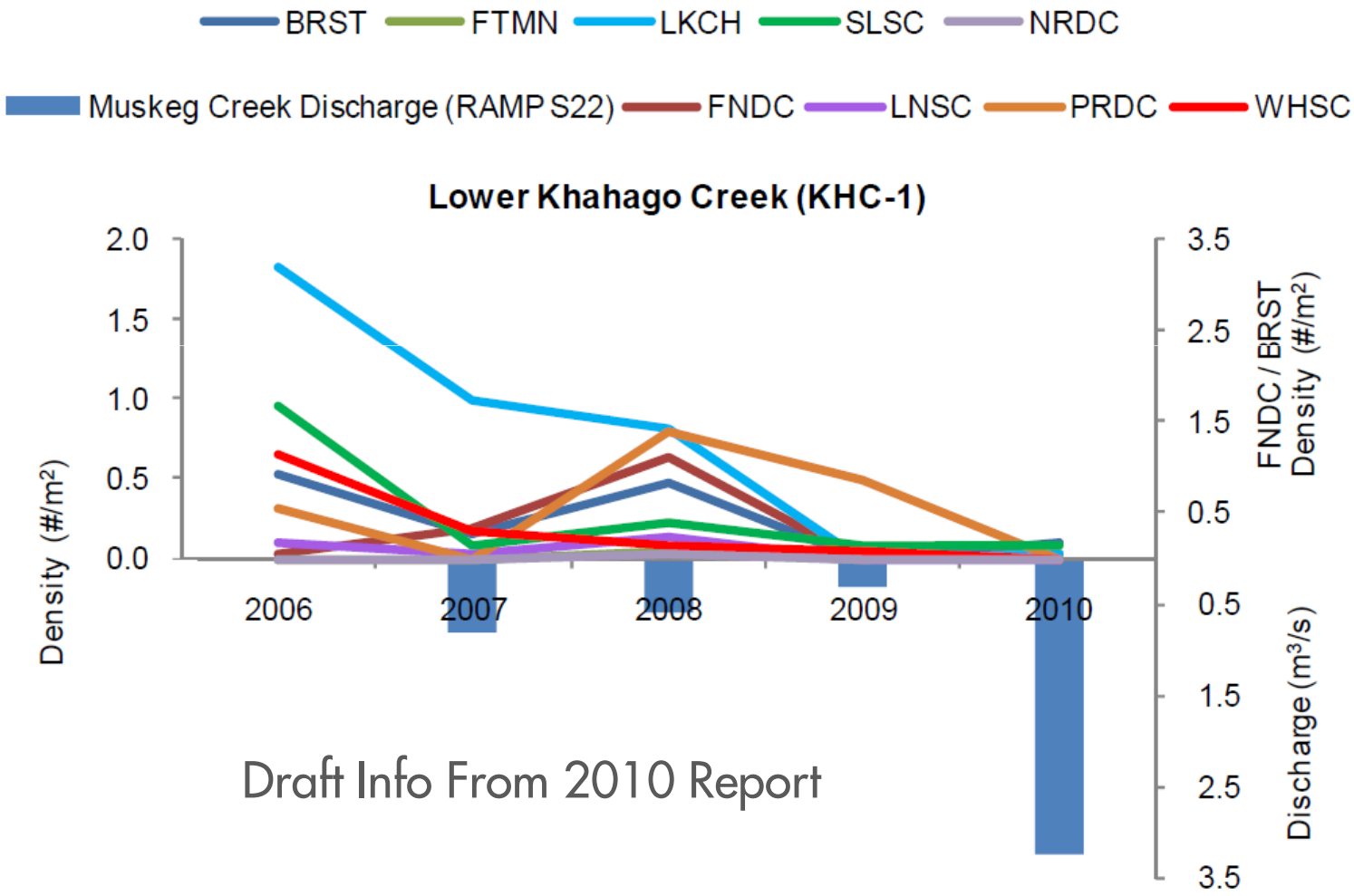
Hearing Exhibit #010-029
Submitted by Métis Nation of Alberta
Date: November 16, 2012

Jackpine Mine Expansion/Pierre River No Net Loss Plan Consultation Meeting

February 17, 2011

Fish Rescue Questions from Fort McKay First Nation

- Noted differences in the species of fish found (Khahago Ck) in the EIA compared to the fish salvage



Draft Info From 2010 Report

Questions from Fort McKay First Nation

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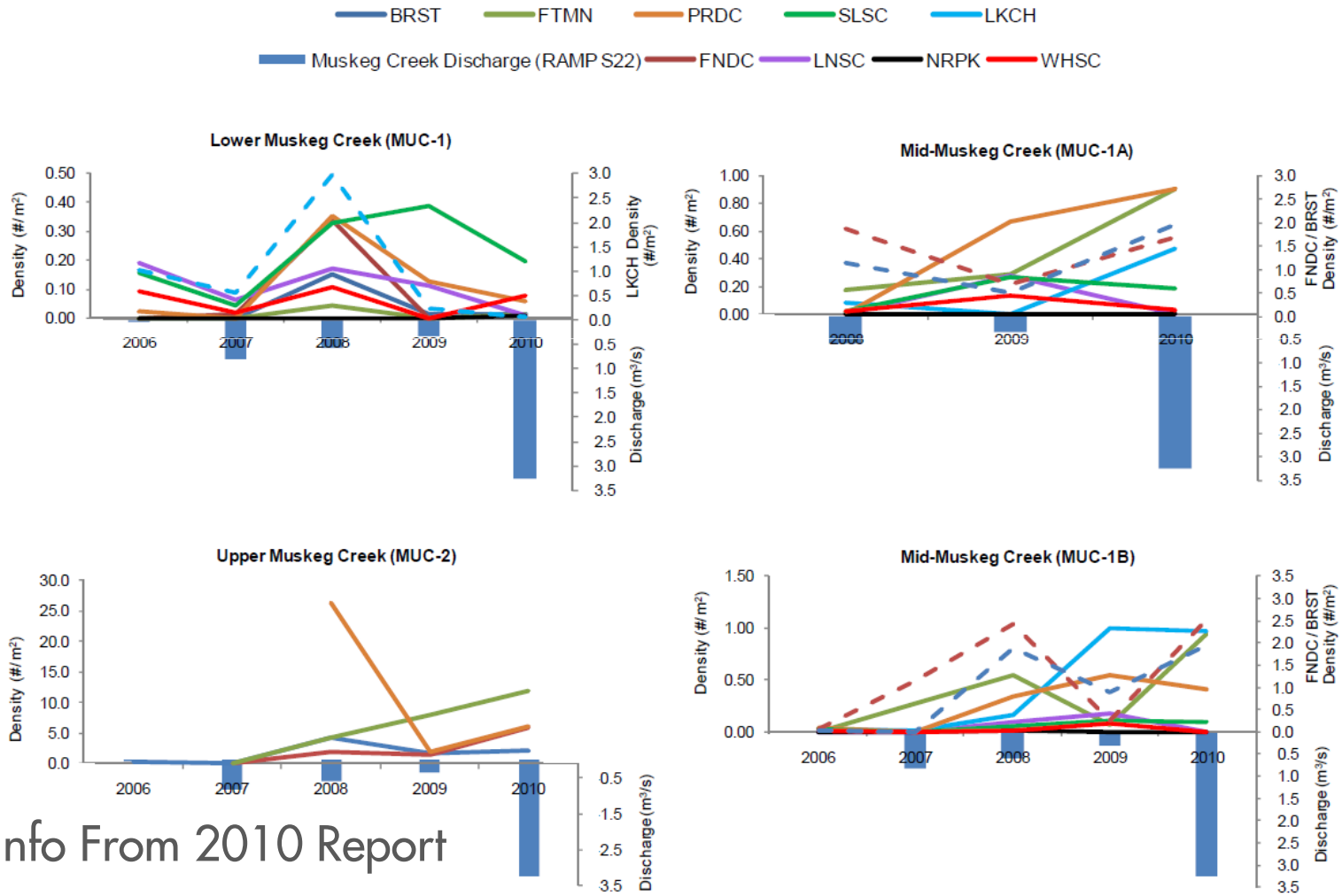

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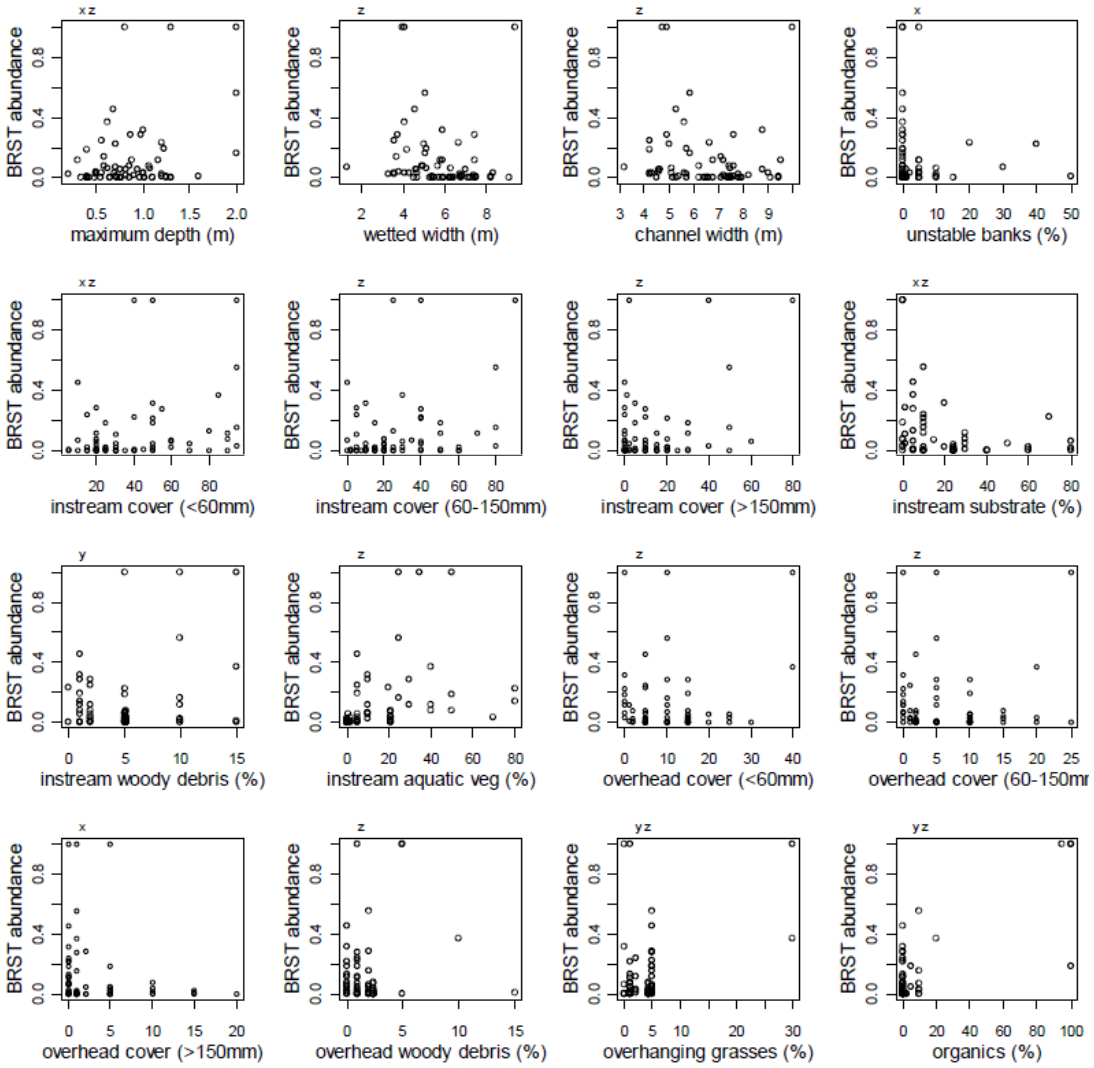
Questions from Fort McKay First Nation

- How do the EIA predictions about fish abundance/biomass compare to the current findings? (related to their HSI/HADD calculations and ratio required for compensation) for Khahago and Sharkbite
  - We cannot convert biomass or abundance into habitat units
  - Biomass and abundance vary greatly from year to year
  - Habitat suitability also varies greatly, but theoretically we compensate to a single habitat unit value for each portion of fish habitat – the average habitat suitability for the average species assemblage times the average habitat area?
  - Don't truly know what that is for any fish habitat except perhaps those monitored for 5 years.
  - Will 1) refine models using monitoring data, 2) use the pre-disturbance and measured habitat characteristics in the models for appropriate species (from fish rescue and Environmental Setting Reports) 3) recalculate habitat units and 4) redo the habitat compensation requirements accounting
  - If habitat losses are greater or lesser than for the NNLP professional judgement modelling, we will update the compensation requirements accordingly.

