McMullen Thermal Conduction Process Experimental Pilot Project
Review of AER Approval 11541, 11541A, 11541B and 11541C
March 16, 2015

Husky Energy

Introductions and Overview

- **Introductions**
- **3.1.1 Subsurface Issues**
  - Related to Resource Evaluation and Recovery – slide 3
- **3.1.2 Surface Operations**
  - Compliance and Issues Not Related to Resource Evaluation and Recovery – slide 69
- **Questions**

3.1.1 Subsurface Issues – Table of Contents

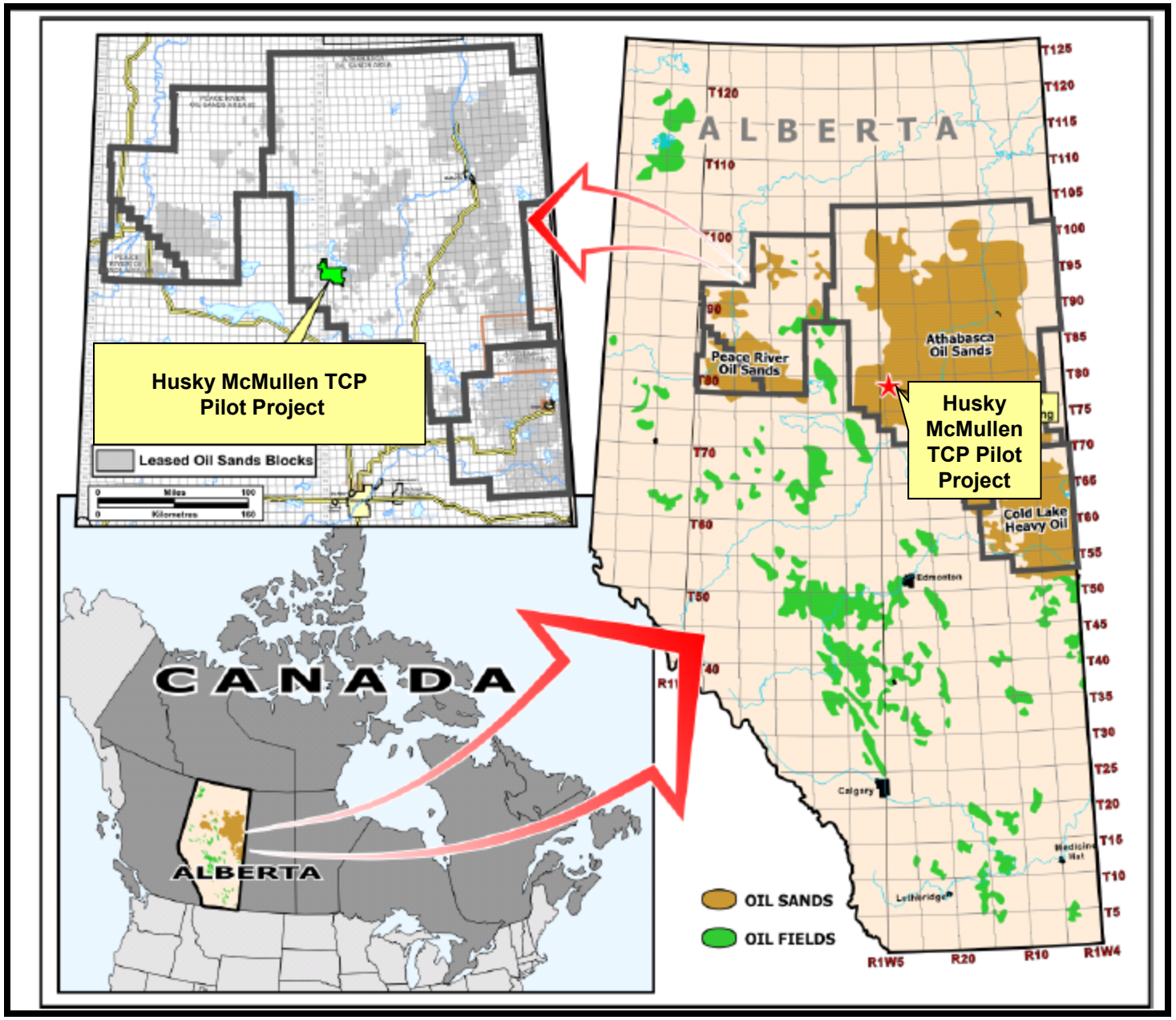
Project Background – AER Approvals

- **December 20, 2010** - AER issued Approval **11541** for the McMullen TCP experimental scheme application (ESRD issued EPEA Approval 265571-00-00 on January 10, 2011)

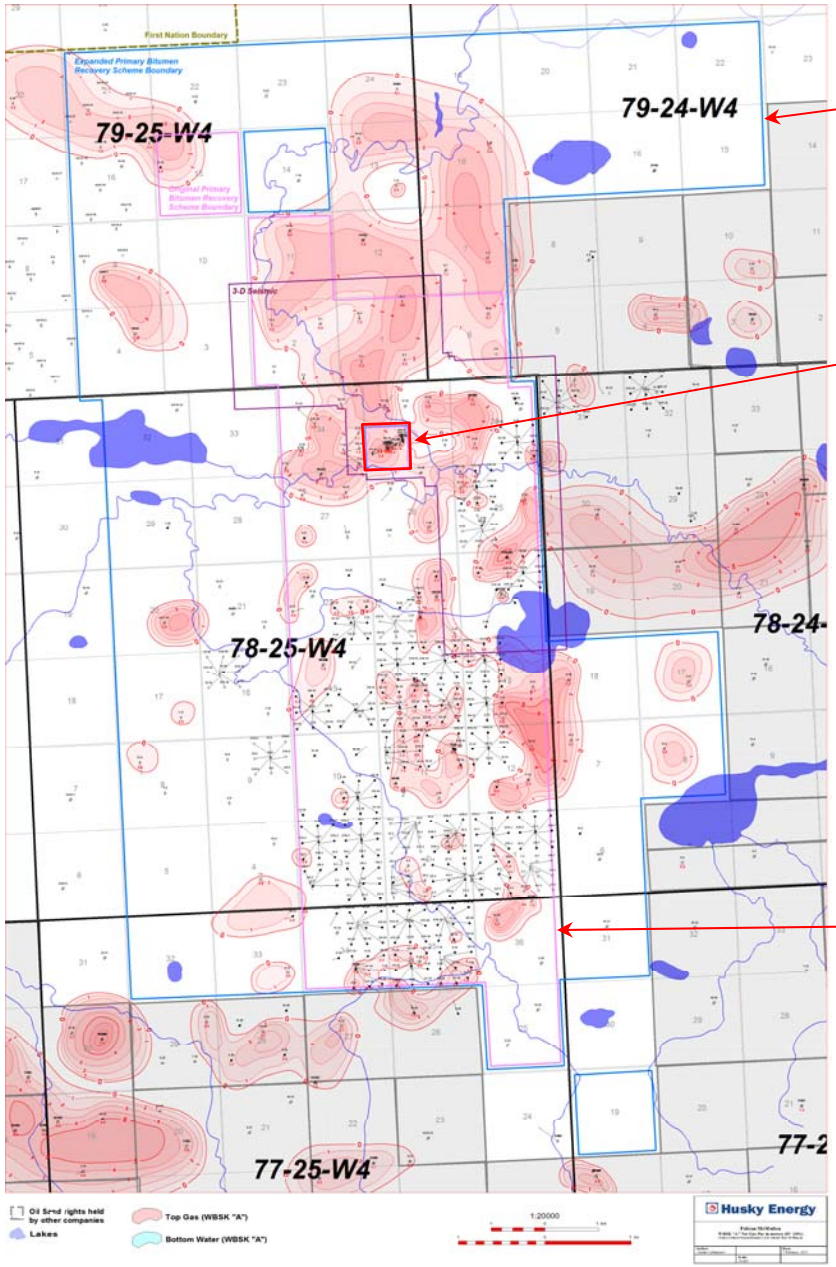
- **January 19, 2012** - AER issued Approval **11541A** for 3 additional HZ production wells as a modification to the scheme

- **August 7, 2013** – AER issued Approval **11541B** for the handling of sour gas at the facility for all production wells

- **October 30, 2013** – AER issued Approval **11541C** to extend the experimental scheme approval and confidentiality period to July 31, 2015


Husky McMullen TCP Pilot Project
Leased Oil Sands Blocks
ALBERTA
Athabasca Oil Sands
Peace River Oil Sands
Cold Lake Heavy Oil
Husky McMullen TCP Pilot Project
Edmonton
Calgary
Lethbridge
Medicine Hat
CANADA
ALBERTA
OIL SANDS
OIL FIELDS
R1W5
R20
R10
R1W4

Wabiskaw “A” Area Gas Cap Map



AER Approved Expanded Primary Area by an additional 41 sections for a total of 68 sections (down-spaced to 36 wells/section)

McMullen TCP Pilot Project
SW 35-78-25W4
Application area

AER Initial Approved Primary Area of 27 sections - down-spaced to 36 wells/section
Husky has drilled 300 wells since 2008

Project Location (SW/4 of 35-78-25W4)

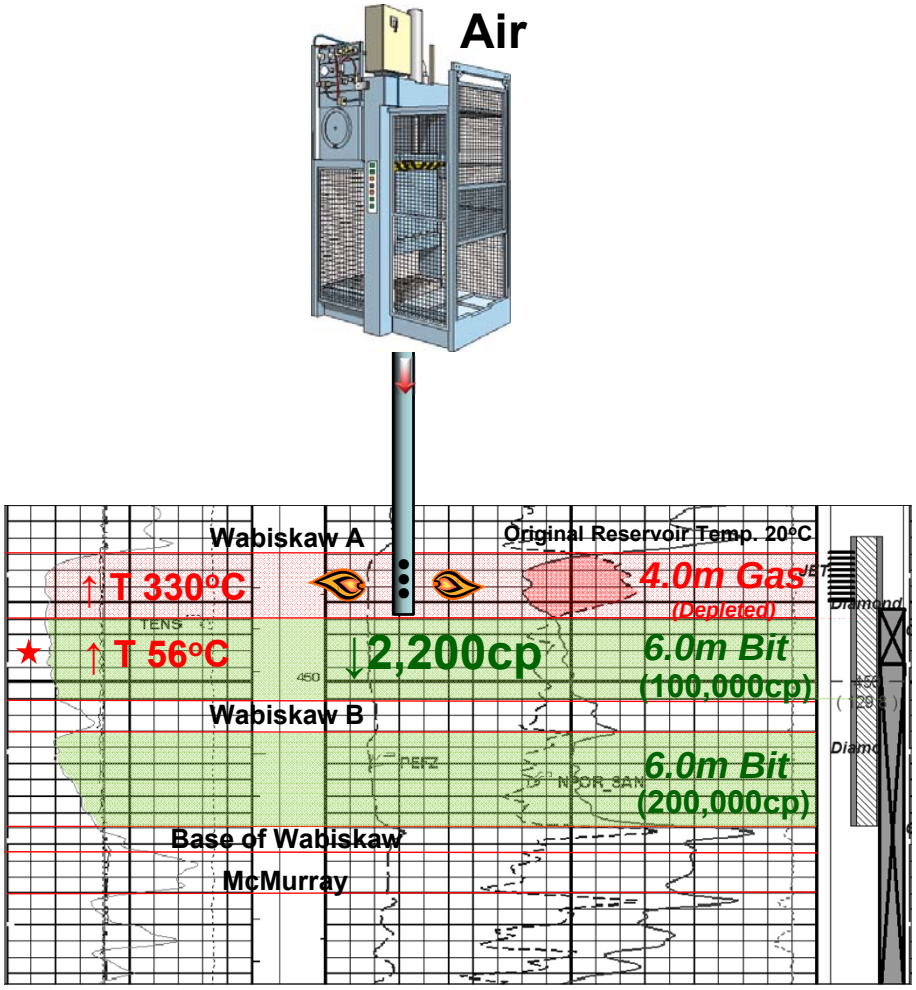
- **Project location is the SW/4 of 35-78-25W4**
  - based on core and log data from 100/03-35-78-25W4 well drilled in Nov 2008
  - well has a depleted gas zone of 4 meters in thickness that overlies a bitumen zone of 6 meters in thickness

- **Thin bitumen zone of 6 meters has excellent reservoir characteristics**
  - classified as a homogeneous, unconsolidated, clean sand with good porosity, excellent permeability and good oil saturation

- **There is no underlying water in contact with the bitumen**

- **The overlying gas cap has a good seal**

McMullen Thermal Conduction Process (TCP) Pilot Scope

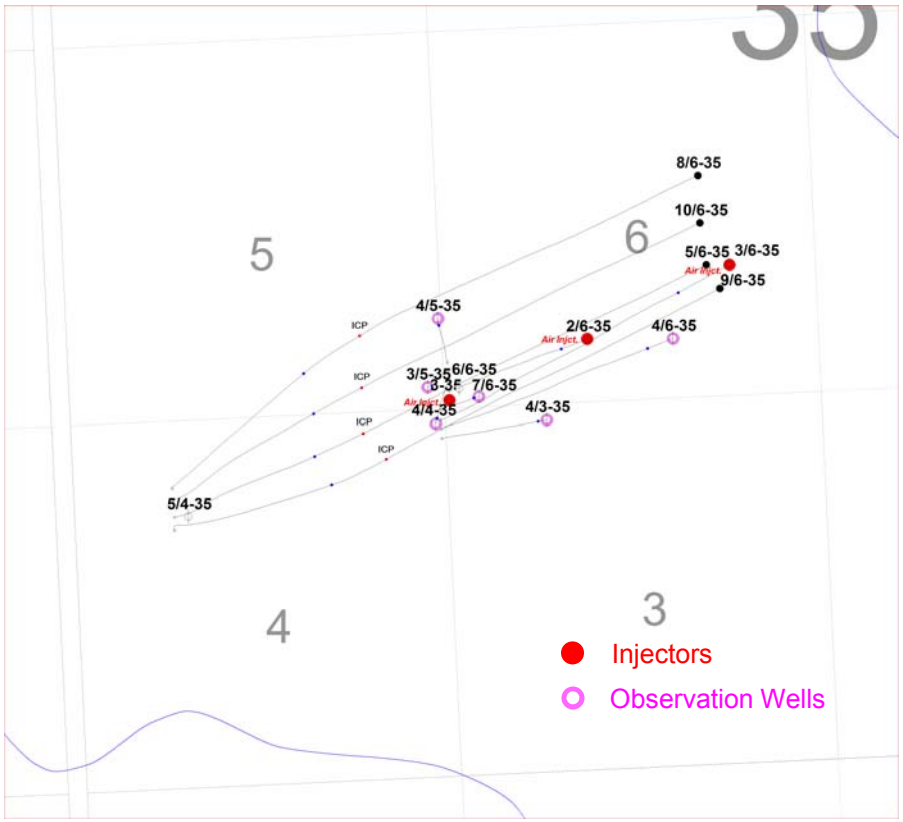


★ *Targeted Zone*

WHAT WE DO & WHY?

- **PURPOSE ?**
  - Recover bitumen underlying depleted gas cap
- **WHAT WE DO ?**
  - Ignite and oxidize residual oil saturation (8-15%) within depleted gas cap
- **HOW WE DID IT ?**
  - **Ignition process:**
    Steam/Linseed Oil/Steam/N^2/Air
    (spontaneously combusts)
  - **Wait** (3-6 months+) for heat to conduct to underlying bitumen
- **WHAT WE SEE ? (within the depleted gas cap)**
  - Combustion zone peak temperature 330°C (burn tube test 600 °C)
- **WHAT WE NEED ? (within bitumen zone)**
  - Heated >56°C to lower viscosity to 2,200cp to start producing
- **WHAT WE GET ?**
  - Flow rate 25m3/day (from 400m HZ Well)
  - Recovery factor >50%

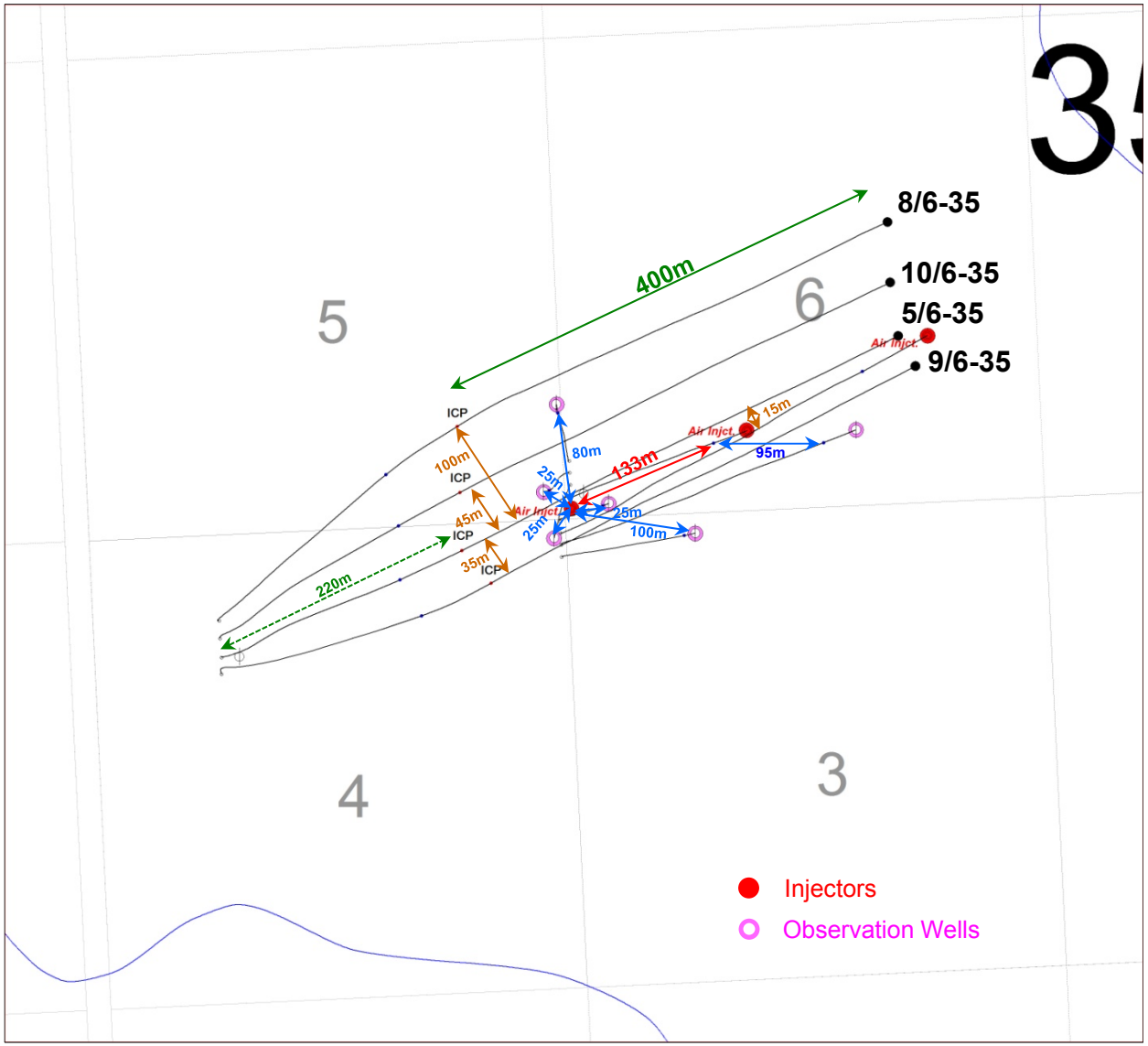
McMullen Thermal Conduction Process – Project Status



Project Status and Timeline

- 2011/2012 - 13 wells drilled and facility construction completed
- Sep 28, 2011 – start of temporary steam
- Dec 8, 2011 – start of first air injection
- Q1 2012 - received approval to drill 3 additional HZ producers
- Aug 1, 2012 – first HZ on prod (H2S detection)
- Oct 2012 - 3rd train air compression added
- Nov 1, 2012 - production re-start
- Oct 2013 - three additional HZ wells on prod
- Sep 18, 2014 – shut-in of air injection
- July 31, 2015 – current expiry of confidential and approval period

McMullen Thermal Conduction Process - Inter-Well Spacing



McMullen TCP Pilot Objectives (Jan 2010)

December 2014 - 37 Months after Start of Air Injection

- Successful ignition and continuous combustion
  - **achieved**
- Heating the underlying bitumen through thermal conduction
  - **as predicted (~25 m3/d;** 25-30% BS&W**)**
- Determine combustion front velocity through the depleted gas zone
  - **as predicted**
- Determine optimal well spacing for future design of a commercial project
  - **requires Pilot expansion to test new spacing**
- No Injected air or combustion gas breakthrough into the horizontal producer
  - **achieved**

Improved Recovery Technique

- **New innovative technology**
  - to recover bitumen underlying a depleted gas cap
- **Thermal recovery process**
  - conducts heat downward from the gas zone to the bitumen leg in order to mobilize the oil for production
- **Combustion reactions**
  - will be confined to the gas zone and results in high temperature oxidation
- **Significant reduction in fresh water usage**
  - over conventional steam assisted methods (CSS and SAGD)
  - water requirements are for initial steaming only (8311 m3 CWE)

Geology/Geoscience

OBIP Reserve Estimate

Volumetric Methodology

Average Reservoir Parameters:

- Net Oil Pay = 6 m
- Porosity = 31%, So = 70%
- Oil FVF = 1.00 m3/m3

Entire approval area - 64 ha (SW/4 section 35-78-25W4)

- OBIP = 833 e3m3

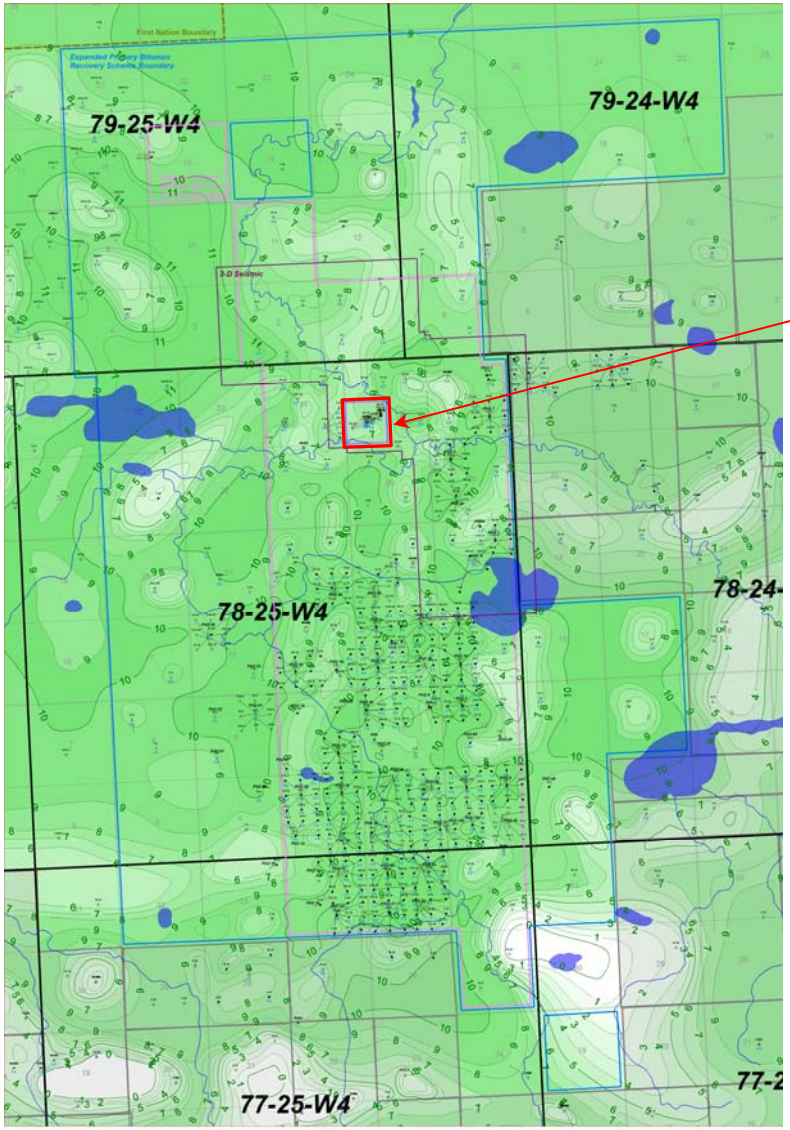
Planned operating portion of the scheme - 13 ha (prior shut-in air injection)

- OBIP = 169 e3m3

Actual operating portion of the scheme - 6 ha (after shut-in air injection)

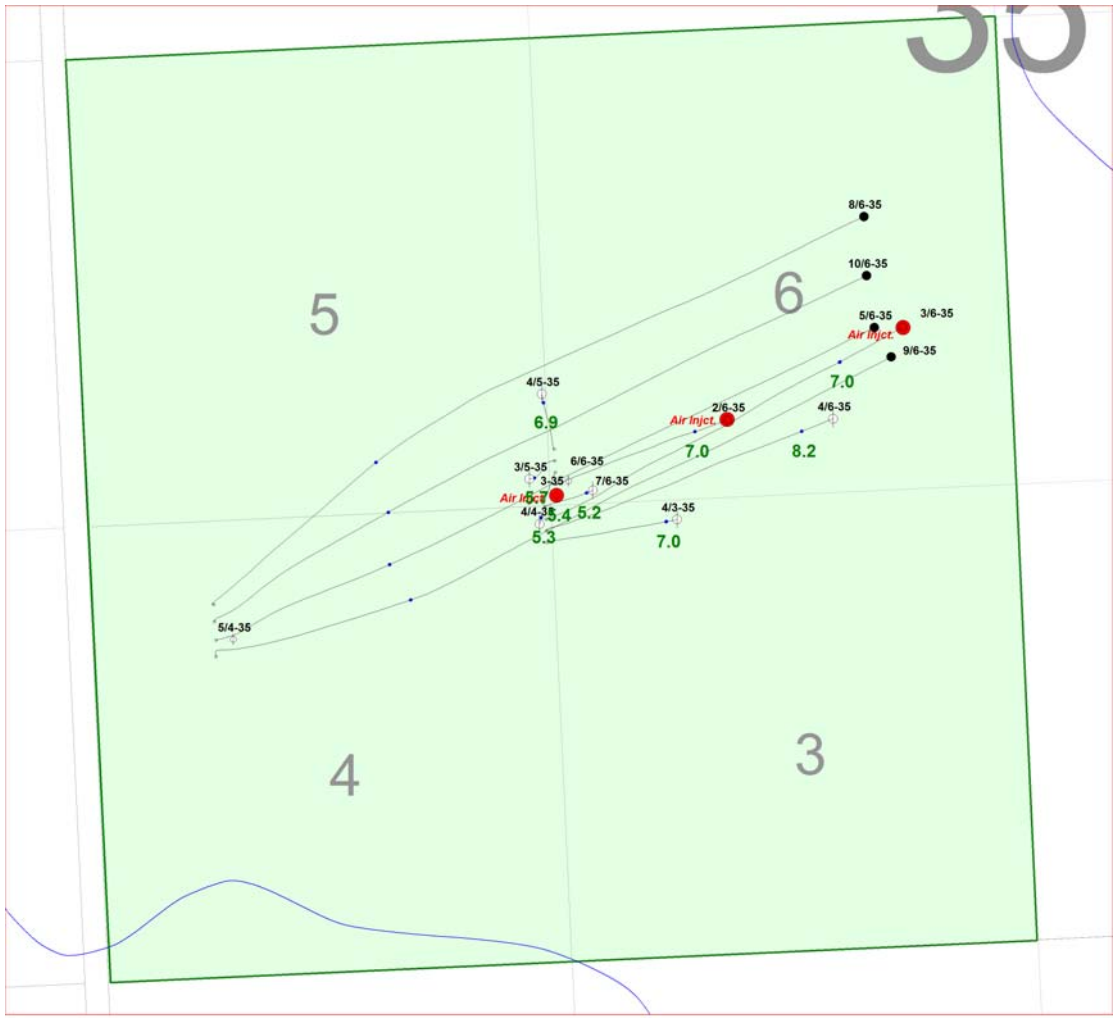
- OBIP = 78 e3m3
- The operating portion of the scheme after shut-in of air injection is the estimated size of the drainage area that was heated by the combustion front at the time of shut-in. The premature shut-in of air injection (and shut-down of combustion) resulted in a smaller portion of the scheme being heated than originally estimated. The actual operating portion of the scheme (6 ha) is based on a drainage area size of 75+75 m wide by 400 m long (length of a HZ well).

