

**PROPOSED BIRDTAIL UNIT NO. 3**

**Application for Enhanced Oil Recovery Waterflood Project**

**Bakken Formation**

**Bakken-Three Forks A Pool (62A)**

**Birdtail, Manitoba**

October 8, 2014

Tundra Oil and Gas Partnership

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## **INTRODUCTION**

Birdtail Units No. 1 and No. 2, located in Township 16 Range 27 west of the prime meridian, first produced in September 1996 and January 1997, respectively (Figure 1). The main production targets in the units are the Middle Bakken and Three Forks A pools.

For the lands north of Birdtail Unit No. 1 and Birdtail Unit No. 2, potential exists for incremental production and reserves from a Waterflood EOR project in the Three Forks and Middle Bakken oil reservoirs. The following represents an application by Tundra Oil and Gas Partnership (Tundra) to establish Birdtail Unit No. 3 (W/2 of Section 29, Section 30, S/2 of Section 31-16-27W1 and Section 25-16-28W1) and implement a Secondary Waterflood EOR scheme within the Three Forks and Middle Bakken formations as outlined on Figure 2.

The proposed project area falls within the existing designated 15-62A Bakken-Three Forks A Pool of the Birdtail Oilfield (Figure 3).

## **SUMMARY**

1. The proposed Birdtail Unit No. 3 will include 1 vertical and 22 horizontal wells within 48 Legal Sub Divisions (LSD's) of the Middle Bakken/Three Forks producing reservoir. The project is located north of Birdtail Unit No. 2 (Figure 2).
2. Total Net Original Oil in Place (OOIP) in Birdtail Unit No. 3 (BTU3) which includes undrilled LSDs has been calculated to be 2,187 E<sup>3</sup>m<sup>3</sup> (13,755 MBBL) for an average of 45.6 net E<sup>3</sup>m<sup>3</sup> OOIP per 40 acre LSD.
3. Cumulative production to the end of June 2014 from the 22 productive wells within the proposed Birdtail Unit No. 3 project area was 70.2 E<sup>3</sup>m<sup>3</sup> of oil, and 57.9 E<sup>3</sup>m<sup>3</sup> of water, representing a 3.2% Recovery Factor (RF) of the OOIP.
4. Estimated Ultimate Recovery (EUR) of current wells with Primary Proved Producing oil reserves in the proposed Birdtail Unit No. 3 project area is estimated to be 155.0 E<sup>3</sup>m<sup>3</sup> (975 MBBL) with 84.8 E<sup>3</sup>m<sup>3</sup> (533 MBBL) remaining as of the end of June 2014.
5. Ultimate Recovery Factor for the proposed Birdtail Unit No. 3 OOIP, under the current Primary Production method, is forecasted to be 7.1%. The proposed unitization will also have 2 additional locations which are expected to recover 12.7 E<sup>3</sup>m<sup>3</sup> (80 MBBL) bringing the Primary Incremental Recovery Factor to 7.7%.
6. Figure 4 shows the production from Birdtail Unit No. 3 peaked in April 2012 at 79.7 m<sup>3</sup> of oil per day (OPD). As of June 2014, production was 40.3 m<sup>3</sup> OPD, 51.4 m<sup>3</sup> of water per day (WPD) and a 56.1% watercut.
7. In April 2012, production averaged 4.0 m<sup>3</sup> OPD per well in Birdtail Unit No. 3. As of June 2014, average per well production has declined to 1.9 m<sup>3</sup> OPD. Decline analysis of the group primary production data forecasts total oil to continue declining at an annual rate of approximately 25% in the project area.
8. Estimated Ultimate Recovery (EUR) of proved oil reserves under Secondary WF EOR for the proposed Birdtail Unit No. 3 has been calculated to be 335.5 E<sup>3</sup>m<sup>3</sup> (2110 MBBL) with 265.3 E<sup>3</sup>m<sup>3</sup> (1669 Mbbl) remaining. An incremental 167.8 E<sup>3</sup>m<sup>3</sup> (1055 MBBL) of proved oil reserves, or 7.7%, are forecasted to be recovered under the proposed Unitization and Secondary EOR production versus the existing Primary Production method.
9. Total RF under Secondary WF in the proposed Birdtail Unit No. 3 is estimated to be 15.4%. Primary accounts for 7.7% (includes 2 infill locations with a RF of 0.6%) and secondary for 7.7%.
10. Based on waterflood response in the analog in the Birdtail Units 1 & 2, the Three Forks and Middle Bakken Formations in the proposed project area are believed to be suitable reservoirs for WF EOR operations.
11. Tundra's first phase of development will require 2 new primary wells to be drilled to complete an effective 20 acres spacing. The results of this phase will dictate if the further infill drilling is required or a 40 acre development such as Birdtail Unit 1 and 2 are sufficient in maximizing the overall recovery from this new unit.
12. Future horizontal injectors, potentially left openhole or completed with multi-stage hydraulic fractures, will be drilled in the proposed Unit (Figure 5), to complete waterflood patterns with alternating horizontal producers, for an effective 40 acre spacing, similar to that of Birdtail Unit 2.

## **TECHNICAL DISCUSSION**

The proposed Birdtail Unit No. 3 project area is located within Township 16, Range 27 W1 of the Birdtail oil field. The proposed Birdtail Unit No. 3 currently consists of 1 vertical and 22 horizontal wells within an area covering the W/2 of Section 29, Section 30, S/2 of Section 31-16-27W1 and Section 25-16-28W1 (**Figure 2**). A project area well list complete with recent production statistics is attached as **Table 3**.

Tundra believes that the waterflood response in Birdtail Units No. 1 and 2 demonstrate potential for incremental production and reserves from a WF EOR project in the subject Middle Bakken and/or Three Forks oil reservoirs in the proposed Birdtail Unit No. 3.

### **Geology**

#### **Stratigraphy:**

The stratigraphy of the reservoir section in Birdtail Unit 3 is shown in cross-section A – A' (**Appendix 1: Birdtail Unit 3 NW-SE Stratigraphic Cross-Section**). The cross section runs from the northwest to the southeast through the proposed unit. The producing sequence from youngest to oldest is: the Upper Bakken Shale, the Middle Bakken fine grained sand/siltstone, the Lyleton 'B' siltstone, and the Lyleton 'C' silty shale. The sequence is unconformably overlain by the Mississippian Lodgepole formation and unconformably underlain by the Devonian Birdbear Formation.

Within the sequence, the Mississippian Middle Bakken unconformably overlies the Devonian Three Forks Group (the Lyleton). The main productive zone is considered to be the Middle Bakken Formation. There may be some remnant Lyleton 'B' reservoir that locally, directly underlies the Middle Bakken and contributes a marginal amount of oil to the system.

#### **Sedimentology:**

The Middle Bakken reservoir consists of fine to coarse grained siltstone to sandstone (often tan colored when oil stained). It can be divided into two units – the upper Middle Bakken and the lower Middle Bakken. The upper Middle Bakken is about 0.5 – 1m thick in the Birdtail Unit 3 area and is mainly considered non-reservoir. It is composed of heavily bioturbated grey siltstone with small brachiopod shells and the occasional crinoid and coral fragments. Pyrite nodules are common. The environmental interpretation of the upper Middle Bakken is an offshore transition/lower shoreface.

The lower Middle Bakken consists of finely laminated grey and tan colored siltstone and fine grained sandstone interbeds with occasional bioturbation. Where there is a higher sand content, bioturbation is rare. The environmental interpretation of the lower Middle Bakken is of a tidal bar and intertidal flat. This is the main reservoir unit of the Middle Bakken and ranges from 2 to 3 meters thick in Birdtail Unit 3 (**Appendix 2: Middle Bakken Net Hydrocarbon Pay Map**).

The upper Lyleton 'B' reservoir unit is at the top and is composed of ripple-cross laminated dolosiltstones increasingly interbedded with tight greenish/grey dolomitic shales with depth. The upper Lyleton 'B' is interpreted to have been deposited in a brackish bay type environment.

The mid to lower Lyleton 'B' and underlying Lyleton 'C' of the Three Forks Group are often called the 'Torquay' Formation. They are generally brick red, light green, and light brown and are mainly composed

of very fine dolomitic siltstones and shales and are considered non-reservoir. The lower Lyleton 'B' and 'C' are interpreted to have been deposited in a sabkha environment.

#### **Structure:**

**Appendix 3: Middle Bakken Subsea Structure Map**, shows the Top Middle Bakken Subsea Structure integrated with proprietary seismic. Locally in the unit, the structure rises towards the East – Northeast and drops to the West – Southwest. All of the Middle Bakken within Birdtail Unit 3 is above the local oil/water contact of -45.0 to -47.5m subsea.

#### **Reservoir Continuity:**

Cross-Section A – A' (**Appendix 1: Birdtail Unit 3 NW-SE Stratigraphic Cross-Section**) and existing production (**Table 3: Birdtail Unit 3 Current Well List**) indicate that there is likely very good lateral continuity in the basal Middle Bakken formation within Birdtail Unit 3. Vertical reservoir continuity within the Middle Bakken and the underlying Lyleton is likely very poor to non-existent due to the heterolithic depositional environment and the multiple thin shale interbeds.

#### **Reservoir Quality:**

Five (5) of the wells within the proposed unit have core analysis in the Middle Bakken formation and have been summarized below:

1. 100/04-29-016-27W1/0, Kmax.h: 7.14 mD.m
2. 100/04-30-016-27W1/0, Kmax.h: 122.93 mD.m
3. 100/09-30-016-27W1/0, Kmax.h: 3.50 mD.m
4. 100/05-31-016-27W1/0, Kmax.h: 10.80 mD.m
5. 100/15-25-016-28W1/0, Kmax.h: 148.51 mD.m

All of the 5 wells summarized above have Kmax.h values that would be acceptable to enhanced oil recovery. Their values indicate that the lower Middle Bakken has good reservoir in the area. As there are only 5 wells in the unit which have Kmax.h values, the values have been posted to the map but have not been contoured due to limited data points. (**Appendix 4: Middle Bakken Kmax.h Values Map**).

The good reservoir interpretation is also supported with the relatively high average porosity values seen in **Appendix 5: Middle Bakken Average Porosity Map** – where the limestone porosity values range from 16.6 to 21% throughout the proposed unit.

#### **Fluid Contacts:**

The oil/water contact locally is considered to be at -45.0 to -47.5m subsea and was mapped by integrating proprietary seismic and well control. The oil/water contact generally runs north south through the southwest quarter of Section 5-17-27W1 and then south through the eastern half of Sections 32 and 29-16-27W1. Please refer to **Appendix 3: Top Middle Bakken Subsea Structure Map**.

### **OOIP Estimates**

Original Oil in Place (OOIP) numbers were calculated by Tundra Geologist Kerri McNeil. Kerri holds a BSc in Geology from the University of Calgary and has 14 years of industry experience. Kerri has worked on properties all over Western Canada (W1M to W6M).

Each vertical well within the unit was petrophysically analyzed by Gille Montsion, incorporating existing conventional core analysis data. Gille comes with 20 years of experience as a Sr. Petrophysist with Canadian Hunter, ConocoPhillips, and Nexen. Gille does all his advanced petrophysics with Tundra's Geolog license and brings consistency to our evaluations.

The petrophysically defined net pay, phi.h, etc. values were then hand contoured in Geoscout by Kerri McNeil and OOIP was calculated on an LSD by LSD basis honoring the well values when present or the interpolated value by mapping if there was no vertical well in the LSD.

Total volumetric original oil-in-place (OOIP) for the Middle Bakken within the proposed Birdtail Unit No. 3 has been calculated to be 2,187 E<sup>3</sup>m<sup>3</sup> (13,755 MBBL) which includes undrilled LSDs. The OOIP was calculated LSD by LSD using the equation  $OOIP = [Ah \phi (1-S_{wi})/Boi]$ , where,

A = Reservoir Area (m<sup>2</sup>)

h = reservoir thickness (m)

phi = reservoir porosity

S<sub>wi</sub> = connate water saturation – assumed to be 0.48 in the area

Boi = Initial Formation Volume factor – assumed to be 1.003 in the area

Cut-offs for the Bakken applied were: porosity greater than or equal to 12% and a water saturation greater than 60%.

An analysis of Middle Bakken formation rock and fluid properties used to characterize the reservoir are provided in **Table 5**.

### **Historical Production**

A historical group production history plot for the proposed Birdtail Unit No. 3 is shown as **Figure 4**. Oil production commenced from the proposed Unit area in November 2009 and peaked during April 2012 at 79.7 m<sup>3</sup> OPD.

As of June 2014, production was 40.3 m<sup>3</sup> OPD, 51.4 m<sup>3</sup> WPD and a 56.1% watercut.

Oil production is currently declining at an annual rate of approximately **25%** under the current Primary Production method.

The field's production rate indicates the need for pressure restoration and maintenance, and waterflooding is deemed to be the most efficient means of re-introducing energy back into the reservoir system and to provide areal sweep between wells.

## **UNITIZATION**

Unitization and implementation of a Waterflood EOR project is forecasted to increase overall recovery of OOIP from the current development by **7.7%**. The basis for unitization is to develop the lands in an effective manner that will be conducive to waterflooding. Unitizing will enable the reservoir to have the greatest recovery possible by allowing the development of additional drilling and injector conversions over time, in order to maintain reservoir pressure and increase oil production.

### **Unit Name**

Tundra proposes that the official name of the new Unit covering the W/2 of Section 29, Section 30, S/2 31-16-27W1 and Section 25-16-28W1 shall be Birdtail Unit No. 3.

### **Unit Operator**

Tundra Oil and Gas Partnership (Tundra) will be the Operator of record for Birdtail Unit No. 3.

### **Unitized Zone**

The Unitized zone(s) to be waterflooded in the Birdtail Unit No. 3 will be the Middle Bakken and Three Forks formations.

### **Unit Wells**

The 1 vertical and 22 horizontal wells to be included in the proposed Birdtail Unit No. 3 are outlined in **Table 3**.

### **Unit Lands**

The Birdtail Unit No. 3 will consist of 48 LSD's as follows:

W/2 of Section 29, of Township 16, Range 27, W1M  
Section 30, of Township 16, Range 27, W1M  
S/2 of Section 31, of Township 16, Range 27, W1M  
Section 25, of Township 16, Range 28, W1M

The lands included in the 40 acre tracts are outlined in **Table 1**.

### **Tract Factors**

The proposed Birdtail Unit No. 3 will consist of 48 tracts based on the 40 acre LSD's containing the 1 vertical and 22 horizontal wells.



The Tract Factor contribution for each of the LSD's within the proposed Birdtail Unit No. 3 was calculated as follows:

- Gross OOIP by LSD, minus cumulative production to date for the LSD as distributed by the LSD specific Production Allocation (PA) % in the applicable producing horizontal or vertical well (to yield Remaining Gross OOIP)
- Tract Factor by LSD = the product of Remaining Gross OOIP by LSD as a % of total proposed Unit Remaining Gross OOIP

Unit tract factor calculations for all individual LSD's based on the above methodology are outlined within **Table 2**.

### **Working Interest Owners**

**Table 1** outlines the working interest (WI) for each individual tract within the proposed Birdtail Unit No. 3, and Tundra Oil and Gas Partnership holds a 100% WI ownership in all the proposed Tracts.

Tundra Oil and Gas Partnership will have a 100% WI in the proposed Birdtail Unit No. 3.

## **WATERFLOOD EOR DEVELOPMENT**

### **Technical Studies**

The waterflood performance predictions for the proposed Birdtail Unit No. 3 are based on the performance in Birdtail Units No. 1 and 2, documented annually in enhanced oil reports submitted to the Petroleum Branch.

Internal reviews included analysis of available open-hole logs; core data; petrophysics; seismic; drilling information; completion information; and production information. These parameters were reviewed to develop a suite of geological maps and establish reservoir parameters to support the calculation of the proposed Birdtail Unit No. 3 OOIP (Table 2).

Unitizing the proposed Birdtail Unit No. 3 will provide an equitable means of maximizing ultimate oil recovery in the project area, which is otherwise not currently achievable given the constraints on drilling full-length horizontals.

### **Reserves Recovery Profiles and Production Forecasts**

The primary waterflood performance predictions for the proposed Birdtail Unit No. 3 are based on oil production decline curve analysis, and the secondary predictions are based on internal engineering analysis performed by the Tundra reservoir engineering group.

