

**PROPOSED WASKADA UNIT NO. 21**

**Application for Enhanced Oil Recovery Waterflood Project**

**Lower Amaranth Formation**

**Lower Amaranth A (03 29A) and Lower Amaranth I Pool (03 29I)**

**Waskada Field, Manitoba**

June 30, 2016

## Tundra Oil and Gas Partnership

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## **INTRODUCTION**

The Waskada Oil Field is located in Townships 1 and 2, Ranges 23-26 W1. The Waskada Lower Amaranth Oil pool was discovered in June 1980 when Omega Hydrocarbons recompleted a former Mississippian producer in the stratigraphically higher Lower Member of the Amaranth Formation. Secondary recovery through waterflood has been initiated throughout much of the pool. Tundra Oil and Gas (Tundra) currently operates Waskada Lower Amaranth Unit 1, 2, 3, 4, 5, 6, 7, 8, 13, 14, 15, 16, 17, 18 and 19 as shown on Figure 1.

In the eastern part of the Waskada field, potential exists for incremental production and reserves from a Waterflood EOR project in the Lower Amaranth oil reservoirs. The following represents an application by Tundra to establish Waskada Unit No. 21 (NE/4 Sec 26, LSD's 1, 7, 8, 9, 10 and 11 of Sec 35, and LSD 12 Sec 36-1-26W1) and implement a Secondary Waterflood EOR scheme within the Lower Amaranth Formation as outlined on Figure 2.

The proposed project area falls within the existing designated 03-29A Lower Amaranth A Pool and 03-29I Lower Amaranth I Pool of the Waskada Oilfield (Figure 3).

## **SUMMARY**

1. The proposed Waskada Unit No. 21 will include 20 horizontal wells and 12 vertical wells, from which 6 of the vertical wells are abandoned and the rest are suspended/inactive, within 11 Legal Sub Divisions (LSD) of the Lower Amaranth producing reservoir. The project is located west of Waskada Unit No. 3, north of Waskada Lower Amaranth Unit No. 1, south of Waskada Unit No. 5 and east of Waskada Unit No. 2 (Figure 2).
2. Total Net Original Oil in Place (OOIP) in Waskada Unit No. 21 has been calculated to be 1,431.4 e<sup>3</sup>m<sup>3</sup> (**9,003.7 Mbbl**) for an average of **130.1 net e<sup>3</sup>m<sup>3</sup> (818.5 Mbbl)** OOIP per 40 acre LSD.
3. Cumulative production to the end of April 2016 from the 32 wells within the proposed Waskada Unit No. 21 project area was **131.9 e<sup>3</sup>m<sup>3</sup> (830.3 Mbbl)** of oil, and **122.4 e<sup>3</sup>m<sup>3</sup> (770.4 Mbbl)** of water, representing a **9.2%** Recovery Factor (RF) of the Net OOIP.
4. Estimated Ultimate Recovery (EUR) of Primary Proved Producing oil reserves in the proposed Waskada Unit No. 21 project area has been calculated to be **134.8 e<sup>3</sup>m<sup>3</sup> (848.2 Mbbl)**, with **2.8 e<sup>3</sup>m<sup>3</sup> (17.8 Mbbl)** remaining as of the end of April 2016.
5. Ultimate oil recovery of the proposed Waskada Unit No. 21 OOIP, under the current Primary Production method, is forecasted to be **9.4%**
6. The production from the Waskada Unit No. 21 peaked in March 2013 at 196.5 m<sup>3</sup> (OPD) as shown in Figure 4. As of April 2016, production was 3.1 m<sup>3</sup> OPD, 10.7 m<sup>3</sup> of water per day (WPD) and a 77.6% watercut.
7. In March 2013, production averaged 8.5 m<sup>3</sup> OPD per well in Waskada Unit No. 21. As of April 2016, average per well production has declined to 0.3 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 **30.0%** in the project area.
8. Estimated Ultimate Recovery (EUR) of proved oil reserves under Secondary WF EOR for the proposed Waskada Unit No. 21 has been calculated to be **182.0 e<sup>3</sup>m<sup>3</sup> (1,145.0 Mbbl)**, with **50.0 e<sup>3</sup>m<sup>3</sup> (314.7 Mbbl)** remaining. An incremental **47.2 e<sup>3</sup>m<sup>3</sup> (296.9 Mbbl)** of proved oil reserves, or **3.3%**, are forecasted to be recovered under the proposed Unitization and Secondary EOR production vs the existing Primary Production method.
9. Total RF under Secondary WF in the proposed Waskada Unit No. 21 is estimated to be **12.7%**.
10. Based on the waterflood response in the adjacent main portion of the Waskada field, the Lower Amaranth Formation in the proposed project area is believed to be a suitable reservoir for WF EOR operations.
11. Existing horizontal wells, with multi-stage hydraulic fractures will be converted to injection to provide waterflood support to existing horizontal/vertical producing wells (Figure 5) within the proposed Waskada Unit No. 21 to complete waterflood patterns.



## **Geology**

### **Stratigraphy:**

The Triassic aged Lower Amaranth formation is the oil producing reservoir that is the subject of this unit application. The stratigraphy of the reservoir section for the proposed unit is shown on the structural cross section attached as Appendix 1. The section runs N to S approximately through the mid-point of the proposed unit. The Lower Amaranth is bounded on top by the Amaranth Evaporite and by the Mississippian Unconformity at the base.

Stratigraphic nomenclature has been modeled after previous operator's (EOG Resources) conventions. The producing sequence in descending order consists of the Lower Amaranth A Unit, Lower Amaranth Green Sand, Lower Amaranth Blue Sand, Lower Amaranth Purple Sand, Lower Amaranth Brown Sand, Lower Amaranth Red Sand, and the Lower Amaranth Lower Sand. The reservoir units are primarily represented by the Green, Blue, Purple, Brown, and Red Sands. The Upper portion of the Lower Amaranth A unit is considered tight, and represents the top seal for the reservoir.

### **Sedimentology:**

The Lower Amaranth reservoir units (top of Green through to base of Red Sand) comprise interlaminated shale, siltstone, and fine grained sandstone. The laminations tend to be range from > 1 cm up to 20 cm in thickness, often show signs of scouring at the base of each laminae, and tend to fine upwards. There are anhydrite beds capping each sub unit within the producing sequence; these anhydrite layers are generally correlatable over the entire Pierson / Waskada / Goodlands area. These anhydrite layers are the basis for the stratigraphic framework that is being used to describe the reservoir within the proposed unit.

The units within the producing sequence have very similar characteristics. Color tends to vary with grain size in that the finer grained material tends to be brick red, while the courser grained material generally tends to be grey to light brown. All of the sub units have a varying component of anhydrite cement, which will appear as mm sized nodules in heavily cemented areas. Finally, well rounded, floating, course, frosted quartz grains are common throughout the entire productive interval.

Lower Amaranth reservoir is interpreted as having been deposited in an arid tidal flat (Sabkha) setting. The stratigraphic divisions (Green, Blue, Purple, Brown, Red, and Lower Sands) are interpreted as representing individual evaporitic cycles, each exhibiting relatively higher depositional energy at the base, grading into very low energy towards the top.

Since each cycle is bound by an erosive surface on the top and bottom, there can be lateral variability in sediment preservation within each cycle. Occasional preservation of high angled cross stratification suggests periods of very high energy during deposition which are interpreted as channel deposits, which help support a tidal flat setting depositional model.

The Upper portion of the Upper Amaranth A unit is made up of brick red shale that is generally not bedded and does not tend to exhibit any sedimentary structures. It is a low permeability zone that represents the top seal to the Lower Amaranth reservoir.

The Lower Sand portion of the Lower Amaranth (immediately beneath the Red Sand), has a lot of the same characteristics as the productive interval, but tends to have much less effective porosity due to abundant anhydrite cement.

#### **Structure:**

Structure contour maps are provided for the top and base of the reservoir interval (Appendices 2 and 3). The reservoir units dip to the southwest, which is consistent with regional dip. Structural mapping based on well control does not indicate the presence of large scale structural features that would indicate an increased risk of faulting within the proposed unit boundary.

#### **Reservoir Continuity:**

There are limited barriers to reservoir continuity that are apparent from the data available. Available data from well logs do not show any apparent lateral facies changes within the proposed unit that would result in significant lateral permeability barriers. An Isopach map of the reservoir interval (Appendix 4) shows that the reservoir thickness remains consistent between about 11.5 meters and 12.5 meters.

Also, as mentioned above, there are no indications of any structural features that could set up any lateral permeability barriers within the proposed unit. The lack of lateral permeability barriers suggests this pool is well suited for secondary oil recovery.

#### **Reservoir Quality:**

Net pay determination within the proposed unit was done by using a sonic porosity cut off. There are a number of steps that were undertaken in order to determine net pay from sonic log data:

- Core data from the entire Waskada / Goodlands area (Appendix 5) was used to determine a relationship between porosity and permeability. Based on a best fit line through the available core analysis it was determined that a core porosity of 10% represents 0.5 md of permeability (Appendix 6).
- Sonic porosity was calculated for wells in which digital sonic data was available (Appendix 7) using the following formula:

$$\text{Sonic Porosity} = \frac{Dt - Dt_{\text{matrix}}}{Dt_{\text{water}} - Dt_{\text{matrix}}}$$

Where

$Dt$  = Sonic travel time (ms/m)

$Dt_{\text{matrix}}$  = Sonic travel time of the rock matrix (198 ms/m)

$Dt_{\text{water}}$  = Sonic travel time of the formation water (681 ms/m)

- In order to translate this relationship to well logs, a comparison between sonic porosity and core porosity was undertaken. A total of 52 wells were found in the Waskada / Goodlands area that had digital sonic curves along with core analysis over the Lower Amaranth reservoir interval (Appendix 8). Sonic Porosity from logs was compared to core porosity from core analysis (Appendix 9), and the data suggests that there is a good relationship between porosity from core and porosity from Sonic data.

From this relationship, a sonic log porosity cut of 10% was used as a pay determination for each logged well. In this way, the porosity / permeability relationship as determined from core can be translated into wells where there is log data available. In turn, this increases the control points for OOIP determination, which increases the resolution of OOIP mapping.

### OOIP Estimates

OOIP values were calculated using the following volumetric equation:

$$OOIP = \frac{Area * Net Pay * Porosity * (1 - Water Saturation)}{Initial Formation Volume Factor of Oil}$$

or

$$OOIP(m^3) = \frac{A * h * \phi * (1 - S_w)}{Bo} * \frac{10,000m^2}{ha}$$

or

$$OOIP(Mbbl) = \frac{A * h * \phi * (1 - S_w)}{Bo} * 3.28084 \frac{ft}{m} * 7,758.367 \frac{bbl}{acre * ft} * \frac{1Mbbl}{1,000bbl}$$

where

|            |                                                                                 |
|------------|---------------------------------------------------------------------------------|
| OOIP       | = Original Oil in Place by LSD (Mbbl, or m <sup>3</sup> )                       |
| A          | = Area (40acres, or 16.187 hectares, per LSD)                                   |
| h * $\phi$ | = Net Pay * Porosity, or Phi * h (ft, or m)                                     |
| Bo         | = Formation Volume Factor of Oil (stb/rb, or sm <sup>3</sup> /rm <sup>3</sup> ) |
| Sw         | = Water Saturation (decimal)                                                    |

For the purposes of this unit application, Bo and Sw were held constant at 1.17 and 40% respectively. The initial oil formation volume factor was adopted from a PVT taken from the 8-26-1-26W1, thought to be representative of the fluid characteristics in the reservoir. Sw determination was set at 40% based analysis of capillary pressure data from six different locations in the Waskada / Goodlands area (6-21-1-25W1, 7-28-1-25W1, 13-10-1-24W1, 15-1-1-25W1, and 14-14-2-25W1).

Average sonic porosity for the proposed Unit area has been included as Appendix 10.

Phi \* h maps were created from sonic porosity log data (Appendix 11). The average phi \* h value within each LSD was calculated using IHS Petra software, this provided the final input into the OOIP calculation.

Total volumetric OOIP for the Lower Amaranth within the proposed unit has been calculated to be 1,431,436 m<sup>3</sup> (9,003,730 bbls).

Tabulated parameters for each LSD from the calculations can be found in Table 1.



Original Oil in Place (OOIP) calculations and geologic summary were prepared by Todd Neely and reviewed by Bill Ward, P. Geol. (VP Exploration at Tundra Oil and Gas).

### **Historical Production**

A historical group production history plot for the proposed Waskada Unit No. 21 is shown as Figure 4. Oil production commenced from the proposed Unit area in November 1981 and peaked during March 2013 at 196.5 m<sup>3</sup> OPD. As of April 2016, production was 3.1 m<sup>3</sup> OPD, 10.7 m<sup>3</sup> of water per day (WPD) and a 77.6% watercut.

From peak production in March 2013 to date, oil production is declining at an annual rate of approximately **30%** under the current Primary Production method.

The remainder of the field's production and decline rates indicate the need for pressure restoration and maintenance. Waterflooding is deemed to be the most efficient means of secondary recovery to introduce energy back into the system and provide a real sweep between wells.

### **UNITIZATION**

Unitization and implementation of a Waterflood EOR project is forecasted to increase overall recovery of OOIP from the proposed project area.

#### **Unit Name**

Tundra proposes that the official name of the new Unit shall be Waskada Unit No. 21.

#### **Unit Operator**

Tundra Oil and Gas Partnership (Tundra) will be the Operator of record for Waskada Unit No. 21.

#### **Unitized Zone**

The Unitized zone(s) to be waterflooded in the Waskada Unit No. 21 will be the Lower Amaranth formation.

#### **Unit Wells**

The 20 horizontal wells and 12 vertical wells to be included in the proposed Waskada Unit No. 21 are outlined in Table 3.

### **Unit Lands**

The Waskada Unit No. 21 will consist of 76 LSDs as follows:

NE/4 Section 26 of Township 1, Range 26, W1M  
LSD's 1, 7, 8, 9, 10 and 11, Section 35 of Township 1, Range 26, W1M  
LSD 12, Section 36 of Township 1, Range 26, W1M

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

### **Tract Factors**

The proposed Waskada Unit No. 21 will consist of 11 Tracts based on the 40 acre LSDs containing the existing 20 horizontal and 12 vertical wells.

The Tract Factor contribution for each of the LSD's within the proposed Waskada Unit No. 21 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)
- Last twelve (12) months production to date for the LSD as distributed by the LSD specific PA % in the applicable producing horizontal or vertical well.
- Tract Factor by LSD = Fifty percent (50%) of the product of Remaining Gross OOIP by LSD as a % of total proposed Unit Remaining Gross OOIP, and fifty percent (50%) of the product of the Last 12 Months Production as a % of total proposed Unit Last 12 Months Production.

Tract Factor calculations for all individual LSDs based on the above methodology are outlined within Table 2. In the past, multiple methods of assigning tract participation factors have been used in the Waskada area. Tundra believes that the above given method provides the most equitable assignment of tract participation factors to all mineral owners, given the geological, reservoir and well completion risks associated with waterflooding horizontal to horizontal wellbores in Lower Amaranth formation.

### **Working Interest Owners**

Table 1 outlines the working interest (WI) for each recommended Tract within the proposed Waskada Unit No. 21. 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 Waskada Unit No. 21.



## **WATERFLOOD EOR DEVELOPMENT**

### **Technical Studies**

The waterflood performance predictions for the proposed Waskada Unit No. 21 Lower Amaranth project are based on internal engineering assessments, as well as empirically observed waterflood performance in nearby Waskada Units 16 and 17, which employed a vertical to vertical waterflood. Utilizing project area specific reservoir and geological parameters, a Black oil simulation model using Exodus software was created by Tundra to evaluate the potential waterflood response using horizontal injectors to flood horizontal producers, which is the configuration that Tundra proposes in Waskada Unit No. 21. While the model was created using geological and historical production data from Waskada Unit 19, in section 34-1-25W1, the results observed in the model were similar to those observed empirically in Units 16 and 17, and deemed representative of what Tundra would expect in Waskada Unit 21.

### **Horizontal Injection Wells and EOR Development**

Primary production from the original vertical/horizontal producing wells in the proposed Waskada Unit No. 21 has declined significantly from peak rate indicating a need for secondary pressure support. Through the process of developing similar waterfloods, Tundra has measured a significant variation in reservoir pressure depletion by the existing primary producing wells. Placing new horizontal wells immediately on water injection in areas without significant reservoir pressure depletion has been problematic in similar low permeability formations, and has a negative impact on the ultimate total recovery of oil.

Tundra proposes to convert up to 7 horizontal oil producing well to water injection wells (WIW) as shown in Figure 5. This conversion scheme would allow for approximately 30 acre effective spacing between offsetting injection wells. Alternative injection configurations may be considered depending on results from offset pilot areas in the Lower Amaranth formation, within the Waskada field. These configurations could result in the conversion of more or less wells to injection than what is shown in Figure 5. Additionally, new horizontal injectors may be considered to be drilled if they are deemed to be essential to improving recovery in the unit.

If new injection wells are drilled in this area, Tundra believes an initial period of producing all new horizontal wells prior to placing them on permanent water injection is essential and all Unit mineral owners will benefit.

Tundra will continue to monitor reservoir pressure, fluid production and decline rates in each pattern to determine when the well will be converted to water injection.

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

The primary waterflood performance predictions for the proposed Waskada Unit No. 21 are based on oil production decline curve analysis. The secondary predictions are based primarily on internal engineering analysis performed by the Tundra reservoir engineering group, utilizing an Exodus simulation model generated in Waskada Unit 19 (described previously), and simulating horizontal injectors offsetting horizontal producers for waterflood development. These results were then compared and contrasted to empirically observed data in Waskada Unit 16 and 17 to ensure proper calibration of data and results.

### Primary Production Forecast

Cumulative production in the Waskada Unit No. 21 project area, to the end of April 2016 from 32 wells, was 131.9 e<sup>3</sup>m<sup>3</sup> of oil and 122.4 e<sup>3</sup>m<sup>3</sup> of water for a recovery factor of **9.2%** of the calculated Net OOIP.

Ultimate Primary Proved Producing oil reserves recovery for Waskada Unit No. 21 has been estimated to be **134.8 e<sup>3</sup>m<sup>3</sup>**, or a **9.4%** Recovery Factor (RF) of OOIP. Remaining Producing Primary Reserves has been estimated to be **2.9 e<sup>3</sup>m<sup>3</sup>** to the end of April 2016.

The expected production decline and forecasted cumulative oil recovery under continued Primary Production is shown in Figures 7 and 8.

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

Tundra proposes to implement an initial phase which consists of 7 Horizontal conversions throughout 2017 to test the efficiency of the Waskada Unit 21 Waterflood.

### Criteria for Conversion to Water Injection Well

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

- Measure reservoir pressures through primary production
- Fluid production rates and any changes in decline rate
- Any observed production interference effects with adjacent vertical and horizontal wells
- Pattern mass balance and/or oil recovery factor estimates
- Reservoir pressure relative to bubble point pressure

The above schedule allows for the proposed Waskada Unit No. 21 project to be developed equitably, efficiently, and moves to 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 reserves.

It should be noted that some of the proposed horizontal injection in Proposed Waskada Unit 21 cross the unit boundary into an existing offset unit. Prior to converting these wells to injection, Tundra will secure an inter-unit injection agreement, which allows for the conversion of wells to injection that cross unit boundaries. The inter-unit injection agreements are a standard clause in all new unit agreements that Tundra proposes, because they are necessary for the most effective development of unitized land.

### Secondary EOR Production Forecast

The proposed project oil production profile under Secondary Waterflood has been developed based on the response observed to date in Waskada Unit 16 and 17, as well as internal Black Oil Simulation model of section 34-1-25W1 in Waskada 19, which simulates a horizontal to horizontal waterflood. (Figure 6).

Secondary Waterflood plots of the expected oil production forecast over time and the expected oil production vs. cumulative oil are plotted in Figures 9 and 10, respectively. Total Secondary EUR for the proposed Waskada Unit No. 21 is estimated to be **182.0 e<sup>3</sup>m<sup>3</sup>** with **50.0 e<sup>3</sup>m<sup>3</sup>** remaining representing a



total secondary recovery factor of **12.7%** for the proposed Unit area. An incremental **47.2** e<sup>3</sup>m<sup>3</sup> of oil, or a **3.3%** recovery factor, are forecasted to be recovered under the proposed Unitization and Secondary EOR production scheme vs. the existing Primary Production method.

### **Estimated Fracture Pressure**

Completion data from the existing producing wells within the project area indicate an actual fracture pressure gradient range of 17.0 to 18.0 kPa/m true vertical depth (TVD).

