



Variations and Implications of Marcellus Shale Flowbacks

Cefalo's, January 14, 2014

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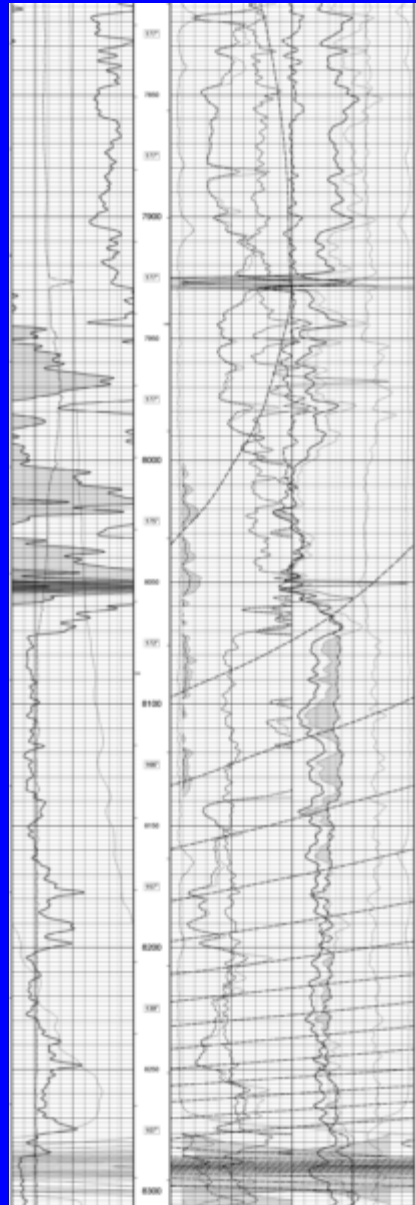
Agenda

- Let's briefly discuss proper lateral placement and hydraulic fracturing stages
- Variations in flowback design in Marcellus
- Implications of Marcellus flowbacks
- Another level in flowback analysis

Lateral/Frac Stage Placement

- Let's see show of hands of those who think landing zone is big driver for shale production
- Who has frac'd hz wells grouping like type rock in frac stages using horizontal well logs
- What on a horizontal well log would trigger skipping part of a lateral

Strat Column



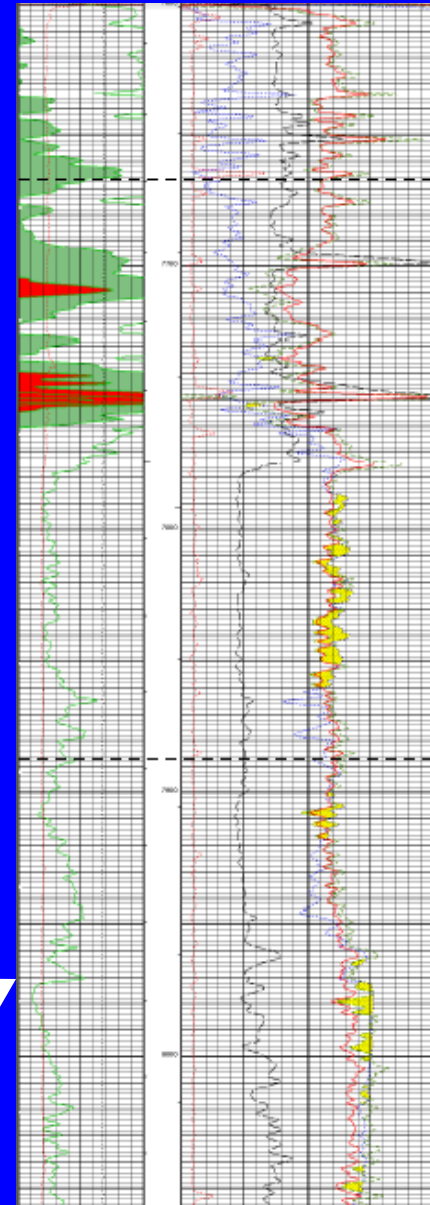
← Hamilton Shale →

← Marcellus Shale →

← Onondaga LS →

← Huntersville Chert →

← Oriskany SS →



Variations in Flowback Design

Starting Water Flow Rates

- Flowback company “A”
 - Low – 40 bwph
 - Middle – 55 – 60 bwph
 - High – 75 – 90 bwph
- Flowback company “B”
 - Vary by customer – 120 – 180 bwph
- Flowback company “C”
 - Maximum opening rate - 215 bwph

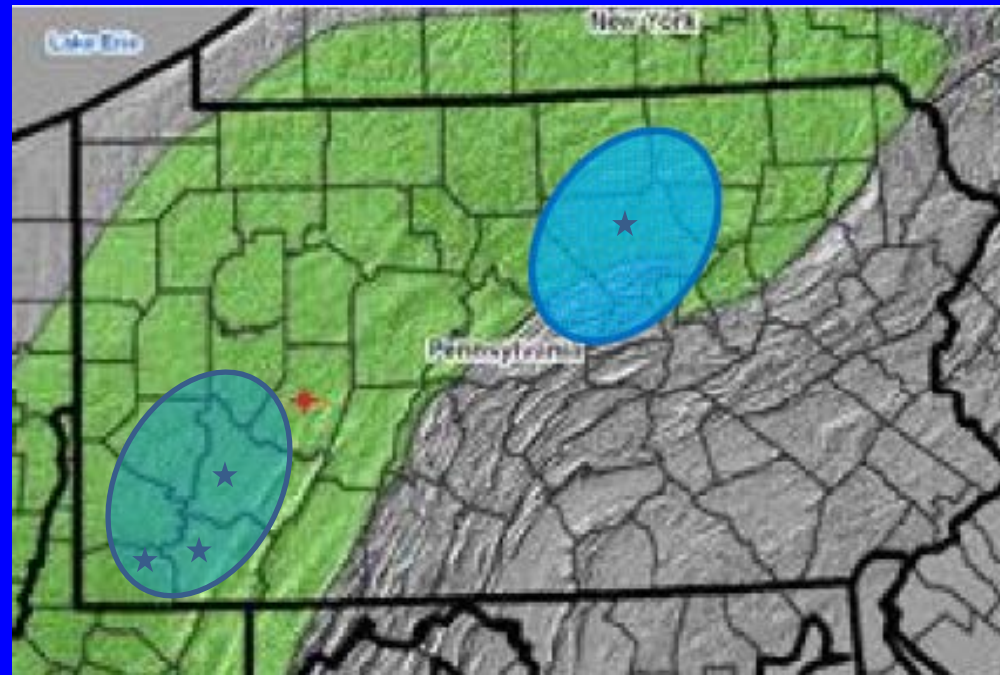
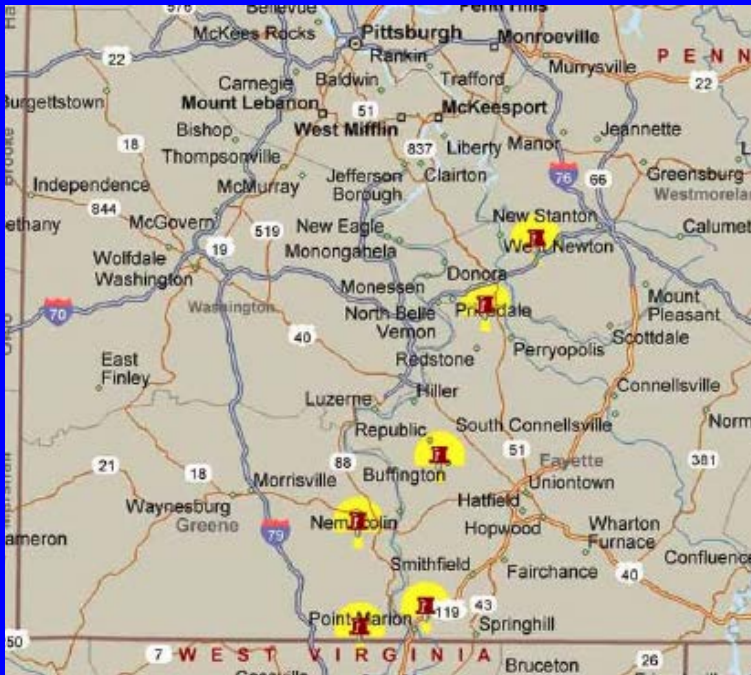
Variations in Flowback Design