Questions from Fort McKay First Nation

- Example of model verification dataset from the last 5 years of monitoring



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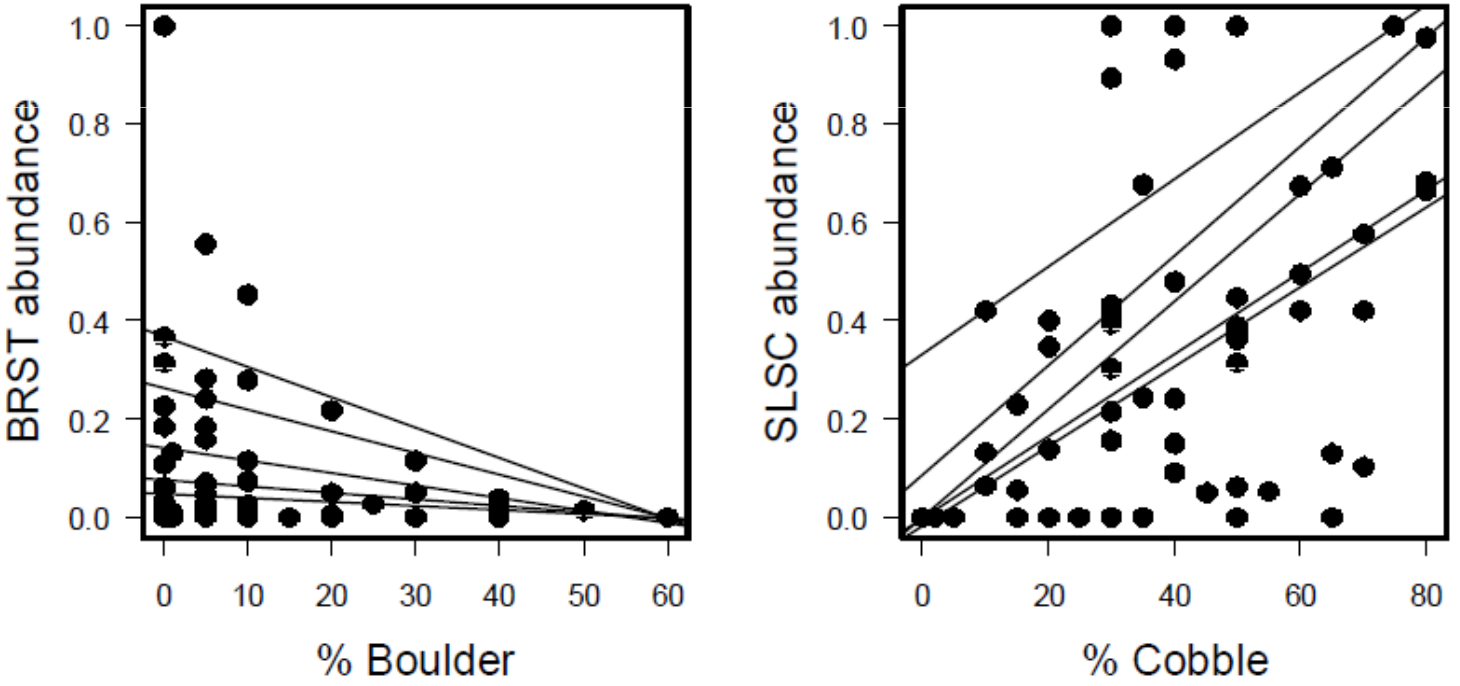
Questions from Fort McKay First Nation

- Example of model verification dataset from the last 5 years of monitoring

Figure 3.29 An example of quantile regression results for two species and two different habitat measures. The regression lines represent 90th, 80th, 70th, 60th and 50th quantiles, from the upper line to lower line, respectively.

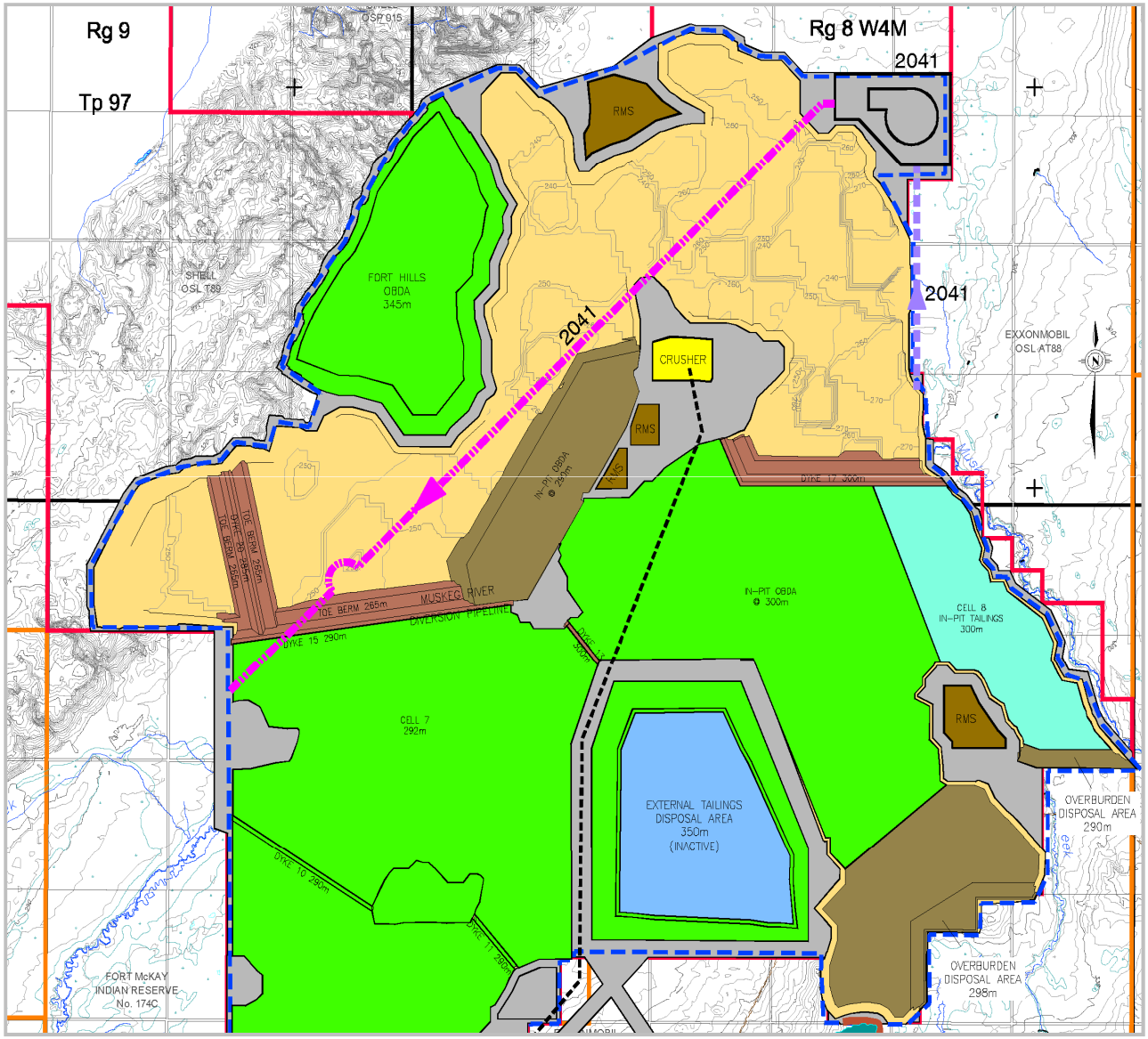
Draft Info From 2010 Report



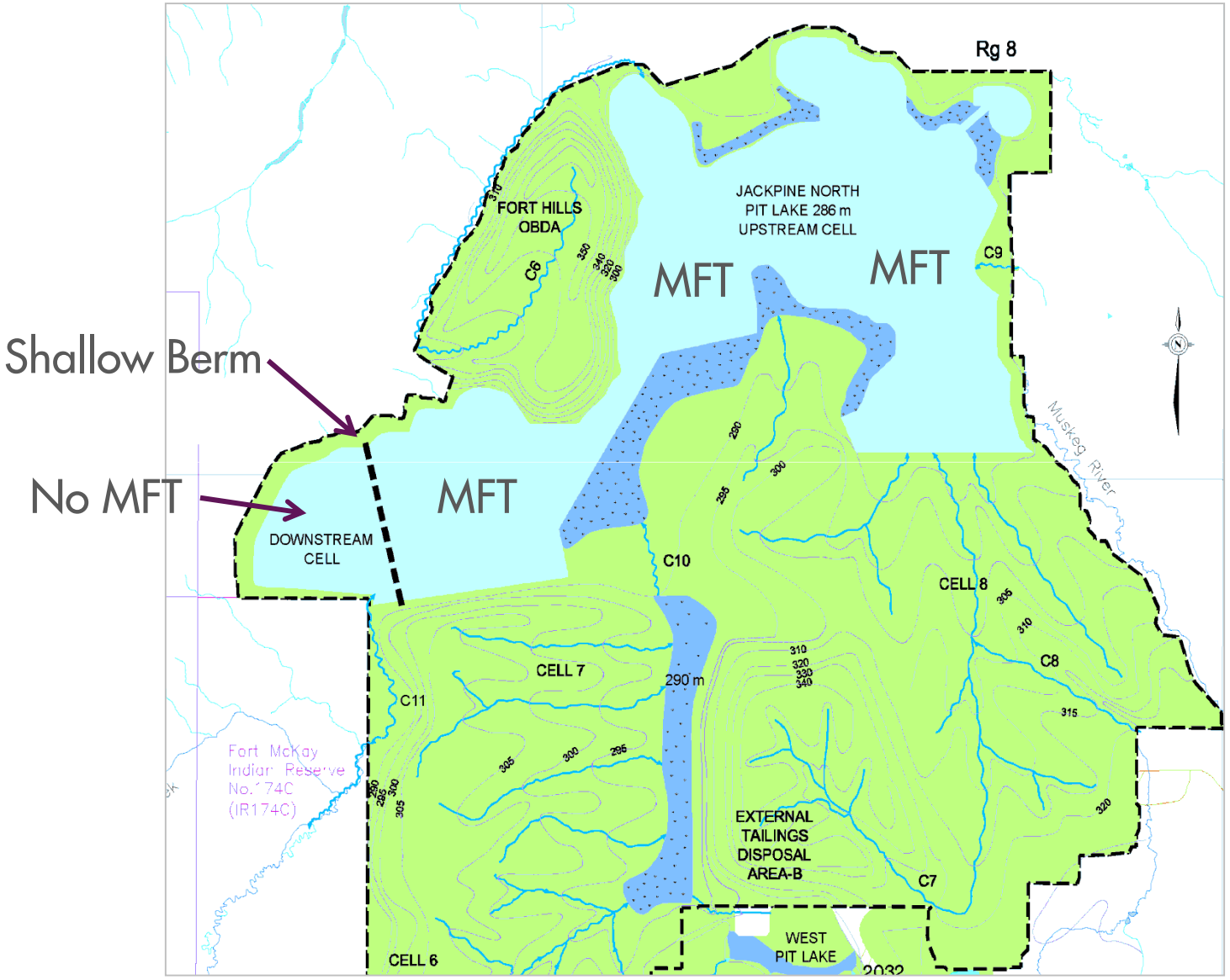
Muskeg River Diversion

- Shell is exploring alternatives to the pipeline proposed in the Application
- No decision has been made on preferred option
- HADD footprint of all alternatives is the same as the Application
  - Makes no difference to NNL Plan
- Regulatory discussion concerning alternatives will be done at some future time

