

Waskada Unit No. 19
Waterflood Progress Report 2015
January 1st through December 31st 2015

Prepared for:
Manitoba Industry, Economic Development and Mines
Petroleum Branch

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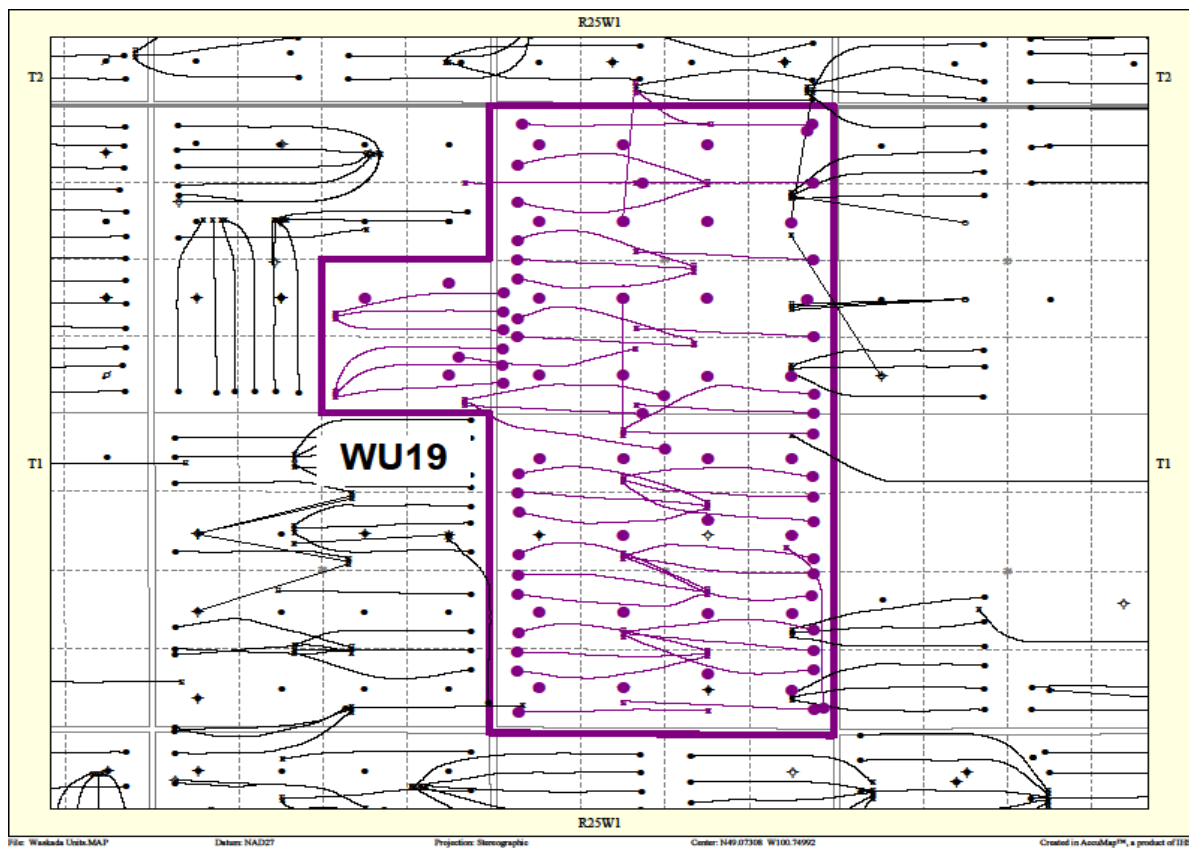
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INTRODUCTION

The Waskada Unit No. 19 pressure maintenance project commenced water injection into the Lower Amaranth A pool in accordance with Manitoba Energy and Mines Order No. PM 14, dated August 1, 2003. Waskada Unit No. 19 was acquired from EOG Resources Canada Inc. effective October 1, 2014 (closing date December 1, 2014) with Tundra Oil and Gas (Tundra) as the new operator. THE EOR project area, outlined in purple in [Figure 1](#), contains 81 wells over 36 LSDs in Township 1, Range 25W1 ([Table 1](#)).

Figure 1: Waskada Unit No. 19 Area Outline



PRODUCTION HISTORY

For the wells included in Waskada Unit No. 19, production started in December 2001 with the 00/13-34-001-25W1/00 well. Oil production peaked at 505.9 m³/d in December 2010. There are currently 58 producing wells in Waskada Unit No. 19. The average production for the unit was 55.76 m³/d of oil and 519.04 m³/d of water and the average WOR was 9.88 m³/m³ at the end of December 2015 ([Table 4](#)). The rates and WOR are presented in [Figure 2](#).

