Cenovus EnCAID approval #10440J Performance presentation

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cenovus ENERGY

Advisory

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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

* Canadian patent CA2594413

AER Dir 054 Section 3.1.1

Subsurface issues related to resource evaluation and recovery

Subsurface issues: Table of contents

1. Scheme background
2. Geology / geoscience
3. Drilling and completions
4. Instrumentation
5. Scheme performance
6. Future plans

Scheme background

Subsurface section 1

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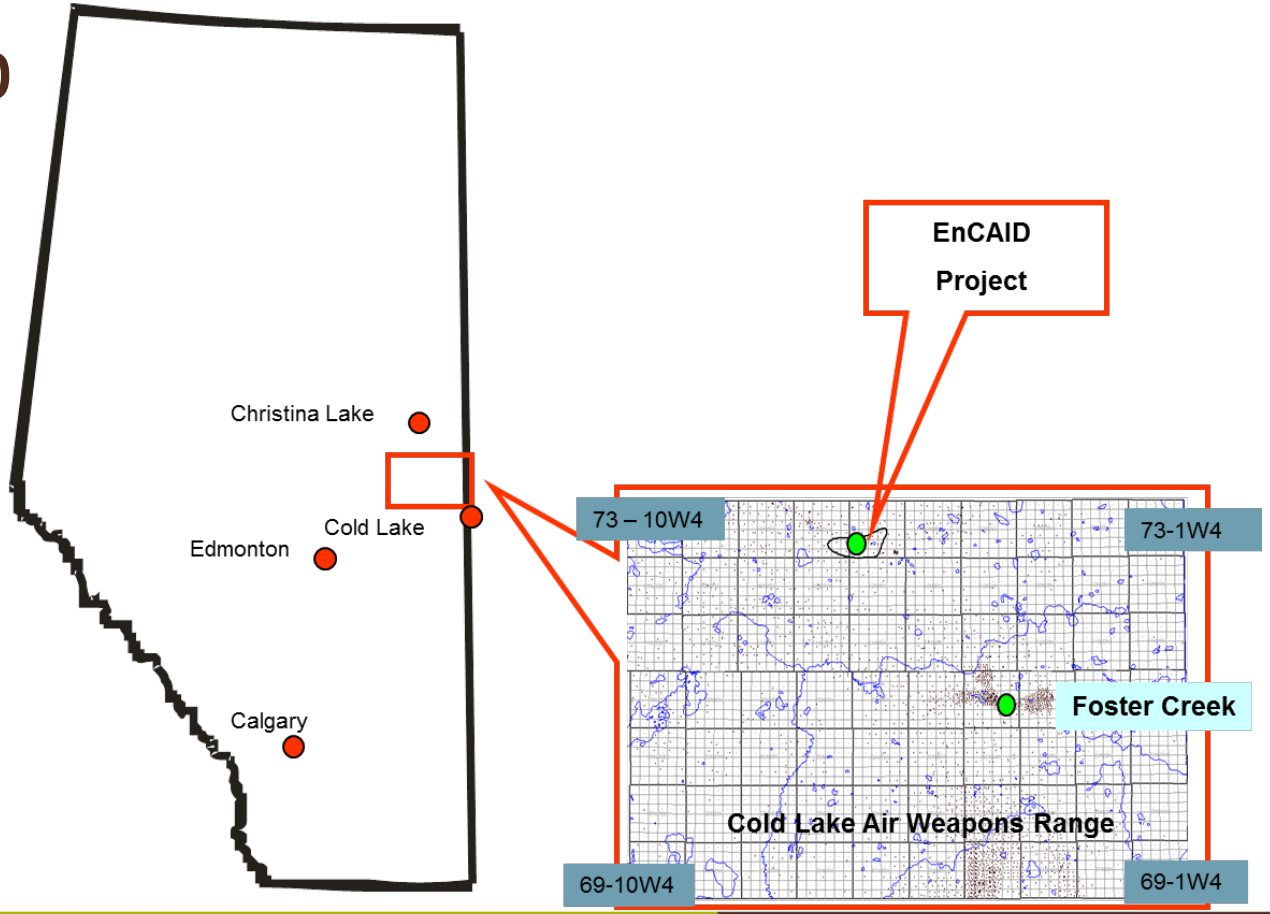
Background

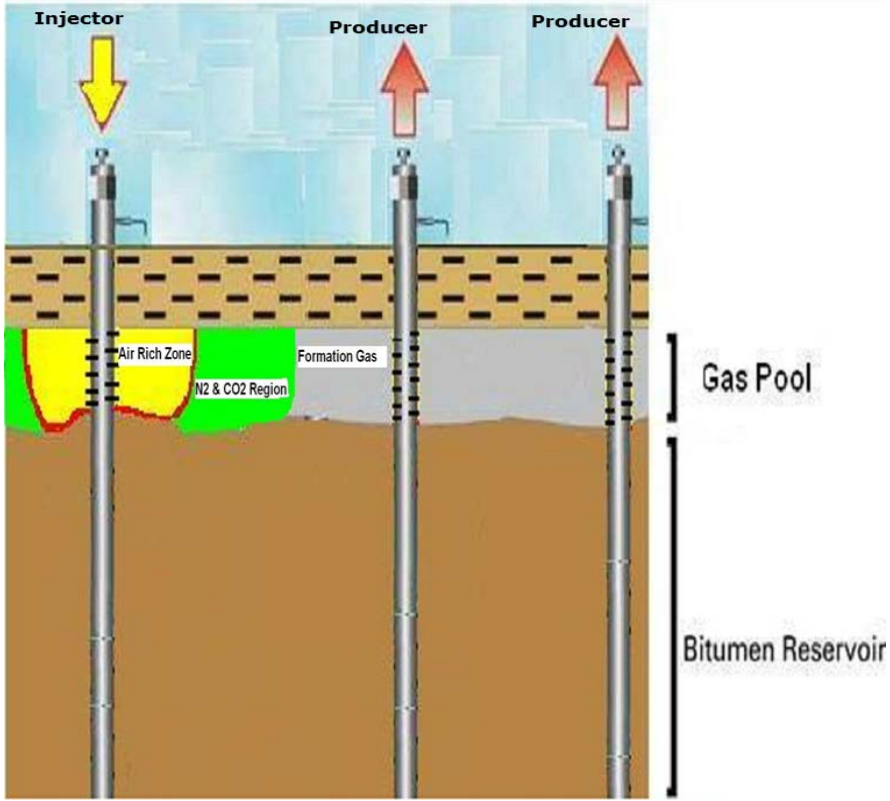
- The EnCAID project is an enhanced recovery scheme which displaces natural gas with combustion gases that are the result of combustion of residual bitumen in gas cap

Location map



Project overview

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



Geological / geoscience

Subsurface section 2

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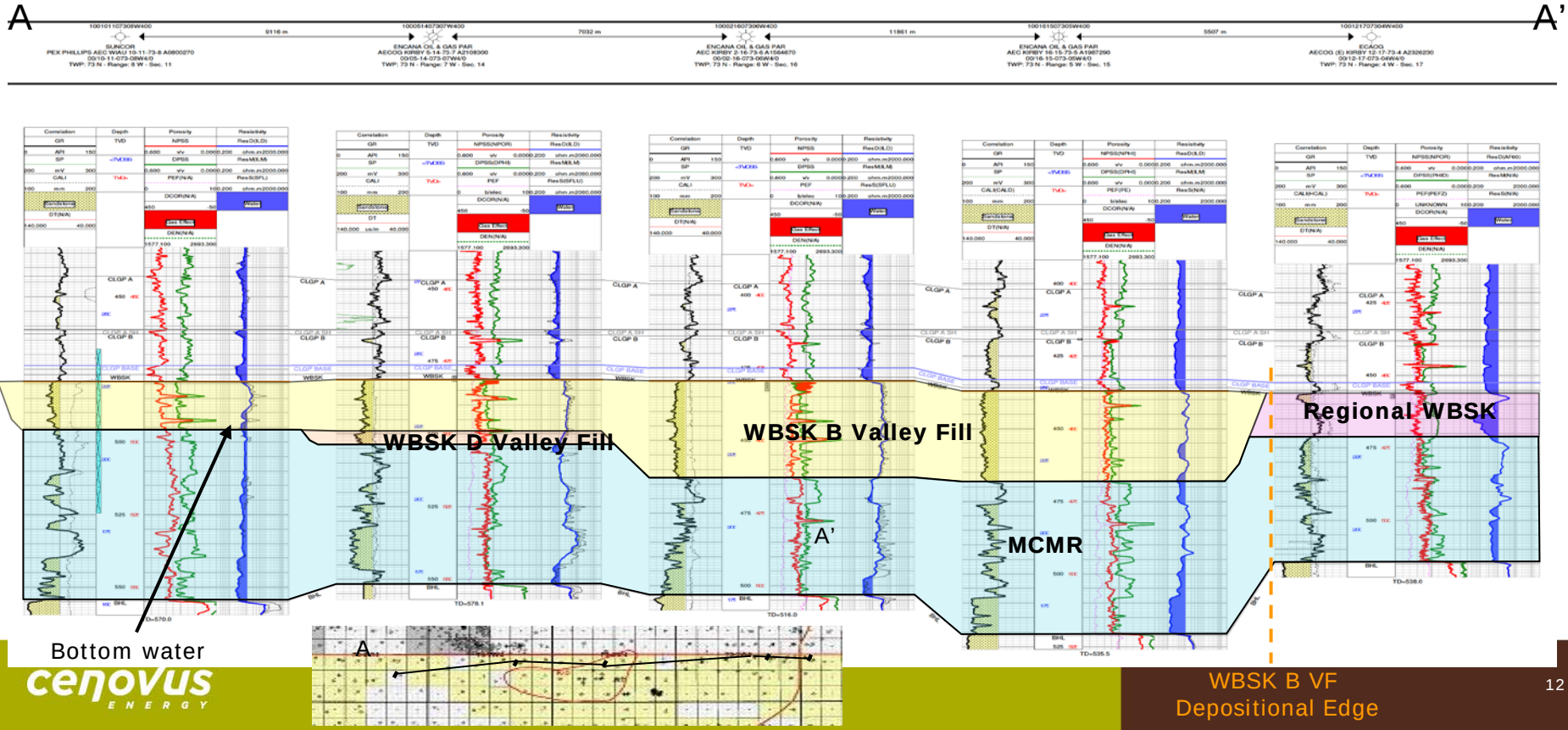
Summary of reservoir properties

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



Drilling and completion

Subsurface section 3

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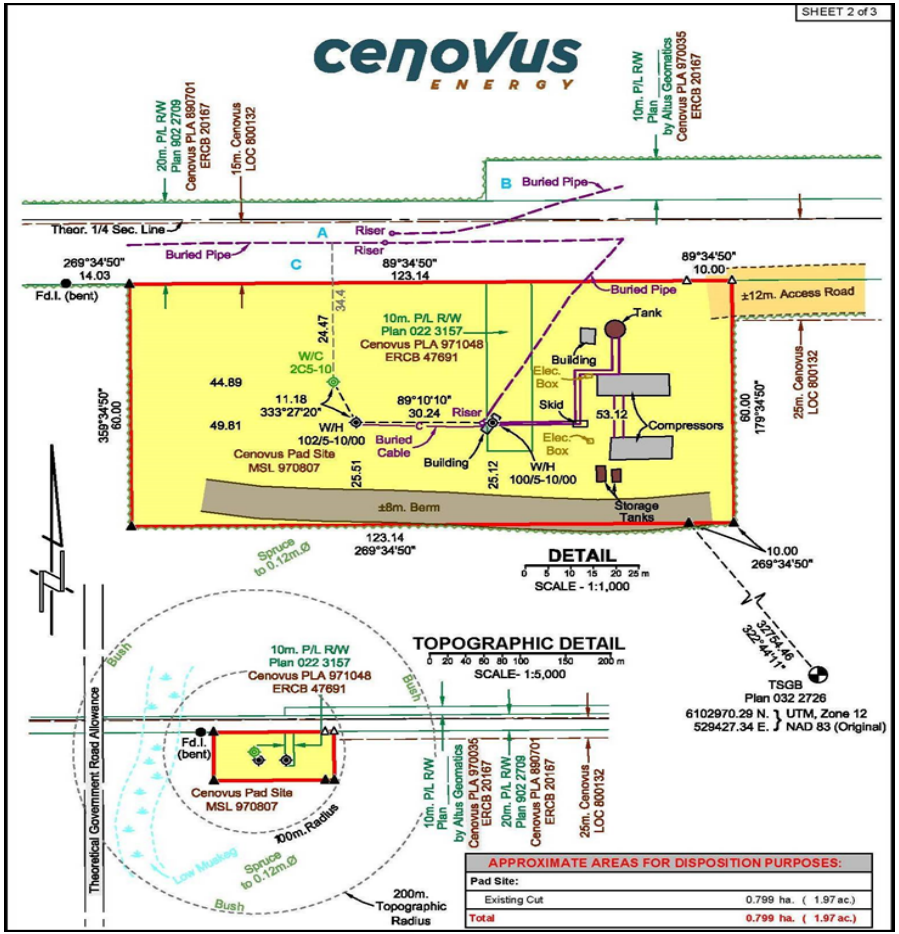
Well layout



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

Subsurface section 4

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Instrumentation in wells

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

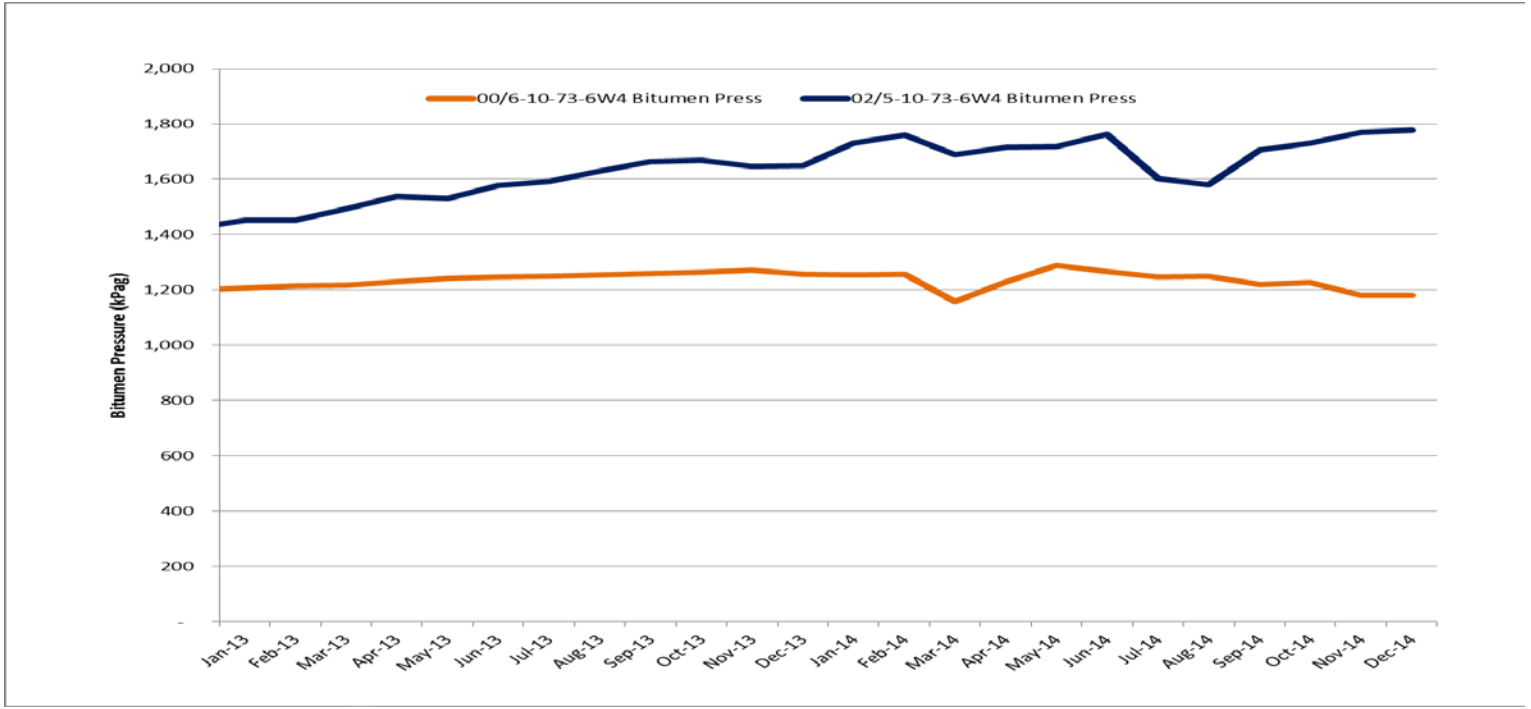
- Equipped with 3 piezometers
- Equipped with 10 thermocouples

