UNCONVENTIONAL®
RESOURCES TECHNOLOGY CONFERENCE
FUELED BY SPE • AAPG • SEG

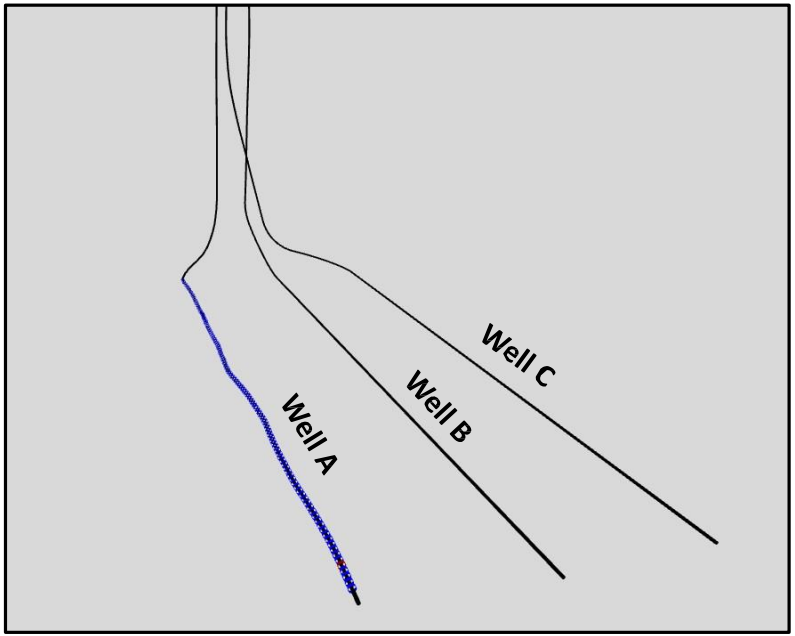
Modeling Multi-Fractured Horizontal Well Completions; a Case for Planar Hydraulic Fractures

Robert Shelley PE, StrataGen
Brian Davidson, StrataGen
Koras Shah, StrataGen

StrataGen®

Well Pad Layout

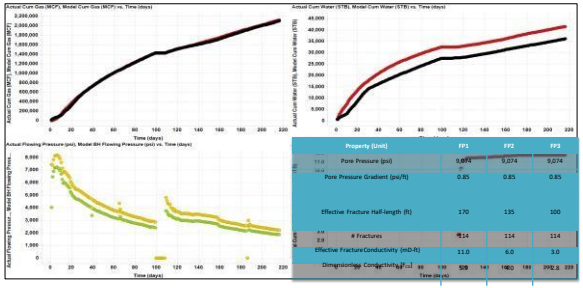
- Three Direct Offsets
  - Similar Prod Start Dates
  - 220 Days Production
- Similar Lateral Lengths
- Different Frac Designs
  - Proppant Volume & Selection
  - Frac Volume
  - Frac Stages Completed



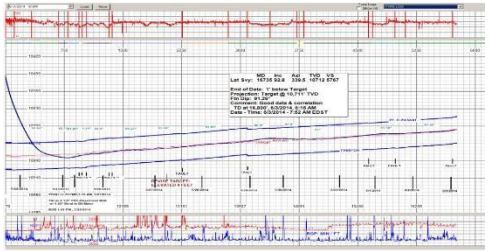
Well	Prop Description	Prop. Wt. (Million Lb.)	Fluid Vol. (Million gal.)	Lateral Length (ft.)	Frac Stages Completed	Perf Clusters per Stage
A	Resin Coated Sand (RCS) - Sand	10.3	9.3	5,800	24	5
B	Low Density Ceramic (LDC) - Sand	11.5	10.3	6,100	24	5
C	Low Density Ceramic (LDC)	7.1	8.8	6,200	21	5

