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Nuts and Bolts of Marcellus Shale Drilling and Hydraulic Fracturing

Editors' Summary

Abundant, inexpensive, and lower in emissions than traditional coal power sources, natural gas is expected to play an enormous role in our energy future. Although the drilling technique of hydraulic fracturing or "fracking" has made it possible to extract natural gas from "plays," such as the Marcellus Shale Play, some members of the public have become increasingly concerned about problems alleged to be associated with fracking and drilling, such as groundwater contamination and air pollution. The economic, energy, and environmental implications of natural gas are amplified by fast-moving legal developments, including many proposals for new studies, regulations, and legislation. Added to federal developments are efforts by some state and local governments to ban drilling within their jurisdictions or to require disclosure of the contents of fracking fluid. On April 14, 2011, ELI brought together an expert panel to discuss these developments in Marcellus Shale, where the issues mirror those of other gas fields across the country.

Panelists:
Joel Burcat, Saul Ewing LLP, Environment and Natural Resources Practice Group (moderator)
Elizabeth A. Nolan, Pennsylvania Department of Environmental Protection
Terry Bossert, Chief Oil & Gas LLC
Deborah J. Nardone, Sierra Club

Rebecca Leamon: We are very pleased to welcome you to "Nuts and Bolts of Marcellus Shale Drilling and Fracking." This is the first seminar in a two-part series. The second seminar will be on May 19th, and the topic of that one is policy implications of Marcellus Shale drilling and fracking. I want to particularly thank our moderator today, Joel Burcat. He was the creative genius behind this series.

Joel Burcat is a partner in the Harrisburg, Pennsylvania, office of Saul Ewing and chair of the firm's Environment and Natural Resources Practice Group. He is a former assistant attorney general with the Pennsylvania Department of Environmental Resources. He's handled a broad range of complex environmental issues, and his clients include owners/operators of natural resource extraction industries, industrial operations, owners and operators of petroleum facilities, municipal authorities, defendants in toxic tort cases, pipeline companies, trade associations, and buyers and sellers of brownfield properties. He is a graduate of Penn State and Vermont Law School. Thank you, Joel.

Joel Burcat: Thank you very much, Rebecca.[1] First of all, let me thank the Environmental Law Institute for hosting these forums. It is obviously a matter of great interest in the Northeast and across the United States, and decision-makers here in Washington and elsewhere are rightfully interested and have expressed a lot of concern regarding what is going on. I think there has been a lot of conflicting information, so we are happy to be able to provide these speakers to talk about the different aspects of Marcellus Shale drilling and hydraulic fracturing, or "fracking." As Rebecca pointed out, next month in May, there will be a program dealing with the policy implications and not dealing with the nuts and bolts issues. This will also be a very timely program with some interesting speakers as well.

Our goal today is to try to provide you with an overview of Marcellus Shale drilling and fracking and to present you with the basic information that you will need, so that you can have a full understanding of this subject. We have a really good and wide-ranging panel here, with Elizabeth Nolan from Pennsylvania's DEP [Department of Environmental Protection], Deborah Nardone from the Sierra Club, and Terry Bossert from Chief Oil & Gas. With this panel, we are going to be able to present the various perspectives on Marcellus Shale drilling.

We are dealing with a situation right now that is rapidly changing. If you go back just six years, you would find that there was virtually no Marcellus Shale drilling in Pennsylvania, and that has changed. DEP's oil and gas program was small and understaffed, or maybe it was appropriately staffed, I should say, for the amount of oil and gas drilling that was being conducted in Pennsylvania at that time.

One thing that we've seen in Pennsylvania is that communities that were very small and, in many cases, dying communities today have seen a huge resurgence, and a

Editors' Note: Slides that accompanied the presentations are available for download at http://www.eli.org/Seminars/past_event.cfm?eventid=606.

1. The views expressed by Mr. Burcat are his personal views and should not be attributed to Saul Ewing LLP or its clients.

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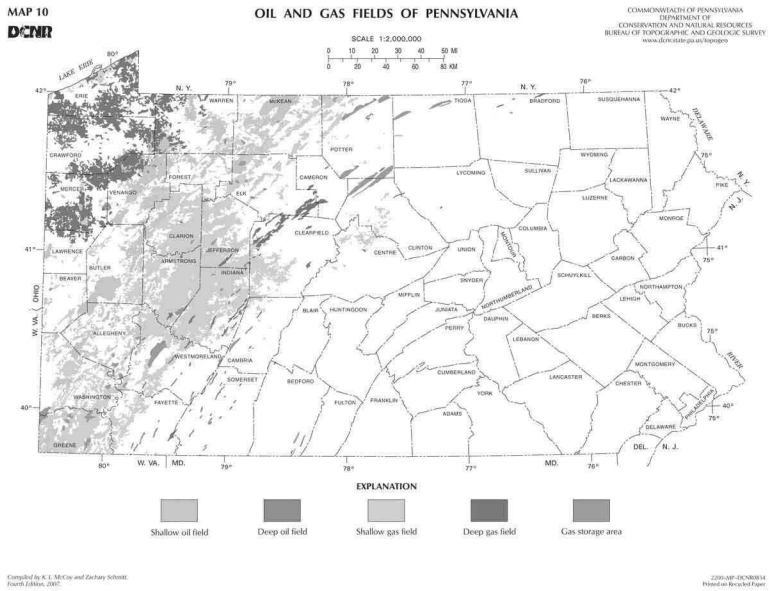


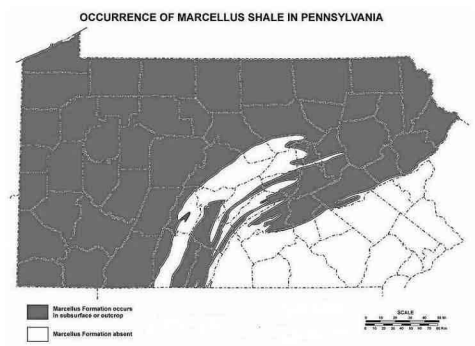
Slide 4: Oil and gas deposits in Pennsylvania.

large number of people have moved into these towns. There are many environmental issues and social issues that have arisen as a result of the large number of people and the quantum of activity that has taken place in Pennsylvania and West Virginia in particular. These are social conditions that will be with us for a long time to come.

An analogy to the Marcellus Shale drilling would be in the late 18th and early 19th centuries, when you had several things going on: canals were being pushed through; mills and dams were being constructed; and later, railroads were being built. In those times, the canals, mills, and railroads brought on significant environmental changes and were considered the equivalent of our heavy industries. They were life-changing experiences for the people who lived in the very rural areas in which those activities took place.

My goal is to provide you with a brief overview. I am going to touch on a number of subjects, and then I'll turn it over to our various speakers who will talk about the different issues in a lot more detail.

The first question we are going to ask is whether anything new is being done to produce the Marcellus in Pennsylvania. The answer begins with the fact that the Marcellus Shale wells themselves are not the deepest wells



Slide 5: Marcellus Shale in Pennsylvania.

in Pennsylvania. There are, according to Pennsylvania DEP records, over 11,000 wells in deeper formations. Marcellus Shale is not the first in Pennsylvania to require horizontal drilling. In Pennsylvania, we have coal-bed methane wells that have utilized horizontal drilling for decades, and horizontal drilling has been utilized across the United States. Marcellus Shale is not the first to use hydraulic fracturing. We will talk a lot more about what hydraulic fracturing is. But it is standard operating procedure in the gas exploration and production industry.

Let's talk about some things that are different. I've placed up on the screen the old Pennsylvania DEP map showing the oil and gas deposits in Pennsylvania (slide 4). You can see that most of the traditional oil and gas fields are in the westernmost and the northwesternmost part of the state.

Here is the map showing the Marcellus Shale in Pennsylvania (slide 5), and as you can see, it covers the entire northern swath of Pennsylvania, as well as a very significant part of western and a big chunk of central Pennsylvania. This difference is really quite huge, because you have no history of oil and gas drilling in many of these locations in Pennsylvania, plus you have a lot of drilling and potential drilling in places that potentially could impact the Delaware River and the Delaware Bay and the Susquehanna River and the Chesapeake Bay.

I thought it would be useful for you to see what oil drilling looked like in Pennsylvania in 1865, and this is a photograph from way back then (slide 6) that shows you the large number of oil wells in the Pioneer Run Creek area. Here is what natural gas drilling looks like in Pennsylvania today (slide 7). I think that there is a common misconception, that with potentially thousands of new gas wells that are going to be drilled in Pennsylvania, the 1865 image is what you are going to see across the horizon. You should understand that the drilling rigs in use for Marcellus drilling are in place only for a short period of time. Terry could talk more specifically about how long they are going to be in place, but they are only in place while the drilling is going on, and then you have other smaller structures that are in place once the gas well has been drilled.

