

**EWART UNIT NO. 3**  
**WATERFLOOD EOR PROJECT**  
**ANNUAL REPORT FOR 2017**

**May 2, 2018**

**Tundra Oil and Gas Partnership**

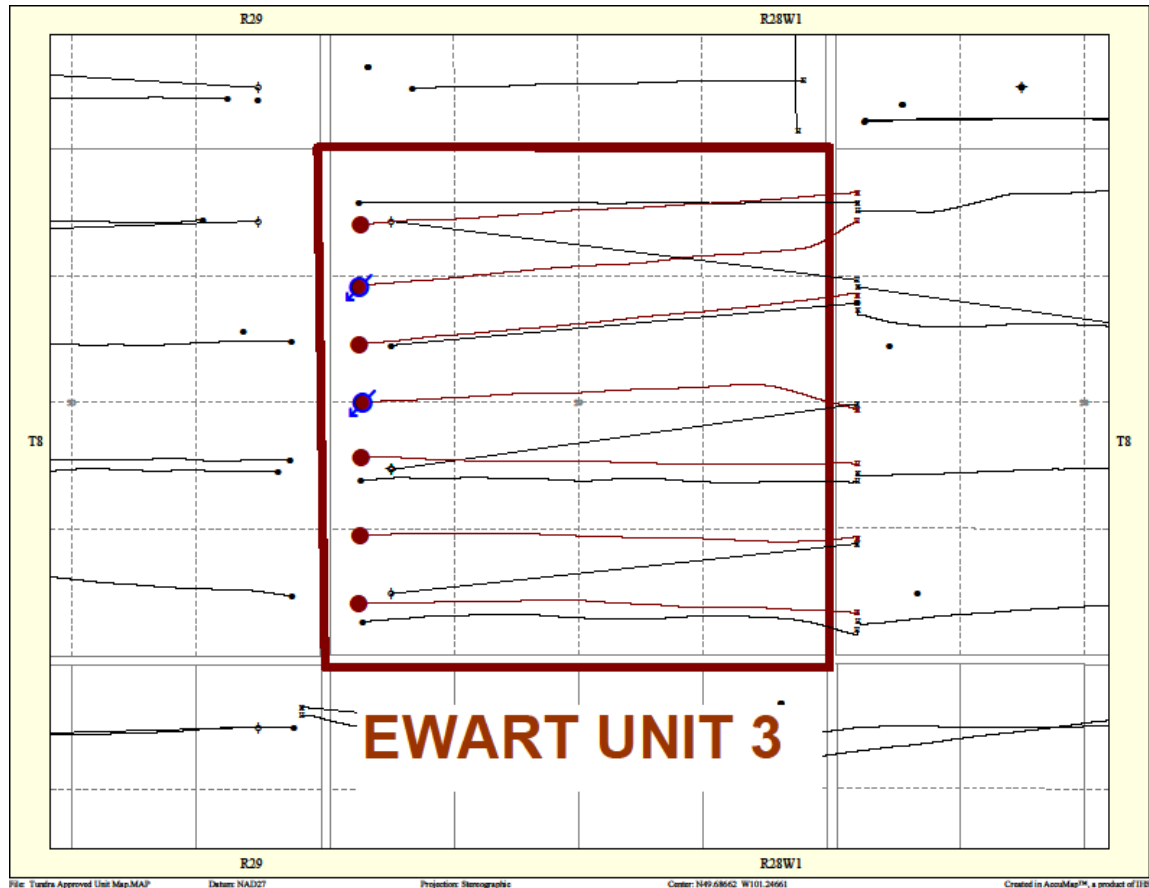
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102/04-29-008-28W1	
102/12-29-008-28W1	
103/12-29-008-28W1	

## **INTRODUCTION**

Ewart Unit No. 3 Enhance Oil Recovery (EOR) Waterflood Project was approved under Waterflood Order No. 30 effective August 1, 2013 with Tundra Oil and Gas (Tundra) as Operator. The Unit area contains 5 producing wells and 2 injectors in 16 LSDs in Township 8 Range 28 W1 as shown in the figure below.

**Figure 1: Ewart Unit No. 3 Area Outline**



In accordance with Section 73 of the Manitoba Drilling and Production Regulation, Tundra hereby submits the following 2017 Annual Progress Report for Ewart Unit No. 3.

## **DISCUSSION**

### **Production History**

For the wells included in Ewart Unit No. 3, production started in December 2008 with the 00/04-29-008-28W1 well. Average oil production peaked at 9.2 m<sup>3</sup>/d per well in March 2012. This production was coming from 6 wells and totaled 55.3 m<sup>3</sup>/d for the Unit. In

December 2017, the Unit was producing 17.90 m<sup>3</sup>/d of oil and 57.49 m<sup>3</sup>/d of water and the average WOR was 2.39 m<sup>3</sup>/m<sup>3</sup>. The rates and WOR are presented in Figure 2.

