



SWD Well Best Management & Operational Practices

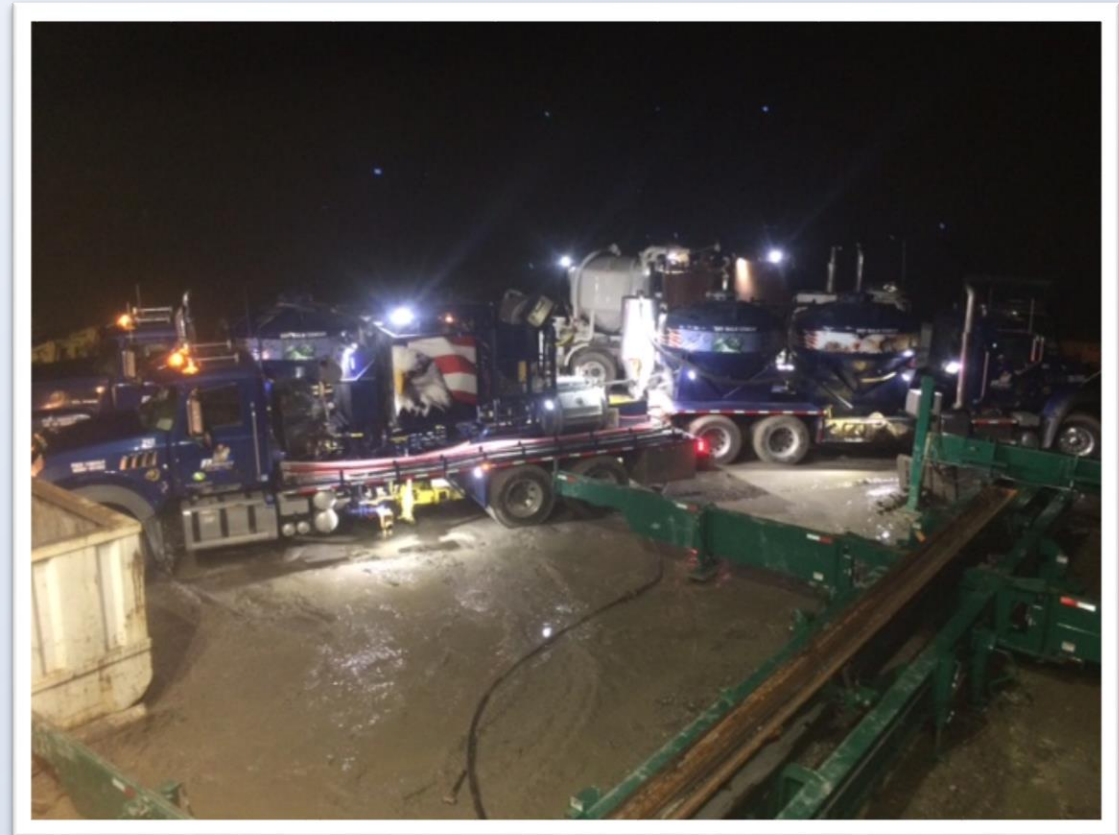
Gavin J James, P.E.

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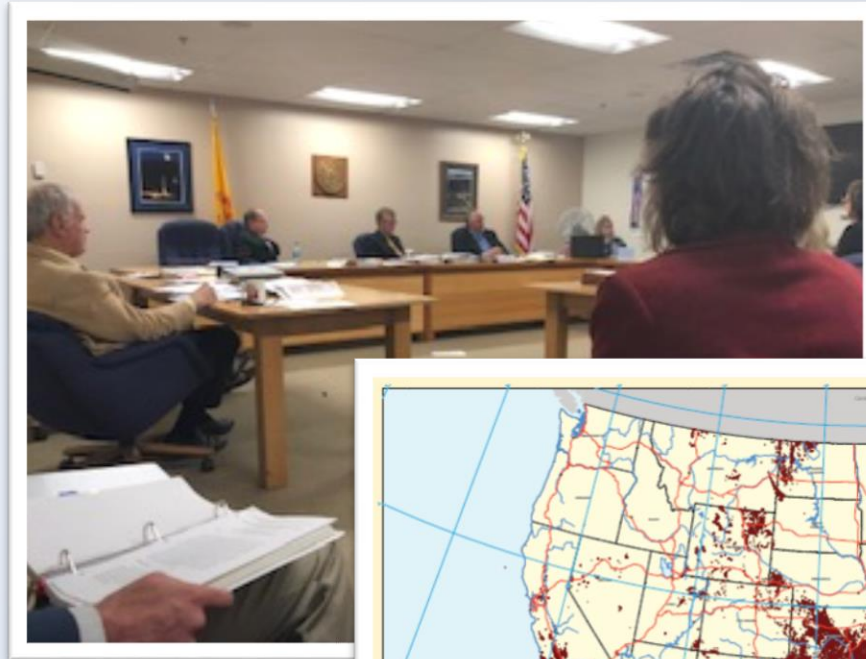
Introduction

