HUDSON RIVERKEEPER
BLACK WARRIOR RIVERKEEPER
DELAWARE RIVERKEEPER NETWORK
GALVESTON BAYKEEPER
LOWER MISSISSIPPI RIVERKEEPER
MOUNTAIN WATERSHED ASSOCIATION
NATURAL RESOURCES DEFENSE COUNCIL
SOUTH RIVERKEEPER
THREE RIVERS WATERKEEPER
YOUGHIOGHENY RIVERKEEPER
WATERKEEPER ALLIANCE
WESTERN LAKE ERIE WATERKEPER ASSOCIATION

March 29, 2010

Mr. Edward Hanlon
Designated Federal Officer
EPA Science Advisory Board (1400F)
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460

Re: Comments on EPA's Proposed Research Approach for Studying Relationships Between Industrial Gas Drilling Utilizing Hydraulic Fracturing and Drinking Water Resources.

Dear Mr. Hanlon:

Riverkeeper, Inc. is an environmental watchdog organization dedicated to protecting the Hudson River and the 2,000-square-mile New York City Watershed that supplies unfiltered drinking water to more than 9 million New Yorkers. For decades, Riverkeeper has worked with local, state and federal agencies on a variety of enforcement and permitting issues to further our mission to protect water quality. We are a founding member of the Waterkeeper Alliance, a global environmental movement uniting more than 190 Waterkeeper organizations around the world.

The Natural Resources Defense Council, Inc. (NRDC) is a national, non-profit legal and scientific organization that has been active for four decades on a wide range of environmental issues, including drinking water protection.

The undersigned organizations have been engaged in the issue of industrial gas production using hydraulic fracturing for years. The more we learn about all aspects of industrial gas production, the more we are concerned regarding impacts to drinking water resources, along with threats to air quality, landscapes, human health and other natural resources. While we recognize that natural gas may play a role in the nation's energy future as we transition to an energy policy utilizing renewable resources, we also recognize that we, as a nation, cannot simply replace one environmental problem with another.

We therefore applaud EPA's decision to study potential risks to drinking water posed by all aspects of hydraulic fracturing. We also strongly support EPA's *Scoping Materials for Initial Design of EPA Research Study on Potential Relationships Between Hydraulic Fracturing and Drinking Water Resources*,[1] which proposes the analysis of impacts throughout the entire natural gas production cycle. It is precisely this scope of analysis – the full lifecycle analysis – that has been overlooked in the recent rush to exploit this technology.

It is imperative that we comprehensively evaluate the full range of potential environmental impacts from gas exploration and production technologies, including hydraulic fracturing, and identify measures to prevent impacts before they occur – something that has not occurred anywhere to date. Unfortunately, in the absence of proper federal regulatory guidance, most states have allowed extensive industrial gas production operations to proceed without attempting to study and/or mitigate environmental impacts.

The approach taken by most states thus far flies in the face of the Precautionary Principle, a fundamental and globally recognized scientific and legal policy that underlies nearly all of our nation's environmental laws. The Precautionary Principle dictates that where there is scientific uncertainty concerning a proposed action, the proponent of such action bears the burden of proving that the activity will not be harmful. In such instances, the role of decision makers is to err on the side of protecting public health and the environment and to respond aggressively to low probability, high-impact events. Taking lead out of gasoline is the classic domestic example of regulating in the face of danger.[2] At a minimum, the Precautionary Principle is about prudent decision making. Therefore, studying potential impacts to drinking water before employing specific technologies on a grand scale is the proper course of action. We urge EPA to highlight the benefits of this approach in the course of its study on hydraulic fracturing.

Pursuant to a Federal Register Notice published March 18, 2010 (75 Fed. Reg. 13125), we hereby submit written information to evaluate and comment on the EPA Office of Research and Development's (ORD) planned research approach to study the potential public health and environmental protection issues that may be associated with hydraulic fracturing. Accordingly, the undersigned organizations offer the following comments on EPA's "Proposed Research Approach for Studying the Potential Relationships Between Hydraulic Fracturing and Drinking Water Resources" for the Science Advisory Board (SAB)'s consideration.

EPA Must Study All Aspects of Industrial Gas Drilling

As a preliminary matter, we support EPA's research approach to analyze how the entire process of hydraulic fracturing may impact both groundwater and surface water drinking supplies. The procedure of hydraulic fracturing, during which water, sand and toxic chemicals are injected into

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[1] *See*: http://yosemite.epa.gov/sab/sabproduct.nsf/0/3B745430D624ED3B852576D400514B76/$File/Hydraulic+Frac+Scoping+Doc+for+SAB-3-22-10+Final.pdf, hereinafter "EPA Scoping Materials."

[2] Ethyl Corp. v. EPA, 541 F.2d 1, (D.C. Cir. 1976) (court acknowledged the high degree of scientific uncertainty, but upheld EPA's decision to regulate lead in gasoline). "Man's ability to alter his environment has developed far more rapidly than his ability to foresee with certainty the effects of his alterations." *Id.* at 6.

natural gas reserves under high pressure, is but one way in which the entire hydraulic fracturing process can impact groundwater and surface waters. Rather than narrowly focusing on the limited process of injecting fluids and sand under high pressure, it is imperative to use a broad, comprehensive lifecycle assessment approach when researching the process and impacts of hydraulic fracturing. Specifically, it is necessary to consider storage and disposal of hydraulic fracturing fluids, wastewater and solid wastes – including the use and contents of open air pits, on-site burial of drilling cuttings – and all potential pathways for environmental impacts from the use of these technologies. In addition to analyzing the full lifecycle impacts of hydraulic fracturing, to adequately analyze impacts to all drinking water resources requires studying the entire process of industrial gas production, including but not limited to exploration, drilling, and more. We believe it is essential that EPA also research the impacts of these other stages of the production process as they are all inter-related. To overlook the many other aspects associated with hydraulic fracturing would be as deficient as analyzing only point source impacts to watercourses while ignoring nonpoint sources such as stormwater and runoff.

Hydraulic fracturing can require at least 3 million gallons of water *per hydrofrack*, and typically each well is fractured many times. Operators must truck in water and chemicals, store them on-site, and properly dispose of the waste (much of the injected fracturing fluid returns to the surface, along with produced water containing significant contaminants, including brines, heavy metals, radionuclides, and organics.) Even though the gas industry claims that toxic chemicals represent less than 1% of the fracturing fluid, the U.S. Geological Survey explains that a typical 3-million-gallon hydrofrack results in 15,000 gallons of chemical waste.[3] In existing Marcellus Shale wells outside of New York this waste is stored on-site in large holding ponds until trucks haul it away.[4] In New York State, the Department of Environmental Conservation estimates that up to 1,340 truckloads will be required for each drilling operation;[5] for multi-well pads, up to 8,900 truckloads.[6]

Drinking water comes from two general sources – underground aquifers and surface water. Accordingly, EPA must study impacts to both groundwater and surface water drinking supplies.

Impacts to Groundwater

Attached to these comments is a Case Studies report on impacts and incidents involving hydraulic fracturing from across the country. Riverkeeper prepared these Case Studies as part of our comments on the *New York State Department of Environmental Conservation Draft Supplemental Generic Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program – Well Permit Issuance for Horizontal Drilling and High-Volume*

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[3] USGS, Water Resources and Natural Gas Production form the Marcellus Shale (2009), available at http://md.water.usgs.gov/publications/fs-2009-3032/fs-2009-3032.pdf.

[4] Where to dispose of this wastewater is also an unanswered question. In Pennsylvania there have been well documented high brine and TDS discharges into the Monongahela River – a drinking water source for over 350,000 people – as a result of the inability of wastewater treatment plants to process industrial gas drilling wastewater.

[5] NY DSGEIS at 6-138, *available at*, http://www.dec.ny.gov/energy/58440.html.

[6] *See id.* at 6-142.

Hydraulic Fracturing to Develop the Marcellus Shale and Other Low-Permeability Gas Reservoirs (" NY DSGEIS"). New York State prepared this DSGEIS under a state law that is the equivalent of the National Environmental Policy Act.

In the Case Studies report, Riverkeeper analyzed impacts and incidents that have occurred as a direct result of horizontal drilling using high-volume hydraulic fracturing. These case studies examine impacts in the Marcellus Shale (Pennsylvania, Ohio, and West Virginia), the Barnett Shale (Texas), and gas drilling activity in Colorado and Wyoming. Importantly, the case studies rely primarily on the investigations, findings and statements of ***state regulators*** from these areas.

