

DUSTY HORWITT, J.D.**ENVIRONMENTAL POLICY EXPERIENCE****Physicians for Social Responsibility, Washington, DC: Consultant, 8/20-present**

- Wrote groundbreaking reports on use in oil and gas wells of forever chemicals (PFAS) nationally and in six states; reports received coverage in outlets including *New York Times*, *Philadelphia Inquirer*, *Denver Post*; report on Colorado prompted the state to enact law banning PFAS in oil and gas extraction and improving oil and gas chemical disclosure; report on New Mexico prompted petition to replicate Colorado's law through regulations; scheduled to serve as expert witness in support of New Mexico's proposed regulations; coordinated with advocates, attorneys, chemists, government staff, to analyze chemical records and develop policy recommendations and advocacy strategies; secured grant funding

Partnership for Policy Integrity, Washington, DC: Senior Counsel, 1/15-7/20**Oil and Gas Program**

- Led five-year project using Freedom of Information Act to investigate secret and potentially toxic drilling and fracking chemicals; wrote reports; secured grant funding; hired interns
 - wrote report on secret fracking chemical use in Ohio; collaborated with battalion chief of Youngstown Fire Department, state NAACP, and others, covered by *Akron Beacon Journal*, *Columbus Dispatch*, *Newsweek*; Ohio Hazardous Materials/Weapons of Mass Destruction Technical Advisory Committee circulated report to hazmat teams
 - wrote report on secret fracking chemical use in Pennsylvania; activists used report to persuade the Delaware River Basin Commission to ban fracking and related activities in the basin, and the Commission enacted a fracking ban in 2021; covered by *WHYY*-radio, *Scranton Times-Tribune*, *StateImpact*
 - helped organize 100+ first responders, health professionals, and scientists to ask EPA to reveal secret drilling and fracking chemicals; covered by *Marketplace (NPR)*
- Wrote chapter on fracking chemical disclosure in *Environmental Issues Concerning Hydraulic Fracturing, Vol. 1* (2017), a textbook published by Elsevier
- Submitted testimony to EPA on agency's study of fracking and drinking water; EPA echoed testimony in removing draft conclusion that fracking was relatively harmless
- Wrote comments urging PA to avoid using natural gas to comply with Clean Power Plan

Bioenergy Program

- Authored petition to Securities and Exchange Commission urging better disclosure of climate impacts of biomass-based products; covered by *Wall Street Journal* among others
- Drafted letters and organized environmental groups in DC, Md., Mass., Ohio and Va. to urge EPA not to treat bioenergy as "carbon neutral" under Clean Power Plan
 - helped convince U.S. Sens. Edward Markey and Elizabeth Warren and U.S. Reps. Don Beyer and Gerald Connolly to send similar letters to EPA

Legal Counsel

- Wrote PFPI's policy on lobbying and political activity; secured media liability coverage

Earthworks, Washington, DC: Senior Analyst, 7/13-8/14

Oil and Gas Program

- Developed and implemented strategy that helped influence Obama administration to ban drilling and fracking in most of George Washington National Forest
 - o placed stories about risks of drilling in *Washington Post*, *L.A. Times*, *WAMU*-radio (NPR)
 - o persuaded government officials in DC area to oppose drilling in forest including DC Water, Alexandria mayor, Arlington County Board, Falls Church City Council, and former Lt. Gov. Don Beyer (now U.S. Rep.)
 - o worked with Sierra Club and others to host nine public forums; filed FOIA requests
- Authored major report on how lax regulations contributed to excessive flaring of natural gas in North Dakota and Texas; received coverage on North Dakota public radio
- Drafted detailed public comments on NY state energy plan highlighting risks of natural gas

Environmental Working Group (EWG), Washington, DC: Senior Counsel, 1/04-6/13

Natural Resources Program

- Developed and led organization's natural resources program focused on oil and gas drilling and metal mining; researched and wrote reports, designed legal, media, and outreach strategies, coordinated with conservation organizations, hunters, anglers and public officials
- Worked extensively with NY elected officials and conservation organizations on efforts that led to ban on high-volume fracking in NY; designed Freedom of Information strategy that resulted in front-page story in the *Albany Times-Union* showing that regulators improperly shared draft regulations exclusively with the drilling industry weeks before sharing them with public
- Conceived, researched, and wrote reports on hydraulic fracturing that included consultation with chemical experts and review of scientific literature; received coverage in outlets including *New York Times*, *Baltimore Sun*, *Dallas Morning News*, *The Diane Rehm Show* and *Marketplace* (NPR); reports helped build support for NY ban on high-volume fracking and helped inspire 2011 Congressional investigation showing widespread use of diesel fuel in hydraulic fracturing and apparent violations of federal law
- Designed reports and outreach strategy to protect Grand Canyon and Colorado River from uranium mining; resulted in a 2012 decision by Secretary of the Interior to protect more than one million acres near the canyon from new mining claims for 20 years, the maximum duration allowed by federal law; built relationships with major Western water providers

Testimony and Public Speaking

- Testified five times before New York City Council on impact of natural gas drilling on city's drinking water, helping to build support for New York State ban on high-volume fracking
- Spoke to citizens' groups and local elected officials in New York, Ohio, Pennsylvania and Virginia to raise awareness about risks of natural gas drilling
- Testified before U.S. Senate and U.S. House of Representatives on mining law reform
- Served as spokesperson in dozens of interviews with outlets including *the Denver Post*, *Los Angeles Times*, and *Wall Street Journal*

Fundraising and Administration

- Secured grants from environmental foundations; hired and supervised interns

CAPITOL HILL EXPERIENCE

U.S. Senator Richard J. Durbin, Washington, DC: Deputy Press Secretary, 2/97-6/99

- Developed messages for and wrote the Senator's newspaper columns and press releases on issues ranging from health insurance to defense spending and the Fair Labor Standards Act
- Produced, wrote, and directed the Senator's monthly television shows

LEGAL EXPERIENCE

Venable LLP, Washington, DC: Summer Associate, 5/01-8/01; Associate, 9/02-8/03

- Researched legal issues for Litigation Group for case on financial fraud
- Prepared discovery materials and deposition strategy for complex litigation

JOURNALISM AND WRITING EXPERIENCE

Freelance Writing

- Researched and published articles on policy and cultural issues in *Detroit News*, *Lansing City Pulse*, *Legal Affairs*, *New York Newsday*, *O, The Oprah Magazine*, *The Washington Post*, and others; received honorable mention in *Best Music Writing 2008* by Da Capo Press

The City News Bureau of Chicago, Chicago, IL: Reporter, 1/95-6/95

- Covered several stories per day from homicides and court hearings to appearances by newsmakers such as Hillary Clinton and Jesse Jackson

EDUCATION

Georgetown University Law Center: Juris Doctor; current member Virginia State Bar

- Wrote paper for Professor Lisa Heinzerling on increasing physical activity for health and environmental benefits; adapted paper for piece published in *O, the Oprah Magazine*
- Wrote paper for Professor Steven Goldberg on the use of cell phones and highway safety; published article in Notre Dame Law School *Journal of Legislation*, 2002

Brown University: B.A. in History

- Significant coursework in biology, geology, environmental studies
- Reporter and features editor for the *Brown Daily Herald*

VOLUNTEERING AND INTERESTS

- Member of Lansing (Michigan) Board of Water & Light Board of Commissioners and Chair of Finance Committee, 10/21-7/23
- Board member of Lansing-based non-profit Capital Area Friends of the Environment
- Certified Energy Master by Virginia Cooperative Extension
- Organized public ceremonies at former high school in Arlington, Virginia, previously Stratford Junior High, Virginia's first racially integrated public school, to commemorate desegregation of Virginia public schools, which occurred at Stratford in 1959; led effort to name new middle school after Dorothy Hamm, an African-American activist who helped lead a lawsuit integrating Stratford and schools throughout Virginia; worked to replace Confederate names in Arlington
- Basketball coach in Arlington, Virginia youth league, guitar, piano, songwriting

**STATE OF NEW MEXICO
DEPARTMENT OF ENERGY, MINERALS AND NATURAL RESOURCES
OIL CONSERVATION COMMISSION**

**IN THE MATTER OF PROPOSED
AMENDMENT TO THE COMMISSION'S
RULES TO ADDRESS CHEMICAL DISCLOSURE AND
THE USE OF PERFLUOROALKYL AND
POLYFLUOROALKYL SUBSTANCES AND
IN OIL AND GAS EXTRACTION,
19.15.2, 19.15.7, 19.15.14, 19.15.16 AND 19.15.25 NMAC**

CASE NO. 23580

DIRECT TECHNICAL TESTIMONY AND EXHIBITS

OF

DUSTY HORWITT, JD

ON BEHALF OF WILDEARTH GUARDIANS

October 21, 2024

1 My name is Dusty Horwitt, and I am a consultant with Physicians for Social
2 Responsibility, a nonprofit organization that works to protect health and the environment. I have
3 spent nearly 20 years conducting research on the health and environmental impacts of oil and gas
4 drilling and fracking and working to protect communities from these impacts. Some of my work
5 has focused on New Mexico. I am an attorney, member of the Virginia State Bar, and a former
6 reporter. I have written a chapter on fracking chemical disclosure for a textbook published by
7 Elsevier in 2017.¹ Multiple media outlets have reported on my work including the *Carlsbad*
8 *Current Argus*,² *NM Political Report*,³ *Santa Fe New Mexican*,⁴ *The Wall Street Journal*,⁵ and
9 *Marketplace* on NPR.⁶ My CV is attached as WG Ex. 9.

10 For the past four years, I have conducted extensive research on the use of PFAS in oil and
11 gas extraction. PFAS are formally known as per- and polyfluoroalkyl substances.⁷ They are a
12 class of laboratory-made chemicals that have useful properties including being oil- and water-
13 resistant.⁸ However, PFAS also have significant harmful characteristics. They are extremely
14 toxic,⁹ are associated with multiple negative health effects including cancer,¹⁰ can be highly
15 mobile in water,¹¹ and are resistant to breaking down in the environment due to a bond between
16 carbon and fluorine atoms,¹² hence their nickname, “Forever Chemicals.” I am the author of
17 PSR’s report *Fracking with Forever Chemicals*¹³ published in 2021, about the use of PFAS in
18 fracking nationally. I am also the lead author of PSR’s reports about the use of PFAS in oil and
19 gas extraction in several states including Colorado,¹⁴ Ohio,¹⁵ Pennsylvania,¹⁶ Texas,¹⁷ West
20 Virginia,¹⁸ and New Mexico.¹⁹ These reports have been covered by outlets including the news
21 organizations based in New Mexico mentioned earlier and also by the *Columbus Dispatch*,²⁰
22 *Denver Post*,²¹ and *New York Times*,²² among others. In 2022, I was invited to testify before the
23 Colorado House of Representatives and State Senate regarding legislation, later signed into law,

1 that banned the use of PFAS in oil and gas wells in Colorado and improved oil and gas chemical
2 disclosure in the state including by requiring disclosure of individual chemicals injected into oil
3 and gas wells without the use of trade secret protections.²³ This prohibition on the use of trade
4 secret chemicals was similar to a provision in a law enacted by California in 2015 which required
5 disclosure of individual chemicals used to stimulate oil and gas wells without the use of trade
6 secret protections.²⁴ Both Colorado's and California's laws echoed the recommendations of an
7 advisory panel to the U.S. Department of Energy in 2014. The panel recommended that oil and
8 gas companies completely disclose the individual chemicals injected into oil and gas wells
9 during hydraulic fracturing without concealing any chemicals through trade secret claims. The
10 panel found that chemical makers frequently believe that the formulas of chemical additives or
11 products used in fracking, which may include several or many individual chemicals, are more
12 important to protect with trade secret claims than the identities of these additives' or products'
13 individual chemical components.²⁵ The 2014 panel also endorsed a finding by a prior DoE panel
14 that "the high level of public concern about the nature of fracturing chemicals suggests that the
15 benefit of immediate and complete disclosure of all chemical components and composition of
16 fracturing fluid completely outweighs the restriction on company action, the cost of reporting,
17 and any intellectual property value of proprietary chemicals."²⁶ The 2014 panel then
18 recommended that oil and gas companies make fracking chemical disclosures "by reporting a list
19 of products and chemicals added [to each oil and gas well] without disclosing which chemical is
20 in each product." Such disclosure would make it extremely difficult, the panel found, for
21 competitors to steal chemical formulas by reverse engineering the list of individual chemicals
22 into a chemical product.²⁷ As one witness told a grand jury investigating pollution from the oil
23 and gas industry in Pennsylvania, "it is like the back of the Kentucky Fried Chicken box

Ingredients do not make a recipe.”²⁸ The petition that is the subject of this week’s hearing asks the New Mexico Oil Conservation Commission to implement rules similar to the law enacted in Colorado. Adopting the rules proposed in the Amended Application for Rulemaking would be an important step forward for New Mexico; these rules would help protect people and the environment, including precious water supplies, from PFAS pollution.

I first learned that PFAS might be used in oil and gas extraction as a result of a Freedom of Information Act request sent to the U.S. Environmental Protection agency in 2014 by Earthworks, an environmental nonprofit where I worked at the time.²⁹ The request asked EPA to disclose its health reviews and regulatory determinations for new chemicals proposed for use in several types of oil and gas extraction including drilling and fracking. EPA conducts these reviews and determinations under the Toxic Substances Control Act’s New Chemicals program that is designed to protect human health and the environment from risks of new chemicals. Over the next several years, EPA responded to the Freedom of Information Act request by disclosing thousands of pages of documents. The documents were challenging to read in part because of multiple trade secret claims, allowed under the Toxic Substances Control Act, that enable chemical manufacturers to conceal information about their chemicals from the public, though not from EPA.³⁰ After extensive analysis, I discovered that in one case reviewed by EPA in 2010-2011, the agency had approved for commercial use three chemicals proposed to be imported for oil and gas extraction.³¹ The chemicals’ manufacturer redacted as trade secrets multiple pieces of information related to the chemicals including the manufacturer’s own name, the chemicals’ specific use, the chemicals’ names, and the chemicals’ Chemical Abstracts Service numbers or CAS numbers.³² CAS numbers are unique identifiers assigned to each chemical by the American Chemical Society.³³ CAS Numbers are considered by scientists to be the best way to identify

chemicals because chemicals can have multiple names and trade names but only one CAS Number.³⁴ Under federal law, when chemical manufacturers redact a chemical's CAS number, they must supply a generic name which provides the public with some idea about the nature of the chemical.³⁵ In this case, the chemical manufacturer supplied a single generic name for all three chemicals: "fluorinated acrylic alkylamino copolymer." Similarly, when manufacturers or importers declare a chemical's specific use to be confidential, they must list a generic use.³⁶ Here, the generic use was listed as "oil and water repellent and release agent."³⁷

EPA regulators expressed concern in writing that these chemicals could degrade into substances similar to PFOA, the most infamous type of PFAS.³⁸ As early as 2005, EPA knew about health and environmental risks associated with PFOA³⁹ and in 2006, EPA created a "stewardship" program in which chemical manufacturers promised to phase out the use and emissions from PFOA and other PFAS by 2015.⁴⁰ Perhaps EPA regulators had these actions on their minds when they reviewed the three chemicals in 2011. "EPA has preliminary evidence," the agency wrote, "including data on other [REDACTED], that suggests that, under some conditions, the...substances could degrade in the environment. EPA has concerns that these degradation products will persist in the environment, could bioaccumulate or biomagnify, and could be toxic (PBT) to people, wild mammals, and birds based on data on analog chemicals, including PFOA and [REDACTED]."⁴¹ The regulators also expressed health concerns about the degradation products of the substances including "liver toxicity, blood toxicity, and male reproductive toxicity....There is also concern for immunosuppression and oncogenicity based on data for [REDACTED]."⁴²

Nonetheless, EPA approved the chemicals for commercial use under certain conditions, many of which were redacted.⁴³ On November 29, 2011, the undisclosed company that had

1 requested that EPA approve the three new chemicals began importing one of the chemicals for
2 commercial use. This chemical was known by EPA case number P-11-0091, according to a
3 document filed with EPA.⁴⁴ EPA records as of 2019 also showed that chemical P-11-0091 was
4 manufactured between August 11, 2018 and August 10, 2019, and may therefore have been used
5 in oil and gas wells, among other uses, at least as recently as this manufacturing period.⁴⁵

6 While working with Physicians for Social Responsibility, I tried to locate this chemical
7 by searching in the FracFocus database for its generic name, fluorinated acrylic alkylamino
8 copolymer. The FracFocus database is maintained by the Groundwater Protection Council,⁴⁶ a
9 nonprofit comprised of regulators from state agencies that regulate groundwater.⁴⁷ The database
10 contains well-by-well hydraulic fracturing chemical disclosure for more than 200,000 hydraulic
11 fracturing treatments,⁴⁸ and 27 states either require or allow oil and gas companies to disclose
12 fracking chemical information to the database.⁴⁹ Since 2017, FracFocus has served as the official
13 repository for hydraulic fracturing chemical disclosure in New Mexico.⁵⁰ FracFocus is the most
14 comprehensive and accessible database of chemicals used in oil and gas wells in the United
15 States even though it shows only fracking chemicals used in oil and gas wells and not all of the
16 chemicals injected downhole including chemicals used in drilling or other stages and methods of
17 oil and gas extraction. Despite the voluminous records stored in FracFocus, I was unable to find
18 evidence of the use in any state of fluorinated acrylic alkylamino copolymer.

19 However, I did find evidence that between 2012 and 2020, oil and gas companies had
20 used several other chemicals for hydraulic fracturing that are PFAS, likely PFAS, or chemicals
21 that could break down into PFAS. These chemicals included meta-
22 Perfluorodimethylcyclohexane and Perfluoro-1,3-dimethylcyclohexane that are listed on EPA's
23 "Master List of PFAS Substances."⁵¹ They also included fluorinated benzoic salts, Fluoroalkyl

1 Alcohol Substituted Polyethylene Glycol, fluoro surfactants – proprietary, nonionic
2 fluorosurfactant (and multiple misspellings of the same term).⁵² PSR consulted with several
3 scientists about whether these chemicals were PFAS. Zacariah Hildenbrand, a research professor
4 in Chemistry and Biochemistry at the University of Texas at El Paso, and Kevin Schug,
5 Shimadzu Distinguished Professor of Analytical Chemistry at the University of Texas at
6 Arlington said that the chemicals were PFAS or could degrade into PFAS. Wilma Subra, who
7 holds a master’s degree in chemistry and has received a John D. and Catherine T. MacArthur
8 Foundation “Genius” Grant for her work helping to protect communities from toxic pollution,
9 identified all of the chemicals as potentially PFAS. Linda Birnbaum, a board-certified
10 toxicologist and former director of the National Institute of Environmental Health Sciences,
11 informed PSR that all of the chemicals are likely to be PFAS.⁵³ The companies used these
12 chemicals in oil and gas wells located in Arkansas, Louisiana, Oklahoma, New Mexico, Texas,
13 and Wyoming.⁵⁴ In New Mexico, we found evidence that companies used both nonionic
14 fluorosurfactants and fluoroalkyl alcohol substituted polyethylene glycol in dozens of wells.⁵⁵ In
15 July 2021, PSR published these findings and our findings about EPA’s approval of the PFOA-
16 like substances in a report entitled “Fracking with ‘Forever’ Chemicals.” We noted that PFAS
17 used in oil and gas wells could put people at risk through multiple exposure pathways, many of
18 them identified by the U.S. Environmental Protection Agency in its 2016 report on fracking and
19 drinking water.⁵⁶

20 We have since focused on the use of PFAS in oil and gas wells in particular states
21 including New Mexico. In April 2023, we published a report about our findings in New Mexico
22 entitled “Fracking with ‘Forever Chemicals’ in New Mexico.” We analyzed the disclosures of
23 chemicals used in hydraulic fracturing of oil and gas wells that oil and gas companies made to

1 the state of New Mexico and/or to the FracFocus database between January 1, 2013 and
2 September 29, 2022. We relied on the open-source version of FracFocus, Open-FF, which is
3 more accurate and informative than the original version of FracFocus but is based on the same
4 data.⁵⁷

5 We found that oil and gas companies have used PFAS for fracking in New Mexico.
6 During our approximately decade-long study period, 22 oil and gas companies injected 227 wells
7 for fracking located across six counties with the PFAS called PTFE, also known as Teflon. We
8 identified the uses of PTFE through listings of the chemical's Chemical Abstracts Service
9 number, 9002-84-0 and by listings of the chemical's name, "Poly(tetrafluoroethylene)."⁵⁸ The
10 mass of these injections totaled 2,605 pounds based on the best available information from the
11 state of New Mexico and FracFocus.⁵⁹ We also found that EOG Resources, Inc. injected 34 wells
12 in Lea County with another PFAS called fluoroalkyl alcohol substituted polyethylene glycol. The
13 combined total weight of these injections was 6,400 pounds according to the best available data
14 from the state of New Mexico and FracFocus.⁶⁰ We identified the uses of fluoroalkyl alcohol
15 substituted polyethylene glycol both by listings of the chemical's Chemical Abstracts Service
16 number, 65545-80-4, and by related listings of the chemical's name.⁶¹ Both PTFE⁶² and
17 fluoroalkyl alcohol substituted polyethylene glycol⁶³ are listed on EPA's Master List of PFAS
18 Substances.

19 However, the number of oil and gas wells in New Mexico that we have been able to
20 definitively identify as fracked with PFAS may significantly underrepresent the total number of
21 such wells. The likely undercount is due in large part to a portion of New Mexico's law that
22 allows chemical manufacturers, well operators and other companies in the chemical supply chain
23 to withhold fracking chemical identities from the public and regulators by designating them as

“trade secrets.”⁶⁴ In our analysis, we classified a fracking chemical as a trade secret if its CAS number was listed as “trade secret,” “confidential,” or “proprietary.” We did not classify a fracking chemical as a trade secret if its CAS number were left blank.⁶⁵ Our data analysis revealed that, between 2013 and 2022, oil and gas well operators disclosed the use of fracking chemicals in 9,066 oil and gas wells in New Mexico⁶⁶ and claimed at least one fracking chemical as a trade secret in 8,293 of these wells – more than 90 percent – located across 11 counties.⁶⁷ The trade secret chemicals used in New Mexico over this roughly 10-year period totaled 243 million pounds according to the best available information from the state of New Mexico and FracFocus.⁶⁸

In an attempt to identify PFAS among these trade secret chemicals, PSR analyzed whether any trade secret chemicals were listed as a surfactant or a fluorosurfactant. According to EPA, surfactants are regularly used in fracking⁶⁹ and lower the surface tension of a liquid, the interaction at the surface between two liquids (called interfacial tension), or the interaction between a liquid and a solid.⁷⁰ Several scientists have written in a peer reviewed journal that compared to other surfactants, fluorosurfactants are “superior in their aqueous surface tension reduction at very low concentrations and are useful as wetting and leveling agents, emulsifiers, foaming agents, or dispersants.”⁷¹ At least some fluorosurfactants are PFAS, including the toxic chemicals PFOA and PFOS.⁷²

Like the larger class of surfactants, fluorosurfactants are also used in fracking, and perhaps other methods and stages of oil and gas production, according to scientific and industry sources. In 2020, several scientists published an article in *Environmental Science: Processes and Impacts* finding that since 1956, PFAS including fluorosurfactants had been used or proposed to be used globally in oil and gas extraction methods including chemical-driven gas production,

1 chemical flooding, fracking, and the drilling that precedes fracking and other oil and gas
2 production techniques.⁷³ In 2008, two authors, one of whom was identified as an employee at
3 chemical manufacturer DuPont, wrote in the peer reviewed *Open Petroleum Engineering*
4 *Journal* that the use of fluorosurfactants was relatively common in the oil and gas industry and
5 that their use was poised to grow. They called fluorosurfactants an “emerging technology” and
6 stated, “While fluorosurfactants have been used in gas and oil exploration for four decades, the
7 increased demand for petroleum and the greater understanding of the benefits of
8 fluorosurfactants have led to growing acceptance for fluorosurfactants throughout the petroleum
9 industry.”⁷⁴ The authors did not directly state that fluorosurfactants used in oil and gas operations
10 were PFAS but they characterized fluorosurfactants in ways that are typically used to describe
11 PFAS. They wrote that “The use of fluorosurfactants is a recent but growing trend due to (i) the
12 exceptional hydrophobic [water-repellent] and oleophobic [oil-repellent] nature of the
13 perfluoroalkyl and perfluoroalkyl ether groups...The bond strength of the carbon-fluorine bond in
14 perfluoroalkyl and perfluoroalkyl ether groups has been demonstrated as the key to remarkable
15 overall stability for fluorochemicals and fluoropolymers.”⁷⁵ This evidence suggests that any time
16 an unidentified surfactant or fluorosurfactant is used in oil and gas extraction, there is a potential
17 that it is a PFAS.

18 Between 2013 and 2022, we found that oil and gas companies used at least one trade
19 secret chemical that they described as a surfactant in 3,680 oil and gas wells in New Mexico,
20 located across 10 counties. PSR determined that a chemical was a surfactant if the chemical’s
21 ingredient name or purpose was listed as a surfactant in the state of New Mexico’s records or in
22 FracFocus. Operators’ names for these chemicals were imprecise, including “surfactant” and

1 “surfactant blend.” These trade secret surfactants totaled 19.3 million pounds based on the best
2 available data from FracFocus.

3 In a subset of the 3,680 wells injected with a trade secret surfactant between 2013 and
4 2022 – 16 wells in Eddy County and 8 wells in Lea County – several oil and gas companies
5 disclosed the use of trade secret fracking chemicals listed with the nonspecific name “nonionic
6 fluorosurfactant” that are apparently fluorosurfactants and may be PFAS. The weight of these
7 chemicals totaled 970 pounds according to the best available data from FracFocus.⁷⁶ Even if
8 some of that volume were PFAS, it could pose significant health and environmental risks,
9 depending on the chemicals’ toxicity.

10 Other types of chemicals used in fracking could pose health risks, too, particularly if
11 these chemicals were not disclosed as a result of trade secret claims, and New Mexicans were
12 unknowingly exposed. In 2016, the EPA published a study of fracking and drinking water in
13 which the agency identified 1,606 chemicals used in fracking fluid and/or found in fracking
14 wastewater, not including PFAS. It is unclear why the agency did not include PFAS in its report.
15 While the agency found high-quality information on health effects for only about 10 percent
16 (173) of the 1,606 chemicals, that information was troubling. EPA reported that health effects
17 associated with chronic oral exposure to these chemicals include carcinogenicity, neurotoxicity,
18 immune system effects, changes in body weight, changes in blood chemistry, liver and kidney
19 toxicity, and reproductive and developmental toxicity.⁷⁷ This information suggests that there is a
20 possibility that any chemical used in fracking operations with an identity concealed by trade
21 secret claims could pose significant health risks whether it is PFAS or not.

22 In addition to allowing trade secret exemptions for fracking chemicals, two additional
23 gaps in New Mexico’s chemical disclosure rules prevent the public from knowing the full list of

chemicals used in oil and gas wells and create the potential that the use of PFAS and other harmful chemicals in the state's oil and gas wells may be more extensive than reported. First, New Mexico does not require public disclosure of chemicals used in drilling, enhanced oil recovery, or in other extraction techniques that are distinct from fracking per se. Chemicals used during the first stage of the drilling process would be highly likely to leach into groundwater because, during this stage, as indicated by EPA, drilling passes directly through groundwater zones⁷⁸ before any casing or cement is inserted into the well to seal it off from the groundwater. The resulting risk of groundwater contamination makes public disclosure of chemicals used in drilling especially important so that New Mexicans will not be unknowingly exposed to PFAS and other chemicals used during oil and gas extraction. It is also possible that drilling chemicals could become part of the wastewater coming out of oil and gas wells⁷⁹ which has been linked to water contamination in New Mexico.⁸⁰ Researchers have found evidence that PFAS may have been used in drilling of oil and gas wells,⁸¹ raising the potential that PFAS may have been used on an undisclosed basis for drilling in New Mexico's oil and gas wells.

PFAS are not the only chemicals of concern that are, or could be used in drilling. In at least some cases, the New Mexico Oil Conservation Division has prohibited oil and gas companies from using "oil base muds" for drilling "until fresh water zones are cased and cemented providing isolation from the oil or diesel. This includes synthetic oils."⁸² Such "muds," according to oilfield services company Schlumberger, are "generally synonymous with drilling fluid."⁸³ According to the Oklahoma State University Extension Service, oil-based muds can include diesel fuel and the highly dangerous chemicals benzene, toluene, ethylbenzene, and xylene.⁸⁴ It is unclear whether New Mexico's prohibition would prohibit the use of PFAS during drilling that passes through fresh water zones. Whether or not it does, disclosing all drilling

chemicals and other chemicals injected into oil and gas wells during any method or stage of extraction is important so that New Mexicans are not unknowingly exposed to toxic chemicals.

Another gap in New Mexico's rules which prevents the public from knowing the full list of chemicals injected into oil and gas wells is lack of disclosure requirements for chemical manufacturers. Chemical manufacturers are the only companies in the oil and gas chemical supply chain that always know the precise contents of the chemicals being used. But New Mexico omits chemical manufacturers from fracking chemical disclosure requirements, requiring disclosure only from each well operator. The state also allows chemical manufacturers to conceal the identities of their chemicals with trade secret claims.⁸⁵ In addition, New Mexico limits manufacturers' responsibility by providing that the Division of Oil and Gas "does not require the reporting of information beyond the material safety data sheet data as described in 29 C.F.R. 1910.1200." This rule means that chemical disclosure is limited to what is required on material safety data sheets (now called safety data sheets) on which chemical manufacturers provide information about their chemical products to protect workers. Chemical products are often composed of more than one chemical, so it is typical for safety data sheets to list multiple chemical ingredients. The public will be able to learn the full list of chemicals used in fracking chemical products only if the manufacturers disclose the full list to oil and gas well operators.

However, it is likely that at least in some cases, the chemical manufacturers will not disclose on the safety data sheets all the ingredients in their fracking chemical products. As several Harvard researchers reported in 2013, manufacturers can legally omit chemical information from the sheets. For example, if a chemical has not been tested and found to be hazardous, it does not need to be disclosed, even if tests would show that it is hazardous.⁸⁶ Therefore, the manufacturers could effectively prevent public disclosure of fracking chemical

1 ingredients if they do not list them on safety data sheets whether or not they also claim the
2 chemicals as trade secrets.

3 We have identified several omissions of individual chemicals from safety data sheets
4 associated with oil and gas chemical products by examining such sheets associated with a
5 handful of oil and gas wells. This experience with a limited number of oil and gas wells suggests
6 that these omissions could be much more common. We identified the omissions in safety data
7 sheets disclosed by oil and gas well operators in West Virginia including at least two operators,
8 Chevron and XTO/ExxonMobil, that also operate in New Mexico. For horizontal gas wells, West
9 Virginia requires disclosures of safety data sheets for oil and gas chemicals as part of a “well site
10 safety plan.” Specifically, the state requires disclosure of safety data sheets “for the chemical
11 components added to the hydraulic fracturing fluid, and completion, production, and work-over
12 activities.”⁸⁷ The terms “completion,” “production,” and “work-over” in West Virginia’s rules
13 are not defined. However, it is apparent from the inclusion of these terms that the safety data
14 sheets apply beyond the fracking phase of operations. The safety data sheets disclosed reflect this
15 interpretation, covering chemical products that are used for drilling if not other stages and
16 methods of extraction.⁸⁸

17 An examination of safety data sheets disclosed in West Virginia shows that the sheets are
18 often incomplete. For example, Chevron disclosed a safety data sheet for a chemical product
19 called “MAGNAFLOC 24” used at a well hydraulically fractured in Marshall County in 2020.
20 The safety data sheet listed urea as comprising 0-5 percent of the product by weight. No other
21 ingredients were listed, so an operator would be unable to tell the public based on this safety data
22 sheet the chemicals that made up the remaining 95-100 percent of MAGNAFLOC 24.⁸⁹ For the
23 same well, Chevron disclosed a safety data sheet for a chemical product called “FRICTION

REDUCER J609.” The safety data sheet listed “ammonium sulfate” as comprising 10-30 percent of the product by weight. No other ingredients were listed, similarly preventing an operator from fully disclosing based on the safety data sheet the ingredients that made up 70-90 percent of the chemical’s weight.⁹⁰ XTO Energy/ExxonMobil disclosed a safety data sheet for a chemical product called “Scale Hib A” used at a well hydraulically fractured in Marion County in 2021. The data sheet listed ethylene glycol as a “hazardous substance” and indicated that it comprised 10-30 percent of Scale Hib A by weight. No other chemical ingredients were listed, so an operator would be unable to tell the public based on this safety data sheet the full list of chemicals that made up 70-90 percent of the weight of Scale Hib A.⁹¹ XTO Energy/ExxonMobil disclosed another safety data sheet for the same well for a chemical product called EC6116A, identified as a biocide. This safety data sheet lists three ingredients, dibromoacetonitrile, 2,2-Dibromo-3-nitrilopropionamide, and polyethylene glycol. Together, they comprise 31-95 percent of the product by weight. But ingredients making up 5-69 percent of the product are not listed, so an operator would be unable to tell the public based on this safety data sheet the full list of chemical ingredients in EC6116A.⁹²

In 2014, attorneys litigating against the oil and gas industry in Pennsylvania reported similar gaps in safety data sheets.⁹³ They cited 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. Range is based in Texas and, as of 2023, owned oil and gas wells that are producing or capable of production in five states.⁹⁴ “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

1 about the actual components of a particular product. As a result, Range is currently in the process
2 of seeking additional information from manufacturers that have failed to provide enough
3 information about their products in the MSDS.”⁹⁵ In one case, Range said that a fracking or
4 stimulation product called “MC SS-5075” was “an Ammonium Bisulfite Solution manufactured
5 by Multi-Chem. The MSDS describes the formula as 45-70% ammonium bisulfite by weight.
6 Range is currently seeking information on the 30-55% missing from the formula.” In another
7 case, Range mentioned that a chemical known as “MC S-2510T” also made by Multi-Chem
8 contained “Ethylene Glycol (30%-60% by weight)” and “Sodium Hydroxide (5% by weight).”
9 Range acknowledged that “we recognize that this formula fails to account for at least 35% of the
10 weight, so we have contacted Multi-Chem for an explanation.” These omissions in safety data
11 sheets used by oil and gas companies operating in both Pennsylvania and West Virginia suggest
12 that New Mexico’s reliance on safety data sheets for hydraulic fracturing chemical disclosure
13 leaves the public significantly uninformed about chemicals to which people might be exposed
14 including extremely toxic chemicals such as PFAS.

15 These disclosure gaps mean that the public in New Mexico may be unknowingly exposed
16 to toxic chemicals including PFAS through various pathways such as the disposal of oil and gas
17 wastewater. This wastewater is a mixture of fluids used to complete the oil and gas well
18 including drilling and fracking fluids and naturally-occurring water from the underground
19 formation that comes to the surface when oil and gas is produced.⁹⁶ From the mid-1980s to 2003,
20 the state’s Oil Conservation Division found almost 7,000 cases of soil and water contamination
21 and 400 cases of groundwater contamination associated with New Mexico’s oil and gas waste
22 pits where wastewater was at least temporarily stored.⁹⁷

1 The potential for exposure specifically to PFAS from oil and gas operations is not purely
2 hypothetical. In one of the few studies in which scientists have examined the link between PFAS
3 and oil and gas extraction, a peer-reviewed article published in November 2023, researchers
4 reported that oil and gas extraction in five counties in northern West Virginia was associated
5 with PFAS pollution. Their evidence showed that in the cases of three private water wells, oil
6 and gas extraction likely caused the pollution. The researchers found that all eight of the surface
7 water samples they collected and 60 percent of the 45 private wells in their study contained at
8 least one of the 21 types of PFAS for which they tested. They also reported that four of the
9 private wells had concentrations above EPA’s proposed maximum contaminant level in drinking
10 water for PFOA.⁹⁸ (EPA finalized these standards in April 2024.⁹⁹) The researchers found that oil
11 and gas wells were a plausible source of PFAS contamination in three private water wells
12 because these water wells “exhibited individual PFAS concentrations above those likely from
13 atmospheric sources even when considering historic deposition” from the former Dupont facility
14 in Parkersburg (now called Chemours Washington Works) where the health and environmental
15 impacts of PFAS first came to light. The researchers added that “Industrial operations related to
16 oil and gas development were the only identifiable sources within 2 km of [the three water wells]
17 even considering agricultural activity and possible biosolids applications.”¹⁰⁰ The counties where
18 the study was conducted – Doddridge, Marshall, Ritchie, Tyler, and Wetzel – include horizontal
19 gas wells into which oil and gas companies reported injecting PTFE and/or trade secret
20 chemicals, according to PSR’s analysis published in 2024 of fracking chemicals used in West
21 Virginia’s horizontal gas wells and disclosed to FracFocus.¹⁰¹ The authors of the peer-reviewed
22 study noted that these counties were home to more than 3,000 completed unconventional oil and
23 gas wells in production. Unconventional wells are typically synonymous with horizontal oil and

1 gas wells that are hydraulically fractured.¹⁰² The authors of the peer-reviewed study also found
2 that the five-county area contains 14,000 active conventional oil and gas wells. Conventional
3 wells are typically vertical and may or may not involve hydraulic fracturing.¹⁰³ Based on the
4 previously cited papers in this testimony indicating that PFAS have been used or proposed for
5 use in oil and gas wells both for fracking and for purposes other than fracking, it is possible that
6 PFAS have been used in both conventional and unconventional oil and gas wells. The authors of
7 the peer-reviewed paper further concluded that “within the larger data set, PFOA detections and
8 concentrations in private water wells were significantly associated with proximity to recently
9 drilled (2018-2020) UOG [unconventional oil and gas] well pads....”¹⁰⁴ However, the
10 researchers cautioned that “observed concentrations were indistinguishable from levels plausibly
11 attributable to atmospheric sources....”¹⁰⁵ They said that their research highlights the need for
12 further studies to determine the sources of PFAS in private water wells, “particularly in regions
13 where reliance on private water wells co-occurs with spatially distributed industrial sources, like
14 oil and gas development.”¹⁰⁶ At least two other studies have found PFAS in drinking water near
15 areas of oil and gas extraction. A 2022 study by the U.S. Geological Survey (USGS) showed that
16 PFAS had polluted dozens of water supplies in West Virginia and that groundwater might be at a
17 high risk of contamination. The authors did not attempt to determine the sources of the PFAS
18 contamination,¹⁰⁷ but some concentrations of the pollution were found in northern West
19 Virginia,¹⁰⁸ the region of most of the state’s horizontal gas wells, including those in which PSR
20 found in a 2024 report that the use of PFAS had been disclosed to FracFocus. A 2023 study by
21 scientists from the USGS and Pennsylvania Department of Environmental Protection (PADEP)
22 reported concentrations of PFAS in Pennsylvania streams located in areas that featured both high
23 numbers of oil and gas wells and combined sewer overflow outfalls.¹⁰⁹ The authors wrote that

1 “Research documenting the impacts of OG [oil and gas] development on PFAS contamination in
2 surface waters is limited, but in this study the CSO [combined sewer overflow outfalls]
3 surrounded by OG development in local catchments could be a potential source of PFAS to
4 surrounding streams.”¹¹⁰

5 The findings in these studies that PFAS had contaminated water supplies near oil and gas
6 extraction as well as the uncertainties that remain about the link between the contamination and
7 oil and gas activities highlight the need for the proposed regulation. It would help prevent PFAS
8 contamination from oil and gas wastewater by prohibiting the use of PFAS in oil and gas
9 operations. The proposed regulation would also help ensure compliance with this provision and
10 prevention of unknowing exposure to toxic substances by prohibiting the use of undisclosed
11 chemicals in downhole operations in New Mexico’s oil and gas wells. Oil and gas well operators
12 would have to disclose all individual chemicals injected into their wells without exception for
13 trade secrets; they would have to disclose chemicals used in all stages and methods of extraction,
14 not just fracking. If chemical manufacturers, the companies that know best which chemicals are
15 being used in oil and gas wells, will not disclose the chemicals in certain products, the proposed
16 rule would simply say you cannot use that product in New Mexico. These steps would empower
17 scientists to test water supplies and other environmental media for all of the chemicals used in
18 New Mexico’s oil and gas wells to determine more conclusively if there are links between
19 pollution and oil and gas extraction. These steps would also help protect New Mexicans’ health
20 and natural resources by preventing unknowing exposure to toxic substances.

21 I appreciate this opportunity to submit testimony and would be happy to answer any
22 questions that you might have.

23 This concludes my testimony, which is accurate to the best of my knowledge.

1	<u>/s/ Dusty Horwitt.</u>	<u>October 20, 2024</u>
2	Dusty Horwitt	Date

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[UEFYL3F1ZXJ5L2NyZWF0ZS8zOQ==](#). Next, I entered user name “DEP” and password “DEP.” On the left side of the screen, I selected “PERMITSOOG”. At the top of screen, I selected “NEW QUERY”. At the top of the screen, in the field entitled “PRIMARY ID,” I inserted the well number with no dashes and an asterisk after it (e.g. 4705102082*). At the bottom left of the screen, I selected “RUN.” Under the column heading “DOCUMENT TYPE” I selected the file entitled “PERMIT – APPROVED – MSDS. The relevant record is on pages 163-169 of the pdf. Schlumberger. Safety Data Sheet for Friction Reducer J609 (Sept. 20, 2010).

⁹¹ WG Exhibit 47 XTO/ExxonMobil. Safety data sheets for Well No. 47-049-02491 hydraulically fractured in Marion County, W.Va. between July 27, 2021 and Sept. 21, 2021. To find the well number, I first visited FracFocus. Find a Well. Accessed August 9, 2024, at <https://www.fracfocus.org/wells/?bbox=-127.69479199999999%2C24.521208%2C-63.98694200000001%2C49.382808>. I selected “SWITCH TO ADVANCED SEARCH.” In the “State” field, I selected “West Virginia.” In the “Operator” field, I selected “XTO Energy/ExxonMobil.” I then selected “Search Jobs.” This search displayed a chemical disclosure record with the well number 47-049-02491. To locate safety data sheets disclosed for this well, I visited Opentext | ApplicationXtender at

<https://documents.dep.wv.gov/AppXtender/DataSources/DEPAX16/account/login?ret=L2RhdGFzb3VyY2VzL0RFUEFYL3F1ZXJ5L2NyZWF0ZS8zOQ==>. Next, I entered user name “DEP” and password “DEP.” On the left side of the screen, I selected “PERMITSOOG”. At the top of screen, I selected “NEW QUERY”. At the top of the screen, in the field entitled “PRIMARY ID,” I inserted the well number with no dashes and an asterisk after it (e.g. 4704902491*). At the bottom left of the screen, I selected “RUN.” Under the column heading “DOCUMENT TYPE” I selected the file entitled “PERMIT – APPROVED – MSDS. The relevant record is on pages 77-85 of the pdf. NALCO. Safety Data Sheet for Scale Hib A (Feb. 4, 2013).

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<https://documents.dep.wv.gov/AppXtender/DataSources/DEPAX16/account/login?ret=L2RhdGFzb3VyY2VzL0RFUEFYL3F1ZXJ5L2NyZWF0ZS8zOQ==>. Next, I entered user name “DEP” and password “DEP.” On the left side of the screen, I selected “PERMITSOOG”. At the top of screen, I selected “NEW QUERY”. At the top of the screen, in the field entitled “PRIMARY ID,” I inserted the well number with no dashes and an asterisk after it (e.g. 4704902491*). At the bottom left of the screen, I selected “RUN.” Under the column heading “DOCUMENT TYPE” I selected the file entitled “PERMIT – APPROVED – MSDS. The relevant record is on pages 59-71 of the pdf. NALCO. Safety Data Sheet for EC6116A (Oct. 21, 2010).

⁹³ WG Exhibit 49 Petitioners’ pleading filed in *Robinson Twp. v. Commonwealth*, Docket No. 284 MD 2012 (June 9, 2014), at 13 FN5.

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<https://www.sec.gov/Archives/edgar/data/315852/000095017024018046/rrc-20231231.htm>.

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⁹⁹ 89 Fed. Reg. 32532 (Apr. 26, 2024).

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PFOA, PFOS and Other PFAS

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PFAS Explained

EPA is committed to providing meaningful, understandable, and actionable information on per- and polyfluoroalkyl substances – known as PFAS – to the American public. The information provided here is intended to explain some of the important background information needed to understand the details of specific actions EPA takes to address PFAS, and other emerging events related to PFAS.

Learn more about different aspects of PFAS on the following pages:

1. Our current understanding of the human health and environmental risks PFAS

[<https://epa.gov/pfas/our-current-understanding-human-health-and-environmental-risks-pfas>](https://epa.gov/pfas/our-current-understanding-human-health-and-environmental-risks-pfas)

2. Increasing our understanding of the health risks from PFAS and how to address them

[<https://epa.gov/pfas/increasing-our-understanding-health-risks-pfas-and-how-address-them>](https://epa.gov/pfas/increasing-our-understanding-health-risks-pfas-and-how-address-them)

PFAS News

Read the latest news from EPA about PFAS.
[<https://epa.gov/pfas/press-releases-related-pfas>](https://epa.gov/pfas/press-releases-related-pfas)

What EPA is Doing

Learn what EPA is doing to address PFAS.
[<https://epa.gov/pfas/pfas-strategic-roadmap-epas-commitments-action-2021-2024>](https://epa.gov/pfas/pfas-strategic-roadmap-epas-commitments-action-2021-2024)

3. Meaningful and achievable action steps that can be taken to reduce risk

<https://epa.gov/pfas/meaningful-and-achievable-steps-you-can-take-reduce-your-risk>

4. PFAS Explained (pdf) <https://www.epa.gov/system/files/documents/2023-10/final-virtual-pfas-explainer-508.pdf> (262.29 KB)

A printable four-page handout about PFAS and actions you can take

What EPA Has Learned So Far

- PFAS are widely used, long lasting chemicals, components of which break down very slowly over time.
- Because of their widespread use and their persistence in the environment, many PFAS are found in the blood of people and animals all over the world and are present at low levels in a variety of food products and in the environment.
- PFAS are found in water, air, fish, and soil at locations across the nation and the globe.
- Scientific studies have shown that exposure to some PFAS in the environment may be linked to harmful health effects in humans and animals.
- There are thousands of PFAS chemicals, and they are found in many different consumer, commercial, and industrial products. This makes it challenging to study and assess the potential human health and environmental risks.
- Learn more about our current understanding of PFAS. <https://epa.gov/pfas/our-current-understanding-human-health-and-environmental-risks-pfas>

What We Don't Fully Understand Yet

- EPA's researchers and partners across the country are working hard to answer critical questions about PFAS:
 - How to better and more efficiently detect and measure PFAS in our air, water, soil, and fish and wildlife
 - How much people are exposed to PFAS
 - How harmful PFAS are to people and the environment
 - How to remove PFAS from drinking water
 - How to manage and dispose of PFAS
- This information will help EPA and state, local, and tribal partners make more informed decisions on how best to protect human health and the environment.
- Learn more about how we are increasing our understanding of the health risks of PFAS. <<https://epa.gov/pfas/increasing-our-understanding-health-risks-pfas-and-how-address-them>>

[PFAS Home](https://epa.gov/pfas) <<https://epa.gov/pfas>>

PFAS Explained

[EPA's Current Understanding](https://epa.gov/pfas/our-current-understanding-human-health-and-environmental-risks-pfas) <<https://epa.gov/pfas/our-current-understanding-human-health-and-environmental-risks-pfas>>

[Increasing Our Understanding](https://epa.gov/pfas/increasing-our-understanding-health-risks-pfas-and-how-address-them) <<https://epa.gov/pfas/increasing-our-understanding-health-risks-pfas-and-how-address-them>>

[Action Steps to Reduce Risk](https://epa.gov/pfas/meaningful-and-achievable-steps-you-can-take-reduce-your-risk) <<https://epa.gov/pfas/meaningful-and-achievable-steps-you-can-take-reduce-your-risk>>

[EPA Actions to Address PFAS](https://epa.gov/pfas/key-epa-actions-address-pfas) <<https://epa.gov/pfas/key-epa-actions-address-pfas>>

[PFAS Strategic Roadmap](https://epa.gov/pfas/pfas-strategic-roadmap-epas-commitments-action-2021-2024) <<https://epa.gov/pfas/pfas-strategic-roadmap-epas-commitments-action-2021-2024>>

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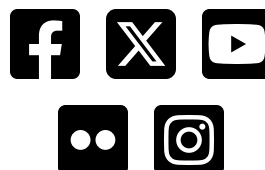
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Per- and Polyfluoroalkyl Substances (PFAS)

Final PFAS National Primary Drinking Water Regulation

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 - Communications Toolkit<<https://epa.gov/sdwa/pfas-communications-toolkit>>
 - Technical Information for States, Tribes and Water Systems
 - Español <<https://epa.gov/sdwa/additional-supporting-materials-final-pfas-npdwr>>
- Regulatory Information and Supporting Documents
- Webinars
- Background



Summary

On April 10, 2024, EPA announced the final National Primary Drinking Water Regulation (NPDWR) for six PFAS. To inform the final rule, EPA evaluated over 120,000 comments submitted by the public on the rule proposal, as well as considered input received

during multiple consultations and stakeholder engagement activities held both prior to and following the proposed rule. EPA expects that over many years the final rule will prevent PFAS exposure in drinking water for approximately 100 million people, prevent thousands of deaths, and reduce tens of thousands of serious PFAS-attributable illnesses.

EPA is also making unprecedented funding available to help ensure that all people have clean and safe water. In addition to the final rule, EPA announced \$1 billion in newly available through the Bipartisan Infrastructure Law <<https://epa.gov/dwcapacity/emerging-contaminants-ec-small-or-disadvantaged-communities-grant-sdc#2024>> to help states and territories implement PFAS testing and treatment at public water systems and to help owners of private wells address PFAS contamination.

EPA established legally enforceable levels, called Maximum Contaminant Levels (MCLs), for six PFAS in drinking water: PFOA, PFOS, PFHxS, PFNA, and HFPO-DA as contaminants with individual MCLs, and PFAS mixtures containing at least two or more of PFHxS, PFNA, HFPO-DA, and PFBS using a Hazard Index MCL to account for the combined and co-occurring levels of these PFAS in drinking water. EPA also finalized health-based, non-enforceable Maximum Contaminant Level Goals (MCLGs) for these PFAS.

Compound	Final MCLG	Final MCL (enforceable levels)
PFOA	Zero	4.0 parts per trillion (ppt) (also expressed as ng/L)
PFOS	Zero	4.0 ppt
PFHxS	10 ppt	10 ppt
PFNA	10 ppt	10 ppt
HFPO-DA (commonly known as GenX Chemicals)	10 ppt	10 ppt

Compound	Final MCLG	Final MCL (enforceable levels)
Mixtures containing two or more of PFHxS, PFNA, HFPO-DA, and PFBS	1 (unitless) Hazard Index	1 (unitless) Hazard Index

The final rule requires:

- Public water systems must monitor for these PFAS and have three years to complete initial monitoring (by 2027), followed by ongoing compliance monitoring. Water systems must also provide the public with information on the levels of these PFAS in their drinking water beginning in 2027.
- Public water systems have five years (by 2029) to implement solutions that reduce these PFAS if monitoring shows that drinking water levels exceed these MCLs.
- Beginning in five years (2029), public water systems that have PFAS in drinking water which violates one or more of these MCLs must take action to reduce levels of these PFAS in their drinking water and must provide notification to the public of the violation.

Supporting Materials

General Information

-  General Fact Sheet: EPA's Final Rule to Limit PFAS in Drinking Water (pdf)
<https://www.epa.gov/system/files/documents/2024-04/pfas-npdwr_fact-sheet_general_4.9.24v1.pdf> (163.59 KB)
-  Frequently Asked Questions and Answers: Final PFAS National Primary Drinking Water Regulation (pdf)
<https://www.epa.gov/system/files/documents/2024-04/pfas-npdwr_qa_general_4.9.24v1.pdf> (218.97 KB)

Communications Toolkit

EPA has developed this toolkit of materials
<<https://epa.gov/sdwa/pfas-communications-toolkit>>

-  **Fact Sheet: Reducing PFAS in Your Drinking Water with a Home Filter (pdf)**
<<https://www.epa.gov/system/files/documents/2024-04/water-filter-fact-sheet.pdf>> (147.58 KB)
for entities that need to communicate about PFAS.
-  **Presentation: Overview EPA PFAS NPDWR (pdf)** <https://www.epa.gov/system/files/documents/2024-04/pfas-npdwr-presentation_4.9.24_overview.pdf> (447.13 KB)
- **Press Release: Biden-Harris Administration Finalizes First-Ever National Drinking Water Standard to Protect 100M People from PFAS Pollution**
<<https://epa.gov/newsreleases/biden-harris-administration-finalizes-first-ever-national-drinking-water-standard>>
- **Español** <<https://epa.gov/sdwa/additional-supporting-materials-final-pfas-npdwr>>

Information for States, Tribes, and Water Systems

-  **Frequently Asked Questions and Answers for Drinking Water Primacy Agencies: Final PFAS National Primary Drinking Water Regulation (pdf)**
<https://www.epa.gov/system/files/documents/2024-04/pfas_npdwr_faqsstates_4.8.24.pdf> (284.64 KB)
-  **Fact Sheet: Understanding the Final PFAS National Primary Drinking Water Regulation Hazard Index Maximum Contaminant Level (pdf)**
<https://www.epa.gov/system/files/documents/2024-04/pfas-npdwr_fact-sheet_hazard-index_4.8.24.pdf> (211.86 KB)
-  **Fact Sheet: Benefits and Costs of Reducing PFAS in Drinking Water (pdf)**
<https://www.epa.gov/system/files/documents/2024-04/pfas-npdwr_fact-sheet_cost-and-benefits_4.8.24.pdf> (191.95 KB)
-  **Fact Sheet: Small and Rural Water Systems (pdf)**
<https://www.epa.gov/system/files/documents/2024-04/pfas-npdwr_fact-sheet_monitoring_4.8.24.pdf> (212.28 KB)
-  **Fact Sheet: PFAS NPDWR Monitoring and Reporting (pdf)**
<https://www.epa.gov/system/files/documents/2024-04/pfas-npdwr_fact-sheet_monitoring_4.8.24_0.pdf> (521.55 KB)
-  **Fact Sheet: Treatment Options for Removing PFAS in Drinking Water (pdf)**
<https://www.epa.gov/system/files/documents/2024-04/pfas-npdwr_fact-sheet_treatment_4.8.24.pdf> (189.59 KB)

-  Fact Sheet: Comparison Between EPA's Proposed and Final PFAS NPDWR (pdf)
<https://www.epa.gov/system/files/documents/2024-04/fact-sheet_proposal-vs.-final-pfas-ndpwr_comparison_final.pdf> (176.83 KB)

Regulatory Information

- Federal Register Notice: Final PFAS National Primary Drinking Water Regulation 
<<https://www.federalregister.gov/documents/2024/04/26/2024-07773/pfas-national-primary-drinking-water-regulation>>
- Federal Register Notice: Final PFAS National Primary Drinking Water Regulation; Correction 
<<https://www.federalregister.gov/documents/2024/06/11/2024-12645/pfas-national-primary-drinking-water-regulation-correction>>
- Find additional supporting materials, including all EPA Technical Support Documents informing the final rule and EPA's Response to Public Comments
<<https://epa.gov/sdwa/additional-supporting-materials-final-pfas-ndpwr>> on the Proposed PFAS NPDWR. These documents, as well as all other supporting information for the Final PFAS NPDWR, are available at www.regulations.gov under Docket ID: EPA-HQ-OW-2022-0114.

Webinars

EPA held three informational webinars for communities, water systems, and other drinking water professionals about the final PFAS NPDWR. The three webinar webinars were similar, with each intended for specific audiences.

- April 16, 2024 General Overview Webinar on the Final PFAS NPDWR
 -  General Overview Webinar Presentation: Final PFAS NPDWR (pdf)
<<https://www.epa.gov/system/files/documents/2024-04/general-overview-webinar-presentation-final-pfas-ndpwr.pdf>> (500.09 KB)
 - Webinar Recording: General Overview of Final PFAS NPDWR 

- April 23, 2024 Drinking Water Utilities and Professionals Technical Overview Webinar on the Final PFAS NPDWR
 -  Drinking Water Utilities and Professionals Technical Overview Webinar on PFAS NPDWR (pdf) <<https://www.epa.gov/system/files/documents/2024-04/drinking-water-utilities-and-professionals-technical-overview-of-pfas-npdwr.pdf>> (773.89 KB)
 - Webinar Recording: Drinking Water Utilities and Professionals Technical Overview of Final PFAS NPDWR 
 - April 30, 2024 Small Drinking Water Systems Webinar Series on Final PFAS NPDWR and PFAS Drinking Water Treatment <<https://epa.gov/water-research/pfas-drinking-water-regulation-and-treatment-methods-webinar>>
 -  Small Drinking Water Systems Webinar Presentation on Final PFAS NPDWR (pdf) <https://www.epa.gov/system/files/documents/2024-05/pfas-npdwr-full-presentation_small-systems-webinar_final508.pdf> (573.21 KB)
-

Background

Under the Safe Drinking Water Act <<https://epa.gov/sdwa>>, EPA has the authority to set enforceable National Primary Drinking Water Regulations (NPDWRs) for drinking water contaminants and require monitoring of public water systems. In March 2021, EPA published Regulatory Determinations for Contaminants on the Fourth Contaminant Candidate List <<https://epa.gov/ccl/regulatory-determination-4>> which included a final determination to regulate PFOA and PFOS in drinking water. As a part of that final determination, EPA indicated it would also evaluate additional PFAS and consider regulatory actions to address groups of PFAS.

On March 24, 2023, EPA proposed <<https://epa.gov/sdwa/proposed-pfas-national-primary-drinking-water-regulation>> the PFAS NDPWR. Concurrent with the proposed rule, EPA also announced preliminary regulatory determinations for PFHxS, PFNA, HFPO-DA, and PFBS in accordance with the Safe Drinking Water Act regulatory development process. EPA proposed to regulate PFOA and PFOS with individual MCLs and PFHxS, PFNA, HFPO-DA, and PFBS using a Hazard Index which accounts for co-occurring mixtures of these four PFAS. Concurrent with the final PFAS NPDWR announced on April 10, 2024, EPA also announced final individual regulatory determinations for PFHxS, PFNA, and

HFPO-DA, and final regulatory determination for mixtures containing two or more of these three PFAS and PFBS. This regulation will also remove many other PFAS when they co-occur with these regulated PFAS.

Further Information

To learn more about PFAS and to find important background information to support understanding the details of specific actions EPA takes to address PFAS and other emerging events related to PFAS <<https://epa.gov/pfas/pfas-explained>>.

Contact Us <<https://epa.gov/sdwa/forms/contact-us-about-safe-drinking-water-act>> to ask a question, provide feedback, or report a problem.

Last updated on July 12, 2024



Per- and Polyfluoroalkyl Substances (PFAS) and Your Health

Per- and Polyfluoroalkyl Substances (PFAS) and Your Health Home

What are the health effects of PFAS?



Statement on Potential Intersection between PFAS Exposure and COVID-19:

CDC/ATSDR understands that many of the communities we are engaged with are concerned about how PFAS exposure may affect their risk of COVID-19 infection. We agree that this is an important question.

CDC/ATSDR recognizes that exposure to high levels of PFAS may impact the immune system. A National Toxicology Program review found that exposure to perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) is an immune hazard to humans based on a high level of evidence that PFOA and PFOS suppressed the antibody response from animals and a moderate level of evidence from studies in humans (NTP, 2016). More research is needed to understand how PFAS exposure may affect illness from COVID-19.

Reference:

NTP (National Toxicology Program). 2016. [Monograph on Immunotoxicity Associated with Exposure to Perfluorooctanoic acid \(PFOA\) and Perfluorooctane Sulfonate \(PFOS\)](#)  .



Research is ongoing to understand the mechanisms of PFAS toxicity. The epidemiological evidence suggests associations between increases in exposure to (specific) PFAS and certain health effects



Increases in cholesterol levels (PFOA, PFOS, PFNA, PFDA)



Lower antibody response to some vaccines (PFOA, PFOS, PFHxS, PFDA)



Changes in liver enzymes (PFOA, PFOS, PFHxS)



Pregnancy-induced hypertension and preeclampsia (PFOA, PFOS)



Small decreases in birth weight (PFOA, PFOS)



Kidney and testicular cancer (PFOA)

The risk of health effects associated with PFAS depends on

- Exposure factors (e.g., dose, frequency, route, and duration)
- Individual factors (e.g., sensitivity and disease burden)
- Other determinants of health (e.g., access to safe water and quality healthcare)

Some animal and human studies find positive associations between PFAS exposure and a much wider range of health effects. However, results of animal studies do not always correlate with human health effects because of physiologic differences between species. Inconsistent findings among human studies and study design limitations are some reasons why other potential health effects are not identified as associated with PFAS.

At this time, scientists are still learning about the health effects of exposures to mixtures of different PFAS. Additional research may change our understanding of the relationship between exposure to PFAS and human health effects.

One way to learn about whether PFAS will harm people is to do studies on lab animals.

- Most animal studies have tested doses of PFAS that are higher than the doses people experience from environmental exposure.
- These animal studies have found that PFAS can cause damage to the liver and the immune system.
- PFAS have also caused low birth weight, birth defects, delayed development, and newborn deaths in lab animals.

Humans and animals react differently to PFAS, and not all effects observed in animals may occur in humans. Scientists have ways to estimate how the exposure and effects in animals compare to what they would be in humans.

What are PFAS?



How Can I be Exposed?



PFAS in the US



Last Reviewed: January 18, 2024

EPA's Per- and Polyfluoroalkyl Substances (PFAS) Action Plan

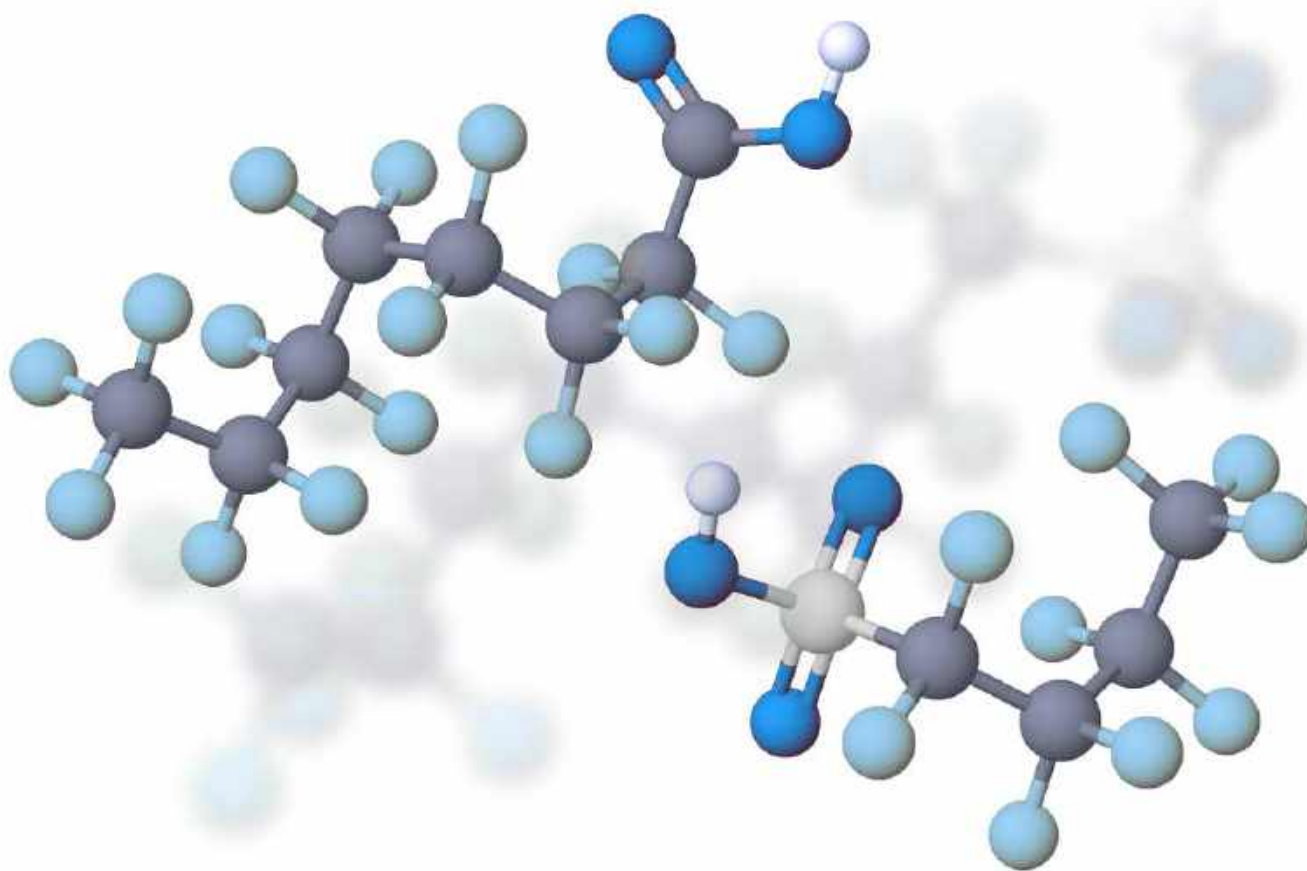


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List of Acronyms

ACRONYM	FULL PHRASE
ASDWA	Association of State Drinking Water Administrators
ASTHO	Association of State and Territorial Health Officials
ASTSWMO	Association of State and Territorial Solid Waste Management Officials
ATSDR	Agency for Toxic Substances and Disease Registry
CAA	Clean Air Act
CCL	Contaminant Candidate List
CDC	Centers for Disease Control and Prevention
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CWA	Clean Water Act
CWS	Community Water System
DoD	Department of Defense
DWSRF	Drinking Water State Revolving Fund
ECOS	Environmental Council of States
ELGs	Effluent Limitations Guidelines
EPA	Environmental Protection Agency
FDA	Food and Drug Administration
GenX	Gen X Chemicals (i.e., HFPO dimer acid and its ammonium salt), also known as (2,3,3,3-tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy)propanoic acid (CASRN 13252-13-6) or hexafluoropropylene oxide (HFPO) dimer acid and 2,3,3,3-tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy)propanoate (CASRN 62037-80-3) or HFPO dimer acid ammonium salt)
HA	Health Advisory
HERO	Health and Environmental Research Online
HFPO	Hexafluoropropylene Oxide
HTT	High Throughput Toxicity Testing
HTTK	High Throughput Toxicokinetic
HUD	Department of Housing and Urban Development
ITRC	Interstate Technology and Regulatory Council
KDHE	Kansas Department of Health and Environment
LCPFAC	Long-Chain Perfluoroalkyl Carboxylate
LGAC	Local Government Advisory Committee
MCL	Maximum Contaminant Level
MDEQ	Michigan Department of Environmental Quality
NIST	National Institute of Technology

NPDES	National Pollutant Discharge Elimination System
NTP	National Toxicology Program
OECD	Organization for Economic Cooperation and Development
PFCA	Perfluoroalkyl Carboxylic Acid
PFAS	Per- and Polyfluoroalkyl Substances
PFBS	Perfluorobutane Sulfonic Acid
PFBA	Perfluorobutanoic Acid
PFHpA	Perfluoroheptanoic Acid
PFHxS	Perfluorohexane Sulfonic Acid
PFNA	Perfluorononanoic Acid
PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctane Sulfonate
PMN	Premanufacture notice
ppt	Parts per Trillion
PWSs	Public Water Systems
RCRA	Resource Conservation and Recovery Act
SDWA	Safe Drinking Water Act
SNUN	Significant New Use Notice
SNURs	Significant New Use Rules
TSCA	Toxic Substances Control Act
UCMR	Unregulated Contaminant Monitoring Rule
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WCIT	Water Contaminant Information Tool

I. Executive Summary

Per- and polyfluoroalkyl substances (PFAS) are a group of synthetic chemicals that have been in use since the 1940s. PFAS are found in a wide array of consumer and industrial products. PFAS manufacturing and processing facilities, facilities using PFAS in production of other products, airports, and military installations are some of the contributors of PFAS releases into the air, soil, and water. Due to their widespread use and persistence in the environment, most people in the United States have been exposed to PFAS. There is evidence that continued exposure above specific levels to certain PFAS may lead to adverse health effects (USEPA 2016a, 2016b, ATSDR 2018a).

The EPA will continue to partner with other federal agencies, states, tribes, and local communities to protect human health and, where necessary and appropriate, to limit human exposure to potentially harmful levels of PFAS in the environment. The EPA is leading the national effort to understand PFAS and reduce PFAS risks to the public through implementation of this Action Plan and through active engagement and partnership with other federal agencies, states, tribes, industry groups, associations, local communities, and the public.

Key EPA Actions Addressing PFAS-Related Challenges

- **Expand toxicity information for PFAS**
- **Develop new tools to characterize PFAS in the environment**
- **Evaluate cleanup approaches**
- **Develop guidance to facilitate cleanup of contaminated groundwater**
- **Use enforcement tools to address PFAS exposure in the environment and assist states in enforcement activities**
- **Use legal tools such as those in TSCA to prevent future PFAS contamination**
- **Address PFAS in drinking water using regulatory and other tools**
- **Develop new tools and materials to communicate about PFAS**

Throughout recent engagements, the EPA heard clearly the public's desire for immediate action to address potential human health and economic impacts from PFAS in the environment.

This Action Plan describes the EPA's approach to identifying and understanding PFAS, approaches to addressing current PFAS contamination, preventing future contamination, and effectively communicating with the public about PFAS. The Action Plan describes the broad actions the EPA has underway to address challenges with PFAS in the environment, including next steps on the four PFAS management actions the EPA announced at the May 2018 National Leadership Summit. The four actions announced at the Summit were:

- Initiating steps to evaluate the need for a maximum contaminant level (MCL) for perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS);
- Beginning the necessary steps to propose designating PFOA and PFOS as "hazardous substances" through one of the available federal statutory mechanisms¹;
- Developing groundwater cleanup recommendations for PFOA and PFOS at contaminated sites;
- Developing toxicity values or oral reference doses (RfDs)² for GenX chemicals³ and perfluorobutane sulfonic acid (PFBS).

In addition to these significant actions, the EPA's PFAS Action Plan identifies more short-term and long-term actions that are currently being implemented to understand and address PFAS. Short-term actions include:

- Developing new analytical methods and tools for understanding and managing PFAS risk;
- Promulgating Significant New Use Rules (SNURs) that require EPA notification before chemicals are used in new ways that may create human health and ecological concerns; and
- Using enforcement actions to help manage PFAS risk, where appropriate.

Short-term actions are generally taking place or expected to be completed within two years. The Action Plan also sets out long-term regulatory and research approaches the EPA will pursue to reduce exposures and to understand the potential human health and environmental risks associated with PFAS. Actions classified as long-term, such as multi-step research initiatives or regulatory actions, are generally expected to take more than two years. Some long-term actions may result in intermediate steps and products that can help to reduce PFAS exposures and protect public health.

Ecological risks are of great concern to many stakeholders due to the widespread distribution and persistence of PFAS in the environment and the wide variety of PFAS chemicals for which environmental fate and transport is currently uncharacterized. While this Action Plan focuses mainly on human health, characterizing potential ecological impacts and risks are important areas of work for the EPA.

Table 1 below summarizes the key actions the EPA is taking to assist states, tribes, and communities in addressing PFAS. These activities are intended to address challenges identified through stakeholder input

¹ There are multiple statutory mechanisms available to designate PFAS as CERCLA hazardous substances, including CERCLA, RCRA, TSCA, CWA, and CAA.

² A reference dose is an estimate of the amount of a chemical a person can ingest daily over a lifetime (chronic RfD) or less (subchronic RfD) that is unlikely to lead to adverse health effects.

³ hexafluoropropylene oxide (HFPO) dimer acid and its ammonium salt

during the PFAS National Leadership Summit, multiple community engagements, and through the public docket (see Appendices B and C for summaries of stakeholder input).

In addition to the highlighted action items in Table 1, the EPA continues to make progress on developing tools and expanding the body of scientific knowledge needed to understand and effectively manage risk from PFAS, including developing PFAS analytical methods, evaluating treatment and remediation techniques for PFAS, understanding the exposure from various environmental media, and evaluating human health impacts of additional PFAS. These activities are described in more detail in Appendix A.

Table 1. Key PFAS-Related Challenges and Planned and Ongoing EPA Actions

Stakeholder Concern or Challenge	EPA Action(s)	Purpose	Anticipated Timeframe
EPA Priority Actions			
Regulatory uncertainty (e.g., MCL) for PFAS in drinking water	Propose a national drinking water regulatory determination for PFOA and PFOS, highlighting key information gathered by the Agency and our partners to date and additional data needs.	Provide the opportunity for the public to comment on and contribute to the information the EPA may consider related to the regulation of PFAS in drinking water.	2019
Hold responsible parties accountable for PFAS releases into the environment	The EPA has initiated the regulatory development process for listing PFOA and PFOS as CERCLA hazardous substances.	Listing PFOA and PFOS as CERCLA hazardous substances would provide additional authority to address PFOA and PFOS, including the ability to require responsible parties to carry out and/or pay for response actions.	Ongoing Started 2018
Provide guidance for groundwater cleanup actions at contaminated sites	Develop interim cleanup recommendations to address groundwater contaminated with PFOA and PFOS.	Recommendations will provide a starting point for making site-specific cleanup decisions. These recommendations may be considered for federal facility and private-party cleanup under CERCLA, RCRA corrective action programs, and state cleanup programs, where appropriate.	Anticipated 2019
Increase understanding about potential human health impacts of additional PFAS	Finalize draft toxicity assessments for GenX chemicals and PFBS; develop additional PFAS toxicity values for PFBA, PFHxA, PFHxS, PFNA, and PFDA.	Finalized toxicity assessments can be combined with specific exposure information by government and private entities to help characterize potential public health risks associated with exposure to these chemicals.	Final toxicity assessments for PFBS and GenX chemicals in 2019; Draft toxicity assessments for five additional PFAS in 2020

Stakeholder Concern or Challenge	EPA Action(s)	Purpose	Anticipated Timeframe
Expand knowledge about whether new PFAS chemicals entering commerce are safe	Use new statutory requirements added by the Frank R. Lautenberg Chemical Safety for the 21 st Century Act to review new PFAS and issue supplemental proposed Significant New Use Rules (SNUR on PFAS).	New chemical reviews under TSCA ensure that unreasonable risks are addressed prior to commercialization. The issuance of SNURs for existing PFAS chemicals prohibits new uses for these chemicals until the EPA determines whether the significant new use presents an unreasonable risk and takes appropriate actions as required by TSCA to address any unreasonable risk.	Ongoing Started in 2016
Short-Term Actions			
<i>Understanding and Addressing PFAS Toxicity and Occurrence</i>			
Establish and curate a clearinghouse of chemical information for PFAS	The EPA's CompTox Chemistry Dashboard has been updated to include several curated lists of PFAS chemicals with links to known chemical, physical, and other properties.	Provide simple access to a comprehensive array of up-to-date information for PFAS of interest.	Ongoing
Expand analytical methods to accurately test for additional PFAS in drinking water	Expand the current drinking water Method 537 to include GenX chemicals and additional PFAS; develop a new drinking water method for additional short-chain PFAS not measured by Method 537.	Improved and/or additional methods would help stakeholders and the EPA accurately test, analyze, and quantify a broader suite of PFAS in their drinking water, including GenX chemicals and other short-chain PFAS.	Method 537.1 completed November 2018; additional methods in 2019
Test for PFAS and PFAS precursors in media other than drinking water	Develop and validate methods for other water matrices (wastewater, surface waters, groundwater), solids (soil, sediment, biosolids, fish tissue), and air (ambient, stack emission, off-gases).	Provide additional methods for stakeholders and the EPA to identify the presence of PFAS in concentrations of concern for media other than drinking water.	2019 – 2021
Coordination across federal agencies with common interests in PFAS toxicity	Participate in a cross-federal-agency working group on PFAS information gathering and sharing.	Better leverage federal investments and reduce redundancies. Provide states, tribes, and communities with consistent cross-federal information for making decisions.	2019

Stakeholder Concern or Challenge	EPA Action(s)	Purpose	Anticipated Timeframe
Identifying and Addressing PFAS Exposures			
Additional robust treatment and remediation technologies for PFAS in the environment	Conduct additional research to identify performance and costs associated with treatment and remediation approaches to address PFAS in the environment, along with any potential unintended consequences associated with specific technologies.	Identify new/additional treatment and remediation options that can be used to address PFAS contamination.	2019
Information about drinking water treatment effectiveness and costs for different PFAS	Incorporate the latest research results for additional PFAS into the EPA's online drinking water treatability database.	Support stakeholders in selecting the most effective drinking water treatment approaches to address concerns with PFAS in the environment.	Ongoing
Hold responsible parties accountable for PFAS releases into the environment	Employ an enforcement strategy that relies first on state and local authorities and utilizes federal authorities as appropriate where, for example, state and local authorities are not available or responsible parties do not address PFAS voluntarily.	Support communities that have PFAS releases by using federal enforcement authorities, where relevant and appropriate.	Ongoing
Understand sources and concentrations of PFAS in the environment	Partner with ECOS to build an interactive map to provide users with easy access to publicly available data on potential PFAS sources and occurrence.	Enable states, tribes, and communities to use the best available data to guide PFAS management decisions.	2019
Risk Communication and Engagement			
Coordinated messaging on PFAS across the federal government	Participate in and coordinate with an interagency PFAS risk communication workgroup to develop consistent communication materials that can be used across the federal government and are informed by the best available science.	Ensure coordinated messaging from the federal government is provided to the states, tribes, and local communities.	Ongoing Start 2019
Communication materials that can be used to inform the public of concerns related to PFAS	Work with other federal agencies, states, and tribes to develop a risk communication toolbox that includes materials and messaging for federal, state, tribal, and local partners to use with the public.	Provide states, tribes, local officials, and utilities with communication tools that convey clear and consistent messages to the public.	2019

Stakeholder Concern or Challenge	EPA Action(s)	Purpose	Anticipated Timeframe
Long-Term Actions			
Increase knowledge about PFAS releases	Explore data availability for listing PFAS chemicals to the Toxics Release Inventory (Section 313 of the Emergency Planning and Community Right-to-Know Act).	Make information about PFAS releases reported by industrial and federal facilities available. This information may be helpful to inform decision-making by communities, government agencies, companies and others.	Start 2019
Reduce PFAS releases into ambient waters and sources of drinking water	Determine if available data and research support the development of Clean Water Act Section 304(a) ambient water quality criteria for human health for PFAS.	When adopted by states and tribes as water quality standards, criteria can be used to set permit limits on discharges to a waterbody and to determine if a waterbody requires cleanup to protect human health and aquatic life.	2021
Hold responsible parties accountable for PFAS releases into the environment	Examine available information and beginning in 2019 seek additional information from industry to explore identification of industrial sources that may warrant potential regulation through national ELGs to be described in preliminary ELG plan 14 (2019).	ELGs require that a technology-based, minimum level of control be applied to any NPDES permit for direct discharge to waters or be directly applicable for indirect dischargers.	Start 2019
Characterize potential health impacts from a broader set of PFAS	Generate PFAS toxicology data through new approaches such as high throughput screening, computational toxicology tools, and chemical informatics for chemical prioritization, screening, and risk assessment.	Inform a more complete understanding of PFAS toxicity for the large set of PFAS chemicals without conventional toxicity data and allow prioritization of actions to potentially address groups of PFAS.	Ongoing
Develop more drinking water occurrence data for a broader group of PFAS	The EPA will propose nationwide drinking water monitoring for PFAS under the next UCMR monitoring cycle utilizing newer methods available to detect more PFAS chemicals and at lower minimum reporting levels (MRLs) than previously possible in earlier monitoring.	Monitoring results will improve understanding of the frequency and concentration of PFAS occurrence in finished U.S. drinking water.	Anticipated 2020
Develop a PFAS data inventory and best practices for contributing data	Develop a data standards best practice that allows sharing of soil, air, water, fish tissue, and other PFAS monitoring data.	Provide a way to share PFAS testing results for media other than drinking water that facilitates integration and easy access and use of PFAS data.	Start 2019

Stakeholder Concern or Challenge	EPA Action(s)	Purpose	Anticipated Timeframe
Access ecological risk information to protect ecosystems	Identify sensitive and susceptible species; synthesize information on bioaccumulation in organisms and food chains; where appropriate develop benchmarks and thresholds for ecological toxicity.	Enable action to protect aquatic ecosystems; establish cleanup levels for contaminated sites; protect recreational and cultural values, such as hunting and fishing.	2022
Understand potential for atmospheric transport of PFAS	Incorporate PFAS information into the EPA atmospheric models to understand the potential for atmospheric fate and transport of PFAS.	Enable risk managers to understand the full range of potential PFAS exposure pathways so that they can prioritize appropriate action.	2022



II. Introduction

Many Americans are concerned about potential health impacts from exposure to per- and polyfluoroalkyl substances (PFAS) in the environment. Over the last decade, there has been a move to the manufacture and use of PFAS that may be less bioaccumulative and may be less likely to cause adverse health effects in humans and the environment. However, contamination from legacy PFAS and uncertainty regarding the safety of newer, alternative, PFAS compounds in the environment are a continuing concern for the federal government, states, tribes, and local communities. The EPA is leading efforts with our federal, state, tribal, and community partners to better characterize and mitigate risks related to the presence of PFAS in the environment. The Agency will work with partners to accomplish these goals through pollution prevention, characterization and remediation of contamination in the environment, evaluation of human health and ecological risks, reducing exposures, development of treatment and remediation technologies, dissemination of risk communication materials, identification of safer alternatives, and use of enforcement authorities and regulatory approaches as appropriate.

This PFAS Action Plan identifies EPA-led short-term actions, longer-term research, and potential regulatory approaches designed to reduce the risks associated with PFAS in the environment. In carrying out this Action Plan, the EPA intends to work closely with its federal partners, states, tribes, and local communities. The challenges associated with PFAS cross multiple environmental media and many potential sources. Effective collaboration among all stakeholders is key to successful characterization, communication, and mitigation of concerns associated with PFAS in the environment. The EPA has heard the concerns expressed by the public through a recent series of EPA-sponsored community engagement meetings and through public comments submitted to the EPA through an open docket. The EPA will work with states, tribes, communities, and other federal agencies to take appropriate steps to protect human health and limit risks from PFAS in the environment. Through implementation of this Action Plan and active engagement with other federal agencies, international organizations, states, tribes, industry groups, associations, local governments, communities, and the public, the EPA will lead the national effort to understand and reduce PFAS risks to the American people. As the EPA learns more about PFAS and the risks they may pose, the Agency may update this Action Plan to reflect that new information.



III. PFAS Identification and Actions Previously Taken by the EPA

The term PFAS refers to per- and polyfluoroalkyl substances. PFAS are a very large group of synthetic chemicals that includes PFOA, PFOS, PFBS, perfluorononanoic acid (PFNA), hexafluoropropylene oxide (HFPO) dimer acid and its ammonium salt (referred to as GenX chemicals), and thousands of other compounds (USEPA 2018a). Due to their strong carbon-fluorine bonds, many PFAS can be very persistent in the environment with degradation periods of years, decades, or longer under natural conditions (Beškoski et al. 2018, Kallenborn 2004, Luo et al. 2015, Parsons et al. 2008, Frömel and Knepper 2010). Differences associated with chain length, chemical structure, and chemical functional groups incorporated into individual PFAS have important implications for mobility, fate, and degradation within the environment, as well as uptake, metabolism, clearance, and toxicity in humans, plants, and other animals. There is evidence that exposure to certain PFAS in the environment can lead to adverse human health effects (ATSDR 2018a, USEPA 2016a, USEPA 2016b). PFOA and PFOS, two of the most widely studied PFAS, have been detected in the blood serum of up to 99% of samples collected between 1999 and 2012 in a population that is representative for the U.S. More recent studies suggest blood levels of PFOA and PFOS have been decreasing since some U.S. manufacturers voluntarily phased out production beginning in 2000⁴(ATSDR 2018a, USEPA 2016a, USEPA 2016b, CDC 2018). Measured body concentrations of other PFAS, including replacement PFAS, are showing different patterns (Kato et al. 2011, Olsen et al. 2008, USEPA 2018b). For example, PFNA in women of child-bearing age increased between 1999-2000 and 2007-2008, while perfluorohexane sulfonic acid (PFHxS) was relatively constant (USEPA 2013). However, because these results are based on a broad national survey, they do not depict the exposure distribution for those who live near PFAS-contaminated sites or people who work in

⁴ The PFOA Stewardship Program began in 2006. PFOS was phased out by 3M between 2000 and 2002.

occupations that use PFAS. There are many PFAS in wide use for which more information regarding their presence, toxicity and mobility in a variety of environmental media is needed.

Stakeholder Concerns

At the PFAS National Leadership Summit, at community engagement events across the country, and through comments submitted to the docket, the EPA has heard about the many challenges communities are facing with PFAS. The EPA heard that effective collaboration is needed at the federal and state levels to compile and reconcile different information sources, better understand exposure impacts, enhance monitoring approaches, and to develop additional information on PFAS. Stakeholders and decision makers have emphasized the need to accelerate the understanding of PFAS toxicity and the impacts of PFAS to ecosystems as well as the need to expand the availability of analytical methods to detect and characterize exposures of concern.

At these events, the EPA also heard many challenges associated with addressing PFAS including:

- Cost burden and affordability concerns for PFAS-impacted communities and utilities, especially for the cost and operating requirements associated with treatment and remediation technologies;
- Lack of hazardous substance listings, precluding the use of Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) cleanup orders and cost recovery for PFAS;
- Lack of enforceable numeric standards;
- Lack of multi-media sampling methods;
- Confusion about different health values from various authorities; and
- Information gaps on how to safely handle PFAS-containing waste byproducts, biosolids, treatment plant residuals, and materials containing PFAS.

Overarching Challenges for PFAS Management

Understanding the scope of PFAS exposure including sources, pathways, populations exposed, and levels of exposure is critical to effectively characterizing the potential human health and environmental risks associated with these compounds. Other unknown and undiscovered PFAS likely exist within the environment as impurities or byproducts of chemical production or as a result of environmental degradation and transformation processes. Health and occurrence data and validated analytical methods are available for certain PFAS (e.g., PFOA and PFOS). However, for most PFAS there is limited or no toxicity information. While validated EPA drinking water measurement methods are available for 18 PFAS today, including PFOA and PFOS, and more are in development, we lack validated analytical methods for national environmental measurements and assessment of exposure for hundreds of other PFAS. Additional challenges to remediation and cleanup include PFAS occurrence as mixtures with other contaminants. There are continuing research needs related to the development of PFAS destruction technologies. Additional tools and information would improve risk characterization, cleanup options, and management decisions. Knowledge of PFAS impacts on human health and the environment is advancing, and the EPA and other organizations are collaborating to generate research and consider new scientific information as it becomes available. To effectively manage PFAS-related exposures and

human health risks when they have been identified, decision makers must consider the potential sources, available technology and if necessary, the regulatory authorities and enforcement tools that may allow federal agencies, states, tribes, and local governments to address PFAS exposure in the environment.

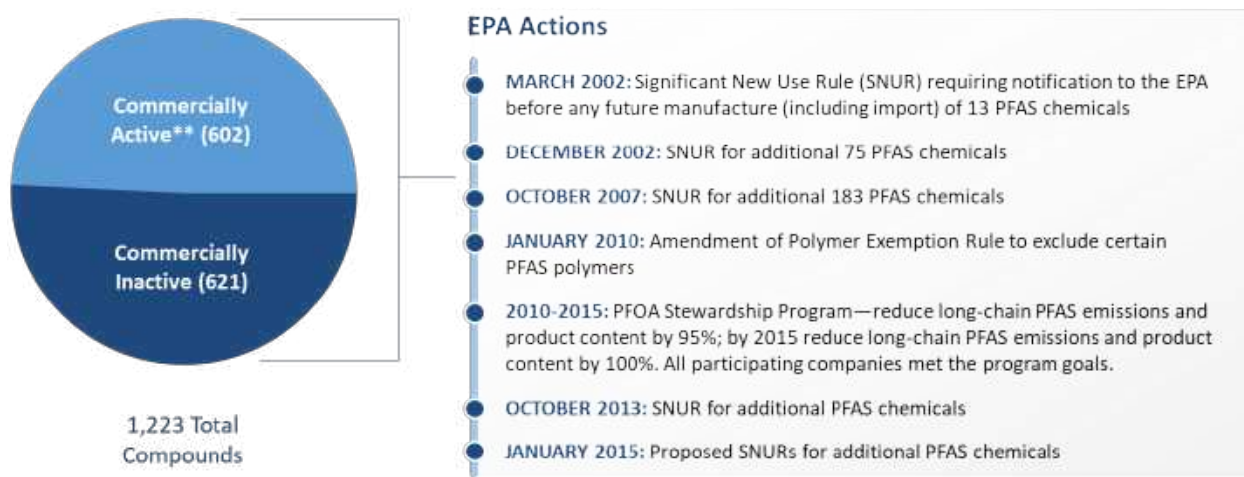
Federal, state, tribal, and local government, communities, and public and private entities will need to partner on developing and implementing management approaches, policies, and solutions to efficiently use limited resources to address PFAS-related risks. While better understanding and reducing the risks posed by PFAS is an important EPA priority, it is not the only public health or environmental challenge faced by our communities. Leveraging resources and partnering is important to ensure the availability of resources to address other priority environmental and public health issues.

While the EPA is evaluating options for development of the most appropriate regulatory programs and tools to address PFAS risks, the EPA also plans to actively lead and support PFAS management efforts using nonregulatory means and enforcement, where appropriate, in partnership with many stakeholders, to protect public health and the environment.

PFAS Use

Over 4,000 PFAS may have been manufactured and used in a variety of industries worldwide since the 1940s (OECD 2018, Guelfo et al. 2018). The EPA's Toxic Substances Control Act (TSCA) Chemical Substance Inventory lists over one thousand PFAS, of which approximately half are known to be commercially active within the last decade. Many PFAS are chemically and thermally stable and demonstrate resistance to heat, water, and oil (Rahman et al. 2014). These properties have made PFAS useful in a variety of consumer products and industrial processes, including firefighting foams, chemical processing, building/construction, aerospace, electronics, semiconductor and automotive industries, stain- and water-resistant coatings (e.g., carpets and rain repellent clothing), food packaging, and in waxes and cleaners (USEPA 2009). Due to their desirable chemical properties for consumer goods, PFAS are widely used in commercial products and can be found in almost every U.S. home and business. All eight companies participating in the EPA's PFOA Stewardship Program voluntarily phased out long-chain PFAS in favor of shorter-chain replacements, which are generally less bioaccumulative and potentially less toxic (Ritter 2010). Previously produced items and imported items may still contain longer-chain PFAS such as PFOA or PFOS (USEPA 2018b). Some replacement PFAS are capable of degrading to PFOA or other long-chain PFAS. Recent research suggests that additional factors aside from chain length may affect the bioaccumulation potential and toxicity of individual PFAS (ITRC 2018a, Ng et al. 2014).

PFAS on the TSCA Inventory*



* The TSCA inventory is a list of chemical substances approved for U.S. commerce. The original inventory was compiled from substances reported under the 1978 TSCA Inventory Reporting Rule, and substances have been added since via a commenced Premanufacture Notice.

** Substances on the TSCA inventory currently designated as commercially active are those reported under the retrospective reporting requirements of the TSCA Inventory Notification (Active/Inactive) rule. These substances were in U.S. commerce at some point between June 2006 and June 2016.

Routes of Exposure

People are exposed to PFAS through the use of consumer products, through occupational exposure, and/or through consuming contaminated food or contaminated drinking water (Fromme et al. 2009). Potential pathways of significant human PFAS exposure include (USEPA 2018a, ATSDR 2018b, Fromme et al. 2009, Ghisi et al. 2018, McGoldrick and Murphy 2016, Stahl et al. 2014, Franko et al. 2012):

- Drinking water from public water and private water systems, typically localized and associated with a release from a specific facility (e.g., manufacturer, processor, landfill, wastewater treatment, or facilities using PFAS-containing firefighting foams);
- Consumption of plants and meat from animals, including fish that have accumulated PFAS;
- Consumption of food that came into contact with PFAS-containing products (e.g., some microwaveable popcorn bags and grease-resistant papers);
- Use of, living with, or otherwise being exposed to commercial household products and indoor dust containing PFAS, including stain- and water-repellent textiles (including carpet, clothing and footwear), nonstick products (e.g., cookware), polishes, waxes, paints, and cleaning products;
- Employment in a workplace that produces or uses PFAS, including chemical production facilities or utilizing industries (e.g., chromium electroplating, electronics manufacturing, or oil recovery); and
- In utero fetal exposure and early childhood exposure via breastmilk from mothers exposed to PFAS.

Potential Human Health Impacts

The majority of research on the potential human health risks of PFAS are associated with oral (ingestion) exposure. Limited data exist on health effects associated with inhalation or dermal exposure to PFAS. Most available toxicity data are based on laboratory animal studies. There are also several human epidemiological studies of PFOA and PFOS. Exposure to some PFAS above certain levels may increase risk of adverse health effects. While many of the same effects are observed for the family of PFAS chemicals, it appears that different adverse effects may be dominant in different PFAS. Depending on the PFAS, increased risks observed in some animal studies include developmental effects to fetuses during pregnancy and infants (e.g., low birth weight, altered puberty, skeletal variations), cancer (e.g., testicular, kidney), liver effects (e.g., tissue damage), immune effects (e.g., changes in antibody production and immunity), thyroid effects related to developmental outcomes, and other effects (e.g., cholesterol changes) (USEPA 2016a, USEPA 2016b). The EPA plans to continue evaluating toxicity information for PFAS; critical information may come from investigating whether exposure to structurally similar PFAS results in similar health effects. Currently, long-chain PFAS are generally thought to present greater toxicity in humans than shorter-chain PFAS (Ritter 2010, Eschauzier et al. 2012), though the toxicities of short-chain PFAS have generally been less thoroughly studied (Danish EPA 2015). Additionally, short-chain PFAS are as persistent in the environment as their longer-chain analogues and are highly mobile in soil and water (Bergström 2014). Due to increasing global production and use, environmental and human exposure to short-chain PFAS is expected to increase over time (Wang et al. 2013). Differences in mobility, fate and persistence in the environment, as well as treatability in environmental media across the complex family of PFAS are expected to contribute to differences in potential exposures and resulting health risks in humans.

History of the EPA's PFAS Actions

The EPA has been actively engaged in preventing risks associated with PFAS. Several statutes provide the EPA with the authority to address PFAS, including TSCA, the Safe Drinking Water Act (SDWA), and CERCLA. This section provides an overview of previous actions the EPA has taken to address PFAS.

Toxic Substances Control Act (TSCA)

Under TSCA, the EPA has broad authority to issue regulations designed to gather health/safety and exposure information on, require testing of, and control exposure to chemical substances and mixtures. TSCA gives the EPA authority to require reporting, record-keeping, and testing of chemical substances and mixtures, and protect against unreasonable risks to human health and the environment from existing chemicals. Among other things, section 5 of TSCA allows the EPA to issue SNURs that require notice to the Agency before chemical substances and mixtures are manufactured (including imported) or processed for significant new uses.

The EPA has used various strategies under TSCA to better understand and reduce exposures to PFAS. For example, in early 2000, the EPA worked with the 3M Company to support the company's voluntary phase-out and elimination of PFOS production and use. As a result of the EPA's 2010/2015 PFOA Stewardship Program, eight major chemical manufacturers and processors agreed to phase out the use

of PFOA and PFOA-related chemicals in their products and emissions from their facilities. All companies met the PFOA Stewardship Program goals by 2015. Through the EPA's work under TSCA, the Agency has also issued various SNURs to require manufacturers (including importers) and processors of certain PFAS chemicals to notify the EPA at least 90 days before starting or resuming significant new uses of these chemicals. This notification would require the EPA to review the significant new use, make a risk determination under section 5, and take appropriate regulatory action based on that risk determination. In 2015, the EPA proposed the most recent SNUR on PFAS to complement the long-chain PFAS phaseout under the 2010/2015 PFOA Stewardship Program by requiring manufacturers (including importers) of PFOA and certain PFOA-related chemicals, including as part of articles, and processors of these chemicals to notify the EPA at least 90 days before starting or resuming new uses of these chemicals. Upon receipt of the notice and prior to any "significant new use" activity commencing, TSCA mandates that the EPA review the potential health and environmental effects, make an affirmative determination on the risks, and take actions necessary to eliminate those risks, as appropriate. The EPA is considering the public comments received on the 2015 proposed SNUR as well as the new statutory requirements added by the Frank R. Lautenberg Chemical Safety for the 21st Century Act as it works to issue a supplemental proposed SNUR on PFAS for the manufacture (including import) of certain long-chain perfluoroalkyl carboxylate (LCPFAC) chemical substances, including as part of categories of certain articles, and the processing of these chemicals.

Safe Drinking Water Act (SDWA)

Section 1412 of the SDWA requires the EPA to publish a list of contaminants known or anticipated to occur in public water systems which may require regulation under the Safe Drinking Water Act (the Contaminant Candidate List). The EPA included PFOA and PFOS on the fourth Contaminant Candidate List (USEPA 2018c). The EPA worked with states and public water systems to characterize the occurrence of six PFAS in the nation's drinking water by including them in the third Unregulated Contaminant Monitoring Rule (UCMR), published in 2012 under the SDWA. The EPA uses the UCMR to collect data for contaminants that are suspected to be present in drinking water and do not have standards set under the SDWA. The EPA collected data for six PFAS in the UCMR: PFOA, PFOS, PFBS, PFNA, PFHxS, and perfluoroheptanoic acid (PFHpA). From 2013-2015, drinking water samples were collected and analyzed in nearly 5,000 public water systems across the nation, accounting for approximately 80% of the U.S. population served by public water systems (USEPA 2016c). The EPA plans to use these monitoring results and other information in the next step in the SDWA regulatory determination process as described below. In addition to the regulatory process, the SDWA provides authority for the Agency to publish drinking water Health Advisories (HAs) which are non-enforceable, health-based drinking water levels. In 2016, the EPA released lifetime Health Advisories for two PFAS (PFOA and PFOS). These Health Advisories provide the public, including the most sensitive populations, with a margin of protection from a lifetime of exposure to PFOA and PFOS from drinking water. Health Advisories are non-enforceable and non-regulatory and provide technical information to state agencies and other public health officials on health effects, analytical methodologies, and treatment technologies associated with drinking water contamination (USEPA 2016a, USEPA 2016b).

Furthermore, pursuant to section 1431(a) of the SDWA, the EPA has authority to take actions the Agency deems necessary to protect public health when a contaminant, whether regulated or not, is

present in or likely to enter a public water system or an underground source of drinking water, and “may present an imminent and substantial endangerment to the health of persons.” This authority enables the EPA to respond to emergency conditions and conditions where contamination threatens public health. This section 1431 authority is distinct from the process to establish National Primary Drinking Water Regulations under section 1412 of the SDWA. The EPA has used its authority under section 1431 to issue orders that require persons who have caused or contributed to PFAS contamination to take actions as may be necessary to protect the health of persons, including actions that reduce or prevent exposures.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

CERCLA, commonly known as Superfund, provides the federal government with authority to respond to releases and threatened releases of hazardous substances, and, if they may present an imminent and substantial endangerment, pollutants and contaminants. CERCLA section 104(e) also provides authority to investigate a site to determine whether hazardous substances, pollutants or contaminants have been or may be released. If there is a release of a hazardous substance, parties responsible for the release may be ordered to respond under CERCLA and/or may be liable under CERCLA for the costs of responding to those releases. PFOA and PFOS are considered CERCLA pollutants or contaminants, not hazardous substances. Thus, federal response/cleanup authority exists where the federal agency with CERCLA authority has made a determination that the PFOA or PFOS release may present an imminent and substantial danger to public health or welfare. In addition, the EPA has initiated the regulatory development process to designate PFOA and PFOS as CERCLA “hazardous substances”, which would extend CERCLA order and cost recovery authorities to address communities affected by PFOA and PFOS contamination.

The EPA supports federal agencies, states, tribes, and local communities by coordinating with others to identify exposures, developing methods in order to measure PFAS in the environment, and supporting cleanup efforts where PFAS has been identified as a risk to human health, including working with other federal partners and using enforcement tools where necessary. Where the EPA finds that there may be an imminent and substantial endangerment to public health or welfare related to PFAS contamination, the Agency will consider using its response authority under CERCLA section 104 or utilizing its enforcement authorities such as the SDWA section 1431 or Resource Conservation and Recovery Act (RCRA) section 7003.

Consistent with CERCLA, the Agency for Toxic Substances and Disease Registry (ATSDR) recently released draft toxicological profiles for multiple PFAS, which included Minimal Risk Levels (MRLs). ATSDR’s MRLs for four PFAS substances (i.e., PFOA, PFOS, PFHxS, and PFNA), when finalized, are intended to serve as screening tools to help public health professionals to determine areas and populations potentially at risk for exposure and can be used as a mechanism to identify hazardous waste sites that are not expected to cause adverse health effects (ATSDR 2018a). The EPA will continue to partner with ATSDR to better understand and communicate risks to human health from PFAS.



IV. Reducing PFAS Exposures: What the EPA Is Doing to Ensure the Problem Is Not Exacerbated

Understanding PFAS in Commerce

Risk Management for PFAS under TSCA

The EPA has the responsibility for reviewing new chemical substances before they enter commerce. The EPA's TSCA New Chemicals program functions as a "gatekeeper" to help manage the potential risk to human health and the environment from chemicals new to the marketplace. TSCA requires the EPA to make risk determinations on new industrial chemicals and provides the EPA with a range of regulatory options to address risks. The EPA has reviewed hundreds of new chemical substitutes for PFOA, PFOS, and other long-chain PFAS under TSCA since 2000. In many cases, the EPA has used its authority under TSCA to impose restrictions on these substances—as well as requiring companies to generate data on physical and chemical properties, environmental fate, toxicokinetics, acute toxicity, irritation and sensitization, repeated dose toxicity,



EPA Priority Action

ACTION: New SNUR on PFAS chemicals.

PURPOSE: In 2015 the EPA proposed the most recent SNUR on PFAS chemicals to complement the long-chain PFAS-phaseout under the 2010/2015 PFOA Stewardship Program.

NEXT STEPS: The EPA is considering the public comments received as well as the new statutory requirements added by the Frank R. Lautenberg Chemical Safety for the 21st Century Act as it works to issue a supplemental proposed SNUR on PFAS.

genotoxicity, reproductive/developmental toxicity, and cancer—as conditions for allowing the substances on the market.

Anyone who plans to manufacture or import a new PFAS chemical substance for a non-exempt⁵ commercial purpose must first provide the EPA with notice, known as a premanufacture notice (PMN). The EPA must review and make an affirmative determination on the PMN. For purposes of TSCA, if a chemical is on the TSCA Inventory, the substance is considered an existing chemical substance in U.S. commerce. Any chemical that is not on the Inventory is considered a new chemical substance.

The EPA is required under TSCA to review PMNs in a 90-day period with the goal of identifying whether there are unreasonable risks and applying appropriate controls to mitigate risks where identified. The EPA uses an integrated approach that draws on knowledge and experience across disciplinary and organizational lines to identify releases and exposures and evaluate concerns regarding health and environmental effects. The EPA evaluation includes an assessment of occupational exposures and facility releases to land, water, and air. The EPA then evaluates the impacts of these releases on environmental receptors (primarily aquatic) as well as to the general population, including susceptible populations. The EPA also conducts, when relevant, an assessment of non-workplace exposures such as those experienced by persons using a specific commercial or consumer product containing a chemical (e.g., paints, cleaners). Product use scenarios used to assess risk may include, as appropriate, assessment of ‘bystanders’ (i.e., persons not actually using the product, but within the exposure vicinity) and subsequent impacts on environmental receptors. As required by TSCA, these evaluations are risk based and consider both hazard and exposure.

By the end of the review period, the EPA must make one of five determinations under TSCA:

1. Insufficient information to perform a reasoned evaluation;
2. Insufficient information and may present unreasonable risk;
3. Not likely to present an unreasonable risk;
4. Presents an unreasonable risk; or
5. Potential for substantial release/exposure.

More information on the EPA’s review and decision-making processes is available on the EPA’s website at: <https://www.epa.gov/reviewing-new-chemicals-under-toxic-substances-control-act-tsca>.

The EPA can designate through rulemaking certain new uses of a chemical as significant new uses. Anyone who plans to manufacture or import a chemical substance for a use that has been designated by the EPA as a significant new use must first provide the EPA with notice, known as a significant new use notice (SNUN). The EPA must review and make an affirmative determination on the notice before that new use can commence, if at all. The EPA has already designated significant new uses for more than 400 PFAS chemicals, including for certain PFAS substances that have been through the new chemical review

⁵ Certain manufacture of chemical substances is excluded or exempt from full PMN notification requirements, including small quantities of substances manufactured solely for research and development, substances manufactured for test marketing, substances manufactured in low-volumes, and substances manufactured with low releases or low exposures. Some of these exemptions (e.g., the Low Volume Exemption) require submission of an application to the EPA for review and potential action.

process but have not yet been commercialized, and for certain PFAS substances used in manufacturing (including importing) and processing of carpets or for treating carpet.

The Agency proposed in 2015 a Significant New Use Rulemaking for Long-Chain Perfluoroalkyl Carboxylate and Perfluoroalkyl Sulfonate Chemical Substances that would require manufacturers (including importers) of PFOA and certain PFOA-related chemicals, including as part of articles, and processors of these chemicals to notify the EPA at least 90 days before starting or resuming new uses of these chemicals in any products. The Agency plans to follow up on the 2015 SNUR.

Depending on the outcome of its review and determination, under TSCA the EPA may take actions on a new PFAS or significant new PFAS use, ranging from imposing restrictions or limitations (e.g., use restrictions, production volume cap, limitation on releases to water, etc.) to an outright prohibition on manufacture to ensure that the substance does not present an unreasonable risk. For example, if the EPA determines that there is insufficient information to perform a reasoned evaluation or that the chemical may present an unreasonable risk, the EPA may issue an order under TSCA that eliminates the potential for unreasonable risk. The EPA can also require the submitter to conduct testing to better understand whether or to what extent the chemical presents risks. Nearly all TSCA new chemicals orders issued by the EPA are consent orders negotiated with the submitter of the notice. Because these orders are binding only on the original PMN submitter for that substance, the EPA typically also issues a Significant New Use Rule that requires notice to the EPA by any manufacturer or processor who wishes to manufacture or process the chemical in a way other than described in the terms and conditions contained in the order.

Over the decades, and in particular since the beginning of the phase-out of long-chain PFAS in 2006 under the PFOA Stewardship Program, the EPA's new chemicals program has developed significant experience in reviewing PFAS substances before they enter the market. More than 300 PMN or SNUN submissions for PFAS substances have been reviewed by the EPA since the beginning of the PFOA Stewardship Program, of which about 200 were regulated by the EPA, typically under a section 5(e) Order. Similarly, more than 300 Low Volume Exemption Applications have been reviewed by the EPA during this period, most of which were granted based on restrictions/controls in the original or amended submissions.

With the restrictions the EPA has imposed on many of these chemicals, together with the data the EPA required to be generated, the TSCA new chemicals program is an important contributor to helping ensure the safe use of PFAS in commerce.

PFAS and the Toxics Release Inventory

Section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA) created the TRI Program. The TRI Program's mission is to provide the public with information about TRI chemicals, including releases, other waste management (e.g., recycling), and pollution prevention from TRI-reporting facilities. The TRI Program is another tool the EPA may use to understand the releases of PFAS by industrial and federal facilities. TRI tracks the management of certain toxic chemicals that may pose a threat to human health and the environment. U.S. facilities in different industry sectors must report annually how much of each chemical is released to the environment and/or managed through recycling,

energy recovery and treatment. A "release" of a chemical means that it is emitted to the air or water or placed in some type of land disposal. The information submitted by facilities is compiled in the Toxics Release Inventory. TRI helps support informed decision-making by companies, government agencies, non-governmental organizations, and the public.

Currently, no PFAS chemicals are included on the list of chemicals required to report to TRI; however, the EPA is considering whether to add PFAS chemicals. In considering listing, the EPA must determine whether data and information are available to fulfill the listing criteria and the extent and utility of the data that would be gathered. For example, hazard data required for TRI listing may be readily available for certain PFAS chemicals, but not others. In addition, in considering if TRI will provide useful information to stakeholders, the EPA also will consider if those PFAS are still active in commerce. The process for listing includes notice and comment rulemaking to list PFAS chemicals for reporting prior to adding these chemicals to the TRI for annual reporting.



V. Understanding PFAS Toxicity to Develop Recommendations and Standards

The EPA is working to understand and address PFAS toxicity through development of human health toxicity assessments on long- and short-chain PFAS. This and other research using advanced toxicological methods will provide a better understanding of PFAS toxicity, including methods for assessing groups of PFAS with similar toxicities and exposures. Toxicity information can be used to provide health protective recommendations and standards for cleanup of environmental media.

The EPA's Actions to Develop Human Health Toxicity Information on PFAS

In 2016, the EPA issued a non-regulatory lifetime Health Advisory (HA) of 70 parts per trillion (ppt) for individual and combined PFOA and PFOS in drinking water. Additional information on the Health Advisories for PFOA and PFOS can be found at <https://www.epa.gov/ground-water-and-drinking-water/drinking-water-health-advisories-pfoa-and-pfos>. The EPA has made it a priority to produce a new toxicity assessment for GenX chemicals and an updated toxicity assessment for PFBS to facilitate hazard characterization and future risk management decisions. The EPA made



EPA Priority Action

ACTION: The EPA is developing toxicity values for GenX chemicals and PFBS.

PURPOSE: Industry has phased out the use of PFOS and PFOA in favor of shorter-chain PFAS such as GenX chemicals and PFBS. Toxicity values for these replacement chemicals will help inform risk management decisions of federal agencies, states, and tribes to protect human health.

NEXT STEPS: The EPA plans to release final toxicity values for GenX chemicals and PFBS in 2019. Toxicity values for five other PFAS are under development.

draft toxicity assessments for GenX chemicals and PFBS available for public comment in 2018 and expects to issue final toxicity assessments for these two compounds in 2019. Concurrently, the EPA plans to generate additional PFAS toxicity data through *in vitro* high throughput toxicity testing (HTT) and high throughput toxicokinetic (HTTK) assays to inform hazard effects characterization and promote prioritization of chemicals for further *in vivo* testing (Judson et al. 2009, Kavlock and Dix 2010). Generating HTT and HTTK data will improve our understanding of PFAS toxicity and potential human health effects for PFAS compounds for which there is currently limited health-related information and can help to inform Agency and stakeholder decision-making regarding human health risk and remediation levels across the broad landscape of PFAS compounds. In the near term, the EPA intends to also continue to use public peer-reviewed available toxicity information to work towards the development of additional PFAS toxicity assessments for perfluorobutanoic acid (PFBA), perfluorohexanoic acid (PFHxA), PFHxS, PFNA, and perfluorodecanoic acid (PFDA).

Groundwater Cleanup Recommendations for PFOA and PFOS

The EPA is developing Interim Recommendations for Addressing Groundwater Contaminated with PFOA and PFOS to support site-specific cleanup efforts. When finalized, the guidance will provide interim recommendations at sites being evaluated and remediated under the EPA's CERCLA federal cleanup program or at federal-led RCRA corrective action sites. The information and recommendations in this guidance may also be useful for other federal agencies, states, tribes, or other regulatory authorities (e.g., approved state RCRA corrective action programs).

Addressing PFAS in Drinking Water through Standards

The EPA is committed to following the Safe Drinking Water Act process for evaluating drinking water standards for PFAS, including an MCL for PFOA and PFOS. That process involves determining: (1) whether a contaminant may have adverse health effects; (2) whether a contaminant is found in public water systems with a frequency and at levels of concern; and (3) whether, in the sole judgment of the Administrator, there is a meaningful opportunity for health risk reduction through a national drinking water regulation. This process includes a formal rulemaking, engagement with the EPA's National Drinking Water Advisory Council, and extensive public participation. These requirements are expressly prescribed under the Safe Drinking Water Act to ensure scientific integrity and transparency for the regulation of contaminants in public water systems.



EPA Priority Action

ACTION: The EPA is developing interim recommendations for addressing groundwater contaminated by PFOA and PFOS.

PURPOSE: These recommendations will assist the EPA, other federal agencies, states, and tribes in developing and implementing cleanup goals for PFOA and PFOS under CERCLA.

NEXT STEPS: The groundwater cleanup recommendations will be released for public comments prior to finalization.

Certain PFAS have been shown to cause adverse health effects at sufficient exposures, and the EPA is continuing to gather and analyze data regarding the frequency and levels of occurrence of the sampled PFAS. Under the third Unregulated Contaminant Monitoring Rule (UCMR3) program the EPA collected data for six PFAS. From January 2013 through December 2015, samples were collected nationally by all public water systems (PWSs) serving more than 10,000 people, as well as from 800 representative PWSs serving 10,000 or fewer people. Additional information can be found at the EPA's UCMR3 website <https://www.epa.gov/dwucmr/third-unregulated-contaminant-monitoring-rule> (USEPA 2016c). The EPA found that 1.3 percent of the PWSs monitored under UCMR3 had measured concentrations of PFOA and PFOS that were greater than the EPA's lifetime HA (lifetime HA limit of 70 ppt or 0.07µg/L) (USEPA 2016a, USEPA 2016b).

Using the occurrence information from UCMR3 and other relevant information, the EPA will propose a regulatory determination for PFOA and PFOS in 2019 for public comment. A regulatory determination is the next step in the SDWA process for developing a national primary drinking water regulation. The Agency also recognizes that there is additional information that the EPA should evaluate regarding PFAS other than PFOA and PFOS, including new monitoring and occurrence data, recent health effects data, and additional information to be solicited from the public, which will inform the development of a national drinking water regulation for a broader class of PFAS in the future.

The EPA also intends to propose nationwide drinking water monitoring for PFAS under the next UCMR monitoring cycle utilizing newer methods available to detect different PFAS and at lower minimum reporting levels (MRLs) than previously possible in earlier monitoring. As part of this process, the EPA intends to solicit pre-proposal stakeholder input in 2019 and issue a proposed drinking water monitoring rule (UCMR5) in 2020.