Figure 2: Waskada Unit No. 19 Production/Injection Rates and WOR vs Time

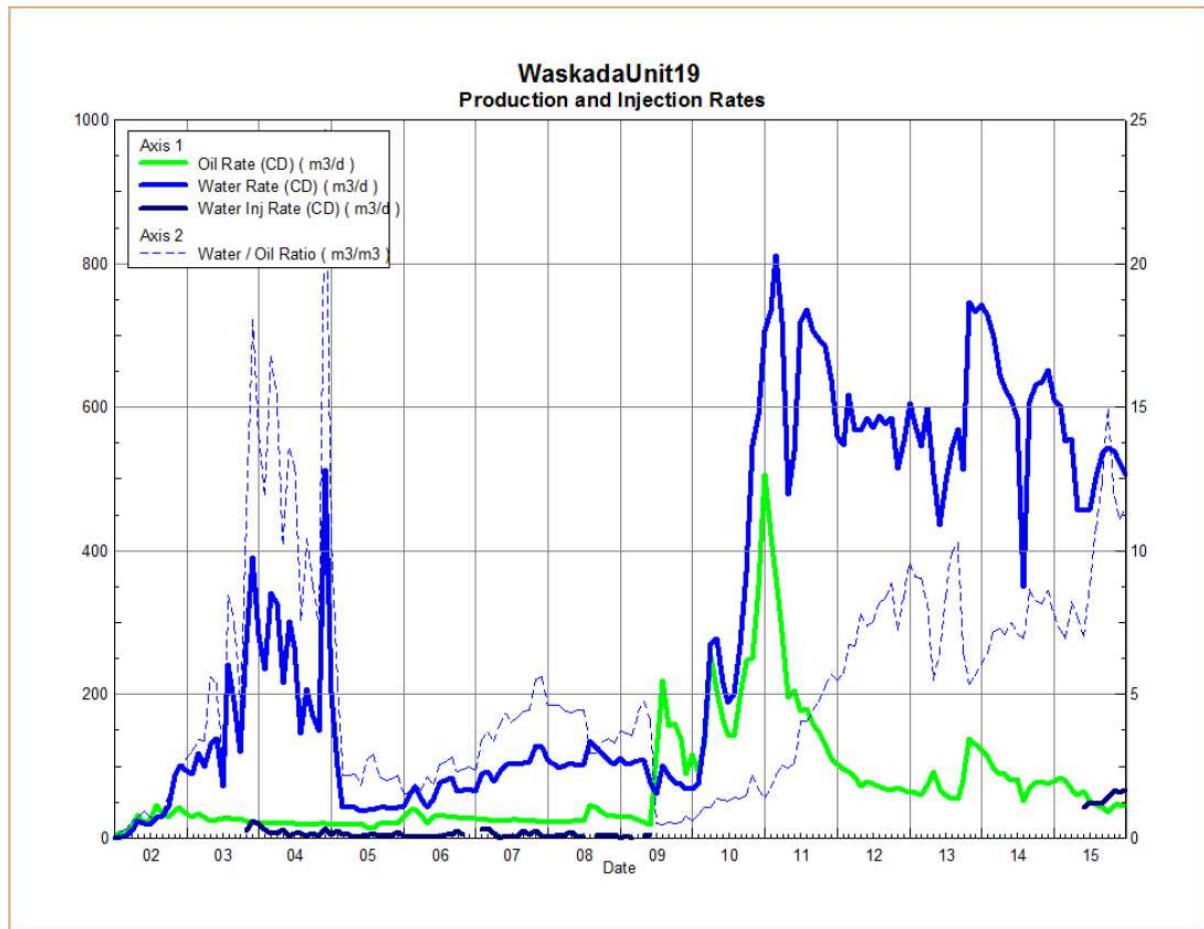
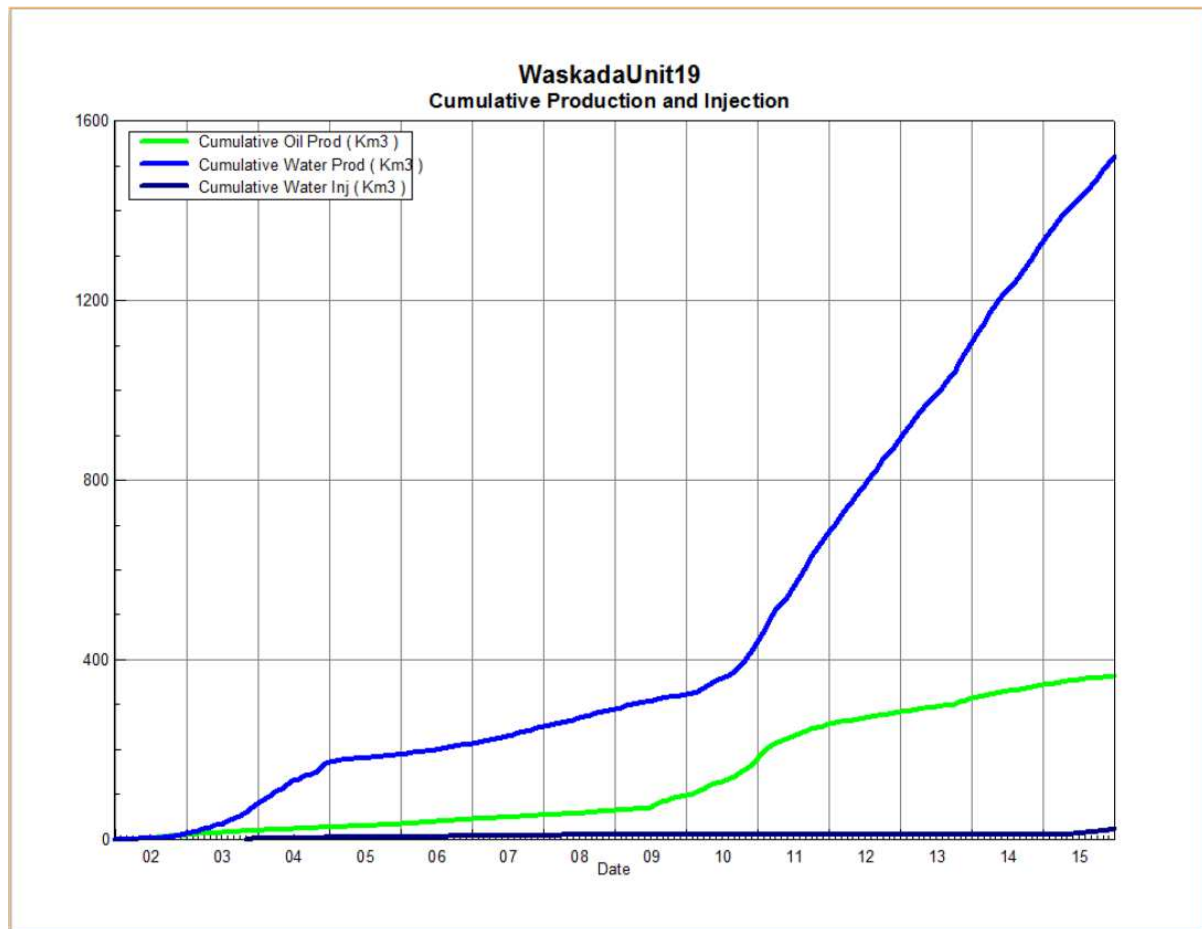


