

## About Hydraulic Fracturing

Hydraulic fracturing, or fracking, is essential to produce oil and natural gas that is otherwise trapped in low-permeability rock formations. It significantly improves the recovery from the reservoir by stimulating the movement of oil and natural gas.

It is important to understand where hydraulic fracturing fits into the entire drilling, well construction/completion and production phases of oil and natural gas activities. Hydraulic fracturing is not a method for drilling or constructing a well.

To reach a hydrocarbon formation thousands of feet below the surface and freshwater resources, the hole (wellbore) is drilled in successive sections through the rock layers. Once the desired length of each wellbore section has been drilled, the drilling assembly is removed, and steel casing is inserted and cemented in place. As the well is constructed, concentric layers of steel casing and cement form the barrier to protect groundwater resources from the contents that will later flow inside the well. Next, only the section of casing within the hydrocarbon formation is perforated at the desired location.

Hydraulic fracturing is a safe and proven technique that has enabled oil and natural gas resources to be developed for more than 60 years.



The well is now ready for the hydraulic fracturing process. This process involves pumping fluid through the perforations. The fracturing fluid itself exerts pressure against the rock, creating tiny cracks, or fractures, in the reservoir deep underground. The fluid is predominantly water, proppants (grains of sand or ceramic particles) and a small fraction of chemical additives.

Once fluid injection stops, pressure begins to dissipate, and the fractures previously held open by the fluid pressure begin to close. Proppants then act as tiny wedges to hold open these narrow fractures, about half the width of a human hair, creating pathways for oil, natural gas and fracturing fluids to flow more easily to the well. A plug is set inside the casing to isolate the stimulated section of the well. The entire perforate-inject-plug cycle is then repeated at regular intervals along the targeted section of the reservoir. Finally, the plugs are drilled out, allowing the oil, natural gas and fluids to flow into the well casing and up to the surface.

The hydrocarbon and fracturing fluid mixture is separated at the surface, and the fracturing fluid (also known as flowback water) is collected in tanks or lined pits. The fracturing fluids are then disposed of according to government-approved methods.

Hydraulic fracturing operations generally occur over a three- to five-day period. The entire well construction process (including hydraulic fracturing) takes about two to three months, compared to the 20- to 30-year productive life of a typical well.

## Importance of Hydraulic Fracturing

Since the late 1940s, more than 1 million wells have been hydraulically fractured in the United States and more than 2 million have been fractured worldwide. When used in conjunction with horizontal drilling, an advanced drilling technology, hydraulic fracturing makes it possible to develop vast unconventional resources. Without hydraulic fracturing and horizontal drilling, resources like tight sands, coalbed methane and shale gas would remain largely undeveloped. According to the U.S. Energy Information Administration, all of these resources combined accounted for 50 percent of U.S. natural gas production in 2009 and are projected to account for 60 percent of supply by 2035.

## A Safe and Proven Technique

Hydraulic fracturing is a safe and proven technique that has enabled oil and natural gas resources to be developed for more than 60 years. The National Petroleum Council reported that up to 95 percent of wells drilled today are hydraulically fractured. Many studies—and decades of history—indicate that oil and natural gas operations, including hydraulic fracturing, are safe when wells are properly designed, constructed and operated.

## Multiple Safeguards Protect Groundwater

Protection of groundwater resources is important through every stage of oil and natural gas development. Below the surface, well integrity is crucial to isolate and protect potable groundwater from hydraulic fracturing and flowback fluids during completion operations and from oil, natural gas and water produced from the reservoir over the well life. Proper well design, construction and monitoring are necessary to ensure groundwater is protected.

A well is much more than a pipe in the ground. After a wellbore is drilled through the rock, concentric layers of steel casing and cement are installed, creating multiple, impermeable barriers between the inside of the well and the earth's strata, including aquifer formations containing freshwater.

Looking at a cross section of a well, the outermost structure typically includes a shallow conductor casing to stabilize the ground at the well surface and always includes surface casing. The surface casing extends to depths below freshwater aquifers in accordance with government regulations and is cemented in place with the explicit intent

### Recent studies find no substantiated connection between hydraulic fracturing and groundwater contamination:

A 2009 study by the Ground Water Protection Council, an association of state regulators, reviewed 10,000 wells and found only one complaint, which proved to be unrelated to hydraulic fracturing.

In 2010, the Interstate Oil & Gas Compact Commission, representing 30 state governments, affirmed that there have been no verified cases of drinking water contamination resulting from hydraulic fracturing operations in states where shale gas is produced.

