2025 GAS LIFT WORKSHOP

Super Sonic Gas Lift Tool – Delaware Pilot: Assess Production Improvement and Gas Injection Reduction

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Agenda

- Gas Lift in the Delaware Basin (Permian)
- Artificial Lift Map
  - Growing number of PAGL/GAPL wells
  - Target wells for the SST application
- Super Sonic GL Tool (SST)
- Candidate Well Selection & Timeline
- Overview of Results (Well A-D)
  - Decline Curve Analysis – 4 pilot wells
- Deep Dive into Well C
  - Multi-phase Meter installed & CO_2 tracer conducted
- Deep Dive into Well D
  - Multi-phase Meter installed & CO_2 tracer conducted
- Conclusions

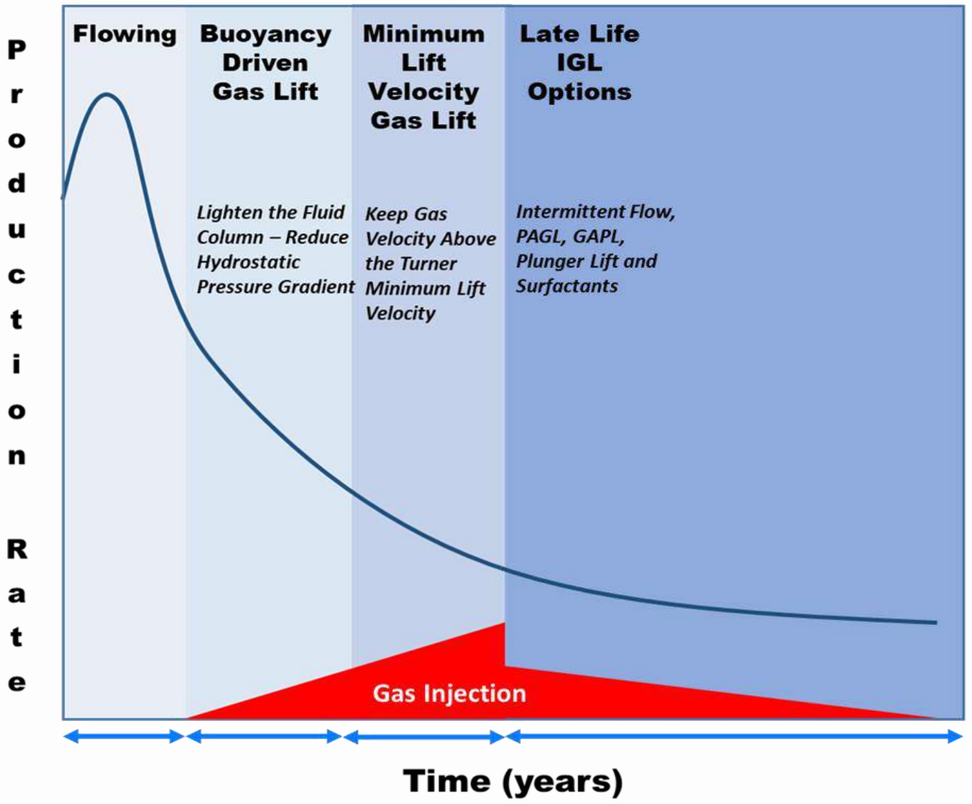
SST Pilot Project – Delaware Basin

Objective:

- Validate production uplift and/or injection gas savings
- Test in 4 wells to better understand technology
- Surface MPM was installed on 2 wells to provide high-resolution real-time data versus periodic well tests

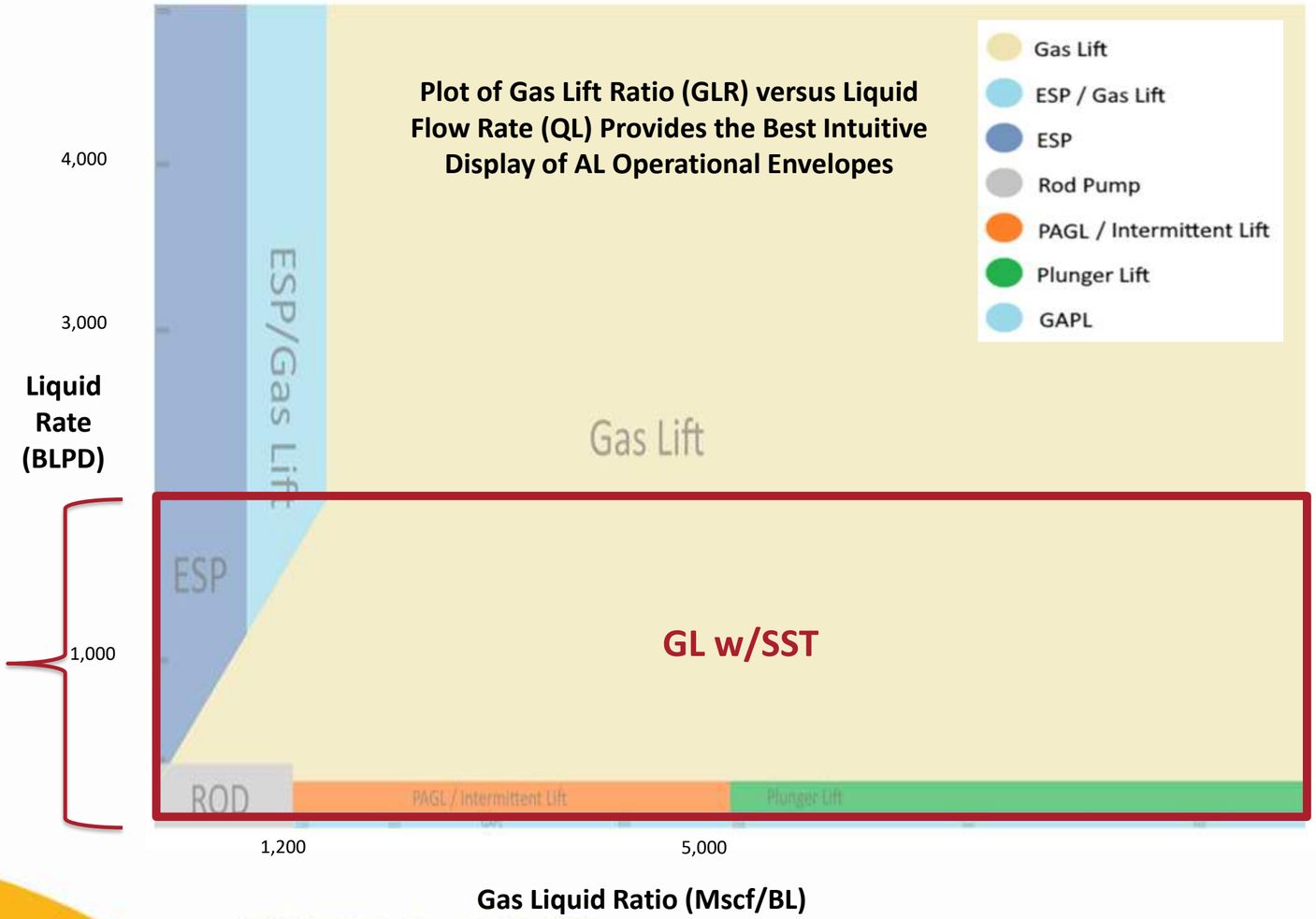
Business Drivers:

- Growing PAGL/GAPL conversion inventory – the costs to convert GL to PAGL/GAPL has increased, leaving wells waiting for budget.
- Uplift – a low-cost way to increase rates and drop BHP is attractive while waiting for conversions.
- Compression Reduction – if reductions comparable to PAGL/GAPL can be shown. Decrease OPEX (buyback gas).



