CSG Drilling & Completions Conference

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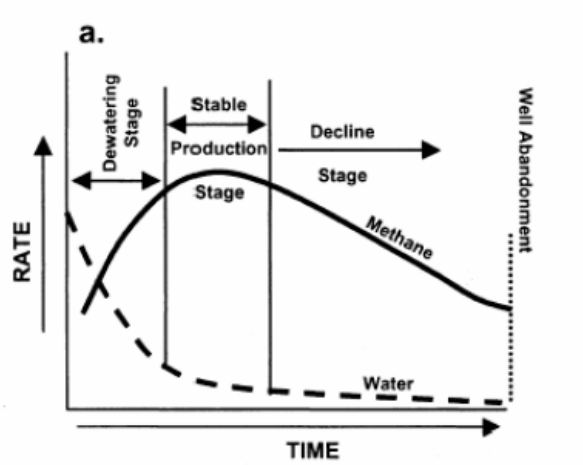
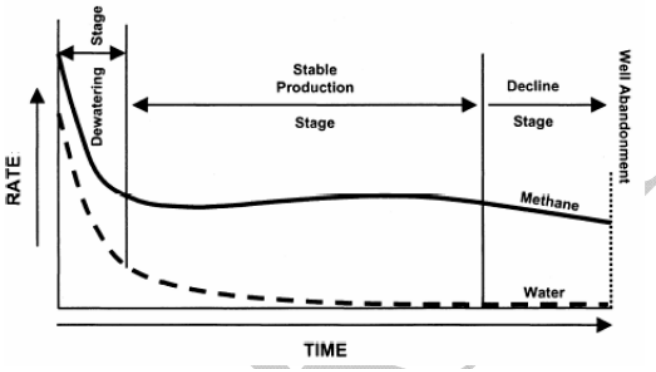
Production profiles

- Permeability is anisotropic (typically 4: 1)
- Low Depositional Energy
  - Permeability changes during the production phase.
    - Depending on the stress environment permeability may decrease during the de-watering phase.
    - Permeability increases during the depletion phase of with gas content.
  - Deliverability profiles are influenced by stress environment

Low Stress



High Stress



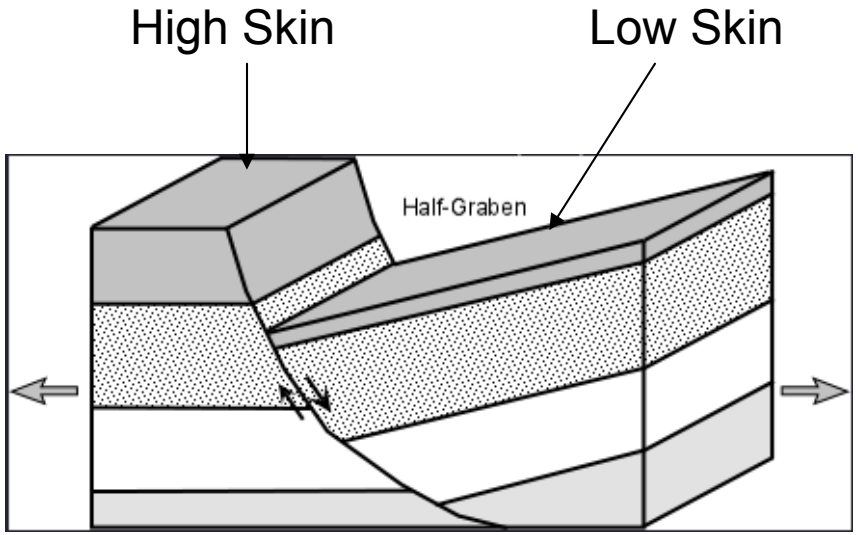
Source: Coalbed gas systems, resources, production and a review of contrasting cases from the San Juan and Powder River Basins; Walter B. Ayers