Well Performance Modeling Approach

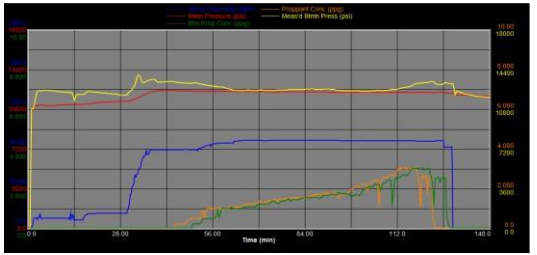
Production History Match



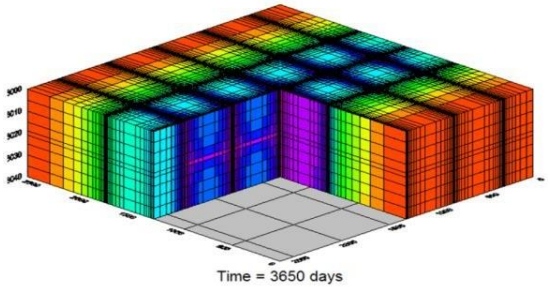
Drilling, Reservoir & Geology



Frac Pressure Match

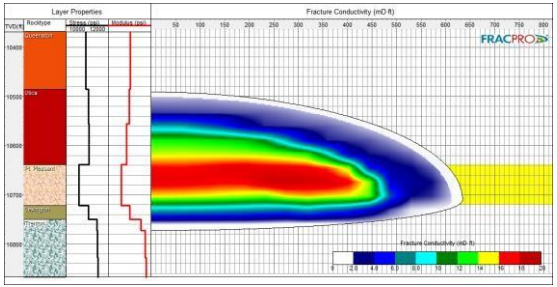


Calibrated Reservoir Model

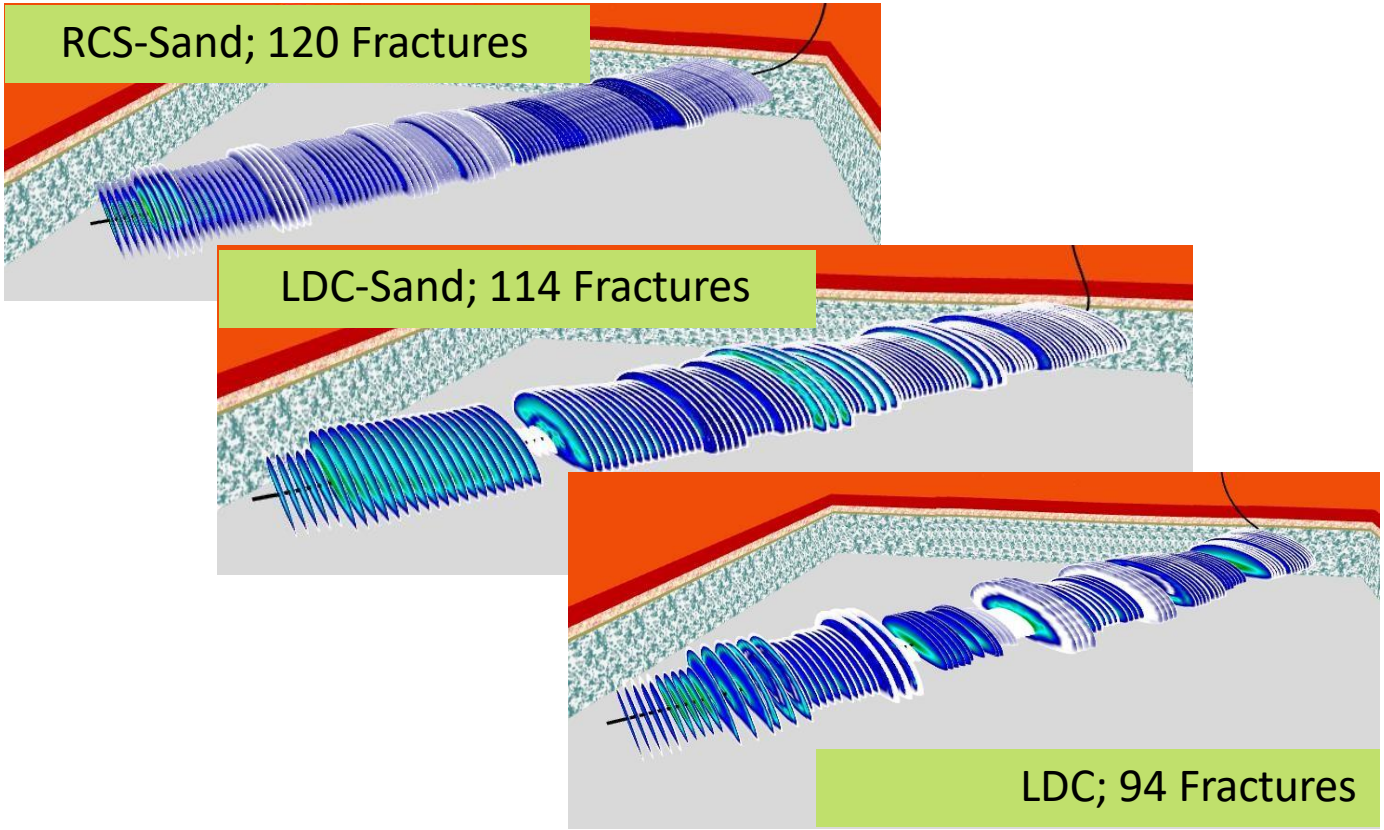


Compare Fracture Characteristics

