Web Conference Summary of
July 30, 2013
Technical Workshop on
Case Studies to Assess Potential Impacts of
Hydraulic Fracturing on Drinking Water Resources

Rick Wilkin and Jeanne Briskin

September 12, 2013
EPA’s Study of the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources

Study Goals:

• Assess whether hydraulic fracturing may impact drinking water resources

• Identify driving factors that may affect the severity and frequency of impacts

For more information:
http://www.epa.gov/hfstudy
Hydraulic Fracturing Water Cycle

**WATER CYCLE STAGES**
- Water Acquisition → Chemical Mixing → Well Injection → Flowback and Produced Water → Wastewater Treatment and Waste Disposal
Primary Research Questions

What are the potential impacts on drinking water resources of:

- **Water Acquisition**
  - Large volume water withdrawals from ground and surface waters?

- **Chemical Mixing**
  - Surface spills on or near well pads of hydraulic fracturing fluids?

- **Well Injection**
  - The injection and fracturing process?

- **Flowback and Produced Water**
  - Surface spills on or near well pads of flowback and produced water?

- **Wastewater Treatment and Waste Disposal**
  - Inadequate treatment of hydraulic fracturing wastewaters?
Retrospective Case Studies

Purpose: To determine if drinking water contamination has occurred at the case study locations and, if so, identify possible sources of contamination

- Bradford County, PA
- Las Animas/Huerfano Counties, CO
- Dunn County, ND
- Washington County, PA
- Wise County, TX
Las Animas/Huerfano Counties (Raton Basin), CO

HF Target Formation

• Coal Bed Methane (Vermejo & Raton Formations)

Drinking Water Resources

• Poison Canyon Formation and nearby underground sources of drinking water

Research Focus

• Ground water and surface water

Sampling events

• October 2011
• May 2012
• November 2012
• April/May 2013
Bradford County, PA

HF Target Formation
• Marcellus Shale

Drinking Water Resources
• Stratified drift & bedrock aquifers and surface water

Research Focus
• Ground water and surface water studies
• Reports of methane in multiple drinking water wells

Sampling events
• October/November 2011
• April/May 2012
• May 2013
Washington County, PA

HF Target Formation
- Marcellus Shale

Drinking Water Resources
- Surficial & shallow confined aquifers and surface water

Research Focus
- Reported changes in drinking water quality
- Reported methane in wells

Sampling events
- July 2011
- March 2012
- May 2013
Wise County, TX

HF Target Formation
• Barnett Shale

Drinking Water Resources
• Trinity aquifer and surface water

Research Focus
• Drinking water wells

Sampling events
• September 2011
• March 2012
• September 2012
• December 2012
• May 2013
Dunn County (Killdeer), ND

HF Target Formation
- Bakken Shale

Drinking Water Resources
- Killdeer aquifer

Research Focus
- Drinking water aquifer

Sampling events
- July 2011
- October 2011
- October 2012
Session 1: Retrospective Case Studies: Background Assessment and Characterization

Participants considered two questions:

1. What are the relative strengths of different approaches to assess background conditions?

2. What are practical approaches to overcoming the challenges in developing a representative background assessment and characterization for a case study?
Session 1: Retrospective Case Studies: Background Assessment and Characterization

Key Themes

Approaches for assessing and characterizing background conditions

- Site-specific geochemistry and background data
- Conceptual site models
- Site characterization to identify appropriate tracers and indicators
- Quantitative “cut-points” rather than absolute values
- Short- and long-term monitoring plans with defined objectives, sampling frequency, and parameters
Session 1: Retrospective Case Studies: Background Assessment and Characterization

Key Themes

Issues regarding background data

- Anthropogenic vs. background contamination
- Importance of geochemistry
- Sample collection and analysis methods may be unknown-quality uncertain
- Regional scales may be useful for identifying trends
- Local scales may be useful for identifying impacts
- Aquifer-specific (depth-related) background and water quality trends
Session 1: Retrospective Case Studies: Background Assessment and Characterization