Application Case – Diversion 2041 to Closure

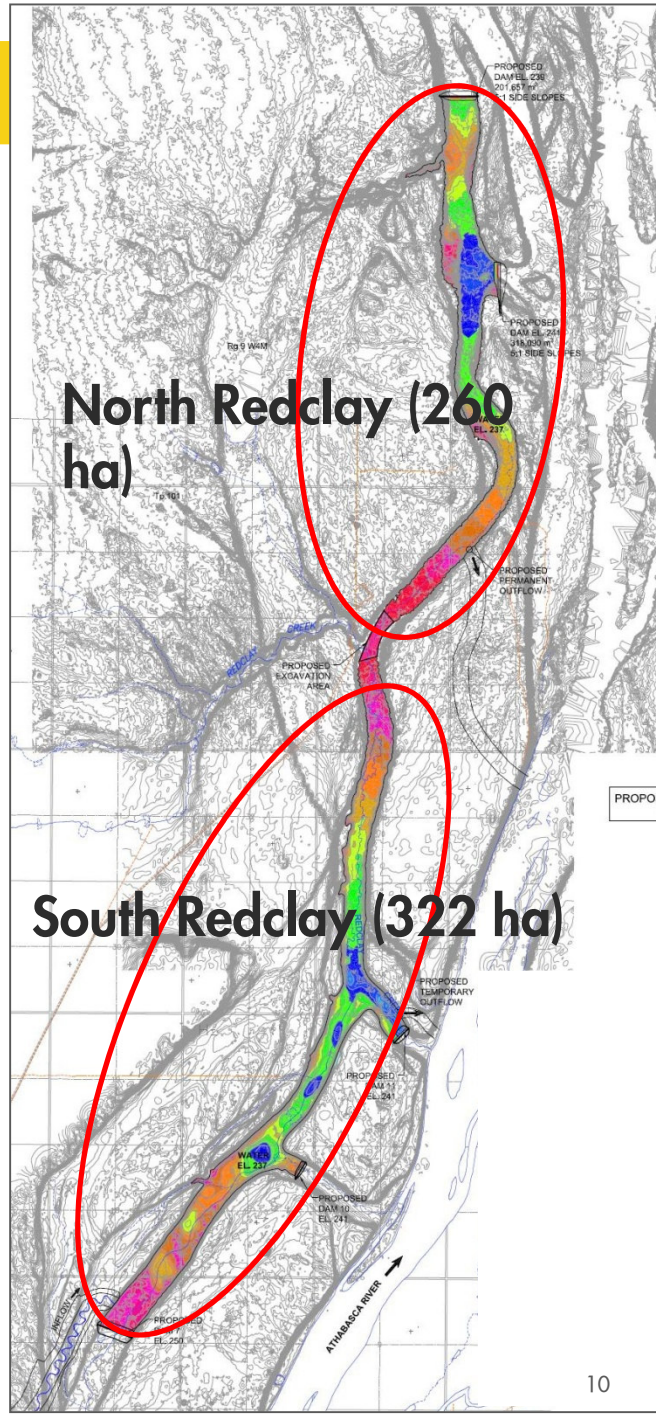


Application Case – Closure Landscape



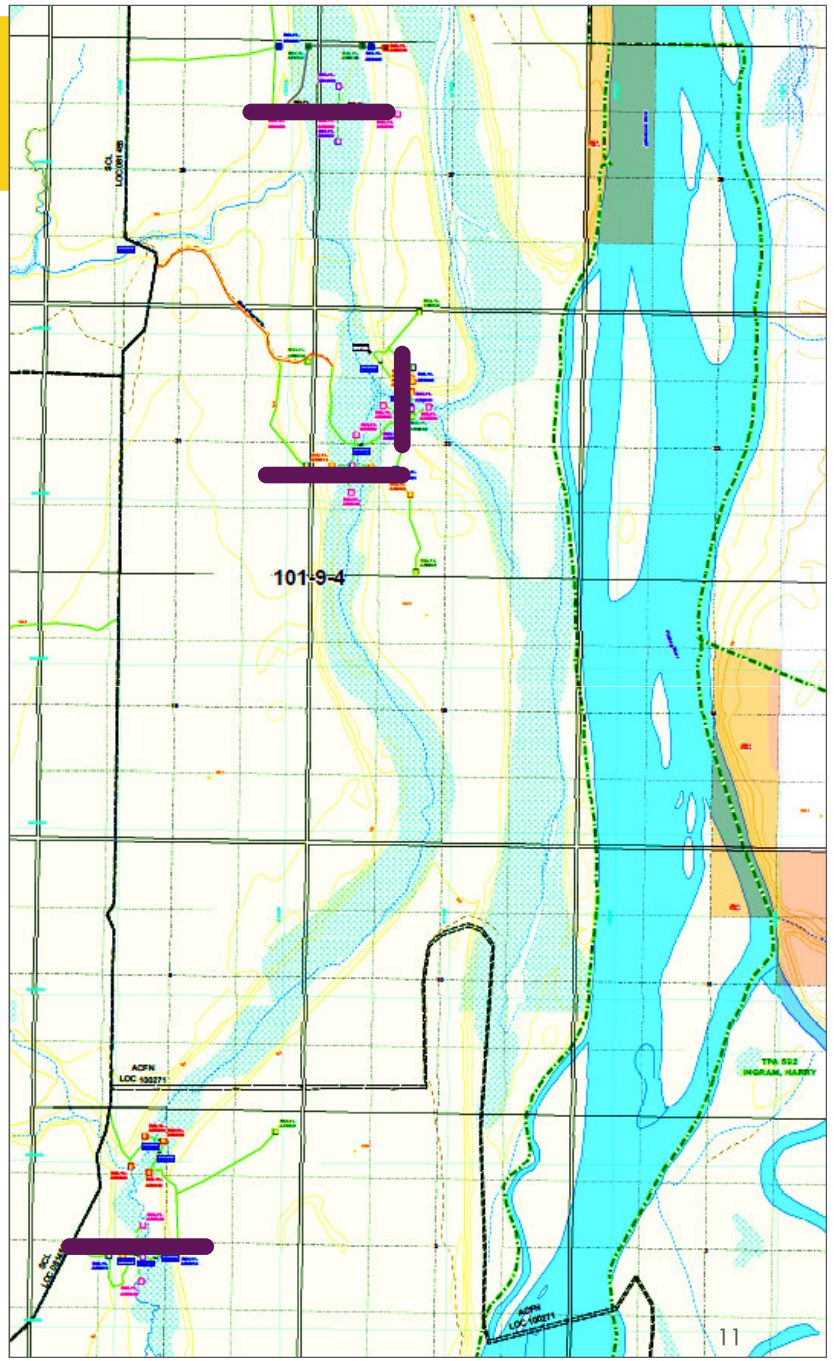
Redclay Lakes – Conceptual Design

- Conceptual design shows maximum potential lake sizes
  - Actual lakes could be smaller
- Lakes naturally split into two construction phases
  - High ground results in 2 separate lakes
  - North Redclay for existing approved projects
  - South Redclay for JPME/PRM



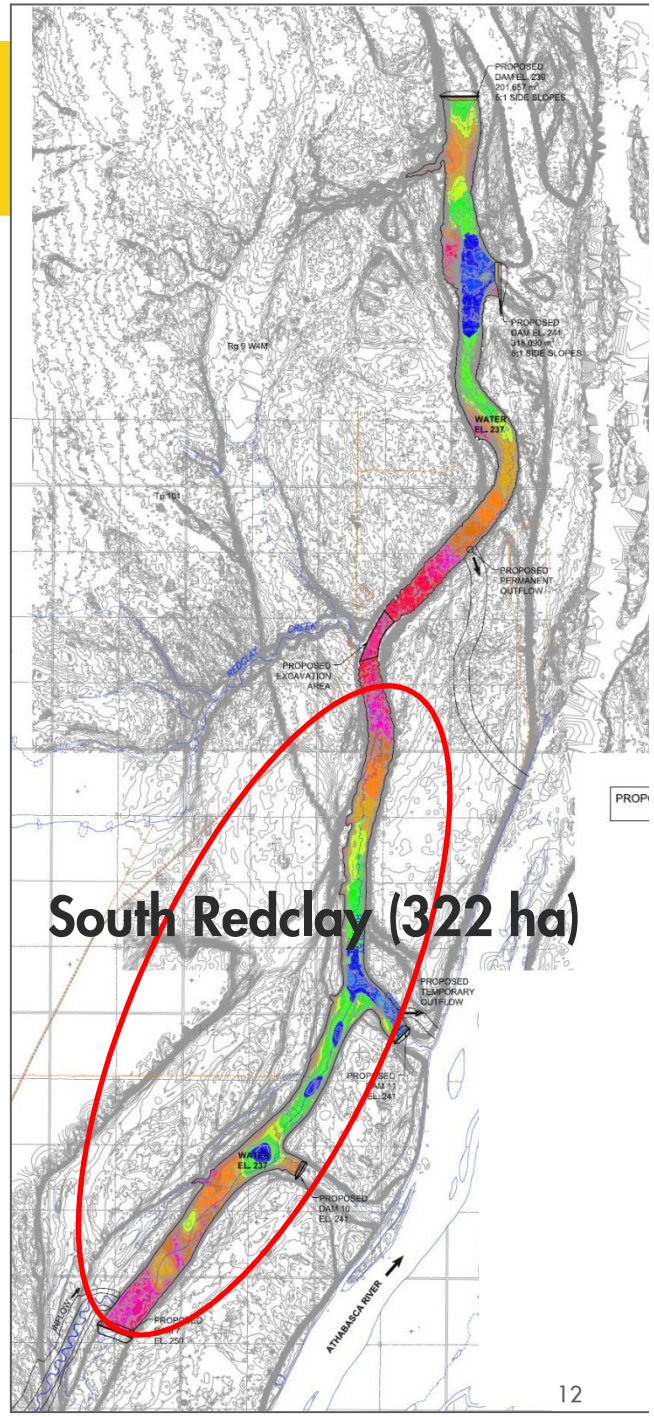
North Redclay Lake (Update on MRME NNL Plan)