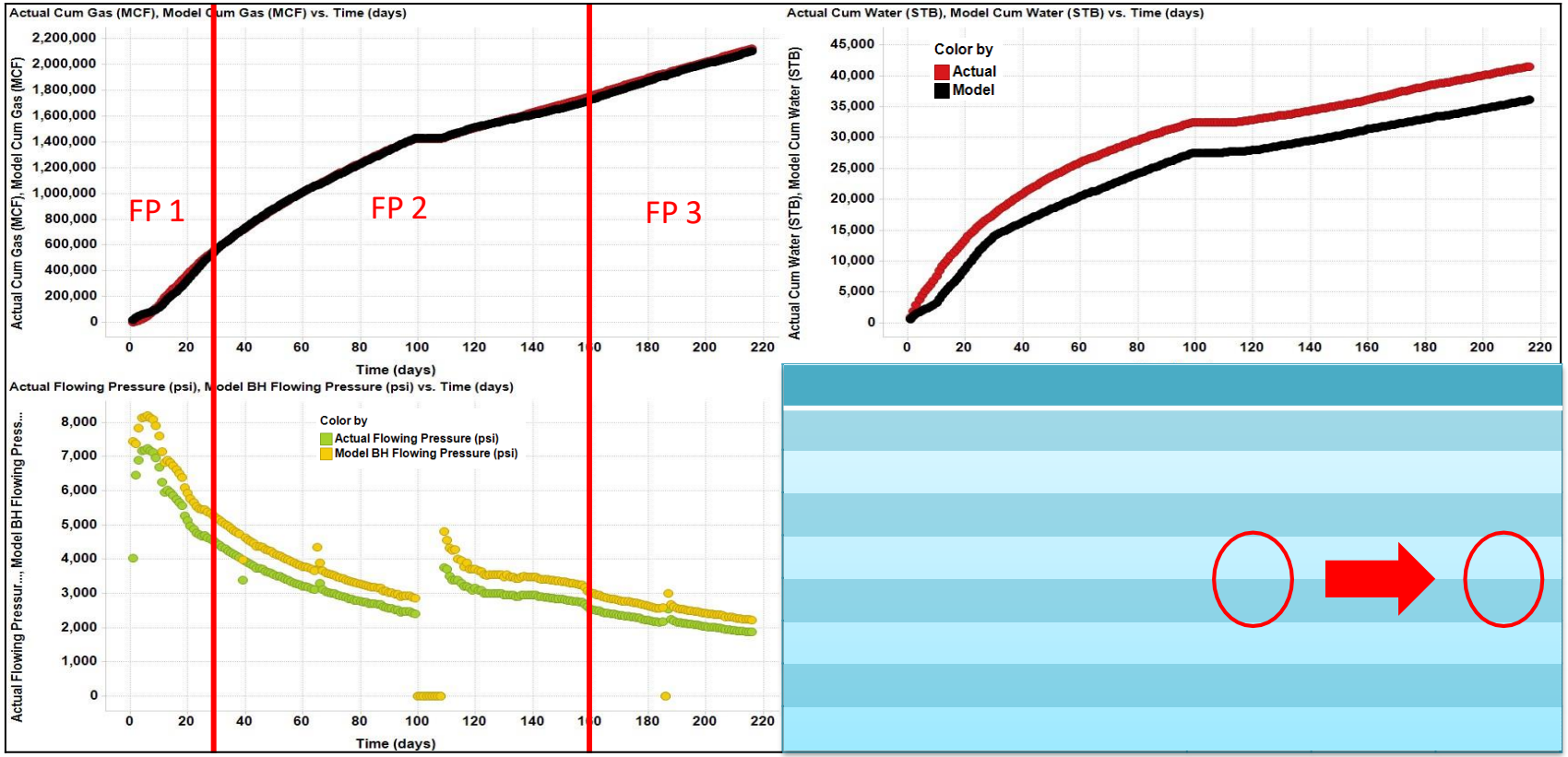
Calibrated Frac Model



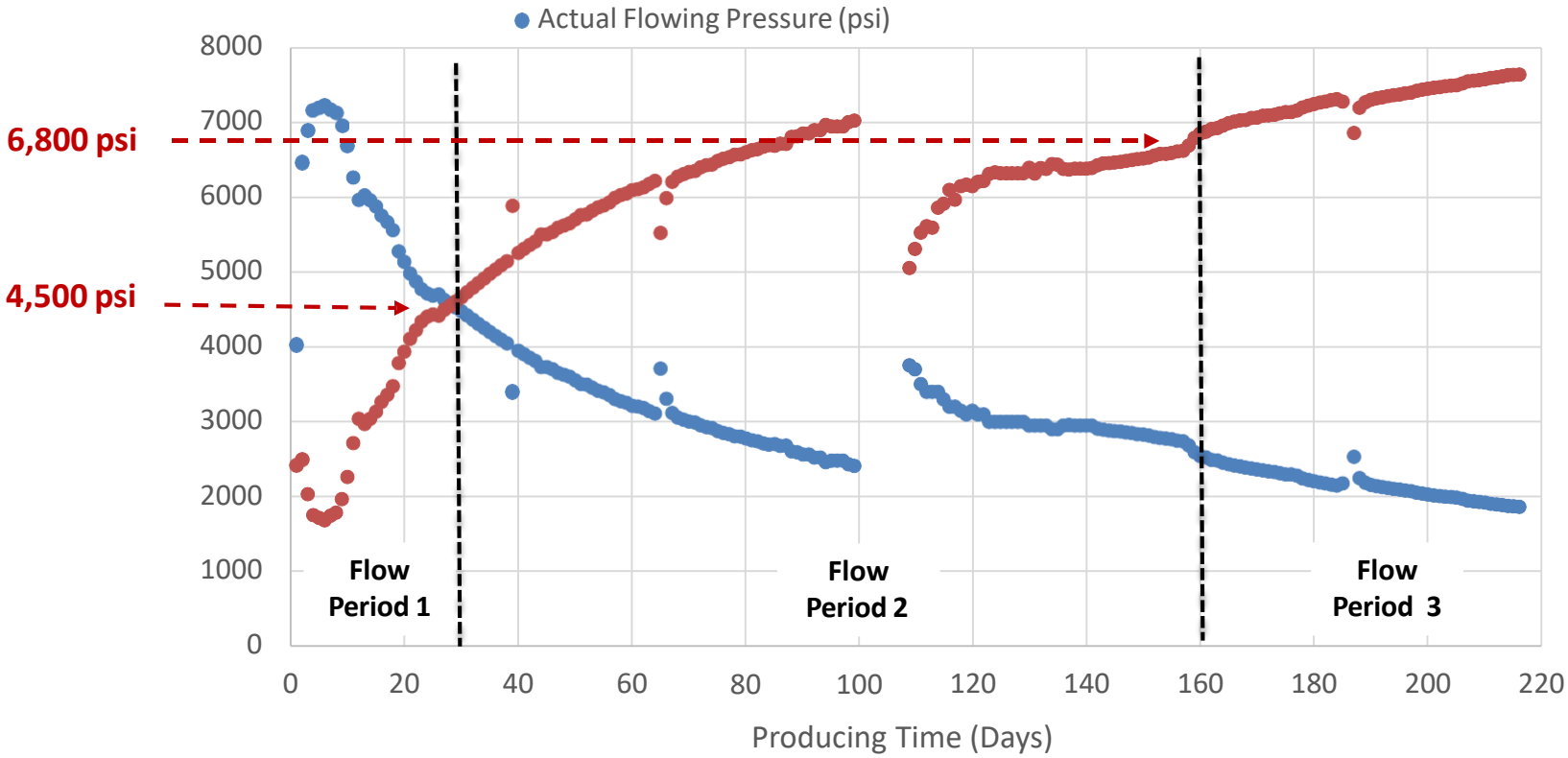
Frac Model Geometry - Wellbore Profile View



