

ATTACHMENT A

HYDROGEOLOGICAL CONDITIONS

TABLE OF CONTENTS

<u>SECTION</u>	<u>PAGE</u>
1 INTRODUCTION.....	1
2 REFERENCES.....	26

LIST OF TABLES

Table A-1	Hydraulic Parameters in Overburden	2
Table A-2	Hydraulic Parameters in Colorado Group.....	3
Table A-3	Hydraulic Parameters in Grand Rapids Formation.....	4
Table A-4	Hydraulic Parameters in Clearwater Formation.....	5
Table A-5	Hydraulic Parameters in McMurray Formation	6
Table A-6	Hydraulic Parameters in Devonian Formations	7
Table A-7	Hydraulic Head Values in Overburden Within Hydrogeology Local Study Area	8
Table A-8	Hydraulic Head Values From DSTs in Bedrock Within Hydrogeology Local Study Area	9
Table A-9	Undifferentiated Overburden Groundwater Results Within Hydrogeology Local Study Area – Major Ions, Arsenic and Hydrocarbon Indicators	10
Table A-10	Overburden Groundwater Quality Results Within Hydrogeology Local Study Area – Dissolved Metals and Trace Elements	12
Table A-11	Bedrock Groundwater Quality Results Within Hydrogeology Local Study Area – Major Ions, Arsenic and Hydrocarbon Indicators	14
Table A-12	Bedrock Groundwater Quality Results Within Hydrogeology Local Study Area – Dissolved Metals and Trace Elements.....	16
Table A-13	Water Well Records Within Hydrogeology Local Study Area	18
Table A-14	Current Groundwater Diversions Within Hydrogeology Local Study Area	19
Table A-15	Existing and Approved Case: Groundwater Withdrawal Rates – Terrace Sand Aquifer	20
Table A-16	Existing and Approved Case: Groundwater Withdrawal Rates – Empress Channel Aquifer	21
Table A-17	Existing and Approved Case: Groundwater Withdrawal Rates – Lower Grand Rapids Aquifer	22
Table A-18	Existing and Approved Case: Groundwater Withdrawal Rates and Wastewater Disposal Rates – Upper Clearwater	23
Table A-19	Existing and Approved Case: Groundwater Rates – Middle Clearwater Aquifer.....	24
Table A-20	Existing and Approved Case: Groundwater Withdrawal Rates and Wastewater Disposal Rates – McMurray Aquifer	25

1 INTRODUCTION

The following tables (A-1 to A-20) summarize local and regional scale hydrogeological data collected prior to construction, operation and reclamation of the Christina Lake Regional Project – Phase 3. The hydrogeologic data was compiled through review and interpretation of geologic and hydrogeologic data sources including:

- regional geological and hydrogeological reports;
- local data compiled by MEG Energy Corp. (MEG); and
- applications for approval to the Energy Resources Conservation Board (ERCB) and Alberta Environment (AENV) for other oil sands projects (Applications).

Table A-1 Hydraulic Parameters in Overburden

Project	Comments	Test	# of Observation Wells	Hydraulic Conductivity				Specific Storage [m ⁻¹]	Reference
				Kh - min [m/s]	Kh - max [m/s]	Kv [m/s]	Kh ^(a) [m/s]		
Empress Channel Aquifer									
EnCana Christina Lake	MW06 (Christina Channel)	-	-	-	-	-	4.0E-04	-	Westwater 2004a
EnCana Christina Lake	OBW 09-17 (Christina Channel)	pump test	-	-	-	-	9.0E-02	-	Westwater 2004a
EnCana Christina Lake	MW12 (Christina Channel)	-	-	-	-	-	1.0E-04	-	Westwater 2004a
EnCana Christina Lake	9-17-076-06 W4M (Christina Channel)	pump test	1	-	-	-	7.6E-04	2.0E-04	CG & S 1998
PanCanadian	9-17-076-06 W4M (Christina Channel)	pump test	-	-	-	-	3.0E-04	-	Van Horne 1998
Jackfish I	12-1-073-06 W4M (Wiau Channel)	pump test	-	6.0E-05	1.0E-04	-	1.0E-04	-	Stein et al. 1993
Canadian Natural Kirby	WSW 11-21 (Wiau Channel)	pump test	-	-	-	-	5.8E-04	-	Golder 2000
Canadian Natural Kirby (RAX 13-21)	13-21-73-7 W4M (Wiau Channel)	pump test	2	-	-	-	3.6E-04	1.3E-06	Waterline 2007
Canadian Natural Kirby	10-29-73-7 W4M (Wiau Channel)	pump test	-	-	-	-	3.9E-04	-	Golder 2000
Tucker	Twp 64; Rge 4 & 5 (Helina Valley)	pump test	-	-	-	-	2.0E-06	-	Husky 2003
Tucker	Twp 64; Rge 4 & 5 (Helina Valley)	pump test	-	-	-	-	1.0E-05	-	Husky 2003
Nabiye and Mahikan North	Regional study area (Helina Valley)	12 tests	-	2.7E-06	3.7E-04	-	8.8E-05	-	Imperial Oil 2003
Empress Unit 3									
EnCana Christina Lake	Empress Unit 3 - MW07, MW13	2 slug tests	-	3.00E-04	4.00E-04	-	-	-	Westwater 2004a
Tucker	Empress Unit 3 (Sand)	4 wells	-	2.8E-07	3.9E-05	-	-	-	Husky 2003
Empress Terrace Sand									
MEG Christina Lake	06-19-077-05 W4M (WSW 6-19), Terrace Sand	pump test	-	-	-	-	1.2E-05	1.9E-05	Westwater 2005a
Jackfish I	12-28-075-06 W4M (PW1)	pump test (48 hr)	1	-	-	-	1.6E-04	-	Matrix 2005
Jackfish I	12-28-075-06 W4M (PW2)	pump test (2 hr)	-	-	-	-	1.9E-04	-	Matrix 2005
North American	11-14-078-09 W4M	pump test	1	-	-	-	2.2E-05	2.5E-05	Westwater 2006
Muriel Lake									
EnCana Christina Lake	Muriel Lake - MW08 (Gravel)	slug test	-	-	-	-	7.0E-03	-	Westwater 2004a
Canadian Natural Kirby (RAX B13-21)	Muriel Lake - 13-21-73-7 W4M	pump test	-	2.5E-05	3.8E-05	-	-	-	Golder 2001
Tucker	Muriel Lake (sand)	4 wells	-	2.7E-06	3.0E-04	-	-	-	Husky 2003
Bonnyville Units 1 and 2									
Canadian Natural Kirby (OBS2006-01)	13-21-73-7 W4M (Bonnyville)	pump test	-	-	-	-	3.5E-05	-	Waterline 2007
Canadian Natural Kirby (OBS2006-02)	13-21-73-7 W4M (Bonnyville)	pump test	-	-	-	-	1.8E-06	-	Waterline 2007
Foster Creek	Bonnyville Unit 1 - MW09, MW13	2 slug tests	-	2.3E-05	1.0E-04	-	-	-	CG&S 1999
Tucker	Bonnyville Unit 1 and Unit 2 (sand)	6 wells	-	3.4E-05	8.5E-04	-	-	-	Husky 2003
Ethel Lake									
MEG Christina Lake	NE-09-077-05 W4M, Ethel Lake (sand and gravel)	3-day pump test	2	-	-	-	4.0E-04	6.0E-04	Aqua Terre 2005
EnCana Christina Lake	MW10, MW03 (sand/gravel/clay)	2 slug tests	-	1.0E-05	7.0E-04	-	-	-	Westwater 2004a, Westwater 2007b
EnCana Christina Lake	MW02, MW09 (sand/gravel/clay)	2 slug tests	-	7.0E-04	1.0E-03	-	-	-	Westwater 2004a, Westwater 2007b
Foster Creek	Ethel Lake - PW01	pump test	-	-	-	-	2.8E-04	9.4E-06	AEC 1999
Foster Creek	Ethel Lake - PW02	pump test	-	-	-	-	3.7E-04	7.0E-06	AEC 1999
Foster Creek	Ethel Lake - PW05	pump test	-	-	-	-	5.3E-04	1.9E-05	AEC 1999
Foster Creek	Ethel Lake - MW11	slug	-	-	-	-	4.5E-05	-	CG&S 1999
Foster Creek	Ethel Lake - MW14	slug	-	-	-	-	5.3E-04	-	CG&S 1999
Tucker	Ethel Lake	1 well	-	-	-	-	1.0E-04	-	Husky 2003
Sand River									
EnCana Christina Lake	Sand River - MW11 (Clay till and gravel)	slug test	-	-	-	-	8.0E-05	-	Westwater 2004a
Foster Creek	Sand River - MW10, MW12 (~36-40 m depth)	2 slug tests	-	1.6E-05	1.7E-05	-	-	-	CG&S 1999
Grand Centre									
Tucker	Grand Centre	1 well	-	-	-	-	8.5E-09	-	Husky 2003
EnCana Christina Lake	Grand Centre - MW05, MW15 (sandy clay till)	2 slug tests	-	4.0E-06	4.0E-04	-	-	-	Westwater 2004a
Undifferentiated Till									
MEG Christina Lake	SE-16-077-05 W4M Shallow Till (1 - 9 m) (clay till, sand)	16 slug tests	-	1.0E-07	8.3E-06	-	1.6E-06	-	Aqua Terre 2007a; Aqua Terre 2007b
MEG Christina Lake	SAGD Pad A, Shallow Till/Sand/Muskeg (1-5m), 3 tests	3 slug tests	-	1.0E-06	3.0E-06	-	-	-	Aqua Terre 2008
Devon Jackfish Project	Shallow Till	7 slug tests	-	8.4E-08	2.8E-07	-	3.6E-07	-	Stantec 2005
Connacher Oil and Gas Ltd.	Shallow Till (sand seams)	4 slug tests	-	3.1E-07	3.6E-06	-	1.2E-06	-	Westwater 2005b
RAX Kirby	01-2 (till)	2 slug tests	-	1.1E-06	1.3E-06	-	-	-	Matrix 2002
Undifferentiated Till - Sand									
Well test	14-31-76-7 W4 (sand)	slug	-	-	-	-	1.4E-04	-	Ozoray 1974
Obs Site 11a	16-2-087-09W4M (sand)	pump test	-	-	-	-	4.6E-07	-	Hackbarth and Nastasa 1979
Devon Jackfish Project	shallow sand	slug	-	-	-	-	3.6E-05	-	Devon 2003; 2006
Canadian Natural Kirby (OBS2006-03)	13-21-73-7 W4M (sand)	pump test	-	-	-	-	1.0E-07	-	Waterline 2007
Bulk									
Regional	-	slug	-	-	-	-	2.1E-07	-	Bachu et al. 1996

^(a) Representative value; average or geometric mean.

- = Not available.

Note: Values in table may be referenced in text with fewer significant digits for ease of reading.

Table A-2 Hydraulic Parameters in Colorado Group

Project	Comments	Test	Hydraulic Conductivity					Porosity	Specific Storage	Reference
			Kh - min [m/s]	Kh - max [m/s]	Kh/Kv	Kv [m/s]	Kh ^(a) [m/s]			
Bulk										
Nabiye and Mahihkan North	Regional study area	7 wells	3.4E-11	4.5E-07	-	-	2.8E-08	-	-	Imperial Oil 2003
Tucker	Twp 62 to 67; Rge 2 to 6	model calibration	-	-	300	3.0E-10	1.0E-07	-	-	Husky 2003
LaBiche Formation										
MEG Christina Lake	SE-16-077-05 W4M	slug	-	-	-	-	5.2E-09	-	-	Aqua Terre 2007a
Viking Formation										
Core analyses	Twp 70 to 103; Rge 1 W4 to 1 W5	12 tests	2.6E-07	6.0E-05	1	-	7.0E-06	33	-	Bachu et al. 1993
Drill-stem tests	Twp 70 to 103; Rge 1 W4 to 1 W5	51 tests	4.6E-10	5.2E-05	-	-	1.9E-07	-	-	Bachu et al. 1993
Core analyses	Twp 60 to 70; Rge 15 W3 to 17 W4	158 tests	4.9E-10	9.6E-05	-	-	3.2E-06	-	4.4E-03	Hitchon et al. 1989
Drill-stem tests	Twp 60 to 70; Rge 15 W3 to 17 W4	1,167 tests	1.2E-11	8.0E-04	-	-	2.4E-07	-	2.3E-03	Hitchon et al. 1989
Joli Fou Formation										
Regional	-	estimate	-	-	-	4.6E-14	-	-	-	Basin Analysis Group 1985

^(a) Representative value; average or geometric mean.