#### **Primary Production Forecast**

Cumulative production in the Birdtail Unit No. 3 project area, to the end of June 2014, was 70.2 E<sup>3</sup>m<sup>3</sup> of oil, and 57.9 E<sup>3</sup>m<sup>3</sup> of water for a recovery factor 3.2% of the calculated Net OOIP.

The estimated Ultimate Recovery (EUR) of current wells with Primary Proved Producing oil reserves in the proposed Birdtail Unit No. 3 project area is estimated to be 155.0 E<sup>3</sup>m<sup>3</sup> (975 MBBL) with 84.8 E<sup>3</sup>m<sup>3</sup> (533 MBBL) remaining as of the end of June 2014.

Primary production plots of the expected production decline and forecasted oil rate v. time and rate v. cumulative oil production are shown in Figures 7 and 8, respectively.

#### **Pre-Production Schedule/Timing for Conversion of Horizontal Wells to Water Injection**

Upon receiving approval from the Petroleum Branch for unitization, Tundra is planning to drill an infill pilot with 2 horizontal wells at 20 acre spacing. Once the impact of infill drilling has been determined, Tundra will proceed with converting the existing producer to water injection. Depending on the result of the first phase of WF, a development plan to maximize oil recovery will proceed accordingly.

#### **Criteria for Conversion to Water Injection Well**

Tundra will monitor the following parameters to assess the best timing for each individual well to be converted from primary production to water injection service:

- Measured reservoir build-up pressures measured by shutting in production
- Fluid production rates, cumulative volumes, and any changes in decline rate over time
- Any observed production interference effects with adjacent wells
- Pattern mass balance and/or oil recovery factor estimates
- Reservoir pressure relative to bubble point pressure

The above schedule allows for the proposed Birdtail Unit No. 3 project to be developed equitably, efficiently, and moves the project to the best condition for the start of waterflood as quickly as possible. It also provides the Unit Operator flexibility to manage the reservoir conditions and response to help ensure maximum ultimate recovery of OOIP.

### **Secondary EOR Production Forecast**

The proposed project oil production profile under Secondary Waterflood has been developed based on the response observed to date in the Birdtail Units No. 1 & 2 WF (Figure 6).

Estimated Ultimate Recovery (EUR) of proved oil reserves under Secondary WF EOR for the proposed Birdtail Unit No. 3 has been calculated to be 335.5 E<sup>3</sup>m<sup>3</sup> (2110 MBBL) with 265.3 E<sup>3</sup>m<sup>3</sup> (1669 MBBL) remaining. An incremental 167.8 E<sup>3</sup>m<sup>3</sup> (1055 MBBL) of proved oil reserves, or 7.7%, are forecasted to be recovered under the proposed Unitization and Secondary EOR production versus the existing Primary Production method. Secondary Waterflood plots of the expected oil production forecast over time and the expected oil production v. cumulative oil are plotted in Figures 9 and 10, respectively.

### **Estimated Fracture Gradient**

Completion data from the producing wells within the project area indicate an actual fracture pressure gradient range of 18.0 to 21.0 kPa/m true vertical depth (TVD). Tundra expects the fracture gradient encountered during completion of the proposed horizontal injection well will be somewhat lower than these values due to expected reservoir pressure depletion.

## **WATERFLOOD OPERATING STRATEGY**

### **Water Source**

Injection water for the proposed Birdtail Unit No. 3 will be supplied from the Lodgepole source water well at 100/02-32-016-27W1. Lodgepole water from the 100/02-32 source well is pumped to the main Birdtail Unit Water Plant at 8-30-16-27W1, filtered, and pumped up to injection system pressure. A diagram of the Birdtail water injection system and new pipeline connection to the proposed Birdtail Unit No. 3 project area injection wells is shown as Figure 9.

Produced water is not currently used for any water injection in the Tundra operated Birdtail Units and there are no current plans to use produced water as a source supply for Birdtail Unit No. 3.

Currently all produced waters are inherently a mixture of Three Forks and Bakken native sources. This mixture of produced waters has been extensively tested for compatibility with 100/02-32 source Lodgepole water, by a highly qualified third party. All potential mixture ratios between the two waters, under a range of temperatures, have been simulated and evaluated for scaling and precipitate

producing tendencies. Testing of multiple scale inhibitors has also been conducted and minimum inhibition concentration requirements for the source water volume determined. At present, continuous scale inhibitor application is maintained into the source water stream out of the Birdtail injection water facility (Birdtail Units No. 1 & 2). Review and monitoring of the source water scale inhibition system is also part of an existing routine maintenance program.

### **Injection Wells**

As most of the existing wells in the proposed Unit area are completed as openhole, Tundra will be converting the existing producers into water injectors after infill impact and WF response time is validated by the first phase of WF development. The new future water injection conversion wells for the proposed Birdtail Unit No. 3 will be cleaned out, and configured downhole for injection as shown in Figure 11.

Any new water injection well will be placed on injection after the pre-production period and approval to inject. Wellhead injection pressures will be maintained below the least value of either:

1. The area specific known and calculated fracture gradient, or
2. The licensed surface injection Maximum Allowable Pressure (MOP)

Tundra has a thorough understanding of area fracture gradients. A management program will be utilized to set and routinely review injection target rates and pressures vs. surface MOP and the known area formation fracture pressures.

All new water injection wells will be surface equipped with injection volume metering and rate/pressure control (Figure 10). An operating procedure for monitoring water injection volumes and meter balancing will also be utilized to monitor the entire system measurement and integrity on a daily basis.

The proposed Birdtail Unit 3 horizontal water injection well rate is forecasted to average 10 – 25 m<sup>3</sup> WPD, based on expected reservoir permeability and pressure.

### **Reservoir Pressure**

The initial reservoir pressure for wells drilled in the Middle Bakken in the proposed Birdtail Unit No. 3 is shown in Figure 12. The estimated reservoir pressure for the proposed unit area is in the range of 3400 - 5000 kPa.

### **Reservoir Pressure Management during Waterflood**

Tundra expects to inject water for a minimum 2 – 4 year period to re-pressurize the reservoir due to cumulative primary production voidage and pressure depletion. Initial Voidage Replacement Ratio (VRR) is expected to be approximately 1.25 to 2.00 within the patterns during the fill up period. As the cumulative VRR approaches 1, target reservoir operating pressure for waterflood operations will be 75-90 % of original reservoir pressure.

### **Waterflood Surveillance and Optimization**

Birdtail Unit No. 3 EOR response and waterflood surveillance will consist of the following:

- Regular production well rate, WOR and WCT testing to monitor waterflood response, breakthrough or fingering
- Daily water injection rate and pressure monitoring v. target
- Evaluation of Hall plots to observe positive or negative skin indicating channeling or out of zone injection
- Gas measurement at individual wells to monitor changes to GOR with waterflood
- Water injection rate/pressure/time vs. cumulative injection plot
- Reservoir pressure surveys as required to establish pressure trends
- Instantaneous and cumulative VRR by pattern and in the overall Unit
- Potential use of chemical tracers to track water injector/producer responses
- Use of some or all: Water Oil Ratio (WOR) trends, Log WOR vs Cum Oil, Hydrocarbon Pore Volumes Injected, Conformance Plots

The above surveillance methods will provide an ever increasing understanding of reservoir performance, and provide data to continually control and optimize the Birdtail Unit No. 3 waterflood operation. Controlling the waterflood operation will significantly reduce or eliminate the potential for out-of-zone injection, undesired channeling or water breakthrough, or out-of-Unit migration. The monitoring and surveillance will also provide early indicators of any such issues so that waterflood operations may be altered to maximize ultimate secondary reserves recovery from the proposed Birdtail Unit No. 3.

### **Economic Limits**

Under the current Primary recovery method, existing wells within the proposed Birdtail Unit No. 3 will be deemed uneconomic when the net oil rate and net oil price revenue stream becomes less than the current producing operating costs. With any positive oil production response under the proposed Secondary recovery method, the economic limit will be significantly pushed out into the future. The actual economic cut off point will then again be a function of net oil price, the magnitude and duration of production rate response to the waterflood, and then current operating costs. Waterflood projects generally become uneconomic to operate when Water Oil Ratios (WOR's) exceed 100.

### **WATER INJECTION FACILITIES**

The Birdtail Unit No. 3 waterflood operation will utilize the Tundra operated well 100/02-32-016-274W1, sourced from the Lodgepole, and water plant (WP) facilities located at the Birdtail 8-30-16-27W1 battery (Figure 9).

A complete description of all planned system design and operational practices to prevent corrosion related failures is shown in Appendix 6. All surface facilities and wellheads will have cathodic protection to prevent corrosion. All injection flowlines will be made of fiberglass so corrosion will not be an issue. Injectors will have a packer set above the Middle Bakken and Three Forks formations, and the annulus between the tubing and casing will be filled with inhibited fluid. Refer to Appendix 6 for additional corrosion control details.

### **NOTIFICATION OF MINERAL AND SURFACE RIGHTS OWNERS**

Tundra is in the process of notifying all mineral rights and surface rights owners of this proposed EOR project and formation of Birdtail Unit No. 3. Copies of the Notices, and proof of service, to all surface rights owners will be forwarded to the Petroleum Branch, when available, to complete the Birdtail Unit No. 3 Application.

Birdtail Unit No. 3 Unitization, and execution of the formal Birdtail Unit No. 3 Agreement by affected Mineral Owners, is expected before the end of Q4 2014. Copies of same will be forwarded to the Petroleum Branch, when available, to complete the Birdtail Unit No. 3 Application.

Should the Petroleum Branch have further questions or require more information, please contact Anh Nguyen, P. Eng. at 403.513.1020 or by email at [anh.nguyen@tundraoilandgas.com](mailto:anh.nguyen@tundraoilandgas.com).

### **TUNDRA OIL & GAS PARTNERSHIP**

Original Signed by Anh Nguyen, P. Eng. October 8<sup>th</sup>, 2014

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**Proposed Birdtail Unit No. 3**  
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Figure No. 1

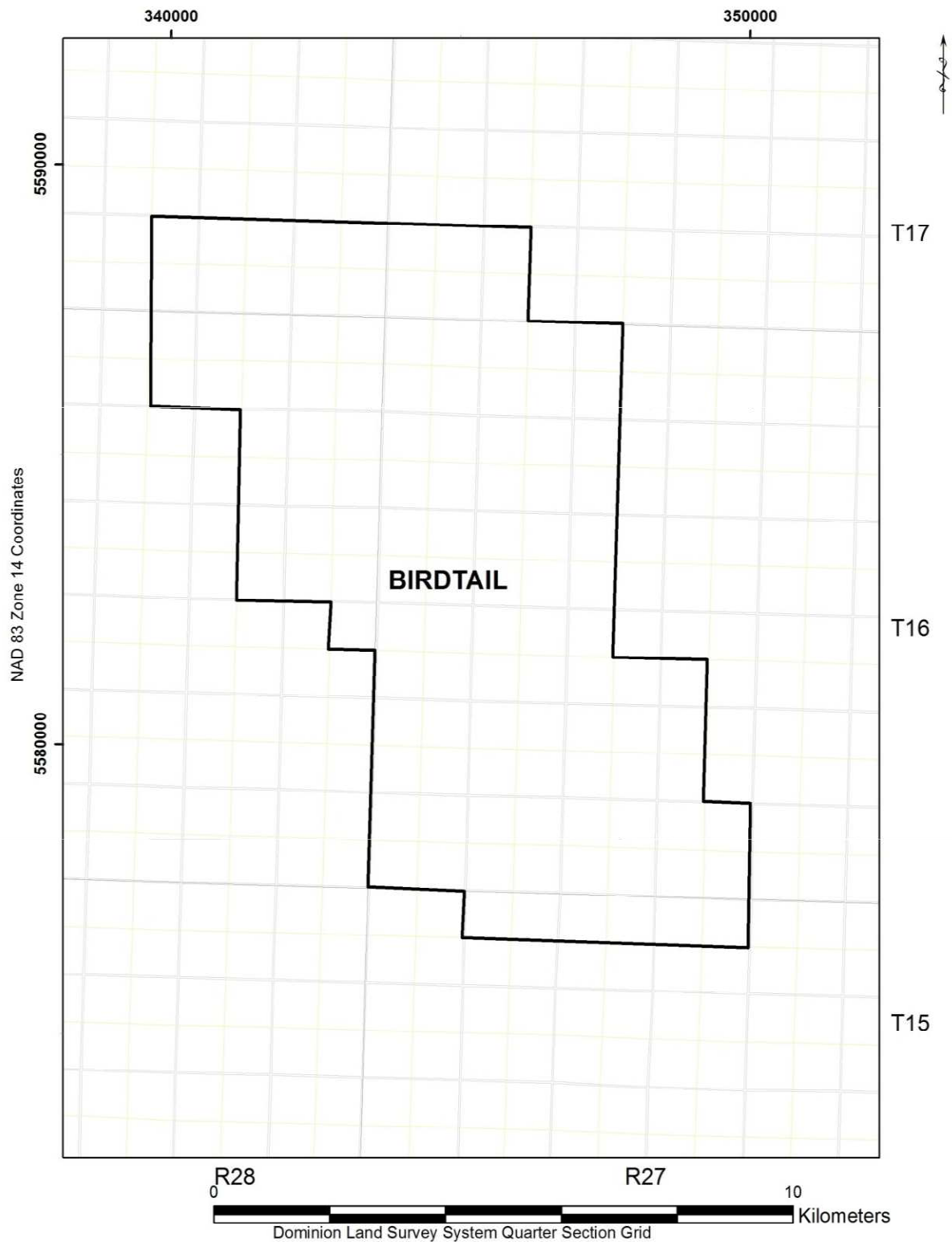


Figure 10 – Birdtail Field (15)

