

Cenovus EnCAID approval #10440L Performance presentation

Alberta Energy Regulator offices
Calgary
February 2017



Cenovus EnCAID* introduction and overview

This presentation was prepared in accordance with AER Directive 054 - Performance presentations, auditing, and surveillance of in situ oil sands schemes

Subsurface issues related to resource evaluation and recovery

- Directive 054, Section 3.1.1

Surface operations, compliance, and issues not related to resource evaluation and recovery

- Directive 054, Section 3.1.2

AER Dir 054 Section 3.1.1

Subsurface issues related to resource evaluation and recovery

Subsurface issues: table of contents

- Background
- Geology/geoscience
- Drilling and completions
- Instrumentation
- Scheme performance
- Future plans

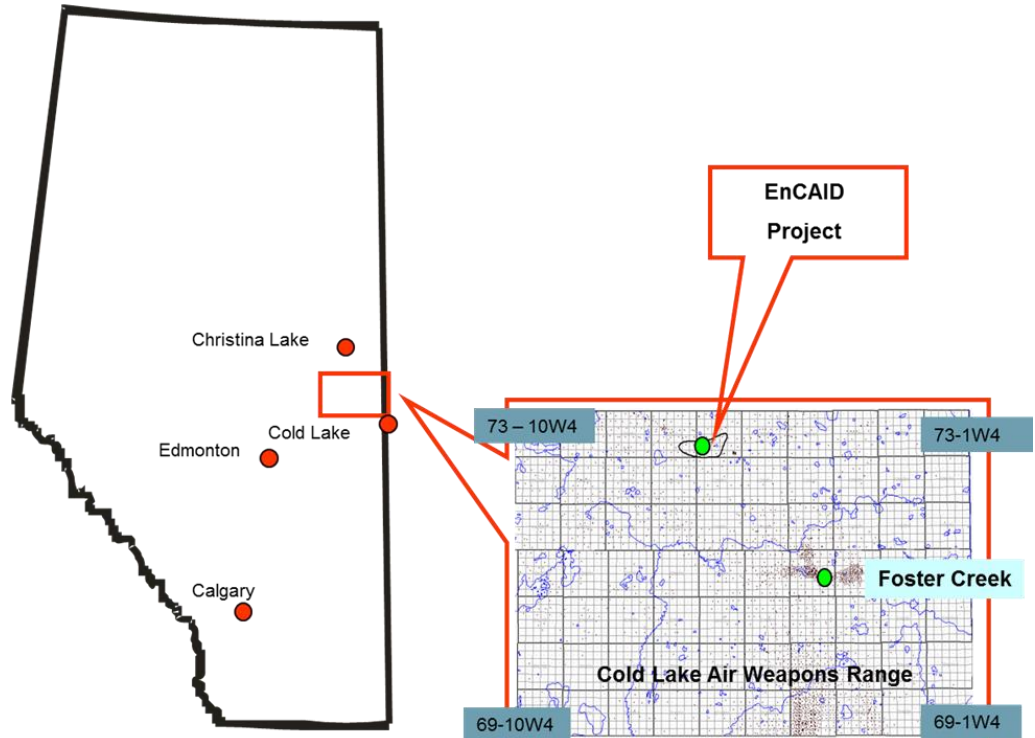
Scheme background

Directive 54 **Subsurface section 1**

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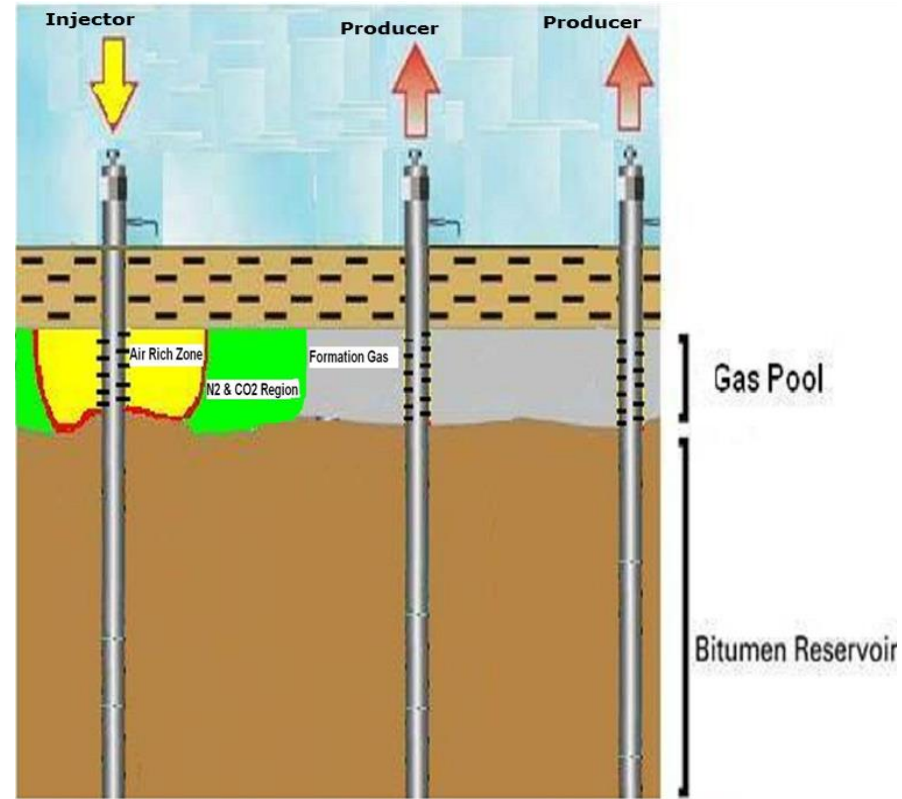
Background

- The EnCAID project is an enhanced recovery scheme which displaces natural gas with combustion gases that are the result of combustion of residual bitumen in gas cap



Project overview

- Combustion of residual bitumen in gas cap
- Allows for displacement and re-pressurization of gas zone
- 100% Cenovus Energy Inc.



Geological/geoscience

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Summary of Wabiskaw gas properties

Depth	465 TVD
Thickness	5 m
Average porosity	~36%
Average gas saturation	~50%
Average water saturation	~30%
Average bitumen saturation	~20%

Wabiskaw stratigraphic cross-section

A

10010110730W400
PEX PHILLIPS AEC WALK 10-11-73-8 A2600270
5012 11-073-0W40
TWP: 73 N - Range: 8 W - Sec. 11

9116 m

100051407307W400
ENICANA OIL & GAS PART
AECO KIRBY 5-14-73-7 A2108300
5012 14-073-0W40
TWP: 73 N - Range: 7 W - Sec. 14

7092 m

100021807306W400
ENICANA OIL & GAS PART
AEC KIRBY 5-16-73-6 A198470
5012 16-073-0W40
TWP: 73 N - Range: 6 W - Sec. 16

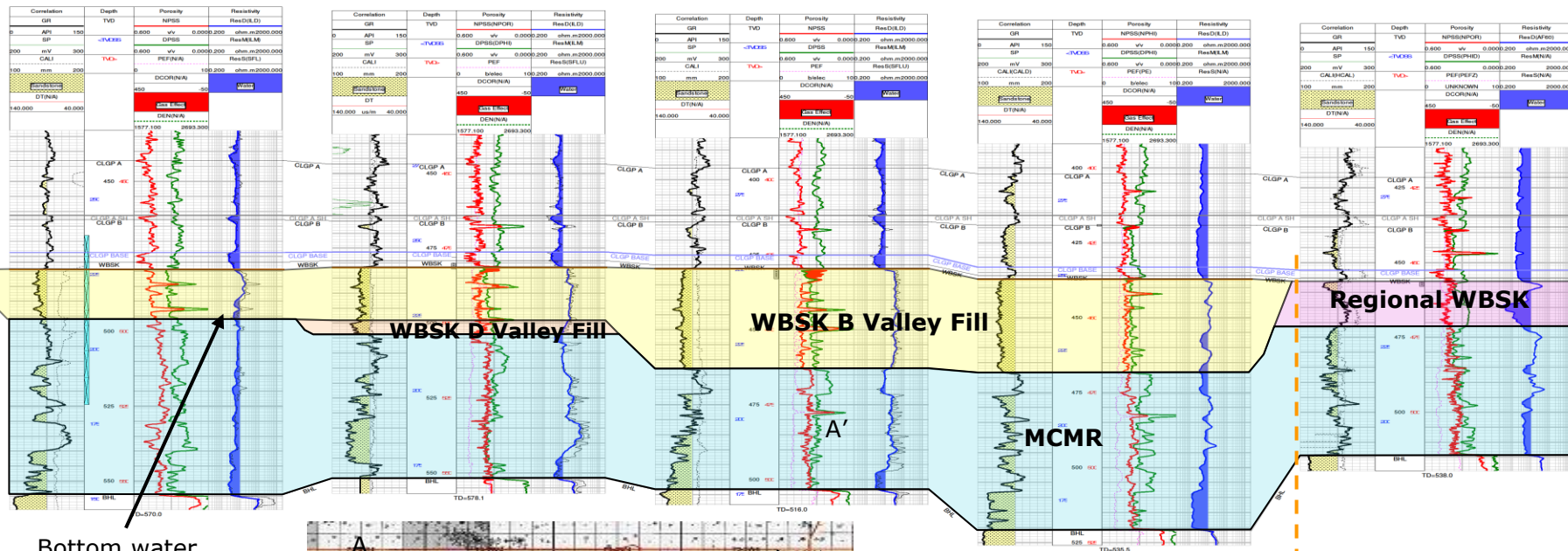
11861 m

100161507305W400
ENICANA OIL & GAS PART
AEC KIRBY 10-15-73-5 A1987290
5012 15-073-0W40
TWP: 73 N - Range: 5 W - Sec. 15

5907 m

100121707304W400
AECOG (E) KIRBY 12-17-73-4 A2326290
5012 17-073-0W40
TWP: 73 N - Range: 4 W - Sec. 17

A'

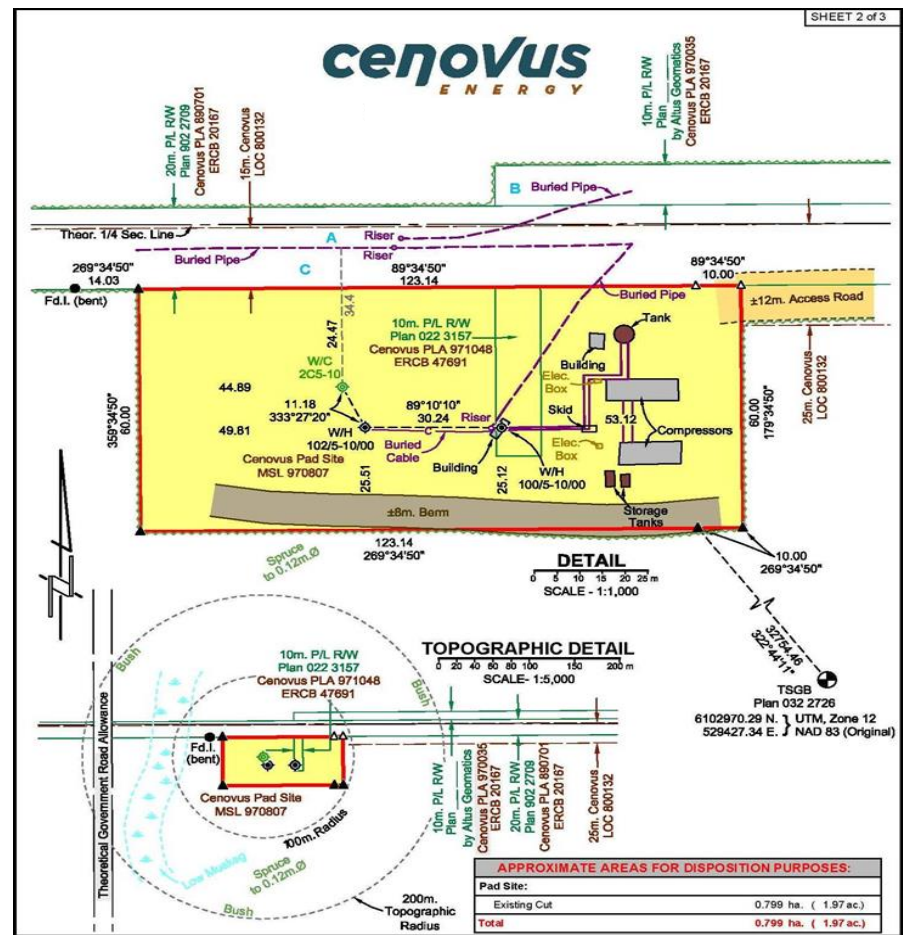


Drilling and completion

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Well layout



Drilling and completion

- No new wells were drilled
- No recompletions
- No workovers

Requirements under subsection 3.1.1 3c – wellbore schematics are included in the appendix