- = Not available.

Note: Values in table may be referenced in text with fewer significant digits for ease of reading.

Table A-3 Hydraulic Parameters in Grand Rapids Formation

Project	Comments	Test	# of Observation Wells	Hydraulic Conductivity					Porosity	Specific Storage	Reference
				Kh - min [m/s]	Kh - max [m/s]	Kh/Kv	Kv [m/s]	Kh ^(a) [m/s]			
Undifferentiated Colony and Grand Rapids											
Jackfish	characterization	-	-	-	-	-	-	1.0E-05	-	1.0E-04	Devon 2003
Foster Creek	Drill Stem Test (DST) analyses	34 tests	-	4.3E-09	1.8E-05	-	-	3.3E-06	-	-	EBA 1999
Core analyses	Twp 70 to 103; Rge 1 W4 to 1 W5	101 tests	-	4.0E-10	6.3E-05	2	-	4.9E-06	35	-	Bachu et al. 1993
Drill-stem tests	Twp 70 to 103; Rge 1 W4 to 1 W5	416 tests	-	8.0E-11	6.7E-05	-	-	4.2E-07	-	-	Bachu et al. 1993
Core analyses	Twp 50 to 70; Rge 15 W3 to 17 W4	8832 tests	-	6.8E-08	1.7E-04	82	4.5E-08	3.7E-06	-	5.5E-03	Hitchon et al. 1989
Drill-stem	Twp 50 to 70; Rge 15 W3 to 17 W4	1497 tests	-	1.0E-11	1.0E-05	-	-	2.6E-08	-	4.5E-04	Hitchon et al. 1989
Tucker Lake	DST analyses; Twp 63 to 66, Rng 3 to 5	10 wells	-	3.8E-09	5.8E-06	-	-	1.9E-07	-	-	Husky 2003
Lower Grand Rapids Aquifer											
North American	13-22-078-10 W4M	air lift	-	-	-	-	-	1.5E-05	-	-	North American 2006
North American	9-21-081-9 W4M	pump test	-	-	-	-	-	8.2E-06	-	-	Westwater 2007a
North American	3-2-079-10 W4M	pump test	-	-	-	-	-	1.7E-05	-	-	Westwater 2007a
Jackfish I	characterization	drill stem	-	-	-	-	-	2.0E-05	-	1.0E-04	Devon 2003
Jackfish I	characterization	core analyses	-	-	-	-	-	4.0E-05	-	1.0E-04	Devon 2003
Jackfish I	100/12-15-075-6W4M	pump test (72 hr)	1	-	-	-	-	2.3E-05	-	4.3E-06	Westwater 2004b
Canadian Natural Kirby	1F2/14-30-73-7	aquifer test	-	1.1E-05	3.3E-05	-	-	-	-	-	Canadian Natural 2007
Canadian Natural Kirby	AA/14-30-73-7	aquifer test	-	3.2E-05	4.1E-05	-	-	-	-	5.5E-05	Canadian Natural 2007
Surmont In-Situ Oil Sands	8-25-083-7 W4M	pump test (24 hr)	-	-	-	-	-	1.1E-05	-	8.6E-06	Sentar 1997
Surmont In-Situ Oil Sands	2-18-083-6 W4M	pump test (72 hr)	3	-	-	-	-	5.0E-05	-	2.5E-06	Matrix 2003
Surmont In-Situ Oil Sands	4-18-083-6 W4M	pump test (72 hr)	3	-	-	-	-	5.0E-05	-	5.0E-06	Matrix 2003
Surmont In-Situ Oil Sands	1-19-083-6 W4M	pump test (72 hr)	4	-	-	-	-	5.0E-05	-	2.5E-06	Matrix 2003
Surmont In-Situ Oil Sands	2-21-083-7 W4M	pump test (72 hr)	-	-	-	-	-	6.7E-06	-	1.7E-05	Matrix 2003
Surmont In-Situ Oil Sands	2-26-083-6 W4M	pump test (72 hr)	-	-	-	-	-	5.7E-05	-	8.6E-07	Matrix 2003
Surmont In-Situ Oil Sands	7-36-085-7 W4M	pump test (72 hr)	-	-	-	-	-	1.8E-05	-	-	Golder 2000
Surmont In-Situ Oil Sands	15-6-085-6 W4M	pump test	-	-	-	-	-	1.5E-05	-	7.5E-08	Stanley 1982
Surmont In-Situ Oil Sands	6-32-084-6 W4M	pump test	-	-	-	-	-	1.8E-05	-	5.0E-06	Stanley 1982
Surmont In-Situ Oil Sands	characterization	short pump test	-	-	-	-	-	6.0E-05	-	7.2E-05	Stantec 1999
Surmont In-Situ Oil Sands	characterization	recovery test	-	-	-	-	-	3.7E-05	-	-	Stantec 1999
Petro-Canada Meadow Creek	characterization	-	-	-	-	-	-	5.0E-05	-	-	Komex 2001
Obs Site 10d	9-24-085-9W4M	drill stem or pump	-	-	-	-	-	1.1E-08	-	-	Hackbarth and Nastasa 1979
Obs Site 11b	16-2-087-09W4N	pump test	-	-	-	-	-	3.8E-05	-	-	Hackbarth and Nastasa 1979

^(a) Representative value; average or geometric mean.

- = Not available.

Note: Values in table may be referenced in text with fewer significant digits for ease of reading.

Table A-4 Hydraulic Parameters in Clearwater Formation

Project	Comments	Test	# of Observation Wells	Hydraulic Conductivity					Porosity	Specific Storage	Reference
				Kh - min [m/s]	Kh - max [m/s]	Kh/Kv	Kv [m/s]	Kh ^(a) [m/s]			
Undifferentiated Clearwater Formation											
Regional		drill stem & pumping	-	1.0E-09	1.0E-06	-	-	1.5E-07	-	-	Hackbarth and Nastasa 1979
Core analyses	Twp 70 to 103; Rge 1 W4 to 1 W5	30 tests ^(b)	-	4.8E-09	4.7E-05	2	-	1.8E-06	31	-	Bachu et al. 1993
Foster Creek	DST analyses	8 tests	-	2.6E-07	1.1E-05	-	-	2.5E-06	-	-	EBA 1999
Core analyses	Twp 50 to 70; Rge 15 W3 to 17 W4	2,549 tests	-	9.7E-10	1.4E-04	2222	8.1E-09	1.8E-05	-	8.0E-04	Hitchon et al. 1989
Drill-stem	Twp 50 to 70; Rge 15 W3 to 17 W4	96 tests ^(b)	-	2.0E-10	1.1E-05	-	-	1.6E-07	-	4.5E-04	Hitchon et al. 1989
Tucker	DST analyses; Twp 64 to 68, Rge 3 to 6	9 wells ^(b)	-	4.3E-08	7.0E-06	-	-	8.0E-07	-	-	Husky 2003
Tucker	16-20-064-04 W4M	5-day pump test	-	-	-	-	-	1.0E-06	-	-	Husky 2003
Upper Clearwater											
MEG Christina Lake	MEG S3 HARDY 8-16-77-5	3.5-day pump test	3	-	-	-	-	1.0E-05	-	5.0E-06	Aqua Terre 2006
Middle Clearwater											
EnCana Christina Lake	F2/11-09-076-06 W4M	3-day pump test	-	-	-	-	-	3.3E-05	-	-	EnCana 2005a
EnCana Christina Lake	F2/09-19-076-06 W4M	3-day pump test	-	-	-	-	-	4.3E-05	-	-	EnCana 2005a
EnCana Christina Lake	F2/13-16-076-06 W4M	4-day pump test	-	-	-	-	-	6.6E-05	-	-	EnCana 2005a
North American	12-02-078-10 W4M	air lift	-	5.1E-07	3.2E-05	-	-	-	-	-	Westwater 2007a
Wabiskaw Member											
Alberta Oil Sands Technology and Research Authority AOSTRA	10-23-072-07 W4M	core analysis	-	1.0E-06	1.8E-05	-	-	6.4E-05	36	-	AOSTRA 1995
Foster Creek	DST analyses	3 tests	-	9.0E-10	2.1E-07	-	-	8.0E-08	-	-	EBA 1999
Core analyses	Twp 70 to 103; Rge 1 W4 to 1 W5	269 tests ^(b)	-	1.0E-09	6.9E-05	2	-	2.5E-06	31	-	Bachu et al. 1993
Drill-stem tests	Twp 70 to 103; Rge 1 W4 to 1 W5	200 tests ^(b)	-	9.0E-11	5.5E-05	-	-	8.4E-08	-	-	Bachu et al. 1993

^(a) Representative value; average or geometric mean.

^(b) Number of tests used to estimate hydraulic conductivity.

- = Not available.

Note: Values in table may be referenced in text with fewer significant digits for ease of reading.

Table A-5 Hydraulic Parameters in McMurray Formation

Project	Comments	Test	# of Observation Wells	Hydraulic Conductivity					Porosity [%]	Specific Storage [m ⁻¹]	Reference
				Kh - min [m/s]	Kh - max [m/s]	Kh/Kv	Kv [m/s]	Kh ^(a) [m/s]			
Undifferentiated											
Foster Creek	DST analyses	1 tests	-	-	-	-	-	2.1E-07	-	-	EBA 1999
Core analyses	Twp 70 to 103; Rge 1 W4 to 1 W5	382 tests ^(b)	-	1.0E-10	1.0E-04	7	-	2.6E-06	32	-	Bachu et al. 1993
Drill-stem tests	Twp 70 to 103; Rge 1 W4 to 1 W5	365 tests ^(b)	-	2.0E-11	8.1E-05	-	-	1.4E-07	-	-	Bachu et al. 1993
McMurray Aquifer											
MEG Christina Lake	10-29-077-05 W4M	pump and injection tests	-	-	-	-	-	2.0E-05	-	-	MEG 2004
MEG Christina Lake		numerical calibration to injection data	4	-	-	-	-	5.4E-05	-	4.00E-06	this study
North American	01-28-078-10 W4M	injection test	-	-	-	-	-	7.0E-05	-	-	North American 2006
North American	09-02-078-10 W4M	pump / injection test	-	-	-	-	-	2.1E-05	-	-	Westwater 2007a
North American	07-03-081-09 W4M	injection test	-	-	-	-	-	5.5E-05	-	-	Westwater 2007a
North American	13-33-078-10 W4M	pump / injection test	-	-	-	-	-	2.0E-05	-	-	Westwater 2007a
Jackfish	characterization	-	-	-	-	-	-	3.0E-07	-	-	Devon 2003
Jackfish	12-15-75-6	injection test	-	-	-	-	-	3.0E-05	-	-	Devon 2003
Canadian Natural Kirby	1F1/14-30-73-7	aquifer test	-	6.7E-06	3.3E-05	-	-	-	-	-	Waterline 2007
Canadian Natural Kirby	AA/14-30-73-7	aquifer test	-	6.7E-06	3.8E-05	-	-	-	-	2.5E-06	Waterline 2007
Canadian Natural Kirby	00/16-25-73-8	aquifer test	-	3.0E-06	1.2E-04	-	-	-	-	4.6E-06	Waterline 2007
AOSTRA	10-23-072-07 W4M	core analyses	-	1.9E-05	8.8E-05	-	-	6.2E-05	37	-	AOSTRA 1995
Conoco Surmont	Project Regional Study Area	-	-	-	-	-	-	6E-05	-	1.0E-05	Gulf 2001
Nexen Long Lake	Project Regional Study Area	-	-	-	-	-	-	5E-05	-	1.0E-05	OPTI/Nexen 2003a
Nexen Long Lake	9-28-85-6	injection test	-	-	-	-	-	7E-05	-	1.0E-05	OPTI/Nexen 2003a
Obs Site 10e	9-24-085-9W4M	drill stem or pump	-	-	-	-	-	4.1E-09	-	-	Hackbarth and Nastasa 1979
Obs Site 10f	9-24-085-9W4M	drill stem or pump	-	-	-	-	-	1.3E-08	-	-	Hackbarth and Nastasa 1979
Obs Site 11d	16-2-087-09W4N	drill stem or pump	-	-	-	-	-	1.9E-07	-	-	Hackbarth and Nastasa 1979
Tucker	DSTs; Twp 68, Rge 3 to 4	3 tests	-	2.5E-07	3.3E-06	-	-	8.2E-07	-	-	Husky 2003
Tucker	14D-29-066-04 W4M	step injection test	-	-	-	-	-	7.0E-05	-	-	Husky 2003
Tucker	13A-20-064-04 W4M	step injection test	-	-	-	-	-	1.0E-04	-	-	Husky Oil 1984
Tucker	12-30-64-4	-	-	-	-	-	-	6.0E-05	-	3.8E-06	Husky 2003
Tucker	8-25-64-5	-	-	-	-	-	-	3.0E-05	-	1.3E-05	Husky 2003
Core analyses	Twp 50 to 70; Rge 15 W3 to 17 W4	482 tests ^(b)	-	1.3E-09	1.1E-04	63	8.6E-08	5.4E-06	-	7.7E-03	Hitchon et al. 1989
Drill-stem	Twp 50 to 70; Rge 15 W3 to 17 W4	137 tests ^(b)	-	6.5E-10	3.1E-04	-	-	3.5E-07	-	-	Hitchon et al. 1989
Orion (Well 11-16)	11-16-063-03 W4M	slug	-	-	-	-	-	7.6E-06	-	-	BlackRock 2001
Alsands	characterization	pump test	-	2.7E-06	5.5E-05	-	-	1.6E-05	-	-	Hackbarth 1979
Site 9-1056	characterization	drill stem	-	-	-	-	-	1.9E-07	-	-	Hackbarth and Nastasa 1979
Other Six Lease Owners (OSLO) Lease 31	characterization	-	-	6.2E-08	2.5E-04	-	-	3.3E-07	-	-	Korol 1985
OSLO Lease 31	characterization	slug	-	4.8E-07	5.0E-05	-	-	-	-	-	Hardy 1988
Synchrude Base Mine	characterization	slug	-	3.2E-09	1.0E-03	-	-	-	-	-	Terracon 1990
Regional		-	-	5.0E-08	3.0E-05	-	-	-	-	-	Wallick and Dabrowski 1982
McMurray Bitumen Aquitard											
RAX Kirby	characterization	average range	-	2.9E-05	6.7E-05	-	-	-	33	-	RAX 2000
OSLO Lease 31	characterization	-	-	2.0E-08	9.5E-08	-	-	-	-	-	Korol 1985
Agar		geotechnical investigation	-	-	-	-	-	1.0E-10	-	-	Agar 1985
Muskeg River	characterization	tritium isotopes	-	-	-	-	4.0E-08	-	-	3.0E-05	Wallick and Dabrowski 1982
Regional	characterization	laboratory	-	3.2E-08	1.0E-05	-	-	-	-	-	Hackbarth and Nastasa 1979
Site 8-716	characterization	drill stem	-	-	-	-	-	3.0E-08	-	-	Hackbarth and Nastasa 1979
Site 9-1150	characterization	drill stem	-	-	-	-	-	8.0E-09	-	-	Hackbarth and Nastasa 1979
Regional		drill stem	-	1.0E-11	1.0E-07	-	-	3.2E-09	-	-	Hackbarth and Nastasa 1979
Regional		drill stem	-	3.5E-10	1.1E-05	-	-	8.8E-07	-	-	Bachu et al. 1993
Regional		core analyses	-	9.6E-11	9.8E-05	-	-	3.8E-07	-	-	Bachu et al. 1993