## **WATERFLOOD OPERATING STRATEGY**

### **Water Source**

The injection water for the proposed Waskada Unit No. 21 will be supplied from the existing Waskada 11-30-001-25W1 Battery source and injection water system. All existing injection water is obtained from the Swan River formation in the 100/05-09-002-25W1 and 100/10-09-002-25W1 licensed water source wells. Swan River water from the two source wells is pumped to the Water Plant at 11-30-001-25W1, filtered, and pumped up to injection system pressure. A diagram of the Waskada water injection system and new pipeline connection to the proposed Waskada Unit No. 21 project area injection wells is shown as Figure 11.

Based on past experience, Tundra does not believe that the produced water can be cleaned to the required specifications feasibly. Therefore, Tundra plans to use source water from a Swan River well as a source supply for Waskada Unit No. 21.

A mixture of produced waters from the Lower Amaranth has been extensively tested for compatibility with 100/05-09 source Swan River water, by a highly qualified third party, prior to implementation by Tundra. 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 Waskada injection water facility. Review and monitoring of the source water scale inhibition system is also part of an existing routine maintenance program.

### **Injection Wells**

New water injection wells for the proposed Waskada Unit No. 21 will be cleaned out and configured downhole for injection as shown in Figures 12 and 13. The horizontal injection well will be stimulated by multiple hydraulic fracture treatments to obtain suitable injection. Tundra has extensive experience with horizontal fracturing in the area, and all jobs are rigorously programmed and monitored during execution. This helps ensure optimum placement of each fracture stage to prevent, or minimize, the potential for out-of-zone fracture growth and thereby limit the potential for future out-of-zone injection.

The new water injection wells 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:

- the area specific known and calculated fracture gradient, or

- 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 are surface equipped with injection volume metering and rate/pressure control. 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 Waskada Unit No. 21 horizontal water injection well rate is forecasted to average 10 - 30 m<sup>3</sup> WPD, based on expected reservoir permeability and pressure.

### **Reservoir Pressure**

No representative initial pressure surveys are available for the proposed Waskada Unit No. 21 project area in the Lower Amaranth producing zone. Tundra assumed operatorship of these properties in 2015, and has been unable to recover any pressure surveys from the original operators.

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

Tundra expects it will take 2-4 years to re-pressurize the reservoir due to cumulative primary production voidage and pressure depletion. Initial monthly 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**

Waskada Unit No. 21 EOR response and waterflood surveillance will consist of the following:

- Regular production well rate and WCT testing
- Daily water injection rate and pressure monitoring vs target
- Water injection rate/pressure/time vs. cumulative injection plot
- Reservoir pressure surveys as required to establish pressure trends
- Pattern VRR
- Potential use of chemical tracers to track water injector/producer responses
- Use of some or all of: 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 Waskada Unit No. 21 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 Waskada Unit No. 21.

#### **On Going Reservoir Pressure Surveys**

Any pressures taken during the operation of the proposed unit will be reported within the Annual Progress Reports for Waskada Unit No. 21 as per Section 73 of the Drilling and Production Regulation.

#### **Economic Limits**

Under the current Primary recovery method, existing wells within the proposed Waskada Unit No. 21 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 Waskada Unit No. 21 waterflood operation will utilize the existing Tundra operated source well supply and water plant (WP) facilities located at 15-09-002-25 W1M Battery. Injection wells will be connected to the existing high pressure water pipeline system supplying other Tundra-operated Waterflood Units.

A complete description of all planned system design and operational practices to prevent corrosion related failures is shown in Figure 14.

#### **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 Waskada Unit No. 21. Copies of the notices and proof of service, to all surface and mineral rights owners will be forwarded to the Petroleum Branch when available to complete the Waskada Unit No. 21 Application.

Waskada Unit No. 21 Unitization, and execution of the formal Waskada Unit No. 21 Agreement by affected Mineral Owners, is expected during Q1 2017. Copies of same will be forwarded to the Petroleum Branch, when available, to complete the Waskada Unit No. 21 Application.

Should the Petroleum Branch have further questions or require more information, please contact Robert [REDACTED] at 403.767.1248 or by email at [robert.prefontaine@tundraoilandgas.com](mailto:robert.prefontaine@tundraoilandgas.com).

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

Original Signed by Robert [REDACTED] July 27, 2016, in Calgary, AB



## **Proposed Waskada Unit No. 21**

### **Application for Enhanced Oil Recovery Waterflood Project**

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| Figure 3  | Lower Amaranth Pool                                                   |
| Figure 4  | Waskada Unit No. 21 Historical Production                             |
| Figure 5  | Waskada Unit No. 21 Development Plan                                  |
| Figure 6  | Waskada Units 16 and 17 Waterflood Production Profile                 |
| Figure 7  | Waskada Unit 21 Primary Recovery – Rate v. Time                       |
| Figure 8  | Waskada Unit 21 Primary Recovery – Rate v. Cumulative Oil             |
| Figure 9  | Waskada Unit 21 Primary + Secondary Recovery – Rate v. Time           |
| Figure 10 | Waskada Unit 21 Primary + Secondary Recovery – Rate v. Cumulative Oil |
| Figure 11 | Waskada 11-30-001-25W1 Water Injection System                         |
| Figure 12 | Typical Water Injection Surface Wellhead Piping Diagram               |
| Figure 13 | Typical Downhole WIW Wellbore Schematic Cemented Liner                |
| Figure 14 | Planned Corrosion Program                                             |

Figure No. 1

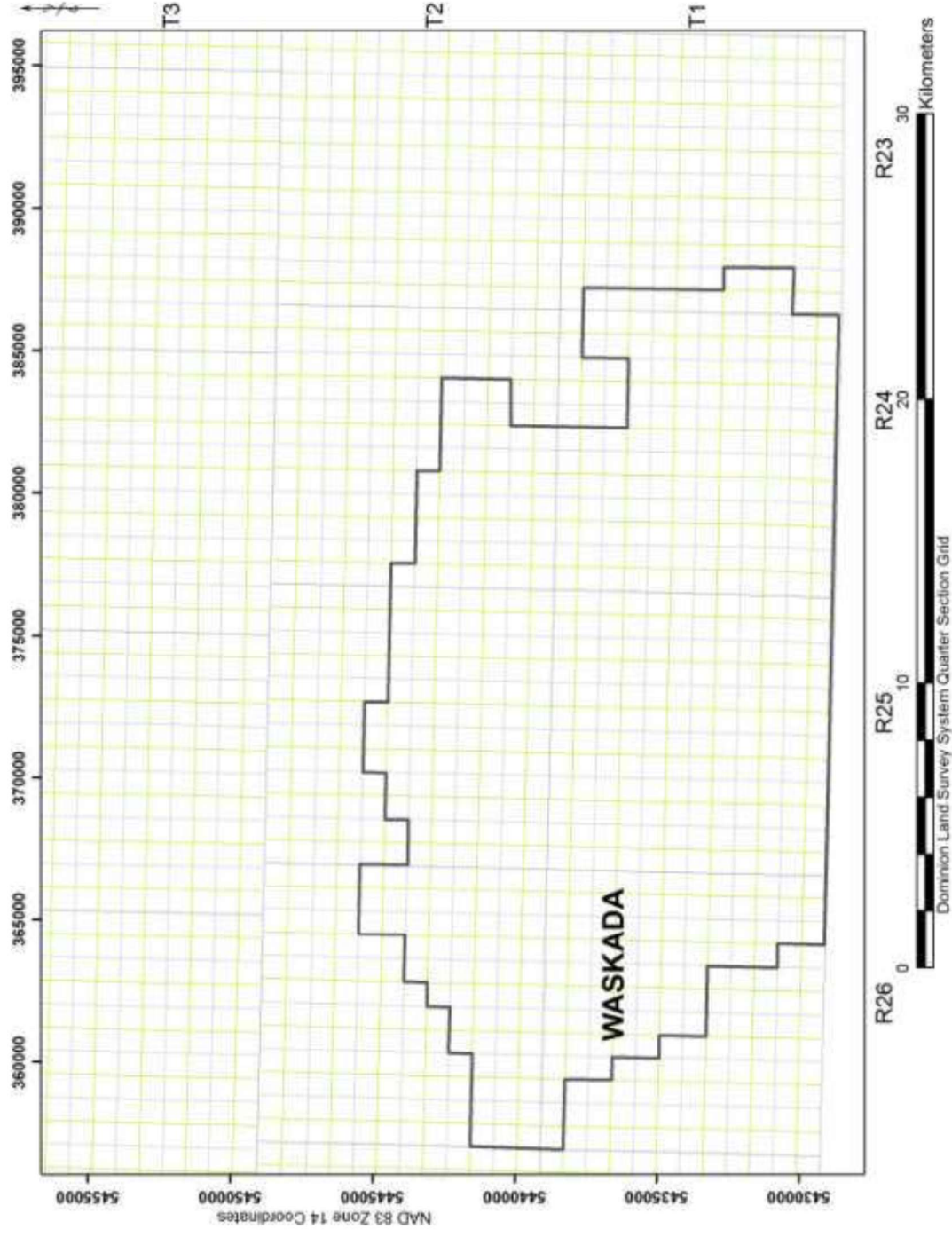
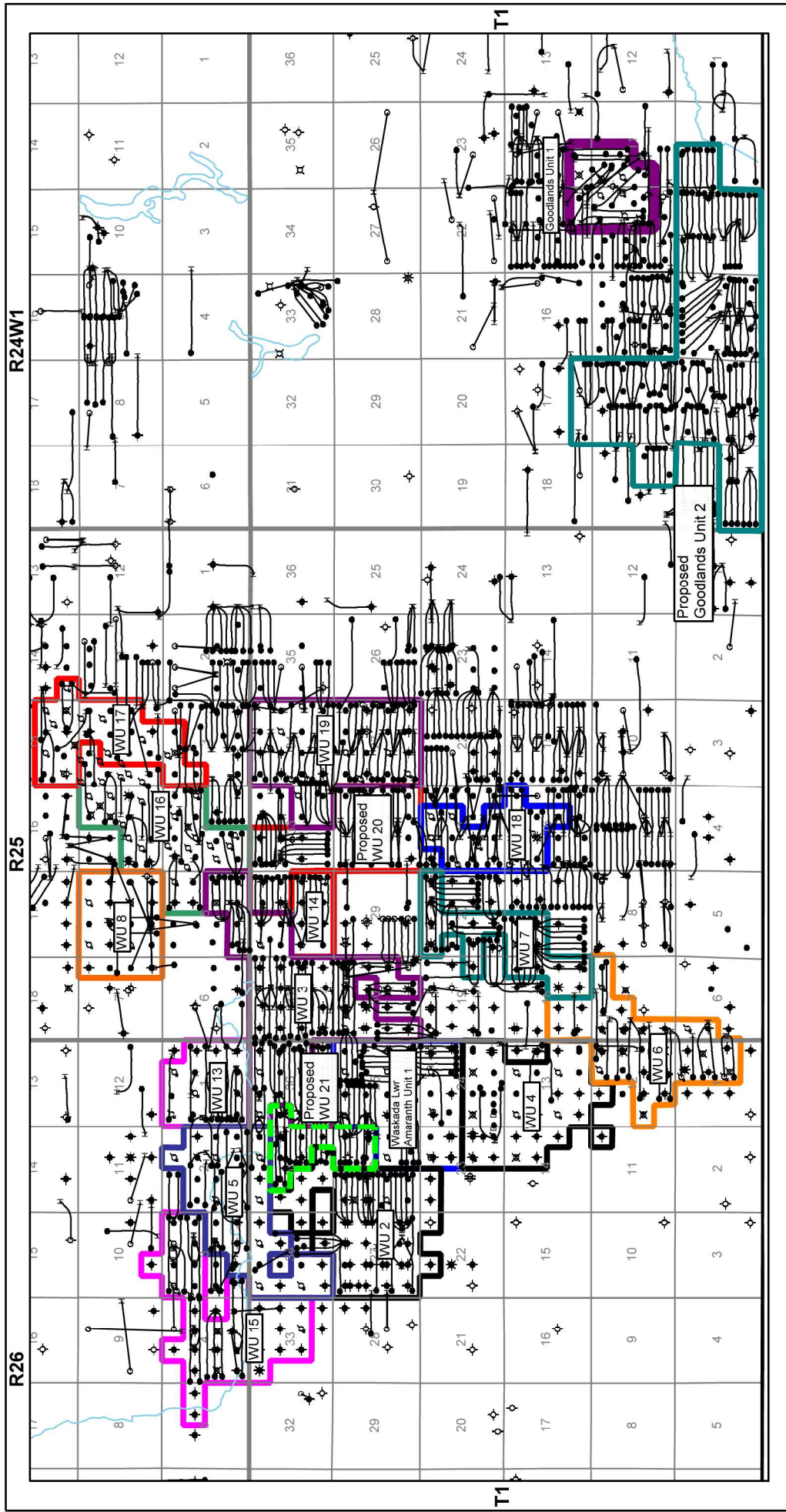


Figure 4 - Waskada Field (03)



Datum: NAD27 Projection: Stereographic DLS Version AB: ATS 2.6, BC: PRB 2.0, SK: STS 2.5, MB: ML107





Figure No. 3

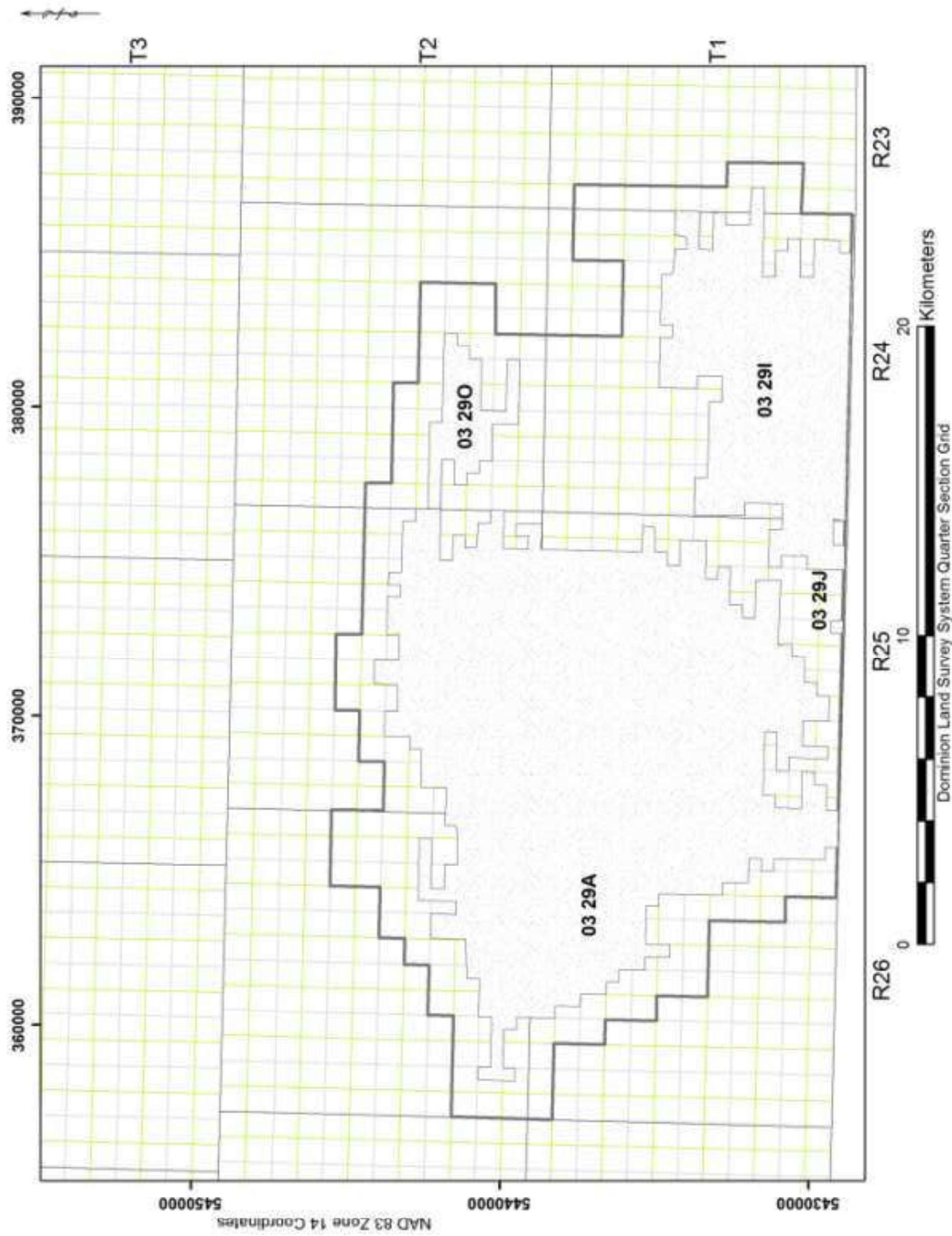
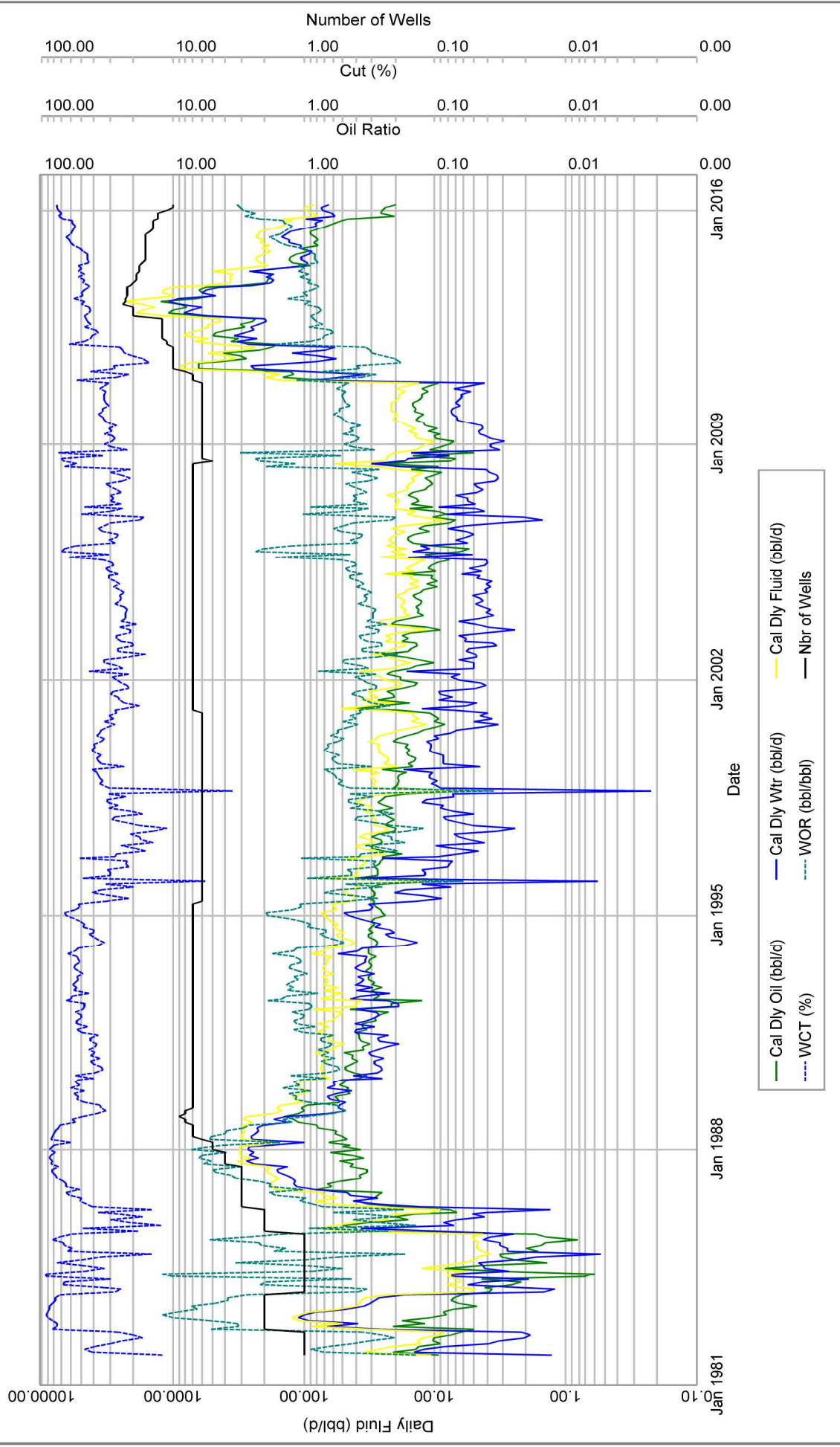


Figure 18 - Waskada Lower Amaranth Pools (03 29A, I, J, K & O)

