall scope of the work and the key areas of concern are identified. The three major tasks included in the problem formulation are:

- the identification of the Chemicals of Potential Concern (COPC);
- the characterization of the people who might be exposed to the COPC; and
- the identification of all relevant pathways of exposure for those people who might be exposed to the COPC.

The baseline information was incorporated in both the identification of the COPC and the characterization of people potentially exposed to the COPC.

As well, the baseline information was intended to provide context for the reviewer regarding the current state of health in the region.

References:

AHW (Alberta Health and Wellness). 2011. *Guidance on Human Health Risk Assessment for Environmental Impact Assessment in Alberta*. August 2011.

ABORIGINAL RIGHTS AND INTERESTS

SIR 63

EIA Volume 5: Terrestrial Resources and Human Environment, Section 8.3.6.1, Tables 8.3-14 to 8.3-17, Pages 8-50 to 8-52. Shell provides the effects of the project on the Culturally Significant Ecosystem of the Fort McKay First Nation. Tables 8.3-14 to 8.3-16 include the Base, Application and Planned Development Cases and shows the loss of land in the low, moderate and intense use areas. Table 8.3-17 provides similar data for each of the Traditional Land Use (TLU)-RSA of Fort McKay First Nation, Mikisew Cree First Nation and Athabasca Chipewyan First Nation.

a) Explain, for each of the tables mentioned above, if the shown disturbances for the Application and Planned Development Cases are before or after reclamation. If it is after reclamation, provide the disturbances before reclamation.

Response:

a) For each of the tables identified above (EIA, Volume 5, Section 8.3.6.1, Tables 8.3-14 to 8.3-17), the EIA Application Case and 2013 PDC indicate disturbances before reclamation.

SIR 64

EIA Volume 5: Terrestrial Resources and Human Environment, Section 8.3.5, pages 8-38 to 8-49 and Section 8.3.6, pages 8-49 to 8-53. Shell assessed the validity of the linkages for key questions TLU-1 and PTLU-1 based on the interview of two RFMA holders in the PRM project area. In the ESR - Cultural, Traditional Land Use Environmental Setting for the Jackpine Mine Expansion & Pierre River Mine Project, Section 3.4.1, Page 3-32 and Section 3.4.2, Page 3-34, Shell states that the RFMA holders in the PRM project area were not Aboriginal persons.

a) Provide the rationale for using two non-Aboriginal persons to provide the information used in the linkage analysis for TLU-1 and PTLU-1.

Response:

a) The non-Aboriginal holders of Registered Fur Management Area (RFMA) #1275 and #2939 were included in the Traditional Land Use (TLU) assessment because trapping was considered a traditional activity for the purposes of the assessment, regardless of whether the trappers were Aboriginal or non-Aboriginal. The information provided by these trappers was not included in the assessment of impacts to Aboriginal TLU.

After the preparation of EIA, Volume 5, Section 8.3.5, it was determined that the wife of the holder of RFMA #1275 is Métis and has actively trapped the RFMA. Additional details of her use of the trapline have become available and are presented in Appendix 3.8, Section 2.10.

The holder of RFMA #2939 is non-Aboriginal. At the time of the interview, no Aboriginal use of the trapline was indicated. No Aboriginal use of the trapline has been identified since the preparation of EIA, Volume 5, Section 8.3.5.

SIR 65

ESR – Terrestrial, Wildlife and Wildlife Habitat Environment Setting for the Jackpine Mine Expansion & Pierre River Mine Project, Section 5. Shell gathered a significant portion of its information regarding TEK and TLU in the project area from two trappers, from participants at a CEMA workshop (FEMA 2005), and from participants in a Resource Use Study (Golder 2007b). The Aboriginal affiliation of the participants to the CEMA workshop and Golder Resource Uses Study was not specified. In the ESR - Cultural, Traditional Land Use Environmental Setting for the Jackpine Mine Expansion & Pierre River Mine Project, Section 3.4.1, Page 3-32 and Section 3.4.2, Page 3-34, Shell states that the trappers were non-Aboriginal. In Mikisew Cree First Nation Indigenous Knowledge and Use Report and Assessment for Shell Canada's Proposed Jackpine Mine Expansion, Pierre River Mine, and Redclay Compensation Lake, February 2012 Section 2.2.1, Pages 24 to 26 the MCFN state that Shell had confused trapper's rights with Aboriginal rights and that individual trapline holders are generally not understood to represent the aboriginal or treaty rights of a First Nation.

a) **Provide the impacts of the project on traditional land use and Aboriginal and treaty rights at the TLU-LSA level by considering the complete project footprint, including the south most part of the project area, the shoreline of the Athabasca River, the bridge, and its access road. In completing this question the panel requests that Shell:**

   (i) **Provide the type and number of sources of information it used.**

   (ii) **Assess the impacts for each of the potentially affected Aboriginal groups.**

(iii) Validate its sources of information by specifying the Aboriginal affiliation of each person who provided information on TLU or TEK.

(iv) Provide details on how Shell has incorporated the information in the assessment of the Project's effects.

Response:

a) The following is in response to the request for project impacts on Traditional Land Use (TLU) and Aboriginal and treaty rights at the TLU-Local Study Area (LSA) level:

i) The TLU Environmental Setting Report (ESR) Update (Appendix 3.8) and TLU assessment (Appendix 2, Section 3.5.1) considered the following information sources:

- *As Long as the Rivers Flow: Athabasca River Knowledge, Use and Change* (Candler et al. 2010).
- *Athabasca Chipewyan First Nation Knowledge and Use Report and Assessment for Shell Canada's Proposed Redclay Compensation Lake* (Candler et al. 2011).
- *Athabasca Chipewyan First Nation Integrated Knowledge and Land Use Report and Assessment for Shell Canada's Proposed Jackpine Mine Expansion and Pierre River Mine*. (Updated September 15, 2012) (Candler et al. 2012a).
- *Ayapaskowinowak: Ta Kiskissotamak Kayas Pimatisowin Oti Kichi (Acknowledge the past, securing the future). The traditional land use of the Mikisew Cree First Nation* (MCFN [no date]).
- *Barb Hermansen: Her Story. The Last Women to Raise Children on the Athabasca River* (Labour and Hermansen 2010).
- *Cultural Assessment Baseline: Pre-development (1960s) to Current (2008)* (Fort McKay 2010a).
- *Cumulative Impacts to FMFN 468 Traditional Lands & Lifeways: Shell Jackpine Mine Expansion and Pierre River Mine Report for Regulatory Hearings* (Labour et al. 2012).
- *Fort Chipewyan Métis Historic Use & Occupancy: Thematic Maps* (Fort Chipewyan Métis 2012).
- *Fort McKay Specific Assessment: Disturbance and Access, Implications for Traditional Use* (Fort McKay 2010b).
- *Fort McKay Submission to the Draft Lower Athabasca Integrated Regional Plan 2011-2021. Appendix C – Intense-, Moderate- and Low-Use Culturally Significant Ecosystems* (Fort McKay 2010c).

- *Fort McKay Submission Regarding the Draft Lower Athabasca Integrated Regional Plan 2011-2012: Fort McKay First Nation and Fort McKay Métis Nation* (Fort McKay 2011).
- *Mark of the Métis: Traditional Knowledge and Stories of the Métis Peoples of Northeastern Alberta* (Fort McMurray Métis Local #1935 2012).
- *Mikisew Cree First Nation Indigenous Knowledge and Use Report and Assessment for Shell Canada's Proposed Jackpine Mine Expansion, Pierre River Mine, and Redclay Compensation Lake* (Candler et al. 2012b).
- *Mikisew Cree Use of Lands and Resources in the Vicinity of the Proposed Shell – Jack Pine and Shell – Pierre River Operations* (Elias 2011).
- *A Narrative of Encroachment Experience by Athabasca Chipewyan First Nation* (Larcombe 2012).
- *Níh boghodi: We are the stewards of our land. An ACFN stewardship strategy for thunzea, et'thén and dechen yághe ejere (woodland caribou, barren-ground caribou and wood bison)* (Marcel et al. 20102).
- *Nistawayaw "Where Three Rivers Meet": Fort McMurray #468 First Nation Traditional Land Use Study* (FM468 2006).
- *Project-Specific Cultural Heritage Assessment. Shell's Proposed Pierre River Mine and Jackpine Mine Expansion: Fort McKay Specific Assessment* (Fort McKay 2010d).
- *Sagow Pimachiwin: Plants and Animals Used by Mikisew Cree First Nation for Food, Medicine and Materials* (public version) (CIER 2011).

ii) A discussion of the PRM's effects on Aboriginal culture, lifestyle and quality of life for each of the potentially affected Aboriginal groups is found in Appendix 7, Section 5.0. The review considers the effects to harvesting opportunities, consisting of the availability of the underlying resource (e.g., wildlife or fish), and access to the resources and preferred harvesting areas (a function of direct disturbance related to development, and land or water access). The methods used to assess the effects are found in Appendix 3.1. The following describes the effects of the 2013 PRM Application Case and PRM on traditional activities within the PRM TLU LSA.

Effects to Access within the LSA

Regarding access, PRM construction and operations are expected to disturb 49% of the area of the LSA. Disturbances may overlap portions of traditional trails in the LSA that are likely used for traditional hunting and trapping on Registered Fur Management Area (RFMA) #1275 (trapped by a member of Fort Chipewyan Métis Local #125 who is the spouse of the RFMA holder), or accessing the LSA portions of unassigned RFMA #2016. A traditional trail will remain in place between the PRM development area and the Athabasca River to provide access alongside the river. Shell will provide access over the proposed bridge and along the bridge access road for Aboriginal traditional land users. Access to areas east of the Athabasca River will not be affected by PRM. The navigability of the Athabasca River under the 2013 PRM Application Case is not expected to be adversely affected.

Effects to Wildlife at the LSA Level

Wildlife considered as Key Indicator Resources (KIRs) for large game hunting are moose, black bear and wood bison. The effects of the 2013 PRM Application Case on wildlife were assessed in the wildlife assessment (Appendix 1, Section 4.4). At the LSA scale, effects to large game KIRs are controlled by changes to habitat as a result of PRM construction and operations. The effects to moose, black bear and wood bison are all assessed as high magnitude for habitat change during PRM construction and operations prior to Closure.

Wildlife considered as KIRs for trapping are beaver, fisher and Canada lynx. The effects of the 2013 PRM Application Case on wildlife were assessed in the wildlife assessment (Appendix 1, Section 4.4). At the LSA scale, effects to trapping KIRs are controlled by impacts to habitat as a result of PRM construction and operations. The effects to beaver, fisher and Canada lynx were all assessed as high magnitude for habitat change at 2013 PRM Application Case during PRM construction and operations prior to Closure.

Effects to Fish at the LSA Level

The effects of the PRM on fish and fish habitat under the 2013 PRM Application Case were assessed in Appendix 1, Section 3.5. The assessment determined that the effects to fish and fish habitat due to PRM are negligible and remain unchanged from the conclusions presented in the EIA Application Case.

Effects to Traditional Plants at the LSA Level

The 2013 PRM Application Case effects to traditional use plant potential in the LSA were assessed within the Terrestrial Vegetation Assessment (Appendix 1, Section 4.3). At the LSA level PRM will result in a 41% (3,316 ha) direct loss of high Traditional Plant Potential (TPP), and a 57% (5,397 ha) loss of moderate TPP, plus an additional 9% (810 ha) loss of moderate TPP due to drawdown.

Other Factors Affecting Traditional Land Use

Odour

Odour has been noted as affecting the use and enjoyment of traditional lands. An analysis of the odour model predictions for the 2013 PDC found that peak odours may be detectable within approximately 20 km of emission sources. Peak predictions may occur for very brief periods, and while peak concentrations in excess of the threshold may be detectable to some individuals, the smell will dissipate quickly and will not be sustained (EIA Volume 3, Section 3.4.7). For example, the frequency of detectable peak odours at Fort McKay, which is about

4 km from the nearest emission sources, was predicted to be 4% of the time, or 351 hours per year in the 2013 PDC. The frequency of detectable odours diminishes with distance from the emission sources. As a result, locations more than 20 km from emission sources are not expected to experience detectable odours.

Noise

While noise from industrial facilities in Alberta is required to be in compliance with Directive 038 (EUB 2007) this does not guarantee that someone engaged in traditional land use will not hear noises from a facility. Noise from oil sands developments has been cited by Aboriginal groups as a concern in that it affects the sense of remoteness that is among the conditions used to define the meaningful practice of rights. A cumulative noise analysis was conducted, which indicated that noises may be heard within 0.9 km of an oil sands facility during the daytime and within 1.9 km of an oil sands facility during the night. Additional analysis was done to account for intermittent noise that would result from bird scare cannons, pile drivers and back-up alarms on large mining trucks. The results indicated that bird scare cannons and pile drivers may be heard about 4.0 km away and back-up alarms 1.0 km away from the source during the day under constant background noise level conditions. At night these distances increase to 6.7 km for bird cannons, 6.5 km for pile drivers and 2.1 km for back-up alarms.

Visual Impacts

The 2013 PDC includes developments located near the Athabasca River, MacKay River, Muskeg River and neighbouring the community of Fort McKay. Additional 2013 PDC disturbances include those within the immediate vicinity of PRM and areas south of Namur Lake. Key visual disturbances associated with development are related to infrastructure. The quality of TLU, related to visual disturbance, is expected to be negligibly impacted by visual disturbances for most locations in the study area. Visual impacts of mining landforms are anticipated to be minimal for cabins, communities, and trapping and hunting activities due to flat terrain and vegetative screening effects on visibility. Visual impacts of processing areas are anticipated to be more moderate at certain sites along the Athabasca River due to closer proximity and increased amount of vegetation clearing resulting in more open viewing opportunities. Water intakes are likely to be visible at sites along the water's edge for river users. Impacts of plumes are expected to be the most visible element as they are widely dispersed and visible at any location with a view of the horizon. However, plumes are most distinct seasonally in winter, and forest cover limits views of the horizon from many locations.

As distance from the Athabasca River and other localized development settings increases beyond 20 km, the likelihood of encountering visible development decreases appreciably. Although features such as active well sites and high-pressure pipelines are present in these more remote areas, most of the visual disturbance is related to features such as cutlines which result in a lower level of visual disturbance.

Effects to Human Health

The effects of the 2013 PDC on human health were considered as part of the Human Health Risk Assessment (Appendix 3.3), and included inhalation of air and dust, and ingestion of water and a variety of country foods (e.g., game, plants). The assessment determined that cumulative environmental risks associated with the additional projects and activities planned for the region are not expected to result in adverse health effects (Appendix 2, Section 3.2.2).

Socio-Economic Effects to Traditional Land Use

A variety of socio-economic factors may also affect, positively and negatively, the continuance of traditional land use activities. Increased training and new economic activities have implications for traditional culture and quality of life. Increased income and rotational work may provide resources and opportunities that can be used to undertake traditional activities; however, a cultural shift can result in a reduction of the practice of a traditional activity, more use of non-Aboriginal languages, and a reduction in the application of traditional values and knowledge. Increased costs and travel time associated with the need to travel farther distances to access abundant or healthy resources may reduce the participation in traditional land use activities. Reduced participation in harvesting activities may also result from a lessening of confidence in the quality of harvested foods from such factors as contamination.

The increase in the non-Aboriginal population is reported to have increased the competition for traditionally harvested resources. Concerns about the negative effects of increased competition for traditional resources may be compounded by the loss of other accessible areas due to industrial development. Concerns have been raised by Aboriginal groups regarding differing perceptions in land stewardship, damages to Aboriginal land user property (e.g., cabins) and increased security concerns, all which may affect participation in traditional land use activities (FMSD 2010).

The sense of disempowerment, stress and concerns about health effects are all factors in the desire of many Aboriginal individuals to move away from areas of high development or to r reduce their participation in traditional activities on the land. Quantifiable data regarding these responses to observed effects and how they affect the maintenance of traditional knowledge and the continuation of traditional land use is unavailable, but existing adverse effects to the maintenance of traditional land use opportunities and traditional knowledge, at a regional and cumulative scale, are reported by First Nations and Métis groups. While it is impossible to attribute these effects on a project by project basis, existing responses are considered in the assessment of effects to traditional land use opportunities and Aboriginal and Treaty Rights.

Community of Fort McKay (Fort McKay First Nation and Fort McKay Métis)

The PRM LSA is situated within the moderate or intense use portions of Fort McKay's 'Culturally Significant Ecosystems'. Therefore, the assessment conservatively assumed that members of the Community of Fort McKay are undertaking TLU activities within the LSA.

Traditional Hunting

The effects to TLU at the LSA level are primarily related to the loss of land due to the PRM footprint and associated access restrictions. Under the 2013 PRM Application Case, disturbance within the LSA is 49% (11,322 ha). This is assessed as an adverse and high magnitude effect. As a result of the amount of land disturbance, effects to large game wildlife and other factors affecting traditional use of land, the effects of the 2013 PRM Application Case on Fort McKay traditional hunting in the LSA will be negative in direction, high in magnitude, local in extent, and long term in duration as they are expected to occur for longer than one Aboriginal generation. They are also irreversible, as the length of duration may interfere with the ability for associated traditional knowledge to be passed intergenerationally.

Traditional Trapping

The effects to TLU at the LSA level are primarily related to the loss of land due to the PRM footprint and associated access restrictions. Disturbance affecting RFMA #2016 is 77% (4,945 ha) at 2013 PRM Application Case. This is considered an adverse and high magnitude effect. As a result of the combination of the high magnitude effect to disturbance on RFMA #2016, disturbances to furbearers and other factors affecting traditional use of lands, to the extent that trapping occurs on RFMA #2016, the effects of the 2013 PRM Application Case will be negative in direction, high in magnitude, local in extent, and long term in duration as they are expected to occur for longer than one Aboriginal generation. They are also irreversible, as the length of duration may interfere with the ability for associated traditional knowledge to be passed intergenerationally.

Traditional Fishing

Effects to traditional fishing in the LSA (including the Athabasca River) at 2013 PRM Application Case, are expected to be negligible. As a result of a combination of effects to fish and fish habitat, access on the Athabasca River and other factors affecting traditional use of land, the effects of the 2013 PRM Application Case on traditional fishing within the LSA are assessed as adverse and low in magnitude. The geographic extent is local. The duration of the effects is long term as they are expected to occur for longer than one Aboriginal generation. They are also irreversible, as the length of duration may interfere with the ability for associated traditional knowledge to be passed intergenerationally.

Traditional Plant Harvesting

The effects to TLU at the LSA level are primarily related to the loss of land due to the PRM footprint and associated access restrictions. Disturbance within the LSA at 2013 PRM Application Case is 49%, an adverse and high magnitude impact. The loss of 41% of high TPP and 66% of moderate TPP within the LSA is also considered an adverse high magnitude impact. As a result of these impacts in combination with other factors affecting traditional use of the land, the effects of the 2013 PRM Application Case on traditional plant and berry harvesting at the LSA level are assessed as negative in direction, high in magnitude, local in extent, and long term in duration as they are expected to occur for longer than one Aboriginal generation. They are also irreversible, as the length of duration may interfere with the ability for associated traditional knowledge to be passed intergenerationally.

Mikisew Cree First Nation

The PRM LSA is situated within the traditional territory of the MCFN. Therefore, the assessment makes the conservative assumption that MCFN members are undertaking TLU activities within the LSA.

Traditional Hunting

The effects to Mikisew Cree First Nation (MCFN) traditional hunting within the LSA are assessed to be the same those assessed for the Community of Fort McKay, above.

Traditional Trapping

Although there are no RFMAs within the LSA that are assigned to members of the MCFN, RFMA #2016 is unassigned and has the potential to be trapped by Aboriginal trappers who are members of the MCFN. If there is trapping on RFMA #2016 by members of the MCFN, the effects of the PRM will be the same as those assessed for the members of the Community of Fort McKay, above.

Traditional Fishing

The effects to MCFN traditional fishing within the LSA are assessed to be the same as those assessed for the Community of Fort McKay, above.

Traditional Plant Harvesting

The effects to MCFN traditional plant harvesting within the LSA are assessed to be the same as those assessed for the Community of Fort McKay, above.

Athabasca Chipewyan First Nation

The PRM LSA is situated within one of the ACFN Homeland Zones. Therefore, the assessment conservatively assumes that members of the ACFN are conducting TLU activities within the LSA

Traditional Hunting

The effects to Athabasca Chipewyan First Nation (ACFN) traditional hunting within the LSA are assessed to be the same as those assessed for the Community of Fort McKay.

Traditional Trapping

Although there are no RFMAs within the LSA that are assigned to members of the ACFN, RFMA #2016 is unassigned and has the potential to be trapped by Aboriginal trappers who are members of the ACFN. If there is trapping on RFMA #2016 by members of the ACFN, the effects of the PRM will be the same as those assessed for the members of the Community of Fort McKay, above.

Traditional Fishing

The effects to ACFN fishing within the LSA are assessed to be the same as those assessed for the Community of Fort McKay.

Traditional Plant Harvesting

The effects to ACFN plant harvesting within the LSA are assessed to be the same as those assessed as the Community of Fort McKay, above.

Fort McMurray #468 First Nation

Traditional Hunting

The effects to Fort McMurray #468 First Nation (FM#468) hunting within the LSA are assessed to be the same as those assessed for the Community of Fort McKay, above.

Traditional Trapping

Although there are no RFMAs within the LSA that are assigned to members of FM468, RFMA #2016 is unassigned and has the potential to be trapped by Aboriginal trappers who are members of FM468. If there is trapping on RFMA #2016 by members of FM468, the effects of the PRM will be the same as those assessed for the members of the Community of Fort McKay, above.

Traditional Fishing

The effects to FM#468 fishing within the LSA are assessed to be the same as those assessed for the Community of Fort McKay, above.

Traditional Plant Harvesting

The effects to FM#468 plant harvesting within the LSA are assessed to be the same as those assessed for the Community of Fort McKay, above.

Fort Chipewyan Métis Local #125

A member of Fort Chipewyan Metis Local #125 (Local #125) is the spouse of the registered holder of RFMA #1275, which is located within the LSA. Therefore, traditional land use activities by members of Metis Local #125 were conservatively assumed to occur within the LSA.

Traditional Hunting

The effects to Fort Chipewyan Métis Local #125 hunting within the LSA are assessed to be the same as those assessed for the Community of Fort McKay.

Traditional Trapping

The effects to Fort Chipewyan Métis Local #125 traditional trapping at the LSA level under the 2013 PRM Application Case are largely determined by the effects to RFMA #1275, trapped by a member of the Fort Chipewyan Metis. Under the 2013 PRM Application Case, disturbance to RFMA #1275 is 47% (6,994 ha). This is assessed as an adverse and high magnitude effect. As the result of this high magnitude effect in combination with effects to furbearers and other factors affecting traditional use of the land, effects to Fort Chipewyan Métis Local #125 traditional trapping at the LSA level are assessed as adverse, high in magnitude, local in extent, and long term in duration as they are expected to occur for longer than one Aboriginal generation. They are also irreversible, as the length of duration may interfere with the ability for associated traditional knowledge to be passed intergenerationally.

Traditional Fishing

The effects to Fort Chipewyan Métis Local #125 fishing within the LSA are assessed to be the same as those for the Community of Fort McKay, above.

Traditional Plant Harvesting

The effects to Fort Chipewyan Métis Local #125 traditional plant harvesting within the LSA are assessed to be the same as those assessed for the Community of Fort McKay.

Fort McMurray Métis Local #1935

The available information suggests that members of Fort McMurray Metis Local #135 (Local #135) may be conducting TLU activities within the larger region in proximity to the LSA. Therefore, the assessment made the conservative assumption that members of Metis Local #135 are undertaking TLU activities within the LSA.

Traditional Hunting

The LSA was not identified as a preferred hunting area for members of Fort McMurray Métis Local #1935. Therefore, the assessment did not identify any effects to Métis Local #1935 hunting under the 2013 PRM Application Case.

Traditional Trapping (Métis Local #1935)

Although there are no RFMAs within the LSA that are assigned to members of Metis Local #1935, RFMA #2016 is unassigned and has the potential to be trapped by Aboriginal trappers who are members of Metis Local #1935. If there is trapping on RFMA #2016 by members of Metis Local #1935, the effects of the PRM will be the same as those assessed for the members of the Community of Fort McKay, above.

Traditional Fishing

The effects to fishing within the LSA by members of Métis Local #1935 are assessed to be the same as those assessed for the Community of Fort McKay, above.

Traditional Plant Harvesting

The effects to plant harvesting within the LSA by members of Métis Local #1935 are assessed to be the same as those assessed for the Community of Fort McKay, above.

iii) The reference list provided for the response to JRP SIR 65a(i), above, provides the Aboriginal affiliation for each source within the entry, with the exception of:

- *As Long as the Rivers Flow: Athabasca River Knowledge, Use and Change* (Candler et al. 2010), which provided TLU information for both the Athabasca Chipewyan First Nation and the Mikisew Cree First Nation.
- *Barb Hermansen: Her Story. The Last Women to Raise Children on the Athabasca River* (Labour and Hermansen 2010), which provided information regarding Fort Chipewyan Métis Local #125 use within the area.

iv) Information provided by Aboriginal groups was used in the assessment of the PRM's effects on wildlife, vegetation and navigable transportation.

The PRM's effects on wildlife considered information from potentially affected Aboriginal groups as follows:

- Aboriginal information regarding bison was used to respond to JRP SIR 41, which asked that Shell "quantify the effects of the Project and other cumulative effects on wood bison within their current core range as identified through TEK."
- Traditional Knowledge was collected and integrated into the Terrestrial Environmental Setting Report Section 5.2.3 (Golder 2007) to help describe baseline conditions for wildlife in the LSA and RSA. An understanding of

baseline conditions was very important for predicting the effects of the Project on wildlife.

- First Nations concerns regarding waterfowl in the Peace-Athabasca Delta were considered in the response to JRP SIR 34.
- The selection of KIRs (e.g., moose, Canada lynx, black bear, fisher, beaver) in the EIA (Volume 3, Section 1.3.5) factored in the importance of these species to traditional harvesting.

Regarding hydrology, the ACFN and MCFN state that Big Creek and Redclay Creek are reported to be navigable at adequate water levels. Transport Canada's assessment of the waterways in and around the PRM area indicate only the Athabasca River is navigable. The design philosophy adopted for the outlet channel from the South Redclay Lake is to create a channel with characteristics similar to those of existing streams in the area; therefore, it is likely that the South Redclay Lake outlet channel will meet ACFN and MCFN's navigability requirements because the predicted changes in water depth are less than a few centimetres. A more detailed discussion of how ACFN and MCFN information was used to assess water navigability in Big Creek, Redclay Creek and the Athabasca River is found in the response to JRP SIR 29.

For the vegetation assessment, a revised list of traditional use plant species identified in Attachment 1 of the 2013 TLU ESR (Appendix 3.8) was used to identify occurrences of traditional use plant species within the LSA (JRP SIR 67). This list of traditional use plant species was revised from the EIA, Volume 5, Section 8.3, Table 8.3-1 to reflect information from the following sources:

- *Mark of the Métis: Traditional Knowledge and Stories of the Métis Peoples of Northeastern Alberta* (Fort McMurray Métis Local #1935 2012); and
- *Sagow Pimachiwin: Plants and Animals Used by Mikisew Cree First Nation for Food, Medicine and Materials* (public version) (CIER 2011).

The information provided by Aboriginal groups was also used to develop the framework used in addressing this SIR. For example, as a result of the information provided Aboriginal groups, the assessment considered the effects of odours, noise, human health, and other socio-economic factors in the assessment.

References:

Candler, C., R. Olsen, S. DeRoy, Firelight Group Research Cooperative, Athabasca Chipewyan First Nation and Mikisew Cree First Nation. 2010. *As Long as the Rivers Flow: Athabasca River Knowledge, Use and Change*. November 26, 2010.

Candler, C., Firelight Group Research Cooperative, with the Athabasca Cree First Nation. 2011. *Athabasca Chipewyan First Nation Knowledge and Use Report and Assessment for Shell Canada's Proposed Redclay Compensation Lake*. Prepared for the Athabasca Chipewyan First Nation. May 3, 2011.

Candler, C., Firelight Group Research Cooperative, with the Athabasca Cree First Nation. 2012a. *Athabasca Chipewyan First Nation Integrated Knowledge and Land Use Report and Assessment for Shell Canada's Proposed Jackpine Mine Expansion and Pierre River Mine*. April 20, 2011 (Updated September 15, 2012). Submitted to Athabasca Chipewyan First Nation Industry Relations Corporation.

Candler, C., Firelight Group Research Cooperative, with the Mikisew Cree First Nation. 2012b. *Mikisew Cree First Nation Indigenous Knowledge and Use Report and Assessment for Shell Canada's Proposed Jackpine Mine Expansion, Pierre River Mine, and Redclay Compensation Lake*. February 15, 2012. Prepared for Mikisew Cree First Nation.

CIER (Centre for Indigenous Environmental Resources). 2011. *Sagow Pimachiwin: Plants and Animals Used by Mikisew Cree First Nation for Food, Medicine and Materials* (public version). Prepared for the Mikisew Cree First Nation Government and Industry Relations.

Elias, P.D. 2011. *Mikisew Cree Use of Lands and Resources in the Vicinity of the Proposed Shell- Jack Pine and Shell – Pierre River Operations*. Prepared for Mikisew Creek First Nation, January 17, 2011.

FM468 (Fort McMurray #468 First Nation). 2006. *Nistawayaw "Where Three Rivers Meet": Fort McMurray #468 First Nation Traditional Land Use Study*. Calgary: Nicomacian Press.

FMSD (Fort McKay Sustainability Department). 2010. Fort McKay Submission to the Draft Lower Athabasca Integrated Regional Plan 2011-2021. Appendix C – Intense. Moderate and Low Use Culturally Significant Ecosystems Maps. June 2011.

Fort Chipewyan Métis (Métis Local 125 Fort Chipewyan Alberta). 2012. *Fort Chipewyan Métis Historic Use & Occupancy: Thematic Maps*.

Fort McKay (Fort McKay Industry Relations Corporation). 2010a. *Cultural Assessment Baseline: Pre-development (1960s) to Current (2008)*. March 2010.

Fort McKay. 2010b. *Fort McKay Specific Assessment: Disturbance and Access, Implications for Traditional Use*. March 2010.

Fort McKay. 2010c. *Fort McKay Submission to the Draft Lower Athabasca Integrated Regional Plan 2011-2021. Appendix C – Intense-. Moderate- and Low-Use Culturally Significant Ecosystems Maps*. June 2011.

Fort McKay. 2010d. *Project-Specific Cultural Heritage Assessment. Shell's Proposed Pierre River Mine and Jackpine Mine Expansion: Fort McKay Specific Assessment*. March 2010.

Fort McKay. 2011. *Fort McKay Submission Regarding the Draft Lower Athabasca Integrated Regional Plan 2011-2012: Fort McKay First Nation and Fort McKay Métis Nation*. June 2011.

Fort McMurray Métis Local #1935. 2012. *Mark of the Métis: traditional knowledge and stories of the Métis peoples of northeastern Alberta*. Winnipeg: Friesens.

Golder (Golder Associates Ltd.). 2007. *Terrestrial Environmental Setting Report for the Jackpine Mine Expansion & Pierre River Mine Project*. Prepared for Shell Canada Limited. Calgary, AB.

Labour, S., B. Dickson and MSES. 2012. *Cumulative Impacts to FMFN 468 Traditional Lands & Lifeways: Shell Jackpine Mine Expansion and Pierre River Mine Report for Regulatory Hearings.* Prepared for Fort McMurray First Nation #468. September 4, 2012.

Labour, S. and B. Hermansen. 2010. *Barb Hermansen: Her Story. The Last Woman to Raise Children on the Athabasca River*. Prepared for Fort Chipewyan Métis, Local 125, December 2010.

Larcombe, P.M. 2012. *A Narrative of Encroachment Experience by Athabasca Chipewyan First Nation*. Prepared for Athabasca Chipewyan First Nation Industry Relations Corporation. Symbion Consultants. Winnipeg, Manitoba. September 28, 2012.

Marcel, P., Firelight Group Research Cooperative, and ACFN (Athabasca Chipewyan First Nation). 2012. *Níh boghodi: We are the stewards of our land. An ACFN stewardship strategy for thunzea, et'thén and dechen yághe ejere (woodland caribou, barren-ground caribou and wood bison*), Prepared for the Athabasca Chipewyan First Nation. April 26 2012.

