

# Keystone Secrets:

Records Show Widespread Use of Secret Fracking Chemicals is a Looming Risk for Delaware River Basin, Pennsylvania Communities



## RESEARCH REPORT

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September 11, 2018



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Cover photo is by Ted Auch, FracTracker Alliance, and shows a drilling rig near Rochester, Pennsylvania (Beaver County) in 2015.

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## Executive Summary

Between 2013 and 2017, drilling companies injected at least one hydraulic fracturing (“fracking”) chemical with an identity kept hidden from the public into more than 2,500 unconventional natural gas wells drilled in Pennsylvania, amounting to 55 percent of the more than 4,500 unconventional gas wells drilled in the state during the five-year period, primarily in the Marcellus and Utica shale formations. In total, companies injected secret fracking chemicals 13,632 times into 2,515 wells. Exemptions in Pennsylvania law virtually guarantee that the use of secret chemicals in the state’s oil and gas wells was higher than detailed in this report.

Records released by the U.S. Environmental Protection Agency (EPA) in response to a Freedom of Information Act request indicate that these chemicals could have serious health effects including irritation to skin and lungs, liver toxicity, developmental toxicity and neurotoxicity. The widespread use of secret fracking chemicals therefore poses serious health risks for people living near Pennsylvania’s unconventional gas wells and for 15 million people who rely on the Delaware River Basin for drinking water. Pennsylvania law suggests that in at least some cases no one – not even first responders acting in an emergency – would be able to learn the chemicals’ identities.

In the coming months, the Delaware River Basin Commission is expected to vote on plan it proposed to ban fracking in the basin – fracking that would be most likely to occur in unconventional gas wells in Pennsylvania’s portion of the four-state area. There is currently a de facto moratorium on fracking in the basin that provides drinking water for New York City and Philadelphia among other cities. The commission is also expected to vote on its seemingly inconsistent proposal to allow related activities inside the basin, including the treatment and discharge into waterways of fracking wastewater from outside the basin. Any fracking or discharges of wastewater would be likely to include some of the secret fracking chemicals discussed in this report.

Fracking in unconventional formations has significantly increased oil and gas extraction, making Pennsylvania the nation’s second-largest natural gas producer while sparking concerns about pollution and health effects, especially related to unidentified fracking chemicals. In response, Pennsylvania and 28 other states have enacted rules that require some public disclosure of these chemicals. However, most if not all of these rules have exceptions that allow companies to withhold chemical identities as trade secrets. This report by Massachusetts-based Partnership for Policy Integrity (PFPI) with analysis of fracking chemical disclosure data by Pennsylvania-based FracTracker Alliance, illustrates that drilling companies have used these exceptions extensively.

The records obtained by PFPI from the EPA show that non-disclosure of fracking chemical identities may leave people unknowingly exposed to harmful substances. Between 2003 and 2014, the EPA identified health concerns about 109 of 126 new chemicals proposed for use in oil and gas drilling and fracking. The chemicals’ manufacturers submitted information about the chemicals for review under a program that requires EPA to screen and regulate new chemicals for health and environmental impacts before they are used commercially. Despite concerns by EPA scientists about the chemicals’ health effects, EPA approved most of the 109 chemicals for use, and 62 were later used in or likely used in oil

and gas wells. Manufacturers took advantage of trade secret protections that are permitted by federal law to conceal 41 of the 62 chemicals' identities. "Concern for liver and kidney toxicity" read an EPA review of one chemical that the agency approved in 2013 for use in "downhole treatment of oil and gas wells." The chemical's identity and the manufacturer's name were confidential.

Health problems related to secret fracking chemicals are not just hypothetical. In Amity and Prosperity, a recent book about fracking in Washington County, Pennsylvania, journalist Eliza Griswold found that several people living near fracked unconventional gas wells, a pit of drilling waste, and a pond of fracking wastewater suffered mysterious illnesses and the deaths of several animals. Yet proving a link between the health problems and the drilling operations was challenging in part because the citizens could never obtain a full list of the chemicals to which they may have been exposed, even with a court order requiring full disclosure by the company in charge of the drilling site. One of the citizens lost his lawsuit for damages due to inability to prove such a link, and the other citizens signed confidential settlements with the drilling interests they had sued that left them "feeling angry and defeated."

The potential for fracking and related activities in the Delaware River Basin raises the possibility that millions of people could find themselves in similar situations. Without knowing fracking chemical identities, citizens and regulators could have great difficulty identifying potential pollution in water supplies or determining what contaminants to remove from wastewater. Compounding the risk is that if the trade secret claims are asserted by the chemical manufacturers as opposed to other companies involved in fracturing unconventional gas wells, Pennsylvania law appears to provide no legal right for anyone to access the chemicals' identities, even first responders or health professionals. This exemption is distinct from the so-called "physician gag rule," recently struck down by the Pennsylvania Supreme Court, that required oil and gas companies to provide secret chemicals to health professionals in certain situations but prevented the health professionals from sharing the information.

Mapping of secret fracking chemical injection sites shows that use is heaviest in southwest Pennsylvania near Pittsburgh and in northeast Pennsylvania near the Delaware River Basin, tracking areas of intensive drilling. A county-by-county table shows that Washington County had the highest number of wells fractured with at least one secret fracking chemical, while Susquehanna County was second. A table of well operators shows that Range Resources injected the most publicly reported secret fracking chemicals of any drilling company. The use of secret chemicals is likely even higher than detailed in this report because of exemptions in Pennsylvania law, including no disclosure requirements for the chemicals used in drilling oil and gas wells – the portion of the oil and gas extraction process that precedes fracking, no requirement that fracking chemicals for so-called "conventional" oil and gas wells be reported to an easily searchable electronic database, and the reporting exemption for chemical manufacturers.

Recommendations include a ban on fracking and related activities in the Delaware River Basin and changes to Pennsylvania law to require disclosure of all chemicals used in fracking and drilling oil and gas wells. The public has a right to know the identities of chemicals used in oil and gas operations so that citizens, first responders, regulators and scientists can determine the chemicals' risks and act to protect health and the environment.

## I. Background: Oil and Gas Chemicals Pose Health Risks

Chemicals are used in many steps of oil and gas extraction, and many are dangerous. Extraction first requires drilling, where companies bore through the earth and then insert a string of steel casing into the empty hole. The casing is secured by injecting cement between the outside of the casing and the rock wall, and successively deeper casings are set until the target formation is reached. The casing and cement are intended to seal the well from nearby groundwater sources. However, poor installation and cracks in the casing or cement can occur that allow oil and gas chemicals to pollute groundwater. During drilling, companies pump chemical additives into the well, sometimes called “drilling mud,” to lubricate the drill bit and to remove rock cuttings.<sup>1</sup> Drilling chemicals have received less scrutiny than chemicals used for hydraulic fracturing (“fracking”) or well stimulation, but EPA has expressed concern that drilling chemicals can have health impacts including blood toxicity, developmental toxicity, kidney toxicity, liver toxicity, and neurotoxicity.<sup>2</sup> One particular area of risk is during the initial drilling when companies often bore directly through groundwater before installing any protective casing or cement.<sup>3</sup> During this phase, chemicals could leach directly into water supplies.

Fracking or well stimulation follows the drilling process in most but not all wells and requires its own chemicals. In fracking, drilling companies typically perforate the drilling pipe that is set in the target formation by setting off mini-explosions inside the pipe. They then typically inject a mixture of water, sand, and chemicals into the well at high pressure. The fluid exits through the perforations and fractures the rock or pressurizes existing fractures, creating pathways for trapped oil and gas to escape and be collected.<sup>4</sup> The sand acts as a “proppant” to keep the fractures open<sup>5</sup> while the chemicals serve a variety of purposes, including reducing friction inside the well casing during high pressure injections, killing bacteria that might impede the flow of gas or oil in the drilling pipe, and thickening the fluid so that sand can be transported farther into the fractures.<sup>6</sup> When fracking is completed, pressure is reduced and the fluid flow reverses, coming up and out of the well. The wastewater output at this step can be produced for the life of the well and can contain the chemicals injected in the fracking fluid, naturally occurring chemicals from the formation, and chemicals created by the transformation of injected chemicals during their time mixed together underground.<sup>7</sup>

In a 2016 study of fracking and drinking water, EPA identified 1,606 chemicals in fracking fluid and wastewater. While the agency found high-quality health effects information for only 173 of these chemicals, the information was troubling. EPA found that “health effects associated with chronic oral exposure to these chemicals include carcinogenicity, neurotoxicity, immune system effects, changes in body weight, changes in blood chemistry, liver and kidney toxicity, and reproductive and developmental toxicity.”<sup>8</sup> These chemicals with well-established health effects included benzene, a known human carcinogen found in both fracking fluid and wastewater;<sup>9</sup> toluene, ethylbenzene, and xylenes, neurotoxic substances found in both fracking fluid and wastewater;<sup>10</sup> and radium-226 and radium-228, known human carcinogens found in elevated levels in fracking wastewater from the Marcellus shale that is drilled for natural gas in Pennsylvania.<sup>11</sup> As EPA noted, key details about many hydraulic fracturing chemicals remain unknown, particularly their health effects and their identities. These unknowns pose health and environmental risks during oil and gas extraction and wastewater disposal.