In addition to the available UCMR data, the EPA plans to evaluate the extensive occurrence information for PFAS in source and drinking waters recently collected by some states, and which other states intend to collect in the future. The Agency has also heard extensive concerns from the public about PFAS that were not monitored as a part of the UCMR3 effort. Within the proposed regulatory determination federal register notice for PFOA and PFOS, the EPA plans to highlight the information that is known by



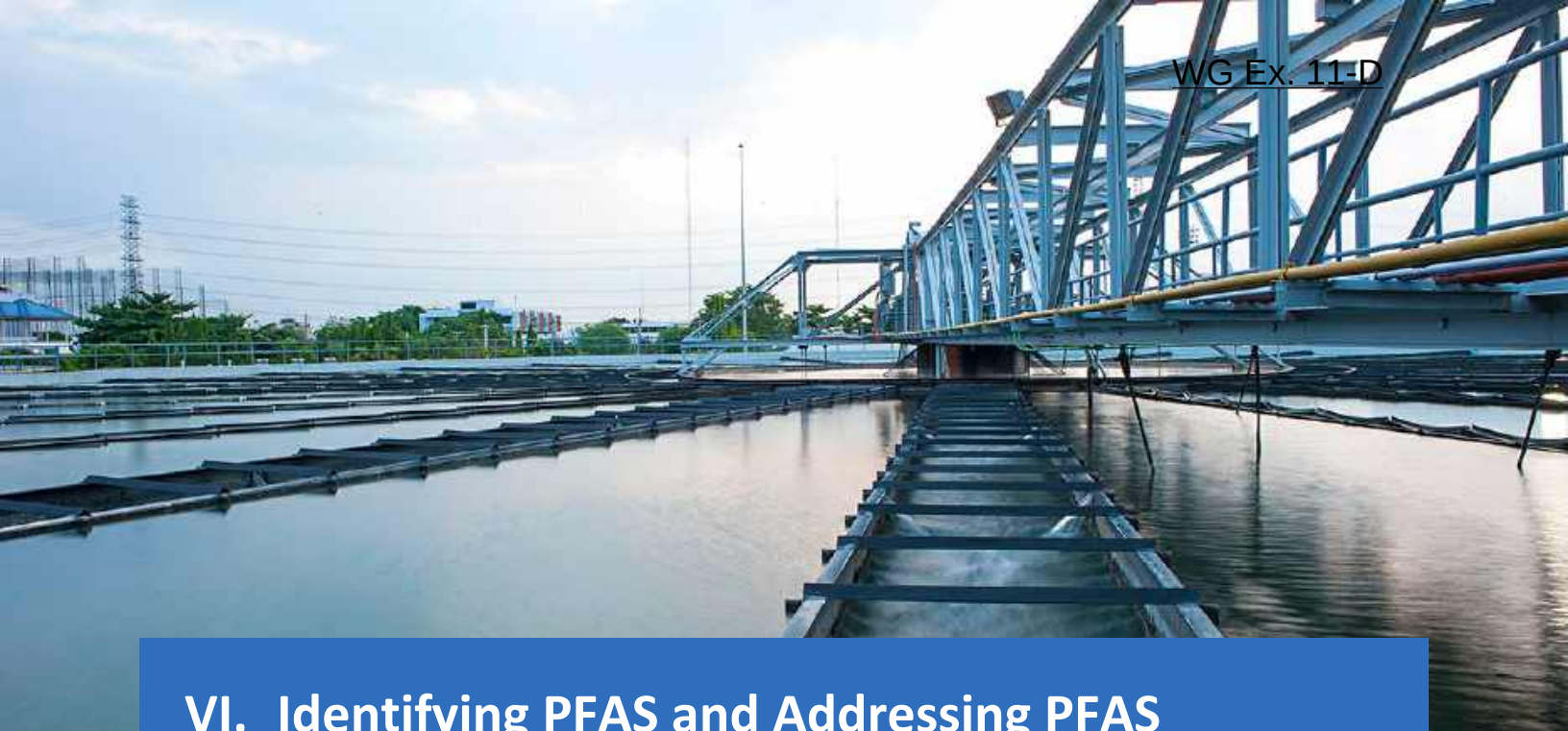
EPA Priority Action

ACTION: The EPA is committed to proposing a regulatory determination for PFOA and PFOS. In addition, the EPA is committed to proposing additional PFAS for the next round of unregulated contaminant monitoring.

PURPOSE: This is the next step in the SDWA process and will enable the EPA to obtain additional information on PFOA, PFOS, and other PFAS compounds to inform regulatory action.

NEXT STEPS: In 2019, propose a regulatory determination for PFOA and PFOS highlighting key information gathered by the Agency to date. The EPA will invite the public to comment on the Agency's efforts to date, including recommending additional information the Agency should consider in its regulatory determination.

the Agency and invite the public to provide additional information that the EPA can consider, including information from additional data sources related to sampling of additional water systems and for a broader suite of PFAS. Based on this and other information (including UCMR finished water data), the EPA will make a final determination for PFOA and PFOS, and as appropriate, other PFAS and take the appropriate next regulatory steps under the SDWA. In the interim, the Agency intends to prioritize prevention and remediation programs to support local communities currently facing PFAS challenges and will exercise its SDWA authorities where necessary and appropriate.



VI. Identifying PFAS and Addressing PFAS Exposures in Affected Communities

The EPA is focused on identifying and addressing PFAS exposures in order to protect people and communities from exposures to PFAS that present an adverse health risk, especially for the most vulnerable members of the exposed population. Additionally, the EPA is focused on providing tools and information to support federal agencies, states, tribes, and local communities to address PFAS in the environment. This work involves coordinating with others to identify exposures, developing methods in order to measure PFAS in the environment, and supporting cleanup efforts where PFAS has been identified as a risk to human health, including working with other federal partners and using enforcement tools where necessary. Where the EPA finds that there may be an imminent and substantial endangerment to public health related to PFAS contamination, the Agency will consider using its response authority under CERCLA section 104 or utilizing its enforcement authorities such as the SDWA section 1431 or RCRA section 7003.

Work with States, Tribes, and Local Governments on Identifying Exposures

Identifying PFAS is the first step in understanding if PFAS exposure may be of concern to a community. PFAS exposure in the general population occurs primarily through consumption of food that has been stored or cooked in materials containing PFAS, eating contaminated food grown in or collected from contaminated soil or water (Ghisi et al. 2018), eating contaminated meat from animals (e.g., fish), contact with household products contact through contaminated soil and dust (Shoeib et al. 2005), or drinking water that has been contaminated with PFAS. Drinking water contamination is typically localized and associated with a specific source of PFAS (for example, an industrial facility where these chemicals were produced or used to manufacture other products; or an airfield, military base, or petroleum or chemical facility at which PFAS containing foams were used for firefighting or training

(USEPA 2018a, Hu et al. 2016, Guelfo et al. 2018)). In addition to the monitoring conducted by the EPA and states as part of the UCMR program (monitored for six PFAS), some states have taken additional steps to understand the occurrence of PFAS contamination in communities with potential PFAS exposures from current or historical activities. In addition, some states have conducted sampling and monitoring more broadly to identify locations with PFAS contamination. These steps include sampling drinking water—either in large water systems that serve multiple communities, private potable wells potentially impacted by releases, or sites where PFAS-containing materials are known to have been used—to gather important baseline data on the presence of PFAS in the environment. A number of environmental monitoring activities are also ongoing to measure and assess trends of PFAS in air, water, fish, wildlife, and sediment. In addition, some states are conducting biomonitoring studies to measure the levels of PFAS in people (ASTHO 2018). States can also consider updating their source water assessments to account for potential PFAS risks based on monitoring results or known sources of contamination. The EPA is working with our partners to develop and disseminate sampling, measurement, and treatment tools to help stakeholders concerned about PFAS in their communities to implement actions to prevent and mitigate harmful human exposures to PFAS.

Many stakeholders have questioned the extent and magnitude of PFAS contamination across the United States. To help fill these information gaps, the EPA intends to compile baseline, publicly available, PFAS environmental data into a visual map. Mapping tools can be used to show known or potential PFAS contamination sources and related information. The EPA may also specify sites of interest to environmental monitoring, such as wildlife refuges and fisheries, as well as additional impacted environmental media (for example, air or soil). These efforts can be used to help assess environmental trends in PFAS concentrations and serve as one source of information for local and regional authorities.

The EPA is also exploring how to coordinate sampling, data sharing, and data evaluation across environmental media and biota to provide online tools that can provide information about PFAS detections for government and public users. The EPA plans to work with state partners to develop data sharing standards so that testing results (either government sampling results or public testing) can be shared in a way that is accessible and useful. The EPA will explore development of a PFAS inventory and data plan. The EPA intends to play a lead role in distributing tools that provide the public with an integrated look at what is known about PFAS detections.

Development of Field and Laboratory Methods to Measure PFAS in the Environment

When available, validated analytical methods for measuring PFAS and PFAS precursors in multiple environmental media enable a more accurate understanding of PFAS occurrence and exposures. This information in turn helps the EPA's effort to focus toxicity studies on the most prevalent PFAS exposures in the environment. With the information produced using validated analytical methods, decision makers can also understand the extent of PFAS contamination and better design and execute remediation and treatment. The EPA recently released an expanded drinking water Method 537.1 to include additional PFAS, including GenX chemicals. Longer-term efforts include the development and multi-lab validation of methods (e.g., SW-846, 40 CFR Part 136) for complex water matrices (e.g., wastewater, surface waters, groundwaters), solids (e.g., soil, sediment, biosolids, fish tissues), air (e.g., ambient, stack emission, off-gases), and other PFAS in drinking water not currently captured by Method 537. In

addition, the EPA continues to collaborate with others to refine and apply high resolution mass spectrometry (HRMS) analytical methods for discovery and identification of additional PFAS in environmental media (McCord et al. 2018, Newton et al. 2017, Strynar et al. 2015). These efforts will support federal partners, states, tribes, and other stakeholders in site assessment and remediation and help characterize the broader environmental occurrence and potential exposure to PFAS compounds in drinking water and other impacted environmental media. For more information on the EPA research plans related to PFAS, please see Section VII.

Risk Assessment Definitions



RESEARCH: The EPA conducts laboratory and field observations, compiles and synthesizes information, and develops models and tools in order to understand toxicity, exposure, treatment, and remediation.



HAZARD IDENTIFICATION & DOSE-RESPONSE ASSESSMENTS: The EPA determines whether exposure to a contaminant (e.g., PFAS) has the potential to cause harm to humans and/or ecological systems, and if so, under what circumstances.



EXPOSURE ASSESSMENTS: The EPA models or measures contamination (e.g., in drinking water) and predicts how people and ecological systems can come in contact with a contaminant, along with the size and characteristics of the population exposed (including the most vulnerable) to estimate exposure.



RISK CHARACTERIZATION: The EPA works to integrate the previous steps to create a comprehensive picture of potential PFAS risks, considering hazard, dose-response, and exposure information.

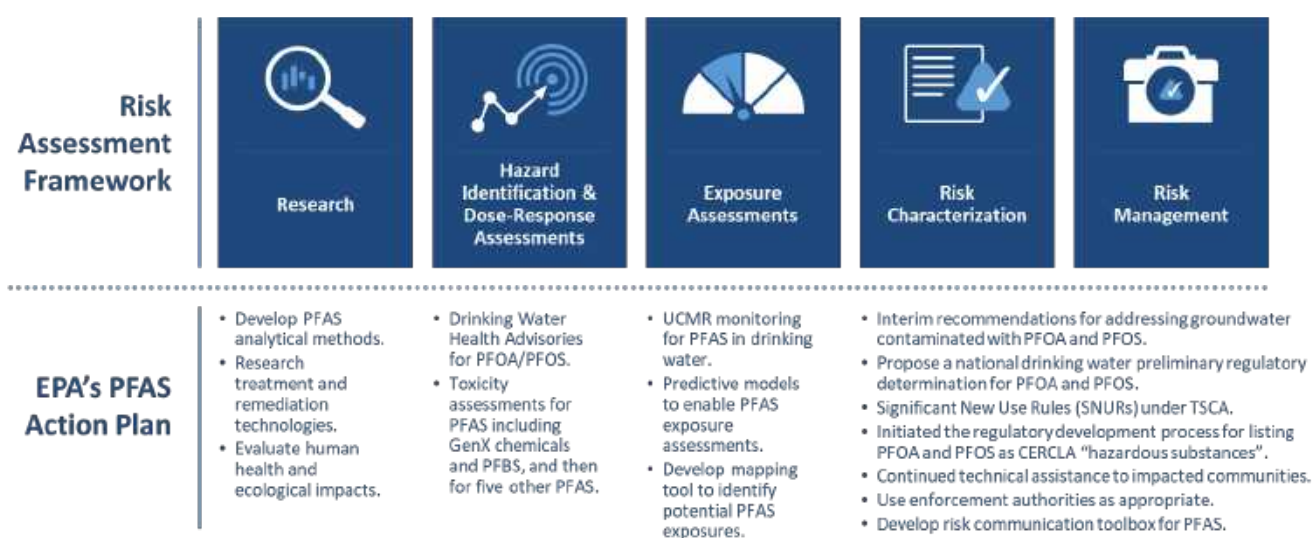


RISK MANAGEMENT: The EPA applies information attained in the previous steps to develop, analyze, and compare options and identify the most appropriate treatment, remediation, or policy response, including how to best exchange information about health or environmental risks among various stakeholders.

Utility of Additional Exposure Information on PFAS

Applying new analytical methods for discovering and measuring PFAS in the environment would enable a better understanding of the sources, types of PFAS, and the exposure pathways which bring PFAS into contact with people and ecosystems. This information could be used to prioritize PFAS for toxicity testing and to facilitate assessment of the relative importance of different pathways (how much PFAS exposure is via food, water, dust, or other media/pathways). This information, combined with more knowledge about PFAS toxicity, could enable stakeholders to identify the PFAS exposures which are of greatest relevance and potential impact to humans and ecosystems, enabling them to prioritize their management efforts and allocate their resources to achieve the maximum reduction in risk. For more information on the EPA's research efforts related to risk assessment, please see Section VII.

EPA Actions and the Risk Assessment Framework



Mitigating PFAS Exposures

To prevent adverse effects to human health and the environment both now and in the future, the EPA is prioritizing short-term exposure prevention and long-term cleanup goals. The EPA will work with federal, state, tribal, and local agencies to employ appropriate authorities, when necessary, to address or prevent PFAS contamination. Potential federal enforcement, regulatory, and response authorities include, for example, the SDWA; RCRA sections 3004(u) and (v); 3005; 3008(h); 3013; and TSCA sections 5, 6, 7, and 8. Additionally, the EPA will continue to develop tools and provide information to support decision-making on mitigating PFAS exposures.

Hazardous Substance Listing for PFAS

In addition to short-term exposure prevention, the EPA will continue to provide technical assistance on site-specific PFAS challenges across the country, including using CERCLA and other authorities, as appropriate, to investigate sites when needed. The EPA is also developing Interim Recommendations for Addressing Groundwater Contaminated with PFOA and PFOS to support site-specific cleanup efforts (see section V). An important long-term action for federal agencies, states, tribes, communities, and the public is the development of additional tools to facilitate cleanup of PFAS-contaminated sites and recover cleanup costs from responsible parties. In order to augment the EPA's ability to use its CERCLA federal response authority, the EPA is moving forward with how best to designate PFOA and PFOS as CERCLA "hazardous substances" using one of the available statutory mechanisms. Following the PFAS Summit in May 2018, the EPA began an intensive effort to examine the statutory options that could be used to designate PFOA and PFOS as CERCLA hazardous substances. This effort included consideration of the benefits and challenges, as well as the timing and criteria for each available option. There are several statutory authorities available to define PFOA and PFOS as CERCLA hazardous substances, including CERCLA, RCRA, TSCA, Clean Water Act (CWA), and the Clean Air Act (CAA). The EPA is initiating the regulatory development process for listing PFOA and PFOS as CERCLA hazardous substances.



EPA Priority Action

ACTION: The EPA has initiated the regulatory development process for listing PFOA and PFOS as CERCLA "hazardous substances" using available statutory mechanisms.

PURPOSE: A "hazardous substance" designation under CERCLA provides more options for the federal government to facilitate use of response and enforcement authorities.

Tools to Mitigate PFAS in Our Nation's Waters

The EPA will continue to work towards providing impacted communities with the tools they need to mitigate risks from PFAS. To further support communities in making decisions about mitigating exposures from drinking water, the EPA intends to continue to update the Drinking Water [Treatability Database](#) for PFAS, including treatability and cost information for different technologies and additional PFAS of concern. The treatability database presents information on the control of contaminants in drinking water through treatment processes such as activated carbon, ion exchange, and high-pressure membranes. The treatability database allows utilities, emergency responders, regulators, and other stakeholders access to comprehensive information gathered in a single location. The EPA is also conducting bench-, pilot-, and full-scale experiments to identify performance and cost of treatment (both capital and operations and maintenance), along with potential unintended consequences of employing specific technologies. Better understanding the capabilities of available treatment technologies will further enable the removal of PFAS in drinking water.

Several states are taking actions related to PFAS, including product labeling and consumer products laws, chemical action plans, listing select PFAS as hazardous wastes or designating select PFAS as hazardous substances through state-specific authorities, and developing standards and guidance values

to limit concentrations of PFAS in groundwater or drinking water (ITRC 2018b). PFAS can be considered pollutants under the Clean Water Act, and states can use National Pollutant Discharge Elimination System (NPDES) permits to control discharges from point sources containing PFAS into receiving waters, including sources of drinking water. To support states in managing their water quality, the EPA will evaluate development of ambient water quality criteria under section 304(a) of the Clean Water Act to facilitate state permitting efforts, if adequate data are available.

Parties responsible for PFAS releases, states, and utilities have acted to reduce exposure to PFAS in drinking water from community water systems and private wells through the installation of treatment systems, providing connections to public water systems, point-of-use filters, point-of-entry treatment systems, or through the provision of bottled water. Conventional drinking water treatment technologies (coagulation, flocculation, clarification, filtration, and disinfection) have not been found to be effective in removing PFAS. Technologies have been found to remove longer-chain PFAS, such as PFOA and PFOS, from drinking water including activated carbon adsorption, ion exchange resins, and high-pressure membranes (Rahman et al. 2014, Eschauzier et al. 2012, Flores et al. 2013). These technologies can be used in drinking water treatment facilities, in point-of-entry systems to treat all the potable water that enters a home or other building, or at the point-of-use of potable water, such as in a kitchen sink (USEPA 2018d). The EPA is currently working to better understand the efficacy of commercially available point-of-use and point-of-entry treatment applications for PFAS. In some cases, these treatment technologies can result in considerable cost to utilities or homeowners within communities that have been impacted by PFAS. Concerns continue to be expressed by communities regarding the potential for ongoing exposure to PFAS that are less well characterized or are less amenable to measurement and/or removal using existing treatment technologies.

Each state administers the Drinking Water State Revolving Fund (DWSRF) to provide low-interest loans for drinking water infrastructure and technical assistance to publicly-owned community water systems (CWSs), privately-owned CWSs, and non-profit non-CWSs to facilitate compliance with national primary drinking water regulations or to significantly further the health protection objectives of the SDWA (USEPA 2018d, USEPA 2018e). Under the SDWA, states may set aside up to up to 31% of their DWSRF capitalization grant to fund state programs and third parties to provide assistance and build the capacity of drinking water systems. DWSRF set-asides can fund laboratory or testing equipment for research or contamination prevention. In addition, states with a synthetic organic chemical monitoring waiver program can use the DWSRF to assist with special-purpose monitoring, including PFAS, at local systems that have not yet tested for PFAS (USEPA 2017).

A detailed understanding of the sources of PFAS contamination can help communities impacted by PFAS with the development of long-term solutions. Common sources of PFAS include groundwater plumes associated with areas where fire-fighting foam was used, wastewater effluent or air emissions from industrial facilities where PFAS are manufactured or used, and landfills, including leachate, where materials with high levels of PFAS have been disposed. If a source (or sources) can be identified, then actions can be taken to remediate, reduce or divert the source, or address exposure. As part of the EPA's statutorily-required Effluent Guidelines planning process, the EPA has reviewed readily-available information about PFAS surface water discharges to identify industrial sources that may warrant further study for potential regulation through national Effluent Limitation Guidelines and Standards (ELGs).

Based on the very limited amount of data available, the EPA has identified several industries that are likely to be discharging PFAS in their wastewater and will begin a more detailed study to evaluate the potential for PFAS presence in their wastewater discharges. As part of this study, the EPA plans to gather more detailed information for the following point-source categories: organic chemicals, plastics, synthetic fibers, pulp and paper, textiles, and airports.

Work with Federal Partners

The EPA continues to collaborate with federal agencies to address challenges associated with PFAS. As part of interagency cross-coordination efforts, additional actions may be taken by other agencies to mitigate existing PFAS exposures. The EPA is working with other federal partners, through outreach on EPA PFAS products such as the GenX chemicals and PFBS toxicity assessments as well as the Interim Recommendations for Addressing Groundwater Contaminated with PFOA and PFOS. The EPA plans to collaborate with other agencies on PFAS-related research, for example on toxicology studies of a broad number of PFAS with the National Institute of Environmental Health Sciences (NIEHS) National Toxicology Program (NTP). Additionally, the EPA will also work with other federal agencies such as the Food and Drug Administration (FDA), as appropriate, to support efforts regarding PFAS-related food safety issues. The EPA plans to continue coordinating with other federal agencies, such as ATSDR, FDA, and the United States Department of Agriculture (USDA), to ensure we are providing clear and consistent risk communications. The EPA also plans to work with federal partners, such as the Department of Defense (DoD) at military sites or USDA with respect to agriculture, to reduce PFAS exposures. DoD activities at military sites have included, for example, identifying the extent of PFAS contamination of drinking water sources as a result of releases from DoD facilities, ensuring that, where such contamination has occurred, communities at or near DoD facilities are not reliant on drinking water above the EPA's Health Advisory value for PFOA or PFOS.



VII. Research, Development and Technical Assistance for Addressing PFAS-Related Public Health Questions

Research, Development, and Technical Assistance

Problem Scoping and Formulation

The science needed to protect public health and the environment from PFAS exposure cuts across many applications and disciplines. The risk assessment/risk management paradigm provides a useful means to assess the state of the science available for informing decisions, and to identify gaps in knowledge needed to address the highest priority issues. *Risk assessment*, the integration of PFAS exposure and toxicity information, helps to determine if, when, and where risk exists (probability of harm) to human health or the environment from PFAS, considering both toxicity and exposure. *Risk management* involves solving a PFAS problem once it has been properly identified and characterized, considering available scientific tools and data, as well as economic, legal, social, technological, and policy factors.

The EPA's initial scoping of information available to decision makers for assessing and managing PFAS risks revealed deficiencies in all key areas of the risk paradigm:

- **Hazard and Toxicity:** There are many PFAS of potential concern to the public that may be found in the environment. Most of these PFAS lack sufficient toxicity data to inform our understanding of the potential for adverse human or ecological effects.
- **Exposure:** Information for many PFAS sources, fate and transport, and human and ecological exposure is sparse, both spatially and temporally.

- **Treatment and Remediation:** There is little information on effective methods and costs for treating or removing PFAS from drinking water, groundwater, wastewater, air, soils, and sediments.
- **Science Communication:** Stakeholders lack easy access to the growing body of technical information that can assist them in applying PFAS science to their specific problems and communicating to their constituents.

The EPA's research program will focus on an integrated set of research activities aimed at filling gaps in our current ability to conduct sound risk assessment and risk management activities. This research program is designed to address these data gaps and enable stakeholders to begin making effective decisions for identifying and mitigating risk from PFAS in the environment, as mentioned in Section VI.

The EPA's PFAS research plan consists of *near term* (<2 years) and *long term* (>2 years) research activities in four areas:

- What are the human health and ecological effects of exposure to PFAS?
- What are the significant sources, fate and transport pathways, and exposures to humans and ecosystems?
- What are the costs and effectiveness of different methods for removing and remediating PFAS in the natural and built environment?
- How does the EPA support stakeholders in using science to protect public health and the environment?

While the activities highlighted in this section are planned to be completed on a longer-term time horizon, many of these efforts will have visible interim milestones and may produce shorter-term products. Many different entities have an interest in—and are actively conducting—research to address PFAS, and so there is a substantial opportunity to advance PFAS science by effective coordination and collaboration amongst these entities. The EPA is committed to leading federal action to protect human health and the environment and to coordinating and cooperating with state and other federal agencies, academia, industry, and non-government organizations to build a body of best available science in the areas described below and to support policy and management decisions and actions by all stakeholders.

Research Area 1: What are the human health and ecological effects of exposure to PFAS?

One of the main research needs is a better understanding of the potential human health and ecological hazards from exposure to PFAS. Characterizing hazards through the development of hazard and dose-response assessments capitalizes on existing scientific information where available. For data-poor PFAS, an integrated approach to testing and assessment includes the use of existing hazard information, where available, coupled with data and information generated from new advances in computational and high throughput toxicology and ecotoxicology. These efforts will help the Agency develop toxicity values for additional PFAS, as discussed in Section V.

Research to advance our understanding of human health and ecological effects of PFAS will consist of three complementary lines of work:

- Development of human health toxicity values where suitable data are available.** The EPA plans to develop cancer and noncancer toxicity values for PFAS where sufficient health effects data currently exist, are publicly available, and adequately support human health toxicity value derivation. The EPA will use established risk assessment guidelines and methods to develop standard toxicity values, such as oral reference doses (RfDs), inhalation reference concentrations (RfCs), oral cancer slope factors (CSFs), and cancer inhalation unit risks (IURs). These assessments will undergo interagency consultation, public comment, and independent external peer-review prior to finalization. The EPA currently has published toxicity assessments for PFOA and PFOS. ***In the near term*** the EPA plans to complete toxicity assessments for GenX chemicals and PFBS. The Agency has begun work on assessments for PFBA, PFHxA, PFHxS, PFDA, and PFNA. The EPA intends to coordinate with federal partners, including ATSDR, on prioritizing and conducting future PFAS toxicity assessments. The EPA will build on work by universities, industry, and other government agencies who are conducting and publishing the peer-reviewed toxicological and epidemiological studies needed to support toxicity assessment.
- Using computational toxicology approaches to fill in gaps.** For the many PFAS for which published peer-reviewed data are not currently available, the EPA plans to use new approaches such as high throughput and computational approaches to explore different chemical categories of PFAS, to inform hazard effects characterization, and to promote prioritization of chemicals for further testing. These data will be useful for filling gaps in understanding the toxicity of those PFAS with little to no available data. ***In the near term***, the EPA intends to complete assays for a representative set of 150 PFAS chemicals, load the data into the [CompTox Chemicals Dashboard](#) for access, and provide peer-reviewed guidance for stakeholders on the use and application of the information. ***In the long term***, the EPA will continue research on methods for using these data to support risk assessments using New Approach Methods (NAMs) such as read-across and transcriptomics, and to make inferences about the toxicity of PFAS mixtures which commonly occur in real world exposures. The EPA plans to collaborate with NIEHS and universities to lead the science in this area and work with universities, industry, and other government agencies to develop the technology and chemical standards needed to conduct this research.
- Ecological toxicity.** Ecological toxicity information is also needed by stakeholders to inform risk assessment and management to protect ecosystems, animals, and plant resources they support, and ultimately the human benefits that stem from these resources, including, for example, the prevention of potential PFAS risks associated with consuming game animals and fish. ***In the long term***, the EPA plans to work to identify species which are sensitive or susceptible to PFAS exposure; gather and synthesize information on bioaccumulation of PFAS in organisms and food chains; and, where indicated, develop benchmarks and thresholds for ecological toxicity. The EPA plans to collaborate with the United States Geological Survey (USGS), United States Army Corps of Engineers (USACE), and universities to lead the science in this area.

Research Area 2: What are the sources, fate and transport pathways, and exposures to humans and ecosystems?

The diversity of the PFAS family of chemicals enables the use of PFAS for many diverse industrial processes and end use products, which in turn means there are numerous potential sources and pathways by which PFAS can move from a source through the environment. Understanding this complexity is necessary to understand PFAS exposure. The EPA plans to address this complexity through two lines of research and development:

- New analytical methods.** Developing, validating, and applying new analytical methods for discovering and measuring PFAS in air, water, and soil will enable a better understanding of the specific subsets of PFAS that exist in the environment, as well as the exposure pathways that potentially bring those PFAS into contact with people and ecosystems. This will enable the creation of datasets to better understand fate and transport pathways and to identify cases where exposures exceed thresholds of concern. ***In the near term***, the EPA plans to develop, validate, and publish reliable sampling and laboratory analytical methods to detect, identify, and quantify PFAS in different environmental media (including drinking water, groundwater, wastewater, air, and soil) and in other kinds of samples (e.g., plant and animal tissue), as needed. This includes analytical methods for known PFAS of concern, as well as methods to identify and detect new, currently unknown, PFAS in the environment. ***In the long term***, the EPA will continue to prioritize, develop, and validate analytical methods for emerging PFAS of concern. The EPA plans to collaborate with USGS, DoD, National Institute of Standards and Technology (NIST), FDA, and private industry to lead the science in this area and rely on universities and industry to develop the technology needed to enable new analytical methods.
- Exposure assessment.** Exposure information enables decision makers to prioritize the PFAS exposures that are of greatest relevance and impact to human health and the environment, enabling them to prioritize management actions and allocate resources to achieve the maximum reduction in risk. ***In the near term***, the EPA plans to develop a mapping tool to house public datasets of known PFAS source and occurrence data, and tools to analyze PFAS exposure through multiple routes (via water, food, inhalation, or dermal contact). ***In the long term***, the EPA intends to build predictive models to enable PFAS exposure assessment from site-specific to national in scope, to better understand where and how PFAS move through the environment to impact people and ecosystems, and to estimate how much PFAS reaches people via air, water, food, and other pathways. The EPA plans to collaborate with the Department of Housing and Urban Development (HUD), ATSDR, and other federal agencies, as appropriate, to lead the science in this area.

Research Area 3: What are the costs and effectiveness of different methods for removing and remediating PFAS in the natural and built environment?

Current technology and approaches for treating or removing chemical contaminants from air, water, and soil are not always effective for PFAS. Better information is needed on the costs and effectiveness of different treatment systems for different PFAS of concern, as well as the development of new treatment technologies that are less expensive, easier to operate, and more sustainable than existing technologies. The EPA is addressing this information need through two related lines of research:

- **Drinking water treatment.** The EPA is evaluating treatment technologies for removal of PFAS from drinking water. States, public water utilities, communities, and federal facilities will benefit by having treatment technology guidance and accurate cost numbers for the treatment of PFAS in drinking water. *In the near term*, the EPA plans to evaluate performance, cost, and potential unintended consequences of drinking water treatment technologies for different PFAS in small, medium, and large systems. The Agency plans to place data in the EPA’s online [Drinking Water Treatability Database and associated cost models](#). The EPA plans to collaborate with states, federal agencies, public water utilities, and private industry to lead the science in this area and will work closely with universities and industry who are developing the treatment technology advances needed to support this research.
- **Contaminated site cleanup.** The complexity of PFAS sources and uses means there are multiple ways that specific sites can become contaminated by PFAS. Examples include improper dumping or disposing of PFAS-contaminated waste, accidental or intentional spills of PFAS-containing products such as firefighting foam, or leaking of PFAS in leachate from landfills. This can result in the contamination of soils, sediments, groundwaters, and surface waters. *In the near term*, the EPA plans to evaluate the effectiveness and cost of existing treatment and remediation technologies for a variety of PFAS-contaminated sites and develop and test new technologies and approaches for cleaning up PFAS contamination. The EPA plans to collaborate with DoD, states, industry, and non-government organizations to lead the science in this area and work closely with universities and industries developing the treatment technology advances needed to support this research.

Research Area 4: How does the EPA support stakeholders in using science to protect public health and the environment?

Stakeholders have varying levels of knowledge and expertise for using the science products that will result from the EPA’s research. Part of the research process therefore involves communication of the Agency’s research in multiple ways to make the science usable to all stakeholders. This communication needs to include the proper context and any applicable limitations inherent in the work. This may also include applying tools in collaboration with stakeholders through technical assistance. The EPA plans to conduct two lines of work in support of stakeholders.

- **Science communication.** PFAS are of interest to a variety of stakeholder groups. It is important that the EPA maintain suitable communication with each of these groups and facilitate access to new research products as they become available. *In the near and long term*, the EPA plans to facilitate access to the research products described in this plan via multiple avenues, including publications, reports, online tools and databases, fact sheets, workshops, webinars, and summaries describing our science. The EPA plans to make this information readily available using the [EPA PFAS website](#) as the main point of access. The EPA intends to collaborate with states, tribes, and communities to lead work in this activity.
- **Technical assistance.** In certain cases, the EPA provides technical advice, assistance, and collaboration to state, tribal, federal, and community partners in a manner consistent with the Agency's goal of Cooperative Federalism. These technical assistance activities inform cost-efficient and cost-effective risk management decisions by the EPA and its partners, as well as help to advance the science through applied research. *In the near and long term*, the EPA plans to continue to prioritize engagement in these activities.



VIII. Risk Communication and Engagement

Risk communication and engagement are critical for the EPA to effectively support communities across the country that are addressing PFAS issues. The EPA is actively working to enhance the way in which agencies communicate about potential human health risks that may be associated with these chemicals. PFAS are a complex group of chemicals that can differ in terms of how they are used, how people are exposed, and how they potentially impact public health and ecosystems. There is a lack of definitive scientific information about many chemicals in the PFAS family, making it challenging to communicate with the public about their associated health risks. The EPA also supports the efforts of other federal partners to develop information related to PFAS. Other agencies may issue different values based on factors such as their own statutory, regulatory, or case-specific analyses and exposure assumptions. The EPA continues to take concrete steps, in cooperation with our federal, state, and tribal partners, to communicate how the efforts of the EPA and other federal, state, and tribal agencies help to protect public health and the environment from risks related to PFAS.

Importance of Effectively Communicating PFAS Information to the Public

At the National Leadership Summit and throughout the community engagements, the EPA heard how important it is to communicate effectively with the public and to be transparent in sharing what is known and unknown in a timely manner. The EPA heard that speaking with one voice and providing consistent messaging across federal, state, tribal, and local authorities helps to build trust and ensures that the public has a clear understanding of any PFAS issues that need to be addressed. The EPA also heard that it is important to clearly explain the actions the Agency is taking, as well as the specific concerns that those actions are intended to address. Other comments submitted to the EPA highlighted how important it is to provide information to stakeholders as quickly as possible, while also taking into account the high levels of uncertainty that surround these chemicals. Appendix B provides additional

discussion about feedback from the community engagements and information submitted to the PFAS docket.

The EPA's Goals and Actions on PFAS Risk Communication

PFAS are of significant interest to a diverse set of stakeholders. Clear and consistent communication from all information sources will help stakeholders determine the most appropriate PFAS risk management approach and help the public understand the response. Through this Action Plan, the EPA's goal is to work with other agencies to:

1. Enhance the public's understanding of PFAS by providing clear and consistent information;
2. Enhance the public's understanding of the regulatory processes available to address PFAS and the different standards established for PFAS;
3. Build trust with the public as we work together to address these chemicals; and
4. Provide the public with an understanding of the uncertainties associated with PFAS measurement, exposure, and toxicity, and the importance of considering these uncertainties when identifying effective risk management actions.

For communities directly impacted by PFAS, the EPA plans to:

1. Work in coordination with other federal agencies and local, state, and tribal governments on clearly communicating PFAS information;
2. In support of responses to PFAS found in communities, work with the community to identify the lead agency and explain the role of each agency involved. Establish contact points responsible for managing community questions;
3. Communicate pathways of exposure and what is being done to mitigate exposure through those pathways;
4. Enhance the public's understanding of the potential human health effects associated with PFAS exposure; and
5. Provide information on tangible steps individuals can take on their own to manage risk.

To best support and leverage the efforts of other federal partners, the EPA is committing in the short-term to convene a federal interagency PFAS risk communication workgroup to ensure, as appropriate, collaborative interagency action and consistent messaging on PFAS toxicity that is informed by the best available science. In addition, the EPA plans to enhance communications with the public on PFAS through the following actions:

1. In 2019, develop a risk communication toolbox that includes materials and messaging for federal, state, tribal and local partners to use to inform the public, as they deem appropriate.
2. Continue to listen to and engage with the public; and

3. Continue to support states, tribes, and local officials who have purview in protecting the environment and public health, including the Environmental Council of States (ECOS), the Association of State and Territorial Health Officials (ASTHO), the Association of Clean Water Administrators (ACWA), the Association of State Drinking Water Administrators (ASDWA), the National Tribal Toxic Council, and the Association of State and Territorial Solid Waste Management Officials (ASTSWMO).

Information Needed by Stakeholders to Effectively Communicate About PFAS

Effective communication at the federal, state, tribal, and local level begins by clearly summarizing what is known and unknown about PFAS, with a focus on the key questions with which the public is most concerned. The EPA will help to advance these efforts by continuing its work with other agencies to develop a risk communication toolbox that will include the following:

- Key messages
- Questions and answers
- Infographics
- Fact sheets
- Sample language/template for potential notifications
- Sample communication materials
- Links to available data sources and tools

The EPA will make available materials and informational fact sheets on the EPA's PFAS webpage as part of the risk communication toolbox and, as necessary, will continuously update the information as the science around PFAS evolves. To find the complete set of tools, visit: <https://www.epa.gov/pfas/pfas-communication-and-outreach-tools>.

Stakeholder Engagement on PFAS

The EPA conducted extensive public outreach in the development of the PFAS Action Plan, including gathering diverse perspectives through the May 2018 National Leadership Summit, direct engagement with the public in impacted communities in five states, engagement with tribal partners, and roundtables conducted with community leaders near impacted sites (USEPA 2018f). The EPA also obtained recommendations from the Local Government Advisory Committee (LGAC), a chartered policy committee comprised of elected and appointed local officials. In addition, the Agency reviewed approximately 120,000 comments in the [public docket](#) that was specifically established to gather input for the Action Plan.

Through these engagements, a broad range of stakeholders provided input to the EPA about ongoing PFAS challenges facing states, tribes, and local communities, as well as specific actions needed from the EPA and state regulators in order to protect the public from PFAS in the environment. Key public priorities include the need for identification and remediation of known sources of contamination; source water protection for drinking water supplies; resources to support effective communication with the

public; long-term policy solutions; reliable, enforceable, and actionable standards and risk information; validated and cost effective analytical and sampling methods and tools; treatment solutions; enforcement strategies to reduce the cost burden on citizens; and coordination among all parties involved in mitigation and response. The Agency received comments identifying the importance of developing and relying on the best available science even if that means not rushing to implement regulatory actions in the near term. Stakeholders also emphasized the need to balance the potential cost and burden associated with managing PFAS with the costs and benefits of addressing other competing public health and environmental protection priorities such as the presence of lead in community water systems. Among other things, the LGAC recommended using existing funding tools, such as the State Revolving Funds to address PFAS, prioritizing PFAS-related risk communication activities, developing new methods and certification programs, and using risk-based approaches to address PFAS contamination issues, being mindful that clean and safe water are valued by every American citizen. The EPA plans to continue to seek feedback from stakeholders on actions to address PFAS.

Information for Individuals Concerned about PFAS

Individuals in communities that are served by a public water system can contact their local water supplier to ask for information on any PFAS monitoring the utility may have conducted. Members of the public are also encouraged to request a copy of their drinking water Consumer Confidence Report. While there are currently no federal drinking water regulations for PFAS, this report provides useful information on other regulated contaminants found in local drinking water. If owners of drinking water wells not regulated by the SDWA (i.e., private potable wells) have reason to believe their well may contain PFAS (e.g., due to proximity to a known contamination site or probable source of PFAS), they could consider contacting their state or local health department for further guidance. Owners may also consider well testing to learn about PFAS that may be in their drinking water. For more information about well testing, please visit <https://www.epa.gov/privatewells/protect-your-homes-water>. The EPA recommends contacting your state for a list of laboratories that are certified to test for PFAS using EPA Method 537. If you find PFAS in your drinking water, certain PFAS can be reduced or removed through

National Leadership Summit

Over 220 participants, including senior officials from 40 states, 3 tribes, Guam, Northern Marianas Islands, 13 federal agencies, congressional staff, and dozens of associations, industry groups, and non-governmental organizations.

Community Outreach

Over 1,000 participants at 7 locations, including community engagements in New Hampshire, Pennsylvania, Colorado, North Carolina, and Kansas; engagement with tribes at the Tribal Lands and Environment Forum and the Saginaw Chippewa Tribe; and a roundtable in Michigan.

Public Docket

Approximately 120,000 comments received.

the use of in-home point-of-use or point-of-entry water filters. It is important to keep in mind that any in-home treatment device should be certified by an independent party, currently available for PFAS (NSF 2018), and should be properly maintained to ensure that the treatment system remains effective over time.

For those concerned about food (plant or animal) collected from an environment that may contain PFAS, the EPA recommends contacting your local health department. All 50 states and some U.S. territories and tribes have fish consumption advisory programs to protect people from potential human health risks of eating contaminated fish caught in local waters. However, due to the limited sampling at this time, few locations have information specific to PFAS. In some states, pollutant levels in certain types of fish and shellfish collected from contaminated bodies of water have led to health-based consumption advisories for some PFAS, particularly PFOS (USEPA 2016d, State Impact Pennsylvania 2018, State of Michigan 2018). The EPA maintains a national database of fish and shellfish advisories issued by states where the public can find information on safe consumption guidelines (<https://fishadvisoryonline.epa.gov/General.aspx>) and for the most up to date information links to state and tribal fish consumption advisory websites (<https://fishadvisoryonline.epa.gov/Contacts.aspx>).



IX. Conclusion

In addition to the four priority actions the EPA announced at its May 2018 National Leadership Summit, this Action Plan highlights the many activities that the EPA plans to lead in collaboration with federal, state, tribal, and local partners to understand, communicate, and take steps to effectively manage potential concerns associated with the presence of PFAS in the environment. Where deemed appropriate and necessary, the EPA will prioritize preventing environmental contamination and identifying approaches that reduce the costs of PFAS management faced by local communities. Efforts discussed in this plan are also intended to encourage the use of safer PFAS formulations and/or PFAS alternatives and limit PFAS discharges, releases, and emissions. Where PFAS contamination in the environment has already occurred, the Agency will facilitate remediation efforts by providing groundwater cleanup recommendations and initiating the regulatory development process for listing certain PFAS as hazardous substances. For those cases where cleanup actions are necessary to prevent exposure to contaminated environmental media, the Agency is evaluating active management and treatment options and evaluating available treatment technologies. The EPA is also proposing a national drinking water regulatory determination for PFOA and PFOS in 2019 for public comment. The Agency will also gather and evaluate additional information that may inform the development of a national drinking water regulation for a broader class of PFAS in the future. The EPA is committed to working with other federal agencies, states, tribes, and local communities to coordinate and advance how we respond to PFAS concerns throughout the country.

The EPA is taking a leadership role to ensure that instances where PFAS pose risk to human health or the environment are identified and quickly addressed. The EPA plans to work in close coordination with multiple entities, including other federal agencies, states, tribes, local governments, water utilities, industry, and the public. This PFAS Action Plan highlights key EPA PFAS-related activities and reinforces the EPA's commitment to better understand potential impacts from a broad suite of PFAS, and, where necessary, take steps to reduce any risks they may pose to public health and the environment.

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Appendix A: EPA PFAS Activities

Appendix A contains a detailed list of completed and ongoing PFAS activities at the EPA. This list is not intended to be exhaustive of all the EPA's activities on PFAS.

Tool/Activity	Purpose	Timeframe
Preventing PFAS Exposures: What is EPA doing to reduce risks from PFAS?		
Significant New Use Rule; Final Rule and Supplemental Proposed Rule: Perfluoroalkyl Sulfonates (67 FR 11008)	The EPA published a SNUR to require notification to the EPA before any future manufacture (including import) of 13 PFAS chemicals specifically included in the voluntary phaseout of PFOS by 3M that took place between 2000 and 2002.	Completed March 2002
Significant New Use Rule: Perfluoroalkyl Sulfonates (67 FR 72854)	The EPA issued a SNUR for 75 PFAS, requiring manufacturers and importers to notify the EPA at least 90 days before starting the manufacture or importation of these chemical substances for the significant new uses described.	Completed December 2002
2010/2015 EPA PFOA Stewardship Program	The EPA launched 2010/2015 PFOA Stewardship Program with eight companies in 2006 to reduce PFAS emissions and product content by 95%; by 2015 reduce PFAS emissions and product content by 100%. All participating companies met the program goals.	Ongoing Started in 2006
Premanufacture Notification Exemption for Polymers; Amendment of Polymer Exemption Rule to Exclude Certain Perfluorinated Polymers (75 FR 4295)	The EPA published a final rule that amended the Polymer Exemption Rule to no longer exclude from eligibility polymers that include any one or more of the following: PFAS, PFAC, or perfluoroalkyl moieties that are covalently bound to either a carbon or sulfur atom where the carbon or sulfur atom is an integral part of the polymer molecule. Compliance date was January 27, 2012.	Completed May 2012
Significant New Use Rules: Perfluoroalkyl Sulfonates and Long-Chain Perfluoroalkyl Carboxylate Chemical Substances (78 FR 62443)	The EPA amended a SNUR to designate as a significant new use PFAS that have completed the new chemical review process under TSCA but have not yet commenced production or import and processing. The EPA also finalized a SNUR to designate as a significant new use LCPFAC chemical substances used in manufacturing (including importing) and processing of carpets or for treating carpet.	Completed October 2013
Significant New Use Rules: Long-Chain Perfluoroalkyl Carboxylate and Perfluoroalkyl Sulfonate Chemical Substances Proposed Rule (80 FR 2885)	The EPA proposed a SNUR for LCPFAC chemical substances that would require manufacturers (including importers) of PFOA and PFOA-related chemicals, including as part of articles, and processors of these chemicals to notify the EPA at least 90 days before starting or resuming new uses of these chemicals in any products. The EPA plans to follow up on the 2015 SNUR.	Completed January 2015

Tool/Activity	Purpose	Timeframe
New Chemicals Program Review of Alternatives for PFOA and Related Chemicals	The EPA has reviewed hundreds of new chemical substitutes for PFOA, PFOS, and other long-chain PFAS under the EPA's New Chemicals Program since 2000. The EPA reviews the new substances to identify whether the range of toxicity, fate, and bioaccumulation issues that have caused past concerns with perfluorinated substances may be present, as well as any issues that may arise by new chemistries, to ensure that the new chemical may not present an unreasonable risk to health or the environment. One outcome of the EPA's review of a PMN for a new chemical substance or review of a SNUN is the issuance of an order under section 5(e) of TSCA. Most TSCA section 5(e) Orders issued by the EPA are Consent Orders that are negotiated with the submitter of the notification.	Ongoing Started 2000
Understanding and Addressing PFAS Toxicity: What is the EPA doing to advance the science to support New Benchmarks?		
Lifetime Health Advisories for PFOA and PFOS	The EPA released lifetime health advisories (HAs) and health effects support documents for PFOA and PFOS. The EPA's HAs, which are not regulations, identify the concentration of PFOA and PFOS in drinking water at or below which adverse health effects are not anticipated to occur over a lifetime of exposure.	Completed May 2016
List of available scientific literature on toxicity for 31 PFAS of interest loaded to the HERO database	The EPA updated the Health and Environmental Research Online (HERO) database with available scientific literature (as of August 2017) on PFAS toxicity to detail which scientific studies the EPA has collected.	Completed April 2018
PFAS Chemical Library	Development of a chemical library of PFAS standards (pure samples of PFAS) to support consistent research and method development across the EPA.	Completed April 2018
Provide states access to GenX chemicals data	Provide states access to test data obtained under TSCA authority for information on GenX chemicals (acid and salt).	Completed March 2018
Information on Transcriptomic and <i>in vitro</i> assay toxicity testing (Tier 0 and Tier I)	Generate and publish first approximation toxicity and toxicokinetic data from the larger universe of PFAS compounds, in order to make inferences about which subcategories of PFAS might be of highest toxicological concern and thus prioritized for further near-term investigation. These data will also be useful for enabling read-across activities for PFAS with little to no available data. Tests will include a battery of transcriptomic <i>in vitro</i> assays (toxicity and kinetics) implemented by the EPA and the NTP.	Anticipated 2019
Tier II PFAS testing	Conduct Tier II <i>in vivo</i> toxicity testing for a subset of prioritized compounds based upon data provided from Tier I testing.	Anticipated 2019

Tool/Activity	Purpose	Timeframe
Tri-Services Ecological Risk Assessment Work Group	The EPA Ecological Risk Assessment Forum has a joint work group with the DoD Tri-Services Environmental Risk Assessment Work Group (TSERAWG) to develop ecological risk assessment screening values for PFAS. The DoD has an interagency agreement between the Air Force Civil Engineering Center and the Department of Energy (DOE) Argonne National Laboratory for the development of screening values for PFAS compounds. The PFAS screening values will be available for use at CERCLA sites and RCRA facilities.	Ongoing
Tools and data for evaluating ecotoxicity effects	Identify sensitive and susceptible taxa, synthesize information on bioaccumulation in organisms and food chains, and develop benchmarks and thresholds for ecological toxicity.	Anticipated 2022
Toxicity assessments for additional PFAS	Development of additional peer-reviewed PFAS toxicity assessments for PFBA, PFHxA, PFHxS, PFNA, and PFDA to support stakeholders.	Anticipated 2020
Toxicity assessments for GenX chemicals and PFBS	Provide toxicity assessments to stakeholders for GenX chemicals and an updated PFBS assessment. Both assessments underwent independent peer-review and review by federal partners prior to public comment.	Draft completed November 2018 Finalize 2019
Update Chemistry Dashboard with Information for Additional PFAS	The CompTox Chemicals Dashboard provides users with information on chemical structures, experimental and predicted physicochemical and toxicity data, and additional links to relevant websites and applications. The EPA updated the Dashboard with additional PFAS.	Completed March 2018
Water Contaminant Information Tool (WCIT) Profiles for PFOA and PFOS	Contaminant Profiles for two PFAS, PFOS and PFOA, to be added to the EPA's Water Contaminant Information Tool .	Completed December 2018
CWA Effluent Guidelines Planning PFAS Review	Through the Clean Water Act Effluent Guidelines Planning process, the EPA is examining readily-available information about PFAS surface water discharges to identify industrial sources that may warrant further study for potential regulation through Effluent Limitation Guidelines.	Ongoing
Interim Recommendations for Addressing Groundwater Contaminated with PFOA and PFOS	The EPA anticipates releasing interim cleanup recommendations to address groundwater contaminated with PFOA and/or PFOS to support stakeholders in their remediation efforts.	Anticipated 2019
Evaluation of CWA 304(a) Ambient water quality criteria for PFAS	The EPA is evaluating available data and research to support development of Clean Water Act Section 304(a) Ambient water quality criteria for PFAS.	Anticipated 2022

Tool/Activity	Purpose	Timeframe
Identifying and Addressing PFAS Exposures: What is the EPA doing to help identify communities with potential PFAS impacts, remediate PFAS exposures, and monitor compliance?		
Method Development	The EPA developed Method 537 for measuring PFOA, PFOS, and 12 other PFAS in drinking water to support the Unregulated Contaminant Monitoring Rule.	Completed 2009
Method Development	The EPA expanded Method 537 to measure four additional short-chain PFAS, including HFPO-DA (GenX chemicals) and ADONA. Method 537.1 is available on the EPA's website.	Completed November 2018
Method Development	Validated Direct Injection Method (SW-846) for quantifying 24 PFAS in surface, ground, and waste water matrices (non-drinking water) and solids (e.g., soil and sediment).	Anticipated 2019
Method Development	Validated Isotope Dilution Method (SW-846) for quantifying 24 PFAS in surface, ground, and waste water matrices (non-drinking water) and solids (e.g., soil and sediment).	Anticipated 2019
Method Development	New validated analytical method for PFAS in drinking water focusing on short-chain PFAS which cannot be measured by Method 537.1.	Anticipated 2019
Method Development	Method for sampling and analyzing PFAS in factory stack air emissions.	Anticipated 2020
Method Development	Testing and developing additional methods for possible refinement, including methods to quantify PFAS precursors; Total Organic Fluorine for a general PFAS detection method; and refinement of non-targeted high-resolution mass spectrometry approaches for suspect screening and novel PFAS discovery.	Ongoing
PFAS Geospatial Analytical Tool	Working with states and other federal partners, the EPA is evaluating how to best develop and maintain a GIS resource to consolidate and present PFAS data to inform analysis and understanding of PFAS sources and occurrence in the environment.	Anticipated 2019
Modeling atmospheric fate and transport of PFAS	Incorporate PFAS information into the EPA air models (e.g., the Community Multiscale Air Quality modeling system, AERMOD atmospheric dispersion model) to inform understanding of the potential and significance of atmospheric transport of PFAS.	Anticipated 2022
Unregulated Contaminant Monitoring Rule 3 for Public Water Systems	The third UCMR required monitoring for 30 contaminants (28 chemicals and two viruses) between 2013 and 2015 using analytical methods developed by the EPA, consensus organizations, or both. The purpose of UCMR3 was to collect occurrence data for contaminants suspected to be present in drinking water, but that do not have regulatory standards set under the SDWA. Six PFAS compounds were included in the UCMR3: PFOS, PFOA, PFNA, PFHxS, PFBS, and PFHpA. Of these six compounds, PFOA and PFOS were found in the greatest number of samples, and 1.3% of the public water systems sampled had results that exceeded the reference dose (lifetime HA limit of 70 ppt or 0.07µg/L).	Completed 2013-2015

Tool/Activity	Purpose	Timeframe
Unregulated Contaminant Monitoring Rule 5	The EPA intends to propose nationwide drinking water monitoring for PFAS under the next UCMR monitoring cycle utilizing newer methods available to detect more PFAS and at lower minimum reporting levels (MRLs) than previously possible in earlier monitoring.	Anticipated 2020-2025
Drinking Water Treatability Database-Update for Additional PFAS	Users can utilize the database to identify effective drinking water treatment processes for PFOA, PFOS, and additional PFAS chemicals. This database is continually updated as additional information becomes available.	Ongoing Updated September 2018
Research for Drinking Water Treatment	Conduct bench-, pilot-, and full-scale experiments to discern performance and cost of treatment (both capital and operations and maintenance), along with potential unintended consequences of employing specific technologies. Following a literature review for data gap identification, granular activated carbon and ion exchange treatment technologies will be tested under varying water qualities.	Anticipated Fall 2019
Treatability Cost Models	Updated drinking water PFAS treatability cost models.	Ongoing Updated September 2018
Evaluation of commercially Point-of-Use (POU) and Point-of-Entry (POE) home treatment systems	Investigate commercially available reverse osmosis and granular activated carbon units that can serve households in a point-of-use or point-of-entry applications for 6 PFAS included in UCMR3.	Completed 2018
Evaluation of treatment technologies for contaminated sites	A series of studies evaluating effectiveness and cost of different combinations of treatment train approaches for remediating contaminated sites.	2021
Fourth Contaminant Candidate List (CCL)	The EPA is required by the Safe Drinking Water Act to publish a list of contaminants known or anticipated to occur in public water systems which may require regulation under the Safe Drinking Water Act. The EPA included PFOA and PFOS on the fourth Contaminant Candidate List (the most recent CCL list).	2016
Fourth Regulatory Determination Process	The EPA is working on the Fourth Regulatory Determination process in which the EPA determines whether to regulate at least five contaminants on the CCL and issue final regulatory determinations after considering public input. The EPA is evaluating available information to determine if contaminants on the CCL, including PFOA and PFOS, meet the three criteria for regulation in accordance with the SDWA: (1) whether a contaminant may have adverse health effects; (2) whether a contaminant is found in public water systems with a frequency and at levels of concern; and (3) whether, in the sole judgment of the Administrator, there is a meaningful opportunity for health risk reduction through a national drinking water regulation.	Ongoing Anticipated 2019

Tool/Activity	Purpose	Timeframe
Collection of Great Lakes Environmental PFAS data	The EPA collects and analyzes environmental samples, including whole fish tissue, sediment, air, and water, to determine concentrations and trends of PFAS in the Great Lakes and occurrence in fish tissue.	Ongoing
Evaluate PFAS exposure through fish consumption	Evaluate temporal and demographic patterns of PFAS exposure and the relationship with fish consumption, in the U.S. general population.	Anticipated 2019
Fish Tissue Contamination Studies	To ensure that communities are aware of levels of PFAS in fish they may consume, continue to analyze PFAS in edible fish tissue as part of the National Rivers and Streams Assessment and the Great Lakes portion of the National Coastal Condition Assessment, and include PFAS in the revised list of target analytes that states may consider including in their fish and shellfish contaminant monitoring and advisory programs.	Ongoing
CERCLA Hazardous Substance Listing	The EPA has initiated the regulatory development process for listing PFOA/PFOA as CERCLA hazardous substances.	Ongoing
Scoping biosolids risk assessment for PFOA/PFOS	The EPA is in the early scoping stages of risk assessment for PFOA and PFOS in biosolids to better understand the implications of PFOA and PFOS in biosolids to determine if there are any potential risks.	Anticipated 2020
Identifying PFAS Risks from Chromic Acid Etch Facilities	The EPA's Office of Research and Development and Region 5 are collaborating on a study to characterize PFAS fume suppressants used at chromic acid etch facilities. Both Minnesota and Michigan have identified high levels of PFOS releases from these facilities, even after PFOS was phased out of the fume suppressant products in 2015. Region 5 is assessing if the current PFOS releases are the result of legacy use of PFOS fume suppressants or related to the replacement chemical formulations.	Ongoing
Identify PFAS sources, concentrations, uses, locations, and exposure routes most likely to pose threats to human health and the environment	Continue to make Toxic Substances Control Act (TSCA) data available where possible; identify sources, uses, and locations; develop information on potential high-impact locations; work with states to develop consistent sampling protocols.	Ongoing
Need to integrate data from multiple sources to better understand the presence of PFAS in the environment	Develop data sharing standards that allows states, tribes, communities, public water systems, and other organizations to contribute data about PFAS testing in a consistent manner.	Ongoing

Tool/Activity	Purpose	Timeframe
EPA TSCA section 5(e) order for GenX Chemicals	In 2009 the EPA entered into a Consent Order under TSCA section 5(e) with Dupont (now Chemours) that imposes requirements on the manufacture, processing, use, and disposal of GenX chemicals. Among other requirements, the Consent Order restricts the releases of the GenX chemicals by requiring the recapture of 99% of the chemicals. It also requires certain worker personal protective equipment as well as certain studies to be performed.	Ongoing
TRI listing for PFAS chemicals	Section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA) created the TRI Program. The TRI Program is another tool EPA may use to understand the releases of PFAS by industrial and federal facilities. Currently, no PFAS chemicals are included on the list of chemicals required to report to TRI; however, the EPA is considering whether to add PFAS chemicals. In considering listing, the EPA must determine whether data and information are available to fulfill the listing criteria and the extent and utility of the data that would be gathered. In addition, in considering if TRI will provide useful information to stakeholders, the EPA also will consider if those PFAS are still active in commerce. The process for listing includes notice and comment rulemaking to list PFAS chemicals for reporting prior to adding these chemicals to the TRI for annual reporting.	Ongoing

Tool/Activity	Purpose	Timeframe
Regions 1 and 3: Safe Drinking Water Act Section 1431 Emergency Orders to Department of Defense	2014 order to Navy at Warminster (PA) NPL Site directing the Navy to address high levels of PFOS discovered in three drinking water supply wells at and off the Warminster Naval Warfare Center where the elevated levels were four times the provisional health advisory level (which was 200 ppt for PFOS and 400 ppt for PFOA) in one case: Where levels in finished drinking water are above the HA for PFOA or PFOS, the Order required the Navy to provide a permanent drinking water supply as soon as practicable, but in no event later than 6 months after execution of the order. 2015 order to Air Force and Air National Guard at Horsham Air Guard Station/Willow Grove (PA) NPL Site (2015): The order directs the Air Guard/Air Force to treat two onsite public water supply wells and supply treatment to any private well found to exceed the provisional health advisory for PFOS in drinking water. Sampling confirmed that the Guard portion of the facility is also (like the Navy portion from Willow Grove) a source of PFOS offsite migration. The order covers long term treatment for private homes and also for short- and long-term public water supply concerns. 2015 order to Air Force for Contamination at Pease Air Force Base (NH) NPL Site: The order directs the Air Force to address contamination from perfluorinated compounds in drinking water at Pease Air Force Base including a number of actions to address the partial loss of the city's water supply attributed to firefighting foams used at the Base. The PFAS contamination resulted in the shutdown of one public water supply well, and two others could have been impacted if action were not taken to control PFAS migration. Under the order, the Air Force will restore contaminated groundwater in the Pease aquifer.	Ongoing
Annex 3, Chemicals of Mutual Concern, of the Great Lakes Water Quality Agreement	The goal of Annex 3 under the Canada-United States Great Lakes Water Quality Agreement (GLWQA) is to reduce the anthropogenic release of chemicals of mutual concern into the waters of the Great Lakes. In 2016, PFOS, PFOA, and LC-PFCAs—or collectively, PFAS—were designated as chemicals of mutual concern. In designating PFAS as a chemical of mutual concern, Canada and the United States have agreed that they may pose a threat to the Great Lakes. An Annex 3 binational strategy for PFAS is under development.	Anticipated September 2019
Belmont and Rockford, Michigan	The EPA is coordinating with the State of Michigan by overseeing a federal CERCLA time-critical removal action focused on hazardous substances at the Wolverine World Wide (Wolverine) Tannery and House Street Disposal Site and providing technical assistance to MDEQ while it responds to PFAS contamination of residential wells from Wolverine's former Tannery, shoe factory, and disposal locations in the Rockford area.	Ongoing

Tool/Activity	Purpose	Timeframe
Regions 3 and 5: Amendment to 2009 Safe Drinking Water Act Section 1431 Emergency Order on Consent with DuPont and Chemours	In 2009, the EPA issued a 1431 order on consent to Chemours' Washington Works Facility that contaminated sources of drinking water in WV and OH primarily via air deposition from the Facility. That order was amended in 2017, incorporating the Lifetime Health Advisory and requiring DuPont and Chemours to offer treatment, connection to a PWS, or bottled water to people on public or private water systems with PFOA levels above 70 ppt. In 2018, at the EPA's request, Chemours has also voluntarily sampled numerous private and PWSs for GenX chemicals.	Ongoing
Region 4 coordination of assistance to North Carolina Department of Environmental Quality (NCDEQ) – Chemours Fayetteville Works Facility	Region 4 has provided ongoing support to the NCDEQ as it has responded to GenX chemicals in the Cape Fear River and Fayetteville area. - Analytical testing via ORD-RTP and Region 4 Science and Ecosystem Support Division labs (testing of raw & finished water in the Cape Fear, rainwater, and air emissions stack testing for GenX chemicals and 22 other PFAS compounds) - Technical input as the state established its interim health goal - Coordinated treatment technique assistance for water systems - Technical assistance with NPDES permitting related matters and air emissions control.	Ongoing Started June 2017
Grant Funding Opportunity: National Priorities: Per- and polyfluoroalkyl substances	The EPA solicited proposals for EPA-G2018-ORD-A1 that included the below desired research areas: - Short-chain PFAS (C4 to C7) - PFAS found as residuals from manufacturing processes - Alternatives for long-chain PFAS ($\geq$ C8) such as per- and poly-fluoroethers - PFAS generated through environmental chemical transformation	Ongoing Completed June 2018
Technical Support	The EPA will continue to assist states and tribes in bringing on PFAS analytical capabilities.	Ongoing

Tool/Activity	Purpose	Timeframe
Risk Communication and Engagement: What is the EPA doing to provide consistent and accurate information and guidance to the public?		
Clearinghouse of PFAS information for states, tribes and local communities	The EPA compiled information from a wide range of sources on measurement, health impacts, and treatment and remediation technologies. The EPA continues to update this site as additional information becomes available.	Ongoing Started 2018
Engagement with states and stakeholders	Ongoing robust engagement effort with states, tribes, local communities, utilities, industry, and the public. Extensive outreach in 2018 included: • 5/22-5/23/2018: PFAS National Leadership Summit • 6/25-26/2018: Exeter, NH (Region 1 wide) Community Engagement • 7/25/2018: Horsham, PA Community Engagement • 8/7-8/2018: Colorado Springs, CO Community Engagement • 8/14/2018: Fayetteville, NC Community Engagement • 8/13/2018: Spokane WA, PFAS session at the Tribal Lands and Environment Forum meeting • 9/5/2018: Leavenworth, KS Community Engagement • 10/4-5/2018: Michigan site visits, Kalamazoo, MI Roundtable	Completed October 2018
EPA Region 7 participation in Kansas PFAS Monitoring Plan Advisory Committee	Region 7 to serve on Kansas Department of Health and Environment Per- and Polyfluoroalkyl Substance Monitoring Plan Advisory Workgroup for drinking water. The KDHE requested the EPA's participation to serve in an advisory capacity on a monitoring plan to be developed with the focus on drinking water.	Started Fall 2018
EPA Region 7 updates on PFAS for states and tribes	Activated the EPA Region 7 Science Council with state representation which will also include a PFAS update on a quarterly basis. The EPA Region 7's Regional POC for PFAS will also update our tribal representatives at the Regional Tribal Operation Committee meetings.	Started March 2018
Federal Remediation Technologies Roundtable Meeting	One-day interagency technical meeting meant to identify and discuss the emerging science behind PFAS characterization and remedial technologies. Technical presentations also remotely broadcasted. Primarily federal agency participation.	Completed November 7, 2018
Internal EPA regional coordination network	Activated internal EPA regional coordination network with representation from all regions and program offices to further support rapid dissemination of information in order to better support states, tribes, and local communities.	Started February 2018
Internal EPA regional coordination for cleanup programs	Created an internal EPA regional coordination group for cleanup programs with representation from all regions to further support rapid dissemination of information in order to better support states, tribes, and local communities.	Started Summer 2016

Tool/Activity	Purpose	Timeframe
Internal EPA Region 7 team	Activated internal EPA Region 7 network with representation from all programs further support rapid dissemination of information in order to better support states, tribes, and local communities.	Started February 2018
Quarterly Meetings with Region 10 Environmental and Health Departments	Region 10 quarterly conference calls with Region 10 PFAS contacts in state environmental and health departments to share information and discuss issues and topics of mutual interest.	Ongoing
Webinar on PFAS State case studies	Webinar showcasing PFAS risk communication activities by states; developed in coordination with ECOS and ASTHO.	Completed June 2018

Appendix B: Summary of PFAS National Leadership Summit and Community Engagements

In 2018, the EPA held a series of public community engagement events that brought together the EPA and state officials, federal partners, local speakers, community groups, and citizens to share perspectives and help inform future Agency actions for managing PFAS. Following the PFAS National Leadership Summit, these sessions continued EPA's commitment to foster an ongoing dialogue with stakeholders to address PFAS.

The National Leadership Summit included representatives from over 40 states, tribes, and territories; 13 federal agencies; congressional staff; associations; industry groups; and non-governmental organizations to engage in discussions about PFAS monitoring, risk characterization, near-term actions, and risk communications strategies. Key perspectives emphasized by participants during the summit included interest in:

1. An expansion of monitoring and sampling in the environment supported by sources of funding;
2. Continued advancement of the understanding of PFAS compounds, potential toxicity, and further development of analytical methods;
3. Increased understanding of exposures beyond drinking water;
4. Robust near-term action while long term actions are completed;
5. Identifying opportunities for collaboration and coordinated data sharing efforts among partners; and
6. Continued public engagement and development of risk communication resources.

The Community Engagements included panel discussions on the current state of science and potential risks posed by PFAS, as well as state and local actions towards 1) Identifying PFAS; 2) PFAS Risk Communications; and 3) Identifying Solutions for PFAS. Following the panel discussions, members of the public shared input and personal stories. During the community listening sessions, the EPA interacted with over 1,000 members of the public and heard from approximately 200 citizens in Exeter, New Hampshire; Horsham, Pennsylvania; Colorado Springs, Colorado; Fayetteville, North Carolina; and Leavenworth, Kansas.

The EPA developed summaries for the PFAS National Leadership Summit and each of the community engagements that can be found on EPA's PFAS webpages: <https://www.epa.gov/pfas/pfas-national-leadership-summit-and-engagement> and <https://www.epa.gov/pfas/pfas-community-engagement>.

Appendix C: Summary of Docket Comments

Background

Following the PFAS National Leadership Summit, the EPA requested input from the public on how the Agency can best help states, tribes, and communities facing PFAS challenges. The EPA has considered these comments in the development of this PFAS Action Plan and will continue to be informed by these comments as the Agency plans its next steps.

Docket Process and Summary of Submissions

The EPA opened the docket on PFAS, OW-2018-0270, from May 2, 2018 to September 28, 2018 and received approximately 120,000 comments via [Regulations.gov](https://www.regulations.gov). The docket comments are summarized below according to the themes requested by the EPA. The docket is available at: <https://www.regulations.gov/docket?D=EPA-HQ-OW-2018-0270>.

1. Obtaining information on ongoing efforts to characterize risks from PFAS and develop monitoring and treatment/cleanup techniques;
2. Informing specific near-term actions, beyond those already underway, that are needed to address challenges currently facing states and local communities;
3. Developing risk communication strategies to address public concerns with PFAS; and
4. General comments.

All comments were reviewed, categorized, and used to support the development of the PFAS Action Plan. The majority of comments received, approximately 97%, were from the public from across the United States representing rural and urban communities. Public citizen comments generally included a request for the EPA and the federal government to assist in managing PFAS in their community, concern for the health of their families and themselves, specific requests for action in managing and limiting PFAS in the environment, a desire to see PFAS removed at the source, a desire for responsible parties to pay for cleanup, and a universal expression for the right to have access to clean and healthy water.

Approximately 2.5% of comments were submitted by organizations, members of Congress, industry, water associations, governmental organizations at all levels, and not-for-profit organizations. The comments generally included support for the development of the PFAS Action Plan, an expression of the need for regulatory action, the need for science-based decisions, a desire for better communication regarding the Agency's planned activities, a request for the EPA to use regulatory authorities to manage PFAS, and a coordinated response from the federal government.

The following information is intended to provide an overview summary of the comments received in the public docket within each theme and is not meant to be comprehensive. Comments provided to the EPA are available in the docket at the link provided above.

Characterize Risks from PFAS and Develop Monitoring and Treatment/Cleanup Techniques

- Undue burden placed on communities and private well owners. Concerns on the costs to the taxpayer associated with treatment of PFAS in water, purchasing bottled water, point-of-use filters, and/or the cost associated with health care stemming from potential PFAS exposure.
- Desire for responsible parties to pay for the cost of cleanup/treatment and monitoring.
- Requests that the EPA consider the cost of treatment in the rulemaking process.
- Federal prioritization of PFAS compounds for additional study and effort.
- Concern on the movement of PFAS through groundwater and the potential for contamination to spread.
- Need for more science-based research and method development to monitor PFAS.

Near-term Actions Needed to Address Challenges Currently Facing States and Local Communities

- Desire for the EPA to use its regulatory authority to regulate PFAS and provide regulatory certainty.
- List PFAS as hazardous substances.
- Develop groundwater cleanup values in a way that encourages site-specific solutions and allow for use of available resources.
- Request for better risk communication and education from the public on health effects, more research on PFAS, identification of PFAS in media other than drinking water, and prevention of industrial releases of PFAS.
- Develop consistent and enforceable standards, including a maximum contaminant level for PFAS that is based on best-available and current science. Some members of the public expressed support for lowering EPA's Health Advisory Level.
- Follow up or expanded water testing and/or blood testing in local communities.
- Concern with the UCMR detection levels (too low and not representative of PFAS presence) and requests to expand the list of PFAS for future UCMR efforts.
- Need for funding for the federal, state, tribal, and local governments to adequately address PFAS.
- Regulate PFAS at the source; prevent PFAS from entering commerce and prevent releases into the environment.
- Concern that families and communities located near military installations are disproportionately affected by PFAS.
- Concern from site-specific contamination, including GenX chemicals.
- Make available technical assistance and funding to individual households and private well owners to address PFAS. Communities need assistance in determining the extent of their contamination.
- Need for new analytical methods to achieve lower detection limits, identify additional PFAS, and monitor in media other than water.

- Need any guidance developed by the EPA to be scalable, with special emphasis for small and tribal communities.

Risk Communication Strategies to Address Public Concern with PFAS

- Concern regarding the quality and accessibility of information from the EPA and other federal agencies. Desire to have information on: the proximity of a community to a PFAS source; the potential exposure of communities to individual and mixtures of PFAS; products that contain PFAS; guideline, standard, and method development process; and access to technical resources such as data, methods, and research.
- Need for a clear and concise communication plan from the EPA to inform the public and stakeholders regarding the risk of PFAS exposure and related the EPA activities (both ongoing and planned).
- Concern on the unknown human health effects from PFAS exposure, the cost of health insurance and mental health coverage from exposure and stress of exposure, and the possible health effects from PFAS exposures.
- Request for comprehensive testing of PFAS in drinking water and blood and communication of risk information in a clear and concise manner that is easy for the public to understand.
- Concern on the lack of risk communication for PFAS in food, such as fish and shellfish.
- Need for a comprehensive risk communication strategy that includes stakeholders and allows for the opportunity for the public to provide comments and questions.

General Comments

- Request the EPA exercise its regulatory authority to limit the use and manufacture of PFAS due to health concerns from exposure from air, water, and food.
- Commenters at community engagements provided both support and appreciation for the opportunity to participate, in addition to implying frustration at feeling excluded from presenting information to the panelists.
- Commenters provided personal accounts of PFAS exposure in their local community and the health and financial impacts of that exposure.
- Encourage the EPA to abide by its mission to protect human health and the environment by ensuring all citizens are provided healthy and clean drinking water and air.

Appendix D: Other Reference Materials

EPA Resources

- EPA's Webpage for Per- and Polyfluoroalkyl Substances (PFAS): <https://www.epa.gov/pfas>
- Information on the EPA Community Engagement Sessions on PFAS: <https://www.epa.gov/pfas/pfas-community-engagement>
- Information on the National Leadership Summit on Per- and Polyfluoroalkyl Substances (PFAS): <https://www.epa.gov/pfas/pfas-national-leadership-summit-and-engagement>
- PFAS National Leadership Summit and Engagement Federal Public Input Docket: <https://www.regulations.gov/> – enter docket number: OW-2018-0270
- Drinking Water Health Advisories for PFOA and PFOS: <https://www.epa.gov/ground-water-and-drinking-water/drinking-water-health-advisories-pfoa-and-pfos>
- Third Unregulated Contaminant Monitoring Rule: <https://www.epa.gov/dwucmr/third-unregulated-contaminant-monitoring-rule>
- Contaminant Candidate List 4: <https://www.epa.gov/ccl/contaminant-candidate-list-4-ccl-4-0>
- EPA Drinking Water Laboratory Method 537 Q&A: <https://www.epa.gov/pfas/epa-drinking-water-laboratory-method-537-qa>
- Research on Per- and Polyfluoroalkyl Substances (PFAS): <https://www.epa.gov/chemical-research/research-and-polyfluoroalkyl-substances-pfas>
- EPA Actions to Address PFAS: <https://www.epa.gov/pfas/epa-actions-address-pfas>
- EPA 2010/2015 PFOA Stewardship Program: <https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/fact-sheet-20102015-pfoa-stewardship-program>
- Drinking Water Treatability Database: <https://iaspub.epa.gov/tdb/pages/general/home.do>
- Case Studies on State-Level Risk Communication of PFAS (EPA and ECOS collaboration): <https://www.ecos.org/documents/state-level-risk-communication-of-pfas-and-habs/>

Additional Resources (Non-EPA Materials)

- ATSDR Webpage Per- and Polyfluoroalkyl Substances (PFAS) and Your Health: <https://www.atsdr.cdc.gov/pfas/>
- ATSDR Overview of Perfluoroalkyl and Polyfluoroalkyl Substances and Interim Guidance for Clinicians Responding to Patient Exposure Concerns: https://www.atsdr.cdc.gov/pfc/docs/pfas_clinician_fact_sheet_508.pdf
- ToxFAQs™ for Perfluoroalkyls: <https://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=1116&tid=237>
- Toxicological Profile for Perfluoroalkyls: <https://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=1117&tid=237>
- CDC Per- and Polyfluorinated Substances (PFAS) Factsheet: https://www.cdc.gov/biomonitoring/PFAS_FactSheet.html

- CDC National Report on Human Exposure to Environmental Chemicals: <https://www.cdc.gov/exposurereport/index.html>
- Interstate Technology Regulatory Council (ITRC) PFAS website: <https://pfas-1.itrcweb.org/>
- ITRC PFAS fact sheets: <https://pfas-1.itrcweb.org/fact-sheets>
- Per- and Polyfluoroalkyl Substances (PFAS) Laboratory Testing Primer for State Drinking Water Programs and Public Water Systems: <https://www.asdwa.org/wp-content/uploads/2018/10/ASDWA-PFAS-Lab-Testing-Primer-10-10-18-Final.pdf>



EPA's Per- and Polyfluoroalkyl Substances (PFAS) Action Plan

EPA 823R18004 | February 2019 | www.epa.gov/pfas

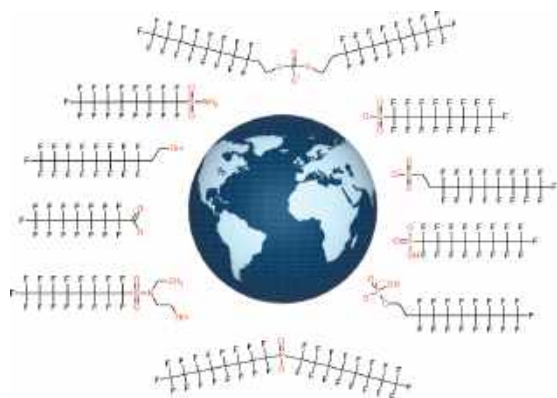
Polyfluorinated Compounds: Past, Present, and Future

Andrew B. Lindstrom,^{†,*} Mark J. Strynar,[†] and E. Laurence Libelo[‡]

[†]National Exposure Research Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711, United States

[‡]Office of Pollution Prevention and Toxics, U.S. Environmental Protection Agency, Washington, D.C. 20460, United States

ABSTRACT: Interest and concern about polyfluorinated compounds (PFCs), such as perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), and an increasing number of other related compounds is growing as more is learned about these ubiquitous anthropogenic substances. Many of these compounds can be toxic, and they are regularly found in the blood of animals and humans worldwide. A great deal of research has been conducted in this area, but a surprising amount remains unknown about their distribution in the environment and how people ultimately become exposed. The utility of these compounds seems to ensure their continued use in one form or another for the foreseeable future, presenting a long-term challenge to scientists, industry leaders, and public health officials worldwide.



INTRODUCTION

Polyfluorinated compounds (PFCs) are useful anthropogenic chemicals that have been incorporated into a wide range of products for the past six decades. This class of compounds includes thousands of chemicals but is best known for the perfluorosulfonates (PFSAs) such as perfluorooctane sulfonate (PFOS), and the perfluorocarboxylic acids (PFCAs) which include perfluorooctanoic acid (PFOA). Their numerous uses and unique physical and chemical characteristics have made it difficult to develop an understanding of how they are distributed in the environment and how people become exposed. Concerns about these compounds have developed as many satisfy the defining characteristics of persistent organic pollutants (POPs): they are toxic, extremely resistant to degradation, bioaccumulate in food chains, and can have long half-lives in humans. After research efforts documented their presence in the environment and wildlife worldwide, and further studies verified that they are very common in human blood serum, efforts were undertaken in the U.S. and elsewhere to limit the production and emission of some of the most widely used PFCs. Recent studies have indicated that these efforts may be responsible for a reduction of some PFCs in the blood of humans and animals in some locations, but other PFCs have remained stable or have even increased. The diversity of the PFCs and their high production

volume has made it difficult to gauge global trends. An additional complication is that some developing regions have taken up the production of materials that have been restricted in other parts of the world, making it difficult to determine if progress is being made with regard to reducing global PFC emissions. Moreover, the utility of polyfluorinated chemistry makes it highly likely that commercial industries will continue to develop and use these materials for the foreseeable future. This feature article will explore some of the important history in this area, summarize much of our current understanding, and briefly consider what might be expected in the near future. Because this is intended to be a general overview, we will highlight what has motivated recent interest and what still needs to be determined.

Figure 1 summarizes the basic structures of some different types of PFCs, organized by the functional group (e.g., carboxylate, sulfonate, alcohol) at one end of the molecule. Polyfluorinated hydrocarbons have multiple sites where hydrogen has been substituted with fluorine (e.g., telomer alcohols), and perfluorinated species have had all of the hydrogens substituted with fluorine (e.g., PFOS and PFOA). These compounds have a number of unique physical and chemical characteristics imparted by the fluorinated region of the molecule, including water and oil repellency, thermal stability, and surfactant properties that make them very useful for a wide range of industrial and consumer-use applications.¹ For example, coating an exterior surface of a textile or paper product leaves the perfluorinated tail of the molecule projecting away from the surface. Because this part of the molecule repels both water and oil, this treatment is ideal for paper packaging, textiles, and other surfaces one wants to keep clean and dry. This chemistry is also useful for surfactants and dispersants, leading to their widespread use as leveling agents for paints, lubricants, mist suppression, and fire fighting foams. A major use of PFCAs is as an emulsifier in the production of fluoropolymers.^{1,2}

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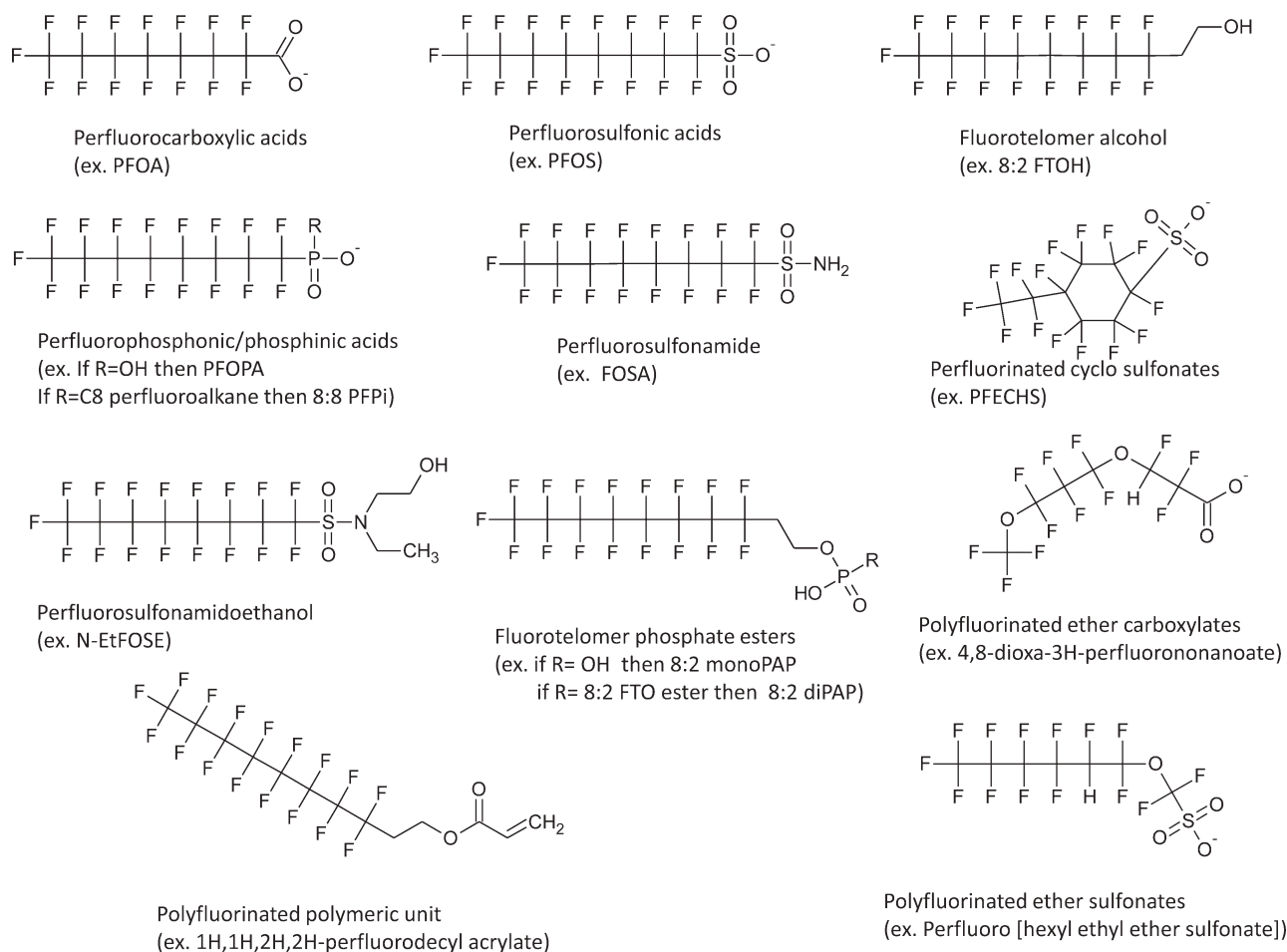


Figure 1. Generic structures for polyfluorinated compounds. The $n = 8$ linear carbon structures are shown for many of these examples, but $n = 4-14$ linear and/or branched carbon units are generally possible.

TOXICITY

Compounds in this class were first produced in the 1940s and 1950s, well before it became common for governmental agencies in the industrialized world to require significant testing of new materials being brought to market. As companies producing these materials continued production and diversification of their product lines, more in-depth evaluations of potential health effects were conducted. The results of many of these investigations were in the form of internal reports that were not published in the peer reviewed literature. By the early 2000s, when it became apparent that PFCs were broadly distributed in the environment³ and almost all human blood samples collected worldwide were found to contain measurable quantities of many PFCs at the ng/mL level,⁴ regulatory agencies began calling for a full review of all previous research and a more thorough evaluation of toxicity began. Studies involving chronic exposure of rats and monkeys to PFOS showed decreased body weight, increased liver weight, and a steep dose-response curve for mortality.⁵⁻⁷ An increase in hepatocellular adenomas and thyroid follicular cell adenomas was observed in rats exposed to high levels of PFOS in their food.⁸ In rodents, PFOA has been associated with increased incidence of liver, pancreas, and testicular tumors as well as weight loss, liver enlargement, and changes in lipid metabolism.⁹⁻¹¹ When either PFOS or PFOA is administered to pregnant mice, there is neonatal mortality and reduced growth for the surviving pups.¹² The carcinogenicity associated with PFOA in rodents has

been found to be mediated by the peroxisome proliferator-activated receptor- α (PPAR- α) pathway,¹³ but the relevance of this mechanism in humans is a matter of scientific debate.

Using these laboratory animal studies to try to estimate potential human health effects is always difficult, but in this case it is made more difficult by the fact that the toxicokinetics of different PFCs differ considerably between animal species and even between different genders within a given species.¹² For example, the half-life of PFOA in female rats is approximately four hours, while in male rats from the same strain it is closer to six days.¹⁴ In mice, the half-life was found to be considerably longer (17-19 days), but the effect of gender was much less pronounced.¹⁵ In humans, data suggest that the half-lives are much longer, with PFOS and PFOA approximately 5.4 and 3.8 years (arithmetic means), respectively,¹⁶ with no difference noted between genders. While half-life has generally been observed to increase in proportion to compound chain length, this is not always true, as perfluorohexane sulfonate (PFHxS, 6 carbons) has a half-life of 8.5 years in humans.¹⁶ This relatively long half-life in humans heightens concerns about potential health effects.

While the toxicity of PFOS and PFOA has been documented in animal studies, investigations of potential health effects in workers occupationally exposed to these compounds have generally shown inconsistent results.¹⁷ These workers may have circulating blood levels of PFCs that are hundreds of times those

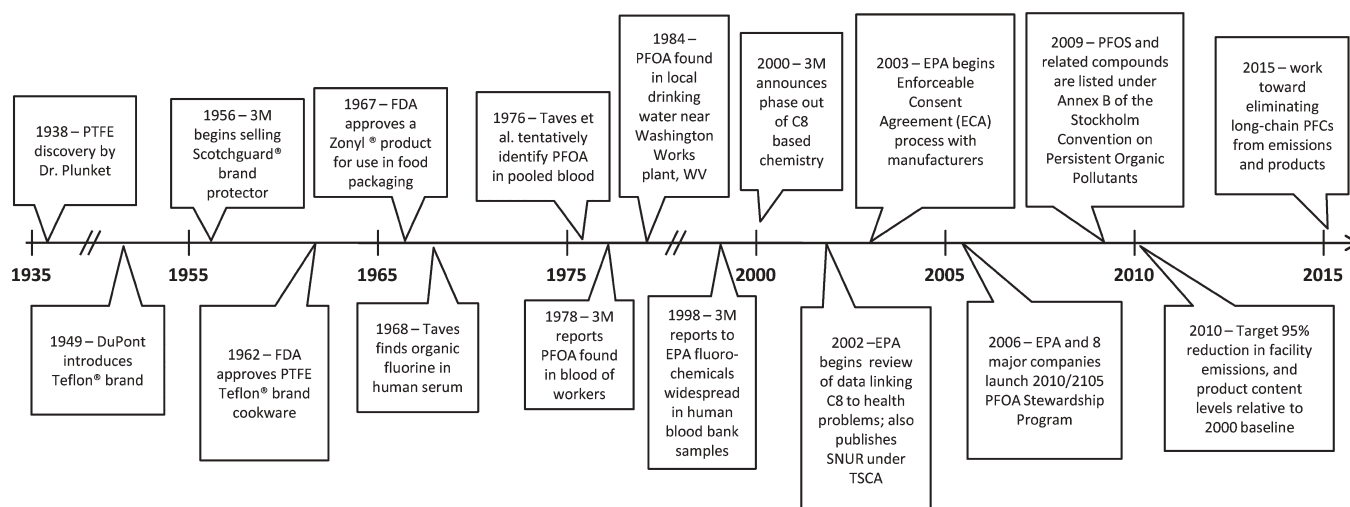


Figure 2. Timeline of important events in the history of polyfluorinated compounds.

of nonoccupationally exposed individuals,¹⁸ but it is difficult to determine conclusive results in these studies (either positive or negative) because sample populations are small, historical exposure levels are uncertain, individuals often have had simultaneous exposures to other compounds, and they may have preexisting conditions that complicate evaluations. In one study of PFOS exposed workers, bladder cancer mortality was elevated among individuals with at least one year of exposure, but this finding was based on an incidence of only three cases.¹⁹ In a subsequent reevaluation of this cohort, bladder cancer incidence was found to be similar to that of the general U.S. population, but a 1.5–2.0-fold risk for the most highly exposed workers could not be ruled out.²⁰ Compared to PFOS, more studies of PFOA exposed workers have been conducted. Several studies have shown a positive association between PFOA exposure and cholesterol, which could have implications for the development of cardiovascular disease.^{18,21–23} PFOA has also been associated with elevated uric acid, which may in turn impact hypertension and cerebrovascular disease.^{21,23} Some studies have found an association between PFOA exposure and prostate cancer,^{24,25} but data are sparse and do not allow conclusive determinations.²⁶ An excellent review of this evolving area of research can be found in Steenland et al.¹⁷

Studies involving more typical background exposures in the general population are also inconsistent but suggest a number of important potential health effects. Among these are studies showing an association between PFOS and PFOA and decreased sperm count,²⁷ a negative association between PFOS and PFOA with birth weight and size,^{28,29} higher blood levels of PFOS and PFOA being related to current thyroid disease,³⁰ and an association between PFOA and elevated cholesterol.³¹ Overall these data are inconclusive and the associations do not necessarily indicate causality. Steenland et al. also cover this literature in their recent review.¹⁷

Considering the widespread environmental occurrence and the potential health effects, the U.S. Environmental Protection Agency (EPA) has issued provisional short-term health advisories for PFOS (200 ng/L) and PFOA (400 ng/L) in drinking water, estimating that short-term consumption below these levels will safeguard public health.³² Chronic exposure guidelines are being developed by the EPA and have been published by various entities for water and food, but little has been done thus far for compounds other than PFOS and PFOA. A review of current global guidelines and regulations can be found in Zushi et al.³³

HISTORY OF PRODUCTION

Among the many ways used to produce PFCs, two major synthetic routes should be discussed. In the electrochemical fluorination (ECF) process, a straight chain hydrocarbon is reacted with HF and electricity to substitute all of the hydrogen atoms with fluorine.¹ Perfluorooctane sulfonyl fluoride (POSF) has been the major target compound produced in this manner, but ECF is a relatively crude process, leading to approximately 70% straight chain POSF with the balance being a variety of branched and cyclic isomers primarily from 4 to 9 carbons in total length. POSF can then be used in a series of reactions to produce *N*-methyl and *N*-ethyl perfluorooctane sulfonamidoethanol (*N*-MeFOSE and *N*-EtFOSE, Figure 1), which historically were used to produce surface coatings for textiles and paper products.^{34,35} All compounds produced from POSF have been thought of as “PFOS equivalents” as these materials have the potential to ultimately degrade or transform to PFOS. In contrast, PFOS itself is extraordinarily stable in the environment, with no known natural mechanism of degradation. The other main process for the production of PFCs is called telomerization.¹ This involves the reaction of perfluoroethylene (a taxogen, $\text{CF}_2=\text{CF}_2$) and perfluoroethyl iodide (a telogen $\text{CF}_3-\text{CF}_2\text{I}$) to produce straight chain prefluorinated iodides with chain lengths that are generally divisible by 2. These perfluorinated iodides are then used as a feedstock to make perfluorinated carboxylic acids, fluorotelomer alcohols, and fluorotelomer olefins that are almost exclusively straight chain without the branched or cyclic materials that are characteristic of ECF synthesis. The fluorotelomer-based materials are used to produce polymers, textile treatments, surfactants, and food contact packaging.³⁶ PFOA, the eight carbon carboxylate, has been widely used as an emulsion polymerization aid in the production of polytetrafluoroethylene (PTFE), an inert polymer used in a wide variety of applications, including nonstick coatings in kitchenware, nonreactive containers for corrosive materials, insulators, lubricants, and many other uses.²

It is also important to note that thousands of different polyfluorinated compounds have been synthesized and used by industry. The polyfluoroalkyl phosphate esters (PAPs) and perfluorinated phosphonic acids (PFPAAs) are two other groups that have recently been gaining attention.^{37,38} Both classes of compounds have multiple congeners which have been identified in

environmental matrices at concentrations that are similar to PFOS, PFOA, and related materials. Moreover, the PAPs have been recently quantified in human blood serum samples, confirming exposures through some unknown pathway(s).³⁵

The history of PFC production is difficult to accurately portray due to the proprietary nature of this information, industry responses to various forms of regulation, and changing product lines. The 3M Company was the major producer of POSF, starting production in 1949, with the total cumulative production estimated to be approximately 96 000 t in the peak years between 1970 and 2002.³⁴ After 3M discontinued production in 2002, other companies began production to meet existing market demands, with an estimated 1000 t per year being produced since 2002.³⁴ The fluorotelomer alcohols have been widely used in the production of polymers and surface coatings with an estimated annual production in 2004 of 11 000–13 000 t/yr.³⁶

As research has demonstrated that many of the long-chain PFCs are toxic, persistent, and bioaccumulative, government and regulatory bodies in some parts of the world have been working toward agreements and regulations that limit the production of some of the PFCs.³³ The EPA worked with 3M to bring about the voluntary discontinuation of PFOS and related compounds between 2000 and 2002. Starting at the same time, a series of Significant New Use Rules (SNUR) were also put in place (2000, 2002, and 2007) in the U.S. to restrict the production and use of materials that contained PFOS or its various precursors. The EPA then worked with eight leading chemical companies in the 2010/2015 PFOA Stewardship Program to reduce emissions and residual content of PFOA and long-chain PFCs by 95% by 2010, with the long-term goal to work toward elimination of long-chain PFCs by 2015.⁴⁰ In 2009, PFOS and related compounds were listed under Annex B of the Stockholm Convention on Persistent Organic Pollutants, which restricts manufacturing and use to a few specific applications.⁴¹ Figure 2 is a summary of some of the key events in PFC history.

REFINING ANALYTICAL APPROACHES

In many ways research in this area has been dependent on improvements in analytical instrumentation, the synthesis and availability of analytical standards, and a gradually increasing sophistication in analytical approaches that have evolved over the past five decades. In 1968 D.R. Taves presented evidence of two forms of fluorine in human blood, one of which was the inorganic fluorine ion, and another which was closely associated with serum albumin having the characteristics of a “large stable molecule...consistent with the presence of a fluorocarbon molecule”.⁴² By 1976 Taves et al. had used NMR to tentatively identify PFOA or a related compound in concentrates from human blood serum, the source of which they speculated to be common household consumer products known to contain PFCs.⁴³ Early analytical methods for the measurement of organic fluorine in the blood of occupationally exposed workers started in the 1970s with a laborious and nonspecific ashing technique similar to that used by Taves et al., but soon progressed to less labor intensive (but still nonspecific) methods involving electron capture detection or microwave plasma detection.⁴⁴ These techniques had relatively high levels of detection (in the $\mu\text{g/mL}$ or ppm range) and only gave tentative identification of the target analytes, but were nonetheless adequate for the evaluation of highly exposed workers. It was only after liquid chromatography/mass spectrometry (LC/MS) instrumentation became

commonly available in the mid- to late-1990s that it became possible to measure PFCs in the low ng/mL (ppb) range, allowing for the first time the accurate evaluation of background levels of PFCs in biological and environmental matrices.⁴⁵ Early work in this area was difficult due to the relatively low concentrations found in most matrices, a lack of pure authentic standards and appropriate internal standards, a lack of standardized extraction and preparation techniques, and relatively poor quality assurance procedures.⁴⁶ A series of interlaboratory comparison studies in the early 2000s indicated relatively poor comparability between laboratories for complex and variable matrices like water and fish, with somewhat better performance for serum samples.^{47,48} Refinement of instrumentation and methods continued, with LC triple quadrupole mass spectrometer (LC/MS/MS) quickly becoming the standard approach used by most laboratories. As research and regulatory interest in these chemicals have increased, commercial laboratories have found a market for high purity standards and mass labeled internal standards, making it possible for more analytical laboratories to take up this research. Better quality assurance procedures, such as the routine use of daughter ion ratios to help distinguish PFCs (such as PFOS), from commonly occurring matrix contaminants, has helped refine compound identification and accuracy considerably.⁴⁹ Another important recent development is the increasing use of standard reference materials (SRM) to develop consensus values for different compounds in differing matrices, thereby providing a way to demonstrate analytical performance in each analytical batch.⁵⁰ At present, instrumentation continues to improve, with lower cost time-of-flight mass spectrometers now becoming available, giving many laboratories the ability to conduct analyses using high resolution mass accuracy and greatly improved specificity.⁵¹

OCCURRENCE IN THE ENVIRONMENT

Early studies which documented the presence of PFOS and other PFCs in the blood of many species of wildlife collected from wide ranging locations around the world sparked initial interest and concern.³ Of particular interest was the fact that PFCs were both ubiquitous in humans⁴ and measurable in the blood of arctic mammals, ocean going birds, and other species only found in remote locations far from human settlement.^{52,53} It was apparent that PFCs, like other POPs, undergo a “global distillation” wherein persistent materials emitted in the temperate regions are transported to polar regions where they can accumulate in the environment far from any known sources. Polar bears, seals, and whales are well-known to accumulate POPs like PCBs, PBDEs, and persistent pesticides, and these species were also found to take up PFOS and some of the long-chain PFCAs.^{54–56} At the same time, other studies began documenting the occurrence of PFCs in rivers, lakes, and oceans worldwide. The highest concentrations of PFCs have typically been documented in areas with direct industrial emissions that have impacted fresh water rivers and lakes with concentrations typically ranging 1–1000s of ng/L.^{57–59} Oceanic levels are typically 3 orders of magnitude lower, with levels of PFOS and PFOA typically being in the range of 10–100 pg/L.⁶⁰

An important environmental concern is that the long-chain PFCs can bioaccumulate as they move through food webs. Compounds with a perfluoroalkyl chain length (number of carbons with fluorine bonds) ≥ 8 are generally more bioaccumulative than those with ≤ 7 .^{61,62} Note that while PFOA has

eight total carbons, only seven are perfluoroalkyl carbons with one additional carboxylate carbon, giving it a tendency to be less well retained in many biological matrices. Humans seem to be an important exception to this observation as PFOA appears to readily accumulate in human serum.⁶³ The functional group also has an effect on bioaccumulation, with a sulfonate being more likely to be retained than a carboxylate of the same size.^{61,64} These general observations form the basis for the call to restrict or eliminate the use of long-chain PFCs (i.e., those $\geq$ C8).⁴⁰

HUMAN EXPOSURE

The fact that virtually all people living in the industrialized world have many PFCs in their blood serum in the ng/mL range⁴ indicates widespread exposure, but developing an understanding how people become exposed is complicated by a number of factors. One of the first important considerations is the long half-life of some PFCs in humans. This slow elimination time makes it difficult to determine how changes in lifestyle, diet, or other exposure-related factors influence blood levels. Studies have also indicated that while age apparently has little influence on circulating PFC levels, gender and ethnicity do seem to influence the accumulation of some compounds.⁶⁵ This indicates that lifestyle and possibly genetic factors play a role in uptake and retention of the PFCs. There are also clear geographical differences that have been observed, indicating that proximity to major sources or degree of urbanization also play an important role.^{57,63} But one of the biggest factors influencing human exposure is likely to be changes in industrial production, which have largely come about in response to regulatory pressures to decrease production and emission of compounds considered to be potentially hazardous. Since 3M terminated production of POSF in 2002, PFOS in North American blood samples has decreased at a rate that is consistent with its half-life in humans, suggesting that the factors responsible for exposure were greatly reduced or eliminated at that time.⁶⁶ It is interesting to note that blood levels of PFOA also began a sharp decline in 2002, but the rate of decrease has been slower than the estimated half-life. This suggests that POSF production may have been related to PFOA exposure in some way, but other sources remain.

The U.S. Center for Disease Control and Prevention (CDC) conducts the National Health and Nutrition Examination Survey (NHANES) on a regular basis to monitor pollutant trends in the U.S. population. In a study summarizing recent NHANES data, geometric mean PFOS and PFOA levels declined by 32% and 25%, respectively from 1999/2000 until 2003/2004.⁶⁷ The most recent NHANES results (2007/2008) indicate that while PFOS concentrations continue to decline, other PFCs have essentially remained flat (PFOA) or have increased (PFHxS, PFNA).⁶⁵ These results suggest that deliberate efforts to reduce the production of PFOS have led to reductions in human exposure (in the U.S.) but the routes of exposure and control mechanisms for other PFCs remain obscure.

Data from other countries indicate a more complex global situation with regard to human blood levels. In a study involving pooled serum samples from Norwegian men aged 40–50 collected from 1977 until 2006, PFOS, PFOA, and perfluoroheptanoic acid (PFHpA) increased by a factor of 9 between 1977 and the mid 1990s.⁶⁸ Between 2000 and 2006 PFOS and PFOA then decreased by a factor of 2. PFHxS, perfluorononanoic acid (PFNA), perfluorodecanoic acid (PFDA), and perfluoroundecanoic acid (PFUnA) also increased between 1977 and the mid

1990s, but their concentrations either leveled off or continued to increase until 2006.⁶⁸ A study in Germany found relatively stable PFOS and PFOA concentrations in adult males between 1977 and 2004,⁶⁹ whereas data from China have indicated dramatically increasing level of PFOS in some parts of this country, while PFOA has remained relatively low.⁷⁰

At present, a number of modeling studies have estimated that low level PFC contamination of food is likely to be responsible for most nonoccupational exposures in industrialized nations. In a recent review, Fromme et al. evaluated potential PFC exposures from indoor and outdoor air, house dust, drinking water, and food.⁷¹ They concluded median uptake of PFOS and PFOA was on the order of 2–3 ng/kg/day, respectively, with food being responsible for greater than 90% of this exposure. However, with the wide variety of foods consumed and the difficulty in establishing sensitive analytical methods that accurately measure contaminants, there is still a great deal of uncertainty about the role of food as an exposure route.⁷² Fish are the most thoroughly examined food item, and an increasing number of studies have begun to suggest that fish from contaminated water bodies may dominate exposures to PFOS and possibly other long-chain PFCAs.^{73,74} For example, in a recent study of fish taken from a contaminated section of the Mississippi River, bluegill filets were found to have median PFOS concentrations of between 50 and 100 ng/g of fillet.⁷⁵ Consumption of a meal sized portion (195 g) of this fish leads to exposures in the range of 150–330 ng/kg/day, which is approximately 100 times higher than the daily intake predicted in the study by Fromme et al.⁷¹ This underscores the facts that fish can be a major source of intake for some people and there is still a great deal to be learned about PFC contamination of food. Studies have also indicated that crops grown on contaminated soils can accumulate PFCs, suggesting that this may also be a source of human exposure.⁷⁶ This may be a particular concern in agricultural areas that receive amendments of biosolids from wastewater treatment plants, as these effluents contain PFC precursors and terminal degradants.^{77,78} It is also clear that consumption of contaminated drinking water can be an important route of human exposure for people living in certain areas that are impacted by industrial emissions. Situations where locally contaminated drinking water resources have been linked with increased blood levels have been documented in Germany,⁶⁹ Japan,⁵⁷ Ohio and West Virginia,⁶³ and Minnesota.⁷⁹

Other potential routes of human exposure include air, house dust, and direct contact with PFC containing consumer use items. Many of the labile precursor materials like telomer and FOSE alcohols are volatile, and studies show that they can occur in the indoor environment at pg/m³–ng/m³ levels.⁸⁰ Once inhaled, these materials may be metabolized by normal enzymatic processes, likely leading to accumulation of the end terminal degradants in vivo. Studies of house dust indicate that contamination in 10–100 ng/g range is quite common,^{81,82} suggesting inhalation of airborne material or the hand to mouth contact (particularly for children) could contribute to human exposure. Direct contact with consumer use items that have been treated with PFCs or which contain residuals from a manufacturing process is another potential source of human exposure.⁸³

THE FUTURE OF PFCs

While most of the research and regulatory effort thus far has focused on PFOS and PFOA, it is important to realize that hundreds to thousands of different polyfluorinated compounds

are currently in use. Moreover, new formulations are being brought to market continuously and little if anything is known about the environmental disposition and toxicity of these compounds.^{84–86} While there has been some success with voluntary controls for some PFCs,⁴⁰ there is limited incentive for companies to join in these voluntary agreements. In fact, considering that the C8-based chemistries often have the most desirable performance characteristics, it is attractive for companies that are not party to the 2010/2015 PFOA Stewardship Program to increase their production of long-chain materials to meet continuing international market demands. Some members of the international community believe that regulations to limit PFC production are unnecessary because there is little evidence of human health effects or environmental damage thus far. Without strong coordinated regulatory efforts, economic factors may simply shift the production of these materials to locations that place greater value on economic development than long-term environmental concerns.

In conclusion, it is evident that scientific and regulatory communities are only starting to understand and effectively manage polyfluorinated compounds. Environmental distributions, routes of human and environmental exposure, and long-term ecological and human health consequences are still poorly described. Limited regulatory controls have been established in some nations, but their long-term effectiveness on a global scale remains to be determined. The extreme stability of the terminal breakdown products and the increasing trend toward an integrated world economy makes a strong case for global research and regulation, especially as new alternatives are being introduced to the market. Environmental professionals of all types face an enormous challenge in trying to meet these pressing research needs. We are at the very beginning of a new age of environmental chemistry.

AUTHOR INFORMATION

Corresponding Author

*Phone: 919-541-0551; fax: 919-541-0905; e-mail: lindstrom.andrew@epa.gov.

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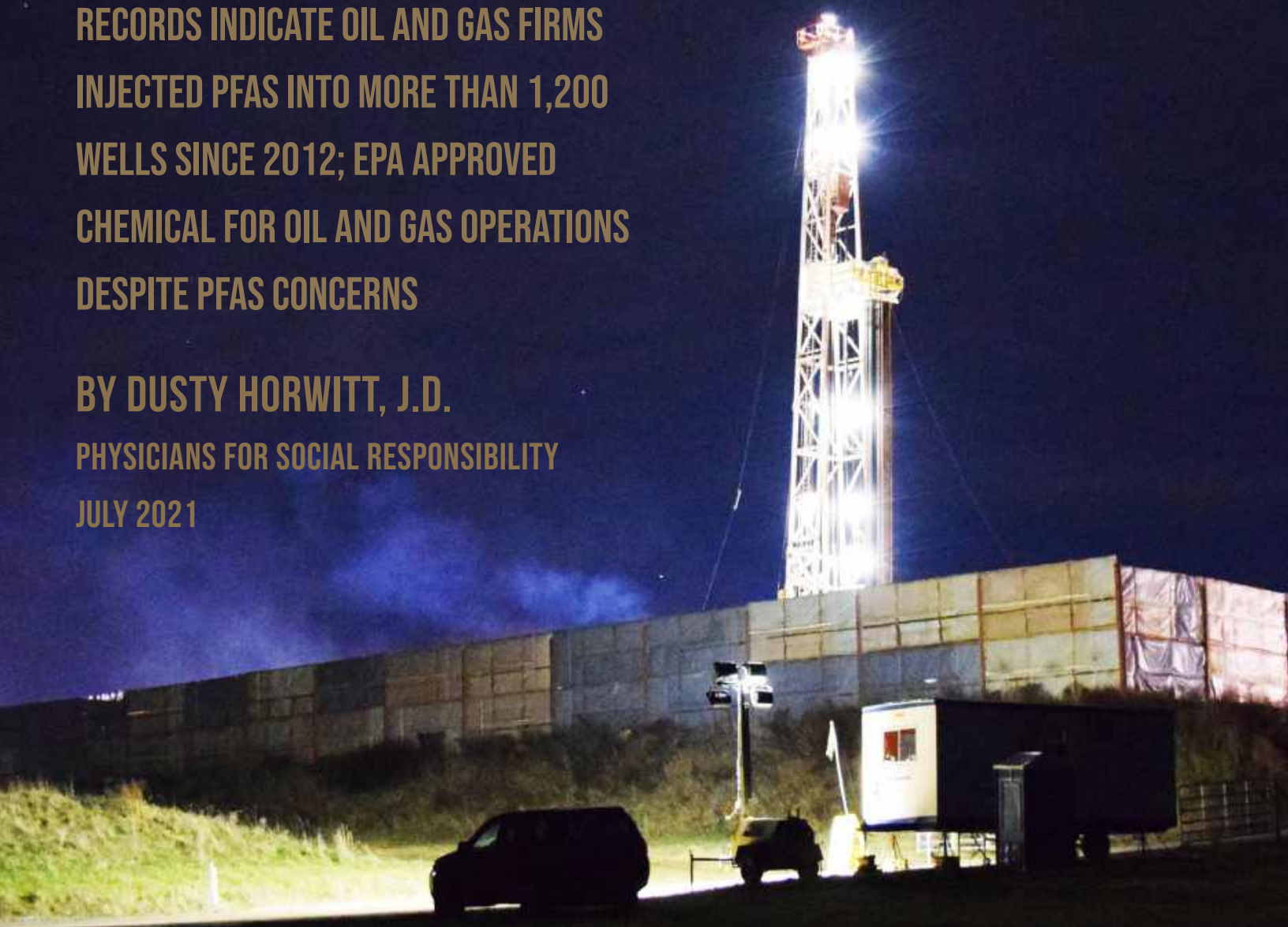
FRACKING WITH “FOREVER CHEMICALS”

RECORDS INDICATE OIL AND GAS FIRMS
INJECTED PFAS INTO MORE THAN 1,200
WELLS SINCE 2012; EPA APPROVED
CHEMICAL FOR OIL AND GAS OPERATIONS
DESPITE PFAS CONCERNS

BY DUSTY HORWITT, J.D.

PHYSICIANS FOR SOCIAL RESPONSIBILITY

JULY 2021



PSR



**PHYSICIANS
FOR SOCIAL
RESPONSIBILITY**

U.S. AFFILIATE OF INTERNATIONAL PHYSICIANS FOR THE PREVENTION OF NUCLEAR WAR

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EXECUTIVE SUMMARY

Evidence suggests that oil and gas companies including ExxonMobil and Chevron have used per- and polyfluoroalkyl substances (PFAS), or substances that can degrade into PFAS, in hydraulic fracturing (“fracking”) for oil and gas in more than 1,200 wells in six U.S. states between 2012 and 2020. The lack of full disclosure of chemicals used in oil and gas operations raises the potential that PFAS could have been used even more extensively than records indicate, both geographically and in other stages of the oil and gas extraction process, such as drilling, that precede the underground injections known as fracking.

PFAS have been linked to cancer, birth defects, pre-eclampsia, and other serious health effects. Toxic in minuscule concentrations, they accumulate inside the human body and do not break down in the environment – hence their nickname, “forever chemicals.” PFAS were widely used for decades in non-stick cookware, stain-resistant carpeting, fire-fighting foam and other products before their highly toxic characteristics became public around the year 2000. Chemical manufacturers Dupont and 3M had known about these chemicals’ environmental and health risks as early as the 1960s and ’70s but failed to sound the alarm.

Evidence related to the use of PFAS in oil and gas operations has not been previously publicized. The apparent use of PFAS in these operations adds an especially hazardous class of chemicals to the list of harmful substances associated with oil and gas extraction and is another potential route of exposure to PFAS. In recent years, a growing number of states have set limits on PFAS pollution in water as researchers have discovered hundreds of sites where PFAS from a

variety of sources have polluted groundwater. In addition, fire departments are disposing of firefighting foam that contains PFAS. “Fire departments are scrambling to get rid of firefighting foam with PFAS in it because EPA says it’s toxic,” said Silverio Caggiano, who retired in June 2021 as Battalion Chief with the Youngstown, Ohio Fire Department and is a hazardous materials expert who has trained with fire-fighting foam that contains PFAS. “So if it’s too dangerous for us to use, why should oil and gas companies get to use it?”

Industry records indicating PFAS use in fracking in Arkansas, Louisiana, Oklahoma, New Mexico, Texas, and Wyoming came to light as part of Physicians for Social Responsibility’s investigation of the U.S. Environmental Protection Agency’s review of three new chemicals proposed in 2010 for use in oil and gas drilling and/or fracking. According to records obtained under a Freedom of Information Act request, EPA regulators worried that the chemicals could break down into products similar to PFOA, the most infamous PFAS, whose use has been largely discontinued in the U.S. as

part of an agreement between chemical makers and EPA. The regulators were also concerned that the degradation products of the three chemicals could be associated with severe health effects including male reproductive toxicity and tumors.

Despite these concerns, EPA approved the chemicals for commercial use, and EPA records show that one of the chemicals was used commercially for unspecified purposes at least as late as 2018. Records further indicate that the chemical was initially imported for commercial use by Dupont, a company that has agreed to pay hundreds of

“There is evidence from human and animal studies that PFAS exposure may reduce antibody responses to vaccines [citations omitted] and may reduce infectious disease resistance.”

EXECUTIVE SUMMARY [CONTINUED]

millions of dollars to settle injury claims related to PFOA pollution. EPA records included only a generic name for the chemical: fluorinated acrylic alkylamino copolymer. More specific identifiers were withheld as trade secrets.

PSR searched for the chemical in FracFocus, a database run by non-governmental organizations where companies operating in more than 20 states disclose well-by-well fracking chemical use. While we did not find the chemical with the name that EPA had approved, we did find other chemicals with related names that had been injected into more than 1,200 wells, the most common of which was “nonionic fluorosurfactant” and various misspellings. Evidence suggests these chemicals are likely PFAS and/or PFAS precursors (substances that could break down into PFAS).

In light of these findings, PSR recommends the following:

- **Health assessment.**

EPA and/or states should evaluate through quantitative analysis whether PFAS and/or PFAS breakdown products associated with oil and gas operations have the capacity to harm human health. All potential pathways of exposure should be examined, including inhalation, ingestion, and dermal contact.

- **Testing and tracking.** EPA and/or states should determine where PFAS and chemicals that may be PFAS have been used in oil and gas operations and where related wastes have been deposited. They should test nearby water, soil, flora, and fauna for PFAS.