In Pennsylvania, state regulators found that gas drilling using high-volume hydraulic fracturing has caused contaminated drinking water, polluted surface waters, polluted air, and contaminated soils. Specifically, the Pennsylvania Department of Environmental Protection (PA DEP) concluded that in one instance high-volume hydraulic fracturing "caused...gas from lower formations to enter fresh groundwater." In another instance the PA DEP found that a well using high-volume hydraulic fracturing had "communicated with [an] abandoned gas well" resulting in natural gas migrating to shallow groundwater and surface soils. In Ohio, state regulators found that inadequate well casing resulted in drinking water contamination and a house exploding. In the Barnett Shale, state regulators found benzene and other toxics in very high concentrations in neighborhoods with nearby gas compressors.

These unambiguous findings by state regulators that industrial gas production utilizing hydraulic fracturing has contaminated drinking water (and resulted in other serious environmental and health impacts) demand that EPA's proposed research approach examine all aspects of hydraulic fracturing.

Impacts to Surface Water Supplies

In addition to considering the potential impacts to subsurface aquifers and drinking water wells, consideration of impacts to surface water supplies is critical.

Our groups are concerned about impacts to all surface water supplies wherever industrial gas production occurs, and we set forth below specific recommendations for the evaluation of such impacts. We highlight two particular surface water resources to which our groups have devoted particular attention for many decades and that are at specific risk from gas production in the Marcellus Shale: the New York City Watershed and the Delaware River Basin.

New York City Watershed

Located largely in the Catskill Mountains, the New York City Watershed is the source of tap water for over half the State's population. Specifically, the Croton, Catskill and Delaware Watersheds deliver approximately 1.2 billion gallons of pristine, unfiltered drinking water each day from 19 upstate reservoirs to more than nine million people living in New York City, Westchester, Putnam, Orange and Ulster Counties. The entire New York City Watershed comprises approximately 4.2% of the State's land, yet supplies *unfiltered* drinking water to half the State's population. All surface water and stormwater runoff within the New York City Watershed drains into reservoirs and travels via gravity through tunnels and aqueducts to the taps

of consumers. The 1,560-square-mile system in the Catskills (one million acres) includes six reservoirs and their drainage basins, hundreds of miles of aqueducts and tunnels, and is home to approximately 60,000 people. Marcellus shale reserves underlie the Catskill and Delaware Watersheds, only 30% of which is protected from shale gas development through fee ownerships, easements or other means.

Riverkeeper played an instrumental role in protecting New York City's drinking water supply watershed when we helped structure the 1997 New York City Watershed Memorandum of Agreement, a landmark agreement that established ground rules for protecting the City's water supply. This agreement set the stage for the City to continue to receive a filtration avoidance determination (FAD) from EPA pursuant to the Safe Drinking Water Act, which allows the City to avoid the cost of building a $10 billion water filtration plant in exchange for strong watershed protection programs.

Delaware River Watershed

The 13,539-square-mile Delaware River Watershed includes portions of New York, Pennsylvania, New Jersey and Delaware. The longest free-flowing river east of the Mississippi, the Delaware is designated a Wild and Scenic River. It supplies over 15 million people with drinking water, including New York City residents, through its reservoirs in the Catskill Mountains. Its exceptional water quality is world renown and the quasi-federal agency that oversees its resources, the Delaware River Basin Commission (DRBC), has merited it Special Protection Waters designation, which requires that its exceptional quality and resources not be degraded. The DRBC also supports a cumulative analysis of the impacts of shale gas extraction on the water resources of the Delaware River Basin. Marcellus shale underlies the upper reaches of the River located in New York and Pennsylvania, encompassing 36% of the total Watershed. The potential for degradation of the River, its water supplies and ecosystems from shale gas extraction and development that employ hydraulic fracturing and horizontal drilling is substantial, and analysis described herein is necessary to prevent degradation before gas drilling commences in the Delaware River's headwaters.

Surface Water Impacts

Land disturbance and its associated stormwater impacts must be considered when studying the impacts of hydraulic fracturing to surface water quality in these and all other potentially impacted surface water resources. The substantial truck traffic, stormwater runoff, wastewater treatment and disposal, on-site spills and leaks, large well pads, and other activities make hydraulic fracturing a significant threat to unfiltered surface drinking water supplies. The addition of impervious surfaces to create access roads in watershed lands adversely impacts water quality, aquatic ecosystems, stormwater control, streambank stabilization, soils, vegetation, and human health. Stormwater impacts associated with the addition of impervious surfaces for access roads, well pads and appurtenances also must be considered. Furthermore, the substantial trucking activity and its potential impacts to surface drinking water supplies must

be studied; this includes increased stormwater runoff and the potential for spills when hauling wastewater away from a well pad.[7]

In its comments on the NY DSGEIS, the New York City Department of Environmental Protection (NYCDEP) reported that "casing or grouting failures, existing subsurface fractures, and fractures created during stimulation that propagate beyond the target formation can create or enhance hydraulic pathways between previously isolated [shale] formations. These pathways can allow drilling and fracturing chemicals or formation material (e.g., hydrocarbons or saline water) to contaminate shallow groundwater and surface water resources."[8] The NY DSGEIS also conceded that "[r]easonably anticipated water resources impacts relate to water withdrawals for hydraulic fracturing; stormwater runoff; surface spills, leaks and pit or surface impoundment failures..."[9] and "[s]pills or releases can occur as a result of tank ruptures, equipment or surface impoundment failures, overfills, vandalism, accidents (including vehicle collisions), ground fires, or improper operations. Spilled, leaked or released fluids could flow to a surface water body or infiltrate the ground, reaching subsurface soils and aquifers."[10]

In addition, withdrawal of surface water or groundwater for high volume hydraulic fracturing can impact the recharging capacity of wetland resources. "It is therefore important to understand the hydrologic relationship between the surface water, groundwater, and wetlands within a watershed to appropriately manage rates and quantities of water withdrawal."[11]

Cumulative Impacts

Analyzing the impacts of hydraulic fracturing operations on a site-by-site basis – even in the context of a lifecycle assessment – ignores the cumulative impacts of multiple wells on a single pad and thousands of wells and pads across a given region. This invites a tragedy of the commons, which exemplifies the cumulative impacts issue and is particularly relevant to industrial gas production. While even one industrial gas well may pose problems in and of itself, hundreds or thousands of wells only compound the problems. For example, one well may use 5 million gallons of water in the fracturing process while a thousand wells would use 5 *billion*

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[7] *See*: Riverkeeper, Comments on the New York State Department of Environmental Conservation Draft Supplemental Generic Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program – Well Permit Issuance for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low-Permeability Gas Reservoirs (hereinafter "Riverkeeper DSGEIS Comments") (December 28, 2009), *available at* http://www.riverkeeper.org/wp-content/uploads/2010/01/Riverkeeper-DSGEIS-Comments-12-28-09.pdf. *See also*, NRDC Comments on Draft Supplemental Generic Environmental Impact Statement on the Oil, Gas, and Solution Mining Regulatory Program (December 31, 2009) (hereinafter "NRDC DSGEIS Comments"), *available at* http://docs.nrdc.org/energy/files/ene_10010401a.pdf

[8] New York City Department of Environmental Protection, Rapid Impact Assessment Report (2009), at ES-3, hereinafter "DEP Report," *available at*, http://www.nyc.gov/html/dep/pdf/natural_gas_drilling/rapid_impact_assessment_091609.pdf.

[9] NY DSGEIS at 6-3.

[10] *See id.* at 6-16.

[11] *See id.* at 6-7.

gallons of water and would present substantial issues regarding water withdrawals and disposal of wastewater from these wells.

There is a broad range of cumulative impacts associated with gas development during the lifecycle of hydraulic fracturing operations.[12] For example, NYCDEP concluded that the "cumulative impact from [truck] trips to tens or hundreds of wells in an area could cause substantial additional stress on transportation infrastructure, resulting in increased erosion, repair costs for damage to DEP-maintained roads or bridges, and potential access problems to DEP facilities."[13]

Other cumulative impacts include but are not limited to: existing water consumption and new withdrawals, wastewater disposal, air pollution, stormwater, waste management failures, disposal wells, and viewshed impacts. All of these issues must be analyzed on site-specific, local and regional bases to properly assess their impacts during the lifecycle of hydraulic fracturing operations.