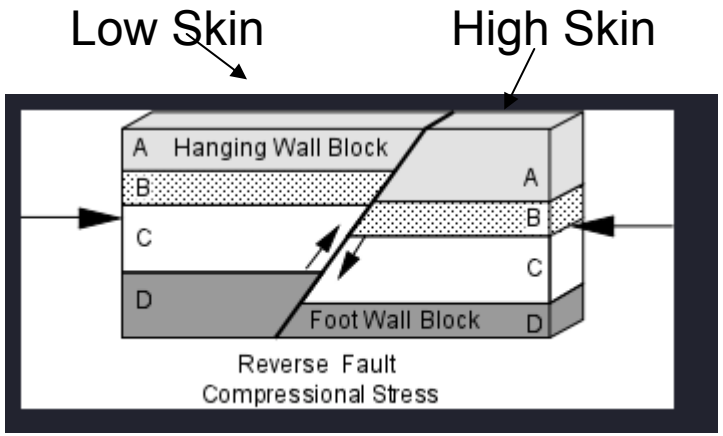
Skin Estimates from DST's

- Skin (conventional) usually refers to damage and related to the ΔP around the wellbore.
- Skin in CSG does not necessarily mean "damage".
- Possible causes of skin:
  - Damage (coal fines, chemical damage etc
  - Desorption near wellbore
  - Stress changes

Observations

- Local Stress may play a role.
- Areas of high skin may coincide with areas of poor deliverability