Instrumentation

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Instrumentation in wells

Observation Well: 102/05-10-73-6W4

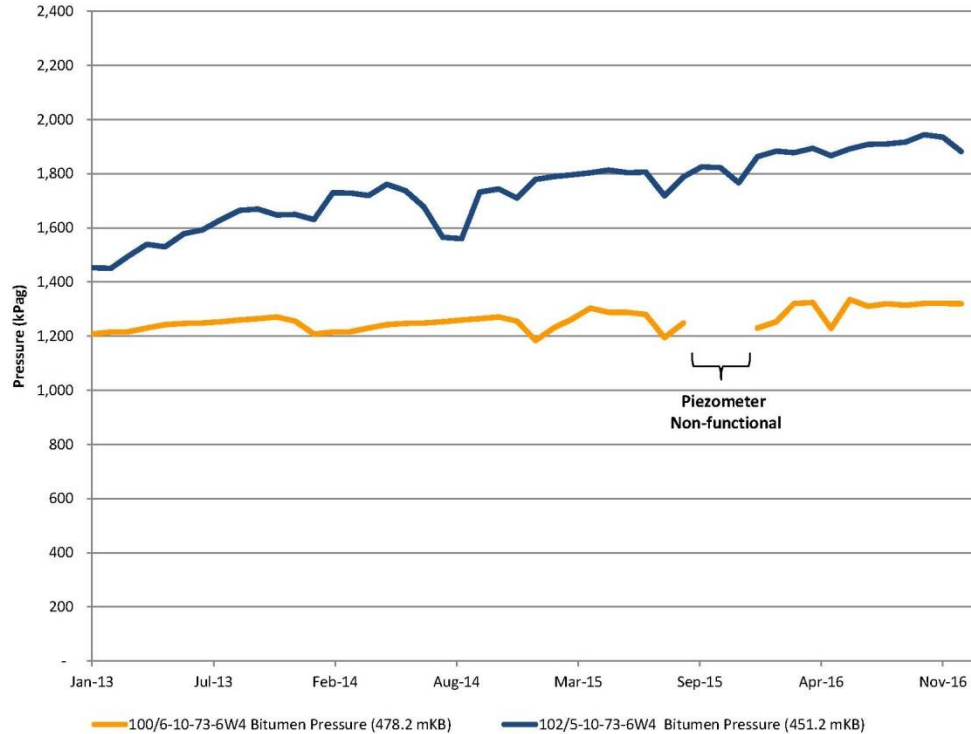
- Equipped with three piezometers
- Equipped with 10 thermocouples

Observation Well: 100/6-10-73-6W4

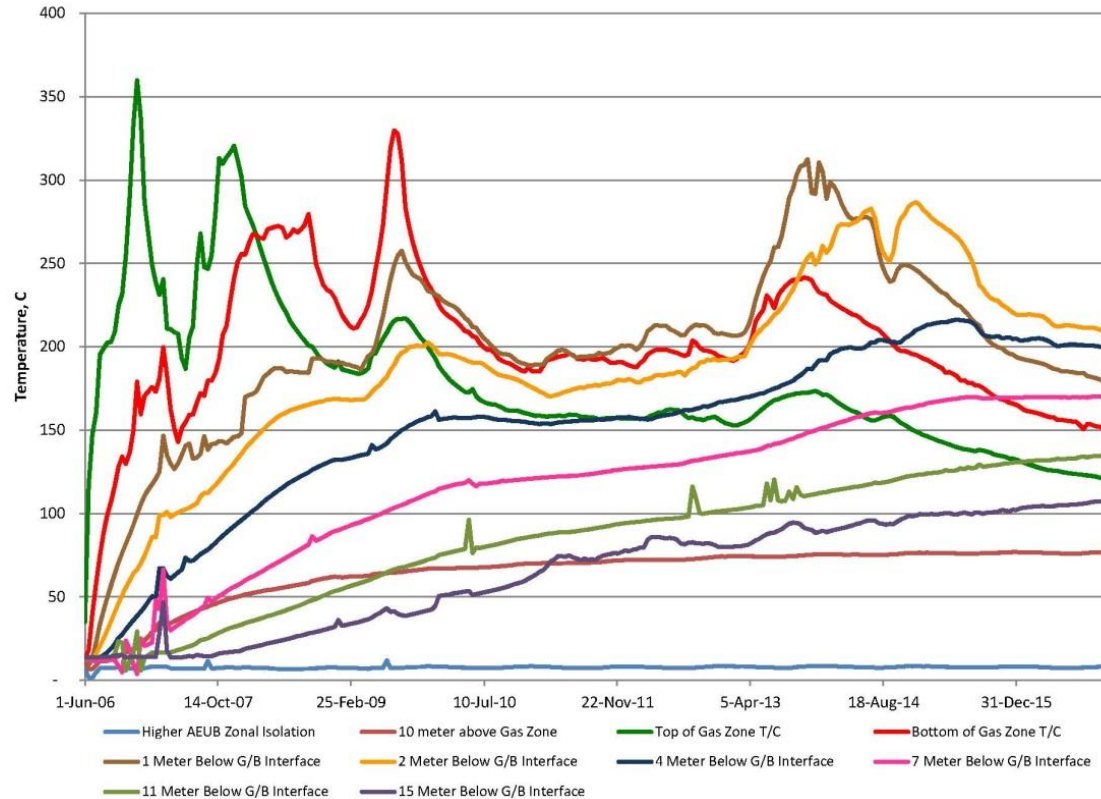
- Equipped with one piezometer
- Equipped with 10 thermocouples

Requirements under subsection 3.1.1 5a – wellbore schematics 5c and 5d are included in the appendix

Observation wells bitumen pressure

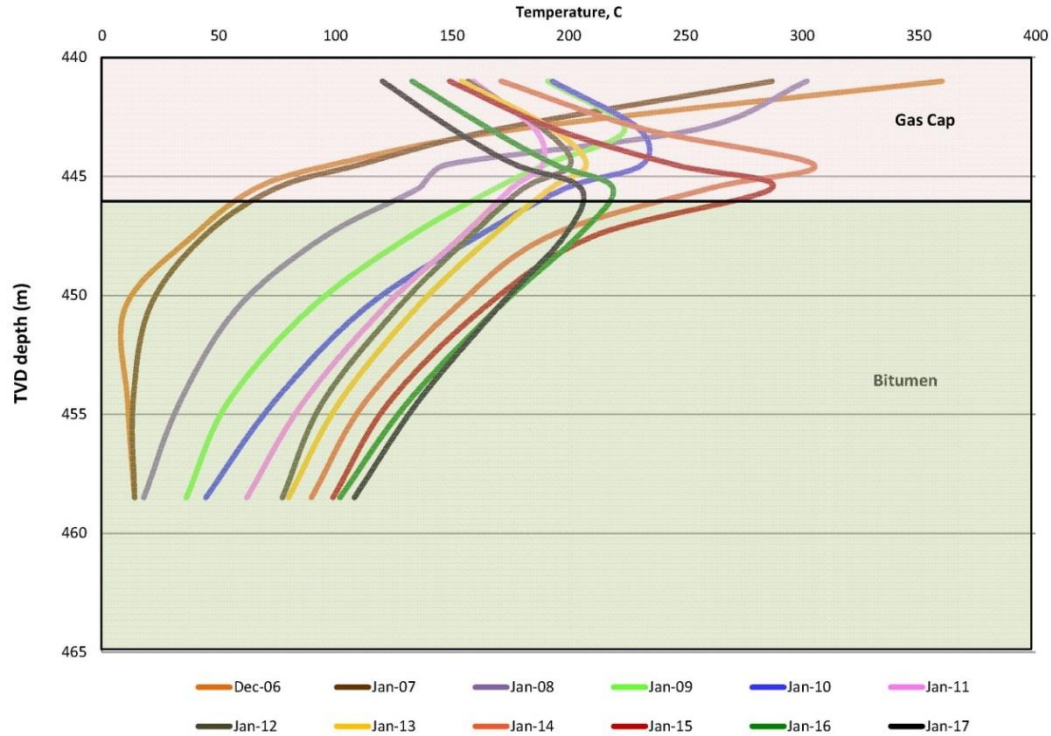


102/05-10-073-06W4 – Temp history



102/05-10-073-06W4/0

Observation well temperature



Scheme performance

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Project performance history

Year	Activity		
2006	June - Ignition and start-up	2012	Jul - Startup of 00/6-7-76-6W4/00 Oct - Primrose sales volumes flowing to Caribou gas facility
2007	Q1 - Nitrogen response at 00/14-9-73-6W4/00 Q2 - Nitrogen response at 00/2-16-73-6W4/00, 00/11-15-73-6W4/00, shut-in 00/14-9-73-6W4/00	2013	Feb - Startup of 00/6-6-73-6W4/00 Mar- Shut-in 00/7-8-73-6W4/00
2008	May - Nitrogen response at 00/1-17-73-6W4/00	2014	Dec - Startup 00/10-12-73-7W4/00
2009	Jan - Gas production shut-in due to 00/6-18-73-6W4/00 segregation repair Jun - Nitrogen response at 00/7-8-73-6W4/00 Oct - Injectivity decrease observed	2016	Feb - Abandoned 00/11-15-73-6W4 Jul - Startup 00/10-11-73-7W4/00
2010	Q1- 00/5-10-73-6W4/00 injector stimulation treatment Q4 - Shut-in 00/1-17-73-6W4/00, 00/2-16-73-6W4/00, 00/11-15-73-6W4/00. Removal of 00/5-10-73-6W4/00 thermocouple string and perform pressure fall off tests		
2011	Q1 - 00/5-10-73-6W4/00 injector stimulation treatment Mar/Apr - 00/11-15-73-6W4/00 flowed N ₂ 85%		