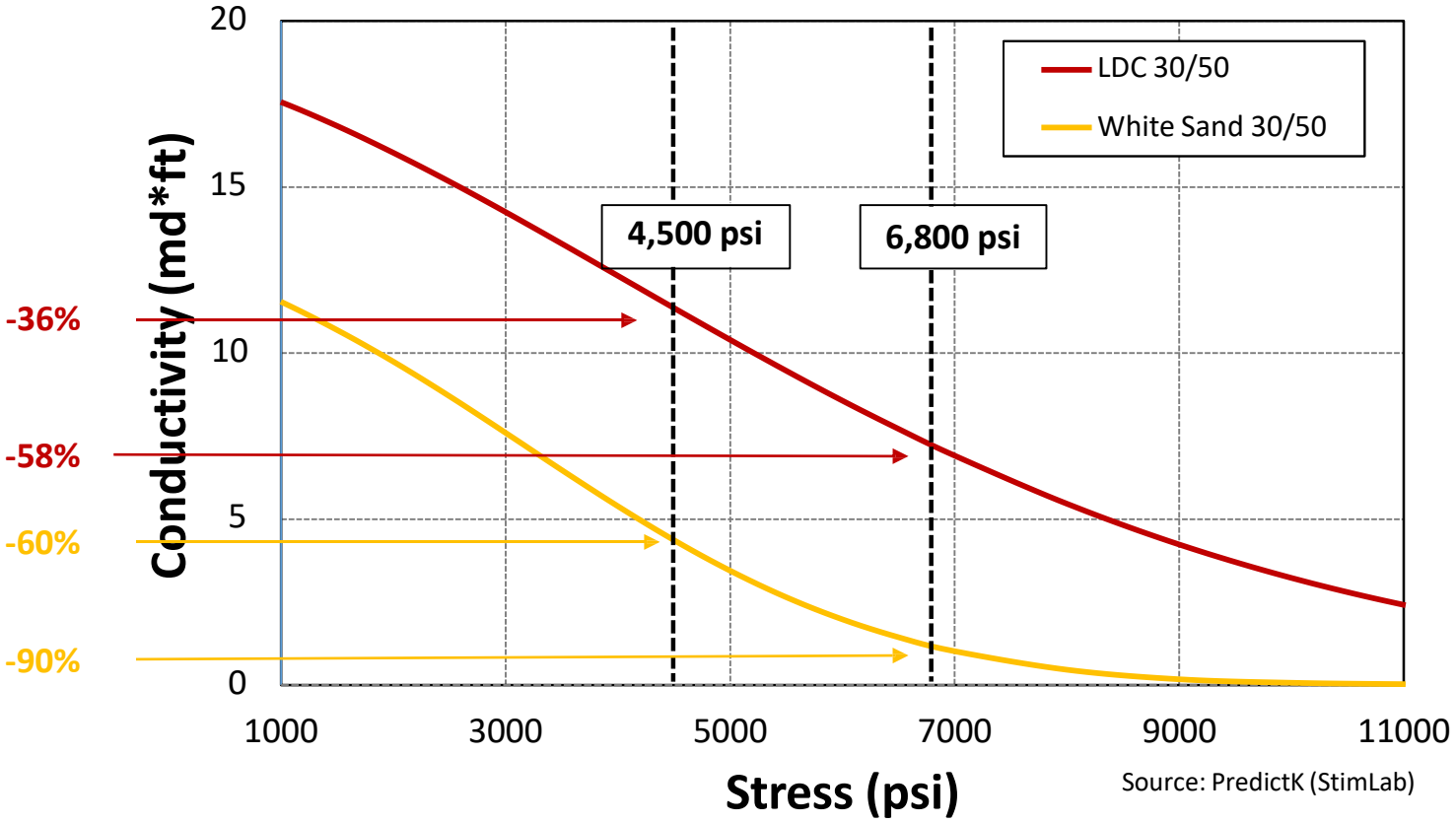
Reservoir Model - Production History Match (Well B)



Surface Flowing Pressure & Stress on Proppant (Well B)

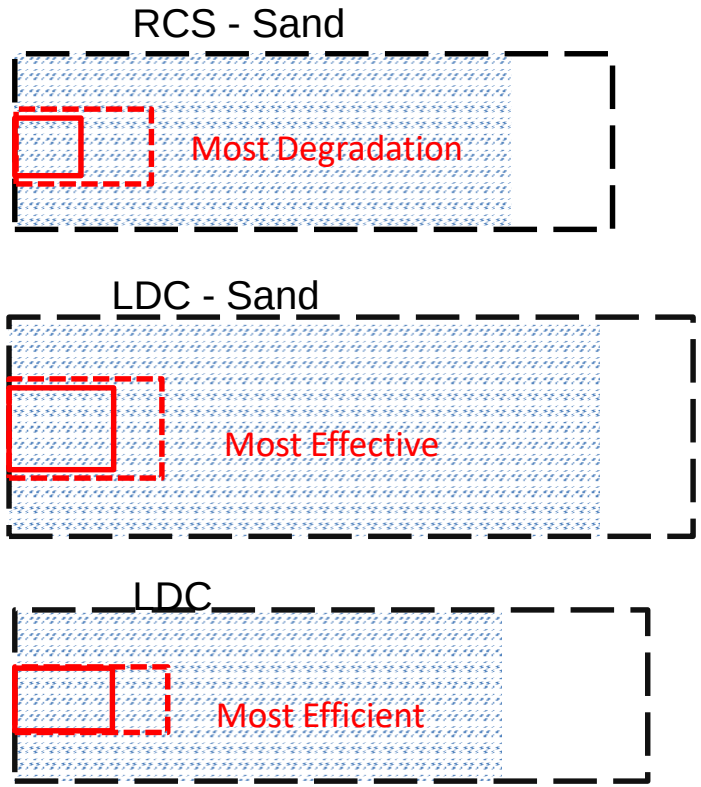


Dynamic Proppant Conductivity



Source: PredictK (StimLab)