R28

R27W1

Figure No. 2

T17

T17

Proposed Birdtail  
Unit No. 3

Birdtail Unit No. 2

T16

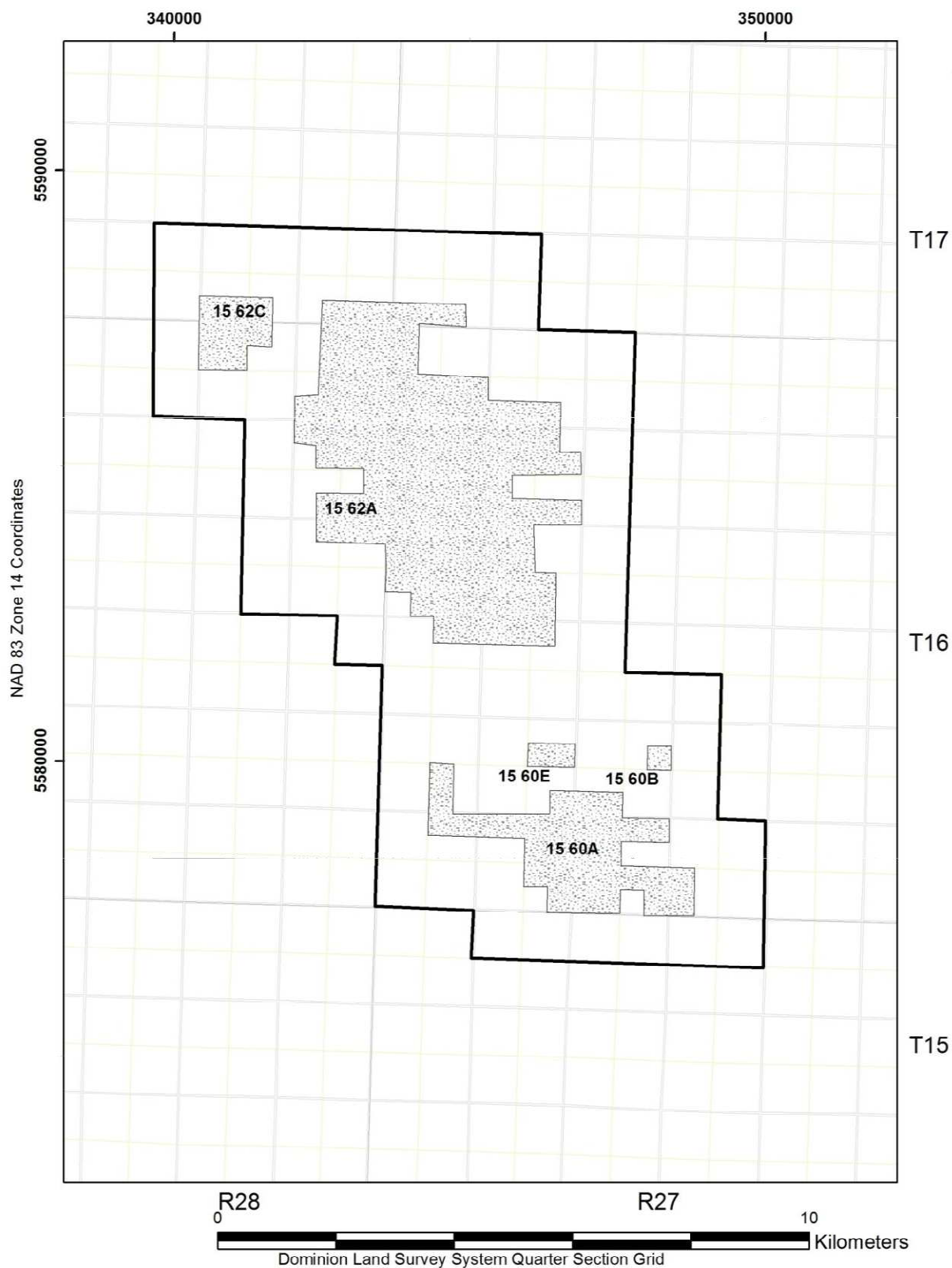
T16

Birdtail Unit No. 1

R28

R27W1

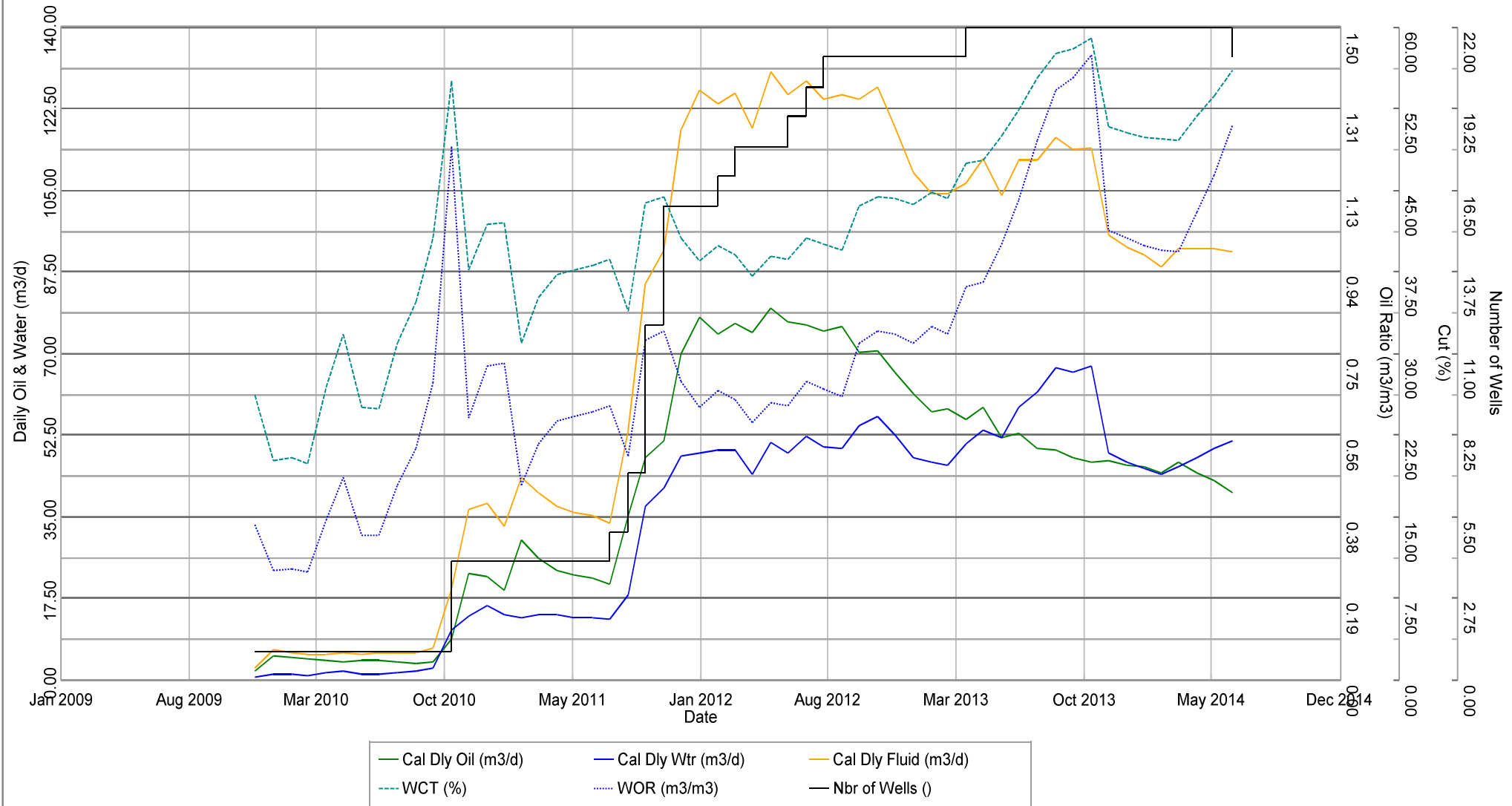
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**Figure 39 - Birdtail Bakken & Bakken-Three Forks Pools  
(15 60A – 15 60E & 15 62A - 15 62B)**

## Production Graph

# of Wells: 23

Fluid: Oil  
Mode: ProducingProd Zone: BAKKEN; THREEFK  
Field: BIRDTAIL (15)  
Pool Code: 62A  
Unit Code:On Prod: 2009-11 to 2014-06  
Cum Oil: 70224.5 m3  
Cum Gas: 0.0 E3m3  
Cum Wtr: 57891.1 m3

R28

R27W1

Figure 5

T17

T17

T16

T16

R28

R27W1

Infill Drills

Future primary locations

Phase 1 Injection Conversion

Phase 2 Injection Conversion

**WELL LEGEND**

## Bottom Hole Locations:

- |                    |                 |
|--------------------|-----------------|
| ○ Location         | ◇ Suspended     |
| ⊠ Service or Drain | ● Oil           |
| ⊞ Dry & Abandoned  | ◆ Abandoned Oil |
| ⊡ Injection        |                 |

## Surface Hole Locations:

- |              |
|--------------|
| — Horizontal |
|--------------|

**Tundra Oil & Gas****Proposed Birdtail Unit 3  
Winj Conversion Schedule**

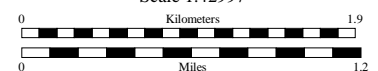
Created in AccuMap™  
Product of IHS  
Datum: NAD27  
Vol. 24 No. 08, Aug. 5 2014  
(403) 770-4646

Author: A. Nguyen  
Date: September 25, 2014  
File: 2013 Birdtail Unit 3 40 acre D  
Scale: 1 : 42997  
Projection: Stereographic  
Center: N50.40383 W101.16818

Grid Information:  
DLS: IHS Enhanced Grid  
NTS: Theoretical Grid  
FPS: Theoretical Grid  
US: IHS US Grid

DLS Version Information:  
AB: ATS 2.6  
BC: PRB 2.0  
SK: STS 2.5  
MB: ML107

Scale 1:42997



## Production Graph

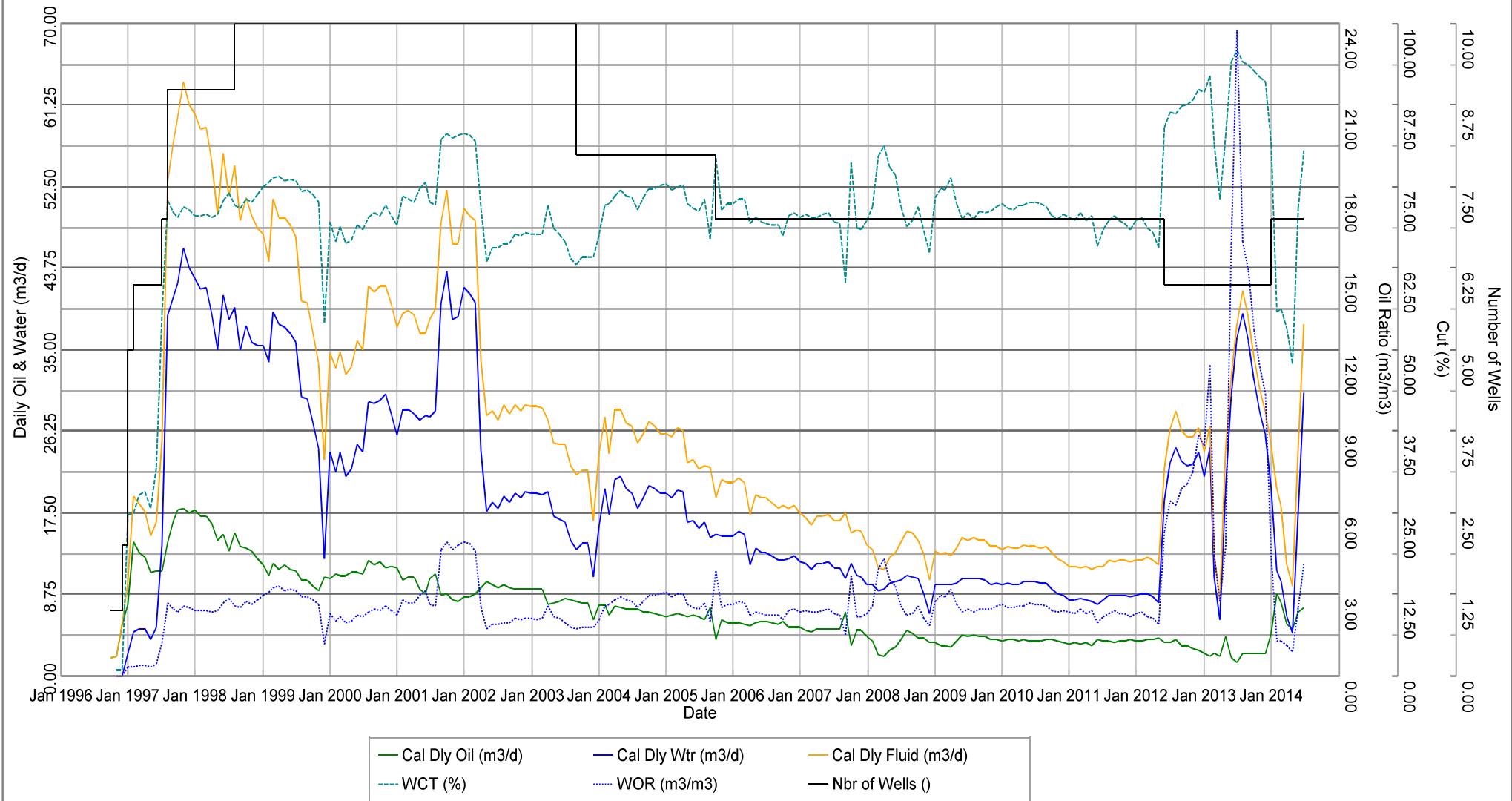
## Birdtail Unit No. 1 Production Profile

# of Wells: 11

Prod Zone: BAKKEN  
 Field: BIRDTAIL (15)  
 Pool Code: 60A  
 Unit Code: 156000

On Prod: 1996-09 to 2014-06  
 Cum Oil: 46708.7 m3  
 Cum Gas: 0.0 E3m3  
 Cum Wtr: 124349.0 m3

Fluid: Water Injection; Oil  
 Mode: Injection; Pumping; Abandoned; Producing



## Production Graph

## Birdtail Unit No. 2 Production Profile

# of Wells: 13

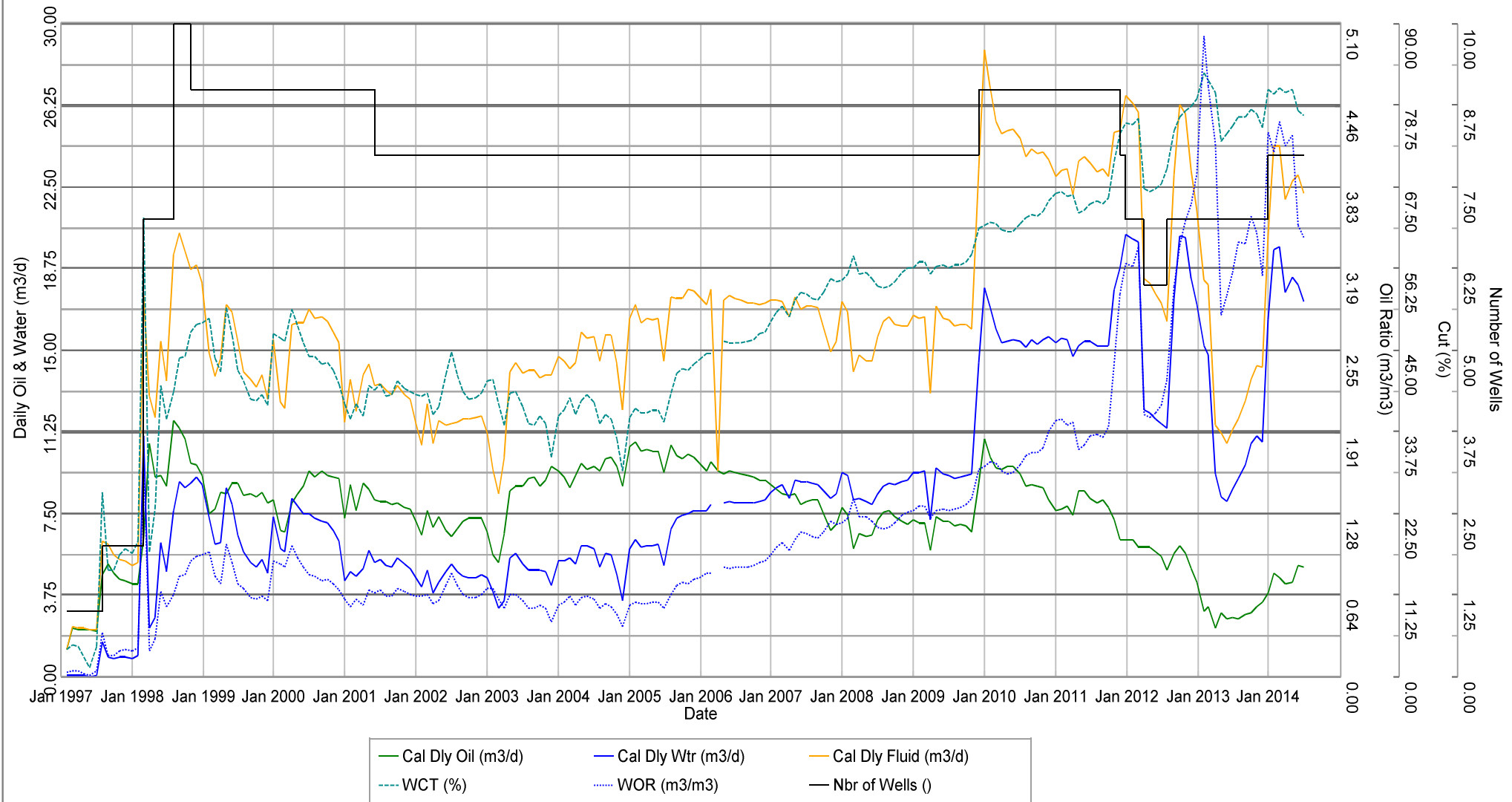
Fluid: Oil; Water Injection  
Mode: Abandoned; Producing; Pumping; InjectionProd Zone: BAKKEN; THREEFK  
Field: BIRDTAIL (15)  
Pool Code: 62A  
Unit Code:On Prod: 1997-01 to 2014-06  
Cum Oil: 48132.8 m3  
Cum Gas: 0.0 E3m3  
Cum Wtr: 54690.7 m3



