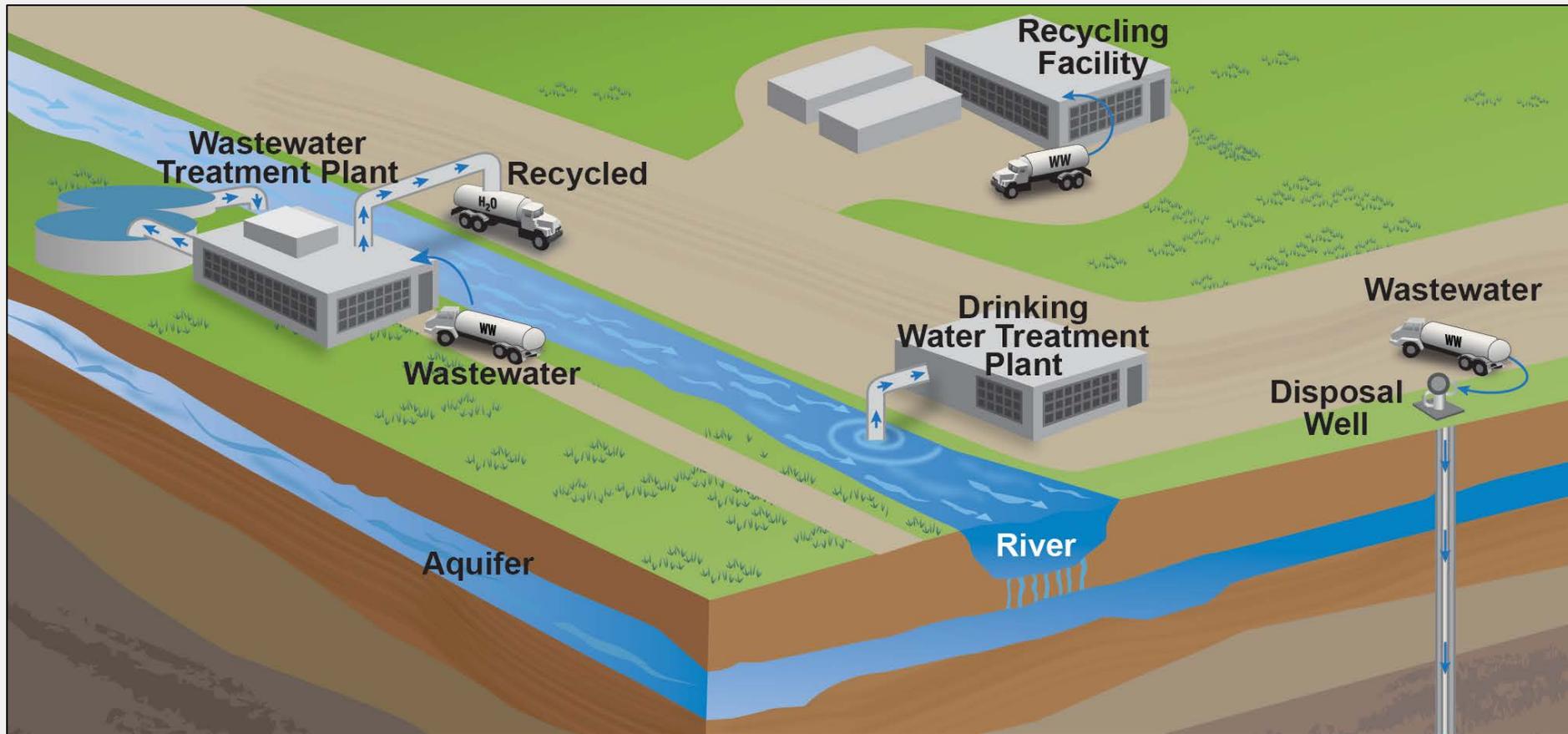


Wastewater Treatment and Waste Disposal

Christopher Impellitteri, PhD



Wastewater Treatment and Waste Disposal



What are the possible impacts of inadequate treatment of hydraulic fracturing wastewater on drinking water resources?

Charge Question #11

EPA is currently able to detect and quantify selected anions, cations and metals in hydraulic fracturing wastewater and is considering modifying analytical methods for detecting selected organics in wastewater.

Please provide recommendations for other specific chemicals that are of interest from a **wastewater treatment** and/or drinking water treatment perspective.