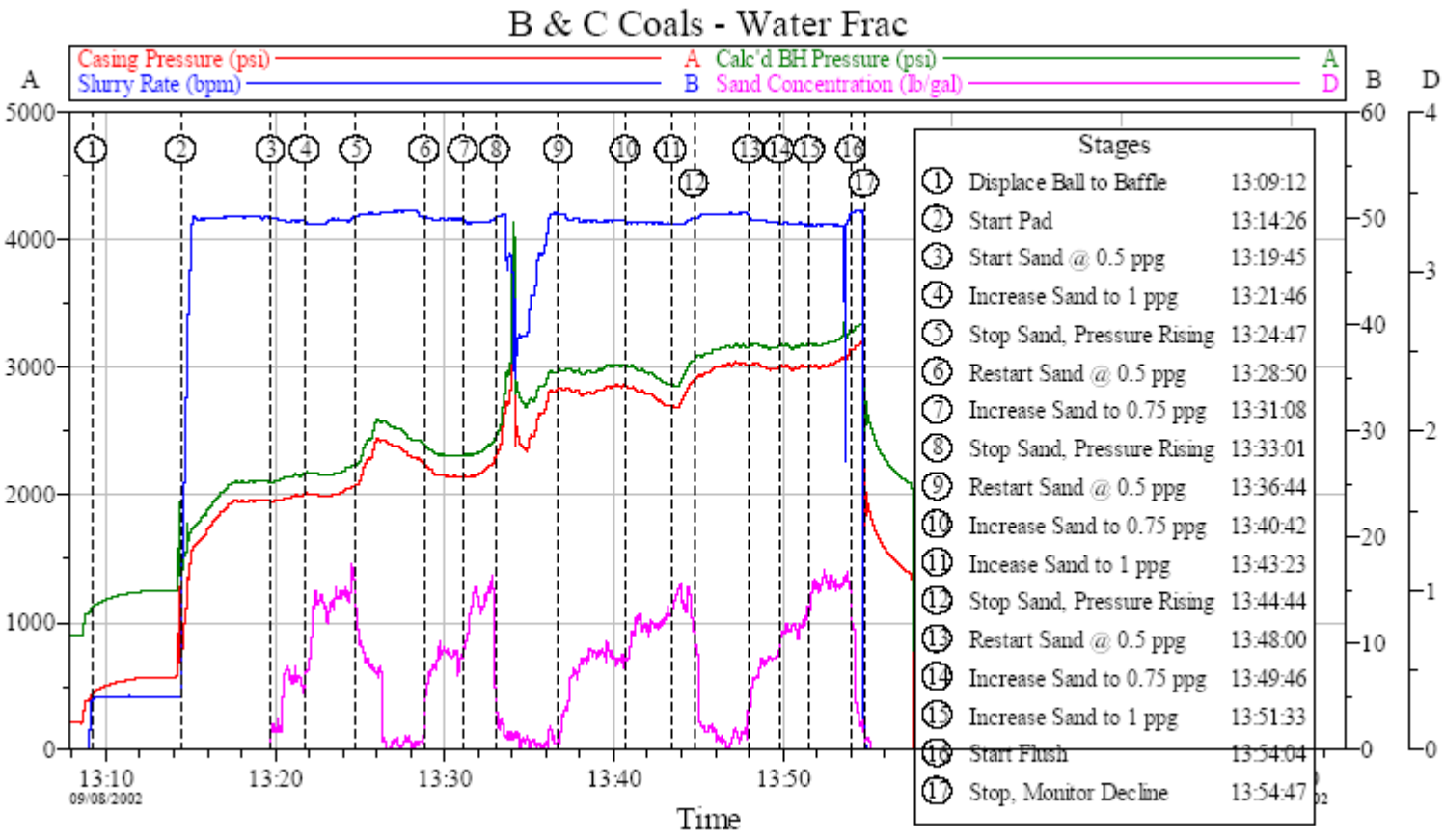
Recommendations

- Keep all DST designs the same.
- The water cushion or back pressure the same for all DST's.
- The water cushion (size) can affect the skin magnitude
- MAP the regional Skin and observe if it matches regional structure.

