StatoilHydro

March 24, 2009

ALBERTA ENERGY RESOURCES CONSERVATION BOARD
640 – 5th Avenue S.W.
Calgary, AB T2P 3G4

Attention: **Mr. Ken Schuldhaus, P.Eng.**

RE: **Supplemental Information Request (2) for Application No. 1523635 (the Application) Kai Kos Dehseh Project – Athabasca Oil Sands Area**

In support of the Application, StatoilHydro Canada Ltd. (StatoilHydro) has completed the responses to the Supplemental Information Request (SIR(2)), dated February 4, 2009, for the Kai Kos Dehseh Project (the Project).

North American Oil Sands Corporation (North American), now StatoilHydro Canada Ltd. (by way of amalgamation) had applied to the Energy Resources Conservation Board (ERCB) and Alberta Environment (AENV) for approval to construct and operate the Kai Kos Dehseh In-Situ Oil Sands Project. StatoilHydro has assumed North American's role as the Application's proponent.

As outlined in the Application, the Project involves four development areas: Leismer, Corner, Thornbury and Hangingstone and the Application addresses StatoilHydro's overall development plan for the Project. The Project development plan is based on the Leismer and Corner development areas being developed first followed by the other two development areas. With this in mind, and with respect to the Project Environmental Impact Assessment (EIA), StatoilHydro wishes to again highlight the EIA's unique nature. To facilitate more openness and transparency of the overall Project development plan in the local communities, StatoilHydro has completed a broader regional EIA that fully outlines the proposed commercial development plan for the overall Project within the approximately 12 townships of oil sands leases now held by StatoilHydro.

This regional EIA approach was developed in full consultation with various regulatory agencies, including the ERCB, AENV and Alberta Sustainable Resource Development (ASRD). Support in principle was received and as result it was agreed that StatoilHydro would apply for overall Project approval based on one regional EIA. To the extent that detailed information for each development area was required, that information would be included, as applicable, in either the Application or any future amendment applications (instead of using separate stand-alone EIAs for each development area).

StatoilHydro believes this regional EIA approach has provided the stakeholders with transparency of its planned implementation for overall Project development and this transparency is in the public interest. The EIA is based on regional data and a conceptual engineering and execution plan. Several of the EIA programs, such as some of the wildlife baseline studies (caribou, moose and wolf), were tailored with feedback from local stakeholders to address their specific interests.

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As overall Project development progresses, subsequent approval amendment applications for each of the Thornbury and Hangingstone development areas will be submitted. StatoilHydro acknowledges that if significant changes in the region occur, AENV may request additional environmental studies to supplement the existing EIA. All future amendment applications will contain the required level of information for each applicable development area and will be based on the acquisition of additional geological, reservoir and engineering information.

With the submission of these responses to the SIR(2) combined with the EIA and the responses to the Round 1 of the SIRs, dated July 23, 2008, StatoilHydro is of the position that the Terms-of-Reference for this EIA have been met. StatoilHydro looks forward to the ERCB's and AENV's decision on the completeness of both the Kai Kos Dehseh Project Application (Volume 1) and the accompanying Environmental Impact Assessment (Volumes 2 – 5).

We trust that you will find the attached responses to your information requests in order.

Yours truly.

STATOILHYDRO CANADA LTD.

Lorne Cannon, P.Eng.
Vice President, Leismer Asset

cc:
Laura Hickman – ERCB
Corinne Kristensen – AENV
Craig Popoff, P.Eng – Director, Regulatory & HSE, StatoilHydro Canada Ltd.

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Title:

**APPLICATION FOR APPROVAL OF
KAI KOS DEHSEH PROJECT
SUPPLEMENTAL INFORMATION REQUEST ROUND 2**

Date:

MARCH 2009

Submitted to:

**ALBERTA ENVIRONMENT
AND ENERGY RESOURCES CONSERVATION BOARD**

Submitted by:

StatoilHydro Canada Ltd.

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StatoilHydro Canada Ltd. Kai Kos Dehseh Project

ERCB Application No. 1523635 EPEA Application No. 001-241311 Water Act File No. 00239880

Supplemental Information Request (2)

TECHNICAL REVIEW

A. GENERAL

1	**SIR 7i, Pages 30 and 31.** Statoil states, "*for consistency, the well pair life will be assumed to end when the instantaneous steam oil ratio reaches 4.0*". a. Values shown in the table indicate that this condition may be reached prior to 50% recovery of the bitumen in place. Confirm that Statoil understands the ERCB currently includes in its SAGD commercial scheme approvals a condition that states, "*Unless otherwise permitted by the Board, steam injection operations, having commenced at a well pad, shall continue until the well pad has produced a minimum of 50 per cent of the in-place volume of crude bitumen assigned to that well pad by the Board.*"

Response

Yes, StatoilHydro understands that a minimum 50% recovery of the original bitumen in place in the Kai Kos Dehseh Project will be required, if it is commercially feasible. The 50% standard is part of the approval conditions for the current Leismer Demonstration Project (LDP).

B. SOURCE AND DISPOSAL WATER

2.	**SIR 8b, Page 33.** Statoil provided the following criteria to locate source and disposal wells in the Basal McMurray Formation: reduction of pressure impacts affecting resource recovery due to the brackish source water withdrawal, proximity to the plant site, and breakthrough of disposal water from the disposal well to the brackish source well. a. For the Leismer Expansion and Corner Hubs, provide a map showing the locations of the proposed source and disposal wells in relation to the pads and SAGD drainage patterns. Indicate on the map the anticipated maximum radius of influence of the source and disposal wells for low and high withdrawal/disposal rates over the life of the project.

Response

Figure 2-1 illustrates the expected SAGD drainage areas for the Leismer Commercial and Leismer Expansion Hubs and the closest Basal McMurray Aquifer source and disposal wells. Also shown on Figure 2-1 is the predicted cumulative effects case pressure change from the source and disposal wells at the end of 2029. This date corresponds to the end of Leismer Commercial and Expansion phases when the pressure effects would be potentially highest. It should be noted that the conservative cumulative effects case prediction includes source and/or disposal for all phases of the Kai Kos Dehseh Project and publicly known in-situ oil sands operator water strategies in the vicinity of the Kai Kos Dehseh Project.

StatoilHydro proposed that the Basal McMurray Aquifer supply and disposal wells for the Corner Hub were to be located in the Leismer/South Leismer development areas (see EIA, Volume 3, Section 5, Table 5.6-5, Table 5.6-6). As such, pressure changes induced by Corner Hub Basal McMurray Aquifer wells do not overlap with the Corner SAGD drainage areas and are not shown on Figure 2-1.

The predicted changes in pressure presented on Figure 2-1 are derived from a regional scale numerical groundwater flow model. StatoilHydro recognizes that one proposed disposal well is located within the Leismer Expansion SAGD drainage area. It is expected that this proposed Basal McMurray Aquifer disposal well will be re-located further away from the SAGD drainage area based upon the results of ongoing drilling and testing programs and local scale reservoir modelling.

2.	b. Provide a discussion on the methodology and geological model used to establish the maximum radius of influence.

Response

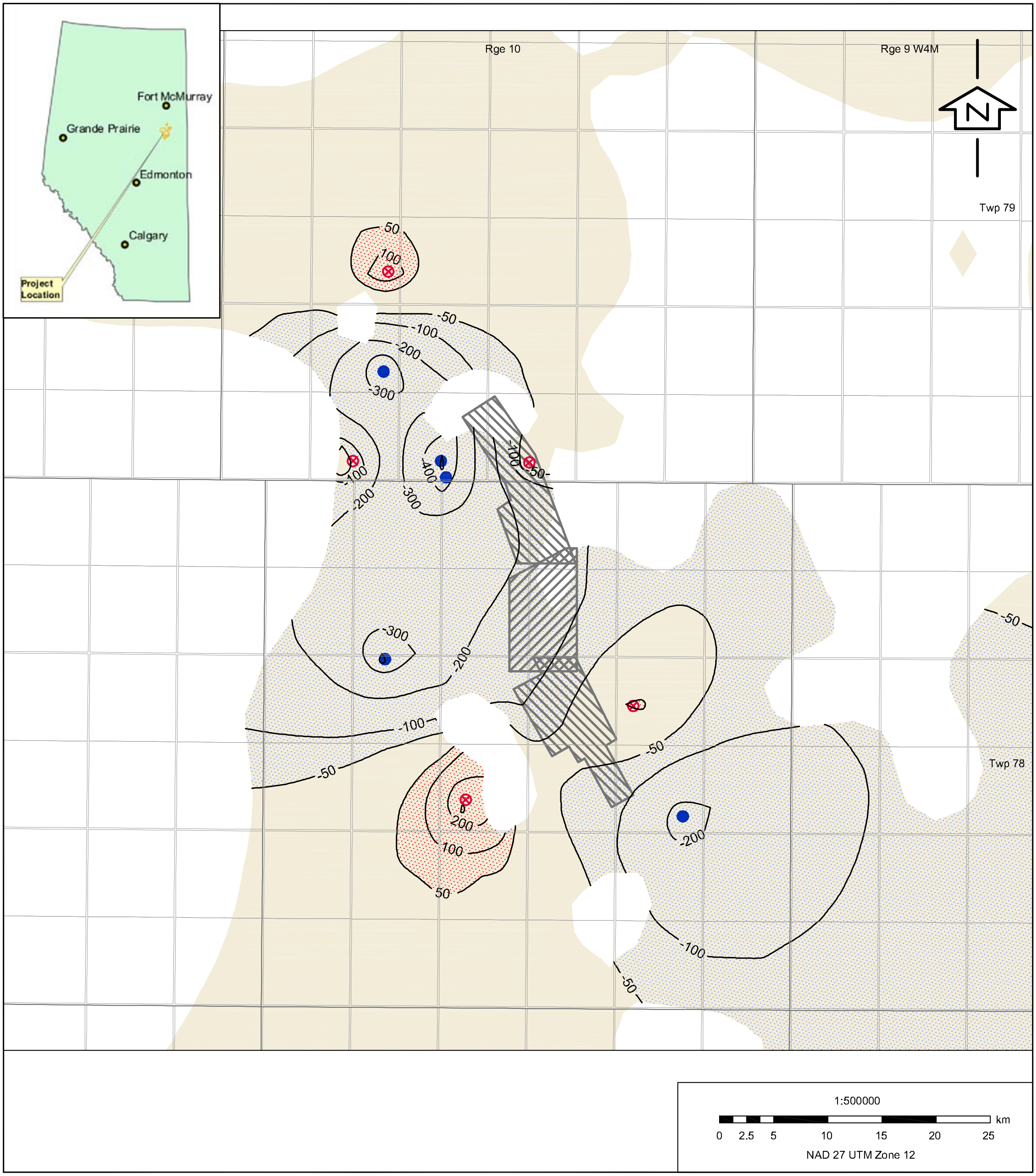
The predicted changes in pressure presented on Figure 2-1 are derived from a regional numerical groundwater flow model. Details regarding the construction and calibration of the regional numerical groundwater flow model are outlined in the EIA Volume 3, Section 5 – Appendix 5D. The methodologies of the geologic mapping utilized in the numerical groundwater flow model are included in the EIA Volume 3, Section 5 – Appendix 5A. The source and disposal rates utilized in the cumulative effects case simulation for publicly known in-situ oil sands operator water strategies in the vicinity of the Kai Kos Dehseh Project are included in the EIA, Volume 3, Section 5, Table 5.5-10. The source and disposal rates utilized in the simulation for the Kai Kos Dehseh Project are included in the EIA, Volume 3, Section 5, Table 5.6-4.

2.	c. Provide a discussion on plans for mitigating breakthrough of disposal water from the disposal well to the source well.

Response

The plans to mitigate breakthrough of disposal water from disposal well to source well include the following:

- Locating the wells based on extensive pump/injection tests and reservoir modelling;
- Planning disposal and brackish source wells in the thick zones of the disposal/brackish source reservoirs to encourage plug flow;
- Installing more than one disposal and source well at the respective locations to encourage a broad transport front;
- Minimizing the amount of disposal water being pumped to disposal (recycling as much of the boiler blowdown as possible);
- Monitoring the conductivity of the brackish source water to detect changes in quality;
- Designing the pipelines based on conservative hydraulics to allow extension of the pipelines to more distant wells located further from the Central Processing Facility (CPF); and
- Delineating alternate disposal and brackish source locations to migrate the push/pull wells should breakthrough occur.



Legend

- Source Well
- Disposal Well
- Basal McMurray Aquifer Present
- SAGD Drainage Area (Leismer Commercial)
- SAGD Drainage Area (Leismer Expansion)
- Decrease in Pressure (kPa), Contour Interval = -50, -100, -200, -300, -400, -500 kPa
- Increase in Pressure (kPa), Contour Interval = 50, 100, 200, 300 kPa

REFERENCE
ALBERTA NTDB DIGITAL OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
SASKATCHEWAN NTDB DATA OBTAINED FROM ISC, AUGUST 2001.
DATUM: NAD 27 PROJECTIONS: UTM ZONE 12

Title:

FIGURE 2-1

PREDICTED PRESSURE CHANGE (BASAL McMURRAY AQUIFER: END OF 2029)

StatoilHydro

Approved: SR	Revision Date: March 19, 2009
File: 4455-IA-09.DWG	
Drawn by: GDE	Checked: BW

F:\4455 NAOSC\Drafting\2009\4455-IA-09.dwg - DD-McM-2029 - February 26, 2009 11:13:13 AM - Barry Wheeler

*PLOT 1:1 = Letter (P)

3.	**SIR 8c, Page 33.** StatoilHydro states, "*If water operations imposed unacceptable pressure deviations onto StatoilHydro's SAGD operations, the locations were dismissed. The analysis resulted in a number of viable Basal McMurray source and disposal locations*." a. Identify the pressure deviations that were deemed acceptable and the associated locations. b. Identify the pressure deviations that were deemed unacceptable and the associated locations. c. Provide the rationale and analysis conducted for establishing whether a pressure deviation was acceptable or unacceptable

Response

Previously, StatoilHydro has used a general evaluation range of up to 400 kPa for acceptable pressure deviations in the Basal McMurray Aquifer. StatoilHydro is currently conducting extensive formation testing of the Basal McMurray. This will improve its understanding of the potential pressure deviations that may develop in individual locations at varying rates. Analysis of the dynamic flow response from individual wells, combined with numerical modelling, will determine the final acceptable pressure deviations in the zone to ensure that StatoilHydro will not be adversely impacting SAGD operations. Details of this analysis will be contained within the disposal well license applications under ERCB Directive 051 and/or ERCB Directive 065, which will be filed when the final locations are determined.

4.	**SIR 8e, Page 34.** Statoil Hydro indicates that if there is more produced water returning than needed, then the non-saline make-up water would be reduced to the minimum required for VRU cooling and utility water needs. Response to **SIR 19a, Page 46** indicates 170 m^3/d is used for VRU cooling, and response **SIR 19b** indicates 7 m^3/hr is used as cooling medium in treating gas trim cooler and 284 m^3/d for pump seal flush. a. Discuss why softened brackish water would not be used for cooling and pump seal flush?

Response

Softened brackish utility water is not considered a viable option by StatoilHydro, as it would be detrimental to many seal applications and would cause significantly increased corrosion, even at very low levels of oxygen.

5.	**SIR 8f iii, Page 35.** StatoilHydro has provided a list of alternative plans that could potentially be implemented, should StatoilHydro decide to *"…modify or discontinue the push-pull plan* (due to) *negative impacts on bitumen or the steam-oil ratio*." a. What is the status of each of the alternative plans?

Response

The status of the alternative plans are as follows.

Alternative A (disposing into a water-wet zone not connected to the resource)

The 2009 drilling program is described in detail in SIR(2) #27.

- StatoilHydro has responded to several hydrogeological questions stating that, "*Collection of additional field data is ongoing as StatoilHydro continues to assess groundwater resources and initiates groundwater monitoring ...*", or a similar response. The analysis of the drilling and testing program will be complete by the end of the third quarter of 2009.

Alternative B (installing Zero Liquid Discharge)

- The study evaluating the installation of a Zero Liquid Discharge system at the Leismer Hub, similar to Petro-Canada McKay River, and at the Corner Hub are ongoing.

Alternative C (altering the operating pressure of the SAGD steam chamber to reduce the impact on the aquifer)

- Altering the operating pressure of the SAGD steam chamber is an operating strategy, which will be tested once the LDP is operational.

Alternative D (selecting alternate locations targeting aquifers in the McMurray Formation)

- Selecting alternate locations targeting aquifers within the McMurray Formation – the next phase of the study of this alternative is part of the 2009 drilling and testing program and the analysis will be complete by the end of the third quarter of 2009. The results of this year's drilling and testing will be the basis for the drilling and testing of this alternative in the 2010 drilling program.

5.	b. Provide the rationale of not implementing any of them.

Response

The rationale for not implementing the above alternative plans is as follows:

Alternative A

The results of the 2009 drilling and testing program have not been analyzed at the time of writing this response. At least one additional drilling and testing program is necessary to provide the basis for changing the strategy presented in the application.

Alternative B

Environmental and economic evaluations of Zero Liquid Discharge including energy consumption, CO_2 emissions and solid waste management are ongoing for the Leismer and Corner hubs. The sub-option of using evaporators to concentre the TDS to a very small disposal flow are also being studied for each hub, in conjunction with deep well disposal exploration. Decisions relating to the implementation of these options are pending completion of all the relevant investigations and evaluations.

Alternative C

See response to SIR(2) #5(a) above

Alternative D

The results of the drilling and testing program have not been analyzed. At least one additional drilling and testing program will be necessary to provide the basis for changing the strategy presented in the Application.

C. FACILITIES

6.	**SIR 14b ii, Page 41.** Statoil Hydro states, "*Wet gas compressor outage does not normally trigger any flaring*." a. Where does the feed (gas) to the wet compressor get sent during a wet gas compressor outage?

Response

There will be no flare at the well pads. If a well pad wet gas compressor experiences an outage, the produced gas accumulates in the wellbore and may ultimately depress the fluid level in production casing below the required level for artificial lift. A spare well pad wet gas compressor is included in the design of the pads. If the spare well pad wet gas compressor cannot be brought on-line, the well pad must eventually be shut-in until compression is available again.

7.	**SIR 15a, Page 42.** Discuss the practicality and feasibility of constraining production to ensure the 1 t/d sulphur limit will not be exceeded. Also, discuss the potential for negatively impacting the efficient operation of the CPF and/or resource recovery from the SAGD wells by constraining production.

Response

StatoilHydro intends to have sulphur recovery in place prior to reaching the maximum sulphur limit of 1 tonne per day (t/d). The maximum sulphur inlet per 3,180 m^3/d (20,000 bpd) CPF is expected to be 0.6 t/d of sulphur, based on the sulphur balance without sulphur recovery in place. With sulphur recovery in place, it is expected to be 0.06 t/d sulphur. Refer to Figure 7-2 or Figure 27-1 from AENV SIR(1) # 7 and ERCB SIR(1) #27, respectively, or SIR(2) #18 below for further clarification. Therefore, it will be unnecessary for StatoilHydro to constrain production. StatoilHydro is currently studying alternate sulphur recovery processes with the intent of installing sulphur recovery at the Leismer Commercial CPF in parallel with the development of Leismer Expansion Hub.

8.	**SIR 20, Pages 46-51.** a. Provide a facility energy balance and energy efficiency using the following format. Energy Balance: Total Energy IN = Total Energy OUT Total Energy IN = Bitumen from Wells + Produced Gas + Natural Gas + Electrical Import + Diluent Feed Total Energy OUT = Saleable Products + Electrical Export + Losses + Uses Energy Efficiency = (Energy OUT in Saleable Products / Total Energy IN)*100 = [(Energy of Dilbit Product + Electrical Export) / (Energy of Diluent + Bitumen Feed + Produced Gas + Purchased NG + Electrical)]*100 Where: Diluent Product = Diluent Feed – Losses to fuel gas system and any other losses during processing Bitumen Product = Bitumen Feed (no losses) Include electrical export only if applicable. b. Provide the liquid heat volume (LHV) for each of the streams or energy content (bitumen, diluent, natural gas, produced gas, electrical, dilbit).

Response

The energy balance for the 3,180 m^3/d (20,000 bpd), 6,360 m^3/d (40,000 bpd) and 34,980 m^3/d (220,000 bpd) production cases are given below. The stream flow rates were previously provided in AENV SIR (1) #7, Figures 7-2, 7-3, and 7-1 for the three cases respectively. The lower heating value (LHV) used in the below calculations for each stream as identified is as follows:

Bitumen LHV = 41.96 GJ/m^3
Produced Gas LHV = 17.3 MJ/m^3
Natural Gas LHV = 32.7 MJ/m^3
Diluent LHV = 30.24 GJ/m^3
Dilbit LHV = 39.61 GJ/m^3

For a 20,000 bpd CPF (i.e., Lesimer Commercial Hub):

Total Energy IN = Bitumen from Wells + Produced Gas + Natural Gas + Electrical Import +
Diluent Feed Total
Energy IN = 133.43 TJ/d + 0.44 TJ/d + 22.18 TJ/d + 1.73 TJ/d + 24.04 TJ/d = 181.82 TJ/d

Where:

Bitumen from Wells = 3,180 m^3/d * 41.96 GJ/m^3 = 133.43 TJ/d
Produced Gas = 25,440 m^3/d * 17.3 MJ/m^3 = 0.44 TJ/d
Natural Gas = 678,330 m^3/d * 32.7 MJ/m^3 = 22.18 TJ/d
Electrical Import = 1,728 GJ/d = 1.73 TJ/d
Diluent Feed Total = 795 m^3/d * 30.24 GJ/m^3 = 24.04 TJ/d

Total Energy OUT = Saleable Products + Electrical Export + Losses + Uses
Energy OUT = 157.45 TJ/d + 24.37 TJ/d = 181.82 TJ/d

Where:

Saleable Products = Dilbit = 3,975 m^3/d * 39.61 GJ/m^3 = 157.45 TJ/d
Electrical Export = 0 TJ/d
Losses + Uses (steam, flue gas, aerial coolers, tanks, piping) = 24,370 GJ/d = 24.37 TJ/d

Energy Efficiency = (Energy OUT in Saleable Products / Total Energy IN)*100
Efficiency = ((157.45 TJ/d) / (181.82 TJ/d))*100 = 87 %

For a 40,000 bpd CPF (i.e. Leismer Expansion Hub or Corner Hub):

Total Energy IN = Bitumen from Wells + Produced Gas + Natural Gas + Electrical Import + Diluent Feed Total
Energy IN = 266.87 TJ/d + 0.88 TJ/d + 44.36 TJ/d + 3.46 TJ/d + 48.08 TJ/d = 363.65 TJ/d

Where:

Bitumen from Wells = 6,360 m^3/d * 41.96 GJ/m^3 = 266.87 TJ/d
Produced Gas = 50,880 m^3/d * 17.3 MJ/m^3 = 0.88 TJ/d
Natural Gas = 1,356,660 m^3/d * 32.7 MJ/m^3 = 44.36 TJ/d
Electrical Import = 3,456 GJ/d = 3.46 TJ/d
Diluent Feed Total = 1,590 m^3/d * 30.24 GJ/m^3 = 48.08 TJ/d

Total Energy OUT = Saleable Products + Electrical Export + Losses + Uses
Energy OUT = 314.90 TJ/d + 48.75 TJ/d = 363.65 TJ/d

Where:

Saleable Products = Dilbit = 7,950 m^3/d * 39.61 GJ/m^3 = 314.90 TJ/d
Electrical Export = 0 TJ/d
Losses + Uses (steam, flue gas, aerial coolers, tanks, piping) = 48,747 GJ/d = 48.75 TJ/d

Energy Efficiency = (Energy OUT in Saleable Products / Total Energy IN)*100
Efficiency = ((314.90 TJ/d) / (363.65 TJ/d))*100 = 87 %

For 220,000 bpd Kai Kos Dehseh Application Case:

Total Energy IN = Bitumen from Wells + Produced Gas + Natural Gas + Electrical Import + Diluent Feed Total
Energy IN = 1,467.76 TJ/d + 4.84 TJ/d + 244.00 TJ/d + 19.01 TJ/d + 264.45 TJ/d
= 2,000.06 TJ/d

Where:

Bitumen from Wells = 34,980 m^3/d * 41.96 GJ/m^3 = 1,467.76 TJ/d
Produced Gas = 279,840 m^3/d * 17.3 MJ/m^3 = 4.84 TJ/d
Natural Gas = 7,461,628 m^3/d * 32.7 MJ/m^3 = 244.00 TJ/d
Electrical Import = 19,008 GJ/d = 19.01 TJ/d
Diluent Feed Total = 8,745 m^3/d * 30.24 GJ/m^3 = 264.45 TJ/d

Total Energy OUT = Saleable Products + Electrical Export + Losses + Uses
Energy OUT = 1,731.95 TJ/d + 268.11 TJ/d = 2,000.06 TJ/d

Where:
Saleable Products = Dilbit = 43,725 m^3/d * 39.61 GJ/m^3 = 1,731.95 TJ/d
Electrical Export = 0 TJ/d
Losses + Uses (steam, flue gas, aerial coolers, tanks, piping) = 268,109 GJ/d = 268.11 TJ/d

Energy Efficiency = (Energy OUT in Saleable Products / Total Energy IN)*100
Efficiency = ((1,731.95 TJ/d) / (2,000.06 TJ/d))*100 = 87 %

9.	**SIR 27, Page 61.** Statoil Hydro indicates that the diluent blend ratio (about 20%) required to meet the pipeline specifications depends on the diluent composition. Provide the expected diluent composition and variance range?

Response

The variance range associated with typical diluents used in SAGD applications can best be described by presenting the range between the expected condensate and OSA (oil sands A synthetic crude) compositions.

The expected condensate diluent properties (as used in the material balances of the Application and subsequent SIRs) is presented in Table 9-1. Similarly, the expected composition and properties for OSA is presented in Table 9-2.

Table 9-1: Condensate Diluent Properties

PARAMETER DESCRIPTION	RESULTS	UNITS	METHOD
Density Analysis			
Measured Relative Density @ 15 ºC	0.7203	-	ASTM D5002
Distillation Analysis			
Initial Boiling Point	33.1	ºC	ASTM D86
Temp @ 5 vol %	46.7	ºC	ASTM D86
Temp @ 10 vol %	51.5	ºC	ASTM D86
Temp @ 15 vol %	55.2	ºC	ASTM D86
Temp @ 20 vol %	59.1	ºC	ASTM D86
Temp @ 25 vol %	63.3	ºC	ASTM D86
Temp @ 30 vol %	68.1	ºC	ASTM D86
Temp @ 35 vol %	73.8	ºC	ASTM D86
Temp @ 40 vol %	80.9	ºC	ASTM D86
Temp @ 45 vol %	89.0	ºC	ASTM D86
Temp @ 50 vol %	97.1	ºC	ASTM D86
Temp @ 55 vol %	104.3	ºC	ASTM D86
Temp @ 60 vol %	112.7	ºC	ASTM D86
Temp @ 65 vol %	121.9	ºC	ASTM D86
Temp @ 70 vol %	134.8	ºC	ASTM D86
Temp @ 75 vol %	151.4	ºC	ASTM D86
Temp @ 80 vol %	178.9	ºC	ASTM D86
Temp @ 85 vol %	242.8	ºC	ASTM D86
Final Boiling Point	301.6	ºC	ASTM D86
Distillation Residue	1.2	vol %	ASTM D86
Distillation Recovery	88.8	vol %	ASTM D86
Distillation Loss	10.0	vol %	ASTM D86
Distillation Naphtha	77.0	vol %	ASTM D86
Distillation Kerosene	10.7	vol %	ASTM D86
Hydrocarbon Types			
Aromatics	6.4	vol %	ASTM D1319
Olefins	0.9	vol %	ASTM D1319
Saturates	92.7	vol %	ASTM D1319

PARAMETER DESCRIPTION	RESULTS	UNITS	METHOD
Organic Halides			
Total Organic Halides as Chloride	<1	µg/g	ASTM D4929
Physical Properties			
Absolute Density @ 15ºC	719.7	kg/m^3	ASTM D5002
API Gravity @ 15ºC	65.0	-	
C5 Insoluble Asphaltene Content	0.068	mass %	MAXX D60
Copper Corrosion	1B	-	ASTM D130
Reid Vapour Pressure	70.7	kPa	ASTM D323
Salt Content	6.0	ppm (mass)	ASTM D3230
Sediment	79.0	ppm (mass)	ASTM D4807
Total Sulphur (S)	0.169	mass %	ASTM D4294
Total Sediment	0.000	vol %	ASTM D4007
Total Water Content	0.050	vol %	ASTM D4007
Total Sediment and Water	0.050	vol %	ASTM D4007
Viscosity Analysis			
Kinematic Viscosity @ 5ºC	0.8167	cSt	ASTM D445
Kinematic Viscosity @ 10ºC	0.7667	cSt	ASTM D445
Kinematic Viscosity @ 20ºC	0.6895	cSt	ASTM D445

Table 9-2: OSA Diluent Properties

PARAMETER DESCRIPTION	RESULTS	UNITS
Distillation Analysis		
Initial boiling point	-42.2	°C
Temp @ 5 vol %	50	°C
Temp @ 10 vol %	88.9	°C
Temp @ 30 vol %	216.1	°C
Temp @ 50 vol %	311.7	°C
Temp @ 70 vol %	371.7	°C
Temp @ 90 vol %	435.6	°C
Temp @ 95 vol %	460	°C
Final boiling point	537.8	°C
Organic Halides		
Chlorides, Organic	< 1	ppm
Chlorides, Total	< 1	ppm

PARAMETER DESCRIPTION	RESULTS	UNITS
Physical Properties		
Specific gravity 15/15°C	0.8566	-
API Gravity @ 15°C	33.7	-
Asphaltenes	< 0.1	mass %
Copper corrosion	1a	-
Reid Vapour Pressure	2.8	psia
Salt content	< 3	mg/L
Bottom solids & water	< 0.1	vol %
Acid Number (TAN)	0.05	mg KOH/g
Ash	0.2	mass %
Bromine number	1.7	-
Carbon residue (MCRT)	0.02	mass %
K-Factor	11.6	-
Insolubles, Toluene	< 0.005	mass %
Hydrogen Sulphide (dissolved)	8	ppm
Mercaptan sulphur	< 10	ppm
Sulphur	0.19	mass %
Wax	0.2	mass %
Components		
Ethane	0.0	vol %
Propane	0.1	vol %
Iso-butane	0.5	vol %
Normal butane	1.8	vol %
Iso-pentane	0.9	vol %
Normal-pentane	2.2	vol %
Cyclo-pentane	0.3	vol %
Iso-hexane	0.0	vol %
Normal-hexane	2.0	vol %
Benzene	0.1	vol %
Metals		
Arsenic	< 0.3	ppm
Iron	< 0.15	ppm
Nickel	< 0.15	ppm
Silicon	< 1	ppm
Sodium	< 1.5	ppm
Vanadium	< 0.05	ppm
Nitrogen - total	426	ppm
Nitrogen - basic	109	ppm
Viscosity Analysis		
Viscosity @ 40°C	4.5	mm^2/s

D. ENVIRONMENT

10.	**SIR 4, Pages 84-85; SIR 87, Page 223; SIR 101, Pages 242-244; SIR 118 and 119, Pages 276 – 279.** StatoilHydro indicates that it has not considered potential future seismic disturbances in its cumulative effects assessment. The ERCB considers all project related disturbances (including seismic) within the LSA to be a component of the Kai Kos Dehseh Project. a. Describe the potential effects (extent, magnitude, etc.) of future seismic activity within the Kai Kos Dehseh LSA, and any mitigation StatoilHydro will employ to minimize these effects at a regional scale. In addition, describe if StatoilHydro has investigated opportunities to re-use existing seismic disturbances rather than creating new disturbance.

Response

StatoilHydro has completed an updated assessment for the Kai Kos Dehseh project (application case). This assessment includes the addition of borrow pits, present and anticipated 3D and 4D seismic, Oil Sands Evaluation (OSE) coreholes and roads, (diluents & dilbit) pipeline, and third-party infrastructure (ATCO powerline). The potential effects of these combined Kai Kos Dehseh disturbances within the Kai Kos Dehseh Local Study Area (LSA) are presented for wildlife and vegetation indicators in SIR(2) #46(b). StatoilHydro has investigated, and will continue to investigate and implement opportunities to re-use existing linear disturbances.

StatoilHydro will minimize the impact from seismic activity at a regional scale with the following mitigation measures, where practical:

- Re-use of seismic lines (e.g., use of 2D or 3D seismic lines for future 4D programs) and existing access wherever possible and practical;
- Reducing soil disturbance, vegetative ground cover, and surface hydrology impacts by cutting and shooting seismic lines only during the winter months when the ground is frozen;
- Minimize the extent and duration of sensory disturbances resulting from seismic activities.
- Minimizing the area disturbed by cutting seismic lines as narrow as possible (i.e., practicing low impact seismic);
- Creating meandering seismic lines to minimize lines of sight for predator species; and
- Reducing access to seismic lines where they intersect with roads, so as to minimize access and human disturbance (e.g., recreation and hunting).

10.	b. StatoilHydro concludes that there will be no impacts to biodiversity as its assessment shows that there will be no "high impacts" from linear disturbance density. The analysis excludes future seismic activity. Comment on how the impact rating may change in consideration of current and future seismic activity in the analysis.

Response

StatoilHydro predicts that linear disturbance from future seismic activity will not cause high impacts to biodiversity within the LSA or RSA (Regional Study Area). The inclusion of the linear disturbance from seismic activity within the application case does not result in any high impacts to any of the assessed wildlife or vegetation indicators.

Seismic line impacts to vegetation are predicted to be low, as the areal impact of seismic clearing is small (approximately 2.3% of the LSA 0.1% of the RSA) Additionally, since new seismic lines are narrow (typically 1.75 m to 3 m) with no soil disturbance, there is very little chance of seismic lines significantly affecting a specific vegetation community, indicator or species.

Seismic lines may act as barriers to wildlife movement of wide-ranging species (Mader 2005) or cause edge effects for species such as forest interior birds. However, some species may benefit from increased edge, especially those taking advantage of the vegetation changes for food or nesting, such as microtines (e.g., deer mice), birds and ducks, grazing ungulates, and small carnivores (Jalkotzy and Nasserden 1997). Wildlife species that require less space to meet their needs are less likely to be impacted by linear disturbance.

Low-impact seismic practices, as performed by StatoilHydro, have been shown to have a minimal impact on bird movement. StatoilHydro typically uses seismic lines with receiver lines 1.75 m wide and source lines a maximum of 3 m in width. Machtans (2006) found that seismic lines have little impact on forest interior species in the boreal forest, with the exception of ovenbirds. However, another study, demonstrated that while ovenbirds did perceive 8 m wide seismic lines as a barrier to movement, they did not perceive low-impact seismic lines as a barrier (Bayne et al. 2005). Large mammals may also be affected by seismic lines if they act as barriers to their movement between high-quality habitats. A number of studies have shown that in many cases narrow seismic lines do not act as barriers for caribou (Dyer et al 2002), forest-dwelling carnivores (Jalkotzy and Nasserden 1997) or bobcats (Millions and Swanson 2007, Lovallo and Anderson 1996). Recent results of the StatoilHydro scat monitoring study (unpublished) confirm that caribou are not avoiding seismic lines within the monitoring program study area.

In many cases, it is not the seismic lines themselves that wildlife avoid, but the crews and noise associated with them while the lines are being cut and shot. Moose have been shown to avoid seismic lines during seismic activity (Jalkotzy and Nasserden 1997), but show no avoidance to pipeline corridors after construction has been completed (Sopuck and Vernam 1986). These disturbance periods will be minimized as much as possible (approximately 2 weeks per year at each active location) by StatoilHydro and seismic lines will only be cleared during winter, avoiding species that are only present during the summer months as well as any critical wildlife nesting or calving periods.

Based on past studies, the amount of seismic line being created within the LSA, and the mitigation measures that StatoilHydro will implement, impacts to biodiversity are predicted to be low to moderate when seismic disturbances are included (see SIR(2) #46(b)).

REFERENCES

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Machtans, C.S. 2006. Songbird response to seismic lines in the western boreal forest: a manipulative experiment. Can. J. Zool. 84: 1421-1430.

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Sopuck LG, Vernam DJ. 1986. Distribution and Movements of Moose (*Alces alces*) in Relation to the Trans-Alaska Oil Pipeline. Arctic 39 (2):138-44.

11.	**SIRs 23 and 24, Page 116.** StatoilHydro indicates that it has conducted site specific soil sampling and rare plant surveys for the Leismer Demonstration CPF and SAGD pads, and that additional soil sampling and rare plant surveys will be completed for the Leismer Commercial and Corner Commercial phases. StatoilHydro's response to SIR 23 also states, *"To date the PDAs have resulted in some pads having to be resized to accommodate the predicted volumes of salvaged materials."* a. As some pads have already been resized to accommodate salvaged soil materials, discuss how StatoilHydro has taken the information obtained from the Demonstration Project and applied it to the designing of the proposed project footprint.

Response

The response to ERCB SIR(1) #23(a) requires additional clarification. The Leismer Commercial Hub Phase will utilize the same SAGD pads as the LDP, and hence there will be no need for additional Pre-Disturbance Assessments (PDAs). Future Leismer Expansion Hub and Corner Hub SAGD well pads will require PDAs.

As a lesson learned from the LDP, larger SAGD pad footprints (157 m by 289 m) were described in the Kai Kos Dehseh Project footprint, that correlate to the resized pads used in the LDP (e.g., LDP SAGD Pad "B", has a constructed footprint of 157 m by 289 m).

11.	b. Clarify when sampling for the Leismer Commercial and Corner Commercial Project Development Areas will be completed.

Response

Please note that there is an inconsistency in the response to ERCB SIR(1) #23(a); the Leismer Commercial Hub phase will utilize the same SAGD pads as the LDP, and hence there is no need for additional PDAs. Future Leismer Expansion Hub and Corner Hub SAGD wellpads will require PDAs.

A PDA is conducted on parts of the footprint that are being developed in the near future (e.g., within a year). The assessment is conducted only within the footprint (e.g., well pad). As indicated in AENV SIR(1) #89(a), #127(a), and #190, PDAs consist of soils and vegetation assessments to gather information required for construction and future reclamation and to identify the presence of rare plants and weeds. The PDAs are required to be submitted to AENV six months prior to proposed pad construction. Based on the six-month lead-time requirement and seasonal nature of some of the field work (e.g., rare plant surveys), StatoilHydro will be conducting the actual field assessments one to two years prior to development of new CPFs and pads.

11.	c. For the Leismer Expansion area component of this proposed project, provide updated maps that clearly display sampling locations, and discuss StatoilHydro's findings and resulting mitigations from additional site-specific soil, vegetation and wildlife assessments. From these findings, describe any anticipated changes to the proposed project layout.

Response

Refer to SIR(2) #11(b) above and refer to SIR(2) #36(a) for a response regarding wildlife and PDAs.

11.	d. Confirm StatoilHydro understands that it needs to contact the ERCB to determine the need for an amendment application for any proposed additions or modifications should the current application be approved based on the project description provided.

Response

StatoilHydro understands that the ERCB requires notification of any proposed material alteration or modification of the SAGD scheme, or to any equipment proposed for use therein, prior to effecting the alteration or modification, to facilitate the ERCB's determination of the need for an amendment application.

12.	**SIR 34, Page 132; SIR 86, Pages 221-222; SIR 104, Pages 252-254.** StatoilHydro states that it will "*incorporate an adaptive management approach when new information is received from future site specific assessments and ongoing monitoring activities.*" a. Provide a more in depth discussion on StatoilHydro's approach to implementing adaptive environmental management and incorporating the results into its operations.

Response

Impacts to environmental resources are predicted using current knowledge of baseline conditions and assumptions based on current understanding of cause and effect. As part of the approval conditions, StatoilHydro will commit to various monitoring programs. To address changing conditions or impacts, proponents must be able to adapt their project as required, hence the term "adaptive environmental management."

Adaptive environmental management involves evaluating and adjusting management policies and practices by monitoring key response indicators. This framework acknowledges that there are inherent uncertainties as to how the indicators will respond to both the project impacts and associated management and mitigation policies, and aims to incorporate a mechanism for adjusting these policies as monitoring dictates and conditions change. The main steps of an effective adaptive environmental management framework are:

1. Acknowledgement of uncertainty about what policy or practice is "best" for the particular management issue;
2. Thoughtful selection of policies or practices to be applied (the assessment and design stages of the cycle);
3. Careful implementation of a plan of action designed to reveal the critical knowledge that is currently lacking;
4. Monitoring of key response indicators;
5. Analysis of the management outcomes in consideration of the original objectives; and
6. Incorporation of the results into future decisions.

StatoilHydro will follow the principles of an adaptive environmental management framework during the construction and operation of the Project. In consultation with regulators, specific key response indicators will be monitored. If mitigation is shown to be ineffective, changes to mitigation, Project design or process will be reviewed and assessed. It is not possible at this time to discuss specifically how StatoilHydro will implement adaptive environmental management into its operations for specific environmental resources or indicators. Results of monitoring will need to be communicated to regulators at regular intervals and it is during this process that StatoilHydro, in consultation with regulators, will determine if or how mitigation measures must be adapted to manage environmental impacts.

12.	b. Regarding the analysis of fecal samples, as outlined in response AENV 104, provide a discussion on what measures and thresholds or target values will be used and how and/or when the results of this testing will trigger specific management actions.

Response

Several measures are being obtained from analysis of caribou, moose and wolf fecal samples collected by the scat monitoring program (see AENV SIR(1) #104(a)). These measures include, but are not limited to the following.

1. DNA measures that enable detection of species, sex, and individual identities from scat samples. These measures enable identification of population abundance through mark-recapture analysis.
2. Diet composition based on scat content. The composition of different prey species in the wolf diet is being measured from hair and DNA that is found in the wolf scat samples.
3. Hormone measures enabling identification of animal nutrition (thyroid hormone) and stress (cortisol).

As stated in the response to AENV SIR(1) #104(a), specific thresholds or target values have not yet been identified, and further analysis of the samples collected to date may provide this information.

13.	**SIR 127b, Page 284.** StatoilHydro states, "*…there may be a need to enlarge the CPF to allow for storage of peat material…by approximately 10%.*" a. Provide StatoilHydro's rationale for not providing the worst case scenario with respect to its footprint calculations

Response

Experience to date with the LDP CPF, and planning for the Leismer Expansion Hub has provided some useful feedback for the Kai Kos Dehseh EIA. As stated in the question, peat stockpiles may be larger than anticipated. After the Round 1 SIR responses were submitted, it became apparent that the Leismer Expansion Hub CPF footprint would be incorporated into the LDP CPF and would be smaller than anticipated, leaving the entire CPF footprint for the Leismer Hub (plant site and stockpiles) within its originally planned footprint. Therefore, StatoilHydro submits that its original footprint calculations remain valid, and are not an understatement of disturbance.

13.	b. Discuss how underestimating the required CPF footprint might impact StatoilHydro's assessment conclusions, and overall project footprint.

Response

The footprint has not been underestimated. Refer to the response to SIR(2) #13(a) above.

13.	c. Revise the proposed project footprint to reflect a more conservative estimate, or if StatoilHydro feels there is no need to revise the overall footprint, discuss how it has incorporated other site specific information to provide some assurance that its current assessment adequately reflects the environmental conditions in the proposed disturbance area.

Response

The footprint has not been underestimated and does not need to be revised. Refer to the response to SIR(2) #13(a) above.

ENVIRONMENTAL IMPACT ASSESSMENT

D. GENERAL

14.	**SIR 2, Page 8.** StatoilHydro states, "*…the Traditional Land Use Studies are forthcoming and expected to be completed in late 2008.*" a. Provide an update on the status of the Traditional Land Use Studies.

Response

StatoilHydro jointly identified with the communities the following Aboriginal groups to be included in the Traditional Ecological Knowledge (TEK) Studies: Chipewyan Prairie Dené First Nation; Conklin Métis Local 193, and; Fort McMurray No. 468 First Nation. The scope of these TEK studies includes both traditional ecological knowledge and traditional land use. Ongoing efforts have been made to complete the TEK Studies with these communities. The status of the TEK Studies for each Community is as follows:

Chipewyan Prairie Dené First Nation

Chipewyan Prairie Dené First Nation (CPDFN) selected 13 Elders and active land users who were then interviewed in January, 2009. The interviewees were selected because of their familiarity with the Project Lease areas and primary areas of interest within the lease areas. In February, 2009, two CPDFN Elders spent two days on a field trip of the Corner Lease.

A preliminary internal report, for CPDFN review only, based on the January, 2009 interviews and the February 2009 field visits is anticipated by the end of March, 2009. Extensive field visits are anticipated for spring/summer 2009 to ground-truth the identified sites/locales. StatoilHydro will continue to report to AENV on the status of the study.

Conklin Métis Local 193

Prior to initiating StatoilHydro's TEK Study with Conklin Métis Local 193 (CML193), StatoilHydro was asked to contribute to the CML 193 Community-based Traditional Land Use Study (TLUS). To this end, StatoilHydro provided capacity training and digital and media equipment to the CML193. With the CML 193 TLUS nearing completion, a series of maps were confidentially provided to StatoilHydro outlining CML's traditional land use sites and potential areas of concern with respect to the Project. These maps will guide the discussions and work required for the StatoilHydro's TEK Study with CML193.

The next steps in the StatoilHydro's TEK Study with CML193 will be to:

- Work with the community to determine the potential for impact to site/use areas and culturally significant locales which have been identified to date;
- Consider the potential for focused studies within the proposed development area i.e., to locate traditional land use areas within the StatoilHydro lease areas; and,

- Identify potential mitigation, follow-up and monitoring recommendations and agreements.

A detailed timeline for these activities will be determined in the upcoming months and StatoilHydro will continue to report to AENV on the status of the studies.

Fort McMurray No. 468 First Nation

Subsequent to the turnover in the Band Office, discussions have resumed with the Fort McMurray No. 468 First Nation (FMFN) Industry Relations Corporation (IRC) regarding the status and completion of the TEK Study for the Project. Discussions with FMFN have been underway since 2007. While a confidential constraints map has been produced showing FMFN traditional land use sites and areas of concern with respect to the Project, future discussions will determine activities and a timeline in the upcoming months. StatoilHydro will continue to report to AENV on the status of the studies.

15.	**SIR 171c, Page 360.** StatoilHydro states, "...existing *resource roads will be upgraded and new access road developed*." a. Clarify which existing road(s) StatoilHydro will upgrade and which new access road(s) StatoilHydro will be developed.

Response

StatoilHydro has upgraded a municipal road identified as RRD9622302 from Conklin Corner to the southern extent of the Waddell Road. This road has been upgraded to accommodate heavy haul vehicles and to have overhead powerline clearance required for larger loads.

The Waddell Road is a pre-existing private road within the Kai Kos Dehseh Project area. The southern 13 km of the Waddell Road has been upgraded to accommodate heavy haul vehicles, including installing a new bridge across the Christina River. A new road from Waddell Road km 13 to the LDP CPF has been built to accommodate heavy haul vehicles. The Waddell Road from km 13 to 35 is currently being maintained, and will be upgraded to accommodate heavy haul vehicles into the Corner Hub site.

Access to the Thornbury and Hangingstone Hubs is planned to use existing access infrastructure from Highway 63 and follow existing winter access roads. The existing winter access roads will require upgrading to allow all season access into the Thornbury and Hangingstone Hubs. Refer to SIR(2) #16(g) Figure 16-1 below for further clarification.

15.	b. Discuss who will be doing these upgrades and provide a timeframe.

Response

Future upgrades to the private road network will be completed by StatoilHydro and other industrial operators as per road use agreements. The timing of these upgrades coincides with the Project development schedule as provided in AENV SIR(1) #79, Figure 79-1.

16.	**SIR 171c, Page 360; SIR 174, Page 362; SIR 175, Page 363; SIR 177, Page 364; SIR 180, Page 367; SIR 182, Pages 369-370.** StatoilHydro states, "*StatoilHydro is in the process of commissioning a Traffic Impact Assessment (TIA) for the Project, and this question has been included in the scope of work for the Assessment. The TIA is expected to be submitted to Alberta Infrastructure & Transportation at the end of August, 2008.*" As a response to the above SIR questions, Statoil has responded, "*…these questions will be addressed once the TIA is complete.*" a. Provide an update on the status of the Traffic Impact Assessment. When does StatoilHydro plan to submit the TIA to regulatory agencies?

Response

The traffic study has been drafted. Once finalized, a meeting with Alberta Infrastructure and Transportation (AT) will take place for review, expected to take place by end May 2009.

16.	b. Provide responses to the SIR questions referenced above.

Response

SIR(1) #171 (c) Identify impacts of increased traffic due to the two proposed permanent camps. Provide details of any infrastructure upgrades that may be required to mitigate these impacts.

Response

The intent of locating camps within the field area is to provide accommodation for workers to decrease the requirement for travel on public roads. This is also supported by having the Leismer Aerodrome located within the field area. Moving people into the field area by plane and then providing accommodation has an over-all decreased affect on traffic on public roads, specifically Highway 63 and Highway 881.

In addition to the initial response to AENV SIR(1) #171(c), the following information is provided.

The two proposed permanent camps include the Leismer Lodge and the Mariana Lake Camp. The Leismer Lodge was completed in January, 2008, and is located within 5 km of the LDP CPF. There are no identified public road traffic impacts associated with the location of the Leismer Lodge, and due to the location of the Lodge, no further infrastructure upgrades will be required. The Mariana Lake Camp is proposed as a future worker accommodation for the Thornbury Hub and Hangingstone Hub CPFs, and supporting public road infrastructure exists for access. StatoilHydro will continue to work with AT and industrial operators regarding future development plans and access to Highway 63. Assessment of impacts and mitigation will be ongoing.

SIR(1) 174

Diluent will be trucked in until a pipeline is constructed in approximately 2012. It is estimated that there will be 60 B-train trucks daily.

a. Identify impacts of this truck traffic and determine if infrastructure upgrading is needed.

Response

Approvals have been obtained for construction of dilbit and diluent pipelines which are expected to be in service at the start-up of the LDP. This eliminates the need for trucking dilbit and diluent to and from the LDP CPF. The elimination of dilbit and diluent trucking will reduce the need for infrastructure upgrading.

SIR(1) 175

StatoilHydro notes that in total, traffic on local roads is estimated to include approximately 110 different vehicles. Of these approximately 20 vehicles are anticipated to be operating only in the local area, and the remaining 90 will use Highway 881 as well as the local Project related roads.

a. Clarify if these 110 daily different vehicles include workers using bus transportation.

b. Clarify if the buses from the camp will need to cross Highway 881. If so, provide a plan to show that the intersection geometry will be adequate.

Response

See Round 1 submission for responses 175 (a) and (b).

c. Provide information on any discussions with Alberta Transportation regarding the increase in total daily construction traffic that StatoilHydro will create on local roads.

Response

StatoilHydro representatives attended an Oil Sands Developer Group (OSDG) meeting with AT where the increased traffic at Conklin Corner was discussed. AT was made aware of predictions of increased traffic, as a result of StatoilHydro activity, as well as other industrial activity.

d. Provide annual average daily traffic (AADT) existing truck volumes for the AM and PM peak hours on Highway 881.

Response

The annual average daily traffic (AADT) for existing truck volumes for the AM and PM peak hours on Highway 881 are provided in Table 16-1.

Table 16-1 AADT and Existing Truck Volumes on Highway 881

Type of Activity	AM Peak Traffic	PM Peak Traffic
Construction	25 semi trailers	3 semi trailers
Operations	30 vehicles	4 vehicles

e. Provide a summary table by development area and hub including AADT volumes and a timeline for construction and operations with the following information:

i. Average on-site personnel Provide annual average daily traffic (AADT) existing truck volumes for the AM and PM peak hours on Highway 881.

Response

See Table 16-2

ii. Number of bus round trip to the hub

Response

See Table 16-2

iii. Size of vehicle and number of movements

Response

Based on the project schedule presented in AENV SIR (1) #79, Figure 79-1, Table 16-2 below includes estimated traffic volumes for 2012, 2014 and 2030. In 2012, it is estimated that heavy truck traffic will include 80 semi trailers and 8 oversized loads. In 2014, it is estimated that heavy truck traffic will include 120 semi trailers and 12 oversized loads. In 2030, there is no heavy truck traffic associated with construction.

Table 16-2 AADT Baseline Summary Table by Hub

Development	Hub	2012			2014			2030		
		AADT	# personnel	# bus trips	AADT	# personnel	# bus trips	AADT	# personnel	# bus trips
Leismer	LDP	245	120	4	77	40	2	93	50	2
	Leismer Commercial	245	120	4	77	40	2	93	50	2
	Leismer Expansion	278	120	4	305	160	5	186	100	3
	Northwest Leismer	0	0	0	0	0	0	186	100	3
	South Leismer	0	0	0	0	0	0	186	100	3
Corner	Corner	555	240	7	610	320	10	373	200	6
	Corner Expansion	555	240	7	610	320	10	373	200	6
Thornbury	Thornbury	200	240	6	160	160	4	185	200	5
	Thornbury Expansion	100	120	3	80	80	2	93	10	3
Hangingstone	Hangingstone	0	0	0	75	80	2	93	100	3
Total		2,178	1,200	35	1,994	1,200	37	1,861	1,110	36

f. Identify the impact of the increased traffic volumes. Provide details of infrastructure upgrades that may be needed on Highway 63 and 881 to mitigate these impacts.

Response

Conclusions of the traffic study state no upgrades to Highway 63 or Highway 881 are anticipated as a result of StatoilHydro traffic impacts.

g. Provide a map showing the access routes to any Project areas and the proposed locations of any intersection upgrades.

Response

A map of the access routes has been provided as Figure 16-1

SIR(1) 177

StatoilHydro indicates that roads within the StatoilHydro Project are technically within Lakeland County, most will be private roads maintained by StatoilHydro or other industrial corporations, including Al-Pac. The road between Conklin and the Waddell Road turn-off is a provincial road.

a. Provide additional details about access to the plant site during construction and operations. In particular, comment on the extent of traffic congestion occurring at the turn-off to the site and how this may impact traffic flow and traffic safety.

Response

Access to the Leismer Commerical and Expansion Hubs and the Corner Hub will be via the Highway 881 turn off at Conklin Corner. The traffic study has predicted for 2012, 2014 and 2030 that no road improvements will be required at this intersection. Access to the Thornberry and Hangingstone areas will be via the Mariana Lakes location at Highway 63, and there are no intersection improvement predictions for this location as well.

SIR(1) 180

StatoilHydro notes that the product will be most noticeable around Conklin and Janvier as they will haul to the Cheecham Terminal and Fort McMurray.

a. Indicate what percentage of the product trucks will go to Cheecham Terminal and to Fort McMurray Terminal.

Response

As an update to the response provided to AENV SIR (1) #180, it is now expected that a diluent and dilbit transfer pipeline will be in place at the time of production at the Leismer CPF, so there will be no need to truck diluent and dilbit out of the Kai Kos Dehseh field area.

b. What is the projected traffic flow (number of vehicles and trucks) through Anzac from the Kai Kos Dehseh Project?

Response

Traffic through Anzac was not specifically monitored. However, the traffic along Highway 881 was monitored at Conklin, at the Janvier turn off and at the Long Lake intersection. Based on these traffic volumes, the following combined north-south volumes for StatoilHydro truck and vehicles associated with the Kai Kos Dehseh Project have been projected for 2012, 2014, and 2030. The total vehicle number represents projected volumes for all vehicle traffic on Highway 881. As determined, the increased traffic resulting from the Kai Kos Dehseh Project operations is expected to be less than 10% error of the AADT calculations. To see a summary of this information, refer to Table 16-3.

Table 16-3 Projected Traffic Flow Through Anzac from the Kai Kos Dehseh Project

Year	Volumes (AADT)		
	StatoilHydro Trucks	StatoilHydro Vehicles	StatoilHydro and all other predicted traffic (vehicle and truck)
2012	4	82	5864
2014	2	82	4221
2030	0	32	4008

SIR(1) 182

StatoilHydro indicates that Fort McMurray First Nation, Anzac and Gregoire Estates will continue to feel an increase in traffic from all the disclosed projects unless the power lines on the south end of Highway 881 are buried, and oversized loads can travel into the region on the south end of Highway 881. Additionally, a project to connect Highway 63 and Highway 881 south of Anzac, known as the Stony Mountain bypass, would alleviate all of the truck traffic through the communities along the north end of Highway 881. Until the bypass is built (no date for a feasibility study has yet been given), all projects will contribute to this increase in traffic. Large oversize loads will likely continue to be staged between midnight and 5 am, reducing conflicts in traffic on the road. Additionally, a connecting road between Highway 881 and Highway 63, located approximately west from Conklin, has been discussed. Again, this is not in the feasibility phase of planning. This road would serve the interest of many companies, including Al-Pac.

a. Provide information on any discussions that StatoilHydro has had with the RMWB and AT regarding mitigation measures to reduce the traffic impacts noted above.

b. Given that the road would serve the interest of many companies, what steps have the companies taken to put the by-pass roads in place?

c. Provide discussions with Provincial Government regarding the connecting road between Highway 881 and Highway 63. How would this road be classified? What is the timeline for construction?

d. Given the importance of Highway 63 as the primary access for communities and industry to the north of the site, has StatoilHydro assessed the risk of a disruption of traffic along Highway 63 in certain emergency situations?

Response

The traffic study has not resulted in any changes to the responses provided in AENV SIR(1) #182.

SIR(1) 183

StatoilHydro indicates that the volume of traffic anticipated for Conklin will be higher in the cumulative case, as many of the announced projects are east of Conklin. Currently, there is a bypass road which alleviates some of the traffic through the community. StatoilHydro does not contribute a large change to the Conklin traffic, except through permanent employees traveling to work and truck traffic passing Conklin turnoff during construction.

a. Provide additional information on how many StatoilHydro employees will travel to work.

Response

StatoilHydro's intention is to have as many workers as possible use the Leismer Aerodrome for travel in and out of the field area, and for these workers to have accommodation at either one of the camps. With construction and future operations workers using these services, the expectation is that approximately 20% of the permanent employees (EIA, Volume 5, Sections 14.8 and 14.9) will reside in the region. It is assumed 25% of these regional residents (20 workers) will live close enough to commute to the site.

b. Identify the impact of these traffic volumes and provide details of the infrastructure upgrades that may be required to mitigate these impacts.

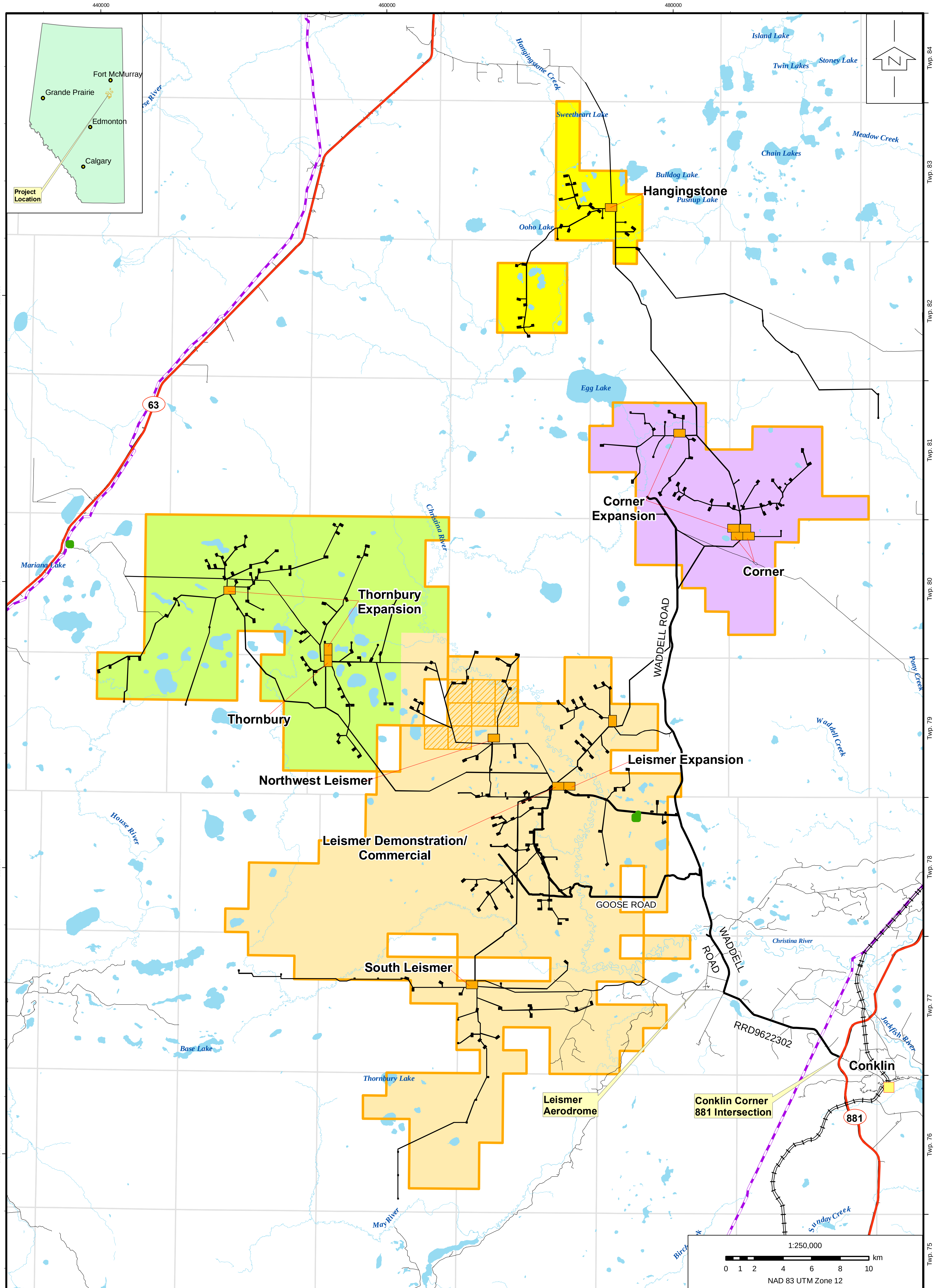
Response

Based on the anticipated volumes of StatoilHydro's traffic flow, in combination with predicted impacts from all other users, no intersection upgrades will be required.

17.	**SIR 182a and c, Pages 369-370 and Volume 5, Section 14.9.15, Page 14-75.** StatoilHydro states, "*…large oversize loads will likely continue to be staged between midnight and 5am, reducing conflicts in traffic on the road. Additionally, a connecting road between Highway 881 and Highway 63, located approximately west from Conklin, has been discussed. Again this is not in the feasibility phase of planning. This road would serve the interest of many companies, including Al-Pac.*" StatoilHydro indicated that discussions have been taken place with Strategic Planning and Policy Division, Planning and Development department, The Regional Airport Authority and Infrastructure and Planning Alberta government. a. Given that other companies in the area are scheduling large oversize loads between midnight and 5am what other mitigation measures StatoilHydro will put in place to reduce traffic impact.

Response

StatoilHydro will participate within the OSDG meetings to help coordinate the shipment of large oversized loads through the Anzac area. Through participation in OSDG meetings, StatoilHydro will also determine if other mitigation measures will be required and how they might be implemented.



Legend

StatoilHydro Lease	Waterbody	Corner Development Area
Joint Venture Land	Watercourse	Hangingstone Development Area
Hub	Major Road	Leismer Development Area
StatoilHydro Project Footprint	Project Access Road	Thornbury Development Area
Camp	Road	City/Town

Title:

FIGURE 16-1

CURRENT PROJECT ACCESS

StatoilHydro

Approved: RL	Revision Date: March 23, 2009
File: FIGURE_16-1_CURRENT_PROJECT_ACCESS.mxd	
Drawn by: RF	Checked: MM

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E. AIR

18.	**SIR 7, Pages 87-92.** The sulphur balance for the project and hubs have been revised using a consistent expected sulphur content of 1.75 % mole H_2S and gas oil ratio (GOR) of 8. The SO_2 emissions are listed in Figure 27-1 (Sulphur as SO_2: 0.06 t/d), Figure 7-1 (Sulphur as SO_2: 0.67 t/d), Figure 7-2 (Sulphur as SO2:0.12 t/d), Figure 7-3 (Sulphur as SO2: 0.12 t/d), and Figure 7-4 (Sulphur as SO2: 0.12 t/d). The sulphur balance for each process output on each figure appears to be Sulphur t/d and not SO2t/d. a. Confirm that the above values are, in fact, emissions of Sulphur as Sulphur, not as SO_2 and that the emissions are: 0.12t/d, 1.34 t/d, 0.24 t/d, 0.24 t/d, respectively.

Clarification to SIR(2) #18:

A sulphur emission value stated in the question is incorrect and should be indicated as:

AENV SIR(1) #7, Figure 7-2 - Sulphur as SO2: 0.06 t/d

Response

The values reported on the figures above are *Sulphur as Sulphur* and not SO_2.

The associated SO_2 emissions would be: 0.12 t/d, 1.34 t/d, 0.12 t/d, 0.24 t/d and 0.24 t/d, for each figure, respectively.

19.	**SIR 21, Pages 114-115 and Volume 2, Section 2.6.1.4.** This section indicates that produced gas upstream of sulphur recovery contains 0.05% H2S. The revised sulphur balance for the Kai Kos Dehseh project uses an upstream H2S content of 1.75%. If the modular concept of the project is based upon each 3180 m^3/d production unit with a GOR of 8, it is expected that upset flaring should account for 2120 m^3/h of gas. This would correspond to an emission rate of 1.16 t/d of SO2 (or 13.5 g/s SO2). Response to SIR1 Question 21, shows a gas composition for OTSG sh/d that is similar but consistent with the above (fuel gas added). However, Volume 2, Section 2.6.2.2, Page 2-43 (and Table 2A2-4) shows an emission rate 0.588 g/s was used in the upset flare modelling. a. Provide air quality modelling for upset flaring consistent with the 1.75% H2S content of the produced gas and 3180 m^3/d production unit with a GOR of 8.

Clarification to SIR(2) #19:

With a concentration of 1.75% H_2S in the produced gas, based on a 3,180 m^3/d (20,000 bpd) CPF and a GOR of 8, the expected upset flaring would account for 1,060 m^3/hr of gas. This corresponds to an emission rate of 0.05 t/d or 13.7 g/s of SO_2 as indicated below.

Response

StatoilHydro has conducted the modelling for this upset flaring scenario. Modelling was conducted using the revised sulphur balance upstream H_2S content of 1.75% based upon each 3,180 m^3/d (20,000 bpd) production unit with a GOR of 8. Table 19-1 shows the revised flaring parameters and gas composition of the stream used in upset modelling.