- **Funding and cleanup.** Oil and gas and chemical firms should be required to provide adequate funding for environmental testing and evaluation, and should PFAS be found, for cleanup. If water cleanup is impossible, the companies responsible for the use of PFAS should pay for alternative sources of drinking water.

- **Public disclosure.** Echoing recommendations by Pennsylvania’s Attorney General in 2020, governments should require full public disclosure of drilling and fracking chemicals before each oil or gas well can be developed. EPA and/or states should inform communities potentially exposed to PFAS about PFAS contamination risks so that the communities can take actions such as water testing and treatment.

- **Moratorium on PFAS use for oil and gas extraction.**

Until testing and investigation are complete, EPA and states should not allow PFAS or chemicals that could break down into PFAS to be manufactured, imported, or used for oil and gas drilling or fracking.

- **Limits on drilling and fracking.** The use of PFAS and of chemicals that break down into PFAS in drilling and fracking should prompt governments to prohibit drilling, fracking, and disposal of related wastewater and solid wastes in areas that are relatively unimpacted by oil and gas pollution, and to increase protections in already-impacted regions. When doubt exists as to the existence or danger of contamination, the rule of thumb should be, “First, do no harm.”

“If water cleanup is impossible, the companies responsible for the use of PFAS should pay for alternative sources of drinking water.”

RECORDS INDICATE PFAS WERE USED IN FRACKING FOR OIL AND GAS

PSR has unearthed evidence suggesting that per- and polyfluoroalkyl substances (PFAS) and/or PFAS precursors (substances that could degrade into PFAS) have been used for hydraulic fracturing (“fracking”) in more than 1,200 oil and gas* wells in six U.S. states, creating risks for oil and gas workers and the public through multiple potential pathways of exposure. The lack of full disclosure of chemicals used in oil and gas operations raises the potential that PFAS could have been used even more extensively than records indicate, both geographically and in other stages of the oil and gas extraction process, such as drilling, that precede the underground injections known as fracking. The apparent use of PFAS in oil and gas production has not been previously publicized and raises concerns about toxic exposures.

PFAS are a class of chemicals known for having several valuable properties, including being slippery, oil- and water-repellant, and able to serve as dispersants or foaming agents.¹ The first PFAS to be sold commercially was discovered by a chemist at Dupont and patented as Teflon. Beginning in 1949, it was used in thousands of products, from nonstick cookware to waterproof clothing to plastics to dental floss.² Other PFAS have been used in food packaging, fire-fighting foam, and in 3M’s widely used fabric protector, Scotchgard.³ PFAS have been called “perfluorinated chemicals,” “polyfluorinated compounds,” or PFCs, though the term currently preferred by the U.S. Environmental Protection Agency (EPA) is PFAS.⁴ PFAS’ nickname “forever chemicals” is rooted in their manufacture, in which hydrocarbon chains of carbon and hydrogen atoms are mixed with hydrofluoric acid. The fluorine atoms in the acid replace the hydrogen atoms in the hydrocarbon chains, forming a bond between fluorine and carbon that is among the strongest in chemistry and barely exists in nature. The result: chemicals that are extremely resistant to breaking down in the environment.⁵

As early as the 1960s and 1970s, researchers inside Dupont and 3M became aware that PFAS were associated with health problems including cancers and birth defects, had

*Gas, the principal component of which is methane, is also known as “natural” gas, “fossil” gas and “fracked” gas

accumulated inside virtually every human being, and persisted in the environment.⁶ Many of these facts, kept internal by the companies, came to light after attorney Rob Bilott filed lawsuits in 1999 and 2001 against Dupont for causing pollution in and around Parkersburg, West Virginia with PFOA, a type of PFAS used to make Teflon.⁷ In December 2011, as part of Dupont’s settlement of the 2001 lawsuit, a team of epidemiologists completed a study of the blood of 70,000 West Virginians and found that there was a probable link between PFOA and kidney cancer, testicular cancer, thyroid disease (over- or under-production of hormones by the thyroid gland), high cholesterol, pre-eclampsia (a potentially dangerous complication during pregnancy characterized by high blood pressure and signs of damage to another organ system, most often the liver and kidneys), and ulcerative colitis (a disease causing inflammation and ulcers in the large intestine or colon).⁸ Mounting evidence of PFAS’s risks has led ten states to develop guidelines for concentrations in drinking water of PFOA and other types of PFAS.⁹ One of these states is Michigan, which set standards in 2020 for drinking water and cleaning up groundwater for PFOA and six other forms of PFAS. (The state acted because EPA had not enacted federal drinking water standards for PFAS.) Michigan’s maximum allowable level of PFAS is no more than eight parts per trillion for PFOA.¹⁰ By extension, these standards indicate that one measuring cup of PFOA could contaminate almost 8 billion gallons of water, six times the 1.3 billion gallons of water used each day by New York City, or the amount of water needed to fill almost 12,000 Olympic-sized swimming pools at about 660,000 gallons per pool.¹¹

PFAS/Fracking Link Began with Investigation of EPA Chemical Approval

PSR found evidence suggesting that PFAS have been used for hydraulic fracturing (“fracking”) in the course of an investigation into EPA’s approval of chemicals proposed for use in oil and gas drilling and fracking. In fracking, energy companies inject into oil and gas wells a mixture of up to tens of millions of gallons of water, sand, and chemicals at high pressure to fracture underground rock formations,

RECORDS [CONTINUED]

unlocking trapped oil and gas. The chemicals serve a variety of purposes including killing bacteria inside the wellbore, reducing friction during high-pressure fracking, and as gelling agents to thicken the fluid so that the sand, suspended in the gelled fluid, can travel farther into underground formations.¹²

In 2020, PSR examined documents disclosed by EPA in response to a Freedom of Information Act (FOIA) request that asked EPA to disclose its health reviews and regulatory determinations for new chemicals proposed for use in oil and gas drilling and fracking.¹³ We discovered documentation of chemicals proposed to be imported for use in drilling and/or fracking. They were identified by EPA case numbers P-11-0091, P-11-0092, and P-11-0093.¹⁴ And EPA agency regulators worried in writing that these chemicals could degrade into PFOA-like substances.

The relevant documents were created by EPA in accordance with the Toxic Substances Control Act (TSCA), which requires among other provisions that chemical manufacturers or importers submit applications, called “premanufacture notices,” in order to receive permission to use new chemicals commercially or to use existing chemicals commercially for new purposes.¹⁵ This system of new-chemicals review

is supposed to protect the public from chemical pollution, but it has been heavily criticized over the years as inadequate, including by Congress’ investigative arm, the Government Accountability Office (GAO). The GAO has consistently

included EPA’s program regulating toxic chemicals on its list of federal government programs at highest risk of waste, fraud, abuse, and mismanagement.¹⁶

Reviewing the EPA’s documents was challenging because TSCA allows companies to withhold from the public virtually all the data they submit to EPA in their premanufacture notices. Companies can shield the information from the public by designating it as confidential business information or CBI.¹⁷ In this case, the submitter marked multiple details as CBI, including the chemicals’ names, structure, use, production volume, and unique numeric identifiers known as Chemical Abstracts Service (CAS) numbers that scientists consider the best way to identify chemicals.¹⁸ When companies withhold specific chemical identifiers from their premanufacture notices, they must provide a generic or less specific name for their chemical(s) so that the public can have some idea what chemical EPA is assessing.¹⁹ Here, a single generic name was listed for all three chemicals: “fluorinated acrylic alkylamino copolymer.”²⁰ Similarly, manufacturers or importers must list a generic use when the specific use is deemed confidential.²¹ Here, the generic use was listed as “oil and water repellent and release agent.”²² Even the company’s name was withheld as confidential,²³ leaving the documents riddled with redactions and blank spaces, as may be seen in figures 1 and 2. PSR was, however, able to determine the



SANITIZED SUBMISSION

PMN Page 3

Part I -- GENERAL INFORMATION						
Section A -- SUBMITTER IDENTIFICATION						
Mark (X) the "Confidential" box next to any subsection you claim as confidential						
1a.	Person Submitting Notice (in U.S.)					Confidential
Name of Authorized Official	(first) XXX	(last) XXX				☒
Position	XXX					
Company	XXX					
Mailing Address (number & street)	XXX					
City	XXX	State		Postal Code	XXX	
email	XXX					
b.	Agent (if Applicable)					Confidential
Name of Authorized Official	(first)	(last)				

Figure 1. “Sanitized” premanufacture notice for chemicals with EPA case numbers P-11-0091, P-11-0092, P-11-0093 showing that the chemicals’ submitter withheld its own name as confidential. The term “sanitized” means that confidential business information has been withheld from the public version of the document.

original submitter’s likely identity by digging deeper into EPA data disclosed as required by TSCA.

Despite the confidentiality, EPA’s health and ecological

hazard assessment and consent order regulating the chemicals P-11-0091, P-11-0092, and P-11-0093 show that the agency was concerned about their health and environmental impacts.

The agency's concerns were based in part on the potential that the chemicals might degrade into substances similar to one of the most infamous PFAS in modern chemistry, PFOA.²⁴ Unfortunately, EPA's assessment and consent order were themselves heavily redacted before being released in response to a FOIA request, preventing a full understanding of EPA's concern. In its consent order, EPA stated:

EPA is concerned that these perfluorinated degradation products may be released to the environment from incomplete incineration of the PMN [premanufacture notice] substances at low temperatures. EPA has preliminary evidence, including data on other [REDACTED], that suggests that, under some conditions, the PMN substances could degrade in the environment. EPA has concerns that these degradation products will persist in the environment, could bioaccumulate or biomagnify, and could be toxic (PBT) to people, wild mammals, and birds based on data on analog chemicals, including PFOA and [REDACTED]. The presumed perfluorinated degradants for these PMN substances include [REDACTED].²⁵

c. Please identify which method you used to develop or obtain the specified chemical identity information reported in this notice (check one).				CBI
Method 1 (CAS Inventory Expert Service - a copy of the identification report obtained from CAS Inventory Expert Service must be submitted as an attachment to this notice) ☒	IES Order Number	152725-1	Method 2 (other source) ☐	
Enter Attachment filename for Part I, Section B, 2. c.			CAS - Inventory Expert Service (2010) #1 (public).pdf ☐	
d. The currently correct Chemical Abstracts (CA) name for the polymer that is consistent with TSCA Inventory listings for similar polymers. ☒				
XXX				
CAS Registry Number (if a number already exists for the substance)			XXX	

Figure 2. "Sanitized" premanufacture notice for chemicals with EPA case numbers P-11-0091, P-11-0092, P-11-0093 showing that the chemicals' submitter withheld the chemicals' Chemical Abstracts Service registry numbers – the surest identifier for a chemical's identity – as confidential.

The acronym PBT stands for (P) persistent, (B) bioaccumulative, and (T) toxic.²⁶ EPA did not answer a question sent via email by PSR about the circumstances in which the substances described in the premanufacture notice might be incompletely incinerated.

In discussing PFOA, to which EPA regulators had likened the degradation products of the three chemicals, the regulators added that

toxicity studies on PFOA indicate developmental, reproductive and systemic toxicity in various species. Cancer may also be of concern. These factors, taken together, raise concerns for potential adverse chronic effects in humans and wildlife."²⁷

EPA also expressed significant health concerns in its health and ecological hazard assessment. The agency wrote:

For the potential incomplete incineration/environmental degradation product, based on the test data for the analogue [REDACTED], concerns are liver toxicity, blood toxicity, and male reproductive toxicity....There is also

RECORDS [CONTINUED]

concern for immunosuppression and oncogenicity based on data for [REDACTED].²⁸

On November 29, 2011, the undisclosed company that had requested the approval of the three new chemicals began importing one of the chemicals for commercial use, the one known by EPA case number P-11-0091, according to a document filed with EPA.²⁹ (The related chemicals, P-11-0092 and P-11-0093, have not been used commercially.³⁰) An additional EPA record shows that chemical P-11-0091 may have been used in oil and gas wells, among other uses, at least as recently as 2018.³¹

Search of Fracking Database Indicates Use of PFAS in Oil and Gas Operations

To determine if the chemical known as P-11-0091 had been used in oil and gas operations, PSR searched for “fluorinated acrylic alkylamino copolymer,” the chemical’s generic name, in a publicly available online database of well-by-well fracking chemical disclosure maintained by FracFocus, a nongovernmental organization run by the Groundwater Protection Council and the Interstate Oil and Gas Compact Commission. The database, which began operating in 2011, contains records on the hydraulic fracturing chemicals used in thousands of wells across the nation. Twenty-five states require or allow reporting of hydraulic fracturing chemicals to the database.³² Companies in states in which reporting to FracFocus is not required can, and sometimes do, report hydraulic fracturing chemical use voluntarily to FracFocus. The database can be searched for chemicals used across multiple wells.³³

While PSR did not find any uses of “fluorinated acrylic alkylamino copolymer,” we did find chemicals with related names had been used to fracture more than 1,200 wells primarily in Texas but also in Arkansas, Louisiana, Oklahoma, New Mexico, and Wyoming between 2012 and 2020. The most frequent use occurred prior to 2016. Chemicals with related names included:

- fluorinated benzoic salts
- Fluoroalkyl Alcohol Substituted Polyethylene Glycol

- fluoro surfactants – proprietary
- meta-Perfluorodimethylcyclohexane
- Perfluoro-1,3-dimethylcyclohexane
- nonionic fluorosurfactant (and multiple misspellings of the same term)

A variety of evidence shows that these chemicals are or could be PFAS and/or PFAS precursors. EPA lists two of the chemicals, meta-Perfluorodimethylcyclohexane and Perfluoro-1,3-dimethylcyclohexane, in the agency’s “Master List of PFAS Substances.”³⁴ According to two chemical experts, both of whom are authors of multiple peer-reviewed articles about chemicals related to oil and gas production,³⁵ all of the chemicals are PFAS or could degrade into PFAS. The two experts are Zacariah Hildenbrand, a research professor in Chemistry and Biochemistry at the University of Texas at El Paso, and Kevin Schug, Shimadzu Distinguished Professor of Analytical Chemistry at the University of Texas at Arlington.³⁶ In addition, Wilma Subra, who has a master’s degree in chemistry and is a recipient of a John D. and Catherine T. MacArthur Foundation “Genius” Grant for her work helping to protect communities from toxic pollution, identified all of the chemicals as potentially PFAS. Subra, based in Louisiana, has spent decades working to reduce and remediate pollution from oil and gas operations.³⁷ And yet another expert, Linda Birnbaum, a board-certified toxicologist and former director of the National Institute of Environmental Health Sciences, informed PSR that all of the chemicals are likely to be PFAS.³⁸

Are any of these chemicals in the FracFocus database the “fluorinated acrylic alkylamino copolymer” approved by EPA? Each of the four chemical and health experts said that was a possibility. However, it is impossible to know conclusively without having the precise identifier, known as a CAS number, both for the EPA-approved chemical and for the chemicals listed in the FracFocus records. CAS numbers are unique numeric identifiers assigned to each chemical by the American Chemical Society. They are the most accurate way

to identify chemicals, because a chemical can have multiple names or trade names but only one CAS number.³⁹

Major Oil and Gas Companies Likely Used PFAS and/or PFAS Precursors

According to the publicly available data in the FracFocus database, more than 130 oil and gas companies reported using the chemicals that, according to experts and EPA's list of PFAS substances, are or could be PFAS and/or PFAS precursors. These companies include some of the most prominent producers of oil and gas. Among them:

- XTO Energy Inc., a subsidiary of ExxonMobil, one of the world's largest oil and gas producers, disclosed using one of the chemicals, nonionic fluorosurfactant, in 78 wells in New Mexico, Oklahoma, and Texas between 2013 and 2019.
- Chevron Corp., another major producer, reported using nonionic fluorosurfactant in 38 wells in New Mexico and Texas in 2013 through 2015.
- Anadarko Petroleum Corp., reported using nonionic fluorosurfactant in eight wells in Texas in 2013-2014. Anadarko was the co-owner, along with BP, of the

Macondo well that spewed millions of gallons of oil into the Gulf of Mexico in 2010.⁴⁰

- EOG Resources, Inc., one of the largest oil producers from shale deposits in the U.S.,⁴¹ reported using fluoroalkyl alcohol substituted polyethylene glycol in 99 wells in New Mexico and Texas from 2012-2014 as well as nonionic fluorosurfactant in one well in Texas in 2014.
- Encana Corp., once one of Canada's largest oil companies, disclosed the use of nonionic fluorosurfactant in four wells in Texas in 2014-2015. Encana moved its corporate headquarters to the U.S. in 2020 and changed its name to Ovintiv.⁴²

The table below shows a sampling of wells fractured by these five companies and the estimated maximum amount, in pounds, of chemicals that may be PFAS used in each well.

Each chemical in the table comprises a tiny percentage of the total amount of hydraulic fracturing fluid injected into each well – in one case as small as 0.00016 percent of the total.⁴⁴ However, because oil and gas companies can inject millions of gallons of hydraulic fracturing fluid into each of their wells, small percentages can add up to hundreds of pounds of chemicals or more. When chemicals are as

Examples of Apparent PFAS Chemicals and/or PFAS Precursors Utilized in Hydraulic Fracturing						
Company	Well Number	State	County	Year	Potential PFAS Used in Well	Estimated Maximum Amount (lbs)
XTOEnergy/ExxonMobil	35-019-26303	OK	Carter	2019	Nonionic Fluorosurfactant	17.60
XTOEnergy/ExxonMobil	35-019-26301	OK	Carter	2019	Nonionic Fluorosurfactant	27.41
Encana (Ovintiv)	42-461-39585	TX	Upton	2015	Nonionic Fluorosurfactant	31.98
EOG Resources, Inc.	30-025-42387	NM	Lea	2015	fluoroalkyl alcohol substituted polyethylene glycol	114.63
EOG Resources, Inc.	30-025-42386	NM	Lea	2015	fluoroalkyl alcohol substituted polyethylene glycol	120.07
Encana (Ovintiv)/Athlon	42-173-36707	TX	Glasscock	2014	Nonionic Fluorosurfactant	324.87
Chevron	42-105-36572	TX	Crockett	2014	Nonionic Fluorosurfactant	25.25
Chevron	42-105-39233	TX	Crockett	2014	Nonionic Fluorosurfactant	23.23
Anadarko	42-105-40668	TX	Crockett	2013	Nonionic Fluorosurfactant	108.10
Anadarko	42-105-40818	TX	Crockett	2013	Nonionic Fluorosurfactant	8.94

Table 1. The estimated maximum amount of chemicals that may be PFAS, in pounds, used by five different oil and gas companies to hydraulically fracture selected wells in New Mexico, Oklahoma and Texas between 2013 and 2019. For a detailed explanation of the calculations in the table, see the endnote.⁴³

RECORDS [CONTINUED]

toxic as PFAS can be, even small quantities could cause extensive contamination through multiple pathways. “There’s a potential for [PFAS] to contaminate a huge amount of water or soil or sediment if it were to spill on the surface,” said chemist Subra in a telephone interview, noting that the amounts of potential PFAS in the table could pose a risk. “It doesn’t take much to be present in those media to be a threat to health.”⁴⁵

In most cases, the declared uses of the chemicals in FracFocus were not much more specific than the generic name offered. Hundreds of uses were listed as some type of surfactant, including “fluoro surfactant” and “water recovery surfactant.”⁴⁶ According to EPA:

surfactants are substances that lower the surface tension of a liquid, the interaction at the surface between two liquids (called interfacial tension), or that between a liquid and a solid. Surfactants may act as detergents, soaps, wetting agents, degreasers, emulsifiers, foaming agents and dispersants.⁴⁷

FracFocus also reflected a handful of other uses, including the use of “meta-Perfluorodimethylcyclohexane” as a tracer. It was injected in four wells in Sublette County, Wyoming in 2015 and 2016.⁴⁸ Tracers are used to help oil and gas companies infer information about underground formations.⁴⁹ EPA documents disclosed in November 2020 show that PFAS have been proposed for use as tracers.⁵⁰

PFAS May Have Been Used for Decades in Oil and Gas Operations

Two sources suggest that the use of PFAS in oil and gas operations dates back decades and involves the use of the chemicals in a range of extraction techniques. The authors of a paper published in 2020 in the peer-reviewed journal *Environmental Science: Processes and Impacts* found that more than 50 PFAS have been used or proposed to be used to extract oil and gas, based on public records dating to 1956 that include patents, journal articles, and databases. The authors cautioned that they were not able to verify the information they found, but the records indicate that PFAS have been used to extend underground fractures, to increase

the permeability of underground formations, to make the surfaces of underground oil-bearing reservoirs water- and oil-resistant, and as foaming agents.⁵¹

In a 2008 paper in *The Open Petroleum Engineering Journal*, two authors, including at least one from Dupont, wrote that:

while fluorosurfactants have been used in gas and oil exploration for four decades, the increased demand for petroleum and the greater understanding of the benefits of fluorosurfactants have led to growing acceptance for fluorosurfactants throughout the petroleum industry.⁵²

The authors did not explicitly say that fluorosurfactants were PFAS, but they wrote that “the use of fluorosurfactants is a recent but growing trend due to (i) the exceptional hydrophobic and oleophobic nature of the perfluoroalkyl and perfluoroalkyl ether groups...”⁵³ Thus, at least some of the fluorosurfactants mentioned in the article appear to be PFAS. Furthermore, the article indicated that use of fluorosurfactants was growing and, referring to them as an “emerging technology,” said that fluorosurfactants showed promise in a variety of extraction techniques including fracking, drilling, and waterflooding.⁵⁴ Like the authors in the 2020 paper in *Environmental Science: Processes and Impacts*, the authors noted that they relied mostly on patents and laboratory models “vs actual oil and gas recovery experiments.”⁵⁵

OIL AND GAS CHEMICALS CAN POSE SERIOUS HEALTH RISKS

Shedding light on the use or possible use of PFAS in oil and gas extraction is important because, for years, people living near oil and gas operations have experienced contaminated water and serious illnesses that they believe are related to the chemicals associated with these activities.⁵⁶ During the 2000s, these concerns intensified as oil and gas companies moved into more heavily populated areas to drill so-called unconventional formations such as coalbed methane and shale.⁵⁷ To reach the new deposits, the companies have used hydraulic fracturing, often combined with horizontal drilling.⁵⁸

As previously discussed, chemicals are injected into oil and gas wells as an integral part of the fracking process. They are also used during drilling, which precedes fracking. During drilling, companies bore deep holes in the earth; these holes typically pass directly through groundwater. Chemicals can be injected in this stage of the process to help keep the drill bit cool and to lift rock cuttings out of the well,⁵⁹ and at this point in the process, no protective structures are in place to keep those chemicals from entering groundwater. Following drilling and fracking, a portion of the water, sand and chemicals injected into oil and gas wells during fracking, as well as naturally occurring contaminants such as carcinogenic benzene⁶⁰ and radium,⁶¹ flow out of the well in the form of wastewater.⁶² Wastewater can reach volumes of millions of gallons per well.⁶³

Use of PFAS in oil and gas operations would add a highly potent substance to an already long list of toxic chemicals associated with oil and gas extraction. In 2016, EPA published a study of fracking and drinking water that identified 1,606 chemicals used in fracking fluid and/or found in wastewater. While the agency found high-quality information on health effects for only 173 of these chemicals, that information was troubling. EPA found that “health effects associated with chronic oral exposure to these chemicals include carcinogenicity [for both benzene and radium], neurotoxicity, immune system effects, changes in body weight, changes in blood chemistry, liver and kidney toxicity, and reproductive and developmental toxicity.”⁶⁴ Chemicals used in the drilling stage can also pose health risks, including developmental toxicity and the formation

of tumors, according to EPA regulators.⁶⁵ A disclosure form filed with the state of Ohio, perhaps the only state to require disclosure of drilling chemicals, shows that Statoil, Norway’s state oil company since renamed Equinor, has used neurotoxic xylene in drilling.⁶⁶

The lack of high-quality health testing data for the other 1,400-odd chemicals identified by EPA does not necessarily mean that they are safe; it might simply mean that they have not been adequately tested. The federal Toxic Substances Control Act (TSCA) has likely contributed to these gaps because it has not required health testing for new chemicals. According to Congress’ investigative arm, the Government Accountability Office, chemical manufacturers have often avoided such testing, and EPA often has not asked for it despite having the authority to do so.⁶⁷ Congress updated TSCA in 2016 to strengthen EPA’s authority to ask for health testing,⁶⁸ but according to the Environmental Defense Fund, the Trump administration EPA failed to use this improved authority.⁶⁹ Separately, EPA noted that its list of chemicals associated with fracking was likely incomplete because chemical manufacturers treat many chemicals used in oil and gas drilling as trade secrets, as permitted by TSCA.⁷⁰

A new health concern related to PFAS and its use or possible use in oil and gas operations is that the chemicals could compromise the effectiveness of vaccines for COVID-19. The U.S. Centers for Disease Control and the Agency for Toxic Substances and Disease Registry issued the following statement in June 2020:

CDC/ATSDR understands that many of the communities we are engaged with are concerned about how PFAS exposure may affect their risk of COVID-19 infection. We agree that this is an important question....CDC/ATSDR recognizes that exposure to high levels of PFAS may impact the immune system. There is evidence from human and animal studies that PFAS exposure may reduce antibody responses to vaccines [citations omitted], and may reduce infectious disease resistance [citation omitted]. Because COVID-19 is a new public health concern, there is still much we don’t know. More

HEALTH RISKS [CONTINUED]



Figure 3 shows an example of a spill of fracking fluids. The photo is from the U.S. Environmental Protection Agency and shows a fire on June 28-29, 2014 at the Eisenbarth Well operated by Statoil (since renamed Equinor) in Monroe County, Ohio. The photographer is not listed.⁷⁴ According to an EPA report, trade secret fracking chemicals along with other chemicals were spilled because of the fire. Fluids that may have contained the trade secret chemicals ran off the well pad into a tributary of the Ohio River. An estimated 70,000 fish died.⁷⁵

research is needed to understand how PFAS exposure may affect illness from COVID-19.⁷¹

Multiple Potential Pathways to Human Exposure

EPA and others have identified multiple pathways through which people could be exposed to the chemicals associated with oil and gas extraction including, potentially, PFAS. The agency indicated that any chemicals used during the first stage of the drilling process would be highly likely to leach into groundwater because during this stage, drilling passes directly through groundwater zones⁷² before any casing or

cement is placed in the well to seal it off from surrounding aquifers.

EPA found that during the fracking phase that follows drilling, exposure pathways could include:

- spills of fracking fluid that seep into groundwater;
- injection of fracking fluid into wells with cracks in the casing or cement, allowing the fluid to migrate into aquifers (much of the fracking fluid can remain underground);

- injection of fracking fluids directly into groundwater;
- underground migration of fracking fluids through fracking-related or natural fractures;
- intersection of fracking fluid with nearby oil and gas wells, and
- spills of wastewater after the fracking process is completed, and inadequate treatment and discharge of fracking wastewater to surface water supplies.⁷³

Additional potential pathways of concern involve wastewater. These include intentional dumping of fracking wastewater into waterways,⁷⁶ spreading wastewater on roads to suppress dust or melt snow and ice,⁷⁷ and the use of wastewater for irrigation of agricultural crops.⁷⁸ In addition to these intentional uses, underground leaks can occur from underground injection wells into which well operators have pumped billions of gallons of drilling and fracking wastewater for disposal.⁷⁹ This injected wastewater is intended to remain in underground formations permanently but has been known to leak and pollute groundwater.⁸⁰ In addition, drilling and fracking chemicals can become airborne at oil and gas sites through various routes⁸¹ including by volatilizing from huge ground-level pools of wastewater⁸² or from tanks that store condensate, a naturally-occurring liquid associated with gas.⁸³

The toxic and secret chemicals used in drilling and fracking can also pose a risk not only to people living near oil and gas production wells in relatively rural areas but also to people living near wastewater disposal sites, especially underground injection wells;⁸⁴ in densely populated areas with oil and gas drilling, such as Los Angeles;⁸⁵ and in urban areas downstream from fracking or wastewater disposal activity.⁸⁶ In 2019, New Jersey governor Philip D. Murphy called for a ban on fracking and the disposal of fracking wastewater in the Delaware River Basin, a multi-state watershed that provides drinking water for more than 13 million people and encompasses parts of Pennsylvania that could be drilled for gas.⁸⁷ “As noted by the Environmental Protection Agency in its 2016 report on the impact of fracking on water resources,”

Murphy wrote:

the ability of regulatory agencies to assess the full impacts of fracking wastes on public health and the environment is hampered by the prevalence of confidentiality claims that prevent disclosure of the chemical constituents of fracking fluids...Therefore, prohibiting all fracking activity in the Basin is vital to avoid injury and preserve the waters of the Basin and protect public health.⁸⁸

In February 2021, the Delaware River Basin Commission, of which Murphy is a member, banned fracking in the Basin, citing in part the risks of chemicals associated with the process.⁸⁹ The decision made permanent a de facto moratorium on fracking that the commission had maintained for more than 10 years.⁹⁰ The commission said that by September 30, 2021 it would propose amendments to its rules regarding the importation of fracking wastewater into the basin and export of freshwater from the Basin.⁹¹

Evidence of Harm to Human Health from Oil and Gas Operations

Residents living near oil and gas operations have increasingly reported illnesses that they believe are related to chemical exposures, while expressing frustration about the secrecy surrounding many of the chemicals used by the oil and gas industry.⁹² In 2020, Pennsylvania’s Attorney General issued a report based on a criminal grand jury investigation of oil and gas drilling pollution in the Keystone State, where drilling for gas in shale formations has surged over the past 15 years.⁹³ That surge has vaulted Pennsylvania into the number two spot among gas-producing states (Texas is number one)⁹⁴ and brought thousands of Pennsylvanians into contact with gas drilling and its impacts. Based on testimony from over 70 households, the attorney general found that

Many of those living in close proximity to a well pad began to become chronically, and inexplicably, sick. Pets died; farm animals that lived outside started miscarrying, or giving birth to deformed offspring. But the worst

HEALTH RISKS [CONTINUED]

was the children, who were most susceptible to the effects. Families went to their doctors for answers, but the doctors didn't know what to do. The unconventional oil and gas companies would not even identify the chemicals they were using, so that they could be studied; the companies said the compounds were “trade secrets” and “proprietary information.” The absence of information created roadblocks to effective medical treatment. One family was told that doctors would discuss their hypotheses, but only if the information never left the room.⁹⁵

In addition to these and other self-reported or anecdotal reports, peer-reviewed studies of people living near oil and gas operations provide scientific evidence of illnesses and other health effects. A 2019 study in the journal *Environment International* examined 3,324 babies born in Colorado between 2005 and 2011 and found that, compared with control groups, congenital heart defects were 1.4 and 1.7 times more likely in babies born to mothers in areas of medium and high unconventional gas drilling, respectively.⁹⁶ A 2018 study in the *Journal of Health Economics* found that babies born between 2003 and 2010 to Pennsylvania mothers living near a functioning shale gas well had a higher incidence of low birth weight compared to babies born of mothers living near a permitted well that had not yet gone into production.⁹⁷ Low birthweight is a leading contributor to infant death in the United States.⁹⁸ A 2017 study in *PLOS One* of Coloradans between birth and 24 years old diagnosed with cancer between 2000 and 2013 found that those between the ages of five and 24 were more than four times more likely to live in areas of heavy oil and gas drilling, compared to controls.⁹⁹ In 2019, Pennsylvania-based FracTracker Alliance conducted a meta-analysis of 142 health studies published between 2016 and 2018 focusing on health impacts of unconventional oil and gas development (UOGD). The analysis concluded, “The results of this study indicate that a variety of health impacts in every major organ system are being experienced by individuals living near UOGD.” Specific health effects included cancer, early infant mortality, pre-term birth, and poor infant health.¹⁰⁰ The Southwest Pennsylvania

Environmental Health Project,¹⁰¹ and PSR and the Concerned Health Professionals of New York,¹⁰² have likewise compiled the substantial and growing number of scientific studies that have found serious health effects associated with oil and gas drilling.

Disadvantaged Communities Bear Disproportionate Oil and Gas Exposure Risks

“Fenceline” communities – people living adjacent or close to oil and gas operations – often bear a disproportionate risk of exposure to drilling and fracking chemicals. And although drilling and fracking take place in the majority of U.S. states, not everyone shares in that risk equally. Rather, oil and gas infrastructure and associated chemicals are frequently located in or adjacent to poor, underserved, and marginalized communities, indigenous communities, and communities of color.¹⁰³ For example, a 2019 analysis conducted in Colorado, Oklahoma, Pennsylvania, and Texas found strong evidence that minorities, especially African Americans, disproportionately lived near fracking wells.¹⁰⁴ A separate study focusing on West Virginia, Ohio, and Pennsylvania found that in Pennsylvania, a higher concentration of unconventional gas wells are located in lower-income communities, and that localized clusters of vulnerable populations are exposed to high levels of well density in all three states.¹⁰⁵ A study of census tract data in western Pennsylvania shows that among nearly 800 gas wells, only two were drilled in communities where home values exceeded \$200,000.¹⁰⁶ And a study published in 2018 found that oil and gas wastewater injection wells in Ohio were disproportionately located in rural, lower-income areas.¹⁰⁷

Various population sectors are more vulnerable than others to harm from chemical exposure. This includes pregnant women; the young, whose vital organs are still in development; people with preexisting medical conditions; the elderly; and those who live where pollutants from multiple sources combine to create a high cumulative load of toxic exposures.¹⁰⁸ Where vulnerable populations also have limited access to health care, their health risks are magnified. In short, the health disparities that already exist in U.S. society combine with proximity to oil and gas operations to impose a disproportionate health burden on the poorest, the

sickest, the young, the elderly, and people of color.

Also at high risk are oil and gas field workers and waste handlers and first responders. Industry workers who may handle or otherwise be exposed to fracking-related chemicals may not have the personal protective equipment needed to shield them from exposure, much less the training necessary to take protective or remedial measures.¹⁰⁹ The same is true for first responders called to an emergency at a site of oil and gas operations. Confidential business information or trade secret claims may hide from them the identity and effects of the chemicals they may be exposed to, leaving them unable to determine how potentially dangerous chemicals should be handled or contained.¹¹⁰

Other Experts Voice Concern about Exposure to PFOA-like Substances

The possibility that people could be unknowingly exposed to PFAS in oil and gas extraction is of concern to other specialists, including experts in toxic exposure and other scientists. Toxicologist David Brown, who has investigated health effects associated with unconventional gas drilling with the Southwest Pennsylvania Environmental Health Project, has suggested two likely pathways to human exposure for PFAS chemicals that could occur in oil and gas extraction: 1) through air, when gas is burned off during flaring, or 2) through the use of contaminated groundwater for bathing, cooking, drinking or washing laundry, which would allow chemicals in the water to be ingested or to be inhaled if the chemicals were to volatilize (evaporate or disperse as a gas) inside the home. “Anything injected down the well will come back up,” said Brown, who also served on a panel that advised the state of Massachusetts Department of Environmental Protection Office of Research and Standards on development of drinking water standards for PFAS. “People will get exposed.” He added that the risks could be significant. “PFAS compounds are sequestered in the body for long periods after ingestion, leading to long-term but undefined health risks. Individuals and communities need to be aware of the presence of such chemicals so that they can take protective action.”¹¹¹

Silverio Caggiano, who retired in June 2021 as Battalion Chief and hazardous materials expert with the Youngstown,

Ohio Fire Department, expressed dismay that the federal government and state governments would act to protect firefighters and the public from PFAS in some ways, but leave them at risk in other ways. He noted that both EPA and the U.S. Fire Administration, a division of the Federal Emergency Management Agency, have issued warnings and initiatives to discontinue the use of old Aqueous Film Forming Foam (AFFF), used to fight fires for years, and to dispose of it properly because it can contain PFAS.¹¹² Yet at the same time, government agencies have failed to acknowledge the potential use of PFAS in association with oil and gas wells. “Fire departments around the country are scrambling to extract any of this older AFFF from their inventories,” he said,

yet when firefighters and first responders are called to a frac well incident, the governments both state and federal act as if this chemical danger doesn’t exist on-site. It makes one wonder who the EPA would cite for contamination if a fire department used old PFAS-containing AFFF to put out a well fire that had PFOA-style chemicals on-site. These games have to end. The jobs of firefighters are dangerous enough without the continuous shell game the chemical industry and regulators play with toxic chemicals.¹¹³

Robert Delaney, a geologist who until his retirement in November 2020 led an initiative for the Michigan PFAS Action Response Team to address contamination of PFAS at U.S. Department of Defense sites in the state, said that communities should be very concerned about the use of PFAS in oil and gas drilling. Delaney spent 36 years working in natural resource protection for the state of Michigan and first warned state officials about the looming problem with PFAS in 2012, though unrelated to oil and gas extraction.¹¹⁴ PFAS, he said,

disperses all over, it doesn’t break down, and the levels at which it is dangerous are so, so low. It becomes an enormous problem. I call it a nightmare contaminant. I used to think that benzene, TCE (trichloroethylene), polyvinyl chloride were the really nasty ones to deal with, and then I saw these.¹¹⁵

HEALTH RISKS [CONTINUED]

Delaney also noted that cleaning up water contaminated with PFAS is expensive if any significant volume is involved, because the water must be run through activated carbon, the same material in Brita filters. The amount of activated carbon needed would be vast and could cost millions of dollars, as it has in the ongoing effort to remove PFAS from drinking water at Michigan's Wurtsmith Airforce Base. And after the activated carbon fills up with PFAS and any additional contaminants in the water, it must be disposed of somewhere. "Part of the problem is landfills won't take it because they don't know how much liability they're taking on" if PFAS waste were to contaminate the landfill, Delaney observed.

As of 2020, Michigan was trying to clean up groundwater at 137 sites that exceed its new standards for PFAS pollution. "There are a lot of sites in Michigan because we are looking," Liesl Clark, director of the Michigan Department of Environment, Great Lakes and Energy told the Detroit Free Press. "If other states were doing the same sorts of work, they would be finding a similar challenge — and some states are."¹¹⁶

Carol Kwiatkowski, former Executive Director of The Endocrine Disruption Exchange, the first organization to catalogue the health effects of chemicals used in oil and gas drilling and fracking, said in an email to PSR that

current efforts to address the problem of PFAS contamination focus on waste incineration or filtering of drinking water. Neither process is 100% effective, nor do they clean up the PFAS that have polluted large river systems or the air. In other words, there is no effective way to remove them.

Kwiatkowski, who is currently Science and Policy Senior Associate at the Green Science Policy Institute, added that "the most effective solution is to stop their use and production as quickly as possible, except for uses where they are absolutely necessary, for example in medical equipment."¹¹⁷ PSR concurs.

EPA OK'D PFAS-RELATED CHEMICALS FOR OIL AND GAS DESPITE RISKS

For years, attorney Bilott, environmentalists, and even the state government of Michigan have raised concerns that EPA was not adequately protecting the public from PFAS pollution.¹¹⁸ EPA's approval of three chemicals for use in oil and gas operations that regulators believed could degrade into PFOA-like substances raises additional concerns about the agency's commitment to protecting people and the environment from dangerous substances.

By the time EPA regulators reviewed the chemicals P-11-0091, P-11-0092, and P-11-0093 in 2010, the agency would have had a firm basis for concern about chemicals that could degrade into PFOA-like substances. It was already well-known that PFOA and PFOS (used to make Scotchgard) were extremely harmful. In 2004, Dupont had settled Bilott's lawsuit alleging PFOA-related harm for \$70 million, plus promises to pay for water filtration and the scientific study that in 2011 found serious health impacts related to PFOA.¹¹⁹ In 2005, EPA reached a then-record \$16.5 million settlement with Dupont after accusing the company of violating TSCA by failing to disclose information about PFOA's toxicity and presence in the environment.¹²⁰ In 2006, EPA invited Dupont, 3M and six other companies to join a "stewardship" program in which the companies promised to achieve a 95 percent reduction of emissions of PFOA and related chemicals by 2010, compared to a year 2000 baseline. The agreement also required the companies to phase out manufacture and use of PFOA by 2015.¹²¹ In 2021, EPA says on its website that the companies reported that they had accomplished the goals either by exiting the PFAS industry or by transitioning to alternative chemicals.

Manufacture and importation of PFOA itself has ceased, though there could still be some PFOA use from existing stocks, and it could be contained in imported items.¹²² However, since the announcement of its PFAS stewardship program in 2006, EPA has allowed multiple new PFAS to be used commercially.¹²³ And in 2015, a group of more than 200 scientists raised health and environmental concerns that the new short-chain PFAS designed to replace PFOA and PFOS may not be safer for health or the environment.¹²⁴ These "replacement" substances may include the parent chemical

or the breakdown products discussed in this report.

Dupont Was the Likely Importer of Chemical P-11-0091

Beyond the health risks of PFOA, EPA should have been troubled by the likely importer of the new chemicals proposed for use in oil and gas operations: Wilmington, Delaware-based Dupont. This tentative identification is based on the EPA-issued "accession number" that was issued for the chemical P-11-0091 that went into commercial use. When EPA receives a notice (called a "notice of commencement") that a chemical is going to be imported or manufactured for commercial use and the chemical's identity is hidden from the public as confidential business information, the agency assigns the chemical an accession number. This number allows the public to find the chemical on the TSCA inventory, a list of existing chemicals in commerce, without learning the chemical's specific identity.¹²⁵ The accession number also allows the public to search for data about the chemical submitted by chemical manufacturers and importers every four years under TSCA's Chemical Data Reporting rule. These data provide EPA and the public with some information about the use of chemicals in commerce in each of the four years preceding the submission year.¹²⁶

Using the accession number – 277420 – that was issued to chemical P-11-0091, PSR searched online data filed in 2016 that provided information on use of this chemical during each of the years 2012 through 2015. The company listed as having imported or manufactured the chemical from 2012 through 2015 was Wilmington, Delaware-based Chemours. There was, however, a puzzling discrepancy: The Chemours company did not exist until July 1, 2015, when it was created by Dupont as a spinoff company that would manufacture "performance chemicals."¹²⁷ Under that timeline, Chemours could not have been reporting on its own chemicals until the second half of 2015. What company, then, was manufacturing or importing the chemical from 2012 until mid-2015?

We believe there is an explanation to be found under EPA reporting guidance. The guidance provides that when a manufacturing division of a company is separated from

EPA OK'D [CONTINUED]

a parent company to become an independent entity, yet continues to manufacture or import the same substances it did previously, it retains the responsibility for reporting the manufacture or importation of those substances over a four-year reporting period, including the manufacturing or importing that it did while a unit of the parent company.¹²⁸ According to at least two different articles in a chemical industry trade publication, Chemours took over what used to be Dupont's performance chemical business – one that included fluorochemicals,¹²⁹ a class that would encompass the chemical with case number P-11-0091 and/or its PFOA-like breakdown products. As the successor of the division of Dupont that manufactured or imported fluorochemicals, Chemours in 2016 would have had a duty under EPA's guidance to report fluorochemicals under its own name that were previously made or imported by Dupont in 2012, 2013, 2014, and for the first half of 2015. The chemical with case number P-11-0091 and accession number 277420 apparently qualified as one of these chemicals.

An alternate explanation could be that Chemours was reporting a chemical previously made by or imported by a company other than Dupont that had merged with, or been acquired by, Chemours. In this scenario, EPA's guidance states that if the other company had ceased to exist following the merger or acquisition, Chemours would have had the duty to report on behalf of the previously separate company.¹³⁰ However, Chemours' Form 10-K filed with the U.S. Securities and Exchange Commission in 2016 does not reflect any mergers and acquisitions involving Chemours in the first half-year of its existence (the second half of 2015).¹³¹ It is therefore likely that it was Dupont and not some other company that originally sent notice to EPA in November 2011 that it was importing chemical P-11-0091. It is also likely that Dupont continued to import or manufacture the chemical through at least July 2015, when Chemours became a separate company.¹³² In February 2021, PSR wrote to Dupont via FedEx delivery service and to Chemours via certified U.S. mail, sharing details of our investigation and asking the companies, among other things, whether Dupont was the original importer of chemical P-11-0091. PSR did not receive a response from either company.)

The likely scenario that Dupont originally imported and/

or manufactured the chemical P-11-0091 should concern the public because Dupont has a history of harming people and polluting the environment with PFOA while withholding knowledge of PFOA's risks.¹³³ As is discussed above, the company in the past failed to communicate to the public the risks of PFOA, and widespread pollution occurred before people and regulators could act to protect themselves. PSR is concerned that a similar result could occur with chemical P-11-0091.

Dupont's likely involvement with chemical P-11-0091, and Chemours' documented involvement, also raise concerns about significant financial damages. In creating Chemours as a separate company, Dupont made Chemours responsible for hundreds of millions of dollars of what was previously Dupont's liability related to PFOA.¹³⁴ In 2019, Chemours sued its own parent company, alleging that Dupont had understated how much liability Chemours would be responsible for. Chemours has already paid hundreds of millions of dollars to settle PFOA-related damage claims against Dupont,¹³⁵ and Dupont itself has agreed to pay hundreds of millions of dollars to settle such claims. Could significant financial damages be associated with chemical P-11-0091 as well?

EPA Regulation of the Chemical Was Lax

One fact is clear: EPA's regulation of chemical P-11-0091 and the two related chemicals that did not go into commercial use was lax. Despite the agency's own finding that these chemicals could break down into PFOA-like substances, EPA did not issue any requirement that follow-up testing be performed to see if the breakdown of the chemicals took place. Neither did the agency call for tracking to determine where the chemicals were being used, or if these substances were contaminating the environment as the agency had feared. Nor did it require that use of the chemicals be prohibited within a certain distance of drinking water sources, homes, or schools.

EPA told the nonprofit organization Partnership for Policy Integrity in 2016 that it does not track where new chemicals are used when they are reviewed and regulated under TSCA and lacked the staff to test for the new chemicals near water supplies.¹³⁶ PSR asked EPA whether the agency

tracked where chemical P-11-0091 was used, but EPA did not respond. Indeed, there are no regulations or statutes that systematically require EPA to report the locations where a chemical is used after it is approved for commercial use. The chemical data reporting system requires reporting in some cases of the location of facilities where chemicals are manufactured or imported, but not the locations of end uses.¹³⁷ There is no indication that EPA tracked the end uses of chemical P-11-0091. In its consent order, EPA did require the importer to conduct certain tests if the company reached certain production volume or importation thresholds. (These thresholds were redacted.) EPA also required the importer to limit impurities in the chemicals to certain levels, provide EPA yearly reports on impurities in the chemicals, and maintain certain records.¹³⁸ EPA also said that the company would “annually analyze the starting material, [REDACTED] for perfluorooctanoic acid (PFOA).”¹³⁹

EPA’s Decision to Approve Chemicals May Have Relied on Dubious Assumptions

Why did EPA approve the chemicals P-11-0091, P-11-0092, and P-11-0093 for commercial use despite its health concerns? The agency offered no explicit reason, but one indication appears in the consent order the agency issued in 2011: EPA wrote that it believed, based on testing data for redacted substances, that the three chemicals would be less likely than PFOA to bioaccumulate in people.¹⁴⁰

EPA also said that testing data on redacted substances “indicate a different and less toxic profile for [REDACTED] (a presumed environmental degradant of the PMN substances) than for PFOA.”¹⁴¹ It is unclear whether the agency was correct, but without careful testing, there is no guarantee that newer chemicals will be safer than the toxic chemicals they replace. The Chicago Tribune has investigated the use of flame retardants, for example, and has found that after toxic flame retardants such as PCBs and PBBs were replaced in the 1970s by substitute chemicals such as PBDEs, the replacement chemicals were found to have toxic problems of their own. Some of these replacements are now being phased out – in favor of yet another generation of flame retardants that have also been associated with health problems.¹⁴²

Even after suggesting that the new chemicals were less of a health and environmental risk than PFOA, EPA expressed misgivings about approving the substances for commercial use. EPA wrote:

However, based on: (1) the persistence of [REDACTED]; (2) potential intermediate fate products; and, (3) the possibility or likelihood that this substance may be used as a major substitute for some uses of PFOA, EPA believes more information is needed on the toxicity of [REDACTED] and possibly other environmental degradants, and the fate and physical/chemical properties of [REDACTED]-derived or related polymers in the environment.¹⁴³

The agency added, “EPA expects the PMN substances or the degradants to be highly persistent”¹⁴⁴ and that “there is high concern for possible environmental effects from the potential persistent degradation product [REDACTED].”¹⁴⁵

To address these concerns, EPA recommended multiple additional tests: reproductive and long-term toxicological testing in rats, a chronic toxicity/carcinogenicity test in rats, and an avian reproduction test in mallard ducks. However, these tests were not required.¹⁴⁶ PSR has asked EPA for the results of any of these health tests, if indeed they were completed, as well as health testing data submitted with the importer’s premanufacture notice that was not included in the release of public records. While we received health testing data for unidentified substances that may be for chemical P-11-0091 (the chemical identity was redacted), we did not receive any documents showing completion of the tests for reproductive and long-term toxicological testing, chronic toxicity/carcinogenicity, or avian reproduction. The health testing data PSR received did not appear to show alarming results but also did not appear to test for degradation products of the chemicals – despite the fact that the degradation products of chemical P-11-0091 were the focus of EPA’s concern.

Another potential – and unstated – reason for EPA’s approval of the chemicals is that EPA generally assumes in its new-chemical reviews that oil and gas chemicals never

EPA OK'D [CONTINUED]

leak, spill, migrate underground, or are otherwise released into the environment accidentally. This assumption is not explicitly stated. Rather, it is apparent in a set of documents that EPA has used for decades to predict exposures to chemicals used in oil and gas drilling and hydraulic fracturing. As analyzed by Partnership for Policy Integrity in a 2016 report, the documents reveal that the agency assumes that any releases of chemicals into the environment will be intentional and controlled, such as disposal of chemical-tainted wastewater into injection wells that EPA assumes will never leak, and the use of wastewater for agriculture.¹⁴⁷ The only exception we are aware of to the agency's assumption that all releases of chemicals will be intentional and controlled was in a 1994 document which said that "several of the surfactants such as alcohol ethoxylates and alkyl phenol ethoxylates, as well as organic in situ crosslinkers such as formaldehyde, are sufficiently volatile to result in air emissions from their use." The same document says, however, that "releases to water are assumed to be negligible."¹⁴⁸ It is a dubious assumption.

EPA's longstanding assumption that accidental releases of chemicals are essentially nonexistent is contradicted by data from EPA itself. As early as 1987, the agency documented unintended releases of drilling mud, fracking fluid, and wastewater in a report to Congress on oil and natural gas wastes.¹⁴⁹ The EPA highlighted spills associated with fracking in its 2016 report on fracking and drinking water.¹⁵⁰ Also in 2016, in a tacit admission that its assumption was unrealistic, EPA told Partnership for Policy Integrity that it had planned to develop a new exposure scenario that accounted for leaks and spills of fracking chemicals.¹⁵¹ In addition, other public sources show that leaks and spills are common in oil and gas operations. For example, Cabot Oil and Gas Corp., Range Resources Corp., and Noble Energy Inc., have told investors that blowouts, leaks, and/or spills are common risks in oil and gas operations.¹⁵² PSR is not aware that EPA has adopted an updated set of assumptions, but in any event, in 2011, EPA generally did not consider accidental releases of oil and gas chemicals as a pathway of exposure. Making this assumption could have enabled EPA to conclude that human exposure to the chemicals would be limited and thus that there would be minimal harm

even from an extremely toxic chemical. This perspective could have influenced the agency's decision to approve the three chemicals. PSR has asked EPA why it approved the chemicals and if the agency's unrealistic exposure assumptions played a role, but as of end-June 2021, has not received a response.

LOCATING WHERE PFAS CHEMICALS HAVE BEEN USED: AN ONGOING CHALLENGE

As previously stated, PSR was able to locate oil and gas wells where PFAS or potential PFAS were used, at least some of which might be chemical P-11-0091. But confidentiality claims and other hurdles make it extremely difficult for the public to know for certain where this particular chemical or other oil and gas chemicals associated with PFAS have or are being used. As is discussed above, people can search for wells in which fracking chemicals were used through the nongovernmental organization FracFocus.¹⁵³ In addition, California operates its own searchable database for fracking chemicals.¹⁵⁴ The most accurate way to search for chemicals through these databases is by CAS number.¹⁵⁵ Other ways to search are by specific chemical name or trade name, but these are less accurate because a single chemical can have multiple names or trade names, and people conducting a search might be looking under the wrong name. Yet in many cases, as is the case with chemical P-11-0091, all these searches are impossible because the chemical's CAS number, specific chemical name, and trade name are redacted as trade secrets.

Exemptions under state rules provide several additional ways for oil and gas companies or chemical makers to shield from public scrutiny the use of oil and gas chemicals. For example, state rules typically allow well operators to withhold chemical identities from the public as trade secrets, just as chemical manufacturers or importers are allowed to do under federal law. So even if a chemical importer decided to remove CBI protection from the chemical's identity under federal law, a well operator could still assert that the identity was a trade secret under state rules.¹⁵⁶ State rules also typically do not require chemical manufacturers or importers to disclose their chemicals at all.¹⁵⁷ There is some evidence that manufacturers and importers may not provide all their fracking chemical identities to well operators or owners, who bear the burden of public disclosure under state rules.¹⁵⁸ In any case, if chemical manufacturers do not disclose fracking chemicals to well operators or owners, these actors cannot disclose the chemicals to the public.¹⁵⁹ Finally, most state rules do not require public disclosure of chemicals used in the drilling process that precedes fracking.

Therefore, if the chemical P-11-0091 were used for drilling as opposed to fracking, there would be no obligation to disclose the chemical publicly under most state rules. Ohio may be the only exception, although Ohio allows well operators to withhold the identities of drilling chemicals as trade secrets.¹⁶⁰

It may be possible to locate where PFAS chemicals have been used by relying on provisions added to TSCA by Congress in 2016. But even under those provisions, there remain challenges. Some of the added provisions in TSCA enable state and tribal governments, health professionals and first responders to obtain confidential information about chemicals. The provisions also allow disclosure in situations "pursuant to discovery, subpoena, other court order, or any other judicial process otherwise allowed under applicable Federal or State law."¹⁶¹ In many of these cases, entities would have to keep the information to themselves and could use it only for limited purposes such as medical treatment,¹⁶² but there is no explicit prohibition on making the information public as part of judicial processes and in other situations.

However, even if officials were to obtain a PFAS chemical's specific identity, especially its CAS number, there is no guarantee that they could require chemical manufacturers or importers to disclose where the chemical had been used. And even if they could, disclosure after an accident has occurred makes it unlikely that first responders will obtain the information in time to provide appropriate treatment to persons who have been exposed to a dangerous substance. Furthermore, as Youngstown, Ohio Fire Department Battalion Chief Caggiano told Partnership for Policy Integrity in 2019, post-incident disclosure deprives first responders of the ability to plan for a hazardous materials response or prevent serious spread of a dangerous pollutant.¹⁶³ In addition, there is no guarantee that a chemical's CAS number – if obtained through TSCA – would appear in fracking chemical disclosure records, even if the chemical had been used in oil and gas wells. Exemptions previously discussed would enable oil and gas well operators to withhold such information from these state-level disclosures.

Finally, compliance with terms of the updated TSCA

LOCATING [CONTINUED]

might be an issue. Reporter Eliza Griswold wrote in her 2019 Pulitzer Prize-winning book, *Amity and Prosperity*, about residents of western Pennsylvania who had sued well owner Range Resources after suffering health impacts and the deaths of animals that they believed were caused by Range's drilling operations near their homes. The residents requested from Range, among other pieces of information, the full list of chemicals used nearby. Range failed to provide the plaintiffs with a full list despite a court order that was in effect for several years. Range's lack of compliance was likely due in part to the fact that Range did not know some of the trade secret chemicals used by its subcontractors. A judge declined to sanction Range for failing to comply with the order. The inability to obtain the chemical identities made it more difficult for the residents to establish that Range had harmed them and may have influenced two residents to sign a confidential legal settlement that, Griswold wrote, "left both of them feeling angry and defeated."¹⁶⁴ As is suggested by this example, it is possible that oil and gas companies may be unable to comply with some of the provisions of TSCA requiring disclosure of confidential chemical identities. EPA, state government officials, and courts may have to force other companies in the supply chain, particularly chemical manufacturers, to provide this information

RECOMMENDATIONS

Considering the evidence that PFAS substances and/or PFAS precursors are being used in oil and gas wells; given EPA's concerns that a chemical the agency approved for commercial use could degrade into PFOA-like substances that would be toxic, persist in the environment, and bioaccumulate in people's bodies; and in light of the potential that people might be unknowingly exposed to these highly toxic substances, PSR recommends the following:

- **Health assessment.** EPA and/or states should evaluate through quantitative analysis whether PFAS and/or PFAS breakdown products associated with oil and gas operations have the capacity to harm human health. All potential pathways of exposure should be examined, including inhalation, ingestion, and dermal contact.
- **Testing and tracking.** EPA and/or states should determine where PFAS and chemicals that may be PFAS have been used in oil and gas operations and where related wastes have been deposited. They should test nearby water, soil, flora, and fauna for PFAS.
- **Funding and cleanup.** Oil and gas and chemical firms should be required to provide adequate funding for environmental testing and evaluation, and should PFAS be found, for cleanup. If water cleanup is impossible, the companies responsible for the use of PFAS should pay for alternative sources of drinking water.
- **Public disclosure.** Echoing recommendations by Pennsylvania's Attorney General in 2020, governments should require full public disclosure of drilling and fracking chemicals before each oil or gas well can be developed. EPA and/or states should inform communities potentially exposed to PFAS about PFAS contamination risks so that the communities can take actions such as water testing and treatment.
- **Moratorium on PFAS use for oil and gas extraction.** Until testing and investigation are complete, EPA and states should not allow PFAS or chemicals that could break down into PFAS to be manufactured, imported, or used for oil and gas drilling or fracking.
- **Limits on drilling and fracking.** The use of PFAS and of chemicals that break down into PFAS in drilling and fracking should prompt governments to prohibit drilling, fracking, and disposal of related wastewater and solid wastes in areas that are relatively unimpacted by oil and gas pollution, and to increase protections in already-impacted regions. When doubt exists as to the existence or danger of contamination, the rule of thumb should be, "First, do no harm."

ENDNOTES

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1111 14th Street NW, #700
Washington, DC 20005
202 667 4260
www.psr.org
psrnatl@psr.org

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**PHYSICIANS
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FRACKING WITH “FOREVER CHEMICALS” IN COLORADO

Evidence Shows Oil and Gas Companies Have Used PFAS in Colorado Wells;
‘Trade Secret’ Laws Limit Public’s Ability to Know Full Extent of Use

By Dusty Horwitt, J.D.
and Barbara Gottlieb
Data Analysis by Gary Allison
January 2022

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Cover photo by Patricia Nelson. It shows a well pad near Bella Romero Elementary School, Greeley, Colorado. Taken June 6, 2018.

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Erratum: This report was corrected on pages i and 1 to state that the oil and gas wells in Colorado definitively known to have been injected with PFAS are located in 10 counties, with most of that use occurring in Weld County.

EXECUTIVE SUMMARY

Previously unpublicized information unearthed by Physicians for Social Responsibility (PSR) shows that a class of extremely toxic chemicals known as PFAS has been used in Colorado's oil and gas wells since at least 2008. However, gaps in Colorado's disclosure rules prevent the public from knowing how widely PFAS – or other toxic chemicals – have been used in oil and gas drilling and extraction. These findings raise concerns that Coloradans may unknowingly be exposed to highly hazardous substances.

PSR analyzed industry data recorded in FracFocus, the official repository for Colorado's oil and gas chemical disclosure, and found that PFAS have been used in Colorado wells, both for hydraulic fracturing ("fracking") and for a separate extraction technique called enhanced oil recovery. The affected wells are located in 10 Colorado counties, with most of that use occurring in Weld County.

However, the number of definitively identified cases of PFAS use may significantly underrepresent the extent of PFAS use in the state. That is in large part because Colorado law allows oil and gas companies to withhold fracking chemical identities from the public and regulators by claiming them as a "trade secret." Between 2011 and 2021, companies claimed trade secret privileges in more than 12,000 wells across 31 Colorado counties. Furthermore, oil and gas companies in the state are not required to publicly disclose chemicals used in other stages or methods of oil and gas extraction, including the drilling that precedes fracking.

By shielding from public view the chemicals injected into oil and gas wells, these disclosure gaps raise the potential that Coloradans may be exposed to PFAS and other toxic chemicals from hundreds or even thousands of wells.

PFAS have been linked to cancer, birth defects, pre-eclampsia, and other serious health effects. Toxic in minuscule concentrations, they are extremely mobile in groundwater and do not break down in the environment – hence their nickname, "forever chemicals."

Among our key findings are:

PFAS have been used in oil and gas extraction in Colorado. Records in FracFocus document that over the past decade, oil and gas companies used a PFAS known as polytetrafluoroethylene (PTFE), commonly known as Teflon, for hydraulic fracturing in Colorado oil and gas wells. Separately, in 2008, a peer-reviewed oil and gas industry journal showed that a type of PFAS called fluorosurfactants had been used in Colorado.

Trade secrets make it extremely difficult to determine how extensively PFAS (and other highly toxic chemicals) have been used in Colorado. The peer-reviewed journal referenced above said in 2008 that fluorosurfactants have been used for oil and gas extraction "for four decades." Separately, in 2020, a scientific paper indicated that PFAS mixtures known as fluorosurfactants have been used in oil and gas extraction globally since 1956. In a report PSR published in 2021, we found that between 2012 and 2020, oil and gas companies had used PFAS, most of them fluorosurfactants, for fracking in six states. Yet, in examining records for the slightly longer period 2011 to 2021, we found no reports of the use of fluorosurfactants in Colorado. This improbable absence may reflect oil and gas companies' extensive use of trade secret confidentiality claims. Of the 12,000 Colorado wells for which oil and gas firms withheld chemical identities as trade secrets over the past decade, more than 3,200 had been injected with chemicals identified as "surfactants." Some of these may be fluorosurfactants.

PFAS pollution at oil and gas wells in Colorado is possible wherever these substances have been used. Over the past decade, oil and gas companies have reported thousands of spills of chemicals and other fluids at oil and gas wells in Colorado, creating risks for groundwater and surface water pollution. Where PFAS chemicals are used, these spills may contain PFAS. Air emissions from flaring constitute another potential route of PFAS pollution from well sites. Coloradans should be allowed to know where they may be exposed to PFAS.

In light of these findings, PSR recommends the following:

- **Halt PFAS use in oil and gas extraction.** Colorado and EPA should prohibit PFAS from being used, manufactured, or imported for oil and gas extraction. Many PFAS are immediately replaceable with less persistent and less toxic substances, including in the oil and gas industry.
- **Expand public disclosure.** Colorado should greatly expand its requirements for public disclosure of oil and gas chemicals. The state could readily follow the example offered by California, a major oil producer that prohibits the use of trade secret claims for fracking chemicals. Colorado should also require disclosure of other chemicals used in oil and gas drilling and extraction, with no minimums placed on the weight or quantity of the chemicals to be disclosed. The state should also require disclosure from chemical manufacturers.
- **Increase testing and tracking.** Colorado and/or the Environmental Protection Agency should determine

where PFAS have been used in oil and gas operations in the state and where related wastes have been deposited and should test nearby water, soil, flora, and fauna for PFAS.

- **Require funding and cleanup.** Oil and gas and chemical firms should be required to fund environmental testing and evaluation where these are needed, and should PFAS be found, also be required to fund cleanup. If water cleanup is impossible, the companies responsible for the use of PFAS should pay for alternative sources of water for drinking and agriculture, as needed.
- **Limit or ban drilling and fracking.** Given the use of highly toxic chemicals including PFAS in oil and gas extraction, Colorado and local governments should prohibit drilling, fracking, and disposal of related wastes in areas relatively unimpacted by oil and gas pollution and should increase protections in already-impacted regions. When doubt exists as to the existence or danger of contamination, the rule of thumb should be, "First, do no harm."

PFAS: A MANMADE THREAT TO HEALTH

Physicians for Social Responsibility (PSR) has identified evidence from industry sources that a highly dangerous class of chemicals, known as per- and polyfluoroalkyl substances (PFAS), as well as chemicals that could degrade into PFAS, known as PFAS precursors,* have been used in Colorado oil and gas wells** for hydraulic fracturing (“fracking”) and enhanced oil recovery. The wells definitively known to have been injected with PFAS are located in 10 Colorado counties, with most of that use occurring in Weld County. However, the wells PSR was able to identify may significantly underrepresent the extent of PFAS use in the state.

PFAS are a class of thousands of manmade chemicals known for having properties that are valuable in multiple contexts, including being slippery, oil- and water-repellant, and able to serve as dispersants or foaming agents.¹ PFAS have been called “perfluorinated chemicals” and “polyfluorinated compounds,” or PFCs, though the term currently preferred by EPA is PFAS.²

The first PFAS to be sold commercially was created by a chemist at Dupont and was patented as Teflon. Since 1949, it has been used in thousands of products, from nonstick cookware to waterproof clothing to plastics to dental floss.³ Other PFAS chemicals have been used in food packaging,

fire-fighting foam, and in 3M’s widely used fabric protector, Scotchgard.⁴

EPA and other regulators have identified PFAS as a serious threat to health and the environment.⁵ And as early as the 1960s and 1970s, researchers inside Dupont and 3M became aware that the PFAS they were manufacturing or using were associated with health problems including cancers and birth defects, had accumulated in virtually every human being, and persisted in the environment.⁶ Many of these facts, kept internal by the companies, came to light after attorney Rob Bilott filed lawsuits in 1999 and 2001 accusing Dupont of causing pollution in and around Parkersburg, West Virginia with PFOA, a type of PFAS used in making Teflon.⁷ In December 2011, as part of Dupont’s settlement of the 2001 lawsuit, a team of epidemiologists completed a study of the blood of 70,000 West Virginians and found a probable link between PFOA and kidney cancer, testicular cancer, thyroid disease (over- or under-production of hormones by the thyroid gland), high cholesterol, pre-eclampsia (a potentially dangerous complication during pregnancy characterized by high blood pressure and signs of damage to other organ systems, most often the liver and kidneys), and ulcerative colitis (a disease causing inflammation and ulcers in the large intestine or colon).⁸

*Throughout this report, when we refer to PFAS, the term includes PFAS and PFAS precursors.

**Gas, the principal component of which is methane, is also known as “natural” gas, “fossil” gas and “fracked” gas.

PFAS: PERSISTENT IN THE ENVIRONMENT

PFAS are not only highly toxic; they also demonstrate extreme persistence in the environment. PFAS' nickname "forever chemicals" reflects their chemistry, in which hydrocarbon chains of carbon and hydrogen atoms are mixed with hydrofluoric acid. The fluorine atoms in the acid replace the hydrogen atoms in the hydrocarbon chains, forming a bond between fluorine and carbon that is among the strongest in chemistry and rarely if ever exists in nature. The result: chemicals that are extremely resistant to breaking down in the environment.⁹

The U.S. Environmental Protection Agency (EPA) reports that there are currently about 650 types of PFAS in commerce.¹⁰ Weak chemical disclosure laws make it difficult for the Agency to identify which PFAS chemicals are used, and where, in the U.S. Yet evidence has mounted over the years of PFAS's risks and of cases of PFAS pollution from a variety of sources, including in Colorado. In 2019, the Denver Post reported that

Colorado officials estimated more than 100,000 residents have relied on public drinking water systems where elevated PFAS levels have been detected in source wells — more people than in any other state.¹¹

In fact, in 2020, PFAS were detected in every single surface water sample analyzed by the state's Department of Public Health and the Environment.¹²

Concern over PFAS pollution has led ten states, though not Colorado, to develop guidelines for concentrations in drinking water of several types of PFAS.¹³ One of these states is Michigan, which set standards in 2020 for limiting PFAS in drinking water and for removing PFAS from groundwater. The standards applied to PFOA and six other forms of PFAS. Michigan's maximum allowable level is no more than eight parts per trillion for PFOA.¹⁴ By extrapolation, these standards suggest that one measuring cup of PFOA could contaminate almost eight billion gallons of water – six times the 1.3 billion gallons of water used each day by New York City, or the amount of water needed to fill almost 12,000 Olympic-sized swimming pools at about 660,000 gallons per pool.¹⁵ The extreme potency of PFOA, as with other PFAS, indicates why health experts are concerned about even minute quantities of these chemicals.

The use of PFAS in oil and gas production in Colorado has only recently been exposed.¹⁶ The lack of full disclosure of chemicals used in oil and gas operations in Colorado raises the potential that PFAS may have been used more extensively than records indicate, both geographically and in additional methods or stages of oil and gas operations, such as drilling, that precede enhanced oil recovery and fracking.

COLORADO'S DISCLOSURE LAWS SHIELD DANGEROUS CHEMICALS

For years, scientists, advocates and regulators in Colorado and other states have raised concerns about the hundreds of industrial chemicals used in fracking of oil and gas wells including potential threats to water resources and health. The Fort Collins Coloradoan reported in 2014 that “fracking has become a polarizing issue in Colorado, in part due to the number of chemical ingredients that oil companies have kept secret from the public.”¹⁷ PSR’s findings indicate these risks persist in alarming ways, despite rules enacted in 2012 that require public disclosure of fracking chemicals in Colorado.¹⁸

Colorado rules require that well operators disclose their fracking chemicals to FracFocus, a database maintained by the Groundwater Protection Council, a nonprofit comprised of regulators from state agencies, and the Interstate Oil and Gas Compact Commission, which represents governors of oil and gas-producing states as well as some oil-producing countries and the U.S. Department of the Interior.¹⁹ Operators must disclose both the name of chemical products used in fracking, and each individual component chemical used in each product. They must also disclose each chemical’s Chemical Abstracts Service (CAS) number, if available.²⁰ CAS numbers are unique numeric identifiers assigned to each chemical by the American Chemical Society. They are the most accurate way to identify chemicals, as a chemical can have multiple names or trade names but only one CAS number.²¹

This system sounds effective on the face of it; however, an important exception allows companies to avoid full

and meaningful disclosure: The law allows chemical manufacturers, well operators and other companies in the chemical supply chain to withhold exact fracking fluid ingredient information if they deem it a “trade secret.”²² In place of a specific chemical identity, they must publicly disclose a chemical family or similar descriptor in place of the specific identity.²³ Regrettably, the use of a descriptor can hide from public view the true identity of dangerous chemicals. This legal loophole effectively undermines the public health benefits of disclosure by preventing health

professionals, state regulators and the public from knowing where PFAS – or other toxic chemicals – have been used in oil and gas wells.

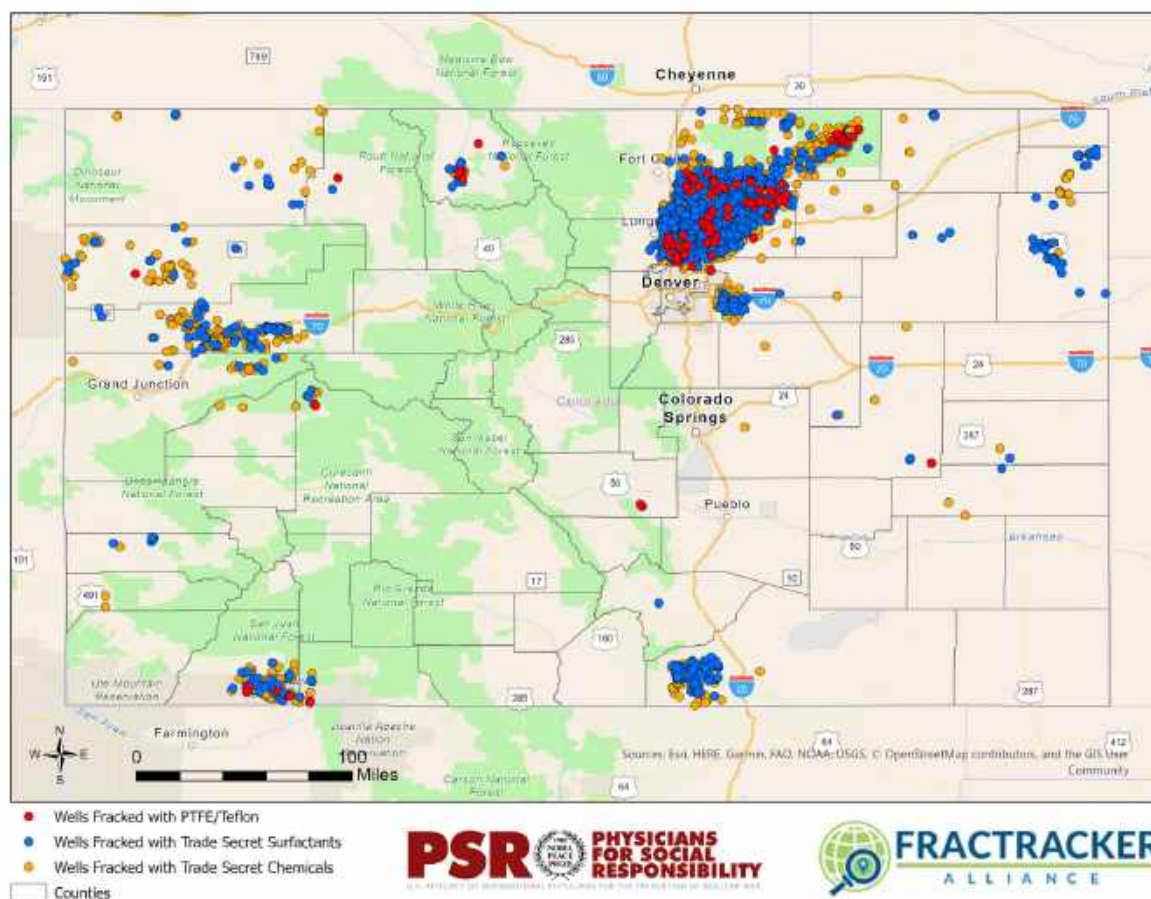
In addition to allowing trade secret exemptions for fracking chemicals, Colorado does not require public disclosure of chemicals used in drilling, enhanced oil recovery, or other extraction techniques that are distinct from fracking per se. This regulatory gap increases the potential that Coloradans

could unknowingly be exposed to PFAS and other chemicals used during the drilling phase and in other phases and methods of oil and gas extraction.²⁴ EPA has indicated that any chemicals used during the first stage of the drilling process would be highly likely to leach into groundwater since during this stage, drilling passes directly through groundwater zones²⁵ before any casing or cement is placed in the well to seal it off from surrounding aquifers. The resulting potential for groundwater contamination makes public disclosure of chemicals used in drilling especially important.

“PSR’s findings indicate these risks persist in alarming ways, despite rules enacted in 2012 that require public disclosure of fracking chemicals in Colorado.”

***Trade secret information is also called “proprietary” or “confidential business information” (CBI).

Colorado Oil & Gas Wells Fracked with PTFE and Trade Secret Chemicals, 2011-2021



This map shows the disclosed use of PTFE/Teflon for use in fracking in Colorado. Wider use of PTFE and other PFAS in the state may be obscured by trade secrets in more than 12,000 wells. An interactive version of this map is available at <https://www.psr.org/resources/colorado-pfas-map/>.

FracFocus Data Reveal Use of PTFE, a PFAS Fluoropolymer, in Colorado

PSR's analysis of oil and gas industry data recorded in FracFocus show that companies have used polytetrafluoroethylene (PTFE), a class of PFAS known as a fluoropolymer, in Colorado oil and gas wells. Oil and gas companies reported using PTFE for fracking in 282 wells in the state, primarily in Weld County between 2012 and 2019. (See maps and tables above and on following pages. An interactive version of the statewide map is available at <https://www.psr.org/resources/colorado-pfas-map/>.) It is unclear for what purpose the PTFE was used; however, PTFE, which is marketed as Teflon, is known for its slipperiness, and fracking chemicals are sometimes used as friction reducers.²⁶

PSR discovered the use of PTFE through use of the open-source version of FracFocus, Open-FF,²⁷ that is more accurate and informative than the original version of FracFocus.²⁸

Fluoropolymers including PTFE are a type of plastic.²⁹ Scientists' and environmentalists' major concerns about PTFE and other fluoropolymers are not related so much to these substances themselves but rather are based on the associated impacts of their production, use, and disposal³⁰: Highly toxic PFAS are used as production aids in the production of PTFE and other fluoropolymers. As was noted in a 2020 scientific paper, these other PFAS have included fluorosurfactants such as PFOA, which has been phased out as a manufacturing aid in the U.S. but is still used in Asia, and GenX, which is similarly harmful and has replaced PFOA in fluoropolymer production.³¹ Fluoropolymers like PTFE can

contain these more toxic PFAS fragments as impurities, and release the compounds if they break down under heat or pressure.³² The authors of the 2020 paper noted that

The levels of leachables...in individual fluoropolymer substances and products depend on the production process and subsequent treatment processes; a comprehensive global overview is currently lacking.³³

In addition, the authors noted that the persistence in the environment of PTFE and other fluoropolymers could pose problems during disposal. "Landfilling of fluoropolymers leads to contamination of leachates with PFAS and can contribute to release of plastics and microplastics," they wrote.³⁴ One of the authors added in an email to PSR that if PTFE were used in high-temperature oil and gas wells, it could undergo a process called "thermolysis" and generate toxic PFAS called perfluoroalkyl carboxylic acids (PFCAs). As a result, he wrote, "there could be some additional problems that need some investigation."³⁵

In 2021, a coalition of environmental groups including the Center for Environmental Health, Clean Water Action, Ecology Center, Environmental Working Group, Natural Resources Defense Council, Safer States, and the Sierra Club shared similar concerns, based on multiple scientific articles, regarding the risks of fluoropolymers such as PTFE. The groups also noted that fluoropolymers are manufactured with chemicals that have an outsized negative effect on climate change.³⁶ Disclosure gaps in Colorado law discussed below may prevent scientists and the public from knowing the extent of PTFE use in oil and gas operations.

Curiously Absent: Disclosure of PFAS Fluorosurfactants in Colorado

Our analysis of data posted in FracFocus also examined the direct use of fluorosurfactants, sometimes called fluorinated surfactants, in fracking in Colorado. As indicated above, these substances that are used to manufacture PTFE are of even greater concern than PTFE itself. Fluorosurfactants are part of a larger group of chemicals known as "surfactants" that, according to EPA,

lower the surface tension of a liquid, the interaction at the surface between two liquids (called interfacial

tension), or that between a liquid and a solid.

Surfactants may act as detergents, soaps, wetting agents, degreasers, emulsifiers, foaming agents and dispersants.³⁷

Surfactants are commonly used in fracking.³⁸

Fluorosurfactants are said to be "superior in their aqueous surface tension reduction at very low concentrations and are useful as wetting and leveling agents, emulsifiers, foaming agents, or dispersants."³⁹ Fluorosurfactants encompass PFOA, PFOS, and hundreds of other less-studied replacement chemicals and mixtures.⁴⁰ Some are known to be extremely toxic to people,⁴¹ could be harmful to animals⁴² and are expected to persist in the environment.⁴³

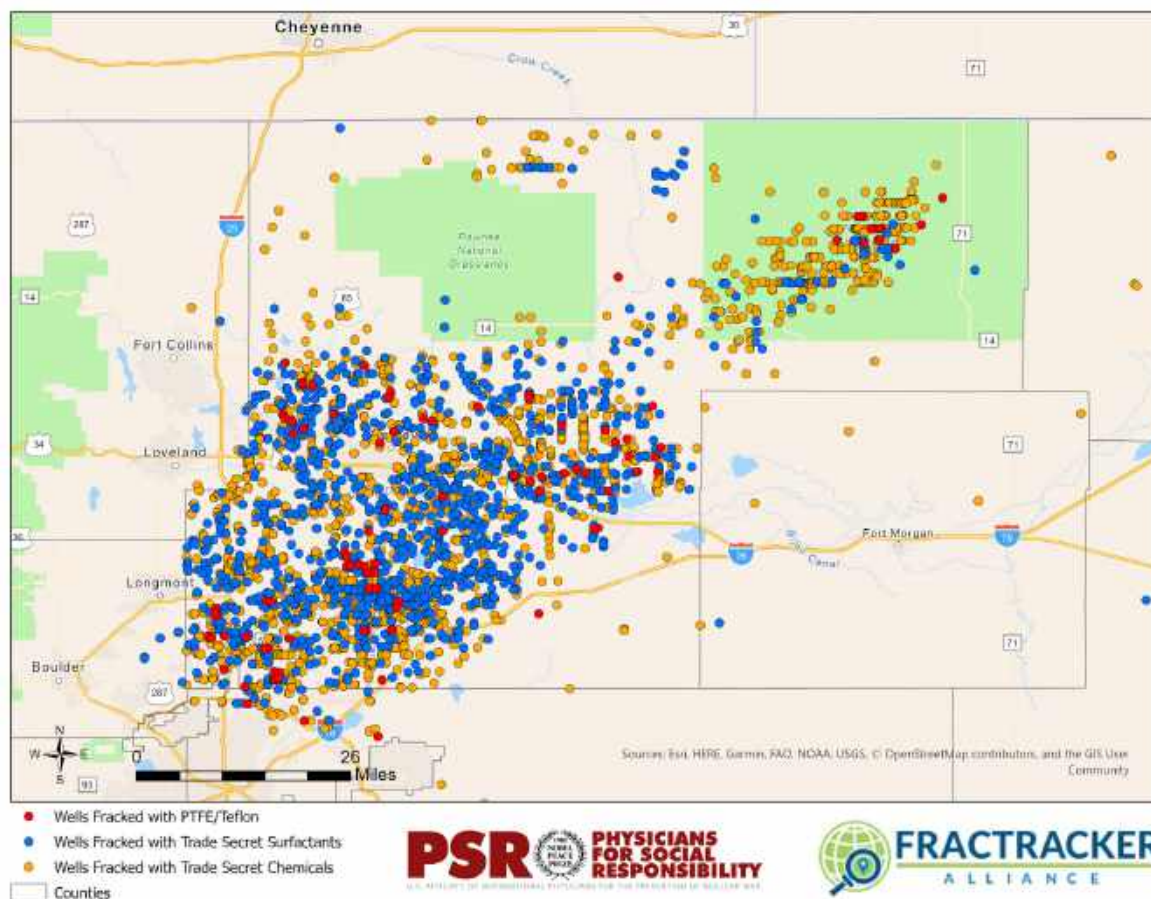
Evidence of fluorosurfactant use in Colorado is surprisingly spotty. In 2008, two authors, one of whom was identified as an employee at DuPont, wrote in the peer-reviewed Open Petroleum Engineering Journal that "cationic polymeric fluorosurfactants in methanol" were used for "enhanced oil recovery" in the state. (According to oilfield service company Schlumberger, enhanced oil recovery, or EOR, can involve injections of chemicals or carbon dioxide into underground formations as well as the use of steam to restore formation pressure and to improve displacement of oil or fluid flow in underground reservoirs.⁴⁴) "This EOR technique using fluorosurfactants," the Open Petroleum Engineering Journal authors wrote,

was employed at a well in Moffat County, Colorado from the Fort Union Sand Formation using methanol, 0.2 weight percent C10-12 alcohol ethoxylates, and 0.01 weight percent of a cationic polymeric fluorosurfactant. After treatment, the gas productivity increased from 100 million cubic feet (MCF) per day to 300 MCF per day.⁴⁵

The authors suggested that the use of fluorosurfactants was relatively common in the oil and gas industry and that their use was about to surge. They referred to fluorosurfactants as an "emerging technology" and stated,

While fluorosurfactants have been used in gas and oil exploration for four decades, the increased demand for petroleum and the greater understanding of the benefits of fluorosurfactants have led to growing acceptance for fluorosurfactants throughout the petroleum industry.⁴⁶

Weld County Oil & Gas Wells Fracked with PTFE and Trade Secret Chemicals, 2011-2021



Trade secret chemicals were widely used in Weld County. From 2011 to 2021, Weld County also showed the highest level among all Colorado counties of the use in fracking of the PFAS known as PTFE/Teflon.

The paper is consistent with a peer-reviewed article published in 2020 in *Environmental Science: Processes and Impacts*. In that article, the authors found evidence that since 1956, PFAS including fluorosurfactants had been used or proposed to be used globally in oil and gas extraction techniques including chemical-driven gas production, chemical flooding, fracking, and the drilling that precedes fracking and other oil and gas production techniques.⁴⁷ The paper on enhanced oil recovery and fluorosurfactants is also consistent with PSR's findings published in July 2021 which found that between 2012 and 2020, oil and gas companies used PFAS in fracking in more than 1,200 wells in six states. Most were fluorosurfactants.⁴⁸

Yet despite evidence of widespread and longstanding use of fluorosurfactants in oil and gas extraction, PSR did not find

further evidence of their use in Colorado beyond the single gas well in Moffat County, despite searching in Open-FF and other online sources. This surprising lack of evidence, as is discussed below, may be due to the significant gaps in reporting requirements for the oil and gas industry in Colorado, rather than to lack of use of fluorosurfactant chemicals.

Extensive Use of 'Trade Secret' Claims Veils Actual Use

The lack of evidence of additional use of PFAS in Colorado's oil and gas wells reflects, at least in part, extensive application of the trade secret provisions in Colorado's chemical disclosure rules. PSR's data analysis revealed that, between 2011 and 2021, Colorado well operators claimed at

least one fracking chemical as a trade secret in 12,623 oil and gas wells. Of these, 9,210 (73 percent) were in Weld County and 2,079 (16.5 percent) were in Garfield County. The trade secret chemicals used in Colorado over this 10-year period totaled almost 414 million pounds.⁴⁹ (See Table 1, next page.) If even a small fraction of this weight were PFAS, that fraction could pose significant health and environmental risks.

Non-disclosure provisions made it impossible to determine if any of these trade secret chemicals were PFAS. In an effort to do so, PSR examined whether any were listed as a surfactant, which could indicate that the chemicals were fluorosurfactants. We found thousands of cases of oil and gas companies using at least one trade secret chemical that was listed as a surfactant. These occurred in 3,221 wells, the majority of which (2,589) were in Weld County.⁵⁰ (See Table 1, next page.) Operators' names for these chemicals were vague, including "surfactant," "amphoteric surfactant," and "proprietary surfactant." These trade secret surfactants totaled almost 12 million pounds. (See examples from individual wells in Table 2.)

Companies using trade secret surfactants include prominent oil and gas producers. Among them are Anadarko Petroleum Corp., the co-owner along with BP of the Macondo well that spewed millions of gallons of oil into the Gulf of Mexico in 2010,⁵¹ and Encana Corp., once one of Canada's largest oil companies until it moved its corporate headquarters to the U.S. in 2020 and changed its name to Ovintiv.⁵² (See Table 3.)

Spills at Colorado Wells Raise Pollution Concerns

When PFAS are used at oil and gas well sites, there is a real risk that they could impact health and the environment, due to the thousands of spills and hundreds of cases of associated pollution that have been documented at oil and gas well sites in Colorado and other states.⁵³ According to an analysis by the Center for Western Priorities, state data from 2012-2020 showed that oil and gas producers in Colorado reported 4,928 spills – an average of more than 1.5 spills per day.⁵⁴ The type of fluids spilled included wastewater or "produced water" that flows out of oil and gas wells from underground formations during production; oil; condensate (a naturally occurring hydrocarbon); "other" fluids; drilling fluid, and flowback or the fracking fluid that flows out of

the well after fracking.⁵⁵ At least some of these fluids could contain PFAS if PFAS were used in those wells, posing risks to groundwater or surface water.

The evidence on spills in Colorado is significant in light of EPA's findings in its 2016 national report on fracking and drinking water. The agency found that fracking-related pollution could follow a number of pathways, including:

- spills of fracking fluid that seep into groundwater;
- injection of fracking fluid into wells with cracks in the casing or cement, allowing the fluid to migrate into aquifers (much of the fracking fluid can remain underground);
- injection of fracking fluids directly into groundwater;
- underground migration of fracking fluids through fracking-related or natural fractures;
- intersection of fracking fluid with nearby oil and gas wells,
- spills of wastewater after the fracking process is completed, and
- inadequate treatment and discharge of fracking wastewater to surface water supplies.⁵⁶

Where PFAS are used at oil and gas sites, they could enter water supplies through one or more of these pathways, thus placing drinking water and agricultural water sources at risk. In addition, in PSR's July 2021 report, toxicologist Dave Brown, former director of environmental epidemiology at the Connecticut Department of Health, noted that PFAS used in oil and gas wells could follow airborne exposure routes. He warned that if PFAS were to enter drinking water, it could subsequently volatilize or become airborne inside homes. Brown also added another potential pathway for airborne exposure: PFAS could become airborne when gas is burned off during flaring at the wellhead.⁵⁷

PFAS Use Could Compound Health Harms from Other Oil and Gas Chemicals

PFAS is by no means the only chemical associated with oil and gas extraction that could cause harm to health. Deeper investigation of PFAS use in oil and gas operations is especially important because exposure to PFAS may be additional to, and could impact or intensify, health effects from those other chemicals.

TABLE No.1 – Disclosed Use of Trade Secret Chemicals and PFAS in Fracking in Colorado Oil and Gas Wells, 2011-2021

County Name	Number of wells with at least one trade secret chemical	Mass of all trade secret chemicals (lbs.)*	Number of wells with trade secret surfactants	Mass of trade secret surfactants (lbs.)*	Number of wells using PTFE	Mass of PTFE (lbs.)*
Adams	231	12,970,690	42	671,214	3	266
Arapahoe	87	4,557,047	28	93,502	0	0
Archuleta	7	7,691	2	88	2	No data available
Boulder	9	37,744	9	10,726	0	0
Broomfield	31	1,375,502	3	3,081	0	0
Cheyenne	2	1,218	1	1,106	0	0
Delta	3	183,751	0	0	0	0
Dolores	2	5,347	0	0	0	0
El Paso	1	60,818	0	0	0	0
Elbert	3	6,655	1	No data available	0	0
Fremont	2	No data available	0	0	2	No data available
Garfield	2,079	15,973,557	268	241,979	0	0
Gunnison	8	251,243	4	38,112	1	No data available
Huerfano	1	22,940	1	3,976	0	0
Jackson	53	3,494,710	29	56,624	6	765
Kiowa	3	5,926	1	1,429	0	0
La Plata	168	192,770	41	6,165	5	5
Larimer	98	4,254,325	6	15,408	0	0
Las Animas	163	65,941	83	27,255	0	0
Lincoln	5	33,562	2	15	1	No data available
Logan	9	2,219	6	771	0	0
Mesa	115	585,750	12	48,934	0	0
Moffat	24	591,243	10	12,342	0	0
Morgan	2	8,452	0	0	0	0
Phillips	23	6,598	15	6,328	0	0
Rio Blanco	226	934,129	21	8,989	2	No data available
Routt	2	7,760	1	211	1	21
San Miguel	10	23,590	9	3,136	0	0
Washington	3	645	3	645	0	0
Weld	9,210	368,255,921	2,589	10,693,593	259	7,840
Yuma	43	5,926	34	5,019	0	0
Total *	12,623	413,923,683	3,221	11,950,659	282	8,900

This table, based on FracFocus data, shows county-by-county the number of Colorado wells in which oil and gas companies injected at least one trade secret fracking chemical, and some of our specific findings. The total mass figures reflect the sum of all records for which we have enough information to calculate a chemical's mass. However, the total mass figures represent an undercount because many fracking chemical disclosures lack sufficient data to perform this calculation.

TABLE No.2 - Examples of Individual Oil and Gas Wells

Well Operator	Well Number	County	Year Fracking Completed	Chemical used in Well	CAS Number	Trade Name	Mass (lbs.)
Bayswater Exploration & Production, LLC	05123401900000	Weld	2021	surfactant	proprietary	Not reported	7,242
Bonanza Creek Energy, Inc.	05123450640000	Weld	2019	amphoteric surfactant	proprietary	Not reported	34,581
Anadarko Petroleum Corporation	05123426300000	Weld	2017	ethoxylated alcohol	proprietary	SFT-82	11,149
SandRidge Energy	05057065530000	Jackson	2016	PTFE	9002-84-0	Not reported	127
TEP Rocky Mountain, LLC	05045225960000	Garfield	2016	nonionic surfactant	proprietary	TFR-0102	107

This table shows a sample of specific wells injected with the types of fracking chemicals referenced in the larger table above: trade secret chemicals such as the “ethoxylated alcohol,” trade secret surfactants such as the “amphoteric surfactant,” and PTFE. We selected the examples to cover a range of years and to represent wells fracked in the two Colorado counties with the most oil and gas extraction: Garfield and Weld. Even the smallest mass shown, 107 pounds for a proprietary nonionic surfactant, would be a significant amount of PFAS if this proprietary chemical were PFAS.

TABLE No.3 - Oil and Gas Companies that Fracked the Most Wells in Colorado with Trade Secret Surfactants, 2011-2021

Well Operator	Number of wells with trade secret surfactants	Total mass (lbs.)*
Anadarko Petroleum Corporation	718	4,660,036
Noble Energy, Inc.	694	1,737,766
Encana Oil & Gas (USA) Inc.	266	1,220,224
Great Western Oil & Gas Company, LLC	208	305,944
PDC Energy	147	346,970
Bill Barrett Corp.	128	320,347
Bonanza Creek Energy, Inc.	124	512,514
Bayswater Exploration & Production, LLC	97	289,736
Synergy Resources Corporation	79	152,788
HighPoint Operating Corporation	66	36,938
TEP Rocky Mountain, LLC	65	8,726
Pioneer Natural Resources	58	23,661
Caerus Oil and Gas, LLC	54	50,706
Laramie Energy, LLC	39	No data available
SRC Energy	39	8,953

This table shows the fifteen oil and gas companies that fracked the most oil and gas wells in Colorado with trade secret surfactants between 2011 and 2021. Surfactants may be more likely to be PFAS than other trade secret chemicals because of the widespread use in oil and gas wells of PFAS known as fluorosurfactants.

In 2016, EPA published a study that identified 1,606 chemicals used in fracking fluid and/or found in fracking wastewater. While the agency found high-quality information on health effects for only 173 of these chemicals, that information was troubling. EPA found that

health effects associated with chronic oral exposure to these chemicals include carcinogenicity [for benzene and radium], neurotoxicity, immune system effects, changes in body weight, changes in blood chemistry, liver and kidney toxicity, and reproductive and developmental toxicity.⁵⁸

Chemicals used in the drilling stage that precedes fracking can also pose health risks, including developmental toxicity and the formation of tumors, according to EPA regulators.⁵⁹ A disclosure form filed with the state of Ohio, perhaps the only state to require disclosure of drilling chemicals, shows that Statoil, Norway's state oil company (since renamed Equinor), has used a neurotoxic chemical, xylene, in drilling.⁶⁰

Chemicals used in oil and gas operations have been found to be associated with harms to human health. Peer-reviewed studies of people living near oil and gas operations in Colorado and other states have found that proximity to active well sites correlates with a variety of diseases and other health effects. A 2019 study in the journal *Environment International* examined 3,324 babies born in Colorado between 2005 and 2011 and found that, compared with control groups, congenital heart defects were 1.4 and 1.7 times more likely in babies born to mothers in areas of medium and high unconventional gas drilling, respectively.⁶¹ A 2017 study in *PLOS One* of Coloradans between birth and 24 years old diagnosed with cancer between 2000 and 2013

found that those between the ages of five and 24 were more than four times more likely to live in areas of heavy oil and gas drilling, compared to controls.⁶²

On a national scale, PSR and Concerned Health Professionals of New York have collaborated to compile and summarize the substantial and growing number of scientific studies that have found serious health effects associated with oil and gas drilling. In the seventh edition (2020), they wrote,

Public health problems associated with drilling and

fracking include poor birth outcomes, respiratory impacts, cancer, heart disease, and mental health problems. Poor birth outcomes have been linked to fracking activities in multiple studies in multiple locations using a variety of methodologies. Studies of mothers living near oil and gas extraction operations

consistently find impairments to infant health, especially elevated risks for low birth weight and preterm birth.⁶³

Low birthweight is a leading contributor to infant death in the United States.⁶⁴

The Southwest Pennsylvania Environmental Health Project⁶⁵ and the Pennsylvania-based FracTracker Alliance⁶⁶ have also examined studies of health impacts of unconventional oil and gas development and reached similar conclusions.

In addition to the findings in peer-reviewed studies, residents living near oil and gas operations have anecdotally reported experiencing illnesses that they believe are related to chemical exposures. Many residents have also expressed frustration over the secrecy surrounding chemicals used by the oil and gas industry.⁶⁷ In 2020, Pennsylvania's Attorney



Frye Farms well pad in Windsor, CO. October 30, 2021. By permission of the photographer.

General issued a report based on a criminal grand jury investigation of oil and gas drilling pollution in the Keystone State. In that state, drilling for gas in shale formations has surged over the past 15 years,⁶⁸ vaulting Pennsylvania into the number two spot among gas-producing states (Texas is number one)⁶⁹ and bringing many more Pennsylvanians into contact with gas drilling and its impacts. Based on testimony from over 70 households, the attorney general found that

Many of those living in close proximity to a well pad began to become chronically, and inexplicably, sick. Pets died; farm animals that lived outside started miscarrying, or giving birth to deformed offspring. But the worst was the children, who were most susceptible to the effects. Families went to their doctors for answers, but the doctors didn't know what to do. The unconventional oil and gas companies would not even identify the chemicals they were using, so that they could be studied; the companies said the compounds were "trade secrets" and "proprietary information." The absence of information created roadblocks to effective medical treatment. One family was told that doctors would discuss their hypotheses, but only if the information never left the room.⁷⁰

Fracking and Chemical Exposure as an Environmental Justice Issue

"Fenceline" communities – people living very close to oil and gas operations – often bear a disproportionate risk of exposure to toxic chemicals and may be particularly at risk from PFAS used in oil and gas extraction. Although drilling and fracking take place in the majority of U.S. states, not everyone shares in that risk equally. Rather, oil and gas infrastructure and associated chemicals are frequently located in or adjacent to poor, underserved, and marginalized communities, Indigenous communities, and other communities of color. For example, a 2019 analysis conducted in Colorado, Oklahoma, Pennsylvania, and Texas found strong evidence that people of color disproportionately lived near fracking wells.⁷¹ Where a pattern of risks affects people of color disproportionately, fracking should be viewed as an Environmental Justice issue.

One such issue may have occurred in 2018 in Greeley,

Colorado, where an oil and gas company built a massive well pad housing 24 wells near Bella Romero Academy, an elementary school in a low-income community where 82 percent of students were Latino, after abandoning an earlier plan to drill the wells near a charter school where most students were white and middle-class. A company spokesperson denied that the wells were located near Bella Romero Academy because of the racial background of the school's students.^{72,73} An analysis of state data showed that in 2019, airborne benzene levels near the school exceeded health-based limits 113 times, including spikes during four full school days.⁷⁴ Benzene is a known cause of leukemia.⁷⁵

With Lax EPA Regulation, States Will Have to Address PFAS

Colorado and other state governments will likely have to take the lead in addressing PFAS pollution, whether from oil and gas operations or other sources. State action will be necessary because EPA has taken only modest steps to protect the public. In 2005, EPA reached a then-record \$16.5 million settlement with Dupont after accusing the company of violating the federal Toxic Substances Control Act (TSCA) by failing to disclose information about PFOA's toxicity and presence in the environment.⁷⁶ In 2006, EPA invited Dupont, 3M and six other companies to join a "stewardship" program in which the companies promised to achieve a 95 percent reduction of emissions of PFOA and related chemicals by 2010, compared to a year 2000 baseline. The agreement also required the companies to phase out emissions and use of these chemicals by 2015.⁷⁷ In 2021, EPA says on its website that the companies reported that they had accomplished those goals either by exiting the PFAS industry or by transitioning to alternative chemicals.⁷⁸ However, since the announcement of its PFAS stewardship program in 2006, EPA has allowed nearly unlimited use of closely related "replacement" chemicals in dozens of industries.⁷⁹ In response, in 2015 a group of more than 200 scientists raised health and environmental concerns that the new PFAS designed to replace PFOA and PFOS may not be safer for health or the environment.⁸⁰

In October 2021, EPA announced a "strategic roadmap" for regulating PFAS that encompasses a goal to set federal drinking water standards for several PFAS chemicals by 2023 as well as commitments to "use all available regulatory and

permitting authorities to limit emissions and discharges from industrial facilities” and “hold polluters accountable.”⁸¹ The plan does not include an examination of PFAS use in the oil and gas industry. (Later that month, 15 members of the U.S. House of Representatives asked EPA to examine this topic.⁸² The month before, PSR asked EPA to collect data on PFAS use in oil and gas extraction, utilizing its authority under TSCA.⁸³)

EPA’s record of lax regulation suggests that at least in the short term, state and local governments will have to play leading roles to protect the public from these dangerous chemicals. In addition, Congress and the executive branch have exempted the oil and gas industry from major

provisions of multiple federal environmental laws. For example, oil and gas waste is exempted from the hazardous waste rules that require cradle to grave tracking and safe handling under the Resource Conservation and Recovery Act. These exemptions also place the burden on state governments to address any PFAS pollution associated with oil and gas extraction.⁸⁴ State and local governments should draw on growing research about PFAS’ risks to better regulate these dangerous chemicals. Among the recent published papers is a peer-reviewed analysis showing that many PFAS are immediately replaceable with less persistent and less toxic substances, including in the oil and gas industry.⁸⁵

COLORADO DISCLOSURE RULES: IN NEED OF SWEEPING REFORM

To protect human health and the environment, multiple reforms are needed in Colorado's disclosure rules. Besides reforming the overly generous trade secret provisions, the state should address multiple exemptions that allow the oil and gas industry to maintain a veil of secrecy over its use of dangerous chemicals.

One such reform should involve requiring public disclosure of all chemicals used in oil and gas extraction, not just those used in fracking. Currently, Colorado requires well operators to compile inventories of at least some chemical products used in techniques other than fracking, but these provisions do not require public disclosure or provide a way for the public to access the information. Well operators are required to maintain Material Safety Data Sheets (MSDS), which originate with chemical manufacturers and indicate health and physical hazards (e.g. flammability) of a chemical product.⁸⁶ Between 2009 and 2020, Colorado required that companies maintain MSDS documents for chemical products "brought to a well site for use downhole during drilling, completion, and workover operations...."⁸⁷ (The term "workover operations" refers to the repair or stimulation of an existing production well for the purpose of restoring, prolonging or enhancing the production of gas or oil.⁸⁸) These records had to be kept on file and available for inspection by the Colorado Oil and Gas Conservation Commission – but not by the public – for at least five years.⁸⁹

Since 2009, Colorado has also required oil and gas companies to maintain an inventory of chemical products (including MSDS, since 2021 called Safety Data Sheets) used downhole at each well site.⁹⁰ The inventory applies to any chemical product in use or in storage at a well site in an amount greater than 500 pounds of cumulative maximum weight of the product present at the site during a quarterly reporting period.⁹¹ The companies must maintain this list "in a readily retrievable format at the Operator's local field office"⁹² and must keep it for five years after plugging and abandonment of the associated well or following closure of an associated oil and gas site.⁹³

Access to these records is limited, as they are held by well operators, not the state. Therefore, they are not public records that would otherwise be subject to the Colorado Freedom of Information Act which defines "public records" in part as "all writings made, maintained, or kept by the state...."⁹⁴ The only explicit scenarios under the rules in which people other than oil and gas companies can access these records apply to government officials, emergency responders, and health professionals.⁹⁵ A physician, physician assistant, nurse practitioner, registered nurse, or emergency medical technician licensed by the State of Colorado has the right to these records for the purpose of diagnosis or treatment of someone who may have been exposed to a chemical used at an oil and gas site.⁹⁶ Emergency responders and other government officials may request the chemical information in defined circumstances including "as a result of a spill or release, a complaint from a potentially adversely Affected Person, or when necessary to protect and minimize adverse impacts to public health, safety, welfare, the environment, and wildlife resources."⁹⁷ The specific names of chemical products and/or constituents of these products listed in a chemical inventory or covered by an MSDS can be withheld as trade secrets.⁹⁸

Another impediment to the public's right to know is that individual PFAS are not commonly listed on MSDS. This is the case even in products such as firefighting foam in which PFAS may be a major ingredient.⁹⁹ Therefore, even if the public could access records related to oil and gas chemicals used in Colorado, the records might not show that PFAS were being used at well sites when, in fact, they were. The omission of PFAS from MSDS may be related to MSDS rules that, according to Harvard researchers, require listing only of "hazardous" chemicals that have been studied for workplace exposure.¹⁰⁰ If PFAS have not been studied for such exposure, then manufacturers would not have to list them. The same researchers noted that federal regulations state that "there is no requirement to test the chemical to determine how to classify its hazards." Instead, chemical manufacturers can rely on existing scientific literature.¹⁰¹ If the literature did

not establish hazards associated with particular PFAS, these substances would not have to be listed on an MSDS. Finally, if a chemical product containing PFAS were used at a well in quantities weighing less than 500 pounds, it would not have to be reported on the chemical inventory.¹⁰² Colorado should amend its rules to require disclosure of all individual chemicals used in oil and gas extraction, with no exceptions for trade secrets and no minimums placed on the weight or quantity of the chemicals to be disclosed. The public needs a full accounting of chemicals used at well sites.

Oil and gas companies have argued that chemical trade secrets are necessary to protect their intellectual property from competitors. However, this interest does not have to mean a complete lack of information on chemical identities for scientists, regulators, and the general public.

California has produced more oil than Colorado over the past five years¹⁰³ and also began requiring full disclosure of fracking chemicals, without trade secret exemptions for individual chemical constituents, in 2015.¹⁰⁴ The methodology utilized in California is consistent with a recommendation issued in 2014 by an advisory panel to the U.S. Department of Energy.¹⁰⁵ The panel suggested that fracking chemicals injected into each well should be disclosed in a random-order list in which the chemicals are listed but disassociated from the trade name of the commercial products they are part of. This form of disclosure would enable the public to

know all the chemicals used in fracking without disclosing to rival chemical manufacturers the exact components of any proprietary formulas.¹⁰⁶ California also has a process where state regulators review secrecy requests from chemical companies to determine whether the information must be kept proprietary.¹⁰⁷ Health and safety data related to fracking fluids are not allowed to be kept from the public.¹⁰⁸

Colorado should also ensure that full chemical disclosure is required from all of the companies in the chemical supply chain, including especially the chemical manufacturers. Currently, Colorado rules require chemical disclosure only from companies further down the supply chain, such as well operators, service providers, and vendors.¹⁰⁹ Chemical manufacturers are implicitly exempted, despite being the only entity that always knows the contents of the chemicals they produce. Evidence suggests that chemical manufacturers do not always tell companies further down the supply chain the full contents of the chemical products they are using; rather, they provide these companies with vague descriptions, generic chemical family names, or MSDS with an incomplete list of chemicals.¹¹⁰ In such cases, the end users may legitimately be unable to disclose all the identities of chemicals used at a particular well – including PFAS – whether under trade secret protection or not. They simply would not have the information. Requiring disclosure of oil and gas chemicals from chemical manufacturers would avoid this problem.

RECOMMENDATIONS

In light of these findings, PSR recommends the following:

- **Halt PFAS use in oil and gas extraction.** Colorado and EPA should prohibit PFAS from being used, manufactured, or imported for oil and gas extraction. Many PFAS are immediately replaceable with less persistent and less toxic substances, including in the oil and gas industry.
- **Expand public disclosure.** Colorado should greatly expand its requirements for public disclosure of oil and gas chemicals. The state could readily follow the example offered by California, a major oil producer that prohibits the use of trade secret claims for fracking chemicals. Colorado should also require disclosure of other chemicals used in oil and gas drilling and extraction, with no minimums placed on the weight or quantity of the chemicals to be disclosed. The state should also require disclosure from chemical manufacturers.
- **Increase testing and tracking.** Colorado and/or the Environmental Protection Agency should determine

where PFAS have been used in oil and gas operations in the state, and where related wastes have been deposited and should test nearby water, soil, flora, and fauna for PFAS.

- **Require funding and cleanup.** Oil and gas and chemical firms should be required to fund environmental testing and evaluation where these are needed, and should PFAS be found, also be required to fund cleanup. If water cleanup is impossible, the companies responsible for the use of PFAS should pay for alternative sources of water for drinking and agriculture, as needed.
- **Limit or ban drilling and fracking.** Given the use of highly toxic chemicals including PFAS in oil and gas extraction, Colorado and local governments should prohibit drilling, fracking, and disposal of related wastes in areas relatively unimpacted by oil and gas pollution and should increase protections in already-impacted regions. When doubt exists as to the existence or danger of contamination, the rule of thumb should be, "First, do no harm."

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1111 14th Street NW, #700
Washington, DC 20005
202 667 4260
www.psr.org
psrnatl@psr.org

 @PSRenvironment and @PSRnuclear
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**PHYSICIANS
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U.S. AFFILIATE OF INTERNATIONAL PHYSICIANS FOR THE PREVENTION OF NUCLEAR WAR

FRACKING WITH “FOREVER CHEMICALS” IN OHIO

Evidence Shows Oil and Gas Companies
Have Used PFAS in Ohio Wells;
‘Trade Secret’ Laws Limit Public’s Ability
to Know Full Extent of Use

By Dusty Horwitt, J.D. and Barbara Gottlieb
Data Analysis by Gary Allison
September 2022



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Cover photo: Jefferson County, Ohio/USA-March 7, 2019: Oil and gas well on a ridgetop in Eastern Ohio. These wells engage in the controversial practice called fracking to extract oil and natural gas. © iStock 2022

Maps by Matt Kelso, FracTracker Alliance

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EXECUTIVE SUMMARY

Previously unpublicized information unearthed by Physicians for Social Responsibility (PSR) shows that a class of extremely toxic and persistent chemicals known as PFAS has been used in Ohio's oil and gas wells since at least 2013. However, gaps in Ohio's disclosure rules prevent the public from knowing how widely PFAS – or other toxic chemicals – have been used in oil and gas drilling and extraction. These findings raise concerns that Ohioans may unknowingly be exposed to highly hazardous substances.

PSR analyzed industry data recorded in FracFocus, one of two official repositories for Ohio's required disclosure of chemicals used in hydraulic fracturing ("fracking") and found that PFAS have been used in Ohio wells for fracking. The affected wells are located in eight Ohio counties: Belmont, Carroll, Columbiana, Guernsey, Harrison, Jefferson, Monroe, and Washington.

In addition, Ohioans could be exposed to PFAS through billions of gallons of wastewater from oil and gas wells in Ohio, Pennsylvania, and West Virginia that have been injected into Ohio's 245 underground injection disposal wells, taken to centralized waste treatment facilities, or spread on roads for de-icing or dust suppression. Pennsylvania records show that between 2012 and 2022, eight wells in that state that had been fracked with PFAS sent their drilling and fracking wastewater to a centralized waste treatment facility in Warren and to injection disposal wells located in 18 other Ohio towns.

However, the number of definitively identified cases of PFAS use may significantly underrepresent the use and presence of PFAS in the state associated with oil and gas operations. That is in large part because Ohio law allows oil and gas companies to withhold fracking chemical identities from the public and regulators by claiming them as a "trade secret." Between 2013 and 2022, companies claimed trade secret privileges in 2,164 wells across 17 Ohio counties. Furthermore, while Ohio is one of two states that require oil and gas companies to publicly disclose at least some of the chemicals used in drilling that precedes fracking, Ohio also allows the companies to withhold these drilling chemical

identities from the public and regulators by claiming them as a "trade secret." Records show that oil and gas companies in Ohio have used this provision to conceal such identities.

By shielding from public view the chemicals injected into oil and gas wells, these disclosure gaps raise the potential that Ohioans may be exposed to PFAS and other toxic chemicals from hundreds or even thousands of oil and gas production wells.

Among our key findings are:

- PFAS have been used in oil and gas extraction in Ohio over the past decade.
- Trade secrets make it extremely difficult to determine how extensively PFAS (and other highly toxic chemicals) have been used in Ohio. PSR's analysis of industry data analysis revealed that, between 2013 and 2022, Ohio well operators claimed at least one fracking chemical as a trade secret in 2,164 oil and gas wells located across 17 counties totaling 162 million pounds.
- It is likely that there is more PFAS use than has been reported. A peer-reviewed oil and gas industry journal said in 2008 that a type of PFAS known as fluorosurfactants had been used for oil and gas extraction "for four decades." In 2020, a scientific paper indicated that fluorosurfactants have been used in oil and gas extraction globally since 1956. In a report PSR published in 2021, we found that between 2012 and 2020, oil and gas companies had used PFAS or PFAS precursors, most of them fluorosurfactants, for fracking in more than 1,200 wells in six states. Yet, in examining records for the similar period 2013 to 2022, we found no reports of the use of fluorosurfactants in Ohio. This improbable absence may reflect oil and gas companies' extensive use of trade secret confidentiality claims.
- Of the Ohio wells for which oil and gas firms withheld chemical identities as trade secrets over the past decade, almost 700 had been injected with chemicals identified

as “surfactants” totaling almost 21 million pounds. Some of these may be fluorosurfactants.

- PFAS pollution of groundwater, surface water and air in Ohio is possible wherever these substances have been used at oil and gas wells and wherever oil and gas wastewater containing PFAS has been disposed of. This includes disposal in injection wells, shipment to wastewater treatment plants, and spreading on roads.
- This variety of potential pathways to exposure raises concerns that PFAS could endanger the environment and people’s health.

In light of these findings, PSR recommends the following:

- **Halt PFAS use in oil and gas extraction.** Ohio should follow the lead of Colorado, a major oil- and gas-producing state which took this action through legislation passed in June 2022. Furthermore, Ohio and the U.S. Environmental Protection Agency (EPA) should prohibit PFAS from being used, manufactured, or imported for oil and gas extraction. Many PFAS are immediately replaceable with less persistent and less toxic substances, including in the oil and gas industry.
- **Expand public disclosure.** Ohio should greatly expand its requirements for public disclosure of oil and gas chemicals. The state could again follow the example offered by Colorado by requiring disclosure of all individual chemicals used in oil and gas wells without exceptions for trade secrets while requiring disclosure on the part of chemical manufacturers, who best know what chemicals are being used. Ohio should also require fracking chemical disclosure

prior to fracking, as have several states including California, West Virginia, and Wyoming.

- **Increase testing and tracking.** Ohio and/or the U.S. EPA should determine where PFAS have been used in oil and gas operations in the state and where related wastes have been deposited and should test nearby water, soil, flora, and fauna for PFAS.
- **Require funding and cleanup.** Oil and gas and chemical firms should be required to fund environmental testing and evaluation in their areas of operation where these are needed, and should PFAS be found, be required to fund cleanup. If water cleanup is impossible, the companies responsible for the use of PFAS should pay for alternative sources of water for drinking and agriculture, as needed.
- **Reform Ohio’s regulations for underground injection disposal wells** to prohibit wells close to underground sources of drinking water, to require groundwater monitoring for contaminants near the wells, and to require full public disclosure of the chemicals in the wastewater.
- **Limit or ban drilling and fracking.** Given the use of highly toxic chemicals, including but not limited to PFAS, in oil and gas extraction, Ohio should prohibit drilling, fracking, and disposal of related wastes in areas relatively unimpacted by oil and gas pollution and should increase protections in already-impacted regions. The state should empower local governments to take such action, too. When doubt exists as to the existence or danger of contamination, the rule of thumb should be, “First, do no harm.”