Production/injection summary

Production operations

Operating for

>10 years

Air injected

~ 270 e⁶m³

Bulk gas recovered

~ 190 e⁶m³

Formation gas recovered

~ 167 e⁶m³

Approved producers

UWI

Status

00/06-05-073-06W4/0

Flowing ~ 52% N₂

00/06-06-073-06W4/2

Flowing ~ 17% N₂

00/06-07-073-06W4/2

Flowing <1% N₂

00/07-08-073-06W4/0

Shut-in >90% N₂

00/11-15-073-06W4/0

Abandoned

UWI

Status

00/02-16-073-06W4/0

Shut-in ~ 84% N₂

00/01-17-073-06W4/0

Shut-in ~ 85% N₂

00/10-11-073-07W4/0

Flowing <1% N₂

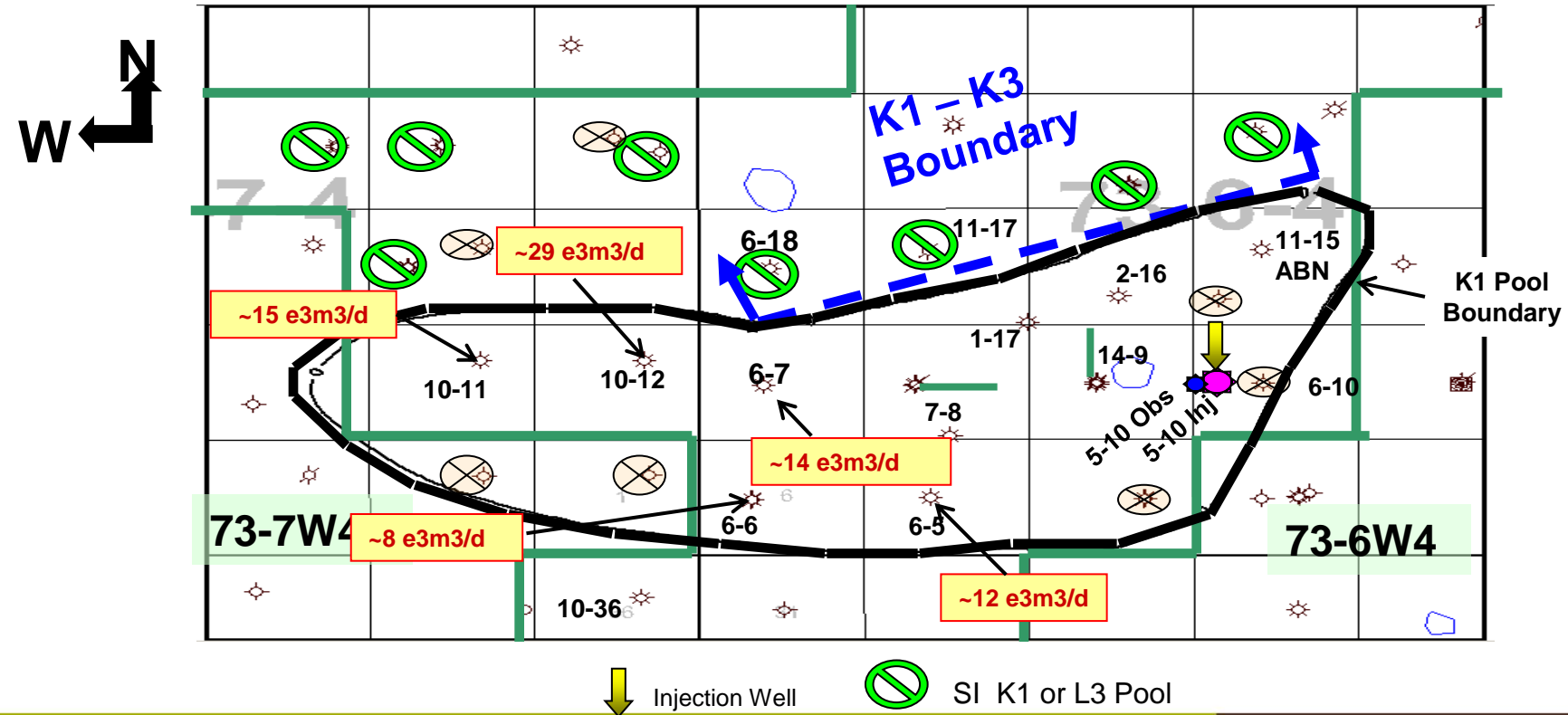
00/10-12-073-07W4/0

Flowing <1% N₂

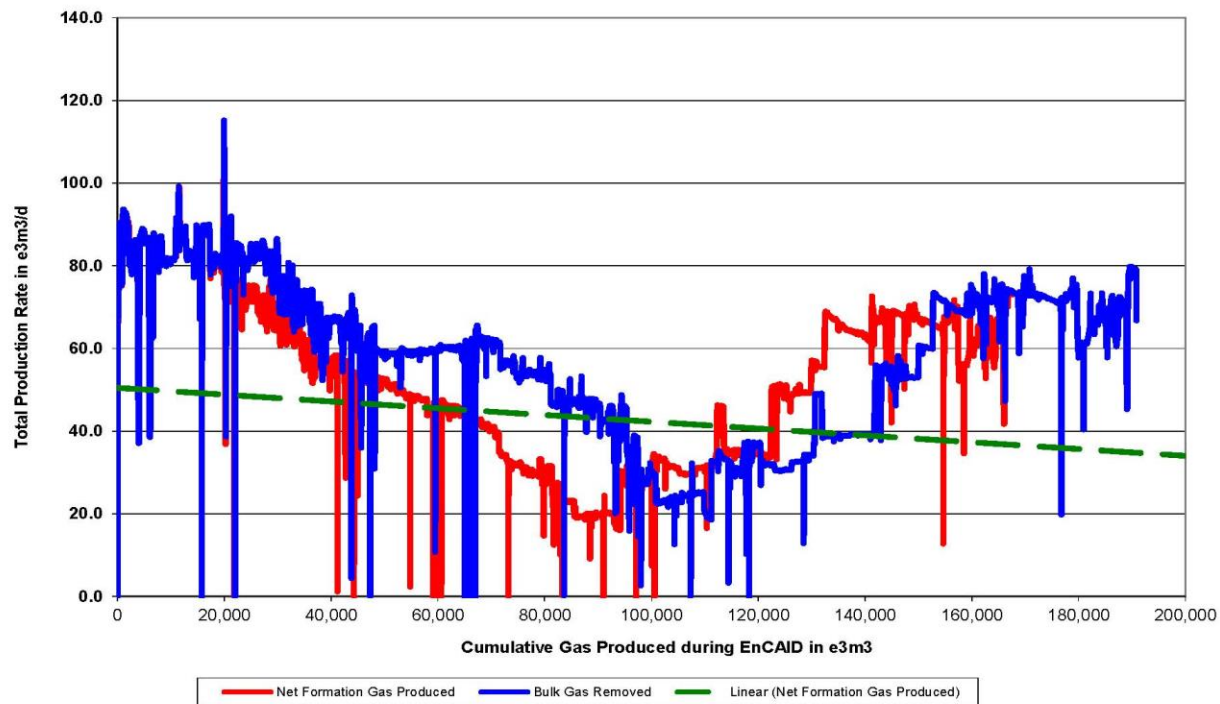
00/14-09-073-06W4/0

Shut-in ~ 86% N₂

K3 pool production



History production



Voidage replacement ratio (VRR) - 2016

January and April

Steady high air injection rates

May to October

Reduce air injection rates due to higher ambient temperatures

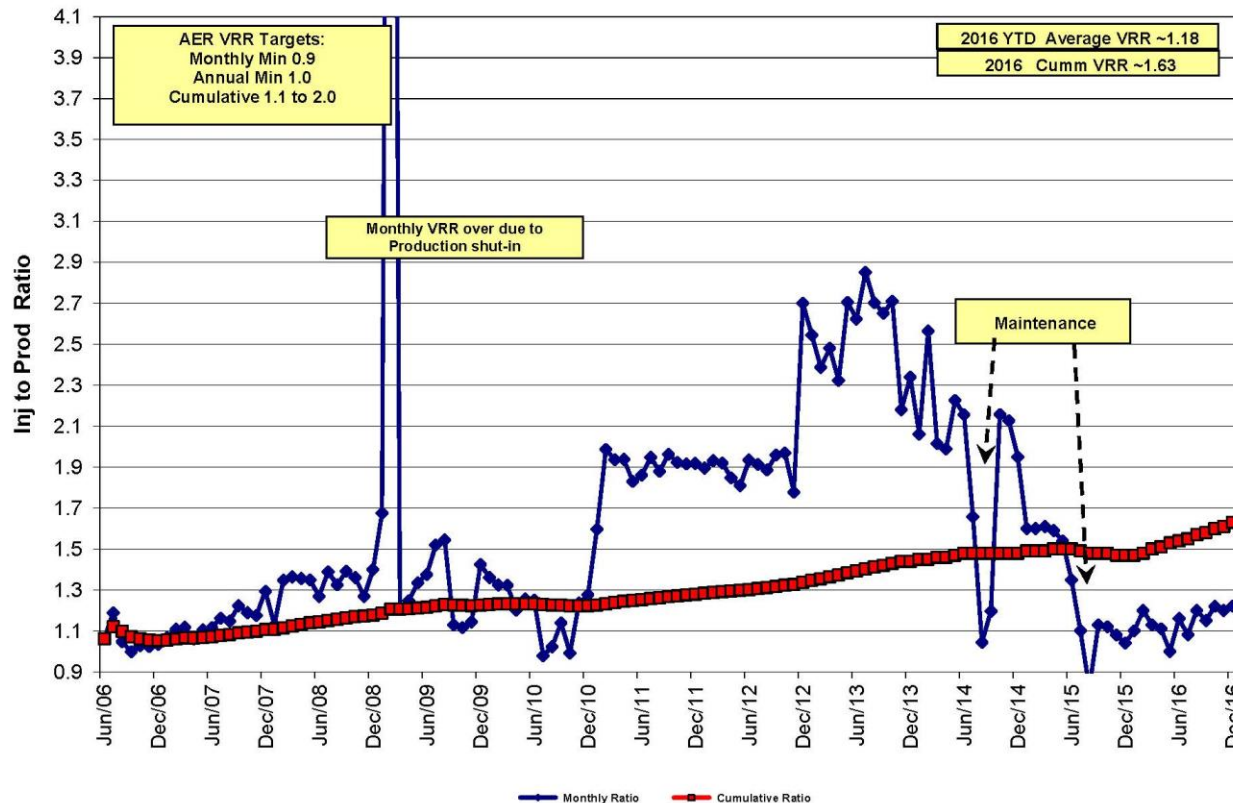
October to December

Steady high air injection rates

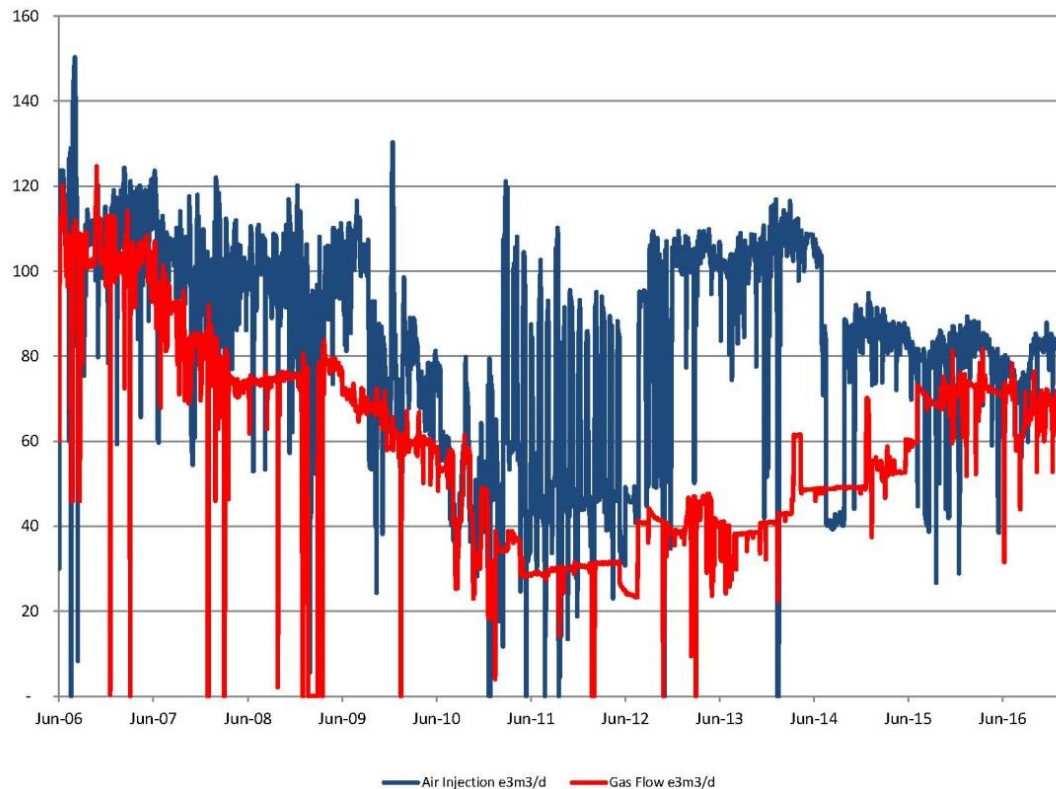
VRR

	Monthly VRR	Cumulative VRR	VRR regulatory approved limit (Min monthly)
January	1.10	1.47	0.90
February	1.20	1.48	0.90
March	1.13	1.50	0.90
April	1.11	1.51	0.90
May	1.00	1.53	0.90
June	1.16	1.54	0.90
July	1.08	1.55	0.90
August	1.20	1.57	0.90
September	1.15	1.58	0.90
October	1.22	1.60	0.90
November	1.20	1.61	0.90
December	1.22	1.63	0.90