Wabiskaw “A”
Net Oil Pay Map



SW 35-78-25W4
Application area

SW 1/4 of Section 35-78-25W4
Wabiskaw “A” Net Oil Pay Values



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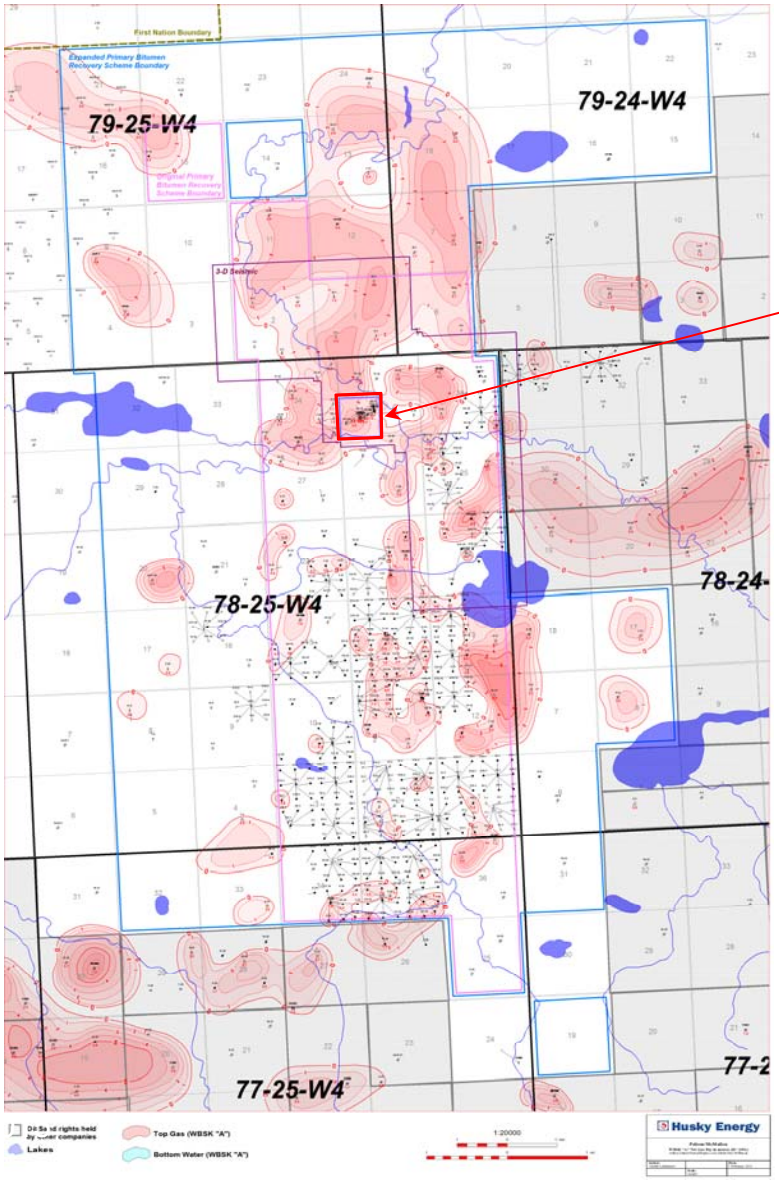
Husky Energy

Pelican/McMullen TCP Project
Net Oil Pay Wabiskaw “A” (metres; por>24%, Resk> 20 Ohms)

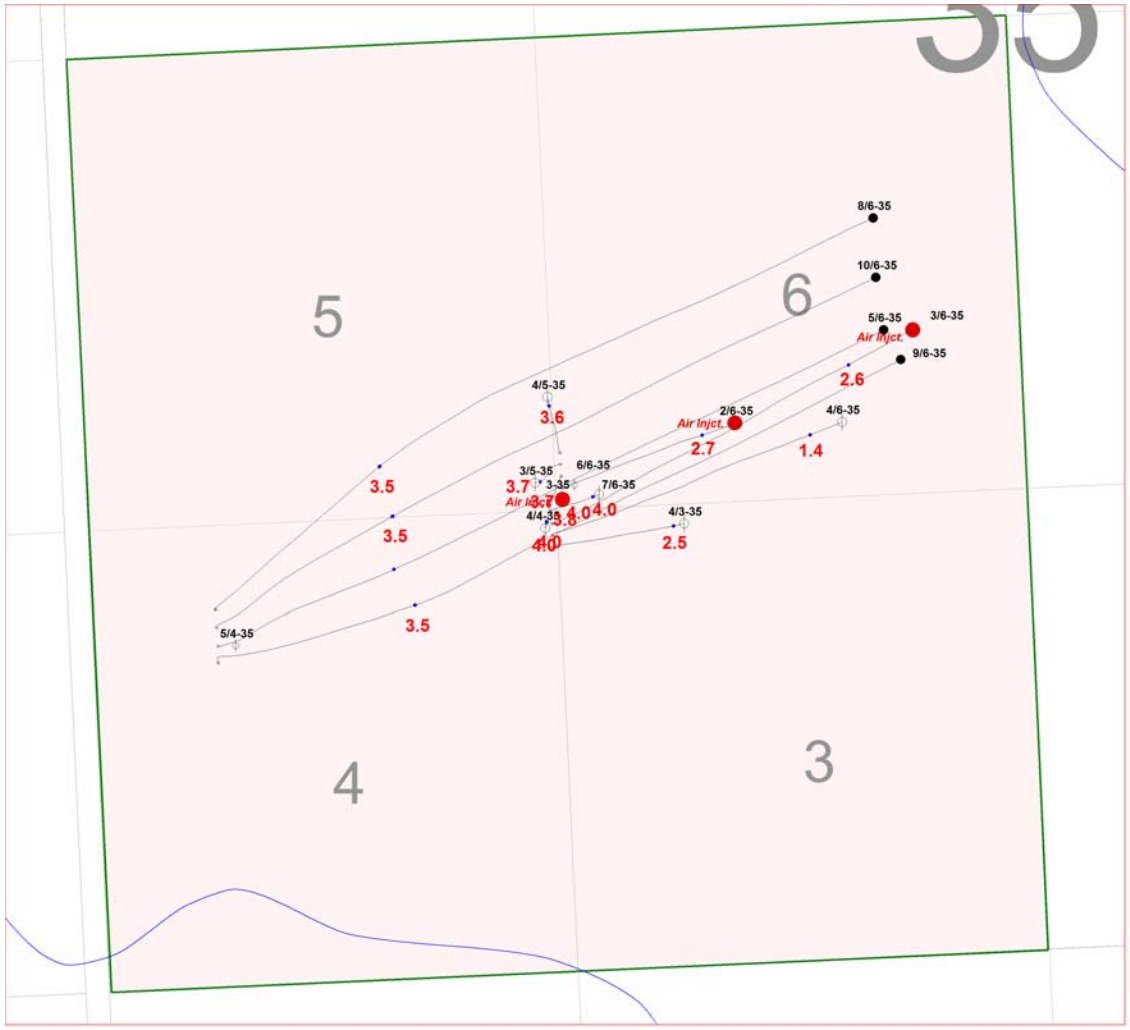
Author: <Andre Laflamme>
Date: 15 January, 2014
Scale: <scale>

Wabiskaw “A”
Net Gas Pay Map



SW 35-78-25W4
Application area

SW 1/4 of Section 35-78-25W4
Wabiskaw “A” Net Gas Pay Values



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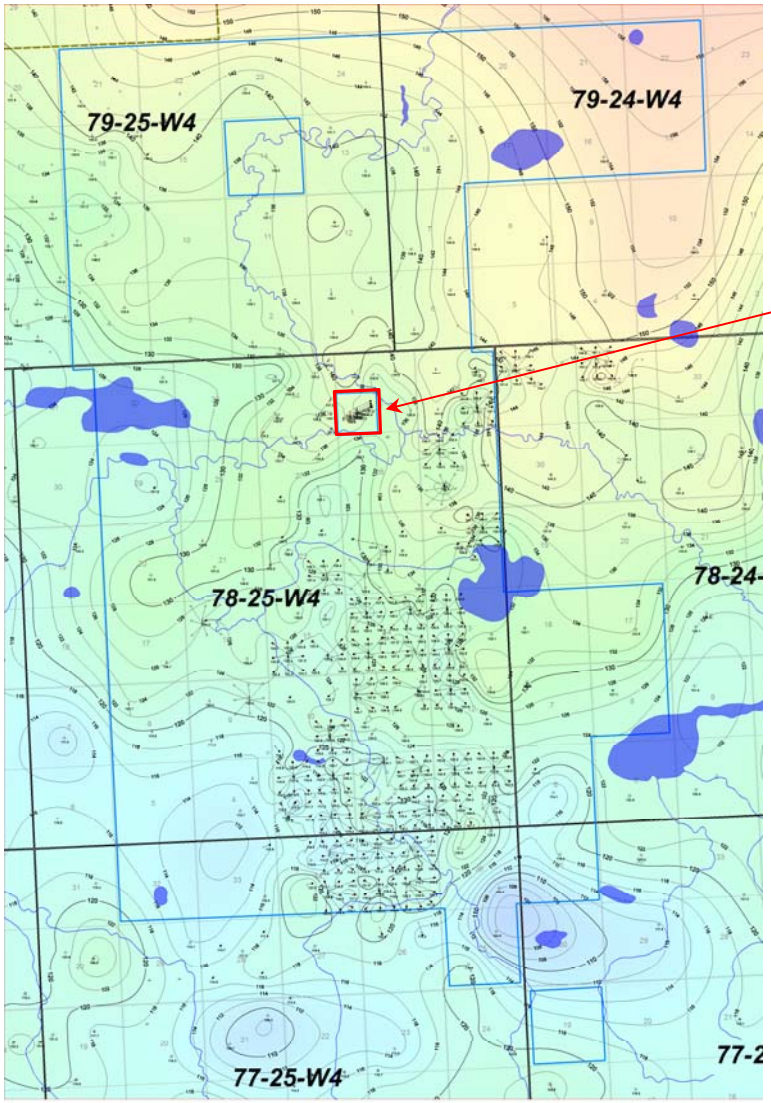
Husky Energy

Pelican/McMullen TCP Project
Net Gas Pay Wabiskaw "A" (metres; por>24%, Resis> 10 Ohms)

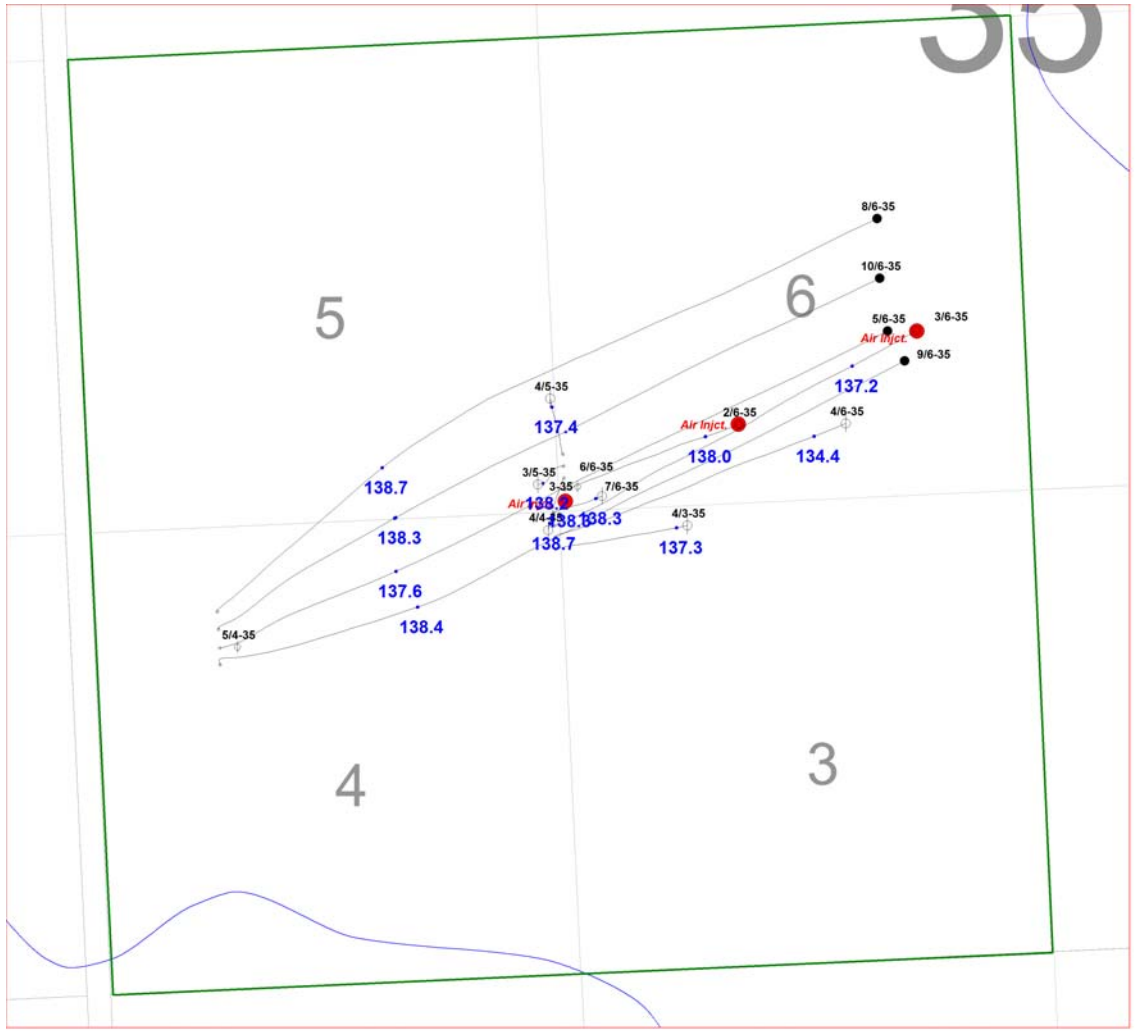
Author: <Andre LaBossiere>
Date: 15 January, 2014
Scale: <scale>

Wabiskaw “A”
Structure Map

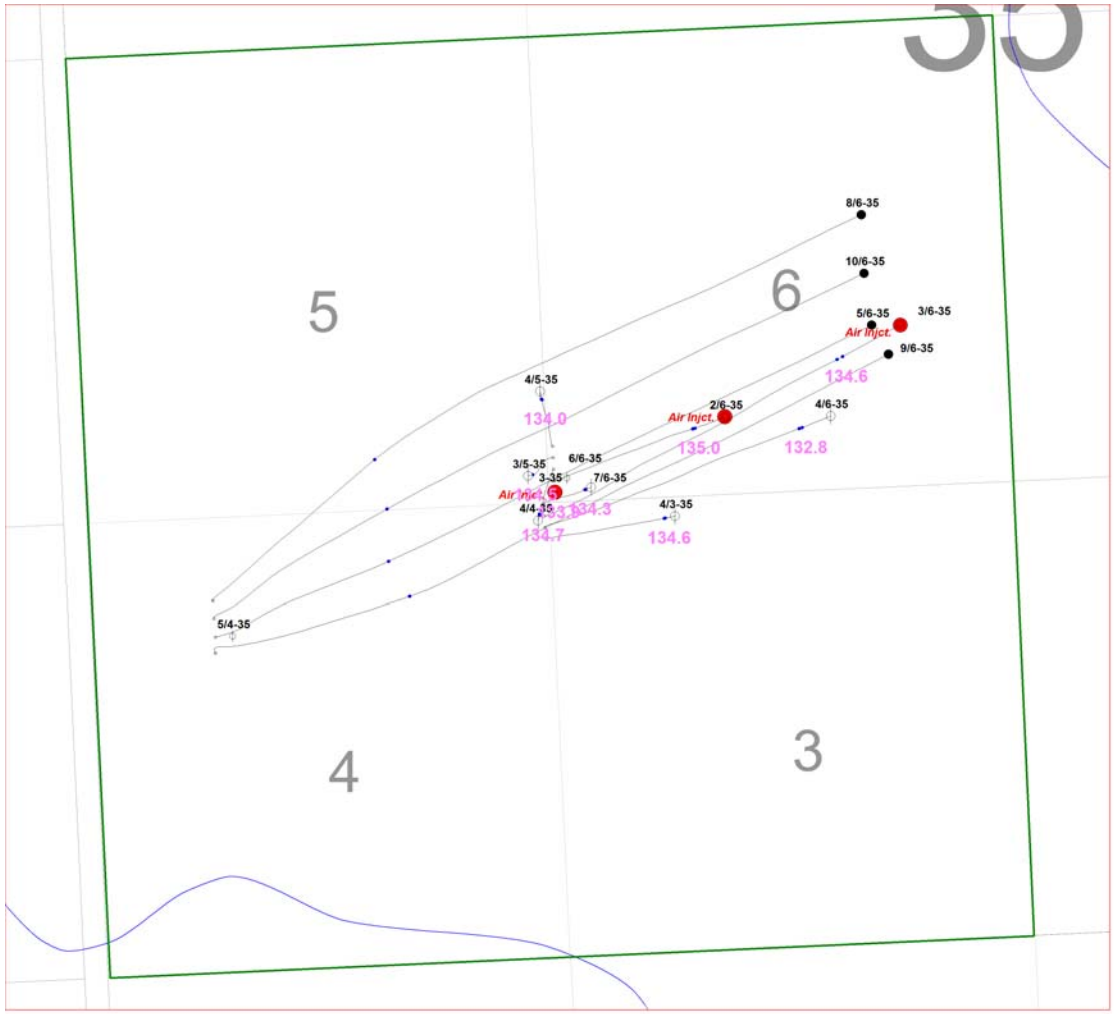


SW 35-78-25W4
Application area

SW 1/4 of Section 35-78-25W4
Wabiskaw “A” Structural Values



SW 1/4 of Section 35-78-25W4
Wabiskaw “A” - Gas/Bitumen Contact Structural Values



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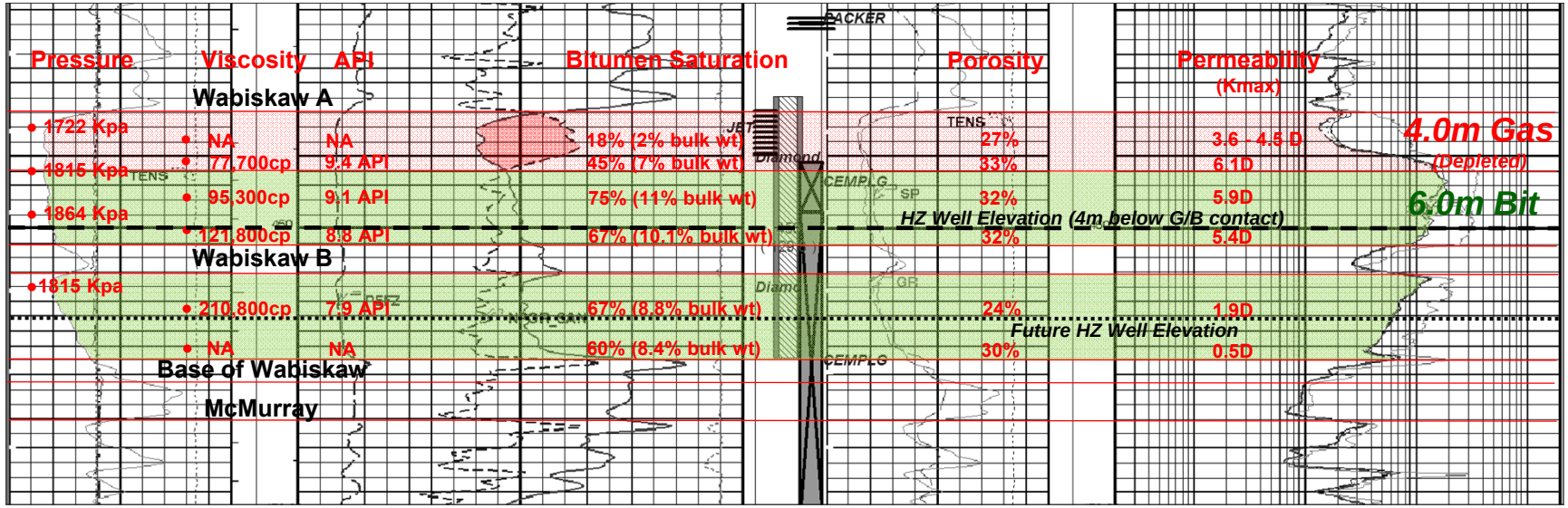
Husky Energy

Pelican/McMullen TCP Project
Wabiskaw “A” Gas/Bitumen Contact Structural Elevation (metres)

Author: <Author>
Date: 15 January, 2014
Scale: <scale>

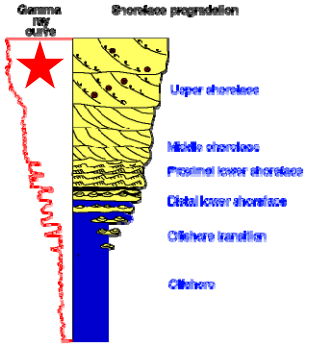
Reservoir & Fluid Characteristics (100/3-35-78-25W4)

