



The Spreading Shadow of the Shale Gas Boom

**Fracking's Growing Proximity to
Day Cares, Schools and Hospitals**

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Fall 2013

Acknowledgments

PennEnvironment Research & Policy Center thanks Samantha Malone, MPH, CPH, FracTracker Alliance; and Celia Lewis, Ph.D., Research and Communications Consultant, Southwest Pennsylvania Environmental Health Project, for their insightful feedback on early drafts of this report. Additional thanks to the FracTracker Alliance for providing online data and visualizations of natural gas extraction impacts at www.fractracker.org. Tony Dutzik and Jordan Schneider at Frontier Group provided editorial assistance.

PennEnvironment Research & Policy Center thanks the Colcom Foundation and the Claneil Foundation for making this report possible. Additionally, Frontier Group thanks ESRI for granting the use of ArcGIS mapping software.

The authors bear responsibility for any factual errors. The recommendations are those of PennEnvironment Research & Policy Center. The views expressed in this report are those of the authors and do not necessarily reflect the views of our funders or those who provided review.

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Cover Photo: Mark Schmerling

Design and Layout: To the Point Publications, www.tothepointpublications.com

An earlier version of this report included data on compressor stations. Geocoded information on the location of those stations was gathered from the Pennsylvania Department of Environmental Protection. We have come to question the accuracy of that information and decided to remove it from our analysis.

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Executive Summary

Using “fracking,” gas companies are drilling near our communities, polluting our air and water, and risking the health of our children and other vulnerable populations. Fracking involves injecting water, sand and chemicals at high pressures deep into the earth, breaking up underground rock formations to release natural gas. Blowouts and fires can occur at well sites, and drilling and extraction can contaminate our air and water, putting the health and well-being of nearby residents at risk.

Gas drilling companies are rapidly working to exploit the resources found in the Marcellus and Utica shale formations, which extend beneath much of Pennsylvania, Ohio, New York, West Virginia and western Maryland. Gas companies have already drilled and fractured more than 10,000 wells in the region, and states are issuing permits for thousands more. **In this five-state region, permitted well sites exist within one mile of more than 400 day care facilities, schools and hospitals.**

To protect our states and our children, states should halt fracking.

Drilling companies are fracking for shale gas in close proximity to many vulnerable Pennsylvanians, Ohioans and West Virginians – with the potential to expand into other nearby states and more urban areas.

- Across the region, permitted fracking well sites exist within one mile of 190 day care facilities, 223 schools, and 5 hospitals. (See Figures ES-1 and ES-2.) The closest well sites are less than 1,000 feet from a day care or school. In Maryland and New York, which have not yet allowed fracking to begin

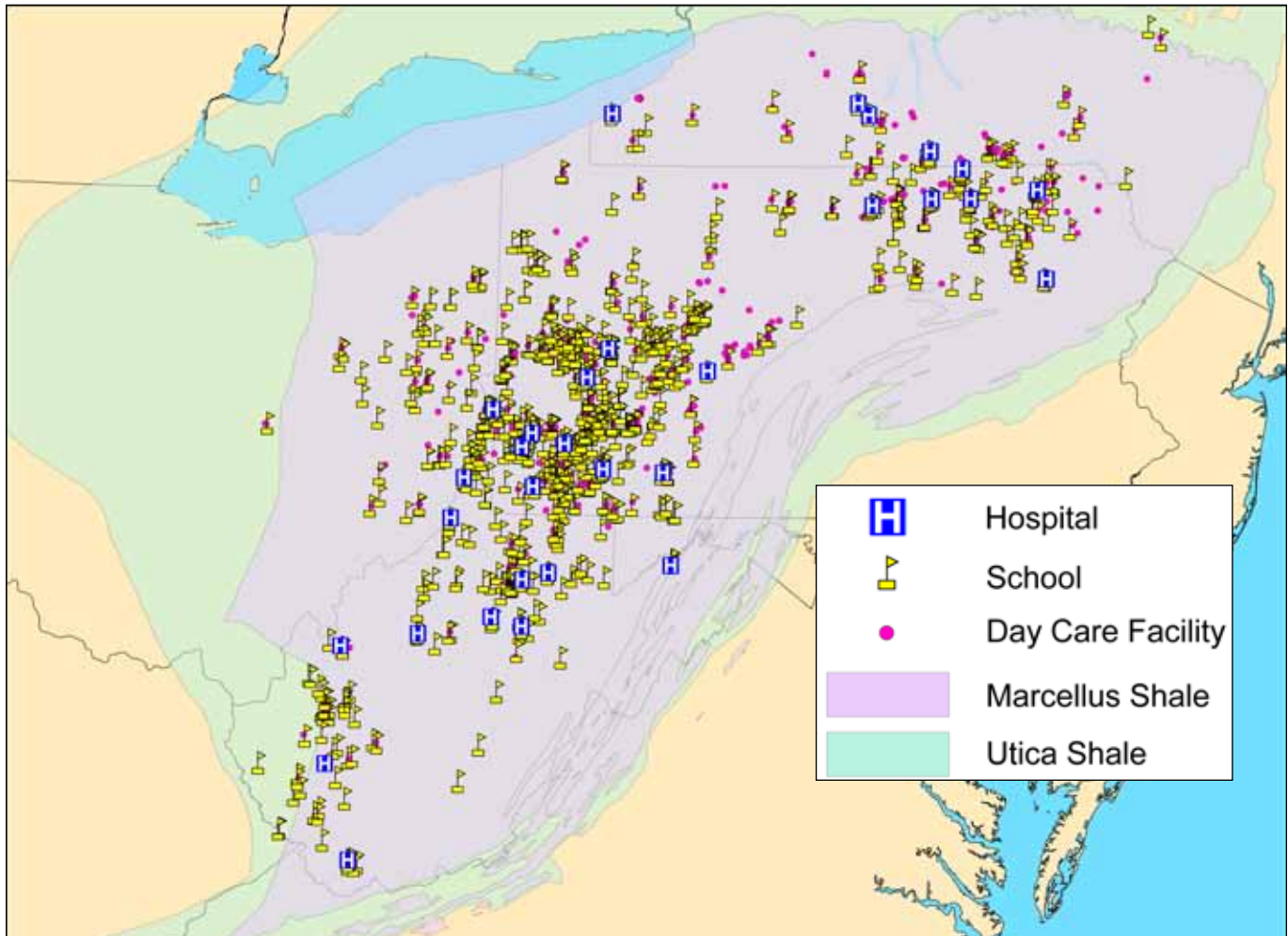
in earnest, more than 8,000 day cares, schools and hospitals overlie areas that could potentially be exploited for shale gas extraction.

- Between 2008 and May 2013, the Pennsylvania Department of Environmental Protection recorded more than 250 violations of regulations intended to protect public safety and the environment at fracking sites within one mile of a day care facility, school or hospital.

Drillers have rapidly expanded fracking and gas extraction efforts.

- Pennsylvania has issued more than 13,500 permits for fracking wells (as of May 2013). Since late 2010, the number of fracking permits issued in Pennsylvania has quadrupled. West Virginia has issued more than 3,200 permits. Ohio has issued nearly 700 permits, while also accepting more than 400 million gallons of drilling wastewater from neighboring states for underground injection disposal in 2012. While Maryland and New York are currently under a drilling moratorium, oil and gas drillers are working to gain access to shale gas deposits in these states.
- There are 60 percent more day care facilities located within one mile of a fracking well in Pennsylvania than there were in late 2010.
- The gas industry has projected drilling on the order of 60,000 new shale wells in Pennsylvania alone over the next two decades. Should this occur, gas extraction activity will move even closer to vulnerable populations across the region, putting more people at risk.

Figure ES-1: Hospitals, Schools and Day Care Facilities within Two Miles of a Permitted Well Site

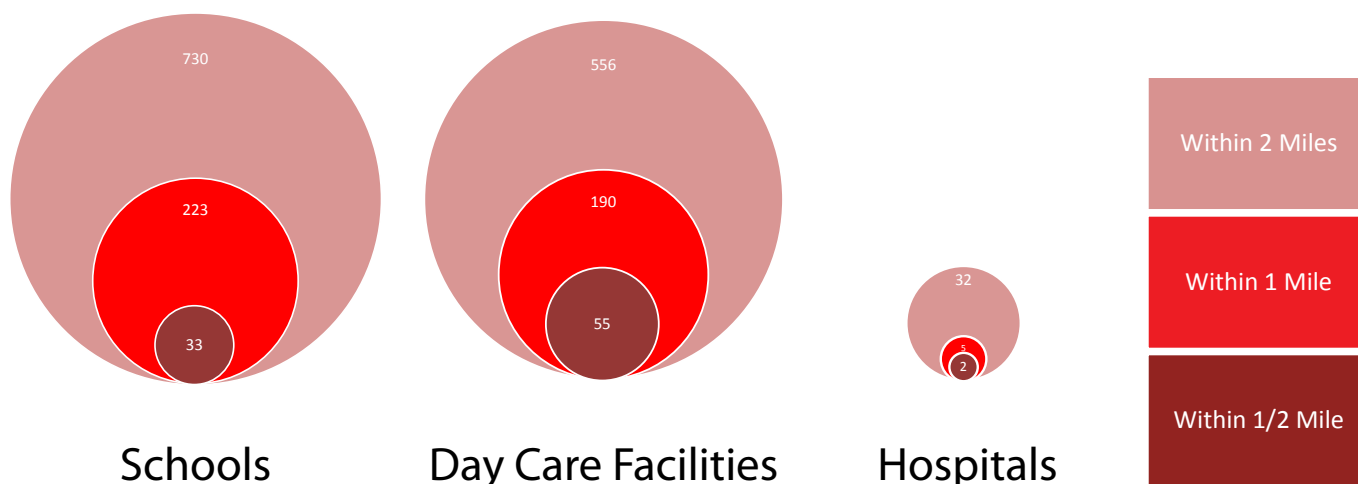


Note: Facilities shown in New York are near sites where oil and gas companies have applied for permits to drill a well into the Marcellus or Utica shales. Most of these sites have not been permitted or drilled yet, but could be if New York lifts its moratorium on fracking.

Fracking and related infrastructure jeopardize the health and safety of nearby residents, especially vulnerable populations.

- Residents living near fracking sites have long suffered from a range of health problems, including headaches, eye irritation, respiratory problems and nausea.
- Children are likely more vulnerable to the impacts of gas extraction because they are still developing. Moreover, they are more likely to play outside near areas that could be impacted by an accident. The elderly and the sick, meanwhile, have fewer defenses against pollution.

Figure ES-2: Proximity of Vulnerable Populations to Permitted Well Sites



The area of the circle is proportional to the number of facilities within the specified distance of a permitted fracking well.

Fracking increases health and safety risks, including truck accidents on nearby roads and fires at well sites.

- Fires at well sites can present an immediate safety threat to nearby residents, occasionally resulting in evacuations of homes and businesses.
- Fracking requires increased truck traffic, which in turn raises the risk of accidents. In the northern tier of Pennsylvania, developing each fracking well requires approximately 400 truck trips for the transport of water and chemicals, and 25 rail cars' worth of sand.
- Fracking sites also create noise and light. Excessive noise exposure can disturb sleep patterns and increase the risk of high blood pressure, heart attacks and strokes. Excessive light is associated with sleep disturbances and depression.

Fracking brings with it the potential for spills, blowouts and well failures that contaminate groundwater supplies.

- According to analysis of Pennsylvania Department of Environmental Protection (PA DEP) records by the *Scranton Times-Tribune*, oil and gas development damaged the water supplies for at least 161 homes, farms, churches and businesses in the state between 2008 and the fall of 2012. In one case, PA DEP found drillers responsible for contamination of the water supply of a home that was 600 feet away from a well.
- Studies in Pennsylvania have found elevated levels of methane and ethane in drinking water wells within one kilometer (0.6 miles) of a well site, suggesting that pathways exist for contaminants to travel underground – whether through faulty well construction, conduits created by drilling, or through fractures in rock created or expanded by the fracturing process.