Key Themes

Statistical approaches

- Averaged and pooled data may dilute signal
- Historical data with "impacted" data may bias the signal
- Stiff and Piper diagrams for graphical presentation of data
- Aquifer-based analysis focused on individual cases
Session 1: Retrospective Case Studies: Background Assessment and Characterization

**Key Themes**

Ground water contamination occurrence and exposure

- Indicators of water contamination
- Cumulative exposure and exposure to mixtures of multiple contaminants
- Clearly define “impact” and how it relates to risk
- Trace contamination to possible sources and provide context
Session 1: Retrospective Case Studies: Background Assessment and Characterization

Key Themes

Practical approaches for overcoming challenges

- Preliminary results from the U.S. DOE NETL studies with tracers
- Geochemical data analysis using appropriate techniques
- Industry and university data may be useful if available
- Collect distributed samples using approved methods
- Case control design
Prospective Case Study Goals

• Understand how site-specific hydraulic fracturing practices prevent impacts to drinking water resources

• Evaluate any changes in water quality over time
Study Approach

Follows development of production well

1. Site Selection
2. Baseline Monitoring
3. Pad Installation / Well Drilling and Completion
4. Hydraulic Fracturing and Flowback Management
5. Oil and/or Gas Production
**Site Selection**

Example **environmental management practices** conducted by well operator

- Consider nearby water resources, slope, etc.

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**Research Approach**

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<thead>
<tr>
<th>EXAMPLE GOALS</th>
<th>EXAMPLE IMPLEMENTATION TASKS</th>
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<tr>
<td>- New development area</td>
<td>- Review historical oil and gas activities and distances</td>
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<tr>
<td>- Relatively shallow ground water of good quality</td>
<td>- Evaluate potential water quality impacts from local pre-existing land uses</td>
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<tr>
<td>- Nearby surface water resources with access for monitoring</td>
<td>- Determine distance and flow path to surface water resources</td>
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<tr>
<td>- Site topography provides good access for monitoring wells</td>
<td>- Identify existing nearby ground water wells</td>
</tr>
<tr>
<td>- Cooperative landowners (access)</td>
<td>- Gather pre-existing water quality information</td>
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<td>- Site visit to confirm</td>
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<td>- Sign access agreements</td>
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Baseline Monitoring

Example environmental management practices conducted by well operator
  • Conduct water quality monitoring

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<tr>
<td>• Install monitoring network</td>
<td>• Determine depth, direction and rate of ground water flow</td>
</tr>
<tr>
<td>• Conduct baseline monitoring</td>
<td>• Drill, log and install monitoring wells at multiple depths</td>
</tr>
<tr>
<td>• Document baseline water quality</td>
<td>• Establish surface water monitoring locations</td>
</tr>
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<td>• Conduct four quarterly water quality and flow monitoring events</td>
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Example environmental management practices conducted by well operator

- Install liners, construct berms
- Install casing and cement, conduct mechanical integrity tests
- Construct secondary containment for tanks/impoundments

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<tr>
<td>• Document well construction details</td>
<td>• Observe pad construction</td>
</tr>
<tr>
<td>• Document well integrity</td>
<td>• Observe drilling and completion of production well</td>
</tr>
<tr>
<td>• Assess any impacts to water quality</td>
<td>• Monitor ground and surface water for any impacts</td>
</tr>
<tr>
<td></td>
<td>• Receive company-provided details on geology, casing materials and depths, cement details and evaluation tools, mechanical integrity test results, etc.</td>
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Hydraulic Fracturing and Flowback Management

Example environmental management practices conducted by well operator

- Choice of hydraulic fracturing fluid components
- Fracture propagation assessment / microseismic monitoring
- Pressure monitoring
- Post-fracture mechanical integrity testing

