Protecting Groundwater During Natural Gas and Oil Drilling

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Introduction

Over the last decade, the United States has seen a tremendous increase in the acknowledged domestic reserve base of natural gas and oil. Much of this increase comes from the discovery and economic viability of unconventional sources such as tight sands (oil) and shale rock formations (natural gas and tight oil). Advanced drilling technologies, which allow companies to access these underground resources, have resulted in a significant increase in the number of wells drilled.

The drilling of a modern natural gas or oil well is a highly technical, complex and regulated activity that requires multiple permits. These permits can cover aspects such as well depth, potential impacts of wellsite construction, measures to protect freshwater aquifers and the completion process.

Drilling

The initial step in drilling a natural gas or oil well is to construct a wellsite, which provides a level surface for the drilling rig and necessary equipment. The wellsite is typically three to five acres in size and takes less than a week to construct. After the padsite is completed, the drilling rig is moved onto the wellsite and set up. Upon completion of this phase, the drilling process begins.

Chesapeake drills both vertical and horizontal wells. The time required to drill a well depends on the target depth, the geological conditions encountered and the length of any horizontal section that is planned. A relatively shallow well at a depth of 4,000 feet might take two to three weeks to drill and complete, while a 10,000-feet-deep well might take four to six weeks.

Drilling a well is accomplished by rotating the drill pipe with a drillbit attached to the end. The drillbit breaks up the rock into small chips (cuttings), which are removed from the wellbore and carried to the surface along with the drilling fluid. The drilling fluid is pumped down the inside of the drill pipe, out through holes in the drillbit and then back to the surface between the outside of the drill pipe and the wellbore.

To ensure protection of freshwater zones, the upper wellbore is often drilled using freshwater or air when drilling at shallow depths. Below the freshwater zone, drilling mud, typically consisting of a mixture of water and bentonite (a natural clay), is used as drilling fluid to cool and lubricate the drillbit and carry cuttings to the surface.

KEY POINTS

- The drilling of a modern natural gas or oil well is a complex and highly regulated activity.
- Many protective layers (casings) are installed in today's wells to control pressure and prevent contamination to aquifers.
- In addition to multiple layers of casing and cement, natural barriers within rock formations act as seals, holding natural gas and oil in the target formation.

In some areas, subsurface rock formations swell when exposed to freshwater. Swelling rock formations can cause a number of problems with casing and well production. To avoid potential problems, operators may elect to use a drilling mud based on saltwater, synthetic polymers or other materials. These types of drilling muds are only used after freshwater zones have been protected behind a minimum of one layer of steel casing and cement.

Well Casing

During the drilling of a well, multiple lengths, or strings, of steel casing are lowered into the wellbore and cemented in place. Each of these strings of casing serves a specific purpose.

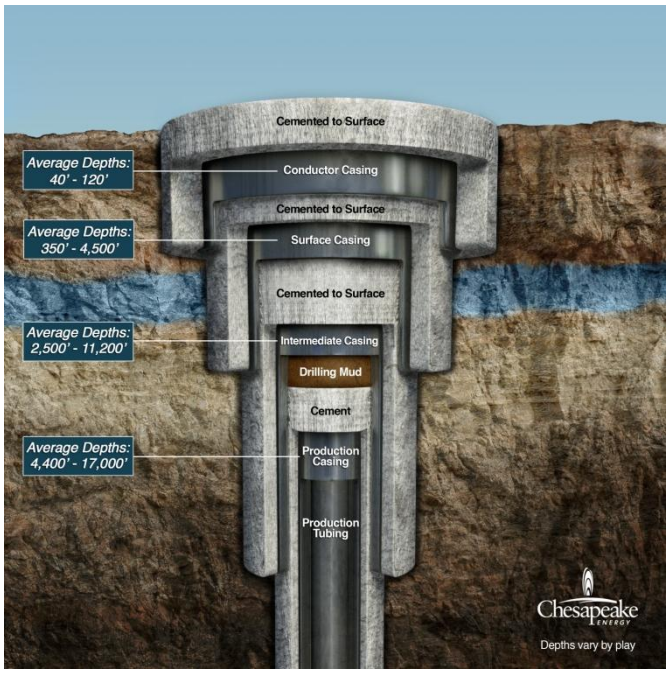
The first string of casing is the conductor casing. Conductor casing is relatively short (approximately 40 to 120 feet). It is a large-diameter steel pipe that serves as the foundation for well construction and prevents loose surface soils from falling into the wellbore.