Another change is the amount of drilling in the Marcellus Shale that is taking place. In a book called *Oil and Gas Developments in Pennsylvania in 1990 With a Ten-Year Review and Forecast*,[2] the Pennsylvania Geologic Survey did identify the Marcellus formation. It stated that production in 1990 was zero, and the cumulative production by the end of 1990 was 75,000 thousand cubic feet. So, let's talk about how things have changed.

In 2005, there were four permits issued for gas wells in the Marcellus formation. Last year, in 2010, there were more than 3,300 permits that were issued. So, you go from zero production in 1990 to 3,300 permits.

2. John A. Harper & Cheryl L. Cozart, Pa. Bureau of Topographic and Geologic Survey, Progress Report 204 (1992).

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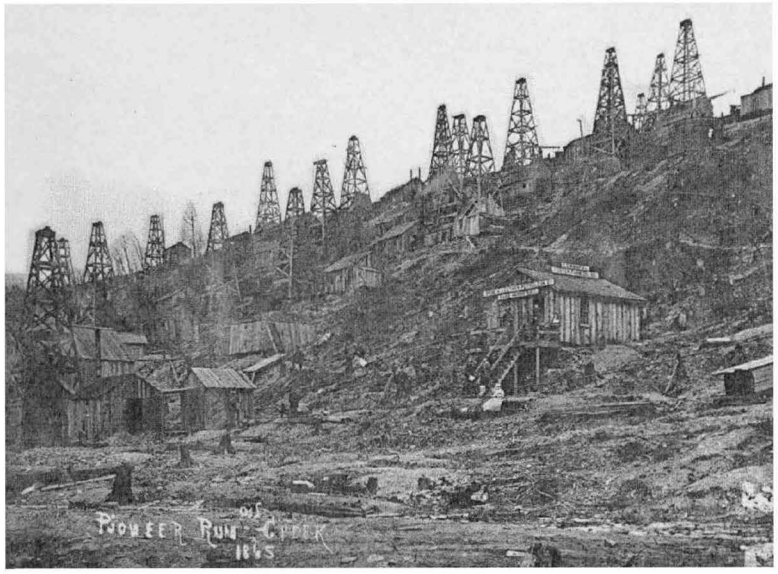

Slide 6: Oil drilling in 1865 Pennsylvania.

Total natural gas production in Pennsylvania in 2005 was 181 million thousand cubic feet, and it is estimated—this is not an apples-to-apples comparison—that the Marcellus Shale will have approximately 500 trillion cubic feet of recoverable gas. The person who has really been the geology rock star in Pennsylvania on this issue is a professor from Penn State University named Prof. Terry Engelder, and this is his most recent prediction. At current usages, this is an approximately 100-year supply. If it were possible simply to get all of the natural gas out of the ground at once, it would provide total U.S. energy consumption for two years. How much more is that? That is 276,000% larger than the gas production in 2005.

Another change that's happened in Pennsylvania are lease payments. In Pennsylvania, it is not uncommon in some places, depending upon the quality of the gas and the thickness of the reserve, to have an upfront payment of $5,000 or more per acre. The royalties trend between 12% and 20%. Pennsylvania has a state minimum royalty of 1/8, which is 12%.[3]

Water usage is also a huge issue. Hydraulic fracturing of a well requires approximately five million gallons of water. The industry has been working hard to try to modify some of their techniques and utilizing different substances other than water to reduce the amount of water needed for fracking.

Let's talk about where in Pennsylvania the Marcellus Shale play is taking place. The largest number of permits is in the northeastern part of the state, in Bradford, Lycoming, Susquehanna, and Tioga Counties, as well as in the southwestern corner of the state, in Fayette, Greene, and Washington Counties.

One of the things that has certainly changed is the use of horizontal drilling. Prior to the Marcellus, much of the drilling done was vertical, although there was horizontal drilling in Pennsylvania that had been going on for some time. Traditional wells go vertically, i.e., straight down, into the formation. Over the past 30 or 40 years, technology has advanced to allow the driller to actually turn the borehole so that it goes horizontally to follow the seam. Like I said at the outset, it is not brand new technology, but when you combine the different technologies all at once, that combination is new.

Let's talk briefly about the regulatory agency structure in Pennsylvania. I'm not going to steal any of Liz's thunder here, but I do want to introduce you to Pennsylvania's regulatory structure. In Pennsylvania, we have a number of different agencies that are involved in the regulatory process. The Pennsylvania DEP is the largest state agency. That is the agency with inspectors and permitting responsibility. The Pennsylvania Fish and Boat Commission has some responsibility both for habitat as well as for stream protection.

Also, very important in Pennsylvania are the River Basin Commissions. These are compact commissions under the U.S. Constitution's Compact Clause. The Delaware River Basin Commission (DRBC) handles those 14 or 15 counties that are within the Delaware River Basin on the eastern side of Pennsylvania. And the Susquehanna River Basin Committee (SRBC) is involved more in the central and central-western part of the state in the Susquehanna River Basin. The SRBC has had a fairly vigorous permitting program, and they have been issuing a significant number of permits for Marcellus operations. The DRBC has been studying the question of issuing permits, and has not yet issued any permits. So, these regulatory agencies have taken on a very significant role in Pennsylvania.

You also have some involvement from the U.S. Environmental Protection Agency (EPA), and there is a question as to the degree of involvement that they ought to have. Right now, their main involvement would be only with underground injection wells and oversight of programs delegated to Pennsylvania. Pennsylvania has very few underground injection wells, compared to Texas and other states. Whereas Texas has thousands of underground injection wells, right now, for commercial purposes in Pennsylvania, there are only seven or eight underground injection wells. This is a minor aspect of waste disposal in Pennsylvania.

To outline the regulatory structure, we begin with the Oil and Gas Act.[4] It was enacted in 1984, and it is the principal regulatory law dealing with oil and gas production. It is limited regarding its scope. In fact, there has been some recent case law in Pennsylvania that has really confined DEP to the strict parameters of the Oil and Gas Act.[5] But that is the principal law dealing with permitting and bonding of wells, casing of wells, the process of drilling, the after-effects of drilling (such as plugging of wells), and enforcement.

3. 58 P.S. §33.

4. 58 P.S. §§601.101 et seq.

5. Foundation Coal Res. Corp. v. DEP, 993 A.2d 1277, 1289-90 (Pa. Commw. 2010).

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The Clean Streams Law[6] is another law that is very important to this process. That is the law that would deal with both erosion and sedimentation control, as well as the disposal of frack water and production water and other production fluids.

We also have the requirement in Pennsylvania for Erosion and Sedimentation Control permits, but we like to call them E&S permits.[7] This deals with various earth disturbance activities that either require a plan or a permit, or both. In terms of dealing with impoundments, the Dam Safety and Encroachments Act is another part of the regulatory structure in Pennsylvania.[8]

The geology of Pennsylvania allows the underground storage of natural gas. Pennsylvania's geography and geology in combination are significant and important. Pennsylvania is on the route of the pipelines that come up from Louisiana, Oklahoma, and Texas, and so virtually all of the interstate pipelines come right through Pennsylvania. Also, the state is very close to the Northeast markets, which is the area that uses most of the natural gas in the United States. In Pennsylvania, we have 65 gas storage fields, where gas can be pumped into storage fields during periods of less consumption, i.e., the summer months, and then the gas can be removed later as needed.

Fracking is a significant issue. Slide 22 shows a detail of a frack, where a frack would take place, and what it might look like. The actual hydrofracturing takes place in the Marcellus Shale seam, at a depth of 5,000 feet to 8,000 feet. So, the fracking does not take place at the upper part of the bore hole—it takes place at the bottom of the borehole in the seam itself. Consequently in Pennsylvania, the fracking is taking place a mile underground. Bear in mind that most private wells are at a depth of less than 500 feet, and 1,000 feet at the deepest. Once you start getting below 500 feet, the quality of the water generally is not going to be adequate for drinking water purposes.

Issues concerning flowback and produced water are very big issues in Pennsylvania. Total dissolved solids in streams are an issue, and there have been questions about the increase of total dissolved solids and increased salinity of a number of streams as a result of the flowback water and process water allegedly finding its way into streams. Approximately 20% of the flowback or produced water is actually returned to the surface. So, in other words, 80% of the fracking water stays underground.