## II. Pennsylvania's Fracking Chemical Disclosure Requirements Leave the Public in the Dark

### A. Drilling Companies Must Disclose Fracking Chemicals – Except for Trade Secrets

States including Pennsylvania have enacted chemical disclosure rules intended to fill some of the data gaps on chemical identities and health effects. Beginning in the mid-2000s, a growing number of citizens and scientists in the western U.S. started raising concerns about drilling and fracking chemicals when natural gas extraction was booming in states such as Colorado, New Mexico, and Wyoming.<sup>12</sup> As energy companies moved east to drill shale formations in states including Pennsylvania, the concerns followed: that drilling companies were using potentially harmful chemicals without publicly disclosing the chemicals' identities.<sup>13</sup> In 2010, Wyoming became the first state to require drilling companies to publicly disclose the identities of at least some chemicals used in hydraulic fracturing. Since that year, at least 28 other states, including Pennsylvania beginning in 2011, have enacted laws or regulations that require public disclosure of at least some of the chemicals used in hydraulic fracturing.<sup>14</sup> These standards provide the public with more information about fracking chemicals than ever before. However, disclosure requirements in Pennsylvania and other states still leave citizens in the dark and create huge risks for drinking water and health considering that drilling companies are typically allowed to withhold fracking chemical identities as trade secrets, and at least some of the secret chemicals are likely to be harmful.

Pennsylvania's law and companion regulations are complex with different standards of disclosure for conventional and unconventional oil and gas wells. Because records on conventional oil and gas wells are more difficult to access, this report focuses only on secret fracking chemicals used in unconventional wells as defined by Pennsylvania law. The state defines "unconventional well" as a well drilled to produce natural gas from "a geologic shale formation existing below the base of the Elk Sandstone or its geologic equivalent stratigraphic interval where natural gas generally cannot be produced at economic flow rates or in economic volumes except by vertical or horizontal well bores stimulated by hydraulic fracture treatments or by using multilateral well bores or other techniques to expose more of the formation to the well bore."<sup>15</sup>

This definition is narrower than the commonly accepted definition of "unconventional well," which usually refers to a well drilled into any formation (coal, sandstone, shale or other material) in which natural gas *or* oil can be extracted in economic quantities only with hydraulic fracturing, often combined with horizontal drilling.<sup>16</sup> Pennsylvania's limited definition means that all oil wells and any natural gas wells not covered by the definition above are considered "conventional wells." Most natural gas wells covered by the "unconventional" definition are those drilled in the Marcellus and Utica shales, the formations that would be fractured in the Delaware River Basin, if fracking were allowed there.

The law provides that well operators fracturing unconventional gas wells must disclose their fracking chemicals to the state Department of Environmental Protection (DEP) and to a database operated by FracFocus, a nongovernmental organization run by the Ground Water Protection Council and the Interstate Oil and Gas Compact Commission.<sup>17</sup> Through FracFocus, users can download the chemical

disclosures and can search and sort the results by chemical, operator, county and other parameters. Pennsylvania-based nonprofit FracTracker Alliance conducted this type of data analysis for this report.

In general, the standards provide that with the exception of trade secrets, well operators must disclose each chemical they intentionally add to the hydraulic fracturing fluid for an unconventional gas well.<sup>18</sup> They must make this disclosure to FracFocus in a particular way. In fracking, drilling companies often add chemicals to the fracking fluid in the form of “additives” or “products” that are comprised of multiple chemicals. Pennsylvania requires that when well operators disclose their individual chemicals to FracFocus, they do so “in a format that does not link chemicals to their respective hydraulic fracturing additive.”<sup>19</sup> The law does not explain the rationale for this provision, but the provision is consistent with the recommendation of a task force organized by the U.S. Secretary of Energy and chaired by John Deutch, a chemistry professor at MIT, former director of the Central Intelligence Agency, and longtime board member of Schlumberger, one of the world’s largest fracking companies.<sup>20</sup> In 2014, the task force recommended an unlinked disclosure regime like Pennsylvania’s because it balanced the public’s interest in knowing the contents of fracking fluid and chemical manufacturers’ interest in hiding chemical product formulas from competitors who could use the formulas to steal business opportunities. The task force called this type of disclosure a “systems approach.”<sup>21</sup> The group wrote:

The Task Force urges industry to pursue complete disclosure rather than protecting trade secrets of uncertain technical merit, especially since compliance has very low, if any, risk of disclosing proprietary information if submission is organized by the chemicals rather than the additives or products to the fluid. A list of chemicals that includes the contributions from all the constituents added makes it extremely difficult to reverse engineer to determine which chemicals and in what proportions these chemicals are present in a particular additive or product with specific trade name. Thus trade secret protection generally can be accomplished by reporting a list of products and chemicals added without disclosing which chemical is in each product.<sup>22</sup>

The task force added that “companies frequently believe that it is the chemical composition of additives (or formulated materials) as a product that is most likely to have proprietary value that deserve exemption from disclosure as a ‘trade secret’.”<sup>23</sup> Following the task force’s recommendation, FracFocus modified its disclosure forms to make a systems disclosure approach its default method beginning in July 2016.<sup>24</sup> However, Pennsylvania has required its systems approach-style disclosure to FracFocus since February 2012.<sup>25</sup>

When disclosing individual chemicals to FracFocus, well operators in Pennsylvania must include among other pieces of information, each chemical’s Chemical Abstracts Service (CAS) number, a unique numeric identifier assigned by the American Chemical Society. Scientists and regulators consider them the best way to identify chemicals because chemicals can have multiple names or trade names but only one CAS number.<sup>26</sup> A CAS number would enable a scientist to locate a chemical’s structure and to test for the chemical in drinking water, according to David Brown, a toxicologist who has investigated health effects associated with unconventional gas drilling with the Southwest Pennsylvania Environmental Health Project. Without a CAS number, it is difficult to know what to test for.<sup>27</sup>



By consulting the FracFocus database, the public can locate unconventional gas wells in which secret chemicals have been used, but not the identities of the secret chemicals themselves. When companies involved in fracking withhold CAS numbers or other pieces of identifying information as trade secrets, well operators are required by Pennsylvania law to designate the information as a trade secret in their disclosure form filed with FracFocus.<sup>28</sup> Separately, when well operators designate fracking chemicals as trade secrets in required disclosures to the DEP, they must reveal the confidential CAS numbers to the DEP, and the DEP is obligated to prevent public disclosure subject to the state's Right-to-Know Law.<sup>29</sup> The major findings in this report are based on trade secret designations in disclosure forms filed with FracFocus where well operators would otherwise have disclosed a CAS number for a chemical. FracTracker Alliance and PFPI identified each case in which a well operator indicated that it was withholding a chemical's CAS number from the public. We counted CAS numbers as secret if they were designated with terms limited to "confidential," "proprietary," "trade secret," and the abbreviations and misspellings "prop," "proprietart," and "propriety."

## B. Many Additional Secret Chemicals Likely Used in Pennsylvania Oil and Gas Wells

We counted instances where CAS numbers were withheld as constituting use of secret chemicals, but this methodology almost certainly undercounts the amount of secret oil and gas chemicals used in Pennsylvania for the following reasons:

1. We report use of secret fracking chemicals but not secret drilling chemicals for conventional or unconventional wells, because there is no Pennsylvania requirement that companies disclose drilling chemical identities. Most drilling chemicals are, therefore, likely to be unknown to the public in Pennsylvania even if not withheld as trade secrets. At the federal level, some chemical manufacturers have declared their drilling chemical identities trade secrets, and the EPA has found that some of these chemicals have serious health risks.<sup>30</sup>
2. The report does not include secret fracking chemicals used in conventional wells. These disclosures are made only to the DEP and are kept primarily in paper records in offices in Meadville and Pittsburgh. These records are therefore difficult to access and analyze.
3. Because of a little-known exemption for chemical manufacturers, some fracking chemicals may not be publicly reported in FracFocus records or to the DEP, whether protected by trade secret designations or not. Under Pennsylvania law, the duty to disclose fracking chemicals publicly to FracFocus (and to DEP) lies with the well operator who is listed in the permit or well registration or otherwise performs certain work on a well.<sup>31</sup> Service providers who conduct fracking for the well operator and vendors who provide fracking chemicals directly to the operator for fracking are required to disclose chemical information to the well operator so that the well operator can make the ultimate public disclosure to FracFocus.<sup>32</sup> However, chemical manufacturers are exempt from this chain of disclosure requirements. In addition, in reporting to FracFocus, operators cannot be held accountable for any inaccuracies in information provided to them by manufacturers, service providers or vendors.<sup>33</sup> The manufacturers are even exempt from disclosure requirements in the case of a spill or release when the DEP, public health officials, emergency managers or first responders would have the right to access secret fracking

chemical information from well operators, service providers and vendors.<sup>34</sup> This exemption from disclosure requirements for chemical manufacturers is distinct from the so-called “physician gag rule,” recently struck down by the Pennsylvania Supreme Court. That rule required well operators, service providers and vendors to disclose secret fracking chemical information to health professionals in certain situations but prevented the health professionals from sharing the information.<sup>35</sup> The exemptions for manufacturers raise the possibility that manufacturers could withhold chemical information – even a chemical’s existence – from other actors in the well-drilling and fracking process.