Surface casing is installed inside the conductor casing and cemented in place to protect freshwater aquifers. Surface casing is installed at varying depths which are determined by state natural gas and oil regulatory agencies. These agencies specify the required depth of the protective casing. These requirements are typically based on regional conditions and are designed to protect fresh groundwater

aquifer resources. In Chesapeake's operating areas, the depth to the base of treatable freshwater generally ranges from approximately 350 to 4,500 feet.

In addition, the surface casing allows a blowout preventer (BOP) to be attached to the top of the drill pipe after it is cemented in place. The BOP is designed to regulate variations in well pressure to prevent an uncontrolled release of natural gas, oil or drilling material. The surface casing also provides structural strength so that the remaining casing strings may be suspended inside the surface casing.

Some wells have an intermediate casing string that is used to provide an additional layer of protection and assist in controlling higher pressures that are often found in deeper formations.



Casing and Cement Program

The final steel casing cemented into the wellbore is the production casing. This casing is eventually perforated within the formation containing the natural gas or oil to allow it to flow through the well. Typically, the zone from which natural gas or oil is produced is a few hundred to several thousand feet below the base of any freshwater aquifer. The production tubing is the final string of steel pipe that is positioned inside the production casing and through which natural gas or oil is brought to the surface.

Each string of casing serves as an additional layer of protection that prevents drilling fluids and groundwater from coming into contact with each other. Once all casing strings are cemented in place, there could be as many as seven or more layers of protective barriers between the inside of the production tubing and water sources.

Natural Geological Protection

In addition to the protections provided by multiple layers of casing and cement, there are natural geological barriers provided by the thousands of feet of rock between the freshwater aquifer and the productive geological formations. These underground rock layers act as seals, holding the natural gas or oil in the target formation.

State natural gas and oil regulatory programs place great emphasis on protecting groundwater. Current well construction requirements consist of installing multiple layers of specifically designed protective steel casing and cement to prevent the migration of fluids into nearby aquifers. These measures are very effective and have been successfully used for many decades in the natural gas and oil industry.

Information Sources

- American Petroleum Institute
- Chesapeake Energy Corporation
- Dr. Michael Economides
- Ground Water Protection Council
- Schlumberger
- U.S. Department of Energy
- U.S. Energy Information Administration

About Chesapeake

Chesapeake Energy Corporation is the second-largest producer of natural gas, a Top 15 producer of oil and natural gas liquids and the most active driller of new wells in the U.S. Headquartered in Oklahoma City, the company's operations are focused on discovering and developing unconventional natural gas and oil fields onshore in the U.S. Chesapeake owns leading positions in the Barnett, Haynesville, Bossier and Marcellus natural gas shale plays and in the Granite Wash, Cleveland, Tonkawa, Mississippi Lime, Bone Spring, Avalon, Wolfcamp, Wolfberry, Eagle Ford, Niobrara, Three Forks/Bakken and Utica unconventional liquids plays. The company has also vertically integrated its operations and owns substantial midstream, compression, drilling, trucking, pressure pumping and other oilfield service assets. For more information on Chesapeake environment initiatives, visit the environment section of CHK.com, HydraulicFracturing.com, NaturalGasAirEmssions.com, NaturalGasWaterUsage.com, AskChesapeake.com or FracFocus.com.