Table 19-2 presents the maximum and 9th highest 1-hour SO_2 predictions for the updated upset scenario using the CALPUFF model based on the event emission rate. The 9th highest SO_2 prediction is less than the Alberta Ambient Air Quality Objective (AAAQO) of 450 ug/m^3.

Table 19-1. Flaring Parameters used in Upset Flare Modelling

Flaring Scenario	**Upset Flaring**
Emission Source	HP Flare
Flaring Event Duration (min)	*20*
Actual Stack Height (m)	32.0
Actual Stack Diameter (m)	0.406
Gas Flow Rate (10^3 std m^3/d)	*25.44*
Flared Gas Composition (mol %): Hydrogen (H_2)	0.020
Helium (He)	0.020
Water (H_2O)	0.000
Nitrogen (N_2)	2.380
Carbon Dioxide (CO_2)	2.700
Hydrogen Sulphide (H_2S)	*1.750*
Methane (CH_4)	91.460
Ethane (C_2H_6)	0.040
Propane (C_3H_8)	0.070

Flaring Scenario	Upset Flaring
i-Butane (*i*-C_4H_{10})	0.100
n-Butane (*n*-C_4H_{10})	0.390
i-Pentane (*i*-C_5H_{12})	0.570
n-Pentane (*n*-C_5H_{12})	0.490
n-Hexane (*n*-C_6H_{14})	0.010
n-Heptane (*n*-C_7H_{16}+)	0.000
Total	100
Flared Gas Net Heating Value (MJ/m^3)	33.55
Effective Stack Height (m)[a]	*37.07*
Equivalent Stack Diameter (m)[a]	*3.845*
Actual Exit Velocity (m/s)	*2.3*
Equivalent Stack Temperature (K)[a]	*1273*
Event SO_2 Emission Rate (g/s)	4.561
Hourly SO_2 Emission Rate (g/s)	*13.682*

Notes: a Pseudo-parameters are calculated using the Alberta Environment Calculation Sheet for Flares, Version 3.0. Effective stack height equals actual stack height plus flame height. Equivalent diameter is calculated based on energy balance considerations that allow the CALPUFF model to represent plume rise from a flare stack.

Table 19-2. Reassessed CALPUFF Model Predictions for Upset Modelling with Revised H_2S Content of 1.75% (in ug/m^3)

	Averaging Period	SO_2 Concentration (ug/m^3)	AAAQO (ug/m^3)
SO_2	1-h Max	303.8	-
SO_2	1-h 9th	240.1	450

20.

SIR 25, Pages 118-121 and Volume 2, Section 2A, Table 2A1-2, Page 2A-5.

The list in Table 2A1-2 is incomplete compared to the EPA general reference provided. Response AENV SIR 25 (c) provided a list of VOCs not found in Table 2A1-2, and therefore not included in the air quality assessment. That list contains several carcinogenic or probable carcinogenic emissions. These emissions are related to United States Environmental Protection Agency estimates for reciprocating engines and turbines.

a. Confirm whether reciprocating engines and turbines are part of the Kai Kos Dehseh project emissions profiles, and include the list of VOC speciation in the air quality and human health assessment.

Response

Reciprocating engines and turbines are not proposed as part of the Kai Kos Dehseh Project; however, they are part of the existing baseline. Therefore, VOC species associated specifically with reciprocating engines and turbines were not included in the air quality and human health assessments of the Kai Kos Dehseh Project. The list of VOC species included in the air quality and human health risk assessments are provided in Table 20-1.

Table 20-1 VOC Species Inclusion List for the Kai Kos Dehseh Project

VOC Species	
1	2-Methylnaphthalene
2	3-Methylchoranthrene
3	7,12-Dimethylbenz(a)anthracene
4	Acenaphthene
5	Acenaphthylene
6	Acetaldehyde
7	Acrolein
8	Anthracene
9	Benzaldehyde
10	Benzene
11	Benzo(a)anthracene
12	Benzo(a)pyrene
13	Benzo(b)fluoranthene
14	Benzo(e)pyrene
15	Benzo(g,h,i)perylene
16	Benzo(k)fluoranthene
17	Chrysene
18	Dibenz(a,h)anthracene
19	Dichlorobenzene
20	Ethylbenzene
21	Fluoranthene
22	Fluorene
23	Formaldehyde
24	Hexane
25	Indeno(1,2,3-cd)pyrene
26	Naphthalene
27	Pentane
28	Perylene
29	Phenanthrene
30	Pyrene
31	Toluene
32	Xylenes

20.	b. Typically, these chemicals are included in the air quality and human health assessments. Discuss whether the conclusions are valid given that these chemicals were not included.

Response

In AENV SIR(1) #25(c), a list of several VOC species were mentioned that have U.S. EPA (Environmental Protection Agency) AP-42 emission factors that were not included in the assessment. Of this list only butane, ethane and propane are emitted from the Kai Kos Dehseh Project. The other VOC species are associated with turbines and reciprocating engines, which are not part of the Kai Kos Dehseh Project. Typically, butane, ethane and propane are not included in a human health assessment unless they are emitted in high enough concentrations to displace oxygen resulting in asphyxiation or to exceed the lower explosive limit (LEL). As the emissions from the Kai Kos Dehseh Project are low for these species relative to asphyxiation thresholds or LELs, they were not included in the air quality and human health assessments.

21.	**SIR 6, Page 86 and SIR 7, Pages 87-92.** a. Provide a discussion as to the basis of the 2.86 t/d of SO2 emissions used in the modelling, including how this number was determined.

Clarification to SIR(2) #21:

The value of 2.86 t/d as reported in the EIA, Volume 2, Section 2.6.1.5, Table 2.6-1 and Appendix 2A, Section 2A2.1, Table 2A2-1, was in error and should have been 2.88 t/d of SO_2 emissions based on 48 OTSGs at 0.06 t/d of SO_2 per OTSG.

Response

The original modelling was prepared for 38,160 m^3/d (240,000 bpd) which includes the Leismer South CPF not intended for operation until 2034. This would account for the 48 OTSG's included in the modelling. However, only 44 OTSG's, accounting for 34,980 m^3/d (220,000 bpd), will be operating simultaneously. Therefore, the total SO_2 emissions for the 34,980 m^3/d case would be 2.64 t/d of SO_2 or 1.32 t/d of sulphur.

Referring to SIR(2) #18 above, one can back-calculate the expected emissions based on the sulphur balance. Here, StatoilHydro reports 1.34 t/d of SO_2 for a peak production of 34,980 m^3/d (220, 000 bpd), which is approximately equivalent to 0.03 t/d SO_2 per OTSG. Therefore, the value which was modelled was approximately double of what would be normally expected, based on the sulphur balance. The value of 0.06 t/d of SO_2 per OTSG was based on preliminary engineering estimates and was overly conservative. Moreover, as stated in AENV SIR(1) #6 and AENV SIR(1) #7, engineering refinements were incorporated into the Project description in the EIA,Volume 1, however, as the air modelling was already conservative, an update of the EIA was not required.

22.	**SIR 10b, Page 94.** StatoilHydro states, "*Where, based on operational, safety and environmental considerations, sour gas will be sweetened in a neighbouring plant, design, logistics and operations will be developed during the detailed engineering phase of each plant.*" a. Clarify if StatoilHydro may have to construct additional pipelines to transport the sweetened gas to a neighbouring plant.

Response

Sweetened gas/produced gas have been included in the interconnecting pipelines, as discussed in the response to SIR(2) #58(b).

23.	**SIR 13a, Page 98.** StatoilHydro states, "*The original estimate of 0.334 t/d of NOx from Once Through Steam Generators (OTSG)s was incorrect. Boiler suppliers, including OTSG manufacturers, are following the provincial codes and CCME guidelines (i.e. maximum NOx emissions of 40 g/GJ); emission levels achieved in practice often are 15 – 20% lower than required by the Code.*" a. Since StatoilHydro has changed its NOx estimate, provide an update of the NOx emissions from the OTSGs, and provide an update of the expected site wide NOx emissions from the project.

Response

Using a conservative site-wide NOx emission factor of 15%, which is lower than the emission limit of 40 g/GJ NOx as given in the CCME, *National Emission Guideline for Commercial/Industrial Boilers and Heaters*, *1998*; calculations indicate 34 g/GJ of NO_X per OTSG at 75.41 MW. This translates into 0.222 t/d NO_X per OTSG and an overall expected site-wide NO_X emissions of 10.79 t/d.

F. WATER

24.	**SIR 38, Table 38-4, Page 141.** a. Verify the turbidity results for 12-33-80-08 W4. Explain why the results are so high.

Response

The turbidity results for 12-33-080-08W4M (Lower Grand Rapids Aquifer) are correct as documented in AENV SIR(1), #38, Table 38-4 (4,040 NTU). The turbidity result for this particular groundwater sample is high because the well screen was damaged during installation and formation sediment entered the wellbore. The presence of sediment in the wellbore increased the turbidity measurement of this sample.

24.	b. Verify the orthophosphate result for 16-09-79-10 W4.

Response

The orthophosphate result for 16-09-079-10W4M as documented in AENV SIR(1) #38, Table 38-4 is erroneous. The correct orthophosphate concentration should have been 0.6 mg/L.

25.	**SIR 38, Table 38-5, Page 143.** a. Verify the turbidity and fluoride results for 10-35-77-10 W4 and explain why the results are so high.

Response

The turbidity and fluoride results for 10-35-077-10W4M (Clearwater B Aquifer) are correct as documented in AENV SIR(1) #38, Table 38-5 (2,600 NTU and 37.2 mg/L, respectively). The turbidity result for this groundwater sample is high because the well completion consisted of a casing perforation; therefore, there was no direct sediment control such as in the case of a screen and gravel pack. In addition, the well was evacuated using an air compressor, rather than a pump for aquifer testing. The utilization of compressed air to evacuate the well increases the likelihood of lifting formation sediment along with the water. As such, the presence of formation sediment in the groundwater sample increased the turbidity measurement of this particular sample.

Similar to the turbidity results, the measurement of fluoride in the groundwater sample was also likely influenced by the completion and well testing technique. The turbidity results and fluoride concentration at the 10-35-077-10W4M location are likely more representative of formation water.

25.	b. Traces of petroleum hydrocarbons (BTEX) were detected in 10-35-77-10 and 11-19-77-10 W4, explain possible origin and proposed monitoring of these parameters in the subject wells.

Response

The origin of these hydrocarbon parameters is interpreted to be due to the natural presence of hydrocarbons in the Clearwater B Aquifer. Groundwater monitoring of these wells is not planned. A horizontal well is planned for this Aquifer, and is reported in SIR(2) #27(a) below.

26.	**SIR 43, Page 157.** StatoilHydro has not yet provided a detailed characterization of the Viking Formation. a. Provide detailed rock characterization for the Viking Formation.

Response

The Viking Formation is a relatively thin, coarsening-upwards sequence, of the Colorado Group, deposited in a shallow epicontinental sea environment (Mossop and Shetsen, 1994). In the RSA, the Viking Formation consists mainly of siltstone and shale with a minor amount of sandstone at the top of the Formation. Where present, the Viking Formation locally occurs at elevations ranging between 433 masl and 460 masl, and its thickness ranges from 6 m to 11 m. Regionally, the Viking Formation is eliminated through erosion north and east of the Stony Mountain Uplands and along stretches of the Athabasca River. Within the LSA, the Viking Formation is eliminated by erosion in the thalweg of the Christina Channel and subcrops in the Wiau and Leismer channels.

Several hydraulic conductivity estimates of the Viking Formation have been documented. Bachu et al. (1993) and Hitchon et al. (1989) both published regional data sets of hydraulic conductivity measurements from drill-stem test (DST) and core analyses (EIA, Volume 3, Section 5.5.3, Table 5.5-2). Representative Viking Formation hydraulic conductivity values from those data sets range from 1×10^{-11} m/s to 8×10^{-4} m/s.

Bachu et al. (1993) notes that hydraulic head values in the Viking Aquifer are mounded below the Stony Mountain Uplands and radially decrease to the north, west and south toward the Clearwater, Athabasca and Beaver rivers. Groundwater flow in the Viking Aquifer is expected to be predominantly horizontal and radial away from the Stony Mountain Uplands towards aquifer outcrops.

REFERENCES

Bachu S., Underschultz, J.R., Hitchon, B. and D. Cotterill. 1993. Regional-Scale Subsurface Hydrogeology in Northeast Alberta. Alberta Research Council Bulletin No. 61.

Hitchon, B., Bachu, S., Sauveplane, C.M., Ing, A., Lytviak, A.T. and J.R. Underschultz. 1989. Hydrogeological and Geothermal Regimes in the Phanerozoic Succession, Cold Lake Area, Alberta and Saskatchewan. Alberta Research Council, Bulletin No. 59, Edmonton, Alberta.

Mossop, G. and I. Shetsen. 1994. Geological Atlas of the Western Canada Sedimentary Basin. Published jointly by the Canadian Society of Petroleum Geologists and the Alberta Research Council in sponsorship association with the Alberta Department of Energy and the Geological Survey of Canada.

27.	**Volume 3, Section 5, Table 5.5-1, Pages 5-18.** StatoilHydro has responded for several hydrogeological questions that, "*Collection of additional field data is on-going as StatoilHydro continues to assess groundwater resources and initiates groundwater monitoring ...*", or a similar response. a. Provide detailed plans for this program (e.g., dates (timeline), areas and horizons of interest, planned surveys and operations).

Response

The water strategy for the Kai Kos Dehseh Project is as presented in the original EIA, Volume 1, Sections 4.4, A2.3, B2.4 and C2.4. StatoilHydro is committed to continuing to evaluate potential saline groundwater sources and aquifers which are candidates for deep disposal. Listed below in Table 27-1 are the wells licensed for StatoilHydro's 2008/2009 winter drilling season to assess Kai Kos Dehseh Project groundwater resources and facilitate groundwater monitoring. The wells are grouped and the examination of timeline, horizons of interest, surveys and operations are discussed below within the context of the target geologic era. The Project water strategy may be refined pending the results of the 2008/2009 winter drilling season. The locations of the referenced wells are shown on Figure 27-1. The parameters that will be assessed in this drilling program will be similar to those in the prior hydrogeological studies included within the EIA.

Table 27-1 Paleozoic Wells – Saline Groundwater Source and/or Disposal – 2008-2009 Drilling Season

Well	Purpose	Drill-Stem Test (DSTs)	Pump Tests	Coring
15-35-78-10W4M	Disposal, Groundwater Source	Based on log evaluation	Based on log and DST data	Coring subject to geological evaluation
1-30-79-10W4M	Disposal, Groundwater Source	Based on log evaluation	Based on log and DST data	Coring subject to geological evaluation
4-33-79-12W4M	Disposal, Groundwater Source	Based on log evaluation	Based on log and DST data	Coring subject to geological evaluation
3-6-81-8W4M	Disposal	Based on log evaluation	Based on log and DST data	Coring subject to geological evaluation
12-7-81-8W4M	Disposal	Based on log evaluation	Based on log and DST data	Coring subject to geological evaluation

The 15-35-78-10W4M, 1-30-79-10W4M, 4-33-79-12W4M, 3-6-81-8W4M and 12-7-81-8W4M, wells will target zones below the Paleozoic subcrop (see Table 27-1). Some of the targeted Paleozoic carbonate zones have the potential to be used for both groundwater source and wastewater disposal purposes. The shallow potential source water zones are expected to have TDS concentrations in the range of 8,000 mg/L to 25,000 mg/L, determined from petrophysical evaluation. The deeper formations will likely have much higher TDS concentrations, and if porous, will be evaluated for disposal purposes. It should be noted there are no wells in the Leismer Project area that currently use zones below the Paleozoic subcrop for disposal purposes. Also, the proposed wells will provide additional information for seismic correlation by testing the Precambrian Basement. Check shot surveys will be run on specific wells to provide more certainty for relating the seismic data to the geological information. This should increase the probability of success in future drilling programs.

Mesozoic Wells – 2008-2009 Drilling Season

Three wells are planned to target the Basal McMurray Formation water-bearing sands for either a saline groundwater source (i.e., 12,000 mg/L to 16,000 mg/L TDS) or disposal purposes (Table 27-2). The first area involves the 14-28-78-10W4M (groundwater source) and 13-33-78-10W4M (disposal) wells that are planned to be used for a "push-pull" scheme at Leismer. Before they are used in these capacities, pump/injection tests are planned to confirm a good sandstone interconnection exists between the two wells. As the basal watersand is overlain by oil sands, the pump/injection tests are planned to assess the potential impact on the bitumen reservoir from the operation of the "push-pull" scheme.

The McMurray Formation watersand at the 13-34-79-6W4M well, greater than 30 km east of the Leismer development area, is planned to evaluate this watersand as a potential groundwater source.

Table 27-2 McMurray Formation – Saline Groundwater Source and Disposal

Well	Purpose	Cores	Drill-Stem Test (DSTs)	Pump Tests	Comments
14-28-78-10W4M	Groundwater Source	N/A	N/A	Test based on log and DST data	"Push-pull" groundwater source well
13-33-78-10W4M	Disposal	N/A	N/A	Test based on log and DST data	"Push-pull" disposal well
13-34-79-6W4M	Groundwater Source	To core sandstone	DST based on log evaluation		

The 11-19-77-10W4M Clearwater B horizontal groundwater source well will be drilled to delineate a large volume brackish water source (Table 27-3). In particular, the well will build on previous experience from the vertical wells 12-2-78-10W4M and 11-19-77-10W4M drilled in 2007 and 2008, respectively. These wells indicate good permeability, in the range of 200 mD; however, the presence of swelling clays and potential gas break-out can complicate matters. Fluid samples from the 11-19-77-10W4M vertical well indicated 6000 mg/L TDS concentration, which is appropriate for source water. This concentration is comparable to that tested in proximal wells (12-02-78-10W4M indicated 6510 mg/L, 6340 mg/L, and 6600 mg/L TDS; 10-35-77-10W4M indicated 7610 mg/L and 7290 mg/L TDS) indicating that this reservoir extends over a large area.

Table 27-3 Clearwater B Watersand – Saline Groundwater Source

Well	Purpose	Pump Tests	Comments
11-19-77-10W4M Horizontal	Groundwater Source	Pump tests	Based on 11-19 vertical well results

The proposed 2009 Grand Rapids Formation wells will evaluate this watersand as a potential non-saline groundwater source (Table 27-4). This cross-bedded, salt and pepper sand has a net aquifer thickness ranging from 25 m to 40 m, and typically indicates a permeability of between 3 D and 4 D. The TDS of the Formation ranges from 1,360 mg/L to 1,500 mg/L. Engineering challenges could include the possibility of gas-saturated water. The clay content of this Formation does not appear to present a problem for the proposed use as a groundwater source.

Supporting evidence:

- 9-21-81-9W4M: net 40 m aquifer thickness; 1500 TDS
- 14-32-80-8W4M: net 25 m aquifer thickness; 1360 TDS
- 11-31-80-8W4M: net 34 m aquifer thickness; 1410 TDS

Wells tested revealed 3-4 Darcy permeability

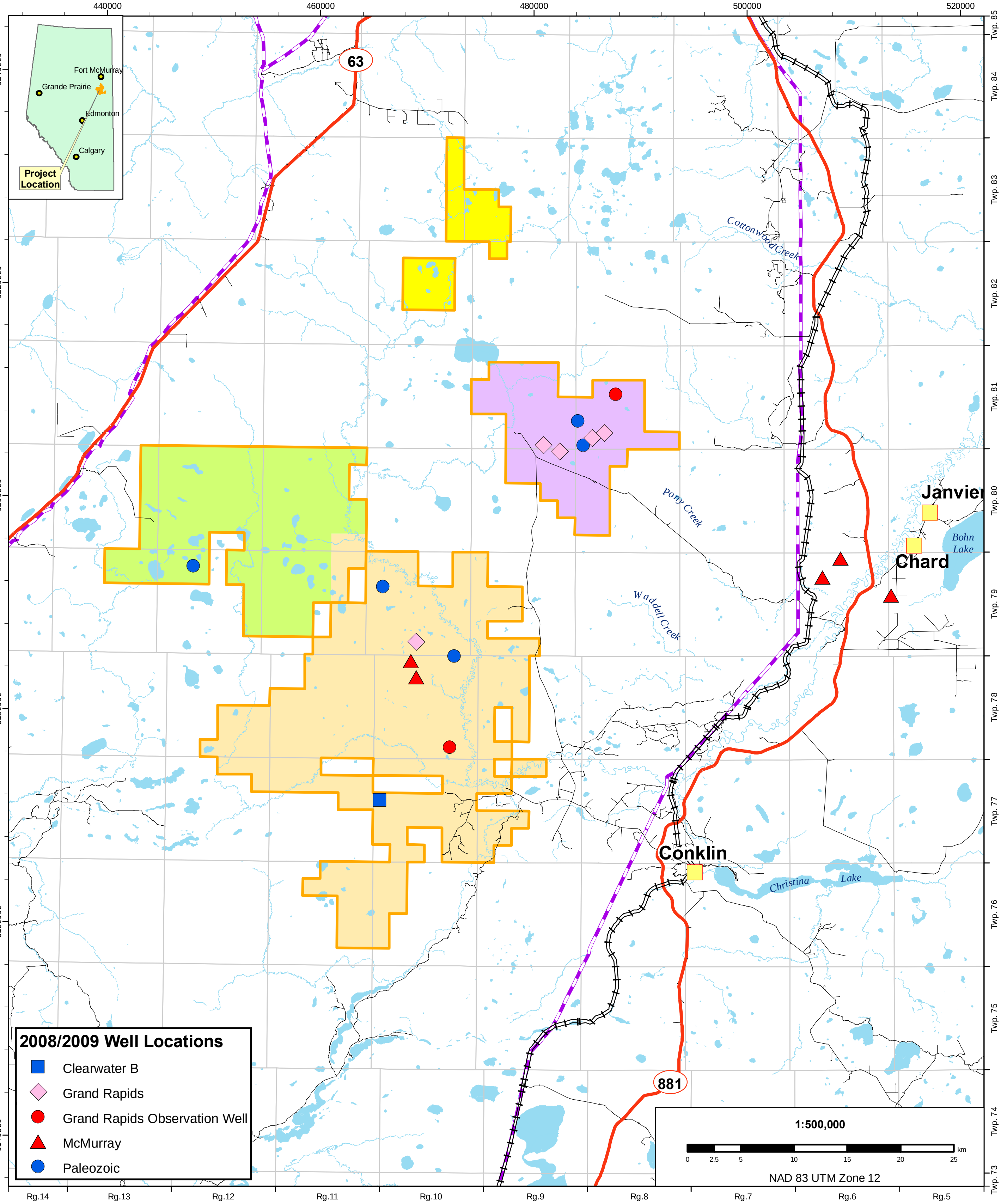
Table 27-4 Grand Rapids Formation – Non-Saline Groundwater Source

Well	Purpose	Pump Tests	Comments
13-36-80-9W4M	Groundwater Source	TBD	Area groundwater source wells define potential
15-5-81-8W4M	Groundwater Source	TBD	Area groundwater source wells define potential
9-6-81-8W4M	Groundwater Source	TBD	Area groundwater source wells define potential
5-2-81-9W4M	Groundwater Source	TBD	Area groundwater source wells define potential

Grand Rapids Formation: Observation Wells

AENV has sanctioned an extended Grand Rapids Formation (Lower Grand Rapids Aquifer) groundwater source well pump test at the 16-4-79-10W4M well. The extended pump test evaluation was requested to reduce the number of observation wells to be drilled and to maximize the utilization of existing wells to provide relevant feedback on the performance of the reservoir. Specifically, the eight Grand Rapids source wells drilled in 2007/2008 will not have to be twinned with observation wells. This represents a variation to the *Water Conservation and Allocation Policy for Oilfield Injection* (OIP), which calls for an observation well to be drilled 150 m from a groundwater source well. During the ongoing operation of these wells, the utilization of available drawdown will not exceed agreed parameters in the source well. Should drawdown rates approach agreed parameters, StatoilHydro will have the option of drilling observation wells to monitor drawdown and optimize withdrawal rates.

In addition to the wells described above, StatoilHydro will be drilling and installing two regional observation wells in the Lower Grand Rapids Aquifer, located at 11-2-78-10W4M and 3-22-81-8W4M, to be drilled in the 2008/2009 season. These wells will monitor the activities of adjacent operators within the context of StatoilHydro’s groundwater withdrawal strategy. The results will provide a baseline to the pumping response and will assist in assessing long-term regional effects.



Legend

StatoilHydro Lease Boundary	Railway
Waterbody	City/Town
Watercourse	Corner Development Area
Major Road	Hangingstone Development Area
Road	Leismer Development Area
Powerline	Thornbury Development Area

Title:

FIGURE 27-1

2008-09 WATER SOURCE AND INJECTION WELLS

StatoilHydro

Approved: RL	Revision Date: Mar. 21, 2009
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28.	**SIR 69, Page 191.** StatoilHydro states, *"…the selection of other more sensitive species such as Arctic grayling for long term study may result in adverse affects on the population over an extended period of time.*" a. Clarify that this statement acknowledges that it is the project that might be the cause of the adverse effects as this statement makes it sound as though the study would be the cause of the adverse effects.

Response

ASRD has identified Arctic grayling as a species that may be sensitive with limited populations in the region. As such a more ubiquitous sport fish/large bodied species (northern pike) was used for the EIA baseline study to reduce stress and potential mortality to Arctic grayling.

To clarify the statement made in AENV SIR(1) #69, StatoilHydro did not acknowledge that the Project will have an adverse affect on the Arctic grayling population. In fact, the response in SIR(1) #69 states that the selection of a sensitive species such as Arctic grayling is inappropriate for long term studies (i.e., multiple EIA baseline studies or multi year monitoring programs) due to unnecessary stress (including mortality) to individual specimens, which may lead to a decrease in population size over time.

29.	**SIR 71, Page 194.** StatoilHydro states, *"… the clearing of pads and roadways could potentially result in the alteration of surface flows during periods of elevated runoff.*" a. Provide detailed hydrological modelling to illustrate how flow will be affected by the surface disturbance and hardening that will result from alteration of the natural landscape to produce roadways and well pads.

Response

The impact of increased runoff from roads and compacted pad surfaces versus natural terrain is well known and could be simulated for a range of hypothetical hydrologic (wet/dry) conditions for illustration. Examples are provided using the SCS runoff model with assumptions provided by Maidement (1992), and applying a 1:25 year, 24-hour storm event of 77 mm (value estimated for the RSA) for soils with moderate and low infiltration rates. SCS curve numbers (CN) for natural (undisturbed) soil range from 55 for a moderate infiltration rate soil to 70 for soils with a low infiltration rate. Modelled runoff from these soils are 5 mm and 18 mm, respectively. When the soil is compacted to produce a roadway or well pad, then the CN number could increase to 82 to 87, and result in a runoff of 35 mm and 44 mm, representing a 140% to 600% increase in runoff. The considerable variability in the increase in runoff will depend on the infiltration of the different soil types and also the degree of compaction. Regardless, produced runoff is mitigated by the measures and best management practices described in the EIA, Volume 3, Section 6.12. For example, at roads, runoff will be collected at ditches and directed into regularly spaced cross-drains or culverts to then be dispersed and infiltrated into the forest floor. At well pads, runoff will be contained by berms or ponds and released to the forest at controlled rates. Erosion and sediment delivery controls will be applied as needed to prevent sediment-laden runoff from directly entering streams. Therefore, any excess runoff created by the Project will be localized, and is not anticipated to affect the natural hydrology of surface flows.

REFERENCES

Maidment, David R. 1992. Handbook of Hydrology. McGraw-Hill.

29.	b. Summarize the projected change in flow regime for the Christina River mainstem in terms of total annual discharge, absolute discharge (m^3), and percent of normal.

Response

The projected change to the natural flow regime of the Christina River associated with Project facilities and operations is anticipated to be below detection limits both in terms of absolute discharge and percentage of normal. This is based on:

- A low amount of surface water usage proposed, restricted to short term tanker truck withdrawals for construction, drilling and dust control; and
- The low amount of surface disturbance proposed by Project facilities, equivalent to 1% or less of the total watershed or sub-watershed area.

Impacts of this magnitude will not be measurable when considering that:

- Annual water yields in the Christina River can naturally fluctuate by a factor of eleven (EIA, Volume 3, Section 6.7.4.2), and
- Flow measurement accuracy is 3-5%.

29.	c. Discuss how such a change might influence fish and fish habitat.

Response

As indicated in the response to SIR(2) #29(b) above, the changes in the natural flow regimes of the Christina River are anticipated to be below detection limits. As a result, it is anticipated that fish and fish habitat will not be influenced.

30.	**SIR 72, Page 194.** StatoilHydro states, "*… the significance ranking does not reflect the potential fish and fish habitat present in the LSA; rather it is related to the level of sport fishing pressure the area is currently subject to*." a. Provide the reference used to determine the current sport fishing pressure (typically expressed as total angling hours per year or angler hours per hectare of water area).

Response

References for the current levels of fishing pressure in the Project area are not available. However, based on the current lack of access roads and rights-of-way (ROWs) in the vicinity of the majority of watercourses and water bodies in the Project area, it can be reasonably assumed that sport fishing pressure is low.

31.	**SIR 74, Pages 195-196.** The question was not answered. The original question related to the creation of access and the resulting increase in recreational use of the area being developed as part of the Project. The response did not address potential impacts of access development on the Arctic grayling population. Monitoring the impacts of the increased access on increased angler use and resultant harvest of the fish populations is analogous to other monitoring being conducted (air, water and soil pollutants that result from activities of the Project). a. Discuss the expected impacts on the Arctic Grayling population. b. What sampling (analogous to the pH monitoring proposed) is planned to monitor the fish populations and detect impacts? c. What metrics would be used as measuring tools? d. What mitigation is planned in the event of adverse impacts? e. How is angler fishing pressure and harvest due to the new access development going to be monitored?

Response

As discussed in the EIA, Volume 3, Section 8.6.4.3, impacts on the Arctic grayling population are expected to be low as a result of Project activities and increased public access.

An impact assessment pertaining to recreation follows. Twenty percent of mobile workers are involved in backcountry activities, resulting in approximately 0.2 backcountry activities per year per mobile worker (Nichols Applied Management and Economic Consultants, 2007). Given that the Project workforce is expected to reach about 1,200 persons at the peak construction phase (EIA, Volume 5, Section 14.9.1), StatoilHydro estimates that Project personnel will contribute a maximum of 240 backcountry trips per year. As stated in AENV SIR(1) #88, fishing is expected to account for 22% of backcountry activities and as such there is expected to be approximately 50 fishing trips per year as a result of the Project workforce. Furthermore, it is not known if Project personnel will use the backcountry surrounding the Project, or if they will use other areas, so this represents a worst-case assessment with respect to Project personnel. Therefore, the predicted level of backcountry recreation by Project personnel is expected to have a low impact on sport fish populations.

Increased site access may also result in increased sport fishing by local residents. StatoilHydro has limited authority to prevent access to areas within the Project lease boundary that are considered public lands. ASRD is responsible for overseeing the regulation of recreational angling in the Province of Alberta. It is expected that ASRD's implementation and enforcement of appropriate sport fishing regulations will sustainably manage the Province's fishery resource. StatoilHydro will work with regulators during the Project approval process in determining whether any access restrictions are warranted and whether they would be within StatoilHydro's authority to implement.

As the project impacts are predicted to be low, StatoilHydro is not planning to monitor fish populations in the area.

REFERENCES

Nichols Applied Management, and Economic Consultants, November 2007. Report on Mobile Workers in the Wood Buffalo Region of Alberta.

G. TERRESTRIAL

32.	**SIR 80, Pages 201-204.** StatoilHydro states, "*If permitted, StatoilHydro would like to revisit the possibility of excavating deeper borrows…*". StatoilHydro also states, "*…this volume of material will be sourced from the StatoilHydro leases, however, in some cases there may be logistical and environmental benefits from sourcing material off-lease.*" StatoilHydro states that borrow areas were not included in the Project footprint. Typically, borrow pits are included as a project disturbance, and included in the environmental assessment. a. Revise, and re-submit the footprint calculations to account for StatoilHydro's total disturbance, including all borrow areas.

Response

StatoilHydro's total footprint is approximately 9,166 ha, as assessed in the revised application case. This includes all preexisting and future seismic, future Oil Sands Evaluation (OSE) wells and access, roads, diluent pipeline, ATCO powerline and borrow pits. A description of this footprint and the Project components that are present in the area is provided in SIR(2) #52(b)(iv).

32.	b. With regards to borrow pits, clarify if StatoilHydro is still wanting approval for deeper borrows. If so, what is the aerial extent and total volume associated with this approach. Also indicate if the areas will be reclaimed as uplands or water features.

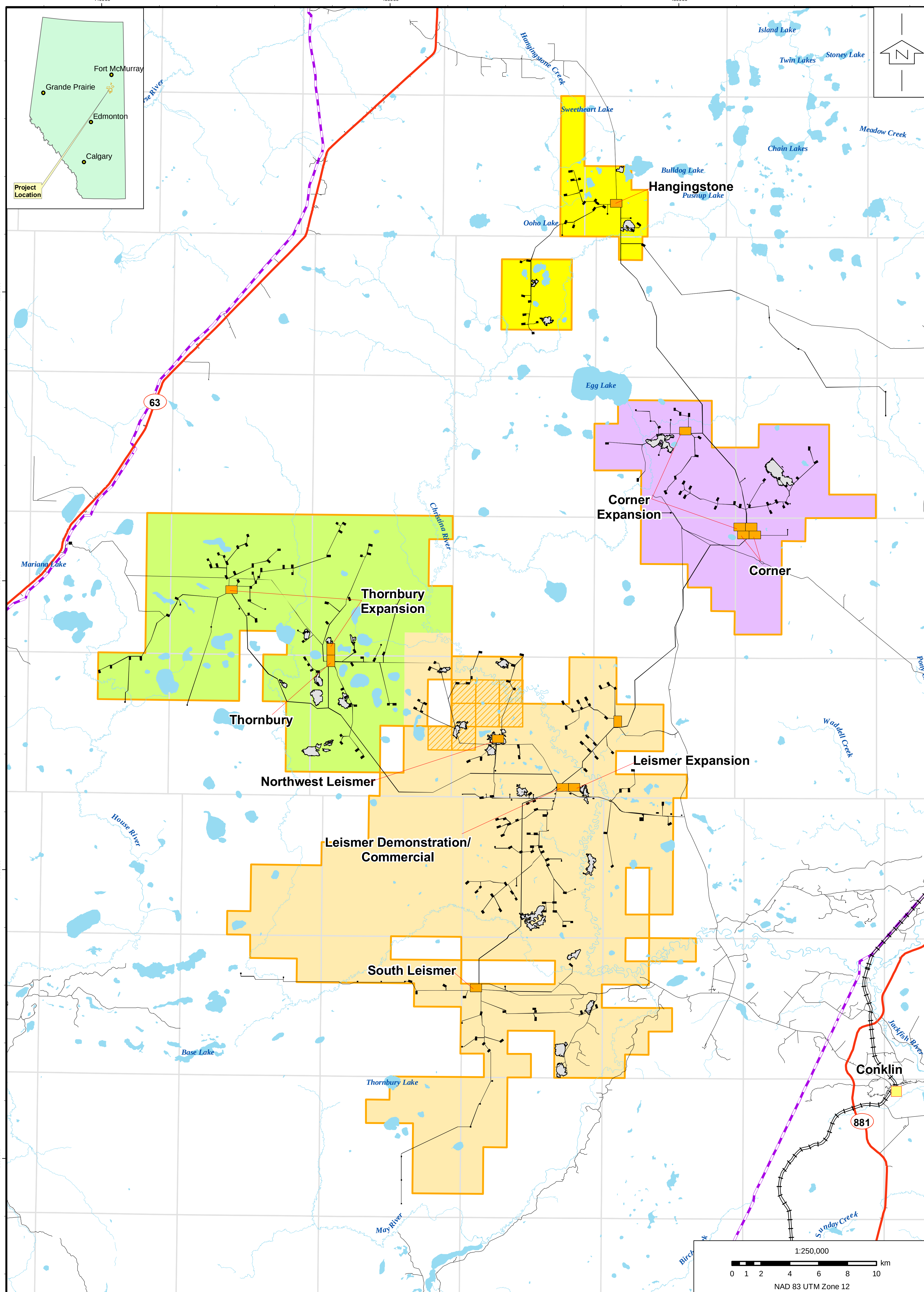
Response

StatoilHydro's opinion is that environmental, logistical and economic benefits arise from using deeper borrows, and therefore StatoilHydro would still seek approval for deeper borrow pits. Should StatoilHydro operate borrow pits that are nominally 3 m below grade, the surface footprint would be reduced significantly (from approximately 2,500 ha to approximately 1,400 ha); and the number of borrow pits would also be reduced, from approximately 30, to approximately 16 pits. Refer to Figure 32-1 for further information. StatoilHydro submits that these areas will be reclaimed as water features, as the depth of the borrow pits would preclude reclamation to uplands.

32.	c. Confirm whether StatoilHydro will be sourcing any borrow materials from off-lease opportunities. If so, discuss the 'environmental benefits' which may be achieved by sourcing material off-lease, and what opportunities have been explored with respect to an off-lease borrow material source (i.e. under what circumstances might this approach be adopted by StatoilHydro.)

Response

StatoilHydro will consider sourcing borrow materials from off-lease sources. Environmental benefits may include reduction of borrow pits in caribou zones and ungulate winter ranges. It may also reduce haul distance and associated impacts, utilize existing infrastructure and potentially reduce the number of borrow pits (should a suitably large source of borrow be identified). StatoilHydro has held discussions with some interested parties with regards to off-lease borrow material sourcing, however discussions have not progressed to the point where StatoilHydro can provide specific feedback on locations and volumes.



Legend

Statoilhydro Lease	Proposed Borrow Pit
Joint Venture Land	Waterbody
Footprint Infrastructure	Watercourse
Hub	City/Town
Major Road	Corner Development Area
Road	Hangingstone Development Area
Powerline	Leismer Development Area
Railway	Thornbury Development Area

Title:

FIGURE 32-1

PROPOSED DEEP BORROW PIT LOCATIONS

StatoilHydro

Approved: RL	Revision Date: March 21, 2009
File: FIGURE_32-1_PROPOSED_DEEP_BORROW_PIT_LOCATIONS.mxd	
Drawn by: RF	Checked: MM

33.	**SIR 85, Figures 85-1 and 85-2, Page 207.** a. StatoilHydro states, "*The EIA is being updated as indicated in AENV SIR Response 85 a ii and b i.*" When will this updated information be submitted to Regulatory agencies for review?

Response

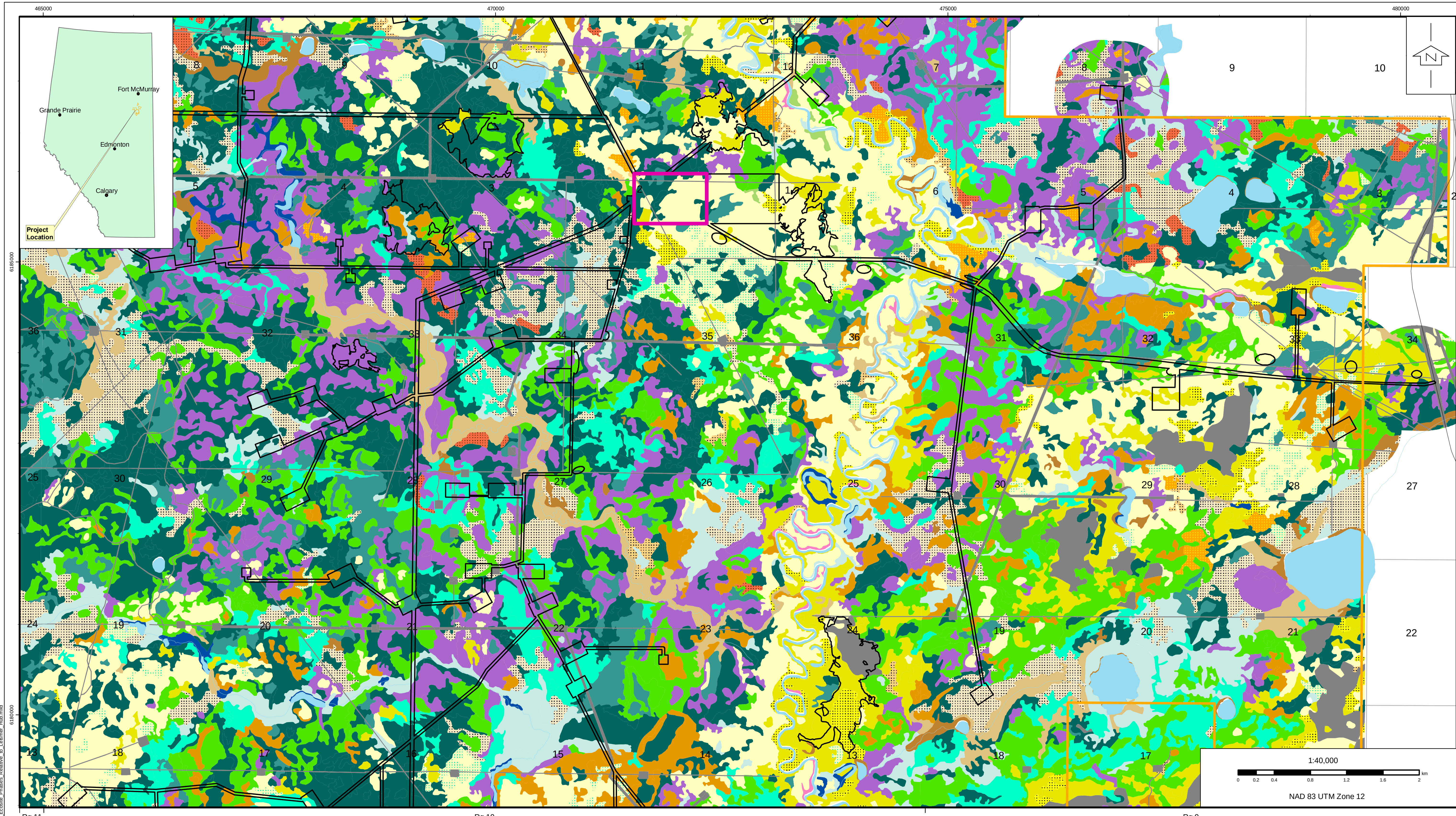
In the Round 1 SIR responses, StatoilHydro updated the EIA for vegetation and wildlife in AENV SIR(1) #85.

The EIA has been updated again to accommodate additional requests in the Round 2 SIRs. The disciplines affected by these changes are vegetation and wildlife. Refer to the response in SIR(2) #41 and SIR(2) #47 for more information on baseline wildlife surveys.

33.	b. The project footprint outline on these figures are too dark to allow identification of the underlying ecosite types. Re-submit these figures in a manner which clearly allows for identification of the footprint and the underlying ecosite types.

Response

The figures have been re-submitted as Figures 33-1 and 33-2 for this response.



Legend

- StatoilHydro Lease Boundary
- Leismer Hub
- Application Footprint
- Waterbody
- Watercourse
- Road

Baseline Ecosite Phase

a1, b1, b2, b3, b4, c1, d1, d2, d3, e1, e2, e3, f1, f2, f3, g1, h1, h2, i1, i2, j1, j2, j3, k1, k2, k3, l1, Flooded, Shrubland, Burn, Disturbed

Title:

FIGURE 33-1

ECOSITE PHASES RELATIVE TO THE LEISMER HUB

StatoilHydro

Approved: RL	Revision Date: March 22, 2009
File: FIGURE_33-1_Ecosite_Phases_Relative_to_Leismer_Hub.mxd	
Drawn by: RF	Checked: MM

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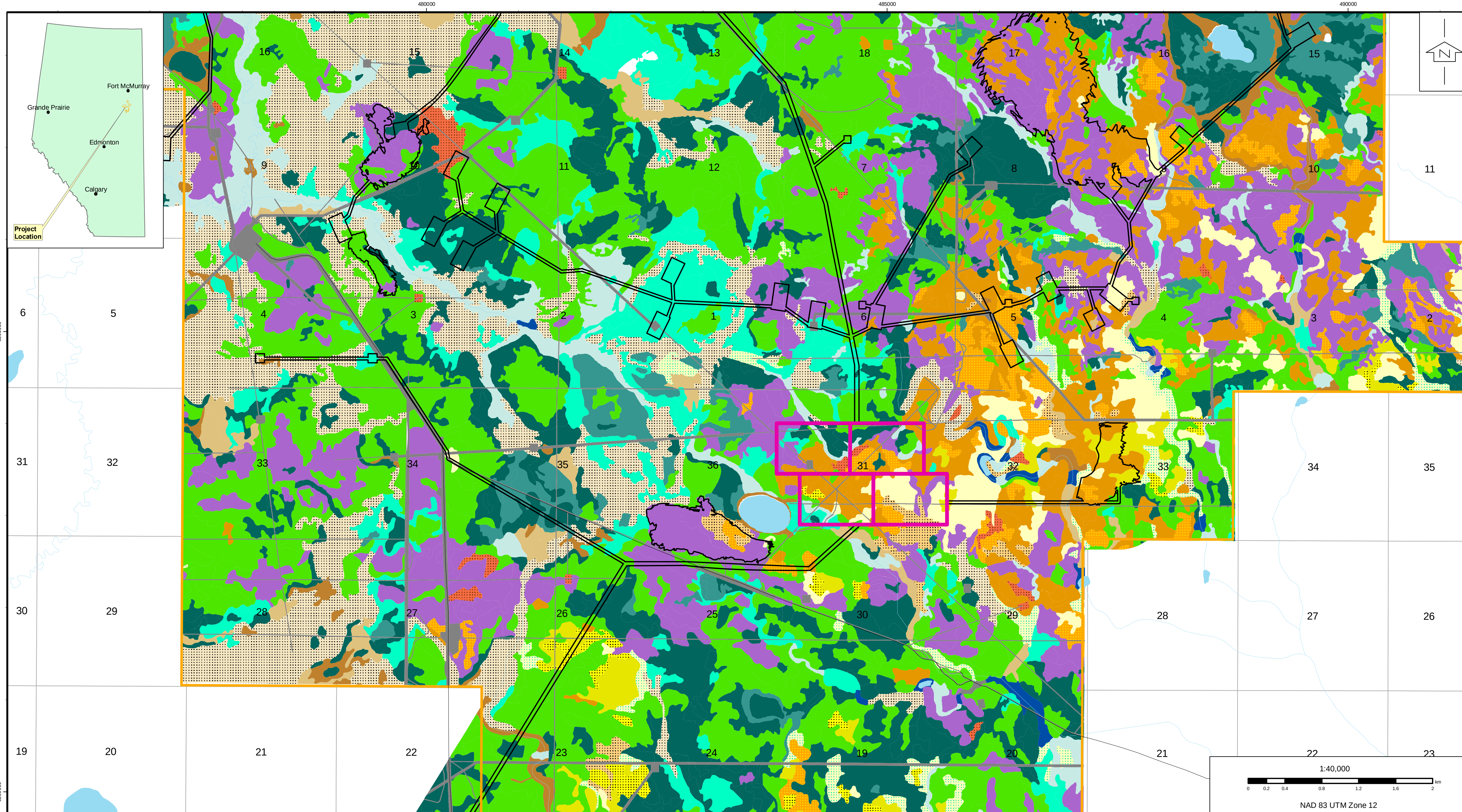


Legend

- StatoilHydro Lease Boundary
- Corner Hub
- Application Footprint
- Waterbody
- Watercourse
- Road

Baseline Ecosite Phase

a1	b4	d3	f1	h1	j1	k2	Shrubland
b1	c1	e1	f2	h2	j2	k3	Burn
b2	d1	e2	f3	i1	j3	l1	Disturbed
b3	d2	e3	g1	i2	k1	Flooded	

Title:

FIGURE 33-2

ECOSITE PHASES RELATIVE TO THE CORNER HUB

StatoilHydro

Approved: RL	Revision Date: March 22, 2009
File: FIGURE_33-2_Ecosite_Phases_Relative_to_Corner_Hub.mxd	
Drawn by: RF	Checked: MM

34.	**SIR 87, Pages 222-223 and SIR 88, Pages 224-226.** StatoilHydro indicates that some components of the project will be carried out by third-party contractors or under separate disposition so they were not included in the cumulative effects assessment. Examples include potential off-site or on-site landfills (response AENV 3), general infrastructure such as bitumen sales, diluent return, fuel supply pipelines, power lines (response AENV 77), a work camp (response AENV 170), 2600 ha of borrow pit (response AENV 80), and future exploration and monitoring seismic activities. As these developments will be induced by the Kai Kos Dehseh project, they are reasonably foreseeable. Although the precise locations of these facilities and disturbances may not be known at this time, the approximate magnitude and other impact assessment criteria should be generally known. The document *Cumulative Effects Assessment in Environmental Impact Assessment Reports Required Under the Alberta Environmental Protection and Enhancement Act* (ERCB, AENV, NRCB) directs that reasonably foreseeable future projects to be considered in cumulative effects assessment include those directly associated with the project under review, or those that will be induced if the project is approved. a. Provide an estimate of the magnitude, extent, duration, reversibility, and cumulative significance of disturbances associated with the project components mentioned above, and assess their contribution to both regional and local cumulative effects.

Response

This was undertaken as part of the response to SIR(2) #46(b).

34.	b. Update the conclusions of the EIA to reflect the findings.

Response

This was undertaken as part of the response to SIR(2) #46(b).

34.	c. Provide a detailed discussion describing the types of sites that will be targeted for various facility developments, particularly for the camp, landfills, and borrow areas.

Response

As requested, additional discussion is provided below regarding the siting requirements for camps, landfills and borrow areas.

Two permanent operations camps are planned for the Project. An east camp will provide operational support to the Leismer, Corner and South Leismer hubs and a west camp will service the Thornbury and Hangingstone hubs. Figure 160-1 (AENV SIR(1) #160) indicates the locations of the camps. The east camp, known as the Leismer Lodge, is currently built and operating to service the construction of the LDP CPF. Siting considerations for the Leismer Lodge included locating it on upland landforms, all weather accessibility, adequate geotechnical conditions, a central location to facilitate servicing both the initial development phase as well as phases related to future hubs and a location that is aesthetically pleasing for the camp occupants. During the construction of the Leismer Lodge, wildlife and vegetation surveys were conducted in an effort to selectively clear the lands needed for the camp, while preserving several patches of old growth forest that still stand in and around the camp. The west camp location was identified in the Mariana Lakes area due to the lack of all weather all season road infrastructure between Leismer and Thornbury. While precise placement of this camp will not be required for several years, locating it on a upland landform, in close proximity to existing Mariana infrastructure was identified for the purposes of the EIA.

No landfills are included in the Project description. As stated in the response to ERCB SIR(1) #17(b), StatoilHydro plans to utilize approved third-party landfills. Therefore, landfill siting has not been considered in the EIA. However, as part of StatoilHydro's waste management policies, certification of third-party landfills will be confirmed by StatoilHydro prior to receiving any wastes from StatoilHydro. As part of these inspections, the location of landfills would be reviewed, both from a trucking risk perspective, as well as from a general siting perspective. StatoilHydro anticipates the landfills to be located on upland landforms.

The siting requirements for geotechnical borrow materials were discussed in the response to AENV SIR(1) #80. Siting is primarily driven by identifying locations of sufficient materials and of appropriate quality in reasonable proximity to areas needing the materials. Based on direction from ASRD, an attempt was made to design landscape borrows that will not ultimately fill with water. These landscape borrows, therefore, need to be located on upland landforms and not extend below the surface water table. In the response to AENV SIR(1) #80, an analysis was conducted which identified that sufficient borrow could be obtained within a reasonable distance from the Project footprint and not result in the creation of new water bodies. However, the constraint of not digging the borrows deeper, results in an increased aerial extent of the proposed borrow areas. A planning level estimation of borrow requirements has been conducted and target borrow locations were provided in AENV SIR(1) #80, Figure 80-1. If permitted, StatoilHydro desires to reexamine the possibility of excavating deeper borrows. The deep borrows would ultimately be reclaimed as water features, as this would reduce the ultimate area of temporary landscape disturbance (see SIR(2) #32, Figure 32-1).

35.	**SIR 127a, Pages 283-284.** StatoilHydro states, "*In general terms, the stockpiles will be contoured to avoid excessive slopes (nominal slope of 1:1) and will be re-vegetated or otherwise protected.*" a. Alberta Environment typically requires stockpiles to be constructed at a slope of 3:1. Confirm StatoilHydro's intention with regard to slopes of stockpiles

Response

Soil stockpiles with 3:1 slopes have less steeply sloping sides than those with 1:1 slopes (run:rise) as proposed by StatoilHydro in the Round 1 of SIR responses. StatoilHydro's intention is to construct stockpiles with appropriate slopes so that they are stable, control erosion and are revegetated so as to ensure the integrity of the stockpiles. StatoilHydro believes this can be achieved using 1:1 soil stockpile slopes and appropriate revegetation techniques, especially with the smaller soil stockpiles associated with Project well pads.

If necessary, soil stockpiles may be constructed with shallower slopes (e.g., 2:1 slope). Alternatively, stockpiles may be constructed with 3:1 slopes within the footprint area, and excess salvaged material stockpiled nearby in existing disturbances or borrow pit areas. If this occurs, the origin and volume of all salvaged material will be documented by StatoilHydro to ensure proper reclamation.

StatoilHydro will meet all AENV requirements with respect to soil stockpile construction for the Project.

35.	b. Discuss whether the proposed footprint can accommodate stockpiles constructed at a slope of 3:1.

Response

Based on experience with the LDP, StatoilHydro believes that the SAGD pads and CPF will be able to accommodate stockpiles constructed at a slope of 3:1 (run:rise), however to minimize footprint, StatoilHydro advocates the use of stockpiles with a stabilized 1:1 slope. Refer to SIR(2) #13(a) for additional information.

35.	c. If not, discuss the impact to your proposed footprint as a result of reconfiguring the stockpiles.

Response

Refer to SIR(2) #35(b) above

36.	**SIR 102, Pages 245-250 and SIR 110, Page 264.** Response AENV 110 indicates that PDA assessments will focus on vegetation and soils for the use in reclamation planning. Response AENV 102b indicates that surveys will be conducted for Canadian toads, owls, and bats to support amendment applications. a. Describe what site-specific wildlife surveys will be included in the PDA process.

Response

As indicated in the response to AENV SIR(1) #89(a), #127(a) and #190, PDAs consist of soils and vegetation assessments to gather information required for construction and future reclamation and to identify the presence of rare plants and weeds, they are not baseline surveys and they are not part of a monitoring program. There are no wildlife surveys planned for PDAs.

The intent of the surveys mentioned in the response to AENV SIR(1) #102(b) is to provide additional wildlife information in the vicinity of the future hubs to support amendment Applications; they are not intended to be included as part of the PDA process.

36.	b. Discuss how this site-specific information will be used to monitor regional changes in wildlife abundance.

Response

As noted in response to SIR(2) #36(a), there are no wildlife surveys conducted for PDAs as wildlife information gathered at a single location (e.g., a wellpad) can't be used to monitor wildlife populations at a regional level.

Monitoring programs will be developed with the conditions of approval. As indicated in SIR(2) #36(a) above, PDAs are one-time surveys to identify site specific information to determine such issues as soil handling and the presence of rare plants.

37.	**SIR 111, Pages 264-265 and SIR 113, Pages 267-268.** In response AENV 113, StatoilHydro indicates that it does not believe that specific wildlife compensation is required. However, in response AENV 111b StatoilHydro states that it believes the project does not affect long-term viability of caribou populations, in part, because of habitat compensation measures. a. Clarify this apparent discrepancy and describe the compensation measures referred to in response AENV 111b.

Response

The use of the term "habitat compensation" in SIR(1) #111(b) is in error. The measures considered in the assessment are more appropriately described as 'habitat mitigation'. For example, to reduce sensory impacts to caribou, it is StatoilHydro's goal to minimize the human use of linear features. During the course of developing the Project, new access roads will intersect existing linear features, which may result in increased human use of those features. If these linear features are obscured by reclaiming the access point, or preventing human use by access control measures then impacts to caribou are reduced. Such measures are considered mitigation as opposed to compensation.

38.	**SIR 85b, Page 213; SIR 111b, Page 265; SIR 112b, Page 266.** StatoilHydro indicates, "*…the cumulative effect of the Project with regional projects in the revised RSA is predicted to reduce caribou habitat availability by 3.3%. However, since caribou populations are suspected to be below carrying capacity in the region and since there will exist a large amount of caribou habitat (784,289.9 HUs) and high quality habitat (306,434.5 HUs) in the revised RSA, the cumulative effect of habitat loss is considered a moderate impact. Furthermore, for both moose and woodland caribou habitat loss is overestimated given how future case data (Project and cumulative projects) available to StatoilHydro was applied in this analysis.*" a. Corroborate the statement that caribou populations are suspected to be below carrying capacity.

Response

Based on the resource selection model (derived from the scat monitoring study), which indicates a large amount of caribou habitat exists in the RSA at baseline (662,483 HUs), and the Alberta Caribou Committee's (ACC) data that indicate caribou populations in the ESAR may be in decline (McLoughlin et al. 2003 and also see SIR(2) #38(b)), it was assumed that caribou are below carrying capacity.

REFERENCES

McLoughlin, P.D., E. Dzus, B. Wynes, and S. Boutin. 2003. Declines in populations of woodland caribou. Journal of Wildlife Management 67:755–761.

38.	Alberta Sustainable Resource Development (ASRD) is encouraged by the effort StatoilHydro has put into gathering caribou data in the Egg-Pony range. However, recent work completed by the Alberta Caribou Committee (ACC) indicates that the East Side Athabasca Range (ESAR) herd is in significant decline. Lambda values for the last four years have been below 1. Consequently, there is significant concern regarding the long-term viability of the ESAR herd. StatoilHydro states, "*StatoilHydro believes that the viability of the caribou population within the region will not be threatened.*" b. Discuss this apparent discrepancy.

Response

Recent work completed by the Alberta Caribou Committee (ACC) suggests that a subset (collared caribou) of the ESAR herd is in decline**.** The ACC's collared animal surveys indicate that collared caribou within the ESAR have had low calf recruitment since 2001-2002. However, the accuracy of the calf recruitment estimates and estimates of caribou population growth from caribou collaring studies in the entire ESAR are not known.

To clarify, StatoilHydro believes that the viability of the caribou population within the region will not be threatened by the Kai Kos Dehseh Project for the following reasons.

1. The StatoilHydro Project is predicted to have only a small impact to the region's caribou habitat, reducing habitat availability by 14.4% at application and 4.7% for the cumulative effects case (SIR(2) #46).

2. There is uncertainty surrounding the relationship between habitat and caribou populations (Dzus 2001, Johnson and Seip 2008). Ecologists have hypothesized that habitat loss can limit caribou populations (Edwards 1954, Bloomfield 1980), but research has not demonstrated that habitat reduction is the cause of population declines. For example, Sorenson et al. (2008) found caribou population declines in Alberta are correlated to the amount of industrial features and young fires on the landscape, but did not able to find causal evidence linking habitat loss to caribou declines. Equally significant, there is no conclusive evidence indicating that caribou populations are limited by habitat availability (Bergerud 1983).

3. At baseline, anthropogenic disturbances are distributed such that 91% of highly and moderately suitable caribou habitats lie within 500 m of the nearest linear disturbance. Despite the uncertainties discussed in (see AENV SIR(1) #131(a)), linear features are hypothesized to facilitate wolves' ability to kill prey and increase the presence of moose and deer (alternate prey species to caribou). In combination, these factors may indirectly increase caribou mortality from wolf predation. However, because baseline caribou habitat has high exposure to linear disturbances and the Project will increase the amount of high quality habitat within 250 m of the nearest linear disturbance by 9%, StatoilHydro believes the proposed Project development is unlikely to substantially increase caribou mortality in the LSA beyond baseline conditions.

4. Resource selection and stress analysis from the scat monitoring suggests that caribou are negatively affected nearer sites of intense human activity (e.g., increased sensory disturbances resulting from traffic and drilling). In contrast, the development footprints alone do not seem to influence caribou stress or resource selection. Since StatoilHydro plans to phase their development by location (in hubs) across the landscape over more than a 30-year period, human activity will be somewhat localized (by hub) in time. Although the peak development phase will still include much of the Project, StatoilHydro believes that impacts to caribou will be localized in time, and thus result in a lower impact than that predicted in the EIA. This is because the EIA assumes that all hubs would be in operation more or less simultaneously.

REFERENCES

Bergerud, A. T. 1983. The natural population control of caribou. Pp. 14-61 in Symposium on natural regulation of wildlife populations. Proceedings of the Northwest Section, The Wildlife Society (F. L. Bunnell, D. S. Eastman, and J. M. Peek, eds.). Forest, Wildlife and Range Experiment Station, University of Idaho, Moscow, ID.

Bloomfield, M. 1980. *Closure of the caribou hunting season in Alberta: Management of a threatened species*. Alberta Energy and Natural Resources, Fish and Wildlife Division, Edmonton, AB. 39 pp.

Dzus, E. 2001. *Status of Woodland Caribou (Rangifer tarandus caribou) in Alberta*. Alberta Environment, Fisheries and Wildlife Management Division and Alberta Conservation Association. Wildlife Status Report No. 30. Edmonton, AB. 47 pp.

Edwards, R. Y. 1954. Fire and the decline of a mountain caribou herd. Journal of Wildlife Management 18:521-596.

38.	c. Discuss StatoilHydro's confidence in predictions around impacts to woodland caribou.

Response

As discussed in SIR(2) #38(b), StatoilHydro believes that the viability of caribou populations in the region will not be threatened by the Kai Kos Dehseh Project for a number of reasons. StatoilHydro has assessed a confidence rating of moderate (impact of habitat availability in the LSA, habitat connectivity) to low (impact of habitat availability in the RSA, direct mortality risk and indirect mortality risk) on the impact predictions. StatoilHydro's overall confidence in the predicted impacts to caribou was assigned recognizing that there are many uncertainties with the management of caribou in the ESAR today. For example, despite historic monitoring that has taken place in the area:

1. There is a low level of confidence in the ESAR caribou population estimate (McLoughlin et al. 2003; Anne Hubbs, Pers. Comm. 28 May 2008);
2. The relationship between habitat and caribou populations is uncertain (Johnson and Seip 2008);
3. The relationship among disturbance, predation, and caribou populations is unknown (see AENV SIR(1) #131(a)); and
4. The consequences of stress (disturbance and nutritional related stress) on caribou population growth and maintenance are uncertain; however, further analysis of fecal samples may provide additional information or certainty.

StatoilHydro's non-invasive monitoring program in collaboration with the University of Washington will allow an estimate of caribou abundance, physiological health, and resource selection. To date, the monitoring program has provided valuable information that provides StatoilHydro with additional confidence in their ability to manage for caribou in the future in a proactive approach.

REFERENCES

Hubbs, Anne. Senior Wildlife Biologist, Fish and Wildlife, Alberta Sustainable Resource Development. Telephone conversation, 28 May 2008.

Johnson, C.J. and D.R. Seip. 2008. Relationship between resource selection, distribution , and abundance: A test with implications to theory and conservation. Population Ecology 50:145–167.

McLoughlin, P.D., E. Dzus, B. Wynes, and S. Boutin. 2003. Declines in populations of woodland caribou. Journal of Wildlife Management 67:755–761.

38.	d. Given the generational time for caribou and given the time frame during which the project will be present on the landscape, discuss likely population effects of the long-term regional habitat deletion.

Response

StatoilHydro does not believe that negative population effects will result from the long-term regional habitat change resulting from the Project for the following reasons.

1. The area of direct habitat reduction by the Project is approximately 9,200 ha (e.g., Project footprint, seismic, borrow pits). The Project footprint encompasses a low amount of habitat relative to the availability of high- and moderate-quality caribou habitat in both the LSA (11.1%) and the RSA (1.3%).

2. There is uncertainty surrounding the relationship between habitat and caribou populations (Dzus 2001, Johnson and Seip 2008). Ecologists have hypothesized that habitat loss can limit caribou populations (Edwards 1954, Bloomfield 1980) but research has not demonstrated that habitat reduction is the cause of population declines. For example, Sorenson et al. (2008) found caribou population declines in Alberta are correlated to the amount of industrial features and young fires on the landscape, but did not unearth causal evidence linking habitat loss to caribou declines. Equally important to the subject of habitat reduction, there is no conclusive evidence indicating that caribou populations are limited by habitat availability (Bergerud 1983).

3. Resource selection and stress analysis from the scat monitoring suggests that caribou are negatively affected nearer sites of intense human activity (e.g., increased sensory disturbances resulting from traffic and drilling). In contrast, the development footprints alone do not seem to show any response on caribou stress or resource selection (or a small positive response with selection). Hence, low habitat reduction such as the StatoilHydro Project footprint, is not likely to result in negative population effects.

REFERENCES

Bergerud, A. T. 1983. The natural population control of caribou. Pp. 14-61 in Symposium on natural regulation of wildlife populations. Proceedings of the Northwest Section, The Wildlife Society (F. L. Bunnell, D. S. Eastman, and J. M. Peek, eds.). Forest, Wildlife and Range Experiment Station, University of Idaho, Moscow, ID.

Bloomfield, M. 1980. Closure of the caribou hunting season in Alberta: Management of a threatened species. Alberta Energy and Natural Resources, Fish and Wildlife Division, Edmonton, AB. 39 pp.

Dzus, E. 2001. Status of Woodland Caribou (Rangifer tarandus caribou) in Alberta. Alberta Environment, Fisheries and Wildlife Management Division and Alberta Conservation Association. Wildlife Status Report No. 30. Edmonton, AB. 47 pp.

Edwards, R. Y. 1954. Fire and the decline of a mountain caribou herd. Journal of Wildlife Management 18:521-596.

Johnson, C.J. and D.R. Seip. 2008. Relationship between resource selection, distribution , and abundance: A test with implications to theory and conservation. Population Ecology 50:145–167.

Sorenson, T., P.D. McLoughlin, D. Hervieux, E. Dzus, J. Nolan, B. Wynes and S. Boutin. 2008. Determining sustainable levels of cumulative effects for boreal caribou. Journal of Wildlife Management 72:900-905.

38.	e. How does StatoilHydro's Caribou Resource Selection Function (RSF) model account for stress related to reproductive pause and age/sex demographics in the Egg-Pony Herd? What assumptions are used in the model?

Response

The caribou resource selection model used by StatoilHydro estimates the probability that a particular resource will be selected by caribou based on the combination of environmental variables that define that resource (Lele and Keim 2006). The models do not account for stress, reproductive status, or age/sex demographics.