Four attorneys with years of experience litigating oil and gas-related cases filed a petition with the state Commonwealth Court in 2014 suggesting that such withholding of information occurs often due to manufacturers’ use of Material Safety Data Sheets (MSDS) that communicate the contents of fracking chemical products that may contain more than one chemical. Material Safety Data Sheets (now called safety data sheets) are required to be prepared by chemical manufacturers to protect workers using the chemicals on the job from hazards identified by the manufacturers.<sup>36</sup> “Many times,” the attorneys wrote

a vendor of a hydraulic fracturing fluid product merely re-labels product manufactured by another company without ever knowing anything about the chemical make-up of the product it has re-labeled other than what may be contained in the manufacturer’s MSDS. If that MSDS does not list the full chemical content of the product the vendor obtained, the vendor has no way of discerning the full chemical make-up of the hydraulic fracturing fluid. Thus, if a service provider or vendor never had possession of the entire chemical content of hydraulic fracturing fluid, then it is impossible for the vendor or service provider to pass that information along to the operator who then cannot possibly disclose to the Department [of Environmental Protection]<sup>37</sup>

Nor would the operators be able to disclose the information to FracFocus.

The attorneys provided as support a document filed in separate litigation by well operator Range Resources in which the company suggested that it was relying on Material Safety Data Sheets from manufacturers to respond to a request for the chemicals used to fracture or stimulate its wells. “The MSDS are often useful for developing some understanding of what is in a particular chemical or product,” Range wrote. “However, they vary widely in terms of usefulness. Some manufacturers include very little information about the actual components of a particular product. As a result, Range is currently in the process of seeking additional information from manufacturers that have failed to provide enough information about their products in the MSDS.”<sup>38</sup> In one case, Range said that a fracking or stimulation product called “MC SS-5075” was “an Ammonium Bisulfite Solution manufactured by Multi-Chem. The MSDS describes the formula as 45-70% ammonium bisulfite by weight. Range is currently seeking information on the 30-55% missing from the formula.”<sup>39</sup> In another case, Range mentioned that a chemical known as “MC S-2510T” also made by Multi-Chem contained “Ethylene Glycol (30%-60% by weight)” and “Sodium Hydroxide (5% by weight).” Range acknowledged that “we recognize that this formula fails to account for at least 35% of the weight, so we have contacted Multi-Chem for an explanation.”

Several researchers from Harvard University wrote in 2013 that MSDS rules are unlikely to result in full disclosure of hydraulic fracturing chemicals. The researchers noted that the rules limit disclosure of chemicals “to those that have been studied for workplace exposure.” Many chemicals used in fracking might not meet this definition, they suggested, and therefore might not be included in MSDS. They also suggested that manufacturers might not list at least some chemicals in MSDS because of a federal regulation that manufacturers are not required to test a chemical to classify its hazards. Manufacturers can instead rely on existing data that may not identify hazards with a particular fracking chemical. A chemical without *identified* hazards would, therefore, not be required to be disclosed on an MSDS even if the chemical were hazardous.<sup>40</sup> These findings raise concerns that fracking chemical disclosure in Pennsylvania understates the number of chemicals being used, with or without trade secret protections.

4. When we counted chemicals used with trade secret protections, we limited our search terms to those that clearly indicated the use of secret chemicals. We excluded CAS number fields that were left blank or had designations such as “NA” or “N/A.” Some of these terms might have been used to designate the use of secret chemicals, but might have been used for other purposes, especially to indicate that a chemical was being disclosed elsewhere on the FracFocus disclosure form.

## II. Secret Fracking Chemical Use in Pennsylvania: Figures and Maps

### A. 55 Percent of Unconventional Wells Injected with Secret Fracking Chemicals

Although our methodology likely undercounted the use of secret chemicals, nonetheless, the reported secret fracking chemical use is alarming. According to our analysis, between 2013 and 2017, oil and gas companies injected secret fracking chemicals a total of 13,632 times into 2,515 unconventional natural gas wells drilled in Pennsylvania. Those wells made up 55 percent of the 4,561 unconventional gas wells drilled in the state during that period, primarily in the Marcellus and Utica shales. The wells received an average of more than five secret fracking chemical injections each and were concentrated in southwestern Pennsylvania near Pittsburgh and northeastern Pennsylvania near the Delaware River Basin, tracking areas of heavy unconventional gas drilling.

## 2,515 of 4,561 (55%) Unconventional Gas Wells in Pennsylvania Injected with Secret Fracking Chemicals, 2013-2017

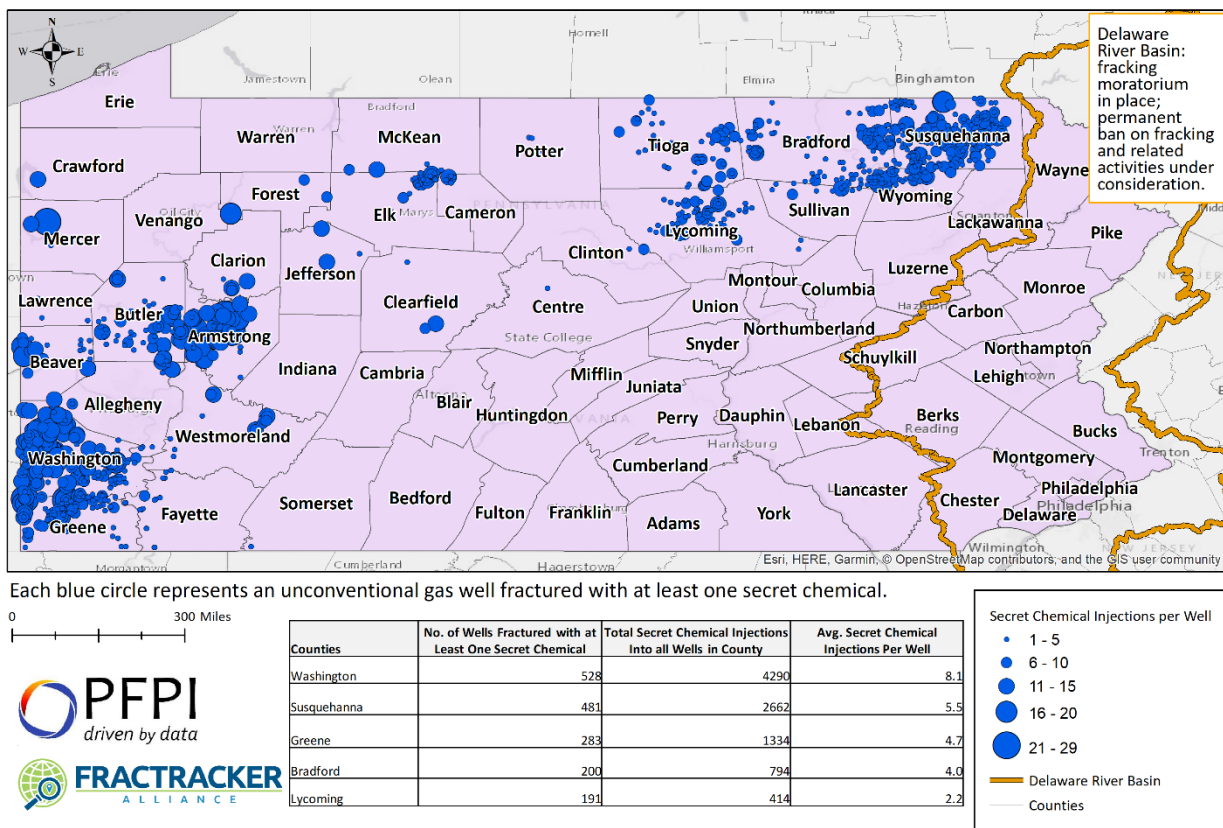


Figure 1. Unconventional gas wells in Pennsylvania hydraulically fractured with at least one secret chemical (available online at <https://bit.ly/2BXrl2g>).

