Water Treatment Solutions for Marcellus Natural Gas Development

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for OUTREACH & RESEARCH (M-COR)
Presentation Topics

- Water Supply and Use
- Flowback Treatment
- Water Reuse
- Disposal Options
- Conclusions
Water Supply Sources Options

• **Municipal Supply vs. Self Supply**
  - Dependent on location, availability, timing
  - Municipal supply access generally quicker but much costlier

• **Surface water vs. Groundwater**
  - Surface water has been a primary source
  - Groundwater wells may work well economically and logistically where sufficient yields can be obtained

• **Alternative water sources**
  - Abandoned mine drainage
  - Wastewater
  - Cooling water
  - Others
Water Supply Considerations

Number of factors to consider:

• Access to water near the drilling project area
• Proximity to well site: piping vs. trucking
• Availability-seasonal or perennial
• Will pass-by flows be required?
• Water quality
• Drilling schedule vs. permitting schedule
• Permitting complexity
• Budget
Water Storage

Storage options:

• Centralized impoundment
• Single pad-dedicated impoundment
• Frac tanks

Storage based on ultimate scale of operations (long vs. short term)
Water Use Data in Susquehanna Basin

- Total water use: 716.0 million gallons (6/1/08 to 5/21/10)
  - 209.2 mgal from public water supply (29%)
  - 506.8 mgal from surface water sites (71%)

- Average total volume of fluid used per well: 3.3 mgal/well
  - 2.8 million gallons of fresh water (85%)
  - 0.5 million gallons or reused flowback (15%)

- Average recovery of flowback: 10.0% (30 day)

- Total amount of flowback reused or sent to disposal
  - Reuse 44.1 million gallons
  - Disposal 21 million gallons
Flowback Water Management

Raw, untreated flowback from a Marcellus gas well

Filtration treatment

Treated flowback ready for reuse
## Sample Marcellus Flowback Water Quality

<table>
<thead>
<tr>
<th>Parameter</th>
<th>“Typical” Analysis – NE PA</th>
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<tbody>
<tr>
<td>pH</td>
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<tr>
<td>aluminum, mg/l</td>
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<td>barium, mg/l</td>
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<td>calcium, mg/l</td>
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<td>lithium, mg/l</td>
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<td>manganese, mg/l</td>
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<tr>
<td>sodium, mg/l</td>
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<td>strontium, mg/l</td>
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<td>sulfate, mg/l SO₄</td>
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<tr>
<td>dissolved solids, mg/l</td>
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<tr>
<td>total hardness, mg/l CaCO₃</td>
<td>54,500</td>
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<tr>
<td>total suspended solids, mg/l</td>
<td>1,200</td>
</tr>
</tbody>
</table>
Parameters of Concern for Reuse of Flowback Water

- Total dissolved solids (chloride) - interference with friction reducers
- Total suspended solids - down hole plugging
- Metals (barium and strontium) - may form precipitates
- Sulfates and carbonates - may form precipitates
- Bacteria – down hole plugging
Flowback Water Management Options

• Direct reuse without treatment (blending)
  • Blending of flowback w/fresh water for subsequent hydrofrac
  • Minimal cost w/increased potential for well plugging issues

• On-site treatment and reuse
  • Re-condition water by chemical or filtration treatment
  • Moderate cost w/minimized potential for well plugging issues

• Off-site treatment and reuse
  • High transportation costs w/same benefit as on-site treatment

• Off-site treatment and disposal
  • High transportation and disposal costs
Flowback Treatment Options

- Blending and dilution with direct discharge (POTWs)
  - No pollutants are removed
- Chemical treatment
  - pH adjustment → precipitation of metals/sulfates
  - Does not remove salts
- Filtration/Membrane Treatment
  - Micro/nano/ultra-filtration
  - Reverse osmosis
  - Removes many compounds, but membranes can become fouled at higher concentrations
- Thermal/Evaporative Technologies
  - Can remove virtually all compounds, very expensive

Still have concentrated compounds to dispose!
Mobile Treatment Process Schematic
Centralized Treatment for Concentrate Disposal
Underground Injection Wells

- Currently 8 injection wells in PA
- Limited injection capacity
- Difficult to permit
- Difficult to find target injection reservoirs
- Prone to plugging
New Treatment Standards

- Any facility that will have a total dissolved solids TDS discharge of > 2000 mg/L will need to install advanced treatment for the following:
  - TDS-500 mg/L
  - Chlorides-250 mg/L

New facilities must meet these standards by January 1, 2011.
A gallon saved is a penny earned!

Pennies per gallon make a big difference when considering millions of gallons!
Thank you!

Questions?