**Figure 2: Ewart Unit No. 3 Production/Injection Rates and WOR vs Time**

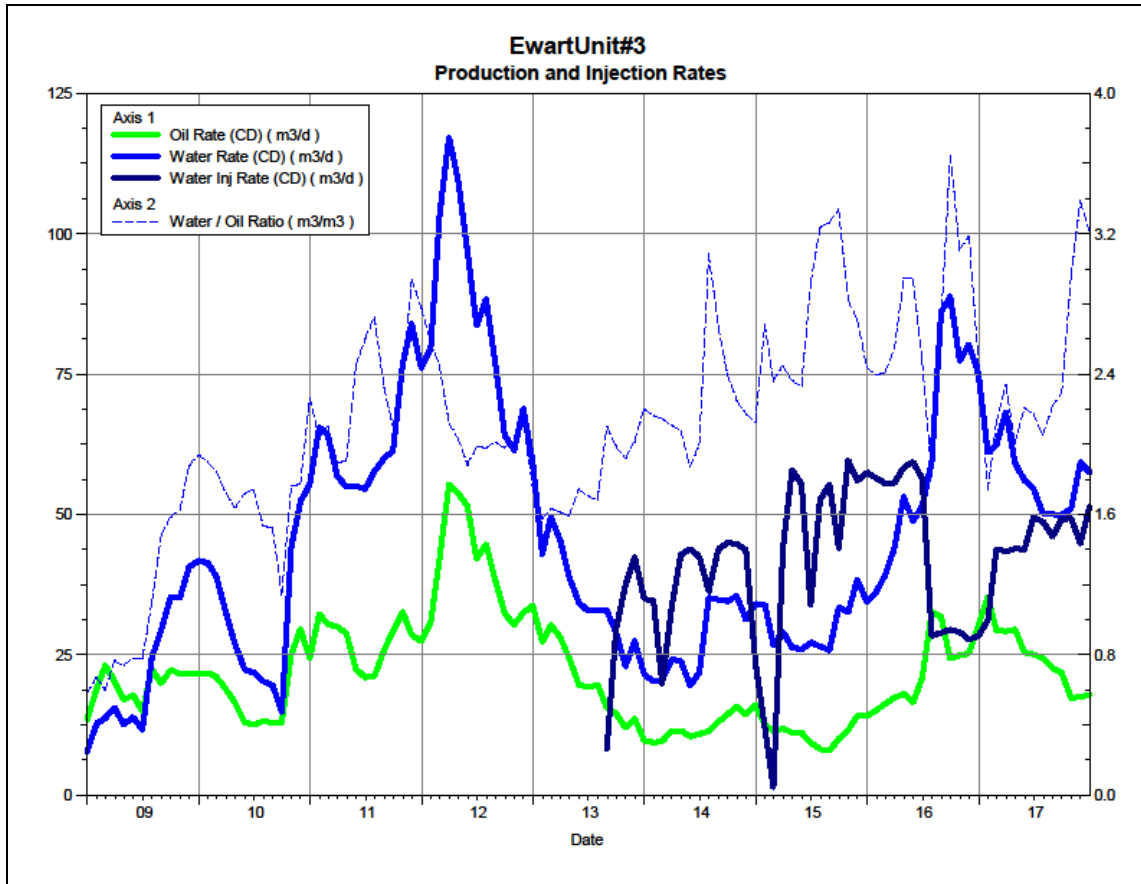
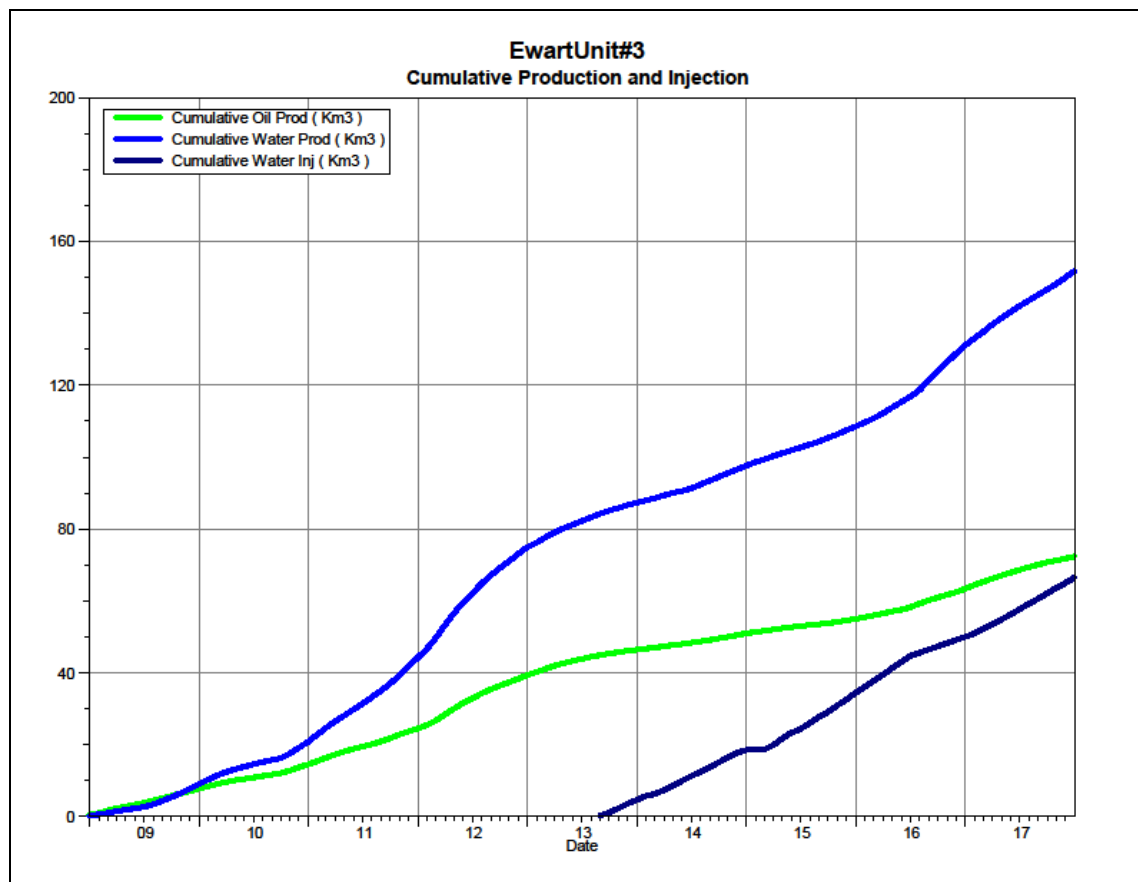