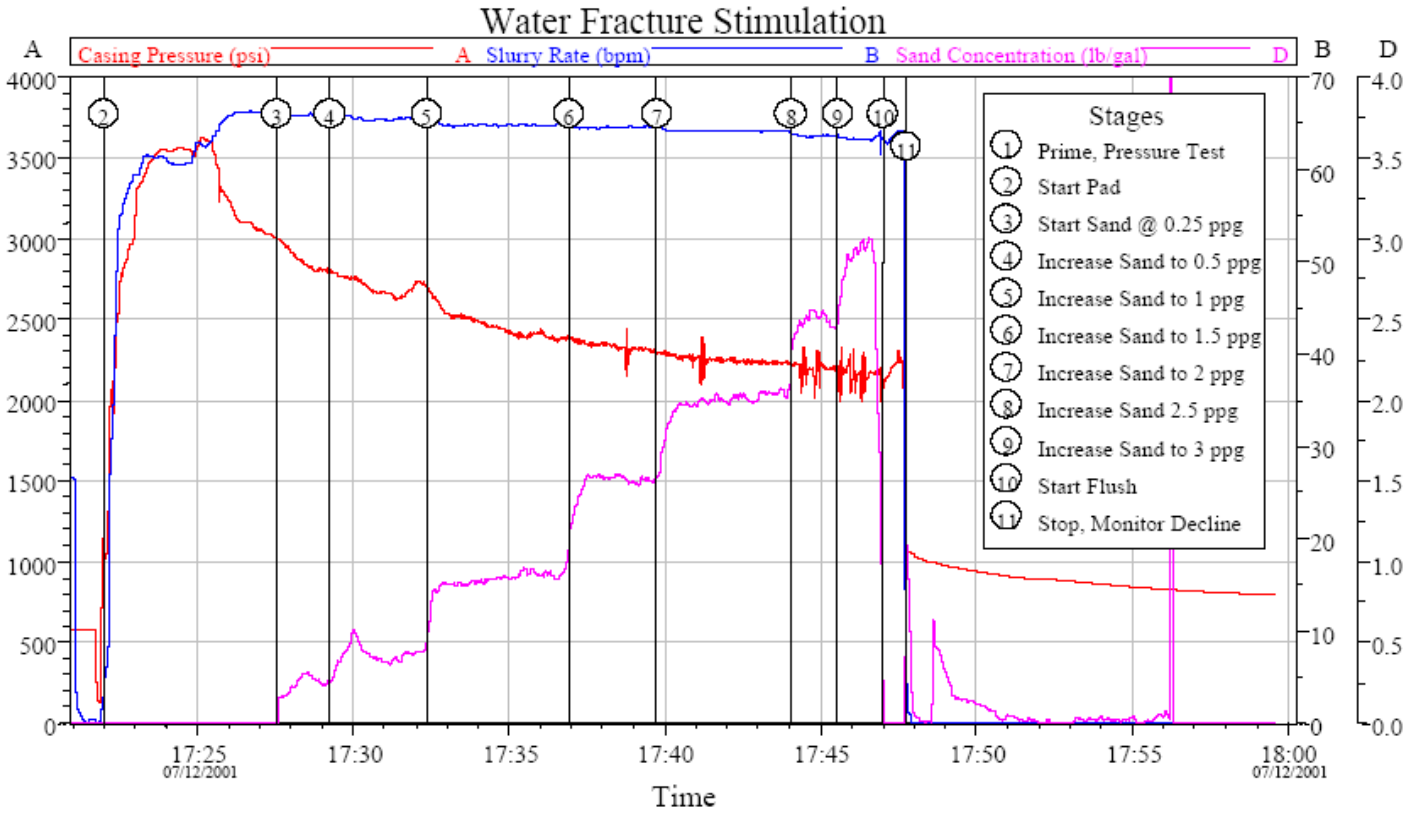
Fracture Stimulation Execution

- Typical Water Frac
- Injecting 25 to 50 BWPM
  - Water Volumes ~ 3000 BBls
  - Sand Volumes + 60,000lbs
- Job Management
  - Pumping rate
  - Sand Concentration
  - Pressure

Typical Good Job.