- Easing regulatory/permitting concerns and extending the life of any given Saltwater Disposal (SWD) well by way of best management and operational practices are quickly coming to the forefront of successful permitting and operational strategies.
- Unlike any point in the history of the oil and gas industry, the demand for Class II SWD wells to dispose of produced and flowback water has become ultra-critical to successful resource development.

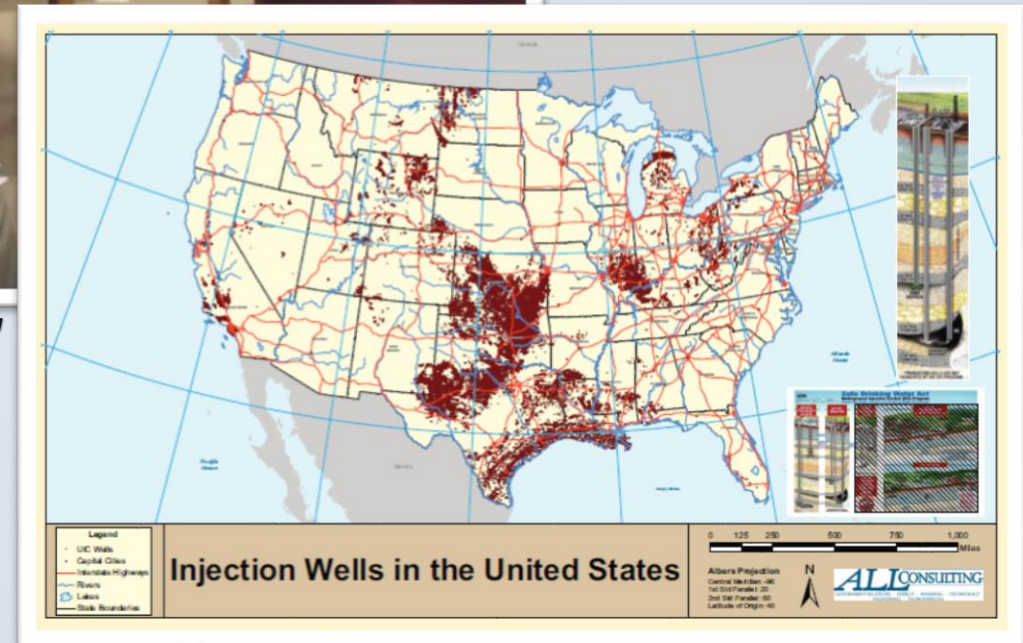


Injection Wells of the United States

- Expansion of “High-Rate” Disposal Wells
- Many Emerging Challenges
 - Seismicity
 - Injectivity
 - Competition
 - Land Issues
 - Investment Risk
- Evolving Regulatory Issues
- Protests
- Timing, Reduced Rates, etc.



