Unconventional Completion Practices: Eagle Ford Shale

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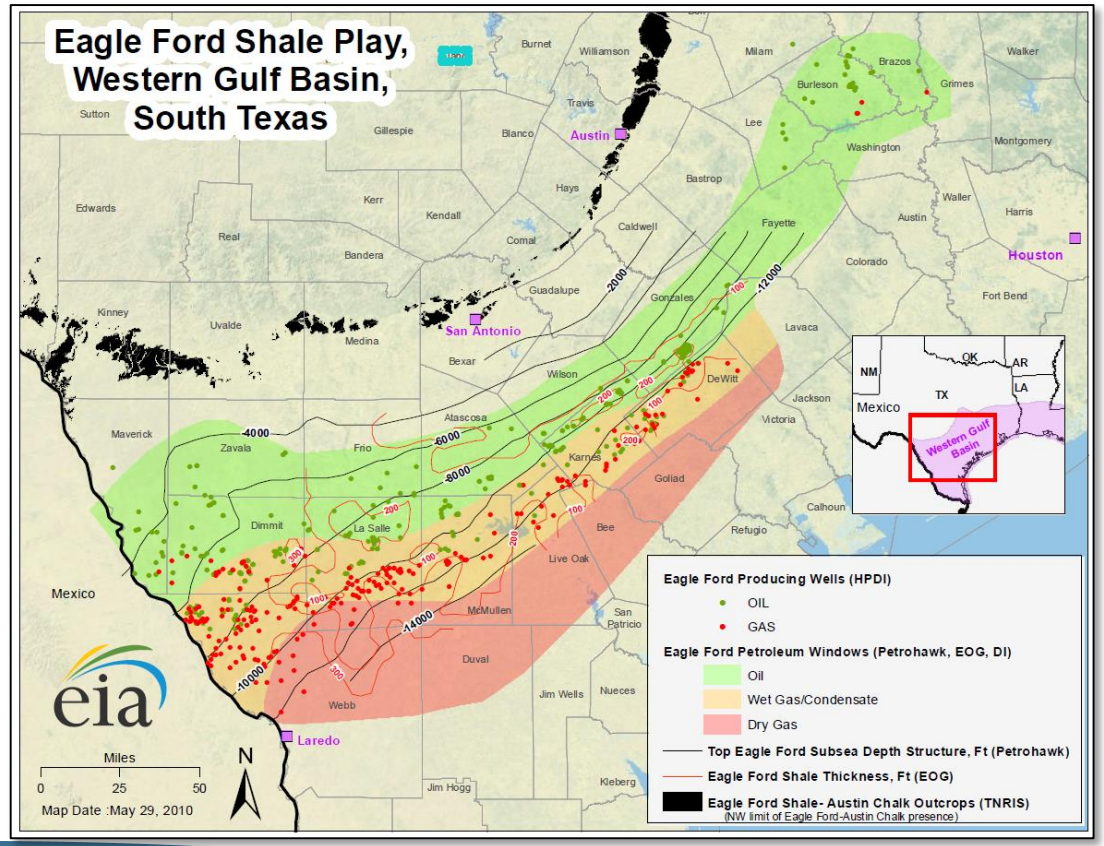
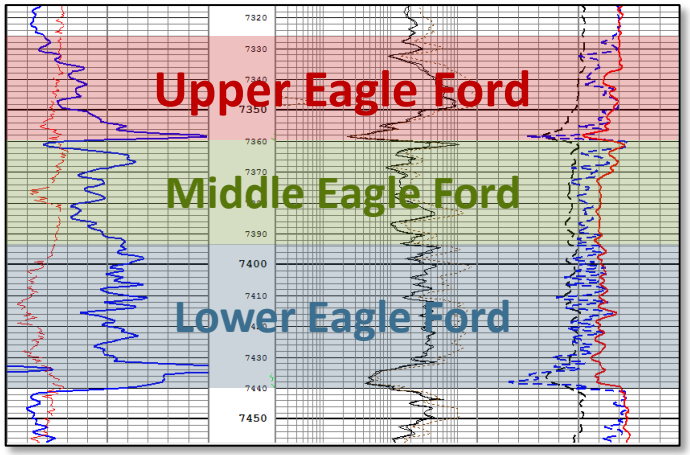
Overview