^(a) Representative value; average or geometric mean.

^(b) Number of tests used to estimate hydraulic conductivity.

- = Not available.

Note: Values in table may be referenced in text with fewer significant digits for ease of reading.

Table A-6 Hydraulic Parameters in Devonian Formations

Project	Comments	Test	Observation Wells	Hydraulic Conductivity					Porosity	Specific Storage	Reference
				Kh - min	Kh - max	Kh/Kv	Kv	Kh ^(a)			
				[m/s]	[m/s]		[m/s]	[m/s]			
Beaverhill Lake											
Core analyses	Twp 50 to 70; Rge 15 W3 to 17 W4	173 tests ^(b)	-	2.0E-10	9.1E-07	0.4	5.8E-09	2.3E-09	-	4E-04	Hitchon et al. 1989
Drill-stem	Twp 50 to 70; Rge 15 W3 to 17 W4	44 tests ^(b)	-	1.6E-10	1.0E-05	-	-	8.4E-08	-	-	Hitchon et al. 1989
Obs Site 10g	9-24-085-9W4M	drill stem	-	-	-	-	-	1.4E-08	-	-	Hackbarth and Nastasa 1979
Obs Site 10h	9-24-085-9W4M	drill stem	-	-	-	-	-	2.6E-08	-	-	Hackbarth and Nastasa 1979
Obs Site 11e	16-2-087-09W4M	drill stem	-	-	-	-	-	3.5E-10	-	-	Hackbarth and Nastasa 1979
Obs Site 11f	16-2-087-09W4M	drill stem	-	-	-	-	-	5.5E-08	-	-	Hackbarth and Nastasa 1979
Obs Site 11g	16-2-087-09W4M	drill stem	-	-	-	-	-	1.6E-08	-	-	Hackbarth and Nastasa 1979
Obs Site 11h	16-2-087-09W4M	drill stem	-	-	-	-	-	5.5E-10	-	-	Hackbarth and Nastasa 1979
Obs Site 11i	16-2-087-09W4M	drill stem or pump	-	-	-	-	-	3.8E-09	-	-	Hackbarth and Nastasa 1979
Obs Site 12e	8-27-088-09W4M	drill stem	-	-	-	-	-	3.9E-09	-	-	Hackbarth and Nastasa 1979
Obs Site 12f	8-27-088-09W4M	drill stem	-	-	-	-	-	1.4E-09	-	-	Hackbarth and Nastasa 1979
Core analyses	Twp 70 to 103; Rge 1 W4 to 1 W5	34 tests ^(b)	-	1.0E-10	1.0E-04	33	-	4.0E-07	31	-	Bachu et al. 1993
Drill-stem tests	Twp 70 to 103; Rge 1 W4 to 1 W5	22 tests ^(b)	-	3.6E-10	1.1E-05	-	-	9.1E-07	-	-	Bachu et al. 1993
Prairie Evaporite											
ARC Site 7		drill-stem	-	-	-	-	-	3.0E-09	-	-	Hackbarth and Nastasa 1979
Core analyses	Twp 70 to 103; Rge 1 W4 to 1 W5	9 tests ^(b)	-	1.0E-10	9.0E-08	2	-	2.0E-09	8	-	Bachu et al. 1993

^(a) Representative value; average or geometric mean.

^(b) Number of tests used to estimate hydraulic conductivity.

- = Not available.

Note: Values in table may be referenced in text with fewer significant digits for ease of reading.

Table A-10 Overburden Groundwater Quality Results Within Hydrogeology Local Study Area - Dissolved Metals and Trace Elements

Legal Sub-Division	Sample Date	Well Identifier	Screen Interval or Depth [mbsgs]	Aluminum [mg/L]	Antimony [mg/L]	Arsenic [mg/L]	Barium [mg/L]	Beryllium [mg/L]	Boron [mg/L]	Cadmium [mg/L]	Chromium [mg/L]	Cobalt [mg/L]	Copper [mg/L]	Lead [mg/L]	Lithium [mg/L]	Mercury [mg/L]
				0.1 ⁽⁴⁾	0.006	0.01	1	nc	5	0.005	0.05	nc	1.0 ⁽⁶⁾	0.01	nc	0.001
Undifferentiated Overburden																
02-16-077-05 W4M	30-May-06	MW05-1A	1.3-3.4	0.01	0.0011	0.0008	0.117	<0.001	<0.05	0.0007	0.006	<0.002	0.004	<0.0001	0.011	<0.0001
02-16-077-05 W4M	30-May-06	MW05-2A	2.3-5.3	0.01	0.0013	0.0040	0.198	<0.001	<0.05	0.0003	<0.005	0.005	0.005	0.0001	0.019	<0.0001
02-16-077-05 W4M	30-May-06	MW05-3A	1.4-4.4	0.02	0.0007	<0.0014	0.103	<0.001	<0.05	0.0003	<0.005	0.007	0.005	0.0002	0.007	<0.0001
02-16-077-05 W4M	30-May-06	MW05-4A	1.2-4.3	0.01	0.0007	<0.0004	0.118	<0.001	<0.05	0.0003	<0.005	<0.002	0.004	<0.0001	0.014	<0.0001
02-16-077-05 W4M	30-May-06	MW05-5A	1.2-4.3	<0.01	0.0006	<0.0004	0.134	<0.001	<0.05	0.0003	0.005	<0.002	0.002	<0.0001	0.014	<0.0001
02-16-077-05 W4M	30-May-06	MW05-6A	1.6-4.6	<0.01	0.0008	0.0039	0.189	<0.001	0.12	0.0003	<0.005	<0.002	0.003	<0.0001	0.037	<0.0001
02-16-077-05 W4M	25-Jun-07	WSFMW101A	3.4-6.4	<0.01	<0.0004	0.0006	0.103	<0.001	<0.05	0.0002	<0.005	0.013	0.001	<0.0001	0.009	<0.0001
02-16-077-05 W4M	25-Jun-07	WSFMW102A	2.1-5.1	0.70	<0.0004	0.0030	0.144	<0.001	<0.05	<0.0001	<0.005	0.013	0.002	0.0015	0.009	<0.0001
02-16-077-05 W4M	25-Jun-07	WSFMW103A	7.2-8.7	0.02	0.0006	0.0039	0.109	<0.001	<0.05	<0.0001	<0.005	0.018	<0.001	0.0001	0.014	<0.0001
02-16-077-05 W4M	25-Jun-07	WSFMW104A	1.3-4.3	0.14	<0.0004	<0.0004	0.144	<0.001	<0.05	<0.0001	<0.005	0.003	0.002	0.0004	0.014	<0.0001
02-16-077-05 W4M	25-Jun-07	WSFMW105A	1.3-4.3	0.03	0.0004	0.0008	0.086	<0.001	<0.05	0.0002	<0.005	0.012	0.002	<0.0001	0.010	<0.0001
02-18-077-05 W4M	26-Jun-07	PAMW101A	3.2-6.2	0.17	<0.0004	0.0037	0.190	<0.001	<0.05	<0.0001	<0.005	0.014	<0.001	0.0005	0.009	<0.0001
02-18-077-05 W4M	26-Jun-07	PAMW102A	1.4-4.4	0.49	<0.0004	0.0009	0.112	<0.001	<0.05	0.0002	<0.005	0.008	0.004	0.0016	0.018	<0.0001
02-18-077-05 W4M	26-Jun-07	PAMW103A	1.4-4.4	0.27	<0.0004	0.0038	0.124	<0.001	<0.05	<0.0001	<0.005	0.008	<0.001	0.0001	0.005	<0.0001
Grand Centre																
03-08-076-06 W4M	08-Jul-03	MW05	3.7-6.7	0.011	<0.0002	0.0004	0.182	<0.0002	0.04	<0.0002	<0.001	0.0039	0.0021	<0.0003	<0.004	-
17-16-076-06 W4M	28-Oct-03	MW15	6.1-12.2	0.011	0.0009	0.0006	0.206	<0.0002	0.26	<0.0002	<0.001	0.0008	0.0009	<0.0003	0.048	-
Sand River																
08-17-076-06 W4M	06-Jun-04	MW11	17.1-23.2	0.003	<0.0002	0.0014	0.0800	<0.0002	1.02	<0.0002	<0.001	<0.0003	<0.0002	<0.0003	0.041	-
Ethel Lake																
03-08-076-06 W4M	28-Oct-03	MW02	77.4-83.5	0.022	<0.0002	<0.0002	0.313	<0.0002	0.48	<0.0002	0.002	0.0003	0.0007	<0.0003	0.038	-
03-08-076-06 W4M	28-Oct-03	MW03	47.5-53.6	0.027	<0.0002	<0.0002	0.188	<0.0002	0.64	<0.0002	0.001	0.0008	0.0003	<0.0003	0.050	-
08-17-076-06 W4M	06-Jun-04	MW09	56.4-62.5	<0.001	<0.0002	0.0009	0.253	<0.0002	0.38	<0.0002	<0.001	<0.0003	<0.0002	<0.0003	0.043	-
08-17-076-06 W4M	06-Jun-04	MW10	36.6-45.7	0.002	<0.0002	0.0007	0.246	<0.0002	0.34	<0.0002	<0.001	<0.0003	<0.0002	<0.0003	0.048	-
08-17-076-06 W4M	06-Jun-04	MW08	70.1-76.2	0.003	<0.0002	0.0011	0.277	<0.0002	0.41	<0.0002	<0.001	<0.0003	<0.0002	<0.0003	0.059	-
02-16-077-05 W4M	30-May-06	MW05-1C	62.3-65.3	<0.01	0.0009	0.0040	0.182	<0.001	0.11	0.0006	0.006	<0.002	0.003	<0.0001	0.037	<0.0001
02-16-077-05 W4M	30-May-06	MW05-3C	55.3-58.3	<0.01	0.0008	0.0033	0.232	<0.001	0.10	0.0004	0.005	<0.002	0.002	<0.0001	0.035	<0.0001
02-16-077-05 W4M	30-May-06	MW05-5C	65.9-69.0	<0.01	0.0011	0.0040	0.115	<0.001	0.42	0.0004	<0.005	<0.002	0.003	<0.0001	0.096	<0.0001
02-18-077-05 W4M	27-Jun-07	PAMW101C	75.6-78.6	0.01	<0.0004	0.0038	0.031	<0.001	0.57	<0.0001	<0.005	<0.002	0.011	<0.0001	0.097	<0.0001
02-18-077-05 W4M	27-Jun-07	PAMW102C	79.3-82.3	0.02	0.0007	0.0765	0.034	<0.001	0.61	<0.0001	<0.005	<0.002	0.006	<0.0001	0.095	<0.0001
02-18-077-05 W4M	27-Jun-07	PAMW103C	75.3-78.3	<0.01	<0.0004	0.0034	0.101	<0.001	0.62	<0.0001	<0.005	<0.002	<0.001	<0.0001	0.100	<0.0001
02-16-077-05 W4M	25-Apr-06	SW-2005-1	52.5-57.4	0.013	<0.0002	0.0062	0.140	<0.0002	0.06	<0.0002	<0.001	0.0011	0.0014	<0.0003	0.019	<0.0005
SW-31-076-05 W4M	3-Aug-06	MEG House Well	54.9-56.4	0.004	<0.0005	0.0037	0.134	-	0.15	<0.0007	0.00085	<0.001	0.003	<0.00014	0.039	<0.0001
SW-32-076-05 W4M	21-Jan-07	DCMW101	71.6-77.7	<0.04	0.0006	0.0760	0.16	<0.001	0.19	<0.0002	<0.01	0.0009	0.0077	<0.0002	0.05	-
Empress Terrace																
06-19-077-05 W4M	13-Mar-05	WSW 6-19	100.6-112.8	<0.01	-	<0.0004	0.031	<0.001	0.97	<0.001	<0.005	<0.002	<0.001	<0.005	-	-
Empress Channel																
08-17-076-06 W4M	6-Jun-04	MW06	137.2-143.3	<0.001	0.0004	0.0525	0.066	<0.0002	0.67	<0.0002	<0.001	<0.0003	0.0005	<0.0003	0.033	-
08-17-076-06 W4M	6-Jun-04	MW07	110.3-116.4	0.006	<0.0002	0.0029	0.101	<0.0002	0.63	<0.0002	<0.001	<0.0003	<0.0002	<0.0003	0.028	-
17-16-076-06 W4M	28-Oct-03	MW12	143.9-154.5	0.006	0.0006	<0.0002	0.0888	<0.0002	1.05	<0.0002	0.002	0.0003	<0.0002	<0.0003	0.030	-
17-16-076-06 W4M	28-Oct-03	MW13	112.8-118.9	0.003	0.0006	<0.0002	0.147	<0.0002	0.60	<0.0002	<0.001	0.0006	0.0003	<0.0003	0.045	-