Current Practice

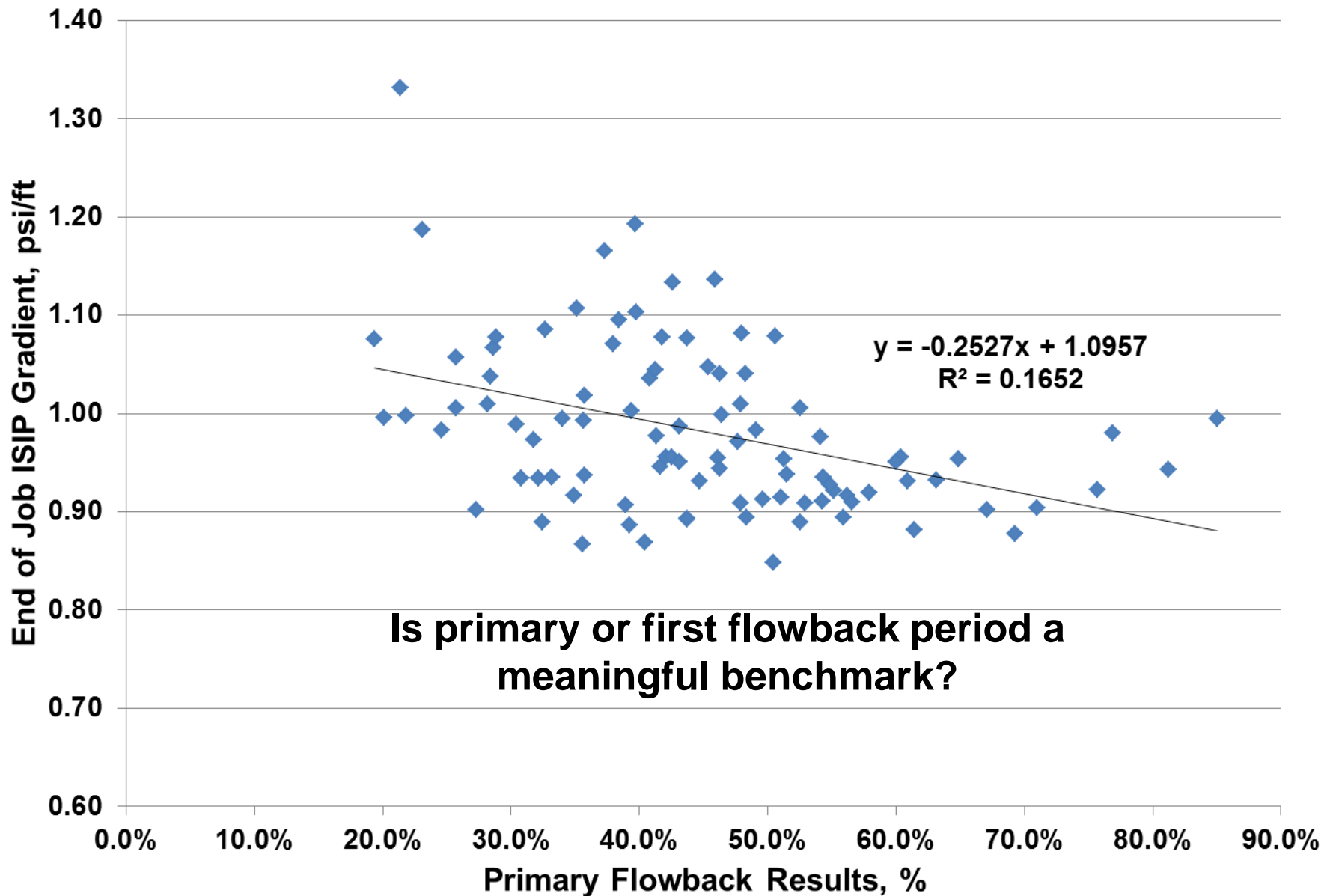
- Marcellus 2013
 - Drill out neutral flow – bbl in and bbl out
 - Seasoning – end of pumping last stage
 - Flowback – avg 80 – 200 bwph; start on 14/64
 - After gas hit – up to max separator – 275 bwph
- Utica/Point Pleasant 2013
 - Drill out neutral flow – bbl in and bbl out
 - All wells seasoned differently
 - Flowback rates harder to hit – gas quickly to surface

Marcellus Shale Database

- 98 Vertical Marcellus Shale Wells
- 43 Horizontal Marcellus Shale Wells



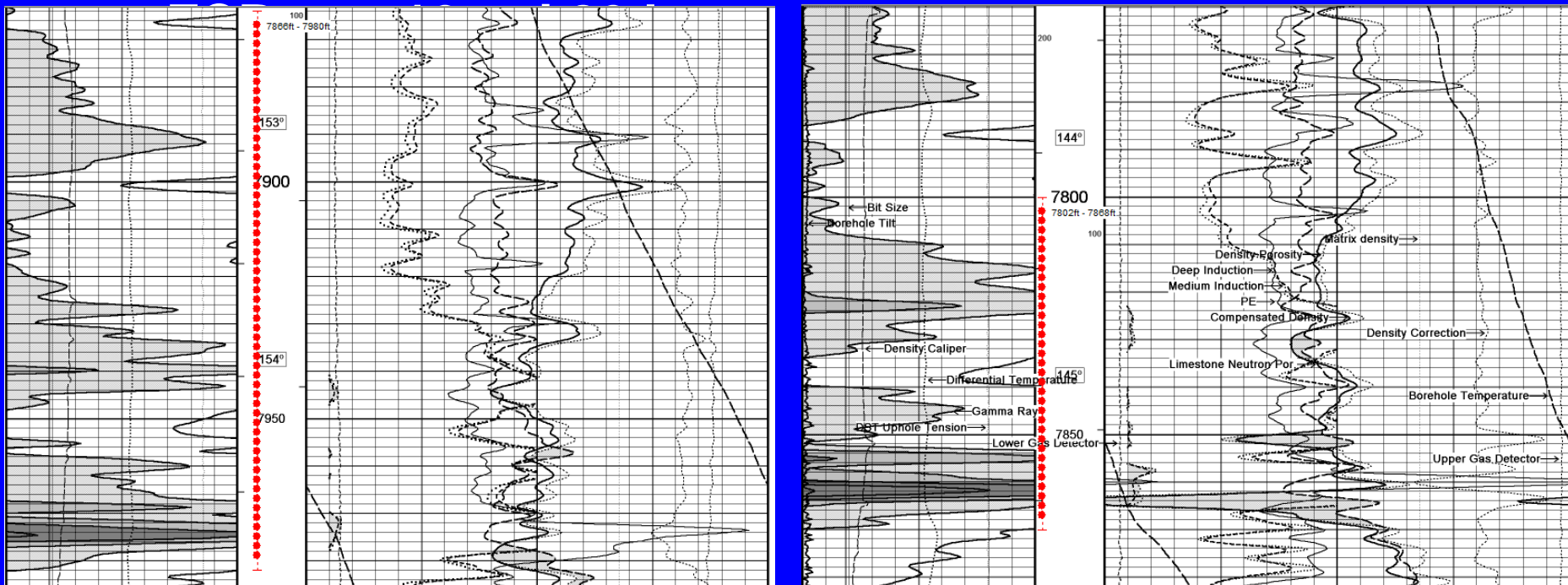
Marcellus Shale Vertical Well EOJ ISIP Gradient vs. Initial Flowback