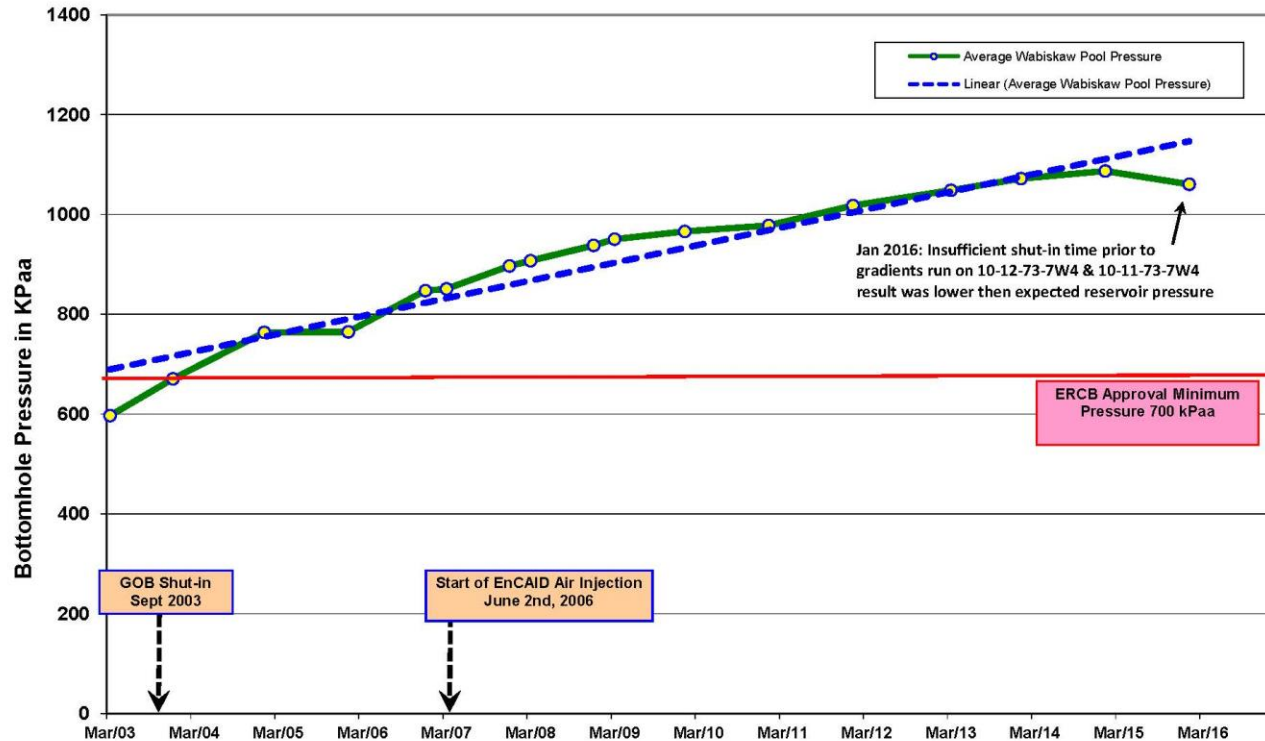
VRR performance



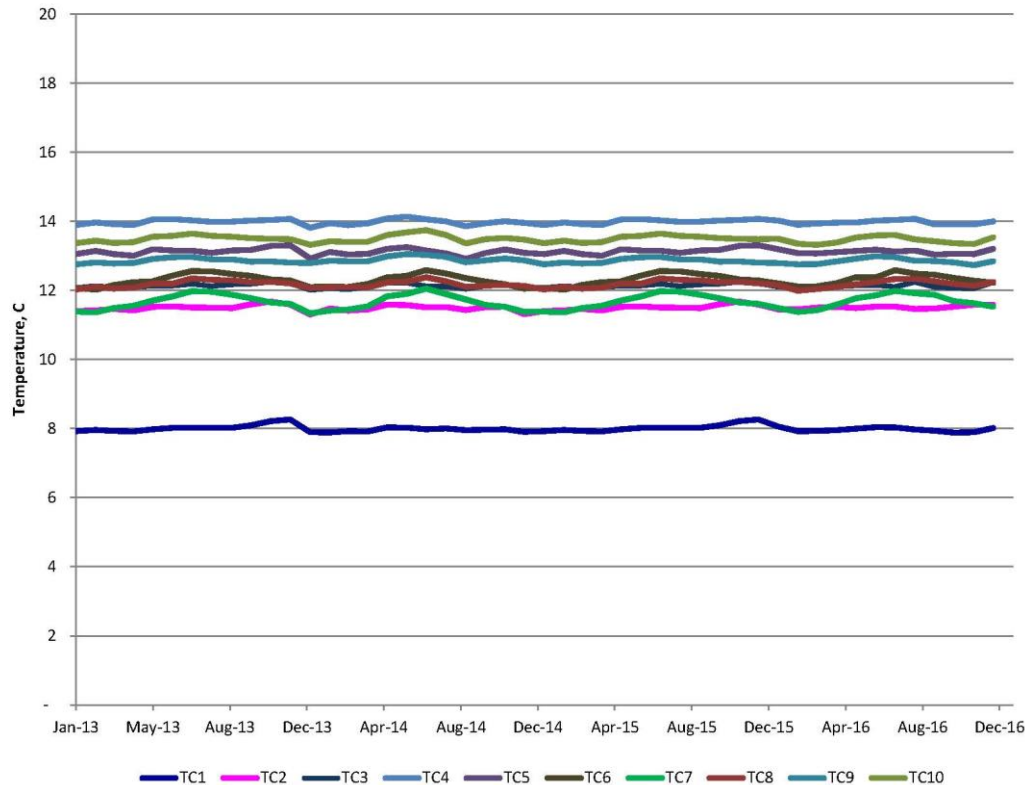
VRR history



K3 pool pressure



Observation 6-10 well temperature

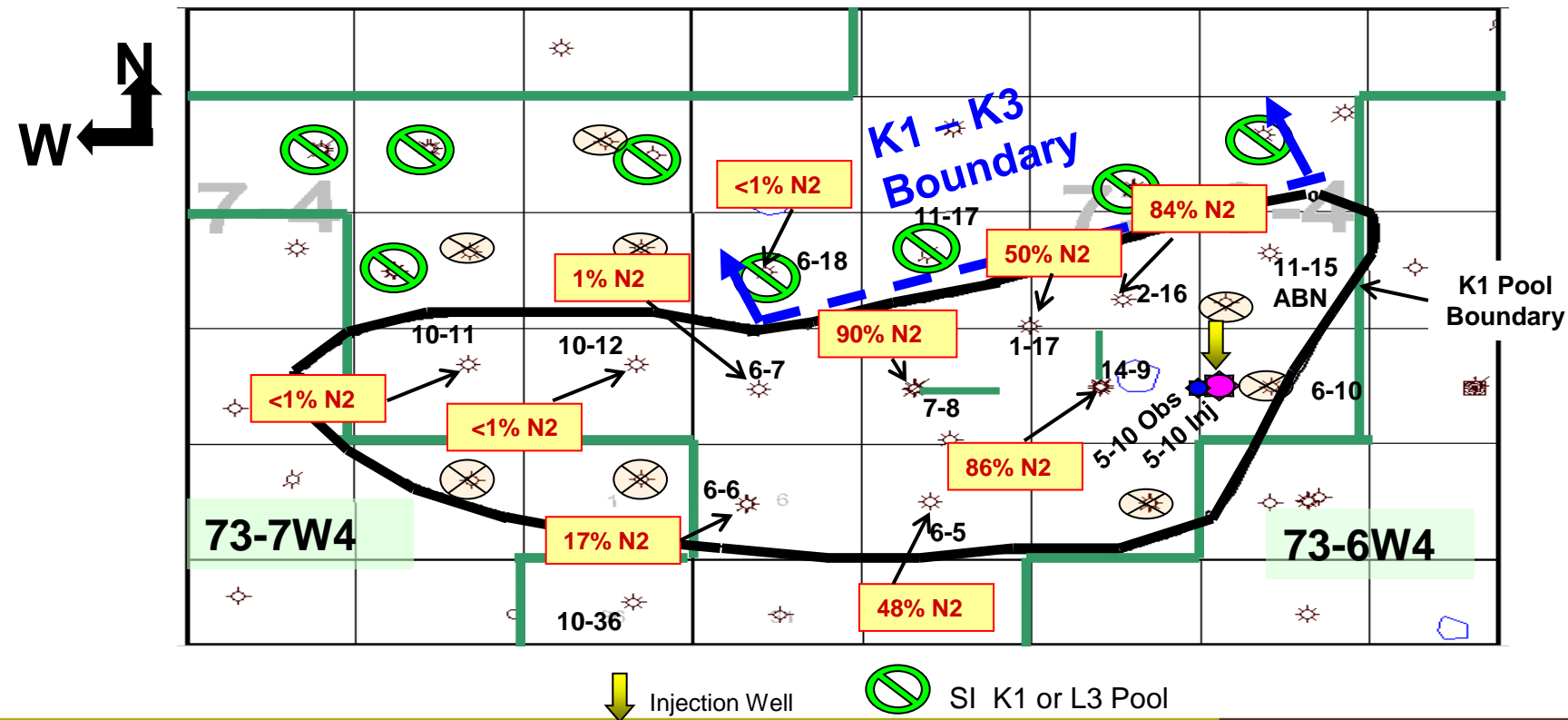


Composition of injected/produced fluids

- EnCAID does not currently sample air injected
- EnCAID captures gas samples for analysis on the schedule located to the right and monitors compositional changes for each well
- Cenovus samples selective wells on more frequent basis than required under Approval 10440L

	Sampling Frequency
00/01-17-073-06W4/0	Annual
00/02-16-073-06W4/0	Annual
00/06-05-073-06W4/0	Semi-annual
00/06-06-073-06W4/2	Semi-annual
00/06-07-073-06W4/2	Semi-annual
00/06-10-073-06W4/2	Annual
00/06-18-073-06W4/0	Annual
00/07-08-073-06W4/0	Annual
00/10-11-073-07W4/0	Semi-annual
00/10-12-073-07W4/0	Semi-annual
00/10-36-072-07W4/2	Annual
00/11-17-073-06W4/0	Annual
00/14-09-073-06W4/0	Annual

Nitrogen response



Wabiskaw K-3 Pool material balance

K-3Repressure Summary Well Data: Mar.1979-Feb.2004

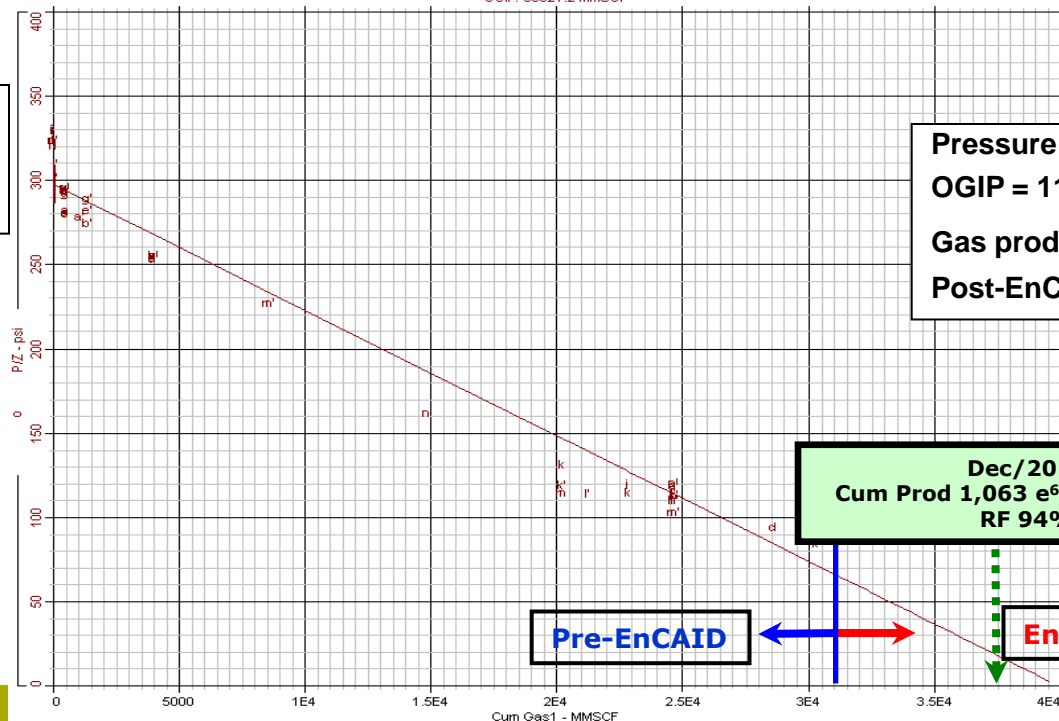
Operator:
Field:
Zone:
Type: Summary
Group: K-3Repressure

Material Balance OGIP (P/Z Analysis)
P/Z Vs Cum Gas1
P/Z aban: 0 psi
RVIP: 39921.2 MMSCF
Gas RRT: 8893.31 MMSCF
OGIP: 39921.2 MMSCF

Production Cums
Oil: 0 MSTB
Gas: 31027.9 MMSCF
Water: 38.3764 MSTB
Cond: 0 MSTB

P/Z - psi
Cum: 31,027.94 MMSCF
Material Balance OGIP - psi
Based On: P/Z
of Segments: 1
Gas CTD: 31,027.94 MMSCF
Gas CTD: 39,921.24 MMSCF
P/Z aban: 0.00 psi
Gas RRT: 8,893.31 MMSCF
RVIP: 39,921.24 MMSCF
OGIP: 39,921.24 MMSCF

Original Pressure
– 2050 kPaa
(300 psia)



Pressure Dec 03 = 662 kPaa or 96 psia

OGIP = 1129 e⁶m³ (39.9 Bcf)

Gas prod = 877 e⁶m³ (31.0 Bcf 77% RF)

Post-EnCAID RF ~ 85 - 87%

Subsurface key learnings

Presence of more than one oxidation front indicates

- fuel remaining in the region swept by the combustion front
- could be either residual oil left behind first oxidation front, or re-saturation with oil from adjacent rock or, possibly from flammable vapor produced from the oxidation and cracking reactions

Continues to be strong correlations between air-injection rate and temperature changes

- first oxidation zone at the bottom of the gas cap was truncated by a reduction in injection rate
- increase in injection rate performed in early 2013 resulted in ignition and combustion of the top of the bitumen

Future plans

Subsurface section 8

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Future plans

- No changes in overall recovery strategy are planned at this time

AER Dir 54 Section 3.1.2

Surface operations, compliance and issues not related to resource evaluation and recovery