Figure 3 shows the cumulative production for Ewart Unit No. 3 to the end of December 2017 as 72.36 e<sup>3</sup>m<sup>3</sup> of oil, and 151.76 e<sup>3</sup>m<sup>3</sup> of water, representing a 12.1% recovery factor of the OOIP (599.5 e<sup>3</sup>m<sup>3</sup>). The cumulative water injected is 66.56 e<sup>3</sup>m<sup>3</sup>.

**Figure 3: Ewart Unit No. 3 Cumulative Oil, Water and Water Injected vs Time**



## **Waterflood Development Plan**

### **Ewart Unit No. 3 Waterflood (WF) Development Plan**

Ewart Unit No. 3 is still in the development phase at the end of 2017. The three (3) proposed horizontal injection wells were drilled in 2011 between the existing horizontal producing wells, completing an effective 20 acre line drive waterflood pattern. All horizontal wells are fracture stimulated to improve the injection rates. In 2012, the proposed injectors were put on production and in 2013, the 02/12-29 and 03/12-29 wells were converted to injectors. Tundra expects to convert the 02/04-29-008-28W1 (02/04-29) producer to an injector in Q1 2018.

Production performance by injector pattern are summarized in Appendix A.

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 EOR Operating Strategy and Performance**

### **Water Source and Quality**

The injection water for Ewart Unit No. 3 was sourced from the 02/16-32-007-29W1 well (Lodgepole formation) until June 2016 when it was switched over to the newly recompleted source water well at 02/14-30-007-28W1 (Mannville formation). The water is treated at the 04-01-008-29W1 filtration plant where it is filtered to 0.1 microns and has scale inhibitor and biocide added. The injection water is then distributed to the injectors through the dedicated infrastructure system.

### **Injection Wellhead Pressures**

Injection started in this Unit in August 2013. The average monthly wellhead injection pressure for each injector is summarized in Appendix C. Since injection in this Unit is still in the early stages, the injectors are still building up to a target injection pressure of 6300 kPaa.

### **Reservoir Pressure**

Where practical, Tundra is committed to collecting pressure data from newly drilled injection wells. For Ewart Unit No. 3, pressure data is currently available for the 02/12-29 and 03/12-29-008-28W1 locations. A summary table is presented in Appendix B. Pressures are corrected to a common datum of -450 m SS for comparison with other units in the area.

### **Well Servicing**

Table 1 lists the maintenance that was required in Ewart Unit No. 3 in 2017.

