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Technologies, Methods *Reflect Industry Quest To Reduce Drilling Footprint*

By Al Pickett
Special Correspondent

Operators, service contractors, equipment manufacturers, and major university and research laboratories are teaming to devise innovative methods to reduce the environmental footprint of onshore drilling, completion and production operations. Examples include drilling multiple horizontal or directional wells from a single pad using smaller and lighter rigs, well site and road construction using low-impact technologies, small-hole coiled tubing drilling, "green" completions in shale gas plays, centralized hydraulic fracturing locations, and recycling flow-back water from large frac jobs.

The term often used to describe the industry's efforts is environmentally friendly drilling (EFD). But how does one go about determining whether a given method or technology actually reduces the environmental footprint of oil and gas operations in the field? The Houston Advanced Research Center–which was started by George Mitchell, the father of the Barnett Shale play 30 years ago–is working to develop an environmental "score card" to rate the impact of EFD efforts, according to Rich Haut, HARC program manager.

"We are helping to emphasize the need for environmental stewardship," he relates. "Safety is a core value of the oil and gas industry. Our goal is to make environmental stewardship in every phase of operations a core value as well."

Haut says HARC and Texas A&M University, along with industry sponsors and stakeholders, operate a program focused on integrating advanced technologies into systems that significantly reduce the impact of drilling and production in environmentally sensitive areas.

The stated objective of the program is to "identify, develop and transfer critical, cost-effective new technologies that can provide policymakers and industry with the ability to develop U.S. domestic reserves in a safe and environmentally friendly manner. We have developed three principles in environmentally friendly drilling," Haut explains. "One, what gets measured gets done. Two, what gets identified gets dealt with. And three, what gets expected gets respected."

Haut, who helped develop a national research program for the U.S. Green Building Council (USGBC) in 2003, says that the USGBC score card gave him the idea of doing something similar for the oil and gas industry. "It hit me," Haut claims. "The U.S. Food & Drug Administration has a score card for nutrition. We have a score card for new construction in the USGBC. I thought surely we could do something for oil and gas."

The first step was drilling operations, Haut notes, since it easily can be determined when an operation starts and stops. More than 80 people attended the first workshop in 2008, according to Haut, a diverse gathering that ranged from environmental groups such as the Natural Resources Defense Council to service companies and operators. He says the group developed six attributes, providing a scoring and weighting value for different activities. The group also saw the need for different score cards for different ecosystems, developing different rating systems for semi-arid regions, upland/woodlands areas and wetlands.

"The score card is almost complete," Haut explains. "It is being reviewed by operating companies and environmental groups. We expect to roll it out by the end of the year. It is going to give us an opportunity for everyone to be on the same page. What does environmentally friendly drilling mean and how do you communicate it? Communities that have drilling activity will be able to compare companies and balance cost effectiveness."

Many oil and gas producers have identified and implemented cost-effective environmental practices and technologies as part of their standard operating procedures. An example of one of the operating companies active in the HARC-led program is Devon Energy Corp., a leading onshore shale player that acquired George Mitchell's company–Mitchell Energy & Development Corp.–eight years ago.

"Being a good steward of the environment has always been important to Devon," emphasizes Brian Woodard, the environmental, health and safety specialist for Oklahoma City-based Devon, which drilled more than 1,100 wells last year. "The blowout in the Gulf of Mexico has placed the industry under a microscope, but we are always searching for new ideas. If we can find a method or technology that is good for the environment and for the bottom line, we will deploy it as soon as possible in our operations."

One example of an increasingly common practice in the industry is pad drilling, where a single pad is used to drill, complete and produce multiple horizontal or directional wells to reduce the overall environmental footprint. "This can be especially important in an urban setting such as the Barnett Shale play in the Dallas-Fort Worth area," Woodard remarks.

Pad Drilling

Although pad drilling has been used in environmentally sensitive regions such as the Rockies for some time, it now is being adopted across the country, according to Tyson Seeliger, U.S. sales and marketing manager for Trinidad Drilling in Houston. Trinidad is a Canadian company that started its U.S. business in 2005 and now has 55 rigs operating in the lower-48, mostly in the Mid-Continent and the Barnett and Haynesville shale plays.