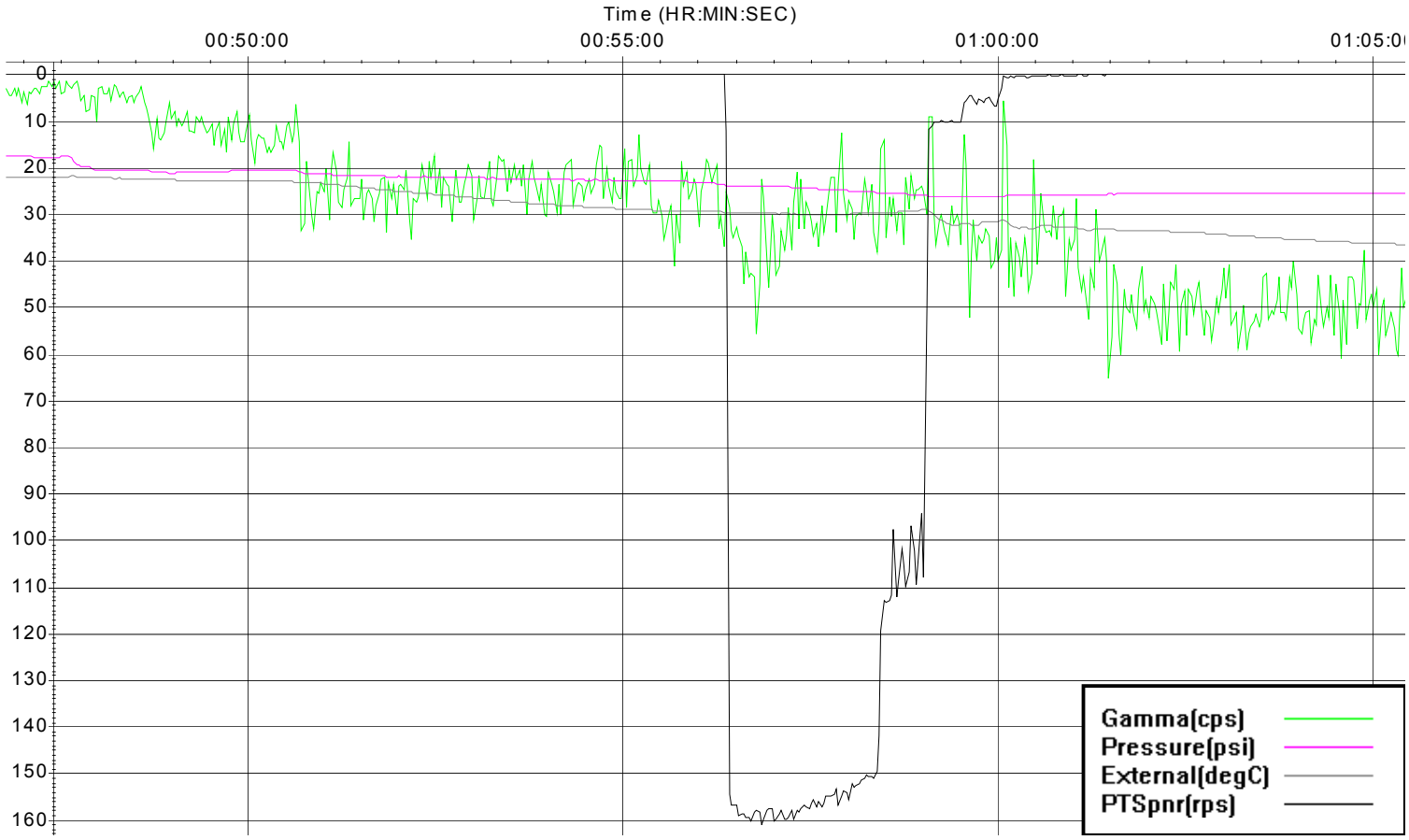
Poor Job


Water Fracture Stimulation
A
Casing Pressure (psi)
A Slurry Rate (bpm)
B Sand Concentration (lb/gal)
D
B
D
4000
3500
3000
2500
2000
1500
1000
500
0
70
60
50
40
30
20
10
0
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
17:25
07/12/2001
17:30
17:35
17:40
17:45
17:50
17:55
18:00
07/12/2001
Time
Stages
1 Prime, Pressure Test
2 Start Pad
3 Start Sand @ 0.25 ppg
4 Increase Sand to 0.5 ppg
5 Increase Sand to 1 ppg
6 Increase Sand to 1.5 ppg
7 Increase Sand to 2 ppg
8 Increase Sand 2.5 ppg
9 Increase Sand to 3 ppg
10 Start Flush
11 Stop, Monitor Decline

Co-mingled production

- Difficult to know
  - which zones are following
  - Each zone contribution
- Production Logging
  - Very difficult to perform
  - Best in wells which produce minor amounts of water i.e < 20 bwpd

Production logging



Multi Seam Frac Stim:

Technique influences how many seams are stimulated.

Single frac per seam is best:

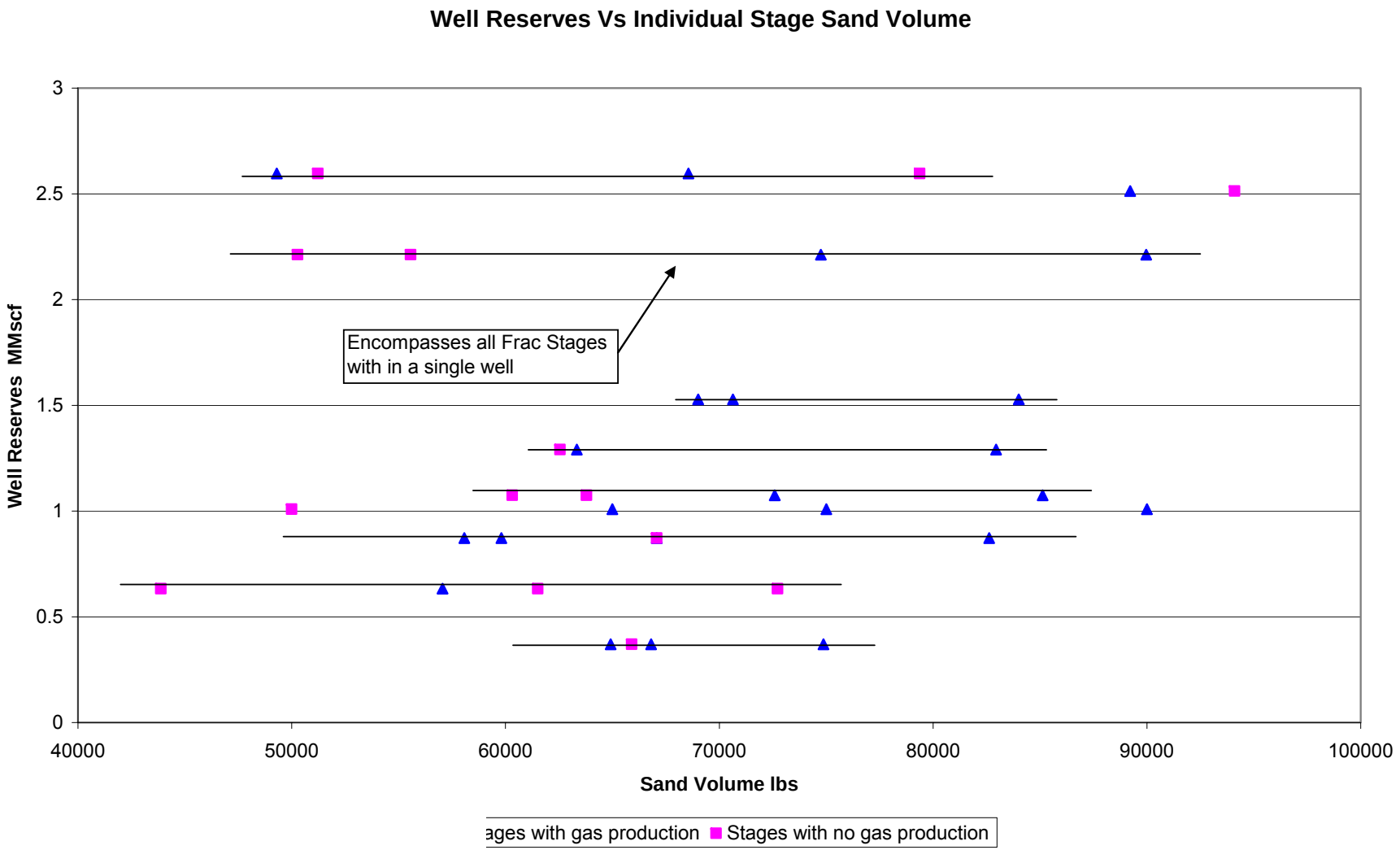
Two seams per frac is doable.

Three and above much more difficult.

Number of Seams per stage	All seams	Fracs with near or total screen-outs	Fracs- trouble free
	Percentage of Seams that flowed (%)	All Seams in each stage that flowed (%)	All Seams in each stage that flowed (%)
one seam	100	100	100
two seams	55	71	25
three seams	25	50	0

The Importance of sand?