### B. Interactive Map: Find Wells Injected with Secret Chemicals Near You

An online [interactive map](#)<sup>1</sup> allows users to zoom into the locations of unconventional natural gas wells that were injected with secret fracking chemicals. Each blue dot represents an unconventional gas well injected with at least one secret chemical. By clicking on the dot, users will see a pop-up window showing the well's API number that is a unique number assigned to each well,<sup>41</sup> county, number of secret chemicals injected into the well, latitude, longitude, and well operator.

<sup>1</sup> Online at <https://bit.ly/2BXrl2g>

### C. Secret Fracking Chemical Use by County

Table 1 shows that Washington County near Pittsburgh had the most wells injected with at least one secret chemical, and the most secret chemical injections. Susquehanna County was second.

County	Number of Wells Fractured with at Least One Secret Chemical	Total Injections of Secret Chemicals into All Wells Fractured	Average Secret Chemical Injections Per Well
Allegheny	41	233	5.7
Armstrong	76	771	10.1
Beaver	31	218	7
Bradford	200	794	4
Butler	105	617	5.9
Cameron	44	97	2.2
Centre	2	4	2
Clarion	6	48	8
Clearfield	6	33	5.5
Clinton	3	14	4.7
Crawford	1	15	15
Elk	75	154	2.1
Fayette	67	237	3.5
Forest	4	42	10.5
Greene	283	1,334	4.7
Jefferson	8	47	5.9
Lawrence	7	13	1.9
Lycoming	191	414	2.2
McKean	52	159	3.1
Mercer	6	56	9.3
Potter	8	17	2.1
Somerset	5	20	4
Sullivan	18	62	3.4
Susquehanna	481	2,662	5.5
Tioga	138	531	3.8
Washington	528	4,290	8.1
Westmoreland	31	222	7.2
Wyoming	98	528	5.4
<b>State Total/Average</b>	<b>2,515</b>	<b>13,632</b>	<b>5.4</b>

Table 1. Unconventional gas wells fractured with at least one secret chemical in each Pennsylvania county (2013-2017), total number of secret fracking chemical injections in all wells in that county, and average number of secret fracking chemical injections per well.

#### D. Some Wells Received Injections of at Least 15 Secret Fracking Chemicals

Drilling companies injected unconventional gas wells with an average of 5.4 secret chemicals. But they injected some wells with almost three times as many – or more (Table 2).

County	Well API Number	Operator	Number of Secret Chemicals Injected
Armstrong	37005310590000	Snyder Brothers Inc.	28
Butler	37019222980000	XTO Energy/ExxonMobil	16
Forest	37053303590000	Seneca Resources Corporation	16
Greene	37059266460001	EQT Production	21
Susquehanna	37115210730000	WPX Energy	16
Washington	37125271580000	Noble Energy, Inc.	21
Wyoming	37131202920000	Carrizo Oil & Gas, Inc.	15

Table 1. Wells in Pennsylvania counties that received a greater than average number of secret chemical injections. API Number is a unique identifier that enables users to find precise longitude and latitude coordinates for a well and to locate the well’s fracking chemical disclosure record in FracFocus.

#### E. Secret Fracking Chemical Use by Well Operator

Several operators injected secret fracking chemicals more than 1,000 times into two hundred or more unconventional natural gas wells (Table 3) between 2013 and 2017. Range Resources was the leading company, injecting secret fracking chemicals 3,867 times into 396 wells.



<b>Operator Name</b>	<b>Number of Wells Fractured with at Least One Secret Chemical</b>	<b>Total Injections of Secret Chemicals into All Wells Fractured</b>	<b>Average Number of Secret Chemical Injections Per Well</b>
Alpha Shale Resource, LP	5	18	3.6
Anadarko Petroleum Corporation	108	110	1
Apex Energy LLC	5	17	3.4
Arrington Oil & Gas Operating LLC	1	6	6
Cabot Oil & Gas Corp	279	1,587	5.7
Campbell Oil & Gas, Inc.	3	31	10.3
Carrizo Oil & Gas, Inc.	44	396	9
Chesapeake Operating, Inc.	241	919	3.8
Chevron USA Inc.	123	440	3.6
Chief Oil & Gas	4	4	1
Citrus Energy Corporation	8	17	2.1
CONSOL Energy Inc.	51	239	4.7
EdgeMarc Energy Holdings, LLC	5	9	1.8
EOG Resources, Inc.	7	13	1.9
EQT Production	266	1,213	4.6
EXCO Resources, Inc.	6	27	4.5
Halcon Resources Corporation	3	58	19.3
Hilcorp Energy Company	4	4	1
Inflection Energy (PA) LLC	3	30	10
JKLM ENERGY	8	17	2.1
MDS Energy Development LLC	20	229	11.5
MDS Energy, Ltd	12	157	13.1
Noble Energy, Inc.	32	325	10.2
Northeast Natural Energy LLC	4	33	8.3
PennEnergy Resources, LLC	31	238	7.7
Pennsylvania General Energy	1	1	1
Range Resources Corporation	396	3,867	9.8
Rex Energy	42	120	2.9
Rice Drilling B, LLC	97	268	2.8
RMD	2	28	14
Seneca Resources Corpoation	236	623	2.6
Shell Oil Company affiliate	102	452	4.4
Snyder Brothers Inc.	30	332	11.1
Southwestern Energy	135	727	5.4
Talisman Energy USA Inc.	123	562	4.6
Vantage Energy Appalachia II LLC	27	110	4.1
Warren E&P, Inc.	2	18	9
WPX Energy	19	197	10.4
XTO Energy/ExxonMobil	30	190	6.3
<b>State Total/Average</b>	<b>2,515</b>	<b>13,632</b>	<b>5.4</b>

Table 2. Number of unconventional gas wells in Pennsylvania into which the operator injected at least one secret chemical, the total number of secret chemical injections in Pennsylvania by each operator, and each operator's average secret chemical injections per well.

### III. Secret Fracking Chemicals May be Harmful, Posing Risks for Health, Drinking Water

#### A. EPA Flagged Drilling, Fracking Chemicals as Health Risks, Including Secret Chemicals

While it is impossible to know exactly what chemicals companies are injecting into unconventional gas wells in Pennsylvania under the cloak of trade secret protection, evidence from EPA suggests that these chemicals may be harmful. In 2014, PFPI and partner nonprofit Earthworks submitted a request to EPA under the Freedom of Information Act requesting the agency's health assessments and regulatory determinations under the New Chemicals program for drilling and fracking chemicals. The New Chemicals program was created by the Toxic Substances Control Act (TSCA), enacted in 1976, to ensure that before new chemicals are used commercially, EPA screens them for health and environmental risks, to better regulate their use. Apparently, EPA had never previously released its health and regulatory determinations for new drilling and fracking chemicals to the public. In response to our FOIA request, the agency has disclosed thousands of pages of records covering 153 chemicals.<sup>42</sup> PFPI reviewed records for 126 of these chemicals and found that EPA had health concerns about 109 of them including "irritation to the eye, skin, and mucous membranes,"<sup>43</sup> kidney toxicity,<sup>44</sup> liver toxicity,<sup>45</sup> neurotoxicity, and developmental toxicity.<sup>46</sup>

EPA allowed most of these 109 chemicals to be manufactured commercially, and 62 of them were used or likely used in oil and gas wells. The agency did not explain why it allowed the chemicals to be used commercially despite its health concerns, but one reason might be that in its new chemical reviews, EPA assumed that oil and gas chemicals never leak, spill or are otherwise accidentally released. This assumption is contradicted by a growing body of evidence showing leaks and spills, including evidence compiled by EPA, but regulators may have used the dubious assumption to conclude that people will not be exposed to the chemicals.<sup>47</sup> The agency also allowed the chemicals to be used despite the fact that chemical manufacturers rarely submitted health testing information for the substances, and EPA rarely used its authority to ask for it. Partly because of this lack of health testing data, the Government Accountability Office has consistently listed EPA's chemical review program on its "high risk list" of federal agencies at highest risk for waste, fraud, abuse, and mismanagement.<sup>48</sup> Chemical manufacturers used provisions under TSCA to withhold the CAS numbers as trade secrets and, in many cases, other identifying information, on 41 of the 62 chemicals.<sup>49</sup>

The manufacturers' secrecy makes it extremely difficult to know where the chemicals are being used. When manufacturers withhold CAS numbers under federal law, they must provide at least a generic chemical name so that citizens can have some idea of what the chemical is.<sup>50</sup> However, such names as "quaternary ammonium compound" are likely to be too imprecise to enable citizens to locate the chemicals in FracFocus or other fracking chemical disclosure databases. FracFocus contains multiple listings for "quaternary ammonium compound" used in Pennsylvania's unconventional gas wells, and those listings are associated with multiple CAS numbers, including some marked as trade secrets. Without a CAS number match between the quaternary ammonium compound reviewed by EPA and any quaternary ammonium compound listed in FracFocus, it would be unclear whether the compound reviewed by EPA were the same quaternary ammonium compound listed in FracFocus as being used in Pennsylvania.