There are issues also with NORM and TENORM, which is naturally occurring radioactive material and technologically enhanced NORM. Bear in mind that when you are removing substances from the ground at a depth of thousands of feet in Pennsylvania (and in other places as well), it is not unlikely that you are going to pick up naturally occurring radioactive material. Hopefully, Terry will be able to address that.

There have been gas migration issues, and whether that has to do with the drilling process or other causes has not been proven. The industry says that gas migration has nothing to do with fracking. If anything, it probably has to do with the drilling process, the presence of shallow gas-bearing seams near the surface, and the construction of drinking water wells. Concerns in places like Dimock, Pennsylvania, have been in the news and publicized quite a bit. Recently, in December 2010, a DEP settlement was publicized for $4.1 million paid to residents in lieu of getting hooked up to water. There continues to be a multimillion-dollar personal injury lawsuit that is being litigated against the drilling company.

Another ongoing issue is the need for water withdrawal permits. The only two River Basin Commissions that really matter in all of this, because of the language of the compacts, are the DRBC and SRBC, which regulate water withdrawals. DEP does not regulate water withdrawals.

Another thing to keep in mind is that Marcellus drilling is not just a Pennsylvania issue. Marcellus Shale is present in New York, Ohio, West Virginia, and the westernmost counties of Maryland and some other locations as well. Another issue to be aware of is the Oneida Shale, which underlies the Marcellus. Although the results are not in, it could be that the Oneida is significant, and maybe even more significant, than the Marcellus Shale.

Looking beyond Pennsylvania, the former governor of New York has both vetoed state legislation in December 2010, that would have suspended the issuance of new oil and gas drilling permits and issued an executive order in December 2010, that prohibited the hydraulic fracturing of horizontal wells until July 2011. Maryland has two counties with Marcellus Shale—Allegany and Garrett Counties—and it is my understanding that while the Maryland Shale Safe Drilling Act did not pass the state Senate, there is the possibility of an executive order limiting drilling of the Marcellus Shale.

Elizabeth Nolan is an assistant counsel in the Bureau of Regulatory Counsel for DEP in Harrisburg, Pennsylvania, and she counsels DEP's Bureau of Oil and Gas Management. Prior to joining the Department in 2010, Elizabeth Nolan served as judicial law clerk in New Hampshire Superior Court in Dover, New Hampshire. She earned a bachelor's degree from Penn State University and a Juris Doctor degree Cum Laude from Vermont Law School. I personally believe that a Penn State and Vermont Law School background is a perfect combination to be an outstanding environmental lawyer.

Elizabeth Nolan: Thanks, Joel, and thank you to the Environmental Law Institute for putting together this great panel to discuss a lot of these very important issues. As Joel mentioned, recent drilling technologies, the combination of hydraulic fracturing and horizontal drilling have made the extraction of natural gas from unconventional shale resources economically available. And while the interest in the economic and energy independence possibilities are

6. 35 P.S. §§691.1 et seq.
7. 25 Pa. Code ch. 102.
8. 32 P.S. §§693.1 et seq.

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high, so too are the interests in protecting Pennsylvania's environmental resources and ensuring that it is done in a manner that safeguards the environment and protects public health and safety.

To start, I'm going to do an overview of the process involved in extracting natural gas from the Marcellus Shale formation as well as an overview of our laws and regulations.

Each stage involved in developing Marcellus Shale presents its own environmental challenges and presents potential environment impacts to surface water, groundwater, and to air.

The process starts with the preparation of the well site and access roads. This involves a great degree of earth disturbance activities. Sedimentation is one of the leading causes of stream impairment in Pennsylvania. The next part of the process is the drilling and construction of the well. Then, the well is hydraulically fractured to extract the resource. Then, the well is put into production. To hydraulically fracture a Marcellus well involves approximately five to nine million gallons of water. This has the potential to impair water quality through diminished stream flows. Large volumes of water are required to complete a Marcellus Shale natural gas well, and large volumes of wastewater are generated as part of the drilling process. This presents water and wastewater storage issues to temporarily contain that freshwater, and then the resulting wastewater during that process. The most significant issue facing Marcellus Shale operators today is wastewater treatment and disposal. The Department has seen an increase in reuse of this wastewater—industrywide approximately 60% of the flowback is used on another frack job. Several operators are reporting 100% reuse. Still, flowback from Marcellus wells represents a growing concern for the Commonwealth's waterways.

Here is a list of some of the laws and regulations that Pennsylvania uses to oversee this industry. And you'll note that these are all Pennsylvania State laws. Hydraulic fracturing is largely exempt from federal regulation. Most notably, the 2005 Energy Policy Act contained some amendments that affected the industry. Under the Clean Water Act (CWA),[9] NPDES [national pollutant discharge elimination system] permits are required for stormwater discharges from construction activities. The 2005 Energy Policy Act redefined the term "oil and gas activities" as used in the CWA. This amendment exempted the construction activities associated with oil and gas activities from NPDES stormwater construction requirements.

And also, the 2005 Energy Policy Act redefined the term "underground injection" as used in the Safe Drinking Water Act (SDWA).[10] The SDWA is a federal law that ensures the quality of drinking water in the United States. Under the SDWA, EPA sets standards for drinking water quality and oversees state, local, and public water suppliers who implement those standards. Additionally, it is under the SDWA that EPA has developed its underground injection program. The purpose of EPA's underground injection program is to prevent underground injection wells from contaminating sources of drinking water. The 2005 Energy Policy Act amended the definition of the term "underground injection." This redefinition specifically excluded the underground injection of fluids or propping agents used in hydraulic fracturing operations related to oil, gas, or geothermal production activities. Under this new definition of underground injection, hydraulic fracturing operations are exempt from the requirements of EPA's underground injection control program. I just want to note that just last month, at the beginning of March, the FRAC Act was reintroduced in both the U.S. House of Representatives and the U.S. Senate. The Act would seek to reverse the exclusion of hydraulic fracturing.

Turning back to the list of Pennsylvania laws, as Joel mentioned, our primary law is the Oil and Gas Act. This is the law that gives the Department of Environmental Protection the authority to permit wells. It contains provisions for well location restrictions, requirements for well site restoration, reporting requirements, bonding requirements, and it contains our enforcement authority. The Oil and Gas Act's implementing regulation, Pennsylvania Code Chapter 78, contains all of the design, construction, and operation requirements for constructing and operating wells. Pennsylvania's Clean Streams Law provides the DEP the legal authority to prevent and abate water pollution. The Oil and Gas Act, combined with the Clean Streams Law, gives the DEP the authority to promulgate rules and to put forth conditions to protect Pennsylvania's water resources.

There isn't enough time today to go through all the applicable laws in Pennsylvania that the Department uses to oversee the natural gas industry. But this list of laws and their implementing regulations create a network of laws that give Pennsylvania the tools to comprehensively regulate the entire process.

The DEP's involvement in the process starts with the well permit. Before a well can be drilled to produce natural gas from the Marcellus formation, an operator has to get a well permit. The well permit covers the well location and authorizes the operator to conduct activities in accordance with the Oil and Gas Act and its implementing regulations, as well as all other applicable laws that are administered by the DEP.

To get a well permit, the operator has to submit a well permit application that contains all the information about the location of the well. DEP reviews well applications to make sure that the proposed well site locations meet all siting requirements. Additionally, the DEP ensures that proper notification has been given to surface landowners and users of water supplies within a thousand feet of the well. The Oil and Gas Act also contains a requirement that the Department, when considering a well permit, consider the impacts to public resources.

I wanted to address some of the surface impacts associated with Marcellus Shale development activities, and some

9. 33 U.S.C. §§1251-1387, ELR Stat. FWPCA §§101-607.
10. 42 U.S.C. §§300f to 300j-26, ELR Stat. SDWA §§1401-1465.

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of our laws and requirements. Prior to the amendments in the 2005 Energy Policy Act, DEP required NPDES permits for stormwater construction activities associated with oil and gas. But in response to the 2005 Energy Policy Act, which exempted those activities from NPDES permitting, DEP issued a general permit to regulate earth disturbances associated with oil and gas activities. DEP issued this permit under the authority of Pennsylvania's Clean Streams Law using a public comment-and-response period. Just this past year, permit requirements for earth disturbances associated with oil and gas activities were codified into our state regulations in Chapter 102. These regulations became effective November 18 of last year.