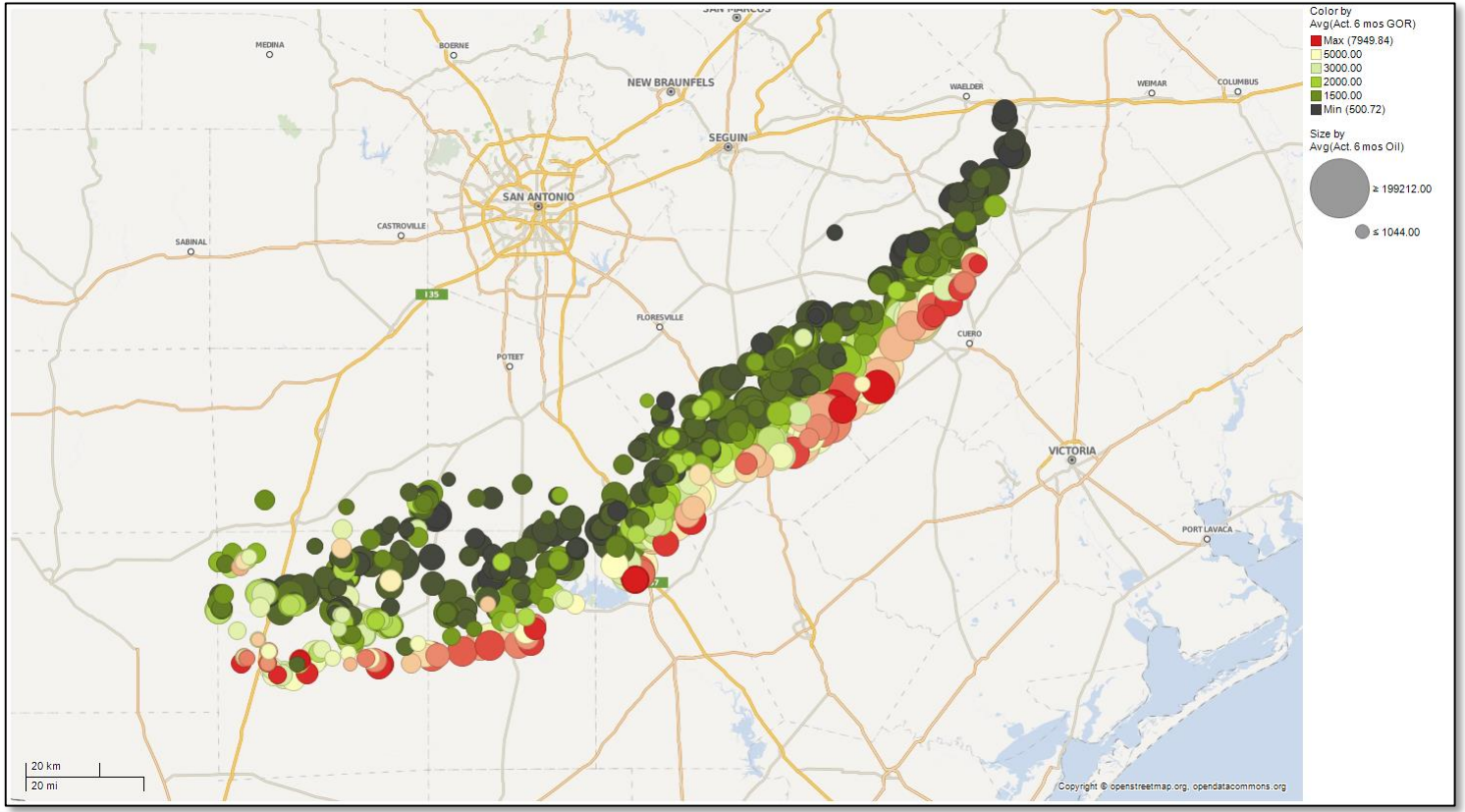
- Eagle Ford Shale Overview
- Determining Reservoir Potential (EFWORX)
- Completion and Stimulation Optimization