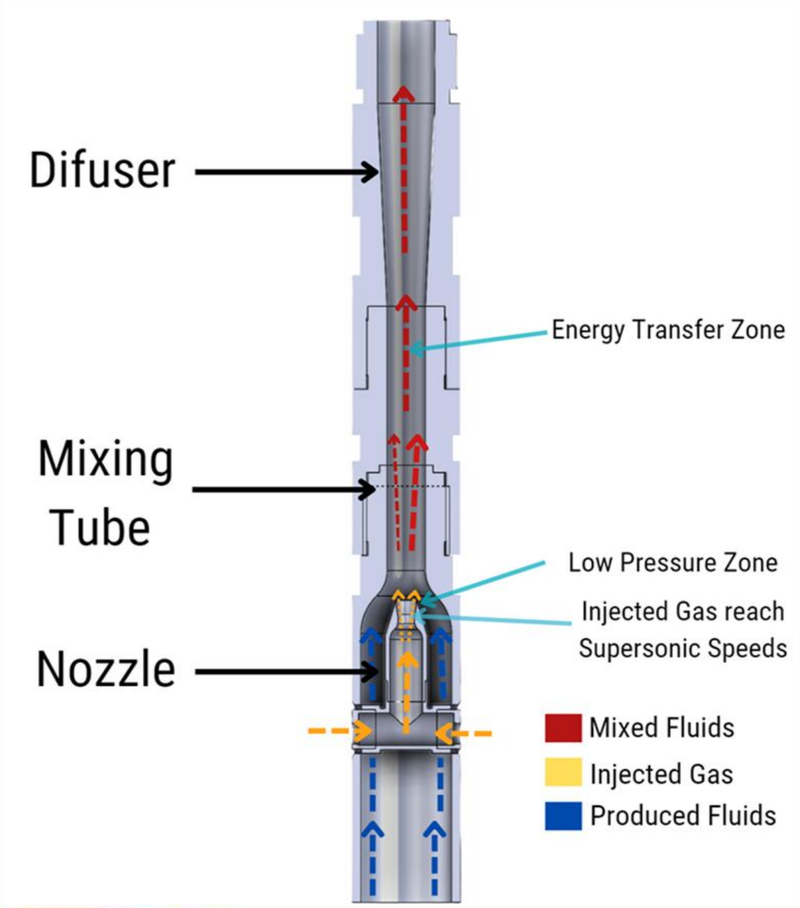
Artificial Lift Map w/ SST

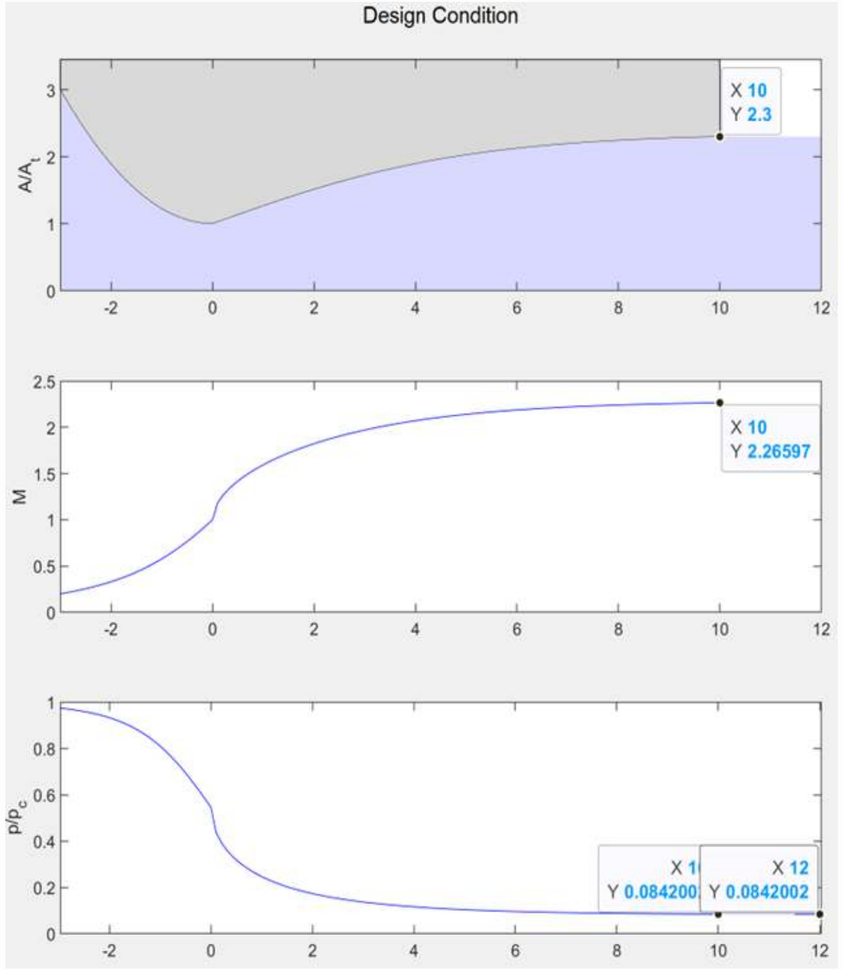
- Higher Volume Artificial Lift
  - ESP, SPHPGL, Annular, etc.
  - QL >1000 BFPD
- Intermittent Gas Lift (IGL) & PAGL/GAPL
  - QL < 300 BFPD
  - GLR < 5,000 SCF/BBL
- Plunger Lift
  - QL < 300 BFPD
  - GLR > 5,000 SCF/BBL
- Rod Pump
  - QL < 400 BFPD
  - GLR < 1,200 SCF/BL
- GL w/SST (*vendor estimate*)
  - QL < 2000 BLPD
  - GLR < 10,000 SCF/BL (Actually 15,000 SCFD/BL)



SST Technology – Overview

- Works on Venturi (Converting Pressure Energy to Kinetic Energy)
- Converging-Diverging Nozzle to reach Supersonic Speed
- Low Pressure Zone at the Throat/Tip of the Nozzle
  - Induce more inflow from reservoir