MCFN (Mikisew Cree First Nation). No date. *Ayapaskowinowak: Ta Kiskissotamak Kayas Pimatisowin Oti Nikan Kichi (Acknowledging the past, securing the future). The traditional land use of the Mikisew Cree First Nation*.

SIR 66

EIA Volume 5: Terrestrial Resources and Human Environment, Page 8-39, Table 8.3-9. Shell shows the extent of high, moderate and low traditional plant potential for the base case and at closure in the TLU-LSA.

a) Provide tables (number of hectares and percentage of the area) and maps indicating the areas of high, moderate and low traditional plant potential in the PRM TLU local and regional study areas for the Pre-industrial, Base, Application and Planned Development Cases before and after reclamation.

b) Provide the surface-area of the portion of the TLU-LSA that lies within the PRM project footprint. Provide the percentage and number of hectares.

Response:

a) Traditional Plant Potential (TPP) is determined by the ecosite phases present in the Local Study Area (LSA) for the 2013 Base Case, 2013 PRM Application Case, 2013 PDC and at Closure. The ecosite phases within the PRM closure landscape were assigned a TPP based upon:

- plant species observed during vegetation field surveys in the Oil Sands Region;
- observed species abundance, characteristic species of each ecosite phase; and
- the known traditional plant species in the Oil Sands Region.

Traditional plant species included species identified by the Community of Fort McKay (Golder 2007), MCFN (CIER 2011), ACFN (ACFN 2003), and Fort McMurray Métis (Fort McMurray Métis Local #1935 2012). Traditional plants are not a separate ecological category of plants, such as ‘rare plant species’, but rather are a clustering of vegetative types identified by Aboriginal groups as having cultural value for either food, medicines or other uses. The plants can be found in various ecosites and ‘traditional plant potential’ is a way of describing areas that have degrees of potential (based upon the presence of ecosites) to produce plants that are of interest to Aboriginal groups.

The areas of high, moderate and low TPP in the LSA for the 2013 Base Case, 2013 PRM Application Case, 2013 PDC and at Closure are shown in Table 66-1. The PIC TPP data was not generated at the LSA scale and has not been included in Table 66-1.

The PIC landcover data at the LSA scale was not available and the Alberta Vegetation Inventory (AVI) data used at the LSA scale was created after development (numerous cutblocks) had already occurred in the LSA. Therefore, it was not possible to re-create LSA-scale data for the type of vegetation that had existed in those areas prior to development.

Table 66-1 Traditional Plant Potential in the Local Study Area

Traditional Plant Potential	2013 Base Case		2013 PRM Application Case		2013 Planned Development Case		Closure	
	[ha]	% of LSA	[ha]	% of LSA	[ha]	% of LSA	[ha]	% of LSA
High	8,077	34	4,761	20	3,753	16	8,566	37
Moderate	9,529	41	4,132	17	2,889	12	6,218	26
Low	5,522	23	14,235	61	16,485	71	8,343	36
Total	**23,129**	**100**	**23,129**	**100**	**23,129**	**100**	**23,129**	**100**

Notes: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Pre-Industrial information was not generated at the LSA scale and therefore not included.

High TPP is expected to be reduced 14.3% between the 2013 Base Case and 2013 PRM Application Case (from 34.9% to 20.6%), and 4.4% between 2013 PRM Application Case and 2013 PDC (from 20.6% to 16.2%) in the LSA. At Closure, high TPP is predicted to be 2.1% greater than 2013 Base Case conditions at 37% of the total LSA and low TPP is predicted to be 12.2% greater than 2013 Base Case at 36.1% of the LSA. The increases in high and low TPP are offset by a reduction in moderate TPP (26.9% of the LSA at Closure compared to 41.2% at 2013 Base Case). The increases in high TPP and low TPP at Closure are due to the increase in uplands areas, and lakes, marsh and shrublands in the Closure landscape. The increases in high TPP and low TPP result in a corresponding reduction in moderate TPP areas.

The TPP within the LSA is shown in Figures 66-1 to 66- 4. The TPP at 2013 Base Case is shown in Figure 66-1, the TPP at 2013 PRM Application Case is shown in Figure 66-2, and the TPP at 2013 PDC is shown in Figure 66-3. Figures 66-1 through 66-3 are all prior to reclamation. The LSA TPP at Closure (after reclamation) is provided in Figure 66-4. As indicated above, there was no LSA-level data available for the PIC. Therefore, no figures are available for the LSA at the PIC.

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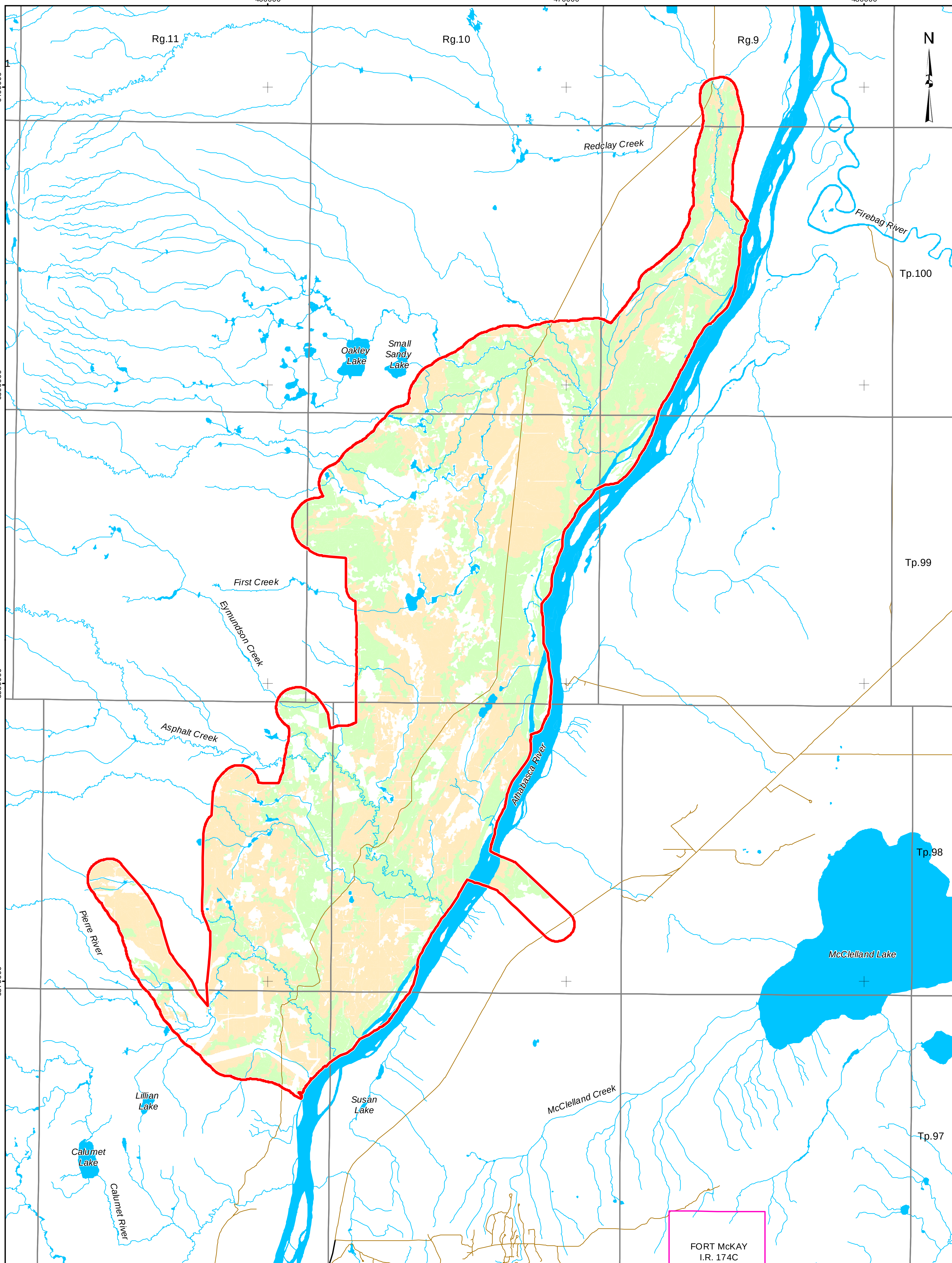

LEGEND

- PAVED ROAD
- UNPAVED ROAD
- INDIAN RESERVE
- PIERRE RIVER MINE LOCAL STUDY AREA
- OPEN WATER

TRADITIONAL PLANT POTENTIAL

- HIGH
- MODERATE
- LOW

4 0 4

SCALE 1:125,000 KILOMETRES

REFERENCE

ALBERTA DIGITAL BASE DATA OBTAINED FROM ALTALIS LTD. © GOVERNMENT OF ALBERTA 2013.
DATUM: NAD83 PROJECTION: UTM ZONE 12N

PROJECT

PIERRE RIVER MINE PROJECT

TITLE

TRADITIONAL PLANT POTENTIAL IN THE TERRESTRIAL LOCAL STUDY AREA – 2013 BASE CASE

Shell Canada Limited

PROJECT		13-1346-0001	FILE No.
DESIGN	MG	10 May 2013	SCALE AS SHOWN / REV. 0
GIS	SB	29 Oct 2013	
CHECK	MG	13 Jun 2013	FIGURE: 66-1
REVIEW	CY	17 Jun 2013	

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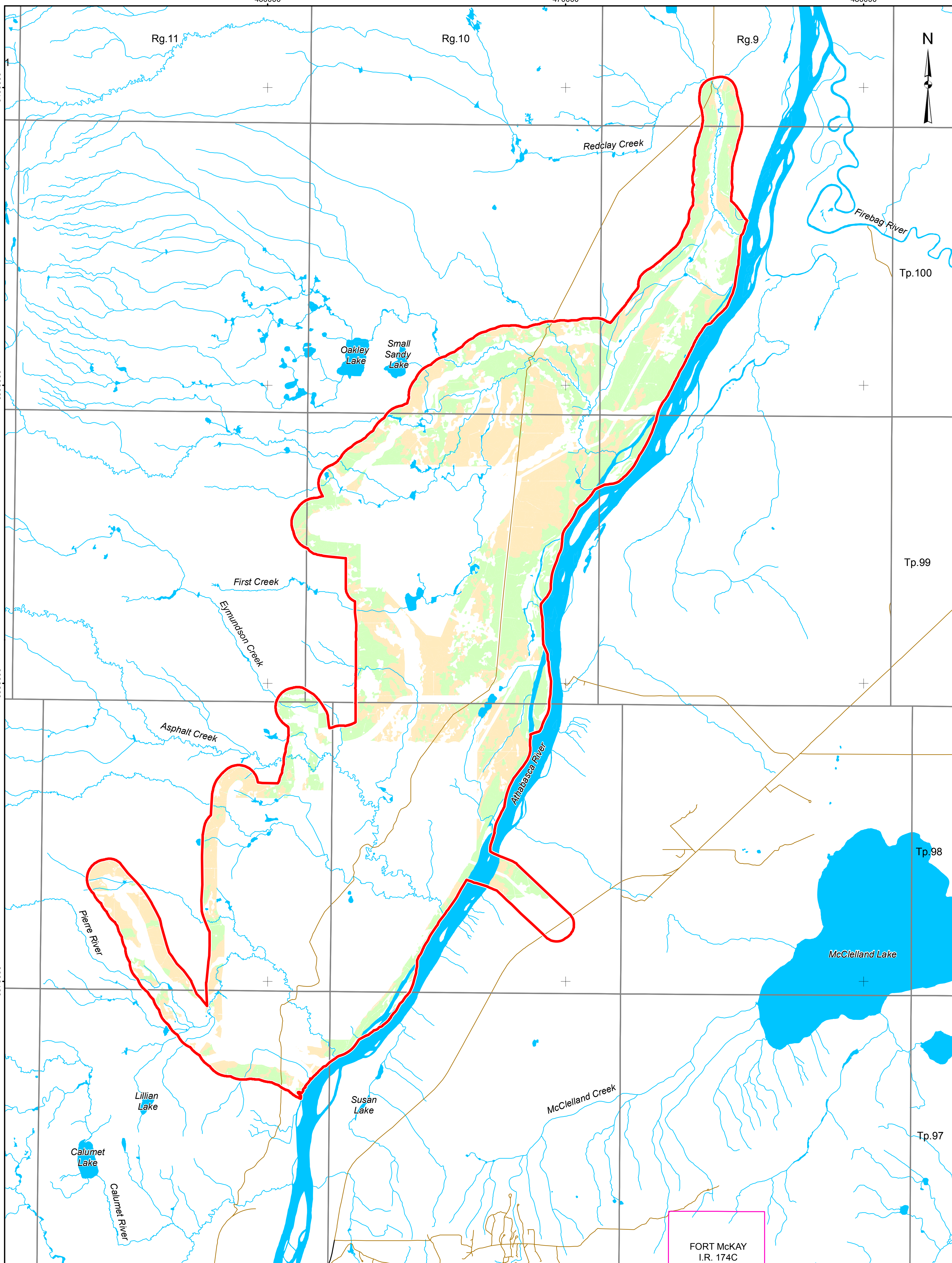

LEGEND

- PAVED ROAD
- UNPAVED ROAD
- INDIAN RESERVE
- PIERRE RIVER MINE LOCAL STUDY AREA
- OPEN WATER

TRADITIONAL PLANT POTENTIAL

- HIGH
- MODERATE
- LOW

4 0 4

SCALE 1:125,000 KILOMETRES

REFERENCE

ALTALIS LTD. PROVIDED THE ALBERTA DIGITAL BASE DATA. © GOVERNMENT OF ALBERTA 2013.

DATUM: NAD83 PROJECTION: UTM ZONE 12N

PROJECT

PIERRE RIVER MINE PROJECT

TITLE

TRADITIONAL PLANT POTENTIAL IN THE TERRESTRIAL LOCAL STUDY AREA – 2013 PRM APPLICATION CASE

Shell Canada Limited

PROJECT		13-1346-0001	FILE No.	
DESIGN	MG	10 May 2013	SCALE AS SHOWN	REV. 0
GIS	SB	28 Oct 2013	**FIGURE: 66-2**	
CHECK	MG	13 Jun 2013		
REVIEW	CY	17 Jun 2013		

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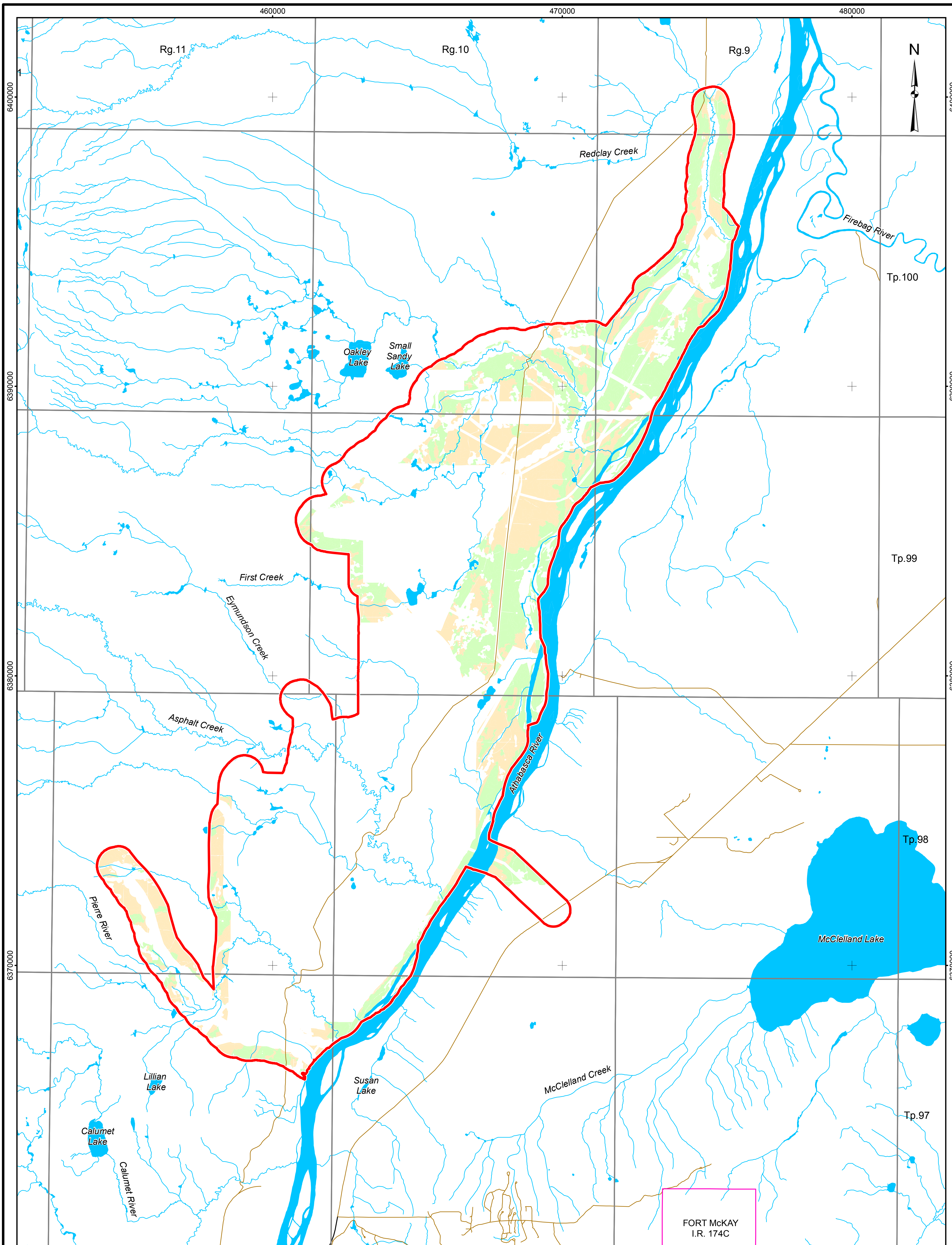

LEGEND

- PAVED ROAD
- UNPAVED ROAD
- INDIAN RESERVE
- PIERRE RIVER MINE LOCAL STUDY AREA
- OPEN WATER

TRADITIONAL PLANT POTENTIAL

- HIGH
- MODERATE
- LOW

4 0 4

SCALE 1:125,000 KILOMETRES

REFERENCE

ALBERTA DIGITAL BASE DATA OBTAINED FROM ALTALIS LTD. © GOVERNMENT OF ALBERTA 2013.
DATUM: NAD83 PROJECTION: UTM ZONE 12N

PROJECT

PIERRE RIVER MINE PROJECT

TITLE

TRADITIONAL PLANT POTENTIAL IN THE TERRESTRIAL LOCAL STUDY AREA - 2013 PLANNED DEVLOPMENT CASE

Shell Canada Limited

PROJECT		13-1346-0001	FILE No.	
DESIGN	MG	10 May 2013	SCALE AS SHOWN	REV. 0
GIS	SB	28 Oct 2013	**FIGURE: 66-3**	
CHECK	MG	13 Jun 2013		
REVIEW	CY	17 Jun 2013		

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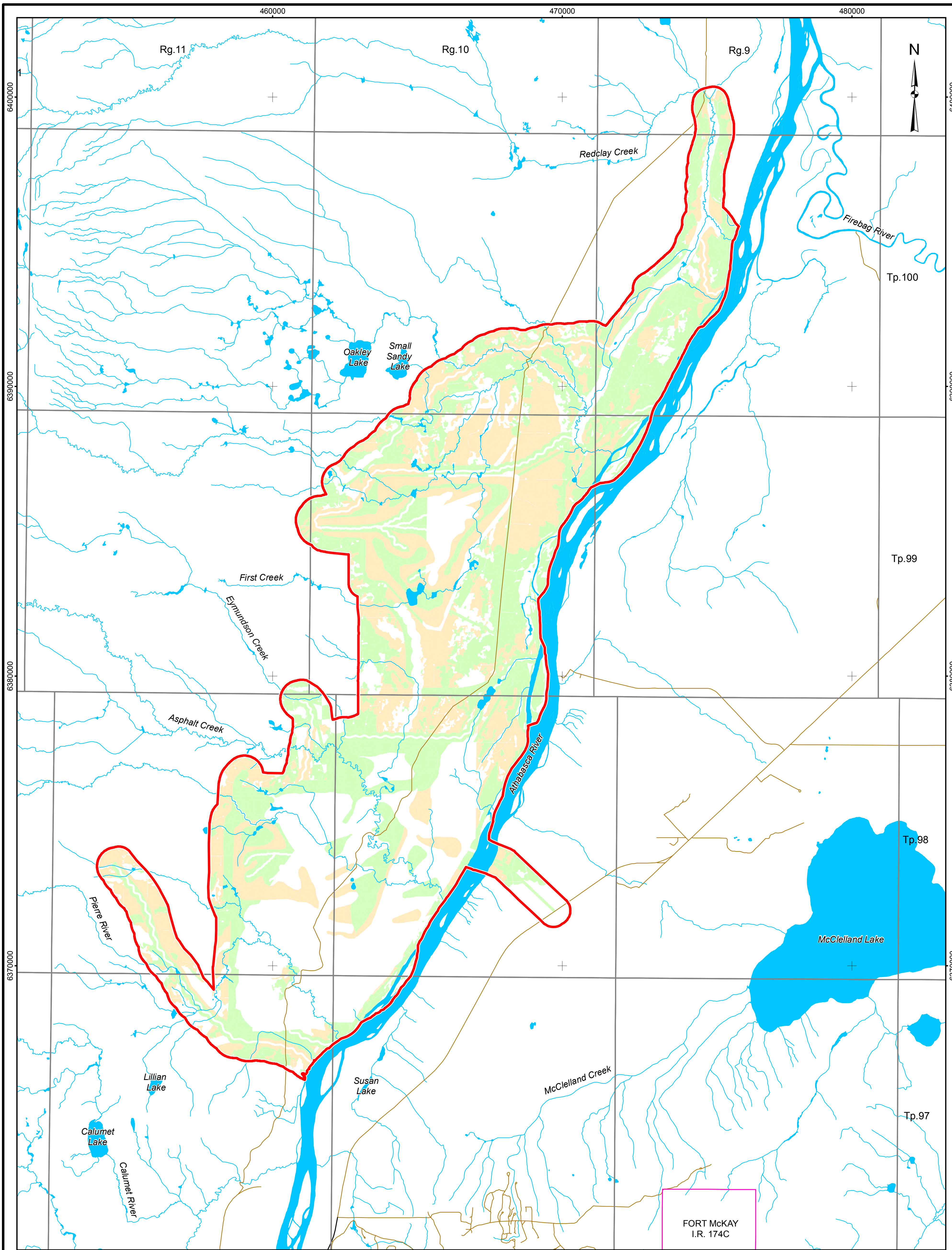


4 0 4

SCALE 1:125,000 KILOMETRES

LEGEND

PAVED ROAD	**TRADITIONAL PLANT POTENTIAL**
UNPAVED ROAD	HIGH
INDIAN RESERVE	MODERATE
PIERRE RIVER MINE LOCAL STUDY AREA	LOW
OPEN WATER	

REFERENCE

ALBERTA DIGITAL BASE DATA OBTAINED FROM ALTALIS LTD. © GOVERNMENT OF ALBERTA 2013.
DATUM: NAD83 PROJECTION: UTM ZONE 12N

PROJECT

PIERRE RIVER MINE PROJECT

TITLE

TRADITIONAL PLANT POTENTIAL IN THE TERRESTRIAL LOCAL STUDY AREA – CLOSURE

Shell Canada Limited

PROJECT		13-1346-0001	FILE No.	
DESIGN	MG	10 May 2013	SCALE AS SHOWN	REV. 0
GIS	SB	28 Oct 2013	**FIGURE: 66-4**	
CHECK	MG	13 Jun 2013		
REVIEW	CY	17 Jun 2013		

The areas of high, moderate and low TPP within the RSA for the PIC, 2013 Base Case, 2013 PRM Application Case, and 2013 PDC conditions are provided in Table 66-2.

Table 66-2 Traditional Plant Potential in the Regional Study Area

Traditional Plant Potential	Pre-Industrial Case		2013 Base Case		2013 PRM Application Case		2013 Planned Development Case	
	[ha]	% of RSA	[ha]	% of RSA	[ha]	% of RSA	[ha]	% of RSA
High	549,863	24	414,244	18	411,473	18	367,385	16
Moderate	1,204,667	52	1,090,403	47	1,084,086	47	1,029,471	45
Low	522,127	22	772,728	33	781,816	34	880,519	38
N/A[(a)]	718	0	-	-	-	-	-	-
Total	**2,277,376**	**100**	**2,277,376**	**100**	**2,277,376**	**100**	**2,277,376**	**100**

(a) TPP information unavailable.

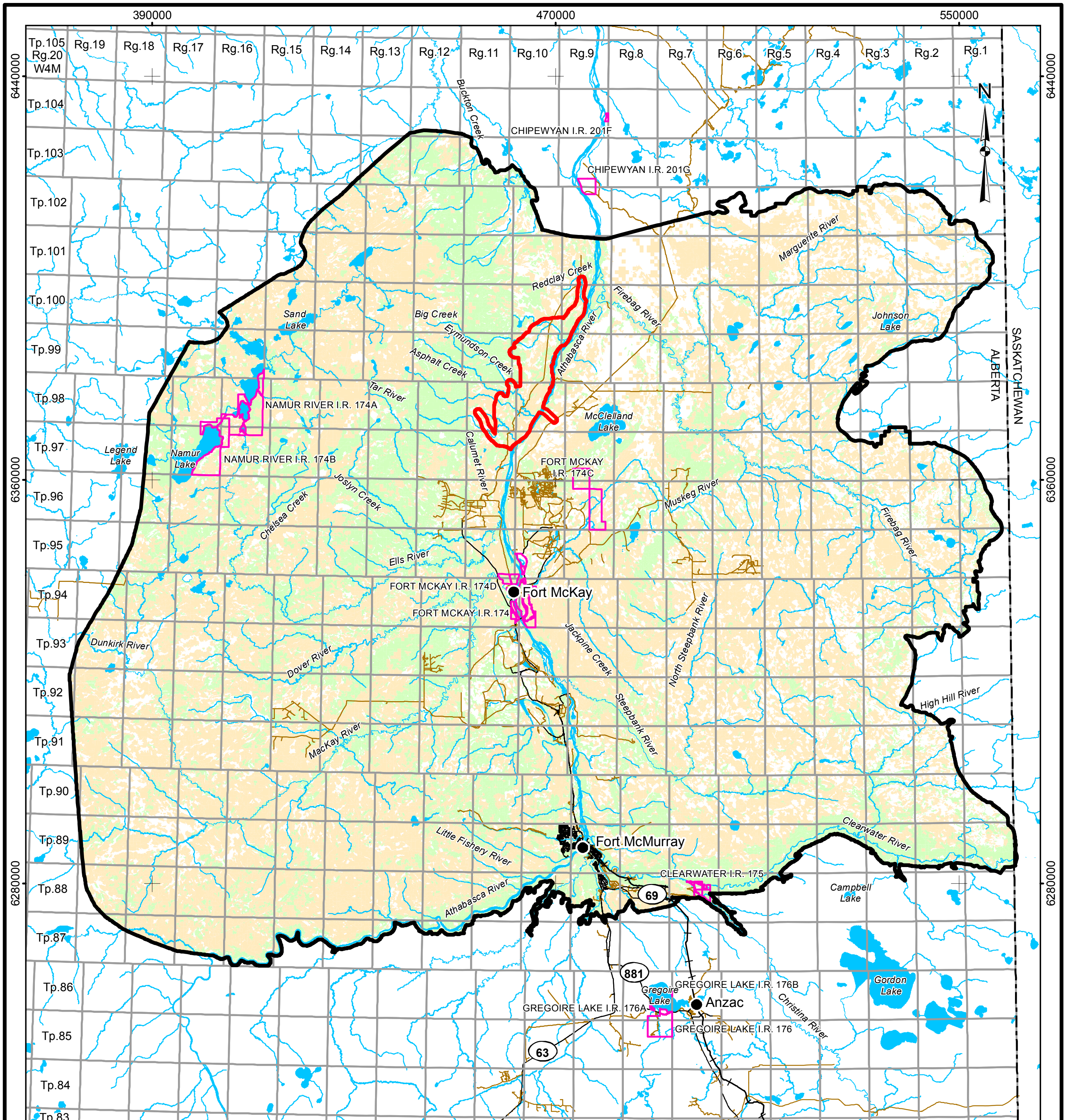
Notes: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Closure information is not available at the RSA scale and therefore not included.

At the RSA level, high TPP is predicted to be 24% of total area at PIC, and will decrease at 2013 Base Case, 2013 PRM Application Case and 2013 PDC to 18%, 18% and 16% respectively (Table 66-2). Moderate TPP is predicted to decrease from the PIC of 52% to 47% at 2013 Base Case, 47% at 2013 PRM Application Case and 45% at 2013 PDC. Low TPP is expected to increase from PIC conditions of 22%, to 33% at 2013 Base Case, 34% at 2013 PRM Application Case and 38% at 2013 PDC.

The TPP within the RSA is shown in Figures 66-5 to 66-8. The TPP for the PIC is shown in Figure 66-5, the TPP at 2013 Base Case is shown in Figure 66-6, the TPP at 2013 PRM Application Case is shown in Figure 66-7, and the TPP at 2013 PDC is shown in Figure 66-8.

b) The PRM footprint is 11,742 ha, and comprises 49.0% of the total 2013 TLU LSA area (23,129.1 ha).