Production Graph

|                    |                                                                |                   |                    |                     |              |
|--------------------|----------------------------------------------------------------|-------------------|--------------------|---------------------|--------------|
| <b>Group:</b>      | proposed waskada unit no. 21.lwell                             | <b>On Prod:</b>   | 1981-11 to 2016-02 | <b>Cum Oil:</b>     | 829122.7 bbl |
| <b># of Wells:</b> | 32                                                             | <b>Prod Form:</b> | AMRNTHL            | <b>Cum Gas:</b>     | 8468.8 mcf   |
| <b>Fluid:</b>      | Oil                                                            | <b>Field:</b>     | WASKADA (3)        | <b>Cum Wtr:</b>     | 766125.4 bbl |
| <b>Mode:</b>       | Comingled; Abandoned; Pumping;<br>Producing; Abandoned Zone... | <b>Pool Code:</b> | 29A                | <b>Cum Inj Oil:</b> | 0.0 bbl      |
|                    |                                                                | <b>Unit Code:</b> | 329A02             | <b>Cum Inj Gas:</b> | 0.0 mcf      |
|                    |                                                                |                   |                    | <b>Cum Inj Wtr:</b> | 0.0 bbl      |





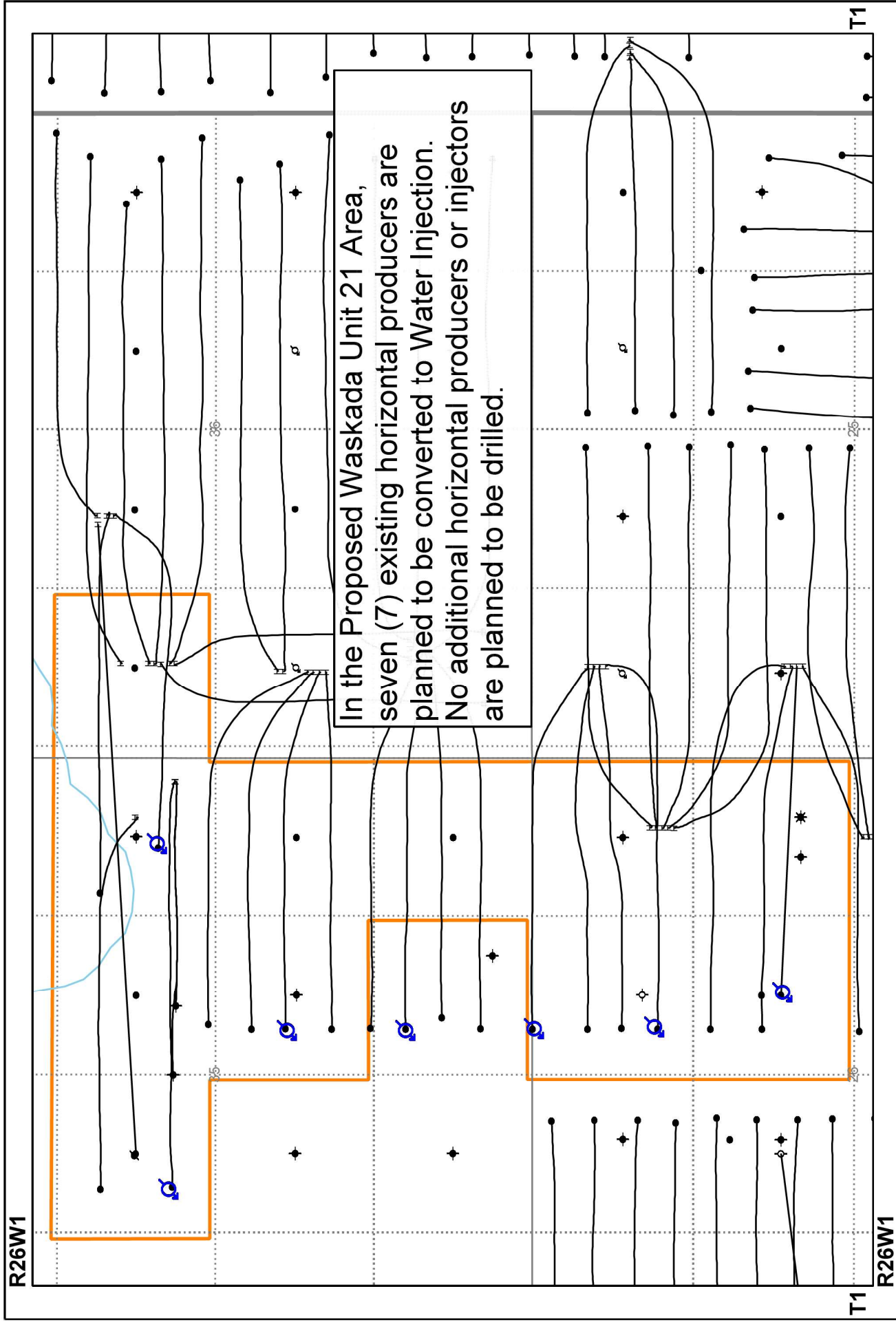


Figure No. 5



Well Information as of 12/4/2015 - Group Well Report

Production Graph

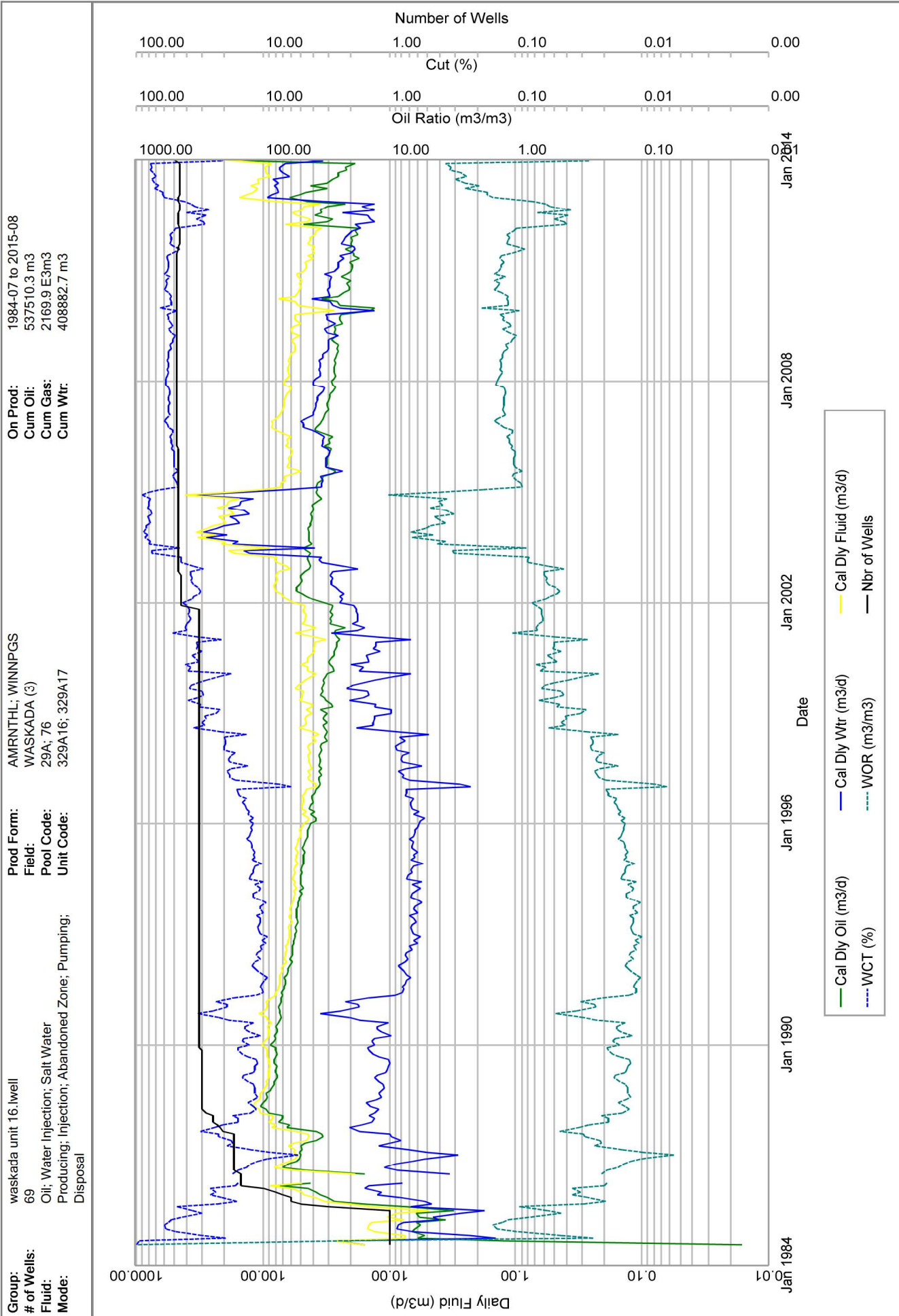
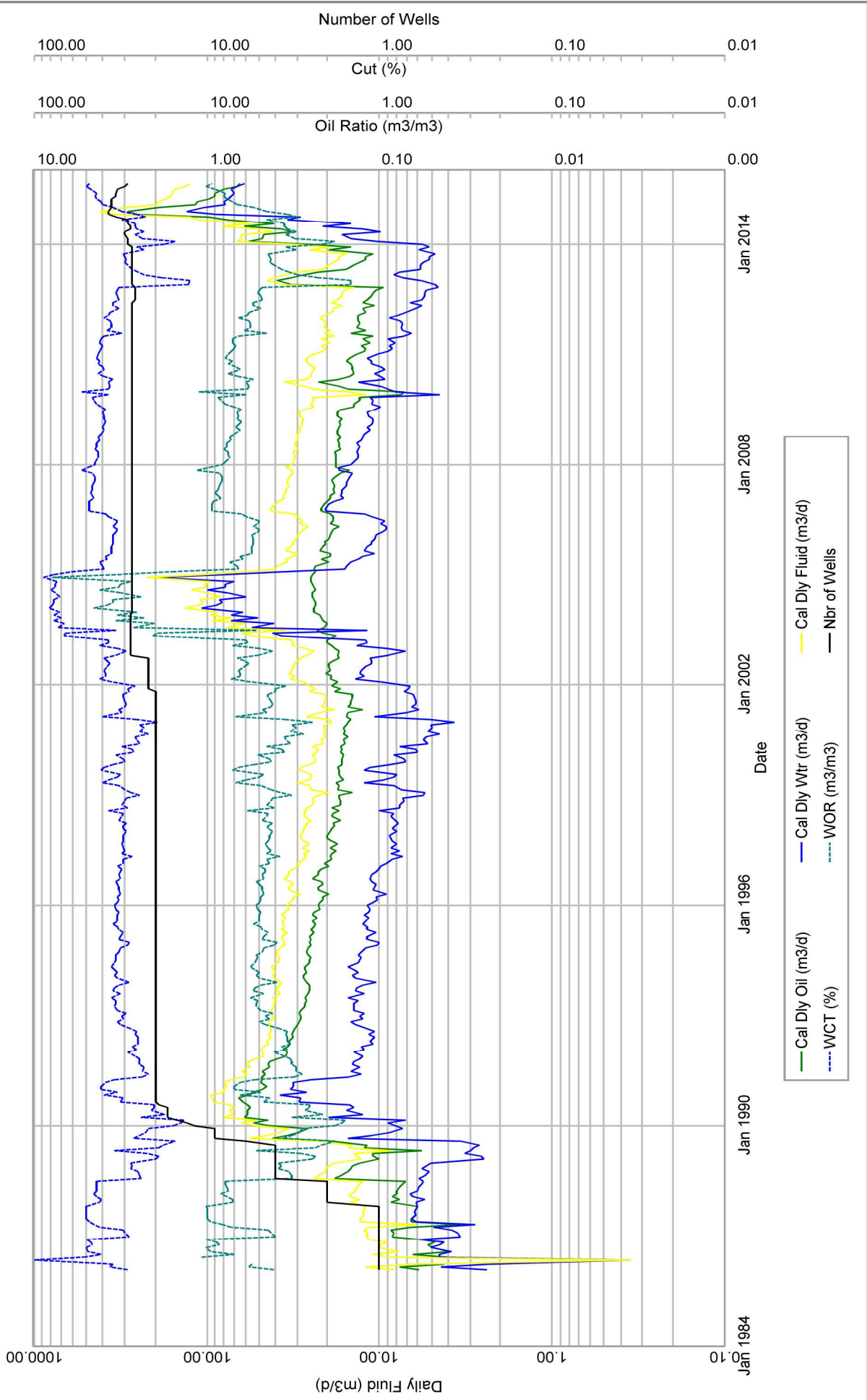


Figure No. 6b

Well Information as of 12/4/2015 - Group Well Report

Production Graph

|             |                                               |            |             |          |                    |
|-------------|-----------------------------------------------|------------|-------------|----------|--------------------|
| Group:      | waskada unit 17.lwell                         | Prod Form: | AMRNTHL     | On Prod: | 1986-01 to 2015-08 |
| # of Wells: | 41                                            | Field:     | WASKADA (3) | Cum Oil: | 270643.6 m3        |
| Fluid:      | Oil; Water Injection                          | Pool Code: | 29A         | Cum Gas: | 1105.9 E3m3        |
| Mode:       | Producing; Pumping; Injection; Abandoned Zone | Unit Code: | 329A17      | Cum Wtr: | 178020.3 m3        |



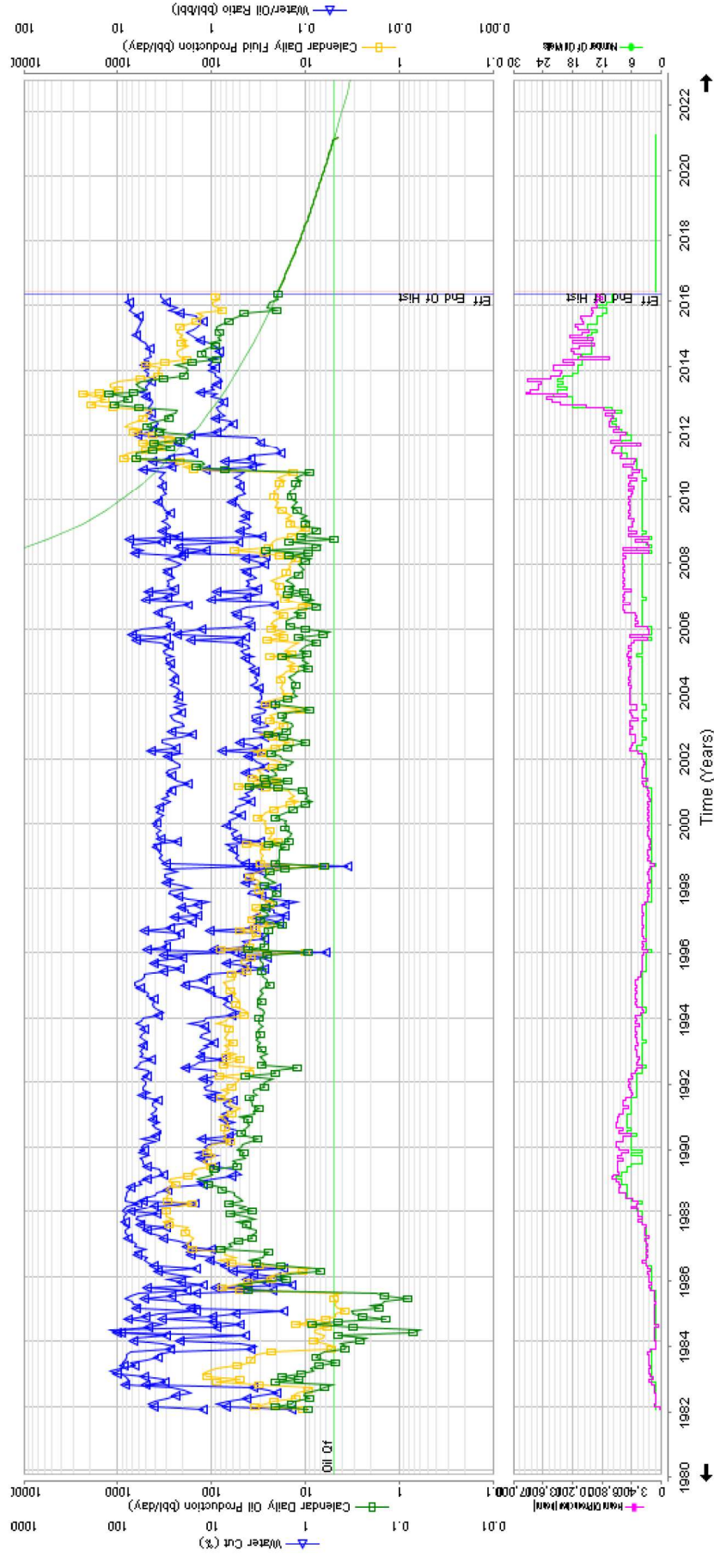
# PRODUCTION AND FORECAST

Figure No. 7

Effective May 01, 2016

Operator: Manitoba  
Province: multi zone (32)  
Field: multi zone (32)  
Pool: multi zone (32)  
Unit: multi zone (32)  
Status:

Waskada Unit 21  
Waskada Unit 21 Base  
Base



|                             |            |                          |           |                        |         |                      |       |
|-----------------------------|------------|--------------------------|-----------|------------------------|---------|----------------------|-------|
| Oil Cum (bbl)               | 830,339    | Gas Cum (Mcf)            | 8,469     | Water Cum (bbl)        | 770,019 | FCond Cum (bbl)      | 0     |
| Oil Rem Rec (bbl)           | 17,843     | Gas Rem Rec (Mcf)        | 0         | Water Rem Rec (bbl)    | 0       | FCond Rem Rec (bbl)  | 0     |
| Oil Ult Rec (bbl)           | 848,182    | Gas Ult Rec (Mcf)        | 8,469     | Water Ult Rec (bbl)    | 770,019 | FCond Ult Rec (bbl)  | 0     |
| Forecast Start (T0)         | 05/01/2016 | Calculation Type         | Undefined | Est Cum Prod (bbl)     | 830,339 | Decline Exp          | 0.300 |
| Forecast End (T1)           | 02/05/2021 | OVIIP (Volumetric) (bbl) | 0         | Remaining Rec (bbl)    | 17,843  | Initial Decline (De) | 30.0  |
| Initial Rate (qi) (bbl/day) | 19.5       | Rec Factor (Volumetric)  | 0.000     | Gas Surface Loss (Mcf) | 0.0     | Reserve Life Index   | 2.93  |
| Final Rate (qf) (bbl/day)   | 5.0        | Ult Recoverable (bbl)    | 848,182   | Gas Total Sales (Mcf)  | 0       | Reserve Half Life    | 1.62  |



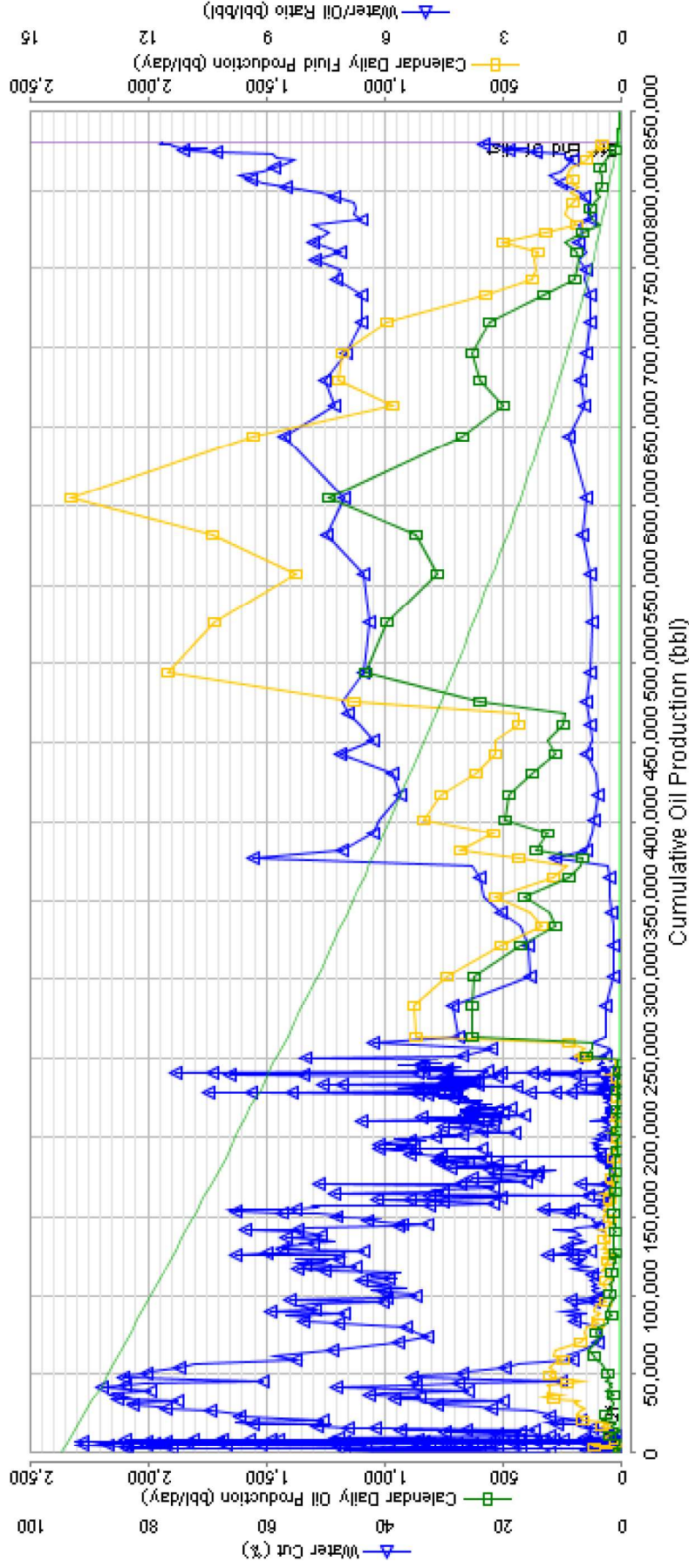
# PRODUCTION AND FORECAST

Figure No. 8

Effective May 01, 2016

Operator: Manitoba  
Province: multi zone (32)  
Field: multi zone (32)  
Pool: multi zone (32)  
Unit: multi zone (32)  
Status:

Waskada Unit 21  
Waskada Unit 21 Base  
Base



|                             |            |                         |           |                        |         |                      |       |
|-----------------------------|------------|-------------------------|-----------|------------------------|---------|----------------------|-------|
| Oil Cum (bbl)               | 830,339    | Gas Cum (Mcf)           | 8,469     | Water Cum (bbl)        | 770,319 | FCond Cum (bbl)      | 0     |
| Oil Rem Rec (bbl)           | 17,843     | Gas Rem Rec (Mcf)       | 0         | Water Rem Rec (bbl)    | 0       | FCond Rem Rec (bbl)  | 0     |
| Oil Ult Rec (bbl)           | 848,182    | Gas Ult Rec (Mcf)       | 8,469     | Water Ult Rec (bbl)    | 770,319 | FCond Ult Rec (bbl)  | 0     |
| Forecast Start (T0)         | 05/01/2016 | Calculation Type        | Undefined | Est Cum Prod (bbl)     | 830,339 | Decline Exp          | 0.300 |
| Forecast End (T1)           | 02/05/2021 | OVIP (Volumetric)       | 0         | Remaining Rec (bbl)    | 17,843  | Initial Decline (De) | 30.0  |
| Initial Rate (qi) (bbl/day) | 19.5       | Rec Factor (Volumetric) | 0.000     | Gas Surface Loss (bbl) | 0.0     | Reserve Life Index   | 2.93  |
| Final Rate (qf) (bbl/day)   | 5.0        | Ult Recoverable (bbl)   | 848,182   | Gas Total Sales (Mcf)  | 0       | Reserve Half Life    | 1.62  |



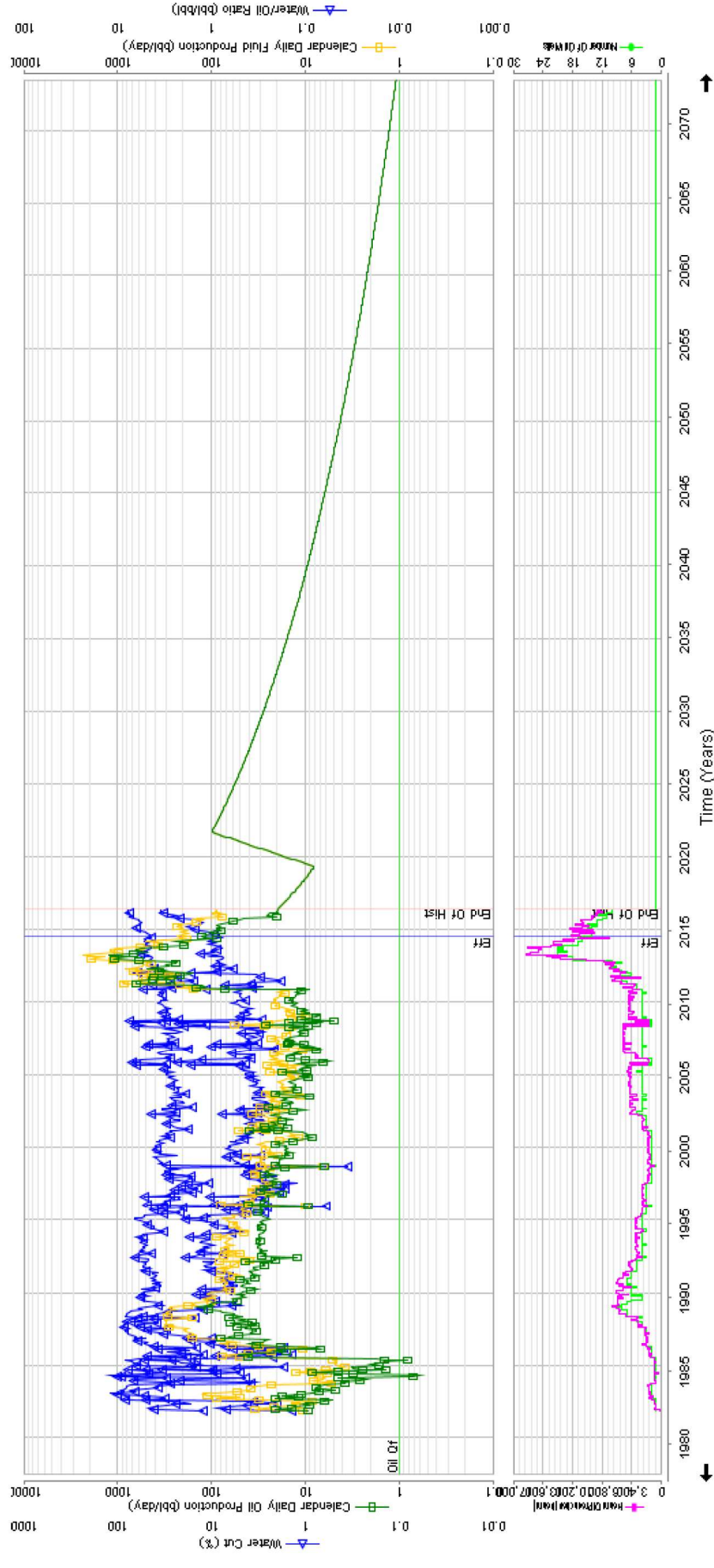
# PRODUCTION AND FORECAST

Figure No. 9

Effective July 01, 2014

Operator: Manitoba  
Province: multi zone (32)  
Field: multi zone (32)  
Pool: multi zone (32)  
Unit: multi zone (32)  
Status:

Waskada Unit 21  
Waskada Unit 21 Base  
Base + Growth: 1



|                             |            |                         |           |                        |         |                      |       |
|-----------------------------|------------|-------------------------|-----------|------------------------|---------|----------------------|-------|
| Oil Cum (bbl)               | 788,078    | Gas Cum (Mcf)           | 0         | Water Cum (bbl)        | 707,400 | FCond Cum (bbl)      | 0     |
| Oil Rem Rec (bbl)           | 356,967    | Gas Rem Rec (Mcf)       | 8,469     | Water Rem Rec (bbl)    | 62,519  | FCond Rem Rec (bbl)  | 0     |
| Oil Ult Rec (bbl)           | 1,145,045  | Gas Ult Rec (Mcf)       | 8,469     | Water Ult Rec (bbl)    | 770,319 | FCond Ult Rec (bbl)  | 0     |
| Forecast Start (T0)         | 07/01/2014 | Calculation Type        | Undefined | Est Cum Prod (bbl)     | 788,078 | Decline Exp          | 0.300 |
| Forecast End (T1)           | 02/04/2075 | OVIP (Volumetric) (bbl) | 0         | Remaining Rec (bbl)    | 356,967 | Initial Decline (De) | 30.0  |
| Initial Rate (qi) (bbl/day) | 126.5      | Rec Factor (Volumetric) | 0.000     | Gas Surface Loss (bbl) | 0.0     | Reserve Life Index   | 10.87 |
| Final Rate (qf) (bbl/day)   | 1.0        | Ult Recoverable (bbl)   | 1,145,045 | Gas Total Sales (Mcf)  | 8,469   | Reserve Half Life    | 10.46 |

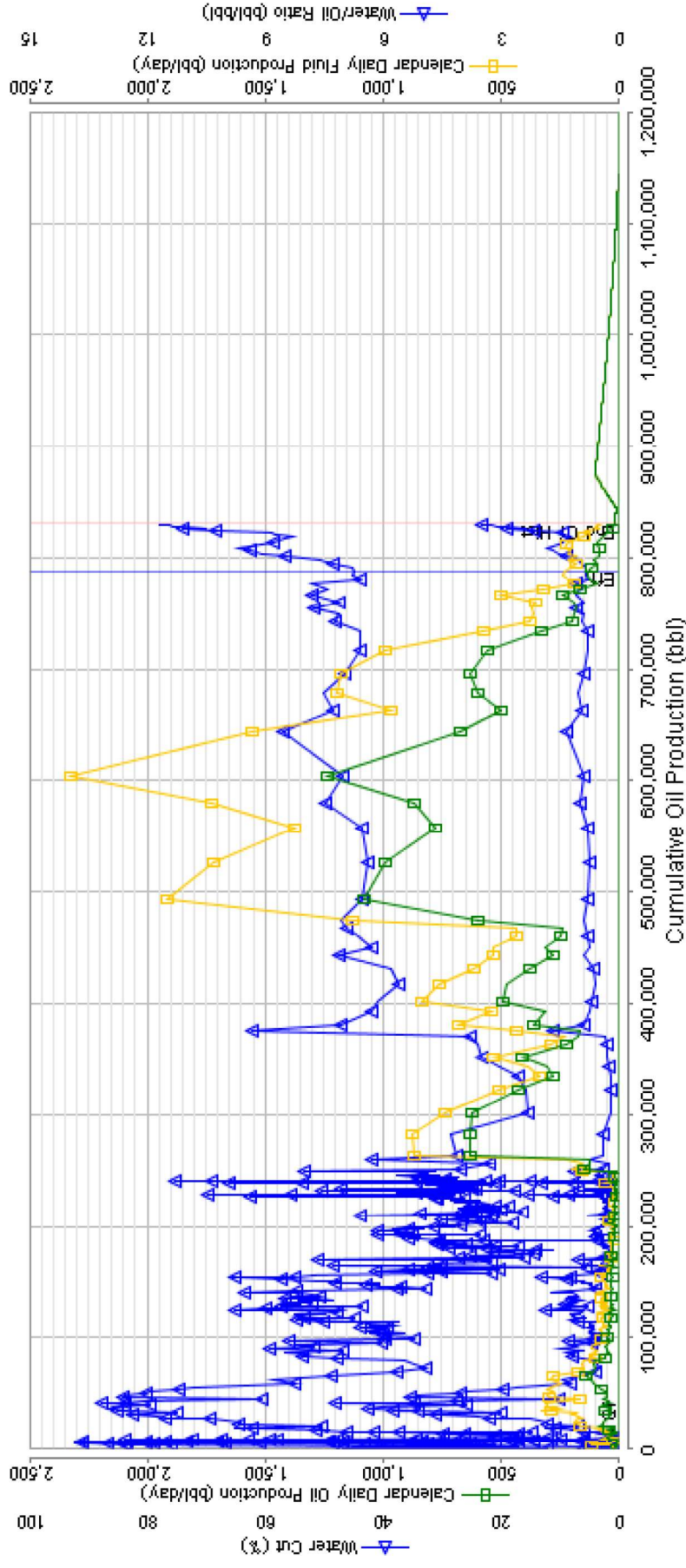
# PRODUCTION AND FORECAST

Figure No. 10

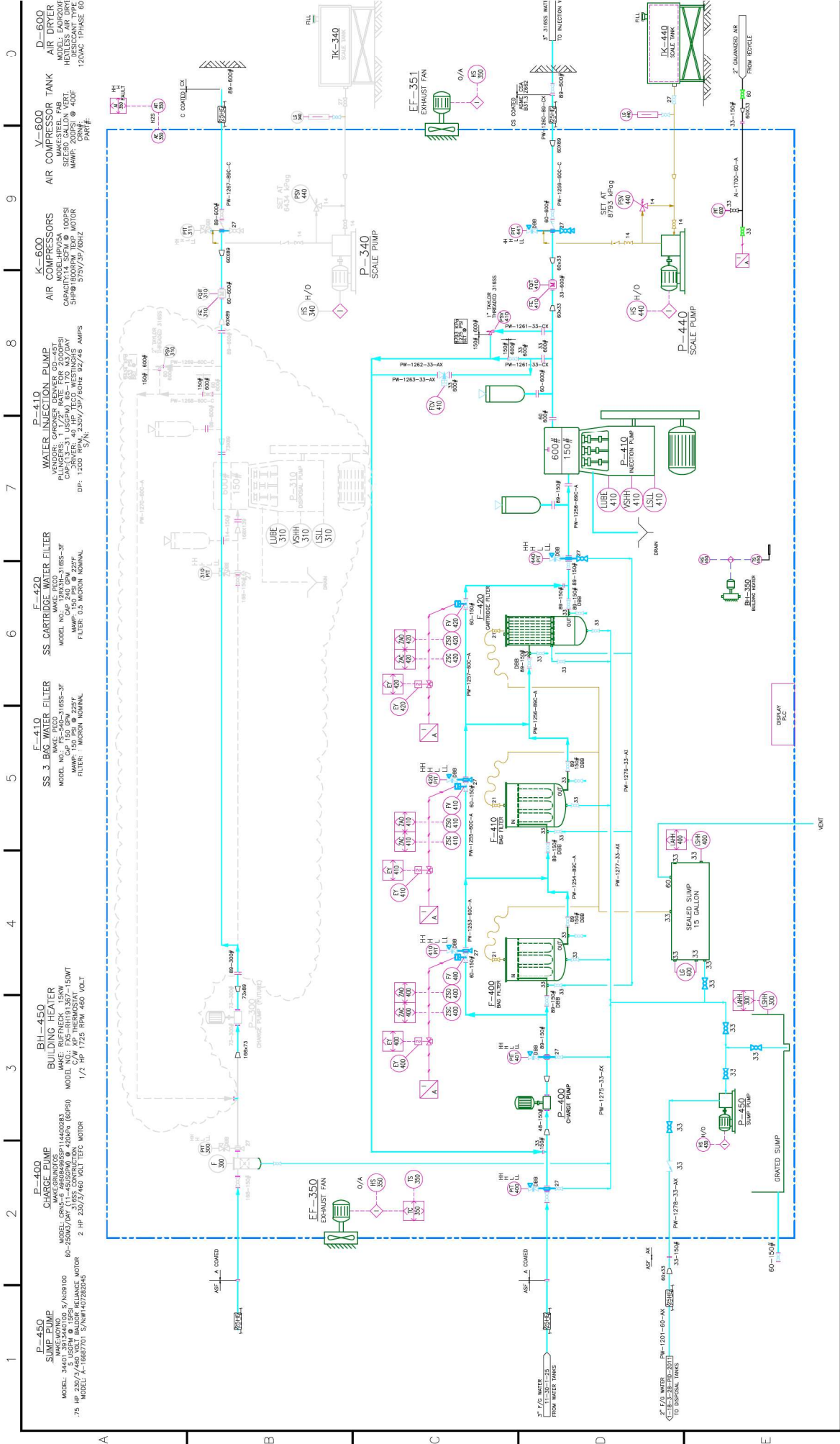
Effective July 01, 2014

Operator: Manitoba  
Province: multi zone (32)  
Field: multi zone (32)  
Pool: multi zone (32)  
Unit: multi zone (32)  
Status:

Waskada Unit 21  
Waskada Unit 21 Base  
Base + Growth 1



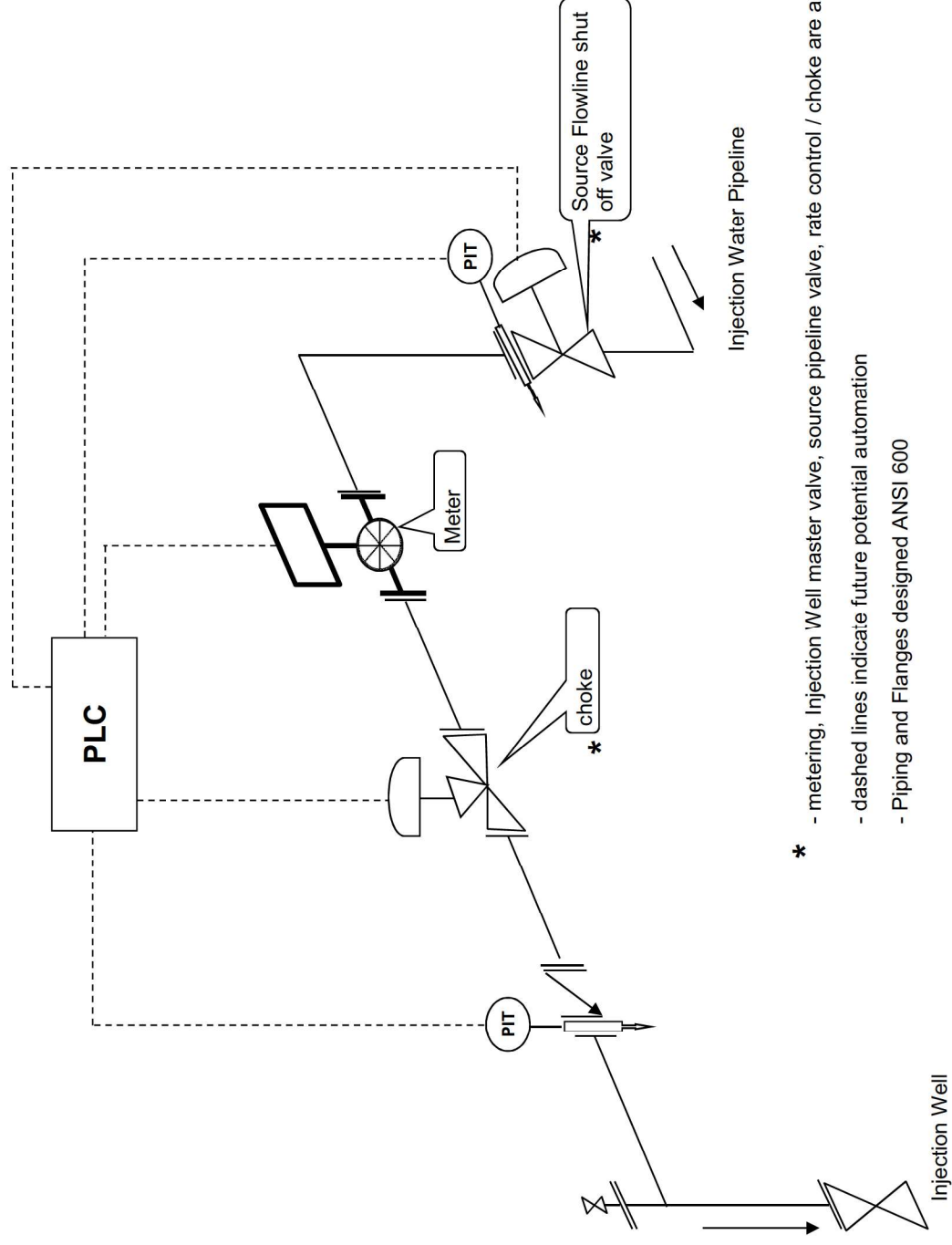
|                             |            |                         |           |                        |         |                      |       |
|-----------------------------|------------|-------------------------|-----------|------------------------|---------|----------------------|-------|
| Oil Cum (bbl)               | 788,078    | Gas Cum (Mcf)           | 0         | Water Cum (bbl)        | 707,400 | FCond Cum (bbl)      | 0     |
| Oil Rem Rec (bbl)           | 356,967    | Gas Rem Rec (Mcf)       | 8,469     | Water Rem Rec (bbl)    | 62,519  | FCond Rem Rec (bbl)  | 0     |
| Oil Ult Rec (bbl)           | 1,145,045  | Gas Ult Rec (Mcf)       | 8,469     | Water Ult Rec (bbl)    | 770,319 | FCond Ult Rec (bbl)  | 0     |
| Forecast Start (T0)         | 07/01/2014 | Calculation Type        | Undefined | Est Cum Prod (bbl)     | 788,078 | Decline Exp          | 0.300 |
| Forecast End (T1)           | 02/04/2075 | OVIP (Volumetric)       | 0         | Remaining Rec (bbl)    | 356,967 | Initial Decline (De) | 30.0  |
| Initial Rate (qi) (bbl/day) | 126.5      | Rec Factor (Volumetric) | 0.000     | Gas Surface Loss (bbl) | 0.0     | Reserve Life Index   | 10.87 |
| Final Rate (qf) (bbl/day)   | 1.0        | Ult Recoverable (bbl)   | 1,145,045 | Gas Total Sales (Mcf)  | 8,469   | Reserve Half Life    | 10.46 |