Manufacturers commonly assert trade secret claims for fracking chemical identities in Pennsylvania according to the recently published Amity and Prosperity by journalist Eliza Griswold, and a Pennsylvania-based attorney, John Smith, featured in the book. The book describes the struggles of Pennsylvanians, and in particular, a woman named Stacey Haney, living in Washington County near three hydraulically fractured unconventional gas wells, a drilling waste pit, and fracking wastewater storage pond. After the drilling activity started in 2009, the neighbors suffered mysterious illnesses and the deaths of several animals that they suspected were caused by air and water contamination from the oil and gas activity.<sup>51</sup> In a lawsuit filed against Range Resources, the well operator that ran the drilling site, Haney asked for a full list of chemicals used at the site – a list that would have been critical to proving that exposure to the chemicals contributed to her family’s health problems. Range said it could not comply with a court order to disclose the chemicals because it did not know all of them. “Range wasn’t simply being obstructionist,” Griswold writes, “it was likely the company didn’t know, since some of the products its subcontractors used were proprietary, and their contents were secret.” At least some of the secret chemical identities were held by a chemical manufacturer.<sup>52</sup> John Smith, one of Haney’s attorneys who has spent years litigating with the oil and gas industry, said in a recent telephone interview that “in my experience, it’s the chemical manufacturers alone that keep the trade secrets.”<sup>53</sup> Smith’s experience suggests that at least some of the chemicals claimed as confidential by manufacturers at the federal level – and for which EPA identified health concerns – could be the same secret chemicals injected into oil and gas wells in Pennsylvania. Haney never received all of the chemical identities she requested, an outcome that may have influenced her to agree to an unsatisfying and confidential settlement.<sup>54</sup>

## B. Health Effects in Pennsylvania Consistent with EPA Concerns

While it is unknown whether people are being exposed to the secret chemicals reviewed by EPA, researchers have identified health problems near unconventional gas wells in Pennsylvania consistent with some of the concerns identified by EPA, including skin conditions, upper respiratory symptoms, low birth weight, and memory loss. A 2015 study of 492 residents with ground-fed water wells in Washington County, Pennsylvania found that residents living within a kilometer of a natural gas well reported skin conditions and upper respiratory symptoms more frequently than those living farther away.<sup>55</sup> Another 2015 study of more than 15,000 births in southwestern Pennsylvania found that babies with the highest exposure to unconventional gas drilling were more frequently born with low birth weight or were small for their gestational age.<sup>56</sup> A 2017 study of almost 8,000 people living in northern and central Pennsylvania found that people with the highest exposure levels to unconventional natural gas wells reported a significantly higher incidence of fatigue, chronic nasal and sinus symptoms, and migraine symptoms compared to people who had lower exposure to wells.<sup>57</sup> A 2017 retrospective review of symptoms reported to a nurse practitioner by 51 self-selected participants found similar symptoms; several of the participants also reported short-term memory loss.<sup>58</sup>

### C. Exposure to Secret Fracking Chemicals is Possible Through Multiple Pathways

Exposure to fracking chemicals including those declared confidential is possible through multiple routes. Such exposure may endanger people, farm animals, pets, wildlife and watersheds like the Delaware River Basin. In its 2016 report on fracking and drinking water, EPA wrote about pathways in hydraulic fracturing that “are more likely than others to result in more frequent or more severe impacts” to drinking water including:

- “Spills during the management of hydraulic fracturing fluids and chemicals or produced water that result in large volumes or high concentrations of chemicals reaching groundwater resources”
- “Injection of hydraulic fracturing fluids into wells with inadequate mechanical integrity, allowing gases or liquids to move to groundwater resources”
- “Injection of hydraulic fracturing fluids directly into groundwater resources” and
- “Discharge of inadequately treated hydraulic fracturing wastewater to surface water resources”<sup>59</sup>

Drilling companies’ warnings to investors in filings required by the U.S. Securities and Exchange Commission support the EPA’s conclusions. Range Resources, which injected at least one secret fracking chemical into more unconventional gas wells in Pennsylvania than any other company, warned investors that its business is subject to risks including “**uncontrollable** flows of oil, natural gas or well fluids”<sup>60</sup> (emphasis added). Noble Energy, which fractured 32 unconventional gas wells in Pennsylvania using at least one secret chemical, told investors that among the risks facing its business were “mishandling of fluids and chemicals” and “possible underground migration of hydrocarbons and chemicals.”<sup>61</sup>

### D. Secrecy for Fracking Chemical Identities, Toxicities Creates Multiple Obstacles to Protecting Health and Environment

When people and scientists are prevented from learning about chemicals’ identities and toxicities, it creates multiple problems for protecting health and the environment, whether for individual citizens or for protecting water supplies such as those in the Delaware River Basin.

#### **Undermining Baseline Testing**

One of the best ways to determine whether oil and gas chemicals have contaminated drinking water is to have a baseline test of water supplies prior to drilling and fracking. This test was called a “pre-drill” by residents in Washington County as reported in Amity and Prosperity. If chemicals associated with drilling and fracking were absent from the water before the oil and gas extraction began but showed up in the water afterward, the change would provide compelling evidence that the oil and gas operations were the source of the problem. In this scenario, citizens would have a better chance to hold drilling companies accountable or take other steps to protect themselves from an identifiable harm. Yet if some chemical identities were not disclosed before drilling and fracking activities begin, the baseline water test would be less effective. Scientists would not know the full range of chemicals to test for prior to drilling, nor would they know all of the chemicals to look for after drilling began to determine if there had been a change in water quality. Not only does Pennsylvania allow the use of secret fracking

chemicals, but the state also does not require disclosure of fracking chemicals until after fracking has occurred, making it difficult to conduct meaningful baseline testing.

### **Tracking Spills**

In its 2016 study of fracking and drinking water, EPA wrote about the difficulty of tracking spills of hydraulic fracturing chemicals, in part due to secret fracking chemicals. “Due to the lack of information on the chemicals used on [the drilling] site (some of which are claimed as CBI [confidential business information]), one would not know what chemicals to include in the lab analysis,” the agency wrote.<sup>62</sup>

### **Difficulty of Assessing Health Risks and Water Pollution**

EPA also discussed how secret fracking chemicals and lack of toxicity information frustrated efforts to determine fracking’s health effects. “Some chemicals and chemical mixtures remain undisclosed because of confidential business information (CBI) claims,” EPA wrote. “When chemicals are claimed as CBI, there is no public means of accessing information on these chemicals. Furthermore, many of the chemicals and chemical mixtures disclosed, or those detected in produced water [wastewater], lack information on properties affecting their movement, persistence, and toxicity in the environment should they be spilled. Better information on these chemicals would allow for a more robust evaluation of potential human health hazards posed, and thus a better understanding about the severity of impacts should the chemicals reach drinking water resources.”<sup>63</sup>

EPA found that high-quality toxicity information was lacking for more than 1,400 of the 1,606 chemicals identified in fracking fluid or drilling wastewater. “This missing information represents a significant data gap that makes it difficult to fully understand the severity of potential impacts on drinking water resources,” the agency wrote.<sup>64</sup>

Knowing chemicals’ identities would enable scientists and regulators to determine if toxicity information exists, and to conduct their own tests for toxicity or other properties. Without such identities, scientists and regulators are largely in the dark.

## **IV. Chemical Families Are No Substitute for Real Disclosure**

When companies drill unconventional gas wells and designate a chemical as a trade secret, Pennsylvania requires that they must provide the public with a rough idea of what chemical was used by disclosing the chemical’s “chemical family or similar description associated with the chemical.”<sup>65</sup> The federal Toxic Substances Control Act has a similar provision. However, these disclosures are inadequate because even chemicals within the same family can have very different toxicities and health effects. Toluene, for example, is part of the chemical families known as “hydrocarbons” and “volatile organic compounds.” It is a naturally occurring chemical in petroleum and has also been used in hydraulic fracturing fluid. It can cause nervous system, kidney and liver problems and is toxic in drinking water at levels greater than 1 part per million.<sup>66</sup> Benzene is in the same chemical families, is found naturally in petroleum, and has also been used in hydraulic fracturing fluid. Unlike toluene, it is a known human carcinogen, and it is 200 times more toxic than toluene. Benzene is considered unsafe in drinking water at levels greater than

5 parts per *billion*.<sup>67</sup> This level of toxicity means that just one gallon of benzene could contaminate about 200 million gallons of drinking water, or two-thirds the quantity treated each day by the city of Philadelphia.<sup>68</sup> Therefore, while the public can know the chemical families of fracking chemicals declared confidential, these disclosures may not be meaningful in regard to chemicals' health effects and toxicities. Only full disclosure of chemicals' identities, especially their CAS numbers, can begin to inform the public adequately about chemical risks from hydraulic fracturing and drilling.