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

- Equipped with 1 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



Scheme performance

Subsurface section 5

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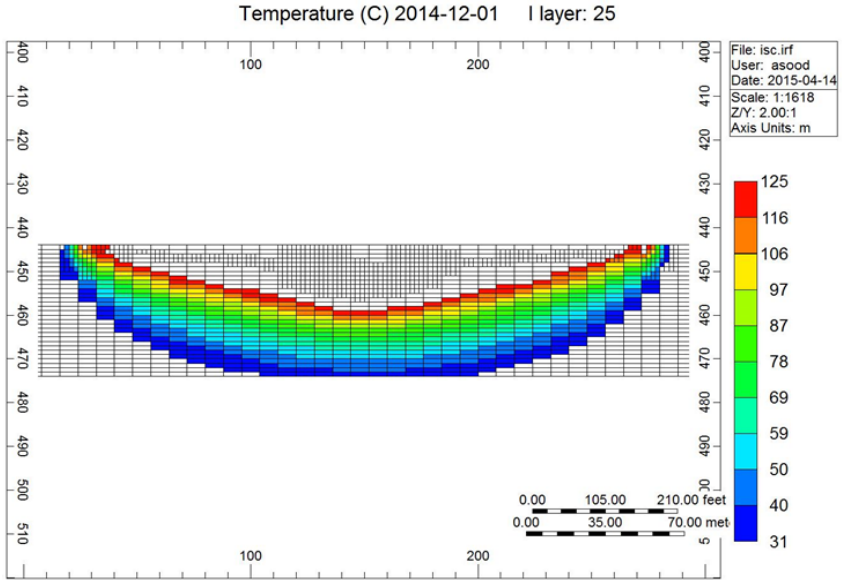
Radius of combustion front

- Exact radius unknown
  - No baseline seismic
  - Single observation well
- Simulated based on
  - 102/5-10 and 104/5-10
  - Actual daily air injection rates
- Combustion front
  - Simulation estimates 90-100m
  - Analytical model estimates radius 120-130m



Project performance history

Year	Activity
2006	June - Ignition and start-up
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
2008	May – Nitrogen response at 00/1-17-73-6W4/00
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, bailed out 57% clay/gelatious crude, 23% carbonates, 20% iron compounds
2010	Q1– 00/5-10-73-6W4/00 injector solvent squeeze treatment 12 liter/m 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 solvent squeeze treatment ~145 liter/m, successfully removed near plugging issue Mar/Apr – 00/11-15-73-6W4/00 flowed N_2 85%
2012	Jul – Startup of 00/6-7-76-6W4/00 Oct – Primrose sales volumes flowing to Caribou gas facility
2013	Feb - Startup of 00/6-6-73-6W4/00 Mar- Shut-in 00/7-8-73-6W4/00
2014	Dec – Startup 00/10-12-73-7W4/00

Production / injection summary

Production Operations

Operating For	Air Injected	Bulk Gas Recovered	Formation Gas Recovered
>7 years	~ 207 e^6m^3	~ 143 e^6m^3	~ 123 e^6m^3

Approved Producers

UWI	Status	UWI	Status
00/06-05-073-06W4/0	Flowing ~ 32% N_2	00/02-16-073-06W4/0	Shut-in ~ 84% N_2
00/06-06-073-06W4/2	Flowing <1% N_2	00/01-17-073-06W4/0	Shut-in ~ 85% N_2
00/06-07-073-06W4/2	Flowing <1% N_2	00/10-11-073-07W4/0	Shut-in <1% N_2
00/07-08-073-06W4/0	Shut-in ~ 92% N_2	00/10-12-073-07W4/0	Shut-in until Dec 19th, 2014
00/11-15-073-06W4/0	Shut-in ~ 82% N_2		

EnCAID estimated project life

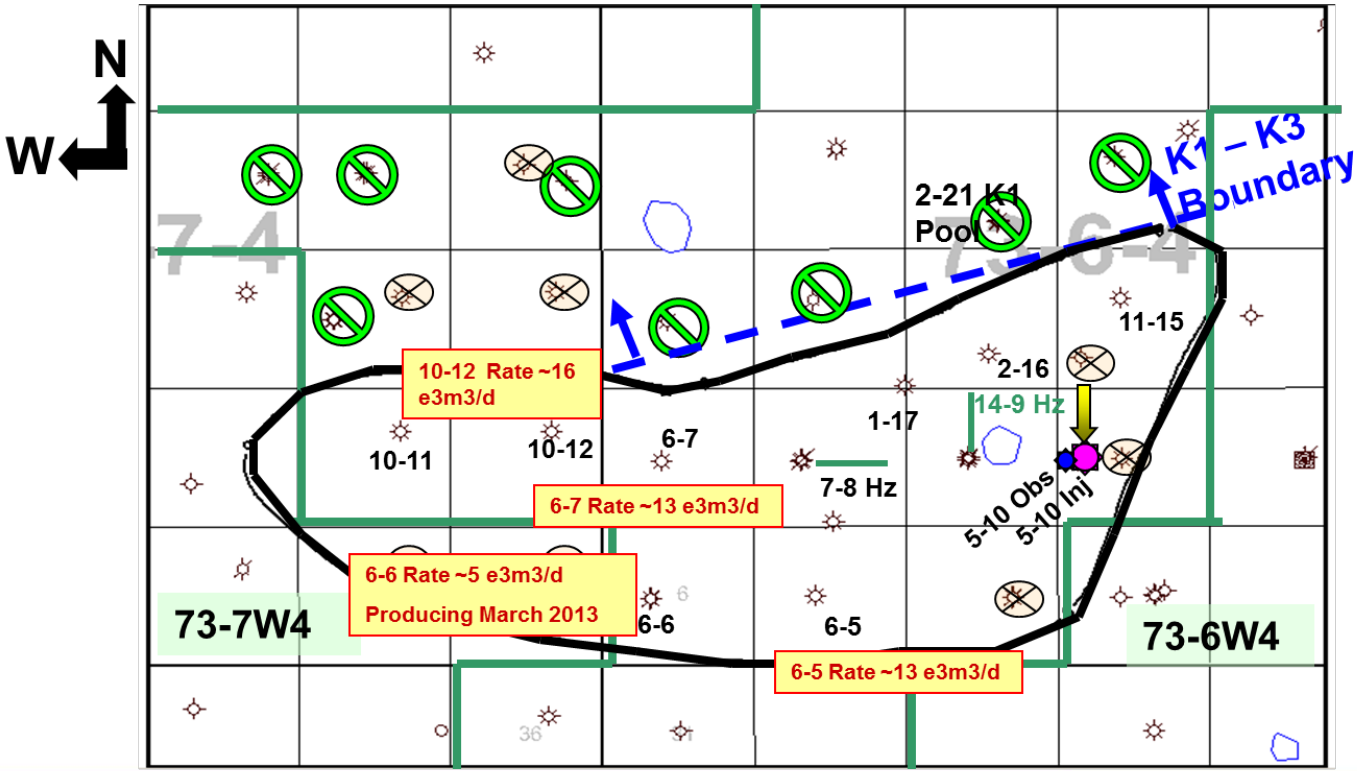
Estimated EnCAID life +/- years

- >2 years
- Or until uneconomical to blend

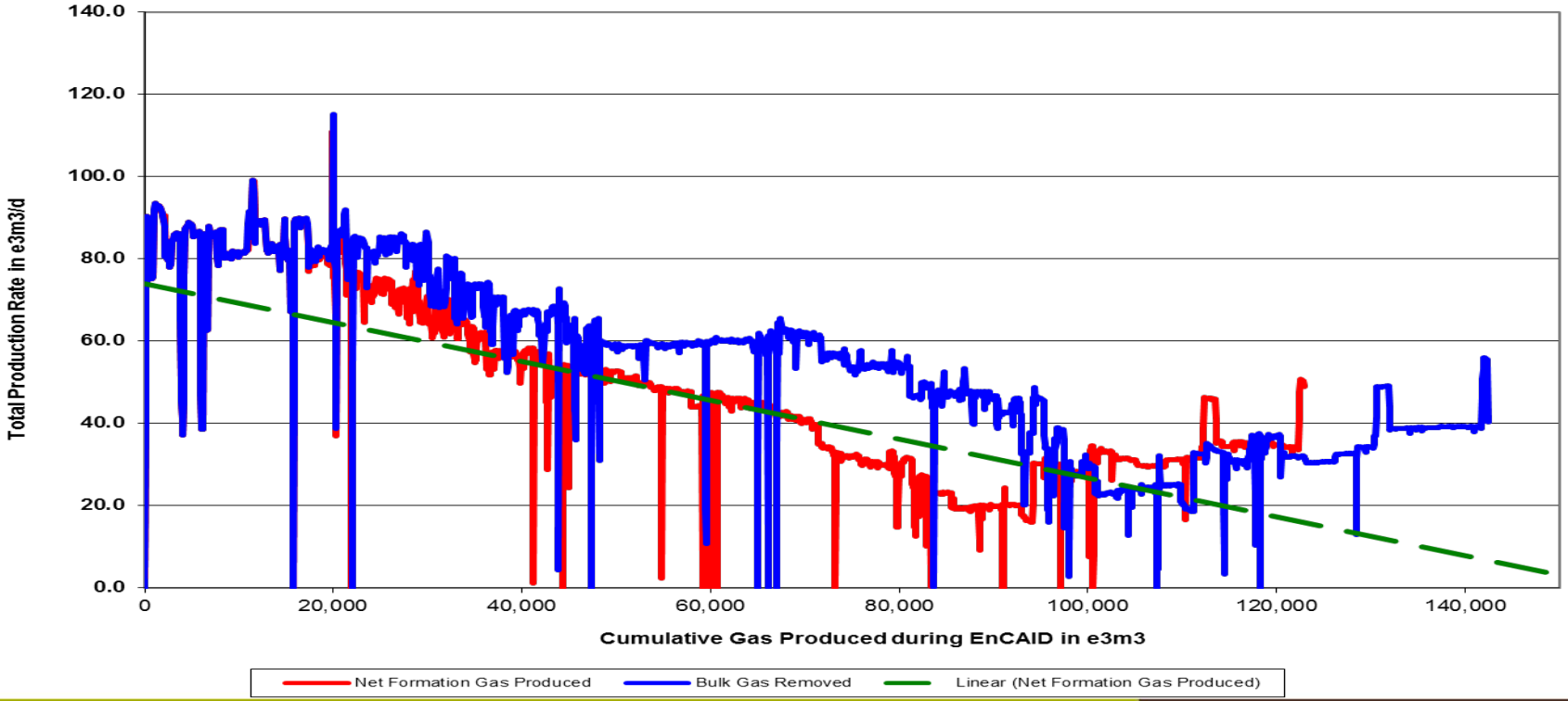
Dependent on N2 blending primarily

- Remaining 5 EnCAID producers will eventually have increasing nitrogen content
- Blend EnCAID produced volumes with production from North Primrose Plant
- At North Primrose Plant, natural gas declines ~15%/year
- TCPL specs has to be met with heat value of minimum 36MJ/m^3
  - Blend ratio of EnCAID gas: North Primrose gas ~ 1:4.5

K3 pool production



History production



Voidage replacement ratio (VRR) - 2014

January and mid-July

- Steady air injection rates
- Minor downtime due to weather related events

Mid-July to late-September

- Reduce air injection - experiment to understand the min air flux rate
- estimated air flux rate between 1.5 – 3.0 MMscf/D
- Air compressors have no turn down ability