- Disposal of fracking wastewater into injection wells – common in eastern Ohio – can also cause drinking water contamination. Nationally, routine testing of injection wells in 2010 revealed that 2,300 failed to meet mechanical integrity requirements established by the U.S. Environmental Protection Agency to prevent contaminants from leaking out.
- Fracturing fluid can contain toxic chemicals including benzene and toluene. Fracking wastewater also contains naturally occurring metals and salts, including arsenic, barium, chromium, lead, strontium and radioactive materials such as radium. These substances pose risks for acute and chronic health impacts, from dizziness to rashes to cancer.

Fracking creates health-threatening air pollution.

- Fracking produces a variety of pollutants that contribute to local and regional air pollution problems. Volatile compounds in natural gas formations and diesel engine exhaust contribute to soot and smog pollution, which reduces lung function among healthy people, triggers asthma attacks, and has been linked to increases in school absences, hospital visits and premature death.
- Fracking also creates hazardous air pollutants, which have been linked to cancer and other serious health effects. Studies have found elevated levels of benzene, toluene and other gases in the

air of communities within a half mile of a well site or associated infrastructure. Toxic emissions can come from the well site itself, from natural gas compressor stations, from the production of fracturing fluid, or from flaring off excess gas.

States and local governments should halt fracking operations.

- As there is currently no proof that drilling companies will operate without contaminating our drinking water, threatening our safety, damaging our forests and parks, and polluting our air, state and local governments should stop further fracking operations.
- New York and Maryland should maintain their existing moratoria on fracking and ban the practice altogether.
- Federal law exempts gas extraction and aspects of wastewater disposal from regulation under key elements of the Resource Conservation and Recovery Act, the Safe Drinking Water Act, the Clean Air Act, the Clean Water Act, and the National Environmental Policy Act. The federal government should apply the nation's core public health and environmental laws to gas extraction just as it would regulate any potential threat to public health or the environment. In particular, wastewater from fracking should be regulated under the same rules that apply to hazardous waste produced by other industries.

Defining “Fracking”

In this report, when we refer to the impacts of “fracking,” we include impacts resulting from all of the activities needed to bring a well into production using hydraulic fracturing, to operate that well, and to deliver the gas or oil produced from that well to market. The oil and gas industry often uses a more restrictive definition of “fracking” that includes only the actual moment in the extraction process when rock is fractured – a definition that obscures the broad changes to environmental, health and community conditions that result from the use of fracking in oil and gas extraction.

Introduction

“Fracking” operations pose a staggering array of threats to our environment and health – contaminating drinking water and harming the health of nearby residents – especially for the most vulnerable among us: our children and our elderly.

People who live in areas with heavy fracking activity often report impacts including contaminated water, strange odors, increased stress and deteriorating health.¹ One survey of residents in Pennsylvania found that people spending time in close proximity to fracking well sites or related infrastructure (such as a natural gas compressor station or a waste pit), reported higher rates of poor health symptoms, including increased fatigue, respiratory irritation, burning eyes, headaches, nausea and sleep disturbance.² Three-quarters of respondents reported throat irritation when living less than 500 feet from fracking infrastructure. Almost two-thirds reported the same symptom at between 500 and 1,500 feet, and more than a quarter at between 1,500 and 4,000 feet. More than half of responding children under age 16 living within 1,500 feet of fracking facilities reported frequent nosebleeds.³

Stories of sick families are becoming all too common across fracking-heavy Pennsylvania, Ohio and West Virginia, where the oil and gas industry has moved rapidly since 2007 to exploit previously inaccessible gas deposits found in the Marcellus and Utica shale formations. And they could become more common in New York and Maryland, where state governments have imposed short-term moratoria on fracking while evaluating its potential impacts.

In this report, we explore how close fracking is happening to the most vulnerable among us, including children and the sick. We explore how rapidly the gas boom has expanded, and how close permitted well sites are to day care facilities, schools and hospitals.

With every passing day, fracking wells move closer to the places where we live and play, putting more people at greater risk. As there is currently no proof that drilling companies will operate without contaminating our drinking water, threatening our safety, damaging our forests and parks, and polluting our air, state and local governments should stop further fracking operations.

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A gas flare near a home in Hickory, Pennsylvania.

Fracking Jeopardizes the Health and Safety of Nearby Residents, Especially Vulnerable Populations

Gas drillers are engaged in the equivalent of a 21st century gold rush. Fracking – the combination of hydraulic fracturing and horizontal drilling – has enabled gas companies to exploit the extensive natural gas deposits in the Marcellus and Utica shale rock formations that underlie much of New York, Pennsylvania, Ohio, Maryland, Virginia and West Virginia. Companies have already drilled or deepened more than 10,000 fracking wells.⁴

A fracking operation is an intense, polluting industrial activity. It involves drilling machinery powered by diesel fuel, trucks hauling millions of gallons of chemical solutions and wastewater, waste storage ponds, and new infrastructure such as gas compressor stations and pipelines. Communities typically aim to site day care facilities, schools, hospitals and homes away from busy industrial zones. However, with fracking, such activity often happens in close proximity to vulnerable people.

Fracking operations can cause blowouts and fires. They can pollute local water supplies with toxic chemicals, or with radioactive minerals dislodged from deep underground. They create air pollution through emissions from diesel engines, evaporation from chemical ponds, and flaring of gas. These impacts threaten public health – and especially the health of vulnerable children, sick people and the elderly, who have fewer defenses against exposure to pollution.

Fracking Has Spread Rapidly in the Marcellus and Utica Shales

The natural gas-rich Marcellus Shale underlies southern New York, the northern and western halves of Pennsylvania, eastern Ohio, West Virginia, and western Maryland at depths of 5,000 to 9,000 feet.⁵ The deeper and older Utica-Point Pleasant Shale lies beneath the Marcellus Shale.

For years, fossil fuels in the Marcellus and Utica shales were presumed to be inaccessible. Over the past decade, however, rising gas prices and the marriage of two previously existing technologies – horizontal drilling and hydraulic fracturing – have enabled the gas industry to tap fossil fuels locked in previously difficult-to-reach rock formations.

This practice – commonly referred to as fracking – widens cracks in the shale, allowing gas trapped there to escape and flow into the well. First, a drilling company drills a vertical well into the shale formation. Then, drilling operators cut horizontal branches into the shale, radiating outward as much as 5,000 feet to reach sections of rock away from the central well and increase the ability of the well to produce gas.⁶

Once the wells are drilled, operators pump water containing sand and a mixture of chemicals into the ground at high pressure. The water forces its way

into cracks in the rock, widening them, and the sand holds those cracks open wide enough for gas to escape. After drilling a well, operators can repeat the process of hydraulic fracturing to boost gas production anywhere from a year to 10 years after the well begins operation.⁷

The oil and gas industry has moved quickly to develop the Marcellus Shale. The industry has already drilled more than 10,000 fracking wells, and states are issuing permits for thousands more.⁹

Gas drilling companies drilled the first test well into Marcellus Shale in 2004.¹⁰ Gas extraction began in earnest in 2007. Since 2007, Pennsylvania has issued more than 13,500 permits for fracking wells.¹¹ Figure 1 shows the cumulative progression of fracking permits in Pennsylvania over time.

West Virginia has issued more than 3,200 drilling permits.¹³ Ohio has issued nearly 700 permits. While Maryland and New York are currently under a drilling moratorium, hundreds of thousands of people live in areas overlying the gas-bearing Marcellus and Utica shale formations. (See Figure 2, page 12.)

The shale gas industry anticipates drilling tens of thousands of new fracking wells across the region in the coming decades. In New York, the industry could deploy up to 56,000 horizontal wells.¹⁴ Pennsylvania could see up to 60,000 Marcellus wells drilled from as many as 15,000 well pads.¹⁵

Drilling in the Utica-Point Pleasant Shale in eastern Ohio began in 2010.¹⁶ By May 2013, Ohio had permitted more than 600 fracking wells in the Utica shale, and more than 300 had been drilled.¹⁷

Figure 1: The Shale Gas Boom: Cumulative Fracking Well Permits Issued in Pennsylvania as of May 2013¹²

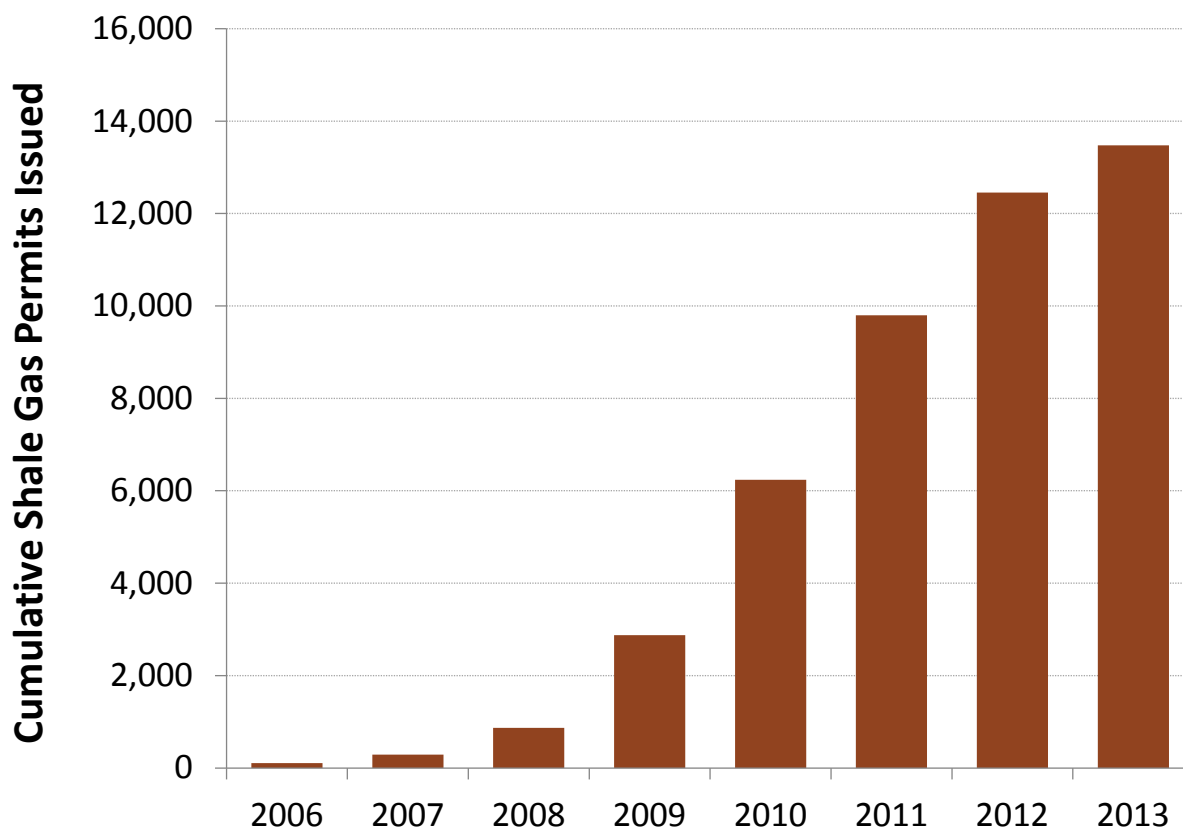
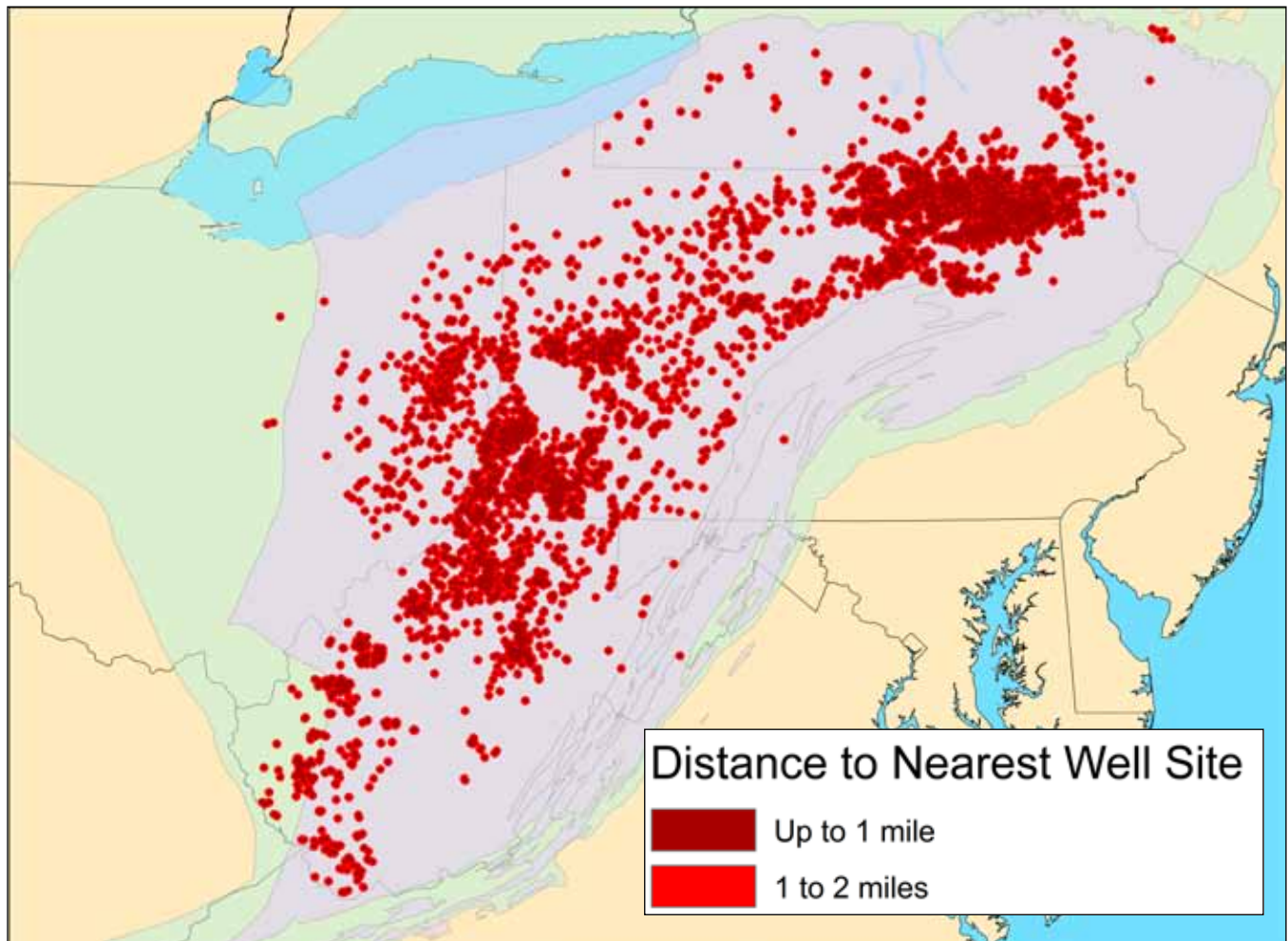


