Web Conference Summary of April 18, 2013 Technical Workshop on Wastewater Treatment and Related Modeling

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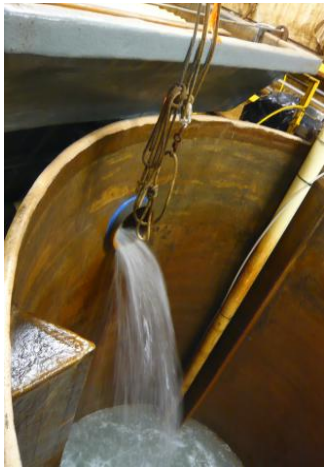


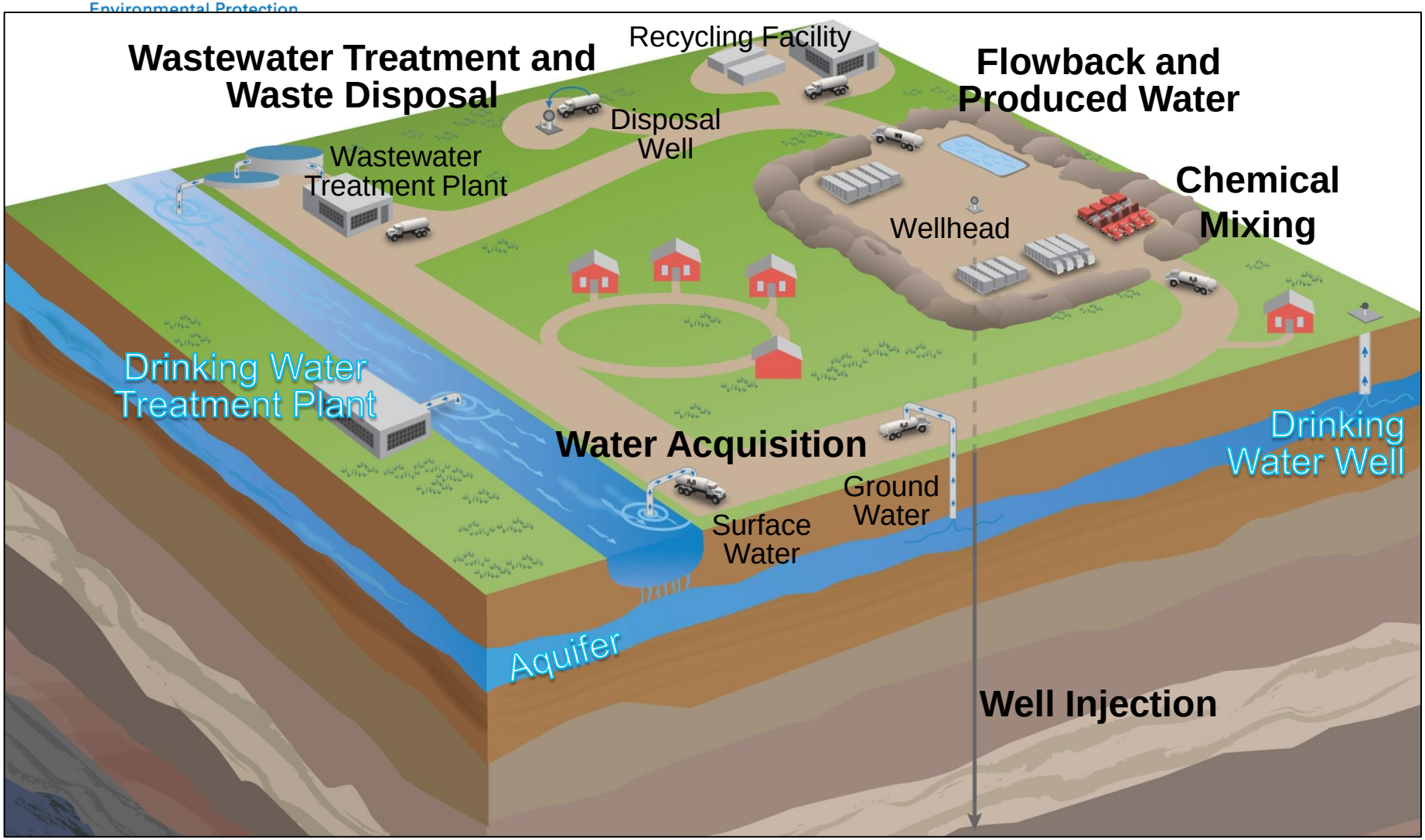

EPA Study of the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources

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

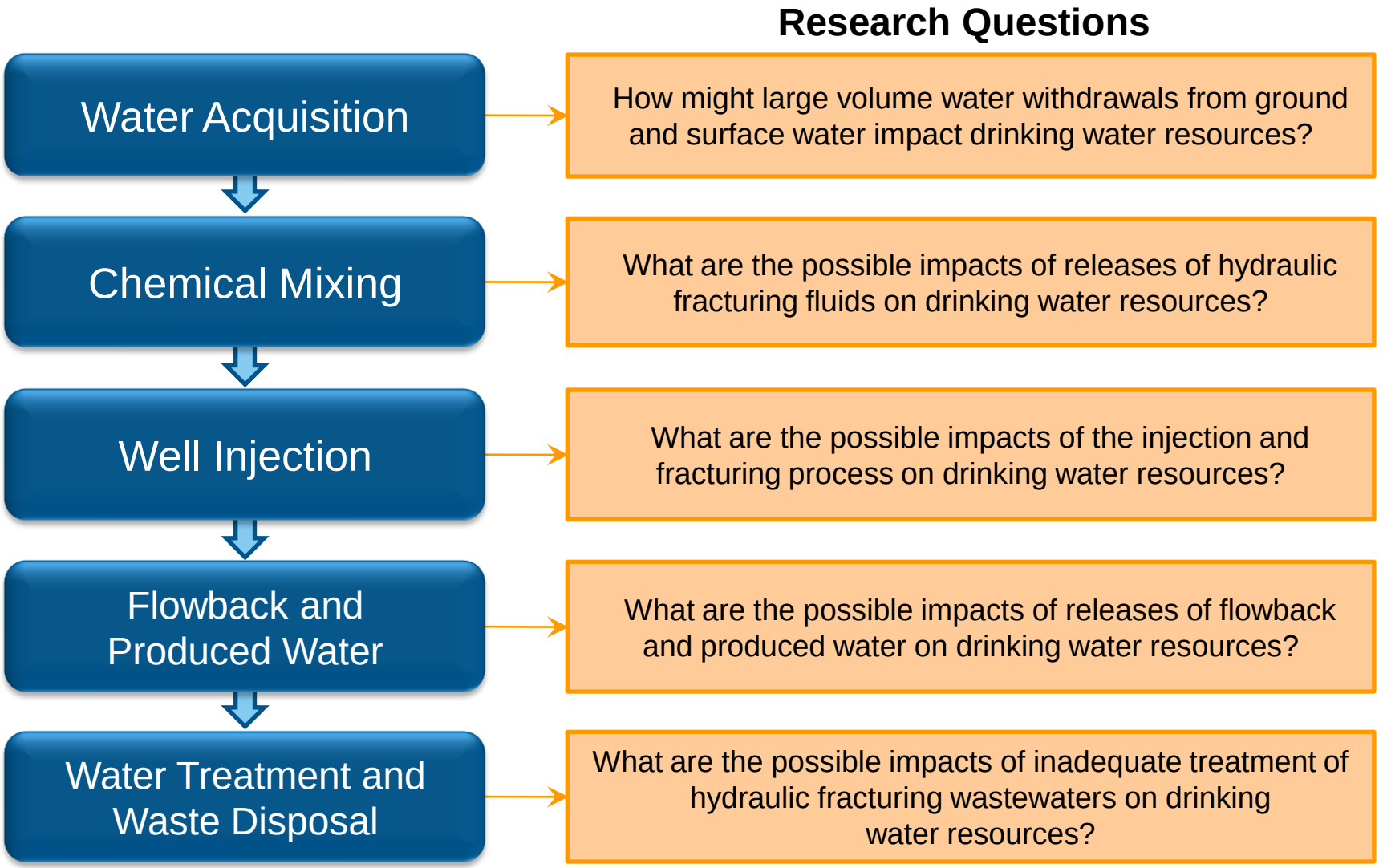
Hydraulic Fracturing Water Cycle



WATER CYCLE STAGES

Water Acquisition → Chemical Mixing → Well Injection →
Flowback and Produced Water → Wastewater Treatment and Waste Disposal