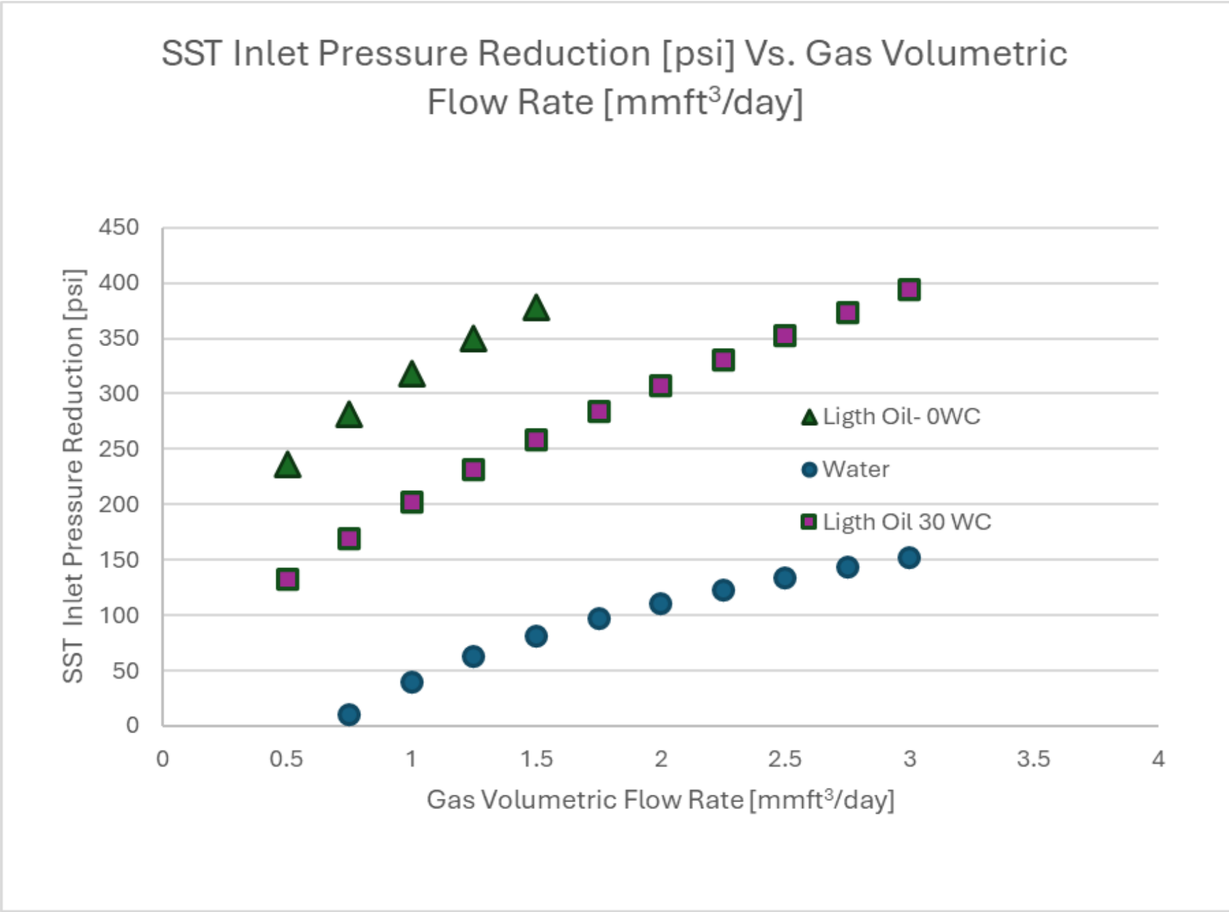




SST Technology – Drawdown

The suction generated by the tool is a function of several factors, but mainly:

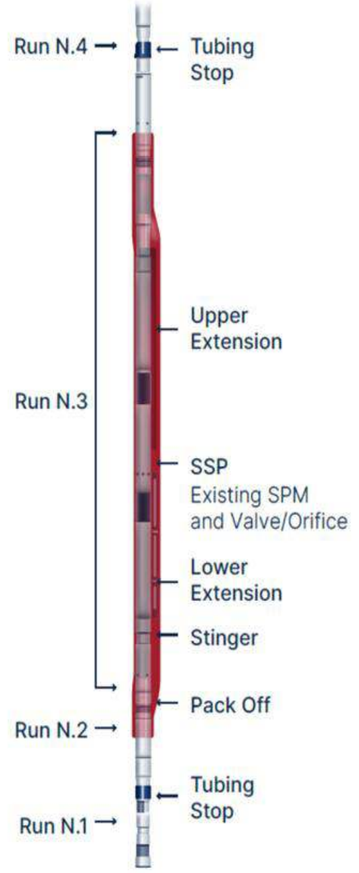
- Pump geometry (throat/nozzle size)
- Injected gas rate and pressure
- Flowing bottomhole pressure
- Produced fluid properties



SST – How it is Installed

- Importance of Landing Location
  - The SST should be placed across the current point-of-injection (POI).
  - Ideally on wells not “Multi-Pointing”.
  - The use of CO_2 Tracer is an effective way to verify the POI and was used in this pilot.
- 4 Run Slickline – Used to set SST across the active GL valve (left picture).
- Single Run Slickline – Used with tubing conveyed system (right picture).

4 Run Slickline

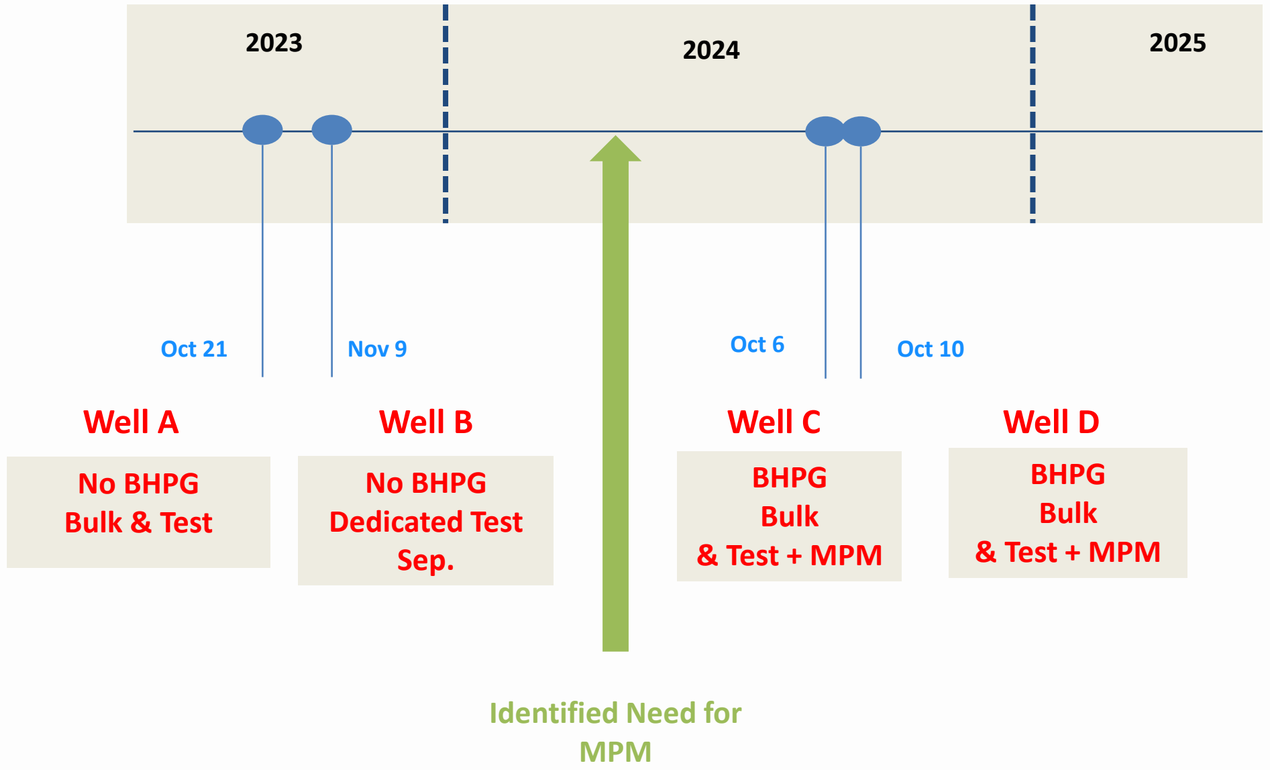


Tubing Deploy or Single Run Slickline

Pilot Timeline – Delaware Basin (New Mexico)

Pilot Well Selection:

- PAGL/GAPL candidate – waiting on conversion
  - Mid-to-Late Life well with a production rate of around 100-200 BFPD.