Surface operations: table of contents

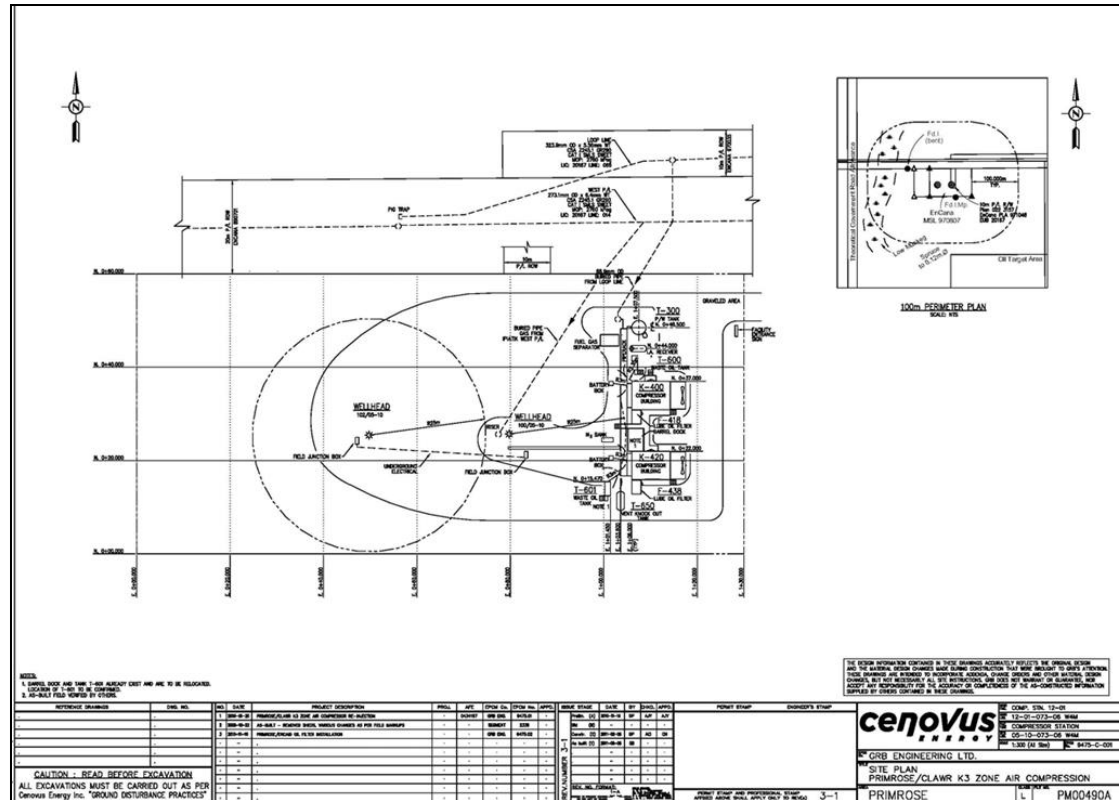
1. Facility overview/modifications
2. Measurement and reporting
3. Environmental issues
4. Compliance statement
5. Future plans

Facility overview/modifications

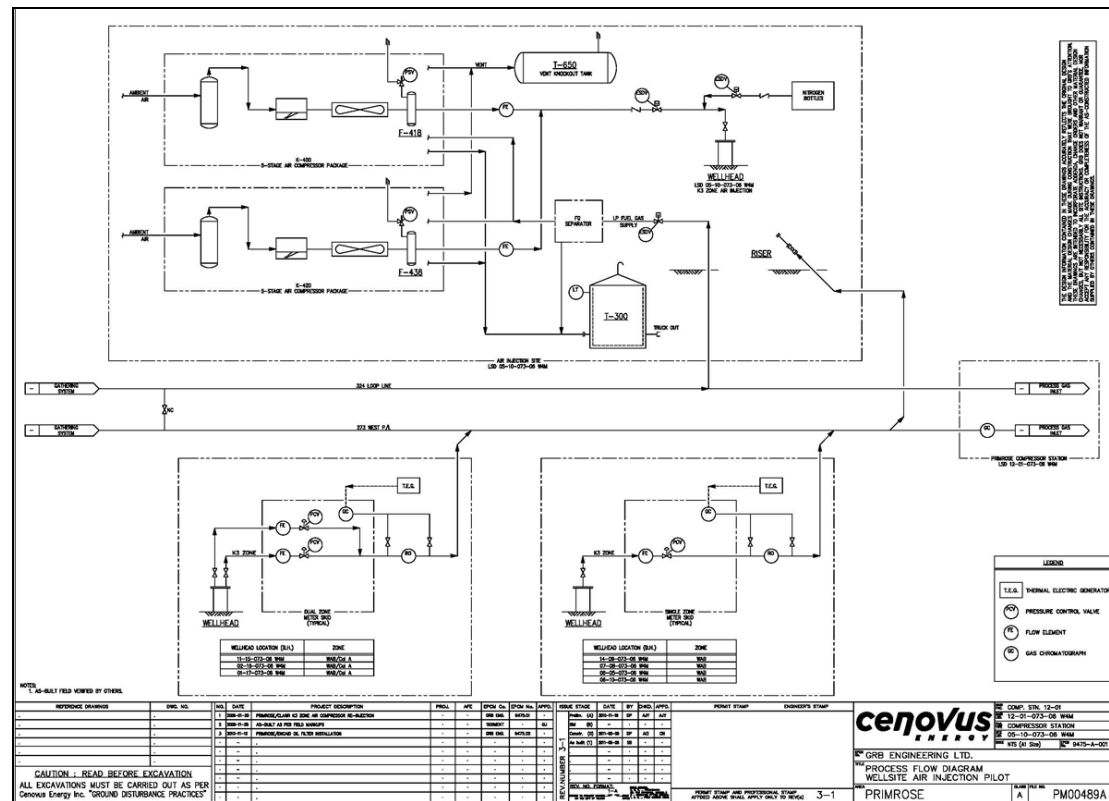
Directive 54 **Subsurface Operations section 1**

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Site Layout



Process flow schematic



Plant performance - 2016

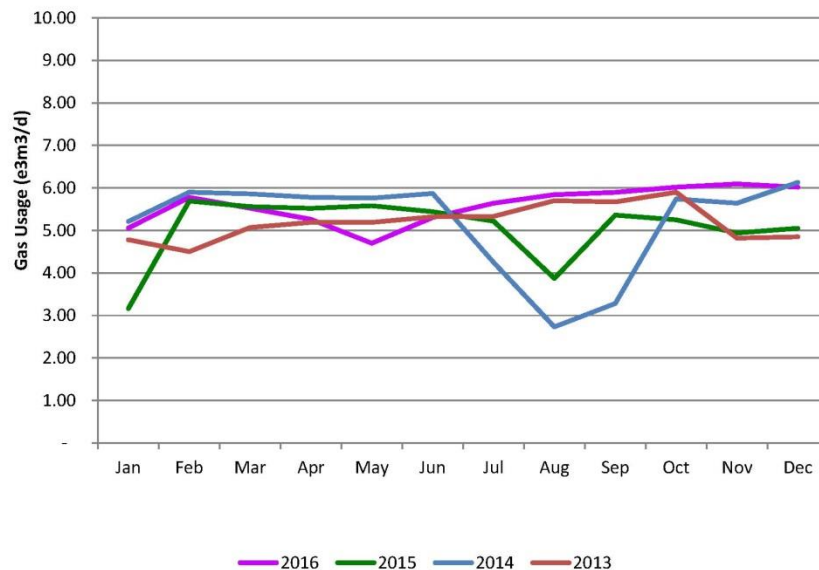
Facility is operating as expected

- Steady air injections
- Some weather related reductions

Gas usage

Usage is as fuel gas for air compressor operations

- Gas source Primrose plant fuel gas
- Total 2016 usage 2,061 e³m³



Green house gas emissions

	2016 (tonnes)	2015 (tonnes)	2014 (tonnes)
January	477	522	477
February	463	439	472
March	476	478	519
April	443	461	498
May	412	482	521
June	446	456	504
July	484	455	405
August	498	335	300
September	487	437	326
October	511	457	511
November	501	413	484
December	513	431	538

Surface facility key learnings

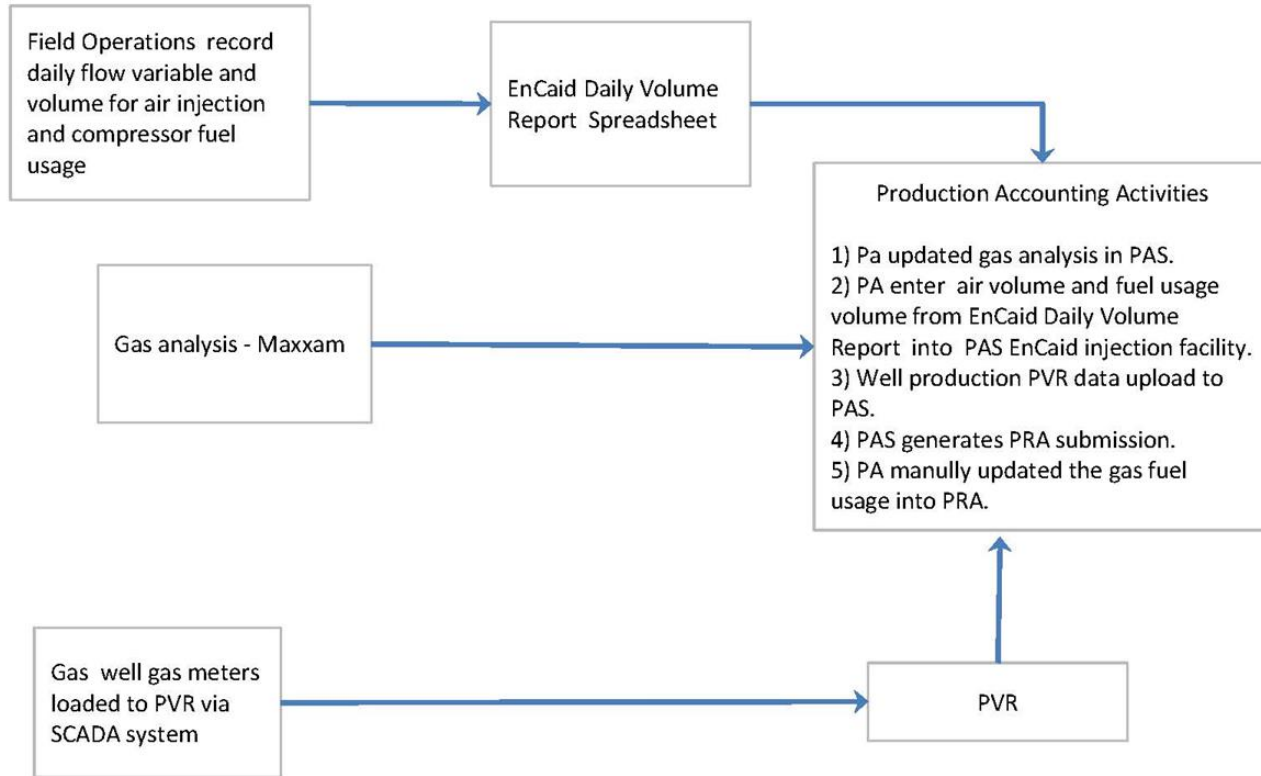
- Safe operation of production and injection wells
- Geographical location provides challenges for instrumentation operations utilizing solar panels during the winter season
- Purity of injection gases plays key role in maintaining injectivity
- Marginal economics to operate in today's pricing environment

Measurement and reporting

Directive 54 **Surface Operations section 2**

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Measurement reporting



Environmental issues

Directive 54 **Subsurface Operations section 7**

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Environmental compliance

No environmental non-compliance events occurred related to EnCAID occurred in 2016

Compliance statement

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Compliance confirmation

No other non-compliance events related to EnCAID occurred in 2016

Non-compliance discussion

Directive 54 **Surface operations section 9**

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Non-compliance confirmation

No non-compliance events related to EnCAID occurred in 2016

Future plans

Directive 54 **Subsurface Operations section 10**

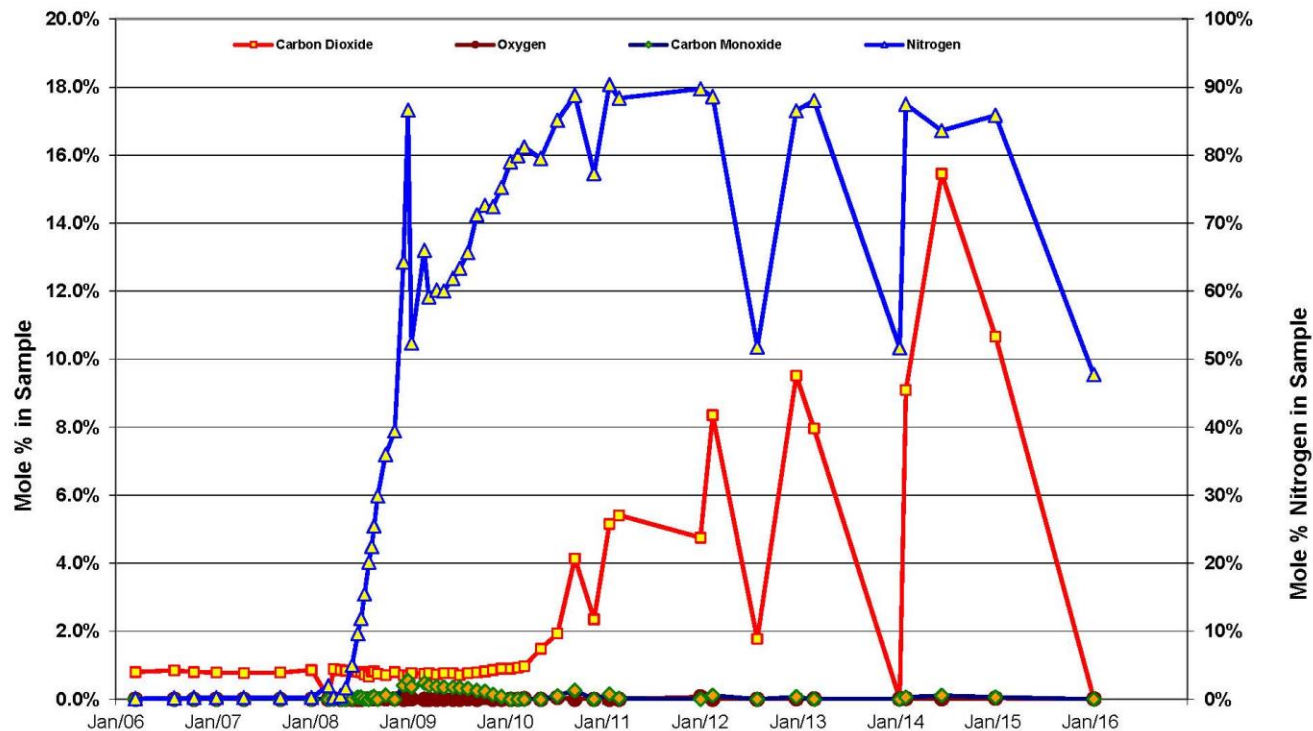
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Future plans

