

Birdtail Unit No. 2

Waterflood Progress Report 2018

January 1st through December 31st 2018

Prepared for:

Manitoba Industry, Economic Development and Mines

Petroleum Branch

Prepared by:

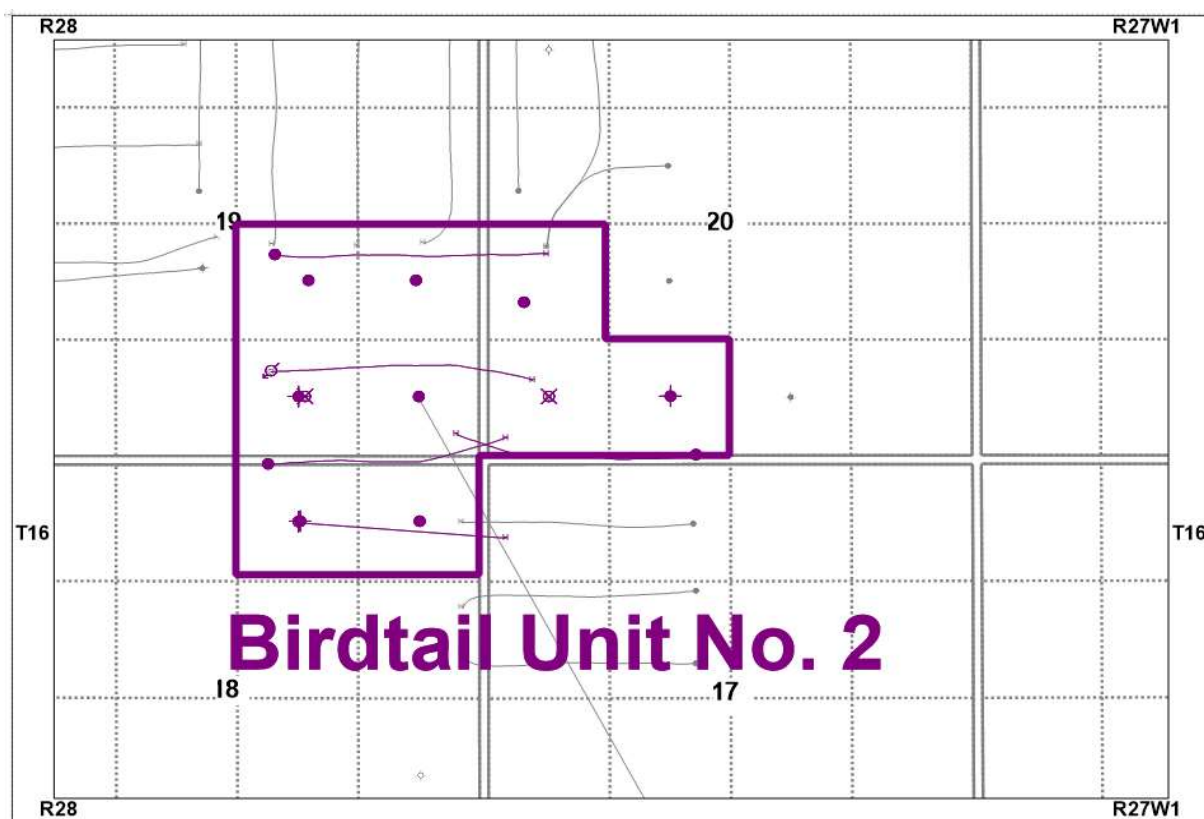
Tundra Oil and Gas

April 10, 2019

INTRODUCTION

Birdtail Unit No. 2 Enhanced Oil Recovery (EOR) Waterflood Project was approved under Waterflood Order No. 8 effective December 1, 2000 with Progress Energy Production Partnership as Operator. Tundra acquired the unit from Progress Energy Production Partnership and became operator in October 2003. The EOR project area contains 15 wells in 9 LSDs in Township 16, Range 27 W1 as shown in the figure below.