**Table 1: Service and Maintenance in Ewart Unit No. 3**

102/13-29-008-28W100	Cemented Liner Cleanout	10/28/2017
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## **Waterflood Performance Discussion**

At the end of 2017, Ewart Unit No. 3 waterflood area had 2 injection patterns in place. Since water injection started in August 2013, there is no waterflood analysis that can be done at this time. Tundra currently plans to produce the 02/04-29 producer until Q1 2018 and then convert it to an injector.

A summary table of the injector pattern(s) is presented in Appendix A. Plots of the production and injection data along with the VRR information are presented in Appendix D for each of the injector pattern(s).

## List of Appendices

Appendix A: Injection Pattern Summary

Appendix B: Reservoir Pressure Summary

Appendix C: Average Monthly Injection Pressure Summary

Appendix D: Injector Pattern Production/Injection Rates, Cumulative and VRR Plots for  
the following injectors:

102/04-29-008-28W1

102/12-29-008-28W1

103/12-29-008-28W1

## Appendix A

### Ewart Unit No. 3 Injection Pattern Summary as of December 2017

Pattern Name	Injector BH Location (008-28W1)	Injector Surf. Location (008-28W1)	Status	No. of Supported Wells	Supported Wells (008-28W1)	Allocation Factor	Pattern Prod Start Month	Inj Start Month	Oil Rate (m³/d)	Water Rate (m³/d)	WOR (m³/m³)	Water Injection (m³/d)	Cum Oil (E³m³)	Cum Water (E³m³)	Cum Inj Water (E³m³)	Monthly VRR	Cum VRR
02/04-29-008-28W1 Injector	02/04-29	03/04-28	Capable of Oil Production	2	04-29, 02/05-29	0.5	Dec 2008	-	4.8	8.4	1.73		23.4	32.3	0.0	0.000	0.000
02/12-29-008-28W1 Injector	02/12-29	02/13-28	Water Injection	2	12-29, 13-29	0.5	Jul 2009	Aug 2013	5.2	20.9	4.06	25.9	16.7	46.5	32.0	0.981	0.498
03/12-29-008-28W1 Injector	03/12-29	03/05-28	Water Injection	2	02/05-29, 12-29	0.5	Sep 2010	Sep 2013	5.5	21.8	3.96	25.5	17.6	48.3	34.5	0.923	0.514



## APPENDIX B

### Ewart Unit No. 3 - Pressure Summary

Location	Test Date	Final Pressure (kPaa)	MPP (mTVD)	KB	Datum Depth	Gradient	Pressure @ -450 masl
102/12-29-008-28W1/00	Dec 17, 2011 - Oct 9, 2012	2681.6	889.7	501.1	-450	8.25	3189
103/12-29-008-28W1/00	Dec 9, 2011 - Jan 13, 2012	6119.2	890.7	499.3	-450	8.25	6603

## Appendix C

### Average Monthly Injection Pressure (kPag)

Month	102/12-29	103/12-29
Aug-13	696	0
Sep-13	0	0
Oct-13	0	0
Nov-13	0	0
Dec-13	0	0
Jan-14	-25	0
Feb-14	-78	0
Mar-14	-78	0
Apr-14	-78	0
May-14	-78	0
Jun-14	-69	494
Jul-14	-61	548
Aug-14	-35	989
Sep-14	187	1310
Oct-14	436	1576
Nov-14	583	1671
Dec-14	1397	2042
Jan-15	1571	2177
Feb-15	1512	2096
Mar-15	776	308
Apr-15	1727	1879
May-15	2285	2486
Jun-15	74	2959
Jul-15	1198	3250
Aug-15	2397	3224
Sep-15	2312	2744
Oct-15	3078	3594
Nov-15	3086	3676
Dec-15	3255	3775
Jan-16	3329	3858
Feb-16	3416	4307
Mar-16	3310	3989
Apr-16	3277	3914
May-16	3774	4470
Jun-16	3667	4570
Jul-16	2021	2772
Aug-16	1329	2227
Sep-16	1059	2068
Oct-16	932	2019
Nov-16	601	1806
Dec-16	423	2037
Jan-17	377	2107
Feb-17	426	3861
Mar-17	405	4199
Apr-17	423	4398
May-17	453	4565
Jun-17	1210	4751
Jul-17	1837	4645
Aug-17	2341	3367
Sep-17	2821	3365
Oct-17	3134	4288
Nov-17	2270	3485
Dec-17	2817	4346