Figure 3 shows the cumulative production for Waskada Unit No. 19 to the end of December 2015 as 364.1 e³m³ of oil, and 1,520.9 e³m³ of water. The cumulative water injected is over 26.5 e³m³.

Figure 3. Waskada Unit No. 19 Cumulative Oil, Water and Water Injected vs. Time



WATERFLOOD HISTORY

Water injection commenced with 4 injector wells on October 2003. Four more injectors were added in November 2003. In 2011, EOG received permission to convert 3 Spearfish injection wells into Mississippian SWD wells. As of the end of December 2015, there are currently 3 active injection wells in Waskada Unit No. 19.

Any future revisions to the waterflood development or surveillance plan would be based on new production or performance response data, technical studies or observed reservoir behavior and reserves recovery interpretations.

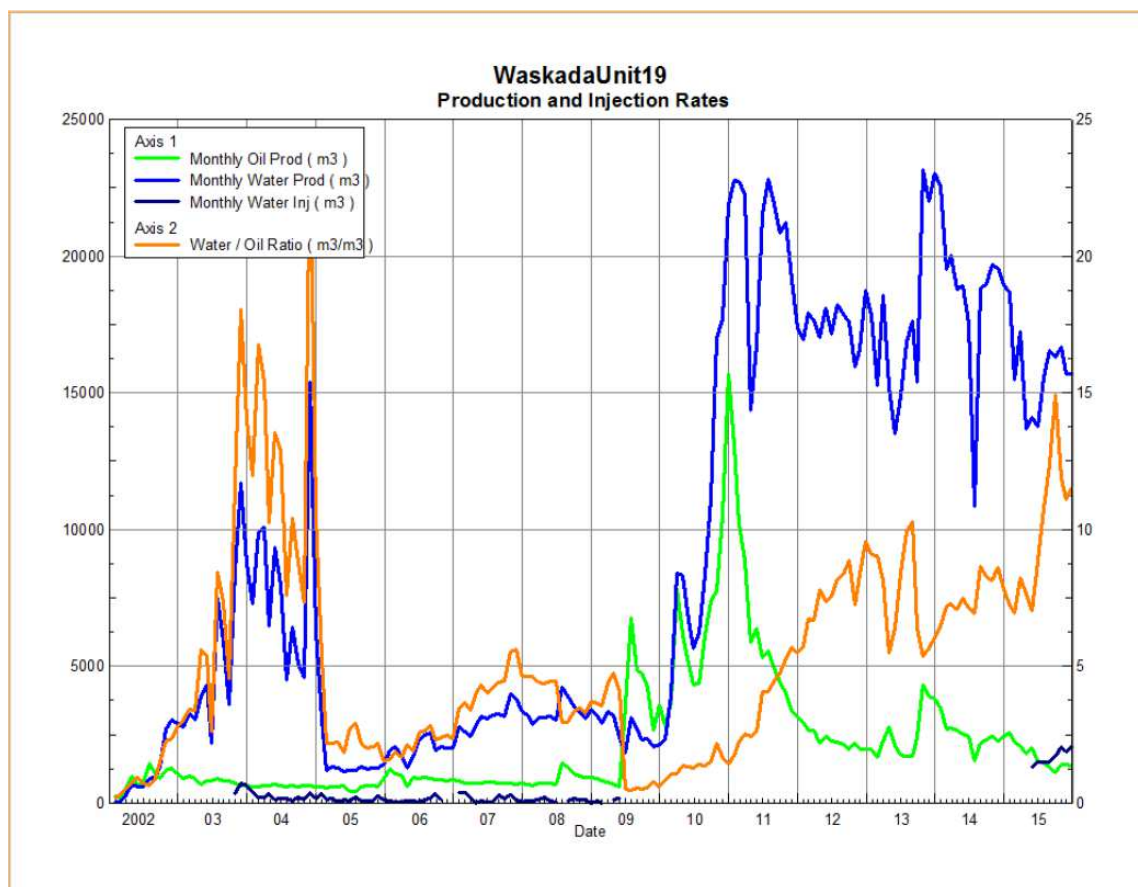
WATERFLOOD PERFORMANCE

From January 1 to December 31 in 2014, Waskada Unit No. 19 produced 209,755 m³ of total fluids (20,310 m³ oil, 189,446 m³ water), and injected 13,492. The cumulative VRR since injection commenced in October 2003 is presently at 0.012. Table 2 summarizes the yearly and cumulative VRR for Waskada Unit No. 19.

When water injection commenced in 2003, there was no visible effect on production. This was due to the fact injection rates were insignificant, and the amount of new wells being brought on production at the same time masked any possible benefits from injection. Until 2009, injection pressures remained high which limits injection rates. As a result, EOG discontinued injection into Waskada Unit No. 19 in August 2009. In 2015, water injection was resumed with the conversion of 3 existing wells.

In 2011, EOG received permission to convert 3 of the Spearfish injection wells to Mississippian disposal wells. The wells converted were 00/06-27, 00/14-27 and 02/02-27-001-25W1.

Figure 4. Waskada Unit No. 19 Production and Injection Rates from 2002-2015



INJECTION WELLHEAD PRESSURES

Individual injection pressure averages for 2015 can be found in **Table 5**.

RESERVOIR PRESSURE

There have been no pressure surveys done on the reservoir.

Gas volumes from the field are measured at the 15-9-2-25W1M battery. There is no individual well gas volume measurement. It is not possible to separate out the gas production from only the wells in Unit 16, so the effectiveness of the pressure maintenance program cannot be evaluated on the GOR.

WELL SERVICING

No maintenance was required on the 81 wells in Waskada Unit No. 19 in 2015.