Need for Field Evaluation

It is critical that the EPA study not be limited to a review of existing literature and data. The analysis must include actual field study of the full range of lifecycle impacts associated with industrial gas drilling. The study should be designed to include substantial field monitoring of actual fracturing and other drilling activities, including geological and hydrological monitoring. In addition, follow-up monitoring and evaluation of water quality in both surface and subsurface drinking water resources should be included.

Other Recommendations

In addition to the foregoing recommendations, our groups suggest the following additional parameters are critical to a well-designed study:

- Evaluation of the availability, current usage and effectiveness of non-toxic drilling and fracturing fluids.
- Evaluation of viable best management practices that should be incorporated in federal and/or state regulatory frameworks for hydraulic fracturing.
- Examination of air impacts related to hydraulic fracturing, including impacts from evaporation of toxic substances from open wastewater storage pits, truck traffic for hauling water and chemicals for fracturing and wastewater, and fossil-fuel burning equipment used in the production process.
- Use of experts on an independent, unbiased, non-conflicted review committee, including experts with geological, hydrological, toxicology, and health expertise.

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[12] *See*: Riverkeeper DSGEIS Comments, *available at* http://www.riverkeeper.org/wp-content/uploads/2010/01/Riverkeeper-DSGEIS-Comments-12-28-09.pdf; *See also* NRDC DSGEIS Comments, *available at* http://docs.nrdc.org/energy/files/ene_10010401a.pdf.

[13] DEP Report at ES-3, 41.

Public Participation

EPA acknowledges in its scoping materials for this study that stakeholder participation will play an important role in the research and development of this study. We commend EPA for expressly recognizing the crucial role that public participation plays in development of science-based environmental policy and "[e]nsuring the stakeholder process is accessible and efficient."[14] We note, however, that these scoping materials were made publicly available only one week before written comments were due. As this process moves forward, we trust that EPA and its SAB will provide the public ample time to review and comment on what likely will be extensive scientific and technical reports.

Summary

For the foregoing reasons, the undersigned organizations propose the following specific topics for SAB consideration during the advisory process:

1. **The adverse impacts to groundwater supplies associated with all aspects of hydraulic fracturing; including but not limited to groundwater consumption; wastewater containment and disposal; potential contamination through existing pathways such as abandoned wells and existing geological faults and fractures; and spills and leaks.**

2. **The adverse impacts to surface water supplies associated with all aspects of hydraulic fracturing, including but not limited to surface water consumption, wastewater containment and disposal, the addition of impervious surfaces, stormwater impacts, and spills and leaks.**

3. **The cumulative impacts to drinking water resources (both groundwater and surface water supplies) from region-wide industrial gas drilling utilizing hydraulic fracturing.**

4. **The need for actual field studies to supplement any review of existing literature and data.**

Thank you for the opportunity to comment on these important issues.

Sincerely,

William Wegner

William Wegner, Staff Scientist
Riverkeeper, Inc.

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[14] *See*: EPA Scoping Materials, at 9.

On behalf of:

Nelson Brooke
Black Warrior Riverkeeper

Tracy Carluccio, Deputy Director
Delaware Riverkeeper Network

Charlotte Wells
Galveston Baykeeper

Paul Orr
Lower Mississippi Riverkeeper

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Youghiogheny Riverkeeper

RIVERKEEPER APPENDIX 1

CASE STUDIES

IMPACTS AND INCIDENTS INVOLVING HIGH-VOLUME HYDRAULIC FRACTURING FROM ACROSS THE COUNTRY

Executive Summary

Since the summer of 2008 Riverkeeper has tracked the prospect of industrial gas drilling in New York State. While gas drilling in New York is not new, what is new is the magnitude, scope, and location of the proposed drilling method of high-volume hydraulic fracturing. Indeed, industrial gas drilling throughout the Marcellus Shale and other shale reserves in New York has the potential to impact the environment and communities dramatically.

To assist in analyzing the DSGEIS and to understand what impacts New Yorkers might expect from this industrial gas drilling activity, the experience from other states where high-volume hydraulic fracturing occurs is very instructive. To that end, Riverkeeper analyzed impacts and incidents that have occurred as a direct result of horizontal drilling using high-volume hydraulic fracturing, the very type of activity the DSGEIS attempts to study. These case studies examine impacts in the Marcellus Shale (Pennsylvania, Ohio, and West Virginia), the Barnett Shale (Texas), and gas drilling activity in Colorado and Wyoming. The case studies rely primarily on the investigations, findings, and statements of ***state regulators*** from these areas.

The case studies demonstrate that horizontal drilling using high-volume hydraulic fracturing results in significant adverse impacts. These impacts result from improper casing of well bores, over-pressured wells, spills and accidents, gas migration via abandoned wells, the inability of wastewater treatment plants to treat flowback and produced water, underground injection of brine wastewater, improper erosion and sediment controls, truck traffic, compressor stations, and the ordinary operation of high-volume hydraulic fracturing wells.

In Pennsylvania state regulators found that gas drilling using high-volume hydraulic fracturing has caused contaminated drinking water, polluted surface waters, polluted air, and contaminated soils. Specifically, the Pennsylvania Department of Environmental Protection (PA DEP) concluded that in one instance high-volume hydraulic fracturing "caused…gas from lower formations to enter fresh groundwater." In another instance the PA DEP found that a well using high-volume hydraulic fracturing had "communicated with [an] abandoned gas well", resulting in natural gas migrating to shallow groundwater and surface soils. In Ohio, state regulators found that inadequate well casing resulted in drinking water contamination and a house exploding. In the Barnett Shale, state regulators found elevated levels of benzene and other toxics in neighborhoods with nearby gas compressors.

The DEC should heed the lessons learned from other states that have experienced high-volume hydraulic fracturing. Through SEQRA, New York has the opportunity to mitigate these impacts before they occur. These case studies highlight specific problems experienced in other states, but also help illustrate areas where the DSGEIS is inadequate.

MARCELLUS SHALE CASE STUDIES

I. Marcellus Shale – Introduction

The Marcellus shale is a rock formation located approximately 5,000 to 8,000 feet below much of State of Pennsylvania, and portions of southern New York, Ohio and West Virginia.[1] It is believed to contain trillions of cubic feet of natural gas.[2] Until recently, the gas trapped within the Marcellus shale formation was thought prohibitively expensive to access.[3] Rising natural gas prices and advances in drilling technology – namely, the advent of the high-volume hydraulic fracturing process – sparked new interest in tapping the gas within the Marcellus shale.[4] Natural gas companies have used high-volume hydraulic fracturing in Pennsylvania, Ohio and West Virginia. Numerous incidents have occurred either during or after such drilling activities that have resulted in gas migration, water pollution and/or air pollution in these states. Some such incidents are described below.

II. Marcellus Shale Case Studies – Water Impacts

A. McNett Township, Lycoming County, PA. On July 27, 2009, the Pennsylvania Department of Environmental Protection ("PA DEP") discovered a natural gas leak involving a well drilled by East Resources.[5] Two water bodies, tributaries of Lycoming Creek, were affected by the release of methane gas.[6] Methane also impacted numerous private drinking water wells in the area, and one resident was forced to evacuate.[7] Additionally, access roads to the well were closed. According to a subsequent PA DEP report, "[t]he suspected cause of the leak is a casing failure of some sort."[8] The company took measures to stop the leak at the source, and the area continues to be monitored by PA DEP.[9] Methane continues to be present in some of the private drinking water wells, and one gas extraction device was installed in a residence.[10] According to PA DEP, "the investigation is ongoing."[11]

B. Dimock Township, Susquehanna County, PA.

1. In January 2009, there were several reports of methane gas migrating to the surface, and at least one report of a drinking water well exploding along Carter Road in Dimock, PA.[12]

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[1] PA DEP, DEP MARCELLUS SHALE FACT SHEET 1 (2009), *available at* http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-76916/0100-FS-DEP4217.pdf

[2] *Id.*

[3] *Id.*

[4] *Id.*

[5] PA DEP, BUREAU OF OIL AND GAS MANAGEMENT, DRAFT REPORT STRAY NATURAL GAS MIGRATION ASSOCIATED WITH OIL AND GAS WELLS 3 (2009) [hereinafter "PA DEP DRAFT REPORT"], "), *available at*, http://www.dep.state.pa.us/dep/subject/advcoun/oil_gas/2009/Stray%20Gas%20Migration%20Cases.pdf (last visited Dec. 15, 2009).