- Stimulation Operations
- Summary

Eagle Ford Shale

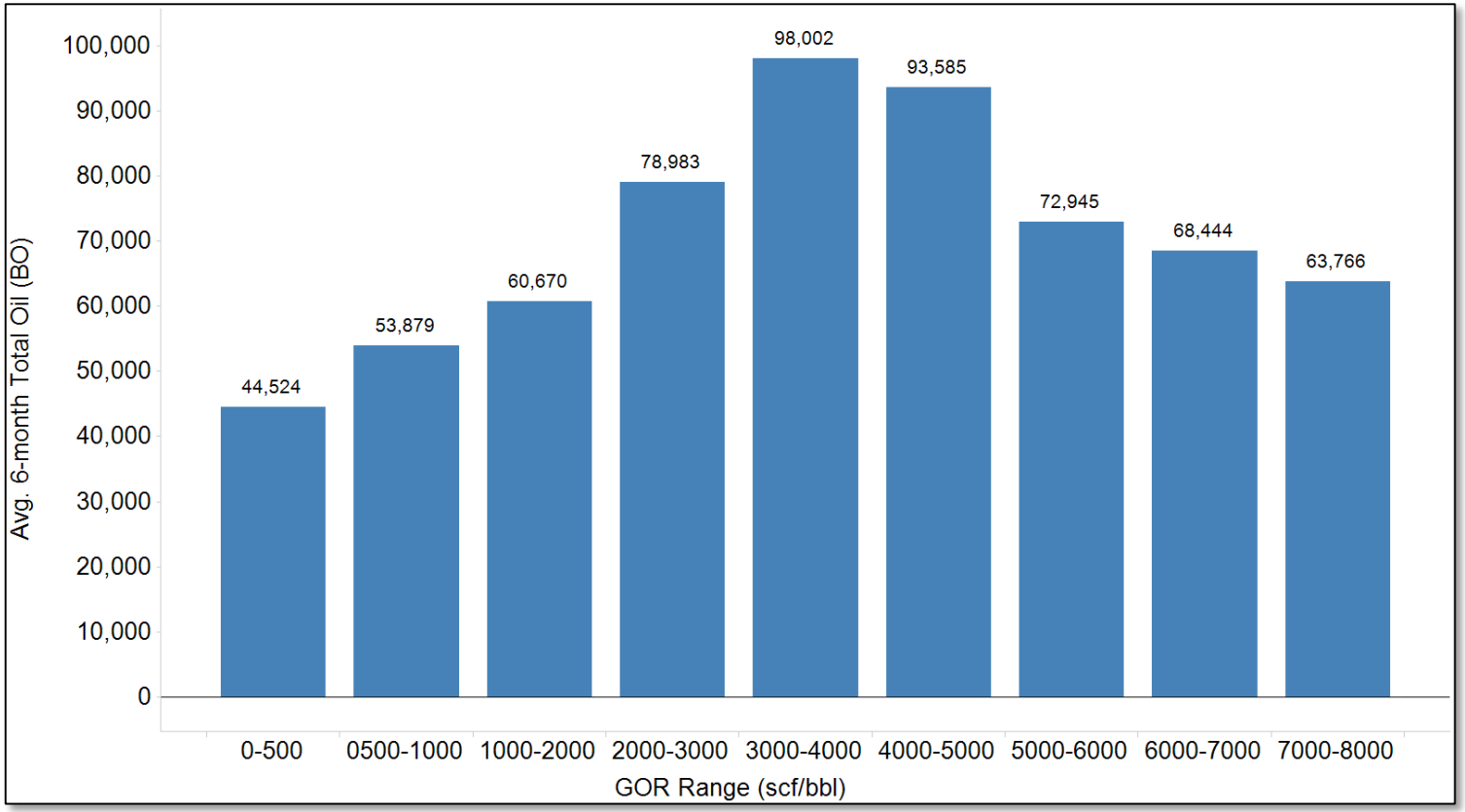




Location Matters (Gas-Oil Ratio Map)