CORROSION AND SCALE PREVENTION

The facilities in Unit 19 are currently using cathodic protection and chemicals to protect against corrosion and scale. All facilities are monitored every 3 months to assess the corrosion and ensure that proper electrical current is being supplied. There have been no issues with corrosion or scale to date.

Biocide chemical is added to the injection water to prevent any sulfide producing bacteria from forming.

CONCLUSION

The current pressure maintenance program is having little effect on oil production in Waskada Unit No. 19. Tundra will maintain the current pressure maintenance program, and continue to monitor production and pressure performance. Plans for future injection conversions and acid treatments to improve unit performance are being considered for 2016.

TABLE NO. 1: WASKADA UNIT NO. 19 WELL SUMMARY

UWI	Type	Status	On Prod Date	Cum Prd Oil (m3)	Cum Prd Water (m3)	Last Prod Date	On Inj Date	Cum Inj Water (m3)	Last Inj Date
100/01-27-001-25W1/0	Vertical	Abandoned Zone	2/1/2003	1,672	7,285	10/31/2015		0	
102/01-27-001-25W1/0	Horizontal	Producing	2/1/2010	3,574	125,015	12/31/2015		0	
103/01-27-001-25W1/0	Horizontal	Producing	12/1/2010	7,135	16,660	12/31/2015		0	
104/01-27-001-25W1/0	Horizontal	Producing	10/1/2013	2,489	2,247	12/31/2015		0	
102/02-27-001-25W1/0	Vertical	Producing	1/1/2006	1,114	32,319	7/31/2011		0	
100/03-27-001-25W1/0	Vertical	Abandoned	2/1/2003	24	741	3/31/2003		0	
100/04-27-001-25W1/0	Vertical	Injection	N/A	0	0		Nov-2003	1,423	10/31/2008
102/04-27-001-25W1/0	Horizontal	Producing	11/1/2010	9,095	31,448	12/31/2015		0	
103/04-27-001-25W1/0	Horizontal	Producing	12/1/2010	7,166	42,860	1/31/2016		0	
100/05-27-001-25W1/0	Vertical	Pumping	10/1/2002	5,659	3,956	12/31/2015		0	
102/05-27-001-25W1/0	Horizontal	Producing	12/1/2010	6,296	9,463	12/31/2015		0	
103/05-27-001-25W1/0	Horizontal	Producing	12/1/2010	4,047	46,907	12/31/2015		0	
104/05-27-001-25W1/0	Horizontal	Producing	9/1/2010	9,445	122,413	3/31/2016		0	
100/06-27-001-25W1/0	Vertical	SWD	N/A	0	0		Nov-2003	1,403	7/31/2009
100/07-27-001-25W1/0	Vertical	Pumping	2/1/2003	3,696	1,837	7/31/2013		0	
100/08-27-001-25W1/0	Vertical	Producing	1/1/2006	1,925	507	7/31/2014		0	
102/08-27-001-25W1/0	Horizontal	Producing	12/1/2010	5,126	29,249	12/31/2015		0	
103/08-27-001-25W1/0	Horizontal	Producing	12/1/2010	4,574	2,666	12/31/2015		0	
104/08-27-001-25W1/0	Horizontal	Producing	10/1/2010	4,102	35,670	12/31/2015		0	
100/09-27-001-25W1/0	Vertical	Abandoned	10/1/2002	226	6,620	10/31/2003		0	
102/09-27-001-25W1/0	Horizontal	Injection	10/1/2010	4,876	8,770	11/30/2015		0	
103/09-27-001-25W1/0	Horizontal	Producing	10/1/2010	5,245	7,213	12/31/2015		0	
104/09-27-001-25W1/0	Horizontal	Injection	8/1/2010	3,223	38,778	3/31/2014		0	
102/10-27-001-25W1/0	Vertical	Abandoned	N/A						
100/11-27-001-25W1/0	Vertical	Pumping	10/1/2002	3,432	66,979	2/28/2015		0	
102/12-27-001-25W1/0	Horizontal	Producing	9/1/2010	8,534	79,548	4/30/2015		0	
103/12-27-001-25W1/0	Horizontal	Producing	9/1/2010	6,580	46,087	12/31/2015		0	
104/12-27-001-25W1/0	Horizontal	Injection	9/1/2010	5,535	25,660	12/31/2015		0	
100/13-27-001-25W1/0	Vertical	Pumping	8/1/2002	3,061	111,529	9/30/2013		0	
102/13-27-001-25W1/0	Horizontal	Producing	9/1/2010	7,924	42,199	12/31/2015		0	
103/13-27-001-25W1/0	Horizontal	Producing	9/1/2010	2,464	46,156	12/31/2015		0	
100/14-27-001-25W1/0	Vertical	SWD	N/A	0	0		Nov-2003	942	12/31/2008
102/14-27-001-25W1/0	Horizontal	Producing	11/1/2010	6,305	13,474	2/28/2014		0	
100/15-27-001-25W1/0	Vertical	Pumping	8/1/2002	4,128	1,976	5/31/2012		0	
100/16-27-001-25W1/0	Vertical	Producing	1/1/2006	1,842	752	7/31/2012		0	