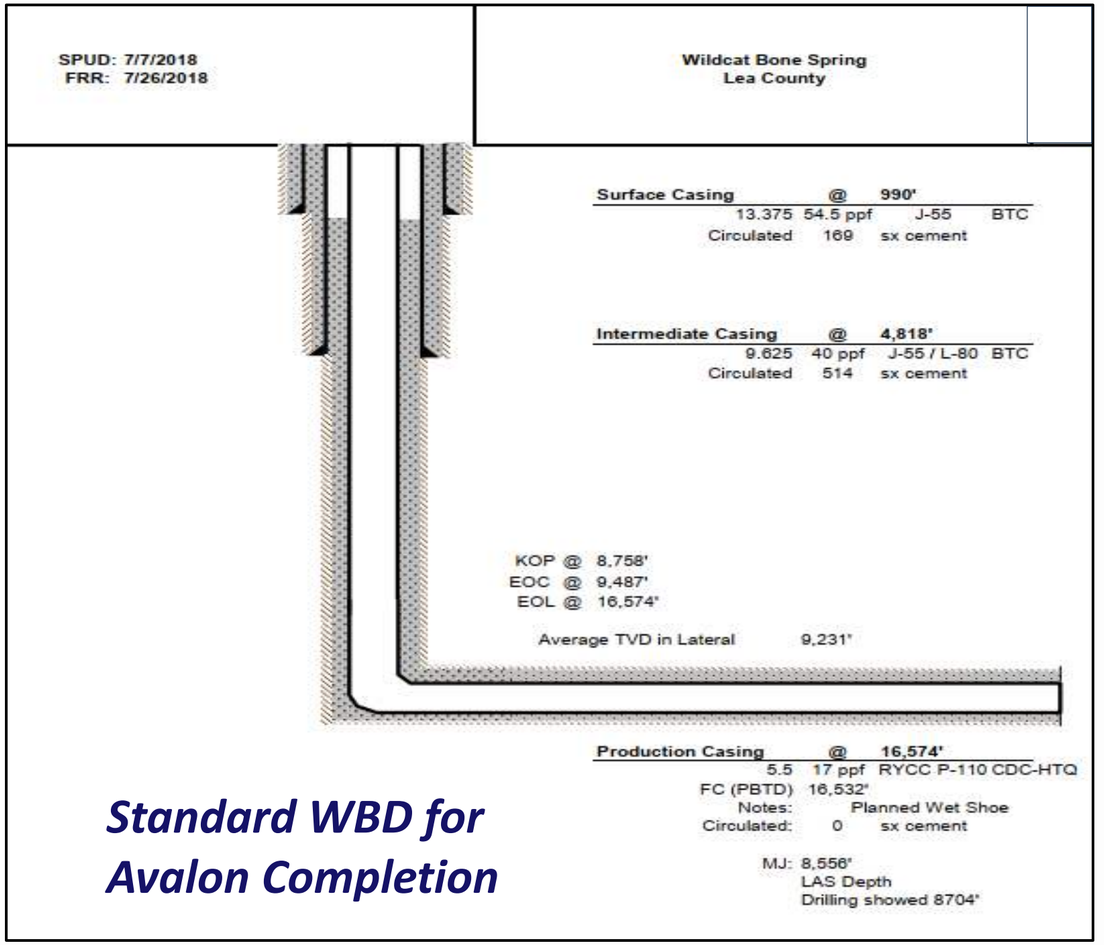
Pilot Wells:

- **Wells A & B** – First wells selected. Oct. and Nov. of 2023 respectively.
- **Well C & D** – Second pair of pilot wells. Both installed in Oct. of 2024.

Details of Pilot Wells

Pilot Well Details:

- 4 Wells included in trial.
- Formations: (1) Wolfcamp A & (3) Avalon wells.
- Avg. TVD in laterals: 12,525’ (WCA) & 9,149’ (Avalons).
- KOPs: 11,941’ & 8,625’.
- Casing: 5-1/2” 23# (WCA) & 5-1/2” 17# (Avalons).
- All 2-7/8” production tubing and GL mandrels w/ packers.
- First production: End of 2017 to June of 2020.

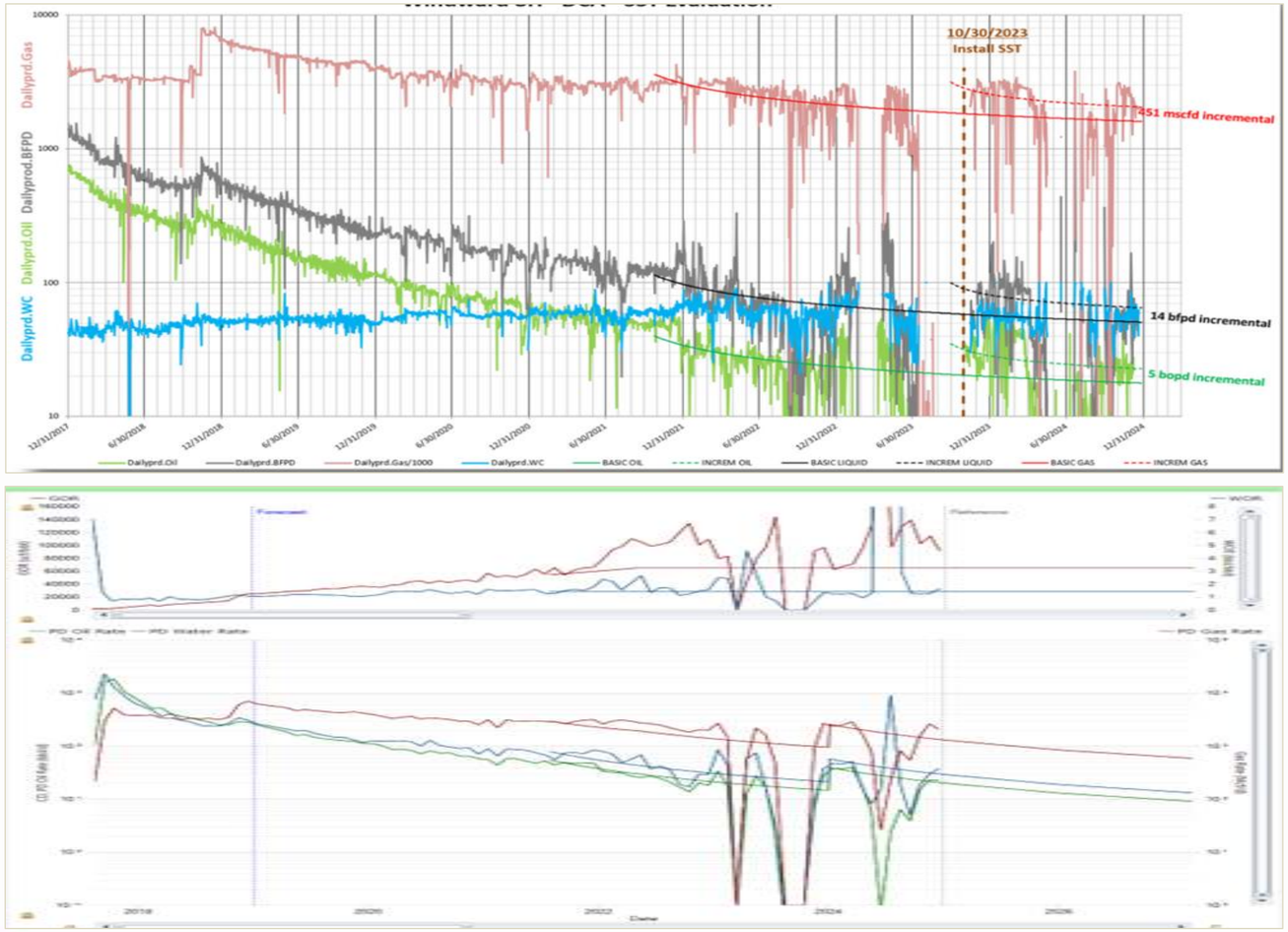


Standard WBD for Avalon Completion

Well A – DCA

Performance:

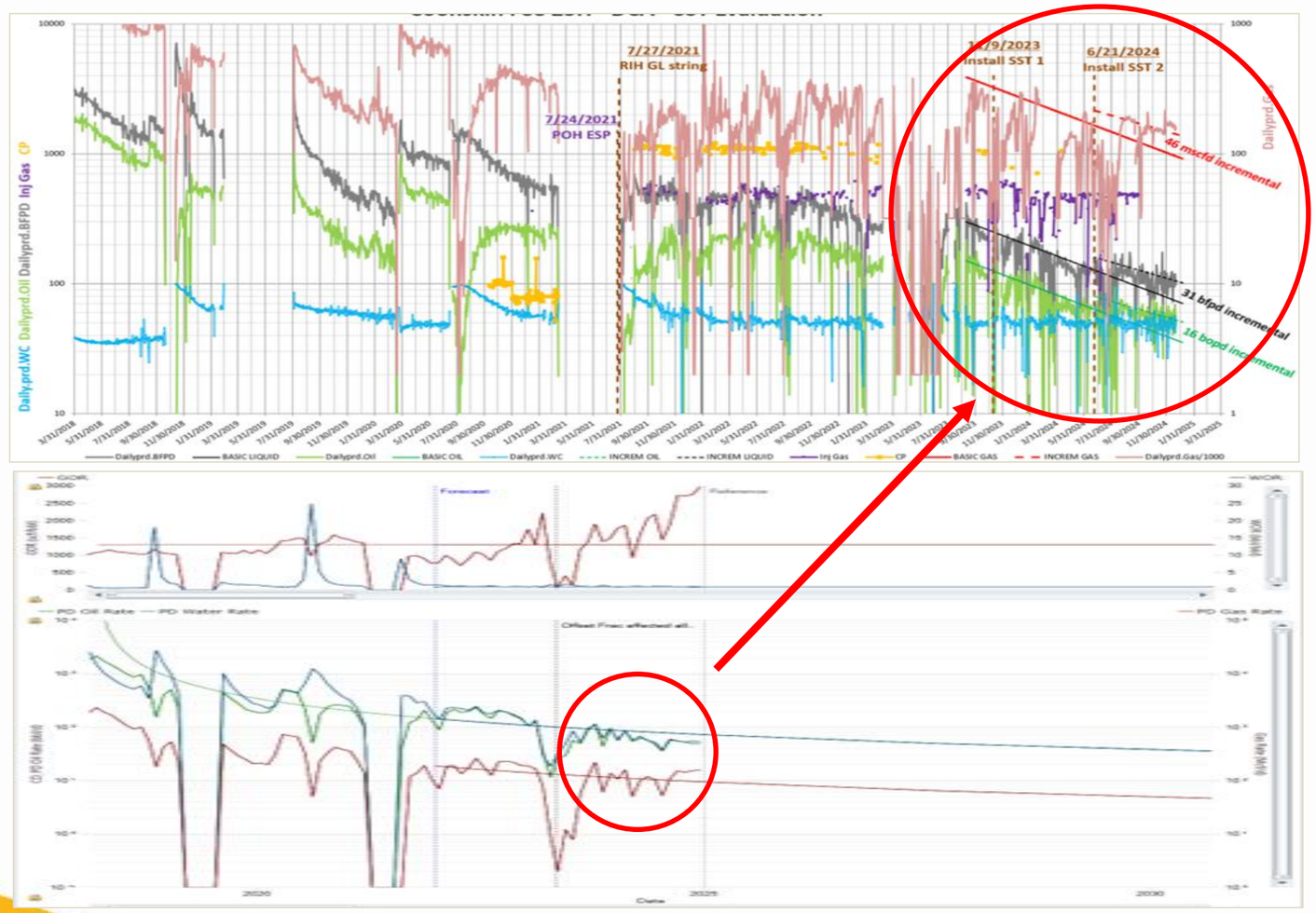
- No Multi-Phase Meter (MPM) data available.
- No CO_2 Tracer run.
- Some Multi-Pointing is suspected.
- ± 14 BOPD oil uplift.
- ± 300 MCF/day gas uplift.



Well B – DCA

Performance:

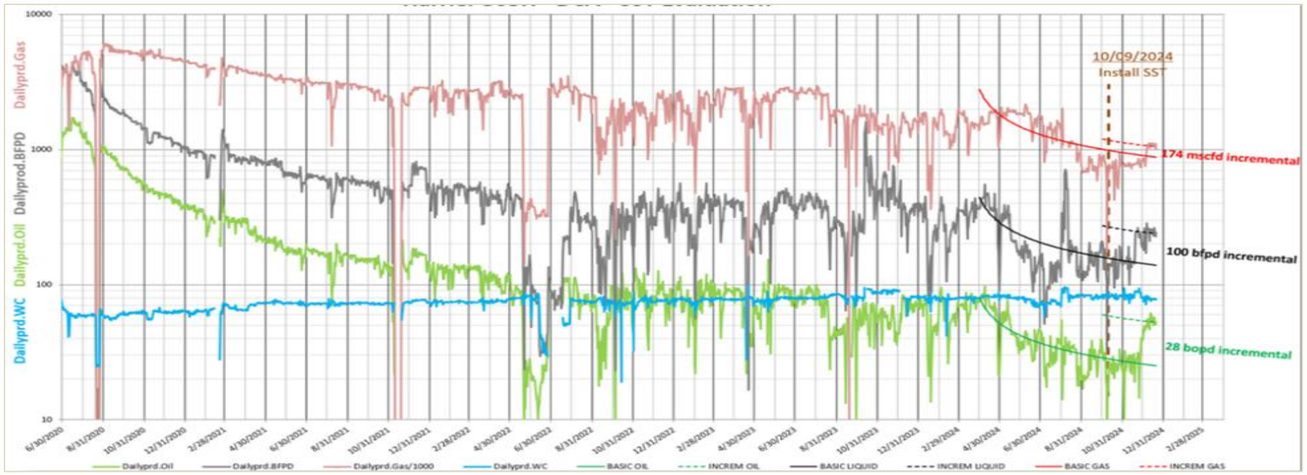
- No MPM data available.
- No CO_2 Tracer run.
- Production data initially not showing production gains.
- Tool installed in the wrong location.
- Repositioned the tool and production gains trend in the right direction.
- ± 31 BOPD oil uplift.
- ± 50 MCF/day gas uplift.

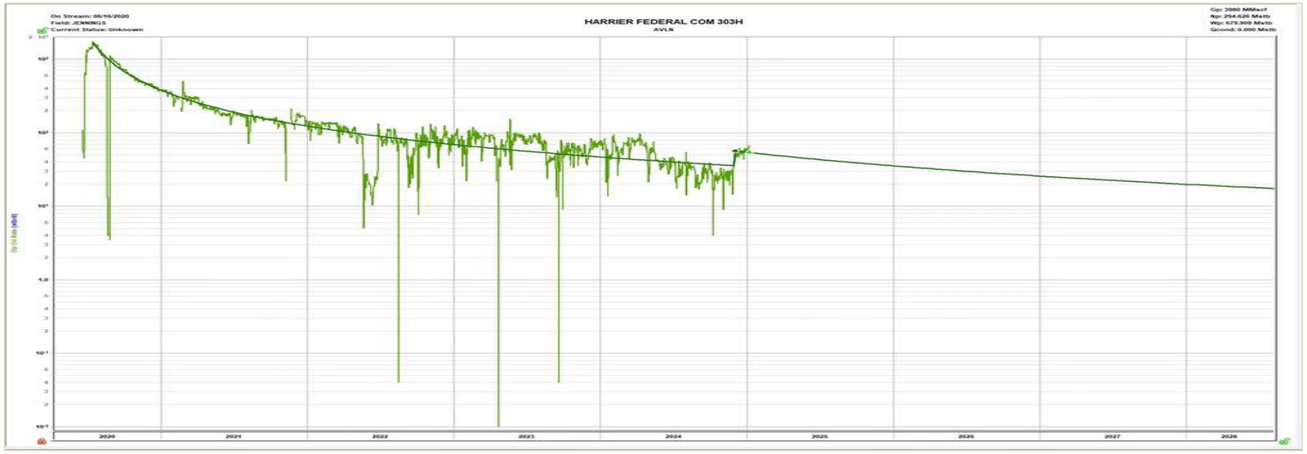


Well C – DCA

Performance:

- MPM data available.
- CO_2 Tracer run for verification of injection point.
- ± 30 BOPD uplift observed for several months.
- Problems with compression uptime prevented understanding long term uplift.