Case History 1

Vertical Marcellus Wells in Same Township

- Well A – Flowback - 28.1% • Well B – Flowback - 75.7%



Does the Marcellus Shale, or do other “shales” contain movable water?

Case History 1

Well A and Well B With Other Area Wells

Primary Flowback Recovery

**Well A –
28.1%**

**Well C –
32.7%**

Well E

Gas Well

Oriskany Well – No Frac
171,400 mg/l Cl
11,000 mg/l Sr
900 mg/l Ba

**Well D –
42.1%**

**Well F –
64.8%**

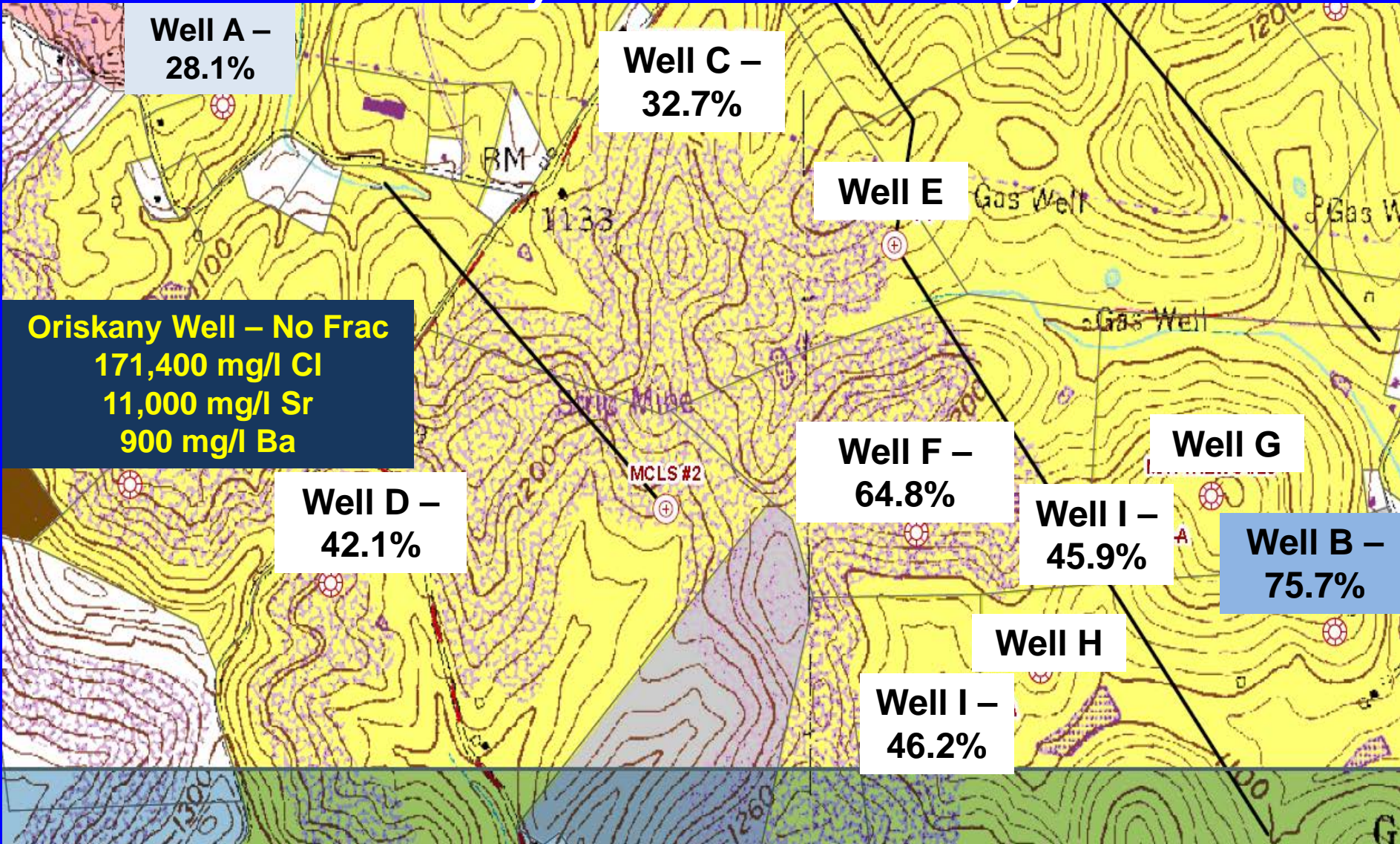
Well G

**Well I –
45.9%**

**Well B –
75.7%**

Well H

**Well I –
46.2%**



Case History I

Vertical Wells in Same Township

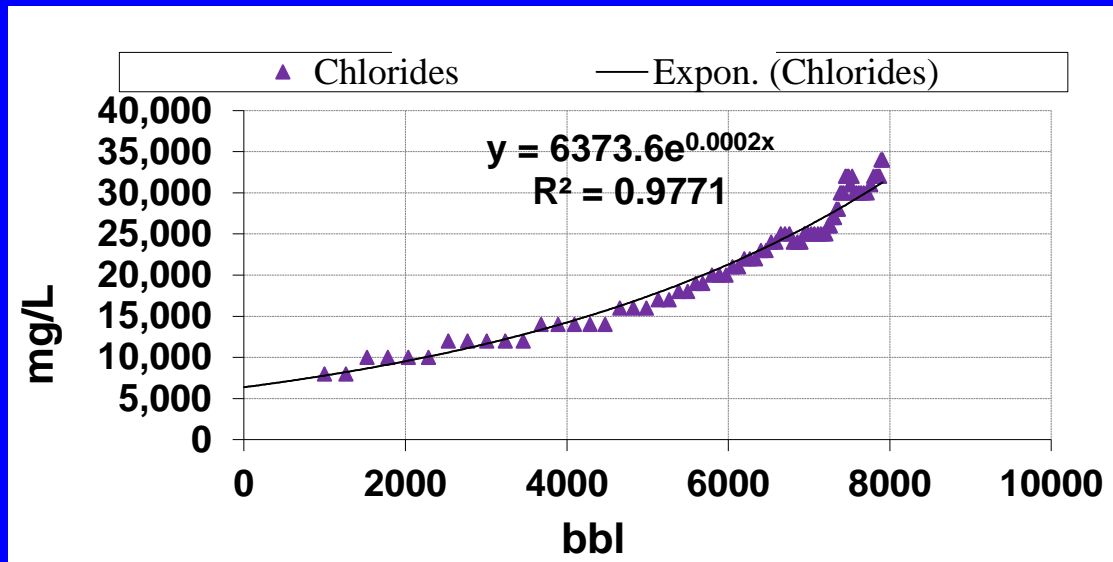
- **Well A – Flowback - 28.1%**
 - Perf'd Interval – 114 ft
 - 1,180,000 gals slick
 - 894,300 # sand
 - 120 bpm ATR
 - EOJ ISIP Gradient – **1.01** psi/foot
 - 157 feet of Marcellus
- **Well B – Flowback – 75.7%**
 - Perf'd Interval – 68 ft
 - 825,710 gals slick
 - 1,010,000 # sand
 - 94.7 bpm ATR
 - EOJ ISIP Gradient – **0.92** psi/foot
 - 152 feet of Marcellus