## **Appendix D**

### **Rates and VRR Plots**

# Pattern: 02/04-29-008-28Inj Set: EwartUnit#3

Oil Formation Vol Factor : 1.07100 m3/m3

Water Formation Vol Factor : 1.00150 m3/m3

Water / Oil Ratio : 1.56 m3/m3

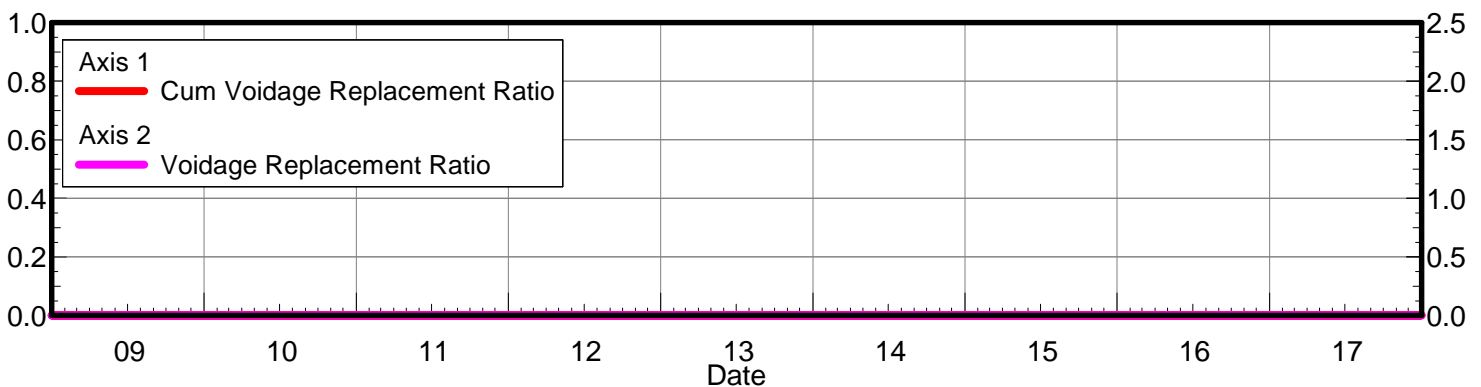
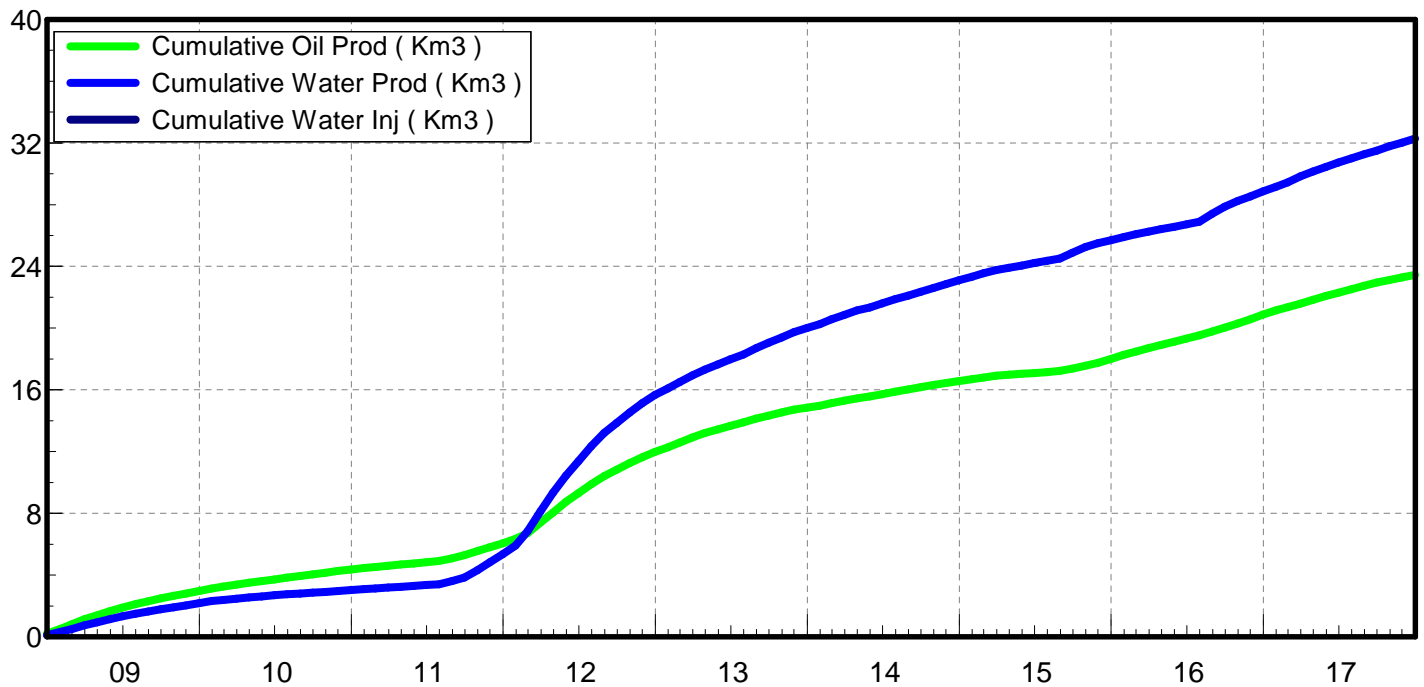
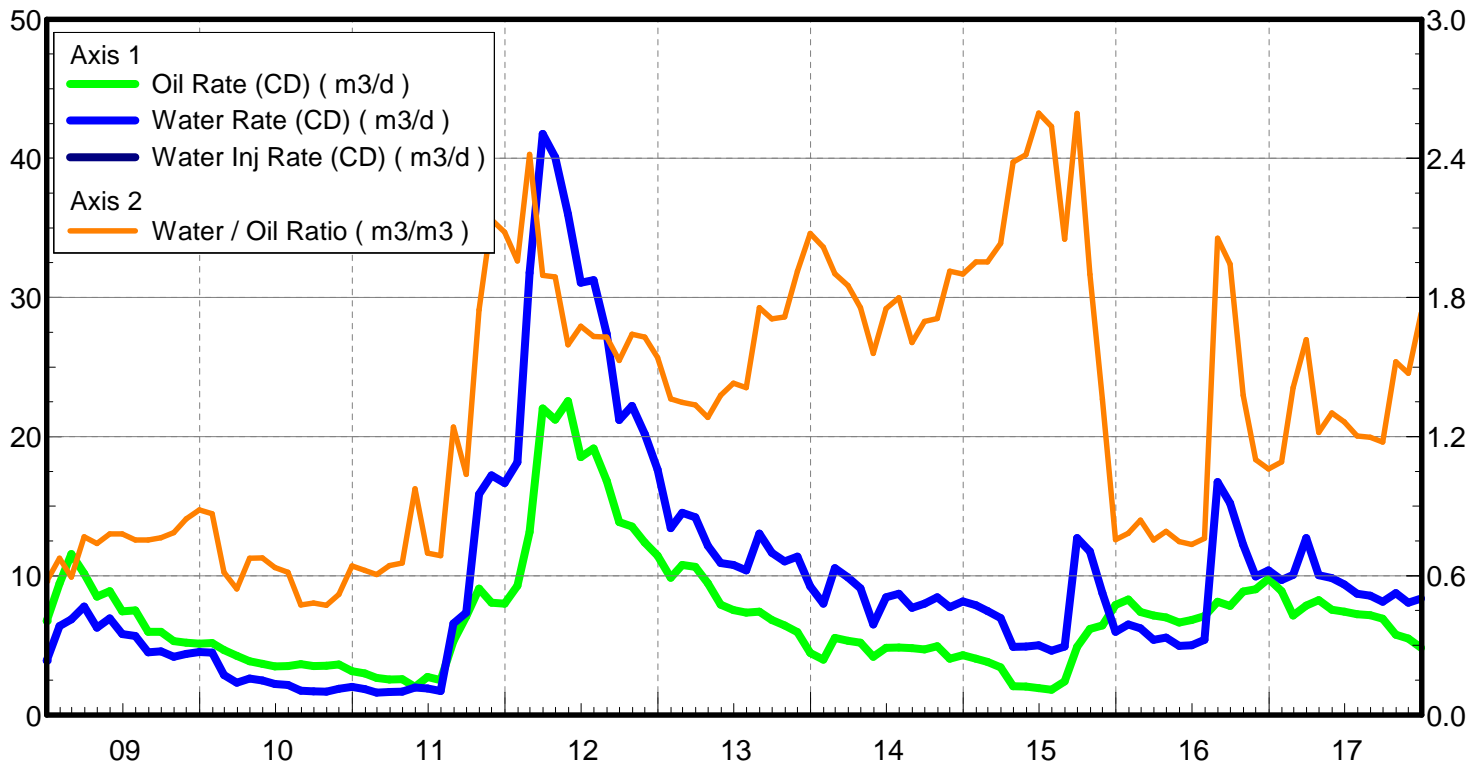
March 05, 2018