Under the requirements of Chapter 102, operators that propose earth disturbances associated with oil and gas activities that will impact five acres or more are required to obtain an erosion and sediment control permit. Most Marcellus projects are greater than the five acres, meaning that the majority of Marcellus operators are required to obtain erosion and sediment control permits. To obtain an erosion and sediment control permit, operators are required to develop an erosion and sediment control plan. An erosion and sediment control plan is a site-specific plan that identifies best management practices to minimize accelerated erosion and sedimentation before, during, and after the earth disturbance activities. Under the Oil and Gas Act, once the well has been completed, the well site must be restored.

In discussing the environmental impacts associated with Marcellus development, one of the biggest concerns raised is the impact of all of the water that is withdrawn to hydraulically fracture wells. There are three entities that oversee water withdrawals in Pennsylvania: the DEP, the SRBC, and the DRBC.

The amount of water that is used to hydraulically fracture a well is often taken from small headwater streams. This has the potential to impair water quality through diminished stream flows. Under the Clean Streams Law, the DEP has a statutory obligation to prevent pollution and maintain designated and existing uses of waters of the Commonwealth.

Accordingly, prior to fracking a well, an operator has to submit a water management plan to the Department outlining all of its water sources. The Department looks at that plan and uses a low-flow analysis, looking at the cumulative impacts of proposed withdrawals on the affected water sources, to verify that that proposed water withdrawal will not cause harm to our waterways.

Operators, to prevent spills and to prepare for accidents, compile Preparedness, Prevention, and Contingency plans, also referred to as a PPC Plan, in which they: first, identify all of the pollutional substances that will be used and generated on the site; second, identify the methods for control and disposal of those substances and wastes; and third, outline the actions to be taken in the event of an emergency.

The hydraulic fracturing process necessitates pits and tanks to contain freshwater and wastewater. Wastes stored on the well site are regulated by the Oil and Gas Act, which contains specific performance and construction standards for how these storage facilities have to be constructed.

Moving on now to groundwater protection issues, gas migration has been a top priority of the Department. When a well is not properly cased and cemented, the natural gas in sub-surface formations has the potential to migrate from the well bore through cracks in the geology and through bedrock and soil. It may adversely affect water supplies and can accumulate in water wells and other structures. Under certain conditions, this may result in a fire or explosion. Because this has been such a concern in Pennsylvania, the Department recently promulgated amendments to Chapter 78 to specifically address issues of gas migration, including improved drilling, casing, and cementing standards.

Based on the gas migration incidents we've seen in Pennsylvania, gas migration seems to be largely caused by overpressuring casing or improper well construction, which is all complicated by Pennsylvania's unique geology. The new Chapter 78 regulations have updated design, construction, and operation standards that focus on well construction and require pressure testing.

The new regulations also contain requirements for inspections. Operators have to inspect active wells quarterly for signs of physical degradation and have to determine whether the pressure in the well is within allowable limits. And if that well fails the inspection, they have to immediately notify the Department. There is also a new provision about gas migration response, i.e., what happens when an operator gets a report that there may be a gas migration incident.

The new regulation also contains new reporting requirements. In response to concerns about what the actual chemicals are in frack fluids, there is a new provision in our regulations that requires operators to disclose a descriptive list of all of the chemical additives used, and then all of the hazardous chemical constituents within the frack fluid.

In terms of wastewater management, as part of the permit application process, operators have to identify where their produced wastewaters will be stored, treated, and disposed. And there are annual reporting requirements where they have to submit the amount and type of waste produced and the method of waste disposal or reuse. The waste that's generated through these operations is considered a residual waste, and operators have to follow our residual waste regulations in terms of keeping all of the records and all of the reporting requirements.

Another new regulation that the Department issued in this past year that became effective on August 21, 2011, was a new TDS [total dissolved solids] rule. It was designed to prevent pollution of Pennsylvania's surface waters from elevated TDS. Elevated TDS may be detrimental to surface waters, and the new regulations include several new requirements to address those concerns, including some

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requirements that the natural gas industry reuse frack flowback and production fluid under certain circumstances.

There is a complete prohibition on direct discharges of wastewater from natural gas operations into Pennsylvania's waters. Wastewater must be taken to permitted centralized waste treatment facilities or to authorized deep injection wells.

In addition to those requirements, the new TDS requirements impose effluent limitations on the centralized waste treatment facilities that accept the natural gas wastewater for several pollutants, including TDS, which mimic the SDWA standards for those contaminants.

All of these rules and regulations do not mean anything unless we have proper inspections and enforcement. The Department has, in the last year, doubled its staff and is now conducting inspections and getting out to these well sites multiple times over the course of the development process. Thank you.

Joel Burcat: Our next speaker is Terry Bossert. Terry is a lawyer and vice president of Government and Regulatory Affairs for Chief Oil & Gas LLC. He joined Chief Oil & Gas in 2010. Previously, he was chair of the Environmental Regulation and Litigation Group in the Harrisburg office of Post & Schell, a Philadelphia-based law firm. In addition, Terry has served as the chief counsel of the Pennsylvania DER [Department of Environmental Resources] and the DEP and has been actively involved in the practice of environmental law for many years. He is a member of the Pennsylvania Climate Change Advisory Committee, having been appointed to that position by the majority leader of the Pennsylvania Senate. Terry received his bachelor's degree from Susquehanna University and his law degree from Dickinson School of Law, now part of Penn State University.

Terry Bossert: I decided not to put together a PowerPoint of random thoughts—I knew that Joel and Liz in particular would cover a lot of the legal aspects, and there seemed to be no sense for me to go through all of that again. I will comment on some of those, but I want to give a different perspective. Let me first talk about where my career started, which was geology, and for some unknown reason, I decided to become a lawyer instead. I should have stayed in geology because looking at Marcellus, it would have been a good place to be.

You saw a slide that showed this big kind of black splotch that's the Marcellus Shale. Well, that is where the Marcellus Shale, is and that's where, if you drill down far enough, you will find a rock that the geologists will tell you whether it's Marcellus Shale. Whether it's got gas in it is another question. It is not uniform throughout that splotch that you saw up there. Some places, it's very thick. Some places, it gets very thin. Kind of ironically, as you move northwest in Pennsylvania toward the traditional oil and gas field, the Marcellus gets very thin and there has been very little activity up there. Now, the Marcellus actually has been produced in some ways for many years because people have drilled through it to get to other deposits, and they have kind of incidentally gotten a little bit of gas out of the Marcellus from that activity.

The other thing you find in the Marcellus is that as you move to the east and the south, you come to the mountain ridges, and the geologic activity has actually created enough heat that in geologic time, the gases actually have been cooked out of the Marcellus. There is a line that our geologists call the SOL line, and I thought that was a geologic term, but it's the term that you think it is, so that if you're on the wrong side of the SOL line, that's what you are.

Also, we have discovered that there are areas where there are inclusions of other formations. So, you will have 30 or 40 feet of Marcellus, then you'll have 20 feet of a limestone deposit, and then you might have 20 feet of Marcellus below that. That complicates the entire process.

And lastly, because the Marcellus was the bed of the ocean at one time, the formation might be going right there along at 5,000 feet and then all of a sudden, because of geologic forces, it's offset by 100 feet, and the Marcellus is down here. Well, we can do horizontal drilling, but we can't go around corners like that and go down 75 feet and go over. So, all of that complicates the process. All of which is to say it's not a sure thing. There are certainly some areas, particularly in Susquehanna County, which in the industry is known as the sweet spot where the shales may be up to 400 feet thick, produces wells that are unbelievable in terms of their production. But you get other areas where people have drilled wells that have turned out to be duds.

I think the geologists have known for probably 75 years—about the same time I've been practicing environmental law—that there was gas in the Marcellus and that you could get that gas by using hydraulic fracturing. But when you drill a vertical well and you do a fracture, you get a limited area and you get a limited amount of gas. And to drill a mile down into the ground and get a little bit of gas out of that wasn't worth it. It was only when you had the combination of the horizontal drilling, which is really technology developed in the offshore oil industry, and the fracturing that made it economically feasible to get shale gas. This pretty much started in Texas in the Barnett Shale in the early 1990s, and there are shale deposits all throughout the United States and increasing discoveries of shale deposits throughout the world.

I just read an article the other day where someone was holding forth on the actual geopolitical aspects of shale gas being available in places like Poland and Germany, and countries that now buy their gas from Russia and feel constrained in some ways by their supply of natural gas. Same thing, deposits have been discovered in India, China, and parts of Africa. This person was holding forth that this was kind of like backyard fuel, all right? You don't have to buy it from some other country. We'll see how that all plays out.