LEGEND

- COMMUNITY
- PAVED ROAD
- UNPAVED ROAD
- RAILWAY
- WATERCOURSE
- INDIAN RESERVE
- PROVINCIAL BOUNDARY
- PIERRE RIVER MINE LOCAL STUDY AREA
- TERRESTRIAL RESOURCES REGIONAL STUDY AREA
- OPEN WATER

TRADITIONAL PLANT POTENTIAL

- HIGH
- MODERATE
- LOW

25 0 25

SCALE 1:1,100,000 KILOMETRES

REFERENCE

ALBERTA DIGITAL BASE DATA OBTAINED FROM ALTALIS LTD. © GOVERNMENT OF ALBERTA 2013. PROVINCIAL BOUNDARY OBTAINED FROM IHS ENERGY INC.
DATUM: NAD83 PROJECTION: UTM ZONE 12N

PROJECT

PIERRE RIVER MINE PROJECT

TITLE

TRADITIONAL PLANT POTENTIAL IN THE TERRESTRIAL REGIONAL STUDY AREA – PRE-INDUSTRIAL CASE

Shell Canada Limited

PROJECT		13-1346-0001	FILE No.	
DESIGN	MG	10 May 2013	SCALE AS SHOWN	REV. 0
GIS	SB	28 Oct 2013	**FIGURE: 66-5**	
CHECK	MG	13 Jun 2013		
REVIEW	CY	17 Jun 2013		

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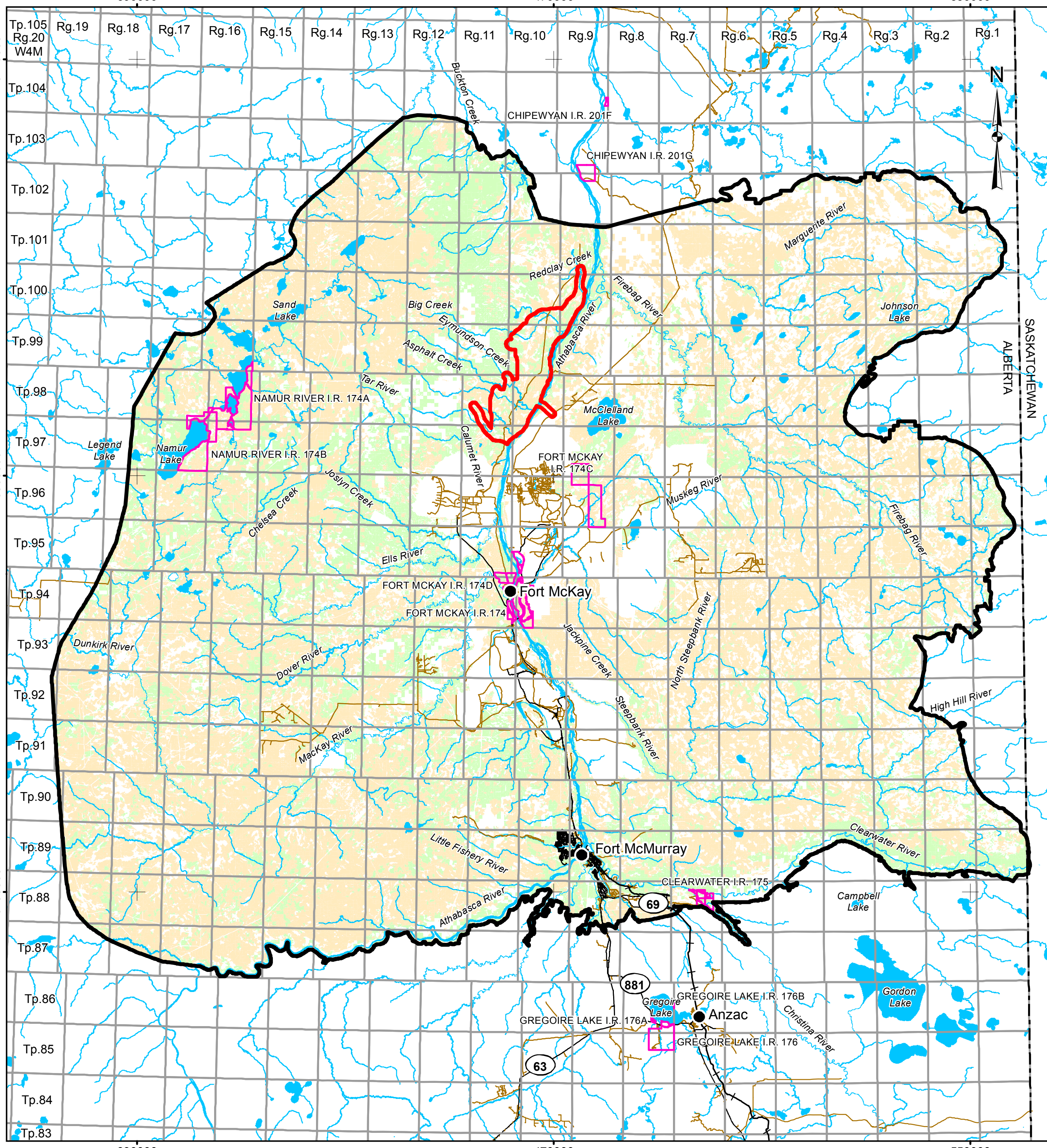

LEGEND

- COMMUNITY
- PAVED ROAD
- UNPAVED ROAD
- RAILWAY
- WATERCOURSE
- INDIAN RESERVE
- PROVINCIAL BOUNDARY
- PIERRE RIVER MINE LOCAL STUDY AREA
- TERRESTRIAL RESOURCES REGIONAL STUDY AREA
- OPEN WATER

TRADITIONAL PLANT POTENTIAL

- HIGH
- MODERATE
- LOW

25 0 25

SCALE 1:1,100,000 KILOMETRES

REFERENCE

ALBERTA DIGITAL BASE DATA OBTAINED FROM ALTALIS LTD. © GOVERNMENT OF ALBERTA 2013. PROVINCIAL BOUNDARY OBTAINED FROM IHS ENERGY INC.
DATUM: NAD83 PROJECTION: UTM ZONE 12N

PROJECT

PIERRE RIVER MINE PROJECT

TITLE

TRADITIONAL PLANT POTENTIAL IN THE TERRESTRIAL REGIONAL STUDY AREA – 2013 BASE CASE

Shell Canada Limited

PROJECT		13-1346-0001	FILE No.	
DESIGN	MG	10 May 2013	SCALE AS SHOWN	REV. 0
GIS	SB	28 Oct 2013	FIGURE: 66-6	
CHECK	MG	13 Jun 2013		
REVIEW	CY	17 Jun 2013		

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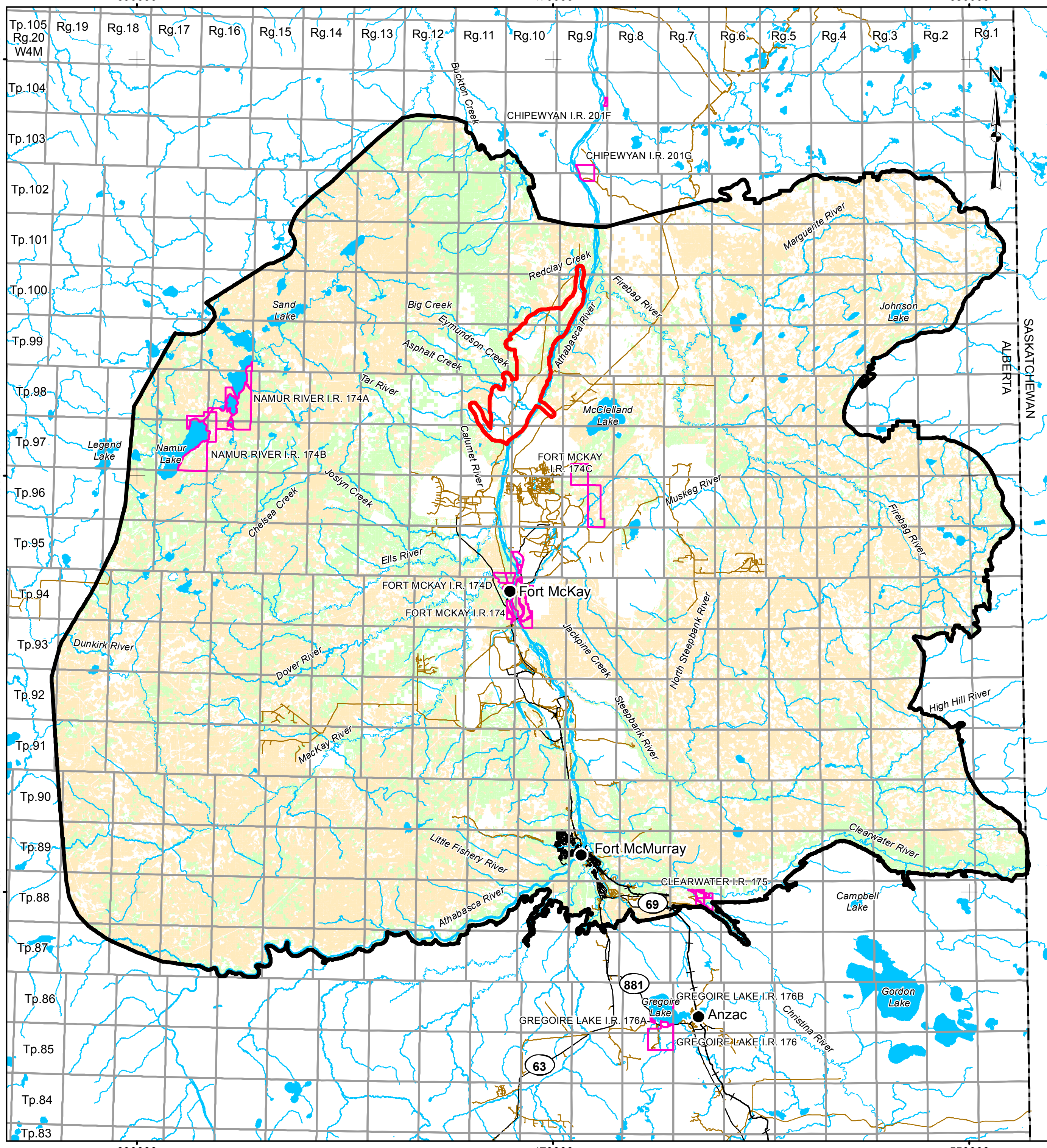

LEGEND

- COMMUNITY
- PAVED ROAD
- UNPAVED ROAD
- RAILWAY
- WATERCOURSE
- INDIAN RESERVE
- PROVINCIAL BOUNDARY
- PIERRE RIVER MINE LOCAL STUDY AREA
- TERRESTRIAL RESOURCES REGIONAL STUDY AREA
- OPEN WATER

TRADITIONAL PLANT POTENTIAL

- HIGH
- MODERATE
- LOW

25 0 25

SCALE 1:1,100,000 KILOMETRES

REFERENCE

ALBERTA DIGITAL BASE DATA OBTAINED FROM ALTALIS LTD. © GOVERNMENT OF ALBERTA 2013. PROVINCIAL BOUNDARY OBTAINED FROM IHS ENERGY INC.
DATUM: NAD83 PROJECTION: UTM ZONE 12N

PROJECT

PIERRE RIVER MINE PROJECT

TITLE

TRADITIONAL PLANT POTENTIAL IN THE TERRESTRIAL REGIONAL STUDY AREA – 2013 PRM APPLICATION CASE

Shell Canada Limited

PROJECT		13-1346-0001	FILE No.	
DESIGN	MG	10 May 2013	SCALE AS SHOWN	REV. 0
GIS	SB	20 Jun 2013	**FIGURE: 66-7**	
CHECK	MG	13 Jun 2013		
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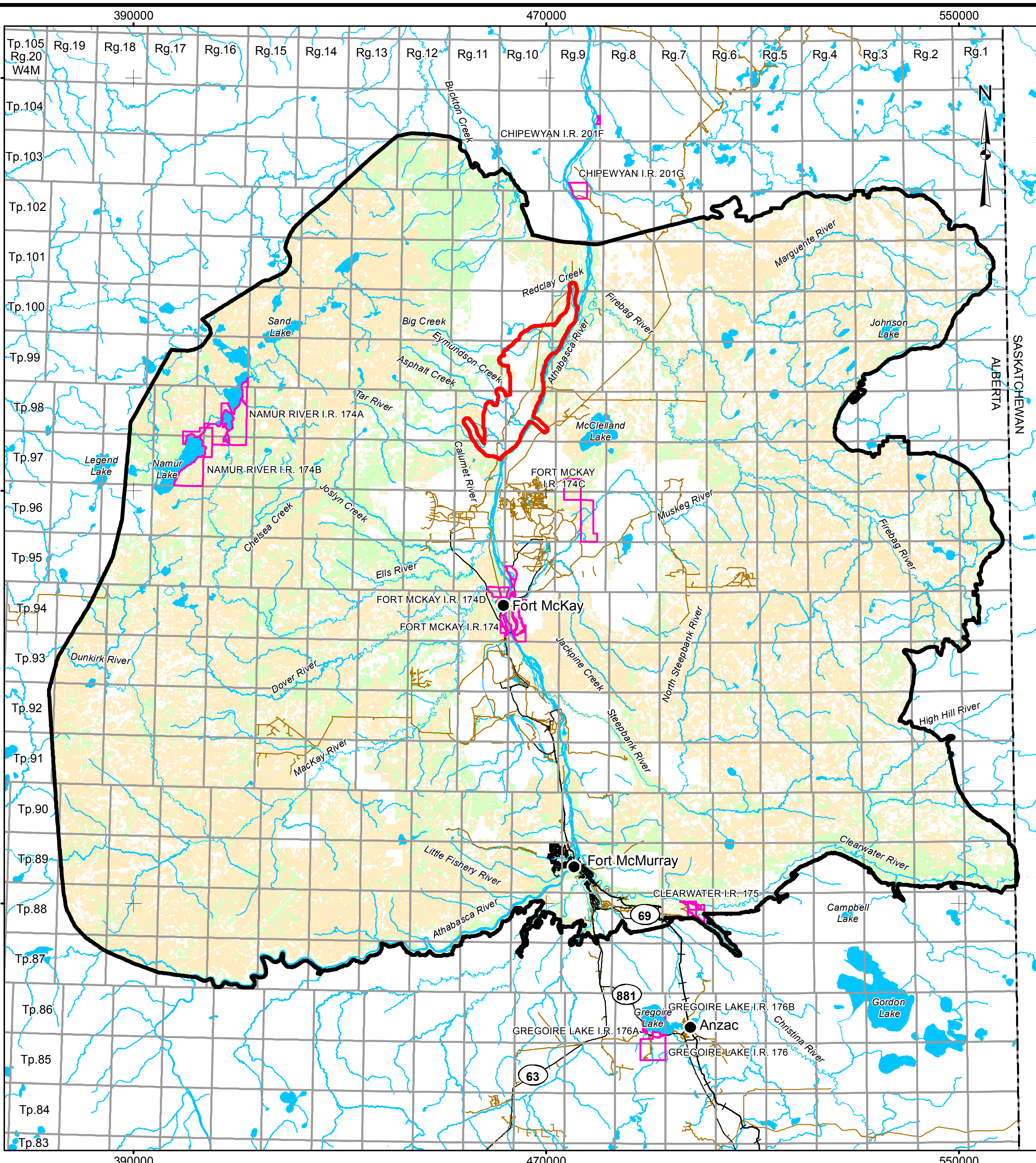

LEGEND

- COMMUNITY
- PAVED ROAD
- UNPAVED ROAD
- RAILWAY
- WATERCOURSE
- INDIAN RESERVE
- PROVINCIAL BOUNDARY
- PIERRE RIVER MINE LOCAL STUDY AREA
- TERRESTRIAL RESOURCES REGIONAL STUDY AREA
- OPEN WATER

TRADITIONAL PLANT POTENTIAL

- HIGH
- MODERATE
- LOW

REFERENCE

ALBERTA DIGITAL BASE DATA OBTAINED FROM ALTALIS LTD. © GOVERNMENT OF ALBERTA 2013. PROVINCIAL BOUNDARY OBTAINED FROM IHS ENERGY INC.
DATUM: NAD83 PROJECTION: UTM ZONE 12N

PROJECT

PIERRE RIVER MINE PROJECT

TITLE

TRADITIONAL PLANT POTENTIAL IN THE TERRESTRIAL REGIONAL STUDY AREA – 2013 PLANNED DEVELOPMENT CASE

Shell Canada Limited

PROJECT		13-1346-0001	FILE No.	
DESIGN	MG	10 May 2013	SCALE AS SHOWN	REV. 0
GIS	SB	20 Jun 2013	**FIGURE: 66-8**	
CHECK	MG	13 Jun 2013		
REVIEW	CY	17 Jun 2013		

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References:

ACFN. 2003. *Footprints on the Land: Tracing the Path of the Athabasca Chipewyan First Nation*. Fort Chipewyan, AB.

Fort Chipewyan Métis (Métis Local 125 Fort Chipewyan Alberta). 2012. Fort Chipewyan Métis Historic Use & Occupancy: Thematic Maps.

Golder. 2007. *Vegetation, wetlands and forest resources environmental setting report for the Jackpine Mine Expansion & Pierre River Mine Project*. Calgary, AB. Prepared for Shell Canada Energy. 2007

CIER. 2011. *Sagow Pimachiwin: Plants and Animals Used by the Mikisew Cree First Nation for Food, Medicine and Materials*. Winnipeg, MB. Prepared by the Centre for Indigenous Environmental Resources for the Mikisew Cree First Nation Government and Industry Relations.

SIR 67

Shell performed field surveys for several KIRs in the terrestrial-LSA for Pierre River, and provided the details in the Terrestrial-ESR. According to the ESR – Terrestrial, Terrestrial Vegetation, Wetlands and forest Resources Environmental Setting for the Jackpine Mine Expansion & Pierre River Mine Project, Section 3.3.1.4, Page 3-14. Shell completed no field surveys specifically to locate and document the abundance and distribution of traditional plant species within the terrestrial-LSAs. However, Shell indicates that it recorded traditional plant species, when observed, on detailed vegetation plot forms.

a) Provide a summary of the data collected with respect to traditional plants recorded on the vegetation plot forms including plant species and abundance, if available.

b) Provide maps showing where Shell found the traditional plant species.

Response:

a) A list of potential traditional use plant species was compiled based on common and scientific names and is presented in Appendix 3.8, Table 1. Traditional use plant species that could be associated with distinct scientific species names were included in a search of the Shell PRM vegetation plot form information to identify traditional use plant occurrences within the PRM Local Study Area (LSA). Within the PRM LSA, 66 traditional use plant species were observed during vegetation surveys. A total of 2,972 occurrences of these 66 species were recorded in the LSA during surveys of 8,316 plots. These occurrences are summarized in Table 67-1.

Table 67-1 Traditional Use Plant Species Occurrences in the Pierre River Mine Local Study Area

Strata	Scientific Species Name	Common Name	Number of Occurrences
Tree/Shrub	*Abies balsamea*	balsam fir	11
	Alnus incana ssp. tenuifolia	river alder	28
	Alnus viridis ssp. crispa	alder	72
	Amelanchier alnifolia	saskatoon	82
	Betula papyrifera	white birch	150
	Larix laricina	tamarack	56
	Picea glauca	white spruce	236
	Picea mariana	black spruce	114
	Pinus banksiana	jack pine	90
	Populus balsamifera	balsam poplar	52
	Populus tremuloides	aspen	227
	Prunus pensylvanica	pin cherry	35
	Prunus virginiana	choke cherry	5
		Tree/Shrub subtotal	*1,158*
Shrub	*Arctostaphylos uva-ursi*	common bearberry	63
	Betula glandulosa	bog birch	12
	Cornus stolonifera	red-osier dogwood	37
	Ledum groenlandicum	common Labrador tea	66
	Lonicera caerulea	fly honeysuckle	3
	Lonicera dioica	twining honeysuckle	41
	Lonicera involucrata	bracted honeysuckle	2
	Oxycoccus microcarpus	small bog cranberry	10
	Ribes americanum	wild black currant	3
	Ribes hudsonianum	northern black currant	6
	Ribes lacustre	bristly black currant	8
	Ribes triste	wild red currant	19
	Rosa acicularis	prickly rose	128
	Rubus idaeus	wild red raspberry	22
	Shepherdia canadensis	Canada buffaloberry	84
	Symphoricarpos albus	snowberry	38
	Vaccinium myrtilloides	common blueberry	99
	Vaccinium vitis-idaea	bog cranberry	143
	Viburnum edule	low-bush cranberry	83
		Shrub subtotal	*867*

Table 67-1 Traditional Use Plant Species Occurrences in the Pierre River Mine Local Study Area (continued)

Strata	Scientific Species Name	Common Name	Number of Occurrences
Forb	*Achillea millefolium*	common yarrow	58
	Aralia nudicaulis	wild sarsaparilla	77
	Aster puniceus	purple-stemmed aster	2
	Campanula rotundifolia	harebell	13
	Cornus canadensis	bunchberry	129
	Cypripedium acaule	stemless lady's-slipper	1
	Epilobium angustifolium	common fireweed	89
	Fragaria vesca	woodland strawberry	2
	Fragaria virginiana	wild strawberry	80
	Galium boreale	northern bedstraw	114
	Galium triflorum	sweet-scented bedstraw	17
	Geocaulon lividum	northern bastard toadflax	57
	Lilium philadelphicum	western wood lily	6
	Lycopodium annotinum	stiff club-moss	21
	Matteuccia struthiopteris	ostrich fern	2
	Mentha arvensis	wild mint	1
	Nuphar lutea ssp. variegata	yellow pond-lily	2
	Petasites frigidus var. palmatus	palmate-leaved coltsfoot	31
	Petasites frigidus var. sagittatus	arrow-leaved coltsfoot	7
	Plantago major	common plantain	1
	Pyrola asarifolia	common pink wintergreen	50
	Rubus arcticus	dwarf raspberry	11
	Rubus chamaemorus	cloudberry	7
	Rubus pubescens	dewberry	87
	Rumex occidentalis	western dock	1
	Sarracenia purpurea	pitcher-plant	1
	Typha latifolia	common cattail	6
	Urtica dioica	common nettle	4
		Forb subtotal	*877*
Graminoid	*Hierochloe hirta ssp. arctica*	sweet grass	1
		Graminoid subtotal	*1*
Lichen	*Cladonia arbuscula*	reindeer lichen	2
	Cladonia mitis	reindeer lichen	85
	Cladonia rangiferina	reindeer lichen	25
	Cladonia stellaris	star-tipped reindeer lichen	28
	Cladonia stygia	reindeer lichen	1
		Lichen subtotal	*141*
Total Species Occurrences			**2,972**

b) Figure 67-1 shows the vegetation plot locations in the PRM LSA. Figures 67-2, 67-3, 67-4, and 67-5 show locations in the PRM LSA where traditional use plant species were found, divided into five strata: trees/shrubs, shrubs, forbs (herbs), graminoids and lichen. Several species within the trees/shrubs, shrubs and forbs strata were common (8% or more of within-strata plots had the species). The five most common species of trees/shrubs identified as traditional use plant species together accounted for 71% of traditional use plant tree/shrub observations. The five most common species of shrub accounted for 62% of traditional use plant shrub traditional use plant observations. The five most common forb species accounted for 57% of traditional use plant forb observations. One graminoid species and five lichen species were identified as traditional use plants and identifiable to species. Figure 3.6-2 of the EIA (EIA, Volume 5, Section 3.6.1.2) shows additional sampled plots where the identified common traditional plant species were not found.

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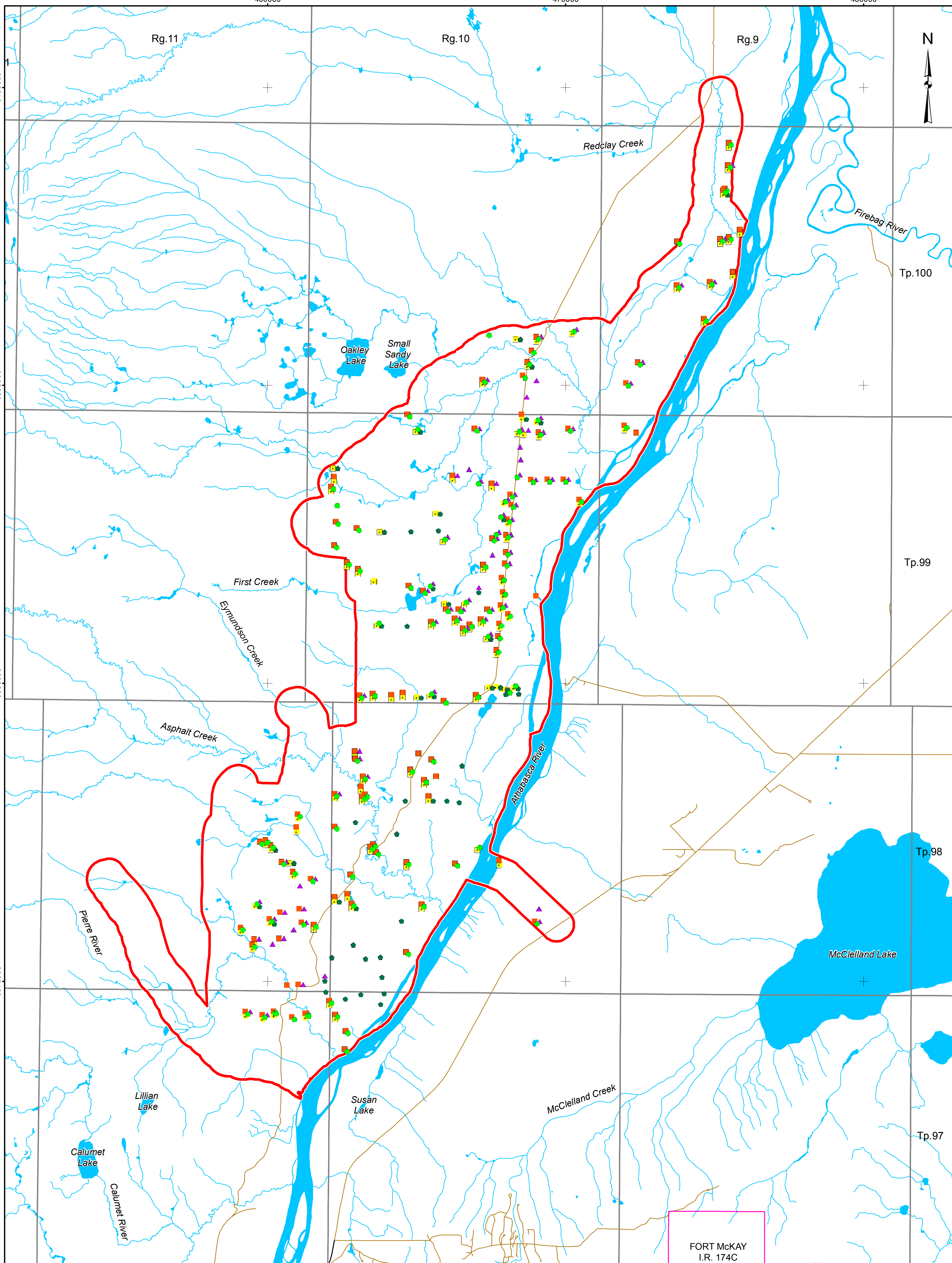

LEGEND

- PAVED ROAD
- UNPAVED ROAD
- INDIAN RESERVE
- PIERRE RIVER MINE LOCAL STUDY AREA
- OPEN WATER

COMMON NAME (*scientific name*; NUMBER OF OCCURRENCES)

- ASPEN (*Populus tremuloides*; 227)
- BLACK SPRUCE (*Picea mariana*; 114)
- JACK PINE (*Pinus banksiana*; 90)
- WHITE BIRCH (*Betula papyrifera*; 150)
- WHITE SPRUCE (*Picea glauca*; 236)

4 0 4

SCALE 1:125,000 KILOMETRES

NOTE

LOCATIONS BASED ON VEGETATION PLOTS SAMPLED; NOT REPRESENTATIVE OF SPECIES DISTRIBUTION.

REFERENCE

ALBERTA DIGITAL BASE DATA OBTAINED FROM ALTALIS LTD. © GOVERNMENT OF ALBERTA 2013. ADDITIONAL VEGETATION PLOTS ARE SHOWN ON FIGURE 3.6-2, SECTION 3.6.1.2 (GOLDER 2007)
DATUM: NAD83 PROJECTION: UTM ZONE 12N

PROJECT

PIERRE RIVER MINE PROJECT

TITLE

TRADITIONAL USE TREES OBSERVED ON VEGETATION PLOTS IN THE TERRESTRIAL LOCAL STUDY AREA

Shell Canada Limited

PROJECT		13-1346-0001	FILE No.	
DESIGN	MA	17 Apr 2013	SCALE AS SHOWN	REV. 0
GIS	SB	28 Oct 2013		
CHECK	MG	13 Jun 2013		
REVIEW	CY	17 Jun 2013		

FIGURE: 67-1

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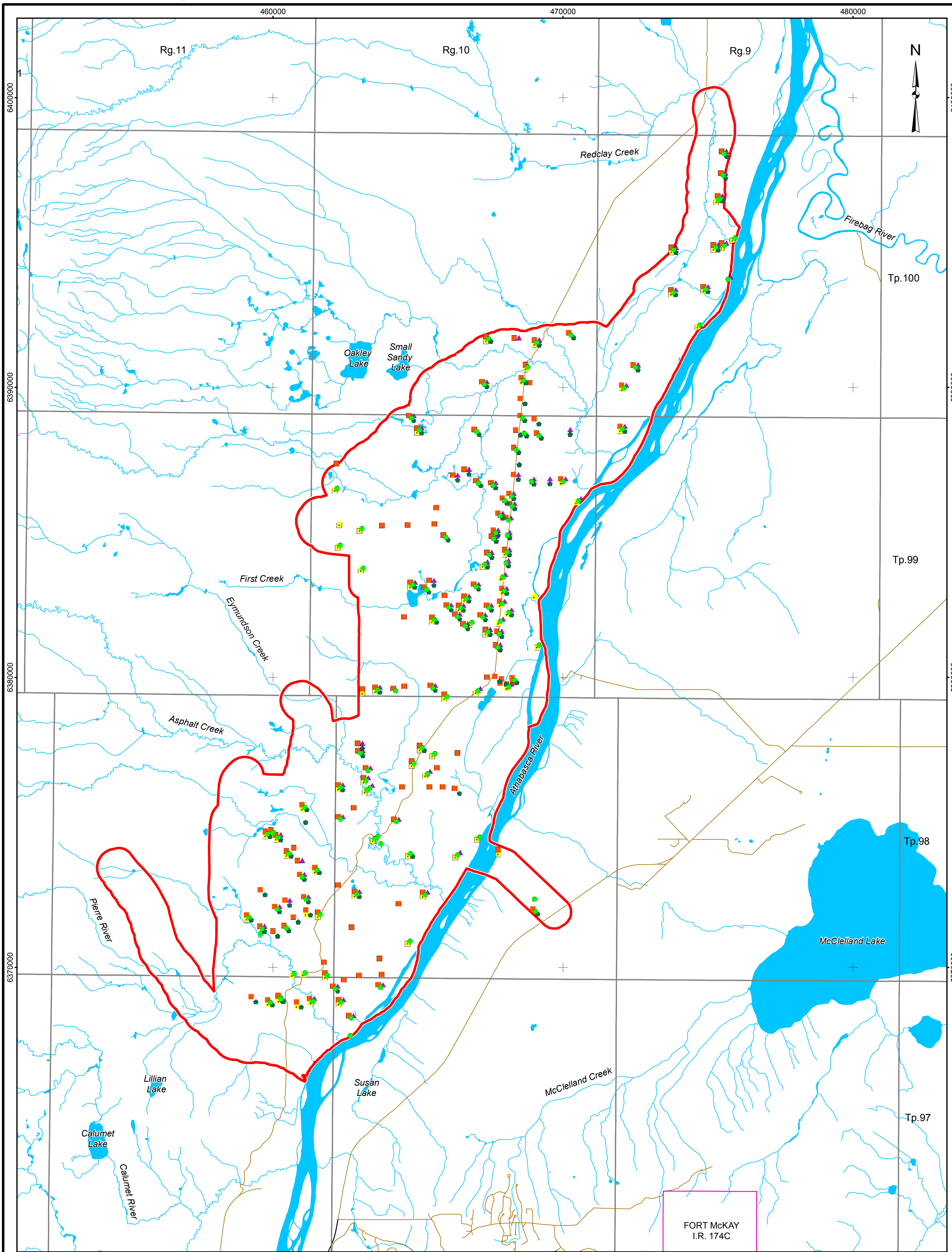

LEGEND

PAVED ROAD	
UNPAVED ROAD	
INDIAN RESERVE	
PIERRE RIVER MINE LOCAL STUDY AREA	
OPEN WATER	

COMMON NAME (*scientific name*; NUMBER OF OCCURRENCES)

- BOG CRANBERRY (*Vaccinium vitis-idaea*; 143)
- CANADA BUFFALOBERRY (*Shepherdia canadensis*; 84)
- COMMON BLUEBERRY (*Vaccinium myrtilloides*; 99)
- LOW-BUSH CRANBERRY (*Viburnum edule*; 83)
- PRICKLY ROSE (*Rosa acicularis*; 128)

4 0 4

SCALE 1:125,000 KILOMETRES

NOTE

LOCATIONS BASED ON VEGETATION PLOTS SAMPLED; NOT REPRESENTATIVE OF SPECIES DISTRIBUTION.