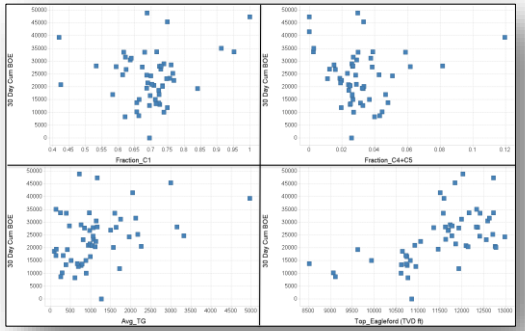


Production Performance by Gas-Oil Ratio



Predictive Modeling – EFWORX

Geology & Drilling

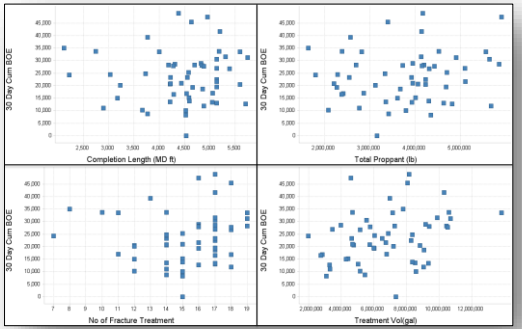


Multi-Variate Analysis

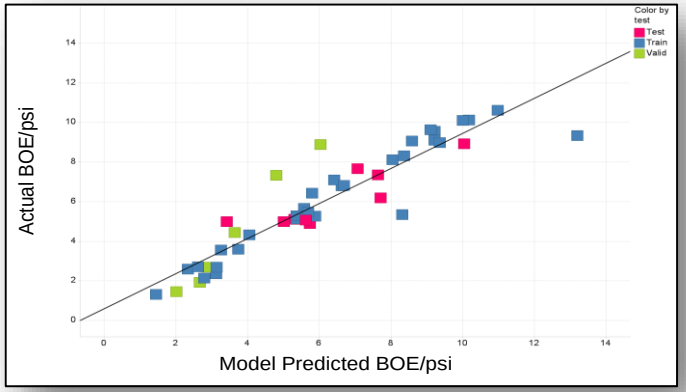
Neural Network Modeling (ANN)

Model Selection & Validation

Completion & Frac



Predictive Model



Predictive Model – EFWORX – Best Practices

Model Predictor	Influence on BOE Productivity +10%	Influence on Oil Productivity +10%
C4+C5 (Butane & Pentane) Totals	14.2%	19.4%
Top of Eagle Ford TVD	12.9%	2.9%
Avg. Gamma Ray	7.4%	6.8%
Total Treatment Fluid Volume	-6.2%	-10.6%
No. of Frac Stages	5.1%	8.9%
Proppant Conductivity & Amount	6.0%	4.5%
Perforation Interval (Net Compl. Length)	5.8%	7.7%
Avg. Injection Rate	5.3%	6.3%
Avg. Mud Log Total Gas Units	-0.4%	-3.5%
Frac Fluid Classification	-4.1%	-5.8%
Gross Completion Length	2.3%	2.5%

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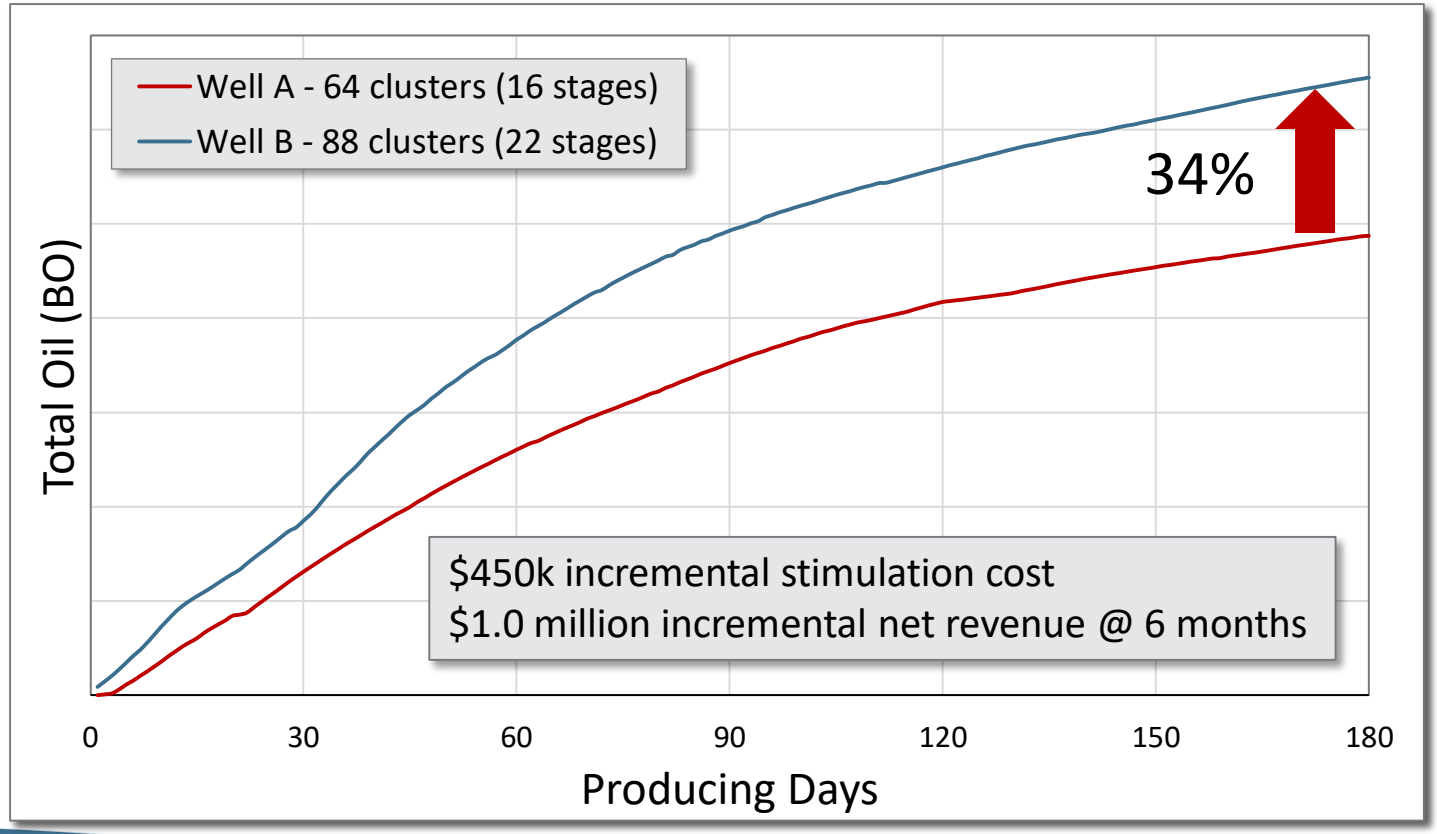
Controllable Completion and Frac Parameters