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Everyone is very interested in the shale gas. There are a lot of foreign companies and interests. We did a tour at the request of the U.S. State Department. We had a lot of wells and a lot of production in Lycoming County, which is Williamsport. Since it's right up I-270, it was the easiest place for the State Department to take these folks. We went up there on a tour, and there were some people there from India, and their main question was: "So, how do we invest?" I mean that was their question. "How do we get into this, and how do we get this technology?"

Another point I think I'd like to make as we discuss the legal requirements and the environmental controls is that, according to geologists, the Marcellus Shale represents the second largest reserve of natural gas in the entire world. The gas field that stretches through Iran and Qatar is the largest, but we are supposedly the second largest.

Before we discuss any of these other issues, the first question is, do you want the gas? If the answer is no, the seminar is over, okay? If the answer is yes, then the debate becomes, how do you get it, and what's the best way to get it, and what controls do you need to minimize, and I emphasize "minimize," the impact? Because in my view, what's been missing in this whole debate has been balance and candor, and I say that on both sides. The industry makes believe we'll show up someday and by using the force, we'll get the gas out of the ground. You will never know we're here, and everyone will have jobs, and everything will be hunky-dory. Well, no.

Actually, what we are going to do is we are going to move in with mobile industrial plants, and we're going to move them around all throughout your neighborhood, and if you lived on a road that the only truck that ever went buy was the guy delivering fuel oil to your neighbor, well, that ain't going to be the way it is anymore. For a while, while we're drilling wells, there is going to be a whole bunch of trucks going past your house, and you're not going to like that. But I use this analogy, and I don't mean to belittle it, but for many, many years, I lived on the last street of a housing development. I had behind me a woods, and then a farm. I loved it. My kids loved it. It was great. And then the farmer, the bozo, sold the farm to somebody, and they built more houses back there, and it really made me mad. I didn't like that change, and I understand when people say that. I live in a rural area. I like the rural area. And now, you've shown up and you put up 150-foot drill rig, and there are lights on it all night, and there are trucks throughout driving up and down the road, and you're a pain in the neck. And I can't argue with people when they say that.

To come back to my question, do you want the gas? Is it better to produce this gas, or is it better to buy liquefied natural gas that's shipped across the ocean? Is it better to get the gas from Texas? Is it better to burn coal? Is it better to burn gasoline in your cars and trucks instead of natural gas? I think that's part of the question.

Now, let me switch from that question to controls. I think there are controls, and there need to be controls, and I think some of these controls need to be improved. I think the industry has learned, and the regulators have learned. But on the other side is everyone blaming every problem there is on hydraulic fracturing. I think the main reason they do that is because they can use the word fracking and then cleverly substitute it for some other word into their jargon.

But actually, hydraulic fracturing has very, very little to do with any of the problems that are associated with what we do. Is there migrating methane? Yup, but that doesn't have anything to do with fracturing. It has to do with drilling through the upper Devonian gas that is above the Marcellus, isolated pockets of gas that we are finding a lot in northern Pennsylvania, not so many in southern Pennsylvania, and not recognizing that, and not casing those wells properly.

I think we've discovered that when you do the so-called three-string casing, which the DEP will now require but some of the companies have been doing for several years, you certainly, if not totally eliminate, greatly minimize those methane migration issues. I think you also have to recognize that there are lots of water wells in Pennsylvania that have had methane in them for years in areas where there has never been any drilling for natural gas, just a natural phenomena, which doesn't make it a good thing to give more or give it to somebody who didn't have it before. But those circumstances exist.

I just want to conclude by saying in addition to the regulations, I think there are some practices out there that the industry has adopted that have not been in regulation that, again, at least from my perspective, I think we ought to think about—I hate to say "mandating," it hurts my bonus if I were to use the word "mandate"—but we ought to think about some way to get them into regulations. One of the things is closed-loop drilling. All the fluids come through a tank. The cuttings are separated out. You use the fluid to drill. Another is, in my view, closed-loop flowback. You don't flow back into pits and impoundments that can overflow. You flow back into tanks. Lining your sites. In Colorado, Oklahoma, Texas, whatever, you'll just see sites that are bare dirt. Putting down liners, particularly when you're going to do fracturing because you have flowback, I think, is an important aspect that we ought to be thinking about requiring.

Water transfers using water overland portable water lines. I'm only talking about the freshwater that you use for fracturing. You build one big impoundment and you take basically plastic water line and heavy duty bolted-together stuff and you run the water over to this well. When you're finished, you pick up all the pipe, and then you move it, and you go over to this well. You're not running the trucks back and forth. Those are the kinds of things that we need to be thinking about.

And the last thing I will say, putting my hat back on as a former DER and then DEP chief counsel, just because EPA doesn't regulate it doesn't mean it's not regulated,. The states have been doing environmental law before EPA was

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invented, and the states will keep on doing environmental law. And in one of the great ironies, when I became chief counsel of the DEP, I had a discussion with the EPA general counsel in which I said: "Well, I'm a states' rights person, not in the George Wallace sense but in the Thomas Jefferson sense." And the answer was: "Well, I'm more Hamiltonian. I'm a federalist." And I thought: "All right, you're the Democrat, I'm the Republican. Now I'm a Jefferson and you're Hamilton." So, it just shows that the world is upside down sometimes in terms of one's view.

Joel Burcat: Thank you very much, Terry. Our final speaker today is Deb Nardone. Deb is the Sierra Club's first Natural Gas Reform campaign director. She works out of State College, Pennsylvania. She oversees the Sierra Club's national campaign to support strong federal and state safeguards against the threats posed by natural gas industry and hydraulic fracturing. She previously worked for the Pennsylvania Council of Trout Unlimited, where she served as a cold water resource specialist developing conservation plans to protect the headwaters upstream from inappropriate development. This work included creating the campaign for Trout Unlimited to address oil and gas development in Pennsylvania. Deb has also worked on watershed protection for the Chesapeake Bay Foundation and the Allegheny Ridge Heritage area.

Deborah J. Nardone: We have in common that we all have at some point been through many classes at Penn State University. And actually, Terry, you and I agree on a whole lot. People might find that surprising. I'm finding it surprising sometimes. But I think we constantly talk about this issue from a very controversial, us-against-them sort of perspective. As part of the Natural Gas Reform Campaign with the Sierra Club, our intention is to minimize environmental degradation due to natural gas. So, how do we get the gas, and how do we minimize the impact? We are very concerned about it from an environmental perspective. We're extremely concerned about it from a human health perspective as well.

I agree with you that we need to have improved controls on the ground and that BMP [best management practices] should be required. Often enough, we do blame one very small piece of the hydraulic fracturing process, hydrofracking to get natural gas, but a lot of the environmental problems that we've seen are problems not associated with that one small process of the gas extraction methods, but many of the pollution events have been because of the larger scale of all of the pieces that happen at natural gas drilling. So yes, I think hydrofracking does get a very bad image. And a lot of the environmental degradation has been because of other reasons other than hydraulic fracturing.

So, the Natural Gas Reform Campaign of the Sierra Club is really focusing on regulatory reform: how do we get local and state regulations that are adequate to control environmental impacts; how do we get federal reform and closing some of those exemptions that Elizabeth had talked about; and then also how do we identify what sensitive areas should be off limits to drilling?

In 2010, there were 1,368 Marcellus wells drilled. And of that, there were 1,544 violations that were issued by the DEP. And that was even as the DEP was ramping up its staff. It didn't have a significant number of staff on the ground. So, the DEP has done a fairly good job at getting out there and issuing potential violations. But it is also a concern that the average over the lifespan of Marcellus wells that have been drilled is for every one drill, there is an incident of 3.14 violations.

How do we get out there to monitor what's going on, monitor the impacts that are happening on the ground, and have enough people out there to actually enforce the regulations that we put in place? There is a whole host of potential environmental problems. Of those violations that I just talked about, this list is where most of the water quality violations have occurred.

This was a study done through the Pennsylvania Land Trust Alliance, and again, this is the one that documented that for every one well drilled, there were the 3.14 violations that had occurred. Of those violations, over 1,000 of them were documented as having the potential to harm water quality. This is on the Pennsylvania Land Trust Alliance website. They did issue a full report with the breakdown of violations from Marcellus wells.

The key environmental issues associated with gas drilling can be generally fairly vast, and I'm not going to have nearly enough time to talk about all of these issues. But the ones that are highlighted in black are the ones that I'd like to quickly run through and address today. As a panel, we were asked to identify and discuss environmental implications surrounding hydraulic fracturing. What I tried to identify were some of those impacts rather than go into depth on issues that are associated with just general gas production, like air quality impacts, cumulative impacts, and all the issues associated with land disturbance from roads and pipelines and compressor stations.