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<tr>
<td>• Document hydraulic fracturing and flowback process</td>
<td>• Observe hydraulic fracturing operations</td>
</tr>
<tr>
<td>• Document fracture propagation</td>
<td>• Monitor ground and surface water for any impacts</td>
</tr>
<tr>
<td>• Document pressure monitoring</td>
<td>• Sample flowback</td>
</tr>
<tr>
<td>• Document post-fracture mechanical integrity testing</td>
<td>• Receive company-provided microseismic data;</td>
</tr>
<tr>
<td>• Assess any impacts to water quality</td>
<td>hydraulic fracturing reports on fluid volumes, pressure curves and chemical additives;</td>
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<tr>
<td></td>
<td>mechanical integrity test results; etc.</td>
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Oil and/or Gas Production

Example environmental management practices conducted by well operator

- Monitor oil, gas and water production

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<tr>
<td>• Document water management practices</td>
<td>• Confirm with operator produced water management volumes and disposal methods</td>
</tr>
<tr>
<td>• Evaluate any changes to water quality</td>
<td>• Monitor produced water for four quarters</td>
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<tr>
<td>• Evaluate for any delayed impacts to ground or surface water</td>
<td>• Conduct four quarterly water quality and flow monitoring events</td>
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Collaboration is Key

**Partners:** US EPA, US Department of Energy, US Geological Survey, host well owner/operator, state agencies, landowners and others

- Design
- Observation
- Interpretation
Water Quality Monitoring

- Use pre-existing monitoring points
  - Private, public, industrial, agricultural wells
  - Springs and surface water bodies within local drainage system

- Install additional targeted monitoring wells
  - Location, depth and number depend on local ground water depth, flow rate and direction
  - Target anticipated flow paths within aquifers
Conceptual Framework for Monitoring

- Production Well and Pad
- Constructed Network (monitoring wells)
- Pre-Existing Monitoring Points
  - Private Well
  - Surface Water
- Hydraulic Fracturing Zone
Anticipated Timeline

**Construct Well Pad and Production Well**
- Q1
- Q2
- Q3
- Q4

**Hydraulic Fracturing and Flowback**
- Q1
- Q2
- Q3
- Q4

**Baseline Sampling**
- Sample pre-existing wells, surface water; conduct geophysics
- Construct monitoring wells

**Post-Fracture Sampling**
- integrity tests
- cement bond logs
- others…
- injection fluids
- flowback
- pressure monitoring

**Monitor water quality and flow indicators**
Technical Challenges

- **Legacy or active fossil fuel extraction and other land use**
  - Existing historical/active fossil fuel extraction (oil, gas or coal), other commercial/private sources (USTs)
  - Prior industrial or commercial activity
    - *Affects analyte choice and interpretation*

- **Site-specific aquifer properties**
  - Direction of ground water flow within study area
  - Rate of ground water flow
    - *Affects monitoring well location and frequency/duration of sampling*
Implementation Challenges

• Access
  – Involves well owner/operator and landowner

• Timing
  – Well development
  – Corridor planning and development

Best approaches to align research and commercial timelines?
Participants considered two questions:

1. What types of conditions, tests, monitoring, sampling, and analysis are needed to assess impacts from hydraulic fracturing processes on drinking water resources in a prospective case study, and why?

2. What approaches can be used in situations where historic and/or ongoing industrial practices (e.g., mining, oil, gas, agriculture, etc.) may confound assessment of impacts of hydraulic fracturing processes on drinking water resources?
Session 2: Prospective Case Studies

Discussion

- Select sites where geology is well characterized (e.g., Marcellus)
- Longer-term studies may add value (if stray gas causes immediate impacts)
- Study effects on production string cement
- Consider regional variation (e.g., produced water management)
- Obtain hydrogeological data
- Consider use of horizontal wells for monitoring shallow ground water under production well pad
- Sample for microbial indicators
- Build conceptual models using lessons learned from retrospective case studies
- ISCMEM’s work to advance environmental modeling
Next Steps

• Reconvene Technical Roundtable on October 23, 2013

• Information on technical workshop series:
  http://www.epa.gov/hfstudy/techwork13.html