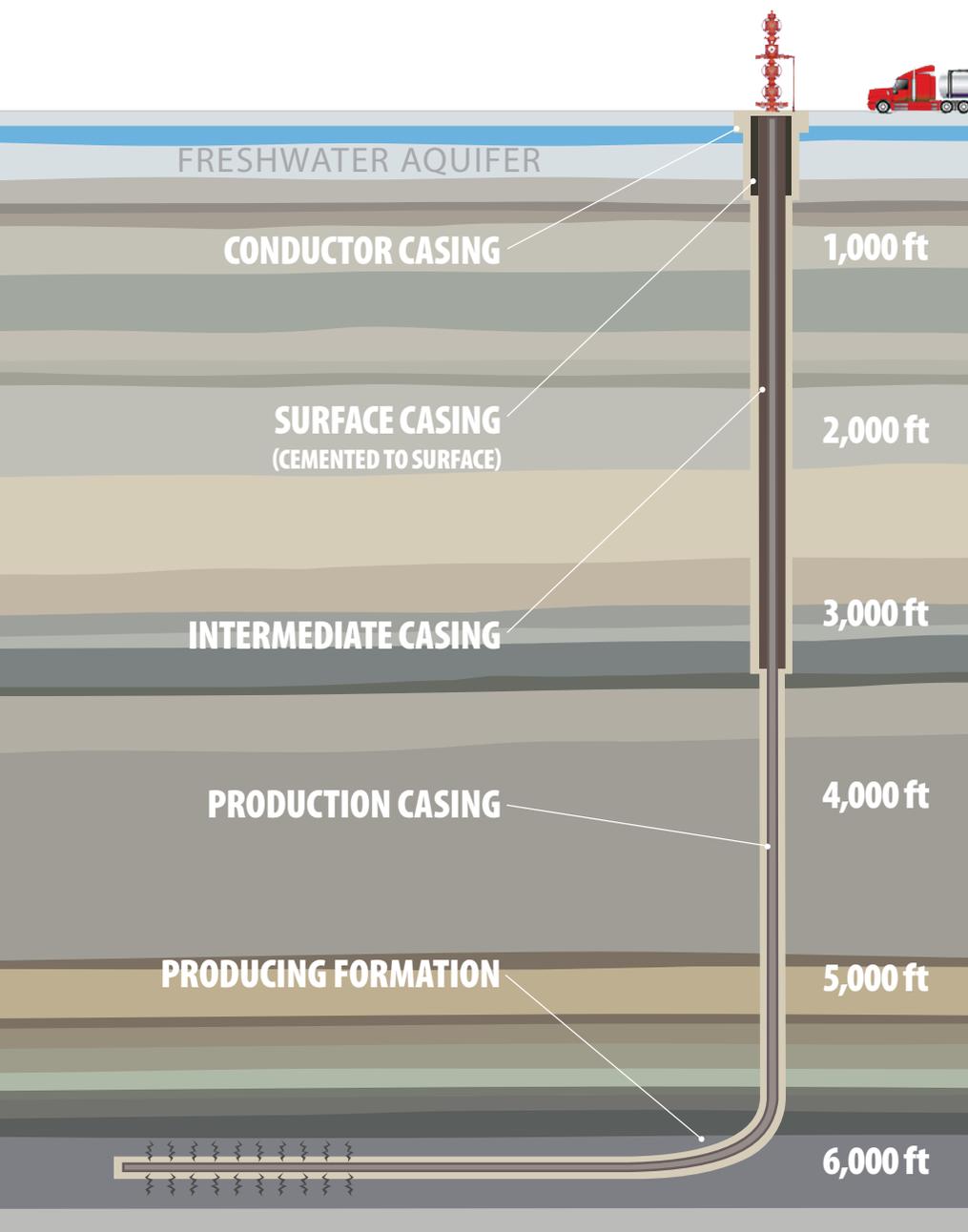
of protecting useable groundwater. Inside this structure, there may be one or more intermediate casings. The innermost structure is a production casing that extends to the bottom of the well. Typically, cement is pumped into the open space between each casing and the rock, forming a complete seal with multiple layers of protection.

To ensure well integrity, the entire system is pressure tested before the hydraulic fracturing process begins. Personnel at the well site continually monitor fluid injection rates and pressures throughout the hydraulic fracturing process. This data can also be transmitted via satellite to remote operation centers for off-site monitoring. Hydraulic fracturing operations are immediately shut down in the event of unexpected pressure responses.

Once hydraulic fracturing is complete and the well is placed into production, the pressure inside the well drops below the pressure of

the hydrocarbons outside the well. This pressure difference causes oil, natural gas and fracturing fluids to migrate into the well. The well is the path of least resistance for hydrocarbons to flow to the surface in a controlled manner, rather than being driven upward through geological barriers.

Beyond the mechanical safeguards of the well itself, groundwater is protected by physical factors. Hydraulic fracturing typically occurs thousands of feet below freshwater aquifers and often more than a mile below the earth's surface. Multiple layers of permeable and impermeable rock separate the targeted hydrocarbon formation from the aquifers, providing natural geologic barriers to the upward migration of fluids.



## FREQUENTLY ASKED QUESTIONS

### Who regulates hydraulic fracturing?

Local, state, federal and national laws and regulations currently govern hydraulic fracturing operations. These rules include well permitting, well materials and construction, air emissions, flowback and produced water disposal, storm water management, and chemical record keeping and reporting.

### Is hydraulic fracturing safe?

Yes. Well operations, including those involving horizontal drilling and hydraulic fracturing, are low risk activities that we manage responsibly. We are confident in our ability to safely and responsibly develop oil and natural gas resources by using proven practices. We follow a set of principles that incorporate established industry standards and are designed to meet or exceed regulatory requirements. These demand diligent focus on every activity, from community consultations about exploration to final site restoration.

### Where does hydraulic fracturing take place?

Hydraulic fracturing takes place in hydrocarbon-bearing formations that are typically thousands of feet below the surface. It would take approximately five Empire State Buildings (1,250 feet each) on top of one another to reach a targeted formation at 6,000 feet below the surface.