



SHALE GAS WATER MANAGEMENT - ISSUES AND SOLUTIONS



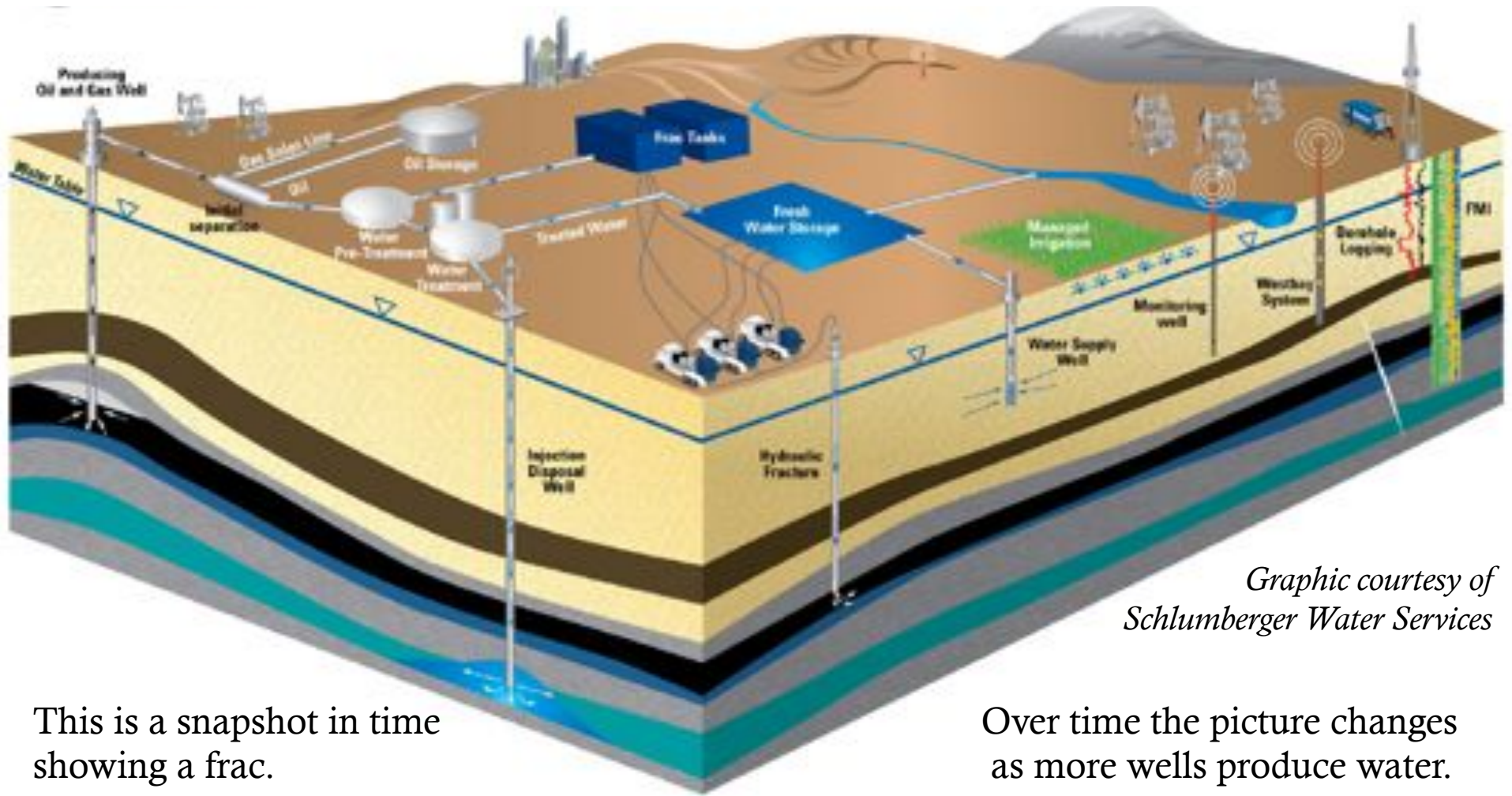
Brent Halldorson
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IOGCC Woodford Summit, University of Oklahoma
March 29-30, 2011

GAS PRODUCERS' NEEDS

- ◆ Short term issues tend to obscure the big picture costs of water management.
- ◆ Needs are constantly changing over time (moving target).
 - ◆ Early stage development tends to favor re-use of flowback.
 - ◆ More mature plays generally require desalination (possibly ZLD).



THE BIG PICTURE



*Graphic courtesy of
Schlumberger Water Services*

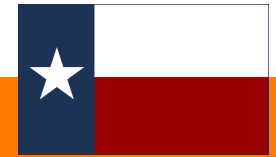
This is a snapshot in time showing a frac.