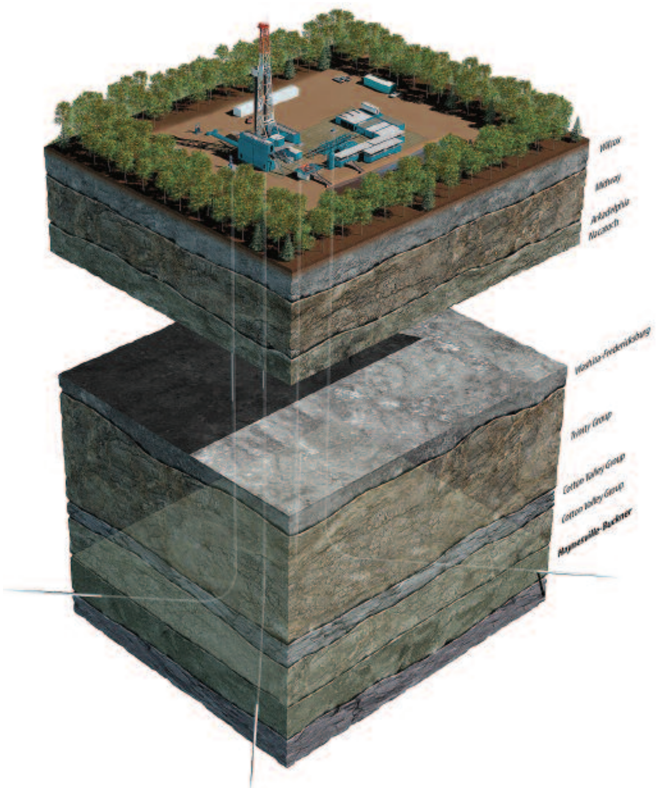
"Pad drilling ties the reduction of the environmental footprint together with efficiency," claims Seeliger, who notes that Trinidad has 29 rigs operating in the Haynesville Shale in East Texas and northwest Louisiana. "In the Barnett, you are drilling in an urban setting. In Canada, there are strict regulations. And in the Marcellus Shale, you cannot get on some locations because of the geography and other surface obstacles."

The solution, Seeliger notes, is to drill more than one well from each pad. "We are drilling as many as eight horizontal wells from a single pad in the Haynesville. You do not need eight roads or eight pits, just one," he points out. "It is a huge savings to the environment."

Pad drilling also drives efficiency gains, Seeliger goes on. "We set a large pad at the corner of where four 640-acre sections meet," he says. "We then drill a well in each section. Thus, each section is held by production. We can then slide over 45 feet and drill four more wells. It is a 'gas factory' approach. We can be drilling, fracturing and producing all at the same time."

Trinidad is manufacturing all of its rigs with built-in skid systems, Seeliger adds, to enable assembled rigs to quickly move within a pad drilling site to drill multiple wells. "We see this as the future," Seeliger adds. "Multiwell pad drilling exponentially reduces the number of required well sites, cuts down on vehicle traffic, and reduces land disturbances for access roads and trenching for gathering lines and production infrastructure."

Another glimpse of the future may be an Encana field test in the Haynesville Shale that is using clean-burning natural gas engines



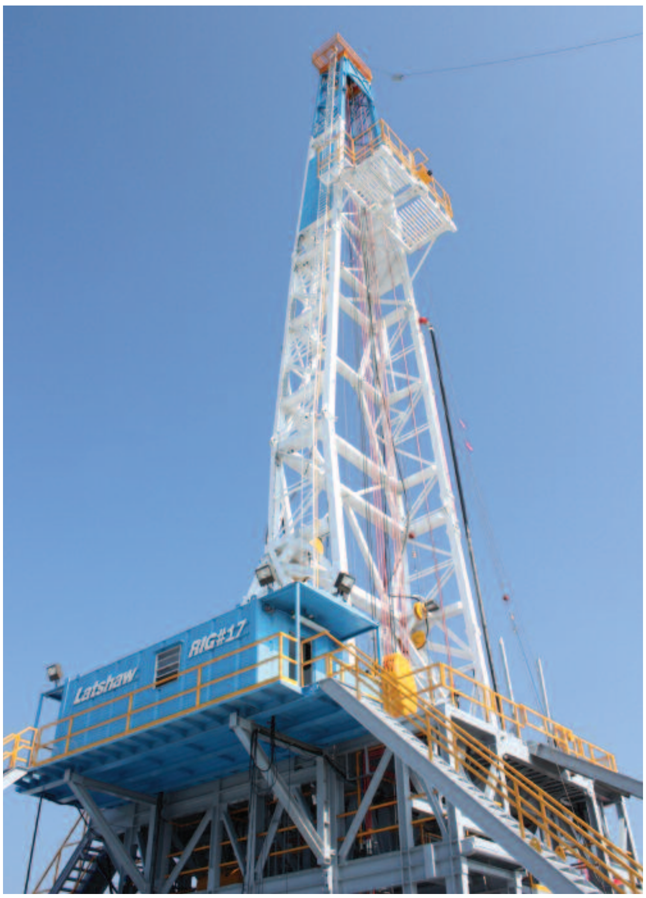
Multiwell pad drilling minimizes the environmental footprint of drilling operations while improving efficiency, enabling simultaneous drilling and completion operations and reducing the number of well sites, vehicle traffic and land surface disturbances. Trinidad Drilling has 29 rigs operating in the Haynesville Shale, drilling as many as eight horizontal wells from a single pad.

