May 2011

SHELL JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

Muskeg River Diversion Alternative Assessment

Submitted to:
Shell Canada Limited

REPORT

Report Number: 10-1346-0001

Golder Associates

Table of Contents

TABLES

FIGURES

1.0 INTRODUCTION

Recent consultation with First Nation stakeholders has prompted Shell to explore alternative development plans that could address concerns associated with displacing the Muskeg River through a pipeline and re-introducing it into a closure pit lake containing Mature Fine Tailings (MFT). These discussions resulted in Shell developing the Muskeg River Diversion Alternative (MRDA) Mine Plan presented in Section 2.

To determine how these incremental changes to the mine development would relate to the Jackpine Mine Expansion (JME) Environmental Impact Assessment (EIA), Shell reviewed its EIA, as amended, to determine whether or not there were any implications to the existing findings and conclusions.

This appendix provides information on how the MRDA and the changes to tailings management practices at the Jackpine Mine, as presented in Section 2 of the Submission of Additional Information to the Joint Review Panels, affect the findings and conclusions of the EIA, as amended.

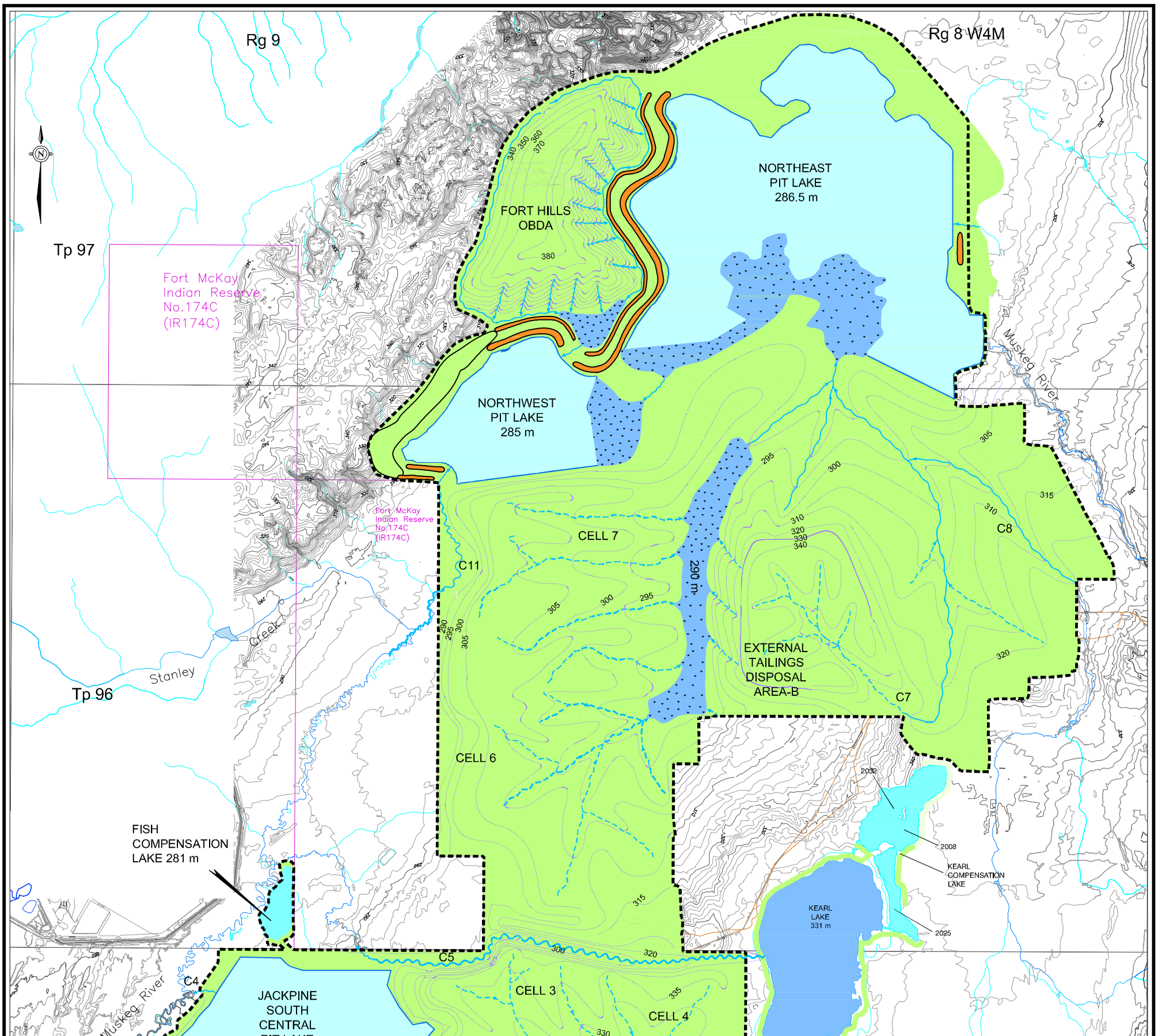
1.1 Muskeg River Diversion Alternative Mine Plan Approach

As described in *Section 2 – Muskeg River Diversion Alternative Mine Plan*, Shell assessed the feasibility of an alternate routing of the Muskeg River in an effort to address concerns raised by First Nations. These concerns include temporary displacement of the river in a pipeline, and pit lakes containing MFT at closure. In an effort to address these concerns, Shell developed an alternate mine plan that would address not only the First Nation concerns, but also show compliance with Energy Resources Conservation Board (ERCB) Directive 074 as outlined in the December 2010 Jackpine Mine - Phase 1 Tailings Management Plan. Modifications to the mine plan having the potential to affect the EIA findings include the following:

- diverting the Muskeg River using a channel around the north boundary of the mine development area during mine operation, increasing the Project development area;
- removing the surge pond and Muskeg River diversion pipelines during mine operation;
- reducing the mine development area and revising mine pit cell locations;
- installing centrifuge technology as part of the recently approved Jackpine Mine - Phase 1 Tailings Management Plan;
- removing MFT from pit lakes;
- eliminating tailings transfers between Muskeg River Mine and Jackpine Mine at closure;
- adding Thickened Tailings drying facilities as part of the recently approved Jackpine Mine - Phase 1 Tailings Management Plan;
- modifying drainage and closure plans, including the sizes and characteristics of pit lakes, and locations of littoral zones;
- extending the mine life by one year to 2050;
- updating process and tailings water balances; and
- modifying the dimensions of the Fort Hills Overburden Disposal Area (OBDA).

The closure drainage plan and the closure planting prescriptions for the MRDA Mine Plan are shown on Figures 1.1-1 and 1.1-2. The implications of the above modifications on the EIA findings and conclusions are discussed in this appendix.

L:\2010\1346\10-1346-0001\5719\08\Report D\Fig 1.1-1 10134600015719D001 CD-MRDA Mine Plan.dwg May 24, 2011 – 9:00am



LEGEND

- EXPANDED JACKPINE MINE
- 330 FINAL RECLAIMED SURFACE CONTOUR
- MAIN CHANNEL
- SECONDARY CHANNEL
- PERMANENT WETLANDS AND LITTORAL ZONE
- RECLAIMED SURFACE
- LAKE
- LAKE PERIMETER LEVEE
- OPERATIONAL BERM (BREACHED AT APPROXIMATELY 500 m SPACING AT CLOSURE)

REFERENCE

ALBERTA DIGITAL DATA OBTAINED FROM ALTALIS LTD. (SEPTEMBER 2004.)
USED UNDER LICENSE. PROJECTION: TRANSVERSE MERCATOR
DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 12

1.5 0 1.5
SCALE KILOMETRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

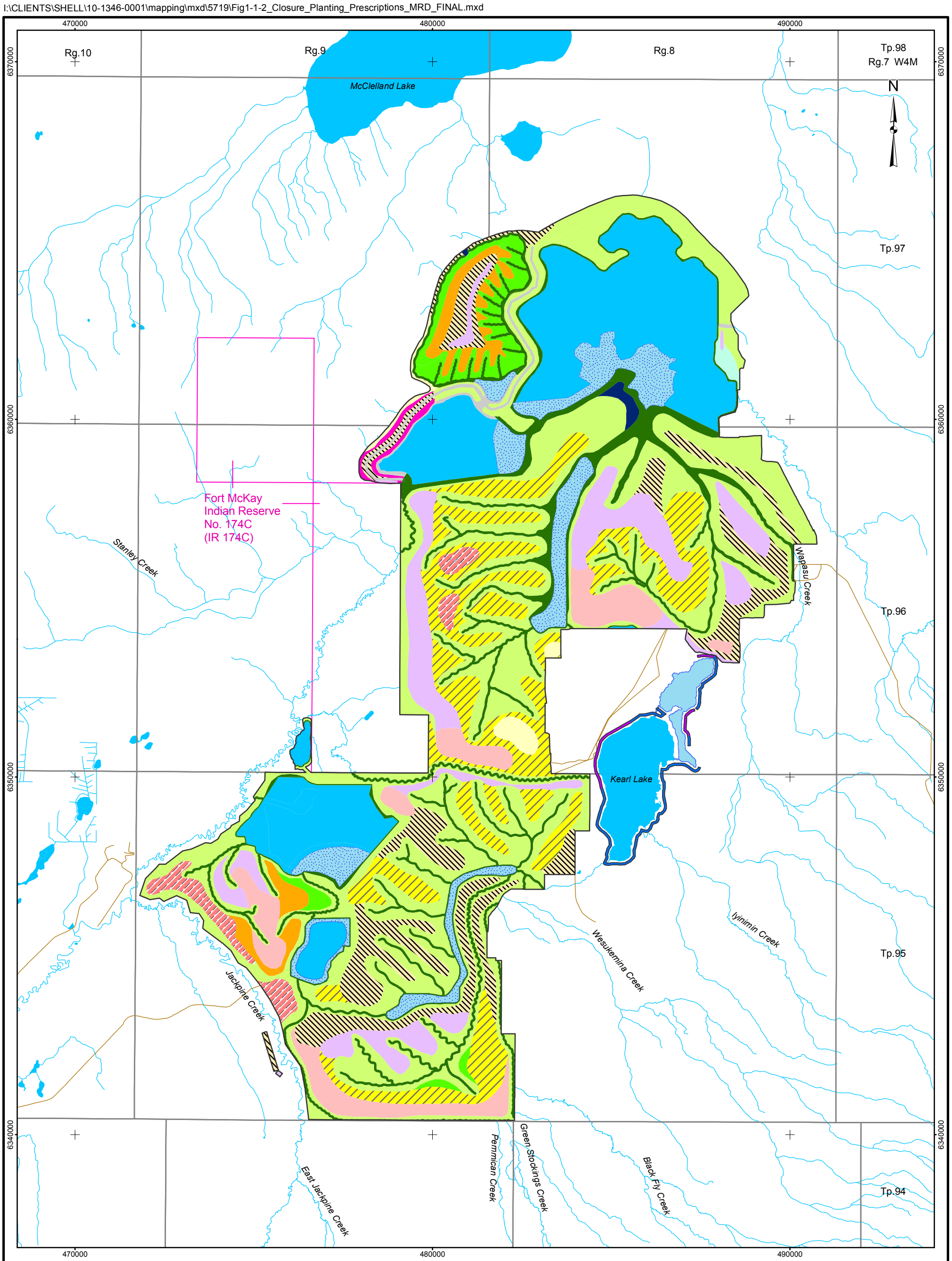
TITLE

CLOSURE DRAINAGE FOR THE MUSKEG RIVER DIVERSION ALTERNATIVE MINE PLAN

Shell Canada Limited

PROJECT 10.1346.0001.5719			FILE No. 10134600015719D001	
DESIGN	MM	19/05/11	SCALE AS SHOWN	REV. 0
CADD	PSR	20/05/11	FIGURE: 1.1-1	
CHECK	MM	24/05/11		
REVIEW	WES	24/05/11		

I:\CLIENTS\SHELL\10-1346-0001\mapping\mxd\5719\Fig1-1-2_Closure_Planting_Prescriptions_MRD_FINAL.mxd



LEGEND

- PUBLIC ROADWAY
- MUSKEG RIVER DIVERSION ALTERNATIVE FOOTPRINT
- INDIAN RESERVE
- OPEN WATER
- COMPENSATION LAKE
- PLANTING PRESCRIPTION FOR LEVEE AREAS ADJACENT TO UPLANDS
- PLANTING PRESCRIPTION FOR LEVEE AREAS ADJACENT TO WETLANDS

RECLAMATION ECOSITE PHASES/WETLANDS TYPES

a1	e1		LITTORAL ZONE
b1	f2		
b3	f3		
b4	g1		
c1	h1		
d1	Sh2		
d2	Sh3		

2 0 2
SCALE 1:100,000 KILOMETRES

REFERENCE

ALBERTA DIGITAL DATA OBTAINED FROM ALTALIS LTD. © GOVERNMENT OF ALBERTA 2008 (ALL RIGHTS RESERVED), AND IHS ENERGY LTD. (AUGUST 2006), USED UNDER LICENSE.
DATUM: NAD83 PROJECTION: UTM ZONE 12

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
RECLAMATION ECOSITE PHASES/WETLANDS TYPES PLANTING PRESCRIPTIONS

Shell Canada Limited

PROJECT NO. 10-1346-0001			FILE No.		N/A
DESIGN	JB	08 Dec 2010	SCALE AS SHOWN	REV.	0
GIS	CH	20 May 2011			
CHECK	AD	20 May 2011			
REVIEW	SS	20 May 2011			

FIGURE: 1.1-2

2.0 AIR QUALITY, NOISE AND ENVIRONMENTAL HEALTH

2.1 Air Quality

The Air Quality Assessment for the Project was presented in Volume 3, Section 3 of the EIA. The MRDA Mine Plan potentially affects the results of the Air Quality Assessment in four ways:

- the development area changed and an area previously considered a developed area is now considered an undeveloped area in the assessment, so air quality predictions on these lands are included and assessed with the regional air quality predictions (sulphur dioxide [SO_2], nitrogen dioxide [NO_2], Potential Acid Input [PAI]);
- the fenceline air quality predictions provided to the Health Risk Assessment (Volume 3, Sections 5.3 and 5.4 of the EIA) will potentially be different based on the modified MRDA fenceline;
- the centrifuge technology approved to be incorporated into the current operation will increase indirect greenhouse gas emissions through increases to grid sourced electricity consumption; and
- creation and operation of a Thickened Tailings drying area (DDA2) is a potential source of dust and Volatile Organic Compounds (VOCs).

Since the change to the development area is relatively small and is located far from the primary Project air emissions sources (e.g., the plant site), there is minimal change to the regional and fenceline air quality predictions presented in the EIA and these changes do not alter the Air Quality Assessment conclusions.

The increase in indirect greenhouse gas emissions from the centrifuge technology is less than 1% of the estimated total greenhouse gas emissions from JME and is considered negligible. As a result, the EIA conclusions with respect to greenhouse gases remain unchanged.

Centrifugation also has the potential to volatilize residual hydrocarbons from the tailings feed. While the chemical properties and concentrations of residual hydrocarbons in the centrifuge feed suggest that a material increase in VOC emissions due to centrifugation is unlikely, Shell does not yet have pilot or commercial scale information to substantiate this claim. Accordingly, Shell will confirm VOC emission rates in future pilot or demonstration facilities, and adaptively manage the emissions, as required, to ensure the environmental consequences assessed in the EIA remain unchanged. As a result, the EIA conclusions with respect to VOC emissions remain unchanged.

Potential emissions from DDA2 include fugitive windblown dust and VOCs. While Shell does not anticipate any issues related to fugitive windblown dust, Shell will extend its dust management practices to DDA2, as required, to manage these emissions.

The environmental consequence ratings and the mitigation measures presented in the Air Quality Assessment are the same for the MRDA Mine Plan. Therefore, the MRDA Mine Plan does not change the Air Quality Assessment findings presented in the EIA, as amended.

2.2 Noise

The Noise Assessment for the Project was presented in Volume 3, Section 4 of the EIA. The MRDA Mine Plan potentially affects the results of the Noise Assessment in two ways:

- modifications to the development area change the location of the ERCB 1.5 km Criteria Boundary for JME, as defined in Volume 3, Section 4.2.2 of the EIA; and
- noise associated with the centrifuge technology will contribute to cumulative noise levels at JME.

The centrifuge technology will be designed such that the residual impact for noise at the ERCB 1.5 km Criteria Boundary will be low, unchanged from the May 2008 EIA Update. The overall environmental consequences for the other parameters considered will remain the same as the EIA, as amended. Since the revised residual impact is rated as low and is still within the ERCB criteria, no additional mitigations other than those outlined in Volume 3, Section 4.6 are required.

2.3 Environmental Health

2.3.1 Human and Wildlife Health Risk

The Human and Wildlife Health Risk Assessment for the Project was presented in Volume 3, Sections 5.3 and 5.4 of the EIA. The changes in the MRDA Mine Plan could affect the results of the risk assessment if it changes the conclusions of the Air Quality Assessment or the Water Quality Assessment.

Because the Air Quality Assessment (Section 2.1) and Water Quality Assessment (Section 3.4) predictions remain the same or similar from the EIA, human and wildlife health risks also remain unchanged from those presented in Volume 3, Sections 5.3.3 and 5.4.3 of the EIA, as amended. Therefore, the changes in the MRDA Mine Plan do not change the Human and Wildlife Health Risk Assessment conclusions presented in the EIA, as amended.

2.3.2 Air Emissions Effects on Ecological Receptors

The Air Emissions Effects on Ecological Receptors Assessment for the Project was presented in Volume 3, Section 5.5 of the EIA. The changes in the MRDA Mine Plan do not change predicted Air Quality concentrations. Therefore, the changes in the MRDA Mine Plan do not alter the assessment results, environmental consequence ratings or mitigation measures presented in the Air Emissions Effects on Ecological Receptors Assessment in the EIA, as amended.

3.0 AQUATIC RESOURCES

3.1 Introduction

The Aquatic Resources Assessment for the Project was presented in Volume 4, Section 6 of the EIA. The changes in the MRDA Mine Plan potentially affect the results of the Aquatic Resources Assessment in ten ways:

- diverting the Muskeg River using a channel around the north boundary of the mine development area during operation;
- removing the surge pond and Muskeg River diversion pipelines during mine operation;
- reducing the mine development area and revising mine pit cell locations;
- removing MFT from pit lakes;
- eliminating inter-site tailings transfer;
- adding an in-pit Thickened Tailings drying area for atmospheric fines drying;
- modifying the closure drainage plan, including the sizes and characteristics of pit lakes, and locations of littoral zones;
- extending the mine life by one year to 2050;
- revising the sequence of mine plan development and mine pit cell locations; and
- updating process and tailings water balances.

The revised snapshot years due to the MRDA Mine Plan are presented in Table 3.1-1, along with those presented in the EIA, Volume 4A, Section 6.2.4, Table 6.2-1 (Shell 2007) and the May 2008 EIA Update, Section 2.6.1, Table 2.6-1 (Shell 2008).

Table 3.1-1 Aquatic Resources Snapshots for the Jackpine Mine Expansion

EIA Snapshots	May 2008 EIA Update Snapshots	Revised Snapshots	Snapshot Description
2012	2012	2012	Project commencement
2033	2029	2033	Maximum muskeg drainage and overburden dewatering
2052	2049	2050	End of mining and maximum closed-circuit operation
2065	2065	2065	Closure
Far Future	Far Future	Far Future	Far Future

Although the timing would be modified, the maximum muskeg drainage and overburden dewatering, and end of mining and maximum closed-circuit operation snapshots will be within the range of years assessed in the EIA, as amended. Since the May 2008 EIA Update findings were comparable to the EIA findings (see Section 2.6 of the 2008 EIA Update; Shell 2008), the timing shift is not anticipated to affect the findings of the Aquatics

Resource Assessment in the May 2008 EIA Update. Therefore, the MRDA Mine Plan does not change the Aquatic Resources Assessment findings presented in the EIA, as amended.