Over time the picture changes as more wells produce water.

KEY WATER ISSUES



BARNETT SHALE

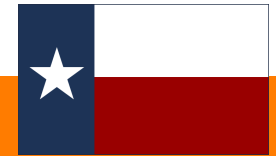


Unique Features

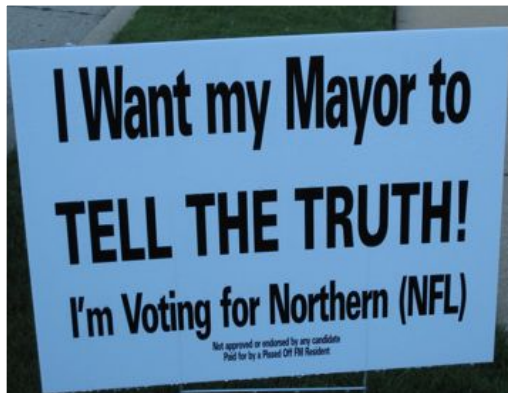
- Low cost SWD options (Ellenburger).
- Limited freshwater availability.
- Most developed shale play to date.
- Urban drilling.
- Relatively flat terrain, low risk of freezing.



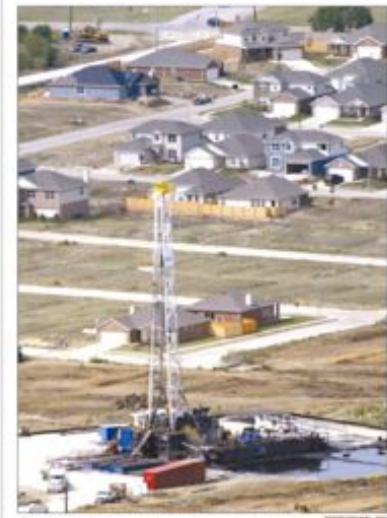
BARNETT SHALE



Urban Drilling



Tempers flare as gas drilling rigs
rise near Alliance-area homes



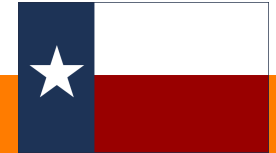
**TOO CLOSE
FOR COMFORT**



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Water Management

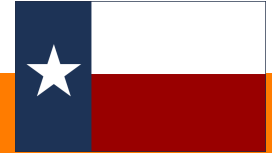
- ◆ Take advantage of low-cost disposal.
 - New SWDs are difficult to permit (Cleburne earthquakes).

- ◆ Freshwater has value:
 - Encourages recycling.
 - Water Management Districts forming.
 - With complete TDS removal the water can be fastlined.

- ◆ Terrain/Climate allows fastlining.



BARNETT SHALE



Example



- Over 700 million gallons of flowback & PW recycled for Devon Energy. 7+ years experience.
- Distilled water is fastlined.
- Move plant to drilling activity – reduces trucking.

Fountain Quail NOMAD
Recycling Facility.



MARCELLUS SHALE



Unique Features

- ◆ Very limited disposal options.
 - Currently utilize SWDs in Ohio or metals-precip plants.
 - High cost (long truck trips).
- ◆ Largest geographic shale play.
- ◆ Near largest US market.
- ◆ N-I-M-B-Y.
- ◆ Difficult terrain.



MARCELLUS SHALE



Difficult Terrain



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Water Management

- ◆ Re-Use as much water as possible on-site.
 - ◆ Logistics dictate re-use of saltwater for fracs.
 - ◆ What level of treatment (if any) is needed?
 - ◆ What effect might high scaling potential water have on the formation?
- ◆ Recycling for discharge is lower cost than SWDs.
 - ◆ Treat water for discharge to new DEP regs (<500ppm TDS, <250ppm Cl).



MARCELLUS SHALE



Example – On Site (“In Field”) Treatment

Fountain Quail
Class II Mobile Pretreatment



	CLASS I	CLASS II	CLASS III	CLASS IV	CLASS V
	Clarification	Clarification Polishing Filter	Clarification UF Membrane	Clarification UF Membrane Ion Exchange	Clarification MVR Evaporation
TSS (mg/L)	50	10	5	5	< 5
Max Particle Size (um)	75	10	1	1	1
Divalent Ion Removal [Ca, Mg, Sr, Ba, SO ₄] (mg/L)	<20%	<20%	<20%	+90%	+99%
Salt Removal [NaCl] (mg/L)	0%	0%	0%	0%	+99%
Relative Cost	1.0	1.2	1.5	2.5	3.5

MARCELLUS SHALE



Example – Centralized (“Near Field”) Treatment



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Which is Correct? Both...