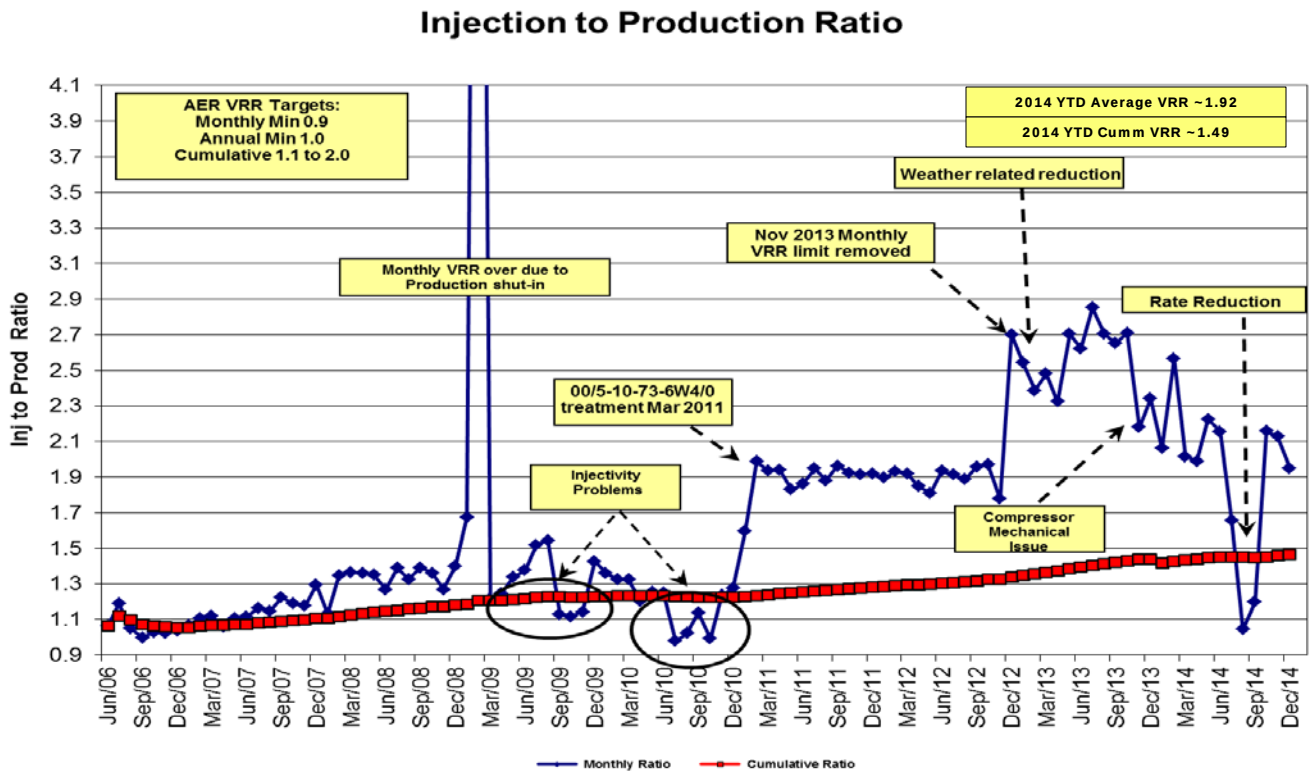
Late September to December

- Minor downtime due to weather
- Resume steady air injection rate

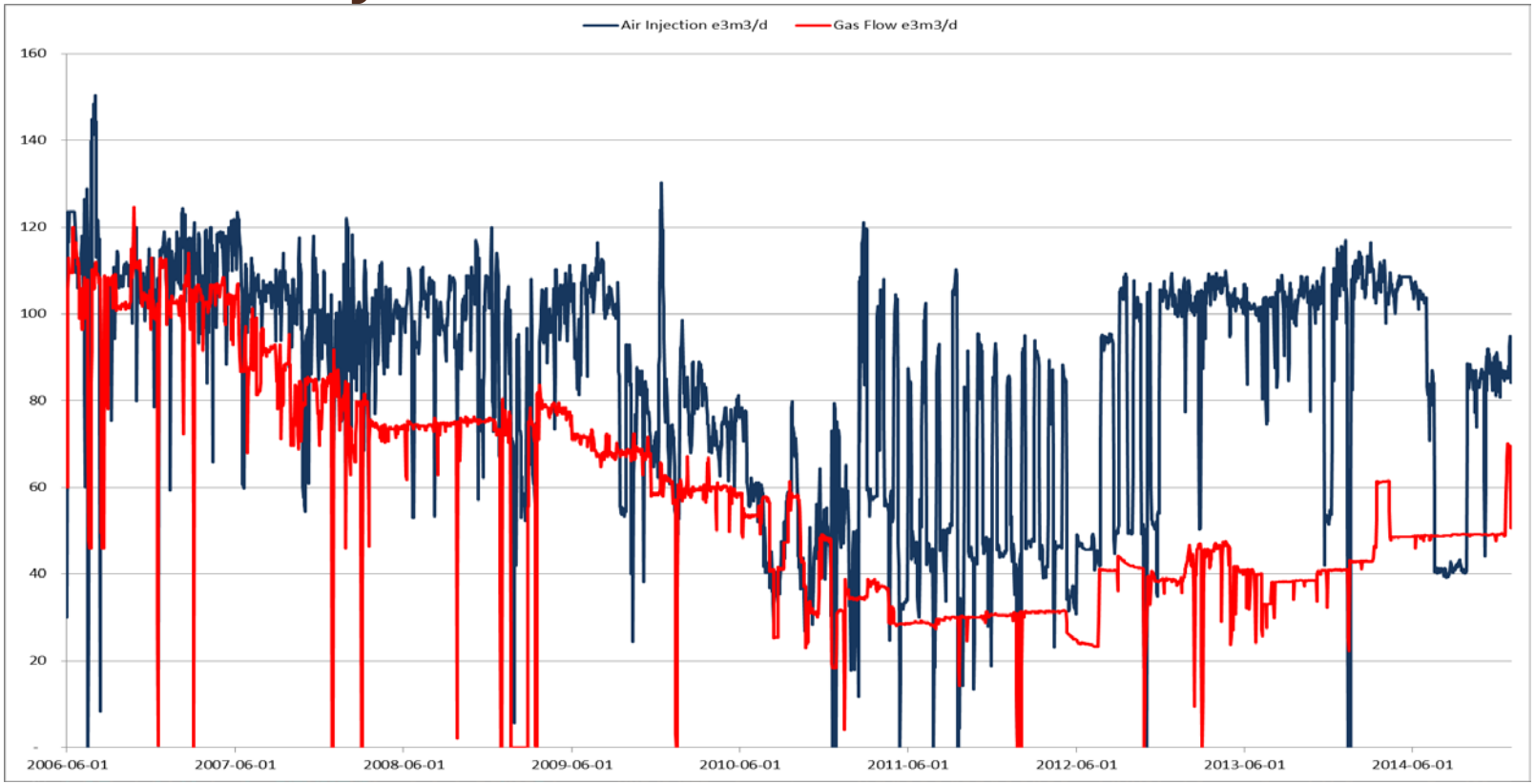
Voidage replacement ratio (VRR)

	Monthly VRR	Cumulative VRR	VRR Regulatory Approved Limits Min Monthly
January	1.92	1.45	0.90
February	1.92	1.45	0.90
March	1.92	1.46	0.90
April	1.92	1.47	0.90
May	1.92	1.47	0.90
June	1.92	1.48	0.90
July	1.92	1.48	0.90
August	1.92	1.48	0.90
September	1.92	1.48	0.90
October	1.92	1.48	0.90
November	1.92	1.48	0.90
December	1.92	1.49	0.90
2014 Average	1.92		

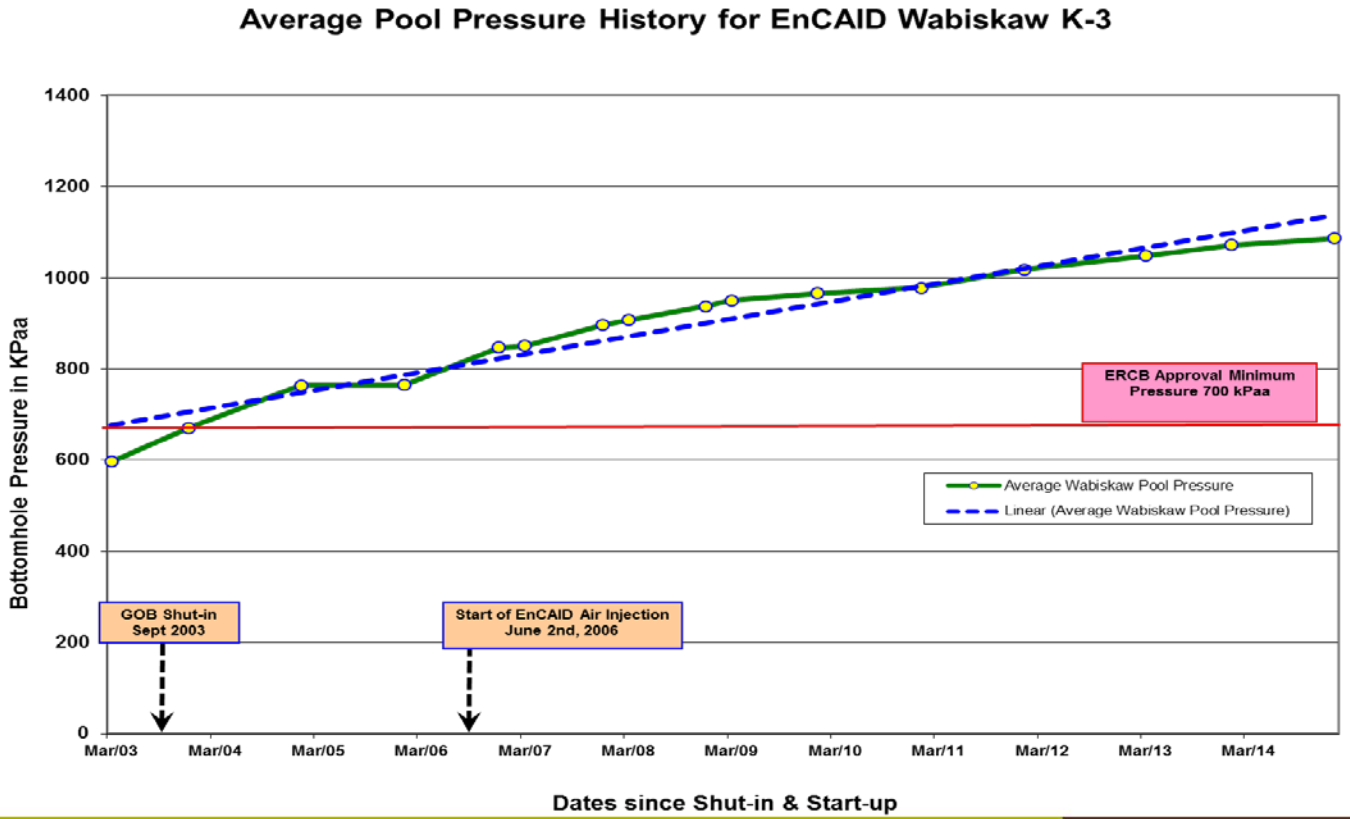
VRR performance



VRR history

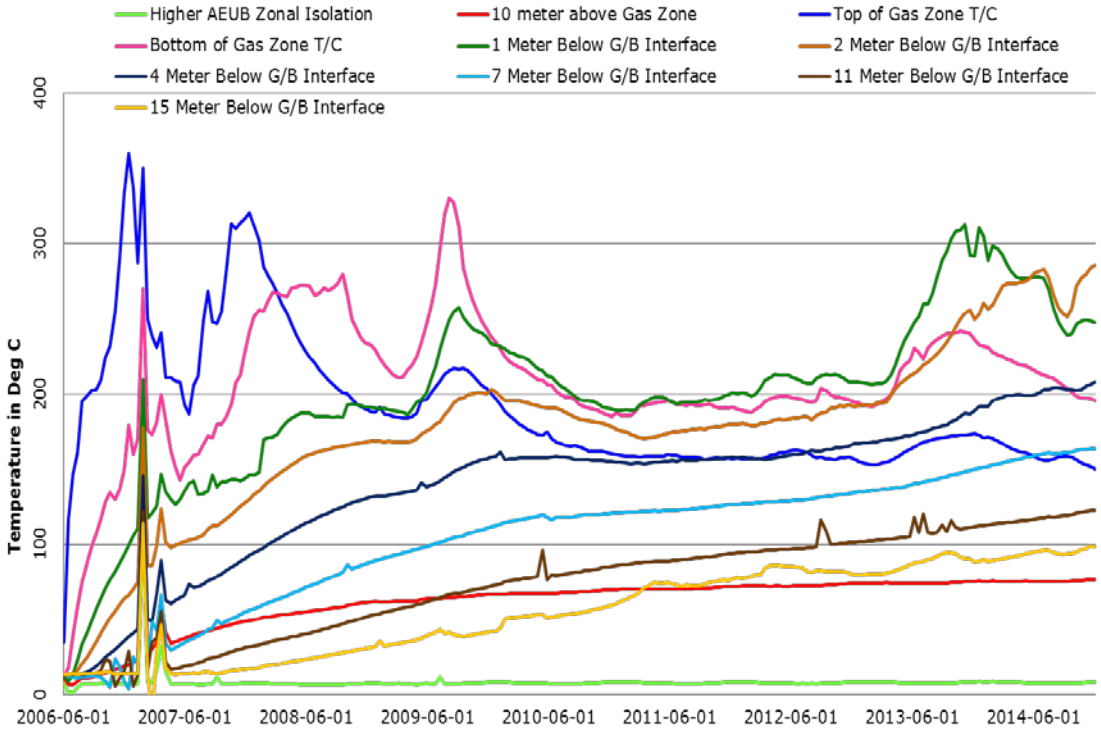


K3 pool pressure

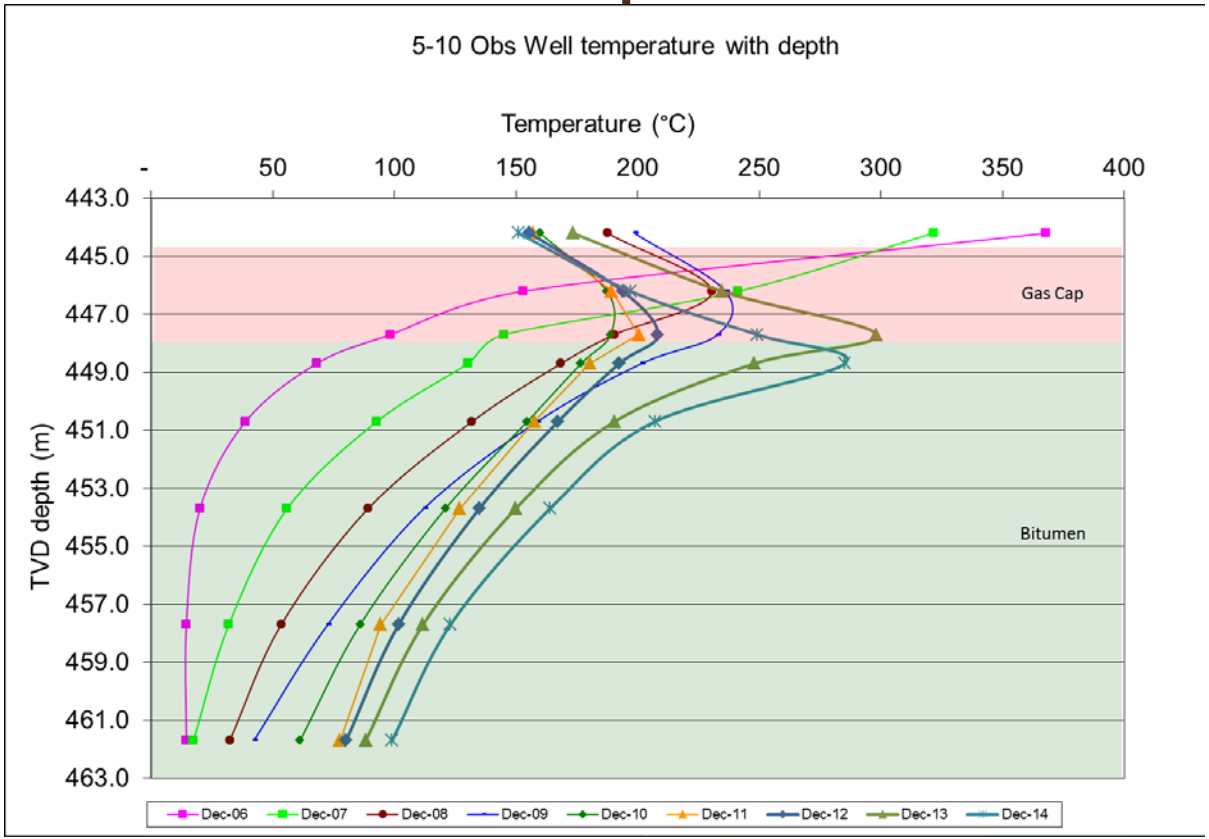


102/05-10-073-06W4 – Temp history

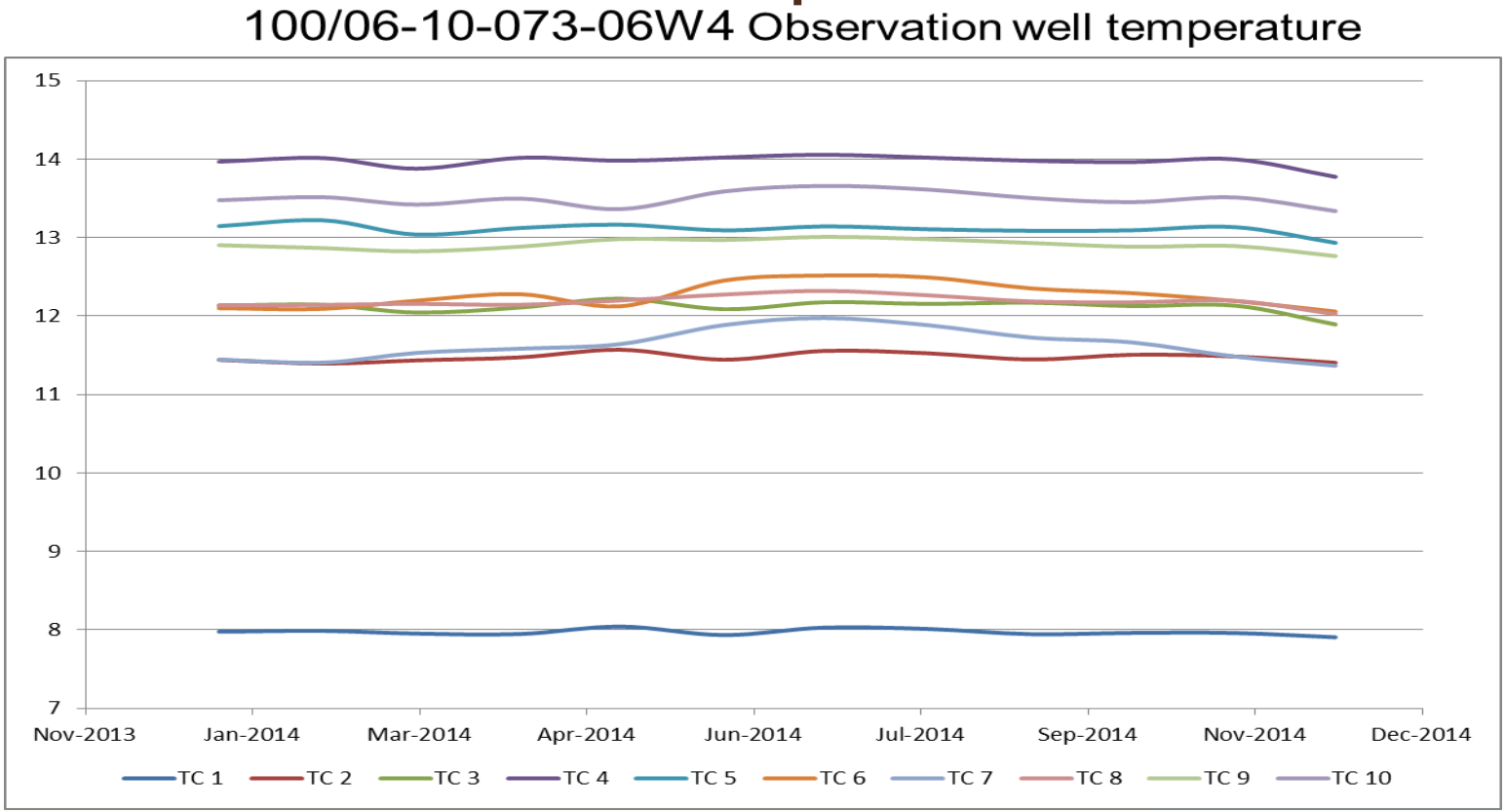
- Well was approved as
  - Cemented & abandoned concept
  - Cement inside tubing ~ 300mKB
  - Monitoring downhole temperature real time
- Downhole schematic
  - Appendix slide #72



