

Bringing Marcellus Shale Gas to Markets – Infrastructure, Workforce Development and Environmental Services

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Marcellus Shale Water Management

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Oilfield Water Management

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).





Shale Gas Water Use





Key Water Issues





Shale	Water Management Drivers	Possible Solutions
Barnett (TX)	 Urban drilling. Abundant disposal wells. Dry climate. 	 Utilize low cost disposal. Pipeline water to reduce trucking costs.
Marcellus (PA)	Very limited disposal capacity.Difficult terrain and climate.	 Re-use of salt brine preferred for initial development of field.
Fayetteville (AR)	 Fresh water has minimal value. Disposal is problematic (recent earthquakes near shallow sandstone SWDs). 	 Treat for environmental discharge. FQWM has first ever NPDES discharge permit for treatment of Fayetteville shale wastewater.
Haynesville (LA)	Limited freshwater supply.Disposal marginal.	 Pipeline distribution and on-site treatment being used.
Eagle Ford (TX)	 Very limited freshwater. Heavy (concentrated) brine used for drilling. 	 FQWM is setting up sites to provide (1) freshwater and (2) concentrated brine – has value for drilling.

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



Central vs. On-Site Treatment





On-Site Treatment

- ROVER Mobile TSS Removal.
- 10,000bbl/d (1,600m³/d) capacity.
- Perform basic on-site water treatment & deliver clean brine.
- Ability to remove Ba, Sr, Fe, etc.







ROVER Example





Perform on-site brine re-use. High capacity (10,000bbl/d), low-cost.



Mobile Treatment

- NOMAD Mobile Evaporator 2,000bbl/d (320m³/d) distillate (pure fresh water, < 100mg/L).
- Complete TDS removal, delivers fresh water.







Barnett Shale Example:

- Over 700 million gallons of flowback and PW recycled in Barnett (back to fresh water).
- Entire Plant is moved to be near drill sites.

Fountain Quail Mobile NOMAD Recycling Facility.

3 Hydraulic Fracture Stimulations using distilled & fresh water

NOMAD Example





Move water recycling equipment near drilling activity to reduce transport costs.



Eagle Ford Example

- New Facility at Kenedy, TX.
- Converts

 waste into (1)
 clean water,
 and (2) clean
 concentrated
 salt brine for
 re-use.





Marcellus Shale Example

- Indoor facility in Williamsport, Pennsylvania -7,500bbl/d (1,200m³/d) treatment.
- Discharge fresh water or return to customer.





2011 IOGCC Award

 Fountain Quail was awarded the IOGCC
 Chairman's Stewardship Award earlier this week in Buffalo, NY.





Central Plant Examples



<u>EnCana SAGD Oilfield Evaporator – Foster Creek,</u> <u>Alberta (Canada)</u>

Feed: Oilfield Produced Water (direct from skim tank)

Product: Distilled Water (60usgpm) for boiler feed water



<u>BP Brine Concentrator - Sarnia, Ontario (Canada)</u> Feed: 12-22wt% dilute salt brine (100 to 220 usgpm)

Product: 26wt% concentrated brine & distilled water (42usgpm)



Flexibility Required





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 <u>and</u> bad). We can learn as much, or more, from what has not worked.



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