Table A-10 Overburden Groundwater Quality Results Within Hydrogeology Local Study Area - Dissolved Metals and Trace Elements (continued)

LSD	Sample Date	Well Identifier	Screen Interval or Depth [m/bgs]	Molybdenum [mg/L]	Selenium [mg/L]	Silver [mg/L]	Thallium [mg/L]	Tin [mg/L]	Titanium [mg/L]	Uranium [mg/L]	Vanadium [mg/L]	Zinc [mg/L]	Reference
				nc	0.01	nc	nc	nc	nc	0.02	nc	5.0 ^(a)	
Undifferentiated Overburden													
02-16-07-05 W4M	30-May-06	MW05-1A	1.3-3.4	<0.005	<0.0004	<0.0001	<0.0001	<0.05	0.001	0.0012	<0.001	0.026	Aqua Terre 2007a
02-16-07-05 W4M	30-May-06	MW05-2A	2.3-5.3	<0.005	<0.0004	<0.0001	<0.0001	<0.05	<0.001	0.0040	<0.001	0.048	Aqua Terre 2007a
02-16-07-05 W4M	30-May-06	MW05-3A	1.4-4.4	<0.005	0.0027	<0.0001	<0.0001	<0.05	<0.001	0.0006	<0.001	0.041	Aqua Terre 2007a
02-16-07-05 W4M	30-May-06	MW05-4A	1.2-4.3	<0.005	<0.0004	<0.0001	<0.0001	<0.05	<0.001	0.0012	<0.001	0.043	Aqua Terre 2007a
02-16-07-05 W4M	30-May-06	MW05-5A	1.2-4.3	<0.005	0.0038	<0.0001	<0.0001	<0.05	<0.001	0.0012	<0.001	0.030	Aqua Terre 2007a
02-16-07-05 W4M	30-May-06	MW05-6A	1.6-4.6	<0.005	<0.0004	0.0002	<0.0001	<0.05	<0.001	<0.0001	<0.001	0.022	Aqua Terre 2007a
02-16-07-05 W4M	25-Jun-07	WSFMW101A	3.4-6.4	<0.005	0.0009	<0.0001	<0.0001	<0.05	<0.001	0.0038	<0.001	0.033	Aqua Terre 2007b
02-16-07-05 W4M	25-Jun-07	WSFMW102A	2.1-5.1	<0.005	0.0004	<0.0001	<0.0001	<0.05	0.033	0.0003	0.009	0.088	Aqua Terre 2007b
02-16-07-05 W4M	25-Jun-07	WSFMW103A	7.2-8.7	<0.005	0.0005	<0.0001	<0.0001	<0.05	0.001	0.0065	<0.001	0.042	Aqua Terre 2007b
02-16-07-05 W4M	25-Jun-07	WSFMW104A	1.3-4.3	<0.005	<0.0004	<0.0001	<0.0001	<0.05	0.006	0.0015	<0.001	0.044	Aqua Terre 2007b
02-16-07-05 W4M	25-Jun-07	WSFMW105A	1.3-4.3	<0.005	0.0010	<0.0001	<0.0001	<0.05	0.001	0.0049	<0.001	0.024	Aqua Terre 2007b
02-18-07-05 W4M	26-Jun-07	PAMW101A	3.2-6.2	<0.005	<0.0004	<0.0001	<0.0001	<0.05	0.011	0.0005	0.005	0.058	Aqua Terre 2008
02-18-07-05 W4M	26-Jun-07	PAMW102A	1.4-4.4	<0.005	0.0008	<0.0001	<0.0001	<0.05	0.012	0.0036	0.002	0.054	Aqua Terre 2008
02-18-07-05 W4M	26-Jun-07	PAMW103A	1.4-4.4	<0.005	<0.0004	<0.0001	<0.0001	<0.05	0.012	0.0007	0.006	0.039	Aqua Terre 2008
Grand Centre													
03-08-07-06 W4M	08-Jul-03	MW05	3.7-6.7	0.0021	-	<0.0001	<0.0002	<0.001	<0.001	0.0043	<0.001	0.0179	Westwater 2005a
17-16-07-06 W4M	28-Oct-03	MW15	6.1-12.2	0.004	<0.007	<0.0001	<0.0002	<0.001	0.002	0.0008	<0.001	0.0051	Westwater 2005a
Sand River													
08-17-07-06 W4M	06-Jun-04	MW11	17.1-23.2	0.0016	<0.007	<0.0001	<0.0002	<0.001	0.010	<0.0004	<0.001	0.0019	Westwater 2005a
Ethel Lake													
03-08-07-06 W4M	28-Oct-03	MW02	77.4-83.5	0.0008	<0.007	<0.0001	<0.0002	<0.001	0.002	<0.0004	<0.001	0.0063	Westwater 2005a
03-08-07-06 W4M	28-Oct-03	MW03	47.5-53.6	0.0009	<0.007	<0.0001	<0.0002	<0.001	0.002	<0.0004	<0.001	0.0075	Westwater 2005a
08-17-07-06 W4M	06-Jun-04	MW09	56.4-62.5	<0.0002	<0.007	<0.0001	<0.0002	<0.001	0.002	<0.0004	<0.001	0.0384	Westwater 2005a
08-17-07-06 W4M	06-Jun-04	MW10	36.6-45.7	<0.0002	<0.007	<0.0001	<0.0002	<0.001	0.006	<0.0004	<0.001	0.0014	Westwater 2005a
08-17-07-06 W4M	06-Jun-04	MW08	70.1-76.2	0.0035	<0.007	<0.0001	<0.0002	<0.001	0.003	<0.0004	<0.001	0.0043	Westwater 2005a
02-16-07-05 W4M	30-May-06	MW05-1C	62.3-65.3	<0.005	<0.0004	<0.0001	<0.0001	<0.05	<0.001	<0.0001	<0.001	0.019	Aqua Terre 2007a
02-16-07-05 W4M	30-May-06	MW05-3C	55.3-58.3	0.005	<0.0004	0.0001	<0.0001	<0.05	<0.001	0.0002	<0.001	0.020	Aqua Terre 2007a
02-16-07-05 W4M	30-May-06	MW05-5C	65.9-69.0	0.011	<0.0004	<0.0001	<0.0001	<0.05	<0.001	0.0007	0.003	0.019	Aqua Terre 2007a
02-18-07-05 W4M	27-Jun-07	PAMW101C	75.6-78.6	0.031	0.0013	<0.0001	<0.0001	<0.05	0.002	0.0002	0.002	0.024	Aqua Terre 2008
02-18-07-05 W4M	27-Jun-07	PAMW102C	79.3-82.3	0.048	0.0019	<0.0001	<0.0001	<0.05	0.003	0.0023	0.012	0.012	Aqua Terre 2008
02-18-07-05 W4M	27-Jun-07	PAMW103C	75.3-78.3	0.026	<0.0004	<0.0001	<0.0001	<0.05	0.001	0.0003	<0.001	0.021	Aqua Terre 2008
02-16-07-05 W4M	25-Apr-06	SW 2005*1	52.5-57.4	0.0025	<0.0002	<0.0001	<0.0002	<0.001	0.010	<0.0004	<0.001	0.0025	Aqua Terre 2005
SW-31-076-05 W4M	3-Aug-06	MEG House Well	54.9-56.4	0.003	<0.0005	0.000007	<0.0006	<0.008	-	<0.00007	0.001	0.100	Unpublished MEG
SW-32-076-05 W4M	21-Jan-07	DCMW101	71.6-77.7	0.0077	<0.001	<0.0001	<0.0002	<0.001	0.004	<0.0001	<0.001	0.036	Aqua Terre 2007c
Empress Terrace													
06-19-07-05 W4M	13-Mar-05	WSW 6-19	100.6-112.8	<0.005	-	<0.005	<0.05	<0.05	0.003	-	0.002	0.104	Westwater 2005c
Empress Channel													
08-17-07-06 W4M	6-Jun-04	MW06	137.2-143.3	0.0166	<0.007	<0.0001	<0.0002	<0.001	0.012	<0.0004	<0.001	0.0120	Westwater 2005a
08-17-07-06 W4M	6-Jun-04	MW07	110.3-116.4	0.0178	<0.007	<0.0001	<0.0002	<0.001	0.010	<0.0004	<0.001	0.0020	Westwater 2005a
17-16-07-06 W4M	28-Oct-03	MW12	143.9-154.5	0.0326	<0.007	<0.0001	<0.0002	<0.001	0.003	<0.0004	<0.001	0.005	Westwater 2005a
17-16-07-06 W4M	28-Oct-03	MW13	112.8-118.9	0.0054	<0.007	<0.0001	<0.0002	<0.001	0.002	<0.0004	<0.001	0.0056	Westwater 2005a

^(a) Aesthetic objective for Health Canada Drinking Water

- = Not available.

nc = No criteria.