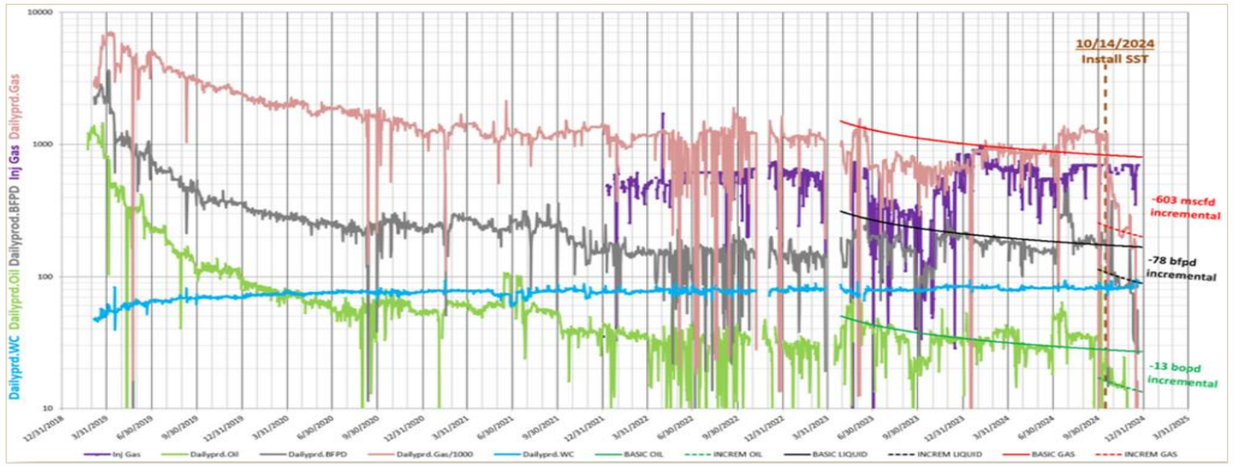


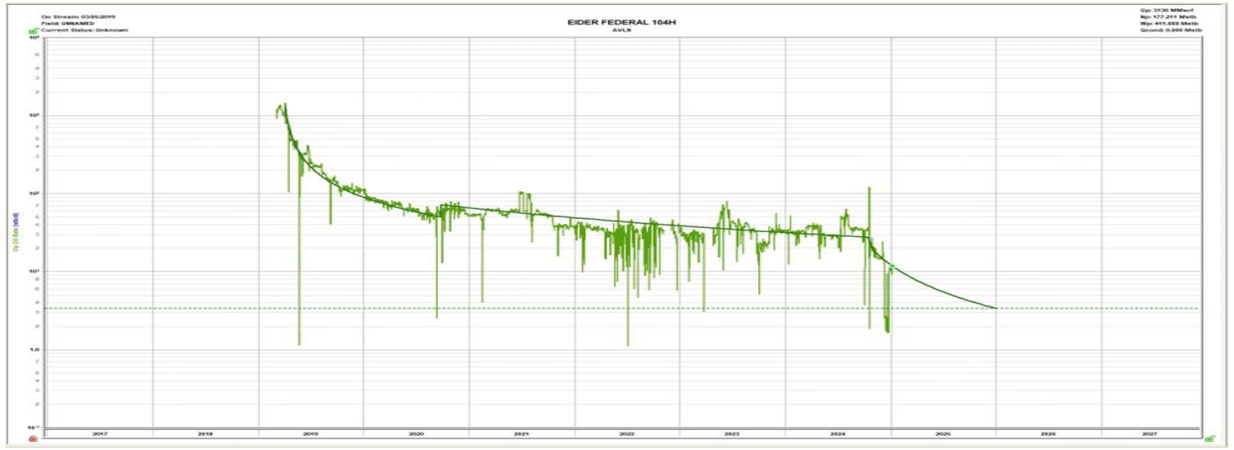


Well D – DCA

Performance

- No uplift.
- MPM showed massive instability in the gas injection and well uptime.
- CO_2 Tracer run for verification of injection point (judgement call made on tool placement).
- Multi-Pointing confirmed on this well.