Figure No. 7

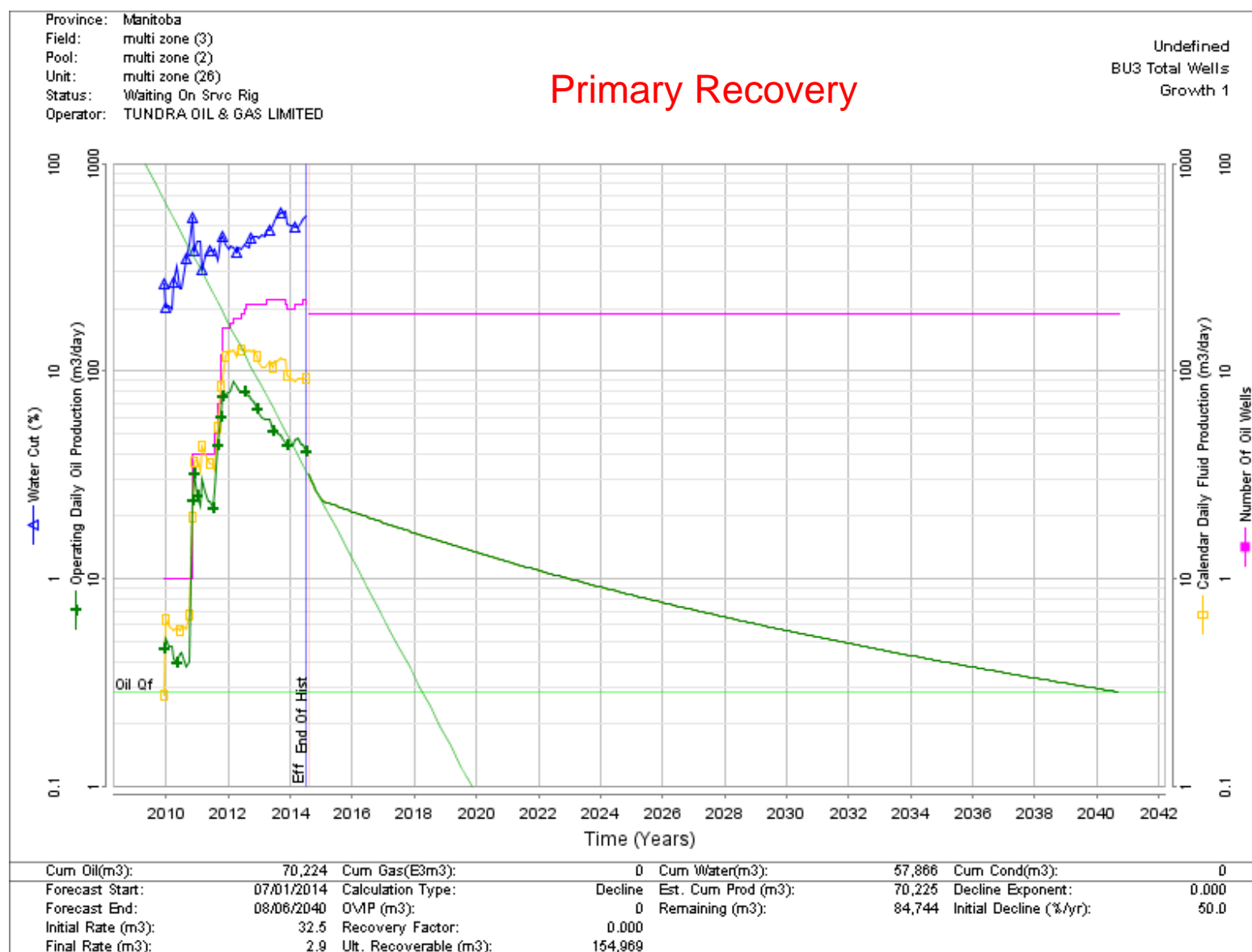


Figure No. 8

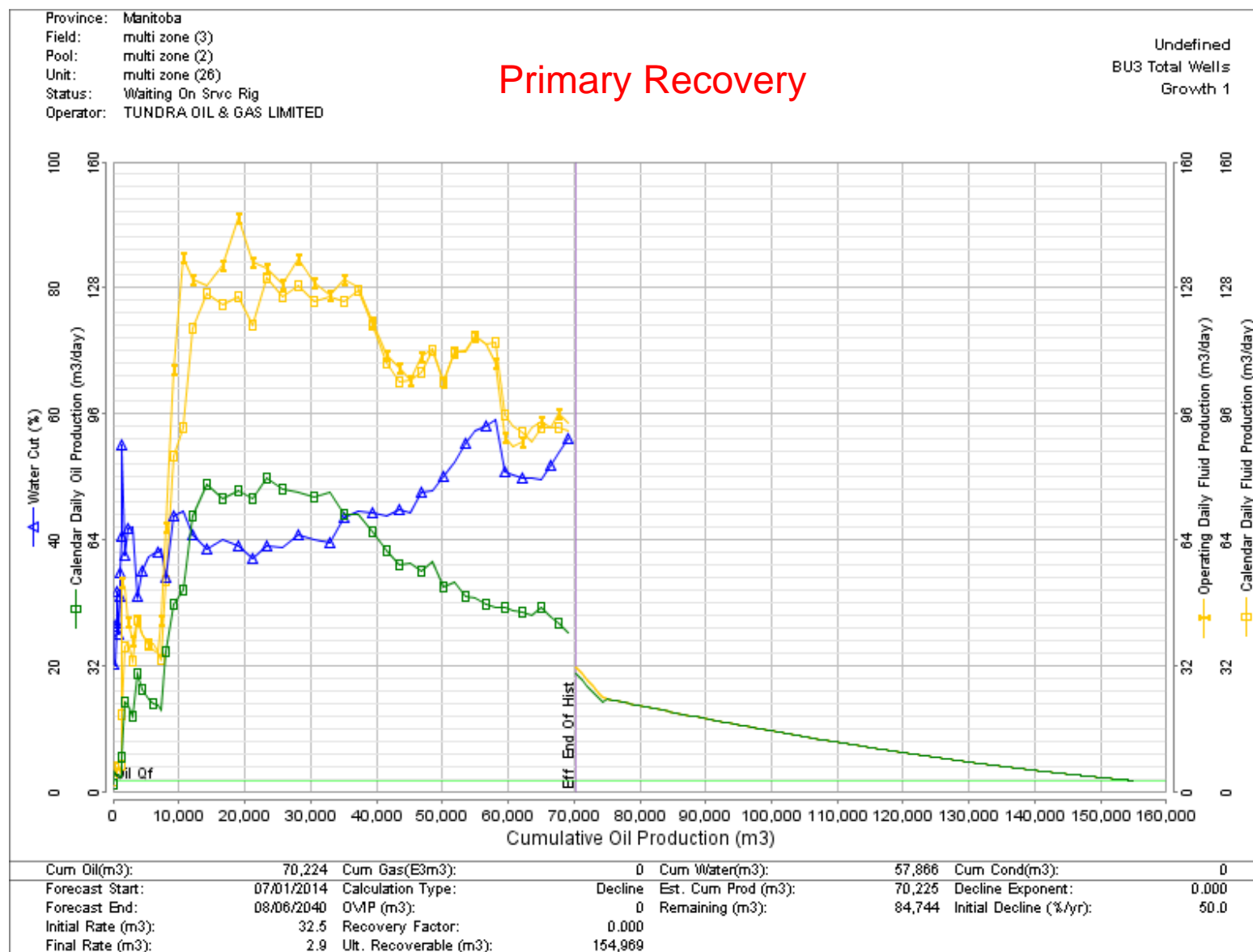


Figure No. 9

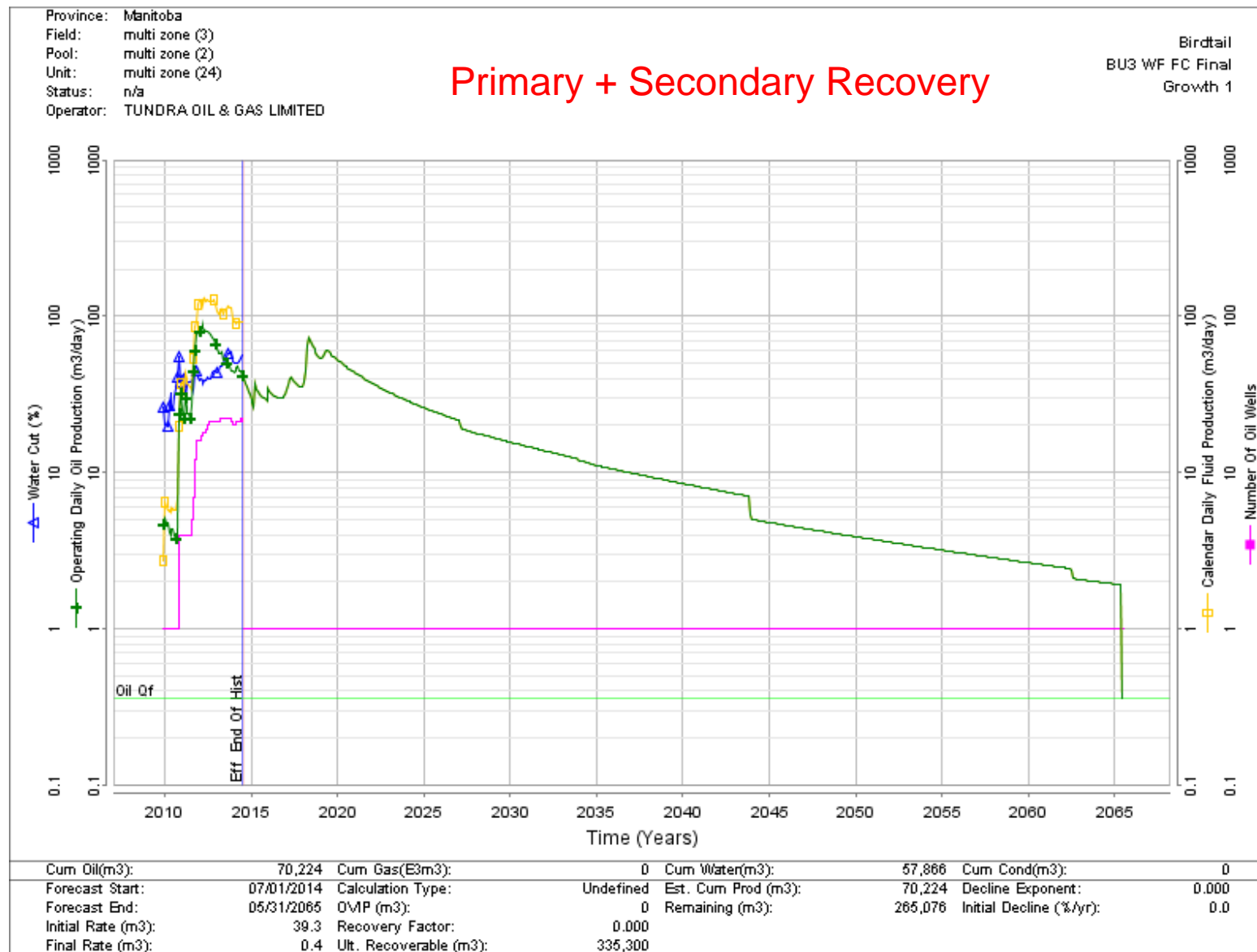
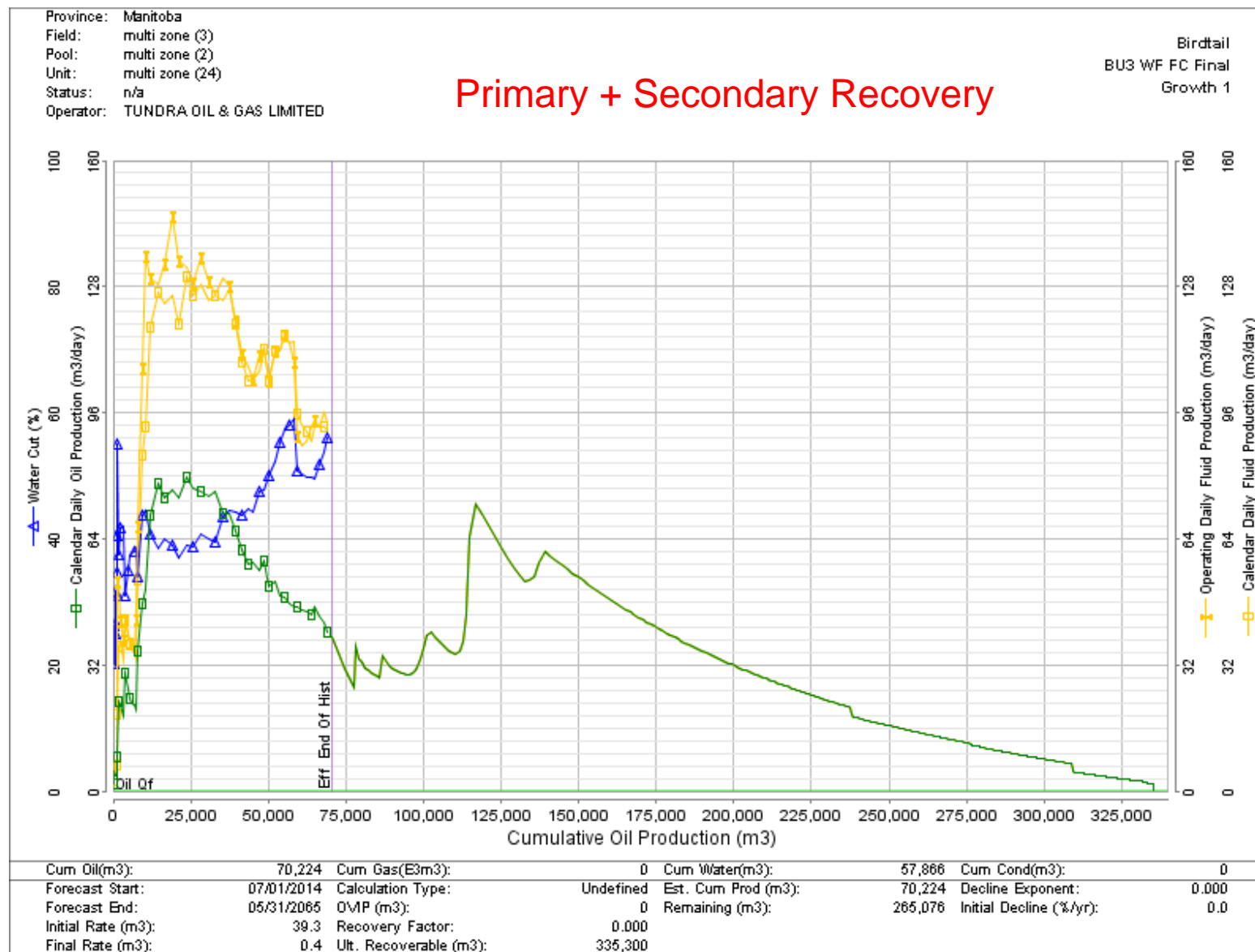