- Geotechnical studies underway
- Drilling program to evaluate the ground conditions at possible dam locations
- Will allow us to determine the financial costs of the various options so we can decide which one we should build
- Still on schedule to provide our best option at the end of Q2 2011
- Detailed design and detailed design consultation begins in late 2011
- Construction to be complete by the end of 2015 – from Authorization



JPME/PRM NNL Plan
South Redclay Lake – Concept

- Required size depends on many variables:
  - Is any compensation still required for JPM1 after North Redclay construction?
  - Will approval be received for Pierre River and Jackpine Mine Expansion projects?
  - What are the geotechnical conditions?
  - Location/size also dependent on water source location
- South Redclay provides a feasible alternative for Shell's JPME/PRM fish habitat compensation requirements
- HADD and compensation requirement would be several years in the future
- Shell continues to look for other options which might replace South Redclay entirely or in part



Habitat Losses – JPME Habitat Units (Preliminary)

Reach Identifier	Reach Identifier	Habitat Area (m^2)	Brook Stickleback	Fathead Minnow	Finescale Dace	Lake Chub	Longnose Sucker	Northern Pike	Pearl Dace	White Sucker
Muskeg River - Reach 6b	**MR-R6b**	212,911	106,455	159,683	106,455	106,455	106,455	138,392	159,683	116,925
Unnamed Creek 9	UC9	3,640	1,820			910			1,820	
Unnamed Waterbody 3	*WB3*	313,080	78,270							
Wapasu Creek - Reach 1	WC-R1	25,125	25,125	25,125		12,563	12,563		18,844	15,211
Wapasu Creek - Reach 2	WC-R2	21,282	21,282	21,282		10,641	10,641		15,962	12,884
Wapasu Creek - Reach 3a	WC-R3a	49,379	23,825	24,689		35,553	29,627		24,689	37,664
Wapasu Creek - Reach 3b	WC-R3b	23,143	11,462	11,572		5,786	11,572		11,572	17,652
Muskeg River - Reach 6b - Minor Tributaries	MR-R6b-TX	33,829	16,915			16,915			25,372	
Unnamed Waterbody 2	*WB2*	84,914	63,686							
Unnamed Waterbody 17	*WB17*	46,450	34,838							
Muskeg River - Reach 6b - Tributary 22	MR-R6b-T22	3,495	1,747			1,747	1,747	2,272	2,621	1,919
Unnamed Waterbody 1	*WB1*	52,710	26,355			26,355	26,355	34,262	34,696	52,710
Unnamed Creek 12	UC12	1,116	837			558	558		558	703
Muskeg River - Reach 6b - Tributary40	MR-R6b-T40	6,709	3,355			3,355			5,032	
Muskeg River - Reach 7	**MR-R7**	20,248	10,124		10,124	10,124	10,124	4,050	20,248	10,451

Habitat Losses – PRM Habitat Units (Preliminary)

Watershed	Reach Identifier	Habitat Area (m^2)	Arctic Grayling	Brassy Minnow	Brook Stickleback	Burbot	Fathead Minnow	Flathead Chub	Lake Chub	Longnose Dace	Longnose Sucker	Northern Pike	Northern Redbelly Dace	Pearl Dace	Slimy Sculpin	Spoonhead Sculpin	Spottail Shiner	Trout-Perch	Walleye	White Sucker	Yellow Perch
Pierre River	PR-R1	35,419	8,855	17,710	17,090	14,345	17,710	26,564	8,855	15,053	17,710	17,710	17,090	17,710	13,282			8,855	35,419	29,822	
	PR-R2	78,780	19,695	78,780	78,780	26,917	78,780		39,390	985	39,390	51,207	78,780	59,085	18,710			19,695	39,390	46,663	
	UC4	47,567		35,675	23,783		35,675		23,783		23,783	9,513	23,783	23,783						29,965	
	UC4-T1	18,726		14,045	9,363		14,045		9,363		9,363	3,745	9,363	9,363						11,797	
	PR-R3	27,171		27,171	27,171		27,171		13,585		13,585		27,171	20,378						16,094	
	PR-R3-TX	5,226			5,226		5,226		2,613		2,613		5,226	3,919						3,095	
Eymundson Creek	EC-R1	43,160	10,790		21,580	17,803	21,580	21,580	10,790		21,580	21,580	21,580	21,580				21,580	21,580	20,640	
	UC1-R1	8,910	8,910		2,228	3,742	4,076	5,101	6,148		5,631		3,386	5,101				4,455		6,606	
	UC1-R2	30,605			15,302	12,752	15,302	15,302	7,651		15,302		15,302	15,302						23,010	
	UC1-R2-TX	17,531			8,765																
	WB5	41,180			0																
	EC-R2	108,373	27,093		47,684	9,031	68,275	54,187	70,443		54,187		47,684	95,369				27,093		72,800	
	UC-11	83,919			41,959		41,959		20,980		41,959		41,959	20,980						51,969	
	EC-R2-TX	84			37																
	EC-R3	32,585	8,146		16,292		16,292	16,292	8,146		16,292		16,292	16,292						16,818	
	EC-R4	55,001			41,250		41,250		27,500				41,250	55,001							
	AC-R1	39,341			19,670		19,670		9,835				19,670	19,670							
	AC-R1-TX	15,814			7,907				3,954												
Big Creek	BC-R1	43,444	21,722		10,861	19,079	10,861	32,583	10,861	13,576	21,722	18,072		32,583	8,146	10,861	27,587	32,583	21,722	17,250	20,325
	BC-R1-T1	62			15																
	BC-R2	79,515			39,360	32,866	39,757		19,879	39,757	39,757			39,757	39,757	39,757				63,111	51,949
	UC7a	11,430			5,715		5,715		2,858		5,715									6,614	
	UC7a-TX	1,610			805																
	UC5	33,855			16,758		16,928		8,464		16,928			16,928	16,928					26,871	
	UC2	17,843			7,137		8,922		4,461		8,922			8,922	6,825					13,724	
	BC-R2-TX	56			27																
	FC-R1	28,554			14,134		14,277		7,139		14,277			14,277	14,277					22,663	
	FC-R2	41,281			27,039		34,160		20,640		20,640			10,320						25,508	
	WB15	259,380			64,845		0		0												
	FC-R2-TX	13,719			8,986																
	FC-R2-WBX	80,864			52,966																
	BC-R3	48,800			12,200		12,200		12,200		24,400			24,400							
	BC-R3-T1	59,595			14,899																
Athabasca River Minor Tributaries	AR-TX	17,270			17,270		17,270		8,635				17,270	4,318							

Habitat Losses – JPME and PRM Summary (Preliminary)

Pierre River HADD

Watershed	Habitat Area (m2)	Arctic Grayling	Brassy Minnow	Brook Stickleback	Burbot	Fathead Minnow	Flathead Chub	Lake Chub	Longnose Dace	Longnose Sucker		Totals
Pierre River	212,889	28,550	173,381	161,413	41,262	178,607	26,564	97,589	16,038	106,444		829,848
Eymundson Creek	476,503	54,939		222,674	43,328	228,404	112,462	165,447		154,951		982,205
Big Creek	720,008	21,722		275,747	51,945	142,820	32,583	86,502	53,333	152,361		817,013
Athabasca River Minor Tributaries	17,270			17,270		17,270		8,635				43,175
	1,426,670	105,211	173,381	677,104	136,535	567,101	171,609	358,173	69,371	413,756		2,672,241

Watershed	Habitat Area (m2)	Northern Pike	Northern Redbelly Dace	Pearl Dace	Slimy Sculpin	Spoonhead Sculpin	Spottail Shiner	Trout-Perch	Walleye	White Sucker	Yellow Perch	
Pierre River	212,889	82,175	161,413	134,238	31,992			28,550	74,809	137,436	0	650,613
Eymundson Creek	476,503	21,580	207,123	249,295				53,128	21,580	191,843	0	744,549
Big Creek	720,008	18,072		147,187	85,933	50,618	27,587	32,583	21,722	175,741	72,274	631,717
Athabasca River Minor Tributaries	17,270		17,270	4,318								21,588
Totals	1,426,670	121,827	385,806	535,038	117,925	50,618	27,587	114,261	118,111	505,020	72,274	2,048,467
										PRM Grand Total		4,720,708

Jackpine Mine Expansion HADD

Reach Identifier	Habitat Area (m^2)	Brook Stickleback	Fathead Minnow	Finescale Dace	Lake Chub	Longnose Sucker	Northern Pike	Pearl Dace	White Sucker	Totals
Muskeg River Reach 6b + Tribs	256,944	128,472	159,683	106,455	128,472	108,202	140,664	192,708	118,844	1,083,500
Wapasu Creek	118,929	81,694	82,668		64,543	64,403		71,067	83,411	447,786
Unnamed Waterbodies	497,154	203,149			26,355	26,355	34,262	34,696	52,710	377,527
Unnamed Creek 12	1,116	837			558	558		558	703	3,214
Unnamed Creek 9	3,640	1,820			910			1,820		4,550
Muskeg River - Reach 7	20,248	10,124		10,124	10,124	10,124	4,050	20,248	10,451	75,245
Totals	898,031	426,096	242,351	116,579	230,962	209,642	178,976	321,097	266,119	1,991,822
								JPME Grand Total		1,991,822

Total
6,712,530

Potential Habitat Gains – Lake Habitat Suitability by Species

Species	HSI
brook stickleback	0.47
fathead minnow	0.47
finescale dace	0.47
lake chub	0.51
longnose sucker	0.50
northern pike	0.43
pearl dace	0.47
slimy sculpin	0.27
spottail shiner	0.55
walleye	0.20
white sucker	0.60

Fish Species Selected for Compensation Lake

Group	Species	In Big Creek or Redclay Creek watersheds?	In Muskeg River Watershed?	In Athabasca River?	Include in Compensation Lake?	Habitat Units Created by Compensation Lake
Large - bodied fish	Arctic grayling	Redclay	Yes	Yes	Yes	?
	burbot	Both	Yes	Yes	Yes	?
	cisco	No	Yes	Yes	No	
	goldeye	No	Yes	Yes	No	
	lake whitefish	No	Yes	Yes	Yes	?
	longnose sucker	Both	Yes	Yes	Yes	2,908,168
	mountain whitefish	No	Yes	Yes	No	
	northern pike	Redclay	Yes	Yes	Yes	2,501,024
	walleye	Redclay	Yes	Yes	Yes	1,163,267
	white sucker	Both	Yes	Yes	Yes	3,494,573
	yellow perch	Big Creek	Yes	Yes	Yes	?
Small - bodied fish	brook stickleback	Both	Yes	Yes	Yes	2,737,538
	fathead minnow	Both	Yes	Yes	Yes	2,737,538
	flathead chub	No	Yes	Yes	No	
	lake chub	Both	Yes	Yes	Yes	2,966,331
	longnose dace	Both	Yes	Yes	Yes	?
	pearl dace	Both	Yes	Yes	Yes	2,737,538
	slimy sculpin	Both	Yes	Yes	Yes	1,541,329
	spoonhead sculpin	Big Creek	Yes	Yes	Yes	?
	spottail shiner	Big Creek	Yes	Yes	Yes	3,171,598
	emerald shiner	No	Yes	Yes	No	
	trout-perch	Redclay	Yes	Yes	Yes	?
	finescale dace	Redclay	Yes	No	Yes	2,737,538
	northern redbelly dace	Redclay	Yes	No	Yes	?
					Total	28,696,442