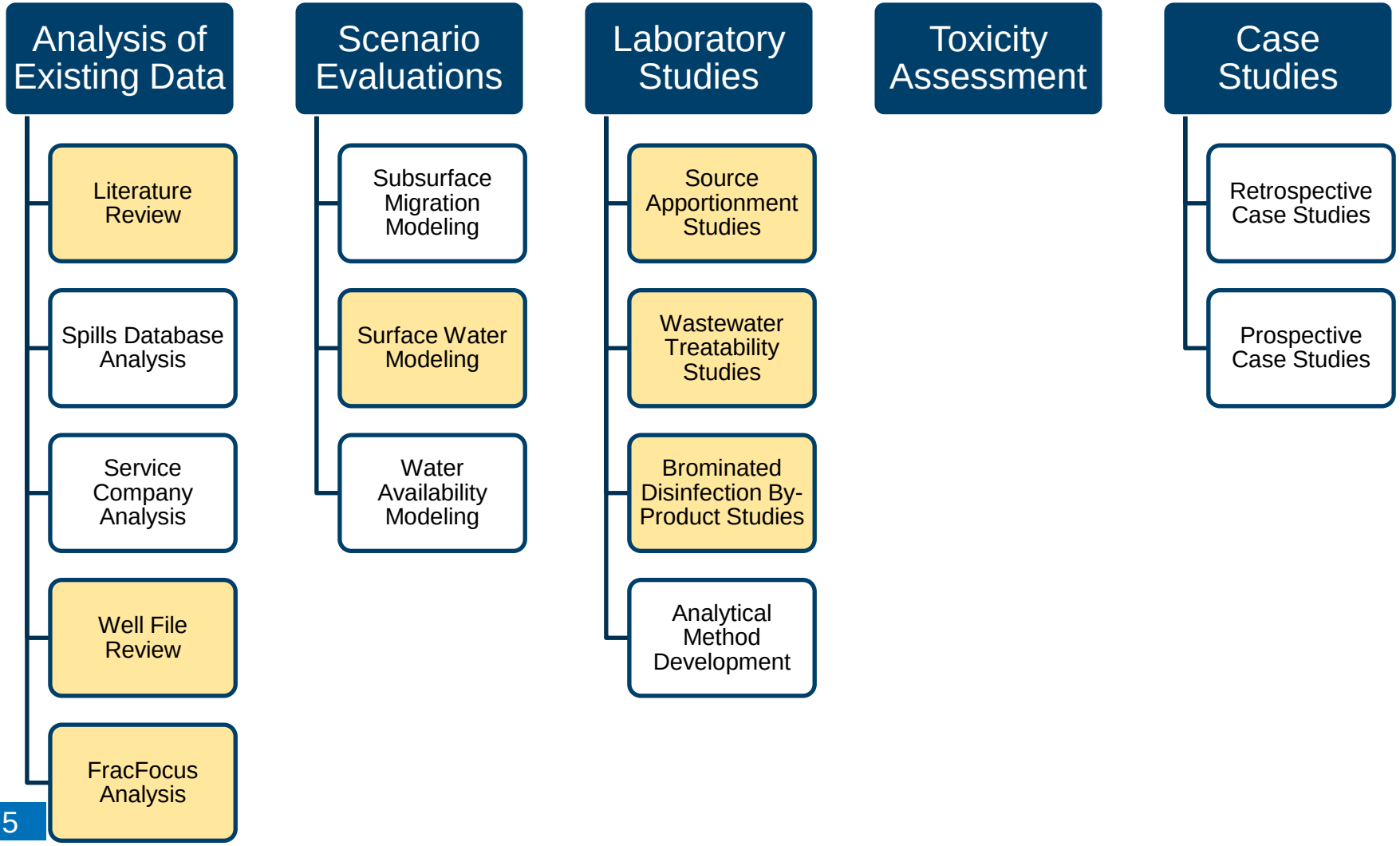
Primary Research Questions



Secondary Research Questions

Secondary Research Questions	Research Projects
What are the common treatment and disposal methods for hydraulic fracturing wastewater and where are these methods practiced?	Literature Review Well File Review FracFocus Analysis
How effective are conventional POTWs and commercial treatment systems in removing organic and inorganic contaminants of concern in hydraulic fracturing wastewater?	Literature Review Wastewater Treatability Studies
What are the potential impacts from surface water disposal of treated hydraulic fracturing wastewater on drinking water treatment facilities?	Literature Review Surface Water Modeling Source Apportionment Studies Brominated Disinfection By-Product Precursor Studies

Types of Research Projects



Literature Review

Analysis of Existing Data

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

Well File Review

Analysis of Existing Data

Objective: Assess well construction and hydraulic fracturing operations as reported by nine oil and gas operators

Research Progress

- Well-specific records:
  - Provided by nine oil and gas operators (includes confidential business information)
  - 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

FracFocus Analysis

Analysis of Existing Data

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

Wastewater Treatability

Laboratory Studies

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 volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), anions, metals/inorganics, total dissolved solids (TDS) and 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

Monte Carlo simulation used to estimate uncertainty in output

Confirm results with USGS tracer data and EPA Water Quality Simulation Package

- Run models with different discharge scenarios and stream flow scenarios based on data collected

Source Apportionment

Laboratory Studies

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

United States Environmental Protection Agency

Discharge Point

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

ISCO Sampler

Sample Discharge