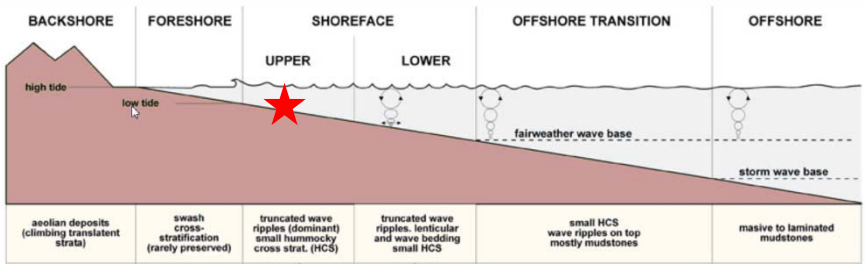


WABISKAW "A"

Marine Shoreline Deposit

- Fine-grained
- Coarsening upward
- Homogeneous & continuous
- Unconsolidated sand

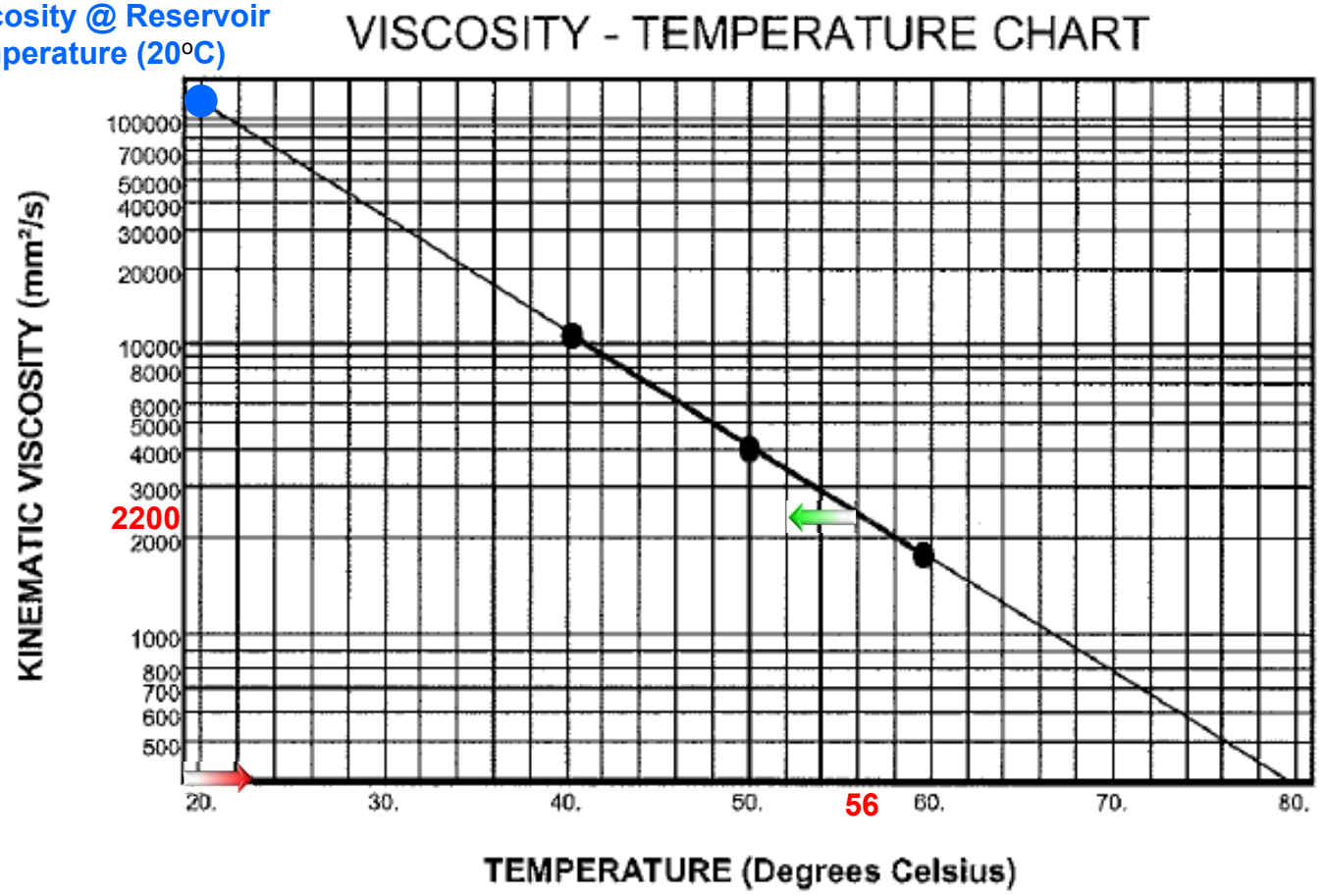




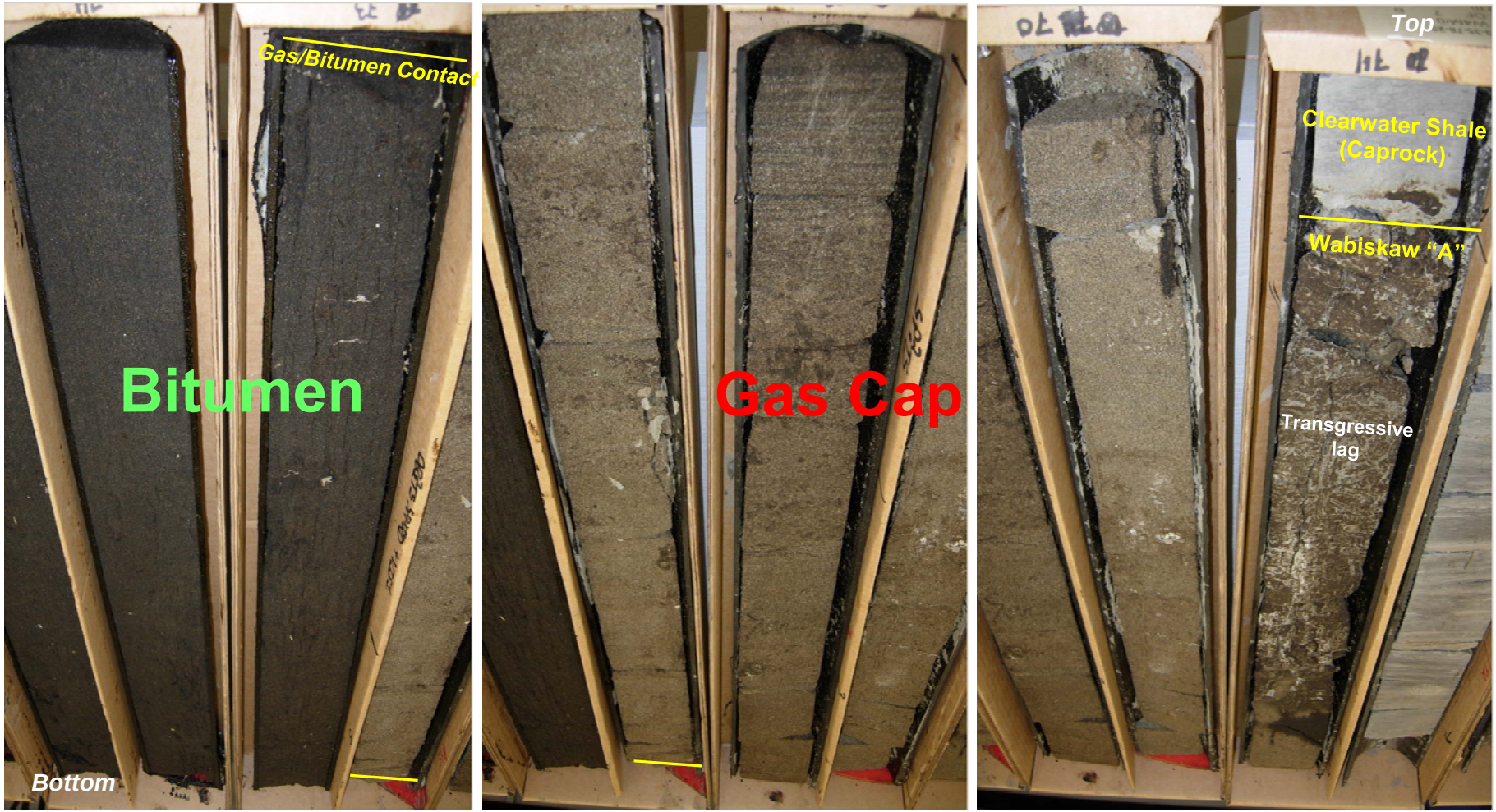
- **Drilling Depth:** ≈ 450m
- **Porosity:** ≈ 31%
- **Permeability:** ≈ 5 Darcies
- **Net Pay:** ≈ 6m
- **Oil Saturation:** ≈ 70%
- **TAN:** 1.3
- **Viscosity (core):** Average 122,000 cp
- **Viscosity (prod):** Average 190,000 cp
- **API:** 8.8
- **Pressure** (current) **:** ≈ 2,250 kPa

McMullen 3-35-78-25W4
Oil Viscosity (4 m below the Gas Cap)

Viscosity @ Reservoir Temperature (20°C)



100/03-35-078-25W4
Fluid Contacts



102/3-35-78-25W4
Mineral Composition in the Gas and Bitumen zones

Core Lab
RESERVOIR OPTIMIZATION

X-RAY DIFFRACTION ANALYSIS
(combined mineral analysis)

Company: Husky Energy Inc.
File No: 52135-08-2307B
Analyst: S.H

Gas Zone **Bitumen Zone**

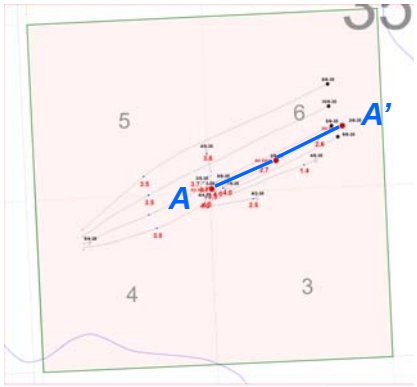
	Husky 102 Pelican 3-35-78-25	Husky 102 Pelican 3-35-78-25				
Sample ID	OB2	OB3	OB4	OB5	OB7	OB8
Depth Interval (m)	443.75	445.3	447.75	450.2	455.45	458.35
Mineral	Whole Rock Weight %	Whole Rock Weight %				
Quartz	93	96	94	94	93	81
K-Feldspar	0	0	1	1	1	2
Plagioclase	0	0	0	0	0	0
Anhydrite	0	0	0	0	0	0
Calcite	0	0	0	0	0	0
Dolomite	0	0	0	0	0	0
Halite	0	0	0	0	0	0
Siderite	0	0	0	0	0	0
Pyrite	0	0	Trace	Trace	Trace	1
Total Clay	7	4	5	5	6	16
Total	100	100	100	100	100	100
Clay Mineral	Relative Clay %	Relative Clay %				
Smectite	0	0	0	0	0	0
Illite / Smectite *	3	8	4	5	9	7
Illite	37	28	33	34	33	34
Kaolinite	21	41	36	32	31	40
Chlorite	39	23	27	29	27	19
Total	100	100	100	100	100	100

*** Illite / Smectite Mixed-Layer Clay**

The percentage of smectite layers in illite / smectite clay: 60-70%

Due to inherent limitations in X-ray diffraction quantification, results must be considered semi-quantitative.

Structural Cross-Section Between the 3 Injectors



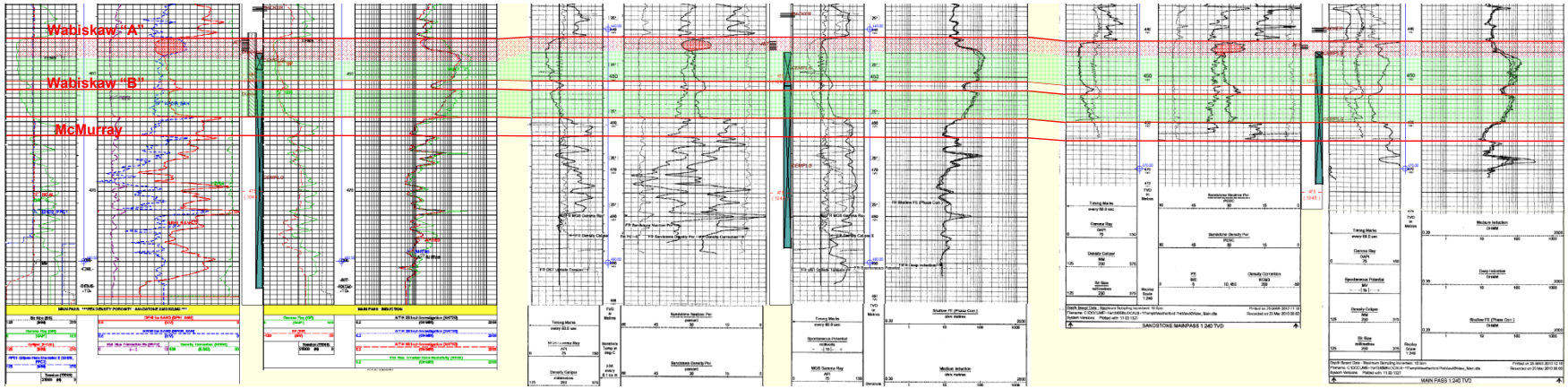
A

A'

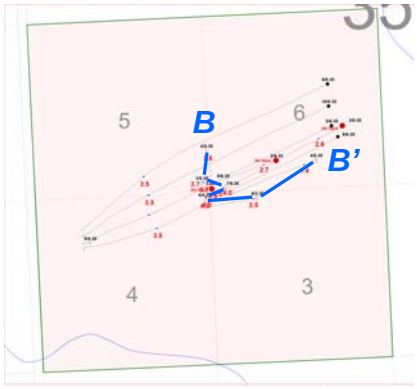
00/03-35-78-25W4
RR 2008-11-19
KB: 579.6m

02/06-35-78-25W4
RR 2010-03-15
KB: 579.5m

03/06-35-78-25W4
RR 2010-03-22
KB: 579.6m

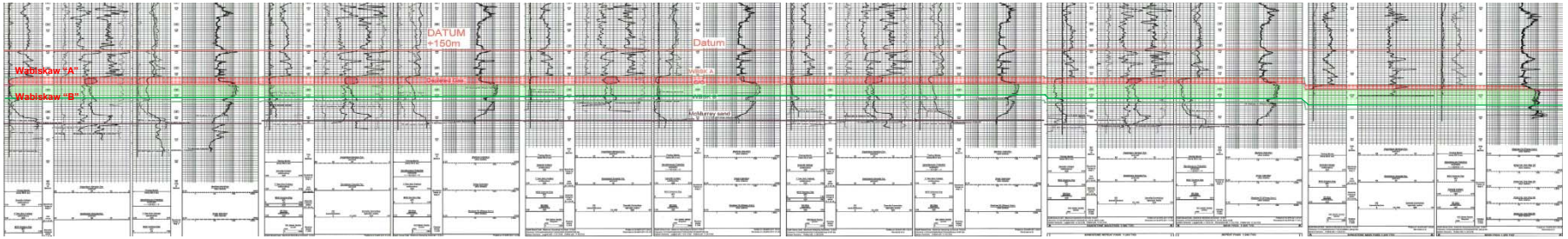


Structural Cross-Section
Between the 6 Observation Wells

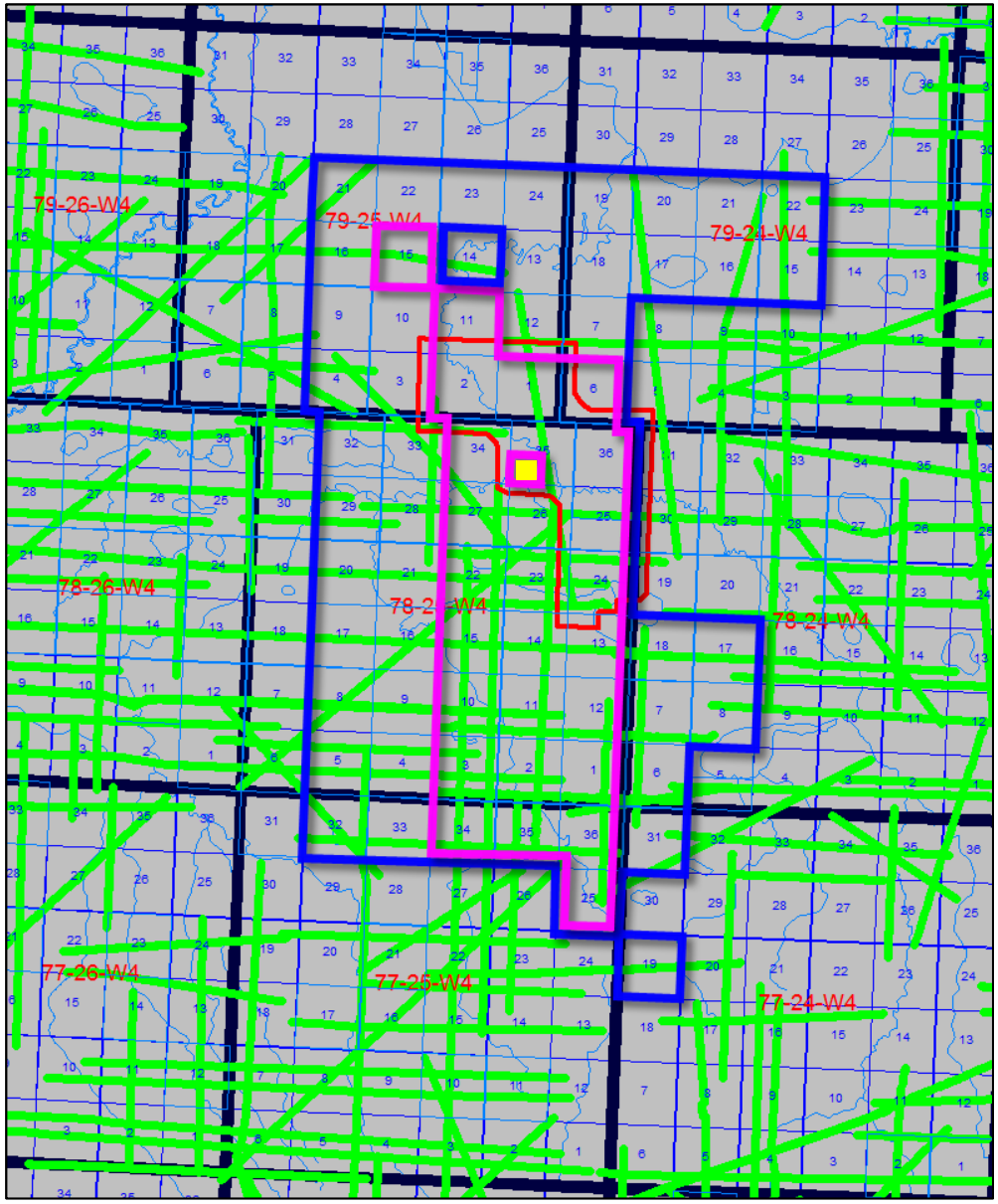


B **B'**

04/05-35-78-25W4	03/05-35-78-25W4	07/06-35-78-25W4	04/04-35-78-25W4	04/03-35-78-25W4	04/06-35-78-25W4
RR 2011-03-11	RR 2011-03-16	RR 2011-03-20	RR 2011-03-29	RR 2011-04-04	RR 2011-03-26
KB: 578.8m	KB: 579.5m	KB: 579.3m	KB: 579.7m	KB: 579.6m	KB: 579.6m



Husky Seismic Coverage



Original Primary Recovery Scheme Boundary

Expanded Primary Recovery Scheme Boundary

TCP Recovery Scheme Boundary

Husky 3-D Seismic Coverage

Husky 2-D Seismic Coverage

Cap Rock Integrity Program

- **Caprock** (overlying Wabiskaw “A”)
  - Clearwater shale sequence (~95 meters thick)

- **Pilot mini-frac test**
  - conducted in March 2010 on the 14-36-78-25W4 well (RR Oct 18, 2008)
  - interpreted in-situ minimum stress in cap rock shale = 8200 kPa
  - fracture gradient = 18.51 kPa/m

- **ERCB scheme MOP Approval:** 5000 kPa

- **Injection pressures**
  - during steaming phase: 2200 - 2500 kPa
  - during air injection phase: 2800 - 3000 kPa (prior to shut-in air injection)
  - air injection shut-in Sep 18, 2014
  - current pressures ~2250 kPa

Surface Monitoring Program

- **Surface heave monitoring is not required**
  - due to the small volume of steam that was injected (8,311 m3 cold water equivalent) prior to start off continuous air injection

Drilling and Completions
&
Instrumentation in Wells

Metering and Monitoring

- **Air injection** will be measured on an individual well basis; four horizontal wells are equipped with production and sales tanks

- **Four Horizontal Oil Production Wells**
  - thermocouples every 25m along the horizontal section
  - pressure sensors at the heel, middle and toe of the horizontal section
  - wells equipped with gas chromatographs to monitor produced gas composition
  - periodic oil & gas samples for analysis
  - issues with malfunctioning thermocouples & pressure sensors

- **Three Air Injection Wells**
  - thermocouples placed at the mid-point of perforations (gas zone)
  - two wells equipped with temperature sensors to indicate potential flow behind pipe

- **Six Observation Wells**
  - 12 thermocouples installed per well (2 above the gas zone, 3 gas zone & 7 bitumen zone)
  - one well equipped with pressure sensors

- **Offsetting Gas Wells**
  - 4 area gas wells equipped gas chromatographs for monitoring of produced gas composition
  - periodic static gradients to monitor reservoir pressure

Thermal Cement Temperature Ratings

4 HZ Production Wells	**Temp Rating**	**Type of Cement**
105/06-35-78-25W4	1000 deg C	**LDP-C-310+0.20% SMS + 0.15% CDF-4P+0.40% CFL-6+0.30%+0.40% CFL-4**
108/06-35-78-25W4	1000 deg C	**LDP-C-310+1%CFR-5+0.5% CFL-3+0.3% Citric Acid+6%Gypsum+1%TAE+0.15%CDF-4P**
109/06-35-78-25W4	1000 deg C	**LDP-C-310+1%CFR-5+0.5% CFL-3+0.3% Citric Acid+6%Gypsum+1%TAE+0.15%CDF-4P**
110/06-35-78-25W4	1000 deg C	**LDP-C-310+1%CFR-5+0.5% CFL-3+0.3% Citric Acid+6%Gypsum+1%TAE+0.15%CDF-4P**

3 Air Injection Wells	**Temp Rating**	**Type of Cement**
100/03-35-78-25W4	360 deg C	**Thermal 40 Expandomix + 1.00% CaCl2 + 0.25% CFR-2 + 0.35% CFL-3**
102/06-35-78-25W4	1000 deg C	**UHTC + 3.0% CFL-6 + 0.20% SMS + 0.20% CR-2 slurry @ 1900 kg/m3**
103/06-35-78-25W4	1000 deg C	**UHTC + 3.0% CFL-6 + 0.20% SMS + 0.20% CR-2 slurry @ 1900 kg/m3**

6 Observation Wells	**Temp Rating**	**Type of Cement**
104/05-35-78-25W4	1000 deg C	**LDP-C-310+0.1% CR-2 + 0.3% CFL-6 + 0.2% SMS + 0.15% CDF-4P**
103/05-35-78-25W4	1000 deg C	**LDP-C-310+0.1% CR-2 + 0.3% CFL-6 + 0.2% SMS + 0.15% CDF-4P**
104/06-35-78-25W4	1000 deg C	**LDP-C-310+0.1% CR-2 + 0.3% CFL-6 + 0.2% SMS + 0.15% CDF-4P**
104/04-35-78-25W4	1000 deg C	**LDP-C-310+0.1% CR-2 + 0.3% CFL-6 + 0.2% SMS + 0.15% CDF-4P**
104/03-35-78-25W4	1000 deg C	**LDP-C-310+0.1% CR-2 + 0.3% CFL-6 + 0.2% SMS + 0.15% CDF-4P**
107/06-35-78-25W4	1000 deg C	**LDP-C-310+0.1% CR-2 + 0.3% CFL-6 + 0.2% SMS + 0.15% CDF-4P**

- 1000 deg C cement is a **special cement** that was ordered from Chesapeake Virginia