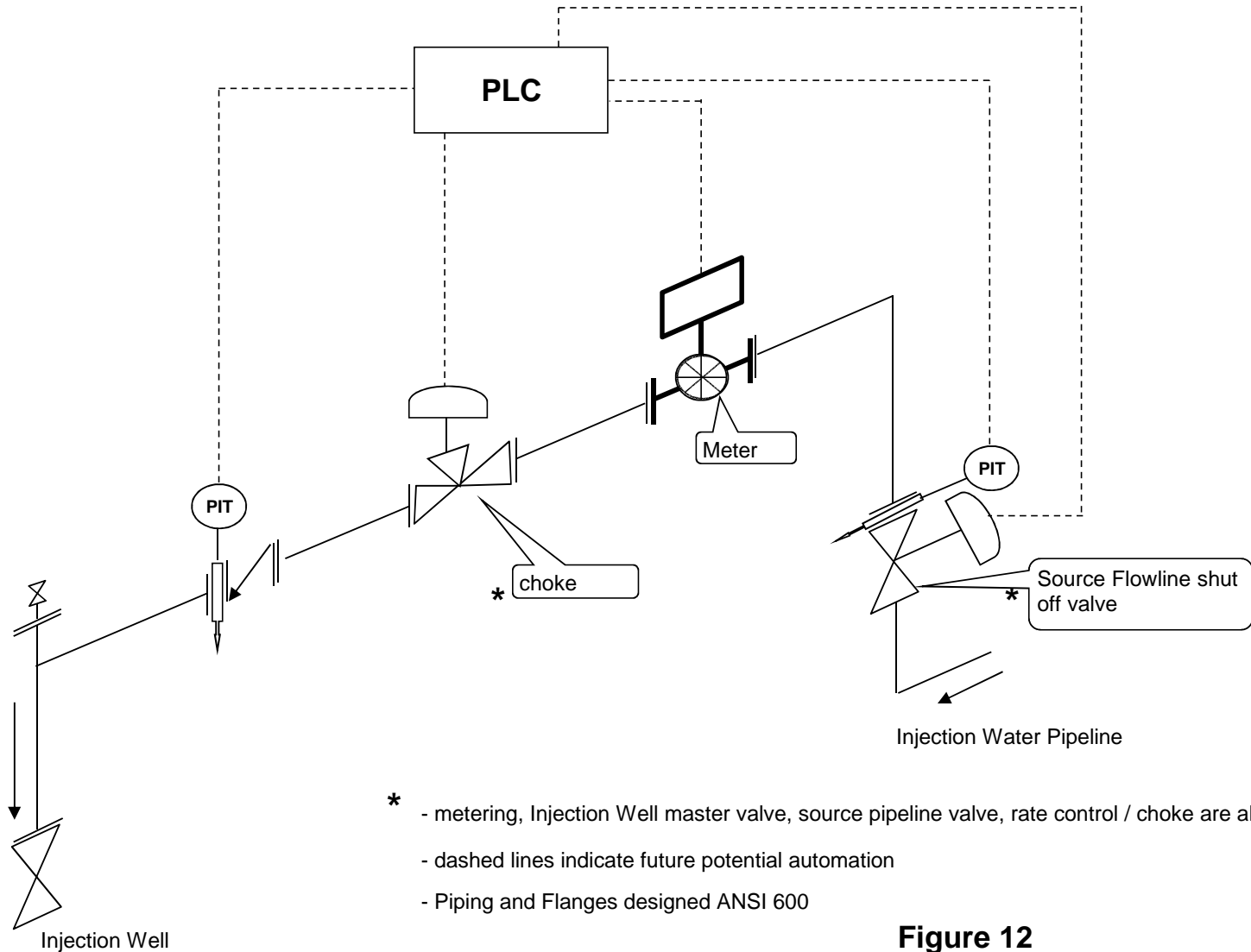
Figure No. 10





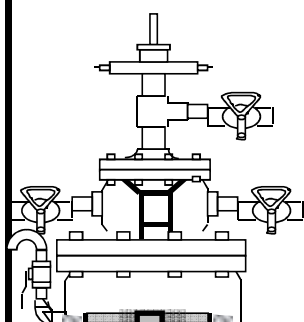
## Birdtail Unit No. 3

### Proposed Injection Well Surface Piping P&ID



**Figure 12**

<b>WELL NAME:</b>				<b>Tundra Birdtail Unit No. 3 HZNTL Open Hole WIW</b>				<b>WELL LICENCE:</b>				
Prepared by		WRJ (average depths)						Date:		2012		
<b>Elevations :</b>												
KB [m]				KB to THF [m]				TD [m]		2400.0		
GL [m]				CF (m)				PBSD [m]				
<b>Current Perfs:</b>		<b>Open Hole</b>				950.0		to		2400.0		
<b>Current Perfs:</b>								to				
<b>KOP:</b>		700 m MD		Total Interval				to				
<b>Tubulars</b>	<b>Size [mm]</b>	<b>Wt - Kg/m</b>	<b>Grade</b>	<b>Landing Depth [mKB]</b>								
Surface Casing	244.5	48.06	H-40 - ST&C	Surface	to	140.0						
Intermed Csg (if run)	177.8	34.23 & 29.76	J-55 - LT&C	Surface	to	950.0						
Open Hole Latera	none	none	none	950.0	to	2400.0						
Tubing	60.3 or 73.0 - TK-99	6.99 or 9.67	J-55	Surface	to	940.0						
<b>Date of Tubing Installation:</b>								<b>Length</b>		<b>Top @</b>		
<b>Item</b>	<b>Description</b>						<b>K.B.--Tbg. Fig.</b>		<b>0.00</b>		<b>m KB</b>	
	Corrosion Protected ENC Coated Packer (set within 15 m of Intermed Csg shoe)											
	60.3 mm or 73 mm TK-99 Internally Coated Tubing											
	TK-99 Internally Coated Tubing Pup Jt											
	Coated Split Dognut											
	Annular space above injection packer filled with inhibited fresh water											
	<b>Bottom of Tubing mKB</b>											
<b>Rod String :</b>												
<b>Date of Rod Installation:</b>												
<b>Bottomhole Pump:</b>												
<b>Directions:</b>												



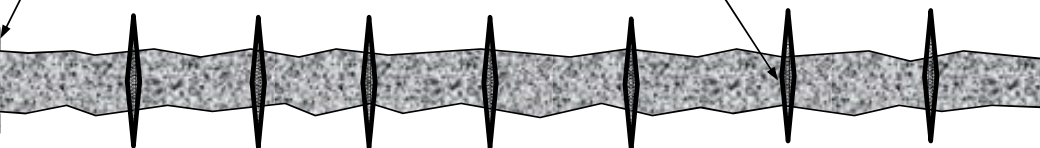
SC = 140mKB

KOP = ~ 700 mMD

### Inhibited Annular Fluid

Injection Packer set within 15 m of Intermediate Casing Shoe / Intermediate Casing Shoe

## Open Hole Fractures



R28

R27W1

T17

T17

T16

T16

R28

R27W1


## Proposed Birdtail Unit No. 3

WELL LEGEND	
Bottom Hole Locations:	
○ Location	◇ Suspended
⊗ Service or Drain	● Oil
◇ Dry & Abandoned	◆ Abandoned Oil
⌘ Injection	
Surface Hole Locations:	
— Horizontal	

WELL LISTS	
●	Birdtail Unit No. 3 Well List

## Tundra Oil and Gas

Figure 14  
BTU3 Initial Reservoir Press

 <small>Copyright © 1991-2014</small>	Created in AccuMap™ Product of IHS Datum: NAD27 Vol. 24 No. 08, Aug 5 2014 (403) 770-4646	Author: Anh Nguyen Date: September 26, 2014 File: Birdtail Unit No. 3 Initial Pr Scale: 1 : 37044 Projection: Stereographic Center: NS0 39681 W101.18837
	Grid Information: DLS: IHS Enhanced Grid NTS: Theoretical Grid FPS: Theoretical Grid US: IHS US Grid	DLS Version Information: AB: ATS 2.6 BC: PRB 2.0 SK: STS 2.5 MB: ML107

Scale 1:37044

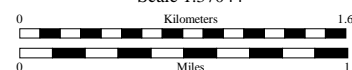




Table No. 1

**Proposed BIRDTAIL UNIT NO. 3**  
**Attached to and made part of an Agreement Entitled**  
**Birdtail Unit No. 3 - Unit Agreement**

Working Interest				Royalty Interest					
Tract No.	Land Description	Owner	Share %	Owner	Share %	Tract Participation	Crown	FH	Lessor Royalty %
1	Lsd. 3-29-16-27W1	Tundra Oil & Gas Partnership	100%	Manitoba Mineral Resources	100.000%	1.220913571%	Yes		CSR
2	Lsd. 4-29-16-27W1	Tundra Oil & Gas Partnership	100%	Manitoba Mineral Resources	100.000%	1.368086225%	Yes		CSR
3	Lsd. 5-29-16-27W1	Tundra Oil & Gas Partnership	100%	Manitoba Mineral Resources	100.000%	1.528368105%	Yes		CSR
4	Lsd. 6-29-16-27W1	Tundra Oil & Gas Partnership	100%	Manitoba Mineral Resources	100.000%	1.293234550%	Yes		CSR
5	Lsd. 11-29-16-27W1	Tundra Oil & Gas Partnership	100%	Manitoba Mineral Resources	100.000%	1.521193846%	Yes		CSR
6	Lsd. 12-29-16-27W1	Tundra Oil & Gas Partnership	100%	Manitoba Mineral Resources	100.000%	1.631715981%	Yes		CSR
7	Lsd. 13-29-16-27W1	Tundra Oil & Gas Partnership	100%	Manitoba Mineral Resources	100.000%	1.616211753%	Yes		CSR
8	Lsd. 14-29-16-27W1	Tundra Oil & Gas Partnership	100%	Manitoba Mineral Resources	100.000%	1.559940150%	Yes		CSR
9	Lsd. 1-30-16-27W1	Tundra Oil & Gas Partnership	100%	Computershare Trust Company of Canada	50.000%	2.247569254%		Yes	16.000000000
				1251521 Alberta Ltd.	50.000%			Yes	16.000000000
10	Lsd. 2-30-16-27W1	Tundra Oil & Gas Partnership	100%	Computershare Trust Company of Canada	50.000%	2.412262516%		Yes	16.000000000
				1251521 Alberta Ltd.	50.000%			Yes	16.000000000
11	Lsd. 3-30-16-27W1	Tundra Oil & Gas Partnership	100%	Computershare Trust Company of Canada	50.000%	2.434794447%		Yes	16.000000000
				1251521 Alberta Ltd.	50.000%			Yes	16.000000000
12	Lsd. 4-30-16-27W1	Tundra Oil & Gas Partnership	100%	Computershare Trust Company of Canada	50.000%	2.509516663%		Yes	16.000000000
				1251521 Alberta Ltd.	50.000%			Yes	16.000000000
13	Lsd. 5-30-16-27W1	Tundra Oil & Gas Partnership	100%	Computershare Trust Company of Canada	50.000%	2.520420169%		Yes	16.000000000
				1251521 Alberta Ltd.	50.000%			Yes	16.000000000
14	Lsd. 6-30-16-27W1	Tundra Oil & Gas Partnership	100%	Computershare Trust Company of Canada	50.000%	2.517606410%		Yes	16.000000000
				1251521 Alberta Ltd.	50.000%			Yes	16.000000000
15	Lsd. 7-30-16-27W1	Tundra Oil & Gas Partnership	100%	Computershare Trust Company of Canada	50.000%	2.496813623%		Yes	16.000000000
				1251521 Alberta Ltd.	50.000%			Yes	16.000000000
16	Lsd. 8-30-16-27W1	Tundra Oil & Gas Partnership	100%	Computershare Trust Company of Canada	50.000%	2.333663511%		Yes	16.000000000
				1251521 Alberta Ltd.	50.000%			Yes	16.000000000
17	Lsd. 9-30-16-27W1	Tundra Oil & Gas Partnership	100%	5991022 Manitoba Ltd.	100.000%	2.379155253%		Yes	15.000000000
18	Lsd. 10-30-16-27W1	Tundra Oil & Gas Partnership	100%	5991022 Manitoba Ltd.	100.000%	2.570719467%		Yes	15.000000000
19	Lsd. 11-30-16-27W1	Tundra Oil & Gas Partnership	100%	5991022 Manitoba Ltd.	100.000%	2.577980582%		Yes	15.000000000
20	Lsd. 12-30-16-27W1	Tundra Oil & Gas Partnership	100%	5991022 Manitoba Ltd.	100.000%	2.559372662%		Yes	15.000000000
21	Lsd. 13-30-16-27W1	Tundra Oil & Gas Partnership	100%	5991022 Manitoba Ltd.	100.000%	2.469009426%		Yes	15.000000000
22	Lsd. 14-30-16-27W1	Tundra Oil & Gas Partnership	100%	5991022 Manitoba Ltd.	100.000%	2.474286089%		Yes	15.000000000
23	Lsd. 15-30-16-27W1	Tundra Oil & Gas Partnership	100%	5991022 Manitoba Ltd.	100.000%	2.534156537%		Yes	15.000000000
24	Lsd. 16-30-16-27W1	Tundra Oil & Gas Partnership	100%	5991022 Manitoba Ltd.	100.000%	2.525790971%		Yes	15.000000000
25	Lsd. 1-31-16-27W1	Tundra Oil & Gas Partnership	100%	Rural Municipality of Birtle	100.000%	2.169556051%		Yes	15.000000000
26	Lsd. 2-31-16-27W1	Tundra Oil & Gas Partnership	100%	Rural Municipality of Birtle	100.000%	2.169911218%		Yes	15.000000000
27	Lsd. 3-31-16-27W1	Tundra Oil & Gas Partnership	100%	Rural Municipality of Birtle	100.000%	1.978876191%		Yes	15.000000000
28	Lsd. 4-31-16-27W1	Tundra Oil & Gas Partnership	100%	Rural Municipality of Birtle	100.000%	1.839912243%		Yes	15.000000000
29	Lsd. 5-31-16-27W1	Tundra Oil & Gas Partnership	100%	Rural Municipality of Birtle	100.000%	1.475461343%		Yes	15.000000000

Working Interest				Royalty Interest					
Tract No.	Land Description	Owner	Share %	Owner	Share %	Tract Participation	Crown	FH	Lessor Royalty %
30	Lsd. 6-31-16-27W1	Tundra Oil & Gas Partnership	100%	Rural Municipality of Birtle	100.000%	1.934421331%		Yes	15.000000000
31	Lsd. 7-31-16-27W1	Tundra Oil & Gas Partnership	100%	Rural Municipality of Birtle	100.000%	2.085958992%		Yes	15.000000000
32	Lsd. 8-31-16-27W1	Tundra Oil & Gas Partnership	100%	Rural Municipality of Birtle	100.000%	2.131877561%		Yes	15.000000000
33	Lsd. 1-25-16-28W1	Tundra Oil & Gas Partnership	100%	6272313 Manitoba Ltd.	100.000%	2.184422215%		Yes	16.000000000
34	Lsd. 2-25-16-28W1	Tundra Oil & Gas Partnership	100%	1251521 Alberta Ltd.	100.000%	2.173306844%		Yes	16.000000000
35	Lsd. 3-25-16-28W1	Tundra Oil & Gas Partnership	100%	6535527 Manitoba Ltd.	100.000%	2.158905080%		Yes	16.000000000
36	Lsd. 4-25-16-28W1	Tundra Oil & Gas Partnership	100%	6535527 Manitoba Ltd.	100.000%	2.112349448%		Yes	16.000000000
37	Lsd. 5-25-16-28W1	Tundra Oil & Gas Partnership	100%	6535527 Manitoba Ltd.	100.000%	1.904581792%		Yes	16.000000000
38	Lsd. 6-25-16-28W1	Tundra Oil & Gas Partnership	100%	6535527 Manitoba Ltd.	100.000%	2.102111217%		Yes	16.000000000
39	Lsd. 7-25-16-28W1	Tundra Oil & Gas Partnership	100%	1251521 Alberta Ltd.	100.000%	2.138325534%		Yes	16.000000000
40	Lsd. 8-25-16-28W1	Tundra Oil & Gas Partnership	100%	6272313 Manitoba Ltd.	100.000%	2.207024197%		Yes	16.000000000
41	Lsd.9-25-16-28W1	Tundra Oil & Gas Partnership	100%	Armand J. Fouillard	23.86875%	2.220904017%		Yes	16.000000000
				Omer J. Fouillard	23.86875%			Yes	16.000000000
				Brian M. Campbell	23.86875%			Yes	16.000000000
				Clint L. Johnston	23.86875%			Yes	16.000000000
				Manitoba Mineral Resources	4.525%		Yes		CSR
42	Lsd. 10-25-16-28W1	Tundra Oil & Gas Partnership	100%	Armand J. Fouillard	25.00000%	2.093019980%		Yes	16.000000000
				Omer J. Fouillard	25.00000%			Yes	16.000000000
				Brian M. Campbell	25.00000%			Yes	16.000000000
				Clint L. Johnston	25.00000%			Yes	16.000000000
43	Lsd. 11-25-16-28W1	Tundra Oil & Gas Partnership	100%	Georgette S. Dupont	100.000%	1.899620713%		Yes	16.000000000
44	Lsd. 12-25-16-28W1	Tundra Oil & Gas Partnership	100%	Georgette S. Dupont	100.000%	1.757781010%		Yes	16.000000000
45	Lsd. 13-25-16-28W1	Tundra Oil & Gas Partnership	100%	Georgette S. Dupont	100.000%	1.733198788%		Yes	16.000000000
46	Lsd. 14-25-16-28W1	Tundra Oil & Gas Partnership	100%	Georgette S. Dupont	100.000%	1.870708385%		Yes	16.000000000
47	Lsd. 15-25-16-28W1	Tundra Oil & Gas Partnership	100%	Armand J. Fouillard	25.00000%	2.143370265%		Yes	16.000000000
				Omer J. Fouillard	25.00000%			Yes	16.000000000
				Brian M. Campbell	25.00000%			Yes	16.000000000
				Clint L. Johnston	25.00000%			Yes	16.000000000
48	Lsd. 16-25-16-28W1	Tundra Oil & Gas Partnership	100%	Armand J. Fouillard	22.87500%	2.211613824%		Yes	16.000000000
				Omer J. Fouillard	22.87500%			Yes	16.000000000
				Brian M. Campbell	22.87500%			Yes	16.000000000
				Clint L. Johnston	22.87500%			Yes	16.000000000
				Manitoba Mineral Resources	8.500%		Yes		CSR