Figure 1: Birdtail Unit No. 2 Area Outline



Birdtail Unit No. 2

Tundra Oil and Gas (Tundra), as the operator of the Birdtail Unit No. 2 Enhanced Oil Recovery (EOR) project hereby submits the 2018 EOR report as per section 73 of the Drilling and Production Regulations.

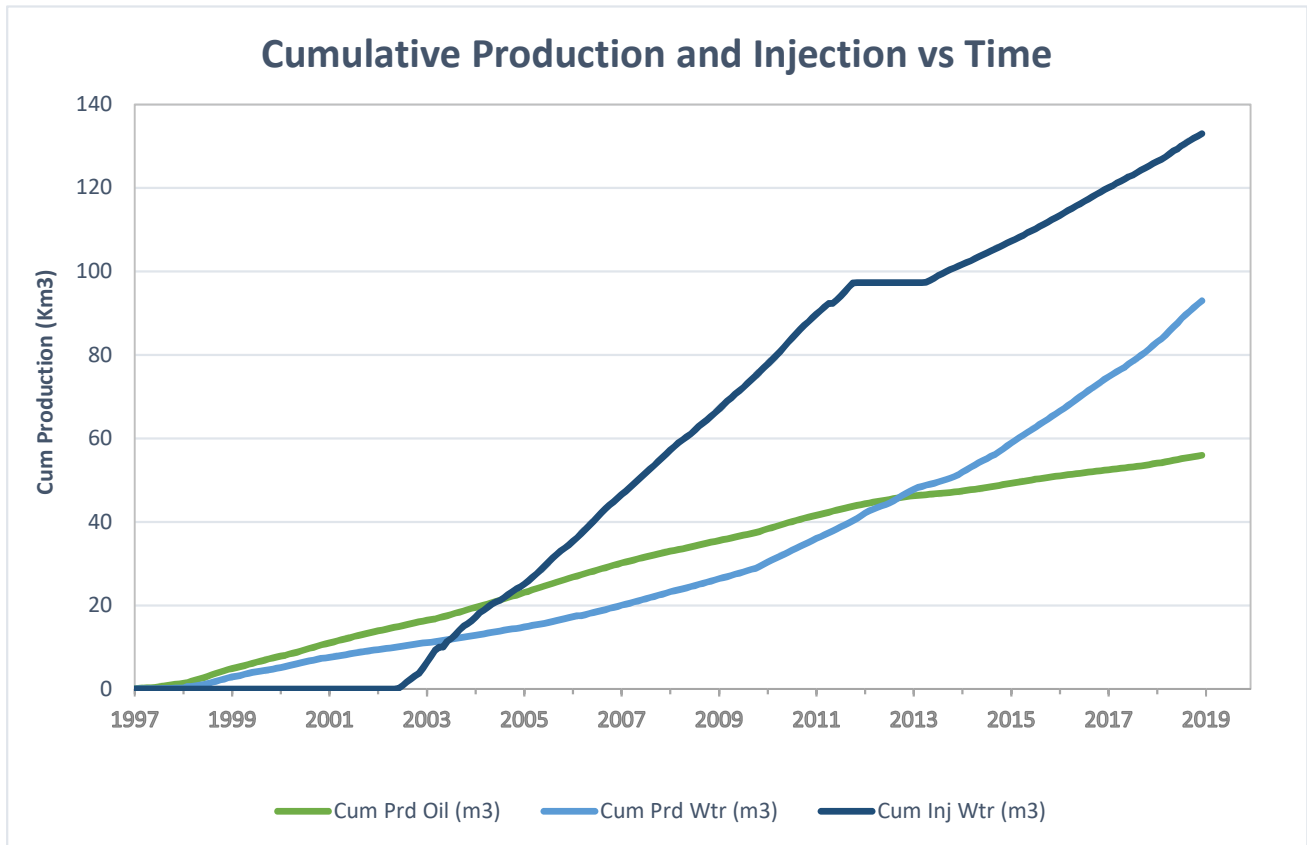
a) Monthly oil and water production rates, injection rate, GOR and WOR