Non-Controllable Reservoir Related Parameters

Completion Optimization – More Fractures, More Contact



Completion System – Sliding Sleeve vs. Plug-and-Perf

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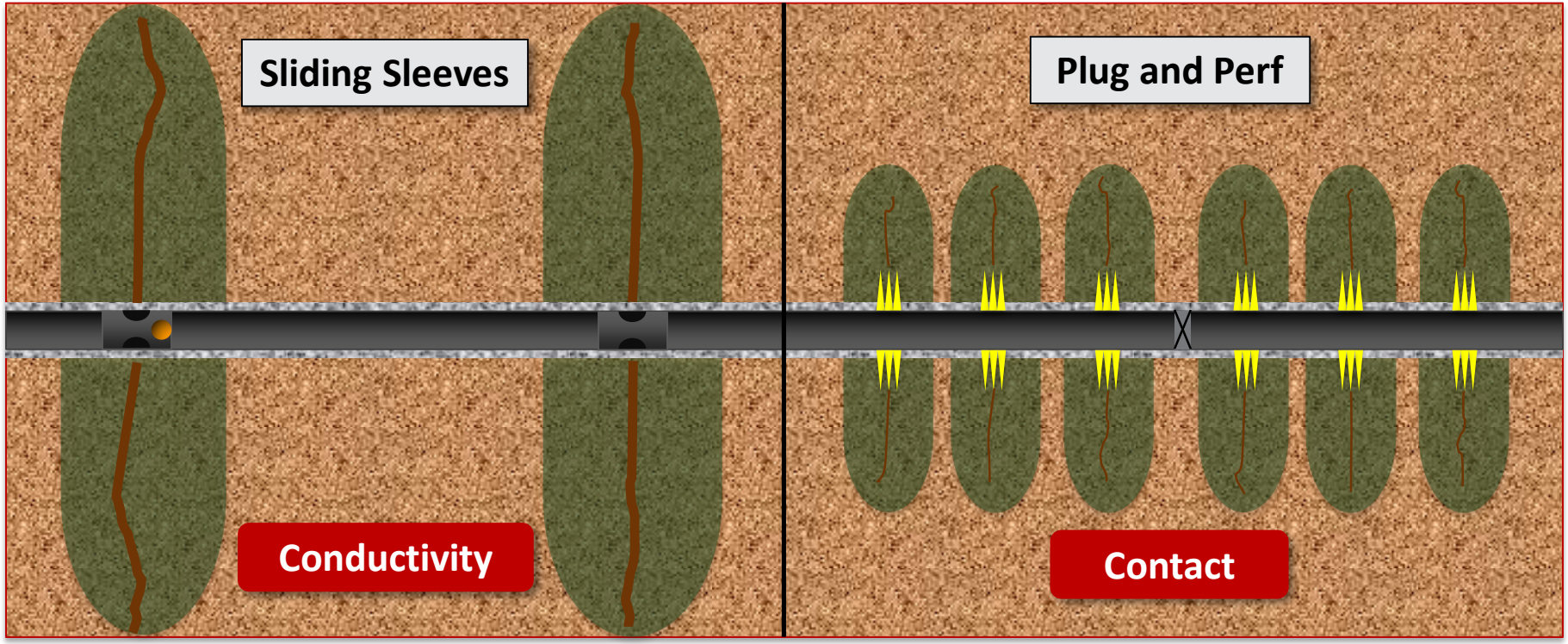
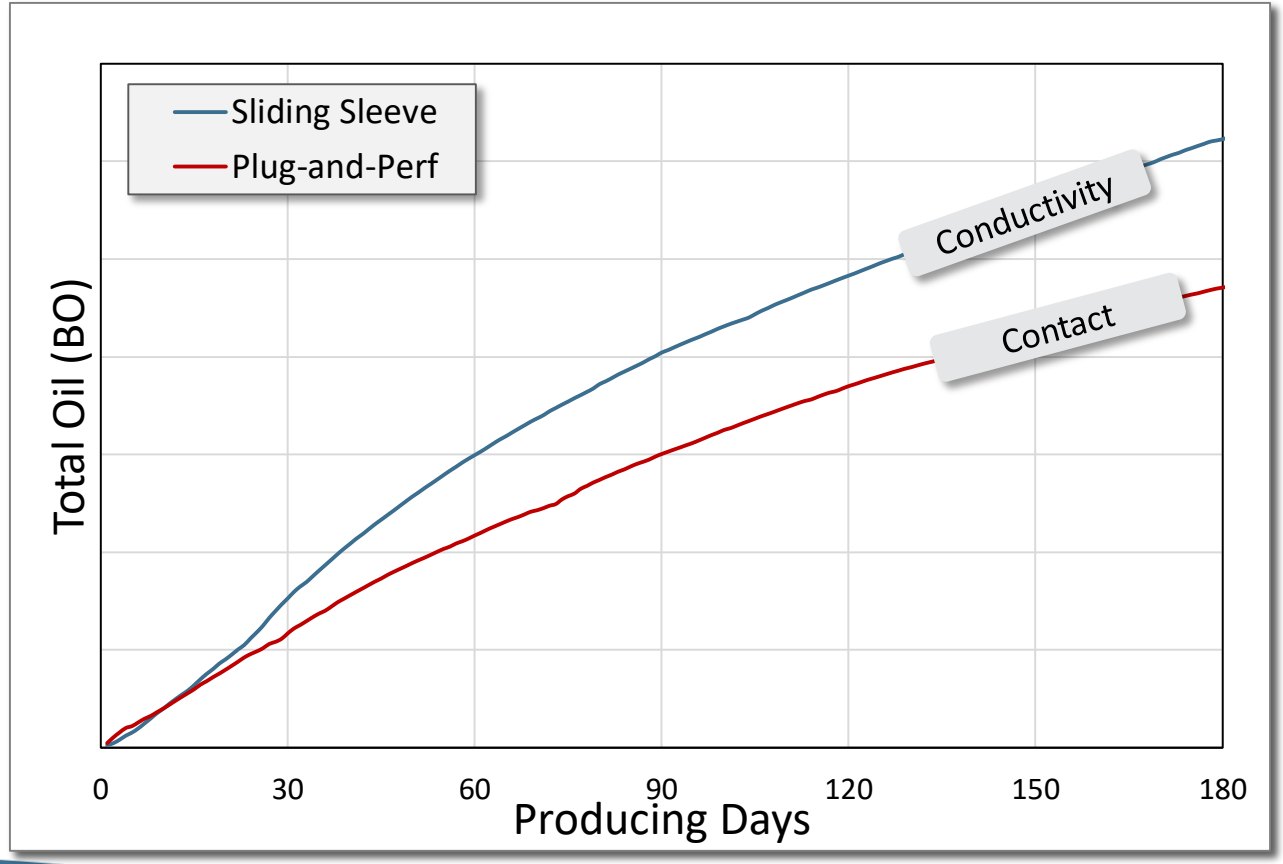