**100.000000000%**

Table No. 2

**Birdtail Unit No. 3**  
**TRACT FACTORS BASED ON OIL-IN-PLACE (OOIP) MINUS CUM OIL PRODUCTION**  
Determination of Working Interests in Proposed Unit

TRACT NO.	LSD-SEC	TWP-RGE	UWI	OOIP (m3)	Hz Cum Prodn June 2014 (m3)	Vertical Cum Prodn June 2014 (m3)	OOIP Minus Cum Oil Prodn (m3)	Tract Factor (%)
1	03-29	016-27W1	03-29-016-27W1	26,130	286.6	0.0	25,843	1.220913571
2	04-29	016-27W1	04-29-016-27W1	29,862	904.1	0.0	28,958	1.368086225
3	05-29	016-27W1	05-29-016-27W1	32,351	0.0	0.0	32,351	1.528368105
4	06-29	016-27W1	06-29-016-27W1	27,374	0.0	0.0	27,374	1.293234550
5	11-29	016-27W1	11-29-016-27W1	32,351	151.9	0.0	32,199	1.521193846
6	12-29	016-27W1	12-29-016-27W1	34,839	301.0	0.0	34,539	1.631715981
7	13-29	016-27W1	13-29-016-27W1	37,328	3,117.7	0.0	34,210	1.616211753
8	14-29	016-27W1	14-29-016-27W1	36,084	3,064.5	0.0	33,019	1.559940150
9	01-30	016-27W1	01-30-016-27W1	48,775	1,201.0	0.0	47,574	2.247569254
10	02-30	016-27W1	02-30-016-27W1	52,259	1,198.9	0.0	51,060	2.412262516
11	03-30	016-27W1	03-30-016-27W1	54,001	2,463.9	0.0	51,537	2.434794447
12	04-30	016-27W1	04-30-016-27W1	55,743	2,624.3	0.0	53,119	2.509516663
13	05-30	016-27W1	05-30-016-27W1	55,743	2,393.5	0.0	53,350	2.520420169
14	06-30	016-27W1	06-30-016-27W1	55,743	2,453.0	0.0	53,290	2.517606410
15	07-30	016-27W1	07-30-016-27W1	54,001	1,151.2	0.0	52,850	2.496813623
16	08-30	016-27W1	08-30-016-27W1	50,517	1,120.6	0.0	49,397	2.333663511
17	09-30	016-27W1	09-30-016-27W1	55,743	1,308.4	4,075.2	50,360	2.379155253
18	10-30	016-27W1	10-30-016-27W1	55,743	1,328.8	0.0	54,414	2.570719467
19	11-30	016-27W1	11-30-016-27W1	55,743	1,175.1	0.0	54,568	2.577980582
20	12-30	016-27W1	12-30-016-27W1	55,743	1,569.0	0.0	54,174	2.559372662
21	13-30	016-27W1	13-30-016-27W1	55,743	3,481.7	0.0	52,261	2.469009426
22	14-30	016-27W1	14-30-016-27W1	55,743	3,370.0	0.0	52,373	2.474286089
23	15-30	016-27W1	15-30-016-27W1	55,743	2,102.7	0.0	53,640	2.534156537
24	16-30	016-27W1	16-30-016-27W1	55,743	2,279.8	0.0	53,463	2.525790971
25	01-31	016-27W1	01-31-016-27W1	47,780	1,856.9	0.0	45,923	2.169556051
26	02-31	016-27W1	02-31-016-27W1	47,780	1,849.4	0.0	45,930	2.169911218
27	03-31	016-27W1	03-31-016-27W1	46,287	4,399.9	0.0	41,887	1.978876191
28	04-31	016-27W1	04-31-016-27W1	43,300	4,355.1	0.0	38,945	1.839912243
29	05-31	016-27W1	05-31-016-27W1	32,434	1,202.8	0.0	31,231	1.475461343
30	06-31	016-27W1	06-31-016-27W1	42,305	1,359.2	0.0	40,946	1.934421331

TRACT NO.	LSD-SEC	TWP-RGE	UWI	OOIP (m3)	Hz Cum Prodn June 2014 (m3)	Vertical Cum Prodn June 2014 (m3)	OOIP Minus Cum Oil Prodn (m3)	Tract Factor (%)
31	07-31	016-27W1	07-31-016-27W1	45,125	972.0	0.0	44,153	2.085958992
32	08-31	016-27W1	08-31-016-27W1	45,125	0.0	0.0	45,125	2.131877561
33	01-25	016-28W1	01-25-016-28W1	47,780	1,542.2	0.0	46,238	2.184422215
34	02-25	016-28W1	02-25-016-28W1	47,780	1,777.5	0.0	46,002	2.173306844
35	03-25	016-28W1	03-25-016-28W1	46,287	589.2	0.0	45,698	2.158905080
36	04-25	016-28W1	04-25-016-28W1	44,794	81.5	0.0	44,712	2.112349448
37	05-25	016-28W1	05-25-016-28W1	40,314	0.0	0.0	40,314	1.904581792
38	06-25	016-28W1	06-25-016-28W1	44,794	298.3	0.0	44,495	2.102111217
39	07-25	016-28W1	07-25-016-28W1	46,287	1,024.8	0.0	45,262	2.138325534
40	08-25	016-28W1	08-25-016-28W1	47,780	1,063.8	0.0	46,716	2.207024197
41	09-25	016-28W1	09-25-016-28W1	47,780	770.0	0.0	47,010	2.220904017
42	10-25	016-28W1	10-25-016-28W1	44,794	490.7	0.0	44,303	2.093019980
43	11-25	016-28W1	11-25-016-28W1	40,314	105.0	0.0	40,209	1.899620713
44	12-25	016-28W1	12-25-016-28W1	37,328	121.1	0.0	37,207	1.757781010
45	13-25	016-28W1	13-25-016-28W1	37,328	641.4	0.0	36,687	1.733198788
46	14-25	016-28W1	14-25-016-28W1	40,314	717.0	0.0	39,597	1.870708385
47	15-25	016-28W1	15-25-016-28W1	46,287	918.1	0.0	45,369	2.143370265
48	16-25	016-28W1	16-25-016-28W1	47,780	966.7	0.0	46,813	2.211613824
				<b>2,186,924</b>	<b>66,150.2</b>	<b>4,075.2</b>	<b>2,116,699</b>	<b>100.000000000</b>

	License		Pool	Producing		On Prod		Cal Dly	Monthly	Cum Prd	Cal Dly	Monthly	Cum Prd		
UWI	Number	Type	Name	Zone	Mode	Date	Prod Date	Oil (m3/d)	Oil (m3)	Oil (m3)	Water (m3/d)	Water (m3)	Water (m3)	WCT (%)	
100/03-29-016-27W1/0	008026	Horizontal	BAKKEN-THREE FORKS A	BAKKEN	Producing	9/1/2011	Jun-2014	0.9	25.7	1190.7	1.4	42.1	1263.7	62.09	
100/11-29-016-27W1/0	008102	Horizontal	BAKKEN-THREE FORKS A	BAKKEN	Producing	9/1/2011	Jun-2014	1.3	39.4	982.8	5.6	167.0	7202.8	80.91	
100/14-29-016-27W1/0	007597	Horizontal	BAKKEN-THREE FORKS A	BAKKEN	Producing	10/1/2010	Jun-2014	3.7	111.1	6182.2	2.9	86.3	6098.7	43.72	
100/02-30-016-27W1/0	007598	Horizontal	BAKKEN-THREE FORKS A	BAKKEN	Producing	10/1/2010	Jun-2014	1.2	36.4	2399.9	1.2	37.4	2195.0	50.68	
102/04-30-016-27W1/0	008488	Horizontal	BAKKEN-THREE FORKS A	BAKKEN	Producing	1/1/2012	Jun-2014	2.5	75.7	5088.2	0.5	16.1	1142.6	17.54	
100/06-30-016-27W1/0	008134	Horizontal	BAKKEN-THREE FORKS A	BAKKEN	Producing	9/1/2011	Jun-2014	2.9	86.2	4846.5	2.7	80.6	3209.9	48.32	
100/07-30-016-27W1/0	008096	Horizontal	BAKKEN-THREE FORKS A	BAKKEN	Producing	9/1/2011	Jun-2014	1.4	43.2	2271.8	6.6	199.0	7319.0	82.16	
100/09-30-016-27W1/0	007087	Vertical	BAKKEN-THREE FORKS A	BAKKEN	Producing	11/1/2009	Jun-2014	1.0	29.9	4075.2	1.0	30.9	3453.4	50.82	
100/11-30-016-27W1/0	008103	Horizontal	BAKKEN-THREE FORKS A	BAKKEN	Producing	8/1/2011	May-2014	0.0	0.2	2447.1	0.9	28.9	1432.5	99.31	
100/14-30-016-27W1/0	008170	Horizontal	BAKKEN-THREE FORKS A	BAKKEN	Producing	10/1/2011	Jun-2014	5.2	154.8	6851.5	1.5	44.8	1223.7	22.44	
100/16-30-016-27W1/0	008108	Horizontal	BAKKEN-THREE FORKS A	BAKKEN	Producing	10/1/2011	Jun-2014	3.3	100.0	4382.5	2.6	79.3	2191.0	44.23	
100/02-31-016-27W1/0	007953	Horizontal	BAKKEN-THREE FORKS A	BAKKEN	Producing	7/1/2011	Jun-2014	2.3	68.2	3758.9	0.7	21.3	1010.5	23.80	
100/03-31-016-27W1/0	007599	Horizontal	BAKKEN-THREE FORKS A	BAKKEN	Producing	10/1/2010	Jun-2014	3.5	105.6	8701.5	2.1	62.9	2349.9	37.33	
100/07-31-016-27W1/0	008089	Horizontal	BAKKEN-THREE FORKS A	BAKKEN	Producing	10/1/2011	Jun-2014	2.2	64.8	3534.0	1.8	53.8	1716.3	45.36	
100/03-25-016-28W1/2	008114	Horizontal	BAKKEN-THREE FORKS A	BAKKEN	Producing	8/1/2011	Jun-2014	2.5	73.9	3722.7	1.9	58.1	2818.3	44.02	
100/04-25-016-28W1/0	009305	Horizontal	BAKKEN-THREE FORKS A	THREEFK,BAKKEN	Producing	3/1/2013	Jun-2014	0.5	14.0	267.8	2.9	86.0	1586.7	86.00	
100/06-25-016-28W1/0	008629	Horizontal	BAKKEN-THREE FORKS A	BAKKEN,THREEFK	Producing	5/1/2012	Jun-2014	2.2	65.8	2386.9	3.0	89.3	3283.8	57.58	
100/09-25-016-28W1/0	008153	Horizontal	BAKKEN-THREE FORKS A	BAKKEN	Producing	10/1/2011	Jun-2014	1.1	32.4	2749.0	2.0	59.5	1856.0	64.74	
102/09-25-016-28W1/0	008735	Horizontal	BAKKEN-THREE FORKS A	BAKKEN	Producing	6/1/2012	Jun-2014	1.0	29.9	915.9	1.3	38.7	1236.8	56.41	
100/12-25-016-28W1/0	008674	Horizontal	BAKKEN-THREE FORKS A	BAKKEN,THREEFK	Producing	7/1/2012	Jun-2014	0.3	9.8	226.1	0.9	26.6	890.7	73.08	
100/13-25-016-28W1/2	008481	Horizontal	BAKKEN-THREE FORKS A	BAKKEN,THREEFK	Producing	2/1/2012	Jun-2014	0.0	0.3	1398.8	8.0	241.4	3336.5	99.88	
102/14-25-016-28W1/3	008481	Horizontal	BAKKEN-THREE FORKS A	BAKKEN	Producing	N/A									
100/16-25-016-28W1/0	008145	Horizontal	BAKKEN-THREE FORKS A	BAKKEN	Producing	9/1/2011	Jun-2014	1.4	42.6	1844.5	0.8	22.5	1073.3	34.56	

57891.1

Table No. 4: Middle Bakken OOIP Calculation

$$\text{OOIP} = \{A \cdot h \cdot \phi (1-S_w)\} / \text{Boi}$$

$$1\text{m}^3 = 6.28981 \text{ bbl}$$

Total OOIP

13,755.337

LSD	Section	Twp	Rge	Avg.Por %	h m	Area m2	Sw est %	1-Sw	Area*h*phi*(1-Sw)	Boi	OOIP m3	OOIP barrels	OOIP MSTB	Comment
3	29	16	27	0.15	2.1	160000	0.48	0.52	26208	1.003	26,130	164,350	164.350	
4	29	16	27	0.15	2.4	160000	0.48	0.52	29952	1.003	29,862	187,829	187.829	
5	29	16	27	0.15	2.6	160000	0.48	0.52	32448	1.003	32,351	203,481	203.481	
6	29	16	27	0.15	2.2	160000	0.48	0.52	27456	1.003	27,374	172,176	172.176	
11	29	16	27	0.15	2.6	160000	0.48	0.52	32448	1.003	32,351	203,481	203.481	
12	29	16	27	0.15	2.8	160000	0.48	0.52	34944	1.003	34,839	219,134	219.134	
13	29	16	27	0.15	3	160000	0.48	0.52	37440	1.003	37,328	234,786	234.786	
14	29	16	27	0.15	2.9	160000	0.48	0.52	36192	1.003	36,084	226,960	226.960	
1	30	16	27	0.21	2.8	160000	0.48	0.52	48922	1.003	48,775	306,787	306.787	
2	30	16	27	0.21	3	160000	0.48	0.52	52416	1.003	52,259	328,701	328.701	
3	30	16	27	0.21	3.1	160000	0.48	0.52	54163	1.003	54,001	339,657	339.657	
4	30	16	27	0.21	3.2	160000	0.48	0.52	55910	1.003	55,743	350,614	350.614	vert
5	30	16	27	0.21	3.2	160000	0.48	0.52	55910	1.003	55,743	350,614	350.614	
6	30	16	27	0.21	3.2	160000	0.48	0.52	55910	1.003	55,743	350,614	350.614	
7	30	16	27	0.21	3.1	160000	0.48	0.52	54163	1.003	54,001	339,657	339.657	
8	30	16	27	0.21	2.9	160000	0.48	0.52	50669	1.003	50,517	317,744	317.744	
9	30	16	27	0.21	3.2	160000	0.48	0.52	55910	1.003	55,743	350,614	350.614	vert
10	30	16	27	0.21	3.2	160000	0.48	0.52	55910	1.003	55,743	350,614	350.614	
11	30	16	27	0.21	3.2	160000	0.48	0.52	55910	1.003	55,743	350,614	350.614	
12	30	16	27	0.21	3.2	160000	0.48	0.52	55910	1.003	55,743	350,614	350.614	
13	30	16	27	0.21	3.2	160000	0.48	0.52	55910	1.003	55,743	350,614	350.614	
14	30	16	27	0.21	3.2	160000	0.48	0.52	55910	1.003	55,743	350,614	350.614	
15	30	16	27	0.21	3.2	160000	0.48	0.52	55910	1.003	55,743	350,614	350.614	
16	30	16	27	0.21	3.2	160000	0.48	0.52	55910	1.003	55,743	350,614	350.614	
1	31	16	27	0.18	3.2	160000	0.48	0.52	47923	1.003	47,780	300,526	300.526	
2	31	16	27	0.18	3.2	160000	0.48	0.52	47923	1.003	47,780	300,526	300.526	
3	31	16	27	0.18	3.1	160000	0.48	0.52	46426	1.003	46,287	291,135	291.135	
4	31	16	27	0.18	2.9	160000	0.48	0.52	43430	1.003	43,300	272,352	272.352	
5	31	16	27	0.17	2.3	160000	0.48	0.52	32531	1.003	32,434	204,003	204.003	vert
6	31	16	27	0.17	3	160000	0.48	0.52	42432	1.003	42,305	266,091	266.091	
7	31	16	27	0.17	3.2	160000	0.48	0.52	45261	1.003	45,125	283,830	283.830	
8	31	16	27	0.17	3.2	160000	0.48	0.52	45261	1.003	45,125	283,830	283.830	
1	25	16	28	0.18	3.2	160000	0.48	0.52	47923	1.003	47,780	300,526	300.526	
2	25	16	28	0.18	3.2	160000	0.48	0.52	47923	1.003	47,780	300,526	300.526	
3	25	16	28	0.18	3.1	160000	0.48	0.52	46426	1.003	46,287	291,135	291.135	
4	25	16	28	0.18	3	160000	0.48	0.52	44928	1.003	44,794	281,743	281.743	
5	25	16	28	0.18	2.7	160000	0.48	0.52	40435	1.003	40,314	253,569	253.569	
6	25	16	28	0.18	3	160000	0.48	0.52	44928	1.003	44,794	281,743	281.743	
7	25	16	28	0.18	3.1	160000	0.48	0.52	46426	1.003	46,287	291,135	291.135	
8	25	16	28	0.18	3.2	160000	0.48	0.52	47923	1.003	47,780	300,526	300.526	
9	25	16	28	0.18	3.2	160000	0.48	0.52	47923	1.003	47,780	300,526	300.526	
10	25	16	28	0.18	3	160000	0.48	0.52	44928	1.003	44,794	281,743	281.743	
11	25	16	28	0.18	2.7	160000	0.48	0.52	40435	1.003	40,314	253,569	253.569	
12	25	16	28	0.18	2.5	160000	0.48	0.52	37440	1.003	37,328	234,786	234.786	
13	25	16	28	0.18	2.5	160000	0.48	0.52	37440	1.003	37,328	234,786	234.786	
14	25	16	28	0.18	2.7	160000	0.48	0.52	40435	1.003	40,314	253,569	253.569	vert
15	25	16	28	0.18	3.1	160000	0.48	0.52	46426	1.003	46,287	291,135	291.135	vert
16	25	16	28	0.18	3.2	160000	0.48	0.52	47923	1.003	47,780	300,526	300.526	
Total OOIP											2,186,924	13,755,337	13,755.337	