The following sections discuss how the other changes in the MRDA Mine Plan affect the results of the Aquatic Resources Assessment.

3.2 Hydrogeology

The Hydrogeology Assessment for the Project was presented in Volume 4, Section 6.3 of the EIA. The changes in the MRDA Mine Plan potentially affect the results of the Hydrogeology Assessment in the following ways:

- seepage from the Thickened Tailings drying area potentially affects groundwater quality results;
- the smaller mine footprint potentially affects Basal Aquifer depressurization, Pleistocene Channel Aquifer dewatering, overburden dewatering, drawdown extent, seepage rates, and outflows to surface water; and
- changed mine pit cell locations and the locations and sizes of pit-lakes potentially affect the groundwater quality results.

Shell will capture surface runoff from DDA2 and direct this water back to the recycle pond for reuse. Additionally, groundwater in the vicinity of DDA2 will be assessed as part of Shell's groundwater monitoring program. If process-affected seepage is found to be migrating toward Shelley Creek or other surface water features, the seepage will be captured through active pumping or by ditching. When the mine advance reaches DDA2, process-affected overburden and groundwater beneath and adjacent to DDA2 will be excavated as part of mining operations.

The drawdown resulting from changes to the pit limits will not change the EIA conclusions. Considering the proposed mitigative measures to control potential seepage, predicted changes in groundwater outflows and groundwater quality effects are similar to or lower than those predicted in the EIA, as amended. Therefore, the changes in the MRDA Mine Plan do not change the Hydrogeology Assessment findings presented in the EIA, as amended. The hydrogeology assessment results are considered in the Hydrology Assessment (Section 3.3) and Water Quality Assessment (Section 3.4).

3.3 Hydrology

The hydrology assessment for the Project was presented in Volume 4, Section 6.4 of the EIA. The development of a MRDA mine plan will potentially affect the results of the surface water hydrology assessment by modifying the following mine features:

- mine plan development area including closed-circuited areas and reduced footprint of the Fort Hills OBDA;
- Muskeg River diversion using diversion channel on the north side of the mine development area during operation (2041 to closure); and
- closure drainage plan for the JME mine development area, including the following updates:
  - the sizes, layouts and locations of pit lakes (Northeast and Northwest Pit Lakes) and littoral zones;
  - MFT removal from Northeast Pit Lake; and

- addition of wetlands between the Fort Hills OBDA and pit lakes.

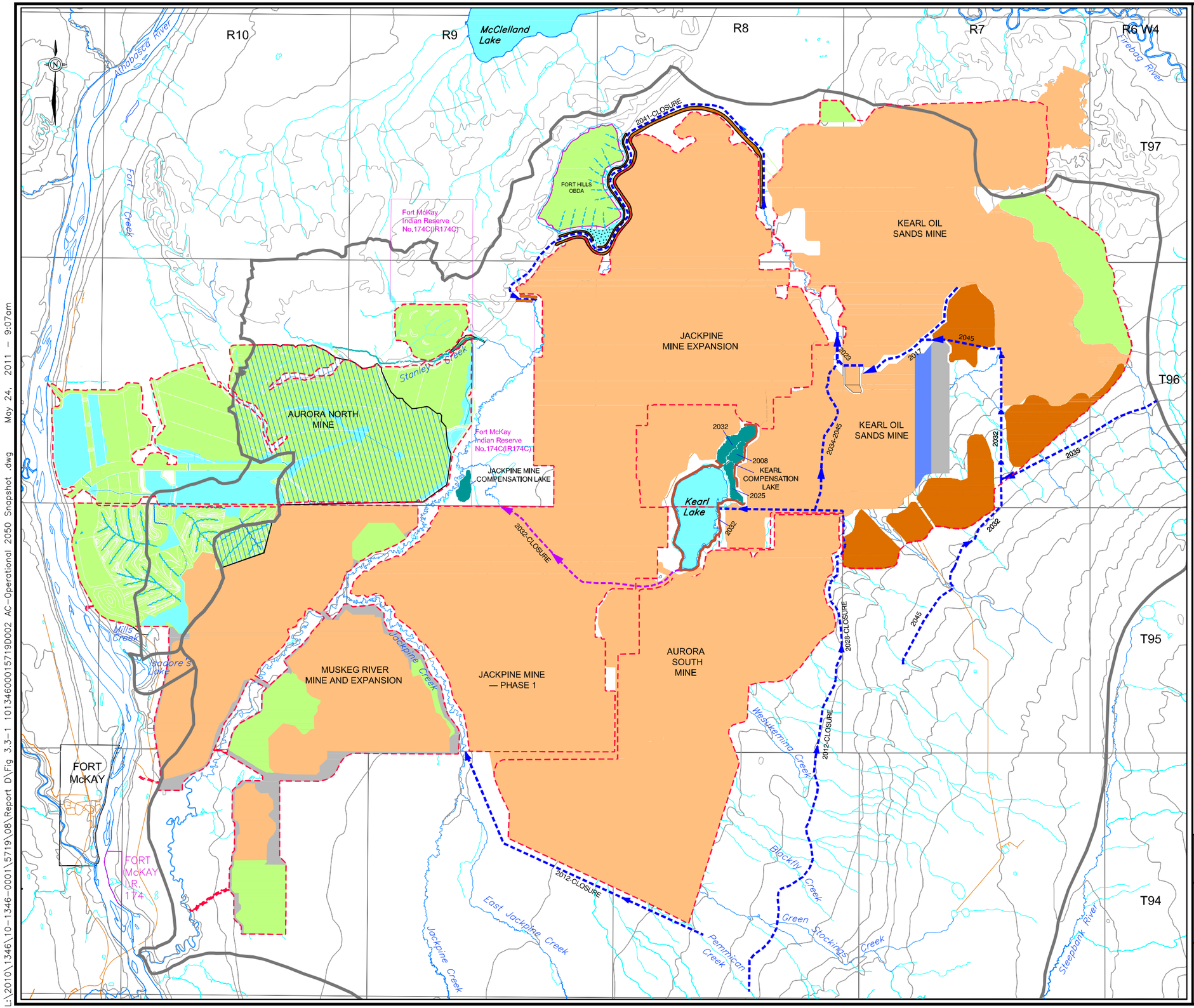
The focus of this assessment is on the Muskeg River watershed where the JME operations will occur.

The revised aquatic resources snapshots are shown in Table 3.1-1. Changes resulting from the MRDA Mine Plan only affect the operational (2050) and closure (2065 and Far Future) snapshots. For the remaining snapshots, flows resulting from the MRDA Mine Plan are expected to be comparable to the Application Case presented in the May 2008 EIA Update, so the MRDA Mine Plan will not affect the findings for the remaining snapshots. Figures 3.3-1 and 3.3-2 show the integrated operational water management and closure drainage plans for the Application Case – operational (2050) and Application Case – closure (2065 and Far Future) snapshots within the Muskeg River watershed that were used in the Aquatic Resources Assessment. The operational (2050) snapshot for the MRDA Mine Plan is different than the corresponding snapshot presented in the EIA. The MRDA Mine Plan replaces the proposed temporary diversion pipeline with an open channel on the north side of the development area. Moreover, the closure (2065 and Far Future) snapshot for the MRDA Mine Plan may potentially affect the results of the surface water hydrology assessment due to mine plan modification described above. Based on this reasoning, only assessment on the operational and closure snapshots are included in this discussion.

The approach used to assess the effect of the Project is the same as the approach outlined in the Volume 4, Section 6.4.2.7 of the EIA (Shell 2007). The residual Project effects on flows and water levels in the receiving streams for the operational and closure snapshots are characterized using the following hydrologic parameters:

- mean annual flows, mean open-water flows, mean ice-cover flows, 7Q10 low flows and 10-year return period flood discharge; and
- flow depth corresponding to mean annual flows, mean open-water flows, mean ice-cover flows, 7Q10 low flows and 10-year return period flood discharge.

The Application Case assessment evaluates the effects of the JME, and the existing and approved developments, including effects due to integration of operational water management and closure drainage plans, on the surface water hydrology within the Local Study Area (LSA) and Regional Study Area (RSA). The Project will include design features and mitigation measures to reduce the effects on hydrology. The design features and mitigation measures, included in the operational water management and closure drainage plans, follow the same management principles, objectives and design criteria, as outlined in the EIA.



LEGEND

- OPEN-CIRCUIT RECLAIMED AREA
- LAKE OR WETLANDS
- OPEN-CIRCUIT OVERBURDEN DISPOSAL AREA AND RMS
- CLOSE-CIRCUIT AREA
- CLEARED AREA
- MUSKEG DRAINAGE AND OVERBURDEN DEWATERING AREA
- DIVERTED AREA FROM MUSKEG RIVER WATERSHED
- MINE DEVELOPMENT BOUNDARY
- WATERSHED DIVIDE
- PROPOSED COMPENSATION LAKE
- LAKE PERIMETER DYKE
- DIVERSION DITCH
- DIVERSION PIPELINE
- OPERATIONAL BERM (BREACHED AT APPROXIMATELY 500 m SPACING AT CLOSURE)

NOTES

1. SNAPSHOTS ARE BASED ON THE LATEST MINE ADVANCE PLANS.
2. FIGURE REPRESENTS OPERATIONAL STATE IN 2049.
3. ALIGNMENT OF DIVERSION DITCHES AND PIPELINES ARE APPROXIMATE.

REFERENCE

ALBERTA DIGITAL DATA OBTAINED FROM ALTALIS LTD. (SEPTEMBER 2004.)
USED UNDER LICENSE.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: UTM ZONE 12

3 0 3
SCALE KILOMETRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

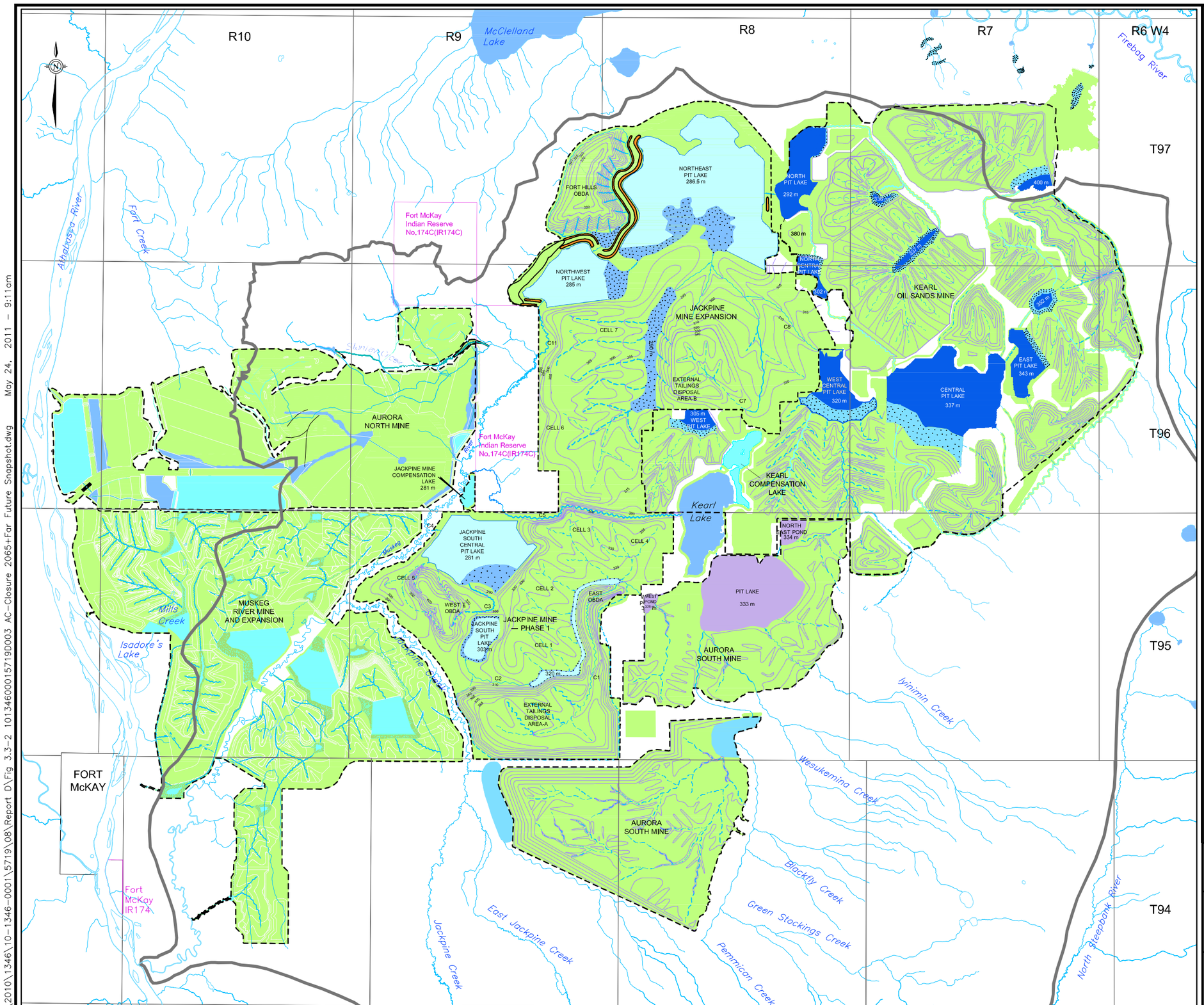
TITLE

APPLICATION CASE OPERATIONAL (2050) SNAPSHOT

Shell Canada Limited

PROJECT	10.1346.0001.5719		FILE	No.10134600015719D002	
DESIGN	MM	19/05/11	SCALE	AS SHOWN	REV. 0
CADD	PSR	19/05/11	FIGURE: 3.3-1		
CHECK	MM	24/05/11			
REVIEW	WES	24/05/11			

L:\2010\1346\10-1346-0001\5719\08\Report D\Fig 3.3-1 10134600015719D002 AC-Operational 2050 Snapshot .dwg May 24, 2011 - 9:07am



LEGEND

- MINE DEVELOPMENT BOUNDARY
- NATURAL WATERSHED DIVIDE
- 300 EXISTING CONTOUR
- 330 FINAL RECLAIMED SURFACE CONTOUR
- MAIN CHANNEL
- SECONDARY CHANNEL
- WETLANDS AND LITTORAL ZONE
- RECLAIMED SURFACE
- LAKE
- KEARL OIL SANDS MINE PIT LAKE
- AURORA SOUTH MINE PIT LAKE / WETLANDS
- SUBMERGED DYKE
- LAKE PERIMETER LEVEE
- KEARL LAKE CLOSURE OUTLET CHANNEL
- OPERATIONAL BERM (BREACHED AT APPROXIMATELY 500 m SPACING AT CLOSURE)

NOTE :

OBDA - OVERBURDEN DISPOSAL AREA

REFERENCE

ALBERTA DIGITAL DATA OBTAINED FROM ALTALIS LTD. (SEPTEMBER 2004.)
USED UNDER LICENSE.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: UTM ZONE 12

3 0 3
SCALE KILOMETRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

APPLICATION CASE CLOSURE (2065 AND FAR FUTURE) SNAPSHOT

Shell Canada Limited

PROJ	10.1346.0001.5719		FILE No.101346000157190003	
DESIGN	MM	19/05/11	SCALE AS SHOWN	REV. 0
CADD	PSR	19/05/11	FIGURE: 3.3-2	
CHECK	MM	24/05/11		
REVIEW	WES	24/05/11		

L:\2010\1346\10-1346-0001\5719\08\Report D\Fig 3.3-2 10134600015719D003 AC-Closure 2065+Far Future Snapshot.dwg May 24, 2011 - 9:11am

Effects on Flows and Water Levels

During Operation

The Hydrology Assessment for the Application Case – operational (2050) snapshot was reviewed. The predicted changes in water levels for Kearl Lake for the MRDA Mine Plan during operation are the same as those presented in the EIA. Predicted changes in Muskeg River flows due to the Project effects at various impact assessment nodes, M0 (downstream of Stanley Creek), M1 (downstream of Muskeg Creek), M2 (downstream of Jackpine Creek), and M3 (at the mouth), are presented in Tables 3.3-1, 3.3-2, 3.3-3 and 3.3-4.

For the 2050 snapshot, the predicted changes in flow parameters from pre-development case are comparable to those presented in the May 2008 EIA Update at various nodes (Nodes M0, M1, M2 and M3) on the Muskeg River. The expected mean annual flow, mean open-water flow, and 10-year flood flow are lower than the pre-development case due to the JME closed-circuit operations, but similar to the May 2008 EIA Update. The expected mean ice-cover flow and 7Q10 low flow are higher than pre-development case due to overburden dewatering flows during operation but similar to the results presented in the May 2008 EIA Update.

For the assessment, the flow statistics for the mean annual, mean open-water, mean ice-cover and 7Q10 low flow parameters are slightly higher than the May 2008 EIA Update at all nodes, except for the mean ice-cover flow at Nodes M0 and M1, which is slightly lower than the values in 2008 EIA Update. The 10-year flood flow statistics are much higher than the 2008 EIA Update due to removal of the surge pond in the MRDA Mine Plan.

Changes to flow depths at the Muskeg River Environment Canada hydrometric station that is located about 6 km from the mouth of the river are shown in Table 3.3-5. The changes to the annual average flow depth and annual maximum flow depth for the MRDA Mine Plan are similar to those presented in the May 2008 EIA Update.