CH. 1

PFAS: A MAN-MADE THREAT TO HEALTH AND THE ENVIRONMENT

a. Man-made and Dangerous

Physicians for Social Responsibility (PSR) has identified evidence from industry sources that a highly dangerous class of chemicals, known as per- and polyfluoroalkyl substances (PFAS), has been used in Ohio oil and gas wells* for hydraulic fracturing ("fracking"). The wells definitively known to have been injected with PFAS between 2013 and 2022 are located in eight Ohio counties: Belmont, Carroll, Columbiana, Guernsey, Harrison, Jefferson, Monroe, and Washington. However, the wells PSR was able to identify may significantly underrepresent the extent of PFAS use in the state.

PFAS are a class of thousands of man-made chemicals known for having properties that are valuable in multiple contexts, including being slippery, oil- and water-repellant, and able to serve as dispersants or foaming agents.¹ PFAS have been called "perfluorinated chemicals" and "polyfluorinated compounds," or PFCs, though the term currently preferred by EPA is PFAS.²

The first PFAS to be sold commercially was created by a chemist at Dupont and was patented as Teflon. Since 1949, it has been used in thousands of products, from nonstick cookware to waterproof clothing to plastics to dental floss.³ Other PFAS chemicals, the most prominent of which are known as PFOA and PFOS, have been used in food packaging, fire-fighting foam, and in 3M's widely used fabric protector, Scotchgard.⁴ The U.S. Environmental Protection Agency (EPA) reports that there are currently about 650 types of PFAS in commerce.⁵ Weak chemical disclosure laws make it difficult for the Agency to identify which PFAS chemicals are used, and where.

EPA and other regulators have identified PFAS as a serious threat to health and the environment.⁶ As early as the 1960s and 1970s, researchers inside Dupont and 3M became aware that the PFAS they were manufacturing or using were associated with health problems including cancers and birth defects, had accumulated in virtually every human being,

and persisted in the environment.⁷ Many of these facts, kept internal by the companies, came to light after attorney Rob Bilott filed lawsuits in 1999 and 2001 accusing Dupont of causing pollution in and around Parkersburg, West Virginia with PFOA, a type of PFAS used in making Teflon.⁸ In December 2011, as part of Dupont's settlement of the 2001 lawsuit, a team of epidemiologists completed a study of the blood of 70,000 West Virginians and found a probable link between PFOA and kidney cancer, testicular cancer, thyroid disease (over- or under-production of hormones by the thyroid gland), high cholesterol, pre-eclampsia (a potentially dangerous complication during pregnancy characterized by high blood pressure and signs of damage to other organ systems, most often the liver and kidneys), and ulcerative colitis (a disease causing inflammation and ulcers in the large intestine or colon).⁹

PFAS are also extremely mobile in water,¹⁰ and in October 2021, EPA announced a "strategic roadmap" for regulating PFAS that encompasses a goal to set federal drinking water standards for PFOA and PFOS by 2023.¹¹ In June 2022, reflecting the growing concern about PFAS, EPA significantly lowered its health advisory level for PFOA and PFOS in drinking water. Previously, in 2016, EPA had set the combined health advisory level for these chemicals at 70 parts per trillion.¹² "The new published peer-reviewed data and draft EPA analyses..." EPA wrote in June 2022, "indicate that the levels at which negative health outcomes could occur are much lower than previously understood."¹³ EPA set its new interim health advisory level for PFOA in drinking water to 0.004 parts per trillion and its interim health advisory level for PFOS to 0.02 parts per trillion.¹⁴ EPA also set new final health advisory levels for two other PFAS known as Gen X (10 parts per trillion) and PFBS (2,000 parts per trillion).¹⁵ EPA said that its interim health advisory levels are intended to provide guidance until enforceable drinking water regulations for PFAS take effect.¹⁶

EPA's new health advisory levels mean that the toxicity of PFOA is almost beyond comprehension. Under EPA's levels,

* Gas, the principal component of which is methane, is also known as "natural" gas, "fossil" gas and "fracked" gas.

five measuring cups of PFOA could contaminate about 140 trillion gallons of water, more than the estimated 128 trillion gallons of water in Lake Erie¹⁷ or the amount of water that New York City would use during 107,500 days at its current consumption rate of 1.3 billion gallons per day.¹⁸

b. Persistent and Widespread in the Environment

PFAS are not only highly toxic; they also demonstrate extreme persistence in the environment. PFAS' nickname "forever chemicals" reflects their chemistry – created by chemical manufacturers – that features a bond between fluorine and carbon atoms that is among the strongest in chemistry and rarely if ever exists in nature. The result: chemicals that are extremely resistant to breaking down in the environment.¹⁹

Evidence has mounted over the years of cases of PFAS pollution from a variety of sources, including in Ohio. Under the state's PFAS Action Plan launched in 2019, the Ohio EPA has coordinated water sampling for six types of PFAS in almost 1,550 public water systems.²⁰ The state used as its action levels the EPA health advisory levels for PFOA and PFOS set in 2016 and the state's own levels for four other types of PFAS.²¹ The testing found detectable levels of PFAS in 106 public drinking water systems, two of which, in Aullwood and Bridgeport, exceeded the state's action levels.²² However, in many of the cases that did not exceed the state's action levels, the detected levels of PFOA and PFOS greatly exceeded the new interim health advisory levels set by EPA in June 2022.²³ Also in June 2022, the Ohio River Valley Water Sanitation Commission, an interstate commission representing Ohio, seven other states and the federal government, released results of a study on PFAS levels in the Ohio River, which borders Ohio for hundreds of miles. In the study, scientists sampled water from 20 locations on the Ohio River, including nine that bordered Ohio, as well as water from locations in two tributaries. The scientists found multiple PFAS at each testing site. At 19 sites they found PFOA with concentrations ranging from 4.88 parts per trillion to 12.90 parts per trillion²⁴ – at least 1,220 times EPA's interim safe level.

While these levels of PFOA in the Ohio River are cause for concern, they do not necessarily mean that drinking water will be contaminated, thanks to the potential removal of the contaminants during treatment.²⁵ However, Louisville radio station WFPL reported that at least on the Kentucky side of the Ohio River, some public drinking water providers did not have the ability to remove PFAS from drinking water.²⁶ On a webpage dated 2022, the Greater Cincinnati Water Works reported that PFOA and three other types of PFAS were "not detected" in drinking water from the Ohio River. However, some earlier test results on the website, including one from earlier in 2022, appear to show levels of detected PFOA and PFOS that are higher than EPA's new interim health advisory levels.²⁷ A representative of Greater Cincinnati Water Works said in an email in August 2022 that the detection levels of PFOA and PFOS were correct and that the agency would correct its erroneous statement that these forms of PFAS were "not detected."²⁸

EPA's new advisory levels are non-binding, but concern over PFAS pollution has led eight states, though not Ohio, to develop enforceable standards for concentrations of several types of PFAS in drinking water.²⁹ One of the most recent to act is Michigan, which set standards in 2020 for limiting PFAS in drinking water and for removing PFAS from groundwater. The standards apply to PFOA and six other forms of PFAS. Michigan's maximum allowable level is no more than eight parts per trillion for PFOA,³⁰ a standard that is one of the lowest among states but is now much more permissive than EPA's health advisory. Even Michigan's standard, however, shows how toxic PFAS can be. By extrapolation, Michigan's standards suggest that five measuring cups of PFOA could contaminate more than 70 billion gallons of water – the amount of water needed to fill more than 106,000 Olympic-sized swimming pools at about 660,000 gallons per pool.³¹ The extreme potency of PFOA, as with other PFAS, indicates why health experts are concerned about even minute quantities of these chemicals.

CH. 2

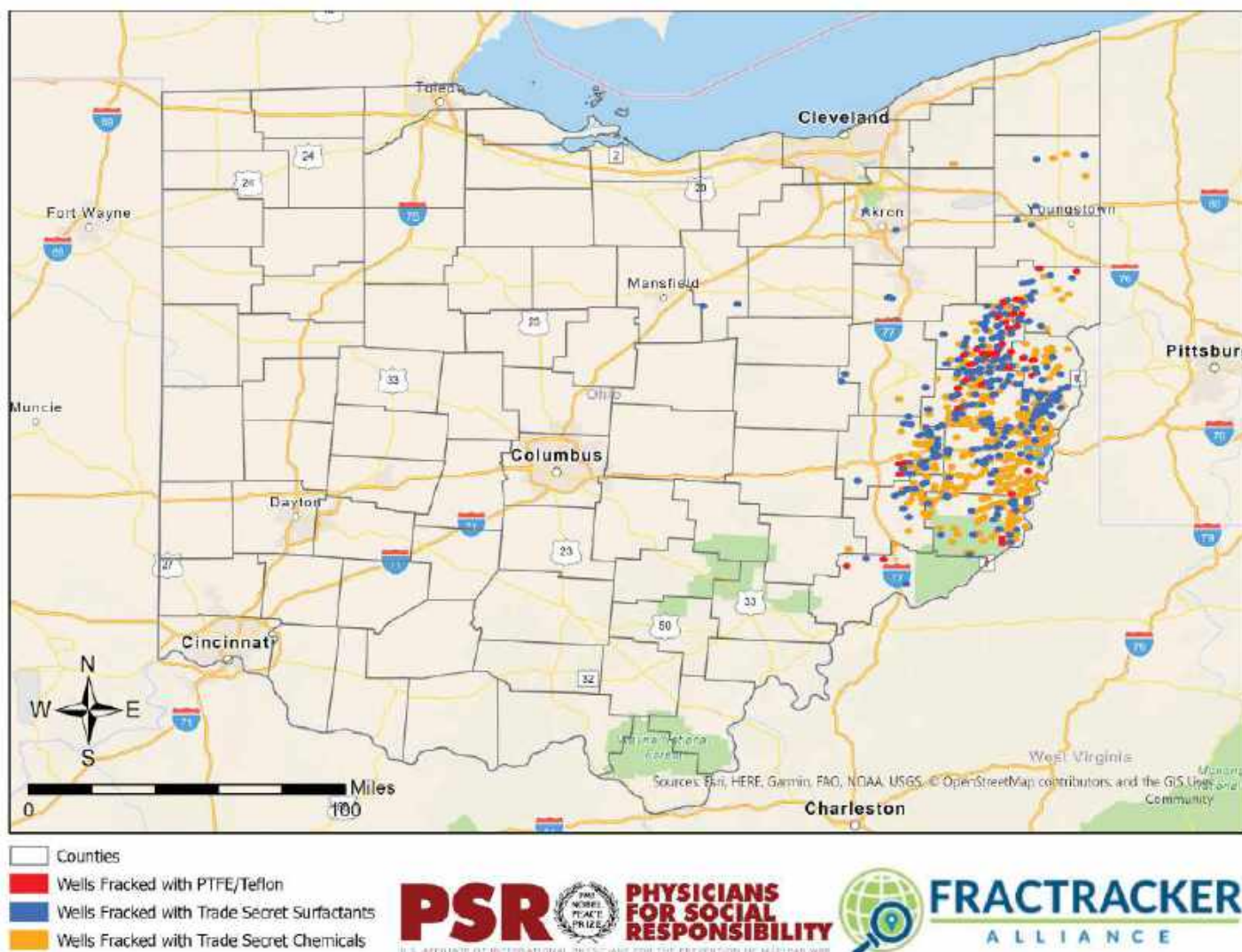
OIL AND GAS COMPANIES USED PFAS IN OHIO

a. Industry Data Reveal Use of PTFE, a PFAS Fluoropolymer

PFAS contamination has been associated with manufacturing facilities, airports, and military bases where firefighting foams and other industrial chemicals that contain the chemicals have been used, according to Wright State University Professor of Earth and Environmental Sciences Abinash Agrawal, who spoke with the Dayton Daily News in 2021 in response to Ohio's PFAS testing program.³² However,

oil and gas operations in the state may be an additional source of contamination.

To identify whether and where PFAS were used in Ohio, PSR analyzed self-reported industry data recorded in FracFocus, a database for the oil and gas industry³³ maintained by the Groundwater Protection Council,³⁴ a nonprofit comprised of regulators from state agencies. PSR used the open-source version of FracFocus, Open-FF, that is more accurate and informative than the original

Ohio Oil & Gas Wells Fracked with PTFE and Trade Secret Chemicals, 2013-2022

This map shows the location of oil and gas wells in Ohio known to have been fracked between 2013 – 2022 using PTFE, trade secret chemicals, and/or trade secret surfactants. An interactive version of the map is available at <https://ft.maps.arcgis.com/apps/webappviewer/index.html?appid=4fe19ca9a17141a6a1f5ac35728ac0fa>.

version of FracFocus.³⁵

Our analysis of the industry's own entries shows that oil and gas companies used the PFAS polytetrafluoroethylene (PTFE) in 101 oil and gas wells in eight Ohio counties between 2013 and 2022. It is unclear for what purpose the PTFE was used; however, PTFE, which is marketed as Teflon, is known for its slipperiness, and fracking chemicals are sometimes used as friction reducers.³⁶ The locations of the wells where PTFE was used are indicated in the map on page 3 and tables on the pages 8 and 9.

PTFE is a fluoropolymer. Fluoropolymers are a type of plastic.³⁷ Scientists' and environmentalists' major concerns about PTFE and other fluoropolymers are not related so much to these substances themselves but rather the associated impacts of their production, use, and disposal, according to a 2020 scientific report.³⁸ The production of PTFE and other fluoropolymers relies on other, highly toxic PFAS that are used as production aids. As the paper noted, these other PFAS have included fluorosurfactants such as PFOA, whose risks are discussed in the previous chapter, and GenX, which is similarly harmful and has replaced PFOA in fluoropolymer production.³⁹ (PFOA has been phased out as a manufacturing aid in the U.S. but is still used in Asia.)⁴⁰ PTFE and other fluoropolymers can contain these more toxic PFAS fragments as impurities that can leach out of the PTFE during use.⁴¹ PTFE may also generate other PFAS if the PTFE breaks down under heat.⁴² The authors of the 2020 paper noted that

The levels of leachables...in individual fluoropolymer substances and products depend on the production process and subsequent treatment processes; a comprehensive global overview is currently lacking.⁴³

In addition, the authors noted that the persistence in the environment of PTFE and other fluoropolymers could pose problems during disposal. "Landfilling of fluoropolymers leads to contamination of leachates with PFAS and can contribute to release of plastics and microplastics," they wrote.⁴⁴ One of the authors added in an email to PSR that if PTFE were used in oil and gas wells that have especially high temperatures, it could

undergo a process called "thermolysis" and generate toxic PFAS called perfluoroalkyl carboxylic acids (PFCAs). As a result, he wrote, "there could be some additional problems that need some investigation."⁴⁵ In 2021, a coalition of environmental groups including the Center for Environmental Health, Clean Water Action, Ecology Center, Environmental Working Group, Natural Resources Defense Council, Safer States, and the Sierra Club shared similar concerns, based on multiple scientific articles, regarding the risks of fluoropolymers such as PTFE. The groups also noted that fluoropolymers are manufactured with chemicals that have an outsized negative effect on climate change.⁴⁶ Disclosure gaps in Ohio law discussed below may prevent scientists and the public from knowing the extent of PTFE use in oil and gas operations.

b. Curiously Absent: Disclosure of PFAS Fluorosurfactants

PSR's findings of PFAS use in Ohio are based on oil and gas company operators' records in FracFocus, a database for the oil and gas industry.⁴⁷ Under Ohio law, operators must disclose in the FracFocus database the name of chemical products used in fracking and each individual component chemical used in each product.⁴⁸ They must also disclose each chemical's Chemical Abstracts Service (CAS) number, if available.⁴⁹ CAS numbers are unique numeric identifiers assigned to each chemical by the American Chemical Society. They are the most accurate way to identify chemicals, as a chemical can have multiple names or trade names but only one CAS number.⁵⁰

Our analysis of FracFocus records also examined the use of fluorosurfactants, sometimes called fluorinated surfactants, in fracking in Ohio. Fluorosurfactants are part of a larger group of chemicals known as "surfactants" that are commonly used in fracking.⁵¹ According to EPA, surfactants lower the surface tension of a liquid, the interaction at the surface between two liquids (called interfacial tension), or that between a liquid and a solid.⁵² While surfactants are commonly used in fracking,⁵³ fluorosurfactants are said to be "superior in their aqueous surface tension reduction at very low concentrations and are useful as wetting and leveling agents, emulsifiers, foaming

agents, or dispersants.”⁵⁴ Fluorosurfactants encompass the dangerous chemicals PFOA and PFOS, as well as hundreds of other less-studied replacement chemicals and mixtures.⁵⁵ Some are known to be extremely toxic to people,⁵⁶ could be harmful to animals,⁵⁷ and are expected to persist in the environment.⁵⁸ As indicated previously, fluorosurfactants are also used to manufacture PTFE and are of even greater concern than PTFE itself.

A variety of industry sources suggest that fluorosurfactants are commonly used in oil and gas extraction. In July 2021, PSR found that according to FracFocus data, between 2012 and 2020, oil and gas companies used PFAS or chemicals that could break down into PFAS in fracking in more than 1,200 wells in six states. Most were fluorosurfactants.⁵⁹ In 2020, an article published in *Environmental Science: Processes and Impacts* showed that since 1956, PFAS, including fluorosurfactants, had been used or proposed to be used globally in oil and gas extraction techniques including chemical-driven gas production, chemical flooding, fracking, and the drilling that precedes fracking and other oil and gas production techniques.⁶⁰ And in 2008, two authors, one of whom was identified as an employee at DuPont, wrote in the peer-reviewed *Open Petroleum Engineering Journal* that the use of fluorosurfactants was relatively common in the oil and gas industry and that their use was about to surge. They referred to fluorosurfactants as an “emerging technology” and stated,

While fluorosurfactants have been used in gas and oil exploration for four decades, the increased demand for petroleum and the greater understanding of the benefits of fluorosurfactants have led to growing acceptance for fluorosurfactants throughout the petroleum industry.⁶¹

Yet despite evidence of widespread and longstanding use of fluorosurfactants in oil and gas extraction, PSR did not find evidence of their use in Ohio, either in Open-FF or in other online sources. This surprising lack of evidence, as is discussed below, may be due to the significant gaps in reporting requirements for the oil and gas industry in Ohio, rather than the lack of use fluorosurfactant chemicals.

c. PFAS Joins a Roster of Dangerous Chemicals Used in Fracking

For years, scientists, advocates and regulators in Ohio and other states have raised concerns about the hundreds of industrial chemicals used in fracking of oil and gas wells, including potential threats to water resources and health. In fracking, energy companies inject into oil and gas wells a mixture of up to tens of millions of gallons of water, sand, and chemicals at high pressure to fracture underground rock formations, unlocking trapped oil and gas. The chemicals serve a variety of purposes including killing bacteria inside the wellbore, reducing friction during high-pressure fracking, and as gelling agents to thicken the fluid so that the sand, suspended in the gelled fluid, can travel farther into underground formations.⁶² In 2016, EPA published a study that identified 1,606 chemicals used in fracking fluid and/or found in fracking wastewater. While the agency found high-quality information on health effects for only 173 of these chemicals, that 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.⁶³

Chemicals used in the drilling stage that precedes fracking can also pose health risks, including developmental toxicity and the formation of tumors, according to EPA regulators.⁶⁴ A disclosure form filed with the state of Ohio, shows that Statoil, Norway’s state oil company (since renamed Equinor), has used a neurotoxic chemical, xylene, in drilling.⁶⁵

PFAS has joined the roster of potentially dangerous chemicals used in fracking. The use of PFAS in oil and gas production in Ohio was exposed in 2021,⁶⁶ but PFAS may have been used more extensively than records indicate, both geographically and in additional methods or stages of oil and gas operations, such as drilling, that precede fracking and in other techniques known as enhanced oil recovery. PFAS used in these operations may add to the cumulative human exposure to PFAS from other sources.

CH. 3

OHIO'S CHEMICAL DISCLOSURE LAWS SHIELD CHEMICAL IDENTITIES



Fire at the Eisenbarth Well operated by Statoil in Monroe County, Ohio, June 28-29, 2014. Credit: U.S. Environmental Protection Agency.

a. Ohio's "Trade Secret" Law Shields Potentially Dangerous Substances, Including PFAS

The danger of exposure to unknown chemicals – PFAS and others – from oil and gas operations persists in Ohio. This is true, despite state rules enacted in 2010 and amended in 2012 that require public disclosure of fracking and drilling chemicals.⁶⁷ The rules require that within 60 days of completing an oil or gas well, well operators disclose their fracking chemicals either to the Ohio Department of Natural Resources or to both the department and FracFocus.⁶⁸ Our analysis showed that about 90 percent of disclosures are made to both. Similarly, within the same 60-day time frame, well owners must disclose to the Department of

Natural Resources, though not to FracFocus, chemicals intentionally added during the initial phase of drilling that precedes fracking. The identities of these drilling chemicals must include CAS numbers.⁶⁹ This provision makes Ohio and Colorado⁷⁰ the only states to require disclosure of at least some chemicals used in drilling. EPA has indicated that any chemicals used during the first stage of the drilling process would be highly likely to leach into groundwater since during this stage, drilling passes directly through groundwater zones⁷¹ before any casing or cement is placed in the well to seal it off from surrounding aquifers. The resulting potential for groundwater contamination makes public disclosure of chemicals used in drilling especially important.

On the face of it, these disclosure requirements sound effective; however, an important exception allows companies to avoid full and meaningful disclosure: The law allows chemical manufacturers, well operators and other companies in the chemical supply chain to withhold exact fracking and drilling fluid ingredient information if they deem it a “trade secret.”⁷² In place of specific fracking chemical identities, oil and gas companies often list generic chemical names such as “inorganic salt” and “proprietary surfactant.”⁷³ Ohio’s drilling chemical records show some similar uses of generic chemical names, such as “phosphates,” “quaternary ammonium chloride,” and “amine derivative.”⁷⁴ Regrettably, the use of such vague descriptors can hide from public view the true identities of dangerous chemicals, including PFAS.

The use of trade secrets to conceal chemicals’ specific identities effectively undermines the public health benefits of disclosure by preventing health professionals, state regulators and the public from knowing where PFAS — or other toxic chemicals — have been used in oil and gas wells. In addition to allowing trade secret exemptions for fracking and drilling chemicals, Ohio does not require public disclosure of chemicals used in enhanced oil recovery or in other extraction techniques that are distinct from fracking per se. These regulatory gaps increase the potential that Ohioans could unknowingly be exposed to PFAS and other chemicals used during multiple phases and methods of oil and gas extraction.⁷⁵

An example of potential exposure to trade secret chemicals occurred in 2014, when a fire at an oil and gas well in Monroe County resulted in the release of unknown chemicals used in oil and gas extraction into a tributary of the Ohio River. State and EPA officials did not learn the chemicals’ identities until five days later, after an estimated 70,000 fish in the tributary had died.⁷⁶ It is unclear whether firefighters who responded to the blaze ever learned the chemicals’ identities. “Firefighters, you know, we have this tradition of running in where people are running out,” retired Youngstown Fire Department Battalion Chief and hazardous materials expert Silverio Caggiano told

Marketplace on NPR in 2017, commenting on the fire and the risks oil and gas chemicals pose to firefighters. “And without the knowledge of what’s in there, running in there may be turning us into victims as well.”⁷⁷

According to an EPA report, trade secret chemicals spilled as a result of the fire, along with other chemicals. Fluids that may have contained the trade secret chemicals ran off the well pad into a tributary of the Ohio River, where an estimated 70,000 fish died.⁷⁸

b. Extensive Use of ‘Trade Secret’ Claims Veils Actual Use

The lack of evidence of additional PFAS use in Ohio’s oil and gas wells may reflect, at least in part, extensive application of the trade secret provisions in Ohio’s chemical disclosure rules. PSR’s data analysis revealed that, between 2013 and 2022, Ohio well operators claimed at least one fracking chemical as a trade secret in 2,164 oil and gas wells located across 17 counties. The trade secret chemicals used in Ohio over this roughly 10-year period totaled 162 million pounds.⁷⁹ (See Table 1, next page.) If even a small fraction of this weight were PFAS, that fraction could pose significant health and environmental risks.

In an effort to determine if any of these trade secret chemicals were PFAS, PSR examined whether any were listed as a surfactant. Surfactants, as noted above, encompass dangerous fluorosurfactants, some of which are extremely toxic to people⁸⁰ and persistent in the environment.⁸¹ We found thousands of cases of oil and gas companies using at least one trade secret chemical that they described as a surfactant. These occurred in 688 wells, spread across 15 counties.⁸² (See Table 1) Operators’ names for these chemicals were vague, including “surfactant” and “surfactant blend.” These trade secret surfactants totaled almost 21 million pounds. (See examples from individual wells in Table 2.) Should even a small percentage of them be fluorosurfactants, they could pose significant threats to human health and the environment.

Companies using trade secret surfactants include prominent oil and gas producers (see Table 3). Among them are Chesapeake Energy Corp., once the second-leading gas producer in the U.S., that recently emerged from a multi-billion-dollar bankruptcy;⁸³ Statoil, now called Equinor, the

Norwegian state-run oil and gas company⁸⁴ whose well fire in Monroe County in 2014 appears in the photograph above; caused unknown chemicals to flow into a tributary of the Ohio River; and ExxonMobil, the nation's largest publicly traded oil and gas company.⁸⁵

Table 1. Disclosed Use in Fracking of Trade Secret Chemicals and PFAS in Ohio Oil and Gas Wells, 2013-2022

County	Number of wells with at least one trade secret chemical	Weight of trade secret chemicals (lbs.)	Number of wells with at least one trade secret surfactant	Weight of trade secret surfactants (lbs.)	Number of wells with PTFE	Weight of PTFE (lbs.)
Ashland	2	5,880	2	4,140	0	0
Belmont	520	17,500,000	86	182,000	4	11
Carroll	295	58,200,000	172	12,700,000	46	263
Columbiana	45	7,480,000	19	1,190,000	12	58
Geauga	1	325	0	0	0	0
Guernsey	199	8,930,000	73	471,000	8	45
Harrison	398	41,100,000	139	4,660,000	18	101
Jefferson	277	15,100,000	94	1,140,000	6	58
Mahoning	2	9,010	2	322	0	0
Monroe	291	8,720,000	55	194,000	3	27
Morgan	2	97	0	0	0	0
Noble	111	4,280,000	30	125,000	0	0
Stark	3	1,880	3	1,100	0	0
Summit	2	1,130	2	663	0	0
Trumbull	7	185,000	4	3,750	0	0
Tuscarawas	6	667,000	4	162,000	0	0
Washington	3	180,000	3	65,800	4	23
Total	2,164	162,000,000	688	20,900,000	101	590

This table, based on FracFocus data, shows county-by-county the number of Ohio wells in which oil and gas companies injected at least one trade secret fracking chemical between 2013 and 2022, at least one trade secret surfactant, and/or PTFE. The total weight figures reflect the sum of all records for which we have enough information to calculate a chemical's weight. However, the total weight figures represent an undercount because many fracking chemical disclosures lack sufficient data to perform this calculation.

Table 2. Examples of Chemical Reporting on Individual Oil and Gas Wells in Ohio

Well Operator	Well Number	County	Year Fracking Completed	Chemical used in Well	CAS Number	Trade Name	Weight of Chemical (lbs.)
Chesapeake Operating, Inc.	3408120636	Jefferson	2016	PTFE	9002-84-0	not reported	21
XTO Energy/ExxonMobil	3401320790	Belmont	2018	PTFE	9002-84-0	not reported	6
Chesapeake Operating, Inc.	3406721356	Harrison	2015	proprietary surfactant	proprietary	report reflects a large set of products	250,244
Gulfport Energy Corporation	3411124769	Monroe	2021	surfactant	proprietary	not reported	13,114
Antero Resources Corporation	3411124413	Monroe	2014	alcohol ethoxylate surfactants	proprietary	Plexslick 953	5,192

This table shows a sample of specific wells injected with the types of fracking chemicals referenced in the larger table above, including trade secret surfactants such as the “alcohol ethoxylate surfactants” and “proprietary surfactant” as well as PTFE. The examples cover a range of years and represent wells fracked in several Ohio counties. Even the smallest mass shown for a proprietary chemical (5,192 pounds for a proprietary surfactant) would be a huge amount of PFAS if this proprietary chemical were PFAS.

Table 3. Oil and Gas Companies that Fracked the Most Wells in Ohio Using Trade Secret Surfactants, 2013-2022

Well Operator	Number of wells with trade secret surfactants	Total weight of trade secret surfactants (lbs.)
Chesapeake Operating, Inc.	270	20,000,000
Ascent Resources - Utica, LLC	164	111,000
Antero Resources Corporation	33	155,000
EAP Ohio LLC	32	114,000
American Energy Utica	26	22,300
Hess Corporation	22	5,780
Eclipse Resources I, LP	22	25,300
Gulfport Energy Corporation	16	39,300
Rice Drilling B, LLC	14	2,340
EQT Production	11	166,000
Southwestern Energy	10	76,300
CONSOL Energy Inc.	10	31,800
PDC Energy	8	7,980
Statoil USA Onshore Properties Inc.	7	7,400
XTO Energy/ExxonMobil	7	15,600

This table shows the fifteen oil and gas companies that fracked the greatest number of oil and gas wells in Ohio with trade secret surfactants between 2013 and 2022. Surfactants may be PFAS, given the widespread use in oil and gas wells of PFAS or potential PFAS known as fluorosurfactants.

CH. 4

PFAS USE IN OIL AND GAS OPERATIONS ENDANGERS HEALTH IN OHIO

a. Multiple Potential Pathways to Exposure

The threats to health from chemicals used in oil and gas operations are well-documented. EPA in its 2016 national report on fracking and drinking water found that fracking-related pollution could follow a number of pathways. Even without examining water contamination impacts or risks from underground disposal wells,⁸⁶ the agency cited the following possible pathways to exposure:

- spills of fracking fluid that seep into groundwater;
- injection of fracking fluid into wells with cracks in the casing or cement, allowing the fluid to migrate into aquifers (much of the fracking fluid can remain underground);
- injection of fracking fluids directly into groundwater;
- underground migration of fracking fluids through fracking-related or natural fractures;
- intersection of fracking fluid with nearby oil and gas wells,
- spills of wastewater after the fracking process is completed, and
- inadequate treatment and discharge of fracking wastewater to surface water supplies.⁸⁷

Where PFAS are among the chemicals used in oil and gas extraction, they too could enter water supplies through one or more of these pathways, thus placing drinking water and agricultural water sources at risk. That risk is substantial, given PFAS' characteristics: toxic in minuscule concentrations, linked to cancer, birth defects, pre-eclampsia, and other serious health effects, extremely mobile in water, and highly persistent in the environment.

In addition, toxicologist Dave Brown, former director of environmental epidemiology at the Connecticut Department of Health, noted in PSR's July 2021 report on PFAS that PFAS used in oil and gas wells could follow airborne exposure

routes. He warned that if PFAS were to enter drinking water, it could subsequently volatilize or become airborne inside homes. Brown also added another potential pathway for airborne exposure: PFAS could become airborne when gas is burned off during flaring at the wellhead.⁸⁸

b. Spills of Fluid, Disposal of Wastewater Raise Pollution Concerns

When PFAS are used at oil and gas well sites, there is a real risk of contamination and exposure due to spills and other accidents. Thousands of spills and accidents, and hundreds of cases of associated pollution, have been documented at oil and gas well sites.⁸⁹ In 2017, for example, the news outlet EnergyWire reported "at least 8,519 spills in 14 producing states" in 2016, with the number of reported spills in Ohio at 51 in 2012, 103 in 2013, 38 in 2014, 76 in 2015, and 53 in 2016.⁹⁰

Another risk that is especially high in Ohio is that PFAS and other chemicals could pollute the environment through the disposal of fracking and/or drilling wastewater. Oil and gas wastewater can contain chemicals injected during the fracking process including trade secret chemicals⁹¹ and thus, potentially, PFAS. It can also contain naturally occurring toxics found underground such as radium, a radioactive element and known human carcinogen.⁹² The major destination for oil and gas wastewater in Ohio is underground injection disposal wells that are intended to hold the wastewater safely underground forever. According to an analysis of state data by FracTracker Alliance, Ohio has 245 of these wells that have become a major repository for wastewater not just from in-state oil and gas wells but also wells located in Pennsylvania and West Virginia.⁹³ The volume of wastewater pumped into Ohio's injection wells rose from 690 million gallons in 2013 to 12.7 billion gallons in 2020, according to a separate analysis of state data by FracTracker Alliance.⁹⁴ This is not surprising, given that wastewater volumes in Ohio average 2.3 million gallons per well.⁹⁵

Meanwhile, researchers have known for decades that wastewater from disposal wells can migrate upward from



A Class II injection well in North Portage County, OH. April 2019. Credit: Ted Auch, FracTracker Alliance, 2019. Aerial support provided by LightHawk.

deep underground through nearby oil and gas wells that have ceased operating but have not been properly sealed off from the surrounding underground rock formation. This migrating wastewater can break out of the abandoned wells and contaminate groundwater located near the earth's surface.⁹⁶ Two different teams of researchers have estimated that Ohio has more than 150,000 abandoned oil and gas wells, only some of which have been plugged.⁹⁷ These wells could serve as conduits for wastewater injected underground to migrate upward, where it could break out of the old wells and seep into ground or surface water.⁹⁸ Ohio does not require groundwater monitoring near wastewater injection wells, so it could be difficult for people living near the

injection wells to know if injected wastewater were migrating upward into groundwater.⁹⁹

c. Evidence of Wastewater Underground Migration

The years 2020 and 2021 witnessed at least two apparent major underground migrations of fracking wastewater from Ohio injection disposal wells. Both impacted or endangered water supplies. In January 2021, more than 1.6 million gallons of what appeared to be fracking wastewater flowed for four days from an unplugged oil and gas well idle since 2012, in Noble County.¹⁰⁰ A nearby tributary, Taylor Fork, was impacted by the spill, resulting in a fish kill. The cause

of the spill was unclear, but there were six active fracking wastewater injection wells in Noble County including three within four miles of the leaking oil and gas well. Another example occurred in September 2020 in Washington County, when fracking wastewater migrated at least five miles from a disposal well to gas-producing wells, causing state officials to worry about possible groundwater contamination.¹⁰¹

Other, smaller incidents have also occurred. In August 2021, Veto Lake, located less than a mile from the same Washington County disposal well mentioned in the preceding paragraph, became contaminated with oil. State officials did not know whether the contamination was connected to the disposal well, but one expert said it was possible.¹⁰² In November, the Parkersburg (WV) News & Sentinel indicated that the source of the oil was an abandoned oil and gas well in the lake that had been improperly plugged.¹⁰³ In addition to these incidents, the state of Ohio told the news outlet StateImpact that there had been 65 spills of oil and gas wastewater between 2018 and 2020.¹⁰⁴

d. Inadequacy of Waste Treatment and Water Treatment Facilities

Wastewater taken to Centralized Waste Treatment (CWT) facilities can also pose risks. According to EPA, a CWT facility “is generally defined as one that accepts industrial materials (hazardous or non-hazardous, solid, or liquid) generated at another facility (off-site) for treatment or recovery.”¹⁰⁵ In a 2018 review of the ability of CWT facilities to handle oil and gas (O&G) wastes, EPA found several causes for concern:

Environmental and human exposure to pollutants in O&G wastewater can occur through multiple pathways related to treatment at CWT facilities. Environmental releases and human interactions with pollutants can occur from discharge of treated effluent to the environment, during transport to CWT treatment facilities, during CWT treatment itself, or through other waste streams such as sludge, spills, and fugitive emissions.¹⁰⁶

EPA found that some facilities

use treatment, such as chemical precipitation, that remove specific pollutants but provide little or no removal of the many other pollutants commonly found in these wastes. As a result, some facilities discharge much greater quantities of pollutants, such as total dissolved solids and chlorides, than others.¹⁰⁷

One facility that appeared to fall in this category of inadequate wastewater treatment was a CWT unit in Warren, Ohio called Patriot Water Treatment, LLC. EPA found that “The facility does not have technologies for TDS [total dissolved solids] or chlorides removal.”¹⁰⁸ Beginning in 2010, the Warren facility accepted oil and gas wastewater, primarily from Pennsylvania and West Virginia, partially treated it, and then paid the city of Warren to send it to the city’s sewage treatment plant, where it was subsequently discharged into the Mahoning River.¹⁰⁹ In 2011, following an exposé by the New York Times about high levels of carcinogenic radium in fracking wastewater in Pennsylvania,¹¹⁰ the Pennsylvania Department of Environmental Protection asked oil and gas companies to voluntarily stop sending wastewater to public sewage treatment plants and commercial waste facilities in the state.¹¹¹ However, the Warren plant continued to accept the wastewater from the Patriot CWT facility.¹¹²

In 2016, EPA prohibited publicly owned treatment works [POTWs] like Warren’s sewage plant from accepting wastewater from onshore oil and gas production “from shale and/or tight geologic formations,” the type of “unconventional oil and gas resources”¹¹³ that are typically drilled in Ohio, Pennsylvania, and West Virginia.¹¹⁴ EPA extended the deadline for compliance for some plants until 2019.¹¹⁵ EPA acted in large part because wastewater from unconventional oil and gas extraction “can contain high concentrations of TDS [total dissolved solids], radioactive elements, metals, chlorides, sulfates, and other dissolved inorganic constituents that POTWs are not designed to remove” and these contaminants

can be discharged, untreated, from the POTW to the receiving stream; can disrupt the operation of the POTW (e.g., by inhibiting biological treatment); can accumulate

in biosolids (sewage sludge), limiting their beneficial use; and can facilitate the formation of harmful DBPs [disinfection byproducts].¹¹⁶

Indeed, environmental advocates uncovered emails showing that a Warren official believed that the wastewater from Patriot was so high in TDS and salts that it was compromising Warren's ability to treat its waste.¹¹⁷ In 2017, Warren stopped accepting oil and gas wastewater from Patriot, following a lawsuit by the Freshwater Accountability Project alleging that the plant was violating its discharge permits under the Clean Water Act.¹¹⁸ Under EPA's rule, drilling companies can still send wastewater from unconventional wells to CWT facilities like Patriot, but the water cannot be sent on to POTWs.¹¹⁹

e. Wells Fracked with PFAS in Pennsylvania Sent Wastes to Ohio

Prior to 2017, Patriot Water Treatment, LLC and multiple injection wells in Ohio received wastewater from unconventional gas wells in Pennsylvania hydraulically fractured with PFAS. Patriot and several landfills also received thousands of tons of drill cuttings – rock fragments or ground-up rock produced during the drilling process – from the wells. The wastewater and drill cuttings could contain not only PTFE and any other PFAS associated with it, but also naturally occurring radium and other toxic chemicals, including additional undisclosed PFAS, as Pennsylvania law allows well owners to use fracking chemicals with identities shielded from the public as trade secrets.¹²⁰ The law also explicitly exempts chemical manufacturers from having to disclose chemicals in their fracking chemical products to the well operators, who must ultimately disclose fracking chemicals to the public.¹²¹ Evidence shows that in at least some cases, chemical manufacturers have not disclosed all of the chemicals to well operators who, in turn, are unable to disclose these chemicals publicly.¹²² As a result, the identities of many chemicals used in fracking fluid in Pennsylvania, and present in fracking wastewater and drill cuttings from Pennsylvania that are shipped to Ohio, may be unknown.

FracFocus records show that between 2012 and 2014,

oil and gas well operators fracked eight wells in Western Pennsylvania with PTFE/Teflon.¹²³ Records with the Pennsylvania Department of Environmental Protection show that millions of gallons of drilling fluid, fracking fluid and wastewater from these wells were shipped to more than 20 injection wells and to the Patriot CWT facility. Drill cuttings were also sent to four different Ohio-based landfills and to Patriot.¹²⁴ In some cases, these practices continued well into 2022.

Gas wells in Pennsylvania sent waste fluids to injection disposal wells in the following towns in Ohio: Atwater, Barnesville, Cambridge, Coolville, Coshocton, Dennison, Dexter City, Fowler, Garrettsville, Hartville, Hiram, Kent, Marietta, Nashport, Newton, Norwich, Rootstown, and Stockport. And they sent thousands of tons of drill cuttings to landfills in Amsterdam, Lowellville, New Spirit, New Springfield, Waynesburg, as well as to Patriot Water Treatment in Warren.¹²⁵

Landfills produce wastewater known as “leachate” when water percolates through the contents of the landfill.¹²⁶ In 2019, local prosecutors asked the Pennsylvania Attorney General's office to investigate after leachate from a landfill that had accepted drill cuttings was taken to a wastewater treatment plant and apparently caused the plant's discharge of treated water to exceed state and federal pollution standards. The plant discharged into the Monongahela River, a major source of drinking water for Western Pennsylvania.¹²⁷ Given that landfills in Ohio have also received drill cuttings that could contain PFAS, radium, and other contaminants and could have sent their leachate to wastewater treatment plants, the danger exists that other waterways could have been subject to similar incidents.

f. Wastewater Dumping and Spreading in Ohio

Other potential pathways for exposure to PFAS-tainted fracking wastewater in Ohio include intentional dumping of wastewater and the spreading of wastewater on roads for de-icing and dust suppression. In 2014, the owner of a Youngstown-based company, Hardrock Excavating LLC, was



A brine hauler in Malaga, OH, May 2017. The briny wastewater that comes out of fracking wells is sometimes spread on roads for dust suppression or as a de-icer. It carries a host of unidentified chemicals. Credit: Ted Auch, FracTracker Alliance, 2017

sentenced to more than two years in prison for directing his employees to illegally discharge oil and gas wastewater that Hardrock Excavating was storing for oil and gas companies. Over the course of two years, the owner directed his employees to wait until after dark and then secretly use a hose to empty some of the wastewater into a wastewater drain. The drain flowed into a tributary of the Mahoning River which flowed into the river itself. According to the U.S. Department of Justice, tests of some of the wastewater showed that it contained “several hazardous pollutants, including benzene and toluene.”¹²⁸ EPA has classified benzene as a known human carcinogen for all routes of exposure¹²⁹ and notes that toluene exposure can affect the

central nervous system.¹³⁰ It is unclear if the wastewater was ever tested for PFAS.

As for spreading wastewater on roads, Ohio law allows local governments to engage in this practice for dust suppression or de-icing, with certain limitations. These limitations include a prohibition on the use of wastewater from horizontal wells and prohibitions on the use of fluids associated with drilling the well, the initial production of wastewater known as “flowback” that contains the fracking fluid, or other fluids “used to treat a well.”¹³¹ In theory, these prohibitions would limit the wastewater to that which occurred naturally in underground formations and would prevent the use of

wastewater containing PFAS, as PFAS would likely be found in oil and gas wells only if it were added to the well. However, Caggiano, the retired Battalion Chief of the Youngstown Fire Department, believes that these rules might be violated in practice, whether intentionally or unintentionally. He cited the potential for tanker trucks hauling waste for spreading on roads to be cross-contaminated with flowback or drilling fluids, and the possibility of bad actors to illegally spread fracking or drilling wastewater that might contain PFAS. “I would not be surprised if drilling fluid or fracking fluid ended up on roads,” he said.¹³²

Even if the wastewater spread on roads were only from underground formations, it could contain dangerous naturally occurring toxics such as carcinogenic radium. In 2017, the Ohio Department of Natural Resources tested AquaSalina, a product used for deicing roads that is naturally occurring formation water from vertical oil and gas wells. The department found that one sample of AquaSalina contained 9,602 picocuries per liter of combined amounts of radium-226 and radium-228. This level exceeded Ohio’s legal limit for radium in oil and gas waste allowed in landfills (0.005 picocuries per liter) by a factor of almost two million. Ohio’s Department of Transportation had been purchasing AquaSalina for deicing since 2013-2014 but announced in August 2021 that it planned to stop buying the fluid without explaining why. The state still had more than 227,000 gallons of the fluid available for use.¹³³

g. PFAS Use Could Compound Health Harms from Other Oil and Gas Chemicals

PFAS is by no means the only chemical associated with oil and gas extraction that could cause harm to health. Deeper investigation of PFAS use in oil and gas operations is especially important because exposure to PFAS may be additional to, and could impact or intensify health effects from, those other chemicals. It is unknown if any of the problems associated with fracking chemicals, some of which are referenced below, are linked to or aggravated by PFAS used in oil and gas operations, but researchers should investigate.

Peer-reviewed studies of people living near oil and gas operations have found that proximity to active well sites correlates with a variety of diseases and other health effects. A 2018 study of 66 households in Belmont County, Ohio found that prevalence of contaminants in drinking water, including toluene, bromoform, and dichlorobromomethane, was higher in homes closer to unconventional oil and gas wells. The study also found that people living closer to multiple wells were more likely to report health issues including wheezing, stress, fatigue, and headache.¹³⁴ A 2019 study in the journal *Environment International* examined 3,324 babies born in Colorado between 2005 and 2011 and found that, compared with control groups, congenital heart defects were 1.4 and 1.7 times more likely in babies born to mothers in areas of medium and high unconventional gas drilling, respectively.¹³⁵ A 2017 study in *PLOS One* of Coloradans between birth and 24 years old diagnosed with cancer between 2000 and 2013 found that those between the ages of five and 24 were more than four times more likely to live in areas of heavy oil and gas drilling, compared to controls.¹³⁶

On a national scale, PSR and Concerned Health Professionals of New York have collaborated to compile and summarize the substantial and growing number of scientific studies that have found serious health effects associated with oil and gas drilling. In the eighth edition (2022) of our report, we wrote,

Public health problems associated with fracking include prenatal harm, respiratory impacts, cancer, heart disease, mental health problems, and premature death..... Poor birth outcomes have been linked to fracking activities in multiple studies in multiple locations using a variety of methods. Studies of mothers living near oil and gas extraction operations consistently find impaired infant health, especially elevated risks for low birth weight and preterm birth. As we go to press, a new study in Pennsylvania finds “consistent and robust evidence that drilling shale gas wells negatively impacts both drinking water and quality of infant health.”¹³⁷

Low birthweight is a leading contributor to infant death in the United States.¹³⁸ The Southwest Pennsylvania Environmental

Health Project¹³⁹ and the Pennsylvania-based FracTracker Alliance¹⁴⁰ have also examined studies of health impacts of unconventional oil and gas development and reached similar conclusions. In addition to the findings in peer-reviewed studies, residents living near oil and gas operations have anecdotally reported experiencing illnesses that they believe are related to chemical exposures.

Many residents have also expressed frustration over the secrecy surrounding chemicals used by the oil and gas industry.¹⁴¹ In 2020, Pennsylvania's Attorney General issued a report based on a criminal grand jury investigation of oil and gas drilling pollution in the Keystone State. In that state, drilling for gas in shale formations has surged over the past 15 years,¹⁴² vaulting Pennsylvania into the number two spot among gas-producing states (Texas is number one)¹⁴³ and bringing many more Pennsylvanians into contact with gas drilling and its impacts. Based on testimony from over 70 households, the attorney general compiled evidence of serious health impacts, finding that

Many of those living in close proximity to a well pad began to become chronically, and inexplicably, sick. Pets died; farm animals that lived outside started miscarrying, or giving birth to deformed offspring. But the worst was the children, who were most susceptible to the effects. Families went to their doctors for answers, but the doctors didn't know what to do. The unconventional oil and gas companies would not even identify the chemicals they were using, so that they could be studied; the companies said the compounds were "trade secrets" and "proprietary information." The absence of information created roadblocks to effective medical treatment. One family was told that doctors would discuss their hypotheses, but only if the information never left the room.¹⁴⁴

Study of the link between PFAS and other chemicals used in fracking would have been unlikely until 2021 because virtually no one knew that PFAS were used in oil and gas extraction until PSR published our report on the topic in July of that year. Now that we know PFAS have been used in oil and gas operations for years, scientists should determine whether there are connections between this use and health effects, for PFAS chemicals individually and as a compounding factor in conjunction with exposure to other fracking chemicals.

h. Fracking and Chemical Exposure as an Environmental Justice Issue

"Fenceline" communities – people living very close to oil and gas operations – often bear a disproportionate risk of exposure to toxic chemicals and may be particularly at risk from PFAS used in oil and gas extraction. Although drilling and fracking take place in the majority of U.S. states, not everyone shares in that risk equally. Rather, oil and gas infrastructure and associated chemicals are frequently located in or adjacent to poor, underserved, and marginalized communities, Indigenous communities, and other communities of color. For example, a 2018 study of the location of oil and gas wastewater disposal wells in Ohio showed that the wells were disproportionately located in lower-income, rural communities.¹⁴⁵ A 2019 analysis conducted in Colorado, Oklahoma, Pennsylvania, and Texas found strong evidence that people of color disproportionately lived near fracking wells.¹⁴⁶ Where a pattern of risks affects people of color and/or lower-income people disproportionately, fracking should be viewed as an Environmental Justice issue – and so too should any resultant exposure to PFAS.

CH. 5

POLICY CAN HELP PROTECT BUCKEYES FROM PFAS IN FRACKING

a. Lax EPA Regulation of PFAS

Ohio and other state governments will likely have to take the lead in addressing PFAS pollution, from oil and gas operations as from other sources. State action will be necessary because EPA has taken only modest steps to protect the public. To make matters worse, Congress and the executive branch have exempted the oil and gas industry from major provisions of multiple federal environmental laws. For example, oil and gas waste is exempted from the hazardous waste rules that require cradle-to-grave tracking and safe handling of hazardous substances under the Resource Conservation and Recovery Act. These exemptions increase the burden on state governments to address any PFAS pollution associated with oil and gas extraction.¹⁴⁷

EPA has taken some steps to protect the public from dangerous PFAS. In 2005, EPA reached a then-record \$16.5 million settlement with chemical manufacturer Dupont after accusing the company of violating the federal Toxic Substances Control Act (TSCA) by failing to disclose information about PFOA's toxicity and presence in the environment.¹⁴⁸ In 2006, EPA invited Dupont, 3M and six other companies to join a "stewardship" program in which the companies promised to achieve a 95 percent reduction of emissions of PFOA and related chemicals by 2010, compared to a year 2000 baseline. The agreement also required the companies to eliminate such emissions and use of these chemicals by 2015.¹⁴⁹ In 2022, EPA says on its website that the companies reported that they had accomplished those goals either by exiting the PFAS industry or by transitioning to alternative chemicals.¹⁵⁰ However, since the announcement of its PFAS stewardship program in 2006, EPA has allowed nearly unlimited use of closely related "replacement" chemicals in dozens of industries.¹⁵¹ In response, in 2015 a group of more than 200 scientists raised health and environmental concerns that the new PFAS designed to replace PFOA and PFOS may not be safer for health or the environment.¹⁵²

In October 2021, EPA announced its "strategic roadmap" for regulating PFAS. This plan encompasses a goal of

setting federal drinking water standards for several PFAS chemicals by 2023, as well as commitments to "use all available regulatory and permitting authorities to limit emissions and discharges from industrial facilities" and "hold polluters accountable."¹⁵³ The plan does not, however, include an examination of PFAS use in the oil and gas industry. (Later that month, 15 members of the U.S. House of Representatives asked EPA to examine this topic.¹⁵⁴ The month before, PSR asked EPA to collect data on PFAS use in oil and gas extraction, utilizing its authority under TSCA.¹⁵⁵) As previously stated, in June 2022, EPA announced new health advisory levels for several types of PFAS. Unfortunately, these standards are advisory and not legally enforceable.¹⁵⁶

b. Ohio Disclosure Rules: In Need of Sweeping Reform

EPA's record of lax regulation suggests that at least in the short term, state and local governments will have to play leading roles to protect the public from these dangerous chemicals. In Ohio, multiple reforms are needed in the state's disclosure rules to lift the veil of secrecy that oil and gas companies have used to conceal the use of PFAS and other potentially dangerous chemicals. One such change should be tighter limits on the use of trade secret provisions.

Oil and gas companies have argued that chemical trade secrets are necessary to protect their intellectual property from competitors. However, this interest does not have to mean a complete lack of information on chemical identities for scientists, regulators, and the public. In 2015, California, a major oil-producing state,¹⁵⁷ began requiring full disclosure of chemicals used for well stimulation, including fracking. The policy did away with trade secret exemptions for the individual chemicals used in fracking products.¹⁵⁸ In June 2022, Colorado, a major producer of oil and gas,¹⁵⁹ followed in California's footsteps but extended the requirements for chemical disclosure to all chemicals used in oil and gas wells, not just fracking or stimulation chemicals.¹⁶⁰

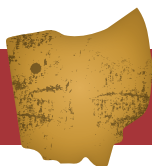
The methodology utilized in California and Colorado is consistent with a recommendation issued in 2014 by an advisory panel to the U.S. Department of Energy:¹⁶¹ that

companies reveal the fracking chemicals injected into each well, providing that information in a list in which the chemicals are disassociated from the trade name of the commercial products they are part of. This form of disclosure enables the public to know all the chemicals used in fracking without disclosing to rival chemical manufacturers the exact components of any proprietary formulas.¹⁶² California also has a process where state regulators review secrecy requests from chemical companies to determine whether the information must be kept proprietary.¹⁶³ Health and safety data related to fracking fluids are not allowed to be hidden from the public.¹⁶⁴ California requires disclosure of the chemicals used prior to fracking¹⁶⁵ as do West Virginia¹⁶⁶ and Wyoming.¹⁶⁷

There is another step Ohio should take to ensure that full chemical disclosure is required from all of the companies in the chemical supply chain. Currently, Ohio rules require chemical disclosure only from companies farther down the supply chain, such as well operators, service providers, and vendors.¹⁶⁸ Chemical manufacturers are implicitly exempted, despite being the only entity that always knows the precise contents of the chemicals they produce. Evidence suggests that chemical manufacturers do not always tell companies farther down the supply chain the full contents of the

chemical products they are using; rather, they provide these companies with vague descriptions, generic chemical family names, or Material Safety Data Sheets with an incomplete list of chemicals.¹⁶⁹ In such cases, the end users may legitimately be unable to disclose all the identities of chemicals used at a particular well – including PFAS – whether under trade secret protection or not. They simply would not have the information. Requiring disclosure of oil and gas chemicals from chemical manufacturers would avoid this problem. Colorado took this step in its June 2022 legislation.

These eminently reasonable and feasible reforms are valuable steps to protect the health of people who may be exposed to PFAS and other dangerous oil and gas chemicals, be they industry workers, residents living near wellsites, or first responders called to the scene of an accident. They can improve health and potentially even save lives. Additional steps to reduce the harms caused by oil and gas extraction are outlined in the following section including a ban on the use of PFAS in oil and gas operations, an action taken in 2022 by Colorado.¹⁷⁰ Among the evidence supporting this measure is a peer-reviewed analysis published in 2021 showing that many PFAS are immediately replaceable with less persistent and less toxic substances, including in the oil and gas industry.¹⁷¹



RECOMMENDATIONS

In light of the findings shared in this report, PSR recommends the following:

- **Halt PFAS use in oil and gas extraction.** Ohio should follow the lead of Colorado, a major oil- and gas-producing state which took this action through legislation passed in June 2022. Furthermore, Ohio and the U.S. Environmental Protection Agency (EPA) should prohibit PFAS from being used, manufactured, or imported for oil and gas extraction. Many PFAS are immediately replaceable with less persistent and less toxic substances, including in the oil and gas industry.

- **Expand public disclosure.** Ohio should greatly expand its requirements for public disclosure of oil and gas chemicals. The state could again follow the example offered by Colorado by requiring disclosure of all individual chemicals used in oil and gas wells without exceptions for trade secrets while requiring disclosure on the part of chemical manufacturers, who best know what chemicals are being used. Ohio should also require fracking chemical disclosure prior to fracking, as have several states including California, West Virginia, and Wyoming.

- **Increase testing and tracking.** Ohio and/or the U.S. EPA should determine where PFAS have been used in oil and gas operations in the state and where related wastes have been

deposited and should test nearby water, soil, flora, and fauna for PFAS.

- **Require funding and cleanup.** Oil and gas and chemical firms should be required to fund environmental testing and evaluation in their areas of operation where these are needed, and should PFAS be found, be required to fund cleanup. If water cleanup is impossible, the companies responsible for the use of PFAS should pay for alternative sources of water for drinking and agriculture, as needed.

- **Reform Ohio's regulations for underground injection disposal wells** to prohibit wells close to underground sources of drinking water, to require groundwater monitoring for contaminants near the wells, and to require full public disclosure of the chemicals in the wastewater.

- **Limit or ban drilling and fracking.** Given the use of highly toxic chemicals, including but not limited to PFAS, in oil and gas extraction, Ohio should prohibit drilling, fracking, and disposal of related wastes in areas relatively unimpacted by oil and gas pollution and should increase protections in already-impacted regions. The state should empower local governments to take such action, too. When doubt exists as to the existence or danger of contamination, the rule of thumb should be, "First, do no harm."



ENDNOTES

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¹⁶ U.S. Environmental Protection Agency. Technical Fact Sheet: Drinking Water Health Advisories for Four PFAS (PFOA, PFOS, GenX chemicals, and PFBS). June 2022, at 4. Accessed Sept. 9, 2022, at <https://www.epa.gov/system/files/documents/2022-06/technical-factsheet-four-PFAS.pdf>.

¹⁷ PSR calculated the amount of PFOA that would contaminate the estimated volume of water contained in Lake Erie using the following data: EPA's interim health advisory level for PFOA is 0.004 parts per trillion. U.S. Environmental Protection Agency. Technical Fact Sheet: Drinking Water Health Advisories for Four PFAS (PFOA, PFOS, GenX chemicals, and PFBS). June 2022, at 4. Accessed Sept. 20, 2022, at <https://www.epa.gov/system/files/documents/2022-06/technical-factsheet-four-PFAS.pdf>. Parts per trillion refers to milligrams per one million liters of water. U.S. Environmental Protection Agency. Environmental Science and Technology Briefs for Citizens. Center for Hazardous Substance Research. Understanding Units of Measurement. Accessed Sept. 20, 2022 at <https://cfpub.epa.gov/ncer/abstracts/index.cfm/fuseaction/display.files/fileid/14285>. One measuring cup contains approximately 237 milliliters. Exploratorium. Cooking Equivalents and Measures. Accessed September 20, 2022 at <https://www.exploratorium.edu/food/measurements>. The density of PFOA is 1.8 grams per milliliter. National Institutes of Health. National Library of Medicine. National Center for Biotechnology Information. PubChem. Perfluorooctanoic Acid. Density. Accessed September 20, 2022 at <https://pubchem.ncbi.nlm.nih.gov/compound/Perfluorooctanoic-acid>. Therefore, the mass of one measuring cup of PFOA is 426.6 grams or 426,600 milligrams. This mass of PFOA is 106,650,000 times greater than 0.004 milligrams (EPA's interim health advisory level per million liters). In order to dilute the mass of the PFOA in an equivalent volume of water, we multiplied 106,650,000 by 1,000,000. The result is 106,650,000,000,000 liters of water. There are 3.785 liters of water per gallon. U.S. Environmental Protection Agency. EPA

ExpoBox Unit Conversion Table. Accessed September 20, 2022 at <https://www.epa.gov/expobox/epa-expobox-unit-conversion-table>. Therefore, 106,650,000,000,000 liters of water is equal to a bit more than 28 trillion gallons of water – the amount of water that could be contaminated to EPA's interim health advisory level by one measuring cup of PFOA. Lake Erie contains an estimated 128 trillion gallons of water. Ohio Department of Natural Resources. Ohio Coastal Atlas, Chapter 2: Lake Erie Watershed (2018), at 35. Accessed Sept. 5, 2022, at https://ohiodnr.gov/static/documents/coastal/ohio-coastal-atlas/CH02_LakeErieWatershed.pdf. Therefore, five measuring cups of PFOA would be more than enough to contaminate the entire volume of water.

¹⁸ PSR calculated this figure by starting with 28 trillion gallons, the amount of water that could be contaminated under EPA's interim health advisory level by one measuring cup of PFOA (see endnote 17) and dividing it by New York City's daily consumption of 1.3 billion gallons of water. New York City. Environmental Protection. History of New York City Drinking Water (2021). Accessed Sept. 5, 2022, at <https://www1.nyc.gov/site/dep/water/history-of-new-york-citys-drinking-water.page>. The result is that one measuring cup of PFOA could contaminate a volume of water equivalent to what New York City would use over more than 21,500 days. Therefore, five measuring cups of PFOA could contaminate the amount of water equivalent to what New York City would use over 107,500 days.

¹⁹ Andrew B. Lindstrom et al. Polyfluorinated Compounds: Past, Present, and Future. Environmental Science & Technology (2011), 45, 7954-7961, 7956. Accessed Sept. 5, 2022, at <https://pubs.acs.org/doi/pdf/10.1021/es2011622>. Shantal Riley. Toxic Synthetic “Forever Chemicals” are in Our Water and on Our Plates. NOVA (PBS) (Nov. 2, 2020). Accessed Sept. 5, 2022, at <https://www.pbs.org/wgbh/nova/article/pfas-synthetic-chemicals-water-toxic/>. Oklahoma State University. Professor's Startup Turns Research into Real-World Solutions. News and Information (Oct. 3, 2018). Accessed Sept. 5, 2022, at <https://news.okstate.edu/articles/arts-sciences/2018/professors-startup-turns-research-into-real-world-solutions.html>.

²⁰ Ohio Environmental Protection Agency. PFAS Action Plan for Drinking Water. Accessed Sept. 5, 2022, at <https://epa.ohio.gov/monitor-pollution/pollution-issues/pfas-action-plan>.

²¹ Ohio Environmental Protection Agency. PFAS Action Plan for Drinking Water. Accessed Sept. 5, 2022, at <https://epa.ohio.gov/monitor-pollution/pollution-issues/pfas-action-plan>.

²² Ohio Environmental Protection Agency. PFAS Testing of Ohio Public Water Systems. Accessed Sept. 5, 2022, at <https://oepa.maps.arcgis.com/apps/MapSeries/index.html?appid=893553c5007f410d9bc55d9cf985342e>. Ismail Turay, Jr. 'Forever Chemicals' Found in 24 Drinking Water Systems in Region (Jan. 25, 2021). Accessed online Sept. 5, 2022 at <https://www.daytondailynews.com/news/forever-chemicals-found-in-24-drinking-water-systems-in-region/3VFPJ45T3FBTZEJBNV2IE2MFCY/>. Ismail Turay, Jr. Aullwood Switching to Public Water After 'Forever Chemicals' Detected in Well. Dayton Daily News (Aug. 23, 2021). Accessed Sept. 5, 2021 at <https://pfasproject.com/2020/10/16/ohio-epa-detects-pfas-in-aullwood-audubon-farm-discovery-center-public-water-system/>. Ohio EPA: Bridgeport, Ohio Water Has Unsafe Chemical Levels, Not Recommended for Drinking. The Intelligencer, Wheeling News-Register (July 21, 2020). Accessed Sept. 5, 2022 at <https://www.theintelligencer.net/news/top-headlines/2020/07/ohio-epa-bridgeport-ohio-water-has-unsafe-chemical-levels-not-recommended-for-drinking/>.

²³ Ohio Environmental Protection Agency. PFAS Testing of Ohio Public Water Systems. Accessed July 18, 2022, at <https://oepa.maps.arcgis.com/apps/MapSeries/index.html?appid=893553c5007f410d9bc55d9cf985342e>. See, e.g., a level of 10.5 parts per trillion PFOA for Farmer Boy Restaurant in Summit County that provides water for 193 people from groundwater and a level of 5.22 parts per trillion PFOA for Wtp-Cambridge in Guernsey County that provides water for 10,635 people from surface water.

²⁴ Ohio River Valley Sanitation Commission. Ambient PFAS Levels in the Ohio River (June 17, 2022), at 1-2, 8. Accessed June 24, 2022, at https://www.orsanco.org/wp-content/uploads/2022/06/Report-Ohio-River-PFAS-ORSANCO_2022-R10.pdf.

²⁵ Ryan Van Velzer. PFAS Found Throughout Ohio River in New Study. WFPL-radio (Louisville). Accessed July 18, 2022, at <https://www.cincinnati-oh.gov/water/water-quality-and-treatment/water-your-health/pfas-and-genx/>.

²⁶ Ryan Van Velzer. PFAS Found Throughout Ohio River in New Study. WFPL-radio (Louisville). Accessed July 18, 2022, at <https://www.cincinnati-oh.gov/water/water-quality-and-treatment/water-your-health/pfas-and-genx/>.

²⁷ Greater Cincinnati Water Works. PFAS and GenX (testing for Richard Miller Treatment Plant). Accessed July 18, 2022, at <https://www.cincinnati-oh.gov/water/water-quality-and-treatment/water-your-health/pfas-and-genx/>.

²⁸ Email from Greater Cincinnati Water Works to Dusty Horwitt (Aug. 18, 2022) (on file with PSR).

²⁹ Interstate Technology Regulatory Council. PFAS – Per- and Polyfluoroalkyl Substances. External Data Tables. Fact Sheets: PFAS Water and Soil Regulatory and Guidance Values Table Excel File. Accessed Sept. 5, 2022, <https://pfas-1.itrcweb.org/>.

³⁰ Michigan Department of Environment, Great Lakes, and Energy. Michigan Adopts Strict PFAS in Drinking Water Standards. News Release (July 22, 2020). Accessed Jan. 12, 2022, at <https://www.michigan.gov/egle/0,9429,7-135--534660--00.html>. Keith Matheny. Michigan's Drinking Water Standards for These Chemicals Now Among Toughest in the Nation. Detroit Free Press (Aug. 3, 2020). Accessed Jan. 12, 2022, at <https://www.freep.com/story/news/local/michigan/2020/08/03/tougher-pfas-standards-drinking-water-michigan/5574268002/>.

³¹ PSR performed the calculation using most of the data in endnote 17. However, in place of EPA's interim health advisory of 0.004 parts per trillion for PFOA, we used Michigan's drinking water standard of eight parts per trillion for PFOA. We found that under Michigan's standard, five measuring cups of PFOA could contaminate more than 70 billion gallons of water. We also relied on the following article. WBLT-TV. Study: Mississippians Drink Enough Beer to Fill 95 Olympic-Sized Swimming Pools over the Festive Season (reporting that an Olympic-sized swimming pool contains 660,000 gallons). Accessed September 20, 2022 at <https://www.wlbt.com/2021/12/15/study-mississippians-drink-enough-beer-fill-95-olympic-sized-swimming-pools-over-festive-season/>. We divided 70 billion gallons of water by 660,000 gallons of water in an Olympic-sized swimming pool. The result was more than 106,000 Olympic-sized swimming pools that could be contaminated by five measuring cups of PFOA under Michigan's drinking water standard.

³² Ismail Turay, Jr. Forever Chemicals Found in 24 Drinking Water Systems in Region. Dayton Daily News (Jan. 25, 2021). Accessed Sept. 5, 2022 at <https://www.daytondailynews.com/news/forever-chemicals-found-in-24-drinking-water-systems-in-region/3VFPJ45T3FBTZEJBNV2IE2MFCY/>.

³³ FracFocus. About. Accessed Sept. 5, 2022, at <https://www.fracfocus.org/index.php?p=about>.

³⁴ Groundwater Protection Council. Overview. Accessed Sept. 5, 2022, at <https://www.gwpc.org/about-us/overview/>.

³⁵ Gary Allison (2022) Open-FF: Transforming the FracFocus Disclosure Data into a Usable Resource [Source Code]. <https://doi.org/10.24433/CO.1058811.v14>

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- ³⁷ Safer States et al. PFAS polymers pose serious health and environmental threats. Accessed Sept. 5, 2022, at <https://www.nrdc.org/sites/default/files/pfas-polymer-fs.pdf>.
- ³⁸ Rainer Lohmann et al. Are Fluoropolymers Really of Low Concern for Human and Environmental Health and Separate from Other PFAS? *Environmental Science & Technology* 2020, 54, 12820-12828, 12821-2. Accessed Sept. 5, 2022, at <https://pubs.acs.org/doi/10.1021/acs.est.0c03244>. Safer States et al. PFAS polymers pose serious health and environmental threats. Accessed Sept. 5, 2022, at <https://www.nrdc.org/sites/default/files/pfas-polymer-fs.pdf>.
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- ⁴⁰ Rainer Lohmann et al. Are Fluoropolymers Really of Low Concern for Human and Environmental Health and Separate from Other PFAS? *Environmental Science & Technology* 2020, 54, 12820-12828, 12821-12822. Accessed Jan. 12, 2022, at <https://pubs.acs.org/doi/10.1021/acs.est.0c03244>.
- ⁴¹ Rainer Lohmann et al. Are Fluoropolymers Really of Low Concern for Human and Environmental Health and Separate from Other PFAS? *Environmental Science & Technology* 2020, 54, 12820-12828, 12823. Accessed Sept. 5, 2022, at <https://pubs.acs.org/doi/10.1021/acs.est.0c03244>.
- ⁴² David A. Ellis et al. Thermolysis of Fluoropolymers as a Potential Source of Halogenated Organic Acids in the Environment. *Nature. Letters to Nature*, Vol. 412 (July 19, 2001). Accessed Sept. 5, 2022 at <https://pubmed.ncbi.nlm.nih.gov/11460160/>.
- ⁴³ Rainer Lohmann et al. Are Fluoropolymers Really of Low Concern for Human and Environmental Health and Separate from Other PFAS? *Environmental Science & Technology* 2020, 54, 12820-12828, 12823. Accessed Sept. 5, 2022, at <https://pubs.acs.org/doi/10.1021/acs.est.0c03244>.
- ⁴⁴ Rainer Lohmann et al. Are Fluoropolymers Really of Low Concern for Human and Environmental Health and Separate from Other PFAS? *Environmental Science & Technology* 2020, 54, 12820-12828, 12823-12824. Accessed Sept. 5, 2022, at <https://pubs.acs.org/doi/10.1021/acs.est.0c03244>.
- ⁴⁵ Electronic mail communication with Ian Cousins, professor, Department of Environmental Science, Stockholm University (Oct. 15, 2021).
- ⁴⁶ Safer States et al. PFAS polymers pose serious health and environmental threats. Accessed Sept. 5, 2022, at <https://www.nrdc.org/sites/default/files/pfas-polymer-fs.pdf>.
- ⁴⁷ FracFocus. About. Accessed Sept. 5, 2022, at <https://www.fracfocus.org/index.php?p=about>.
- ⁴⁸ Ohio Rev. Code § 1509.10(A)(10)(b).
- ⁴⁹ Ohio Rev. Code § 1509.10(A)(10)(b).
- ⁵⁰ FracFocus. Chemical Names & CAS Registry Numbers. Accessed Sept. 5, 2022, at <https://www.fracfocus.org/index.php/explore/chemical-names-cas-registry-numbers>. American Chemical Society. CAS Registry. Accessed Sept. 5, 2022, at <https://bit.ly/3nnGpv4>.
- ⁵¹ 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 5-19. Accessed Sept. 5, 2022, at <https://www.epa.gov/hfstudy>.
- ⁵² U.S. Environmental Protection Agency. Criteria for Biodegradability Claims on Products Registered under FIFRA. Accessed Mar. 30, 2021, at <https://www.epa.gov/pesticide-labels/criteria-biodegradability-claims-products-registered-under-fifra>.
- ⁵³ 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 5-19. Accessed Sept. 5, 2022, at <https://www.epa.gov/hfstudy>.
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⁵⁶ Gloria B. Post. Recent U.S. State and Federal Drinking Water Guidelines for Per- and Polyfluoroalkyl Substances. *Environmental Toxicology and Chemistry* (Aug. 26, 2020). Accessed Sept. 7, 2022, at <https://setac.onlinelibrary.wiley.com/doi/10.1002/etc.4863>. The Lawyer Who Became Dupont's Worst Nightmare. *New York Times Magazine* (Jan. 6, 2016). Accessed Sept. 7, 2022, at <https://www.nytimes.com/2016/01/10/magazine/the-lawyer-who-became-duponts-worst-nightmare.html?searchResultPosition=1>.

⁵⁷ U.S. Environmental Protection Agency. PFAS Explained (last updated Oct. 18, 2021). Accessed Sept. 7, 2022, at <https://www.epa.gov/pfas/pfas-explained>.

⁵⁸ U.S. Environmental Protection Agency. PFAS Explained (last updated Oct. 18, 2021). Accessed Sept. 7, 2022, at <https://www.epa.gov/pfas/pfas-explained>.

⁵⁹ Dusty Horwitt. Fracking with Forever Chemicals. *Physicians for Social Responsibility* (July 2021), at 4, 10. Accessed Sept. 7, 2022, at <https://www.psr.org/wp-content/uploads/2021/07/fracking-with-forever-chemicals.pdf> (additional data on file with PSR).

⁶⁰ Juliane Glüge et al. An Overview of the Uses of Per- and Polyfluoroalkyl Substances (PFAS) – Electronic Supplementary Information 1. *Environmental Science: Processes and Impacts* (Oct. 30, 2020) at 50-51, 53. Accessed online Sept. 7, 2022, at <https://pubs.rsc.org/en/content/articlelanding/2020/em/d0em00291g#!divAbstract>.

⁶¹ Peter M. Murphy and Tracy Hewat. Fluorosurfactants in Enhanced Oil Recovery. *The Open Petroleum Engineering Journal*, 1, 58-61, 58 (2008). Accessed Sept. 7, 2022, at <https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.858.5125&rep=rep1&type=pdf>.

⁶² 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 3-18 through 3-22, 5-7, 5-8, 5-11, 5-16, 6-67. EPA Report # 600/R-16/236F. Accessed Sept. 7, 2022, at <https://www.epa.gov/hfstudy>. Genevieve A. Kahrilas et al. Biocides in Hydraulic Fracturing Fluids: A Critical Review of Their Usage, Mobility, Degradation, and Toxicity. *Environ. Sci. Technol.* 201549116-32 (Nov. 26, 2014). Accessed Sept. 7, 2022, at <https://pubs.acs.org/doi/10.1021/es503724k>.

⁶³ 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 9-1. Accessed Sept. 7, 2022, at <https://www.epa.gov/hfstudy>.

⁶⁴ See, e.g., U.S. Environmental Protection Agency. Focus report for chemical with EPA case number P-06-0676. Washington, DC: New Chemicals Program; 2006 (on file with PSR).

⁶⁵ Ohio Department of Natural Resources, Division of Oil and Gas Resources Management, Oil and Gas Well Locator, Form 8(A) for well API Number 34-111-24285. Accessed Sept. 7, 2022, at <https://gis.ohiodnr.gov/MapView/?config=oilgaswells>.

⁶⁶ Public Employees for Environmental Responsibility. Revealed: EPA Data on PFAS Sites (Oct. 17, 2021). Accessed Jan. 12, 2022, at <https://www.peer.org/blog-revealed-epa-data-on-potential-pfas-sites/> (showing approximately 40 oil and gas sites in eastern Ohio that “may be handling” PFAS, according to EPA including one “well pad” and several sites described as a “pad”).

⁶⁷ Ohio Rev. Code § 1509.10(b) (created by SB 165, §1 128th General Assembly, effective 6/30/2010; amended by HB 153, §101.01 129th General Assembly, effective 9/29/2011; amended by SB 315, §101.01 129th General Assembly, effective 9/10/2012).

⁶⁸ Ohio Rev. Code § 1509.10(A)(10)(a-b), (11)(F-G).

⁶⁹ Ohio Rev. Code § 1509.10 (A)(9)(a).

⁷⁰ Colorado General Assembly. HB22-1348. Senate Amended 3rd Reading (May 11, 2022). Accessed Sept. 8, 2022, at https://leg.colorado.gov/sites/default/files/documents/2022A/bills/2022a_1348_rer.pdf.

⁷¹ 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 3-14, 3-15, 10-14. Accessed Sept. 5, 2022, at <https://www.epa.gov/hfstudy>.

⁷² Ohio Rev. Code § 1509.10(A)(9)(a) and (10)(b), (11)(1).

⁷³ FracFocus. Find a Well. Accessed Sept. 8, 2022 at <https://fracfocusdata.org/DisclosureSearch/Search.aspx>. See, e.g., FracFocus Record for well with API number 34-067-21688 in Harrison County, Ohio, hydraulically fractured between Dec. 23, 2021 and Jan. 10, 2022 (reporting use of proprietary “inorganic salt”); FracFocus Record for well with API number 34-111-24742 in Monroe County, Ohio, hydraulically fractured between Feb. 4, 2020 and Mar. 5, 2020 (reporting use of “proprietary surfactant”).

⁷⁴ Ohio Department of Natural Resources. Division of Oil and Gas. Well Locator. Accessed Sept. 8, 2022 at <https://gis.ohiodnr.gov/MapView/WellSummaryCard.asp?api=34111242880000> (showing Form 8A for well with API number 34-111-24285 in Monroe County, reporting use of trade secret “phosphates,” “quaternary ammonium chloride,” and “amine derivative.”)

⁷⁵ Juliane Glüge et al. An Overview of the Uses of Per- and Polyfluoroalkyl Substances (PFAS) – Electronic Supplementary Information 1. Environmental Science: Processes and Impacts (Oct. 30, 2020) at 50-51. Accessed Sept. 7, 2022, at <https://pubs.rsc.org/en/content/articlelanding/2020/em/d0em00291g#!divAbstract>.

⁷⁶ U.S. Environmental Protection Agency. Statoil Eisenbarth Well Response. POLREP #1 (June 29, 2014). Accessed

Sept. 8, 2022, at https://response.epa.gov/site/sitrep_profile.aspx?site_id=9350&counter=21767. Laura Arenschiold. Fracking Fire Points out Failings. Columbus Dispatch (Aug. 31, 2014). Accessed Sept. 8, 2022, at <https://www.dispatch.com/story/news/environment/2014/08/31/fracking-fire-points-out-failings/23774273007/>.

⁷⁷ 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). Accessed Sept. 8, 2022, at <https://www.marketplace.org/2017/11/15/epas-legalized-suppression-fracking-chemical-secrets/>.

⁷⁸ U.S. Environmental Protection Agency. Statoil Eisenbarth Well Response. POLREP #1 (June 29, 2014). Accessed Sept. 8, 2022, at https://response.epa.gov/site/sitrep_profile.aspx?site_id=9350&counter=21767. Laura Arenschiold. Fracking Fire Points out Failings. Columbus Dispatch (Aug. 31, 2014). Accessed Sept. 8, 2022, at <https://www.dispatch.com/story/news/environment/2014/08/31/fracking-fire-points-out-failings/23774273007/>. Fortune. ExxonMobil. Accessed Sept. 8, 2022, at <https://fortune.com/company/exxon-mobil/>.

⁷⁹ PSR calculated the estimated maximum amounts of trade secret chemicals used in each well in Ohio primarily by using disclosures by well operators for each well listed in FracFocus. We then aggregated the maximum amounts for each well to calculate county-by-county and state-wide totals. To illustrate the methodology, we will use as an example the figures from XTO Energy/ExxonMobil’s well number 35-019-26303 fractured in Carter County, Oklahoma in 2019. We estimated the total mass of the hydraulic fracturing fluid used in each well in pounds by multiplying the gallons of water listed as being used as the base fluid for the hydraulic fracturing fluid (223,650 in this case) by 8.33, the number of pounds in a gallon of water as listed in a table of the weights of various solvents published by the U.S. Environmental Protection Agency. See U.S. Environmental Protection Agency. Conversion from Gallons to Pounds of Common Solvents. Accessed Sept. 9, 2022, at <https://www.epa.gov/p2/pollution-prevention-tools-and-calculators>. That quantity of water in the XTO Energy/ExxonMobil example weighs approximately 1,863,005 pounds. We then calculated the total mass of the fracturing fluid by multiplying the mass of the water in pounds by 100 and dividing that product by the listed maximum concentration

in percent by mass of water in the fracturing fluid (78.31797). The estimated total maximum mass of the fracturing fluid in the example is 2,378,770 pounds. Next, we multiplied the listed maximum concentration in percent by mass of the potential PFAS chemical in the fracturing fluid (0.00074) by the total estimated mass of the fluid. The result was an estimated maximum of 17.6 pounds of potential PFAS used to fracture the well.

⁸⁰ Gloria B. Post. Recent U.S. State and Federal Drinking Water Guidelines for Per- and Polyfluoroalkyl Substances. Environmental Toxicology and Chemistry (Aug. 26, 2020). Accessed Sept. 7, 2022, at <https://setac.onlinelibrary.wiley.com/doi/10.1002/etc.4863>. The Lawyer Who Became Dupont’s Worst Nightmare. New York Times Magazine (Jan. 6, 2016). Accessed Sept. 7, 2022, at <https://www.nytimes.com/2016/01/10/magazine/the-lawyer-who-became-duponts-worst-nightmare.html?searchResultPosition=1>.

⁸¹ U.S. Environmental Protection Agency. PFAS Explained (last updated Oct. 18, 2021). Accessed Sept. 7, 2022, at <https://www.epa.gov/pfas/pfas-explained>.

⁸² PSR determined that a chemical was a surfactant if the chemical’s ingredient name or purpose was listed in FracFocus as a surfactant.

⁸³ Jennifer Hiller. Chesapeake Energy Emerges from Bankruptcy and Shifts Back to Natural Gas. Reuters (Feb. 9, 2021). Accessed Sept. 8, 2022, at <https://www.reuters.com/article/us-chesapeake-energy-bankruptcy/chesapeake-energy-emerges-from-bankruptcy-and-shifts-back-to-natural-gas-idUSKBN2A92Z7>.

⁸⁴ Equinor. The Norwegian State as Shareholder. Accessed Sept. 8, 2022, at <https://www.equinor.com/about-us/the-norwegian-state-as-shareholder>.

⁸⁵ Fortune. ExxonMobil. Accessed Sept. 8, 2022, at <https://fortune.com/company/exxon-mobil/>.

⁸⁶ 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 8-25. Accessed Sept. 5, 2022, at <https://www.epa.gov/hfstudy>.

⁸⁷ 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-3, 4-8, 6-39. Accessed Sept. 5, 2022, at <https://www.epa.gov/hfstudy>.

⁸⁸ Dusty Horwitt. Fracking with Forever Chemicals. Physicians for Social Responsibility (July 2021), at 15. Accessed Sept. 8, 2022, at <https://www.psr.org/wp-content/uploads/2021/07/fracking-with-forever-chemicals.pdf>.

⁸⁹ Bruce Finley. Drilling Spills Reaching Colorado Groundwater; State Mulls Test Rules. Denver Post (Dec. 8, 2012) (reporting that in Colorado, “Oil and gas have contaminated groundwater in 17 percent of the 2,078 spills and slow releases that companies reported to state regulators over the past five years, state data show”). Accessed Sept. 8, 2022, at <https://www.denverpost.com/2012/12/08/drilling-spills-reaching-colorado-groundwater-state-mulls-test-rules/>.

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1111 14th Street NW, #700
Washington, DC 20005
202 667 4260
www.psr.org
psrnatl@psr.org

 @PSRenvironment and @PSRnuclear
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**PHYSICIANS
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U.S. AFFILIATE OF INTERNATIONAL PHYSICIANS FOR THE PREVENTION OF NUCLEAR WAR

Fracking with “Forever Chemicals” in Pennsylvania

Oil and Gas Companies Used PFAS in Pennsylvania Wells;
Extent of Use Obscured by 160 Million Pounds of Trade Secret Chemicals;
Rural Areas at Risk

By Dusty Horwitt, J.D. & Barbara Gottlieb

Data Analysis by Gary Allison

October 2023



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Cover photo: Fluids impoundment at Wherry unconventional gas well pad, West Bethlehem Township, Washington County, Pa., April 5, 2021.
Photo credit: Courtesy of Marcellus Air.

Maps by Matt Kelso, FracTracker Alliance

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EXECUTIVE SUMMARY

Information unearthed and analyzed by Physicians for Social Responsibility (PSR) shows that since 2012, oil and gas companies* used in Pennsylvania's unconventional or "fracking" gas wells a class of extremely toxic and persistent chemicals known as PFAS. During that same period, the companies used 160 million pounds of unidentified chemicals that could themselves be PFAS. The companies withheld these chemical identities from the public as "trade secrets," a practice allowed by state law.

PFAS are a class of chemicals known for their toxicity at extraordinarily low levels, their multiple negative health effects including cancer, and their persistence in the environment, leading to their nickname, "forever chemicals." Using these chemicals may be particularly risky because PFAS could not only cause contamination near well sites; they could also pollute places where solid waste and enormous volumes of toxic wastewater from oil and gas wells are disposed of, miles from well sites.

Data publicly disclosed by the oil and gas industry indicates that between 2012 and 2022, two oil and gas companies injected the PFAS known as PTFE or Teflon into a total of eight unconventional gas wells in Western Pennsylvania. **However, this number of industry-reported instances may significantly underrepresent the reality of PFAS use in the Keystone State, due to weaknesses in state reporting rules.**

One major hindrance to quantifying the use of PFAS chemicals is the extensive use of trade secret or Confidential Business Information designations. Between 2012 and 2022, oil and gas companies injected more than 5,000 unconventional gas wells with at least one trade secret chemical per well, totaling 160 million pounds. Oil and gas companies injected more than 1,200 wells with incompletely identified chemicals that could be fluorosurfactants, a class of chemical that includes multiple PFAS.

During the same decade-long period, 15 oil and gas companies operating in Pennsylvania injected oil and gas wells in other states with fracking chemicals that are PFAS or potential PFAS, while not reporting that they used these substances in their Pennsylvania wells. These substances include PTFE/Teflon and fluoroalkyl alcohol substituted polyethylene glycol, both of which have been identified as PFAS by EPA. In addition, five companies operating in Pennsylvania disclosed that they injected wells in five other states with nonionic fluorosurfactants, a class of chemicals identified as PFAS, potential PFAS, or precursors that could degrade into PFAS. Yet in Pennsylvania, only two companies reported the use of a single PFAS, PTFE, in eight wells. This raises questions about whether some companies are using PFAS in Pennsylvania on an undisclosed basis.

Should only a fraction of the unidentified chemicals used in Pennsylvania's unconventional gas wells be PFAS, they could pose a significant threat to human health.

It is difficult to access fracking chemical data in Pennsylvania for conventional wells that can be developed without fracking – far more difficult than it is for unconventional gas wells that must typically be hydraulically fractured or "fracked." This difficulty explains why this report focuses on unconventional gas wells. This and other regulatory hurdles prevent the public from knowing how widely PFAS – or other toxic chemicals – have been used in unconventional gas wells or in other types of oil and gas wells. Another potential route of contamination from PFAS is the use in fracking of water already tainted with PFAS. State regulations do not require testing for contaminants in water used for fracking. Our findings, including the gaps in our findings, raise concerns that Pennsylvanians may unknowingly be exposed to highly hazardous PFAS chemicals, particularly in rural areas where most unconventional gas wells are drilled and fracked.

* This report refers to "oil and gas companies" or the "oil and gas industry" even when discussing only unconventional gas wells, as some of the companies that operate unconventional gas wells also operate oil wells, whether in Pennsylvania or other states.

An interactive map showing the locations of wells injected with PFAS and trade secret chemicals is [available here](#). Users can zoom in to identify wells near them.

In light of our findings, PSR recommends the following:

- **Halt PFAS use in oil and gas extraction.** Pennsylvania and the U.S. Environmental Protection Agency (EPA) should prohibit PFAS from being used, manufactured, or imported for oil and gas extraction. Many PFAS are replaceable with less-persistent and less-toxic alternatives. In taking this step, Pennsylvania would be following the lead of Colorado, a major oil- and gas-producing state that in June 2022 passed legislation banning the use of PFAS in oil and gas wells.
- **Expand public disclosure.** Pennsylvania should greatly expand its requirements for public disclosure of oil and gas chemicals. The state could again follow the example offered by Colorado by requiring disclosure of all individual chemicals used in oil and gas wells, without exceptions for trade secrets. This action can be done while still protecting product formulas as trade secrets. Pennsylvania should also require disclosure on the part of chemical manufacturers and require chemical disclosure prior to permitting, as have California, West Virginia, and Wyoming.
- **Increase testing and tracking.** Pennsylvania and/or the U.S. EPA should determine where PFAS have been used in oil and gas operations in the state and where related wastes have been deposited. They should test nearby residents, water, soil, flora, and fauna for PFAS, both for the particular type(s) of PFAS used and for organic fluorine to detect the presence of other PFAS and/or their breakdown products. They should use testing equipment sensitive enough to detect PFAS at a level of single-digit parts per trillion or lower.
- **Require funding and cleanup.** Oil and gas and chemical manufacturing firms should be required to fund environmental testing for PFAS in their areas of operation, and should PFAS be found, be required to fund cleanup. If cleanup of water sources is impossible, companies

responsible for the use of PFAS should pay for alternative sources of water for homes, schools, hospitals, agriculture and other uses for as long as needed.

- **Remove Pennsylvania's oil and gas hazardous waste exemption.** Pennsylvania exempts oil and gas industry wastes from state hazardous waste rules. Pennsylvania should follow New York's lead and remove its state-level hazardous waste exemption for the oil and gas industry.
- **Reform Pennsylvania's regulations for oil and gas production wells and underground injection disposal wells.** The state should prohibit production wells and underground wastewater disposal wells close to underground sources of drinking water, homes, health care facilities and schools; require groundwater monitoring for contaminants near the wells, and for disposal wells, require full public disclosure of chemicals in the wastewater.
- **Transition to renewable energy and better regulation.** Given the use of highly toxic chemicals in oil and gas extraction, including but not limited to PFAS, as well as climate impacts of oil and gas extraction and use, Pennsylvania should transition away from fracking and move toward renewable energy and energy efficiency while providing economic support for displaced oil and gas workers. As long as drilling and fracking continue, the state should better regulate these practices so that Pennsylvanians are not exposed to toxic substances and should empower local governments also to regulate the industry. When doubt exists as to the existence or danger of contamination, the rule of thumb should be, "First, do no harm."

CH. 1 PFAS: A MANMADE THREAT TO HEALTH AND THE ENVIRONMENT, USED IN PENNSYLVANIA'S OIL AND GAS WELLS

a. PFAS Used in Pennsylvania Wells

Physicians for Social Responsibility (PSR) has identified evidence from publicly reported oil and gas industry* records that a highly dangerous class of chemicals, known as per- and polyfluoroalkyl substances (PFAS), has been used for hydraulic fracturing (“fracking”) in Pennsylvania’s unconventional gas** wells and that such use could be much more extensive than reported. PFAS are known for their toxicity at extremely low levels,¹ their multiple negative health effects including cancer,² and their persistence in the environment, which has endowed them with their nickname, “forever chemicals.”³ Fracking is the stage of oil and gas operations that typically involves high-pressure injections into oil and gas wells of up to tens of millions of gallons of water, sand, and chemicals to fracture rock formations and free up trapped oil and gas.^{4***} It is possible that PFAS have also been used in additional stages and methods of oil and gas production in Pennsylvania.

The use of PFAS in oil and gas production in Pennsylvania was first exposed in 2021 in an editorial by the Philadelphia Inquirer⁵ that was prompted by a report from Physicians for Social Responsibility about the use of PFAS in oil and gas operations in other states.⁶ Later in 2021, the nonprofit Public Employees for Environmental Responsibility published a report based on U.S. Environmental Protection Agency data indicating that PFAS had been used in oil and gas operations in Pennsylvania.⁷ PSR’s findings in this report, however, go even further. Based on fracking chemical disclosures made by oil and gas well operators to the nongovernmental organization FracFocus, PSR is able to identify not only the unconventional gas wells definitively known to have been injected with PFAS between 2012 and 2022, but also the wells injected with trade secret chemicals and, for the first time, the staggering quantities of these unidentified substances.

The wells known to be injected with PFAS consist of eight wells injected with PTFE, also known as Teflon and identified by the U.S. Environmental Protection Agency (EPA) as a PFAS.⁸ One of these wells, fracked by Chesapeake Operating Inc. with 18 pounds of PTFE, was located in Beaver County;⁹ three wells fracked by Hilcorp Energy Company with 12 pounds of PTFE were located in Lawrence County,¹⁰ and four wells fracked by Chesapeake Operating Inc. with an unknown amount of PTFE were located in Washington County.¹¹ See Appendix C for more detail about PTFE. PSR was able to identify wells injected with PTFE through disclosure of Chemical Abstract Service (CAS) numbers, unique numeric identifiers assigned to each chemical by the American Chemical Society.¹² Scientists consider CAS numbers the best way to identify chemicals because chemicals can have multiple names or trade names but only one CAS number.¹³

The larger story, however, is the staggering number of wells injected with trade secret chemicals that could be PFAS. PSR found that between 2012 and 2022, oil and gas companies disclosed the use of fracking chemicals in more than 7,200 unconventional gas wells and injected more than 5,000 (70 percent) with at least one trade secret fracking chemical. These chemicals totaled 160 million pounds. In these cases, oil and gas companies did not disclose a CAS number for the chemical, preventing the public from knowing what these chemicals are. Oil and gas companies injected more than 1,000 of the wells with trade secret surfactants, a category of chemical that may be more likely to be PFAS because they include a subcategory known as fluorosurfactants that are often PFAS. According to EPA, surfactants are commonly used in fracking.¹⁴ These substances lower the surface tension of a liquid, the interaction at the surface between two liquids (called interfacial tension), or the interaction between

* This report refers to “oil and gas companies,” the “oil and gas industry,” etc. even when discussing only unconventional gas wells because at least some of the companies that operate unconventional gas wells also operate oil wells, whether in Pennsylvania or other states.

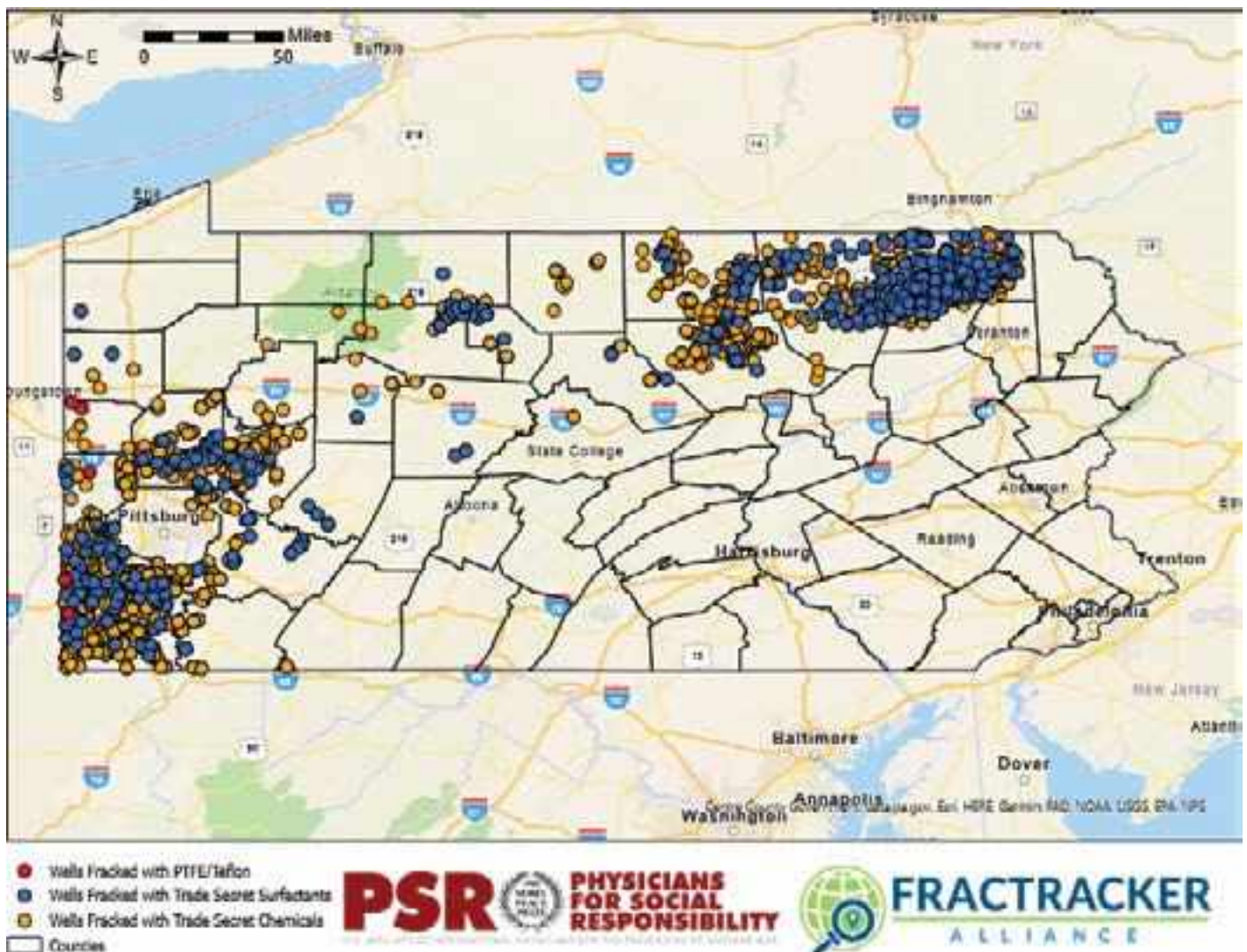
** Gas, the principal component of which is methane, is also known as “natural” gas, “fossil” gas and “fracked” gas.

*** In this report, the term “fracking” is used to discuss a particular stage in oil and/or gas production as distinct from other stages or methods of production such as drilling that precedes fracking. The terms “oil and gas production,” “oil and gas extraction,” and “oil and gas operations” cover the entire process of producing oil and/or gas.

a liquid and a solid.¹⁵ Compared to other surfactants, fluorosurfactants are said to be “superior in their aqueous surface tension reduction at very low concentrations and are useful as wetting and leveling agents, emulsifiers, foaming agents, or dispersants.”¹⁶ At least some fluorosurfactants are PFAS, including the dangerous chemicals PFOA and PFOS¹⁷ and 8:2 fluorotelomer alcohol,¹⁸ a nonionic fluorosurfactant¹⁹ that can break down into PFOA.²⁰

The use of PFAS and trade secret chemicals that may be PFAS is particularly alarming as Pennsylvania’s gas production has increased by almost 45 times between 2005 and 2021, from 168 billion cubic feet to 7.5 trillion cubic feet.²¹ These increases have led to modest gains in jobs in the major gas-producing counties²² and somewhat more revenue for the state.²³ But they also mean more greenhouse gas emissions²⁴ and greater risk of pollution from PFAS and other toxic substances associated

Figure 1. Pennsylvania Oil & Gas Wells Fracked with PFAS and Possible PFAS, Including Trade Secret Chemicals, 2012-2022



This map shows the location of oil and gas wells in Pennsylvania known to have been fracked between January 1, 2012 and September 29, 2022 using PTFE/Teflon (a known PFAS), trade secret chemicals, and/or trade secret surfactants. An interactive version of the map is available at <https://ft.maps.arcgis.com/apps/webappviewer/index.html?appid=dc81f7ec3af64541a1875e8e6e5add60> where users can zoom in to identify wells near them. For a detailed explanation of data sources, see Appendix A.

with gas extraction, including an increased risk of exposure to naturally occurring carcinogenic radium that emerges from Marcellus Shale wells in millions of gallons of wastewater.²⁵

b. Oil and Gas Operations Provide Many Potential Routes of Exposure to PFAS

Oil and gas operations in Pennsylvania deserve scrutiny as a possible source of PFAS contamination, given the documented use of PFAS in the state's oil and gas wells and the potential that people could be exposed to such PFAS via multiple pathways.

EPA in a 2016 national report on fracking and drinking water found that fracking-related pollution could follow a number of pathways that could impact surface water and groundwater. The agency cited the following possible pathways to exposure:

- spills of fracking fluid that seep into groundwater;
- injection of fracking fluid into wells with cracks in the casing or cement, allowing the fluid to migrate into aquifers (see opposite diagram)
- injection of fracking fluids directly into groundwater;
- underground migration of fracking fluids through fracking-related or natural fractures;
- intersection of fracking fluid with nearby oil and gas wells,
- spills of wastewater after the fracking process is completed, and
- inadequate treatment and discharge of fracking wastewater to surface water supplies.²⁶

PFAS used in oil and gas extraction could pollute water through any of these pathways, plus other routes discussed in more detail in Chapter 4, including through airborne releases and disposal of oil and gas wastewater in underground injection wells, a pathway that EPA did not examine in its 2016 report.²⁷

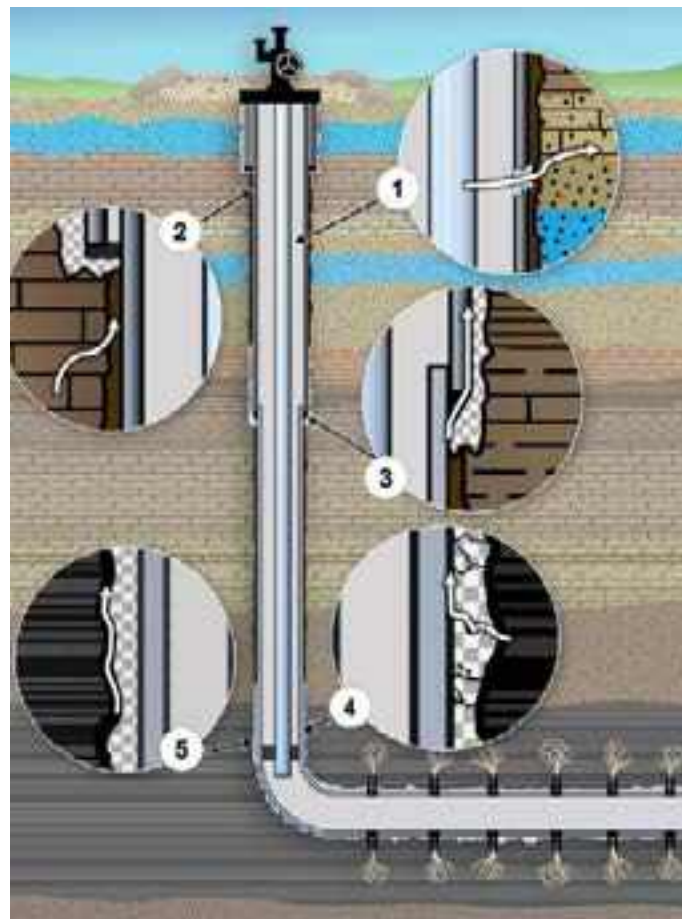


Diagram from U.S. Environmental Protection Agency's 2016 report on fracking and drinking water (p. ES-29) shows the various pathways through which fluid can migrate up an oil or natural gas well and potentially pollute groundwater including through leaks in the steel casing or cement designed to seal off the casing from the groundwater. EPA wrote that "These pathways (represented by the white arrows) include: (1) a casing and tubing leak into the surrounding rock, (2) an uncemented annulus (i.e., the space behind the casing), (3) microannuli between the casing and the cement, (4) gaps in cement due to poor cement quality, and (5) microannuli between the cement and the surrounding rock." EPA noted that the diagram is not to scale.

c. Manmade and Dangerous: PFAS's History and Health Effects

PFAS are a class of thousands of synthetic chemicals manufactured to have properties that are valuable in multiple industrial contexts, such as being slippery, oil- and water-repellant, and able to serve as dispersants or foaming agents.²⁸ PFAS have been called "perfluorinated chemicals"

and “polyfluorinated compounds,” or PFCs, though the term currently preferred by EPA is PFAS.²⁹

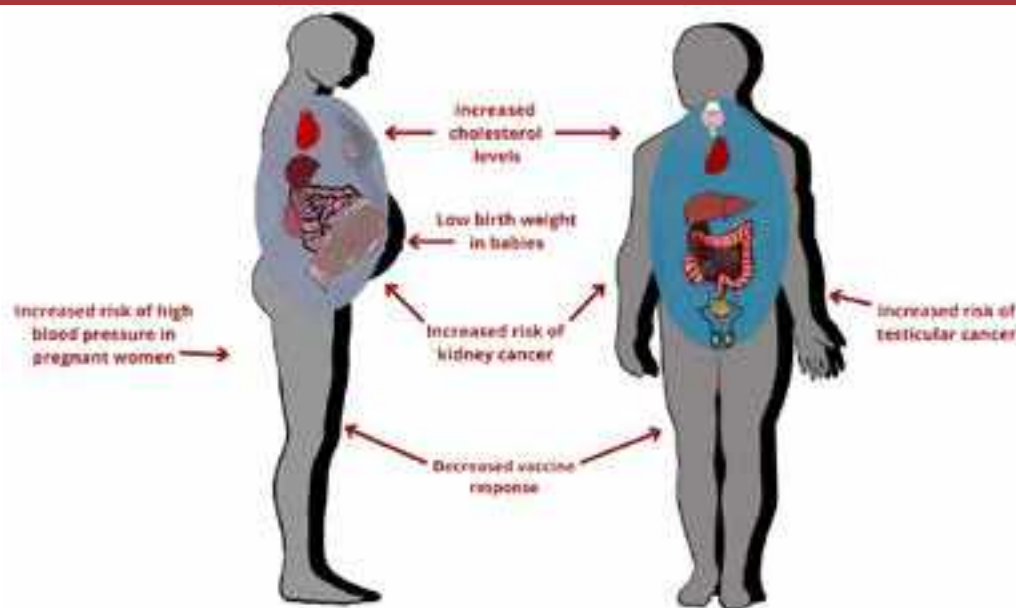
The first PFAS to be sold commercially was created by a chemist at Dupont and was patented as Teflon. Since 1949, it has been used in thousands of products, from nonstick cookware to waterproof clothing to plastics to dental floss.³⁰ Other PFAS chemicals, the most prominent of which are known as PFOA and PFOS, were used in food packaging, fire-fighting foam, and in 3M’s widely used fabric protector, Scotchgard.³¹ EPA reported in 2021 that about 650 types of PFAS remained in commerce.³² Weak chemical disclosure laws make it difficult for the Agency to identify which PFAS chemicals are used, and where.

Between the 1960s and 1990s, researchers inside Dupont and 3M became aware that at least some of the PFAS they were manufacturing or using, particularly PFOA and PFOS, were associated with health problems including cancers and birth defects, had accumulated in people worldwide, and persisted in the environment.³³ Many of these facts, kept internal by the companies, came to light after attorney Rob Bilott filed lawsuits in 1999 and 2001 accusing Dupont

of causing pollution in and around Parkersburg, West Virginia with PFOA, a type of PFAS then used in making PTFE (Teflon).³⁴ In December 2011, as part of Dupont’s settlement of the 2001 lawsuit, a team of epidemiologists completed a study of the blood of 70,000 West Virginians and found a probable link between PFOA and kidney cancer, testicular cancer, thyroid disease (over or under-production of hormones by the thyroid gland), high cholesterol, pre-eclampsia (a potentially dangerous complication during pregnancy characterized by high blood pressure and signs of damage to other organ systems, most often the liver and kidneys), and ulcerative colitis (a disease causing inflammation and ulcers in the large intestine or colon).³⁵

Current peer-reviewed scientific research on PFAS suggests that exposure to certain levels of some PFAS may lead to adverse health outcomes. Research findings differ, as different studies have examined different PFAS chemicals, different types or levels of exposure, and different exposed populations. However, some findings are more widely endorsed; for example, the U.S. Environmental Protection Agency (EPA)³⁶ and the Center for Disease Control and Prevention’s Agency for Toxic Substances and Disease

POTENTIAL HEALTH EFFECTS OF PFAS EXPOSURE



Exposure to PFAS chemicals can result in a variety of serious health effects including those indicated above. Source: U.S. Environmental Protection Agency, Agency for Toxic Substances and Disease Registry. Graphic by Astra Robles.

Registry (ATSDR)³⁷ agree that exposure to high levels of certain PFAS may lead to increased risk of high blood pressure in pregnant women; low birth weight in babies; increased risk of kidney or testicular cancer; decreased vaccine response, and increased cholesterol levels. Research is ongoing to determine the health effects of different levels of exposure to different PFAS, including the health effects of long-term, low-level PFAS exposure, especially in children.

PFAS are not only highly toxic; they also demonstrate extreme persistence in the environment. PFAS' nickname "forever chemicals" reflects their chemistry – created by chemical manufacturers – that features a bond between fluorine and carbon atoms that is among the strongest in chemistry and rarely if ever exists in nature. The result: chemicals that are extremely resistant to breaking down.³⁸ PFAS are also extremely mobile in water,³⁹ making them able to spread through the environment via groundwater or surface water. Another risk, discussed in Chapter 3, is that PFAS could compound the health effects from other dangerous chemicals associated with oil and gas production.

d. EPA – and Pennsylvania – Recognize Risks of PFAS

EPA has been slow to regulate PFAS, but the agency has taken actions, particularly in recent years, that recognize PFAS's extraordinary risks. In June 2022, reflecting growing public concern about PFAS, EPA significantly lowered its non-binding health advisory level for PFOA and PFOS in drinking water. Previously, EPA had set the combined health advisory level for these two chemicals at 70 parts per trillion.⁴⁰

"The new published peer-reviewed data and draft EPA analyses [citation omitted] indicate that the levels at which negative health outcomes could occur are much lower than previously understood," EPA wrote in June 2022.⁴¹ EPA lowered its new interim health advisory level for PFOA in drinking water to 0.004 parts per trillion and its interim health advisory level for PFOS to 0.02 parts per trillion.⁴² EPA also set new final health advisory levels for two other PFAS, known as GenX and PFBS, at 10 parts per trillion and 2,000 parts per trillion, respectively.⁴³ EPA

said that its interim health advisory levels were intended to provide guidance until enforceable drinking water regulations for PFAS take effect.⁴⁴ EPA explained that its health advisory level "is designed to be protective of noncancer effects over a lifetime of exposure, including sensitive populations and life stages, and is typically based on data from experimental animal toxicity and/or human studies." The agency wrote that exposure to PFOA, PFOS, and Gen X is associated with cancer. But the agency had not yet developed cancer risk concentrations in water for these substances. EPA added that, at least for PFOA and PFOS, the interim health advisory levels could change following review by its Science Advisory Board.⁴⁵

EPA then in March 2023 released proposed legally enforceable "Maximum Contaminant Levels" for six PFAS in drinking water. These regulations, unlike health advisories, must take into account whether a particular level of protection can be achieved and at what cost.⁴⁶ For this reason, they may be much less stringent than the health advisories. The MCLs proposed by EPA included a level of four parts per trillion for both PFOA and PFOS. EPA also proposed an MCL Goal or non-enforceable target of zero for both of these PFAS. The agency proposed that drinking water providers limit the combined levels of four other types of PFAS: PFNA, PFHxS, PFBS, and/or GenX Chemicals.⁴⁷ The MCLs would require public water systems to monitor for the six PFAS, notify the public about the levels of these PFAS, and reduce levels of the six PFAS in drinking water if levels exceed the MCLs.⁴⁸ The agency said that it expects to finalize the regulations by the end of 2023,⁴⁹ though the Pennsylvania Environmental Quality Board has stated that the rules are not expected to take effect until several years after that date.⁵⁰

Even the higher MCL figures demonstrate the extraordinary toxicity of some types of PFAS. At a level of four parts per trillion, a measuring cup of PFOA could contaminate 28 billion gallons of water,⁵¹ more than 90 times the 300 million gallons of drinking water treated each day by Philadelphia.⁵²

Pennsylvania has also taken action to identify and regulate PFAS pollution. In March 2021, the Pennsylvania

Department of Environmental Protection (DEP) completed sampling of concentrations for 18 types of PFAS at 372 public water systems and 40 baseline sites.⁵³ These baseline sites featured at least 75 percent forested land and were located at least five miles from potential sources of contamination such as airports, manufacturing facilities, and military bases.⁵⁴ The DEP found PFOA in 112 of the 412 samples at an average concentration of 7.5 parts per trillion and a median concentration of 5.3 parts per trillion.⁵⁵ The agency found PFOS in 103 of the 412 samples at an average concentration of 9.9 parts per trillion and a median concentration of 6.5 parts per trillion.⁵⁶ All of these average and median concentrations were much higher than EPA's health advisory levels and somewhat higher than EPA's proposed drinking water standard. Environmental Working Group, a nonprofit, has also found elevated levels of PFAS pollution – some staggering high – in public drinking water systems, and at military bases and industrial sites.⁵⁷

Following its sampling program, and before EPA announced its drinking water standards in March 2023, Pennsylvania in January issued drinking water standards for PFOA and PFOS that applied to 3,117 water systems in the state.⁵⁸ For PFOA, the state's Environmental Quality Board set an enforceable Maximum Contaminant Level of 14 parts per trillion and a non-enforceable maximum contaminant Goal of 8 parts per trillion.⁵⁹ For PFOS, the Board set an enforceable MCL of 18 parts per trillion⁶⁰ and a maximum contaminant Goal of 14 parts per trillion.⁶¹ "Although the EPA has started the process of setting more stringent standards for PFOA and PFOS in drinking water," the Board wrote, "that process is expected to take years to complete. For that reason, these more protective standards for this Commonwealth will better protect the health of residents in this Commonwealth."⁶²

Several experts told PSR that because of the extreme potency of certain types of PFAS and the fact that chemical makers have created thousands of these forever chemicals, they would recommend particular testing methods to detect PFAS in the environment. The scientists are Linda Birnbaum, Ph.D., D.A.B.T., A.T.S., a board-certified

toxicologist and former director of the National Institute of Environmental Health Sciences;⁶³ Zacariah Hildenbrand Ph.D., research professor in Chemistry and Biochemistry at the University of Texas at El Paso;⁶⁴ Kevin Schug Ph.D., Shimadzu Distinguished Professor of Analytical Chemistry at the University of Texas at Arlington,⁶⁵ and Wilma Subra, holder of a master's degree in chemistry and recipient of a John D. and Catherine T. MacArthur Foundation "Genius" grant for her work helping to protect communities from toxic pollution.⁶⁶ All were in agreement in recommending the use of testing equipment that can detect PFAS in concentrations at least as low as single-digit parts per trillion. They further recommended testing for total organic fluorine in addition to testing for specific types of PFAS. Total organic fluorine is a marker that would indicate the presence of PFAS even if a specific PFAS were not tested for. Testing for specific PFAS might fail to detect other forms of PFAS present in the sample.

e. PFAS in Oil and Gas Operations May Threaten Rural Areas, Add to PFAS from Other Sources

The risk of PFAS pollution from oil and gas operations is likely to be particularly high in rural areas and may add to PFAS pollution from better-studied sources such as military bases. The risk to rural areas is based partly on the fact that most unconventional fracked gas wells, if not other types of wells, are developed in rural areas.⁶⁷ In addition, people in rural areas rely on private wells for drinking water that may not be tested for PFAS or other contaminants as frequently as public water supplies.⁶⁸ In total, about 2.5 million Pennsylvanians (about 20 percent of the state's population)⁶⁹ rely on private water wells.⁷⁰ Water wells near oil and gas operations may be at particular risk of contamination from PFAS as a result of leaks, spills, or underground migration of PFAS from the oil and gas wells. However, PSR is aware of only one test for PFAS in a private water well in Pennsylvania near an oil and gas extraction site (see Chapter 3). This lack of testing means that Pennsylvanians living near oil and gas operations may be unknowingly exposed to PFAS through their water wells and other pathways.