Thermal Cement Wellbore Integrity

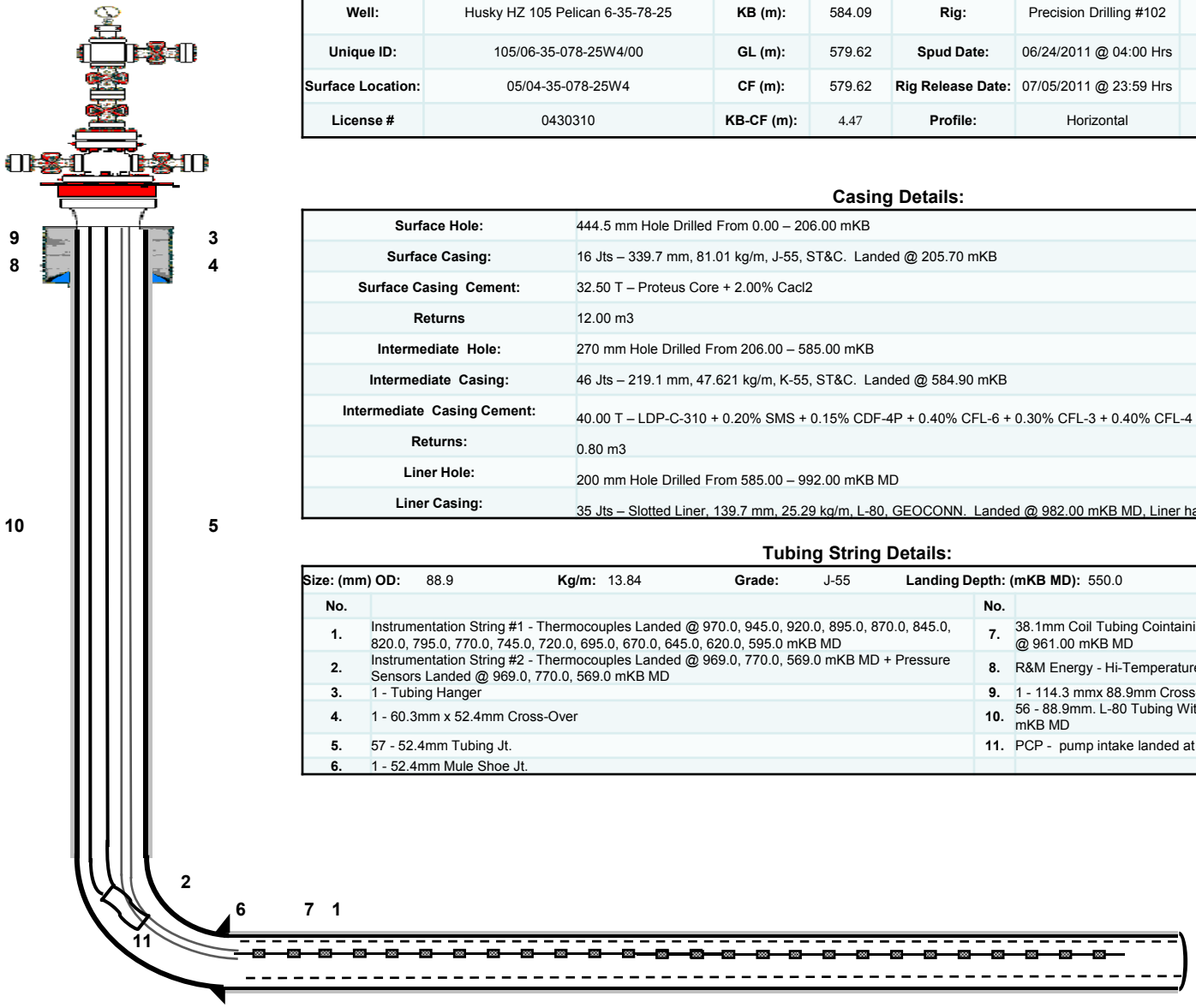
- **100/03-35-78-25W4 drilled in Nov 2008 as an evaluation well**
  - thermal cement rated for 360^{o}C
  - the Project location was based on core and log data from this well
  - was converted to an air injection well for the Project

- **Observed temperatures in the 100/03-35-78-25W4 air injection well**
  - max temp of 220^{o}C during the 30 day steaming phase (Oct 2011)
  - temperatures constant 20 – 25^{o}C since start of air injection (Dec 2011)

- **Peak combustion temperatures were recorded in two observation wells**
  - 103/05-35 and 104/04-35-78-25W4 wells
  - highest combustion temperatures observed in the **gas zone ~330^{o}C**

- **There has been no indication of wellbore integrity issues within the Project**

Producing HZ Well- 105/06-35-078-25W4



Well:	Husky HZ 105 Pelican 6-35-78-25	**KB (m):**	584.09	**Rig:**	Precision Drilling #102	**TD (mKB MD):**	992.00
Unique ID:	105/06-35-078-25W4/00	**GL (m):**	579.62	**Spud Date:**	06/24/2011 @ 04:00 Hrs	**TVD (mKB MD):**	454.40
Surface Location:	05/04-35-078-25W4	**CF (m):**	579.62	**Rig Release Date:**	07/05/2011 @ 23:59 Hrs	**PBTD (mKB MD):**	981.59
License #	0430310	**KB-CF (m):**	4.47	**Profile:**	Horizontal	**PB (mKB MD):**	

Casing Details:

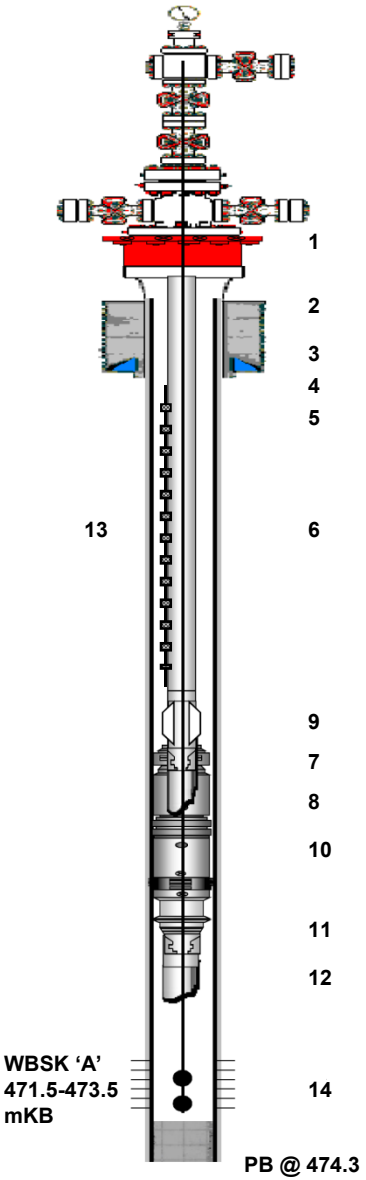
Surface Hole:	444.5 mm Hole Drilled From 0.00 – 206.00 mKB
Surface Casing:	16 Jts – 339.7 mm, 81.01 kg/m, J-55, ST&C. Landed @ 205.70 mKB
Surface Casing Cement:	32.50 T – Proteus Core + 2.00% Cacl2
Returns	12.00 m3
Intermediate Hole:	270 mm Hole Drilled From 206.00 – 585.00 mKB
Intermediate Casing:	46 Jts – 219.1 mm, 47.621 kg/m, K-55, ST&C. Landed @ 584.90 mKB
Intermediate Casing Cement:	40.00 T – LDP-C-310 + 0.20% SMS + 0.15% CDF-4P + 0.40% CFL-6 + 0.30% CFL-3 + 0.40% CFL-4
Returns:	0.80 m3
Liner Hole:	200 mm Hole Drilled From 585.00 – 992.00 mKB MD
Liner Casing:	35 Jts – Slotted Liner, 139.7 mm, 25.29 kg/m, L-80, GEOCONN. Landed @ 982.00 mKB MD, Liner hanger top @ 557.60 mKB MD

Tubing String Details:

Size: (mm) OD: 88.9 **Kg/m:** 13.84 **Grade:** J-55 **Landing Depth: (mKB MD):** 550.0

No.		No.	
1.	Instrumentation String #1 - Thermocouples Landed @ 970.0, 945.0, 920.0, 895.0, 870.0, 845.0, 820.0, 795.0, 770.0, 745.0, 720.0, 695.0, 670.0, 645.0, 620.0, 595.0 mKB MD	**7.**	38.1mm Coil Tubing Cointaining Both Instrumentation Strings - Landed @ 961.00 mKB MD
2.	Instrumentation String #2 - Thermocouples Landed @ 969.0, 770.0, 569.0 mKB MD + Pressure Sensors Landed @ 969.0, 770.0, 569.0 mKB MD	**8.**	R&M Energy - Hi-Temperature Tubing Rotator
3.	1 - Tubing Hanger	**9.**	1 - 114.3 mmx 88.9mm Cross-Over
4.	1 - 60.3mm x 52.4mm Cross-Over	**10.**	56 - 88.9mm. L-80 Tubing With Bevelled Couplings. Landed @ 501.3 mKB MD
5.	57 - 52.4mm Tubing Jt.	**11.**	PCP - pump intake landed at 501.30 mKB MD
6.	1 - 52.4mm Mule Shoe Jt.		

Injection Well- 102/06-35-078-25W4



Well:	Husky 102 Pelican 6-35-78-25	**KB (m):**	579.46	**Rig:**	Precision Drilling #164	**TD (mKB MD):**	529.00
Unique ID:	102/06-35-078-25W4/00	**GL (m):**	575.32	**Spud Date:**	3/15/2010 3:30:00 PM	**TVD (mKB MD):**	492.12
Surface Location:	04/06-35-078-25W4	**CF (m):**	575.41	**Rig Release Date:**	3/15/2010 11:59:00 PM	**PBTD (mKB MD):**	522.20
License #	0418707	**KB-CF (m):**	4.05	**Profile:**	Directional	**PB (mKB MD):**	474.30 (Cement Top)

Casing Details:

Surface Hole:	349 mm Hole Drilled From 0.00 – 199.00 mKB MD
Surface Casing:	15 Jts – 244.5 mm, 48.068 kg/m, H-40, ST&C. Landed @ 199.00 mKB MD
Surface Casing Cement:	22.00 T – Proteus CO + 2.00% CaCl2 + 1.00% CFR-2
Returns	4.00 m3
Production Hole:	222 mm Hole Drilled From 199.00 – 529.00 mKB MD
Production Casing:	44 Jts + 1 Marker Jt - 177.8 mm, 34.228 kg/m, L-80, QB2. Landed @ 529.00 mKB MD
Production Casing Cement:	Scavenger - 1.00 T - UHTC; Lead - 15.40 T – UHTC + 0.30% CFL-6 + 0.20% CR-2 + 0.20% SMS
Returns:	2.00 m3

Tubing String Details:

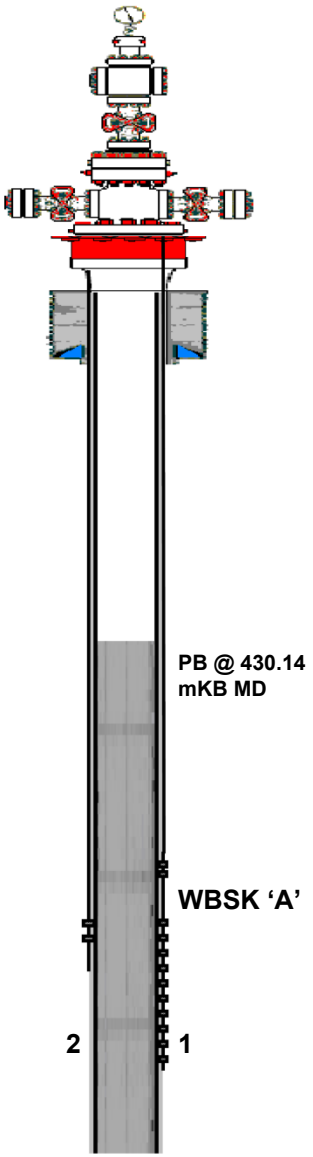
Size: (mm) OD: 88.9 **Kg/m:** 13.84 **Grade:** J-55 **Landing Depth: (mKB MD):**

No.		No.	
1	1 - 179.4 mm × 88.9 mm Tubing Hanger	8	1 - 88.9 mm Box Up x 101.6 mm Mule Shoe Down
2	1 - 88.9 mm Tubing Jt.	9	1 - 88.9 mm x 101.6 mm x 4.50 m Thermal PermaPack Locating Assembly
3	1 - 88.9 mm x 3.10 m Pup Jt.	10	1 - 177.8 mm Thermal PermaPack Permanent Seal Bore Packer c/w 101.6 mm x 4.50 m Integral Seal Bore
4	1 - 88.9 mm x 1.80 m Pup Jt.	11	1 - 114.3 mm x 69.9 mm SXN Nipple (67 mm No-Go Nipple)
5	1 - 88.9 mm x 1.20 m Pup Jt.	12	1 - 114.3 mm Wireline Re-Entry Guide
6	47 - 88.9 mm Tubing Jt.	13	Thermocouples @ 472.50, 472.50, 443.00, 415.00, 387.00, 358.00, 330.00, 302.00, 275.00, 247.00 mKB MD
7	1 - 88.9 mm x 69.9 mm SX Nipple	14	Thermocouples @ 473.50, 472.25 mKB MD

Isolation Equipment:

Date Set	Make:	Model:	Depth Set (mKB MD):	Pressure Tested:
July 14, 2011	Logan	177.8 mm Thermal PermaPack Permanent Seal Bore Packer	465.00	7 MPa @10 mins
April 17, 2011	Sanjel	1.20 m3 LDP-C-310 (UHTC) + 0.30% CFL-6 + 0.20% SMS + 0.10% CR-2	522.20-482.60	
July 13, 2011	Sanjel	1.30 T - LDP-C-310 (UHTC) + 0.30% CFL-6 + 0.20% SMS + 0.10% CR-2	482.60-474.30	

Observation Well- 104/03-35-078-25W4



Well:	Husky 104 Pelican 3-35-78-25	**KB (m):**	579.60	**Rig:**	Precision Drilling #163	**TD (mKB MD):**	487.00
Unique ID:	104/03-35-078-25W4/00	**GL (m):**	575.40	**Spud Date:**	03/30/2011 @ 12:45 Hrs	**TVD (mKB MD):**	464.83
Surface Location:	04/04-35-078-25W4	**CF (m):**	575.65	**Rig Release Date:**	04/04/2011 @ 20:00 Hrs	**PBTD (mKB MD):**	
License #	0419607	**KB-CF (m):**	3.95	**Profile:**	Directional	**PB (mKB MD):**	430.14 (Cement Top)

Casing Details:

Surface Hole:	349 mm Hole Drilled From 0.00 – 171.00 mKB MD
Surface Casing:	13 Jts – 244.5 mm, 48.068 kg/m, H-40, ST&C. Landed @ 171.00 mKB MD
Surface Casing Cement:	20.00 T – Proteus Core + 2.00% CaCl2 + 1.00% CFR-2 + 0.15% CDF-4P
Returns	5.00 m3
Production Hole:	222 mm Hole Drilled From 171.00 – 487.00 mKB MD
Production Casing:	35 Jts + 3 Marker Jt - 114.3 mm, 14.14 kg/m, J-55, ST&C . Landed @ 484.20 mKB MD
Production Casing Cement:	29.40 T – LDP-C-310 + 0.10% CR-2 + 0.20% SMS + 0.30% CFL-6 + 0.15% CDF-4P
Returns:	5.00 m3
Liner Hole:	N/A
Liner Casing:	N/A

Tubing String Details:

No.	
1	Instrumentation String #1 (Outside Of Casing): Thermocouples @ 476.27, 475.14, 474.01, 472.01, 471.75, 470.62, 469.49, 468.36, 467.22, 464.96, 452.52, 451.38 mKB MD
2	Instrumentation String #2 (Outside Of Casing): Thermocouples @ 470.62, 464.53 mKB MD & Pressure Sensors @ 470.62, 465.53 mKB MD

Artificial Lift

- **HZ 105/06-35 and HZ 108/06-35-078-25W4 production wells**
  - currently equipped with high temperature metal to metal 80MET1000 PCP
  - initially equipped with a high temperature 12-ML-17 PCP (rated for a max of 175 deg C)
  - HZ 105/06-35 on prod Nov 2012

- **HZ 109/06-35-078-25W4 production well**
  - currently equipped with high temperature metal to metal 80MET1000 PCP
  - initially equipped with a high temperature 12-ML-44 PCP
  - changed to a 16-ML-44 PCP (rated for a max of 175 deg C)
  - on production September 2013

- **HZ 110/06-35-078-25W4 production well**
  - currently equipped with high temperature metal to metal 80MET1000 PCP
  - initially equipped with a high temperature 16-ML-44 PCP (rated for a max of 175 deg C)
  - on production October 2013

- **HZ 108/06-35-078-25W4 production well**
  - equipped with high temperature 12-ML-17 PCP
  - well started back up October 2014
  - on production October 2013 (shut-in December 2nd 2013)

4-D Seismic

- **Lateral distribution of heat**
  - too small to be resolved on 3D or 4D seismic surveys
- **4D seismic data**
  - no plans to acquire at this time

TCP Scheme Performance

First steam injection on September 28, 2011

First air injection on December 8, 2011
Shut-in air injection on September 18, 2014

HZ 105/06-35 on production November 1, 2012
HZ 109/06-35 on production September 30, 2013
HZ 110/06-35 on production October 6, 2013
HZ 108/06-35 on production October 18, 2013 (SI Dec 2/13)

HZ 108/06-35 re-start on production October 8, 2014

The purpose of the initial steam injection was to raise the formation temperature in each of the 3 injection wells to 180 – 200 deg C to allow for ignition when switching over to air injection. The criterion for the start-up of each HZ well was that 9 of the 16 thermocouples located along the horizontal section of the wellbore would be heated to a temperature of at least 56 deg C, which would result in a bitumen viscosity of 2,200 cp or less and a flow rate of 25 m^3/d or higher.

Injection & Production History

- **Start-up of air injection on December 8, 2011**
  - injection rate increase to 15 e3m3/day on Dec 12, 2011
  - injection rate increase to 20 e3m3/day on Dec 28, 2011
  - injection rate increase to 25 e3m3/day on Jan 30, 2012
  - injection rate increase to 40 e3m3/day on Feb 17, 2012
  - injection rate increase to 45 e3m3/day on Mar 16, 2012
  - injection rate increase to 55 e3m3/day on Apr 24, 2012
  - injection rate increase to 65 e3m3/day on Jul 16, 2012 (two trains)
  - injection rate increase to 90 e3m3/day on Oct 17, 2012 (third train)
  - shut-in air injection on September 18, 2014 (2 years & 10 months)

- **Shut-in of air injection** was due to increasing concentrations of nitrogen observed in several of Husky's surrounding primary wells in the area and the potential risk of shutting in even more primary oil production

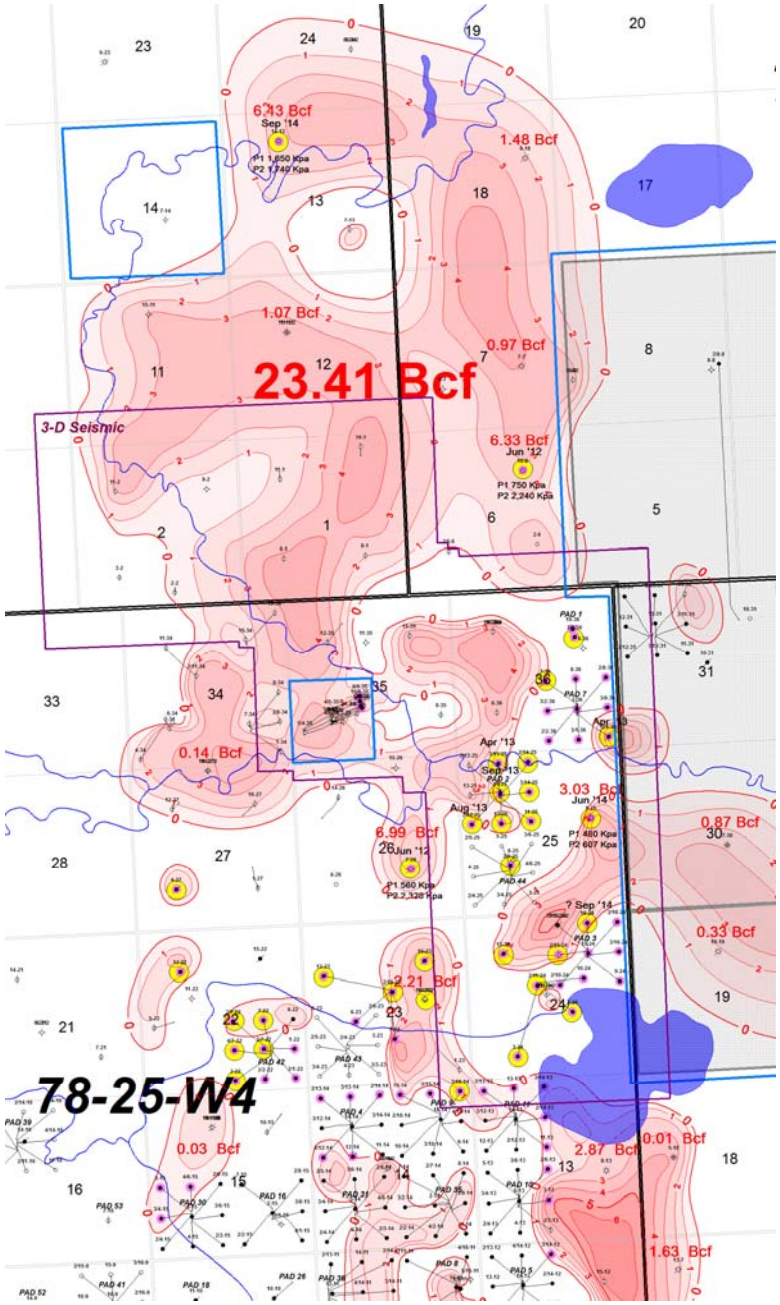
- **HZ 105/06-35-78-25W4 on initial production for 4 days in August 2012**
  - shut-in due to the detection of H2S, production re-start was on November 1, 2012

- **HZ's 109/06-35, 110/06-35 & 108/06-35-78-25W4 were placed on production in September and October 2013**
  - 108/06-35 shut-in on Dec 2, 2013 to allow bitumen zone to be further heated; was placed back on production October 8, 2014