							Recovery Factor	
UWI	OOIP [10 <sup>3</sup> m <sup>3</sup> ]	OOIP [Mbbls]	Cum Oil [10 <sup>3</sup> m <sup>3</sup> ]	Cum Oil [Mbbls]	EUR 10 <sup>3</sup> m <sup>3</sup>	EUR Mbbls	Current	Ultimate RF
00/03-29-016-27W1/0	56	352.2	1.1907	7.5	3.0	19.0	2.1%	5.4%
00/11-29-016-27W1/0	67	422.6	0.9828	6.2	3.3	20.9	1.5%	5.0%
00/14-29-016-27W1/0	73	461.7	6.1822	38.9	11.8	74.3	8.4%	16.1%
00/02-30-016-27W1/0	101	635.5	2.3999	15.1	4.2	26.4	2.4%	4.2%
02/04-30-016-27W1/0	110	690.3	5.0882	32.0	13.1	82.3	4.6%	11.9%
00/06-30-016-27W1/0	111	701.2	4.8465	30.5	10.3	64.6	4.3%	9.2%
00/07-30-016-27W1/0	105	657.4	2.2718	14.3	5.3	33.4	2.2%	5.1%
00/09-30-016-27W1/0	111	701.2	4.0752	25.6	6.3	39.4	3.7%	5.6%
00/11-30-016-27W1/0			2.4471	15.4	5.0	31.4	2.2%	4.5%
00/14-30-016-27W1/0	111	701.2	6.8515	43.1	18.4	115.7	6.1%	16.5%
00/16-30-016-27W1/0	111	701.2	4.3825	27.6	9.4	58.8	3.9%	8.4%
00/02-31-016-27W1/0	96	601.1	3.7589	23.6	7.5	47.4	3.9%	7.9%
00/03-31-016-27W1/0	90	563.5	8.7015	54.7	16.5	103.5	9.7%	18.4%
00/07-31-016-27W1/0	120	753.9	3.5340	22.2	7.6	47.8	2.9%	6.3%
00/03-25-016-28W1/2	96	601.1	3.7227	23.4	6.9	43.2	3.9%	7.2%
00/04-25-016-28W1/0	91	572.9	0.2678	1.7	0.9	5.8	0.3%	1.0%
00/06-25-016-28W1/0	94	591.7	2.3869	15.0	9.9	62.1	2.5%	10.5%
00/09-25-016-28W1/0	111	701.2	2.7490	17.3	4.1	25.9	2.5%	3.7%
02/09-25-016-28W1/0	93	582.3	0.9159	5.8	3.3	20.5	1.0%	3.5%
00/12-25-016-28W1/0	78	488.4	0.2261	1.4	0.4	2.4	0.3%	0.5%
00/13-25-016-28W1/2	78	488.4	1.3988	8.8	3.6	22.4	1.8%	4.6%
00/16-25-016-28W1/0	94	591.7	1.8445	11.6	4.4	27.8	2.0%	4.7%

**1,997                      12560.5                      70.225                      441.7                      155.0                      975.2                      3.2%                      7.1%**

**1195.0** OOIP values for undrilled LSDs

84.8                      533.5

**2,187                      13755.6**

Jun-14

Project                      Cum Oil, mbbls                      Current RF (Total)

Birdtail Unit No 3                      441.7                      **3.2%**

**Reserves, mbbls                      Comments                      RF, %**

Pilot WF Inc. Recoverable, mbbls                      80                      0.6%

Estimate WF Recoverable, mbbls                      975                      100% of primary EUR                      7.1%

WF EUR                      1,055                      7.7%

**Total Recovery                      2,110                      WF response                      15.4%**

Estimate EUR under WF                      **1,055**

Incremental RF (Total), %                      **7.7%**

**Tundra Oil & Gas Ltd.**  
**Tundra Birdtail (1-36) 03-31-016-27W1/00**  
52134-2011-0219

### SUMMARY OF PVT DATA

#### Reported Reservoir Conditions

Reservoir Pressure .....	5 000	kPa(a)
Reservoir Temperature .....	20.0	°C

#### Pressure-Volume Relations

Saturation Pressure .....	372	kPa(g)
Avg. Single-Phase Compressibility .....	6.28	E-7 v/v/kPa ( 34 474 to 372 kPa(g) )
Thermal Exp. @ 34 474 kPa(g) .....	1.00600	V at 20.0 °C / V at 15.0 °C

#### Reservoir Fluid Viscosity

15.2 mPa·s at 372 kPa(g) and 20.0 °C

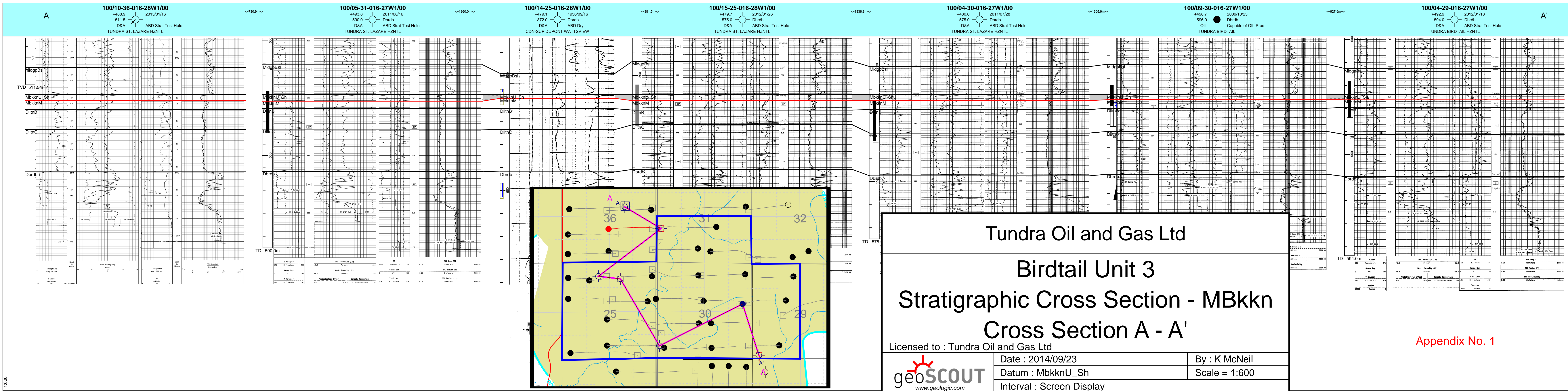
#### Separator Test Results

Separator Conditions		Formation Volume Factor (A)	Total Solution Gas/Oil Ratio (B)	Tank Oil Gravity ( °API at 15.6 °C )
kPa(g)	°C			
0	15.0	1.003	0.4	30.4

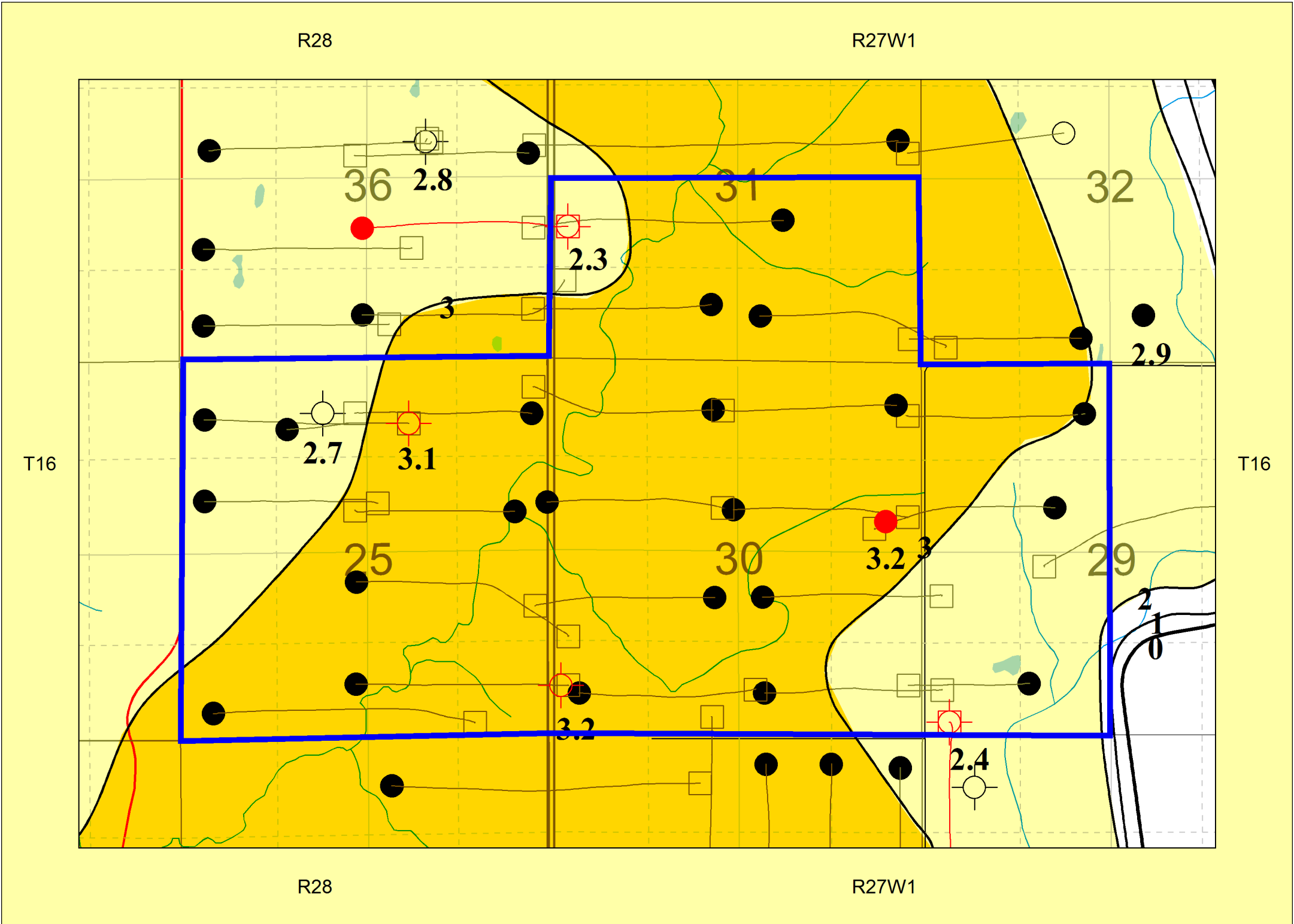
(A) Cubic metres of saturated oil per cubic metre of stock tank oil at 15.0 °C.

(B) Total standard cubic metres of gas per cubic metre of stock tank oil at 15.0 °C.









Legend

Wells

BkknCoredWells

Project Wells

Hydrography

Major

Minor Lake

Minor River

Grid

DLS - Township

DLS - Section

DLS - Quarter Section

DLS - Legal Subdivision

Transportation

Primary Roads

Secondary Roads

Local Roads

Other Roads

Rail Line

Airport

Boundaries

Heritage Rangeland

Recreation Area

Wilderness Area

Wildland

Provincial Parks

State Parks

National Parks

Military Bases

Native Reserves

Cities

Towns

Villages

Rural Municipalities

Counties

Provincial Boundary

State Boundary

Map Boundary

WELL SYMBOLS

● OIL	⊕ D&A	⊕ AO	⊕ WI	○ LCT
⊕ PTN	⊕ ATH	⊕ WD	⊕ AWD	⊕ STN
⊕ SO	⊕ AWI	⊕ PTO	⊕ J&A	⊕ RDR
⊕ GM	⊕ AWS	⊕ WSC	⊕ SUS	⊕ FSW
⊕ DRL	⊕ CMM	⊕ SL		