Table 3.3-1 Changes to Application Case Assessment Results for Muskeg River Flows at Node M0

Expected Value of Parameter for Snapshot Conditions	Pre-Development	End of Operation (2050)		2065 and Far Future	
		May 2008 EIA Update (Change From Pre-Development)	MRDA Mine Plan (Change From Pre-Development)	May 2008 EIA Update (Change From Pre-Development)	MRDA Mine Plan (Change From Pre-Development)
area contributing to runoff [km^2]	480.	-252.	-235.	27.5	27.5
mean annual discharge [m^3/s]	1.36	-0.335	-0.270	0.063	0.103
mean open-water discharge [m^3/s]	2.22	-0.686	-0.570	-0.547	-0.511
mean ice-cover discharge [m^3/s]	0.163	0.160	0.150	0.901	0.955
7Q10 low flow discharge [m^3/s]	0.006	0.174	0.177	0.183	0.242
10-year flood peak discharge [m^3/s]	22.0	-16.3	-9.33	-15.9	-16.0

Table 3.3-2 Changes to Application Case Assessment Results for Muskeg River Flows at Node M1

Expected Value of Parameter for Snapshot Conditions	Pre-Development	End of Operation (2050)		2065 and Far Future	
		May 2008 EIA Update (Change From Pre-Development)	MRDA Mine Plan (Change From Pre-Development)	May 2008 EIA Update (Change From Pre-Development)	MRDA Mine Plan (Change From Pre-Development)
area contributing to runoff [km^2]	890.	-444.	-427.	-85.6	-85.6
mean annual discharge [m^3/s]	2.43	-0.709	-0.650	-0.030	0.007
mean open-water discharge [m^3/s]	3.96	-1.39	-1.27	-0.867	-0.831
mean ice-cover discharge [m^3/s]	0.300	0.228	0.222	1.11	1.16
7Q10 low flow discharge [m^3/s]	0.008	0.220	0.238	0.372	0.375
10-year flood peak discharge [m^3/s]	40.7	-30.7	-24.4	-27.3	-27.6

Table 3.3-3 Changes to Application Case Assessment Results for Muskeg River Flows at Node M2

Expected Value of Parameter for Snapshot Conditions	Pre-Development	End of Operation (2050)		2065 and Far Future	
		May 2008 EIA Update (Change From Pre-Development)	MRDA Mine Plan (Change From Pre-Development)	May 2008 EIA Update (Change From Pre-Development)	MRDA Mine Plan (Change From Pre-Development)
area contributing to runoff [km^2]	1333.	-511.	-495.	-40.1	-40.1
mean annual discharge [m^3/s]	3.54	-0.729	-0.670	0.237	0.281
mean open-water discharge [m^3/s]	5.80	-1.42	-1.31	-0.522	-0.484
mean ice-cover discharge [m^3/s]	0.421	0.202	0.200	1.24	1.29
7Q10 low flow discharge [m^3/s]	0.014	0.223	0.238	0.399	0.419
10-year flood peak discharge [m^3/s]	51.5	-29.1	-22.6	-24.9	-25.7

Table 3.3-4 Changes to Application Case Assessment Results for Muskeg River Flows at Node M3

Expected Value of Parameter for Snapshot Conditions	Pre-Development	End of Operation (2050)		2065 and Far Future	
		May 2008 EIA Update (Change From Pre-Development)	MRDA Mine Plan (Change From Pre-Development)	May 2008 EIA Update (Change From Pre-Development)	MRDA Mine Plan (Change From Pre-Development)
area contributing to runoff [km^2]	1475.	-584.	-568.	-30.2	-30.2
mean annual discharge [m^3/s]	3.75	-0.830	-0.770	0.289	0.326
mean open-water discharge [m^3/s]	6.13	-1.58	-1.48	-0.493	-0.465
mean ice-cover discharge [m^3/s]	0.463	0.177	0.182	1.32	1.37
7Q10 low flow discharge [m^3/s]	0.016	0.222	0.234	0.400	0.422
10-year flood peak discharge [m^3/s]	50.8	-27.4	-21.0	-22.9	-23.1

Table 3.3-5 Changes to Application Case Assessment Results for Muskeg River Flow Depths at Environment Canada Hydrometric Station

Expected Value of Parameter for Snapshot Conditions	Pre-Development		End of Operation (2050)		2065 and Far Future	
			May 2008 EIA Update (Change From Pre-Development)	MRDA Mine Plan (Change From Pre-Development)	May 2008 EIA Update (Change From Pre-Development)	MRDA Mine Plan (Change From Pre-Development)
	Discharge [m^3/s]	Depth [m]	Combined Effects [m]	Combined Effects [m]	Combined Effects [m]	Combined Effects [m]
Average Flow Depth						
mean annual discharge	3.75	0.76	-0.021	-0.020	0.007	0.009
mean open-water discharge[(a)]	6.13	0.83	-0.041	-0.038	-0.013	-0.012
mean ice-cover discharge[(a)]	0.463	0.68	0.005	0.005	0.034	0.035
7Q10 low flow discharge	0.016	0.67	0.006	0.006	0.010	0.011
10-year flood peak discharge	50.8	1.98	-0.707	-0.542	-0.591	-0.596
Maximum Flow Depth						
mean annual discharge	3.75	0.87	-0.027	-0.025	0.010	0.011
mean open-water discharge[(a)]	6.13	0.95	-0.052	-0.049	-0.016	-0.015
mean ice-cover discharge[(a)]	0.463	0.76	0.006	0.006	0.044	0.046
7Q10 low flow discharge	0.016	0.75	0.007	0.008	0.013	0.014
10-year flood peak discharge	50.8	2.43	-0.909	-0.697	-0.761	-0.767

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

During operation, the Muskeg River will be diverted using an open channel on the north side of the mine development area. The new diversion channel will be, for the most part, constructed in an area with relatively flat natural ground topography, and thus flow velocities in the channel will be low. During the post-construction "conditioning" period, some erosion of the new channels are anticipated, potentially with total suspended solids concentrations in excess of regulatory guidelines. The duration of the conditioning period could range from several days to several weeks. Sediment generation in the channel will be minimized by re-vegetation of stream banks, overbank areas and berms as soon as possible after construction and by the use of channel armour (riprap), where required. Relevant regulatory guidelines and standards of best management practices will be followed during construction activities. These mitigation measures will reduce the risk of increased sediment loadings to the receiving stream.

At Closure

The Hydrology Assessment for the Application Case – closure (2065 and Far Future) snapshot was reviewed. The predicted changes in water levels for Kearl Lake for the MRDA Mine Plan at closure are the same as those presented in the EIA. Tables 3.3-1, 3.3-2, 3.3-3, 3.3-4 and 3.3-5 provide predicted changes in Muskeg River flows due to the Project effects at impact assessment nodes (Nodes M0, M1, M2 and M3).

The mean open-water flow and the 10-year peak flow will be reduced and the mean ice-cover flow and 7Q10 low flow will be increased compared to the pre-development case due to the attenuation effects of the pit lakes. The combined effect would be increase in mean annual flow at all four nodes (Nodes M0, M1 M2 and M3) on the

Muskeg River compared to the pre-development value. The expected changes for the MRDA Mine Plan assessment are comparable to the results presented in the May 2008 EIA Update.

The incremental increases to the annual average and maximum flow depths at closure are similar to the results presented in the May 2008 EIA Update.

Conclusions

This assessment shows that the predicted effects on the surface hydrologic conditions in the Jackpine Creek, Kearl Lake, Muskeg River and the Athabasca River for the MRDA Mine Plan are practically the same as those presented in the EIA as updated. Based on the analysis, the MRDA Mine Plan, employing the mitigation measures identified in the Hydrology Assessment in the EIA, does not alter the results presented in the Hydrology Assessment in the EIA. The revised results are further considered in the Water Quality and Fish and Fish Habitat Assessments (Sections 3.4 and 3.6, respectively).

3.4 Water Quality

The Water Quality Assessment for the Project was presented in Volume 4, Section 6.5 of the EIA. The following assessment considers the environmental effects associated with the MRDA Mine Plan on watercourses and waterbodies in the Aquatic Resources LSA during operations and closure.

In most cases, changes within the MRDA Mine Plan would have no change or positive impacts on water quality compared to what was presented in the EIA, as amended. Examples of changes that would result in negligible changes to water quality include a 89 ha change in mine footprint and a small change in key snapshot years. Examples of changes that would result in positive impacts to water quality include improved fines sequestration and exclusion of MFT from the pit lakes.

In the MRDA Mine Plan, fine tailings will be eliminated from the aquatic landscape through a variety of means. Fines will be dried in DDA2, sequestered in Non-Segregating Tailings (NST) at a higher rate than originally anticipated and the remaining inventory will be thickened in centrifuges. Consequently, the pit lakes will contain no MFT.

The elimination of MFT from pit lakes will result in better overall pit lake water quality. Water quality will be improved because, instead of MFT, the remaining volume will be filled with Athabasca River water. Additionally, the long-term flux of tailings water that would otherwise be expressed from the MFT will also not be present in MFT-free pit lakes.

In these cases, reassessment was considered unnecessary because water quality would be as good as or better than that presented in the EIA, as amended, making these previously presented results a more conservative estimate of environmental impacts.

In the review of the MRDA Mine Plan, two changes were noted that could potentially result in decreased water quality compared to that presented in the EIA, as amended. These changes were as follows:

- creation and operation of DDA2 that will remove process-affected water from fine tailings; and
- creation of deeper pit lakes, which necessitates re-evaluation of meromictic and aeration potential.

The MRDA Mine Plan will include design features and mitigation measures to reduce the Project effects on water quality. The design features and mitigation measures included in the operational water management and closure drainage plans follow the same management principles, objectives and design criteria as outlined in the EIA.

Creation and Operation of a Thickened Tailings Drying Area

A Thickened Tailings drying area will be constructed and operated to the north of the planned closed-circuited area. As fine tailings are placed in the drying area, process-affected water will be released over a large area. This water will have to be managed according to practices currently planned for the closed-circuited water system. Mitigation planned for the closed-circuited water system has been designed to minimize impacts to receiving waterbodies and watercourses, as described in the EIA, Volume 4A, Section 6.1.2.4. Surface water and groundwater monitoring during operations and closure is described in Volume 4B, Appendix 4-9.

Based on the mitigation outlined in Section 3.2, effects on water quality due the construction and operation of DDA2 are expected to be negligible.

Creation of Deeper Pit Lakes

The deeper water columns of the revised pit lakes warranted evaluation of their potential to mix vertically and remain aerobic. The volumes, surface areas and other characteristics of the revised Northeast and Northwest Pit Lakes are listed in Table 3.4-1. The EIA model was rerun accounting for these changes. In addition to lake bathymetries, configuration of inflows, tributaries and seepage were modified to reflect MFT-free pit lakes. Other inputs remained the same as in the previous model.

Table 3.4-1 Characteristics of Pit Lakes

	Jackpine South Pit Lake	Jackpine South Central Pit Lake	Jackpine Northeast Pit Lake	Jackpine Northwest Pit Lake
total volume [Mm^3]	52	138	556	152
water volume [Mm^3]	52	138	556	152
tailings volume [Mm^3]	0	0	0	0
surface elevation [m]	303	281	286.5	285
mean water depth [m]	30	22	28	27
bottom material	overburden	overburden	overburden	overburden
discharge begins	2065	2065	2065	2065
discharge receptor	South Pit Lake	Muskeg River	Northwest Pit Lake	Muskeg River
mean annual outflow [m^3/s]	0.22	0.25	1.2	1.2
mean residence time [yr]	8	14	15	4
source waters	reclaimed landscape runoff, NST and seepage	Jackpine South Pit Lake, reclaimed landscape runoff, NST and seepage	Muskeg River, reclaimed landscape runoff, and NST flux and seepage, Kearl North Pit Lake and Kearl West Central Pit Lake	Jackpine Northeast Pit Lake, reclaimed landscape runoff, and seepage

The model predicted that both pit lakes would be dimictic. Example temperature profiles are shown in Figure 3.4-1 for a typical year. In both pit lakes, inverse thermal stratification begins in winter and is typically stable by April. Stratification persists until air temperature warms in the spring. During this time the lake surface warms and the ice-melted water mixes downward. This continues until temperatures in the lake are isothermal in summer. Thereafter, the surface water temperature continues to increase and stratification re-appears until the lake reaches maximum stability in September. Then, as air temperature drops in the autumn, the lake surface cools and the cooler water mixes downward. The isothermal conditions lead to a fall turnover, and then the cycle repeats itself annually.

Permanent vertical stratification, or meromixis, is not predicted to develop in either pit lake. The time-depth profile of total dissolved solids (TDS) and dissolved oxygen (DO) concentrations during the first 20 years at the deepest segment of Northeast Pit Lake are shown on Figures 3.4-2 and 3.4-3. This segment represents the deepest section of the proposed pit lakes. Concentrations in the contour plots are divided into a number of intervals and values in each interval are represented with an identical color. Figure 3.4-2 indicates that the TDS would stratify seasonally along with temperature, as indicated by the annual cycles of gradients with depth. Total dissolved solids stratification is mainly predicted to occur near the lake bed, with a relatively homogenous profile occurring annually in the majority of the water column.

As shown in Figure 3.4-3, the lakes are anticipated to have vertical gradients of DO, with lower concentrations near the lake bed throughout all of the years. Due to the replenishment during the annual or semi-annual vertical mixing, DO concentrations would be well above the aquatic life chronic guideline of 6.5 mg/L in most of the waterbody at all times. In addition, the DO in the lake would be sufficient for aerobic degradation of organic constituents.

This assessment indicates that the predicted effects on surface water quality in the Jackpine Creek, Kearl Lake, Muskeg River and pit lakes as well as the Athabasca River for the MRDA Mine Plan are less than or the same as those presented in the EIA, as amended.

Figure 3.4-1 Development of Thermal Stratification at Northeast Pit Lake (Typical Year)

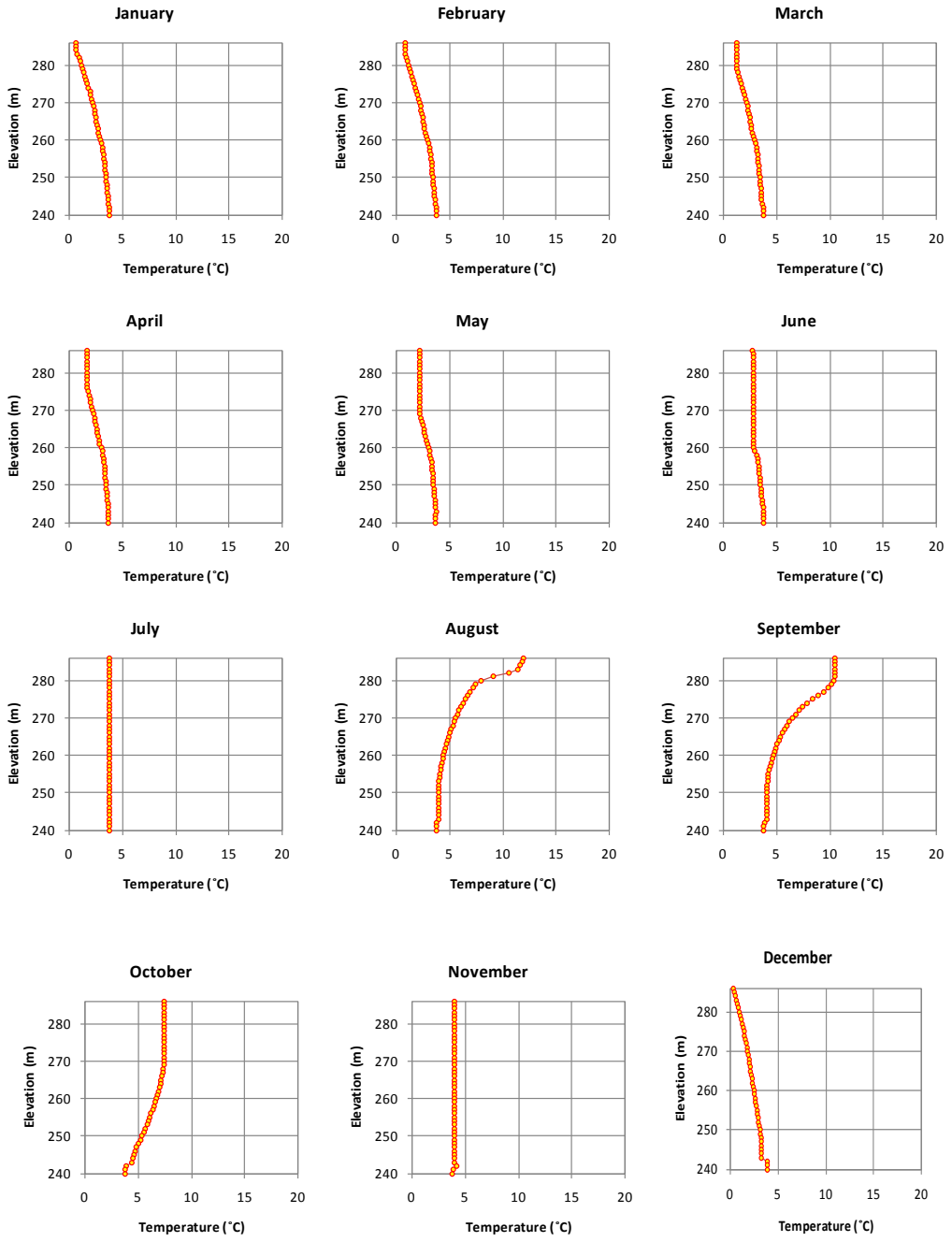


Figure 3.4-2 Contour of TDS (mg/L) at the Deepest Segment of Northeast Pit Lake

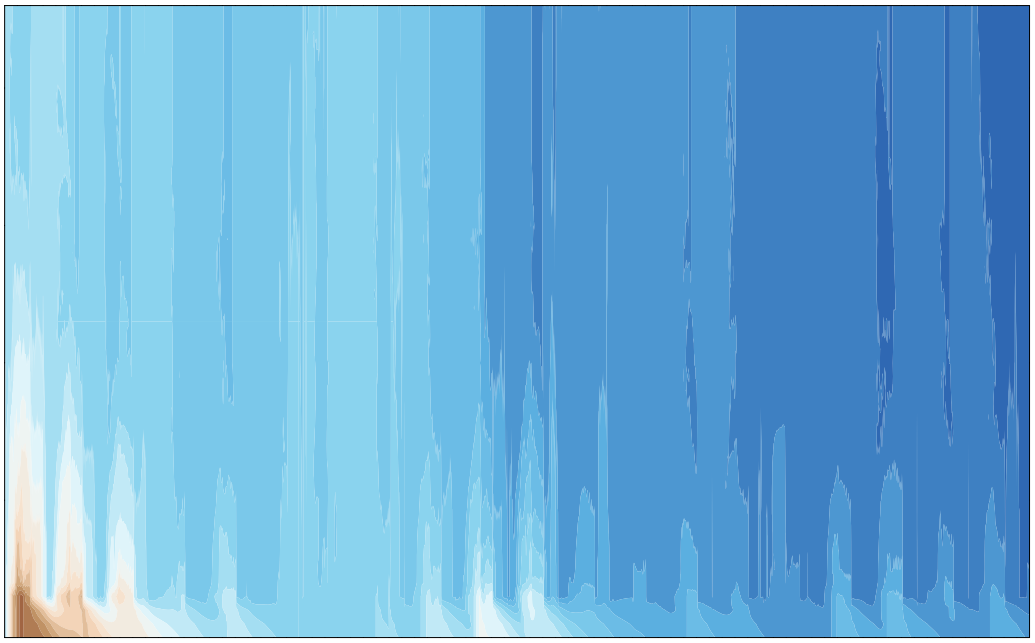
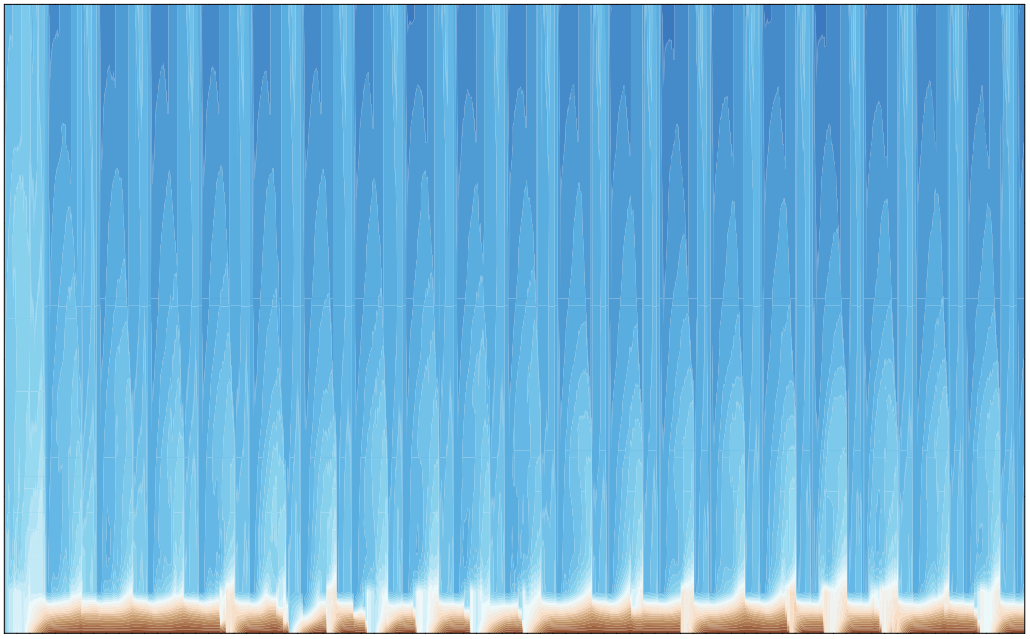


Figure 3.4-3 Contour of DO (mg/L) at the Deepest Segment of Northeast Pit Lake



3.5 Aquatic Health

The Aquatic Health Assessment for the Project was presented in Volume 4, Section 6.6 of the EIA. The MRDA Mine Plan affects the results of the Aquatic Health Assessment by modifying the results of the Water Quality Assessment (Section 3.4). The Water Quality Assessment takes into consideration results of the Hydrogeology and Hydrology Assessments.