Sliding Sleeve vs. Plug-and-Perf – Initial Results



Plug-and-Perf Optimization (Proppant Amount)

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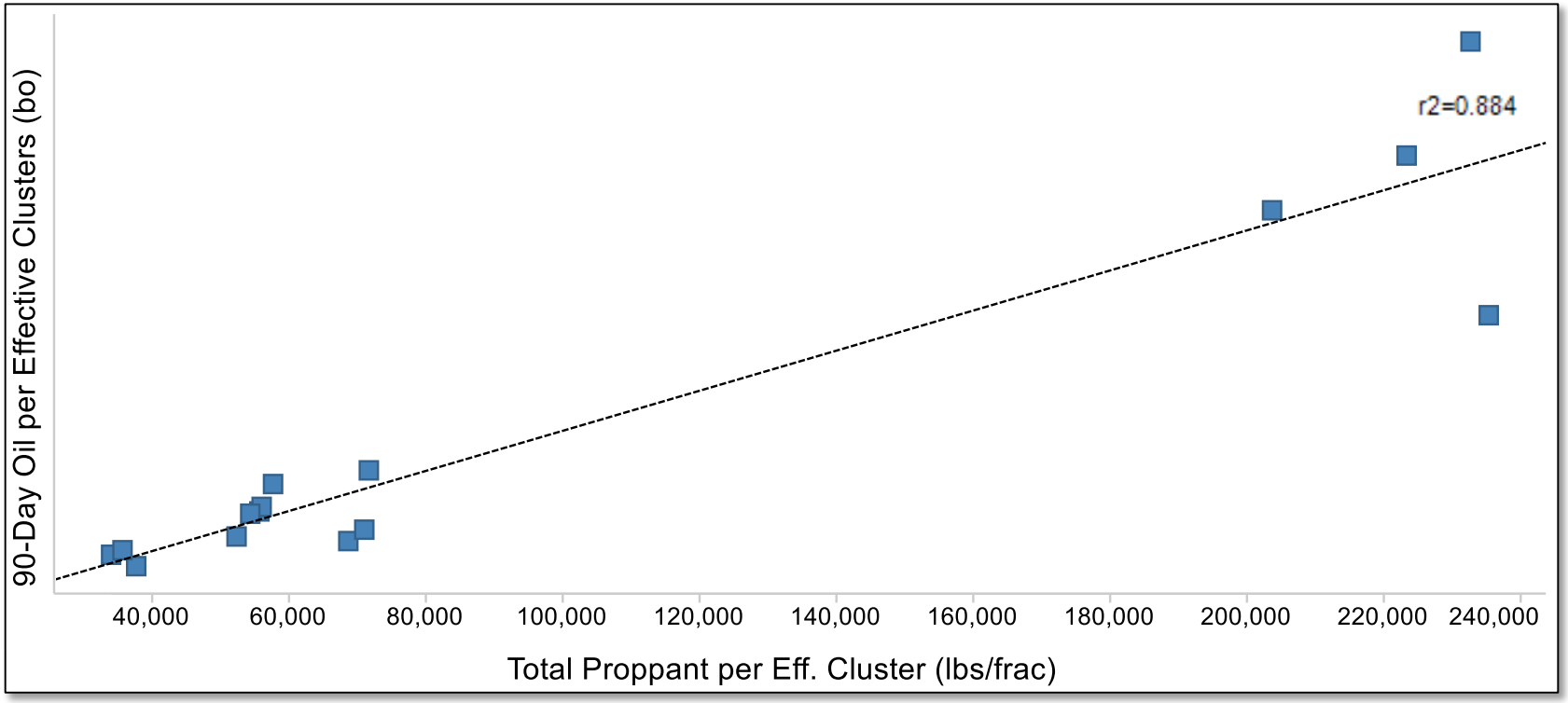
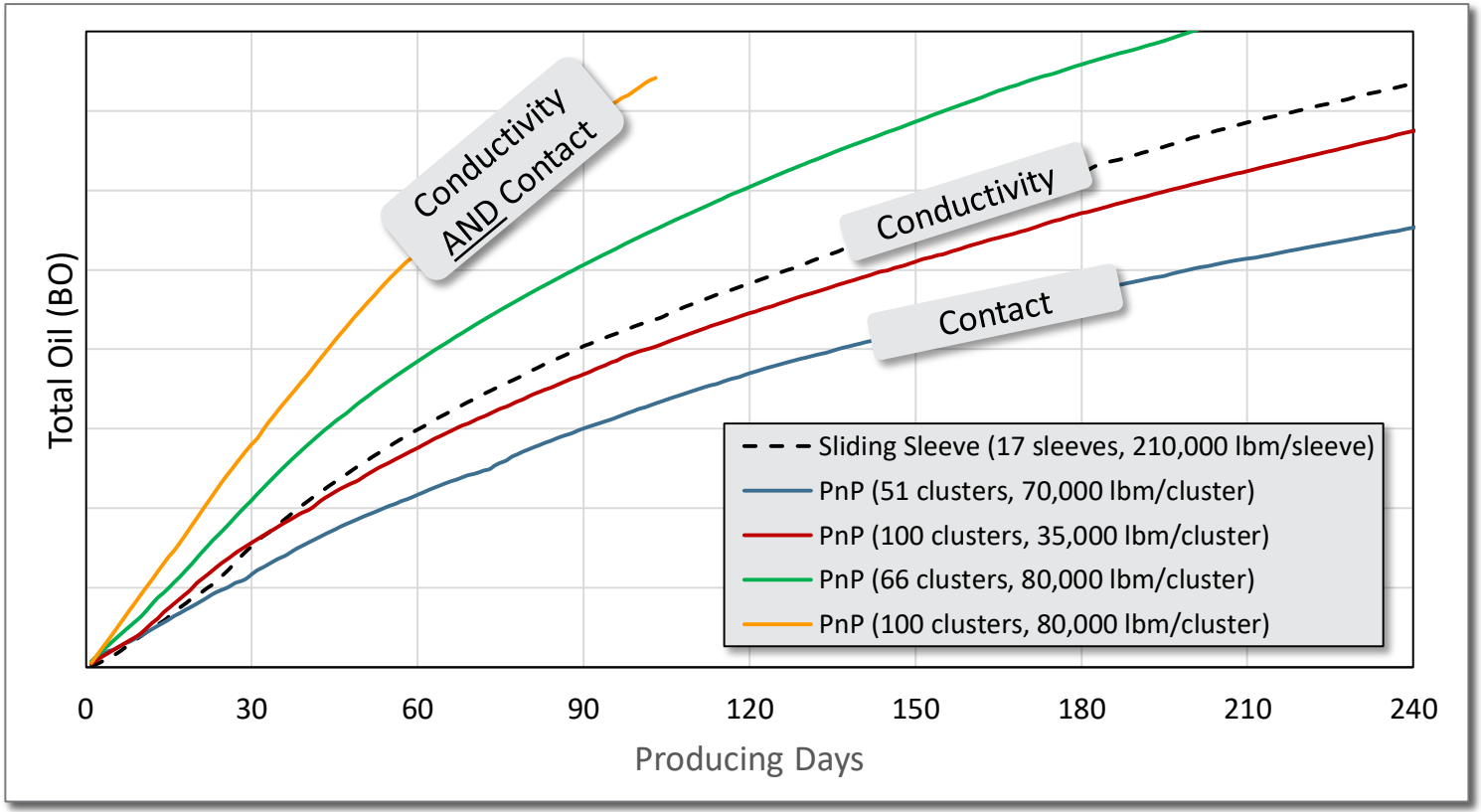


Plug-and-Perf Optimization (Proppant Amount)



Incr. Cost	180-day Incr. Revenue	Incr. EUR
-17%	-23%	-15%
0%	-10%	2%
+28%	+23%	+23%
+56%	+61%	+65%