[6] *Id.*

[7] *Id.*

[8] *Id.*

[9] *Id.*

[10] *Id.*

[11] PA DEP DRAFT REPORT, *supra* note 5, at 3.

[12] PA DEP, *DEP Continues to Analyze Dimock Water Supplies*, PA DEP Daily News Releases, Mar. 27, 2009, http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5459 (last visited Dec. 12, 2009).

The PA DEP called the event a "significant gas migration," and both free and dissolved natural gas have been found in numerous wells in the vicinity.[13] Upon preliminary testing, the PA DEP found that four wells in the area contained elevated levels of methane.[14] After further investigation, the agency discovered that nine wells contained methane, four at levels indicating a threat of explosion.[15] The gas migration occurred close to high-volume hydraulic fracturing sites of Cabot Oil & Gas Corporation ("Cabot"). The PA DEP noted that the "area has not experienced previous drilling and recent gas drilling in the vicinity has targeted the Marcellus Shale." It conducted isotopic analysis in an attempt to discern the source of the stray gas.[16] The PA DEP determined that the gas did indeed originate in the target drilling formation of Cabot, and ruled out the possibility that the gas was produced by bacteria or originated from a shallower gas-bearing formation.[17]

The PA DEP issued Cabot a notice of violation on February 27, 2009, citing the company's failure to comply with Pennsylvania's Oil and Gas Act.[18] The Notice also stated that "[PA DEP's] investigation revealed that Cabot had caused or allowed gas from lower formations to enter fresh groundwater."[19] In November 2009, the PA DEP and Cabot signed a consent order resolving the violations, which requires Cabot to get PA DEP approval for any future well casing or cementing plans.[20] The PA DEP new release regarding the consent order stated that "DEP inspectors discovered that the well casings on some of Cabot's natural gas wells were cemented improperly or insufficiently, allowing natural gas to migrate to groundwater."[21]

2. On September 16, 2009, more incidents in Dimock, PA were linked to Cabot when the two liquid gel spills occurred at the company's Heitsman natural gas well pad.[22] The spills polluted a wetland and caused a fish kill in Stevens Creek.[23] The PA DEP issued a notice of violation to Cabot for the spills.[24] In response to this event, the PA DEP stated:

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[13] PA DEP DRAFT REPORT, *supra* note 5, at 3.
[14] PA DEP, *DEP Continuing Investigation Into High Methane Levels in Susquehanna County Wells*, PA DEP Daily News Releases, Jan. 23, 2009, http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5406 (last visited Dec. 12, 2009).
[15] PA DEP, *supra* note 12.
[16] PA DEP, *supra* note 14.
[17] NEW YORK CITY DEP'T OF ENVTL. PROT., RAPID IMPACT ASSESSMENT REPORT: IMPACT ASSESSMENT OF NATURAL GAS PRODUCTION IN THE NEW YORK CITY WATER SUPPLY WATERSHED 53 (2009), *available at* http://www.nyc.gov/html/dep/pdf/natural_gas_drilling/rapid_impact_assessment_091609.pdf [hereinafter "NYCDEP RAPID IMPACT ASSESSMENT"]; *See also* Notice of Violation Letter from Craig Lobbins, PA DEP Regional Manager, to Thomas Liberatore, Cabot Oil & Gas Corporation , Vice President (Feb. 27, 2009) (on file with the Pace Environmental Litigation Clinic).
[18] Notice of Violation Letter from Craig Lobbins, Regional Manager of the PA DEP, to Thomas Liberatore, Vice President of Cabot Oil & Gas Corporation (Feb. 27, 2009) (on file with the Pace Environmental Litigation Clinic).
[19] *Id.*
[20] PA DEP, *DEP Reaches Agreement with Cabot to Prevent Gas Migration, Restore Water Supplies in Dimock Township*, PA DEP Daily News Releases, Nov. 4, 2009, http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5722 (last visited Dec. 13. 2009).
[21] *Id.*
[22] PA DEP, *DEP Issues Violation Notice to Cabot Oil and Gas,* PA DEP Daily News Releases, Sept. 23, 2009, http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5676 (last visited Dec. 13, 2009).
[23] *Id.*
[24] *Id.*

> the notice of violation cites Cabot for an unpermitted discharge of polluting substances, an unpermitted discharge of residual waste, two unpermitted encroachments on Stevens Creek, not containing polluting substances at the well site, and an unpermitted discharge of industrial waste. These were violations of the Pennsylvania Clean Streams Law, Pennsylvania Solid Waste Management Act, the Dam Safety and Encroachments Act, and the Oil and Gas Act.[25]

The two spills involved a lubricant gel used in the high-volume hydraulic fracturing process and totaled over 8,000 gallons.[26] According to Cabot, the releases were caused by failed pipe connections.[27] In addition, a third spill occurred on September 22, 2009 at the same site.[28] This subsequent spill involved 420 gallons of the same lubricant gel.[29]

Following these three spills, on September 25, 2009, PA DEP ordered Cabot to cease all high-volume hydraulic fracturing activities until the company "completes a number of important engineering and safety tasks."[30] PA DEP fined Cabot $56,650 and on October 16, 2009, allowed Cabot to resume high-volume hydraulic fracturing activities after it submitted the required documents to PA DEP.[31]

C. Foster Township, McKean County, PA. In April 2009, drilling activities conducted by Schreiner Oil & Gas impacted at least seven drinking water supplies along Hedgehog Lane in Foster, PA.[32] Stray gas became evident in numerous wells and residents complained. Two of the affected water supplies contained methane and five had iron and manganese above established drinking water standards.[33] After investigating, the PA DEP found that "the stray gas occurrence is a result of 26 recently drilled wells, four of which had excessive pressure at the surface casing seat and others that had no cement returns."[34] The PA DEP also issued Schreiner a notice of violation regarding this incident for failing to submit well records.[35] Prior to that notice, the PA DEP

> had issued three notices of violation to Schreiner pertaining to drilling on Hedgehog Lane. On November 13, DEP cited Schreiner for over-pressured wells. On February 19, DEP issued a notice of violation for pit violations and failure to

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[25] *Id.*
[26] *Id.*
[27] *Id.*
[28] PA DEP, *supra* note 22.
[29] *Id.*
[30] PA DEP, *DEP Orders Cabot Oil and Gas to Cease All Gas Well Fracking in Susquehanna County,* PA DEP Daily News Releases, Sept. 25, 2009, http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5678 (last visited Dec. 13, 2009).
[31] PA DEP, *DEP Fines Cabot Oil and Gas Corp. $56,650 for Susquenhanna County Spills,* PA DEP Daily News Releases, Oct. 22, 2009, http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5705 (last visited Dec. 13, 2009).
[32] PA DEP, *DEP Identifies Responsibility for Bradford Township Gas Migration/Water Supply Problems* PA DEP Daily News Releases, May 5, 2009, http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5494 (last visited Dec. 12, 2009).
[33] *Id.*
[34] *Id.*
[35] *Id.*

post a well permit. On March 20, DEP cited Schreiner for new over-pressured wells and failure to submit well records.[36]

D. Hamlin Township, McKean County, PA. In September 2007, a migration of natural gas caused "a change in water quality and a minor explosion in a community water well."[37] Additionally, combustible gas was discovered in several private water wells within Kushequa village.[38] The PA DEP determined through an investigation that a specific over-pressured gas well was the cause of the stray gas release.[39] Also, "additional production casing was placed in the suspect well to permanently resolve the problem."[40] The responsible party was issued a Consent Order and Civil Assessment and must plug 15 orphan wells adjacent to the affected water wells.[41] PA DEP has stated that "[a] small percentage of abandoned wells leak oil or acidic water from mines, which contaminates streams and drinking water supplies."[42]

E. Knox Township, Jefferson County, PA. On April 18, 2009, fugitive gas began escaping from a domestic drinking water well in Knox, PA.[43] An investigation ensued and the PA DEP also discovered combustible gas in an adjacent drinking water well.[44] The PA DEP believes that the likely cause of the fugitive gas migration is a recently drilled neighboring gas well.[45] The PA DEP is also investigating three additional reports of water quality issues that could be associated with the recent high-volume hydraulic fracturing activities in the area.[46]

F. Liberty Township, McKean County, PA. In January 2008, PA DEP responded to a complaint regarding fugitive gas in a domestic drinking water well in Liberty, PA.[47] Further investigation revealed that two nearby recently drilled gas wells were over-pressured, "exceeding the amount of allowable pressure on the casing seat."[48] The operator of the wells "placed packers and additional production casing . . . thereby eliminating pressure on the casing seat. The water well was aggressively pumped and over time the amount of combustible gas in the well bore decreased significantly."[49] When the amount of gas decreased to an allowable amount, the wells were brought back into production.[50]