Figure 2: Locations of Permitted Fracking Well Sites in the Marcellus and Utica Shale Region



Note: Well sites shown in New York represent locations where companies have applied for permits to drill a well into the Marcellus or Utica shales. Most of these sites have not been permitted or drilled yet, but could be if New York lifts its moratorium on fracking.

Fracking Exposes Nearby Residents to Pollution and Safety Risks

Extracting gas or oil from shale deposits poses significant risks to public health and safety near well sites. Fires, truck traffic and noise can affect people close to the fracking site, while water contamination and air pollution present a more widespread danger.

Accidents at a well site immediately threaten the well-being of anyone in the area. Spills or leaks can contaminate groundwater supplies with chemicals used in hydraulic fracturing fluid, or with naturally occurring toxic metals, hydrocarbons and salts from the shale formation.

Exhaust from thousands of trucks and diesel-fueled equipment operating 24 hours a day, smoke from

flares or fires – plus hazardous chemicals evaporating from the well, from wastewater, or from gas processing or transport equipment – could contaminate local areas with unhealthy levels of air pollution.

Residents living near fracking sites have long suffered from a range of health problems, including headaches, eye irritation, respiratory problems and nausea. Children are likely more vulnerable to the impacts of gas extraction because they are still developing. Moreover, they are more likely to be outside playing near areas which could be impacted by an accident. The elderly and the sick, meanwhile, have fewer defenses against pollution exposure.

Safety Risks from Fires, Traffic and Noise

Fires from Well Blowouts

Blowouts are the uncontrolled release of gas, oil or water from a well. Skip Roupp, the Deputy Emergency Management Director of Bradford County in northeastern Pennsylvania, told National Public Radio that experts expect one blowout for every 1,000 wells drilled.¹⁸

Blowouts can result in fires, creating an immediate health threat for anyone in the area – including burns, smoke inhalation or exposure to especially high concentrations of air pollution. Several high-profile blowouts and fires in the past several years illustrate the risk.

Defining “Fracking”

Public debates about fracking often descend into confusion and contradiction due to a lack of clarity about terms. To the oil and gas industry, which seeks to minimize the perceived impacts, “fracking” refers only to the actual moment in the extraction process where rock is fractured by pumping fluid at high pressure down the well bore. Limiting the definition of fracking in this way also allows the oil and gas industry to use its long history of hydraulic fracturing in traditional, vertical wells – a process with fewer impacts than the technology being used in oil and gas fields today – to create a false narrative about the safety of fracking. It is only according to this carefully constructed definition that ExxonMobil CEO Rex Tillerson could say, as he did in a Congressional hearing in 2011, that “[t]here have been over a million wells hydraulically fractured in the history of the industry, and there is not one, not one, reported case of a freshwater aquifer having ever been contaminated from hydraulic fracturing.”⁸

Just as only a small portion of an iceberg is visible above the water, only a small portion of the impacts of fracking are the direct result of fracturing rock. Each step in the process of extracting oil or gas from a fracked well has impacts on the environment, public health and communities. Thus, any reasonable assessment of fracking **must** include the full cycle of extraction operations before and after the moment where rock is cracked open with fluid under high pressure.

In this report, when we refer to the impacts of “fracking,” we include impacts resulting from all of the activities needed to bring a well into production using hydraulic fracturing, to operate that well, and to deliver the gas or oil extracted from that well to market.



Fracking increases truck traffic to haul water, sand and chemical additives, as these trucks are doing.

- In July 2013, an explosion occurred at a well site in West Virginia, injuring at least seven people, including four workers with potentially life-threatening burns. Pat Heaster, the local county director of emergency services, told the *Charleston Gazette* that tanks for storing flowback water from the fracking process exploded.¹⁹
- A March 2013 blowout in Washington Township, Wyoming County, Pa., released natural gas and hundreds of thousands of gallons of wastewater. Authorities, worried about a potential explosion, evacuated nearby houses until Carrizo Oil and Gas could control the well.²⁰
- In April 2011, a well on the Morse Farm in Leroy Township, outside Canton in Bradford County, Pa., blew out during the hydraulic fracturing process. The well, owned by Chesapeake Energy, spilled thousands of gallons of chemicals, contaminating nearby farm fields and Towanda Creek, a tributary of the Susquehanna River. Emergency officials evacuated at least seven families.²¹

- In April 2010, a tank and open pit storing waste fluid in Hopewell Township, Washington County, Pa., caught fire, sending flames 100 feet into the air and spewing a plume of black smoke across the countryside. Kyle Lengauer, a nearby resident, told the *Pittsburgh Post-Gazette* that the explosion came after days of smelling gas odors. “We actually left our house on Sunday because the fumes were so bad and we were so nauseated,” he said.²²
- Out of 7,000 wells drilled in Texas from 2006 to mid-2011, 127 wells blew out, resulting in fourteen fires, three deaths and 14 injuries.²³

Explosions also can happen at other steps in the natural gas extraction process. For example, a compressor station that moves natural gas in pipelines in Susquehanna County, Pa., exploded in March 2012. The explosion damaged the building housing the compressor and rattled homes up to a half mile away.²⁴

Truck Traffic

Fracking requires the transportation of massive amounts of water, sand and chemicals to and from well sites. In the northern tier of Pennsylvania, developing each fracking well requires approximately 400 truck trips for the transport of water and chemicals and 25 rail cars’ worth of sand.²⁵ Increased traffic volume leads to more accidents – and resulting injuries or deaths.²⁶

Noise and Light

Fracking turns quiet rural communities or plots of land into small industrial zones. Well construction, drilling, fracking and the ongoing operation of machinery generate significant levels of local noise and light.

Excessive amounts of noise can harm nearby residents. Possible impacts include high blood pressure, interrupted sleep, cognitive impairment and increased risk of cardiovascular health events such

as strokes or heart attacks.²⁷ Unnatural levels of light, which can accompany a nearby 24-hour-a-day drilling operation, can disrupt peoples' natural biological rhythms. Such disruptions are linked to diseases ranging from sleep disturbances to depression. Long-term disruption can contribute to cardiovascular disease and cancer.²⁸

Drinking Water Pollution

Fracking can pollute both groundwater and surface waterways such as rivers, lakes and streams. In rural areas, where the bulk of fracking takes place, residents may rely on groundwater for household and agricultural use.

According to analysis of Pennsylvania Department of Environmental Protection (PA DEP) records by the *Scranton Times-Tribune*, oil and gas development damaged the water supplies for at least 161 homes, farms, churches and businesses in the state between 2008 and the fall of 2012. In one case, PA DEP found drillers responsible for contamination – including barium, strontium, salts and methane gas – in the water supply of a home that was 600 feet away from a well. Barium levels rose to more than 20 times higher than the safe level set in drinking water regulations.²⁹

Another analysis by Dr. Robert Jackson at Duke University and his colleagues found that Pennsylvania residences within 1 kilometer (about 0.6 miles) of a well site were more likely to be contaminated with methane and ethane gas potentially related to drilling. Homes within 1 kilometer of wells had methane and ethane levels that were six and 23 times higher than homes further away, respectively.³⁰

Fracking has polluted drinking water sources in a variety of ways.

- Spills and well blowouts have released fracking chemicals, flowback or produced water (water already in the shale) to groundwater and surface water.³¹

- Waste pits containing flowback and produced water have frequently failed.³²
- Faulty well construction has caused methane and other substances to find their way into groundwater.³³

Recent studies have suggested that fracking may also pose a longer-term threat of groundwater contamination. One study used computer modeling to conclude that natural faults and fractures in the Marcellus Shale region could accelerate the movement of fracking chemicals – possibly bringing these contaminants into contact with groundwater in a matter of years.³⁴ In addition, a recent study by researchers at Duke University found evidence for the existence of underground pathways between the Marcellus Shale and groundwater supplies closer to the surface.³⁵

Potential Contaminants

Gas extraction from shale deposits can contaminate water supplies with pollutants including methane gas, drilling fluid, hydraulic fracturing fluid, or naturally occurring contaminants forced up through the well. Many of these substances have toxic properties and can cause both acute and long-term health impacts.

Chemicals Added to Hydraulic Fracturing Fluid

Drilling companies have used more than 600 different chemicals in fracturing fluid.³⁶

In general, fracturing fluid used in the Marcellus contains about 84 percent water, 15 percent sand and 1 percent chemical additives, by weight.³⁷ Although the chemical additives are a relatively small fraction of the fracturing fluid by volume, this still represents a large amount of chemicals due to the significant volumes of water needed for fracturing. A well that requires 3 million gallons of fluid would require on the order of 250,000 pounds of chemicals.³⁸ Drilling

as many as 60,000 Marcellus wells could require more than 10 billion pounds of chemicals.

The chemical additives give the fluid the ability to carry grains of sand deep into cracks in the shale, propping open fractures. In response to requests from New York state regulators, a subset of gas drilling companies submitted a list of 235 different chemicals that can be used in fracturing additives to the state Department of Environmental Conservation.³⁹ These chemicals include toxic solvents such as benzene, toluene and xylene. A searchable database of what chemicals were used in which wells is available at fracfocus.org, although reporting by industry is voluntary.