102/16-27-001-25W1/0	Horizontal	Producing	8/1/2010	5,296	27,652	3/31/2016		0	
103/16-27-001-25W1/0	Horizontal	Producing	8/1/2010	5,178	6,751	12/31/2015		0	
104/16-27-001-25W1/0	Horizontal	Producing	3/1/2013	2,228	1,391	1/31/2016		0	
100/01-33-001-25W1/0	Vertical	Pumping	3/1/2002	4,823	49,476	6/30/2014		0	
100/07-33-001-25W1/0	Vertical	Pumping	3/1/2002	3,473	5,858	12/31/2013		0	
100/08-33-001-25W1/0	Vertical	Injection	N/A	0	0		Nov-2003	1,411	5/31/2009
100/01-34-001-25W1/0	Vertical	Pumping	3/1/2002	3,533	1,069	12/31/2015		0	
102/01-34-001-25W1/0	Horizontal	Producing	6/1/2009	9,035	1,504	2/29/2016		0	
103/01-34-001-25W1/0	Horizontal	Producing	3/1/2013	3,997	1,843	12/31/2015		0	
100/02-34-001-25W1/0	Vertical	Injection	N/A	0	0		Oct-2003	2,475	5/31/2009
100/03-34-001-25W1/0	Vertical	Pumping	3/1/2002	4,862	1,595	1/31/2015		0	
102/03-34-001-25W1/0	Horizontal	Injection	6/1/2009	11,281	83,848	11/30/2015		0	
103/03-34-001-25W1/0	Horizontal	Producing	11/1/2010	6,376	2,404	12/31/2015		0	
100/04-34-001-25W1/0	Vertical	Abandoned Zone	12/1/2005	1,311	32,105	5/31/2010		0	
102/04-34-001-25W1/0	Horizontal	Producing	2/1/2010	6,526	1,971	12/31/2015		0	
103/04-34-001-25W1/0	Horizontal	Producing	9/1/2013	4,494	22,166	12/31/2015		0	
104/04-34-001-25W1/0	Horizontal	Producing	9/1/2013	3,277	32,938	12/31/2015		0	
105/04-34-001-25W1/0	Horizontal	Producing	9/1/2013	5,449	3,715	12/31/2015		0	
100/05-34-001-25W1/0	Vertical	Pumping	6/1/2002	4,268	1,619	6/30/2013		0	
102/05-34-001-25W1/0	Horizontal	Producing	6/1/2009	7,939	1,719	12/31/2015		0	
103/05-34-001-25W1/0	Horizontal	Injection	2/1/2010	6,321	1,687	3/31/2015		5,491	12/31/2015
104/05-34-001-25W1/0	Horizontal	Producing	3/1/2010	11,026	29,362	12/31/2015		0	
105/05-34-001-25W1/0	Horizontal	Producing	9/1/2013	3,432	39,439	12/31/2015		0	
106/05-34-001-25W1/0	Horizontal	Producing	9/1/2013	2,698	41,188	12/31/2015		0	
107/05-34-001-25W1/0	Horizontal	Producing	9/1/2013	7,210	4,993	12/31/2015		0	
100/06-34-001-25W1/0	Vertical	Producing	12/1/2005	2,271	536	6/30/2012		0	
100/07-34-001-25W1/0	Vertical	Pumping	3/1/2002	5,162	1,528	11/30/2014		0	
100/08-34-001-25W1/0	Vertical	Injection	N/A	0	0		Oct-2003	1,675	12/31/2008
102/08-34-001-25W1/0	Horizontal	Producing	6/1/2009	5,200	1,222	12/31/2015		0	
100/09-34-001-25W1/0	Vertical	Producing	6/1/2002	4,558	1,568	11/30/2012		0	
102/09-34-001-25W1/0	Horizontal	Producing	6/1/2009	7,151	1,011	8/31/2013		0	
100/10-34-001-25W1/0	Vertical	Injection	N/A	0	0		Oct-2003	3,204	5/31/2009
100/11-34-001-25W1/0	Vertical	Abandoned Zone	6/1/2002	4,500	1,984	10/31/2014		0	
100/12-34-001-25W1/0	Vertical	Abandoned Zone	12/1/2005	2,822	717	8/31/2013		0	
102/12-34-001-25W1/0	Horizontal	Injection	6/1/2009	7,656	3,742	2/28/2015		5,714	12/31/2015
103/12-34-001-25W1/0	Horizontal	Producing	3/1/2010	4,827	1,859	12/31/2015		0	
104/12-34-001-25W1/0	Horizontal	Producing	3/1/2010	5,078	9,678	12/31/2015		0	
100/13-34-001-25W1/0	Vertical	Pumping	12/1/2001	5,272	1,836	5/31/2015		0	
102/13-34-001-25W1/0	Horizontal	Producing	3/1/2010	10,088	68,731	12/31/2015		0	
103/13-34-001-25W1/0	Horizontal	Producing	3/1/2010	7,606	3,047	12/31/2015		0	
100/14-34-001-25W1/0	Vertical	Abandoned Zone	12/1/2005	1,659	721	4/30/2012		0	
102/14-34-001-25W1/0	Horizontal	Injection	7/1/2008	8,110	10,093	6/30/2015		2,069	12/31/2015
100/15-34-001-25W1/0	Vertical	Pumping	6/1/2002	4,204	1,446	7/31/2012		0	
100/16-34-001-25W1/0	Vertical	Abandoned	N/A	0	0		Oct-2003	479	8/31/2004
102/16-34-001-25W1/0	Horizontal	Producing	6/1/2009	7,652	2,045	12/31/2015		0	
103/16-34-001-25W1/0	Horizontal	Producing	8/1/2010	5,728	5,909	12/31/2015		0	