On-Site Treatment
TSS Removal
Limit Downhole Scaling



Central Treatment
TDS Removal
Alternate to Disposal

Filtration
DAF
Oil Separation – *walnut shell filters, hydrocyclones*
Clarifiers
Softeners
Electro-Coag

Precipitation

Membranes –
UF, RO, EDR, etc.

Evaporators
Crystallizers
Waste Heat Systems -
use pipeline compressor heat.



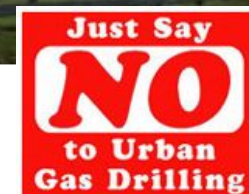
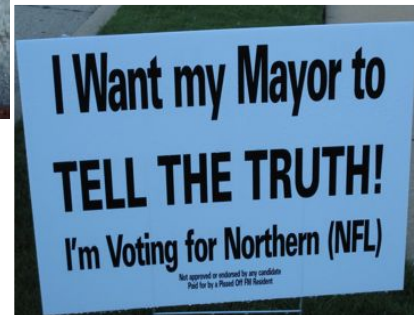
Shale	Water Management Drivers	Possible Solutions
Fayetteville (AR)	<ul style="list-style-type: none"> - Fresh water has minimal value. - Disposal is problematic (recent earthquakes at shallow sandstone SWDs). 	<ul style="list-style-type: none"> - Treat for environmental discharge. - FQWM has first ever NPDES discharge permit for treatment of Fayetteville shale wastewater.
Haynesville (LA)	<ul style="list-style-type: none"> - Limited freshwater supply. - Disposal marginal. 	<ul style="list-style-type: none"> - Pipeline distribution and on-site treatment being used.
Eagle Ford (TX)	<ul style="list-style-type: none"> - Very limited freshwater. - Heavy (concentrated) brine used for drilling. 	<ul style="list-style-type: none"> - FQWM is setting up sites to provide (1) freshwater and (2) concentrated brine – has value for drilling.
Horn River (BC Canada)	<ul style="list-style-type: none"> - Large multi-well pads. - Cold weather. 	<ul style="list-style-type: none"> - Central facilities.
Woodford (OK)	<ul style="list-style-type: none"> - Not as pressured as other shale plays towards disposal or recycling. 	<ul style="list-style-type: none"> - Mobile on site systems have been used.

Individual states are “laboratories” with unique drivers and regulations. Comparisons and competition often help develop better solutions.



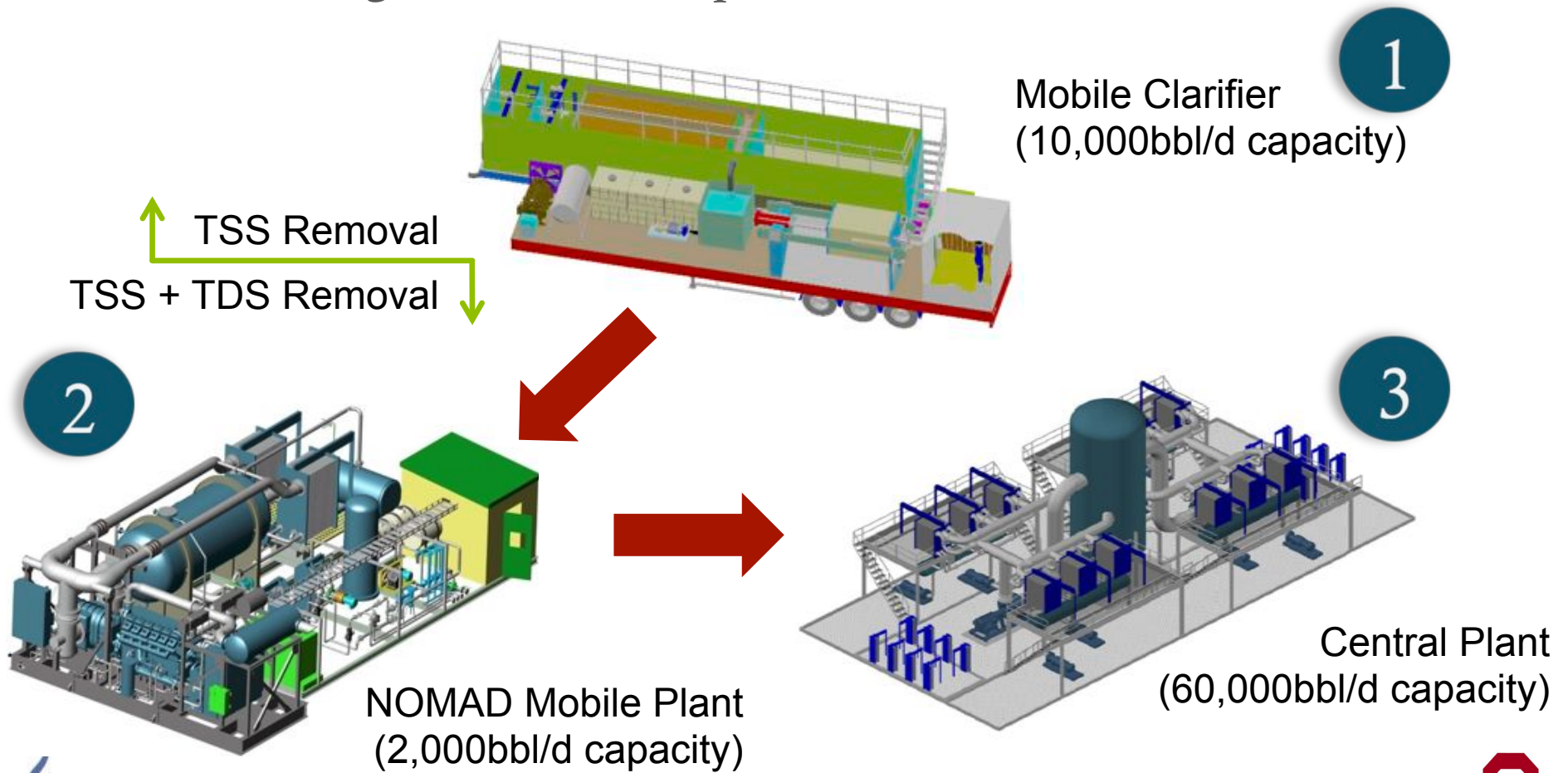
THE WILDCARDS...