Doctors and health scientists have associated many of these pollutants with a wide variety of acute illnesses and long-term diseases, including cancer, asthma and problems with the liver, kidney or central nervous system.⁴⁰ Evolving understanding of long-term exposure to small amounts of these types of contaminants suggests that contaminants from gas extraction could have serious impacts on public health, especially near well sites.⁴¹

Little information is available on the toxicity of many fracking chemicals, particularly at prolonged exposure to combinations of chemicals at low levels of exposure, as would be caused by contamination of an aquifer used for drinking water.

Naturally Occurring Contaminants

After the pressure of hydraulic fracturing is released on a well in the Marcellus formation, on the order of 9 to 35 percent of the fracturing fluid flows back up to the surface – totaling between 200,000 and 2.7 million gallons per well.⁴² In Pennsylvania, fracking produced 830 million gallons of waste water in 2011, a 570 percent increase from 2004.⁴³ In addition to fracturing chemicals, this fluid can contain salt and other substances from the rock formation that have

been liberated by the drilling and fracturing process, plus the results of any chemical reactions happening in the well. Waste fluid can contain radioactive minerals as well.

These contaminants can include:

- **High levels of salt.** The Marcellus and Utica-Point Pleasant shales developed from an ancient ocean. The process of hydraulic fracturing causes high levels of salt to mobilize in the fracturing fluid.
- **Heavy metals.** An analysis of flowback water from wells in Pennsylvania and West Virginia found a variety of hazardous metals, including arsenic, antimony, barium, cadmium, chromium, cobalt, copper, iron, lead, molybdenum, nickel, silver, strontium, thallium and titanium.⁴⁴ Arsenic causes cancer.⁴⁵ Very low levels of lead exposure have been linked to kidney damage, learning difficulties, mental and physical developmental problems and behavioral changes.⁴⁶
- **Hydrocarbons.** Shale deposits can sometimes contain hydrocarbons heavier than methane, including benzene, toluene, ethylbenzene and xylene, chemicals associated with cancer and other serious health problems.⁴⁷
- **Radioactive elements.** Flowback water samples from several Marcellus wells in Pennsylvania and West Virginia all contained radioactive components, including radium.⁴⁸ According to reporting by *ProPublica*, samples drawn from test wells in New York showed radium levels “as high as 267 times the limit safe for discharge into the environment and thousands of times the limit safe for people to drink.”⁴⁹ Long-term exposure to even low levels of radioactivity can increase the odds of developing cancer. Pennsylvania has recently announced it will undertake a year-long study of radioactive waste from fracking.⁵⁰

How Contaminants Reach Water Supplies

Contaminants can reach water supplies through faulty well construction, through surface spills, through improper wastewater disposal, or potentially through migration from the shale layer itself.

Faulty Well Construction or Abandoned Well Shafts

Shale deposits lie thousands of feet beneath the surface. Wells drilled to reach shale formations pass through a layer of earth that contains aquifers, or underground reservoirs of water, in the first thousand feet. Many people rely upon these underground supplies for drinking water – especially in rural areas, where municipal water supplies may not be available.

Drilling a well creates a conduit that could carry contaminants into groundwater. Gas drilling companies use metal casing pipes and cement to line wells. The casing pipes are intended to isolate the well from non-gas bearing rock layers and allow gas and fluids to pass into or out of the well without contaminating drinking water supplies.

If the well casings do not function properly, fracturing fluid and water in the shale formation could contaminate groundwater supplies. During fracturing, operators increase the pressure inside the well to as high as 10,000 pounds per square inch – pressure that could force contaminants through any improperly sealed gaps in the casing.⁵¹ After fracturing, the pressure of the earth could potentially force anything in the well up into groundwater layers through any poorly sealed gaps in the casing.

According to analysis by the group Physicians, Scientists and Engineers for Healthy Energy, about six to seven percent of new wells drilled in Pennsylvania from 2010 through 2012 were structurally unsound.⁵²

Finally, gas could be traveling underground through natural cracks or aquifers. For example, in one

case, experts at Isotech Laboratories documented that gases that led to an explosion at a business in Hutchinson, Kansas, were from a gas storage well that was seven miles away.⁵³

Surface Contamination at the Well Site

Spills caused by tank ruptures, wastewater impoundment failures, overfills or accidents – or by sloppy handling of dangerous substances – can contaminate nearby soils, groundwater, streams or wetlands. States have documented hundreds of instances of water contamination resulting from surface spills at gas well sites.⁵⁴ For example:

- From May to December 2009, Atlas Resources spilled fracturing fluid and other pollutants at 13 wells, prompting an \$85,000 fine from the Pennsylvania Department of Environmental Protection.⁵⁵
- Workers emptying wastewater from a holding pond in Butler County, Pa., spilled approximately 840 gallons on the ground, triggering a notice of violation from the state Department of Environmental Protection.⁵⁶
- In November, 2009, Talisman Energy spilled more than 4,000 gallons of contaminated flowback water from a hydraulic fracturing operation into a tributary of Weiber Creek in Bradford County, Pa.⁵⁷
- In September 2009, Cabot Oil and Gas caused three spills in Dimock Township, Pa., in less than a week, dumping 8,000 gallons of fracturing fluid components into Stevens Creek and a nearby wetland.⁵⁸
- In May 2010, a fracturing wastewater pit owned by East Resources leaked into a farm field. The Pennsylvania Department of Agriculture quarantined 28 cattle exposed to the fluid to prevent any contaminated meat from reaching the market.⁵⁹

Ohio's Injection Wells Increase Safety and Water Pollution Risks for Nearby Communities

Safety risks and water contamination can also occur in the immediate vicinity of wastewater injection wells.

Ohio accepts shipments of drilling wastewater from neighboring states for disposal in one of 179 underground injection wells. In 2012, Ohio accepted more than 400 million gallons of wastewater for injection disposal, more than half from Pennsylvania and West Virginia.⁶⁰ Wastewater disposal volume doubled between 2006 and 2011.⁶¹ State regulators are permitting the construction of more injection wells, which will enable Ohio to accept greater volumes of wastewater.⁶²

Documented problems with injection wells include:

- Injection wells can cause earthquakes. For example, on New Year's Eve in 2011, a 4.0 earthquake shook Youngstown, Ohio. Seismic experts at Columbia University determined that fluid or pressure from the injection well affected a nearby underground fault.⁶³ With the rise of fracking in 2007 in the northeastern United States, wastewater volumes have increased. At the same time, the number of earthquakes in the central United States, where injection well disposal is common, has increased by more than 1,100 percent compared to earlier decades.⁶⁴ Scientists at the U.S. Geological Survey have concluded that humans are likely the cause.⁶⁵ After reviewing data on the Oklahoma quake, Dr. Geoffrey Abers, a seismologist at the Lamont-Doherty Earth Observatory, concluded that, "the risk of humans inducing large earthquakes from even small injection activities is probably higher" than previously thought.⁶⁶ Earthquakes triggered by injection well wastewater disposal have happened in Oklahoma, Arkansas, Texas, Ohio and Colorado, with the earliest happening in the 1960s. The largest quake likely related to injection well activity – a magnitude 5.7 temblor in Oklahoma that happened in 2011 – injured two people, destroyed 14 homes and buckled highways.⁶⁷ Scientists determined that the initial trigger point for the quake was within 200 meters of active injection wells.⁶⁸
- Fluid pumped into injection wells could contaminate drinking water supplies, especially if the well infrastructure fails. For example, a disposal well in Bell Township, Clearfield County, Pa., lost mechanical integrity in April 2011, but the operator, EXCO Resources, continued to inject fracturing wastewater into the well for another five months.⁶⁹ The U.S. EPA fined the company nearly \$160,000 for failing to protect drinking water supplies. Nationally, routine testing of injection wells in 2010 revealed that 2,300 failed to meet mechanical integrity requirements established by the U.S. Environmental Protection Agency.⁷⁰
- Pressure from injection wells could also cause underground rock layers to crack, accelerating the ability of wastewater to migrate into drinking water aquifers. For example, at two injection wells in Ohio, toxic chemicals pumped underground in the 1980s, supposedly secure for at least 10,000 years, migrated into a well within 80 feet of the surface over the course of two decades.⁷¹ Investigators believe that excessive pressure within the injection well caused rock to fracture, allowing chemicals to escape.

Air Pollution

Fracking and related activities also create air pollution. From the diesel exhaust produced by trucks and equipment to gases vented from wells, condensers or waste ponds, this air pollution poses risks to the health of nearby residents.

Smog-Forming Emissions

Gas extraction creates large amounts of smog-forming pollution. According to estimates by the New York Department of Environmental Conservation, constructing and operating a single well generates nearly 70,000 pounds of smog-forming emissions in the first year of operation.⁷²

Smog-forming emissions from multiple sources make air quality unhealthy across many states overlying the Marcellus and Utica shales. In Pennsylvania, counties in and around Allentown, Lancaster, Philadelphia, Pittsburgh and Reading are in violation of federal health standards for smog.⁷³ In Ohio, all or part of 22 counties near Cleveland, Cincinnati and Columbus have smog levels that threaten public health.⁷⁴ Several communities in southern and western New York also fail to meet air quality standards.⁷⁵ Increased emissions from shale gas extraction could worsen air quality across the entire region.

Hazardous Air Pollutants from Trucks, Equipment and Gas Flaring

Closer to well sites, hazardous air pollutants pose a direct threat to public health. Gas extraction operations produce a variety of hazardous air pollutants, including diesel soot from trucks and pump engines, contaminants from processing the substances that come up out of the well, and fumes evaporating from fracturing water waste ponds.

In Texas, monitoring by the Texas Department of Environmental Quality detected levels of benzene – a known cancer-causing chemical – in the air that were high enough to cause immediate human health

concern at two sites in the Barnett Shale region, and at levels that pose long-term health concern at an additional 19 sites. Several chemicals were also found at levels that can cause foul odors.⁷⁶ Less extensive testing conducted by the Pennsylvania Department of Environmental Protection detected components of natural gas, particularly methane, in the air near Marcellus Shale drilling operations.⁷⁷ Air monitoring in Arkansas has also found elevated levels of volatile organic compounds (VOCs) – some of which are also hazardous air pollutants – at the perimeter of hydraulic fracturing sites.⁷⁸

In 2012, researchers at the University of Colorado, Denver, published a study showing that sites within a half mile of fracking wells in western Colorado showed elevated levels of hazardous air pollution, especially during the “well completion” phase of production.⁷⁹

Diesel Soot

Diesel engines operate throughout the drilling and fracturing process. These engines produce sooty exhaust, packed with dangerous and toxic chemicals. While a well is being drilled, diesel engines on the drilling rig operate 24 hours a day. After drilling, operators fracture the shale with millions of gallons of pressurized water, sand and chemicals. Transporting all of the equipment and material to the well pad, and then trucking away the waste, requires hundreds to thousands of trips by diesel-powered trucks per well.⁸⁰ Additionally, injecting the fracturing fluid into the well and pressurizing the system requires the operation of pumps, typically also powered by diesel engines.⁸¹

Diesel particulate exhaust can remain suspended in the air for weeks. The particles can travel through building shells and conventional heating and air conditioning filters. When inhaled, they are able to penetrate deep into the lung. The chemicals delivered into the body by inhaled particulates are very

dangerous. Some of them cause cancer, some cause irritation to lung tissues, and some cause changes in the function of the heart.⁸² As a result, particulates cause and aggravate a host of health problems, including lung cancer and cardiovascular disease.

Particulate pollution can cause irreversible damage to children, interfering with the growth and development of the lungs. For example, researchers at the University of Southern California followed the health of over 1,000 ten-year-olds until they reached 18. Children who lived in areas with higher levels of particulate pollution were less able to breathe with normal capacity.⁸³

Particulate pollution is also deadly, killing upwards of 50,000 Americans across the country every year. In fact, according to the largest study of the effects of particulates on mortality, breathing sooty air at the levels found in major U.S. cities is about as dangerous as living or working with a smoker.⁸⁴

Gas Flares, Venting and Blowouts

The drilling process can accidentally puncture underground pockets of gas, which returns to the surface in drilling fluid, and can be vented into the atmosphere, creating air pollution. A well blowout produces the same impacts – but at a higher volume.

Once a well is fractured, wastewater, often containing gas, returns to the surface. Gas drilling companies typically dispose of the extra gases by flaring them. Incomplete combustion of the waste gas results in air pollution.