Source: ALL Consulting



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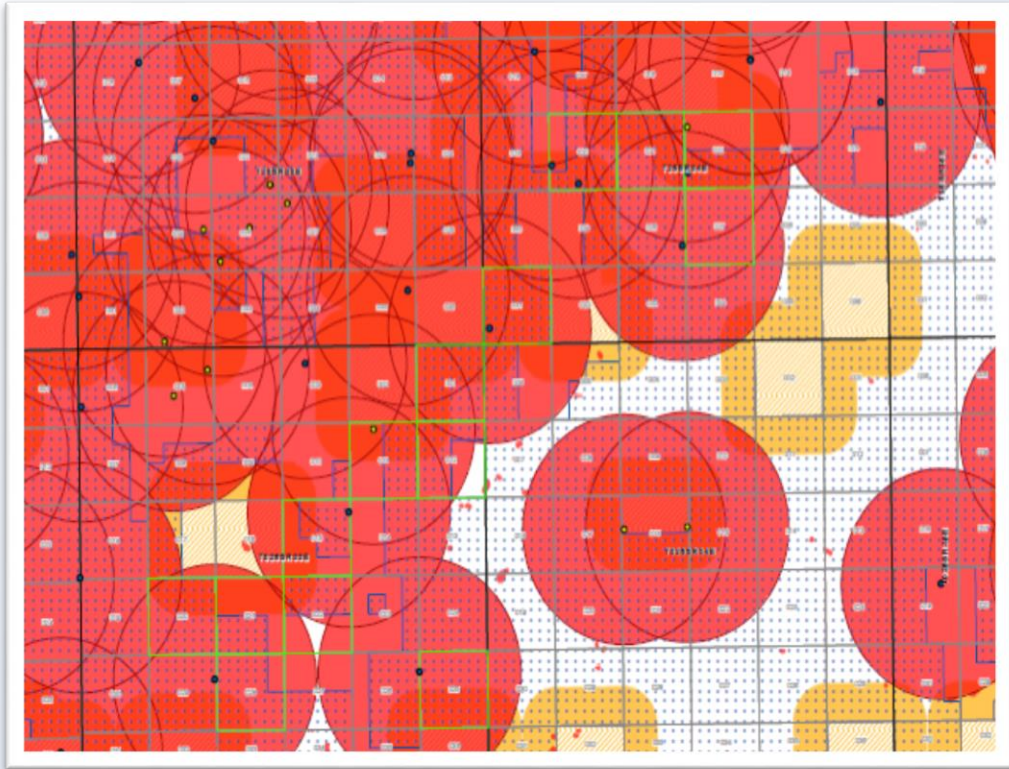


Disposal Well Planning

The planning of oilfield SWD wells (Class II or Class I [WY]) has become far more complicated than at any time in history. Densely spaced high-volume disposal wells have become more typical in response to needs resulting from unconventional development using Horizontal Drilling & High-Volume Hydraulic Fracturing.

- Well Siting Considerations
- Permitting Complications
- Induced Seismicity
- Geology/Groundwater Protection
- Injection Zone Suitability
- Well Design Considerations
- Drilling/Cementing
- Logging/Testing
- Mechanical Integrity
- Substantiated Need
- Operation/Facility Issues
- Etc.

Well Siting Considerations & Substantiating Need

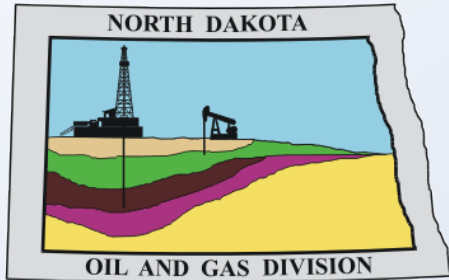


Source: ALL Consulting

- State-Specific Challenges
 - New Mexico 1.5-mile “Pseudo Rule”
 - Restrictions on Deep Zones
 - Critically Stressed Faults/Area Concerns
- Proximity of other Disposal Wells
- Roads/Utilities v. Remote Locations
- Existing and Planned Development
- Regional Considerations (e.g., Towns, Schools, Traffic, etc.)
- Other (e.g., Mining, Seismicity, etc.)



Permitting



- Regulatory Agencies are Under-Staffed, Overwhelmed with Permit Applications, and Attempting to Address New Issues.
- The Absolute Perfection of Applications is Imperative to Avoid Delays or Lose Your Place in Line.
- New Formations Being Used for Injection May Not Be Fully Understood/Defined.