Note: **Bold** denotes exceedance of Health Canada (2007) Drinking Water Guideline

Table A-11 Bedrock Groundwater Quality Results Within Hydrogeology Local Study Area - Major Ions, Arsenic and Hydrocarbon Indicators

Legal Sub-Division	Well Identifier	Sample Type	Unit/Formation	Sample Type	Hydrochemical Type	pH	Electrical Conductivity (EC) [μ S/cm]	Total Dissolved Solids [mg/L]	Sodium [mg/L]	Potassium [mg/L]	Calcium [mg/L]	Magnesium [mg/L]	Arsenic [mg/L]	Iron [mg/L]	Manganese [mg/L]	Chloride [mg/L]	Bicarbonate [mg/L]	Sulphate [mg/L]
						6.5-8.5 ^(a)	nc	$\leq 200^{(a)}$	$\leq 200^{(a)}$	nc	nc	nc	nc	nc	nc	nc	nc	nc
6-33-076-05 W4M	6-33-076-05 W4M	Well	Lower Grand Rapids	30-Aug-05	Na-HCO ₃ -Cl	8.99	1990	1170	497	5	<2	<1	<0.0002	<0.1	<0.05	210	720	<9
07-19-076-06 W4M	100/07-19-076-06 W4M/00	DST	Upper Clearwater	-	Na-Cl-HCO ₃	8.8	-	3623	1266	-	26	8	-	-	-	1575	704	31
8-16-77-05 W4M	MEG S3 HARDY 8-16-77-5	Well	Upper Clearwater	20-May-06	Na-HCO ₃ -Cl	8.90	2750	1680	716	<4	<2	1	0.012	<0.1	<0.05	384	990	<9
3-16-77-05 W4M	MEG S2 HARDY 3-16-77-5	Well	Upper Clearwater	24-May-06	Na-HCO ₃ -Cl	8.85	2640	1590	665	<4	3.0	1	0.006	<0.1	0.11	330	1040	<9
6-33-076-05 W4M	6-33-076-05 W4M	Well	Upper Clearwater	27-Aug-05	Na-Cl-HCO ₃	8.65	4100	2290	888	5	3	2	<0.002	0.11	<0.05	1050	602	<9
100/03-17-076-06 W4M	Brackish Water Well A1	Well	Middle Clearwater	-	-	-	-	3851	-	-	-	-	-	-	-	-	-	-
100/03-17-076-06 W4M	Brackish Water Well A2	Well	Middle Clearwater	-	-	-	-	3841	-	-	-	-	-	-	-	-	-	-
100/03-17-076-06 W4M	Brackish Water Well A3	Well	Middle Clearwater	-	-	-	-	3842	-	-	-	-	-	-	-	-	-	-
100/03-17-076-06 W4M	Brackish Water Well A4	Well	Middle Clearwater	-	-	-	-	3847	-	-	-	-	-	-	-	-	-	-
100/03-17-076-06 W4M	Brackish Water Well A5	Well	Middle Clearwater	-	-	-	-	3841	-	-	-	-	-	-	-	-	-	-
1F2/13-16-076-06 W4M	Brackish Water Well B1	Well	Middle Clearwater	-	-	-	-	3655	-	-	-	-	-	-	-	-	-	-
1F2/13-16-076-06 W4M	Brackish Water Well B2	Well	Middle Clearwater	-	-	-	-	3656	-	-	-	-	-	-	-	-	-	-
1F2/13-16-076-06 W4M	Brackish Water Well B3	Well	Middle Clearwater	-	-	-	-	3756	-	-	-	-	-	-	-	-	-	-
1F2/13-16-076-06 W4M	Brackish Water Well B4	Well	Middle Clearwater	-	-	-	-	3766	-	-	-	-	-	-	-	-	-	-
1F2/13-16-076-06 W4M	Brackish Water Well B5	Well	Middle Clearwater	-	-	-	-	3769	-	-	-	-	-	-	-	-	-	-
1F2/09-16-076-06 W4M	Brackish Water Well C1	Well	Middle Clearwater	-	-	-	-	3784	-	-	-	-	-	-	-	-	-	-
1F2/09-16-076-06 W4M	Brackish Water Well C2	Well	Middle Clearwater	-	-	-	-	3774	-	-	-	-	-	-	-	-	-	-
1F2/09-16-076-06 W4M	Brackish Water Well C3	Well	Middle Clearwater	-	-	-	-	3784	-	-	-	-	-	-	-	-	-	-
1F2/09-16-076-06 W4M	Brackish Water Well C4	Well	Middle Clearwater	-	-	-	-	3778	-	-	-	-	-	-	-	-	-	-
1F2/09-16-076-06 W4M	Brackish Water Well C5	Well	Middle Clearwater	-	-	-	-	3763	-	-	-	-	-	-	-	-	-	-
1F2/11-06-076-06 W4M	Brackish Water Well D1	Well	Middle Clearwater	-	-	-	-	3884	-	-	-	-	-	-	-	-	-	-
1F2/11-06-076-06 W4M	Brackish Water Well D2	Well	Middle Clearwater	-	-	-	-	3909	-	-	-	-	-	-	-	-	-	-
1F2/11-06-076-06 W4M	Brackish Water Well D3	Well	Middle Clearwater	-	-	-	-	3934	-	-	-	-	-	-	-	-	-	-
1F2/11-06-076-06 W4M	Brackish Water Well D4	Well	Middle Clearwater	-	-	-	-	3996	-	-	-	-	-	-	-	-	-	-
1F2/11-06-076-06 W4M	Brackish Water Well D5	Well	Middle Clearwater	-	-	-	-	3904	-	-	-	-	-	-	-	-	-	-
06-26-076-06 W4M	100/06-26-076-06 W4M	DST	Middle Clearwater	-	Na-Cl-HCO ₃	8.5	-	4105	1355	-	47	33	-	-	-	1626	839	195
11-14-076-06 W4M	100/11-14-076-06 W4M	DST	Middle Clearwater	-	Na-Cl	8.3	-	4079	1450	-	15.0	7.0	-	-	-	1830	771	6.0
15-02-076-06 W4M	100/15-02-076-06 W4M	DST	Middle Clearwater	-	Na-Cl-HCO ₃	8.8	-	5093	1774	11	24	20	-	-	-	2155	1000	43.0
13-16-076-06 W4M	AA/13-16-076-06 W4M	DST	Middle Clearwater	-	Na-Cl	8.5	-	4027	1360	4	18.2	7.3	-	7.21	-	1900	686	1
03-16-076-06 W4M	F2/03-16-076-06 W4M	DST	Middle Clearwater	-	Na-Cl	8.3	-	4403	1560	4.6	5.1	6.8	-	0.31	-	1970	837	<0.1
01-01-076-05 W4M	100/01-01-076-05 W4M/00	DST	Lower Clearwater	-	Na-Cl	7.7	-	17437	6320	26	160	157	-	-	-	10160	581	33
09-20-076-05 W4M	100/09-20-076-05 W4M	DST	Lower Clearwater	-	Na-Cl-HCO ₃	8.6	-	4781	1650	9	14.0	12.0	-	-	-	1750	954	354.0
02-18-077-04 W4M	100/02-18-077-04 W4M	DST	Undiff. McMurray	-	Na-Cl	8.3	-	9979	3420	12	105	35	-	-	-	4810	1235	362
05-15-078-04 W4M	100/05-15-078-04 W4M	DST	Undiff. McMurray	-	Na-Cl	7.3	-	15340	5330	68	115	114	-	-	-	8496	1187	30
06-22-078-04 W4M	100/06-22-078-04 W4M	DST	Undiff. McMurray	-	Na-Cl	8.2	-	16564	5730	24	200	176	-	-	-	9400	771	263
10-05-077-06 W4M	100/10-05-077-06 W4M	DST	Undiff. McMurray	-	Na-Cl	7.6	-	9878	3592	-	84	24	-	-	-	5156	966	56
10-30-078-04 W4M	100/10-30-078-04 W4M	DST	Undiff. McMurray	-	Na-Cl	7.8	-	17212	6484	139	110.1	130.6	-	-	-	9304.1	1035.9	7.6
11-18-077-05 W4M	100/11-18-077-05 W4M	DST	Undiff. McMurray	-	Na-Cl	8	-	8892	3200	14	44	33	-	-	-	4367	1233	1
13-01-078-06 W4M	100/13-01-078-06 W4M	DST	Undiff. McMurray	-	Na-Cl	8.6	-	5634	1950	31	37	14	-	-	-	2700	836	21
13-10-076-04 W4M	100/13-10-076-04 W4M	DST	Undiff. McMurray	-	Na-Cl	8.07	-	5652	1910	11.6	17.8	7.3	-	-	-	2740	933	32.7
10-23-076-07 W4M	100/10-23-076-07 W4M	DST	Undiff. McMurray	-	Na-Cl	8.1	-	8947	3430	11.2	10.8	30.9	-	-	-	4240	1220	-
07-16-076-06 W4M	102/07-16-076-06 W4M	DST	McMurray Aquifer	-	Na-Cl	8.1	-	12015	4090	18	61	60	-	-	-	6320.3	1433.5	7
04-16-076-06 W4M	100/04-16-076-06 W4M	DST	McMurray Aquifer	-	Na-Cl	8.2	-	12634	4430	27.7	59.6	64.3	-	0.1	-	6500	1550	2.5
07-16-076-06 W4M	102/07-16-076-06 W4M/00	DST	McMurray Aquifer	-	Na-Cl	8.1	-	12015	4090	18	61	60	-	-	-	6320.3	1433.5	7
04-29-077-04 W4M	4-29 Well	Well	McMurray Aquifer	-	Na-Cl	8	-	11000	4210	24	49	67	-	<0.1	0.25	5960	1500	<9
10-29-077-05 W4M	10-29-077-05 W4M	Well	McMurray Aquifer	-	-	-	-	10000	-	-	-	-	-	-	-	-	-	-
10-29-077-05 W4M	10-29-077-05 W4M	Well	McMurray Aquifer	-	-	-	-	10300	-	-	-	-	-	-	-	-	-	-

Table A-11 Bedrock Groundwater Quality Results Within Hydrogeology Local Study Area - Major Ions, Arsenic and Hydrocarbon Indicators (continued)