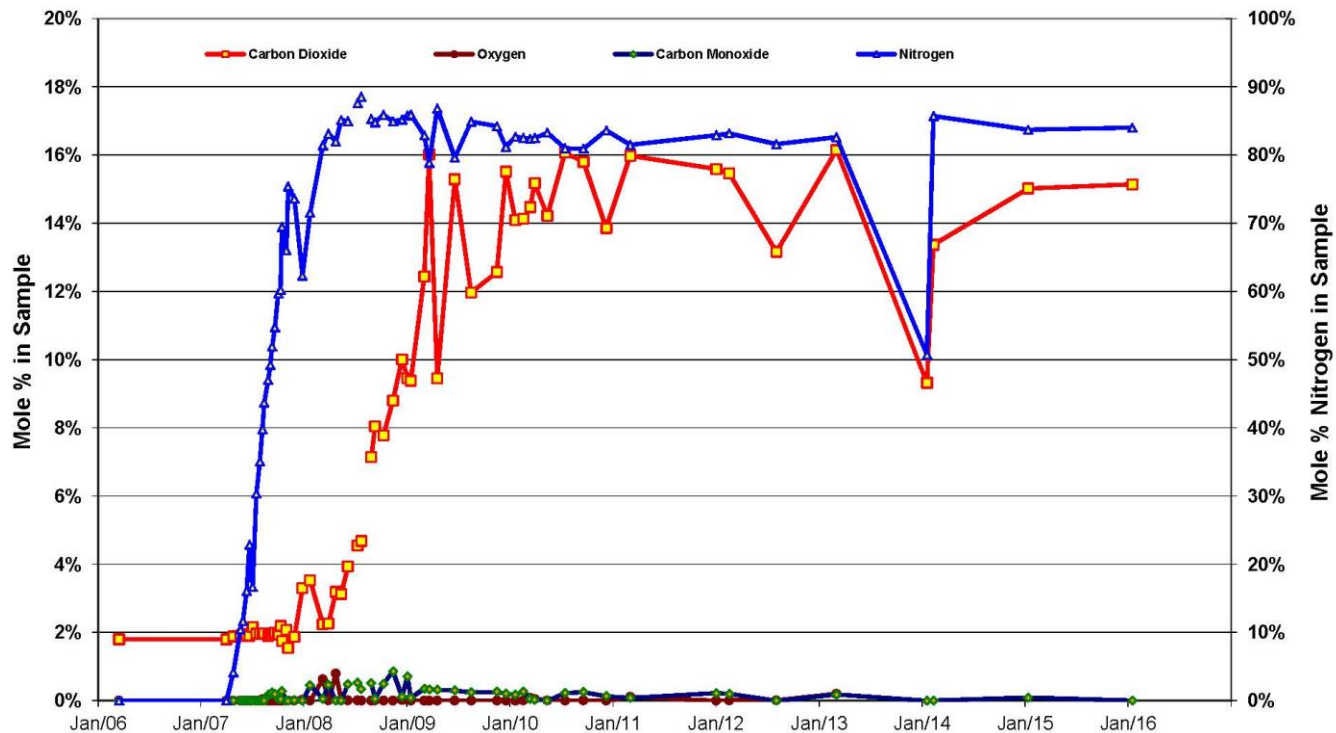
- No major initiatives or plans that may require submission of an application are being contemplated at this time
- No changes to overall plant design or amendments are anticipated at this time
- Operate the project until it is economic