REFERENCE

ALBERTA DIGITAL BASE DATA OBTAINED FROM ALTALIS LTD. © GOVERNMENT OF ALBERTA 2013.ADDITIONAL VEGETATION PLOTS ARE SHOWN ON FIGURE 3.6-2, SECTION 3.6.1.2 (GOLDER 2007)
DATUM: NAD83 PROJECTION: UTM ZONE 12N

PROJECT

PIERRE RIVER MINE PROJECT

TITLE

TRADITIONAL USE SHRUBS OBSERVED ON VEGETATION PLOTS IN THE TERRESTRIAL LOCAL STUDY AREA

Shell Canada Limited

PROJECT		13-1346-0001	FILE No.	
DESIGN	MA	17 Apr 2013	SCALE AS SHOWN	REV. 0
GIS	SB	28 Oct 2013		
CHECK	MG	13 Jun 2013		
REVIEW	CY	17 Jun 2013		

FIGURE: 67-2

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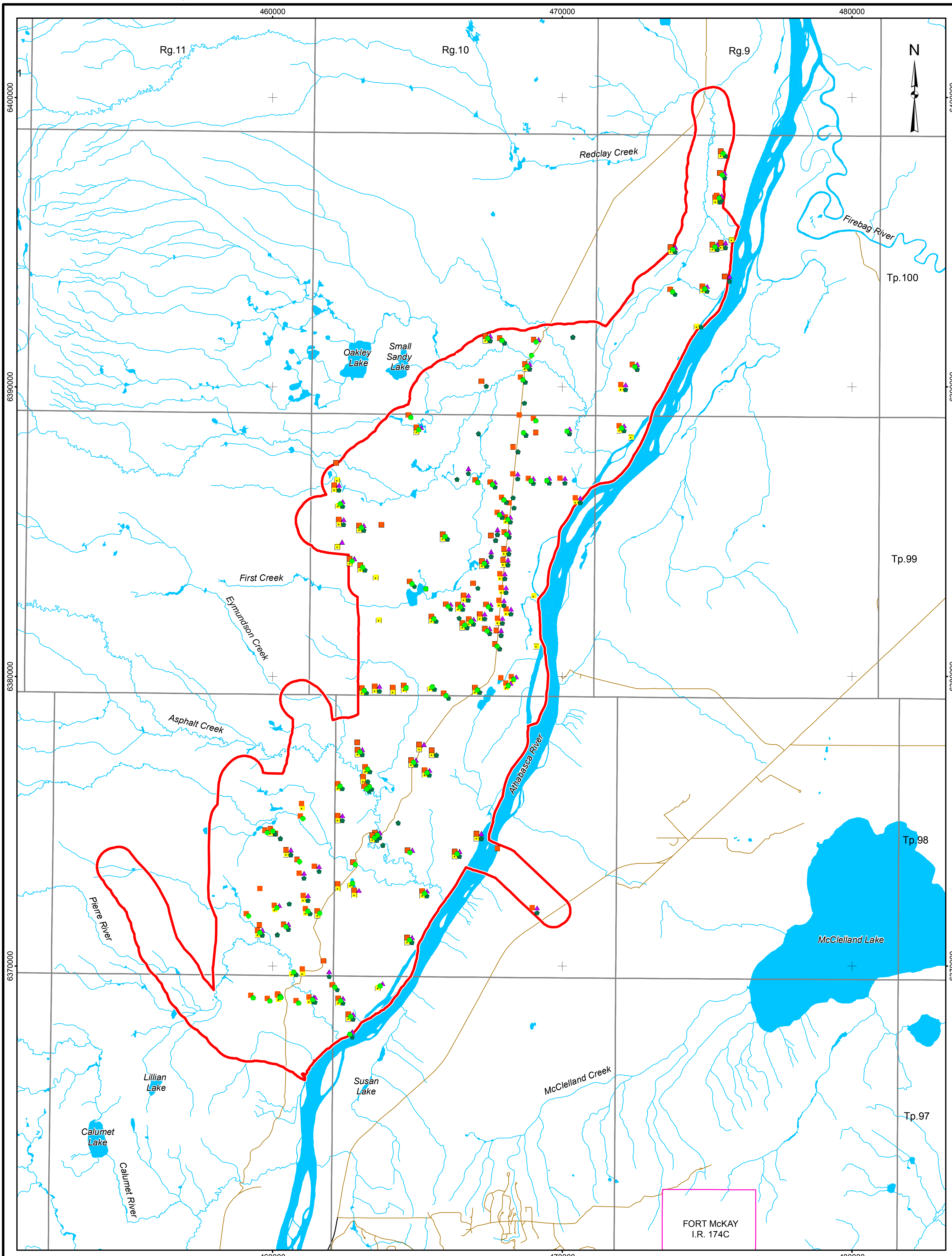

LEGEND

- PAVED ROAD
- UNPAVED ROAD
- INDIAN RESERVE
- PIERRE RIVER MINE LOCAL STUDY AREA
- OPEN WATER

COMMON NAME (*scientific name*; NUMBER OF OCCURRENCES)

- BUNCHBERRY (*Cornus canadensis*; 129)
- COMMON FIREWEED (*Epilobium angustifolium*; 89)
- DEWBERRY (*Rubus pubescens*; 87)
- NORTHERN BEDSTRAW (*Galium boreale*; 114)
- WILD STRAWBERRY (*Fragaria virginiana*; 80)

4 0 4

SCALE 1:125,000 KILOMETRES

NOTE

LOCATIONS BASED ON VEGETATION PLOTS SAMPLED; NOT REPRESENTATIVE OF SPECIES DISTRIBUTION.

REFERENCE

ALBERTA DIGITAL BASE DATA OBTAINED FROM ALTALIS LTD. © GOVERNMENT OF ALBERTA 2013. ADDITIONAL VEGETATION PLOTS ARE SHOWN ON FIGURE 3.6-2, SECTION 3.6.1.2 (GOLDER 2007)
DATUM: NAD83 PROJECTION: UTM ZONE 12N

PROJECT

PIERRE RIVER MINE PROJECT

TITLE

TRADITIONAL USE FORBS OBSERVED ON VEGETATION PLOTS IN THE TERRESTRIAL LOCAL STUDY AREA

Shell Canada Limited

PROJECT		13-1346-0001	FILE No.	
DESIGN	MA	17 Apr 2013	SCALE AS SHOWN	REV. 0
GIS	SB	28 Oct 2013		
CHECK	MG	13 Jun 2013	FIGURE: 67-3	
REVIEW	CY	17 Jun 2013		

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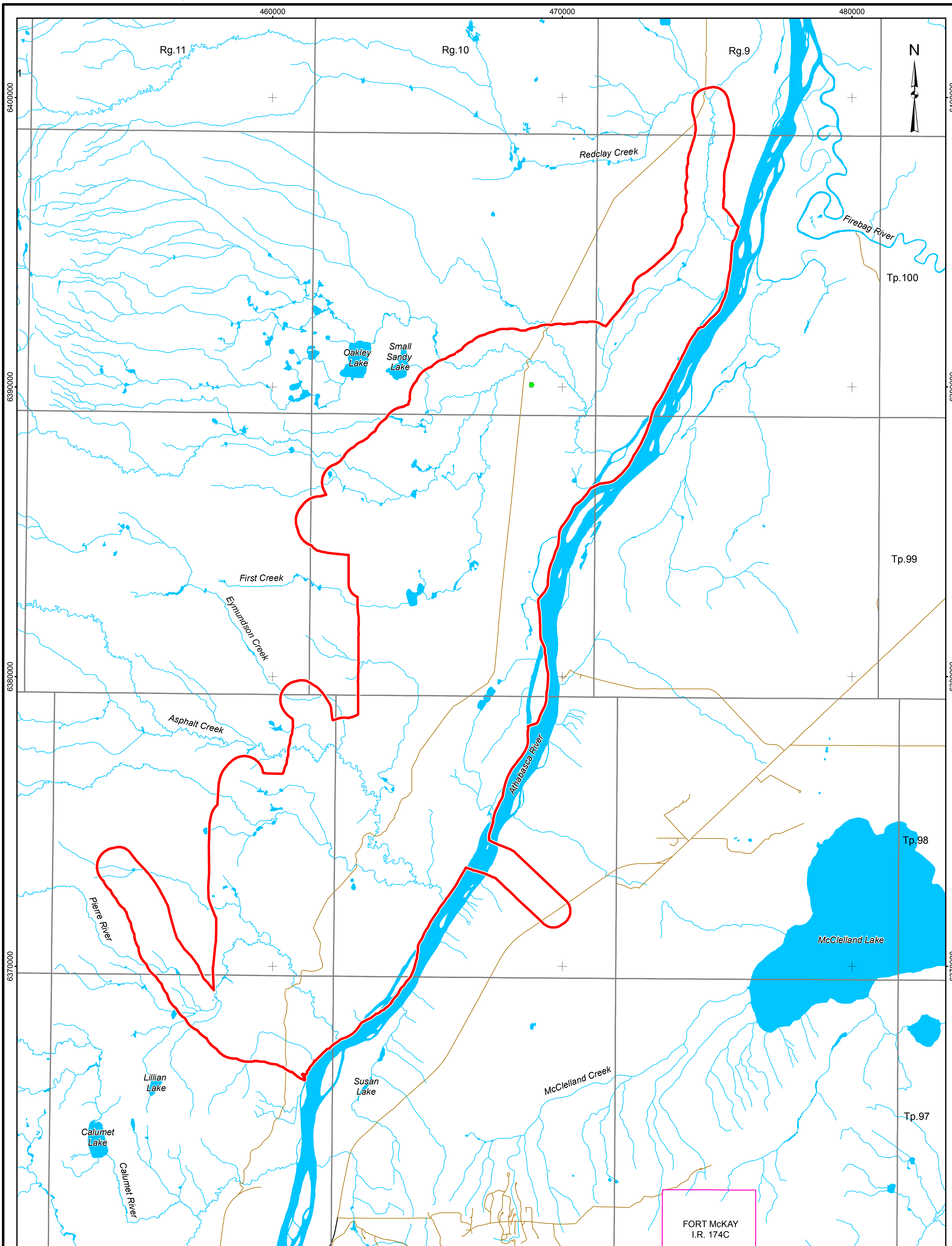

LEGEND

- PAVED ROAD
- UNPAVED ROAD
- INDIAN RESERVE
- PIERRE RIVER MINE LOCAL STUDY AREA
- OPEN WATER

COMMON NAME (*scientific name*; NUMBER OF OCCURRENCES)

- SWEET GRASS (*Hierochloe hirta ssp. arctica*; 1)

4 0 4

SCALE 1:125,000 KILOMETRES

NOTE

LOCATIONS BASED ON VEGETATION PLOTS SAMPLED; NOT REPRESENTATIVE OF SPECIES DISTRIBUTION.

REFERENCE

ALBERTA DIGITAL BASE DATA OBTAINED FROM ALTALIS LTD. © GOVERNMENT OF ALBERTA 2013.ADDITIONAL VEGETATION PLOTS ARE SHOWN ON FIGURE 3.6-2, SECTION 3.6.1.2 (GOLDER 2007)
DATUM: NAD83 PROJECTION: UTM ZONE 12N

PROJECT

PIERRE RIVER MINE PROJECT

TITLE

TRADITIONAL USE GRAMINOIDS OBSERVED ON VEGETATION PLOTS IN THE TERRESTRIAL LOCAL STUDY AREA

Shell Canada Limited

PROJECT		13-1346-0001	FILE No.	
DESIGN	MA	17 Apr 2013	SCALE AS SHOWN	REV. 0
GIS	SB	28 Oct 2013	**FIGURE: 67-4**	
CHECK	MG	13 Jun 2013		
REVIEW	CY	17 Jun 2013		

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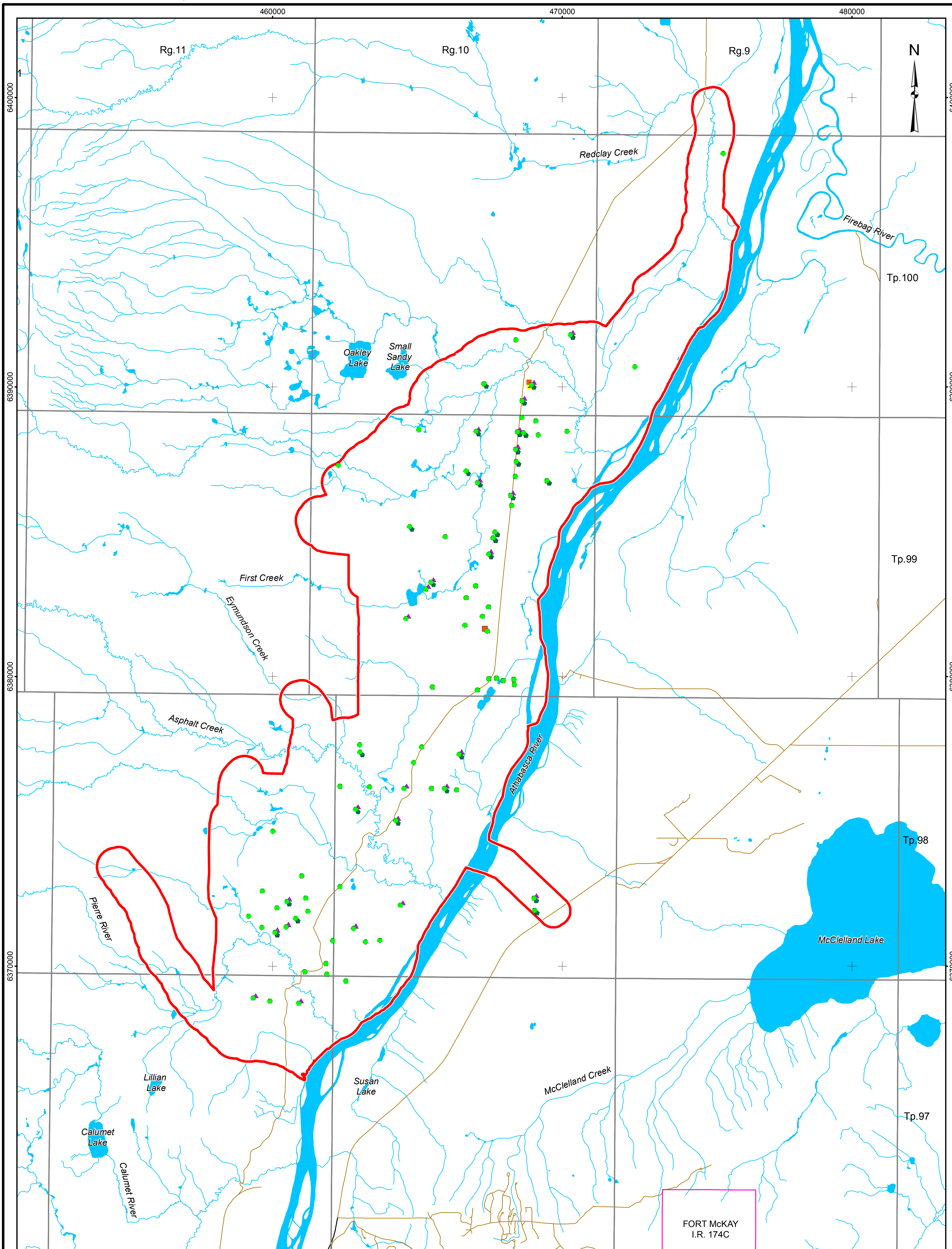

LEGEND

- PAVED ROAD
- UNPAVED ROAD
- INDIAN RESERVE
- PIERRE RIVER MINE LOCAL STUDY AREA
- OPEN WATER

COMMON NAME (*scientific name*; NUMBER OF OCCURRENCES)

- REINDEER LICHEN (*Cladonia arbuscula*; 2)
- REINDEER LICHEN (*Cladonia mitis*; 85)
- REINDEER LICHEN (*Cladonia rangiferina*; 25)
- REINDEER LICHEN (*Cladonia stygia*; 1)
- STAR-TIPPED REINDEER LICHEN (*Cladonia stellaris*; 28)

4 0 4

SCALE 1:125,000 KILOMETRES

NOTE

LOCATIONS BASED ON VEGETATION PLOTS SAMPLED; NOT REPRESENTATIVE OF SPECIES DISTRIBUTION.

REFERENCE

ALBERTA DIGITAL BASE DATA OBTAINED FROM ALTALIS LTD. © GOVERNMENT OF ALBERTA 2013.VEGETATION PLOTS ARE SHOWN ON FIGURE 3.6-2, SECTION 3.6.1.2 (GOLDER 2007)
DATUM: NAD83 PROJECTION: UTM ZONE 12N

PROJECT

PIERRE RIVER MINE PROJECT

TITLE

TRADITIONAL USE LICHEN OBSERVED ON VEGETATION PLOTS IN THE TERRESTRIAL LOCAL STUDY AREA

Shell Canada Limited

PROJECT		13-1346-0001	FILE No.	
DESIGN	MA	17 Apr 2013	SCALE AS SHOWN	REV. 0
GIS	SB	28 Oct 2013	**FIGURE: 67-5**	
CHECK	MG	13 Jun 2013		
REVIEW	CY	17 Jun 2013		

SIR 68

The Alberta Environment Final Terms of Reference Environmental Impact Assessment (EIA) report for the Shell Canada Limited Jackpine Mine Expansion & Pierre River Mine, November 28, 2007, Section 5.5, Page 16, requires Shell explain the significance of land use changes for the maintenance of traditional lifestyle. It also requires in Section 5.6.3, e) i), page 19 that Shell discuss the significance of the changes to vegetation for the availability and quality of plants for traditional, food and medicinal and other purposes. Shell states in the Submission of Additional Traditional Knowledge and Traditional Land Use Information to the Joint Review Panel, September 2011, Section 5.1, Page 5, that it discusses significance from a scientific perspective and in an ecological context only and thus did not assess the significance of the project effects and cumulative effects to traditional lifestyle or to the changes in vegetation for the availability and quality of plants for traditional, food and medicinal and other traditional purposes.

a) Explain the significance of land use changes for the maintenance of traditional lifestyle.

b) Discuss the significance of the changes to vegetation for the availability and quality of plants for traditional, food and medicinal and other purposes.

c) Describe Shell's methodology for the determination of the significance.

Response:

a) Appendix 2, Section 4.4 discusses the significance of the cumulative effects for the 2013 PRM Application Case and PRM (construction and operations) on the Community of Fort McKay (Fort McKay First Nation and Fort McKay Métis), Mikisew Cree First Nation (MCFN), Athabasca Chipewyan First Nation (ACFN), Fort McMurray #468 First Nation (FM468), Fort Chipewyan Métis Local #125 and Fort McMurray Métis Local #1935. The assessment methods used to determine the significance for the Traditional Land Use assessment is found in Appendix 3.1. The following summarizes the effects classifications and significance of the 2013 PRM Application Case and PRM (construction and operations) on the traditional land use of each of the potentially affected Aboriginal groups and the effects Post-Reclamation.

The effects to traditional land use under the 2013 PRM Application Case were determined for each of the potentially affected Aboriginal groups. The effects of the 2013 PRM Application Case were determined for traditional hunting, trapping, fishing, and plant and berry harvesting opportunities. Harvesting opportunities were considered to be a combination of the availability of each underlying resource (e.g., wildlife, fish) and access to the resource. The assessment also considered the effects on traditional harvesting activities from odour, noise, visual effects, human health effects and socio-economic effects. A summary of the effects classification for each of the potentially affected Aboriginal groups is found in Table 68-1, below.

Table 68-1 Effects Classification Summary and Significance for Traditional Land Use Under the 2013 PRM Application Case

Aboriginal Group	Effects Classification for Traditional Land Use[(a)]	Significance Prior to Reclamation
Community of Fort McKay	High	Significant
Mikisew Cree First Nation	Moderate to High	Significant
Athabasca Chipewyan First Nation	High	Significant
Fort McMurray #468 First Nation	Moderate to High	Significant
Fort Chipewyan Métis Local #125	Low to High (Effects mostly limited to use of RFMA #1275)	Not significant
Fort McMurray Métis Local #1935	High (Trapping not assessed)	Significant

(a) All effects classifications were assessed as negative in direction, regional in extent, long term in duration and irreversible, therefore only the magnitude has been provided within the table.

Significance Post-Reclamation

While it is not possible to determine the RSA closure landscape in detail because detailed reclamation plans are not available for all projects in the 2013 PRM Application Case, the assessment assumes that project-related disturbances will generally be reclaimed to allow wildlife re-population in preferred harvesting areas throughout RSA, and access to resources and preferred harvesting areas by traditional harvesters. Although the 2013 PRM Application Case was not expected to have a significant effect on fish abundance, the closure landscape is expected to facilitate access to preferred fishing areas. As a result, the opportunities for traditional wildlife harvesting (trapping, hunting and fishing) are expected to increase as a result of the closure landscape.

The effects to traditional plant harvesting opportunities within the RSA are also generally expected to increase. While the combined high and moderate traditional plant potential is expected to remain much the same at Closure as under the 2013 PRM Application Case, the decrease in land disturbance is expected to provide easier access to preferred harvesting areas. As a result of the closure landscape, the effects of the 2013 PRM Application Case post-reclamation on traditional harvesting opportunities are assessed as not significant.

Socio-economic factors can also influence the undertaking of traditional harvesting. These include a variety of socio-economic factors, such as desire to continue with traditional land use activities, engagement in wage employment, and perceptions of contamination relating to water, wildlife, or vegetation. While these factors have been identified as present for Aboriginal groups assessed in the 2013 PRM Application Case, it is not possible to determine the degree to which they will affect Aboriginal populations at the time of reclamation or closure.

A discussion of the connections between Traditional Land Use, Culture, Lifestyle and Quality of Life is found in Appendix 7, Section 2.0, and is summarized below.

While effects on culture cannot be attributed to a single project, effects on Aboriginal culture, lifestyle and quality of life can be described for the region. Members of Aboriginal groups in the region have reported that they are experiencing cultural erosion or cultural change. These changes can have implications for quality of life in several ways, including effects on community cohesion, the value system, feelings of disempowerment, marginalisation and vulnerability, loss of pride in cultural identity and relationships with the land, and community health. Traditional Knowledge and Land Use is integral to maintaining Aboriginal culture and reducing these adverse quality of life effects; therefore, effects on land use opportunities have been used as the basis for describing potential implications for Aboriginal cultural practices and transmission.

As defined by Aboriginal groups, the meaningful practice of traditional land use rights requires certain conditions to be met in the physical environment. Disturbed lands may not be considered available by some members of Aboriginal groups for the meaningful practice of rights until at least after reclamation. If areas are avoided while disturbed, Traditional Knowledge of and connection to these specific areas, a generation or more in the future, is likely to be lost (Appendix 7, Section 3.3.2). Observed effects on the environment have resulted in changing patterns and intensity of land use (i.e., through avoidance, abandonment and adaptation), which in turn have resulted in effects on intangible elements of Aboriginal culture: changes in passing on knowledge, and changes in relationships and cultural knowledge and practice in communities over time.

The 2013 Planned Development Case (PDC) considers changes in disturbance areas compared to the 2013 PRM Application Case. The 2013 PDC also considers the results of wildlife, vegetation and fish and fish habitat assessments to determine effects on the abundance of traditional resources. With respect to wildlife KIRs of interest to Aboriginal groups (i.e., moose and black bear), populations are predicted to continue to be viable. In addition, the 2013 PDC considers preferred harvesting areas, changes in access to preferred harvesting areas, air, noise, visual and odour effects, water quality effects, and individual and/or community responses to observed environmental effects. Changes in access and the distribution of wildlife resources may mean that traditional land use and non-Aboriginal recreational and harvesting activities will become more concentrated in undisturbed areas/areas away from oil sands facilities, thus potentially increasing the possibility of interactions between these growing populations within relatively smaller landscapes over time. Current hunting data suggest low densities of non-Aboriginal hunters in the region and that non-Aboriginal hunting success (based on overall harvesting levels) is increasing at a regional scale. The concentration of non-Aboriginal hunters tends to be in the southern parts of the region, especially in Wildlife Management Units (WMUs) directly north and west of the Cold Lake Air Weapons Range suggesting that some areas (i.e., southern areas of the region) are used for non-Aboriginal hunting more than others (i.e., northern areas of the region). The potential for competition for resources is therefore not uniform within the region. Hunting success for the Aboriginal population is not available for comparison.

In addition to effects on access to and abundance of traditional resources, psycho-social factors, such as confidence in the quality of harvested foods, and feelings of safety and remoteness or other personal factors (e.g., personal sensitively to noise, odour or visual stimuli) contribute to the motivation to undertake traditional activities. Lack of confidence in country food is an example of an effect that illustrates the need for community-based monitoring in the region. While the PRM is not expected to adversely affect the quality of country food, it will result in a direct loss of land within the traditional territories of the FMFN, ACFN, MCFN, and FM468 available for continuing traditional activities. The contribution of the PRM (or any single oil sands project) to the 2013 PDC in terms of disturbance is small; therefore the focus of this report has been the cumulative effects of development since the 1960s. In other words, with respect to effects on the practice of traditional land use and Aboriginal culture, the effects of one project cannot be separated from the whole or from a pre-development context.

As described by Larcombe (2012), there is insufficient information and data to reliably comment on the state or vulnerability of the First Nations way of life or if their ability to pursue and enjoy the rights and benefits of traditional use and knowledge is at, or near, or beyond sustainability thresholds. Notwithstanding this uncertainty, effects on traditional lands and resources (whether observed by Aboriginal groups or assessed in an EIA process) since pre-development have induced or caused responses (i.e., displacement, avoidance and abandonment, and adaptation) that have affected the how, where, when, what and whys of the practice of traditional land use and passing on Traditional Knowledge (TK) in the region. Aboriginal groups have in turn, consistently reported negative implications for the sustainability of their land-based culture and the related lifestyle and quality of life in their communities.

Cultural change as a result of development has led to a number of stressors and concerns; however, Aboriginal rates of participation and employment in in the wage economy is high relative to Aboriginal populations in comparative communities (see Appendix 8, JRP SIR 69B). First Nations have businesses and business groups that serve oil sands projects and oil sands operators fund economic development in small communities. Members of Aboriginal groups have expressed specific concerns regarding effects on traditional land use (as an element of traditional culture) due to the PRM and have overarching concerns regarding the overall scale and pace of development in the region (i.e., cumulative effects) and their frustration regarding their lack of influence in land use decisions.

In response to the potential effects of the PRM on traditional harvesting activities, lifestyle and culture, Shell has undertaken various policies and commitments to mitigate impacts. A description of Shell's policies and commitments regarding Aboriginal culture are found in Appendix 7, Attachment A.

b) The following summarizes the effects classifications of the 2013 PRM Application Case and PRM (during construction and operations) on traditional plant harvesting as it relates to each of the Aboriginal groups in part a), above. A determination of significance was not made specifically for traditional plant harvesting, but rather for the overall effects of the 2013 PRM Application Case and PRM during Construction and Operations on traditional land use activities. A summary of the cumulative effects on traditional land use activities is found in Appendix 2, Section 4.4. The Regional Study Area (RSA) level effects classification for traditional plant harvesting considers the effects of the 2013 PRM Application Case on traditional plant harvesting opportunities, and the effects of other factors, such as odour, noise and visual impacts, effects to human health, and socio-economic effects. A description of these other factors affecting traditional land use are found in the response to JRP SIR 65a(ii).

Community of Fort McKay

The RSA-level effects classification to traditional plant and berry harvesting for the Community of Fort McKay considers the effects on harvesting opportunities (consisting of a combination of effects to the resource base, disturbance to preferred harvesting areas, and effects to access of preferred harvesting areas), plus possible added effects resulting from odour, noise and visual impacts, effects to surface water quality, and individual or community responses to observed environmental effects.

The effects to combined high and moderate traditional plant potential were assessed as moderate at 2013 PRM Application Case at the RSA level. At the 2013 PRM Application Case, disturbance to Fort McKay preferred plant and berry harvesting areas (moderate and intense use portions of the Traditional Plant CSE) are 33% (156,206 ha), negative in direction and high effect. Access limitations to preferred harvesting areas in the 2013 PRM Application Case are assessed as substantially interfering with people’s ability to access these preferred areas and therefore assessed as negative in direction and high in magnitude. As a result of the above factors, the effects to traditional plant and berry harvesting opportunities in the RSA under the 2013 PRM Application Case are assessed as adverse in direction and high in magnitude.

As a result of the high magnitude impact to traditional plant and berry harvesting opportunities in the RSA, and the additional effects of odours, noise, visual impacts, human health effects and socio-economic effects, the effects to traditional plant and berry harvesting in the 2013 PRM Application Case were assessed as negative in direction, high in magnitude, regional in extent, and long term in duration as they are expected to occur for longer than one Aboriginal generation. The effects are also considered irreversible, as the length of duration is likely to interfere with the ability for associated traditional knowledge to be passed intergenerationally. While the effect to traditional plant and berry harvesting is assessed as high, PRM independently only contributes 1% (9,250 ha) of disturbance to preferred harvesting areas.

Mikisew Cree First Nation

At the RSA level, the effects classification on MCFN traditional plant and berry harvesting considers the effects on harvesting opportunities (consisting of a combination of effects to the resource base, disturbance to preferred harvesting areas, and effects to access of preferred harvesting areas), plus possible added effects resulting from odour, noise and visual impacts, effects to surface water quality, and individual or community responses to observed environmental effects.

The effects to combined high and moderate traditional plant potential were assessed as moderate in magnitude in the 2013 PRM Application Case for the RSA level. In the 2013 PRM Application Case, disturbance to MCFN preferred plant and berry harvesting areas considered the overlapping area of the MCFN traditional territory and the RSA. This effect was determined to be 18% (296,435 ha), negative in direction and moderate in magnitude.

The administration centre for the MCFN is Fort Chipewyan but they have indicated that many of their members reside in Fort McMurray or communities farther south; therefore, access is considered from both north of the RSA and south from Fort McKay. It is assumed that MCFN members travelling south into the RSA are using the northern portions of the RSA for harvesting.

Effects on access to MCFN lands within the RSA for MCFN members from reserves and communities north of the RSA may be discernible but are not considered substantial. Therefore the effect on access to MCFN lands for plant and berry harvesting in the northern portion of the RSA for members living in Fort Chipewyan and other areas north of the RSA is assessed as a negative in direction and low in magnitude.

Effects on access to MCFN lands within the RSA for MCFN members living in Fort McMurray and southern communities are considered substantial. Therefore, the effect on access to MCFN lands for traditional plant and berry harvesting in the RSA for members living in Fort McMurray is considered negative in direction and high in magnitude.

As a result of the high magnitude effect to high traditional plant potential areas, effects to traditional plant and berry harvesting opportunities in the RSA under the 2013 PRM Application Case for the MCFN are assessed as negative in direction and high in magnitude.

As a result of the high magnitude impact to traditional plant and berry harvesting opportunities, and considering the additional effects of odours, noise, visual impacts, human health effects and socio-economic effects, the effects to traditional plant and berry harvesting at the RSA level in the 2013 PRM Application Case are assessed as negative in direction, high in magnitude, regional in extent, and long term in duration as they are expected to occur for longer than one Aboriginal generation. The effects are also considered irreversible, as the length of duration is likely to interfere with the ability for associated traditional knowledge to be passed intergenerationally. While the effect to traditional plant and berry harvesting is high, the majority of the impacts are already experienced in the 2013 Base Case. The incremental effect of PRM, when viewed independently, disturbs, only 1% (11,322 ha) of the portion of MCFN traditional territory overlapping the RSA.

Athabasca Chipewyan First Nation

The RSA level effects classification to traditional plant and berry harvesting for the ACFN considers the effects on harvesting opportunities (consisting of a combination of effects to the resource base, disturbance to preferred harvesting areas, and effects to access of preferred harvesting areas), plus possible added effects resulting from odour, noise and visual impacts, effects to surface water quality, and individual or community responses to observed environmental effects.

The effects to combined high and moderate traditional plant potential were assessed as moderate in the 2013 PRM Application Case for the RSA level. In the 2013 PRM Application Case, disturbance to ACFN preferred plant and berry harvesting areas, considered the overlapping area of the ACFN k'es hochela nene Homeland Zone and Fort McKay and Fort McMurray Proximate Zones that overlap the RSA to be 4% and 30% respectively. Therefore, disturbance to ACFN homeland zones within the RSA under the 2013 PRM Application Case are assessed as adverse in direction and low in magnitude. Disturbance to ACFN proximate zones in the RSA are considered adverse in direction and high in magnitude.

The administration centre for the ACFN is Fort Chipewyan but they have indicated that many of their members reside in Fort McMurray or communities farther south; therefore access is considered from both north of the RSA and south from Fort McKay. It is assumed that ACFN members travelling south into the RSA are using the northern portions of the RSA for harvesting. Access from reserves and communities north of the RSA is likely to be discernibly affected but is not expected to materially affect access to preferred areas and therefore is assessed as a low magnitude effect. For individuals living in Fort McMurray and southern communities, people's access to preferred plant harvesting areas is predicted to be substantially interfered with and therefore assessed as an effect that is negative in direction and high in magnitude.

As a result of the high magnitude effects to the portion of the ACFN Proximate Zone within the RSA and to the moderate effects to areas of high and moderate traditional plant potential, the effects to traditional plant harvesting opportunities for ACFN members are assessed as adverse in direction and high in magnitude.

As a result of the high magnitude impact to traditional plant and berry harvesting opportunities, and effects related to odours, noise, visual impacts, human health effects and socio-economic effects, the effects to ACFN traditional plant harvesting in the 2013 PRM Application Case are assessed as negative in direction, high in magnitude, regional in extent, and long term in duration as they are expected to occur for longer than one Aboriginal generation. The effects are also considered irreversible, as the length of duration is likely to interfere with the ability for associated traditional knowledge to be passed intergenerationally. While the effect to traditional plant and berry harvesting is high, the incremental impacts of PRM, when viewed independently, have little effect. PRM accounts for only 1% (6,774 ha) of the disturbance to the ACFN Homeland Zone and 1% (4,548 ha) of the disturbance to ACFN Proximate Zones.