TABLE NO. 2 - Waskada Unit No. 19 VRR Calculations

Date	Monthly Oil Prod m3	Cum Oil Prod Km3	Monthly Water Prod m3	Cum Water Prod Km3	Water Oil Ratio m3/m3	Monthly Water Inj m3	Cum Water Inj Km3	VRR	Cum VRR
2001	4	0.004	0	0.000	0.00		0.000	0.000	0.000
2002	10,244	10.248	14,062	14.062	1.37		0.000	0.000	0.000
2003	9,591	19.839	65,411	79.473	6.82	1,818	1.818	0.024	0.018
2004	7,425	27.264	93,300	172.773	12.57	2,937	4.755	0.029	0.023
2005	7,093	34.357	16,885	189.658	2.38	2,138	6.893	0.085	0.030
2006	10,975	45.332	24,031	213.689	2.19	1,631	8.524	0.044	0.032
2007	8,780	54.112	37,568	251.257	4.28	2,421	10.945	0.051	0.035
2008	10,771	64.883	40,022	291.279	3.72	1,487	12.432	0.028	0.034
2009	34,114	98.998	31,617	322.895	0.93	579	13.011	0.008	0.030
2010	81,848	180.845	117,546	440.441	1.44	0	13.011	0.000	0.020
2011	75,155	256.000	243,772	684.213	3.24	0	13.011	0.000	0.013
2012	27,659	283.659	209,773	893.986	7.58	0	13.011	0.000	0.010
2013	30,379	314.038	213,317	1,107.303	7.02	0	13.011	0.000	0.009
2014	29,739	343.777	224,198	1,331.500	7.54	0	13.011	0.000	0.007
2015	20,310	364.090	189,446	1,520.946	9.33	13,492	26.503	0.063	0.012

TABLE NO. 3

**Tundra Oil and Gas
Waskada Unit No. 19
2015 Injection Volumes**

Well Location	Date	Hours On	H ₂ O Inj Cal-d avg (m ³ /d)	Monthly Injected H ₂ O (m ³)
Unit No. 19 Total:				
	Jan-15	0	0	0
	Feb-15	0	0	0
	Mar-15	0	0	0
	Apr-15	0	0	0
	May-15	0	42.2	1,309
	Jun-15	0	49.4	1,483
	Jul-15	0	48.1	1,490
	Aug-15	0	48.0	1,488
	Sep-15	0	57.0	1,710
	Oct-15	0	66.4	2,058
	Nov-15	0	63.3	1,899
	Dec-15	0	66.3	2,055
2015 Group Totals:				13,492
Unit No. 19 Total:				
	2001	0		
	2002	0		
	2003	0	19.8	1,818
	2004	0	8.0	2,937
	2005	0	5.9	2,138
	2006	0	5.4	1,631
	2007	0	6.6	2,421
	2008	0	4.4	1,487
	2009	0	2.7	579
	2010	0	0.0	0
	2011	0	0.0	0
	2012	0	0.0	0
	2013	0	0.0	0
	2014	0	0.0	0
	2015	0	55.1	13,492
Group Totals:				26,503