to power its rigs, according to Seeliger. "You have to have a pipeline to deliver the gas to the rig, which is a challenge right now in the Haynesville," he notes. "Encana is bringing in natural gas liquids and regasifying the NGLs to test the concept, but it is a very promising idea."

Minimizing Surface Exposure

Trent Latshaw, president of Latshaw Drilling Co. in Tulsa, says his company has built new rigs since 2005 that are not only designed to minimize surface exposure, but also to move faster and reduce fuel consumption. More than half of Latshaw's rigs are involved in horizontal drilling in the Woodford, Haynesville and Barnett shales, as well as a shale oil play in southeastern New Mexico. While acknowledging that horizontal drilling has become the drilling method of choice in shale plays because of its ability to improve well economics, he says a side benefit of horizontal drilling is a reduction in surface exposure.

"Horizontal drilling in the Barnett, of course, has allowed drilling in an urban area, where you can drill under the Dallas-Fort Worth Airport or Colonial Country Club. Minimizing surface exposure, however, probably is not as important in Texas or Oklahoma as it is in Wyoming or Alaska, where you are trying to minimize disruption of wilderness," he notes. "In the Pinedale Anticline, for example, they are trying to minimize road traffic and the number of times the rig has to be moved. That is why they have gone to multiwell pads in the Rockies. It is a lot more important in those areas."



Latshaw Drilling Company's new Rig No. 17 was designed for extended-reach horizontal drilling in oil and gas shale plays. The 2,000-horsepower diesel-electric/SCR rig has a depth capacity of 25,000 feet. It is equipped with a 500-ton AC top drive, 1,600-horsepower triplex mud pumps, a 1,200 barrel closed-loop mud system, three gen sets, and a 142-foot mast with a 1.25 million-pound static hook load. For multiwell pad drilling, it has a roller skidding system built into the sub that allows the rig to be moved forward, backward, sideways or at 45-degree angles with pipe racked in the mast.

In addition to reducing the footprint of the drilling rig itself, Latshaw says operators are deploying other methods to reduce the impact on the local environment, including closed-loop mud systems.

"Some operators are trying to do away with reserve pits," he explains. "They are using steel tanks for a closed-loop system. The cuttings and other fluid discharges from the well are dumped into the steel tanks, where vacuum trucks will suck it out of the tanks and haul it off for disposal. This not only reduces the footprint, but also does away with the potential hazard of spills out of an earthen reserve pit."

Low-Impact Rigs

The minimal environmental impact design features of San Antonio-based Pioneer Drilling's new 60 Series™ rigs are proving effective in the Marcellus Shale play, according to Donald G. Lacombe, senior vice president of marketing. "These rigs adapt to the environment with minimal disturbance," he explains. "They have rounded-bottom tanks, which make it easier to clean and much easier to haul off fluids, thereby saving time and cost."

Lacombe says 60 Series rigs are smaller, making them easier to move from location to location on the narrow, winding roads in Pennsylvania. "It is not like West Texas," he says of the terrain in the Appalachian Mountains. "We have six rigs deployed in the Marcellus. They are being used in environmentally friendly pad drilling, and the majority have skid packages, which minimize surface disturbance and reduce overall well costs. Operators like the 60 Series rigs for their adaptability in the varying topography and climate."

According to Lacombe, Pioneer came up with the round rounded-bottom, cylindrical mud tanks in the late 1990s. Instead of sticking a hose in the top of a square tank, which he says increases the possibility of a spill, the rounded tank has a side valves that vacuum trucks can access to suck the fluid out more efficiently. The round design also makes the cleaning process much easier and minimizes the fluid haul off.