Case History 1

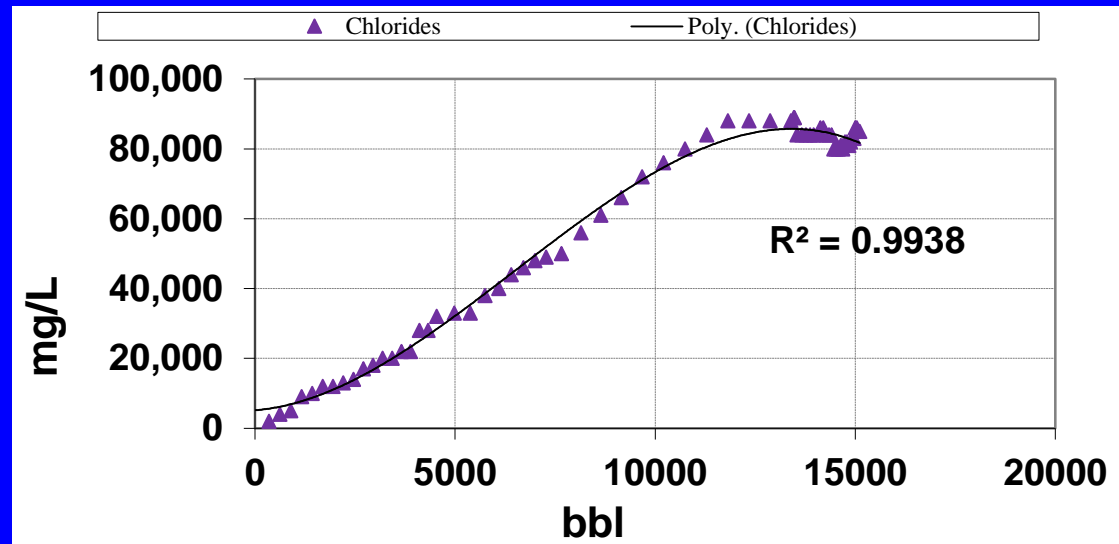
Vertical Wells in Same Township

- **Vertical Well A – 28.1%**
 - Open on 24/64; 3775 psi
 - 24 hours – 769 psi FCP
 - 5264 bbls back
 - 36 choke @ 27.8 hrs
 - 2-in gut line @ 50 hrs
- **Vertical Well B – 75.7%**
 - Open on 24/64; 3450 psi
 - 24 hours – 725 FCP
 - 6705 bbls back
 - 36 choke @ 18.25 hrs
 - 48 choke @ 28 hrs

Primary Flowback Chlorides



Vertical Well A - Recovered 28.1% of 29,214 bbls in 90 Hours

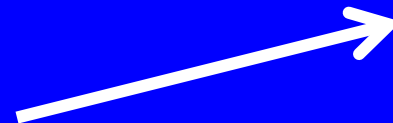


Vertical Well B - Recovered 75.7% of 18,603 Bbls Pumped in

Case History 1

Vertical Wells in Same Township

- **Well A – Flowback -28.1%**
 - FCP to < 10 psi 80 hrs
 - No measureable gas
 - Final Cl- - 34,000 mg/l
 - 180 Day Stats
 - Gas – 20831 Mscf
 - Water – 2159 bbls
 - % FR – 36.1
- **Well B – Flowback 75.7%**
 - Measureable gas @ 40 hrs; Max 2.272 MMscf/D
 - Final Cl- - 89,000 mg/l
 - 180 Day Stats
 - Gas – 82479 Mscf
 - Water – 13469 bbls
 - % FR – 241.9