A fracking site in Westmoreland County, Pa., Oct. 2022. Photo credit: Ted Auch. Photo courtesy of FracTracker Alliance.

f. PFAS: Among Many Dangerous Chemicals Used in Oil and Gas Extraction

When used in oil and gas operations, PFAS may add to the cumulative human exposure to a host of toxic substances. In fracking, chemicals serve a variety of purposes, including killing bacteria inside the wellbore, reducing friction during high-pressure fracking, and thickening the fluid so that the sand, suspended in the gelled fluid, can travel farther into underground formations.⁷¹

In its 2016 study of fracking and drinking water, the EPA identified 1,606 chemicals used in fracking fluid and/or found in fracking wastewater. While the agency found high-quality information on health effects for only about 10 percent (173) of these chemicals, that 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.⁷²

Chemicals used in the drilling stage that precedes actual fracturing can also pose health risks, including developmental toxicity and the formation of tumors, according to EPA regulators.⁷³ A disclosure form filed with the state of Ohio, one of only two states to require public disclosure of drilling chemicals (Colorado is the other),⁷⁴ shows that Statoil, Norway's state oil company (since renamed Equinor), has used the neurotoxic chemical xylene in drilling.⁷⁵ In short, when chemicals used in drilling, fracking or other stages and methods of oil and gas operations come into contact with people or the environment, they can produce serious negative health effects.⁷⁶ The use of PFAS in fracking and/or drilling operations would only multiply these health risks.

CH. 2 CHEMICAL DISCLOSURE LAWS SHIELD CHEMICAL IDENTITIES

Due to Pennsylvania's byzantine system of oil and gas chemical disclosure, it is impossible to know how widely PFAS or other toxic chemicals have been used in the state's oil and gas wells. This set of rules features, among other elements that frustrate the public's right to know, opportunities for oil and gas companies to hide fracking chemical identities behind trade secret claims, conceal the identities of chemicals used in other stages and methods of extraction such as the drilling that precedes fracking, and allow chemical manufacturers – the companies who know best what chemicals are being used – to avoid disclosure of chemical ingredients. Pennsylvania also has different standards for fracking chemical disclosure in conventional and unconventional wells, requiring the public to consult multiple repositories in order to secure full information.

Many residents living near oil and gas operations have reported serious health impacts while expressing frustration over the secrecy surrounding chemicals used by the oil and gas industry.⁷⁷ In 2020, the Attorney General's criminal grand jury documented these experiences, finding that

Many of those living in close proximity to a well pad began to become chronically, and inexplicably, sick. Pets died; farm animals that lived outside started miscarrying, or giving birth to deformed offspring. But the worst was the children, who were most susceptible to the effects. Families went to their doctors for answers, but the doctors didn't know what to do. The unconventional oil and gas companies would not even identify the chemicals they were using, so that they could be studied; the companies said the compounds were "trade secrets" and "proprietary information." The absence of information created roadblocks to effective medical treatment. One family was told that doctors would discuss their hypotheses, but only if the information never left the room.⁷⁸

Pennsylvania's rules and laws regarding oil and gas chemical disclosure mean that oil and gas companies could be using PFAS or other toxics much more widely than has been reported, leaving Pennsylvanians at risk of serious health problems.

a. Extensive Use of "Trade Secret" Claims Veils Actual Use

Perhaps the most prominent shortcoming in Pennsylvania law that could conceal wider use of PFAS in oil and gas wells is the ability for oil and gas companies to withhold from the public, though not from regulators, information on their use of fracking chemicals deemed trade secrets, for both unconventional gas wells⁷⁹ and conventional oil and gas wells.⁸⁰ This provision is an exception to the general requirement that oil and gas well operators are required to publicly disclose their fracking chemicals, whether to FracFocus⁸¹ or to the DEP (see section e pg. 15).⁸² According to the DEP, well operators, well service providers, chemical suppliers/vendors, and chemical manufacturers can all declare that a fracking chemical is a trade secret.⁸³ In these cases, the company declaring the trade secret must submit to the DEP a "Registration of Trade Secret-Confidential Proprietary Stimulation Fluid Chemical Information" form.⁸⁴ The submitter must include on the form the CAS Number and/or name of the chemical claimed as a trade secret. The submitter must also assign a code to the chemical in a format designated by the DEP and must include a justification for the trade secret claim.⁸⁵ The code is used in place of the chemical name and/or CAS Number in the publicly available Completion Report required to be submitted electronically to the DEP for each oil and gas well.⁸⁶ Through this system, the DEP learns the identities of trade secret chemicals, but the public does not. Trade secret claims can thus hide from public view the true identities of dangerous chemicals, including PFAS.

In 2021, the Philadelphia Inquirer reported in an editorial that the state's list of trade secret chemicals contained about 430 substances and that the newspaper had asked the DEP if the agency "would audit the list for 'forever chemicals' — not disclosing the name of the substance or other details." The Inquirer wrote that "a spokesperson wrote that such review is 'possible' but time-consuming as 'staff will need to review approximately 90 individual paper submissions' to identify the chemicals."⁸⁷

Table 1. Disclosed Use of Trade Secret Chemicals in Pennsylvania Oil and Gas Wells, 2012-2022

County Name	Number of wells injected with at least one trade secret chemical	Mass of all trade secret chemicals (lbs.)	Number of wells injected with trade secret surfactants	Mass of trade secret surfactants (lbs.)
Allegheny	107	3,980,000	19	1,860
Armstrong	150	1,160,000	17	1,720
Beaver	79	3,660,000	3	4,280
Bradford	458	14,100,000	168	1,790,000
Butler	219	4,550,000	65	118,000
Cameron	92	937,000	40	77,400
Centre	2	11,300	0	0
Clarion	6	117,000	0	0
Clearfield	7	136,000	2	5,600
Clinton	18	105,000	2	3,260
Crawford	1	60,700	1	918
Elk	154	1,260,000	43	4,360
Fayette	89	2,060,000	3	777
Forest	4	33,000	0	0
Greene	654	22,200,000	40	28,900
Indiana	4	10,400	4	2,350
Jefferson	10	821,000	1	18,900
Lawrence	8	65,300	0	0
Lycoming	290	5,500,000	24	41,900
McKean	80	660,000	15	59,200
Mercer	7	432,000	2	4,850
Potter	16	256,000	0	0
Somerset	5	88,300	0	0
Sullivan	51	1,640,000	10	153,000
Susquehanna	949	21,600,000	443	1,000,000
Tioga	264	5,010,000	55	167,000
Washington	1,082	60,800,000	179	798,000
Westmoreland	63	1,400,000	16	46,100
Wyoming	193	7,660,000	82	463,000
Total	5,062	160,000,000	1,234	4,790,000

This table shows by county the number of Pennsylvania wells in which oil and gas companies injected at least one trade secret fracking chemical and/or at least one trade secret surfactant. It also shows the total combined weight of these chemicals by county and statewide. The total weight figures reflect the sum of all records for which we have enough information to calculate a chemical's weight. However, the total weight figures represent an undercount because many fracking chemical disclosures lack sufficient data to perform this calculation. The wells injected with trade secret surfactants are a subset of the wells injected with trade secret chemicals. For a more detailed explanation of data sources, see Appendix A.

Table 2. Oil and Gas Companies that Fracked Unconventional Gas Wells in Pennsylvania Using Trade Secret Chemicals and Trade Secret Surfactants, 2012-2022

Operator	No. of wells injected with at least one trade secret chemical	Mass of all trade secret chemicals (lbs.)	No. of wells injected with at least one trade secret surfactant	Mass of all trade secret chemicals (lbs.)
Range Resources Corporation	816	49,100,000	147	487,000
EQT Production	780	33,700,000	15	25,300
Chesapeake Operating, Inc.	545	25,600,000	224	2,820,000
Cabot Oil & Gas Corp	509	7,220,000	327	356,000
Seneca Resources Corporation	447	3,610,000	128	229,000
Southwestern Energy	343	12,000,000	34	188,000
Chevron USA Inc.	151	2,920,000	3	778
Talisman Energy USA Inc.	140	1,860,000	47	No data available
XTO Energy/ExxonMobil	118	1,380,000	63	133,000
Repsol O&G, LLC.	114	999,000	3	128
Rice Drilling B, LLC	109	1,540,000	31	40
Anadarko Petroleum Corporation	109	86,100	0	0
Shell Oil Company affiliate	107	1,730,000	29	82,100
Snyder Brothers Inc.	99	942,000	9	1,350
PennEnergy Resources, LLC	71	1,470,000	0	0
CONSOL Energy Inc.	69	1,530,000	8	4,970
Carrizo Oil & Gas, Inc.	49	1,050,000	44	19,000
CNX Gas Company LLC	43	734,000	12	301,000
Rex Energy	42	338,000	4	265
Alta Resources	40	3,280,000	0	0
Noble Energy, Inc.	32	2,200,000	12	3,550
EdgeMarc Energy Holdings, LLC	27	1,320,000	0	0
COTERRA ENERGY INC.	27	308,000	14	842
Vantage Energy Appalachia II LLC	27	177,000	0	0
BKV Operating LLC	22	804,000	10	19,700
WPX Energy	20	628,000	14	1,400
Greylock Production LLC	20	518,000	13	3,910
MDS Energy Development LLC	20	54,100	4	364
EOG Resources, Inc.	20	37,200	5	247
Olympus Energy	19	82,600	5	455
Apex Energy LLC	17	560,000	4	41,100
JKLM ENERGY	15	220,000	0	0
MDS Energy, Ltd	12	31,500	1	No data available
Pennsylvania General Energy	11	195,000	0	0
Citrus Energy Corporation	8	43,500	7	41,700
EXCO Resources, Inc.	7	101,000	1	3,260
Rockdale Marcellus, LLC	6	936,000	0	0
Hilcorp Energy Company	6	77,700	0	0
Huntley & Huntley Energy Exploration	6	41,200	6	515
Inflection Energy (PA) LLC	5	69,300	3	11,800
Alpha Shale Resource, LP	5	849	0	0

Table 2. (CONTINUED) Oil and Gas Companies that Fracked Unconventional Gas Wells in Pennsylvania Using Trade Secret Chemicals and Trade Secret Surfactants, 2012-2022

Operator	No. of wells injected with at least one trade secret chemical	Mass of all trade secret chemicals (lbs.)	No. of wells injected with at least one trade secret surfactant	Mass of all trade secret surfactants (lbs.)
Northeast Natural Energy LLC	4	102,000	0	0
LOLA Energy PetroCo	4	56,000	0	0
Chief Oil & Gas	4	38,500	0	0
Halcon Resources Corporation	3	323,000	3	5,770
Campbell Oil & Gas. Inc	3	66,800	2	5,600
Energy Corporation of America	3	8,960	0	0
Warren E&P, Inc.	3	4,910	0	0
INR Operating, LLC	2	125,000	0	0
Clean Energy Exploration and Production	2	21,400	0	0
RMD	2	No data available	0	0
Travis Peak Resources, LLC	1	4,400	0	0
Arrington Oil & Gas Operating LLC	1	2,330	1	2,330
Endeavour Operating Corp	1	No data available	1	No data available
Total	5,066*	160,000,000	1,234	4,790,000

This table shows the oil and gas companies that fracked unconventional gas wells in Pennsylvania with trade secret chemicals and trade secret surfactants between January 1, 2012 and September 29, 2022. The wells injected with trade secret surfactants are a subset of the wells injected with trade secret chemicals. For a more detailed explanation of data sources, see Appendix A. Please note: separate companies in this table could now be the same company as a result of subsequent mergers and/or name changes.

*In this table, the total number of unconventional gas wells that companies operating in Pennsylvania injected with at least one trade secret chemical (5,066) differs slightly from the total number reported in table 1 (5,062) because a handful of the 5,062 wells were fracked more than once, but by different operators, and those handful of wells are counted more than once in this table.

“Compared with Pennsylvania’s important efforts to test water for those substances,” the Inquirer commented, “reviewing 90 paper submissions for critical information about potential risk seems a minor cost.”⁸⁸

The lack of evidence of additional PFAS use in Pennsylvania’s oil and gas wells may reflect extensive use of the trade secret provisions in Pennsylvania’s chemical disclosure rules. PSR’s data analysis revealed that, between 2012 and 2022, Pennsylvania well operators listed at least one fracking chemical as a trade secret in 5,062 unconventional gas wells located across 29 counties (Table 1). The weight of the trade secret chemicals used in these wells over this roughly 10-year period totaled 160 million pounds.⁸⁹ If even a small fraction of this weight were PFAS, that fraction could pose significant health and environmental risks.

In an effort to determine if any of these trade secret

chemicals were PFAS, PSR examined whether any were listed as a surfactant. (Surfactants, as noted in chapter 1, encompass dangerous fluorosurfactants, some of which are PFAS.) We found thousands of cases of oil and gas companies using at least one trade secret chemical that they described as a surfactant. These occurred in 1,234 wells, spread across 23 counties.⁹⁰ Operators’ names for these chemicals were vague, including “proprietary surfactant 00015”⁹¹ and “proprietary surfactant blend.”⁹² The weight of these trade secret surfactants totaled almost five million pounds. Should even a small percentage of them be fluorosurfactants, they could include PFAS, and pose significant and long-lasting threats to human health and the environment. Yet the public cannot know what these chemicals are, due to the extensive use of trade secret protections.

These data show that multiple oil and gas companies have injected oil and gas wells in Pennsylvania with trade secret

TABLE 3. Examples of Individual Unconventional Gas Wells

Well Operator	Well Number	County	Year Fracking Completed	Chemical used in Well	CAS Number	Trade Name	Mass (lbs.)
Chesapeake Operating, Inc.	3712527156	Washington	2014	PTFE	9002-84-0	ambiguous	non calculable
Chesapeake Operating, Inc.	3700720415	Beaver	2014	PTFE	9002-84-0	ambiguous	19
Cabot Oil & Gas Corp	3711522540	Susquehanna	2020	nonionic surfactants	proprietary	not reported	3,102
Range Resources Corporation	3712527583	Washington	2015	surfactants	proprietary	StimOil ENX	35,179
Seneca Resources Corporation	3711722086	Tioga	2021	proprietary surfactant blend	proprietary	NFR-64	23,892

This table shows a sample of wells injected with the types of fracking chemicals referenced in the larger table above, including trade secret surfactants such as the “nonionic surfactants” and “proprietary surfactant blend” as well as PTFE. The examples cover a range of years and represent wells fracked in several Pennsylvania counties. Even the smallest mass shown for a proprietary chemical (3,102 pounds for nonionic surfactants) could be a highly dangerous amount if this proprietary chemical were PFAS.

chemicals that could be PFAS or other toxic substances.

Table 2 identifies the companies responsible for this activity, as well as the quantities of trade secret chemicals and trade secret surfactants they injected.

b. Examples of Individual Wells Injected with PFAS and/or Trade Secret Chemicals

FracFocus data show that in some cases, oil and gas companies have injected hundreds or even thousands of pounds of trade secret chemicals into unconventional gas wells for fracking. If the toxicities of some of these chemicals were similar to those of PFOA or PFOS, these quantities would be enough to contaminate vast amounts of water. Table 3 provides selected examples of the chemicals reported to have been used in several Pennsylvania wells.

c. Lack of Disclosure of Drilling Chemicals Could Also Conceal PFAS Use

Another exemption in Pennsylvania’s disclosure rules that prevents the public from knowing the extent of PFAS use in oil and gas wells is that well operators are not required

to disclose the chemicals used in the drilling process that precedes fracking. During drilling, companies bore deep holes in the earth. Working in successive stages, companies bore deeper and deeper until the production zone is reached where the oil and/or gas are located.⁹³ During the first stage of drilling, these holes typically pass directly through groundwater.⁹⁴ Chemicals can be injected in this stage of the process to help keep the drill bit cool and to help lift rock cuttings out of the well.⁹⁵ EPA has indicated that any chemicals used during this first stage of the drilling process would be highly likely to leach into groundwater, because only after drilling through the groundwater zone is complete do oil and gas companies seal off the well from the groundwater by inserting into the well steel pipe known as casing as well as cement that fills the space between the outside of the pipe and the groundwater and rock formation.⁹⁶ Chemicals could infiltrate the groundwater before the casing and cement are in place.

Chemicals used in the drilling stage could include PFAS as well as other substances that can pose health risks. A peer-reviewed scientific paper published in 2020 reported that the PFAS known as fluorosurfactants have at least

been proposed for use in drilling.⁹⁷ EPA regulators have found that chemicals proposed for use in drilling could lead to developmental harms and the formation of tumors.⁹⁸ A disclosure form filed with the state of Ohio shows that Statoil, Norway's state oil company (since renamed Equinor), has used a neurotoxic chemical, xylene, in drilling.⁹⁹ If chemicals used in drilling were to come into contact with people or the environment, negative health effects could result. This potential makes it critically important for these chemicals to be disclosed publicly. However, there is no such requirement in Pennsylvania, creating the potential that people could be unknowingly exposed to PFAS and other dangerous chemicals used during the drilling process that precedes fracking.

d. Chemical Manufacturers' Exemption May Also Obscure PFAS Use in Oil & Gas Wells

Pennsylvania rules may obscure the extent of PFAS use in oil and gas wells in an additional respect: The rules for both unconventional gas wells and conventional oil and gas wells clearly exempt chemical manufacturers from having to disclose the ingredients in their fracking chemical products to the well operators who must ultimately disclose the fracking chemicals to the public.¹⁰⁰ As a result, it is likely that well operators are using at least some fracking chemicals unknowingly. Some of these chemicals could be PFAS.

Chemical manufacturers are in the best position to know the identities of individual fracking chemicals, whether these chemicals are used individually or as ingredients in fracking chemical products comprised of more than one chemical. Yet evidence shows manufacturers often withhold chemical identities from other companies in the supply chain. In 2014, four attorneys with years of experience litigating oil and gas-related cases in Pennsylvania filed a petition with the state Commonwealth Court suggesting manufacturers often withhold chemical identities from other companies in the supply chain. The attorneys discussed the use of Material Safety Data Sheets (MSDS) that manufacturers use to communicate the contents of fracking chemical products. The federal Occupational Safety and Health Administration

(OSHA) requires chemical manufacturers to prepare MSDS (now called safety data sheets) to order to protect workers using the chemicals from on-the-job hazards.¹⁰¹ The attorneys wrote that these sheets often omit chemical ingredients.

Many times, 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 relabeled 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].¹⁰²

The attorneys provided as support a record filed in a separate case by well operator Range Resources in which Range suggested that it was relying on MSDS from manufacturers to reply to a request for the chemicals used to fracture or stimulate its wells. Range said that the chemical information in these sheets could be incomplete. "The MSDS are often useful for developing some understanding of what is in a particular chemical or product," Range wrote, continuing,

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.¹⁰³

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.”¹⁰⁴ 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.”¹⁰⁵

In 2011, the U.S. House of Representatives’ Committee on Energy and Commerce minority staff issued a report on hydraulic fracturing chemicals in which they asked the 14 leading oil and gas service companies to “disclose the types and volumes of the hydraulic fracturing products they used in their fluids between 2005 and 2009 and the chemical contents of those products.”¹⁰⁶ While the committee staff found, among other things, that the companies used products containing 29 chemicals that are known or possible human carcinogens, they also found that the companies could not completely respond to the committee staff’s request because of chemical information withheld by chemical manufacturers.

In many instances, the oil and gas service companies were unable to provide the Committee with a complete chemical makeup of the hydraulic fracturing fluids they used. Between 2005 and 2009, the companies used 94 million gallons of 279 products that contained at least one chemical or component that the manufacturers deemed proprietary or a trade secret. Committee staff requested that these [service] companies disclose this proprietary information. Although some companies did provide information about these proprietary fluids, in most cases the companies stated that they did not have access to proprietary information about products they purchased “off the shelf” from chemical suppliers. In these cases, the companies are injecting fluids containing chemicals that they themselves cannot identify.¹⁰⁷

Researchers at Harvard University wrote in 2013 that rules for creating safety data sheets are unlikely to result in complete disclosure of fracking chemicals by chemical

manufacturers. The researchers observed that the rules limit disclosure of chemicals to those that are hazardous and have been studied for workplace exposure. Many chemicals used in fracking might not have been studied for workplace exposure, they wrote, and therefore might not be disclosed in safety data sheets. The researchers also wrote that manufacturers might not list at least some substances in safety data sheets because federal regulations provide that substances are deemed hazardous or not due to existing test data; therefore, if no test data shows that a substance is hazardous, it would not have to be listed on a safety data sheet, even if the chemical were, in fact, hazardous. No new testing is required.¹⁰⁸ These chemicals, in turn, would not be disclosed to companies in the fracking chemical supply chain, leaving the companies unable to disclose these chemicals to the public.

A final example of how chemical manufacturers do not or may not disclose all of the chemicals used in fracking or other oil and gas extraction techniques is found in the book *Amity and Prosperity*. In this book, which won the 2019 Pulitzer Prize for general nonfiction, author Eliza Griswold focused on a woman named Stacey Haney, who lived in western Pennsylvania near three hydraulically fractured unconventional gas wells, a drilling waste pit, and a fracking wastewater storage pond. In 2009, after drilling activity began, Haney and her neighbors suffered unexplained illnesses and the deaths of animals. They suspected the illnesses and deaths were caused by air and water contamination from the gas activity.¹⁰⁹ In a lawsuit filed against Range Resources, the well operator that ran the drilling site, Haney sought a full list of chemicals used at the site. This list would have been important to prove that exposure to the chemicals contributed to her family’s health problems. The court ordered Range to disclose the substances, but the company said it could not comply 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.”¹¹⁰ At least some of the secret chemical identities were held by a chemical manufacturer.¹¹¹ After years of

litigation, Haney and another plaintiff accepted a confidential settlement that “left them feeling angry and defeated.”¹¹²

“The company never provided the plaintiffs with a definitive list of all the chemicals used at the site,” Griswold wrote, and the court “refused to sanction Range for not complying” with the court order to disclose its chemicals.¹¹³

Considering these examples, it is important for states to require disclosure of fracking chemicals directly from the chemical manufacturers so that the public can know if dangerous chemicals such as PFAS are being used in oil and gas wells. Yet Pennsylvania’s rules not only fail to require such disclosure; they also eliminate incentives for well operators or other companies in the oil and gas chemical supply chain to seek accurate chemical information from the manufacturers so that the information can be publicly disclosed. Pennsylvania’s rules for unconventional gas wells provide that “a vendor, service provider or operator shall not be required to do any of the following... Disclose chemicals that are not disclosed to it by the manufacturer, vendor or service provider.”¹¹⁴ A second section of Pennsylvania’s rules for unconventional gas wells similarly removes the incentive for other companies in the fracking chemical supply chain to hold accountable the chemical manufacturers for public disclosure of fracking chemicals.¹¹⁵

The rules for conventional oil and gas wells also shield chemical manufacturers from fracking chemical disclosure requirements by providing that a well operator must disclose “a list of the chemicals in the Material Safety Data Sheets, by name and chemical abstract service number, corresponding to the appropriate chemical additive.”¹¹⁶ This provision means that disclosure is limited to what is required on the safety data sheets, and therefore well operators are not responsible for compiling chemical information from manufacturers that is not on the sheets. As stated above, manufacturers do not have to include on the sheets chemicals that have not been studied for workplace exposure or those for which there is no data identifying the substances as hazardous. Therefore, the manufacturers do not have to disclose the identities of at least some chemicals, and operators would not have to disclose these chemicals publicly, including, perhaps, PFAS.

e. Pennsylvania’s Rules Direct Fracking Chemical Data to Multiple Repositories

Another challenge the public faces in determining what chemicals oil and gas companies have used in Pennsylvania is that the state has two different systems of fracking chemical disclosure, resulting in disclosure of these chemicals to multiple repositories. For so-called “unconventional” wells, the state provides that gas well operators publicly disclose their fracking chemicals to the FracFocus database, an online repository that can be searched and sorted by multiple terms including type of chemical used.¹¹⁷ The state defines unconventional wells as gas wells in “a geological shale formation existing below the base of the Elk Sandstone or its geologic equivalent stratigraphic interval” from which gas cannot be economically produced unless particular extraction techniques are used including fracking.¹¹⁸ In the case of conventional wells, which the state defines as oil wells and all other gas wells, Pennsylvania requires oil and gas companies to disclose fracking chemicals to the Pennsylvania Department of Environmental Protection.¹¹⁹ As of 2018, the records for conventional wells were stored as paper records in offices in Meadville and Pittsburgh¹²⁰ and were not accessible remotely.¹²¹ In 2022, the Department of Environmental Protection reported that well operators can disclose fracking chemicals for conventional wells electronically or on paper to the appropriate office (Meadville, Pittsburgh, or Williamsport). The electronic disclosures are available online but are stored in pdf files that must be reviewed individually and cannot be searched and sorted as a group.¹²²

Due to the time it would require to access the records for conventional wells from four different sources (online, Meadville, Pittsburgh, and Williamsport), none of which is easily searchable, PSR has limited this report to an analysis of fracking chemicals disclosed as used in unconventional gas wells. On the one hand, this analysis is robust because it covers more than 7,000 wells, and unconventional gas wells have largely accounted for Pennsylvania’s boom in gas production over the past two decades.¹²³ However, this



An oil and gas well site in Westmoreland County, Pa., Sept. 2021. Photo credit: Ted Auch. Photo courtesy of FracTracker Alliance.

analysis is incomplete, because it leaves Pennsylvanians uninformed about the chemicals they might be exposed to through conventional oil and gas wells. As of 2021, there were close to 40,000 conventional oil and gas wells operating in Pennsylvania.¹²⁴

The difficulty of analyzing chemicals used in conventional wells is particularly troubling because in 2022, the DEP published a report surveying operators with 11 or more conventional wells which showed significant problems with regulatory compliance. Among the shortcomings that the DEP highlighted was improper abandonment of wells and a lack of reporting about waste production and the structural integrity of wells:

Over the past five years, DEP's OOGM [Office of Oil and Gas Management] has identified significant

non-compliance with laws and regulations in the conventional oil and gas industry, particularly regarding improper abandonment of oil and gas wells, as well as reporting requirements for hydrocarbon and waste production and mechanical integrity assessments [related to structural soundness of oil and gas wells]... The reporting non-compliance denies DEP and the public critical information about the operating status of individual wells. Overall performance is so poor among operators with 11 or more conventional oil and gas wells that the failure to report seems to be an industry-wide rule rather than the exception.¹²⁵

The lack of reporting suggests that many conventional wells may pose unknown environmental risks to the public – risks that could be intensified if toxic chemicals such as PFAS are being used. But the public will have a difficult time discovering

what chemicals may be present, due in part to the state's fracking chemical disclosure records for conventional wells that are difficult and time-consuming to search.

f. Fracking Data, Published Papers Suggest Underreporting of PFAS Use in Pennsylvania

An indication that oil and gas companies operating in Pennsylvania might not have fully disclosed their use of PFAS is evidence that more of them have disclosed use of PFAS in oil and gas wells when they operate in other states than they have in Pennsylvania. Only two oil and gas companies, Chesapeake Operating, Inc. and Hilcorp Energy, reported using PFAS (in this case, PTFE) in a total of eight of Pennsylvania's unconventional gas wells between 2012 and 2022. However, during the same period, fifteen other oil and gas companies that fracked oil and gas wells in Pennsylvania reported using PTFE for fracking in 346 wells across nine other states. Chesapeake Operating and Hilcorp Energy also reported using PTFE in oil and gas wells outside Pennsylvania. One of the 15 companies, EOG Resources, also disclosed using another PFAS, fluoroalkyl alcohol substituted polyethylene glycol, in 86 wells across New Mexico and Texas, and five of the companies disclosed using chemicals that may be PFAS, known as nonionic fluorosurfactants, in Oklahoma, New Mexico, and Texas. The specific identities of the nonionic fluorosurfactants were withheld from the public under trade secret claims, but three chemists and a board-certified toxicologist who examined this chemical name believe that nonionic fluorosurfactants could be PFAS.¹²⁶ The disclosed use of PFAS or potential PFAS in hundreds of oil and gas wells in other states by oil and gas companies operating in Pennsylvania raises questions about whether these companies are using these chemicals in Pennsylvania more widely than they have reported.

An additional indication that the use of PFAS in oil and gas wells in Pennsylvania could be more widely used than disclosed are two papers showing that the use of PFAS in oil and gas wells dates back decades and encompasses a variety of extraction techniques. In 2020, several scientists

published an article in *Environmental Science: Processes and Impacts* showing that since 1956, PFAS including fluorosurfactants had been used or proposed to be used globally in oil and gas extraction techniques including chemical-driven gas production, chemical flooding, fracking, and the drilling that precedes fracking and other oil and gas production techniques.¹²⁷ In 2008, two authors, one of whom was identified as an employee at DuPont, wrote in the peer-reviewed *Open Petroleum Engineering Journal* that the use of fluorosurfactants was relatively common in the oil and gas industry and that their use was about to surge. They referred to fluorosurfactants as an "emerging technology" and stated,

While fluorosurfactants have been used in gas and oil exploration for four decades, the increased demand for petroleum and the greater understanding of the benefits of fluorosurfactants have led to growing acceptance for fluorosurfactants throughout the petroleum industry.¹²⁸

The authors did not explicitly say that fluorosurfactants used in oil and gas operations were PFAS, but they described the fluorosurfactants in ways that are commonly used to describe PFAS. They wrote that

The use of fluorosurfactants is a recent but growing trend due to (i) the exceptional hydrophobic [water-repellent] and oleophobic [oil-repellent] nature of the perfluoroalkyl and perfluoroalkyl ether groups... The bond strength of the carbon-fluorine bond in perfluoroalkyl and perfluoroalkyl ether groups has been demonstrated as the key to remarkable overall stability for fluorochemicals and fluoropolymers.¹²⁹

This evidence suggests that any time an unidentified fluorosurfactant or unidentified surfactant is used in oil and gas production, there is a potential that it is a PFAS. Companies operating oil and gas wells in Pennsylvania have used fluorosurfactants for fracking in other states. It is important to know if they have used these substances in Pennsylvania as well.

Table 4. Use of PFAS and Potential PFAS in Other States by Pennsylvania Oil & Gas Companies

Operator Name	Number of Unconventional Wells in Pa. with Fracking Chem. Disclosure of Any Type of Chemical	Disclosure of PTFE/Teflon for Fracking in Other States (no. of wells)	Disclosure of Nonionic Fluorosurfactants for Fracking in Other States (no. of wells)	Disclosure of Fluoroalkyl Alcohol Substituted Polyethylene Glycol for Fracking in Other States (no. of wells)
Cabot Oil & Gas Corp	689	Texas (1)		
Chesapeake Operating, Inc.	583	Texas (86) Ohio (78) Wyoming (12) West Virginia (11) Oklahoma (6) Pennsylvania (5) Louisiana (1)		
Southwestern Energy	536	Colorado (2) West Virginia (1)		
Chevron USA Inc.	246		Texas (26) New Mexico (11)	
XTO Energy/ExxonMobil	186	Texas (32) New Mexico (7) Ohio (4) Oklahoma (4) West Virginia (4)	Texas (67) Oklahoma (6) New Mexico (4)	
Anadarko Petroleum Corporation	112	Colorado (95) Wyoming (38)	Texas (8)	
Hilcorp Energy Company	87	Pennsylvania (3)		
Carrizo Oil & Gas, Inc.	50	Texas (15)		
Noble Energy, Inc.	46	Colorado (30)		
EOG Resources, Inc.	22	Texas (4)	Texas (2)	Texas (65) New Mexico (31)
WPX Energy	20	New Mexico (9)		
EXCO Resources, Inc.	12	Texas (87) Louisiana (1)		
Northeast Natural Energy LLC	4	West Virginia (9)		
Halcon Resources Corporation	3	Texas (2) Mississippi (1)		
Arrington Oil & Gas Operating LLC	1		Texas (3)	

This table shows the companies that disclosed the use of any and all fracking chemicals in Pennsylvania's unconventional gas wells between 2012 and 2022 and also disclosed the use of PFAS or potential PFAS for fracking in other states during the same period. The types of PFAS or potential PFAS disclosed as being used for fracking in other states include PTFE/Teflon, fluoroalkyl alcohol substituted polyethylene glycol, and nonionic fluorosurfactants. The numbers in (parentheses) show how many wells in each state the companies disclosed as being injected with the particular type of chemical. For example, the cell in the top of the table's third column from the left shows that between 2012 and 2022, Cabot Oil & Gas Corp. fractured one well in Texas with PTFE/Teflon. For a more detailed explanation of data sources, see Appendix A.

CH. 3

HEALTH STUDIES LINK OIL AND GAS OPERATIONS TO ILLNESS

a. Oil, Gas Well Proximity Associated with Disease

A robust and reliable body of scientific studies of PFAS in oil and gas operations – both their presence and their health effects – does not yet exist. However, peer-reviewed scientific studies of people living near oil and gas operations have correlated proximity to active well sites with a variety of diseases and other health effects. It is not unreasonable to extrapolate that, should PFAS have been used in those operations, it could be associated with some of those health effects.

A 2021 study comparing health data in Pennsylvania and New York counties atop the Marcellus Shale found that years of exposure to unconventional natural gas operations in Pennsylvania were associated with higher hospitalization and death rates from acute myocardial infarction (heart attack) than what was found in New York, where no unconventional gas operations took place.¹³⁰ The study was made possible by the natural experiment created by New York's moratorium and later ban on fracking and Pennsylvania's decision to pursue shale gas extraction.¹³¹ Similarly, researchers from Johns Hopkins University analyzed data on more than 12,000 heart failure patients in Pennsylvania and compared those with and those without hospitalizations. They found that heart failure patients living near unconventional gas extraction sites were significantly more likely to become hospitalized.¹³² The authors of both the New York/Pennsylvania study¹³³ and the study focused solely on Pennsylvania¹³⁴ suggested that particulate matter emitted from fracking operations and the stress associated with living nearby might have played a role in the findings. Neither study examined PFAS exposure, but one of the health impacts associated with PFAS exposure is high cholesterol that is, in turn, associated with heart attacks.¹³⁵ These associations, and the known use of PFAS in oil and gas operations, point to the need for more study of the use of PFAS in oil and gas operations and associated health effects.

PSR has collaborated with Concerned Health Professionals of New York to compile and summarize the substantial and growing number of scientific studies that have

found serious health effects associated with oil and gas operations. At least two of these health effects, low birth weight in babies and heart disease (that can be linked to high cholesterol) are generally associated with exposure to PFAS, though the research to date has not investigated whether these health effects are specifically linked to PFAS used in oil and gas operations. In the eighth edition (2022) of our report, we wrote,

Public health problems associated with fracking include prenatal harm, respiratory impacts, cancer, heart disease, mental health problems, and premature death... Poor birth outcomes have been linked to fracking activities in multiple studies in multiple locations using a variety of methods. Studies of mothers living near oil and gas extraction operations consistently find impaired infant health, especially elevated risks for low birth weight and preterm birth. As we go to press, a new study in Pennsylvania finds “consistent and robust evidence that drilling shale gas wells negatively impacts both drinking water and quality of infant health.”¹³⁶

Low birthweight is a leading contributor to infant death in the United States.¹³⁷

b. Studies Needed on PFAS

PSR is not aware of published studies that have analyzed well sites for PFAS or that have analyzed health effects related to potential use of PFAS at well sites. We are aware of only two studies of PFAS associated with oil and gas operations, both conducted by government agencies, and both focused on Pennsylvania. In 2023, the DEP tested a water well for PFAS at the Washington County home of Bryan Latkanich¹³⁸ in response to Latkanich's complaint that nearby oil and gas operations had contaminated his water with PFAS.¹³⁹ The DEP reported that it found some PFAS in Latkanich's water (PFOS at 2.3 parts per trillion, as well as PFHxS and PFOSA), but it found no evidence that PFAS was used in the nearby oil and gas operations, specifically a gas well pad operated by Chevron about 500 feet from the Latkanich home that was the site of two unconventional

gas wells.¹⁴⁰ The DEP speculated that the source of the PFAS could be, among many potential sources, water that already contained PFAS being used for fracking in the unconventional gas wells. State regulations do not require testing for chemicals contained in water used in fracking.¹⁴¹

These testing results are not necessarily reassuring. The PFOS concentration was 115 times higher than EPA's health advisory level of 0.02 parts per trillion, though below the EPA's proposed drinking water standard of four parts per trillion. DEP tested for 36 types of PFAS and found only three types in the Latkanich well, but there are thousands of types of PFAS in use. A test for total organic fluorine, which the DEP did not conduct, might have indicated the presence of additional PFAS. The lack of evidence of PFAS use at nearby oil and gas operations could have been consistent with actual lack

of use, or it could have reflected the use of PFAS chemicals for which the DEP did not test and which regulators or even the companies conducting the gas operations may not have known about. For the second study focusing on PFAS associated with oil and gas operations, see Appendix B.

In the bigger picture, the lack of testing for PFAS at oil and gas sites is not surprising; there were few if any grounds to test for PFAS in connection with oil and gas operations prior to July 2021, when PSR first publicized the probable use of these chemicals in oil and gas extraction. Now that we know PFAS have been used in oil and gas operations for years, scientists should determine where this use takes place and whether there are connections between this use and health effects, for PFAS chemicals individually and as a compounding factor in conjunction with exposure to other fracking chemicals.



An oil and gas fluids impoundment near Zelienople, Pennsylvania, 2015. Photo credit: Ted Auch. Photo courtesy of FracTracker Alliance.

CH. 4 EXPOSURE PATHWAYS TO PFAS ASSOCIATED WITH OIL AND GAS OPERATIONS IN PENNSYLVANIA

As indicated by EPA in the agency's 2016 report on fracking and drinking water, there are multiple pathways through which contaminants associated with oil and gas operations in Pennsylvania can jeopardize health and the environment. These include leaks and spills of chemicals at well sites, leaks and spills of wastewater at well sites or disposal sites, underground migration into groundwater from production wells or wastewater disposal wells used as underground repositories for wastewater, spreading of wastewater on roads for dust suppression and deicing, and dumping at landfills of solid waste that could be tainted with toxic substances. All of these concerns would apply to PFAS as well as to other contaminants.

a. Disposal of Waste Intensifies Pollution Concerns

The risk that PFAS and other chemicals associated with oil and gas drilling could pollute the Pennsylvania environment is especially high because of the staggering volumes of wastewater and solid waste generated by oil and gas extraction. The volumes are so high largely because of the scale of many of the unconventional gas wells being drilled in Pennsylvania compared to conventional wells drilled in past decades. Developing each well involves injecting millions of gallons of water, sand and fracking fluid. A portion this mixture returns to the surface in the form of wastewater known as “flowback.” In 2016, the EPA reported that flowback *per well* in the Marcellus and Utica shale formations that are exploited for gas in Pennsylvania can total between 300,000 and one million gallons over the first 10 days after fracking.¹⁴² In addition, following flowback, huge volumes of naturally occurring water from underground formations, known as “produced water,” flow out of the wells, potentially for years.¹⁴³ In 2016, EPA reported that five years after a well was drilled in the Marcellus shale, it would still be producing wastewater at a rate of hundreds of gallons per day.¹⁴⁴

The wastewater, whether flowback or produced water, can contain chemicals intentionally added to the fracking fluid such as PFAS; naturally occurring contaminants found in underground formations, including radium,

which occurs in significant concentrations in wastewater from Pennsylvania;¹⁴⁵ and may contain chemicals that are products of reactions that occur in underground formations such as those between fracking chemicals and naturally occurring compounds in the formation such as methane.¹⁴⁶ Intentionally added drilling fluids, as well as naturally occurring water encountered during drilling, may be part of the wastewater mix.¹⁴⁷ In addition, drilling the wells involves boring into the earth 9,000 feet vertically and 10,000 additional feet or more horizontally.¹⁴⁸ This process produces tons of rock shards known as “drill cuttings” that could be contaminated with human-made or naturally occurring toxics.¹⁴⁹ FracTracker Alliance has found that wastewater and drill cuttings are the two largest waste streams produced by oil and gas operations in Pennsylvania. According to the organization's analysis of Pennsylvania Department of Environmental Protection oil and gas waste reports, in 2022, oil and gas wells in Pennsylvania generated more than 2.6 billion gallons of wastewater.¹⁵⁰ That liquid waste was transported to 598 facilities in Pennsylvania, New York, Ohio, and West Virginia, with almost 90 percent of the wastewater and 80 percent of the solid waste remaining in Pennsylvania. Most of the wastewater went to other well pads where wastewater can be reused to offset the need for fresh water;¹⁵¹ to residual waste processing facilities that appear to include facilities for wastewater storage and treatment;¹⁵² to injection disposal wells where wastewater is injected underground for supposedly permanent disposal, and to storage facilities pending disposal or reuse.

Pennsylvania's oil and gas wells produced more than 2.1 billion pounds of solid waste, largely consisting of drill cuttings, but also including produced fluids reported in tons, soil contaminated from spills, and synthetic liner material. The solid waste was transported to 53 facilities in the same four states, with most of the waste going to Pennsylvania landfills. Other destinations for solid waste included reuse at other well pads, residual waste processing facilities, and disposal at injection wells. If some of the wastewater or solid waste were tainted with PFAS, it could pose risks to the environment or health, both at the well sites where the

waste is generated, and also at waste disposal sites that can be miles away. See the map below [and an interactive online version](#) from FracTracker for destinations for this waste.

The reported volumes of waste from oil and gas wells could be even larger than reported. In 2014, the Pittsburgh Post-Gazette reported that nine landfills located in southwestern Pennsylvania reported accepting three to four times the amount of oil and gas waste that operators told the DEP that they sent to the landfills. The DEP told the Post-Gazette that it did not verify reports on the volume of oil and gas wastewater that oil and gas wells operators sent to centralized waste treatment facilities or underground injection wells, but the DEP had no reason to doubt the figures.¹⁵³

The potential for oil and gas waste to contain PFAS is not just hypothetical, according to an analysis of Pennsylvania state records in 2022 by Environmental Health News.¹⁵⁴

The publication found that the eight wells in Pennsylvania injected with PTFE/Teflon produced more than 23 million gallons of liquid waste and 30,390 tons of solid waste between 2012 and 2022.¹⁵⁵ A map developed for the publication by FracTracker Alliance showed that this waste was transported to at least 97 sites for reuse or disposal in Pennsylvania, Ohio, and West Virginia.¹⁵⁶

Robert Delaney, a retired geologist and Superfund specialist with the Michigan Department of Environmental Quality (now called the Michigan Department of Environment, Great Lakes, and Energy), told Environmental Health News that "If there were PFAS in any of those waste products, it's likely that it would have gotten into the environment in some of those locations." Delaney spent 36 years working in natural resource protection for the state of Michigan and first warned state officials about the looming problem with PFAS in 2012, though unrelated to oil and gas extraction.¹⁵⁷ "The

Figure 2. Facilities Accepting Pennsylvania Oil and Gas Waste in 2022



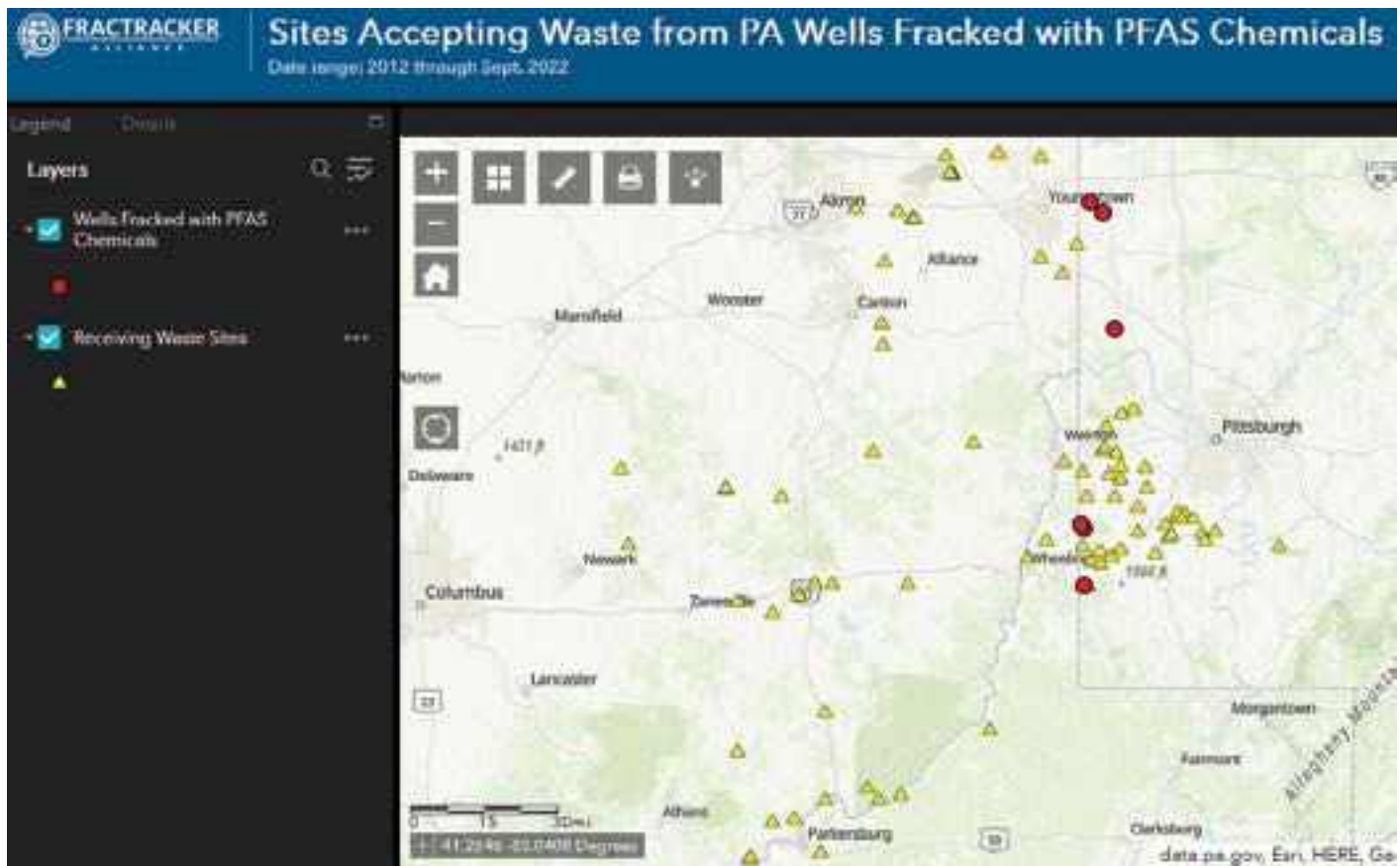
Map courtesy of FracTracker Alliance shows destinations in 2022 for liquid and solid waste generated by oil and gas wells in Pennsylvania. An interactive version of the map is available at <https://ft.maps.arcgis.com/apps/webappviewer/index.html?appid=4c61de38fe714bf699349e0c7dbef779>.

odds are that just as there were spills at the well pads, there have been spills and leaks at these disposal sites,” Delaney told Environmental Health News. “All these places that accepted the waste didn’t know that they were dealing with PFAS. And the things you do to treat other chemicals doesn’t work on them...these chemicals never go away.”¹⁵⁸

When Environmental Health News first asked the Pennsylvania Department of Environmental Protection to comment on the use of PFAS in oil and gas operations in Pennsylvania, the Department responded that “absent a spill or release on the surface or below surface, there is no reason to conclude that wellsite fluids (whether including PFAS compounds or not) would have reached nearby soils or drinking water.”¹⁵⁹ The publication then found evidence

that there were two spills at one of the wells, known as Paul Schlinski 8H, in 2017 and 2020, and informed the DEP.¹⁶⁰ DEP spokesperson James Thrasher told the publication, “Given the time period between the use of the PFAS chemicals and the releases, the small amount of the spills, that the spills were contained to the gravel of the well pad, and that they were remediated quickly, DEP does not have current plans to sample for PFAS at this location.” Thrasher explained that chemicals used in fracking are likely to be contained in so-called “flowback water” that typically emerges from wells within the first 30 days after fracking. In contrast, the spills occurred four years after fracking and were of produced water that primarily consists of naturally occurring brine from underground formations. His comments implied that the produced water was unlikely to contain chemicals that

Figure 3. Sites Accepting Waste from Pennsylvania Wells Fracked with PFAS Chemicals



Map developed by FracTracker Alliance for Environmental Health News showing destinations for liquid and solid waste from eight Pennsylvania oil and gas wells where oil and gas companies reported using PTFE/Teflon for fracking between 2012 and 2022. An interactive map of these sites is available here: <https://www.ehn.org/fracking-pennsylvania-pfas-2658837888.html>.

were used in fracking.¹⁶¹ Delaney, the Superfund specialist, told Environmental Health News that Pennsylvania officials should at least test for PTFE near the well sites where the chemical was used and consider testing at the locations where waste from these wells was disposed of.¹⁶² PTFE, a PFAS, persists, after all, in the environment.

b. Leaks, Spills Raise Pollution Concerns

As indicated by the cases of waste from wells injected with PTFE, one of the major pathways through which PFAS could contaminate water or soil is leaks and spills of drilling fluids, fracking fluids, or wastewater. These leaks and spills are common in oil and gas operations in Pennsylvania, as well as in other states, and they may be more common and serious than publicly reported. In 2017, a team of researchers published a paper in which they found that between 2005 and 2014, unconventional oil and gas well operators in Pennsylvania reported 1,293 spills from drilling through energy production.¹⁶³ The researchers calculated that the wells involved had an average spill rate of 4.3 percent during the period; this figure was defined as the total number of spills divided by the number of well-years during the period.¹⁶⁴ The researchers found that the total reported volume of spills in Pennsylvania during the period was 260,000 gallons. However, the authors cautioned that “Pennsylvania may have ‘missing’ volumes data because reporting of spills has only been required by telephone; agency guidance discouraged written notification.” The researchers added that regulations set to take effect in 2016 would require written reports for spills greater than 42 gallons or when a spill may pollute Pennsylvania waters (These regulations for unconventional gas wells are in effect as of 2023).¹⁶⁵

The freedom of the industry to self-report and the informal reporting of spills by telephone suggest that the number of spills and their volume could have been greater than was reported, increasing the potential for contamination by PFAS and other toxic substances.

Additional evidence from the criminal grand jury investigation conducted by Pennsylvania’s Attorney General

mentioned in Chapter 2 suggests that oil and gas-related spills and contamination may be more frequent and severe than reported. The grand jury heard testimony about the experience of more than 70 households, a sample size restricted by the Attorney General’s limited jurisdiction over environmental crimes in Pennsylvania.¹⁶⁶ The grand jury also heard testimony from dozens of current and former employees of the DEP and Pennsylvania Department of Health.¹⁶⁷ The grand jury was dubious that spills were accurately and comprehensively reported, given that inspectors often relied on industry self-reporting of spills or denials that a spill had occurred and did not visit spill sites. “DEP employees would investigate citizen complaints simply by calling the [oil or gas well] operator and asking him what happened,” the grand jury found. “If the operator sent in a photo purporting to show that no spill had occurred, the matter could be closed without ever leaving the office.”¹⁶⁸

The grand jury also found that the DEP used test methods known as a “suite code” to detect water contamination from oil and gas operations that often did not include testing for at least some of the contaminants likely to be associated with oil and gas extraction. The grand jury reported that

An operator might be using a particular compound on a specific occasion that is not universally present at fracking sites. If DEP did not check the operator’s records to see what he was using when a spill occurred (if the chemicals were fully disclosed), the Department would never know what to test for. Reliance on the standard suite code would actually be detrimental, because it would give a clean bill of health to water that might in fact be dangerously contaminated.¹⁶⁹

PFAS was not one of the contaminants tested for by the DEP,¹⁷⁰ raising the potential that Pennsylvanians could have been unknowingly exposed to dangerous PFAS chemicals through oil and gas-related leaks and spills.

In some cases, authorities have documented water contamination from leaks and spills due to oil and gas operations. In 2018, Pennsylvania’s DEP fined a West Virginia

company \$1.7 million for a host of violations at more than a dozen well sites in Pennsylvania, including a leak of fluid from holes in the liner of a wellsite pit. The release killed nearby vegetation and impacted groundwater and a spring used for drinking water.¹⁷¹ In a separate incident in 2014, the DEP fined Range Resources a record \$4.15 million to settle violations that contaminated soil and groundwater near seven impoundments in Washington County; the impoundments held millions of gallons of fracking wastewater. The DEP reported that the violations included a release of 25 barrels of fracking fluid onto the ground; failure to prevent fracking fluid from flowing from a pipe onto soil and into a tributary of Brush Run, a state-designated High Quality stream, causing harm to aquatic life; and failure to contain about 400 barrels of used fracking fluids, which were released into soil and an adjacent stream.¹⁷² Also in 2014, the Pittsburgh Post-Gazette analyzed DEP records showing that oil and gas operations had contaminated or reduced the flow of 243 private water supplies since the end of 2007. Some of the water supplies were contaminated through spills, the newspaper reported, though the records did not describe in much detail how the water supplies were impacted.¹⁷³

c. Underground Injection Wells, Abandoned Wells Put Drinking Water at Risk

Another major pathway through which PFAS-tainted oil and gas wastewater could contaminate surface or groundwater is through underground injection into disposal wells. Wastewater from the eight unconventional gas wells in Pennsylvania that were injected with PTFE was injected into more than three dozen different underground injection wells in Ohio.¹⁷⁴

The potential for pollution from oil and gas wastewater is not unfounded. Researchers have known for decades that wastewater from injection disposal wells can contaminate groundwater. In some cases, the wastewater, a mixture of naturally occurring brine and oil and gas waste, has migrated upward from deep underground, moving through nearby oil and gas wells, many of which have ceased operating but have not been properly sealed off from the surrounding

underground rock formations.¹⁷⁵ This migrating wastewater can break out of abandoned wells and contaminate groundwater near the earth's surface.¹⁷⁶

In 1985, the Texas Department of Agriculture quoted the then-existent Congressional Office of Technology Assessment regarding the “insidious” problem of underground injection of oil and gas wastewater. The congressional office had noted that such wastewater is typically injected in exactly the places where prior drilling has created opportunities for the wastewater to migrate through abandoned or closed wells into groundwater.¹⁷⁷ In 1989, Congress’ investigative arm, the General Accounting Office (now the Government Accountability Office) reported on almost two dozen incidents of drinking water contamination associated with wastewater disposal wells.¹⁷⁸ Many of these cases involved wastewater migrating up abandoned oil and gas wells.¹⁷⁹

Pennsylvania’s own injection wells are not currently a major destination for wastewater from the state’s oil and gas wells. Instead, Pennsylvania trucks far more of its oil and gas wastewater to neighboring Ohio. As of 2023, Pennsylvania had only 12 underground wastewater injection wells,¹⁸⁰ compared to 245 as of 2022 in Ohio,¹⁸¹ where the geology is more favorable and permitting is easier. However, Inside Climate News reported in 2023 that minutes taken at a DEP Oil and Gas Technical Advisory Board meeting in 2021 alluded to a study from Tetra Tech, a consulting firm, saying that Pennsylvania would need between 17 and 34 extra disposal wells to handle the current amount of oil and gas wastewater produced in the state.

Inside Climate News also reported that a company called Penneco was planning a second injection well near Monroeville in western Pennsylvania.¹⁸³ Some local residents were opposing the well, as was the Plum Borough Council, which filed an appeal against its own appointed zoning board after the zoning board approved the well.¹⁸⁴

Aside from underground injection wells, Pennsylvania is home to thousands of abandoned oil and gas wells, many of them unplugged and in unmarked locations. The world’s

first commercial oil well was drilled in Titusville, Pennsylvania in 1859,¹⁸⁵ but oil and gas companies were not required to plug non-producing wells until 1984 and were not required to register old wells until 1985. Largely as a result, the state is riddled with old, unplugged or improperly plugged wells. Estimates of the number of these “orphan” wells, as they are known, range in the hundreds of thousands, but the true number may never be known. As noted earlier, the DEP found in 2023 that the practice of abandoning oil and gas wells, at least for conventional wells, has continued into the present day.¹⁸⁶

Recent history shows that wastewater from injection wells, potentially contaminated with PFAS or other dangerous chemicals, could reach these abandoned wells and migrate up the well shaft. This scenario could occur both in Pennsylvania and across the state line in Ohio where injection disposal wells are more common. Since 2020, two cases – one suspected to have involved an injection well, the other known to have done so – have been documented. In January 2021, more than 1.6 million gallons of what appeared to be fracking wastewater flowed for four days from an unplugged oil and gas well in Noble County, Ohio, idle since 2012.¹⁸⁷ A nearby tributary, Taylor Fork, was impacted by the spill, resulting in a fish kill. The cause of the spill was unclear, but there were six active fracking wastewater injection wells in Noble County, including three within four miles of the leaking oil and gas well. Another example occurred in September 2020 in Washington County, Ohio, when fracking wastewater from a disposal well migrated at least five miles to gas-producing wells, causing state officials to worry about possible groundwater contamination.¹⁸⁸

Abandoned wells could also be conduits for fracking fluid injected into active oil and gas production wells as opposed to disposal wells – fracking fluid that may be tainted with PFAS or other toxics. In 2022, the Pittsburgh Post-Gazette reported that a man in New Freeport reported that he witnessed “a geyser” of water erupting from the location of an abandoned well on his property. He learned that a Pennsylvania-based oil and gas company, EQT Corp., was simultaneously fracking a horizontal well more than

a mile away. The next day, EQT notified DEP about a “well communication” issue, a term that refers to a situation in which one well interacts with another. The company, however, told the Post-Gazette that it did not know if its fracking had caused the geyser. The company and the DEP were investigating. Several neighbors reported that they thought the apparent communication impacted their water.¹⁸⁹ In one case, a person who took a shower on the day of the incident later broke out in hives.¹⁹⁰

The Post-Gazette’s reporting indicated that communication with abandoned wells may be more common than reports reflect because it is likely that no one would be nearby to observe impacts in an abandoned well.¹⁹¹ Over the previous six years, oil and gas companies had reported to DEP 45 suspected cases of well communication. Most of these suspected cases were discovered by operators of shale gas wells adjacent to the wells that were the apparent source of the communication. These adjacent operators noticed changes in pressure or other impacts in their own wells. But if no one were near an abandoned well with which an active well communicated, the result could be water or soil contamination unknown to the public, whether from PFAS or other toxics.

Compounding these problems is that oil and gas production wells in Pennsylvania can be located as close as 500 feet from a building or water well in the case of unconventional wells, and within 200 feet in the case of conventional wells.¹⁹² This reality means that abandoned wells can be located near people’s homes, and communication of toxic fluids from a production well or disposal well nearby could emerge from an abandoned well and pollute well water or soil at a residence. Fluids from the well could also migrate directly into groundwater that feeds a private water well. And airborne pollutants could easily travel such a short distance (see section f below). The Attorney General’s grand jury recommended a setback or no-drilling zone of 2,500 feet from homes and 5,000 feet from schools and hospitals. These distances that would be more protective but perhaps not protective enough:¹⁹³ In 2012, a New York office of the U.S. Geological Survey warned that if the type of fracking

practiced in Pennsylvania were allowed in New York, fracking could jeopardize water supplies within a radius of up to five square miles.¹⁹⁴

d. Road Spreading

Road spreading -- the practice of spraying oil and gas wastewater on roads for deicing or dust suppression -- constitutes another pathway through which PFAS used in oil and gas wells could jeopardize Pennsylvanians' health. Researchers at Penn State University have found salts, metals, and radioactive elements in runoff from road spreading at levels higher than are considered healthy for people and the environment. There is no evidence that they tested for PFAS, but any chemical contained in the wastewater could run off of roads and contaminate water sources. The researchers also found that road spreading is no more effective at controlling dust than rainwater, a conclusion that the oil and gas industry disputes.¹⁹⁵ Two actions have created a partial ban on road spreading in Pennsylvania. In 2016, DEP banned the practice of road spreading with wastewater from unconventional gas wells.¹⁹⁶ In 2018, as a result of a settlement of an Environmental Hearing Board appeal, DEP's Oil and Gas Program halted the practice of approving road spreading of conventional wastewater.¹⁹⁷ However, road spreading with conventional wastewater has continued under a provision of the Solid Waste Management Act called "coproduct determination," in which a company can use industrial waste in place of a commercially available product if the industrial waste does "not present a greater threat of harm to human health and the environment than use of an intentionally manufactured product or produced raw material." The law requires various tests to demonstrate this relative level of safety. However, the tests do not require analysis for PFAS or radium.¹⁹⁸ As indicated earlier, PFAS could be used for drilling in conventional wells, even if the wells are not fracked.

The nonprofit Better Path Coalition found that conventional oil and gas drilling companies spread more than 2.2 million gallons of their wastewater on roads in Pennsylvania between 2018 and the end of 2020,¹⁹⁹ and more than 977,000

additional gallons in 2021,²⁰⁰ bringing the four-year total to more than 3.1 million gallons. This wastewater could have contained PFAS or other toxics, but it is impossible to know without adequate testing.

e. Landfills

When solid waste from oil and gas operations is taken to landfills, Pennsylvanians could also be impacted by chemicals in that waste, including, potentially, PFAS. Landfills produce their own dangerous wastewater, known as "leachate," when rainwater percolates through the contents of the landfill, comes in contact with buried wastes, and leaches out their chemicals or constituents.²⁰¹ Should the rainwater contact oil and gas waste tainted with PFAS and leach out those chemicals, and if that leachate were to escape from the landfill, it could cause contamination.

One case in Fayette County, Pennsylvania demonstrates the potential of leachate from oil and gas waste to cause water pollution, although it is unknown whether PFAS were involved. In 2019, local prosecutors asked the Pennsylvania Attorney General's office to investigate after leachate from a landfill that had accepted drill cuttings was taken to a wastewater treatment plant that discharged into the Monongahela River, a major source of drinking water for Western Pennsylvania.²⁰² While accepting leachate from the landfill, the plant's discharge of treated water exceeded state and federal pollution standards for several pollutants including ammonia-nitrogen because its treatment system stopped functioning, allowing pollutants to pass through, according to the local prosecutors' complaint.²⁰³ A test of the landfill's leachate in 2019 detected "volatile organic compounds (VOCs), including Xylene, Ethylbenzene, Naphthalene, 1,3, 5 Trimethylbenzene and 1, 2, 4 Trimethylbenzene... All of these contaminants (sic) are constituents of diesel fuel and are associated with waste streams from unconventional wells," an attorney for the wastewater treatment plant wrote in a letter accompanying a consent order prohibiting the landfill from sending its leachate to the treatment plant for 90 days.²⁰⁴ Oilfield services company Schlumberger²⁰⁵ and the Oklahoma State

University Extension²⁰⁶ have stated that diesel fuel has been, or may currently be used, in drilling of oil and gas wells. The treatment plant's superintendent wrote in an affidavit that the plant was able to effectively treat its wastewater during a two-week experiment when it temporarily stopped accepting waste from the landfill – an experiment which showed that the landfill's waste was causing the treatment plant to exceed pollution control standards.²⁰⁷

A more recent case involved allegations that leachate from a landfill in Pennsylvania contaminated a creek near York with PFAS, though the source of the PFAS in the landfill was unspecified. In 2023, Lower Susquehanna Riverkeeper Ted Evgeniadis sued Modern Landfill and its owner Republic Services, asking a federal judge to force the company to comply with the Clean Water Act and to impose penalties for alleged violations.²⁰⁸ Evgeniadis asserted that the landfill was discharging extremely high levels of PFAS into the creek in violation of the law. In his written complaint, he stated that he tested discharges from the landfill into Kreutz Creek as well as areas of the creek downstream from the discharges and found levels of PFOS at 374.3 parts per trillion, levels of PFOA at 847 parts per trillion and added that “25 other PFAS compounds were also measured at very high levels.”²⁰⁹ DEP records show that in April 2019, Modern Landfill received three tons of produced fluid from unconventional gas wells,²¹⁰ but it is unclear that this volume of fluid was accurate because records of oil and gas waste shipments and deliveries in Pennsylvania are often inconsistent.²¹¹ Nor is it clear or whether gas-related waste contributed to the high PFAS levels near the landfill.

f. Volatilizing, Flaring Could Pollute Air with PFAS

PFAS used in oil and gas wells could follow airborne exposure routes, according to toxicologist David Brown, former director of environmental epidemiology at the Connecticut Department of Health. Brown, who has investigated health effects associated with unconventional gas drilling for the Southwest Pennsylvania Environmental Health Project, warned that if PFAS were to enter drinking water, it could subsequently volatilize or become airborne inside homes.²¹²

Brown also added another potential pathway for airborne exposure: PFAS could become airborne when gas is either vented or burned off during flaring at the wellhead.²¹³

Bolstering Brown's concern, both the EPA and the Interstate Technology Regulatory Council say that PFAS can be spread through air. Neither source mentions pathways from oil and gas operations, perhaps because such pathways have only recently come to the public's attention. On a webpage devoted to “PFAS Analytical Methods Development and Sampling Research,” EPA includes a heading entitled “Source (Air) Emissions.” It states under that heading that “There are diverse sources of [air] emissions, including chemical manufacturers, commercial applications, and thermal treatment incineration processes. EPA is developing test methods for measuring PFAS source emissions.”²¹⁴ The Interstate Technology Regulatory Council (ITRC), a state-led environmental coalition that includes members from state, federal, tribal, and international agencies as well as academia, the private sector and the general public,²¹⁵ reported that “Under certain conditions, particularly within industrial stack emissions, or during fire suppression, incineration, or combustion, PFAS can be transported through the atmosphere.”²¹⁶ The ITRC added that deposition of PFAS could result in pollution of soil, groundwater, or other media:

Short-range atmospheric transport and deposition can result in PFAS contamination in terrestrial and aquatic systems near points of significant emissions, impacting soil, groundwater, and other media of concern (citation omitted). Evidence of releases has been observed in areas where hydrologic transport could not plausibly explain the presence of PFAS in groundwater, with the extent of contamination reaching several miles from sources and in distribution patterns independent of regional hydrology (citations omitted).²¹⁷

If PFAS are used in oil and gas wells, this information indicates that nearby residents should be concerned about airborne emissions.



John Day unconventional gas well site and fluids impoundment in Amwell Township, Washington County, Pa., June 7, 2021. The Pennsylvania Department of Environmental Protection (DEP) cited discharges from this impoundment as some of the violations and releases that prompted the DEP's \$4.15 million fine against Range mentioned on page 25 of this report. Photo credit: Courtesy of Marcellus Air.

CH. 5

OIL & GAS-RELATED CHEMICAL EXPOSURE AS AN ENVIRONMENTAL JUSTICE ISSUE

“Fenceline” communities – people living close to oil and gas operations – often bear a disproportionate risk of exposure to toxic chemicals. Thus, they may be particularly at risk from PFAS used in oil and gas extraction. Although drilling and fracking take place across the U.S., not everyone shares in the risks equally. Rather, oil and gas infrastructure and associated chemicals are frequently located in or adjacent to lower-income, underserved, and marginalized communities, notably Black, Indigenous, and other communities of color, as has been documented in a variety of studies.

A 2019 analysis conducted in Colorado, Oklahoma, Pennsylvania, and Texas found strong evidence that African Americans disproportionately lived near fracking wells in Texas and Oklahoma, while Hispanics disproportionately lived near fracking wells in Texas and urban Colorado. “In Pennsylvania,” the study reported, “where natural gas drilling

generally takes place in counties with low shares of minorities, no environmental disparities by race/ethnicity are found, however we do find significantly lower incomes near fracking wells.”²¹⁸ Similarly, in 2017, FracTracker Alliance published an analysis that found that out of almost 800 oil and gas wells drilled in Allegheny, Armstrong, and Butler counties between 2010 and 2014, only two were drilled in census tracts where the median home value was \$200,000 or greater.²¹⁹ A separate study published in 2015 found that census tracts in Pennsylvania with potential exposure to unconventional wells have a higher percentage of lower-income people.²²⁰

Where a pattern of risks affects people of color and/or lower-income people disproportionately, oil and gas production methods should be viewed and addressed as an Environmental Justice issue. So too should any oil- and gas-related exposure to PFAS.



Unconventional gas well in Union Township, Washington County, Pa., May 19, 2014. Photo credit: Courtesy of Marcellus Air.

CH. 6

POLICY CAN HELP PROTECT PENNSYLVANIANS FROM PFAS IN FRACKING

a. Modest Federal Protections from PFAS Pollution

Governments at all levels will have to do more to protect the public from PFAS, as EPA has taken only modest steps to do so, while Congress and the executive branch have exempted the oil and gas industry from major provisions of multiple federal environmental laws. For example, oil and gas operations are exempt from important permitting and pollution control requirements of the Clean Water Act, including the stormwater runoff permit requirement.²²¹ Fracking is exempted from the Safe Drinking Water Act pollution control measures unless diesel is used in the fracking process.²²² Oil and gas waste is exempted from the hazardous waste rules that require cradle-to-grave tracking and safe handling of hazardous substances under the Resource Conservation and Recovery Act.²²³ These exemptions increase the burden on state governments to address any PFAS pollution associated with oil and gas extraction.²²⁴

EPA has taken some steps to protect the public from dangerous PFAS. In 2005, EPA reached a then-record \$16.5 million settlement with chemical manufacturer Dupont after accusing the company of violating the federal Toxic Substances Control Act (TSCA) by failing to disclose information about PFOA's toxicity and presence in the environment.²²⁵ In 2006, EPA invited Dupont, 3M and six other companies to join a "stewardship" program in which the companies promised to achieve a 95 percent reduction of emissions of PFOA and related chemicals by 2010, compared to a year 2000 baseline. The agreement also required the companies to eliminate such emissions and use of these chemicals by 2015.²²⁶ In 2022, EPA said on its website that the companies reported that they had accomplished those goals, either by exiting the PFAS industry or by transitioning to alternative chemicals.²²⁷ EPA reported in 2022 that the manufacture and use of at least one PFAS, PFOA, had been phased out in the U.S., and that no chemical company had reported making PFOS in the U.S. since 2002. EPA did note that existing stocks of PFOA might still be used, and imported products may contain some PFOA,²²⁸ and a 2020 scientific article reported that

PFOA was still used in Asia. EPA stated that limited ongoing uses of PFOS remain. Since the announcement of its PFAS stewardship program in 2006, EPA has allowed nearly unlimited use of closely related "replacement" chemicals in dozens of industries.²³¹ In response, in 2015 a group of more than 200 scientists raised health and environmental concerns that the new PFAS designed to replace PFOA and PFOS may not be safer for health or the environment.²³²

In October 2021, EPA announced a "strategic roadmap" for regulating PFAS. This plan encompasses a goal of setting federal drinking water standards for several PFAS chemicals by 2023, as well as commitments to "use all available regulatory and permitting authorities to limit emissions and discharges from industrial facilities" and "hold polluters accountable."²³³ The plan does not, however, include an examination of PFAS use in the oil and gas industry. (Later that month, 15 members of the U.S. House of Representatives asked EPA to examine this topic.²³⁴ The month before, PSR had asked EPA to collect data on PFAS use in oil and gas extraction, utilizing its authority under TSCA.²³⁵) As previously stated, in June 2022, EPA announced new health advisory levels for several types of PFAS and in March 2023, announced a plan to regulate six types of PFAS in drinking water. In August 2022, EPA proposed designating PFOA and PFOS as hazardous under Superfund.²³⁶ This designation would enable affected parties to more easily hold oil and gas companies accountable for cleanup costs if PFOA and PFOS were found at oil and gas sites. Under Superfund, liability does not require negligence, and any potentially responsible party (PRP) can be held liable for cleanup of an entire site when it is difficult to distinguish contributions to pollution among several parties. As EPA writes about Superfund, "[i]f a PRP sent some amount of the hazardous waste found at the site, that party is liable."²³⁷

In acting belatedly to regulate at least some types of PFAS in drinking water, EPA is following the lead of several states, including Pennsylvania. As of 2023 nine states, including at least several with contaminated military sites, had developed enforceable standards for concentrations of several types of PFAS in drinking water.²³⁸

b. Pennsylvania's Disclosure Rules: In Need of Sweeping Reform

In Pennsylvania, multiple reforms are needed to protect the public from the use of PFAS in oil and gas operations, including changing the state's chemical disclosure rules to lift the veil of secrecy that oil and gas companies have used to conceal the use of potentially dangerous chemicals including, perhaps, PFAS. One such change is tighter limits on the use of trade secret provisions.

Oil and gas companies have argued that chemical trade secrets are necessary to protect their intellectual property from competitors. However, this interest does not have to mean a complete withholding of chemical identities from scientists, regulators, and the public. In 2015, California, a major oil-producing state,²³⁹ began requiring full disclosure of the individual chemicals used for well stimulation, including fracking.²⁴⁰ In June 2022, Colorado, a major producer of oil and gas,²⁴¹ followed in California's footsteps but extended the disclosure requirements to all chemicals used in oil and gas wells, not just fracking or stimulation chemicals.²⁴²

The methodology utilized in California and Colorado is consistent with a recommendation issued in 2014 by an advisory panel to the U.S. Department of Energy: that companies reveal the fracking chemicals injected into each well, providing that information in a list in which the chemicals are disassociated from the trade name of the commercial products they are part of.²⁴³ This form of disclosure enables the public to know all the chemicals used in fracking without disclosing to rival chemical manufacturers the exact components of proprietary formulas.²⁴⁴ In a similar way, food producers keep recipes secret while disclosing individual ingredients, enabling the public to know the contents of food products but making it difficult for rival producers to recreate valuable food brands. For unconventional wells, Pennsylvania requires that individual chemicals injected into each well be disclosed, disassociated from chemical products.²⁴⁵ However, the state's simultaneous allowance of trade

secret claims for individual chemicals, unlike California and Colorado, ensures that Pennsylvania's disclosure technique results in less than full disclosure.

California, Colorado and other states have additional provisions in their oil and gas chemical disclosure rules that could be models for Pennsylvania. California has a process under which state regulators review secrecy requests from chemical companies to determine whether the information must be kept proprietary,²⁴⁶ and health and safety data related to fracking fluids are not allowed to be hidden from public view under California law.²⁴⁷ California also requires disclosure of fracking chemicals before fracking begins,²⁴⁸ as do West Virginia²⁴⁹ and Wyoming.²⁵⁰ Colorado, in its June 2022 legislation, required chemical disclosure from chemical manufacturers.²⁵¹ The Pennsylvania Attorney General's grand jury endorsed many of these measures, recommending full chemical disclosure of all chemicals used in oil and gas wells before they can be used.²⁵²

These reasonable and feasible reforms are valuable steps to protect the health of people who may be exposed to PFAS and other dangerous oil and gas chemicals, be they industry workers, residents living near well sites, or first responders called to the scene of an accident. They can improve health and potentially save lives. Additional steps to reduce the harms caused by oil and gas extraction are outlined in the recommendations section, including a ban on the use of PFAS in oil and gas operations, an action that Colorado took in 2022.²⁵³ Among the evidence supporting the feasibility of this measure is a peer-reviewed analysis published in 2021 showing that many PFAS are immediately replaceable with less-persistent and less-toxic substances, including for use in the oil and gas industry.²⁵⁴

c. Pennsylvania's Hazardous Waste Rules Also in Need of Reform

Pennsylvania's state government has recognized the dangers of PFAS but, in doing so, has illuminated another gap in state rules that should be closed to protect the public from PFAS use in oil and gas operations. Subtitle C of RCRA is our

nation's law that requires safe management of hazardous waste from "cradle-to-grave."²⁵⁵ In 2021, in response to a request from New Mexico's Governor Michelle Lujan Grisham to regulate PFAS under Subtitle C, EPA Administrator Michael Regan said that the agency would initiate a rulemaking process to declare four types of PFAS to be "Hazardous Constituents" under RCRA – PFOA, PFOS, PFBS, and GenX – as a step toward listing them under Subtitle C. He also said that EPA would initiate a rulemaking to "clarify that emerging contaminants such as PFAS can be addressed through RCRA corrective action."²⁵⁶

Yet under both the federal RCRA²⁵⁷ and the state's implementation of the federal law in the Solid Waste Management Act,²⁵⁸ oil and gas wastes are exempt from hazardous waste requirements. This exemption allows drilling companies to take solid oil and gas waste to municipal landfills that have inadequate testing for radioactivity and other toxics, according to Duquesne University microbiologist John Stolz.²⁵⁹ Similarly, the exemption allows oil and gas companies to inject their liquid waste underground into so-called Class II wells designated for oil and gas waste; these wells have lower standards of environmental protection than Class I wells that are designated for hazardous waste. For example, operators of Class I hazardous waste injection wells must analyze an area of at least two miles' radius from the well to ensure that there are no adjacent wells that could be conduits allowing the oil and gas waste to migrate to the surface.²⁶⁰ Class II wells can analyze an area as small as within a quarter-mile radius.²⁶¹

Pennsylvania could act to regulate oil and gas waste as hazardous by following the example of New York State, which in 2020 enacted legislation to designate oil and gas waste as hazardous.²⁶² State Senator Rachel May, one of the bill's sponsors, said in a statement,

Wastewater from fracking can contain carcinogenic compounds and naturally occurring radioactive materials. The regulatory loophole that allowed waste from fracking and crude oil processing to be treated as

standard industrial waste means it enters local sewage treatment facilities, sometimes with radiation levels hundreds of times the safe limit, it then flows directly back into our waterways – the source of drinking water for thousands of New Yorkers.²⁶³

May issued her statement before it was widely known that PFAS was used in oil and gas operations, but considering the oil and gas industry's record of using PFAS, the statement could apply as well to these dangerous "forever" chemicals. Continuing to exempt oil and gas wastes from hazardous waste treatment means that PFAS in these wastes would be exempt, too, with potentially serious consequences for Pennsylvanians.



RECOMMENDATIONS

In light of the findings shared in this report, PSR recommends the following:

- **Halt PFAS use in oil and gas extraction.** Pennsylvania and the U.S. Environmental Protection Agency (EPA) should prohibit PFAS from being used, manufactured, or imported for oil and gas extraction. Many PFAS are replaceable with less-persistent and less-toxic alternatives. In taking this step, Pennsylvania would be following the lead of Colorado, a major oil- and gas-producing state that in June 2022 passed legislation banning the use of PFAS in oil and gas wells.
- **Expand public disclosure.** Pennsylvania should greatly expand its requirements for public disclosure of oil and gas chemicals. The state could again follow the example offered by Colorado by requiring disclosure of all individual chemicals used in oil and gas wells, without exceptions for trade secrets. This action can be done while still protecting product formulas as trade secrets. Pennsylvania should also require disclosure on the part of chemical manufacturers and require chemical disclosure prior to permitting, as have California, West Virginia, and Wyoming.
- **Increase testing and tracking.** Pennsylvania and/or the U.S. EPA should determine where PFAS have been used in oil and gas operations in the state and where related wastes have been deposited. They should test nearby residents, water, soil, flora, and fauna for PFAS, both for the particular type(s) of PFAS used and for organic fluorine to detect the presence of other PFAS and/or their breakdown products. They should use testing equipment sensitive enough to detect PFAS at a level of single-digit parts per trillion or lower.
- **Require funding and cleanup.** Oil and gas and chemical manufacturing firms should be required to fund environmental testing for PFAS in their areas of operation, and should PFAS be found, be required to fund cleanup. If cleanup of water sources is impossible, companies responsible for the use of PFAS should pay for alternative sources of water for homes, schools, hospitals, agriculture and other uses for as long as needed.
- **Remove Pennsylvania's oil and gas hazardous waste exemption.** Pennsylvania exempts oil and gas industry wastes from state hazardous waste rules. Pennsylvania should follow New York's lead and remove its state-level hazardous waste exemption for the oil and gas industry.
- **Reform Pennsylvania's regulations for oil and gas production wells and underground injection disposal wells.** The state should prohibit production wells and underground wastewater disposal wells close to underground sources of drinking water, homes, health care facilities and schools; require groundwater monitoring for contaminants near the wells, and for disposal wells, require full public disclosure of chemicals in the wastewater.
- **Transition to renewable energy and better regulation.** Given the use of highly toxic chemicals in oil and gas extraction, including but not limited to PFAS, as well as climate impacts of oil and gas extraction and use, Pennsylvania should transition away from fracking and move toward renewable energy and energy efficiency while providing economic support for displaced oil and gas workers. As long as drilling and fracking continue, the state should better regulate these practices so that Pennsylvanians are not exposed to toxic substances and should empower local governments also to regulate the industry. When doubt exists as to the existence or danger of contamination, the rule of thumb should be, "First, do no harm."



APPENDIX A

Data Sources for PFAS Used in Pennsylvania's Oil and Gas Wells

To identify where, and to what extent, PFAS and trade secret chemicals were used at unconventional gas wells in Pennsylvania, PSR analyzed well-by-well reports of fracking chemicals recorded in FracFocus, a database for the oil and gas industry²⁶⁴ maintained by the Groundwater Protection Council, a nonprofit comprised of regulators from state agencies.²⁶⁵ The dates of these records extend from January 1, 2012 to September 29, 2022. PSR consulted the open-source version of FracFocus, [Open-FF](#),²⁶⁶ which is more accurate and informative than the original version of FracFocus. For example, Open-FF corrects for numerous spellings of the same term and consolidates the spellings into a single, corrected term. For more information about the differences between FracFocus and Open-FF, see the link above.

Under Pennsylvania law, well operators must disclose the fracking chemicals used in unconventional gas wells to the FracFocus database. Disclosure must occur within 60 days after hydraulic fracturing treatment.²⁶⁷ Based on the disclosure forms available on FracFocus' website, operators must list, among other things, each individual chemical injected into the well and each chemical's CAS number, if available.²⁶⁸ There are, however, significant exceptions to disclosure requirements under Pennsylvania's rules, including an exception for chemicals designated a trade secret²⁶⁹ as discussed in Chapter 2 and Chapter 6.



APPENDIX B

Government Scientists Investigate Link between Pennsylvania Oil and Gas Wells, PFAS Pollution

In August 2023, as we prepared to go to press, a study conducted by the U.S. Geological Survey (USGS) and the Pennsylvania Department of Environmental Protection (DEP) with implications for PFAS use in oil and gas operations in Pennsylvania was published in a peer-reviewed journal. The study may be the first, or one of the first, by government agencies to recognize oil and gas wells as “facilities that have been documented as potential sources of PFAS.”²⁷⁰ In making this determination, the authors relied on two sources, also cited by PSR in this report, providing evidence of PFAS use in oil and gas operations including a 2008 paper by Murphy and Hewat²⁷¹ and a 2020 paper by Glüge.²⁷² The authors also relied on a paper published in 2022 by Hussain et al.²⁷³

The study by USGS and DEP detailed testing by scientists of surface water in Pennsylvania from 161 streams for 33 different types of PFAS.²⁷⁴ The goals of the study included measuring PFAS concentrations, determining the sources of PFAS, and comparing PFAS concentrations to health and environmental standards.²⁷⁵ The scientists found that 123 of the streams, 76 percent, contained one or more of the 33 types of PFAS.²⁷⁶ In addition, 16 of the streams contained levels of PFOA that exceeded EPA’s proposed drinking water standard for PFOA, and 11 streams had concentrations of PFOS that exceeded EPA’s proposed drinking water standard for PFOS.²⁷⁷

While the scientists did not report a direct link between oil and gas wells and the types of PFAS for which they tested, they did find concentrations of PFAS in streams located in areas that featured both high levels of oil and gas wells and combined sewer overflow outfalls²⁷⁸ (pipes that discharge into streams the combination of wastewater from homes and businesses, and runoff from roads, typically during rain storms).²⁷⁹ The scientists commented that “Research documenting the impacts of OG [oil and gas] development on PFAS contamination in surface waters is limited, but in this study the CSO [combined sewer overflow outfalls]

surrounded by OG development in local catchments could be a potential source of PFAS to surrounding streams.”²⁸⁰

While the study recognized a potential link between oil and gas wells and PFAS pollution in water, the extent of such pollution cannot yet be determined for several reasons. First, the researchers tested for only 33 PFAS out of thousands that have been manufactured. It is possible that oil and gas companies used types of PFAS for which the researchers did not sample. (The researchers stated that future investigation could involve testing for total organic fluorine that could indicate the presence of non-specific PFAS without having to test for individual types.)²⁸¹ Second, it is nearly impossible for researchers to test for all the types of PFAS potentially used in oil and gas wells because multiple regulatory gaps allow oil and gas companies and chemical manufacturers to withhold the identities of the chemicals used in oil and gas wells. Third, the researchers did not sample groundwater. PFAS used in oil and gas wells may be especially likely to impact groundwater because PFAS may be used in drilling that precedes fracking,²⁸² and has been used in fracking fluids.²⁸³ These PFAS could infiltrate groundwater through multiple pathways including during the first stage of drilling when the drill bit passes directly through groundwater before steel casing or cement is placed in the well to separate the well from the groundwater,²⁸⁴ through leaks and cracks in the casing and/or cement after these protective materials are installed,²⁸⁵ migration up adjacent faults²⁸⁶ or adjacent active and abandoned oil and gas wells,²⁸⁷ and through surface spills.²⁸⁸ More research and transparency is necessary to fully characterize the extent of PFAS pollution in water supplies located near oil and gas wells or near sites where oil and gas waste is disposed of.

APPENDIX C

Health and Environmental Risks of PTFE/Teflon

Polytetrafluoroethylene (PTFE) is the type of PFAS that oil and gas companies disclosed as being used for fracking in eight unconventional gas wells in Pennsylvania between 2012 and 2022. PTFE is a fluoropolymer, a type of plastic.²⁸⁹ Scientists²⁹⁰ and environmentalists²⁹¹ major concerns about PTFE and other fluoropolymers are related less to these substances themselves, but rather to the associated impacts of their production, use, and disposal. The production of PTFE and other fluoropolymers relies on the use of other, highly toxic PFAS that are used as production aids. As noted in a peer-reviewed study published in 2020, these other PFAS have included fluorosurfactants such as PFOA, whose risks are discussed in the previous chapter, and GenX, which is similarly harmful and has replaced PFOA in fluoropolymer production.²⁹² PTFE and other fluoropolymers may contain these more toxic PFAS fragments, and those fragments may leach out of the PTFE during use.²⁹³ The authors of the 2020 paper noted that

The levels of leachables...in individual fluoropolymer substances and products depend on the production process and subsequent treatment processes; a comprehensive global overview is currently lacking.²⁹⁴ In addition, PTFE may generate other PFAS if the PTFE breaks down under heat.²⁹⁵

The 2020 paper authors noted that the persistence in the environment of PTFE and other fluoropolymers could pose problems during disposal, observing that “Landfilling of fluoropolymers leads to contamination of leachates with PFAS and can contribute to release of plastics and microplastics.”²⁹⁶ One of the authors added in an email to PSR that if PTFE were used in oil and gas wells that have especially high temperatures, defined in publications by oilfield services company, Schlumberger, as 300°-350° F or higher for so-called “high-pressure, high-temperature wells,”²⁹⁷ the PTFE could undergo a process called “thermolysis” and generate toxic PFAS called perfluoroalkyl carboxylic acids (PFCAs). As a result, he wrote, “there could be some additional problems that need some investigation.”²⁹⁸ A spokesperson for the

Pennsylvania Department of Environmental Protection told PSR in June 2023 that members of the department’s sub-surface team “have found no producing formation in the 300F range or above.”²⁹⁹

In 2021, a coalition of national environmental organizations including the Center for Environmental Health, Clean Water Action, Ecology Center, Environmental Working Group, Natural Resources Defense Council, Safer States, and the Sierra Club voiced several environmental and health concerns regarding the risks of fluoropolymers such as PTFE, based on their review of multiple scientific articles. The groups also noted that fluoropolymers are manufactured with chemicals that have an outsized negative effect on climate change.³⁰⁰

Public records make it difficult to know for what purpose PTFE was used in Pennsylvania’s unconventional gas wells. For all eight wells in which the substance was injected, multiple purposes were listed for multiple chemical products, and it was unclear which purpose was connected to which product. In addition, the individual chemical components of the products were listed together in a separate portion of each disclosure form, making it impossible to know which components were part of which product or for what purpose the components were used.³⁰¹ However, PTFE, which is marketed as Teflon, is known for its slipperiness, suggesting it might have been used as a friction reducer, a common purpose for fracking chemicals.³⁰²



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⁵⁰ Pa. Bulletin Doc. No. 23-46 (Jan. 14, 2023), at 12. Accessed Aug. 7, 2023, at <https://www.pacodeandbulletin.gov/Display/pabull?file=/secure/pabulletin/data/vol53/53-2/46.html>.

⁵¹ EPA's proposed MCL for PFOA and PFOS is four parts per trillion. 88 Fed. Reg. 18638, 18639 (Mar. 29, 2023). Accessed August 7, 2023, at <https://www.federalregister.gov/documents/2023/03/29/2023-05471/pfas-national-primary-drinking-water-regulation-rulemaking#addresses>. Parts per trillion refers to milligrams per one million liters of water. U.S. Environmental Protection Agency. Environmental Science and Technology Briefs for Citizens. Center for Hazardous Substance Research. Understanding Units of Measurement. Accessed Aug. 7, 2023, at <https://cfpub.epa.gov/ncer/abstracts/index.cfm/fuseaction/display.files/fileid/14285>. One measuring cup contains approximately 237 milliliters. Exploratorium. Cooking Equivalents and Measures. Accessed Aug. 7, 2023, at <https://www.exploratorium.edu/food/measurements>. The density of PFOA is 1.8 grams per milliliter. National Institutes of Health. National Library of Medicine. National Center for Biotechnology Information. PubChem. Perfluorooctanoic Acid. Density. Accessed Aug. 7, 2023, at <https://pubchem.ncbi.nlm.nih.gov/compound/Perfluorooctanoic-acid>. Therefore, the mass of one measuring cup of PFOA is 426.6 grams or 426,600 milligrams. This mass of PFOA is 106,650 times greater than four milligrams (EPA's interim health advisory level per million liters). In order to dilute the mass of the PFOA in an equivalent volume of water, we multiplied 106,650 by 1,000,000. The result is 106,650,000,000 liters of water. There are 3.785 liters of water per gallon. U.S. Environmental Protection Agency. EPA Expo Box Unit Conversion Table. Accessed Aug. 7, 2023, at <https://www.epa.gov/expobox/epa-expobox-unit-conversion-table>. Therefore, 106,650,000,000 liters of water is equal to a bit more than 28 billion gallons of water.

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⁵³ Pa. Bulletin Doc. No. 23-46 (Jan. 14, 2023), at 335. Accessed June 6, 2023, at <https://www.pacodeandbulletin.gov/Display/pabull?file=/secure/pabulletin/data/vol53/53-2/46.html>.

⁵⁴ Pa. Bulletin Doc. No. 23-46 (Jan. 14, 2023), at 334-335. Accessed Aug. 7, 2023, at <https://www.pacodeandbulletin.gov/Display/pabull?file=/secure/pabulletin/data/vol53/53-2/46.html>.

⁵⁵ Pa. Bulletin Doc. No. 23-46 (Jan. 14, 2023), at 335. Accessed Aug. 7, 2023, at <https://www.pacodeandbulletin.gov/Display/pabull?file=/secure/pabulletin/data/vol53/53-2/46.html>.

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⁶¹ Pa. Bulletin Doc. No. 23-46 (Jan. 14, 2023), at 339. Accessed Aug. 7, 2023, at <https://www.pacodeandbulletin.gov/Display/pabull?file=/secure/pabulletin/data/vol53/53-2/46.html>.

⁶² Pa. Bulletin Doc. No. 23-46 (Jan. 14, 2023), at 345. Accessed June 6, 2023, at <https://www.pacodeandbulletin.gov/Display/pabull?file=/secure/pabulletin/data/vol53/53-2/46.html>.

⁶³ Electronic mail communication with Linda Birnbaum (Mar. 10, 2023).

⁶⁴ Electronic mail communication with Zacariah Hildenbrand (Mar. 14, 2023).

⁶⁵ Electronic mail communication with Kevin Schug (Mar. 14, 2023).

⁶⁶ Electronic mail communication with Wilma Subra (Mar. 14, 2023).

⁶⁷ Office of the Attorney General, Commonwealth of Pennsylvania. Report 1 of the Forty-Third Statewide Investigating Grand Jury (June 25, 2020), at 23, 28, 42, 96. Accessed Aug. 7, 2023, at <https://www.attorneygeneral.gov/wp-content/uploads/2020/06/FINAL-fracking-report-w.responses-with-page-number-V2.pdf>.

⁶⁸ U.S. Census Bureau. Quick Facts. Pennsylvania; United States. Accessed Aug. 7, 2023, at <https://www.census.gov/quickfacts/table/PA,US/PST045222>.

⁶⁹ U.S. Census Bureau. Quick Facts. Pennsylvania; United States. Accessed Aug. 7, 2023, at <https://www.census.gov/quickfacts/table/PA,US/PST045222>.

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⁷⁵ Ohio Department of Natural Resources, Division of Oil and Gas Resources Management, Oil and Gas Well Locator, Form 8(A) for well API Number 34-111-24285. Accessed Aug. 7, 2023, at <https://gis.ohiodnr.gov/MapViewer/?config=oilgaswells>.

⁷⁶ Concerned Health Professionals of New York and Physicians for Social Responsibility. Compendium of Scientific, Medical, and Media Findings Demonstrating Risks and Harms of Fracking (Unconventional Gas and Oil Extraction), Eighth Edition (2022). Accessed Aug. 7, 2023, at <https://www.psr.org/blog/frackingcompendium-8th-edition-now-available/>.

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⁷⁹ 58 Pa.C.S. § 3222.1(d)(1).

⁸⁰ Pa. Rules Title 25 § 78.122(c).

⁸¹ 58 Pa.C.S. § 3222.1(b)(2) and Pa. Rules Title 25 § 78a.122(b) (unconventional wells).

⁸² 58 Pa.C.S. § 3222(b.1)(1)(iii) and Pa. Rules Title 25 § 78.122(b)(6) (conventional wells).

⁸³ Pennsylvania Department of Environmental Protection. Registration of Trade Secret-Confidential Proprietary Stimulation Fluid Chemical Information Form Instructions for form 8000-FM-OOGM0132, at 1. Accessed Aug. 7, 2023, at <https://www.depgreenport.state.pa.us/elibrary/GetFolder?FolderID=3096>.

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⁸⁹ Gary Allison (2021) Open-FF: Transforming the FracFocus Disclosure Data into a Usable Resource [Source Code]. Accessed Aug. 7, 2023, at <https://doi.org/10.24433/CO.1058811.v15>. PSR accessed Open-FF data set downloaded from FracFocus on Sept. 29, 2022.

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⁹¹ FracFocus. Find a Well. Well with API Number 37-115-21853 fracked between Oct. 31, 2017 and Nov. 7, 2017 in Susquehanna County. Accessed Aug. 7, 2023, at <https://fracfocusdata.org/DisclosureSearch/Search.aspx>.

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⁹⁴ 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 10-14. EPA Report# 600/R-16/236F. Accessed Nov. 12, 2020 at <https://www.epa.gov/hfstudy>.

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⁹⁷ Juliane Glüge et al. An Overview of the Uses of Per- and Polyfluoroalkyl Substances (PFAS) – Electronic Supplementary Information 1. Environmental Science: Processes and Impacts (Oct. 30, 2020) at 50-51. Accessed online Aug. 7, 2023, at <https://pubs.rsc.org/en/content/articlelanding/2020/em/d0em00291g#!divAbstract>.

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⁹⁹ Ohio Department of Natural Resources, Division of Oil and Gas Resources Management, Oil and Gas Well Locator, Form 8(A) for well API Number 34-111-24285. Accessed Aug. 7, 2023, at <https://gis.ohiodnr.gov/MapView/?config=oilgaswells>.

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- ¹⁰⁶ United States House of Representatives Committee on Energy and Commerce, Minority Staff. Chemicals Used in Hydraulic Fracturing (April 2011), at 2 (on file with PSR).
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- ¹⁰⁸ Kate Konschnik et al. 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. Accessed Aug. 7, 2023, at <https://blogs.harvard.edu/environmentallawprogram/files/2013/04/4-23-2013-LEGAL-FRACTURES.pdf>.pdf. 29 CFR § 1910.1200; 2023.
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- ¹¹¹ Eliza Griswold. Amity and Prosperity (2018), at 260-261.
- ¹¹² Eliza Griswold. Amity and Prosperity (2018), at 304.
- ¹¹³ Eliza Griswold. Amity and Prosperity (2018), at 302.
- ¹¹⁴ 58 Pa.C.S. § 3222.1(c), (c)(1).
- ¹¹⁵ 58 Pa.C.S. § 3222.1(b)(7-9).
- ¹¹⁶ 25 Pa. Code § 78.122(b)(6)(iii).
- ¹¹⁷ 58 Pa.C.S. § 3222.1(b)(2) and Pa. Rules Title 25 § 78a.122 (unconventional wells).
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McIntyre Wild Area, Lycoming County, Pa., April 2021. Photo credit: Rebecca Johnson. Photo courtesy of FracTracker Alliance.



1111 14th Street NW, #700
Washington, DC 20005
202 667 4260
www.psr.org
psrnat@psr.org

 @PSRenvironment and @PSRnuclear
 /psrnational

FRACKING WITH “FOREVER CHEMICALS” IN TEXAS

Oil and Gas Companies Used PFAS in Texas Wells;
Extent of Use Obscured by Six Billion Pounds
of “Trade Secret” Chemicals

By Dusty Horwitt, J.D.
and Barbara Gottlieb
Data Analysis by Gary Allison
February 2023



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Cover photo shows oil and gas fields around Midland, Texas, April 2012. Photo credit: Jane Pargiter, EcoFlight.

Maps by Matt Kelso, FracTracker Alliance

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EXECUTIVE SUMMARY

Previously unpublicized information unearthed by Physicians for Social Responsibility (PSR) shows that since at least 2013, oil and gas companies used in Texas oil and gas wells more than 43,000 pounds of a class of extremely toxic and persistent chemicals known as PFAS. However, gaps in Texas's disclosure rules prevent the public from knowing how widely PFAS – or other toxic chemicals – have been used in oil and gas drilling and extraction. These findings raise concerns that Texans may unknowingly be exposed to highly hazardous substances.

PFAS are a highly dangerous class of chemicals, known for their toxicity at extremely low levels, their multiple negative health effects including cancer, and their resistance to breaking down in the environment, leading to their nickname, “forever chemicals.”

PSR analyzed industry self-reported data recorded in FracFocus, the official repository for Texas's required disclosure of chemicals used in hydraulic fracturing (“fracking”), and found that between 2013 and 2022, oil and gas companies injected more than 1,600 oil and gas wells in 73 counties with some 43,000 pounds of the PFAS known as PTFE/Teflon. Oil and gas companies injected 1,222 wells in 66 counties with more than 53,000 pounds of additional chemicals that are PFAS, likely PFAS, or precursor chemicals that could degrade into PFAS.

However, the number of definitively identified or likely cases of PFAS use may significantly underrepresent the use and presence of PFAS associated with oil and gas operations in the state. That is in large part because Texas law allows oil and gas companies and chemical manufacturers to withhold fracking chemical identities from the public and potentially even from regulators by claiming them as a “trade secret.” Between 2013 and 2022, companies claimed trade secret privileges in over 58,000 oil and gas wells located across 183 of Texas's 253 counties. The unidentified trade secret chemicals used in Texas over this roughly decade-long period totaled 6.1 billion pounds. An interactive map showing the locations of wells injected with PTFE/Teflon, fluorosurfactants, and trade secret chemicals is available

here [<https://ft.maps.arcgis.com/apps/webappviewer/index.html?appid=9cff28a549d84fbeb908444bbcaf16bf>].

By shielding from public view the chemicals injected into oil and gas wells, trade secret claims and other gaps in disclosure rules raise the potential that Texans may be directly exposed, or their groundwater and well water may be exposed, to PFAS and other toxic chemicals from hundreds or even thousands of oil and gas production wells.

Among our key findings are:

- A PFAS known as PTFE/Teflon was used in oil and gas extraction in Texas over the past decade in at least 1,625 oil and gas wells in 73 counties.
- A PFAS and potential fluorosurfactant called fluoroalkyl alcohol substituted polyethylene glycol was used in at least 65 wells between 2013 and 2022. Fluorosurfactants are part of a larger group of chemicals known as “surfactants” that are commonly used in fracking and can reduce the surface tension of a liquid among other properties. Fluorosurfactants encompass the dangerous PFAS known as PFOA and PFOS and hundreds of other less-studied replacement chemicals and mixtures. Some are known to be extremely toxic to people, could be harmful to animals, and are expected to persist in the environment.
- Trade secrets make it extremely difficult to determine how extensively PFAS (and other highly toxic chemicals) have been used in Texas. PSR's analysis of FracFocus data revealed that, between 2013 and 2022, Texas well operators declared at least one fracking chemical a trade secret in 58,199 oil and gas wells in 183 counties. Trade secret chemicals used in Texas over this roughly decade-long period totaled 6.1 billion pounds.
- In addition, over the past decade, oil and gas firms fracked 30,700 wells, spread across 171 counties, with at least one trade secret surfactant totaling 331 million pounds. Some of these may be fluorosurfactants.

Evidence shows that fluorosurfactants that are PFAS have been used in oil and gas extraction for decades. This evidence combined with data showing extensive trade secret use in Texas's oil and gas wells indicates that PFAS has been used more extensively than publicly reported to FracFocus.

- PFAS pollution of groundwater, surface water and air in Texas is possible wherever these substances have been used at oil and gas wells and wherever oil and gas wastewater containing PFAS has been disposed of. This includes disposal in injection wells and spreading the fluid onto soil in various types of land application, both common practices in Texas.
- This variety of potential pathways to exposure raises concerns that PFAS could endanger the environment and people's health.

In light of these findings, PSR recommends the following:

- **Halt PFAS use in oil and gas extraction.** Texas should follow the lead of Colorado, a major oil- and gas-producing state which banned the use of PFAS in oil and gas wells through legislation passed in June 2022. Furthermore, Texas and the U.S. Environmental Protection Agency (EPA) should prohibit PFAS from being used, manufactured, or imported for oil and gas extraction. Many PFAS are immediately replaceable with less persistent and less toxic substances, including for use in the oil and gas industry.
- **Expand public disclosure.** Texas should greatly expand its requirements for public disclosure of oil and gas chemicals. The state could again follow the example offered by Colorado by requiring disclosure of all individual chemicals used in oil and gas wells without exceptions for trade secrets, while requiring disclosure on the part of chemical manufacturers who know best what chemicals are being used. Texas should also require chemical disclosure prior to fracking, as have several states including California, West Virginia, and Wyoming.
- **Increase testing and tracking.** Texas and/or the U.S. EPA should determine where PFAS have been used in oil and gas operations in the state and where related wastes have been deposited and should test nearby residents, water, soil, flora, and fauna for PFAS.
- **Require funding and cleanup.** Oil and gas and chemical firms should be required to fund environmental testing for PFAS in their areas of operation where these are needed, and should PFAS be found, be required to fund cleanup. If water cleanup is impossible, the companies responsible for the use of PFAS should pay for alternative sources of water for drinking, household uses, and agriculture, as needed.
- **Reform Texas's regulations for underground injection disposal wells to prohibit wells** close to underground sources of water, to require groundwater monitoring for contaminants near the wells, and to require full public disclosure of the chemicals in the wastewater.
- **Transition to renewable energy, better regulation.** Given the use of highly toxic chemicals in oil and gas extraction, including but not limited to PFAS, as well as climate impacts of oil and gas, Texas should transition away from fracking and move toward renewable energy and efficiency. This transition should be structured to provide economic support for oil and gas workers. However, as long as we have drilling and fracking, the state should better regulate these practices so that Texans are not exposed to toxic substances. The state should also empower local governments to regulate the industry. When doubt exists as to the existence or danger of contamination, the rule of thumb should be, "First, do no harm."

CH. 1

PFAS: A MANMADE THREAT TO HEALTH AND THE ENVIRONMENT

a. Introduction to PFAS: Toxic, Persistent, and Used Widely in Texas's Oil and Gas Wells

Physicians for Social Responsibility (PSR) has identified evidence from industry documents that a highly dangerous class of chemicals, known as per- and polyfluoroalkyl substances (PFAS), has been used in Texas's oil and gas* wells for hydraulic fracturing ("fracking"). PFAS are known for their toxicity at extremely low levels,¹ their multiple negative health effects including cancer,² and their persistence in the environment, hence their nickname, "forever chemicals."³

The Texas oil and gas wells definitively known to have been injected with PFAS between 2013 and 2022 include 1,625 wells in 73 counties that were injected with PTFE, also known

as Teflon⁴ and identified by EPA as a PFAS. (See Table 1, excerpted below and presented in full in the Appendix.) Another 1,222 wells in 63 counties were injected with fluorosurfactants or potential fluorosurfactants, including 65 wells injected with fluoroalkyl alcohol substituted polyethylene glycol, also identified as a PFAS by EPA.⁵ The other fluorosurfactants are likely to be PFAS or precursors that could degrade into PFAS, according to three chemists and a board-certified toxicologist who reviewed the fluorosurfactants' names for PSR.⁶ The likely use of PFAS in oil and gas production in Texas was first exposed in 2021, initially by PSR⁷ and subsequently in a report by Public Employees for Environmental Responsibility.⁸ The wells PSR was able to identify in this report as injected with PFAS or chemicals likely to be PFAS may significantly underrepresent the extent of PFAS use in the state's oil and gas wells due to

*Gas, the principal component of which is methane, is also known as "natural" gas, "fossil" gas and "fracked" gas.

Table 1. Excerpt (full table in Appendix). Disclosed Use in Fracking of Fluorosurfactants, Potential Fluorosurfactants, and PTFE in Texas Oil and Gas Wells, 2013-2022

County	Number of wells injected with fluorosurfactants, potential fluorosurfactants	Mass of fluorosurfactants, potential fluorosurfactants (lbs.)	Number of wells injected with PTFE	Mass of PTFE (lbs.)
Anderson	1	3	1	13
Andrews	74	1,024	115	3,231
Archer	1	15	0	0
Atascosa	0	0	51	299
Baylor	2	56	0	0
Bee	0	0	2	*ND
Borden	15	222	0	0
Bosque	1	ND	0	0
Brazos	0	0	1	13
Burleson	1	ND	7	44
C-Z in Appendix	see Appendix	see Appendix	see Appendix	see Appendix
Total	1,222	53,398	1,625	43,829

This table, based on FracFocus data covering the dates January 1, 2013 through Sept. 29, 2022, shows county-by-county the number of Texas wells in which oil and gas companies injected PTFE for fracking, identified by EPA as a PFAS, or used at least one fluorosurfactant or potential fluorosurfactant for fracking. In this table, the term "fluorosurfactant" encompasses disclosed uses of "nonionic fluorosurfactant" while the term "potential fluorosurfactant" encompasses disclosed uses of "fluoroalkyl alcohol substituted polyethylene glycol," identified by EPA as a PFAS. Two chemists identified nonionic fluorosurfactants as either PFAS or precursors that could degrade into PFAS. A third chemist identified them as likely PFAS, and a board-certified toxicologist identified them as potential PFAS. The total weight figures reflect the sum of all records for which we have enough information to calculate a chemical's weight.

*ND = No data available.

gaps in chemical disclosure rules that allow oil and gas companies to conceal from the public the identities of chemicals.

b. Manmade and Dangerous

PFAS are a class of thousands of manmade chemicals known for having properties that are valuable in multiple contexts, including being slippery, oil- and water-repellant, and able to serve as dispersants or foaming agents.⁹ PFAS have been called “perfluorinated chemicals” and “polyfluorinated compounds,” or PFCs, though the term currently preferred by EPA is PFAS.¹⁰

The first PFAS to be sold commercially was created by a chemist at Dupont and was patented as Teflon. Since 1949, it has been used in thousands of products, from nonstick cookware to waterproof clothing to plastics to dental floss.¹¹ Other PFAS chemicals, the most prominent of which are known as PFOA and PFOS, have been used in food packaging, fire-fighting foam, and in 3M’s widely used fabric protector, Scotchgard.¹² EPA reported in 2022 that the manufacture and use of PFOA has been phased out in the U.S. and no chemical company has reported making PFOS in the U.S. since 2002. EPA states that existing stocks of PFOA might still be used, and imported products may contain some PFOA. There are limited ongoing uses of PFOS.¹³ The U.S. Environmental Protection Agency (EPA) reports that there are currently about 650 types of PFAS in commerce.¹⁴ Weak chemical disclosure laws make it difficult for the Agency to identify which PFAS chemicals are used, and where.

EPA and other regulators have identified PFAS as a serious threat to health and the environment.¹⁵ Between the 1960s and 1990s, researchers inside Dupont and 3M became aware that the PFAS they were manufacturing or using were associated with health problems including cancers and birth defects, had accumulated in people worldwide, and persisted in the environment.¹⁶ Many of these facts, kept internal by the companies, came to light after attorney Rob Bilott filed lawsuits in 1999 and 2001 accusing Dupont of

causing pollution in and around Parkersburg, West Virginia with PFOA, the type of PFAS used in making Teflon.¹⁷ In December 2011, as part of Dupont’s settlement of the 2001 lawsuit, a team of epidemiologists completed a study of the blood of 70,000 West Virginians and found a probable link between PFOA and kidney cancer, testicular cancer, thyroid disease (over- or under-production of hormones by the thyroid gland), high cholesterol, pre-eclampsia (a potentially dangerous complication during pregnancy characterized by high blood pressure and signs of damage to other organ systems, most often the liver and kidneys), and ulcerative colitis (a disease causing inflammation and ulcers in the large intestine or colon).¹⁸ PFAS are also extremely mobile in water.¹⁹

In June 2022, reflecting the growing concern about PFAS, EPA significantly lowered its health advisory level for PFOA and PFOS in drinking water. Previously, in 2016, EPA had set the combined health advisory level for these chemicals at 70 parts per trillion.²⁰ “The new published peer-reviewed data and draft EPA analyses...” EPA wrote in June 2022, “indicate that the levels at which negative health outcomes could occur are much lower than previously understood.”²¹ EPA set its new interim health advisory level for PFOA in drinking water to 0.004 parts per trillion and its interim health advisory level for PFOS to 0.02 parts per trillion.²² EPA also set new final health advisory levels for two other PFAS known as GenX and PFBS at 10 parts per trillion and 2,000 parts per trillion, respectively.²³ EPA said that its interim health advisory levels are intended to provide guidance until enforceable drinking water regulations for PFAS take effect.²⁴

EPA’s new interim health advisory levels mean that the toxicity of PFOA is almost beyond comprehension. Under EPA’s levels, one tablespoon of PFOA would be enough to contaminate 1.75 trillion gallons of water, which is greater than the total storage capacity of the Toledo Bend Reservoir (1.5 trillion gallons), Texas’s largest reservoir,²⁵ and more than 4,000 times greater than the 435.4 million gallons of drinking water that the City of Houston’s main system produces each day.²⁶ PFOS is extraordinarily toxic, too.

c. Persistent in the Environment, and Widespread

PFAS are not only highly toxic; they also demonstrate extreme persistence in the environment. PFAS' nickname "forever chemicals" reflects their chemistry – created by chemical manufacturers – that features a bond between fluorine and carbon atoms that is among the strongest in chemistry and rarely if ever exists in nature. The result: chemicals that are extremely resistant to breaking down in the environment.²⁷

Evidence has mounted over the years of cases of PFAS pollution from a variety of sources, including in Texas. In 2019, the nonprofit Environmental Working Group reported that many of the nation's highest concentrations of PFAS in groundwater have been discovered at military sites, including in Texas, according to federal government data that the organization examined.²⁸ Of the 100 military bases with the highest concentrations of PFAS – many of them shockingly high – seven were located in Texas

- The eighth-highest concentration in the nation: Grand Prairie Armed Forces Reserve Complex in Grand Prairie near Dallas.²⁹ 1,247,000 parts per trillion for PFOA and PFOS.
- The sixteenth-highest concentration: Sheppard Air Force Base, just north of Wichita Falls.³⁰ 850,000 parts per trillion for PFHxS.
- The twentieth-highest concentration: Joint Base San Antonio,³¹ located in and around San Antonio. 767,000 parts per trillion for PFOA and PFOS.
- The twenty-second-highest concentration: Dyess Air Force Base, located in Abilene.³² 702,000 parts per trillion for PFHxS.
- The forty-ninth-highest concentration: Randolph Air Force Base, located northeast of San Antonio.³³ 175,000 parts per trillion for PFOA and PFOS.

- The seventy-ninth-highest concentration: Kelly Air Force Base, a now-closed base located in San Antonio.³⁴ 77,200 parts per trillion for PFHxS,
- The eighty-seventh-highest concentration: Ellington Field Joint Reserve Base, located in Houston.³⁵ 61,000 parts per trillion for PFOA and PFOS.³⁶

The Pentagon helped develop fluorinated foams in the 1960s.³⁷

In a report issued in April 2022, the U.S. Centers for Disease Control Agency for Toxic Substances and Disease Registry (ATSDR) concluded that firefighting foam had contaminated private drinking water wells near Reese Technology Center in Lubbock, formerly Reese Air Force Base.³⁸ The agency found that potentially as early as the 1970s, the base had used aqueous film-forming foam (AFFF) for firefighting training. The foam contained PFAS. "Over time," the agency found, "the PFAS from the AFFF entered the ground, moved into the groundwater to offsite locations, and affected nearby private wells."³⁹ For affected homes, the Air Force installed whole-house water treatment systems and supplied bottled water. The water in all households tested by the Air Force met or was below EPA's health advisory level for PFAS set in 2016. (Residents of a small number of homes declined to have their water tested, so it is possible that levels of PFAS in water at these homes could have been higher.)⁴⁰

The ATSDR report also showed that the concentrations of two types of PFAS in blood samples from people who lived near the base were higher than the national average: Concentrations of PFHxS were 4.2 times the national average, while concentrations of PFOA were 1.2 times the national average. Concentrations of three other types of PFAS (PFOS, PFNA, and PFDA) were not higher than the national average.⁴¹

The case of the former Reese Air Force Base provides a window into Texas's lax standards for PFAS in water. The ATSDR wrote in its 2022 report on Reese Air Force Base that

actions taken by the Air Force reduced PFAS levels in drinking water in the affected area below EPA [2016] health advisory for PFOS and PFOA and Texas Commission on Environmental Quality's (TCEQ's) protective concentration levels (PCLs) for multiple PFAS.⁴²

However, ATSDR's statement raises concerns. First, the statement implies that Texas's protective concentration levels for PFAS apply to drinking water, when in fact, drinking water standards for PFAS do not exist in Texas.⁴³ The state's protective concentration levels apply to cleaning up groundwater contamination.⁴⁴ Second, these groundwater contamination limits for residential properties include limits of 290 parts per trillion for PFOA and 560 parts per trillion for PFOS. When compared with EPA's interim health advisory levels of 0.004 parts per trillion for PFOA and 0.02 parts per trillion for PFOS, it appears that Texas's limits on PFAS in groundwater are far from safe.

Finally, the case also highlights how any testing and regulatory standards for PFAS used prior to EPA's June 2022 interim health advisory levels may be inadequate to protect the public. ATSDR, for example, reported that its tests for most types of PFAS at Reese Air Force Base, including PFOA and PFOS, were not sensitive enough to detect concentrations lower than two parts per trillion.⁴⁵

It is possible that these PFAS could have been present in drinking water at Reese Air Force Base at levels lower than the detection limit but far higher than EPA's June 2022 interim health advisory levels. ATSDR also reported that it used as a cleanup standard the EPA's health advisory level set in 2016 (70 parts per trillion for PFOA and PFOS) because that level is more conservative than Texas's protective concentration levels. But under EPA's more protective June 2022 interim health levels, the ATSDR's highest detected level of PFOA in drinking water at Reese Air Force Base, 4.6 parts per trillion, is 1,150 times too high, reflecting EPA's new understanding of PFAS' extreme toxicity.