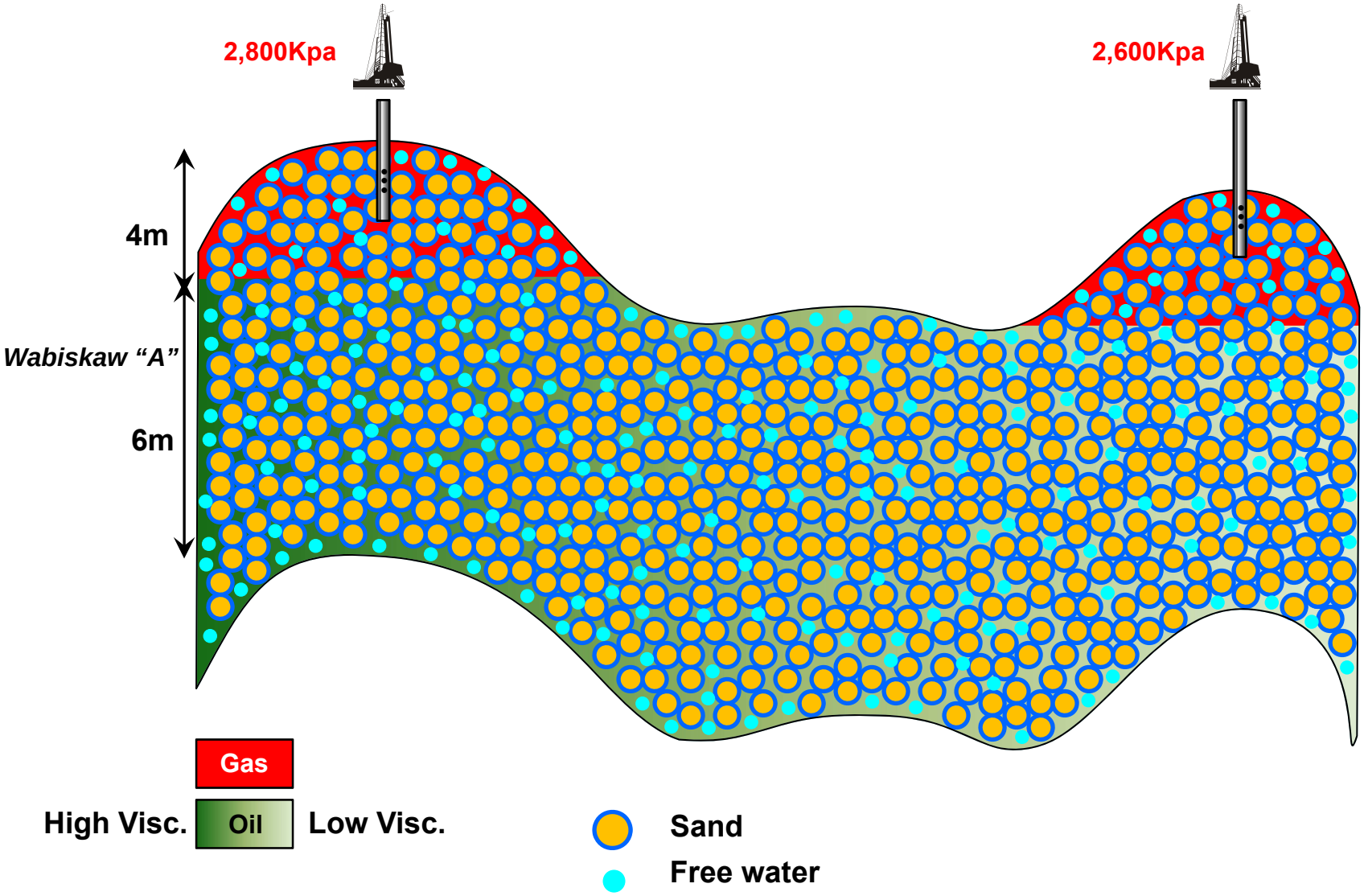
N_2 Monitoring

Wells monitored for N_2

Wells with N_2 detected

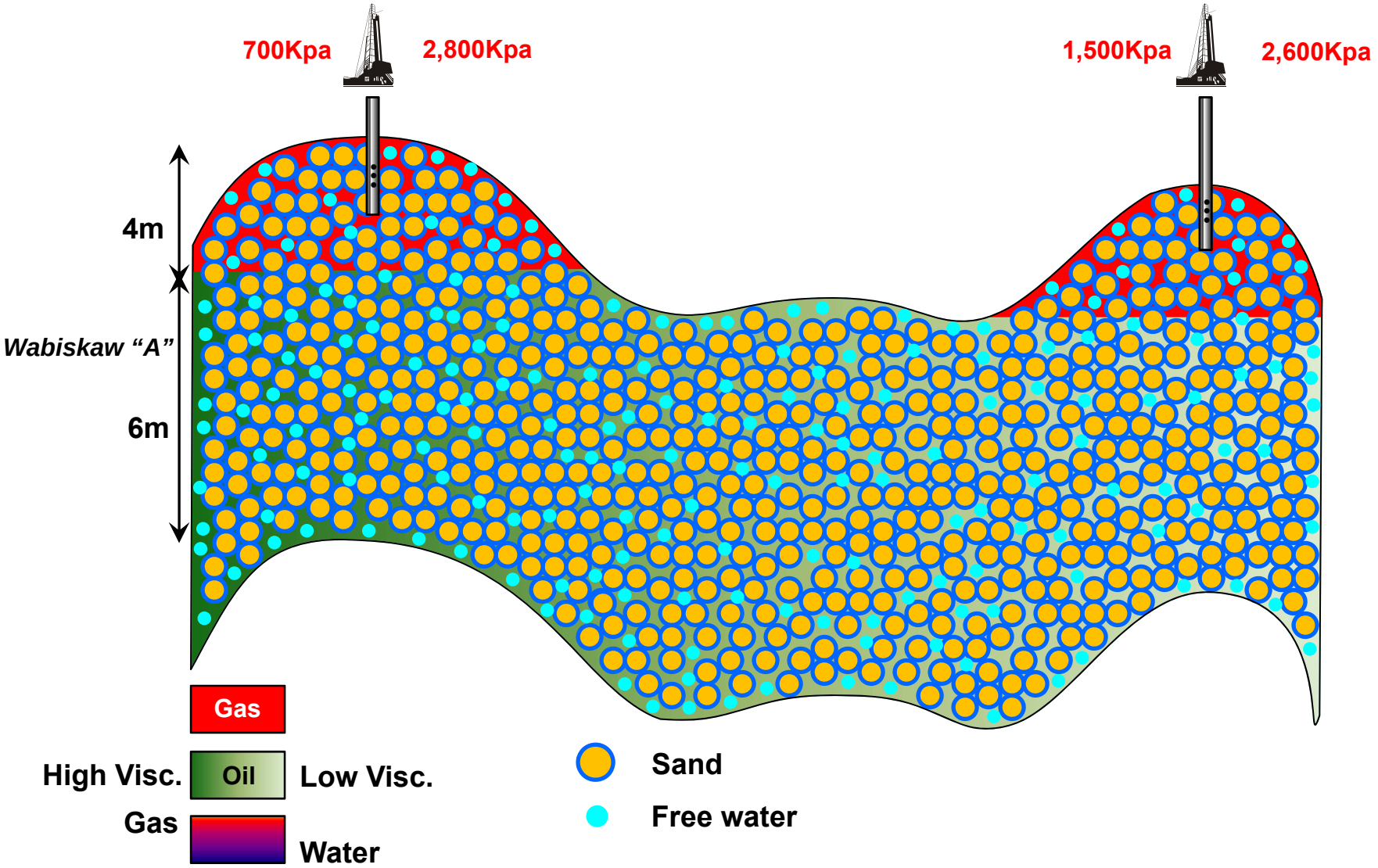


N_2 Breakthrough Mechanism -Gas Discovery-



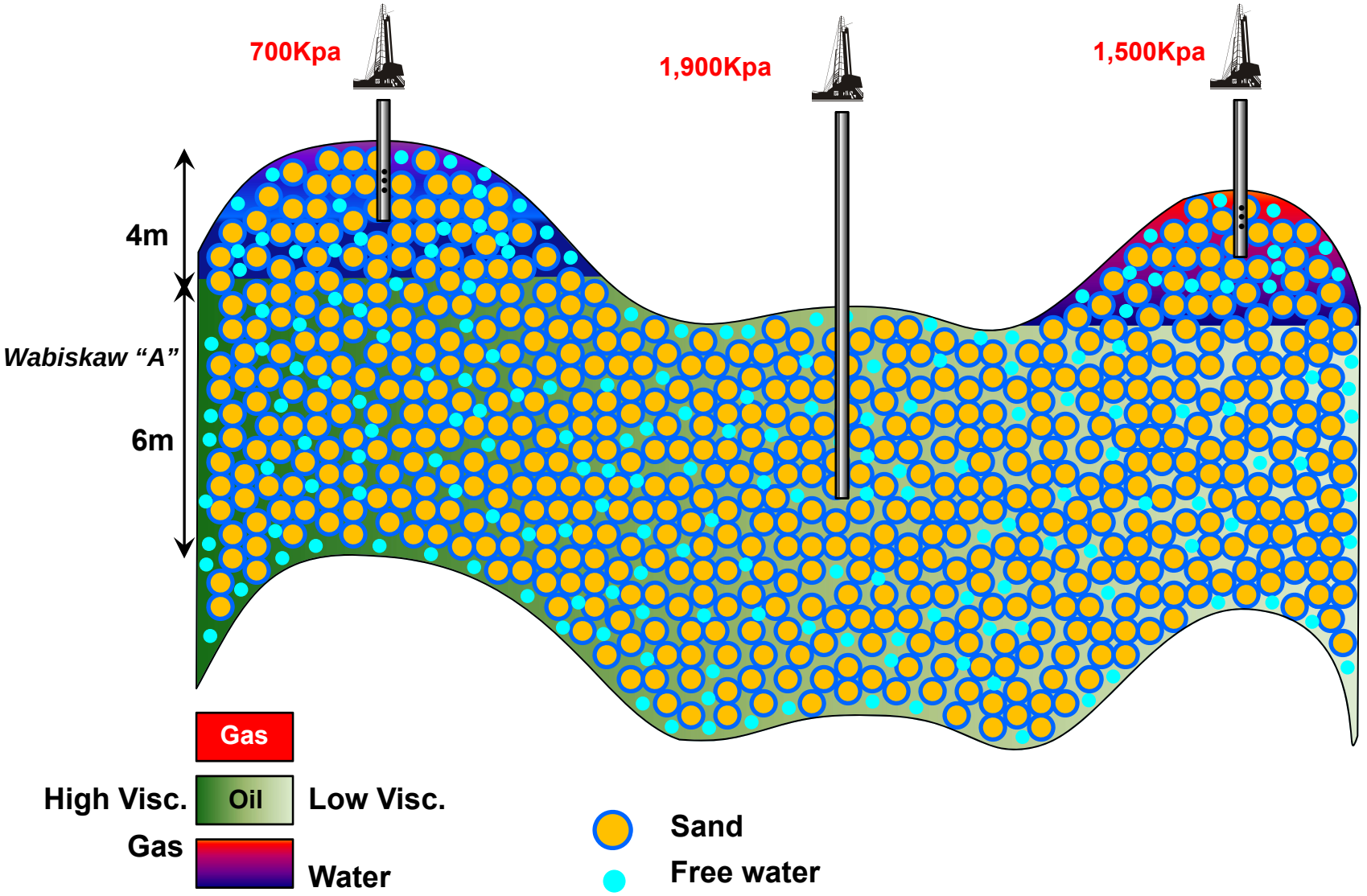
This slide illustrates two gas wells (4 m gas over 6 m bitumen) drilled at initial reservoir pressures ranging from 2600 to 2800 kPa

N_2 Breakthrough Mechanism -Gas Depletion-



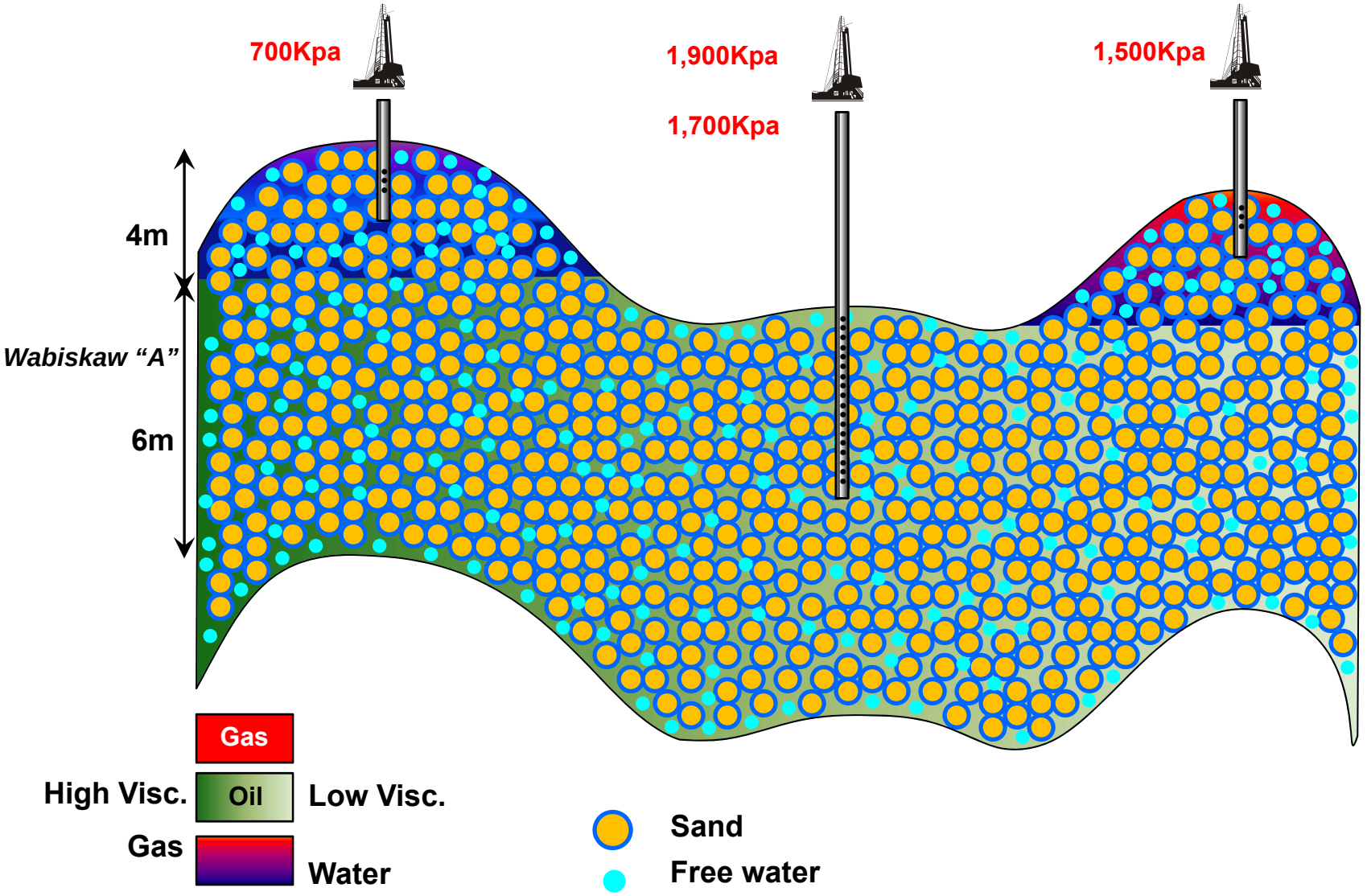
The two gas wells are placed on production, depleting the reservoir pressure (700 – 1500 kPa) and eventually filling the void space in the gas cap with formation water from the underlying bitumen zone

N_2 Breakthrough Mechanism -Bitumen Discovery-



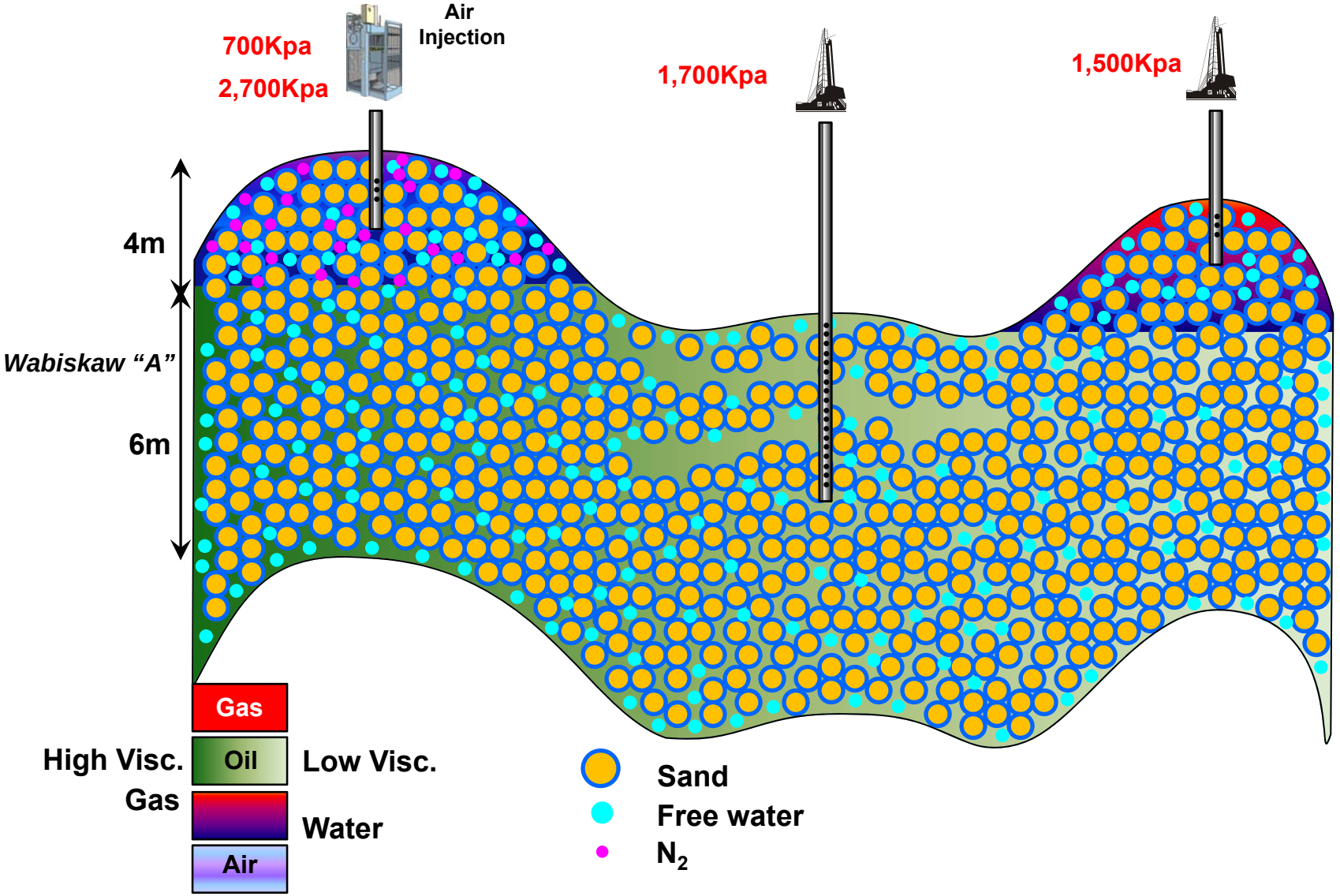
A bitumen well is drilled for primary production, the reservoir pressure is depleted (1900 kPa) due to the production from the two offsetting gas wells

N_2 Breakthrough Mechanism -Bitumen Production-



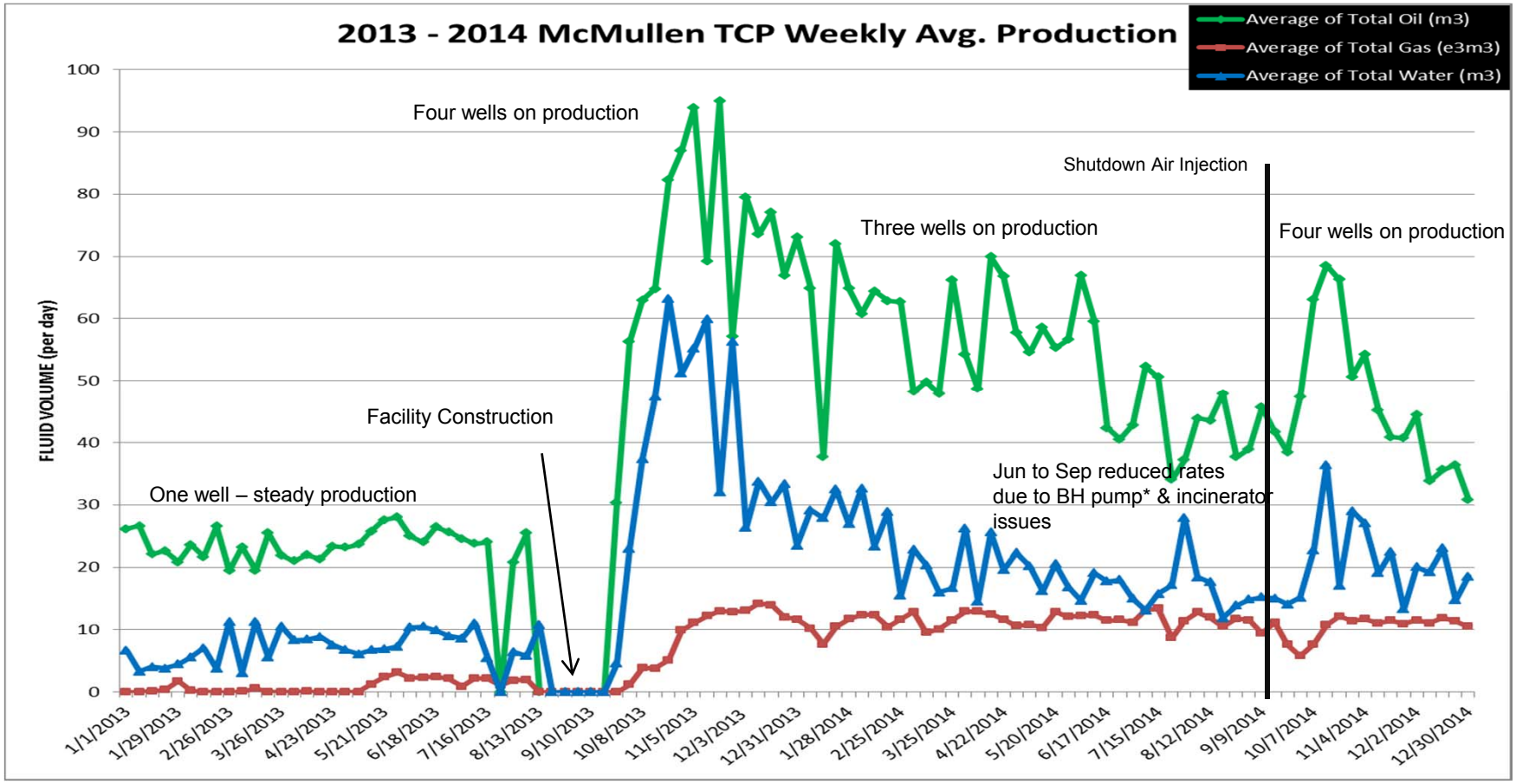
The bitumen well is placed on primary production which creates wormholes in the reservoir and the pressure is further reduced (1700 kPa)

N_2 Breakthrough Mechanism -Air Injection-



An air injection well is drilled in the depleted gas cap and continuous air injection increases the pressure from 700 kPa to 2700 kPa. Oxygen (O_2) is spent at the combustion front while nitrogen (N_2) travels from the injection well through the bitumen zone and ends up being produced (breakthrough) at both the offsetting primary bitumen and gas wells.