**Does the Marcellus Shale
produce water from its matrix?**

Case History 1

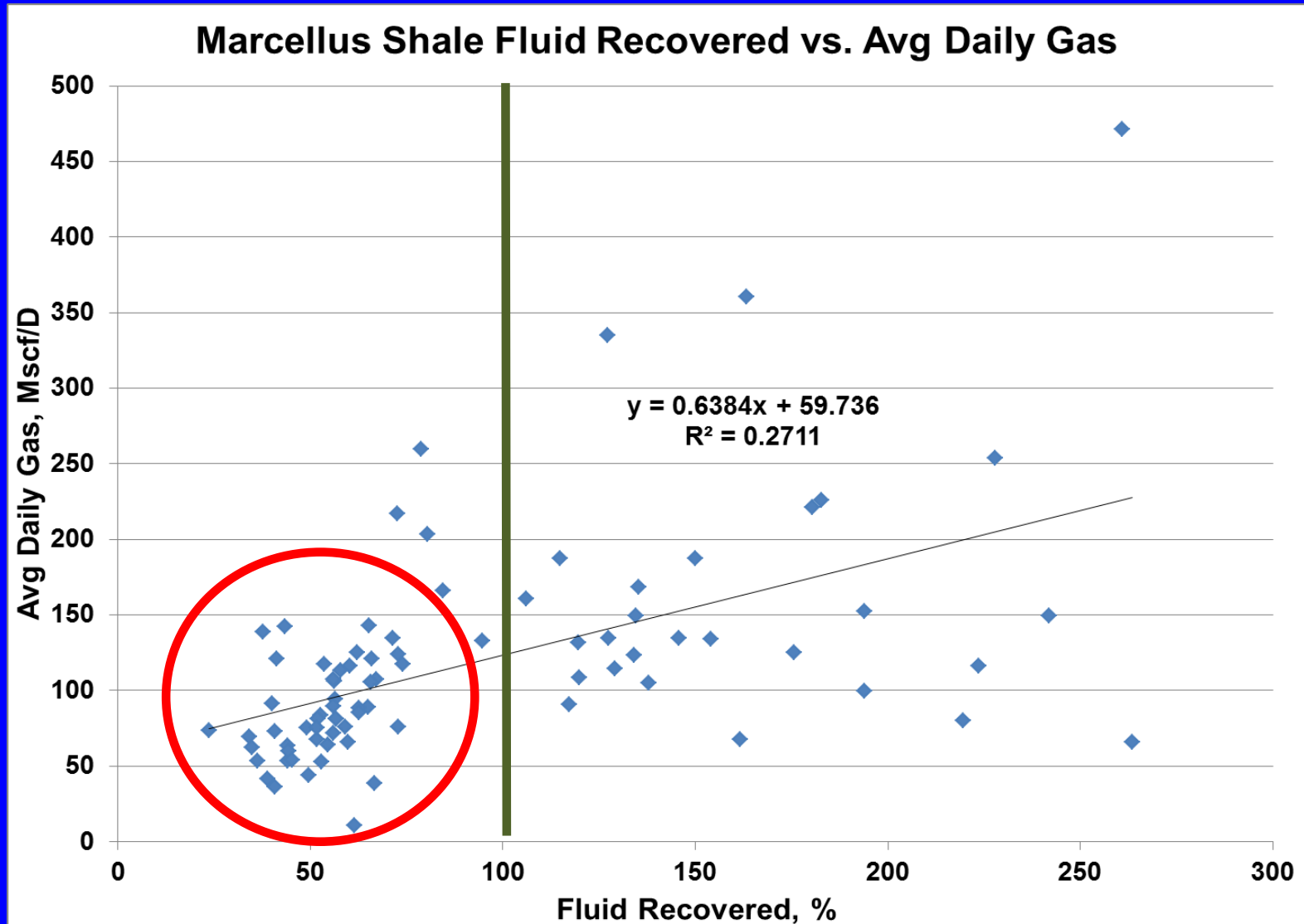
Vertical Wells in Same Township

- **Well A – Flowback - 28.1%**
 - Sampled
 - SG – 1.11
 - Cl – 101,000 mg/l
 - K – 180 mg/l
 - Ba – 3,600 mg/l
 - Sr – 1,800 mg/l
 - Na – 37,000 mg/l
 - Ca – 17,000 mg/l
- **Well B – Flowback -75.7%**
 - Sampled 12/6/2009
 - SG – 1.191
 - Cl - 195,000 mg/l
 - K - 3,629 mg/l
 - Ba – 1,406 mg/l
 - Sr – 6,210 mg/l
 - Na – 90,100 mg/l
 - Ca – 25,270 mg/l

Same Source of Brine?

What Drives Fluid Recovery?

Vertical Well Database



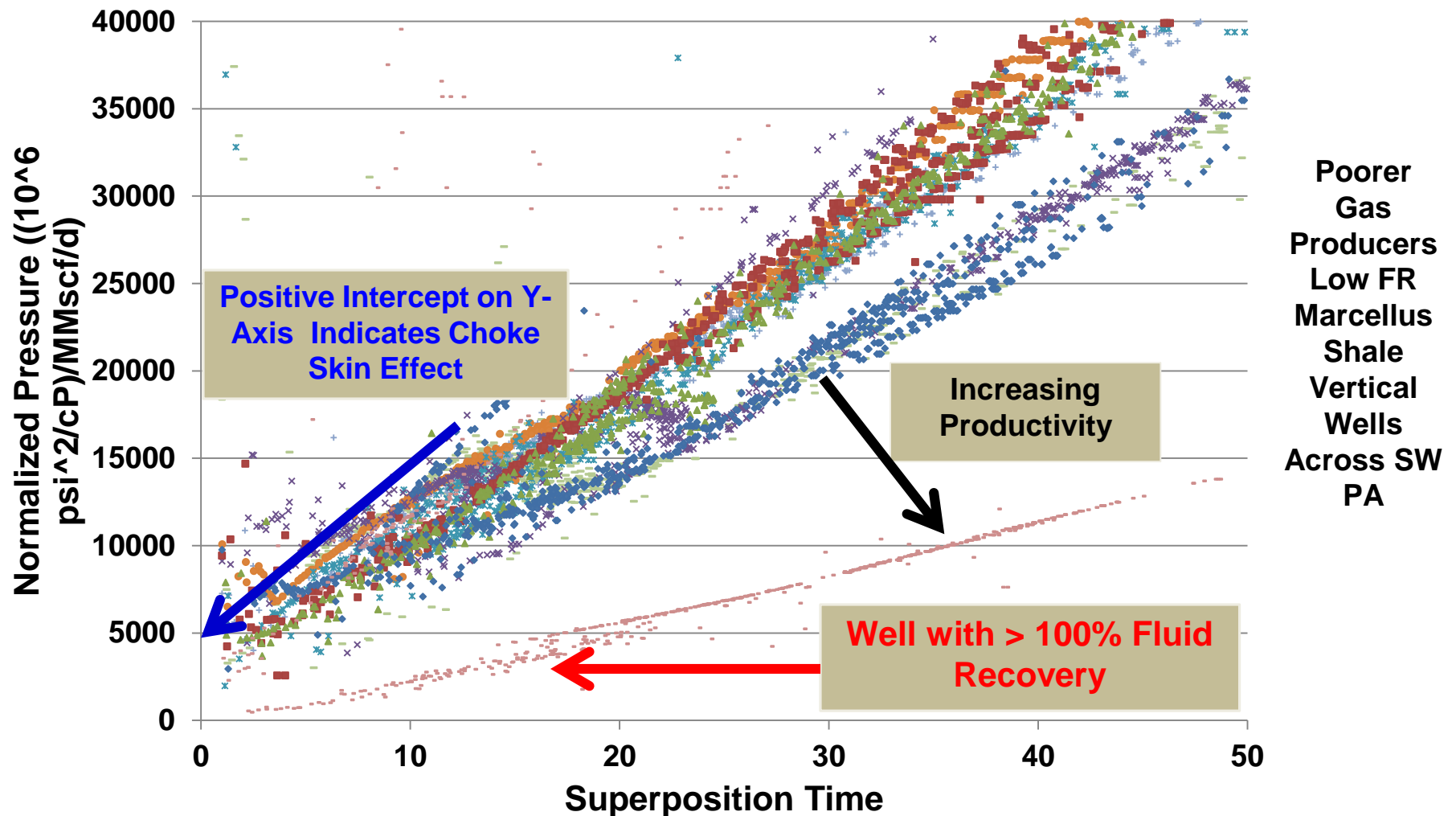
What About Chem Tracers?