means expected in lake, but not included in habitat gains calculations

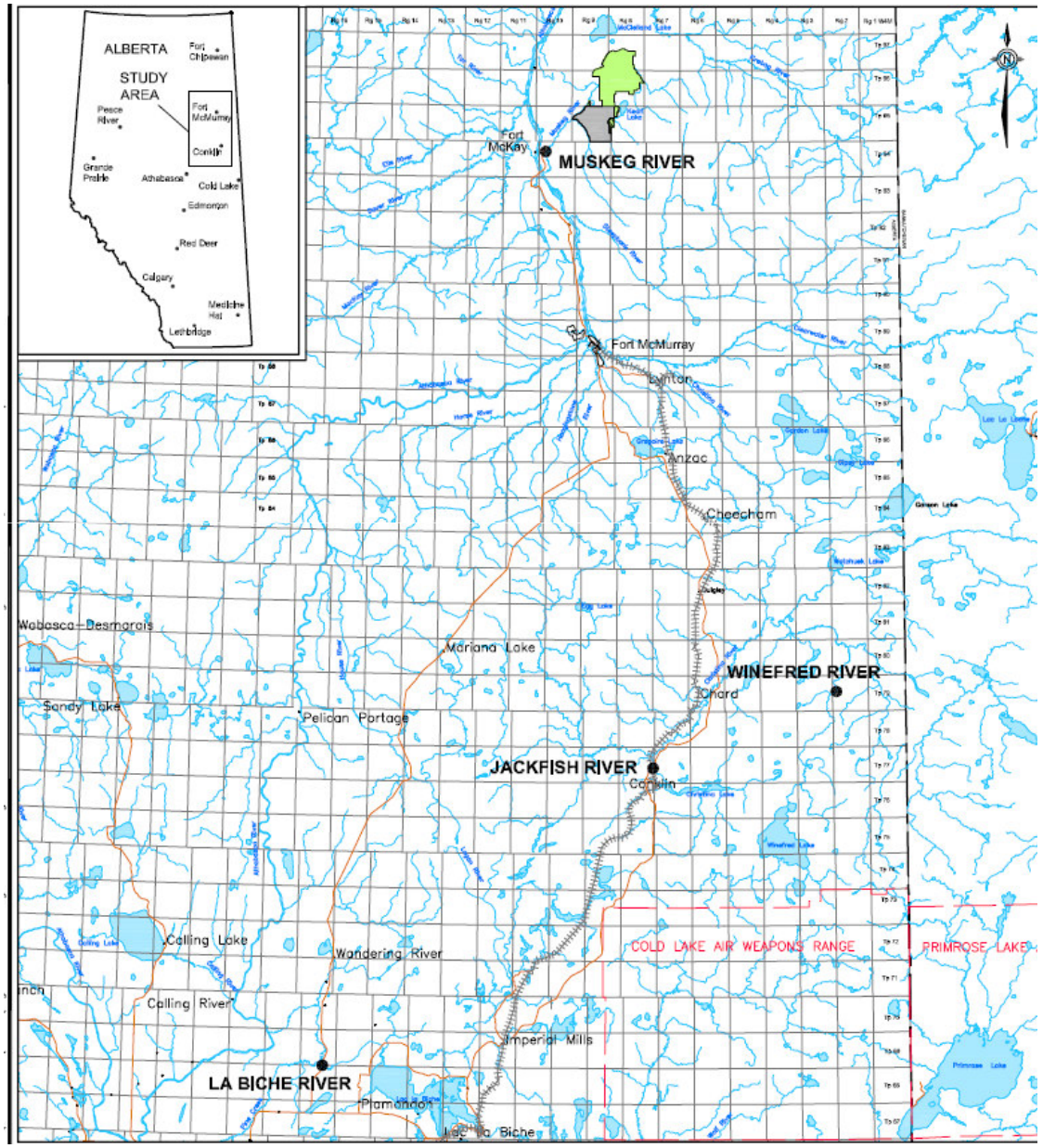
Other Compensation Issues

- No HADD calculated for downstream effects of flow changes for the Muskeg River (reaches 1 to 5)
  - Dependent on outcome of surrogate stream and other analyses
- No HADD calculated for Athabasca River water withdrawals
  - Dependent on DFO policy paper
- No HADD calculated for Athabasca River water intake at PRM
  - Very small HADD, compensation will be addressed when design and resulting footprint impacts known
- South Redclay can easily provide enough compensation for all potential outcomes of these unknowns.

Surrogate Stream Analysis - Background

- Need to define Net impact of change. No model exists to determine net impact.
  - Winter flows increase – potentially positive.
  - Flood flows decrease – potentially negative.
  - Higher flows during droughts – potentially positive.
- Surrogate stream assessment (selected existing streams in region similar to future Muskeg River flow regime) – lake controlled hydrology – dampened hydrograph, similar size to future Muskeg River.
- Key study areas:
  - Fish species use – what do these rivers support?
  - Winter habitat conditions – winter flow, dissolved oxygen
  - Beaver dam density – effect of reduced floods on dams and fish passage
  - Habitat Diversity and Channel morphology – reduced floods and effects on channel forming processes

Surrogate Stream Analysis - Locations



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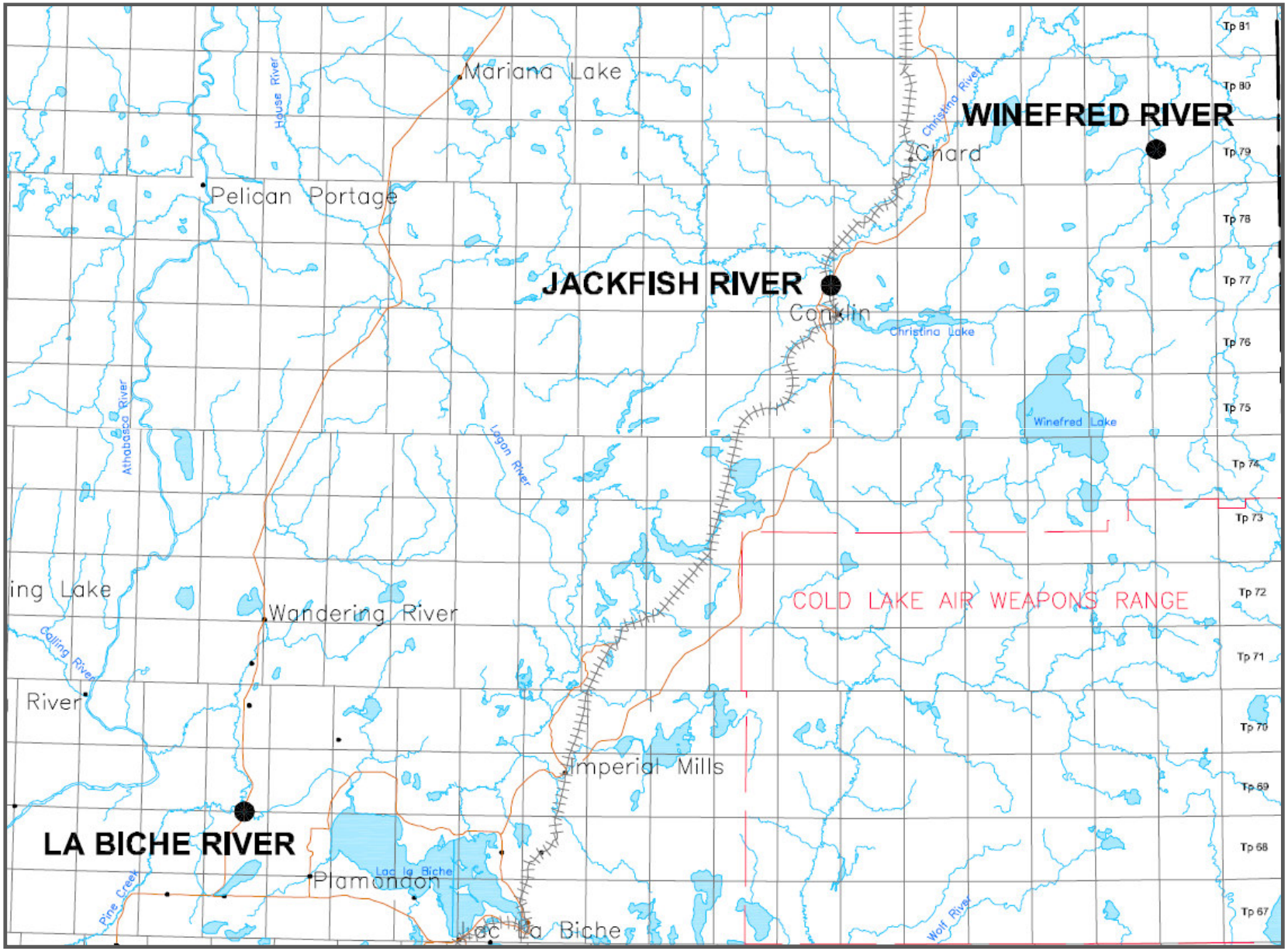


Surrogate Stream Analysis – Winefred River

Surrogate Stream Analysis – Winefred River

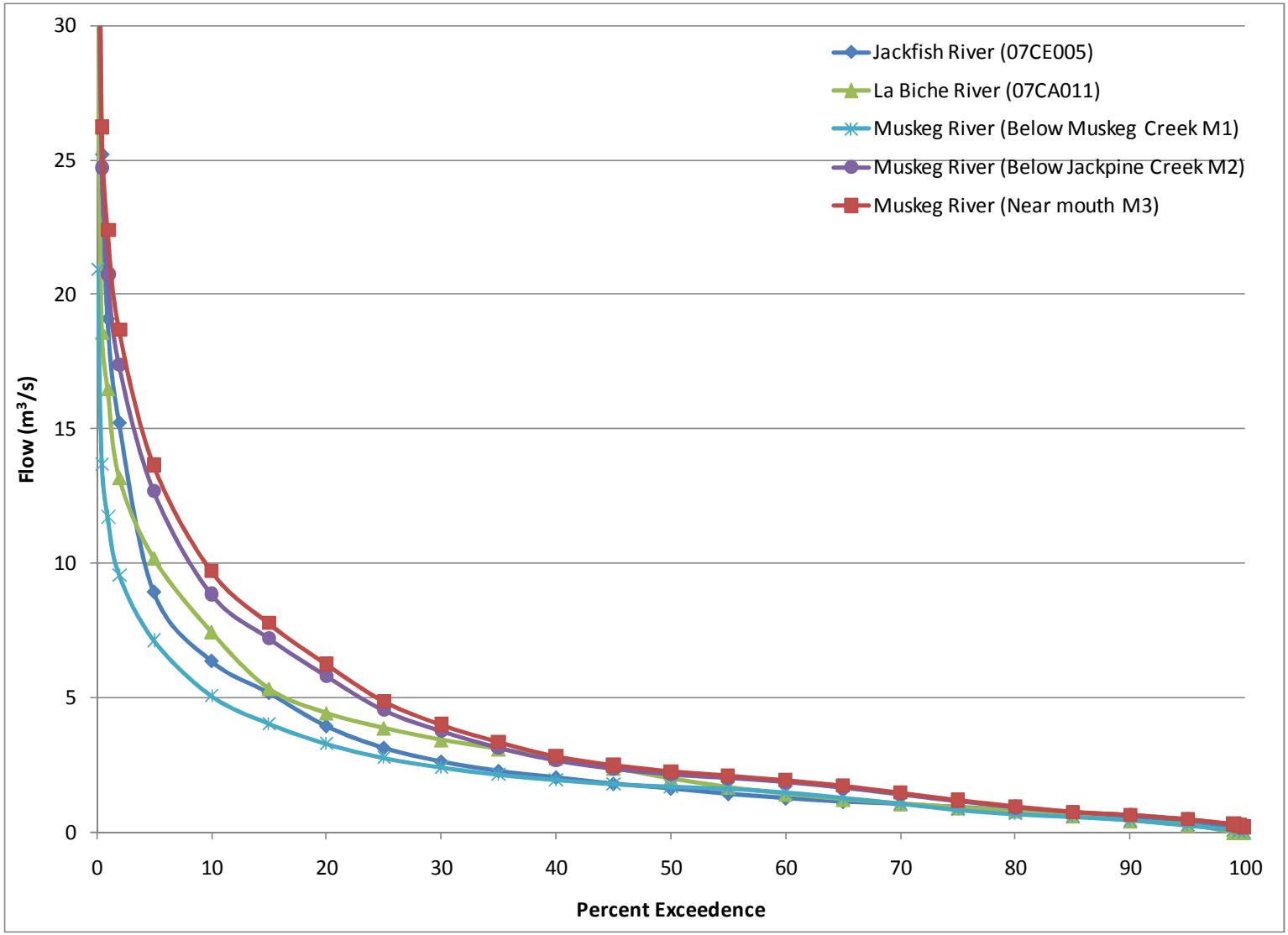
Surrogate Stream Analysis – LaBiche River

