Overview of Hydraulic Fracturing Wastewater Research

Technical Workshop Series:
Wastewater Treatment and Related Modeling

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EPA Study of the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources

EPA Study Goals:

- Assess the potential impacts of hydraulic fracturing on drinking water resources
- Identify the driving factors that affect the severity and frequency of any 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

Research Questions

Water Acquisition

- How might large volume water withdrawals from ground and surface water impact drinking water resources?

Chemical Mixing

- What are the possible impacts of releases of hydraulic fracturing fluids on drinking water resources?

Well Injection

- What are the possible impacts of the injection and fracturing process on drinking water resources?

Flowback and Produced Water

- What are the possible impacts of releases of flowback and produced water on drinking water resources?

Water Treatment and Waste Disposal

- What are the possible impacts of inadequate treatment of hydraulic fracturing wastewaters on drinking water resources?
Secondary Research Questions

What are the common treatment and disposal methods for hydraulic fracturing wastewater and where are these methods practiced?

How effective are conventional POTWs and commercial treatment systems in removing organic and inorganic contaminants of concern in hydraulic fracturing wastewater?

What are the potential impacts from surface water disposal of treated hydraulic fracturing wastewater on drinking water treatment facilities?

Research Projects

- Literature Review
- Well File Review
- FracFocus Analysis

- Literature Review
- Wastewater Treatability Studies

- Literature Review
- Source Apportionment Studies
- Brominated Disinfection By-Product Precursor Studies
Types of Research Projects

Analysis of Existing Data
- Literature Review
- Spills Database Analysis
- Service Company Analysis
- Well File Review
- FracFocus Analysis

Scenario Evaluations
- Subsurface Migration Modeling
- Surface Water Modeling
- Water Availability Modeling

Laboratory Studies
- Source Apportionment Studies
- Wastewater Treatability Studies
- Brominated Disinfection By-Product Studies
- Analytical Method Development

Toxicity Assessment

Case Studies
- Retrospective Case Studies
- Prospective Case Studies
Objective: Collect information on wastewater treatment and disposal from hydraulic fracturing operations to inform project plans and interpretations of results

Research Progress
- Evaluate information on wastewater treatment and disposal from hydraulic fracturing operations from existing papers and reports, focusing on peer-reviewed literature
- Follow procedures identified in study plan

Next Step
- Continue to review and assess literature related to wastewater treatment and disposal according to research questions in the study plan
Objective: Assess well construction and hydraulic fracturing operations as reported by nine oil and gas operators

Research Progress

• Well-specific records:
  o Provided by nine oil and gas operators (includes confidential business information)
  o Includes hydraulic fracturing wastewater treatment and disposal practices for 332 wells hydraulically fractured in 2009 and 2010

• Extraction of available data from the well files is underway

Next Steps

• Work with oil and gas operators to clarify information provided
• Analyze data to address research questions
Objective: Collect information on water volumes and sources as reported by oil and gas companies

Research Progress
• Extracted data, checked for quality issues, and organized in a database for analysis
• Developed draft queries to address research questions

Next Steps
• Analyze water usage
• Summarize data by water source or type
Objective: Assess effectiveness of wastewater treatment processes on selected chemicals found in hydraulic fracturing wastewater

Commercial Treatment Systems
- Field studies
- Collect influent, effluent, and residuals samples
- Analyze concentrations of VOCs, SVOCs, anions, metals/inorganics, TDS, radionuclides

Wastewater Treatment Facility/Biological Processes
- Bench studies with chemostat reactors
- Blend hydraulic fracturing wastewater with synthetic municipal wastewater
- Collect influent and effluent samples
- Monitor effects on biological processes within wastewater
Surface Water Modeling

**Scenario Evaluations**

**Objective:** Identify possible concentrations of selected chemicals at public water system intakes downstream from wastewater treatment facilities

- Collect model inputs from the National Pollutant Discharge Elimination System monitoring reports and USGS stream water quality and flow rate data
- Use three modeling approaches to determine potential bromide and radium levels downstream
  1. Steady-state mass balance model
  2. Transient empirical model
  3. Hybrid empirical-numerical model
- Run models with different discharge scenarios and stream flow scenarios based on data collected

Monte Carlo simulation used to estimate uncertainty in output

Confirm results with USGS tracer data and EPA Water Quality Simulation Package
Objective: Identify proportion of hydraulic fracturing wastewater that may impact public water system intakes downstream from wastewater treatment facilities

Sample Analyses

- Field studies on two rivers
- Collect samples upstream and various distances downstream from discharge
- Analyze samples for suite of elements and ions including strontium 87/86 ratios

Modeling

- Compare two rivers using peer-reviewed models
- Identify and quantify contaminant source types using receptor models
- Receptor models include Unmix, Positive Matrix Factorization, Chemical Mass Balance
Source Apportionment

Laboratory Studies

Discharge Point
Discharge includes hydraulic fracturing wastewater, coal-fired power plant effluents, mining effluent, and road salt

Sample Upstream

Sample Discharge

Sample Downstream

Sample Drinking Water Intake

ISCO Sampler
Brominated Disinfection By-Product Precursor Studies

Laboratory Studies

**Objective:** Assess the contribution of hydraulic fracturing wastewater to formation of brominated disinfection by-products at public water systems

**Total Trihalomethanes**
- Focus on the formation of brominated trihalomethanes
- Bench studies
- Compare equimolar concentrations of bromide in spiked laboratory water and blended effluents
- Maintain chloride:bromide ratio found in effluents in spiked waters
  - Eliminate chloride:bromide ratio as a variable
Are there other sources of data and/or samples which could be obtained for further study?

What are the most important future research topics regarding wastewater management and water reuse?