MONTH	Cal Dly Oil m ³ /day	Cal Dly Wtr m ³ /day	Cal Inj Wtr m ³ /day	WOR m ³ /m ³	GOR m ³ /m ³
Jan-2018	5.33	26.13	17.87	4.91	0
Feb-2018	4.50	24.95	17.04	5.55	0
Mar-2018	5.32	29.75	18.45	5.60	0
Apr-2018	6.89	32.34	24.70	4.69	0
May-2018	6.37	32.38	24.19	5.08	0
Jun-2018	5.72	31.71	16.30	5.54	0
Jul-2018	6.02	34.98	22.65	5.81	0
Aug-2018	6.06	29.52	20.74	4.87	0
Sep-2018	5.14	27.85	19.30	5.42	0
Oct-2018	5.15	27.93	18.90	5.43	0
Nov-2018	5.41	27.32	18.17	5.05	0
Dec-2018	5.79	25.29	17.84	4.37	0

b) Cumulative volume of oil, gas and water produced and fluid injected

2018 PRODUCTION	
Produced Oil (m ³)	2,062
Produced Gas (m ³)	0
Produced Water (m ³)	10,661
Fluid Injected (m ³)	7,191
CUMULATIVE PRODUCTION	
Produced Oil (m ³)	55,974
Produced Water (m ³)	92,990

Birdtail Unit No. 2



c) Monthly wellhead injection pressure for each injection well

MONTH	03/02-19 Inj		Birdtail Unit 2	
	Inj Water (m ³)	Avg Inj P (kPa)	Inj Water (m ³)	Avg Inj P (kPa)
Jan-2018	554.0	4124	554.0	4124
Feb-2018	477.0	3991	477.0	3991
Mar-2018	572.0	3329	572.0	3329
Apr-2018	741.0	3963	741.0	3963
May-2018	750.0	4199	750.0	4199
Jun-2018	489.0	4178	489.0	4178
Jul-2018	702.0	4200	702.0	4200
Aug-2018	643.0	4188	643.0	4188
Sep-2018	579.0	4171	579.0	4171
Oct-2018	586.0	4180	586.0	4180
Nov-2018	545.0	4136	545.0	4136
Dec-2018	553.0	4140	553.0	4140
Total	7191.0		7191.0	
Avg Inj P		4066		4066

MONTH	Jan-2018	Feb-2018	Mar-2018	Apr-2018	May-2018	Jun-2018	Jul-2018	Aug-2018	Sep-2018	Oct-2018	Nov-2018	Dec-2018
Total m3	554.0	477.0	572.0	741.0	750.0	489.0	702.0	643.0	579.0	586.0	545.0	553.0
Daily (m³/d)	17.87	17.04	18.45	24.70	24.19	16.30	22.65	20.74	19.30	18.90	18.17	17.84

2018 AVG. ANNUAL DAILY INJECTION = 19.68 m3/d

CUMULATIVE INJECTION TO Dec 31, 2017 = 125,837 m3

TOTAL 2018 ANNUAL INJECTION = 7,191 m3
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CUMULATIVE INJECTION TO Dec 31, 2018 = 133,028 m3

d) Summary of the result of any survey of reservoir pressure conducted in 2018. N/A

e) **Date and type of any well servicing.**

Well	Service Description	Date

f) **Calculations of voidage replacement ratio on a monthly and cumulative basis**