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[36] *Id.*
[37] PA DEP DRAFT REPORT, *supra* note 5, at 4.
[38] *Id.*
[39] *Id.*
[40] *Id.*
[41] *Id.*
[42] PA DEP, *Governor Rendell Says PA Protecting Communities, Miners from Abandoned Oil, Gas Wells – Says $2.3 Million Will Plug 150 Abandoned Wells, Safeguard Public Health, Drinking Water,* PA DEP Daily News Releases, Sept. 19, 2007, http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=4748 (last visited Dec. 15, 2009).
[43] PA DEP DRAFT REPORT, *supra* note 5, at 4.
[44] *Id.*
[45] *Id.*
[46] *Id.*
[47] PA DEP DRAFT REPORT, *supra* note 5, at 5.
[48] *Id.*.
[49] *Id.*
[50] *Id.*

G. Hamlin Township, McKean County, PA. In June 2006 the PA DEP responded to two water quality and diminution complaints in Hamlin, PA.[51] It found that "a change in water quality was evident."[52] The PA DEP also noted that "over-pressured conditions" had been present at a recently drilled nearby gas well.[53] Subsequently, the operator drilled new drinking water wells for the impacted residents; however, gas was encountered during the drilling process.[54] When the operator then placed additional production casing into the gas well, the PA DEP noted a marked decrease in the amount of gas in the recently drilled water wells.[55] The problem has since diminished.[56]

H. Alexander Investigation, Washington County, PA. In September 2006, a migration of natural gas impacted several private drinking water supplies and surface soils in Washington County, PA.[57] PA DEP determined that a well that had been recently drilled using high-volume hydraulic fracturing had "communicated with [an] abandoned gas well."[58] As a result, the natural gas migrated to shallow groundwater and surface soils in the area.[59] Investigation by the PA DEP revealed that fracturing activity at the recently drilled well had "created [a] pathway to [the] abandoned well and [caused] further migration into the shallow groundwater system."[60]

I. Howe Township, Forest County, PA. In June 2005, stray natural gas entered two springs that serve as domestic water supplies to residents of Howe, PA.[61] The area has a long history of oil and gas drilling activity.[62] PA DEP discovered that the gas migration began close to the same time when two gas wells, located more that 3000 feet away, were being drilled using high-volume hydraulic fracturing.[63] According to the PA DEP, the "new gas wells are in regulatory compliance and additional measures were taken to prevent a gas migration."[64] All efforts to more definitively identify the cause of the migration have been unsuccessful.[65]

J. Monongahela River, TDS violations: On October 11, 2008 the PA DEP first determined that the levels of total dissolved solids ("TDS") in the Monongahela River exceeded federal and state water quality standards.[66] On October 22, 2008, the PA DEP announced that it would begin

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[51] PA DEP DRAFT REPORT, *supra* note 5, at 6.
[52] *Id.*
[53] *Id.*
[54] *Id.*
[55] *Id.*
[56] *Id.*
[57] PA DEP DRAFT REPORT, *supra* note 5, at 7-8.
[58] *Id.*.
[59] *Id.*
[60] PA DEP DRAFT REPORT, *supra* note 5, at 8.
[61] *Id.* at 12.
[62] *Id.*
[63] *Id.*
[64] PA DEP DRAFT REPORT, *supra* note 5, at 12-13.
[65] *Id* at 13.
[66] PA DEP, *Total Dissolved Solids in Monongahela River Drop Significantly Below State, Federal Limits*, PA DEP Daily News Releases, Jan. 21, 2009, http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5404 (last visited Dec. 12, 2009).

investigating the source of these "unusually high" levels of TDS.[67] In order to immediately address the problem, the PA DEP directed

> all sewage treatment plants accepting gas well drilling wastewater, and which discharge to the Monongahela River or its tributaries, to drastically reduce the volume of gas well drilling wastewater they accept to one percent of their daily flow. Currently gas well drilling wastewater constitutes up to 20 percent of those plants daily flow. The restrictions will reduce the volume of drilling wastewater treated by 90 to 95 percent.[68]

PA DEP traced the high TDS levels to "delivery of highly mineralized wastewater to municipal wastewater treatment plants from natural gas drilling operations."[69] A New York City DEP report noted that "[w]ater samples analyzed downstream of several wastewater treatment plant discharges in the Monongahela indicated TDS levels nearly twice the allowable limit and nearly five times average levels."[70]

On August 7, 2009, the PA DEP announced that TDS levels in the Monongahela River again exceeded drinking water quality standards.[71] And again on October 14, 2009, the PA DEP made the same announcement.[72]

K. Cogan House Township and Mifflin Township, Lycoming County, PA. On May 30, 2008 the PA DEP ordered Range Resources – Appalachia, LLC and Chief Oil and Gas, LLC to cease their surface water withdrawals from local streams due to violations of Pennsylvania's Clean Streams Law.[73] PA DEP's Regional Office Director stated that "[high-volume hydraulic fracturing] can often times consume millions of gallons of water. In the course of their operations, neither Range Resources nor Chief Oil and Gas have taken the necessary precautions to protect nearby streams from pollution or impairment during the drilling process."[74] The companies were within the jurisdiction of the Susquehanna River Basin Commission, and were required to obtain water withdrawal permits, but failed to do so.[75] The cease orders remain in effect until each company acquires all necessary permits.[76]

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[67] PA DEP, *DEP Investigates Source of Elevated Total Dissolved Solids in Monongahela River,* PA DEP Daily News Releases, Oct. 22, 2008, http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5337 (last visited Dec. 12, 2009).
[68] *Id.*
[69] NYCDEP RAPID IMPACT ASSESSMENT, *supra* note 17, at 54.
[70] *Id.*
[71] PA DEP, *DEP Detects Elevated Levels of Total Dissolved Solids in Monongahela River*, PA DEP Daily News Releases, Aug. 7, 2009, http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5619 (last visited Dec. 12, 2009).
[72] PA DEP, *DEP Detects Total Dissolved Solids Over Standards in Monongahela River*, PA DEP Daily News Releases, Oct. 14, 2009, http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5694 (last visited Dec. 12, 2009).
[73] NYCDEP RAPID IMPACT ASSESSMENT, *supra* note 17, at 55.
[74] PA DEP, *DEP Orders Partial Shutdown of Two Natural Gas Drilling Operations in Lycoming County* PA DEP Daily News Releases, May 30, 2008, http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5079 (last visited Dec. 12, 2009).
[75] *Id.* NYCDEP RAPID IMPACT ASSESSMENT, *supra* note 17, at 55.
[76] PA DEP, *supra* note 74.

L. Athens Township, Bradford County, PA. In January 2005, Columbia Natural Resources, LLC violated Pennsylvania environmental regulations when it failed to implement proper erosion and sedimentation control measures along a road it constructed in connection with its natural gas drilling activities.[77] This resulted in contamination of two waterways and a wetland in Athens, PA.[78] Columbia also filled a portion of the wetland without obtaining a permit from PA DEP, another violation.[79] On June 24, 2005, PA DEP fined the company $6,500 for its violations.[80]

M. Bainbridge Township, Geauga County, OH. On December 15, 2007 an explosion occurred inside a home in Bainbridge, OH.[81] Two residents in the home were not injured but the structure was damaged significantly.[82] After investigation, the Ohio Department of Natural Resources ("Ohio DNR") determined that nearby high-volume hydraulic fracturing operations, conducted by Ohio Valley Energy Systems Corp. ("OVESC"), caused the explosion.[83] According to an April 16, 2009 Order from the Ohio DNR, OVESC began drilling the English No. 1 natural gas well in the area on October 18, 2007.[84] The investigation further revealed that:

> Accumulation and confinement of deep, high-pressure gas in the surface-production casing annulus of the English No. 1 well, between November 16 and December 15, 2007, resulted in over-pressurization of the annulus. This over-pressurized condition resulted in the invasion, or migration of natural gas from the annulus of the well into natural fractures in the bedrock below the base of the cemented surface casing. This gas migrated vertically through fractures into the overlying aquifers, discharged or exited the aquifers through local water wells, and entered some inhabited structures in the area in varying concentrations through groundwater.[85]