TABLE NO. 4

**Tundra Oil and Gas
Waskada Unit No. 19
2015 Production Volumes**

Date	Hours On	Oil Rate (CD) m3/d	Monthly Oil Prod m3	Water Rate (CD) m3/d	Monthly Water Prod m3	Water Oil Ratio m3/m3	Well Count
Jan-15	33,648	83.23	2,580	601.56	18,648	7.23	45
Feb-15	30,216	79.68	2,231	552.40	15,467	6.93	45
Mar-15	31,152	67.49	2,092	556.37	17,248	8.24	42
Apr-15	27,504	59.40	1,782	456.18	13,686	7.68	38
May-15	28,488	65.03	2,016	455.90	14,133	7.01	38
Jun-15	26,256	51.95	1,559	458.64	13,759	8.83	36
Jul-15	28,872	46.67	1,447	502.02	15,563	10.76	39
Aug-15	29,808	43.07	1,335	534.55	16,571	12.41	40
Sep-15	28,248	36.36	1,091	543.01	16,290	14.94	39
Oct-15	29,160	45.39	1,407	538.40	16,691	11.86	39
Nov-15	28,152	46.97	1,409	522.56	15,677	11.13	39
Dec-15	26,232	43.89	1,361	506.89	15,714	11.55	35
	347,736		20,310		189,446		

Date	Hours On	Oil Rate (CD) m3/d	Monthly Oil Prod m3	Water Rate (CD) m3/d	Monthly Water Prod m3	Water Oil Ratio m3/m3	Well Count
2001	24	0.11	4	0.00	0	0.00	1
2002	68,280	28.07	10,244	38.53	14,062	1.37	9
2003	129,672	26.28	9,591	179.21	65,411	6.82	17
2004	132,144	20.29	7,425	254.92	93,300	12.57	16
2005	131,304	19.43	7,093	46.26	16,885	2.38	16
2006	187,747	30.07	10,975	65.84	24,031	2.19	23
2007	195,888	24.05	8,780	102.93	37,568	4.28	23
2008	201,480	29.43	10,771	109.35	40,022	3.72	24
2009	197,640	93.46	34,114	86.62	31,617	0.93	28
2010	308,304	224.24	81,848	322.04	117,546	1.44	41
2011	463,440	205.90	75,155	667.87	243,772	3.24	68
2012	447,576	75.57	27,659	573.15	209,773	7.58	62
2013	413,376	83.23	30,379	584.43	213,317	7.02	55
2014	410,280	81.48	29,739	614.24	224,198	7.54	49
2015	347,736	55.76	20,310	519.04	189,446	9.88	40
	3,634,891		364,086		1,520,946		

TABLE NO. 5 - Average Injection Pressures

	00/02-34 Inj	00/04-27 Inj	00/06-27 Inj	00/07-27 Inj	00/08-33 Inj	00/08-34 Inj	00/10-34 Inj	00/14-27 Inj	02/03-34 Inj
Year	Inj Pressure (kPa)	Inj Pressure (kPa)	Inj Pressure (kPa)	Inj Pressure (kPa)	Inj Pressure (kPa)	Inj Pressure (kPa)	Inj Pressure (kPa)	Inj Pressure (kPa)	Inj Pressure (kPa)
2014	0.0	0.0	4575.8	0.0	0.0	0.0	0.0	3695.5	0.0
2015	3196.4	0.0	4099.7	0.0	2986.0	3156.2	3169.3	3282.6	0.0

	02/04-34 Inj	02/09-27 Inj	02/12-34 Inj	02/14-34 Inj	03/04-27 Inj	03/05-34 Inj	04/09-27 Inj	04/12-27 Inj	
Year	Inj Pressure (kPa)	Inj Pressure (kPa)	Inj Pressure (kPa)	Inj Pressure (kPa)	Inj Pressure (kPa)	Inj Pressure (kPa)	Inj Pressure (kPa)	Inj Pressure (kPa)	
2014	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2015	0.0	0.0	50.2	0.0	0.0	51.3	0.0	0.0	