Operator: TUNDRA\_OIL\_AND\_GAS\_PARTNER

Oil Rate (CD) : 4.83 m3/d

Water Rate (CD) : 8.35 m3/d

Water Inj Rate (CD) : \* m3/d



# Pattern: 02/12-29-008-28Inj Set: EwartUnit#3

Oil Formation Vol Factor : 1.07100 m3/m3

Water Formation Vol Factor : 1.00150 m3/m3

Water / Oil Ratio : 5.13 m3/m3

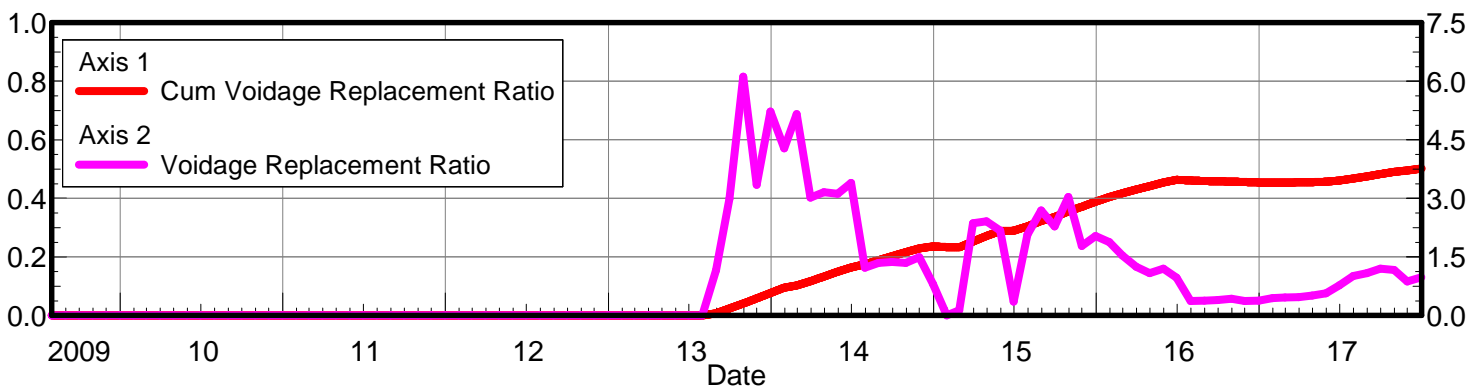
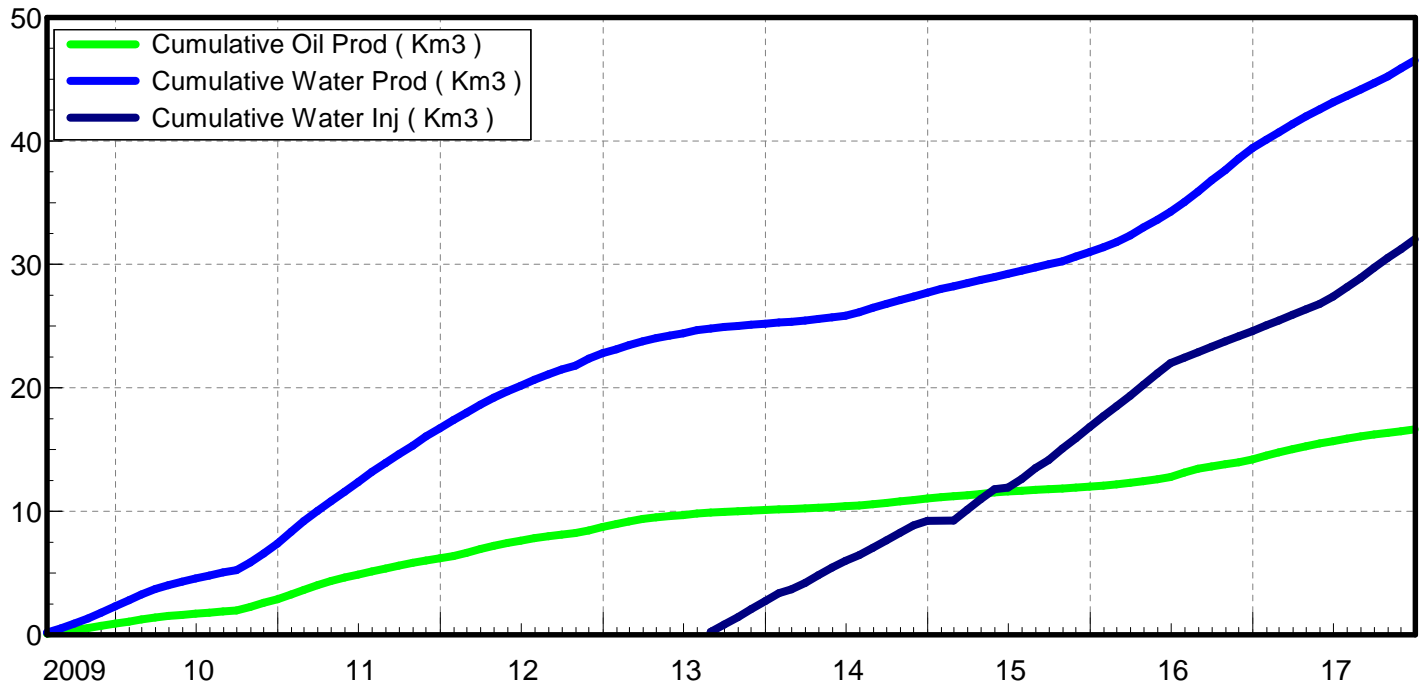
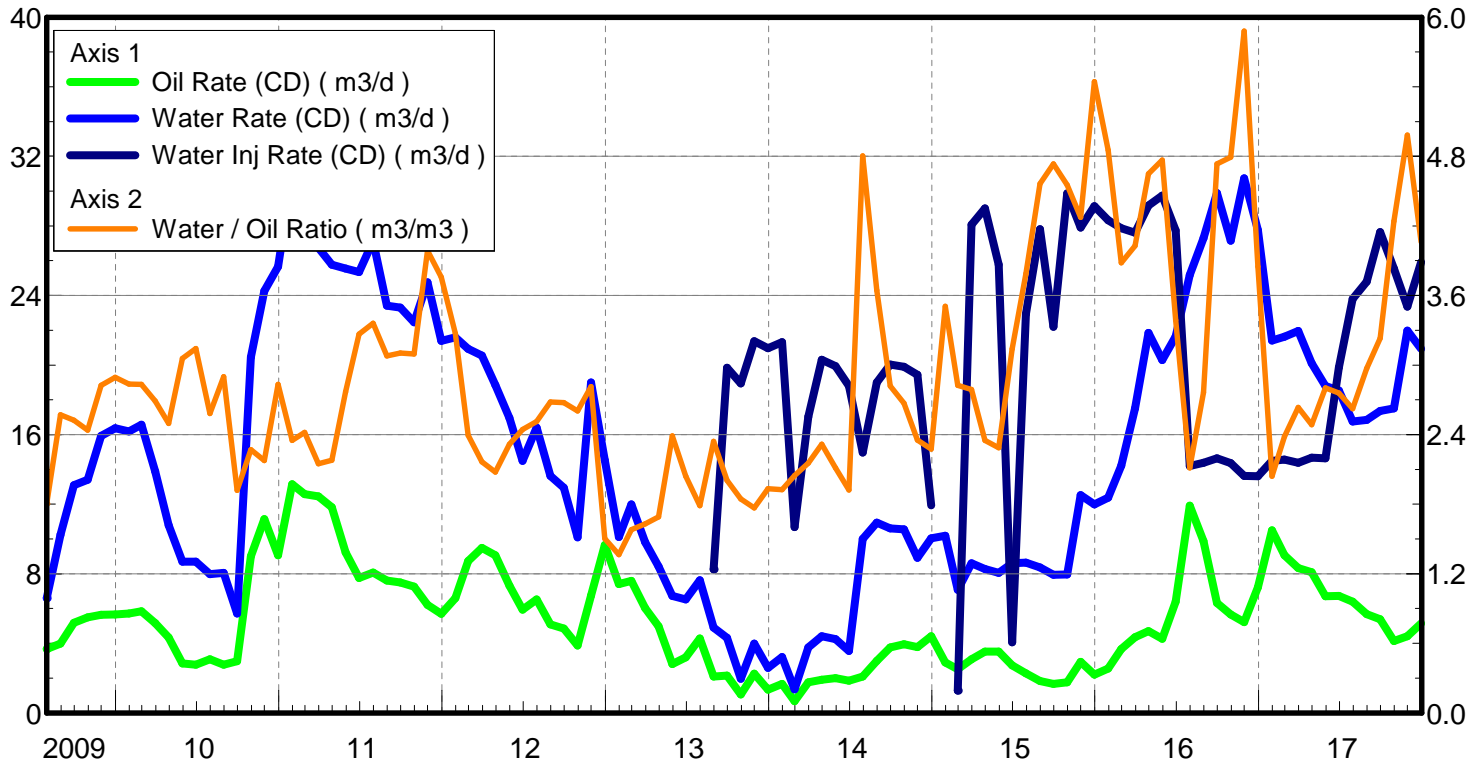
March 05, 2018

Operator: TUNDRA\_OIL\_AND\_GAS\_PARTNER

Oil Rate (CD) : 5.15 m3/d

Water Rate (CD) : 20.92 m3/d

Water Inj Rate (CD) : 25.93 m3/d



# Pattern: 03/12-29-008-28Inj Set: EwartUnit#3

Oil Formation Vol Factor : 1.07100 m3/m3

Water Formation Vol Factor : 1.00150 m3/m3

Water / Oil Ratio : 4.60 m3/m3

March 05, 2018

Operator: TUNDRA\_OIL\_AND\_GAS\_PARTNER

Oil Rate (CD) : 5.50 m3/d

Water Rate (CD) : 21.78 m3/d

Water Inj Rate (CD) : 25.52 m3/d