Although 60 Series rigs are smaller, he says they are still capable of drilling to a total depth of 13,000 feet. "From 10 years ago to today, our industry has evolved, and it has become a good steward of the environment," Lacombe notes. "The industry has learned and adapted technology, but continues to change with new discoveries. We are trying to streamline costs and save the environment while still providing the energy our country needs."

Centralized Fracturing

Building on the concept of drilling multiple wells from a single pad, Williams Production RMT Company in Denver is pushing the envelope by using remote/centralized pads for fracturing operations in tight gas sands in the Parachute area of the Piceance Basin in western Colorado.

"We started out calling it a 'remote frac,' since we were fracturing from a location separate from where the well was drilled," explains Mike Paules, senior environmental, health and safety manager. "We are drilling on 10-acre downhole spacing in the Piceance Basin. When we started fracturing multiple pads from a single central pad location, we changed the name from remote

Williams Production RMT Company is using centralized pads to hydraulically fracture multiple tight gas sands wells on 10-acre spacing from a single central pad location in the Piceance Basin in Colorado. Working on as many as 22 wells simultaneously, the company has fractured as many as 140 wells from a centralized location, some as far as three miles away.

frac location to centralized frac location."

Paules reports that Williams has hydraulically fractured as many as 140 wells from a single centralized location, some almost three miles from the centralized frac location. Since the rigs can be skidded in two directions, Paules says the frac crews can conduct fracturing operations while the drilling crews are drilling. Williams Production dubs the method simultaneous operations (SIMOPs), in which the company can be producing, fracturing and drilling wells at the same time off the same pad.

"We have worked on as many as 22 wells simultaneously," Paules comments. "There are numerous advantages to the centralized frac locations with SIMOPs. In addition to getting the gas to market quicker, it reduces surface disturbance by using existing pads for frac equipment and allowing smaller pad sizes for drilling and SIMOPs."

He adds that the centralized frac location supports reusing produced water to pump hydraulic fracturing treatments and reduces truck traffic and the time to transfer water. Because Williams treats the water on the site and the company fractures the wells in multiple stages, it can be treating and preparing the water for the next stage while fracturing the previous stage.

"For a single pad, it reduces water truck trips by at least 30 percent," Paules claims. "For several multiwell pads, it reduces truck trips by 90 percent. It also reduces mobilization and demobilization of fracturing equipment, which means less time, less fuel and less traffic."

Less truck traffic also reduces emissions, dust, noise, erosion and the potential for vehicular injuries, spills and property damage, according to Paules. Reduced truck traffic also means less wear and tear on the roads, while creating less of a disturbance to wildlife and landowners.

"Increased efficiency results in lower fracturing costs, and it supports a 'get-in, get-out' approach to minimize overall impact," Paules concludes. "It keeps costs down while protecting the environment, so it is a win-win for everyone."

Access Road Systems

While air emissions and water usage are certainly vital issues in environmentally friendly drilling, the impact of access roads and drilling pads also has been identified by the EFD program as one of the major problems to be managed when conducting oil and gas operations in environmentally sensitive areas.

David Burnett, director of technology of the Global Petroleum Research Institute at Texas A&M University, says the EFD program has been identifying technology and sponsoring research in reducing surface impact since 2005. Several major projects are under way specifically addressing such technology, according to Burnett.

"We have had three different types of temporary road projects funded to determine a less impactful way to build lease roads and well pads, and to see how they held up in desert settings," Burnett observes.

One type of temporary road is the Newpark DURA-BASE™ composite mat system. Each pad measures four by eight feet, is three inches thick and is made of recycled plastic. Each pad weighs 1,000 pounds, and the pads can be latched together. "You can build a road in a couple of hours that can handle heavy oil field equipment," explains Burnett. "When you are done with the road, you unlatch it and pick it up. It is being used in Louisiana and the Gulf Coast region where there is soft soil. It has also been used in the Appalachian Basin for three years."

The second type of low-impact oil and gas lease road designed to reduce the environmental impact of field development in sensitive desert ecosystems is what Burnett calls "artificial gravel," made by Scott Environmental Services. When the oil company is done with the road, it simply plows it up, returning the desert to its original state, according to Burnett.

"Normally, lease roads are built of gravel or caliches," he says. "This artificial gravel is a mix of pit sludge, solid waste and concrete to make the road base. We are testing it in the desert to determine that it does not turn into dust or wash out into the soil. We are monitoring the soil for a year."