|                                                                                                                               |  |                                                                                                                                |  |                                                                                                               |  |                                                                                                             |  |                                                                                                                     |  |                                                                                                                                                                                                                                                                                                                                                                                                    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| P-450<br>SUMP PUMP<br>MODEL 34010-301340100 5/NA09100<br>75 HP 320/340 VOLT 3-1504 AIR LINE<br>MODEL A-1688701 5/NA1407282045 |  | P-400<br>CHARGE PUMP<br>MODEL GRW-4-48000000011400083<br>60-25000/0-25000 3-1504 AIR LINE<br>2 HP 230/340 VOLT 3-1504 AIR LINE |  | BH-450<br>BUILDING HEATER<br>MAKE: RUFFNECK 150W 150WT<br>MODEL C/W 4P THERMOSTAT<br>1/2 HP 1725 RPM 460 VOLT |  | F-410<br>SS 3 BAG WATER FILTER<br>MODEL NO. FS-50-3168S-3F<br>MAMP 150 PSI @ 2227<br>FILTER: MICRON NOMINAL |  | F-420<br>SS CARTRIDGE WATER FILTER<br>MODEL NO. FS-50-3168S-3F<br>MAMP 150 PSI @ 2227<br>FILTER: 0.5 MICRON NOMINAL |  | P-410<br>WATER INJECTION PUMP<br>VARIABLE SPEED DRIVE<br>CAPACITY: 100 GPM<br>DRIVER: 40 HP TECO WESTINGHOUSE<br>DP: 120 PSI @ 35/50/60/70/80/90/100/110/120/130/140/150/160/170/180/190/200/210/220/230/240/250/260/270/280/290/300/310/320/330/340/350/360/370/380/390/400/410/420/430/440/450/460/470/480/490/500/510/520/530/540/550/560/570/580/590/600/610/620/630/640/650/660/670/680/690/700/710/720/730/740/750/760/770/780/790/800/810/820/830/840/850/860/870/880/890/900/910/920/930/940/950/960/970/980/990/1000/1010/1020/1030/1040/1050/1060/1070/1080/1090/1100/1110/1120/1130/1140/1150/1160/1170/1180/1190/1200/1210/1220/1230/1240/1250/1260/1270/1280/1290/1300/1310/1320/1330/1340/1350/1360/1370/1380/1390/1400/1410/1420/1430/1440/1450/1460/1470/1480/1490/1500/1510/1520/1530/1540/1550/1560/1570/1580/1590/1600/1610/1620/1630/1640/1650/1660/1670/1680/1690/1700/1710/1720/1730/1740/1750/1760/1770/1780/1790/1800/1810/1820/1830/1840/1850/1860/1870/1880/1890/1900/1910/1920/1930/1940/1950/1960/1970/1980/1990/2000/2010/2020/2030/2040/2050/2060/2070/2080/2090/2100/2110/2120/2130/2140/2150/2160/2170/2180/2190/2200/2210/2220/2230/2240/2250/2260/2270/2280/2290/2300/2310/2320/2330/2340/2350/2360/2370/2380/2390/2400/2410/2420/2430/2440/2450/2460/2470/2480/2490/2500/2510/2520/2530/2540/2550/2560/2570/2580/2590/2600/2610/2620/2630/2640/2650/2660/2670/2680/2690/2700/2710/2720/2730/2740/2750/2760/2770/2780/2790/2800/2810/2820/2830/2840/2850/2860/2870/2880/2890/2900/2910/2920/2930/2940/2950/2960/2970/2980/2990/3000/3010/3020/3030/3040/3050/3060/3070/3080/3090/3100/3110/3120/3130/3140/3150/3160/3170/3180/3190/3200/3210/3220/3230/3240/3250/3260/3270/3280/3290/3300/3310/3320/3330/3340/3350/3360/3370/3380/3390/3400/3410/3420/3430/3440/3450/3460/3470/3480/3490/3500/3510/3520/3530/3540/3550/3560/3570/3580/3590/3600/3610/3620/3630/3640/3650/3660/3670/3680/3690/3700/3710/3720/3730/3740/3750/3760/3770/3780/3790/3800/3810/3820/3830/3840/3850/3860/3870/3880/3890/3900/3910/3920/3930/3940/3950/3960/3970/3980/3990/4000/4010/4020/4030/4040/4050/4060/4070/4080/4090/4100/4110/4120/4130/4140/4150/4160/4170/4180/4190/4200/4210/4220/4230/4240/4250/4260/4270/4280/4290/4300/4310/4320/4330/4340/4350/4360/4370/4380/4390/4400/4410/4420/4430/4440/4450/4460/4470/4480/4490/4500/4510/4520/4530/4540/4550/4560/4570/4580/4590/4600/4610/4620/4630/4640/4650/4660/4670/4680/4690/4700/4710/4720/4730/4740/4750/4760/4770/4780/4790/4800/4810/4820/4830/4840/4850/4860/4870/4880/4890/4900/4910/4920/4930/4940/4950/4960/4970/4980/4990/5000/5010/5020/5030/5040/5050/5060/5070/5080/5090/5100/5110/5120/5130/5140/5150/5160/5170/5180/5190/5200/5210/5220/5230/5240/5250/5260/5270/5280/5290/5300/5310/5320/5330/5340/5350/5360/5370/5380/5390/5400/5410/5420/5430/5440/5450/5460/5470/5480/5490/5500/5510/5520/5530/5540/5550/5560/5570/5580/5590/5600/5610/5620/5630/5640/5650/5660/5670/5680/5690/5700/5710/5720/5730/5740/5750/5760/5770/5780/5790/5800/5810/5820/5830/5840/5850/5860/5870/5880/5890/5900/5910/5920/5930/5940/5950/5960/5970/5980/5990/6000/6010/6020/6030/6040/6050/6060/6070/6080/6090/6100/6110/6120/6130/6140/6150/6160/6170/6180/6190/6200/6210/6220/6230/6240/6250/6260/6270/6280/6290/6300/6310/6320/6330/6340/6350/6360/6370/6380/6390/6400/6410/6420/6430/6440/6450/6460/6470/6480/6490/6500/6510/6520/6530/6540/6550/6560/6570/6580/6590/6600/6610/6620/6630/6640/6650/6660/6670/6680/6690/6700/6710/6720/6730/6740/6750/6760/6770/6780/6790/6800/6810/6820/6830/6840/6850/6860/6870/6880/6890/6900/6910/6920/6930/6940/6950/6960/6970/6980/6990/7000/7010/7020/7030/7040/7050/7060/7070/7080/7090/7100/7110/7120/7130/7140/7150/7160/7170/7180/7190/7200/7210/7220/7230/7240/7250/7260/7270/7280/7290/7300/7310/7320/7330/7340/7350/7360/7370/7380/7390/7400/7410/7420/7430/7440/7450/7460/7470/7480/7490/7500/7510/7520/7530/7540/7550/7560/7570/7580/7590/7600/7610/7620/7630/7640/7650/7660/7670/7680/7690/7700/7710/7720/7730/7740/7750/7760/7770/7780/7790/7800/7810/7820/7830/7840/7850/7860/7870/7880/7890/7900/7910/7920/7930/7940/7950/7960/7970/7980/7990/8000/8010/8020/8030/8040/8050/8060/8070/8080/8090/8100/8110/8120/8130/8140/8150/8160/8170/8180/8190/8200/8210/8220/8230/8240/8250/8260/8270/8280/8290/8300/8310/8320/8330/8340/8350/8360/8370/8380/8390/8400/8410/8420/8430/8440/8450/8460/8470/8480/8490/8500/8510/8520/8530/8540/8550/8560/8570/8580/8590/8600/8610/8620/8630/8640/8650/8660/8670/8680/8690/8700/8710/8720/8730/8740/8750/8760/8770/8780/8790/8800/8810/8820/8830/8840/8850/8860/8870/8880/8890/8900/8910/8920/8930/8940/8950/8960/8970/8980/8990/9000/9010/9020/9030/9040/9050/9060/9070/9080/9090/9100/9110/9120/9130/9140/9150/9160/9170/9180/9190/9200/9210/9220/9230/9240/9250/9260/9270/9280/9290/9300/9310/9320/9330/9340/9350/9360/9370/9380/9390/9400/9410/9420/9430/9440/9450/9460/9470/9480/9490/9500/9510/9520/9530/9540/9550/9560/9570/9580/9590/9600/9610/9620/9630/9640/9650/9660/9670/9680/9690/9700/9710/9720/9730/9740/9750/9760/9770/9780/9790/9800/9810/9820/9830/9840/9850/9860/9870/9880/9890/9900/9910/9920/9930/9940/9950/9960/9970/9980/9990/10000/10010/10020/10030/10040/10050/10060/10070/10080/10090/10100/10110/10120/10130/10140/10150/10160/10170/10180/10190/10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0/18540/18550/18560/18570/18580/18590/18600/18610/18620/18630/18640/18650/18660/18670/18680/18690/18700/18710/18720/18730/18740/18750/18760/18770/18780/18790/18800/18810/18820/18830/18840/18850/18860/18870/18880/18890/18900/18910/18920/18930/18940/18950/18960/18970/18980/18990/19000/19010/19020/19030/19040/19050/19060/19070/19080/19090/19100/19110/19120/19130/19140/19150/19160/19170/19180/19190/19200/19210/19220/19230/19240/19250/19260/19270/19280/19290/19300/19310/19320/19330/19340/19350/19360/19370/19380/19390/19400/19410/19420/19430/19440/19450/19460/19470/19480/19490/19500/19510/19520/19530/19540/19550/19560/19570/19580/19590/19600/19610/19620/19630/19640/19650/19660/19670/19680/19690/19700/19710/19720/19730/19740/19750/19760/19770/19780/19790/19800/19810/19820/19830/19840/19850/19860/19870/19880/19890/19900/19910/19920/19930/19940/19950/19960/19970/19980/19990/20000/20010/20020/20030/20040/20050/20060/20070/20080/20090/20100/20110/20120/20130/20140/20150/20160/20170/20180/20190/20200/20210/20220/20230/20240/20250/20260/20270/20280/20290/20300/20310/20320/20330/20340/20350/20360/20370/20380/20390/20400/20410/20420/20430/20440/20450/20460/20470/20480/20490/20500/20510/20520/20530/20540/20550/20560/20570/20580/20590/20600/20610/20620/20630/20640/20650/20660/20670/20680/20690/20700/20710/20720/20730/20740/20750/20760/20770/20780/20790/20800/20810/20820/20830/20840/20850/20860/20870/20880/20890/20900/20910/20920/20930/20940/20950/20960/20970/20980/20990/21000/21010/21020/21030/21040/21050/21060/21070/21080/21090/21100/21110 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Proposed Injection Well Surface Piping P&ID

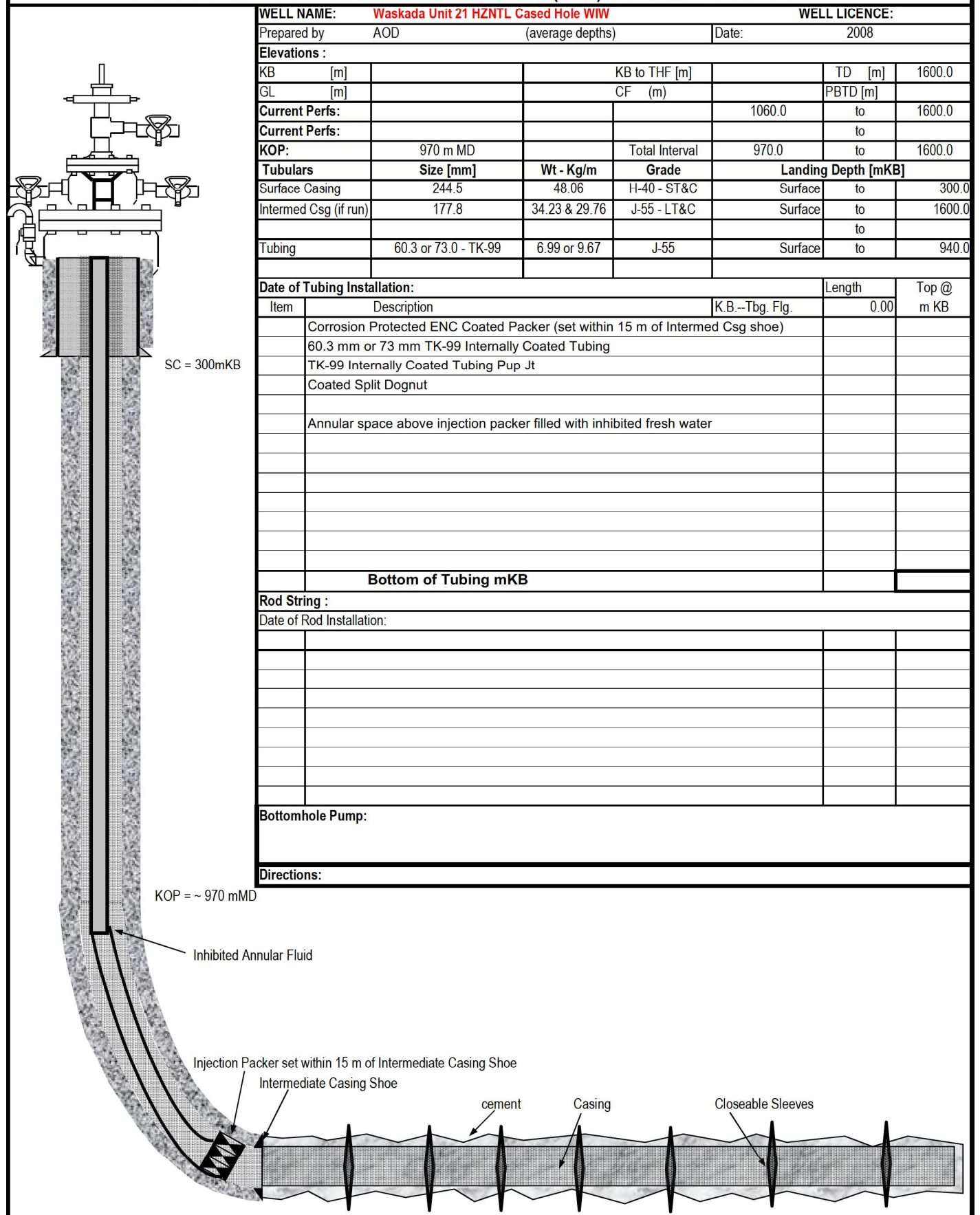


- \* - metering, Injection Well master valve, source pipeline valve, rate control / choke are all standard
- dashed lines indicate future potential automation
- Piping and Flanges designed ANSI 600

Figure No. 13

## Tundra Oil And Gas Partnership

### TYPICAL CASED HOLE WATER INJECTION WELL (WIW) DOWNHOLE DIAGRAM



## **Waskada Unit No. 21**

### **EOR Waterflood Project**

#### **Planned Corrosion Control Program \*\***

##### **Source Well**

- Continuous downhole corrosion inhibition
- Continuous surface corrosion inhibitor injection
- Downhole scale inhibitor injection
- Corrosion resistant valves and internally coated surface piping

##### **Pipelines**

- Source well to 11-30-1-25 Water Plant – Fiberglass
- New High Pressure Pipeline to Unit 9 injection wells – 2000 psi high pressure Fiberglass

##### **Facilities**

- 11-30-1-25 Water Plant and New Injection Pump Station
  - Plant piping – 600 ANSI schedule 80 pipe, Fiberglass or Internally coated
  - Filtration – Stainless steel bodies and PVC piping
  - Pumping – Ceramic plungers, stainless steel disc valves
  - Tanks – Fiberglass shell, corrosion resistant valves

##### **Injection Wellhead / Surface Piping**

- Corrosion resistant valves and stainless steel and/or internally coated steel surface piping

##### **Injection Well**

- Casing cathodic protection where required
- Wetted surfaces coated downhole packer
- Corrosion inhibited water in the annulus between tubing / casing
- Internally coated tubing surface to packer
- Surface freeze protection of annular fluid
- Corrosion resistant master valve
- Corrosion resistant pipeline valve

##### **Producing Wells**

- Casing cathodic protection where required
- Downhole batch corrosion inhibition as required
- Downhole scale inhibitor injection as required

**Figure 14**

\*\* subject to final design and engineering



**Proposed Waskada Unit No. 21  
Application for Enhanced Oil Recovery Waterflood Project**

**List of Tables**

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| Table 1 | Tract Participation                        |
| Table 2 | Tract Factor Calculation                   |
| Table 3 | Current Well List and Status               |
| Table 4 | Original Oil in Place and Recovery Factors |
| Table 5 | Reservoir and Fluid Properties             |

**TABLE NO. 1: TRACT PARTICIPATION FOR PROPOSED WASKADA UNIT NO. 21**

| Tract No. | Working Interest |                    | Royalty Interest |                         | Tract Participation |                |
|-----------|------------------|--------------------|------------------|-------------------------|---------------------|----------------|
|           | Land Description | Owner              | Share (%)        | Owner                   | Share (%)           | Tract (%)      |
| 1         | 09-26-001-26W1M  | Tundra Oil and Gas | 100%             | Rowe Mini Ltd.          | 100%                | 11.826959161%  |
| 2         | 10-26-001-26W1M  | Tundra Oil and Gas | 100%             | Rowe Mini Ltd.          | 100%                | 10.271275095%  |
| 3         | 15-26-001-26W1M  | Tundra Oil and Gas | 100%             | Rowe Mini Ltd.          | 100%                | 10.057433071%  |
| 4         | 16-26-001-26W1M  | Tundra Oil and Gas | 100%             | Rowe Mini Ltd.          | 100%                | 9.466998509%   |
| 5         | 01-35-001-26W1M  | Tundra Oil and Gas | 100%             | Moamco Enterprises Ltd. | 100%                | 13.130365090%  |
| 6         | 07-35-001-26W1M  | Tundra Oil and Gas | 100%             | Moamco Enterprises Ltd. | 100%                | 11.762555536%  |
| 7         | 08-35-001-26W1M  | Tundra Oil and Gas | 100%             | Moamco Enterprises Ltd. | 100%                | 11.719188790%  |
| 8         | 09-35-001-26W1M  | Tundra Oil and Gas | 100%             | Lee Oil Ltd.            | 100%                | 5.724551332%   |
| 9         | 10-35-001-26W1M  | Tundra Oil and Gas | 100%             | Lee Oil Ltd.            | 100%                | 5.777224768%   |
| 10        | 11-35-001-26W1M  | Tundra Oil and Gas | 100%             | Lee Oil Ltd.            | 100%                | 5.817067319%   |
| 11        | 12-36-001-26W1M  | Tundra Oil and Gas | 100%             | Lee Oil Ltd.            | 100%                | 4.446381328%   |
|           |                  |                    |                  |                         |                     | 100.000000000% |