LSD	Well Identifier	Sample Type	Unit/Formation	Sample Date	Hydrochemical Type	Carbonate	Fluoride	Hardness	Total Phenols	Dissolved Organic Carbon	Benzene	Toluene	Ethylbenzene	Xylene	F1 Hydrocarbon Fraction (C6-C10)	F2 Hydrocarbon Fraction (C10-C16)	Reference
						[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	
						<i>nc</i>	1.5	<i>nc</i>	<i>nc</i>	<i>nc</i>	0.005	0.024^(a)	0.0024^(a)	0.32^(a)	<i>nc</i>	<i>nc</i>	Health Canada 2007
6-33-076-05 W4M	6-33-076-05 W4M	Well	Lower Grand Rapids	30-Aug-05	Na-HCO ₃ -Cl	102	2.9	<9	30-Aug-05	11.2	-	-	-	-	-	-	
07-19-076-06 W4M	100/07-19-076-06 W4M/00	DST	Upper Clearwater	-	Na-Cl-HCO ₃	13	-	-	-	-	-	-	-	-	-	-	Devon 2006
8-16-77-05 W4M	MEG S3 HARDY 8-16-77-5	Well	Upper Clearwater	20-May-06	Na-HCO ₃ -Cl	88	3.2	4	20-May-06	7.4	<0.001	<0.001	<0.001	<0.001	<0.2	<0.1	Aqua Terre 2006
3-16-77-05 W4M	MEG S2 HARDY 3-16-77-5	Well	Upper Clearwater	24-May-06	Na-HCO ₃ -Cl	78	3.7	10	24-May-06	4.6	<0.001	<0.001	<0.001	<0.001	<0.2	<0.1	Aqua Terre 2006
6-33-076-05 W4M	6-33-076-05 W4M	Well	Upper Clearwater	27-Aug-05	Na-Cl-HCO ₃	39	1.6	20	27-Aug-05	7.9							
100/03-17-076-06 W4M	Brackish Water Well A1	Well	Middle Clearwater	-	-	-	-	-	-	-	-	-	-	-	-	-	Matrix 2007
100/03-17-076-06 W4M	Brackish Water Well A2	Well	Middle Clearwater	-	-	-	-	-	-	-	-	-	-	-	-	-	Matrix 2007
100/03-17-076-06 W4M	Brackish Water Well A3	Well	Middle Clearwater	-	-	-	-	-	-	-	-	-	-	-	-	-	Matrix 2007
100/03-17-076-06 W4M	Brackish Water Well A4	Well	Middle Clearwater	-	-	-	-	-	-	-	-	-	-	-	-	-	Matrix 2007
100/03-17-076-06 W4M	Brackish Water Well A5	Well	Middle Clearwater	-	-	-	-	-	-	-	-	-	-	-	-	-	Matrix 2007
1F2/13-16-076-06 W4M	Brackish Water Well B1	Well	Middle Clearwater	-	-	-	-	-	-	-	-	-	-	-	-	-	Matrix 2007
1F2/13-16-076-06 W4M	Brackish Water Well B2	Well	Middle Clearwater	-	-	-	-	-	-	-	-	-	-	-	-	-	Matrix 2007
1F2/13-16-076-06 W4M	Brackish Water Well B3	Well	Middle Clearwater	-	-	-	-	-	-	-	-	-	-	-	-	-	Matrix 2007
1F2/13-16-076-06 W4M	Brackish Water Well B4	Well	Middle Clearwater	-	-	-	-	-	-	-	-	-	-	-	-	-	Matrix 2007
1F2/13-16-076-06 W4M	Brackish Water Well B5	Well	Middle Clearwater	-	-	-	-	-	-	-	-	-	-	-	-	-	Matrix 2007
1F2/09-16-076-06 W4M	Brackish Water Well C1	Well	Middle Clearwater	-	-	-	-	-	-	-	-	-	-	-	-	-	Matrix 2007
1F2/09-16-076-06 W4M	Brackish Water Well C2	Well	Middle Clearwater	-	-	-	-	-	-	-	-	-	-	-	-	-	Matrix 2007
1F2/09-16-076-06 W4M	Brackish Water Well C3	Well	Middle Clearwater	-	-	-	-	-	-	-	-	-	-	-	-	-	Matrix 2007
1F2/09-16-076-06 W4M	Brackish Water Well C4	Well	Middle Clearwater	-	-	-	-	-	-	-	-	-	-	-	-	-	Matrix 2007
1F2/09-16-076-06 W4M	Brackish Water Well C5	Well	Middle Clearwater	-	-	-	-	-	-	-	-	-	-	-	-	-	Matrix 2007
1F2/11-06-076-06 W4M	Brackish Water Well D1	Well	Middle Clearwater	-	-	-	-	-	-	-	-	-	-	-	-	-	Matrix 2007
1F2/11-06-076-06 W4M	Brackish Water Well D2	Well	Middle Clearwater	-	-	-	-	-	-	-	-	-	-	-	-	-	Matrix 2007
1F2/11-06-076-06 W4M	Brackish Water Well D3	Well	Middle Clearwater	-	-	-	-	-	-	-	-	-	-	-	-	-	Matrix 2007
1F2/11-06-076-06 W4M	Brackish Water Well D4	Well	Middle Clearwater	-	-	-	-	-	-	-	-	-	-	-	-	-	Matrix 2007
1F2/11-06-076-06 W4M	Brackish Water Well D5	Well	Middle Clearwater	-	-	-	-	-	-	-	-	-	-	-	-	-	Matrix 2007
06-26-076-06 W4M	100/06-26-076-06 W4M	DST	Middle Clearwater	-	Na-Cl-HCO ₃	10	-	-	-	-	-	-	-	-	-	-	Devon 2006
11-14-076-06 W4M	100/11-14-076-06 W4M	DST	Middle Clearwater	-	Na-Cl	-	-	-	-	-	-	-	-	-	-	-	Devon 2006
15-02-076-06 W4M	100/15-02-076-06 W4M	DST	Middle Clearwater	-	Na-Cl-HCO ₃	66.0	-	-	-	-	-	-	-	-	-	-	Devon 2006
13-16-076-06 W4M	AA/13-16-076-06 W4M	DST	Middle Clearwater	-	Na-Cl	29.3	-	-	-	-	-	-	-	-	-	-	Devon 2006
03-16-076-06 W4M	F2/03-16-076-06 W4M	DST	Middle Clearwater	-	Na-Cl	10.6	-	-	-	-	-	-	-	-	-	-	Devon 2006
01-01-076-05 W4M	100/01-01-076-05 W4M/00	DST	Lower Clearwater	-	Na-Cl	-	-	-	-	-	-	-	-	-	-	-	Devon 2006
09-20-076-05 W4M	100/09-20-076-05 W4M	DST	Lower Clearwater	-	Na-Cl-HCO ₃	38.0	-	-	-	-	-	-	-	-	-	-	Devon 2006
02-18-077-04 W4M	100/02-18-077-04 W4M	DST	Undiff. McMurray	-	Na-Cl	-	-	406	-	-	-	-	-	-	-	-	Matrix 2007
/05-15-078-04 W4M	100/05-15-078-04 W4M	DST	Undiff. McMurray	-	Na-Cl	-	-	755	-	-	-	-	-	-	-	-	Matrix 2007
06-22-078-04 W4M	100/06-22-078-04 W4M	DST	Undiff. McMurray	-	Na-Cl	-	-	1222	-	-	-	-	-	-	-	-	Matrix 2007
10-05-077-06 W4M	100/10-05-077-06 W4M	DST	Undiff. McMurray	-	Na-Cl	-	-	308	-	-	-	-	-	-	-	-	Matrix 2007
10-30-078-04 W4M	100/10-30-078-04 W4M	DST	Undiff. McMurray	-	Na-Cl	0	-	811	-	-	-	-	-	-	-	-	Matrix 2007
11-18-077-05 W4M	100/11-18-077-05 W4M	DST	Undiff. McMurray	-	Na-Cl	-	-	245	-	-	-	-	-	-	-	-	Matrix 2007
13-01-078-06 W4M	100/13-01-078-06 W4M	DST	Undiff. McMurray	-	Na-Cl	44	-	150	-	-	-	-	-	-	-	-	Matrix 2007
13-10-076-04 W4M	100/13-10-076-04 W4M	DST	Undiff. McMurray	-	Na-Cl	-	-	74	-	-	-	-	-	-	-	-	Matrix 2007
10-23-076-07 W4M	100/10-23-076-07 W4M	DST	Undiff. McMurray	-	Na-Cl	-	-	-	-	-	-	-	-	-	-	-	Devon 2006
07-16-076-06 W4M	102/07-16-076-06 W4M	DST	McMurray Aquifer	-	Na-Cl	0	-	399	-	-	-	-	-	-	-	-	Matrix 2007
04-16-076-06 W4M	100/04-16-076-06 W4M	DST	McMurray Aquifer	-	Na-Cl	-	-	-	-	-	-	-	-	-	-	-	Devon 2006
07-16-076-06 W4M	102/07-16-076-06 W4M/00	DST	McMurray Aquifer	-	Na-Cl	-	-	-	-	-	-	-	-	-	-	-	Devon 2006
04-29-077-04 W4M	4-29 Well	Well	McMurray Aquifer	-	Na-Cl	<6	<1	-	-	-	-	-	-	-	-	-	MEG 2006
10-29-077-05 W4M	10-29-077-05 W4M	Well	McMurray Aquifer	-	-	-	-	-	-	-	-	-	-	-	-	-	Westwater 2005a
10-29-077-05 W4M	10-29-077-05 W4M	Well	McMurray Aquifer	-	-	-	-	-	-	-	-	-	-	-	-	-	Westwater 2005a

^(a) Aesthetic objective for Health Canada Drinking Water.

- = Not available.

nc = No criteria.

Note: **Bold** exceeds Health Canada (2007) Drinking Water Guideline.

Table A-12 Bedrock Groundwater Quality Results Within Hydrogeology Local Study Area - Dissolved Metals and Trace Elements

Legal Sub-Division	Well Identifier	Sample Type	Unit/Formation	Sample Date	Aluminum [mg/L]	Antimony [mg/L]	Arsenic [mg/L]	Barium [mg/l]	Beryllium [mg/L]	Boron [mg/L]	Cadmium [mg/L]	Chromium [mg/L]	Cobalt [mg/L]	Copper [mg/L]	Lead [mg/L]	Lithium [mg/L]	Mercury [mg/L]
					0.1 ^(a)	0.006	0.01	1	nc	5	0.005	0.05	nc	1.0 ^(a)	0.01	nc	0.001
6-33-076-05 W4M	6-33-076-05 W4M	Well	Lower Grand Rapid	30-Aug-05	<0.05	<0.002	<0.002	0.05	<0.001	5.52	<0.0001	<0.005	<0.001	0.01	0.008	0.08	-
8-16-77-05 W4M	MEG S3 HARDY 8-16-77-5	Well	Upper Clearwater	20-May-06	<0.05	0.003	0.012	0.03	<0.001	6.99	<0.005	<0.005	<0.001	<0.01	<0.001	0.12	<0.0001
3-16-77-05 W4M	MEG S2 HARDY 3-16-77-5	Well	Upper Clearwater	24-May-06	<0.05	0.003	0.006	0.05	<0.001	6.77	<0.0001	<0.005	<0.001	0.02	0.001	0.13	<0.0001
6-33-076-05 W4M	6-33-076-05 W4M	Well	Upper Clearwater	27-Aug-05	<0.05	<0.002	<0.002	0.17	<0.001	5.43	<0.0001	<0.0050	<0.001	<0.01	0.007	0.17	-

Table A-12 Bedrock Groundwater Quality Results Within Hydrogeology Local Study Area - Dissolved Metals and Trace Elements (continued)

Legal Sub-Division	Well Identifier	Sample Type	Unit/Formation	Sample Date	Molybdenum	Selenium	Silver	Thallium	Tin	Titanium	Uranium	Vanadium	Zinc	Reference
					[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	
					<i>nc</i>	<i>0.01</i>	<i>nc</i>	<i>nc</i>	<i>nc</i>	<i>nc</i>	<i>0.02</i>	<i>nc</i>	<i>5.0^(a)</i>	Health Canada 2007
6-33-076-05 W4M	6-33-076-05 W4M	Well	Lower Grand Rapids	30-Aug-05	<0.01	<0.002	<0.001	<0.0005	<0.01	0.035	<0.005	0.010	<0.01	
8-16-77-05 W4M	MEG S3 HARDY 8-16-77-5	Well	Upper Clearwater	20-May-06	<0.01	<0.002	<0.001	<0.0005	<0.01	<0.005	<0.005	0.015	<0.01	Aqua Terre 2006
3-16-77-05 W4M	MEG S2 HARDY 3-16-77-5	Well	Upper Clearwater	24-May-06	<0.01	<0.002	<0.001	<0.0005	<0.01	<0.005	<0.005	0.01	0.02	Aqua Terre 2006
6-33-076-05 W4M	6-33-076-05 W4M	Well	Upper Clearwater	27-Aug-05	<0.01	<0.002	<0.001	<0.0005	<0.01	<0.005	<0.005	<0.001	<0.01	-

^(a) Aesthetic objective for Health Canada Drinking Water.

– = Not available.

nc = No criteria.

Note: **0.02** exceeds Health Canada (2007) Drinking Water Guideline.