Induced Seismicity

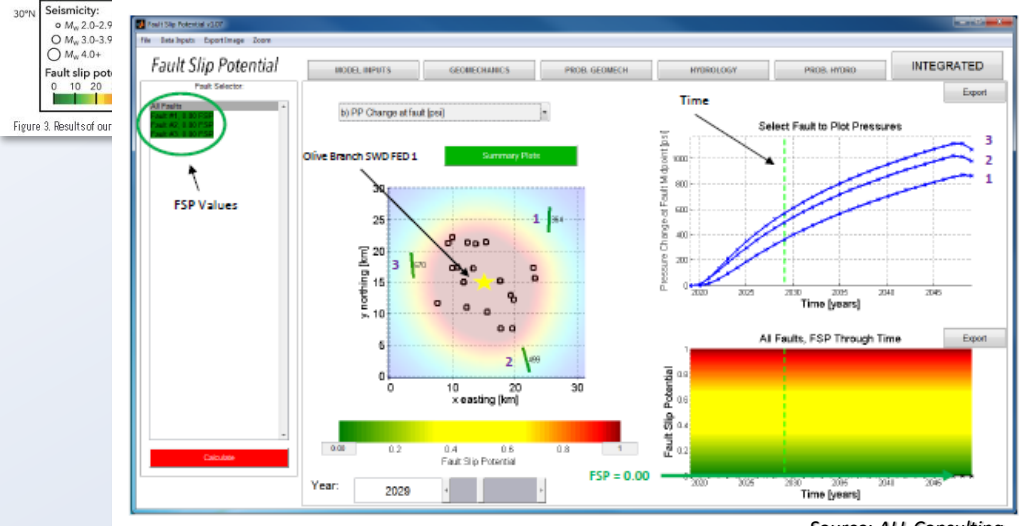
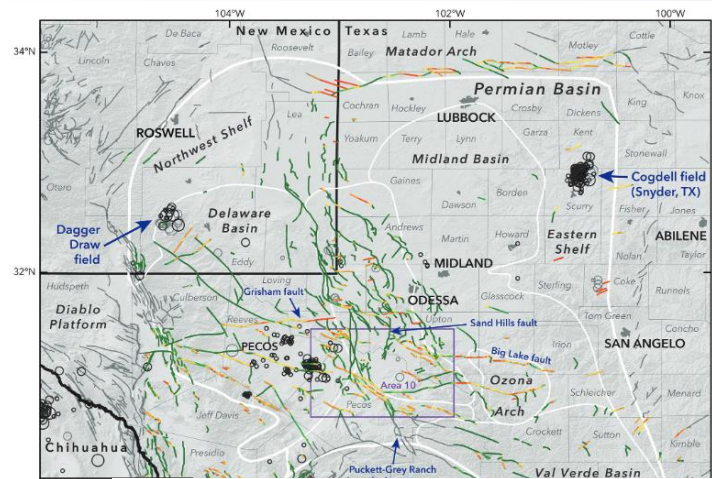


Figure 3. Results of our

Source: ALL Consulting

- Area Faulting & Critically Stressed Faults
- FSP Modeling
- Reservoir Capacity & Pressurization
- Seismic History & Hot Spots
- Seismic Monitoring
- Ground Motion Monitoring
- Monitoring & Mitigation Planning
- Ongoing Testing & Operations