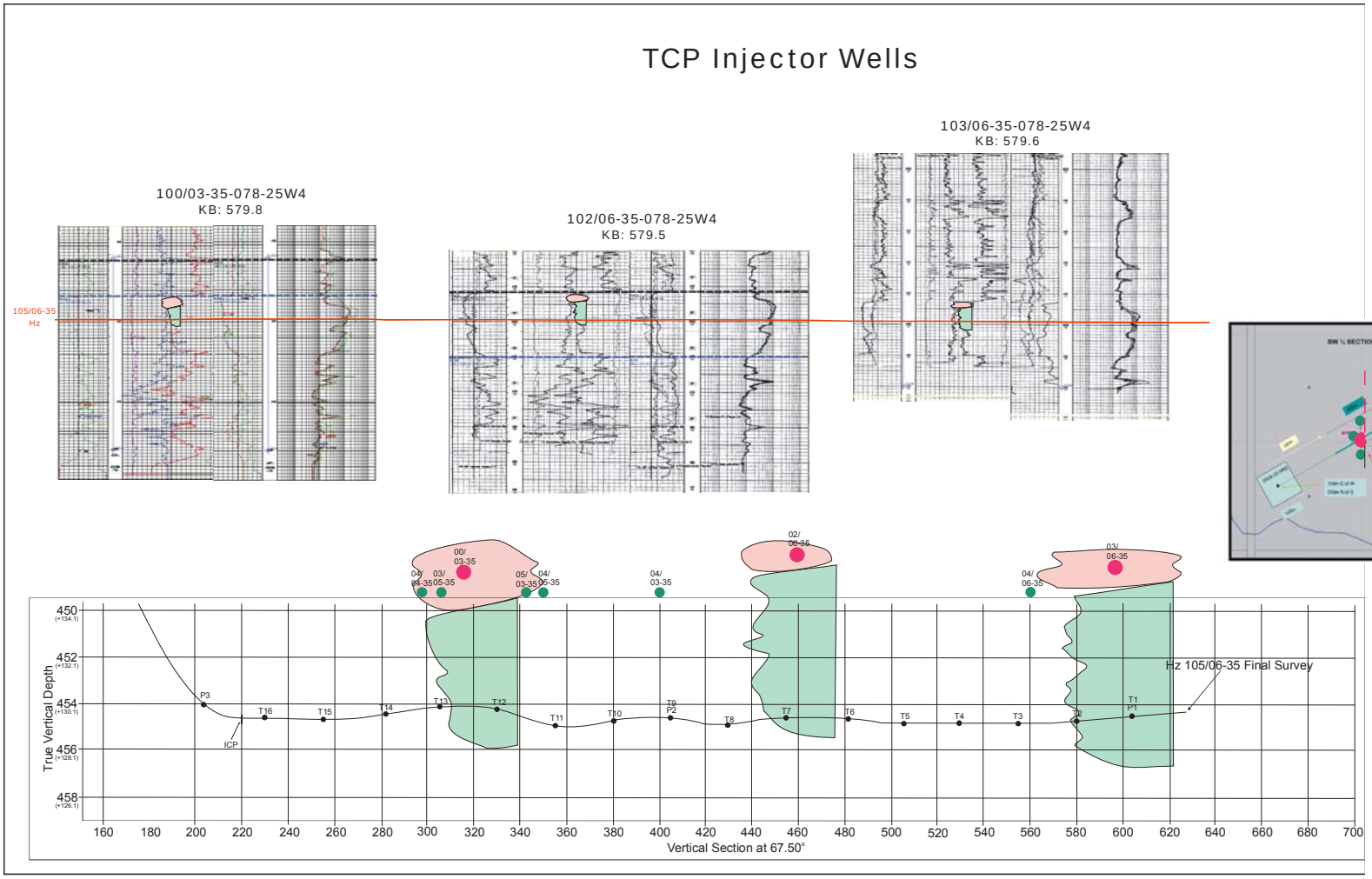
McMullen TCP Update – Dec 31, 2014



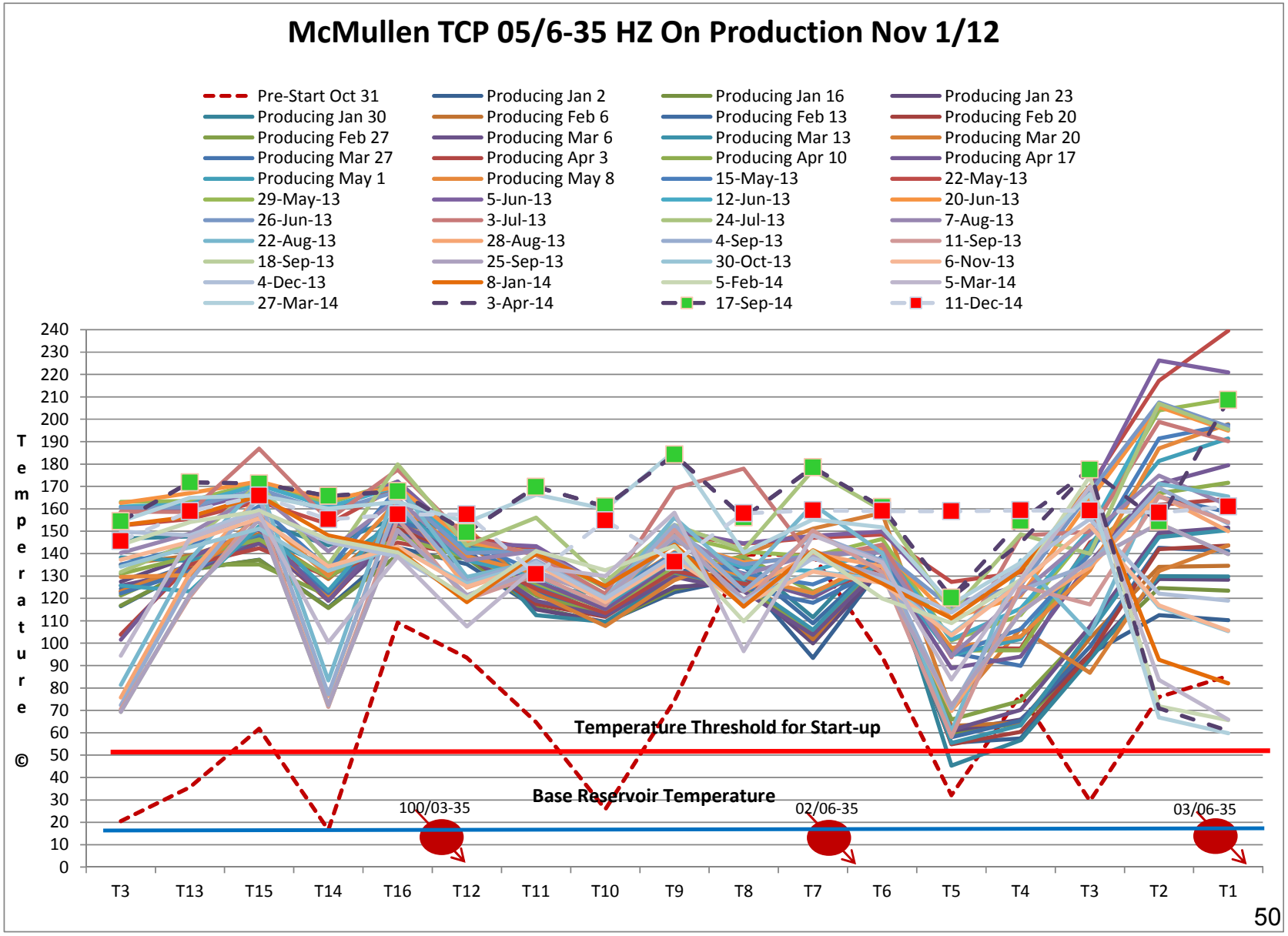
- Cum oil of 32.0 e3m3 (201.5 mbbl), 41% recovery to date, 50% estimated final
- Process performs as expected based on produced gas analysis and observed temperatures
  - produced gas is predominately combustion gases (79% N2, 17% CO_2 plus small amounts of reservoir gas)
- Oil production from 4 wells - 35 m3/day (220 bopd)

** The original elastomer stator PC pumps were replaced by metal to metal PCP's.*

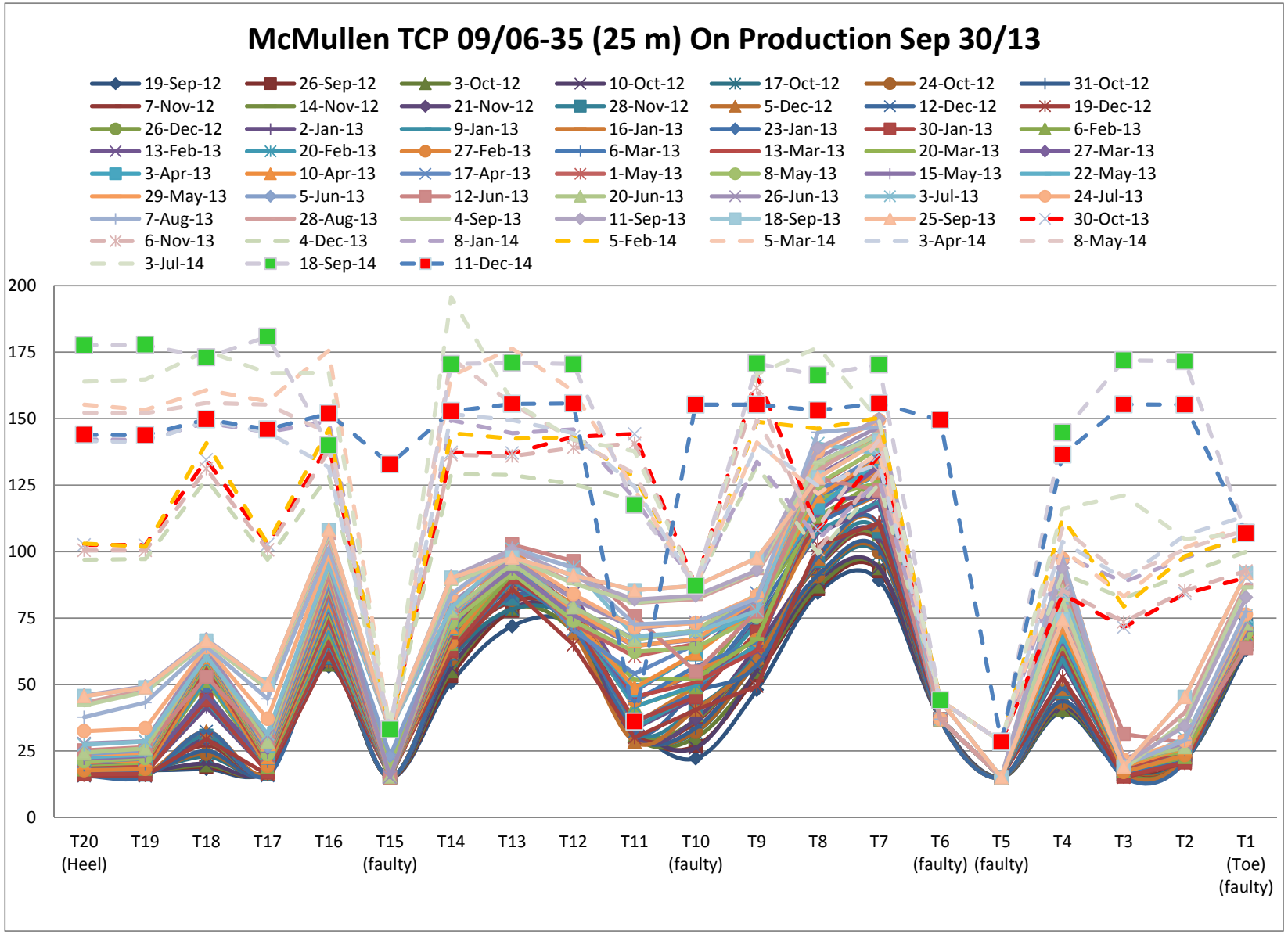
HZ 105/06-35-78-25W4 Thermocouple Placement



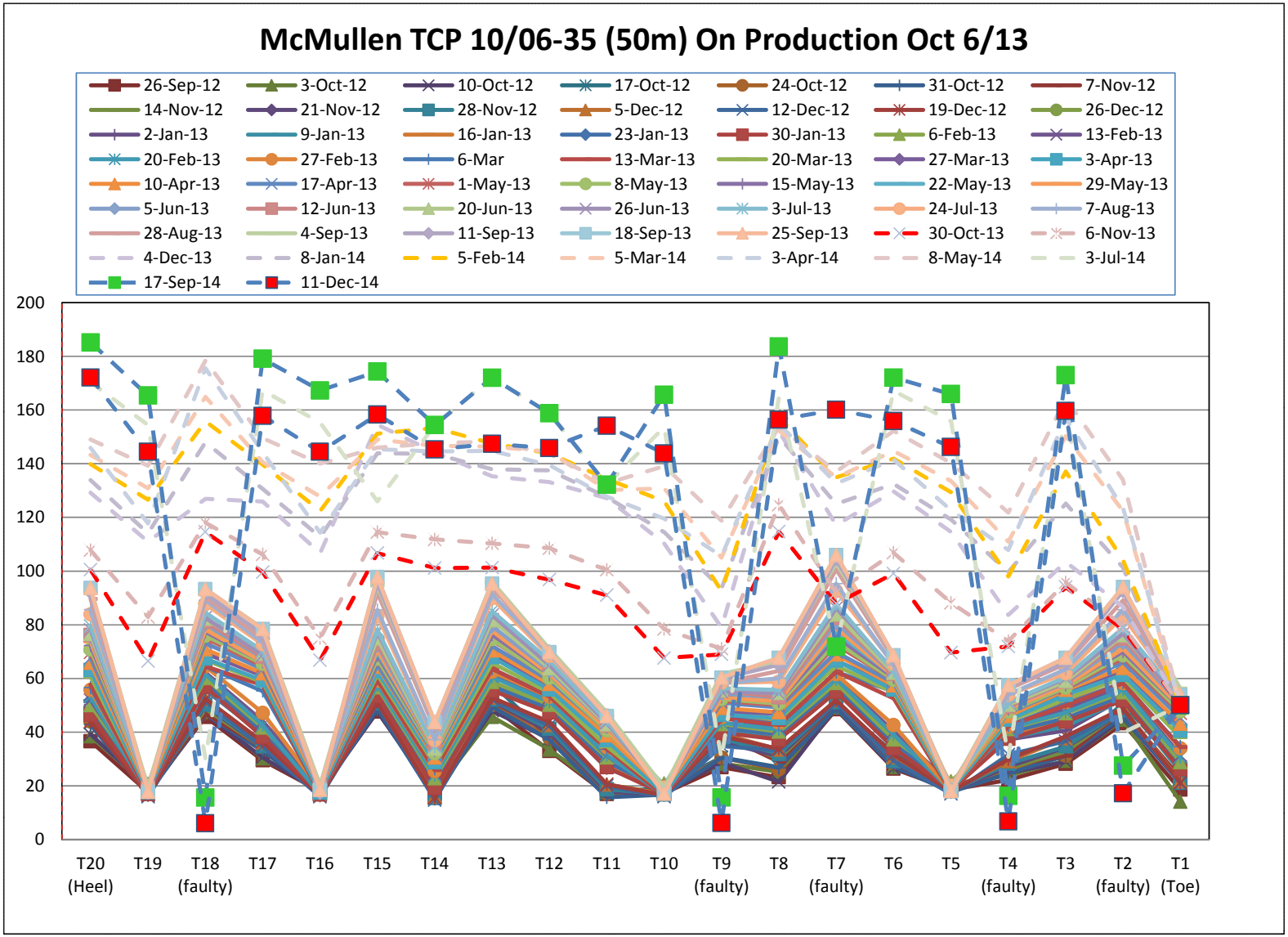
McMullen TCP Pilot Project



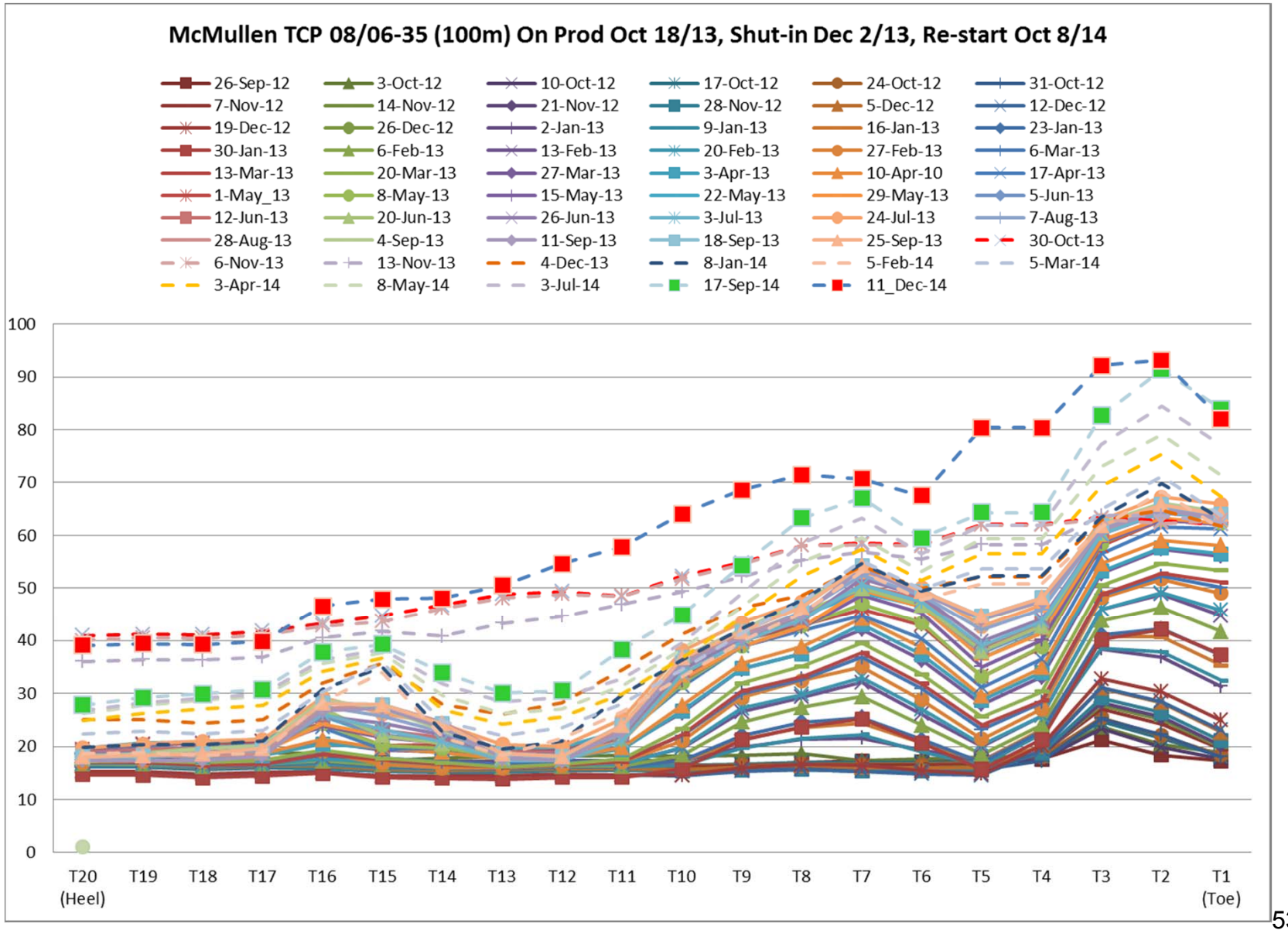
McMullen TCP Pilot Project



McMullen TCP Pilot Project

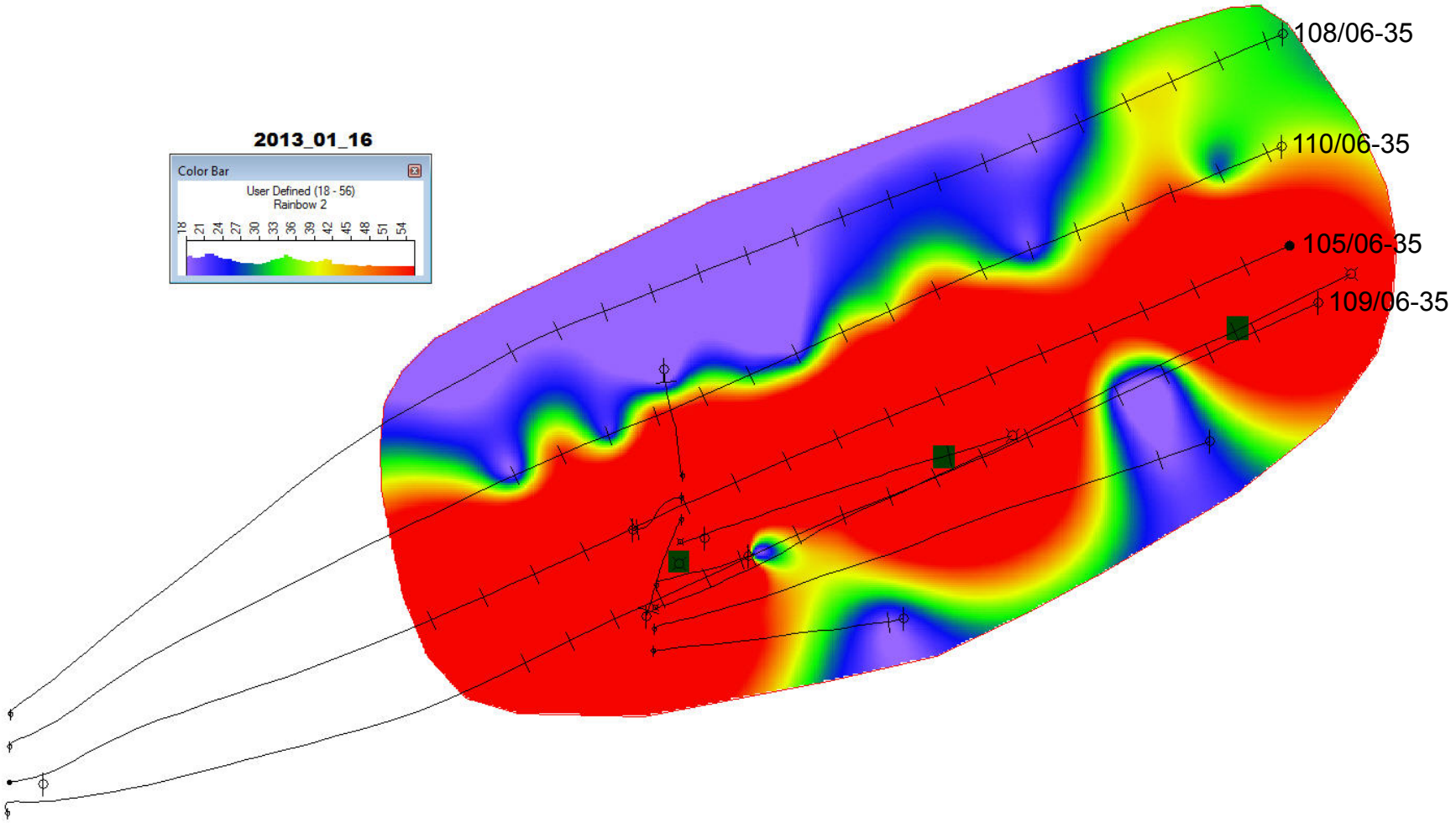


McMullen TCP Pilot Project



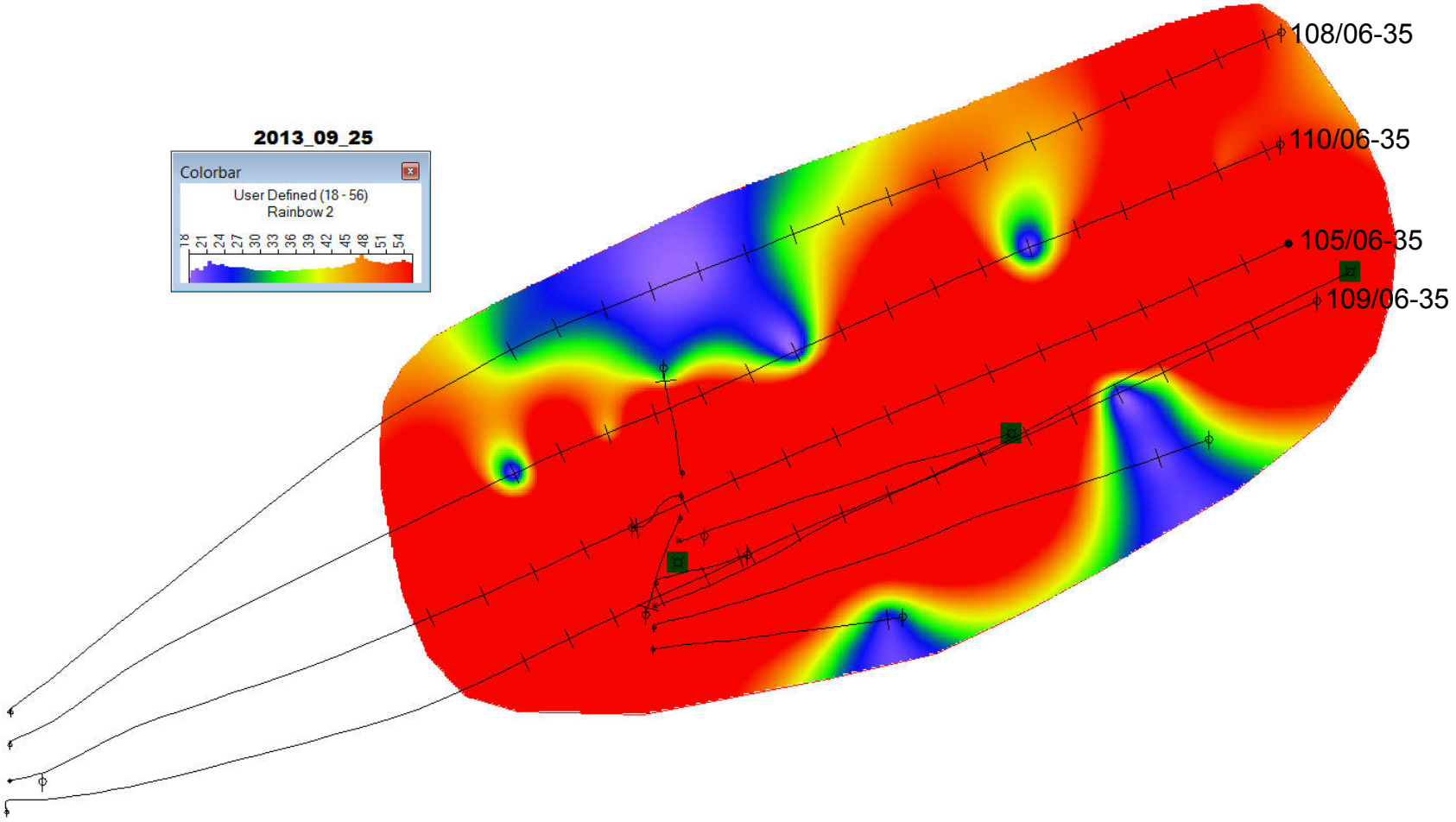
McMullen TCP – Heat Response – January 16, 2013