Predicted surface water quality concentrations in Jackpine Creek, Kearl Lake, Muskeg River and pit lakes as well as the Athabasca River are expected to be the same as or better than was assessed in the EIA, Volume 4A, Section 6.5. The environmental consequence ratings and the mitigation measures presented in the Aquatic Health Assessment are the same for the MRDA Mine Plan. Therefore, the MRDA Mine Plan does not change the Aquatic Health Assessment findings presented in the EIA, as amended.

3.6 Fish and Fish Habitat

The Fish and Fish Habitat Assessment for the Project was presented in Volume 4, Section 6.7 of the EIA. The following assessment considers the environmental effects associated with the MRDA Mine Plan with a focus on the Muskeg River watershed where most of the JME activities will occur.

The Fish and Fish Habitat Assessment takes into consideration results of the Hydrology, Water Quality and Aquatic Health Assessments (Sections 3.3, 3.4 and 3.5, respectively).

Fish and fish habitat has been assessed using the methods described in Volume 4, Section 6.7 of the EIA. The approach used for this assessment is consistent with the EIA, as amended. Mitigation and compensation measures for fish and fish habitat are the same as those described in Volume 4, Section 6.7 of the EIA, and are being further defined in the draft No Net Loss Plan currently under development.

Minor changes in streamflow and habitat accessibility within the Muskeg River in the 2050 (maximum closed circuit) and Far Future snapshots relative to the conditions assessed in the EIA, as amended. Consequently, the linkages associated with changes in streamflow are carried through to the assessment below. Water Quality (Section 3.4) and Aquatic Health (Section 3.5) results for the MRDA Mine Plan are predicted to be the same or better than in the EIA as amended and the linkage analysis for these pathways would remain invalid, consistent with what was presented in the EIA.

Changes in Habitat Area

The MRDA Mine Plan will not change the estimated fish habitat areas for watercourse segments and waterbodies directly lost due to the JME. As a result, the preliminary estimates of habitat area losses associated with the JME provided in the EIA (Volume 4, Section 6.7.5.3) and the Conceptual Compensation Plan (CCP) (Volume 4, Appendix 4-6 of the EIA) are consistent with the MRDA Mine Plan. The details of the proposed habitat compensation for the Project are currently being developed in the draft No Net Loss Plan and remain unchanged by the MRDA Mine Plan.

Changes in Streamflows

A summary of the predicted changes in mean annual discharge, mean open-water discharge, mean ice-cover discharge, 7Q10 low flow discharge, 2-year flood peak discharge and 10-year flood peak discharge for the 2050 and closure time snapshots and at four node locations on the Muskeg River are presented in Tables 3.3-1 to 3.3-4. All other time snapshots will remain unchanged from the EIA as amended.

Changes in flow parameters in the Muskeg River predicted for the Application Case – 2050 snapshot of maximum closed-circuit operations compared with the change in flows predicted for the EIA as amended are presented and summarized in the Hydrology Assessment (Section 3.3). The flow parameters for the Application Case - 2050 time snapshot presented in the May 2008 EIA Update and those for the MRDA Mine Plan are similar for all nodes on the Muskeg River, with the exception of the 2-year and 10-year peak flow statistics. The MRDA Mine Plan results in a smaller change in peak flow statistics relative to Base Case, and therefore the potential impacts associated with reduced peak flows during operations as described in the EIA as amended would be reduced.

Changes in flow parameters in the Muskeg River predicted after closure for the MRDA Mine Plan compared with the change in flows predicted for the EIA, as amended are presented and summarized in the Hydrology Assessment (Section 3.3). The flow parameters in the Far Future time snapshot presented in the May 2008 EIA Update and those for the MRDA Mine Plan are similar for all nodes on the Muskeg River, with differences relative to the May 2008 EIA Update of less than 0.74 m^3/s for peak flow statistics, 0.04 m^3/s for mean flow statistics and 0.05 m^3/s for ice-covered and low flow statistics. In the instance of the peak flow statistic, the change relative to the May 2008 EIA Update resulted in a flow value that was more similar to the original flow assessed in the EIA.

In general, the effects of changes in streamflow on fish habitat and fish abundance in the Muskeg River are as described in the EIA as amended, with smaller changes to peak flows predicted for the Application Case – 2050 snapshot. Furthermore, as discussed in the EIA, Shell will compensate for the loss of fish habitat associated with JME effects and participate in regional monitoring programs in the Muskeg River. A detailed assessment of habitat losses due to the Project will be included in the draft No Net Loss Plan.

Changes in streamflows at closure are similar to those described in the EIA, as amended with very little change to the peak flow statistics, so there is no change to the EIA, as amended conclusions for channel morphology, benthic invertebrate communities or drift, or habitat accessibility in the Muskeg River.

Habitat Accessibility

The MRDA Mine Plan will maintain habitat connectivity within the upper Muskeg River during operations and the smaller reduction in peak flows during the Application Case – 2050 snapshot would also reduce the potential for disruption of spring fish migrations. As a result, the MRDA Mine Plan would have a reduced impact on fish accessibility compared to the assessment provided in the EIA as amended.

Conclusions

This assessment shows that the predicted effects on fish and fish habitat are essentially the same as those presented in the EIA, as amended for the Muskeg River watershed for the MRDA Mine Plan, with improved habitat accessibility during the Application Case – 2050 snapshot. Based on the analysis, the MRDA Mine Plan does not alter the environmental consequence ratings and mitigations presented in the Fish and Fish Habitat Assessment in the EIA, as amended.

4.0 CLOSURE, CONSERVATION AND RECLAMATION

4.1 Introduction

This section discusses changes to the conceptual Closure, Conservation and Reclamation (C,C&R) Plan to reflect the changes in the MRDA Mine Plan. The MRDA Mine Plan is presented in Section 2 of the May 2011 Submission of Information to the Joint Review Panel. The Closure Drainage Plan is presented in Section 2.2.6, Closure Drainage Plan & Closure Landscape. The closure plan includes the development areas created by soil salvage and clearing for the developments associated with the 20,724 ha MRDA Mine Plan footprint. This C,C&R Plan does not include areas that are indirectly affected by surface water drawdown or impoundment.

The following amendments to the MRDA Mine Plan have dictated changes to the C,C&R Plan:

- larger Project development area resulting from the diversion of the Muskeg River to the north of the mine pit;
- reconfiguration of the Fort Hills OBDA; and
- alterations to the closure drainage plan (channels, littoral zones and pit lakes).

All amendments to the MRDA Mine Plan are described in detail in Section 2.

Conservation and reclamation goals and principles are consistent with the C,C&R Plan for JME (Appendix II; Shell 2008). This plan presents the areal extent of target vegetation types and estimated timber productivity ratings at closure, expected land capability classifications, and an estimate of the overall reclamation material balance for the MRDA Mine Plan.

4.2 Closure Planning Considerations

The MRDA Mine Plan will result in a larger development footprint and a reconfiguration of the Fort Hills OBDA and pit lakes. The Jackpine Mine – Phase 1 area will remain identical to the JME Update (Appendix II; Shell 2008) at closure, except for the reconfiguration of the littoral zones in the Jackpine South Central Pit Lake. The following assumptions specific to this amended closure plan were made for closure planning (i.e., soil placement and revegetation) purposes:

- The operational berms used to control drainage from the Fort Hills OBDA will be recontoured to integrate with adjacent topography at closure.
- The other areas disturbed by the construction of the operational diversion channel will be permanently reclaimed immediately following construction.
- Areas that are disturbed by operations, but where no soil is salvaged, will be revegetated as soon as practical.

General closure planning assumptions considered in this closure plan are consistent with those presented in the C,C&R Plan for JME (Appendix II; Shell 2008) and the Kearl Lake Levee Assessment (Section 2.0, Appendix B, Shell 2009).

4.3 Closure and Reclamation Plan

The revegetation goal is to provide a diverse vegetation community mix on the reclaimed landscape that will integrate with surrounding developed and undeveloped areas, and achieve land capability classes equivalent to those present in pre-development conditions. The planting prescriptions presented in the C,C&R Plan for JME (Appendix II; Shell 2008) consider variations in slope, aspect, drainage, reclamation material, depth and composition to start the process of reaching a target ecosite (OSVRC 1998). Shell is aware of the updated *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region* (AENV 2010) and plans to utilize them in operational closure and reclamation planning. The planting prescriptions for the MRDA Mine Plan are consistent with the C,C&R Plan for JME (Appendix II; Shell 2008), so that a direct comparison can be achieved with the terrestrial assessment. Shell will utilize the most current revegetation guidelines available at the time of reclamation, to ensure that closure landscapes are designed to meet reclamation certification criteria agreed upon by stakeholders.

Figure 1.1-2 presents the closure target planting prescriptions and Table 4.3-1 provides the changes to predevelopment ecosite phases and target ecosite phases at closure. The net changes for upland ecosites, wetlands and non-vegetation types are the same or similar to those presented in the May 2008 EIA Update (Shell 2008).

Table 4.3-1 Vegetation Types (Ecosite Phases, Wetlands Types and Other Types) to be Cleared and Reclaimed in the MRDA Mine Plan Development Area

Map Code	Description	Pre Development		Closure		Net Change[(a)]	
		Area [ha]	% of Development Area	Area [ha]	% of Development Area	Area [ha]	% of Development Area
Central Mixedwood Natural Subregion Ecosite Phases							
a1	lichen jack pine	170	1	981	5	811	4
b1	blueberry jack pine-aspen	533	3	143	1	-390	-2
b2	blueberry aspen (white birch)	403	2	0	0	-403	-2
b3	blueberry aspen-white spruce	155	1	76	<1	-79	-<1
b4	blueberry white spruce-jack pine	56	<1	330	2	274	2
c1	Labrador tea-mesic jack pine-black spruce	92	<1	2,440	12	2,348	12
d1	low-bush cranberry aspen	760	4	1,508	7	748	3
d2	low-bush cranberry aspen-white spruce	1,875	9	1,614	8	-261	-1
d3	low-bush cranberry white spruce	428	2	0	0	-428	-2
e1	dogwood balsam poplar-aspen	266	1	44	<1	-222	-1
e2	dogwood balsam poplar-white spruce	36	<1	0	0	-36	-<1
e3	dogwood white spruce	1	<1	0	0	-1	-<1
f2	horsetail balsam poplar-white spruce	68	<1	445	2	377	2
f3	horsetail white spruce	257	1	417	2	160	1
g1	Labrador tea-subhygric black spruce-jack pine	145	1	6,254	30	6,109	29
h1	Labrador tea/horsetail white spruce-black spruce	140	1	51	<1	-89	-<1
Pj-Lt	jack pine-tamarack complex	14	<1	0	0	-14	-<1
central mixedwood ecosite phase subtotal		*5,399*	26	*14,303*	69	*8,904*	*43*

Table 4.3-1 Vegetation Types (Ecosite Phases/Wetlands Types) to be Cleared and Reclaimed in the MRDA Mine Plan Development Area (continued)

Map Code	Description	Pre Development		Closure		Net Change[a]	
		Area [ha]	% of Development Area	Area [ha]	% of Development Area	Area [ha]	% of Development Area
Wetlands							
BFNN	forested bog	<1	<1	0	0	-<1	-<1
BONN	open bog	61	<1	0	0	-61	-<1
BTNI	wooded bog with internal lawns	553	3	0	0	-553	-3
BTNN	wooded bog	506	2	0	0	-506	-2
BTNR	wooded bog with internal lawn with islands of forested peat plateau	3	<1	0	0	-3	-<1
BTXC	wooded bog with collapsed scars	12	<1	0	0	-12	-<1
FFNN	forested fen	2	<1	0	0	-2	-<1
FONG	graminoid fen	767	4	0	0	-767	-4
FONS	shrubby fen	1,995	10	0	0	-1,995	-10
FOPN	open patterned fen	185	1	0	0	-185	-1
FTNI	wooded fen with internal lawns	409	2	0	0	-409	-2
FTNN	wooded fen	2,957	14	0	0	-2,957	-14
FTPN	wooded patterned fen	229	1	0	0	-229	-1
MONG	marsh	524	3	0	0	-524	-3
SONS	shrubby swamp	1,503	7	0	0	-1,503	-7
STNN	wooded swamp	485	2	0	0	-485	-2
WONN	shallow open water	23	<1	0	0	-23	-<1
	wetlands subtotal	*10,214*	*49*	*0*	*0*	*-10,214*	*-49*
Miscellaneous Vegetation Types							
BUu	burn upland	926	4	0	0	-926	-4
BUw	burn wetlands[b]	1,855	9	0	0	-1,855	-9
Sh	shrubland	361	2	0	0	-361	-2
Sh2	shrubland type 2	0	0	149	1	149	1
Sh3	shrubland type 3	0	0	1,795	9	1,795	9
	miscellaneous vegetation types subtotal	*3,142*	*15*	*1,944*	*10*	*-1,198*	-5
Non-Vegetation Types							
Lake	lake	1,442	7	3,374	16	1,932	9
River	river	16	<1	0	0	-16	-<1
Littoral zone	littoral zone	0	0	1,104	5	1,104	5
	non-vegetation types subtotal	*1,458*	*7*	*4,478*	*21*	*3,020*	*14*
Disturbances							
cutblock	cutblock	37	<1	0	0	-37	-<1
DIS	disturbance	474	2	0	0	-474	-2
	disturbances subtotal	*511*	*2*	*0*	*0*	*-511*	*-2*
Total		**20,724**	**100**	**20,724**	**100**	**0**	**0**

[a] This table presents ecosites for the areal extent of the development footprint including the approved closure plan for the Jackpine Mine – Phase 1 and pre-development ecosites for the JME.

[b] Net change from pre-development to Closure in the entire development area.

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

Revised ratings for timber productivity at closure based on the target ecosites are presented in Table 4.3-2. The proportions of areas for productive and non-productive timber are very similar to those presented in the May 2008 EIA Update (Shell 2008).

Table 4.3-2 Timber Productivity Rating for Target Closure Ecosites

Timber Productivity Rating Description	Pre-Development		Closure Area[(a)]		Net Change	
	area	%	[ha]	%	area	%
Timber Productive						
good	4,619	22	4,695	23	76	0
moderate	2,917	14	3,302	16	385	2
fair	362	2	6,305	30	5,943	29
subtotal	*7,899*	*38*	*14,303*	*69*	*6,405*	*31*
Non-timber Productive						
unproductive	5,504	27	0	0	-5,504	-27
non-treed[(b)]	5,390	26	1,944	9	-3,446	-17
non-vegetated[(c)]	1,932	9	4,478	22	2,546	12
subtotal	*12,825*	*62*	*6,422*	*31*	*-6,404*	*-31*
Total	**20,724**	**100**	**20,724**	**100**	**0**	**0**

(a) The C,C&R plan presents pre-development information for the areal extent of the development footprint only. The terrestrial assessment (Section 5) considers the LSA and the approved closure plan areas for the Jackpine Mine – Phase 1.

(b) Non-treed types include open terrestrial and wetlands types.

(c) Non-vegetated types include water types and disturbances.

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

The predicted closure land capability classifications are shown on Figure 4.3-1 and changes to pre-development land capability classes and the target land capability classes at closure are presented in Table 4.3-3. The changes in land capability classes are similar to the May 2008 EIA Update (Shell 2008) due to the similarities in closure assumptions, and reclamation guidelines and principles. There are shifts in the types of Class 5 where there will be less lake surface area and greater areas of littoral zones. These changes are a result of the amended MRDA Mine Plan (Section 2).

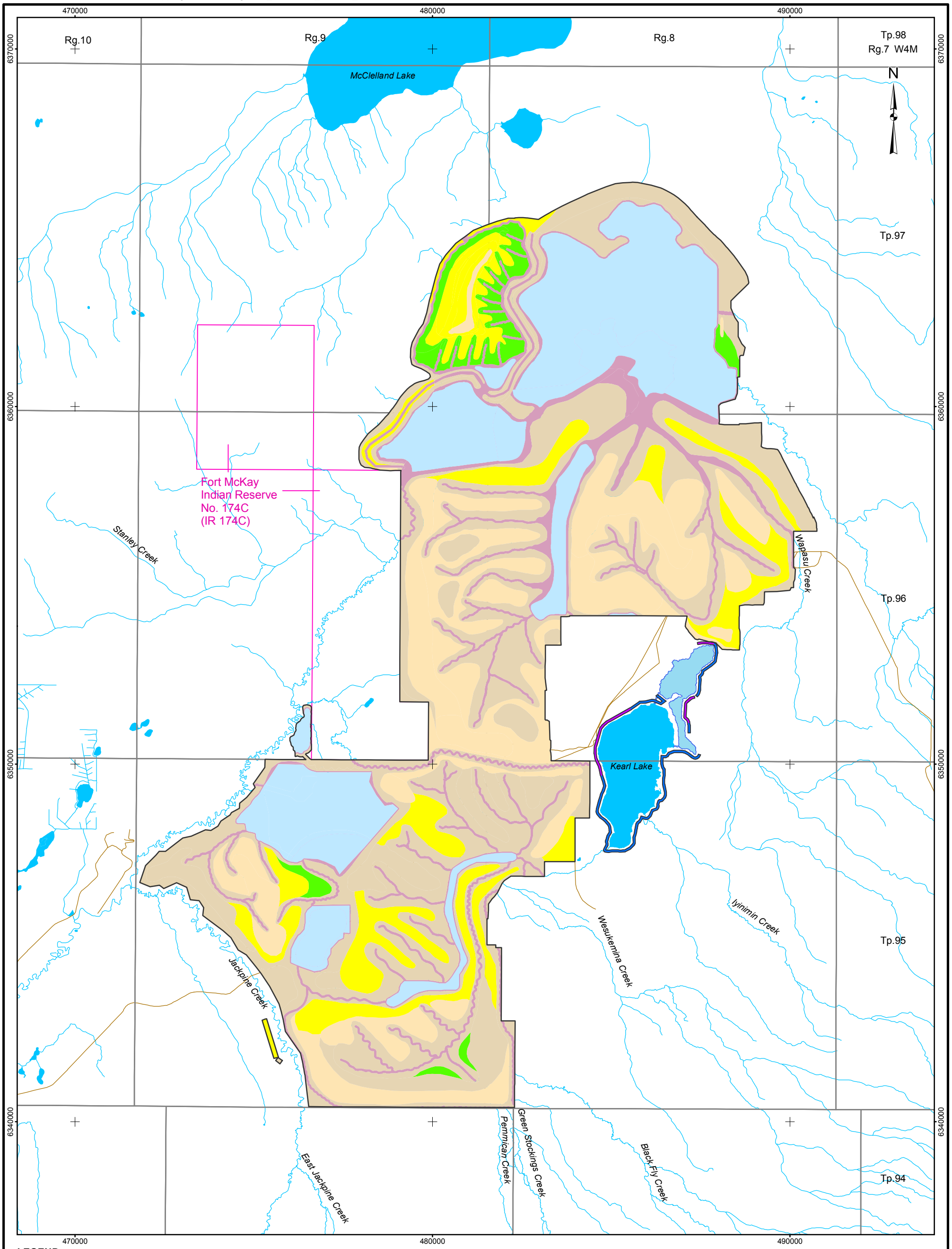
Table 4.3-3 Changes in Predicted Forestry Capability Class Following Reclamation in the MRDA Mine Plan Development Area

Forestry Capability Class	Pre-Development		Closure		Net Change	
	[ha]	% of Development Area	[ha]	% of Development Area	[ha]	% of Development Area
1 (high)	59	<1	489	2	430	2
2 (moderate)	1,827	9	2,235	11	408	2
3 (low)	130	<1	3,999	19	3,869	19
4 (conditionally productive)	3,460	17	7,529	36	4,069	19
5 (non-productive)	14,893	72	1,994	10	-12,899	-62
5 Aquatics (littoral zone)	0	0	1,104	5	1,104	5
5 Lakes (water)	55	<1	3,328	16	3,273	16
compensation lake	0	0	45	<1	45	<1
disturbances	300	1	0	0	-300	-1
Total	**20,724[(a)]**	**100**	**20,724**	**100**	**0**	**0**

[(a)] The C,C&R plan presents pre-development information for the areal extent of the development footprint only. The terrestrial assessment (Section 5) considers the LSA and the approved closure plan areas for the Jackpine Mine – Phase 1.