Table A-13 Water Well Records Within Hydrogeology Local Study Area

Legal Sub-Division	Section	Township	Range	Meridian	Alberta Environment Well ID	Well Owner	Ground Elevation [mas]	Date Completed	Proposed Use	Well Record Type	Static Water Level [mbgs]	Static Water Level [mas]	Well Depth [mbgs]	Screened Interval [mbgs]	Hydrostratigraphic Unit
0	1	76	7	4	0278944	ALTA HOUSING	594	-	Domestic	Chemistry	-	-	12.2	n/a	Undiff. Overburden Aquifer/Aquitard
0	1	76	7	4	0278945	#BUNK HOUSE	594	-	Domestic	Chemistry	-	-	45.7	n/a	Undiff. Overburden Aquifer/Aquitard
10	14	76	7	4	0278947	Home Oil Co Ltd #HOLE 2	594	1981-10-10	Industrial	Test Hole	-	-	73.2	n/a	-
10	14	76	7	4	0278949	Home Oil Co Ltd	594	1981-09-10	Industrial	Test Hole	-	-	106.7	n/a	-
10	14	76	7	4	0278950	Home Oil Co Ltd #HOLE 3	594	10/15/1981	Industrial	Test Hole	3.1	591	80.8	76.2 - 80.8	Undiff. Overburden Aquifer/Aquitard
-	36	76	7	4	0279037	Conklin Fire Hall	564	-	Domestic	Chemistry	-	-	n/a	n/a	-
10	8	76	6	4	0040913	Pan Canadian #TH 1	577	1/26/2001	Observation	New Well	-	-	152.4	132.9 - 139.0	Empress Channel Aquifer
10	8	76	6	4	0040914	Pan Canadian #TH 2	577	1/27/2001	Observation	New Well	-	-	83.5	77.4 - 83.5	Ethel Lake Aquifer
10	8	76	6	4	0040915	Pan Canadian #TH 3	577	1/28/2001	Observation	New Well	-	-	53.6	47.5 - 53.6	Undiff. Overburden Aquifer/Aquitard
10	8	76	6	4	0040916	Pan Canadian #TH 4	577	1/28/2001	Observation	New Well	-	-	24.4	18.3 - 24.4	Undiff. Overburden Aquifer/Aquitard
10	8	76	6	4	0040917	Pan Canadian #TH 5	577	1/28/2001	Observation	New Well	-	-	6.7	3.7 - 6.7	Undiff. Overburden Aquifer/Aquitard
10	8	76	6	4	1500078	Pan Canadian	577	1/31/2001	Domestic	New Well	-	-	86.6	77.7 - 81.1	Ethel Lake Aquifer
10	8	76	6	4	1500085	Pan Canadian	577	3/21/2001	Domestic	New Well	-	-	42.1	29.9 - 32.9	Undiff. Overburden Aquifer/Aquitard
7	16	76	6	4	0040918	Pan Canadian #TH 21	567	3/21/2001	Observation	New Well	-	-	158.2	143.9 - 154.5	Empress Channel Aquifer
7	16	76	6	4	0040919	Pan Canadian #TH 17	567	2001-06-03	Observation	New Well	-	-	118.9	112.8 - 118.9	Empress Channel Aquifer
7	16	76	6	4	0040920	Pan Canadian #TH 18	567	2001-06-03	Observation	New Well	-	-	24.1	18.0 - 24.1	Undiff. Overburden Aquifer/Aquitard
7	16	76	6	4	0040921	Pan Canadian #TH 19	567	2001-07-03	Observation	New Well	-	-	12.2	6.1 - 12.2	Undiff. Overburden Aquifer/Aquitard
8	17	76	6	4	0040922	Pan Canadian #TH 7	565	2001-02-02	Observation	New Well	-	-	148.4	137.2 - 143.3	Empress Channel Aquifer
8	17	76	6	4	0040923	Pan Canadian #TH 9	565	2/20/2001	Observation	New Well	-	-	116.4	110.3 - 116.4	Empress Channel Aquifer
8	17	76	6	4	0040924	Pan Canadian #TH 10	565	2/20/2001	Observation	New Well	-	-	76.2	70.1 - 76.2	Undiff. Overburden Aquifer/Aquitard
8	17	76	6	4	0040925	Pan Canadian #TH 11	565	2/20/2001	Observation	New Well	-	-	62.5	56.4 - 62.5	Undiff. Overburden Aquifer/Aquitard
8	17	76	6	4	0040926	Pan Canadian #TH 12	565	2/21/2001	Observation	New Well	-	-	45.7	39.6 - 45.7	Undiff. Overburden Aquifer/Aquitard
8	17	76	6	4	0040927	Pan Canadian #TH 13	565	2/21/2001	Observation	New Well	-	-	22.9	16.8 - 22.9	Undiff. Overburden Aquifer/Aquitard
9	17	76	6	4	0298114	Pan Can	563	1998-09-03	Industrial	New Well	3.0	560	143.3	127.4 - 139.6	Empress Channel Aquifer
9	17	76	6	4	0298237	Pan Can (C.S. RES)	563	1998-09-03	Industrial	New Well	3.5	559	143.3	127.4 - 139.6	Empress Channel Aquifer
9	17	76	6	4	0298238	Pan Can (C.S. RES)	563	1998-11-03	Observation	New Well	1.3	562	140.2	126.8 - 139.0	Empress Channel Aquifer
8	17	76	6	4	1500992	EnCana	565	2002-04-12	Observation	New Well	-	-	12.2	8.5 - 10.1	Undiff. Overburden Aquifer/Aquitard
9	17	76	6	4	1500993	EnCana	563	2002-04-12	Observation	New Well	-	-	11.6	5.5 - 8.5	Undiff. Overburden Aquifer/Aquitard
9	17	76	6	4	1500994	EnCana	563	2002-04-12	Observation	New Well	-	-	29.0	18.3 - 22.9	Undiff. Overburden Aquifer/Aquitard
9	17	76	6	4	1501044	Pan Canadian	563	2001-08-03	Industrial	New Well	-	-	139.6	103.6 - 124.1	Empress Channel Aquifer
-	31	76	6	4	0278940	ALTA Housing	556	1984-01-17	Domestic	New Well	18.3	538	44.2	19.8 - 21.3	Undiff. Overburden Aquifer/Aquitard
-	31	76	6	4	0278941	ALTA Housing	556	1981-01-17	Domestic	New Well	12.8	543	54.9	22.9 - 24.3	Undiff. Overburden Aquifer/Aquitard
SW	31	76	5	4	0157579	Lapointe, Jose	556	-	Domestic	Chemistry	-	-	30.5	-	Undiff. Overburden Aquifer/Aquitard
5	31	76	5	4	0278934	Can Worldwide	572	1986-10-08	Domestic	New Well	6.4	565	56.7	54.9 - 56.4	Ethel Lake Aquifer
8	4	77	5	4	0279184	MEG Energy Corp	572	1986-10-11	Domestic	New Well	7.9	564	66.5	62.5 - 64.0	Ethel Lake Aquifer
15	9	77	5	4	1911661	MEG Energy Corp	585	2005-10-08	Monitoring	New Well	20.1	565	70.1	63.3 - 66.3	Ethel Lake Aquifer
15	9	77	5	4	1911670	MEG Energy Corp	585	2005-10-08	Monitoring	New Well	20.9	564	64.0	56.3 - 59.3	Ethel Lake Aquifer
15	9	77	5	4	1911677	MEG Energy Corp	585	2005-10-06	Industrial	New Well	20.5	565	58.0	53.1 - 58.0	Ethel Lake Aquifer
2	16	77	5	4	1911619	MEG Energy Corp	585	2005-10-03	Monitoring	New Well	94.2	491	139.3	133.5 - 136.5	La Biche Aquitard
2	16	77	5	4	1911655	MEG Energy Corp	585	2005-10-12	Monitoring	New Well	20.9	564	70.0	66.9 - 70.0	Ethel Lake Aquifer
6	19	77	5	4	1501063	MEG Energy Corp	564	2005-03-07	Other	New Well	-	-	112.8	101.8 - 104.9	Terrace Sand Aquifer
6	19	77	5	4	1695019	MEG Energy Corp	564	2005-03-09	Observation	New Well	-	-	112.8	100.6 - 112.8	Terrace Sand Aquifer
-	32	76	4	4	0279027	Ovintal, Margaret	564	1988-01-06	Domestic	New Well	7.3	557	43.6	41.8 - 43.3	Undiff. Overburden Aquifer/Aquitard
NW	15	78	4	4	0279270	Triton Winfield	579	1989-02-15	Domestic and Industrial	New Well	19.2	560	85.3	70.1 - 73.1	Undiff. Overburden Aquifer/Aquitard
12	36	76	6	4	0162384	Venture Seismic Ltd #SP416	556	1990-12-17	Industrial	Flowing Shot Hole	-	-	9.8	-	-
12	36	76	6	4	0162385	Venture Seismic Ltd.	556	1990-12-17	Industrial	Flowing Shot Hole	-	-	9.8	-	-
7	26	78	6	4	0279273	Amoco Can Ltd #113	549	1977-03-09	Industrial	Flowing Shot Hole	-	-	15.2	-	-
7	26	78	6	4	0279276	Amoco Petro#109	549	1977-03-09	Industrial	Flowing Shot Hole	-	-	15.2	-	-
9	27	78	6	4	0279278	Amoco Can#85	556	1977-03-09	Industrial	Flowing Shot Hole	-	-	15.2	-	-
14	14	76	5	4	0278933	Chevron Standard #285	579	1976-12-08	Industrial	Flowing Shot Hole	-	-	n/a	-	-
9	31	76	5	4	0162379	Venture Seismic	579	12/21/1990	Industrial	Flowing Shot Hole	-	-	9.8	-	-
9	31	76	5	4	0162380	Venture Seismic	579	12/17/1990	Industrial	Flowing Shot Hole	-	-	9.8	-	-
9	31	76	5	4	0162381	Venture Seismic	579	12/17/1990	Industrial	Flowing Shot Hole	-	-	9.8	-	-
9	31	76	5	4	0162382	Venture Seismic	579	12/17/1990	Industrial	Flowing Shot Hole	-	-	9.8	-	-
9	31	76	5	4	0162383	Venture Seismic Ltd #SP411	579	-	Industrial	Flowing Shot Hole	-	-	9.8	-	-
16	27	78	5	4	0279280	Pioneer Exp Inc #241	541	1988-02-08	Industrial	Flowing Shot Hole	-	-	11.9	-	-

Table A-14 Current Groundwater Diversions Within Hydrogeology Local Study Area

Location	User	Source Aquifer	Production Interval [mbgs]	Alberta Environment Licence No.	Average Daily Water Diversion [m ³ /d]	Maximum Daily Water Diversion [m ³ /d]	Expiry Date	Purpose	Reference
NE-09-077-05 W4	MEG Energy Corporation	Ethel Lake Aquifer	52.5 - 57.4	00227262-00-00	400	400	12-Feb-10	Industrial Utility, Camp	AENV 2006a
08-16-077-05 W4	MEG Energy Corporation	Clearwater	275.4 - 299.6	00233515-00-00	2100	1600	16-Oct-11	Industrial Steam Injection	AENV 2006b
03-16-077-05 W4		Clearwater	274.5 - 295.3			1600			
09-17-076-06 W4	EnCana Corporation	Empress Channel Aquifer	127.4 - 139.6	00082524-00-00, -01, -02	5000	5000	30-Aug-25	Industrial Steam Injection	AENV 2000
NE-08-076-06 W4	EnCana Corporation	Ethel Lake Aquifer	79.2 - 84.1	00149718-00-00, -01, -02, -03	10	70	06-May-26	Camp Use	AENV 2001b
NE-08-076-06 W4	EnCana Corporation	Ethel Lake Aquifer	79.2 - 84.1	00226094-00-00	86	26.3	13-Dec-15	Camp Use	AENV 2005
13-16-076-06 W4	EnCana Corporation	Clearwater	277.0 - 289.0	00239361-00-00	780	2900	21-May-08	Industrial Steam Injection	AENV 2007c
SE-17-076-06 W4	EnCana Corporation	Empress Channel Aquifer	127.4 - 139.6	00239375-00-00	1574	1500	21-May-08	Industrial Steam Injection	AENV 2007d
03-17-076-06 W4	EnCana Corporation	Clearwater	N/A	00240546-00-00, -01	5000	1700	01-May-08	Industrial Steam Injection	AENV 2007e
09-16-076-06 W4		Clearwater	277.0 - 297.0						
11-16-076-06 W4		Clearwater	278.0 - 305.0						

Table A-15 Existing and Approved Case: Groundwater Withdrawal Rates – Terrace Sand Aquifer

Time	Devon ARL Corporation	Japan Canada Oil Sands Ltd.
	Jackfish Project	Hangingsstone Project
	Devon 2006	JACOS 1997; AENV 1998a; AENV 1998b; AENV 1998c; AENV 2007b
Year	[m ³ /d]	[m ³ /d]
2000	0	0
2001	0	1,200
2002	0	1,200
2003	0	1,200
2004	0	1,200
2005	44	1,200
2006	90	1,200
2007	40	1,200
2008	16	1,200
2009	99	1,200
2010	34	1,200
2011	15	1,200
2012	15	1,200
2013	15	1,200
2014	15	1,200
2015	15	1,200
2016	15	1,200
2017	15	1,200
2018	15	1,200
2019	15	1,200
2020	15	1,200
2021	15	1,200
2022	15	1,200
2023	15	1,200
2024	15	1,200
2025	15	1,200
2026	15	1,200
2027	15	1,200
2028	15	1,200
2029	15	1,200
2030	15	1,200
2031	15	1,200
2032	15	1,200
2033	0	1,200
2034	0	1,200
2035	0	1,200
2036	0	1,200
2037	0	1,200
2038	0	1,200
2039	0	1,200
2040	0	1,200
2041	0	1,200
2042	0	1,200
2043	0	1,200
2044	0	1,200
2045	0	1,200
2046	0	0
2047	0	0

Note: Assuming groundwater withdrawal from the Empress Terrace Aquifer.