Surrogate Stream Analysis – LaBiche River

Surrogate Stream Analysis – Jackfish River

Surrogate Stream Analysis – Jackfish River

Surrogate Stream Analysis - Flows



Daily Flow Duration Curves for Jackfish River (1982-1995), La Biche River (1982-1995) and the Far Future Muskeg River (simulated based on 1953-2006)

Surrogate Stream Analysis – Channel Characteristics

Comparison of Surrogate Stream and Muskeg River Channel Characteristics (need Reach 5)

	Winefred River	Jackfish River	Current Muskeg River (Reach 3) –	La Biche River	Current Muskeg River (Reach 4)
Measured Flow Summer 2008	5.33	2.46	5.04	1.81	4.61
Average Wetted /Channel Widths (m) **	27.8 / 28.2	29.8 / 30.4	16.9/18.5	18.8 / 19.8	16.7 / 17.1
Riparian	boreal mixedwood	boreal mixedwood	boreal mixedwood	deciduous/grass -sedge	willow/alder
% Riffle / Run / Pool	18 / 82 / 0	22 / 75 / 3	11 / 89 / 0	0 / 100 / 0	0 / 95 / 5
% Instream Cover	23.9	29.5	22.5	73.3	27.7
% Overhead Cover	14.4	5.4	6.9	10	12
Maximum Depth (m)	0.53 - 1.40	0.38 - 1.50	0.45 - 1.18	1.5	1.65 - 2.40
Substrate (dominant/sub-dominant)	Co / Bo	Co / Bo	Co / Sa	Sa / Cl / Si	Sa / Co
Surface Water Slope (%)	0.067	0.061	0.077	0.019	0.022

Surrogate Stream Analysis – Beaver Dams

Summary of Frequency of Beaver Dams with Winefred, Jackfish, La Biche and Muskeg Rivers

	Winefred River	Jackfish River	La Biche River	Muskeg River		
				Reach 3	Reach 4	Reach 5
Field Surveys						
Distance Surveyed (km)	1.37	1.26	0.83	-	-	-
Beaver Dams	0	1	0	-	-	-
Aerial Photography						
Distance Assessed (km)	21.62	15.78	27.13	7.8	17.55	16.31
Complete Dams	1	3	0	0	2	2
Breached Dams	0	1	0	1	0	5
Woody Debris	0	2	0	1	0	0

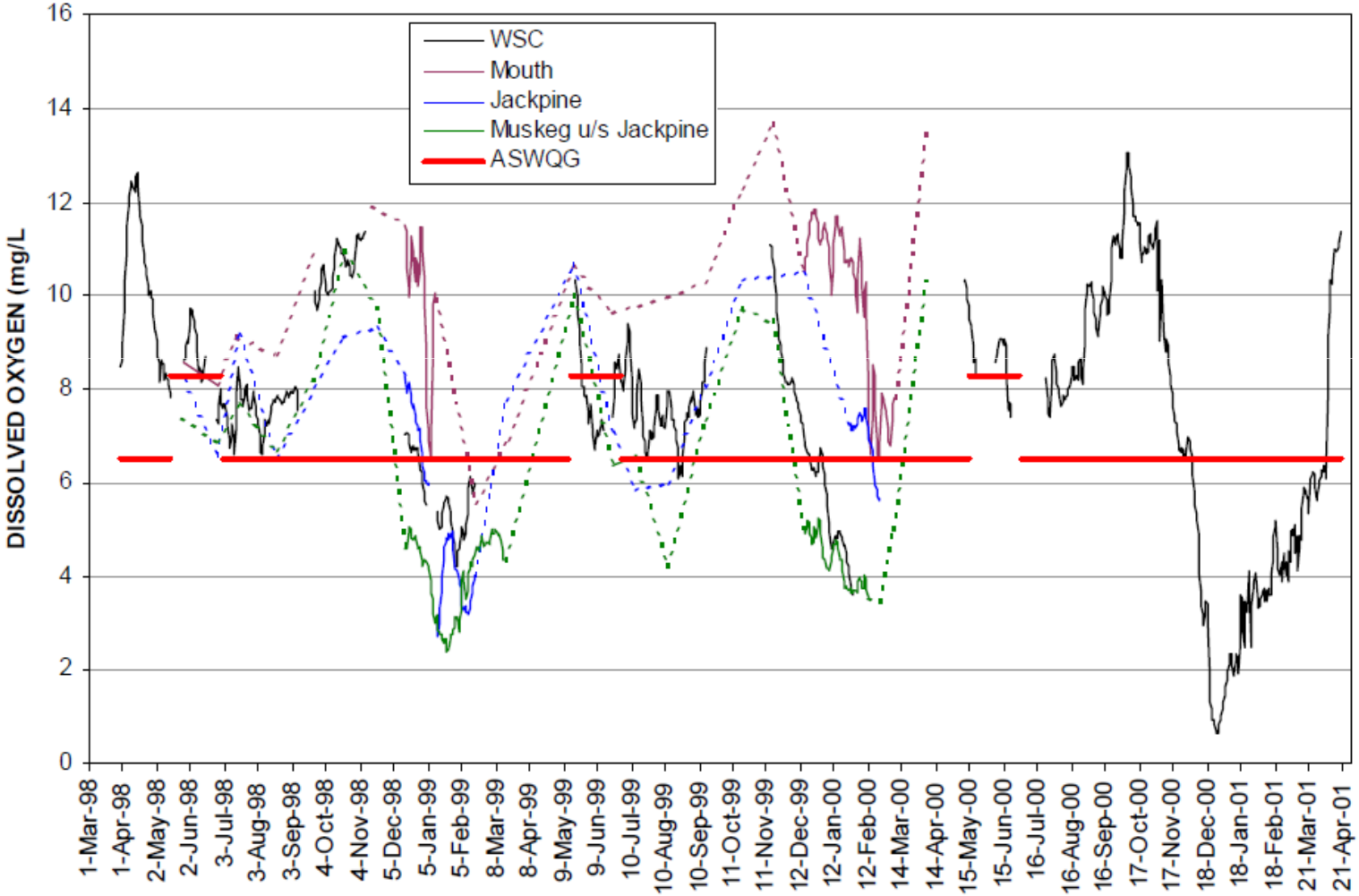
Surrogate Stream Analysis – Dissolved Oxygen

Seasonal Water Quality Parameters for the Surrogate Streams

Site	Season	Temperature (°C)	YSI Dissolved Oxygen (mg/L)	Winkler DO (mg/L)	pH	Specific Conductance (µS/cm)	Total Suspended Solids (mg/L)
Winefred River	30-Jul-08	19.4	8.8	8.5	8	189	6
	28-May-09	10.6	12	10.8	8	142	-
	20-Mar-09	0.4	11.7	9.0	7	230	-
Jackfish River	06-Jul-08	17.4	10.4	9.5	8	132	<3
	28-May-09	7.9	11	11.3	8	176	-
	20-Mar-09	0.5	10.8	9.8	7	204	-
La Biche River	07-Jul-08	20	10.7	9.0	9	211	6
	29-May-09	16.3	10.4	10.0	8	287	-
	20-Mar-09	0.2	10.8	9.8	7	338	-

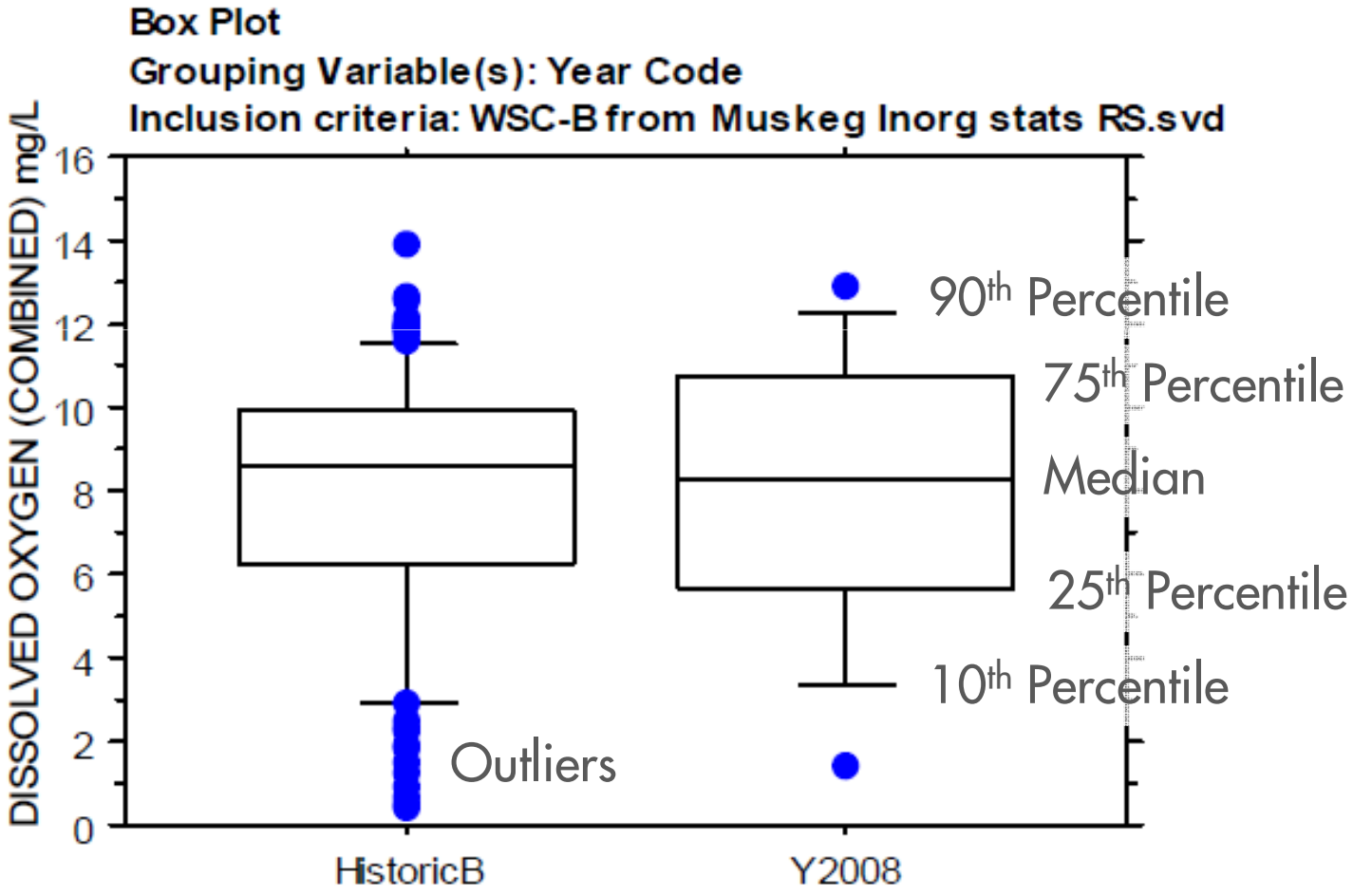
Muskeg River – Historical Dissolved Oxygen