Observation well temperature



Observation well temperature

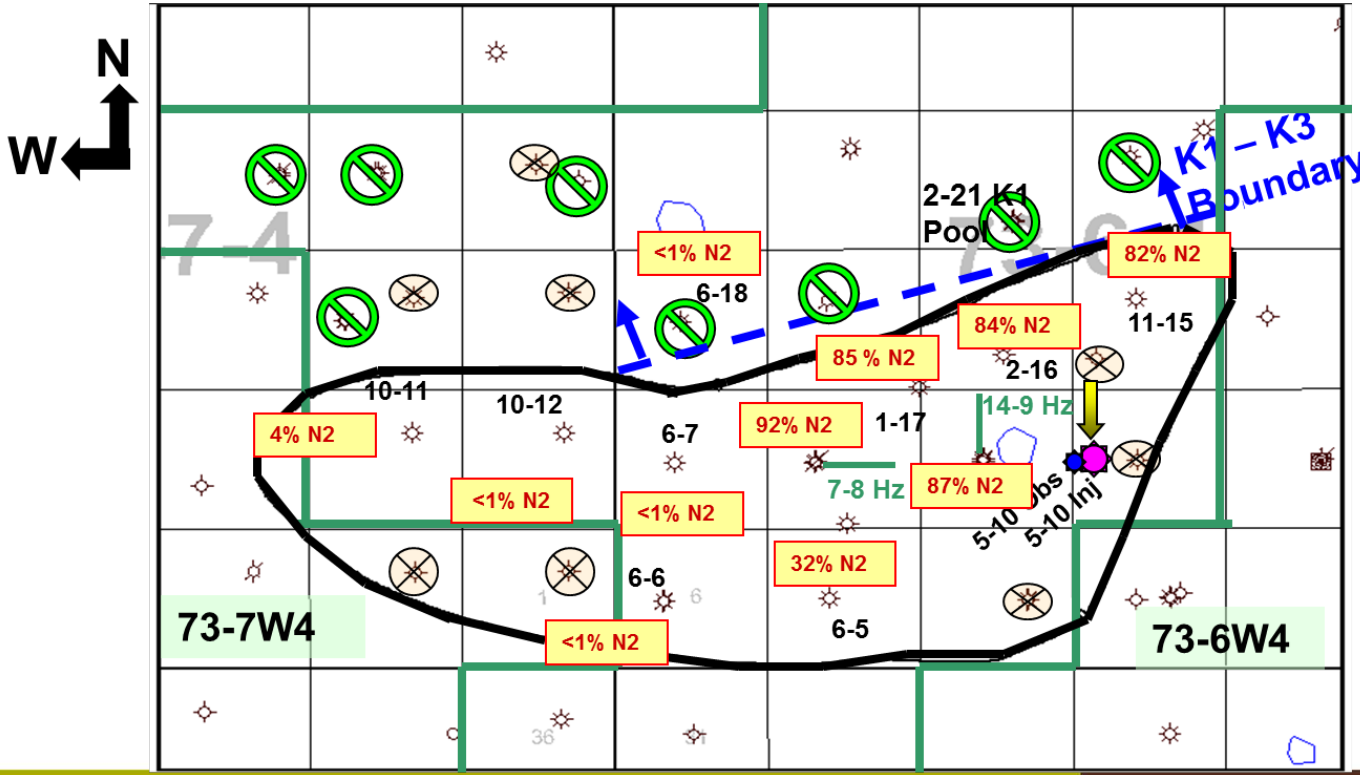


Composition of injected / produced fluids

- 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 then required under Approval 10440J
  - Once to six times / annum, varies with lease accessibility

Location	Min Approval Sampling Frequency
00/6-10-73-6W4/2	Semi- annual
00/6-5-73-6W4/0	Semi- annual
00/6-6-73-6W4/2	Semi- annual
00/6-7-73-6W4/2	Semi- annual
00/7-8-73-6W4/0	Semi- annual
00/11-15-73-6W4/0	Semi- annual
00/2-16-73-6W4/0	Semi- annual
00/1-17-73-6W4/0	Semi- annual
00/10-11-73-7W4/0	Semi- annual
00/10-12-73-7W4/0	Semi- annual
00/6-18-73-6w4/0	Annual
00/10-36-72-7W4/2	Annual
00/11-17-73-6W4/0	Annual
00/14-9-73-6W4/0	Annual

Nitrogen response



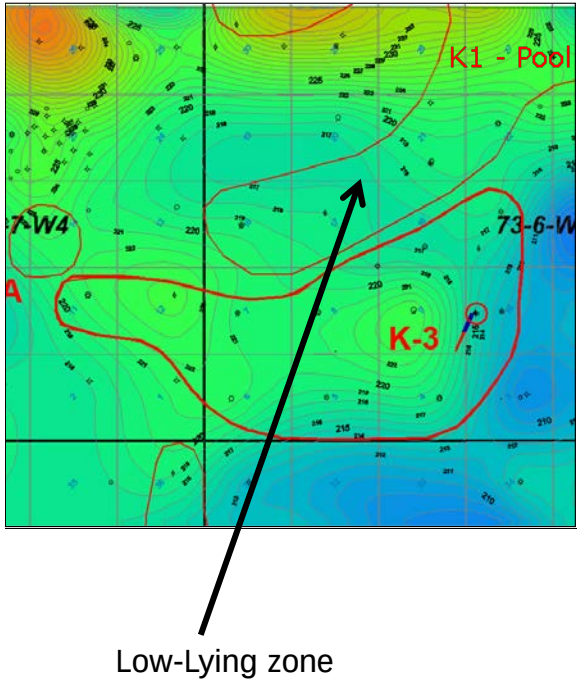
Nitrogen response outside K3 pool

Nitrogen took more than 8 years to show sign of migration to K1 pool

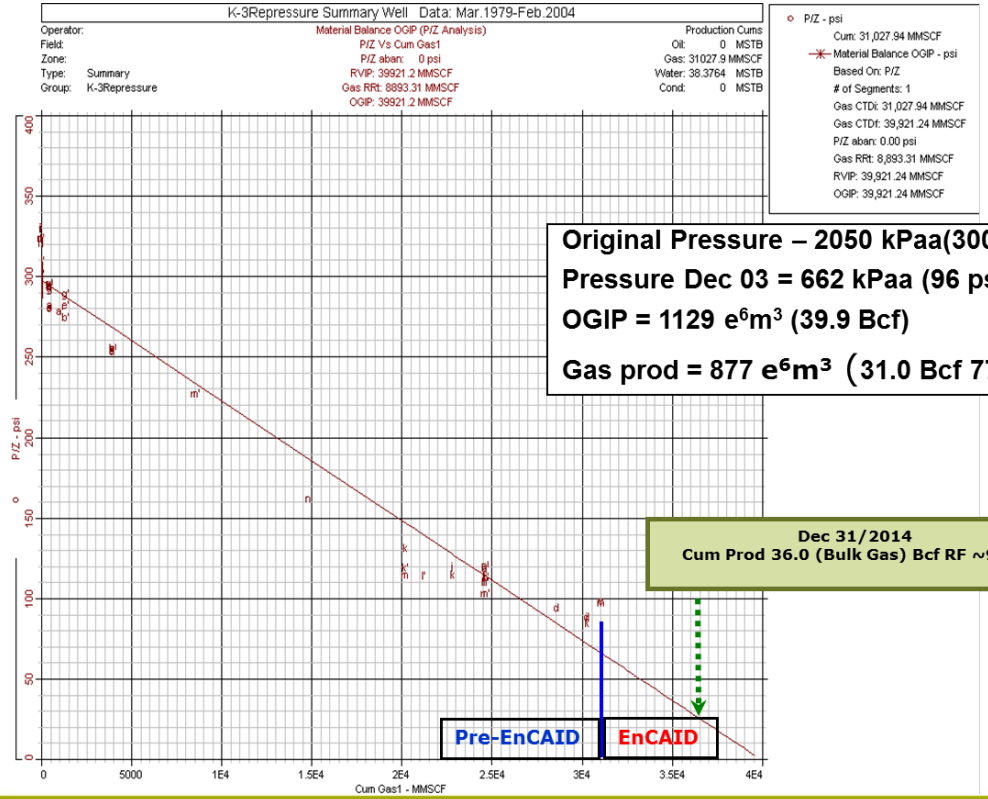
- Prior to December 2014 N_2<1% on 6-18-73-6W4M
- Post December 2014 N_2~7% on 6-18-73-6W4M

Low lying structural zone along the north side of Section 18 & 17 creates a barrier to the rest of K1 pool.

Typically significantly thinner ~1m thick gas cap in section 18 & 17



K-3 Pool Material Balance



Original Pressure – 2050 kPaa(300 psia)

Pressure Dec 03 = 662 kPaa (96 psia)

OGIP = 1129 e^6m^3 (39.9 Bcf)

Gas prod = 877 e^6m^3 (31.0 Bcf 77% RF)

Dec 31/2014
Cum Prod 36.0 (Bulk Gas) Bcf RF ~90%

Subsurface key learnings

- Maintaining continuous air injection is key to maintaining steady combustion front
- Nitrogen effects on produced gas must be monitored on an ongoing basis and forecasted for future impacts on plant operations and gas sales quality
- Recognize value of thermocouple data for predication and history matching simulations
- Generation of thermal conductive heating into the bitumen
- Provides a process for recovering gas that would otherwise not be recoverable due to GOB shut-in

Future plans

Subsurface section 6

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Future plans

- No changes in overall recovery strategy are planned at this time
- Amendment for horizontal air injection well

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

Surface section 1

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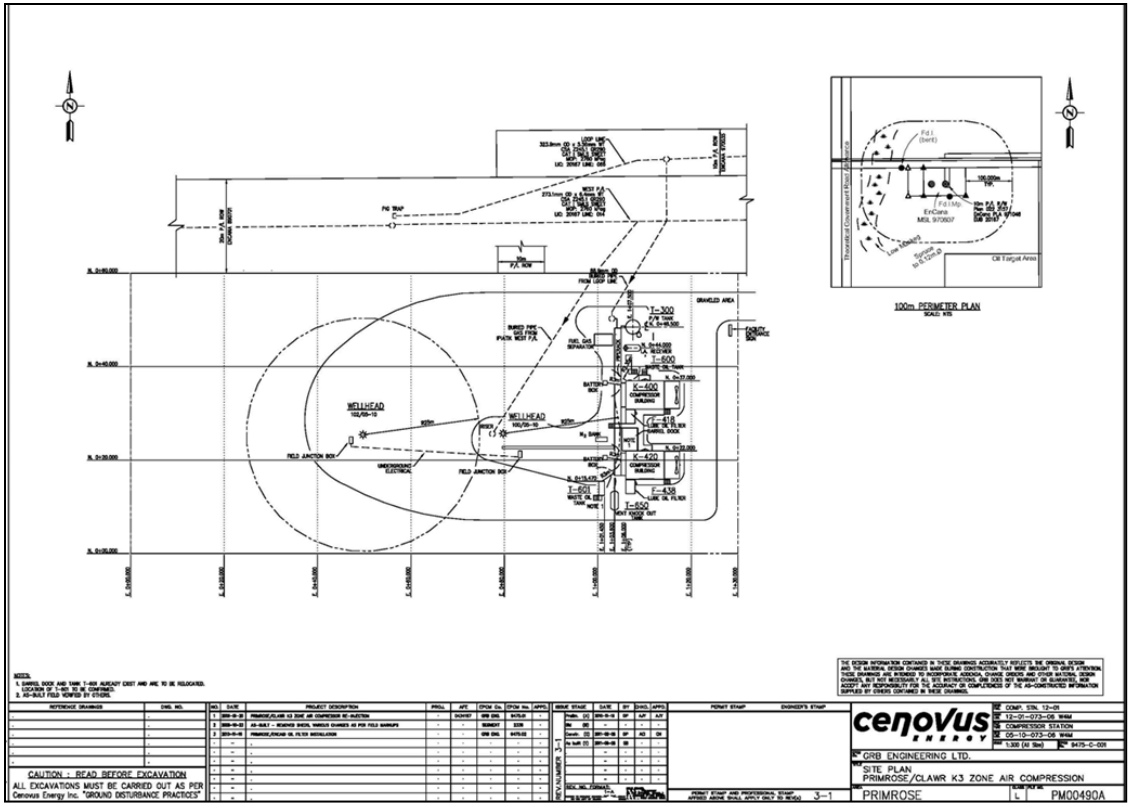
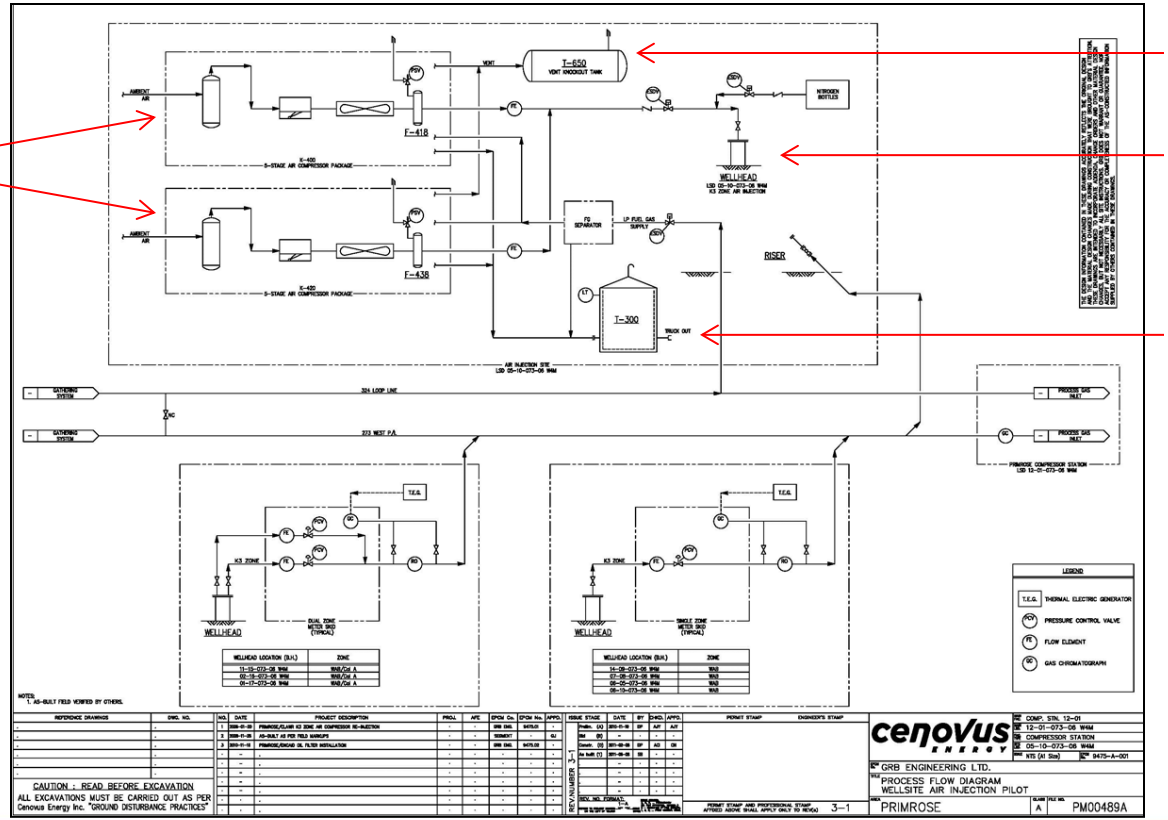
Site Layout