VOIDAGE CALCULATIONS

OIL FORMATION VOLUME FACTOR (Rm3/Sm3) = 1.071

MONTH	Mth Oil Prod (m3)	Cum Oil Prod (Km3)	Mth Water Prod (m3)	Cum Water Prod (Km3)	Mth Water Inj (m3)	Cum Water Inj (Km3)	VRR	Cum VRR
Jan-2018	165.1	54.08	809.9	83.14	554.0	126.39	0.561	0.896
Feb-2018	125.9	54.20	698.7	83.84	477.0	126.87	0.572	0.894
Mar-2018	164.8	54.37	922.2	84.76	572.0	127.44	0.521	0.891
Apr-2018	206.7	54.57	970.3	85.73	741.0	128.18	0.622	0.889
May-2018	197.5	54.77	1003.8	86.73	750.0	128.93	0.617	0.887
Jun-2018	171.6	54.94	951.4	87.69	489.0	129.42	0.431	0.883
Jul-2018	186.7	55.13	1084.3	88.77	702.0	130.12	0.547	0.880
Aug-2018	188.0	55.32	915.2	89.69	643.0	130.77	0.576	0.878
Sep-2018	154.1	55.47	835.6	90.52	579.0	131.34	0.579	0.876
Oct-2018	159.5	55.63	865.9	91.39	586.0	131.93	0.565	0.874
Nov-2018	162.3	55.79	819.6	92.21	545.0	132.48	0.549	0.872
Dec-2018	179.6	55.97	784.1	92.99	553.0	133.03	0.566	0.870

g) **An outline of the method used for quality control and treatment of the injected fluid**

The injection water for Birdtail Unit No. 2 is sourced from the 00/02-19-016-27W/2 well (Lodgepole formation). The water is treated at the 09-05-16-27W1 battery where it is filtered to 0.50 microns and has scale inhibitor added.

h) **A report of any unusual performance problems and remedial measures taken or being considered. N/A**

i) **Any other information necessary to evaluate the project**

j) Well List

Birdtail Unit No.2 Well List

<i>UWI</i>	<i>Type</i>	<i>Status</i>	<i>Future Plans</i>
100/15-18-016-27W1/0	Vertical	Abandoned	-
102/15-18-016-27W1/0	Horizontal	Producing	-
103/15-18-016-27W1/0	Horizontal	Drilled & Cased	-
100/16-18-016-27W1/0	Vertical	Producing	-
100/01-19-016-27W1/0	Vertical	Pumping	-
100/02-19-016-27W1/0	Vertical	Abandoned Zone	-
102/02-19-016-27W1/0	Vertical	Abandoned	-
103/02-19-016-27W1/0	Horizontal	Injection	-
100/07-19-016-27W1/0	Vertical	Producing	-
102/07-19-016-27W1/0	Horizontal	Producing	-
100/08-19-016-27W1/0	Vertical	Producing	-
100/03-20-016-27W1/0	Vertical	Abandoned Zone	-
102/03-20-016-27W1/0	Horizontal	Producing	-
100/04-20-016-27W1/0	Vertical	Abandoned	-
100/05-20-016-27W1/0	Vertical	Pumping	-

k) Discussion

The original oil-in-place (OOIP) of $393 \text{ e}^3\text{m}^3$ with cumulative oil recovered to date of $53.9 \text{ e}^3\text{m}^3$ results in a recovery factor of 13.7%. The ultimate expected recoverable reserve based on decline analysis is $64.7 \text{ e}^3\text{m}^3$ or an ultimate recovery factor of 16.4%. The overall performance of this waterflood has been good as indicated by an expected recovery factor of 16.4% and increased or flattened oil production since water injection began in 2002.

The vertical injectors at 02/02-19-016-27W1/0 (02/02-19) and 00/04-20-016-27W1/0 (00/04-20) were suspended in October 2011. The 03/02-19-016-27W1/0 (03/02-19) horizontal well was converted to a water injector in April 2013 after a short production period. Ultimately, it is expected that the 02/15-18-016-27W1/0 and 02/07-19-016-27W1/0 horizontal producers will benefit the most from the new 03/02-19 water injector. Tundra will continue to closely monitor the response of the reconfigured waterflood in this unit and make any appropriate changes as required to the injection targets and wells.