Fort McMurray #468 First Nation

The RSA level effects classification to traditional plant and berry harvesting for the FM468 considers the effects on harvesting opportunities (consisting of a combination of effects to the resource base, disturbance to preferred harvesting areas, and effects to access of preferred harvesting areas), plus possible added effects resulting from odour, noise and visual impacts, effects to surface water quality, and individual or community responses to observed environmental effects.

The effects to combined high and moderate traditional plant potential were assessed as moderate in the 2013 PRM Application Case for the RSA level. In the 2013 PRM Application Case, disturbance to FM468 preferred plant and berry harvesting areas (considered the overlapping area of the RSA and FM468 traditional territory) was assessed at 18% (284,363 ha), an adverse in direction and moderate in magnitude impact. Disturbance in the 2013 PRM Application Case is considered to substantially interfere with people’s ability to access preferred harvesting area and is therefore assessed as adverse and high in magnitude. As a result of the high magnitude effect to the access of preferred plant and berry harvesting areas, the effects to traditional plant and berry harvesting opportunities in the RSA in the 2013 PRM Application Case are assessed as adverse in direction and high in magnitude.

As a result of the high magnitude impact to traditional plant and berry harvesting opportunities in the RSA, and the additional effects of odours, noise, visual impacts, human health effects and socio-economic effects, the effects to traditional plant and berry harvesting in the 2013 PRM Application Case are assessed as negative in direction, high in magnitude, regional in extent, and long term in duration as they are expected to occur for longer than one Aboriginal generation. The effects are also considered irreversible, as the length of duration is likely to interfere with the ability for associated traditional knowledge to be passed intergenerationally. While the effect to traditional plant and berry harvesting is high for the 2013 PRM Application Case, PRM contributes less than 1% (6,345 ha) of the total disturbance to preferred areas.

Fort Chipewyan Métis Local #125

The RSA level effects classification to traditional plant and berry harvesting for the Fort Chipewyan Métis Local #125 considers the effects on harvesting opportunities (consisting of a combination of effects to the resource base, disturbance to preferred harvesting areas, and effects to access of preferred harvesting areas), plus possible added effects resulting from odour, noise and visual impacts, effects to surface water quality, and individual or community responses to observed environmental effects.

The effects to combined high and moderate traditional plant potential were assessed as moderate in the 2013 PRM Application Case for the RSA level. Disturbance to preferred traditional plant and berry harvesting areas are assessed as adverse in direction and high in magnitude due to the substantial disturbance (47%) in the area of RFMA #1275 and smaller disturbances along the Athabasca River, and the McClelland Lake harvesting areas. While access to the Firebag River and McClelland Lake for Fort Chipewyan Métis Local #125 members travelling from Fort Chipewyan will not be affected, access may be discernibly affected for members travelling to those areas from Fort McMurray. As a result of the high magnitude to RFMA #1275 the effects to traditional plant and berry harvesting opportunities in the RSA in the 2013 PRM Application Case are assessed as adverse in direction and high in magnitude. The effects are limited to the users of RFMA #1275 and individuals who use the McClelland Lake and Firebag River areas.

As a result of the high magnitude impact to traditional plant and berry harvesting opportunities, and odours, noise, visual impacts, human health effects and socio-economic effects, the effects to traditional plant and berry harvesting in the 2013 PRM Application Case area assessed as negative in direction, high in magnitude, regional in extent, and long term in duration as they are expected to occur for longer than one Aboriginal generation. The effects are also considered irreversible, as the length of duration is likely to interfere with the ability for associated traditional knowledge to be passed intergenerationally. The impacts are limited to individuals using the RSA for traditional plant harvesting.

Fort McMurray Métis Local #1935

The RSA level effects classification to traditional plant and berry harvesting for the Fort McMurray Métis Local #1935 considers the effects on harvesting opportunities (consisting of a combination of effects to the resource base, disturbance to preferred harvesting areas, and effects to access of preferred harvesting areas), plus possible added effects resulting from odour, noise and visual impacts, effects to surface water quality, and individual or community responses to observed environmental effects.

The effects to combined moderate and high traditional plant potential were assessed as moderate in the 2013 PRM Application Case for the RSA level. Disturbance is considered to have substantially affected preferred Fort McMurray Metis Local #1935 plant and berry harvesting areas within the RSA and is therefore assessed as adverse in direction and high in magnitude. Similarly, substantial adverse effects on the access to preferred plant and berry harvesting areas within the RSA have already occurred in the 2013 PRM Application Case and are therefore assessed as high in magnitude. As a result of the above factors, the effects to traditional plant and berry harvesting opportunities are assessed as adverse in direction and high in magnitude.

As a result of the high magnitude impact to traditional plant and berry harvesting opportunities, and the additional effects of odours, noise, visual impacts, human health effects and socio-economic effects, the effects to traditional plant harvesting in the 2013 PRM Application Case were assessed as negative in direction, high in magnitude, regional in extent, and long term in duration as they are expected to occur for longer than one Aboriginal generation. The effects are also considered irreversible, as the length of duration is likely to interfere with the ability for associated traditional knowledge to be passed intergenerationally.

c) A description of the methodology to determine the effects classification and significance for the Traditional Land Use Assessment is found in Appendix 3.1, Section 2.10 and Section 2.11.3.

References:

Larcombe, P. 2012. *A Narrative of Encroachment Experienced by Athabasca Chipewyan First Nation*. Prepared for Athabasca Chipewyan First Nation Industry Relations Corporation. Symbion Consultants. Winnipeg, Manitoba.

SIR 69

The Alberta Environment Final Terms of Reference Environmental Impact Assessment (EIA) report for the Shell Canada Limited Jackpine Mine Expansion & Pierre River Mine, November 28, 2007, Section 10, requires Shell to assess the socio-economic factors. The Panel's Terms of Reference requires it to consider any effects on hunting, fishing, trapping, cultural and other traditional uses of the land as well as related effects on lifestyle, culture and quality of life of the Aboriginal persons.

a) Provide a cumulative assessment of the project's effects on Aboriginal culture, lifestyle and quality of life of Aboriginal persons for each First Nation or Aboriginal group potentially affected before and after reclamation using a pre-industrial baseline.

b) Provide an assessment of the socio-economic effects for each First Nation or Aboriginal group respecting Aboriginal rights and interests before and after reclamation.

Response:

a) Shell completed a review of the potential PRM and cumulative effects on Aboriginal culture, lifestyle and quality of life. Details are contained in Appendix 7 – Cultural Effects Review and are summarized below.

This review begins from the pre-industrial context and describes current and ongoing effects on the environment, traditional land use, knowledge, culture and way of life that have been described by Aboriginal groups in submissions to the JRP. This review is supplemented with a summary of environmental assessment estimates of potential future cumulative effects on traditional resources and use before and after reclamation. The review also includes consideration of recent assessment results from other EIA components including human health risk, wildlife, fish, air quality, noise and visual aesthetics.

Members of Aboriginal groups in the region have reported that they are experiencing cultural erosion or cultural change. These changes can have implications for quality of life in several ways, including effects on community cohesion, the value system, feelings of disempowerment, marginalization and vulnerability, loss of pride in cultural identity and relationships with the land, and community health. Traditional Knowledge (TK) and Traditional Land Use (TLU) is integral to maintaining Aboriginal culture and reducing these adverse quality of life effects; therefore, effects on land use opportunities have been used as the basis for describing potential implications for Aboriginal cultural practices and transmission.

As defined by Aboriginal groups, the meaningful practice of TLU rights requires certain conditions to be met in the physical environment. Observed effects on the environment have resulted in changing patterns and intensity of land use (i.e., through avoidance, abandonment and adaptation), which in turn have resulted in effects on intangible elements of Aboriginal culture: changes in passing on knowledge, and changes in relationships and cultural knowledge and practice in communities over time.

The 2013 Planned Development Case (PDC) considers changes in disturbance areas compared to the 2013 PRM Application Case. The 2013 PDC also considers the results of wildlife, vegetation, and fish and fish habitat assessments to determine effects on the abundance of traditional resources. With respect to wildlife KIRs of interest to Aboriginal groups (i.e., moose and black bear), populations are predicted to continue to be viable. In addition, the 2013 PDC considers preferred harvesting areas, changes in access to preferred harvesting areas, air, noise, visual and odour effects, water quality effects, and individual and/or community responses to observed environmental effects. Changes in access and the distribution of wildlife resources may mean that TLU and non-Aboriginal recreational and harvesting activities will become more concentrated in undisturbed areas/areas away from oil sands facilities, thus potentially increasing the possibility of interactions between these growing populations within relatively smaller landscapes over time.

In addition to effects on access to and abundance of traditional resources, psycho-social factors, such as confidence in the quality of harvested foods, and feelings of safety and remoteness or other personal factors (e.g., personal sensitively to noise, odour or visual stimuli) contribute to the motivation to undertake traditional activities. Lack of confidence in country food is an example of an effect that illustrates the need for community-based monitoring in the region.

As described by Larcombe (2012), there is insufficient information and data to reliably comment on the state or vulnerability of the First Nations way of life or if their ability to pursue and enjoy the rights and benefits of traditional use and knowledge is at, or near, or beyond sustainability thresholds. Notwithstanding this uncertainty, effects on traditional lands and resources (whether observed by Aboriginal groups or assessed in an EIA process) since pre-development have induced or caused responses (i.e., displacement, avoidance and abandonment, and adaptation) that have affected the how, where, when, what and whys of the practice of TLU and passing on TK in the region. Aboriginal groups have in turn, consistently reported negative implications for the sustainability of their land-based culture and the related lifestyle and quality of life in their communities. The concerns expressed by members of Aboriginal groups regarding traditional culture are not necessarily related to a single oil sands project but, rather, the scale and pace of development in the region overall and their frustration regarding their lack of influence in land use decisions.

b) Shell completed an assessment of the socio-economic effects on First Nations and Aboriginal groups respecting Aboriginal rights and interests before and after reclamation. Details are contained in Appendix 8 – JRP SIR 69b Assessment of Socio-Economic Effects on Aboriginal Groups and are summarized below.

The assessment builds on the response given to a similar question put forward during the recent Shell JME regulatory review process (May 2012). The assessment takes into consideration responses from the regulator, Aboriginal groups and other stakeholders to recent oil sands socio-economic assessments, updated and relevant socio-economic information, and additional interviews with representatives of agencies and authorities that provide programs and services for Aboriginal community members.

Oil sands industry development has contributed to several socio-economic pressures that local First Nations and other Aboriginal groups face, including: changes in family and community practices and relations; increasing social stressors; and, increased pressures on housing and regional services.

Some of these stresses are driven by socio-economic changes, such as changes in regional population, or increased access to employment and business opportunities. Some are driven by environmental effects that can lead to avoidance of or displacement from lands on which traditional pursuits take place. Many Aboriginal groups have raised concerns with respect to well-being in their communities, including negative effects related to increased wage economy participation and reduced engagement in traditional activities (e.g., decreased community cohesion, changing social values).

Aside from oil sands development, other external influences have had and are likely to continue having an important effect on the socio-economic conditions of local Aboriginal peoples, including:

- the rural and remote location of Aboriginal communities and reserves;
- government policies and supports for Aboriginal peoples; and
- increased interaction with the broader society via advancements in technology (e.g., satellite, internet, cell phones).

From a socio-economic perspective, oil sands development has also provided several benefits to Aboriginal people in the region, including:

- the negotiation of benefit agreements between Aboriginal communities and industrial proponents;
- increased wages and benefits;
- increased employment and business opportunities;
- increased access to education and training opportunities;
- increased access to a broader range of local services and amenities (e.g., emergency, health and social services); and
- increased industry support for community programs and infrastructure (e.g., financial and in-kind contributions to social groups, education institutions, and health care providers).

As documented in Appendix 8, the Aboriginal people and communities in the region lead many other Aboriginal communities in terms of employment, income, community well-being index, and housing quality and quantity. However, they trail the population as a whole. The data on educational attainment is mixed.

Shell's PRM project will contribute to both the stresses and benefits discussed above. Shell is committed to taking action to minimize the stresses and maximize the benefits from PRM, including:

- using full-service camps during both construction and operations;
- complementing existing regional resources with in-camp security and on-site health services;
- providing support for local community initiatives, where appropriate; and
- working with the Industry Relations Corporations and employment coordinators to identify and remove barriers to employment, wherever possible.

Taking into consideration likely ongoing socio-economic effects from larger external influences and the actions and mitigations being taken by Shell, the magnitude of the Project-related socio-economic effects on Aboriginal groups in Fort McMurray, Fort Chipewyan, and Fort McKay are expected to be negligible.

References:

Larcombe, P.M. 2012. *A Narrative of Encroachment Experienced by Athabasca Chipewyan First Nation*. Symbion Consultants. September 28, 2012. Winnipeg, MB. 198 pp.

SIR 70

Under the Joint Review Panel Agreement Terms of Reference- January 25, 2012, the Joint Review Panel shall consider "Any effects of alteration to access into areas used by aboriginal persons for traditional uses."

a) Provide an assessment of potential effects of alteration to access into areas used by Aboriginal persons for traditional uses as well as access to and use of reserve lands. Include any potential effects of alteration related to fragmentation, water quality and water quantity.

b) Assess the cumulative effects of fragmentation and loss of connectivity on traditional land use and on the exercise of Aboriginal and Treaty Rights.

c) Assess the cumulative effects of fragmentation and loss of connectivity on the avoidance of use and loss of enjoyment of Aboriginal peoples.

d) Specify which Aboriginal groups that access the land in the regional or local study area, are affected by the above and explain how they are affected.

e) Explain how access by aboriginal persons and loss of aboriginal land uses will be mitigated or compensated, before and after closure.

Response:

a) An assessment of the potential effects of alteration to access into areas used for traditional activities (including access to reserve lands) is found in Appendix 2, Section 3.5.1. A further assessment of the potential effects of alteration related to fragmentation, water quality and water quantity is found in Appendix 7, Section 3.2.

b) The cumulative effects on traditional harvesting opportunities were assessed in response to JRP SIR 8 (Appendix 2, Section 3.5.1) and considered changes in access and effects to the potentially affected Aboriginal groups. An assessment of the cumulative effects on the exercise of Aboriginal and Treaty Rights is found in response to JRP SIR 69a (Appendix 7, Section 3.2).

c) A discussion of the cumulative effects of access on avoidance of use and loss of enjoyment of Aboriginal peoples is found in the response to JRP SIR 69a, Appendix 7, Section 3.0.

d) The cumulative effects on traditional harvesting opportunities and Aboriginal and Treaty rights were assessed in response to JRP SIR 8 (Appendix 2, Section 3.5.1) and JRP SIR 69a (Appendix 7, Section 3.0) and considered changes in access and effects to the following potentially affected Aboriginal groups:

- Community of Fort McKay (Fort McKay First Nation and Fort McKay Métis);
- Mikisew Cree First Nation;
- Athabasca Chipewyan First Nation;
- Fort McMurray #468 First Nation;
- Fort Chipewyan Métis Local #125; and
- Fort McMurray Métis Local #1935.

e) The traditional trail will remain in place between the PRM Development area and the Athabasca River to provide access alongside the river. Shell will also provide access to the proposed bridge and access road for Aboriginal traditional land users. Shell proposes to use progressive reclamation and will meet with each of the potentially affected Aboriginal groups to include them in the design and implementation of the reclaimed landscape.

Shell is also undertaking the following mitigations:

- Shell will minimize as far as is practicable the land disturbance and practice progressive reclamation.
- Shell actively participates in the Cumulative Environmental Management Association (CEMA), the Reclamation Working Group (RWG), and Sustainable Ecosystems Working Group (SEWG), which addresses issues of relevance to Traditional Land Uses.
- Shell, through the Oil Sands Developers Group (OSDG) and other agencies, supported the Land Use Secretariat of Alberta Environment and Sustainable Resource Development (ESRD) and its work on developing a Lower Athabasca Regional Plan (LARP), which set out economic, environmental and social outcomes and objectives for the region over the next 10 years.

- Shell actively participates in regional multi-stakeholder planning and research initiatives that consider the long-term sustainability of effective Traditional Land Use.

CAPACITY OF RENEWABLE RESOURCES

SIR 71

Joint Review Panel Agreement Terms of Reference- January 25, 2012, Page 15. The JRP TOR defines renewable resources as fish, wildlife, trees, water quality and quantity, and airshed which are replaced and replenished, on an ongoing basis, either naturally or by human actions. The Joint Panel is required to consider the capacity of renewable resources that are likely to be significantly affected by the Project to meet the needs of the present and those of the future. The Panel notes that assessing the effects of the Project on a renewable resource is not the same as assessing the capacity of a renewable resource. Both ACFN and MCFN have expressed concern regarding potential residual effects on renewable resources and their capacity to meet the needs of both current (specifically due to loss of use during construction and operations) and future generations. For any of the above renewable resources that Shell indicates would have a high environmental consequence in the LSA,

a) Assess the residual biophysical effects on the renewable resources and the resulting capacity of those resources to meet the needs of a) current (loss of use during the 25-30 year construction and operation period) and b) future generations.

b) Describe specific indicators used to evaluate capacity of renewable resources and the criteria applied to measure effects on that capacity.

c) Separate PRM specific effects on all renewable resources rather than the combined JPME/PRM results currently reported in the EIA. Ensure that the analysis details short and longer term LSA- level effects as well as at the RSA level.

d) Provide evidence from research or peer-reviewed literature to support Shell's prediction that old- growth forest and traditional plants will be restored to pre-disturbance conditions without application of any specific reclamation measures.

e) Assess the cumulative effects of the Project on the capacity of renewable resources to support the exercise of Aboriginal and Treaty Rights and Aboriginal traditional use in the RSA.

Response:

a) The 2013 PRM Application Case during operations conservatively represents the time period in which the needs of current generations will be expressed, while the 2013 Planned Development Case (PDC) before and after reclamation represents the time periods in which the needs of future generations will be expressed.

This assessment considers residual biophysical effects on renewable resources, which are fish, wildlife, trees, water quality and quantity, and airshed. Environmental consequences are not assessed directly for water quantity, but rather for the aquatic receptors of fish and water quality. Negative environmental consequences in the LSA are predicted to be negligible for fish and airshed, moderate for trees, and range from negligible to low for water quality. These Key Indicator Resources (KIRs) are discussed further below to provide additional context. High and negative environmental consequences in the Local Study Area (LSA) are predicted only for wildlife KIRs. During construction and operations, habitat loss of high environmental consequence in the LSA is predicted for all wildlife KIRs, for which effects to the capacity of renewable resources are discussed in depth. However, for the purpose of this response only those wildlife KIRs that are harvested by humans are defined as a renewable resource, which include:

- beaver;
- black bear;
- Canada lynx;
- fisher;
- horned grebe;
- moose;
- wolverine;
- woodland caribou; and
- wood bison.

Residual biophysical effects to renewable resources are assessed during operations from the PIC to the 2013 Base Case and the 2013 PRM Application Case in Appendix 2, Section 4, and from the PIC to the 2013 PDC in Appendix 2, Section 5. The assessment of effects includes consideration of both landscape change due to development and potential related changes to rates of harvest of renewable resources due to factors such as increased access and the influx of Project personnel. The risk of increased harvest rates due to increased access is mitigated by controlling access to roads developed for

PRM. The risk of increased rates of harvest due to the influx of Project personnel is mitigated by prohibiting staff and contractors from hunting and trapping on site (April 2010 Pierre River Mine, Supplemental Information, Round 2, AENV 74a). The harvest of trees is not affected by access, but rather by established forest licenses and the province's Annual Allowable Cut (AAC), which is not expected to increase rates of forest harvest in the future. Therefore, after mitigation, the expected future pressures of human harvest of renewable resources in the RSA are similar to those in the present, and the main factor affecting the capacity of renewable resources will be landscape change due to development. The following provides an assessment of effects on the specific renewable resources identified in the JRP TOR.

Fish

A negligible environmental consequence was assessed for fish habitat and abundance within the PRM Aquatics LSA due, in part, to compensation offsets for loss of fish habitat through the creation of the proposed South Redclay Lake. Similarly, compensation offset requirements associated with projects considered under the 2013 PDC would result in a negligible environmental consequence for fish habitat and abundance within the LSA. Therefore, the capacity of fish habitat and abundance to meet the needs of the present and those of the future are not likely to be significantly affected by PRM or the 2013 PDC, and are not examined further.

Wildlife

The capacity of wildlife resources to meet the needs of current and future generations may be generally equated to a determination of the ecological resilience of those resources to landscape change and the expected pressures of human harvest. Resilience refers to the ability of ecological systems to absorb disturbance and maintain system integrity and function (Holling 1973; Levin et al. 1998). Cumulative effects to wildlife, including the predicted effects of human harvest, are considered to be significant if they compromise resilience such that populations are likely to no longer be self-sustaining, ecologically effective populations. Self-sustaining populations are healthy populations that will be present for many generations. An ecologically effective population is one that is sufficiently abundant to maintain its interactions with other components of the ecosystem and contribute to ecological integrity (Soule et al. 2003), thereby meeting the needs of current and future generations. A population that is predicted to be self-sustaining and ecologically effective after consideration of landscape change and human harvesting pressures is predicted to have the capacity to meet the needs of both current and future generations. However, a population that is not predicted to be self-sustaining or ecologically effective does not necessarily represent a significant effect if cumulative effects within the RSA are not likely to be causal or contributing factors to the compromised resilience of that population. For example, if a species is declining in Alberta or across its North American range, but the cause of the decline is not associated with PRM or cumulative effects within the RSA, then the cumulative effects assessment would conclude that the effects within the RSA are not significant.

The assessment of the overall capacity of an environmental resource to support the ongoing and future use of that resource is focused at the RSA level. This is because the LSA is delineated based primarily on the footprint of the development and the listed renewable resources are present throughout the RSA, which is defined based on ecological and biophysical rationale. Aboriginal groups make use of renewable resources throughout their traditional territories, which in many cases extend beyond the RSA.

Wildlife renewable resources that have socio-economic or cultural importance, that may be affected by PRM, and for which residual biophysical effects were assessed, include beaver, black bear, Canada lynx, fisher, horned grebe (a surrogate for waterfowl), moose, wolverine, wood bison and woodland caribou. For all these Key Indicator Resources (KIRs), environmental consequences of effects to habitat in the LSA were assessed as high prior to reclamation. Renewable resources within the LSA will be effectively unavailable during construction and operations prior to reclamation. However, at the RSA scale, 2013 Base Case disturbances comprise 14% of the RSA, while construction of PRM will result in an additional disturbance of less than 1% of the RSA. Disturbances due to the 2013 PDC will disturb an additional 5% of the RSA, for a total disturbance of about 20% of the RSA. Therefore, 80% of the RSA remains undisturbed in the 2013 PDC.

From the PIC to the 2013 Base Case and 2013 PRM Application Case during construction and operations, population declines in the RSA are predicted to be of moderate environmental consequence for beaver, black bear, Canada lynx, fisher, moose, and horned grebe, and high for wolverine (Appendix 2, Section 4.3.3.1.1). From the PIC to the 2013 PDC, the environmental consequence of population declines in the RSA are predicted to be moderate for beaver, black bear and moose and high for Canada lynx, fisher, horned grebe and wolverine (Appendix 2, Section 5.3.3.1.1). Given the areal extent of remaining high suitability habitat in the RSA (Appendix 3.7, Section 1.3, Table 1.3-2) and data suggesting that their populations are relatively stable or at worst slowly declining, it is unlikely that the resilience of populations of these species in the RSA has been or will be compromised as a result of development to the point that they no longer have the capacity to support the needs of current and future generations.

The wood bison population in the RSA is unlikely to be limited by the availability of habitat, but rather by the effects of unregulated hunting, predation and disease (e.g., bovine tuberculosis, bovine brucellosis, anthrax). An examination of telemetry collar data collected between March and July 2013 shows that the home range of the Ronald Lake herd overlaps with WBNP (Government of Alberta 2013), and therefore bison of the Ronald Lake herd are likely to interact with diseased bison herds that occur in and around the park. However, although the Ronald Lake herd may be diseased, a recent analysis of blood and tissue samples have led to an estimated rate of disease in the herd that is between 0% and 12% for tuberculosis and brucellosis (Government of

Alberta 2013). Therefore, the herd appears to be either free of these diseases or infected at a rate that is lower than the sampling strategy was capable of detecting, and lower than the 30% to 50% rate of disease present in herds in and around Wood Buffalo National Park (Government of Alberta 2013). Unregulated harvest likely affects the Ronald Lake population. Harvest pressure is associated with winter access across the Athabasca River by ice bridge (Powell and Morgan 2010). It is unlikely that development in the RSA from the PIC has contributed to the decline of this species. After the implementation of access control to mitigate the risk of increased hunting mortality due to increased access, the combined effects of incidental sources of mortality associated with changes in the RSA between the PIC and the 2013 PRM Application Case and 2013 PDC are predicted to result in a low environmental consequence for wood bison abundance. It is unlikely that the resilience of the wood bison population in the RSA has been or will be compromised as a result of development to the point that it no longer has the capacity to support the needs of current and future generations.

Woodland caribou are virtually absent from the LSA, which is located outside designated caribou areas. However, the Red Earth, Richardson and West Side of the Athabasca River (WSAR) woodland caribou ranges occur in the RSA, and appear to be declining to extirpation. In the absence of wildlife management intervention, extirpation is predicted whether or not further development occurs in the RSA. The woodland caribou decline in the RSA appears to be due to the indirect effects of industrial development on predator-prey dynamics. The net environmental consequence for the effects of changes in the RSA from the PIC to the 2013 Base Case, the 2013 PRM Application Case and the 2013 PDC on woodland caribou are all high. The majority of these effects occur between the PIC and the 2013 Base Case. For example, over 99% of the high suitability woodland caribou habitat that is predicted to be lost from the PIC to the 2013 PRM Application Case was lost from the PIC to the 2013 Base Case. Nonetheless, the cumulative effects of development in the RSA appear to have exceeded ecological thresholds such that the woodland caribou population is no longer self-sustaining and ecologically effective. Therefore these are considered Significant effects. In the absence of management intervention, woodland caribou in the RSA no longer have the capacity to meet the needs of current or future generations.

After reclamation, black bear, beaver, Canada lynx, fisher, moose and wolverine will see increases in the availability of quality habitat in a reclaimed landscape relative to the landscape prior to reclamation and in the PIC because of a higher proportion of terrestrial uplands in the RSA (Appendix 2, Section 4.3.3.3). There is a predicted decline in high suitability habitat for bison after reclamation because of a decline in preferred graminoid wetlands (Appendix 2, Section 4.3.3.3). Within the LSA there is a predicted increase in high suitability habitat for horned grebe after reclamation due primarily to the increased areal extent of lakes, although overall in the RSA the conversion of wetlands to upland habitats is likely to result in a decline. However, as effects to wood bison and horned grebe (a surrogate for waterfowl) prior to reclamation did not compromise the capacity of their populations to meet the needs of current and future generations, effects after reclamation are also unlikely to compromise their capacity. Woodland caribou habitat availability after reclamation will not substantially change relative to habitat availability prior to reclamation, but the species will experience a decrease in the amount of high suitability habitat after reclamation relative to the PIC.

Trees

Project and planned development effects to trees are assessed as changes in area of productive forests. Productive forests are those forest stands with aspen (*Populus tremuloides*), jack pine (*Pinus banksiana*), balsam poplar (*Populus balsamifera*) or white spruce (*Picea glauca*) as the principal tree species (Appendix 1, Section 4.3.1.4). Environmental consequences for productive forest were assessed as negative and moderate in the LSA (Appendix 1, Section 4.3.1.4) and negligible in the RSA during PRM construction and operations. After reclamation, productive forests in the LSA and RSA are predicted to increase due to the conversion of wetlands to uplands (Appendix 1, Section 4.3.1.4).

Before or after reclamation, it is unlikely that the resilience of productive forests (i.e., trees) in the RSA has been or will be compromised as a result of development to the point that they no longer have the capacity to support the needs of current and future generations.

Water Quality

Potential effects to water quality were assessed in the LSA and RSA for the 2013 PRM Application Case in Appendix 1 and for the 2013 PDC in Appendix 2. The indicators applied to the water quality assessment consisted of approximately 50 water quality constituents, including major ions, nutrients, metals, and whole effluent toxicity. The full list of constituents is provided in the appendices mentioned above. Predicted concentrations of these constituents were compared to several sets of criteria, including Pre-Industrial conditions, provincial and federal water quality guidelines and chronic effects benchmarks that were derived for aquatic species that are present in the Oil Sands Region (Appendix 3.6). Changes to water quality were considered by the wildlife and human health components which predicted no adverse health impacts due to cumulative developments. The environmental consequences of changes to water quality concentrations in the 2013 PRM Application Case are predicted to be negligible in the Athabasca River, and low to negligible in the Pierre River and Eymundson and Big creeks. The water quality and aquatic health assessment also concluded that the PRM pit lakes are expected to be able to support viable aquatic ecosystems and discharged waters are not anticipated to impair aquatic health in receiving streams. Therefore, changes in water quality are not predicted to impair the ability of future generations to meet their needs.

Airshed

The effects of changes to the airshed and its capacity as a renewable resource were considered through the assessment of the potential changes to air quality over time, and the consequent impacts, if any, to human health, odours, wildlife health, soil, water and vegetation. For example, the Human Health Risk Assessment (Appendix 1, Section 2.3) concluded that emissions from PRM in combination with emissions from other sources (i.e., the 2013 PRM Application Case) are not expected to result in adverse health effects in the area. The health risks were characterized using regulatory health-based criteria that are designed to be protective of even the most sensitive subgroups in an exposed population (e.g., individuals with compromised health, elderly, pregnant women). Moreover, the changes between the 2013 Base Case and the 2013 PRM Application Case are negligible (Appendix 1, Section 2.2), suggesting that the PRM is not expected to contribute appreciably to health risks in the region. Therefore, the capacity of the airshed to meet the needs of current and future generation is not likely to be significantly affected by PRM.

Conclusions

Woodland caribou in the RSA are currently declining to extirpation due to the indirect effects of industrial development on predator-prey dynamics. In the absence of wildlife management intervention, extirpation is predicted whether or not further development occurs in the RSA. Therefore these are considered Significant effects, and woodland caribou in the RSA no longer have the capacity to meet the needs of current or future generations. For all other renewable resources in the RSA (i.e., fish, wildlife, trees, water quality and airshed), Shell has determined that changes in the RSA from the PIC to the 2013 Base Case, the 2013 PRM Application Case and the 2013 PDC are not likely to result in significant adverse environmental effects according to ecological thresholds. There will be effects to KIRs of high environmental consequence within the LSA during operations and at Closure. Wildlife habitat availability will be lost within the LSA during operations, but will recover after reclamation as vegetation communities become established and mature, and wildlife populations return from adjacent intact habitat elsewhere in the RSA. The capacity of those renewable resources to meet the needs of current and future generations will not be significantly impacted by the Project or other planned developments in the RSA during construction and operations or after reclamation. Therefore, there is not likely to be any significant adverse effects due to the Project or other planned developments on the capacity of fish, wildlife, trees, water quality, water quantity and airshed to meet the needs of current and future generations in the RSA.

b) Of the renewable resources that occur in the RSA, only wildlife KIRs are predicted to experience effects of high environmental consequence in the LSA. Therefore, as discussed in part a), the specific indicators used to evaluate the capacity (i.e., resilience) of renewable resources include changes in the abundance of beaver, black bear, Canada lynx, fisher, horned grebe (a surrogate for waterfowl), moose, wolverine, wood bison and woodland caribou.

The criteria used to measure effects on the capacity of renewable resources include direction (positive/negative), magnitude, geographic extent, duration, reversibility, and frequency of the effect at both the LSA and RSA scales (EIA, Volume 3, Section 1.3.6). These criteria are included in the environmental consequence rating for effects for each KIR and SAR. Additionally, ecological context is considered throughout the assessment; for example, through the detailed discussion of population trends and factors limiting populations. Ecological context is also considered explicitly in the determination of significance for wildlife by setting the effects of landscape change in the context of the resilience of regional wildlife populations and, by extension, their capacity to meet the needs of present and future generations. Cumulative effects are considered to be significant if they compromise population resilience and the capacity of a renewable resource to meet the needs of present and future generations.

c) The change from the 2013 Base Case to the 2013 PRM Application Case discussed in the response to part a) considers PRM specific effects on renewable resources at the LSA and RSA scale rather than JME/PRM results combined. Further details on the assessed effects to renewable resources due to PRM are discussed in Appendix 1.

d) Old-growth forest and traditional use plant species are expected to be available in the reclaimed LSA. Undisturbed areas and areas with minimal disturbance (i.e., no vegetation clearing or soil removal) will exist within the LSA during construction and operations. Undisturbed areas will continue to provide renewable resources through the Far Future scenario. Areas with minimal disturbance may return to pre-disturbance conditions within the 80-year Far Future Scenario; however, areas within the PRM footprint will require specific reclamation techniques to recover from development. These techniques are detailed below.