After the wastewater has stopped flowing out of the well, drilling companies connect the gas flow to a pipeline. Before the gas can be shipped to market, it must be cleaned of impurities, including water and larger hydrocarbon molecules. Gas processing units typically vent impurities to the atmosphere as air pollution.

To transport the gas from the well to market, drilling companies operate compressor stations, typically within four to six miles of a group of wells.⁸⁵ These compressor stations are typically powered by combustion engines fueled by raw or processed natural gas, which generates pollution-laden exhaust.⁸⁶ Compressor stations are different than wells because they operate continuously as long-term sources of air pollution, whereas air pollution from wells peaks during the “completion” phase of drilling.

According to estimates by the New York Department of Environmental Conservation, the process of drilling, well completion and finally producing gas from the well for a year produces the following emissions in the nearby vicinity of a Marcellus Shale well:⁸⁷

- 90,400 pounds of carbon monoxide;
- 4,800 pounds of sulfur dioxide and combustion soot; and
- 440 pounds of toxic air pollutants, such as benzene.

Hazardous Air Pollutants from Wastewater Ponds

When wastewater is stored in an open-air pit, chemicals used in the fracturing fluid can evaporate into the air, creating pollution. In a 2009 assessment of the impacts of fracking, the New York Department of Environmental Conservation estimated that the flowback water from a single well could emit 6,500 pounds of methanol into the air from a storage pit.⁸⁸ The department noted that other compounds of concern that could evaporate from a flowback pit in harmful amounts include formaldehyde, acrylamide, naphthalene, glutaraldehyde and other chemicals that evaporate easily.⁸⁹ Overall, the agency determined that a flowback water storage pond could be defined as a “major source” of hazardous air pollution.⁹⁰

Health Problems Due to Fracking

Fracking produces pollution that affects the health of workers, nearby residents and even people living far away. Toxic substances in fracking chemicals and produced water, as well as pollution from trucks and compressor stations, have been linked to a variety of negative health effects. Chemical components of fracturing fluids, for example, have been linked to cancer, endocrine disruption, and neurological and immune system problems.⁹¹

Nearby Residents Getting Sick

Emissions from fracking well sites contain numerous substances that make people sick. Residents living near fracking sites have long suffered from a range of health problems, including headaches, eye irritation, respiratory problems and nausea.⁹²

Systematic studies of the health impacts of fracking on nearby populations are not yet available. However, early research indicates reason for concern and for further, more comprehensive studies. In western Pennsylvania, for example, residents living near one fracking well site have complained of rashes, blisters and other health effects that they attribute to a wastewater impoundment.⁹³ An investigation by the investigative journalism website *ProPublica* uncovered numerous similar reports of illness in western states.⁹⁴

A recent study by researchers at the Colorado School of Public Health found that residents living within a half mile of natural gas wells in one area of Colorado were exposed to air pollutants that increased their risk of illness.⁹⁵ The report noted that “health effects, such as headaches and throat and eye irritation reported by residents during well completion activities occurring in Garfield County, are consistent with known health effects of many of the hydrocarbons evaluated in this analysis.”⁹⁶ The report, based on

three years of monitoring, found elevated levels of benzene, ethylbenzene, toluene and xylene in the air. These pollutants cause cancer and acute health impacts.

Researchers Michelle Bamberger and Robert Oswald interviewed residents near oil and gas drilling operations, most involving fracking, in six different states. They found indications that fracking-related pollution had killed cows, sterilized farm animals, and resulted in stillborn offspring or offspring with birth defects.⁹⁷ Some owners even noted that dogs and cats that had walked on roads where fracking wastewater had been spread tended to lick their paws and get sick, some dying within a few days.⁹⁸

Similarly, researchers at the University of Pittsburgh Graduate School of Public Health interviewed Pennsylvania residents concerned about the impacts of nearby drilling operations on multiple occasions over the course of two years, identifying 59 different health impacts and 13 different sources of stress. From the initial interview to the final interview, most participants reported that their perceived health troubles had increased.⁹⁹ Health workers at the Southwest Pennsylvania Environmental Health Project have documented similar symptoms in people concerned that their health may have been harmed by nearby gas drilling activities.¹⁰⁰

Children and the Elderly Are Particularly Vulnerable to the Harmful Impacts of Fracking

Children and the elderly are especially vulnerable to air and water pollution caused by fracking.

Children are more vulnerable to the impacts of gas extraction, and indeed all pollution, because they are still developing. Their respiratory, immune and nervous systems are more susceptible to damage from toxic chemicals. Children are also more likely to play outdoors, where their exposure to dangerous



Fracking often occurs close to residential locations. Here, a drilling rig sits behind a barn on a Dimock, Pennsylvania, farm.

substances in the air would be relatively higher than an adult. Finally, children have less ability to detoxify dangerous chemicals compared to adults.¹⁰¹

Short-term exposure to hazardous pollutants could cause acute distress, with symptoms including difficulty breathing, wheezing, watery or itchy eyes, rashes or headaches. Very high exposures could cause nausea, vomiting, lack of coordination or more serious impacts.¹⁰²

However, children are far more likely to be exposed to sustained, low levels of mixtures of different chemicals over long periods of time – which may not produce obvious symptoms right away. Exposure to low levels of many of the chemicals used in or gener-

ated by gas extraction activities could contribute to a variety of health effects, including asthma, cancer, birth defects, damage to the reproductive system and impaired brain development.¹⁰³

The elderly and the sick, meanwhile, have reduced tolerance for pollution exposure. For example, people with pre-existing cardiovascular disease are more likely to suffer a heart attack or a stroke after exposure to elevated levels of soot pollution, such as that from a diesel truck or a drilling rig.¹⁰⁴ In one study, within hours of exposure to soot levels called “moderate” by the U.S. environmental protection agency, people were 34 percent more likely to suffer a stroke.¹⁰⁵

Other Vulnerable Populations

Although beyond the scope of this report, many other groups of people are particularly vulnerable to harm from exposure to pollution from natural gas drilling and extraction. For example, the poor may be more affected by pollution exposure due to inadequate nutrition and increased levels of stress, or because they are more likely to already be in fair or poor health or suffering from disabilities.¹⁰⁶ Poor individuals are also less able to cope with symptoms or illnesses that could be caused by exposure to pollution from fracking, because they may struggle to afford treatment or to be away from work while recovering.¹⁰⁷ State and federal leaders should protect all vulnerable populations from harm due to fracking, with fair treatment and meaningful participation for all.

Fracking Puts Our Health and Safety at Risk

Drilling for shale gas is occurring in close proximity to many vulnerable people. Across Pennsylvania, Ohio and West Virginia, permitted well sites exist within two miles of more than 1,300 day care facilities, schools and hospitals – locations where some of the most vulnerable among us are likely to be found. (See Figure 3.) In Maryland and New York, which have not yet allowed fracking to begin in earnest, more than 8,000 such facilities overlie areas that could potentially be exploited for shale gas extraction. In this five-state region, permitted well sites exist within one mile of more than 400 day care facilities, schools and hospitals. Tables 1, 2 and 3 break down the results by facility and state.

The results of this analysis provide a conservative and limited snapshot of the exposure of vulnerable populations to the risks of fracking. In particular, they

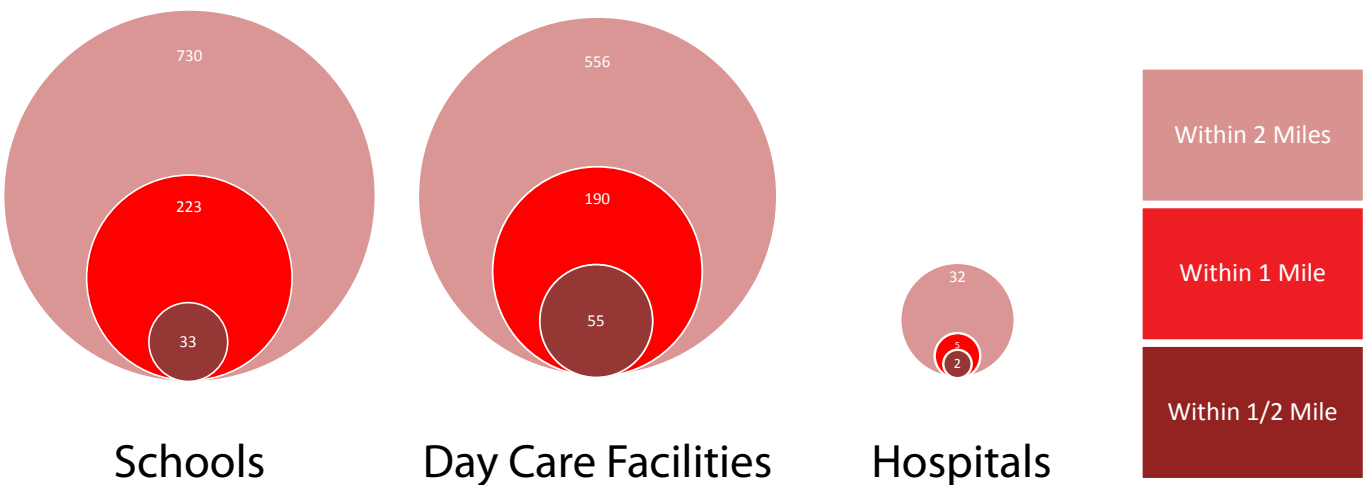
do not consider the location of residences, or the location of gas processing or transportation infrastructure beyond Pennsylvania. (See Methodology on page 33.)

Drilling Is Happening Close to Vulnerable Populations

Day Care Facilities

The five states in the Marcellus and Utica shale region license more than 42,000 day care facilities, including both day care centers and family-run day care facilities in private homes. More than 13,000 of these facilities are located in areas overlying the gas-bearing shale formations where gas extraction could potentially happen.

Figure 3: Proximity of Vulnerable Populations to Permitted Well Sites in Pennsylvania, Ohio and West Virginia



The area of the circle is proportional to the number of facilities within the specified distance of a permitted fracking well.

Table 1: Number of Facilities within One-Half Mile of a Permitted Fracking Well Site

	Day Care	School	Hospital
Pennsylvania	51	26	2
West Virginia	2	5	0
Ohio	2	2	0

Drilling has not yet begun in earnest in Maryland or New York.

Table 2: Number of Facilities within One Mile of a Permitted Fracking Well Site

	Day Care	School	Hospital
Pennsylvania	171	147	4
West Virginia	13	71	0
Ohio	6	5	0

Table 3: Number of Facilities within Two Miles of a Permitted Fracking Well Site

	Day Care	School	Hospital
Pennsylvania	462	446	15
West Virginia	58	214	12
Ohio	36	70	0

Table 4: Number of Facilities Overlying Gas-Bearing Shale Formations in Maryland and New York