Sample Upstream

Sample Downstream

Sample Drinking Water Intake

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

Workshop Structure

- Two Sessions
  - Hydraulic Fracturing Wastewater Treatment
  - Current and Future Trends in Hydraulic Fracturing Wastewater Management
- Participants were from EPA, DOE, states, industry, academia and non-governmental organizations
  - Industry included: oil & gas companies, commercial laboratories and water treatment facilities
  - 51 participants present

Session 1: Wastewater Treatment
Questions for Consideration

Participants considered three questions

- What are some modern and potential future trends in reuse, recycling, zero-liquid discharge and commercial transport?
- How to manage, dispose and characterize residuals of hydraulic fracturing?
- What are the consequences of disposal via landfills or beneficial reuse?

Session 1: Wastewater Treatment
Participant Comments

Wastewater reuse/recycling

- Trend is to 100% reuse and zero-discharge
  - Some participants stated that operators are targeting, and some have achieved,100% reuse
  - Increased reuse/recycling is expected by some to lessen impacts to drinking water
- Where reuse is not available or economically feasible, management alternatives include underground injection or treatment/disposal
- Very different water treatment issues from area to area; there is no single solution to wastewater management

Session 1: Wastewater Treatment
Participant Comments

Chemical issues for reuse

- Some operators are using water higher in TDS than in the past (especially with slickwater fracturing)
- Gel and cross linked formulations for use in high TDS waters is an active area of research
- Industry is searching for less toxic additives for fracturing fluids

Session 1: Wastewater Treatment
Participant Comments

Wastewater transport and mobile treatment

- Costs to transport wastewater to treatment/reuse facilities can total 25-75% of water management costs
- Centralized treatment makes sense where there is a critical mass of well pads
- Mobile treatment units are promising for areas where pads are more sparse