The third prototype was designed by graduate students at the University of Wyoming, who received $10,000 in prize money to build their concept for testing this summer, according to Burnett. The road is comprised of composite planks that are linked by stainless steel cable. The linked composite planks look like snow fence, he says.

"Composite mats already are being used as well pads, but they will have to show it will hold up to heavy truck traffic" he adds, noting that the prototype testing is being done at an old tire testing track in West Texas, which is now a Texas A&M research facility. "We are hoping to find a research partner to fund the remediation, to see if we can remediate the soil after the road is taken back up."

Microhole VSP Imaging

Among the technologies being studied by the Department of Energy's National Energy Technology Laboratory are advanced simulation and visualization capabilities to enhance production and minimize environmental impacts associated with developing unconventional resources, according to Roy Long, technology manager in the NETL's Sugarland, Tx., office.

Because there are so many more wells being drilled in the nation's numerous shale plays, Long says one of the key EFD goals is to resolve the issues that accompany higher well densities and rig counts. "There is impact to everything we do," Long notes. "That is a real issue, because we still will be burning lots of oil and gas for years to come."

Although there is no one silver bullet, according to Long, he advocates microhole vertical seismic profiling technology to image sweet spots and monitor production in complex reservoirs using 4-D seismic. The NETL's Microhole Technologies Initiative, which is billed as a mature field focus with unconventional gas applications, seeks to demonstrate ultrahigh-resolution imaging using state-of-the-art geophones and microseismic instrumentation installed without the conventional completion rig.

"We hope to have active seismic to optimize the development of the well," Long continues. "There is a need for better information on reservoirs to know how to optimally design and monitor frac jobs."

He says NETL has a demonstration project with Whiting Petroleum Corp. on a carbon dioxide enhanced oil recovery operation in the Wickett Field in the Permian Basin, in which shallow microholes are being used for high-resolution VSP surveying and permanent microseismic monitoring.

Whiting utilized the same concept in North Dakota to optimize fracturing in the Bakken oil shale. One permanent monitoring well was drilled to 2,000 feet in a 640-acre unit, where two horizontal were drilled. Microseismic data were monitored during the multistage fracs to optimize fracture operations. When the microseismic slows/stops, the frac job is terminated.

"The easy oil and gas has been found," Long remarks. "Now we are looking for unconventional reservoirs and unconventional approaches in conventional reservoirs. The ability to improve seismic imaging and get more information means not only increased production, but also improved drilling performance, which means lower cost and a reduced impact on the environment."

Coiled Tubing Drilling

Coiled tubing drilling is among the key technologies that the NETL sees as high-potential solutions for reducing environmental impact while also improving drilling efficiency and cost, according to Long.

And nowhere has the success of CT drilling been more evident than in the Cretaceous Niobrara Shale, a tight oil and gas-bearing formation in eastern Colorado, western Kansas and southwest Nebraska, Long says. "Advanced Drilling Technology (ADT) and Rosewood Resources drilled 25 small-bore wells with coiled tubing rigs in the Niobrara," he reports. "They drilled and completed 3,000-foot wells in 19 hours and drilled a total 300,000 feet of hole in seven months."

Long notes that using the ADT hybrid coiled tubing rig to drill the wells made 1 trillion cubic feet of shallow bypassed tight gas in the Niobrara economic while also reducing the cost of drilling the wells by 25 to 38 percent and minimizing the environmental impact. "Drilling with coiled tubing is not applicable in all situations," he states. "But in the right applications, it can produce significant economic, operational and environmental benefits."

In this photo of a Devon Energy Barnett Shale multiwell pad site in the Barnett Shale play near Haslet, Tx., a wellhead is being put into place next to two existing wellheads, while another waits to be installed.

He says some of the larger hybrid CT rigs with 3½-inch diameter coil tubing have 12,000-14,000 foot coil/rotary depth capability. "Coiled tubing decreases the mobilization cost by significantly decreasing the number of loads. For example, the ADT rig uses three tractor-trailer units that move in and link together, and there is little loading or unloading except for handling equipment on the catwalk (also modularized)," Long explains. "There was no surface damage during the ADT demonstrations because the rig was in and out so quickly. You are using the appropriate size of rig to drill a hole sized for the reservoir. The ADT hybrid CT rigs have a limited rotary capability and can run casing."