Seasonal Dissolved Oxygen for the Muskeg River (to be supplemented) from McEachern and Noton 2002, Overview Of Water Quality In The Muskeg River Basin July 1972 To March 2001

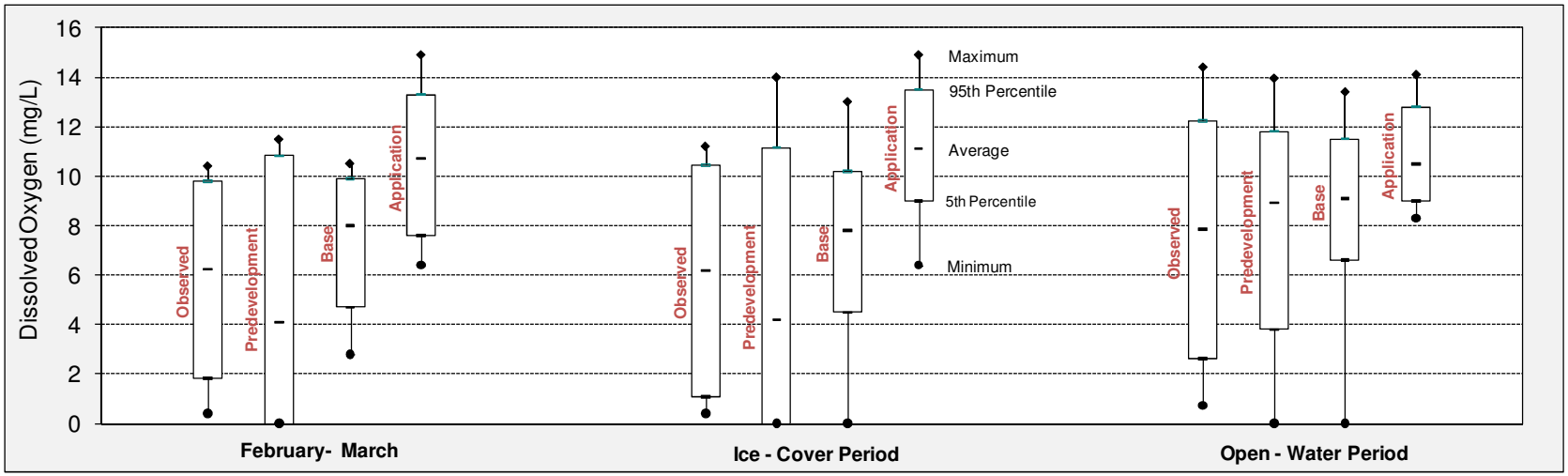


Muskeg River – Historical Dissolved Oxygen

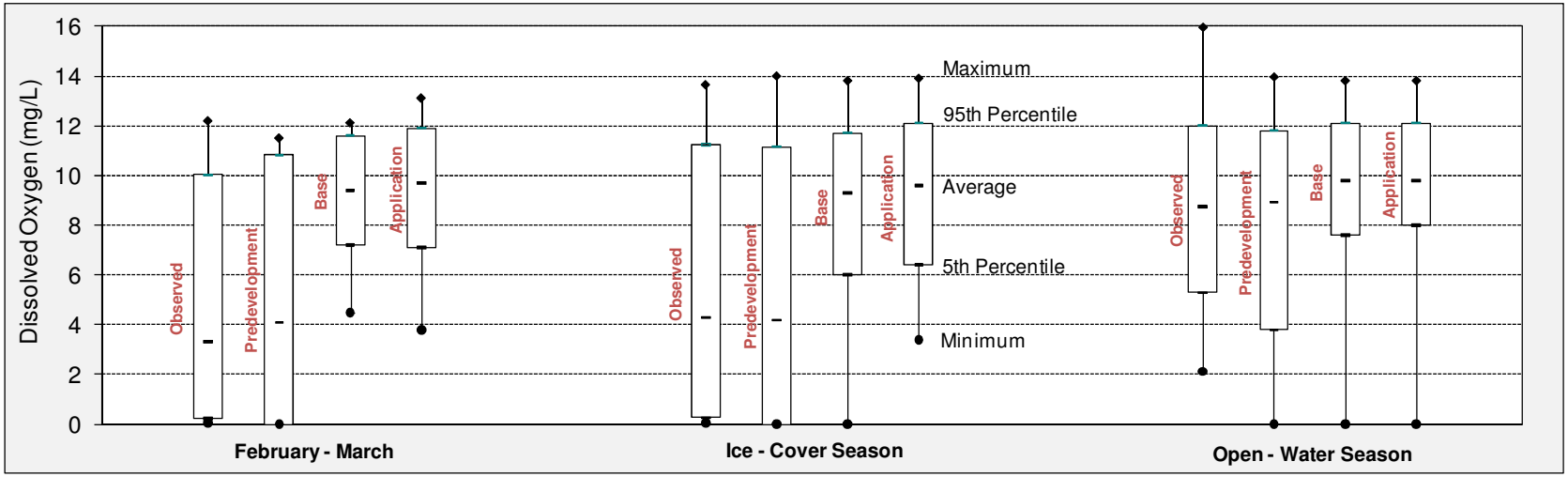
All seasons dissolved oxygen data for WSC Station on Muskeg River (to be supplemented) from AENV Muskeg River Watershed Integrated Water Quality Monitoring Program Annual Report, September 2009



Muskeg River - Dissolved Oxygen Modelling



Node M0 – Muskeg River downstream of Stanley Creek (preliminary)



Node M3 – Near the mouth of Muskeg River (preliminary)

Surrogate Stream Analysis – Fish Species Use

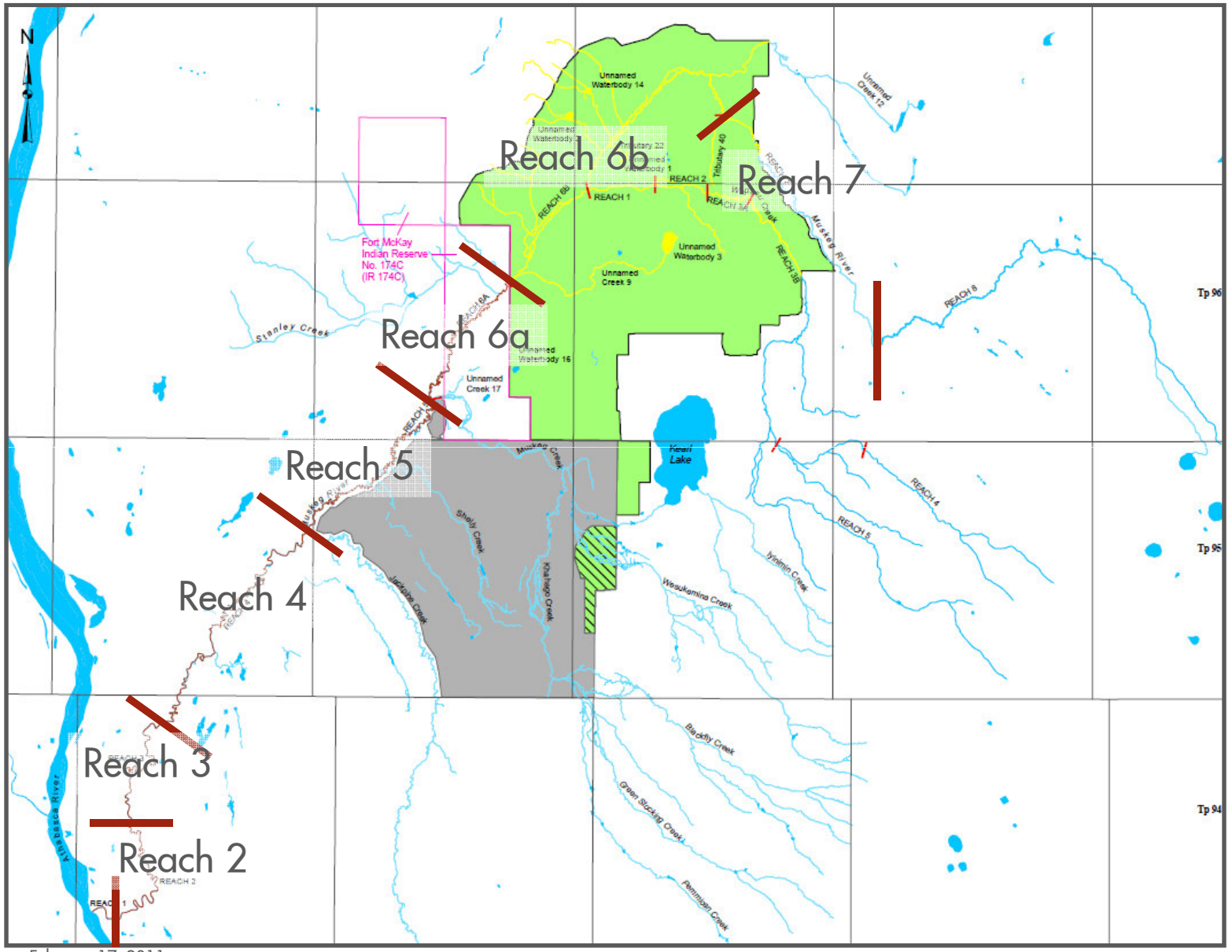
Category	Species		Surrogate Stream			Muskeg River		
	Common Name	Scientific Name	Winefred River	Jackfish River	La Biche River	Reach 3	Reach 4 Below Jackpine Creek	Reach 5 Below Muskeg Creek
Sport Fish	Burbot	*Lota lota*	▲	■ ▲	■	-	-	-
	Walleye	*Sander vitreus*	■	■ ▲	■	●	●	●
	Mountain whitefish	*Prosopium williamsoni*	-	-	■	●	●	-
	Goldeye	*Hiodon alosoides*	-	-	▲	-	-	-
	Northern pike	*Esox lucius*	-	■ ▲	■ ▲	●	●	●
	Arctic grayling	*Thymallus arcticus*	■	■ ▲	-	●	●	●
	Lake whitefish	*Coregonus clupeaformis*	-	-	-	-	●	-
	Yellow perch	*Perca flavescens*	■	-	-	-	●	-
Non-sport Fish	White sucker	*Catostomus commersonii*	■▲	■ ▲	▲	●	●	●
	Longnose sucker	*Catostomus catostomus*	■ ▲	■ ▲	-	●	●	●
Forage Fish	Brook stickleback	*Culaea inconstans*	■	-	■	●	●	●
	Lake chub	*Couesius plumbeus*	■ ▲	-	-	●	●	●
	Spottail shiner	*Notropis hudsonius*	■	-	▲	-	-	-
	Iowa darter	*Etheostoma exile*	■	-	-	-	-	-
	Slimy sculpin	*Cottus cognatus*	-	▲	-	●	●	●
	Spoonhead sculpin	*Cottus ricei*	-	-	-	●	●	-
	Pearl dace	*Margariscus margarita*	-	-	-	●	●	●
	Fathead minnow	*Pimephales promelas*	-	-	-	●	●	-
	Northern redbelly dace	*Phoxinus eos*	▲	-	-	●	●	-
	Longnose dace	*Rhinichthys cataractae*	▲	-	-	●	●	-
	Flathead chub	*Platygobio gracilis*	-	-	▲	-	-	-
	Trout-perch	*Percopsis omiscomaycus*	-	-	▲	●	●	●
	Finescale Dace	*Phoxinus neogaeus*	▲	-	-	-	●	-