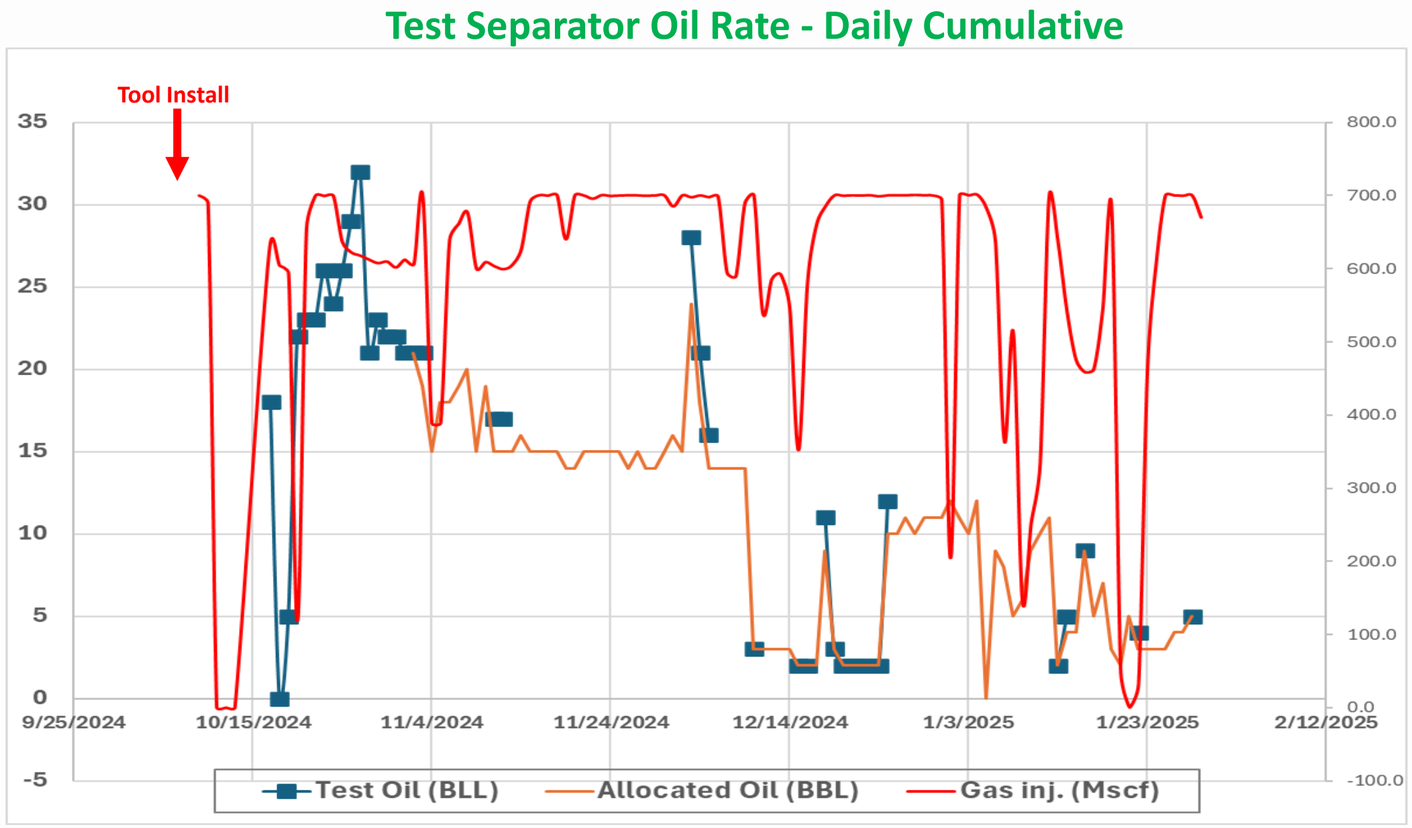




Pilot Results – Well D

Performance

- Slight initial uplift
- Observations
  - Multi-Pointing evident
  - Gas injection variability later in the test
  - Finally, gas was just circulating through upper valves, i.e. not the SST



CO_2 Tracer – Well C

Prep Work:

- CO_2 Tracer was conducted to determine the exact injection point / GLV.
- Survey showed 100% of injection gas to be going through the orifice.
- Based on this, we were confidently able to place the tool where injection gas was occurring (POI).

	Mandrel	Depth (MD)	% Return	Rate by %
Injection from Mandrel # (depths in ftMD, rate in mscfd, mandrels from bottom up)	1	8,287	100.0%	270.0

CO_2 Baseline	9.37%
IPR Qmax (BLPD, from WinGLUE Vogel IPR)	176
Pwf (psi, from WinGLUE PPM)	998
Tubing Size	2-7/8" 6.5#
Casing Size	5-1/2" 17#

Comments

In this report Mandrel #9 is the shallowest mandrel and Mandrel #1 is the deepest mandrel. This survey shows single-point injection from the orifice installed in the first mandrel. No leaks were observed up the hole. An Echometer test shows the fluid level is at 8290 ftMD. The calculated lift gas throughput at Mandrel #1 is 495 mscfd using Thornhill-Craver. The calibrated lift gas throughput is 270 mscfd.

Valve #	Depth TVD ft	Depth MD ft	TV deg F	TCF	Port Size	R	PT psi	DPC psi	PSC psi	PVC psi	OP psi	PSO psi	PD at 60F psi	PTRO psi
9	2150	2154	121	0.8798	16/64	0.1580	758	82	1117	1199	1282	1200	1055	1255
8	3300	3306	126	0.8701	16/64	0.1580	869	106	1097	1203	1265	1160	1047	1245
7	4200	4208	130	0.8638	16/64	0.1580	907	120	1077	1197	1251	1132	1034	1230
6	5000	5010	133	0.8591	16/64	0.1580	918	130	1057	1187	1238	1108	1020	1210
5	5750	5761	135	0.8554	16/64	0.1580	928	139	1037	1176	1222	1084	1006	1195
4	6450	6464	137	0.8528	16/64	0.1580	936	145	1017	1163	1205	1060	991	1175
3	7100	7121	139	0.8510	16/64	0.1580	921	150	997	1147	1190	1040	976	1160
2	7750	7777	139	0.8498	16/64	0.1580	912	155	977	1132	1173	1019	962	1140
1	8385	8418	140	0.8492	14/64	OV								

CO_2 Tracer – Well D

Prep Work:

- CO_2 Tracer(s) conducted to determine the exact injection point / GLV.
- **First survey showed** 61.5% of injection gas going through second to last GLV & 38.5% of injection gas going through orifice.

Results:

- Based on this information, we decided to place the tool across the orifice.
- **Second survey showed** now 70% of injection gas into third-from-bottom GLV & 30% now going through second-to-last.
- The tool caused the GL injection point to stage up.

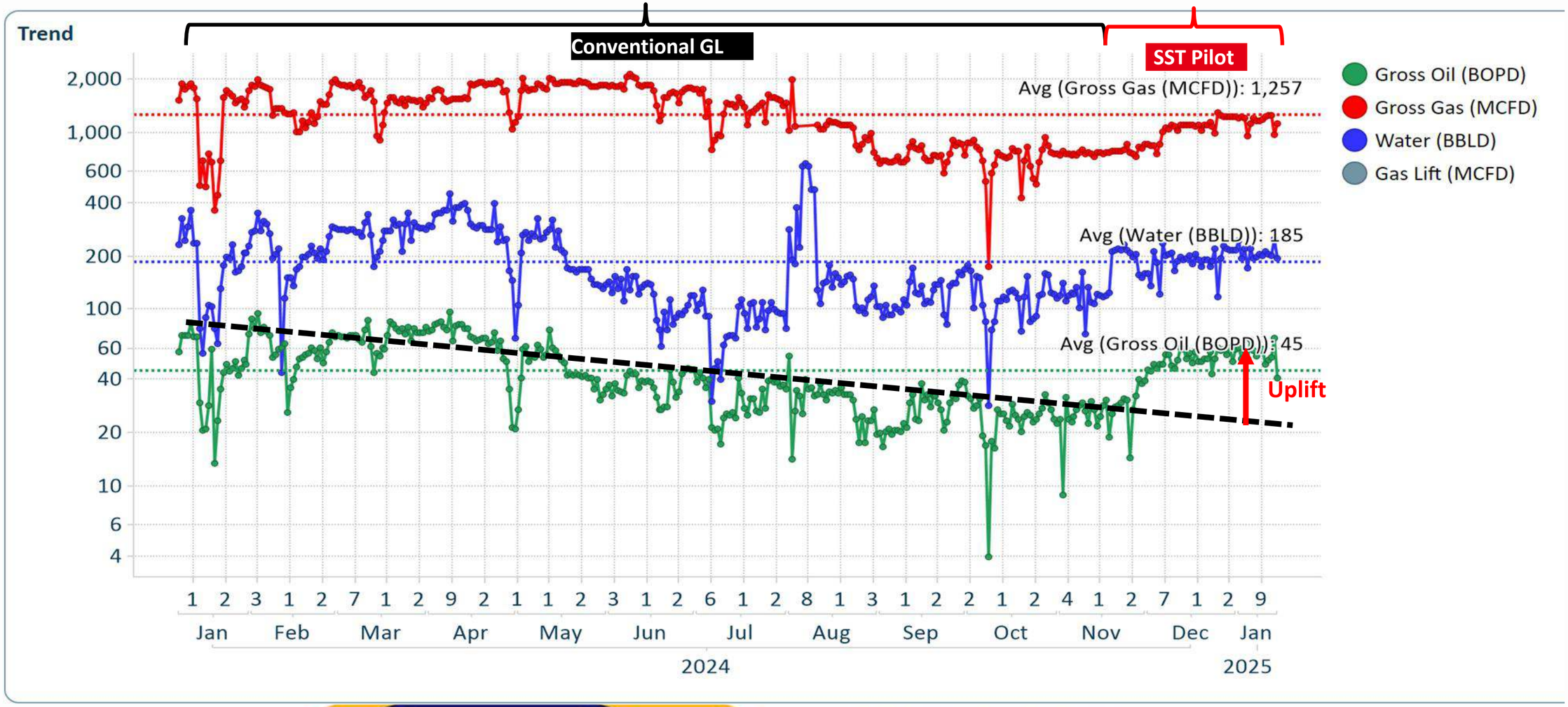
	Mandrel	Depth (MD)	% Return	Rate by %
CO2 Tracer from 9/27/2024	2	8,166	61.5%	439.7
Injection from Mandrel #	1	8,627	38.5%	275.3
(depths in ftMD, rate in mscfd, mandrels from bottom up)	3	7,608	69.8%	547.7
CO2 Tracer from 1/30/2025	2	8,166	30.2%	237.3
CO_2 Baseline	7.19%			
IPR Qmax (BLPD, from WinGLUE Vogel IPR)	284			
Pwf (psi, from WinGLUE PPM)	990			
Tubing Size	2-7/8" 6.5#			
Casing Size	5-1/2" 17#			