## V. Secret Fracking Chemicals Put Delaware River Basin at Risk

In November 2017, the Delaware River Basin Commission proposed to ban hydraulic fracturing in the basin based in part on the use of confidential chemicals in hydraulic fracturing.<sup>69</sup> The basin serves as a source of drinking water for approximately 15 million people, including residents of Philadelphia and New York City.<sup>70</sup> The heavy use of secret chemicals in Pennsylvania adds weight to the commission's concern. If fracking were allowed in the basin, the most likely place for drilling companies to operate would be in Pennsylvania's portion of the basin that sits atop the Marcellus and Utica shales. Drilling companies would presumably use secret fracking chemicals to access unconventional gas in these formations just as they have in other parts of the state. Considering the risk that these chemicals may be harmful, that they would leak, spill, or migrate underground, and that regulators would be unlikely to know either their identities or their toxicities, allowing fracking in the basin amounts to a serious gamble with drinking water for millions of people. The other risks from fracking unrelated to secret chemicals, including the production of wastewater from natural gas wells with naturally occurring radioactive elements,<sup>71</sup> only bolsters the commission's case.

Strangely, the commission has proposed allowing wastewater from fracking outside the basin to be treated and discharged to waters inside the basin. The commission has proposed to allow such importation of wastewater if it is treated at a centralized waste treatment facility (CWT) and meets other standards. Among the most important of these other requirements is that the entity that wishes to treat and discharge the wastewater conduct an "analysis, characterization and quantification of all pollutants of concern" as defined in an EPA technical document. The entity must also show that "the acute and chronic toxicity of the waste, measured as Whole Effluent Toxicity (WET), have been evaluated."<sup>72</sup>

However, based in part on the significant data gaps regarding fracking chemical identities and toxicities, it is unlikely that operators of CWT facilities could effectively meet these standards or protect the public from fracking-related pollutants. One problem is that fracking wastewater is likely to contain secret chemicals that may not appear in EPA's technical document. Therefore, it seems possible that a facility operator could conduct an analysis of "all pollutants of concern" that have been included in EPA's technical document but fail to analyze secret chemicals that are not listed – chemicals that might be harmful. In its national study of fracking and drinking water, EPA expressed doubts about whether centralized waste treatment facilities could effectively treat fracking wastewater due to unknown contaminants. EPA did not explicitly name secret fracking chemicals, but it is likely that the agency's reservations would apply to these substances. "There may be unknown constituents in the wastewater," EPA wrote. "The effectiveness of treatment cannot be evaluated for constituents for which the



wastewater has not been tested. This makes it challenging to know the degree to which effluent from a CWT is protective of public health.”<sup>73</sup> It is also doubtful that facility operators would be able to measure the acute and chronic toxicity of the wastewater when EPA has found high-quality toxicity values to be lacking for more than 1,400 chemicals found in fracking fluid or wastewater.

## VI. Recommendations

Considering the extensive use of secret fracking chemicals in Pennsylvania, Partnership for Policy Integrity recommends the following policy changes:

**1. The Delaware River Basin Commission should ban fracking and importation of fracking wastewater treatment and discharge in the basin.** Regarding fracking, there is too great a risk that it would result in leaks, spills, or underground migration of secret chemicals that would contaminate waters of the basin. Drilling, which precedes the fracking process, might pollute the basin with additional secret chemicals. Officials would have difficulty identifying pollution without knowing what chemicals to test for. Contamination could, therefore, spread and infiltrate water supplies before officials could prevent such harm. The wastewater produced by each fracked well multiplies the risk because wastewater in shale wells can often contain naturally occurring radioactivity among other contaminants. Regarding importation of fracking wastewater for treatment and discharge, the risks are also too great. Treatment officials could have difficulty identifying and removing secret chemicals that would almost certainly be in the wastewater considering the wide use of such chemicals in Pennsylvania wells that would be the likely source for wastewater imports. Even if the officials could identify the secret chemicals, it is likely that they would not know the chemicals’ toxicities and might not be able to ensure that any post-treatment discharges of the chemicals were at safe levels.

**2. Pennsylvania should require disclosure of all fracking chemicals with no exceptions for trade secrets and should extend disclosure requirements to chemical manufacturers.** The state has already adopted a disclosure mechanism that strikes a balance between the public’s right to know and fracking companies’ interest in protecting the identities of their products from competitors: the state requires public disclosure of fracking chemicals to FracFocus “in a format that does not link chemicals to their respective hydraulic fracturing additive.”<sup>74</sup> This approach was endorsed for hydraulic fracturing chemicals across the nation by a task force of the U.S. Secretary of Energy in 2014.<sup>75</sup> While the task force stopped short of calling for disclosure of fracking chemicals in all cases, Pennsylvania should go a step further and require full disclosure without the use of trade secret protections. EPA records show that these chemicals may pose serious health risks, and that people are likely to be exposed. It is unfair and dangerous to continue a legal regime in which people could be unknowingly exposed to harmful chemicals. Fracking companies already have enough protection under Pennsylvania’s law. The law’s chemical disclosure requirements should extend to all companies involved in fracking oil and gas wells, including chemical manufacturers that are currently exempt.

**3. The state should require disclosure of all chemicals used in the drilling and fracking processes.** Chemicals used in drilling may be even riskier than fracking chemicals because at least some of the drilling chemicals may be injected into wells before any steel casing or cement is installed that would seal off the well from groundwater. These chemicals could directly infiltrate groundwater supplies.

Ohio appears to be the only major drilling state that requires public disclosure of some drilling chemicals. Pennsylvania should follow Ohio's lead and require drilling chemicals – and any other chemicals used at oil and gas wells – to be disclosed to the same repository as fracking chemicals.

**4. Pennsylvania should require disclosure of fracking chemicals to the same database for all wells.**

Currently, the state requires disclosure of fracking chemical information for unconventional wells to FracFocus and the DEP, but the same information for conventional wells must be disclosed to the DEP alone. This system forces the public to go to different places to access related information and prevents the public from easily searching for the use of potentially dangerous chemicals across both unconventional and conventional wells. Whether FracFocus or the state is the single repository, Pennsylvania should ensure that the chemical disclosure information can be easily searched and sorted by different variables including CAS number.

**5. Chemical disclosure should occur before drilling and fracking begins.** Such pre-disclosure would provide citizens and regulators with the opportunity to raise questions about the use of potentially dangerous chemicals and to conduct meaningful baseline water testing prior to drilling and fracking activity. Several states require fracking chemical disclosure before fracking begins, including California, West Virginia (for some wells), and Wyoming.

## VII. Appendix: Methodology

For this report, FracTracker Alliance and Partnership for Policy Integrity (PFPI) analyzed well-by-well fracking chemical disclosures made to FracFocus, a nongovernmental organization that began operating in 2011. FracFocus collects such records from across the nation. As of April 2015, the dataset included fracking chemical disclosures for 23 states,<sup>76</sup> some made voluntarily, others required by state law such as those for unconventional gas wells in Pennsylvania. FracFocus enables users to search well-by-well disclosures to its database by CAS number, chemical name, county, operator, state and other variables.<sup>77</sup> Users with some computer database skills can view the results, making it possible to see, as we did in this report, data including how many unconventional wells in Pennsylvania drilling companies injected with secret fracking chemicals.

For this analysis, FracTracker Alliance downloaded FracFocus' entire dataset as of February 2018. FracTracker searched well-by-well fracking chemical disclosure records in Pennsylvania for terms entered for each well in the "CASnumber" including "confidential," "proprietary," and "trade secret," that would indicate that a well operator withheld the chemical's unique CAS Number from the public as a trade secret. We also included several abbreviations and misspellings of these terms including "prop," "proprietart," and "propriety." We did not use ambiguous terms such as "NA" and "N/A," one of which ("n/a") was used in a previous analysis of FracFocus.<sup>78</sup> These search terms may indicate secret chemical use in some cases but not in others.

FracTracker limited its analysis to wells with fracturing job end dates of January 1, 2013 or later and wells with fracturing job start dates of December 31, 2017 or earlier. FracTracker and Partnership for Policy Integrity made this decision because prior to November 2012, well operators submitted fracking

chemical disclosures to FracFocus only in Portable Document Format (PDF). These records cannot be searched for chemicals through automated computer search functions. In November 2012, FracFocus upgraded to what the organization calls “FracFocus 2.0,” giving well operators the option to submit records in eXtensible Markup Language (XML). Such records are searchable for chemicals with automated computer search functions. Beginning on June 1, 2013, FracFocus made XML the exclusive format for fracking chemical disclosures. FracTracker and PFPI were, therefore, confident that searches for secret fracking chemicals disclosed in 2013 would show at least a significant portion of the secret chemicals used in Pennsylvania’s unconventional gas wells in that year and in all such wells through 2017. We believed that this set of five years of relatively complete disclosures would provide a robust picture of secret fracking chemical use. We excluded 2018 chemical disclosures simply because the year is not yet complete.