Assumptions inherent to the statistical method used are described in Lele and Keim (2006) and Manly et al. (2002), and include but are not limited to:

1. caribou may potentially revisit a location;
2. pellet locations arising from the same caribou are spatially and temporally independent;
3. pellet locations are collected from a random sample of caribou; and
4. resources are constant over the period of study.

Additionally, collected pellet locations are representative of winter habitat use, available sites are defined within the dog-team search area and can be used or unused sites.

REFERENCES

Lele, S.R. and J.L. Keim. 2006. Weighted distributions and estimation of resource selection probability functions. Ecology 87(12): 3021-3028.

Manly, B.F.J., L.L. McDonald, D.L. Thomas, T.L. McDonald and W.P. Erickson. 2002. Resource Selection by Animals: Statistical Analysis and Design for Field Studies. 2nd edition. Kluwer Press, Boston, Massachusetts. 240 pp.

38.	f. In the context of population viability, provide a discussion on the expected changes to age class structure and the consequent changes to fecundity as a result of low recruitment in the Egg-Pony herd.

Response

Although there is no evidence for reduced caribou fecundity in Alberta (Edmonds and Smith 1991, Stuart-Smith et al. 1997), the ACC's collared animal surveys indicate that collared caribou within the ESAR have had low calf recruitment since 2001-2002. The implication is that caribou may be entering a period with a low number of eligible breeding females (those between 3-9 years old). As a result, there may be lower calf production in the future resulting in a lower number of population recruits. Assuming that recruitment estimates are accurate and mortality remains constant, population growth rates will decline.

However, the accuracy of the calf recruitment estimates and estimates of caribou population growth from caribou collaring studies in the ESAR are not fully known since they are based on a small sample of collared caribou. StatoilHydro, in collaboration with the University of Washington, has been conducting an intensive monitoring study that enables accurate estimation of caribou population abundances from DNA in scat and mark-recapture analysis. Options exist to compare, evaluate and harmonize regional and provincial caribou monitoring measures from caribou collaring studies with the more intensive scat detection approach being conducted in the Egg Pony Caribou Herd Range (by StatoilHydro in collaboration with the University of Washington).

REFERENCES

Edmonds, E. J., and K. G. Smith. 1991. *Mountain caribou calf production and survival, and calving and summer habitat use in west-central Alberta*. Wildlife Research Series No. 4, Alberta Fish and Wildlife Division, Edmonton, AB. 16 pp.

Stuart-Smith, A. K., C. J. A. Bradshaw, S. Boutin, D. M. Hebert, and A. B. Rippin. 1997. Woodland Caribou relative to landscape patterns in northeastern Alberta. Journal of Wildlife Management 61:622-633.

38.	g. Discuss the impacts on the caribou population during construction and operational phases of the project, and the population's ability to recover from these impacts after closure.

Response

For the EIA, the activities of the Project's construction and operational phases are pooled together as the application case. This provides for a worst-case scenario with all components of the Project assumed to be present the landscape simultaneously. The main Project effects that are assumed to negatively impact caribou are.

1. Negative impacts on caribou stress and habitat selection associated with sensory disturbances resulting from high levels of human activity on the landscape. The influences of these effects have been observed as responses by caribou in the scat monitoring studies (from fecal hormone analysis and resource selection analysis).

2. Indirect effects from habitat alteration (creation of additional linear features or additional deer and moose habitat that increase alternate prey species abundance for wolves) that may result in an increased abundance or ability for wolves to prey upon caribou. StatoilHydro does not believe that negative caribou population effects will result from this impact as discussed in SIR(2) #38(b).

3. Direct habitat loss from Project development. StatoilHydro does not believe that negative caribou population effects will result from this impact as discussed in SIR(2) #38(d).

4. Habitat connectivity may be impeded by Project development. StatoilHydro predicts that, with mitigation (as per EIA, Volume 4, Section 11.6.3.1) the impact of the Project on habitat connectivity will be low during the application case. StatoilHydro believes that habitat connectivity will improve following the decommissioning of the Project, but StatoilHydro is less confident about population level effects resulting from reduced connectivity during application.

As outlined in SIR(2) #46(b), the impacts to caribou range from moderate (impact of habitat availability in the LSA, habitat connectivity) to low (impact of habitat availability in the RSA, direct mortality risk and indirect mortality risk). StatoilHydro believes that caribou will be able to recover from these impacts after closure for reasons provided in the response to SIR(2) #38(b) above.

39.	**Appendix B, Page 1: Updated Resource Selection Model Analysis.** a. How were the updated RSF/RSPF models validated?

Response

The technique used to validate the caribou and moose models is presented in the EIA, Volume 4, Appendix 11A and SIR(1) Appendix B. As described in Appendix B, model fit was recently evaluated and compared for the resource selection probability function (RSPF) models based on the residual sum of squares (Neter et al. 1996). Residuals were measured as the difference between the predicted model values (expected) and the proportion of observed pellet locations among equal-interval habitat classifications (bins).

REFERENCES

Neter, J., M. Kutner, W. Wasserman and C. Nachtsheim. 1996. Applied Linear Statistical Models. McGraw-Hill/Irwin, Chicago, Illinois, USA. 1408 pp.

39.	b. Present the results of the RSF validation.

Response

See EIA, Volume 4, Appendix 11A and SIR(1) Appendix B.

For reference, the residual sum of squares for the final moose and caribou models are as follows, where a model with good fit has a residual sum of square approximate to zero – see Table 39-1.

Table 39-1. Residual Sum of Squares for the Final Moose and Caribou Models – Kai Kos Dehseh Project

Model	Residual Sum of Squares (# bins)
Moose LSA	0.70 (15)
Moose RSA	1.05 (6)
Caribou LSA	0.14 (20)
Caribou RSA	0.05 (15)

39.	c. How did the models perform? If performance is poor, provide an updated validated model.

Response

Caribou models for the LSA and RSA, and the moose LSA model performed well (i.e., expected and observed values were similar; see above Table 39-1). A plot and discussion of model fit for specific habitat bins is provided in the EIA, Volume 4, Appendix 11A and, more recently, in SIR(1) Appendix B.

The moose RSA model resulted in relatively weak fit with the pellet data when lower accuracy vegetation covariates were considered. In comparison, covariates related to forest-stand attributes, derived from Alberta Vegetation Inventory (AVI) data that was used in the LSA, greatly improve model fit for moose. Alberta Ground Cover Classification (AGCC) data was used due to incomplete AVI coverage within the entire RSA, computational difficulties with such a large dataset, and the prohibitive cost associated with obtaining AVI coverage within the entire RSA.

40.	**SIR 88c, Page 226.** This response addresses the impacts of the project on recreational users, but not the impacts of recreational users on wildlife. The project will increase access for recreational users, which will impact fish and wildlife. a. Provide an assessment of the impacts of access and subsequent recreational use on wildlife.

Response

The impact of increased access is discussed in EIA, Volume 4, Section 11.6.5. An impact assessment pertaining to recreation follows.

Twenty percent of mobile workers are involved in backcountry activities, resulting in approximately 0.2 backcountry activities per year per mobile worker (Nichols Applied Management and Economic Consultants, 2007). Given that the Project workforce is expected to reach about 1,200 persons at the peak construction phase (EIA, Volume 5, Section 14.9.1), StatoilHydro estimates that Project personnel will contribute a maximum of 240 backcountry trips per year. However, it is not known if Project personnel will use the backcountry surrounding the Project, or if they'll use other areas, so this represents a worst-case assessment.

Because backcountry recreation frequently occurs near roads and other access points (Schallenberger 1980, Westworth 2002, Forman et al. 2003), direct impacts are expected to occur primarily in areas immediately surrounding the easily accessable Project footprint (i.e., roads). Because human disturbance may result in the displacement of animals, impacts are predicted to be subregional for species whose home ranges are small relative to the size of the LSA, and regional for species whose home ranges extend beyond the boundaries of the LSA. Although impacts are expected to last over the life of the Project, data indicate that nutritional and behavioural stress in moose and caribou populations decline following the cessation of activity (EIA, Volume 4, Section 11.5.1) and that the avoidance of human features is largely due to the intensity of use (SIR(1) Appendix B). The impact of recreation on wildlife is therefore expected to be reversible both in the short term, when the intensity of recreation varies due to seasonal changes, and long term, when vegetation re-growth impedes human activity following Project closure. Overall, recreation by Project personnel is expected to have a low impact on wildlife. Confidence in this impact assessment is high, as it is based on a strong understanding of human activity patterns (e.g., Forman et al. 2003) and the relationship between wildlife and human activity. Furthermore, there is a high degree of certainty surrounding the maximum number of Project personnel.

REFERENCES

Forman, R.T.T., Bissonette, J., Clevenger, A., Cutshall, C., Dale, V., Fahrig, L., Goldman, C., Heanue, K., Jones, J., Sperling, D., Swanson, F., Turrentine, T. and T. Winter. 2003. Road ecology: Science and Solutions. Island Press, Washington DC. 481 pp.

Nichols Applied Management, and Economic Consultants, November 2007. Report on Mobile Workers in the Wood Buffalo Region of Alberta.

Schallenberger, A. 1980. Review of oil and gas exploitation impacts on grizzly bears. International Conference on Bear Research and Management. 4:271-276.

Westworth Associates Environmental Ltd. 2002. A Review and Assessment of Existing Information for Key Wildlife and Fish Species in the Regional Sustainable Development Strategy Study Area – Volume 1: Wildlife. Sustainable Ecosystems Working Group. 283 pp.

41.	**SIR 89, Page 227; SIR 102b, Page 247; SIR 117, Page 273.** StatoilHydro states they, "*…will conduct surveys for Canadian Toads, owls, and bats as part of the application amendments required for the future hub developments and plans to continue the scat monitoring program.*" The Terms of Reference (TOR) 4.8.3.1 a) states, "*Identify and describe: existing wildlife resources (amphibians, reptiles, birds and terrestrial and aquatic mammals), their use and potential use of habitats in the Study Areas.*" a. Identify how StatoilHydro has fulfilled clause 4.8.3.1 a) in the TOR for the following: i. Amphibians, ii. Bats, iii. Terrestrial Mammals, iv. Breeding Birds, and v. Owls.

Response

StatoilHydro utilized accepted EIA techniques to identify and describe existing wildlife resources, and their use and potential use of habitats in the Study Areas. These techniques included:

- Use of indicator species or species groups that were representative of broader groups of wildlife resources (please refer to the EIA Volume 4, Section 11.4.2 for additional information regarding the use of indicator species);

- Accepted survey and modelling methodologies, and
- Consultation with regulators.

Table 41-1 identifies indicator species for amphibians, mammals, breeding birds and owls. The species, survey methods and modelling techniques listed in the table were derived from accepted EIA techniques, consultation with ASRD from January to May 2006 (Peter Weclaw, pers.comm., May 2006), and also *EIA Baseline Surveys Required as of August 2006* (Peter Weclaw, pers. comm., August 2006).

Table 41-1 Indicator Species Selected for the Wildlife Baseline Assessment in the EIA

Wildlife Resource	Indicator Species	Survey methodology	Model
Amphibians	Canadian Toad	Amphibian nocturnal	HSI
Mammals	Northern Long-eared Bat	Bat surveys	Not required
	Beaver	No survey required	HSI
	Muskrat	No survey required	HSI[1]
	Snowshoe hare	Winter tracking	HSI[1]
	Fisher	Winter tracking	HSI[2]
	Lynx	Winter tracking	HSI
	Wolf	Scat monitoring, winter tracking	Not required
	Black bear	No survey required	HSI[2]
	Moose	Scat monitoring, winter tracking	HSI[1]
	Woodland caribou	Scat monitoring, winter tracking	HSI[1]
Birds	Mixedwood forest bird community	Breeding birds	Habitat association
	Old-growth forest bird community	Breeding birds	Habitat association
	Northern Goshawk	No survey required	HSI
	Barred Owl	Call playback	HSI[1]
	Boreal Owl	Call playback	HSI[2]
	Great Gray Owl	Call playback	HSI[2]

1 – Habitat Suitability Index (HSI) models used in the Application and revised to RSF or RSPF during first and second round of SIRs (see SIR(2) #53).

2 – Species included as an indicator in the Application but subsequently removed (see SIR(2) #53).

The baseline assessment provided in the EIA and updated through the Round 1 SIRs, includes information from the LSA as well as several baseline studies within the RSA, some of which overlap parts of the LSA. By including data within the LSA and RSA, StatoilHydro has provided higher survey effort (i.e., number of sites surveyed) and more data than other EIAs in the region (see SIR(1) #102(b)). This level of effort subsequently provides a comprehensive understanding of wildlife resources within the Study Areas (LSA and RSA).

Numerous studies have been conducted within northern Alberta and elsewhere on many of the species found within the RSA. These studies provide detailed information on the habitat requirements of these species, which are fairly consistent among similar ecological areas. For this reason, it is possible to make inferences about wildlife in one area, without having to conduct intensive research projects for every project at every location. It is not possible to study every location within even a small study area, no matter what survey intensity is employed, and therefore inferences will have to be made on habitat use within areas that are not surveyed. This has been the standard approach to wildlife assessments in northeast Alberta.

In order to make inferences on habitat use in areas that were not surveyed, it must be demonstrated that these areas are ecologically similar to surveyed areas. StatoilHydro has conducted reviews of its data collection and can confirm the areas are ecologically similar. To demonstrate this, a comparison of habitat availability between areas surveyed within the LSA and RSA and areas not surveyed within the LSA was conducted for snowshoe hare, woodland caribou, and moose. This was done using the RSPF models for baseline for each of these species. Using three species that utilize different habitat types, the graphs (Figures 41-1 to 41-3) show that the mosaic of habitats available to wildlife is consistent across the areas surveyed in the LSA and RSA and those areas not surveyed within the LSA. Since these are ecologically similar, it is valid to make inferences on habitat use within areas of the LSA that were not sampled.

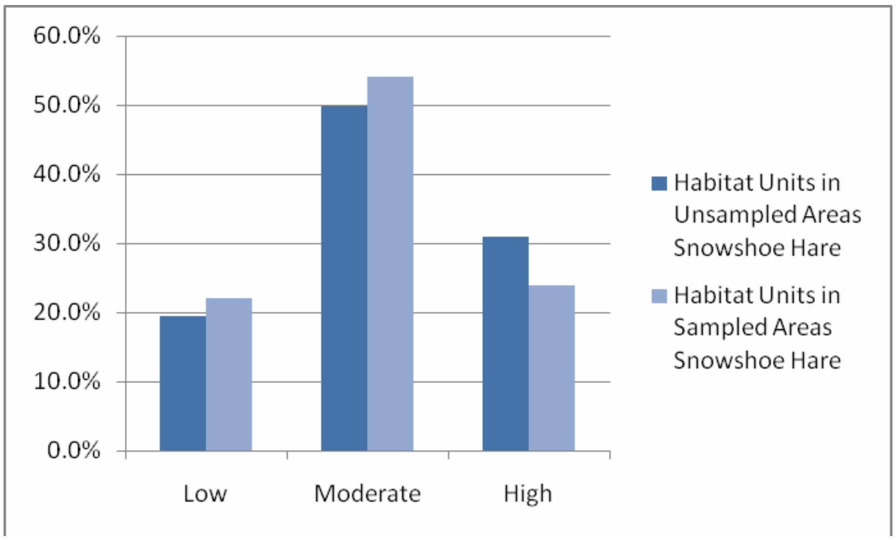


Figure 41-1. Habitat availability for snowshoe hare within sampled and unsampled areas.

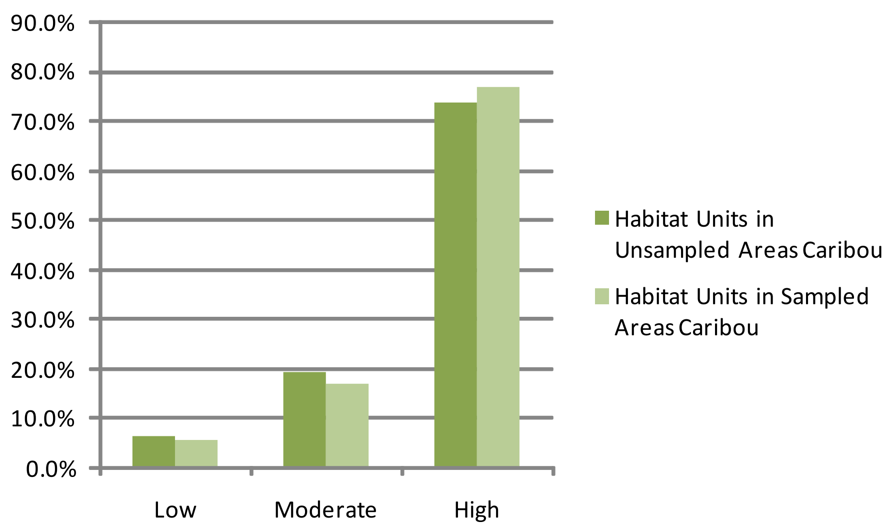


Figure 41-2. Habitat availability for woodland caribou within sampled and unsampled areas.

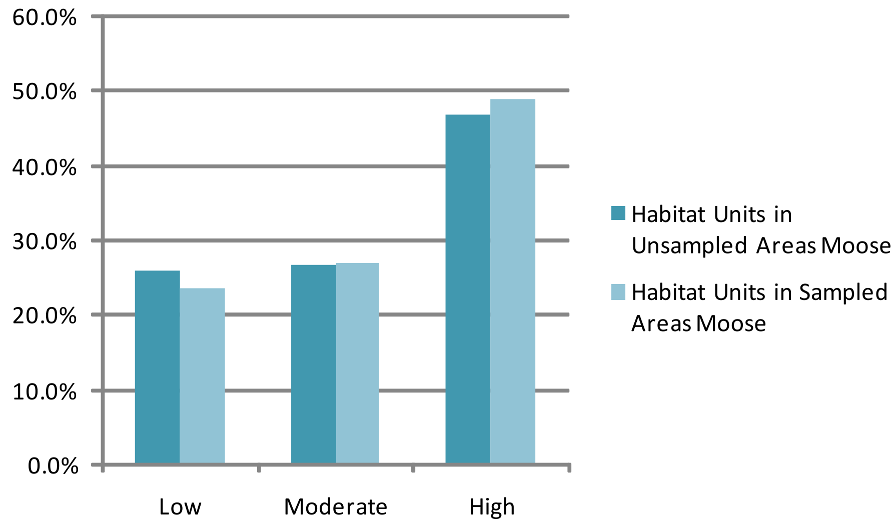


Figure 41-3. Habitat availability for moose within sampled and unsampled areas.

For the Kai Kos Dehseh EIA, StatoilHydro conducted surveys and provided models as described in Table 41-1. Surveys were conducted specifically for the Kai Kos Dehseh Project and were supplemented with data from within the RSA. Subsequent to the EIA, StatoilHydro has continued to supplement the dataset from baseline studies within the RSA. The methods used allow StatoilHydro to identify and describe existing wildlife resources, their use and potential use of habitats in the Study Areas and therefore have met the TOR. An elaboration on the amount of data collected, and adequacy of the data and models for amphibians, bats, terrestrial mammals, breeding birds and owls, follows.

Amphibians

As Table 41-1 shows, the Canadian toad was selected as the indicator species for amphibians, with amphibian nocturnal studies conducted and an HSI model prepared. Extensive toad surveys were conducted in the Study Areas including 463 points in the RSA and 56 points in the LSA (Figure 41-4). The surveys identified Canadian toads east of Highway 881 and north of Janvier, and at one location southwest of the LSA (Figure 41-4). No Canadian toads were found within the LSA. The lack of toad observations west of Highway 881 may suggest the prevalence of lowland habitat types is limiting Canadian toad distribution in those areas. Given the lack of toad observations within the LSA, StatoilHydro used a model which was validated using data collected from within the RSA, that allowed for a habitat use (and potential use) model to be developed, and Project impacts to be determined. The Canadian toad model has also been validated for other projects where Canadian toads have been observed (Deer Creek Energy 2006, OPTI/Nexen 2006).

Bats

The StatoilHydro surveys, and regional data, allowed StatoilHydro to determine species composition and relative abundance within the Study Areas (Figure 41-5). Bat surveys were conducted within and near the Leismer Commercial and Expansion, Corner, and Hangingstone hub areas in 2006 and 2008 (Figure 41-5) and focused on areas where bats are most likely to occur (i.e., feeding areas near old growth forests). The purpose of the bat surveys was to determine presence/not detected (particularly for the northern long-eared bat, a species at risk). The surveys were not however, required for the purpose of assessing the potential impacts of the Project since no bat species was selected as an indicator. Since there is no habitat model available for bats, and the bat survey data (presence/not detected) is not suitable for bat habitat model validation, bats are not suitable as an indicator for the EIA. As many bat species rely on snags (for roosting) typically found in old growth forests, surrogate indicator species were selected (i.e, northern goshawk, barred owl, old growth forest bird community) to determine potential impacts to old growth forest species.

Terrestrial Mammals

Baseline information was obtained for terrestrial mammals through the scat monitoring program and winter tracking surveys. Scat dog survey squares, including the control area added in 2009, are shown in Figure 41-6. The scat monitoring provides the most current and comprehensive data for moose, caribou and wolf gathered in Alberta.

Winter tracking to support the EIA totals 431 km (Figure 41-7) including an additional tracking survey conducted in 2009 to increase baseline survey information for terrestrial mammals in the LSA. This tracking data provides a large amount of habitat use information for winter-active terrestrial mammals throughout the LSA and within the RSA.

Models were prepared in accordance with Table 41-1 and modified based on recent regulatory requirements (see SIR(2) #53). Terrestrial mammal species currently assessed include lynx (and snowshoe hare), moose and caribou.

Breeding Birds

Indicators used in the impact assessment for birds included the mixedwood forest and old growth forest bird communities, as identified in Table 41-1. Impacts to these communities were assessed based on habitat associations and direct disturbance as opposed to an HSI model. Individual songbird species were not selected as indicator species, and therefore results of breeding bird surveys do not contribute to the assessment of Project impacts.

A total of 531 breeding bird points have been surveyed in the Study Areas (Figure 41-8). In 2008 approximately 100 breeding bird points were surveyed in the RSA; however, these points have not yet been analyzed or included here. The level of survey effort is higher than any other EIA conducted in the region (see AENV SIR(1) #102(b)). This survey intensity has provided a thorough understanding of baseline songbird conditions within the Study Areas, and StatoilHydro submits that this level of effort suitably meets the TOR.

Owls

Owl surveys provide presence/not detected information and do not provide information on habitat use by owls. Since critical information required for model validation is not obtained, owl surveys do not contribute to the impact assessment. Three owl species (i.e., boreal owl, barred owl, great gray owl) were included as indicators, as shown on Table 41-1. However, as a result of recent changes in regulatory requirements, the boreal owl and great gray owl were removed as indicators (see SIR(2) #53).
A total of 338 survey points were established within the Study Areas (Figure 41-9). The survey effort provides sufficient information on owl presence within the Study Areas.

REFERENCES

Deer Creek Energy Ltd (Deer Creek Energy). 2006. Application for Approval of the Joslyn North Mine Project. Submitted to Alberta Energy and Utilities Board and Alberta Environment. Volume 5, Consultant Report #14.

OPTI Canada Inc. and Nexen Inc. (OPTI/Nexen). 2006. Application for Approval of the Long Lake South Project. Submitted to Alberta Energy and Utilities Board and Alberta Environment. Volume 4, Appendix 11A.

Weclaw, Peter. Senior Wildlife Biologist, Fish and Wildlife, Alberta Sustainable Resource Development. Email correspondence, 4 May 2006.

Weclaw, Peter. Senior Wildlife Biologist, Fish and Wildlife, Alberta Sustainable Resource Development. Email correspondence, 30 August 2006.

41.	b. Where field data are incomplete or lacking across the Local Study Area (LSA) for the above list, provide additional baseline survey data and provide an updated assessment. If StatoilHydro wishes to submit a detailed survey plan to fulfill clause b above, including timing, proposed sampling locations, method, etc., ASRD would be pleased to review this plan and provide comment to StatoilHydro to ensure supplemental surveys to be undertaken will meet the needs of the environmental assessment process.

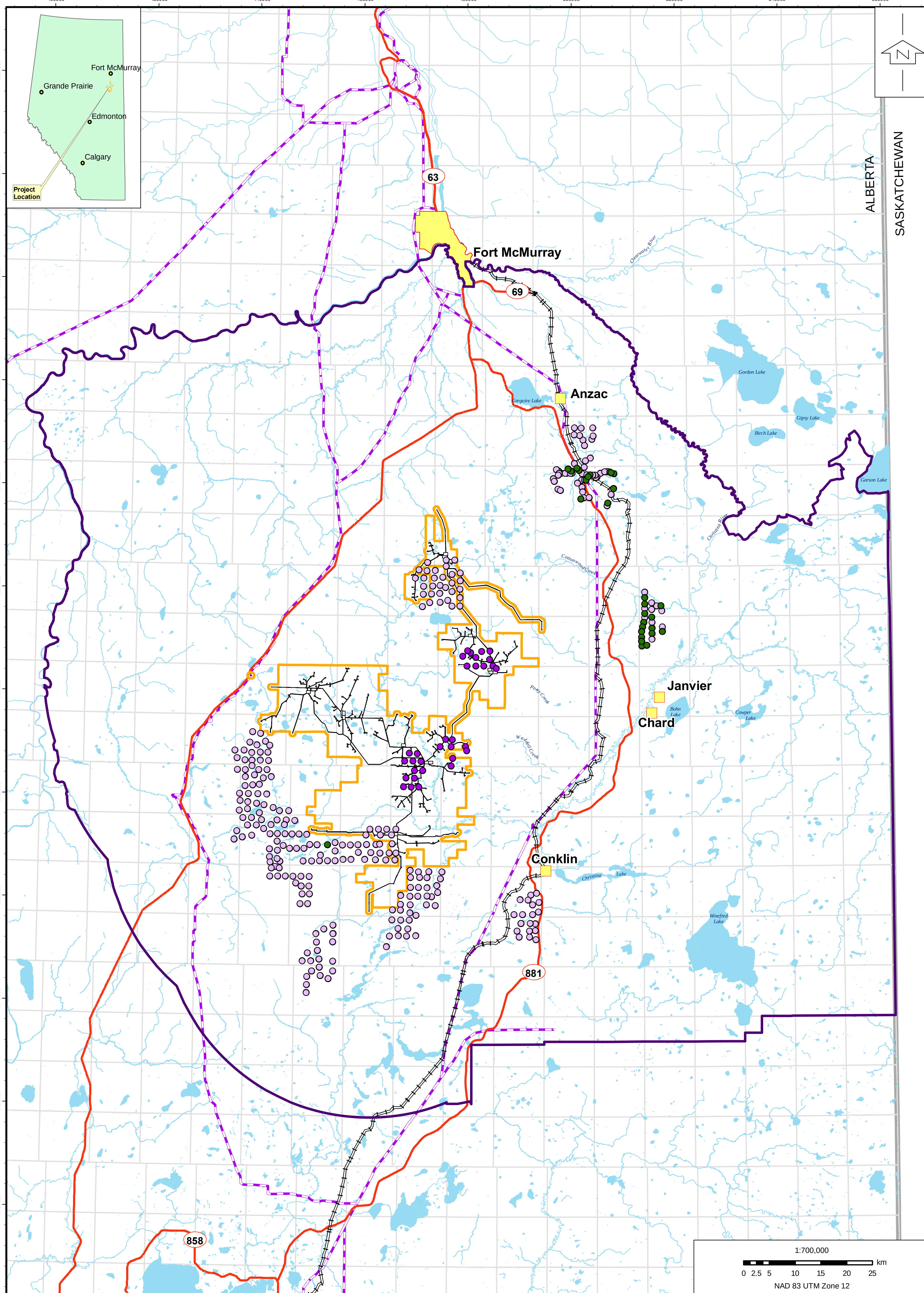
Response

StatoilHydro has met the TOR as described in Clause 4.8.3.1. Specifically, StatoilHydro has provided a description of wildlife use and potential use of habitats in the Study Areas (see SIR(2) #41(a)). However, StatoilHydro conducted an additional winter tracking survey in 2009, is conducting a 2009 scat monitoring program and will conduct an additional breeding bird survey in June 2009 using recognized protocols.

Remaining surveys include owl, Canadian toad, and bat surveys, the results of which will not affect the conclusions of the impact assessment. The survey data will provide presence and distribution information. Sampling within the initial development areas is sufficient. StatoilHydro proposes to conduct these surveys in the vicinity of the future hubs to provide information supporting the future amendment Applications as follows.

- Thornbury; 2010
- Hangingstone; 2013
- Northwest Leismer; 2015
- South Leismer; 2026

Due to the uncertainty of footprint of these future hubs and the shelf life of the survey data, it is prudent to complete these surveys when there is greater footprint certainty. As stated above, these surveys will not change the conclusions of the EIA.



Legend

- StatoilHydro Wildlife RSA
- StatoilHydro Wildlife LSA
- Project Footprint
- Waterbody
- Watercourse
- Major Road
- Powerline
- Railway
- City/Town
- Toad Survey Locations Completed for EIA
- Toad Survey Locations Completed Since EIA
- Canadian Toad Observations

Title:

FIGURE 41-4

CANADIAN TOAD SURVEY LOCATIONS AND OBSERVATIONS WITHIN THE LOCAL AND REGIONAL STUDY AREAS

StatoilHydro

Approved: RL	Revision Date: March 23, 2009
File: FIGURE_41-4_CANADIAN_TOAD_SURVEY_LOCATIONS_AND_OBSERVATIONS_WITHIN_THE_LSA_AND_RSA.mxd	
Drawn by: RF	Checked: MM

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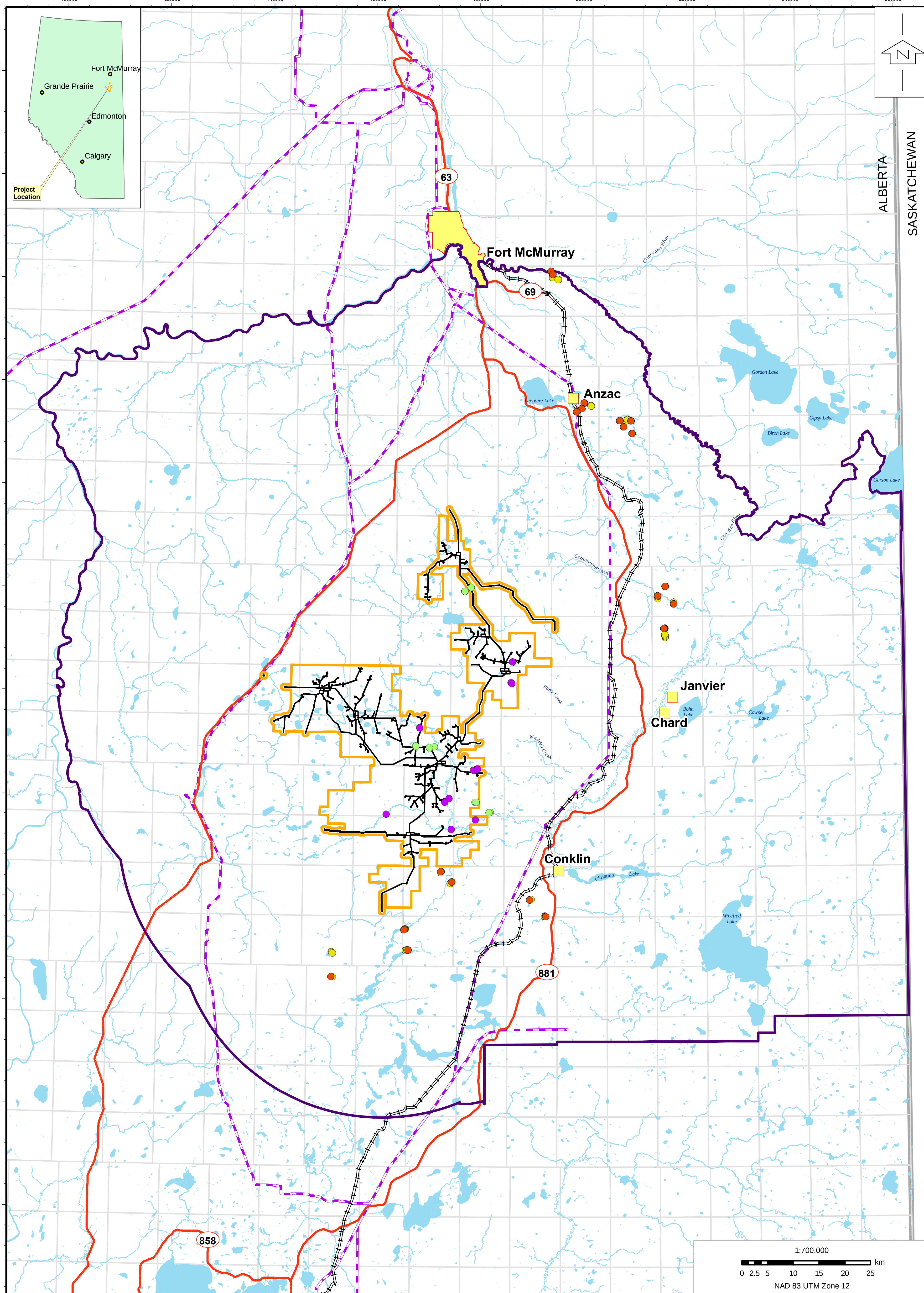

Legend

- StatoilHydro Wildlife RSA
- StatoilHydro Wildlife LSA
- Project Footprint
- Waterbody
- Watercourse
- Major Road
- Powerline
- Railway
- City/Town
- 2006 LSA Survey Site
- 2008 LSA Survey Site
- Regional Bat Netting Site
- Regional Bat Acoustic Site

Title:

FIGURE 41-5

BAT SURVEY LOCATIONS WITHIN THE LOCAL AND REGIONAL STUDY AREAS

StatoilHydro

Approved: RL	Revision Date: March 22, 2009
File: FIGURE_41-5_BAT_SURVEY_LOCATIONS_WITHIN_THE_LSA_AND_RSA.mxd	
Drawn by: RT	Checked: MM

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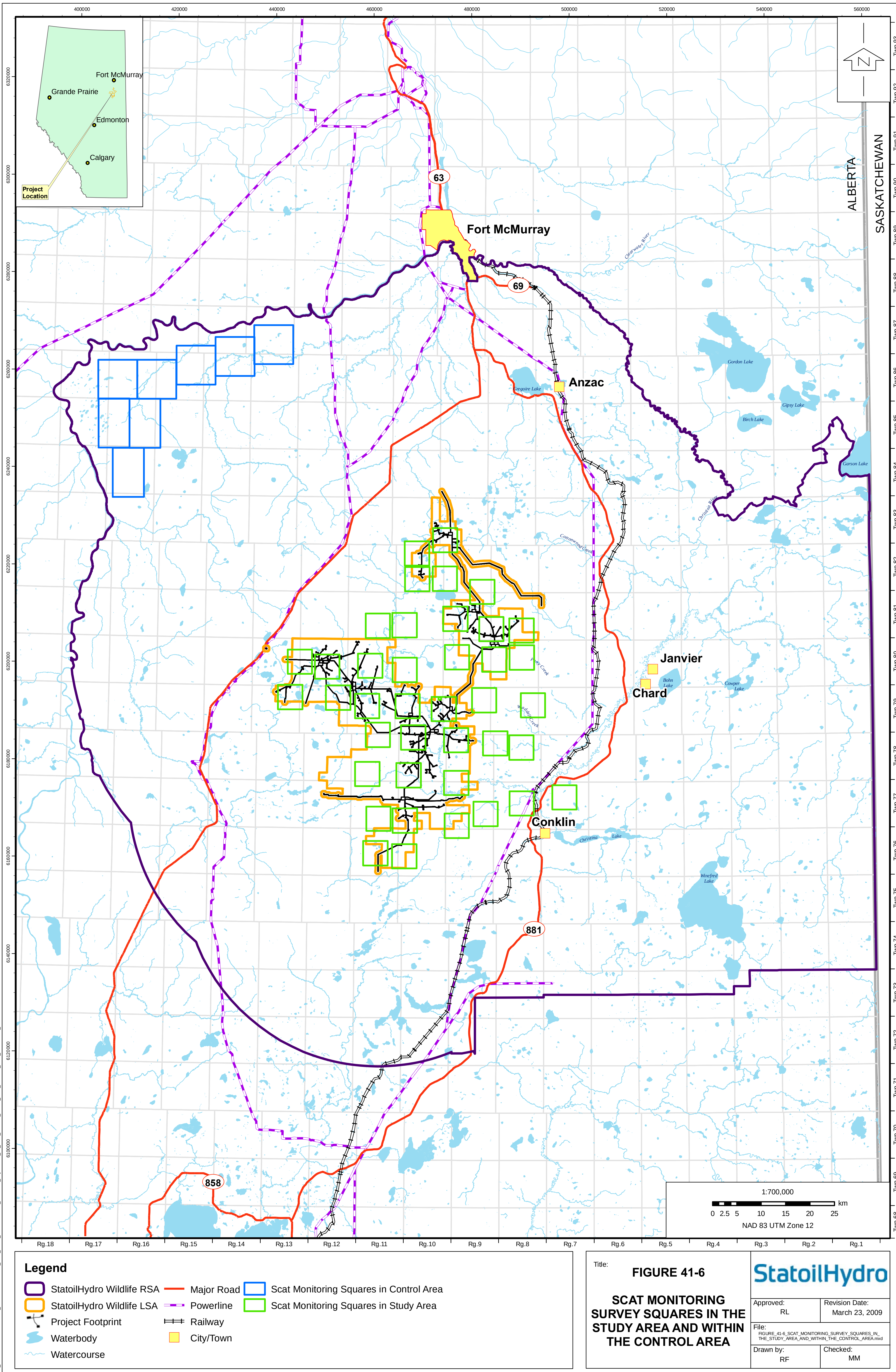

Title:

FIGURE 41-6

SCAT MONITORING SURVEY SQUARES IN THE STUDY AREA AND WITHIN THE CONTROL AREA

StatoilHydro

Approved: RL	Revision Date: March 23, 2009
File: FIGURE_41-6_SCAT_MONITORING_SURVEY_SQUARES_IN_THE_STUDY_AREA_AND_WITHIN_THE_CONTROL_AREA.mxd	
Drawn by: RF	Checked: MM

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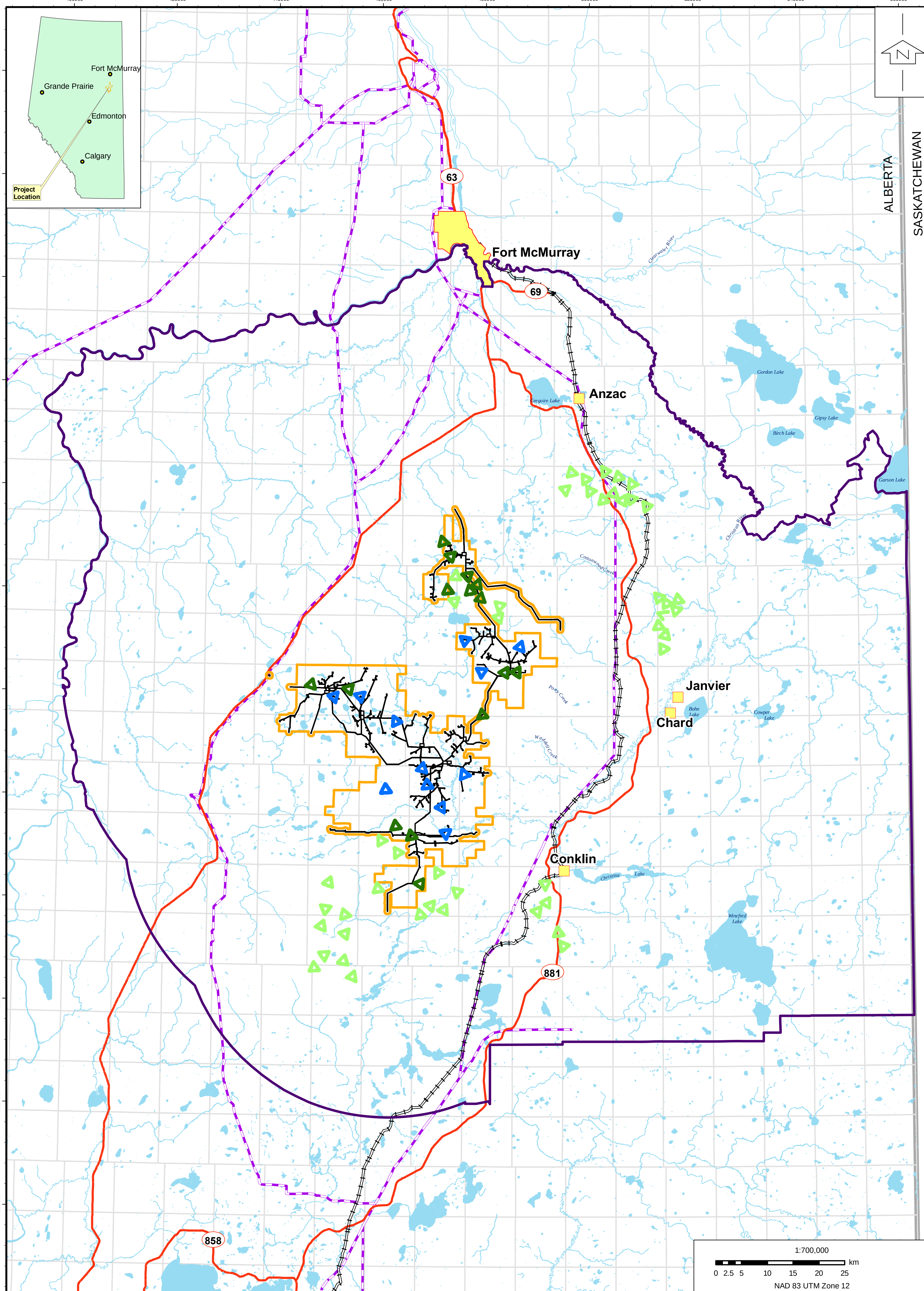


Legend

- StatoilHydro Wildlife RSA
- StatoilHydro Wildlife LSA
- Project Footprint
- Waterbody
- Watercourse
- Major Road
- Powerline
- Railway
- City/Town
- Pre 2009 Transect Outside LSA
- Pre 2009 Transect Inside LSA
- 2009 Winter Transect

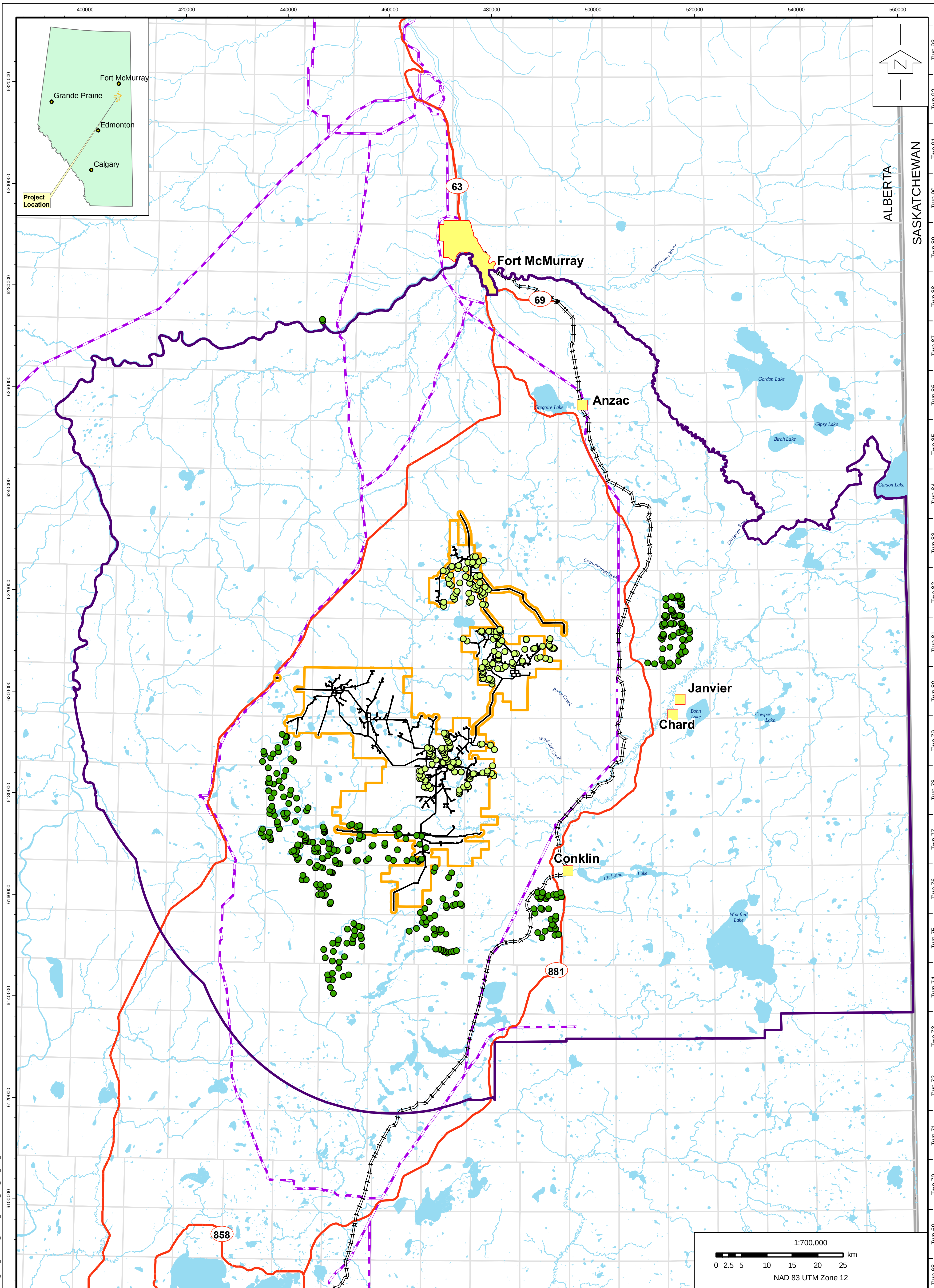
Title:

FIGURE 41-7

WINTER TRACKING TRANSECTS WITHIN LOCAL AND REGIONAL STUDY AREAS

StatoilHydro

Approved: RL	Revision Date: March 23, 2009
File: FIGURE_41-7_WINTER_TRACKING_TRANSECTS_WITHIN_THE_LSA_AND_RSA.mxd	
Drawn by: RF	Checked: MM



Legend

- StatoilHydro Wildlife RSA
- StatoilHydro Wildlife LSA
- Project Footprint
- Waterbody
- Watercourse
- Major Road
- Powerline
- Railway
- City/Town
- Breeding Bird Points Completed for EIA
- Breeding Bird Points Completed Since EIA

Title:

FIGURE 41-8

BREEDING BIRD SURVEY POINTS WITHIN THE LOCAL AND REGIONAL STUDY AREAS

StatoilHydro

Approved:	Revision Date:
RL	March 23, 2009
File: FIGURE_41-8_BREEDING_BIRD_SURVEY_POINTS_WITHIN_THE_LSA_AND_RSA.mxd	
Drawn by: RF	Checked: MM

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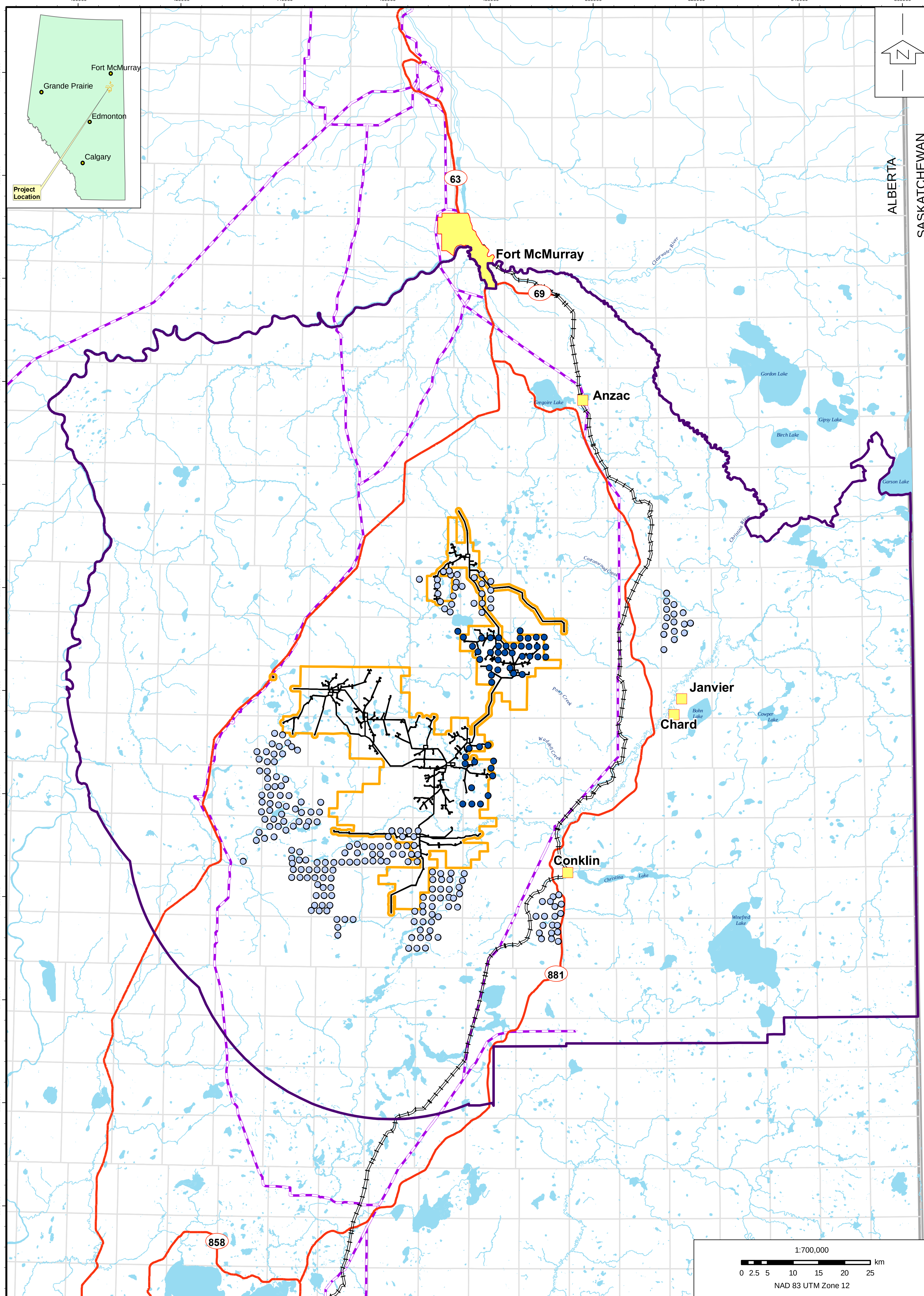

Legend

- StatoilHydro Wildlife RSA
- StatoilHydro Wildlife LSA
- Project Footprint
- Waterbody
- Watercourse
- Major Road
- Powerline
- Railway
- City/Town
- Owl Survey Point Completed For EIA
- Owl Survey Point Completed Since EIA

Title:

FIGURE 41-9

OWL SURVEY POINTS WITHIN THE LOCAL AND REGIONAL STUDY AREAS

StatoilHydro

Approved: RL	Revision Date: March 23, 2009
File: FIGURE_41-9_OWL_SURVEY_POINTS_WITHIN_THE_LSA_AND_RSA.mxd	
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42.	**SIR 107a, Page 261.** Nocturnal owl surveys were conducted from May 17-25. These surveys were intended to target barred owls; however the surveys were conducted after the recommended time frame. Lisa Priestley does not recommend surveying past May 3rd (Lisa Priestly, pers. comm. Oct 2008). Three Northern pygmy-owls were detected incidentally during barred owl surveys. Northern pygmy-owls are active diurnally, and the project area is not within the pygmy-owl's historic range. a. Provide scientific rationale for conducting nocturnal owl surveys outside the recommended time frame, including any relevant peer-reviewed literature.

Response

The barred owl survey was conducted after the recommended time frame. However, due to the late timing of the regulatory decision requesting an owl survey, Lisa Priestley was contacted to ensure the validity of conducting the survey in May. As stated in AENV SIR(1) #107, Lisa Priestley approved of the timing of the survey (Lisa Priestley, pers. comm. May 5, 2006). In her correspondence, Ms. Priestley indicated that owls will respond to calls, however, since barred owls are nesting, the broadcast survey should only be conducted once.

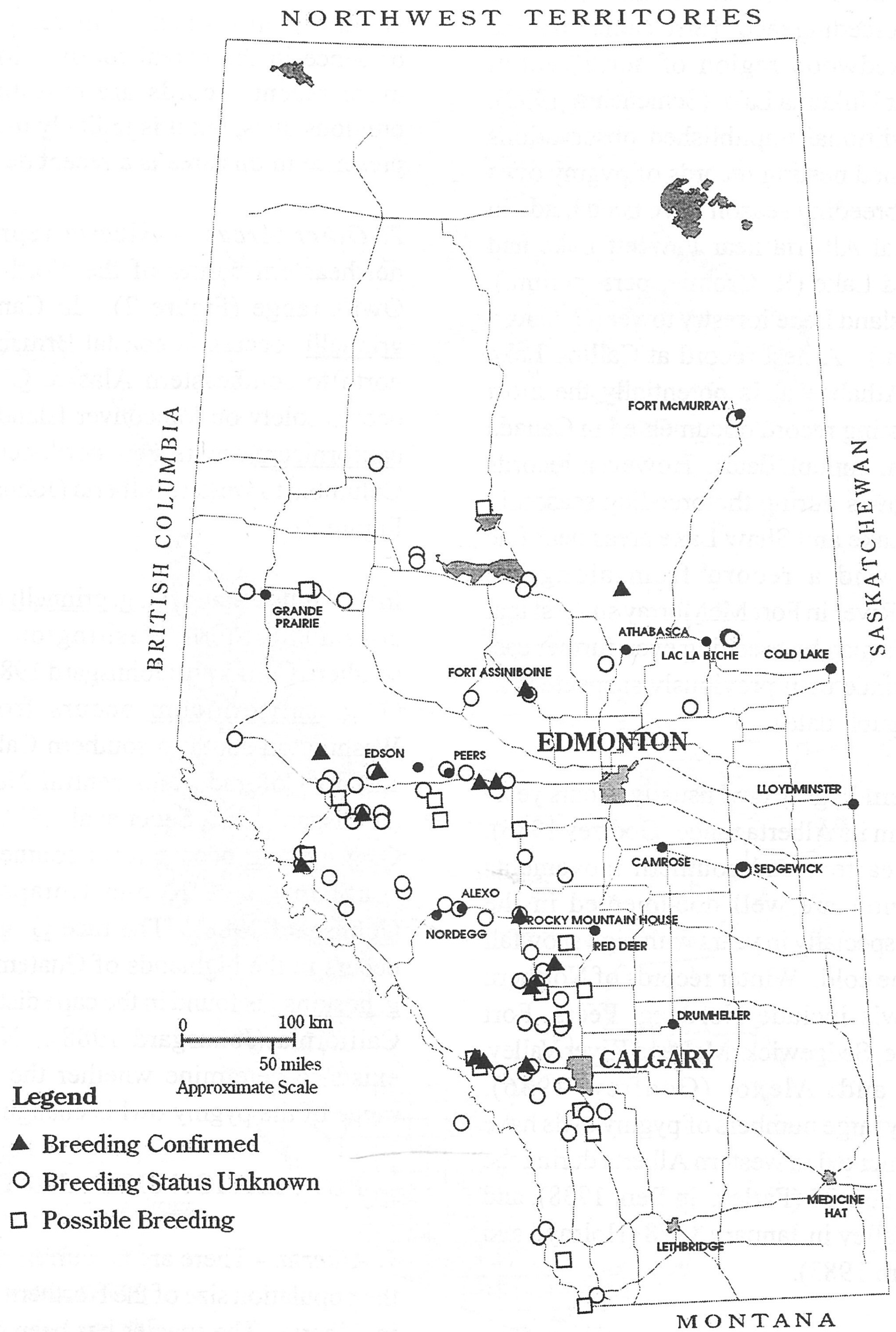
42.	b. Discuss StatoilHydro's confidence in the detection of northern pygmy-owls in the LSA.

Response

StatoilHydro has engaged experienced and qualified wildlife biologists that have conducted numerous owl and bird surveys in the oil sands region. Furthermore, the northern pygmy owl has a very distinctive call that is easy to identify by even an inexperienced observer. The observations are not outside the pygmy owl's historic range. A review of the Fisheries and Wildlife Management Division's status report on the pygmy owl shows this species has been observed during the breeding season near Lac La Biche and in Fort McMurray (Figure 42-1). The status report "*suggests that pygmy owls may be breeding further east in the province than previously suspected*" (Hannah 1999). Finally, the northern pygmy owl is crepuscular, not exclusively diurnal (Hannah 1999) and the owls were heard calling at sunset.

REFERENCE

Hannah, K. C. 1999. Status of the Northern Pygmy Owl (*Glaucidium gnoma californicum*) in Alberta. Alberta Environment, Fisheries and Wildlife Management Division, and Alberta Conservation Association, Wildlife Status Report No. 20, Edmonton, AB. 20 pp.



Modifed from Hannah 1999

Observations are from 1965-1999.
Circles indicate observations with unknown breeding status.

Title:

FIGURE 42-1

NORTHERN PYGMY OWL (*Glaucidium gnoma californicum*) OBSERVATIONS IN ALBERTA

StatoilHydro

Approved: RL	Revision Date: March 20, 2009
File: F:\4455 NAOSC\514 North American\SIRs\SIR Round 2 Final Answers\draft SIRs\Figures\Figure_42-1_Pygmy_Owl.pdf	
Drawn by: N/A	Checked: MM

43.	**SIR 90c, Page 229.** The question was not answered. a. Provide a monitoring plan to monitor this and any other rare plant communities/species which may be directly or indirectly affected by the project.

Response

To clarify the response to AENV SIR(1) #90(c); since there are no anticipated effects of the Project to surface water quantity, there are no plans to conduct rare plant monitoring for that specific impact.

44.	**SIR 99a, Page 241.** StatoilHydro states, "…*total available caribou habitat in the LSA following reclamation is estimated to decrease by 0.8% and the impact to caribou habitat in the LSA at closure was deemed to be negligible in the assessment*." a. Given that caribou require old growth forest patches, and lichen communities require at least 40 years before they can provide an adequate food source, provide a discussion on the quality of caribou habitat that will be present at closure.

Response

The closure scenario was modelled based on a time frame 70 years after reclamation, as identified in the EIA, Volume 4, Section 11.2.3. This time frame was selected because assessing conditions immediately following reclamation would essentially be the same as the application case. The time frame selected allows for forest succession and maturation.

The Project footprint was assumed to be a high use human disturbance which is avoided by caribou, and a zone of influence was applied to those areas. Immediately following reclamation, the high use disturbance is no longer present and therefore, habitat adjacent to the disturbance is no longer affected thus returning the habitat capability in the zone of influence to baseline conditions.

45.	**SIR 100, Page 242.** The industry-led group looking to address connectivity and wildlife corridor issues in the oil sands region south of Fort McMurray is being led by Devon. a. Provide a commitment to participate in this group.

Response

StatoilHydro will commit to participating in this group.

46.	**SIR 101 iv, v, vi, Page 244.** a. Using knowledge of well bore length and depth to resource, estimate the grid size and frequency that Statoil anticipates requiring for their 4D seismic programs.

Response

4D seismic requires a grid pattern of source and receiver lines. Source lines allow access for the seismic source (typically StatoilHydro uses mini-vibroseis equipment). Receiver lines allow access for the placement and collection of monitoring equipment (geophones). The spacing between source lines is 56 m. The source lines are all 3 m wide (except for areas near creeks, where it is hand cut to 1.75 m). All source lines are oriented north/south. StatoilHydro estimates a receiver spacing of 46.7 m between lines. The receiver lines are generally 1.75 m wide running east/west. StatoilHydro anticipates 4D seismic programs will be conducted annually during the operating life of the reservoir steamchamber. Each operating steamchamber will have its own 4D seismic program. The grid size and frequency is subject to change during the course of the project.

46.	b. Provide an update to the EIA which includes the impacts of anticipated 4D seismic on wildlife and vegetation.

Response

Wildlife

Following is an updated impact assessment that includes the addition of borrow pits, anticipated 3D and 4D seismic, Oil Sands Evaluation (OSE) coreholes and roads, diluent and dilbit pipeline, and third-party infrastructure (e.g. ATCO powerline) for the application case. The Project will result in the direct loss of habitat and reduced habitat effectiveness for certain wildlife indicators (see SIR(2) #53(b) and #53(c) for an updated list of wildlife indicators) and will effect vegetation resources. A summary of the baseline, application, and cumulative effects cases for each wildlife and vegetation indicator is given below along with a discussion of the impacts. A final impact rating summary for wildlife is provided in Table 46-1 and for vegetation in Table 46-20.

Since there are no other planned developments within the LSA, aside from Project-related activity, there is no cumulative effects case within the LSA. There are planned developments within the RSA that are not part of the Kai Kos Dehseh Project and therefore a cumulative effects case is provided for moose and caribou within the RSA. The remaining wildlife indicators were not assessed within the RSA for two reasons: 1) the remaining indicators have small home ranges and are are less likely to be impacted cumulatively by other projects in the RSA; and/or 2) due to regulatory changes, all habitat models must be validated. AGCC data is used to determine habitat availability within the RSA. The AGCC data lacks specific habitat attributes (e.g., stand age, stand height, confier density) required to develop, validate and/or fit robust models. Because the additional disturbances affect primarily habitat use, this response only updates impact assessments related to habitat availability.

Impacts to habitat availability differ from those reported in SIR(1) Appendix A for two reasons. First, as discussed above, the application case reported here accounts for the addition of borrow pits, anticipated 3D and 4D seismic, OSE coreholes and roads, diluent and dilbit pipeline, and third-party infrastructure (e.g. ATCO powerline). Second, the following changes have been included in the assessment reported here:

- A better understanding of high-use and low-use human disturbances allowed the reclassification of baseline disturbances.

- For the models used in the SIR(1) EIA update, the perimeter of existing seismic areas was delineated and the entire area was considered unsuitable habitat (i.e., zero habitat quality) for the indicators. For this update, the actual areas to be cleared by seismic were used, providing a more accurate assessment.

- New regional projects (ConocoPhillips Farm In, Enerplus Kirby, PetroBank May River, a municipal gravel pit) have been included in the cumulative effects case that were not included in SIR(1).

- Where possible, the footprint of regional projects has been updated.

For caribou, the following changes have also been included in this assessment:

- Across the RSA, caribou avoidance for areas near high human use was limited to 5,500 m (i.e., distances >5,500 m from high use disturbances were classified as =5,500 m prior to the application of the caribou habitat selection model provided in SIR(1) Appendix B). This change was based on a better understanding of caribou's response to high use disturbances.

- An improved Digital Elevation Model (DEM) was used to calculate terrain complexity.

Overall, development is predicted to negatively impact habitat availability of the indicators (Table 46-1). The expected environmental impact is moderate for most indicators due to the magnitude of the impact. These ratings consider that the Project represents the worst-case scenario as this assessment assumes (1) the Leismer Commercial and Expansion, Corner, and Thornbury hubs will be developed simultaneously and remain for the life of the Project, (2) the borrow pits added to the application case footprint (see SIR(2) #32) will all be used and will be a long-term impact with moderate human use, and (3) OSE monitoring wells and access are active throughout the life of the Project.

The Leismer Commercial and Expansion, Corner, and Thornbury hubs will be developed in a phased approach. However, this phased approach will only reduce the impact a small amount since peak development will include a large amount of the planned development.

The borrow pit footprint, which represents 27% of the footprint, is very conservative. Not all borrow pits will be excavated at the same time and the borrow pit will be excavated in phases over period of up to five years. As new parts of the pit are excavated, previously excavated areas are reclaimed. StatoilHydro proposes to excavate deeper borrow pits as opposed to large shallow borrow pits, which would reduce the footprint required (SIR(2) #32(c)).

Finally, OSE wells and access will be active for approximately one winter. Because this impact assessment over estimates both habitat deletion and human use at any one point in time during the application case, the predicted environmental impact represents a conservative, worst-case scenario.

Table 46-1 Final Impact Rating Summary for Project Effects on Habitat Availability and Reduced Habitat Effectiveness[1]

Indicator	Direction	Extent	Magnitude	Duration	Frequency of Occurrence	Permanence	Level of Confidence	Environmental Impact at Application	Environmental Impact for Cumulative Effects
Canadian toad	Negative	Sub-regional	Medium	Long term	Continuous	Reversible	Moderate	Moderate	NA
Northern goshawk	Negative	Sub-regional	Medium	Long term	Continuous	Reversible	Moderate	Moderate	NA
Barred owl	Negative	Sub-regional	Medium	Long term	Continuous	Reversible	Moderate	Moderate	NA
Mixedwood forest bird community	Negative	Sub-regional	Medium	Long term	Continuous	Reversible	Moderate	Moderate	NA
Old growth forest bird community	Negative	Sub-regional	Medium	Long term	Continuous	Reversible	Moderate	Moderate	NA
Beaver	Negative	Sub-regional	Low	Long term	Continuous	Reversible	Moderate	Low	NA
Lynx	Negative	Sub-regional	Medium	Long term	Continuous	Reversible	Moderate	Moderate	NA
Moose	Negative	Sub-regional	Medium	Long term	Continuous	Reversible	Moderate	Moderate	NA
Woodland caribou	Negative	Sub-regional	Medium	Long term	Continuous	Reversible	Moderate	Moderate	NA
Moose regional assessment	Negative	Regional	Negligible	Long term	Continuous	Reversible	Low	Negligible	Low
Woodland caribou regional assessment	Negative	Regional	Low	Long term	Continuous	Reversible	Low	Low	Low

[1] Based on assessment criteria provided in EIA Volume 4 Section 11 Table 11.4-3

Canadian Toad

Habitat clearing at application is predicted to result in a 8.7% loss in habitat availability for Canadian toad, most of which is within moderate and high quality habitat (Table 46-2, Figure B-1 and B-2). The overall environmental impact for the application case is considered moderate and reversible in the long term. Confidence in these predictions is moderate, as the assessment is based on a good understanding of Canadian toad habitat requirements and high quality data.