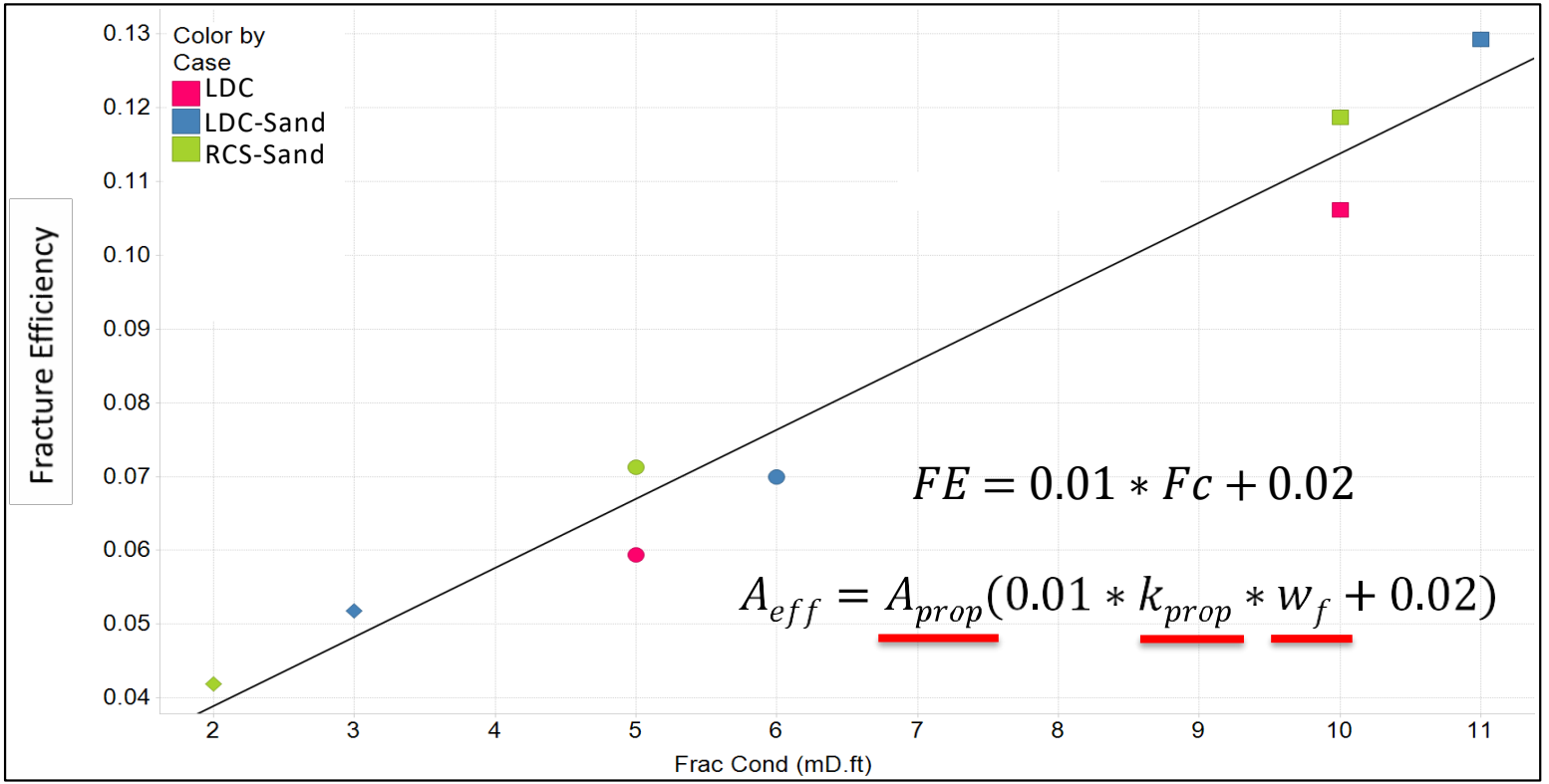
Fracture Profiles



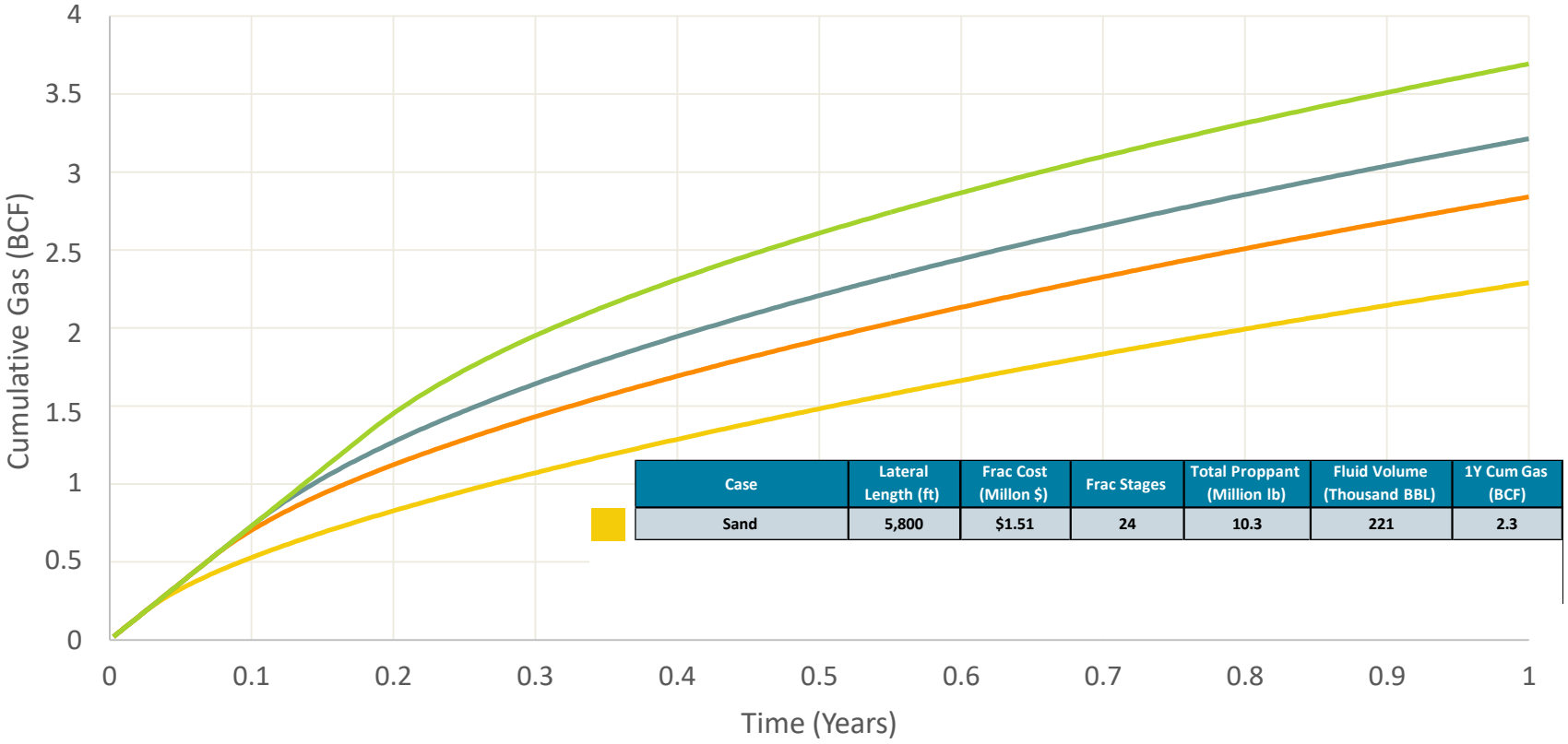
Fracture Characteristics	RCS-Sand	LDC-Sand	LDC
Proppant (lb)	85,800	100,900	75,500
Fluid Volume (gal)	77,500	90,400	93,600
Avg Created Half-Length (ft)	650	730	680
Avg. Propped Half-Length (ft)	540	630	530
Avg Propped height (ft)	200	230	190
Effective Half-Length (ft)	150 - 75	170 - 100	165 - 100
Effective Height (ft)	85 - 60	110 - 75	65 - 60
Effective Cond. (md-ft)	10 - 2	11 - 3	10 - 5
Contributing Area (Msqft/frac)	25.5 – 9.0	37.4 – 15.0	21.5 – 12.0
Fracture Efficiency %	12.0 - 4.2	12.9 - 5.3	10.5 - 6.1

Relationship Between Fracture Efficiency and Conductivity

Fracture Efficiency (FE) = Effective Area (A_{eff})/Propped Area (A_{prop})