Another example of PFAS pollution in Texas associated with the use of fire-fighting foam was the discovery of PFAS in the

Houston Ship Channel in 2019 following a major fire. The fire began March 17 of that year in Deer Park at a chemical storage facility operated by Intercontinental Terminals Company (ITC). Use of fire-fighting foam containing PFAS may have been a source of the PFAS in the channel.⁴⁶

Concern over PFAS pollution has led eight other states, including at least some with contaminated military sites, to develop enforceable standards for concentrations of several types of PFAS in drinking water.⁴⁷ One of the most recent to act is Michigan, which set standards in 2020 for limiting PFAS in drinking water and for removing PFAS from groundwater. The standards apply to PFOA and six other forms of PFAS. Michigan's maximum allowable level is no more than eight parts per trillion for PFOA,⁴⁸ a standard that is one of the lowest among states but is now much more permissive than EPA's interim health advisory level. Even Michigan's standard, however, shows how toxic PFAS can be. By extrapolation, Michigan's standards suggest that one measuring cup of PFOA could contaminate almost eight billion gallons of water – the amount of water needed to fill almost 12,000 Olympic-sized swimming pools at about 660,000 gallons per pool.⁴⁹ The extreme potency of PFOA, as with other PFAS, indicates why health experts are concerned about even minute quantities of these chemicals.

CH. 2

USE OF PFAS IN TEXAS BY OIL AND GAS COMPANIES

a. Disclosed Use of Fluorosurfactants, PTFE

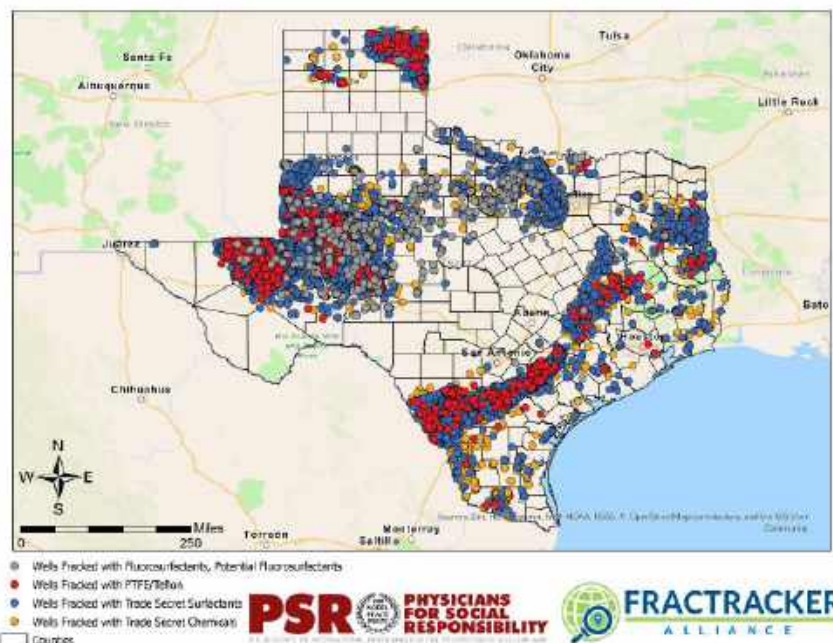
While PFAS contamination in Texas is often associated with military bases, oil and gas operations in the state deserve scrutiny as a possible additional source of PFAS contamination. To identify where PFAS were used in Texas, PSR analyzed self-reported industry data on the well-by-well use of fracking chemicals recorded in FracFocus, a database for the oil and gas industry⁵⁰ maintained by the Groundwater Protection Council,⁵¹ a nonprofit comprised of regulators from state agencies. PSR consulted the open-source version of FracFocus, Open-FF,⁵² that is more accurate and informative than the original version of FracFocus.⁵³

Under Texas law, operators must disclose in the FracFocus database the name of chemical products used in fracking and each individual component chemical used in each product.⁵⁴ Companies must also disclose each chemical's Chemical Abstracts Service (CAS) number, if available.⁵⁵ CAS numbers

are unique numeric identifiers assigned to each chemical by the American Chemical Society.⁵⁶ They are the most accurate way to identify chemicals, as a chemical can have multiple names or trade names but only one CAS number.⁵⁷ CAS numbers enable researchers to access scientific information about each chemical including the chemical's structure and any available toxicological information. There is, however, a significant exception for chemicals designated a trade secret.⁵⁸ We discuss this important exception below in chapter three.

Our analysis of CAS numbers available in the industry's own entries shows that since 2013, oil and gas companies used at least two types of PFAS for fracking in oil and gas wells in Texas: fluoroalkyl alcohol substituted polyethylene glycol and PTFE. The industry also injected fluorosurfactants disclosed without CAS numbers that might be PFAS or could degrade into PFAS according to several scientists cited below, and injected into thousands of wells trade secret chemicals and trade secret surfactants that could be PFAS. This evidence

TEXAS OIL & GAS WELLS INJECTED WITH PTFE, FLUOROSURFACTANTS, POTENTIAL FLUOROSURFACTANTS, AND TRADE SECRET CHEMICALS



This map shows the location of oil and gas wells in Texas known to have been fracked between January 1, 2013 and September 29, 2022 using PTFE/Teflon (a known PFAS), fluoroalkyl alcohol substituted polyethylene glycol (a known PFAS), fluorosurfactants that are likely to be PFAS or PFAS precursors, trade secret chemicals, and/or trade secret surfactants. An interactive version of the map and detailed explanation of the data are available at <https://ft.maps.arcgis.com/apps/webappviewer/index.html?id=9cff28a549d84fbeb908444bbcaf16bf>.

raises the possibility that the use of PFAS has been much more extensive than publicly disclosed.

b. Industry Data Reveal Use of Fluorosurfactants

Fluorosurfactants are part of a larger group of chemicals known as “surfactants” that are commonly used in fracking.⁵⁹ According to EPA, surfactants lower the surface tension of a liquid, the interaction at the surface between two liquids (called interfacial tension), or that between a liquid and a solid.⁶⁰ Compared to other surfactants, fluorosurfactants are said to be “superior in their aqueous surface tension reduction at very low concentrations and are useful as wetting and leveling agents, emulsifiers, foaming agents, or dispersants.”⁶¹ Fluorosurfactants encompass the dangerous chemicals PFOA and PFOS, as well as hundreds of other less-studied replacement chemicals and mixtures.⁶² Some are known to be extremely toxic to people,⁶³ could be harmful to animals,⁶⁴ and are expected to persist in the environment.⁶⁵ In most cases, it was unclear for what specific purposes the fluorosurfactants were used in Texas’s oil and gas wells. Entries in the “purpose” field in FracFocus were vague, including “surfactants,” “fluoro surfactant,” or “water recovery surfactant.”

Industry sources suggest that fluorosurfactants are commonly used in oil and gas extraction. In July 2021, PSR found that according to FracFocus data, between 2012 and 2020, oil and gas companies used PFAS or chemicals that could break down into PFAS in fracking in more than 1,200 wells in six states including in Texas. Most were fluorosurfactants.⁶⁶ In 2020, several scientists published an article in *Environmental Science: Processes and Impacts* showing that since 1956, PFAS including fluorosurfactants had been used or proposed to be used globally in oil and gas extraction techniques including chemical-driven gas production, chemical flooding, fracking, and the drilling that precedes fracking and other oil and gas production techniques.⁶⁷ In 2008, two authors, one of whom was identified as an employee at DuPont, wrote in the peer-reviewed *Open Petroleum Engineering Journal* that the use of fluorosurfactants was relatively common in the oil and gas industry and that their use was about to surge. They referred to fluorosurfactants as an “emerging technology” and stated,

While fluorosurfactants have been used in gas and oil exploration for four decades, the increased demand for petroleum and the greater understanding of the benefits of fluorosurfactants have led to growing acceptance for fluorosurfactants throughout the petroleum industry.⁶⁸

c. Possibly a Fluorosurfactant, Definitely PFAS

Information from several reputable sources (see section d on next page) show that oil and gas companies injected into 1,222 oil and gas wells in Texas fluorosurfactants or potential fluorosurfactants that are PFAS, likely PFAS, or PFAS precursors that can degrade into PFAS. These chemicals were listed as “fluoroalkyl alcohol substituted polyethylene glycol” and “nonionic fluorosurfactants.” Fluoroalkyl alcohol substituted polyethylene glycol, injected into 65 wells, is clearly a PFAS because it is listed on EPA’s Master List of PFAS Substances. The FracFocus records showed that this substance has a CAS number of 65545-80-4.⁶⁹ This identifier enabled PSR to locate the chemical on EPA’s Master List of PFAS Substances where it is listed under a different name.⁷⁰ Its purpose as declared in FracFocus records is “oil field surfactant,” suggesting that it could be a fluorosurfactant.⁷¹

Limited toxicological data is available about this substance, but according to data on the website of the National Library of Medicine’s ChemIDplus, at high doses, the chemical is associated with convulsions or effects on the threshold at which a seizure could occur; dyspnea, or shortness of breath; and muscle weakness.⁷² A safety data sheet for the chemical published by its manufacturer says little about human health effects. “To the best of our knowledge,” the safety data sheet says, referencing the substance using a trade name Zonyl® FSO-100, “the chemical, physical, and toxicological properties have not been thoroughly investigated.” Regarding impacts to the environment, the safety data sheet says, “Toxic to aquatic life with long lasting effects...Avoid release to the environment...Collect spillage...Dispose of contents/ container to an approved waste disposal plant.”⁷³ A message on the website of ChemPoint, a chemical distributor, suggests that this chemical was phased out due to concerns that it could break down into PFOA or



Photo credit: Mansfield, Texas neighborhood with drill rigs in the background (Earthworks)

PFOS. A message apparently from Chemours, a company spun off from Dupont, says

Zonyl® fluorosurfactant and repellent grades were discontinued between 2009 and 2014. Capstone® fluorosurfactants [a new type of fluorosurfactant] and repellents were introduced as sustainable replacements that meet the goals of the U.S. EPA 2010/15 PFOA Stewardship Program. They are based on short-chain molecules that cannot break down to PFOA or PFOS in the environment.⁷⁴

As is discussed below, scientists have raised concerns about the health and environmental effects of these replacement chemicals.

In total, fluoroalkyl alcohol substituted polyethylene glycol and nonionic fluorosurfactants were injected into 1,222 oil

and gas wells located in 66 counties. The weight of these chemicals totaled at least 53,398 pounds⁷⁵ (see Table 1 in Appendix). Even if some of that volume were PFAS, it could pose significant health and environmental risks, depending on the chemicals' toxicity. The locations of the wells where fluorosurfactants or potential fluorosurfactants were used are displayed in the map on page 5; the counties where they were used are shown in Table 1 in the Appendix. As detailed below, the use of fluorosurfactants and perhaps other PFAS may be much wider in Texas than the Open-FF records indicate.

d. Challenges in Identifying Fluorosurfactants

The fluorosurfactants listed as being used in most of the 1,222 wells were "nonionic fluorosurfactants." According to two Texas university-based chemists, both of whom are authors of multiple peer-reviewed articles about

chemicals related to oil and gas production,⁷⁶ nonionic fluorosurfactants are PFAS or could degrade into PFAS. The two chemists are Zacariah Hildenbrand, Ph.D., a research professor in Chemistry and Biochemistry at the University of Texas at El Paso, and Kevin Schug, Ph. D., Shimadzu Distinguished Professor of Analytical Chemistry at the University of Texas at Arlington.⁷⁷ In addition, Wilma Subra, holder of a master's degree in chemistry and recipient of a John D. and Catherine T. MacArthur Foundation "Genius" grant for her work helping to protect communities from toxic pollution, identified both chemicals as potential PFAS. Subra, based in Louisiana, has spent decades working to reduce and remediate pollution from oil and gas operations.⁷⁸ And yet another expert, Linda Birnbaum, a board-certified toxicologist and former director of the National Institute of Environmental Health Sciences, informed PSR that the chemicals are likely to be PFAS.⁷⁹

PSR had to rely on scientists to identify these chemicals as PFAS or PFAS precursors because the oil and gas companies that made the public disclosures to FracFocus withheld as trade secrets the chemicals' CAS numbers, data that would have enabled a precise identification of the chemicals. The identification that was available in the FracFocus records included only generic names such as nonionic fluorosurfactant and trade names such as "S-222" and "Plexsurf WRS A," information insufficient to identify the chemicals with specificity. The purposes for which these chemicals were used included "water recovery surfactant," "fluorosurfactant," and "surfactant."

Another hurdle was the multiple spellings of "nonionic fluorosurfactant" that made it difficult to identify all of the wells into which these substances were injected. Open-FF was able to identify wells in which these chemicals were used by accounting for misspellings (e.g. "noionic fluorosurfactant"). However, a member of the public searching FracFocus might not realize that the database allows multiple spellings of the same substance and could fail to identify wells injected with nonionic fluorosurfactants simply by searching for the correct spelling of the term but not any of the incorrect spellings.⁸⁰ As a result, some users

of FracFocus might not know that a PFAS or potential PFAS was used in an oil and gas well in their community. This shortcoming highlights the advantage of Open-FF and points to the need for FracFocus to correct misspellings.

e. Use of PTFE, a PFAS Fluoropolymer

PSR also found, based on industry data in FracFocus, that the known PFAS polytetrafluoroethylene (PTFE) was used for fracking in 1,625 oil and gas wells in 73 Texas counties between 2013 and 2022. This chemical was listed in FracFocus by CAS number (9002-84-0)⁸¹ and appears on EPA's Master List of PFAS Substances.⁸² The weight of these uses of PTFE totaled 43,829 pounds (see Table 1 in Appendix). The FracFocus records do not show for what purpose the PTFE was used; however, PTFE, which is marketed as Teflon, is known for its slipperiness, and some fracking chemicals are used as friction reducers.⁸³ The locations of the wells where PTFE was used are displayed in the map on page 5, and the counties where they were used appear in Table 1 in the Appendix.

PTFE is a fluoropolymer, a type of plastic.⁸⁴ Scientists' and environmentalists' major concerns about PTFE and other fluoropolymers are related less to these substances themselves, but rather to the associated impacts of their production, use, and disposal, according to a 2020 scientific report.⁸⁵ The production of PTFE and other fluoropolymers relies on other, highly toxic PFAS that are used as production aids. As the report noted, these other PFAS have included fluorosurfactants such as PFOA, whose risks are discussed in the previous chapter, and GenX, which is similarly harmful and has replaced PFOA in fluoropolymer production.⁸⁶ (PFOA has been phased out as a manufacturing aid in the U.S. but is still used in Asia.⁸⁷) PTFE and other fluoropolymers may contain these more toxic PFAS fragments that can leach out of the PTFE during use.⁸⁸ The authors of the 2020 paper noted that

The levels of leachables...in individual fluoropolymer substances and products depend on the production process and subsequent treatment processes; a comprehensive global overview is currently lacking.⁸⁹

PTFE may also generate other PFAS if the PTFE breaks down under heat.⁹⁰ In addition, the authors noted that the persistence in the environment of PTFE and other fluoropolymers could pose problems during disposal. “Landfilling of fluoropolymers leads to contamination of leachates with PFAS and can contribute to release of plastics and microplastics,” they wrote.⁹¹ One of the authors added in an email to PSR that if PTFE were used in oil and gas wells that have especially high temperatures, it could undergo a process called “thermolysis” and generate toxic PFAS called perfluoroalkyl carboxylic acids (PFCAs). As a result, he wrote, “there could be some additional problems that need some investigation.”⁹² A 2008 publication from oilfield services company Schlumberger indicated that at least some “high-pressure, high-temperature” wells (defined as having temperatures of at least 300° F and pressures of at least 10,000 pounds per square inch) are located in Texas.⁹³ In 2021, a coalition of environmental groups including the Center for Environmental Health, Clean Water Action, Ecology Center, Environmental Working Group, Natural Resources Defense Council, Safer States, and the Sierra Club shared similar concerns, based on their review of multiple scientific articles, regarding the risks of fluoropolymers such as PTFE. The groups also noted that fluoropolymers are manufactured with chemicals that have an outsized negative effect on climate change.⁹⁴ Disclosure gaps in Texas law, discussed below, may prevent scientists and the public from knowing the extent of PTFE use in oil and gas operations.

f. PFAS Joins a Roster of Dangerous Chemicals Used in Fracking

PFAS has joined the roster of potentially dangerous chemicals used in fracking. When used in oil and gas operations, PFAS may add to the cumulative human exposure to a host of toxic substances.

For years, scientists, advocates and regulators in Texas and other states have raised concerns about the hundreds of industrial chemicals used in fracking of oil and gas wells, including their potential threats to human health and to water resources. In fracking, energy companies inject into oil and gas

wells a mixture of up to tens of millions of gallons of water, sand, and chemicals at high pressure to fracture underground rock formations, unlocking trapped oil and gas. The chemicals serve a variety of purposes including killing bacteria inside the wellbore, reducing friction during high-pressure fracking, and as gelling agents to thicken the fluid so that the sand, suspended in the gelled fluid, can travel farther into underground formations.⁹⁵ In 2016, EPA published a study that identified 1,606 chemicals used in fracking fluid and/or found in fracking wastewater. While the agency found high-quality information on health effects for only 173 of these chemicals, that 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.⁹⁶

In 2022, a team of chemists led by the University of Toledo used specialized extraction methods to establish the presence of many toxic and cancer-causing contaminants in fracking wastewater collected from the Permian Basin and Eagle Ford formations in Texas. The pollutants, which can cause harm to humans and wildlife, included volatile organic compounds, hazardous heavy metals such as lead, and radioactive uranium. Some of these hazardous contaminants represent chemical additives used in the fracking fluid, while others represent naturally occurring contaminants mobilized from the underground fracture zone. In total, the researchers detected 266 different dissolved organic compounds and 29 elements.⁹⁷

Chemicals used in the drilling stage that precedes fracking can also pose health risks, including developmental toxicity and the formation of tumors, according to EPA regulators.⁹⁸ A disclosure form filed with the state of Ohio, one of only two states to require public disclosure of drilling chemicals (Colorado is the other),⁹⁹ shows that Statoil, Norway's state oil company (since renamed Equinor), has used a neurotoxic chemical, xylene, in drilling.¹⁰⁰ If chemicals used in drilling, fracking or other stages and methods of oil and gas operations were to come into contact with people or the environment, negative health effects could result.

CH. 3

TEXAS'S CHEMICAL DISCLOSURE LAW SHIELDS CHEMICAL IDENTITIES

a. Texas's "Trade Secret" Law Shields Possible Use of PFAS

The danger of exposure to unknown chemicals – PFAS and others – from oil and gas operations persists in Texas. This risk continues, despite state rules enacted in 2012¹⁰¹ that generally require public disclosure of fracking and drilling chemicals.¹⁰² The rules require that within 90 days after completion of an oil or gas well or 150 days after drilling is complete, whichever is first, well operators must disclose their fracking chemicals to FracFocus.¹⁰³

On the face of it, these disclosure requirements seem effective; however, an important exception allows companies to avoid full and meaningful disclosure: The law allows chemical manufacturers, well operators and other companies in the chemical supply chain to withhold exact fracking and drilling fluid ingredient information if they deem it a trade secret.^{**104} In place of specific fracking chemical identities, oil and gas companies must list "the chemical family or other similar description associated with such chemical ingredient."¹⁰⁵ In the Texas FracFocus records, examples of these generic descriptions include "nonionic fluorosurfactant"¹⁰⁶ and "proprietary surfactant blend."¹⁰⁷ Regrettably, the use of such vague descriptors can hide from public view the true identities of dangerous chemicals, including PFAS.

Texas's rules suggest that even regulators may not learn the identities of all chemicals claimed as trade secrets. The rules provide that chemical disclosure begins with chemical suppliers and service companies disclosing fracking chemical identities to well operators, who must ultimately make disclosure to the public and the agency that regulates Texas's oil and gas operations, the Railroad Commission of Texas.¹⁰⁸ However, an investigation by the U.S. House of Representatives found in 2011 that between 2005 and 2009, the 14 leading service providers

...used 94 million gallons of 279 products that contained at least one chemical or component that

the manufacturers deemed proprietary or a trade secret. Committee staff requested that these [service] companies disclose this proprietary information. Although some companies did provide information about these proprietary fluids, in most cases the companies stated that they did not have access to proprietary information about products they purchased "off the shelf" from chemical suppliers. In these cases, the companies are injecting fluids containing chemicals that they themselves cannot identify.¹⁰⁹

If these practices have continued, service companies will be unable to inform well operators about every chemical identity in fracking chemical products, and the well operators would be unable to inform the Railroad Commission.

The use of trade secrets to conceal chemicals' specific identities effectively undermines the public health benefits of disclosure by preventing health professionals, the public, and potentially state regulators, from knowing where PFAS – or other toxic chemicals – have been used in oil and gas wells.

In addition to allowing trade secret exemptions for fracking and drilling chemicals, Texas does not require public disclosure of chemicals used in drilling, enhanced oil recovery, or in other extraction techniques that are distinct from fracking per se. EPA has indicated that any chemicals used during the first stage of the drilling process would be highly likely to leach into groundwater since during this stage, drilling passes directly through groundwater zones¹¹⁰ before any casing or cement is placed in the well to seal it off. The resulting potential for groundwater contamination makes public disclosure of chemicals used in drilling especially important. These regulatory gaps increase the potential that Texans could unknowingly be exposed to PFAS and other chemicals used during multiple phases and methods of oil and gas extraction.¹¹¹

b. Extensive Use of 'Trade Secret' Claims

Extensive application of the trade secret provisions under

^{**} Trade secret information is also called "proprietary" or "confidential business information" (CBI).

Texas's fracking chemical disclosure rules may mask even more extensive use of PFAS in the state's oil and gas wells than has been disclosed. PSR's data analysis revealed that, between 2013 and 2022, Texas well operators claimed at least one fracking chemical as a trade secret in 58,199 oil and gas wells located across 183 of Texas's 253 counties. The trade secret chemicals used in Texas over this roughly 10-year period totaled 6.1 billion pounds (see Table 2 excerpted below and available in full in the Appendix).¹¹² If even a small fraction of this weight were PFAS, that fraction could pose significant risks to health and the environment. (PSR included in our analysis of trade secret chemicals those chemicals in Open-FF whose specific identities were explicitly labelled "proprietary," "trade secret," or "confidential business information" in place of a CAS number. PSR did not include as trade secrets additional unidentified chemicals for which the CAS number in Open-FF is blank.)

In an effort to identify any PFAS among these trade secret chemicals, PSR examined whether any were listed as a surfactant. Surfactants, as noted above, encompass dangerous fluorosurfactants, some of which are extremely toxic to people¹¹³ and persistent in the environment.¹¹⁴ We found thousands of cases of oil and gas companies using at least one trade secret chemical that they described as a surfactant. These occurred in 30,700 wells, spread across 171 counties.¹¹⁵ (See the excerpt from Table 2, below, and the full table in the Appendix.) Operators' names for these chemicals were vague, including "surfactant" and "surfactant blend." These trade secret surfactants totaled 331 million pounds. (See examples from individual wells in Table 3 below.) While we cannot know what these trade secret chemicals are, should even a small percentage of them be fluorosurfactants, they could pose significant threats to human health and the environment.

Table 2. Disclosed Use in Fracking of Trade Secret Chemicals in Texas Oil and Gas Wells, 2013-2022

County	Number of wells injected with at least one trade secret chemical	Mass of all trade secret records (lbs.)	Number of wells injected with at least one trade secret surfactant	Mass of trade secret surfactants (lbs.)
Anderson	4	39,100	1	443
Andrews	2,603	70,400,000	1,670	8,050,000
Angelina	18	1,640,000	2	9,450
Aransas	6	2,680	2	458
Archer	47	12,200	19	3,560
Atascosa	772	21,000,000	332	2,280,000
Austin	2	6,880	1	1,450
Bastrop	1	28,700	0	0
Baylor	3	12,500	0	0
Bee	5	297,000	4	11,300
Additional B-Z in Appendix	See Appendix	See Appendix	See Appendix	See Appendix
Total	58,199	6,120,000,000	30,700	331,000,000

This excerpted table, based on FracFocus data covering the dates January 1, 2013 through Sept. 29, 2022, shows county-by-county the number of Texas wells in which oil and gas companies injected for fracking at least one trade secret chemical or at least one trade secret surfactant. The total weight figures reflect the sum of all records for which we have enough information to calculate a chemical's weight. However, the total weight figures represent an undercount because many fracking chemical disclosures lack sufficient data to perform this calculation.

Below, Table 3 shows examples of the types and quantities of fracking chemicals injected into individual wells. In some cases, oil and gas companies injected hundreds or even thousands of pounds of PFAS or trade secret chemicals into oil and gas wells for fracking. Even in the case below in which

a company injected just two pounds of fluorosurfactant for fracking, this quantity would be enough to contaminate vast amounts of water if the fluorosurfactant had a toxicity similar to that of PFOA or PFOS.

Table 3. Examples of Chemical Reporting on Individual Oil and Gas Wells in Texas

Well Operator	Well Number	County	Year Fracking Completed	Chemical used in Well	CAS Number	Trade Name	Mass (lbs.)
Sable Permian Resources	4238340217	Reagan	2019	PTFE	9002-84-0	not reported	2,035
Juno Operating Company II, LLC	4210731828	Crosby	2014	nonionic fluorosurfactant	Proprietary	S-222	2
Endeavor Energy Resources	4231740584	Martin	2017	nonionic fluorosurfactant	00-00-0 (ambiguous)	WRS-3	1,349
Chesapeake Operating, Inc.	4212738447	Dimmit	2022	proprietary surfactant blend	Proprietary	not reported	95
Pioneer Natural Resources	4231740216	Martin	2016	surfactant	Proprietary	not reported	9,554

This table shows illustrative samples of specific oil and/or gas wells injected with the types of fracking chemicals referenced in the larger tables above, including fluorosurfactants, trade secret surfactants such as the “proprietary surfactant blend,” and PTFE. The examples cover a range of years and represent wells fracked in several Texas counties.

Tables 4 and 5, excerpted on the following page, show some of the oil and gas companies that fracked the most wells in Texas between 2013 and 2022 using fluorosurfactants and PTFE, respectively. (Both tables are displayed in full in the Appendix.) Companies that used these chemicals include prominent oil and gas producers ExxonMobil, the nation’s

largest publicly traded oil and gas company,¹¹⁶ Chevron USA, Inc., the nation’s second largest oil and gas company,¹¹⁷ and Pioneer Natural Resources Co., the largest oil producer in the Permian Basin which straddles Texas and New Mexico.¹¹⁸

Table 4. Excerpt (full table in Appendix). Oil and Gas Companies that Fracked the Most Wells in Texas Using Fluorosurfactants, 2013-2022

Well Operator	Number of wells injected with fluorosurfactants potential fluorosurfactants	Total weight of fluorosurfactants (lbs.)
Athlon Energy Operating LLC	195	10,771
Juno Operating Company II, LLC	148	141
Delta Oil & Gas Ltd.	110	4
EOG Resources, Inc.	67	22,336
XTO Energy/ExxonMobil	67	745
LCS Production Company	48	16
Citation Oil and Gas Corp.	30	31
Chevron USA Inc.	26	155
Brigadier Operating LLC	25	ND*
Urban Oil and Gas Group	25	10
PPC Operating Company LLC	22	ND
Petrobal Omega 1, LLC	21	186
Apache Corporation	18	180
Laredo Petroleum, Inc.	16	4,721
Blackbeard Operating	14	393

This excerpted table shows the oil and gas companies that fracked the greatest number of oil and gas wells in Texas with fluorosurfactants or potential fluoro surfactants between January 1, 2013 and Sept. 29, 2022. More companies are listed in the full table in the appendix. Fluorosurfactants may be PFAS or precursors that could degrade into PFAS. The full table contains an expanded caption.

Table 5. Excerpt (full table in Appendix). Oil and Gas Companies that Fracked the Most Wells in Texas Using PTFE, 2013-2022

Well Operator	Number of wells with PTFE	Total mass of PTFE (lbs.)
BHP Billiton Petroleum	196	3,237
Cimarex Energy Co.	123	1,172
Pioneer Natural Resources	117	670
Occidental Oil and Gas	115	2,718
Ring Energy, Inc.	113	4,827
EXCO Resources, Inc.	87	1,003
Chesapeake Operating, Inc.	86	329
Apache Corporation	70	738
Forest Oil Corporation	69	897
Guidon Energy Management Services LLC	55	9,301
Matador Production Company	39	382
Lonestar Resources, Inc.	32	892
XTO Energy/ExxonMobil	32	1,208
ConocoPhillips Company/Burlington Resources	26	243
Sundance Energy	26	57

This excerpted table shows the fifteen oil and gas companies that fracked the greatest number of oil and gas wells in Texas with PTFE between January 1, 2013 and Sept. 29, 2022. More companies are listed in the full table in the appendix. The full table contains an expanded caption.

CH. 4

PFAS USE IN OIL AND GAS OPERATIONS ENDANGERS HEALTH IN TEXAS

a. Multiple Potential Pathways to Exposure

Where PFAS are among the chemicals used in oil and gas extraction, they could enter water supplies through spills, injection wells, land application, or other pathways, thus placing drinking water and agricultural water sources at risk. That risk is potentially substantial, given PFAS' characteristics: toxic in minuscule concentrations, linked to cancer, birth defects, pre-eclampsia, and other serious health effects, highly mobile in water, and extremely persistent in the environment.

EPA in its 2016 national report on fracking and drinking water found that fracking-related pollution could follow a number of pathways. Even without examining water contamination risks from underground disposal wells,¹¹⁹ the agency cited the following possible pathways to exposure:

- spills of fracking fluid that seep into groundwater;
- injection of fracking fluid into wells with cracks in the casing or cement, allowing the fluid to migrate into aquifers;
- injection of fracking fluids directly into groundwater;
- underground migration of fracking fluids through fracking-related or natural fractures;
- intersection of fracking fluid with nearby oil and gas wells,
- spills of wastewater after the fracking process is completed, and
- inadequate treatment and discharge of fracking wastewater to surface water supplies.¹²⁰

b. Evidence of Fracking-Related Water Contamination

The potential in Texas for water contamination through these pathways, from PFAS or other fracking chemicals, is not just hypothetical. In 2017, the news outlet EnergyWire reported on spills at oil and gas sites in Texas and other states that had

occurred over a five-year period. EnergyWire found that the number of reported spills in Texas was 1,965 in 2012; 2,142 in 2013; 2,500 in 2014; 2,793 in 2015; and 2,069 in 2016.¹²¹

Texas faces particular risks of spills at well sites due to hurricanes and heavy storms. According to an El Paso Times report from 2016,

Scores of photographs taken by state emergency-management officials show that when floodwaters rise in Texas, they inundate oil wells and fracking sites, sweeping crude and noxious chemicals into rivers throughout the Lone Star State....Many of the photos shot during Texas's recent floods show swamped wastewater ponds at fracking sites, presumably allowing wastewater to escape into the environment — and potentially into drinking-water supplies.¹²²

If even small amounts of PFAS were involved in some of these spills, they could cause significant contamination.

Evidence suggests that underground migration of contaminants from oil and gas production wells has occurred. In 2017, an analysis published in *Science of the Total Environment* of groundwater in the Eagle Ford Shale region in southern Texas found sporadic instances of multiple volatile organic compounds (VOCs) and dissolved gas, providing evidence that "groundwater quality is potentially being affected by neighboring [drilling and fracking] activity, or other anthropogenic activities, in an episodic fashion." The authors concluded that more extensive investigation was needed of possible groundwater contamination in the Eagle Ford basin.¹²³

Several earlier studies also found evidence of underground contamination that appeared to be associated with fracking operations. In 2016, a team of researchers from the University of Texas compared measurements of contaminants in groundwater collected before the expansion of unconventional oil and gas development in the Cline Shale region of western Texas to subsequent measurements made over a 13-month period. The researchers detected alcohols,

chlorinated compounds, and hydrocarbon co-contaminants that corresponded with the number of oil and gas production wells in the area.¹²⁴ In 2015, many of the same researchers published a study in which they documented widespread drinking water contamination throughout the Barnett Shale in northern Texas, a region that has been heavily drilled for gas. The study, which analyzed 550 water samples from public and private water wells, found elevated levels of 19 different chemical compounds associated with fracking including the carcinogen benzene, neurotoxic toluene, methanol, ethanol, and strikingly high levels of 10 different metals. The researchers said that the findings

do not necessarily identify [unconventional oil and gas] activities as the source of contamination; however, they do provide a strong impetus for further monitoring and analysis of groundwater quality in this region as many of the compounds we detected are known to be associated with [unconventional oil and gas extraction] techniques.¹²⁵

In 2013, University of Texas at Arlington researchers found elevated levels of arsenic and other heavy metals in some samples from private drinking water wells located within three kilometers of active natural gas wells in the Barnett Shale region. The levels of contaminants were higher than those in well water inside the region that was farther than three miles from gas wells and higher than levels in well water outside the region.¹²⁶

These studies did not test for PFAS. This lack of testing is not surprising; there were few if any grounds to test for PFAS in connection with oil and gas operations prior to July 2021, when PSR first publicized the probable use of these chemicals in oil and gas extraction.

c. Disposal of Wastewater Raises Pollution Concerns

Another risk that is especially high in Texas is that PFAS and other chemicals could pollute the environment through the disposal of fracking and/or drilling wastewater. Fracking fluid wastewater, which is brought back to the surface after

fracking is completed, can contain chemicals injected during the fracking process, including trade secret chemicals,¹²⁷ and thus, potentially, PFAS. It can also contain naturally occurring toxics found underground such as radium, a radioactive element and known human carcinogen.^{128, 129, 130} Much of the oil and gas wastewater generated in Texas is subsequently disposed in underground injection or disposal wells.¹³¹ In the case of injection wells, wastewater from oil and gas wells is injected into oil wells in order to facilitate oil production. The wastewater increases or maintains pressure in an oil field depleted by prior production and displaces or sweeps additional oil toward producing wells. This type of secondary recovery is sometimes called waterflooding.¹³² In the case of disposal wells, oil and gas wastewater is injected for permanent disposal.¹³³ As of July 2015, there were 26,100 active injection wells and 8,100 active disposal wells in the state.¹³⁴

The environmental nonprofit Earthworks detailed in a 2021 report that between January 2012 and December 2020, oil and gas companies injected into underground wells 28.4 billion gallons of fracking “flowback” waste, the wastewater that first comes out of wells during fracking; 3.1 trillion gallons of “produced water” that flows out of wells after the flowback, and almost 332 million gallons of liquid, radioactive waste.¹³⁵ If even a small percentage of this staggering amount of wastewater were tainted with PFAS, it could create significant pollution if it were to enter groundwater or surface water.

Meanwhile, researchers have known for decades that wastewater from injection wells can migrate upward from deep underground, moving through nearby oil and gas wells, many of which have ceased operating but have not been properly sealed off from the surrounding underground rock formations.¹³⁶ This migrating wastewater can break out of the abandoned wells and contaminate groundwater located near the earth’s surface.¹³⁷ The threat that this scenario creates is particularly acute in Texas, where 60 percent of the state’s water comes from groundwater.¹³⁸ In 1985, the Texas Department of Agriculture reported that oil and gas wastewater migrating up through abandoned, improperly

plugged wells was a common source of water contamination in oil and gas production areas:

When a water well is experiencing an oilfield pollution problem (typically, high chlorides), the pollution source is often difficult to track down. The source could be a leak in the casing of a disposal well, leakage behind the casing due to poor cement bond, old saltwater evaporation pits, or, most often, transport of contaminants through an improperly plugged abandoned well [underscore in original].¹³⁹

The department even had a name for this phenomenon: “saltwater breakout,” in which the salty oil and gas wastewater migrated up the abandoned well and then broke out near the surface, contaminating groundwater.¹⁴⁰ In one case in 1984 in Palo Pinto County, the department reported, “investigation found oil and salt coming up through an improperly plugged well. The water was coming from an injection well one-half mile away.”¹⁴¹ The department quoted the Congressional Office of Technology Assessment regarding the “insidious” problem of underground injection of oil and gas wastewater: that it is typically injected in exactly the places where prior drilling has opened up opportunities for the wastewater to migrate into groundwater.¹⁴²

James Osborne, a reporter with the Houston Chronicle, wrote in September 2022 that the potential that injected oil and gas wastewater could migrate up abandoned oil and gas wells is still a risk to Texas’s groundwater supplies. He reported that according to the Railroad Commission of Texas there are 150,000 inactive oil and gas wells in Texas.¹⁴³ An advocacy group, Commission Shift, that tracks the Railroad Commission, found that 17,000 of these wells have not operated for 20 years.¹⁴⁴

Additionally, as Cyrus Reed, Conservation Director at the Texas chapter of the Sierra Club told Osborne, the list of known abandoned wells is always growing. “The Railroad Commission is plugging about 1,000 to 1,400 wells a year, but as you plug one well, another comes on,” Reed said. “We’re

always playing catchup.” Ron Green, a former hydrologist at the Southwest Research Institute, a non-profit research organization in San Antonio, told Osborne that the extent of groundwater pollution caused by injected wastewater migrating up abandoned oil and gas wells is unknown and may not manifest itself for years, but there is at least one indication that it is occurring.¹⁴⁵ Water sampling in the Carrizo-Wilcox aquifer in South Texas beneath the Eagle Ford shale, a major oil- and gas-producing region, shows that the aquifer has become more saline, Green said, indicating that injected wastewater could be infiltrating water supplies.¹⁴⁶ Further compounding the problem, the true number of abandoned wells in Texas may never be known due to poor or nonexistent record-keeping, according to reporting by StateImpact in 2012.¹⁴⁷

Several other types of oil and gas waste disposal could pose serious risks to Texans if the waste were contaminated with PFAS. One disposal technique used in Texas is the spreading of wastewater on land (“land application”).¹⁴⁸ Texas’s permitting process does not require testing of this wastewater for radioactive contaminants, even though it is well known that such wastewater may contain radioactivity. Nor does the state require testing for PFAS.¹⁴⁹ Other oil and gas waste disposal methods used in Texas include taking waste to commercial surface waste management facilities or landfills, burial of wastes in pits at well sites or other locations, and surface water discharge.¹⁵⁰ The presence of PFAS could add to contamination threats in each type of disposal.

Local governments have little say in waste disposal decisions, even when oil and gas waste disposed of in Texas comes from out of state. An investigation conducted in 2021 by DeSmog found that at least one company imported oilfield waste for disposal at a West Texas facility from other states and even other countries. Some of the waste had extremely high levels of radioactivity. It is unclear whether this waste was tested for PFAS, but any PFAS in the waste would add to its risk.¹⁵¹ Earthworks noted that local governments have little power to prevent waste facilities from locating in or near their jurisdictions.¹⁵² In addition, in 2015, state lawmakers

passed HB 40 that stripped local governments of most power to regulate oil and gas production wells.¹⁵³

d. Volatilizing, Flaring Could Pollute Air with PFAS

PFAS used in oil and gas wells could follow airborne exposure routes, according to toxicologist Dave Brown, former director of environmental epidemiology at the Connecticut Department of Health who has investigated health effects associated with unconventional gas drilling with the Southwest Pennsylvania Environmental Health Project. He warned that if PFAS were to enter drinking water, it could subsequently volatilize or become airborne inside homes. Brown also added another potential pathway for airborne exposure: PFAS could become airborne when gas is burned off during flaring at the wellhead.¹⁵⁴

Flaring is significant in Texas, creating a potential pathway

for PFAS-tainted air emissions from oil and gas wells. A study published in 2018 used remote sensing data that incorporated infrared observations of combustion sources to estimate exposure of local residents to hazardous air pollutants from associated flaring operations in the Eagle Ford shale region in South Texas. The researchers confirmed extensive flaring in close proximity to homes.¹⁵⁵ In 2014, a four-part investigation by the San Antonio Express-News found that natural gas flaring in the Eagle Ford Shale in 2012 emitted more than 15,000 tons of volatile organic compounds such as carcinogenic benzene and other contaminants. This quantity of pollution was roughly equal to the pollution that would be released each year by six oil refineries. No state or federal agency was tracking the emissions from individual flares, the Express-News found.¹⁵⁶ These studies did not examine PFAS pollution but raise the potential that PFAS could have been present in the staggering amount of pollution emanating from the flared gas.



Pump jack and flare in Eagle Ford Shale in South Texas, May 2015. Photo credit: Earthworks

e. PFAS Could Compound Health Harms from Other Oil and Gas Chemicals

PFAS is by no means the only chemical associated with oil and gas extraction that could cause harm to health. Deeper investigation of PFAS use in oil and gas operations is especially important because exposure to PFAS may be additional to those other chemicals and could impact or intensify health effects caused by them. It is unknown if any of the problems associated with fracking chemicals, some of which are referenced below, are linked to or aggravated by PFAS used in oil and gas operations, but researchers should investigate.

Peer-reviewed studies of people living near oil and gas operations, including those in Texas, have found that proximity to active well sites correlates with a variety of diseases and other health effects. A 2021 study of more than three million pregnant women in Texas showed that living within one kilometer of an active oil or gas well increased the odds of gestational hypertension (high blood pressure) and eclampsia¹⁵⁷ (onset of seizures or coma during pregnancy or childbirth).¹⁵⁸ A 2020 study of pregnant women living in the Eagle Ford Shale area of South Texas found that exposure to a high number of nightly flaring events was associated with a 50 percent increase in the risk of preterm birth.¹⁵⁹ A 2020 study in Texas documented a link between natural gas extraction from both conventional and unconventional wells and frequency of hospitalization for childhood asthma.¹⁶⁰ Several studies conducted in Colorado, another major producer of oil and gas, also found associations between proximity to oil and gas operations and health effects, including congenital heart defects in newborns¹⁶¹ and cancer diagnoses among Coloradans from birth to 24 years old.¹⁶²

On a national scale, PSR and Concerned Health Professionals of New York have collaborated to compile and summarize the substantial and growing number of scientific studies that have found serious health effects associated with oil and gas drilling. In the eighth edition (2022) of our report, we wrote,

Public health problems associated with fracking include prenatal harm, respiratory impacts, cancer, heart disease, mental health problems, and premature death.... Poor birth outcomes have been linked to fracking activities in multiple studies in multiple locations using a variety of methods. Studies of mothers living near oil and gas extraction operations consistently find impaired infant health, especially elevated risks for low birth weight and preterm birth. As we go to press, a new study in Pennsylvania finds “consistent and robust evidence that drilling shale gas wells negatively impacts both drinking water and quality of infant health.”¹⁶³

Low birthweight is a leading contributor to infant death in the United States.¹⁶⁴

Many residents living near oil and gas operations have expressed frustration over the secrecy surrounding chemicals used by the oil and gas industry.¹⁶⁵ In 2020, Pennsylvania’s Attorney General issued a report based on a criminal grand jury investigation of oil and gas drilling pollution in the Keystone State. Drilling for gas in shale formations has surged in that state over the past 15 years,¹⁶⁶ vaulting it into the number two spot among gas-producing states (Texas is number one)¹⁶⁷ and bringing many more Pennsylvanians into contact with gas drilling and its impacts. Based on testimony from over 70 households, the attorney general compiled evidence of serious health impacts, finding that

Many of those living in close proximity to a well pad began to become chronically, and inexplicably, sick. Pets died; farm animals that lived outside started miscarrying, or giving birth to deformed offspring. But the worst was the children, who were most susceptible to the effects. Families went to their doctors for answers, but the doctors didn’t know what to do. The unconventional oil and gas companies would not even identify the chemicals they were using, so that they could be studied; the companies said the compounds were “trade secrets” and “proprietary information.” The absence



Marathon Oil facility in Karnes County Texas, May 2015. Photo credit: Earthworks

of information created roadblocks to effective medical treatment. One family was told that doctors would discuss their hypotheses, but only if the information never left the room.¹⁶⁸

Now that we know PFAS have been used in oil and gas operations for years, scientists should determine whether there are connections between this use and health effects, for PFAS chemicals individually and as a compounding factor in conjunction with exposure to other fracking chemicals.

f. Fracking and Chemical Exposure as an Environmental Justice Issue

“Fenceline” communities – people living close to oil and gas operations – often bear a disproportionate risk of exposure to toxic chemicals and may be particularly at risk

from PFAS used in oil and gas extraction. Although drilling and fracking take place in the majority of U.S. states, not everyone shares in that risk equally. Rather, oil and gas infrastructure and associated chemicals are frequently located in or adjacent to low-income, underserved, and marginalized communities, Indigenous communities, and other communities of color.

In 2021, researchers used satellite observations and census data to show that 83 percent of the flaring from unconventional oil and gas wells in the contiguous United States between March 2012 and February 2020 took place in three basins: the Williston Basin in North Dakota, Permian Basin in west Texas, and the Western Gulf Basin in southern Texas and Louisiana. They estimated that over half a million people in these basins lived within three miles of a flare, with 39 percent of them living near more than 100 flares each night. The researchers also reported that in

these regions, Black, Indigenous, and people of color were disproportionately exposed to flaring.¹⁶⁹

Other studies have also found disproportionate impacts on people of color. A 2020 study found that compared to white residents, Hispanic residents living in the Eagle Ford shale region were disproportionately exposed to flaring from unconventional oil and gas wells.¹⁷⁰ Hispanic residents were exposed to more (or more frequent) flares even though they were less likely than white residents to live near unconventional oil and gas wells. The researchers speculated that the increased exposure “may be driven by difference in political marginalization between Hispanic and non-Hispanic white communities in the region.” They explained that

marginalized communities are often targeted for the citing of locally unwanted land uses because of the perceived lack of political power and limited resources to challenge industrial practices [endnotes omitted]. These communities often receive less government oversight, which may increase the local levels of pollution, ultimately exacerbating health disparities.

In 2016, a public health research team showed that in the Eagle Ford shale region, disposal wells for fracking wastewater were more than twice as common in areas where residents are more than 80 percent people of color than in majority-white communities. They also found that disposal wells were disproportionately located in areas with high rates of poverty.

But even in these areas, the association with race was predominant. “Adjusting for both poverty and rurality,” the researchers wrote, “we still found that as the proportion of people of color in the census block group increased, so did the presence of disposal wells.” Since 2007, they reported, Texas had permitted more than 1,000 waste disposal wells in the Eagle Ford Shale region, where groundwater is the primary source of drinking water.¹⁷¹

A 2019 analysis conducted in Colorado, Oklahoma, Pennsylvania, and Texas found strong evidence that African

Americans disproportionately lived near fracking wells in Texas and Oklahoma, while Hispanics disproportionately lived near fracking wells in Texas and urban Colorado. “The question, who bears the costs of unconventional natural gas drilling, is of great relevance not only for the U.S., but worldwide,” the researchers wrote.

According to estimates by Measham and Fleming (2014), around 300 million people across six continents in populated areas live on land that overlies shale-energy reservoirs. As unconventional gas drilling is expanding across the world, regulation of hydraulic fracturing in the U.S. will have an impact on its regulation in other countries, and hereby on its environmental and human health consequences.¹⁷²

Economics as well as race can be a determinant of disproportionate risk. In 2015, a study found that those economically benefiting most from shale gas fracking in Denton, Texas, mostly lived elsewhere, while the environmental impacts remained local and affected those who did not have a voice in mineral-leasing decisions. “Non-mineral owners are essentially excluded from the private decisions,” the authors wrote, “as the mineral owners not only receive the direct monetary benefits, but also hold a great deal of state-sanctioned power to decide if and how [shale gas development] proceeds.”¹⁷³

Where a pattern of risks affects people of color and/or lower-income people disproportionately, fracking should be viewed as an Environmental Justice issue – and so too should any resultant exposure to PFAS.

CH. 5

POLICY CAN HELP PROTECT TEXANS FROM PFAS IN FRACKING

a. EPA Regulation of PFAS: Lax

Governments at all levels will have to do more to protect the public from PFAS, in large part because EPA has taken only modest steps to do so, while Congress and the executive branch have exempted the oil and gas industry from major provisions of multiple federal environmental laws. For example, oil and gas waste is exempted from the hazardous waste rules that require cradle-to-grave tracking and safe handling of hazardous substances under the Resource Conservation and Recovery Act. These exemptions increase the burden on state governments to address any PFAS pollution associated with oil and gas extraction.¹⁷⁴

EPA has taken some steps to protect the public from dangerous PFAS. In 2005, EPA reached a then-record \$16.5 million settlement with chemical manufacturer Dupont after accusing the company of violating the federal Toxic Substances Control Act (TSCA) by failing to disclose information about PFOA's toxicity and presence in the environment.¹⁷⁵ In 2006, EPA invited Dupont, 3M and six other companies to join a "stewardship" program in which the companies promised to achieve a 95 percent reduction of emissions of PFOA and related chemicals by 2010, compared to a year 2000 baseline. The agreement also required the companies to eliminate such emissions and use of these chemicals by 2015.¹⁷⁶ In 2022, EPA said on its website that the companies reported that they had accomplished those goals either by exiting the PFAS industry or by transitioning to alternative chemicals.¹⁷⁷ However, since the announcement of its PFAS stewardship program in 2006, EPA has allowed nearly unlimited use of closely related "replacement" chemicals in dozens of industries.¹⁷⁸ In response, in 2015 a group of more than 200 scientists raised health and environmental concerns that the new PFAS designed to replace PFOA and PFOS may not be safer for health or the environment.¹⁷⁹

In October 2021, EPA announced a "strategic roadmap" for regulating PFAS. This plan encompasses a goal of setting federal drinking water standards for several PFAS chemicals by 2023, as well as commitments to "use all

available regulatory and permitting authorities to limit emissions and discharges from industrial facilities" and "hold polluters accountable."¹⁸⁰ The plan does not, however, include an examination of PFAS use in the oil and gas industry. (Later that month, 15 members of the U.S. House of Representatives asked EPA to examine this topic.¹⁸¹ The month before, PSR asked EPA to collect data on PFAS use in oil and gas extraction, utilizing its authority under TSCA.¹⁸²) As previously stated, in June 2022, EPA announced new health advisory levels for several types of PFAS. Unfortunately, these standards are advisory and not legally enforceable.¹⁸³

And in August 2022, EPA proposed designating PFOA and PFOS as hazardous under Superfund.¹⁸⁴ This designation would enable affected parties to more easily hold oil and gas companies accountable for cleanup costs if PFOA and PFOS were found at oil and gas sites because under Superfund, liability does not require negligence and any potentially responsible party (PRP) can be held liable for cleanup of an entire site when it is difficult to distinguish contributions to pollution among several parties. As EPA writes about Superfund, "[i]f a PRP sent some amount of the hazardous waste found at the site, that party is liable."¹⁸⁵

b. Texas Disclosure Rules: In Need of Reform

In Texas, multiple reforms are needed to protect the public from the use of PFAS in oil and gas operations, including changing the state's chemical disclosure rules to lift the veil of secrecy that oil and gas companies have used to conceal the use of potentially dangerous chemicals including, perhaps, PFAS. One such change should be tighter limits on the use of trade secret provisions.

Oil and gas companies have argued that chemical trade secrets are necessary to protect their intellectual property from competitors. However, this interest does not have to mean a complete lack of information on chemical identities for scientists, regulators, or the public. In 2015, California, a major oil-producing state,¹⁸⁶ began requiring full disclosure of chemicals used for well stimulation, including fracking. The policy did away with trade secret exemptions for the

individual chemicals used in fracking products.¹⁸⁷ In June 2022, Colorado, another major producer of oil and gas, followed in California's footsteps but extended the disclosure requirements to all chemicals used in oil and gas wells, not just fracking or stimulation chemicals.¹⁸⁸

The methodology utilized in California and Colorado is consistent with a recommendation issued in 2014 by an advisory panel to the U.S. Department of Energy: that companies reveal the fracking chemicals injected into each well, providing that information in a list in which the chemicals are disassociated from the trade name of the commercial products they are part of.¹⁸⁹ This form of disclosure enables the public to know all the chemicals used in fracking without disclosing to rival chemical manufacturers the exact components of any proprietary formulas.¹⁹⁰ California also has a process under which state regulators review secrecy requests from chemical companies to determine whether the information must be kept proprietary.¹⁹¹ Health and safety data related to fracking fluids are not allowed to be hidden from public view under California law.¹⁹² California also requires disclosure of the chemicals used prior to fracking,¹⁹³ as do West Virginia¹⁹⁴ and Wyoming.¹⁹⁵

Texas should also ensure that full chemical disclosure is required from all the companies in the chemical supply chain. Currently, Texas rules require chemical disclosure from the supplier or service provider to the well operator, who is ultimately responsible for making public disclosure.¹⁹⁶ Chemical manufacturers, however, are explicitly exempted from this chain of reporting, despite being the only entity that always knows the precise contents of the chemicals they produce. Texas's existing rules exempt chemical manufacturers by providing that

a supplier is not responsible for any inaccuracy in information that is provided to the supplier by a third party manufacturer of the [fracking] additives. A service company is not responsible for any inaccuracy in information that is provided to the service company by the supplier. An operator is not responsible for any

inaccuracy in information provided to the operator by the supplier or service company.¹⁹⁷

Therefore, the operator, who must ultimately make public disclosure, has no legal incentive to hold the supplier or service company accountable for providing accurate fracking chemical information, as the operator cannot be held accountable for inaccurate information from those sources. The service company likewise has no incentive to hold the supplier accountable, and the supplier has no similar incentive to hold the manufacturer accountable. In theory, the operator might have the ability to hold the manufacturer accountable for providing accurate chemical information if the manufacturer provided chemical additives directly to the operator, but this scenario seems unlikely; manufacturers can avoid that type of accountability by providing their chemicals for use in fracking through a supplier.

An additional section in Texas law provides that "a supplier, service company, or operator is not required to...disclose ingredients that are not disclosed to it by the manufacturer, supplier, or service company."¹⁹⁸ This section more definitively eliminates the incentive that an operator, supplier, or service company might have to demand full disclosure of fracking chemical ingredients by a chemical manufacturer.

The 2011 congressional investigation mentioned in chapter three, as well as additional evidence, suggests that chemical manufacturers do not always tell companies farther down the supply chain the full contents of the chemical products they are using. Rather, they provide these companies with vague descriptions, generic chemical family names, or Material Safety Data Sheets with an incomplete list of chemicals.¹⁹⁹ In such cases, the end users may legitimately be unable to disclose all the identities of chemicals used at a particular well – including PFAS – whether under trade secret protection or not. They simply would not have the information. Requiring disclosure of oil and gas chemicals by chemical manufacturers would avoid this problem. Colorado took this step in its June 2022 legislation.²⁰⁰



Oil and gas fields around Midland, Texas, April 2012. Photo credit: Jane Pargiter, EcoFlight

These eminently reasonable and feasible reforms are valuable steps to protect the health of people who may be exposed to PFAS and other dangerous oil and gas chemicals, be they industry workers, residents living near well sites, or first responders called to the scene of an accident. They can improve health and potentially save lives. Additional steps to reduce the harms caused by oil

and gas extraction are outlined in the following section, including a ban on the use of PFAS in oil and gas operations, an action that Colorado took in 2022.²⁰¹ Among the evidence supporting the feasibility of this measure is a peer-reviewed analysis published in 2021 showing that many PFAS are immediately replaceable with less persistent and less toxic substances, including for use in the oil and gas industry.²⁰²



RECOMMENDATIONS

In light of the findings shared in this report, PSR recommends the following:

- **Halt PFAS use in oil and gas extraction.** Texas should follow the lead of Colorado, a major oil- and gas-producing state which banned the use of PFAS in oil and gas wells through legislation passed in June 2022. Furthermore, Texas and the U.S. Environmental Protection Agency (EPA) should prohibit PFAS from being used, manufactured, or imported for oil and gas extraction. Many PFAS are immediately replaceable with less persistent and less toxic substances, including for use in the oil and gas industry.

- **Expand public disclosure.** Texas should greatly expand its requirements for public disclosure of oil and gas chemicals. The state could again follow the example offered by Colorado by requiring disclosure of all individual chemicals used in oil and gas wells without exceptions for trade secrets, while requiring disclosure on the part of chemical manufacturers who know best what chemicals are being used. Texas should also require chemical disclosure prior to fracking, as have several states including California, West Virginia, and Wyoming.

- **Increase testing and tracking.** Texas and/or the U.S. EPA should determine where PFAS have been used in oil and gas operations in the state and where related wastes have been deposited and should test nearby residents, water, soil, flora, and fauna for PFAS.

- **Require funding and cleanup.** Oil and gas and chemical firms should be required to fund environmental testing for PFAS in their areas of operation where these are needed, and should PFAS be found, be required to fund cleanup. If water cleanup is impossible, the companies responsible for the use of PFAS should pay for alternative sources of water for drinking, household uses, and agriculture, as needed.

- **Reform Texas's regulations for underground injection disposal wells** to prohibit wells close to underground sources of water, to require groundwater monitoring for

contaminants near the wells, and to require full public disclosure of the chemicals in the wastewater.

- **Transition to renewable energy, better regulation.**

Given the use of highly toxic chemicals in oil and gas extraction, including but not limited to PFAS, as well as climate impacts of oil and gas, Texas should transition away from fracking and move toward renewable energy and efficiency. This transition should be structured to provide economic support for oil and gas workers. However, as long as we have drilling and fracking, the state should better regulate these practices so that Texans are not exposed to toxic substances. The state should also empower local governments to regulate the industry. When doubt exists as to the existence or danger of contamination, the rule of thumb should be, "First, do no harm."



APPENDIX

Table 1. Disclosed Use in Fracking of Fluorosurfactants, Potential Fluorosurfactants, and PTFE in Texas Oil and Gas Wells, 2013-2022

County	Number of wells injected with fluorosurfactants, potential fluorosurfactants	Mass of fluorosurfactants, potential fluorosurfactants (lbs.)	Number of wells injected with PTFE	Mass of PTFE (lbs.)
Anderson	1	3	1	13
Andrews	74	1,024	115	3,231
Archer	1	15	0	0
Atascosa	0	0	51	299
Baylor	2	56	0	0
Bee	0	0	2	ND*
Borden	15	222	0	0
Bosque	1	ND	0	0
Brazos	0	0	1	13
Burleson	1	ND	7	44
Callahan	2	ND	0	0
Cherokee	0	0	1	3
Cochran	4	37	0	0
Coke	3	ND	0	0
Coleman	15	2	0	0
Concho	9	5	0	0
Cottle	1	ND	1	1
Crane	14	148	1	ND
Crockett	27	5,479	5	87
Crosby	163	158	0	0
Culberson	0	0	83	864
Dawson	6	31	1	2
De Witt	0	0	86	418
Dimmit	0	0	105	824
Eastland	7	2	0	0
Ector	6	216	1	1
Fayette	0	0	5	ND
Fisher	8	15	1	37
Frio	0	0	20	666
Gaines	22	131	43	1,525
Garza	2	7	0	0
Glasscock	55	6,622	30	172
Gonzales	0	0	74	1,313
Grayson	3	165	3	3
Grimes	0	0	2	68
Guadalupe	1	1	0	0
Hansford	0	0	1	22
Hardeman	1	ND	0	0
Harris	0	0	5	1
Harrison	0	0	1	1,015
Haskell	10	1	0	0
Hemphill	1	1	22	103

Table 1. Continued

County	Number of wells injected with fluorosurfactants, potential fluorosurfactants	Mass of fluorosurfactants, potential fluorosurfactants (lbs.)	Number of wells injected with PTFE	Mass of PTFE (lbs.)
Hockley	3	ND	0	0
Houston	0	0	6	27
Howard	78	2,765	12	289
Irion	16	5,516	8	101
Jack	69	470	0	0
Jackson	1	ND	0	0
Jones	7	3	0	0
Karnes	0	0	42	1,173
Kent	2	ND	0	0
King	14	4	0	0
La Salle	0	0	62	579
Lee	0	0	2	7
Leon	0	0	8	81
Lipscomb	0	0	20	102
Live Oak	0	0	16	113
Loving	27	5,542	61	1,816
Madison	0	0	9	135
Marion	0	0	1	ND
Martin	29	4,491	92	9,617
Maverick	0	0	3	5
McMullen	0	0	34	215
Midland	55	6,363	34	240
Mitchell	11	34	0	0
Montague	2	9	0	0
Nacogdoches	0	0	5	34
Nolan	35	13	0	0
Ochiltree	0	0	43	175
Oldham	0	0	5	4
Palo Pinto	25	81	0	0
Pecos	22	278	14	145
Potter	0	0	3	20
Reagan	19	5,565	10	9,291
Reeves	21	4,412	208	5,256
Roberts	1	36	7	26
Robertson	0	0	1	ND
Runnels	2	ND	0	0
Rusk	1	ND	4	16
San Augustine	0	0	5	ND
San Jacinto	0	0	1	3
Schleicher	6	9	0	0

Table 1. Continued

County	Number of wells injected with fluorosurfactants, potential fluorosurfactants	Mass of fluorosurfactants, potential fluorosurfactants (lbs.)	Number of wells injected with PTFE	Mass of PTFE (lbs.)
Scurry	6	ND	3	605
Shackelford	6	7	0	0
Shelby	0	0	1	40
Smith	1	1	0	0
Starr	0	0	2	ND
Stephens	126	9	0	0
Sterling	7	113	3	31
Stonewall	63	48	0	0
Sutton	1	2	0	0
Taylor	15	5	0	0
Terrell	0	0	1	5
Terry	0	0	1	ND
Throckmorton	8	86	0	0
Tom Green	1	2	0	0
Upton	19	1,705	20	62
Walker	0	0	1	ND
Ward	7	600	62	568
Washington	0	0	4	40
Webb	0	0	22	128
Wharton	0	0	1	ND
Wheeler	0	0	11	29
Wichita	29	10	0	0
Wilson	0	0	1	ND
Winkler	18	318	3	655
Wise	5	558	0	0
Yoakum	0	0	16	486
Young	9	2	0	0
Zapata	0	0	1	0
Zavala	0	0	88	985
Total	1,222	53,398	1,625	43,829

This table, based on FracFocus data covering the dates January 1, 2013 through Sept. 29, 2022, shows county-by-county the number of Texas wells in which oil and gas companies injected PTFE, identified by EPA as a PFAS, or used at least one fluorosurfactant or potential fluorosurfactant for fracking. In this table, the term “fluorosurfactant” encompasses disclosed uses of “nonionic fluorosurfactant” while the term “potential fluorosurfactant” encompasses disclosed uses of “fluoroalkyl alcohol substituted polyethylene glycol,” identified by EPA as a PFAS. Nonionic fluorosurfactants may be PFAS or precursors that could degrade into PFAS. The total weight figures reflect the sum of all records for which we have enough information to calculate a chemical's weight. However, the total weight figures represent an undercount because many fracking chemical disclosures lack sufficient data to perform this calculation. Not all Texas counties are shown; only those in which FracFocus showed the use in fracking of fluorosurfactants, potential fluorosurfactants, and PTFE.

*ND = No data available.

Table 2. Disclosed Use in Fracking of Trade Secret Chemicals in Texas Oil and Gas Wells, 2013-2022

County	Number of wells injected with at least one trade secret chemical	Mass of all trade secret records (lbs.)	Number of wells injected with at least one trade secret surfactant	Mass of trade secret surfactants (lbs.)
Anderson	4	39,100	1	443
Andrews	2,603	70,400,000	1,670	8,050,000
Angelina	18	1,640,000	2	9,450
Aransas	6	2,680	2	458
Archer	47	12,200	19	3,560
Atascosa	772	21,000,000	332	2,280,000
Austin	2	6,880	1	1,450
Bastrop	1	28,700	0	0
Baylor	3	12,500	0	0
Bee	5	297,000	4	11,300
Bexar	4	ND*	4	0
Borden	145	5,130,000	53	127,000
Bosque	1	5	1	2
Brazoria	1	ND	1	ND
Brazos	324	17,600,000	182	1,800,000
Brewster	1	566	1	333
Brooks	39	1,960,000	1	ND
Brown	1	ND	1	ND
Burleson	420	16,700,000	160	1,890,000
Caldwell	3	1,200	1	ND
Calhoun	4	10,500	0	0
Callahan	5	71	3	19
Carson	2	ND	0	0
Cass	7	331,000	3	8,310
Chambers	4	11,100	3	197
Cherokee	47	1,550,000	21	226,000
Clay	42	34,800	20	9,580
Cochran	54	362,000	49	132,000
Coke	12	57,300	3	7,120
Coleman	13	98	2	26
Colorado	4	6,840	3	723
Concho	9	682	8	59
Cooke	41	536,000	13	16,900
Cottle	6	88,900	5	22,200
Crane	796	5,790,000	651	847,000
Crockett	468	4,890,000	242	1,440,000
Crosby	367	240,000	338	45,400
Culberson	813	43,100,000	453	2,130,000
Dallas	22	203,000	0	0
Dawson	130	46,500,000	85	493,000
De Witt	1,259	73,200,000	576	1,600,000
Denton	362	2,600,000	28	102,000

Table 2. Continued

County	Number of wells injected with at least one trade secret chemical	Mass of all trade secret records (lbs.)	Number of wells injected with at least one trade secret surfactant	Mass of trade secret surfactants (lbs.)
Dickens	2	352	2	100
Dimmit	2,472	184,000,000	1,060	48,200,000
Duval	9	29,700	4	516
Eastland	5	4,390	5	804
Ector	1,347	24,600,000	1,030	5,270,000
Fayette	99	5,230,000	61	438,000
Fisher	34	56,400,000	15	34,300
Fort Bend	3	3,160	1	2,010
Freestone	51	108,000	32	40,000
Frio	321	39,500,000	155	461,000
Gaines	600	3,590,000	432	310,000
Garza	37	59,600	15	7,160
Glasscock	1,932	80,200,000	1,110	10,300,000
Goliad	7	17,800	5	3,180
Gonzales	1,129	31,700,000	394	1,890,000
Grayson	45	132,000	28	70,600
Gregg	20	445,000	10	22,800
Grimes	28	531,000	20	60,700
Hale	1	7,210	1	2,900
Hansford	21	395,000	13	23,700
Hardeman	10	36,300	5	1,740
Hardin	7	17,400	2	977
Harris	4	1,210	0	0
Harrison	228	9,450,000	101	341,000
Hartley	12	116,000	5	5,320
Haskell	16	6,600	7	806
Hemphill	292	16,500,000	122	816,000
Henderson	5	5,540	3	1,460
Hidalgo	127	2,390,000	11	9,820
Hockley	71	149,000	61	36,100
Hood	21	226,000	8	3,480
Hopkins	3	479	1	308
Houston	48	428,000	17	76,800
Howard	2,639	570,000,000	1,390	18,800,000
Hudspeth	3	13,300	3	7,330
Hutchinson	9	132,000	3	1,200
Irion	825	634,000,000	440	4,040,000
Jack	428	867,000	325	278,000
Jackson	2	ND	2	ND
Jasper	9	25,600	5	5,020
Jeff Davis	4	316,000	1	362
Jefferson	5	5,260	2	165
Jim Hogg	10	14,200	0	0

Table 2. Continued

County	Number of wells injected with at least one trade secret chemical	Mass of all trade secret records (lbs.)	Number of wells injected with at least one trade secret surfactant	Mass of trade secret surfactants (lbs.)
Jim Wells	1	242	1	74
Johnson	56	557,000	25	31,600
Jones	21	582	3	8
Karnes	3,059	187,000,000	1,260	5,780,000
Kenedy	14	134,000	3	6,470
Kent	4	9,060	4	4,510
King	21	4,290	9	25
Kleberg	24	93,700	12	13,200
Knox	1	39	0	0
La Salle	2,590	192,000,000	1,030	27,200,000
Lavaca	276	20,000,000	180	877,000
Lee	55	1,810,000	26	76,800
Leon	57	554,000	28	112,000
Liberty	6	23,400	3	2,980
Limestone	23	319,000	11	24,600
Lipscomb	203	5,840,000	128	737,000
Live Oak	429	32,100,000	218	896,000
Loving	2,156	98,500,000	910	3,220,000
Lubbock	7	6,160	6	1,440
Lynn	2	990	0	0
Madison	149	1,790,000	75	349,000
Marion	1	ND	0	0
Martin	3,543	213,000,000	1,940	26,900,000
Matagorda	4	19,400	4	3,590
Maverick	57	1,030,000	19	42,700
McCulloch	3	301	2	49
McMullen	1,342	111,000,000	667	29,700,000
Medina	49	7	0	0
Midland	4,447	572,000,000	2,920	31,900,000
Milam	48	1,060,000	19	178,000
Mitchell	125	645,000	97	69,200
Montague	326	6,440,000	133	28,800
Montgomery	3	10,000	1	529
Moore	7	1,540	5	307
Nacogdoches	50	3,790,000	4	14,800
Navarro	4	55,800	4	2,900
Newton	7	230,000	3	7,760
Nolan	50	116,000	35	46,200
Nueces	4	6,800	3	1,480
Ochiltree	268	3,890,000	168	767,000
Oldham	15	197,000	6	7,520
Orange	10	26,200	8	18,200
Palo Pinto	107	173,000	76	49,100

Table 2. Continued

County	Number of wells injected with at least one trade secret chemical	Mass of all trade secret records (lbs.)	Number of wells injected with at least one trade secret surfactant	Mass of trade secret surfactants (lbs.)
Panola	446	17,500,000	152	1,260,000
Parker	79	336,000	32	32,900
Pecos	602	35,700,000	349	4,840,000
Polk	30	391,000	11	9,720
Potter	25	612,000	8	9,080
Reagan	1,745	1,210,000,000	1,040	14,800,000
Reeves	3,561	254,000,000	1,640	21,600,000
Roberts	145	10,100,000	73	297,000
Robertson	101	3,430,000	50	219,000
Runnels	6	9,000	3	187
Rusk	132	8,330,000	85	909,000
San Augustine	110	5,000,000	30	401,000
San Jacinto	8	5,540	2	42
San Patricio	12	16,200	9	3,800
Schleicher	42	845,000	33	469,000
Scurry	171	42,800,000	77	147,000
Shackelford	10	387	4	140
Shelby	49	1,220,000	27	335,000
Sherman	3	148	2	20
Smith	45	4,180,000	20	149,000
Starr	63	292,000	3	1,940
Stephens	78	36,400	57	7,560
Sterling	77	938,000	48	203,000
Stonewall	85	32,700	31	10,400
Sutton	15	45,500	13	22,900
Tarrant	518	6,780,000	216	279,000
Taylor	17	467	5	191
Terrell	10	165,000	8	25,600
Terry	30	114,000	20	26,900
Throckmorton	75	180,000	27	41,700
Tom Green	14	184,000	10	19,200
Trinity	2	154,000	1	1,260
Tyler	12	516,000	5	11,200
Upshur	17	454,000	10	86,300
Upton	2,567	863,000,000	1,820	19,400,000
Van Zandt	4	114,000	1	24
Victoria	1	ND	0	0
Walker	10	403,000	7	14,500
Waller	5	3,520	5	1,790
Ward	1,368	39,900,000	658	1,860,000
Washington	79	2,270,000	21	81,900
Webb	1,784	112,000,000	862	11,900,000
Wharton	16	6,670	9	215

Table 2. Continued

County	Number of wells injected with at least one trade secret chemical	Mass of all trade secret records (lbs.)	Number of wells injected with at least one trade secret surfactant	Mass of trade secret surfactants (lbs.)
Wheeler	270	15,200,000	182	3,040,000
Wichita	78	23,000	40	4,220
Wilbarger	48	42,600	23	11,200
Willacy	4	10,700	4	2,790
Wilson	90	1,870,000	45	175,000
Winkler	591	17,700,000	333	1,220,000
Wise	519	3,110,000	80	212,000
Wood	15	719,000	11	248,000
Yoakum	709	8,390,000	546	1,410,000
Young	37	12,800	19	1,760
Zapata	45	54,700	9	3,950
Zavala	192	18,100,000	85	3,030,000
Total	58,199	6,120,000,000	30,700	331,000,000

This table, based on FracFocus data, shows county-by-county the number of Texas wells in which oil and gas companies injected at least one trade secret fracking chemical or at least one trade secret surfactant between January 1, 2013 and September 29, 2022. The total weight figures reflect the sum of all records for which we have enough information to calculate a chemical's weight. However, the total weight figures represent an undercount because many fracking chemical disclosures lack sufficient data to perform this calculation. Not all Texas counties are shown, only those in which FracFocus showed the use in fracking of trade secret chemicals.

*ND = No data available.

Table 4. Oil and Gas Companies that Fracked Wells in Texas Using Fluorosurfactants or Potential Fluorosurfactants, 2013-2022

Well Operator	Number of wells injected with fluorosurfactants, potential fluorosurfactants	Total weight of fluorosurfactants (lbs.)
Athlon Energy Operating LLC	195	10,771
Juno Operating Company II, LLC	148	141
Delta Oil & Gas Ltd.	110	4
EOG Resources, Inc.	67	22,336
XTO Energy/ExxonMobil	67	745
LCS Production Company	48	16
Citation Oil and Gas Corp.	30	31
Chevron USA Inc.	26	155
Brigadier Operating LLC	25	ND*
Urban Oil and Gas Group	25	10
PPC Operating Company LLC	22	ND
Petrobal Omega 1, LLC	21	186
Apache Corporation	18	180
Laredo Petroleum, Inc.	16	4,721
Blackbeard Operating	14	393
Hunt Oil Company	12	4
Atlas Energy, L.P.	11	ND
Bullet Development, LLC	11	ND
Sheridan Production Company, LLC	10	11
RSP Permian, LLC	9	2,160
Anadarko Petroleum Corporation	8	32
Cinnabar Energy, LTD.	8	5
Jilpetco, Inc.	8	ND
PETEX	8	ND
Resolute Natural Resources	8	593
Sojourner Drilling Corporation	8	3
Clear Fork, Inc.	7	ND
Endeavor Energy Resources	7	7,051
Oakridge Oil and Gas, LP	7	3
Phoenix PetroCorp, Inc.	7	ND
S. B. Street Operating, Inc.	7	2
TXP, Inc.	7	6
Boaz Energy II Operating, LLC	6	10
Delta CO2, LLC	6	3
GeoSurveys, Inc.	6	6
Griffin Petroleum Company	6	6
The Cumming Company, Inc.	6	11
Best Petroleum Explorations, Inc.	5	89
Mid-Con Energy Operating, LLC	5	1
Midville Energy	5	7
Prime Operating Company	5	364
5L Properties, Inc.	4	2
Abraxas Petroleum Corporation	4	3

Table 4. Continued

Well Operator	Number of wells injected with fluorosurfactants, potential fluorosurfactants	Total weight of fluorosurfactants (lbs.)
Compass Energy Operating, LLC	4	ND
Green Century Exploration & Production, LLC	4	4
Merit Energy Company	4	14
Sharp Image Energy, Inc.	4	ND
Stovall Operating Co.	4	3
Surge Operating, LLC	4	5
Walter Exploration Company	4	23
Arrington Oil & Gas Operating LLC	3	549
Choice Exploration, Inc.	3	ND
LADD OIL & GAS CORPORATION	3	ND
Lime Rock Resources, LP	3	56
MWS Producing, Inc.	3	22
Newark E&P Operating, LLC	3	162
Stanolind Operating LLC	3	8
TALL CITY OPERATIONS LLC	3	668
Telesis Operating Co., Inc.	3	ND
Verado Energy, Inc.	3	2
Atoka Operating Permian, LLC	2	56
Bridwell Oil Company	2	2
Buffco Production, Inc.	2	4
Cazar Energy, Inc.	2	ND
Cholla Petroleum, Inc.	2	ND
Encana Oil & Gas (USA) Inc.	2	59
Imperial Gas Resources, LLC	2	ND
MECO IV, LLC	2	ND
Pendragon Oil Co.	2	ND
Quantum Resources Management, LLC	2	82
Rainbow Seven Oil and Gas	2	6
Raw Oil & Gas, Inc.	2	5
Rover Operating Company, LLC	2	ND
Silver Creek Oil & Gas, LLC	2	ND
Silver Creek Permian OP CO, LLC	2	38
THE EDMAR COMPANY, LLC	2	53
Texas Energy Holdings, Inc.	2	1
Texxol Operating Company	2	370
Tradition Resources LLC	2	2
Unit Petroleum	2	38
Allegro Investments, Inc.	1	ND
Antle Operating, Inc.	1	ND
Atoka Operating, Inc.	1	23
BKM Production	1	54
BRG Lone Star LTD	1	1
BlackWell Exp & Development, LLC	1	89
Braka Operating, LLC	1	1

Table 4. Continued

Well Operator	Number of wells injected with fluorosurfactants, potential fluorosurfactants	Total weight of fluorosurfactants (lbs.)
Breck Operating Corp.	1	ND
Canan Mowrey Operating, LLC	1	1
Clayton Williams Energy, Inc.	1	2
Cooper Oil & Gas, LLC	1	84
Dallas Production, Inc	1	ND
Devon Energy Production Company L.P.	1	ND
E. N. Patton Oil Company, Inc.	1	1
Elephant Oil & Gas	1	16
EnerVest, Ltd.	1	2
Enexco, Inc.	1	10
Finley Resources, Inc.	1	ND
Four C Oil and Gas Corporation	1	ND
Gunn Oil Company	1	ND
HW Operating, LLC	1	ND
Heights Energy Corporation	1	2
HighMount Exploration & Production	1	431
JVA Operating Company, Inc.	1	ND
Jagged Peak Energy	1	ND
John M. Clark, Inc.	1	ND
Katsco Energy, Inc.	1	ND
King Operating Corp.	1	ND
LP Operating, LLC	1	ND
Lainco, Inc.	1	2
Legacy Exploration, LLC I	1	10
N S P Operating Group LLC	1	ND
Ogden Resources Corporation	1	6
Oil Projects, LLC	1	ND
Pablo Energy II, LLC	1	56
Ray Richey Managment Company, Inc.	1	189
Redbud E&P, Inc.	1	9
Rover Petroleum Operating, LLC	1	3
SDX Resources, Inc.	1	27
Scout Energy Partners	1	ND
Southlake Exploration Inc.	1	ND
Southwest Royalties, Inc.	1	5
Stephens & Johnson Operating Co.	1	2
Strand Energy, L.C.	1	22
TACOR Resources, Inc.	1	10
Three J Energy, Inc.	1	1
Trey Resources Inc.	1	ND
Trio Consulting & Management, LLC	1	ND
Upham Oil & Gas Company	1	ND
Van Operating	1	ND
White Knight Production LLC	1	78

Table 4. Continued

Well Operator	Number of wells injected with fluorosurfactants, potential fluorosurfactants	Total weight of fluorosurfactants (lbs.)
Worsham-Steed Gas Storage, LLC	1	ND

This excerpted table shows oil and gas companies that fracked oil and gas wells in Texas with fluorosurfactants or potential fluorosurfactants between January 1, 2013 and September 29, 2022. In this table, the term “fluorosurfactant” encompasses disclosed uses of “nonionic fluorosurfactant” while the term “potential fluorosurfactant” encompasses disclosed uses of “fluoroalkyl alcohol substituted polyethylene glycol.” Fluorosurfactants may be PFAS or precursors that could degrade into PFAS. “Fluoroalkyl alcohol substituted polyethylene glycol” is a PFAS according to EPA. The total weight figures for each company reflect the sum of all records for which we have enough information to calculate a chemical’s weight. However, the total weight figures for each company may represent an undercount because many fracking chemical disclosures lack sufficient data to perform this calculation.

*ND = No data available.

Table 5. Oil and Gas Companies that Fracked Wells in Texas Using PTFE, 2013-2022

Well Operator	Number of wells injected with PTFE	Total mass of PTFE (lbs.)
BHP Billiton Petroleum	196	3,237
Cimarex Energy Co.	123	1,172
Pioneer Natural Resources	117	670
Occidental Oil and Gas	115	2,718
Ring Energy, Inc.	113	4,827
EXCO Resources, Inc.	87	1,003
Chesapeake Operating, Inc.	86	329
Apache Corporation	70	738
Forest Oil Corporation	69	897
Guidon Energy Management Services LLC	55	9,301
Matador Production Company	39	382
Lonestar Resources, Inc.	32	892
XTO Energy/ExxonMobil	32	1,208
ConocoPhillips Company/Burlington Resources	26	243
Sundance Energy	26	57
Texas American Resources Company	24	132
Atlas Energy, L.P.	21	191
Rosetta Resources	21	454
COG Operating LLC	19	96
Murphy Exploration and Production USA	19	288
MEWBOURNE OIL COMPANY	17	90
Carrizo Oil & Gas, Inc.	15	ND*
U.S. Energy Development Corp.	15	61
Parsley Energy Operations, LLC	14	130
Pacesetter Energy, LLC	12	64
Aethon Energy Operating LLC	11	75
Devon Energy Production Company L. P.	11	137
Protege Energy III LLC	10	337
SM Energy	10	98
Energy & Exploration Partners Operating, LP	8	89
LeNorman Operating LLC	8	35
REOC, LLC	8	22
Sanguine Gas Exploration	8	25
Brigham Resources Operating, LLC	6	128
Freedom Production, Inc.	6	51
Parallel Petroleum LLC	6	36
Caird Operating, LLC	5	21
Clayton Williams Energy, Inc.	5	64
Endeavor Energy Resources	5	67
Linn Energy, LLC	5	ND
Sable Permian Resources	5	9,268
Titan Energy, LLC	5	ND
Verdun Oil Company	5	4
VirTex Operating Company, Inc.	5	589

Table 5. Continued

Well Operator	Number of wells injected with PTFE	Total mass of PTFE (lbs.)
EOG Resources, Inc.	4	24
Eagle Oil & Gas co.	4	9
Kinder Morgan Tejas Pipeline, LLC	4	ND
CML Exploration, LLC	3	103
CRIMSON ENERGY PARTNERS IV, LLC	3	23
Discovery Natural Resources LLC	3	55
El Toro Resources LLC	3	8
Greystone Oil & Gas LLP	3	30
Penn Virginia Corporation	3	6
Resolute Natural Resources	3	41
Sabine Oil & Gas LLC	3	19
SilverBow Resources	3	9
Smith Production	3	1
Tracker Resource Dev III, LLC	3	11
Verado Energy, Inc.	3	605
Arris Petroleum Corporation	2	7
BP America Production Company	2	1
BlackBrush O & G, LLC	2	488
EnerQuest Operating L.L.C.	2	2
GeoSouthern Operating II, LLC	2	ND
Halcon Resources Corporation	2	23
ImPetro Operating LLC	2	655
JAMEX, Inc.	2	14
Juneau Energy, LLC	2	1
Lime Rock Resources, LP	2	8
Longfellow Energy, LP	2	2
MD America Energy LLC	2	50
MDC TEXAS ENERGY	2	79
Mr. (sic)	2	14
Sabinal Energy	2	5
Slawson Exploration Company, Inc.	2	2
Sundown Energy L.P.	2	1
Teal Natural Resources	2	4
Unit Petroleum	2	10
Woodbine Production Corp	2	15
ZTC Petro Investments LP	2	10
American Energy Permian Basin	1	11
Arrow Oil & Gas, LLC.	1	1
BVX Operating Inc.	1	2
Ballard Exploration Company, Inc.	1	1
Brahman Resource Partners LLC	1	6
Bright Horizon Resources	1	22
Cabot Oil & Gas Corp	1	2
Cimarron Engineering LLC	1	ND
Clear Water, Inc.	1	ND

Table 5. Continued

Well Operator	Number of wells injected with PTFE	Total mass of PTFE (lbs.)
Comstock Oil & Gas	1	7
Covey Park Operating, LLC	1	ND
Endeavor Natural Gas, LP	1	1
Enduring Resources LLC	1	ND
EnerVest, Ltd.	1	1
Gunn Oil Company	1	1
Hurd Enterprises	1	ND
ITEXCO TEXAS, LLC	1	ND
Jagged Peak Energy	1	8
Jones Energy Ilc	1	ND
Lewis Energy Group	1	7
Mego Resources, LLC	1	ND
Metano Energy III, LP	1	ND
Moriah Operating, LLC	1	38
Oasis Petroleum	1	55
Primexx Operating Corporation	1	9
Recoil Resources Operating Inc.	1	ND
Sabalo Operating, LLC	1	13
SandRidge Energy	1	1
Sierra Resources, LLC	1	30
Siltstone Resources Operating II, LLC	1	10
Silver Tusk Operating Co. LLC	1	23
Spindletop Oil & Gas	1	4
Stroud Petroleum, Inc.	1	ND
THE EDMAR COMPANY, LLC	1	2
Tanos Exploration II, LLC	1	1,016
Texas Presco, Inc.	1	15
Tidal Petroleum, Inc.	1	3
Triumph Exploration, Inc.	1	7
Vess Oil Corp	1	4
W&T Offshore, Inc.	1	ND

This excerpted table shows the oil and gas companies that fracked oil and gas wells in Texas with PTFE between January 1, 2013 and September 29, 2022.

*ND = No data available.



ENDNOTES

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- ³ Toxic Synthetic “Forever Chemicals” are in Our Water and on Our Plates. NOVA (PBS) (Nov. 2, 2020). Accessed Sept. 5, 2022, at <https://www.pbs.org/wgbh/nova/article/pfas-synthetic-chemicals-water-toxic/>.
- ⁴ U.S. Environmental Protection Agency. Master List of PFAS Substances. Polytetrafluoroethylene. CAS number 9002-84-0. Accessed Nov. 9, 2022, at <https://comptox.epa.gov/dashboard/chemical/details/DTXSID7047724?list=PFASMASTER>.
- ⁵ U.S. Environmental Protection Agency. Master List of PFAS Substances. Poly(oxy-1,2-ethanediyl), .alpha.-hydro-. omega.-hydroxy-, ether with .alpha.-fluoro-.omega.-(2-hydroxyethyl) poly(difluoromethy). CAS number 65545-80-4. Accessed Nov. 9, 2022, at <https://comptox.epa.gov/dashboard/chemical/details/DTXSID6049727>.
- ⁶ The three chemists are Zacariah Hildenbrand, a research professor in Chemistry and Biochemistry at the University of Texas at El Paso, Kevin Schug, Shimadzu Distinguished Professor of Analytical Chemistry at the University of Texas at Arlington, and Wilma Subra, holder of a master's degree in chemistry and recipient of a John D. and Catherine T. MacArthur Foundation “Genius” Grant for her work helping to protect communities from toxic pollution. The board-certified toxicologist is Linda Birnbaum, former director of the National Institute of Environmental Health Sciences.
- ⁷ Dusty Horwitt. Fracking with Forever Chemicals. Physicians for Social Responsibility (July 2021), at 15. Accessed Sept. 8, 2022, at <https://www.psr.org/wp-content/uploads/2021/07/fracking-with-forever-chemicals.pdf>.
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- ⁹ U.S. Environmental Protection Agency. Research on Per- and Polyfluoroalkyl Substances (PFAS) (last updated Nov. 10, 2021). Accessed Nov. 7, 2022, at <https://www.epa.gov/chemical-research/research-and-polyfluoroalkyl-substances-pfas>. David Andrews and Bill Walker. Environmental Working Group. Poisoned Legacy (April 2015), at 6. Accessed Nov. 7, 2022, at <https://www.ewg.org/research/poisoned-legacy>. Andrew B. Lindstrom et al. Polyfluorinated Compounds: Past, Present, and Future. Environmental Science & Technology (2011), 45, 7954-7961, 7954. Accessed Nov. 7, 2022, at <https://pubs.acs.org/doi/pdf/10.1021/es2011622>.
- ¹⁰ U.S. Environmental Protection Agency. What are PFCs and How Do They Relate to Per- and Polyfluoroalkyl Substances (PFASs)? (Jan. 19, 2017). Accessed Nov. 7, 2022, at https://19january2017snapshot.epa.gov/pfas/what-are-pfcs-and-how-do-they-relate-and-polyfluoroalkyl-substances-pfass_.html. EPA noted that the acronym, PFCs, can also refer to perfluorocarbons that are distinct from PFAS or perfluorinated chemicals. Perfluorocarbons are not toxic, but they are a powerful and long-lasting greenhouse gas. Andrew B. Lindstrom et al. Polyfluorinated Compounds: Past, Present, and Future. Environmental Science & Technology (2011), 45, 7954-7961, 7954. Accessed Nov. 7, 2022, at <https://pubs.acs.org/doi/pdf/10.1021/es2011622>.
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- ¹⁸⁴ U.S. Environmental Protection Agency. EPA Proposes Designating Certain PFAS Chemicals as Hazardous Substances Under Superfund to Protect People’s Health (Aug. 26, 2022). Accessed Dec. 24, 2022, at <https://www.epa.gov/newsreleases/epa-proposes-designating-certain-pfas-chemicals-hazardous-substances-under-superfund>.
- ¹⁸⁵ U.S. Environmental Protection Agency. Superfund Liability (July 25, 2022). Accessed Dec. 24, 2022, at <https://www.epa.gov/enforcement/superfund-liability>.
- ¹⁸⁶ U.S. Department of Energy. Energy Information Administration. Petroleum & other Liquids. Crude Oil Production. Annual – Thousand Barrels. Accessed Sept. 9, 2022, at https://www.eia.gov/dnav/pet/pet_crd_crpdn_adc_mbbbl_a.htm.

¹⁸⁷ Cal. Public Resources. § 3160 (j)(2)(A) (providing that “Notwithstanding any other law or regulation, none of the following information shall be protected as a trade secret...The identities of the chemical constituents of additives [in well stimulation treatment fluids], including CAS identification numbers..

¹⁸⁸ Colorado General Assembly. HB22-1348. Senate Amended 3rd Reading (May 11, 2022). Accessed Sept. 9, 2022, at https://leg.colorado.gov/sites/default/files/documents/2022A/bills/2022a_1348_rer.pdf.

¹⁸⁹ U.S. Department of Energy. Secretary of Energy Advisory Board Task Force Report on FracFocus 2.0 (Mar. 28, 2014). Accessed Sept. 9, 2022, at https://www.energy.gov/sites/default/files/2014/04/f14/20140328_SEAB_TF_FracFocus2_Report_Final.pdf.

¹⁹⁰ U.S. Department of Energy. Secretary of Energy Advisory Board Task Force Report on FracFocus 2.0 (Mar. 28, 2014). Accessed Sept. 9, 2022, at https://www.energy.gov/sites/default/files/2014/04/f14/20140328_SEAB_TF_FracFocus2_Report_Final.pdf.

¹⁹¹ Cal. Public Resources. § 3160 (j)(5-7).

¹⁹² Cal. Public Resources § 3160 (j)(2).

¹⁹³ Cal. Public Resources. § 3160(d)(6).

¹⁹⁴ W. Va. Code §§ 22-6A-7(e)(5), 22-6A-10(b).

¹⁹⁵ Wyoming Admin. Code Ch. 3 § 45(a).

¹⁹⁶ 16 Tex. Admin. Code § 3.29(c).

¹⁹⁷ 16 Tex. Admin. Code § 3.29(c)(2)(C)(3).

¹⁹⁸ 16 Tex. Admin. Code § 3.29(d)(1).

¹⁹⁹ For example, in 2014, four attorneys with years of experience litigating oil and gas-related cases in Pennsylvania filed a petition with the state Commonwealth Court suggesting manufacturers often withhold chemical identities from other companies in the supply chain. See Petitioners’ pleading filed in Robinson Twp. v. Commonwealth, Docket No. 284 MD 2012 (June 9, 2014), at 13 FN5 (on file with PSR). The attorneys provided as support a record filed in a separate case by well operator Range Resources in which Range suggested that it was relying on Material Safety Data Sheets from manufacturers to reply 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.” See *Kiskadden v. Department of Environmental Protection v. Range Resources – Appalachia, LLC*. Docket No. 2011-149-R. 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) (on file with PSR).

²⁰⁰ Colorado House Bill 22-1348(2)(f) (enacted June 8, 2022). Accessed Sept. 8, 2022, at https://leg.colorado.gov/sites/default/files/2022a_1348_signed.pdf.

²⁰¹ Colorado House Bill 22-1348(2)(A)(II) (enacted June 8, 2022). Accessed Sept. 8, 2022, at https://leg.colorado.gov/sites/default/files/2022a_1348_signed.pdf.

²⁰² Julianne Glüge et al. Information Requirements under the Essential-Use Concept: PFAS Case Studies. *Environmental Science & Technology* (Oct. 5, 2021). Accessed Sept 9, 2022, at <https://pubs.acs.org/doi/10.1021/acs.est.1c03732>.



1111 14th Street NW, #700
Washington, DC 20005
202 667 4260
www.psr.org
psrnat@psr.org

 @PSRenvironment and @PSRnuclear

 /psrnational

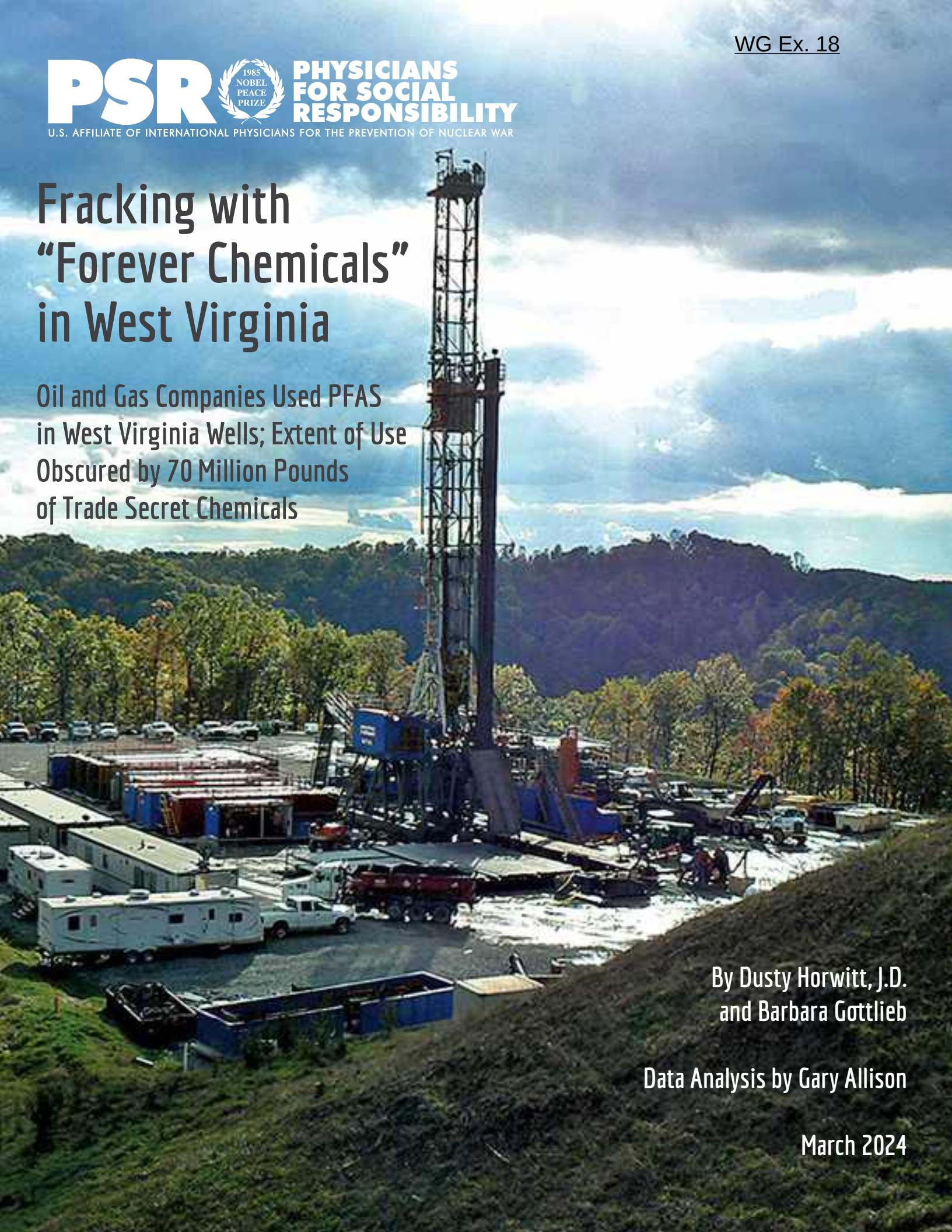
Fracking with “Forever Chemicals” in West Virginia

Oil and Gas Companies Used PFAS
in West Virginia Wells; Extent of Use
Obscured by 70 Million Pounds
of Trade Secret Chemicals

By Dusty Horwitt, J.D.
and Barbara Gottlieb

Data Analysis by Gary Allison

March 2024





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Cover photo: Gas well in Doddridge County, W.Va. Photo credit: courtesy of Diane Pitcock, WV Host Farms Program. **Maps:** Matt Kelso, FracTracker Alliance. **We thank the following for their contributions to this report:** Linda Aller, Hydrogeologist, Bennett & Williams Environmental Consultants, Inc.; Jenna Dodson, M.S., Staff Scientist, West Virginia Rivers; Angie Rosser, M.A., Executive Director, West Virginia Rivers; Evan Hansen, M.S., Principal, Downstream Strategies. **Graphic Design:** twocatsgraphics.com



EXECUTIVE SUMMARY

Over the past decade, wells drilled horizontally for natural gas have been responsible for a surge in gas production in West Virginia. Information unearthed and analyzed by Physicians for Social Responsibility (PSR) shows that since 2013, oil and gas companies have hydraulically fractured or “fracked” some of these wells with a class of extremely toxic and persistent chemicals known as PFAS. During that same period, the companies injected nearly 2,000 horizontal gas wells with a total of almost 70 million pounds of unidentified chemicals, some of which could be PFAS. The companies withheld these chemicals’ identities from the public as “trade secrets,” a practice allowed by state law.

PFAS, or per- and polyfluoroalkyl substances, are a class of laboratory-created chemicals that have been widely used for decades in consumer products and for industrial purposes. The chemicals are useful because of their resistance to heat, oil, stains, grease, and water. But their value comes with a high cost. PFAS are known for their toxicity at extraordinarily low levels, their multiple negative health effects, and their persistence in the environment, leading to their nickname, “forever chemicals.” Among the health effects that can be caused by PFAS are kidney cancer, testicular cancer, thyroid disease, high cholesterol, preeclampsia, ulcerative colitis, and decreased vaccine response.

PFAS’ negative health effects first came to light as a result of litigation in the Parkersburg, West Virginia area around the year 2000, when Dupont was sued for polluting the area with a dangerous PFAS. In 2023, West Virginia’s government enacted the PFAS Protection Act to protect residents from PFAS-related pollution. The legislation was a response to a study, ordered by the state legislature in 2020, in which scientists from the U.S. Geological Survey found PFAS in dozens of groundwater and surface water sources for West Virginia’s public drinking water systems. West Virginia Rivers, a nonprofit, placed the figure of contaminated water sources at 130, relying on raw data from the USGS study and updated health advisory levels from the U.S. Environmental Protection Agency. The USGS study, published in 2022, did

not examine the sources of PFAS pollution, but the PFAS Protection Act, among other provisions, directs the West Virginia Department of Environmental Protection (WVDEP) to develop action plans to identify and address such sources. It also requires certain facilities to disclose the use of specified types of PFAS.

Relatively little study has been conducted on the link between oil and gas operations and PFAS pollution, perhaps because the use of PFAS in oil and gas extraction has only recently come to light. But in November 2023, perhaps the first peer-reviewed study to examine the connection in West Virginia found some evidence of PFAS pollution from oil and gas operations, particularly in three private water wells where nearby oil and gas operations were the only identifiable sources of PFAS within more than 1.24 miles.

This report suggests that some of the sources of PFAS in West Virginia could be oil and gas wells or facilities where solid waste and enormous volumes of toxic wastewater from oil and gas production are taken for disposal.

Data publicly disclosed by the oil and gas industry shows that in West Virginia between 2013 and 2023, five oil and gas companies injected the PFAS known as PTFE or Teflon into a total of 43 horizontal gas wells located in eight counties in northern West Virginia. **However, this small number of industry-reported instances may significantly underrepresent the reality of PFAS use in West Virginia’s oil and gas wells, given crucial gaps in state reporting rules.**

One major hindrance to quantifying the use of PFAS chemicals is oil and gas companies’ extensive use of “trade secret,” “proprietary,” or “Confidential Business Information” designations to conceal the identities of fracking chemicals that must otherwise be disclosed to the public. Between 2013 and 2022, oil and gas companies injected 1,912 horizontal gas wells in 15 West Virginia counties with at least one trade secret chemical per well. Almost 400 of

* This report refers to “oil and gas companies” or the “oil and gas industry” even when discussing only horizontal gas wells, as some of the companies that operate horizontal gas wells also operate oil wells, whether in West Virginia or other states.

these wells were injected with incompletely identified chemicals that may be fluorosurfactants, a class of chemical that includes multiple PFAS. **Should only a fraction of the unidentified chemicals used in West Virginia's oil and gas wells be PFAS, they could pose a significant threat to human health.**

Four other gaps under West Virginia rules that may conceal wider use of PFAS in oil and gas wells include 1) missing information in “well site safety plans” designed to show what chemicals are being used at oil and gas well sites; 2) the absence of chemical disclosure requirements for oil and gas wells (such as vertical wells) that do not meet the definition of “horizontal gas wells”; 3) lack of chemical disclosure requirements for chemical manufacturers, the companies that know best what chemicals are in the products used in oil and gas wells; and 4) no disclosure requirements for chemicals unintentionally injected into oil and gas wells, such as in water that is contaminated with PFAS from industrial emissions or earlier fracks.

Overall, these multiple reporting gaps prevent the public from knowing how widely PFAS – to say nothing of other toxic chemicals – have been used in West Virginia's oil and gas wells. That fact, when taken with our findings that PFAS have in fact been used, raise concerns that West Virginians may unknowingly be exposed to highly hazardous PFAS chemicals. This potential may be particularly high in rural areas where most oil and gas drilling occurs and people often rely on groundwater for drinking water.

An interactive map showing the locations of West Virginia horizontal gas wells injected with PFAS and trade secret chemicals is available here: <https://ft.maps.arcgis.com/apps/webappviewer/index.html?appid=7294f90f7a194216a2d6126e973a823a>. Users can zoom in to identify wells near them.

In light of these findings, PSR recommends the following:

- **Halt PFAS use in oil and gas extraction.** West Virginia and the U.S. Environmental Protection Agency (EPA)

should prohibit PFAS from being used, manufactured or imported for oil and gas extraction. Many PFAS are replaceable with less-persistent and less-toxic alternatives. In taking this step, West Virginia would be following the lead of Colorado, a major oil- and gas producing state that in June 2022 passed legislation banning the use of PFAS in oil and gas wells.

- **Expand public disclosure.** West Virginia should greatly expand its requirements for public disclosure of oil and gas chemicals. The state could again follow the example offered by Colorado by requiring disclosure of all individual chemicals used in oil and gas wells, without exceptions for trade secrets. This action can be taken while still protecting product formulas as trade secrets. West Virginia should also require chemical disclosure prior to permitting for all oil and gas wells, as do California and Wyoming, and should require disclosure on the part of chemical manufacturers, as does Colorado. This provision would enable the WVDEP to identify and address sources of PFAS using the PFAS Protection Act. Finally, West Virginia should expand the disclosure requirements in the PFAS Protection Act to cover oil and gas production and waste disposal facilities, to the extent that they are not already covered.
- **Increase testing and tracking.** West Virginia and/or the U.S. EPA should determine where PFAS have been used in oil and gas operations in the state and where related wastes have been deposited. They should test nearby residents, water, soil, flora, and fauna for PFAS, both for the particular type(s) of PFAS used and for organic fluorine to detect the presence of other PFAS and/or their breakdown products. They should use testing equipment sensitive enough to detect PFAS at concentrations below proposed or adopted maximum contaminant levels and/or other relevant regulatory guidelines or recommended limits. Such testing and tracking should be made a part of the action plans under the PFAS Protection Act for water sources near oil and gas production or waste disposal sites.

- **Require funding and cleanup.** Oil and gas companies and the firms that manufacture the oil and gas chemicals used should be required to fund environmental testing for PFAS in their areas of operation and, should PFAS be found, to fund cleanup. If cleanup of water sources is impossible, companies responsible for the use of PFAS should pay for alternative sources of water for homes, schools, hospitals, agriculture and other uses for as long as needed.
- **Remove West Virginia's oil and gas hazardous waste exemption.** West Virginia exempts oil and gas industry wastes from state hazardous waste rules. The state should follow New York's lead and remove its hazardous waste exemption for the oil and gas industry.
- **Reform West Virginia's regulations for oil and gas production wells and underground injection disposal wells.** The state should prohibit production wells and underground wastewater disposal wells in buffer zones near underground sources of drinking water and near homes, health care facilities and schools. The size of the zones should be determined by scientific evidence specific to West Virginia. The state should also require groundwater monitoring for contaminants near the wells and, for disposal wells, require full public disclosure of chemicals in the wastewater.
- **Transition to renewable energy and better regulation.** Given the use of highly toxic chemicals in oil and gas extraction, including but not limited to PFAS, as well as the climate impacts of oil and gas extraction and use, West Virginia should transition away from fracking, move toward renewable energy and efficiency, and provide economic support and job training for displaced oil and gas workers. As long as drilling and fracking continue, the state should better regulate these practices so that West Virginians are not exposed to toxic substances; it should also empower local governments to regulate the industry.

When doubt exists as to the existence or danger of contamination, the rule of thumb should be, "First, do no harm."

CH. 1

PFAS: A LABORATORY-MADE THREAT TO HEALTH AND THE ENVIRONMENT

a. PFAS Used in West Virginia's Horizontal Gas Wells

Physicians for Social Responsibility (PSR) has identified evidence from publicly reported oil and gas industry* records that a highly dangerous class of chemicals, known as per- and polyfluoroalkyl substances (PFAS), has been used in West Virginia's horizontal gas** wells for hydraulic fracturing ("fracking") and that such use could be much more extensive than reported. PFAS are known for their toxicity at extremely low levels,¹ their multiple negative health effects including cancer,² and their persistence in the environment, which has endowed them with their nickname "forever chemicals."³ These properties, and the multiple pathways of potential exposure in oil and gas extraction, mean that West Virginians could face unrecognized health risks from the use of these chemicals for fracking in horizontal gas wells. These risks may also be posed by other stages and methods of oil and gas extraction, including the drilling that precedes fracking and non-horizontal (vertical) wells drilled for oil and/or gas.

b. Laboratory-made and Dangerous: PFAS's History and Health Effects

PFAS are a class of thousands of synthetic chemicals manufactured to have properties that are valuable in multiple industrial contexts, including being slippery, oil- and water-repellant, and able to serve as dispersants or foaming agents.⁴ PFAS have been called PFCs or perfluorinated chemicals, though the term currently preferred by EPA is per- and polyfluoroalkyl substances or PFAS.⁵

The first PFAS to be sold commercially was created by a chemist at Dupont and was patented as Teflon. Since 1949, it has been used in thousands of products, from nonstick cookware to waterproof clothing to plastics to dental floss.⁶ Other PFAS chemicals, the most prominent of which are

known as PFOA and PFOS, were used in food packaging, fire-fighting foam, and in 3M's widely used fabric protector, Scotchgard.⁷ EPA reported in 2021 that about 650 types of PFAS remained in commerce.⁸ Weak chemical disclosure laws make it difficult for the Agency to identify which PFAS chemicals are used, and where.

Between the 1960s and 1990s, researchers inside Dupont and 3M became aware that at least some of the PFAS they were manufacturing or using, particularly PFOA and PFOS, were associated with health problems including cancers and birth defects, had accumulated in people's bodies worldwide, and persisted in the environment.⁹ Many of these facts were kept internal by the companies but came to light after attorney Rob Bilott filed lawsuits in 1999 and 2001. The suits accused Dupont of causing pollution in and around Parkersburg with PFOA, a type of PFAS then used in making PTFE (Teflon).¹⁰

In December 2011, as part of Dupont's settlement of the 2001 lawsuit, a team of epidemiologists completed a study of the blood of 70,000 West Virginians and found a probable link between PFOA and multiple health effects¹¹ including kidney cancer, testicular cancer, thyroid disease (over or under-production of hormones by the thyroid gland),¹² high cholesterol, pre-eclampsia (a potentially dangerous complication during pregnancy characterized by high blood pressure and signs of damage to other organ systems, most often the liver and kidneys),¹³ and ulcerative colitis (a disease causing inflammation and ulcers in the large intestine or colon).¹⁴

Current peer-reviewed scientific research on PFAS suggests that exposure to certain levels of some PFAS may lead to adverse health outcomes. Research findings differ, as different studies have examined different PFAS chemicals, different types or levels of exposure, or different exposed

* This report refers to "oil and gas companies," the "oil and gas industry," etc., even when discussing only horizontal gas wells because at least some of the companies that operate horizontal gas wells also operate oil wells, whether in West Virginia or other states.

** Gas, the principal component of which is methane, is also known as "natural" gas, "fossil" gas and "fracked" gas.

populations. However, some findings are more widely endorsed; for example, the U.S. Environmental Protection Agency (EPA)¹⁵ and the U.S. Centers for Disease Control and Prevention's Agency for Toxic Substances and Disease Registry (ATSDR)¹⁶ agree that exposure to high levels of certain PFAS may lead to increased risk of high blood pressure in pregnant women; low birth weight in babies; increased risk of kidney and testicular cancer; decreased vaccine response; and increased cholesterol levels. Research is ongoing to determine the health effects of different levels of exposure to different PFAS, including the health effects of long-term, low-level PFAS exposure, especially in children.

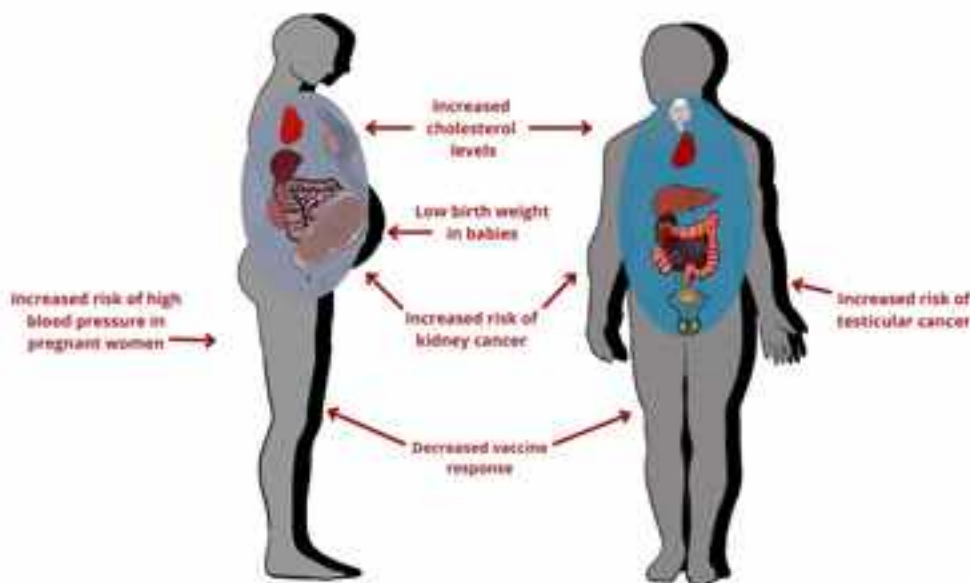
PFAS are not only highly toxic; they also demonstrate extreme persistence in the environment. PFAS' nickname "forever chemicals" reflects their chemistry – created by chemical manufacturers – that features a bond between fluorine and carbon atoms that is among the strongest in chemistry and rarely if ever exists in nature. The result: chemicals that are extremely resistant to breaking down,¹⁷

whether in the environment or in the human body. PFAS are also extremely mobile in water,¹⁸ making them able to spread through the environment via groundwater or surface water. Another risk, discussed later in this chapter, is that PFAS may compound the health effects caused by other dangerous chemicals used in oil and gas production.

c. EPA Recognizes Risks of PFAS

EPA has been slow to regulate PFAS, but the agency has taken actions, particularly in recent years, that recognize PFAS's extraordinary risks. In June 2022, reflecting growing public concern about PFAS, EPA significantly lowered its non-binding health advisory level for PFOA and PFOS in drinking water. Previously, EPA had set the combined health advisory level for these two chemicals at 70 parts per trillion.¹⁹ "The new published peer-reviewed data and draft EPA analyses [citation omitted] indicate that the levels at which negative health outcomes could occur are much lower than previously understood," EPA wrote in June 2022.²⁰ EPA lowered its new interim health advisory level for PFOA

Figure 1: Potential Health Effects of PFAS Exposure



Exposure to PFAS chemicals can result in a variety of serious health effects including those indicated above. Source: U.S. Environmental Protection Agency, Agency for Toxic Substances and Disease Registry. Graphic by Astra Robles.

in drinking water to 0.004 parts per trillion and its interim health advisory level for PFOS to 0.02 parts per trillion.²¹ EPA also set new final health advisory levels for two other PFAS, known as GenX and PFBS, at 10 parts per trillion and 2,000 parts per trillion, respectively.²²

EPA explained that its interim health advisory levels were intended to provide guidance until enforceable drinking water regulations for PFAS take effect,²³ further stating that its health advisory level

is designed to be protective of noncancer effects over a lifetime of exposure, including sensitive populations and life stages, and is typically based on data from experimental animal toxicity and/or human studies.²⁴

The agency wrote that exposure to PFOA, PFOS, and Gen X is associated with cancer, but the agency had not yet developed cancer risk concentrations in water for these substances. EPA added that, at least for PFOA and PFOS, the interim health advisory levels could change following review by its Science Advisory Board.²⁵ EPA then in March 2023 released proposed legally enforceable “Maximum Contaminant Levels” (MCL) for six PFAS in drinking water. These regulations, unlike health advisories, must take into account whether a particular level of protection can be achieved and at what cost.²⁶ For this reason, they may be much less stringent than the health advisories.

The MCLs proposed by EPA included a level of four parts per trillion for both PFOA and PFOS. EPA also proposed an MCL Goal or non-enforceable target of zero for both of these PFAS. In addition, the agency proposed that drinking water providers limit the combined levels of four other types of PFAS: PFNA, PFHxS, PFBS, and/or GenX Chemicals.²⁷ EPA commented that it was regulating the four types of PFAS together because “low levels of multiple PFAS, that individually would not likely result in adverse health effects, when combined in a mixture are expected to result in adverse health effects.”²⁸ The MCLs would require public water systems to monitor for the six PFAS, notify the public about the levels of these PFAS, and reduce levels of the six PFAS in drinking water if levels exceeded the MCLs.²⁹ In

early 2023, the agency said that it expected to finalize the regulations by the end of 2023,³⁰ but has extended that timetable to early 2024.³¹ The state of Pennsylvania has forecast, however, that the rules may not take effect until several years later.³²

Even the higher MCL figures demonstrate the extraordinary toxicity of some types of PFAS. At a level of four parts per trillion, one cup of PFOA could contaminate 28 billion gallons of water,³³ almost three times the 10 billion gallons of water that West Virginia American Water provides to Charleston and surrounding communities each year.³⁴

Several experts told PSR that because of the extreme potency of certain types of PFAS and the fact that chemical makers have created thousands of these forever chemicals, they would recommend the use of testing equipment that can detect PFAS in microscopic concentrations below proposed or adopted maximum contaminant levels and/or other relevant regulatory guidelines or recommended limits. They further recommended testing for total organic fluorine in addition to testing for specific types of PFAS. Total organic fluorine is a marker that would indicate the presence of PFAS even if a specific PFAS were not detected. Testing for specific PFAS only might fail to detect other forms of PFAS present in the sample.