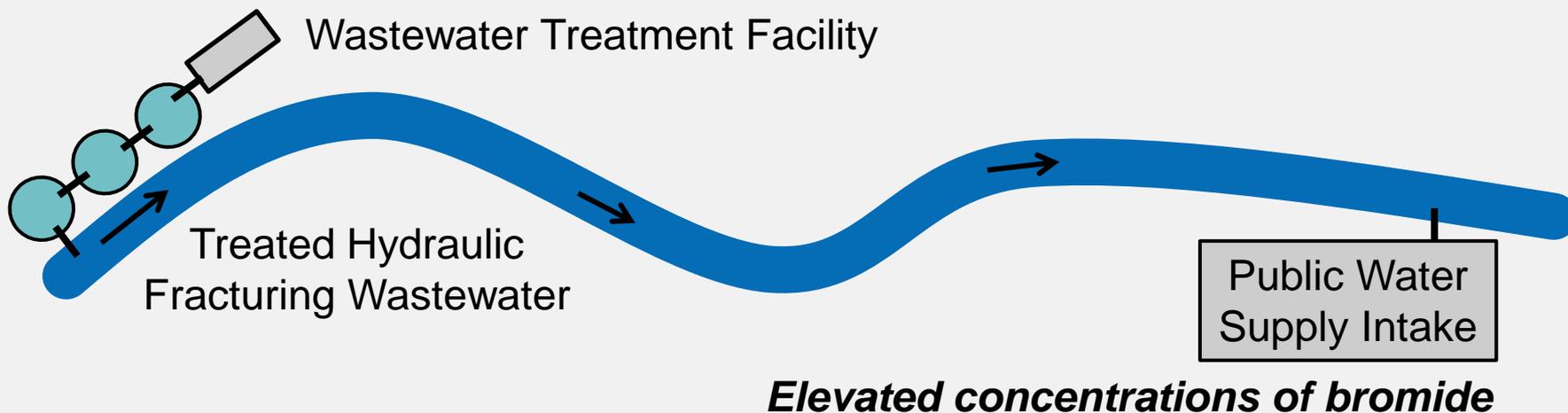
Wastewater Composition

- Chemicals used in the hydraulic fracturing fluid
 - Including breakdown and reaction products
- Chemicals found in the fractured formation
 - Brine (total dissolved solids, chloride, bromide)
 - Trace elements (e.g., mercury, lead, arsenic)
 - Naturally occurring radioactive material (e.g., radium, thorium, uranium)
 - Gases (e.g., methane, hydrogen sulfide)
 - Organic material (e.g., polycyclic aromatic hydrocarbons, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs))

Wastewater Research Projects

PROJECT	DESCRIPTION
Wastewater Treatability Studies	Assessment of the efficacy of common wastewater treatment processes on removing selected chemicals found in hydraulic fracturing wastewater
Br-DBP Precursor Studies	Assessment of the ability of chemicals found in hydraulic fracturing wastewater to form brominated disinfection byproducts (Br-DBPs) during drinking water treatment processes
Source Apportionment Studies	Development of a method to identify the potential source(s) of surface water contamination
Surface Water Modeling	Modeling of concentrations of selected chemicals at public water supplies downstream from wastewater treatment facilities discharging treated hydraulic fracturing wastewater

Br-DBP Precursor Studies



GOALS

- Analyze and characterize wastewater for presence of halides (bromide, chloride)
- Evaluate effects of high TDS upon chlorination of surface water receiving discharges of treated wastewater

Wastewater Treatability Studies

Identify Common Treatment Processes

- Publicly-owned treatment works (POTWs) (e.g., biological processes)
- Commercial treatment systems (e.g., chemical precipitation, evaporation)