Table 46-2 Impacts to Canadian Toad Habitat Availability in the LSA at Application

	Habitat Quality	Baseline	Application
Habitat availability in the LSA (HU)	Total	37,859	34,569
	High	19,819	17,835
	Moderate	6,861	6,191
	Low	11,179	10,542
Change in habitat availability (HU, %)	Total		-3290 (-8.7%)
	High		-1,984 (-10.0%)
	Moderate		-669 (-9.8%)
	Low		-637 (-5.7%)
Environmental impact			Moderate

Northern Goshawk

Clearing at application is predicted to result in a 13.6% loss of HU for the northern goshawk (Table 46-3, Figures B-3 and B-4). This loss occurs in moderate and high quality habitat, where 1,219 HU (18.5%) and 551 HU (28.6%) are predicted to be lost by clearing and functional habitat loss, respectively. Habitat loss will be incurred throughout the upland habitats in Leismer Commercial and Expansion, Corner, and Thornbury hubs. The LSA provides only a small amount of high quality habitat for the northern goshawk at baseline (1.9% of the LSA) and the high quality habitat impacted is small in area, therefore, the environmental impact is considered moderate and reversible in the long term. Confidence in these predictions is moderate, as the assessment is based on a good understanding of goshawk habitat requirements and high quality data.

Table 46-3 Impacts to Northern Goshawk Habitat Availability in the LSA at Application

	Habitat Quality	Baseline	Application
Habitat availability in the LSA (HU)	Total	12,854	11,103
	High	1,930	1,379
	Moderate	6,608	5,389
	Low	4,316	4,336
Change in habitat availability (HU, %)	Total		-1,751 (-13.6%)
	High		-551 (-28.6%)
	Moderate		-1,219 (-18.5%)
	Low		20 (0.5%)
Environmental impact			Moderate

Barred Owl

Clearing is predicted to result in an 15.8% loss of HU for the barred owl at application (Table 46-4, Figure B-5 and B-6). Habitat loss will be incurred in primarily moderate and high quality habitats, where 12.7% and 20.2% are predicted to be lost at application, respectively. Habitat availability will primarily be reduced by the deletion of habitat, but will also be reduced by human disturbance near roads and facilities.

Impacts at application will be sub-regional, medium in magnitude, and long-term. Impacts are predicted to be sub-regional because the home range of barred owls in western Canada is considerably smaller than the LSA (Mazur et al. 1998, Olsen et al. 2006, Takats 1998). Although habitat clearing is expected to result in a long-term impact, impacts will be reversible in the long term, as forest regeneration will increase the availability of large-diameter trees preferred by nesting barred owls (Livezey 2007). The environmental impact is considered moderate. Confidence in these predictions is moderate, as the assessment is based on a good understanding of barred owl habitat requirements and high quality data.

Table 46-4 Impacts to Barred Owl Habitat Availability in the LSA at Application

	Habitat Quality	Baseline	Application
Habitat availability in the LSA (HU)	Total	41,812	35,223
	High	22,494	17,949
	Moderate	16,968	14,808
	Low	2,350	2,466
Change in habitat availability (HU, %)	Total		-6,589 (-15.8%)
	High		-4,545 (-20.2%)
	Moderate		-2,160 (-12.7%)
	Low		116 (4.9%)
Environmental impact			Moderate

Mixedwood Forest Bird Community

At baseline, 5.7% of the LSA is considered suitable for the mixedwood forest bird community (Table 46-5, Figure B-7). Of the suitable habitat available to mixedwood forest birds, 631 HU is predicted to be lost at application (8.9%; Table 46-5, Figure B-8). Impacts will be long-term, sub-regional, and medium in magnitude. The environmental impact is considered moderate and reversible in the long term given the regeneration of habitat following Project completion. Confidence in these predictions is moderate, as the assessment is based on a good understanding of mixedwood forest bird community habitat requirements and high quality data.

Table 46-5 Impacts to Mixedwood Forest Bird Community Habitat Availability in the LSA at Application

	Baseline	Application
Habitat availability in the LSA (HU)	7,114	6,484
Change in habitat availability (HU, %)		-631 (-8.9%)
Environmental impact		Moderate

Old Growth Forest Bird Community

There are 7,046 HU of suitable habitat for old growth birds in the LSA at baseline (5.6% of the LSA, Table 46-6, Figure B-9). Of the suitable habitat available to old growth forest birds at baseline, 466 HU (6.6%) are predicted to be lost at application (Table 46-6, Figure B-10). Appropriate management of timber harvesting in the region will help maintain the distribution of older stands across the landscape as juvenile stands are left to mature into advanced stages of development. Since old growth forest recovery is long term, the impact on the old growth forest bird community in the LSA is medium in magnitude and is considered a moderate impact. Confidence in this assessment is moderate, as the assessment is based on a good understanding of mixedwood forest bird community habitat requirements and high quality data but factors that contribute to the longer-term abundance of old growth forest in the LSA include both predictable anthropogenic disturbances and unpredictable variables such as fire and climate.

Table 46-6 Impacts to Old Growth Forest Bird Community Habitat Availability in the LSA at Application

	Baseline	Application
Habitat availability in the LSA (HU)	7,046	6,580
Change in habitat availability (HU, %)		-466 (-6.6%)
Environmental impact		Moderate

Beaver

There are a total of 6,714 HU of suitable habitat for beaver at baseline (Table 46-7, Figure B-11). The Project is predicted to result in a decrease of 158 HU (2.4%) at application (Table 46-7, Figure B-12). These impacts will result from the clearing of terrestrial habitats (e.g., d1) adjacent to lakes and streams. Impacts will be long-term, sub-regional in extent and low in magnitude. The impact is considered low. Confidence in this assessment is moderate as the assessment is based on a good understanding of beaver habitat requirements and high quality data.

Table 46-7 Impacts to Beaver Habitat Availability in the LSA at Application

	Habitat Quality	Baseline	Application
Habitat availability in the LSA (HU)	Total	6,714	6,556
	High	3,061	3,008
	Moderate	2,011	1,863
	Low	1,642	1,686
Change in habitat availability (HU, %)	Total		-158 (-2.4%)
	High		-54 (-1.7%)
	Moderate		-148 (-7.4%)
	Low		44 (2.7%)
Environmental impact			Low

Lynx

Habitat use by lynx is closely associated with the distribution of their primary prey, snowshoe hare (Koehler and Aubrey 1994), which select areas that have high conifer density, contain pine in the canopy, are near edges, and/or are in wetlands (SIR (2) Appendix C). Lynx tend to be sensitive to habitat alteration and human developments and may alter their movement patterns or occupancy in response to these activities (Mowat et al. 1999), especially in the presence of coyotes (Bayne et al. 2008). Potential impacts to lynx habitat and populations include habitat clearing as well as habitat fragmentation as a result of an increase in linear features.

Lynx populations in the boreal forest are dependent upon snowshoe hares (Boutin et al. 1995; Krebs et al. 2001; Koehler and Aubrey 1994; Mowat et al. 1999). Lynx populations are limited by prey availability, trapping and habitat loss (Todd 1985; Westworth 2002). While changes in the snowshoe hare population will largely determine the population of lynx, recent research in northern Alberta has found a negative association between road density, coyote abundance, and lynx occurrence (Bayne et al. 2008; Nielsen et al. 2007). Because of uncertainty in both present and future coyote populations, coyote abundance at baseline and application were assumed to equal the median value observed by Bayne et al. (2008) in northeast Alberta between 2002 and 2005.

As a result of holding coyote abundance constant, predicted changes in habitat effectiveness are caused solely by changes in hare habitat selection and road density. Overall, approximately 7.7% of the LSA is considered highly suitable habitat for lynx at baseline (Table 46-8, Figure B-13). At application, there is a predicted decrease of 11,390 HU (23.9%). Highly and moderately suitable habitats are predicted to decline by 63.6% and 36.1% at application, increasing the prevalence of low quality habitat by 27.5% (Table 46-8, Figure B-14).

The predicted change in lynx habitat is related to changes in snowshoe hare habitat. At baseline, there are 53,416 HU of suitable habitat available for the snowshoe hare (Table 46-9, Figure B-15). At application, there is a predicted decrease of 3,617 snowshoe hare HU (6.8%, Table 46-9, Figure B-16). Because changes in hare habitat availability are low relative to the changes in lynx habitat availability, predicted changes in lynx habitat are related primarily to changes in road density rather than hare habitat. At baseline, road density in the LSA is approximately 0.031 km/km^2, which is above what Nielsen et al. (2007) defined as reference conditions (approximately 0.024 km/km^2). At application, road density is predicted to increase to 0.755 km/km^2, environmental conditions being equal, reducing the probability of lynx occurrence by 29% (Nielsen et al. 2007).

Of note, 86.3% of the ROWs included in the application case are associated with OSE monitoring wells, which are only used for one winter. Because lynx occupancy is only affected by roads that are cleared of snow (thereby permitting access by coyotes) the inclusion of the OSE well access roads overestimates the impact on lynx occupancy over the life of the Project. Removing OSE access roads from the assessment reduces the amount of predicted habitat loss to 11.2% (total), 29.7% (high quality habitat), and 16.5% (moderate quality habitat). Given that any one OSE access road will only be cleared of snow for a single winter, the actual change to lynx habitat availability is likely closer to 11.2% than 23.9%.

Overall, the impacts are considered medium in magnitude, subregional in extent, long-term in duration, reversible, and are considered a moderate impact. Confidence in these predictions is moderate, as they are based on high-quality data and a strong understanding of the relationship between snowshoe hare, coyotes, roads, and lynx.

Table 46-8 Impacts to Lynx Habitat Availability in the LSA at Application

	Habitat Quality	Baseline	Application
Habitat availability in the LSA (HU)	Total	47,586	36,195
	High	6,818	2,478
	Moderate	28,716	18,347
	Low	12,052	15,369
Change in habitat availability (HU, %)	Total		-11,390 (-23.9%)
	High		-4,339 (-63.6%)
	Moderate		-10,369 (-36.1%)
	Low		3,318 (27.5%)
Environmental impact			Moderate

Table 46-9 Impacts to Snowshoe Hare Habitat Availability in the LSA at Application

	Habitat Quality	Baseline	Application
Habitat availability in the LSA (HU)	Total	53,416	49,799
	High	15,357	12,776
	Moderate	27,927	26,977
	Low	10,132	10,045
Change in habitat availability (HU, %)	Total		-3,617 (-6.8%)
	High		-2,581 (-16.8%)
	Moderate		-950 (-3.4%)
	Low		-86 (-0.9%)
Environmental impact			Low

Moose

At baseline, there are 45,333 HU of suitable habitat available for moose (Table 46-10, Figure B-17). The Project is predicted to result in an overall decrease of 3,360 HU in the LSA (Table 46-10, Figure B-18). This decrease in habitat availability will primarily occur in high quality habitat, by both the clearing of vegetation and from the potential displacement of moose from habitat types near areas of human use and traffic (e.g., actively utilized roads, facilities and other human infrastructure). These effects are expected to result in a long-term, medium magnitude impact as only a 7.4% reduction in moose habitat availability from baseline conditions in the LSA will occur over the life of the Project.

Landscape disturbances that convert forest to younger age classes may improve browse availability for moose as stand vegetation regenerates, provided hunting pressure and other factors are managed (Rempel et al. 1997). For this reason, the Project development is considered reversible over the long term, assuming moose browse is regenerated in reclaimed areas and human use and activity decreases.

The impact of habitat loss on moose in the LSA is predicted to be moderate. Confidence in this prediction is considered moderate because the assessment is based on a good understanding of habitat selection by moose, high-quality data, and knowledge for the development area.

Table 46-10 Impacts to Moose Habitat Availability in the LSA at Application

	Habitat Quality	Baseline	Application
Habitat availability in the LSA (HU)	Total	45,333	41,973
	High	22,398	17,267
	Moderate	10,928	12,166
	Low	12,007	12,540
Change in habitat availability (HU, %)	Total		-3,360 (-7.4%)
	High		-5,131 (-22.9%)
	Moderate		1,239 (11.3%)
	Low		533 (4.4%)
Environmental impact			Moderate

Within the RSA, there are 766,792 HU of suitable habitat for moose (Table 46-11, Figure B-19). The Project is predicted to result in an overall decrease of 3,305 HU in the RSA (Table 46-11, Figure B-20). In contrast, the cumulative effects case is predicted to reduce habitat availability in the RSA by 11,005 HU (Table 46-11, Figure B-21). These decreases in habitat availability will primarily occur in moderate and low quality habitat, by both the clearing of vegetation and from the potential displacement of moose from habitat types near areas of human use and traffic (e.g., actively utilized roads, facilities and other human infrastructures). These effects are expected to result in a long-term, low magnitude impact as only a 0.4% (application) and 1.4% (cumulative effects case) reduction in moose habitat availability from baseline conditions in the RSA will occur over the life of the Project.

The impact of habitat loss on moose in the RSA is predicted to be negligible (application) to low (cumulative effects case). Confidence in this prediction is considered low because the assessment is based on a good understanding of habitat selection by moose, low-quality landscape data, and poor knowledge for developments within the region.

Table 46-11 Impacts to Moose Habitat Availability in the RSA at Application and Cumulative Effects Case

	Habitat Quality	Baseline	Application	Cumulative
Habitat availability in the LSA (HU)	Total	766,792	673,487	755,787
	High	44,041	43,966	43,660
	Moderate	347,930	346,601	343,672
	Low	374,821	372,920	368,454
Change in habitat availability (HU, %)	Total		-3,305 (-0.4%)	-11,005 (-1.4%)
	High		-75 (-0.2%)	-380 (-0.9%)
	Moderate		-1,329 (-0.4%)	-4,258 (-1.2%)
	Low		-1,901 (-0.5%)	-6,367 (-1.7%)
Environmental impact			Negligible	Low

Woodland Caribou

There are 63,859 HU of suitable habitat for caribou at baseline (Table 46-12, Figure B-22). At application, the Project is predicted to reduce habitat availability in the LSA by 8,742 HU (13.7%, Table 46-12, Figure B-23). High quality habitat is predicted to be reduced by 30.4%, largely as a result of the addition of shallow landscape borrow pits to the Project footprint. This impact is overestimated since the amount of land required for borrow pits, which represents 27% of the footprint, has been substantially overestimated to provide flexibility in borrow material needs and locations. In addition, not all borrow pits will be excavated at the same time and the entire borrow pit will not be excavated at one time. Within each borrow area, clearing and excavation will be phased over a period of up to five years. The excavation process moves across the identified area over time, reclaiming areas where borrow material has been fully excavated. Finally, StatoilHydro still prefers the possibility of excavating borrow pits deeper, thus reducing the area needed by these large landscape level borrow pits (SIR(2) #32(c)). This would decrease the impacts to caribou and other wildlife species. The scat monitoring program has provided extensive data on habitat use, which was used to develop an accurate RSPF model for caribou. StatoilHydro can use results of the monitoring program for adaptive management. Although not yet conducted, StatoilHydro will be able to modify their borrow pit locations to avoid high quality caribou habitat. Therefore, the impacts noted above will be less than predicted.

Habitat availability will primarily be reduced by reducing high quality habitats near areas of human use and traffic (e.g., actively utilized roads, facilities and other human infrastructure). The effect of human use and habitat clearing are expected to result in a long-term, medium-magnitude impact as a 13.7% reduction in caribou habitat availability from baseline conditions in the LSA will occur over the life of the Project.

Caribou habitat selection is largely affected by human activity rather than the presence of human features (SIR(1), Appendix B). Removing traffic and human use in and near the LSA at closure is predicted to increase the selection of habitats in the LSA, based on the resource selection models. Assuming access roads are reclaimed and human use and activity is removed from the area, Project impacts are considered reversible over the long term.

The environmental impact on caribou is considered moderate given that the Project footprint (e.g., borrow pits) is very conservative. As part of its adaptive management strategy, StatoilHydro will optimize its borrow pit footprint, utilizing feedback from the regulators regarding borrow pit depth, final reclamation criteria and location (habitat). Confidence in this prediction is considered moderate because the assessment is based on a good understanding of habitat selection by caribou, and high-quality data and knowledge for the development area.

Baseline habitat availability reported in Table 46-12 differs from that reported in SIR(1) Appendix A because a better understanding of high-use and low-use human disturbances allowed the reclassification of baseline disturbances.

Table 46-12 Impacts to Woodland Caribou Habitat Availability in the LSA at Application

	Habitat Quality	Baseline	Application
Habitat availability in the LSA (HU)	Total	63,859	55,117
	High	38,433	26,750
	Moderate	19,282	20,972
	Low	6,144	7,394
Change in habitat availability (HU, %)	Total		-8,742 (-13.7%)
	High		-11,638 (-30.4%)
	Moderate		1,690 (8.8%)
	Low		1,250 (20.3%)
Environmental impact			Moderate

Within the RSA, there are 686,762 HU of suitable habitat available for caribou (Table 46-13, Figure B-24). At application, the Project is predicted to result in a decrease of 13,777 HU in the RSA (Table 46-13, Figure B-25) and the cumulative effects case is predicted to reduce habitat availability in the RSA by 23,037 HU (Table 46-13, Figure B-26). The combined effect of human use and habitat clearing is expected to result in a long-term, low-magnitude impact as a 2.0% (application case) and 3.4% (cumulative effects case) reduction in caribou habitat availability from baseline conditions in the LSA will occur over the life of the Project.

Caribou habitat selection is largely affected by human activity rather than the presence of human features (SIR(1) Appendix B). Removing traffic and human use in and near the LSA at closure is predicted to increase the selection of habitats in the RSA, based on the resource selection models. Assuming access roads are reclaimed and human use and activity is removed from the area, Project impacts are considered reversible over the long term.

The environmental impact on caribou is considered low because the impact, which has a low magnitude, can be reversed by reducing human use. Confidence in this prediction is considered low because the assessment is based on a good understanding of habitat selection by caribou, low-quality landscape data, and poor knowledge for developments within the region.

Table 46-13 Impacts to Woodland Caribou Habitat Availability in the RSA at Application and Cumulative Effects Case

	Habitat Quality	Baseline	Application	Cumulative
Habitat availability in the LSA (HU)	Total	686,762	672,985	663,726
	High	235,776	213,063	206,567
	Moderate	214,806	226,836	227,708
	Low	236,072	232,997	229,341
Change in habitat availability (HU, %)	Total		-13,777 (-2.0%)	-23,037 (-3.4%)
	High		-22,713 (-9.6%)	-29,208 (-12.4%)
	Moderate		12,029 (5.6%)	12,901 (6.0%)
	Low		-3,095 (-1.3%)	-6,732 (-2.9%)
Environmental impact			Low	Low

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Vegetation

The vegetation impact assessment for the Project was updated for the Round 2 SIRs and included the following changes:

- A new LSA as presented in the Round 1 SIRs (AENV SIR(1) #85), which includes the updated Project footprint; and
- A new application case that consists of the previous Project footprint plus borrow pits, present and future seismic activities, future OSE well pads and access, a diluent pipeline and ATCO powerline ROW.

Vegetation indicators that were updated included ecological land units (upland vegetation communities, wetlands and peatlands), communities of limited distribution, productive forests, merchantable forests, old-growth forests, traditional and medicinal plants, and potential rare plant habitat. No changes of the Project impacts to rare plants, rare communities, acid deposition or non-native and invasive species are expected from the original EIA.

A summary of the baseline and application cases for each vegetation indicator is given below along with a discussion of the impacts. Vegetation impacts are assessed at the closure scenario, when all applicable mitigation (i.e., reclamation) is completed. A final impact rating summary is provided in Table 46-20.

Ecological Land Units

Terrestrial upland vegetation accounts for approximately 44,322 ha (35.3%) of the LSA at baseline (Table 46-14). Project development at application will require the removal of 4,421 ha (10.0%) of upland vegetation. At closure, all disturbed upland areas will be reclaimed to equivalent upland ecosite phases. Baseline disturbances already existing on the landscape will also be reclaimed, therefore, upland areas will increase. Disturbed wetlands will be reclaimed to the g1 upland ecosite phase and transitional g1 areas. Seismic lines that exist in the LSA at the application case are predicted to have naturally revegetated by closure. Therefore, upland vegetation areas will increase by 1,562 ha (3.5%) at closure.

Impacts to terrestrial upland ecosite phases at closure are predicted to be positive in direction, local in extent, low in magnitude, medium term in duration, isolated in frequency, and reversible in the medium term with medium confidence. The environmental impact is low.

Wetlands make up about 68,812 ha (55.0%) of the LSA at baseline (Table 46-14). The application case will see the disturbance of 3,636 ha (5.3%). At closure, as peatlands are reclaimed to upland areas, wetlands will lose approximately 1,129 ha (1.6%) in the LSA.

Impacts to wetlands at closure are rated as negative in direction, local in extent, low in magnitude, long-term in duration, isolated in frequency, irreversible, with medium confidence. The environmental impact is low.

Communities of Limited Distribution

Only ecosite phases within the Lower Boreal Highlands Subregion were considered as communities of limited distribution, given the extremely small proportion of the LSA that is made up of Central Mixedwood ecosite phases (see the EIA, Volume 4, Section 10.6.2).

Communities of limited distribution (making up less than 1% of the LSA) in the LSA include b2, b3, d3 and f1 (Table 46-14). All of these ecosite phases will lose area at the application case, with ecosite phase b2 losing the largest area and proportion of its baseline area (146 ha or 18.0%). At closure, all of these ecosite phases will show small increases in area, except ecosite phase f1, which will show no change from baseline.

Impacts to communities of limited distribution at closure are rated as positive in direction, negligible in magnitude, local in extent, medium-term in duration, isolated in frequency, reversible in the medium-term, with medium confidence. The environmental impact is predicted to be low.

Economic Forests

Productive Forests

The LSA at baseline contains 103,435 ha (82.6%) of forested lands, of which 87,084 ha (69.5%) are productive (Table 46-15). Forested lands will decrease by 7.4% (7,629 ha) at application.

The objective of the conservation and reclamation plan is to reclaim sites in upland forested areas to ecosite phases and land uses that will be the same as, or similar to, pre-disturbance conditions. All of the borrow pit areas at application will be reclaimed to corresponding upland ecosite phases, ecosite phase g1 or g1-transitional areas that will be forested and productive. All of the additional disturbances (seismic lines, powerline ROWs, pipeline ROWs) are also predicted to have naturally revegetated to the original vegetation community present at baseline, including forested and productive areas. Therefore, it is predicted that forested and productive areas in the LSA will increase at closure as existing disturbances on the landscape are reclaimed. This is the same as is predicted in the original EIA.

Impacts to productive forests in the LSA are predicted to be positive in direction, local in extent, negligible in magnitude, medium-term in duration, isolated in frequency, reversible in the medium-term, with medium confidence. The environmental impact is predicted to be low.

Table 46-14 Impacts at Application on Ecosite Phases and Wetlands in the LSA

Ecosite Phase	Baseline Case	Application Case			Closure Scenario		
	Area (ha)	Area (ha)	Change in Area (ha)	Change in Area (%)	Area (ha)	Change in Area (ha)	Change in Area (%)
Central Mixedwood Natural Subregion							
a1	10	10	0	0.0	10	0	0.0
b1	115	113	-2	-1.7	115	0	0.0
b3	27	26	-1	-3.7	27	0	0.0
b4	42	42	0	0.0	42	0	0.0
c1	57	56	-1	-1.8	57	0	0.0
d1	498	495	-3	-0.6	498	0	0.0
d2	303	300	-3	-1.0	303	0	0.0
d3	108	108	0	0.0	108	0	0.0
e1	316	310	-6	-1.9	316	0	0.0
e2	77	77	0	0.0	77	0	0.0
e3	18	18	0	0.0	18	0	0.0
f1	4	4	0	0.0	4	0	0.0
f2	8	8	0	0.0	8	0	0.0
f3	2	2	0	0.0	2	0	0.0
g1	79	79	0	0.0	79	0	0.0
g1/transitional	0	0	0	N/A	4	4	N/A
h1	97	95	-2	-2.1	96	-1	-1.0
i1	550	546	-4	-0.7	550	0	0.0
i2	36	35	-1	-2.8	36	0	0.0
j1	38	38	0	0.0	38	0	0.0
j2	117	115	-2	-1.7	117	0	0.0
k1	14	14	0	0.0	14	0	0.0
k2	216	213	-3	-1.4	213	-3	-1.4
k3	62	62	0	0.0	62	0	0.0
Total Central Mixedwood	*2,794*	*2,766*	*-28*	*-1.0*	*2,794*	*0*	*0.0*

Ecosite Phase	Baseline Case	Application Case			Closure Scenario		
	Area (ha)	Area (ha)	Change in Area (ha)	Change in Area (%)	Area (ha)	Change in Area (ha)	Change in Area (%)
Lower Boreal Highlands Natural Subregion							
a1	1,917	1,695	-222	-11.6	1,923	6	0.3
b1	3,373	2,918	-455	-13.5	3,382	9	0.3
b2	809	663	-146	-18.0	813	4	0.5
b3	481	429	-52	-10.8	482	1	0.2
c1	9,876	8,868	-1,008	-10.2	9,903	27	0.3
d1	7,468	6,437	-1,031	-13.8	7,549	81	1.1
d2	3,212	2,912	-300	-9.3	3,214	2	0.1
d3	1,090	1,007	-83	-7.6	1,091	1	0.1
e1	1,290	1,194	-96	-7.4	1,292	2	0.2
f1	79	71	-8	-10.1	79	0	0.0
g1	12,966	11,964	-1,002	-7.7	13,162	196	1.5
g1/transitional	0	0	0	N/A	1,230	1,230	N/A
h1	34,272	32,269	-2,003	-5.8	33,493	-779	-2.3
h2	5,806	5,468	-338	-5.8	5,722	-84	-1.4
i1	6,573	6,200	-373	-5.7	6,467	-106	-1.6
i2	6,098	5,820	-278	-4.6	6,044	-54	-0.9
j1	8,758	8,403	-355	-4.1	8,702	-56	-0.6
j2	3,263	3,138	-125	-3.8	3,241	-22	-0.7
j3	3,009	2,855	-154	-5.1	2,984	-25	-0.8
Total Lower Boreal Highlands	*110,340*	*102,311*	*-8,029*	*-7.3*	*110,773*	*433*	*0.4*
Other							
Burn	3,296	3,115	-181	-5.5	3,115	-181	-5.5
Burn-Clearcut	38	38	0	0.0	38	0	0.0
Burn Regenerating	796	747	-49	-6.2	900	104	13.1
Meadow	15	15	0	0.0	15	0	0.0
NMC - cutbank	1	1	0	0.0	1	0	0.0
Shrubland	33	32	-1	-3.0	33	0	0.0
Total Other	*4,179*	*3,948*	*-231*	*-5.5*	*4,102*	*-77*	*-1.8*
Water							
NWF - Flooded	276	267	-9	-3.3	276	0	0.0
NWL - Lakes	2,119	2,090	-29	-1.4	2,119	0	0.0
NWR - Rivers	380	362	-18	-4.7	380	0	0.0
Total Water	*2,775*	*2,719*	*-56*	*-2.0*	*2,775*	*0*	*0.0*

Ecosite Phase	Baseline Case	Application Case			Closure Scenario		
	Area (ha)	Area (ha)	Change in Area (ha)	Change in Area (%)	Area (ha)	Change in Area (ha)	Change in Area (%)
Disturbance							
Borrow Pits	0	2,491	2,491	N/A	0	0	N/A
Clearcut	1,424	1,286	-138	-9.7	1,286	-138	-9.7
Clearings	46	38	-8	-17.4	38	-8	-17.4
Cutlines	1,339	1,422	83	6.2	1,279	-60	-4.5
Industrial	29	639	610	2,103.4	21	-8	-27.6
Pipeline	0	50	50	N/A	0	0	N/A
Right-of-ways	1,380	1,523	143	10.4	1,265	-115	-8.3
Seismic	0	2,772	2,772	N/A	0	0	N/A
Transmission Lines	0	29	29	N/A	0	0	N/A
Transportation	153	1,140	987	645.1	138	-15	-9.8
Wellsites	255	1,580	1,325	519.6	243	-12	-4.7
Total Disturbance	*4,626*	*12,970*	*8,344*	*180.4*	*4,270*	*-356*	*-7.7*
Data Unavailable	502	502	0	0.0	502	0	0.0
Total	**125,216**	**125,216**	**0**	**0.0**	**125,216**	**0**	**0.0**

Table 46-15 Impacts at Application on Productive Forests in the LSA

Timber Productivity Rating	Baseline Case	Application Case		
	Area (ha)	Area (ha)	Change in Area (ha)	Change in Area (%)
Central Mixedwood Natural Subregion				
Forested Area				
Good	1,708	1,694	-14	-0.8
Medium	637	629	-8	-1.3
Fair	51	51	0	0.0
Total Productive	2,396	2,374	-22	-0.9
Unproductive	3	3	0	0.0
Total Forested	2,399	2,377	-22	-0.9
Non-forested Area	1,004	1,026	22	2.2
Total Central Mixedwood	*3,403*	*3,403*	*0*	*0.0*
Lower Boreal Highlands Natural Subregion				
Forested Area				
Good	19,774	17,708	-2,066	-10.4
Medium	48,470	44,818	-3,652	-7.5
Fair	16,444	15,426	-1,018	-6.2
Total Productive	84,688	77,952	-6,736	-8.0
Unproductive	16,348	15,477	-871	-5.3
Total Forested	101,036	93,429	-7,607	-7.5
Non-forested Area	20,274	27,881	7,607	37.5
Total Lower Boreal Highlands	*121,310*	*121,310*	*0*	*0.0*
Total Productive Area	**87,084**	**80,326**	**-6,758**	**-7.8**
Total Forested Area	**103,435**	**95,806**	**-7,629**	**-7.4**

Merchantable Forests

The LSA at baseline contains 35,534 ha (28.4%) of merchantable forest (Table 46-16). This area will decrease by 3,616 ha (10.2%) at application.

Similar to productive forests, all merchantable forest disturbed by the Project will be reclaimed to the forested and productive baseline conditions. It is predicted that merchantable areas will also be returned to the same condition on reclamation, including existing baseline disturbances. The area of merchantable forest is therefore predicted to increase, which is the same as predicted in the original EIA.

Impacts to merchantable forests in the LSA are predicted to be positive in direction, local in extent, negligible in magnitude, medium-term in duration, isolated in frequency, reversible in the medium-term, with medium confidence. Confidence is medium as merchantability depends in the growth rate of the reclaimed areas, which could be significantly affected by soil reclamation techniques, future climate change and competition with other vegetation. The environmental impact is predicted to be low.

Table 46-16 Impacts at Application on Merchantable Forests in the LSA

Ecosite Phase	Baseline Case	Application Case		
	Area (ha)	Area (ha)	Change in Area (ha)	Change in Area (%)
Central Mixedwood Natural Subregion				
a1	10	10	0	0.0
b1	109	107	-2	-1.8
b3	27	26	-1	-3.7
b4	42	42	0	0.0
c1	57	56	-1	-1.8
d1	497	494	-3	-0.6
d2	298	295	-3	-1.0
d3	108	107	-1	-0.9
e1	316	310	-6	-1.9
e2	77	77	0	0.0
e3	18	18	0	0.0
f1	4	4	0	0.0
f2	3	3	0	0.0
f3	0	0	0	N/A
g1	48	47	-1	-2.1
h1	69	68	-1	-1.4
i1	158	156	-2	-1.3
Total Central Mixedwood	*1,841*	*1,820*	*-21*	*-1.1*

Ecosite Phase	Baseline Case	Application Case		
	Area (ha)	Area (ha)	Change in Area (ha)	Change in Area (%)
Lower Boreal Highlands Natural Subregion				
a1	1,123	969	-154	-13.7
b1	3,188	2,748	-440	-13.8
b2	792	647	-145	-18.3
b3	469	417	-52	-11.1
c1	6,723	5,985	-738	-11.0
d1	7,341	6,318	-1,023	-13.9
d2	3,122	2,826	-296	-9.5
d3	928	862	-66	-7.1
e1	763	705	-58	-7.6
f1	66	58	-8	-12.1
g1	5,182	4,855	-327	-6.3
h1	3,986	3,699	-287	-7.2
j1	10	9	-1	-10.0
Total Lower Boreal Highlands	*33,693*	*30,098*	*-3,595*	*-10.7*
Total Merchantable Forest	**35,534**	**31,918**	**-3,616**	**-10.2**

Old-Growth Forests

The LSA contains approximately 7,249 ha of old-growth forest at baseline (Table 46-17). At application, 592 ha (8.2%) of this area will be disturbed. Old-growth forest takes a minimum of 110 years to develop and therefore, will not be restored within the closure scenario timeline. However, given sufficient time, old-growth will develop within the LSA after Project closure.

At closure, impacts to old-growth forests are predicted to be negative in direction, local in extent, low in magnitude, long-term in duration, isolated in frequency, reversible in the long-term with medium confidence. The environmental impact is predicted to be low.

Table 46-17 Impacts at Application to Old-growth Forests in the LSA

Old Growth Type	Baseline Case	Application case			Closure Scenario		
	Area (ha)	Area (ha)	Change in Area (ha)	Change in Area (%)	Area (ha)	Change in Area (ha)	Change in Area (%)
Central Mixedwood Natural Subregion							
Coniferous	145	144	-1	-0.7	144	-1	-0.7
Deciduous	121	120	-1	-0.8	120	-1	-0.8
Mixedwood	160	159	-1	-0.6	159	-1	-0.6
Total Central Mixedwood	*426*	*423*	*-3*	*-0.7*	*423*	*-3*	*-0.7*

Old Growth Type	Baseline Case	Application case			Closure Scenario		
	Area (ha)	Area (ha)	Change in Area (ha)	Change in Area (%)	Area (ha)	Change in Area (ha)	Change in Area (%)
Lower Boreal Highlands Natural Subregion							
Coniferous	3,892	3,652	-240	-6.2	3,652	-240	-6.2
Deciduous	698	613	-85	-12.2	613	-85	-12.2
Mixedwood	2,233	1,969	-264	-11.8	1,969	-264	-11.8
Total Lower Boreal Highlands	*6,823*	*6,234*	*-589*	*-8.6*	*6,234*	*-589*	*-8.6*
Total Old Growth Forest	7,249	6,657	-592	-8.2	6,657	-592	-8.2

Traditional and Medicinal Plants

At baseline, the LSA contains 33,267 ha (26.6%) of blueberry habitat, 17,961 ha (14.3%) of cranberry habitat and 4,023 ha (3.2%) of strawberry habitat (Table 46-18).

Blueberry habitat will decrease by 9.6% (33,512 ha) at application (Table 46-18). At closure upland areas will be reclaimed and blueberry habitat will increase by 0.7% (245 ha). The impact to blueberry habitat is predicted to be positive in direction, local in extent, negligible in magnitude, medium-term in duration, isolated in frequency, reversible in the medium-term, with medium confidence. The environmental impact is predicted to be low.

Cranberry habitat will decrease by 11.1% (1,987 ha) at application (Table 46-18). At closure as upland areas are reclaimed, cranberry habitat will increase by 0.3% (45 ha). The impact to cranberry habitat is predicted to be positive in direction, local in extent, negligible in magnitude, medium-term in duration, isolated in frequency, reversible in the medium-term, with high confidence. The environmental impact is predicted to be low.

Strawberry habitat will decrease by 8.8% (356 ha) at application (Table 46-18). At closure, as upland areas are reclaimed, cranberry habitat will increase by less than 0.1% (2 ha). The impact to cranberry habitat is predicted to be positive in direction, local in extent, negligible in magnitude, medium-term in duration, isolated in frequency, reversible in the medium-term, with high confidence. The environmental impact is predicted to be low.

Potential Rare Plant Habitat

At baseline, the LSA contains 25,077 ha (20.0%) of high, 46,669 ha (37.3%) of moderate, 35,790 ha (28.6%) of low and 13,486 ha (10.8%) of very low potential rare plant habitat (Table 46-19).

At application, the Project will affect 1,136 ha (4.5%) of high potential rare plant habitat, 3,247 ha (9.1%) of low potential rare plant habitat and 1,440 ha (10.7%) of very low potential rare plant habitat (Table 46-19). Moderate potential rare plant habitat increases by 6,025 (12.9%) as disturbed areas increase with development.

At closure, high potential rare plant habitat will decrease by 241 ha (1.0%), moderate potential rare plant habitat will decrease by 1,076 ha (2.3%), low potential rare plant habitat will increase by 1,389 ha (3.9%) and very low potential rare plant habitat will increase by 37 ha (0.3%).

At closure, impacts to potential rare plant habitat are predicted to be negative in direction, local in extent, low in magnitude, long-term in duration, isolated in frequency, irreversible, with medium confidence. The environmental impact is predicted to be low.

Table 46-18 Impacts at Application to Traditional and Medicinal Plants in the LSA

Ecosite Phase	Baseline Case	Application Case			Closure Scenario		
	Area (ha)	Area (ha)	Change in Area (ha)	Change in Area (%)	Area (ha)	Change in Area (ha)	Change in Area (%)
Central Mixedwood Natural Subregion							
Blueberry Habitat							
a1	10	10	0	0.0	10	0	0.0
b1	115	113	-2	-1.7	115	0	0.0
b2	0	0	0	N/A	0	0	N/A
b3	27	26	-1	-3.7	27	0	0.0
b4	42	42	0	0.0	42	0	0.0
c1	57	56	-1	-1.8	57	0	0.0
d2	303	300	-3	-1.0	303	0	0.0
g1	79	79	0	0.0	79	0	0.0
Total Blueberry Habitat	*633*	*626*	*-7*	*-1.1*	*633*	*0*	*0.0*
Cranberry Habitat							
b1	115	113	-2	-1.7	115	0	0.0
d1	498	495	-3	-0.6	498	0	0.0
d2	303	300	-3	-1.0	302	-1	-0.3
d3	108	108	0	0.0	108	0	0.0
e1	316	310	-6	-1.9	316	0	0.0
e2	77	77	0	0.0	77	0	0.0
e3	18	18	0	0.0	18	0	0.0
f1	4	4	0	0.0	4	0	0.0
f2	8	8	0	0.0	8	0	0.0
f3	2	2	0	0.0	2	0	0.0
Total Cranberry Habitat	*1,449*	*1,435*	*-14*	*-1.0*	*1,448*	*-1*	*-0.1*
Strawberry Habitat							
b3	27	26	-1	-3.7	27	0	0.0
d2	303	300	-3	-1.0	302	-1	-0.3
Total Strawberry Habitat	*330*	*326*	*-4*	*-1.2*	*329*	*-1*	*-0.3*

Ecosite Phase	Baseline Case	Application Case			Closure Scenario		
	Area (ha)	Area (ha)	Change in Area (ha)	Change in Area (%)	Area (ha)	Change in Area (ha)	Change in Area (%)
Lower Boreal Highlands Natural Subregion							
Blueberry Habitat							
a1	1,917	1,695	-222	-11.6	1,923	6	0.3
b1	3,373	2,918	-455	-13.5	3,382	9	0.3
b2	809	663	-146	-18.0	813	4	0.5
b3	481	429	-52	-10.8	482	1	0.2
b4	0	0	0	N/A	0	0	N/A
c1	9,876	8,868	-1,008	-10.2	9,903	27	0.3
d2	3,212	2,912	-300	-9.3	3,214	2	0.1
g1	12,966	11,964	-1,002	-7.7	13,162	196	1.5
Total Blueberry Habitat	*32,634*	*29,449*	*-3,185*	*-9.8*	*32,879*	*245*	*0.8*
Cranberry Habitat							
b1	3,373	2,918	-455	-13.5	3,382	9	0.3
d1	7,468	6,437	-1,031	-13.8	7,500	32	0.4
d2	3,212	2,912	-300	-9.3	3,214	2	0.1
d3	1,090	1,007	-83	-7.6	1,091	1	0.1
e1	1,290	1,194	-96	-7.4	1,292	2	0.2
e2	0	0	0	N/A	0	0	N/A
e3	0	0	0	N/A	0	0	N/A
f1	79	71	-8	-10.1	79	0	0.0
f2	0	0	0	N/A	0	0	N/A
f3	0	0	0	N/A	0	0	N/A
Total Cranberry Habitat	*16,512*	*14,539*	*-1,973*	*-11.9*	*16,558*	*46*	*0.3*
Strawberry Habitat							
b3	481	429	-52	-10.8	482	1	0.2
d2	3,212	2,912	-300	-9.3	3,214	2	0.1
Total Strawberry Habitat	*3,693*	*3,341*	*-352*	*-9.5*	*3,696*	*3*	*0.1*
Total Blueberry Habitat	33,267	30,075	-3,192	-9.6	33,512	245	0.7
Total Cranberry Habitat	17,961	15,974	-1,987	-11.1	18,006	45	0.3
Total Strawberry Habitat	4,023	3,667	-356	-8.8	4,025	2	0.0

Table 46-19 Impacts at Application to Rare Plant Potential Habitat in the LSA

Ecosite Phase	Baseline Case	Application Case			Closure Scenario		
	Area (ha)	Area (ha)	Change in Area (ha)	Change in Area (%)	Area (ha)	Change in Area (ha)	Change in Area (%)
Central Mixedwood Natural Subregion							
High Rare Plant Potential							
j1	38	38	0	0.0	38	0	0.0
j2	117	115	-2	-1.7	117	0	0.0
k1	14	14	0	0.0	14	0	0.0
k2	216	213	-3	-1.4	213	-3	-1.4
Total High	*385*	*380*	*-5*	*-1.3*	*382*	*-3*	*-0.8*
Moderate Rare Plant Potential							
d3	108	108	0	0.0	108	0	0.0
i1	550	546	-4	-0.7	550	0	0.0
k3	62	62	0	0.0	62	0	0.0
l1	0	0	0	N/A	0	0	N/A
NWL - Lakes	26	26	0	0.0	26	0	0.0
Regenerating Burn	0	0	0	N/A	0	0	N/A
Disturbed	497	525	28	5.6	497	0	0.0
Total Moderate	*1,243*	*1,267*	*24*	*1.9*	*1,243*	*0*	*0.0*
Low Rare Plant Potential							
b1	115	113	-2	-1.7	115	0	0.0
d1	498	495	-3	-0.6	498	0	0.0
d2	303	300	-3	-1.0	303	0	0.0
e1	316	310	-6	-1.9	316	0	0.0
e3	18	18	0	0.0	18	0	0.0
g1	79	79	0	0.0	79	0	0.0
g1/transitional	0	0	0	N/A	4	4	N/A
i2	36	35	-1	-2.8	36	0	0.0
Shrubland	1	1	0	0.0	1	0	0.0
NWF - Flooded	12	12	0	0.0	12	0	0.0
Total Low	*1,378*	*1,363*	*-15*	*-1.1*	*1,382*	*4*	*0.3*
Very Low Rare Plant Potential							
a1	10	10	0	0.0	10	0	0.0
b2	0	0	0	N/A	0	0	N/A
b3	27	26	-1	-3.7	27	0	0.0
b4	42	42	0	0.0	42	0	0.0
c1	57	56	-1	-1.8	57	0	0.0
e2	77	77	0	0.0	77	0	0.0
f1	4	4	0	0.0	4	0	0.0
f2	8	8	0	0.0	8	0	0.0
f3	2	2	0	0.0	2	0	0.0
h1	97	95	-2	-2.1	96	-1	-1.0
Total Very Low	*324*	*320*	*-4*	*-1.2*	*323*	*-1*	*-0.3*

Ecosite Phase	Baseline Case	Application Case			Closure Scenario		
	Area (ha)	Area (ha)	Change in Area (ha)	Change in Area (%)	Area (ha)	Change in Area (ha)	Change in Area (%)
Lower Boreal Highlands Natural Subregion							
High Rare Plant Potential							
i1	6,573	6,200	-373	-5.7	6,467	-106	-1.6
i2	6,098	5,820	-278	-4.6	6,044	-54	-0.9
j1	8,758	8,403	-355	-4.1	8,702	-56	-0.6
j2	3,263	3,138	-125	-3.8	3,241	-22	-0.7
Total High	*24,692*	*23,561*	*-1,131*	*-4.6*	*24,454*	*-238*	*-1.0*
Moderate Rare Plant Potential							
d3	1,090	1,007	-83	-7.6	1,091	1	0.1
h1	34,272	32,269	-2,003	-5.8	33,493	-779	-2.3
j3	3,009	2,855	-154	-5.1	2,984	-25	-0.8
NWL - Lakes	2,092	2,064	-28	-1.3	2,092	0	0.0
Regenerating Burn	796	747	-49	-6.2	830	34	N/A
Disturbed	4,167	12,485	8,318	199.6	3,860	-307	-7.4
Total Moderate	*45,426*	51,427	*6,001*	*13.2*	*44,350*	*-1,076*	*-2.4*
Low Rare Plant Potential							
b1	3,373	2,918	-455	-13.5	3,382	9	0.3
d1	7,468	6,437	-1,031	-13.8	7,500	32	0.4
d2	3,212	2,912	-300	-9.3	3,214	2	0.1
e1	1,290	1,194	-96	-7.4	1,292	2	0.2
g1	12,966	11,964	-1,002	-7.7	13,162	196	1.5
g1/transitional	0	0	0	N/A	1,228	1228	N/A
h2	5,806	5,468	-338	-5.8	5,722	-84	-1.4
Shrubland	33	32	-1	-3.0	33	0	0.0
NWF - Flooded	264	255	-9	-3.4	264	0	0.0
Total Low	*34,412*	*31,180*	*-3,232*	*-9.4*	*35,797*	*1385*	*4.0*
Very Low Rare Plant Potential							
a1	1,917	1,695	-222	-11.6	1,923	6	0.3
b2	809	663	-146	-18.0	813	4	N/A
b3	481	429	-52	-10.8	482	1	0.2
c1	9,876	8,868	-1,008	-10.2	9,903	27	0.3
f1	79	71	-8	-10.1	79	0	0.0
Total Very Low	13,162	11,726	*-1,436*	*-10.9*	13,200	*38*	*0.3*
Total High Potential Habitat	25,077	23,941	-1,136	-4.5	24,836	-241	-1.0
Total Moderate Potential Habitat	46,669	52,694	6,025	12.9	45,593	-1,076	-2.3
Total Low Potential Habitat	35,790	32,543	-3,247	-9.1	37,179	1,389	3.9
Total Very Low Potential Habitat	13,486	12,046	-1,440	-10.7	13,523	37	0.3

Summary of Updated Impacts

While the updated application case involves greater disturbance of vegetation during the Project operation from the original EIA, residual vegetation impacts at closure are very similar to those assessed in the original EIA, as the closure scenario is little changed. All of the updated impacts to vegetation indicators remain low environmental impacts and are summarized in Table 46-20.

Table 46-20 Summary of Updated Potential Impacts on Vegetation Indicators in the LSA

Indicator	Direction	Extent	Magnitude	Duration	Frequency of Occurrence	Permanence	Level of Confidence	Final Impact Rating at Closure
Upland Vegetation Communities	Positive	Local	Low	Medium-term	Isolated	Medium-term	Medium	Low
Wetlands and Peatlands	Negative	Local	Low	Long-term	Isolated	Irreversible	Medium	Low
Communities of Limited Distribution	Positive	Local	Negligible	Medium-term	Isolated	Medium-term	Medium	Low
Productive Forests	Positive	Local	Negligible	Medium-term	Isolated	Medium-term	Medium	Low
Merchantable Forests	Positive	Local	Negligible	Medium-term	Isolated	Medium-term	Medium	Low
Old-Growth	Negative	Local	Low	Long-term	Isolated	Long-term	Medium	Low
Traditional Plants – Blueberries	Positive	Local	Negligible	Medium-term	Isolated	Medium-term	Medium	Low
Traditional Plants – Cranberries	Positive	Local	Negligible	Medium-term	Isolated	Medium-term	High	Low
Traditional Plants - Strawberries	Positive	Local	Negligible	Medium-term	Isolated	Medium-term	High	Low
Potential Rare Plant Habitat	Negative	Local	Low	Long-term	Isolated	Irreversible	Medium	Low

47.

SIR 102b, Pages 247-248.

StatoilHydro states, "…*surveys conducted were focused on the two initial development areas since these are being applied for in this Application*." StatoilHydro also states, "…*to supplement local data and support the EIA for the entire LSA, regional data was also used.*" StatoilHydro further states, *"…based on this information and the response to AENV SIR 102a, StatoilHydro does not plan on conducting additional surveys specifically to support the EIA with the exception of a bat survey since sampling intensity was affected by weather*."

a. Provide a discussion and updated maps to illustrate how regional wildlife data were incorporated into the EIA. Did these regional wildlife data include information from neighbouring leases/operators, and if so, which ones? Indicate which surveys points have been added since the SIR response.

Response

For the EIA, information including data from regional baseline studies was used. Since submission of the EIA, additional data from regional baseline studies conducted by other oil sands lease holders

(OPTI/Nexen and MEG Energy Corp.) has been included. Figures 41-4 through 41-9 (see SIR(2) #41(a)) provide survey locations within the RSA. These figures identify those survey points surveyed in:

- the EIA;
- those additional survey points reported in the responses to round 1 SIR; and
- those additional survey points since the responses to the round 1 SIRs.

Owls and bats are primarily nocturnal and difficult to detect, and protocols for EIA level surveys focus on obtaining presence/not detected information. More intensive surveys to determine habitat use information for these groups of wildlife are long-term research level projects and not required for EIAs. For EIAs, information on nesting habitat or roosting habitat is not obtained and therefore model validation is not possible. The regional data confirms that these species are found in the region where suitable habitat occurs. All survey sites for owls and bats within the RSA are illustrated in Figure 41-5 and 41-9.

There were no Canadian toads found within the LSA and with the exception of one Canadian toad, all were found east and northeast of the LSA (Figure 41-4). It is possible that the prevalence of lowland habitat types is limiting Canadian toad distribution within the LSA. Regional Canadian toad data were used to validate the Canadian toad model for the impact assessment. In this case, regional data was required to validate the Canadian toad model since no Canadian toads were found within the LSA.

Breeding bird surveys provide information on distribution, relative abundance and habitat use by songbirds. However, no songbird species were selected as an indicator, and therefore data from the breeding bird survey does not contribute to the impact assessment. Information obtained is for baseline purposes only. A total of 531 breeding bird survey points have been surveyed in the LSA and RSA (Figure 41-8). This survey intensity within the LSA and RSA provides a very good understanding of distribution, relative abundance and habitat use by songbirds within the Study Areas. As indicated in SIR(2) #41, since areas sampled and not sampled are ecologically similar, these data can be used to describe songbird use of unsampled portions of the LSA.

The scat monitoring program is providing the most current and comprehensive data on moose, caribou, and wolf in Alberta and results of this monitoring will help to provide an accurate population estimate and can help better define factors that affect population dynamics. The information from this monitoring was used to develop resource selection probability function models for moose and caribou, which improves StatoilHydro’s understanding of potential Project impacts within the LSA. The areas surveyed for the scat monitoring, including the control area, are provided in Figure 41-6.

Winter tracking sampling intensity within the RSA reported in AENV SIR(1) #102(b) was 357 km. This tracking data provides a large amount of habitat use information for most winter active terrestrial mammals. Combining survey data from the RSA was necessary to obtain enough observations of hare and lynx to develop and validate the models for these species. Data from a single project would be insufficient. Despite this high level of survey intensity, StatoilHydro conducted an additional winter tracking survey in February, 2009. Hare and lynx data from this 74 km of tracking was used to further validate the models; however, the increased data did not result in any changes in the models and therefore no change to the impact assessment reported in SIR(2) #46(b). All winter tracking survey transects to date are shown in Figure 41-7.

47.	b. Discuss whether the addition of regional wildlife data has changed the results of the assessment.

Response

As indicated above, information from owl, bat, and breeding bird surveys do not contribute to the impact assessment because survey data obtained is not suitable for use in model validation and/or these groups are not wildlife indicators for the impact assessment. The regional surveys for these groups contribute to the understanding of the presence, habitat use (breeding bird survey), and distribution of species across the LSA and RSA, but do not change the results of the assessment.

There were no Canadian toads found within the LSA, and therefore model validation using local data was not possible. The Canadian toad model used in the impact assessment has been validated by the regional Canadian toad data. The regional winter tracking data aided in the development of a RSPF for hare which was used in the lynx model (see SIR(2) #46(b), #53). Although a comparison of impacts with the EIA cannot be made because the model and application case footprint have changed, a more accurate model was prepared using the regional data set. As indicated in SIR(2) #46, impacts to lynx are still considered moderate. The additional winter tracking survey in the LSA in February 2009 (providing 74 km of tracking data) did not change the RSPF for snowshoe hare, and subsequently lynx, and did not change the impact prediction.

47.	c. Explain StatoilHydro's position that additional sampling is not required. Include a discussion on sampling intensity/effort.

Response

Please refer to SIR (2) #41 for StatoilHydro's position on adequacy of sampling including sampling intensity. Additional sampling is not required because it is StatoilHydro's position that the TOR have been met.

47.	d. Provide a justification for why sampling was not conducted in the areas within the LSA.

Response

As stated in SIR(2) #41(a), information on habitat use from baseline surveys within sampled areas of the LSA and RSA can be used to infer habitat use within unsampled areas of the LSA, provided the areas are ecologically similar. StatoilHydro has demonstrated this ecologically similarity. Where relevant, these data (winter tracking, scat monitoring, and Canadian toad surveys) were used in model validation to improve confidence in impact predictions for Project effects on changes in habitat availability. Other surveys (breeding birds, owls, and bats) do not contribute to the impact assessment. Surveys for these species, within the conceptual development areas (i.e., future hubs), are best done at a time relevant to when these projects will be developed since a number of factors (e.g., forest succession) may affect wildlife use patterns over time.

Since the Round 1 SIRs were submitted, StatoilHydro has conducted a winter tracking survey within unsampled areas of the LSA (February 2009) to augment existing survey data. Data from this survey did not change the impact predictions for species such as lynx, moose, and woodland caribou.

47.	e. Provide a plan and schedule of implementation to augment field survey data for these areas. The surveys should be conducted no later than 2010.

Response

An additional winter tracking survey (74km) was conducted in February, 2009. See Figure 41-7, which shows complete coverage of the LSA.

A breeding bird survey will be conducted in June, 2009. As stated above, breeding bird surveys do not contribute to the impact assessment. However, StatoilHydro has committed to adding to the knowledge of songbird occurrence, relative abundance, and distribution within the LSA and RSA. The songbird survey will focus on areas of the LSA that have not been sampled, including the future hub locations.

Remaining surveys include owl, Canadian toad, and bat surveys, the results of which will not affect the conclusions of the impact assessment. The survey data will provide presence and distribution information. Sampling within the initial development areas is sufficient. StatoilHydro proposes to conduct these surveys in the vicinity of the future hubs to provide information supporting the future amendment Applications as follows.

- Thornbury; 2010
- Hangingstone; 2013
- Northwest Leismer; 2015
- South Leismer; 2026

Due to the uncertainty of footprint of these future hubs and the shelf life of the survey data, it is prudent to complete these surveys when there is greater footprint certainty. As stated above, these surveys will not change the conclusions of the EIA.

48.	**SIR 102b, Pages 247-248.** Statoil states, "…*a bat survey will be conducted in the initial development areas in 2008*." a. When will the results be submitted to regulatory agencies?

Response

A bat survey was completed late in the summer of 2008, and the results are provided in Appendix A.

49.	**SIR 114, Page 268.** The draft guidelines StatoilHydro committed to are under revision to reflect new research and policies. a. Provide a commitment to adhere to the Boreal Caribou Committee Strategic Plan and Industrial Guidelines for Boreal Caribou Ranges in Northern Alberta and the Recommended Land Use Guidelines for Key Ungulate Areas.

Response

StatoilHydro commits to comply with the Boreal Caribou Committee Strategic Plan and Industrial Guidelines for Boreal Caribou Ranges in Northern Alberta and the Recommended Land Use Guidelines for Key Ungulate Areas and reaffirms, notwithstanding that it is a draft document, that StatoilHydro has been required by ASRD to commit to the September 20, 2007 *DRAFT Wildlife Guidelines for the Use of Aboveground Pipeline*s. Therefore, StatoilHydro also commits to the key mitigation strategies as outlined in this version of the draft document, and as referred to in AENV SIR(1) #114.

50.	**SIR 114c, Page 271.** StatoilHydro states, "*…mitigation measures focus on reducing new disturbances during sensitive timing windows, i.e. not conducting new ground disturbances during the caribou calving period and avoidance of bird nests if clearing is required between May 1 and August 15*." A multi-stakeholder group including industry committed to 'early in, early out' in order to protect caribou during sensitive times of the year. Caribou are sensitive during the pre-calving period, which occurs from late February until mid to late April. a. Provide a revised commitment to an 'out' date that will effectively protect caribou.

Response

StatoilHydro submits a Caribou Protection Plan to ASRD for approval each year, and the 'out' date is defined in the Caribou Protection Plan. The Caribou Protection Plan for 2008/2009 has an 'out' date of March 31st.

50.	StatoilHydro did not reference any mitigation measures to avoid conflict with bears in their camp locations and potential disturbance of hibernating bears. b. Discuss StatoilHydro's commitment to mitigating bear issues.

Response

To reduce the likelihood of bear-human encounters in the vicinity of the Project, StatoilHydro has developed a bear management plan. This plan outlines a number of bear management strategies for the Project targeting: 1) the safety of employees and contractors; 2) the protection of property; and 3) bear conservation. The purpose of the bear management plan is to minimize bear-human conflict in, and surrounding, the Project area.

This management plan has two major components: 1) Bear Awareness and Avoidance and 2) Project area management, and is intended to:

- Prevent risk of injury to humans or bears;
- Decrease property damage resulting from bears;
- Decrease the number of bears translocated from the facility area;
- Prevent the disturbance of hibernating bears;
- Prevent bears from seeking refuge around buildings or other infrastructure; and
- Decrease resources expended in dealing with bear-human conflicts.

50.	c. Identify StatoilHydro's commitment to "Bear Aware"

Response

Bear awareness and avoidance is a major component of StatoilHydro's bear management plan. StatoilHydro's commitment to being "Bear Aware" includes 1) Staff Training and 2) A Bear Smart Program:

1. Staff Training

The Bear Awareness and Avoidance program was created by the Alberta Safety Council to provide the most recent available information on bear avoidance for members of the public and industry. Training consists of educational materials designed to reduce bear-human conflicts. Upon successful completion of this program, StatoilHydro staff can become certified instructors able to teach this course to other staff members. Staff members who work in roles where the potential for bear encounters exist should receive Bear Awareness and Avoidance training from certified StatoilHydro instructors. Training may include a review of the following videos:

- Staying Safe in Bear Country: A Behavioral-Based Approach to Reducing Risk (IBA 2001a); and,
- Working in Bear Country: For Industrial Managers, Supervisors and Workers (IBA 2001b).

2. Bear Smart Program

StatoilHydro is developing a Bear Smart Program which outlines bear management procedures to be followed by all StatoilHydro employees and contractors working on the Project. Potential procedures are outlined below.

- If working alone in remote areas of the Project, staff should be equipped with appropriate bear deterrent devices (i.e., pepper spray, air horn, bangers) and should have training on how to use these devices.
- Making food or food waste unavailable to bears by storing all garbage and waste water in designated areas and/or enclosed and approved bear proof containers.
- Storing all chemicals or petroleum products properly to avoid access.
- Posting and adhering to bear warning signs where problem bears have been reported.
- Establishing a rule - never approach a bear -their behaviour is unpredictable, and they can attack if surprised or threatened or are defending territory, kills or cubs.

REFERENCES

International Association for Bear Research and Management (IBA). 2001a. Staying Safe in Bear Country: a Behavioral-based Approach to Reducing Risk video. Produced by Wild Eye Productions, Atlin, British Columbia.

IBA. 2001b. Working in Bear Country: for Industrial Managers, Supervisors, and Workers video. Produced by Wild Eye Productions, Atlin, British Columbia.

Miramar Hope Bay Ltd. 2003. Wildlife Mitigation Plan - Doris North Project. Prepared by Andy McMullen's Bearwise for Miramar Hope Bay Ltd. North Vancouver, B.C.

50.	d. Identify StatoilHydro's commitment to fencing camps and other areas that might serve to attract bears to mitigate/minimize the incidence of 'problem bears'.

Response

The following Facility Area Management is part of StatoilHydro's bear management plan:

Facility Area Management

Permanent camp locations will incorporate the following mitigations to minimize the potential for human/bear interactions.

- Improving visibility where humans are most likely to surprise bears, such as outside of kitchens and storage areas. Areas such as blind corners, storage drums, dumpsters or clumps of vegetation may conceal bears.
- Skirting should be attached to buildings and elevated walkways to prevent bears from taking refuge under them.
- Providing proper lighting at building exits, along pathways and outside work areas, so people can move about the facility safely at night.

- Using fences as a barrier device to prevent bears from entering camps. This will serve to reduce bear-human conflicts and property damage by bears, and minimize the risk of "problem bears".

Waste, including food waste, garbage, and recycling from camps needs to be dealt with as follows:

- Garbage will be stored in bear-resistant containers and transported to an approved disposal facility.
- Excess garbage and recyclable waste will be securely bagged and stored inside a closed, hard-sided building until space in the containers is available.
- All bear-proof garbage containers will be marked with "bear proof" signage to reinforce employee education.
- Employees collecting garbage will report any repairs necessary to maintain containers in a bear proof condition. Daily garbage pickup will be required in areas of known bear hazards to ensure containers are not filled beyond capacity.
- All waste disposal contracts will ensure bear-proof food storage, preparation and garbage handling requirements are included and that these requirements are followed by the contractor.

50.	e. Identify StatoilHydro's commitment to developing and implementing methods to survey for bear dens in the season prior to disturbance in order to discourage use of these locations in the year slated for disturbance.

Response

Clearing of areas is considered to involve a low probability of discovering bear dens, and the hazards associated with bear den surveys do not warrant conducting surveys. If bear dens are found, ASRD will be contacted to determine a course of action.

51.	**SIR 98, Page 240.** StatoilHydro states, "…*during operations, noise may affect species such as songbirds within 100m of the well pad*." a. Provide peer-reviewed literature to support this statement at the decibel levels predicted.

Response

As stated in AENV SIR(1) #98, the well pads will be using electric downhole pumps which emit no noise. However, there are some noise emitting equipment, such as small pumps and air compressors, but these are located within buildings and it is expected that the noise emitted will be minimal. The noise levels modelled were found to be below permissible night-time sound levels (PSLs) of 40 dBA within about 100 m of the well pad. In many cases, due to the placement of the noise emitting equipment, the

40 dBA noise contour will not extend beyond the edge of the well pad in many cases (see Figures 51-1 through 51-5). A sound level of 40 dBA is equivalent to a quiet office or living room. A sound level of 50 dBA is equivalent to moderate rainfall or a quiet street.

Noise levels are rarely identified in literature regarding impacts of noise on birds. Also, many noise studies do not account for other factors that may affect abundance including edge effects, traffic mortality, and visual cues from vehicles (Habib et al. 2007, Bayne et al 2008). In one study, conducted in northern Alberta that accounted for these other factors, bird densities were significantly lower near compressor stations where sound levels 300 m from the compressor station averaged 48 dBA (Bayne et al 2008). However, two-thirds of bird species in this study were unaffected. Another study suggested that sound levels above 50 dBA may be deleterious to songbirds (Kaseloo 2005), although this affect is not universal to all bird species since some don't appear to be affected by noise. A sound level of 40 dBA is considered a conservative noise level to describe impacts to songbirds adjacent to well pads.

REFERENCES

Bayne, E.M., L. Habib and S. Boutin. 2008. Impacts of chronic anthropogenic noise from energy-sector activity on abundance of songbirds in the boreal forest. Conservation Biology 22:1186-1193.

Habib, L.D., E.M. Bayne and S. Boutin. 2007. Chronic industrial noise affects pairing success and age structure of ovenbirds Seiurus aurocapilla. Journal of Applied Ecology 44:176-184.

Kaseloo, P.A. 2005. Synthesis of noise effects on wildlife populations. IN: Proceedings of the 2005 International Conference on Ecology and Transportation, Eds. Irwin CL, Garrett P, McDermott KP. Center for Transportation and the Environment, North Carolina State University, Raleigh, NC: pp. 33-35.

51.	b. Provide peer-reviewed literature references that address impacts of noise on songbirds, and revise the assessment based on this information.

Response

Recent studies indicate negative responses by some songbirds to anthropogenic noise (Rheindt 2003, Slabbekoorn and Peet 2003, Brumm 2004, Fuller et al. 2007, Habib et al. 2007, Swaddle and Page 2007, Bayne et al. 2008, Slabbekoorn and Ripmeester 2008). Specifically, chronic noise can reduce the efficacy of vocal communication among individuals by interfering with call or song transmission, potentially reducing pairing success (Habib et al. 2007, Swaddle and Page 2007) and territory defense (Brumm 2004). In addition, for some species, chronic noise can increase vulnerability to nest predation by masking predator warning calls (Yong 2008). These effects therefore reduce habitat availability (Bayne et al. 2008), potentially decreasing reproductive success (Habib et al. 2007, Swaddle and Page 2007), and increase predation risk (Slabbekoorn and Ripmeester 2008). Certain songbird species can alter their vocalization characteristics or timing to adapt to increased anthropogenic noise (Langemann et al. 1998, Brumm 2004, Patricelli and Blickley 2006, Slabbekoorn and den Boer-Visser 2006, Wood and Yezerinac 2006, Fuller et al. 2007). Such plasticity in vocalization behaviour has not been investigated in species occurring in the Project area.

Songbird responses to anthropogenic noise vary both among species and with the frequency and intensity of noise present (Slabbekoorn and Peet 2003, Bayne et al. 2008). In the Project area (i.e., the western boreal forest), few studies have investigated the effects of noise on breeding songbirds and little information is available on particular species responses to chronic noise. An exception is white-throated sparrow, yellow-rumped warbler, red-eyed vireo and ovenbird, which all show negative responses to elevated noise levels (Habib et al. 2007, Bayne et al. 2008). Specifically, in the presence of chronic industrial noise, abundance of white-throated sparrow, yellow-rumped warbler and red-eyed vireo is significantly lower than areas adjacent to noiseless well pads (Bayne et al. 2008), while ovenbirds have reduced pairing success (Habib et al. 2007). However, two-thirds of species assessed in the study (Habib et al. 2007) were not affected.

The specific intensity at which noise affects songbirds in the Project area is unknown, although the study by Bayne et al. (2008) indicated that one-third of species were significantly affected at noise levels averaging 48 dBA, 300 m from compressor stations. Based on research conducted by the Environment Council of Alberta, the BSL is assumed to represent the average rural ambient sound level in Alberta. Since two-thirds of species noted above were not affected at 48 dBA, and since 40 dBA is considered the ambient rural sound level in Alberta, the nightime Basic Sound Level (BSL) of 40 dBA, as outlined in ERCB Directive 038 (Alberta Energy and Utilities Board 2007) was used as a threshold of baseline noise conditions. As stated in ERCB Directive 038.