Traditional Use Plants

When planting prescriptions are assigned to the closure landscape, the goal is to design a range of ecosite phases that should support a variety of traditional end land uses. These planting prescriptions include species that are preferentially used by Aboriginal groups, such as blueberry (*Vaccinium myrtilloides*), bog cranberry (*Vaccinium vitis idaea*), lowbush cranberry (*Vibrnum edule*), rose (*Rosa acicularis*), bearberry (*Arctostaphylos uva-ursi*), white spruce (*Picea glauca*), black spruce (*Picea mariana*) and poplar (*Populus* spp.). Traditional use plants are commonly used in oil sands reclamation; these plants are part of the planting prescription in the Conservation, Closure and Reclamation Plan for the PRM (EIA, Volume 5, Appendix 5-2, Section 3.4, Table 18).

When available, Shell plans to use the litter, fragmented litter and humus (LFH) soil horizon as a coversoil for reclaimed areas. The use of LFH for reclamation practices allows the successful propagation of many more upland boreal plant species, including traditional use plants, that were previously unavailable in commercial seed mixes (Lanoue and Qualizza 2000; Mackenzie and Naeth 2010). Direct placement of suitable material to reclamation areas will be implemented where practical to enhance site revegetation as dormant, in situ, native seed and viable root fragments are transferred with the soil material (EIA, Volume 5, Appendix 5-2, Section 2.5.2). Spreading the material on a reclamation area in early spring can result in the emergence of a variety of native forbs, wildflowers, grasses and woody-stemmed species over the late spring and summer (Straker and Donald 2010).

Old Growth Forest

Old growth forest characteristics such as multi-layered tree canopy, high diversity of microhabitats (e.g., woody debris, downed logs, snags), a mosaic of stand ages and canopy gaps, develop over 60 to 120 years (Frelich and Reich 1995; Parish et al. 1999). The extent and addition of old growth forest is largely determined by two main factors; average longevity of the dominant tree species and the return interval of major disturbances such as fires (Kneeshaw and Gauthier 2003). The onset age for old growth varies with dominant tree species type (Schneider 2002; Uhlig et al. 2001) as described in Section 3.3.6.1 of the Terrestrial Vegetation, Wetlands, and Forest Resources Environment Setting Report (Golder 2007).

Fire is the dominant major natural disturbance in northern Alberta. Historic fire return intervals range from 50 to 150 years (Bergeron et al 2004). However, other sources have used 60 and 80 years in fire cycle modelling (Al-Pac 2007; Andison 2003). Over the past 50 years, there has been an observed shift from shorter to longer fire cycles, probably due to climate change and fire protection systems (Bergeron et al. 2004). Fire protection has the ability to increase old growth forest as unburned forests are able to reach old growth status (de Groot et al. 2003). However, the present landscape in western Canada is drier than the historical landscape, which may result in an increase in fire frequency and/or burn size (de Groot et al 2003; Macias and Johnson 2008). The combination of drier landscape and fire suppression may be reducing the number of small fires, but could cause an increase in large catastrophic wildfires by providing more available fuel (Macias and Johnson 2008).

Potential for Old Growth Development within the Local Study Area

Although the undisturbed portion of the LSA will be subject to stochastic events such as disease, insects and forest fires, assuming normal fire patterns, mixedwood stands may reach a mature stage about 80 years following natural establishment or planting (Al-Pac 2007; EIA, Volume 5, Section 1.3.5). It is expected that the reclaimed landscape will be capable of supporting some old growth forest after 100 years or more (see Andison 2003 for average old growth ages by tree species; EIA, Volume 5, Section 2.5.4, Appendix 5-2). The type and age of dominant tree species within the undisturbed proportions of the study area will determine when forests could reach onset age for old growth, given no large major disturbances such as fires. However, during the summer of 2011, a large portion of the LSA was burned in the Richardson Fire, a wildfire that burned more than 700,000 hectares in the Oil Sands Region (CBC News 2011).

Because a large portion of the LSA experienced this major fire in 2011, old growth forest may take more than 100 years to establish in areas undisturbed by the PRM. During the

40-year life of PRM (EIA, Volume 1, Section 1), burned areas that are left undisturbed by PRM will achieve an age of 40 years, given no additional major disturbance such as burn. Such regenerated stands, if dominated by deciduous, mixed wood or jack pine trees, could be approaching or reaching old growth status at Far Future (80 years after reclamation, 120 year old forest). In particular, white spruce, balsam fir, black spruce and tamarack stands would be expected to achieve old growth status beyond the Far Future 80-year timeframe.

Shell will be implementing fire suppression and fire control measures in and around the PRM area. Fire suppression increases the potential for unburned and undisturbed areas to age and develop into old growth forest. Assuming normal fire patterns and implementation of fire control and prevention management within the PRM area, unburned and undisturbed portions of the LSA can be expected to have high old growth forest development potential.

Shell's reclamation goal is to achieve maintenance-free, self-sustaining ecosystems with a capability equivalent to predevelopment conditions (EIA, Volume 2, Section 20.3). Equivalent land capability "means that the ability of the land to support various land uses after conservation and reclamation is similar to the ability that existed prior to an activity being conducted on the land, but that the individual land uses will not necessarily be identical" (AENV 2010). Undisturbed portions of the LSA are expected to mature into old growth forest within the 80-year Far Future scenario. Burned, disturbed and reclaimed portions will take longer to mature. Disturbed and reclaimed areas may require planting, monitoring and mitigations. Disturbed and reclaimed areas will likely not return to pre-disturbance conditions within the 80-year Far Future scenario. However, if left undisturbed, the reclaimed landscape can mature to old growth conditions if management systems allow. Therefore, the potential does exist for the reclaimed landscape to support old growth forest.

e) With the exception of woodland caribou, the response to JRP SIR 71a above concluded that there is not likely to be significant adverse effects due to the PRM or other planned developments on the capacity of fish, wildlife, trees, water quality and airshed to meet the needs of current and future generations in the RSA. Regarding traditional plants, about 80% of the RSA will remain undisturbed, and the response to JRP SIR 71d above indicated that undisturbed areas in the LSA will continue to provide traditional plant species during construction and operations. Traditional plant species will become available in the reclaimed LSA. The practice of traditional land use activities relies upon several factors such as the availability of underlying resources (e.g., wildlife, fish, traditional plants), access to the resources, and socio-economic factors such as fear of contamination or human health issues related to development. The results in JRP SIR 71a and 71d indicate that the capacity of wildlife, fish, trees, traditional plants, and water quality to support traditional harvesting treaty rights will remain during the 2013 PDC and will not be a large factor in determining the overall effects of the 2013 PDC on traditional hunting, trapping, fishing, or plant and berry harvesting.

References:

AENV (Alberta Environment). 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, AB. December 2009. 342 pp.

Al-Pac (Alberta-Pacific Forest Industries Inc.). 2007. *Alberta-Pacific FMA Area Forest Management Plan (Revised) September 2007 (Approved September 2008): Chapter 3*. FMA Area Forest Management Implementation. September 2007. Prepared by: Alberta-Pacific Forest Industries Inc. Boyle, Alberta.

Andison, D. 2003. *Natural Levels of Forest Age-Class Variability on the Alberta-Pacific FMA*. Bandaloop Landscape-Ecosystem Services. November, 2003. Belcarra, BC.

Bergeron, Y., M. Flannigan, S. Gauthier, A. Leduc and P. Lefort. 2004. *Past, current and future fire frequency in the Canadian boreal forest: implications for sustainable forest management*. Ambio. 33(6): 356-360.

CBC News. 2011. *Northern Alta. Fire surges to size of P.E.I*. CBC news online, accessed 26 April, 2013. Available at: http://www.cbc.ca/news/canada/edmonton/story/2011/06/15/edmonton-richardson-wildfire-pei.html

de Groot, W.J., P.M. Bothwell, D.H. Carlsson and K.A. Logan. 2003. *Simulating the Effects of Future Fire Regimes on Western Canadian Boreal Forests*. Journal of Vegetation Science 14, 355-364.

Frelich, L.E. and P.B. Reich. 1995. *Spatial patterns and succession in a Minnesota southern-boreal forest*. Ecological Monographs 65 (3): 325-346.

Golder (Golder Associates Ltd.). 2007. *Terrestrial Vegetation, Wetlands, and Forest Resources Environment Setting Report for the Jackpine Mine Expansion & Pierre River Mine Project*. Prepared for Shell Canada Limited. Calgary, AB. Submitted December 2007.

Government of Alberta. 2013. *Ronald Lake bison (Bison bison): winter 2012-1013 activities*. Progress report (final). 39 pp.

Holling, C.S. 1973. *Resilience and stability in ecological systems*. Annual Review of Ecology and Systematics 4: 1–24.

Kneeshaw, D. and S. Gauthier. 2003. *Old growth in the boreal forest: A dynamic perspective at the stand and landscape level*. Environmental Reviews. 11(S1): S99-S114.

Lanoue, A. and C. Qualizza. 2000. *LFH and shallow mineral horizons as inoculants on reclaimed areas to improve native species catch*. 1999 Status Report. Syncrude Canada Ltd., Fort McMurray, Alberta, Canada.

Levin, S., S. Barrett, S. Aniyar, W. Baumol, C. Bliss, B. Bolin, P. Dasgupta, P. Ehrlich, C. Folke, I.M. Gren, C.S. Holling, A.M. Jansson, B.-O. Jansson, D. Martin, K.-G. Mäler, C. Perrings and E. Sheshinsky. 1998. *Resilience in Natural and Socioeconomic Systems*. Environment and Development Economics 3: 222-235.

Macias F.M. and E.A. Johnson. 2008. *Climate and wildfires in the North American boreal forest*. Philosophical Transactions of the Royal Society B 363: 2317–2329.

Mackenzie, D.D. and M.A. Naeth. 2010. *The role of the forest propagule bank in assisted natural recovery after oil sands mining*. Restoration Ecology 18(4): 418-427.

Parish, R., J.A. Antos and M.-J. Fortin. 1999. *Stand development in and old-growth subalpine forest in southern interior British Columbia*. Canadian Journal of Forestry Research 29: 1347-1356.

Powell, T. and T. Morgan. 2010. *Ronald Lake bison (Bison bison) survey: February 2010*. Alberta Sustainable Resource Development, Wildlife Division. Fort McMurray, Alberta. 14 pp.

Schneider, R.R. 2002. *Alternative Futures: Alberta's Boreal Forest at the Crossroads*. The Federation of Alberta Naturalists. Edmonton, AB.

Soule, M.E., J.A. Estes, J. Berger and C.M. Del Rio. 2003. *Ecological effectiveness: Conservation goals for interactive species*. Conservation Biology 17:1238-1250.

Straker, J. and G. Donald. 2010. *Developing the Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region*. CEMA, Fort McMurray, AB. pp. 14. https://circle.ubc.ca/bitstream/handle/2429/30356/22%20Straker.pdf?sequence=1

Uhlig, P., G. Harris, C. Craig, B. Bowling, B. Chambers, B. Naylor and G. Beemer. 2001. *Old-growth forest definitions for Ontario*. Ontario Ministry of Natural Resources, Queen's Printer for Ontario, Toronto. 27 pp.

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EIA Volume 5: Terrestrial Resources and Human Environment, Section 8.3.6.1, Table 8.3-13, Page 8-50. Shell provides information on the amount of disturbance as a result of the project in the currently active Registered Fur Management Areas (RFMAs) on each side of the Athabasca River. However, no information is provided on the amount of potential disturbance in the inactive RFMA intersecting with the south most portion of the mine footprint.

a) Provide the amount of disturbance in the base, application and planned development case before and after reclamation, for each of the potentially affected RMFAs, on both sides of the Athabasca River, regardless of activity status.

b) Assess the significance of the impact on the trapping rights for the active RFMAS before and after reclamation.

c) Assess the change in functionality of the inactive RFMA intersecting the south most portion of the mine footprint before and after reclamation.

Response:

a) The LSA disturbances within each of the potentially affected RFMAs for the 2013 Base Case, 2013 PRM Application Case, 2013 Planned Development Case (PDC) and at Closure are shown in Table 72-1.

Table 72-1 Local Study Area Disturbances to Potentially Affected Registered Fur Management Areas

RFMA	RFMA Area Within LSA [ha]	Disturbance at 2013 Base Case		Disturbance at 2013 PRM Application Case		Disturbance at 2013 Planned Development Case		Disturbance at Closure	
		[ha]	[%]	[ha]	[%]	[ha]	[%]	[ha]	[%]
1275	14,902	886	6	6,944	47	9,511	64	400	3
2016	6,425	605	9	4,943	77	4,943	77	81	1
2331	340	194	57	206	61	206	61	180	53
2939	1,024	17	2	317	31	317	31	15	1

The RSA disturbances to the potentially affected traplines for the 2013 Base Case, 2013 PRM Application Case and 2013 PDC are shown in Table 72-2. It is not possible to determine the RSA disturbances at Closure due to the lack of Closure landscape information at the RSA level.

Table 72-2 Regional Study Area Disturbances to Potentially Affected Registered Fur Management Areas

RFMA	RFMA Area [ha]	Disturbance at 2013 Base Case		Disturbance at 2013 PRM Application Case		Disturbance at 2013 Planned Development Case	
		[ha]	[%]	[ha]	[%]	[ha]	[%]
1275	55,403	5,677	10	12,097	22	38,710	70
2016	15,713	3,098	20	7,680	49	7,680	49
2331	29,207	3,019	10	3,031	10	3,031	10
2939	9,216	120	1	420	5	1,055	11

b) Registered Fur Management Area #1275 is trapped by a member of the Fort Chipewyan Métis Local #125. Under the 2013 PRM Application Case, disturbance to RFMA #1275 is 22% (12,097 ha) (Table 72-2). This is assessed as an adverse and high magnitude effect. The net effects of the 2013 PRM Application Case on beaver, fisher and Canada lynx were also assessed as high magnitude and regional in geographic extent during PRM construction and operations (Appendix 1, Section 4.4). As the result of the high magnitude effects on land disturbance and furbearers, the effects to trapping on RFMA #1275 at the LSA level were assessed as negative in direction, high in magnitude, regional in extent and long term in duration because they are expected to occur for longer than one generation. The effects are also considered irreversible, as the length of duration may interfere with the ability for associated traditional knowledge to be passed between generations. Given the high magnitude impacts and the long-term duration, the effects are expected to have a substantial effect on trapping in RFMA #1275 and are considered significant.

Registered Fur Management Area #2016 is an unassigned trapline. There is no information to indicate that it is being trapped. To the extent that it may be trapped by Aboriginal trappers, the effects to trapping on the RFMA are expected to be the same as those assessed for RFMA #1275.

Registered Fur Management Area #2331 is held by a non-Aboriginal trapper. Under the 2013 PRM Application Case, disturbance to RFMA #2331 is 10% (3,031 ha). This is assessed as a moderate impact. As a result of this impact in combination with the high magnitude impacts on furbearer abundance described above, the effects to trapping on RFMA #2331 are assessed as negative in direction and high in magnitude. The geographic extent is considered regional and long term in duration because they are expected to occur for longer than one generation. The effects are also considered irreversible. Because the impacts are expected to result in a substantial change in trapping on the RFMA, the effects to trapping on RFMA #2331 are considered significant.

Registered Fur Management area #2939 is held by a non-Aboriginal trapper. Under the 2013 PRM Application Case, disturbance to RFMA #2939 is 5% (420 ha). This is assessed as a low magnitude impact. As a result of this impact in combination with the high magnitude impacts on furbearer abundance described above, the effects to trapping on RFMA #2939 are assessed as low to high, and regional in extent. The duration is considered long term because it will last longer than one generation. The effects are also considered irreversible. The low to moderate impacts on trapping within RFMA #2939 are not expected to result in substantial changes in the overall use in the RFMA. As a result, the effects are considered not significant.

The wildlife assessment (Appendix 2, Section 4.3.4.2.24.3) indicates that at Closure, there will be increased quality habitat for Canada lynx, fisher and beaver, compared to the Pre-Industrial Case (PIC). At Closure, 3% of RFMA #1275 will remain disturbed, compared to 6% at 2013 Base Case (Table 72-1). While it is not possible to determine the RSA Closure landscape for the RSA portions of RFMAs #1275, #2016, #2331 and #2939, the assessment assumes that the project-related disturbances will generally be reclaimed to allow wildlife re-population within the RFMA. As a result, the effects to trapping on these RFMAs post-reclamation are considered not significant.

Registered Fur Management Areas #2331 and #2939 are held by non-Aboriginal trappers.

c) Registered Fur Management Area #2016 is an unassigned trapline. The disturbances to the LSA portion of RFMA #2016 for the 2013 Base Case, 2013 PRM Application Case, 2013 PDC and at Closure are shown in Table 72-1. The disturbances to the RSA portion of the RFMA for each of the assessment cases are shown in Table 72-2. It is not possible to determine the disturbance at Closure for the RSA portion of RFMA #2016 due to the lack of Closure landscape information for all projects in the 2013 PRM Application Case.

Traditional Plant Potential (TPP) for the LSA portion of RFMA #2016 at 2013 Base Case, 2013 PRM Application Case and at Closure is presented in Table 72-3.

Table 72-3 Traditional Plant Potential for Local Study Area Portion of Registered Fur Management Area #2016

TPP for RFMA #2016	2013 Base Case		2013 PRM Application Case		Closure	
	[ha]	[%]	[ha]	[%]	[ha]	[%]
High	1,814	28	417	6	1,533	24
Moderate	3,195	50	653	10	1,317	20
Low	1,416	22	5,356	83	3,576	56
Total Area LSA Overlap	**6,426**	**100**	**6,426**	**100**	**6,426**	100

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

The amount of high TPP at Closure in the LSA portion of RFMA #2016 is approximately equal to the 2013 Base Case as shown in Table 72-3. The reduction in moderate TPP at Closure, compared to 2013 Base Case is the result of an increase in wetlands areas and fewer upland areas at Closure compared to 2013 Base Case.

The effects to trapping on RFMA #2016 were assessed in part (b). The functionality of RFMA #2016 for traditional trapping is expected to be impaired during the PRM construction and operations, but is further expected to return to 2013 Base Case conditions following reclamation.

ACCIDENTS AND MALFUNCTIONS

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Submission of Information to the Joint Review Panel May 2011, Section 3.2, Page 36. Shell provided some information on potential accidents and malfunctions of the Project. The Panel's Terms of Reference also require information on sensitive elements of the environment and how potential accidents and malfunctions may impact those elements. Sensitive elements of the environment may include, but are not limited to, communities, homes, natural sites of interest, areas of major use, species at risk, protected areas, and high-value wildlife habitats that may be affected in the event of an accident or major malfunction.

a) Provide an analysis of the environmental effects to sensitive elements of the environment, of all accidents and malfunctions listed in the May 2011 submission.

Response:

a) The following sections describe potential accident and malfunction scenarios and provide an analysis of the environmental effects to sensitive elements of the environment for the accidents and malfunctions relevant to PRM as listed in the *May 2011, Submission of information to the Joint Review Panel*, Section 3.2.

Shell considers the management of Health, Safety, Security and Environment (HSSE) an integral part of its operations. Shell incorporates a Hazards and Effects Management Process as a key part of its HSSE management system. The Hazard and Effects Management Process is used for identification and risk assessment of HSSE hazards, the evaluation and implementation of control and recovery measures, and to document that major HSSE risks have been reduced to as low as practicable. As part of the HSSE management system for site hazards, an emergency preparedness and response program will be developed as described in the PRM Project Description, Volume 12, Section 12. Emergency response plans, resources and trained personnel will be in place to execute responses appropriate to potential emergency scenarios. The plan will provide structure and guidance for responding to incidents such as spills, fires, loss of containment, and injuries.

Scenarios selected in this assessment are intended to be representative of accidents and malfunctions that may potentially result in a significant impact to public safety and/or the natural environment. For each scenario, a discussion is provided on the plans, measures and systems employed by Shell to reduce the likelihood of the incident occurring together with an assessment of the potential effects should all of these preventative measures fail. The information is based on a conceptual preliminary design of the PRM and on experience gathered from current operations. The basis of assessment is consistent with the present preliminary level of project design.

Shell's assessment considers the probability of the potential consequences and the environmental effects related to the potential scenarios listed in Table 73-1.

Table 73-1 Accidents and Malfunction Scenarios for PRM October 2013 Submission

Scenario	PRM October 2013 Submission Accidents and Malfunction Scenarios
1	Hydrocarbon storage tank loss of containment with ignition
2	Hydrocarbon pipeline loss of containment and spill into watercourse (Athabasca River)
3	Accidental release of solvent to tailings pond
4	External tailings disposal area dyke failure
5	Mining pit high-wall failure
6	Process upset causing emergency flaring
7	Spill from transporting hazardous wastes
8	Migratory birds landing on external tailings disposal areas and becoming oiled

In the *May 2011 Submission of Information to the Joint Review Panel*, accident and malfunction scenarios were listed for the combined JME and PRM projects. However, the following three accident and malfunction scenarios from the May 2011 submission are not applicable to PRM:

- *overburden disposal area failure into the Muskeg River;*
- *failure of the Muskeg River diversion pipeline system; and*
- *failure of the Muskeg Creek diversion pipeline system.*

The "hydrocarbon pipeline loss of containment and spill into watercourse" assesses a potential pipeline failure on the bridge over the Athabasca River.

Changes in the PRM design have also eliminated the accident and malfunction scenario presented in the May 2011 submission for *Asphaltene Energy Recovery Unit Emissions Control Upset.* On January 18, 2012, Shell filed a letter to the JRP which stated it was no longer seeking approval for Asphaltene Energy Recovery (AER) in the Jackpine Mine Expansion application. This change will also apply to the Pierre River Mine application, thereby eliminating the scenario.

Shell considered other potential accidents and malfunctions that may occur with respect to the Joint Review Panel Terms of Reference. Scenarios of handling chemicals and waste onsite were reviewed but none were identified that would likely have a significant impact to the natural external environment. Shell's Jackpine Mine – Phase 1 approved waste management facility and plans address onsite waste handling impacts. The PRM is anticipated to have similar plans based on this experience. Shell has provided a scenario to cover the transportation of hazardous waste from the facility. Shell has combined this case with the concern of increased traffic in the area potentially leading to increased vehicle collisions. Each of the eight accident or malfunction scenarios listed in Table 73-1 are defined by impact criteria which include: likelihood of occurrence and environmental consequences which are described by magnitude, geographic extent, duration and reversibility.

Likelihood of Occurrence

Likelihood of occurrence refers to how likely an event is to occur. In making this likelihood determination, Shell considers the relevant historical (i.e., Shell and industry) frequency of such an event and the corrective actions that may or may not be taken. Based on professional judgment, experience with similar projects, and industry knowledge, likelihood is expressed qualitatively as follows:

- Likely: Could occur several times over plant lifetime.
- Unlikely: Could occur once for every 10 to 20 similar plants in industry over 20 to 30 years of plant lifetime.
- Very Unlikely: Could occur one time for every 100 to 200 similar plants in the world over 20 to 30 years of plant lifetime.
- Extremely Unlikely: Has already occurred in the industry but corrective action has been taken to prevent reoccurrence.
- 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 thousands, e.g., process vessels, storage).

Environmental Consequence

The environmental consequence rating consolidates the results of the impact criteria into one rating. The consolidation allows the effects from different scenarios to be compared using a common rating so that areas of greatest potential concern can be identified. The resulting environmental consequence ratings are negligible, low, moderate or high.

A summary of the eight accident and malfunction scenarios, the likelihood of occurrence, and environmental consequence including magnitude, geographic extent, duration, and reversibility of the effects specific to PRM is provided in Table 73-2.

Magnitude

Magnitude describes the intensity, or severity of an effect. It is often described as the amount of change in a measurable parameter or variable relative to the baseline condition, guideline value, or other defined standard. Magnitude is assessed for effects to the environment and effects to public safety and health. It is defined as follows:

Magnitude of Effect to the Environment

- No effect: No effect.
- Slight effect: Slight environmental damage - contained within the premises.
- Minor effect: Minor environmental damage.
- Moderate effect: Limited environmental damage that will require cleaning up.
- Major effect: Severe environmental damage that will require extensive measures to restore beneficial uses of the environment.
- Massive effect: Persistent severe environmental damage that will lead to loss of commercial, or recreational use, or loss of natural resources over a wide area.

Table 73-2 Probability and Consequences of Potential Accidents and Malfunctions

Accident or Malfunction	Likelihood of Occurrence	Environmental Consequence				
		Magnitude of Effect to People, the Environment, or Both	Geographic Extent of Effects	Duration of Effects	Reversibility	Environmental Consequence
1. Hydrocarbon storage tank loss of containment with ignition	Extremely Unlikely to Remote	Environment: Minor People: Slight injury or health effect	Regional	Short-term	Reversible	Low
2. Hydrocarbon pipeline loss of containment and spill into watercourse (Athabasca River)	Very Unlikely to Extremely Unlikely	Environment: Major People: no linkage	Regional	Medium-term	Reversible	High
3. Accidental release of solvent to tailings pond	Likely	Environment: Minor People: No injury or health effect	Regional	Short-term	Reversible	Low
4. External tailings disposal area dyke failure	Remote	Environment: Massive People: No effect to slight effect	Beyond regional	Medium-term	Reversible	High
5. Mining pit high-wall failure	Extremely Unlikely	Environment: Moderate People: no linkage	Local	Medium-term	Reversible	Moderate
6. Process upset causing emergency flaring	Likely to Unlikely	Environment: Minor People: No injury or health effect	Regional	Short-term	Reversible	Low
7. Spill from transporting hazardous wastes	Unlikely	Environment: Minor People: No injury or health effect	Local	Short-term	Reversible	Low
8. Migratory birds landing on external tailings disposal areas and becoming oiled	Unlikely	Environment: Minor (for population) People: no linkage	Beyond regional	Short-term	Reversible (for population)	Low

Note: As noted in the May 2011, *Submission of Information to the Joint Review Panel*, Section 3.2, Page 36, the above scenarios are intended to be representative of accidents and malfunctions that may result in a significant impact to the public safety and/or the natural environment. They are not intended to assess the effects of industrial accidents on site.

Magnitude of Effect to Public Safety and Health

- no injury or health effect;
- slight injury or health effect;
- minor injury or health effect;
- major injury or health effect;
- permanent total disability or fatality; and
- more than one fatality.

Geographic Extent

Spatial extent of effects is categorized as follows:

- Internal: Internal to the operational areas of the PRM.
- Local: Effect restricted to the applicable Environmental Impact Assessment (EIA) Local Study Area (LSA).
- Regional: Effect extends beyond the LSA into the applicable EIA Regional Study Area (RSA).
- Beyond Regional: Effect extends beyond the RSA.

Duration

Duration refers to the length of time over which an environmental effect occurs. It is the length of time for an environmental component to recover from the event. Duration of effects is categorized qualitatively as:

- Short term: occurring or persisting under 3 years.
- Medium term: occurring or persisting 3 years to less than 20 years.
- Long term: occurring or persisting over 20 years.

Reversibility

Reversibility indicates the potential for recovery of the ecological end point. An effect is defined as irreversible if the resource element cannot be restored to pre-impact condition within the long-term as defined under duration.

Significance

The Canadian Environmental Assessment Agency (CEAA 2013) states that "deciding whether a project is likely to cause significant adverse environmental effects is central to the concept and practice of environmental assessment". For the purposes of determining environmental significance in this assessment, the concept of the environmental significance is consistent with CEAA's concept of the likely significant adverse environmental effects.

Adverse effects are considered changes in the environment with harmful effects, such as negative effects on health, threats to endangered species, loss of or damage to habitats, or discharges of toxic or persistent chemicals, microbiological agents or nutrients (CEAA 2013). Effects are considered either Adverse or Non-adverse.

The assessment of whether an effect is significant is based on the environmental consequence rating, knowledge of environmental issues in the Athabasca Oil Sands Region, and professional judgement. Adverse effects have been considered either Significant or Insignificant.

Significance ratings for federally-listed species at risk can be determined using two distinct assessment approaches: ecological thresholds and resource management criteria, as described in Appendix 3.1. Using ecological thresholds, adverse effects to federally-listed species at risk may be either 'Significant' or 'Not Significant' depending on environmental consequence, ecological context and professional judgement. Using the resource management criteria approach any adverse effect on federally listed species at risk is Significant; therefore, further discussion in this response regarding the significance of effects to federally listed species is in reference to significance as determined using the ecological threshold approach.

A 'Likely' effect is an adverse environmental effect with a high probability to occur (CEAA 2013). Consideration is given to the likelihood of the scenario resulting in the effect as well as the uncertainty associated with the information used to identify the effect. Significant adverse effects have been considered either Likely or Not Likely based on the likelihood of occurrence information. The likelihood of occurrence ranging from Unlikely to Remote were all designated as Not Likely.

Receptors

The Joint Review Panel (JRP) has requested "an analysis of the environmental effects to sensitive elements of the environment, of all accidents and malfunctions listed in the May 2011 Submission."

For purposes of this response, the term "receptors" will be used to identify these sensitive elements. Based on examples provided in the JRP request, the receptors considered for this response are listed in Table 73-3. These scenarios consider effects off-site that have the potential to impact the public or the natural environment.

Table 73-3 Receptors Considered in Assessing Accidents and Malfunctions for Pierre River Mine

Local Communities and Trapper Cabin Receptors	Culturally Important Features, Natural Sites of Interest, Areas of Major Use and Protected Area Receptors	Federally Listed Species at Risk	Wildlife Key Indicator Resources
Fort McKay Fort Chipewyan Fort McMurray Trapper Cabins	Namur River (IR 174A) Namur Lake (IR 174B) Fort McKay (IR 174,174D) Poplar Point (IR 201G) Public Worker Camps Athabasca River Peace Athabasca Delta Wood Buffalo National Park	Canada warbler common nighthawk horned grebe little brown myotis northern myotis olive-sided flycatcher peregrine falcon red knot rusty blackbird short-eared owl western (boreal) toad whooping crane wolverine (western population) wood bison yellow rail	Canadian toad fisher moose barred owl beaver black bear black-throated green warbler Canada lynx

The effects assessment for receptors identified in Tables 73-4 and 73-5 was conducted as follows:

- For each scenario, a linkage analysis was conducted for:
  - effects on environment and public health (people) for community receptors;
  - effects on habitat and population for Species at Risk and wildlife Key Indicator Resources; and
  - effects on environment for the remaining receptors.
- For valid linkages, potential effects were identified and reported in terms of impact criteria including the magnitude of effects, geographic extent, duration and reversibility.
- For valid linkages, environmental consequence ratings were developed based on the impact criteria values.
- The likelihood of occurrence for each scenario is presented in Table 73-2.

The magnitude of effects ratings for each scenario and receptor are presented in Tables 73-4 and 73-5. Valid linkages present magnitude ratings and individual linkages are indicated. The following sections present a discussion on the potential impacts for each accident or malfunction scenario on the receptors listed in Table 73-3.