Process flow schematic



Plant performance - 2014

January to July

- Steady air injections
- Some weather related reductions

July 16 to September 24, 2014

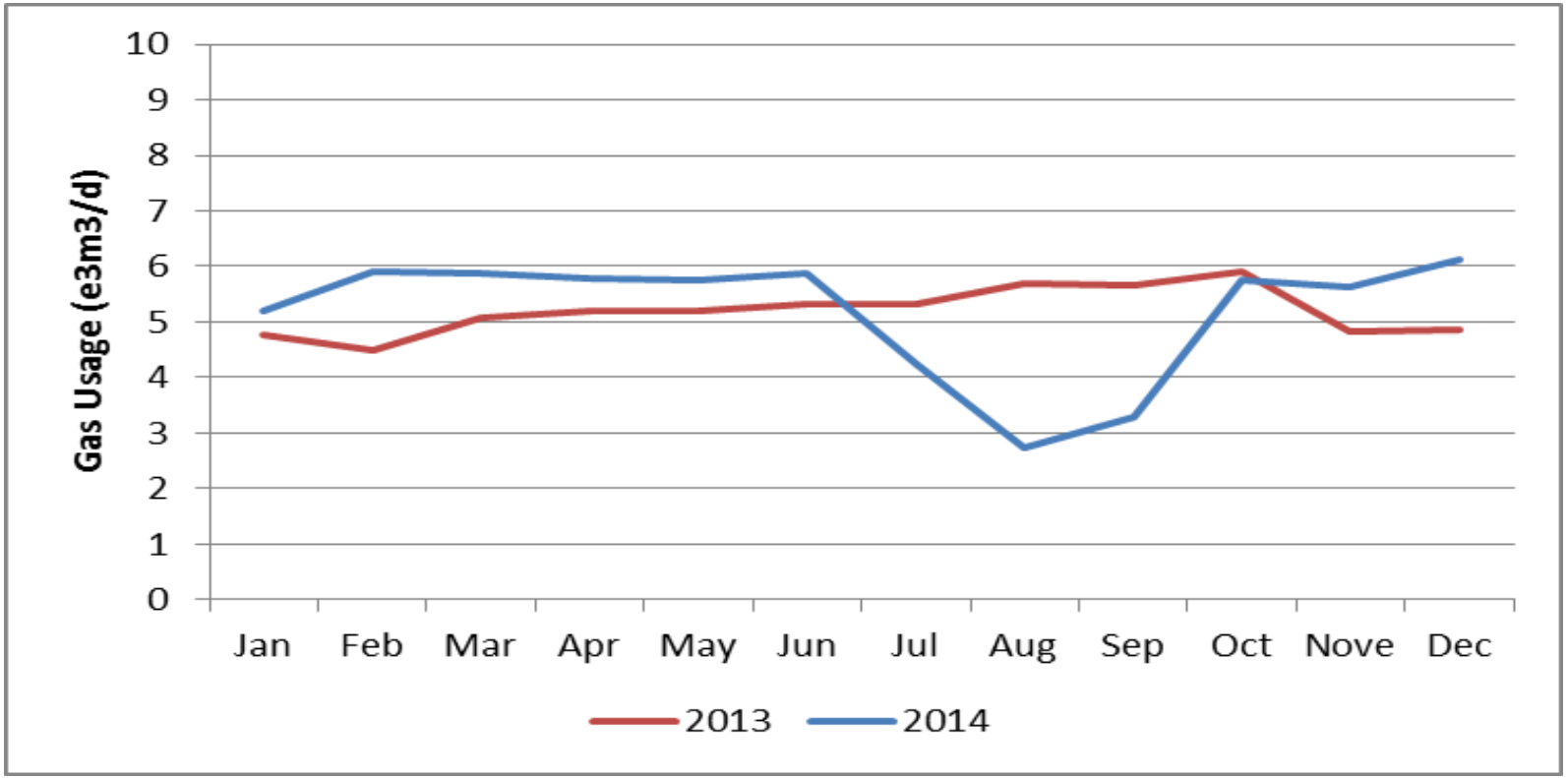
- Reduced air injection rate

August to year end

- Resumption of steady air injections

Facility is operating as expected

Gas usage



Gas usage

	2014 (e^3m^3/D)	2013 e^3m^3/D)
January	5.21	4.78
February	5.90	4.50
March	5.86	5.07
April	5.78	5.19
May	5.76	5.19
June	5.87	5.32
July	4.25	5.33
August	2.73	5.7
September	3.28	5.67
October	5.74	5.9
November	5.64	4.82
December	6.13	4.85

Green house gas emissions

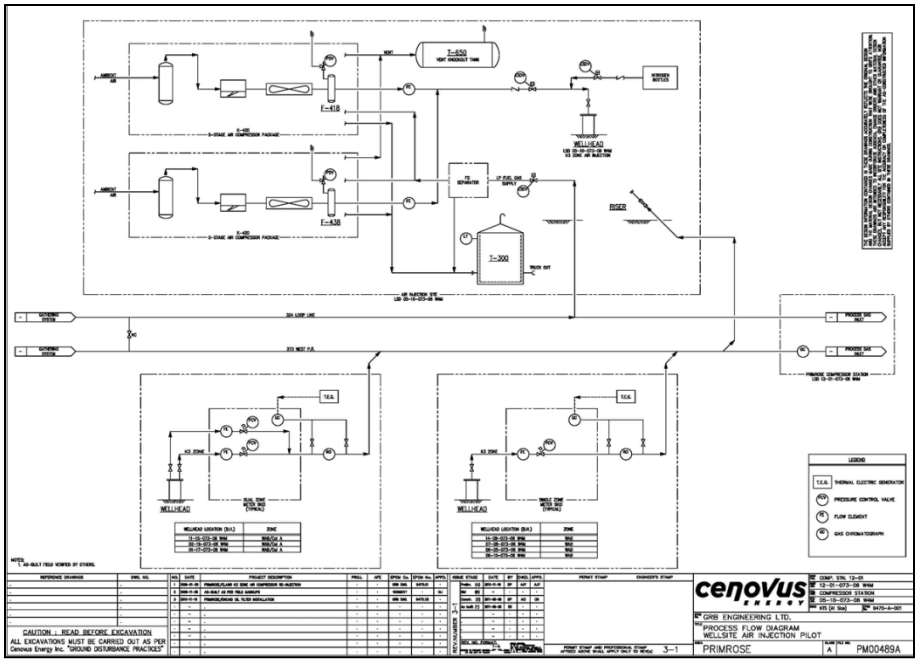
	2014 Tonnes	2013 Tonnes
January	477	323
February	472	275
March	519	342
April	498	340
May	521	351
June	504	349
July	405	361
August	300	386
September	326	371
October	511	399
November	484	315
December	538	342

Surface gas migration

Year	Observations
2005	No development yet at EnCAID site, set base line
2006	LEL disappeared when went to "Methane elimination mode" which is standard practice for these tests
2007	LEL detection in "Full Gas Detection Mode" disappeared in "Methane Elimination Mode" suggesting "Swamp gas" Report noted clay cap over most of the sites could be trapping methane from organic peat decomposition
2008	Collected low pressure gas samples for analysis at 5-10 & 11-15. Most tests confirmed "biogenic gas
2009	SDS concluded that in their opinion it is a biogenic gas/swamp gas problem. Single Sample showed above 100% LEL came from wet, sloppy & drilling mud type of soil west of well center
2010	SDS opinion it is a biogenic gas/swamp gas problem. 2010 LEL readings less then 2009 LEL readings. No samples taken
2011	SDS opinion is that gas detected through field screening is swamp gas from the organic material beneath the well site. The gas sample collected contained insufficient hydrocarbons for carbon isotope analysis.
2012	No test undertaken
2013	SDS considered two samples to be inconclusive as soil around the well center were highly saturated & swampy. No sample was submitted for isotope analysis
2014	SDS considered it was a biogenic gas/swamp gas problem.

Surface facility key learnings

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



Measurement and reporting

Surface section 2

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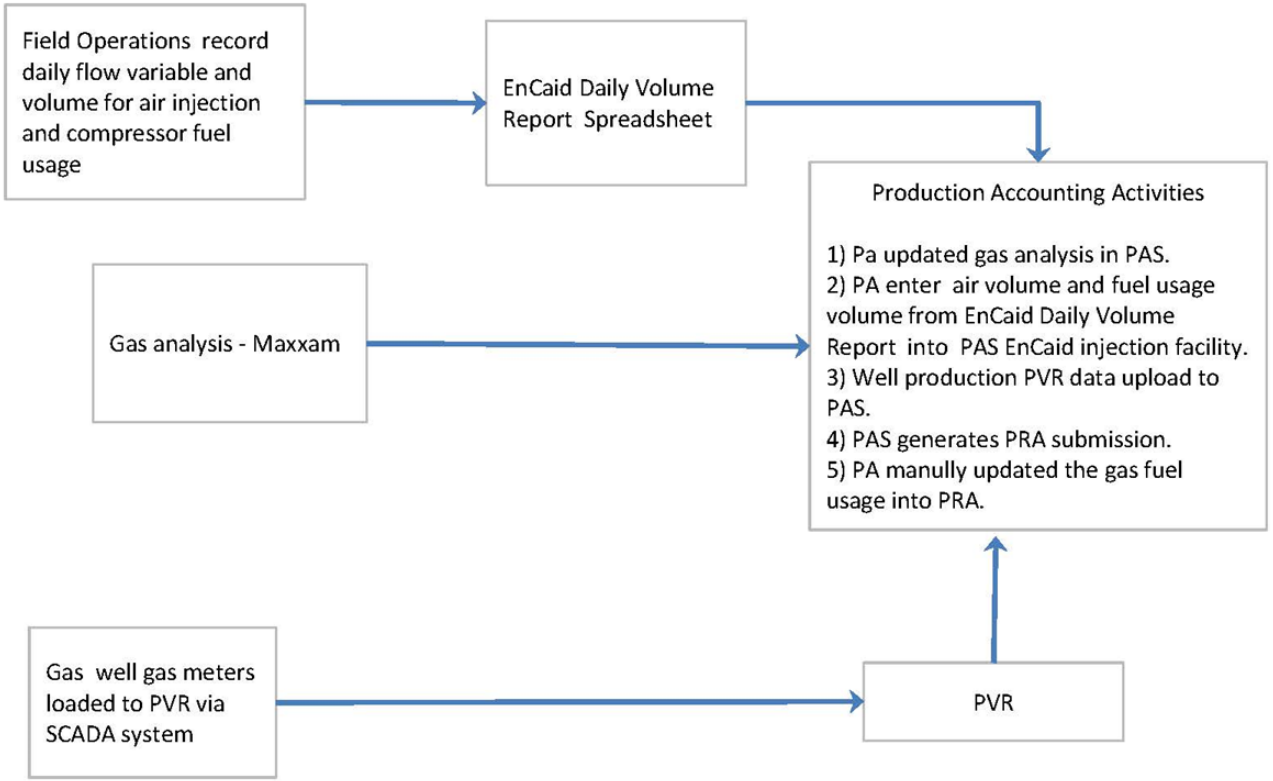
Measurement reporting



Environmental issues

Surface section 3

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Environmental compliance

- No environmental noncompliance events occurred since the last performance review

Compliance statement

Surface section 4

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Compliance confirmation

- No noncompliance events occurred since the last performance review

Future plans

Surface section 5

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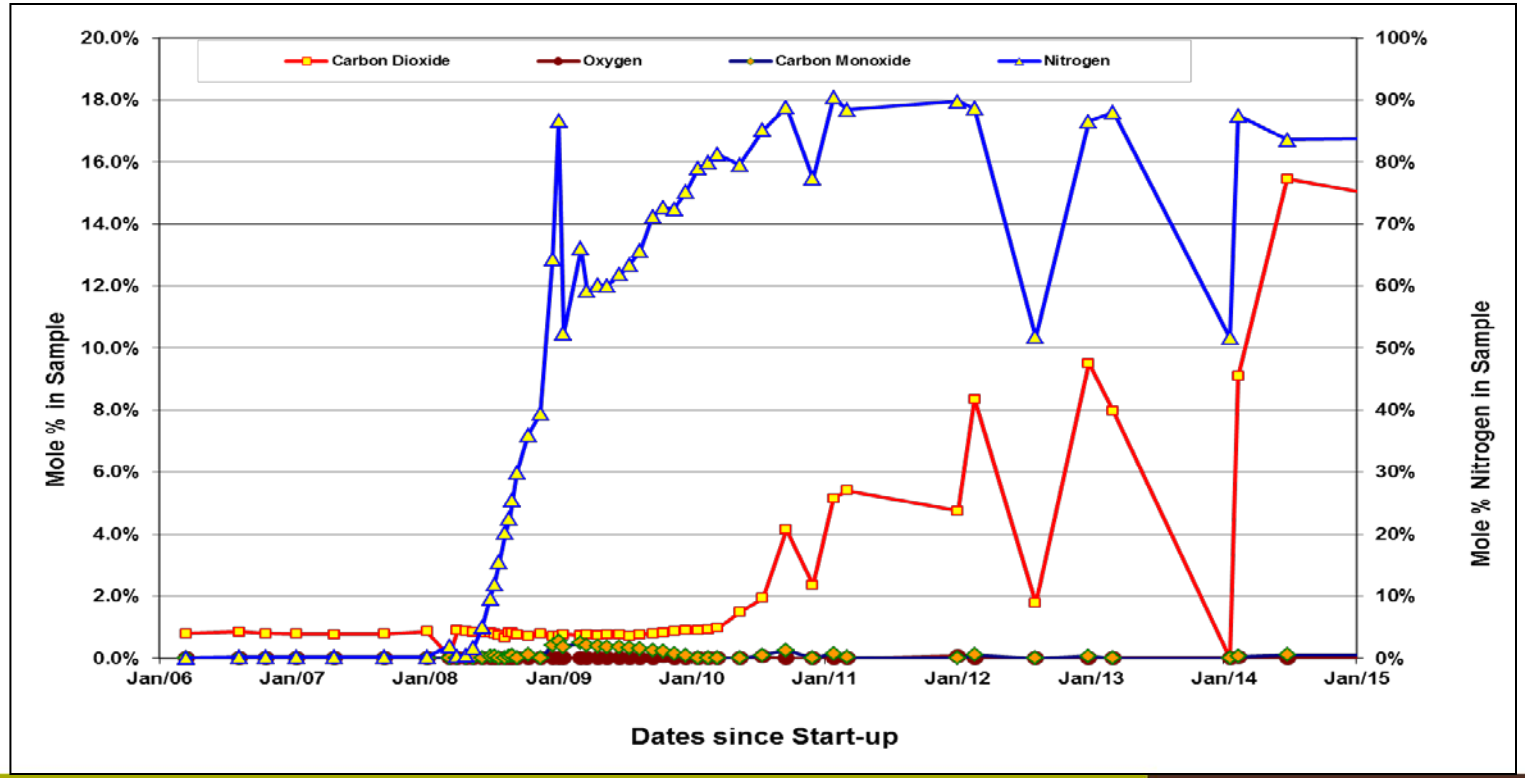
Future plans

