Opportunity for Stakeholder Input on EPA's Hydraulic Fracturing Research Study: *Study Design*

Natural gas plays a key role in our nation's clean energy future, and hydraulic fracturing (HF) is one way of accessing this vital resource. Over the past few years, the use of HF for gas extraction has increased and expanded over a wider diversity of geographic regions and geologic formations. While HF was predominately used in coalbed methane extraction in the 1990s, it has been used in recent years to extract natural gas from shale formations. Shale gas is expected to comprise over 20% of the total U.S. gas supply by 2020. At the same time, concern is mounting among the public, media, and Congress over the potential impacts of HF on drinking water. Due to the increasing use of HF and these growing concerns, EPA announced in March 2010 that it will study the relationship between HF and drinking water. To help design this study, EPA is identifying the key interactions between HF and water resources. EPA seeks input from the public and stakeholders regarding these interactions.

The Hydraulic Fracturing Process

EPA is examining the entire HF process -- from obtaining the water necessary for fracturing fluids to operations to disposal of wastes -- to assess potential impacts on water resources. There are several steps in the HF process.

First, necessary site infrastructure is built, which includes well construction. Production wells may be drilled in the vertical direction only or paired with horizontal or directional sections. Vertical well sections may be drilled hundreds to thousands of feet below the land surface and lateral sections may extend several thousand feet away from the well. Next, fluids made up of water and chemical additives are pumped through the well into a geologic formation at high pressure. When the pressure exceeds the rock strength, the fluids open or enlarge fractures that can extend several hundred feet away from the well. A propping agent (such as sand or ceramic beads) is then pumped into the fractures to keep them from closing once the pumping pressure is released. After fracturing is completed, the fracturing fluids (water and chemical additives) return to the surface due to internal pressure of the geologic formation or pumping done at the surface. Recovered fracturing fluids, referred to as flowback, may be stored in tanks or pits. There are several management options for the wastewater, including treatment and discharge into surface water, underground injection, or recycling.

Potential Impacts to Water

Water is involved in many parts of the HF process. There are four main phases of water use in HF operations:

1. Acquisition of water for well drilling and fracturing operations;
2. Mixing water with chemicals and proppant (e.g., sand, ceramic beads) for the fracturing operation itself, injection of fracking fluids, and return of wastewater to the surface;
3. Storage of wastewater;
4. Treatment, disposal, or recycling of wastewater.

The HF process may affect both surface and ground water. It may pose risks to drinking water supplies by reducing the volume of available drinking water and/or introducing contaminants into the drinking water supply. These risks can be classified as impacts to water quantity and quality.

Potential Impacts on Water Availability (Quantity)

The HF process uses a large volume of water and thus may affect water availability. It is estimated that it takes two to five million gallons of water to drill and fracture a well. This water can come from either ground or surface water sources depending on the location of the well. The use of large volumes of water could stress drinking water supplies, especially in drier regions where aquifer or surface water recharge is limited. Large withdrawals of waters for HF could potentially lead to lowered water tables or dewatered drinking water aquifers, decreased stream flows, and reduced volumes of water in surface water reservoirs (Table 1). This could negatively affect the availability of water for drinking and other uses in areas where HF is occurring.

Potential Impacts on Water Quality

Underground sources of drinking water (USDWs) are usually accessed at depths of less than 1,000 feet, while natural gas production wells are typically drilled to depths ranging from 1,000 to 8,000 feet. However, deeper USDWs are also present in the U.S. and may occur at depths coincident with oil and gas reservoirs. There are several potential mechanisms by which contaminants could be introduced into drinking water supplies or USDWs during HF, including:

- Transport of contaminants through natural fractures in the rock into adjacent drinking water aquifers;
- Transport of contaminants into underground drinking water zones through the fractures produced during the hydraulic fracturing process;
- Transport of contaminants into drinking water through abandoned or other pre-existing wells;
- Leakage of contaminants from production wells (e.g., improperly constructed or damaged wells);
- leaching of contaminants from improperly lined storage or drilling pits; and
- Spills of the HF fluids into surface water bodies used for drinking water.

When HF fluids or flowback water are introduced into the subsurface, they could potentially alter the natural conditions that exist in the underground environment. Changes in the geologic formation could lead to the release of naturally occurring metals, radionuclides, organic contaminants and gases present in rock and/or cause the migration of contaminants from the natural gas reservoir into adjacent geologic formations.

The HF process may also impact surface water quality. For example, total dissolved solids (TDS) could increase significantly in surface water from discharges from wastewater treatment facilities or runoff of wastewater into nearby surface waters. Wastewater treatment facilities that accept wastewater from HF sites are sometimes not capable of reducing TDS to concentrations that the receiving water is capable of diluting to safe levels. High TDS discharges can cause adverse impacts to receiving streams used for drinking water supplies.

Table 1: Potential impacts to surface and ground water resources from the hydraulic fracturing process.

Water in the HF process	Surface Water Impacts	Ground Water Impacts
Water Used in Fracturing Fluids	Decreased surface water flows	Lowered water table, dewatered aquifer
Hydraulic Fracturing (including injection of fracturing fluids and return of wastewater to the surface)	Potential runoff to streams from leaks, spills, accidents	Abandoned wells as conduits to adjoining drinking water aquifers Well failure or poor construction, leading to leakage to adjoining drinking water aquifers Fractures or faults leading to leakage to adjoining drinking water aquifers
Storage of Wastewater	Storage pit water runoff to streams from leaks, spills, accidents	Pit water leaching to underground sources of drinking water
Disposal, Treatment, Recycling of Wastewaters	Wastewater treatment plant discharges to surface water Wastewater spills	Well failure or poor construction, leading to fluid migration into adjoining drinking water aquifers

Stakeholder Input

EPA is seeking input from stakeholders and the public to help inform the development of the study design. In particular, the Agency would appreciate responses to these questions related to the table presented here:

1. Can you suggest additional pathways of exposure that could impact drinking water resources from the hydraulic fracturing process?
2. In your experience, what are the most important processes and pathway(s) of exposure that would adversely impact drinking water resources?
3. What current practices in your region do you think pose the most threat to drinking water resources from hydraulic fracturing?
4. Can you provide data, studies, reports, or other information to help us assess the relative importance of these potential impacts?