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<sup>1</sup> U.S. Environmental Protection Agency. Hydraulic fracturing for oil and gas: impacts from the hydraulic fracturing water cycle on drinking water resources in the United States. Washington, DC: Office of Research and Development, at ES-29, 3-14, 3-15, 10-14; 2016. EPA Report # 600/R-16/236F. See <https://www.epa.gov/hfstudy>. [hereinafter EPA Fracking & Drinking Water Study, 2016]

<sup>2</sup> U.S. Environmental Protection Agency. SAT Report for confidential chemical with tracking number P-09-0085 (Dec. 9, 2008). U.S. Environmental Protection Agency. Focus Report for confidential chemical with tracking number P-12-0072 (Dec. 15, 2011).

<sup>3</sup> EPA Fracking & Drinking Water Study, 2016, at 10-14.

<sup>4</sup> Id. at 3-18 through 3-22, 6-67.

<sup>5</sup> Id. at 5-7, 5-16.

<sup>6</sup> Id. at 5-11.

<sup>7</sup> Id. at 5-56, 5-57, 8-11, 8-12.

<sup>8</sup> Id. at 9-1.

<sup>9</sup> Id. at Appendix G-12.

<sup>10</sup> Id. at Appendix G-14, G-15.

<sup>11</sup> Id. at Appendix G-56. E.L. Rowan et al. U.S. Geological Survey. Radium Content of Oil- and Gas-Field Produced Waters in the Northern Appalachian Basin (USA): Summary and Discussion of Data. See <https://pubs.usgs.gov/sir/2011/5135/>.

<sup>12</sup> Wylie S. Corporate bodies and chemical bonds: an STS analysis of natural gas development in the United States. Ph.D. Thesis in History, Anthropology, and Science, Technology and Society. See <https://dspace.mit.edu/handle/1721.1/69453>; 2011. DeGette D. Boom in gas drilling fuels concerns in Colorado. News Release 2009. See <https://degette.house.gov/media-center/in-the-news/boom-in-gas-drilling-fuels-contamination-concerns-in-colorado>.

<sup>13</sup> Lustgarten A. New York’s gas rush poses environmental threat. ProPublica 2008. See <https://www.propublica.org/article/new-yorks-gas-rush-poses-environmental-threat-722>. Associated Press. Halliburton Begins Disclosing Hydrofracking Chemicals Used in Pennsylvania on New Website (Nov. 15, 2010). See [https://www.syracuse.com/have-you-heard/index.ssf/2010/11/halliburton\\_begins\\_disclosing.html](https://www.syracuse.com/have-you-heard/index.ssf/2010/11/halliburton_begins_disclosing.html). Laura Legere. Gas Rules Offer More – But Not Complete – Disclosure of Fracking Chemicals. Scranton Times-Tribune (Nov. 7, 2010). See <https://www.thetimes-tribune.com/news/gas-rules-offer-more-but-not-complete-disclosure-of-fracking-chemicals-1.1060647>

<sup>14</sup> Dusty Horwitt, Hydraulic Fracturing Chemical Disclosure: Can the Public Know What’s Going Into Oil and Gas Wells? in Environmental Issues Concerning Hydraulic Fracturing, Vol. 1, at 76-78.

<sup>15</sup> 58 Pa.C.S. § 3203. Definitions, “Unconventional Formation” and “Unconventional Well.”

<sup>16</sup> EPA Fracking & Drinking Water Study, 2016 at 3-7.

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See <https://www.epa.gov/hfstudy>. Schlumberger. Oilfield Glossary. Unconventional Resource. Accessed online at [http://www.glossary.oilfield.slb.com/en/Terms/u/unconventional\\_resource.aspx](http://www.glossary.oilfield.slb.com/en/Terms/u/unconventional_resource.aspx).

<sup>17</sup> 58 Pa.C.S. § 3222 (b) and (b.1), 3222.1(b).

<sup>18</sup> 58 Pa.C.S. § 3222 (b.1)(1)(iii), § 3222.1 (b)(2), and Pa. Rules Title 25 § 78a.122 (b) (unconventional wells).

<sup>19</sup> 58 Pa.C.S. § 3222.1 (b)(2).

<sup>20</sup> U.S. Department of Energy. Secretary of energy advisory board task force report on FracFocus 2.0, at 2, 23. See [https://www.energy.gov/sites/prod/files/2014/04/f14/20140328\\_SEAB\\_TF\\_FracFocus2\\_Report\\_Final.pdf](https://www.energy.gov/sites/prod/files/2014/04/f14/20140328_SEAB_TF_FracFocus2_Report_Final.pdf). See, e.g., Schlumberger N.V. (Schlumberger Limited), Form 10-K filed with U.S. Securities and Exchange Commission (Feb. 16, 2007), at 81 (listing John Deutch as one of the company’s directors).

<sup>21</sup> Id. at 2.

<sup>22</sup> Id. at 13.

<sup>23</sup> Id. at 7.

<sup>24</sup> Dusty Horwitt, Hydraulic Fracturing Chemical Disclosure: Can the Public Know What’s Going Into Oil and Gas Wells? in Environmental Issues Concerning Hydraulic Fracturing, Vol. 1, at 97. Kevin A. Schug and Zacariah L. Hildenbrand, eds.

<sup>25</sup> Pennsylvania General Assembly. Act of Feb. 14, 2012, P.L. 87, No. 13. See <https://bit.ly/2wFJv2s>.

<sup>26</sup> American Chemical Society. CAS registry fact sheet. See

<https://www.cas.org/about-cas/cas-fact-sheets/registry-fact-sheet>; 2017. American Chemical Society. CAS fact sheet. See <https://www.cas.org/about-cas/cas-fact-sheets>; 2017. FracFocus. What chemicals are used. See <http://fracfocus.org/chemical-use/what-chemicals-are-used>; 2017.

<sup>27</sup> Telephone interview with David Brown (Aug. 28, 2018).

<sup>28</sup> 58 Pa.C.S. § 3222.1 (b).

<sup>29</sup> 58 Pa.C.S. § 3222(b.2).

<sup>30</sup> See, e.g., Premanufacture Notice for EPA record number P-12-0072 (a “clay and shale formation stabilizer in well stimulation and drilling mud formulations”). The company’s manufacturer, CorsiTech (now owned by EcoLab) declared its CAS number confidential. EPA had health concerns about the chemical including blood, developmental, kidney, and liver toxicity. See EPA record number P-12-0072, FOCUS Report (Dec. 15, 2011) at 2.

<sup>31</sup> 58 Pa.C.S. § 3203, Definitions, “Well operator.”

<sup>32</sup> 58 Pa.C.S. § 3222.1 (b)(1).

<sup>33</sup> 58 Pa.C.S. § 3222.1 (b)(9).

<sup>34</sup> 58 Pa.C.S. § 3222.1 (d)(2)(ii).

<sup>35</sup> Robinson Twp. v. Commonwealth, 147 A.3d 536, 575-576 (Pa. 2016).

<sup>36</sup> U.S. Department of Labor. Occupational Safety and Health Administration. Hazard Communication Standard. See <https://www.osha.gov/dsg/hazcom/index.html>; 2017. U.S. Department of Labor. Occupational Safety and Health Administration. Hazard Communication Standard, FAQ’s, What Hazard Communication Standard Provisions are Unchanged in the Revised HCS? See <https://www.osha.gov/dsg/hazcom/hazcom-faq.html>. U.S. Department of Labor. Occupational safety and health administration. 29 CFR § 1910.1200; 2018.

<sup>37</sup> Petitioners’ pleading filed in Robinson Twp. v. Commonwealth, Docket No. 284 MD 2012 (June 9, 2014), at 11 FN6.

<sup>38</sup> Permittee Range Resources – Appalachia, LLC’s Amended Responses and Objections to Appellant’s Request for Production of Documents and Request for Admission. Filed with Commonwealth of Pennsylvania Environmental Hearing Board (April 24, 2013).

<sup>39</sup> Id.

<sup>40</sup> Kate Konschnik, Margaret Holden, Alexa Shasteen. Legal fractures in chemical disclosure Laws: why the voluntary chemical disclosure registry FracFocus fails as a regulatory compliance tool. Harvard Law School, Environmental Law Program Policy Initiative; 2013, at 5. See <http://blogs.harvard.edu/environmentallawprogram/files/2013/04/4-23-2013-LEGAL-FRACTURES.pdf>. 29 CFR § 1910.1200; 2018.