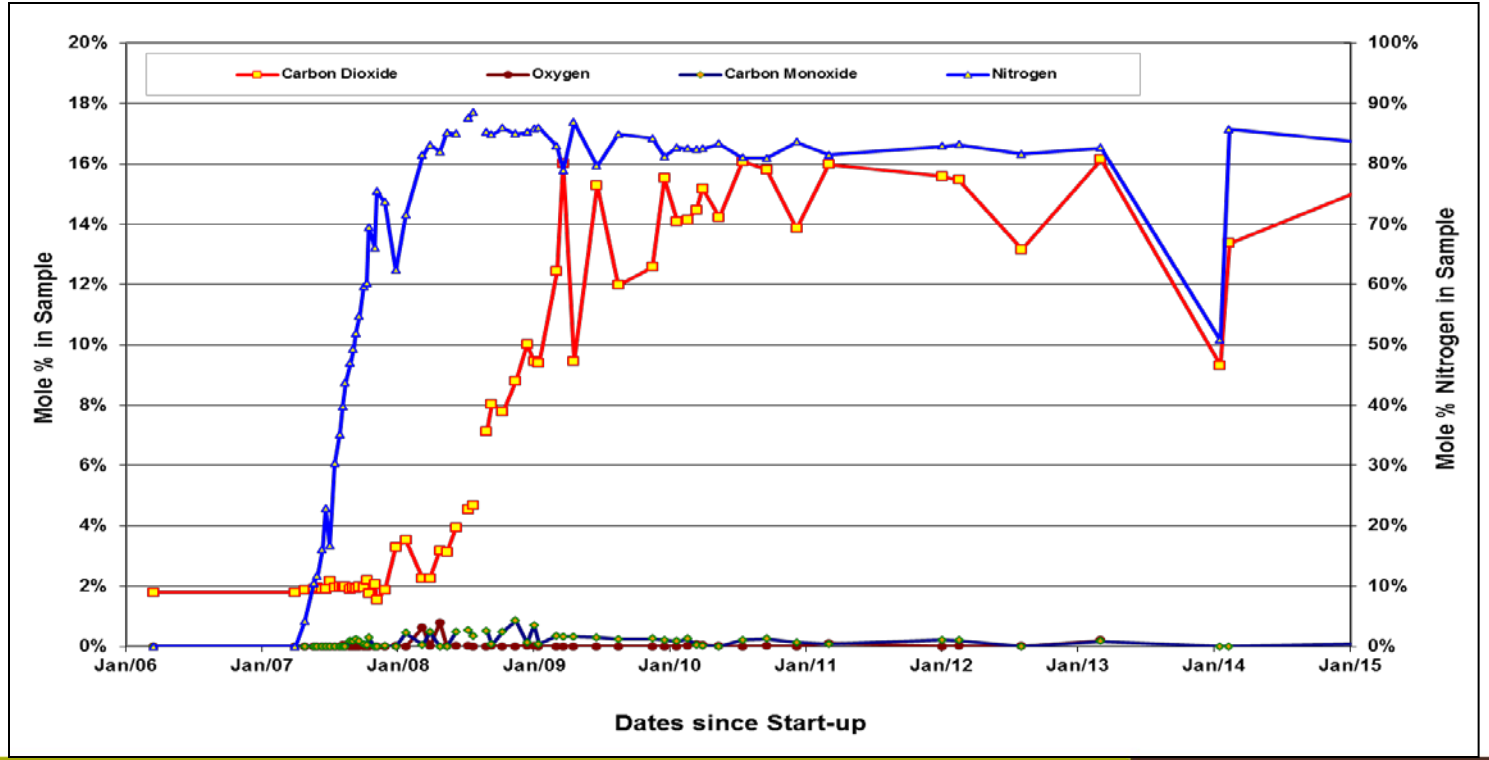
- No major initiatives or plans that may require submission of an application are being contemplated at this time
- No changes to overall plant design or amendments are anticipated at this time
- Tie in high pressure piping from new horizontal air injector to existing facility

