Footprint Reduction

Development of unconventional oil and gas (UOG) must be done in responsible ways to minimize surface disturbance and impacts on the surrounding habitats. Technology-driven best practices and strategies are reducing surface footprints on well pad sites and surrounding areas. Additional assessments help mitigate surface disturbance impacts on habitats from UOG operations. More and better tools and models are required to assess trends in development intensity and to maximize well drainage and efficiency from fewer wells on smaller pads. Investments by the Department of Energy's (DOE's) Office of Fossil Energy (FE) and the National Energy Technology Laboratory (NETL) have led to substantial progress in addressing these issues. Tools and technologies developed are assisting with well pad siting and density decisions, identifying location-specific subsurface geologic and wellbore risks to the surface, and minimizing environmental impacts of well pad access roads.

Goals

- To reduce the amount of land and time needed for oil and gas development;
- To ensure all three phases of land use—planning before development, minimizing impact during development, and restoring the land following completion—are adopted;
- To constrain development intensity, which will result in fewer well locations (maximize per well drainage and efficiency);
- To minimize well siting impacts; and
- To ensure minimum land impact from infrastructure development, so as to reduce noise and traffic.

What Is Known

- Shale gas development can have impacts on habitat and landscapes during all aspects of the operation, including exploration, development, and closure.
- Surface disturbance involves site preparation, well pad construction, and road, pipeline, and other infrastructure development.
- The primary driver of surface footprint impacts is associated with roads and pipelines.
- Each well pad, which remains active as long as a well can be re-stimulated, currently requires three acres with an equivalent amount for infrastructure.
- The amount of surface disturbance for horizontal wells is less than that needed for vertical drilling. Horizontal drilling technology used in shale gas plays allows for more wells to radiate outward from a single pad. Fewer well pads reduce the number of roads, pipelines, and the amount of infrastructure needed.
- More than half of the well pads in Pennsylvania are built on slopes with risks of excess surface water movement and erosion.

Figure 1. Shale gas well in the Appalachian Basin shows a well pad sited on a slope with an access road. The well pad siting and access road are examples of surface impacts that must be addressed.

- Habitat fragmentation occurs when infrastructure is installed or land clearing takes place in order to allow access to a well location.
- An assessment by the EPA revealed that trucks and roads used during oil and gas development processes have an effect on the surrounding environment through localized noise pollution. The *Eagle Ford Shale Task Force Report* for the Railroad Commission of Texas identified increased traffic and deterioration of roads and bridges among the infrastructure impacts from shale gas development.
- State agencies oversee the well itself, while local governments are generally responsible for upstream activities, such as road access to drilling sites. While state laws and regulations can vary, their stringency has increased in recent years.
- The longer operations are in place, the easier it will be to quantify the long-term effects of shale gas production on well pad sites and surrounding areas.

Figure 2. Typical Marcellus well pad with multiple adjacent trees (GoMarcellusshale.com)

Research Results

DOE and others developed new technologies and equipment to mitigate impacts from well pad sites and access roads during UOG development.

- Uncertainty about key subsurface elements, such as hydrocarbon distribution and leakage pathways, can result in inefficient UOG development. The integrated software tool geoWELL is a map-based application that provides quick access to websites of primary sources of subsurface geologic and welbore (oil, gas, and underground injection) information for appropriate U.S. state, tribal, and federal agencies.

- UOG development at well pad sites can result in access road degradation and other land disturbances. The Environmentally Friendly Drilling program developed a layered mat, roll-out road system design using composite building materials to minimize the environmental impacts of well pad access roads. They have also tested new types of disappearing roads in a desert-like environment to demonstrate their effectiveness on conventional road construction and usage damage. (Houston Advanced Research Center)

- A primary concern with UOG development is potential impact to groundwater quality. A geospatial analysis tool is being developed that can assist with well pad siting and density decisions that may result in a smaller regional water footprint, and reduce risk of other environmental impacts. Geographical Information System (GIS) based tools will help minimize the potential effects of gas production on water resources. (Colorado State University)

Direction for Future Progress

Technology development and research opportunities include tools that assess future trends in UOG development intensity. Researchers can build on existing GIS-based tools to continue to improve well pad siting practices. There is also the opportunity to advance software tools like geoWELL to further understand risks and reduce surface footprint at well pad sites. Additionally, analytical models that support the development of new stimulation approaches that enable expanded, dynamically-controlled, and more efficient reservoir drainage from fewer numbers of wells on smaller pads should become a focus of future technology endeavors.

Policies and practices should include strategies and mitigation measures for well pad sites such as: avoiding disturbances to sensitive areas such as wetlands, waterways, and wildlife habitats when locating drilling sites; sizing the well pad itself and immediate surroundings to the space available to minimize the disturbed area; and reclaiming the land upon completion of drilling activities to help restore natural habitats. The well pad and infrastructure can be designed to be as efficient and minimally obstructive as possible. Site specific evaluations are the best way to determine the extent of fragmentation and the impact that development may have. Roads and transportation also create surface impacts, and best practices for mitigating these disturbances include: keeping road development to a minimum; using existing access roads as much as possible; and using unimproved roads as little as possible during wet weather.