Tundra Oil and Gas Ltd

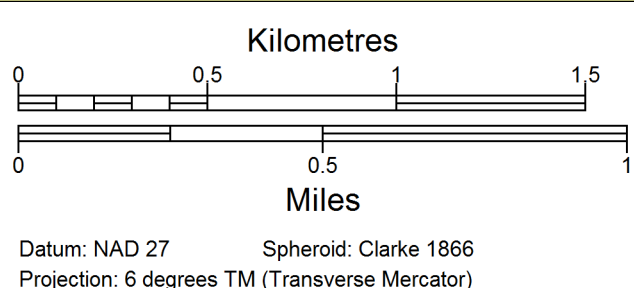
Birdtail Unit 3

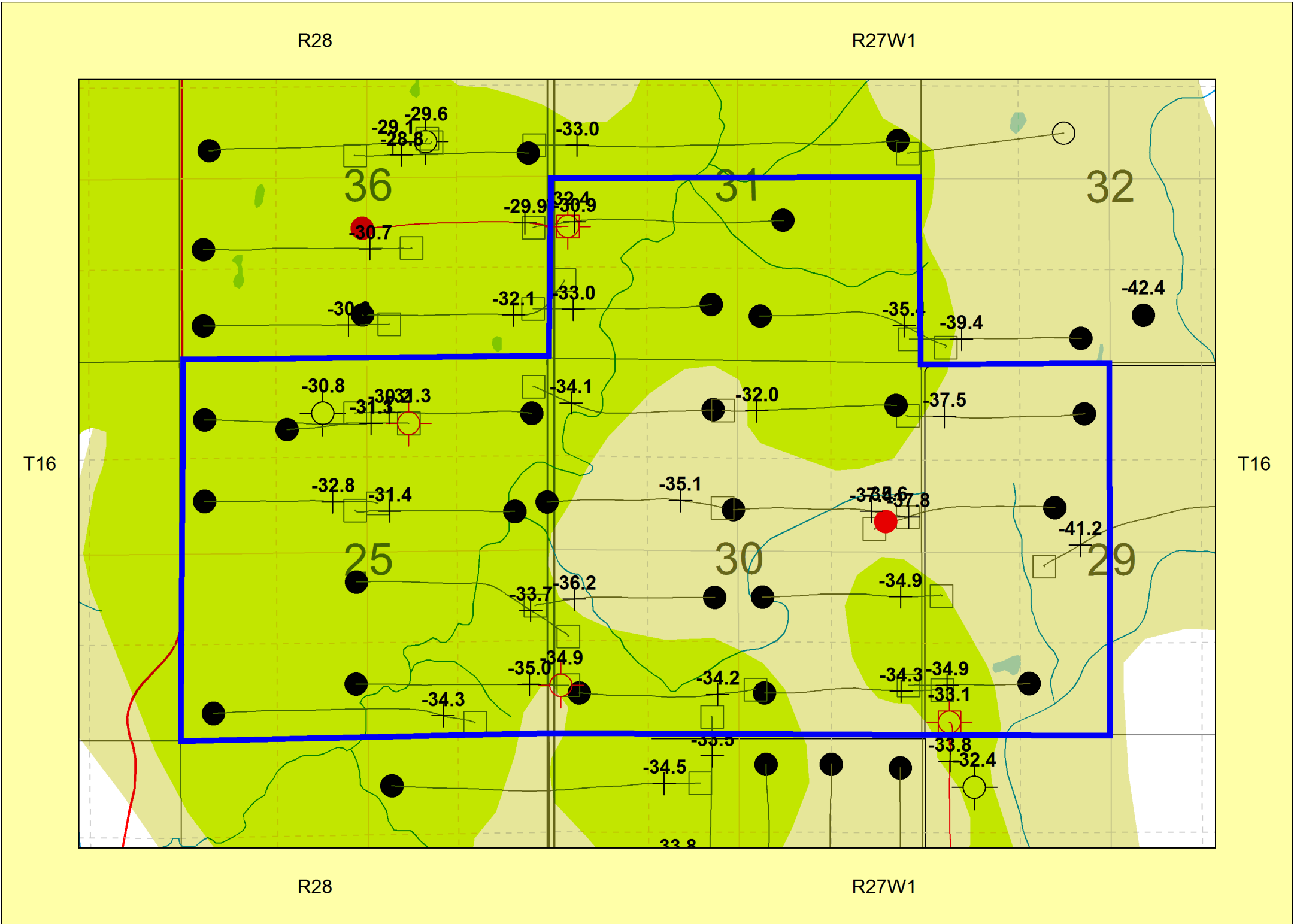
Middle Bakken Net Hydrocarbon Pay Map

(1m Contour Intervals)

Licensed to : Tundra Oil and Gas Ltd

geoSCOUT www.geologic.com	By : K McNeil	Date : 2014/09/23
	Scale = 1:20000	Project : NorthBakken





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State Boundary

Map Boundary

WELL SYMBOLS

● OIL	⊕ D&A	⊕ AO	⊕ WI	○ LCT
⊕ PTN	⊕ ATH	⊕ WD	⊕ AWD	⊕ STN
⊕ SO	⊕ AWI	⊕ PTO	⊕ J&A	⊕ RDR
⊕ GM	⊕ AWS	⊕ WSC	⊕ SUS	⊕ FSW
⊕ DRL	⊕ CMM	⊕ SL		

Tundra Oil and Gas Ltd

Birdtail Unit 3

Top Middle Bakken Subsea Structure Map

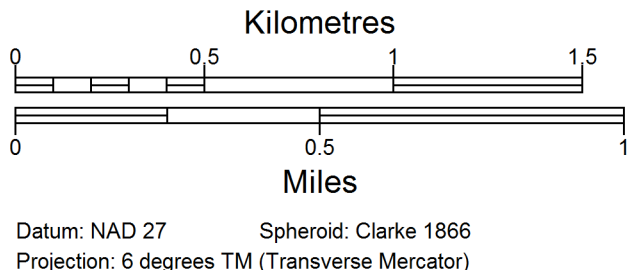
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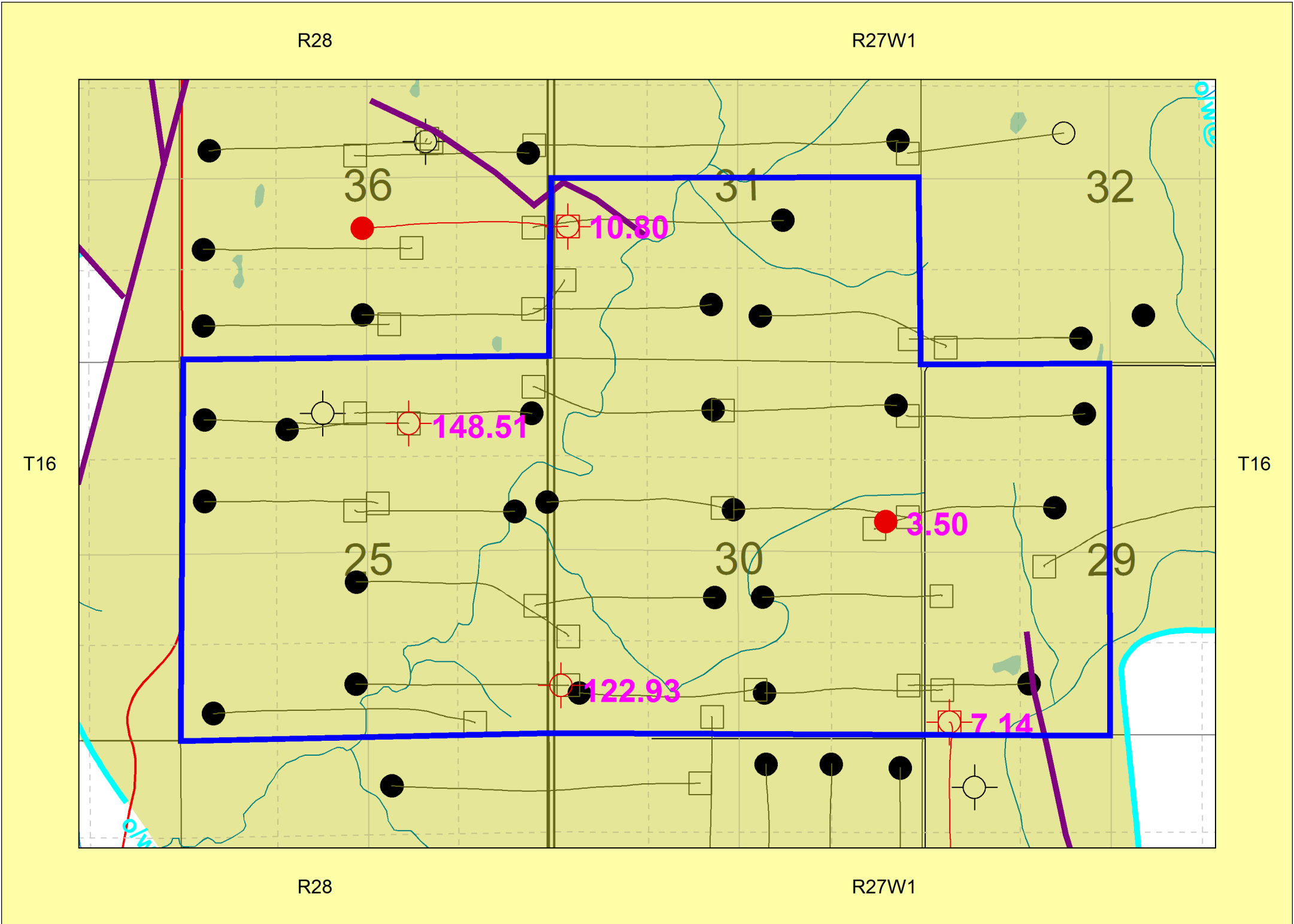
Licensed to : Tundra Oil and Gas Ltd

By : K McNeil	Date : 2014/09/23
Scale = 1:20000	Project : NorthBakken

geoSCOUT

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Legend

Wells

BkknCoredWells

Project Wells

Hydrography

Major

Minor Lake

Minor River

Grid

DLS - Township

DLS - Section

DLS - Quarter Section

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Airport

Boundaries

Heritage Rangeland

Recreation Area

Wilderness Area

Wildland

Provincial Parks

State Parks

National Parks

Military Bases

Native Reserves

Cities

Towns

Villages

Rural Municipalities

Counties

Provincial Boundary

State Boundary

Map Boundary

WELL SYMBOLS

OIL

PTN

SO

GM

DRL

D&A

ATH

AWI

AWS

CMM

AO

WD

PTO

WSC

SL

WI

AWD

J&A

SUS

LCT

STN

RDR

FSW

Tundra Oil and Gas Ltd

Birdtail Unit 3

Middle Bakken Kmax.h Values Map

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geoSCOUT

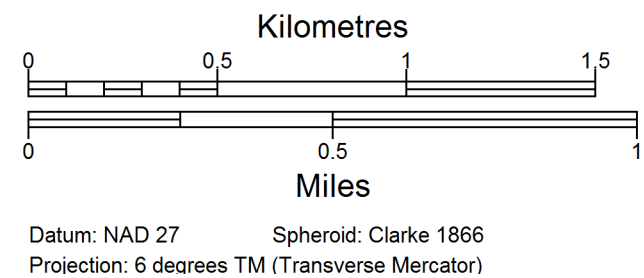
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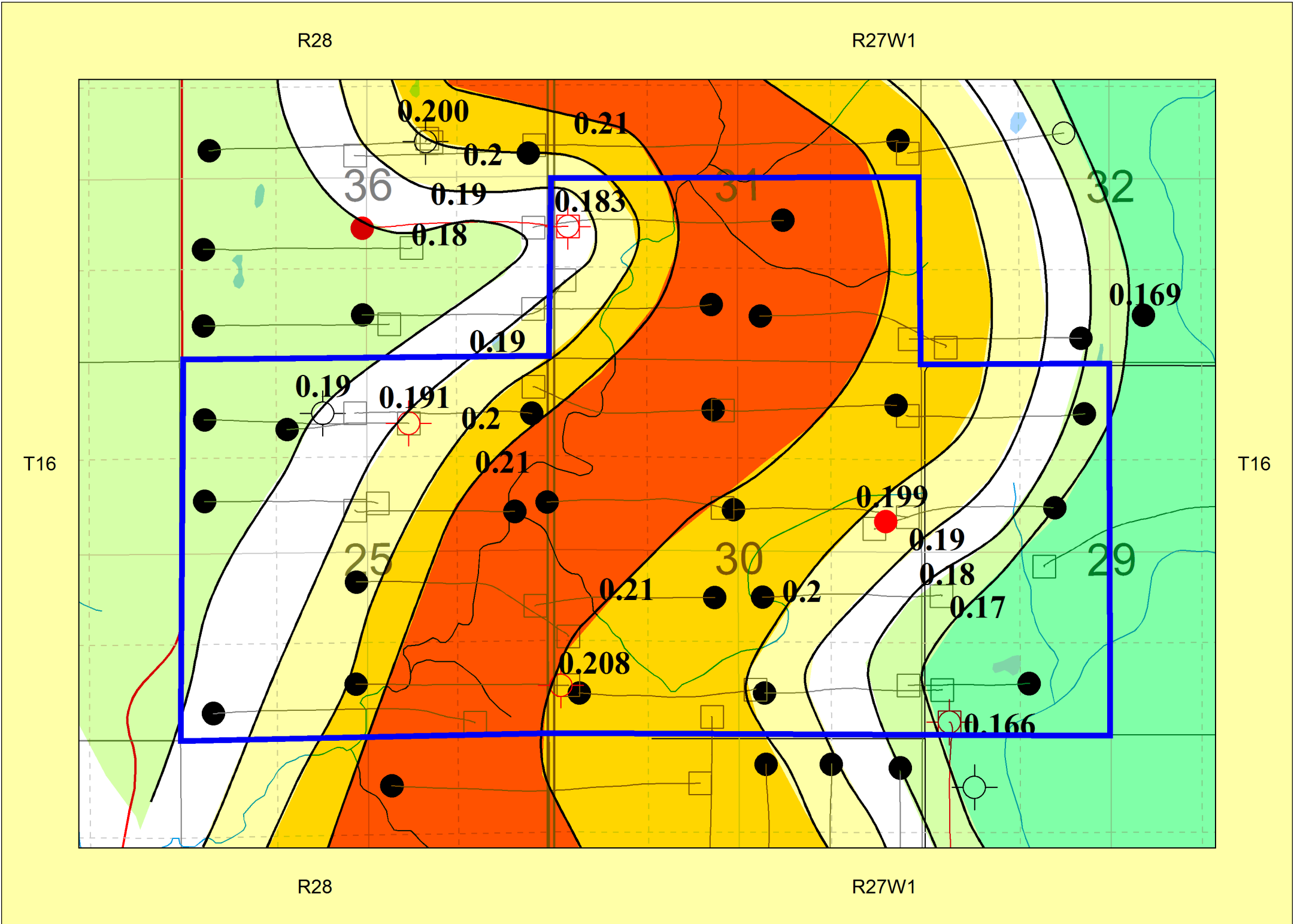
By : K McNeil

Scale = 1:20000

Date : 2014/09/23

Project : NorthBakken





Legend

Wells

BkknCoredWells

Project Wells

Hydrography

Major

Minor Lake

Minor River

Grid

DLS - Township

DLS - Section

DLS - Quarter Section

DLS - Legal Subdivision

Transportation

Primary Roads

Secondary Roads

Local Roads

Other Roads

Rail Line

Airport

Boundaries

Heritage Rangeland

Recreation Area

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Provincial Boundary

State Boundary

Map Boundary

WELL SYMBOLS

● OIL	⊕ D&A	⊕ AO	⊕ WI	○ LCT
⊕ PTN	⊕ ATH	⊕ WD	⊕ AWD	⊕ STN
⊕ SO	⊕ AWI	⊕ PTO	⊕ J&A	⊕ RDR
⊕ GM	⊕ AWS	⊕ WSC	⊕ SUS	⊕ FSW
⊕ DRL	⊕ CMM	⊕ SL		

Tundra Oil and Gas Ltd

Birdtail Unit 3

Middle Bakken Average Porosity Map

(0.01% Contour Intervals)

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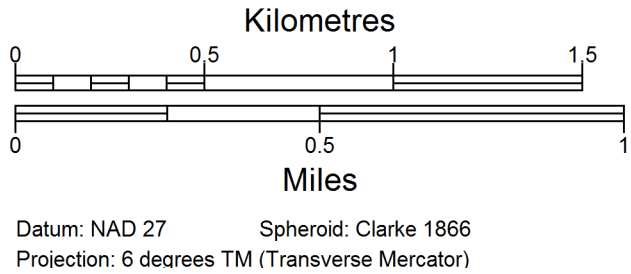
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## **Appendix 6 – Corrosion Controls**

### *Injection Wells*

- Corrosion inhibitor in the annulus between tubing and casing.
- Surface freeze protection of annular fluids near surface.
- Corrosion-resistant valves on wellhead and flowline.
- Corrosion-resistant flowline equipment.
- Installation of cathodic protection to protect casing.
- Scale inhibitor protection as needed.
- Bacteria control chemical treatments when needed.
- Water injector packer will be coated for corrosion resistance.

### *Producing Wells*

- Downhole corrosion inhibitor, either batch or daily injection, as needed.
- Scale inhibitor treatment daily injection as required for horizontal wells.
- Paraffin treatment daily injection if needed.
- Casing cathodic protection where required.

### *Pipelines*

- The water source line will be Flexcord 2000# pipe.
- Injection lines will be a mix of Flexpipe 601 pipe and Centron 2000# pipe.
- Producing lines existing as per original flowline licenses.
- 

### *Facilities*

#### **8-30-16-27W1 Water Plant**

- Plant piping – internally coated, fiberglass or stainless steel.
- Filtration – stainless steel.
- Pumps – ceramic plungers, stainless steel disc valves.
- Tanks – fiberglass with stainless steel valves.