Appendix

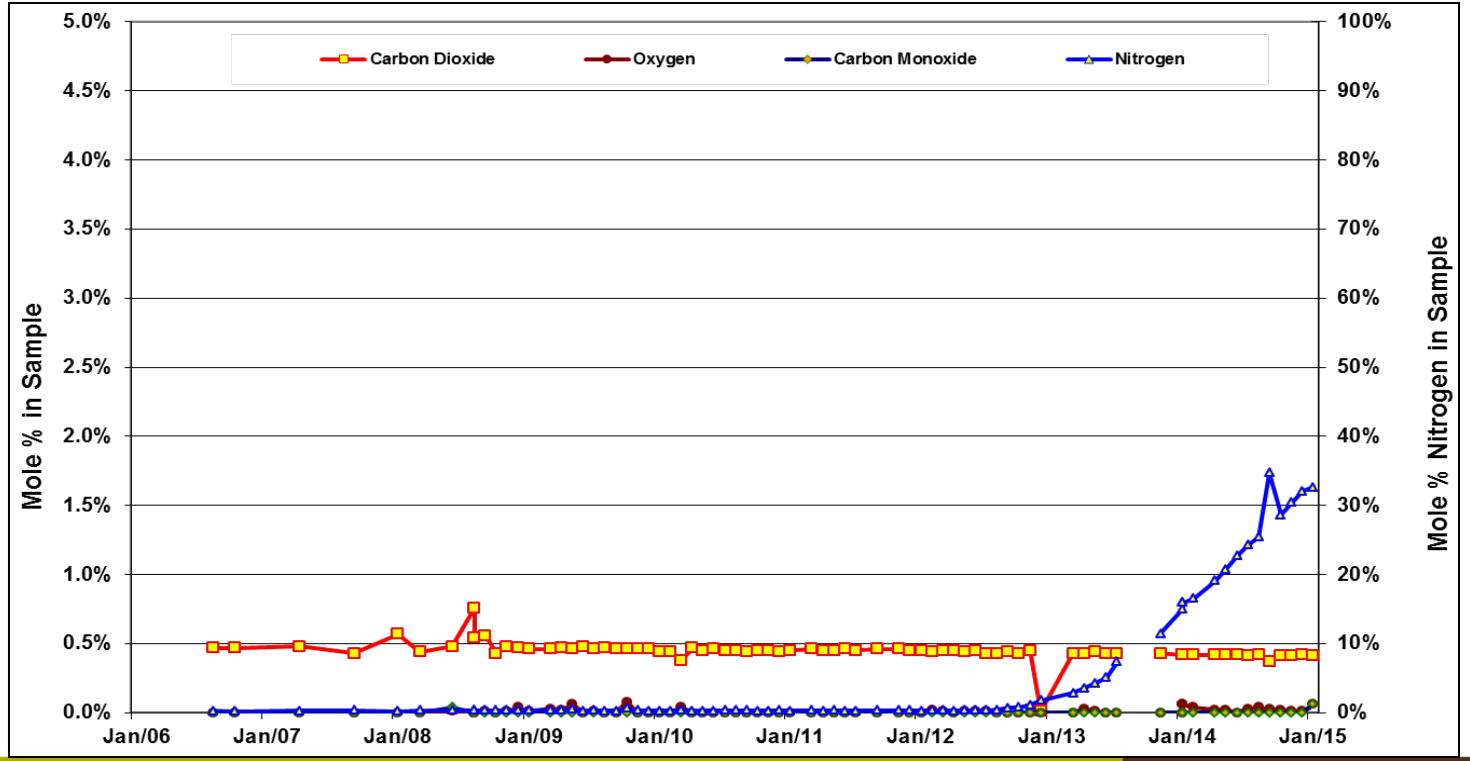
Gas composition 00/1-17-73-6W4/0



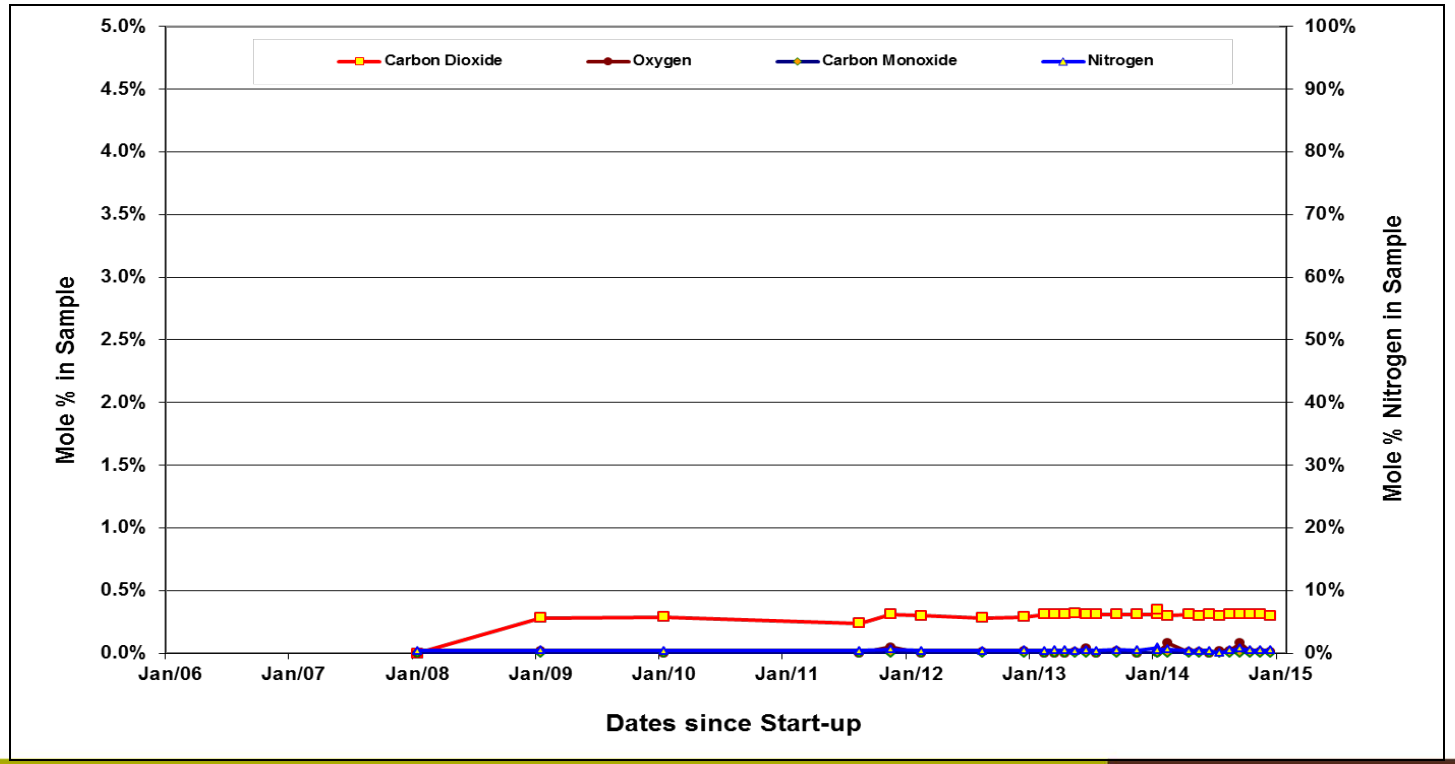
Gas composition 00/2-16-73-6W4/0



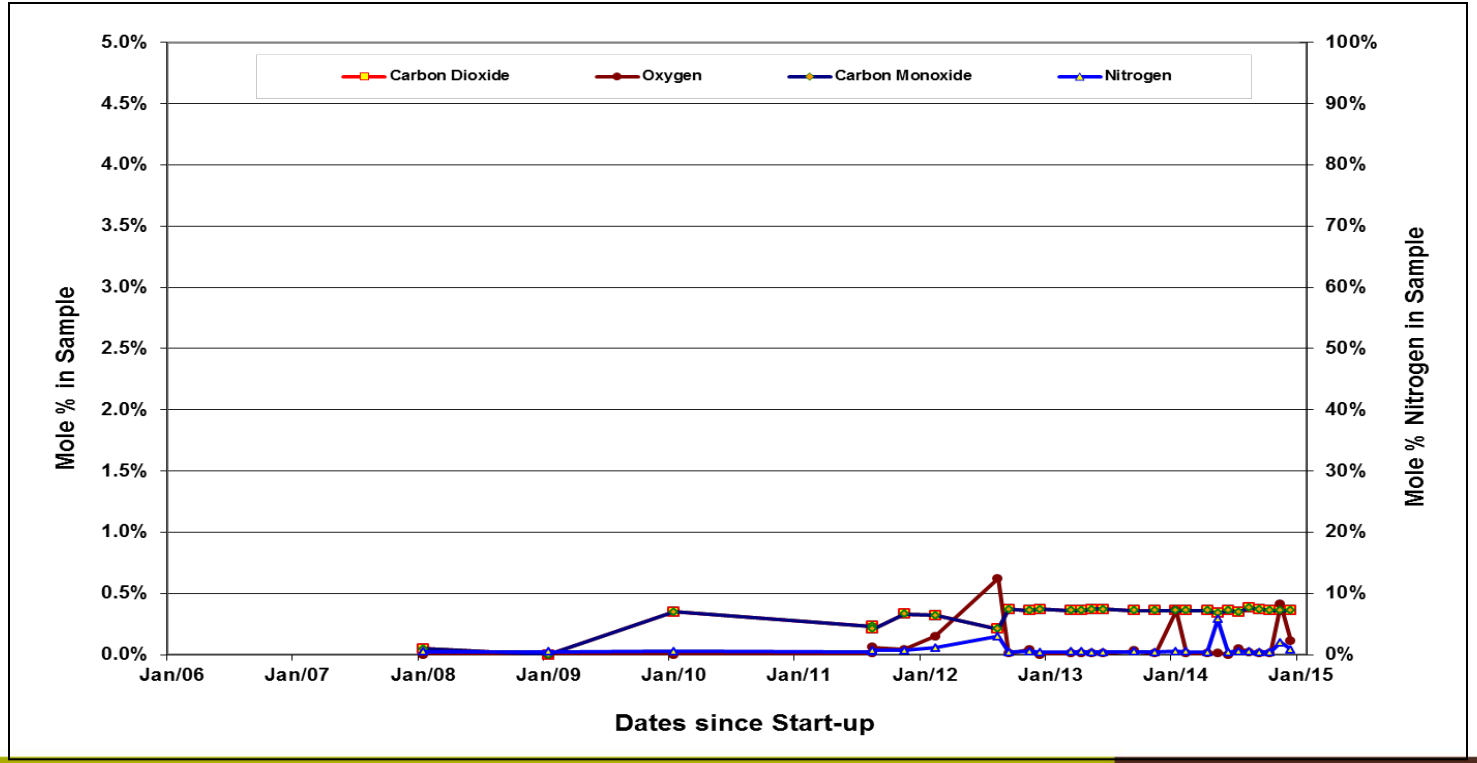
Gas composition 00/6-5-73-6W4/0



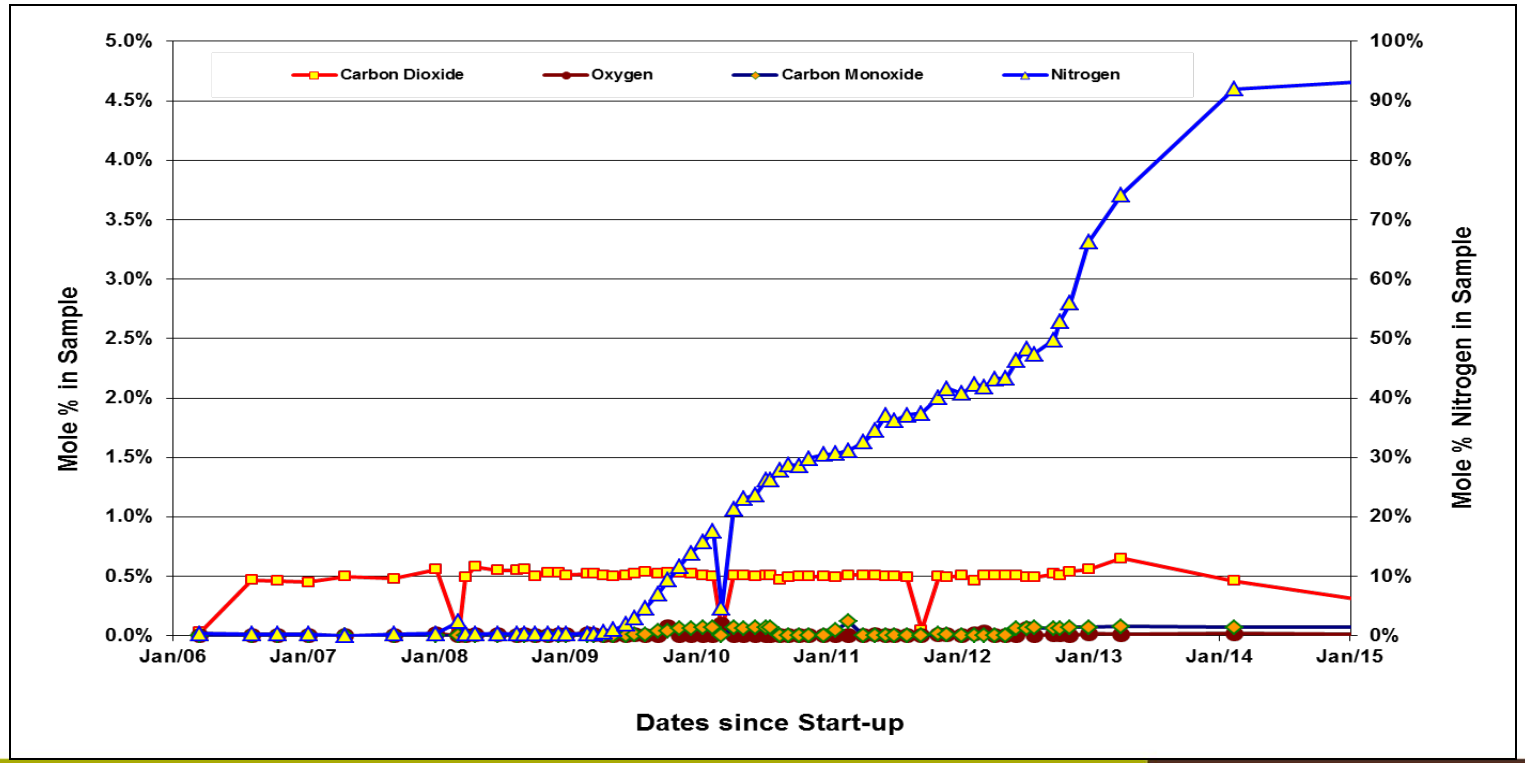
Gas composition 00/6-6-73-6W4/0



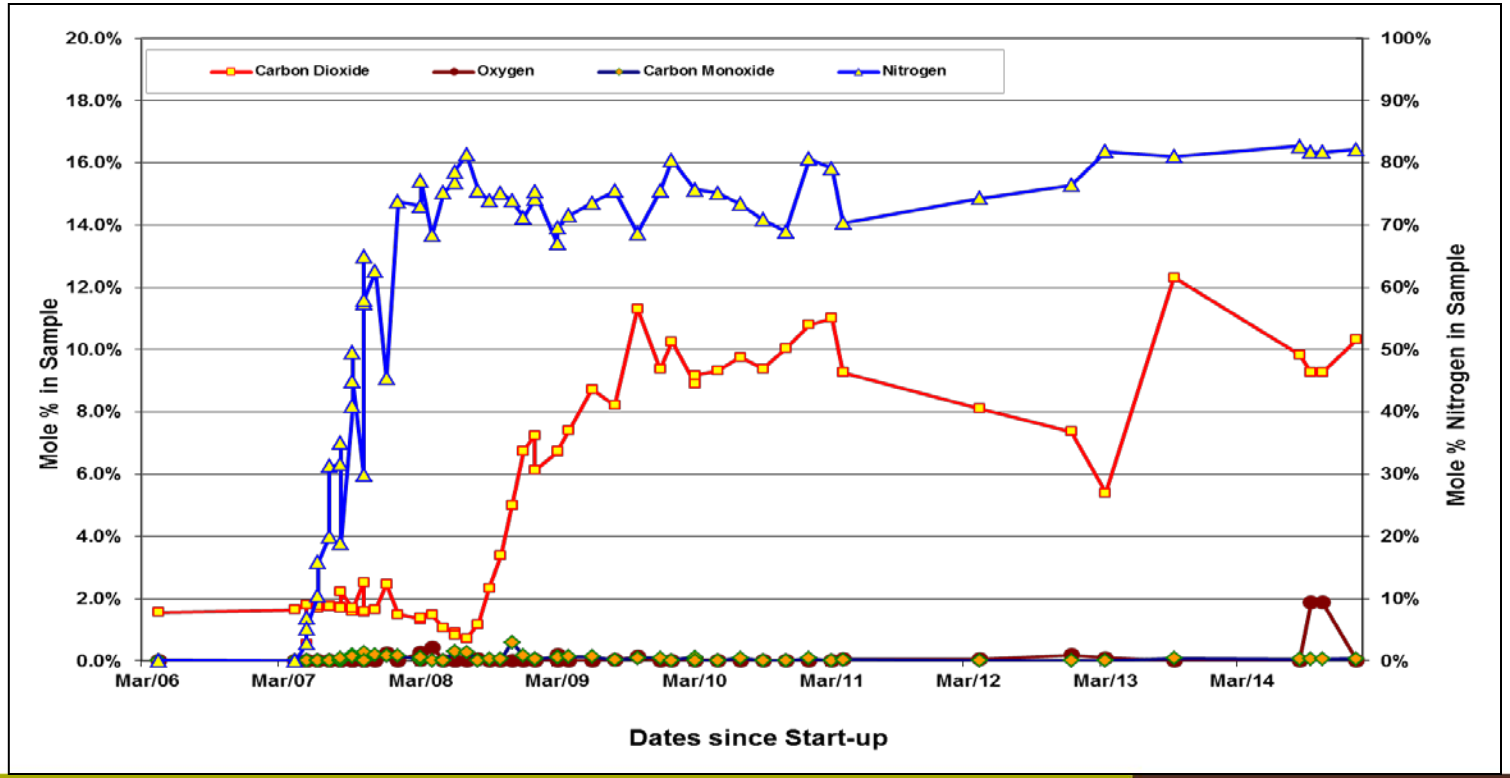
Gas composition 00/6-7-73-6W4/0



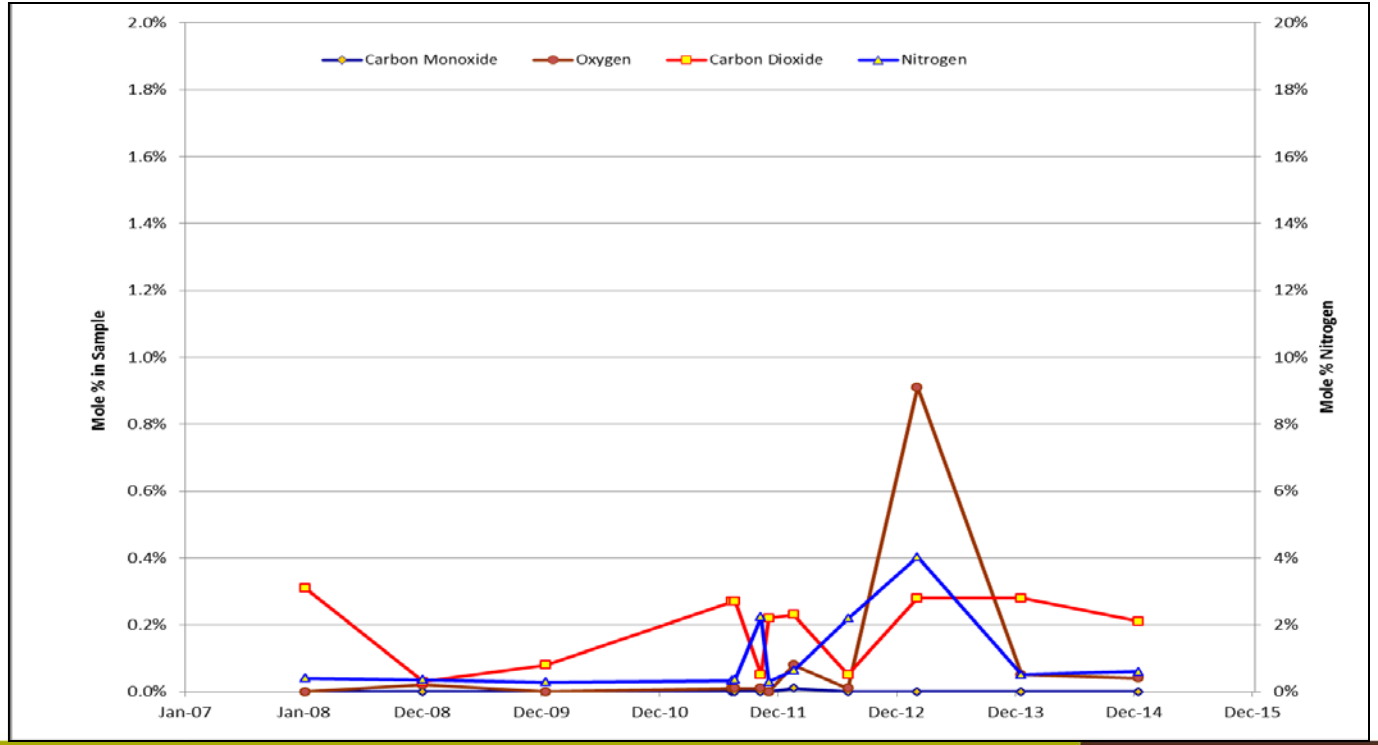
Gas composition 00/7-8-73-6W4/0



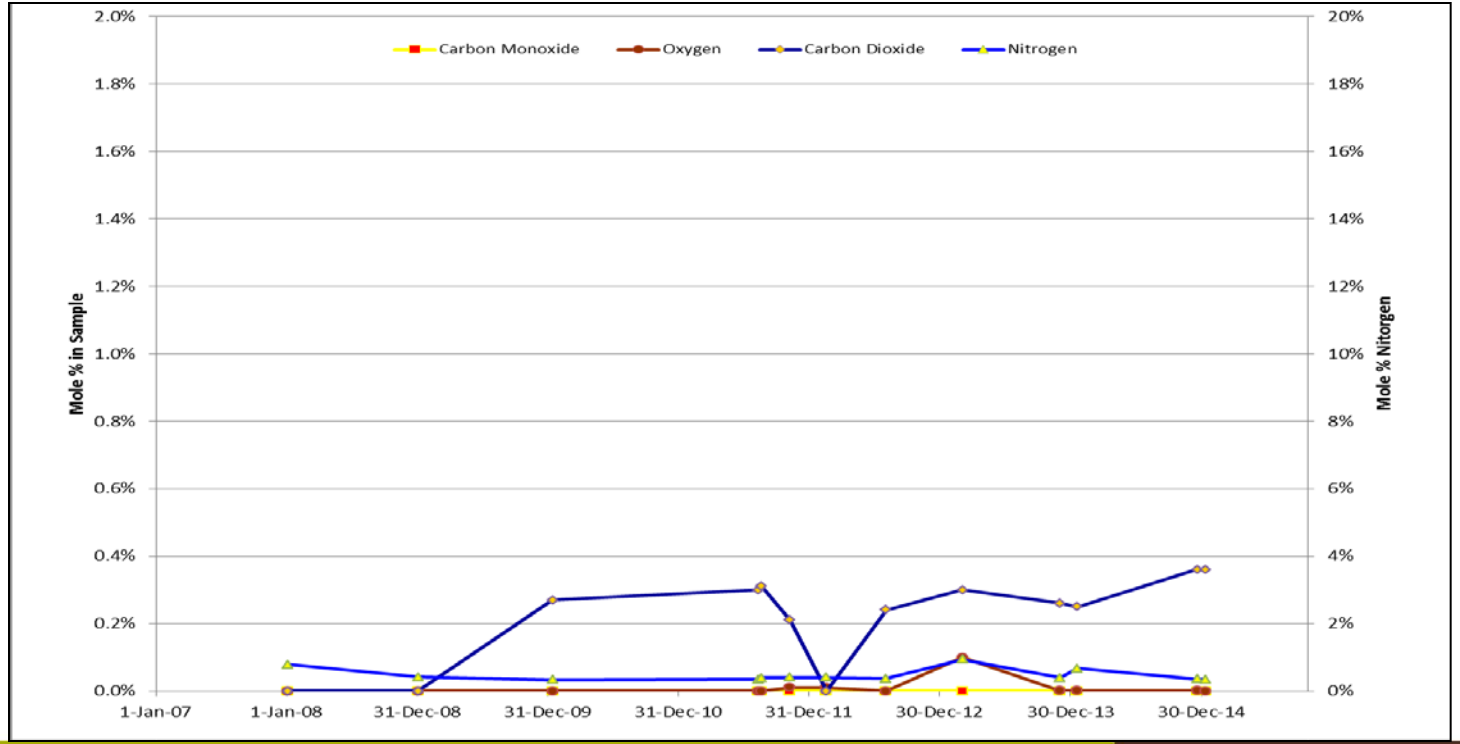
Gas composition 00/11-15-73-6W4/0



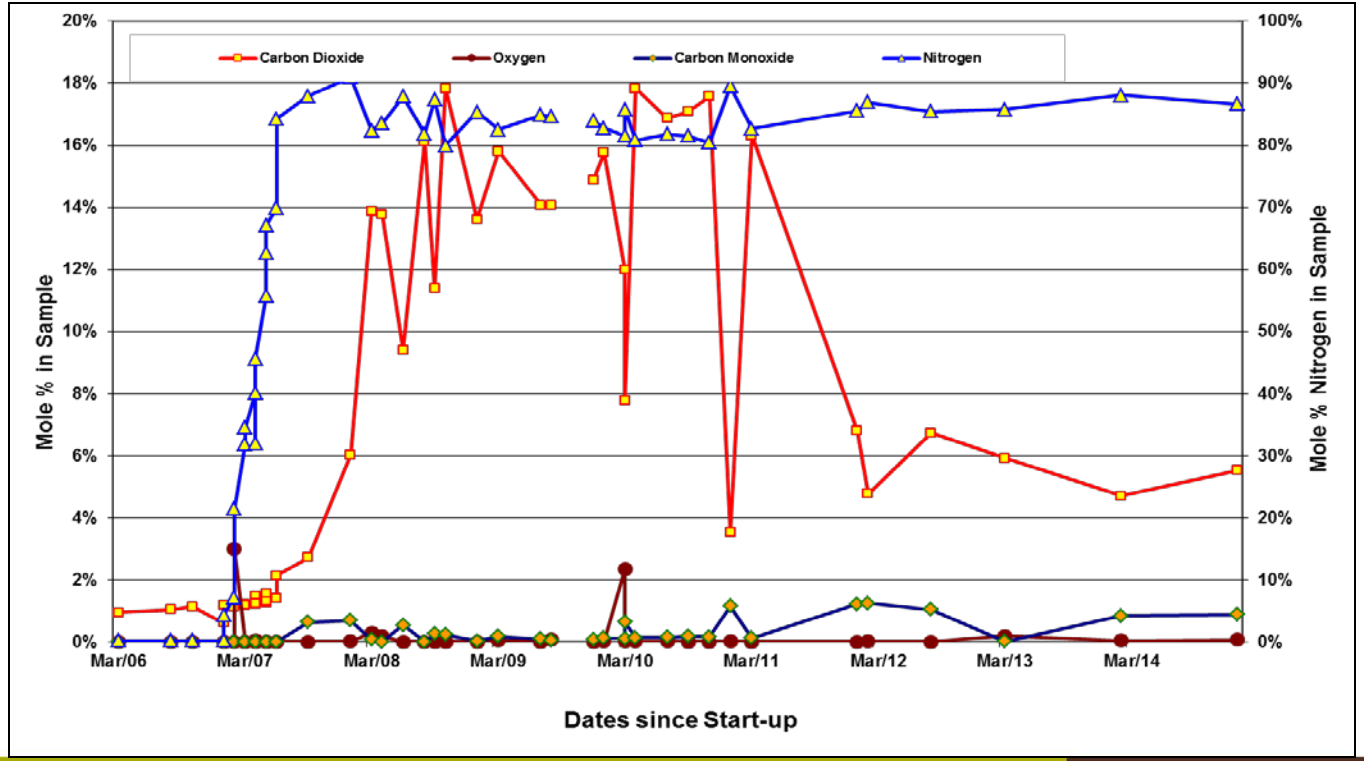