In addition to the explosion, the drilling operations led to significant water contamination in the area. According to the Ohio DNR, this specific event contaminated "22 domestic and one public water supply."[86] A letter from the Ohio Department of Health regarding well sampling in

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[77] PA DEP, *DEP Fines West Virginia Company $6,500 For Environmental Violations in Bradford County* PA DEP Daily News Releases, June 24, 2005, http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=3503 (last visited Dec. 13, 2009).
[78] *Id.*
[79] *Id.*
[80] *Id.*
[81] Letter from John F. Husted, Chief of the Ohio Department of Natural Resources, Division of Mineral Resource Management (Aug. 28, 2008), *available at* http://www.dnr.state.oh.us/Portals/11/bainbridge/cover_letter.pdf. *See also* OHIO DEP'T OF NATURAL RES., DIVISION OF MINERAL RES. MGMT., REPORT ON THE INVESTIGATION OF THE NATURAL GAS INVASION IN BAINBRIDGE TOWNSHIP OF GEAUGA COUNTY OHIO 3 (2008), *available at* http://www.dnr.state.oh.us/Portals/11/bainbridge/report.pdf [hereinafter "REPORT ON BAINBRIDGE INVESTIGATION"].
[82] REPORT ON BAINBRIDGE INVESTIGATION, *supra* note 81, at 3.
[83] *See* Ohio DNR, Order by the Chief to Ohio Valley Energy Systems Corp., Apr.14, 2008, *available at* http://ohiodnr.com/portals/11/bainbridge/2009-order-by-chief.pdf. *See also* Ohio DNR, Order by the Chief to Ohio Valley Energy Systems Corp., Apr.16, 2008, *available at* http://ohiodnr.com/portals/11/bainbridge/2009-order-by-chief-2.pdf. *See also* REPORT ON BAINBRIDGE INVESTIGATION, *supra* note 81, at 3.
[84] ODNR, Order by the Chief to Ohio Valley Energy Systems Corp., Apr. 16, 2008, *supra* note 83, ¶ 2.
[85] *Id.* ¶ 4.
[86] REPORT ON BAINBRIDGE INVESTIGATION, *supra* note 81, at 4.

the area after the event stated that "of the 78 wells sampled, 45 had measurable levels of dissolved methane in the water. Many of the 78 wells sampled had iron, manganese, and less commonly aluminum and total dissolved solids, at levels exceeding U.S. EPA Secondary Maximum Contaminant Levels."[87] In response to this incident, the Ohio DNR directed OVESC to (i) remedy inadequate primary cementing of the production casing of English Well No. 1; (ii) isolate the deep high-pressure gas zones that were the source of the overpressurization of the aquifers; and (iii) eliminate the confinement of annular gas which caused the build-up of pressure.[88] The Ohio DNR's report on this event states that:

> [r]emedial cementing operations completed by OVESC in mid-December, 2007 have effectively isolated and sealed deep, high-pressure gas bearing zones. As a result, natural gas from deep formations can no longer migrate up the surface-production casing annulus of the English #1 well and migrate into local aquifers.[89]

N. Dunkard Creek, Monongalia County, WV. On September 1, 2009 a substantial fish kill in Dunkard Creek, along the West Virginia- Pennsylvania border, was reported to the West Virginia Department of Environmental Protection ("WV DEP").[90] According to PA DEP over "30 stream miles" in PA and WV were "impacted by a discharge, originating from West Virginia, and contains high levels of total dissolved solids (TDS)"; "at least 16 species of freshwater mussels and at least 18 species of fish were killed by this pollution event in Dunkard Creek."[91] Agencies in both West Virginia and Pennsylvania investigated the incident, which was traced to a bloom of golden algae in the creek.[92] The Creek is in a heavy oil and gas drilling area, and the WV DEP has received numerous complaints from residents who suspect that companies are illegally dumping oil and gas drilling waste into the waterway.[93]

III. Marcellus Shale Case Studies – Air and Soil Impacts.

A. McCalmont Township, Jefferson County, PA. In April 2008 PA DEP was informed of "a large fugitive expression" in Little Sandy Creek in McCalmont, PA.[94] Amounts of combustible natural gas were discovered in the basement of a nearby residence upon

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[87] Letter from Robert C. Frey, Ph.D., Chief of the Health Assessment Section of the Ohio Bureau of Environmental Health, Ohio Department of Health to Scott Kell, Deputy Chief of the Ohio Department of Natural Resources Division of Mineral Resource Management (Sept. 10, 2008), *available at* http://www.dnr.state.oh.us/bainbridge/tabid/20484/Default.aspx (last visited Dec. 16, 2009) and http://www.dnr.state.oh.us/Portals/11/bainbridge/10-31-08_resident_mailing_odh_letter.pdf (last visited Dec. 16, 2009).

[88] REPORT ON BAINBRIDGE INVESTIGATION, *supra* note 80, at 5.

[89] *Id.*

[90] News Release, WV DEP, DEP Actively Investigating Dunkard Creek Fish Kill (Sept. 21, 2009), *available at* http://www.wvdep.org/Docs/18246_Sept_21_2009_press_release.pdf.

[91] PA DEP, *DEP, Fish and Boat Commission Monitoring Dunkard Creek Fish Kill*, PA DEP Daily News Releases, Sept. 18, 2009, http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5671 (last visited Dec. 13, 2009).

[92] News Release, WVDEP, Update on Dunkard Creek Fish Kill Investigation (Oct. 5, 2009), *available at* http://www.wvdep.org/Docs/18245_October_5_2009_press_release.pdf. *See also* Patrick Campbell, WV DEP Presentation on "Dunkard Creek Aquatic Wildlife Kills, September, 2009" (Oct. 9, 2009) *available at* http://www.wvdep.org/Docs/18239_dunkardaqlkillpvc.pdf.

[93] PA DEP, *supra* note 90.

[94] PA DEP DRAFT REPORT, *supra* note 5, at 4.

investigation.[95] PA DEP determined that the gas was entering the house "through an un-sealed sump opening in the concrete floor of the basement."[96] Additionally, the investigation revealed "two recently drilled gas wells were over-pressured and were producing from different geologic strata."[97] PA DEP conducted isotopic analysis of the wells which indicated that one of the wells was the probable source.[98] The residence continued to be monitored and the amount of gas in the sump was determined to be decreasing.[99]

B. Dimock Township, Susquehanna County, PA. There have been two reports of "diesel fuel leaking from tanks at high-volume hydraulic fracturing drilling operations run by Cabot Oil & Gas Corp. near Dimock Township in northeastern Pennsylvania."[100] The first leak was caused by "a loose fitting on a tank and resulted in approximately 800 gallons of diesel entering a wetland located approximately 350 feet from the tank."[101] The second leak resulted in "approximately 100 gallons of diesel resulting in soil contamination."[102] PA DEP directed that the soil be removed and "indicated there was no suspected groundwater contamination."[103]

C. Millcreek Township, Erie County, PA. A gas migration episode in November and December of 2007 caused residents of Walnut Creek in Millcreek, PA to be evacuated from their homes for over two months.[104] Fugitive gas was discovered in the soil and "natural gas levels in and around homes . . . were found to be at explosive levels."[105] PA DEP investigations and isotopic analysis of the gas revealed that recently drilled gas wells in the area caused the migration.[106] PA DEP assessed a $32,000 civil penalty against First Alliance Church for this gas migration, which kept five families out of their homes for 39 days. First Alliance Church had hired a contractor to drill for natural gas on its property.[107]

IV. Marcellus Shale Case Studies – Permit/Regulatory Violations.

A. U.S. Energy Cease & Desist Order. On July 10, 2009, PA DEP issued a cease and desist order against U.S. Energy Development Inc. "for persistent and repeated violations of environmental laws and regulations."[108] The order prohibits U.S. Energy "from conducting all earth disturbance, drilling and hydro-fracturing operations."[109] The basis of the order is the