■ = Surrogate stream species data from FWMIS, Rhude 1976;

▲ = Surrogate stream species captured during 2008/2009 field surveys;

● = Species documented in Muskeg River

Muskeg River IFN Modelling Results – Reach Definitions



Muskeg River IFN Modelling Results - Preliminary

MEAN OF DIFFERENCES FROM NATURAL FOR ALL WEEKS

Reach 2	2039-Base	2039-App	2065-Base	2065-App	Rev1a
Wetted Area	29.84%	31.93%	47.00%	50.59%	44.21%
NRPK-A	26.05%	27.17%	43.61%	45.51%	40.81%
NRPK-J	26.05%	27.05%	40.94%	42.25%	38.20%
WALL-A	42.43%	52.10%	101.56%	121.58%	107.40%
WALL-J	40.56%	47.42%	80.97%	95.26%	82.35%
LNSC-A	37.61%	47.70%	115.32%	137.30%	123.98%
LNSC-J	35.05%	39.55%	66.90%	76.10%	66.51%
Wetted Area (Winter)	168.57%	142.85%	308.36%	375.57%	253.99%

MAXIMUM WEEKLY MEAN OF DIFFERENCES CHANGE FROM NATURAL

Reach 2	2039-Base	2039-App	2065-Base	2065-App	Rev1a
Wetted Area	-4.77%	-6.22%	-3.23%	-4.23%	-3.89%
NRPK-A	-8.86%	-12.11%	-4.97%	-6.37%	-5.37%
NRPK-J	-5.56%	-8.01%	-3.24%	-3.69%	-3.11%
WALL-A	0.61%	-1.93%	2.36%	3.93%	1.24%
WALL-J	1.46%	0.53%	1.01%	2.06%	0.32%
LNSC-A	-18.86%	-25.95%	-7.15%	-11.61%	-9.45%
LNSC-J	-2.42%	-4.97%	-0.10%	-0.75%	-0.57%
Wetted Area (Winter)	9.96%	2.89%	18.20%	22.73%	2.18%

MEAN OF DIFFERENCES FROM NATURAL FOR ALL WEEKS

Reach 3	2039-Base	2039-App	2065-Base	2065-App	Rev1a
Wetted Area	29.56%	31.77%	45.80%	48.74%	42.15%
NRPK-A	29.31%	31.06%	40.13%	41.12%	35.47%
NRPK-J	29.63%	31.28%	36.48%	36.55%	32.01%
WALL-A	42.50%	53.01%	102.62%	123.64%	106.03%
WALL-J	45.68%	55.61%	96.18%	115.12%	97.75%
LNSC-A	43.38%	55.62%	116.36%	141.17%	120.74%
LNSC-J	36.71%	42.39%	71.02%	81.68%	70.08%
Wetted Area (Winter)	170.84%	146.25%	306.27%	369.63%	250.58%

MAXIMUM WEEKLY MEAN OF DIFFERENCES CHANGE FROM NATURAL

Reach 3	2039-Base	2039-App	2065-Base	2065-App	Rev1a
Wetted Area	-8.25%	-10.25%	-5.68%	-7.45%	-6.85%
NRPK-A	-7.52%	-9.10%	-5.69%	-7.35%	-6.52%
NRPK-J	-3.49%	-4.15%	-3.50%	-4.51%	-4.17%
WALL-A	-9.01%	-13.95%	-3.33%	-5.47%	-5.17%
WALL-J	1.19%	-1.69%	3.57%	3.11%	-1.11%
LNSC-A	-18.12%	-24.72%	-7.35%	-12.77%	-11.41%
LNSC-J	-2.94%	-6.02%	0.09%	-0.86%	-1.33%
Wetted Area (Winter)	10.02%	3.51%	18.44%	22.26%	2.45%

Muskeg River IFN Modelling Results - Preliminary

MEAN OF DIFFERENCES FROM NATURAL FOR ALL WEEKS

Reach 4	2039-Base	2039-App	2065-Base	2065-App	Rev1a
Wetted Area	29.27%	32.18%	43.67%	46.45%	39.88%
NRPK-A	29.82%	32.30%	36.99%	37.28%	32.57%
NRPK-J	25.46%	26.58%	28.08%	24.31%	22.59%
WALL-A	36.39%	41.35%	54.88%	62.33%	52.62%
WALL-J	47.55%	56.99%	59.13%	68.37%	58.57%
LNSC-A	37.55%	43.71%	61.92%	72.50%	61.14%
LNSC-J	37.82%	42.87%	51.31%	57.37%	48.87%
Wetted Area (Winter)	204.27%	177.13%	358.13%	428.64%	293.54%

MAXIMUM WEEKLY MEAN OF DIFFERENCES CHANGE FROM NATURAL

Reach 4	2039-Base	2039-App	2065-Base	2065-App	Rev1a
Wetted Area	-12.89%	-15.42%	-10.31%	-13.33%	-12.46%
NRPK-A	-6.04%	-6.99%	-6.74%	-7.43%	-7.17%
NRPK-J	-9.90%	-11.60%	-9.33%	-11.41%	-10.27%
WALL-A	0.47%	-0.42%	0.51%	0.73%	0.30%
WALL-J	13.24%	12.91%	5.89%	6.65%	0.06%
LNSC-A	-2.13%	-4.44%	-1.50%	-1.53%	-1.85%
LNSC-J	6.88%	6.18%	4.76%	5.50%	0.53%
Wetted Area (Winter)	14.88%	7.21%	24.42%	29.57%	7.06%

MEAN OF DIFFERENCES FROM NATURAL FOR ALL WEEKS

Reach 5	2039-Base	2039-App	2065-Base	2065-App	Rev1a
Wetted Area	8.00%	24.19%	26.60%	42.16%	33.06%
NRPK-A	11.53%	23.51%	26.30%	38.78%	29.42%
NRPK-J	7.05%	12.15%	15.96%	25.09%	20.81%
WALL-A	27.67%	43.09%	44.35%	56.35%	44.46%
WALL-J	44.87%	55.22%	55.14%	62.83%	51.23%
LNSC-A	28.92%	52.07%	53.45%	74.67%	57.47%
LNSC-J	33.36%	42.44%	43.46%	49.26%	39.97%
Wetted Area (Winter)	129.68%	128.01%	228.51%	256.23%	164.04%

MAXIMUM WEEKLY MEAN OF DIFFERENCES CHANGE FROM NATURAL

Reach 5	2039-Base	2039-App	2065-Base	2065-App	Rev1a
Wetted Area	-37.68%	-46.12%	-27.89%	-48.21%	-40.60%
NRPK-A	-38.26%	-44.18%	-27.38%	-44.91%	-38.88%
NRPK-J	-32.80%	-47.81%	-11.24%	-49.51%	-35.34%
WALL-A	-2.94%	-3.04%	-3.10%	-3.82%	-4.12%
WALL-J	17.93%	11.59%	16.46%	6.19%	-1.95%
LNSC-A	-5.02%	-5.94%	-5.60%	-7.19%	-7.26%
LNSC-J	9.36%	5.25%	7.55%	4.20%	-1.97%
Wetted Area (Winter)	4.52%	-4.26%	29.54%	31.32%	-17.62%

Muskeg River IFN Modelling Results - Preliminary

MEAN OF DIFFERENCES FROM NATURAL FOR ALL WEEKS

Reach 6a	2039-Base	2039-App	2065-Base	2065-App	Rev1a
Wetted Area	48.16%	59.62%	66.43%	66.19%	57.46%
NRPK-A	49.00%	55.24%	63.87%	60.07%	53.10%
NRPK-J	34.45%	35.96%	39.95%	31.88%	30.58%
WALL-A	76.54%	96.59%	108.92%	119.16%	101.27%
WALL-J	74.30%	90.17%	100.49%	109.12%	93.95%
LNSC-A	82.82%	114.48%	126.68%	141.74%	118.62%
LNSC-J	67.15%	79.99%	88.72%	95.89%	82.85%
Wetted Area (Winter)	323.12%	303.55%	488.83%	551.88%	430.43%

MAXIMUM WEEKLY MEAN OF DIFFERENCES CHANGE FROM NATURAL

Reach 6a	2039-Base	2039-App	2065-Base	2065-App	Rev1a
Wetted Area	-12.83%	-22.70%	-9.02%	-35.58%	-28.56%
NRPK-A	-14.43%	-24.74%	-10.16%	-34.36%	-28.57%
NRPK-J	-13.89%	-26.36%	-7.98%	-37.21%	-26.35%
WALL-A	-2.37%	-9.48%	-2.58%	-16.56%	-15.36%
WALL-J	4.69%	-1.16%	2.75%	-5.44%	-5.27%
LNSC-A	-4.40%	-14.38%	-3.74%	-24.25%	-21.43%
LNSC-J	1.67%	-1.45%	0.42%	-7.55%	-7.51%
Wetted Area (Winter)	12.10%	0.96%	26.79%	36.93%	10.60%

Potential Geomorphic Change Resulting from Flow Change

Objective of Study - For Closure:

- characterize the geomorphic and flow characteristics of five downstream reaches of the Muskeg River (Reaches 2 to 6a);
- compare historical aerial photographs and recent satellite imagery to qualitatively characterize modes and rates of morphologic change; and
- predict potential channel responses to flow alterations.

Potential Geomorphic Change Resulting from Flow Change

Table E3: Modelled Changes to Peak Flows in Reach 2

Return Period (Year)	Pre-development	Max Closed-Circuit Snapshot (2049)		Closure	
	Peak Flow (m^3/s)	Peak Flow (m^3/s)	Change from Pre-development	Peak Flow (m^3/s)	Change from Pre-development
2	22.9	12.0	-47.5%	12.7	-44.7%
10	50.8	23.1	-54.5%	27.7	-45.5%
100	85.4	35.4	-58.5%	51.7	-39.4%

Table E4: Modelled Changes to Peak Flows in Reach 6a

Return Period (Year)	Pre-development	Max Closed-Circuit Snapshot (2049)		Closure	
	Peak Flow (m^3/s)	Peak Flow (m^3/s)	Change from Pre-development	Peak Flow (m^3/s)	Change from Pre-development
2	9.9	4.2	-57.8%	2.4	-75.3%
10	23.2	5.7	-75.2%	6.2	-73.3%
100	42.3	7.3	-82.7%	12.4	-70.7%

Potential Geomorphic Change Resulting from Flow Change

Table E5: Estimated Return Periods for Peak Flows in Reach 2

Peak Flow (m^3/s)	Return Period (Year)	
	Pre-development	**Closure**
12.7	1.3	2
22.9	2	7
39.5	5	35
50.8	10	95

Potential Geomorphic Change Resulting from Flow Change

Preliminary Conclusions

- Flows have been variable, but channel has been stable for last 52 years (from airphotos)
- Peak flows will be reduced
- Over a long time period (many decades), it is expected the channel will change to adapt to the lower peak flows
- Information is preliminary but will be presented in detail in draft NNL Plan