Gas composition 00/10-11-73-7W4/0



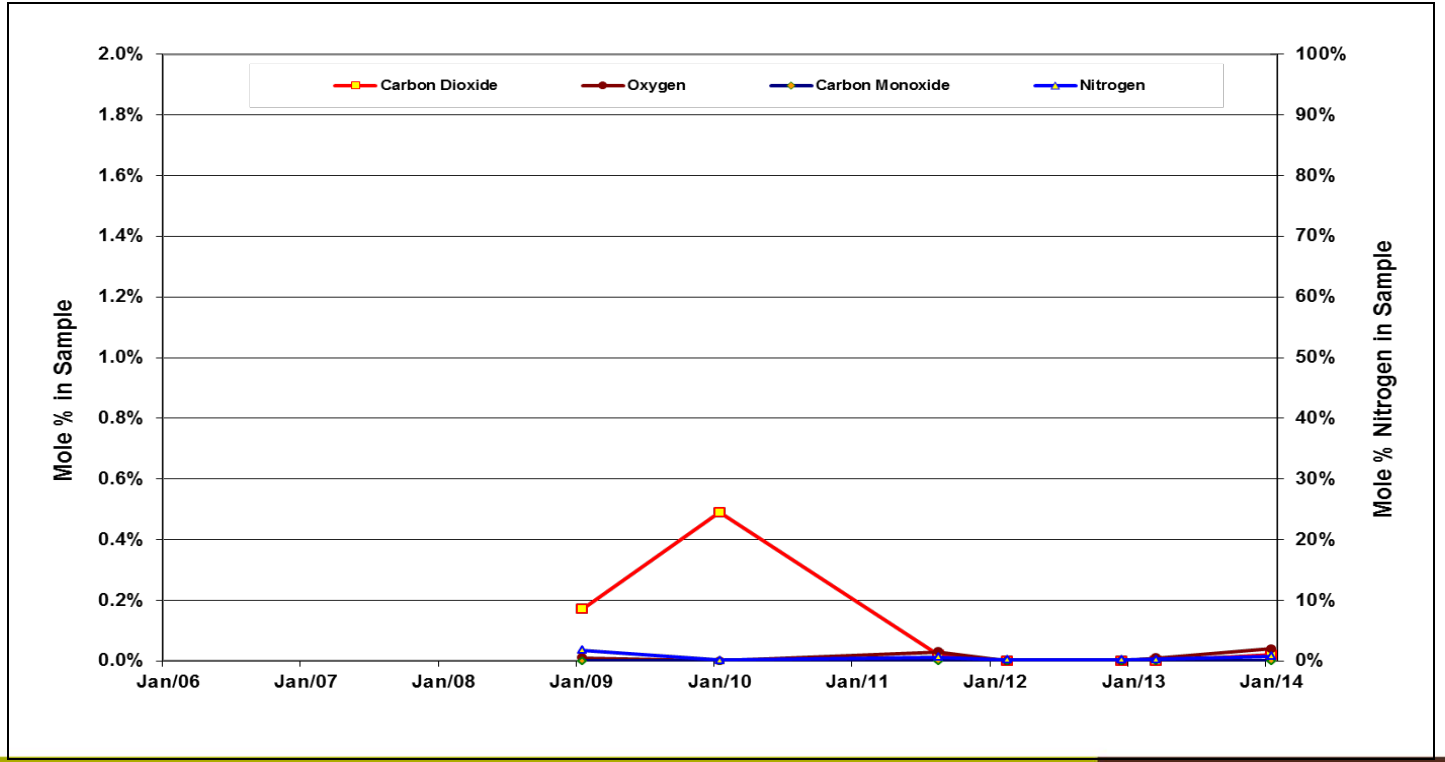
Gas composition 00/10-12-73-7W4/0



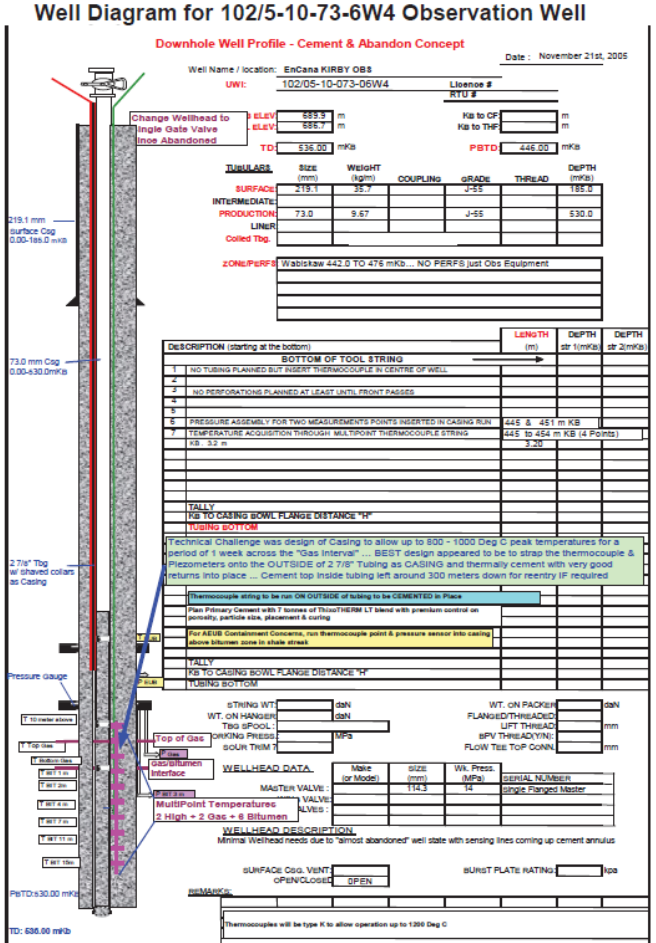
Gas composition 00/14-9-73-6W4/0



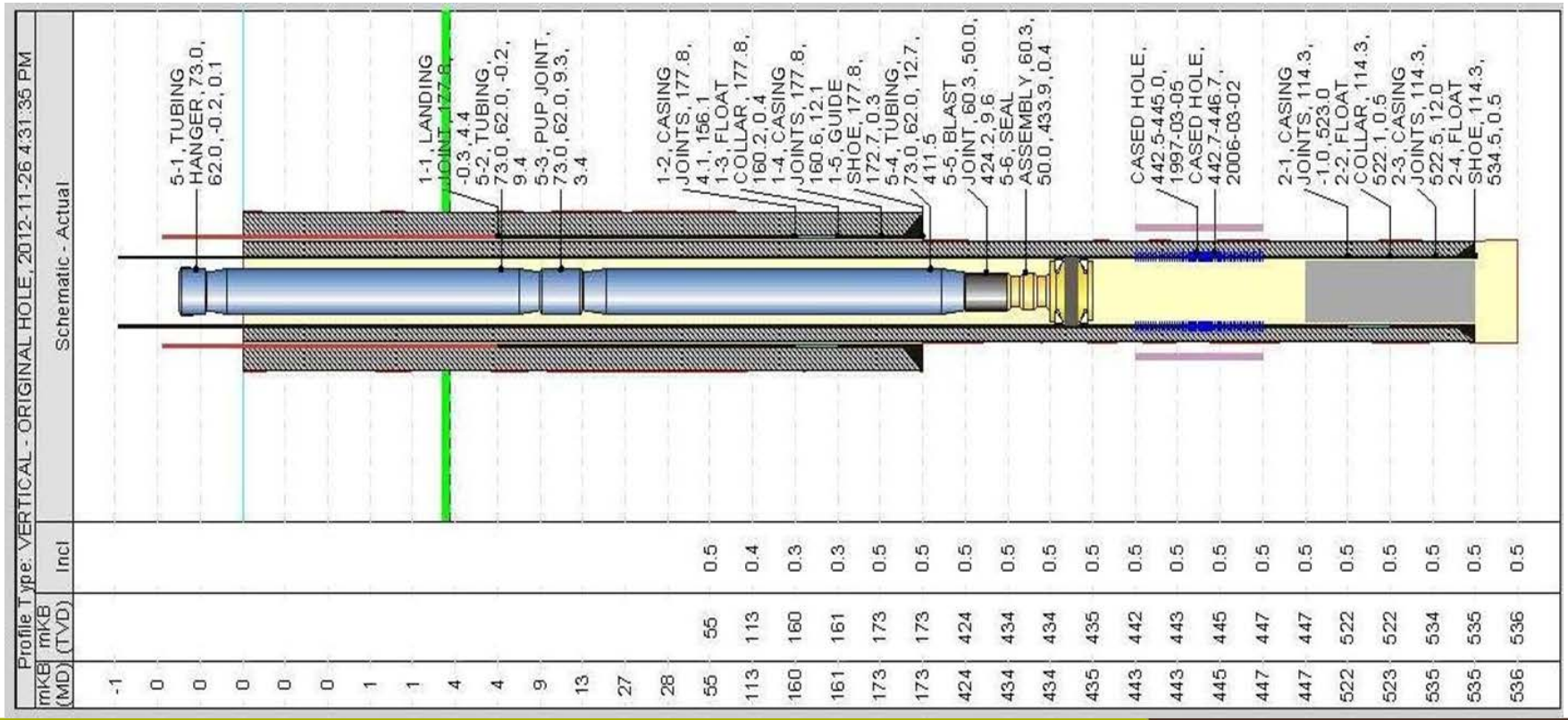
Gas composition 00/6-18-73-6W4/0



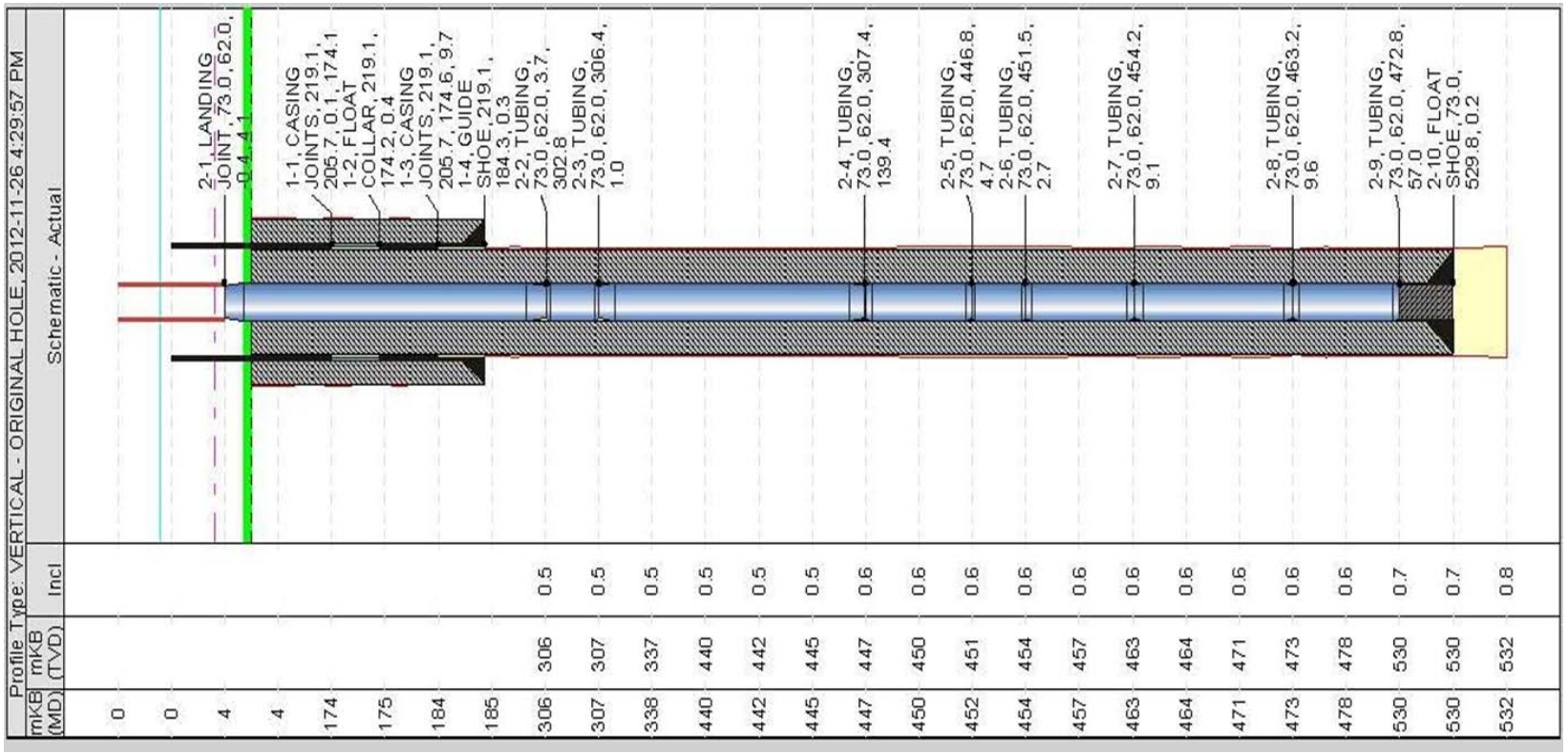
102/5-10-073-06W4M DH schematic



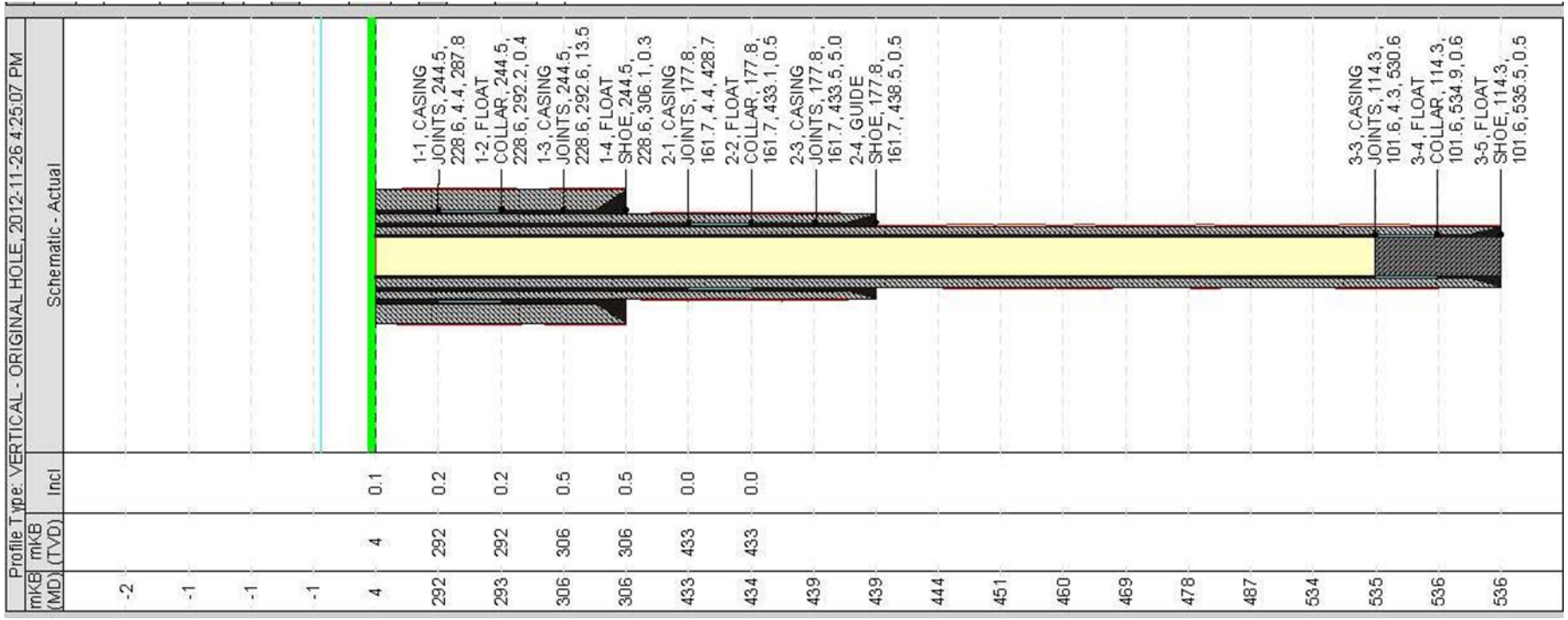
100/05-10-073-06W4 wellbore schematic



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



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



QUESTIONS