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[95] *Id.*
[96] *Id.*
[97] *Id.*
[98] *Id.*
[99] *Id.*
[100] NYCDEP RAPID IMPACT ASSESSMENT, *supra* note 17, at 54.
[101] *Id.*
[102] *Id.*
[103] *Id.*
[104] PA DEP DRAFT REPORT, *supra* note 5, at 5.
[105] PA DEP, *DEP Assesses Penalty for 2007 Gas Migration That Forced Evacuation in Erie County*, PA DEP Daily News Releases, July 8, 2009, http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5569 (last visited Dec. 13, 2009).
[106] PA DEP DRAFT REPORT, *supra* note 5, at 5-6.
[107] PA DEP, *supra* note 104.
[108] PA DEP, *DEP Orders U.S. Energy to Cease Drilling Operations Throughout Pennsylvania*, PA DEP Daily News Releases, July 10, 2009, http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5574 (last visited Dec. 12, 2009).
[109] *Id.*

company's 302 violations since August 2007, 197 of which remain unresolved.[110] The violations included "failure to implement measures to prevent accelerated erosion, unpermitted discharges, failure to restore well sites, encroachments into streams and wetlands without obtaining required permits, and failure to plug abandoned wells."[111] The cease and desist order was later lifted when a consent agreement was signed in which PA DEP assessed U.S. Energy a $200,000 civil penalty and required it to work under an environmental management plan.[112]

B. Revocation of Permits Issued to Ultra Resources Inc. and Fortuna Energy Inc. On October 28, 2009, PA DEP revoked three erosion and sedimentation control permits issued to Ultra Resources Inc. and Fortuna Energy Inc. because of technical deficiencies.[113] The deficiencies, namely the failure to provide for best management practices and some inaccurate calculations, were discovered after the permits had been approved.[114] The Chesapeake Bay Foundation challenged the permits, causing PA DEP to re-examine and subsequently revoke them.[115]

C. Synd Enterprises and Vertical Resources Cease & Desist Order. On December 12, 2006, PA DEP issued a cease and desist order to the owners of Synd Enterprises, Inc. and Vertical Resources.[116] The companies had "continued and numerous violations" of Pennsylvania law and had "shown a lack of ability or intention to comply with the provisions of the commonwealth's environmental laws."[117]. Additionally PA DEP sought civil penalties of $657,040 to perform cleanup activities and plug wells.[118] Among the violations cited in the order were "over-pressured wells that cause gas migration and contaminate groundwater; failure to implement erosion and sedimentation controls at well sites which has caused accelerated erosion; unpermitted discharges of brine onto the ground; and encroachments into floodways and streams without permits."[119]

On June 15, 2007, the PA DEP and Synd entered into a consent agreement whereby the owners of Synd had to pay a $400,000 civil penalty and "must refrain from owning or operating any future oil and gas operations in the commonwealth and must dissolve their other active companies here."[120]

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[110] *Id.*
[111] *Id.*
[112] PA DEP, *DEP Reaches Agreement with U.S. Energy*, PA DEP Daily News Releases, Aug. 12, 2009, http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5624 (last visited Dec. 12, 2009).
[113] PA DEP, *DEP Revokes Erosion and Sedimentation Control Permits for Two Gas Companies*, PA DEP Daily News Releases, Oct. 28, 2009, http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=5710 (last visited Dec. 12, 2009).
[114] *Id.*
[115] *Id.*
[116] PA DEP, *DEP Seeks $657,040 Civil Penalty Against New York Company For Environmental Damage in Allegheny National Forest*, PA DEP Daily News Releases, Jan. 11, 2007, http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=4367 (last visited Dec. 13, 2009).
[117] *Id.*
[118] *Id.*
[119] *Id.*
[120] PA DEP, *DEP Fines Oil and Gas Operator $400,000 For Violations*, PA DEP Daily News Releases, June 15, 2007, http://www.ahs2.dep.state.pa.us/newsreleases/default.asp?ID=4549 (last visited Dec. 13, 2009).

BARNETT SHALE CASE STUDIES

I. Introduction

The Barnett Shale is substantially similar geologically to the Marcellus Shale formation. The Barnett Shale underlies the cities of Dallas and Fort Worth and surrounding counties, covering approximately 5,000 square miles.[121] Because the Barnett Shale underlies the city of Fort Worth, Texas, the impact of drilling and exploration is felt somewhat differently than the effects of Marcellus drilling, which occurs in more rural areas. There are approximately 12,000 gas wells and 1,300 natural gas compressors operating in the Barnett Shale.[122] Since large-scale horizontal drilling began in the Barnett in 2002, there have been reports of water pollution, air pollution, geological disturbances, and impact on human health and wildlife linked to high-volume hydraulic fracturing drilling practices.[123]

II. Barnett Shale Case Studies – Water Impacts

A. City of Midland, Midland County, TX. In April 2009, a private well in Midland, Texas, was confirmed to be contaminated with fifty times the acceptable level of hexavalent chromium.[124] The Texas Commission on Environmental Quality (TCEQ) has tested about 240 wells and added filters to 42, where hexavalent chromium levels were found to exceed safe levels.[125] The source of this chromium-6 contamination has not been determined, but the TCEQ is investigating a link to natural gas drilling in the area.[126] Specifically, TCEQ made a connection to Schlumberger gas facilities in the area. In a press statement, the company denied that a source had been determined, but stated that the source was likely an adjacent operation. The TCEQ held public meetings in May and July 2009 to provide information on remediation to residents, but still has not identified a source.[127] The TCEQ has referred the area to the EPA for inclusion on the National Priorities List.[128]

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[121] Texas Commission on Environmental Quality, Barnett Shale Geological Area. http://www.tceq.state.tx.us/implementation/barnettshale (last visited Dec. 14, 2009).

[122] *Health Issues Follow Natural Gas Drilling in Texas*, NPR, Nov. 3, 2009. http://www.npr.org/templates/story/story.php?storyId=120043996 (last visited Nov. 13, 2009).

[123] Until recently, drilling in the Barnett Shale was limited to bigger regional and national energy companies. On December 14, 2009, Exxon Mobil Corp. announced that it would acquire Texas-based XTO Energy in a $31 billion deal. http://www.eenews.net/ew/2009/12/15/1 (last visited Dec. 15, 2009).

[124] *EPA grants extension for further testing of chromium contaminated area*, Midland Reporter-Telegram, Dec. 3, 2009. http://www.mywesttexas.com/articles/2009/12/03/news/top_stories/epa_grants_extension_for_testing_of_chromium.txt (last visited Dec. 16, 2009).

[125] Texas Commission on Environmental Quality, *Cleanup in Midland Couty: West County Road 112, Midland, TX,* http://www.tceq.state.tx.us/remediation/sites/cr112.html (last visited Dec. 16, 2009).

[126] Texas Commission on Environmental Quality, *West County Road-112 Groundwater Plume Midland County, Texas, Site Update September 2009*, http://www.tceq.state.tx.us/assets/public/remediation/variousremediationsites/westcr112/092409meeting.pdf (last visited Dec. 16, 2009).

[127] Texas Commission on Environmental Quality, *TCEQ Holds Public Meeting on Water Well Contamination*, http://www.tceq.state.tx.us/comm_exec/communication/media/05-09midlandmeeting.html (last visited Dec. 16, 2009); Texas Commission on Environmental Quality, *TCEQ Holds Public Meeting on Water Well Contamination*,

III. Barnett Shale Case Studies – Air Impacts

A. Town of DISH, Denton County, TX. Reports of human illness and animal deaths led the town of DISH, Texas to spend 15% of its $70,000 annual budget on an air quality study of the effects of gas wells and compressor stations within the town and just across town lines.[129] The study, conducted in August 2009 by an independent environmental consulting firm, found the "presence in high concentrations of carcinogenic and neurotoxin compounds in ambient air near and/or on residential properties."[130] The compounds found "were in excess of what would normally be anticipated in ambient air" in communities like these.[131] These compounds included benzene, xylene, carbon disulfide, napththalene, dimethyl disulphide, methyl ethyl disulphide, and pyridine metabolites.[132] Many of the compounds were found in levels that exceeded either short or long term Effects Screening Levels established by the TCEQ.[133]

B. Dallas-Fort Worth, Denton and Dallas Counties, TX. The Dallas-Fort Worth area has seen a dramatic impact on its air quality from natural gas drilling in the Barnett Shale. A report by Al Amendariz of Southern Methodist University, and now EPA Region 6 Regional Administrator, found that the pollutant emissions from natural gas drilling activities per day surpassed those produced by all of the vehicle traffic in the Dallas-Fort Worth region.[134]

In addition to the independent study undertaken by Dish, the Texas Commission on Environmental Quality (TCEQ) is conducting a large-scale air monitoring program.[135] The initial results of that study found benzene levels in the air around Forth Worth to exceed short-term limits. Because benzene is a human carcinogen and the Barnett Shale gas is thought to be fairly "dry" the excessive levels are alarming to regulators. While the TCEQ is continuing its monitoring, officials have referred the findings to the EPA. The TCEQ met with the eight biggest operators in the Barnett Shale, and asked them to

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http://www.tceq.state.tx.us/comm_exec/communication/media/06-09midlandchrome2.html (last visited Dec. 16, 2009).