Session 1: Wastewater Treatment
Participant Comments

Water sharing

- Produced water is starting to be considered as an asset
- Depending on the location, there may be legal/liability issues with transporting wastewater for reuse by another entity
- Texas has recently changed regulations to facilitate water sharing

Session 1: Wastewater Treatment
Participant Comments

Beneficial reuse of solids

- Sodium chloride (industrial uses, road salt) and calcium chloride (drilling mud) are commonly reused
- Improved characterization of solids from wastewater treatment is needed
- Concentration of more hazardous materials is a challenge
- Some feel it may be better to simply keep most/all of the waste solids down-hole

Session 1: Wastewater Treatment
Participant Comments

Disposal of solids in landfills

- Residuals may go to municipal solid waste facilities
- Residuals mixed with inert material (e.g. sawdust) will not prevent leaching of chemicals
- There may be concerns for waste residuals going to landfills which have waste-to-energy programs
- One alternative to more expensive RCRA Subclass C (hazardous waste) landfills may be the use of specialized industrial landfills (as is the case in Pennsylvania)

Session 2: Trends in Wastewater Management
Questions for Consideration

United States Environmental Protection Agency

Participants considered six questions

- What are the contributions of selected contaminants from hydraulic fracturing relative to other potential sources of contamination?
- What are some applications of surface and subsurface modeling?
- How much flowback or produced water is created, and what happens to it?
- How do we currently monitor wastewater disposition?
- How do the projected volumes of wastewater compare to wastewater management capacity, including underground injection wells and treatment systems?
- What are the regional differences in wastewater quantity and quality and potential impacts on drinking water sources?

Session 2: Trends in Wastewater Management
Participant Comments

Relative contributions of hydraulic fracturing contaminants versus other contaminants

- Challenging to determine relative contribution
- Look at a suite of chemicals
- Chloride may be better as a tracer in ground water vs. surface water
- Tiered approach (general water quality monitoring followed by in depth analysis if a parameter is "triggered")

Session 2: Trends in Wastewater Management
Participant Comments

Possible modeling applications

- Potential impacts from brackish water withdrawal to nearby freshwater aquifers
- Potential impacts from leachate in unlined construction/demolition landfills
- Economic models combined with system-based dynamic models to look at socio-economic issues involving water reuse

Session 2: Trends in Wastewater Management
Participant Comments

Water volumes and dispositions

- Wastewater volumes vary
  - Flowback water volumes vary across regions and plays
  - Produced water volume changes over the life of the well
- Inconsistent data
  - Tracking/reporting standards and accessibility of data are very different from state to state
  - Several participants recommended more consistent reporting
  - Reporting on a regular bases could help prevent unsafe disposal
  - The practical aspects of tracking wastewater in large complex systems were noted
- Collaboration between industry and government to develop long-term water resource management plans and data

Regional differences

- Water volumes
  - Marcellus and Utica formations are using much more water compared with western plays; wastewater volumes (total) are increasing
  - In the Bakken, less water is used and less water is returned
  - Slick water fracturing uses more water than gel fracturing (by factor of 2-3)
- Water quality
  - NE Marcellus wastewater has higher TDS but lower volumes (generally) relative to SW Marcellus
  - Oklahoma has a wide variation in water quality across plays

Next Steps

Next workshops are:

- June 3 – Subsurface Modeling
- June 4 – Water Acquisition Modeling
- TBD – Hydraulic Fracturing Case Studies

Information on technical workshops can be found at: http://www.epa.gov/hfstudy/techwork13.html

Disclaimer

The U.S. Environmental Protection Agency, through its Office of Research and Development, organized and conducted the Technical Workshop on Wastewater Treatment and Related Modeling. The summary presented here has been subjected to the Agency's peer and administrative review and has been approved for external publication. Any opinions expressed are those of the workshop participants and do not necessarily reflect the views of the Agency, therefore, no official endorsement should be inferred. Any mention of trade names or commercial products does not constitute endorsement or recommendation for use.