



Shale Gas: Environmental Considerations

An Online Continuing Education Course for Engineers

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Shale Gas: Environmental Considerations

Natural gas is an important part of the nation's energy supply, and is a clean-burning, affordable and reliable source of energy. Unconventional sources of natural gas have become a major component of that future supply and shale gas is rapidly emerging as a critical part of that resource. There exists an extensive framework of federal, state, and local requirements designed to manage virtually every aspect of the natural gas development process. These regulatory efforts are primarily led by state agencies and include such things as ensuring conservation of gas resources, prevention of waste, and protection of the rights of both surface and mineral owners while protecting the environment. As part of their environmental protection mission, state agencies are responsible for safeguarding public and private water supplies, preserving air quality, addressing safety, and ensuring the proper containment and disposal of wastes from drilling and production.

In order to make sound decisions about future shale gas development, it is important to understand the process of drilling and producing shale gas wells (Exhibit 1) and the attendant environmental considerations. A key element in the emergence of shale gas production has been the refinement of cost-effective horizontal drilling and hydraulic fracturing technologies. These two processes, along with the implementation of protective best management practices (BMPs), have allowed shale gas development to move into areas that previously would have been inaccessible. Accordingly, it is important to understand the technologies and practices employed by the industry and their ability to prevent or minimize the potential effects of shale gas development on human health and the environment and on the quality of life in the communities in which shale gas production is located.

Many of the human and environmental considerations associated with shale gas production are common to all oil and gas development. However, the horizontal drilling and hydraulic fracturing that have become the standard for modern shale gas development bring with them new considerations as well as new ways to reduce impacts. As shale gas development has spread into more densely populated areas, new challenges have been encountered and new technologies and practices have been developed to meet these challenges. In addition, collaborations between industry, regulators and the public have created innovative environmental solutions to problems that at first seemed insurmountable.

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One consideration associated with traditional gas development has been the surface disturbance required for access roads and well pads. Horizontal drilling provides a means to significantly reduce surface disturbance and a host of related concerns.

Mineral Leasing

Companies negotiate a private contract or lease that allows mineral development and compensates the mineral owners. Lease terms vary and can contain stipulations or mitigation measures pertinent to protect various resources. (Several weeks to years)

Permits

The operator must obtain a permit authorizing the drilling of a new well. Surveys, drilling plans, and other technical information are frequently required for a permit application. The approved permit may require site specific environmental protection measures. Other permits such as water withdrawal or injection permits may also be required. (Several weeks to months)

Road and Pad Construction

Once permits are received, roads are constructed to access the wellsite. Well pads are constructed to safely locate the drilling rig and associated equipment during the drilling process. Pits may be excavated to contain drilling fluids. (Several days to weeks)

Drilling and Completion

A drilling rig drills the well and multiple layers of steel pipe (called casing) are put into the hole and cemented in place to protect fresh water formations. (Weeks or months)

Hydraulic Fracturing

A specially designed fracturing fluid is pumped under high pressure into the shale formation. The fluid consists primarily of water along with a proppant (usually sand) and about 2% or less of chemical additives. This process creates fractures in rock deep underground that are "propped" open by the sand, which allows the natural gas to flow into the well. (Days)

Production

Once the well is placed on production, parts of the wellpad that are no longer needed for future operations are reclaimed. The gas is brought up the well, treated to a useable condition, and sent to market. (Interim Reclamation: days; Production: years)

Workovers

Gas production usually declines over the years. Operators may perform a workover which is an operation to clean, repair and maintain the well for the purposes of increasing or restoring production. Multiple workovers may be performed over the life of a well. (Several days to weeks)

Plugging and Abandonment/Reclamation

Once a well reaches its economic limit, it is plugged and abandoned according to State standards. The disturbed areas, including well pads and access roads, are reclaimed back to the native vegetation and contours or to conditions requested by the surface owner. (Reclamation Activity: Days; Full Restoration: Years)

EXHIBIT 1: PROCESS OF SHALE GAS DEVELOPMENT (DURATION)

Another set of considerations associated with traditional oil and gas development are the conflicts that arise from split estates. In some instances mineral rights and surface rights are not owned by the same party. This is referred to as “split estate” or severed minerals. The condition of split estate is more prevalent in western states where the federal government owns much of the mineral rights. In the mid-west and eastern states, where shale gas development resources are more prevalent, only a small percentage of the lands are associated with a federal split estate. However, these same areas frequently have private-private split estate scenarios where the surface owner differs from the mineral estate owner. In these cases the mineral owner may be another individual or a business enterprise such as a coal company.

It is important to understand that surface owners who do not own minerals rights are still afforded certain protections.

A split-estate situation, regardless of its nature, can result in conflicts especially in areas where active mineral resource development is not commonplace. Land-owners can be surprised to find that the mineral lease holder is entitled to reasonable use of the land surface even though they do not own the surface. However, it is important to understand that surface owners who do not own minerals rights are still afforded certain protections. If the mineral owner does not own the surface where drilling will occur, a separate agreement may be negotiated (in some states it is required) with the land owner to ensure that he or she is compensated for the use of the land and to set requirements for reclaiming the land when operations are complete.

Shale gas development within or near existing communities has created challenges for production companies. New technologies have generally allowed these challenges to be met successfully. In some cases, a combination of modern shale gas technologies and the innovative use of BMPs has been required to allow development to continue without compromising highly valued community resources.