Table 73-4 Linkages and Magnitude of Effect for Non-Wildlife Receptors

Accident or Malfunction Scenario	Local Communities and Trapper Cabins				Culturally Important Features, Natural Sites of Interest, Areas of Major Use and Protected Areas							
	Fort McKay	Fort Chipewyan	Fort McMurray	Trapper Cabins	Namur River (IR 174A)	Namur Lake (IR 174B)	Poplar Point (IR 201G)	Fort McKay (IR174, 174D)	Public Worker Camps	Athabasca River	Peace Athabasca Delta	Wood Buffalo National Park
1. Hydrocarbon storage tank loss of containment with ignition	Environment: Minor People: Slight injury or health effect	No linkage	No linkage	Environment: Minor People: Slight injury or health effect	No linkage	No linkage	No linkage	Environment: Minor People: Slight injury or health effect	Environment: Minor People: Slight injury or health effect	Environment: Minor	No linkage	No linkage
2. Hydrocarbon pipeline loss of containment and spill into watercourse (Athabasca River)	No linkage	No linkage	No linkage	No linkage	No linkage	No linkage	No linkage	No linkage	No linkage	Environment: Major	No linkage	No linkage
3. Accidental release of solvent to tailings pond	No linkage	No linkage	No linkage	Environment: Minor People: No injury or health effect	No linkage	No linkage	No linkage	Environment: Minor People: No injury or health effect	Environment: Minor People: No injury or health effect	Environment: Minor	No linkage	No linkage
4. External tailings disposal area dyke failure	No linkage	Environment: No effect to Slight effect People: No injury or health effect	No linkage	No linkage	No linkage	No linkage	No linkage	No linkage	No linkage	Environment: Major	Environment: Moderate	Environment: Moderate
5. Mining pit high-wall failure	No linkage	No linkage	No linkage	No linkage	No linkage	No linkage	No linkage	No linkage	No linkage	No linkage	No linkage	No linkage
6. Process upset causing emergency flaring	No linkage	No linkage	No linkage	Environment: Minor People: No injury or health effect	No linkage	No linkage	No linkage	Environment: Minor People: No injury or health effect	Environment: Minor People: No injury or health effect	Environment: No effect	Environment: Minor People: No injury or health effect	No linkage
7. Spill from transporting hazardous wastes	No linkage	Environment: Slight People: No injury or health effect	No linkage	No linkage	No linkage	No linkage	No linkage	No linkage	No linkage	Environment: Minor	Environment: Slight	Environment: Slight
8. Migratory birds landing on external tailings disposal areas and becoming oiled	No linkage	No linkage	No linkage	No linkage	No linkage	No linkage	No linkage	No linkage	No linkage	No linkage	No linkage	No linkage

Notes: “No effect” is defined as no measurable effect.

As noted in the *May 2011, Submission of Information to the Joint Review* Panel, Section 3.2, Page 36, the above scenarios are intended to be representative of accidents and malfunctions that may result in a significant impact to the public safety and/or the natural environment. They are not intended to assess the effects of industrial accidents on site.

Table 73-5 Linkages and Magnitude of Effect for Wildlife Receptors

Accident or Malfunction	Federally Listed Species at Risk													
	Canada Warbler	Common Nighthawk	Horned Grebe	Little Brown Myotis And Northern Myotis	Olive-Sided Flycatcher	Peregrine Falcon	Red Knot	Rusty Blackbird	Short-Eared Owl	Western (Boreal) Toad	Whooping Crane	Wolverine (Western Population)	Wood Bison	Yellow Rail
1. Hydrocarbon storage tank loss of containment with ignition	Habitat: Minor Population: No effect	Habitat: Minor Population: No effect	Habitat: Minor Population: No effect	Habitat: Minor Population: No effect	Habitat: Minor Population: No effect	Habitat: Minor Population: No effect	Habitat: Minor Population: No effect	Habitat: Minor Population: No effect	Habitat: Minor Population: No effect	Habitat: Minor Population: No effect	Habitat: Minor Population: No effect	Habitat: Minor Population: No effect	Habitat: Minor Population: No effect	Habitat: Minor Population: No effect
2. Hydrocarbon pipeline loss of containment and spill into watercourse (Athabasca River)	No linkage	No linkage	Habitat: Major Population: No effect	No linkage	No linkage	No linkage	No linkage	No linkage	No linkage	Habitat: Major Population: No effect	No linkage	No linkage	No linkage	No linkage
3. Accidental release of solvent to tailings pond	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect
4. External tailings disposal area dyke failure	Habitat: Massive Population: No effect	Habitat: Massive Population: No effect	Habitat: Massive Population: No effect	Habitat: Massive Population: No effect	Habitat: Massive Population: No effect	Habitat: Massive Population: No effect	Habitat: Massive Population: No effect	Habitat: Massive Population: No effect	Habitat: Massive Population: No effect	Habitat: Massive Population: No effect	Habitat: Massive Population: No effect	Habitat: Massive Population: No effect	Habitat: Massive Population: No effect	Habitat: Massive Population: No effect
5. Mining pit high-wall failure	No linkage	No linkage	Habitat: Moderate Population: No effect	No linkage	No linkage	No linkage	No linkage	No linkage	No linkage	Habitat: Moderate Population: No effect	No linkage	No linkage	No linkage	No linkage
6. Process upset causing emergency flaring	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect
7. Spill from transporting hazardous wastes	Habitat: Minor Population: No effect	Habitat: Minor Population: No effect	Habitat: Minor Population: No effect	Habitat: Minor Population: No effect	No linkage	No linkage	No linkage	No linkage	Habitat: Minor Population: No effect	Habitat: Minor Population: No effect	No linkage	Habitat: Minor Population: No effect	No linkage	No linkage
8. Migratory birds landing on external tailings disposal areas and becoming oiled	No linkage	No linkage	Habitat: No effect Population: Slight	No linkage	No linkage	No linkage	Habitat: No effect Population: Slight	Habitat: No effect Population: Slight	No linkage	No linkage	Habitat: No effect Population: Minor	No linkage	No linkage	Habitat: No effect Population: Slight

Table 73-5 Linkages and Magnitude of Effect for Wildlife Receptors (continued)

Accident or Malfunction	Wildlife Key Indicator Resources							
	Canadian Toad	Fisher	Moose	Barred Owl	Beaver	Black Bear	Black-Throated Green Warbler	Canada Lynx
1. Hydrocarbon storage tank loss of containment with ignition	Habitat: Minor Population: No effect	Habitat: Minor Population: No effect	Habitat: Minor Population: No effect	Habitat: Minor Population: No effect	Habitat: Minor Population: No effect	Habitat: Minor Population: No effect	Habitat: Minor Population: No effect	Habitat: Minor Population: No effect
2. Hydrocarbon pipeline loss of containment and spill into watercourse (Athabasca River)	Habitat: Major Population: No effect	No linkage	No linkage	No linkage	Habitat: Major Population: No effect	No linkage	No linkage	No linkage
3. Accidental release of solvent to tailings pond	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect
4. External tailings disposal area dyke failure	Habitat: Massive Population: No effect	Habitat: Massive Population: No effect	Habitat: Massive Population: No effect	Habitat: Massive Population: No effect	Habitat: Massive Population: No effect	Habitat: Massive Population: No effect	Habitat: Massive Population: No effect	Habitat: Massive Population: No effect
5. Mining pit high-wall failure	Habitat: Moderate Population: No effect	No linkage	No linkage	No linkage	Habitat: Moderate Population: No effect	No linkage	No linkage	No linkage
6. Process upset causing emergency flaring	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect	Habitat: No effect Population: No effect
7. Spill from transporting hazardous wastes	Habitat: Minor Population: No effect	Habitat: Minor Population: No effect	Habitat: Minor Population: No effect	Habitat: Minor Population: No effect	Habitat: Minor Population: No effect	Habitat: Minor Population: No effect	Habitat: Minor Population: No effect	Habitat: Minor Population: No effect
8. Migratory birds landing on external tailings disposal areas and becoming oiled	No linkage	No linkage	No linkage	No linkage	No linkage	No linkage	No Linkage	No linkage

Note: Based on the ecological threshold assessment approach to significance determination.

Hydrocarbon Releases (Scenarios 1 and 2)

The management of hydrocarbons and chemicals is integral to the operation of an oil sands processing facility. Large quantities of bitumen recovered from oil sands and the light hydrocarbon (paraffinic solvent) used in the froth treatment process to dilute and transport the bitumen will be stored and handled within the boundaries of the approved facility. Other chemicals used from time to time in the recovery of the bitumen from oil sands may also be stored and handled within the bitumen recovery facilities. Accidents due to the failure of a pipeline, tank and/or other storage vessel, or a malfunction (process upset) can cause inadvertent release of such hydrocarbons to the localized external environment.

The principal controls for preventing an inadvertent release of hydrocarbons relate to the design of the plant facilities, the operating procedures, the physical integrity of the process components and the process safety management systems in place to control changes to the facility and process. The accident and malfunction scenarios related to hydrocarbon release are assessed as Scenario 1 and 2.

Scenario 1 Hydrocarbon Storage Tank Loss of Containment With Ignition

Loss of hydrocarbon containment at a storage tank could result in either an un-ignited release (into the surrounding berm area, the plant area or the atmosphere), an ignited release (tank or pump fire), or an internal tank explosion. Along with standard practices and regulations for constructing and operating storage tanks, special consideration is given to the location of the tanks. These tanks are located within the operating complex where the area is restricted from the public, within a closed-circuit drainage system, and appropriate setback from residents and primary watercourses. It is extremely unlikely an incident would occur which would have an impact on public safety and/or the surrounding environment.

Risks and Mitigations

The potential for loss of hydrocarbon containment at a storage tank can occur due to: liquid overfill; vapour overpressure; pump seal failures; corrosion; failure of connections such as flanges, gaskets, hoses, flexes, or screwed connections; drains/bleeders left open; or improper ventilation or failure of the internal components such as mixer seal failure, floating roof inadvertent landing or hold-up.

For hydrocarbon storage tanks, Shell incorporates the following where appropriate to prevent or mitigate the effects of a major loss of containment:

- thorough detailed engineering design for tank design, material selection and layout;
- containment dyke with an impermeable liner and volume capacity equivalent to 110% of a single tank, and area road/ditches that provide further containment (in the event of a breached dyke);
- fixed foam systems on tanks to minimize the chance of ignition;

- installation of mobile water cannons/fire foam cannons and high capacity hydrants to fight fires;
- motor-operated valves with relief valves;
- caps on foundations with corrosion prevention to ensure the tank remains stable/level;
- perimeter fencing to keep out wildlife and uncontrolled personnel;
- appropriate process control systems that include instrumentation and alarms, automatic trips and isolation systems;
- operating procedures for routine visual inspections and checks, start-up and shutdown;
- Pressure Equipment Integrity Management Program for corrosion (surveys, cleaning, maintenance);
- ignition control – removal of potential sources of ignition such as open flames, control rate of filling to prevent static buildup, tank and floating roof grounding/bonding to eliminate static electricity, design temperature and vapour space for auto ignition;
- installation of gas detection equipment to alert operator response; and
- automatic levee pump out system with no open gravity drains.

In particular, solvent and diluted bitumen tanks have an internal carbon steel floating roof to keep the level of hydrocarbon evaporation low and the vapour space within the tank below the lower explosive limit. The tanks also contain a foam delivery system piped in from the surrounding dyke to a rim seal foam injection system that can be used to extinguish rim seal fires from inside the tank. Should the tank surface become fully involved in flames, foam would be applied to the tank using cannons to deliver foam over the external wall of the tank.

For the environmental impact analysis, Shell selected a diluted bitumen fire resulting from the collapse of a storage tank due to improper ventilation because it would result in the largest loss of primary containment. Shell selected diluted bitumen material for the impact analysis because it has both light and heavy hydrocarbon components that provide different effects on the external environment. A loss of primary containment from a hydrocarbon storage tank has happened in industry, but the likelihood of occurrence for this scenario is considered extremely unlikely to remote due to the mitigation measures that Shell employs.

Response Measures

A loss of containment from a storage tank is evident to operating personnel via alarms on an unexpected change in fluid level and/or pressure in the tank and would be visually confirmed by Operations. Emergency response plans would be initiated to isolate, stop and control the release of the hydrocarbon. Any additional or related plant piping/equipment would be shutdown, isolated and depressurized. The foam suppression system would be engaged to minimize the chance of ignition. If the hydrocarbon within the tank ignites, either of the following responses would be taken:

- workers would assume a safe observation position and allow the hydrocarbon to burn out in a controlled manner; or
- an emergency response team would actively fight the fire through the use of mobile firefighting equipment, foam cannons, and firewater application to cool adjacent tanks, equipment and structures.

For a large hydrocarbon release, Shell may call on external specialized support services that exist through the Mutual Aid Partner arrangement in place between the existing oil sand operating companies. When necessary, downstream residential communities would be notified via the emergency response call out system located in the emergency response command centre.

Potential Impacts

For the hydrocarbon storage tank loss of containment scenario, linkages were identified for all receptors in Tables 73-4 and 73-5 with the exception of: Fort Chipewyan, Fort McMurray, Namur River, Namur Lake, Poplar Point, Peace-Athabasca Delta, and Wood Buffalo National Park. The magnitude of effects on the environment for a storage tank loss of containment and ignition at affected receptors would be minor, and the magnitude of the health effects to people at Fort McKay, Trapper Cabins, Fort McKay and Public Worker Camps may be slight injury or health effects as the smoke plume would cause noticeable discomfort and/or minor respiratory irritation. The effect on wildlife habitat would be minor. Individuals from a wildlife species that may be near the hydrocarbon release at the time of the event may experience health effects but there would be no measurable effect on the population of the species. The extent of effects would be regional, with its duration being short-term and fully reversible.

Based on these results, the highest environmental consequence for a hydrocarbon storage tank loss of containment for any receptor is low. The likelihood of occurrence for this scenario is extremely unlikely to remote (Table 73-2).

The effects of this scenario are adverse, minor and not likely. Therefore, this scenario is not likely to result in any significant adverse environmental effect.

Scenario 2 Hydrocarbon Pipeline Loss of Containment and Spill Into Watercourse (Athabasca River)

The following provides information on general pipeline design and monitoring, followed by an analysis of the impacts of a failure on one of three pipelines crossing the Athabasca River.

Risks and Mitigations

Three 915-mm-diameter process pipelines will be suspended under the PRM Athabasca River bridge and will tie into diluted bitumen and solvent return pipelines in the Corridor pipeline system which transports the products to Shell's Scotford Upgrader. A pipeline leak may occur as a result of corrosion, erosion, vibration/thermal stress, mechanical connection failure, contact with mobile equipment, plugging, over pressure, improper design/installation, or sabotage. Shell follows rigorous engineering, installation and operating guidelines for all major pipeline installations to manage these risks. These guidelines cover:

- pipe design (thickness, connections, bends, heat tracing, insulation);
- material selection (temperature and pressure parameters, internal coating requirements, corrosion/erosion allowance);
- pressure equipment integrity management programs;
- secondary containment casing when appropriate; and
- instrumentation requirements used for monitoring, alarms, and system interlocks.

Hydrocarbon pipelines have leak detection systems that include material balances with differential alarms and additional leak detection instrumentation at river crossings. Where appropriate for large-diameter pipelines, internal inspection with mobile pipeline inspection equipment may be employed. Operating procedures are implemented to cover the start-up, operation and shutdown of each pipeline. These procedures also include a management of change process to control the effects of changing operating parameters or material characteristics.

Shell will ensure that the design and construction of the pipeline crossing includes suitable containment of fluids if a rupture occurs. The design for the pipeline river crossing has not been completed. Therefore, details on emergency containment are not currently available. The design process will incorporate a review of other similar pipeline crossings of the Athabasca River, and will be subject to a Hazards and Effects Management Process review. The design will consider such features as leak detection, emergency shutoff and secondary containment.

The detailed design has not been completed for this installation. However, during engineering and design, careful consideration will be given to specifying a suitable double-wall pipe configuration, fittings, and other materials and equipment to maximize the integrity and reliability of the river crossing. In addition:

- a physical integrity and inspection program will be conducted before commissioning, and then regularly during the operating life of the pipelines;
- the pipelines will be checked routinely for any signs of integrity issues, consistent with the specified use; and

- a cathodic protection system will be considered for each of the pipelines.

The emergency response procedures will have a spill contingency plan, including:

- isolating the source of the spill;
- spill containment and recovery;
- sampling;
- notifications; and
- mutual aid and area spill co-operative resources will be available and used, if required.

The design of the pipeline facilities will minimize the possibility of a spill occurring. In the unlikely event of a spill reaching the Athabasca River, mitigation will include:

- using booms to recover the oil spill;
- removing the spill mechanically if the spill is on ice;
- cleaning up the spill, as appropriate; and
- sampling river water.

Response Measures

In the event of a hydrocarbon pipeline failure (leak, over pressure), a vapour cloud, flash fire, pool fire, or un-ignited liquid spill could occur. To mitigate the effects of such a release and the associated consequences, pipeline design features will include safety features such as:

- isolation points (including remote operated isolation);
- back flow protection (check valves);
- emergency shutdown systems;
- fixed monitors (deluge systems and fixed foam systems);
- fire hydrants;
- fireproofing of support structures;
- hydrocarbon and fire detectors; and
- pressure relief systems (venting at a safe location, thermal relief, and flare).

Operations in conjunction with an emergency response team would assess the situation and employ the necessary controls to stop the release and mitigate any impacts on personnel safety, the natural environment and further asset damage.

The following scenario evaluates a diluted bitumen pipeline release over the Athabasca River. This release could be due either to severe undetected corrosion or a high impact on the line resulting in the contents of the pipeline section being released into or near the river. If this were to occur, the pipeline leak detection system would alert Shell's operations to the spill. Shut off valves would then be automatically closed to limit the extent of the spill to a relatively small section of pipe, and an emergency response crew would deploy containment equipment downstream to prevent the spill from travelling further. The first access point for containment would likely be the river access road where crews would deploy an angled boom across the river to collect oil at the beach with oil skimmers and vacuum trucks. A water sampling program would be initiated in the river to track the progress of the spill, with further booms deployed as required. The appropriate government agencies would be immediately informed. Stakeholders downstream would also be advised as necessary of any potential impacts.

A loss of containment from a pipeline has been heard of in the industry; however, the likelihood of occurrence for the pipeline to fail at the river crossing as described is considered very unlikely to extremely unlikely.

Potential Impacts

The extent of effects would be regional for the pipeline loss of containment scenario. It is anticipated that the diluent would flash off and the heavier bitumen would eventually drop out to the river bed and along the shores of the river. The duration of effects would be medium-term and reversible. Linkages were identified for the following receptors: Athabasca River, horned grebe, western (boreal) toad, Canadian toad, and beaver. The magnitude of effects on the environment for the pipeline loss of containment would be major as environmental effects may require extensive measures to remediate, and a loss of natural resources over a wide area could occur. Further downstream, environmental effects would be minor. The effect on wildlife habitat within the watercourses is major in magnitude. Individuals from a species that may be in the affected watercourses at the time of the event may experience health effects but there would be no effect on the population of the species. The duration of effects would be medium-term and reversible.

Based on these results, the highest environmental consequence for a receptor resulting from a pipeline loss of containment for any receptor is high. The likelihood of occurrence for this scenario remains very unlikely to extremely unlikely (Table 73-2).

The effects of this scenario are adverse, major but very unlikely to extremely unlikely. Therefore, this scenario is not likely to result in any significant adverse environmental effect.

Scenario 3 Accidental Release of Solvent to Tailings Pond

The Tailings Solvent Recovery Unit (TSRU) treats the underflow tailings stream from the second stage settler of the high-temperature froth treatment unit. The TSRU consists of a two-stage separation process designed to recover paraffinic solvent such that an overall site loss of solvent is minimized and within the regulatory requirement of less than 4 volumes of solvent for 1,000 volumes of bitumen produced per year. The majority of the solvent loss occurs in the tailings discharge stream sent to the tailings ponds. The TSRU tailings discharge stream consists of mineral solids, asphaltene and unrecovered paraffinic solvent. An accident or malfunction in the TSRU complex could cause excessive losses of solvent to the tailings pond.

Risks and Mitigations

Process upsets and mechanical failures have the potential to reduce the recovery of solvent from the TSRU discharge stream. For example, if the TSRU heater failed due to erosion or plugging, the amount of solvent that flashes off the tailings stream is reduced resulting in higher level of solvent released to the tailings pond. For the impact analysis, Shell considered a malfunction where the TSRU heater fails and for a period of up to 30 minutes (until the backup heater is started up) the recovery of the solvent is reduced.

Shell has had occurrences of reduced solvent recovery in the past; however, corrective actions have been made that have reduced the frequency. The likelihood of occurrence for the scenario provided is still likely as it could occur several times over the life of the PRM.

Response Measures

Shell is committed to managing the TSRU process within the prescribed solvent loss limit and ensuring that untreated TSRU tailings are not directed to the tailings pond. Should a process malfunction occur there would be indications of an abnormal process condition such as steam flow changes and reduced TSRU operating temperatures. These changes would indicate an operational malfunction within the TSRU and the potential for higher levels of paraffinic solvent potentially being discharged to the tailings pond. A field operator would be dispatched to assess whether the operating malfunction is minor and could be rectified while operations continue (i.e., switch to the backup heater), or of a major concern that requires immediate shut down of the process unit. For worker protection an exclusion zone around the TSRU discharge may be implemented requiring atmospheric gas testing and safe conditions before entry. Atmospheric monitoring may be installed within the plant area to measure any air quality effects that may result from the operational malfunction.

Potential Impacts

For this scenario, linkages were identified for the following receptors in Table 73-4: Trapper Cabins, Fort McKay, Public Worker Camps, Athabasca River, and all wildlife receptors (Table 73-5). The magnitude of effects on the environment from an excess release of solvent to the tailings pond would be minor. The magnitude of effects for public health would be no injury or health effect, because past quantitative analysis (i.e., Muskeg River Mine Expansion) has indicated that predicted ground-level air concentrations of Volatile Organic Compounds (VOCs) associated with this type of event will not materially change the conclusions of the Human Health Risk Assessment. For wildlife receptors, there would be no effect on habitat or the population. The extent of the effects could be regional, while its duration would be short-term and reversible.

Based on these results, the highest environmental consequence for a receptor for an accidental release of solvent to tailings pond is low. The likelihood of occurrence for this scenario is likely. The effects of this scenario are adverse, minor and likely. Therefore, this scenario is not likely to result in any significant adverse environmental effect.

Scenario 4 External Tailings Disposal Area Dyke Failure

During the initial years of mine operation, tailings disposal areas external to the mining area will be constructed to contain process-affected water and tailings generated from the bitumen extraction process. A failure of a tailings containment dyke could impact the natural environment and lead to personal injury or on-site fatality resulting from the release of water and mineral solids slurry.

Risks and Mitigations

The potential causes of a dyke failing include: an internal failure of the beached tailings, seismic activity, overtopping of contained water, or sabotage. These events are considered remote because mitigation measures and operational barriers are implemented throughout the design, monitoring and testing of these structures as described below.

External Tailings Disposal Areas (ETDA) are designed and constructed using conservative engineering practices that meet or exceed oil sand standards of practice and in accordance with Provincial Dam Safety Guidelines with an end construction safety factor of 1.3. Exploratory drilling and geophysical (seismic) survey is conducted to determine the nature and stability of the dyke foundation material. The containment dykes are then designed and constructed according to existing foundation materials; if unsuitable materials are present, these will be removed before the containment dyke is constructed. To provide a solid foundation and minimize the possibility of seepage through the foundation, where required, the overburden is stripped back to establish a foundation of known geo-technical stability. Each dyke is built upon a starter dyke comprised of compacted materials, with dyke fill added in a staged manner during cell construction.

Design criteria also account for the possibility of seismic activity over the lifetime of the structure. Although the occurrence of seismic activity in this area is believed to be low, the level of seismic hazard (both local and distant events) is routinely reviewed by participation in industry working groups.

To ensure that the ETDA is meeting design expectations, regular monitoring and interpretation of performance will be carried out to confirm that the design conditions are met and, if not, to undertake corrective measures as required. Operations personnel regularly monitor the tailings ponds and dykes and will notify the geotechnical engineer of any deviations that may be observed during events such as:

- monitoring the water table with standpipe piezometers in dykes and foundations to indicate dyke stability;
- monitoring slope inclinometers for discrete soil movements which may indicate instability;
- visual inspection of general dyke condition (e.g., toe deformation, erosion, cracking, bulging);
- monitoring of pond water levels and freeboard (minimum 3 m) to prevent overtopping; and
- monitoring of exit flows from drains for volumes, water quality, suspended sediments and water chemistry.

The geotechnical design, construction and performance of the ETDA will be reviewed every 6 months by independent third-party experts and Shell. The process of constructing, operating, monitoring, review and implementation of corrective actions form a cycle of continuous improvement annually and throughout the life of the facility. By taking these measures, any failure of the tailings containment dyke is considered remote.

Response Measures

To comply with the *Alberta Public Safety Services Act*, the *Disaster Services Ac*t and the Alberta *Water Act*, Water (Ministerial) Regulation, Part 6 – Dam and Canal Safety Guidelines, Shell has developed an emergency response system that provides:

- internal emergency response chain of command;
- external emergency response chain of command to stakeholders in the region;
- notification by Shell to agencies responsible for public emergencies and safety; and
- mobilization of emergency response teams, evacuation of workers, and activation of the Shell crisis response command centres.

In the remote event the integrity of the dyke is compromised, Shell would take immediate actions to:

- secure the immediate area and ensure workers are accounted for and safe;
- initiate the Incident Command System at the appropriate level of response according to the Emergency Response Plan;
- divert flows away from ETDA and/or a shutdown of tailings production at the discretion of the Incident Commander;

- request regional and mutual aid support if an assessment of the situation reveals that response capabilities beyond those available at site are required;
- initiate remedial works as appropriate (e.g., pumping out of ponds, repairs/shoring up the dykes); and
- ensure remedial works are conducted in a responsible manner.

Dam failures have occurred in the general mining industry, but have not occurred in the oil sands industry. The likelihood of occurrence is considered remote because the event, while physically possible, has never happened in the oil sands industry in a period of 20 to 30 years. Tailings disposal areas in the oil sands region are recognized to be designed and operated to meet some of the most conservative criteria in the mining industry.

Potential Impacts

For the ETDA dyke failure scenario, potential linkages were identified for Fort Chipewyan, Athabasca River, the Peace-Athabasca Delta, Wood Buffalo National Park and all wildlife receptors. In the remote event that this scenario occurs, the direction of the dyke failure would determine which of the identified receptors would actually be affected. The magnitude of effects on the environment from an ETDA dyke failure would be massive to watercourses, waterbodies and wildlife habitat in the vicinity of the ETDA as there would be persistent, severe environmental effects that could lead to loss of commercial or recreational use and loss of natural resources over a wide area. Further downstream from the PRM site, the environmental effects would decrease with distance. Individuals from a species that may be in the vicinity of the ETDA at the time of the event may experience health effects but there would be no effect on the population of the species. The extent of effects would be beyond regional. The duration of effects would be medium-term and reversible.

Based on these results, the highest environmental consequence for a receptor as a result of an ETDA dyke failure is high. The likelihood of occurrence for this scenario is remote. The effects of this scenario are adverse, massive but remote. Therefore, this scenario is not likely to result in any significant adverse environmental effect.

Scenario 5 Mining Pit High-Wall Failure

Shell’s tailings facilities and major earth structures (dams, disposal areas, pit walls) at the mine are managed according to the Mining Association of Canada guidelines and Alberta Environment and Sustainable Resource Development Dam Safety requirements. Shell applies the following preventative barriers to each of these structures to prevent an accident or malfunction:

- staged site investigations to provide reliable design input;
- geotechnical designs by qualified professionals that meet or exceed oil sands industry standards of practice;

- instrumentation plans and reading schedules to address potential failure modes and performance of the structure;
- regular inspections;
- a quality assurance and control program for monitoring construction activities;
- monthly summaries and review of construction and instrumentation performance;
- annual review/audit by independent engineering experts;
- annual review by the regulator(s);
- annual review with Shell senior management; and
- identification of and implementation of corrective actions.

The above constitutes a safety framework for all major earth structures that ensures continuous improvement and structure safety.

Truck and shovel mining results in high-walls of overburden and oil sands which exposes workers and equipment to potential hazards. The integrity and stability of these walls is critical to a safe mine operation. Therefore, overall slope angles for pit walls are designed based on a minimum safety factor of 1.2. Safety factors for setbacks to critical structures (i.e., plant site facilities, waste dumps, rivers and tailings dams) are set higher (1.3 to 1.5) due to the greater potential consequences of failure.

Risks and Mitigations

A high-wall failure can potentially cause injuries, on-site fatalities, equipment damage, and/or production interruption within the mine-pit area but it is extremely unlikely that any failure would affect the external natural environment. Shell maintains setbacks from roads, infrastructure, non-mineable lease boundaries and watercourses to mitigate the consequences of environmental impact and any potential crest instability. Based on geology, potential failure modes are used to determine the stability for the overall pit wall angles. Other modes of failure such as local bench-scale block movements and sloughing in rich ore zones could potentially occur and will be addressed on an operational basis.

Shell manages these risks with:

- increased operational drilling and design updates;
- proper engineering design of mine workings using conservative and best engineering practices;
- training and competency of shovel operators;
- continuous monitoring of face stability by mine geologists;
- core sampling in advance of the mine face to identify high clay areas which may be unstable;

- limiting high-wall height; and
- mine excavation work practices.

Response Measures

The above practices during operation of the mine reduce the likelihood of high wall failures such that they are typically localized (i.e., less than 500,000 bank cubic metres) and are cleaned up using existing mining equipment.

High-wall mine pit failures have occurred in the industry; localized bench movements occur often, but with low impact. Large failures have not occurred in the oil sands industry, although they have in the general mining industry. The likelihood of occurrence is physically possible but is extremely unlikely to cause an impact to the external natural environment. In the event offsite impacts were to occur, Shell would work with the appropriate agencies and lease owner to determine appropriate remedial actions.

Potential Impacts

The magnitude of effects to the environment for a high-wall mine pit failure would be moderate if the failure occurs on the periphery of the mine and there is an observed off-site effect or damage. The extent of effects would be local. The duration of effects for a large failure would be medium-term and reversible.

Linkages were identified for horned grebe, western (boreal) toad, Canadian toad and beaver for this scenario. The magnitude of effects to the environment for a high-wall mine pit failure would be moderate if the failure occurs on the periphery of the mine and there is an observed off-site effect or damage. For wildlife receptors, the effect on habitat would be moderate, if the area where the event occurs contains habitat. There would be no effect on the species' populations. The extent of effects would be local. The duration of effects for a large failure would be medium-term and reversible.

Based on these results, the highest environmental consequence for a receptor for a high-wall mine pit failure is moderate, The likelihood of occurrence for this scenario is extremely unlikely. The effects of this scenario are adverse, moderate and extremely unlikely. Therefore, this scenario is not likely to result in any significant adverse environmental effect.

Scenario 6 Process Upset Causing Emergency Flaring

Continuous flaring will not be used at PRM. Flaring may be used as a mitigation to safely dispose of process gas during upset events or during plant start-up and shutdown. This specific scenario considers the impacts from the flare when a major process upset requires emergency flaring. During an emergency flaring event, there will be increased air emissions released from the flare stacks into the atmosphere.

Risks and Mitigations

For the design of the flare system, all potential overpressure scenarios are considered and their relief loads calculated. The scenario that results in the largest relief load becomes the design case and this sets the diameter and height of the flare stack. The height is determined such that under the worst-case scenario the radiant heat from the flare does not exceed the maximum permissible at grade. Line of sight surveys are also conducted to minimize the visual impact to neighboring communities.

The relief and blow down system will collect and dispose of solvent vapours that might be generated during a process upset, or during a plant start-up or shut down. The system will consist of a flare gas collection system and a low-pressure elevated flare, and will accommodate loads from froth treatment, the Sulphur Recovery Unit (SRU) and the Tailings Solvent Recovery Unit (TSRU).

Flaring will be minimized for the PRM and will only occur in limited situations, such as for upset and emergency conditions, start-up and decommissioning. Flaring would last approximately 15 minutes per event. The increased emissions would be released from the flare stack into the atmosphere. These releases are discussed in the EIA, Appendix 3-8, Section 4.1.

The scenario considered was a loss of recycle cooling water which affects operation of the froth treatment, the SRU and the TSRU. In this case, all solvent vapours would be sent to the flare. This event has occurred within Shell and the likelihood of occurrence for this event was rated to be likely to unlikely, estimating once in 11 years (EIA, Appendix 3-8, Section 4.1). It therefore could happen several times over the plant's lifetime.

Response Measures

Emergency flaring is the response measure for incidents that have the potential to overpressure equipment such as a fire or the failure of a pump or valve, or loss of cooling. As the pressure rises, relief valves open sending hydrocarbons to the flare. This flaring maintains the pressure below the maximum allowable working pressure of the vessels and pipes. For most scenarios, there are instrumented protection systems built into the control logic to prevent the pressure from rising to the point where flaring becomes necessary. This response measure often involves initiating a controlled shutdown of the unit. Should these systems fail to prevent the overpressure situation, flaring will occur until the plant can be brought back under control. Flaring incidents are recorded and reported as required.