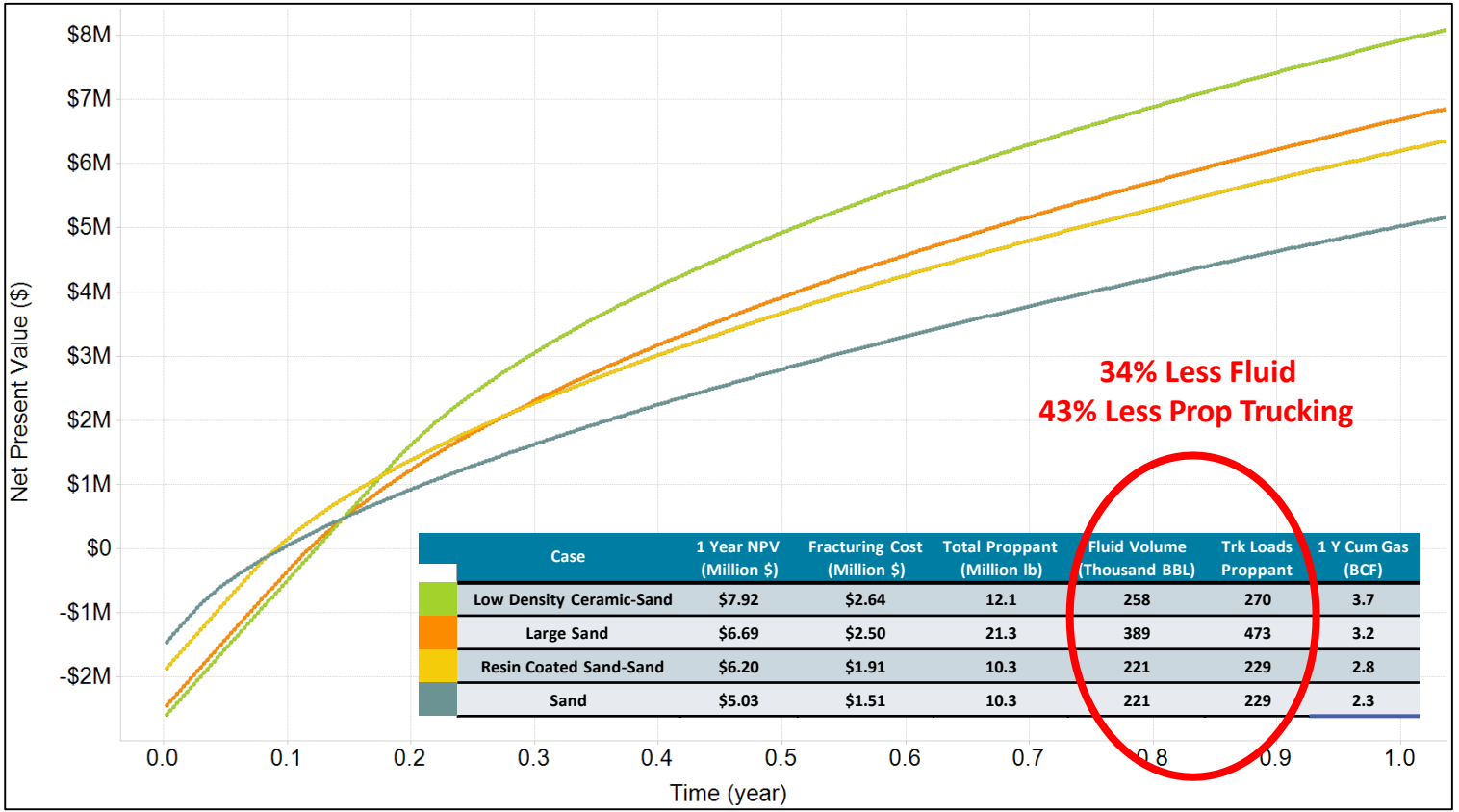


Frac Design Production Forecasts



Case	Lateral Length (ft)	Frac Cost (Millon $)	Frac Stages	Total Proppant (Million lb)	Fluid Volume (Thousand BBL)	1Y Cum Gas (BCF)
Sand	5,800	$1.51	24	10.3	221	2.3

Frac Design Economic Forecasts



Case	1 Year NPV (Million $)	Fracturing Cost (Million $)	Total Proppant (Million lb)	Fluid Volume (Thousand BBL)	Trk Loads Proppant	1 Y Cum Gas (BCF)
Low Density Ceramic-Sand	$7.92	$2.64	12.1	258	270	3.7
Large Sand	$6.69	$2.50	21.3	389	473	3.2
Resin Coated Sand-Sand	$6.20	$1.91	10.3	221	229	2.8
Sand	$5.03	$1.51	10.3	221	229	2.3

Conclusions

- There is significant hydraulic fracture inefficiency due to stranding of large portions of the propped fracture area which consequently do not contribute to well performance.
  - Increasing fracture conductivity appears to mitigate this issue resulting in improved fracture effectiveness, greater effective frac length and area.
- Proppant placement difficulties which reduce cluster efficiency, proppant and treatment volumes placed; decrease fracture effectiveness and well production.
  - These issues can be caused by formation and/or completion/frac design issues.
- This data indicates that a hydraulic fracture's effectiveness degrades over time. It was necessary to incorporate fracture degradation to match the production performance of these wells.
  - Pressure drawdown due to production which increases the stress on proppants appears to reduce fracture conductivity and effective fracture area.

Thank You!