**TABLE NO. 2: TRACT FACTOR CALCULATIONS FOR WASKADA UNIT NO. 21**  
**TRACT FACTORS BASED ON OIL-IN-PLACE (OOIP) - CUMULATIVE PRODUCTION & LAST 12 MONTHS OF PRODUCTION TO APRIL 2016**

| LS-SE | Tract           | OOIP (m3)        | HZ Wells Cum Alloc Prod (m3) | Vert Wells Cum Prodn (m3) | Sum HZ + Vert Alloc Cum Prodn | OOIP - Cum       | OOIP-Cum by LSD/Total OOIP | Last 12 Months Alloc Prod (m3) | Vt Wells Last 12 Months Prod (m3) | Sum HZ + Vert Alloc Last 12 Months Prod (m3) | Alloc Last 12 Months Prod by LSD/Total Prod | 50% OOIP-Cum + 50% Last 12 Months Prod Tract Factor | Tract           |
|-------|-----------------|------------------|------------------------------|---------------------------|-------------------------------|------------------|----------------------------|--------------------------------|-----------------------------------|----------------------------------------------|---------------------------------------------|-----------------------------------------------------|-----------------|
| 09-26 | 09-26-001-26W1M | 121,261          | 7,516.8                      | 666.0                     | 8,182.8                       | 113,078          | 0.086303108                | 262.9                          | 0.0                               | 262.9                                        | 0.150236076                                 | 0.118269592                                         | 09-26-001-26W1M |
| 10-26 | 10-26-001-26W1M | 117,941          | 5,981.2                      | 4.8                       | 5,986.0                       | 111,955          | 0.085446253                | 209.9                          | 0.0                               | 209.9                                        | 0.119979249                                 | 0.102712751                                         | 10-26-001-26W1M |
| 15-26 | 15-26-001-26W1M | 129,107          | 8,453.9                      | 0.0                       | 8,453.9                       | 120,653          | 0.092084299                | 190.8                          | 0.0                               | 190.8                                        | 0.109064363                                 | 0.100574331                                         | 15-26-001-26W1M |
| 16-26 | 16-26-001-26W1M | 119,372          | 8,560.0                      | 6,811.9                   | 15,371.9                      | 104,000          | 0.079374748                | 192.4                          | 0.0                               | 192.4                                        | 0.109965222                                 | 0.094669985                                         | 16-26-001-26W1M |
| 01-35 | 01-35-001-26W1M | 125,323          | 5,518.8                      | 2,376.6                   | 7,895.4                       | 117,427          | 0.089622637                | 302.7                          | 0.0                               | 302.7                                        | 0.172984664                                 | 0.131303651                                         | 01-35-001-26W1M |
| 07-35 | 07-35-001-26W1M | 135,782          | 8,086.3                      | 713.1                     | 8,799.4                       | 126,983          | 0.096915556                | 242.0                          | 0.0                               | 242.0                                        | 0.138335555                                 | 0.117625555                                         | 07-35-001-26W1M |
| 08-35 | 08-35-001-26W1M | 142,955          | 8,131.8                      | 9,818.0                   | 17,949.8                      | 125,006          | 0.095406618                | 243.2                          | 0.0                               | 243.2                                        | 0.138977158                                 | 0.117191888                                         | 08-35-001-26W1M |
| 09-35 | 09-35-001-26W1M | 136,690          | 11,723.7                     | 2,126.0                   | 13,849.7                      | 122,840          | 0.093753953                | 36.3                           | 0.0                               | 36.3                                         | 0.020737074                                 | 0.057245513                                         | 09-35-001-26W1M |
| 10-35 | 10-35-001-26W1M | 133,380          | 6,463.2                      | 2,531.5                   | 8,994.7                       | 124,385          | 0.094933102                | 36.1                           | 0.0                               | 36.1                                         | 0.020611394                                 | 0.057772248                                         | 10-35-001-26W1M |
| 11-35 | 11-35-001-26W1M | 135,151          | 5,822.3                      | 1,931.2                   | 7,753.5                       | 127,398          | 0.097232101                | 33.4                           | 0.0                               | 33.4                                         | 0.019109246                                 | 0.058170673                                         | 11-35-001-26W1M |
| 12-36 | 12-36-001-26W1M | 134,474          | 5,675.2                      | 12,281.9                  | 17,957.1                      | 116,517          | 0.088927627                | 0.0                            | 0.0                               | 0.0                                          | 0.000000000                                 | 0.044463813                                         | 12-36-001-26W1M |
|       |                 | <b>1,431,436</b> | <b>81,933.2</b>              | <b>39,261.0</b>           | <b>121,194.2</b>              | <b>1,310,241</b> | <b>1.000000000</b>         |                                |                                   | <b>1,750</b>                                 | <b>1.000000000</b>                          | <b>1.000000000</b>                                  |                 |



Table No. 3: Waskada Unit No. 21

| Short UWI | UWI                  | License Number | Type       | Pool Name        | Producing Zone | Mode           | On Prod Date | Prod Date | Cal Dly Oil (m3/d) | Monthly Oil (m3) | Cum Prd Oil (m3) | Cal Dly Water (m3/d) | Monthly Water (m3) | Cum Prd Water (m3) | Cal Dly Gas (E3m3/d) | Monthly Gas (E3m3) | Cum Prd Gas (E3m3) | WCT (%) | Last 12 Months Oil Prod (m3) |  |
|-----------|----------------------|----------------|------------|------------------|----------------|----------------|--------------|-----------|--------------------|------------------|------------------|----------------------|--------------------|--------------------|----------------------|--------------------|--------------------|---------|------------------------------|--|
| 09-26     | 100/09-26-001-26W1/2 | 002763         | Vertical   | LOWER AMARANTH A | AMRNTHL        | Abandoned Zone | 8/1/1982     | Aug-1983  | 0.6                | 18.7             | 333.6            | 2.5                  | 76.9               | 3216.0             |                      | 0.0                | 0.0                | 80.44   | 0                            |  |
| 09-26     | 102/09-26-001-26W1/2 | 003149         | Vertical   | LOWER AMARANTH A | AMRNTHL        | Abandoned      | 7/1/1987     | Dec-1988  | 0.5                | 16.8             | 332.4            | 10.0                 | 308.8              | 8492.7             |                      | 0.0                | 0.0                | 94.84   | 0                            |  |
| 10-26     | 100/10-26-001-26W1/2 | 002388         | Vertical   | LOWER AMARANTH A | AMRNTHL        | Producing      | 7/1/2008     | Apr-2014  | 0.1                | 3.8              | 4.8              | 0.2                  | 5.9                | 6.9                |                      | 0.0                | 0.0                | 60.82   | 0                            |  |
| 102/10-26 | 102/10-26-001-26W1/0 | 009333         | Horizontal | LOWER AMARANTH A | AMRNTHL        | Producing      | 2/1/2013     | Apr-2016  | 0.3                | 8.1              | 4,710.6          | 1.1                  | 32.0               | 5197.4             |                      | 0.0                | 10.5               | 79.80   | 233.5                        |  |
| 103/10-26 | 103/10-26-001-26W1/0 | 009334         | Horizontal | LOWER AMARANTH A | AMRNTHL        | Producing      | 2/1/2013     | Apr-2016  | 0.8                | 23.4             | 4,701.5          | 1.6                  | 49.3               | 3632.4             |                      | 0.0                | 0.0                | 67.81   | 127.1                        |  |
| 104/10-26 | 104/10-26-001-26W1/0 | 009335         | Horizontal | LOWER AMARANTH A | AMRNTHL        | Producing      | 2/1/2013     | Nov-2015  | 0.0                | 0.1              | 4,377.0          | 0.0                  | 0.2                | 2219.5             |                      | 0.0                | 15.5               | 66.67   | 148.7                        |  |
| 105/10-26 | 105/10-26-001-26W1/0 | 009336         | Horizontal | LOWER AMARANTH A | AMRNTHL        | Producing      | 2/1/2013     | Apr-2016  | 0.4                | 10.7             | 5,485.2          | 4.2                  | 126.3              | 8145.3             |                      | 0.0                | 15.1               | 92.19   | 188.1                        |  |
| 102/15-26 | 102/15-26-001-26W1/0 | 008812         | Horizontal | LOWER AMARANTH A | AMRNTHL        | Producing      | 10/1/2012    | Mar-2015  | 0.0                | 0.7              | 3,506.1          | 0.0                  | 1.5                | 3002.6             |                      | 0.0                | 0.0                | 68.18   | 0                            |  |
| 103/15-26 | 103/15-26-001-26W1/0 | 008832         | Horizontal | LOWER AMARANTH A | AMRNTHL        | Producing      | 10/1/2012    | Aug-2015  | 0.2                | 5.4              | 5,493.4          | 0.3                  | 7.9                | 6144.9             | 0.0                  | 0.5                | 6.1                | 59.40   | 20.9                         |  |
| 104/15-26 | 104/15-26-001-26W1/0 | 008833         | Horizontal | LOWER AMARANTH A | AMRNTHL        | Producing      | 10/1/2012    | Nov-2015  | 0.0                | 0.6              | 4,205.9          | 0.1                  | 2.2                | 3808.2             |                      | 0.0                | 15.6               | 78.57   | 223.5                        |  |
| 16-26     | 100/16-26-001-26W1/0 | 003951         | Vertical   | LOWER AMARANTH A | AMRNTHL        | Abandoned      | 4/1/1986     | Apr-1995  | 0.1                | 2.5              | 6,811.9          | 1.8                  | 52.8               | 25021.4            |                      | 0.0                | 0.0                | 95.48   | 0                            |  |
| 01-35     | 100/01-35-001-26W1/0 | 004927         | Vertical   | LOWER AMARANTH A | AMRNTHL        | Pumping        | 1/1/2001     | Aug-2013  | 0.0                | 0.3              | 2,376.6          |                      | 0.0                | 0.0                | 422.3                | 0.0                | 0.0                | 0.00    | 0                            |  |
| 02-35     | 100/02-35-001-26W1/0 | 002389         | Vertical   | LOWER AMARANTH A | AMRNTHL        | Abandoned      | 11/1/1981    | Feb-1989  | 0.0                | 0.4              | 1,236.9          | 0.1                  | 2.7                | 1020.2             |                      | 0.0                | 0.0                | 87.10   | 0                            |  |
| 102/02-35 | 102/02-35-001-26W1/0 | 008749         | Horizontal | LOWER AMARANTH A | AMRNTHL        | Producing      | 10/1/2012    | Apr-2015  | 0.1                | 4.0              | 1,456.3          | 0.1                  | 2.4                | 1583.4             |                      | 4.7                | 4.7                | 37.50   | 4                            |  |
| 103/02-35 | 103/02-35-001-26W1/0 | 008750         | Horizontal | LOWER AMARANTH A | AMRNTHL        | Producing      | 10/1/2012    | Dec-2015  | 0.2                | 7.6              | 2,319.5          | 0.7                  | 20.7               | 3079.8             |                      | 0.0                | 16.4               | 73.14   | 164.1                        |  |
| 104/02-35 | 104/02-35-001-26W1/0 | 008765         | Horizontal | LOWER AMARANTH A | AMRNTHL        | Producing      | 10/1/2012    | Apr-2016  | 0.1                | 2.1              | 3,109.8          | 0.6                  | 18.1               | 4447.5             |                      | 0.0                | 12.1               | 89.60   | 283.8                        |  |
| 105/02-35 | 105/02-35-001-26W1/0 | 008811         | Horizontal | LOWER AMARANTH A | AMRNTHL        | Producing      | 10/1/2012    | Apr-2016  | 0.1                | 4.2              | 4,879.1          | 0.6                  | 16.8               | 4186.3             |                      | 0.0                | 15.2               | 80.00   | 123.6                        |  |
| 07-35     | 100/07-35-001-26W1/2 | 003433         | Vertical   | LOWER AMARANTH A | AMRNTHL        | Abandoned Zone | 12/1/1988    | Nov-2011  | 0.0                | 0.3              | 713.1            |                      | 0.0                | 0.0                |                      | 0.0                | 0.0                | 0.00    | 0                            |  |
| 102/07-35 | 102/07-35-001-26W1/0 | 008033         | Horizontal | LOWER AMARANTH A | AMRNTHL        | Producing      | 12/1/2011    | Apr-2016  | 0.3                | 9.9              | 4,220.4          | 0.3                  | 8.4                | 3770.9             |                      | 0.0                | 18.7               | 45.90   | 89.8                         |  |
| 103/07-35 | 103/07-35-001-26W1/0 | 008804         | Horizontal | LOWER AMARANTH A | AMRNTHL        | Producing      | 2/1/2012     | Apr-2016  | 0.6                | 16.6             | 4,286.9          | 0.4                  | 13.1               | 3005.7             |                      | 0.0                | 20.7               | 44.11   | 224.2                        |  |
| 104/07-35 | 104/07-35-001-26W1/0 | 008805         | Horizontal | LOWER AMARANTH A | AMRNTHL        | Producing      | 2/1/2012     | Apr-2016  | 0.2                | 5.4              | 5,513.0          | 0.1                  | 2.3                | 2891.8             |                      | 0.0                | 18.1               | 29.87   | 82.3                         |  |
| 105/07-35 | 105/07-35-001-26W1/0 | 008779         | Horizontal | LOWER AMARANTH A | AMRNTHL        | Producing      | 10/1/2012    | Apr-2016  | 0.2                | 6.1              | 3,078.2          | 0.3                  | 8.0                | 2404.1             |                      | 0.0                | 8.8                | 56.74   | 174.3                        |  |
| 08-35     | 100/08-35-001-26W1/0 | 003334         | Vertical   | LOWER AMARANTH A | AMRNTHL        | Comingled      | 7/1/1985     | Jan-2012  | 0.1                | 3.1              | 9,818.0          | 0.1                  | 1.7                | 1615.8             |                      | 0.0                | 0.0                | 35.42   | 0                            |  |
| 09-35     | 100/09-35-001-26W1/2 | 003100         | Vertical   | LOWER AMARANTH A | AMRNTHL        | Abandoned      | 4/1/1988     | May-2008  | 0.0                | 0.0              | 2,126.0          | 0.0                  | 0.3                | 238.3              |                      | 0.0                | 0.0                | 100.00  | 0                            |  |
| 102/09-35 | 102/09-35-001-26W1/0 | 007886         | Horizontal | LOWER AMARANTH A | AMRNTHL        | Producing      | 2/1/2011     | May-2014  | 0.6                | 17.7             | 5,822.5          | 0.3                  | 9.0                | 2581.4             |                      | 0.0                | 0.0                | 33.71   | 0                            |  |
| 103/09-35 | 103/09-35-001-26W1/0 | 007887         | Horizontal | LOWER AMARANTH A | AMRNTHL        | Producing      | 3/1/2011     | Jan-2014  | 0.2                | 5.0              | 5,456.4          | 0.1                  | 4.0                | 1716.0             |                      | 0.0                | 0.0                | 44.44   | 0                            |  |
| 10-35     | 100/10-35-001-26W1/2 | 003889         | Vertical   | LOWER AMARANTH A | AMRNTHL        | Comingled      | 12/1/1987    | May-2008  | 1.7                | 52.4             | 2,531.5          | 1.0                  | 31.5               | 192.4              |                      | 0.0                | 0.0                | 37.54   | 0                            |  |
| 103/0-35  | 103/10-35-001-26W1/0 | 008806         | Horizontal | LOWER AMARANTH A | AMRNTHL        | Producing      | 12/1/2011    | Sep-2013  | 0.3                | 8.6              | 1,362.6          | 0.3                  | 7.8                | 2080.0             |                      | 0.0                | 0.0                | 47.56   | 0                            |  |
| 11-35     | 100/11-35-001-26W1/2 | 003996         | Vertical   | LOWER AMARANTH A | AMRNTHL        | Suspended      | 5/1/1988     | Apr-2013  | 0.0                | 0.0              | 1,931.2          | 0.0                  | 0.1                | 591.6              |                      | 0.0                | 0.0                | 100.00  | 0                            |  |
| 102/11-35 | 102/11-35-001-26W1/3 | 004505         | Horizontal | LOWER AMARANTH A | AMRNTHL        | Producing      | 11/1/2010    | Apr-2016  | 0.2                | 6.2              | 11,563.3         | 1.6                  | 48.8               | 5467.2             |                      | 0.0                | 61.1               | 88.30   | 100.3                        |  |
| 103/11-35 | 103/11-35-001-26W1/0 | 007888         | Horizontal | LOWER AMARANTH A | AMRNTHL        | Producing      | 3/1/2011     | Oct-2013  | 0.0                | 0.4              | 5,903.5          | 0.0                  | 0.1                | 3391.8             |                      | 0.0                | 0.0                | 20.00   | 0                            |  |
| 12-36     | 100/12-36-001-26W1/2 | 002983         | Vertical   | LOWER AMARANTH A | AMRNTHL        | Comingled      | 10/1/1988    | Feb-2013  | 0.0                | 0.5              | 12,281.9         | 0.0                  | 0.3                | 8772.1             |                      | 0.0                | 0.0                | 37.50   | 0                            |  |
|           |                      |                |            |                  |                |                |              |           |                    |                  | 131,949.1        |                      |                    |                    |                      |                    |                    |         |                              |  |
|           |                      |                |            |                  |                |                |              |           |                    |                  | 122,417.6        |                      |                    |                    |                      |                    |                    |         |                              |  |

**Table No. 4: OOIP Calculation**

| Polygon Name    | Total Area (MTR x MTR) | Data Area (MTR x MTR) | ROIP (MBO) | ROIP (BBL)       | ROIP (m <sup>3</sup> ) | Phih   | SW = 40%<br>Porosity = 10%<br>BO = 1.17 |
|-----------------|------------------------|-----------------------|------------|------------------|------------------------|--------|-----------------------------------------|
| 09-26-001-26W1M | 161,704.26             | 161,704.26            | 762.73     | 762,730.00       | 121,261                | 1.4623 |                                         |
| 10-26-001-26W1M | 161,586.24             | 161,586.24            | 741.85     | 741,850.00       | 117,941                | 1.4233 |                                         |
| 15-26-001-26W1M | 161,641.11             | 161,641.11            | 812.08     | 812,080.00       | 129,107                | 1.4401 |                                         |
| 16-26-001-26W1M | 161,523.55             | 161,523.55            | 750.85     | 750,850.00       | 119,372                | 1.5587 |                                         |
| 01-35-001-26W1M | 161,663.99             | 161,663.99            | 788.28     | 788,280.00       | 125,323                | 1.5117 |                                         |
| 07-35-001-26W1M | 161,823.87             | 161,823.87            | 854.07     | 854,070.00       | 135,782                | 1.6362 |                                         |
| 08-35-001-26W1M | 161,794.42             | 161,794.42            | 899.19     | 899,190.00       | 142,955                | 1.723  |                                         |
| 09-35-001-26W1M | 161,925.73             | 161,925.73            | 859.78     | 859,780.00       | 136,690                | 1.6461 |                                         |
| 10-35-001-26W1M | 161,955.32             | 161,955.32            | 838.96     | 838,960.00       | 133,380                | 1.606  |                                         |
| 11-35-001-26W1M | 161,984.63             | 161,984.63            | 850.10     | 850,100.00       | 135,151                | 1.627  |                                         |
| 12-36-001-26W1M | 162,014.19             | 162,014.19            | 845.84     | 845,840.00       | 134,474                | 1.6381 |                                         |
|                 |                        |                       |            | <b>9,003,730</b> | <b>1,431,436</b>       |        |                                         |

| <div>Table No. 5</div> <div>Proposed Waskada Unit 21</div> <div>LOWER AMARANTH FORMATION ROCK &amp; FLUID PARAMETERS</div> |                    |                                    |  |
|----------------------------------------------------------------------------------------------------------------------------|--------------------|------------------------------------|--|
| Formation Pressure                                                                                                         | 8500 kPa           | Initial Average Reservoir Pressure |  |
| Formation Temperature                                                                                                      | 45 C               |                                    |  |
| Saturation Pressure                                                                                                        | 4220 kPa           | Bubble Point                       |  |
| GOR                                                                                                                        | 20 - 50 m3/m3      | Gas Oil Ratio                      |  |
| API Oil Gravity                                                                                                            | 37.2               |                                    |  |
| Swi (fraction)                                                                                                             | 0.40               | Initial Water Saturation           |  |
| Produced Water Specific Gravity                                                                                            | 1.08               |                                    |  |
| Produced Water pH                                                                                                          | 7.1 - 7.3          |                                    |  |
| Produced Water TDS                                                                                                         | 180,000            |                                    |  |
| Wettability                                                                                                                | Moderately oil-wet |                                    |  |