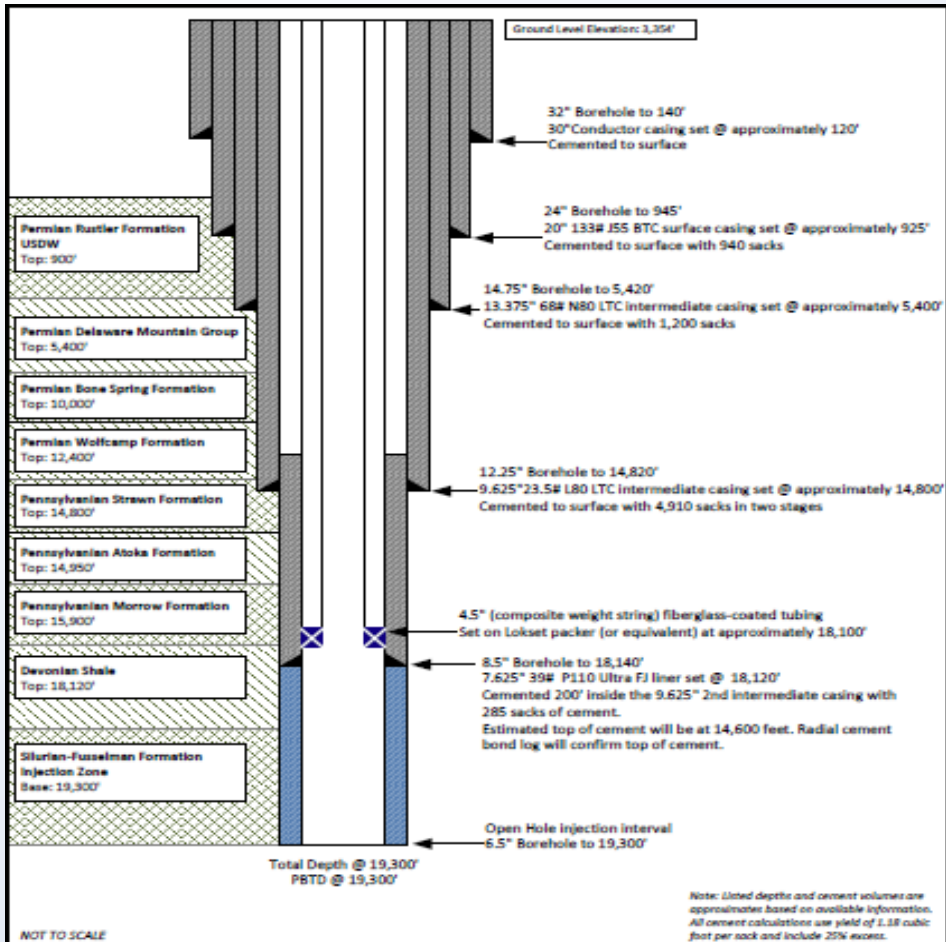
Geology & Groundwater Protection

System	Series	Lithostratigraphic unit		
Mississippian	Chesterian	undivided		
	Meramecian			
	Osagian			
	Kinderhookian			
Devonian	Upper	Woodford Shale		
	Middle			
	Lower	Thirtyone Fm.		
Silurian	Pridolian	Wristen Gp.	Fasken Fm.	Frame Fm.
	Ludlovian			Wink Fm.
	Wenlockian			
	Llandoveryan	Fusselman Fm.		
Ordovician	Upper	Montoya Fm.		
	Middle	Simpson Gp.		
	Lower	Ellenburger Fm.		

Broadhead, R.F. 2005. "Regional aspects of the Wristen petroleum system, southeastern New Mexico." New Mexico Bureau of Geology and Mineral Resources, Open-File Report No. 485.

- General Avoidance of Ultra-Deep Target Zones
- Upper & Lower Confinement
- USDW Identification & Protection
- Mechanical Integrity Testing
- Area Faults
- Drilling/Completion Challenges
- Correlative Rights Issues
- Injectivity/Capacity
- Completion Type (open hole v. perf.)
- Suitability of Receiving Zone(s)
- Costs & Challenges

Well Design, Drilling, Casing & Cementing



Source: ALL Consulting

- Casing Setting Depths
- Multi-String Design Challenges
- Casing Hangers
- Permanent v. Retrievable Packers
- Open Hole v. Perforated Completions
- Tubing Size & Resultant Issues
- Multi-Stage Cement Jobs
- Injection Zone Sampling/Testing

Logging, Testing & Well Treatment



Source: ALL Consulting

- Logging Selection
- Injection Profiling
- Injection Zone Pressure Issues
- Injectivity Testing
- Step Rate Testing
- Acidizing
- Production Interference
- ZOEI Considerations

Operations & Facilities



Source: ALL Consulting

- Continuous Rate & Pressure Monitoring
- Lightning Protection
- Skim Oil Separation
- Pre-Treatment
- Water Transportation
- Seismic Monitoring
- Re-Occurring Testing
- Recycling Potential
- Operation Staff Training
- Preparation for Audits
- Compliance Management

Opposition & Regulatory Uncertainties



Source: ALL Consulting

- Public Opposition
- Protests
 - Industry, Competitors, Landowners, State Lands, Municipalities, NGOs
- High-Activity Areas
 - Lea & Eddy County (New Mexico)
- Regulatory Action Uncertainties
- State Agency Staffing Challenges
- Multi-Governmental Agencies
 - Federal Lands, Reservations, etc.
- Uncertainties
 - Injectivity, Critical Faults, Confinement, etc.
- Seismicity AOIs
- NORM/TENORM

Conclusions

- Planning and timing are perhaps more critical today with SWD permitting than at any time in history.
- The SWD well landscape is changing.
 - Midstream water companies are expanding.
 - Individual companies are preparing large numbers of permit applications.
 - Protests are common.
 - Regulators are overwhelmed.
 - Scrutiny of SWD Well Permit Applications is at an all-time high.
- Although we are many years into the implementation of the Class II UIC Program, many new issues are arising.



Source: ALL Consulting



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ALL Consulting Qualifications

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*Registered Professional Engineers in 34 States
Experience Permitting >2,000 Injection Wells
ALL employs 3 Former State UIC Directors (TX, OH, MT)
Testifying Experts*

(Petroleum Engineering, Induced Seismicity, Underground Injection, Well Integrity, Pits/Impoundments, Well Interference & Frac Hits, Hydraulic Fracturing, Facility Design/Safety, Spill/Release Investigation, and more)

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