1. Regulations.
2. Politicians.
3. Public / NIMBY.
4. Media.
5. Water / Gas Pipelines.



FLEXIBILITY REQUIRED

- Example: Start with mobile pretreatment, then NOMAD, graduate to base plant as need increases.



WHAT IS NEEDED?

1. Common Sense Approach.

- ▶ Economics and regulation will determine how water is managed.
- ▶ Consider the big picture of overall water management.

2. Range of Solutions.

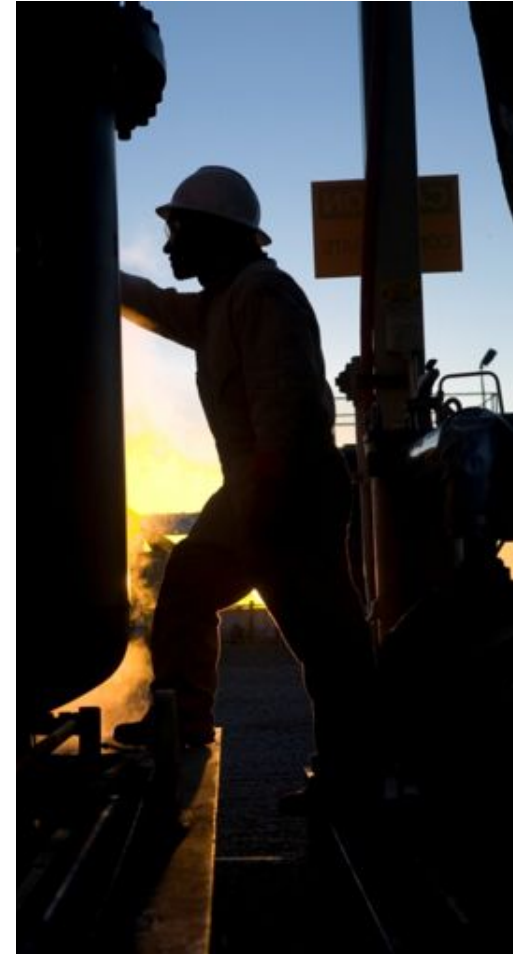
- ▶ Look for a proven track record. Talk to the customers.
- ▶ Nobody has “the magic cure”.
- ▶ Technology must be based on real science backed up with real results.

3. Flexibility.

- ▶ Solution must be adaptable to the changing needs of the industry.
- ▶ Example: Start with mobile NOMAD, build fixed plant as need increases.

4. Cooperation.

- ▶ Share results and experiences (good and bad). We can learn as much, or more, from what has not worked.



SHARE EXPERIENCE

Dallas Shale Gas Conference – October 27, 2010

💧 Over 75 attendees, *many competitors.*



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