So, talking about water withdrawals, Elizabeth had set about the number of millions of gallons that are required to hydraulically fracture each well. It is two to five million gallons on average; that is a statistic that I heard a lot of talk about, how much two to five million gallons is. Given that, we'll see thousands of wells in Pennsylvania drilled. That's many, many millions of gallons of water that will be used.

The interesting part about this is you hear the comparison often enough about the water consumed. It's a cumulative loss—it's water that's consumed. People compare it often to things like golf courses or manufacturing, etc. The interesting part about those, when a golf course uses two to five million gallons of water or 12 million gallons of water, they are using it to water their greens, and so it's not technically cumulatively lost. It actually makes its way back into the hydrologic cycle. Whereas with the hydraulic fracturing, on average, 90% of that water is staying below ground, so it's water that never makes its way back into our streams

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and our groundwater. And so, while it may not seem like it's that significant of a number per well, when you take a look at the thousands of wells that will be drilled over time, that's a fairly large impact of water that will never make it back into the hydrologic regime and to the water table.

The SRBC has a fairly stringent good set of water quality regulations on the books. The DRBC is closing their public comment process tomorrow about what their natural gas regulations will look like. And again, the DEP is administering water withdrawals in the Ohio Basin, because there is no River Basin Commission.

Prior to working with the Sierra Club, I was working with Trout Unlimited, and I worked with a lot of anglers who spend time fishing wild brook trout streams up in the mountains of Pennsylvania. The big concern was even though it's being regulated, there were still issues around the potential impact to the aquatic species that inhabited the streams that the water was being withdrawn from. They have a pass-by flow requirement, so after so many millions of gallons, after so much water is withdrawn based on what's actually in those streams, the drillers would be cut from not allowing to withdraw water anymore.

In our best-case scenarios, in our high-quality and our exceptional-value streams that are the best of the best that we have in Pennsylvania, there can be no more than a 10% impact. So, if you have a stream channel that looks like this, you can't have 10% of the sub-surface of that river bottom be exposed. The science shows that for aquatic species, for the bugs and the fish and things like that that live in those streams, if you have a 10% loss of habitat, you also generally have a consistent direct effect a 10% decline in aquatic species.

While that may not seem that significant, when you're talking about high-quality and exceptional-value streams, that's what that designation is based on. It's based on the diversity and the number of aquatic species in that stream. If you see a 10% decline in aquatic species, that could potentially make the difference between a high-quality stream and a cold-water stream. And so, I think that the River Basin Commissions are doing a great job at regulating water withdrawals, but again, it's not something that has no impact.

Again, it's inconsistent water withdrawal regs. You've got three different regulatory agencies trying to manage water withdrawal. A lot of confusion from people who live there about whether the truck goes back up to the stream is withdrawing water or depositing water, and I'm sure the trucking companies and the drillers are also confused about the kinds of regulations where they're allowed to withdraw from. Ultimately, it would be really nice to see consistent water withdrawal regs across the state that are protective of the things that live in the stream, and also for the people who use those streams.

The DRBC, part of their regs are talking about having assessment prior to withdrawals. I believe the SRBC also goes out in those assessments prior to withdrawals. Does the DEP go out and do an assessment prior to allowing a withdrawal permit?

Elizabeth Nolan: Yes.

Deborah J. Nardone: And the assessment piece is important so you know what's there. Over time, you can actually take a look at cumulative impacts from water withdrawals.

Wastewater issue has been talked about a tremendous amount in Pennsylvania. I wanted to just run down a quick list of what kinds of chemicals are contained in the frack fluids that do go below ground. Lots of items go down for various reasons, which Terry can better explain than I can. But also, as it's down there and it's in contact with the formation, it's coming back up with many things other than just those chemicals, so it does have the high solids or the high conductivity or high salts, chlorides, sulfates, heavy metals.

We talked about TENORM and NORM. There, we also heard a lot about wastewater treatment in Pennsylvania, and Pennsylvania is a very different state from most gas-producing states in that because of the lack of underground injection wells, most of our wastewater, if it's not being recycled and reused for the next frack job, it's going to a wastewater treatment facility, essentially being treated for biologics off the top, diluted, and discharged. Again, I don't need to go into detail about the information that's been going out about what's actually in those wastewaters. The DEP did pass their new wastewater regs, their Chapter 95 regs. Is that currently being implemented or is it still in the development stage?

Elizabeth A. Nolan: It was effective as of August 21 of last year, so it's currently effective and being implemented.

Deborah J. Nardone: Great. Some companies are stating that they're recycling almost 100% of their frack water. There is a really mixed audience about the recycling issue. Some really see it as a benefit because of not having to take it to a wastewater treatment facility and having it disposed of in our surface waters.

Other folks are very concerned that as you recycle it, because of the chemicals they are using and because of the contaminants that it picks up when it's in contact with the underground formations, it becomes more polluted over time. As you use it and then you dilute it down to dilute what's in the water, there is a concern about how toxic the water then becomes over time as you recycle it and what the lifetime then is on the casings and whether we may not see any pollution implications for 75 or 100 years, but what happens to those casings in 125 years and 150 years? Will they really be viable and have the ability to protect our drinking water supplies? So, there is a very mixed bag out there when it comes to wastewater treatment and whether treatment either by surface water underground injection is better than recycling.

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We have talked a lot today about the drinking water contamination aspects. There has been contamination reported in several Pennsylvania counties. Again, this is where I think hydrofracking gets the bad rap. Actually, just a couple of days ago, there was a Senate hearing where I heard several government officials say there has never been any reported contamination events because of hydraulic fracturing, and I'm so confused as to why we still hear that, because it's been proven time and time again that there has been contamination.

It hasn't been because of that very small piece of the industrial process called hydraulic fracturing, but there has been water, drinking water contamination because of gas extraction. It may be leaky liners that are storing the water in impoundments. It could be spills that occur on the surface. It could be a truck tanker that spilled over and dumped its load and went into somebody's yard and then contaminated their well. The methane issues that we see in Dimock were thermogenic gas attributable to the shale layer that they were hydraulically fracturing. And so, it wasn't the biogenic gas. It wasn't the gas that you would normally find in a drinking well supply that was very close to the surface. It was thermogenic gas that is found very deep underground and consistent with the shale layer that they were drilling. So again, I don't know why people continue to say there has never been any water contamination due to hydraulic fracturing. There has been water contamination due to hydraulic fracturing, and due to the drilling process in general.

Of a big concern in Pennsylvania are those special protection watersheds. I talked about the high-quality and exceptional-value watersheds that we have. We have a significant number of wilderness trout streams, and particularly where the Marcellus play is very active in the northeastern and north central part of the state, it has a very rural, densely forested, beautiful section of Pennsylvania where some of the best water quality flows off the mountains in Pennsylvania. There is a very big concern about what the impact from the industrial process of gas extraction is doing to those watersheds and to the potential designation of exceptional value and high quality.

In Pennsylvania, we do have a fast-track permitting process, regardless of what the designation of the stream is. So, if it's a high-quality, exceptional-value, cold-water or warm-water fishery, it doesn't matter as long as a professional geologist or a field surveyor signs off on the E&S [erosion and sediment], the GP-1, or the well permits. In some cases, in tracking some of the expedited permits, we have seen permits issued in three to five days through the DEP.

There is a very big concern that I understand that as professionals, you are required to ensure that what's on those documents is factual, and I believe that the DEP also assumes that what's on those documents is factual. But the fact that actually the DEP is not going out and looking at the site prior to issuing the permit is a very big concern, because if you are an engineer and you are doing the permit and you're based in Houston, I'm sure you have a person that's going out and taking a look at the site. But you may not know that there is a wetland on the site that doesn't show up on a map, or an intermittent or ephemeral stream that doesn't show up on the map that you're using to put together your permit. So, there is a big concern about the fast-track permitting system in Pennsylvania and that it has potential implications to really jeopardize the exceptional-value and high-quality designations.

We talked about earth disturbance and stormwater again. The E&S GP-1 is greater than five acres. We question then what happens under five acres, and over the last couple of years, we've seen a large group of the sites be 4.9 acres, so that they don't have to go through the E&S GP-1 process. And again, that GP-1 process is a secondary check to make sure that you show that you have some form of post-construction stormwater and that you're not degrading water quality. In Pennsylvanian exceptional-value and high-quality streams, the law is that those streams cannot be degraded below the existing water quality. When you are exempt from having to prove that you're not degrading water quality and you're throwing 4.9-acre well-pad sites all over the hillside, you're not liable for showing that you're not impacting or degrading water quality. It's just another loophole that I feel Pennsylvania needs to close in order to effectively regulate oil and gas development.