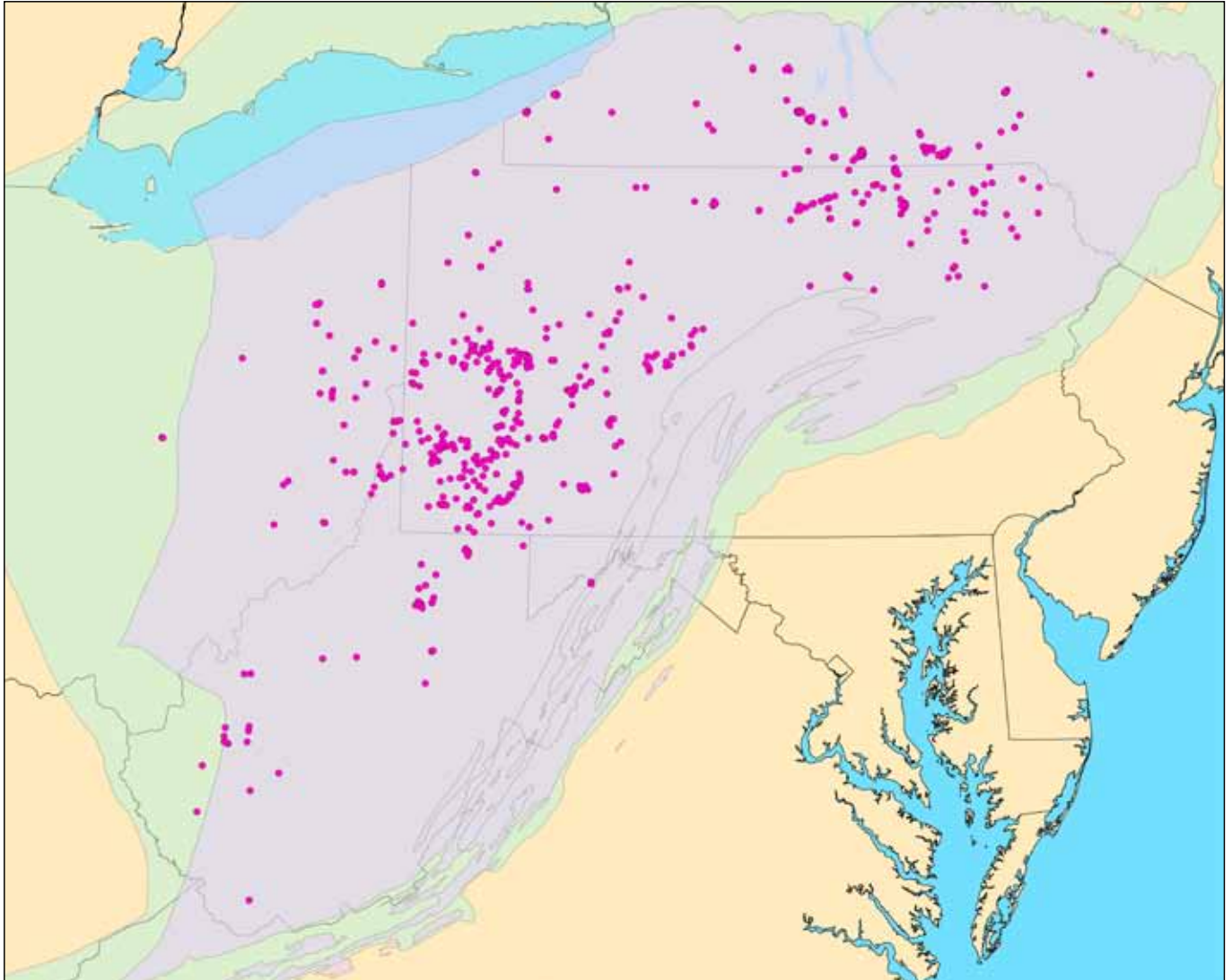
	Day Care	School	Hospital
New York	5,319	2,501	450
Maryland	144	45	3

Photo: Mark Schmerling



Drilling for shale gas occurs in close proximity to inhabited areas, such as at this drilling site in Pennsylvania.

Figure 4: Day Care Facilities within Two Miles of a Permitted Fracking Well Site



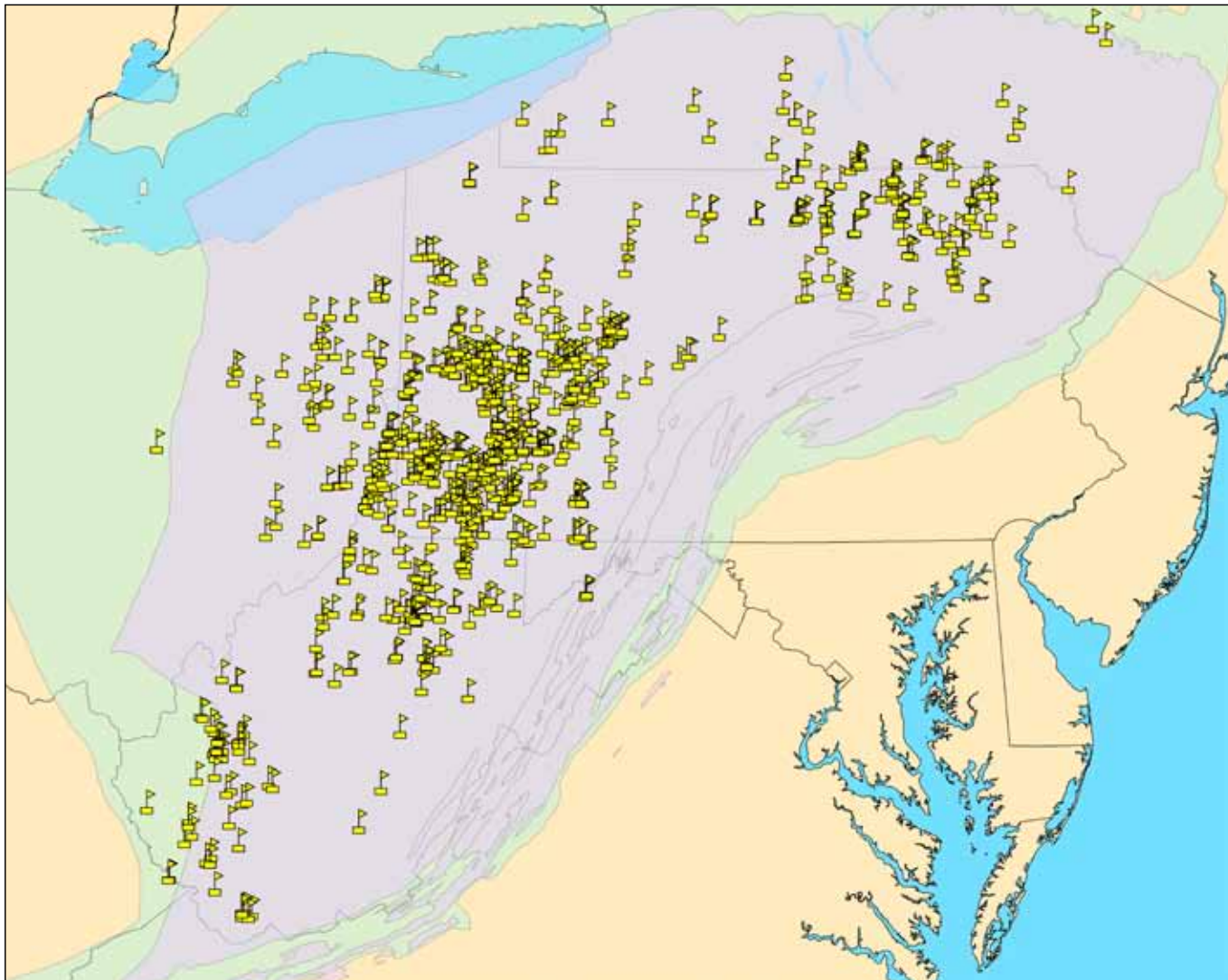
Facilities shown in New York are near sites where oil and gas companies have applied for permits to drill a well into the Marcellus or Utica shales. Most of these sites have not been permitted or drilled yet, but could be if New York lifts its moratorium on fracking.

Across the region, permitted hydraulic fracturing well sites exist within a half mile of 55 day care facilities and within one mile of 190 day care facilities. Within two miles of existing wells or permitted leases, there are more than 556 day care facilities. (See Figure 4.) The closest day care facility is 450 feet from a permitted well site. There are 11 different child care facilities in Pennsylvania that have had five or more fracking permits issued within a half-mile radius.

Schools

There are about 20,000 schools in Ohio, West Virginia, Maryland, Pennsylvania and New York, where children from kindergarten to 12th grade go to learn and prepare for life in the larger world. About 12,000 of these schools are located in the broad swath of land overlying the Utica and Marcellus shale formations, where fracking could potentially occur. Children at school facilities that rely on well

Figure 5: Schools within Two Miles of a Permitted Shale Well Site

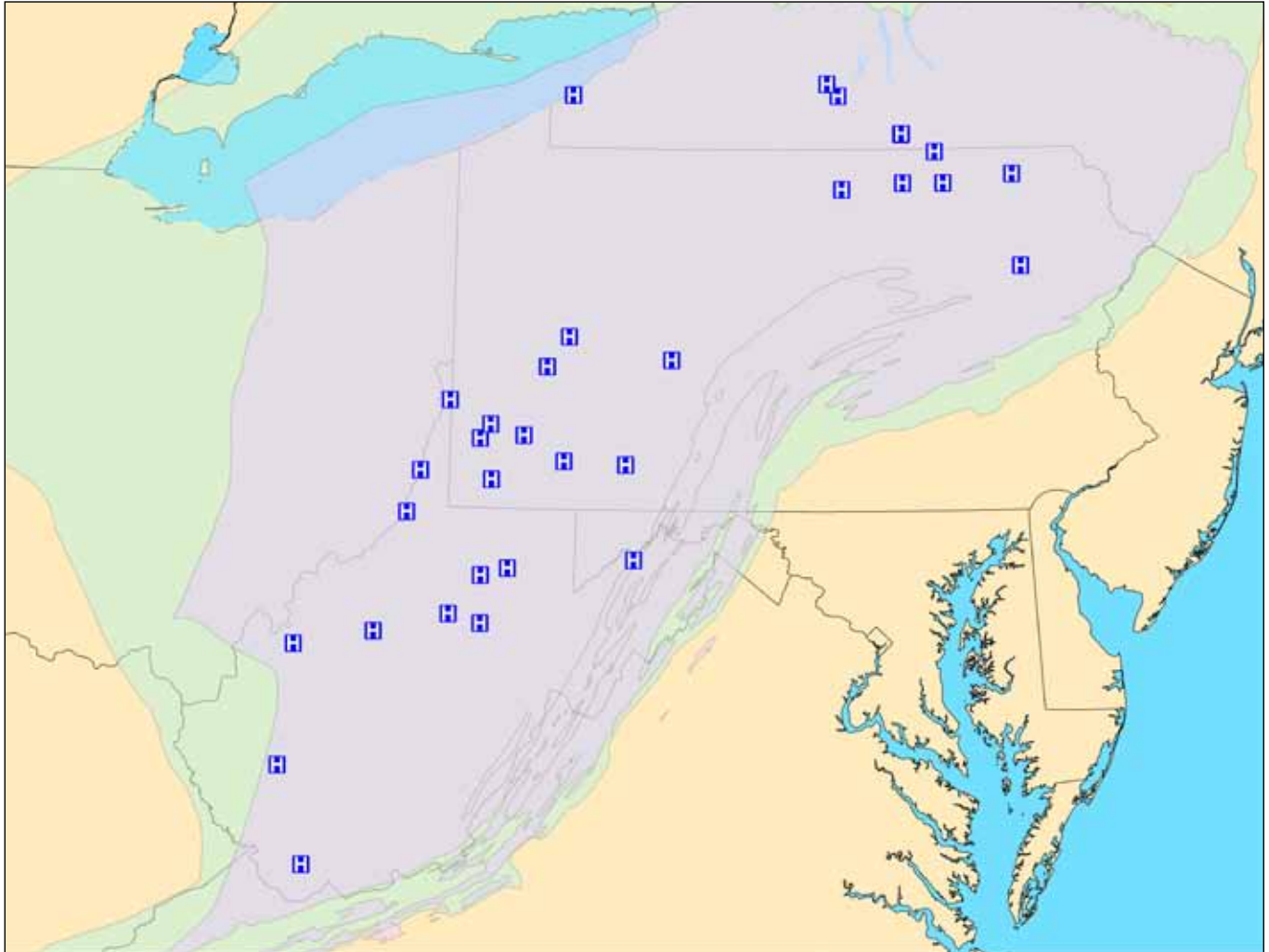


water are particularly vulnerable to gas extraction-related water contamination. All children at schools in close proximity to well sites are vulnerable to air pollution exposure.

More than 30 schools are within a half mile of the nearest fracking well. 223 schools are within one mile of a permitted well site and 730 are within two miles of a well site. (See Figure 5.) The closest

school, in Finleyville, Pa., is less than 600 feet from a permitted well site. Six different Pennsylvania schools have had five or more fracking permits issued within a half-mile radius. Schools in McDonald, East Smithfield and Washington, Pa., have had between 10 and 15 fracking permits issued within a half mile of school facilities.