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

I:\CLIENTS\SHELL\10-1346-0001\mapping\mxd\5719\Fig4-3-1_Predicted _Closure_Land_Capabilities_MRD_FINAL.mxd



LEGEND

- PUBLIC ROADWAY
- INDIAN RESERVE
- MUSKEG RIVER DIVERSION ALTERNATIVE FOOTPRINT
- OPEN WATER
- COMPENSATION LAKE
- PLANTING PRESCRIPTION FOR LEVEE AREAS ADJACENT TO UPLANDS
- PLANTING PRESCRIPTION FOR LEVEE AREAS ADJACENT TO WETLANDS

LAND CAPABILITY

- WATER (0)
- HIGH CAPABILITY (1)
- MODERATE CAPABILITY (2)
- LOW CAPABILITY (3)
- CONDITIONALLY PRODUCTIVE (4)
- NON PRODUCTIVE (5 - TERRESTRIAL)
- NON PRODUCTIVE (5 - WETLANDS AND AQUATICS)

REFERENCE

ALBERTA DIGITAL DATA OBTAINED FROM ALTALIS LTD. © GOVERNMENT OF ALBERTA 2008 (ALL RIGHTS RESERVED), AND IHS ENERGY LTD. (AUGUST 2006), USED UNDER LICENSE.
DATUM: NAD83 PROJECTION: UTM ZONE 12

2 0 2
SCALE 1:100,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
PREDICTED CLOSURE LAND CAPABILITY CLASSIFICATIONS

Shell Canada Limited

PROJECT NO. 10-1346-0001			FILE No.	N/A
DESIGN	JB	08 Dec 2010	SCALE AS SHOWN	REV. 0
GIS	CH	20 May 2011		
CHECK	AD	20 May 2011		
REVIEW	SS	20 May 2011		

FIGURE: 4.3-1

4.4 Reclamation Material Balance

The conservation and reclamation principles considered for the MRDA Mine Plan are consistent with those presented in the C,C&R Plan for JME (Appendix II; Shell 2008). The total cumulative reclamation material volumes will be verified in closure and reclamation planning required as part of an *Environmental Protection and Enhancement Act* (EPEA) approval in the future. The volume estimates of stripped reclamation material are derived from the soil map unit areas, their series composition, and estimated salvage depths. The locations of upland soil and peat-mineral soil types for salvage within the Jackpine Mine – Phase 1 and JME development areas are described in the *Terrestrial Environmental Setting Report for the Jackpine Mine Expansion and Pierre River Mine Project* (Golder 2007).

Table 4.4-1 presents the estimated volumes of reclamation material available and required for the MRDA Mine Plan development area. These volumes have been calculated to confirm that there is sufficient reclamation material to execute the closure plan for the expanded Jackpine Mine given the changes noted for the MRDA Mine Plan. The May 2008 EIA Update (Shell 2008) included lower subsoil in the calculations for available reclamation material, but they have not been included here. If soil materials described in the prescriptions are not available at the time of reclamation, suitable reclamation materials (i.e., peat-mineral mix, suitable overburden) may be used in conjunction with salvaged upland soils to establish reclamation targets, with emphasis on direct placement. The annual detailed soil placement and revegetation plans will be provided during operations as required by the EPEA approval conditions.

Table 4.4-1 Estimated Overall Reclamation Material Balance for the MRDA Mine Plan Development Area

	Medium to Fine Upland Surface Soil	Coarse Upland Surface Soil	Medium to Fine Upland Subsoil	Coarse Upland Subsoil	Peat-Mineral Mix
	[1,000 m^3]	[1,000 m^3]	[1,000 m^3]	[1,000 m^3]	[1,000 m^3]
Reclamation Material Available	9,139	5,947	8,824	10,381	116,073
Reclamation Material Required	9,139	5,947	16,576	5,353	52,085
Balance	**0**	**0**	**-7,751**	**5,028**	**63,998**

All upland surface soil will be used in reclamation. There is sufficient upland surface soil to place on reclamation prescriptions for ecosites a through d. Prescriptions for ecosites e through h and Sh2 and Sh3 will utilize peat-mineral mix as a reclamation amendment.

There is a deficit in medium to fine upland subsoil volumes because the balances only consider the available upper medium to fine uplands subsoil volumes. Lower subsoil will be salvaged where necessary or suitable medium to fine overburden will be used to fulfill the requirements for reclamation soil prescriptions.

Given the excess, only enough poor subsoil will be salvaged for what is required or any excess will be used as mineral capping material for reclamation and closure operations. This capping material will be used according to approval conditions for reclamation of the closure landscape.

There is an excess of peat-mineral mix available for reclamation purposes. Peat-mineral mix will be salvaged from mining areas only and from designated areas within the Kearl Lake Levee development area. Shell will

preferentially salvage transitional soils and salvage at least the top 1 m metre of peat from deep peat areas. The goal will be to salvage sufficient material for reclamation so that no residual stockpiles of peat-mineral mix remain at closure.

4.5 Summary

The closure plan presented in this section confirms that the MRDA Mine Plan will result in a similar closure and reclamation plan to what was provided in the May 2008 EIA Update. Minor modifications that were required for the MRDA Mine Plan include:

- greater area of littoral zones and smaller pit lake surface area due to D074 compliance;
- more shrubland prescriptions as a result of the increase in drainage channels surrounding the Fort Hills OBDA;
- reduced areal extent of f2 and f3 target ecosites due to the reconfiguration of the Fort Hills OBDA; and
- increased areal extent of g1 target ecosites due to an increase in level topography at closure and the addition of the diversion channel.

5.0 TERRESTRIAL RESOURCES

5.1 Introduction

The Terrestrial Assessment for the Project was presented in Volume 5, Section 7 of the EIA (Shell 2007). The MRDA Mine Plan will result in modification of the development area and the C,C&R plan presented for the Project in the EIA updates (Shell 2008, 2009b) (Section 4), and potentially affects the results of the Terrestrial Assessment in the following ways, described in more detail in Section 4.2:

- the Project development footprint increases by 89 ha due to diversion of the Muskeg River to the north of the mine pit;
- 33 ha of the footprint extends outside the original LSA in the northwest;
- reconfiguration of the Fort Hills OBDA;
- alterations to the closure drainage plan (channels, littoral zones and pit lakes); and
- creation and operation of a Thickened Tailings drying area (DDA2).

At closure, the open channel used to divert the Muskeg River will be closed and reclaimed such that the river will be directed through the Northeast Pit Lake, then through the Northwest Pit Lake to rejoin with natural flows on the west side of the JME. No new linkages are required for the MRDA Mine Plan relative to the EIA, as amended.

The MRDA Mine Plan is compared to the EIA (Shell 2007) and previous EIA updates (Shell 2008, 2009b), as appropriate. To focus this analysis on changes associated with the MRDA Mine Plan, the 169 ha of the Kearl Lake Levee (direct impact area of 92 ha and a potential impoundment area of 77 ha) is included in area totals for the MRDA Mine Plan analysis.

To analyze the effects due to the MRDA Mine Plan, a revised LSA of 29,624 ha was used, which falls within the Central Mixedwood Natural Subregion (Figure 5.1-1). The LSA incorporates 18,341 ha associated with JME (Shell 2008), 169 ha associated with the Kearl Lake Levee (Shell 2009) and 11,004 ha associated with the Jackpine Mine – Phase 1 approved closure plan area. This contrasts with the C,C&R plan, which presents pre-development information for the areal extent of the development footprint only. The LSA also includes a less than 1% (111 ha) increase in study area size compared to the amended (Shell 2008) EIA LSA, due to 33 ha of the MRDA Mine Plan footprint that extends outside the original JME LSA and 78 ha of the new LSA buffer. Within the revised LSA, developments associated with the MRDA Mine Plan result in a Project footprint of approximately 20,724 ha. Excluding the 7,828 ha footprint of the Jackpine Mine – Phase 1 area, the MRDA Mine Plan footprint is 12,896 ha.

The LSA and footprint components used in this MRDA Mine Plan Project Update are presented in Table 5.1-1.

Table 5.1-1 Local Study Area and Footprint Components

Local Study Area or Footprint Component	Local Study Area (Base Case and Closure)	Loss/Alteration due to the Project (Application Case Footprint)
	Area [ha]	Area [ha]
MRDA Mine Plan (excluding the Kearl Lake Levee, Jackpine Mine – Phase 1 and the NW MRDA Mine Plan footprint portion)	18,341	-
Northwest MRDA Mine Plan footprint portion that is outside Original JME LSA	33	-
Northwest LSA buffer around footprint	78	-
Kearl Lake Levee (excluding impoundment area)	92	-
Kearl Lake Levee Impoundment Area (between Kearl Lake and the Kearl Lake Levee)	77	-
Jackpine Mine – Phase 1 LSA	11,004	-
MRDA Mine Plan footprint (excluding the Kearl Lake Levee and Jackpine Mine – Phase 1)	-	-12,804
Kearl Lake Levee (site clearing Footprint)	-	-92
Jackpine Mine – Phase 1 Closure Plan approved area	-	-7,828
Total	**29,624**	**-20,724**

- = Not applicable.

Residual impacts and environmental consequences were assessed at the local and regional scales using the same approach and criteria as described in the EIA (Volume 5, Section 7.5 and Volume 3, Section 1.3.6). To directly compare this assessment with the EIA, as amended, the effects of the Project on the JME and Pierre River Mine (PRM) (21,136 ha) LSAs were considered.

I:\CLIENTS\SHELL\10-1346-0001\mapping\mxd\5719\Fig5-1-1_Local_Study_Area_Extended_FINAL.mxd

470000 480000 490000

6370000 6360000 6350000 6340000

Rg.10 Rg.9 Rg.8 Tp.98 Rg.7 W4M

Tp.97 Tp.96 Tp.95 Tp.94

N

McClelland Lake

Fort McKay
Indian Reserve
No. 174C
(IR 174C)

Stanley Creek

Kearl Lake

Wapasu Creek

Iyinimin Creek

Wesukemina Creek

Muskeg River

Jackpine Creek

East Jackpine Creek

Pemmican Creek

Green Stockings Creek

Black Fly Creek

LEGEND

- PUBLIC ROADWAY
- INDIAN RESERVE
- OPEN WATER
- JACKPINE MINE - PHASE 1 APPROVED AREA
- JACKPINE MINE - PHASE 1 PROJECT FOOTPRINT
- JACKPINE MINE EXPANSION EIA LOCAL STUDY AREA
- MUSKEG RIVER DIVERSION ALTERNATIVE FOOTPRINT
- KEARL LAKE LEVEE
- INSIDE KEARL LAKE LEVEE
- LOCAL STUDY AREA

2 0 2

SCALE 1:100,000 KILOMETRES

REFERENCE

ALBERTA DIGITAL DATA OBTAINED FROM ALTALIS LTD. © GOVERNMENT OF ALBERTA 2008. ALL RIGHTS RESERVED,
IHS ENERGY LTD. (AUGUST 2006)
DATUM: NAD83 PROJECTION: UTM ZONE 12

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

JACKPINE MINE EXPANSION
MUSKEG RIVER DIVERSION ALTERNATIVE
LOCAL STUDY AREA

Shell Canada Limited

PROJECT NO. 10-1346-0001			FILE No.	N/A
DESIGN	AD	24 Jan. 2011	SCALE AS SHOWN	REV. 0
GIS	CH	20 May 2011		
CHECK	AD	20 May 2011		
REVIEW	SS	20 May 2011		

FIGURE: 5.1-1

5.1.1 Incremental Changes in Loss/Alteration

Incremental changes comparing the MRDA Mine Plan to the EIA, as amended can be interpreted as follows. Null values indicate that soils and terrain, terrestrial vegetation, wetlands and forestry, wildlife and wildlife habitat, and biodiversity resources are equally affected by the MRDA Mine Plan and the EIA, as amended. For incremental changes in loss/alteration, positive values indicate resources that are more affected by the MRDA Mine Plan; that is, resources that experience a larger MRDA Mine Plan footprint effect relative to the EIA, as amended. Negative incremental changes in loss/alteration values indicate resources that are less affected by the MRDA Mine Plan; that is, resources that experience a smaller MRDA Mine Plan footprint effect relative to the EIA, as amended. Incremental changes in net change were assessed in the LSA for MRDA Mine Plan and in the JME and PRM LSAs for the EIA (Shell 2007). For incremental changes in net change, positive values indicate resources that are less affected by the MRDA Mine Plan at closure; that is, resources for which the MRDA Mine Plan has a larger unaffected LSA area at closure relative to the unaffected LSA areas occurring at closure in the EIA, as amended. Negative incremental changes in net change values indicate resources that are more affected by the MRDA Mine Plan at closure; that is, resources for which MRDA Mine Plan has less unaffected LSA area at closure relative to the unaffected LSA areas occurring at closure in the EIA (Shell 2007) and EIA updates (Shell 2008, 2009b).

5.2 Soils and Terrain

The Soils and Terrain Assessment for the Project was presented in Volume 5, Section 7.5 of the EIA.

Soil and terrain resources have been assessed using the methods described in Volume 5, Section 7.2 of the EIA. Direct losses created by site clearing and soil salvage to soils and terrain were recalculated and a qualitative analysis was completed to account for the modifications to the mine plan. Comparisons of changes as a result of the MRDA Mine Plan are presented for each applicable measurement endpoint.

Direct Loss/Alteration of Soils and Terrain Units in the Local Study Area

Direct impacts are associated with disturbance areas created by site clearing and soil salvage for the MRDA Mine Plan footprint (20,724 ha). This includes the 12,896 ha Application Area (Table 5.2-1) which excludes impacts from the Jackpine Mine – Phase 1 Project footprint (7,828 ha) (Shell 2008 and 2009b).

The MRDA Mine Plan footprint results in the direct disturbance of 3,155 ha of upland terrain units, as well as the disturbance of 9,682 ha of wetland terrain units (Table 5.2-1). The loss/alteration of these terrain units will result in increased areas of reconstructed landforms at closure. From Base Case to closure, the net increase of 10,077 ha of reconstructed landforms is due to these alterations of natural terrain units and the reclamation of disturbed terrain units.

Table 5.2-1 Changes to Soil Units due to MRDA Mine Plan

Soil Type (Terrain Type)	Base Case[a]	Loss/Alteration due to the Project[b]	Closure[a]	Net Change due to the Project[c]		
	Area [ha]	Area [ha]	Area [ha]	Area [ha]	% of LSA	% of Resource
Mineral Soils (Upland Terrain)	4,758	-3,155	1,603	-3,155	-11	-66
Organic Soils (Wetland Terrain)	13,555	-9,682	3,873	-9,682	-33	-71
Reclaimed Soils (Reconstructed Landforms)	6,492	-6,169	16,569	10,077	34	155
Disturbed Soils (Disturbed Terrain)	2,607	-278	2,329	-278	-1	-11
Littoral (Shallow Open Water)	0	0	1,104	1,104	4	n/a
Water (Including Pit Lakes)	2,212	-1,440	4,146	1,934	7	87
Total	**29,624**	**-20,724**	**29,624**	**0**	**0**	**0**
Jackpine Mine - Phase 1 Total[d]	11,004	7,828	11,004	0	0	0
Application Area	**18,621**	**12,896**	**18,621**	**0**	**0**	**0**

(a) Base Case and Closure were evaluated in the LSA for MRDA Mine Plan.

(b) Loss/Alteration is the footprint area attributed to MRDA Mine Plan (Section 5.1).

(c) Net change due to the Project is calculated as the difference between MRDA Mine Plan Base Case and Closure (including areas within the approved Jackpine Mine – Phase 1 area (11,156 ha), a value upon which the environmental consequence is assessed).

(d) This value represents the approved Jackpine Mine – Phase 1 area (11,156 ha) minus areas of the Kearl Lake Levee found within the Jackpine Mine – Phase 1 area (152 ha). The Kearl Lake Levee is included in the Application Area for MRDA Mine Plan assessment.

n/a = Not applicable.

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

Direct loss/alteration of soils is due to the permanent loss of natural wetland soil types and terrain units, and conversion to pit lakes, littoral wetlands and upland reconstructed landforms. The environmental consequence for the direct loss/alteration of soils does not change as a result of the MRDA Mine Plan (Table 5.2-1). The effects of the MRDA Mine Plan on soil as a result of site clearing is predicted to remain as a high positive environmental consequence (loss of 3,155 ha of mineral soils and a 10,077 ha increase in reclaimed soils) for upland soils due to the creation of upland reconstructed landforms. The effects of the MRDA Mine Plan on soil as a result of site clearing is predicted to remain as a high negative environmental consequence (loss of 10,077 ha) for wetland terrain units in the LSAs and negligible environmental consequence in the RSA.

Direct Effects on Key Indicator Resources

The MRDA Mine Plan footprint is predicted to increase the area of land capability (AENV 2006) for forestry classes 1 to 3 by 5,710 ha at closure (Table 5.2-2). The change due to the MRDA Mine Plan compared to the EIA, as amended will not change the Project environmental consequence for this Key Indicator Resource (KIR).

Table 5.2-2 Land Capability for Forestry Changes due to MRDA Mine Plan

Land Capability	Base Case		Loss/Alteration due to the Project		Closure		Net Change Due to the Project[(a)]		
	Area [ha]	% of LSA	Area [ha]	% of LSA	Area [ha]	% of LSA	Area [ha]	% of LSA	% of Resource
1	29	0	-21	0	496	2	468	2	1,640
2	1,138	4	-801	-3	2,572	9	1,434	5	126
3	99	0	-49	0	4,049	14	3,950	13	3,981
4	2,874	10	-1,686	-6	8,717	29	5,843	20	203
5	14,174	48	-10,280	-35	5,887	20	-8,286	-28	-58
Unclassified Reclaimed Soils	6,492	22	-6,169	-21	323	1	-6,169	-21	-95
Disturbed	2,607	9	-278	-1	2,329	8	-278	-1	-11
Water	2,212	7	-1,440	-5	4,146	14	1,933	7	87
Water (reclaimed littoral wetlands)	n/a	n/a	n/a	n/a	1,104	4	1,104	4	n/a
Total	**29,624**	**100**	**-20,724**	**-70**	**29,624**	**100**	**0**	**0**	**0**

(a) Net change due to the Project is calculated as the difference between the MRDA Mine Plan Base Case and closure, a value upon which the environmental consequence is assessed.

n/a = Not applicable.

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

The incremental changes in loss/alteration and net change at closure in the LSA on soil and terrain units due to the Project (MRDA Mine Plan) relative to the EIA, as amended are shown in Tables 5.2-3 and 5.2-4 and can be interpreted as described in Section 5.1.1. The MRDA Mine Plan footprint is predicted to result in a total decrease in development area of 89 ha (<1% of the LSA) compared to the EIA, as amended. As the MRDA Mine Plan represents a small increase in disturbance area relative to the EIA, as amended, the environmental consequence for the direct loss/alteration of soils and terrain units does not change as a result of MRDA Mine Plan compared to the EIA, as amended. The effects of MRDA Mine Plan as a result of site clearing are predicted to result in a high positive environmental consequence for upland terrain units and mineral soils and a high negative environmental consequence for wetland terrain units and organic soils. Compared to the EIA, as amended, there will be an increase in constructed landscapes at Closure of 377 ha due to MRDA Mine Plan, largely because of the 89 ha increase in total disturbance area in MRDA Mine Plan, and a reconfiguration of the closure plan resulting in more reclamation of lands otherwise classified as industrial disturbance.