'Green' Completions

Reducing emissions is a focal point for operators not only during drilling, but also during completion and production operations. An example of this is what Devon Energy dubs "green" completions, or capturing methane in the flow back stream following hydraulic fracturing, according to Woodard.

"When you complete a well and flow it back, you have natural gas produced with the water," Woodard explains. "In the Barnett Shale, we have the opportunity to use our company-owned midstream assets to lay a pipeline and flow wells back through a separator, thus removing the sand and water and capturing the remaining gas in a pipeline, rather than venting or flaring the gas. Therefore, we are producing more gas while also reducing methane emissions."

According to Woodard, Devon has been able to quantify a reduction of 13 billion cubic feet of emissions in the Barnett Shale area of North Texas by using green completions. "That is 13 Bcf of gas production that we otherwise would not have sold," he emphasizes.

Of course, to be able to capture methane during flow back, a company must install a gathering line to the well, he notes. "You have to be confident the well will make commercial production rates because you must install the pipeline before the well is completed," Woodard states. "That means you also have to have a good understanding of the reservoir attributes to properly size your pipeline."

As an example of a methane emissions reduction in Devon's production and midstream operations, Woodard points to an initiative to retrofit continuous-bleed pneumatic pilot valves on field separators and controllers using Wellmark's Mizer™ valve.

"Gas is bled off continuously from separators using high bleed pilot valves," he explains. "Prior to the inception of EPA's Natural Gas Star Program, the industry commonly used high-bleed pneumatic valves. However, Devon launched an effort in 1990 to begin specifying the use of low-bleed valves at our operations. We recognized that the Mizer valve presented an opportunity to reduce emissions by retrofitting existing high-bleed controllers to make them low bleed.

"We also have worked collaboratively with the Verdeo Group, Inc. in Washington to develop the first U.S. carbon offset methodology for a fugitive methane emission reduction project in the oil and gas sector," Woodard notes. "This methodology will enable companies to generate carbon offset credits by replacing existing high-bleed pneumatic controllers with low-bleed options.

The American Carbon Registry has approved this methodology, and we are going back and retrofitting the high-bleed valves on controllers."

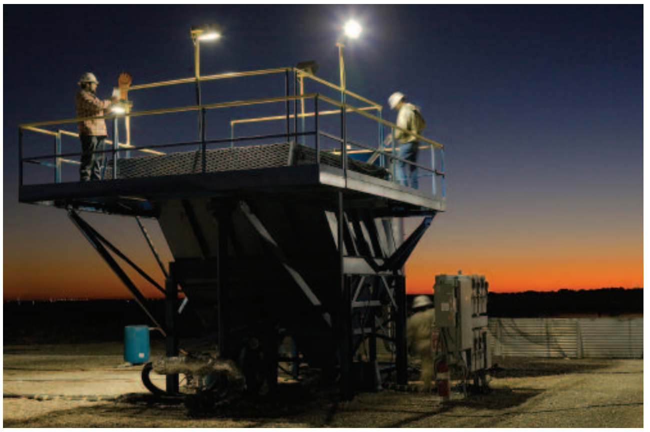
As with capturing methane emissions during frac flow back, Woodard says installing the low-bleed valves has both economic and environmental justifications. "Gas is retained in the pipeline and that is what we are in business for," he states.

The large quantities of water required for hydraulic fracturing in the production of shale gas is another focal point of Devon's environmental initiatives. In the Barnett Shale, where Devon is the largest producer, the company has been using the Fountain Quail portable distillation system for several years.

"We were one of the first oil and gas companies to recycle water," he relates. "Any sort of water recycling is costly, but we do it because it is the right thing to do. We treat the water to use again for hydraulic fracturing. That reduces water usage, which is a big issue. We have recycled 400 million gallons of water in the Barnett Shale since 2006. That is enough to fracture at least 100 Barnett Shale wells."

Because of the problems with produced water in the Marcellus play, Long says one of the possible alternatives could be using foam fracturing instead of slick water to see if it can achieve reservoir conductivity.

"Foam fracturing feasibility was established during NETL's Eastern Gas Shales program in the mid-1970s," he concludes. "With today's operators moving toward multistage fracture treatments and a focus on achieving fracture 'complexity' (away from the old standard of fracture length), it is possible the new foam fracturing methods could see a resurgence." ❒



Shown here is one of Devon Energy's water recycling stations in the Barnett Shale. The machinery includes the first stage of the recycling process, where flocculent is added to make the fine particles congeal. The congealed matter settles to the bottom, making it easier to remove solids from the water.