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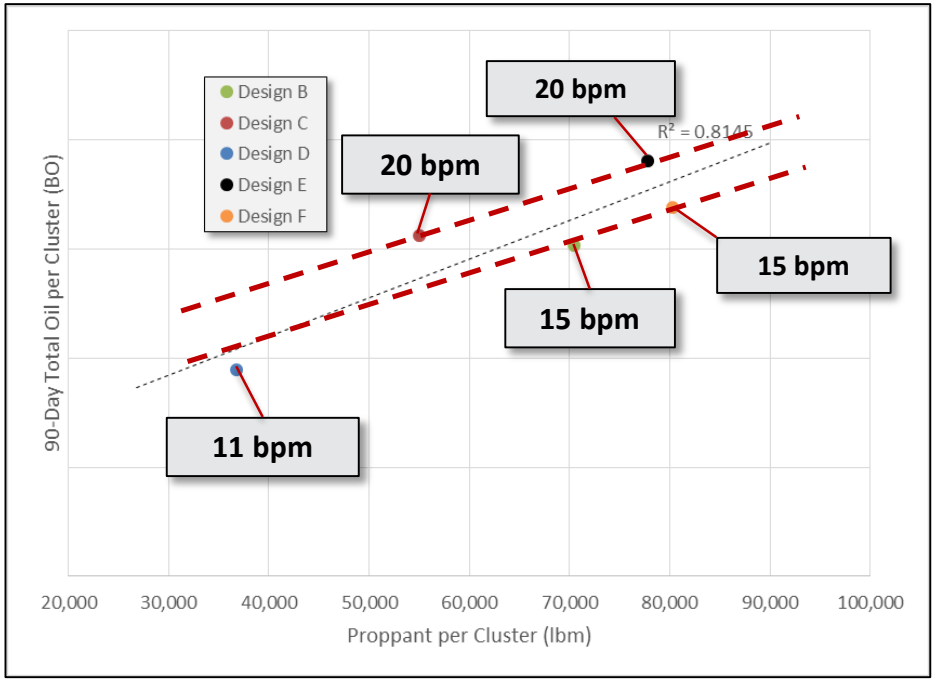
Injection Rate per Cluster



Clusters per Stage	Eff. Injection Rate per Cluster (bbls/min)
3	20
4	15
5	12
6	10

(at 60 bbls/min total injection rate)

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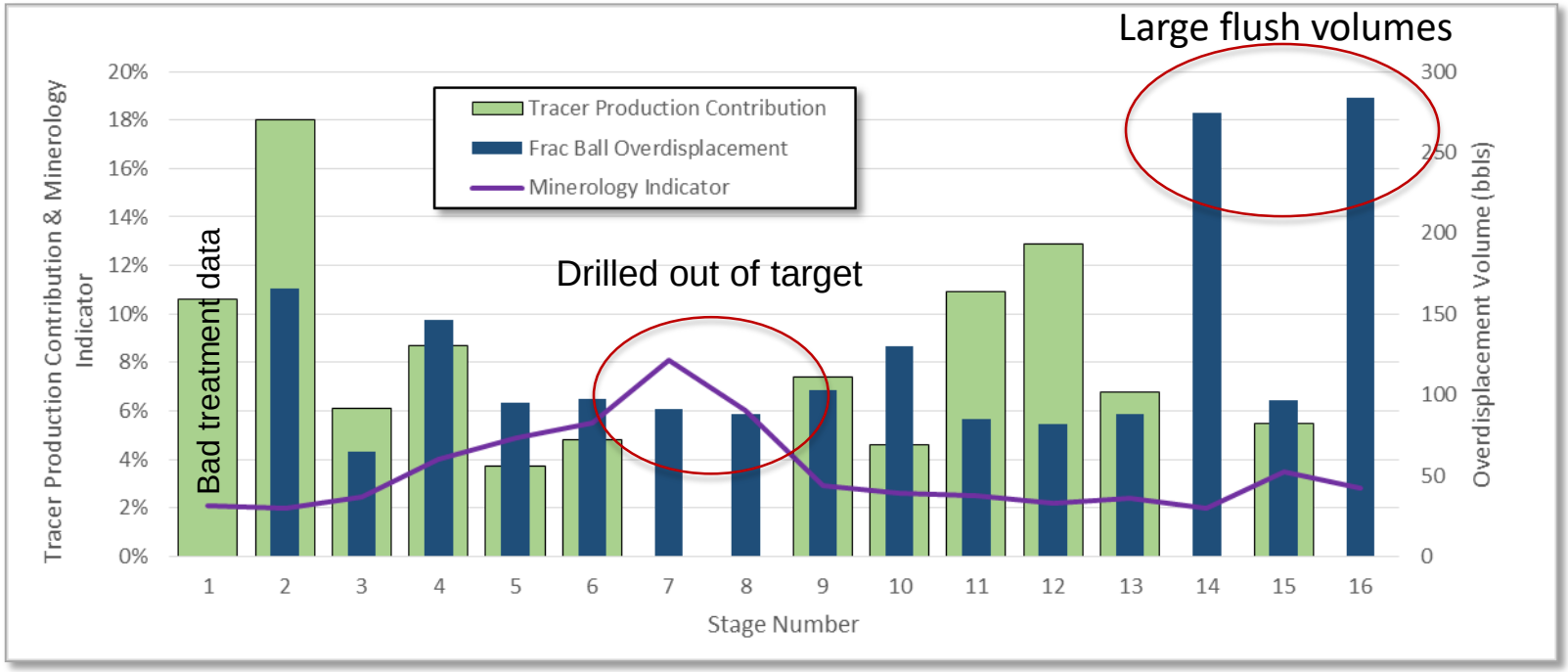
Over-Flushing Fracture Stimulation Treatments