Table 5.2-3 Incremental Changes to Terrain Units due to MRDA Mine Plan

Terrain Units	Loss/Alteration Due to MRDA Mine Plan[(a)]		Net Change due to the MRDA Mine Plan[(a)]	
	Area [ha]	% of LSA	Area [ha]	% of LSA
Existing Terrain Units				
Wetland Terrain Units				
bog (B)	10	<1	-10	-<1
shallow bog (Bs)	0	0	0	0
fen (N)	20	<1	-20	-<1
shallow fen (Ns)	-6	-<1	6	<1
wetland terrain units subtotal	*23*	*<1*	*-23*	*1*
Upland Terrain Units				
fluvial (F)	0	0	0	0
glaciofluvial (Fg)	55	<1	-55	-<1
glaciofluvial/moraine (Fg/M)	-5	-<1	5	<1
glaciolacustrine (Lg)	0	0	0	0
moraine (M)	-64	-<1	64	<1
upland terrain units subtotal	*-15*	*-<1*	*15*	*<1*
existing terrain units subtotal	*8*	*<1*	*-8*	*<1*
Other Terrain Units				
reconstructed landforms	0	0	377	1
water	0	0	-415	-1
water (littoral wetlands)	0	0	126	<1
disturbed	81	<1	-81	-<1
other terrain units subtotal	*81*	*<1*	*8*	*<1*
Total	**89**	**<1**	**0**	**0**

(a) See Section 5.1.1 Incremental Changes in Loss/Alteration.

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

Table 5.2-4 Incremental Changes to Soil Units due to MRDA Mine Plan

Soil Series, Reclaimed Soils and Non-Soil	Loss/Alteration due to MRDA Mine Plan[(a)]		Net Change due to MRDA Mine Plan[(a)]	
	Area [ha]	% of LSA	Area [ha]	% of LSA
Organic Soils				
Albian	78	<1	-78	-<1
Hartley	-6	-<1	6	<1
Mikkwa	12	<1	-12	-<1
McLelland	-50	-<1	50	<1
McLelland Shallow	-9	-<1	9	<1
Mariana	0	0	0	0
Muskeg	5	<1	-5	-<1
Muskeg Shallow	-7	-<1	7	<1
organic soils subtotal	*23*	*<1*	*-23*	*1*
Mineral Soils				
Algar Lake	0	0	0	0
Bitumount	-2	-<1	2	<1
Ells River	0	0	0	0
Firebag	0	0	0	0
Fort	3	<1	-3	-<1
Horse River	-55	-<1	55	<1
Halverson	0	0	0	0
Kinosis	0	0	0	0
Livock	-4	-<1	4	<1
Mildred	56	<1	-56	-<1
Miscellaneous Mineral	-12	-<1	12	<1
McMurray	0	0	0	0
Namur	0	0	0	0
Norberta	0	0	0	0
Steepbank	0	0	0	0
Sutherland	-2	-<1	2	<1
Wanham	0	0	0	0
Winefred	0	0	0	0
mineral soils subtotal	*-16*	*-<1*	*16*	*<1*
Other Soil Types				
Reclaimed	0	0	377	1
Disturbed	81	<1	-81	-<1
Water	0	0	-415	-1
water (reclaimed littoral wetland)	0	0	126	<1
other soil types subtotal	*81*	*<1*	*7*	*<1*
Total	**89**	**<1**	**0**	**0**

(a) See Section 5.1.1 Incremental Changes in Loss/Alteration.

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

Summary

The larger MRDA Mine Plan footprint increases the loss/alteration of soils and terrain due to the Project by 89 ha (less than 1% of the LSA). The primary differences due to MRDA Mine Plan are the increase in the development footprint, the increase of reconstructed landforms, and the reduction of pit lakes in the MRDA Mine Plan Closure landscape compared to the EIA, as amended. The environmental consequences and mitigation measures for soils and terrain resources are the same as in the EIA, as amended.

5.3 Terrestrial Vegetation, Wetlands and Forest Resources

The Terrestrial Vegetation, Wetlands and Forest Resources Assessment for the original EIA was presented in Volume 5, Sections 7.3 through 7.6 of the EIA (Shell 2007).

Terrestrial vegetation, wetlands and forest resources have been assessed using the methods described in Volume 5, Section 7.2 of the EIA (Shell 2007). To examine the effects of MRDA Mine Plan, direct and indirect effects were assessed. Direct losses created by soil salvage and site clearing to terrestrial vegetation, wetlands and forest resources were assessed and a qualitative analysis was completed to account for this modification to the mine plan. Areas predicted to be directly affected by water impoundment (Kearl Lake Levee, 77 ha) and indirectly affected by surficial aquifer drawdown (4,446 ha) are also examined. Finally, comparisons of changes as a result of MRDA Mine Plan are presented for each applicable terrestrial vegetation, wetlands and forest resources KIR.

Overview of Direct Loss from Site Clearing in the Local Study Area

Direct impacts are associated with disturbance areas created by site clearing and soil salvage for the MRDA Mine Plan footprint (20,724 ha). This update also examines the 12,896 ha Application Area (Table 5.2-1) which excludes impacts from the Jackpine Mine – Phase 1 Project footprint (7,828 ha).

Incremental changes comparing MRDA Mine Plan to the EIA, as amended can be interpreted as described in Section 5.1.1. At Application Case, 5,399 ha of terrestrial upland vegetation (excluding burned uplands [BUu]) and 10,214ha of wetlands (excluding burned wetlands [BUw]) will be lost or altered due to the Project (Table 5.3-1, Figure 5.3-1). Relative to the EIA, as amended, there is a less than 1% (89 ha) decrease in footprint due to MRDA Mine Plan at Application Case, including less disturbance to uplands (21 ha less) and more disturbance to wetlands (129 ha more) (Table 5.3-2).

At closure, upland vegetation will increase overall by 8,902ha, or 127% of the resource (% of resource corresponds to percentage of baseline amount) as compared to the Base Case (Table 5.3-1, Figure 5.3-1). At closure, wetlands will decrease by 10,276 ha (74% of the resource) (Table 5.3-1, Figure 5.3-1). At closure, small additional incremental net changes occur for uplands (increase of 188 ha) and wetlands (loss of 129 ha) due to the MRDA Mine Plan (Table 5.3-2), compared to the EIA, as amended. The 415 ha decrease in lake area due to MRDA Mine Plan results from the decrease in size of pit lakes at closure compared to the EIA, as amended (Table 5.3-2).

Incremental area changes associated with MRDA Mine Plan do not affect the conclusions or environmental consequences assessed for terrestrial vegetation and wetlands in the EIA (Shell 2007).

Table 5.3-1 Land Cover Types (Ecosite Phases, Wetlands Types and Other Types) in the MRDA Mine Plan Local Study Area

Land Cover Type	Base Case[a]	Loss/Alteration due to the Project [b]	Closure[a]	Net Change due to the Project[c]		
	Area [ha]	Area [ha]	Area [ha]	Area [ha]	% of LSA	% of Resource
Central Mixedwood Natural Subregion Ecosite Phases	7,026	-5,399	15,928	8,902[d]	30	127
Wetlands Types	13,895	-10,214	3,618	-10,276[d]	-35	-74
Miscellaneous Vegetation Types	3,469	-3,142	2,259	-1,210[d]	-4	-35
Non-Vegetation Types	2,233	-1,458	5,253	3,020	10	135
Disturbances	3,001	-511	2,567	-434[d]	-1	-14
Total	**29,624**	**-20,724**	**29,624**	**0**	**0**	**0**
Jackpine Mine- Phase 1 Total[e]	11,004[f]	-7,828	11,004[f]	0	0	0
Application Area	**18,621**	**-12,896**	**18,621**	**0**	**0**	**0**

(a) Base Case and closure were evaluated in the LSA for MRDA Mine Plan.

(b) Loss/Alteration is the footprint area attributed to MRDA Mine Plan at Application Case (Section 5.1).

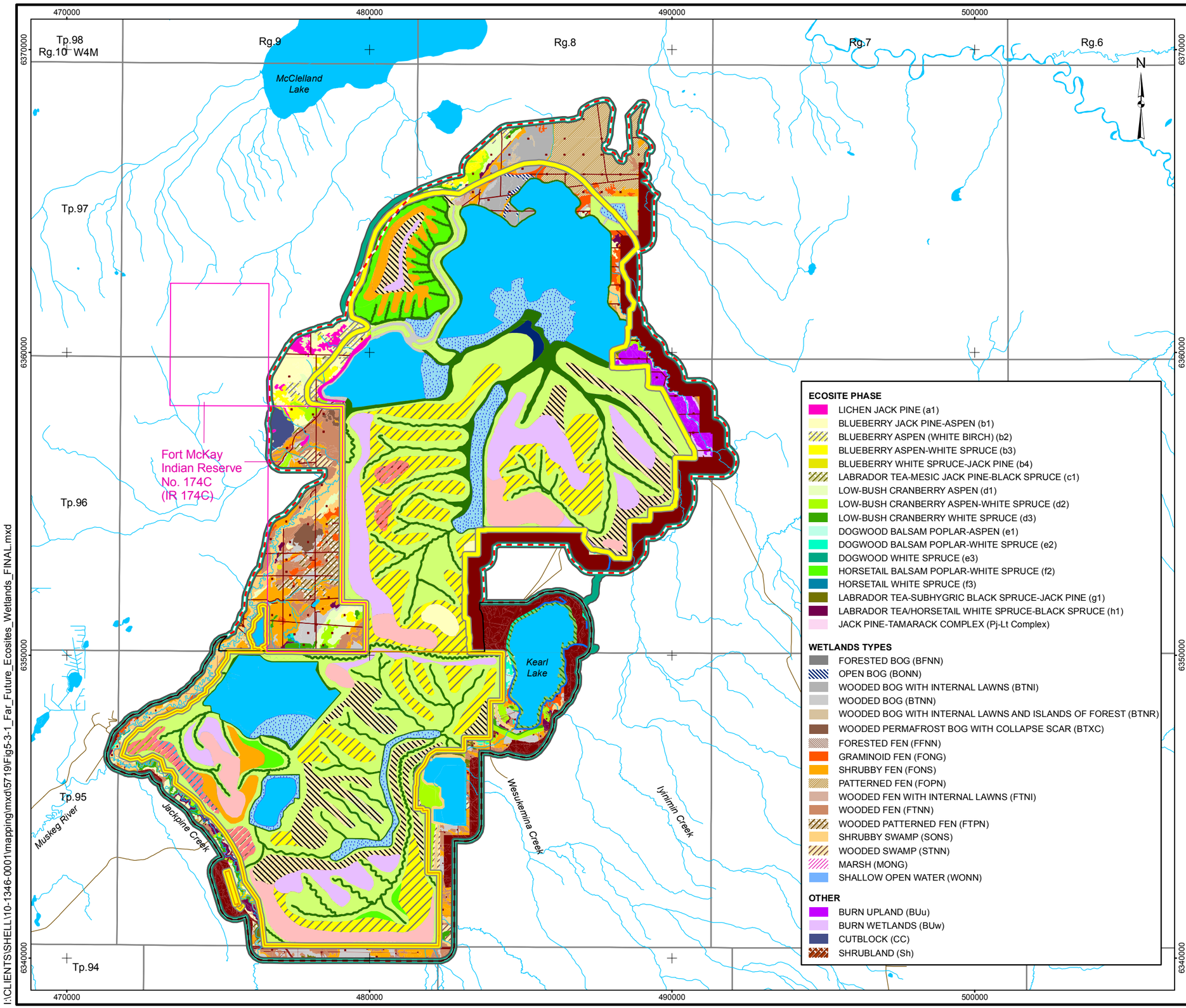
(c) Net change due to the Project is calculated as the difference between MRDA Mine Plan Base Case and closure, a value upon which the environmental consequence is assessed.

(d) Additional areas not disturbed at Application Case may be affected after closure due to water impoundment of 77 ha between Kearl Lake and the levee. Although these areas will not be disturbed at Application Case they are conservatively considered permanently disturbed following the impoundment due to uncertainty associated with the water level (Section 5.3.2.1). Therefore, net change due to the Project may be greater than the loss/alteration due to MRDA Mine Plan.

(e) The Jackpine Mine – Phase 1 area has been previously approved. It has been presented as the total LSA area to show the changes brought about by the integration of the Jackpine Mine – Phase 1 and MRDA Mine Plan Closure Plans.

(f) This value represents the approved Jackpine Mine – Phase 1 area (11,156 ha) minus 152 ha portion of the Kearl Lake Levee that is found within the Jackpine Mine – Phase 1 area. The Kearl Lake Levee is included in the Application Area for MRDA Mine Plan assessment.

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



ECOSITE PHASE

- LICHEN JACK PINE (a1)
- BLUEBERRY JACK PINE-ASPEN (b1)
- BLUEBERRY ASPEN (WHITE BIRCH) (b2)
- BLUEBERRY ASPEN-WHITE SPRUCE (b3)
- BLUEBERRY WHITE SPRUCE-JACK PINE (b4)
- LABRADOR TEA-MESIC JACK PINE-BLACK SPRUCE (c1)
- LOW-BUSH CRANBERRY ASPEN (d1)
- LOW-BUSH CRANBERRY ASPEN-WHITE SPRUCE (d2)
- LOW-BUSH CRANBERRY WHITE SPRUCE (d3)
- DOGWOOD BALSAM POPLAR-ASPEN (e1)
- DOGWOOD BALSAM POPLAR-WHITE SPRUCE (e2)
- DOGWOOD WHITE SPRUCE (e3)
- HORSETAIL BALSAM POPLAR-WHITE SPRUCE (f2)
- HORSETAIL WHITE SPRUCE (f3)
- LABRADOR TEA-SUBHYGRIC BLACK SPRUCE-JACK PINE (g1)
- LABRADOR TEA/HORSETAIL WHITE SPRUCE-BLACK SPRUCE (h1)
- JACK PINE-TAMARACK COMPLEX (Pj-Lt Complex)

WETLANDS TYPES

- FORESTED BOG (BFNN)
- OPEN BOG (BONN)
- WOODED BOG WITH INTERNAL LAWNS (BTNI)
- WOODED BOG (BTNN)
- WOODED BOG WITH INTERNAL LAWNS AND ISLANDS OF FOREST (BTNR)
- WOODED PERMAFROST BOG WITH COLLAPSE SCAR (BTXC)
- FORESTED FEN (FFNN)
- GRAMINOID FEN (FONG)
- SHRUBBY FEN (FONS)
- PATTERNED FEN (FOPN)
- WOODED FEN WITH INTERNAL LAWNS (FTNI)
- WOODED FEN (FTNN)
- WOODED PATTERNED FEN (FTPN)
- SHRUBBY SWAMP (SONS)
- WOODED SWAMP (STNN)
- MARSH (MONG)
- SHALLOW OPEN WATER (WONN)

OTHER

- BURN UPLAND (BUu)
- BURN WETLANDS (BUw)
- CUTBLOCK (CC)
- SHRUBLAND (Sh)

LEGEND

- PUBLIC ROADWAY
- MUSKEG RIVER DIVERSION ALTERNATIVE FOOTPRINT
- LOCAL STUDY AREA
- JACKPINE MINE - PHASE 1 APPROVED AREA
- JACKPINE MINE - PHASE 1 PROJECT FOOTPRINT
- JACKPINE MINE EXPANSION EIA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PLANTING PRESCRIPTION FOR LEVEE AREAS ADJACENT TO UPLANDS
- PLANTING PRESCRIPTION FOR LEVEE AREAS ADJACENT TO WETLANDS
- PREDICTED LEVEE IMPOUNDMENT AREA
- EXISTING AND APPROVED URBAN INDUSTRIAL DISTURBANCE

RECLAMATION ECOSITE PHASES/WETLANDS TYPES (LEGEND)

- a1
- b1
- b3
- b4
- c1
- d1
- d2
- e1
- f2
- f3
- g1
- h1
- Sh2
- Sh3
- LITTORAL ZONE

REFERENCE

ALBERTA DIGITAL DATA OBTAINED FROM ALTALIS LTD. © GOVERNMENT OF ALBERTA 2008 (ALL RIGHTS RESERVED), AND IHS ENERGY LTD. (AUGUST 2006), USED UNDER LICENSE.
DATUM: NAD83 PROJECTION: UTM ZONE 12

5 0 5
SCALE 1:125,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE
CLOSURE ECOSITE PHASES/WETLANDS TYPES IN THE MUSKEG RIVER DIVERSION ALTERNATIVE LOCAL STUDY AREA

Shell Canada Limited

PROJECT NO. 10-1346-0001			FILE No.	N/A
DESIGN	AD	23 Jan. 2011	SCALE AS SHOWN	REV. 0
GIS	CH	20 May 2011		
CHECK	AD	20 May 2011		
REVIEW	SS	20 May 2011		

FIGURE: 5.3-1

I:\CLIENTS\SHELL\10-1346-0001\mapping\mxd\5719\Fig5-3-1_Far_Future_Ecosites_Wetlands_FINAL.mxd

Table 5.3-2 Incremental Changes to Ecosite Phases, Wetlands Types and Other Types due to MRDA Mine Plan

Map Code	Description	Loss/Alteration due to Muskeg River Diversion[(a)]		Net Change due to Muskeg River Diversion[(a)]	
		Area [ha]	% of LSA	Area [ha]	% of LSA
Central Mixedwood Natural Subregion Ecosite Phases					
a1	lichen jack pine	17	<1	-90	-<1
b1	blueberry jack pine-aspen	-40	-<1	-92	-<1
b2	blueberry aspen (white birch)	-26	-<1	26	<1
b3	blueberry aspen-white spruce	-2	-<1	78	<1
b4	blueberry white spruce-jack pine	13	<1	-13	-<1
c1	Labrador tea-mesic jack pine-black spruce	-2	-<1	-230	-1
d1	low-bush cranberry aspen	13	<1	-171	-1
d2	low-bush cranberry aspen-white spruce	3	<1	183	1
d3	low-bush cranberry white spruce	1	<1	-1	-<1
e1	dogwood balsam poplar-aspen	3	<1	41	<1
e2	dogwood balsam poplar-white spruce	0	0	0	0
e3	dogwood white spruce	-<1	-<1	<1	<1
f2	horsetail balsam poplar-white spruce	0	0	-58	0
f3	horsetail white spruce	0	0	-133	0
g1	Labrador tea-subhygric black spruce-jack pine	-3	-<1	674	2
h1	Labrador tea/horsetail white spruce-black spruce	1	<1	-25	-<1
Pj-Lt	jack pine-tamarack complex	0	0	0	0
	central mixedwood ecosite phase subtotal	*-21*	*-<1*	*188*	*1*
Wetlands Types					
BFNN	forested bog	0	0	0	0
BONN	open bog	9	<1	-9	-<1
BTNI	wooded bog with internal lawns	63	<1	-63	-<1
BTNN	wooded bog	7	<1	-7	-<1
BTNR	wooded bog with internal lawn with islands of forested peat plateau	3	<1	-3	-<1
BTXC	wooded bog with collapsed scars	<1	<1	-<1	-<1
FFNN	forested fen	0	0	0	0
FONG	graminoid fen	-20	-<1	20	<1
FONS	shrubby fen	-<1	-<1	<1	<1
FOPN	open patterned fen	71	<1	-71	-<1
FTNI	wooded fen with internal lawns	3	<1	-3	-<1
FTNN	wooded fen	-6	-<1	6	<1
FTPN	wooded patterned fen	0	0	0	0
MONG	marsh	0	0	0	0
SONS	shrubby swamp	1	<1	-1	-<1
STNN	wooded swamp	-1	-<1	1	<1
WONN	shallow open water	0	0	0	0
	wetlands subtotal	*129*	*<1*	*-129*	*-<1*
Miscellaneous Vegetation Types					
BUu	burn upland	**-70**	-<1	70	<1

Table 5.3-2 Incremental Changes to Ecosite Phases, Wetlands Types and Other Types due to MRDA Mine Plan (continued)

Map Code	Description	Loss/Alteration due to Muskeg River Diversion[a]		Net Change due to Muskeg River Diversion[a]	
		Area [ha]	% of LSA	Area [ha]	% of LSA
BUw	burn wetlands(b)	**-32**	-<1	32	<1
Me	meadow	**0**	0	0	0
Sh	shrubland	**1**	<1	-1	-<1
Sh2[b]	reclaimed shrubland type 2	n/a	n/a	109	<1
Sh3[b]	reclaimed shrubland type 3	n/a	n/a	102	<1
	miscellaneous vegetation types subtotal	*-101*	*-<1*	*312*	*1*
Non-Vegetation Types					
lake	lake	0	0	-415	-1
littoral zone[b]	littoral zone	n/a	n/a	126	<1
river	river	0	0	0	0
	non-vegetation types subtotal	*0*	*0*	*-289*	*-1*
Disturbances					
cutblock	cutblock	0	0	0	0
DIS	disturbance	82	<1	-82	0
impoundment[c]	area between Kearl Lake and Kearl Levee	n/a	n/a	0	0
	disturbances subtotal	*82*	*<1*	*-82*	*0*
Total		**89**	**<1**	**0**	**0**

[a] See Section 5.1.1 Incremental Changes in Loss/Alteration.