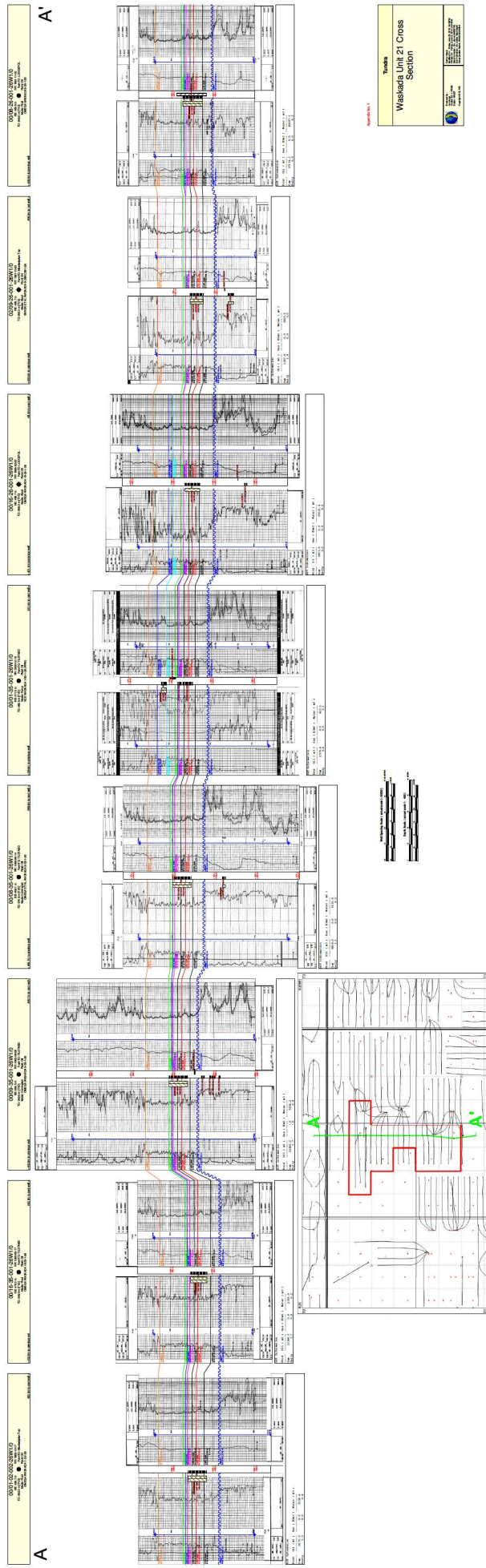


**Proposed Waskada Unit No. 21**

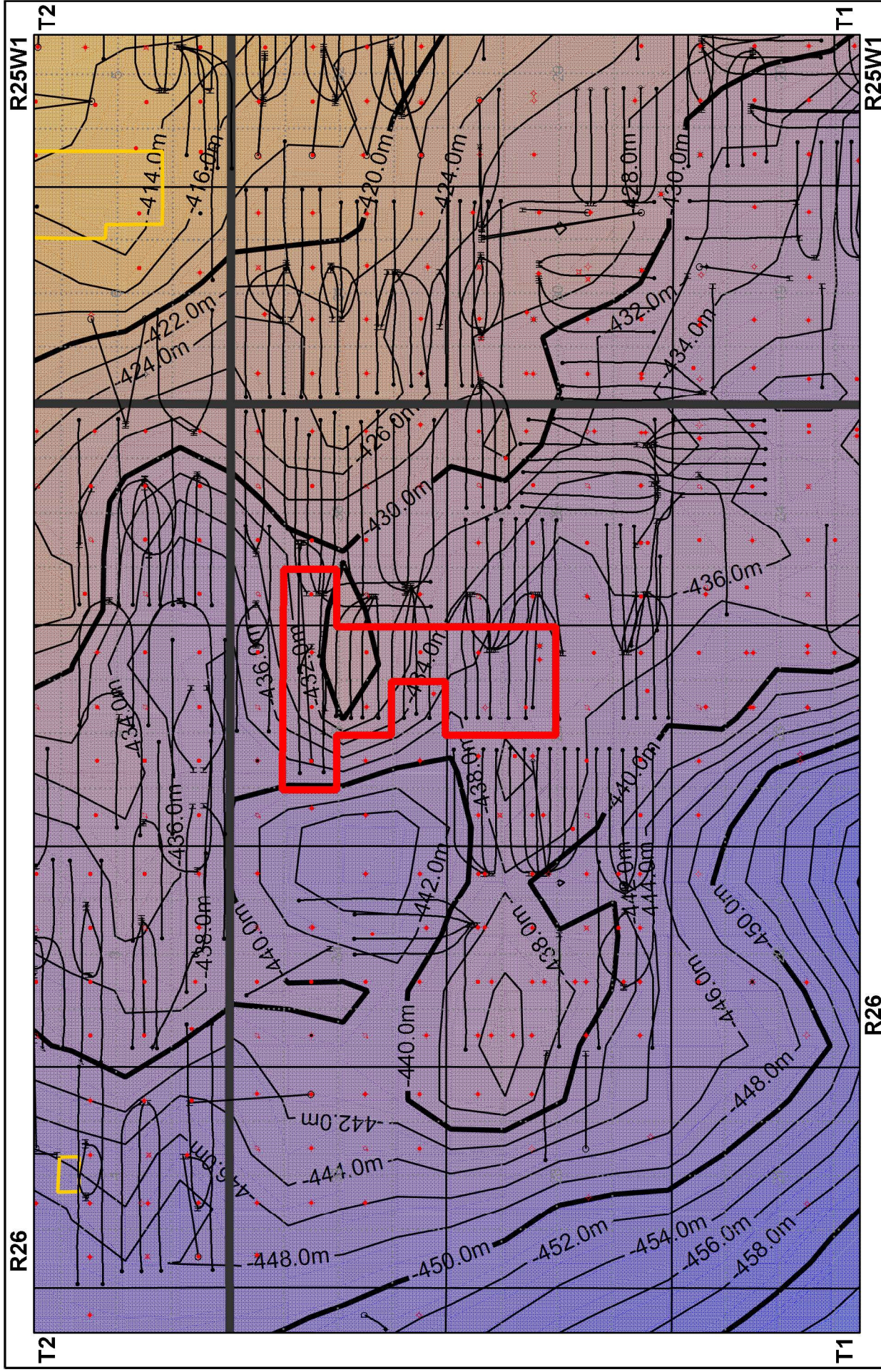
**Application for Enhanced Oil Recovery Waterflood Project**

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| Appendix 11 | Reservoir Phi-h at 10% Porosity Cutoff        |







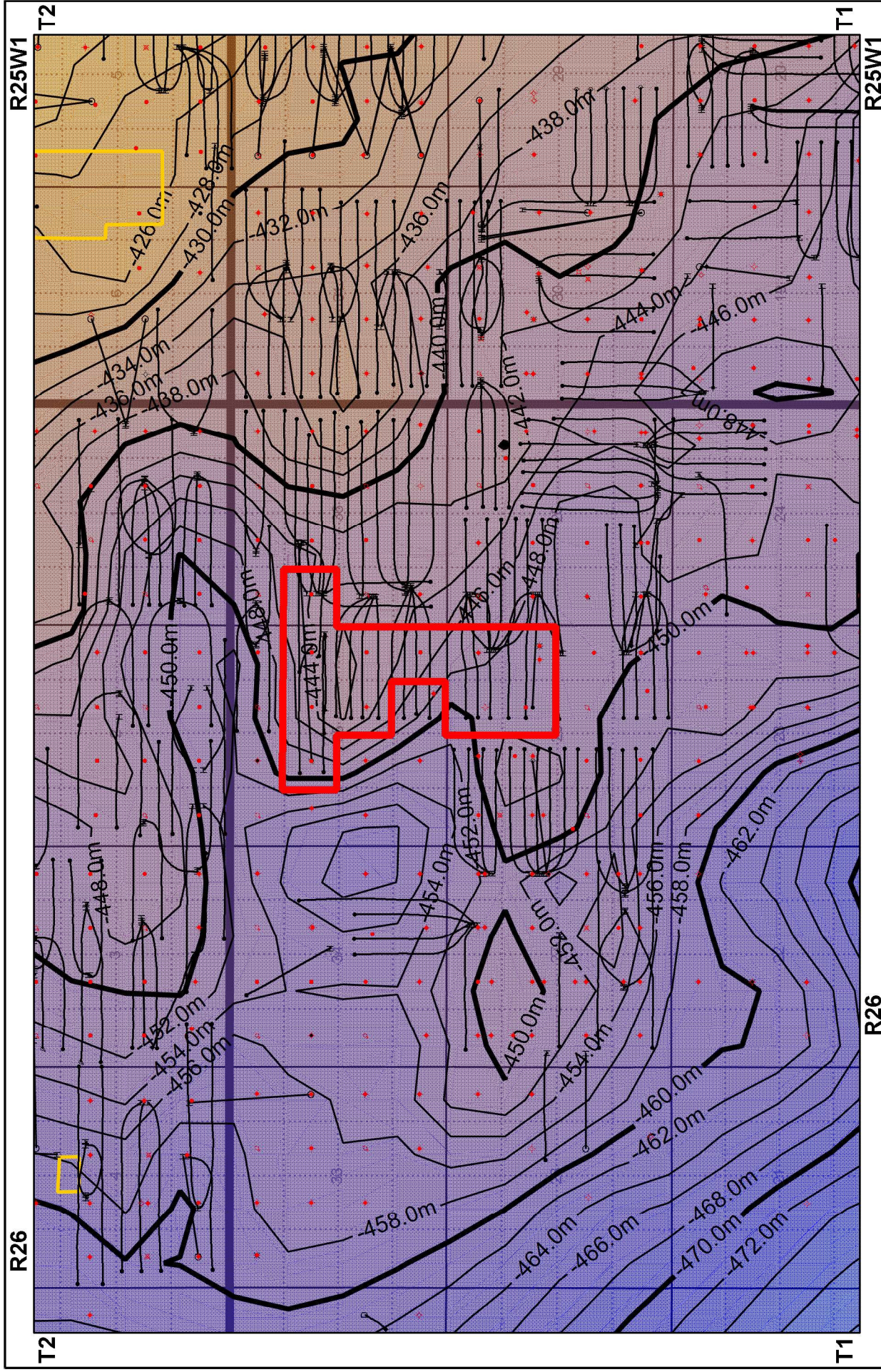
## Appendix No. 2



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|                                            |
|--------------------------------------------|
| Waskada Unit 21 Application                |
| Green Sand Structure<br>(Top of Reservoir) |
| June 07, 2016                              |





### Appendix No.3



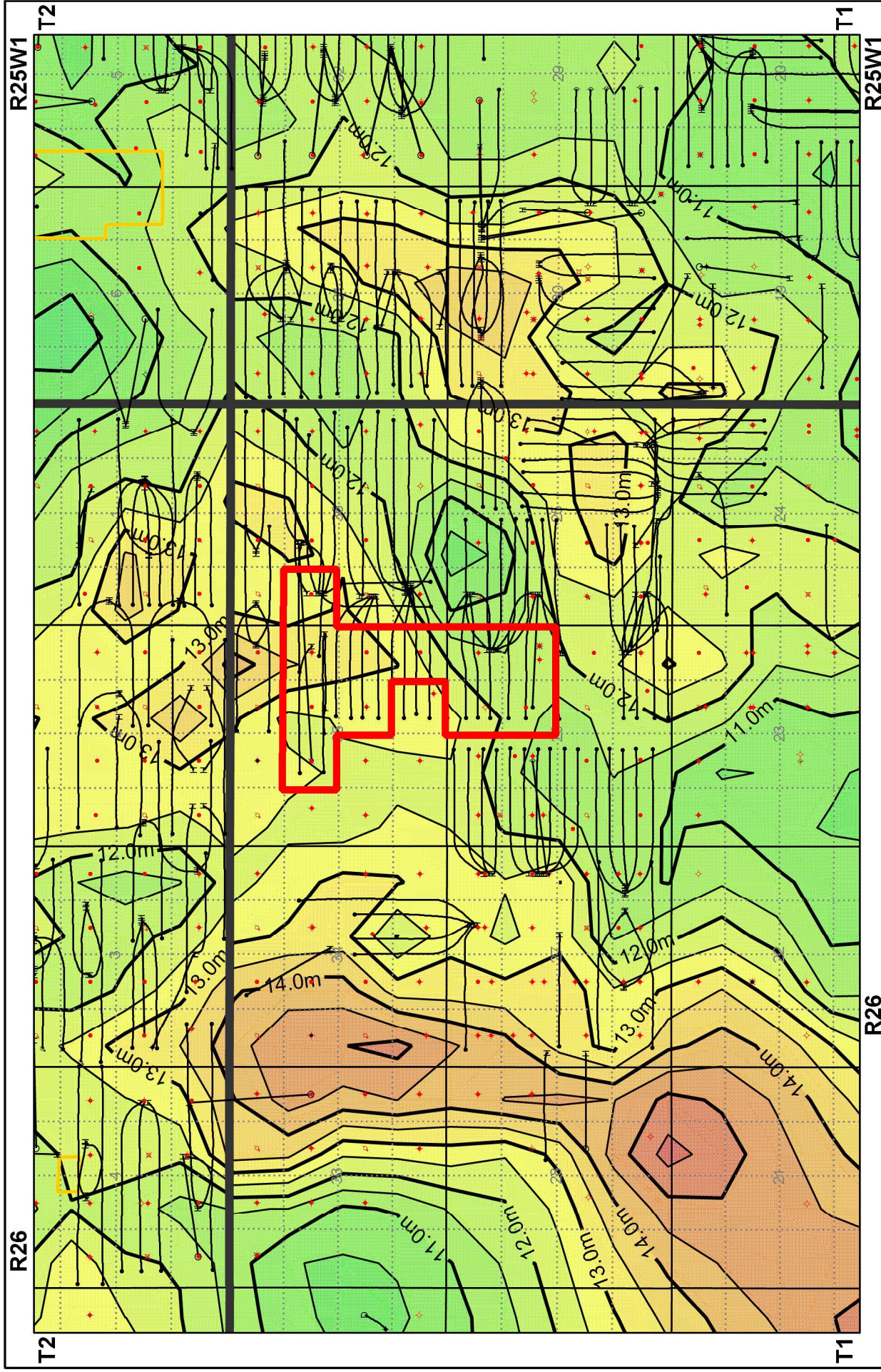
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Waskada Unit 21 Application

Lower Sand Structure  
(Base of Reservoir)

June 07, 2016



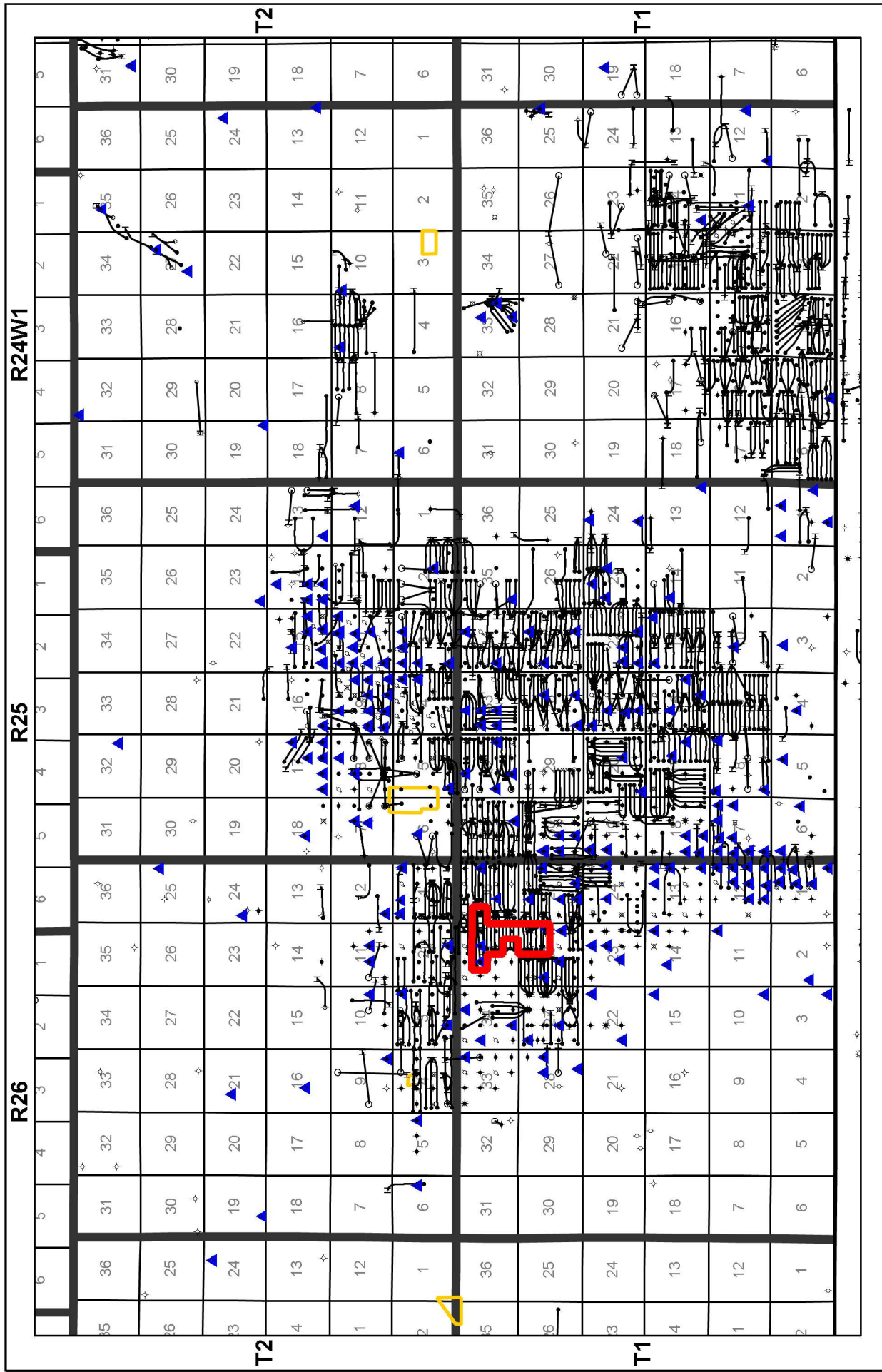


## Appendix No. 4

|                               |
|-------------------------------|
| Waskada Unit 21 Application   |
| Reservoir Isopach             |
| (Green to Lower Sand Isopach) |
| June 07, 2016                 |