The other thing is in April 2009, County Conservation Districts who would generally review sedimentation plans and stormwater control plans were removed from the process of secondary approval. And who knows better what's happening, what's there, what wetlands, what streams, what potential impacts there are, than County Conservation Districts? They are local. They can actually go out and take a look at the site. They were removed from the review process. It's another area I think has the potential to be improved by bringing the County Conservation Districts back into the review process.

As far as inspection, enforcement, and monitoring, I really feel that having some form of monitoring prior to issuing well permits is crucial, so that we can get some good baseline data and understand what the cumulative impacts are across Pennsylvania as drilling continues. At this point, there is no water quality monitoring required prior to fracturing. There is this 1,000-foot perimeter zone of—help me out here—

Elizabeth A. Nolan: Presumption.

Deborah J. Nardone: Presumption, thank you, in which if somebody's well becomes contaminated and it's within 1,000 feet of the fracturing job, then they are assuming that the company is liable. But what happens outside of that zone of presumption? The landowners are required to prove whether their well is contaminated because of the hydraulic fracturing process or because of the well drilling process. Having premonitoring would really solve a lot of that, whether it be private water supplies,

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surface water or groundwater. Required monitoring prior would help determine what and who is responsible for methane contamination.

We talked about the federal exemptions. So, not only do we have a lot of work to do at the state level; we also have a lot of work to do at the federal level in closing a lot of those exemptions. This is a list of aspects of federal law in which the oil and gas industry is exempt. It's not a blanket exemption. They are not exempt from all aspects of these laws. They are exempt from certain aspects of these laws.

Pennsylvania is in the target in the eyes of a lot of people. All the other shale plays are closely watching to see how Pennsylvania regulates. Because it's a fast-moving play, I think Pennsylvania really has the opportunity to get it right and to effectively regulate, to effectively monitor. Instead of being the guinea pig and seeing things all over the media about let's not do what Pennsylvania is doing, I think Pennsylvania has the opportunity to step up not only from the regulatory end, but from the industry end.

If the industry really wants to prove that it has the ability to do it right, then let's let them do it right, but they need to show us that they can by getting a regulatory framework in place, increasing the number of opportunities to do baseline monitoring, and then in Pennsylvania, also passing a severance check. So, we have the ability for the communities that are being impacted to deal with the aspects of drilling and how they are being impacted, whether it's from environmental or social impacts. Pennsylvania has a real opportunity, and at this point, we're not showing that it has opportunity. I think people are looking very closely and saying let's not do what they're doing in Pennsylvania.

Joel Burcat: Thank you, Deb. I wanted to give the panelists the opportunity to respond to the others. Terry, do you want to respond to any comments made by any of the other panelists?

Terry Bossert: No, actually, I think there is a lot of agreement. But I think we need to get together and sort out this: what's fracturing, and what does it cost? The debate keeps evolving. When you first started, everyone was saying hydraulic fracturing is contaminating water wells, and what they meant by that was that the materials that were injected into the ground at 6,000 feet were somehow making their way to the surface and contaminating water wells, and that is not happening. And when regulators say there has been no evidence that that has happened, I think they are accurate. People don't finish the sentence and say there have been instances of contamination from drilling the well and intersecting the gas. I hate to see us spending a whole lot of time arguing about what's fracturing and what's not fracturing—it's really the issue of how you prepare the well the right way, so you don't have the problem.

I'm surprised no one's used the term "Halliburton" in terms of the exemption. I mean, if you say Halliburton in front of anything, it makes it bad, per se. I think the EPA's assumption for many years was that injection of fluids for fracturing wells was not covered by the SDWA until there was a court decision that said yes, I think maybe it is, and then Congress changed the law. So, it's not like it was just put in when we've discovered the Marcellus Shale. It had to do with Alabama and—

Elizabeth A. Nolan: It was never really regulated. That was never really regulated by the SDWA.

Terry Bossert: Right, right.

Elizabeth A. Nolan: Prior to it. It was just because of that court decision at the [U.S. Court of Appeals for the] Eleventh Circuit.

Joel Burcat: Deb, do you have any response to any comments?

Deborah J. Nardone: No. By being able to go last, I think I got to address what I wanted to say about them. I think the public disclosure piece is very important in Pennsylvania. Pennsylvania is in the process of requiring a disclosure. Thirty days after drilling commences, they have to supply a report. It's still not public disclosure, and I think that is another part—

Elizabeth A. Nolan: Those are public files.

Deborah J. Nardone: Are they? Okay. Great.

Terry Bossert: Have you looked at Frac Focus?

Deborah J. Nardone: I have, yes.

Terry Bossert: Ground Water Protection Council just came out with an online system where you can upload the results of every fracturing job.

Deborah J. Nardone: Does it actually say "This is the concentration of this chemical that went in this hole," or is it just the list of everything that they could be using?

Terry Bossert: You know, I haven't looked at it that closely yet.

Elizabeth A. Nolan: They posted individual Well Completion Reports that do have that information. And the information that is submitted to the Department is on a Well Completion Report that is submitted to the regional office where the well is located. It's a well-specific record that contains a descriptive list of all of the chemical additives by percent by volume, as well as all of the hazardous chemical constituents by percent by volume. Those records are kept in our public files.

However, it is important to note that Pennsylvania's Right to Know Law allows an operator to designate certain infor-

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mation as containing confidential proprietary information when submitting this information to the Department. So, an operator can, when it submits a well completion, designate that some of the information is proprietary, and then the Department is required to follow the requirements in the Right to Know Law. So, whether this information is public or not depends on the Right to Know Law process.

Joel Burcat: There are a number of companies in the drilling business that have posted on their websites what is in their frack fluids, so you can actually just go to the website and see the various substances as well as the percentages.

Elizabeth A. Nolan: I know two of those operators, for anyone who wants to look, are Range Resources and EQT Corporation. They have their Well Completion Reports posted on their website with that information.

Joel Burcat: And Chief too.

Elizabeth A. Nolan: And Chief too, sorry, Terry.

Joel Burcat: I wanted to give them credit. Elizabeth, is there anything you wanted to comment on before we take the questions from the audience?

Elizabeth A. Nolan: Sure. I had just one point of clarification. After I finished speaking, I realized I didn't mention the presumption of liability for water supplies. As Deb mentioned, there is this 1,000-foot area of presumption, so within the Oil and Gas Act, if a water supply is contaminated and it's 1,000 feet within a well and it's six months after the completion of drilling, the operator of that well is presumed to have caused that contamination.

Audience Member: Only within six months?

Elizabeth A. Nolan: Yes, only within the six months for the presumption of liability. But even if you are not within that presumptive time period or within that 1,000 feet, if water is contaminated by either pollution or diminution, the operator is statutorily obligated to restore or replace that water supply with an alternate supply that's adequate in quality and quantity for the purposes served by that supply. In our latest amendments to Chapter 78, the Department outlined what qualifies as an adequate restored or replaced water supply and what it means to be a replacement supply that fulfills the operator's obligation to restore or replace that water supply.

So, regardless of the distance location, if the Department finds that water has been contaminated by either drilling the well or other operations, that operator is required to restore or replace water supplies. Once we get a water supply complaint, the Department has 10 days to investigate and 45 days to make a determination. So, it's not the landowner's responsibility to make any sort of showing. They are required to be notified of a well application and can choose to do a pre-drill survey to preserve a claim if they would later want to, but they have no obligation to do so.

Audience Member: And now, who pays for that?

Elizabeth A. Nolan: If they choose to do the pre-drill survey, then the landowner is responsible for paying for that.

Deborah J. Nardone: Liz, can you address the recent NOV [notice of violation] issue with the secretary needing approval before an NOV could be issued on the ground.

Elizabeth A. Nolan: For the next three months, all NOVs or enforcement actions involving Marcellus Shale are being vetted through our central office. The purpose of this temporary policy is to address inconsistencies identified in our regional office. You can look at our website and you can take a look at some of our inspection reports in between the different regions. We have inconsistencies of how NOVs are being issued and how they are being followed up. And so, it's a measure to address those inconsistencies and develop a consistent enforcement strategy throughout the entire state for this industry.

Joel Burcat: What I'd like to do is address some of the questions from the audience. And we actually have four questions that are similar, so I'm going to combine them. Do you believe that the federal government should have a greater role in regulating Marcellus Shale development?