[b] These map codes are specific to the closure landscape and are described in the C,C&R Plan (Section 4).

[c] The 77 ha impoundment area between Kearl Lake and Kearl Levee is conservatively treated as permanently disturbed at closure.

n/a = Not applicable.

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

Ecosite phases are as defined in Beckingham and Archibald (1996).

Wetlands types are as defined in Halsey et.al (2004).

Overview of Indirect Effects due to Changes in Hydrogeology and Hydrology

A subregional area, referring to the area within the RSA in and around the PRM and JME LSAs, was assessed for surface water hydrology impacts (Shell 2007). Drawdown dewatering of the basal and surficial aquifers associated with the JME and PRM LSAs has an effect on the surface water hydrology. The drawdown isopleths presented in the December 2009 Project Update conservatively represent the MRDA Mine Plan, so they were used in this assessment. The areal extent of wetlands potentially affected by surficial aquifer drawdown from JME is 4,446 ha (Table 5.3-3, Figure 5.3-2). Adding the 2,483 ha of PRM wetlands affected by drawdown (reported in the EIA 2007), a total of 6,929 ha (14% of the LSA) of wetlands could be potentially affected by drawdown, which is 1% of the RSA wetlands (1,039,328 ha; Shell 2007).

Table 5.3-3 Wetlands Potentially Affected by Groundwater Drawdown within the Subregional Study Area

Map Code	Description	Loss/Alteration Due to Drawdown from the MRDA Mine Plan		
		Inside JME LSA [ha]	Outside JME LSA [ha]	Total [ha]
BTNI	wooded bog with internal lawns	-161	-39	-200
BTNN	wooded bog	-146	-226	-372
BTNR	wooded bog with raised islands of forested peat plateau	-15	0	-15
Buw	burn wetlands	-56	-50	-106
FONG	graminoid fen	-99	-103	-202
FONS	shrubby fen	-251	-608	-859
FOPN	open patterned fen	-593	-949	-1,542
FTNN	wooded fen	-184	-695	-879
FTPN	wooded patterned fen	0	0	0
MONG	marsh	0	0	0
SONS	shrubby swamp	-117	-36	-153
STNN	wooded swamp	-55	-58	-114
WONN	shallow open water	-1	-4	-5
Total		**-1,677**	**-2,769**	**-4,446**

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

Section 5.3.2.3 describes the drawdown effects on relevant vegetation KIRs within wetlands and riparian areas. Effects of groundwater drawdown on uplands vegetation and economic forests are considered negligible because precipitation and surface water runoff infiltration into soils are the predominant water sources for uplands vegetation and forest resources (Shell 2009). Therefore, drawdown is not predicted to affect the following KIRs: lichen jack pine communities, economic forests, high traditional plant potential and dust (Shell 2009).

Direct and Indirect Effects on Key Indicator Resources

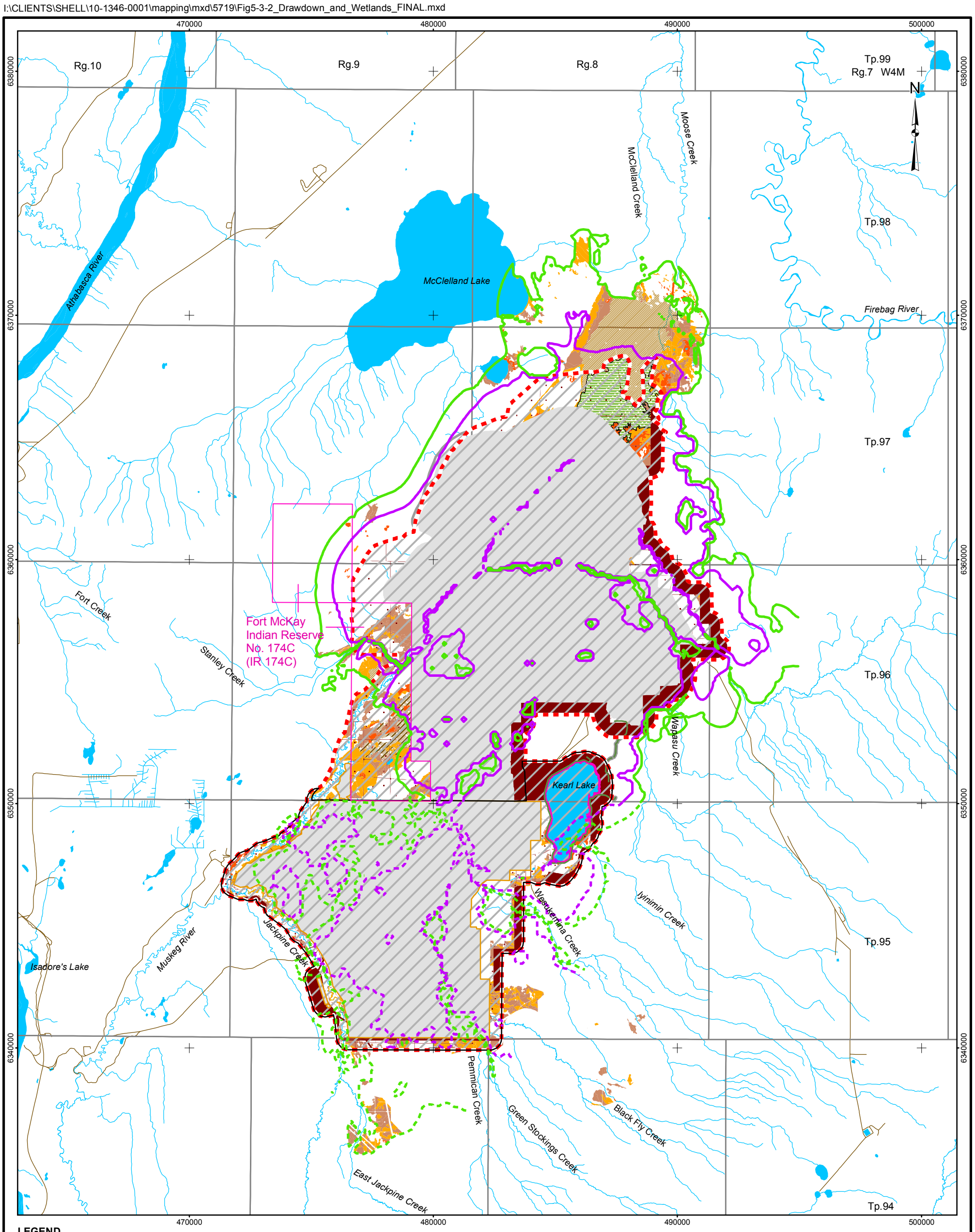
Lichen Jack Pine Communities

The MRDA Mine Plan is predicted to result in a net increase in lichen jack pine communities of 811 ha (3% of the LSA) from Base Case to closure. At closure, MRDA Mine Plan results in a 90 ha incremental net decrease (less than 1% of the LSA) in lichen jack pine communities (lichen jack pine [a1] ecosite phase) as compared to the EIA, as amended. The MRDA Mine Plan will not change the Project environmental consequence for lichen jack pine communities (Shell 2008).

Riparian Communities

The MRDA Mine Plan is predicted to cause a net decrease of 378 ha (1% of the LSA) of riparian communities (defined in the EIA [Shell 2007]) from Base Case to closure. However, at closure, the MRDA Mine Plan results in an incremental net increase in riparian community area of 57 ha (less than 1% of the LSA) when compared to the EIA, as amended. The groundwater drawdown in the MRDA Mine Plan is predicted to disturb (i.e., result in an indirect loss of) 584 ha of riparian communities, compared to a predicted drawdown disturbance of 598 ha in JME in the 2009 EIA Update (Shell 2009). Combined direct and indirect effects will cause a net decrease of 962 ha (3% of the LSA) in riparian communities in and around the LSA. The MRDA Mine Plan and water drawdown will not change the environmental consequence for riparian communities (Shell 2007).

I:\CLIENTS\SHELL\10-1346-0001\mapping\mxd\5719\Fig5-3-2_Drawdown_and_Wetlands_FINAL.mxd



LEGEND

- PUBLIC ROADWAY
- INDIAN RESERVE
- JACKPINE PHASE 1 APPROVED AREA
- JACKPINE PHASE 1 PROJECT FOOTPRINT
- JACKPINE MINE EXPANSION EIA LOCAL STUDY AREA
- MUSKEG RIVER DIVERSION ALTERNATIVE FOOTPRINT
- KEARL LAKE LEVEE
- INSIDE KEARL LAKE LEVEE
- LOCAL STUDY AREA
- LENTICULAR FEN
- OPEN WATER
- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE

GROUNDWATER DRAWDOWN ISOPLETH

- 0.1 m - JACKPINE MINE - PHASE 1
- 1.0 m - JACKPINE MINE - PHASE 1
- 0.1 m - JACKPINE MINE EXPANSION
- 1.0 m - JACKPINE MINE EXPANSION

FEN WETLANDS TYPES

- FORESTED FEN (FFNN)
- GRAMINOID FEN (FONG)
- SHRUBBY FEN (FONS)
- PATTERNED FEN (FOPN)
- WOODED FEN WITH INTERNAL LAWNS (FTNI)
- WOODED FEN (FTNN)
- WOODED PATTERNED FEN (FTPN)

REFERENCE

ALBERTA DIGITAL DATA OBTAINED FROM ALTALIS LTD. © GOVERNMENT OF ALBERTA 2008 (ALL RIGHTS RESERVED), AND
IHS ENERGY LTD. (AUGUST 2006), USED UNDER LICENSE.
DATUM: NAD83 PROJECTION: UTM ZONE 12

5 0 5
SCALE 1:150,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
WETLANDS POTENTIALLY AFFECTED BY GROUNDWATER DRAWDOWN IN AND NEAR THE MUSKEG RIVER DIVERSION ALTERNATIVE LOCAL STUDY AREA

Shell Canada Limited

PROJECT NO. 10-1346-0001			FILE No.	N/A
DESIGN	AD	24 Jan. 2011	SCALE AS SHOWN	REV. 0
GIS	CH	20 May 2011		
CHECK	AD	20 May 2011		
REVIEW	SS	20 May 2011		

FIGURE: 5.3-2

Old Growth Forest

Overall, 388 ha (1% of the LSA) of old growth forest will be lost from Base Case to closure due to the MRDA Mine Plan. Of this area, the MRDA Mine Plan is predicted to cause a 28 ha net increase (less than 1% of the LSA) in the amount of old growth present at closure compared to the EIA, as amended. The groundwater drawdown is predicted to disturb 98 ha of old growth forest in wetlands, compared to a predicted disturbance of 102 ha of wetlands old growth in the 2009 EIA Update (Shell 2009). Combined direct and indirect effects will cause a net decrease of 486 ha (1% of the LSA) in old growth forest in and around the LSA. The MRDA Mine Plan and water drawdown effects will not change the environmental consequences assessed for old growth in the EIA (Shell 2007).

Peatlands (Fens and Bogs) including Patterned Fens

The MRDA Mine Plan is predicted to cause a net decrease of 9,605 ha (32% of the LSA) of peatlands (including burned wetlands [BUw]) from Base Case to closure. At closure, the MRDA Mine Plan results in an incremental net decrease in peatlands of 97 ha (less than 1% of the LSA) compared to the EIA, as amended. The groundwater drawdown is predicted to disturb 4,070 ha of peatlands compared to a predicted disturbance of 6,399 ha in the 2009 EIA Update (Shell 2009). Combined direct and indirect effects will thus cause a net decrease of 13,674 ha (46% of the LSA) in peatlands in and around the LSA.

The MRDA Mine Plan is predicted to cause a net decrease of 414 ha (1% of the LSA) in patterned fens from Base Case to closure. At closure, the MRDA Mine Plan results in an incremental 71 ha (less than 1% of the LSA) net decrease of patterned fens, specifically open patterned fens (FOPN) compared to the EIA, as amended. The groundwater drawdown is predicted to disturb 1,542 ha of patterned fens, compared to a predicted disturbance of 1,627 ha in the 2009 EIA Update (Shell 2009). Combined direct and indirect effects will thus cause a net decrease of 1,956 ha (7% of the LSA) in patterned fens in and around the LSA.

The MRDA Mine Plan and water drawdown will not change the environmental consequences for wetlands (including peatlands and patterned fens).

Economic Forests

Overall, productive economic forest will increase by 6,401 ha (22% of the LSA) from Base Case to closure as a result of the MRDA Mine Plan. Compared to the EIA, as amended, the MRDA Mine Plan at closure results in an incremental net increase in productive economic forest of 290 ha (1% of the LSA). This occurs because there is a tendency to replace disturbed wetlands (unproductive areas for forestry) with uplands (largely productive economic forest) at closure and the MRDA Mine Plan footprint disturbs more wetlands. The MRDA Mine Plan will not change the positive environmental consequence for economic forests (Shell 2007). Changes in hydrogeology and hydrology are not predicted to affect economic forests.

Rare Plants, Rare and Special Plant Communities and Rare Plant Potential

Rare plant records for the LSA include records obtained from Alberta Conservation Information Management System (ACIMS 2011) and take into account species that are no longer listed as rare (ANHIC 2000; Gould 2000, 2006; Kemper 2009). Rare plant occurrences were also based on past EIA surveys in the LSA (Shell 2007, 2008; Imperial Oil 2005). Overall at Closure, the MRDA Mine Plan will affect 209 known rare plant occurrences (71% of known rare plant occurrences in and around the LSA). Compared to the EIA, as amended, the MRDA Mine Plan at Closure results in an incremental net loss of 26 additional known rare plant occurrences. The groundwater drawdown will affect 73 known rare plant occurrences (20% of rare plant occurrences in and

around the LSA). Combined direct and indirect effects will cause a net loss of 282 rare plant occurrences (96% of known rare plant occurrences in and around the LSA).

The lenticular patterned fen (642 ha), a special plant community, falls entirely within the drawdown area, within the boundaries of the original JME LSA. The lenticular patterned fen will not be further affected by the MRDA Mine Plan. There are no rare plant communities in and around the LSA. The river alder/ostrich fern and sparsely vegetated slope plant communities in the PRM LSA will not be affected by the MRDA Mine Plan and are thus not considered here (Shell 2009).

Overall at closure, the MRDA Mine Plan will result in the loss of 9,077 ha of high rare plant potential area. Compared to the EIA, as amended, the MRDA Mine Plan at closure results in an incremental net loss of 58 ha of areas of high rare plant potential. The groundwater drawdown will affect 3,650 ha of high rare plant potential area compared to a predicted disturbance of 3,670 ha in Shell (2009b). Combined direct and indirect effects will cause a net decrease of 12,727 ha (43% of the LSA) in high rare plant potential areas in and around the LSA. The changes outlined above will not change the environmental consequences for rare plants, rare and special plant communities and rare plant potential (Shell 2007).

Traditional Plant Potential

The MRDA Mine Plan is predicted to cause a decrease of 424 ha (1% of the LSA) in the areal extent of high traditional plant potential from Base Case to closure. The MRDA Mine Plan causes an incremental net decrease of 7 ha (less than 1% of the LSA) in areas of high traditional plant potential at closure compared to the EIA, as amended. The MRDA Mine Plan will not change the environmental consequences for areas with high traditional plant potential (Shell 2007). Changes in hydrogeology and hydrology are not predicted to affect areas with high traditional plant potential, which are all terrestrial ecosite phases.

Dust

Although the creation and operation of DDA2 is a potential source of additional dust, the inclusion of the MRDA Mine Plan area is not expected to increase the amount of dust released from the site, as per mitigation measures discussed in the EIA (Volume 5, Section 7.5.2) and the Air Quality Section (2.1) of this appendix. Therefore, the environmental consequence is expected to remain the same (Shell 2007).

Summary

The MRDA Mine Plan increases the footprint to be developed in the LSA by 89 ha (less than 1%) relative to the EIA, as amended. All environmental consequences predicted in the EIA, as amended remain the same based on the net changes from the MRDA Mine Plan. Positive influences of MRDA Mine Plan on the environmental consequences of certain KIRs are also noted. At Closure, the MRDA Mine Plan results in incremental increases in riparian communities (1% of the LSA), old growth forest (less than 1% of the LSA) and economic forest (1% of the LSA) compared to the EIA, as amended. Reconstructed landforms, such as the Fort Hills OBDA, and pit lakes will also be smaller in size in the MRDA Mine Plan closure landscape compared to the EIA, as amended. The environmental consequences for terrestrial vegetation, wetlands and forest resources are the same as those outlined in the EIA (Volume 5, Section 7.1.3, Shell 2007).

5.4 Wildlife and Wildlife Habitat

The Wildlife Assessment for the Project was presented in Volume 5, Sections 7.3 through 7.6 of the original JME EIA (Shell 2007). The assessment of potential impacts on wildlife in the EIA follows a focused approach as

outlined in Kennedy and Ross (1992). This approach involves determining and addressing the most significant consequences of the development activities being proposed using wildlife KIRs. The effects of the Project were also assessed for each federally-listed wildlife species at risk (SAR). This information is provided in Appendix 3 - Responses to Federal Information Requests - Round 2, Federally Listed Species at Risk Assessment (May 2011).

Wildlife resources have been assessed using the methods described in Volume 5, Section 7.2 of the EIA. To examine the effects of MRDA Mine Plan, direct and indirect effects on wildlife abundance, wildlife habitat and barriers to movement were addressed qualitatively by considering changes in ecosite phases and wetlands types and their value for each wildlife KIR. Wildlife KIRs were the same as those used in the EIA and were selected based on the criteria set out in Table 7.2-2 of the EIA (Volume 5, Section 7.2.6.2).

Wildlife Abundance

For wildlife, no new linkages are required for the MRDA Mine Plan relative to the EIA, as amended. Changes due to the MRDA Mine Plan represent a less than 1% (89 ha) increase in footprint at Application Case compared to the EIA, as amended. Although this change may result in an incremental increase in the effects of the Project on wildlife abundance, the additional effects will be highly localized and occur over a small area in relation to the Project as a whole. Therefore, the MRDA Mine Plan results in no changes to predicted environmental consequences for wildlife abundance. The environmental consequences of the Project on wildlife abundance vary by KIR (Shell 2007, 2008).