Potential Impacts

For the process upset causing an emergency flaring scenario, linkages were identified for the following receptors: trapper cabins, Fort McKay, public worker camps, Athabasca River and all wildlife receptors listed in Table 73-5. The magnitude of effects to the environment from emergency flaring are rated minor, because there are no sulphur compounds in the flare gas and the increase in emissions is expected to be minor. The magnitude of effects to people will be no injury or health effect because emergency flaring will not result in any increases in ambient SO_2 or H_2S concentrations since there are no sulphur compounds in the flare gas. For wildlife receptors, there would be no effect on habitat or the population. The extent of effects is regional. The duration of effects will be short-term, because the flare would only last 15 minutes, after which the emissions would cease. Any related effects will be reversible, because once the flaring has stopped the emissions would cease.

Based on these results, the highest environmental consequence for a receptor for the process upset causing emergency flaring scenario is low. The likelihood of occurrence for this scenario is likely to unlikely. The effects of this scenario are adverse, minor but likely. Therefore, this scenario is not likely to result in any significant adverse environmental effect.

Scenario 7 Spill from Transporting Hazardous Wastes

The PRM will result in an increased amount of waste generated and as a result, will increase the amount of hazardous waste transported to/from the site. The PRM will also result in an increased amount of traffic, particularly along Highway 63 between Fort McMurray and the PRM site. An accident could occur that involves passenger vehicles, buses carrying site personnel, transport trucks carrying heavy equipment and/or hazardous goods. The potential exists that people may be seriously injured in a traffic accident and/or an environmental spill may occur should a transport truck be involved.

Risks and Mitigations

A vehicle accident may occur as a result of any one or combination of the following causes:

- vehicle failure (or inadequate for conditions and purpose);
- poor road surfaces (pot holes, uneven surface, sharp bends);
- major weather storms (poor visibility, icy surface);
- obstructions on the road (fallen loads, wildlife); and
- driver errors (speeding, inattention, fatigue).

Measures to prevent and/or mitigate accidents include proper engineering design of roads, ongoing driver training of contractors and staff, equipment maintenance, appropriate road surfacing and clearing, the use of personal protective devices (seat belts, air bags), safe work practices (bus transportation, driver training), appropriate timing of journeys to reduce traffic volumes, and encouragement of staff interventions on unsafe practices.

As described in the EIA, Volume 1, Socio-economic Impact Assessment Summary, Section 18.3, page 18-2D, the key transportation-related mitigation initiatives that will be undertaken to reduce potential impacts of increased highway traffic include:

- Use of the Shell Albian Sands Aerodrome as the primary point of entry and departure for construction workers associated with the PRM. This initiative will reduce the amount of related personnel road travel between the PRM site and Fort McMurray as well as the amount of vehicular traffic between Fort McMurray and other areas, particularly Edmonton.
- Ensuring the Albian Sands Village and any additional construction camps have appropriate facilities to reduce the need for construction workers to travel to Fort McMurray during their active shift period.
- A combination of aircraft and bus transportation will be implemented to move operations personnel to and from the PRM area. Scheduling the movement of wide loads and heavy construction traffic to off-peak hours; i.e., those times when site personnel are not being transported to and from the various project sites at shift changes.
- The strict enforcement of drug and alcohol restrictive policies for contractors and employees.
- Working with the local RCMP detachment in Fort McKay to assist in resolving regionally based Project-related impacts.
- The implementation of driver safety training for employees and the evaluation of contractor's driver safety programs to increase safety awareness and improve driving competency. Driver safety training will be mandatory for new employees expected to drive vehicles as part of their work duties. Contractors will be expected to comply with Shell safety policy standards with respect to the safe operation of road vehicles.
- Continuing to work with other operating companies, developers and the Regional Municipality of Wood Buffalo (RMWB) to address transportation issues that are outside Shell's direct control.

Third-party contractors will be responsible for transporting materials to the PRM site as well as removing hazardous waste. Shell's contractor selection criteria and performance monitoring requires strict compliance to transportation of hazardous goods standards, and will include the following:

- Requirements under the *Transportation of Dangerous Goods Act 1992* and the associated Regulations.
- Access protocols for all vehicles and personnel entering the PRM site.
- The provision of Workplace Hazardous Materials Information System (WHMIS) training to all those personnel on site who are required to identify, label and use hazardous materials.

- Emergency response training that will include Hazardous Material (HAZMAT).
- Training and use of equipment.

For the impact assessment, Shell considered a spill of waste oil from a transport truck due to a collision. Traffic accidents while transporting hazardous materials have happened in the industry but the likelihood of a spill of hazardous material is considered unlikely.

Response Measures

Shell has on-site medical facilities staffed with trained professionals capable of assessing the medical condition of personnel involved in vehicle accidents. The staff will be able to attend to minor medical issues with on-site ambulance transportation available to take injured personnel to the regional hospital facilities in Fort McMurray. Helicopter transportation of impacted personnel to Fort McMurray, or if necessary, Edmonton will also be on call for critical situations.

Shell also has an onsite response team trained to assess and handle hazardous spill incidents. Should the situation require capabilities over and above that available on site, external support will be available through the following:

- Mutual assistance agreements with Syncrude Canada Ltd., Suncor Energy Inc., Canadian Natural Resources Limited and the Regional Municipality of Wood Buffalo (RMWB) to provide equipment and operators for emergency response.
- The regional Area Y Oil Spill Co-operative involving all active oil sands operators, pipeline operators and the RMWB.

For the offsite case described above, Shell may also be involved in the emergency response through the Mutual Aid agreement. Resources for these incidents are requested and coordinated through the Wood Buffalo Emergency Coordination Centre.

When responding to a hazardous spill, efforts to minimize environmental impacts may include:

- stopping the flow of the product from the source;
- eliminating ignition sources and any open flame within an appropriate area around the spill;
- containing the flow of released hazardous material through such actions as constructing a dyke with earth or other impervious barrier, blocking any entry to waterways, construction of an interceptor trench or underflow dam;
- flagging off or, by other means, isolating the spill area;
- if the spill has reached a natural waterbody, deployment of a containment boom to contain the spilled material and if required, the application of oil sorbent materials;

- spill cleanup using adsorbents and removing contaminated soils/snow for disposal at an approved disposal site; and
- use of a vacuum truck to remove any free fluids and transport them to an approved disposal site.

Potential Impacts

For the spill from transporting hazardous waste scenario, the event was assumed to occur along Highway 63 north of the Peter Lougheed Bridge and south of Canterra Road. Linkages were identified for Fort Chipewyan, Athabasca River, Peace-Athabasca Delta, Wood Buffalo National Park, and all wildlife receptors except olive-sided flycatcher, peregrine falcon, red knot, rusty blackbird, whooping crane, wood bison and yellow rail. The magnitude of effects to the environment for traffic accidents while transporting hazardous materials would be minor because this would be a small spill off-site that could travel the approximately 1 km distance to the Athabasca River. Further downstream, the environmental effects would be reduced. Wildlife habitat in the vicinity of the spill could be affected but there would be no effect on species populations. The extent of effects would be local. The duration of effects is short-term because it is a relatively small volume so if it reached the river it would not have a lasting impact, and the consequence is reversible.

Based on these results, the highest environmental consequence for the spill from transporting hazardous waste scenario is low. The likelihood of occurrence for this scenario is very unlikely to extremely unlikely. The effects of this scenario are adverse, minor and unlikely. Therefore, this scenario is not likely to result in any significant adverse environmental effect.

Scenario 8 Migratory Birds Landing on External Tailings Disposal Areas and Becoming Oiled

The bitumen extraction process requires the storage of process-affected water that may contain deleterious substances which have the potential to harm migratory birds. Shell supports the need for industry to standardize monitoring across all sites with ETDAs and supports research to help reduce the number of bird fatalities as a result of mining activities. Shell has led the development and deployment of Bird Activated (RADAR based) deterrent systems to reduce the frequency of migratory birds landing on ponds. As a requirement of the Alberta *Environmental Protection and Enhancement Act* (EPEA) approval requirements at the Jackpine and Muskeg River mines, Shell has submitted a Water Bird Protection Plan with Alberta Environment and Sustainable Resource Development (ESRD) that describes how Shell's bird deterrent system operates and would be utilized for future site development and expansion. Shell provides a summary of this information here and includes a discussion on the potential risk of migratory birds landing on the ponds due to environmental conditions beyond the control of the PRM.

Risks and Mitigations

Shell mitigates the risk of bird landings with a Peregrine Systems (2008) BirdAvert™ system at the Jackpine Mine and Muskeg River Mine sites, and this same system would be used at PRM. The manufacturer's test results during a spring and fall waterfowl migration found the expected rate of deterrent to be 96.9% to 99%.

The BirdAvert™ uses marine radar to detect birds in flight, and once detected, hazing devices are triggered over a radio link. The hazing devices (land and water-based deterrents) at each unit will include sound (raptor attack call and propane-fired cannons) and light (strobes and motion such as mechanical peregrine falcons). The on-demand system adaptively manages the process by collecting data to determine the most effective strategy in bird deterrence. The BirdAvert™ is continually monitored and linked into a Blackberry messaging system with 24-hour coverage to report on the functionality of the system. If a problem is detected, an alert would be sent to ensure prompt action is taken to repair the system. In the event of a power failure, the system will switch over to battery mode and will continue to function for a few hours. Should the radar and data storage unit fail, all the deterrent units begin operating in random mode.

Shell will provide the necessary resources to operate and monitor the bird deterrent system. For example, at the Jackpine Mine, a team of 2 to 3 people are dedicated to operating the bird deterrent system daily during the migration season which is typically from mid-April to November. This team uses flares, boats and other means to keep birds from landing and staying on the ponds. This crew is also responsible for monitoring and reporting bird activity on ponds with process-affected water and the Jackpine Mine – Phase 1 Compensation Lake. The monitoring protocols are outlined in the *Oil Sands Bird Contact Monitoring Plan for 2011* as developed by Dr. Rob Ronconi, Dr. Colleen Cassady-St. Claire, industry and ESRD (Ronconi 2011).

Regardless of the deterrent system in operation, there are documented incidents where strong winds, rain and/or snow are such that birds have no other choice but to land. In some cases the deterrent systems will not prevent fatigued birds from taking to the ground and ponds. This is an example where environmental conditions may have a direct impact on the PRM.

The scenario of migratory birds landing on external tailings disposal areas and becoming oiled has occurred in recent oil sands history and it is likely this could happen over the PRM's life. Due to the plans in place, it is unlikely Shell's deterrent system would not be in operation as required. For the impact analysis, Shell considered the scenario where over a 1,000 birds are forced to land due to weather conditions and are contaminated due to contact with the tailings ponds. This case is considered to be less likely than events with fewer birds but would likely result in a higher environmental impact (see potential impacts below).

Response Measures

Regardless of the reason (malfunction or environmental conditions) waterfowl may choose to land on tailings ponds. Shell has designed plans to recover and mitigate the impacts to the birds. In the event that birds have landed on the tailings ponds and have become oiled, the environmental response team would be notified immediately. Alberta Environment and Sustainable Resource Development, Fish and Wildlife representatives would be contacted and requested to provide guidance on further actions. The response team has access to marine vessels and various specialized small equipment to aid in the capture of the birds. Injured birds would be assessed and treated on a case-by-case basis. Generally, birds are assessed to determine the extent of the injury (amount of oil they are covered in) and if the injury is not severe, the bird is rehabilitated onsite by the designated environmental specialist or sent to a designated bird rehabilitation centre. If the injury is assessed to cause imminent mortality, the bird is euthanized onsite by the designated environmental specialist. Shell Albian applies annually to ESRD for a regulated research permit and collection license which authorizes designated employees to handle wildlife mortalities as well as rehabilitate and release injured wildlife back to the natural environment. Under these authorizations, Shell is obligated, upon renewal, to report all wildlife observations (including handled, injured and dead) into the Alberta Fisheries and Wildlife Management Information system database.

Potential Impacts

The magnitude of effects to the environment for migratory birds landing on external tailings disposal areas and becoming oiled is expected to be minor from a population perspective. The extent of effects would be beyond regional as this will affect migratory birds. The duration of effects is short-term and reversible from a population perspective.

The original assessment considered a flock of waterfowl forced to land. In this assessment, the receptors potentially affected by this scenario include Species at Risk and wildlife Key Indicator Resources. Linkages were identified for horned grebe, red knot, rusty blackbird, whooping crane, and yellow rail, which are migratory bird species that will not be present in flocks of a 1,000 birds. For these species, typical migratory group sizes and population estimates were reviewed. Based on this review, the magnitude of effects to the populations of these migratory bird species if this scenario were to occur would be slight for horned grebe, red knot, rusty blackbird and yellow rail, and minor for whooping crane based on the assessment approach using ecological thresholds. This scenario has no effect on habitat. The extent of effects would be beyond regional because this will affect migratory birds. The duration of effects is short-term and reversible from a population perspective.

Based on these results, the highest environmental consequence for a receptor for this scenario is low (whooping crane) (Table 73-5). The likelihood of occurrence for this scenario is unlikely for 1,000 birds. The likelihoods of occurrence for the Species at Risk migratory birds are reduced based on the low abundance rates of these species, as follows: very unlikely for horned grebe, very unlikely to extremely unlikely for red knot, extremely unlikely for rusty blackbird, and extremely unlikely to remote for whooping crane and yellow rail.

The effects of this scenario are adverse, minor and unlikely based on the assessment approach using ecological thresholds. Therefore, using that assessment approach, this scenario is not likely to result in any significant adverse environmental effect.

References:

CEAA (Canadian Environmental Assessment Agency). 2013. *Reference Guide: Determining Whether A Project is Likely to Cause Significant Adverse Environmental Effects*. Available at: http://www.ceaa-acee.gc.ca/default.asp?lang=En&n=D213D286-1. Accessed on July 18, 2013.

Ronconi, R.A. 2011. *Oil Sands Bird Contact Monitoring Plan for 2011*. Prepared for Albian Sands Energy Ltd., Canadian Natural Resources Limited, Imperial Oil, Suncor Energy Inc. and Syncrude Canada Ltd. Final Report March 16, 2011. Updated April 6, 2011. 33 pp.

SIR 74

Submission of Information to the Joint Review Panel - May 2011, Section 3.2, Page 36. The information regarding accidents and malfunctions were generalized incidences that may be expected to occur with either the JPME or PRM. The Panel notes that there are differences in the design of PRM that may warrant additional analysis.

a) Conduct an analysis of the potential for an accident or malfunction associated with pipelines that would follow the site access road and cross over the Athabasca River and provide an analysis of the potential environmental effects associated with any such accident or malfunction

b) Conduct an analysis of potential landsides that may occur along the western pit limit and the potential environmental effects associated with any accident or malfunction

c) Discuss any other project-specific accidents or malfunctions that may occur with PRM.

d) Describe mitigation measures designed to avoid accidents and malfunctions associated with the above as well as mitigation measures to mitigate any effects from a potential accident or malfunction.

Response:

a) The potential for an accident or malfunction associated with pipelines, and the potential effects are discussed in the *May 2011, Submission of Information to the Joint Review Panel,* Section 3.2.2.2.

As noted in the preamble to this SIR, the PRM project is different than JPME in that a major pipeline water crossing is required. Preliminary design details of this water crossing were provided in the *August 2010, Jackpine Mine Expansion & Pierre River Mine Project, Federal Information Requests*, page 16.

Shell's current infrastructure plan includes a utility corridor that would parallel the site access road as depicted in the Pierre River Mine Environmental Impact Assessment (EIA, Volume 2, Section 8). This corridor would contain:

- a natural gas pipeline;
- a solvent return pipeline (915 mm diameter);
- a diluted bitumen pipeline (915 mm diameter); and
- a spare 915 mm diameter line.

The pipeline corridor and pipelines would follow current industry engineering practice, similar to other existing lines that have been operating for many years without incident.

A loss of pipeline containment has historically occurred in the industry, however the likelihood of occurrence for the pipeline to fail is considered very unlikely to extremely unlikely.

While some of the previous information relates to JPME (i.e., release into Jackpine Creek), the engineering design, operation, and response to a pipeline incident would be identical for PRM including such features as:

- appropriate pipe design;
- material selection;
- pressure equipment integrity management programs; and
- instrumentation and leak detection systems.

Design features specific to the PRM water crossing could include:

- secondary containment casing to protect the hydrocarbon pipelines;
- instrumentation for leak detection into the secondary casing;
- block values to isolate the pipeline crossing from the main pipeline;

- appropriate physical barriers to protect exposed sections; and
- corrosion management systems and routine inspection.

A loss of pipeline containment has historically occurred in the industry, however the likelihood of occurrence for this pipeline to fail is considered very unlikely to extremely unlikely due to the range of preventative measures described above that Shell will have in place.

The environmental consequences of a hydrocarbon release could be high depending on the volume and type of material released. The environmental effect of a potential accident or malfunction on this water crossing is discussed further in JRP SIR 73 along with specifics pertaining to mitigation and response measures.

b) The potential for a landslide occurring along the western pit limit of Lease 9 is considered extremely unlikely. Shell does not believe that the western pit limit of Lease 9 presents any unusual geotechnical challenges, because the Clearwater formation is not present in this area. This will be confirmed during future delineation of the resource. The current design is based on industry practice and experience, validated through stability assessments. The mine pit is subdivided into sectors based on the presence or absence of Clearwater Formation in the overburden. The design of final pit walls will ensure a safety factor is maintained, and shallower slopes will be applied if the geological environment and geotechnical stability warrants such a change. Further mitigation measures to stabilize pit wall slopes, such as toe buttressing, will be implemented if required. These final pit wall designs will be provided to the Alberta Energy Regulator, as mining approaches the area.

A detailed discussion of a mine high wall failure was included in the May 2011, Submission of Information to the Joint Review Panel, Section 3.2.3.2 as well as the May 2012, Joint Review Panel Supplemental Information Requests, JRP SIR 33, page 3-100. An analysis of the potential environmental effects from a similar incident at PRM are described in JRP SIR 73.

c) At this time Shell does not foresee any other accidents or malfunctions that would be specific to the Pierre River Mine, other than described in the response to JRP SIR 73.

d) Shell considers the management of Health, Safety, Security and Environment (HSSE) an integral part of its operations. Shell incorporates a Hazards and Effects Management Process (HEMP) as a key part of its HSSE management systems. The HEMP is used for identification and risk assessment of HSSE hazards, the evaluation and implementation of control and recovery measures, and to document that major HSSE risks have been reduced to as low as practicable. Its aim is to ensure hazards are identified, the risks assessed and proper barriers are put in place to prevent or recover from an HSSE event such as those described above.

The HSSE management system for the Pierre River Mine will include the evaluation of significant site hazards and the preparation of an emergency preparedness and response program as described in the Project Description of the EIA (EIA, Volume 2, Section 12). Emergency response plans, resources and trained personnel will be in place to execute responses appropriate to potential emergency scenarios. The plans will provide structure and guidance for responding to such incidents as spills, fires, loss of containment, and injuries.

SIR 75

Submission of Information to the Joint Review Panel - May 2011, Section 3.2.7, Page 64. Shell states that "regardless of the deterrent system in operation, there are documented incidents where strong winds, rain and/or snow are such that birds have no other choice but to land. In some cases the deterrent systems will not prevent fatigued birds from taking to the ground and ponds".

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

b) Describe the process in which the system is upgraded as required or evaluated for effectiveness in reducing avian mortality.

Response:

a) Shell's historical information of avian interactions for both the Jackpine Mine and the Muskeg River Mine are shown in Figures 75-1 and 75-2. The graphics also include statistics of bird mortalities that are not tailings-related such as building contact, vehicular, electrocution and other unknown causes.

Shell is unable to provide information related to other oil sands operators' annual reports on wildlife and tailings pond interactions; however, all operators are required to report all wildlife and bird fatalities to Alberta Environment and Sustainable Resource Development (ESRD) as they occur, annually. Shell's experience over the past 11 years of operation is that 10 to 11 birds die per year, on average, from interactions with tailings. There have been no tailings-related non-avian mortalities at Shell. From mid-April to the end of October, Shell operates its bird deterrent systems. In reference to the historical information provided, all Shell's deterrent systems were in place and functioning when these mortalities occurred.

There are two publicly documented incidents where a large number of birds came into contact with floating bitumen and died. The first major incident occurred at the Syncrude Aurora North tailings pond during April 2008.

The second incident took place on October 26, 2010 during the fall migration. An ice storm forced a flock of birds to immediately land. At Shell's Jackpine Mine operation, birds were observed landing in the camp parking lot, on haul roads and in the crusher pocket. The only fatality was a bird that was accidently killed by a haul truck. It is believed that other operators reported numerous birds had died in their main tailings ponds during this same event. Following its investigation, ESRD did not find fault with any of the operators as a result of the bird fatalities from this. The investigation was conducted by Dr. Colleen Cassady St. Clair and her report is publicly available (http://environment.gov.ab.ca/info/library/8679.pdf).

Shell employs a Peregrine Systems BirdAvert™ system at its operations. This technology was a substantial innovation in the field of avian deterrence which was superior to other deterrent systems in place when Shell first began using it. Since that time, most operators have adopted the use of radar-activated on-demand deterrent systems. Further detailed information regarding the types of bird deterrents employed by Shell are contained in December 2009 Jackpine Mine Expansion, Supplemental Information, Volume 1, SIR 442, and in June 2010 Jackpine Mine Expansion, Supplemental Information, Round 2, SIR 37.

Figure 75-1 Jackpine Mine Avian Mortalities (2009 to 2012)

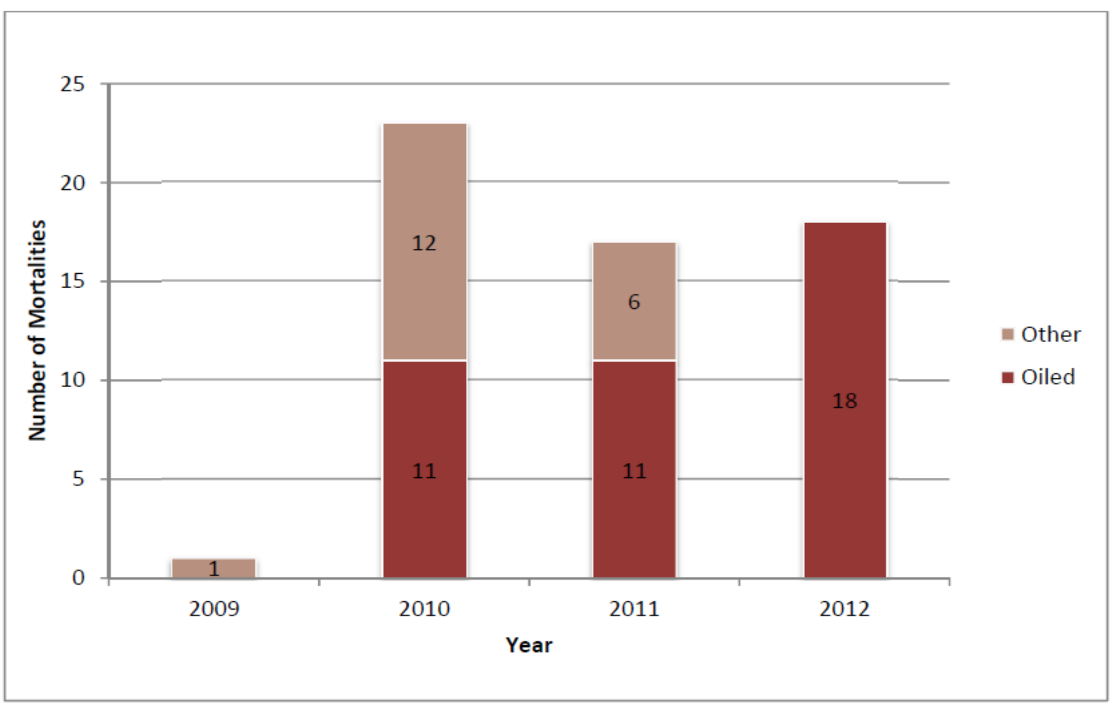
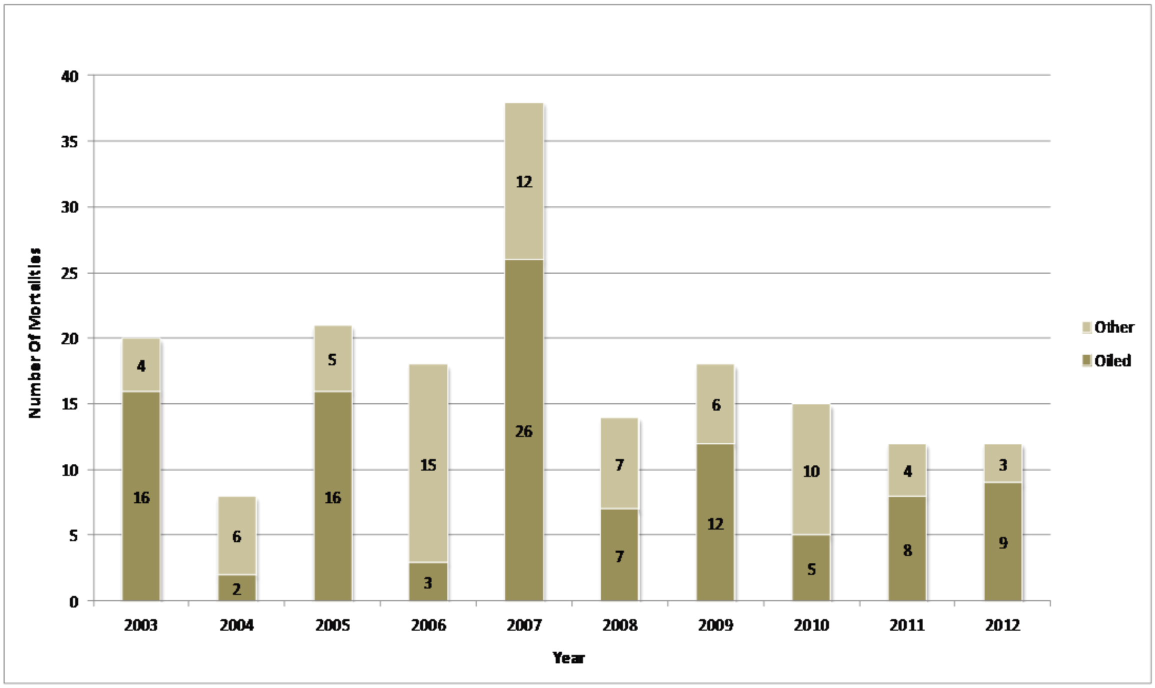


Figure 75-2 Muskeg River Mine Avian Mortalities (2003 to 2012)

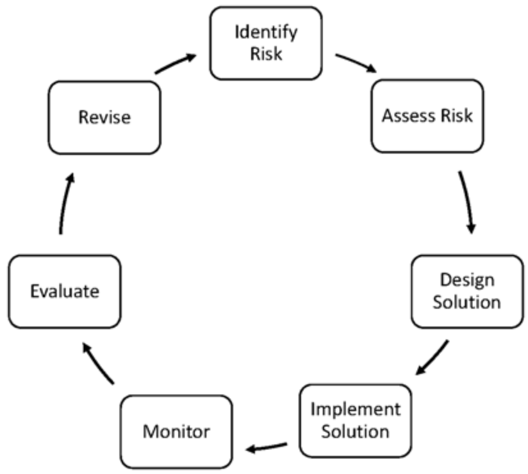


b) Upgrades to the system are completed, as required, as Shell provides feedback to the vendor routinely (i.e., redesign of air cannon barrels to allow for longer life span; new design of float bottoms to allow for easier deployment and retrieval; updates to software).

Over the years, the system has gone through several advancements from upgrades to software and computer hardware, to new advancements in its radar capabilities. The largest step change to the system was the ability to have real time information being sent to remote devices to allow field staff to monitor the network as a whole, as well as individual units.

Shell uses the Adaptive Management Process to determine the effectiveness of the "on-demand system". This management process is based on a seven-step cycle that allows operations to identify potential issues which then lead into implementation of solutions that decrease uncertainty (Figure 75-3).

Figure 75-3 Seven-Step Cycle of the Adaptive Management Process



The adaptive management process has guided operations to implement changes to the on-demand style of bird deterrents which allows for continuous improvement in deterring waterfowl and other bird species.

In consideration of annual variables such as bird population fluctuations, their propensity to land on any given facility, and annual mortality rate by oiling, the on-demand system provides flexibilities yet maintains its reliability to deter birds. The advantages of the on-demand system allows the user to determine such things as seasonal flight patterns, propensity of birds to frequent specific areas of the facility, variations in the number of birds flying over the pond at different times of the year, and compare effectiveness of different deterrent types across the facility. In turn, Shell's operations can review and apply a more effective strategy in bird-deterrence through the placement location, timing, intensity, density and type of deterrent equipment employed.

Addressing the fine-scale measures of success will likely increase the chances of observing an improvement to bird deterrence on a more coarse scale, such as strict annual mortality rates. Data management review of the on-demand system is a key element in the adaptive management process and is used to improve bird deterrence on the facilities. Further, increased crew training on the bird deterrent systems to handling equipment improvements are also important elements in continuously improving the bird deterrent system.

As time progresses (i.e., during monitoring and evaluation stages), a comparative analysis between the mortality rates of the on-demand and the industry-standard may yield a significant difference in bird deterrence.

FOLLOW-UP AND MONITORING

SIR 76

The Panel notes that the *Joint Canada-Alberta Implementation Plan for Oil Sands Monitoring* will be fully implemented in 2015.

a) Describe Shell's planned participation in the Joint Canada-Alberta Implementation Plan for Oil Sands Monitoring.

Response:

a) Shell is participating in the *Joint Canada-Alberta Implementation Plan for Oil Sands Monitoring* (JOSM) *Program* through several mechanisms. All regional monitoring associated with air, land and water will be conducted through the JOSM program and led by an Independent Monitoring Agency that is currently being established by the Governments of Alberta and Canada. Shell is providing input into the governance of that Agency as well as into the transitioning from the existing regional monitoring programs and legacy organizations through the Canadian Association of Petroleum Producers (CAPP) JOSM Shadow Committee and Transition Working Group. The governments of Alberta and Canada have agreed that Canada's Oil Sands Innovation Alliance (COSIA), specifically the COSIA Monitoring Director, will be the oil sands industry focal point for all technical discussions/input to JOSM. As such, Shell is participating in the COSIA Monitoring Working Group and providing technical input through that mechanism.

In addition, the Governments of Alberta and Canada are establishing Technical Advisory Committees (TAC) inclusive of multi-stakeholder groups including industry for each component of JOSM. The Terms of Reference for the Air TAC has just been established as the first committee. Shell will be participating on several of the multi-stakeholder JOSM TACs.

Shell is also financially contributing to the JOSM program through the funding formula developed through CAPP. The JOSM must be successful for all parties including industry to ensure sustainable development and environmental protection. Shell is committed to supporting the success of JOSM through the mechanisms established.

ERRATA

SIR 77

When discussing water-bearing units in the bottom of the McMurray Formation, the term “Basal Watersands” is frequently used in Volume 2 and other sections of the Application materials. Portions of Volume 4A and other sections use the term “Basal Aquifer” when discussing what appears to be the same unit. Clarify if the terms “Basal Watersands” and “Basal Aquifer” refer to the same unit. If not, provide a discussion on what the two terms specifically refer to, and if the terms are appropriately used throughout the application materials.

Response:

The terms “Basal Watersands” and “Basal Aquifer” refer to the same water-bearing unit at the base of the McMurray Formation

Although the terms appear to be used liberally and interchangeably in various reference materials, there appear to be some preferences in usage:

- In the mining context, the term “watersands” is generally used to describe those sand units within the McMurray Formation that are water-saturated, rather than bitumen-saturated. Hence, the terminology “Basal Watersands” describes sand units in the McMurray Formation that are water-saturated and are at the base of the formation.
- In the regional hydrogeology context, the term “Basal Aquifer” is generally preferred (i.e., Bachu et al. 1993; Hackbarth and Nastasa 1979) because it conveys the meaning of water availability and water transmissivity, inherent in the definition of an aquifer.

References:

Bachu, S., J.R. Underschultz, B. Hitchon and D.K. Cotterill. 1993. *Regional-Scale Subsurface Hydrogeology in Northeast Alberta*. Alberta Geological Survey Bulletin 61.

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