Terry Bossert: I don't see any place or any program that requires EPA to do something more than they're doing. I believe the states are handling the situation. I think exempting drill pad sites from NPDES permits is sort of a dumb thing. But on the other hand, you have a state permit that does essentially the same thing, so I don't see any big deal there. I think the states are perfectly capable of handling the situation. EPA sets air quality standards that are parts of the various states' programs. The states all have that water quality criteria. So, EPA is involved in that sense, but I don't think they need to get involved in the permitting side of things.

Deborah J. Nardone: In many situations, if it's exempted from federal law, the states don't necessarily pick up and regulate for those certain aspects that they're exempted for. And so, I do think that for consistency across the country, and especially as other gas plays really pick up, that it is the role of the federal government to step in and regulate things like hydrogen sulfide through the Clean Air Act (CAA)[11] that's exempt at this point. Their ramifications or implications have significant human health impacts, and that's ultimately the role of EPA, not only to protect the environment, but to protect human health. So, bringing them back into compliance with NPDES, the SDWA, and

11. 42 U.S.C. §§7401-7671q, ELR Stat. CAA §§101-618.

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the CWA, I think is the role of the federal government, and they should be stepping in and better regulating.

Elizabeth A. Nolan: The only comment that I'll make is in promulgating our latest Chapter 78 regs that really dealt with casing and cementing and well design standards, that doing that at the state level was really important because of Pennsylvania's geology, which is very different than in places like in Arkansas and Texas. So, having that be at the state level and being able to have our rules and regulations to specifically address concerns that only Pennsylvania presents has been very, very important and needed.

Joel Burcat: Let me just add my comments, and that is that EPA tends to use a one-size-fits-all approach. EPA's approach would be to say what works in Pennsylvania is going to have to work in Alaska or California or some other place. And the reason, for example, that there are thousands of underground injection wells in Texas and only seven in Pennsylvania is because of the geology of Pennsylvania. The geology of Pennsylvania does not appear to accommodate underground injection.

So, there are certainly many, many significant differences, and I think the states and Pennsylvania have a lengthy history of environmental regulation. States like Pennsylvania certainly have the ability and the wherewithal to regulate. My personal view is that right now, it is being done appropriately at the state level.

Let me ask another question from the audience. The question deals with whether there are pretreatment standards for the discharge of flowback water to wastewater treatment plants, but let me broaden it a little bit and include the disposal of flowback water and production water from hydrofracking once that water is too contaminated to use any further for hydrofracking purposes. So, what standards are there, and what would you like to see?

Elizabeth A. Nolan: We discussed the TDS regs, so there are no pretreatment standards for when wastewater comes into a centralized treatment works, but there are the effluent standards that are calculated at the end of pipe.

Deborah J. Nardone: Right. And when the Chapter 95 rules were updated, the 500 milligrams per liter TDS was a significant step forward. There were lots of people in Pennsylvania that were excited about the DEP's step forward in that. I think there is also a concern that while we're talking up barium and strontium and chlorides and TDS, that there are a lot of other things that are coming out at the end of the pipe that don't necessarily have effluent standards at this point.

Elizabeth A. Nolan: That's true. And we're looking into what those standards should be and working with these treatment facilities. The TDS regs also require a radiation action plan and radiation monitoring equipment. So, we are working with those treatment facilities to implement all of the testing for the things that aren't included in the TDS regs.

And also, last November, the Department started doing some in-stream monitoring for Radium-226 and 228, and all of those tests thus far have indicated that there is nothing that's higher than background in areas that are located downstream to a lot of these wastewater facilities that have been accepting natural gas wastewater.

Deborah J. Nardone: Is there an end-of-type threshold for all of the contaminants that come out?

Elizabeth A. Nolan: Just for specific contaminants.

Audience Member: There are a number of chemicals and other substances that are in the flowback waters that are being released to POTWs [publicly owned treatments works]. Many of these POTWs do not have permit standards for those substances. Should there be some standards, and what should the DEP be doing if there are no standards for those substances?

Elizabeth A. Nolan: DEP is constantly reviewing all of our standards, and we're taking a look at those permit requirements. I can't tell you exactly what our next steps are now, but we're currently developing a plan to address those concerns and will be taking a look at the permit conditions and amending permits accordingly.

Terry Bossert: I think it's important to understand how NPDES permitting is done and also what we do. Before we can send any of our wastewater to a treatment facility, we have to fill out a form, 26R, and it's got to analyze our waste. The DEP has to say that the facility can take that waste. And I think it's also important to distinguish between public treatment facilities like sewage plants and centralized waste treatment facilities that are industrial waste treatment facilities, and they have totally different capabilities.

It's not uncommon for a facility to have a permit that doesn't list every conceivable substance that comes into that facility. The DEP will look at what's the influent likely to be at that facility. They may decide that it's at a level that they don't have to set a limit. They may decide that it is co-removed by a process that removes some other contaminant. And frankly, it might be something for which there is no water quality criteria or regulation, and they won't set a limit. It doesn't mean in many cases that it's not removed from the process, because the pH [hydrogen ion concentration] adjustment, settling, filtration, etc., process removes a lot of contaminants at one time. Whether you list them or whether you don't list them, they come out together.

Now, that's not to say that you shouldn't have a good identification of what's gone into the plant. While I'm saying that, I just want to touch on something that Deborah raised: concern about recycling water. You continue to build up the contaminants and build up the contaminants.

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And what is evolving in the field is two methods, but a method to produce what my operations guys call clean salty water. In other words, everything, all the other contaminants have been taken out of it, but you still have the high TDS and the high salt, so that some have centralized treatment facilities to do this.

There are increasingly companies that actually have mobile facilities that will come to the drill site and they will filter the material and they will remove the contaminants other than the TDS. Then, we basically take the salty water and use it to fracture the next well. The problem frankly with the salt is the only really viable technology is distillation or evaporation. Then the byproduct is salt. We sell the salt to the Department of Transportation, and they put it back on the roads, and it gets washed into the creek.

Deborah J. Nardone: So, that leaves the TDS or leaves the chlorides?

Joel Burcat: Well, they are part of the TDS. It's in there with the chlorides and the TDS. But like the strontium, the barium, some of the chemicals that have come back with it, they're filtered out within the particulates. They are filtered and precipitated and you can use the water again.

Here's another audience question. Has there been any subsidence associated with fracking of the Marcellus Shale or other shale, and is the risk of subsidence dependent on the depth of the shale?

Terry Bossert: I'm not aware of any subsidence, and I don't think the way that fracturing works that that's very likely to be any kind of a concern at 5,000 to 8,000 feet. Basically, we put a five-inch pipe in and we fracture, but if people have the picture in their mind that we basically blow the shale to smithereens and create a void down there, that's not the way it happens. We make cracks in it. The reason we have what they call proppant, which is sand, is to hold the cracks open, but the cracks right at the point of fracture, the crack might be an inch wide and it gets gradually smaller. It's basically to stimulate the flow of gas through these cracks and through the sand matrix, so it doesn't obliterate the seam.

Joel Burcat: Liz, can you speak generally to the air quality regulatory program regarding Marcellus Shale? What is the status of the air quality regulation in Pennsylvania?

Elizabeth A. Nolan: Air quality could be a topic for an entire other panel. I can report that the Department has recently conducted three monitoring tests. They are preliminary tests to evaluate the human health impacts from air emissions at drill pads and compression stations. Those tests have not detected anything that will cause any immediate human health impacts, but we still are looking at the results of those tests and looking at what cumulative impacts the air emissions have at different parts of the Marcellus development process.

Audience Member: The CAA could be enforced by EPA at these sites, is that correct?

Terry Bossert: The air program would be enforced by the DEP, because it's a delegated program to the state, yes.

Audience Member: But, they did have to apply the federal and state standards?

Terry Bossert: They have to apply the federal standards.

Elizabeth A. Nolan: That's right.

Terry Bossert: For example, we use the EPA-approved "lean-burn engines." I'll just throw this out for the DEP. The standard is two grains per horsepower. You can buy engines these days right off the shelf that produce 0.5. So frankly, since I'm putting them in at 0.5, I want everybody to put them in 0.5, to be blunt about it. So, those kinds of things can be looked at and improved.

Deborah J. Nardone: There are aspects though of the CAA that are exempted, and there was, similar to the FRAC Act, the BREATHE Act that was introduced at the same time to bring back into compliance some of the exemptions for clean air.

Joel Burcat: I want to thank our panelists and ELI for this most interesting and timely discussion.