Appendix

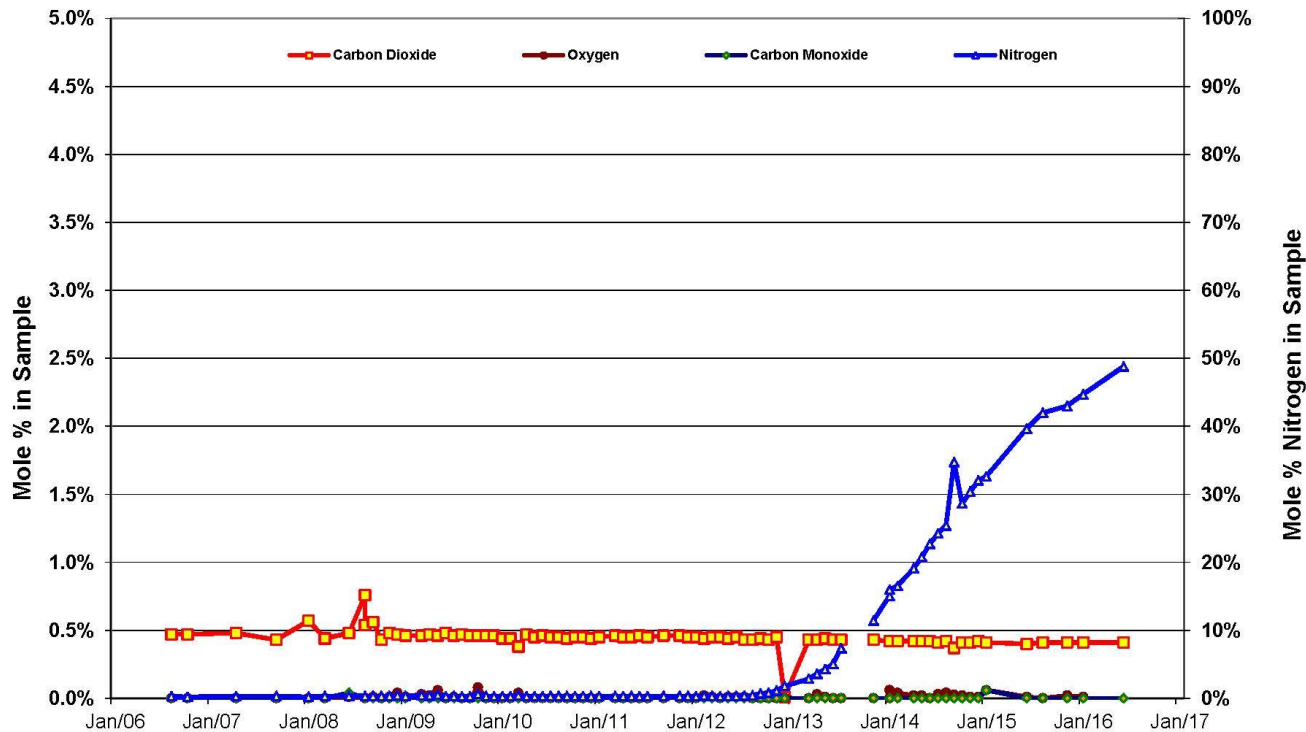
Gas composition 00/1-17-73-6W4/0



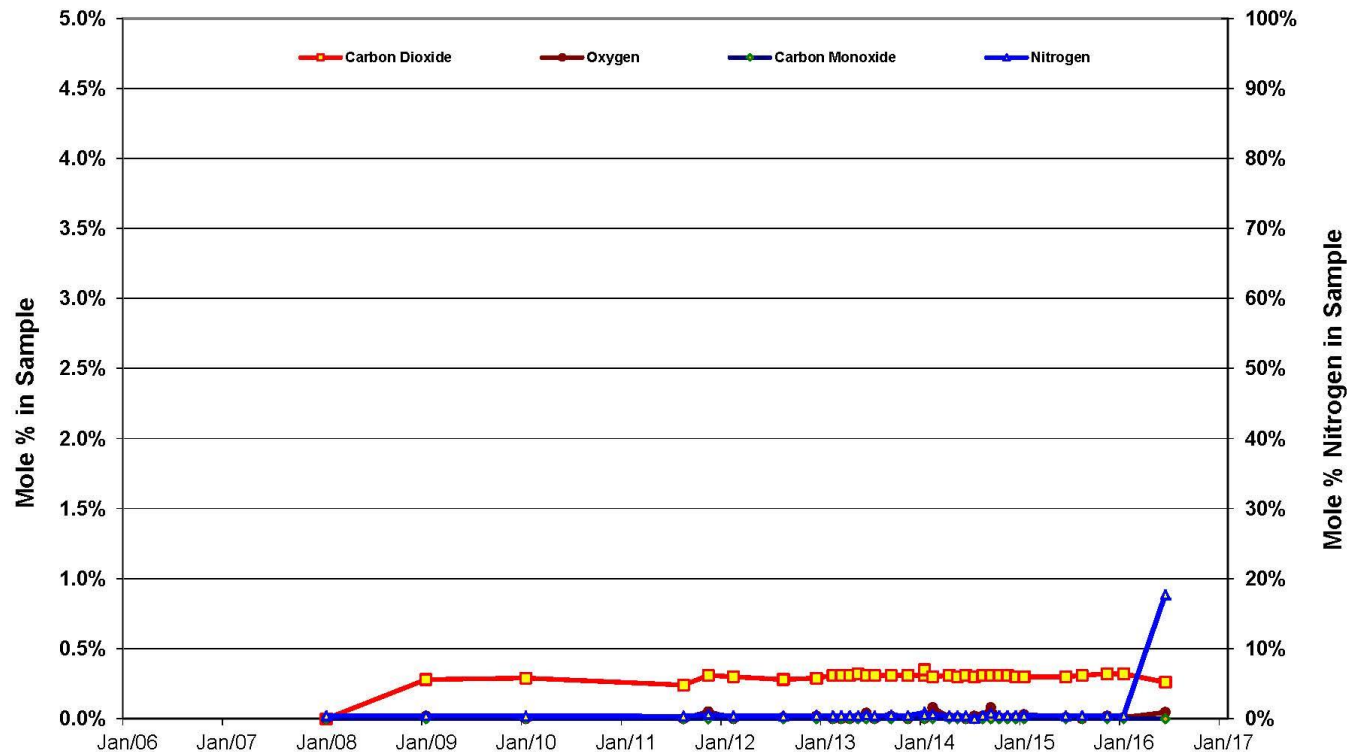
Gas composition 00/2-16-73-6W4/0



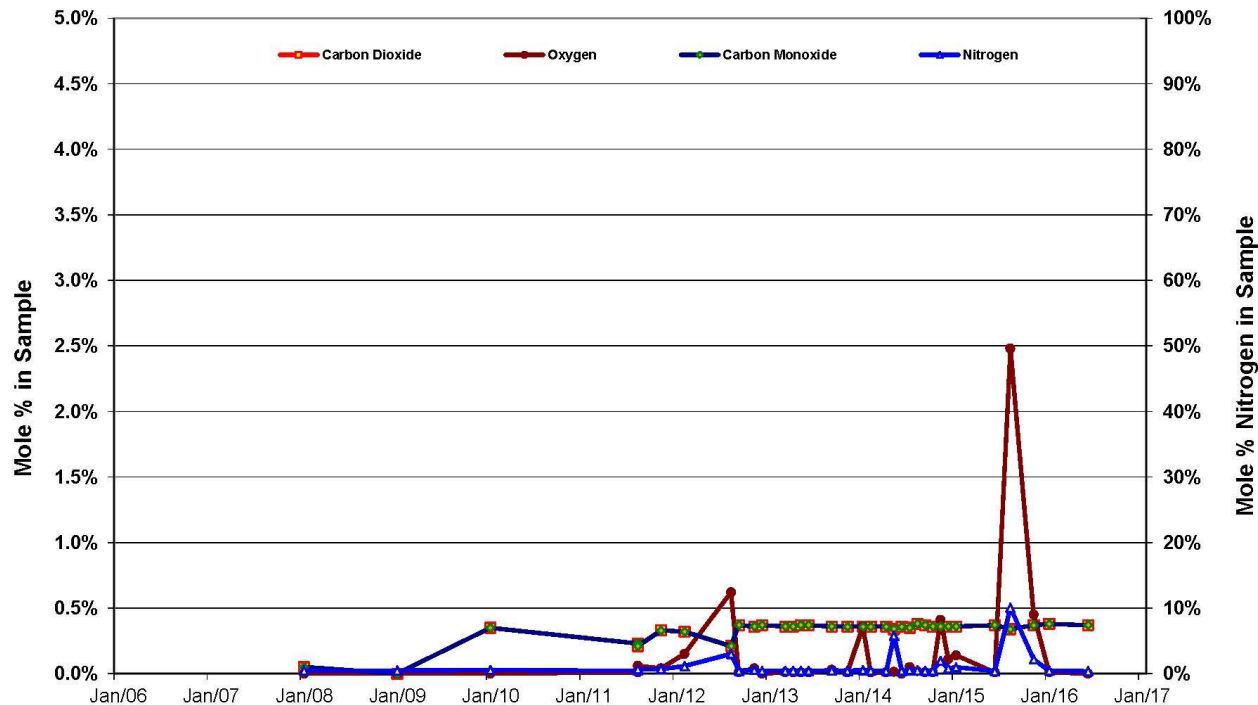
Gas composition 00/6-5-73-6W4/0



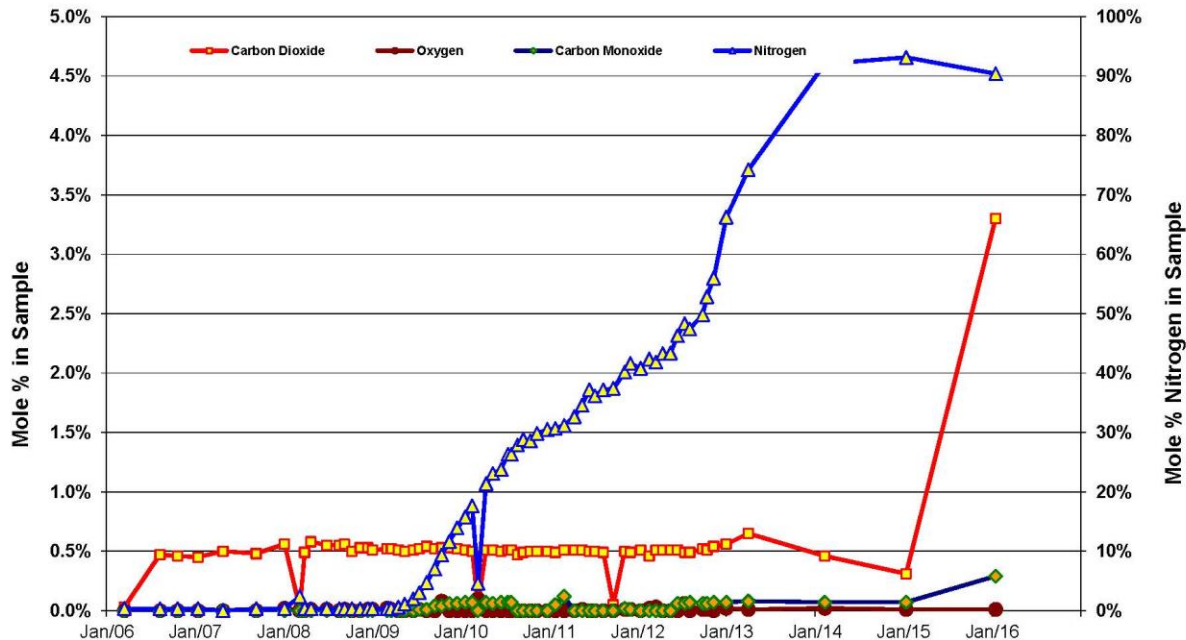
Gas composition 00/6-6-73-6W4/0



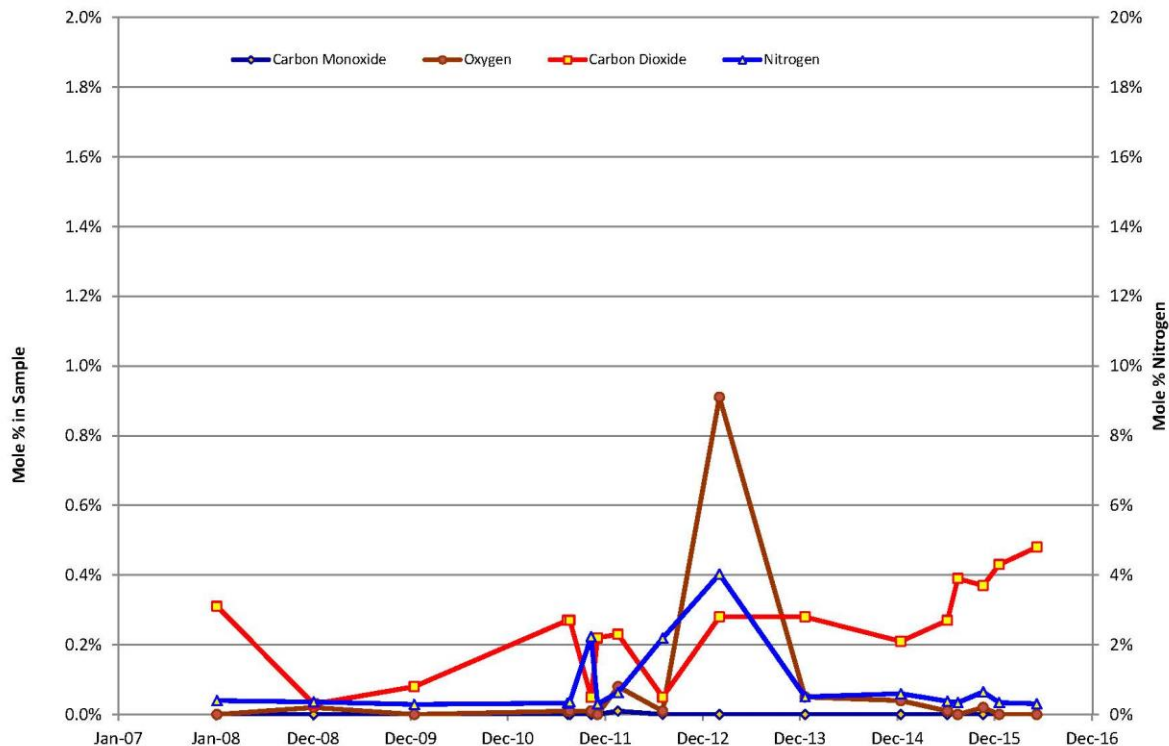
Gas composition 00/6-7-73-6W4/0



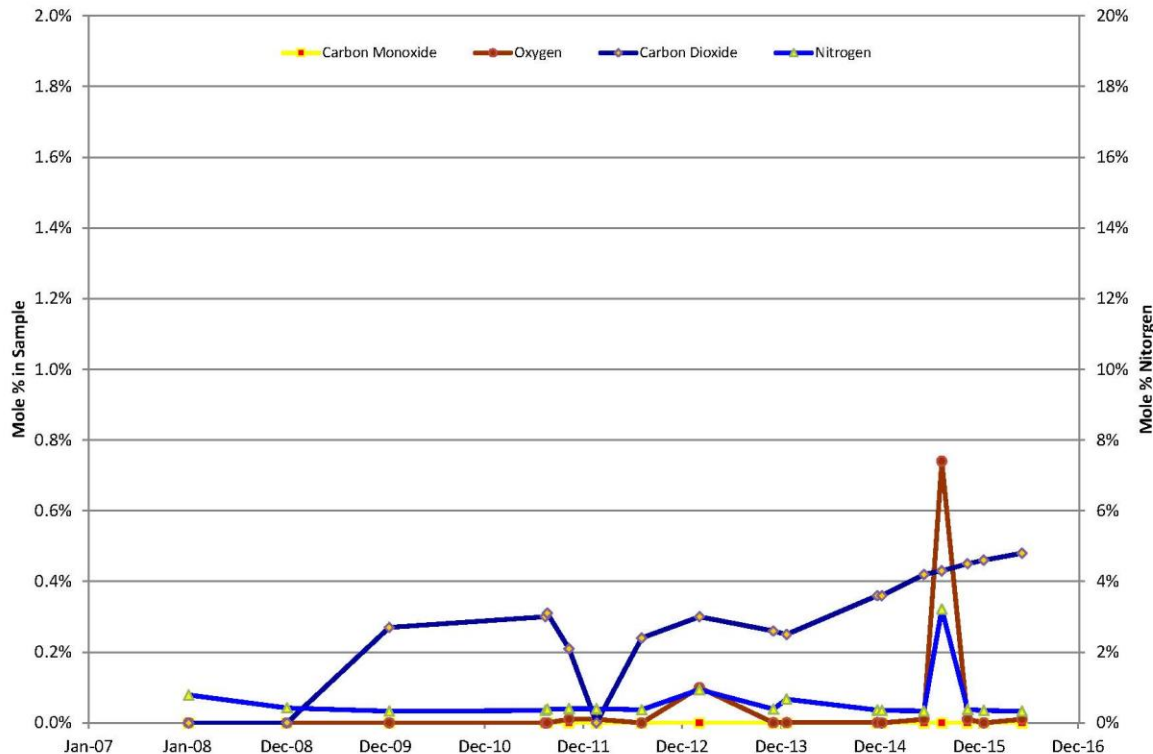
Gas composition 00/7-8-73-6W4/0



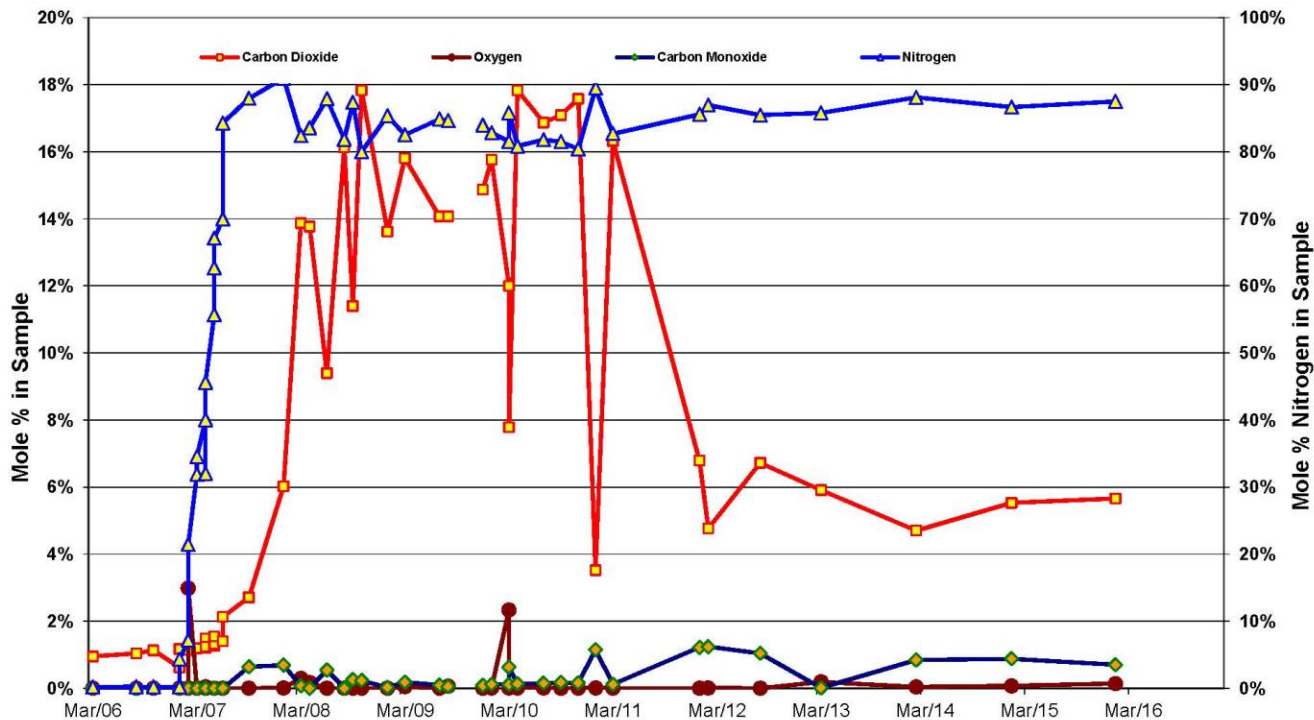