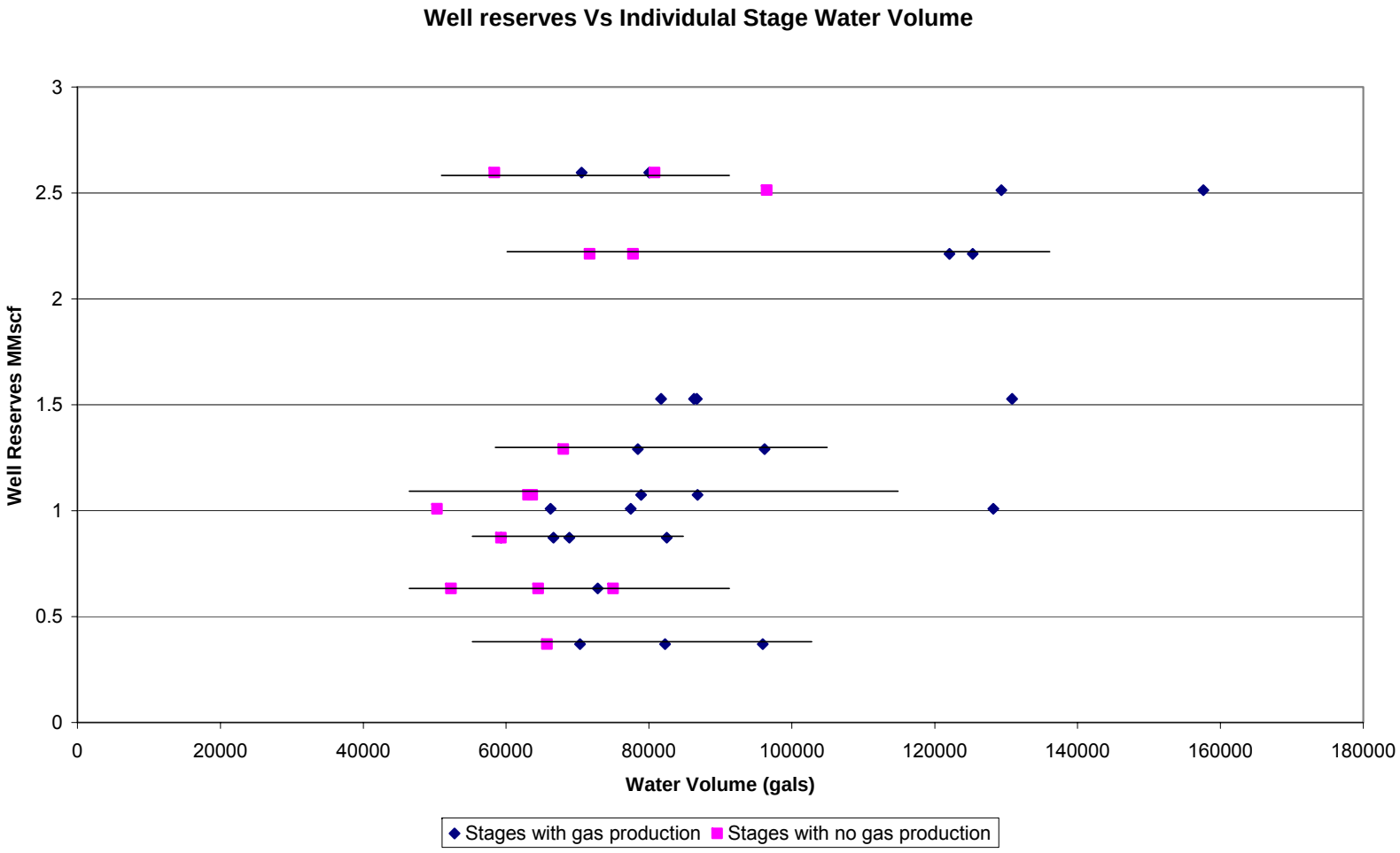
What Role does sand play? Is it just asperity



Water Volume is important.

Seams with no production Water Volume << Seams with production Water Volume

Reminiscant of Shale Play Fracs



Frac Recovery factor

- Fracture Stimulation is usually performed in low permeable areas.
- First Frac Stim results in low recovery often <20%
- Production decline due to healing of the induced Fracs
- To Restore production & improve recovery – Re-fracs are a must.

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