> “ERCB continues to examine peer-reviewed scientific literature and has concluded to date that typical industrial noise regulated under its jurisdiction does not significantly impact the physiology and habituation patterns of animals over the long term. The literature does suggest that animals might temporarily avoid an area until they become familiar with or acclimatized to industrial noise.”

ERCB Directive 038 (Alberta Energy and Utilities Board 2007) allows for regional daytime and nighttime sound levels of 50 dBA and 40 dBA; respectively (see Noise Impact Assessment, EIA, Volume 2, Section 3). Examples of sound levels include:

- Soft whisper at 1.5 m 30 dBA
- Quiet office or living room 40 dBA
- Moderate rainfall 50 dBA
- Quiet street 50 dBA

To assess noise impacts on songbirds, the nighttime BSL was used rather than the daytime BSL of 50 dBA for a more conservative approach. It was assumed that local songbirds were adapted to this BSL of 40 dBA as songbird vocalizations commonly evolve to ambient noise levels (Ryan and Brenowitz 1985). Under this assumption, noise levels greater than 40 dBA were considered to potentially affect local songbirds.

Elevated noise levels during Project operations are associated with CPFs only; all pumps used are noiseless (see response to SIR(2) #51(a). For all nine CPFs, average emitted noise intensity is predicted to attenuate to below 40 dBA within approximately 1000 m of the facility (Figures 51-1 through 51-5), suggesting a relatively localized effect on songbirds in the area. Across the LSA, 2.2% of all baseline habitat, 2.8% of baseline old growth forest and 3.6% of baseline mixedwood forest fall within the area where noise levels are greater than 40 dBA. Thus, they may potentially be affected by Project-associated noise (Table 51-1). These values are minimal and suggest a small effect on habitat availability and indirect mortality for songbirds inhabiting these habitat types.

Given the short distance over which noise attenuates to below to 40 dBA, the small area of habitat penetrated by noise levels over 40 dBA, and since not all species are affected by noise at this level, impacts are predicted to be low. The effects of noise on habitat availability and indirect mortality to songbirds are considered long-term. However, impacts are expected to be reversible since Project-associated noise will cease once the Project is decommissioned and reclaimed.

Table 51-1. Areas affected by Project-related Noise Levels ≥40 dBA.

	Baseline		Application	
	Area (ha)	% of LSA	Area (ha) Affected	% of Baseline Habitat Affected
Undisturbed habitat	121,560	96.48	2,660	2.19
Old growth forest	4,109	3.26	115	2.80
Mixedwood forest	7,706	6.12	274	3.56

REFERENCES

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Bayne, E.M., L. Habib and S. Boutin. 2008. Impacts of chronic anthropogenic noise from energy-sector activity on abundance of songbirds in the boreal forest. Conservation Biology 22:1186-1193.

Brumm, H. 2004. The impact of environmental noise on song amplitude in a territorial bird. Journal of Animal Ecology 73:434-440.

Fuller, R.A., P.H. Warren, and K.J. Gaston. 2007. Daytime noise predicts nocturnal singing in urban robins. Biology Letters 3:368-370.

Habib, L.D., E.M. Bayne and S. Boutin. 2007. Chronic industrial noise affects pairing success and age structure of ovenbirds Seiurus aurocapilla. Journal of Applied Ecology 44:176-184.

Langemann, U., B. Gauger and G.M. Klump. 1998. Auditory sensitivity in the great tit: perception of signals in the presence and absence of noise. Animal Behaviour 56:763-769.

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Swaddle, J.P. and L.C. Page. 2007. High levels of environmental noise erode pair preferences in zebra finches: implications for noise pollution. Animal Behaviour 74:363-368.

Wood, W.E. and S.M. Yezerinac. 2006. Song sparrow (Melospiza melodia) song varies with urban noise. The Auk 123:650-659.

Yong, E. 2008. City songbirds change their tune. New Scientist 197:33-35.

51.	c. Are estimates of the effects of noise on songbirds based on average or maximum decibel levels? Provide peer-reviewed literature to support your discussion.

Response

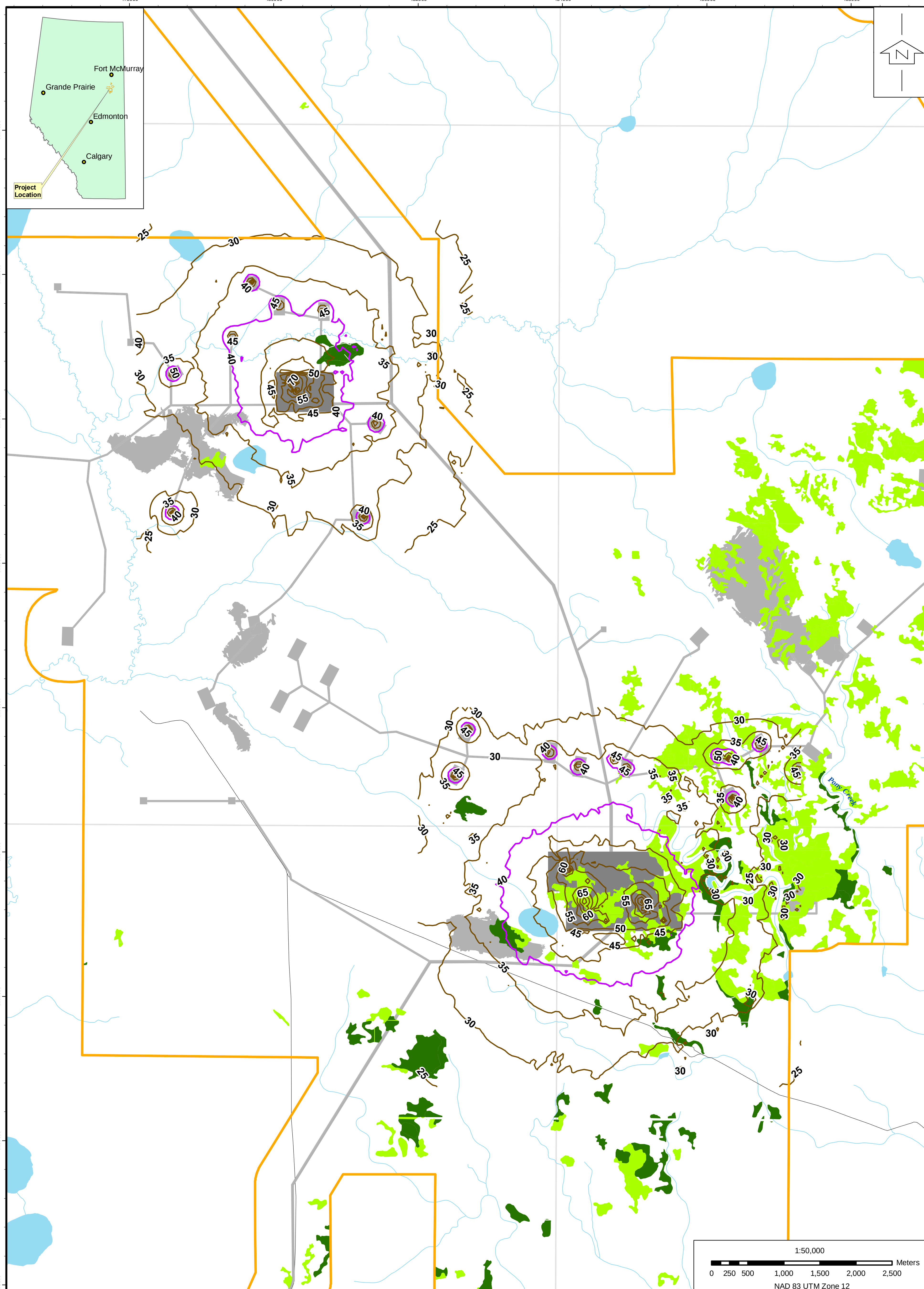
The noise modelling was not conducted using worst-case scenarios, rather the modelling was conducted using representative conditions (see the EIA Noise Assessment, Volume 2, Section 3.5 for methods on noise modelling). As such, the calculation method used for noise propagation follows ISO Standard 9613, Attenuation of Sound during Propagation Outdoors (ISO, 1993 and 1996). Receptors are assumed to be downwind from noise sources.

As indicated in SIR(2) #51(b), a conservative sound level of 40 dBA was used to determine impacts to songbirds.

REFERENCES

International Organization for Standardization (ISO). 1993. Standard 9613-1, Acoustics – Attenuation of sound during propagation outdoors – Part 1: Calculation of absorption of sound by the atmosphere. Geneva, Switzerland.

International Organization for Standardization (ISO). 1996. Standard 9613-2, Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation. Geneva, Switzerland.



Legend

- StatoilHydro Wildlife LSA
- CPF/Hub
- Footprint
- Oldgrowth
- Mixedwood
- Waterbody
- Watercourse
- Major Road
- Road
- Noise Contour 40dBA
- Noise Contour 5dBA Interval

Title:

FIGURE 51-1

NOISE ASSESSMENT IN STATOILHYDRO LOCAL STUDY AREA (CORNER PORTION)

StatoilHydro

Approved: RL	Revision Date: March 21, 2009
File: FIGURE_51-1_NOISE_ASSESSMENT_IN_STATOILHYDRO_LSA_CORNER_PORTION.mxd	
Drawn by: RF	Checked: MM

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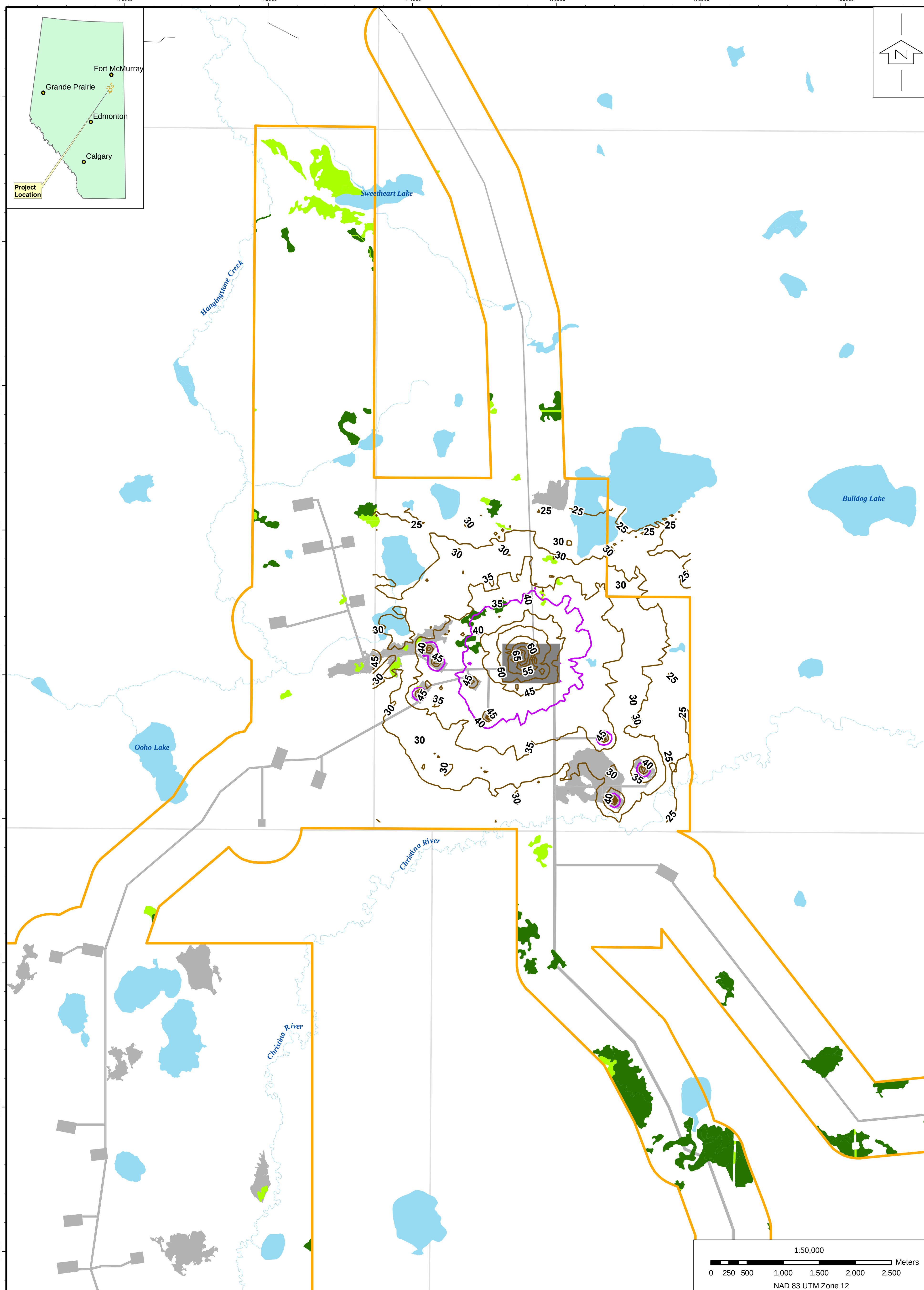

Legend

- StatoilHydro Wildlife LSA
- CPF/Hub
- Footprint
- Oldgrowth
- Mixedwood
- Waterbody
- Watercourse
- Major Road
- Road
- Noise Contour 40bBA
- Noise Contour 5dBA Interval

Title:

FIGURE 51-2

NOISE ASSESSMENT IN STATOILHYDRO LOCAL STUDY AREA (HANGINGSTONE PORTION)

StatoilHydro

Approved: RL	Revision Date: March 21, 2009
File: FIGURE_51-2_NOISE_ASSESSMENT_IN _STATOILHYDRO_LSA_HANGINGSTONE_PORTION.mxd	
Drawn by: RF	Checked: MM

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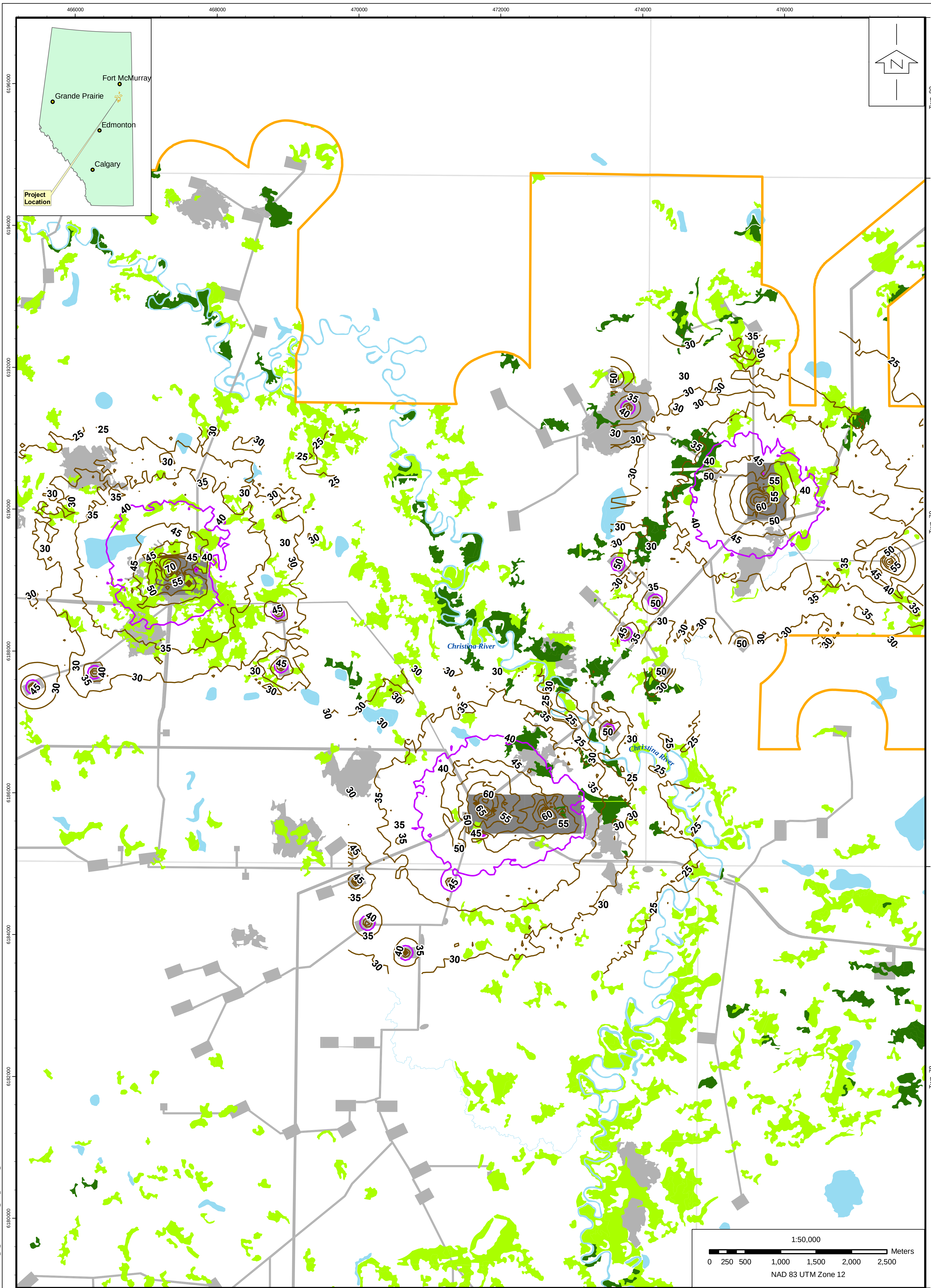

Legend

- StatoilHydro Wildlife LSA
- CPF/Hub
- Footprint
- Oldgrowth
- Mixedwood
- Waterbody
- Watercourse
- Major Road
- Road
- Noise Contour 40bBA
- Noise Contour 5dBA Interval

Title:

FIGURE 51-3

NOISE ASSESSMENT IN STATOILHYDRO LOCAL STUDY AREA (LEISMER PORTION)

StatoilHydro

Approved: RL	Revision Date: March 21, 2009
File: FIGURE_51-3_NOISE_ASSESSMENT_IN_STATOILHYDRO_LSA_LEISMER_PORTION.mxd	
Drawn by: RF	Checked: MM

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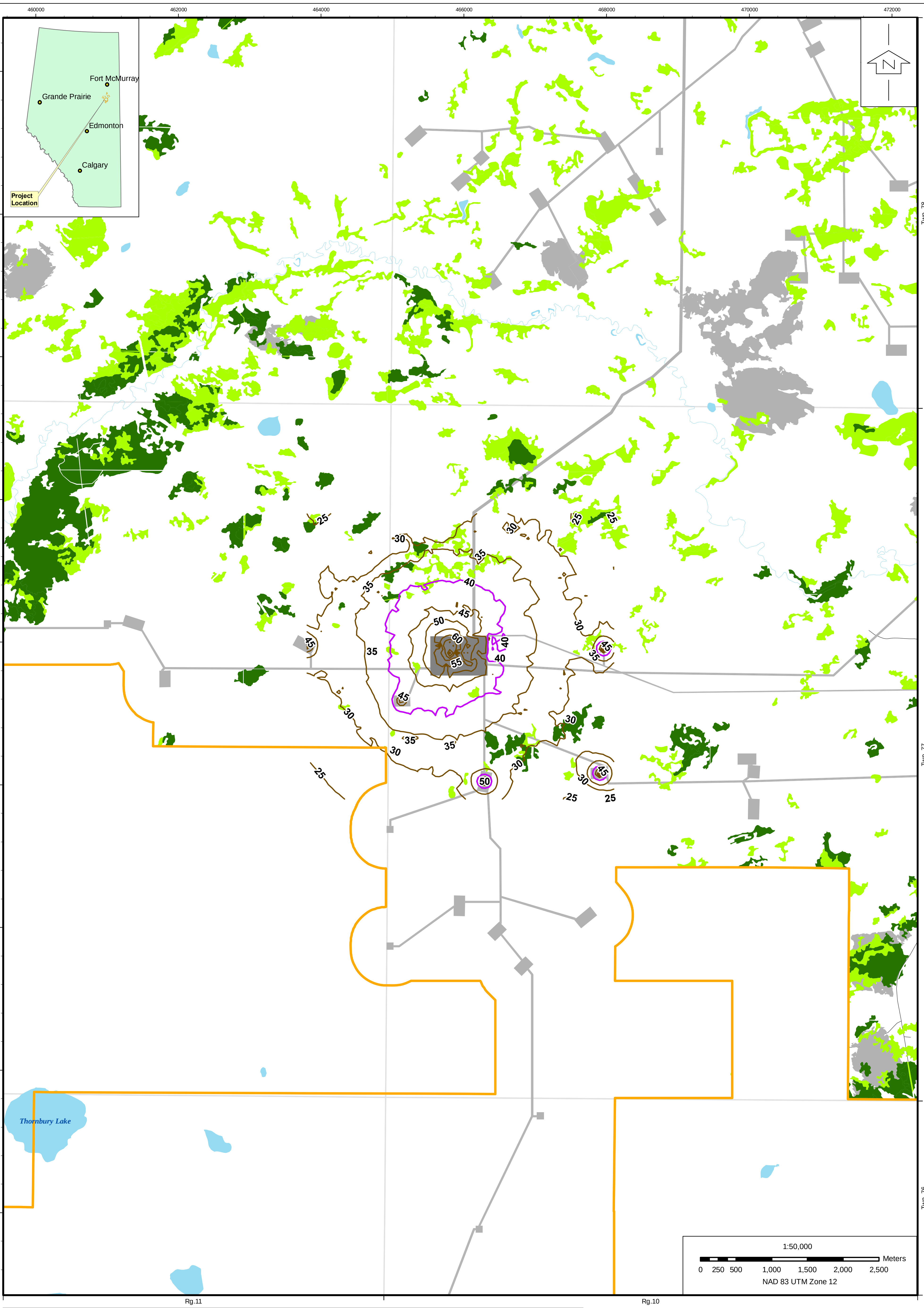

Title:

FIGURE 51-4

NOISE ASSESSMENT IN STATOILHYDRO LOCAL STUDY AREA (LEISMER SOUTH PORTION)

StatoilHydro

Approved: RL	Revision Date: March 21, 2009
File: FIGURE_51-4_NOISE_ASSESSMENT_IN _STATOILHYDRO_LSA_LEISMER_SOUTH_PORTION.mxd	
Drawn by: RF	Checked: MM

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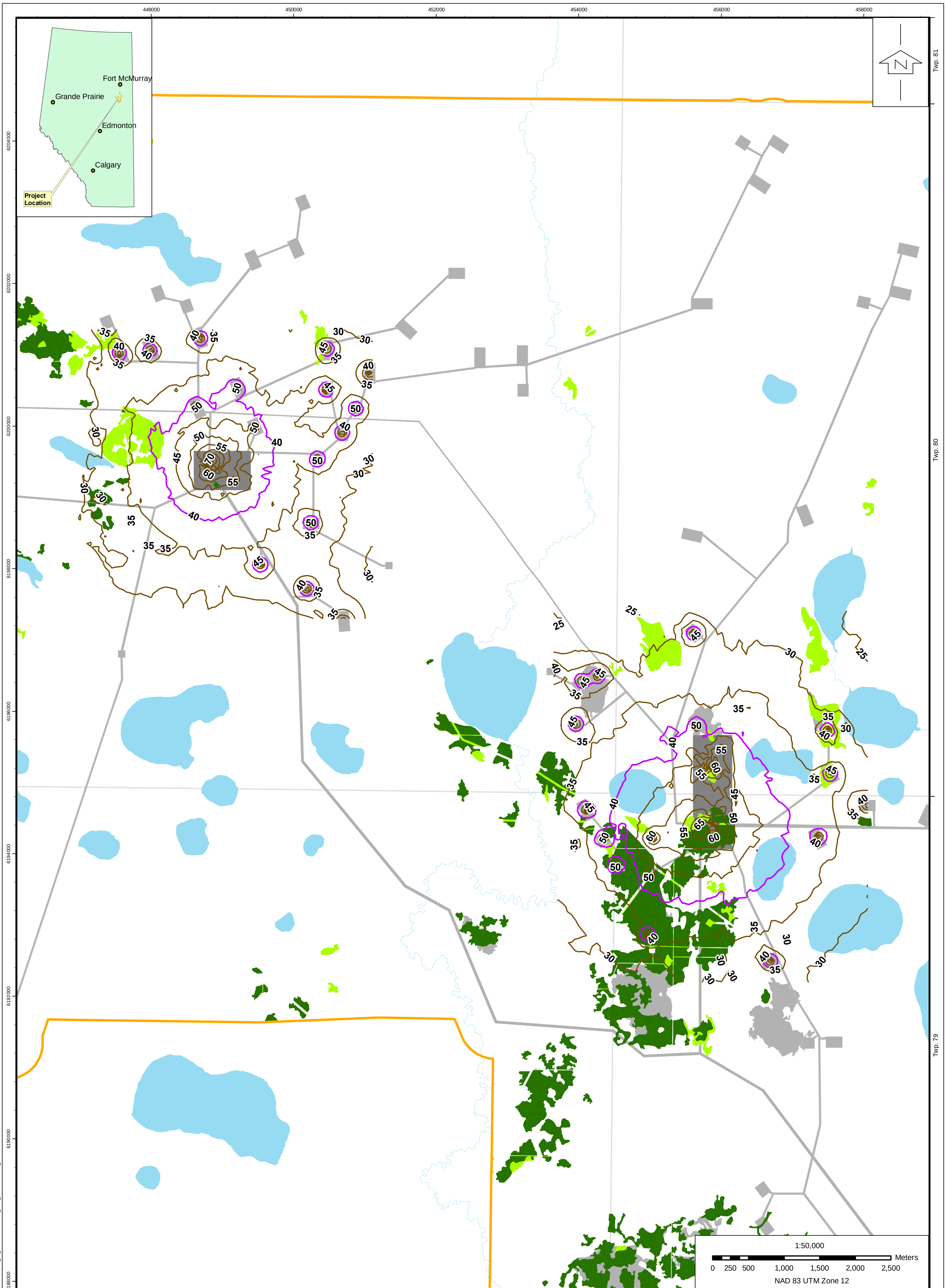

Legend

StatoilHydro Wildlife LSA	Waterbody
CPF/Hub	Watercourse
Footprint	Major Road
Oldgrowth	Road
Mixedwood	Noise Contour 40bBA
	Noise Contour 5dBA Interval

Title:

FIGURE 51-5

NOISE ASSESSMENT IN STATOILHYDRO LOCAL STUDY AREA (THORNBURY PORTION)

StatoilHydro

Approved:	Revision Date:
RL	March 22, 2009

File: FIGURE_51-5_NOISE_ASSESSMENT_IN_STATOILHYDRO_LSA_THORNBURY_PORTION.mxd

Drawn by:	Checked:
RF	MM

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52.	**SIR 87b, Page 223.** a. How much of the existing linear disturbance at the LSA level is a consequence of exploration completed in support of the Kai Kos Dehseh project?

Response

Approximately 730 ha of exploration seismic disturbance was present in the LSA at the temporal boundary for the baseline scenario (March 2007). This includes lands previously disturbed as part of oil and gas exploration in the region.

52.	b. When all past and future disturbance in support of the Kai Kos Dehseh project have been taken into account, what amount of the LSA (area, area including buffer, percentage area, percentage area including buffer) has been disturbed due to: i. Pre-project seismic exploration (2D, 3D); ii. Other project disturbances (roads, well pads, camps, 4D/monitoring seismic, pipelines, etc.). iii. Non-project related disturbances (forestry, towns, etc.) iv. Future project-related development (presented as application case).

Response

When all reasonably foreseeable past and future disturbance in support of the Kai Kos Dehseh Project is taken into account, the following amount of the LSA will have been disturbed.

i. Pre-project disturbance exploration will include:

- 2D Seismic: Approximately 330 ha (0.3% of the LSA); and
- 3D Seismic: Approximately 750 ha (0.6% of the LSA).

ii. Other project disturbances will include:

- 4D Seismic: Approximately 1,760 ha (1.4% of the LSA);
- OSE corehole sites: Approximately 500 ha (0.4% of the LSA);
- OSE access: Approximately 240 ha (0.2% of the LSA);
- Diluent pipeline and ROW: Approxaimately 50 ha (< 0.1% of the LSA); and
- ATCO powerline and ROW: Approximately 30 ha (<0.1% of the LSA).

iii. There is no publicly available information regarding future non-project related disturbances (e.g., forestry, towns, etc.) within the LSA, and as such StatoilHydro cannot comment on the amount of this disturbance likely to occur within the LSA over the life of the Project.

iv. Future Project-related development, or in other words, the Project footprint presented as the revised application case, comprises approximately 9,200 ha (7.3%) of the LSA. The revised application case includes the disturbances detailed above in (i) and (ii) as well as the following additional Project disturbances:

- Borrow pits: 2,491 ha (2.0% of the LSA);
- Roads: 1,074 ha (0.9% of the LSA);
- SAGD well pads: 882 ha (0.7% of the LSA);
- Central Processing Facilities: 616 ha (0.5% of the LSA);
- Pipeline ROW: 380 ha (0.3% of the LSA);
- Groundwater monitoring well pads: 49 ha (< 0.1% of the LSA);
- Camps: 13 ha

The areas of the disturbances plus buffer have not been included, as the term "buffer" has not been defined in the question. Appropriate buffer areas will vary greatly depending on the wildlife or plant species in question; therefore, a single value for a buffer distance around disturbances will have limited value in assessing Project impacts. Regions of influence where habitat effectiveness has been reduced near anthropogenic disturbance are identified in the EIA, Volume 4, Section 11.4.2.3, Appendix 11A, and in SIR(1) Appendix B.

See also SIR(2) 32(a).

53.	**SIR 117, Page 273.** The Terms of Reference state, "*…if habitat models are used to evaluate impacts, models will be modified, calibrated, and validated by comparing model predictions with wildlife data from the Study Area(s).*" a. Describe data and data sources that were used to evaluate wildlife models.

Response

Canadian Toad

A model validation for the Project was conducted using data on habitat use by toads from a Canadian toad survey performed within the RSA. A total of 47 Canadian toads were detected at 21 sites during the survey. Canadian toad locations were overlaid on habitat suitability maps, and toad locations were queried to the corresponding habitat values. All Canadian toad observations were calling toads in wetland habitats. Most of these wetlands are too small to appear on the ecosite phase map; however, Canadian toad locations were mapped as wetlands. All of the toads occurred in high-quality habitat (i.e., wetlands within 1000 m of suitable denning habitat).

Northern Goshawk

Model accuracy was validated for approximately 90 locations in a Study Area northwest of Fort McMurray by calculating:

$Accuracy_r = 1 - |field\ rating_r - model\ rating_r|$

where the field rating was determined for each location (r) by northern goshawk expert Todd Mahon. Total model accuracy was determined by taking the mean accuracy over all locations. Total model accuracy was 83%.

Barred Owl

Barred owls are rarely observed during wildlife surveys conducted in northeastern Alberta. As a result, localized model validation is difficult. However, the model was parameterized in north-central Alberta and published in a peer-reviewed journal. The literature indicates that the habitat requirements of barred owls are consistent across the western boreal forests, despite relatively low sample sizes (Livezey 2007). The model was constructed based on information from Calling Lake, Alberta, which is approximately 100 km from the LSA. Based on the similarities between the sites, use of this model for the assessment is assumed to be valid.

Beaver

Empirical beaver presence data within the RSA, collected in October 2008, was used to validate the model. Observation of a beaver lodge, cache or dam was enumerated as beaver presence with 28 sites recorded. All dams recorded on the survey were within waterbodies immediately adjacent to high quality terrestrial habitats.

Canada Lynx

The lynx model was validated using lynx and hare winter tracking data from within the LSA and RSA. A total of 48 lynx and 6,736 hare locations were defined by track locations within the Project LSA and RSA (see SIR(2) Appendix C).

Moose

The moose resource selection models were evaluated for fit using pellet data collected during the scat monitoring program in 2006 and 2007. Model fit was evaluated using 796 moose pellet group locations collected within the LSA and RSA (see SIR(1) Appendix B).

Woodland Caribou

The woodland caribou resource selection models were evaluated for fit using pellet data collected during the scat research monitoring program. Model fit was evaluated using 1,188 caribou pellet group locations collected within the LSA and RSA (see SIR(1) Appendix B).

REFERENCE

Livezey, K.B. 2007. Barred owl habitat and prey: a review and synthesis of the literature. The Journal of Raptor Research 41:177-201.

53.	b. Provide a revised list of validated HSI models. The decision as to which species models are to be validated should be based on: i. Niche overlap between species with similar habitat requirements; i. Availability of peer reviewed validation; iii. Availability of peer reviewed data; iv. Plans for winter, spring and early summer baseline data collection that might serve to validate existing models (refer to SIR 41).

Response

HSI models have been developed through extensive peer-reviewed literature and professional experience, and have been used extensively within the Alberta Oil Sands Region for many years in numerous EIAs. HSI models are a planning tool used to estimate potential project impacts on indicator species, but they do not determine absolute impacts or population effects.

The indicator species included in the assessment for the Project are fairly consistent with other EIAs in the region. Wildlife species selected as indicators for the EIA included those identified through consultation with ASRD as required indicators for an EIA in the region (Peter Weclaw, Pers. Comm. August 30, 2006). The method of assessment identified in that correspondence was the use of HSI models. However, due to recent changes in requirements, and concerns with model validation using only local data (as opposed to peer-reviewed literature and research), other techniques have been employed where extensive local data is available (e.g., resource selection models) and the indicator species list has been revised to evaluate the impact of altered habitat availability.

StatoilHydro has included the following indicators in its wildlife habitat impact assessment.

- *Canadian toad*. Included because it serves as an indicator for amphibians and other wetland-dependent wildlife, and has little niche overlap with most of the other wildlife indicators included within the assessment. StatoilHydro used the same habitat model in its most recent impact assessment (SIR(2) #46) as they did in the original EIA. This HSI model was developed in northeast Alberta and has since been validated using data from the RSA.

- *Northern goshawk*. Included because it is sensitive to forest clearing and removal and is an umbrella species for mature and old growth forest dependent species. StatoilHydro implemented an HSI model that was parameterized and validated in northeast Alberta as part of an ongoing project west and north of Fort McMurray. This model replaces the non-validated model used in the original EIA.

- *Barred owl*. Like the northern goshawk, included because it is sensitive to forest clearing and human disturbance, and is an umbrella species for mature and old growth forest dependent species. The resource selection model used by StatoilHydro was developed within the boreal mixedwood ecoregion near Calling Lake, Alberta (Olsen et al. 2006). This model replaces the non-validated model used in the original EIA. Habitat use by barred owls is fairly consistent across northern Alberta and Saskatchewan (Livezey 2007) and therefore it is assumed that this model from a location approximately 60 km away is applicable to the LSA.

- *Beaver*. Included because it serves as an indicator for wetland and riparian-associated species, including waterfowl, river otter, muskrat, and a variety of songbirds and amphibians; has little niche overlap with most of the other wildlife indicators included within the assessment; and is important socio-economically. The model has been validated using data from within the RSA.

- *Canada lynx*. Included because it serves as an indicator for a major prey species within the boreal forest (snowshoe hare), is sensitive to increased road density, and is important socio-economically. Because of its dependence on snowshoe hare which select for dense conifer habitats (SIR(2) Appendix C), the lynx has little niche overlap with other wildlife indicators. StatoilHydro implemented an HSI model recently developed for lynx in northeast Alberta (SIR(2) Appendix C). This model was developed and empirically evaluated using data obtained from the LSA and RSA (SIR(2) Appendix C). This model replaces the non-validated model used in the original EIA.

- *Moose*. Included because of its socio-economic importance for subsistence and recreational hunters, and its ecological role as a prey species for large carnivores. Moose are an umbrella species, as their management may affect large carnivore species (i.e., wolves, black bears), as well as alternate ungulate prey species (i.e., deer, caribou). StatoilHydro applied the same empirically evaluated models presented in SIR(1) Appendix B.

- *Woodland caribou*. Included because it serves as an umbrella for large wetland complexes, is sensitive to human disturbance, has little niche overlap with other wildlife indicators included in this assessment, and because there is a social and political initiative for their conservation and management. StatoilHydro applied the same empirically evaluated models presented in SIR(1) Appendix B.

In addition, StatoilHydro has included the *mixedwood forest bird community* and *old growth forest bird* community as indicators. These two species groups were included because they serve as an umbrella for a variety of species that depend on mixedwood (e.g., boreal owl, yellow-bellied sapsucker, pileated woodpecker, blue-headed vireo, blue jay, black-capped chickadee, brown creeper, red-breasted nuthatch, winter wren, magnolia warbler, Cape May warbler, black-throated green warbler, Canada warbler, western tanager, rose-breasted grosbeak and white-winged crossbill) and old growth forests (e.g., northern goshawk, barred owl, boreal owl, black-backed woodpecker, pileated woodpecker, brown creeper, Cape May warbler, black-throated green warbler, bay-breasted warbler, and western tanager), and because the niche of other wildlife indicators included within this assessment only partially overlap with these two bird communities. StatoilHydro did not model use or selection by these two bird communities, but rather assessed the impact of the Project on two forest types: mixedwood forests and old growth forests. Because these indicators were not evaluated using models, validation was not necessary.

StatoilHydro has removed the following wildlife indicators from its habitat assessment.

- *Great gray owl*. Removed because there was no data on habitat use within the LSA or RSA to validate a model, no applicable peer-reviewed model was available, and great gray owls have similar habitat and nesting requirements as northern goshawks and barred owls, and therefore did not contribute greatly to the habitat assessment.

- *Boreal owl*. Removed because there was no data within the LSA or RSA to validate a model, no applicable peer-reviewed model was available, and boreal owls have similar nesting preferences as barred owls (cavities in mature and old growth forests).

- *Muskrat*. Removed because there was no data within the LSA or RSA to validate a model, no applicable peer-reviewed model was available, and muskrats have similar habitat requirements as beavers and therefore did not contribute greatly to the habitat assessment.

- *Fisher*. Removed because potential confusion between fisher and marten tracks prevented model validation, and no applicable peer-reviewed model was available.

- *Bear*. Removed because there were not enough data within the LSA or RSA to validate a model, and issues are primarily related to human conflict rather than habitat change.

Refer to SIR(2) #46(b) for the revised impact assessment for these indicators and SIR(2) #41 and #47 for details regarding existing data collection and its relevance to validating habitat models.

REFERENCES

Weclaw, Peter. Senior Wildlife Biologist, Fish and Wildlife, Alberta Sustainable Resource Development. Email correspondence, 30 August 2006.

Livezey, K.B. 2007. Barred owl habitat and prey: a review and synthesis of the literature. The Journal of Raptor Research 41:177-201.

Olsen, B.T., S.J. Hannon and G.S. Court. 2006. Short-term Response of Breeding Barred Owls to Forestry in a Boreal Mixedwood Forest Landscape. Avian Conservation and Ecology – Ecologie et conservation des oiseaux 1(3): 1.

53.	c. Provide a clear rationale for each model included on the revised list.

Response

Provided below is a biological and statistical justification for the specific habitat models listed in SIR(2) #53(b). Refer to SIR(2) #53(b) for an explanation for the inclusion of specific wildlife indicators used in the habitat assessment.

- *Canadian toad*. The HSI model used by StatoilHydro provides an index of habitat quality for Canadian toads. Canadian toads require breeding habitat (wetlands) and hibernacula (areas with sandy soils), and use aspen dominated forests in summer (Beiswenger 1988, Garcia et al. 2004, Kuyt 1991). As a result, StatoilHydro employed an HSI in which optimal habitat is represented by locations where all three resources are found in close proximity. This model was developed based on professional experience and reviewed by a Canadian toad expert (Patrick Garcia). The model was validated using data from within the RSA (see SIR(2) #53(a)).

- *Northern goshawk*. The HSI model used by StatoilHydro provides an index of nesting habitat quality for northern goshawks. StatoilHydro modelled nesting habitat because it represents the most limiting habitat factor. Optimal nesting habitat is generally characterized by mature upland forests containing even canopy, large sub-canopy branches for nest platforms, moderate understory structure, and open flyways (Schaffer 1998, Mahon Pers. Comm. 2008), whereas foraging habitat can encompass a wider range of forest conditions (Widen 1989, Mahon Pers.

Comm. 2008). This model was originally developed using in-situ nest site investigations in British Columbia (Mahon and Doyle 2003, Mahon et al. 2008). The model was subsequently parameterized for and validated in the boreal forest of northeast Alberta using additional site investigations by Mr. Mahon (Mahon unpublished data).

- *Barred owl*. The resource selection function used by StatoilHydro (Olsen et al. 2006) estimates the relative probability that a particular resource within the summer home range of a barred owl will be selected based on the combination of environmental variables that define that resource (Manly et al. 2002, Lele and Keim 2006). StatoilHydro estimated the relative selection of summer habitat, because the non-breeding season home range encompasses the breeding season home range of most barred owls (Mazur 1997), and therefore includes both nesting and foraging habitats. This model was selected because it was developed in the boreal mixedwood ecoregion and has been validated in peer-review (Olsen et al. 2006). Although this model was developed outside of the RSA, habitat use by barred owls is fairly consistent across northern Alberta and Saskatchewan (Livezey 2007). Furthermore, the model was originated from a study near Calling Lake, Alberta, which is located approximately 100 km southwest of the LSA.

- *Beaver*. The HSI model used by StatoilHydro provides an index of habitat quality for beaver. The beaver is an umbrella species for other aquatic wildlife including muskrat, waterfowl, riparian songbirds, and amphibians. The beaver model was validated using data from within the RSA.

- *Canada lynx*. The HSI model used by StatoilHydro provides an index of winter habitat quality for lynx. StatoilHydro modelled winter habitat availability because of data availability and the fact that lynx survival is lowest during the winter months (Poole 1994). The lynx model was developed and empirically evaluated using data obtained from the LSA and RSA (SIR(2) Appendix C). Unlike most HSIs, the lynx model was derived from two empirical relationships:

  Within the boreal forest, lynx populations are strongly related to the 10-year cycle of their principal prey, the snowshoe hare (Elton and Nicholson 1942; Keith 1963; Hodges 1999). As a result, lynx are frequently associated with habitat used by snowshoe hare (Koehler and Aubry 1994), including various aged forests and structural classes with dense understories (McCord and Cardoza 1992). As a result, lynx were linked to snowshoe hare by comparing the distribution of lynx observations to resource selection by hare. Given the tight ecological relationship between these two species, and the fact that habitat use by lynx was similar to that of hares under the same availability (SIR(2) Appendix C), habitat selection by snowshoe hare was used as one covariate in the lynx HSI.

  Although lynx tolerate moderate densities of low-use roads (McKelvey et al. 1999), research indicates they are negatively influenced by the presence of both roads and coyotes (Bayne et al. 2008). Bayne et al. (2008) found that the occupancy rate of lynx was unaffected by road density in areas where coyotes were not detected, but that the occupancy rate declined as a function of road density with increasing coyote activity. Because coyotes were observed in the LSA, road density was used as a second covariate in the lynx HSI following the empirical relationship derived by Bayne et al. (2008).

  For more information on the lynx model, please refer to SIR(2) Appendix C.

- *Moose* and *woodland caribou*. The resource selection models used by StatoilHydro estimate the probability that a particular resource will be selected based on the combination of environmental variables that define that resource (Manly et al. 2002, Lele and Keim 2006). StatoilHydro estimated the probability that a resource would be used by moose/caribou in winter because winter is the most nutritionally-limited season for temperate and boreal ungulates (e.g. Parker et al. 2009). The models were developed and empirically evaluated using pellet locations obtained from within the LSA and RSA as part of the scat monitoring program (SIR(2) #53(a); SIR(1) Appendix B). Refer to (SIR(1) Appendix B) for more information on the moose/caribou models.

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Personal Communications

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53.	d. Revise and update the impact assessment predictions using these validated models as appropriate.

Response

Refer to SIR(2) #46(b) for the updated impact assessment.

See also SIR(2) #41(a)

H. HEALTH

54.	**SIR 148, Pages 308-310.** StatoilHydro states, *"…the potential contribution of background acetaldehyde exposures, as described in this assessment, theoretically would contribute 1.3 nasal tumours per 100,000 people.*" StatoilHydro also states, "*…the current assessment suggests that background benzene exposures may contribute to the development of about 2.4 per 100,000 people*." StatoilHydro further states, "*…the estimated lifetime cancer risk (LCR) of 58 per 100,000 for formaldehyde*." a. Would it be correct to assume exposure is over a lifetime? If not, explain.

Response

It is correct to assume that exposure, as characterized in the HHRA, would occur over a lifetime. The chronic exposure limits for the carcinogens were based upon quantitative observations from long-term epidemiological or toxicological studies.

54.	StatoilHydro states, *"…the estimated LCR of 58 per 100,000 for background formaldehyde suggests that formaldehyde may contribute to existing incidence of respiratory tumours*." b. Provide evidence to support this conclusion.

Response

The estimated lifetime cancer risk (LCR) of 58 in 100,000 includes existing sources of formaldehyde from indoor and outdoor sources. This predicted LCR is a function of the following:

- Assumed background air concentrations (indoor and outdoor)
- Predicted contributions from sources in the study area (e.g. sources included in the baseline, application and cumulative effects cases).
- The exposure limit selected in the assessment and its toxicological basis.

The assumed background concentrations for indoor and outdoor air were obtained from the scientific literature, due to a lack of information specifically for the Study Areas. As a result, there is some potential for uncertainty associated with these numbers.

There is also some uncertainty as to the carcinogenic potential of formaldehyde in humans. The exposure limit (RsC of 0.77 ug/m^3) was selected as it represents the most conservative exposure limit available from the agencies surveyed, and it is based upon tumour incidence data from rodent studies.

There is potential for uncertainty associated with estimates of risks that include background, such as the LCR of 58 in 100,000. The true contribution of background formaldehyde exposures to background cancer risks is unknown.

To provide further context as to the cancer risks predicted in the HHRA, an assessment of background concentrations reported in the scientific literature has been conducted, and associated LCRs have been predicted using the exposure limit applied in the HHRA (0.77 ug/m^3).

Table 54-1 below, presents a summary of measured ambient formaldehyde concentrations from North America, along with ranges of lifetime cancer risks associated with these concentrations.

Table 54-1 Measured Ambient Air Concentrations of Formaldehyde in North America and Associated Lifetime Cancer Risks

	Air Concentration (ug/m^3)	Description	LCR[1]
Canada			
Montréal, QC Ottawa, ON Windsor, ON Toronto, ON Winnipeg, MB Vancouver, BC	<0.05 (MDL) to 27.5	Range of ambient 24-hour air concentrations collected from Canadian urban areas between 1989 and 1998 (GC 2001).	<0.06 to 36
Saint John, NB Montréal, QC	<0.05 (MDL) to 12.03	Range of ambient 24-hour air concentrations collected from suburban areas of Canada between 1989 and 1998 (GC 2001).	<0.06 to 16
L'Assomption, QC Simcoe, ON	<0.05 (MDL) to 9.11	Range of ambient 24-hour air concentrations collected from rural areas of Canada that are considered to be affected by urban and industrial sources between 1989 and 1998 (GC 2001; WHO 2000).	<0.06 to 12
Kejimkujik Park, NS Mount Sutton, QC St. Anicet, QC Egbert, ON	<0.05 (MDL) to 9.88	Range of ambient 24-hour air concentrations collected from rural areas of Canada between 1989 and 1998 (GC 2001).	<0.06 to 13
Montréal, QC Ottawa, ON Windsor, ON Toronto, ON Winnipeg, MB Vancouver, BC Saint John, NB Montréal, QC L'Assomption, QC Simcoe, ON Kejimkujik Park, NS Mount Sutton, QC St. Anicet, QC Egbert, ON	0.78 to 8.76	Range of ambient long-term (1 month to 1 year) air concentrations collected from rural areas of Canada between 1989 and 1998 mean concentrations (GC 2001).	1.0 to 11
Toronto, ON	22.15	Average of 6 ambient 24-hour air concentrations collected during 30-day period July 14-August 12, 1995 (GC 2001).	29
Prince Rupert, BC	0.08 to 14.7	Range of ambient 12- to 25-hour air concentrations collected from roofs of buildings at four sites in urban, residential and industrial areas of Prince Rupert during 1994 and 1995 (GC 2001).	0.10 to 19
Near a forest production plant	1.71 to 4.4	Range of maximum ambient 24-hour air concentrations collected between 1995 and 1996 (GC 2001).	2.2 to 5.7

	Air Concentration (ug/m^3)	Description	LCR[1]
USA			
California	3.6	Average ambient air concentration collected between 1998 and 1999 (Cal EPA 2001).	4.7
All states	0.99 to 15	Annual average ambient air concentration (US EPA 2008a).	1.3 to 19
Urban site (unknown)	1 to 20	Annual average ambient air concentration (WHO 2000).	1.3 to 26

Note:

Lifetime cancer risks calculated using chronic exposure limit of 0.77 ug/m^3 for formaldehyde

The shaded row represents the concentration selected for use in the HHRA (to represent background air in a rural area).

The range of lifetime cancer risks associated with measured formaldehyde concentrations in outdoor air appear to range from 0.1 to 36 in 100,000.

The indoor air concentration used in the HHRA was obtained from a Canadian resource (GC 2001). Based upon data collected by Health Canada in the 1990s, various statistics were generated. These values are summarized in Table 54-2, and similar to Table 54-1, the associated lifetime cancer risk for each concentration is presented.

Table 54-2 Summary of Measured Indoor Air Concentrations and Predicted Lifetime Cancer Risks (GC 2001)

	Concentration (ug/m^3)	Description	LCR
Measured formaldehyde concentrations in Canadian homes, median	30	Pooled data from seven studies involving 151 samples. Data represent a combination of active and passive sampling.	39
Measured formaldehyde concentrations in Canadian homes, arithmetic mean	36	Pooled data from seven studies involving 151 samples. Data represent a combination of active and passive sampling.	47
Measured formaldehyde concentrations in Canadian homes, 95^{th}%ile	85	Pooled data from seven studies involving 151 samples. Data represent a combination of active and passive sampling.	110
Measured formaldehyde concentrations in Canadian homes, 99^{th}%ile	116	Pooled data from seven studies involving 151 samples. Data represent a combination of active and passive sampling.	151

Note: The shaded row represents the concentrations selected for use in the HHRA (represent background air in a rural area)

Table 54-2 suggests that, when the exposure limit used in the HHRA is applied to indoor air concentrations of formaldehyde reported in the literature, the background lifetime cancer risk may range from 39 to 151 in 100,000.

The background concentration used in the HHRA for chronic formaldehyde incorporated both indoor and outdoor formaldehyde concentrations. Combined, the background concentration representing indoor and outdoor air was about 45 ug/m^3. Using the Risk-Specific Concentration (associated with 1 in 100,000 cancer incidence) of 0.77 ug/m^3 for the incidence of nasal tumours, this background concentration results in an LCR of 58 in 100,000.

Some studies have found a link between background exposures to VOCs and tumour incidence. For example, Wu et al. (2003) examined indoor air concentrations of formaldehyde in five different office buildings, and concentrations were observed to range from 0.1 - 0.89 ppm (123 – 1,095 ug/m^3). Assuming occupational exposure (8-h/day, 5.5-days/week, 45-weeks/year), Wu et al. calculated the increase in the probability of cancer occurring against a background of continuous exposure to formaldehyde and a unit risk estimate from the U.S. EPA (which is equivalent to the RsC of 0.77 ug/m^3 used in the HHRA). Based on the range of 8-hour concentrations measured (123 – 1,095 ug/m^3), the estimated cancer probability was determined to range from 21 to 175 in 100,000. This range is higher than what is predicted in the HHRA, as is the air concentration of formaldehyde.

The exposure limit upon which the formaldehyde risks are determined is based on the incidence of nasal tumours in rodents exposed to concentrations greater than 7,200 ug/m^3 (an exposure concentration about 160-times higher than the background concentration assumed in the HHRA). It is recognized that there is some uncertainty associated with the U.S EPA (1991) RsC value which is based upon the rodent carcinogenicity data (Litelpo and Meek 2003). However, the U.S. EPA has not completed a formal reassessment of formaldehyde risks at this time nor have the quantitative carcinogenicity limits from the U.S. EPA been formally withdrawn. Modelling conducted by Litelpo and Meek (2003) suggests that the carcinogenic risks of formaldehyde may be overstated when biological-based cancer risk models are used to evaluate carcinogenic risks. As formaldehyde has been observed to be reactive at the physiological site of contact (i.e. upper airways), the differences in anatomy, ventilation and breathing between rodents and humans should be considered. As such, the exposure limit used in predicting cancer risks associated with formaldehyde are likely overly conservative, resulting in risks potentially being overstated. However, until revised quantitative risk estimates are derived by jurisdictional authorities, based upon scientific weight of evidence, the magnitude by which the cancer risks of formaldehyde are being overpredicted is unknown.

In summary, a range of lifetime cancer risks is associated with exposure to indoor and outdoor air in Canada, based upon the use of the U.S. EPA RsC. However, it is possible that uncertainties associated with both the background air predictions and the toxicological basis of the exposure limit may affect the quality of the predicted LCR.

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Wu PC, Li YY, Lee CC, Chiang CM, Su HJJ. 2003. Risk assessment of formaldehyde in typical office buildings in Taiwan. Indoor Air 13: 359-363.

54.	StatoilHydro states, "…the ACR data (reported by the ACB 2005) is used to illustrate the relative prevalence of various tumour types in the population, and is not intended to be a direct comparison." A better discussion would be to compare results from the Human Health Risk Assessment (HHRA) to lifetime background cancer rates in Canada and Alberta. c. Discuss Canada's and Alberta's background lifetime cancer rates in relation to results of the HHRA for the carcinogens.

Response

It is estimated that, over a lifetime, 40% to 45% of people will develop some form of cancer (CCS et al. 2008). When translated to a rate per 100,000 people, this risk is about 40,000 to 45,000 per 100,000. Based on review of publicly available information from the Alberta Cancer Board and Canadian Cancer Society, StatoilHydro was unable to find reports on lifetime probabilities of developing specific types of cancer for Albertans and Canadians.

The U.S. National Cancer Institute (NCI) does present statistics on the lifetime risk of developing certain types of cancer in the U.S. population. Based on rates from 2003-2005, 1 in 79 men and women born in the United States will be diagnosed with leukemia at some time during their lifetime. The NCI does not provide specific lifetime cancer risks for nasopharyngeal tumours (critical toxicological effect for formaldehyde) or nasal adenocarcinoma (critical toxicological effect for acetaldehyde). It does, however, provide lifetime risks for cancer of the lungs, bronchus, larynx, oral cavity and pharynx. According to the NCI, 1 in 14 people will be diagnosed with cancer of the lung and bronchus during their lifetime, while 1 in 274 people will be diagnosed with cancer of the larynx. The lifetime probability of developing lung cancer in Canada (without adjustment for smoking status) is approximately 1 in 14 as well (Villleneuve and Mao, 1994). Again based on rates from 2003-2005, 1 in 99 people will be diagnosed with cancer of the oral cavity and pharynx during their lifetime. These lifetime cancer risks are all considerably greater than those presented in the HHRA for acetaldehyde (1.3 in 100,000 for nasal cancer), benzene (2.4 in 100,000 for leukemia), and formaldehyde (58 in 100,000 for nasopharyngeal cancer).

The LCRs calculated in the HHRA are not epidemiological-based values (meaning that they are predicted not observed). They are quantitative estimates based upon predicted data, literature-based background air data, and exposure limits. Thus, any inherent uncertainties in the data or limits used affect the quality of the LCR prediction. The LCR estimates are believed to be conservative predictions within the context of the HHRA. Only further observation of cancer incidence rates in Alberta will provide information as to the accuracy of the predicted values.

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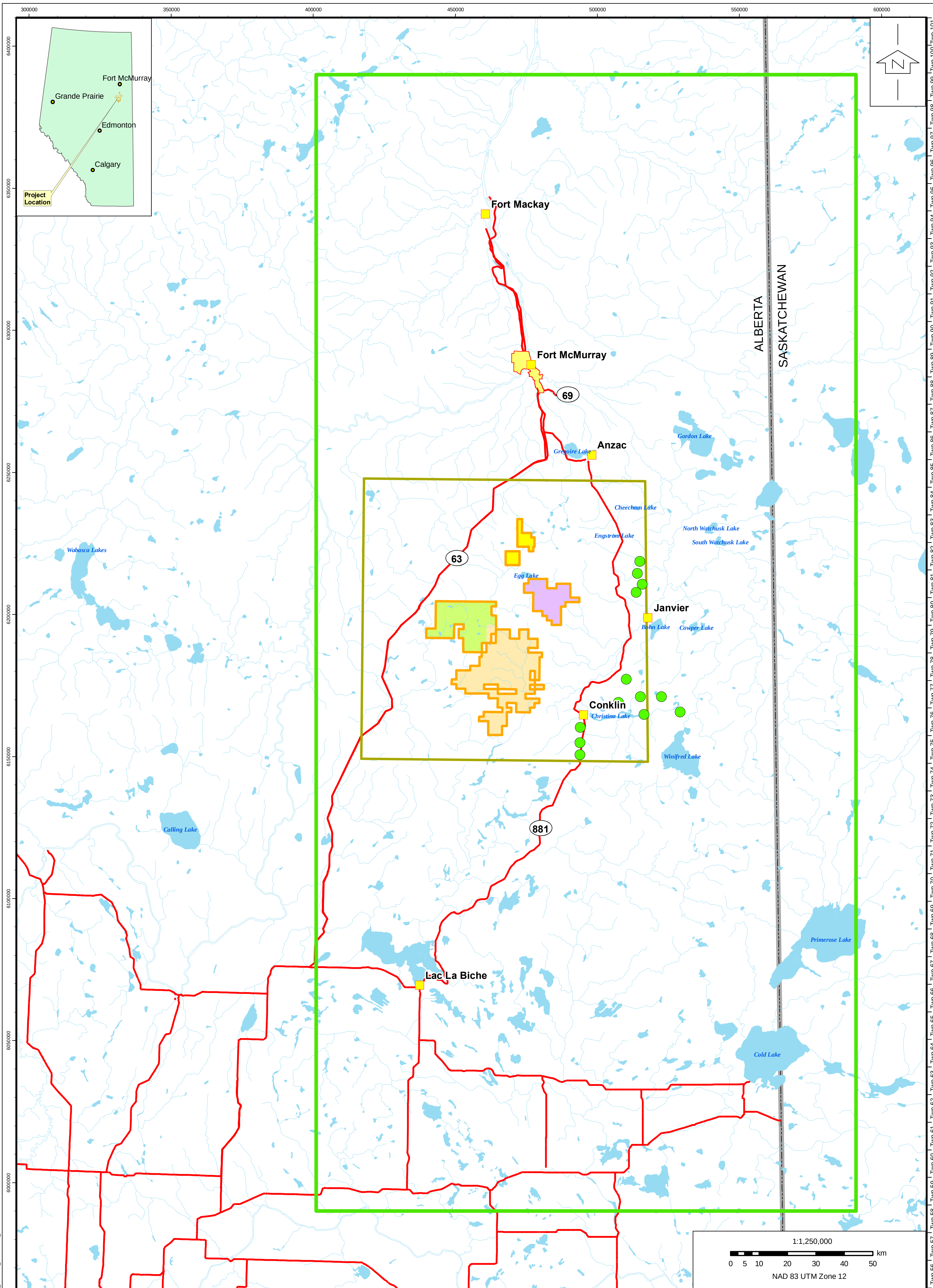
55.	**SIR 150, Pages 310-315.** SIR 150 asked to confirm whether the HHRA will be updated with measured data from the soil/vegetation sampling program as was stated in the EIA. StatoilHydro states, "…*given the proximity of the StatoilHydro Project area to these other locations, it is feasible that the background concentrations in soil and vegetation are similar. As such, the approach used in the original HHRA is the most appropriate and it is StatoilHydro's view that an update is not required*." a. Provide evidence to support this conclusion (e.g., location of the samples relative to Statoil's project; statistical evidence that samples are representative of the area which includes this application) and provide justification why StatoilHydro should not contribute to the sampling in the region in support of the HHRA.

Response

Measured soil and vegetation data from three other applications within the HHRA LSA and RSA were evaluated. This includes data collected from other industrial operators in the Surmont, Christina Lake and Jackfish areas. The location of these human health sampling locations is shown in Figure 55-1. Most of these sampling locations are within 20 km to 30 km of the Kai Kos Dehseh Project area, and given their proximity should accurately represent background concentrations of COPCs in soil and vegetation within the Kai Kos Dehseh Project area. However, for all of the COPCs from these three projects, measured concentrations were below analytical detection limits in the soil and vegetation samples, and therefore it is not possible to statistically compare these samples to provide evidence that they are representative of the area that includes the Kai Kos Dehseh Application. In general, soil and vegetation background levels of COPCs have presented at non-detectable levels for most EIAs in the Athabasca Oil Sands area.

Based on this information, StatoilHydro believes that an update is not required for the HHRA with respect to the Kai Kos Dehseh Application. However, StatoilHydro is supportive of any future regional HHRA monitoring initiatives that may be developed between AENV and regional operators. StatoilHydro will also meet, or exceed, any regulatory requirements with respect to monitoring during Kai Kos Dehseh Project operations.



Legend

StatoilHydro Health RSA	Watercourse	Corner Development Area
StatoilHydro Health LSA	Major Road	Hangingstone Development Area
StatoilHydro Lease	City/Town	Leismer Development Area
Waterbody	Human Health Sampling Area	Thornbury Development Area

Title:

FIGURE 55-1

HUMAN HEALTH SAMPLING LOCATIONS

StatoilHydro

Approved: RL	Revision Date: March 23, 2009
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56.	**SIR 151, Pages 316-328.** StatoilHydro presents a consolidated discussion on the Cumulative Environmental Affects case for the set of Risk Quotient (RQ) values. a. What are the indoor and outdoor emission sources that are contributing to the RQ exceedances?

Response

The Table provided in AENV SIR(1) #151(b) has been expanded to list possible sources of COPCs. In the case of acrolein, acetaldehyde, benzene and formaldehyde, the risk estimates are primarily attributable to the assumed background concentrations (indoor and outdoor) obtained from scientific literature. As the background concentrations used in the assessment were based upon measurements reported in literature and were not predicted, the exact sources cannot be determined. However, based upon scientific information available regarding possible sources of the COPCs, it is possible to identify some general sources that are relevant to the background air concentrations used in the assessment.

Table 55-1 below describes possible contributing sources to the indoor and outdoor air concentrations used in the HHRA. Refer to the EIA, Volume 2, Appendix 2A (Air Emissions Inventory) for a detailed account of all air emissions, along with their sources, in the air quality regional study area.

Table 55-1 Summary of Potential Indoor and Outdoor Sources of Volatile Organic Compounds

COPC	Primary Contributor to Exceedance	Possible sources in Outdoor or Indoor Air	References
Acute Inhalation Assessment			
Acrolein	Residential receptor only. Acrolein RQ attributable to existing/approved ambient sources included in Baseline, Application and CEA cases. Also related to the conservative exposure limit used in the assessment.	Indoor Background Air Not relevant as an indoor air concentration was not added to background for the acute assessment Outdoor Background Air Vehicle emissions, diesel combustion	
$PM_{2.5}$	Residential receptors only. $PM_{2.5}$ RQ values attributable to existing/approved ambient sources included in Baseline, Application and CEA cases, given the similarity of the RQ values.	Combustion sources (natural and anthropogenic), physical processes	

COPC	Primary Contributor to Exceedance	Possible sources in Outdoor or Indoor Air	References
Chronic Inhalation Assessment - Non Cancer			
Acrolein	All receptors. The background indoor air concentration assumed in the HHRA contributed the most risk to all assessment cases.	Indoor Background Air Tobacco smoke, pyrolysis by-products from animal and vegetable fats, polyethylene and polyvinyl materials, wood, combustion emissions, furnaces, secondary formation from other volatile organic compounds Outdoor Background Air Vehicle emissions, forest fires, agricultural burns, wood burning stoves, secondary formation from other volatile organic compounds	US EPA 2003, Seamen et al. 2007, Gilbert et al. 2005, GC 2000
Chronic Inhalation Assessment - Cancer			
Acetaldehyde	All receptors. Chronic LCR values included background indoor and outdoor air. In all instances, the assumed indoor air concentration of acetaldehyde (~21.5 ug/m^3) appeared to contribute the most risk to the background LCR of 1.3, which was included in the Baseline, Application and CEA cases.	Indoor Background Air Tobacco smoke, food preparation, building materials, latex paint, carpet backing, consumer products Outdoor Background Air Combustion sources, wood-burning stoves, furnaces, power plants, waste incineration, secondary formation	GC 2000
Benzene	All receptors. Chronic LCR values included background indoor and outdoor air. In all instances, both the indoor and outdoor air measurements used as background contributed risk to the background LCRs.	Indoor Background Air Tobacco smoke, consumer products (cleaning compounds, paints, adhesives, rubber products, surface coatings) Outdoor Background Air Forest fires, vehicle emissions, combustion, gasoline, chemical manufacturing, iron and steel production, industrial and municipal effluents	GC 1993 Wallace 1989
Formaldehyde	All receptors. Chronic LCR values included background indoor and outdoor air concentrations, which contributed to the background LCRs.	Indoor Background Air Off-gassing of building materials (wood paneling, plywood, particle board, latex paint, carpets and textiles, resins, some insulation types, vinyl flooring, flooring finish, wall coverings), heat sources such as stoves and heaters, consumer products (industrial and household cleaning products and disinfectants, cosmetics, lotions), furnishings, tobacco smoke, food preparation, permanent press clothing, Outdoor Background Air Brush and forest fires (including agricultural burns), bacteria, algae, vegetation, incomplete fuel combustion from vehicles, wood-burning stoves, waste incinerators, power plants, chemical manufacturing plants, pulp and paper mills, forestry product plants, tire and rubber plants, refineries, coal processing plants, textile mills, automotive plants, metal products industrial plants, secondary formation from other volatile organic compounds	GC 2001, California OEHHA 2001

For all of the COPCs evaluated in Table 55-1, there appears to be a diverse list of potential contributing sources to background air concentrations. Given that the background air concentrations used are the primary contributors to the RQ and LCR values predicted for the baseline, application and cumulative cases, the potential background sources identified are also relevant to these assessment cases. As the values used in the HHRA for background outdoor and indoor air were obtained from the scientific literature, it is not possible to ascertain the relative contributions of the various sources to the numbers used.

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57.	**SIR 152, Pages 328-330.** StatoilHydro states, "…*fleet metal emissions related to construction would be considerably less than for operations*." a. What would the metal concentrations be for operations? Update the HHRA accordingly.