Figure 6: Hospitals within Two Miles of a Permitted Shale Well Site



Facilities shown in New York are near sites where oil and gas companies have applied for permits to drill a well into the Marcellus or Utica shales. Most of these sites have not been permitted or drilled yet, but could be if New York lifts its moratorium on fracking.

Hospitals

Children are not the only vulnerable population to be concerned about. People who are already suffering from illness severe enough to require hospitalization are particularly ill-suited to handle the effects of acute exposure to air or water pollutants.

Across the region, two hospitals are within a half mile, and five hospitals are within one mile of a well or a permitted fracking well site. Within two miles of such sites, there are more than 30 hospitals. (See Figure 6.) Two hospitals – one in Monongahela, Pa. and one in Ripley, W.Va. – are less than 1,400 feet from a permitted well site.

Many Vulnerable People Live in Areas Overlying the Marcellus and Utica Shales in New York and Maryland

If New York or Maryland were to lift their current moratoria on fracking, the gas industry could drill new wells in close proximity to vulnerable people. The Utica Shale exists under much of southern and western New York, as well as western Maryland. The Marcellus Shale occupies a similar extent. Across this area, New York has more than 5,300 day care facilities and Maryland has more than 140. (See Table 5 for information about schools and hospitals).

Table 5: Number of Facilities Overlying Gas-Bearing Shale Formations in Maryland and New York

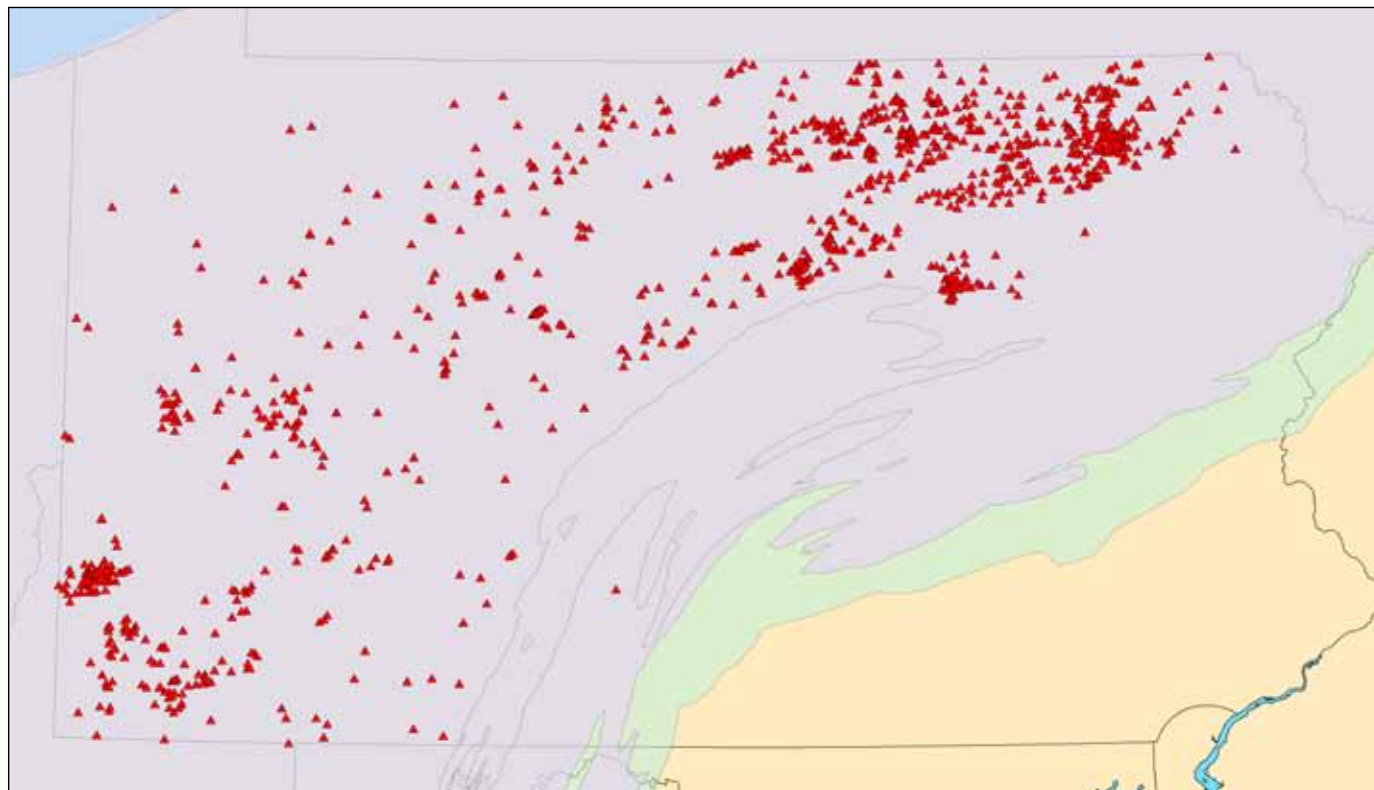
	Day Care	School	Hospital
New York	5,319	2,501	450
Maryland	144	45	3

Environmental and Safety Violations at Fracking Well Sites in Pennsylvania

Fracking in close proximity to schools, day care centers and hospitals risks exposing vulnerable people to air and water pollution and other impacts from fracking. Many of these risks would be present even if gas drillers obeyed oil and gas regulations to the letter. Unfortunately, many drillers don't follow the rules – leading to an even greater potential for damage.

From January 2008 through May 2013, the Pennsylvania Department of Environmental Protection recorded more than 3,200 violations of regulations intended to protect water quality and the environment.¹⁰⁸ The leading violators during this period were Cabot Oil & Gas, Chesapeake Energy and Talisman Energy, each with more than 200 violations.

Figure 7: Pennsylvania Fracking Wells Found in Violation of State Regulations (January 2008 – May 2013)



A violation implies that a drilling company broke a rule intended to protect Pennsylvania's natural resources or the health and safety of the public – indicating improper construction, poor waste disposal, lack of preparedness for an accident, or an actual leak or spill – and the company was caught by an inspector. Traffic and road safety violations by chemical, water and waste haulers are not included in these figures.

Mapping experts at the FracTracker Alliance identified the locations where these violations occurred. (See Figure 7.) More than 250 were in close proximity to vulnerable Pennsylvanians:

- 74 violations happened within one mile of a day care facility;
- 178 violations occurred within one mile of a school; and
- One violation took place within one mile of a hospital.

At a distance of up to two miles, the total number of violations near day care facilities, schools and hospitals were more than 600, 376 and 15, respectively.

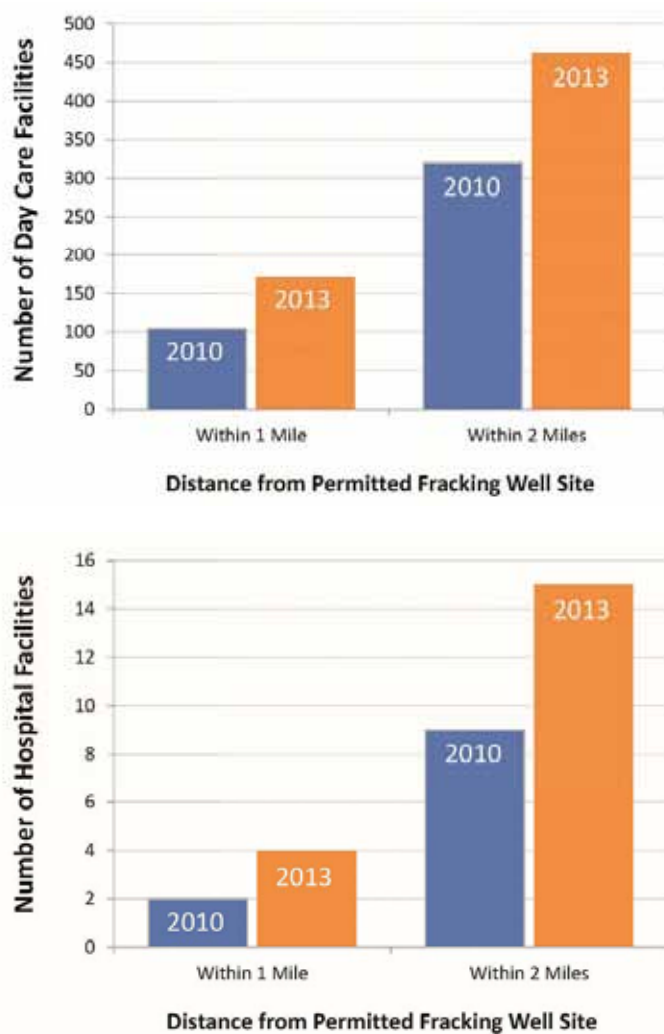
Change since 2010 in Pennsylvania

Drilling companies are expanding the amount of fracking and gas extraction in close proximity to vulnerable populations. PennEnvironment Research & Policy Center published a similar analysis in 2011 using fracking well permit data from 2007 through November 15, 2010. At that time, permitted well sites existed within two miles of more than 320 day care facilities, 67 schools and nine hospitals statewide.

Since late 2010, Pennsylvania has quadrupled the number of shale gas fracking permits it has issued, from 3,450 to more than 13,300. The additional drilling activity has:¹⁰⁹

- Doubled the number of hospitals within one mile of a well site, and increased the number within two miles by 67 percent; and
- Increased the number of day care facilities within one and two miles of a permitted well site by 64 and 44 percent, respectively. (See Figure 8.)

Figure 8: Increase in the Number of Day Care Facilities and Hospitals in Close Proximity to Permitted Well Sites from November 2010 to May 2013¹¹⁰



Policy Recommendations

The gas industry has projected drilling more than 60,000 new fracking wells into the Marcellus and Utica shales over the next two decades. Should this occur, gas extraction activity will move into even greater proximity to more vulnerable populations across the region.

As there is currently no proof that drilling companies will operate without contaminating our drinking water, threatening our safety, damaging our forests and parks, and polluting our air, state and local governments should stop further fracking operations.

States and Local Governments Should Halt Fracking

- Pennsylvania, Ohio and West Virginia should stop further fracking operations. New York and Maryland should maintain their existing moratoria on fracking and ban the practice altogether.
- Pennsylvania should repeal provisions within Act 13, a law that limits the ability of local communities to oversee drilling activity within their boundaries.
- Wherever they can, local governments should protect their communities and their health by banning fracking and the processing and disposal of fracking waste within their borders.

Communities Already Living with Fracking Operations Should At Least Be Granted the Minimum Health Protections of Our Nation's Core Environmental Laws

Federal law exempts shale oil and gas extraction from regulation under six key environmental policies that typically apply to industrial activities:¹¹¹

- 1) The **Resource Conservation and Recovery Act** (RCRA) is our nation's primary hazardous waste law. In the Marcellus Shale region alone, fracking has already generated billions of gallons of wastewater that is often laced with cancer-causing and even radioactive materials. Yet oil and gas operations are currently exempt from RCRA, and so this toxic wastewater from fracking is currently exempt from our nation's rules to protect public health from hazardous waste.
- 2) The **Safe Drinking Water Act** is meant to protect the quality of drinking water in the United States, whether in surface rivers or underground aquifers. In 2005, Congress amended the law to exempt gas extraction through hydraulic fracturing from all of the provisions of the law, except when diesel fuels are injected underground.

3) The **Clean Water Act** is the key law protecting America's rivers, streams and lakes from industrial discharges and runoff. For decades, all runoff from oil and gas extraction or production facilities has been exempt from regulation, except for sediment runoff caused by construction activity. In 2005, Congress passed the Energy Policy Act, which removed the Environmental Protection Agency's authority to regulate even sediment runoff from oil and gas-related construction sites.

4) The **Clean Air Act** is the cornerstone tool for ensuring that all Americans have healthy air to breathe. The law treats oil and gas wells – and often pipeline compressors and pump stations – as individual and separate sources of pollution. By failing to aggregate these sources of emissions by company and industry, the law fails to require operators to adequately control their polluting emissions – allowing the industry to pollute the air with few federal restrictions.