- 13 months after start of air injection
- first HZ well on production Nov 2012



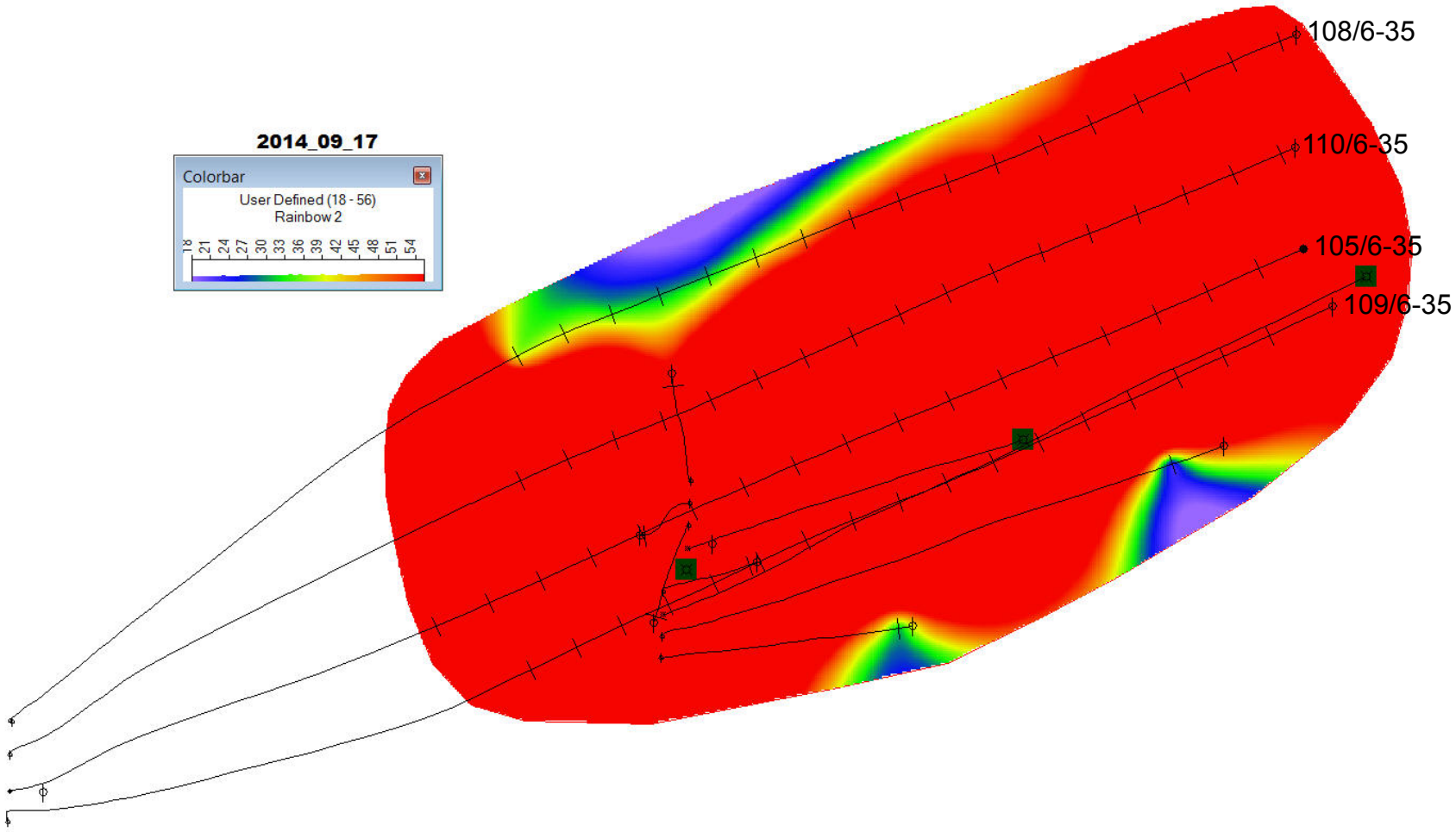
McMullen TCP – Heat Response – September 25, 2013

- 21 months after start of air injection
- just prior to placing remaining 3 HZ wells on production



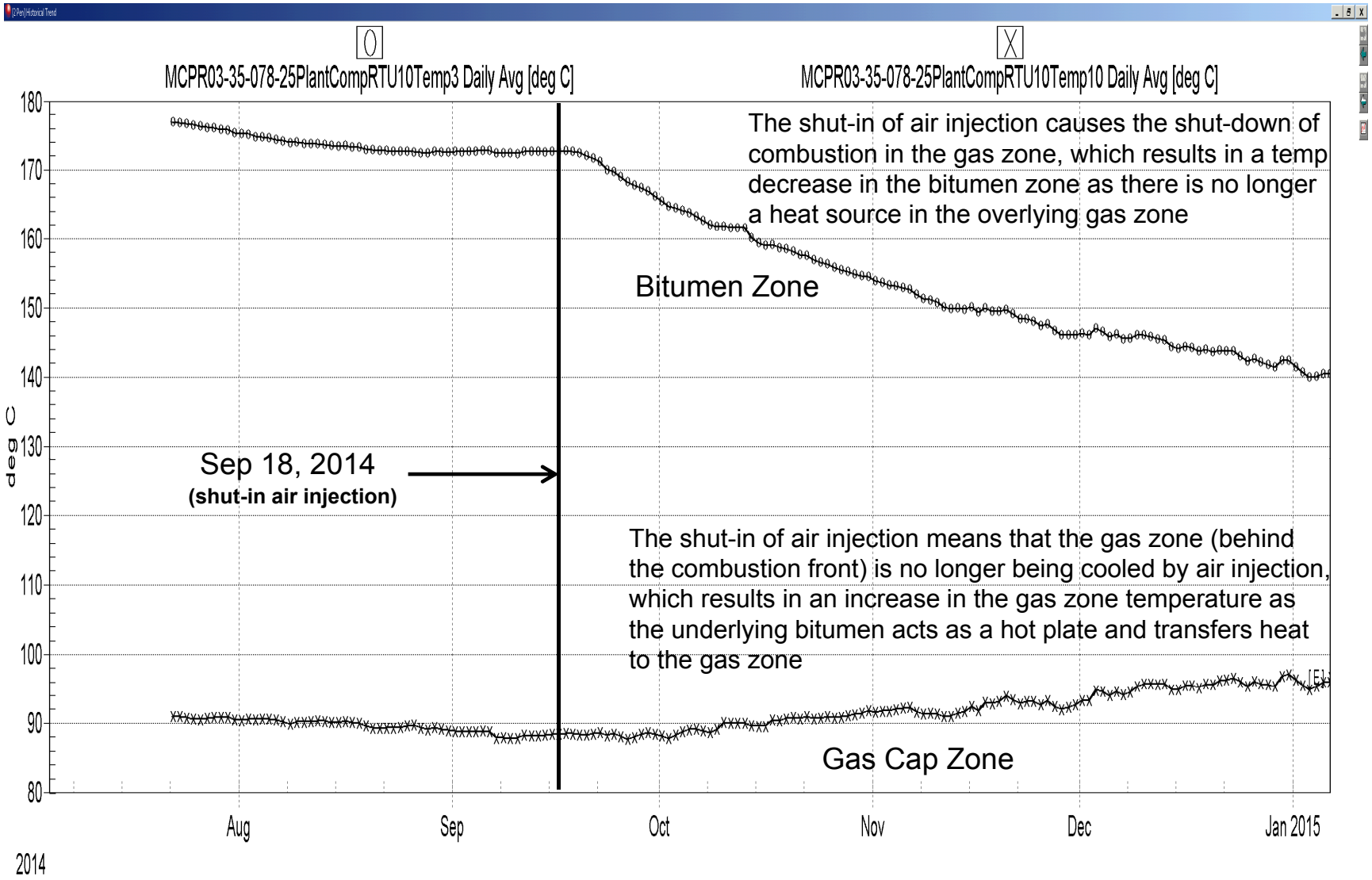
McMullen TCP – Heat Response – September 17, 2014

- 34 months after start of air injection
- just prior to shut-in air injection on Sep 18, 2014



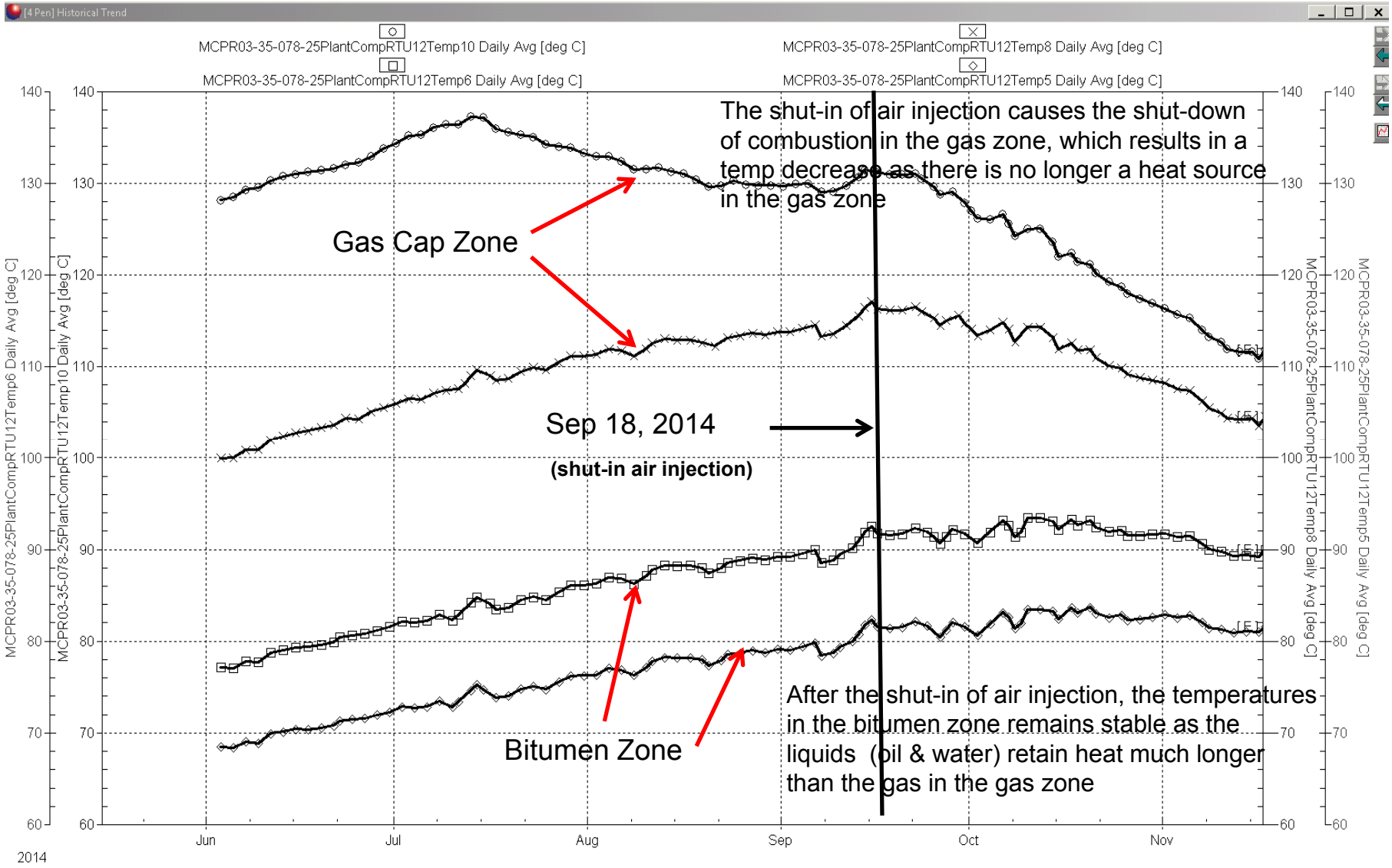
103/5-35-78-25W4 OBS Well – Temperatures

(25 m from 100/03-35-78-25W4 air injector)

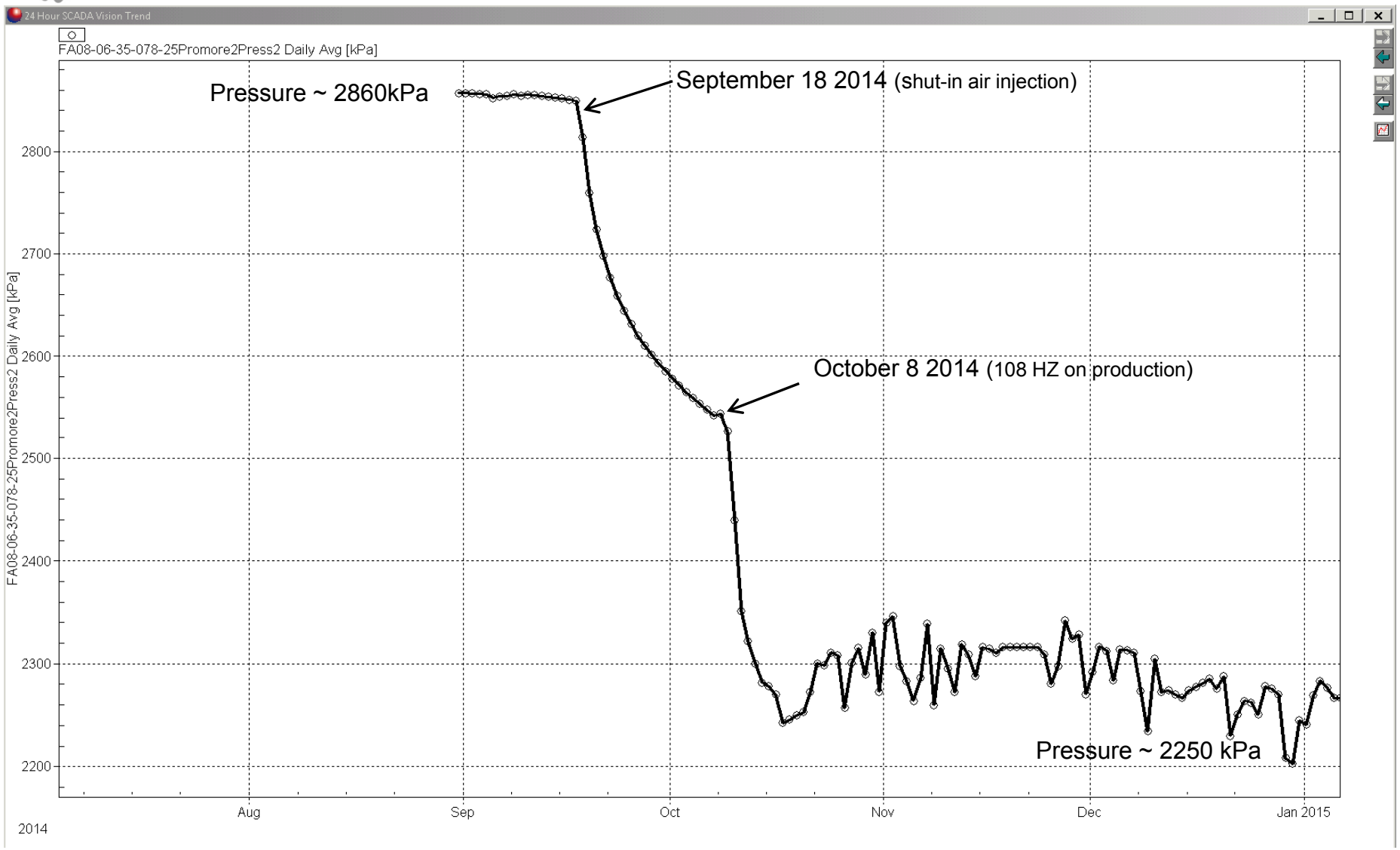


104/5-35-78-25W4 OBS Well – Temperatures

(87 m north of 100/03-35-78-25W4 air injector, ahead of the combustion front)



HZ 108/6-35-78-25W4M Well – Pressures

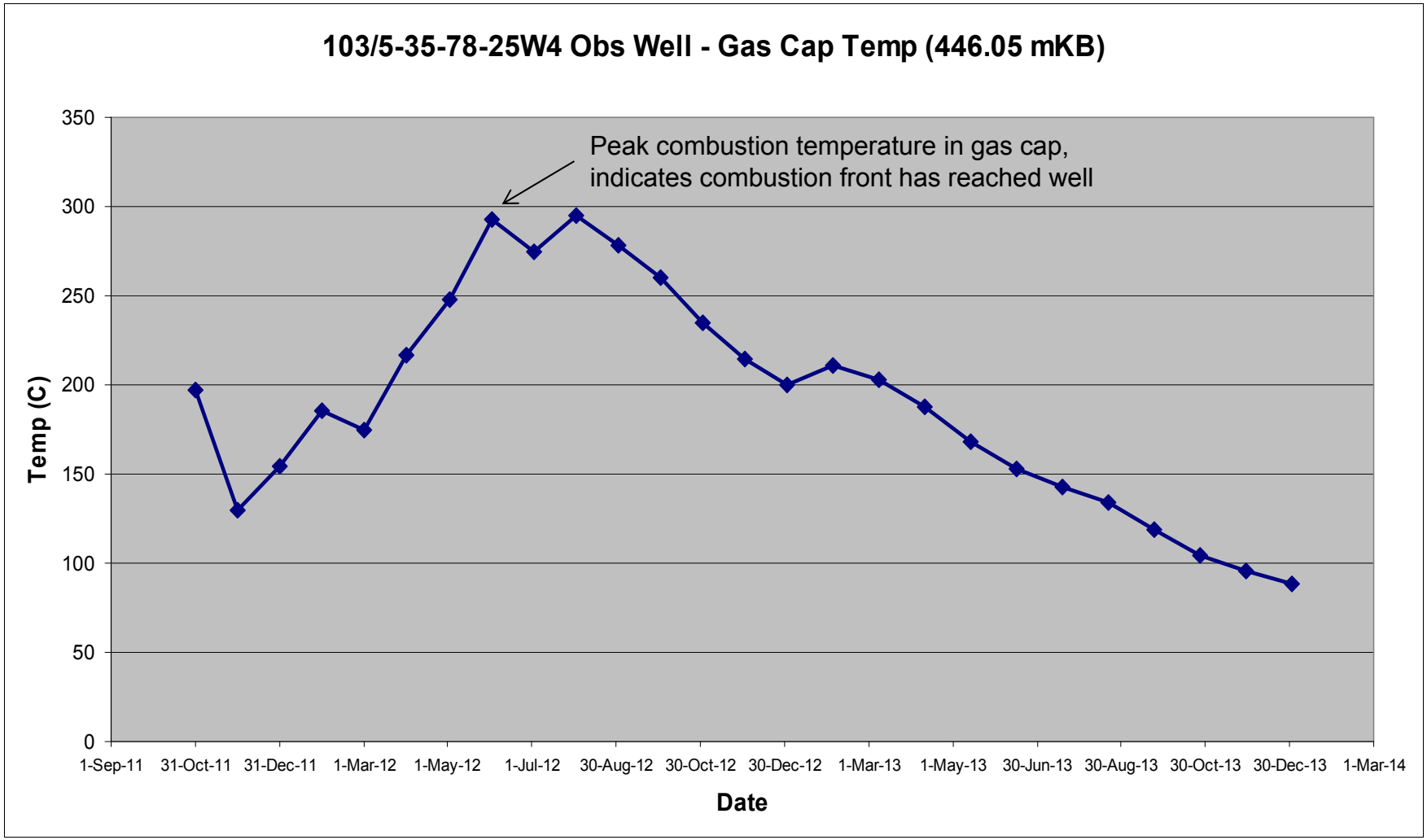


Calculated Combustion Radius vs Time for a 4 meter thick gas cap

Years	Calculated GIP	Inj Air	Cum Inj	Front velocity	Front velocity	Calculated Radius	Comments
	m3	m3/day	E3m3	m/d	ft/d	m	
2012	29,851	52,900	20,896	0.134	0.440	53	actual
2013	76,727	89,900	53,709	0.080	0.263	82	actual
2014	**103,759**	**72,500**	**72,632**	**0.048**	**0.160**	**96**	**actual**
2015	145,474	80,000	101,832	0.048	0.159	114	estimated
2016	187,188	80,000	131,032	0.041	0.137*	129	estimated

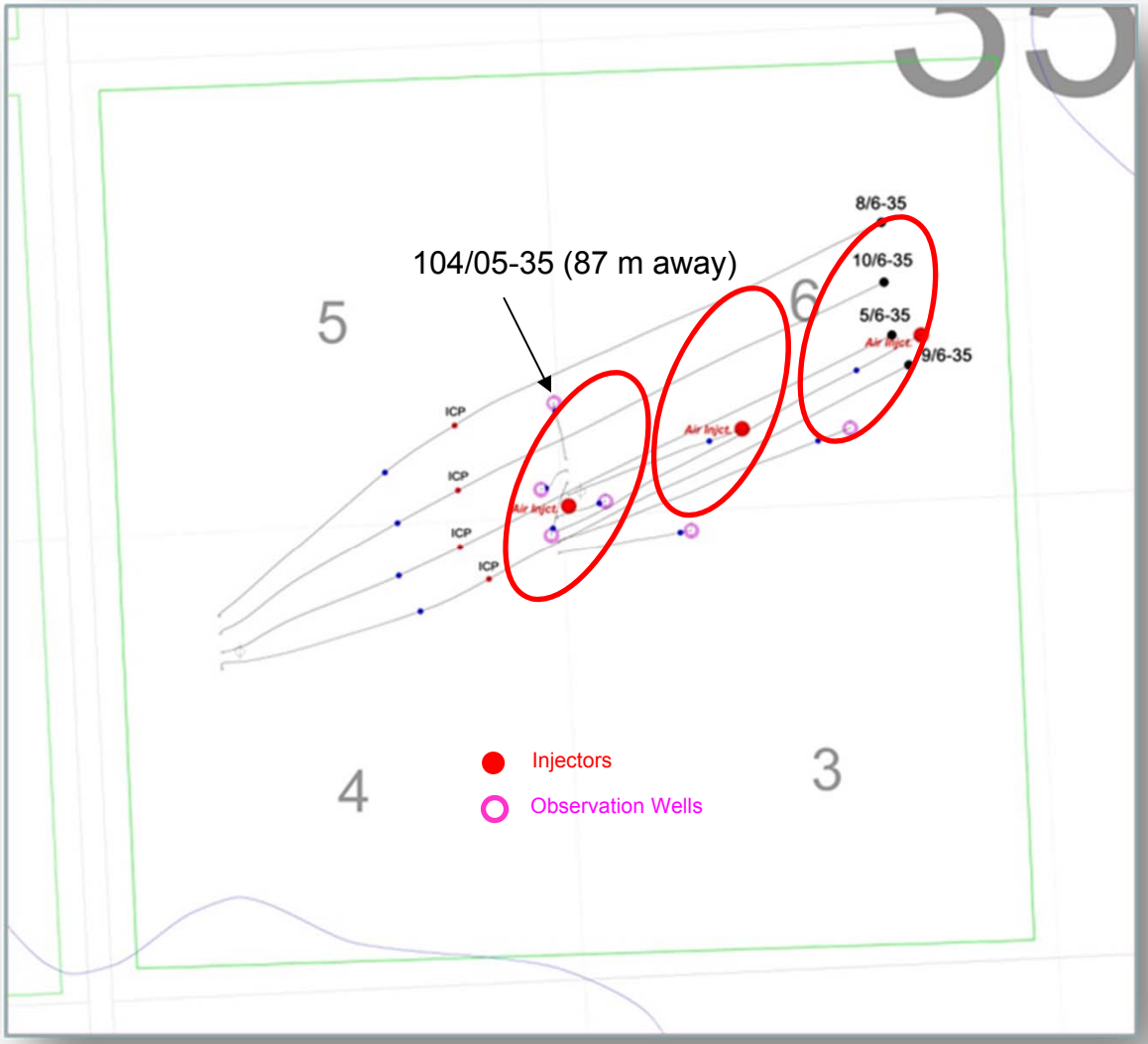
*Technical literature recommends a minimum burning velocity of 0.125 ft/d in order to have satisfactory combustion (Nelson and McNeil, “How to engineer an in-situ combustion project”, Oil and Gas Journal June 5, 1961).