The experts recommending these testing protocols are Linda Aller, a hydrogeologist with Bennett & Williams Environmental Consultants, Inc, who has consulted with the Little Hocking (Ohio) Water Association on all aspects of PFAS since 2002 (Little Hocking was impacted by PFAS pollution from Dupont’s factory in Parkersburg) as well as other PFAS-impacted areas;³⁵ Linda Birnbaum, Ph.D., D.A.B.T., A.T.S., a board-certified toxicologist and former director of the National Institute of Environmental Health Sciences;³⁶ Zacariah Hildenbrand Ph.D., research professor in Chemistry and Biochemistry at the University of Texas at El Paso;³⁷ and Wilma Subra, holder of a master’s degree in chemistry and recipient of a John D. and Catherine T. MacArthur Foundation “Genius” grant for her work helping to protect communities from toxic pollution.³⁸

d. PFAS: Among Many Dangerous Chemicals Used in Fracking, Drilling

Chemicals used in the fracturing stage of oil and gas production serve a variety of purposes including killing bacteria inside the wellbore, reducing friction during high-pressure fracking, and thickening the fluid so that the sand, suspended in the gelled fluid, can travel farther into underground formations.³⁹ When chemicals used in fracking come into contact with people or the environment, they can produce serious negative health effects.⁴⁰ The use of PFAS in fracking operations could add to the cumulative human exposure to a host of toxic substances, multiplying the health risks.

In its 2016 study of fracking and drinking water, the EPA identified 1,606 chemicals used in fracking fluid and/or found in fracking wastewater. While the agency found high-quality information on health effects for only about 10 percent (173) of these chemicals, that 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.⁴¹ Chemicals used in the drilling stage that precedes actual fracturing can also pose health risks, including developmental toxicity and the formation of tumors, according to EPA regulators.⁴² A disclosure form filed with the state of Ohio, one of only two states to explicitly require public disclosure of drilling chemicals (Colorado is the other),⁴³ shows that Statoil, Norway's state oil company (since renamed Equinor), has used the neurotoxic chemical xylene in drilling.⁴⁴ Xylene can cause effects ranging from headaches, dizziness and confusion to loss of muscle coordination, and in high doses, death.⁴⁵ West Virginia requires some disclosure of drilling chemicals under its "site safety plan" requirements, discussed in Chapter 4.

e. Oil and Gas Operations Provide Many Potential Routes of Exposure to PFAS

Oil and gas operations in West Virginia deserve scrutiny

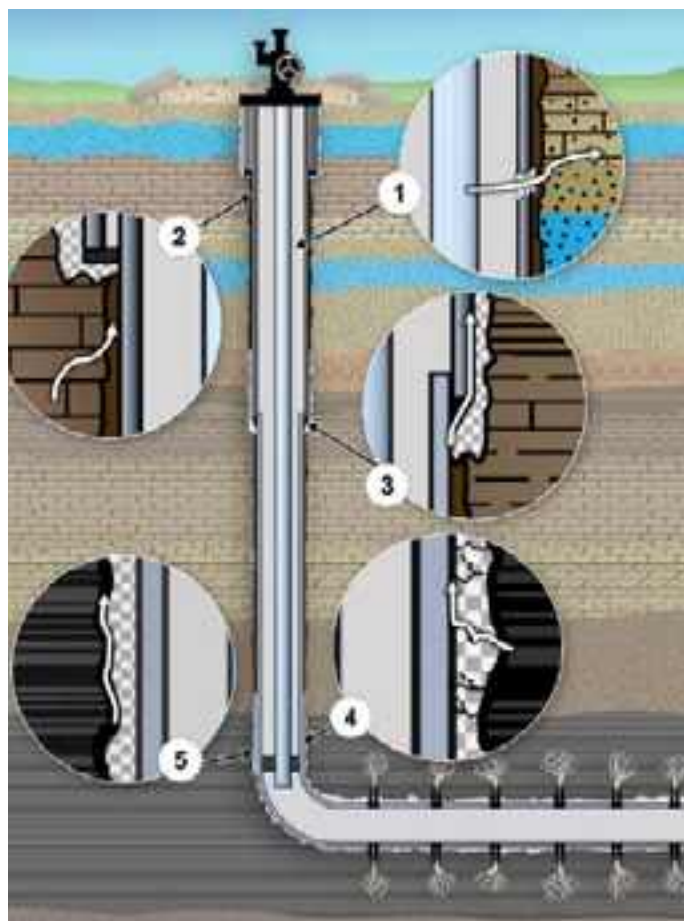


Diagram from U.S. Environmental Protection Agency's 2016 report on fracking and drinking water (p. ES-29) shows the various pathways through which fluid can migrate up an oil or natural gas well and potentially pollute groundwater including through leaks in the steel casing or cement designed to seal off the casing from the groundwater. EPA noted that the diagram is not to scale.

as a possible source of PFAS contamination, given the documented use of PFAS in the state's horizontal gas wells and the potential that people could be exposed to such PFAS via multiple pathways. EPA in a 2016 national report on fracking and drinking water found that fracking-related pollution could follow several pathways that could impact surface water and groundwater. The agency cited the following possible pathways to exposure:

- spills of fracking fluid that seep into groundwater;
- injection of fracking fluid into wells with cracks in the casing or cement, allowing the fluid to migrate into aquifers;

- injection of fracking fluids directly into groundwater;
- underground migration of fracking fluids through fracking-related or natural fractures;
- intersection of fracking fluid with nearby oil and gas wells,
- spills of wastewater after the fracking process is completed, and
- inadequate treatment and discharge of fracking wastewater to surface water supplies.⁴⁶

Another important potential pathway for PFAS contamination during oil and gas extraction is through the drilling that precedes fracking. During drilling, companies bore deep holes in the earth in successive stages. With each subsequent stage, companies bore deeper until the production zone is reached where the oil and/or gas are located.⁴⁷ During the first stage of drilling, these holes typically pass directly through groundwater.⁴⁸ Chemicals can be injected in this stage of the process to help keep the drill bit cool and to help lift rock cuttings out of the well.⁴⁹ A 2020 paper noted that PFAS had been proposed for use in drilling fluids.⁵⁰ Further investigation of this possible use is needed, as EPA has indicated that any chemicals used during this first stage of the drilling process would be highly likely to leach into groundwater, since only after drilling through the groundwater zone is completed do oil and gas companies insert steel pipe and cement to seal off the well from groundwater.⁵¹ Two other important potential routes of exposure to PFAS related to oil and gas extraction are discussed in more detail in Chapter 6: disposal of oil and gas wastewater in underground injection wells, a pathway that EPA did not examine in its 2016 report,⁵² and airborne releases.

f. Oil, Gas Well Proximity Are Associated with Disease

A robust and reliable body of scientific studies of PFAS in oil and gas operations – both their presence and their health effects – does not yet exist. Nor are there many studies focusing on the potential health impacts of oil and gas operations specifically on West Virginians. However, peer-reviewed scientific studies of people living near oil

and gas operations have in multiple states correlated proximity to active well sites with a variety of diseases and other negative health effects. It is not unreasonable to think that, should PFAS have been used in those oil and gas operations, it could be associated with some of those harmful health effects.

A 2021 study comparing health data in Pennsylvania and New York counties atop the Marcellus Shale formation found that years of exposure to unconventional natural gas operations in Pennsylvania were associated with higher hospitalization and death rates from acute myocardial infarction (heart attack) than was found in New York, where no unconventional gas operations took place.⁵³ The study was made possible by the natural experiment created by New York's moratorium and later ban on fracking and Pennsylvania's decision to pursue shale gas extraction.⁵⁴ Similarly, researchers from Johns Hopkins University analyzed data on more than 12,000 heart failure patients in Pennsylvania and compared those with hospitalizations and those without hospitalizations. They found that heart failure patients living near unconventional gas extraction sites were significantly more likely to be hospitalized.⁵⁵ The authors of both the New York/Pennsylvania study and the study focused solely on Pennsylvania suggested that particulate matter emitted from fracking operations and the stress associated with living nearby might have played a role in the findings. Neither study examined PFAS exposure, but one of the health impacts associated with PFAS exposure is high cholesterol that is, in turn, associated with heart attacks.⁵⁶ These associations, and the known use of PFAS in oil and gas operations, point to the need for more study of the use of PFAS in oil and gas operations and associated health effects.

PSR has collaborated with Concerned Health Professionals of New York to produce the Compendium of Scientific, Medical, and Media Findings Demonstrating Risks and Harms of Fracking (Unconventional Gas and Oil Extraction). This encyclopedic document compiles and summarizes the substantial and growing number of scientific studies that have found serious health effects associated with oil and



Halliburton fracking operation in Wetzel County, W.Va., Jan. 1, 2016. Photo credit: Bill Hughes.

gas operations. At least two of these health effects, low birth weight in babies and heart disease (that can be linked to high cholesterol), are generally associated with exposure to PFAS, though the research to date has not investigated whether these health effects are specifically linked to PFAS used in oil and gas operations. Low birthweight is a leading contributor to infant death in the United States.⁵⁷

PSR is not aware of published studies that have analyzed whether the use of PFAS at oil and gas well sites is related to health effects in people living near the wells or near well waste disposal sites. This lack of analysis is regrettable but not surprising. There were few if any grounds to test for PFAS in connection with oil and gas operations prior to July 2021, when PSR first publicized the use of these chemicals in oil and gas extraction. Now that we know PFAS have been used in oil and gas operations for years, scientists should determine where this use takes place and whether there are connections between this use and health effects, both for PFAS chemicals individually and as a compounding factor in conjunction with exposure to other fracking chemicals.

CH. 2

PFAS USE IN WEST VIRGINIA'S OIL AND GAS WELLS AND GROWING EVIDENCE OF PFAS POLLUTION

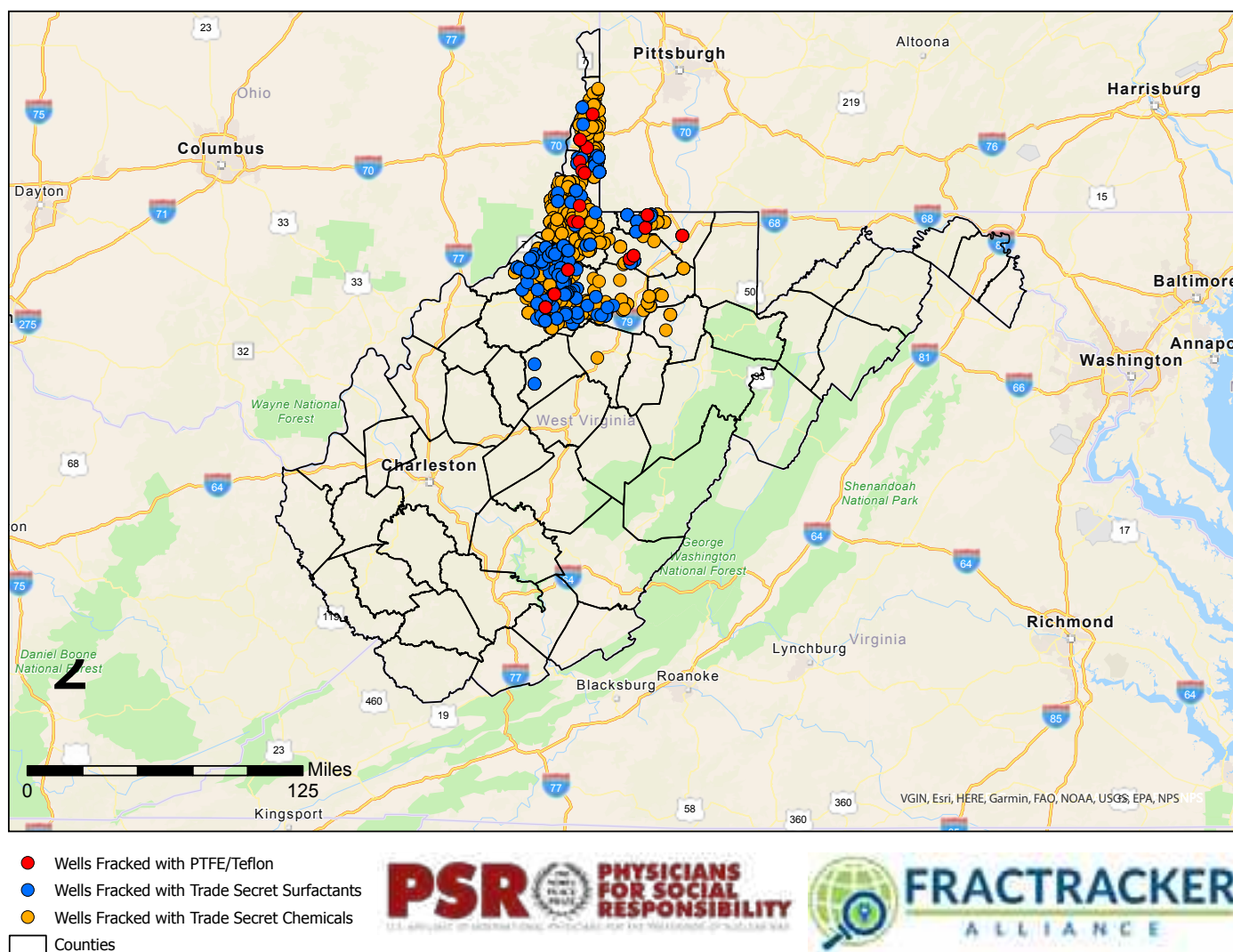
a. PTFE Injected into Horizontal Gas Wells in Eight West Virginia Counties

The West Virginia horizontal gas wells PSR has identified as having been injected with PFAS consist of 43 wells injected with PTFE, also known as Teflon and identified by the U.S.

Environmental Protection Agency (EPA) as a PFAS.⁵⁸ The wells are located in eight counties, primarily in northern West Virginia: Brooke, Doddridge, Marion, Marshall, Monongalia, Ohio, Tyler, and Wetzel (see Table 1 in Chapter 3).

The larger story, however, is the disclosure gaps in West

Figure 3. West Virginia Horizontal Gas Wells Fracked with PFAS and Trade Secret Chemicals that Could Include PFAS, 2013-2022



This map shows the location of horizontal gas wells in West Virginia known to have been fracked between January 1, 2013 and September 29, 2022 using PTFE/Teflon (a known PFAS), trade secret chemicals, and/or trade secret surfactants. An interactive version of the map is available at <https://ft.maps.arcgis.com/apps/webappviewer/index.html?appid=7294f90f7a194216a2d6126e973a823a> where users can zoom in to identify wells near them. For a detailed explanation of data sources, see the Appendix.

Virginia law. These gaps shield vital data from disclosure, preventing scientists and the public from knowing the extent of the use of PTFE and other PFAS in the state's oil and gas operations. The use of PFAS in oil and gas production in other states was first documented in 2021 in a report by PSR that relied on industry records disclosed to the nongovernmental organization FracFocus. Later that year, a report by Public Employees for Environmental Responsibility showed a limited use of PFAS in West Virginia's oil and gas wells through an analysis of EPA records.⁵⁹ PSR's findings in this report, however, go even further. Based on a more comprehensive review of fracking chemical disclosures made to FracFocus, PSR is able to identify not only the horizontal gas wells definitively known to have been injected with PFAS between 2013 and 2022, but also the wells injected with unidentified "trade secret" chemicals and the staggering quantities of these unidentified substances. Figure 3 (page 8) shows the locations of the horizontal gas wells injected with disclosed PFAS, undisclosed trade secret chemicals, and a subset of trade secret chemicals (discussed in Chapter 4) known as surfactants.

Fracking is the stage of oil and gas operations that typically involves high-pressure injections into oil and gas wells of up to tens of millions of gallons of water, sand, and chemicals to fracture rock formations and free up trapped oil and gas.^{60***} Over the past two decades, oil and gas companies have increased gas and oil production by combining fracking with horizontal drilling. Drilling horizontal wells involves drilling down vertically to a target depth, then steering the drill bit horizontally to create a horizontal portion of the well often called a "lateral." This technique allows well operators to access more of the targeted oil and/or gas production zone.⁶¹ Horizontal gas wells are responsible for the surge in gas production over the past decade that made West Virginia the nation's fourth-leading gas-producing state in 2022.⁶² It is possible that PFAS have

been used not only in fracking in horizontal gas wells in West Virginia, but also in other stages and methods of oil and gas production, including vertically drilled wells and the drilling that precedes fracking.

b. PFAS Use in Oil and Gas Operations May Threaten West Virginia's Water Supplies, Add to PFAS from Other Sources

Evidence shows that PFAS has already contaminated surface water and groundwater in West Virginia, and some of the findings implicate oil and gas operations as a potential source of the pollution. Investigation of the link between oil and gas operations in West Virginia and PFAS pollution has been performed by researchers from several institutions including Yale University and published in a peer-reviewed paper in November 2023. **The researchers found that oil and gas operations in five counties in northern West Virginia were associated with PFAS pollution and that, in several cases, these operations likely caused the pollution.** The researchers found that all eight surface water samples and 60 percent of the 45 private wells in their study contained at least one of the 21 types of PFAS for which they tested. They also reported that four of the private wells had concentrations above EPA's proposed maximum contaminant level in drinking water for PFOA.⁶³ The researchers found that three water wells appear likely to have been contaminated with PFAS from oil and gas wells because these water wells "exhibited individual PFAS concentrations above those likely from atmospheric sources even when considering historic deposition" from the former Dupont facility in Parkersburg (now called Chemours Washington Works) where the health and environmental impacts of PFAS first came to light. The researchers added that "Industrial operations related to oil and gas development were the only identifiable sources within 2 km of [the three water wells] even considering agricultural activity and possible biosolids applications."⁶⁴

*** In this report, the term "fracking" is used to discuss a particular stage in oil and/or gas production as distinct from other stages or methods of production such as drilling that precedes fracking. The terms "oil and gas production," "oil and gas extraction," and "oil and gas operations" cover the entire process of producing oil and/or gas.

The counties where the study was conducted – Doddridge, Marshall, Ritchie, Tyler, and Wetzel – include horizontal gas wells into which oil and gas companies reported injecting PTFE and/or trade secret chemicals, according to PSR's analysis in this report. The researchers noted that these counties were home to more than 3,000 completed unconventional oil and gas wells in production. Unconventional wells are typically synonymous with horizontal oil and gas wells.⁶⁵ The researchers also found that the five-county area contains 14,000 active conventional oil and gas wells. Conventional wells are typically vertical and may or may not involve hydraulic fracturing.⁶⁶ Based on data cited later in this report by PSR, it is possible that PFAS has been used in both conventional and unconventional oil and gas wells (see Chapter 5). The authors further concluded that “within the larger data set, PFOA detections and concentrations in private water wells were significantly associated with proximity to recently drilled (2018-2020) UOG [unconventional oil and gas] well pads....”⁶⁷ However, the researchers cautioned that “observed concentrations were indistinguishable from levels plausibly attributable to atmospheric sources....”⁶⁸ They said that their research highlights the need for further studies to determine the sources of PFAS in private water wells, “particularly in regions where reliance on private water wells co-occurs with spatially distributed industrial sources, like oil and gas development.”⁶⁹

A 2022 study by the U.S. Geological Survey (USGS) showed that PFAS had polluted dozens of water supplies in West Virginia and that groundwater might be at a high risk of contamination. The USGS sampled drinking water supplies for 279 public water systems and detected PFAS more often and in higher concentrations in groundwater than in surface water sources. West Virginia Rivers, a nonprofit, placed the figure of contaminated water sites at 130, relying on raw data from the USGS study and updated health advisory levels from the U.S. Environmental Protection Agency. The USGS did not investigate the sources of this pollution;⁷⁰ however, some concentrations of the pollution were found in northern West Virginia,⁷¹ the region of most of the state's horizontal gas wells, including those in which

the use of PFAS has been disclosed (compare Figure 3, page 8, with Figure 4).

The USGS report indicated that West Virginia's groundwater supplies might be especially likely to be contaminated with PFAS due to the relatively young age of recharge water in West Virginia's aquifers. The agency noted that groundwater age has been identified as a leading indicator of PFAS contamination in groundwater in the eastern U.S. and that aquifers containing recharge-water less than 60 years old have higher rates of PFAS occurrence. The USGS also stated that age-tracer data from previous studies on West Virginia's groundwater resources showed that all aquifers of West Virginia contain recharge-water less than 60 years old. This fact, the USGS found, “indicates that all the groundwater aquifers in the State are potentially susceptible to PFAS contamination [citation omitted] if a source of contamination exists within the recharge area of the aquifer....”⁷³ The report also found that

a surface water intake may be vulnerable to contamination from PFAS if a source exists within its catchment area [also known as its watershed], but concentrations may be highly variable due to environmental conditions or because of operations at the specific source.⁷⁴

West Virginians may, therefore, be at especially high risk of exposure to PFAS from oil and gas operations, given that at least some oil and gas operations involve PFAS, oil and gas extraction can contaminate groundwater, and the state's aquifers are particularly vulnerable to PFAS contamination.

More research is needed about the extent and sources of PFAS pollution in West Virginia and whether oil and gas operations could be contributing to such contamination. This need is especially critical, given that almost 40 percent of West Virginians receive their drinking water from groundwater, according to the USGS.⁷⁵ The USGS 2022 report stated that it did not test private water wells for PFAS and that the tests it conducted could not be used to

extrapolate PFAS concentrations in groundwater in aquifers that underlie much of the state. “PFAS exposure to private homeowners who rely on these aquifers as a primary

drinking-water source is currently unknown,” the agency wrote. The USGS proposed testing private water wells for PFAS as a potential subject for future study and suggested

Figure 4. Sites in W.Va. Where U.S. Geological Survey Detected PFAS in Groundwater and Surface Water

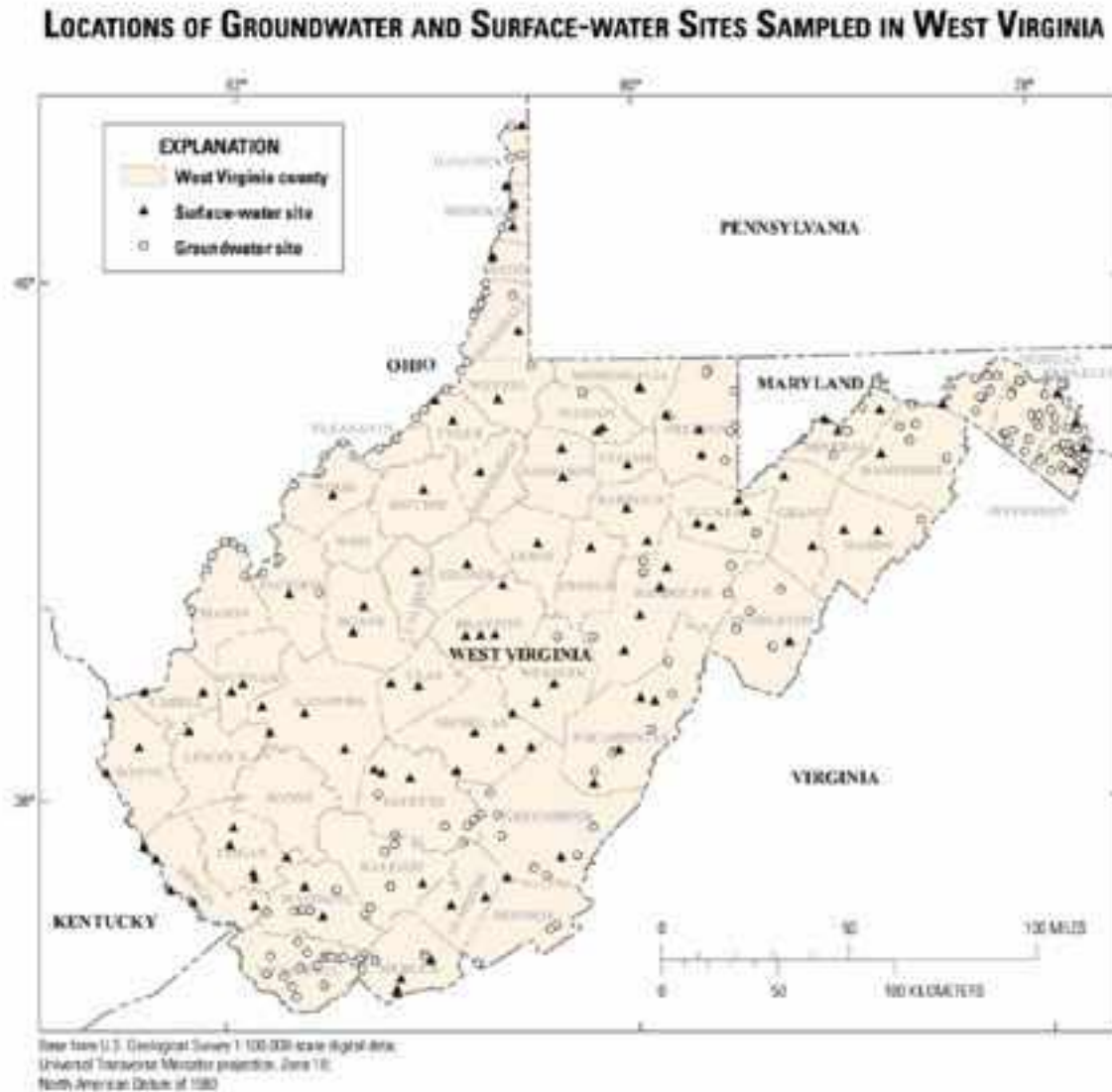


Figure 4 shows a map from the U.S. Geological Survey's report by Mitchell McAdoo et al., “Occurrence of Per- and Polyfluoroalkyl Substances and Inorganic Analytes in Groundwater and Surface Water Used as Sources for Public Water Supply in West Virginia” (2022).⁷² The map depicts groundwater and surface water sites in West Virginia where USGS scientists detected PFAS, as well as the concentrations of PFAS detected at each site. The sites provide source water for public drinking water systems. Concentrations are reported in parts per trillion. The reporting level (the level at which the laboratory reported a detected value without qualification) is approximately 3.8 parts per trillion. Therefore, concentrations of PFAS at the sites marked in green ranged from about 3.8 to 20 parts per trillion. The USGS does not provide precise information about the locations of the tests because “West Virginia State Law § 22-26-4 and USGS policy concerning the release of sensitive water related information prohibits the release of public water system infrastructure location information.”

that “the major sources and exposure pathways of PFAS in West Virginia” could be the focus of future investigation.⁷⁶

Studies indicating an association between PFAS pollution and oil and gas extraction echo related findings in neighboring Pennsylvania. A 2023 study by scientists from the USGS and Pennsylvania Department of Environmental Protection (PADEP) reported concentrations of PFAS in Pennsylvania streams located in areas that featured both high numbers of oil and gas wells and combined sewer overflow outfalls.⁷⁷ The authors wrote that

Research documenting the impacts of OG [oil and gas] development on PFAS contamination in surface waters is limited, but in this study the CSO [combined sewer overflow outfalls] surrounded by OG development in local catchments could be a potential source of PFAS to surrounding streams.⁷⁸

Also in 2023, the PADEP tested a water well for PFAS at a home in Washington County in response to a homeowner’s complaint that nearby oil and gas operations had contaminated his water with PFAS.⁷⁹ The PADEP reported that it found some PFAS in the water (PFOS at 2.3 parts per trillion, as well as PFHxS and PFOSA). While they found no evidence that PFAS was used in the nearby oil and gas operations, specifically two unconventional gas wells operated by Chevron about 500 feet from the home in question,⁸⁰ the PADEP speculated that the source of the PFAS could be, among many potential sources, water that already contained PFAS being used for fracking in the unconventional gas wells. Pennsylvania’s regulations – and West Virginia’s – do not require testing for or disclosure of chemicals contained in water used in fracking.⁸¹ It is possible that water used for fracking could be contaminated with PFAS by prior fracking operations, as a significant portion of water used in fracking in Pennsylvania – and West Virginia – is reused fracking wastewater.⁸²

CH. 3

PFAS USED IN WEST VIRGINIA'S OIL AND GAS WELLS: WHAT, AND WHERE

a. PTFE, a PFAS, Used for Fracking in West Virginia's Horizontal Gas Wells

The type of PFAS disclosed as being used in West Virginia's horizontal gas wells is PTFE, a fluoropolymer and a type of plastic.⁸³ The major concerns about PTFE and other fluoropolymers raised by scientists⁸⁴ and environmentalists⁸⁵ are related less to these substances themselves, and more to the associated toxic impacts of their production, use, and disposal. The production of PTFE and other fluoropolymers relies on the use of other, highly toxic PFAS that are used as production aids. As noted in a peer-reviewed study published in 2020, these other PFAS have included fluorosurfactants such as PFOA, whose risks are discussed in Chapter 1, and GenX, which is similarly harmful and has replaced PFOA in fluoropolymer production.⁸⁶ PTFE and other fluoropolymers may contain these more toxic PFAS fragments, and those fragments may leach out of the PTFE during use.⁸⁷ The authors of the 2020 paper noted that

The levels of leachables...in individual fluoropolymer substances and products depend on the production process and subsequent treatment processes; a comprehensive global overview is currently lacking.⁸⁸

In addition, PTFE may generate other PFAS if the PTFE breaks down under heat.⁸⁹

The 2020 paper authors noted that the persistence in the environment of PTFE and other fluoropolymers could pose problems during disposal, observing that "Landfilling of fluoropolymers leads to contamination of leachates with PFAS and can contribute to release of plastics and microplastics."⁹⁰ One of the authors added in an email to PSR that if PTFE were used in oil and gas wells that have especially high-temperatures, defined in publications by oilfield services company Schlumberger as 300° to 350° F or higher for so called "high-pressure, high-temperature wells,"⁹¹ the PTFE could undergo a process called thermolysis and generate toxic PFAS called perfluoroalkyl carboxylic acids (PFCAs). As a result, he wrote, "there could be some additional problems that need some investigation."⁹² A

representative from the West Virginia Department of Environmental Protection (WVDEP) said that the department was not aware of such wells in the state.⁹³

In 2021, a coalition of national environmental organizations including the Center for Environmental Health, Clean Water Action, Ecology Center, Environmental Working Group, Natural Resources Defense Council, Safer States, and the Sierra Club voiced several environmental and health concerns regarding the risks of fluoropolymers such as PTFE, based on their review of multiple scientific articles. Among these concerns were the release into the environment of other toxic PFAS used to produce fluoropolymers, including PFOA⁹⁴ and perfluorocarboxylic acids (PFCAs).⁹⁵ These PFAS can be released both when fluoropolymers are manufactured and when they are used. PFOA's health concerns are discussed above. Evidence suggests that PFCAs may be associated with various health impacts including effects on the liver, thyroid, kidney and immune system.⁹⁶ The groups also noted that fluoropolymers are manufactured with chemicals that over a 20-year period are much more powerful at warming the climate than carbon dioxide.⁹⁷

b. Data Show Which Companies Fracked Horizontal Wells with PTFE, and Where

Oil and gas companies that have disclosed using PTFE for fracking in West Virginia (Table 1, next page) include Irving, Texas-based ExxonMobil Corp.,⁹⁸ the nation's largest publicly traded oil and gas company;⁹⁹ and Denver-based Antero Resources Corp.¹⁰⁰ According to West Virginia University, which received a \$4 million gift from Antero in 2023, Antero is the largest producer of natural gas and natural gas liquids in West Virginia.¹⁰¹ Natural gas liquids include, among several types of fluids, propane that is used for small stoves and barbecues and ethane that is used in plastics production.¹⁰²

PSR was able to identify wells injected with PTFE through oil and gas industry records disclosed to FracFocus that include Chemical Abstracts Service (CAS) numbers, unique numeric identifiers assigned to millions of chemicals by the American

Table 1. Disclosed Use in Fracking of PTFE in West Virginia Horizontal Gas Wells, 2013-2022

County	Number of wells injected with PTFE	Mass of PTFE (lbs.)	Well Operator(s)
Brooke	2	11	Chesapeake Operating, Inc.
Doddridge	12	369	Antero Resources Corporation
Marion	4	13	XTO Energy/ExxonMobil
Marshall	4	no data available	Chesapeake Operating, Inc.
Monongalia	9	20	Northeast Natural Energy LLC
Ohio	4	no data available	Chesapeake Operating, Inc.
Tyler	6	164	Antero Resources Corporation
Wetzel	2	23	Southwestern Energy; Chesapeake Operating, Inc.
Total	43	602	five companies

This table shows by county the number of West Virginia's horizontal gas wells in which oil and gas companies injected PTFE for fracking between January 1, 2013 and September 29, 2022 as well as the name(s) of the companies making the injections. "No data available" means that records in FracFocus showed the use of PTFE in several wells but provided insufficient data to calculate how much was used. For a more detailed explanation of data sources, see the Appendix.

Chemical Society.¹⁰³ Scientists consider CAS numbers the best way to identify chemicals because chemicals can have multiple names or trade names but only one CAS number.¹⁰⁴

PSR identified PTFE through its CAS Number, 9002-84-0.

However, the FracFocus records make it difficult to know for what precise purpose PTFE was used in these wells; well operators listed either no purpose or various purposes for multiple chemical products, and the individual chemical components of these products were listed in a separate portion of the disclosure form, making it impossible to know which components were part of which product.¹⁰⁵ PTFE, which is marketed as Teflon, is known for its slipperiness, suggesting it might have been used as a friction reducer, a common purpose for fracking chemicals.¹⁰⁶

CH. 4

CHEMICAL DISCLOSURE LAWS SHIELD CHEMICAL IDENTITIES

a. West Virginia's Lax Chemical Disclosure Rules Could Conceal PFAS Use

West Virginia's system of oil and gas chemical disclosure makes it impossible to know how widely PTFE, other PFAS, or other toxic chemicals have been used in the state's oil and gas wells. One salient feature of the state's rules that frustrate the public's right to know is the use of trade secret claims that allow oil and gas companies to hide the identities of fracking chemicals. The rules appear to require something akin to full chemical disclosure for horizontal gas wells – even for non-fracking chemicals – under a “well site safety plan.” But upon closer inspection, the disclosures under at least some of these plans are riddled with gaps that thwart full knowledge of chemicals used at horizontal

gas wells. Additionally, West Virginia's rules allow chemical manufacturers – the companies who know best what chemicals are being used in oil and gas operations – to avoid full disclosure of chemical ingredients. Finally, the chemical disclosure rules apply only to specifically defined horizontal gas wells, meaning that they do not apply to other oil or gas wells, including vertical wells. Most wells drilled over the past decade in West Virginia have been horizontal gas wells, but some vertical wells continue to be drilled, and vertical wells make up the bulk of wells drilled historically in West Virginia.

b. West Virginia's Fracking Chemical Disclosure Law

Since 2011, West Virginia has required disclosure of chemicals used for hydraulic fracturing or “stimulation”



A drilling rig in Marshall County, W.Va., Jan. 26, 2018. Photo credit: Ted Auch, FracTracker Alliance.

of horizontal gas wells.¹⁰⁷ “Stimulation” is not currently defined under West Virginia law,¹⁰⁸ but it is often synonymous with fracking.¹⁰⁹ (A previous version of West Virginia law requiring fracking chemical disclosure defined “stimulate” as “any action taken by a well operator to increase the inherent productivity of an oil or gas well, including, but not limited to, fracturing, shooting or acidizing, but excluding cleaning out, bailing or workover operations.”¹¹⁰) A horizontal gas well is defined as

any [gas] well site, other than a coalbed methane well, drilled using a horizontal drilling method, and which disturbs three acres or more of surface, excluding pipelines, gathering lines and roads, or utilizes more than two hundred ten thousand gallons of water in any thirty day period.¹¹¹

If a horizontal gas well uses more than 210,000 gallons of water from water sources located in West Virginia in any thirty-day period, the well operator must make fracking chemical disclosures both before¹¹² and after¹¹³ fracking or stimulation of the well. If the well uses less than 210,000 gallons of water from water sources located in West Virginia in any thirty-day period but meets the other definitions for a horizontal gas well, the well operator or service provider is required to make fracking chemical disclosures only after fracking or stimulation.¹¹⁴ All disclosures after fracking or stimulation must be made to the FracFocus database.¹¹⁵ This database, maintained by the Groundwater Protection Council, a nonprofit comprised of regulators from state agencies that regulate groundwater,¹¹⁶ contains well-by-well hydraulic fracturing chemical disclosure for the oil and gas industry.¹¹⁷ Fracking chemical disclosure prior to fracking must be made to the Secretary of the Department of Environmental Protection as part of the application for the well’s work permit.¹¹⁸

PSR’s analysis of FracFocus data for more than 2,500 fracking treatments on West Virginia’s horizontal gas wells between 2013 and 2022 found that oil and gas companies used an average of more than 14 million gallons of water per treatment – more than 19 times the amount that triggers

the disclosure requirement. Only four fracking treatments during this period involved less than 210,000 gallons of water. It is unclear whether all of the water reported for fracking treatments was used within a 30-day period or whether the water came from sources located in West Virginia, but fracking treatments usually occur over a period of less than 14 days¹¹⁹ and water for fracking is usually obtained close to the fracking operations, as EPA reported in its 2016 report on fracking and drinking water. On that basis, it is probable that almost all the fracking treatments that PSR analyzed in this report met West Virginia’s threshold for disclosure of fracking chemicals.

c. Extensive Use of “Trade Secret” Claims Veils Chemical Use in Horizontal Gas Wells

Under West Virginia’s fracking chemical disclosure system for horizontal gas wells, perhaps the most prominent measure that could conceal wider use of PFAS is the ability for oil and gas companies to withhold from the public the identities of fracking chemicals that are deemed trade secrets.¹²⁰ Over the past decade, oil and gas companies have used this exception extensively. PSR found that between 2013 and 2022, oil and gas companies, while disclosing the use of fracking chemicals in more than 2,500 wells, also injected more than 1,900 wells of those wells – almost 75 percent – with at least one trade secret fracking chemical.¹²¹ The CAS numbers for these chemicals were not revealed, preventing the public from knowing whether or not these unidentified chemicals were PFAS. **The weight of these chemicals, injected into horizontal gas wells located across 15 counties, totaled 69 million pounds.**¹²² If even a small fraction of this weight were PFAS, that fraction could pose significant health and environmental risks.

Furthermore, oil and gas companies injected almost 400 of the 1,900 wells with trade secret surfactants,¹²³ a category of chemical that includes a subcategory known as fluorosurfactants, some of which are known to be PFAS. These wells were spread across 12 counties. According to EPA, surfactants are commonly used in fracking,¹²⁴ including to generate and stabilize foam fracking fluids and to help

Table 2. Disclosed Use of Trade Secret Chemicals in West Virginia Horizontal Gas Wells, 2013-2022

County	No. of wells injected with at least one trade secret chemical	Mass of all trade secret records (lbs.)	No. of wells injected with at least one trade secret surfactant	Mass of trade secret surfactants (lbs.)
Barbour	6	1,730,000	0	0
Brooke	12	1,430,000	2	11,200
Doddridge	369	9,670,000	84	230,000
Gilmer	3	138,000	2	496
Harrison	80	1,280,000	10	23,300
Lewis	1	4,800	0	0
Marion	43	786,000	7	8,050
Marshall	327	14,100,000	70	460,000
Monongalia	103	3,980,000	23	11,300
Ohio	117	3,980,000	1	5,450
Pleasants	13	365,000	7	33,400
Ritchie	151	6,760,000	19	40,800
Taylor	17	221,000	0	0
Tyler	357	16,500,000	145	577,000
Wetzel	240	8,180,000	24	119,000
Total	1,912	69,100,000	394	1,520,000

This table shows by county the number of West Virginia horizontal gas wells into which oil and gas companies disclosed that they injected at least one trade secret fracking chemical and/or at least one trade secret surfactant between January 1, 2013, and September 29, 2022. It also shows the total combined weight of these chemicals by county and statewide. The total weight figures reflect the sum of all records for which we have enough information to calculate a chemical's weight. Because many fracking chemical disclosures lack sufficient data to perform this calculation, the total weight figures may represent an undercount. The wells injected with trade secret surfactants are a subset of the wells injected with trade secret chemicals. For a more detailed explanation of data sources, see the Appendix.

one unmixable fluid disperse into another unmixable fluid "by reducing the interfacial tension between the two liquids to achieve stability."¹²⁵ Compared to other surfactants, fluorosurfactants are said to be "superior in their aqueous surface tension reduction at very low concentrations and are useful as wetting and leveling agents, emulsifiers, foaming agents, or dispersants."¹²⁶ At least some fluorosurfactants are PFAS, including the dangerous chemicals PFOA and PFOS,¹²⁷ and 8:2 fluorotelomer alcohol,¹²⁸ a nonionic fluorosurfactant¹²⁹ that can break down into PFOA.¹³⁰

How many of the trade secret surfactants are PFAS is impossible to determine from the available FracFocus data. Operators' names for these chemicals were vague, including "proprietary nonionic surfactant"¹³¹ and "nonionic surfactant."¹³² The weight of these trade secret surfactants totaled more than 1.5 million pounds. Should even a small percentage of them be PFAS, they could pose significant and long-lasting threats to human health and the environment. Table 2 above shows county-by-county where trade secret chemicals and trade secret surfactants were used to frack horizontal gas wells in West Virginia.

Table 3. Oil and Gas Companies that Fracked Horizontal Gas Wells in West Virginia Using Trade Secret Chemicals and Trade Secret Surfactants, 2013-2022

Operator Name	No. of wells injected with at least one trade secret chemical	Mass of all trade secret chemicals (lbs.)	No. of wells injected with at least one trade secret surfactant	Mass of all trade secret surfactants (lbs.)
Antero Resources Corporation	686	30,200,000	228	902,000
EQT Production	258	5,800,000	10	757
Southwestern Energy	202	6,000,000	10	57,400
Tug Hill Operating, LLC	165	3,600,000	28	8,000
Noble Energy, Inc.	117	8,150,000	45	7,290
Northeast Natural Energy LLC	98	3,980,000	18	10,200
Chesapeake Operating, Inc.	74	3,300,000	3	445,000
Jay-Bee Oil & Gas, Inc.	62	583,000	31	72,800
Stone Energy Corporation	56	2,200,000	0	0
Chevron USA Inc.	32	1,050,000	0	0
Triad Hunter LLC.	24	238,000	3	4,370
XTO Energy/ExxonMobil	24	222,000	7	8,050
CONSOL Energy Inc.	22	1,910,000	2	2,450
CNX Gas Company LLC	16	288,000	5	1,090
Arsenal Resources	14	292,000	0	0
American Energy – Marcellus, LLC	14	117,000	0	0
PDC Energy	14	no data available	0	0
Mountaineer Keystone, LLC	12	437,000	0	0
Statoil USA Onshore Properties Inc.	10	no data available	0	0
Tribune Resources, LLC	5	380,000	0	0
American Petroleum Partners Operating, LL	4	206,000	4	951
Ascent Resources – Marcellus, LLC	4	163,000	0	0
Total	1,913*	69,100,000	394	1,520,000

This table shows the oil and gas companies that disclosed that they fracked horizontal gas wells in West Virginia with trade secret chemicals and trade secret surfactants between January 1, 2013, and September 29, 2022. The wells injected with trade secret surfactants are a subset of the wells injected with trade secret chemicals. “No data available” means that records in FracFocus showed the use of trade secret chemicals but provided insufficient data to calculate how much was used. For a more detailed explanation of data sources, see the Appendix. Please note: Separate companies in this table could now be the same company as a result of subsequent mergers and/or name changes.* The total number of horizontal gas wells that companies operating in West Virginia injected with at least one trade secret chemical (1,913) differs slightly in this table from the total number reported in Table 2 (1,912) because one well was fracked more than once, but by different operators, and that well is counted twice in this table.

The use of these chemicals is particularly alarming as West Virginia’s gas production increased nearly ten times from about 256 billion cubic feet in 2010 to more than 2.6 trillion cubic feet in 2022, according to data available from the U.S. Department of Energy.¹³³ While these increases mean more tax revenue for the state,¹³⁴ higher gas production

also means more wells being drilled and fractured, with the associated risk of pollution from PFAS and other toxic substances.¹³⁵

Multiple oil and gas companies have injected oil and gas wells in West Virginia with trade secret chemicals that

Table 4. Examples of Individual Horizontal Gas Wells

Well Operator	Well Number	County	Year Fracking Completed	Chemical used in Well	CAS Number	Trade Name	Mass (lbs.)
Antero Resources Corporation	4701706699	Doddridge	2017	PTFE	9002-84-0	not reported	63
Chesapeake Operating, Inc.	4710302973	Wetzel	2014	PTFE	9002-84-0	ambiguous	23
Tug Hill Operating, LLC	4705102327	Marshall	2022	proprietary non-ionic surfactant	proprietary	ProHib 100	513
Jay-Bee Oil & Gas, Inc.	4707302558	Pleasants	2018	nonionic surfactant	proprietary	not reported	2745
Noble Energy, Inc.	4702105747	Gilmer	2013	surfactant mixture	proprietary	not reported	243

This table shows a sample of wells injected with the types of fracking chemicals referenced in the larger table above, including trade secret surfactants such as “proprietary non-ionic surfactant” and “nonionic surfactant” as well as PTFE. The examples cover a range of years and represent wells fracked in several West Virginia counties. Even the smallest mass shown for a proprietary chemical (243 pounds for “surfactant mixture”) could be a highly dangerous amount if this proprietary chemical were PFAS.

could be PFAS or other toxic substances. Table 3 identifies the companies responsible for this activity, as well as the quantities of trade secret chemicals and trade secret surfactants they injected.

FracFocus data show that in some cases, oil and gas companies have injected hundreds or even thousands of pounds of trade secret chemicals into individual horizontal gas wells for fracking. Table 4 provides selected examples of horizontal gas wells in West Virginia injected with particular chemicals, whether PTFE or trade secret substances, and the weight of these substances. If the toxicities of some of these chemicals were similar to those of PFOA or PFOS, these quantities would be enough to contaminate vast amounts of water.

d. Some disclosure is required, but not to the public

West Virginia provides two limited scenarios in which oil and gas companies can be required to disclose the identities of trade secret chemicals. Upon request by the chief of the Office of Oil and Gas or the chief's designee(s), well operators or service providers (companies that typically conduct

hydraulic fracturing)¹³⁶ can be required to disclose trade secret chemical identities to state regulators as part of an investigation involving a trade secret chemical. However, the Office of Oil and Gas chief or designee(s) must keep the information confidential.¹³⁷

Similarly, upon request by a health professional to address a medical emergency or for diagnostic or treatment purposes, well operators or service providers must provide trade secret chemical identities and potentially other confidential information about trade secret chemicals. The health professionals must keep this information confidential.¹³⁸ Neither the public nor first responders such as firefighters have a right to see the confidential chemical identities under West Virginia law. The federal Toxic Substances Control Act allows first responders and the public to access trade secret chemical identities under certain circumstances, but it is unclear how quickly such information could be obtained in the event of an emergency.¹³⁹ Similarly, federal rules under the Occupational Safety and Health Administration allow health professionals to access trade secret chemical information under certain scenarios, but these rules do not appear to provide similar rights to firefighters.¹⁴⁰

e. “Well Site Safety Plan” Disclosures Could Conceal PFAS Use at Horizontal Gas Wells

To a limited degree, West Virginia has exceeded the chemical disclosure requirements of many oil- and gas-producing states by requiring some disclosure of both fracking and non-fracking chemicals used in horizontal gas wells. (Most oil- and gas-producing states require disclosure only of chemicals used in fracking.¹⁴¹) West Virginia implements this broader disclosure through a “well site safety plan,” required to be filed with the Department of Environmental Protection in order for an oil and gas company to obtain a permit to begin work on a horizontal gas well.¹⁴² As part of the plan, oil and gas companies must provide to the DEP and others, including the surface land owner and local emergency planning officials, Safety Data Sheets “for the chemical components added to the hydraulic fracturing fluid, and completion, production, and work-over activities.” Safety Data Sheets identify the health or physical (e.g. fire) hazards associated with a chemical product.¹⁴³ Under federal regulations that establish uniform, nationwide standards, chemical manufacturers must ensure that chemical distributors and employers that use the chemicals are provided with Safety Data Sheets so that employers and employees can be warned about these hazards. The terms “completion,” “production,” and “work-over” in West Virginia’s rules are not defined. However, it is apparent from the inclusion of these terms that the Safety Data Sheets apply beyond the fracking phase of operations. The actual disclosures reflect this interpretation.

However, the disclosures are significantly incomplete, apparently reflecting multiple weaknesses in Safety Data Sheets. PSR carefully examined the disclosures for one of the wells featured above in Table 4: Antero Resources’ well fracked in Doddridge County in 2017.¹⁴⁴ We also examined some of the disclosures for a second well in Table 4: Jay-Bee Oil & Gas Inc.’s well fracked in Pleasants County in 2018.¹⁴⁵ (More examination was beyond the scope of this report because the records are voluminous: Antero Resources disclosed 431 pages of Safety Data

Sheets for its well in Doddridge County, while Jay-Bee Oil & Gas Inc. disclosed 1,732 pages of Safety Data Sheets for its well in Pleasants County; furthermore, the documents were not easily searchable.) While the Safety Data Sheets provided information about drilling chemicals and other non-fracking chemicals, they had many gaps, including the following for Antero Resources’ well in Doddridge County:

- The PFAS known as PTFE was not listed on the Safety Data Sheets as one of the chemicals used at the well site, even though the company listed it in the FracFocus records as being used for fracking.
- Several other chemicals listed in FracFocus also did not appear to be listed in the Safety Data Sheets, including alcohols, C12-14, ethoxylated; alcohols, C14-15, ethoxylated; and methanol.
- More than a dozen substances in the Safety Data Sheets were listed as “proprietary” or “confidential,” meaning that their identities were not revealed.
- Multiple Safety Data Sheets included unlisted chemicals defined as “non-hazardous” but with no further information.

Multiple Safety Data Sheets listed ingredients for a chemical product that added up to less than 100 percent of the product. For example, a product called AIRFOAM-HD listed one chemical component, glycol ethers, that made up between 7 to 13 percent of the product, but no other ingredients were listed. A product called SWF listed the same component, glycol ethers, as comprising 15 to 40 percent of the product, but again, no other ingredients were listed. A third product, called BIO CLEAR® 2000, listed the ingredient 2,2-dibromo-3-nitrilopropionamide as making up 20 percent of the product; no other ingredients were listed.

Some of these same types of shortcomings were apparent in the Safety Data Sheets for the well in Pleasants County fracked by Jay-Bee Oil & Gas Inc.

Well Site Safety Plans Difficult to Access

West Virginia's well site safety plans provide at least some additional information about chemicals used at horizontal gas well sites. However, the chemical information in these plans, contained on Safety Data Sheets, was difficult to access.

To obtain the information, PSR had to receive a web link from the West Virginia Department of Environmental Protection (WVDEP) – a link that would have been difficult to find online without the Department's assistance. The WVDEP also supplied username and password information for the web site and detailed instructions for accessing the information – necessary pieces that again were not readily available on the web site. PSR was able to locate chemical disclosure information for only four of five wells we searched for. That information was voluminous: The smallest file for the four wells contained 431 pages of Safety Data Sheets; the largest



Drilling site and fluids impoundments in West Virginia, 2012. Photo credit: West Virginia Surface Owners' Rights Organization.

contained 1,762 pages of Safety Data Sheets. These pages were initially viewable one at a time. Once exported, the files could be scrolled through, but they were not searchable by key words. We made one of the documents somewhat searchable by key words with the help of software. Still, it

took roughly 10 hours to review and compile the chemicals used for just one horizontal gas well.

The chemical information in the Well Site Safety Plans, though incomplete, is of some use to the public, first responders, and others. But it is much more difficult to access than the information in FracFocus, in which fracking chemicals appear in a succinct searchable list for each well. The obstacles

encountered by a would-be reader or analyst make the Well Site Safety Plans and their respective Safety Data Sheets of limited value in identifying potentially harmful chemicals used in West Virginia wells.

f. Safety Data Sheet Rules' Loopholes Prevent Full Chemical Disclosure

Researchers at Harvard University wrote in 2013 that the rules for creating Safety Data Sheets are unlikely to result in complete disclosure of fracking chemicals; these chemicals would include PFAS. The researchers observed that the rules limit disclosure to chemicals previously studied for workplace exposure. Many chemicals used in fracking might not meet this standard, they suggested, and therefore might not be disclosed in Safety Data Sheets.¹⁴⁶ The researchers also suggested that manufacturers might

not list some substances in Safety Data Sheets because of a rule that manufacturers are not required to test a chemical to identify its hazards.¹⁴⁷ Instead, manufacturers can use existing data that may not show hazards of a particular chemical. Such chemicals would then not be required to be disclosed on a Safety Data Sheet even if the chemical were in fact hazardous.¹⁴⁸ These chemicals, in turn, would not be disclosed to companies in the fracking chemical supply chain, leaving the companies unable to disclose these chemicals to the public. The rules for Safety Data Sheets also allow chemical makers to withhold chemical ingredients as trade secrets.¹⁴⁹ These holes in the disclosure

rules for Safety Data Sheets may explain many of the gaps we observed in chemical disclosure under West Virginia's well site safety plans.

Litigation in Pennsylvania revealed additional cases in which chemical manufacturers omitted critical information from Safety Data Sheets, thus preventing oil and gas companies from making full disclosure of the chemicals they used in oil and gas wells. In 2014, four attorneys with years of experience litigating oil- and gas-related cases in Pennsylvania filed a petition with the state's Commonwealth Court in which they wrote that Safety Data Sheets (then called Material Safety Data Sheets or MSDS) often do not include complete lists of chemical ingredients:

Many times, 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 relabeled 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].¹⁵⁰

The attorneys provided as support a record filed in a separate case by well operator Range Resources in which Range suggested that it was relying on MSDS from manufacturers to reply to a request for the chemicals used to fracture or stimulate its wells. Range said that the chemical information in these sheets could be incomplete. "The MSDS are often useful for developing some understanding of what is in a particular chemical or product," Range wrote, continuing,

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.¹⁵¹

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.¹⁵²

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."¹⁵³

g. Chemical Manufacturers' Exemption May Obscure PFAS Use in Oil & Gas Wells

Chemical manufacturers are in the best position to know the identities of individual fracking chemicals, whether these chemicals are used individually or as ingredients in fracking chemical products. Yet there is no requirement under West Virginia law that chemical manufacturers disclose the ingredients in their products to the well operators and service providers who must ultimately disclose the fracking chemicals to the public.¹⁵⁴ This omission may also obscure the extent of PFAS use in oil and gas wells. In fact, the well site safety plans show that in at least some cases, chemical manufacturers have not disclosed all of their fracking chemicals to well operators who, as a result, are unable to disclose these chemicals publicly.

A congressional investigation shows that the chemical manufacturers' lack of disclosure of oil and gas chemicals goes back at least more than a decade. In 2011, the U.S. House

of Representatives' Committee on Energy and Commerce minority staff issued a report on hydraulic fracturing chemicals in which they asked the 14 leading oil and gas service companies to "disclose the types and volumes of the hydraulic fracturing products they used in their fluids between 2005 and 2009 and the chemical contents of those products."¹⁵⁵ While the committee staff found, among other things, that the companies used products containing 29 chemicals that are known or possible human carcinogens, they also found that the companies could not completely respond to the committee staff's request because of chemical information withheld by chemical manufacturers.¹⁵⁶

As a result of incomplete disclosure by chemical manufacturers, it is likely that well operators and service providers are using at least some fracking chemicals unknowingly and therefore cannot disclose these chemicals publicly. Some of these chemicals could be PFAS.

One situation exists that might make disclosure more likely: where service providers are also chemical manufacturers. Baker Hughes¹⁵⁷ and Halliburton,¹⁵⁸ for example, are service providers that conduct fracking and are also chemical manufacturers. If such companies conducted fracking and supplied their own fracking chemicals, they would know exactly what chemicals they were using and could make full public disclosure if they opted not to assert trade secret claims. However, companies may prefer to shield chemical identities behind trade secret provisions.

h. West Virginia's Chemical Disclosure Rules Cover Only Horizontal Gas Wells

A final shortcoming in West Virginia's chemical disclosure rules is that the rules apply only to horizontal gas wells, even though vertical wells have also often been hydraulically fractured with chemicals¹⁵⁹ and can be injected with chemicals in other stages or methods of extraction, such as the drilling that precedes fracking.¹⁶⁰ Companies that operate vertical wells or horizontal wells that do not meet the definition of "horizontal gas wells" under West Virginia

law would not have to disclose their chemicals, either under requirements specifically focused on fracking chemicals or as part of a well site safety plan.

According to data from the WVDEP, most wells drilled in the state between January 1, 2013 and December 31, 2022 — 2,554, to be precise — were horizontal gas wells for which chemical disclosure requirements applied, compared to only 38 vertical wells and 29 horizontal wells that were not considered "horizontal gas wells."¹⁶¹ Oil and gas operators were not required to disclose chemical usage for these 67 wells — a very small number.¹⁶² However, operators were not required by law to disclose chemical usage for any oil and gas wells in West Virginia before 2011, when fracking chemical disclosure rules and well site safety plan rules went into effect.¹⁶³ That exempts a massively larger number of wells from chemical disclosure: The West Virginia Geological and Economic Survey reported as of June 2009, that 145,000 oil and gas wells had been drilled in West Virginia over the past 150 years.¹⁶⁴ West Virginians could be unknowingly exposed to dangerous chemicals used in those older wells, potentially including long-lasting PFAS chemicals.

CH. 5

EVIDENCE SUGGESTS WIDER PFAS USE THAN REPORTED IN WEST VIRGINIA'S OIL & GAS WELLS

Several sources say that PFAS have a history of use in the oil and gas industry. This little-known evidence increases the concern that at least some of the trade secret chemicals and other undisclosed chemicals in West Virginia's oil and gas wells could be PFAS.

In the 2023 study of PFAS in Pennsylvania's streams referenced in chapter 2, researchers from the U.S. Geological Survey and PADEP recognized oil and gas wells as among "facilities that have been documented as potential sources of PFAS."¹⁶⁵ In making this determination, the authors relied on three sources that suggest that the use of PFAS in oil and gas wells dates back decades and encompasses a variety of extraction techniques. One was a paper published in 2008 in the peer-reviewed *Open Petroleum Engineering Journal* by two authors, one of whom was identified as an employee at DuPont. This paper noted that

while fluorosurfactants have been used in gas and oil exploration for four decades, the increased demand for petroleum and the greater understanding of the benefits of fluorosurfactants have led to growing acceptance for fluorosurfactants throughout the petroleum industry.¹⁶⁶

The authors did not explicitly say that fluorosurfactants used in oil and gas operations were PFAS, but they described the fluorosurfactants in ways that are commonly used to describe PFAS. They wrote that

The use of fluorosurfactants is a recent but growing trend due to (i) the exceptional hydrophobic [water-repellent] and oleophobic [oil-repellent] nature of the perfluoroalkyl and perfluoroalkyl ether groups... The bond strength of the carbon-fluorine bond in perfluoroalkyl and perfluoroalkyl ether groups has been demonstrated as the key to remarkable overall stability for fluorochemicals and fluoropolymers.¹⁶⁷

This evidence suggests that any time an unidentified fluorosurfactant or unidentified surfactant is used in oil and gas production, there exists the potential that it is a PFAS.

The second source was a paper published in 2020 in *Environmental Science: Processes and Impacts* in which the authors showed that since 1956, PFAS including fluorosurfactants had been used or proposed to be used globally in oil and gas extraction techniques; these included chemical-driven gas production, chemical flooding, fracking, and the drilling that precedes fracking and other oil and gas production techniques.¹⁶⁸ The fact that these two papers date the use or potential use of PFAS in oil and gas wells as far back as the 1950s or 1960s indicates that in addition to horizontal oil and gas wells, PFAS may have been used in vertical oil and gas wells. Vertical wells were predominant¹⁶⁹ until the mid-2000s when horizontal wells combined with hydraulic fracturing became "the industry standard" according to EPA.¹⁷⁰

The third source is a 2022 paper published in the peer-reviewed *Advances in Colloid and Interface Science* in which several authors from the Center for Integrative Petroleum Research at King Fahd University of Petroleum & Minerals in Saudi Arabia stated that "The fluorinated surfactants are very attractive to oilfield industries due to their distinct surface/interface properties and excellent thermal/chemical stabilities."¹⁷¹ The authors also cited the 2008 *Open Petroleum Engineering Journal* paper in stating that "Fluorinated surfactants are efficient in numerous enhanced oil recovery (EOR) processes including modification of surface properties of reservoir formation, enhancing the wetting of subterranean, [sic] and increasing foams stability." Like the authors of the 2008 article, the authors of the 2022 paper described fluorosurfactants in ways typically used to describe PFAS including as having "both water and oil repellency" and having a carbon-fluorine bond.¹⁷² However, the authors concluded that "Despite the enormous potential of fluorinated surfactants in the petroleum industry, their usage seems to be limited due to environmental concerns."¹⁷³ The multiple regulatory gaps that allow oil and gas companies to withhold the identities of their chemicals from the public in West Virginia and other states make this statement impossible to verify.

CH. 6

EXPOSURE PATHWAYS TO PFAS ASSOCIATED WITH WEST VIRGINIA OIL AND GAS OPERATIONS

a. Disposal of Waste Intensifies Pollution Concerns in West Virginia

As indicated by EPA and discussed in Chapter 1 of this report, there are multiple pathways through which PFAS and other contaminants associated with oil and gas operations could jeopardize health and the environment. In this chapter we examine some of those pathways, including leaks and spills at well sites and wastewater disposal sites; underground migration of wastes into groundwater from abandoned wells and wastewater disposal sites; spreading of wastewater on roads for dust suppression and deicing; and air pathways.

The risk that PFAS and other chemicals associated with oil and gas drilling could pollute the environment is especially high in West Virginia because of the staggering volumes of wastewater and solid waste generated by oil and gas extraction, particularly for horizontal gas wells. The volumes are so high largely because operating horizontal gas wells involves injecting millions of gallons of fracking fluid, a portion of which returns to the surface in the form of wastewater known as “flowback.” The flow of flowback out of the well can last for several weeks.¹⁷⁴ In 2016, the EPA reported that flowback in the Marcellus and Utica shale formations in West Virginia¹⁷⁵ and other states can total between 300,000 and one million gallons per well over the first 10 days.¹⁷⁶ In addition, following flowback, huge volumes of naturally occurring water from underground formations, known as “produced water,” flow out of the wells, potentially for years.¹⁷⁷ In 2016, EPA reported that five years after a typical well was drilled in the Marcellus shale, it would still be producing wastewater at a rate of hundreds of gallons per day.¹⁷⁸ In total, the wastewater, whether flowback or produced water, can contain a variety of dangerous substances. These may be the chemicals intentionally added to the fracking fluid, such as PFAS; naturally occurring contaminants in underground formations, such as radium, that occurs in significant concentrations in wastewater from West Virginia,¹⁷⁹ or chemicals that are products of reactions that occur in underground formations.¹⁸⁰ Intentionally added drilling fluids used to drill wells prior to fracking, or naturally

occurring water encountered during drilling, may also be part of the wastewater mix, according to EPA.¹⁸¹

These vast quantities of chemical-laden wastewater are sometimes reused to fracture other wells. The majority of oil and gas wastewater, however, is disposed of by being forced into underground injection wells.¹⁸² Whether wastewater is disposed of or reused, it often requires transport by truck,¹⁸³ with the attendant risk of accidents and spills.¹⁸⁴ Over the past decade, scientists and regulators have identified several likely or potential cases of pollution from oil and gas wastewater in West Virginia. These studies raise concerns that if PFAS were present in oil and gas wastewater, it could contaminate water and perhaps other resources. Unfortunately, there is no evidence that wastewater has been tested for PFAS.

- In a paper published in 2016, scientists from the U.S. Geological Survey reported the results of a study of contaminants downstream of an underground injection well in West Virginia into which oil and gas wastewater had been pumped for disposal.¹⁸⁵ Underground injection into disposal wells is the leading method of disposal of oil and gas wastewater.¹⁸⁶ Compared with background measurements upstream of the facility, the researchers found elevated concentrations downstream of contaminants including types of chloride, calcium, sodium, strontium, and barium. These substances are associated with unconventional oil and gas wastewater and with naturally occurring water from the Appalachian basin that includes the Marcellus and Utica shale formations then being drilled for natural gas. Sediments downstream were also high in radium, which is associated with oil and gas wastewater in West Virginia.¹⁸⁷ The researchers noted that while they could not determine the pathways for contamination, “these data provide evidence demonstrating that activities at the disposal facility are impacting a nearby stream and altering the biogeochemistry of nearby ecosystems.”¹⁸⁸

- In another paper published in 2016, scientists shared the results of a study of markers for endocrine

disruptors near another West Virginia underground injection disposal well for oil and gas waste.¹⁸⁹ Endocrine disruptors, which include PFAS,¹⁹⁰ are chemicals that can interfere with the endocrine system.¹⁹¹ The endocrine system comprises hormones that control or regulate various biological processes, for example, blood sugar levels and the functioning of reproductive organs.¹⁹² In comparison to water samples upstream, the scientists found several markers for endocrine-disrupting chemicals adjacent to and downstream from the disposal well. The scientists concluded that “these data raise concerns for human and animal health nearby.”¹⁹³

- In a paper published in 2015, researchers from Duke University, Dartmouth College, and Stanford University reported finding elevated levels of iodide, bromide, and ammonium in samples of wastewater from fracking operations in both the Marcellus shale, located in part in West Virginia, and the Fayetteville Shale, located in Arkansas. The researchers found elevated levels of iodide and ammonium in discharged effluents from oil and gas wastewater treatment sites in Pennsylvania and in wastewater from an oil and gas wastewater spill in West Virginia. The scientists wrote that “Bromide, iodide, and ammonium in surface waters can impact stream ecosystems and promote the formation of toxic brominated-, iodinated-, and nitrogen disinfection byproducts during chlorination at downstream drinking water treatment plants. Our findings indicate that discharge and accidental spills of OGW [oil and gas wastewater] to waterways pose risks to both human health and the environment.”¹⁹⁴

Drilling the wells also generates vast quantities of waste material, in this case solid waste. Horizontal wells involve boring into the earth thousands of feet vertically and thousands of additional feet horizontally.¹⁹⁵ The West Virginia Geological and Economic Survey reported that in 2019 the average combined depth and length of 2,758 horizontal wells reporting production of natural gas or natural gas liquids in the Marcellus shale was 14,131 feet.¹⁹⁶ Drilling these wells produces tons of rock shards known as “drill cuttings”

that could be contaminated with human-made or naturally occurring toxics.¹⁹⁷ These toxics could include PFAS, which may be used in drilling as a foaming agent.¹⁹⁸

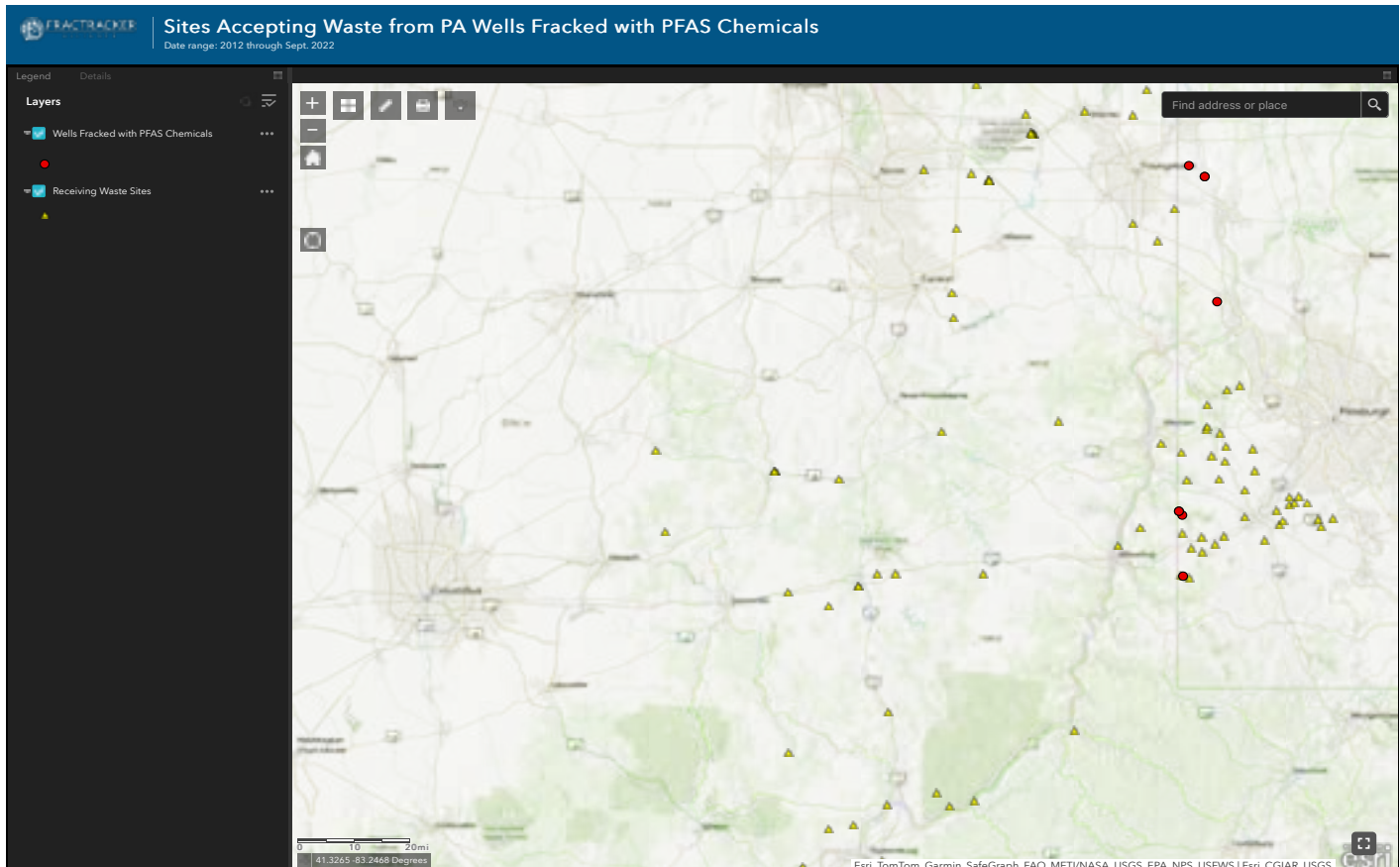
b. Oil and Gas Waste Can Impact Communities Miles from Production Wells

Sites far from oil and gas production wells can also be impacted by oil and gas wastes potentially containing PFAS. In neighboring Pennsylvania, the state tracks where oil and gas wastes from each production well are shipped. The records show that these wastes can be transported miles from well sites, including to disposal sites in West Virginia. Pennsylvania’s records of waste disposal show that the potential for oil and gas waste to contain PFAS is not just hypothetical, according to an analysis of state records in 2022 by Environmental Health News.¹⁹⁹ The publication found that eight unconventional gas wells in Pennsylvania injected with PTFE produced more than 23 million gallons of liquid waste and 30,390 tons of solid waste between 2012 and 2022.²⁰⁰ A map, (see next page) below, developed for the publication by FracTracker Alliance showed that this waste was transported to at least 97 sites for reuse or disposal in Pennsylvania, Ohio, and West Virginia.²⁰¹

West Virginia disposal sites include the towns of:

- Colliers, where J.P. Mascaro & Sons Brooke County Landfill received more than 281 tons of drill cuttings combined from the Bernard McCulley Was 5H well²⁰² and Paul Schilinski Was 8H well,²⁰³ both fracked in Washington County, PA.
- New Martinsville, where Wetzel County Landfill received more than 70 tons of fracking fluid waste combined from the Fred Jones Was 6H well,²⁰⁴ fracked in Washington County, PA. and the Roberts Bea 6H well,²⁰⁵ fracked in Beaver County, PA.
- Parkersburg, where the Northwestern Landfill operated by Waste Management received more than 70 tons of drill cuttings from the Paul Schilinski Was 8H well,²⁰⁶ fracked in Washington County, PA.

Figure 5: Sites Accepting Waste from PA Wells Fracked with PFAS Chemicals



This map, developed by FracTracker Alliance for Environmental Health News, shows destinations for liquid and solid waste from eight Pennsylvania oil and gas wells where companies reported using PTFE/Teflon for fracking between 2012 and 2022. Reprinted with permission. An interactive map of these sites is available here: <https://www.ehn.org/fracking-pennsylvania-pfas-2658837888.html>.

- St. Mary's, where the Eureka Station Crosstex Energy centralized treatment plant for recycling received more than 150,000 gallons of produced fluids and other oil and gas wastes from the Bernard McCulley Was 5H well,²⁰⁷ Fred Jones Was 6H well,²⁰⁸ and the Paul Schilinski Was 8H well,²⁰⁹ all fracked in Washington County, PA.
- Wheeling, where Short Creek Landfill operated by American Disposal Services received almost 3,500 tons of drill cuttings from the Bernard McCulley Was 5H well,²¹⁰ Fred Jones Was 6H well,²¹¹ and Paul Schilinski Was 8H well,²¹² all fracked in Washington County, PA.

One or more well pads in West Virginia received for reuse, likely in a production well, a combined total of more than 4.5 million gallons of produced fluids and other oil and gas wastes from the Bernard McCulley Was 5H well,²¹³ Fred Jones Was 6H well,²¹⁴ and the Paul Schilinski Was 8H well,²¹⁵ all fracked in Washington County, PA.*

Considering the vast use in Pennsylvania's oil and gas wells of undisclosed chemicals (identified by PSR in 2023²¹⁶), there is a potential that the waste from any oil or gas well in Pennsylvania contains PFAS and that communities near oil and gas waste disposal sites in West Virginia that accept

* The volume of drill cuttings or fluid disposed of in West Virginia from Pennsylvania's unconventional gas wells injected with PFAS are as of March 2023.

this waste could be at risk of contamination.²¹⁷ Figure 6 is a map from FracTracker Alliance showing the locations of the facilities in West Virginia that received oil and gas waste from Pennsylvania in 2022. Users can click on a link below the map to view an interactive version that enables users to zoom in on their communities.

Robert Delaney, a retired geologist and Superfund specialist previously with for the Michigan Department of Environmental Quality (now called the Michigan Department of Environment, Great Lakes, and Energy), spoke to Environmental Health News about the shipments of waste from Pennsylvania gas wells that had been fracked with PTFE. He said that “If there were PFAS in any of those waste products, it’s likely that it would have gotten into the environment in some of those locations.”²¹⁸ Delaney spent 36 years working in natural resource protection for the state of

Michigan and first warned state officials about the looming problem with PFAS in 2012, though unrelated to oil and gas extraction.²¹⁹ Delaney told Environmental Health News,

The odds are that just as there were spills at the well pads, there have been spills and leaks at these disposal sites. All these places that accepted the waste didn’t know that they were dealing with PFAS. And the things you do to treat other chemicals doesn’t work on them... these chemicals never go away.²²⁰

When Environmental Health News first asked the Pennsylvania Department of Environmental Protection (PADEP) to comment on the use of PFAS in oil and gas operations in Pennsylvania, the Department responded that “absent a spill or release on the surface or below surface, there is no reason to conclude that wellsite fluids (whether

Figure 6. Facilities Accepting Pennsylvania Oil and Gas Waste in 2022



This map, developed by FracTracker Alliance for Environmental Health News, showing destinations for liquid and solid waste from eight Pennsylvania oil and gas wells where companies reported using PTFE/Teflon for fracking between 2012 and 2022. Reprinted with permission. An interactive map of these sites is available here: <https://www.ehn.org/fracking-pennsylvania-pfas-2658837888.html>.

including PFAS compounds or not) would have reached nearby soils or drinking water.”²²¹ EHN then found evidence that there were two spills at one of the wells in 2017 and 2020, and informed the PADEP.²²² In response, PADEP spokesperson James Thrasher told the publication,

Given the time period between the use of the PFAS chemicals and the releases, the small amount of the spills, that the spills were contained to the gravel of the well pad, and that they were remediated quickly, DEP does not have current plans to sample for PFAS at this location.²²³

In his comments to EHN, Thrasher suggested that the produced water was unlikely to contain chemicals that were used in fracking.²²⁴ Delaney, however, suggested to EHN that Pennsylvania officials should at least test for PTFE near the well sites where the chemical was used and consider testing at the locations where waste from these wells was disposed of.²²⁵ Given that PFAS have earned the moniker “forever chemicals” due to their persistence in the environment, Delaney’s advice may also apply to disposal sites in West Virginia.

c. Abandoned Wells Put Drinking Water at Risk

Due to the state’s long history of oil and gas drilling, dating back to 1859,²²⁶ West Virginia is riddled with thousands of abandoned oil and gas wells that could serve as pollution pathways for PFAS or other toxics associated with oil and gas extraction or waste disposal.²²⁷ Researchers have known for decades that oil and gas wells which have ceased operating but have not been properly sealed off from the surrounding underground rock formations can be conduits for oil and gas-related water pollution.²²⁸ Fluids associated with oil and gas wells can migrate up these abandoned wells and contaminate groundwater near the earth’s surface²²⁹ or, potentially, surface water.²³⁰ Such fluids could include fracking fluid injected into adjacent oil and gas production wells,²³¹ or oil and gas wastewater injected into adjacent disposal wells.²³²

Evidence of pollution risks associated with abandoned oil and gas wells dates at least to the 1980s and involves a

fracking operation in West Virginia. In 1987, EPA concluded in a report to Congress on oil and gas wastes that fracking fluid from a gas production well had contaminated a water well in Jackson County owned by a man named James Parsons.²³³ “When fracturing the Kaiser gas well on Mr. James Parson’s property, fractures were created allowing migration of fracture fluid from the gas well to Mr. Parson’s water well,” the agency wrote. “This fracture fluid, along with natural gas was present in Mr. Parson’s water, rendering it unusable.”²³⁴ While EPA did not discuss the precise pathway for contaminants from the gas production well to the water well, the nonprofit Environmental Working Group reported in a 2011 paper that there were four abandoned gas wells on Parson’s property that could have served as vertical conduits for the fracking fluid.²³⁵

In a more contemporary case, in 2022, the Pittsburgh Post-Gazette reported that a man in New Freeport, PA recounted having witnessed “a geyser” of water erupting from the location of an abandoned well on his property. He learned that a Pennsylvania-based oil and gas company, EQT Corp., was simultaneously fracking a horizontal well more than a mile away. The next day, EQT notified the Pennsylvania Department of Environmental Protection (PADEP) about a well communication issue; the term refers to a situation in which one well interacts with another. The company, however, told the Post-Gazette that it did not know if its fracking had caused the geyser. Several neighbors were quoted as saying that they thought the apparent well communication also impacted their water; one said her son took a shower on the day of the incident and later broke out in hives.

If this was a case of well communication, it was not an isolated incident. Over the previous six years, oil and gas companies had reported to the PADEP 45 suspected cases of well communication. Most were discovered by operators of active shale gas wells adjacent to other active shale gas wells that were the apparent source of the communication. The operators noticed changes in pressure or other impacts in their own wells. In contrast, it is less likely that anyone would be monitoring abandoned wells to identify a communication

incident.²³⁶ Thus, communication with abandoned wells may be more common than reports reflect. The result could be water or soil contamination entirely unknown to the public, whether from PFAS or other toxics.

Compounding these problems is that in West Virginia, horizontal gas wells can be located as close as 250 feet from a water well, and the center of a well pad can be as close as 625 feet from an occupied home. Vertical oil and gas wells can be as close as 200 feet from a water well or a home.²³⁷ Given this potential for proximity, toxic fluids from a well – abandoned or in active production – could pollute well water or soil at a residence. And airborne pollutants can easily travel such a short distance. In 2021, a criminal grand jury convened by Pennsylvania's Attorney General recommended a setback or no-drilling zone of 2,500 feet (about a half-mile) from homes and 5,000 feet from schools and hospitals.²³⁸ These distances would be somewhat protective but perhaps not protective enough: In 2012, a New York office of the U.S. Geological Survey warned that if the type of shale gas fracking practiced in West Virginia were allowed in New York, fracking could jeopardize water supplies within an area of up to five square miles.²³⁹ Water protection would then require no-drilling setbacks closer to 2.23 miles, not 2,500 feet.

The risk of pollution through abandoned oil and gas wells is multiplied by the presence of injection disposal wells, where liquid wastes from oil and gas wells are injected underground as a means of disposal – a common practice in the oil and gas industry.²⁴⁰ In 1983, the then-existent Congressional Office of Technology Assessment reported on the “insidious” problem of underground injection of oil and gas wastewater. The congressional office had noted that such wastewater is typically injected in exactly the places where prior drilling has created opportunities for the wastewater to migrate through abandoned or closed wells into groundwater.²⁴¹ In 1989, Congress’ investigative arm, the General Accounting Office (now the Government Accountability Office) reported on almost two dozen incidents of drinking water contamination associated with wastewater disposal wells.²⁴² Many of these cases involved wastewater migrating up abandoned oil and gas wells.²⁴³ It

is not known how much injected wastewater might contain PFAS.

Migration into water supplies of oil and gas wastewater injected into disposal wells may be even more likely in West Virginia because disposal wells in the state are poorly regulated, according to a report published by the nonprofit Natural Resources Defense Council (NRDC) in 2019.²⁴⁴ NRDC reviewed records for 19 injection wells specifically designated for the disposal of oil and gas wastewater²⁴⁵ listed in 2015 in a database maintained by the WVDEP.²⁴⁶ NRDC found multiple deficiencies, including that state regulators failed for 13 of the 19 injection wells to conduct mechanical integrity tests every five years as required by state law. Mechanical integrity tests are designed to detect leaks in the wells and the potential that wastewater could migrate upward into underground sources of drinking water through an adjacent vertical conduit such as a nearby abandoned well.²⁴⁷

These deficiencies are particularly worrisome in light of recent experiences in Ohio, where injection disposal wells are common. In January 2021, in Noble County, Ohio, more than 1.6 million gallons of what appeared to be fracking wastewater flowed for four days from an unplugged oil and gas well that had been idle since 2012.²⁴⁸ A nearby tributary, Taylor Fork, was impacted by the spill, resulting in a fish kill. The cause of the fluid flow was unclear, but there were six active fracking wastewater injection wells in Noble County, including three within four miles of the leaking oil and gas well. Another example occurred in September 2020 in Washington County, Ohio, when fracking wastewater migrated at least five miles from a disposal well to gas-producing wells, causing state officials to worry about possible groundwater contamination.²⁴⁹ In 2023, the Ohio Department of Environmental Protection suspended injections at six oil and gas wastewater injection wells after concluding that wastewater from the wells had migrated up nearby oil and gas production wells. These injection wells included two in Noble County in January,²⁵⁰ one in Athens County in May,²⁵¹ and three in Athens County in June.²⁵² **In each case, the Department concluded among other things that if the wells continued to operate, “additional impacts may occur in the future**

and are likely to contaminate the land, surface waters, or subsurface waters....”²⁵³

d. Spreading Oil and Gas Wastewater on Roads

Another pathway through which PFAS used in oil and gas wells could jeopardize West Virginians’ health is through the practice of spreading oil and gas wastewater on roads for deicing or dust suppression.²⁵⁴ West Virginia allows the practice only for “the wintertime application of natural gas well brines in order to minimize the formation of bonded snow and ice to roadway surfaces by utilizing the melting capabilities of salt brine.”²⁵⁵ The state places further limitations on this use of brines, including that the brines can come only from vertical wells and that concentrations of 12 types of chemicals in the brines must be below certain levels.²⁵⁶

However, West Virginia’s limitations on spreading oil and gas wastewater on roads are insufficient to protect the public. There are no limits on PFAS in the wastewater that can be spread on roads, and no guarantee that the wastewater from vertical wells would lack PFAS. Nor are there limits on radium, a radioactive and carcinogenic element that has been found in the type of brine used for road-spreading in the northeastern U.S. In 2018, scientists wrote in a peer-reviewed paper that

analyses of O&G [oil and gas] wastewaters spread on roads in the northeastern, (sic) U.S. show that these wastewaters have salt, radioactivity, and organic contaminant concentrations often many times above drinking water standards....The potential toxicity of these wastewaters is a concern as lab experiments demonstrated that nearly all of the metals from these wastewaters leach from roads after rain events, likely reaching ground and surface water... Spreading O&G wastewater on roads can harm aquatic life and pose health risks to humans.²⁵⁷

There is no indication that the scientists tested for PFAS, but if there were PFAS in the wastewater used for road-

spreading, it seems likely that PFAS, which is highly mobile in water, could likewise run off of roads and pose health and environmental risks.

e. Leachate from Landfills

West Virginians could also be impacted by PFAS when solid waste from oil and gas operations is taken to landfills, if the waste were tainted with “forever” chemicals from oil and gas wells. As noted above, waste from eight Pennsylvania unconventional gas wells known to have been injected with PFAS was taken to landfills in West Virginia. When rainwater percolates through the contents of the landfill and comes in contact with buried wastes, it leaches out their chemicals or constituents, creating a wastewater known as “leachate.”²⁵⁸ Should rainwater contact oil and gas waste tainted with PFAS and leach out the forever chemicals, that leachate could cause contamination if it escaped or was collected and disposed of improperly.

One possible example of improper disposal comes from Fayette County, Pennsylvania, where in 2019 local prosecutors asked the Pennsylvania Attorney General’s office to investigate after leachate from a landfill that had accepted oil and gas drill cuttings was taken to a wastewater treatment plant. That wastewater was apparently responsible for the plant’s discharge of treated water that exceeded state and federal pollution standards. The plant discharged into the Monongahela River, a major source of drinking water for Western Pennsylvania.²⁵⁹ It is unknown whether PFAS was involved.

A case that did involve PFAS allegations that leachate from a landfill in Pennsylvania had contaminated a creek near York with PFAS. In 2023, Lower Susquehanna Riverkeeper Ted Evgeniadis sued Modern Landfill and its owner Republic Services, asking a federal judge to force the company to comply with the Clean Water Act and institute penalties for alleged violations.²⁶⁰ Evgeniadis asserted in a written complaint that the landfill was discharging extremely high levels of PFAS into a local creek in violation of the law: discharges with levels of PFOS at 374.3 parts per trillion, levels of PFOA at

847 parts per trillion, “and 25 other PFAS compounds also measured at very high levels.”²⁶¹ The source of the PFAS in the landfill was unspecified. PADEP records show that in April 2019, Modern Landfill received three tons of produced fluid from unconventional gas wells,²⁶² but it is unclear that this volume of fluid was accurate because records of oil and gas waste shipments and deliveries in Pennsylvania are often inconsistent.²⁶³ Nor is it clear whether gas-related waste contributed to the high PFAS levels near the landfill. In 2015, at the direction of the West Virginia legislature, a team of researchers led by Marshall University studied the disposal in municipal landfills of drilling waste such as rock fragments unearthed during the drilling process. The researchers did not analyze similar disposal of fracking waste.²⁶⁴ The authors found “little concern with regards to the leachate from drill cuttings that were placed in approved and permitted landfills, once that leachate was processed through a correctly operated treatment facility.”²⁶⁵ However, there is no indication that the researchers tested any landfill materials or leachate for PFAS.

f. Volatilizing, Flaring Could Pollute Air with PFAS

PFAS used in West Virginia’s oil and gas wells could follow airborne exposure routes, according to toxicologist David Brown, former director of environmental epidemiology at the Connecticut Department of Health. Brown has investigated health effects associated with unconventional gas drilling for the Southwest Pennsylvania Environmental Health Project and has expressed concerns about PFAS. He told PSR that if PFAS were to enter drinking water, it could subsequently volatilize or become airborne inside homes. Brown added that PFAS could become airborne outdoors when gas is burned off during flaring or venting at the oil and gas wellhead.²⁶⁶

Bolstering Brown’s concern, both the EPA and the Interstate Technology Regulatory Council say that PFAS can be spread through air, though neither source mentions pathways from oil and gas operations, perhaps because such pathways have only recently come to the public’s attention. On a



Drill cuttings from shale gas development being dumped at the Wetzel County (W.Va.) Landfill, Nov. 10, 2014. Photo credit: Bill Hughes.

webpage devoted to “PFAS Analytical Methods Development and Sampling Research, EPA includes a heading entitled “Source (Air) Emissions” and states that

There are diverse sources of emissions, including chemical manufacturers, commercial applications, and thermal treatment incineration processes. EPA is developing test methods for measuring PFAS source emissions.²⁶⁷

The Interstate Technology Regulatory Council (ITRC), a state-led environmental coalition that includes members from state, federal, tribal, and international agencies as well as representatives from academia, the private sector and the general public,²⁶⁸ reported that “Under certain conditions, particularly within industrial stack emissions, or during fire suppression, incineration, or combustion, PFAS can be transported through the atmosphere.”²⁶⁹ The ITRC added that deposition of PFAS could result in pollution of soil, groundwater, or other media:

Short-range atmospheric transport and deposition can result in PFAS contamination in terrestrial and aquatic systems near points of significant emissions, impacting soil, groundwater, and other media of concern (citation omitted). Evidence of releases has been observed in areas where hydrologic transport could not plausibly explain the presence of PFAS in groundwater, with the extent of contamination reaching several miles from sources and in distribution patterns independent of regional hydrology (citations omitted).²⁷⁰

Where PFAS are used in oil and gas wells, this information indicates that nearby residents should be concerned about airborne emissions.



The overlook at Grandview, W.Va. New River Gorge National Park and Preserve, July 30, 2023. Photo credit: daveynin.



OIL & GAS-RELATED CHEMICAL EXPOSURE AS AN ENVIRONMENTAL JUSTICE ISSUE

“Fenceline” communities – people living close to oil and gas operations – often bear a disproportionate risk of exposure to toxic chemicals. This may place them particularly at risk from PFAS where it is used in oil and gas extraction.

Although drilling and fracking take place in the majority of U.S. states, not everyone shares in the risks equally. Rather, oil and gas infrastructure and associated chemicals are frequently located in or adjacent to lower-income, underserved, and marginalized communities. Evidence suggests that this disproportionality is the case in West Virginia, which has the third-highest poverty rate of the 50 states, according to a review of Census data by the West Virginia Center on Budget & Policy.²⁷¹ Clark University researchers conducted an analysis published in 2015 in which they used sophisticated Geographic Information Systems (GIS) tools to examine whether vulnerable populations were disproportionately exposed to pollution from unconventional gas wells in West Virginia, Ohio, and Pennsylvania. The researchers found clusters of vulnerable populations concentrated near unconventional gas wells in all three states, with West Virginia’s disproportionately affected populations characterized by higher percentages of poverty, elderly population, and lower education level.²⁷² Where a pattern of risks affects lower-income people and/or people of color disproportionately, oil and gas production methods should be viewed and addressed as an issue of Environmental Justice. So too should any oil and gas related exposure to PFAS. Extra steps should be taken to inform the affected communities, hear their concerns, and work with them to remediate the problems.

CH. 8

POLICY CAN HELP PROTECT WEST VIRGINIANS FROM PFAS IN FRACKING

a. Federal Protections from PFAS Pollution are Modest

Governments at all levels will have to do more to protect West Virginians from PFAS, in large part because EPA has taken only modest steps to do so, while Congress and the executive branch have exempted the oil and gas industry from major provisions of multiple federal environmental laws. For example, oil and gas waste is exempted from the hazardous waste rules that require cradle-to-grave tracking and safe handling of hazardous substances under the Resource Conservation and Recovery Act. These exemptions increase the burden on state governments to address any PFAS pollution associated with oil and gas extraction.²⁷³

EPA has taken some steps to protect the public from dangerous PFAS. In 2005, EPA reached a then-record \$16.5 million settlement with chemical manufacturer Dupont after accusing the company of violating the federal Toxic Substances Control Act (TSCA) by failing to disclose information about PFOA's toxicity and presence in the environment.²⁷⁴ In 2006, EPA invited Dupont, 3M and six other companies to join a "stewardship" program in which the companies promised to achieve a 95 percent reduction of emissions of PFOA and related chemicals by 2010, compared to a year 2000 baseline. The agreement also required the companies to eliminate such emissions and use of these chemicals by 2015.²⁷⁵ In 2022, EPA said on its website that the companies reported that they had accomplished those goals, either by exiting the PFAS industry or by transitioning to alternative chemicals.²⁷⁶ EPA reported in 2022 that the manufacture and use of at least one PFAS – PFOA – had been phased out in the U.S., and that no chemical company had reported making PFOS in the U.S. since 2002. EPA noted that existing stocks of PFOA might still be used, and imported products may contain some PFOA.²⁷⁷ A 2020 scientific article reported that PFOA was still used in Asia.²⁷⁸ EPA stated that limited ongoing uses of PFOS remain.²⁷⁹ However, since the announcement of its PFAS stewardship program in 2006, EPA has allowed nearly unlimited use of closely related "replacement" chemicals in dozens of industries.²⁸⁰ In response, in 2015 a group of

more than 200 scientists raised health and environmental concerns that the new PFAS designed to replace PFOA and PFOS may not be safer for health or the environment.²⁸¹

In October 2021, EPA announced a "strategic roadmap" for regulating PFAS. This plan encompassed a goal of setting federal drinking water standards for several PFAS chemicals by 2023, as well as commitments to "use all available regulatory and permitting authorities to limit emissions and discharges from industrial facilities" and "hold polluters accountable."²⁸² The plan does not, however, include an examination of PFAS use in the oil and gas industry. (Later that month, 15 members of the U.S. House of Representatives asked EPA to examine this topic.²⁸³ The month before, PSR had asked EPA to collect data on PFAS use in oil and gas extraction, utilizing its authority under TSCA.²⁸⁴)

As previously stated, in June 2022, EPA announced new health advisory levels for several types of PFAS and in March 2023, EPA announced a plan to regulate six types of PFAS in drinking water. Additionally, in August 2022, EPA proposed designating PFOA and PFOS as hazardous under Superfund.²⁸⁵ And in April 2023, EPA asked for public comment on potentially designating seven additional PFAS as hazardous under Superfund.²⁸⁶ This designation would enable affected parties to more easily hold oil and gas companies accountable for cleanup costs if PFOA and PFOS were found at oil and gas sites because under Superfund, liability does not require negligence, and any potentially responsible party (PRP) can be held liable for cleanup of an entire site when it is difficult to distinguish contributions to pollution among several parties. As EPA writes about Superfund, "[i]f a PRP sent some amount of the hazardous waste found at the site, that party is liable."²⁸⁷

In acting belatedly to regulate at least some types of PFAS in drinking water, EPA is following behind the leadership taken by several states. As of 2023, nine states, but not West Virginia, had developed enforceable standards for concentrations of several types of PFAS in drinking water.²⁸⁸

b. West Virginia's Disclosure Rules: In Need of Sweeping Reform

In West Virginia, multiple reforms are needed to protect the public from the use of PFAS in oil and gas operations. One needed reform is to change the state's chemical disclosure rules to lift the veil of secrecy that oil and gas companies have used to conceal the use of potentially dangerous chemicals, possibly including PFAS. One initial step should be to establish tighter limits on the use of trade secret provisions.

Oil and gas companies have argued that chemical trade secrets are necessary to protect their intellectual property from competitors. However, this interest does not have to mean a complete withholding of information on chemical identities from scientists, regulators, and the public. In 2015, California, a major oil-producing state,²⁸⁹ began requiring full disclosure of chemicals used for well stimulation, including fracking. The policy did away with trade secret exemptions for the individual chemicals used in fracking products.²⁹⁰ In June 2022, Colorado, a major producer of oil and gas,²⁹¹ followed in California's footsteps but extended the disclosure requirements to all chemicals used in oil and gas wells, not just fracking or stimulation chemicals.²⁹²

The methodology utilized in California and Colorado is consistent with a recommendation issued in 2014 by an advisory panel to the U.S. Department of Energy: that companies reveal the fracking chemicals injected into each well, providing that information in a list in which the chemicals are disassociated from the trade name of the commercial products they are part of.²⁹³ This form of disclosure enables the public to know all the chemicals used in fracking without disclosing to rival chemical manufacturers the exact components of proprietary formulas.²⁹⁴ In a similar way, food producers keep recipes secret while disclosing individual ingredients, enabling the public to know the contents of food products but making it difficult for rival producers to recreate valuable food brands.

California and other states have additional provisions in their oil and gas chemical disclosure rules that could be models

for West Virginia. California has a process under which state regulators review secrecy requests from chemical companies to determine whether the information must be kept proprietary.²⁹⁵ Health and safety data related to fracking fluids are not allowed to be hidden from public view under California law.²⁹⁶ Colorado, in its June 2022 legislation, required chemical disclosure from chemical manufacturers.²⁹⁷ This last reform would address many of the gaps seen in the Safety Data Sheets created by chemical manufacturers that West Virginia horizontal gas well operators are required to disclose as part of well site safety plans.

These reasonable and feasible reforms are valuable steps to protect the health of people who may be exposed to PFAS and other dangerous oil and gas chemicals, be they industry workers, residents living near well sites, or first responders called to the scene of an accident. They can improve health and potentially save lives.

Additional steps to reduce the harms caused by oil and gas extraction are outlined in the recommendations section of this report. They include a ban on the use of PFAS in oil and gas operations, an action that Colorado took in 2022.²⁹⁸ Among the evidence supporting the feasibility of this measure is a peer-reviewed scientific analysis published in 2021 showing that many PFAS are immediately replaceable with less-persistent and less-toxic substances, including for use in the oil and gas industry.²⁹⁹

c. West Virginia's Hazardous Waste Rules Also in Need of Reform

West Virginia's state government has recognized the dangers of PFAS but, in doing so, has illuminated another gap in state rules that should be closed to protect the public from PFAS use in oil and gas operations: the exemption of oil and gas wastes from hazardous waste requirements. Subtitle C of the Resource Conservation and Recovery Act (RCRA) is our nation's law that requires safe management of hazardous waste from "cradle-to-grave."³⁰⁰ Yet under both the federal RCRA³⁰¹ and West Virginia's implementation of the federal

law in the Hazardous Waste Management Act,³⁰² oil and gas wastes are exempt from hazardous waste requirements.

This exemption allows drilling companies to take solid oil and gas waste that might be hazardous to municipal landfills that do not accept materials designated as hazardous.³⁰³ Similarly, the exemption allows oil and gas companies to inject their liquid waste underground for disposal into Class II wells designated for oil and gas waste. Class II wells have lower standards of environmental protection than Class I wells that are designated for hazardous waste. For example, operators of Class II wells can analyze an area as small as that within a quarter-mile radius of the well to ensure that there are no adjacent wells that could be conduits allowing the oil and gas waste to migrate to the surface.³⁰⁴ For Class I hazardous waste injection wells, this area of review is at least two miles.³⁰⁵

West Virginia could act to regulate oil and gas waste as hazardous by following the example of New York State, which in 2020 enacted legislation to designate oil and gas waste as hazardous.³⁰⁶ State Senator Rachel May, one of the bill's sponsors, said in a statement,

Wastewater from fracking can contain carcinogenic compounds and naturally occurring radioactive materials. The regulatory loophole that allowed waste from fracking and crude oil processing to be treated as standard industrial waste means it enters local sewage treatment facilities, sometimes with radiation levels hundreds of times the safe limit, it then flows directly back into our waterways – the source of drinking water for thousands of New Yorkers.³⁰⁷

May issued her statement before it was widely known that PFAS was used in oil and gas operations, but considering the oil and gas industry's now-documented record of using PFAS, the statement could apply to oil and gas wastes in West Virginia or other states. Continuing to exempt oil and gas wastes from hazardous waste treatment means that where PFAS is present in these wastes, it could enter waterways and the public drinking water system, with potentially serious consequences for West Virginians.

CH. 9

RECOMMENDATIONS

In light of the findings shared in this report, PSR recommends the following:

- **Halt PFAS use in oil and gas extraction.** West Virginia and the U.S. Environmental Protection Agency (EPA) should prohibit PFAS from being used, manufactured or imported for oil and gas extraction. Many PFAS are replaceable with less-persistent and less-toxic alternatives. In taking this step, West Virginia would be following the lead of Colorado, a major oil- and gas-producing state that in June 2022 passed legislation banning the use of PFAS in oil and gas wells.
- **Expand public disclosure.** West Virginia should greatly expand its requirements for public disclosure of oil and gas chemicals. The state could again follow the example offered by Colorado by requiring disclosure of all individual chemicals used in oil and gas wells, without exceptions for trade secrets. This action can be taken while still protecting product formulas as trade secrets. West Virginia should also require chemical disclosure prior to permitting for all oil and gas wells, as do California and Wyoming, and should require disclosure on the part of chemical manufacturers, as does Colorado. This provision would be critical to enable the WVDEP to identify and address sources of PFAS using the PFAS Protection Act. Finally, West Virginia should expand the disclosure requirements in the PFAS Protection Act to cover oil and gas production and waste disposal facilities to the extent that they are not already covered.
- **Increase testing and tracking.** West Virginia and/or the U.S. EPA should determine where PFAS have been used in oil and gas operations in the state and where related wastes have been deposited. They should test nearby residents, water, soil, flora, and fauna for PFAS, both for the particular type(s) of PFAS used and for organic fluorine to detect the presence of other PFAS and/or their breakdown products. They should use testing equipment sensitive enough to detect PFAS at concentrations below proposed or adopted maximum contaminant levels and/or other relevant regulatory guidelines or recommended limits. Such testing and tracking should be made a part of the WVDEP's action plans under the PFAS Protection Act
- for water sources near oil and gas production or waste disposal sites.
- **Require funding and cleanup.** Oil and gas companies and the firms that manufacture oil and gas chemicals should be required to fund environmental testing for PFAS in their areas of operation and, should PFAS be found, be required to fund cleanup. If cleanup of water sources is impossible, companies responsible for the use of PFAS should pay for alternative sources of water for homes, schools, hospitals, agriculture and other uses for as long as needed.
- **Remove West Virginia's oil and gas hazardous waste exemption.** West Virginia exempts oil and gas industry wastes from state hazardous waste rules. West Virginia should follow New York's lead and remove its state-level hazardous waste exemption for the oil and gas industry.
- **Reform West Virginia's regulations for oil and gas production wells and underground injection disposal wells.** The state should prohibit production wells and underground wastewater disposal wells in buffer zones near underground sources of drinking water, homes, health care facilities and schools. The size of the zones should be determined by scientific evidence specific to West Virginia. The state should also require groundwater monitoring for contaminants near the wells, and for disposal wells, require full public disclosure of chemicals in the wastewater.
- **Transition to renewable energy and better regulation.** Given the use of highly toxic chemicals in oil and gas extraction, including but not limited to PFAS, as well as climate impacts of oil and gas extraction and use, West Virginia should transition away from fracking and move toward renewable energy and efficiency while providing economic support for displaced oil and gas workers. As long as drilling and fracking continue, the state should better regulate these practices so that West Virginians are not exposed to toxic substances and should empower local governments also to regulate the industry. **When doubt exists as to the existence or danger of contamination, the rule of thumb should be, "First, do no harm."**



APPENDIX

Data Sources for PFAS Used in West Virginia's Oil and Gas Wells

To identify where and in what quantities PFAS and trade secret fracking chemicals were used at horizontal gas wells in West Virginia, PSR analyzed well-by-well reports of fracking chemicals recorded in FracFocus, a database³⁰⁸ maintained by the Groundwater Protection Council,³⁰⁹ a nonprofit comprised of regulators from state agencies. The dates of these records extend from January 1, 2013 to September 29, 2022. PSR consulted the open-source version of FracFocus, Open-FF,³¹⁰ which is more accurate and informative than the original version of FracFocus.³¹¹ To determine the weights of the fracking chemicals injected into horizontal gas wells, we used the methodology detailed in endnote 122.

Under West Virginia law, well operators must disclose the fracking chemicals used in horizontal gas wells to the FracFocus database.³¹² Disclosure must occur within 90 days after completing the permitted work on a well.³¹³ Based on West Virginia's rules³¹⁴ and disclosure forms available on FracFocus' website, operators must list, among other things, each individual chemical injected into the well and each chemical's CAS number, if available.³¹⁵ There are, however, significant exceptions to disclosure requirements under West Virginia's rules, including an exception for chemicals designated a trade secret³¹⁶ that are discussed in Chapter 4 and Chapter 8.



ENDNOTES

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- ² U.S. Environmental Protection Agency. Our Current Understanding of the Human Health and Environmental Risks of PFAS. Accessed Oct. 4, 2023, at <https://www.epa.gov/pfas/our-current-understanding-human-health-and-environmental-risks-pfas>.
- ³ Toxic Synthetic “Forever Chemicals” are in Our Water and on Our Plates. NOVA (PBS) (Nov. 2, 2020). Accessed Oct. 4, 2023, at <https://www.pbs.org/wgbh/nova/article/pfas-synthetic-chemicals-water-toxic/>.
- ⁴ U.S. Environmental Protection Agency. Research on Per- and Polyfluoroalkyl Substances (PFAS) (last updated Nov. 10, 2021). Accessed Oct. 4, 2023, at <https://www.epa.gov/chemical-research/research-and-polyfluoroalkyl-substances-pfas>. David Andrews and Bill Walker. Environmental Working Group. Poisoned Legacy (April 2015), at 6. Accessed Oct. 4, 2023, at <https://www.ewg.org/research/poisoned-legacy>. Andrew B. Lindstrom et al. Polyfluorinated Compounds: Past, Present, and Future. Environmental Science & Technology (2011), 45, 7954-7961, 7954. Accessed Oct. 4, 2023, at <https://pubs.acs.org/doi/pdf/10.1021/es2011622>.
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¹¹¹ W. Va. Code § 22-6A-4(6).

¹¹² W. Va. Code § 22-6A-7(e)(5).

¹¹³ W. Va. Code § 22-6A-7(e)(5), W. Va. Code R. § 35-8-10.1.a., and W. Va. Code R. § 35-8-10.1.b.

¹¹⁴ W. Va. Code R. § 35-8-10.1.a, and W. Va. Code R. § 35-8-10.1.b.

¹¹⁵ W. Va. Code § 22-6A-7(e)(5), W. Va. Code R. § 35-8-10.1.a., and W. Va. Code R. § 35-8-10.1.b.

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¹¹⁸ W. Va. Code § 22-6A-7(e)(5).

¹¹⁹ 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 3-18. EPA Report# 600/R-16/236F. Accessed Oct. 12, 2023, at <https://www.epa.gov/hfstudy>.

¹²⁰ W. Va. Code R. § 35-8-10.1.a.

¹²¹ Gary Allison (2021) Open-FF: Transforming the FracFocus Disclosure Data into a Usable Resource [Source Code]. Accessed Oct. 26, 2022, at <https://doi.org/10.24433/CO.1058811.v15>. PSR accessed Open-FF data set downloaded from FracFocus on Sept. 29, 2022.

¹²² PSR calculated the amounts of trade secret chemicals used in each well in West Virginia and the combined weight of these chemicals primarily by using disclosures by well operators for each well listed in FracFocus. We then aggregated the amounts for each well to calculate county-by-county and state-wide totals. To illustrate the methodology, we will use as an example the figures from XTO Energy/ExxonMobil's well number 35-019-26303 fractured in Carter County, Oklahoma in 2019. We estimated the total mass of the hydraulic fracturing fluid used in each well in pounds by multiplying the gallons of water listed as being used as the base fluid for the fracturing fluid (223,650 in this case) by 8.33, the number of pounds in a gallon of water as listed in a table of the weights of various solvents published by the U.S. Environmental Protection Agency. See U.S. Environmental Protection Agency. Conversion from Gallons to Pounds of Common Solvents. Accessed Jan. 12, 2022, at <https://>

www.epa.gov/p2/pollution-prevention-tools-and-calculators. That quantity of water in the XTO Energy/ExxonMobil example weighs approximately 1,863,005 pounds. We then calculated the total mass of the fracturing fluid by multiplying the mass of the water in pounds by 100 and dividing that product by the listed maximum percent concentration of water in the fracturing fluid (78.31797). FracFocus lists only maximum concentrations of components of the fracturing fluid; there is no minimum-maximum range. The estimated total maximum mass of the fracturing fluid in the example is 2,378,770 pounds. Next, we multiplied the listed maximum concentration in percent by mass of the potential PFAS chemical in the fracturing fluid (0.00074) by the total estimated mass of the fluid. The result was an estimated maximum of 17.6 pounds of potential PFAS used to fracture the well. PSR included in our analysis of trade secret chemicals those chemicals in Open-FF whose specific identities were explicitly labeled "proprietary," "trade secret," or "confidential business information" in place of a CAS number. PSR did not include as trade secrets additional unidentified chemicals for which the CAS number in Open-FF is blank. The total weight figures reflect the sum of all records for which we have enough information to calculate a chemical's weight. Because many fracturing chemical disclosures lack sufficient data to perform this calculation, the total weight figures may represent an undercount. On the other hand, FracFocus' use of maximum concentration figures may produce an overcount. PSR's weight figures are based on the best available data.

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- ¹³⁷ W. Va. Code R. § 35-8-2(2.3)(stating that “‘chief’ means Chief of the Office of Oil and Gas as designated by the Secretary of the Department of Environmental Protection”) and W. Va. Code R. § 35-8-10.1(d)(providing that in the event of an investigation into a chemical declared confidential, a well operator shall provide the confidential chemical's identity and potentially other confidential information about the substance upon request to the chief or the chief's designee, and the state officials must keep the information confidential).
- ¹³⁸ W. Va. Code R. § 35-8-2(2.13)(stating that “‘Health care professional’ means a physician, physician assistant, nurse practitioner, registered nurse, or emergency medical technician licensed by the State of West Virginia.”) and W. Va. Code R. § 35-8-10.1(e)(providing that upon request by a health professional to address a medical emergency or for diagnostic or treatment purposes, well operators must provide trade secret chemical identities and potentially other confidential information about trade secret chemicals, and the health professionals must keep this information confidential.)
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¹⁵⁰ Petitioners' pleading filed in Robinson Twp. v. Commonwealth, Docket No. 284 MD 2012 (June 9, 2014), at 13 FN5 (on file with PSR).

¹⁵¹ Kiskadden v. Department of Environmental Protection v. Range Resources – Appalachia, LLC. Docket No. 2011-149-R. 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) (on file with PSR).

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¹⁵⁶ United States House of Representatives Committee on Energy and Commerce, Minority Staff. Chemicals Used in Hydraulic Fracturing (April 2011), at 2 (on file with PSR).

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¹⁶² Electronic mail communication between West Virginia Department of Environmental Protection, Office of Oil and Gas and PSR Consultant Dusty Horwitt (Nov. 22, 2023) (on file with PSR).

¹⁶³ Earl Ray Tomblin, Governor of West Virginia, Exec. Order No. 4-11 (July 12, 2011) (providing that for a horizontal gas well in the Marcellus Shale formation that requires withdrawals of water in West Virginia in amounts exceeding 210,000 gallons during any month, the operator of the well must file with the state a water management plan that includes a list of the “anticipated additives that may be used in water used for fracturing or stimulating a well”; and “upon well completion, a list of the additives that were actually used in the fracturing or stimulating of the well shall be submitted as part of the completion report.”) (on file with PSR). Natalie E. Tennant, Secretary of State of West Virginia, Notice of an Emergency Rule (Aug. 22, 2011) (providing that all applications for a work permit for horizontal oil or gas well sites that will disturb three or more acres of surface must include a well site safety plan). The West Virginia

State Legislature later in 2011 enacted slightly modified legislation encompassing the executive order and emergency rule. See 2011 W. Va. Acts H.B. 401 (passed Dec. 14, 2011; in effect from passage). West Virginia also enacted regulations implementing the legislation. See W. Va. Code R. § 35-8-5 and 35-8-10.

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1111 14th Street NW, #700
Washington, DC 20005
202 667 4260
www.psr.org
psrnatl@psr.org

 @PSREnvironment and @PSRnuclear
 /psrnational

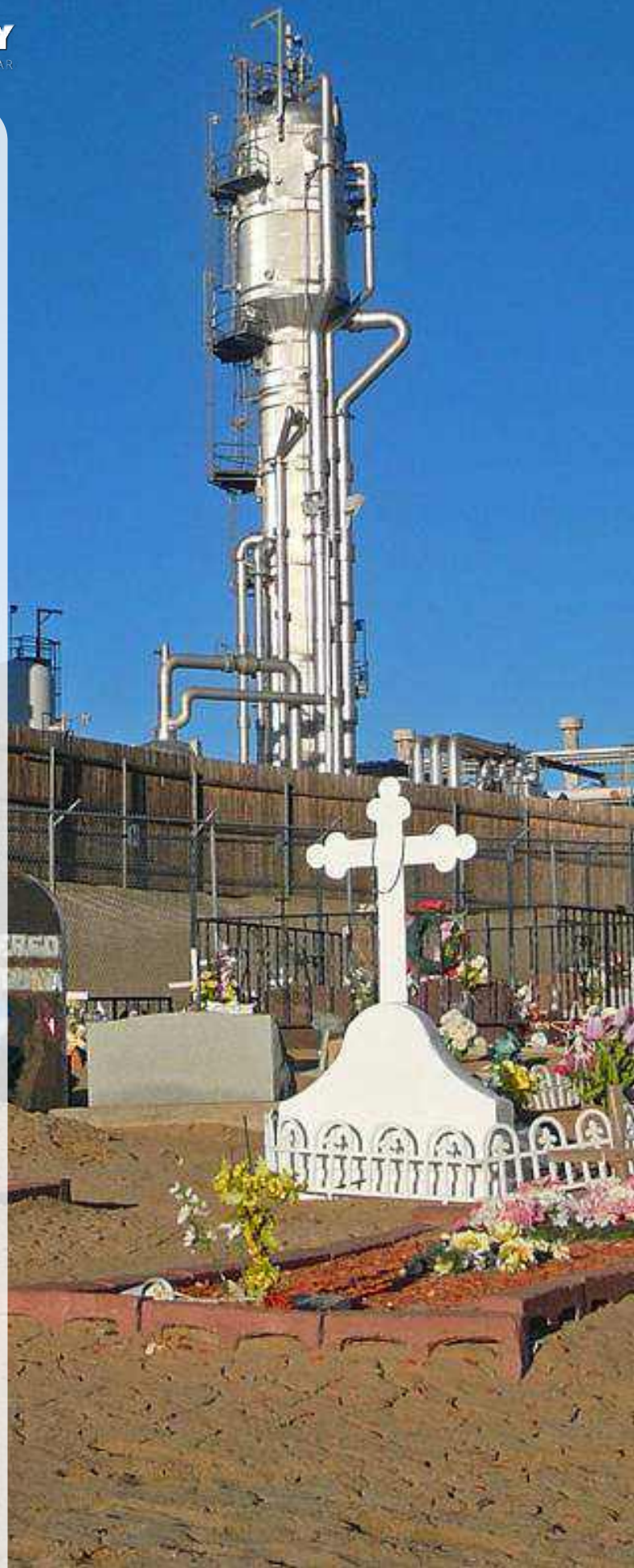
FRACKING WITH “FOREVER CHEMICALS” IN NEW MEXICO

Evidence Shows Oil
and Gas Companies
Have Used PFAS in New
Mexico Wells; Water
Risks Especially High
for Groundwater-
Dependent State

By Dusty Horwitt, J.D.
and Barbara Gottlieb

Data Analysis by Gary Allison

April 12, 2023





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EXECUTIVE SUMMARY

Previously unpublicized information unearthed by Physicians for Social Responsibility (PSR) shows that since at least 2013, oil and gas companies used in New Mexico's oil and gas wells a class of extremely toxic and persistent chemicals known as PFAS. However, gaps in New Mexico's disclosure rules prevent the public from knowing how widely PFAS – or other toxic chemicals – have been used. These findings raise concerns that New Mexicans may unknowingly be exposed to highly hazardous substances that are toxic in minuscule amounts.