In one instance, Chesapeake Energy Corporation constructed a well pad near a popular Fort Worth community area, known as the Trinity Trail System, to develop natural gas from the Barnett Shale. The Trinity Trail System is located on private land and consists of a 35-mile network of paved and natural surface pathways. The drilling pad was constructed approximately 200 feet from one portion of the trail. During the initial planning stages, proposed use of this land for development of natural gas was met with significant opposition by the public. Maintaining healthy populations of upland hardwood forest habitat was important to the community because such woodlots are rare in urban settings.

To address the concerns of the community, the company sponsored public meetings and opinion surveys; provided landscape plans; planted trees and shrubs; and enhanced the general area by improving irrigation and lowering maintenance requirements. The well pad was specifically designed to be as small as possible in order to reduce the well’s footprint. Preventative construction practices were used that helped to preserve many of the existing trees. The

construction zone was isolated from view using a 16-ft barrier fence with sound baffling. This approach benefitted both parties: the company was able to produce the shale gas, important community resources were protected, and at no point in the process was any portion of the trail closed.

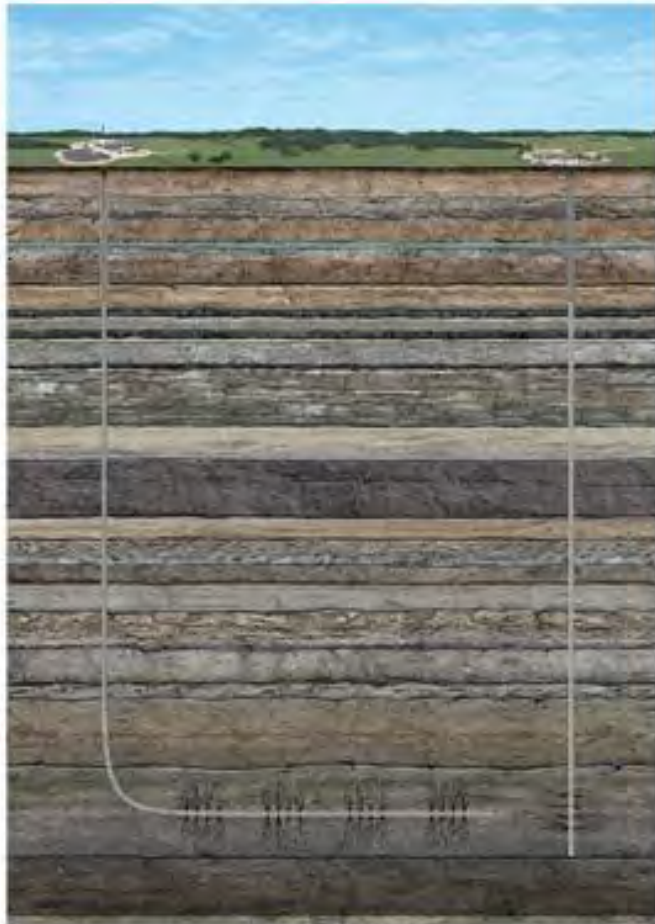


EXHIBIT 2: HORIZONTAL AND VERTICAL WELL COMPLETIONS

Source: John Perez, Copyright ©, 2008

conventional gas wells. Both horizontal drilling and hydraulic fracturing are established technologies with significant track records; horizontal drilling dates back to the 1930s and hydraulic fracturing has a history dating back to the 1950s. The key difference between a shale gas well and a conventional gas well is the reservoir stimulation (large-scale hydraulic fracturing) approach performed on shale gas wells.

The evolution of the Barnett Shale play toward favoring horizontal wells resulted from improvements in the technology combined with the economic benefits of the greater reservoir exposure that a horizontal well provides over a vertical well. While both well types may be used to recover the resource, shale gas operators are increasingly relying on horizontal well

The following discussions describe the general process of development with emphasis on the horizontal drilling and hydraulic fracturing technologies that are the hallmarks of modern shale gas production.

The course also describes the environmental considerations that accompany shale gas development and the technologies and practices that are in place to prevent or minimize impacts.

Horizontal Wells

Modern shale gas development is a technologically driven process for the production of natural gas resources. Currently, the drilling and completion of shale gas wells includes both vertical and horizontal wells (Exhibit 2). The emerging shale gas basins are expected to follow a trend similar to the Barnett Shale play with increasing numbers of horizontal wells as the plays mature.

The technologies utilized by operators to drill shale gas wells are similar to the drilling techniques that have been industry standards for drilling of

completions to optimize recovery and well economics. Exhibit 2 illustrates how horizontal drilling provides more exposure to a formation than does a vertical well. For example, in the Marcellus Shale in Pennsylvania, a vertical well may be exposed to as little as 50 ft of formation while a horizontal well may have a lateral wellbore extending in length from 2,000 to 6,000 ft within the 50- to 300-ft thick formation. This increase in reservoir exposure creates a number of advantages over vertical wells drilling.

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There are a wide range of well types, from vertical to horizontal. While vertical wells are generally less economical.

vertical or horizontal well. On a per well basis, production is often



Source: ALL Consulting, 2008
Active Drilling Rig In The Barnett Shale Play

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mile section could require separate well pad. Wells (potentially more), access the same reservoir permeability of shale at closer spacing in order to effectively

vertical wells at 100 ft or less, to efficiently access the tight shale reservoirs. In addition, horizontal drilling can significantly reduce the overall number of well pads, access roads, pipeline routes, and production facilities required, thus minimizing habitat fragmentation, impacts to the public, and the overall environmental footprint. Devon Energy Corporation reports that the use of horizontal wells in the Barnett Shale has allowed the company to replace 3 or 4 vertical wells with a single horizontal well.