<sup>41</sup> West Virginia Department of Environmental Protection. API number explanation. See

<http://www.dep.wv.gov/oil-and-gas/GI/Documents/API%20Number%20Explanation.pdf>; 2017. The API Well Number used to be assigned and maintained by the American Petroleum Institute (API), but in 2010, API transferred the system of well classification to Professional Petroleum Data Management Association. The association has

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since renamed the well number the “US Well Number” and modified the numbering system. Professional Petroleum Data Management Association. US Well Number Standard. See [https://ppdm.org/ppdm/PPDM/Well\\_ID\\_US\\_WG.aspx?WebsiteKey=927055e8-ec5d-4b51-96ef-5dbe0a133439](https://ppdm.org/ppdm/PPDM/Well_ID_US_WG.aspx?WebsiteKey=927055e8-ec5d-4b51-96ef-5dbe0a133439). The term API Number is still used, however, including in the FracFocus database.

- <sup>42</sup> Records from FOIA request EPA-HQ-2015-001149 on file with PFPI.
- <sup>43</sup> See, e.g., EPA record number L-14-0273, FOCUS Report (April 30, 2014).
- <sup>44</sup> See, e.g., EPA record number P-13-0369, SAT Report (Aug. 19, 2014) at 2.
- <sup>45</sup> See, e.g., EPA record number P-12-0072, FOCUS Report (Dec. 15, 2011) at 2.
- <sup>46</sup> See, e.g., EPA record number P-10-0050, SAT Report (Nov. 26, 2014) at 2.
- <sup>47</sup> Dusty Horwitt. Toxic Secrets. Partnership for Policy Integrity (April 7, 2016), at 22-27. See [http://www.pfpi.net/wp-content/uploads/2016/04/PFPI\\_ToxicSecrets\\_4-7-2016.pdf](http://www.pfpi.net/wp-content/uploads/2016/04/PFPI_ToxicSecrets_4-7-2016.pdf).
- <sup>48</sup> See, e.g., U.S. Government Accountability Office. High-risk Series: an update. [Publication No. GAO-09-271]; 2009, at 22-24. See <http://www.gao.gov/assets/290/284961.pdf>. U.S. Government Accountability Office. High-risk Series: an update. [Publication No. GAO-15-290]; 2017, at 425-429. See <http://www.gao.gov/assets/690/682765.pdf>.
- <sup>49</sup> Many of the findings from our investigation are contained in a report we published in 2016. See Dusty Horwitt. Toxic Secrets (April 7, 2016). See [http://www.pfpi.net/wp-content/uploads/2016/04/PFPI\\_ToxicSecrets\\_4-7-2016.pdf](http://www.pfpi.net/wp-content/uploads/2016/04/PFPI_ToxicSecrets_4-7-2016.pdf). Two stories broadcast by Marketplace on NPR contain updated information about our investigation. See Scott Tong. Documents Show Undisclosed EPA Health Concerns on Fracking Chemicals (Nov. 14, 2017). See <https://www.marketplace.org/2017/11/14/world/documents-show-undisclosed-epa-health-concerns-fracking-chemicals-0>. Scott Tong. “The Public Has a Right to Know”: Fracking Companies Don’t Have to Disclose Chemicals Linked to Health Concerns. Marketplace (Nov. 15, 2017). See <https://www.marketplace.org/2017/11/15/sustainability/epas-legalized-suppression-fracking-chemical-secrets>.
- <sup>50</sup> 40 CFR § 720.85 (a)(2) and (a)(3).
- <sup>51</sup> Eliza Griswold. *Amity and Prosperity* (2018), at 12-13, 41, 50-51, 53.
- <sup>52</sup> *Id.* at 259-261.
- <sup>53</sup> Telephone interview with John Smith (August 15, 2018).
- <sup>54</sup> Eliza Griswold. *Amity and Prosperity*, at 302-304.
- <sup>55</sup> Peter Rabinowitz et al. Proximity to natural gas wells and reported health status: results of a household survey in Washington County, Pennsylvania. *Environmental Health Perspectives* (2015) 123, 21-26. doi: 0.1289/ehp.1307732. See <https://ehp.niehs.nih.gov/1307732/>.
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- <sup>58</sup> Beth Weinberger et al. Health symptoms in residents living near shale gas activity: A retrospective record review from the Environmental Health Project, *Preventive Medicine Reports* 8 (2017) 112-115.
- <sup>59</sup> EPA Fracking & Drinking Water Study, 2016 at 10-3.
- <sup>60</sup> Range Resources Corp. Form 10-K, filed with the U.S. Securities and Exchange Commission (Feb. 28, 2018), at 29.
- <sup>61</sup> Noble Energy, Inc. Form 10-K, filed with the U.S. Securities and Exchange Commission (Feb. 20, 2018), at 50.
- <sup>62</sup> EPA Fracking & Drinking Water Study, 2016 at 5-62, 5-63.
- <sup>63</sup> U.S. Environmental Protection Agency. Hydraulic fracturing for oil and gas: impacts from the hydraulic fracturing water cycle on drinking water resources in the United States. Washington, DC: Office of Research and Development; 2016, at 10-25. EPA Report # 600/R-16/236F. See <https://www.epa.gov/hfstudy>.
- <sup>64</sup> U.S. Environmental Protection Agency. Hydraulic fracturing for oil and gas: impacts from the hydraulic fracturing water cycle on drinking water resources in the United States. Washington, DC: Office of Research and Development; 2016, at ES-45 to ES-46 and 9-1. EPA Report # 600/R-16/236F. See <https://www.epa.gov/hfstudy>.
- <sup>65</sup> 58 Pa. Cons. Stat. § 3222.1 (b)(3) and Pa. Rules Title 25 § 78a.122 (b).
- <sup>66</sup> U.S. Environmental Protection Agency. (2016). Table of Regulated Drinking Water Contaminants. Retrieved from <http://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants>. Agency for Toxic



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- <sup>67</sup> U.S. Environmental Protection Agency. (2016). Table of Regulated Drinking Water Contaminants. Retrieved from <http://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants>. Agency for Toxic Substances & Disease Registry. Benzene. See <https://www.atsdr.cdc.gov/substances/toxsubstance.asp?toxid=14>. EPA National Fracking & Drinking Water Study, at 5-57.
- <sup>68</sup> City of Philadelphia. Water. See <http://www.phila.gov/water/wu/Pages/default.aspx>.
- <sup>69</sup> Delaware River Basin Commission, Administrative Manual and Special Regulations Regarding Natural Gas Development Activities; Additional Clarifying Amendments, 83 Fed. Reg. 1586, 1588 (proposed Jan. 12, 2018).
- <sup>70</sup> Delaware River Basin Commission. Basic Information. See <http://www.state.nj.us/drbc/basin/>. Delaware River Basin Commission. Resolution directing the Executive Director to publish for public comment revised draft regulations regarding certain natural gas development activities in the Delaware River Basin (Sept. 11, 2017). Accessed at [http://www.state.nj.us/drbc/library/documents/ResForMinutes\\_nat-gas\\_initiate-rulemkgDRAFT.pdf](http://www.state.nj.us/drbc/library/documents/ResForMinutes_nat-gas_initiate-rulemkgDRAFT.pdf). City of Philadelphia. Drinking Water Treatment. See <http://www.phila.gov/water/wu/drinkingwater/treatment/Pages/default.aspx>.
- <sup>71</sup> Delaware River Basin Commission, Administrative Manual and Special Regulations Regarding Natural Gas Development Activities; Additional Clarifying Amendments, 83 Fed. Reg. 1586, 1589 (proposed Jan. 12, 2018).
- <sup>72</sup> Delaware River Basin Commission. Proposed New 18 CFR Part 440 – Hydraulic Fracturing in Shale and Other Formations, 440.1, 440.5(f).
- <sup>73</sup> EPA Fracking & Drinking Water Study, 2016 at 8-34.
- <sup>74</sup> 58 Pa.C.S. § 3222.1 (b)(2).
- <sup>75</sup> U.S. Department of Energy. Secretary of energy advisory board task force report on FracFocus 2.0, at 2. See [https://www.energy.gov/sites/prod/files/2014/04/f14/20140328\\_SEAB\\_TF\\_FracFocus2\\_Report\\_Final.pdf](https://www.energy.gov/sites/prod/files/2014/04/f14/20140328_SEAB_TF_FracFocus2_Report_Final.pdf).
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- <sup>77</sup> FracFocus. FracFocus Data Download. See <http://fracfocus.org/data-download>.
- <sup>78</sup> Archana Dayalu and Katherine Konschnik. FracFocus Chemical Disclosure Registry 1.0 and 2.0 Data Conversion and Cleaning Methods Paper, at 13, Supplement to Archana Dayalu and Katherine Konschnik, Hydraulic Fracturing Chemicals Reporting: Analysis of Available Data and Recommendations for Policymakers, Energy Policy 88 (2016) 504-514. See <https://dataverse.harvard.edu/file.xhtml?persistentId=doi:10.7910/DVN/EFNV5J/TG0ZOC&version=3.0>. The authors conducted part of their analysis including CAS Numbers identified as “n/a,” but excluded these designations for another portion of their analysis.