5) The **National Environmental Policy Act** ensures that all branches of government consider the impacts of any activity they undertake on the health and well-being of people and their air, land and water. In 2005, the Energy Policy Act allowed the oil and gas industries to carry out a variety of activities without the thorough environmental review normally required by the National Environmental Policy Act, instead allowing a more limited review under a designation called a "categorical exclusion." For example, the categorical exclusion allows a company to drill new wells in an exist-

ing gas field, or add a new pipeline to an existing corridor, without new environmental review, even if the original review did not consider that level of development. This categorical exclusion puts the burden on the public to show that harm is occurring, rather than on oil and gas drilling companies to prove that their plans are safe.

6) The **Toxics Release Inventory** – which is authorized under the Emergency Planning and Community Right-to-Know Act – compiles information from a wide variety of industries about their discharges of hazardous chemicals to air, water and land. However, the Environmental Protection Agency, which implements the law, does not require the oil and gas extraction industry to report toxic releases. This leaves the public in the dark about the amounts of chemicals emitted into the air or water after hydraulic fracturing operations are complete.

At a minimum, the federal government should eliminate these exemptions and apply the nation's core public health and environmental laws to the hydraulic fracturing industry just as it would regulate any other potential threat to public health or the environment. In particular, wastewater from fracking should be regulated under the same rules that apply to hazardous waste by other industries.

Methodology and Data Sources

We used ESRI ArcGIS geographic information system software to plot the locations of permitted well sites, regulatory violations in Pennsylvania, day care facilities, schools and hospitals, and to calculate the distances between the different points. Throughout the calculations, we maintained all data layers in the NAD 1983 State Plane Pennsylvania North projected coordinate system, with units in United States feet, to ensure accurate distance calculation.

Sources of Data

Extent of the Marcellus and Utica Shales

Mapping data describing the extent of U.S. shale gas deposits come from the Energy Information Administration of the U.S. Department of Energy, available at www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/maps/maps.htm#geodata.

Locations and Identities of Well Sites

Pennsylvania

We obtained information about the locations of permitted well sites and details about the companies that applied for permits from the Pennsylvania Department of Environmental Protection (PA DEP), with assistance from FracTracker Alliance (www.fracktracker.org). We focused on permits for “unconventional” wells – which, according to the Pennsylvania DEP, are “drilled into an Unconventional formation, which is defined as a geologic shale formation below the

base of the Elk Sandstone or its geologic equivalent where natural gas generally cannot be produced except by horizontal or vertical well bores stimulated by hydraulic fracturing.”¹¹²

Information on permits issued from 2007 through May 9, 2013 was obtained from the Pennsylvania Department of Environmental Protection, *Permits Issued Detail Report*, available at www.portal.state.pa.us/portal/server.pt/community/oil_and_gas_reports/20297. This data was used to map the locations of permitted well sites, as well as to calculate statistics on trends in permit numbers issued over time.

The Pennsylvania DEP also reported which well sites oil and gas drilling companies had actually developed as of 9 May 2013, in a database titled *SPUD Data Report*, also available at www.portal.state.pa.us/portal/server.pt/community/oil_and_gas_reports/20297.

Information on the nature and location of violations of DEP regulations at Marcellus wells in Pennsylvania was compiled by Matt Kelso at the FracTracker Alliance. The file, titled *Pennsylvania Unconventional Violations Geolocated 5-10-13*, is available at www.fracktracker.org/downloads/pa-unconventional-violations-geolocated-5-10-13/.¹¹³

West Virginia

We obtained information about the locations of permitted well sites and details about the companies that applied for permits from the West Virginia Department of Environmental Protection (W.Va. DEP),

with assistance from FracTracker Alliance (www.fracktracker.org). The data reflect permits issued up until May 13, 2013. The permits are for wells targeting the Marcellus or Utica shales. FracTracker Alliance removed 17 records from the original data, which is available through the W.Va. DEP Resource Extraction Data Viewer (at tagis.dep.wv.gov/fogm/), because the wells were located outside the state boundary.

Ohio

We obtained information about the locations of permitted well sites and details about the companies that applied for permits from the Ohio Department of Natural Resources, Division of Oil & Gas Resources. Shale well permit activity is separated into Marcellus and Utica categories, and contained in spreadsheets entitled *Cumulative Permitting Activity*, available at oilandgas.ohiodnr.gov/shale#SHALE. This report includes well sites permitted through May 2, 2013.

New York

New York has had a moratorium on fracking in place since 2008, to give state leaders a chance to evaluate the impacts of the process. However, oil and gas drilling companies have applied for permits to drill about 271 wells that target the Marcellus or Utica shales as of May 2013. We obtained information about these potential well sites and their locations from the New York Department of Environmental Conservation, *New York's Oil & Gas Database*, available at www.dec.ny.gov/cfm/xtapps/GasOil/. Oil and gas drilling companies have drilled and activated exploratory wells at 28 locations as of May 2013.

Maryland

Maryland also has a temporary moratorium on fracking in place. In 2011, Maryland Governor Martin O'Malley ordered regulatory agencies to prepare a study on the potential impacts of fracking in Maryland, and no wells have yet been permitted.

Locations of Day Care Facilities, Schools and Hospitals

We obtained addresses of relevant facilities from state regulatory agencies as described below. We removed any facilities without a physical address, such as those with only post office box information. We used the Yahoo Maps service to translate addresses into latitude/longitude coordinates for use in mapping software.¹¹⁴ Yahoo does not guarantee its geocoding service to 100 percent accuracy. Additionally, any possible typographical mistakes in the address database provided by the states could introduce error into the geolocation process. Any discrepancies between the geocoded coordinates and the actual location of the facility building could introduce error into distance calculations.

Pennsylvania

We obtained a listing of addresses of day care facilities from the State of Pennsylvania, Office of Child Development and Early Learning, Research Department (www.ocdelresearch.org).¹¹⁵ The list of providers, current as of March 2013, includes child care centers, family child care homes and group child care homes.

We obtained a listing of school facility addresses from the Pennsylvania Department of Education, *EdNA: Education Names and Addresses*, available at www.edna.ed.state.pa.us/ReportSearch.asp. Facilities included regular elementary, middle and secondary schools; private academic schools; charter schools; and non-public, non-licensed schools (such as those affiliated with a church or other religious institution). The database was accessed on 5 June 2013.

Hospital addresses came from a database maintained by the Pennsylvania Department of Health, *Health Care Facilities*, available at app2.health.state.pa.us/commonpoc/content/publiccommonpoc/normalSearch.asp, accessed on 15 May 2013. We focused only on hospitals, excluding other types of health care facilities.

West Virginia

We obtained a listing of addresses of day care facilities from the State of West Virginia, Department of Health and Human Resources, Bureau for Children and Families (available at www.wvdhhr.org/bcf/ece/cccenters/), accessed 15 May 2013. The list of providers only includes child care centers, not family or group child care homes. The state agency was unable to provide a list of other types of child care facilities.

We obtained a listing of school facility addresses from the West Virginia Department of Education, *W.Va. School Directory*, available at wvde.state.wv.us/ed_directory/. Facilities included public and non-public schools. We excluded administrative facilities. The database was accessed on 19 May 2013.

Hospital addresses came from a database maintained by the West Virginia Department of Health and Human Resources, Bureau for Public Health, Office of Health Facility Licensure (available at www.wvdhhr.org/ohflac/FacilityLookup/Default.aspx, accessed on 19 May 2013.) We focused on acute care hospitals and critical access hospitals, excluding other types of health care facilities.

Ohio

We obtained a listing of addresses of day care facilities from the Ohio Department of Job and Family Services (available at www.odjfs.state.oh.us/cdc/), accessed 18 May 2013. We focused on full-time day care centers, family day care homes (Type A), and registered day camps.

We obtained a listing of school facility addresses from the Ohio Department of Education, *Ohio Educational Directory System (OEDS) Reports*, available at webapp2.ode.state.oh.us/data/Extract_OED_ad-dgrades.asp. Facilities included public elementary, middle and high schools; and non-public schools such as those affiliated with religious institutions. We excluded administrative facilities. The database was accessed on 19 May 2013.

Hospital addresses came from a database maintained by the Ohio Department of Health, Division of Quality Assurance, available at publicapps.odh.ohio.gov/EID/Default.aspx, accessed on 18 May 2013. We focused on hospitals (category L89), excluding other types of health care facilities.

New York

We obtained a listing of addresses of day care facilities from the New York State Open Government website, *Child Care Regulated Programs*, available at data.ny.gov/Human-Services/Child-Care-Regulated-Programs/cb42-qumz, accessed 20 May 2013. The listing included both day care centers and family day care homes; however some facilities did not have a publicly available address listing and were therefore omitted.

We obtained a listing of school facility addresses from the New York State Department of Education, *The Directory of Public and Non-Public Schools and Administrators for The State of New York*, available at www.nysed.gov/admin/bedsdata.html. Facilities included public elementary, middle and high schools; charter schools; and non-public schools such as those affiliated with religious institutions. We excluded administrative facilities. The database was accessed on 17 May 2013.

Hospital addresses came from a database housed on the New York State Open Government website, *Managed Care Institutional Provider Network Data: December 31, 2012*, available at health.data.ny.gov/Health/Managed-Care-Institutional-Provider-Network-Data-D/ivv7-qybs. The listing included hospitals and medical centers.

Maryland

We obtained a listing of addresses of day care facilities as of May 2013 from TJ Bennett at the Maryland State Department of Education, Division of Early Childhood Development, Office of Child Care. (The data is described at the following website:

www.marylandpublicschools.org/MSDE/divisions/child_care/lists.) The listing included both child care centers and family day care homes, as well as religious-based child care centers.

We obtained a listing of school facility addresses from Cindy Schaefer at the Maryland State Department of Education on 21 May 2013, *Directory of Maryland Public Education*, available in printable format at mdedirectory.org/. Facilities included public elementary, middle and high schools; charter schools; and non-public schools such as those affiliated with religious institutions. We excluded administrative facilities.

Hospital addresses came from a database maintained by the Maryland Department of Health & Mental Hygiene, Office of Health Care Quality, *Acute, General and Special Hospitals*, available at dhmh2.dhmh.state.md.us/ohcq/about_ohcq/licensee_directory.htm, accessed 21 May 2013.

Calculating Distances

We used ESRI ArcGIS geographic information system software to plot the locations of the permitted well sites, violations, day care facilities, schools and hospitals together on a map.

We used the “buffer” proximity analysis tool to draw circles of half mile, one mile and two mile radii around each well. We then selected day care, school and hospital facilities that fell within the boundary of the circles at each radius. Counting the relevant facilities at each distance yielded the number of facilities within the specified distance of a permitted well site.

To calculate the distance to the nearest day care, school or hospital from each well site, we performed a “spatial join” between the permitted well site data layer and the data describing the locations of the relevant facilities.

Justification for Focusing on Facilities within One-Half Mile, One Mile and Two Miles of a Well Site

This analysis examines distance from day care centers, schools and hospitals as a first-order approach to better understand the risk that fracking and shale gas extraction poses to vulnerable populations in the region, and to examine how drilling activity is moving closer to more people over time. We chose to examine the number of facilities within one-half, one and two miles of a well site for the following reasons:

1. Evidence that gas can travel underground at least one mile and as much as seven miles from a well to contaminate a home’s water supply suggests that people living within a one- or two-mile radius of a well are potentially vulnerable to water contamination.¹¹⁶ Studies in Pennsylvania have found elevated levels of methane and ethane in drinking water wells within one kilometer (0.6 miles) of a well site.¹¹⁷
2. Air pollution goes where the wind blows. Researchers in Colorado have measured elevated levels of hazardous air pollutants at a half-mile distance from a well site or associated infrastructure.¹¹⁸

The analysis does not attempt to estimate potential exposures to specific chemicals at specific distances from well sites.

Limitations

The analysis is largely limited to permitted well sites only, and does not consider gas processing and refining infrastructure. The analysis also does not consider the locations of homes; only the locations of day care facilities, schools and hospitals. The potential for exposure to the risks of gas extraction also exists in residential areas, for vulnerable populations including the children and the sick, as well as other residents. As a result, this study paints a conservative picture of the proximity of fracking in the Marcellus and Utica shale region to vulnerable populations.

Notes

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3. Ibid.

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7. 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*, Chapter 5.10, September 2009.

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