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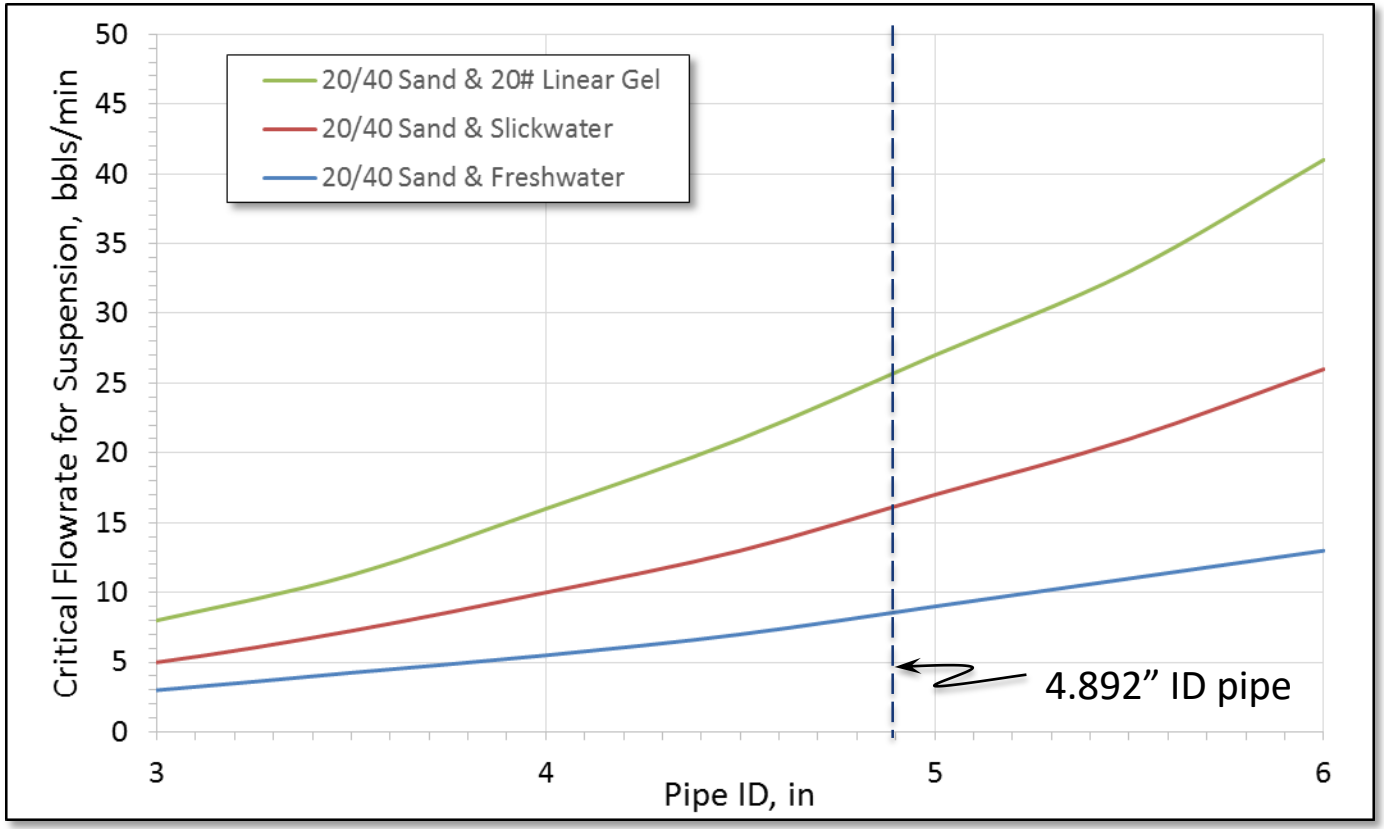
Proppant Suspension Velocities



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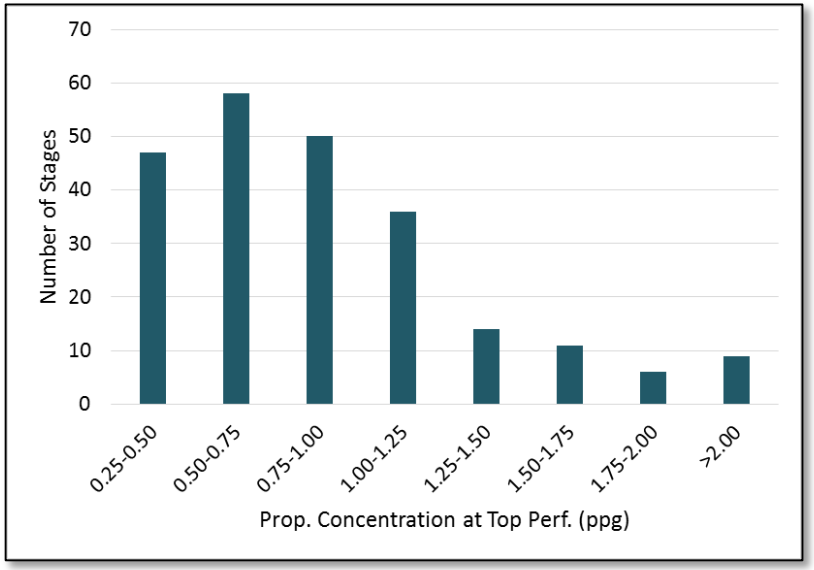
Over-Flush Minimization Field Results

0
Wireline
Issues



	Maximum	Average
Proppant Concentration at Top Perforation (lbm/gal)	4.26	0.91
Length of Proppant Trail in Wellbore (ft)	1,391	254
Amount of Proppant in Wellbore (lbm)	1,777	138
Total Stages with Proppant Remaining in Wellbore	231	

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Summary

- Well performance potential is dictated by the reservoir
  - Rock: Permeability, Porosity, Thickness
  - Fluids: Viscosity, GOR, Pore Pressure
- Reservoir quality data may not be readily available
  - Limited public data early in a play's development
  - STRATAGEN predictive models (e.g., EFWORX) can account for reservoir potential
- Completion and frac practices are also very important
  - Number of frac stages & clusters (more contact)
  - Amount of proppant per cluster (more conductivity)
  - Avg. injection rate per cluster (contact and conductivity)
  - Over-flushing may adversely impact continuity between wellbore and fracs
- More contact and conductivity improves short-term and long-term production results

Thank you!

QUESTIONS?