Comments

In this report Mandrel #12 is the shallowest mandrel and Mandrel #1 is the deepest mandrel. Two CO2 returns were recorded during this survey. Using the available information, the returns are matched to the failed unloading valves installed in Mandrel #1 (8627 ftMD) and in Mandrel #2 (8166 ftMD). The fluid level could not be determined. No fluid level was evident in the Echometer tests.

Valve #	Valve Desc.	Depth TVD	Depth MD	TV	TCF	Port Size	R	PT	PTR	PSC	PVC	OP	PSO	PSET
12	TP-1	2000	2000	121	0.8785	12/64	0.0950	714	68	1101	1183	1232	1150	1150
11	TP-1	3000	3000	124	0.8717	12/64	0.0950	916	87	1063	1186	1214	1091	1140
10	TP-1	3575	3575	127	0.8681	12/64	0.0950	902	86	1024	1171	1199	1052	1125
9	TP-1	4150	4150	129	0.8648	12/64	0.0950	887	84	985	1155	1184	1014	1105
8	TP-1	4725	4726	130	0.8617	12/64	0.0950	873	83	947	1141	1169	975	1085
7	TP-1	5300	5301	132	0.8588	12/64	0.0950	858	82	908	1125	1153	936	1070
6	TP-1	5875	5877	133	0.8563	12/64	0.0950	844	80	870	1111	1139	898	1050
5	TP-1	6450	6453	135	0.8541	12/64	0.0950	829	79	832	1096	1124	860	1035
4	TP-1	7025	7029	136	0.8522	12/64	0.0950	815	77	793	1081	1109	821	1020
3	TP-1	7600	7605	137	0.8507	12/64	0.0950	801	76	755	1067	1095	783	1005
2	TP-1	8175	8181	137	0.8497	12/64	0.0950	838	80	716	1051	1074	739	985
1	TP-1	8638	8645	138	0.8491	12/64	0.0950			578	932	948	594	875

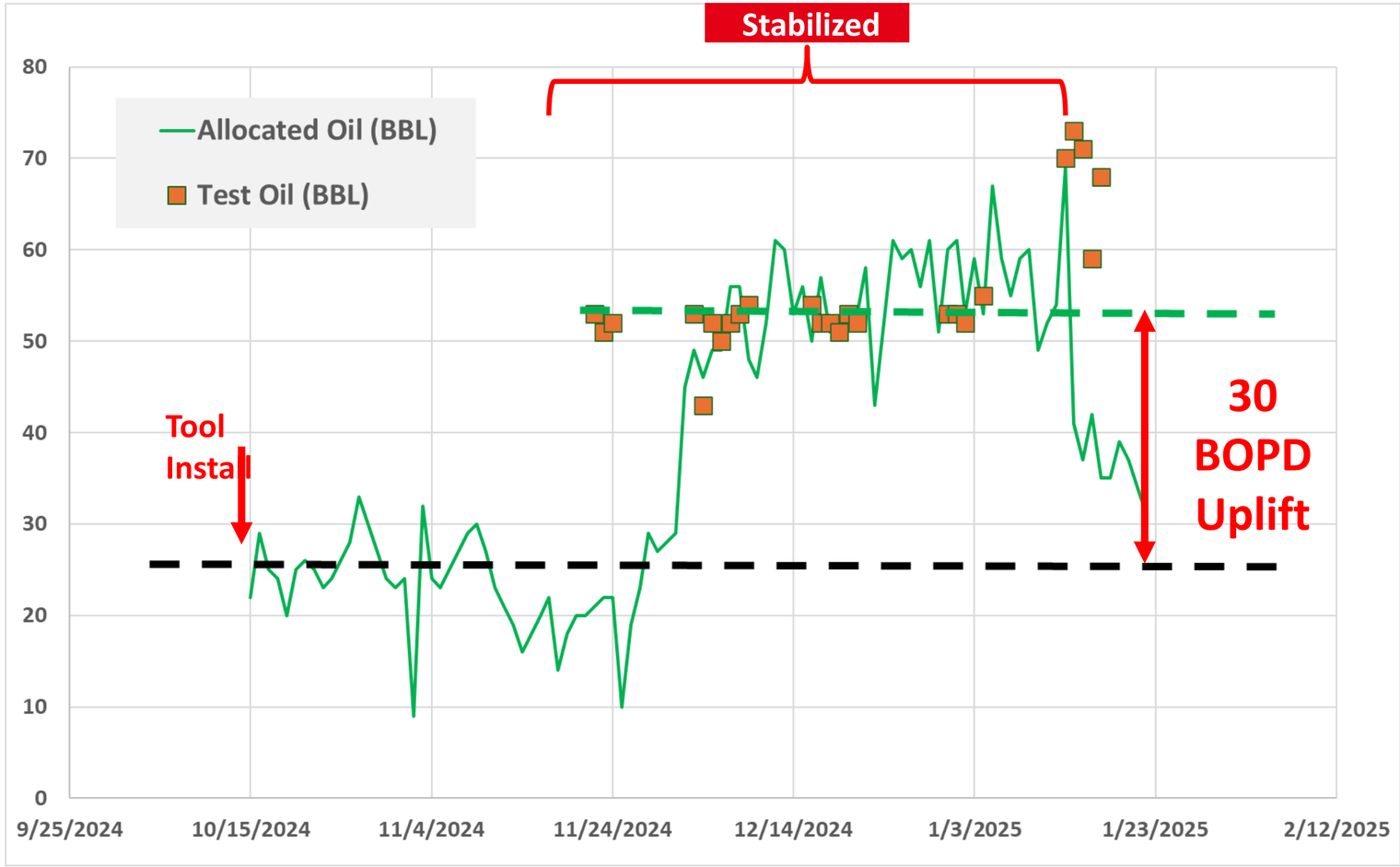
Overview – Pilot Well C



Pilot Results – Well C

Performance:

- 30 BOPD Uplift
- Observations:
  - Several weeks before new well test was performed after SST install.
  - It took a week before new well tests are used in allocation process.
  - Compressor issues caused production rate drops in 2025.



Test Separator Oil Rate

Conclusions

- **Production Increase**
  - A production increase was observed when the injected gas passes through the SST.
  - Some indication of reduce gas requirement seen, but compression was too unstable to fully demonstrate.
- **Knowing the Active Valve**
  - The pilots showed that it is critical to know the active valve for the SST to provide benefit.
  - Multi-Pointing and holes in tubing greatly reduce the benefits.
- **Operational Instabilities in the Delaware**
  - Conducting pilots in many areas of the Delaware is difficult due to compressor and takeaway issues.
- **Concept Validation**
  - The pilot was able to demonstrate a positive benefit for this technology and moving to install in additional wells.

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