60% Fluid Recovery Initial Flowback

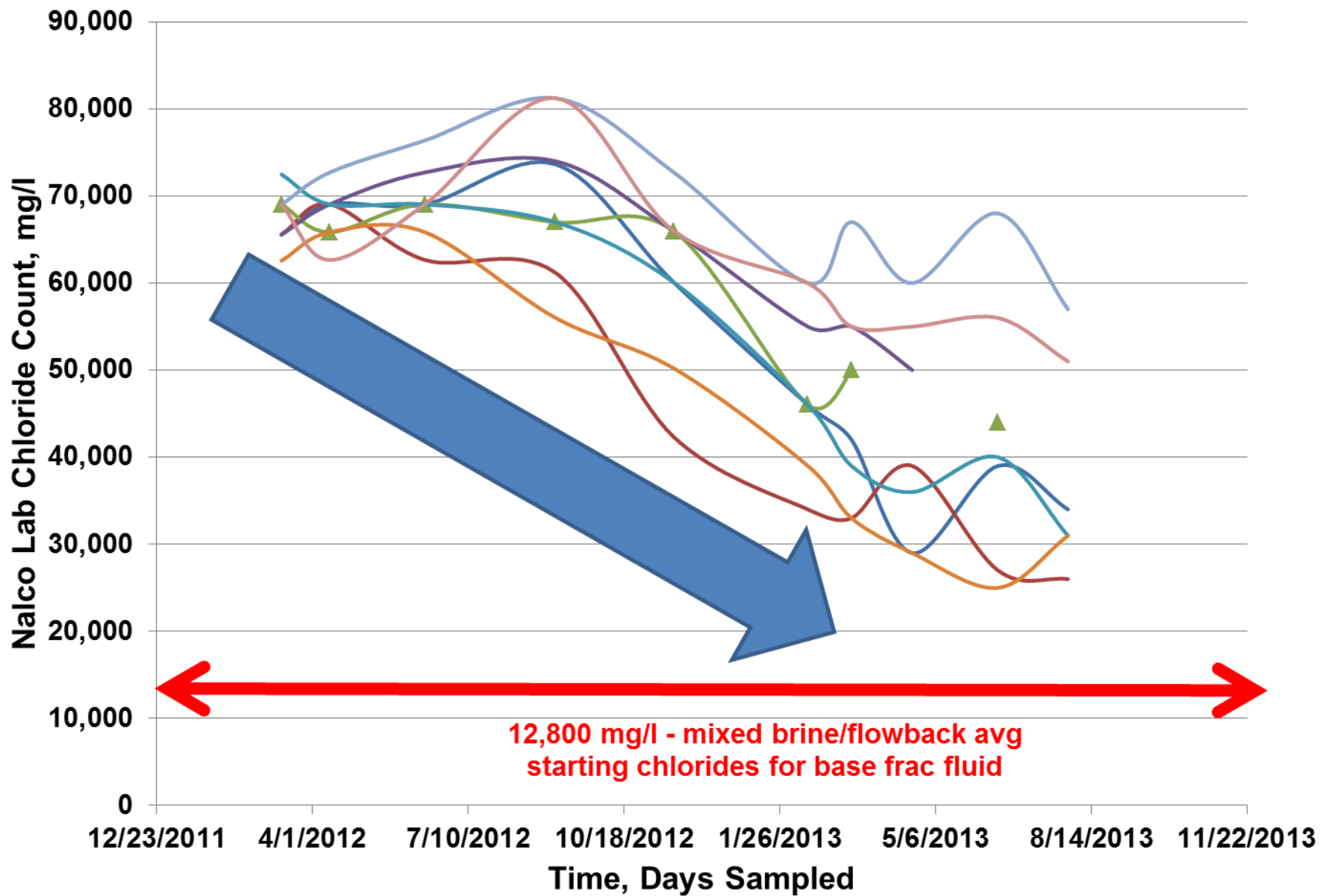
163% Fluid Recovery – 560 days

					Tracer, ppb							
					Stage 1							
Key		Flowback	Sample Date	Sample Type	CFT 1100	CFT Total ppb	Sodium	Potassium	Calcium	Magnesium	Total Chlorides (calculate	
>200	1	not given	05/13/10 08:30	Water (Produced)	232.7	233	42094	1833	9958	1021	87250	
150 to 200	2	not given	05/13/10 20:30	Water (Produced)	197.7	198	43494	1816	10771	1087	91028	
100 to 150	3	not given	05/14/10 18:30	Water (Produced)	184.9	185	45905	1947	11680	1167	96711	
70 to 100	4	not given	05/15/10 19:30	Water (Produced)	190.5	191	45924	1944	11990	1185	97339	
50 to 70	5	not given	05/16/10 21:30	Water (Produced)	153.8	154	48892	2055	12939	1274	103962	
35 to 50	6	not given	05/18/10 22:00	Water (Produced)	166.1	166	48291	2027	12760	1252	102626	
25 to 35	7	not given	05/21/10 09:00	Water (Produced)	141.1	141	51499	2156	13796	1354	109826	
17 to 25	8	not given	05/22/10 07:30	Water (Produced)	140.3	140	50909	2132	13556	1332	108407	
12 to 17	9	not given	05/24/10 09:30	Water (Produced)	108.8	109	53369	2201	14329	1406	113851	
8 to 12	10	not given	05/27/10 09:30	Water (Produced)	111.0	111	55201	2279	14694	1449	117520	
5 to 8	11	not given	05/31/10 07:30	Water (Produced)	106.7	107	55381	2279	14780	1454	117966	
3 to 5	12	not given	06/05/10 10:00	Water (Produced)	95.2	95	56708	2326	15178	1491	120869	
2 to 3	13	not given	02/05/13 12:40	Water (Produced)	16.0	16	37588	1813	8672	486	76434	
1 to 2					Avg ppb	141.9	142	48866	2062	12700	1228	103368
0.05 to 1					% total ppb from Stage	100.0%	100.0%					
					% total ppb @ last sample	100.0%						

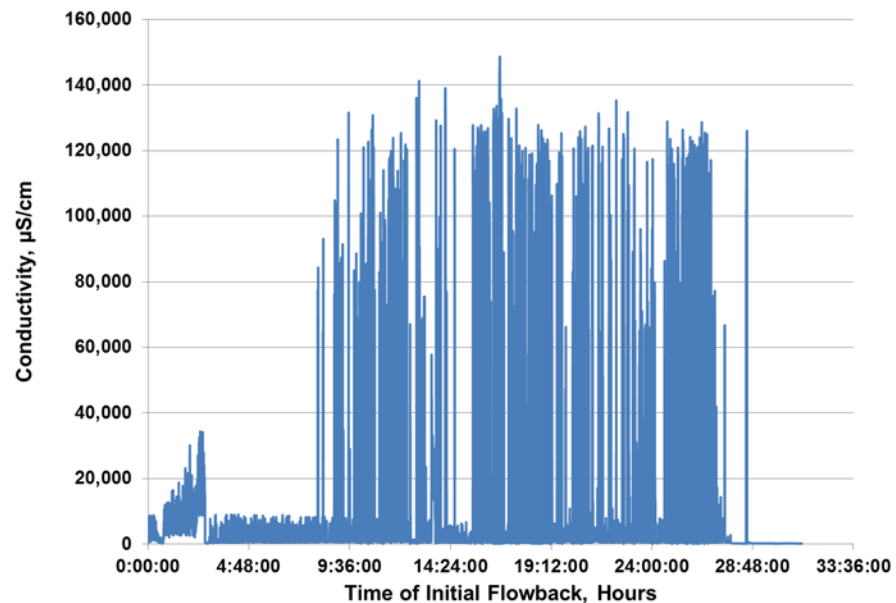
High Water Better Perm



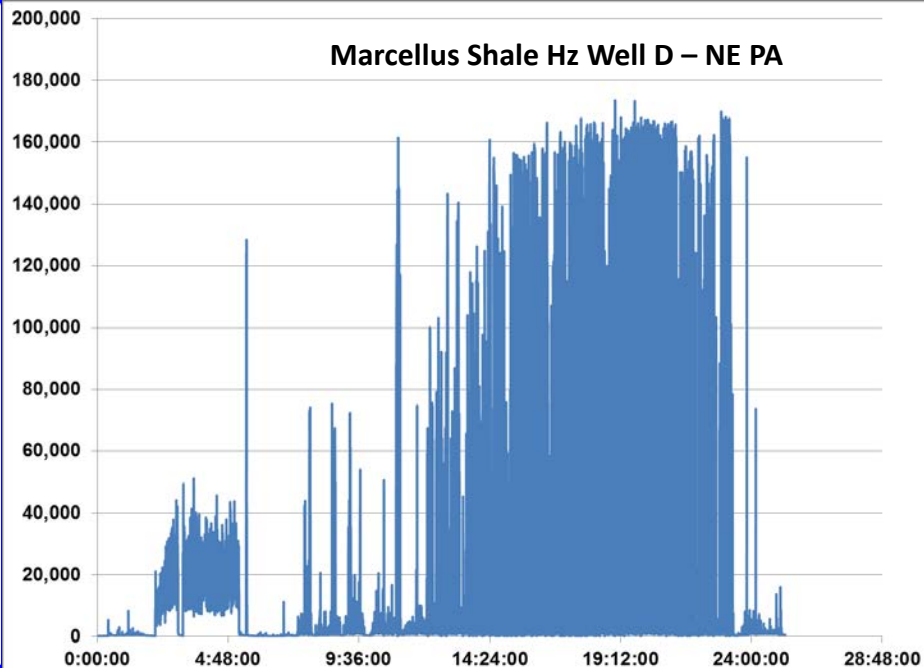
SW PA Marcellus Shale - Horizontal Well Chlorides Over Time