[128] EPA, *Search Superfund Site Information, West CR 112* Groundwater, http://cfpub.epa.gov/supercpad/cursites/csitinfo.cfm?id=0606992 (last visited Dec. 16, 2009).

[129] *State Tests Air Around Drilling And Pipeline Sites,* KERA, *Oct. 14, 2009,* http://www.publicbroadcasting.net/kera/news.newsmain/article/0/1/1566121/North.Texas/State.Tests..Air.Around.Drilling.And.Pipeline.Sites (last visited Nov. 12, 2009).

[130] Wolf Eagle Environmental, *DISH Air Study Results*, Sept. 15, 2009 at 9, *available at*, http://www.townofdish.com/objects/DISH_Air_Study.pdf (last visited Nov. 12, 2009).

[131] *Id.*

[132] *Id.*

[133] *State Tests Air Around Drilling and Pipeline Sites,* KERA.

[134] Al Armendariz, *Emissions from Natural Gas Production in Barnett Shale Area and Opportunities for Cost-Effective Improvements*, Jan. 26, 2009, http://www.edf.org/documents/9235_Barnett_Shale_Report.pdf. (last visited Nov. 13, 2009).

[135] *Cancer-causing toxin found in air near gas facilities,* WFAA, Oct. 30, 2009. http://www.wfaa.com/sharedcontent/dws/wfaa/latestnews/stories/wfaa091029_mo_drilling.2669d39e4.html (last visited Nov. 13, 2009).

voluntarily reduce emissions from drilling operations after the TCEQ investigation found hydrocarbon vapors escaping from drilling machinery and storage tanks, and significant levels of benzene in some locations.[136] The TCEQ is expected to release the results of the study in late 2009 or early 2010.[137]

The TCEQ Toxicology Division issued a memo on October 27, 2009 reviewing the health effects documented in the DISH report.[138] The memo "strongly" recommended additional sampling in the area.[139] While the memo stated that the monitored concentrations of benzene in DISH did not exceed short-term limits, it also concluded that "the monitored concentrations of benzene at several of the sampling locations could pose a long-term health risk to residents if representative of normal and prolonged ambient conditions." [140]

The City of Fort Worth has been inquiring into the effects of drilling activity on the air quality around Forth Worth. Most recently, on December 8, 2009 the TCEQ and Fort Worth Department of Environmental Management presented information regarding ongoing investigative efforts to the Fort Worth City Council.[141]

IV. Barnett Shale Case Studies – Geological Impacts

A. City of Cleburne, Johnson County, TX. In addition to the effects on air quality and related health impacts, gas drilling in the Barnett has been linked to minor earthquakes in the Fort Worth region.[142] Since the beginning of 2008, the Dallas-Fort Worth area has experienced at least 18 earthquakes. In the town of Cleburne, less than thirty miles from Fort Worth.

At least seven earthquakes were documented in Cleburne alone between June and July 2009, with another possible earthquake reported on September 30, 2009. While a formal link has not been established, it is suspected that there is a link between disposing of gas drilling wastewater and the quakes.[143] The town of Cleburne had not registered an

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[136] *State worried about air pollution near Barnett Shale* wells, Fort Worth Star-Telegram, Nov. 22, 2009, http://www.star-telegram.com/804/story/1782464.html (last visited Nov. 22, 2009).
[137] *Id.*
[138] Texas Commission on Environmental Quality, *Health Effects Review of Ambient Air Monitoring Data Collected by Wolf Eagle Environmental Engineers and Consultants for DISH, TX,* October 27, 2009, http://www.tceq.state.tx.us/assets/public/implementation/barnett_shale/healthEffectsReview.pdf. (last visited Dec. 14, 2009).
[139] *Id.*
[140] *Id.*
[141] Fort Worth City Council, *Pre-Council Agenda*, Dec. 8, 2009. http://www.fortworthgov.org/council_packet/create_precouncil_agenda.asp?mode=V (last visited Dec. 14, 2009) Video of the meeting is available at http://fortworthgov.granicus.com/ViewPublisher.php?view_id=2 (last visited Dec. 15, 2009).
[142] *Is Drilling to Blame for Texas Quakes?,* NPR, June 30, 2009, http://www.npr.org/templates/transcript/transcript.php?storyId=106059425 (last visited Nov. 13, 2009).
[143] *Cleburne quakes probably related to gas drilling, expert says,* Dallas Morning News, June 8, 2009, http://www.dallasnews.com/sharedcontent/dws/dn/latestnews/stories/060909dnmetquakes.40620de.html (last visited Nov. 13, 2009).

earthquake in its 142-year history, prior to the June quakes.[144] A research team at Southern Methodist University is monitoring seismic activity around the Cleburne area. It is suspected that the quakes may be linked to the underground injection of wastewater from the hydraulic fracturing process. Chesapeake Energy closed two of its salt water disposal wells in the area after the quakes.[145]

[144] *Temblors Rattle Texas Town,* Wall Street Journal, June 12, 2009 http://online.wsj.com/article/SB124476331270108225.html. (last visited Nov. 13, 2009).

[145] *Chesapeake shuts two re-injection wells down as a precaution.* Cleburne Times-Review. Aug. 14, 2009, http://www.cleburnetimesreview.com/local/local_story_226123755.html. (last visited Nov. 13, 2009).

WYOMING AND COLORADO CASE STUDIES

I. Wyoming and Colorado Case Studies – Water Impacts

A. Pavillion, Fremont County, WY. In response to complaints of foul odors and taste in residential wells, EPA Region 8 funded an investigation into the source and nature of the contamination.[146] The report considered data collected from residential and municipal wells in Pavillion, Wyoming in March and May 2009. The report found heightened levels of hazardous contaminants in a number of drinking water wells, including the same chemicals used in a nearby hydraulic fracturing operation.[147] EPA found that oil and gas activity in the region was a potential source of contamination, and that the agency would be working with gas producer EnCana in the area to mitigate the effects of drilling on the water supply.[148] The Pavillion area is currently being considered for addition to the National Priorities List.[149]

B. Garfield County, CO. A report prepared for Garfield County, CO found a correlation between increased levels of methane and chloride in groundwater in areas proximate to gas drilling activity.[150] The report elaborated that the positive correlation between drilling activity and increased levels of dissolved methane in the groundwater suggested, "drilling and production activities are the cause."[151]

The Colorado Oil and Gas Conservation Commission (COGCC) reports an ongoing problem with ground water contamination in Garfield County.[152] The COGCC has required EnCana, the gas producer in that region, to remediate this contamination and provide quarterly reports on the state of the groundwater. The COGCC reports that methane and BTEX (benzene, toluene, ethylbenzene, and total xylenes) have been the principal forms of contamination. [153]

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[146] URS Operating Services, Inc., Site Inspection – Analytical Results Report, Pavillion Area Groundwater Investigation Site. CERCLIS ID# WYN000802735. Aug. 2009, http://www.earthworksaction.org/pubs-others/EPA_2009_Pavillion_Groundwater_Report.pdf (last visited Dec. 16, 2009).

[147] *Id.*

[148] EPA Region 8, *Pavillion Groundwater Investigation, Pavillion Wyoming, Phase I Sampling Results* (PowerPoint Presentation) Aug. 11, 2009, http://www.earthworksaction.org/pubs-others/EPA_2009_Pavillion_Groundwater.ppt (last visited Dec. 15, 2009).

[149] EPA, *Search Superfund Site Information, Pavillion Area Ground Water Study*, http://cfpub.epa.gov/supercpad/cursites/csitinfo.cfm?id=0802735 (last visited Dec. 16, 2009).

[150] Review of Phase II Hydrogeologic Study, Prepared for Garfield County. Geoffrey Tyne. Dec. 20, 2009. http://www.garfield-county.com/Index.aspx?page=1143 (last visited Dec. 15, 2009).

[151] *Id.*

[152] Colorado Oil and Gas Conservation Commission, *FY 2008-2009 Report to the Water Quality Control Commission and Watery Quality Control Division of the Colorado Department of Public Health and Environment*, Nov. 2009, http://cogcc.state.co.us/Library/WQCC_WQCD_AnnualReports/WQCC08_09RPT.pdf (last visited Dec. 16, 2009).

[153] *Id.*