Identify Chemicals for Study

- Anions, metals/inorganics, TDS, radionuclides
- VOCs, SVOCs being considered

Conduct Experiments

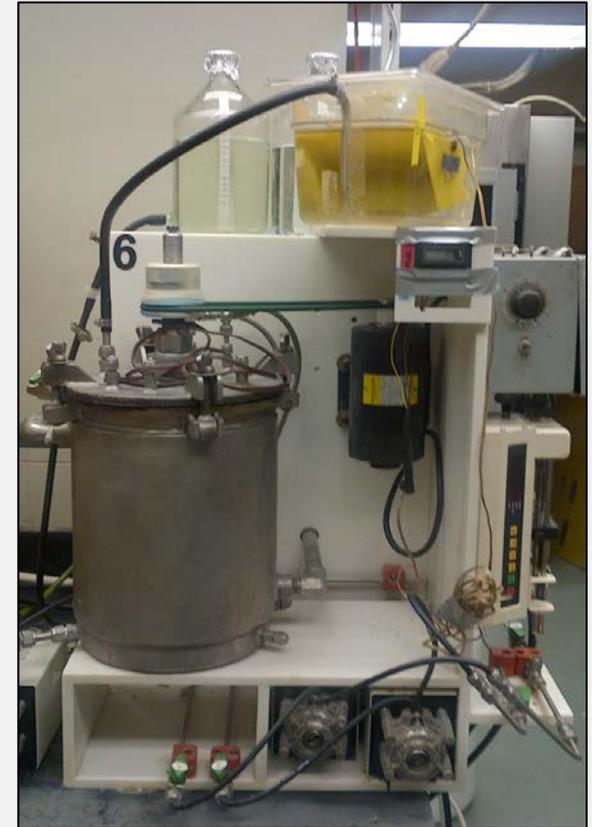
Identify partitioning of selected chemicals during common treatment processes

Chemical / Physical Processes

- Commercial treatment systems
- Field studies
- Treatment processes
 - Coagulation, flocculation, filtration, distillation
- Sample collection
 - Influent, effluent, residuals
- Analytes
 - Anions, metals/inorganics, TDS, radionuclides
 - VOCs, SVOCs under consideration

Biological Processes

- POTWs
- Bench studies with chemostat reactors
 - Blend hydraulic fracturing wastewater with synthetic municipal wastewater
- Sample collection
 - Influent, effluent
- Monitor effects on biological processes
- Analytes
 - Anions, metals/inorganics, TDS
 - VOCs and SVOCs under consideration



Potential Analytes

GROUP	EXAMPLES
VOCs	<ul style="list-style-type: none">• Benzene• Chloroform
SVOCs	<ul style="list-style-type: none">• Fluoranthene• Napthalene• Phenol
Anions	<ul style="list-style-type: none">• Bromide• Chloride• Sulfate
Metals / Inorganics	<ul style="list-style-type: none">• Arsenic• Chromium
Radionuclides	<ul style="list-style-type: none">• Radium• Thorium• Uranium

Analytes must be measurable in high-TDS matrices

Charge Question #12

What key trends in **wastewater management**, if any, may affect the volume and/or composition of hydraulic fracturing wastewater being treated and discharged to surface water?

Wastewater Management Practices

Options

- Disposal through underground injection control wells
- Treatment followed by:
 - Reuse for additional hydraulic fracturing activities
 - Direct discharge to surface water (under NPDES permit)
 - Indirect discharge to surface water (via POTW)
 - Underground injection of treated brine
 - Beneficial reuse
- Evaporation ponds

General Decision Criteria

- Availability of treatment/disposal/reuse options
- Treatment/disposal/reuse cost
- Transportation cost
- Local or regional water needs/availability

Wastewater Management Practices

EPA will obtain a “snapshot” of hydraulic fracturing wastewater management practices

PROJECT	ANTICIPATED AVAILABLE INFORMATION
Well File Review	Volume and final disposition of flowback and produced water from wells hydraulically fractured in 2009-10
FracFocus Analysis	Data on water types reported in FracFocus by volume and geographic location, focusing on recycled water, between January 2011 and February 2013
Literature review	Current state of the science with respect to hydraulic fracturing wastewater management and reuse

Technical Stakeholder Input*

- Potential local impacts and public opinion play a role in disposal of hydraulic fracturing wastewater
- Saline water can be used in some hydraulic fracturing fluids, but this may negatively impact equipment
- Recycling occurs when it is cost-effective
- High TDS concentrations limit effectiveness of some treatment technologies
- Produced water volumes may exceed the potential for reuse, leading to a future need for treatment and disposal
- Concern about management of treatment residuals

Technical Stakeholder Input*

- Industry is rapidly changing, with an increased emphasis on using recycled or brackish/salt water
- Long-term vision involves sharing water
- Improved monitoring and tracking of wastewater needed
- Option for full scale watershed study, tiered with suite of chemicals identified

Charge Questions

11. EPA is currently able to detect and quantify selected anions, cations and metals in hydraulic fracturing wastewater and is considering modifying analytical methods for detecting selected organics in wastewater. Please provide recommendations for other specific chemicals that are of interest from a **wastewater treatment** and/or drinking water treatment perspective.

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