**Table A-16 Existing and Approved Case: Groundwater Withdrawal
Rates – Empress Channel Aquifer**

Time	EnCana Corporation	Canadian Natural	Nexen/OPTI	PetroBank
	Christina Lake Thermal Project	Kirby Pilot Project	Long Lake Project	Whitesands In-Situ Project
	Phases 1A/1B			
	Matrix 2007	AENV 2001a	OPTI/Nexen 2002	Orion 2003
Year	[m ³ /d]	[m ³ /d]	[m ³ /d]	[m ³ /d]
2000	0	0	0	0
2001	0	1,200	0	0
2002	790	1,200	0	0
2003	2,398	1,200	0	0
2004	2,810	1,200	0	0
2005	2,877	1,200	0	0
2006	101	1,200	0	0
2007	477	1,200	1,211	575
2008	477	0	1,211	575
2009	477	0	1,211	575
2010	477	0	1,211	575
2011	477	0	1,211	575
2012	477	0	1,211	575
2013	477	0	1,211	0
2014	477	0	1,211	0
2015	477	0	1,211	0
2016	477	0	1,211	0
2017	477	0	1,211	0
2018	477	0	1,211	0
2019	477	0	1,211	0
2020	477	0	1,211	0
2021	477	0	1,211	0
2022	477	0	1,211	0
2023	477	0	1,211	0
2024	477	0	1,211	0
2025	477	0	1,211	0
2026	477	0	1,211	0
2027	477	0	1,211	0
2028	477	0	1,211	0
2029	477	0	1,211	0
2030	477	0	1,211	0
2031	477	0	1,211	0
2032	477	0	1,211	0
2033	477	0	1,211	0
2034	477	0	1,211	0
2035	477	0	1,211	0
2036	477	0	1,211	0
2037	477	0	1,211	0
2038	477	0	1,211	0
2039	477	0	1,211	0
2040	477	0	1,211	0
2041	477	0	1,211	0
2042	477	0	1,211	0
2043	0	0	1,211	0
2044	0	0	1,211	0
2045	0	0	1,211	0
2046	0	0	1,211	0
2047	0	0	0	0

**Table A-17 Existing and Approved Case:
Groundwater Withdrawal Rates – Lower Grand Rapids Aquifer**

Time	Connacher	Petro-Canada	Devon ARL Corporation	Nexen/OPTI	ConocoPhillips Corporation
	Great Divide Project	Meadow Creek Project	Jackfish Project	Long Lake Project	Surmont Project
	Connacher 2005; Canadian Natural 2007: AENV 2007a	Petro-Canada 2001	Devon 2006	OPTI/Nexen 2002	ConocoPhillips 2006; Gulf 2001
Year	[m ³ /d]	[m ³ /d]	[m ³ /d]	[m ³ /d]	[m ³ /d]
2000	0	0	0	0	0
2001	0	0	0	0	0
2002	0	0	0	0	0
2003	0	0	0	0	0
2004	0	0	0	0	0
2005	0	0	0	0	0
2006	0	0	0	0	523
2007	447	2,172	5,000	7,789	1,981
2008	447	2,172	1,500	7,789	2,536
2009	447	2,172	1,200	7,789	2,178
2010	447	2,172	1,200	7,789	6,017
2011	447	2,172	1,200	7,789	9,419
2012	447	2,172	1,200	7,789	10,908
2013	447	2,172	1,200	7,789	10,908
2014	447	2,172	1,200	7,789	10,908
2015	447	2,172	1,200	7,789	10,908
2016	447	2,172	1,200	7,789	10,913
2017	447	2,172	1,200	7,789	8,673
2018	447	2,172	1,200	7,789	8,673
2019	447	2,172	1,200	7,789	8,673
2020	447	2,172	1,200	7,789	5,179
2021	447	2,172	1,200	7,789	5,179
2022	447	2,172	1,200	7,789	5,179
2023	447	2,172	1,200	7,789	5,179
2024	447	2,172	1,200	7,789	5,179
2025	447	2,172	1,200	7,789	5,146
2026	447	2,172	1,200	7,789	5,146
2027	447	2,172	1,200	7,789	5,146
2028	447	2,172	1,200	7,789	5,146
2029	447	2,172	1,200	7,789	5,123
2030	447	2,172	1,200	7,789	5,053
2031	447	2,172	1,200	7,789	5,053
2032	0	0	1,200	7,789	5,053
2033	0	0	0	7,789	5,053
2034	0	0	0	7,789	4,095
2035	0	0	0	7,789	3,904
2036	0	0	0	7,789	3,904
2037	0	0	0	7,789	3,904
2038	0	0	0	7,789	3,904
2039	0	0	0	7,789	1,952
2040	0	0	0	7,789	1,952
2041	0	0	0	7,789	1,952
2042	0	0	0	7,789	1,952
2043	0	0	0	7,789	976
2044	0	0	0	7,789	976
2045	0	0	0	7,789	976
2046	0	0	0	7,789	0
2047	0	0	0	0	0

**Table A-18 Existing and Approved Case:
Groundwater Withdrawal Rates and Wastewater Disposal Rates – Upper
Clearwater Aquifer**

Time	MEG Energy Corp.	Connacher
	Christina Lake Regional Project	Great Divide Project
	Phases 1 & 2/2B	
	MEG 2007	Connacher 2005; Canadian Natural 2007; AENV 2007a
Year	[m ³ /d]	[m ³ /d]
2000	0	0
2001	0	0
2002	0	0
2003	0	0
2004	0	0
2005	0	0
2006	0	0
2007	1,113	-447
2008	1,113	-447
2009	1,113	-447
2010	1,113	-447
2011	2,672	-447
2012	2,672	-447
2013	2,672	-447
2014	2,672	-447
2015	2,672	-447
2016	2,672	-447
2017	2,672	-447
2018	2,672	-447
2019	2,672	-447
2020	2,672	-447
2021	2,672	-447
2022	2,672	-447
2023	2,672	-447
2024	2,672	-447
2025	2,672	-447
2026	2,672	-447
2027	2,672	-447
2028	2,672	-447
2029	2,672	-447
2030	2,672	-447
2031	2,672	-447
2032	2,672	0
2033	2,672	0
2034	2,672	0
2035	2,672	0
2036	0	0
2037	0	0
2038	0	0
2039	0	0
2040	0	0
2041	0	0
2042	0	0
2043	0	0
2044	0	0
2045	0	0
2046	0	0
2047	0	0

Note: Negative values indicate injection.

**Table A-19 Existing and Approved Case:
Groundwater Withdrawal Rates – Middle Clearwater
Aquifer**

Time	EnCana Corporation Christina Lake Thermal Project Phases 1A/1B Matrix 2007
Year	[m ³ /d]
2000	0
2001	0
2002	0
2003	0
2004	0
2005	663
2006	3,164
2007	694
2008	694
2009	694
2010	694
2011	694
2012	694
2013	694
2014	694
2015	694
2016	694
2017	694
2018	694
2019	694
2020	694
2021	694
2022	694
2023	694
2024	694
2025	694
2026	694
2027	694
2028	694
2029	694
2030	694
2031	694
2032	694
2033	694
2034	694
2035	694
2036	694
2037	694
2038	694
2039	694
2040	694
2041	694
2042	694
2043	0
2044	0
2045	0
2046	0
2047	0

**Table A-20 Existing and Approved Case:
Groundwater Withdrawal Rates and Wastewater Disposal Rates – McMurray Aquifer**

Time	MEG Energy Corp.	Canadian Natural	EnCana Corporation	Petro-Canada	PetroBank	Devon ARL Corporation	ConocoPhillips Corporation	Japan Canada Oil Sands Ltd.
	Christina Lake Regional Project Phases 1 & 2/2B	Kirby Pilot Project	Christina Lake Thermal Project Phases 1A/1B	Meadow Creek Project	Whitesands In-Situ Project	Jackfish Project	Surmont Project	Hangingsstone Project
	MEG 2007	Canadian Natural 2007	Matrix 2007	Petro-Canada 2001	Orion 2003	Devon 2006	ConocoPhillips 2006; Gulf 2001	JACOS 1997; AENV 1998a; AENV 1998b; AENV 1998c; AENV 2007b
Year	[m ³ /d]	[m ³ /d]	[m ³ /d]	[m ³ /d]	[m ³ /d]	[m ³ /d]	[m ³ /d]	[m ³ /d]
2000	0	0	0	0	0	0	0	0
2001	0	-1,200	0	0	0	0	0	-1,200
2002	0	-1,200	-1,361	0	0	0	0	-1,200
2003	0	-1,200	-2,600	0	0	0	0	-1,200
2004	0	-1,200	-2,800	0	0	0	0	-1,200
2005	0	-1,200	-3,100	0	0	0	0	-1,200
2006	0	-1,200	-2,800	0	0	0	-1,074	-1,200
2007	-1,089	-1,200	-2,800	-290	-147	-2,500	-813	-1,200
2008	-1,089	0	-949	-290	-147	-1,800	-1,041	-1,200
2009	-1,089	0	-949	-290	-147	-1,400	-894	-1,200
2010	-1,089	0	-949	-290	-147	-1,400	-4,329	-1,200
2011	-2,614	0	-949	-290	-147	-1,400	-4,968	-1,200
2012	-2,614	0	-949	-290	-147	-1,400	-4,478	-1,200
2013	-2,614	0	-949	-290	0	-1,400	-4,478	-1,200
2014	-2,614	0	-949	-290	0	-1,400	-4,478	-1,200
2015	-2,614	0	-949	-290	0	-1,400	-4,478	-1,200
2016	-2,614	0	-949	-290	0	-1,400	-4,480	-1,200
2017	-2,614	0	-949	-290	0	-1,400	8,855	-1,200
2018	-2,614	0	-949	-290	0	-1,400	8,855	-1,200
2019	-2,614	0	-949	-290	0	-1,400	8,855	-1,200
2020	-2,614	0	-949	-290	0	-1,400	8,855	-1,200
2021	-2,614	0	-949	-290	0	-1,400	8,855	-1,200
2022	-2,614	0	-949	-290	0	-1,400	8,855	-1,200
2023	-2,614	0	-949	-290	0	-1,400	8,855	-1,200
2024	-2,614	0	-949	-290	0	-1,400	8,855	-1,200
2025	-2,614	0	-949	-290	0	-1,400	8,883	-1,200
2026	-2,614	0	-949	-290	0	-1,400	8,883	-1,200
2027	-2,614	0	-949	-290	0	-1,400	8,883	-1,200
2028	-2,614	0	-949	-290	0	-1,400	8,883	-1,200
2029	-2,614	0	-949	-290	0	-1,400	8,903	-1,200
2030	-2,614	0	-949	-290	0	-1,400	8,962	-1,200
2031	-2,614	0	-949	-290	0	-1,400	8,962	-1,200
2032	-2,614	0	-949	0	0	-1,400	8,962	-1,200
2033	-2,614	0	-949	0	0	0	8,962	-1,200
2034	-2,614	0	-949	0	0	0	9,792	-1,200
2035	-2,614	0	-949	0	0	0	9,957	-1,200
2036	0	0	-949	0	0	0	9,957	-1,200
2037	0	0	-949	0	0	0	9,957	-1,200
2038	0	0	-949	0	0	0	9,957	-1,200
2039	0	0	-949	0	0	0	11,646	-1,200
2040	0	0	-949	0	0	0	11,646	-1,200
2041	0	0	-949	0	0	0	11,646	-1,200
2042	0	0	-949	0	0	0	11,646	-1,200
2043	0	0	0	0	0	0	12,490	-1,200
2044	0	0	0	0	0	0	12,490	-1,200
2045	0	0	0	0	0	0	12,490	-1,200
2046	0	0	0	0	0	0	0	0
2047	0	0	0	0	0	0	0	0

Note: Negative values indicate injection.

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