103/5-35-78-25W4 OBS Well Gas Cap Temperatures (25 m from 100/03-35-78-25W4 Air Injector)



Front Velocity 25 m in 180 days – 0.138 m/d

Estimated Combustion Front Position



Ultimate Recovery - Volumetric Method

Average Reservoir Parameters:

- Net Oil Pay = 6 m, Oil FVF = 1.00 m3/m3
- Porosity = 31%, So = 70%
- Recovery Factor = 50%

Entire approval area - 64 ha (SW/4 section 35-78-25W4)

- OBIP = 833 e3m3
- ROIP = 416.5 e3m3

Planned operating portion of the scheme - 13 ha (prior to shut-in of air injection)

- OBIP = 169 e3m3
- ROIP = 84.5 e3m3

Actual operating portion of the scheme - 6 ha (after shut-in of air injection)

- OBIP = 78 e3m3
- Cum oil produced = 32 e3m3
- RF to date = 41%

Thermal EOR Recovery Factors

- **McMullen TCP Pilot estimated > 50%**
  - simulation to confirm (current RF is 41%)

- **Other In-Situ Fields**
  - Suplacu de Barcau Field, Romania - 56%, in operation since 1965
  - Balol/Santhal Fields India - 39/45%, in operation since 1990
  - Bellevue, Louisiana - 60%, in operation since 1970

- **SAGD - 45 to 65%**

- **CSS - 25 to 45%**

Temporary Steam – Pressure, Temperature and Quality

- No steam injection in 2012, 2013 and 2014

McMullen TCP Performance to December 2014

- **Reservoir pressure**
  - original 1750 kPa to 3000 kPa; current ~2250 kPa (since shut-in of air injection)
- **H2S concentration**
  - between 400 – 2200 ppm (average ~ 1000 ppm)
- **Oil production rate**
  - peak rate 90 m3/day (560 bopd Nov 2013)
  - current 35 m3/day (220 bopd Dec 2014)
- **Cumulative oil production**
  - 32.0 e3m3 (201.5 mbbl) - recovery factor 41% (Dec 2014)
- **Total air injected (3 injectors)**
  - 218 e6m3 (7.7 Bcf) - as of shut-in on Sep 18, 2014

Summary of Pilot Key Learning's

December 2014 - 37 Months after Start of Air Injection

- **Safe and continuous operation of the air injection facilities**

- **Successful heating of the underlying bitumen through thermal conduction**
  - oil rates as predicted (25 m3/d, 25-30% BS&W)
  - recovered 32.0 e3m3 (201.5 mbbl)

- **Successful ignition and continuous combustion**
  - based on produced gas analysis and observed temperatures

- **Combustion front radius**
  - travelled a distance of ~96 m after 34 months of air injection and the front radius was estimated to travel 130 m after 5 years

- **Effect of N_2 on offsetting primary production**
  - future design process requires a waste gas management program for the handling of produced gases

Pilot Future Plans – 2015

- **Request extension of scheme approval/confidential period**
  - submission letter sent on February 26, 2015
  - request extension of scheme approval to July 31, 2018 and confidential status to July 31, 2016
  - current approval expires July 31, 2015

- **Ongoing monitoring of the Pilot Project**
  - gather additional key performance data to assess thermal effect without air injection and combustion; key to future development
  - effect of nitrogen on offsetting primary wells

- **Waste gas management program (for handling of produced gases)**
  - future options: membrane, cryogenic and PSA solutions for gas processing and design capabilities – uneconomic at current oil price

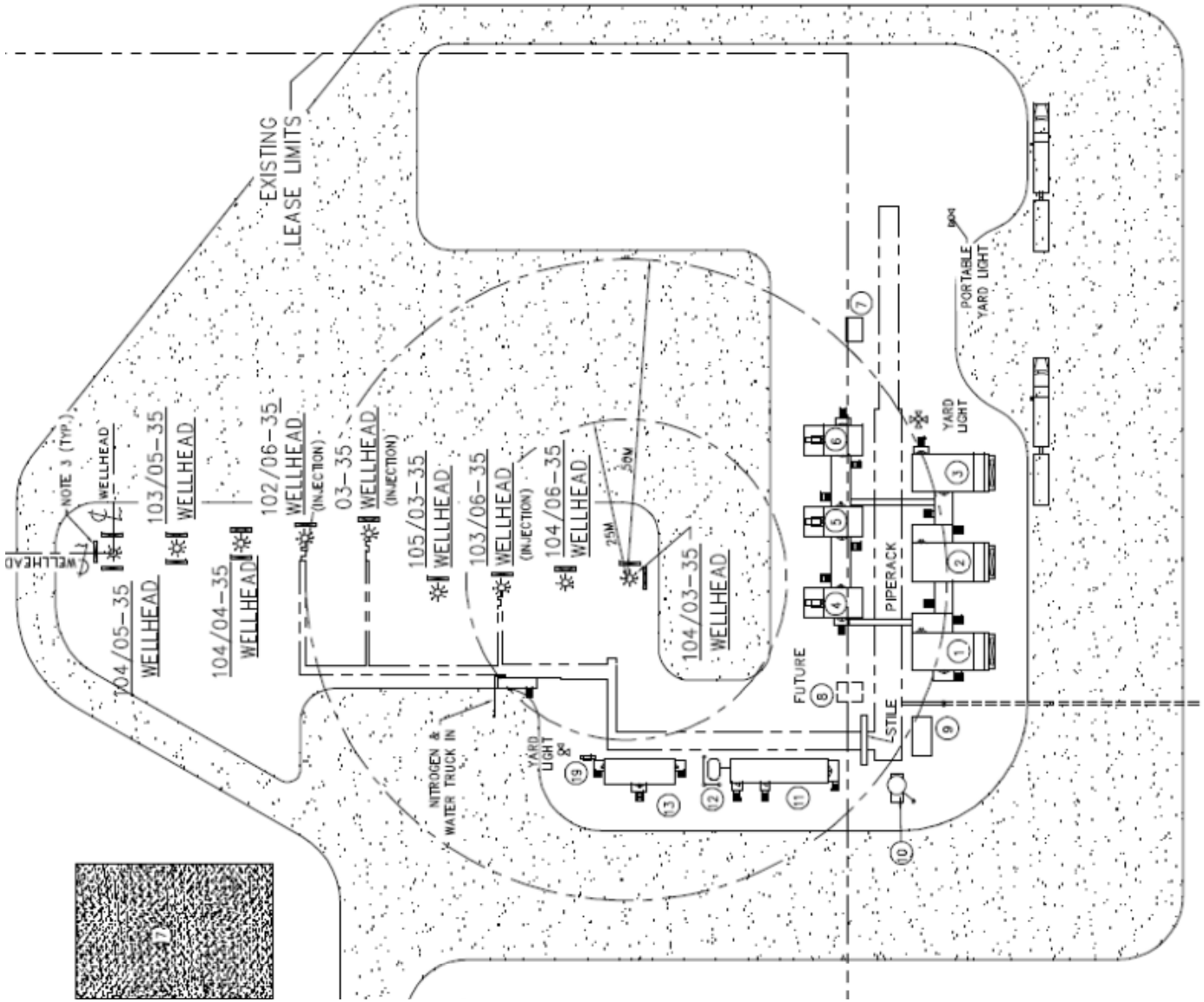
- **Pilot expansion application activities**
  - CMG numerical simulation, geological study
  - no expansion activities are planned as Project is not economic at current oil price

3.1.2 Surface Operations, Compliance, and Issues Not Related to Resource Evaluation and Recovery

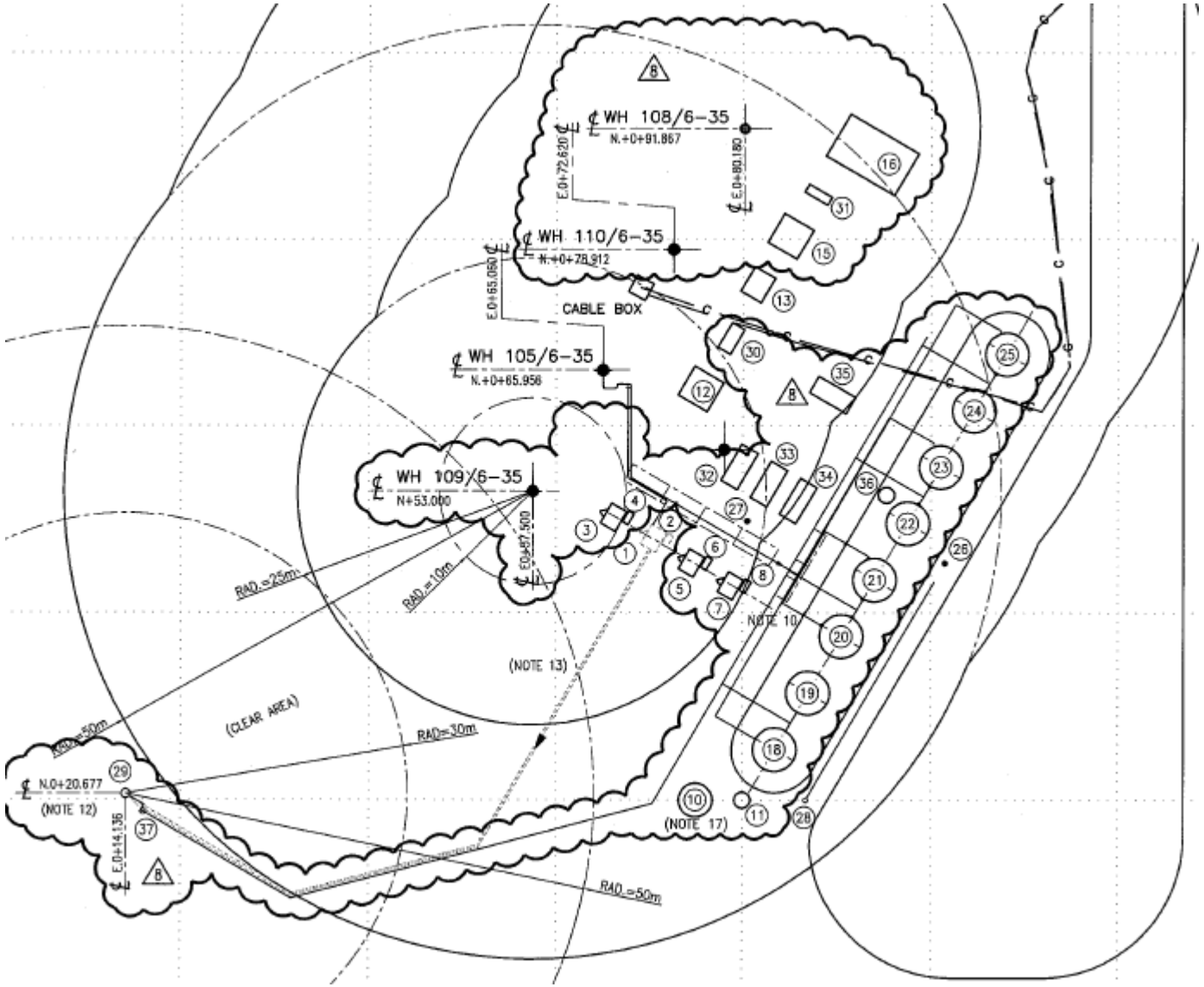
3.1.2 Surface Issues – Table of Contents

McMullen TCP Project Site (November 7, 2013)

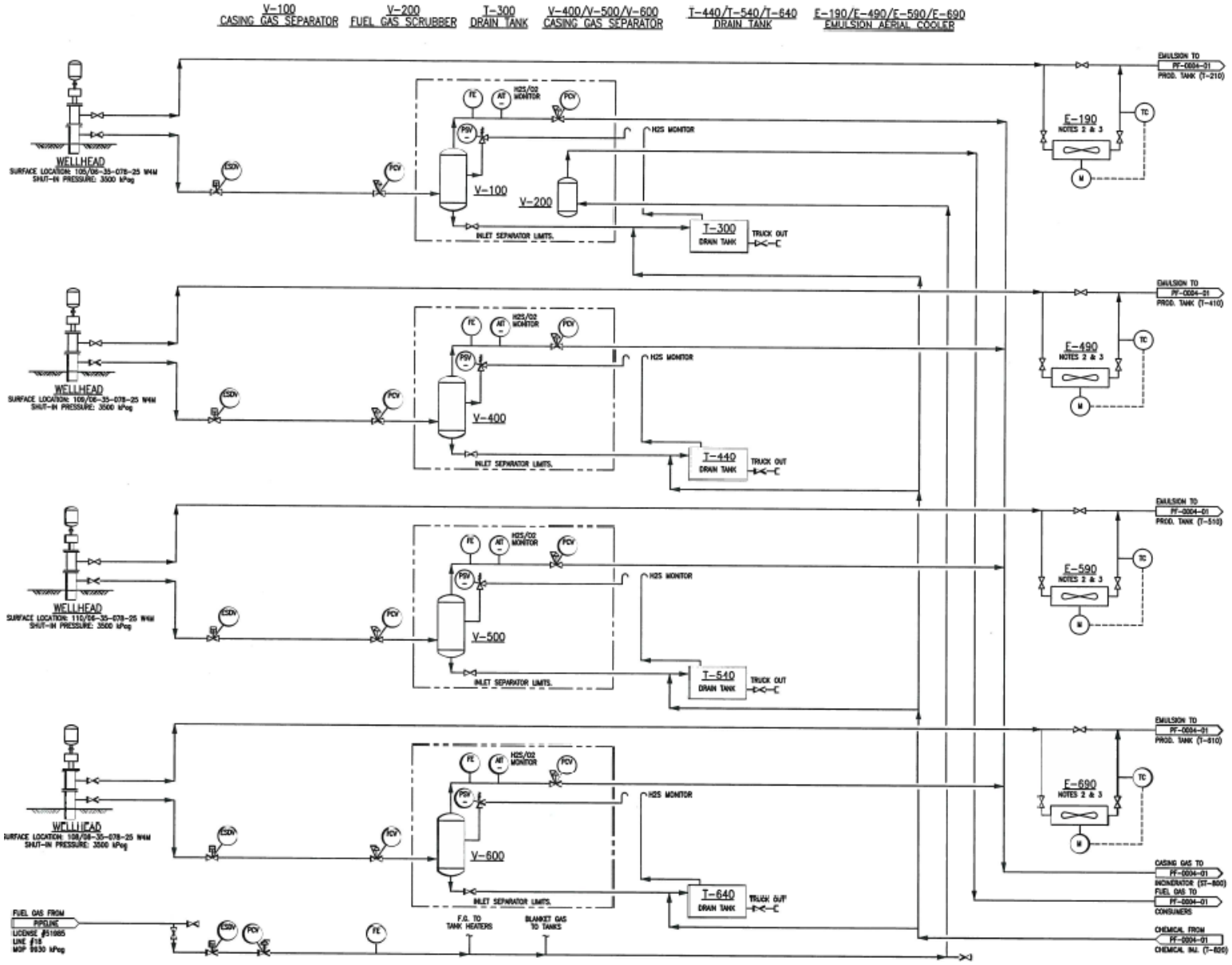
McMullen TCP Plot Plan



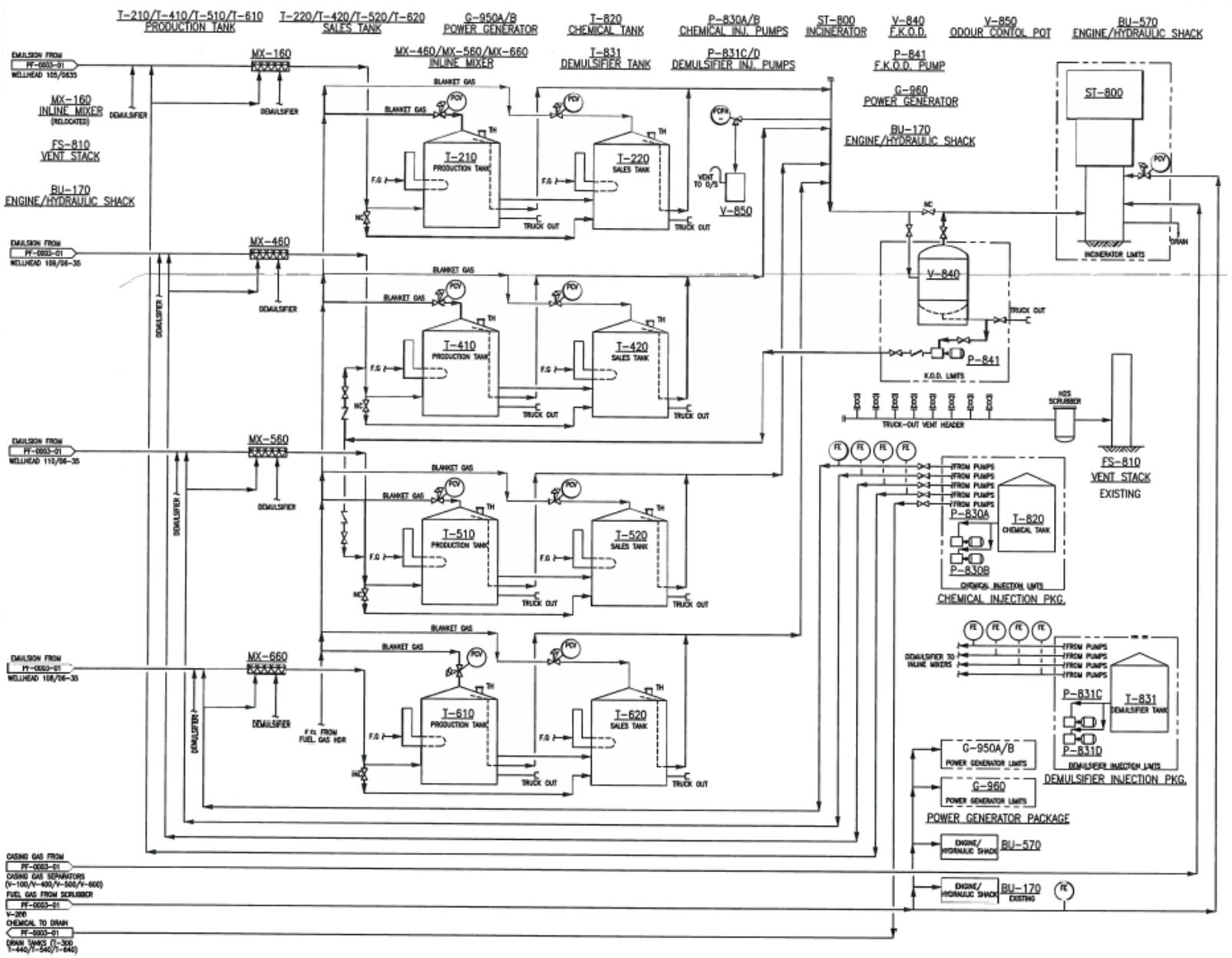
McMullen TCP – Production Facilities Plot Plan



McMullen TCP – Production Process Flow (1/2)



McMullen TCP – Production Process Flow (2/2)



Facility Performance

- **Bitumen treatment**
  - bitumen sales started in November 2012
  - H2S scavenger injected to neutralize emulsion to meet sales specifications
  - majority of the bitumen was trucked to Tervita High Prairie in 2014

- **Water treatment**
  - water trucking started in November 2012
  - primarily disposed at Husky's 16-11-078-25W4 (No. 9056B) disposal facility after being treated with H2S scavenger (on site tanks)

- **Steam generation**
  - there was no steam generation in 2014

Facility Performance

- **Power consumed in 2014 -** generated onsite by a 151 kW unit at the injection pad and a 151 kW unit at the production pad

- **Fuel gas usage in 2014**

	Monthly Volume (e3m3)		
Month	04-35-078-25W4 Prod. Pad	03-35-078-25W4 Inj. Pad	Total
Jan-14	108.1	758.2	866.3
Feb-14	99.3	661	760.3
Mar-14	107.6	753	860.6
Apr-14	104.8	634.3	739.1
May-14	105.2	522.7	627.9
Jun-14	96.4	492.4	588.8
Jul-14	95.2	506.2	601.4
Aug-14	98.7	493.6	592.3
Sep-14	90.4	253.5	343.9
Oct-14	100.5	0	100.5
Nov-14	108.7	0	108.7
Dec-14	109	0	109
Grand Total	1223.9	5074.9	6298.8

Shut-in air injection on Sep 18, 2014

Facility Performance

- **Latest facility design for the additional production wells**
  - incorporates the incineration of all tank vapors and casing gas produced

- **Green house gas emissions:**

2014 Green House Gas Emissions				ERCB License	Exceed ERCB License
CO_2	**CH_4**	**N_2O**	**CO_2E**	**CO_2**	**CO_2**
tonnes/year	tonnes/year	tonnes/year	tonnes/year	tonnes/year	Yes/No
13,535.42	221.85	0.21	19,144.9	51,319.00	No

2014 NOx and CO Emissions		ERCB License	Exceed ERCB License?
NO_X	**CO**	NO_X	NO_X
tonnes/year	tonnes/year	tonnes/year	Yes/No
90.64	76.50	182.82	No

Measurement & Reporting

- **Well production**

	105			109			110			108		
Month	Oil (m3)	Water (m3)	Gas (e3m3)	Oil (m3)	Water (m3)	Gas (e3m3)	Oil (m3)	Water (m3)	Gas (e3m3)	Oil (m3)	Water (m3)	Gas (e3m3)
Jan-14	548.9	129.4	27.9	380.3	320.3	107.9	997.9	412.9	169.3	0.0	0.0	8.4
Feb-14	395.0	124.0	20.4	463.7	304.1	150.0	904.1	336.9	152.7	0.0	0.0	7.2
Mar-14	272.9	96.6	82.8	382.4	175.0	103.1	994.8	304.2	156.4	0.0	0.0	0.0
Apr-14	553.5	123.2	173.3	507.8	296.5	155.8	740.8	223.3	42.6	0.0	0.0	0.0
May-14	244.5	53.6	70.4	492.5	236.1	132.9	1042.1	278.5	151.2	-35.2	35.2	0.0
Jun-14	298.1	54.8	34.6	448.8	232.5	171.1	829.3	226.8	148.7	0.0	0.0	0.0
Jul-14	265.6	78.6	62.9	411.7	159.1	140.7	712.5	208.8	143.5	0.0	0.0	0.0
Aug-14	189.3	137.2	73.0	365.8	244.8	157.4	735.4	215.4	141.7	0.0	0.0	0.0
Sep-14	60.5	8.0	0.0	305.1	188.7	99.5	891.0	238.1	194.0	0.0	0.0	3.7
Oct-14	416.3	104.3	62.7	278.5	145.1	104.8	926.0	250.6	103.4	250.7	246.0	22.8
Nov-14	202.5	82.6	77.4	272.5	141.8	99.2	716.1	234.8	130.3	171.2	199.2	33.2
Dec-14	161.4	66.7	64.7	285.5	184.6	113.2	565.5	176.8	145.7	151.3	149.7	29.5
Total	3608.5	1059.0	750.2	4594.5	2628.6	1535.6	10055.4	3106.9	1679.3	537.9	630.1	104.7

- **Each well is treated as a single well battery:**
  - liquids: sales = production
  - gas: individual orifice meter used to measure gas production

- **Proration factors** – N/A

- **Optimization of test durations** – N/A

- **New measurement technology** - No

Measurement & Reporting

2014 Injection volumes

- no steam was injected in 2014
- air injection volumes
    - air is compressed through a screw and a reciprocating compressor
    - air is then metered using an orifice plate for each individual well

Air Injection Volumes at 03-35-078-25W4 Injection Pad – Per Well

Month	Volume (e3m3)	Daily Rate/Well (e3m3/d)
Jan-14	8525	91
Feb-14	7126	84
Mar-14	8155	87
Apr-14	7053	78
May-14	6020	65
Jun-14	5434	60
Jul-14	5719	61
Aug-14	5701	61
Sep-14	3161	35
Oct-14	0	0
Nov-14	0	0
Dec-14	0	0

Shut-in air injection on Sep 18, 2014

Water Production & Injection

- **Produced water volumes**

	105	109	110	108
2014 Total Water (m3)	1059.0	2628.6	3106.9	630.1

- **No produced water recycle volumes or percent**

- **Disposal wells**
  - 16-11-078-25W4 and 10-23-078-25W4
  - Approval No. 9056B

Sulphur Production

- **There is no sulphur recovery** (all produced gas is incinerated at 04-35-78-25W4)

Summary of 2014 Quarterly SO_2 Emissions				
Months	Monthly Sulphur (tonnes)	Monthly SO_2 [a)] (tonnes)	Quarter	Quarterly SO2 (tonnes)
January	0.49	0.99	1	2.92
February	0.47	0.94		
March	0.50	0.99		
April	0.31	0.62	2	3.49
May	0.47	0.95		
June	0.96	1.92		
July	0.46	0.91	3	2.95
August	0.48	0.96		
September	0.54	1.08		
October	0.41	0.82	4	1.84
November	0.51	1.01		
December	0.00	0.00		

- **Sulphur balance**
  - SO_2 emissions based on 100% conversion of H_2S to SO_2
- **Sulphur emissions**
  - expected to remain far below 1 tonne/d in the near future, therefore no sulphur recovery methods will be required

Sulphur Production

- **Facility**
  - approved for 0.41 tonnes of SO_2 per day

Month/Year	Jan-2014	Feb-2014	Mar-2014	Apr-2014	May-2014	Jun-2014	Jul-2014	Aug-2014	Sep-2014	Oct-2014	Nov-2014	Dec-2014
Daily Peak SO2 (t/d)	0.040	0.037	0.038	0.028	0.040	0.037	0.036	0.041	0.043	0.036	0.038	0.000
AESRD Approved SO2 (t/d)	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41
Exceeds Approval limit (Yes/No)	No	No	No	No	No	No	No	No	No	No	No	No

- **McMullen Project - Under EPEA approvals**
  - there is no requirement to monitor ambient air quality

Environmental Issues - Reporting

- **Annual Monitoring and Reporting (March 31st)**
  - Air emission and summary and evaluation report
  - Industrial wastewater and runoff report
  - Groundwater monitoring program
    - shallow groundwater – no indication of adverse impacts
    - Quaternary channel thermal – temp increase ~2.5^{0}C (from baseline)
    - Dissolved arsenic concentrations consistent with baseline values
    - Continue monitoring per EPEA Approval

- **Other Monitoring and Reporting**
  - Soil monitoring (2014 and 2018)
  - Soil management Plan Proposal 2015
  - Soil management Program 2015
    - required as a result of salinity exceedance in the top 15 cm of soil near the tank farm load outs

- **Participation in Alberta Biodiversity Monitoring Institute (ABMI)**

Compliance

- To the best of Husky's knowledge, we are currently compliant with all regulatory approval conditions and associated requirements

Future Plans – Major Activities & Target Dates

- **Request for extension of scheme approval and confidential period**
  - Approval to July 31, 2018 and confidential status to July 31, 2016

- **Ongoing monitoring Pilot Project performance**
  - thermal effect without air injection and combustion
  - gather additional key performance data
  - critical learnings for future development design

- **Pilot expansion application activities (future development)**
  - CMG numerical simulation – completed in 2015
  - no expansion activities are planned as Project is not economic at current oil price

Thank You