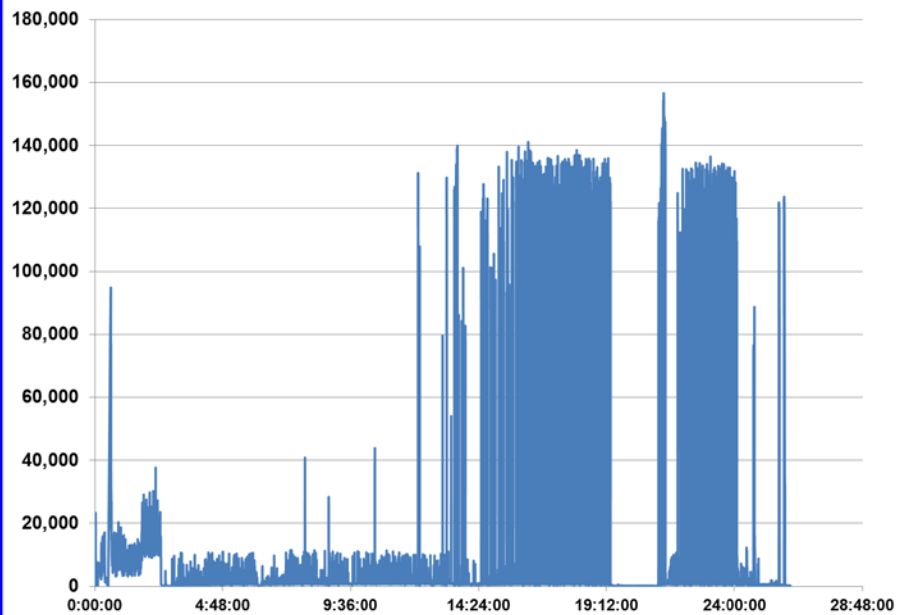
Marcellus Shale Hz Well A - NE PA



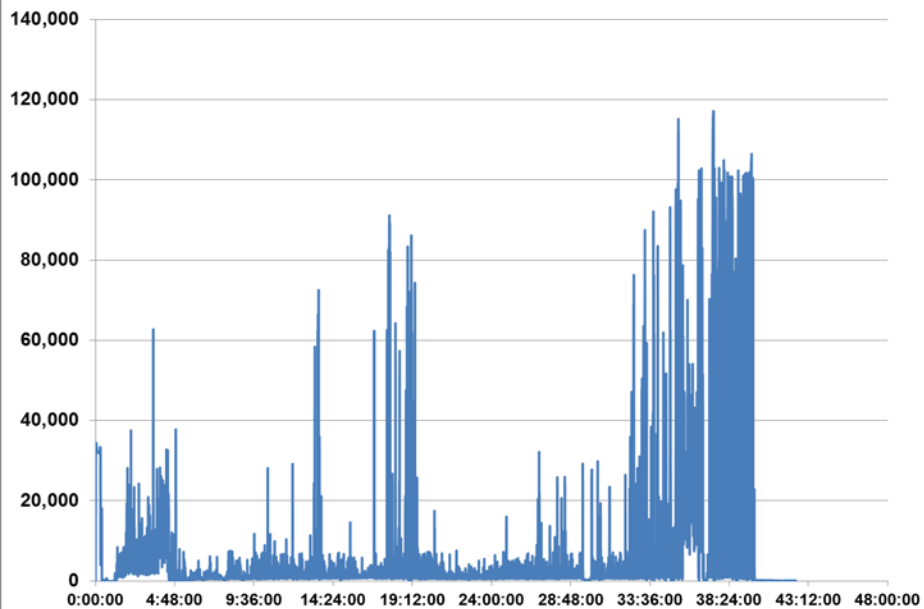
Marcellus Shale Hz Well D – NE PA

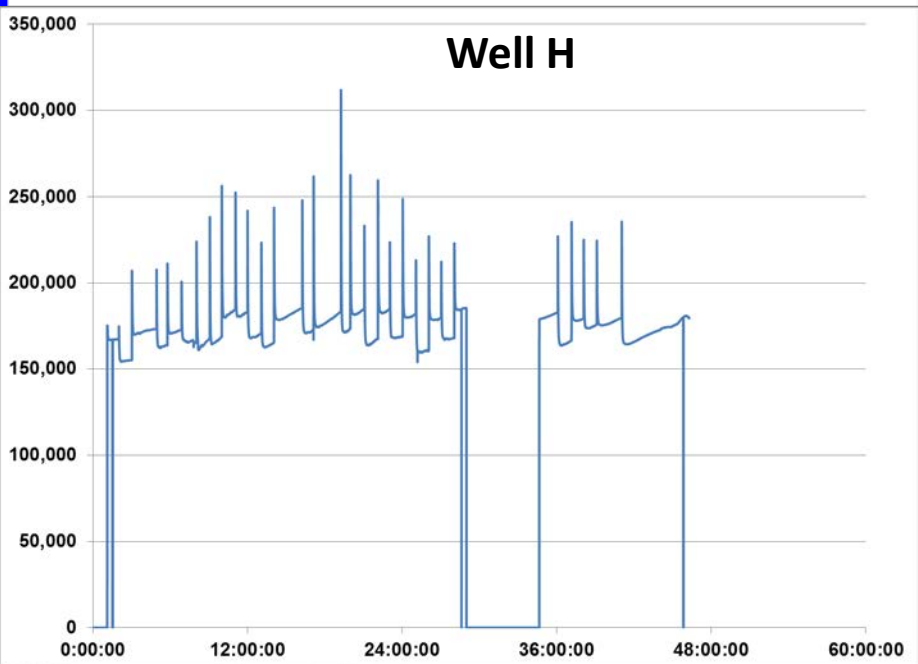
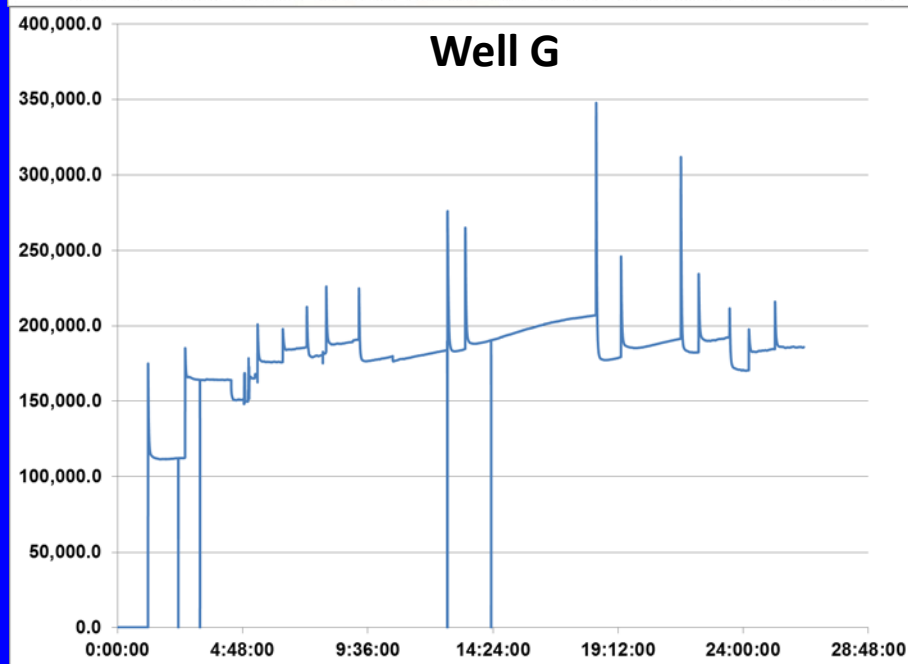
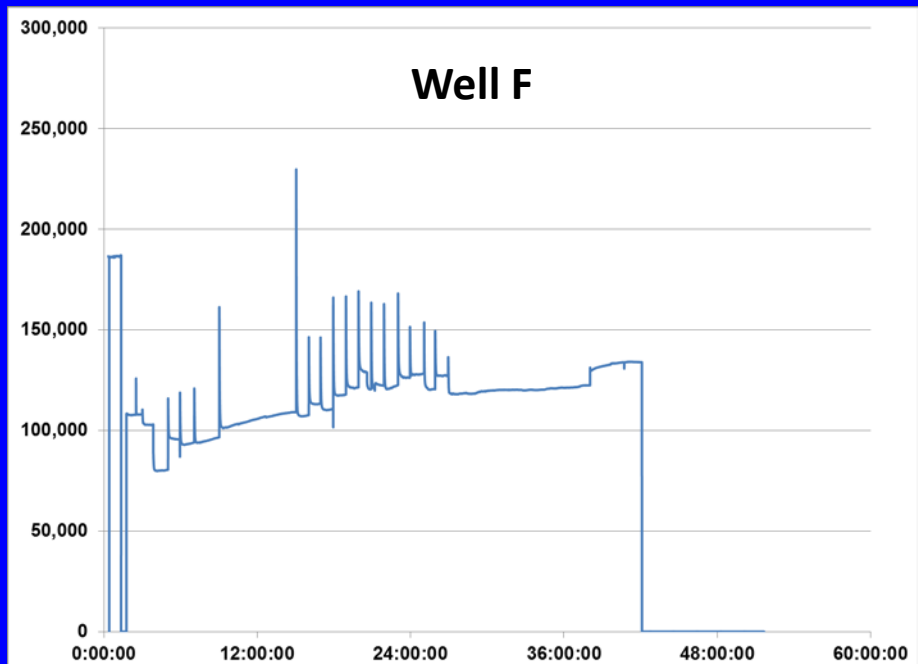
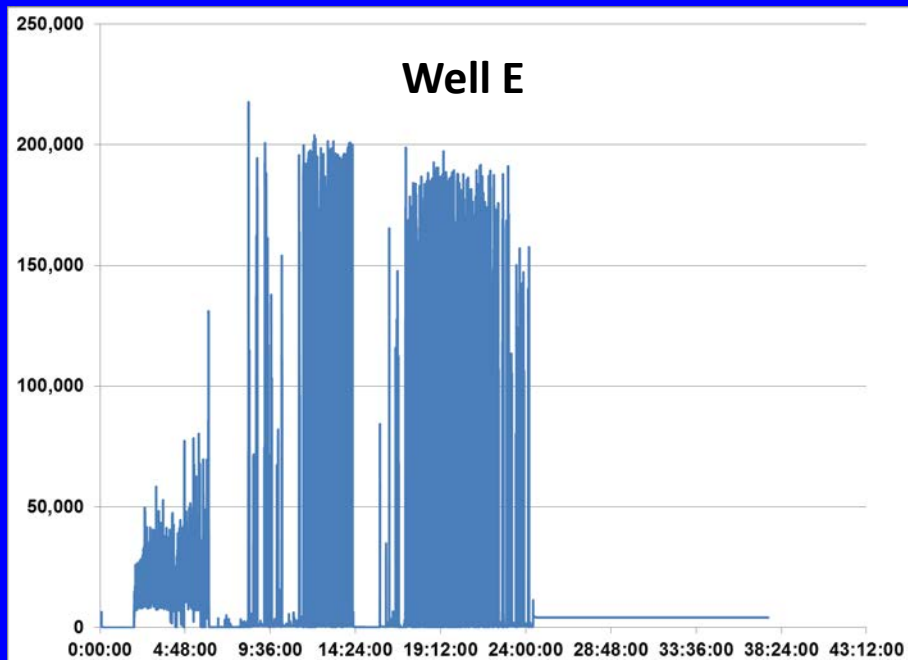


Well C - Marcellus Shale Flowback - Conductivity



Marcellus Shale Flowback - Conductivity





Possible Source of Brine and Gas?!

Honors History of The Appalachian Basin

opened in the Onondaga formation in Pennsylvania (Jan. 1940), some gas has been encountered in this formation in at least two other localities. In 1920, an open flow of about 500,000 cubic feet of gas per day was obtained at a depth of 6,822 feet in the upper part of the Onondaga formation in the Booth and Flinn No. 1 well of the Peoples Natural Gas Company at McCance in Westmoreland County. The gas occurred in a cherty limestone a few feet below the Marcellus black shale of the Hamilton group. When an attempt was made several years later to deepen the well, salt water was encountered in a chert a short distance below the gas-bearing zone. Booth and Flinn No. 2, located about 500 feet from No. 1 and drilled to a total depth of 7,756 feet, encountered only a show of gas and no water in this zone. Although these wells are on the Chestnut Ridge anticline, they are not favorably situated with respect to the domes along its axis.

Wm. E. Snee and Potter Development Company's Indiana Savings and Trust No. 1 well on the Laurel Hill anticline in Fairfield Township in eastern Westmoreland County also encountered an open flow of about 500,000 cubic feet of gas per day in the cherty Onondaga formation. A little salt water entered the well from the lower part of the formation. After the Oriskany sandstone had been penetrated, the flow of water increased greatly.

It is not likely that the Summit pool represents the only occurrence of commercial quantities of gas in the Onondaga formation. Other domes along prominent folds, such as the Chestnut Ridge and Laurel Hill anticlines, in the area over which the Onondaga retains its cherty character, can be looked upon as

Fettke, Charles R., Summit Gas Pool, Fayette County, PA, Progress Report 124, Bureau of Topographic and Geological Survey, Pennsylvania June 1940.

Conclusions

- Variations in flowback rates practiced in Marcellus/Utica Shale
- Often remarkable differences are seen in volume and composition of flowback water among wells in same area
- Water below the Marcellus is a possibility when considering flowback in certain areas of the play

Questions?