Response

Any potential metal emissions from Project operations would be attributable to fuel combustion; however, as noted in the response to AENV SIR(1) #152(b), evidence has been provided to illustrate that, if any metals are formed from the combustion of natural gas, they have been shown to be below detection limits. Therefore, the HHRA is complete and any conclusions with respect to justifying the exclusion of metals related to operation of the Project are appropriate.

With respect to construction activities for the Project, it is expected that some metals related to engine and brake wear will be released in small quantities. Any metals discharged during construction will be in trace amounts, and would be similar to other construction sites in Alberta.

I. ALBERTA ENVIRONMENT APPROVALS

58.	**Volume 1, Section 5.2.15.2, Page 105.** Statoil Hydro states, "…*sour gas will be treated at Leismer, Thornbury, and Corner hubs*." **Table 2A2-1, Volume 2, Appendix A, Page 2A-7** indicates that Hangingstone will also have sulphur recovery. a. Provide a list of the central processing facilities and indicate those facilities that will or will not have sulphur recovery.

Response

StatoilHydro plans to install Sulphur Recovery Units (SRUs) at the CPFs listed in the Table 58-1. StatoilHydro will ensure it remains within regulatory requirements as addressed in SIR(2) #7. Table 58-1 lists 12 CPFs and 10 hubs. A hub is the CPF and the associated field facilities over the life of the Project. Five of the CPFs will have SRUs, and will be sized according to the capacity required as shown below. Refer to Figure 58-1 for the locations of the hubs and sulphur recovery units as well as the capacity of the SRUs. Note that the South Leismer Hub (20,000 bpd capacity) will not be operational until 2034. At this time, some of the initial CPFs will no longer be in operation; therefore, the total maximum simultaneous capacity will not exceed 220,000 bpd.

Table 58-1 Central Processing Facilities and Location of Sulphur Recovery Facilities

CPF	Capacity (bpd)	Hub	Sulphur Recovery	Sulphur Recovered At
LDP	10,000	LDP	No	Not initially required[1]
Leismer Commercial[2]	10,000	Leismer Commercial[2]	Yes	Leismer Commercial[2]
Leismer Expansion	20,000	Leismer Expansion	No	Leismer Commercial
Corner 1	20,000	Corner	Yes	Corner 1
Corner 2	20,000		Yes	Corner 2
Thornbury 1	20,000	Thornbury	Yes	Thornbury 1
Thornbury 2	20,000		No	Thornbury 1
Corner Expansion	40,000	Corner Expansion	No	Corner 1 or Corner 2
Hangingstone	20,000	Hangingstone	Yes	Hangingstone
Thornbury Expansion	20,000	Thornbury Expansion	No	Thornbury 1
NW Leismer	20,000	NW Leismer	No	Leismer Commercial
South Leismer[3]	20,000	South Leismer	No	Leismer Commercial
12	**240,000**	**10**	**5**	**5**

[1] Will be recovered at the Leismer Commercial SRU

[2] The SRU at Leismer Commercial is not planned to be operational until Leismer Expansion is ramping up

[3] Not operational until 2034

58.	b. For central processing facilities that will not have the capability of sweetening the produced gas, clarify what will happened to the sour produced gas (pipeline to other central facility, combusted in steam generators, flared or other).

Response

For the CPFs that will not have the capability of sweetening the produced gas, the sour produced gas will be sent via pipeline to a CPF with sulphur recovery capabilities, as indicated in Table 58-1 above. Where there are sulphur recovery and mixed fuel (sweetened produced gas and fuel gas), they will be sent back to the CPF to be combusted in the OTSGs.

58.	c. If pipelined to another central facility, the SO2 for the receiving facility would be greater than the nominal sulphur production for a 3180 m^3/d hub. Provide the sulphur balance in this case. Update the air quality modelling for the steam generators to account for this sulphur balance. Provide air quality modelling in support of upset conditions that accounts for this additional gas inlet capacity.

Response

As sweetened gas will be sent back to the CPFs, where the produced sour gas came from, there will be no increase in SO_2 emissions from the CPF, where the SRU is located. Therefore, no update to the sulphur balance is required. However, upset flare modelling has been updated to take additional processing capacity into account.

In the event of an upset, the transported sour produced gas may be flared at the site of a hub with a SRU. Upset modelling was conducted to account for increased gas flow as a result of transport of sour produced gas to a SRU. Three potential flow rates were assessed; 1,060 m^3/hr, 2,120 m^3/hr, and 3,180 m^3/hr (which account for the 20,000 bpd, 40,000 bpd and 60,000 bpd cases, respectively). Table 58-2 illustrates the flaring parameters and gas composition used in the upset modelling.

Table 58-3 presents the maximum and 9th highest 1-hour SO_2 predictions for the upset scenarios using the CALPUFF model. The 9th highest SO_2 predictions are less than the AAAQO of 450 ug/m^3 for all scenarios modelled.

Table 58-2 Flaring Parameters used in Upset Flare Modelling

Flaring Scenario	**Upset Scenario 1**	**Upset Scenario 2**	**Upset Scenario 3**
Emission Source	**HP Flare**	**HP Flare**	**HP Flare**
Production Rate (bpd)	***20,000***	***40,000***	***60,000***
Flaring Event Duration (min)	***20***	***20***	***20***
Actual Stack Height (m)	32.0	32.0	32.0
Actual Stack Diameter (m)	0.406	0.406	0.406
Gas Flow Rate (103 std m^3/d)	***25.44***	***50.88***	***76.31***

Flaring Scenario	Upset Scenario 1	Upset Scenario 2	Upset Scenario 3
Flared Gas Composition (mol %): Hydrogen (H_2)	0.020	0.020	0.020
Helium (He)	0.020	0.020	0.020
Water (H_2O)	0.000	0.000	0.000
Nitrogen (N_2)	2.380	2.380	2.380
Carbon Dioxide (CO_2)	2.700	2.700	2.700
Hydrogen Sulphide (H_2S)	***1.750***	***1.750***	***1.750***
Methane (CH_4)	91.460	91.460	91.460
Ethane (C_2H_6)	0.040	0.040	0.040
Propane (C_3H_8)	0.070	0.070	0.070
i-Butane (i-C_4H_{10})	0.100	0.100	0.100
n-Butane (n-C_4H_{10})	0.390	0.390	0.390
i-Pentane (i-C_5H_{12})	0.570	0.570	0.570
n-Pentane (n-C_5H_{12})	0.490	0.490	0.490
n-Hexane (n-C_6H_{14})	0.010	0.010	0.010
n-Heptane (n-C_7H_{16+})	0.000	0.000	0.000
Total	100	100	100
Flared Gas Net Heating Value (MJ/m^3)	33.55	33.55	33.55
Effective Stack Height (m)b	***37.07***	***39.06***	***40.57***
Equivalent Stack Diameter (m)b	***3.845***	***3.845***	***3.845***
Actual Exit Velocity (m/s)	***2.3***	***4.5***	***6.8***
Equivalent Stack Temperature (K)b	***1273***	***1273***	***1273***
Event SO_2 Emission Rate (g/s)	4.561	9.121	13.681
Hourly SO_2 Emission Rate (g/s)	***13.682***	***27.364***	***41.043***

Notes: Pseudo-parameters are calculated using the Alberta Environment Calculation Sheet for Flares Ver. 3.0. Effective stack height equals actual stack height plus flame height. Equivalent diameter is calculated based on energy balance considerations that allow the CALPUFF model to represent plume rise from a flare stack.

Table 58-3 CALPUFF Model Predictions for Upset Modelling Associated with Increased Flow of Sour Produced Gas (in ug/m³).

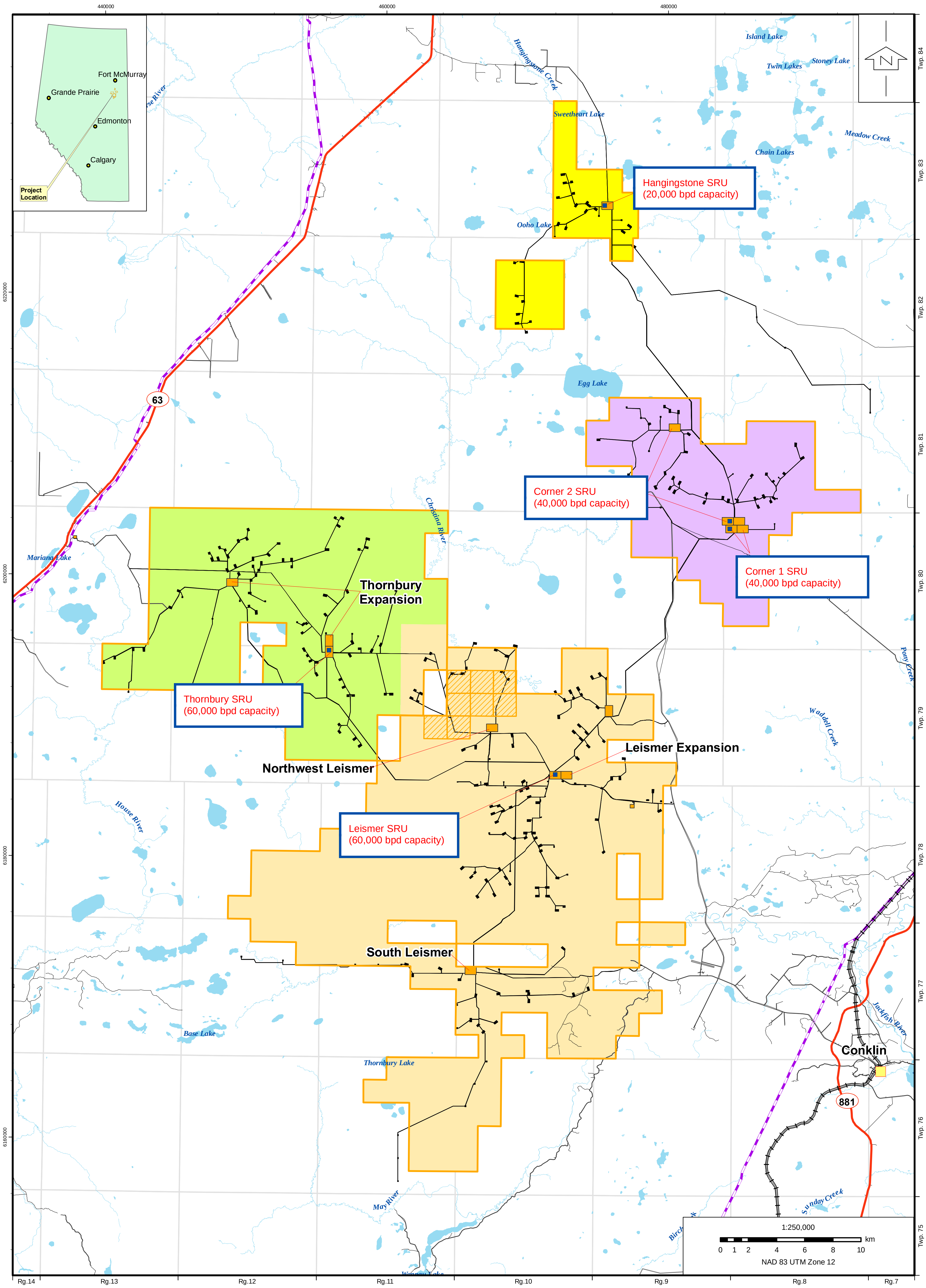
Scenario	Averaging Period	SO_2 Concentration (ug/m³)	AAAQO (ug/m³)
Scenario 1 (20,000 bpd)	1-h Max	303.8	-
	1-h 9th	240.1	450
Scenario 2 (40,000 bpd)	1-h Max	421.5	-
	1-h 9th	217.4	450
Scenario 3 (60,000 bpd)	1-h Max	317.1	-
	1-h 9th	240.0	450

58.	d. If flared or combusted in the OTSGs, confirm that air quality modelled provided to date, supports these emissions.

Response

As the transported sour produced gas will be sweetened, then transported back to the original hub, combustion emissions from the OTSGs will remain unchanged. Thus, the air quality modelling for normal operating conditions is correct and up-to-date.

See also SIR(2) 22(a); SIR(2) 19(a)



Legend

- StatoilHydro Lease
- Hub with SRU
- Footprint Infrastructure
- Joint Venture Lands
- Waterbody
- Watercourse
- City/Town
- Major Road
- Road
- Powerline
- Railway
- Corner Development Area
- Hangingstone Development Area
- Thornbury Development Area
- Leismer Development Area

Title:

FIGURE 58-1

LOCATIONS OF SULPHUR RECOVERY UNITS (SRU)

StatoilHydro

Approved: RL	Revision Date: March 22, 2009
File: FIGURE_58-1_LOCATIONS_OF_SULPHUR_RECOVERY_UNITS_(SRU).mxd	
Drawn by: RF	Checked: MM

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59.	**SIR 34, Page 132.** StatoilHydro states, "…*innovative monitoring approaches will be taken.*" The response to SIR 34 was answered addressing wildlife monitoring. a. In the context of hydrogeological monitoring, what, if any, innovative monitoring approaches are being taken?

Response

The innovative hydrogeological monitoring being employed in the Kai Kos Dehseh Project development is as follows. Subsequent to discussions with StatoilHydro regarding the Leismer project groundwater diversion licensing, AENV agreed to waive the requirement for dedicated observation wells and extended pump tests on each source well, provided that one long-term pump test and pressure build-up evaluation would be conducted at the 16-4-79-10W4M well, and monitored in adjacent wells penetrating the Grand Rapids Formation. This longer-term pump test is planned for the 2008/2009 drilling season.

Drawdown measurements for reporting purposes are normally determined at nearby observation wells and calculated to a distance of 150 m from the source well. Instead, StatoilHydro proposes to measure drawdown in the pumped wells. Should the maximum allowable drawdown be reached, then the use of the source well would be discontinued, or an observation well would be installed and used for the maximum allowable drawdown measurement reporting requirements. Alternatively, if maximum drawdown is reached in one well, another option would be to reduce the pumping rate in that well, and maintain the drawdown in the wellbore at below the maximum drawdown.

60.	**SIR 38, Page 137.** StatoilHydro has not provided data for the Clearwater A aquifers. a. Provide actual testing data for the Clearwater A aquifers. (i.e., hydraulic head values, hydraulic conductivity, coefficient of storativity, sustainable yield calculations as well as baseline chemical data).

Response

StatoilHydro has provided hydrogeological data for the Clearwater A Aquifer. In the EIA, Volume 3, Section 5, Appendix 5C and Figure 5.5-27 summarize TDS concentrations from Clearwater A Aquifer groundwater samples. Additional groundwater chemistry analyses from samples collected from the Clearwater A Aquifer were summarized in AENV SIR(1) #50 Table 50-1. In addition to the groundwater chemistry data, hydraulic head values posted on Figure 5.5-26 (EIA, Volume 3, Section 5) were derived from Clearwater Formation DST pressures. DSTs are typically performed on permeable portions of the formation; therefore, the majority of the posted hydraulic head values north of Township 82 were collected from, and are representative of, the Clearwater A Aquifer.

Concurrent to the preparation of the Kai Kos Dehseh Project Application and EIA, OPTI Canada Inc. and Nexen Inc. (OPTI/Nexen) also submitted an application for approval of their Long Lake South Project

(OPTI/Nexen, 2006). OPTI/Nexen published eight pumping test results and 19 hydraulic head values for the Clearwater A Aquifer. (Note: OPTI/Nexen refers to the Clearwater A Aquifer as the Clearwater 'B' Aquifer in their project area.) The horizontal hydraulic conductivity values of the Clearwater A Aquifer ranged from 3.8 x 10^{-6} m/s to 7.2 x 10^{-6} m/s (OPTI/Nexen, 2006). Hydraulic heads in the OPTI/Nexen Project area ranged from 434 masl to 459 masl and are consistent with values published by StatoilHydro in Volume 3, Section 5, Figure 5.5-26. Clearwater A Aquifer TDS concentrations published by OPTI/Nexen ranged from 3,020 mg/L to 34,400 mg/L.

Since the submission of the Kai Kos Dehseh Project Application, MEG Energy Corp. (MEG) has submitted an application for approval of the Phase 3 Project (MEG, 2008). As published by MEG, analysis of the pumping test (with 2 observation wells) concluded a horizontal hydraulic conductivity of 1 x 10^{-5} m/s and a specific storage of 5 x 10^{-6} m^{-1}. These values are consistent with the values utilized in the Kai Kos Dehseh Project numerical groundwater flow model. The Clearwater A Aquifer TDS concentrations published by MEG ranged from 1,590 mg/L to 3,623 mg/L.

The Clearwater A Aquifer is not expected to be utilized for the Kai Kos Dehseh Project until 2016 at the Hangingstone development area. As such, StatoilHydro is planning to continue to evaluate the Clearwater A Aquifer in future water well testing programs.

REFERENCES

MEG Energy Corp. (MEG). 2008. Application for Approval of the Christina Lake Regional Project Phase 3. Submitted to Alberta Energy and Utilities Board and Alberta Environment. April, 2008.

OPTI Canada Inc. and Nexen Canada Ltd. (OPTI/Nexen). 2006. Application for Approval of the Long Lake South Project. Submitted to Alberta Energy and Utilities Board and Alberta Environment. December, 2006.

61.	**SIR 51, Pages 168-169.** StatoilHydro has responded that the 50% contour is not shown. a. Provide revised map Figure 5.6-22 with 50% contour.

Response

Figure 61-1 is a revised version of Figure 5.6-22 with the 50% aquifer productivity contour included.

61.	b. Explain why over 50% reduction in aquifer productivity in some areas was interpreted as "*moderate*" impact.

Response

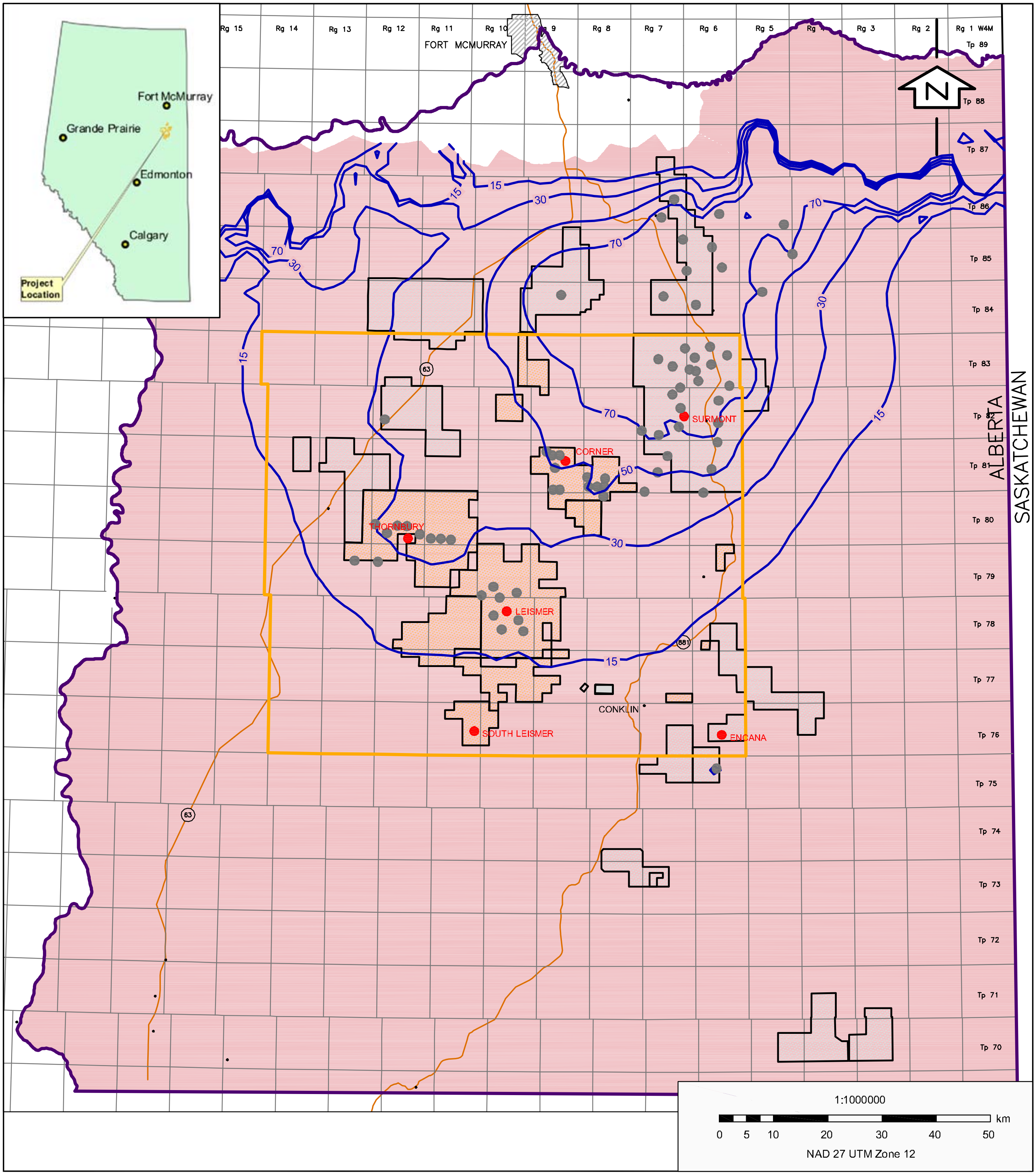
In the application case, a decrease in Lower Grand Rapids Aquifer productivity of greater than 50% is predicted to occur in the northeast portion of the Corner development area in 2037 (Figure 61-1).

As described in the EIA, Volume 3, Section 5.6.3.3, the majority of this drawdown is predicted to occur in the baseline case. StatoilHydro recognizes the drawdown limit (for non-saline aquifers) of 50% of the available hydraulic head as outlined in the *Water Conservation and Allocation Guideline for Oilfield Injection* (2006). Although a greater than 50% reduction in Aquifer productivity is predicted to occur in 2037 in the vicinity of the Corner development area, StatoilHydro will ensure that the available drawdown will not exceed the 50% limit as a result of StatoilHydro's operations by optimizing its water well network and pumping rates. Other operators in the area would likely adopt a similar strategy.
As such, the final impact rating is considered moderate.

REFERENCES

Alberta Environment (AENV), 2006. Water Conservation and Allocation Guideline for Oilfield Injection – 2006. ISBN No. 0-7785-3144-7, Pub No. I/969.

*PLOT 1:1 = Letter (P)



LEGEND

KAI KOS DEHSEH Project	Simulated Change % AP (10)
Adjacent *Insitu* Oil Sands Project	Observation Well
StatoilHydro Hydrogeology RSA	Source Well
StatoilHydro Hydrogeology LSA	
Lower Grand Rapids Aquifer	

REFERENCE
ALBERTA NTDB DIGITAL OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
SASKATCHEWAN NTDB DATA OBTAINED FROM ISC, AUGUST 2001.
DATUM: NAD 27 PROJECTIONS: UTM ZONE 12

Title: **FIGURE 61-1**

SIMULATED CHANGE IN LOWER GRAND RAPIDS AQUIFER PRODUCTIVITY APPLICATION CASE (END OF 2037)

StatoilHydro

Approved: SR	Revision Date: March 19, 2009
File: 4455-IMPACTASSESS-09.DWG	
Drawn by: GDE	Checked: BW

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J. ERRATA

62.	**SIR 38, Table 38-4, Page 141** a. pH for 03-04-7910 W4 and turbidity for 09-21-81-08 W4, 12-33-80-08 W4 & 0302-79-10 W4 exceed the referenced criteria and should be bolded/colour-coded as such.

Response

A revised Table 38-4 is presented as Table 62-1.

Table 62-1 Lower Grand Rapids Aquifer Chemistry

Parameter	Units	GCDWQ	09-21-81-08W4M 13-Jan-07 15:00	12-33-80-08W4M 28-Jan-07 17:10	03-02-79-10W4M 21-Mar-07 16:40	16-04-79-10W4M 15-Mar-08 11:00	16-09-79-10W4M 9-Mar-08 4:20	11-31-80-08W4M 3-Mar-08 19:00	04-09-79-10W4M 23-Feb-08 14:20	14-32-80-08W4M 26-Feb-08 3:00	03-04-79-10W4M 17-Feb-08 13:20	07-10-79-10W4 6-Feb-08 3:30
Ion Balance	%		102	107	112	85.4	106	107	99.0	110	103	95
pH	-	6.5-8.5 [2]	**8.8**	**8.7**	**9**	**8.91**	**8.8**	**8.8**	**8.9**	**8.8**	8.9	**8.8**
Conductivity	µS/cm		2,520	2,320	2,220	2,440	2,440	2,510	2,370	2,380	2,390	2,300
TDS (Calculated)	mg/L	500 [2]	**1,470**	**1,460**	**1,390**	**1,360**	**1,370**	**1,410**	**1,370**	**1,360**	**1,380**	**1,300**
Alkalinity (PP as $CaCO_3$)	mg/L		49	37	76	62	62	58	79	58	69	62
Alkalinity (Total as $CaCO_3$)	mg/L		844	940	850	933	871	856	876	864	859	804
Hardness ($CaCO_3$)	mg/L		10	34	9	7	3	4	<1	3	10	5
Turbidity	NTU	1 [1]	5.9	4,040	23.9	**2.3**	**4.9**	**3.8**	**1.8**	**2.1**	**1.1**	**1**
Silica (as SiO_2)	mg/L		4.2	10.8	6.5	7.5	7.1	7.8	7.3	7.6	10.3	4.1
Total Suspended Solids	mg/L		61	11,200	39	3	6	<3	<3	3	<3	<3
True Color	mg/L		319	171	1600	242	460	220	480	260	490	390
Major Cations												
Dissolved Calcium (Ca)	mg/L		2.1	2.3	2.3	1.69	0.9	1.0	<0.5	1.2	1.9	1.8
Dissolved Magnesium (Mg)	mg/L		1.2	6.9	0.9	0.69	0.3	0.3	<0.1	<0.1	1.2	0.1
Dissolved Potassium (K)	mg/L		3.7	13.6	2.9	2.26	1.7	1.6	1.6	3.0	2.1	1.7
Dissolved Sodium (Na)	mg/L	200 [2]	**611**	**617**	**614**	**517**	**561**	**583**	**573**	**566**	**585**	**525**
Major Anions												
Carbonate (CO_3^{2-})	mg/L		58	44	91	74	<5	<5	95	<5	85	92
Bicarbonate (HCO_3^-)	mg/L		910	1,060	852	987	911	902	876	913	875	792
Dissoved Sulphate (SO_4^{2-})	mg/L	500 [2]	2.2	0.7	<0.5	<1	0.6	1.1	2.9	5.2	0.6	2.7
Dissolved Chloride (Cl^-)	mg/L	250 [2]	**338**	**255**	**253**	**279**	**284**	**310**	**263**	**263**	**273**	**282**
Hydroxide (OH^-)	mg/L		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Fluoride (F^-)	mg/L	1.5 [1]	**3.09**	**3.4**	**2.8**	**3.0**	**3.49**	**3.89**	**3.88**	**3.79**	**3.75**	**3.36**
Sulphide (S)	mg/L		<0.003	0.008	0.005							
Nutrients												
Dissolved Nitrate (N)	mg/L	10 [1]	0.1	0.05	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dissolved Nitrite (N)	mg/L	3.2 [1]	<0.05	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nitrite plus Nitrate (N)	mg/L		0.1	<0.07	<0.07	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ammonia (N)	mg/L		2.09	1.37	1.93	1.31	1.31	1.29	1.42	1.35	1.35	0.67
Orthophosphate (P)	mg/L		0.34	0.55	0.62	0.58	0.6	0.84	0.53	0.82	0.99	0.64
Total Phosphate (P)	mg/L		0.41		0.61	0.615	0.622	0.930	0.597	0.906	1.10	0.643
Organics												
Total Organic Carbon	mg/L		21	9	14	5	21	16	22	17	23	19
Dissolved Organic Carbon	mg/L		17	7	14	5	9	11	8	16	11	8
Phenols (4AAP)	mg/L	0.004 [3]	<0.002	0.007	0.006	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	0.001
Naphthenic Acids	mg/L		<1	1	<1	<1	1	<1	<1	<1	<1	<1
Oil and Grease			<1	-	---	---	---	---	---	---	---	---
F1 (C_6-C_{10})	mg/L	4.6 [4]	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
F2 (C_{10}-C_{16})	mg/L	2.1 [4]	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1	<0.05	<0.05
Benzene Purgeable	mg/L	0.005 [1]	0.0013	<0.0005	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Toluene Purgeable	mg/L	0.024 [2]	<0.0005	<0.0005	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Ethylbenzene Purgeable	mg/L	0.0024 [2]	<0.0005	<0.0005	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Xylenes (Total) Purgeable	mg/L	0.3 [2]	<0.0005	<0.0005	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
F1-BTEX			<0.1	<0.1	<0.1	---	---	---	---	---	---	---

Notes:

Bold - concentration equals or exceeds selected water quality guidelines.
1 - Maximum Allowable Concentration (Health Canada, 2007)
2 - Aesthetic Objective (Health Canada, 2007)
3 - Surface Water Quality Guidelines for Use in Alberta (AENV, 1999)
4 - Alberta Tier 1 Soil and Groundwater Remediation Guidelines (AENV, 2007)

Table 62-1 (Continued) Lower Grand Rapids Aquifer Chemistry

Parameter	Units	GCDWQ	09-21-81-08W4M		12-33-80-08W4M		03-02-79-10W4M		16-04-79-10W4M		16-09-79-10W4M		11-31-80-08W4M		04-09-79-10W4M		14-32-80-08W4M		03-04-79-10W4M		07-10-79-10W4M	
			13-Jan-07		28-Jan-07		21-Mar-07		15-Mar-08		9-Mar-08		3-Mar-08		23-Feb-08		26-Feb-08		17-Feb-08		6-Feb-08	
			15:00		17:10		16:40		11:00		4:20		19:00		14:20		3:00		13:20		3:30	
			Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Aluminum (Al)	mg/L	0.1 [3]	0.02	0.67	0.01	96.6	0.02	0.81	<0.025	0.029	<0.01	0.03	<0.01	0.05	0.02	0.08	0.02	0.05	0.05	0.07	0.02	0.07
Antimony (Sb)	mg/L	0.006 [1]	0.0011	0.0011	0.0006	0.0009	0.0005	0.0005	<0.00050	<0.00050	<0.0004	0.0006	<0.0004	<0.0004	0.0008	0.0008	0.0009	0.0008	<0.0004	<0.0004	0.0004	0.0005
Arsenic (As)	mg/L	0.010 [1]	0.0044	0.004	0.0038	**0.0159**	0.0022	0.0014	<0.00050	<0.00050	0.0028	0.0021	0.0021	0.0027	0.0028	0.0033	0.0069	0.0068	0.0022	0.0015	0.0023	0.0025
Barium (Ba)	mg/L	1 [1]	0.0511	0.0611	0.065	0.705	0.0117	0.0792	0.0428	0.0703	0.067	0.085	0.068	0.077	0.068	0.080	0.071	0.073	0.033	0.042	0.070	0.091
Beryllium (Be)	mg/L		<0.0005	<0.001	<0.0005	0.005	<0.0005	<0.001	<0.0025	<0.0025	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth (Bi)	mg/L		<0.00005	<0.0001	<0.00005	0.0011	<0.00005	<0.0001	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Boron (B)	mg/L	5 [1]	**5.52**	**5.19**	**5.76**	**5.61**	**5.72**	**6.73**	4.11	4.34	3.93	**5.67**	**6.92**	**5.81**	**5.45**	**6.46**	**6.00**	**5.68**	**6.81**	**6.18**	**5.69**	**5.38**
Cadmium (Cd)	mg/L	0.005 [1]	<0.0001	<0.0002	<0.0001	0.0014	<0.0001	<0.0002	<0.00025	<0.00025	<0.0001	<0.0002	<0.0001	<0.0002	<0.0001	<0.0002	<0.0001	<0.0002	<0.0001	<0.0002	<0.0001	<0.0002
Calcium (Ca)	mg/L		---	2.6	---	12.5	---	1.7	1.69	1.59	0.9	1.8	1.0	1.7	<0.5	1.4	1.2	1.5	1.9	1.8	1.8	2.8
Chromium (Cr)	mg/L	0.05 [1]	0.0005	<0.005	0.014	0.124	<0.005	0.0073	<0.0025	<0.0025	<0.005	<0.005	0.008	0.012	<0.005	0.006	<0.005	<0.005	0.017	<0.005	0.011	0.011
Cobalt (Co)	mg/L		0.0005	0.0009	0.0002	0.0816	0.0004	0.0009	<0.00050	<0.00050	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Copper (Cu)	mg/L	1 [2]	0.0048	0.04	0.0014	0.138	0.0088	0.033	0.00195	0.00055	<0.001	0.002	0.004	0.004	0.003	0.003	0.001	0.006	0.002	0.002	<0.001	0.007
Iron (Fe)	mg/L	0.3 [2]	**0.319**	**1.59**	0.08	**110**	0.03	**1.84**	0.065	0.289	0.030	0.281	0.126	**0.525**	0.108	0.149	**0.389**	**0.501**	0.122	**0.343**	0.035	**1.79**
Lead (Pb)	mg/L	0.01 [1]	0.0019	0.0034	<0.0001	**0.0805**	<0.0001	**0.0166**	<0.00050	0.00087	<0.0001	0.0005	0.0002	**0.0032**	**0.0023**	**0.0030**	**0.0018**	**0.0088**	0.0010	0.0020	0.0002	**1.74**
Lithium (Li)	mg/L		0.112	0.108	0.14	0.289	0.0999	0.103	0.087	0.089	0.115	0.11	0.121	0.11	0.101	0.11	0.105	0.10	0.114	0.1	0.104	0.1
Magnesium (Mg)	mg/L		---	1.7	---	21.4	---	1	0.69	0.68	0.3	0.9	0.3	0.9	<0.1	1.0	<0.1	0.8	1.2	0.8	0.1	1.1
Manganese (Mn)	mg/L	0.05 [2]	0.007	0.014	0.016	3.26	0.03	0.044	0.00237	0.00482	0.002	0.004	0.006	0.010	0.006	0.006	0.008	0.008	0.006	0.009	0.004	0.015
Mercury (Hg)	mg/L	0.001 [1]	---	---	---	---	---	---	<0.000050	<0.000050	<0.0001	<0.0002	<0.0001	<0.0002	<0.0001	<0.0002	<0.0001	<0.0002	<0.0001	<0.0002	<0.0001	<0.0002
Molybdenum (Mo)	mg/L		0.0127	0.0135	0.0076	0.0085	0.0035	0.0039	0.00107	0.00201	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Nickel (Ni)	mg/L		0.0049	0.0237	0.0007	0.148	0.0019	0.0601	<0.0025	<0.0025	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.007
Potassium (K)	mg/L		---	3.9	---	16	---	1.9	2.26	2.12	1.7	2.3	1.6	2.0	1.6	2.3	3.0	2.0	2.1	1.8	1.7	2.0
Selenium (Se)	mg/L	0.01 [1]	<0.0004	0.0039	0.0024	0.0051	0.0005	0.0005	<0.0050	<0.0050	0.0017	0.0056	0.0015	0.003	0.0007	0.0012	0.0012	0.0041	0.0012	0.0019	0.0010	0.0019
Silicon (Si)	mg/L		1.8	3.2	3.3	64.6	2.9	5	3.11	3.44	2.8	3.1	3.5	3.4	3.2	3.4	3.2	3.1	4.7	4.4	3.4	3.3
Silver (Ag)	mg/L		---	<0.0004	---	<0.0004	---	<0.0004	<0.000050	<0.000050	<0.0001	<0.0004	<0.0001	<0.0004	<0.0001	<0.0004	<0.0001	<0.0004	<0.0001	<0.0004	<0.0001	<0.0004
Sodium (Na)	mg/L	200 [2]	---	**590**	---	**490**	---	**499**	**517**	**584**	**561**	**536**	**583**	**523**	**573**	**565**	**566**	**512**	**585**	**508**	**525**	**489**
Strontium (Sr)	mg/L		0.165	0.174	0.145	0.777	0.0861	0.163	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Sulphide	mg/L	0.05 [2]	---						-	0.015	-	0.015	-	0.010	-	0.012	-	0.005	-	0.003	-	0.012
Sulphur (S)	mg/L		0.6	1.3	<0.5	2.1	0.5	<0.5	<1.0	<1.0	<0.5	<0.5	<0.5	<0.5	4.3	0.6	0.6	0.5	1.6	0.6	1.5	1.4
Thallium (Tl)	mg/L		<0.00005	0.0002	<0.00005	0.0008	<0.00005	0.0001	<0.00050	<0.00050	0.0002	<0.0001	0.0002	0.0003	0.0002	0.0003	<0.0001	0.0005	<0.0001	0.0007	<0.0001	0.0004
Tin (Sn)	mg/L		<0.0002	<0.0004	<0.0002	<0.0004	<0.0002	<0.0004	<0.00050	<0.00050	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Titanium (Ti)	mg/L		0.051	0.062	0.0014	0.323	0.0021	0.123	<0.0050	0.0503	0.002	0.078	0.002	0.051	0.003	0.084	0.005	0.054	0.004	0.076	0.002	0.067
Uranium (U)	mg/L	0.02 [1]	0.0041	0.0037	0.0002	0.0128	0.0001	0.0002	<0.000050	0.000108	<0.0001	0.0001	<0.0001	0.0001	0.0007	0.0008	0.0006	0.0008	0.0001	0.0002	<0.0001	0.0001
Vanadium (V)	mg/L		0.0162	0.0186	0.0049	0.137	0.006	0.0248	<0.0050	0.0103	0.007	0.014	0.002	0.01	0.008	0.016	0.006	0.007	0.005	0.017	0.004	0.016
Zinc (Zn)	mg/L	5 [2]	0.041	0.063	0.008	0.366	0.007	0.042	<0.025	<0.025	0.003	0.023	0.005	0.017	0.137	0.108	0.101	0.102	0.061	0.129	0.015	0.164

Notes:

Bold - concentration equals or exceeds selected water quality guidelines.
1 - Maximum Allowable Concentration (Health Canada, 2007)
2 - Aesthetic Objective (Health Canada, 2007)
3 - guideline applies only to drinking water treatment plants

63.	**SIR 38, Table 38-5, Page 143** a. Turbidity for 10-35-77-10 W4 & 12-02-77-10 W4 exceed the referenced criteria and should be bolded/colour-coded as such.

Response

A revised Table 38-5 is presented as Table 63-1.

Table 63-1 Clearwater B Aquifer Chemistry

Parameter	Units	GCDWQ	10-35-77-10W4M 16-Jan-07 14:15	12-02-78-10W4M 26-Feb-07 9:58	11-19-77-10W4M 6-Feb-08 0:00
Ion Balance	%		91.5	108	96.0
pH	-	6.5-8.5 [2]	6.7	8.1	8.5
Conductivity	µS/cm		13,000	11,300	9,720
TDS (Calculated)	mg/L	500 [2]	**7,290**	**6,600**	**5,790**
Alkalinity (PP as $CaCO_3$)	mg/L		<5	<5	27
Alkalinity (Total as $CaCO_3$)	mg/L		66	792	691
Hardness ($CaCO_3$)	mg/L		201	70	88
Turbidity	NTU	1 [1]	2,600	50.9	**900**
Silica (as SiO_2)	mg/L		64.5	8.3	7.3
Total Suspended Solids	mg/L		1630	79	1670
True Color	mg/L		105	8	14
Major Cations					
Dissolved Calcium (Ca)	mg/L		47.7	11.4	15.4
Dissolved Magnesium (Mg)	mg/L		20	176	12.0
Dissolved Potassium (K)	mg/L		22.3	10	9.5
Dissolved Sodium (Na)	mg/L	200 [2]	**2,560**	**2,580**	**2,200**
Major Anions					
Carbonate (CO_3^{2-})	mg/L		<5	<5	33
Bicarbonate (HCO_3^-)	mg/L		80	967	775
Dissoved Sulphate (SO_4^{2-})	mg/L	500 [2]	24.9	2	10.1
Dissolved Chloride (Cl^-)	mg/L	250 [2]	**4,540**	**3,340**	**3,130**
Hydroxide (OH^-)	mg/L		<5	<5	<5
Fluoride (F^-)	mg/L	1.5 [1]	**37.2**	**0.7**	1.24
Sulphide (S)	mg/L		<0.02	0.012	
Nutrients					
Dissolved Nitrate (N)	mg/L	10 [1]	<0.1	<0.1	<0.1
Dissolved Nitrite (N)	mg/L	3.2 [1]	<0.05	<0.1	<0.05
Nitrite plus Nitrate (N)	mg/L		<0.1	<0.1	<0.1
Ammonia (N)	mg/L		65.1	4.82	8.53
Orthophosphate (P)	mg/L		3.83	<0.01	<0.01
Total Phosphate (P)	mg/L		165	0.08	1.15
Organics					
Total Organic Carbon	mg/L		675	<1	29
Dissolved Organic Carbon	mg/L		713	<1	29
Phenols (4AAP)	mg/L	0.004 [3]	0.049	0.021	**0.026**
Naphthenic Acids	mg/L		3	<1	<1
Oil and Grease			-	---	---
F1 (C_6-C_{10})	mg/L	4.6 [4]	0.1	<0.1	0.2
F2 (C_{10}-C_{16})	mg/L	2.1 [4]	1.4	<0.05	0.62
Benzene Purgeable	mg/L	0.005 [1]	<0.005	<0.0005	**0.118**
Toluene Purgeable	mg/L	0.024 [2]	<0.005	<0.0005	**0.0250**
Ethylbenzene Purgeable	mg/L	0.0024 [2]	**0.015**	<0.0005	0.00149
Xylenes (Total) Purgeable	mg/L	0.3 [2]	0.085	<0.0005	0.00265
F1-BTEX			<0.1	<0.1	---

Table 63-1 (continued). Clearwater B Aquifer Chemistry

Parameter	Units	GCDWQ	10-35-77-10W4M		12-02-78-10W4M		11-19-77-10W4M	
			16-Jan-07		26-Feb-07		6-Feb-08	
			14:15		9:58		12:00:00 AM	
			Dissolved	Total	Dissolved	Total	Dissolved	Total
Aluminum (Al)	mg/L	0.1 [3]	2.07	19.4	0.02	1.09	**0.17**	**63.2**
Antimony (Sb)	mg/L	0.006 [1]	**0.01**	**0.0135**	0.001	0.0004	0.0065	0.0166
Arsenic (As)	mg/L	0.010 [1]	**0.0635**	**0.0779**	0.0154	**0.014**	0.0081	**0.0258**
Barium (Ba)	mg/L	1 [1]	0.102	**1.65**	**1.31**	**1.33**	0.740	**1.68**
Beryllium (Be)	mg/L		0.0012	0.001	<0.0005	<0.001	<0.001	<0.001
Bismuth (Bi)	mg/L		0.00022	0.0004	0.0001	0.0005	---	---
Boron (B)	mg/L	5 [1]	**5.38**	4.63	**5.69**	**5.51**	4.98	**5.47**
Cadmium (Cd)	mg/L	0.005 [1]	0.0003	0.001	0.0001	**<0.0002**	0.0003	**0.0090**
Calcium (Ca)	mg/L		---	69.9	---	19.7	15.4	28.6
Chromium (Cr)	mg/L	0.05 [1]	0.181	0.181	<0.005	0.009	0.043	0.307
Cobalt (Co)	mg/L		0.004	0.0332	0.0004	0.0014	<0.002	0.026
Copper (Cu)	mg/L	1 [2]	0.0454	0.617	0.0155	0.22	1.55	14.8
Iron (Fe)	mg/L	0.3 [2]	**7.73**	**133**	**3.85**	**7.87**	**2.53**	**125**
Lead (Pb)	mg/L	0.01 [1]	0.0039	**0.45**	**0.014**	**1.87**	**0.103**	**5.9**
Lithium (Li)	mg/L		0.735	0.683	0.582	0.624	0.465	0.55
Magnesium (Mg)	mg/L		---	52.4	---	14.3	12.0	32.6
Manganese (Mn)	mg/L	0.05 [2]	**0.247**	**1.4**	**0.129**	**0.176**	0.167	1.13
Mercury (Hg)	mg/L	0.001 [1]	**---**	**---**	**---**	**---**	0.0002	**0.0022**
Molybdenum (Mo)	mg/L		0.142	0.194	0.0091	0.0078	0.148	6.16
Nickel (Ni)	mg/L		0.0524	0.18	0.0052	0.0786	0.009	0.108
Potassium (K)	mg/L		---	**31.4**	**---**	**177**	9.5	18.3
Selenium (Se)	mg/L	0.01 [1]	<0.0004	0.001	0.0029	<0.0004	0.0081	**0.0192**
Silicon (Si)	mg/L		18.8	47.3	4	7	3.7	135
Silver (Ag)	mg/L		---	<0.0004	---	<0.0004	<0.0001	<0.0004
Sodium (Na)	mg/L	200 [2]	---	**2,660**	---	**2,350**	**2,200**	**1,870**
Strontium (Sr)	mg/L		1.27	2.6	2.67	2.64	---	---
Sulphide	mg/L	0.05 [2]					-	<0.002
Sulphur (S)	mg/L		6.6	12.4	1	0.8	4.1	6.5
Thallium (Tl)	mg/L		0.00136	0.0023	0.0006	0.0002	<0.0001	0.0071
Tin (Sn)	mg/L		0.0008	0.0043	0.0002	0.0068	<0.05	<0.05
Titanium (Ti)	mg/L		0.594	0.946	<0.0003	0.041	0.002	0.939
Uranium (U)	mg/L	0.02 [1]	0.0019	0.0024	0.0002	0.0002	0.0028	0.0049
Vanadium (V)	mg/L		0.0867	0.131	<0.001	---	0.014	0.293
Zinc (Zn)	mg/L	5 [2]	0.124	0.567	0.89	1.61	0.115	2.21

Notes:

Bold - concentration equals or exceeds selected water quality guidelines.
1 - Maximum Allowable Concentration (Health Canada, 2007)
2 - Aesthetic Objective (Health Canada, 2007)
3 - guideline applies only to drinking water treatment plants

APPENDIX A.

UPDATED BAT SURVEY FOR THE KAI KOS DEHSEH PROJECT

Appendix A – Updated Bat Survey for the Kai Kos Dehseh Project

Bat surveys are conducted to determine the presence, sex, age, reproductive status and size of bats or bat groups. Two bat surveys were conducted for the EIA in the LSA: July 30–August 4 and August 14–16, 2006. Sampling intensity was low due to weather and very limited access. To supplement this data, additional bat surveys were conducted in the LSA July 30 to August 14, 2006 and August 5 to 8, 2008 and data from a bat survey conducted for OPTI/Nexen from August 16-18, 2006 near the future Hangingstone Hub was also used. Two methods were used to detect bats: mist netting (physically capturing bats) and using the AnaBat II Bat Detector (identifying bats through their echolocation calls) with Compact Flash Zero Crossings Analysis Interface Module (CF ZCAIM; Titley Electronics).

Mist nets were placed at four different sites in 2006, six different sites in 2008, and two sites in the Hangingstone area along cutlines and overgrown trails between old growth forests (roosting habitat) and wet areas such as streams, bogs and marshes (foraging habitat) (Figure 41-5). To survey during peak bat activity, mist nets were set up shortly after dusk and dismantled between 0300–0515 hours (British Columbia Ministry of Environment, Lands and Parks 1998). The total mist netting effort was 127.0 (2006) and 222.2 (2008) net-hours (a single net set up for one hour equals one net-hour). The nets ranged from 1.8 to 9.1 m high and 3 to 12 m wide.

To decrease stress and the probability of injury to bats, nets were monitored constantly and bats were removed quickly after capture (CCAC 2006 website). Individual bats were placed into cloth bags and held for an hour to allow food to clear the digestive tract for a more accurate weight measurement during processing. Data collected on individual bats and net locations were based on protocols developed for bat surveys in Alberta (Vonhof 2000).

Measurements of the captured bats included species identification, sex, reproductive status, age (according to juvenile/adult characteristics), weight (using a digital scale) and forearm length (using calipers) (British Columbia Ministry of Environment, Lands and Parks 1998). Bats were released immediately following processing.

Bat detectors were used to identify bat species by their echolocation calls. Due to overlap in sonograms, some calls cannot be distinguished to species and species groups have been created (i.e., silver-haired bat/big brown bat, high frequency bat, low frequency bat, Myotis sp.). Use of the AnaBat II Bat Detector helps provide information on species that typically would not be captured by mist netting, especially bats that forage high up in the forest canopy (British Columbia Ministry of Environment, Lands and Parks 1998). The bat detector is able to distinguish between foraging versus navigating activity (i.e., feeding buzzes versus navigation passes), which gives more information regarding bat behaviour at a site. An AnaBat II Bat Detector with CF ZCAIM attachment was set up in the vicinity of the nets each night to compare netting success versus activity levels recorded. Digital recording files were analyzed to determine species and activity levels at each site. To differentiate among species, all sonogram data were visualized; examination of call characteristics was necessary to differentiate similar species using AnaLook version 4.9j (Corben 2004). The minimum frequency and call slope (of the main body of the bat call) were used, along with overall call shape and pattern of calls to determine species categories. A set of criteria established by Patriquin and Barclay (2003) were used for discriminating between background noise and calls.

Bat Survey Results

No bats were captured within the LSA during the 2006 bat survey. At the mist netting locations, bats were observed flying over early in the evening (i.e., immediately after sunset) indicating that while no bats were caught in the net, it is possible that a roost was located near the netting locations.

A total of 22 bats were captured within the LSA during the 2008 bat survey and 4 bats were captured in the Hangingstone area in 2006 (Table A-1). The captures included one northern long-eared bat, nine little brown bats and 15 silver-haired bats. An additional northern long-eared bat was caught; however, due to the timing of capture (close to dawn) it was released immediately before additional data such as weight and forearm length could be recorded. The number of juvenile and adult bats captured is presented in Table A-2. Capture rate was 3.0 bats per night or 0.07 bats per net-hour. Other surveys in the region have found similar results. For the Rio Alto Kirby Project wildlife surveys, capture rates were 0.06 bats per net-hour; however, no northern long-eared bats were captured (Rio Alto 2002). Additional bat surveys conducted in northern Alberta for the Canadian Natural Horizon project had a capture rate of 0.08 bats per net-hour (CNRL 2002).

The 2006 analyses of the AnaBat recordings indicated that several bat species were detected in the area (Table A-3). Several little brown bats were detected at the sites, along with one red bat. Along with these two species, activity was recorded that could potentially be from silver-haired or big brown bats. The recordings of echolocation calls of big brown bats cannot be distinguished from silver-haired bats.

In addition to the bat species captured in 2008, analyses of the AnaBat recordings indicated that eastern red and hoary bats are potentially found in the area (Table A-3). Additional calls that were grouped as silver-haired/big brown were also detected in 2008. Silver-haired bats were captured in the mist nests at several of the sites sampled; however, echolocation calls of either silver-haired or big brown bats were detected at all sites with the AnaBat. Big brown bats were not captured during the survey, and little information is available on the distribution of this species in the region. The majority of low-frequency and silver-haired/big brown bat passes recorded with the AnaBat detector are likely silver-haired bats. The majority of high-frequency bat passes recorded with the AnaBat detector are likely *Myotis* species.

All four bat species listed as Species At Risk (northern long-eared bat, silver-haired bat, eastern red bat and hoary bat) were detected with certainty in the LSA.

Table A-1 Bat Captures Within Each Ecosite Phase

Ecosite Phase	Number of Nets	Little brown	Northern long-eared	Silver-haired
b1	4	---	---	6
c1	2	1	--	--
d1	30	6	---	5
d2	6	2	---	4
h1	4	---	2	---
Total	46	9	2	15

Table A-2 Age and Sex of Bat Species Captured

Species	Adult		Juvenile			
	Female	Male	Female	Male	Unknown	Total
Little Brown Bat	3	3	2	---	1	6
Northern Long-Eared Bat	2	---	---	---		2
Silver-Haired Bat	3	1	3	8		14
Total	8	3	5	8	1	22

Table A-3 Bat Species Detected with Anabat II Detector

Common Name	30-Jul-06	8-Aug-06	17-Aug-06	18-Aug-06	5-Aug-08	6-Aug-08	7-Aug-08	Total
Big Brown or Silver-Haired Bat	3	3	2		117	80	124	329
Eastern Red Bat	---	1		5	9	---	---	15
Hoary Bat	---	---			5	7	10	22
Silver-Haired Bat	---	---			31	4	3	38
Little Brown Bat	4	8		1	8	11	9	41
Myotis Species	---	---			8	10	21	39
Northern-Long Eared Bat	---	---			1	---	4	5
High Frequency	---	3			20	6	9	38
Low Frequency	---	---			1	5	3	9

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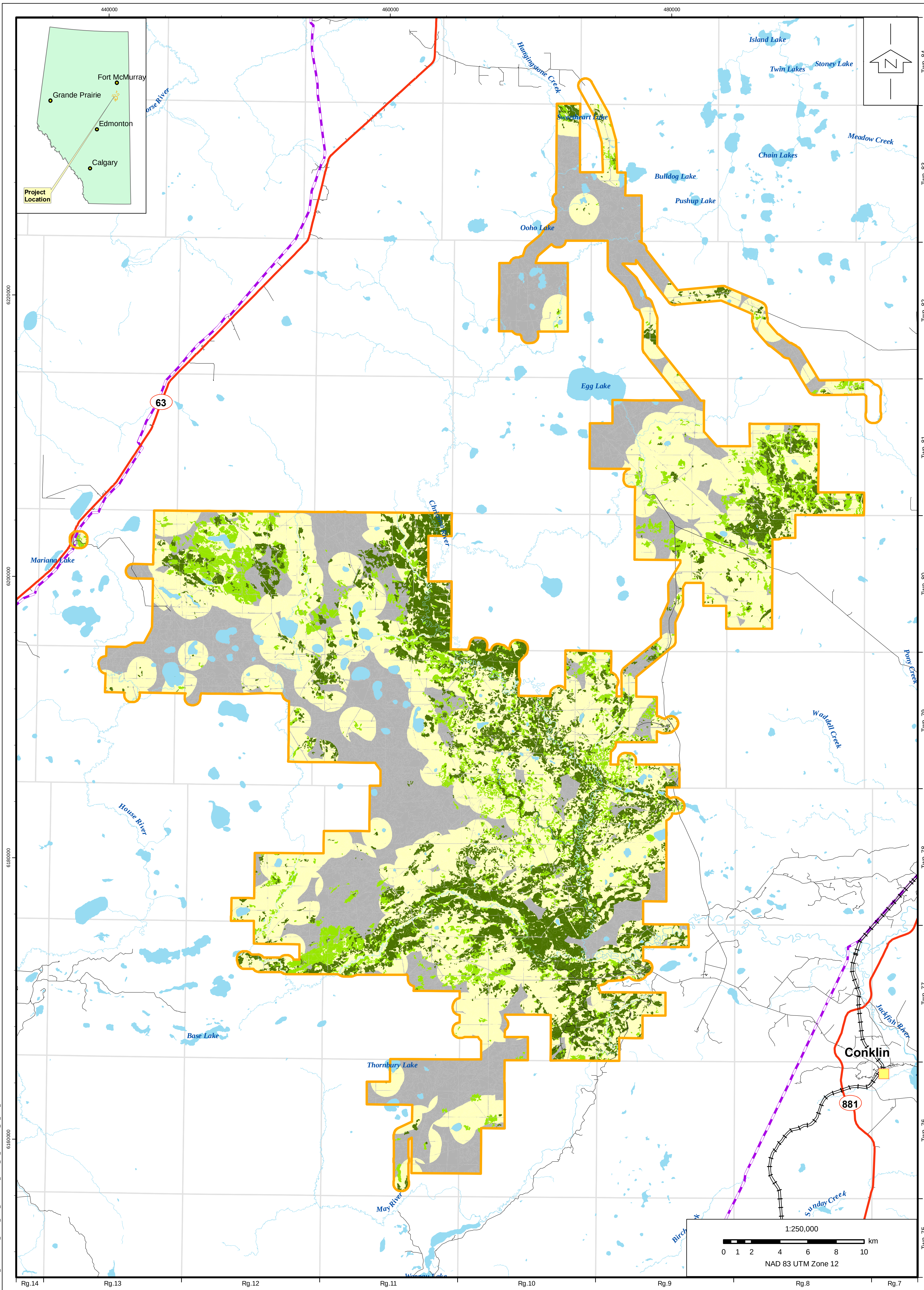
APPENDIX B.

FIGURES OF HABITAT SUITABILITY AT BASELINE, APPLICATION AND CUMULATIVE EFFECTS FOR WILDLIFE INDICATORS



Legend

- StatoilHydro Wildlife LSA
- City/Town
- Waterbody
- Watercourse
- Major Road
- Road
- Powerline
- Railway

Habitat Suitability

- High
- Moderate
- Low
- Unsuitable

Title:

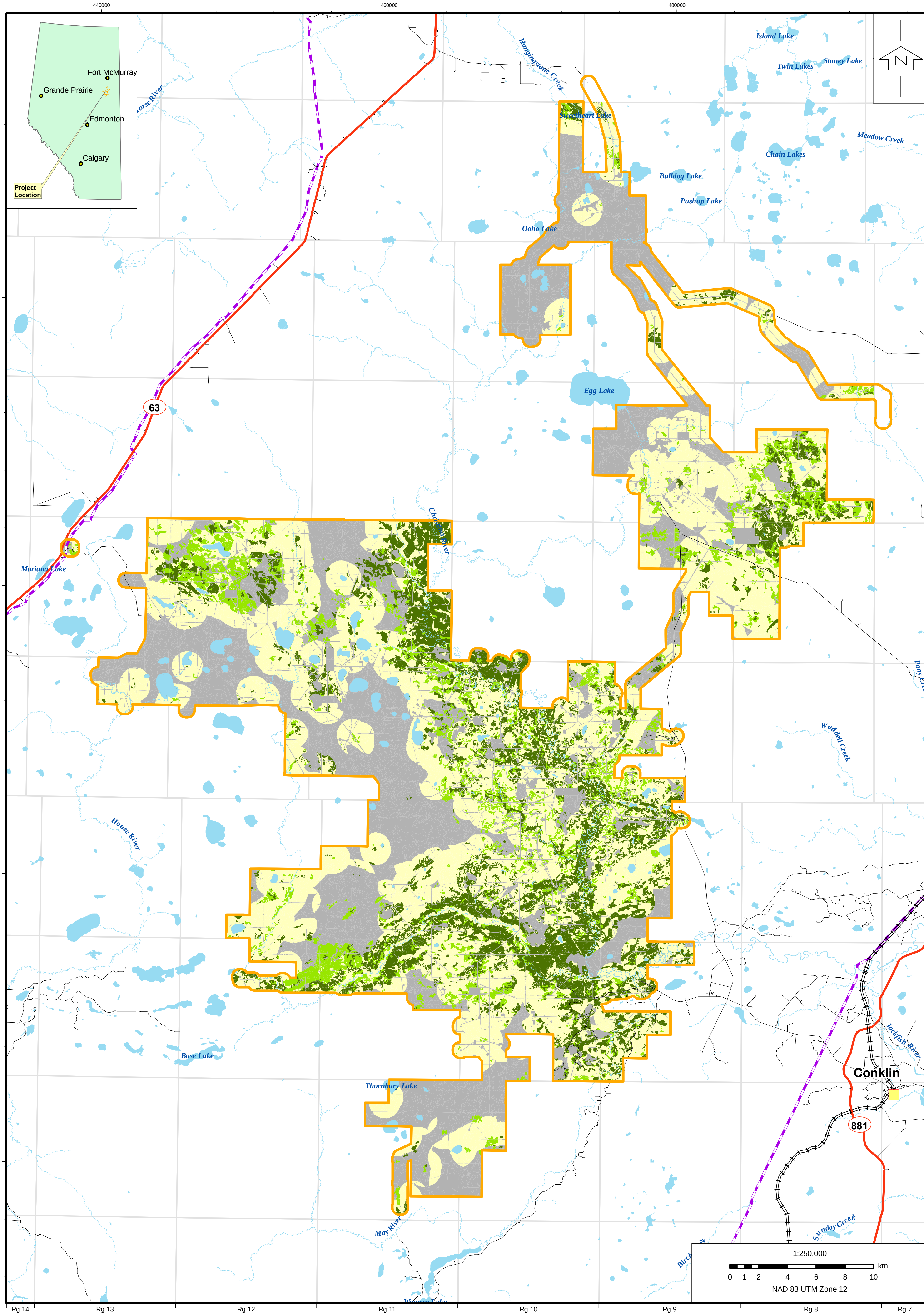
FIGURE B-1

HABITAT SUITABILITY FOR CANADIAN TOAD AT BASELINE IN THE LSA

StatoilHydro

Approved: RL	Revision Date: March 21, 2009
File: FIGURE_B-1_HABITAT_SUITABILITY_INDEX_FOR_CANADIAN_TOAD_AT_BASELINE_IN_THE_LSA.mxd	
Drawn by: RF	Checked: MM

I:4455_514\MAPS\FIGURES\011_WILDLIFE\FIGURE_B-1_HABITAT_SUITABILITY_INDEX_FOR_CANADIAN_TOAD_AT_BASELINE_IN_THE_LSA.mxd



Legend

- StatoilHydro Wildlife LSA
- City/Town
- Waterbody
- Watercourse
- Major Road
- Road
- Powerline
- Railway

Habitat Suitability

- High
- Moderate
- Low
- Unsuitable

Title:

FIGURE B-2

HABITAT SUITABILITY FOR CANADIAN TOAD AT APPLICATION IN THE LSA

StatoilHydro

Approved: RL	Revision Date: March 21, 2009
File: FIGURE_B-2_HABITAT_SUITABILITY_INDEX_FOR_CANADIAN_TOAD_AT_APPLICATION_IN_THE_LSA.mxd	
Drawn by: RF	Checked: MM

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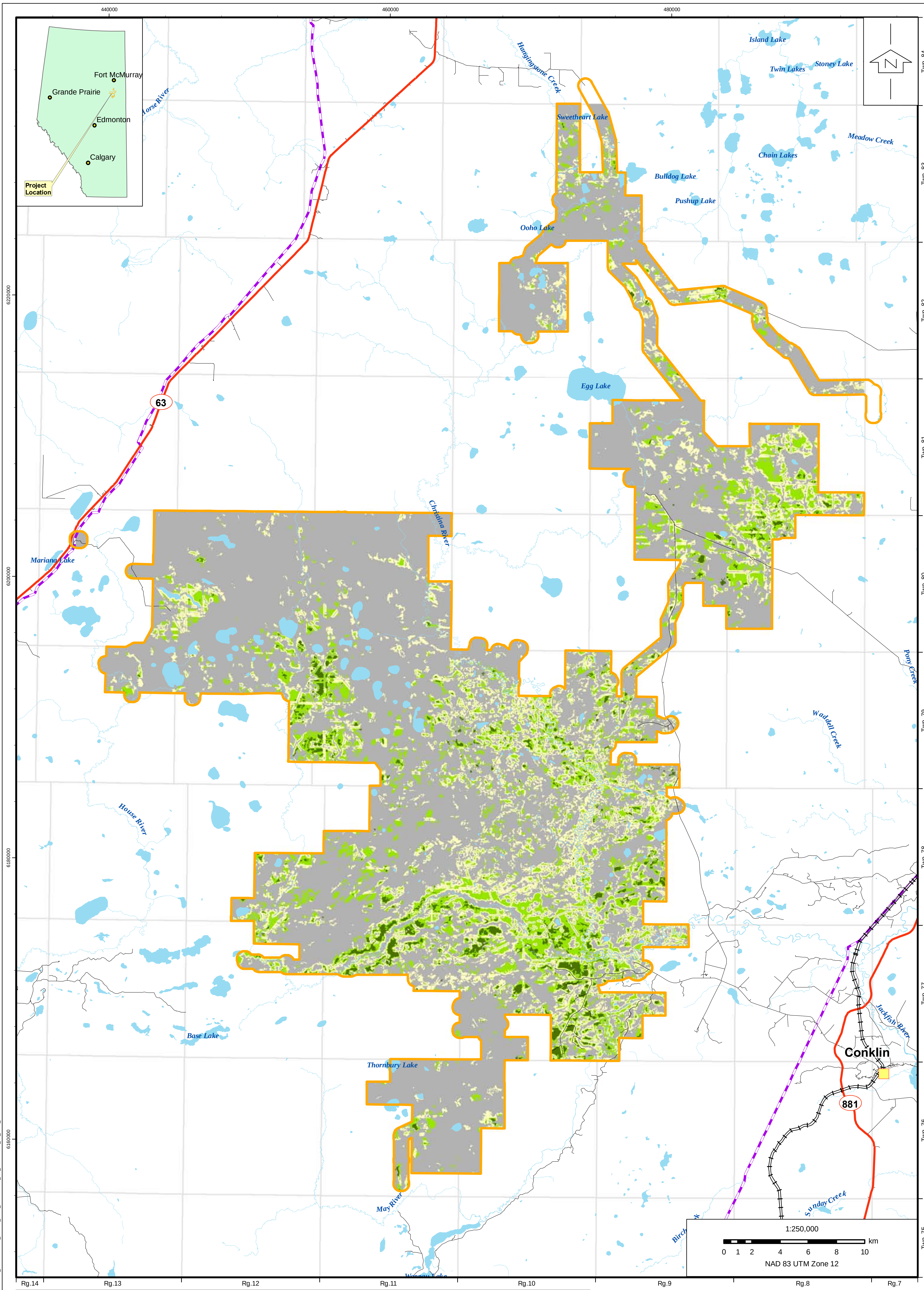


Legend

- StatoilHydro Wildlife LSA
- City/Town
- Waterbody
- Watercourse
- Major Road
- Road
- Powerline
- Railway

Habitat Suitability

- High
- Moderate
- Low
- Unsuitable

Title:

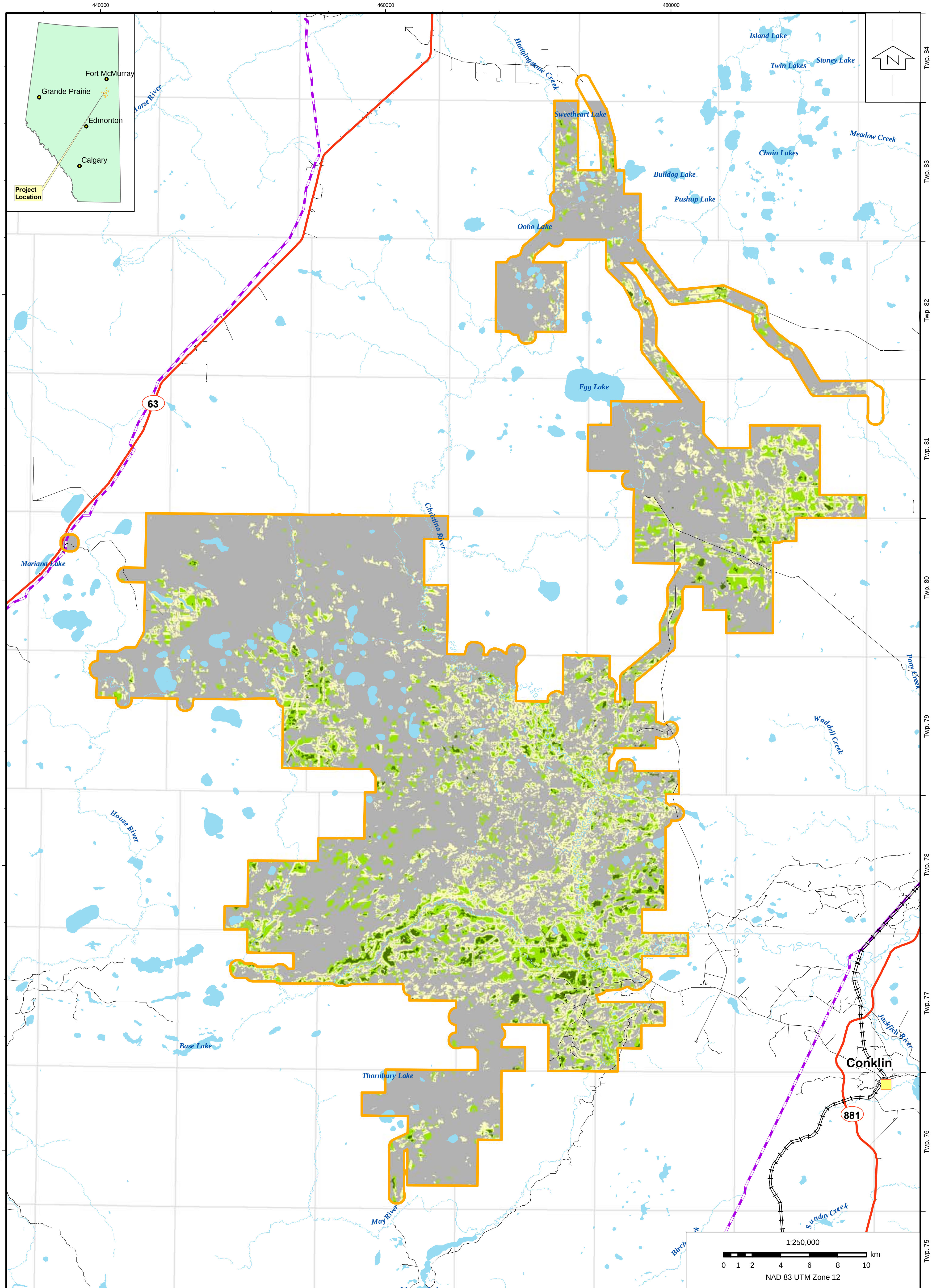
FIGURE B-3

HABITAT SUITABILITY FOR NORTHERN GOSHAWK AT BASELINE IN THE LSA

StatoilHydro

Approved: RL	Revision Date: March 21, 2009
File: FIGURE_B-3_HABITAT_SUITABILITY_INDEX_FOR_GOSHAWK_AT_BASELINE_IN_THE_LSA.mxd	
Drawn by: RF	Checked: MM

I:\4455_514\MAPS\FIGURES\011_WILDLIFE\FIGURE_B-3_HABITAT_SUITABILITY_INDEX_FOR_GOSHAWK_AT_BASELINE_IN_THE_LSA.mxd



Legend

- StatoilHydro Wildlife LSA
- City/Town
- Waterbody
- Watercourse
- Major Road
- Road
- Powerline
- Railway

Habitat Suitability

- High
- Moderate
- Low
- Unsuitable

Title:

FIGURE B-4

HABITAT SUITABILITY FOR NORTHERN GOSHAWK AT APPLICATION IN THE LSA

StatoilHydro

Approved: RL	Revision Date: March 21, 2009
File: FIGURE_B-4_HABITAT_SUITABILITY_INDEX_FOR_GOSHAWK_AT_APPLICATION_IN_THE_LSA.mxd	
Drawn by: RF	Checked: MM

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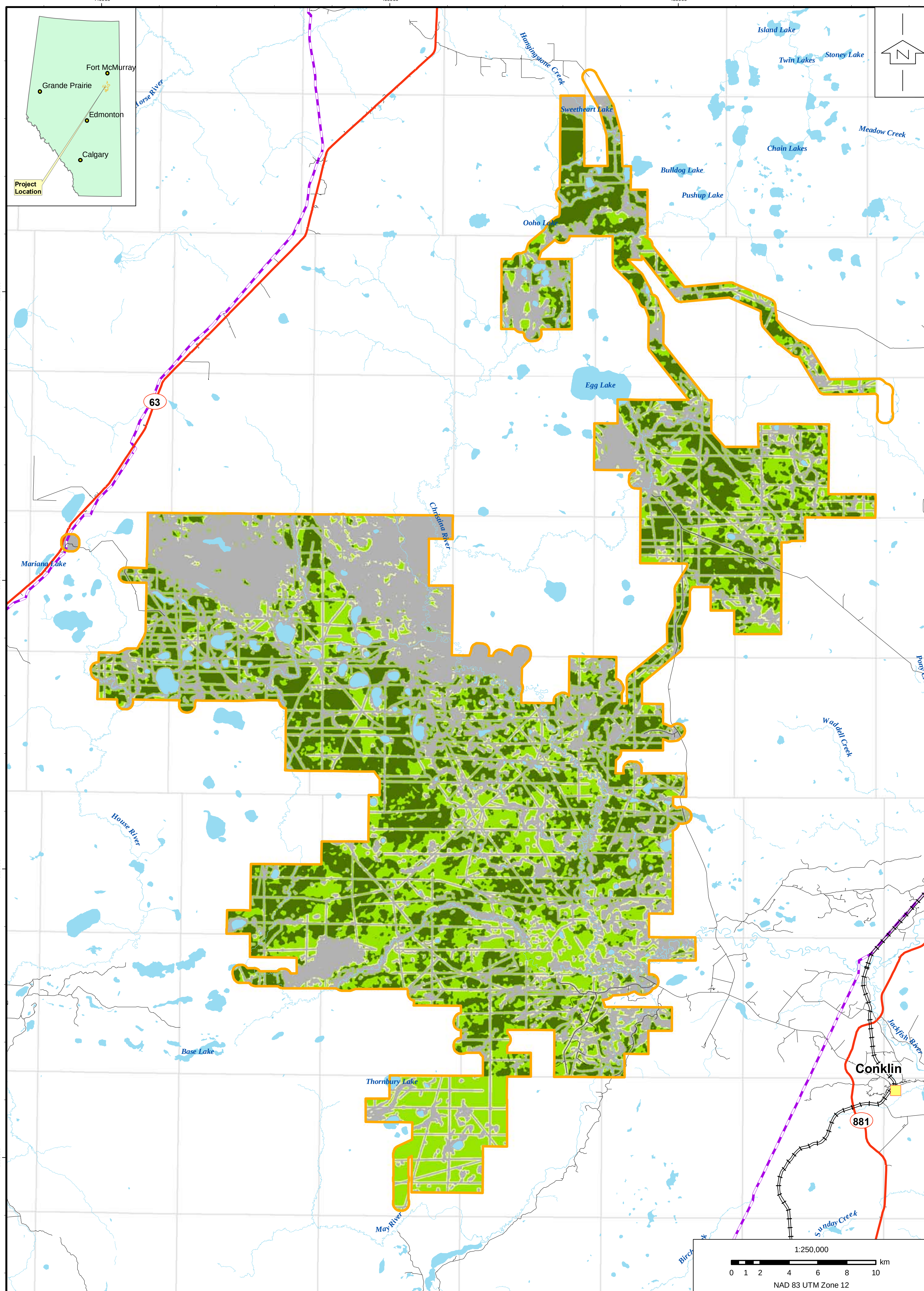

Legend

- StatoilHydro Wildlife LSA
- City/Town
- Waterbody
- Watercourse
- Major Road
- Road
- Powerline
- Railway

Habitat Suitability

- High
- Moderate
- Low
- Unsuitable

Title:

FIGURE B-5

HABITAT SUITABILITY FOR BARRED OWL AT BASELINE IN THE LSA

StatoilHydro

Approved: RL	Revision Date: March 21, 2009
File: FIGURE_B-5_RESOURCE_SELECTION_FUNCTION_FOR_BARRED_OWL_AT_BASELINE_IN_THE_LSA.mxd	
Drawn by: RF	Checked: MM

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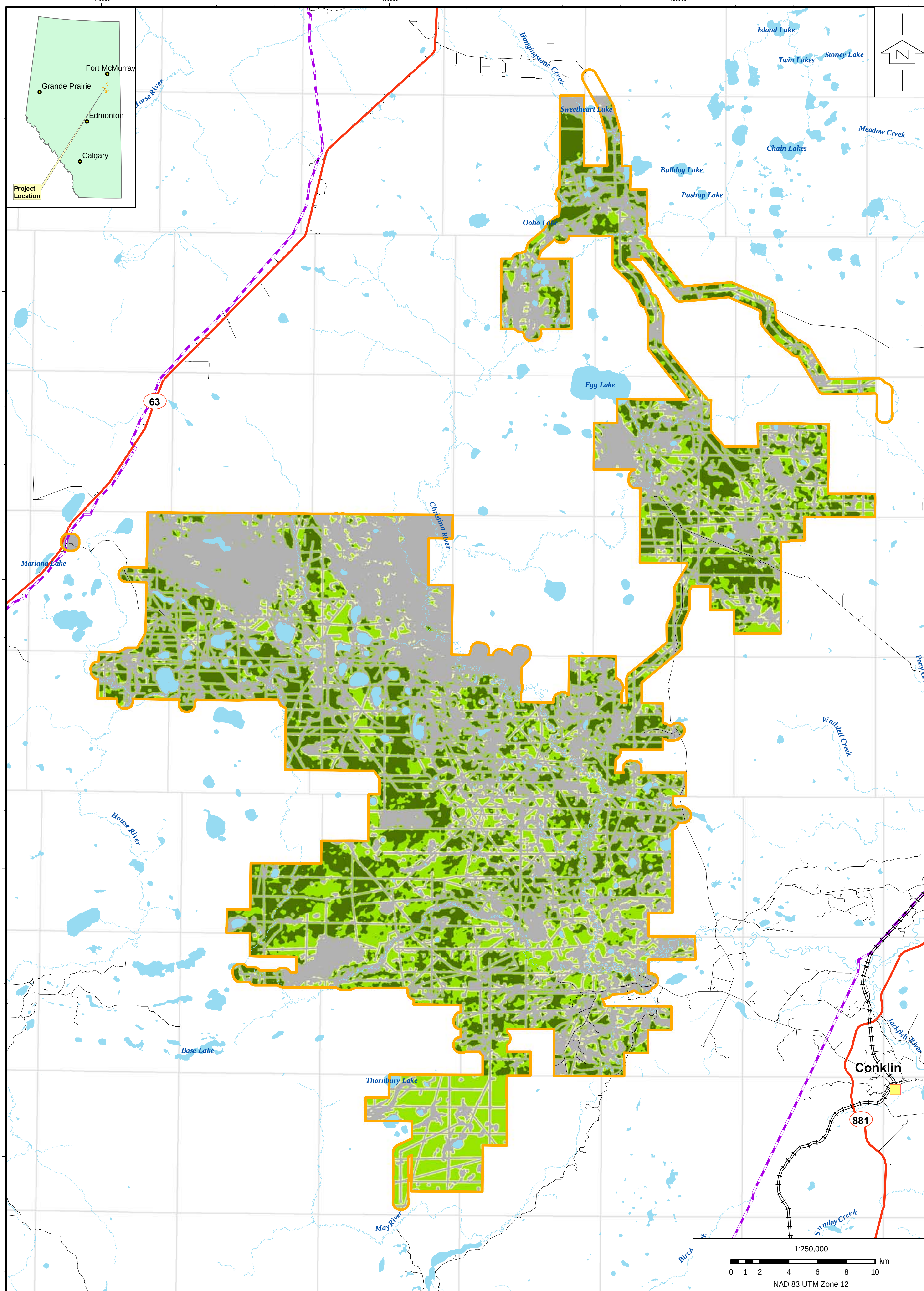

Legend

- StatoilHydro Wildlife LSA
- City/Town
- Waterbody
- Watercourse
- Major Road
- Road
- Powerline
- Railway

Habitat Suitability

- High
- Moderate
- Low
- Unsuitable

Title:

FIGURE B-6

HABITAT SUITABILITY FOR BARRED OWL AT APPLICATION IN THE LSA

StatoilHydro

Approved: RL	Revision Date: March 21, 2009
File: FIGURE_B-6_RESOURCE_SELECTION_FUNCTION_FOR_BARRED_OWL_AT_APPLICATION_IN_THE_LSA.mxd	
Drawn by: RF	Checked: MM

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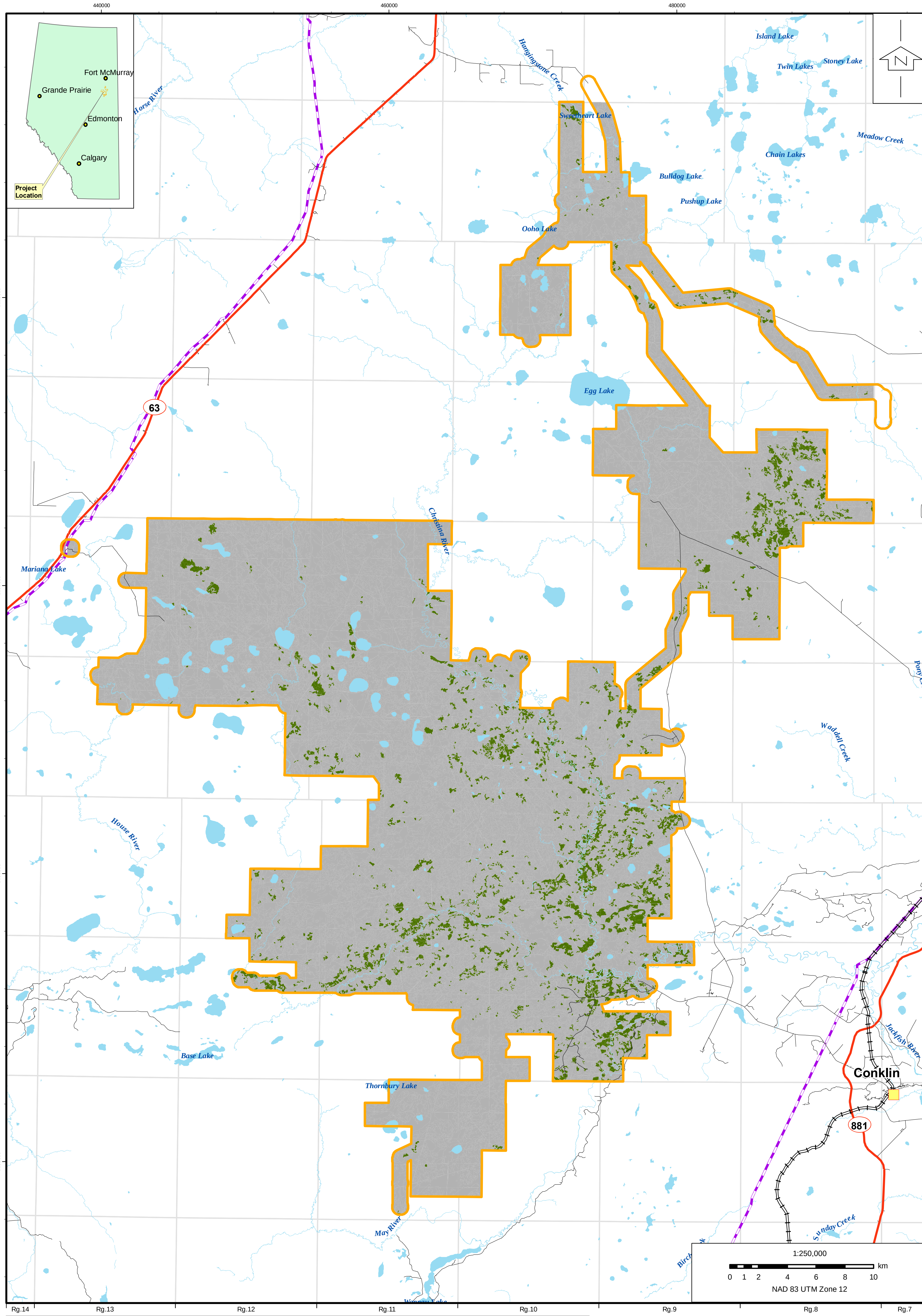


Legend

- StatoilHydro Wildlife LSA
- City/Town
- Waterbody
- Watercourse
- Major Road
- Road
- Powerline
- Railway

Habitat Suitability

- High
- Unsuitable

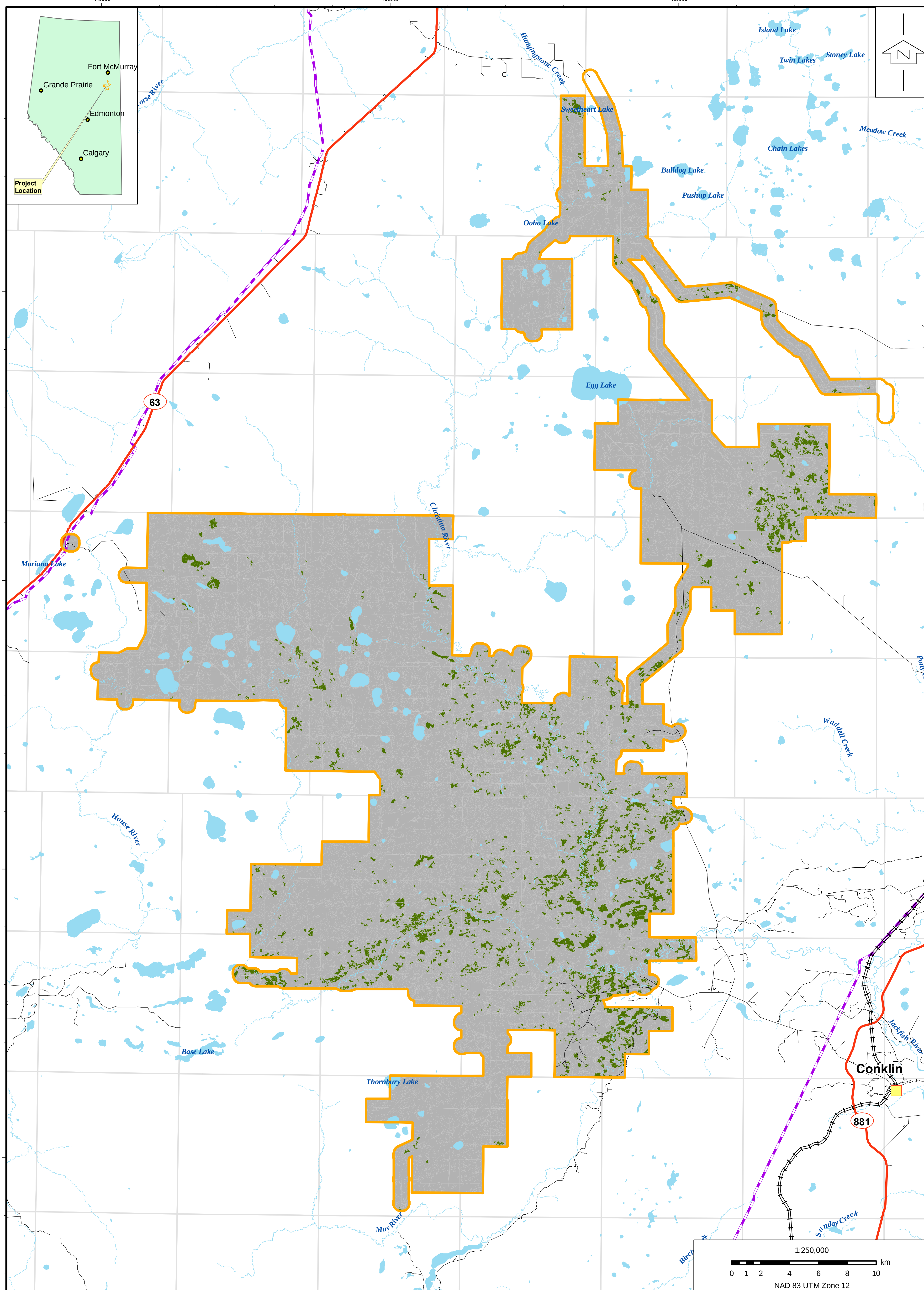
Title:

FIGURE B-7

HABITAT SUITABILITY FOR MIXEDWOOD FOREST BIRD COMMUNITY AT BASELINE IN THE LSA

StatoilHydro

Approved: RL	Revision Date: March 21, 2009
File: FIGURE_B-7_HABITAT_SUITABILITY_INDEX_FOR_MIXEDWOOD_FOREST_BIRD_COMMUNITY_AT_BASELINE_IN_THE_LSA.mxd	
Drawn by: RF	Checked: MM



Legend

- StatoilHydro Wildlife LSA
- City/Town
- Waterbody
- Watercourse
- Major Road
- Road
- Powerline
- Railway

Habitat Suitability

- High
- Unsuitable

Title:

FIGURE B-8

HABITAT SUITABILITY FOR MIXEDWOOD FOREST BIRD COMMUNITY AT APPLICATION IN THE LSA

StatoilHydro

Approved: RL	Revision Date: March 21, 2009
File: FIGURE_B-8_HABITAT_SUITABILITY_INDEX_FOR_MIXEDWOOD _FOREST_BIRD_COMMUNITY_AT_APPLICATION_IN_THE_LSA.mxd	
Drawn by: RF	Checked: MM

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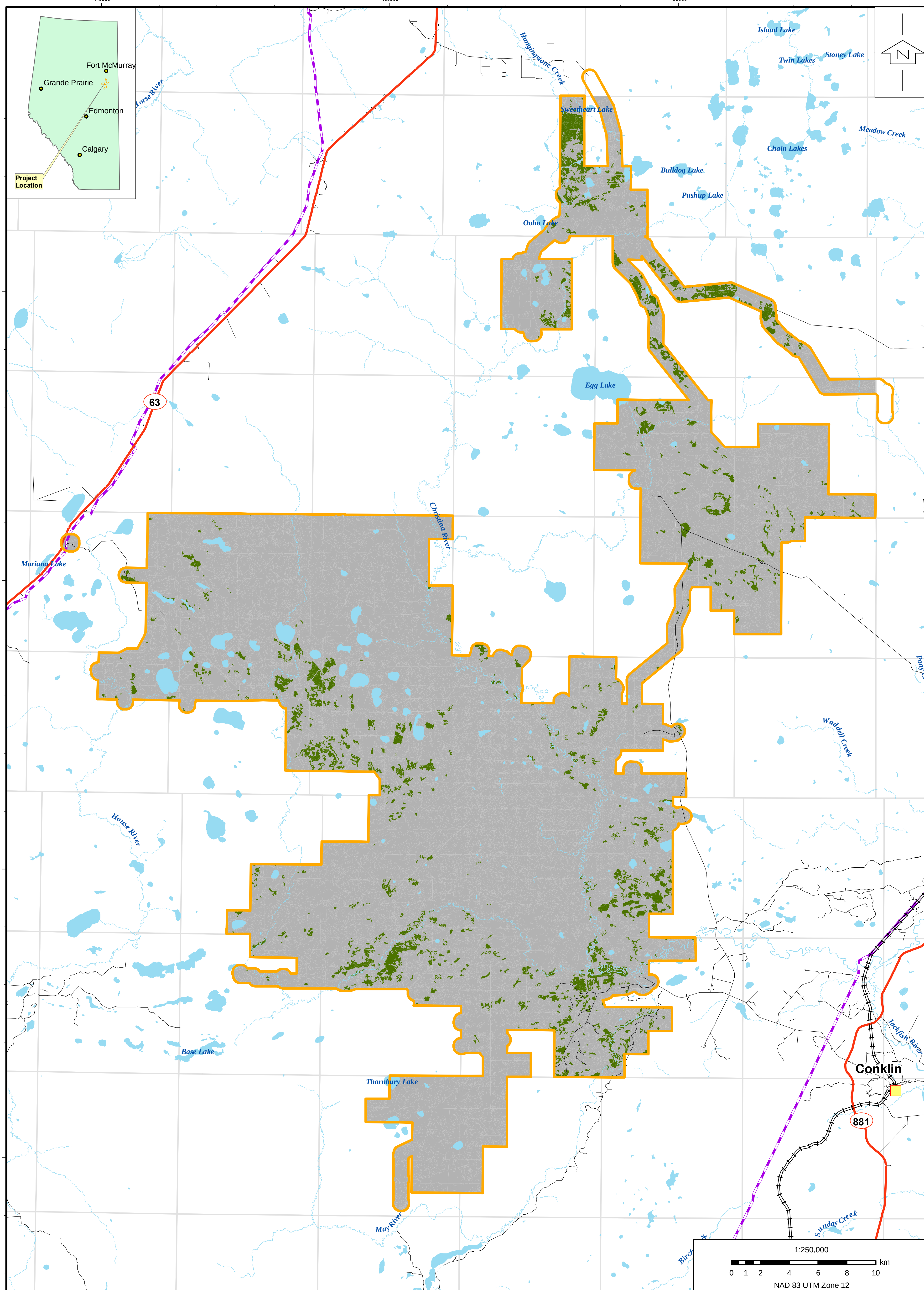

Legend

- StatoilHydro Wildlife LSA
- City/Town
- Waterbody
- Watercourse
- Major Road
- Road
- Powerline
- Railway

Habitat Suitability

- High
- Unsuitable

Title:

FIGURE B-9

HABITAT SUITABILITY FOR OLD GROWTH FOREST BIRD COMMUNITY AT BASELINE IN THE LSA

StatoilHydro

Approved: RL	Revision Date: March 21, 2009
File: FIGURE_B-9_HABITAT_SUITABILITY_INDEX_FOR_OLDGROWTH_FOREST_BIRD_COMMUNITY_AT_BASELINE_IN_THE_LSA.mxd	
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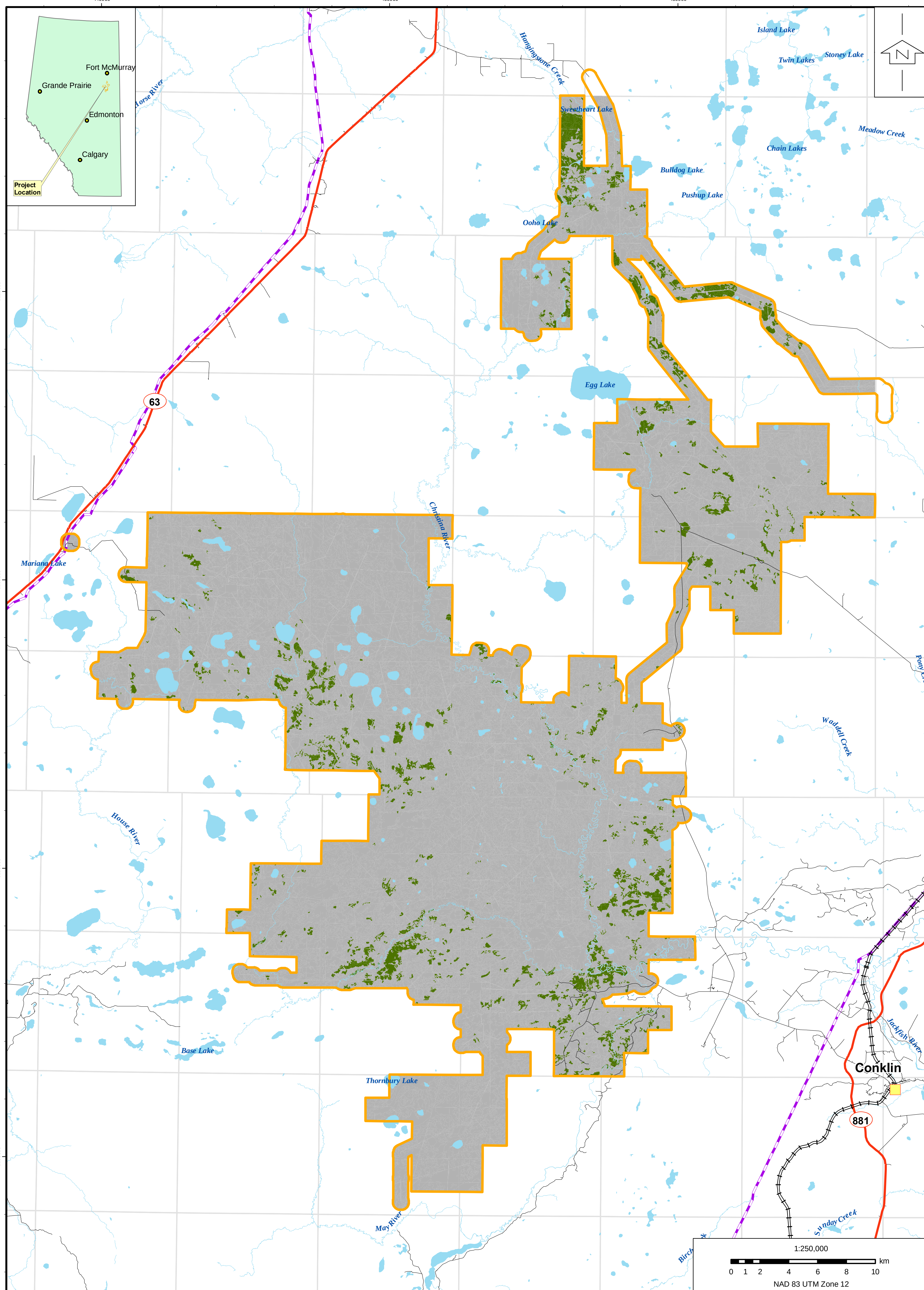

Legend

- StatoilHydro Wildlife LSA
- City/Town
- Waterbody
- Watercourse
- Major Road
- Road
- Powerline
- Railway

Habitat Suitability

- High
- Unsuitable

Title:

FIGURE B-10

HABITAT SUITABILITY FOR OLD GROWTH FOREST BIRD COMMUNITY AT APPLICATION IN THE LSA

StatoilHydro

Approved:	Revision Date:
RL	March 21, 2009

File: FIGURE_B-10_HABITAT_SUITABILITY_INDEX_FOR_OLDGROWTH_FOREST_BIRD_COMMUNITY_AT_APPLICATION_IN_THE_LSA.mxd

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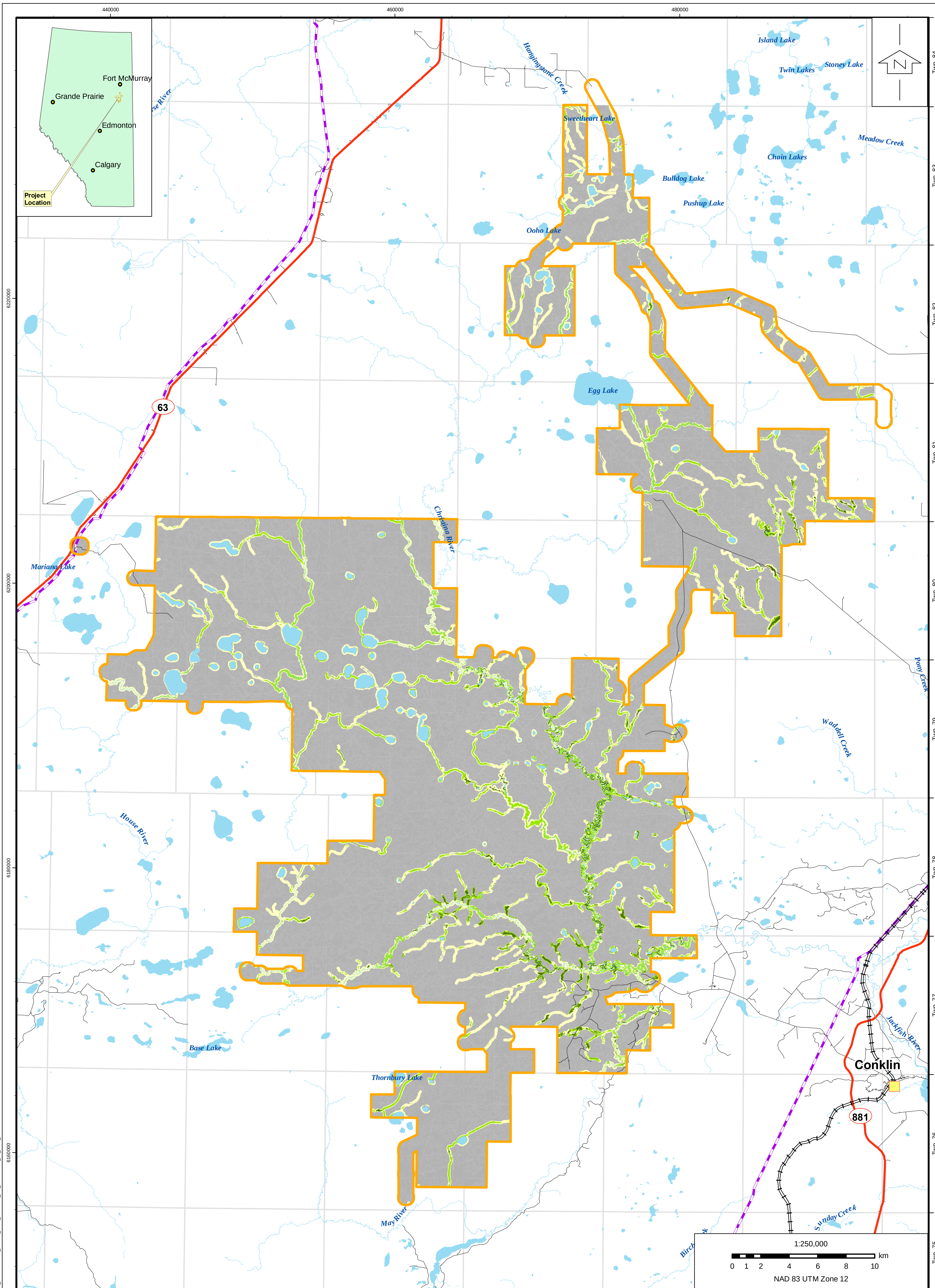

Legend

- StatoilHydro Wildlife LSA
- City/Town
- Waterbody
- Watercourse
- Major Road
- Road
- Powerline
- Railway

Habitat Suitability

- High
- Moderate
- Low
- Unsuitable

Title:

FIGURE B-11

HABITAT SUITABILITY FOR BEAVER AT BASELINE IN THE LSA

StatoilHydro

Approved: RL	Revision Date: March 21, 2009
File: FIGURE_B-11_HABITAT_SUITABILITY_INDEX_FOR_BEAVER_AT_BASELINE_IN_THE_LSA.mxd	
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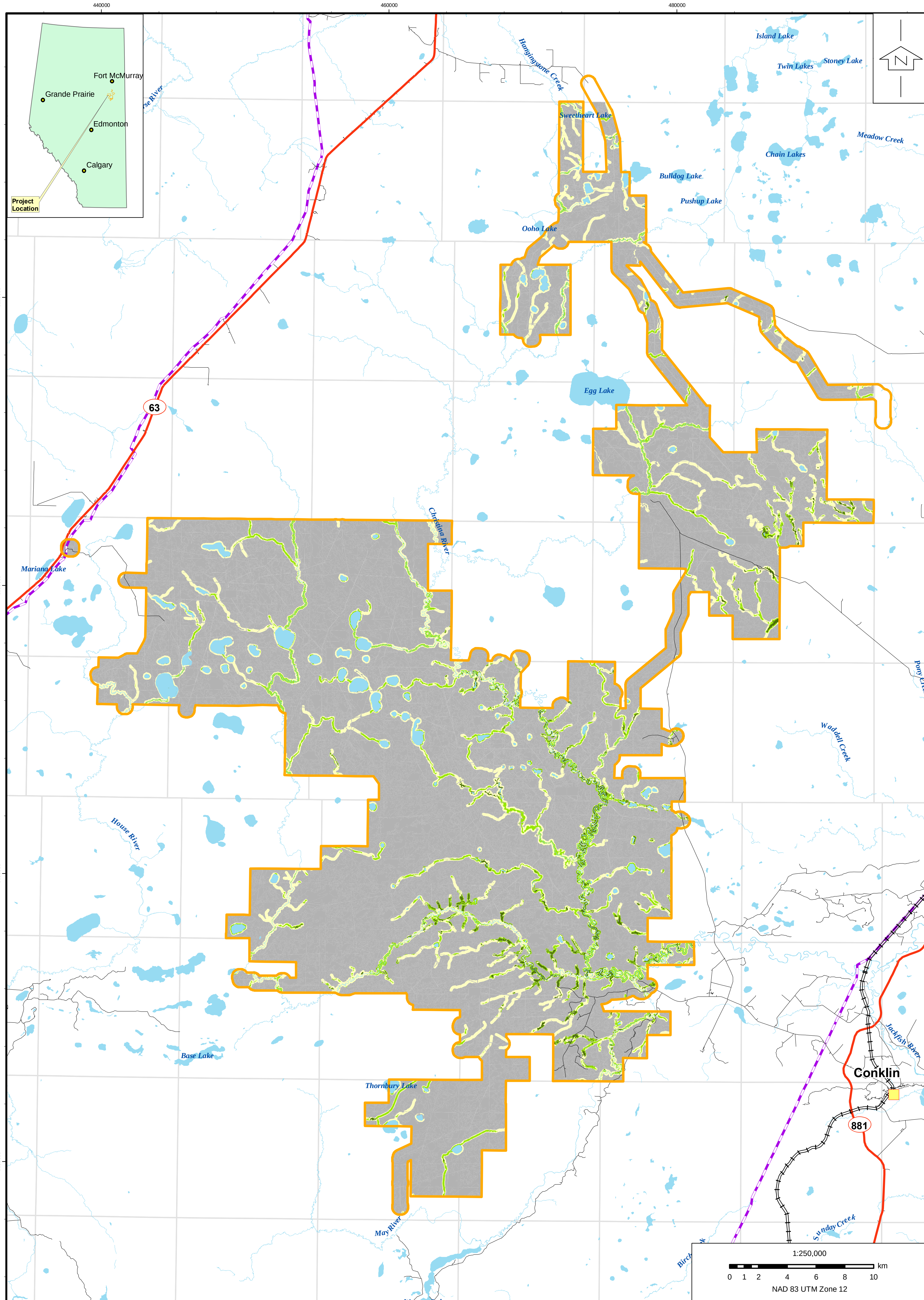

Legend

- StatoilHydro Wildlife LSA
- City/Town
- Waterbody
- Watercourse
- Major Road
- Road
- Powerline
- Railway

Habitat Suitability

- High
- Moderate
- Low
- Unsuitable

Title:

FIGURE B-12

HABITAT SUITABILITY FOR BEAVER AT APPLICATION IN THE LSA

StatoilHydro

Approved: RL	Revision Date: March 21, 2009
File: FIGURE_B-12_HABITAT_SUITABILITY_INDEX_FOR_BEAVER_AT_APPLICATION_IN_THE_LSA.mxd	
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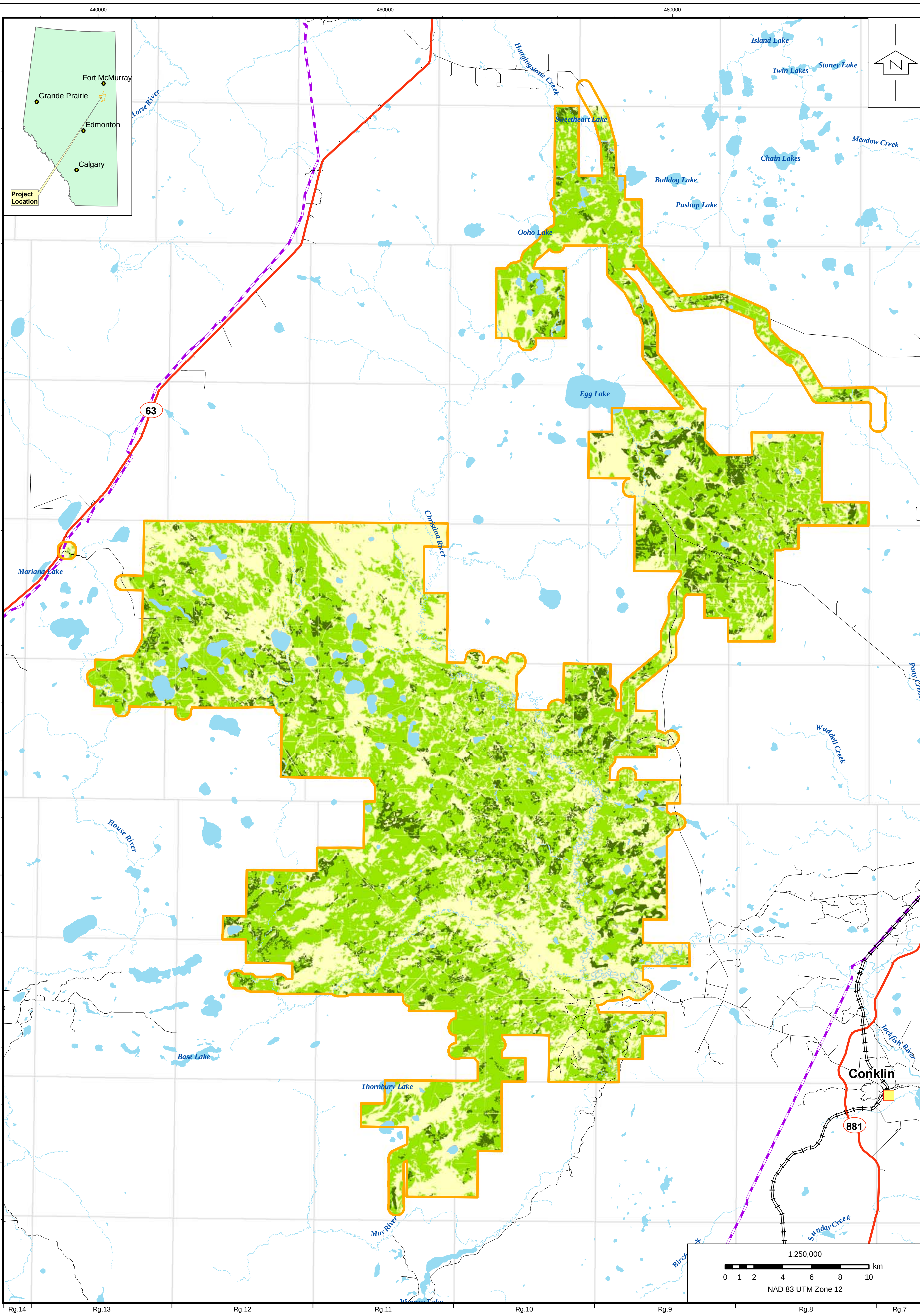

Legend

- StatoilHydro Wildlife LSA
- City/Town
- Waterbody
- Watercourse
- Major Road
- Road
- Powerline
- Railway

Habitat Suitability

- High
- Moderate
- Low
- Unsuitable

Title:

FIGURE B-13

HABITAT SUITABILITY FOR LYNX AT BASELINE IN THE LSA

StatoilHydro

Approved: RL	Revision Date: March 21, 2009
File: FIGURE_B-13_HABITAT_SUITABILITY_INDEX_FOR_LYNX_AT_BASELINE_IN_THE_LSA.mxd	
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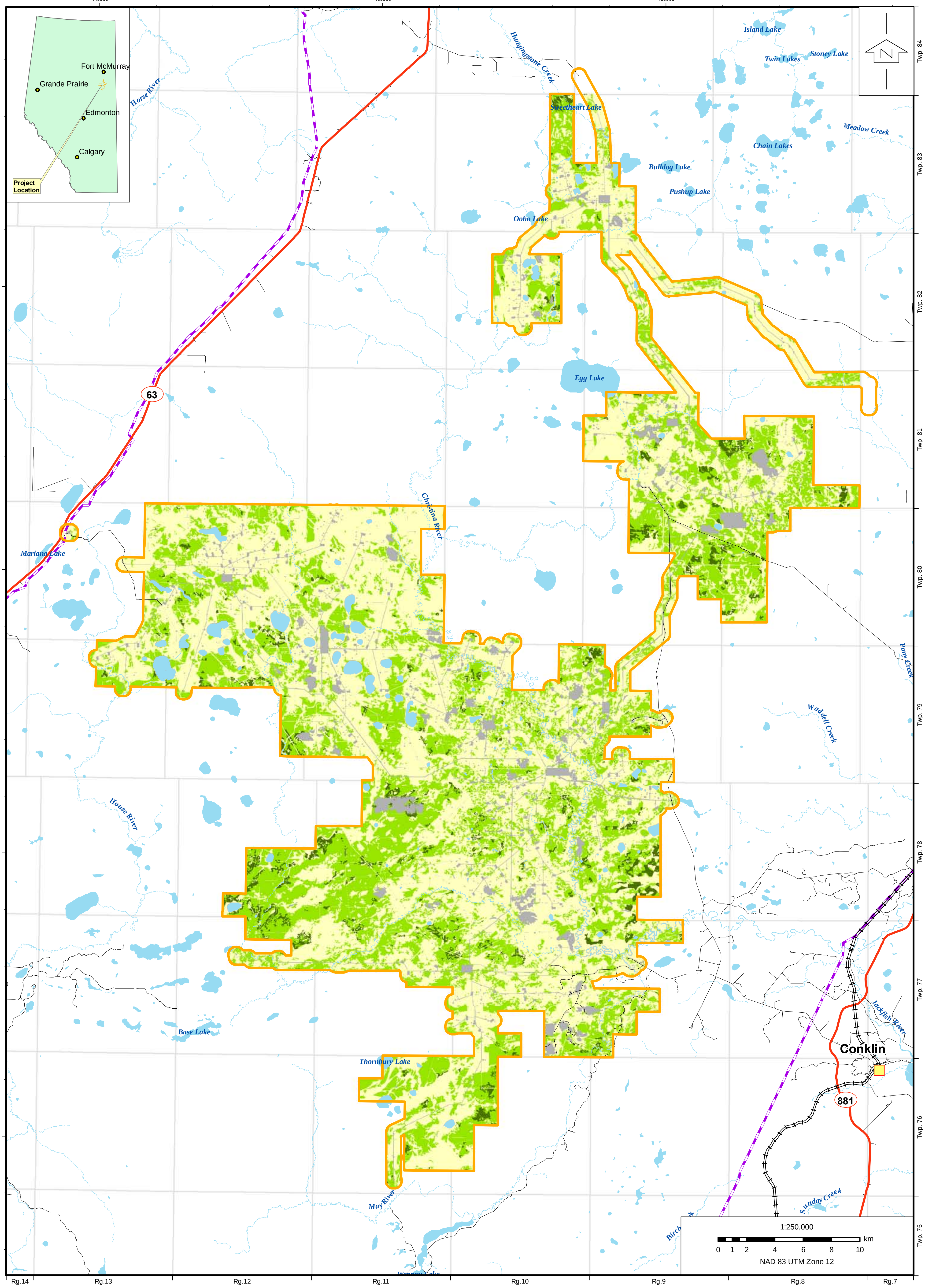

Legend

- StatoilHydro Wildlife LSA
- City/Town
- Waterbody
- Watercourse
- Major Road
- Road
- Powerline
- Railway

Habitat Suitability

- High
- Moderate
- Low
- Unsuitable

Title:

FIGURE B-14

HABITAT SUITABILITY FOR LYNX AT APPLICATION IN THE LSA

StatoilHydro

Approved: RL	Revision Date: March 21, 2009
File: FIGURE_B-14_HABITAT_SUITABILITY_INDEX_FOR_LYNX_AT_APPLICATION_IN_THE_LSA.mxd	
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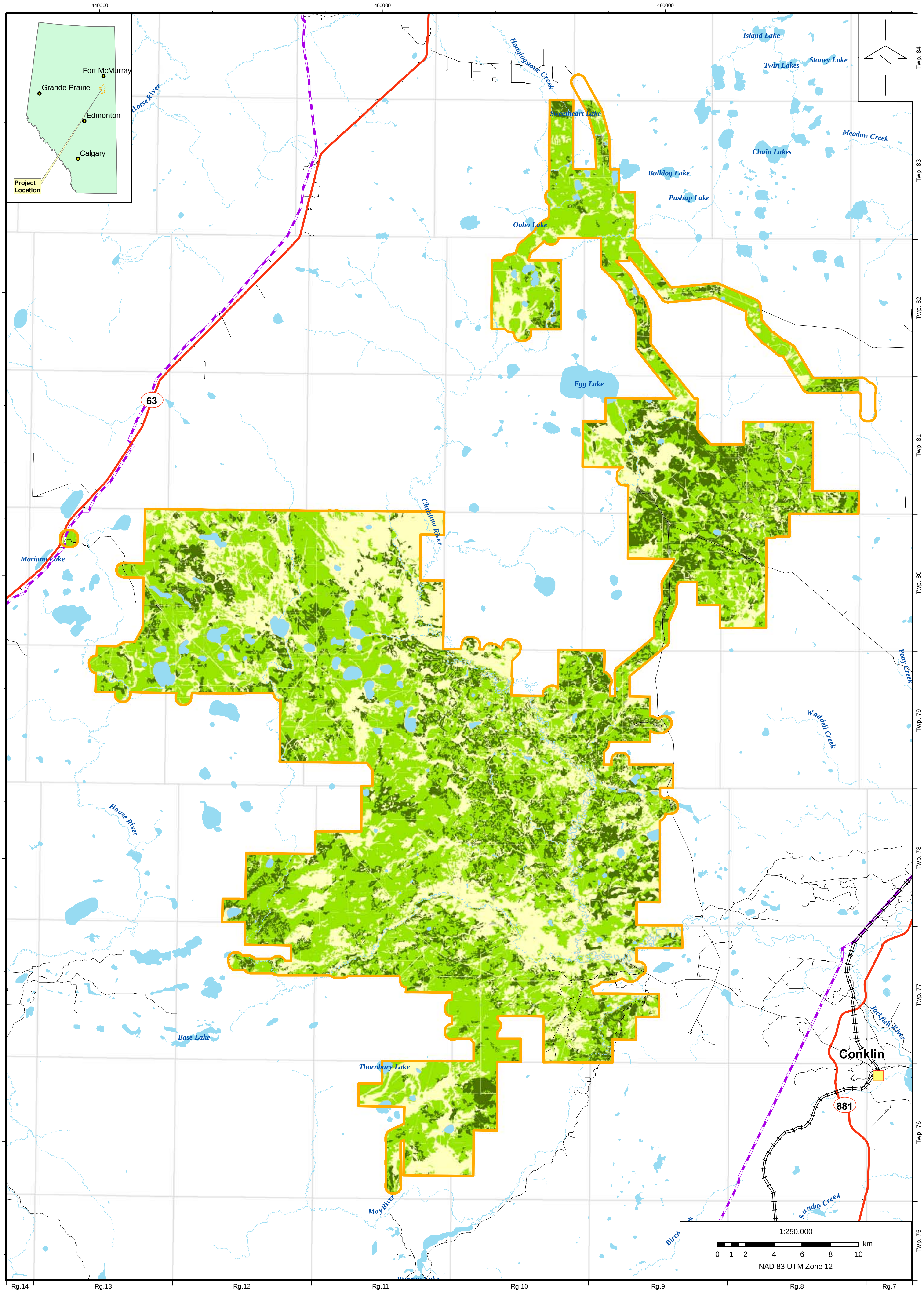

Legend

- StatoilHydro Wildlife LSA
- City/Town
- Waterbody
- Watercourse
- Major Road
- Road
- Powerline
- Railway

Habitat Suitability

- High
- Moderate
- Low
- Unsuitable

Title:

FIGURE B-15

HABITAT SUITABILITY FOR SNOWSHOE HARE AT BASELINE IN THE LSA

StatoilHydro

Approved: RL	Revision Date: March 21, 2009
File: FIGURE_B-15_RESOURCE_SELECTION_FUNCTION_FOR_SNOWSHOE_HARE_AT_BASELINE_IN_THE_LSA.mxd	
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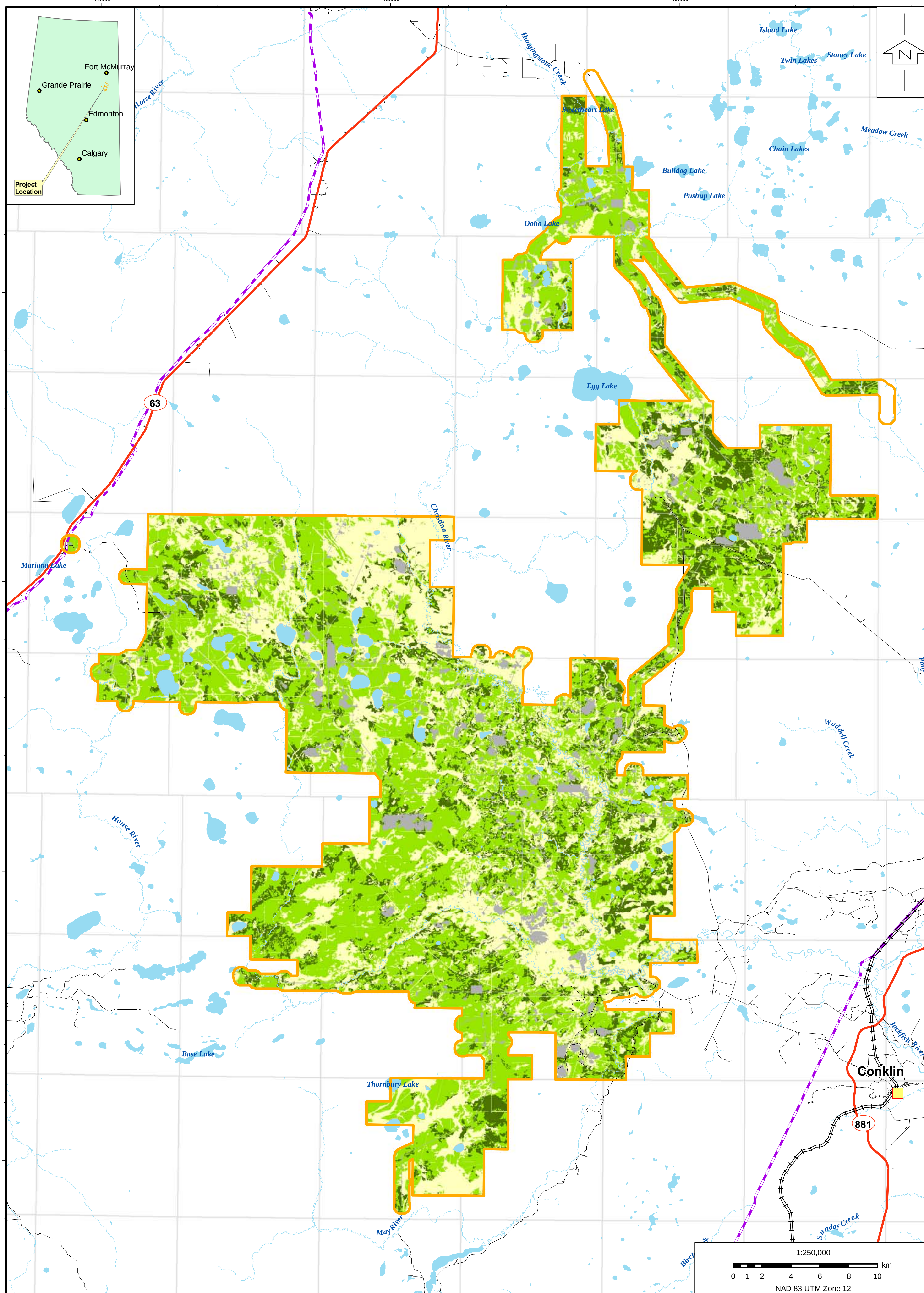

Legend

- StatoilHydro Wildlife LSA
- City/Town
- Waterbody
- Watercourse
- Major Road
- Road
- Powerline
- Railway

Habitat Suitability

- High
- Moderate
- Low
- Unsuitable

Title:

FIGURE B-16

HABITAT SUITABILITY FOR SNOWSHOE HARE AT APPLICATION IN THE LSA

StatoilHydro

Approved: RL	Revision Date: March 21, 2009
File: FIGURE_B-16_RESOURCE_SELECTION_FUNCTION_FOR_SNOWSHOE_HARE_AT_APPLICATION_IN_THE_LSA.mxd	
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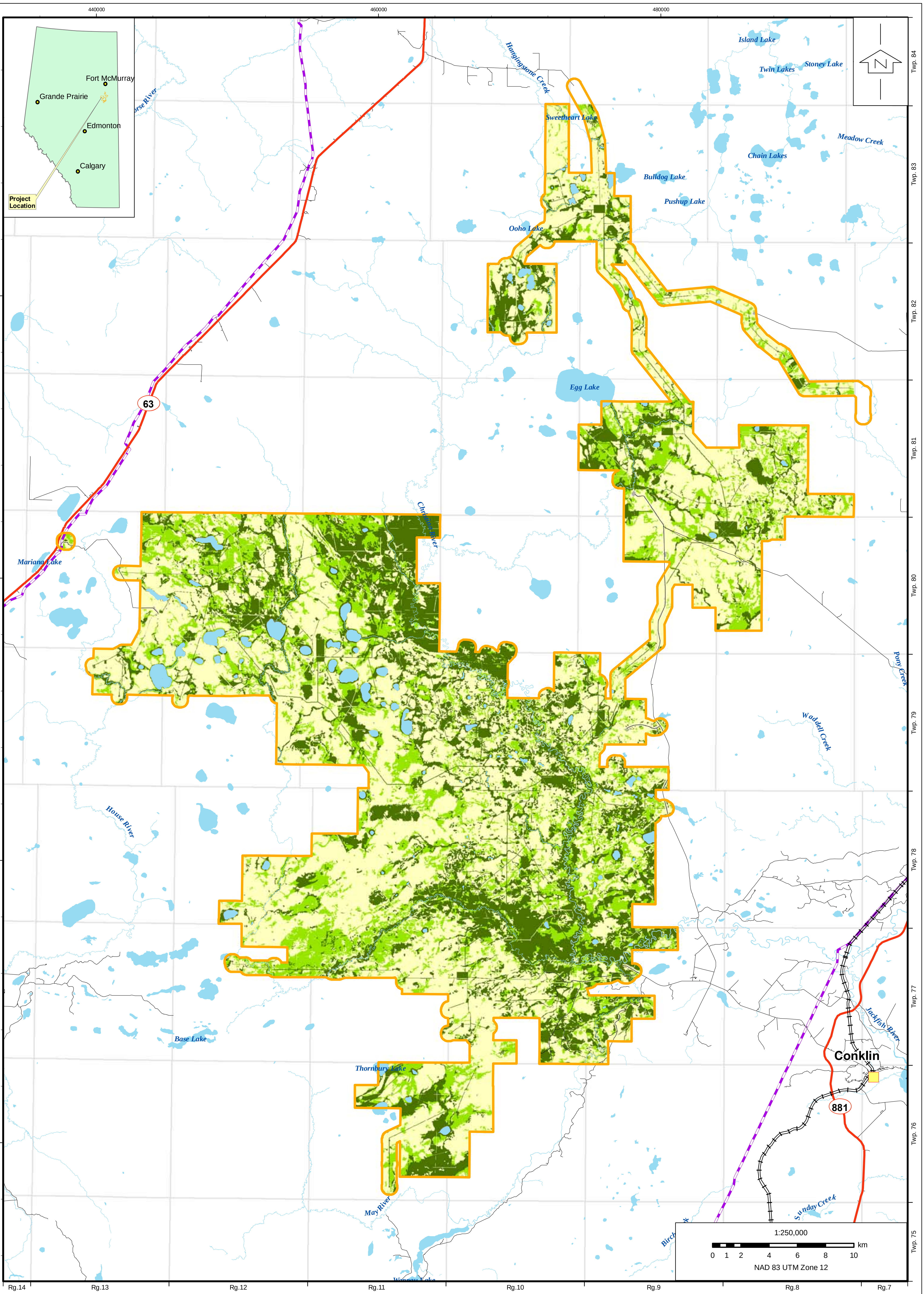

Legend

- StatoilHydro Wildlife LSA
- City/Town
- Waterbody
- Watercourse
- Major Road
- Road
- Powerline
- Railway

Habitat Suitability

- High
- Moderate
- Low
- Unsuitable

Title:

FIGURE B-17

HABITAT SUITABILITY FOR MOOSE AT BASELINE IN THE LSA

StatoilHydro

Approved: RL	Revision Date: March 21, 2009
File: FIGURE_B-17_RESOURCE_SELECTION_PROBABILITY_FUNCTION_FOR_MOOSE_AT_BASELINE_IN_THE_LSA.mxd	
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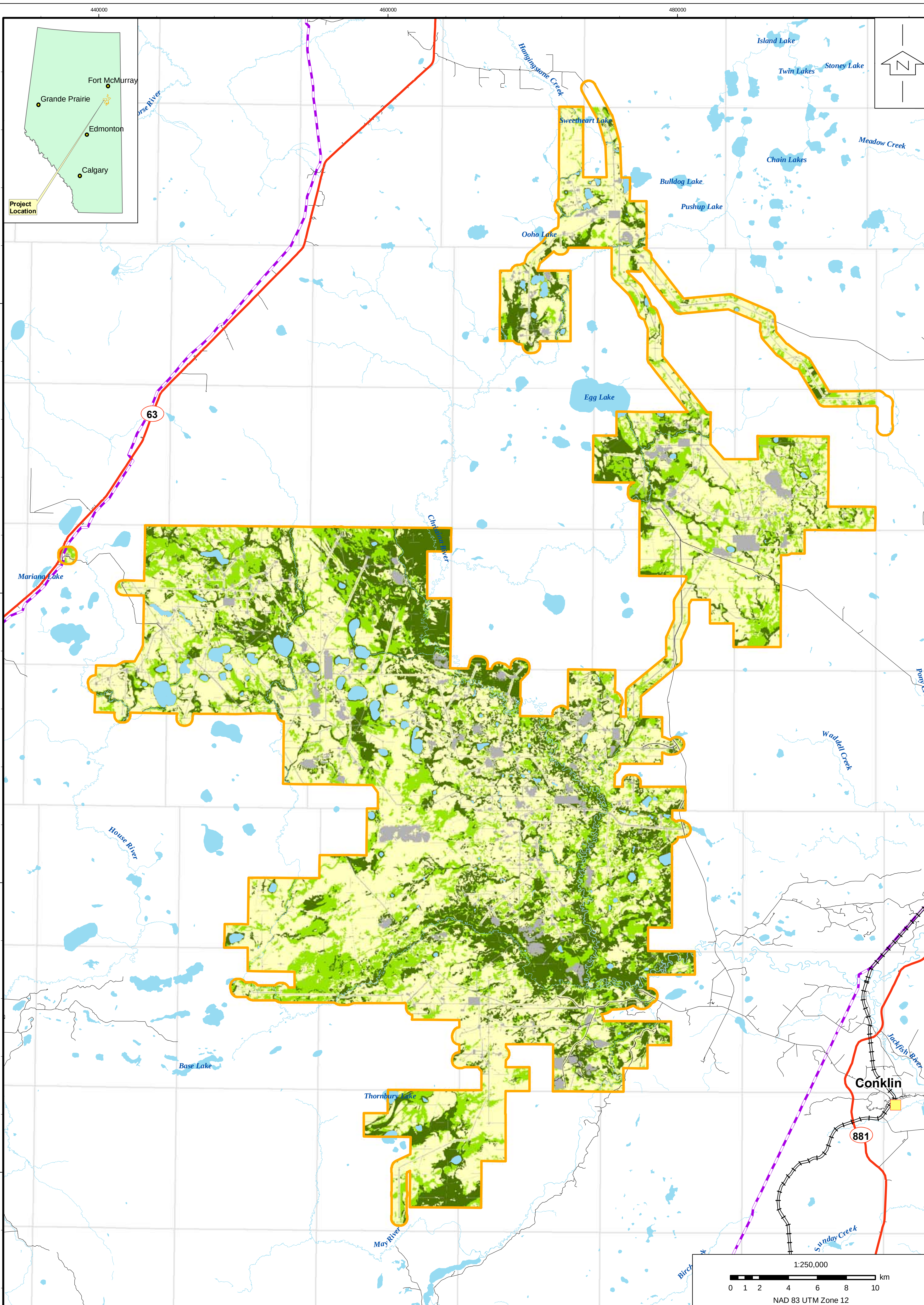

Legend

- StatoilHydro Wildlife LSA
- City/Town
- Waterbody
- Watercourse
- Major Road
- Road
- Powerline
- Railway

Habitat Suitability

- High
- Moderate
- Low
- Unsuitable

Title:

FIGURE B-18

HABITAT SUITABILITY FOR MOOSE AT APPLICATION IN THE LSA

StatoilHydro

Approved: RL	Revision Date: March 21, 2009
File: FIGURE_B-18_RESOURCE_SELECTION_PROBABILITY_FUNCTION_FOR_MOOSE_AT_APPLICATION_IN_THE_LSA.mxd	
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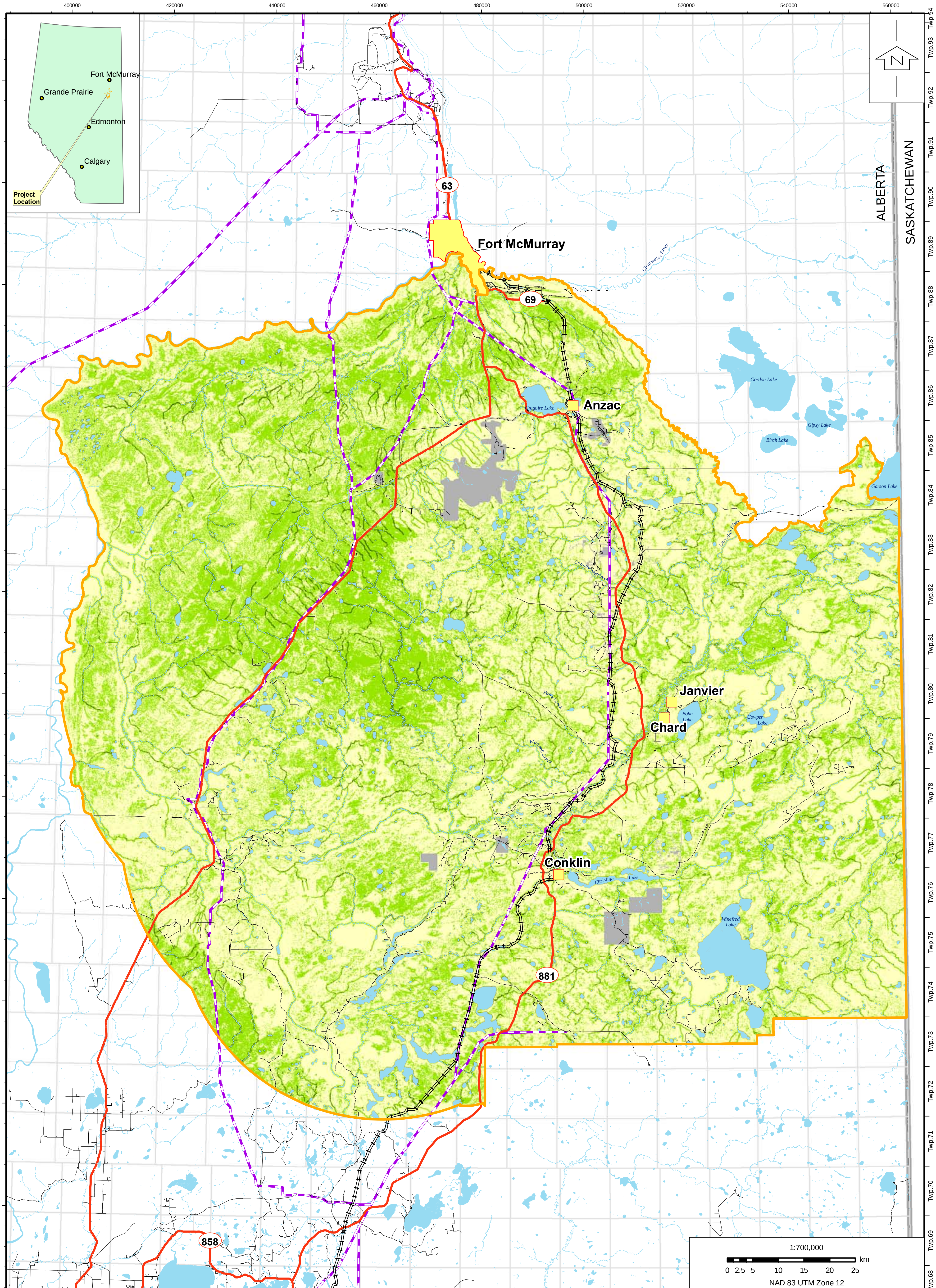

Legend

- StatoilHydro Wildlife RSA
- City/Town
- Waterbody
- Watercourse
- Major Road
- Road
- Powerline
- Railway

Habitat Suitability

- High
- Moderate
- Low
- Unsuitable

Title:

FIGURE B-19

HABITAT SUITABILITY FOR MOOSE AT BASELINE IN THE RSA

StatoilHydro

Approved: RL	Revision Date: March 21, 2009
File: FIGURE_B-19_RESOURCE_SELECTION_PROBABILITY_FUNCTION_FOR_MOOSE_AT_BASELINE_IN_THE_RSA.mxd	
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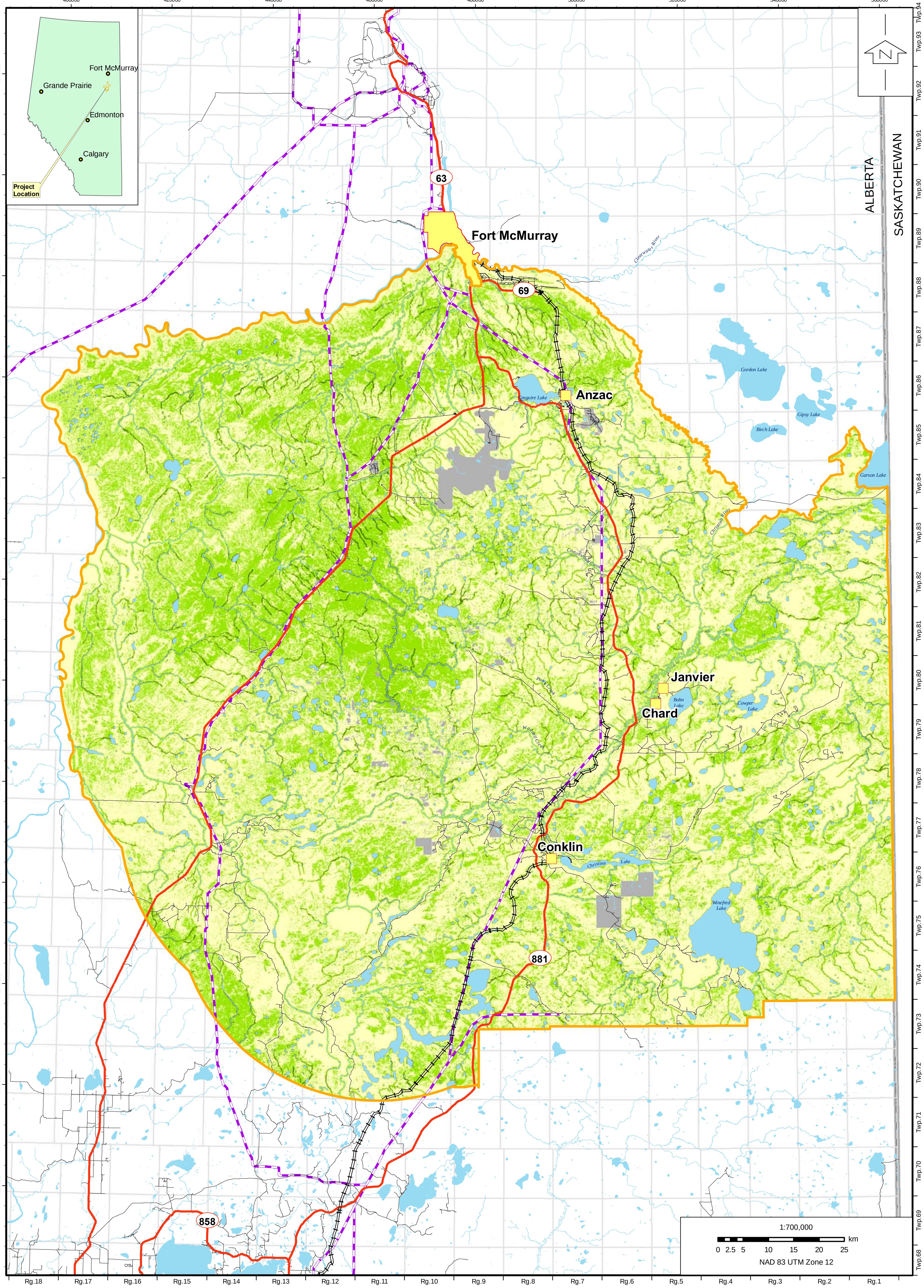

Legend

- StatoilHydro Wildlife RSA
- City/Town
- Waterbody
- Watercourse
- Major Road
- Road
- Powerline
- Railway

Habitat Suitability

- High
- Moderate
- Low
- Unsuitable

Title:

FIGURE B-20

HABITAT SUITABILITY FOR MOOSE AT APPLICATION IN THE RSA

StatoilHydro

Approved: RL	Revision Date: March 21, 2009
File: FIGURE_B-20_RESOURCE_SELECTION_PROBABILITY_FUNCTION_FOR_MOOSE_AT_APPLICATION_IN_THE_RSA.mxd	
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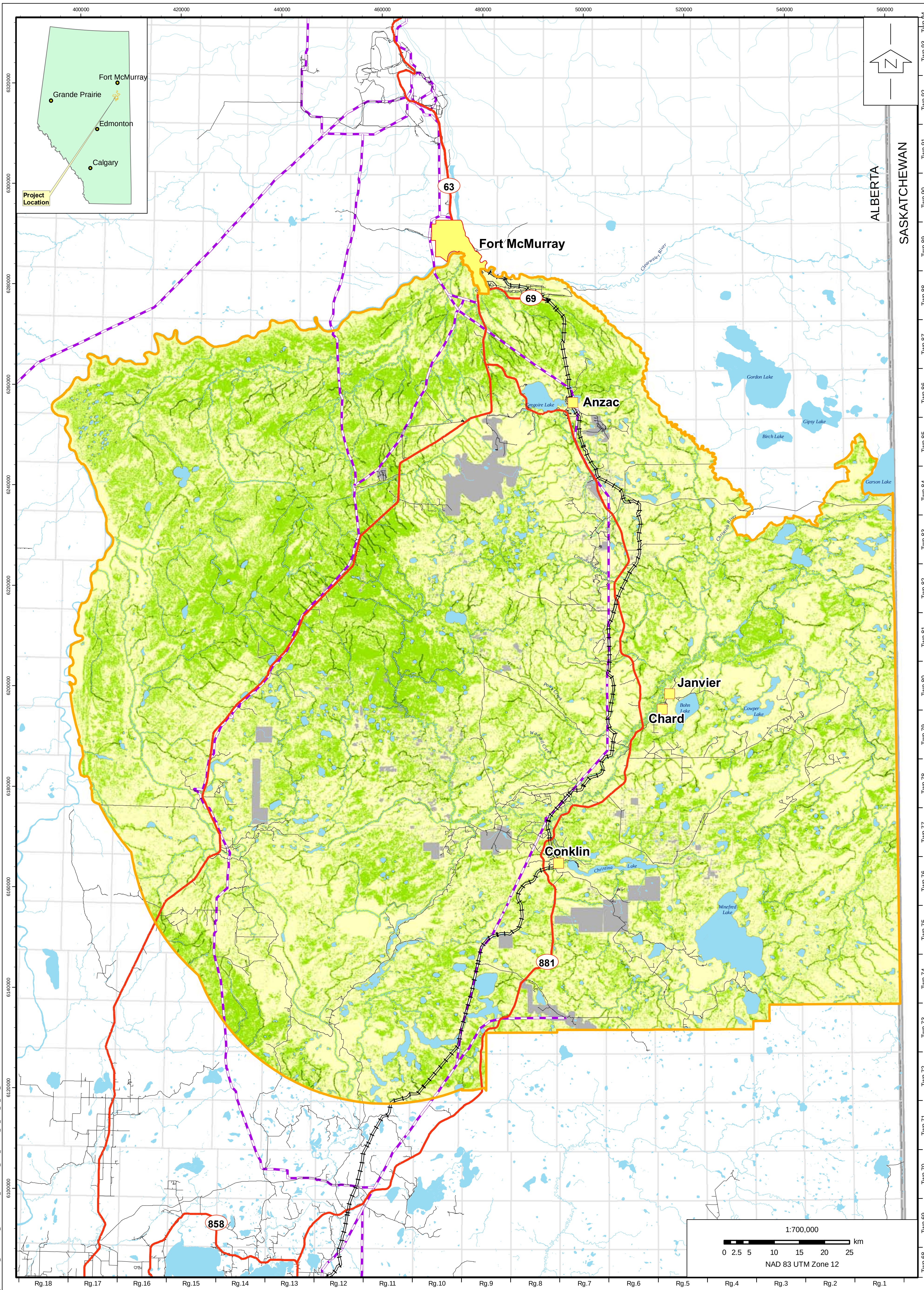

Legend

- StatoilHydro Wildlife RSA
- City/Town
- Waterbody
- Watercourse
- Major Road
- Road
- Powerline
- Railway

Habitat Suitability

- High
- Moderate
- Low
- Unsuitable

Title:

FIGURE B-21

HABITAT SUITABILITY FOR MOOSE AT CUMULATIVE EFFECTS CASE IN THE RSA

StatoilHydro

Approved: RL	Revision Date: March 25, 2009
File: FIGURE_B-21_RESOURCE_SELECTION_PROBABILITY_FUNCTION_FOR_MOOSE_AT_CEC_IN_THE_RSA.mxd	
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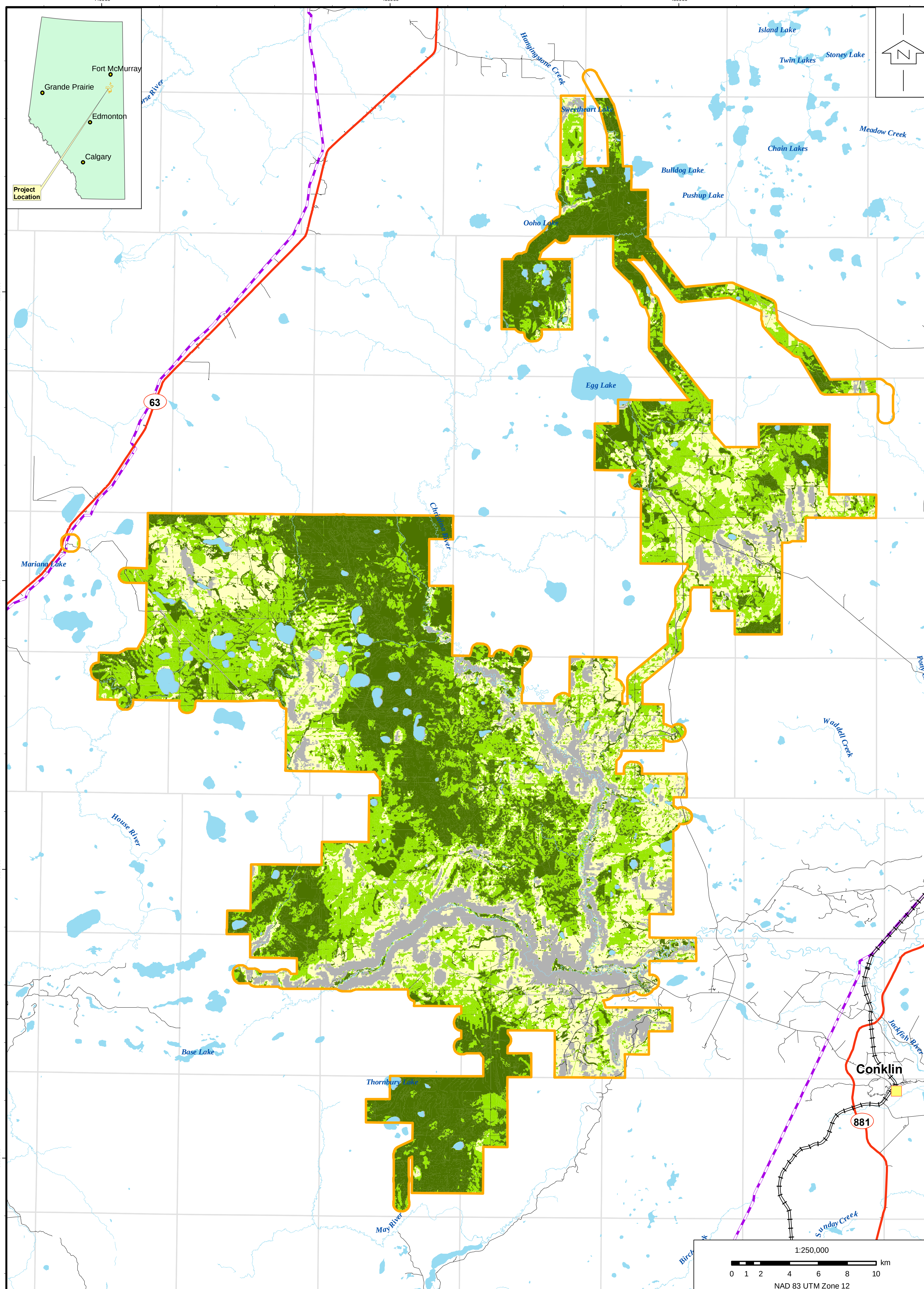

Legend

- StatoilHydro Wildlife LSA
- City/Town
- Waterbody
- Watercourse
- Major Road
- Road
- Powerline
- Railway

Habitat Suitability

- High
- Moderate
- Low
- Unsuitable

Title:

FIGURE B-22

HABITAT SUITABILITY FOR CARIBOU AT BASELINE IN THE LSA

StatoilHydro

Approved: RL	Revision Date: March 21, 2009
File: FIGURE_B-22_RESOURCE_SELECTION_PROBABILITY_FUNCTION_FOR_CARIBOU_AT_BASELINE_IN_THE_LSA.mxd	
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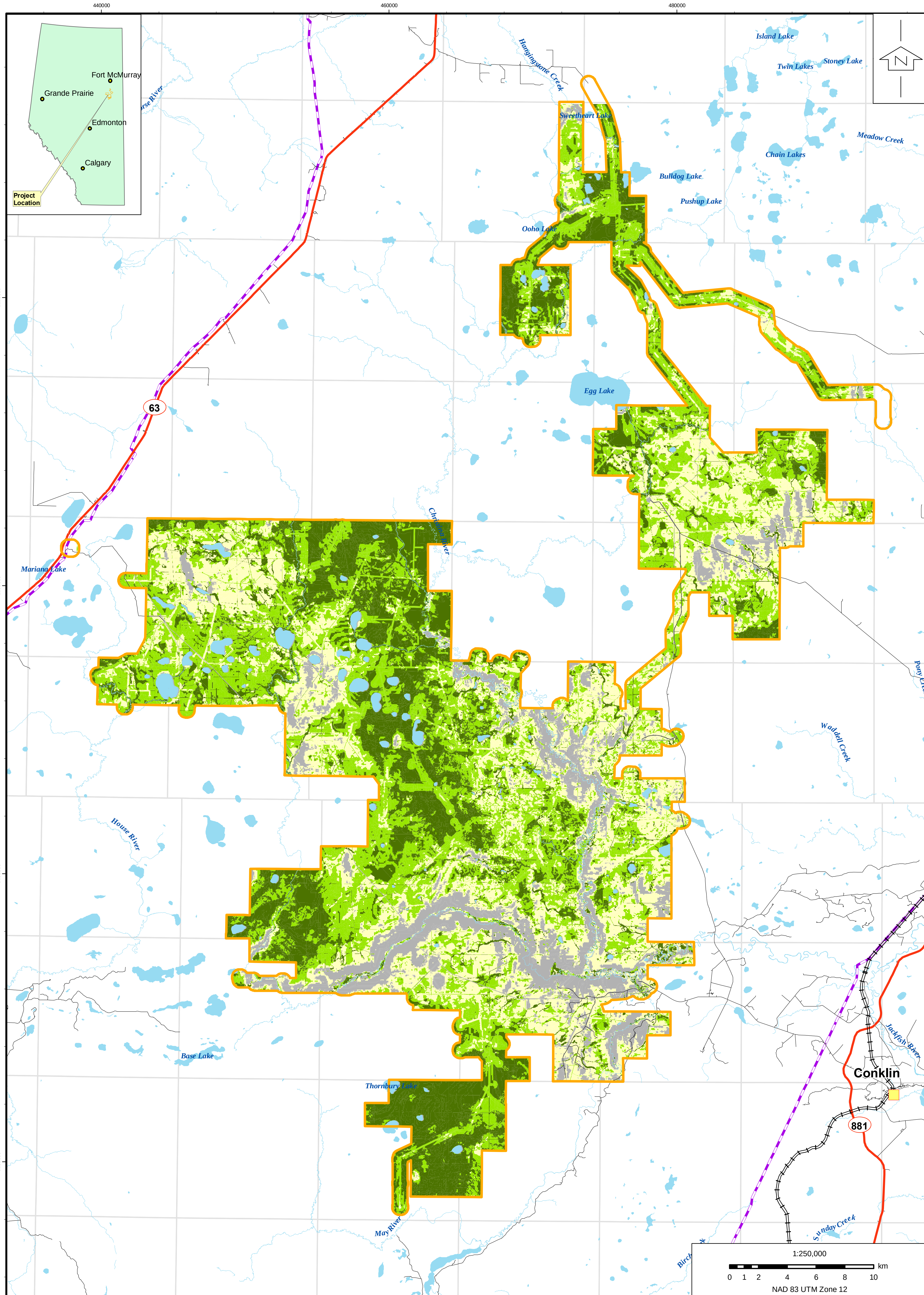

Legend

- StatoilHydro Wildlife LSA
- City/Town
- Waterbody
- Watercourse
- Major Road
- Road
- Powerline
- Railway

Habitat Suitability

- High
- Moderate
- Low
- Unsuitable

Title:

FIGURE B-23

HABITAT SUITABILITY FOR CARIBOU AT APPLICATION IN THE LSA

StatoilHydro

Approved: RL	Revision Date: March 21, 2009
File: FIGURE_B-23_RESOURCE_SELECTION_PROBABILITY_FUNCTION_FOR_CARIBOU_AT_APPLICATION_IN_THE_LSA.mxd	
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Title:

FIGURE B-24

HABITAT SUITABILITY FOR CARIBOU AT BASELINE IN THE RSA

StatoilHydro

Approved: RL

Revision Date: March 21, 2009

File: FIGURE_B-24_RESOURCE_SELECTION_PROBABILITY_FUNCTION_FOR_CARIBOU_AT_BASELINE_IN_THE_RSA.mxd

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Legend

- StatoilHydro Wildlife RSA
- City/Town
- Waterbody
- Watercourse
- Major Road
- Road
- Powerline
- Railway

Habitat Suitability

- High
- Moderate
- Low
- Unsuitable

Title:

FIGURE B-25

HABITAT SUITABILITY FOR CARIBOU AT APPLICATION IN THE RSA

StatoilHydro

Approved: RL	Revision Date: March 21, 2009
File: FIGURE_B-25_RESOURCE_SELECTION_PROBABILITY_FUNCTION_FOR_CARIBOU_AT_APPLICATION_IN_THE_RSA.mxd	
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Legend

- StatoilHydro Wildlife RSA
- City/Town
- Waterbody
- Watercourse
- Major Road
- Road
- Powerline
- Railway

Habitat Suitability

- High
- Moderate
- Low
- Unsuitable

Title:

FIGURE B-26

HABITAT SUITABILITY FOR CARIBOU AT CUMULATIVE EFFECTS CASE IN THE RSA

StatoilHydro

Approved: RL	Revision Date: March 25, 2009
File: FIGURE_B-26_RESOURCE_SELECTION_PROBABILITY_FUNCTION_FOR_CARIBOU_AT_CEC_IN_THE_RSA.mxd	
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APPENDIX C.

MODEL DERIVATION AND EVALUATION

Appendix C – Model Derivation and Evaluation

Northern Goshawk

Introduction

The northern goshawk (goshawk; *Accipiter gentilis*) is a circumpolar forest raptor found in boreal, montane, and temperate forests (Brown and Amadon 1989). In North America, the goshawk inhabits forests from northwestern Alaska and southern Newfoundland, south to Mexico, Tennessee, and Virginia (Johnsgard 1990). The species is listed as Sensitive in Alberta (ASRD 2006), where it resides in the Boreal, Foothill, and Rocky Mountain Natural Regions (Semenchuk 1992). Goshawks are usually year-round residents, but in the northern part of their range will seasonally migrate south during periods of low prey availability (Keith et al. 1977; Mueller et al. 1977). Similarly, goshawks that live in high elevation forests will seasonally migrate to low elevation forests in response to reduced prey (Reynolds et al. 1992).

This habitat suitability model gives an index of nesting habitat quality for northern goshawks. Optimal nesting habitat is generally characterized by mature upland forests containing an even canopy, large sub-canopy branches for nest platforms, moderate understory structure, and open flyways (Schaffer 1998; Mahon, pers. comm. 2008). Although goshawks tolerate a wider range of conditions when foraging, foraging habitat is similar to nesting habitat (Widen 1989; Mahon, pers. comm. 2008). This model was originally developed using in-situ nest site investigations in British Columbia (Mahon and Doyle 2003, Mahon et al. 2008). The model was subsequently parameterized for and validated in the boreal forest of northeastern Alberta using additional site investigations (Mahon unpublished data).

Review of Important Habitat Components

Nesting

Mature, large-diameter trees are important nesting habitat as goshawks predominately nest in a primary branch fork located at the base of a tall forest canopy tree (Schaffer 1998). Large trees benefit goshawks by facilitating access (Hayward and Escano 1983; Moore and Henny 1983; Reynolds et al. 1982; Speiser and Bosakowski 1987) and ensuring an unobstructed view of the surrounding forest (Janes 1985). Although nests have been located in fairly small trees (5 m tall; Godfrey 1986), goshawks in Alberta predominately nest high (mean = 22 m) in trembling aspen trees (*Populus tremuloides*) with a mean diameter at breast height (DBH) of 30 cm (n=47; Schaffer 1998).

Foraging

Goshawks primarily prey on small mammals and birds. Across their North American range, mammals accounted for 58% to 94% of the biomass consumed whereas birds accounted for 6% to 42% of the diet (Boal and Mannan 1994; Doyle and Smith 1994; Mahon and Doyle 2003; Schaffer 1998; Zachel 1985). Direct observation of foraging in west-central Alberta indicates that 84% of the biomass consumed by goshawks is snowshoe hare (*Lepus americanus*) and red squirrel (*Tamiasciurus hudsonicus*; Schaffer 1998).

Goshawks tend to forage in mature forests because they represent the best compromise between attack manoeuvrability and concealment (Widen 1989). Young forests often contain dense understories that limit visibility and access to prey (Widen 1989) while extremely dense closed-canopy forests often lack sub-canopy trees facilitating concealment and perching (Mahon, pers. comm. 2008). Mature forests also contain large snags and woody debris that provide perches and plucking posts (Reynolds et al. 1992;

Schnell 1958). Overall, goshawks select foraging habitat similar to nesting habitat but tolerate a wider range of conditions (Mahon, pers. comm. 2008).

Habitat Effectiveness

Goshawks are most strongly affected by habitat and prey availability (Mahon, pers. comm. 2008; Snyder and Wiley 1976), but human disturbance may impact goshawks during the nesting season. Vehicle traffic and industrial activity around the nest can reduce attentiveness (Richardson and Miller 1997) and changes to nesting and foraging habitat can reduce habitat quality or remove habitat altogether (Beier and Drennan 1997; Bosakowski and Speiser 1994; Crocker-Bedford 1990; Kennedy 1988; Moore and Henny 1983; Reynolds 1989; Reynolds et al. 1982).

Model Construction

Overview

Suitable goshawk nest sites are found in tall, mature and old growth mixedwood forests, away from hard edges. Areas that are close to hard edges are less suitable than those that are >100 m away from edges. When applied to landscapes, the model made two key assumptions. First, it either assumed that goshawks were limited by nest sites rather than home ranges, or that home range selection was adequately estimated by nest site selection. Second, it assumed that goshawks were not limited by prey availability.

Model Variables

The model included habitat variables for stand age (years), stand height (m), canopy closure (%), forest composition (%), slope (%), and distance from edge (m). Stand age, stand height, and slope were modelled as continuous variables:

Table C-1 Northern Goshawk Suitability Indices for Stand Age, Height, and Slope

Age (years)	Rating
0 – 40	0
40 – 90	=(age-40) * 0.16667
>90	1

Height (m)	Rating
0 – 12	0
12 – 24	= (height-12) * 0.08333
>24	1

Slope (%)	Rating
0 – 60	1
60 – 100	=1+(slope-60) * -0.0125
>100	0.5

where the value given in the rating column was used in the calculation of habitat suitability.

Edge (i.e., the interface between mature forest and either non-forest or early seral habitat) was modelled as a conditional categorical variable. Hard edges, defined as interfaces where the difference in height between two adjacent stands is >10 m, and the shorter stand is ≤10 m, were modelled as:

Table C-2 Northern Goshawk Suitability Index for Distance to Edge

Edge distance (m)	Rating
0 – 50	0.4
50 – 100	0.7
>100	1

whereas soft edges, defined as those interfaces not meeting the two conditions described above were given a rating = 1.

Within this model, edges resulting from natural features (e.g., burns, wetlands) were treated the same as those resulting from anthropogenic disturbances (e.g., roads, wellpads). Canopy closure was modelled as a categorical variable:

Table C-3 Northern Goshawk Suitability Index for Canopy Closure

AVI closure code	Canopy Closure (%)	Rating
A	6 – 30	0.3
B	31 – 50	0.65
C	51 – 70	1
D	71 – 100	0.9

Forest composition was modelled as a conditional categorical variable:

Table C-4 Northern Goshawk Suitability Index for Forest Composition

Stand (confirmed spp.)	Stand (generalized)	Rating	
		If <80%	If ≥80%
Sw (White spruce)	Sw	1	0.9
Se (Engelmann spruce)	Sw	1	0.9
Sb (Black spruce)	Sb	0.4	0.4
Pl (Lodgepole pine)	P	1	1
Pj (Jack pine)	P	0.85	0.85
Pa (White-bark pine)	P	0.7	0.7
Pf (Limber pine)	P	1	1
- Undifferentiated pine	P (pine)	1	1
Fb (Balsam fir)	Fb	0.8	0.8
Fa (Alpine fir)	Fb	0.7	0.7
Fd (Douglas fir)	Fd	1	1
La (Alpine larch)	Lt	0.6	0.6
Lt (Tamarack)	Lt	0.6	0.6
Lw (Western larch)	Lt	0.6	0.6
Aw (Trembling aspen)	A	1	0.8
Pb (Balsam poplar)	A	0.8	0.7
- Undifferentiated aspen/poplar	A (aspen)	1	0.8
Bw (White birch)	Bw	0.6	0.6
Road		Null	Null
NF (Non-forested)[a]		Null	Null
NP (Non-productive) [b]		Null	Null

[a] NF classification taken from British Columbia VRI classification for non-forest cover (areas that can produce commercial forests, but currently do not; MFR 2007). In Alberta, assumed to include natural, non-forested areas (i.e., SO, SC, HG, BR, HF in the AVI; ASRD 2005)

[b] NP classification taken from British Columbia VRI classification for non-productive cover (areas incapable of supporting commercial forests; e.g., icefield, alpine, rock, river, agriculture, range; MFR 2007). In Alberta, assumed to include all non-vegetated areas and anthropogenic vegetated areas (ASRD 2005).

Suitability ratings for stands with multiple species were calculated by multiplying each species' percent composition by their respective rating and summing the products, e.g.:

$Sw_{70}Aw_{20}Pj_{10} = 0.7(1.0) + 0.2(1.0) + 0.1(0.85) = 0.985$

Model Mechanics

Using the suitability ratings given above, nesting habitat suitability was calculated for some location r as:
$HSI_r = \text{mean}(S_{1r}, S_{2r}) * S_{3r} * S_{4r} * S_{5r} * S_{6r}$

where S_1 is stand age, S_2 is stand height, S_3 is canopy closure, S_4 is forest composition, S_5 is slope, and S_6 is distance from edge.

Validation

Model accuracy was validated for approximately 90 locations in northeastern Alberta by calculating:
$Accuracy_r = 1 - |\text{field rating}_r - \text{model rating}_r|$

where the field rating was determined for each location r by northern goshawk expert Todd Mahon. Total model accuracy was determined by taking the mean accuracy over all locations. Total model accuracy was 83%.

Barred Owl

Introduction

The barred owl (*Strix varia*) is a resident of the forested regions of Alberta (Olsen 2005) and North America (Johnsgard 1988). This species inhabits forests from coastal British Columbia and Oregon, across the southern boreal forest and parkland to the forested regions of eastern North America south of James Bay (Johnsgard 1988). In Alberta, the barred owl is listed as Sensitive (ASRD 2006).

This resource selection model (Manly et al. 2002) gives the relative probability of selection by barred owls within their summer home range (April to September; Olsen et al. 2006). In western North America, barred owls are associated with mature forests (Livezey 2007) and primarily nest and forage in mature mixedwood forests (Mazur et al. 1998; Olsen et al. 2006; Takats 1998). Nests predominately occur in the cavities of balsam poplar (*Populus balsamifera*) and trembling aspen with mean DBH ranging from 52 to 74 cm (Mazur et al. 1997; Takats 1998). Despite tolerating some anthropogenic features (Mazur 1997), barred owls are sensitive to human disturbances including roads and habitat removal associated with timber harvest (Bosakowski et al. 1987; Hannon unpublished data; Smith 1978). This model was developed using VHF data from the area surrounding Calling Lake, Alberta (April to September 1994 to 1998), and vegetation data are derived from Alberta Vegetation Inventory (AVI). The model was assumed to include high quality nesting habitat since the non-breeding home range encompasses the breeding home range of most owls (Mazur 1997). Adaptations to the original model are discussed below.

Review of Important Habitat Components

Nesting

Barred owls predominately nest in cavities (83%, n=341; Livezey 2007), especially in Alberta (94%, n=16; Olsen et al. 2006; Takats 1998), making mature large-diameter trees vital to nesting habitat. In Alberta, barred owls nest in balsam poplar and trembling aspen larger than 34 cm DBH (Olsen et al.

2006; Takats 1998). Although nests have been located in trees as small as 34 cm, the mean DBH of nest trees in Alberta ranges from 52 to 74 cm (Mazur et al. 1997; Takats 1998). Across their North American range, barred owls nest in trees that average 66 cm DBH (n=94, Livezey 2007).

Foraging

Barred owls opportunistically prey on small mammals, birds, amphibians, reptiles, fish, and invertebrates (Bent 1961). Across their North American range, the diet of barred owls consists of 72% mammals, 10% birds, 7% insects and spiders, 6% amphibians, and 5% other (n=7077, Livezey 2007). The apparent importance of vertebrate prey is likely overestimated, as remains of soft-bodied prey do not appear in owl pellets (Livezey 2007). Nevertheless, diets are strongly seasonal, with mammals accounting for 98% of the winter diet and 59% of the summer diet (Livezey 2007). Investigation of pellets and prey remains in west-central Alberta indicate that the diet of barred owls consists of 46% mammals, 25% birds, 25% wood frogs, and 5% invertebrates (Takats 1998).

Few studies have explored habitat use by foraging barred owls (Livezey 2007). Generally, it is believed that mature forests provide good foraging habitat because their low stem densities provide subcanopy flyways (Fuller 1979; Haney 1997; Nicholls and Warner 1972; McGarigal and Fraser 1984). However, compared to nesting, foraging barred owls are more tolerant of low canopy closure, small trees, and less ground cover (Takats 1998). Within their summer home range, barred owls in central Alberta use primarily old coniferous and mixedwood forest, young deciduous forest, treed bog, and wetlands for roosting and foraging (Olsen et al. 2006). Overall, barred owls in central Alberta select for old coniferous forest, young deciduous forest, and old cutblocks, but avoid old deciduous forest and young cutblocks (Olsen et al. 2006).

Habitat Area

Barred owls defend individual home ranges, which remain stable over time (Bent 1961; Nicholls and Fuller 1987). Across their range, annual home ranges average 782 ha for males (n=16) and 539 ha for females (n=20; Livezey 2007). However, home ranges vary by habitat and season. In southern Saskatchewan, home ranges varied from 38 to 2678 ha (n=15; Mazur 1997) whereas those in central Alberta averaged 338 ha (n=9; Olsen 1999). Seasonal home ranges are larger during non-breeding than during breeding (Livezey 2007) with non-breeding ranges encompassing breeding ranges entirely for most owls (Mazur 1997).

Habitat Effectiveness

Barred owls respond inconsistently to human disturbance. Research indicates that barred owls are negatively correlated with human habitation (Smith 1978) and avoid forests adjacent to major roads (Bosakowski et al. 1987). However, active nests have been located within 25 m of all-season roads (Mazur 1997). Despite these inconsistencies, evidence indicates that habitat removal has negative consequences for barred owls in Alberta. Timber harvest reduced barred owl detections in central Alberta by 33% while increasing great horned owl (*Bubo virginianus*) detections by 60% (Hannon unpublished data), likely due to the combined effect of habitat loss and the increased predation by great horned owls (Laidig and Dobkin 1995).

Model Construction

Overview

Within their home ranges, barred owls select areas with high proportions of old coniferous forest, young deciduous forest, and/or old cutblocks, and/or avoid areas with high proportions of old deciduous forest and/or young cutblocks (defined below) during the end of the breeding season and into the non-breeding season. Selection estimates surrounding proposed development activities were modified by a disturbance coefficient to reflect reduced habitat effectiveness in proximity to human developments and activities.

When applied to landscapes, the model made several assumptions. First, it assumed that intra-home range selection reflects home range selection (i.e., selection does not change appreciably with scale). Second, because non-breeding home ranges encompass most owls' breeding home ranges (Mazur 1997), the model assumed that estimated high-quality habitats capture high-quality nesting habitat. Third, because barred owls are dietary generalists (Bent 1961; Livezey 2007), resource selection was assumed to not be limited by prey availability.

Model Variables

The important model variables influencing resource selection were assumed to reflect nesting and foraging behaviours (Table C-5).

Table C-5 Barred Owl Resource Selection Variables

Name	Code (*x*)	Definition
Old deciduous mixedwood	OD	Forested stand with >50% deciduous, ≥80 years old
Old coniferous mixedwood	OC	Forested stand with >50% coniferous, ≥80 years old
Young deciduous mixedwood	YD	Forested stand with >50% deciduous, <80 years old
Young cutblock	YCB	Vegetated disturbances <30 years old[a]
Old cutblock	OCB	Vegetated disturbances ≥30 years old[b]

[a] originally defined as harvested cutblocks, including partial cuts and salvage areas, <30 years old (Olsen et al. 2006)

[b] originally defined as harvested cutblocks, including partial cuts and salvage areas, >30 years old (Olsen et al. 2006)

Because barred owls are moderately sensitive to human disturbances, the application scenario was modified by the following disturbances coefficients:

Table C-6 Barred Owl Disturbance Coefficients

Name	Description	ROI (m)	Disturb. Coef.
Heavy use	Human disturbances with regular motor vehicle access, railways, industrial sites, active well sites, settlements	0 – 50	0
		50.1 – 100	0.5
		> 100	1.0
Moderate use	No regular road maintenance, irregular traffic use (not daily)	NA	NA
Low use	Trails, abandoned roads, existing seismic and utility corridors	NA	NA

Statistical Model

One statistical model applicable to a use/available study design (Manly et al. 2002) was employed in analysis of the data. The model followed the exponential form of the resource selection function (RSF), and thus gave the relative probability of resource selection by animals (Johnson et al. 2006). The exponential RSF model takes the form:

$$\pi(\underline{x};\beta) = \exp(\underline{\chi}\beta)$$

where β are parameter estimates for the variables $\underline{x}$.

Model Mechanics

For each location (e.g., GIS pixel), the areal proportion xP for each variable x was calculated within a circle with a 100 m radius centered on the pixel of interest. The RSF was then calculated as:

$$RSF = \exp(-0.619 + (0.012 * YDP) + (0.007 * OCP) + (0.036 * OCBP) - (0.005 * ODP) - (0.011 * YCBP))$$

Baseline was determined by

Applying the RSF to a landscape of interest

OUTPUT = (RSF/MaxValue RSF) * Unsuitable habitat

and application by

Applying the RSF to a landscape of interest

OUTPUT = (RSF/MaxValue RSF) * Unsuitable habitat

Apply disturbance coefficients to proposed Project footprint (not the anthropogenic features existing at baseline)

where RSF was the resource selection function, OUTPUT was the mapped output, and Unsuitable habitats were anthropogenic and natural features that have no habitat value (e.g., subdivisions, industrial parks, bodies of water).

Model Validation

Barred owls are rarely observed during wildlife surveys conducted in northeastern Alberta. As a result, localized model validation is difficult. However, the model was parameterized in north-central Alberta and published in a peer-reviewed journal. The literature indicates that the habitat requirements of barred owls are consistent across the western boreal forests, despite relatively low sample sizes (Livezey 2007). The model was constructed based on information from Calling Lake, Alberta which is approximately 100 km from the LSA. Based on the similarities between the sites, use of this model for the assessment is assumed to be valid.

Canada Lynx and Snowshoe Hare

Introduction

A lynx Habitat Suitability Index (HSI) has been used extensively for impact assessment in the oil sands region. However, due to a low occurrence of habitat use information specifically within the region, model validation has been problematic. In order to changing requirements, a resource selection model was developed for the snowshoe hare and subsequently used to assess habitat suitability by lynx. The following sections provide details of snowshoe hare habitat requirements and life requisites and the resource selection model.

A resource selection model was estimated for snowshoe hare from winter tracking transect data collected within the LSA and data collected within the RSA. Data collected from within the RSA is from similar ecological areas. Surveys were conducted between January and March 2006 to 2008 (this includes surveys within the LSA in 2006). The snowshoe hare resource selection model is hence considered applicable to the types of resources that snowshoe hare will select during these winter months. Winter is generally considered the critical annual season for snowshoe hare survival (Conroy et al. 1979).

Snowshoe hares are known to prefer dense cover in second-growth mixedwood and coniferous forests (Beuhler and Keith 1982; Conroy et al. 1979; Litvaitis et al. 1985). They rarely use open landscapes because of greater exposure to predators and lack of food (Keith et al. 1984; MacCraken et al. 1988; Pietz and Tester 1983). Snowshoe hares are herbivores and consume a wide variety of grasses, forbs, and shrubs, the proportions of which are dependent on season and availability in a given habitat (Pease et al. 1979; Wolff 1978). Their winter diet consists largely of current annual growth of browse species, including trembling aspen, birch (*Betula* spp.), rose (*Rosa acicularis)*, white spruce (*Picea glauca)*, balsam poplar, willow, Saskatoon (*Amelanchier alnifolia*), and alder (Keith 1983; MacCracken et al. 1988; Wolff 1978). Snowshoe hares are an important prey item for many carnivores including northern goshawk, great horned owl, marten, fisher, marten, lynx, fox, and coyote, (Bateman 1986; Brand and Keith 1979; Koehler and Aubry 1994; O'Donoghue et al. 1998; Powell and Zielinski 1994; Prugh 2005; Rohner and Krebs 1996; Schaffer 1998).

Review of Important Habitat Components

The variables used and the associated relationships in the resource selection model is consistent with known habitat use patterns and life requisites that have previously been documented as important habitat factors for snowshoe hare. The final resource selection model is comprised of covariates related to shrub and tree composition in forest stands. The composition of shrub and tree layers in forest stands are considered important factors for snowshoe hare habitat given life requisites associated with forage and cover (shelter).

Food Habits

Snowshoe hare typically feed on twigs less than or equal to 4 mm in diameter (de Vos 1964; Pease et al. 1979; Sinclair et al. 1982). They can consume twigs up to 15 mm in diameter (Pease et al. 1979), but select thin stems to take advantage of the negative relationship between stem diameter and nutritional quality (Grigal and Moody 1980; Wolff 1980). Although snowshoe hare usually forage on vegetation below 1.5 m tall (Keith et al. 1984), they can use higher branches as snow accumulates in winter (de Vos 1964; Keith et al. 1984).

The diet of snowshoe hare varies seasonally. During the growing season, snowshoe hares feed on a variety of leaves, herbs and green plant material (Bider 1961; Trapp 1962; Wolff 1978). Wolff (1978) found that blueberry (*Vaccinium myrtilloides*), high-bush cranberry (*Viburnum opulus*), fireweed (*Epilobium* spp.) and horsetails (*Equisetum* spp.) made up 47% of the spring diet of hares in Alaska, while leaves of birch, willow, rose and other deciduous shrubs made up 76% of the summer diet.

In late fall and winter, hares forage primarily on buds, twigs, bark, needles and the evergreen leaves of woody plants. Deciduous browse consumed by snowshoe hares include alder, willow, Labrador tea (*Ledum groenlandicum*), dogwood (*Cornus stolonifera*), elderberry (*Sambucus* spp.), blueberry, raspberry

(*Rubus* spp.), birch, aspen, balsam poplar, buffaloberry (*Sheperdia canadensis*), and rose (MacCracken et al. 1988; Parker 1986; Smith et al. 1988; Walski and Maritz 1977). Coniferous browse include pine, spruce, larch (*Larix laricina*), hemlock (*Tsuga* spp.), cedar (*Thuja* spp.), and fir (*Abies* spp.) (Parker 1986; Walski and Maritz 1977). In the boreal forest, preferred browse generally includes pine (*Pinus* spp.), white spruce, black spruce (*Picea mariana*), willow, birch, alder, Labrador tea, blueberry, raspberry, and rose (de Vos 1964; O'Farrell 1965; Smith et al. 1988; Trapp 1962; Wolff 1978). However, where available, pines tend to be preferred over spruce (de Vos 1964). Preferred browse differs near the southern edge of the boreal forest, as black spruce, Labrador tea, low-bush cranberry, honeysuckle (*Lonicera* spp.), and snowberry (*Symphoricarpos albus*) were found to be largely unpalatable in central Alberta (Keith et al. 1984) while aspen, black spruce, jack pine, larch, alder, willow, dwarf birch (*Betula pumila*), and high-bush cranberry are common foods in eastern Alberta (Koski et al. 1977). These differences may be caused, in part, by forage availability (Pease et al. 1979) as the diet of hares may be comprised largely of conifers when preferred deciduous browse is scarce (Parker 1986).

Cover

Vegetation cover in the forest canopy and shrub layers has been documented as an important component of habitats used by snowshoe hare (Adams 1959; Buehler and Keith 1982; Dolbeer and Clark 1975; Keith and Surrendi 1971; MacCracken 1988; Orr and Dodds 1982; Wolfe et al. 1982). Cover is perceived to be more important than forage availability (Carreker 1985) and species composition (Litvaitis et al. 1985; Wolfe et al. 1982) because it provides protection from low temperatures (thermal cover) and predators (security cover) while supplying browse (Buehler and Keith 1982; Wolff 1980). Generally, hare select for dense overstory and understory cover; however, because forage abundance can vary inversely with canopy cover, high canopy closure can reduce hare densities (Orr and Dodds 1982; Richmond and Chien 1976). Thus optimal habitat usually has moderately dense cover in both the overstory and understory (Conroy et al. 1979).

Habitat use by snowshoe hares varies regionally as both coniferous and deciduous forest can provide adequate cover for hares (Ferron and Ouellette 1992; Litvaitis et al. 1985; Parker 1986; Rogowitz 1988; Wolff 1980). In summer, when leaves provide cover, hares in Minnesota use upland habitats consisting of aspen, birch, willow and maple (*Acer* spp.), and lowland habitats containing alder (Green and Evans 1940) while hares in central Alberta use upland aspen stands (Keith and Surrendi 1971). Aspen stands with dense understories are preferred above those with sparse understories, although this has not been tested in Alberta (Wolfe et al. 1982). Because they provide superior year-round cover, coniferous stands are believed to be more important to hares than deciduous stands (Litvaitis et al. 1985). Hares are associated with coniferous forests across much of their range (Adams 1959; Dolbeer and Clark 1975; Grange 1932; St-Georges et al. 1995; Telfer 1972; Walski and Maritz 1977) especially following population declines (Fuller and Heisey 1986; Hik 1995; Keith 1966; Wolff 1980). Dense spruce and spruce-fir stands are particularly important across much of the boreal and coastal forests (Orr and Dodds 1982; St-Georges et al. 1995; Wolff 1980).

Similar to other regions, snowshoe hares in Alberta generally use coniferous and deciduous stands containing dense understories (Keith et al. 1984). Penner (1976) reported that snowshoe hare in the Alberta Oil Sands Environmental Research Program (AOSERP) study area preferred forests that contain aspen-willow, mixedwood with a moderately high coniferous component, tall shrub, high-density black spruce forest, and undisturbed areas, and avoided large clearcuts. Other studies found that hare use patches of small black spruce and alder near bogs, patches of hazelnut (*Corylus* spp.), areas of dense aspen and willow (Keith 1966), and dense stands of immature hardwoods (Meslow and Keith 1968). Track surveys completed in northeastern Alberta found that mixedwood forests support high hare concentrations and that spruce forests and large shrubland areas were used moderately (Duncan et al. 1986).

Open areas have the potential to provide high quality forage, but are often associated with high mortality (Rohner and Krebs 1996). As a result, hares tend to avoid open areas (Gashwiler 1959; Keith and Windberg 1978; Pietz and Tester 1983; St-Georges et al. 1995). In order to take advantage of the forage provided by open areas, hares select dense forested stands near shrub edges (St-Georges et al. 1995), and use ecotones (Ferron and Ouelette 1992; Wolfe et al. 1982) and small openings with nearby cover (Conroy et al. 1979).

Special Habitat Requirements

Snowshoe hares are more likely to be found in areas of high habitat interspersion than areas of single-age forest cover (Conroy et al. 1979) as it allows hares to shift habitat use seasonally (Wolff 1980). In Utah, snowshoe hares migrate to more open areas in summer where herbaceous foods are more abundant (Wolfe et al. 1982).

Habitat use by hares can change with the abundance of hares. Hares are restricted to dense conifer stands following population declines (Keith 1966), only expanding into more marginal habitats with less cover as abundance increases (Fuller and Heisey 1986; Hik 1995; Wolff 1980).

Anthropogenic Influences

The movement of snowshoe hares can be impeded by open areas including clearings and paved roads (Brocke 1975; Conroy et al. 1979). However, their use of edges (St-Georges et al. 1995; Wolfe et al. 1982) and ability to exploit narrow movement corridors (Brocke 1975) may mitigate the potentially isolating effects of disturbance.

Snowshoe hares are sensitive to activities that alter the amount of available cover. For example, precommercial thinning decreases hare abundance by reducing forest cover (Griffin and Mills 2007). In contrast, hare density increases when forest fires increase shrub and seedling density (Keith and Surrendi 1971; Meslow and Keith 1968). Following commercial logging, the density of hares peaks from 11 to 25 years (Burgason 1977; Parker 1984) depending on site conditions. Ultimately hares use disturbed areas once trees are able to provide adequate shelter.

Model Construction

A use/available study design (Keating and Cherry, 2004; Lele and Keim, 2006; Manly et al., 2002) was employed in the analysis of data and in the development of statistical models. In this analysis, used sites were defined by locations where hares were observed (n=6,736) during winter tracking surveys. The used sites represent the types of habitats that hares were observed to use. Available sites were defined by each 25 m transect segment that was sampled (n= 14,167) during winter tracking surveys. The available sites represent those types of habitats that were available to hares and where hare may have been observed during winter tracking surveys. Statistical analysis was conducted in the statistical software program R Statistical Computing Version 2.6.2©. In the following sections, the statistical models used, the final model selected, and an evaluation of the final models fit within the LSA is presented.

Statistical Model

Two statistical models, both applicable to the use/available study design (Keating and Cherry, 2004; Lele and Keim, 2006; Manly et al. 2002), were employed to analyze the data. The first model, the exponential form of the RSF, is the most common modelling approach for estimating the relative probability of resource selection by animals (Johnson et al. 2004; 2005; 2006). The second, the Logistic RSPF, was recently identified as an advantageous, alternative approach for estimating the probability of resource selection by animals. The Logistic RSPF model takes the form:

$$\pi(\underline{x};\beta) = \frac{\exp(\underline{x}\beta)}{1+\exp(\underline{x}\beta)}$$

The exponential RSF model takes the form:

$$\pi(\underline{x};\beta) = \exp(\underline{\chi}\beta)$$

where β are parameter estimates for the variables $\underline{x}$.

Snowshoe Hare Covariates

To predict site selection by wintering snowshoe hares, two continuous covariates and four categorical covariates were used in the final model. The continuous covariates included conifer density and distance to edge. Conifer density was measured as the density of fir, spruce, and pine trees in the canopy plus the density in the understory layer (measured from AVI data). The categorical covariates included locations with >3% pine in the canopy, locations with conifers in the understory, wetlands, and harvest blocks <15 years old.

Conifer density was included to account for its importance in providing cover (Orr and Dodds 1982; St-Georges et al. 1995; Walski and Maritz, Wolff 1980,) and forage (Buehler and Keith 1982; Wolff 1980). An index of conifer density was included as a covariate by combining percent conifer composition by stand density.

Distance to edge was included as a surrogate for habitat interspersion. Interspersion is important as it provides a good compromise between cover and access to high quality forage associated with seral habitats (Ferron and Ouelette 1992; St-Georges et al. 1995; Wolfe et al. 1982) and allows seasonal habitat shifts (Wolff 1980). Due to the emphasis on cover and seral habitats, edge was defined as the interface between two adjacent stands where the difference in stand height was greater than10 m, and the height of the shorter stand was less than 10 m tall. Areas with pine in the canopy and conifer in the understory were included to account for their potential importance as a source of forage (de Vos 1964) and a source of cover (Litvaitis et a. 1985). Wetlands were included because they include many preferred forage species, such as spruce, willow, birch, alder, and Labrador tea (O'Farrell 1965; Smith et al. 1988; Trapp 1962; Wolff 1978). Finally, harvest blocks less than15 years old were included given a potential scarcity of vegetation cover (Rohner and Krebs 1996).

Biological Models

Standard statistical model selection steps (forward step model selection) and multi-model inference procedures were conducted when analysing the data as per Burnham and Anderson (2002). The final model selected assumes the logistic form of the resource selection probability function and was estimated for the LSA using covariates derived from AVI data.

The Bayesian Information Criterion (BIC) value (Burnham and Anderson, 2002) for the fitted exponential RSF and the fitted Logistic RSPF models are provided in Table C-7. A model with a smaller BIC value is considered to provide a better fit.

Table C-7 BIC Values for Best Fit Multiple Covariate Models

Model	BIC value
LSA Exponential RSF	-2327.91
LSA Logistic RSPF	-2140.25

The Logistic RSPF model for snowshoe hare derived from LSA data provides a better fit than the RSA model under assumptions of the BIC. The parameter estimates (β) and the standard errors for the final snowshoe hare model is provided in Table C-8. All covariates were significantly different from zero.

Table C-8 Estimated Coefficients (β) and Standard Errors (SE) for the Model Covariates used in the Logistic RSPF

LSA Snowshoe Hare Model Covariates	Logistic RSPF	
	B	SE
Intercept	-1.29	$5.31\ 10^{-3}$
Density of conifer trees	1.26	$9.74\ 10^{-3}$
Distance to edge	$-2.4\ 10^{-3}$	$1.59\ 10^{-8}$
Locations with >3% pine in the canopy	1.25	$3.92\ 10^{-3}$
Locations with conifers in the understory	1.62	$1.76\ 10^{-2}$
Wetlands	0.34	$2.93\ 10^{-1}$
Harvest blocks <15 years old	-2.46	$4.84\ 10^{-2}$

Based on the final model, wintering snowshoe hare select sites:

- Having higher densities of pine, spruce and fir trees;
- Are near edges;
- Are located in stands with more than 3% pine in the canopy;
- Are located in stands with pine, spruce, and fir in the understory;
- Are located in wetlands; and/or
- Are not located in harvest blocks younger than 15 years old.

Model Evaluation

Evaluation Techniques

A measure of the residual sum of squares (RSS; Keim and Lele 2007) was used to determine the fit of the final models at baseline condition.

The final output of an RSF is a value between zero and infinity and the output of an RSPF is a probability (between zero and one). Hence RSF and RSPF output values were equally scaled into an index by dividing each pixel value by the maximum model value attained (with respect to each model considered) within the LSA. This conversion allowed the models to be scaled between 0 and 1.0, where a value of 1.0 represents the most selected sites.

To calculate the RSS the final model was categorized into a grouping of ordinal bins (groupings or classes of selection probability) where the highest ranked bins contained the most likely selected habitat types and vice versa. The models were classified into 10 equally distributed bins, wherein each bin contained multiple (>10) used and available locations. For each bin, the area (number of pixels) and the number of hare observations predicted by the model in the LSA was calculated. Using these data the proportion of observed and the predicted-value (expected) proportion of observed locations was calculated for each bin using the following calculations.

Used Proportion = # of hare locations/∑ hare locations in all bins

Predicted-value = the bin mid-point value * (Area/∑ Area in all bins)

To derive the predicted value, the mid-point value of the model interval at each bin was used as per Johnson et al. (2005), and Boyce and McDonald (1999). The RSS was calculated using the Log transformation of the predicted-value and the used proportion using the function:

$$J = \sum_{i=1}^{K} \{(y_i - x_i) - (\bar{y} - \bar{x})\}^2$$

where; K was the total number of bins, y_i was the logarithmic transformation of the proportion of predicted use, and x_i was the logarithmic transformation of the proportion of observed use. If a model has a good fit, one expects:

- A linear relationship between the used proportion and the predicted value on the Log scale, to have a slope of 1.0 (with an intercept defined by the relationship); and
- A RSS value approximate to zero.

A bar plot was created to illustrate the fit of the final RSPF model among each of the 10 equally distributed bins. The bar plot depicts the proportion of total hare locations (the Used Proportion, as defined above) occurring in each bin and the randomly expected proportion of hare locations expected in each bin with respect to area in the LSA. If the fit of the model is strong, one would expect the Used Proportion to be incrementally greater (linearly) than the randomly expected proportion in the highest ranked bins, and vice versa. Bins are labelled on the x-axis of the bar plot as the mid-point of the selection probability for each bin, wherein a selection probability nearer 1.0 represents a higher ranked bin.

Evaluation Results

The RSS value for the RSF and RSPF model is 0.26 and 0.13, respectively. As expected given the BIC values, the RSPF model provides a better fit to the data (as the RSS value is nearer zero). Furthermore, the RSS value is near zero (0.13) for the RSPF model indicating a good fit between the observed hare locations and expected distribution of hare locations in the LSA given the RSPF model among 10 equally distributed bins. A bar plot of the observed proportion of hare locations in each bin and the randomly expected proportion of hare locations in each bin is provided in Figure C-1. It is apparent in this plot that higher ranked bins (selection probabilities nearer 1.0) have an incrementally greater proportion of observed hare locations than randomly expected, as compared to lower ranked bins (selection probabilities nearer 0.0). For the purpose of the assessment; a “low quality habitat” would have selection probabilities ranging from greater than zero to 0.33; a “moderate quality habitat” would have selection probabilities ranging between 0.33 and 0.66; a “high quality habitat” would have a selection probability greater than 0.66. The selection of habitats by wintering snowshoe hare increases linearly from low to high quality habitat classes, as compared to random expectation.

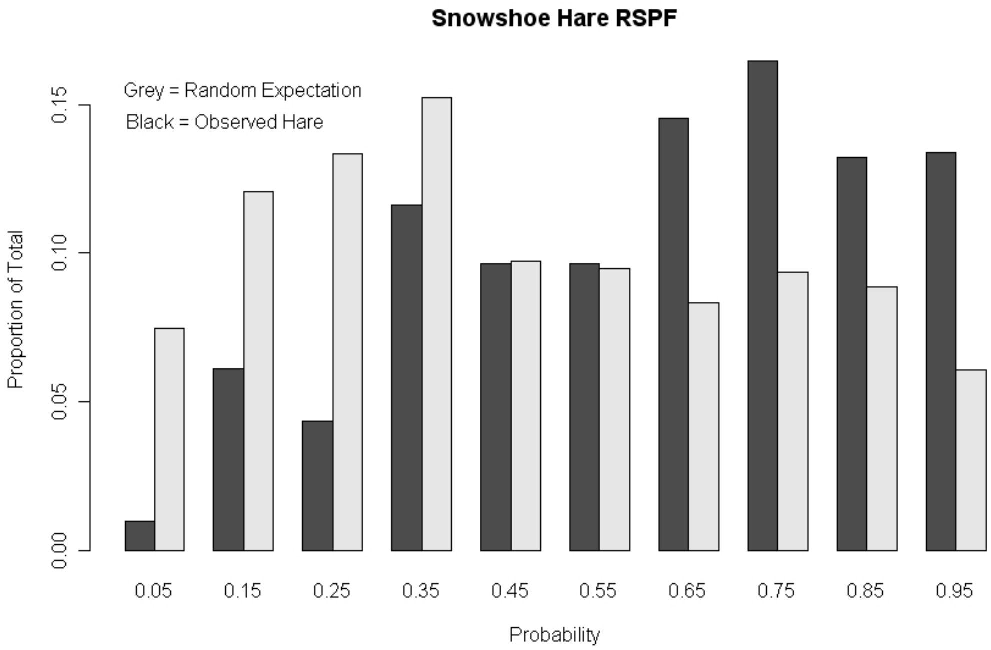

Figure C-1 Bar plot depicting the distribution of observed snowshoe hare locations relative to random expectation among 10 equal-interval resource selection classes.

Model Mechanics

For each landscape, the probability of selection at the LSA level was calculated as:

$$RSPF = \frac{\exp(-1.29 + (1.26 * C) - (0.0024 * D) + (1.25 * P) + (1.62 * UC) + (0.34 * W) - (2.46 * H))}{1 + \exp(-1.29 + (1.26 * C) - (0.0024 * D) + (1.25 * P) + (1.62 * UC) + (0.34 * W) - (2.46 * H))}$$

where *C* was the density of conifer trees, *D* was the distance to the nearest edge in meters to a maximum of 450 m (where edge was defined as the interface between two adjacent stands where the difference in stand height was >10 m and the shorter stand was <=10 m), *P* were areas with more than 3% pine in the canopy, *UC* were areas with conifers in the understory, W were wetlands, and *H* were harvest blocks less than 15 years old. Hare resource selection was estimated by removing unsuitable habitats from the landscape, (i.e., lakes, rivers, roads, industrial facilities, well pads, and highways).

Snowshoe Hare as a Surrogate for Lynx

Overview

Within the boreal forest, lynx populations are strongly related to the 10-year cycle of their principal prey, the snowshoe hare (Elton and Nicholson 1942; Keith 1963; Hodges 1999). As a result, lynx are frequently associated with habitat used by snowshoe hare (Koehler and Aubry 1994), including various aged forests and structural classes with dense understories (McCord and Cardoza 1992). In the following analysis, lynx and snowshoe hare locations were used to determine whether the snowshoe hare model in the above description of model mechanics satisfactorily predicted the types of habitats used by lynx.

Evaluation Techniques

Lynx (n=48) and hare (n=6,736) locations were defined by track locations as identified on page C-12 under evaluation techniques. The probability of selecting the observed covariates was obtained by applying the snowshoe hare model to the lynx and snowshoe hare locations. The density of observations was then plotted against the probability of selection.

The resulting figure (Figure C-2) gives the intensity of use by lynx and snowshoe hare across the available snowshoe hare habitats (as defined by the snowshoe hare RSPF). Because habitat availability remained constant, used distributions can be compared between species.

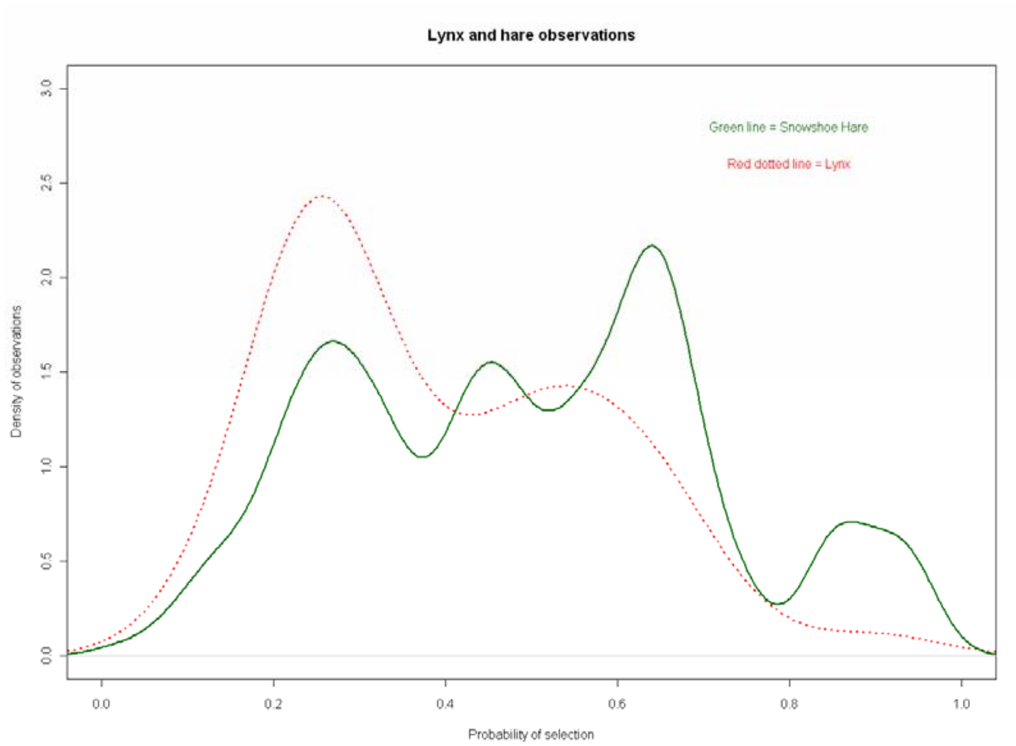

Figure C-2 Intensity of Use by Lynx and Snowshoe Hare Against the Probability of Selection by Snowshoe Hares

Evaluation Results

Lynx used low, moderate, and high suitability habitats as selected by snowshoe hares. The fact that use was not higher in habitats with high probabilities of selection was to be expected; habitats that are strongly selected can receive relatively low use in areas where high-quality habitat is relatively uncommon.

Although lynx did not use those habitats most highly selected by hares – likely because hare selected these areas to reduce predation risk – the used distribution of lynx largely reflects the used distribution of hares. At low and moderate probabilities of selection, lynx use mirrors that of hares. The similarity between the two distributions provides evidence that lynx use habitats based on the amount of use by hares.

Given the tight ecological relationship between these two species (Elton and Nicholson 1942; Hodges 1999; Keith 1963) and the fact that habitat use by lynx is similar to that of hares under the same availability, habitat selection by snowshoe hare was used to approximate habitat suitability for lynx.

Lynx Habitat Model

Lynx (*Lynx canadensis*) inhabit areas with daily human presence (Brand and Keith 1979) and appear to tolerate moderate densities of low-use roads (McKelvey et al. 1999). However, lynx are negatively influenced by the presence of both roads and coyotes (Bayne et al. 2008). Bayne et al. (2008) found that the occupancy rate of lynx was unaffected by road density in areas where coyotes were not detected, but that the occupancy rate declined as a function of road density with increasing coyote activity. Because coyotes were observed in the LSA, the habitat value for lynx was reduced in areas with higher road density.

The lynx habitat model was calculated as:

$$HSI_{Lyns} = RSPF_{Hare} * Lynx\ occumpancy$$

where lynx occupancy was estimated from the combined effects of road density and coyote activity (Bayne et al. 2008). Coyote activity was assumed to be the median value observed by Bayne et al. (2008) in northeastern Alberta between 2002 and 2005, whereas road density (km/km^2) was measured across the LSA. The relationship between lynx occupancy and road density, at the assumed coyote activity level, was calculated as:

$$Lynx\ occupancy = -0.26667 * road\ density + 0.9$$

approximating the relationship given in Bayne et al. (2008). Because the published relationship (Bayne et al. 2008) is only provided for road densities ranging from 0 to 1.5 km/km^2, densities exceeding 1.5 km/km^2 were assumed to be equal to 1.5 km/km^2.

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