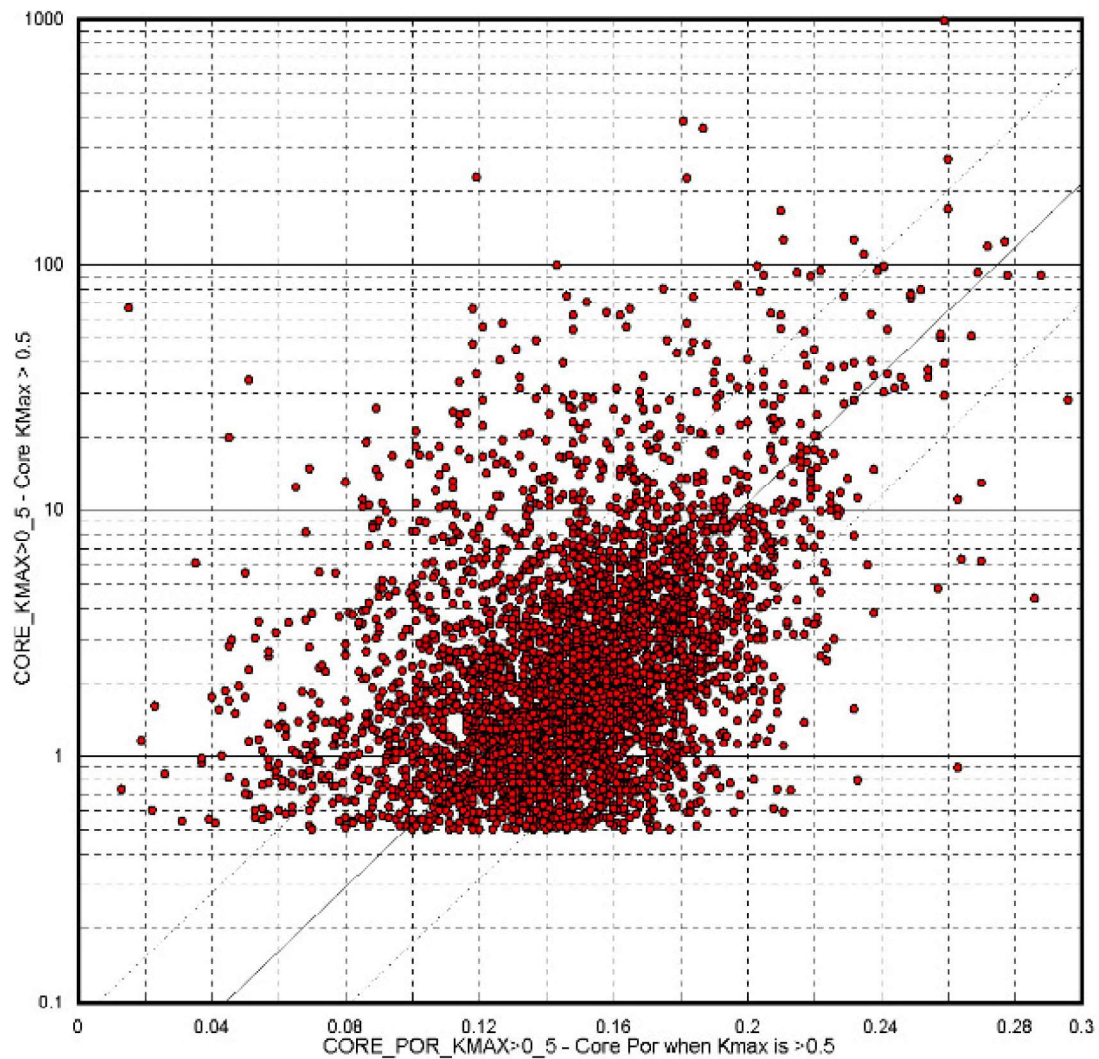




# Tundra Pierson Waskada Project

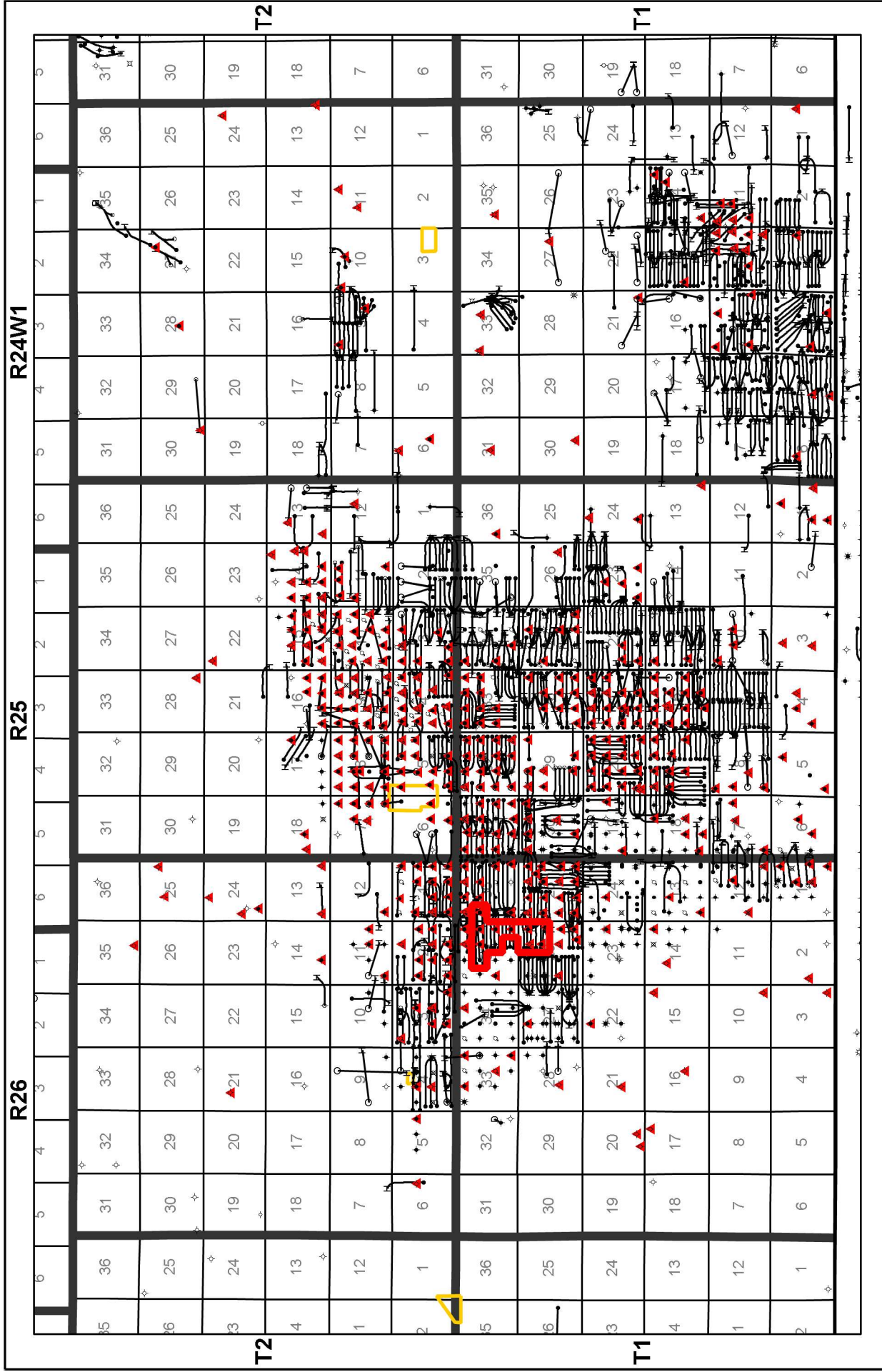
## Core Kmax vs Core Porosity >0.5mD

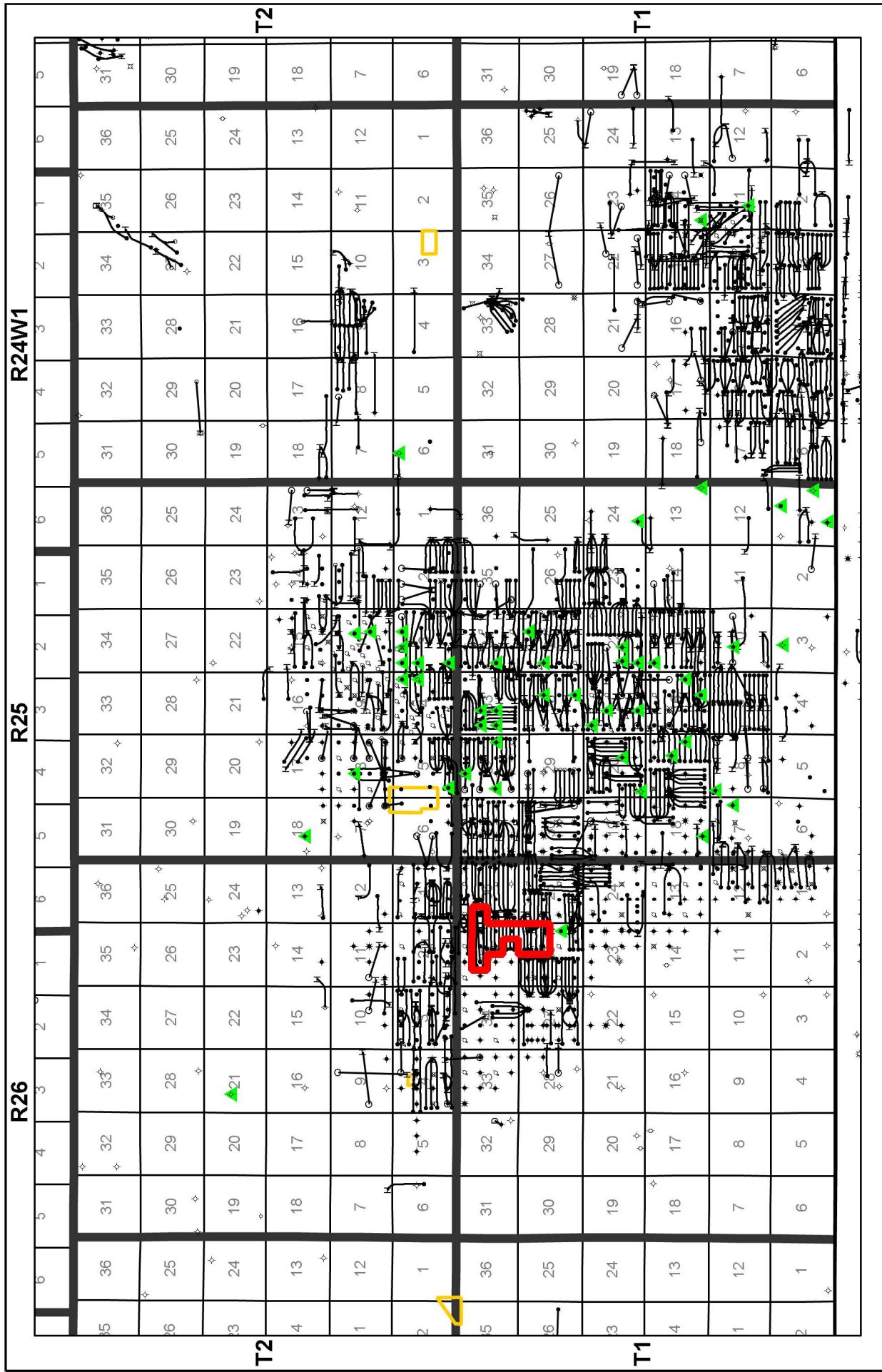
10686 Samples for 231 out of 231 Wells



$\text{LOG}(\text{CORE\_KMAX}>0.5) = 12.99873743 * \text{CORE\_POR\_KMAX}>0.5 - 1.5681$  Corr=0.422 StdErr=0.4908

Appendix No. 6

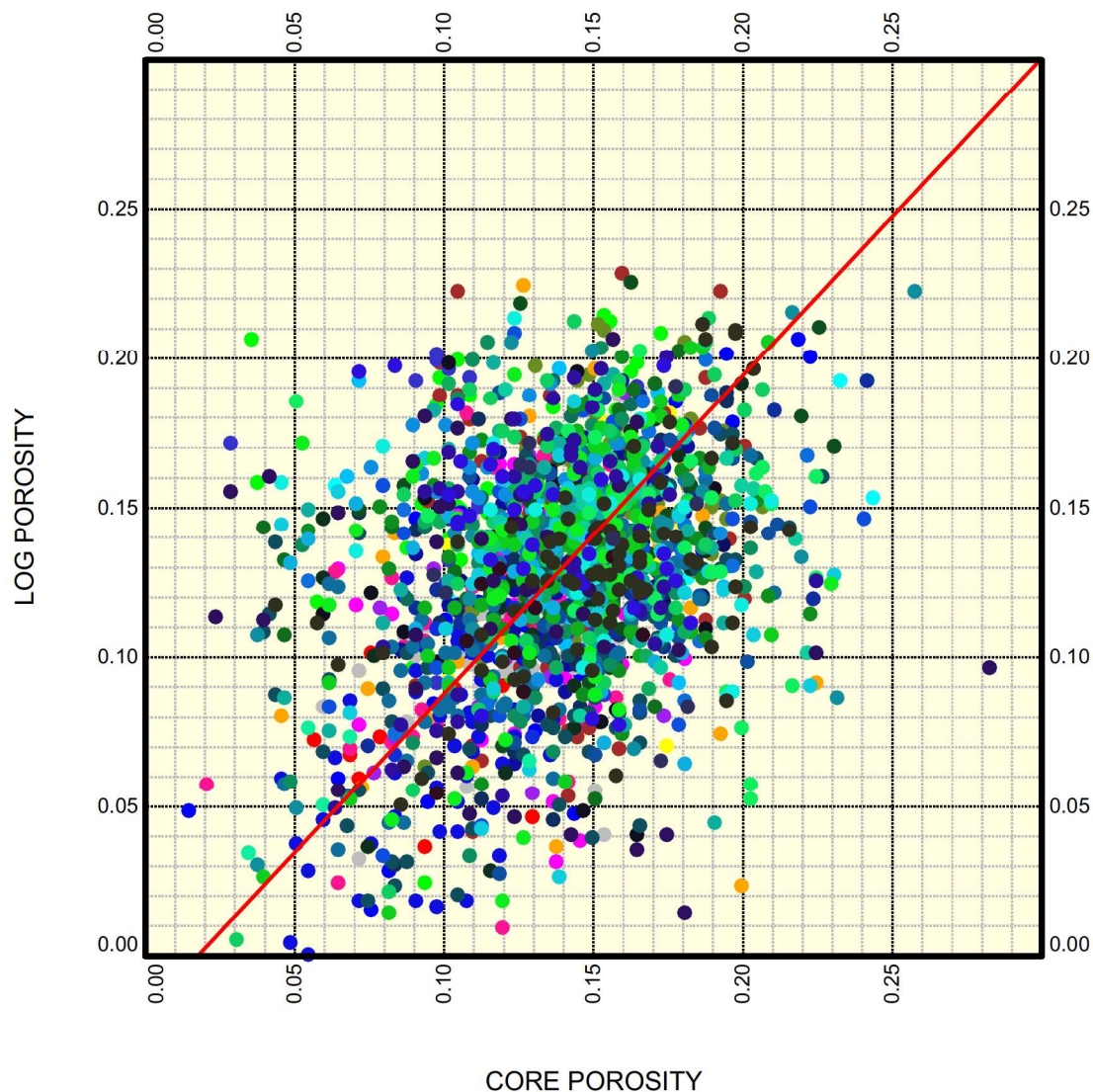






# Log Porosity vs Core Porosity Crossplot

Well: 52 Wells



Wells:

|                  |                  |                  |                  |                  |
|------------------|------------------|------------------|------------------|------------------|
| 100011300125W100 | 100021600125W100 | 100022800125W100 | 100030100125W100 | 100031800125W100 |
| 100032100125W100 | 100032400125W100 | 100040300225W100 | 100040500225W100 | 100041400124W100 |
| 100042000125W100 | 100042200125W100 | 100052200125W100 | 100053200125W100 | 100053300125W100 |
| 100053400125W100 | 100061100124W100 | 100061800225W100 | 100062200125W100 | 100063300125W100 |
| 100071000225W100 | 100072000125W100 | 100080100125W100 | 100081600125W100 | 100081700125W100 |
| 100082600126W100 | 100083200125W100 | 100090400225W100 | 100090700125W100 | 100101000225W100 |
| 100101700125W100 | 100102800125W100 | 100110800225W100 | 100111000125W100 | 100112100125W100 |
| 100112100226W100 | 100113300125W100 | 100120300225W100 | 100122700125W100 | 100123300125W100 |
| 100130300225W100 | 100130800125W100 | 100131500125W100 | 100132100125W100 | 100140300125W100 |
| 100140300225W100 | 100140600224W100 | 100143200125W100 | 100150100125W100 | 100150300225W100 |
| 100152700125W100 | 100160400225W100 |                  |                  |                  |

Intervals: U-GREEN\_SAND U-BLUE\_SAND U-PURPLE\_SAND U-BROWN\_SAND U-RED\_SAND U-LWR\_SAND

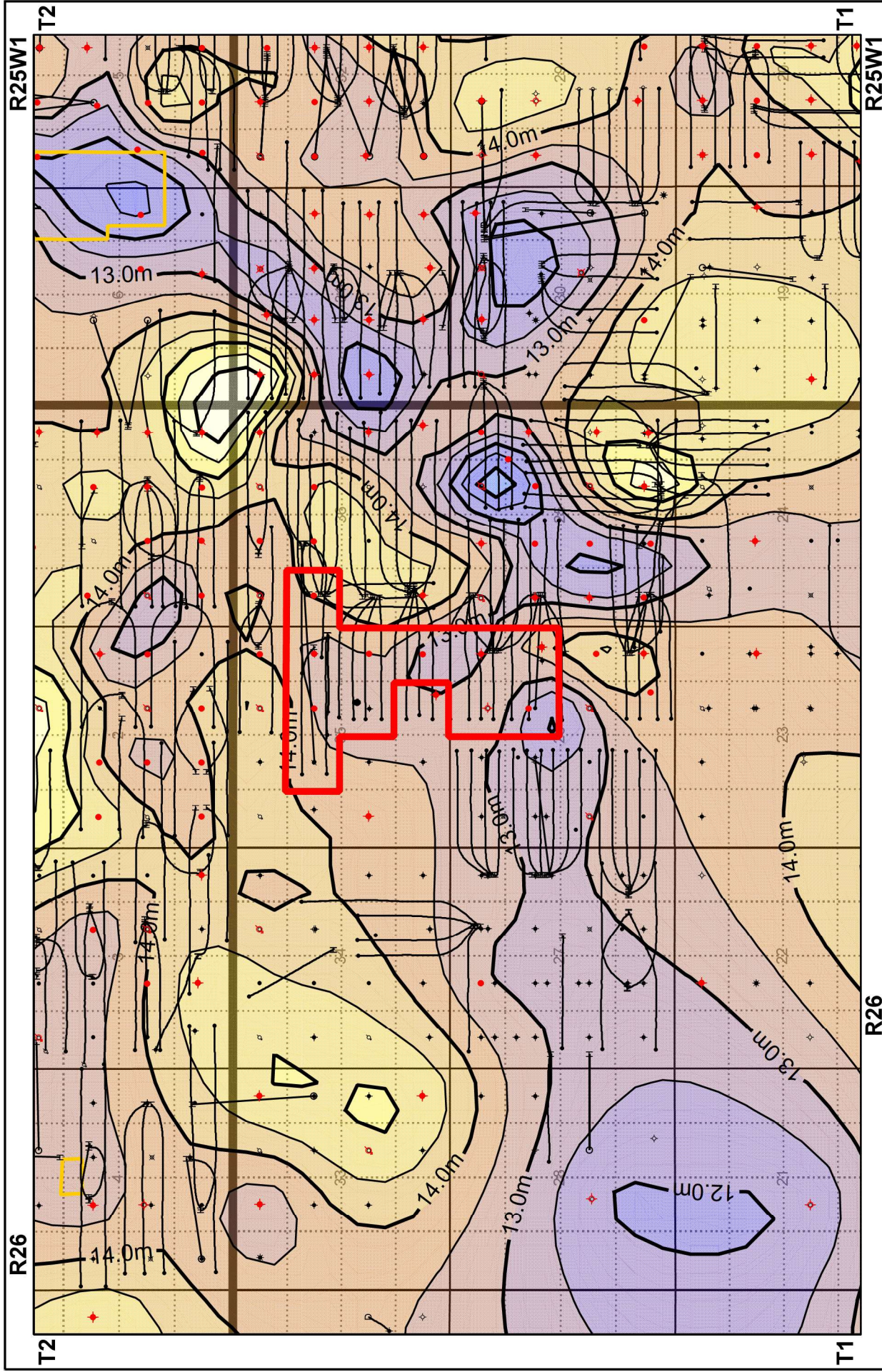
Functions:

test: Regression Logs: CORE.POROSITY, PHIE, CC: 0.329356

PHIE = (-0.0186548 + 1.06436\*(POROSITY))

Appendix No. 9



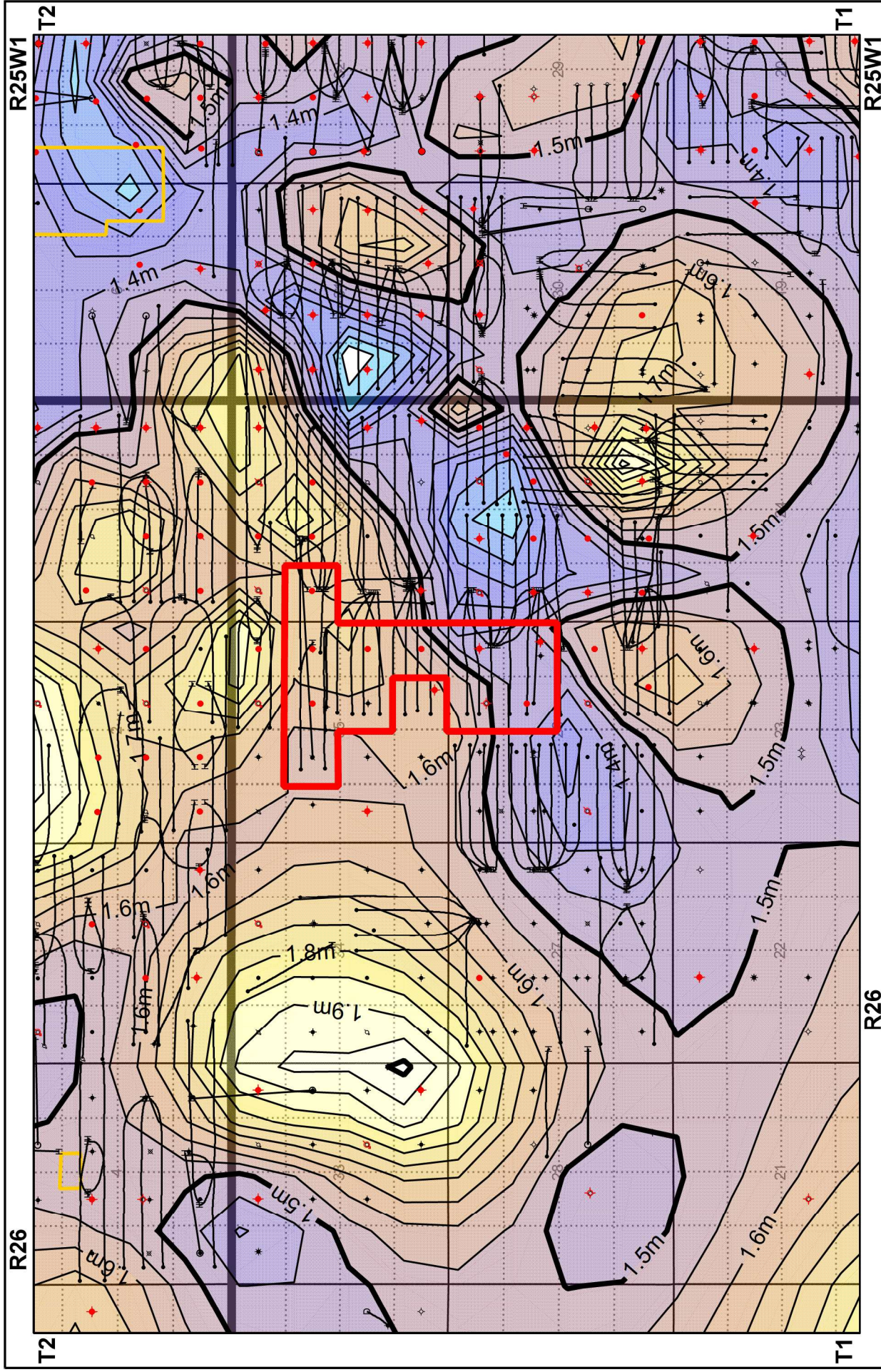


## Appendix No. 10

|                                                                                              |
|----------------------------------------------------------------------------------------------|
| <b>Waskada Unit 21 Application</b>                                                           |
| Mean Sonic Porosity from Top Green to Base Red<br>Control Points in Red<br>Values in Percent |
| July 12, 2016                                                                                |







## Appendix No. 11

|                                              |
|----------------------------------------------|
| Waskada Unit 21 Application                  |
| Phi <sup>th</sup> at 10% cut off             |
| Top Green to Base Red Sand (Total Reservoir) |
| July 12, 2016                                |