Wildlife Habitat

Changes due to MRDA Mine Plan represent a less than 1% (89 ha) increase in the Project footprint at Application Case, and therefore a slight increase in habitat lost during construction and operations (Table 5.3-2). During construction and operations, the assessment of direct habitat loss for all KIRs is not changed by the MRDA Mine Plan. This incremental increase in the effects of the Project on wildlife habitat is highly localized and occurs over a small area in relation to the Project as a whole. Therefore, there will be no change to the Project's assessed effects for direct and indirect habitat loss due to the MRDA Mine Plan.

Compared to the EIA, as amended, the MRDA Mine Plan C,C&R plan results in an increase in the amount of upland habitat (188 ha) and a decrease in the amount of wetlands habitat (129 ha) present at closure, both of which represent a 1% change in the LSA (Table 5.3-2). Due to the small landscape change in the reclamation plan as a result of MRDA Mine Plan, the net environmental consequences for the effects of the Project on high suitability wildlife habitat will not change from those previously assessed for black bear, moose, beaver, fisher/marten, Canada lynx, black-throated green warbler, Canadian toad, barred owl and yellow rail.

Effects on Wildlife Movement

After closure and reclamation, the MRDA Mine Plan is not predicted to create any additional impediments to wildlife movement, and may result in fewer barriers for some species due to the decrease in the size of pit lakes. Despite this potential improvement in the landscape for wildlife movement, to be conservative it is predicted that there are no changes to the Project environmental consequence for wildlife movement due to the MRDA Mine Plan during construction and operations and after closure relative to the EIA as amended.

Summary

MRDA Mine Plan is predicted to increase the direct and indirect effects of the Project on wildlife abundance, habitat and movement. However, the incremental increase in the effects of the Project on wildlife is highly localized and occurs over a small area in relation to the Project as a whole. Therefore, the MRDA Mine Plan will not change the environmental consequences for wildlife and wildlife habitat that were previously reported (Shell 2007, 2008, 2009b).

5.5 Biodiversity

The Biodiversity Assessment for the Project was presented in Volume 5, Sections 7.3 through 7.6 of the EIA (Shell 2007).

Effects of the MRDA Mine Plan were evaluated for biodiversity by considering changes in ecosite phases and wetlands types ranked high, moderate and low for biodiversity potential. Biodiversity potential represents the relative contribution of a vegetation type to the overall biological diversity of an area. This section presents the change in areas of biodiversity potential as a result of the MRDA Mine Plan.

Changes to biodiversity potential in the LSA due to the Project (including MRDA Mine Plan) are summarized in Table 5.5-1. Overall, the Project is expected to reduce high and moderate biodiversity potential areas by 5,810 ha (74% of resource) and 788 ha (9% of resource), respectively. Low biodiversity potential areas are expected to increase by 6,599 ha (49% of resource). Net changes in high, moderate and low biodiversity potential areas due to the JME portion of the previous EIA update were -73%, -2% and 44%, respectively (Table 9, Section 1.2, Appendix 4; Shell 2008). Incremental changes to biodiversity potential in the LSA due to the MRDA Mine Plan are discussed in more detail below.

Table 5.5-1 Biodiversity Potential in the MRDA Mine Plan Local Study Area

Biodiversity Potential	Base Case[a]	Loss/Alteration due to MRDA Mine Plan[b]	Closure[a]	Net Change due to the Project[c]		
	Area [ha]	Area [ha]	Area [ha]	Area [ha]	% of LSA	% of Resource
High	7,839	-5,808	2,029	-5,810[d]	-20	-74
Moderate	8,308	-6,067	7,520	-788[d]	-3	-9
Low	13,477	-8,849	20,076	6,599[d]	22	49
Total	**29,624**	**-20,115**	**29,624**	**0**	**0**	**0**
Jackpine Mine- Phase 1 Total[e]	11,004[f]	-7,828	11,004[f]	0	0	0
Application Area	**18,621**	**-12,287**	**18,621**	**0**	**0**	**0**

(a) Base Case and Closure were evaluated in the LSA for the MRDA Mine Plan.

(b) Loss/alteration is the footprint area attributed to MRDA Mine Plan at Application Case (Section 5.1)

(c) Net change due to the Project is calculated as the difference between the MRDA Mine Plan Base Case and closure, a value upon which the environmental consequence is assessed.

(d) Additional areas not disturbed at Application Case may be affected after closure due to water impoundment of 77 ha between Kearl Lake and the Kearl Lake Levee. Although these areas will not be disturbed at Application Case they are conservatively considered permanently disturbed following the impoundment due to uncertainty associated with the water level (Section 5.3.2.1). Therefore, net change due to the Project may be greater than the loss/alteration due to MRDA Mine Plan.

(e) The Jackpine Mine - Phase 1 area has been previously approved. It has been presented as the total LSA area to show the changes brought about by the integration of the Jackpine Mine - Phase 1 and MRDA Mine Plan Closure Plans.

(f) This value represents the approved Jackpine Mine – Phase 1 area (11,156 ha) minus 152 ha portion of the Kearl Lake Levee that is found within the Jackpine Mine – Phase 1 area. The Kearl Lake Levee is included in the Application Area for MRDA Mine Plan assessment.

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

Incremental differences in biodiversity potential resulting from the MRDA Mine Plan are presented in Table 5.5-2 and can be interpreted as explained in the Incremental Changes in Loss/Alteration section (Section 5.1.1).

Closure of the MRDA Mine Plan results in a 69 ha net decrease in high biodiversity potential areas, a 505 ha net decrease in moderate biodiversity potential areas and a 574 ha net increase in low biodiversity potential areas compared to the EIA, as amended. The difference in closure landscapes is due to a combination of changes in the MRDA Mine Plan C,C&R plan compared to the previous EIA updates (Shell 2008 and 2009b), as well as a larger Project footprint compared to the EIA footprint (Shell 2007). The primary differences as they relate to biodiversity are summarized below:

- An additional 69 ha of high-ranked wetlands types will be disturbed in the larger MRDA Mine Plan Project footprint compared to the JME Project footprint.
- An additional 25 ha of the moderate-ranked ecosite phases and wetlands types will be disturbed in the larger MRDA Mine Plan Project footprint compared to the EIA footprint (Shell 2007). There will also be less horsetail balsam poplar-white spruce (f2) and horsetail white spruce (f3) ecosite phases as well as lake areas, which are ranked moderate for biodiversity potential. This change is due to a reduction of these types in the MRDA Mine Plan closure landscape; in particular pit lakes will be smaller in size.
- Approximately 5 ha of low-ranked ecosite phases and wetlands types will not be disturbed in the larger MRDA Mine Plan Project footprint compared to the EIA footprint (Shell 2007). There will be less Labrador tea-mesic jack pine-black spruce (c1) and low-bush cranberry aspen (d1) ecosite phases at Closure because fewer areas will be reclaimed to these ecosite phases in the MRDA Mine Plan C,C&R plan compared to the EIA, as amended. In contrast, there will be more of the low-bush cranberry aspen-white spruce (d2) and Labrador tea-subhygric black spruce-jack pine (g1) ecosite phases as well as reclaimed shrubland types 2 and 3 at closure because more areas will be reclaimed to these types in the MRDA Mine Plan C,C&R plan compared to the EIA, as amended.

Within the LSA, incremental changes associated with the MRDA Mine Plan represent negligible to low changes in high, moderate and low biodiversity potential areas when compared to previous EIA updates (Shell 2008 and 2009b).

Table 5.5-2 Incremental Changes to Biodiversity Potential Classes due to the MRDA Mine Plan

Map Code	Description	Loss/Alteration due to the MRDA Mine Plan[(a)]		Net Change due to the MRDA Mine Plan[(a)]	
		Area	% of LSA	Area	% of LSA
High Biodiversity Potential					
FFNN	forested fen	0	0	0	0
FOPN	open patterned fen	71	<1	-71	-<1
FTNI	wooded fen with internal lawns	3	<1	-3	-<1
FTNN	wooded fen	-6	-<1	6	<1
FTPN	wooded patterned fen	0	0	0	0
MONG	marsh	0	0	0	0
SONS	shrubby swamp	1	<1	-1	-<1
	High Biodiversity Potential Subtotal	*69*	*<1*	*-69*	*-<1*

Table 5.5-2 Incremental Changes to Biodiversity Potential Classes due to the MRDA Mine Plan (continued)

Map Code	Description	Loss/Alteration due to the MRDA Mine Plan[a]		Net Change due to the MRDA Mine Plan[a]	
		Area	% of LSA	Area	% of LSA
Moderate Biodiversity Potential					
b2	blueberry aspen (white birch)	-26	-<1	26	<1
e3	dogwood white spruce	-<1	-<1	<1	<1
f2	horsetail balsam poplar-white spruce	0	0	-58	-<1
f3	horsetail white spruce	0	0	-133	-<1
BFNN	forested bog	0	0	0	0
BONN	open bog	9	<1	-9	-<1
BTNI	wooded bog with internal lawns	63	<1	-63	-<1
BTXC	wooded bog with collapsed scars	<1	<1	-<1	-<1
FONG	graminoid fen	-20	-<1	20	<1
FONS	shrubby fen	-<1	-<1	<1	<1
STNN	wooded swamp	-1	-<1	1	<1
WONN	shallow open water	0	0	0	0
lake	lake	0	0	-415	-1
littoral zone[b]	littoral zone	n/a	n/a	126	<1
	Moderate Biodiversity Potential Subtotal	*25*	*<1*	*-505*	*-2*
Low Biodiversity Potential					
a1	lichen jack pine	17	<1	-90	-<1
b1	blueberry jack pine-aspen	-40	-<1	-92	-<1
b3	blueberry aspen-white spruce	-2	-<1	78	<1
b4	blueberry white spruce-jack pine	13	<1	-13	-<1
c1	Labrador tea-mesic jack pine-black spruce	-2	-<1	-230	-1
d1	low-bush cranberry aspen	13	<1	-171	-1
d2	low-bush cranberry aspen-white spruce	3	<1	183	1
d3	low-bush cranberry white spruce	1	<1	-1	-<1
e1	dogwood balsam poplar-aspen	3	<1	41	<1
e2	dogwood balsam poplar-white spruce	0	0	0	0
g1	Labrador tea-subhygric black spruce-jack pine	-3	-<1	674	2
h1	Labrador tea/horsetail white spruce-black spruce	1	<1	-25	-<1
Pj-Lt	jack pine-tamarack complex	0	0	0	0
BTNN	wooded bog	7	<1	-7	-<1
BTNR	wooded bog with internal lawn with islands of forested peat plateau	3	<1	-3	-<1
BUu	burn upland	-70	-<1	70	<1
BUw	burn wetlands(b)	-32	-<1	32	<1
Me	meadow	0	0	0	0
Sh	shrubland	1	<1	-1	-<1
Sh2[b]	reclaimed shrubland type 2	n/a	n/a	109	<1
Sh3[b]	reclaimed shrubland type 3	n/a	n/a	102	<1
river	river	0	0	0	0
cutblock	cutblock	0	0	0	0
DIS	disturbance	82	<1	-82	-<1
impoundment[c]	area between Kearl Lake and Kearl Levee	n/a	n/a	0	0
	Low Biodviersity Potential subtotal	*-5*	*-<1*	*574*	*2*

Table 5.5-2 Incremental Changes to Biodiversity Potential Classes due to the MRDA Mine Plan (continued)

Map Code	Description	Loss/Alteration due to the MRDA Mine Plan[a]		Net Change due to the MRDA Mine Plan[a]	
		Area	% of LSA	Area	% of LSA
Total		**89**	**<1**	**0**	**0**

[a] See Section 5.1.1 Incremental Changes in Loss/Alteration.

[b] These map codes are specific to the closure landscape and are described in the C,C&R Plan (Section 4).

[c] The impoundment area between Kearl Lake and the Kearl Lake Levee is conservatively treated as permanently disturbed at closure.

n/a = Not applicable.

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

Ecosite phases are as defined in Beckingham and Archibald (1996).

Wetlands types are as defined in Halsey et.al (2004).

Summary

Effects of the MRDA Mine Plan were evaluated for biodiversity by considering changes in ecosite phases, wetlands types and other land cover types ranked high, moderate and low for biodiversity potential. The MRDA Mine Plan is expected to reduce high and moderate biodiversity potential areas by 5,810 ha (74% of resource) and 788 ha (9% of resource), respectively. Low biodiversity potential areas are expected to increase by 6,599 ha (49% of resource). Net changes in high, moderate and low biodiversity potential areas due to the JME portion of the EIA were -73%, -2% and 44%, respectively (Shell 2008). Therefore, the MRDA Mine Plan will not affect the conclusions or environmental consequence assessed for the Project (Shell 2008).

6.0 HUMAN ENVIRONMENT

6.1 Traditional Knowledge and Land Use

The Traditional Land Use Assessment for the Project was presented in Volume 5, Section 8.3 of the EIA. The MRDA Mine Plan increases the amount of developed area by 89 ha. Since the change in footprint is relatively small, there is a minimal change to the effects on Local Registered Fur Management Areas and Culturally Significant Ecosystems. Therefore, the changes in the MRDA Mine Plan do not change the Traditional Land Use Assessment findings presented in the EIA, as amended.

6.2 Resource Use

The Resource Use Assessment for the Project was presented in Volume 5, Section 8.4 of the EIA. Since the change in footprint is relatively small, there is a minimal change to the site clearing effects on the following resource use components: Environmentally Significant Areas; forestry; hunting; fishing; and berry picking. The environmental consequence ratings and the mitigation measures presented in the Resource Use Assessment are the same for the MRDA Mine Plan. Therefore, the changes in the MRDA Mine Plan do not change the Resource Use Assessment findings presented in the EIA, as amended.

6.3 Visual Aesthetics

The Visual Aesthetics Assessment for the Project was presented in Volume 5, Section 8.5 of the EIA. The assessment considered three viewpoints near JME. The view of JME from the nearby viewpoints is expected to be the same as there are no major landscape differences in the MRDA Mine Plan. The environmental consequence ratings and the mitigation measures presented in the Visual Aesthetics Assessment are the same for the MRDA Mine Plan. Therefore, the changes in the MRDA Mine Plan do not change the Visual Aesthetics Assessment findings presented in the EIA, as amended.

6.4 Historical Resources

The Historical Resources Assessment was presented in Volume 5, Section 8.6 of the EIA. The 89 ha footprint increase from the MRDA Mine Plan will not affect any known historical resources. Therefore, the changes in the MRDA Mine Plan do not change the Historical Resources Assessment findings presented in the EIA, as amended.

7.0 REFERENCES

ACIMS (Alberta Conservation Information Management System). 2011. ACIMS Database - Element Occurrences (Parts 1 and 2, Non-sensitive and Sensitive Occurrences). Parks Division, Alberta Tourism, Parks and Recreation. Available on line: http://tpr.alberta.ca/parks/heritageinfocentre/datarequests/default.aspx. Data Downloaded January 20, 2011.

AENV (Alberta Environment). 2006. Land Capability Classification for Forestry.

AENV. 2010. Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region, 2nd Edition. Prepared by the Terrestrial Subgroup of the Reclamation Working Group of the Cumulative Environmental Management Association, Fort McMurray, AB. December 2009.

ANHIC (Alberta Natural Heritage Information Centre). 2000. Preliminary Plant Community Tracking List. Alberta Environment. Edmonton, Alberta.

Beckingham, J. D. and J. H. Archibald. 1996. Field Guide to Ecosites of Northern Alberta. Natural Resources Canada, Northern Forestry Centre, Northwest Region. Special Report 5. Edmonton, AB. 516 pp.

Gould, J. 2000. Alberta Natural Heritage Information Centre Preliminary Lichen Tracking List. Parks Division, Alberta Tourism, Parks and Recreation. Available on line: http://tpr.alberta.ca/parks/heritageinfocentre/docs/lichen_tl_cover.pdf. Accessed January 24, 2011.

Gould, J. 2006. Alberta Natural Heritage Information Centre Tracking and Watch Lists – Vascular Plants, Mosses, Liverworts and Hornworts. Alberta Community Development, Parks and Protected Areas Division, Edmonton, Alberta.

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

Halsey, L.A., D.H. Vitt, D. Beilman, S. Crow, S. Mehelcic, R. Wells. 2004. Alberta Wetland Inventory Classification System Version 2.0. Alberta Sustainable Resource Development. Edmonton, Alberta.

Imperial Oil (Imperial Oil Resources Ventures Limited). 2005. Kearl Oil Sands Project - Mine Development. Volume 1 to 9. Submitted to Alberta Energy and Utilities Board and Alberta Environment. Prepared by Imperial Oil Resources Ventures Limited in association with Golder Associates Ltd., AXYS Environmental Consulting Ltd., Komex International Inc. and Nichols Applied Management. Calgary, AB. Submitted July 2005.

Kennedy, A.J. and W.A. Ross. 1992. An approach to integrate impact scoping with environmental impact assessment. Environmental Management 16(4):475-484.

Kemper, J.T. 2009. Alberta Natural Heritage Information Centre Vascular and Non-vascular Plant Tracking and Watch Lists. Alberta Tourism, Parks and Recreation, Parks Division, Edmonton, Alberta. Available on-line: http://www.tpr.alberta.ca/parks/heritageinfocentre/docs/2009_ACIMS_TL_Sept2009.pdf. Accessed October 25, 2010.Manci, K.M., D.N. Gladwin, R. Villella and M.G. Cavendish. 1988. Effects of Aircraft

Noise and Sonic Booms on Domestic Animals and Wildlife: A Literature Synthesis. U.S. Department of the Interior, Fish and Wildlife Service, National Ecology Research Center. Fort Collins, CO.

OSVRC (Oil Sands Vegetation Reclamation Committee). 1998. Guidelines for Reclamation of Terrestrial Vegetation in the Oil Sands Region. 48 pp + Appendices.

Shell (Shell Canada Limited). 2007. Jackpine Mine Expansion & Pierre River Mine Project Application and Environmental Impact Assessment. Volumes 1, 2, 3, 4 and 5. Submitted to Alberta Energy and Utilities Board and Alberta Environment, December 2007. Calgary, AB.

Shell. 2008. Application for Approval of the Jackpine Mine Expansion & Pierre River Mine Project Environmental Impact Assessment Update. Submitted to the Energy Resources Conservation Board and Alberta Environment. May 2008.

Shell. 2009. Application for Approval of the Jackpine Mine Expansion Project. Supplemental Information. Volume 1: Project Update and ERCB SIRs, Volume 2: AENV SIRs and Supplements. Submitted to the Energy Resources Conservation Board and Alberta Environment. December 2009.

Report Signature Page

GOLDER ASSOCIATES LTD.

Steven Strawson, BA
Project Manager

Wayne Speller, M.Eng., P.Eng.
Principal, Project Director

SNS/WES/kf

Golder, Golder Associates and the GA globe design are trademarks of Golder Associates Corporation.

c:\documents and settings\kfreeman\my documents\mrda assessment - 26may11_kf.docx

At Golder Associates we strive to be the most respected global company providing consulting, design, and construction services in earth, environment, and related areas of energy. Employee owned since our formation in 1960, our focus, unique culture and operating environment offer opportunities and the freedom to excel, which attracts the leading specialists in our fields. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees who operate from offices located throughout Africa, Asia, Australasia, Europe, North America, and South America.

Africa	+ 27 11 254 4800
Asia	+ 86 21 6258 5522
Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

solutions@golder.com
www.golder.com

Golder Associates Ltd.
102, 2535 - 3rd Avenue S.E.
Calgary, Alberta, T2A 7W5
Canada
T: +1 (403) 299 5600

Golder Associates