Gas composition 00/10-11-73-7W4/0



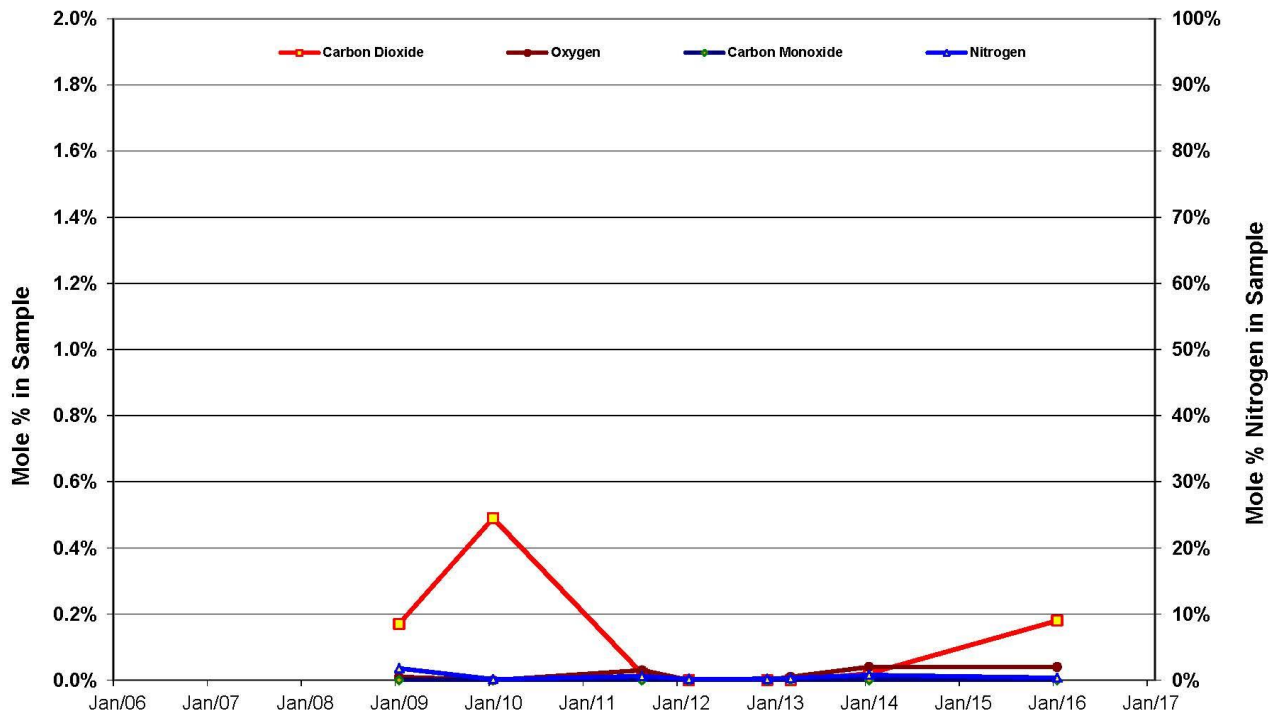
Gas composition 00/10-12-73-7W4/0



Gas composition 00/14-9-73-6W4/0



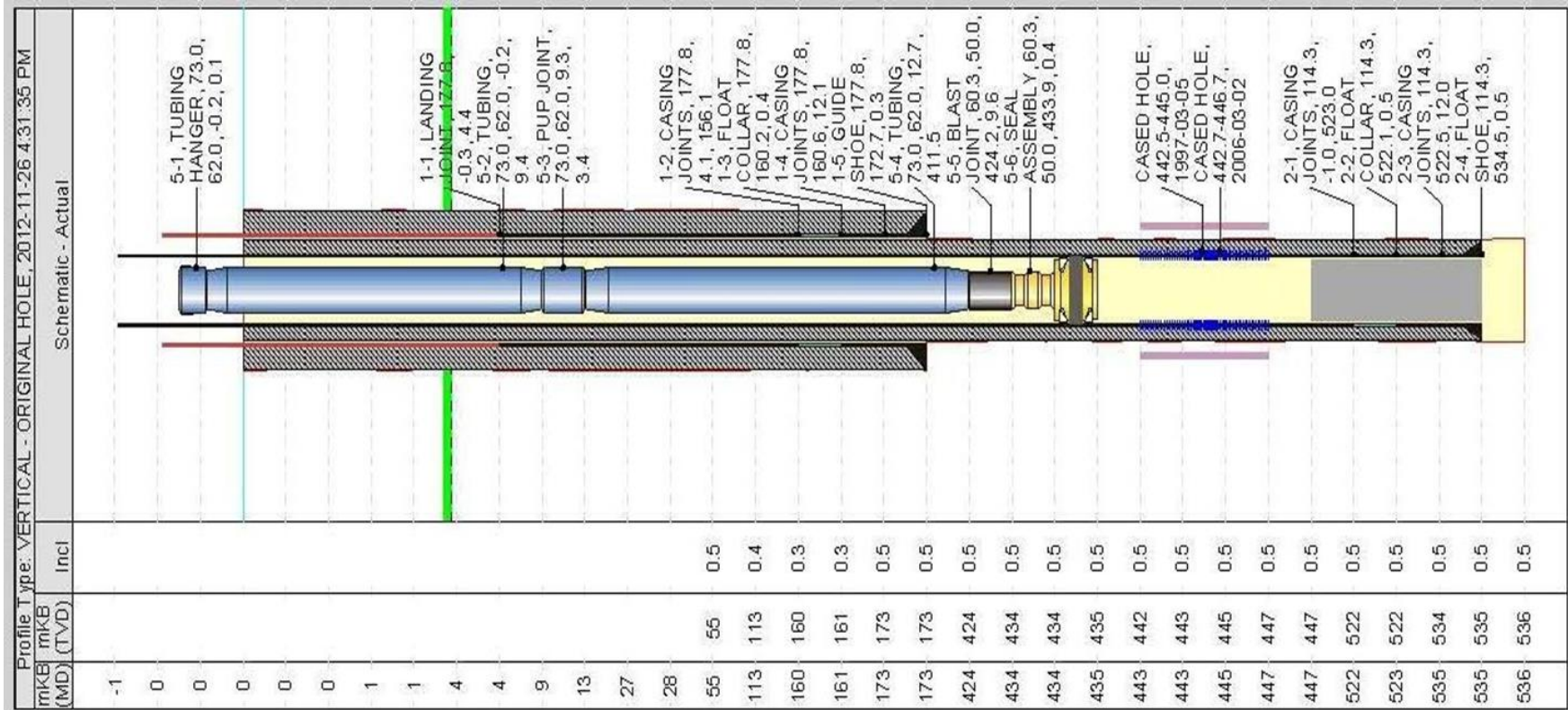
Gas composition 00/6-18-73-6W4/0



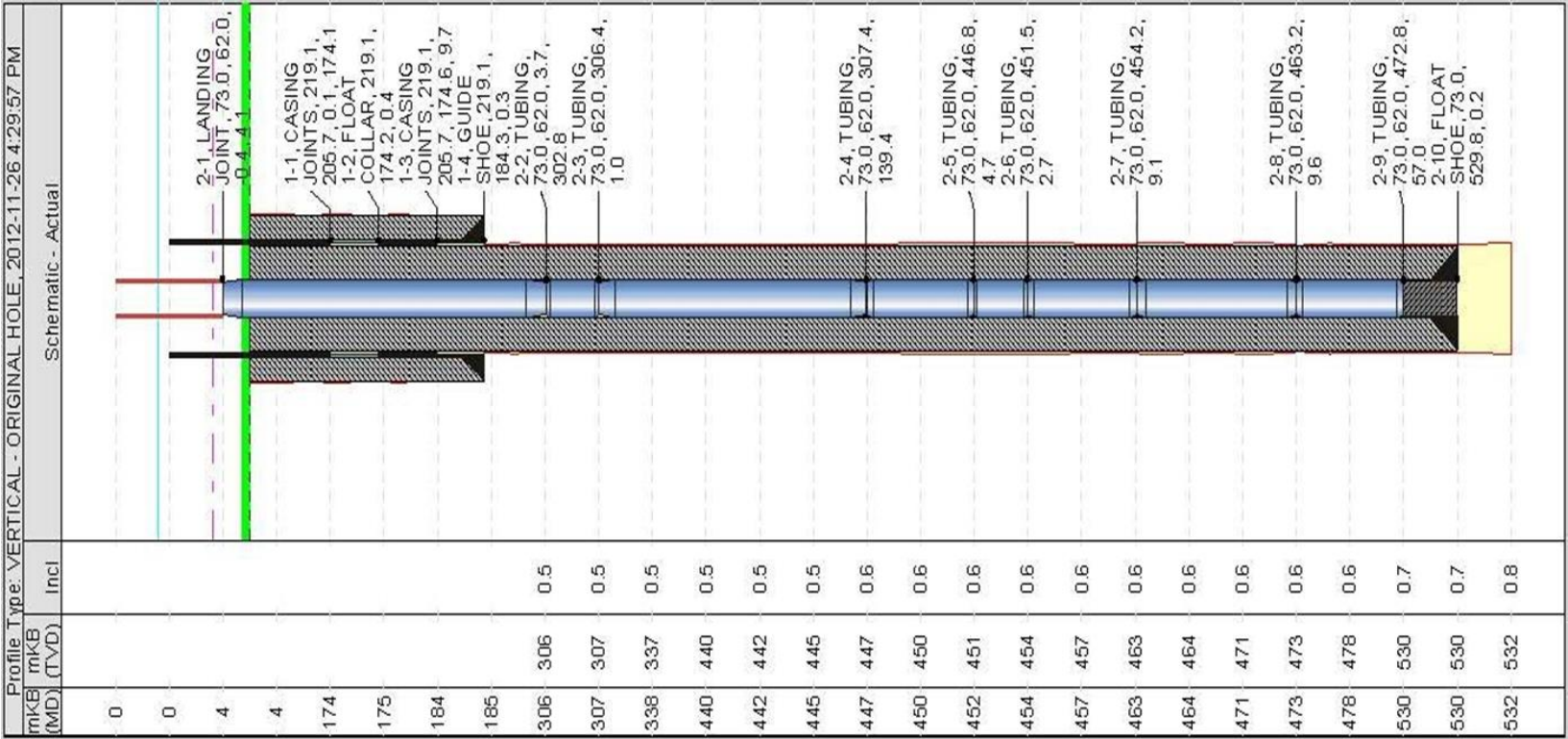
Downhole instrumentation layout



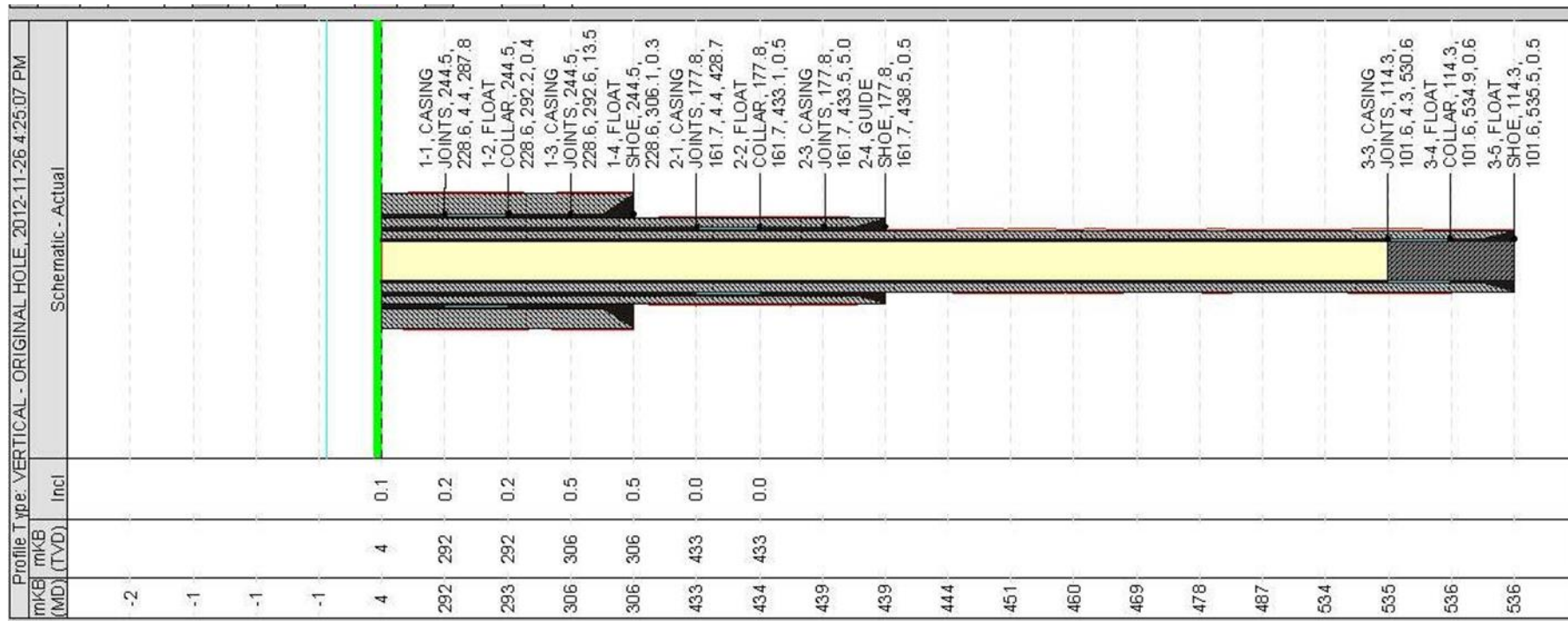
100/05-10-073-06W4 wellbore schematic



102/05-10-073-06W4 wellbore schematic



103/05-10-073-06W4 wellbore schematic



Thank you