PFAS are a class of chemicals known for their toxicity at extraordinarily low levels, their multiple negative health effects including cancer, and their persistence in the environment, leading to their nickname, “forever chemicals.” Using these chemicals may be particularly risky in a state where 80 percent of the population depends on groundwater for drinking water. Oil and gas production and waste disposal operations can contaminate groundwater with toxic chemicals including PFAS – and, once contaminated, groundwater is particularly difficult to clean up.

The present report is based on data publicly disclosed by the oil and gas industry regarding the use of chemicals in the stage of oil and gas operations known as hydraulic fracturing, or fracking. We found that between 2013 and 2022, oil and gas companies injected more than 200 oil and gas wells in six counties, in both the Permian and San Juan Basins, with the PFAS known as PTFE (marketed as Teflon). Oil and gas companies also injected wells in Lea County in the Permian Basin with the PFAS called fluoroalkyl alcohol substituted polyethylene glycol.

However, the number of cases of PFAS use we have been able to definitively identify in New Mexico oil and gas extraction may significantly underrepresent the reality. That is in large part because New Mexico law allows oil and gas companies to withhold fracking chemical identities from the public and regulators by claiming them as “trade secrets.”

Between 2013 and 2022, oil and gas companies disclosed their use of fracking chemicals in 9,066 oil and gas wells. Of

those wells, the companies injected more than 8,200 (over 90 percent) with at least one trade secret chemical per well. Trade secret chemicals used over this period totaled more than 240 million pounds. Information about these chemicals was limited, but scientific experts told PSR that chemicals injected into two dozen wells in the Permian Basin were PFAS, may be PFAS, or are precursor chemicals that could degrade into PFAS. Oil and gas companies injected more than 3,600 of the 8,200 wells with surfactants that could be fluorosurfactants, a class of chemical that include multiple PFAS. Should only a fraction of the unidentified chemicals used in New Mexico's oil and gas wells be PFAS, they could pose a significant threat. (An interactive map showing the locations of wells injected with PFAS and trade secret chemicals is <https://psr.org/new-mexico-pfas-map/>. Users can zoom in to identify wells near them.)

By shielding from public view the chemicals injected into oil and gas wells, weak disclosure rules raise the potential that New Mexicans may be directly exposed, or their groundwater and well water may be exposed, to PFAS (and other toxic chemicals) from hundreds or even thousands of oil and gas wells and waste disposal sites.

In light of these findings, PSR recommends the following:

- **Halt PFAS use in oil and gas extraction.** New Mexico should follow the lead of Colorado, a major oil- and gas-producing state that in June 2022 passed legislation banning the use of PFAS in oil and gas wells. Furthermore, New Mexico and the U.S. Environmental Protection Agency (EPA) should prohibit PFAS from being used, manufactured, or imported for oil and gas extraction. Many PFAS are replaceable with less-persistent and less-toxic alternatives.
- **Expand public disclosure.** New Mexico should greatly expand its requirements for public disclosure of oil and gas chemicals. The state could again follow the example offered by Colorado by requiring disclosure of all individual chemicals used in oil and gas wells, without

exceptions for trade secrets, while still protecting chemical product formulas. New Mexico should also require disclosure on the part of chemical manufacturers and require chemical disclosure prior to permitting, as have California, West Virginia, and Wyoming.

- **Increase testing and tracking.** New Mexico and/or the U.S. EPA should determine where PFAS have been used in oil and gas operations in the state and where related wastes have been deposited. They should test nearby residents, water, soil, flora, and fauna for PFAS, both for the particular type(s) of PFAS used and for organic fluorine to detect the presence of other PFAS. and/or their breakdown products. Testing equipment should be used that is sensitive enough to detect PFAS at a level of single-digit parts per trillion or lower.

- **Require funding and cleanup.** Oil and gas and chemical firms should be required to fund environmental testing for PFAS in their areas of operation, and should PFAS be found, be required to fund cleanup. If water cleanup is impossible, companies responsible for the use of PFAS should pay for alternative sources of water for household and agricultural uses, as needed.

- **Remove New Mexico's oil and gas hazardous waste exemption.** New Mexico exempts oil and gas industry wastes from state hazardous waste rules. New Mexico should follow New York's lead and remove its state-level hazardous waste exemption for the oil and gas industry.
- **Reform New Mexico's regulations for oil and gas production wells and underground injection disposal wells.** The state should prohibit production

wells and underground wastewater disposal wells close to underground sources of drinking water, homes, health care facilities and schools, require groundwater monitoring for contaminants near the wells, and for disposal wells, require full public disclosure of chemicals in the wastewater.

- **Transition to renewable energy and better regulation.** Given the use of highly toxic chemicals in oil and gas extraction, including but not limited to PFAS, as well as climate impacts of oil and gas extraction and use, New Mexico should transition away from oil and



Ruins at Chaco Culture National Historic Park, near Nageezi, New Mexico, Sept. 2009. Photo Credit: SkybirdForever, https://commons.wikimedia.org/wiki/File:Chaco_Canyon_-_Pueblo_Bonito_kiva_and_ruins.JPG.

gas production and move toward renewable energy and efficiency while providing economic support for displaced oil and gas workers. As long as drilling and fracking continue, the state should better regulate these practices so that New Mexicans are not exposed to toxic substances and should empower local governments also to regulate the industry. When doubt exists as to the existence or danger of contamination, the rule of thumb should be, "First, do no harm."

CH. 1

PFAS: A MANMADE THREAT TO HEALTH AND THE ENVIRONMENT USED IN NEW MEXICO'S OIL AND GAS WELLS

a. PFAS Used in New Mexico Wells

Physicians for Social Responsibility (PSR) has identified evidence from publicly reported oil and gas industry records that a highly dangerous class of chemicals, known as per- and polyfluoroalkyl substances (PFAS), has been used in New Mexico's oil and gas* wells for hydraulic fracturing ("fracking"). PFAS are known for their toxicity at extremely low levels,¹ their multiple negative health effects including cancer,² and their persistence in the environment, which has endowed them with their nickname, "forever chemicals."³ Fracking is the stage of oil and gas operations that typically involves high-pressure injections into oil and gas wells of up to tens of millions of gallons of water, sand, and chemicals to fracture rock formations and free up trapped oil and gas.^{4**} It is possible that PFAS have been used in additional stages and methods of oil and gas production in New Mexico.

The likely use of PFAS in oil and gas production in New Mexico was first exposed in 2021, initially in a report by PSR⁵ and subsequently by Public Employees for Environmental Responsibility.⁶ Based on fracking chemical disclosures made to the state and to the nongovernmental organization FracFocus, PSR is now able to identify New Mexico oil and gas wells definitively known to have been injected with PFAS between 2013 and 2022. They include 227 wells in six counties that were injected with PTFE, also known as Teflon and identified by the U.S. Environmental Protection Agency (EPA) as a PFAS.⁷ Another 34 wells in Lea county were injected with fluoroalkyl alcohol substituted polyethylene glycol, also identified as a PFAS by EPA.⁸ (See chapter 2 for details on these chemicals.) In reaching definitive conclusions about these chemicals, PSR relied on Chemical Abstracts Service (CAS) numbers that are unique numeric identifiers assigned to chemicals by the American Chemical Society.⁹ Scientists consider

* Gas, the principal component of which is methane, is also known as "natural" gas, "fossil" gas and "fracked" gas.

** In this report, the term "fracking" is used to discuss a particular stage in oil and/or gas production as distinct from other stages or methods of production such as drilling that precedes fracking. The terms "oil and gas production," "oil and gas extraction," and "oil and gas operations" cover the entire process of producing oil and/or gas.

Table 1. Disclosed Use in Fracking of PFAS and Possible PFAS in New Mexico Oil and Gas Wells, 2013-2022

Chemical Name	Chemical Abstracts Service (CAS) Number	PFAS or PFAS Precursor?	Source of Determination as PFAS or PFAS Precursor
PTFE/Teflon	9002-84-0	PFAS	Identified as PFAS on EPA's Master List of PFAS
Fluoroalkyl alcohol substituted polyethylene glycol	65545-80-4	PFAS	Identified as PFAS on EPA's Master List of PFAS
Nonionic fluorosurfactant	Unknown (identity withheld as a trade secret)	Could be PFAS or PFAS precursor.	Some chemical experts identify nonionic fluorosurfactants as PFAS or PFAS precursors, others as likely to be PFAS or possibly PFAS.
Trade secret surfactants	Unknown (identity withheld as a trade secret)	Could include fluorosurfactants that are PFAS or PFAS precursors.	No determination possible where chemical identity is withheld.
Trade secret chemicals	Unknown (identity withheld as a trade secret)	Could include PFAS or PFAS precursors.	No determination possible where chemical identity is withheld.

This table shows the types of chemicals that are PFAS or could be PFAS that oil and gas companies injected for fracking into oil and gas wells in New Mexico between January 1, 2013 and September 29, 2022. PFAS precursors are chemicals that can break down into PFAS. Some scientists believe that if a chemical can break down into a PFAS, it could or should be considered a PFAS.¹²

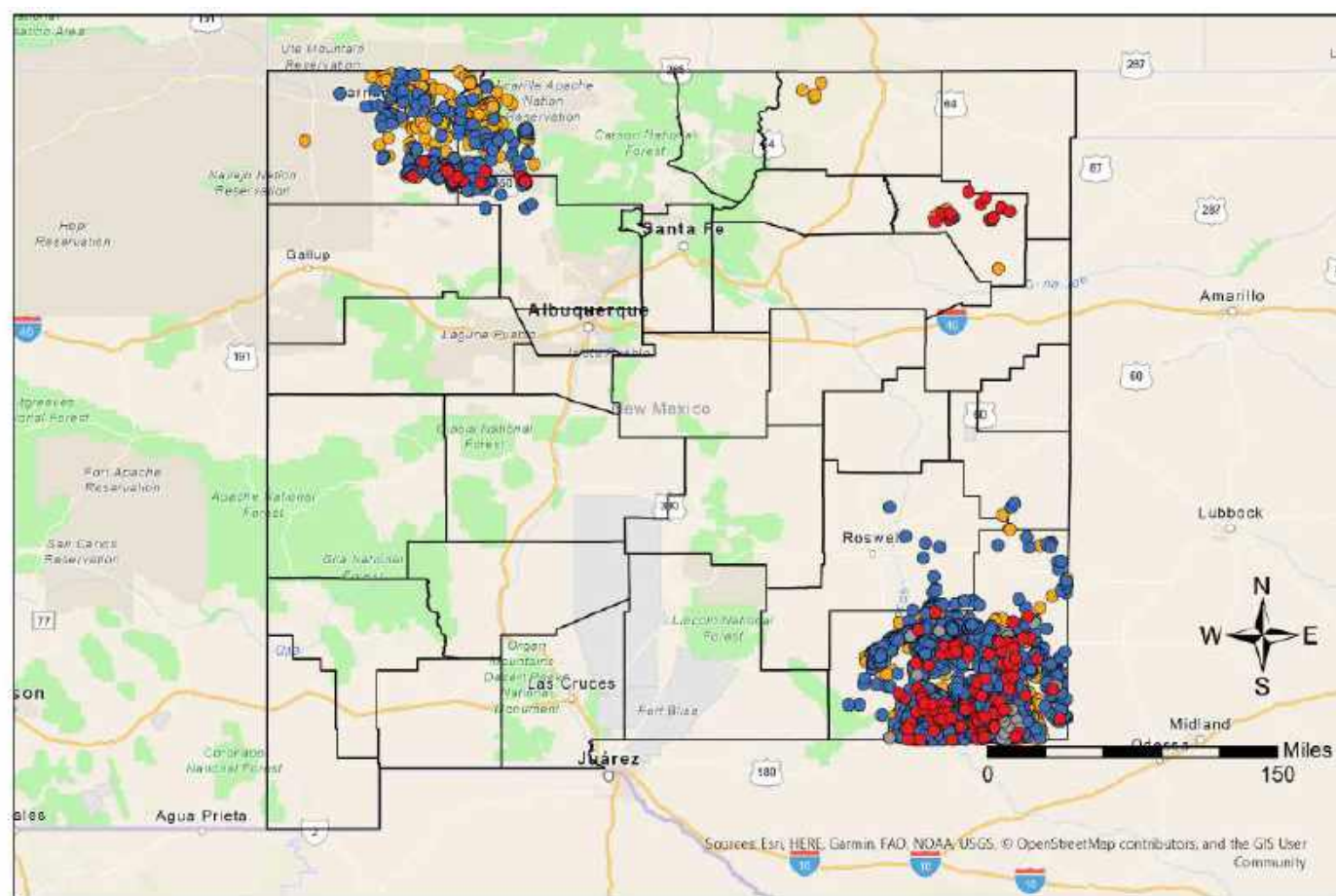
CAS numbers the best way to identify chemicals because chemicals can have multiple names or trade names but only one CAS number.¹⁰

(chemicals that could degrade into PFAS), according to three chemists and a board-certified toxicologist who reviewed the fluorosurfactants' names.¹¹

In addition, PSR found that oil and gas companies injected 24 wells in Eddy and Lea Counties with unspecified nonionic fluorosurfactants that could be PFAS or precursors

The wells injected with PFAS or possible PFAS may significantly underrepresent the extent of PFAS use in the state's oil and gas wells, due to gaps in chemical disclosure

New Mexico Oil & Gas Wells Fracked with PFAS and Possible PFAS, Including Trade Secret Chemicals, 2013-2022



- Wells Fracked with Fluoroalkyl Alcohol Substituted Polyethylene Glycol (a PFAS), Fluorosurfactants (possibly PFAS)
- Wells Fracked with PTFE/Teflon (a PFAS)
- Wells Fracked with Trade Secret Surfactants (possibly PFAS)
- Wells Fracked with Trade Secret Chemicals (possibly PFAS)
- Counties

PSR **PHYSICIANS FOR SOCIAL RESPONSIBILITY**
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FRACTRACKER
ALLIANCE

This map shows the location of oil and gas wells in New Mexico known to have been fracked between January 1, 2013 and September 29, 2022 using PTFE/Teflon (a known PFAS), fluoroalkyl alcohol substituted polyethylene glycol (a known PFAS), fluorosurfactants that may be PFAS or PFAS precursors, trade secret chemicals, and/or trade secret surfactants. An interactive version of the map is available at <https://psr.org/new-mexico-pfas-map/>. Users can zoom in to identify wells near them. For a more detailed explanation of data sources, see the Appendix.

rules, including those that allow oil and gas companies to conceal from the public as trade secrets the specific identities of chemicals they use in fracking. **PSR's review of fracking chemical disclosure in New Mexico found that oil and gas companies disclosed that they used fracking chemicals between 2013 and 2022 in 9,066 oil and gas wells. Of those wells, the companies injected more than 90 percent with at least one trade secret chemical and more than 40 percent with at least one trade secret surfactant. Some of these trade secret chemicals could be PFAS.**

The use of these chemicals is particularly alarming as New Mexico's oil production has increased seven-fold in roughly a decade, from about 65.5 million barrels in 2010 to more than 457 million barrels in 2021,¹³ and gas production has roughly doubled from about a trillion cubic feet in 2013 to more than two trillion cubic feet in 2021.¹⁴ While these increases, driven largely by production in the Permian Basin,¹⁵ mean more revenue for the state,¹⁶ they also mean more wells being drilled and fractured, more greenhouse gas emissions,¹⁷ and more opportunities for drilling companies to use PFAS or other toxic chemicals.

b. Manmade and Dangerous: PFAS's History and Health Effects

PFAS are a class of thousands of synthetic chemicals manufactured to have properties that are valuable in multiple industrial contexts, including being slippery, oil- and water-repellant, and able to serve as dispersants or foaming agents.¹⁸ PFAS have been called "perfluorinated chemicals" and "polyfluorinated compounds," or PFCs, though the term currently preferred by EPA is PFAS.¹⁹

The first PFAS to be sold commercially was created by a chemist at Dupont and was patented as Teflon. Since 1949, it has been used in thousands of products, from nonstick cookware to waterproof clothing to plastics to dental floss.²⁰ Other PFAS chemicals, the most prominent of which are known as PFOA and PFOS, were used in food packaging, fire-fighting foam, and in 3M's widely used fabric protector,

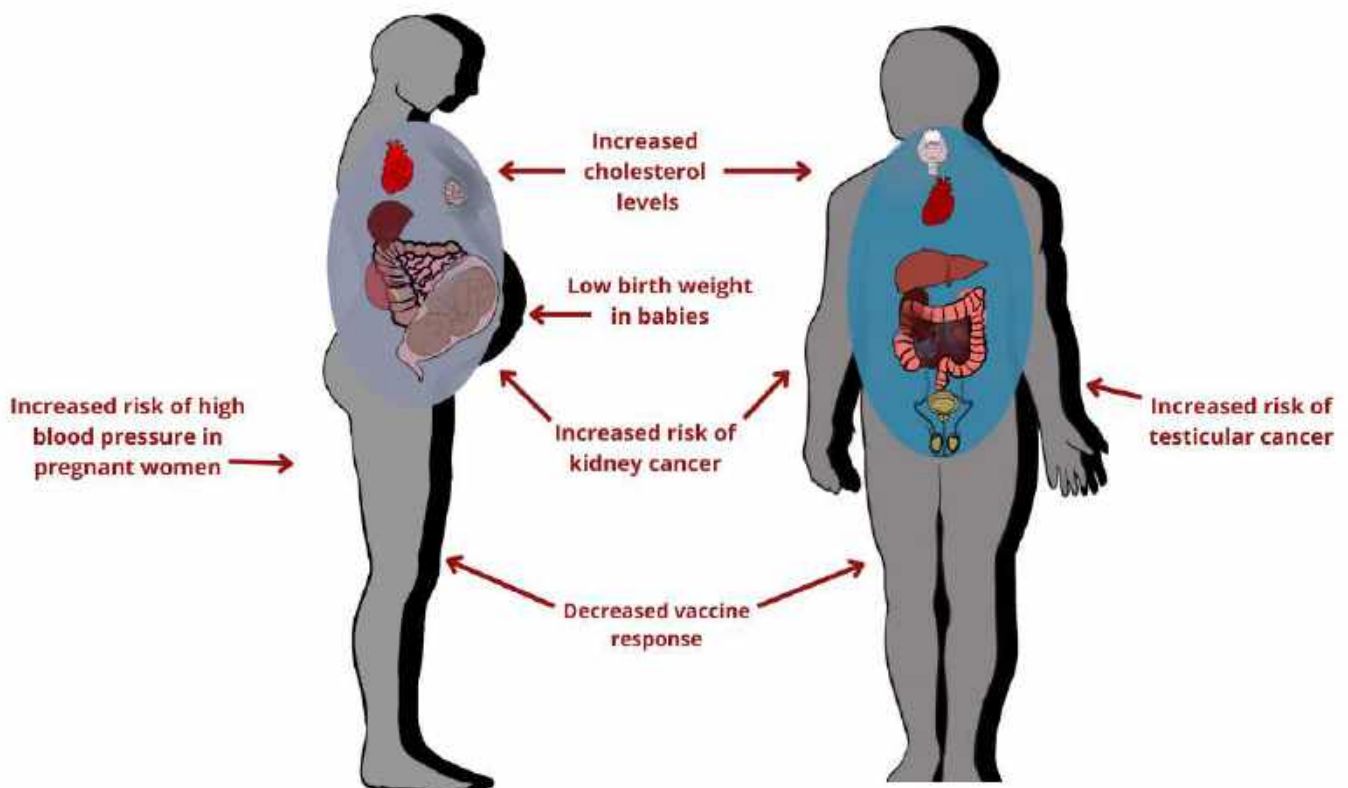
Scotchgard.²¹ EPA reported in 2021 that about 650 types of PFAS remained in commerce.²² Weak chemical disclosure laws make it difficult for the Agency to identify which PFAS chemicals are used, and where.

Between the 1960s and 1990s, researchers inside Dupont and 3M became aware that at least some of the PFAS they were manufacturing or using, particularly PFOA and PFOS, were associated with health problems including cancers and birth defects, had accumulated in people worldwide, and persisted in the environment.²³

Many of these facts, kept internal by the companies, came to light after attorney Rob Bilott filed lawsuits in 1999 and 2001 accusing Dupont of causing pollution in and around Parkersburg, West Virginia with PFOA, a type of PFAS then used in making PTFE (Teflon).²⁴ In December 2011, as part of Dupont's settlement of the 2001 lawsuit, a team of epidemiologists completed a study of the blood of 70,000 West Virginians and found a probable link between PFOA and kidney cancer, testicular cancer, thyroid disease (over- or under-production of hormones by the thyroid gland), high cholesterol, pre-eclampsia (a potentially dangerous complication during pregnancy characterized by high blood pressure and signs of damage to other organ systems, most often the liver and kidneys), and ulcerative colitis (a disease causing inflammation and ulcers in the large intestine or colon).²⁵

Current peer-reviewed scientific research on PFAS suggests that exposure to certain levels of some PFAS may lead to adverse health outcomes. Research findings differ, as different studies have examined different PFAS chemicals, different types or levels of exposure, or different exposed populations. However, some findings are more widely endorsed; for example, the U.S. Environmental Protection Agency (EPA)²⁶ and the Center for Disease Control and Prevention's Agency for Toxic Substances and Disease Registry (ATSDR)²⁷ agree that exposure to high levels of certain PFAS may lead to increased risk of high blood pressure in pregnant women; low birth weight in babies;

POTENTIAL HEALTH EFFECTS OF PFAS EXPOSURE



Exposure to PFAS chemicals can result in a variety of serious health effects including those indicated above. Source: U.S. Environmental Protection Agency, Agency for Toxic Substances and Disease Registry. Graphic by Astra Robles

increased risk of kidney or testicular cancer; decreased vaccine response, and increased cholesterol levels. Research is ongoing to determine the health effects of different levels of exposure to different PFAS, including the health effects of long-term, low-level PFAS exposure, especially in children.

See graphic above.

PFAS are not only highly toxic; they also demonstrate extreme persistence in the environment. PFAS' nickname "forever chemicals" reflects their chemistry – created by chemical manufacturers – that features a bond between fluorine and carbon atoms that is among the strongest in

chemistry and rarely if ever exists in nature. The result: chemicals that are extremely resistant to breaking down.²⁸ PFAS are also extremely mobile in water,²⁹ making them able to spread through the environment via groundwater or surface water. Another risk, discussed in Chapter 5, is that PFAS could compound the health effects from other dangerous chemicals associated with oil and gas production.

c. EPA Recognizes Risks of PFAS

EPA has been slow to regulate PFAS, but the agency has taken actions, particularly in recent years, that recognize

PFAS's extraordinary risks. In June 2022, reflecting growing public concern about PFAS, EPA significantly lowered its non-binding health advisory level for PFOA and PFOS in drinking water. Previously, EPA had set the combined health advisory level for these chemicals at 70 parts per trillion.³⁰ **"The new published peer-reviewed data and draft EPA analyses..." EPA wrote in June 2022, "indicate that the levels at which negative health outcomes could occur are much lower than previously understood."**³¹ EPA set its new interim health advisory level for PFOA in drinking water to 0.004 parts per trillion and its interim health advisory level for PFOS to 0.02 parts per trillion.³² EPA also set new final health advisory levels for two other PFAS known as GenX and PFBS at 10 parts per trillion and 2,000 parts per trillion, respectively.³³ EPA said that its interim health advisory levels were intended to provide guidance until enforceable drinking water regulations for PFAS take effect.³⁴

EPA then in March 2023 released proposed standards for levels of six PFAS in drinking water. These included a level of four parts per trillion for both PFOA and PFOS. EPA explained in an email, sent in response to a question from PSR, the difference between the health advisory levels and the proposed drinking water standards:

Health advisories reflect EPA's assessment of health risks of a contaminant based on the best available science and provide advice and information on actions that water systems may take to address contamination for these and other PFAS.³⁵

Besides focusing on possible health effects, health advisories differ from rules in that they do not take into account whether a particular level of protection can be achieved or at what cost.³⁶ In this respect they resemble EPA's proposed Maximum Contaminant Level Goal, which for PFOA and PFOS is zero in drinking water.

EPA's interim health advisory levels mean that the toxicity of PFOA is almost beyond comprehension. According to EPA's advisory levels, one tablespoon of PFOA would be enough to contaminate 1.75 trillion gallons of water,³⁷ which is more

than twice the total storage capacity of Elephant Butte Reservoir (720 billion gallons),³⁸ which forms New Mexico's largest lake on the Rio Grande River in the southwestern part of the state.³⁹ (Current levels in the lake are far below total storage capacity due to drought.⁴⁰) EPA's new health advisory levels further show that PFOS is similarly extraordinarily toxic. In March 2023, EPA proposed drinking water regulations that would limit the amount of PFOA and PFOS in drinking water to four parts per trillion. The agency also proposed that drinking water providers limit the combined levels of four other types of PFAS: PFNA, PFHxS, PFBS, and/or GenX Chemicals. The agency said that it expects to finalize the rule by the end of 2023.⁴¹

Several experts told PSR that because of the extreme potency of certain types of PFAS and the fact that chemical makers have created thousands of these forever chemicals, they would recommend particular testing methods to detect PFAS in the environment. The scientists are Linda Birnbaum, Ph.D., D.A.B.T., A.T.S., a board-certified toxicologist and former director of the National Institute of Environmental Health Sciences;⁴² Zacariah Hildenbrand Ph.D., research professor in Chemistry and Biochemistry at the University of Texas at El Paso;⁴³ Kevin Schug Ph.D., Shimadzu Distinguished Professor of Analytical Chemistry at the University of Texas at Arlington,⁴⁴ and Wilma Subra, holder of a master's degree in chemistry and recipient of a John D. and Catherine T. MacArthur Foundation "Genius" grant for her work helping to protect communities from toxic pollution.⁴⁵ All were in agreement in recommending the use of testing equipment that can detect PFAS in concentrations at least as low as single-digit parts per trillion. They further recommended testing for total organic fluorine in addition to testing for specific types of PFAS. Total organic fluorine is a marker that would indicate the presence of PFAS even if a specific PFAS were not tested for. Testing for specific PFAS only might fail to detect other forms of PFAS present in the sample.

d. PFAS Already Present in New Mexico's Environment

Evidence has mounted over the years of cases of PFAS pollution from a variety of sources, including in New Mexico.

In 2018, the U.S. Air Force reported that PFAS had been detected in groundwater below Cannon Air Force base in Clovis and beneath Holloman Air Force base outside Alamogordo.⁴⁶

At Cannon Air Force base, the levels were as high as 26,200 parts per trillion in groundwater for combined PFOA and PFOS.⁴⁷ At Holloman Air Force base, the levels reached as high as 1,294,000 parts per trillion for combined PFOA and PFOS.⁴⁸ (As noted above, EPA's health advisory levels for PFOA and PFOS in drinking water are 0.004 parts per trillion and 0.02 parts per trillion, respectively.) In both cases, the pollution was linked to the use of firefighting foam that contained PFAS.⁴⁹ It is unclear whether both PFOA and PFOS were in the foam. The Interstate Technology Regulatory Council reports that firefighting foam used between the 1960s and 2002 can contain both types of PFAS as well as precursors that may degrade into PFOA.⁵⁰ The pollution near Cannon Air Force Base devastated a local dairy farm. Because of the pollution, farmer Art Schaap told the Albuquerque

Journal in 2022 that since he learned of the PFAS contamination in his water in 2018, he had been unable to sell his cow's milk or meat. He was forced to euthanize thousands of cows, and he and the state must determine how to safely dispose of the PFAS-tainted carcasses so that the persistent pollutants do not cause further contamination. "I've lost so much money, I don't know if I can restart," Schaap told the Journal.⁵¹

The state Environment Department began a water sampling effort in mid-2020 with support from the U.S. Geological Survey to determine levels of PFAS around the state, and the concentrations discovered showed some cause for concern.⁵² The sampling, which ran from August 2020 to November 2021, focused on ground and surface water supplies in 19 New Mexico counties.⁵³ In a news release published in January 2021, the Department reported that "To date, the data from this effort does not indicate any imminent public health threats....None of the results received so far show levels of PFOS or PFOA at or above the [EPA's] Lifetime Health Advisory." However, that health advisory of 70 parts per

trillion of combined PFOA and PFOS is now outdated. Under EPA's June 2022 interim health advisory levels for PFOA and PFOS, multiple samples of water in New Mexico's sampling for PFAS have levels that are now judged unsafe. They range from 145 times to 9,000 times EPA's interim health advisory levels for PFOA and PFOS, including:

- 2.9 parts per trillion of PFOS in the Melrose water system in Curry County (145 times EPA's interim health advisory level);
- 8 parts per trillion of PFOA in the Alamogordo Domestic Water System/Golf Course Well in Otero County (2,000 times EPA's interim health advisory level), and
- 36 parts per trillion of PFOA in spring 10 of the Cloudcroft Water System in Otero County (9,000 times EPA's interim health advisory level).

"If, during the study, levels of PFOS and PFOA are detected in drinking water resources above the Lifetime Health Advisory," the department wrote, "NMED will work with public water systems to identify the best mitigation options, if requested." It is unclear if the department will take the same steps if the levels detected are above EPA's much more protective interim health advisory levels. The department has said on a separate website that "PFAS contamination in New Mexico is one of the New Mexico Environment Department's top priorities, as is the protection of human health and the environment."⁵⁴ The Department added that in the absence of federal drinking water standards for PFAS, it was considering developing standards of its own.⁵⁵

e. Oil and Gas Operations Provide Many Potential Routes of Exposure to PFAS

Oil and gas operations in New Mexico deserve scrutiny as a possible additional source of PFAS contamination due to the now-documented use of PFAS in the state's oil and gas wells and the potential that people could be exposed to PFAS via multiple pathways.



An oil and/or gas site in Aztec, New Mexico, Sept. 2008. Photo credit: Jane Pargiter, EcoFlight.

EPA in its 2016 national report on fracking and drinking water found that fracking-related pollution could follow a number of pathways that could impact surface- and groundwater. The agency cited the following possible pathways to exposure:

- spills of fracking fluid that seep into groundwater;
- injection of fracking fluid into wells with cracks in the casing or cement, allowing the fluid to migrate into aquifers;
- injection of fracking fluids directly into groundwater;
- underground migration of fracking fluids through fracking-related or natural fractures;
- intersection of fracking fluid with nearby oil and gas wells,
- spills of wastewater after the fracking process is completed, and
- inadequate treatment and discharge of fracking wastewater to surface water supplies.⁵⁶

PFAS used in oil and gas extraction could pollute water

through any of these pathways, plus other routes discussed in more detail in Chapter 5 including through airborne releases and disposal of oil and gas wastewater in underground injection wells, a pathway that EPA did not examine in its 2016 report.⁵⁷

PFAS contamination could further reduce available water supplies. EPA reported in 2013 that “about 87 percent of New Mexico’s public water supply comes from groundwater. No other southwestern state gets such a large percentage of its domestic water from groundwater sources.”⁵⁸ A representative of the federal Bureau of Reclamation told the Carlsbad Current-Argus in 2021 that in the Pecos River Basin in southeastern New Mexico, 80 percent of water was consumed by agricultural interests for irrigation, and 64 percent of that water came from groundwater. Much of the Pecos Basin overlaps with the heavily drilled Permian Basin.⁵⁹ The EPA stated in 2015 that “because groundwater usually moves slowly, contaminants generally undergo less dilution than when in surface water.”⁶⁰ The agency added that

[b]ecause ground water generally moves slowly, contamination often remains undetected for long periods of time. This makes cleanup of a contaminated water supply difficult, if not impossible. If a cleanup is undertaken, it can cost thousands to millions of dollars.⁶¹

Furthermore, water supplies are expected to shrink in future years as the climate heats up, making clean water supplies even more important. The Bureau of Reclamation forecast that in coming years, farmers in the basin will encounter higher temperatures and scarcer water.⁶² PFAS contaminate could further reduce available water supplies.

f. PFAS: Among Many Dangerous Chemicals Used in Fracking

When used in oil and gas operations, PFAS may add to the cumulative human exposure to a host of toxic substances. In the fracturing stage of oil and gas production, chemicals serve a variety of purposes including killing bacteria inside the wellbore, reducing friction during high-pressure fracking,

and thickening the fluid so that the sand, suspended in the gelled fluid, can travel farther into underground formations.⁶³ In its 2016 study of fracking and drinking water, the EPA identified 1,606 chemicals used in fracking fluid and/or found in fracking wastewater. While the agency found high-quality information on health effects for only about 10 percent (173) of these chemicals, that 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.⁶⁴

Chemicals used in the drilling stage that precedes actual fracturing can also pose health risks, including developmental toxicity and the formation of tumors, according to EPA regulators.⁶⁵ A disclosure form filed with the state of Ohio, one of only two states to require public disclosure of drilling chemicals (Colorado is the other),⁶⁶ shows that Statoil, Norway’s state oil company (since renamed Equinor), has used the neurotoxic chemical xylene in drilling.⁶⁷ In short, when chemicals used in drilling, fracking or other stages and methods of oil and gas operations come into contact with people or the environment, they can produce serious negative health effects.⁶⁸

CH. 2

PFAS USED IN NEW MEXICO'S OIL AND GAS WELLS: A DEEPER LOOK

a. PTFE (Teflon), a PFAS Fluoropolymer

One of the types of PFAS used for fracking in New Mexico's oil and gas wells between 2013 and 2022 was PTFE, commonly known as Teflon.

PTFE is a fluoropolymer, a type of plastic.⁶⁹ Scientists⁷⁰ and environmentalists⁷¹ major concerns about PTFE and other fluoropolymers are related less to these substances themselves, but rather to the associated impacts of their production, use, and disposal. The production of PTFE and other fluoropolymers relies on the use of other, highly toxic PFAS that are used as production aids. As noted in a peer-reviewed study published in 2020, these other PFAS have included fluorosurfactants such as PFOA, whose risks are discussed in the previous chapter, and GenX, which is similarly harmful and has replaced PFOA in fluoropolymer production.⁷² PTFE and other fluoropolymers may contain these more toxic PFAS fragments, and those fragments may leach out of the PTFE during use.⁷³ The authors of the 2020 paper noted that

The levels of leachables...in individual fluoropolymer substances and products depend on the production process and subsequent treatment processes; a comprehensive global overview is currently lacking.⁷⁴

In addition, PTFE may generate other PFAS if the PTFE breaks down under heat.⁷⁵

The 2020 paper authors noted that the persistence in the environment of PTFE and other fluoropolymers could pose problems during disposal, observing that "Landfilling of fluoropolymers leads to contamination of leachates with PFAS and can contribute to release of plastics and microplastics."⁷⁶ One of the authors added in an email to PSR that if PTFE were used in oil and gas wells that have especially high temperatures, defined in publications by oilfield services company, Schlumberger, as 300°-350° F or higher for so-called "high-pressure, high-temperature wells,"⁷⁷ the PTFE could undergo a process called "thermolysis" and generate toxic PFAS called perfluoroalkyl carboxylic acids (PFCAs). As a result, he wrote, "there could be some additional problems that need some investigation."⁷⁸ A representative from New Mexico's Oil Conservation Division said that wells with the characteristics described by Schlumberger "would be atypical for any oil or gas producing wells in New Mexico." He added that the Oil Conservation Division does not track pressures or temperatures inside oil and gas wells, though operators sometimes report downhole pressures during initial production testing or "may report the temperatures in the well logs."⁷⁹ These data are publicly accessible online.⁸⁰

In 2021, a coalition of national environmental organizations including the Center for Environmental Health, Clean Water Action, Ecology Center, Environmental Working Group, Natural Resources Defense Council, Safer States, and the Sierra Club voiced several environmental and health concerns regarding the risks of fluoropolymers such as

Table 2. Disclosed Use in Fracking of PTFE in New Mexico Oil and Gas Wells, 2013-2022

County Name	Number of wells injected with PTFE	Mass of PTFE (lbs.) ⁸⁴
Eddy	113	2028
Harding	14	2
Lea	74	557
Rio Arriba	2	2
San Juan	18)	10
Sandoval	6	6
Total	227	2605

This table shows by county the number of New Mexico wells in which oil and gas companies injected PTFE for fracking between 2013 and 2022. For a more detailed explanation of data sources, see the Appendix.

PTFE, based on their review of multiple scientific articles. The groups also noted that fluoropolymers are manufactured with chemicals that have an outsized negative effect on climate change.⁸¹

Public records make it difficult to know for what purpose PTFE was used. In most cases, either no purpose or various purposes were listed for chemical products, but the individual chemical components of these products were listed in a separate portion of the disclosure form, making it impossible to know which components are part of which product.⁸² However, PTFE, which is marketed as Teflon, is known for its slipperiness, suggesting it might have been used as a friction reducer, a common purpose for fracking chemicals.⁸³

Oil and gas companies that have disclosed using PTFE for fracking in New Mexico (Table 3) include ExxonMobil Corp.,

the nation's largest publicly traded oil and gas company,⁸⁵ and Devon Energy Corp.⁸⁶ and Occidental Petroleum Corp.,⁸⁷ both major producers in the Permian Basin.

Disclosure gaps in New Mexico law, discussed below, may prevent scientists and the public from knowing the extent of the use of PTFE and other PFAS in the state's oil and gas operations.

b. Fluoroalkyl Alcohol Substituted Polyethylene Glycol

The other type of PFAS disclosed as being used for fracking in New Mexico's oil and gas wells between 2013 and 2022 was fluoroalkyl alcohol substituted polyethylene glycol. EOG Resources, a major oil producer in the Permian and San Juan Basins,⁸⁸ injected 34 wells, all in Lea County, with a total of 6,400 pounds of this chemical. Fluoroalkyl alcohol

Table 3. Oil and Gas Companies that Fracked Wells in New Mexico Using PTFE, 2013-2022

Well Operator	Number of wells injected with PTFE	Total mass of PTFE (lbs.)
Devon Energy Production Company L. P.	60	456
Occidental Oil and Gas	45	354
Matador Production Company	23	204
Yates Petroleum Co.	22	No data available
Cimarex Energy Co.	13	134
Encana Oil & Gas Inc.	12	20
Whiting Petroleum	10	1
WPX Energy	9	No data available
XTO Energy/ExxonMobil	7	1286
BreitBurn Operating LP	6	2
ConocoPhillips Company/Burlington Resources	4	30
Energen Resources Corp.	3	No data available
COG Operating LLC	2	10
Dugan Production Corp.	2	No data available
Kaiser-Francis Oil Company	2	No data available
BOPCO, L.P.	1	No data available
DGP Energy	1	14
Mewbourne Oil Co.	1	No data available
Murchison Oil and Gas Co.	1	7
Oxy USA Inc.	1	No data available
Tap Rock Resources	1	90
V-F Petroleum Inc.	1	No data available

This table shows the oil and gas companies that fracked oil and gas wells in New Mexico with PTFE between 2013 and 2022. For a more detailed explanation of data sources, see the Appendix.

substituted polyethylene glycol is listed on EPA's Master List of PFAS Substances under a different name.⁸⁹ PSR was able to identify it there using its CAS number of 65545-80-4, which appears in the FracFocus records.⁹⁰ Its purpose as declared in FracFocus is "oil field surfactant," suggesting that it could be a fluorosurfactant,⁹¹ a type of chemical discussed in more detail in Chapter 3.

Limited toxicological data is available about chemical 65545-80-4, but according to data on the website of the National Library of Medicine's ChemIDplus, at high doses, the chemical is associated with convulsions or effects on the threshold for seizures; dyspnea, or shortness of breath; and muscle weakness.⁹² A safety data sheet for the chemical published by its manufacturer says little about human health effects. "To the best of our knowledge," the safety data sheet says, referencing the substance using a trade name Zonyl® FSO-100, "the chemical, physical, and toxicological properties have not been thoroughly investigated."

Regarding impacts to the environment, the safety data sheet says, "Toxic to aquatic life with long lasting effects..."

Avoid release to the environment...Collect spillage...Dispose of contents/ container to an approved waste disposal plant."⁹³ A message on the website of ChemPoint, a chemical distributor, suggests that this chemical was phased out due to concerns that it could break down into PFOA or PFOS. A message apparently from Chemours, a company spun off from Dupont, says

Zonyl® fluorosurfactant and repellent grades were discontinued between 2009 and 2014. Capstone® fluorosurfactants [a new type of fluorosurfactant] and repellents were introduced as sustainable replacements that meet the goals of the U.S. EPA 2010/15 PFOA Stewardship Program. They are based on short-chain molecules that cannot break down to PFOA or PFOS in the environment."⁹⁴

However, as is discussed below, scientists have raised concerns about the health and environmental effects of these replacement chemicals.

Table 4. Disclosed Use of Fluoroalkyl Alcohol Substituted Polyethylene Glycol in New Mexico Oil and Gas Wells, 2013-2022

Well Operator	Number of wells injected with fluoroalkyl alcohol substituted polyethylene glycol – all in Lea County	Total weight of fluoroalkyl alcohol substituted polyethylene glycol (lbs.)
EOG Resources, Inc.	34	6,400

This table shows that EOG Resources, Inc., fracked oil and gas wells in New Mexico with fluoroalkyl alcohol substituted polyethylene glycol between 2013 and 2022. For a more detailed explanation of data sources, see the Appendix.

CH. 3

NEW MEXICO'S CHEMICAL DISCLOSURE LAWS SHIELD CHEMICAL IDENTITIES

a. New Mexico's "Trade Secret" Law Shields Potentially Dangerous Substances, Including PFAS

The danger of exposure to unknown chemicals – PFAS and others – from oil and gas operations persists in New Mexico, despite state rules that generally require public disclosure of fracking and drilling chemicals.⁹⁵ On the face of it, these disclosure requirements seem effective. However, an important exception allows companies to avoid full and meaningful disclosure: The law allows chemical manufacturers, well operators and other companies in the chemical supply chain to withhold exact fracking and drilling fluid ingredient information if they deem it a trade secret.^{** 96} In some cases in New Mexico fracking chemical disclosure records, oil and gas operators disclose generic names of chemicals while withholding as trade secrets their specific identities. These generic identifiers include “nonionic fluorosurfactant,”⁹⁷ a chemical identified as PFAS or possible PFAS by several scientists as discussed below, and “proprietary Acid Inhibitor/Surfactant.”⁹⁸ Regrettably, the use of such vague descriptors can hide from public view the true identities of dangerous chemicals, including PFAS. The use of trade secrets to conceal chemicals’ specific identities effectively undermines the public health benefits of disclosure by preventing health professionals, first responders, state regulators and the public from knowing where PFAS – or other toxic chemicals – have been used in oil and gas wells.

In addition to allowing trade secret exemptions, New Mexico does not require public disclosure of chemicals used in drilling, enhanced oil recovery, or in other extraction techniques that are distinct from fracking per se. Chemicals used during the first stage of the drilling process would be highly likely to leach into groundwater since during this stage, according to EPA, drilling passes directly through groundwater zones⁹⁹ before any casing or cement is placed in the well to seal it off. The resulting potential for groundwater contamination makes public disclosure of chemicals used in drilling especially important, as these

regulatory gaps increase the potential that New Mexicans could unknowingly be exposed to PFAS and other chemicals used during oil and gas extraction.¹⁰⁰

In at least some cases, the New Mexico Oil Conservation Division has prohibited oil and gas companies from using “oil base muds” for drilling “until fresh water zones are cased and cemented providing isolation from the oil or diesel. This includes synthetic oils.”¹⁰¹ Such “muds,” according to oilfield services company Schlumberger, are “generally synonymous with drilling fluid.”¹⁰² According to the Oklahoma State University Extension Service, oil-based muds can include diesel fuel and the highly dangerous chemicals benzene, toluene, ethylbenzene, and xylene.¹⁰³

It is unclear whether New Mexico’s prohibition would prohibit the use of PFAS during drilling that passes through fresh water zones.

b. Extensive Use of “Trade Secret” Claims Veils Actual Use

PSR found extensive application of the trade secret provisions under New Mexico’s fracking chemical disclosure rules – so extensive that it could serve to mask widespread use of PFAS in the state’s oil and gas wells. Our data analysis revealed that, between 2013 and 2022, New Mexico’s well operators claimed at least one fracking chemical as a trade secret in 8,293 oil and gas wells located across 11 counties. The trade secret chemicals used in New Mexico over this roughly 10-year period totaled 243 million pounds (see Table 5).¹⁰⁴ If even a small fraction of this weight were PFAS, that fraction could pose significant risks to health and the environment. In an effort to identify PFAS among these trade secret chemicals, PSR examined whether any were listed as a surfactant or a fluorosurfactant. According to EPA, surfactants are commonly used in fracking¹⁰⁵ and lower the surface tension of a liquid, the interaction at the surface between two liquids (called interfacial tension), or

^{**} Trade secret information is also called “proprietary” or “confidential business information” (CBI).

the interaction between a liquid and a solid.¹⁰⁶ Compared to other surfactants, fluorosurfactants are said to be “superior in their aqueous surface tension reduction at very low concentrations and are useful as wetting and leveling agents, emulsifiers, foaming agents, or dispersants.”¹⁰⁷ At least some fluorosurfactants are PFAS, including the dangerous chemicals PFOA and PFOS¹⁰⁸ and 8:2 fluorotelomer alcohol,¹⁰⁹ a nonionic fluorosurfactant¹¹⁰ that can break down into PFOA.¹¹¹ Two scientists told PSR that all or most fluorosurfactants could be classified as a PFAS¹¹² while two other scientists were uncertain.¹¹³

Like the broader class of surfactants, fluorosurfactants are also used in fracking, and perhaps other stages and methods of oil and gas extraction, according to scientific and industry sources. In 2020, several scientists published an article in *Environmental Science: Processes and Impacts* showing that since 1956, PFAS including fluorosurfactants had been used or proposed to be used globally in oil and gas extraction techniques including chemical-driven gas production, chemical flooding, fracking, and the drilling that precedes fracking and other oil and gas production techniques.¹¹⁴ In 2008, two authors, one of whom was identified as an employee at DuPont, wrote in the peer-reviewed *Open Petroleum Engineering Journal* that the use of fluorosurfactants was relatively common in the oil and gas industry and that their use was about to surge. They referred to fluorosurfactants as an “emerging technology” and stated,

While fluorosurfactants have been used in gas and oil exploration for four decades, the increased demand for petroleum and the greater understanding of the benefits of fluorosurfactants have led to growing acceptance for fluorosurfactants throughout the petroleum industry.¹¹⁵

The authors did not explicitly say that fluorosurfactants used in oil and gas operations were PFAS but they described the fluorosurfactants in ways that are commonly used to describe PFAS. They wrote that “The use of fluorosurfactants is a recent but growing trend due to (i) the exceptional hydrophobic [water-repellent] and oleophobic [oil-repellent] nature of the perfluoroalkyl and perfluoroalkyl ether

groups...The bond strength of the carbon-fluorine bond in perfluoroalkyl and perfluoroalkyl ether groups has been demonstrated as the key to remarkable overall stability for fluorochemicals and fluoropolymers.”¹¹⁶ This evidence suggests that any time an unidentified surfactant or fluorosurfactant is used in oil and gas production, there is a potential that it is a PFAS.

We found thousands of cases of oil and gas companies using at least one trade secret chemical that they described as a surfactant. These occurred in 3,680 wells, spread across 10 counties (see Table 5).¹¹⁷ Operators’ names for these chemicals were vague, including “surfactant” and “surfactant blend.” These trade secret surfactants totaled 19.3 million pounds. (See examples from individual wells in Table 8 below.) While we cannot know what these trade secret chemicals are, should even a small percentage of them be fluorosurfactants that are PFAS, they could pose significant threats to human health and the environment.

In 24 wells (16 in Eddy County and 8 in Lea County), oil and gas companies disclosed the use of trade secret chemicals listed with the nonspecific name “nonionic fluorosurfactant” that are apparently fluorosurfactants and may be PFAS. The weight of these chemicals totaled 970 pounds.¹¹⁸ Even if some of that volume were PFAS, it could pose significant health and environmental risks, depending on the chemicals’ toxicity. According to two Texas university-based chemists, Hildenbrand and Schug, both of whom are authors of multiple peer-reviewed articles about chemicals related to oil and gas production,¹¹⁹ nonionic fluorosurfactants are PFAS or could degrade into PFAS. In addition, Subra, the chemist and MacArthur Foundation “Genius” grant winner, identified the chemicals as potential PFAS.¹²⁰ Still another expert, toxicologist Birnbaum, informed PSR that the chemicals are likely to be PFAS.¹²¹ Birnbaum added that PFAS, perhaps including the nonionic fluorosurfactants used in New Mexico’s oil and gas wells, could degrade into one or more smaller PFAS¹²² (Hildenbrand agreed). Birnbaum,¹²³ Hildenbrand,¹²⁴ Subra,¹²⁵ and Schug¹²⁶ generally agree that if a chemical can break down into a PFAS, it could or should be considered a PFAS.

PSR has had to rely on scientists to identify these chemicals as PFAS, potential PFAS, or PFAS precursors because the oil and gas companies that made the public disclosures to FracFocus withheld as trade secrets the chemicals' CAS numbers, data that would have enabled a precise identification of the chemicals. The identification in the FracFocus records included only the generic name "nonionic fluorosurfactant" and the trade name "S-222" for the product containing the nonionic fluorosurfactants,¹²⁷ information

insufficient to identify the chemicals with specificity. The fact that only one trade name was listed each time the chemical was reported suggests that the fluorosurfactant might be the same chemical in each use, but it is impossible to know without a CAS number. The sole purpose for which these chemicals were listed: "Surfactants."¹²⁸ The locations of the wells where nonionic fluorosurfactants were used are displayed in the map on page two.

Table 5. Disclosed Use of Trade Secret Chemicals in New Mexico Oil and Gas Wells, 2013-2022

County Name	No. of wells injected with at least one trade secret chemical	Mass of all trade secret chemicals (lbs.)	No. of wells injected with trade secret surfactants	Mass of trade secret surfactants (lbs.)	No. of wells injected with nonionic fluoro-surfactants	Mass of nonionic fluoro-surfactants (lbs.)
Chaves	62	2,590,000	41	174,000	0	0
Colfax	4	615	0	0	0	0
De Baca	1	1,490	1	273	0	0
Eddy	3,787	110,000,000	1,895	9,120,000	8	106
Harding	15	2,820	3	33	0	0
Lea	3,606	120,000,000	1,435	8,270,000	16	860
McKinley	2	397	2	11	0	0
Rio Arriba	271	1,980,000	68	138,000	0	0
Roosevelt	5	15,000	2	12,300	0	0
San Juan	415	5,200,000	179	1,140,000	0	0
Sandoval	125	2,590,000	55	415,000	0	0
Total	8,293	243,000,000	3,681	19,300,000	24	966

This table shows by county the number of New Mexico wells in which oil and gas companies injected at least one trade secret fracking chemical, at least one trade secret surfactant, and/or at least one unspecified nonionic fluorosurfactant. It also shows the total combined weight of these chemicals by county and statewide. The total weight figures reflect the sum of all records for which we have enough information to calculate a chemical's weight. However, the total weight figures represent an undercount because many fracking chemical disclosures lack sufficient data to perform this calculation. The wells injected with trade secret surfactants are a subset of the wells injected with trade secret chemicals. The wells injected with unspecified nonionic fluorosurfactants are a subset of the wells injected with trade secret chemicals and trade secret surfactants. For a more detailed explanation of data sources, see the Appendix.

Data show that multiple oil and gas companies have injected oil and gas wells in New Mexico with trade secret chemicals that could be or could break down into PFAS. The excerpted

table below shows the 15 companies that fracked the most wells in New Mexico between 2013 and 2022 with at least one trade secret chemical.

Table 6. Excerpt (full table in Appendix). Oil and Gas Companies that Fracked the Most Wells in New Mexico Using Trade Secret Chemicals and Trade Secret Surfactants, 2013-2022

Operator	Number of wells injected with trade secret chemicals	Number of wells injected with trade secret surfactants
EOG Resources, Inc.	1177	214
COG Operating LLC	844	438
Devon Energy Production Company L. P.	586	358
Mewbourne Oil Company	575	116
Occidental Oil and Gas	498	141
XTO Energy/ExxonMobil	442	203
Apache Corporation	439	386
Cimarex Energy Co.	336	186
Matador Production Company	288	63
Chevron USA Inc.	264	189
Hilcorp Energy Company	203	0
ConocoPhillips Company/Burlington Resources	161	112
WPX Energy	148	21
Kaiser-Francis Oil Company	131	67
Lime Rock Resources II-A, L.P.	129	91

This excerpted table shows the oil and gas companies that fracked the greatest number of oil and gas wells in New Mexico with trade secret chemicals and trade secret surfactants between January 1, 2013 and September 29, 2022. The full table showing all of the companies that fracked at least one well with trade secret chemicals and trade secret surfactants between January 1, 2013, and September 29, 2022, is located in the appendix. The wells injected with trade secret surfactants are a subset of the wells injected with trade secret chemicals. For a more detailed explanation of data sources, see the Appendix.

Erratum: The heading for the middle column in Table 6 on page 15 was corrected to show that the numbers in that column reflect the number of wells injected with trade secret chemicals, 2013-2022.

Table 7. Oil and Gas Companies that Fracked Wells in New Mexico Using Nonionic Fluorosurfactants, 2013-2022

Well Operator	Number of wells injected with nonionic fluorosurfactants	Total weight of fluorosurfactants (lbs.)
Chevron USA Inc.	11	46
Apache Corporation	5	90
XTO Energy/ExxonMobil	4	814
COG Operating LLC	2	16
Nadel and Gussman Permian, LLC	1	<1
Seely Oil Co.	1	ND

This table shows the oil and gas companies that fracked oil and gas wells in New Mexico with unspecified nonionic fluorosurfactants between January 1, 2013 and September 29, 2022. The wells injected with the unspecified nonionic fluorosurfactants are a subset of the wells injected with trade secret chemicals and the wells injected with trade secret surfactants. For a more detailed explanation of data sources, see the Appendix.

ND=No Data Available

c. Examples of Individual Wells Injected with PFAS, Trade Secret Chemicals

Industry-disclosed data have allowed PSR to identify multiple types of fracking chemicals, including trade secret substances, that are injected into individual wells, as well as the quantities used. In some cases, oil and gas companies

injected hundreds or even thousands of pounds of PFAS or trade secret chemicals into oil and gas wells for fracking. If the toxicities of some of these chemicals were similar to those of PFOA or PFOS, these quantities would be enough to contaminate vast amounts of water. Table 8 provides examples of the chemicals reported in several New Mexico wells.

Table 8. Examples of Chemical Reporting on Individual Oil and Gas Wells in New Mexico

Well Operator	Well Number	County	Year Fracking Completed	Chemical as Identified	CAS Number	Trade Name	Mass (lbs.)
EOG Resources, Inc.	3002542386	Lea	2015	fluoroalkyl alcohol substituted polyethylene glycol	65545-80-4	Plexflow RTS	120
XTO Energy/ExxonMobil	3002542709	Lea	2015	nonionic fluorosurfactant	trade secret	S-222	226
XTO Energy/ExxonMobil	3001542928	Eddy	2018	PTFE	9002-84-0	not reported	394
DJR Operating, LLC	3004321335	Sandoval	2020	surfactant 1	trade secret	FN2-02	29,400
Apache Corporation	3001545800	Eddy	2021	Surfactant Blend	trade secret	FRAQ SLIQ PFR-5560	4,559

This table shows illustrative samples of specific oil and/or gas wells injected with the types of fracking chemicals referenced in the larger tables above, including the identified PFAS fluoroalkyl alcohol substituted polyethylene glycol, fluorosurfactants, the identified PFAS PTFE, and trade secret surfactants such as “surfactant 1.” The examples cover a range of years and represent wells fracked in several New Mexico counties. For a detailed explanation of data sources, see the Appendix

CH. 4

EXPOSURE PATHWAYS TO PFAS ASSOCIATED WITH OIL AND GAS OPERATIONS IN NEW MEXICO

a. Evidence of Oil and Gas Drilling-Related Spills

The potential in New Mexico for water contamination from PFAS or other chemicals used in oil and gas operations is not just hypothetical. In 2017, the news outlet EnergyWire reported on spills at oil and gas sites in New Mexico and other states that had occurred over a five-year period. EnergyWire found 847 reported spills in New Mexico in 2012, 777 in 2013, 1,303 in 2014, 1,471 in 2015, and 1,311 in 2016.¹²⁹ According to the Center for Western Priorities, oil and gas companies operating in New Mexico reported 1,368 liquid spills in the state in 2021. The total volume spilled in 2021 was more than 4.7 million gallons, of which more than four million gallons was “produced water.”¹³⁰ The remaining roughly 660,000 gallons was oil. New Mexico considers produced water to be a mixture that flows out of oil and gas wells, made up of the naturally occurring water from underground and “flowback” or wastewater from drilling and/or fracturing injected into the well that returns to the surface.¹³¹ As such, produced water in New Mexico could contain PFAS or other man-made chemicals added to drilling and/or fracking fluid as well as naturally occurring contaminants found in the formation water such as radioactive substances.¹³²

The EPA has indicated that oil can also contain residues of chemicals used in oil wells.¹³³ Therefore, it is possible that spills of produced water or oil could contain PFAS, even small amounts of which could cause significant and dangerous contamination. A review of New Mexico Oil Conservation Division records by the Center for Biological Diversity and WildEarth Guardians found that the number of spills reported in 2022 increased to more than 1,450.¹³⁴

In 2019, a well operated by Enduring Resources, located in the exterior boundaries of the Counselors Chapter of the Navajo Nation Government,¹³⁵ spilled almost 60,000 gallons of oil and oil and gas wastewater.¹³⁶ A report prepared by a consultant for Enduring Resources found that the spill entered two tributaries of Escavada Wash and that

groundwater in the area is less than 50 feet below the ground surface.¹³⁷ The New Mexico Bureau of Geology & Mineral Resources suggests that a wash is a wide, shallow streambed that is dry most of the time and that washes are similar to arroyos.¹³⁸ A state report found that the spill impacted groundwater or surface water – the report did not specify which type.¹³⁹ A 2018 report from the New Mexico Bureau of Geology and Mineral Resources suggests that the spill would have been likely to contaminate groundwater in part because “it is considered that a depth-to-water of less than 50 ft has high susceptibility” to contamination from oil and gas-related spills and because “[a]rroyo and valley bottoms are uniformly considered to be high susceptibility” for groundwater contamination following such spills.¹⁴⁰

One particularly high-profile spill occurred in January 2020 when a pipeline carrying produced water burst at night, awakening Penny Aucoin and her husband Carl George and showering their home in Otis, New Mexico with wastewater for an hour. Aucoin told the NM Political Report that she was forced to euthanize 18 chickens and a dog and give up her remaining goat. She added that a county official informed her that she could not eat her chicken eggs or the chickens’ meat and that she probably should avoid eating anything grown on her property. She and her husband reached a settlement¹⁴¹ with the company that owned the pipeline, WPX Energy,¹⁴² but Aucoin said that she remained concerned. She said during a news conference in January 2021,

The dispute has been resolved amicably, but what scares me now is that people are blissfully unaware of the dangers that come with fracking, including the enormous amount of flow back waste [produced water] produced during the fracking process.

Aucoin said that she would be moving out of the area.¹⁴³

b. Disposal of Wastewater Raises Pollution Concerns

The risk that PFAS and other chemicals could pollute the

environment through the disposal of produced water is especially high because of the huge volumes involved. State data show that in 2022, the volume of produced water from New Mexico's oil and gas wells was almost 85 billion gallons, up from 67 billion gallons in 2021, and 57 billion gallons in 2020.¹⁴⁴

According to a presentation by the state Environment Department, as of 2019, the most common method of produced water disposal was underground injection into wells that carry the wastewater into "deep, isolated geologic formations."¹⁴⁵ About 10 percent of the produced water was reused in oil and gas fields, where wastewater from oil and gas wells can be injected into oil wells to facilitate oil production in a process known as enhanced oil recovery or EOR. The surge of drilling in the Permian Basin has increased the generation of produced water and the need for more underground injection wells. Earthworks reported that

[a]s of December, 2019, New Mexico had 983 active Class II disposal wells and 3,249 Class II EOR wells, for a total of 4,232. With the rapid expansion of Permian Basin development, the number of injection well permit applications has dramatically risen over time, with 538 new applications in 2019.¹⁴⁶

If even a small percentage of the staggering amount of wastewater injected underground were tainted with PFAS, it could create significant pollution should it enter groundwater or surface water.

That fear is not unfounded; researchers have known for decades that produced water from injection wells can contaminate groundwater. In some cases, the produced water has migrated upward from deep underground, moving through nearby oil and gas wells, many of which have ceased operating but have not been properly sealed off from the surrounding underground rock formations.¹⁴⁷ This migrating wastewater can break out of abandoned wells and contaminate groundwater near the earth's surface.¹⁴⁸ In 1985, the Texas Department of Agriculture reported that

it had a name for this phenomenon: "saltwater breakout," a reference to the high salt content of produced water.¹⁴⁹ The department quoted the Congressional Office of Technology Assessment regarding the "insidious" problem of underground injection of oil and gas wastewater. The Congressional office noted that such wastewater is typically injected in exactly the places where prior drilling has created opportunities for the wastewater to migrate into groundwater.¹⁵⁰ The department further reported that produced water could contaminate groundwater through leaks in an injection well's steel or cement casing, designed to seal the well off from groundwater supplies.¹⁵¹ The consequences of such events are particularly acute in New Mexico with its heavy reliance on groundwater.

In 1989, Congress' investigative arm, the General Accounting Office (now the Government Accountability Office) found multiple cases of water contamination linked to underground injection wells, including in New Mexico. The agency cited a case in Lea County where leaks in the casing of an injection well operated by Texaco caused contamination of a farm.

During the 1970s, 20 million gallons of salt water leaked from a Texaco disposal well in Lea County, New Mexico, into portions of a drinking water source, the Ogallala aquifer. Some of the brine made its way into a rancher's irrigation well, damaging his crop and, according to the rancher, ultimately causing the foreclosure of his farm property. On the basis of the results of a pressure test, the rancher successfully sued Texaco in 1977 for damages. Texaco subsequently made repairs to the well, and it is now operating in compliance with UIC [underground injection control] regulations. Texaco was not required to clean the aquifer, however, because, according to the Chief of New Mexico's Environment Bureau, the cost could not be economically justified.¹⁵²

New Mexico's Governor's Office reported in 2022 that there were 1,700 abandoned oil and gas wells on private and state land.¹⁵³ (It is unclear how many are on federal land in New Mexico.) The potential for contamination through these wells is cause for concern. The state plugs about 50



Oil and gas wastewater is dumped from a truck into one of a series of unlined pits at the R360 waste disposal facility outside Hobbs, New Mexico, 2019. Photo credit: Melissa A. Troutman.

wells per year, but the governor said that the rate would significantly increase as the result of a \$43.7 million infusion from the federal Interior Department provided by the federal Infrastructure Investment and Jobs Act, passed in mid-2022.

Several other types of oil and gas waste disposal could pose serious risks to New Mexicans if the waste were contaminated with PFAS. One is the disposal of oil and gas waste in earthen pits known as impoundments. New Mexico has a well-documented history of groundwater contamination due to disposal of oil and gas waste in earthen pits. From the mid-1980s to 2003, the state's Oil Conservation Division found almost 7,000 cases of soil and water contamination from oil and gas waste pits and 400 cases of groundwater contamination.¹⁵⁴ This evidence prompted the state to enact the "pit rule" in 2008 that prohibited those

unlined pits that were most likely to cause contamination, strengthened the standards for pit liners, mandated that all pits have a permit, and banned new pits within certain distances of water resources and homes.¹⁵⁵ New, permanent and temporary pits, for example, were prohibited within 1,000 feet of homes, schools, or drinking water wells used by five or more families.¹⁵⁶ According to Earthworks, the pit rule was effective in reducing contamination: In its first two years of operation, there were no groundwater violations at pits covered by the rule. Meanwhile, oil and gas drilling expanded in the state, indicating that the rule did not hinder oil and gas extraction.¹⁵⁷

However, in 2013, after opposition to the pit rule from the oil and gas industry, lawmakers passed new legislation relaxing protections. As a result, companies can now locate temporary pits containing "low chloride" fluid within 100 feet

of perennial water courses, 200 feet from springs, wells or lakes, and 300 feet from homes or schools.¹⁵⁸ Such fluid with low chloride levels could pose risks if it were tainted with other toxics such as PFAS. Whereas the pit rule prohibited burying of waste at well sites unless the waste met more stringent health and environment

al standards (e.g. benzene levels in temporary pits 50-100 feet above groundwater could not exceed 0.2 parts per million),¹⁵⁹ the new rule allows burying at well sites of waste under much more permissive standards (benzene levels in temporary pits 51-100 feet above groundwater cannot exceed 10 parts per million).¹⁶⁰ As indicated by these standards, this waste often contains dangerous contaminants including carcinogenic hydrocarbons such as benzene.¹⁶¹ This report suggests that the waste could contain PFAS, too. Neither the pit rule nor the new rule mention

PFAS, but by allowing for the more permissive treatment of oil and gas waste, the new rule increases the risk of contamination from waste that could contain these highly toxic and persistent pollutants.

Earthworks identified other methods of oil and gas waste disposal in New Mexico that could pose risks for PFAS contamination including taking the waste to treatment plants, recycling facilities, landfills, and “landfarms,” where contaminated soils, drill cuttings, and tank bottoms are allowed to be spread over land.¹⁶²

c. Volatilizing, Flaring Could Pollute Air with PFAS

PFAS used in oil and gas wells could follow airborne exposure routes, according to toxicologist David Brown, former director of environmental epidemiology at the Connecticut



A poorly lit flare at Rustler Breaks SWD #6/ API #30-015-45034, a San Mateo Midstream facility in Eddy County, New Mexico, Sept. 2022. Photo credit Charlie Barrett, Earthworks.

Department of Health who has investigated health effects associated with unconventional gas drilling with the Southwest Pennsylvania Environmental Health Project. He warned that if PFAS were to enter drinking water, it could subsequently volatilize or become airborne inside homes. Brown also added another potential pathway for airborne exposure: PFAS could become airborne when gas is burned off during flaring at the wellhead or vented unburned at the wellhead.¹⁶³

Flaring and venting are used extensively in New Mexico, suggesting that airborne PFAS through these pathways could be a risk in the state. The Howard Center for Investigative Journalism analyzed satellite data and found that between 2012 and 2020, oil and gas operators on federal land in New Mexico flared more than 138 billion cubic feet of gas,¹⁶⁴ enough to power more than 1.1 million homes for a year, according to a home energy consumption estimate by Popular Science magazine.¹⁶⁵ Gas is flared or vented unburned in emergencies and when there is insufficient pipeline capacity to bring the gas to market.¹⁶⁶ Insufficient pipeline capacity has been an issue in the Permian Basin in recent years when oil prices were much higher than gas prices, leaving oil and gas companies with little incentive to build pipelines to transport and sell the gas that was extracted along with the oil.¹⁶⁷ Soaring gas prices due to the war in Ukraine may change that equation, but it takes time to construct pipelines, and gas may not be captured if it cannot be transported to market.

In 2021, New Mexico enacted rules designed to reduce flaring and venting of gas.¹⁶⁸ However, some New Mexicans are skeptical that the rules can be enforced, considering that New Mexico had only 11 well inspectors as of end-2022 but 51,000 operating oil and gas wells.¹⁶⁹ Continued flaring and venting may provide another pathway for PFAS contamination from oil and gas wells.

Louisiana-based chemist Subra told PSR that the risk of airborne PFAS exposure might even be an issue for people living hundreds of miles from oil and gas fields.¹⁷⁰ Noting that gas from across the nation is delivered via pipeline

to liquefied natural gas (LNG) facilities in Louisiana and Texas on the coast of the Gulf of Mexico, she proposed that residents of these communities ought to know if they are being exposed to PFAS in the gas from air emissions related to transforming the gas into a liquid for export. Bolstering Subra's concern, Reuters reported that in 2020, an LNG export facility in Corpus Christi, Texas operated by Cheniere Energy, Inc., exceeded permitted limits for air emissions in 293 instances. At least some of the emissions were volatile organic compounds from chemicals removed from the natural gas during the liquefaction process.¹⁷¹ Reuters did not report that PFAS was released, but it is unclear whether anyone monitored for it. Some of the gas to be exported as LNG that could contain PFAS may arrive at the Gulf Coast from New Mexico. The Energy Information Administration reported in 2022 that three new pipelines will allow gas producers in the Permian basin to reach LNG export facilities on Texas's Gulf Coast.¹⁷²

CH. 5

HEALTH STUDIES LINK OIL AND GAS OPERATIONS TO ILLNESS

a. Oil, Gas Well Proximity Associated with Disease

Peer-reviewed studies of people living near oil and gas operations have found that proximity to active well sites correlates with a variety of diseases and other health effects. While studies are lacking on health effects in New Mexico, a 2021 study of more than three million pregnant women in Texas showed that living within one kilometer of an active oil or gas well increased the odds of gestational hypertension (high blood pressure) and eclampsia¹⁷³ (a pregnancy-related high blood pressure disorder that can induce seizures or coma).¹⁷⁴ A 2020 study of pregnant women living in the Eagle Ford Shale area of South Texas found that exposure to a high number of nightly flaring events was associated with a 50 percent increase in the risk of preterm birth.¹⁷⁵ A 2020 study in Texas documented a link between natural gas drilling and production from both conventional and unconventional wells and frequency of hospitalization for childhood asthma.¹⁷⁶ Several studies conducted in Colorado, another major producer of oil and gas, also found associations between proximity to oil and gas operations and health effects, including congenital heart defects in newborns¹⁷⁷ and cancer diagnoses among Coloradans from birth to 24 years old.¹⁷⁸

PSR has collaborated with Concerned Health Professionals of New York to compile and summarize the substantial and growing number of scientific studies that have found serious health effects associated with oil and gas operations. In the eighth edition (2022) of our report, we wrote,

Public health problems associated with fracking include prenatal harm, respiratory impacts, cancer, heart disease, mental health problems, and premature death.... Poor birth outcomes have been linked to fracking activities in multiple studies in multiple locations using a variety of methods. Studies of mothers living near oil and gas extraction operations consistently find impaired infant health, especially elevated risks for low birth weight and preterm birth. As we go to press, a new study in Pennsylvania finds “consistent and robust evidence that drilling shale

gas wells negatively impacts both drinking water and quality of infant health.”¹⁷⁹

Low birthweight is a leading contributor to infant death in the United States.¹⁸⁰

Many residents living near oil and gas operations have reported serious health concerns while expressing frustration over the secrecy surrounding chemicals used by the oil and gas industry.¹⁸¹ In 2020, Pennsylvania’s Attorney General issued a report based on a criminal grand jury investigation of oil and gas drilling pollution in the Keystone State. Drilling for gas in shale formations has surged in that state over the past 15 years,¹⁸² vaulting it into the number two spot among gas-producing states (Texas is number one)¹⁸³ and bringing many more Pennsylvanians into contact with gas drilling and its impacts. Based on testimony from over 70 households, the attorney general compiled evidence of serious health impacts, finding that

Many of those living in close proximity to a well pad began to become chronically, and inexplicably, sick. Pets died; farm animals that lived outside started miscarrying, or giving birth to deformed offspring. But the worst was the children, who were most susceptible to the effects. Families went to their doctors for answers, but the doctors didn’t know what to do. The unconventional oil and gas companies would not even identify the chemicals they were using, so that they could be studied; the companies said the compounds were “trade secrets” and “proprietary information.” The absence of information created roadblocks to effective medical treatment. One family was told that doctors would discuss their hypotheses, but only if the information never left the room.¹⁸⁴

b. Studies Needed on PFAS

PSR is not aware of published studies that have analyzed well sites for PFAS or that have analyzed health effects related to potential use of PFAS at well sites. This lack of testing is not surprising; there were few if any grounds to



Angel Peak Scenic Area, Farmington, New Mexico, May 2012. New Mexico's natural beauty is well worth protecting. Photo credit: Judy Gallagher, <https://creativecommons.org/licenses/by/4.0/>.

test for PFAS in connection with oil and gas operations prior to July 2021, when PSR first publicized the probable use of these chemicals in oil and gas extraction. Now that we know PFAS have been used in oil and gas operations for years, scientists should determine whether there are connections between this use and health effects, for PFAS chemicals individually and as a compounding factor in conjunction with exposure to other fracking chemicals.

CH. 6

OIL & GAS-RELATED CHEMICAL EXPOSURE AS AN ENVIRONMENTAL JUSTICE ISSUE

a. Disproportionate Impacts on Environmental Justice Communities

“Fenceline” communities – people living close to oil and gas operations – often bear a disproportionate risk of exposure to toxic chemicals and thus may be particularly at risk from PFAS used in oil and gas extraction. Although drilling and fracking take place in the majority of U.S. states, not everyone shares in the risks equally. Rather, oil and gas infrastructure and associated chemicals are frequently located in or adjacent to lower-income, underserved, and marginalized communities, notably Black, Indigenous, and other communities of color.

In 2021, researchers used satellite observations and census data to show that 83 percent of the flaring from

unconventional oil and gas wells in the contiguous United States between March 2012 and February 2020 took place in three basins: the Permian Basin in New Mexico and Texas, the Williston Basin in North Dakota, and the Western Gulf Basin in southern Texas and Louisiana. They estimated that over half a million people in these basins lived within three miles of a flare, with 39 percent of them living near more than 100 flares each night. The researchers also reported that in these regions, Black, Indigenous, and people of color were disproportionately exposed to flaring.¹⁸⁵

Other studies have also found disproportionate impacts on people of color. A 2020 study found that compared to white residents, Hispanic residents living in the Eagle Ford shale region of Texas were disproportionately exposed to



Nighttime flaring, just north of Chaco Culture National Historical Park near Nageezi, New Mexico, Oct. 2014. Photo credit: Dom Smith, EcoFlight.

flaring from unconventional oil and gas wells, even though they were less likely than white residents to live near unconventional oil and gas wells.¹⁸⁶ In 2016, a public health research team showed that in the Eagle Ford shale region, disposal wells for fracking wastewater were more than twice as common in areas where residents were more than 80 percent people of color than in majority-white communities. They also found that disposal wells were disproportionately located in areas with high rates of poverty, but even in these areas, the association with race was predominant. “Adjusting for both poverty and rurality,” the researchers wrote, “we still found that as the proportion of people of color in the census block group increased, so did the presence of disposal wells.” Since 2007, they reported, Texas had permitted more than 1,000 waste disposal wells in the Eagle Ford Shale region, where groundwater is the primary source of drinking water.¹⁸⁷

A 2019 analysis conducted in Colorado, Oklahoma, Pennsylvania, and Texas found strong evidence that African Americans disproportionately lived near fracking wells in

Texas and Oklahoma, while Hispanics disproportionately lived near fracking wells in Texas and urban Colorado. “The question, who bears the costs of unconventional natural gas drilling, is of great relevance not only for the U.S., but worldwide,” the researchers wrote.

b. Navajo Survey Shows Health Impacts

All chapters of the Navajo Nation in New Mexico were identified in 2020 as “environmental justice” communities by the United States Bureau of Land Management.¹⁸⁸ In 2021, the Counselor Chapter of the Navajo Nation in New Mexico conducted a health and cultural survey regarding oil drilling operations in the Counselor, Torreon, and Ojo Encino chapters that identified health risks and distrust of regulators and oil companies. The chapter conducted its health survey under the guidance of the Southwest Pennsylvania Environmental Health project, which had conducted similar surveys in other communities with oil and gas drilling. Among other things, the chapter measured the levels of fine particulate matter (PM_{2.5}) through air monitors near people’s

Table 9. Wells on NM Federal, State, and Tribal Land Fracked with PFAS and Possible PFAS, 2013-2022

Type of fracking chemical injected	No. Wells in state	Total Mass in state (lbs.)	No. Wells on Federal Land	Total Mass Federal Land (lbs.)	No. Wells on State Land	Total Mass State Land (lbs.)	No. Wells on Tribal Land	Total Mass Tribal Land (lbs.)
	9066	--	4468	--	2350	--	192	--
Trade Secret chemicals	8293	243,000,000	4072	115,000,000	2153	54,600,000	186	2,040,000
Trade Secret surfactants	3681	19,300,000	1813	10,900,000	954	4,740,000	86	230,000
Fluoro-surfactants	24	965	12	790	10	164	0	0.0
65545-80-4	34	6,400	8	1,370	17	3,060	0	0.0
PTFE	227	2,610	113	1,650	53	552	3	data not available

This table shows the number of oil and gas wells in New Mexico -- statewide, on federal land, on state-owned land, and on tribal land -- that oil and gas companies fracked between 2013 and 2022 with at least one trade secret chemical, at least one trade secret surfactant, at least one fluorosurfactant, fluoroalkyl alcohol substituted polyethylene glycol (CAS Number 65545-80-4, a known PFAS), or PTFE (a known PFAS). The total weight figures reflect the sum of all records for which PSR has enough information to calculate a chemical’s weight. For a detailed explanation of data sources, see the Appendix.

homes on the side of the home nearest to the closest oil wells. The readings showed the PM_{2.5} levels, generally recorded between peak releases, were significantly higher at six of eight measuring sites compared to median levels in other non-Navajo communities with oil and gas operations. Residents living near a source of such air pollution are at greater risk for contracting or intensifying respiratory or cardiovascular diseases.¹⁸⁹ In a survey of health symptoms of 80 residents of the Counselor Chapter, more than 60 percent reported 11 symptoms during the year after drilling began near their homes, including sore throat, cough, and sinus problems. This number of reported health symptoms was greater than the number reported by respondents living near oil and gas wells in other communities in the U.S.¹⁹⁰ Separately, the Chapter conducted a cultural survey regarding the effects of oil drilling, collecting data from 136 randomly selected adults in the three chapters. Among other findings, 104 respondents strongly agreed with the statement, “Our local leaders have spoken out against drilling

and no one at the tribal, state or federal level, including BLM and BIA, has listened.” One hundred and seventeen strongly agreed with the statement, “The oil companies have no respect for land, people & life.”¹⁹¹

PSR found that about 97 percent of the wells in New Mexico drilled on tribal land for which oil and gas companies disclosed the use of fracking chemicals were injected with at least one trade secret fracking chemical. This percentage was a bit higher than for wells drilled statewide (about 91 percent). But the total number of wells drilled on tribal land was much smaller, so it is unclear whether this difference was statistically significant.

Where a pattern of risks affects people of color and/or lower-income people disproportionately, oil and gas production methods should be viewed and addressed as an Environmental Justice issue. So too should any oil and gas-related exposure to PFAS.

CH. 7

POLICY CAN HELP PROTECT NEW MEXICANS FROM PFAS IN OIL & GAS OPERATIONS

a. Modest Federal Protections from PFAS Pollution

Governments at all levels will have to do more to protect the public from PFAS, in large part because EPA has taken only modest steps to do so, while Congress and the executive branch have exempted the oil and gas industry from major provisions of multiple federal environmental laws. For example, oil and gas waste is exempted from the hazardous waste rules that require cradle-to-grave tracking and safe handling of hazardous substances under the Resource Conservation and Recovery Act. These exemptions increase the burden on state governments to address any PFAS pollution associated with oil and gas extraction.¹⁹²

EPA has taken some steps to protect the public from dangerous PFAS. In 2005, EPA reached a then-record \$16.5 million settlement with chemical manufacturer Dupont after accusing the company of violating the federal Toxic Substances Control Act (TSCA) by failing to disclose information about PFOA's toxicity and presence in the environment.¹⁹³ In 2006, EPA invited Dupont, 3M and six other companies to join a "stewardship" program in which the companies promised to achieve a 95 percent reduction of emissions of PFOA and related chemicals by 2010, compared to a year 2000 baseline. The agreement also required the companies to eliminate such emissions and use of these chemicals by 2015.¹⁹⁴ In 2022, EPA said on its website that the companies reported that they had accomplished those goals, either by exiting the PFAS industry or by transitioning to alternative chemicals.¹⁹⁵ EPA reported in 2022 that the manufacture and use of at least one PFAS, PFOA, had been phased out in the U.S., and that no chemical company had reported making PFOS in the U.S. since 2002. EPA noted that existing stocks of PFOA might still be used, and imported products may contain some PFOA.¹⁹⁶ A 2020 scientific article reported that PFOA was still used in Asia.¹⁹⁷ EPA stated that limited ongoing uses of PFOS remain.¹⁹⁸ Since the announcement of its PFAS stewardship program in 2006, EPA has allowed nearly unlimited use of closely related "replacement" chemicals in dozens of industries.¹⁹⁹

In response, in 2015 a group of more than 200 scientists raised health and environmental concerns that the new PFAS designed to replace PFOA and PFOS may not be safer for health or the environment.²⁰⁰

In October 2021, EPA announced a "strategic roadmap" for regulating PFAS. This plan encompasses a goal of setting federal drinking water standards for several PFAS chemicals by 2023, as well as commitments to "use all available regulatory and permitting authorities to limit emissions and discharges from industrial facilities" and "hold polluters accountable."²⁰¹ The plan does not, however, include an examination of PFAS use in the oil and gas industry. (Later that month, 15 members of the U.S. House of Representatives asked EPA to examine this topic.²⁰² The month before, PSR asked EPA to collect data on PFAS use in oil and gas extraction, utilizing its authority under TSCA.²⁰³ As previously stated, in June 2022, EPA announced new health advisory levels for several types of PFAS; unfortunately, these standards are advisory and not legally enforceable.²⁰⁴ In August 2022, EPA proposed designating PFOA and PFOS as hazardous under Superfund.²⁰⁵ This designation would enable affected parties to more easily hold oil and gas companies accountable for cleanup costs if PFOA and PFOS were found at oil and gas sites because under Superfund, liability does not require negligence, and any potentially responsible party (PRP) can be held liable for cleanup of an entire site when it is difficult to distinguish contributions to pollution among several parties. As EPA writes about Superfund, "[i]f a PRP sent some amount of the hazardous waste found at the site, that party is liable."²⁰⁶ Finally as previously stated, in March 2023, EPA announced a plan to regulate six types of PFAS in drinking water.

In acting belatedly to regulate at least some types of PFAS in drinking water, EPA is following the lead of several states. As of 2023 nine states, including at least several with contaminated military sites, had developed enforceable standards for concentrations of several types of PFAS in drinking water.²⁰⁷ One of those to act is Michigan, which set standards in 2020 for limiting PFAS in drinking water and

for removing PFAS from groundwater. The standards apply to PFOA and six other forms of PFAS. Michigan's maximum allowable level is no more than eight parts per trillion for PFOA,²⁰⁸ a standard that is one of the lowest among states but is now much more permissive than EPA's interim health advisory level. Even Michigan's standard, however, shows how toxic PFAS can be. By extrapolation, Michigan's standard suggests that one measuring cup of PFOA could contaminate almost eight billion gallons of water – the amount of water needed to fill almost 12,000 Olympic-sized swimming pools at about 660,000 gallons per pool.²⁰⁹

b. New Mexico Disclosure Rules: In Need of Sweeping Reform

In New Mexico, multiple reforms are needed to protect the public from the use of PFAS in oil and gas operations, including changing the state's chemical disclosure rules to lift the veil of secrecy that oil and gas companies have used to conceal the use of potentially dangerous chemicals including, perhaps, PFAS. One such change should be tighter limits on the use of trade secret provisions.

Oil and gas companies have argued that chemical trade secrets are necessary to protect their intellectual property from competitors. However, this interest does not have to mean a complete withholding of information on chemical identities from scientists, regulators, and the public. In 2015, California, a major oil-producing state,²¹⁰ began requiring full disclosure of chemicals used for well stimulation, including fracking. The policy did away with trade secret exemptions for the individual chemicals used in fracking products.²¹¹ In June 2022, Colorado, a major producer of oil and gas,²¹² followed in California's footsteps but extended the disclosure requirements to all chemicals used in oil and gas wells, not just fracking or stimulation chemicals.²¹³

The methodology utilized in California and Colorado is consistent with a recommendation issued in 2014 by an advisory panel to the U.S. Department of Energy: that companies reveal the fracking chemicals injected into each well, providing that information in a list in which

the chemicals are disassociated from the trade name of the commercial products they are part of.²¹⁴ This form of disclosure enables the public to know all the chemicals used in fracking without disclosing to rival chemical manufacturers the exact components of proprietary formulas.²¹⁵ In a similar way, food producers keep recipes secret while disclosing individual ingredients, enabling the public to know the contents of food products but making it difficult for rival producers to recreate valuable food brands. In addition, California has a process under which state regulators review secrecy requests from chemical companies to determine whether the information must be kept proprietary.²¹⁶ Health and safety data related to fracking fluids are not allowed to be hidden from public view under California law.²¹⁷ California also requires disclosure of fracking chemicals before fracking begins,²¹⁸ as do West Virginia²¹⁹ and Wyoming.²²⁰

New Mexico should also ensure that full chemical disclosure is required from all the companies in the chemical supply chain. Currently, New Mexico rules require chemical disclosure from the well operator.²²¹ Chemical manufacturers, however, are exempted from this reporting, despite being the only entity that always knows the precise contents of the chemicals they produce. Not only does New Mexico omit chemical manufacturers from disclosure requirements and allow them to claim trade secrets; it also limits their responsibility by providing that the Division of Oil and Gas “does not require the reporting of information beyond the material safety data sheet data as described in 29 C.F.R. 1910.1200.” This provision means that disclosure is limited to what is required on material safety data sheets (now called safety data sheets) on which chemical manufacturers list information about their chemicals to protect workers. Well operators are not responsible for compiling chemical information from manufacturers that is not disclosed on the sheets.²²² As several Harvard researchers reported in 2013, manufacturers can legally omit chemical information from the sheets. For example, if a chemical has not been tested and found to be hazardous, it does not need to be disclosed, even if tests would show that it is hazardous.²²³ Therefore, the manufacturers could effectively withhold this information from public disclosure with or without trade secret protection.



Flaring near Chaco Culture National Historic Park, Dec. 2014. Photo credit: Jane Pargiter, EcoFlight.

Evidence suggests that chemical manufacturers do not always tell companies farther down the supply chain the full contents of the chemical products they are using; rather, they provide these companies with vague descriptions, generic chemical family names or, as the Harvard researchers suggested, Material Safety Data Sheets with an incomplete list of chemicals.²²⁴ In such cases, the end users may legitimately be unable to disclose all the identities of chemicals – including PFAS – used at a particular well, whether under trade secret protection or not. They simply would not have the information. Requiring disclosure of oil and gas chemicals by chemical manufacturers would avoid this problem. Colorado took this step in its June 2022 legislation.²²⁵

These reasonable and feasible reforms are valuable steps to protect the health of people who may be exposed to PFAS and other dangerous oil and gas chemicals, be they industry

workers, residents living near well sites, or first responders called to the scene of an accident. They can improve health and potentially save lives. Additional steps to reduce the harms caused by oil and gas extraction are outlined in the following section, including a ban on the use of PFAS in oil and gas operations, an action that Colorado took in 2022.²²⁶ Among the evidence supporting the feasibility of this measure is a peer-reviewed analysis published in 2021 showing that many PFAS are immediately replaceable with less-persistent and less-toxic substances, including for use in the oil and gas industry.²²⁷

c. New Mexico Hazardous Waste Rules Also in Need of Reform

New Mexico's state government has recognized the dangers of PFAS but, in doing so, has illuminated another gap in

state rules that should be closed to protect the public from PFAS use in oil and gas operations. In 2021, Governor Michelle Lujan Grisham petitioned EPA to list the class of chemicals known as PFAS as hazardous under Subtitle C of the federal Resource Conservation and Recovery Act (RCRA) or, alternatively, “list individual PFAS chemicals under RCRA known to have harmful effects to humans and the environment.”²²⁸ Subtitle C of RCRA is our nation’s law that requires safe management of hazardous waste from “cradle-to-grave.”²²⁹ Gov. Lujan Grisham emphasized how important this policy change would be for New Mexico, writing

I implore EPA to do what is immediately necessary to protect the people and environment of the United States from the real and potentially devastating effects of exposure to PFAS....Without a uniform regulatory process addressing PFAS from manufacture to disposal, states like New Mexico will be left attempting to use a patchwork of statutory and regulatory authorities that may or may not provide enough oversight...²³⁰

EPA administrator Michael Regan replied later in 2021 that the agency would initiate a rulemaking process to declare four types of PFAS to be hazardous under RCRA: PFOA, PFOS, PFBS, and GenX. He also said that EPA would initiate a rulemaking to “clarify that emerging contaminants such as PFAS can be addressed through RCRA corrective action.”²³¹

Yet under both the federal RCRA²³² and the state’s implementation of the federal law,²³³ oil and gas wastes are exempt from hazardous waste requirements. This exemption likely means that even if EPA acted on the governor’s petition and declared PFAS hazardous, oil and gas wastes containing PFAS would not be subject to hazardous waste protections. New Mexico could act to avoid this problem and regulate oil and gas waste as hazardous by following the example of New York State. In 2020, New York enacted legislation to designate oil and gas waste as hazardous.²³⁴ State Senator Rachel May, one of the bill’s sponsors, said in a statement,

Wastewater from fracking can contain carcinogenic compounds and naturally occurring radioactive

materials. The regulatory loophole that allowed waste from fracking and crude oil processing to be treated as standard industrial waste means it enters local sewage treatment facilities, sometimes with radiation levels hundreds of times the safe limit, it then flows directly back into our waterways – the source of drinking water for thousands of New Yorkers.²³⁵

May issued her statement before it was widely known that PFAS was used in oil and gas operations, but considering the oil and gas industry’s record of using PFAS, these chemicals could be present in oil and gas wastes whether in New York, New Mexico, or other states. Continuing to exempt oil and gas wastes from hazardous waste treatment means that PFAS in these wastes would likely be exempt, too, with potentially serious consequences for New Mexicans.



RECOMMENDATIONS

In light of the findings shared in this report, PSR recommends the following:

- **Halt PFAS use in oil and gas extraction.** New Mexico should follow the lead of Colorado, a major oil- and gas-producing state that in June 2022 passed legislation banning the use of PFAS in oil and gas wells. Furthermore, New Mexico and the U.S. Environmental Protection Agency (EPA) should prohibit PFAS from being used, manufactured, or imported for oil and gas extraction. Many PFAS are replaceable with less-persistent and less-toxic alternatives.
- **Expand public disclosure.** New Mexico should greatly expand its requirements for public disclosure of oil and gas chemicals. The state could again follow the example offered by Colorado by requiring disclosure of all individual chemicals used in oil and gas wells, without exceptions for trade secrets, while still protecting chemical product formulas. New Mexico should also require disclosure on the part of chemical manufacturers and require chemical disclosure prior to permitting, as have California, West Virginia, and Wyoming.
- **Increase testing and tracking.** New Mexico and/or the U.S. EPA should determine where PFAS have been used in oil and gas operations in the state and where related wastes have been deposited. They should test nearby residents, water, soil, flora, and fauna for PFAS, both for the particular type(s) of PFAS used and for organic fluorine to detect the presence of other PFAS. and/or their breakdown products. Testing equipment should be used that is sensitive enough to detect PFAS at a level of single-digit parts per trillion or lower.
- **Require funding and cleanup.** Oil and gas and chemical firms should be required to fund environmental testing for PFAS in their areas of operation, and should PFAS be found, be required to fund cleanup. If water cleanup is impossible, companies responsible for the use of PFAS should pay for alternative sources of water for household and agricultural uses, as needed.
- **Remove New Mexico's oil and gas hazardous waste exemption.** New Mexico exempts oil and gas industry wastes from state hazardous waste rules. New Mexico should follow New York's lead and remove its state-level hazardous waste exemption for the oil and gas industry.
- **Reform New Mexico's regulations for oil and gas production wells and underground injection disposal wells.** The state should prohibit production wells and underground wastewater disposal wells close to underground sources of drinking water, homes, health care facilities and schools, require groundwater monitoring for contaminants near the wells, and for disposal wells, require full public disclosure of chemicals in the wastewater.
- **Transition to renewable energy and better regulation.** Given the use of highly toxic chemicals in oil and gas extraction, including but not limited to PFAS, as well as climate impacts of oil and gas extraction and use, New Mexico should transition away from oil and gas production and move toward renewable energy and efficiency while providing economic support for displaced oil and gas workers. As long as drilling and fracking continue, the state should better regulate these practices so that New Mexicans are not exposed to toxic substances and should empower local governments also to regulate the industry. When doubt exists as to the existence or danger of contamination, the rule of thumb should be, "First, do no harm."



APPENDIX

Data Sources for PFAS Used in New Mexico's Oil and Gas Wells

To identify where PFAS were used at oil and gas wells in New Mexico, PSR analyzed data from the state Oil Conservation Division that is part of the Energy, Minerals and Natural Resources Department. These data, based on reports from oil and gas well operators, show well-by-well which fracking chemicals were used.²³⁶ These data date from January 1, 2013 to early 2018, likely because a change in state rules in September 2017 required reporting to the FracFocus database rather than to the state.²³⁷ PSR also relied on the well-by-well reports of fracking chemicals recorded in FracFocus, a database for the oil and gas industry²³⁸ maintained by the Groundwater Protection Council,²³⁹ a nonprofit comprised of regulators from state agencies. The dates of these records extend from January 1, 2013 to September 29, 2022. PSR consulted the open-source

version of FracFocus, Open-FF,²⁴⁰ which is more accurate and informative than the original version of FracFocus.²⁴¹

Under current New Mexico law, operators must disclose the fracking chemicals used in each well to the FracFocus database using the “current edition of the hydraulic fluid product component information form published by FracFocus.” Disclosure must occur within 45 days after hydraulic fracturing treatment.²⁴² Based on the disclosure forms available on FracFocus’ website, operators must list, among other things, each individual chemical injected into the well and each chemical’s CAS number, if available.²⁴³ New Mexico’s prior fracking chemical disclosure rules required disclosure of similar information.²⁴⁴ There are, however, significant exceptions to disclosure requirements under New Mexico’s rules, including an exception for chemicals designated a trade secret²⁴⁵ that are discussed in Chapter 3 and Chapter 7.

Table 6. Oil and Gas Companies that Fracked Wells in New Mexico Using Trade Secret Chemicals and Trade Secret Surfactants, 2013-2022.

Operator	Number of wells injected with trade secret chemicals	Number of wells injected with trade secret surfactants
EOG Resources, Inc.	1177	214
COG Operating LLC	844	438
Devon Energy Production Company L. P.	586	358
Mewbourne Oil Company	575	116
Occidental Oil and Gas	498	141
XTO Energy/ExxonMobil	442	203
Apache Corporation	439	386
Cimarex Energy Co.	336	186
Matador Production Company	288	63
Chevron USA Inc.	264	189
Hilcorp Energy Company	203	0
ConocoPhillips Company/Burlington Resources	161	112
WPX Energy	148	21
Kaiser-Francis Oil Company	131	67
Lime Rock Resources II-A, L.P.	129	91
BTA Oil Producers LLC	121	27
Marathon Oil	108	3
Mack Energy Corp	105	76
RKI Exploration & Production, LLC	100	55
Burnett Oil Co., Inc.	99	47
BOPCO, L.P.	86	64
Yates Petroleum Corporation	84	71
LRE Operating, LLC	82	64
Encana Oil & Gas (USA) Inc.	76	40
Tap Rock Resources	73	1
Centennial Resource Production, LLC	70	10
DJR Operating, LLC	70	63
Energen Resources Corporation	68	20
Advance Energy Partners Hat Mesa LLC	53	22
Murchison Oil & Gas Inc	47	44
Dugan Production Corp.	46	27
Novo Oil & Gas Texas, LLC	44	39
Logos Operating, LLC	42	21
Franklin Mountain Energy	39	0
Enduring Resources LLC	36	26
Vanguard Permian LLC	34	14
BP America Production Company	33	16
OXY USA WTP Limited Partnership	33	23

Table 6. Oil and Gas Companies that Fracked Wells in New Mexico Using Trade Secret Chemicals and Trade Secret Surfactants, 2013-2022.

Operator	Number of wells injected with trade secret chemicals	Number of wells injected with trade secret surfactants
Titus Oil & Gas Production, LLC	30	16
Caza Operating, LLC	23	13
Endurance Resources LLC	23	22
Chisholm Energy Operating, LLC	21	2
Legacy Reserves Operating LP	21	10
Ameredev Operations LLC	20	5
EnerVest, Ltd.	20	19
SM Energy	18	2
Colgate Operating, LLC	16	1
Gmt Exploration Company LLC	15	14
BreitBurn Operating LP	14	8
Burlington Resources Oil & Gas Company LP	14	14
Nearburg Producing Co	14	14
Longfellow Energy, LP	13	9
Redwood Operating LLC	13	4
Percussion Petroleum LLC	12	10
Steward Energy II, LLC	12	7
Fasken Oil & Ranch Ltd	11	10
Nadel and Gussman Permian, LLC	11	10
Read & Stevens, Inc.	10	10
Whiting Petroleum	10	3
Linn Operating, Inc.	9	2
Cross Timbers Energy, LLC	8	6
Pride Energy Company	8	8
Strata Production Co.	8	6
Chesapeake Operating, Inc.	7	7
Elm Ridge Exploration Company LLC	7	0
Forty Acres Energy LLC	7	6
Legend Natural Gas Iii Limited Partnership	7	1
McElvain Energy, Inc.	7	5
Regeneration Energy, Corp	7	6
Alamo Permian Resources, LLC	6	5
Manzano LLC	5	4
V-F Petroleum Inc	5	3
Atlas Energy, L.P.	4	0
Avant Operating, LLC	4	0
Capstone Natural Resources, LLC	4	4
Lynx Petroleum Consultants Inc	4	4

Table 6. Oil and Gas Companies that Fracked Wells in New Mexico Using Trade Secret Chemicals and Trade Secret Surfactants, 2013-2022.

Operator	Number of wells injected with trade secret chemicals	Number of wells injected with trade secret surfactants
Marshall & Winston Inc	4	4
Premier Oil & Gas Inc	4	4
Rockcliff Energy Operating	4	0
Special Energy Corporation	4	4
Hadaway Consulting and Engineering, LLC	3	3
Nemo Fund I, LLC	3	3
Stephens & Johnson Operating Co.	3	1
Sundown Energy LP	3	0
Catena Resources Operating, LLC	2	2
Foundation Energy Management, LLC	2	2
IACX Production	2	2
ICA Energy Operating LLC	2	0
Koch Exploration Company, LLC	2	2
Maverick Operating, LLC	2	2
Memorial Resource Development LLC	2	0
OneEnergy Partners Operating, LLC	2	0
Quantum Resources Management, LLC	2	2
Sg Interests I Ltd	2	2
SIMCOE LLC	2	0
Texland Petroleum, LP	2	2
Thompson Engr & Prod Corp	2	1
Amtex Energy Inc.	1	0
BAM Permian Operating, LLC	1	1
BC Operating, Inc.	1	1
Boaz Energy, LLC.	1	1
Chuza Oil Company	1	1
Clayton Williams Energy Inc.	1	0
CML Exploration, LLC	1	1
Cobra Oil & Gas Corporation	1	1
D J Simmons Inc	1	1
DGP Energy	1	0
Forge Energy, LLC	1	1
Harvey E Yates Co	1	1
HEXP Operating, LLC	1	1
Hunt Cimarron Limited Partnership	1	1
Huntington Energy, LLC	1	0
ImPetro Operating LLC	1	1
Mammoth Exploration, LLC	1	1

Table 6. Oil and Gas Companies that Fracked Wells in New Mexico Using Trade Secret Chemicals and Trade Secret Surfactants, 2013-2022.

Operator	Number of wells injected with trade secret chemicals	Number of wells injected with trade secret surfactants
Mar Oil & Gas Corp.	1	0
Merit Energy Company	1	1
Merrion Oil & Gas Corp	1	1
Ridgeway Arizona Oil Corp.	1	0
Robert L. Bayless, Producer LLC	1	1
Running Horse Production Company	1	0
San Juan Resources, Inc.	1	0
Seely Oil Co	1	1
Tacitus LLC	1	0
Western Refining Southwest, Inc.	1	0

This table shows the oil and gas companies that fracked oil and gas wells in New Mexico with trade secret chemicals and trade secret surfactants between January 1, 2013 and September 29, 2022. The wells injected with trade secret surfactants are a subset of the wells injected with trade secret chemicals.

*ND = No data available.



New Mexico must strengthen its protections from PFAS and other pollution related to oil and gas extraction to safeguard its land and people. View from Deep Access Cave, Carlsbad Caverns National Park, Sept. 2020. Photo credit: Dan Pawlak, National Park Service.



ENDNOTES

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¹⁰⁴ PSR calculated the estimated maximum amounts of trade secret chemicals used in each well in New Mexico primarily by using disclosures by well operators for each well listed in FracFocus. We then aggregated the maximum amounts for each well to calculate county-by-county and state-wide totals. To illustrate the

methodology, we will use as an example the figures from XTO Energy/ExxonMobil's well number 35-019-26303 fractured in Carter County, Oklahoma in 2019. We estimated the total mass of the hydraulic fracturing fluid used in each well in pounds by multiplying the gallons of water listed as being used as the base fluid for the fracturing fluid (223,650 in this case) by 8.33, the number of pounds in a gallon of water as listed in a table of the weights of various solvents published by the U.S. Environmental Protection Agency. See U.S. Environmental Protection Agency. Conversion from Gallons to Pounds of Common Solvents. Accessed Jan. 12, 2022, at <https://www.epa.gov/p2/pollution-prevention-tools-and-calculators>. That quantity of water in the XTO Energy/ExxonMobil example weighs approximately 1,863,005 pounds. We then calculated the total mass of the fracturing fluid by multiplying the mass of the water in pounds by 100 and dividing that product by the listed maximum percent concentration of water in the fracturing fluid (78.31797). The estimated total maximum mass of the fracturing fluid in the example is 2,378,770 pounds. Next, we multiplied the listed maximum concentration in percent by mass of the potential PFAS chemical in the fracturing fluid (0.00074) by the total estimated mass of the fluid. The result was an estimated maximum of 17.6 pounds of potential PFAS used to fracture the well. PSR included in our analysis of trade secret chemicals those chemicals in Open-FF whose specific identities were explicitly labeled "proprietary," "trade secret," or "confidential business information" in place of a CAS number. PSR did not include as trade secrets additional unidentified chemicals for which the CAS number in Open-FF is blank.

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¹¹⁷ PSR determined that a chemical was a surfactant if the chemical's ingredient name or purpose was listed in FracFocus as a surfactant.

¹¹⁸ PSR calculated the estimated maximum amounts of trade secret chemicals used in each well in New Mexico primarily by using disclosures by well operators for each well listed in FracFocus. We then aggregated the maximum amounts for each well to calculate county-by-county and state-wide totals. To illustrate the

methodology, we will use as an example the figures from XTO Energy/ExxonMobil's well number 35-019-26303 fractured in Carter County, Oklahoma in 2019. We estimated the total mass of the fracking fluid used in each well in pounds by multiplying the gallons of water listed as being used as the base fluid for the fracking fluid (223,650 in this case) by 8.33, the number of pounds in a gallon of water as listed in a table of the weights of various solvents published by the U.S. Environmental Protection Agency. See U.S. Environmental Protection Agency. Conversion from Gallons to Pounds of Common Solvents. Accessed Sept. 9, 2022, at <https://www.epa.gov/p2/pollution-prevention-tools-and-calculators>. That quantity of water in the XTO Energy/ExxonMobil example weighs approximately 1,863,005 pounds. We then calculated the total mass of the fracking fluid by multiplying the mass of the water in pounds by 100 and dividing that product by the listed maximum percent concentration.

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²⁰³ Physicians for Social Responsibility. Comments submitted to the U.S. Environmental Protection Agency in reference to Docket Identification (ID) Number EPA-HQ-OPPT-2020-0549 (Sept. 27, 2021).

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²⁰⁹ Tim Buckland. Toxic GenX: Defining Parts Per Trillion. *Wilmington (N.C.) Star News* (August 18, 2017). Accessed Jan. 12, 2022, at <https://www.starnewsonline.com/news/20170818/what-does-140-parts-per-trillion-look-like>.

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²¹⁶ Cal. Public Resources. § 3160 (j)(5-7).

²¹⁷ Cal. Public Resources § 3160 (j)(2).

²¹⁸ Cal. Public Resources. § 3160(d)(6).

²¹⁹ W. Va. Code §§ 22-6A-7(e)(5), 22-6A-10(b).

²²⁰ Wyoming Admin. Code Ch. 3 § 45(a).

²²¹ New Mexico Admin. Code 19.15.16.19

²²² New Mexico Admin. Code 19.15.16.19(B)(1).

²²³ Kate Konschnik et al. 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-LEGALFRACTURES.pdf>. 29 CFR § 1910.1200; 2018.

²²⁴ For example, in 2014, four attorneys with years of experience litigating oil and gas-related cases in Pennsylvania filed a petition with the state Commonwealth Court suggesting manufacturers often withhold chemical identities from other companies in the supply chain. See Petitioners' pleading filed in Robinson Twp. v. Commonwealth, Docket No. 284 MD 2012 (June 9, 2014), at 13 FN5 (on file with PSR). The attorneys provided as support a record filed in a separate case by well operator Range Resources in which Range suggested that it was relying on Material Safety Data Sheets from manufacturers to reply 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." See *Kiskadden v. Department of Environmental Protection v. Range Resources – Appalachia, LLC*. Docket No. 2011-149-R. 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) (on file with PSR).

²²⁵ Colorado House Bill 22-1348(2)(f) (enacted June 8, 2022). Accessed Sept. 8, 2022, at https://leg.colorado.gov/sites/default/files/2022a_1348_signed.pdf

²²⁶ Colorado House Bill 22-1348(2)(A)(II) (enacted June 8, 2022). Accessed Sept. 8, 2022, at https://leg.colorado.gov/sites/default/files/2022a_1348_signed.pdf.

²²⁷ Julianne Glüge et al. Information Requirements under the Essential-Use Concept: PFAS Case Studies. *Environmental Science & Technology* (Oct. 5, 2021). Accessed Sept 9, 2022, at <https://pubs.acs.org/doi/10.1021/acs.est.1c03732>.

²²⁸ Letter from Michelle Lujan Grisham to EPA Administrator Michael Regan regarding the listing of PFAS as hazardous under the federal Resource Conservation and Recovery Act (June 23, 2021). Accessed Jan. 19, 2023, at https://www.epa.gov/system/files/documents/2021-10/508compliant_ezd5442262_2021-06-23-governor-letter-to-epa-for-pfas-petition.pdf-incoming-document.pdf.

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²³⁰ Letter from Michelle Lujan Grisham to EPA Administrator Michael Regan regarding the listing of PFAS as hazardous under the federal Resource Conservation and Recovery Act (June 23, 2021), at 1-2. Accessed Jan. 19, 2023, at https://www.epa.gov/system/files/documents/2021-10/508compliant_ezd5442262_2021-06-23-governor-letter-to-epa-for-pfas-petition.pdf-incoming-document.pdf.

²³¹ Letter from EPA Administrator Michael S. Regan to New Mexico Governor Michelle Lujan Grisham (Oct. 26, 2021). Accessed Jan. 20, 2023, at https://www.epa.gov/system/files/documents/2021-10/oct_2021_response_to_nm_governor_pfas_petition_corrected.pdf.

²³² U.S. Environmental Protection Agency. Regulatory Determination for Oil and Gas and Geothermal Exploration, Development and Production Wastes. 53 FR 25447 (July 6, 1988). Accessed Jan. 20, 2023, at <https://archive.epa.gov/epawaste/nonhaz/industrial/special/web/pdf/og88wp.pdf>.

²³³ N.M. Admin. Code 19.15.36.13(F)(1)(referencing form C-138). Accessed Feb. 20, 2023, at <https://www.srca.nm.gov/parts/title19/19.015.0036.html>. Form C-138 accessed Feb. 20, 2023, at <https://www.emnrd.nm.gov/ocd/wp-content/uploads/sites/6/2022-1011-C-138-with-updated-instructions.pdf>.

²³⁴ S. 3392 (signed by governor Aug. 3, 2020). Accessed Jan. 20, 2023, at <https://www.nysenate.gov/legislation/bills/2019/s3392>.

²³⁵ New York State Senator Rachel May. Legislature Closes Decade Long Loophole on Treatment of Hazardous Fracking Waste. News Release (July 22, 2020). Accessed Jan. 20, 2023, at <https://www.nysenate.gov/newsroom/press-releases/rachel-may/legislature-closes-decade-long-loop-hole-treatment-hazardous>.

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²³⁷ N.M. Reg. Volume XXIII, Number 3 (Feb. 15, 2012), at 68 (N.M. Admin. Code 19.15.16.19.16) (requiring fracking chemical disclosure to the state) and N.M. Reg. Volume XXVIII, Issue 18 (Sept. 26, 2017), at 757-758 (N. M. Admin. Code 19.15.16.19) (requiring fracking chemical disclosure to FracFocus. Accessed Dec. 20, 2022, at <https://www.srca.nm.gov/nmac-home/new-mexico-register/>.

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²³⁹ Groundwater Protection Council. Overview. Accessed Sept. 5, 2022, at <https://www.gwpc.org/about-us/overview/>.

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²⁴⁴ N.M. Reg. Volume XXIII, Number 3 (Feb. 15, 2012), at 68 (N.M. Admin. Code 19.15.16.19.16) Accessed Dec. 20, 2022, at <https://www.srca.nm.gov/nmac-home/new-mexico-register/>.

²⁴⁵ N.M. Admin. Code § 19.15.16.19(B)(2).



1111 14th Street NW, #700
Washington, DC 20005
202 667 4260
www.psr.org
psrnat@psr.org

 @PSRenvironment and @PSRnuclear

 /psrnational

An Act

HOUSE BILL 22-1348

BY REPRESENTATIVE(S) Froelich and Caraveo, Amabile, Bacon, Bernett, Cutter, Duran, Gray, Hooton, Jodeh, Kennedy, Kipp, Lindsay, Lontine, Sirota, Bird, Boesenecker, Gonzales-Gutierrez, McCormick, Ricks, Titone, Valdez A., Weissman, Benavidez, Herod, Snyder, Sullivan, Woodrow;
also SENATOR(S) Winter, Buckner, Donovan, Ginal, Gonzales, Hansen, Jaquez Lewis, Lee, Moreno, Pettersen, Story, Zenzinger, Fenberg.

CONCERNING ENHANCED OVERSIGHT OF THE CHEMICALS USED IN OIL AND GAS PRODUCTION, AND, IN CONNECTION THEREWITH, MAKING AN APPROPRIATION.

Be it enacted by the General Assembly of the State of Colorado:

SECTION 1. Legislative declaration. (1) The general assembly hereby finds and declares that:

(a) There are tens of thousands of active oil and gas wells in Colorado;

(b) Many different types of products that contain chemical additives are used by operators during the drilling and stimulation of these wells to

Capital letters or bold & italic numbers indicate new material added to existing law; dashes through words or numbers indicate deletions from existing law and such material is not part of the act.

break up the subsurface and extract oil and gas from the ground;

(c) While water and sand can make up the vast majority of these products, the amount of chemical additives injected into a well can add up to tens of thousands of gallons because of the amount of these products that are used during the course of an oil and gas operation;

(d) When these chemical additives are injected into a well, there is a high risk of contamination to nearby groundwater or surface water; and

(e) Some chemicals used in chemical products, such as perfluoroalkyl and polyfluoroalkyl chemicals and biocides, have high aquatic toxicity and can be incredibly harmful to human health and the environment.

(2) The general assembly further finds and declares that:

(a) Even though exposure to these chemical additives poses a danger to public health and the environment, scientists, state and local regulators, and the public lack full access to information about the chemical additives used in oil and gas production in the state;

(b) While Colorado requires the reporting of certain chemical information for products that are used in hydraulic fracturing (fracking) operations for input into a third-party database, there are broad exemptions allowed for chemical information that is deemed proprietary or confidential by the operator or supplier of a product;

(c) In recent years, thousands of operators who conduct fracking operations have used trade secrecy claims to avoid disclosing information about the chemicals that they use in their operations;

(d) Operators and suppliers of the products often do not have knowledge of the chemical information that they are required to report to the state;

(e) As a result of the amount of trade secrecy claims and the operators' and suppliers' lack of knowledge of specific chemical information, information about the chemical additives that are used in fracking operations in the state is vastly underreported;

(f) Greater transparency regarding chemical use in oil and gas production is urgently needed and can be achieved by:

(I) Requiring manufacturers and disclosers, rather than operators, to disclose information about chemicals that are used in oil and gas production in the state;

(II) Requiring the Colorado oil and gas conservation commission to gather the chemical information so that the disclosure of specific chemical information can be separated from the trade name of a product, which will thereby protect any proprietary information; and

(III) Ensuring that operators disclose chemical information to the state, local governments, and communities in close proximity to operations after the operations have commenced; and

(g) A full inventory of the chemicals used in oil and gas production will:

(I) Assist state agencies, local governments, health-care professionals, public health officials, and scientists in determining if highly hazardous chemicals are being used in oil and gas production; and

(II) Encourage the disclosers and users of products that contain highly hazardous chemicals to use less toxic alternatives in future products and oil and gas operations.

(3) Therefore the general assembly determines and declares that the state should enact a regulatory scheme that provides full disclosure of the chemicals that are being deposited into the environment through oil and gas production because:

(a) Coloradans have the right to know what chemicals are being deposited into the environment where they live, work, and recreate; and

(b) State and local governments and regulators need this chemical information to adequately protect the people, water systems, wildlife, and environment of Colorado.

SECTION 2. In Colorado Revised Statutes, **add** 34-60-132 as

follows:

34-60-132. Disclosure of chemicals used in downhole oil and gas operations - chemical disclosure lists - community notification - reports - definitions - rules - repeal. (1) AS USED IN THIS SECTION, UNLESS THE CONTEXT OTHERWISE REQUIRES:

(a) (I) "ADDITIVE" MEANS A CHEMICAL OR COMBINATION OF CHEMICALS ADDED TO A BASE FLUID FOR USE IN A HYDRAULIC FRACTURING TREATMENT.

(II) "ADDITIVE" INCLUDES PROPPANTS.

(b) "BASE FLUID" MEANS THE CONTINUOUS PHASE FLUID TYPE, SUCH AS WATER, USED IN A HYDRAULIC FRACTURING TREATMENT.

(c) "CHEMICAL" MEANS ANY ELEMENT, CHEMICAL COMPOUND, OR MIXTURE OF ELEMENTS OR CHEMICAL COMPOUNDS THAT HAS A SPECIFIC NAME OR IDENTITY, INCLUDING A CHEMICAL ABSTRACTS SERVICE NUMBER.

(d) "CHEMICAL ABSTRACTS SERVICE NUMBER" MEANS THE UNIQUE NUMERICAL IDENTIFIER ASSIGNED BY THE CHEMICAL ABSTRACTS SERVICE TO A CHEMICAL.

(e) "CHEMICAL DISCLOSURE INFORMATION" MEANS THE INFORMATION DISCLOSED TO THE COMMISSION UNDER SUBSECTIONS (2)(a)(I) AND (3)(a)(I) OF THIS SECTION.

(f) "CHEMICAL DISCLOSURE LIST" MEANS A LIST OF CHEMICALS USED IN DOWNHOLE OPERATIONS AT A WELL SITE.

(g) "CHEMICAL DISCLOSURE WEBSITE" MEANS A WEBSITE THAT IS CAPABLE OF DISPLAYING CHEMICAL DISCLOSURE LISTS AND CAN BE ACCESSED BY THE PUBLIC.

(h) (I) "CHEMICAL PRODUCT" MEANS ANY PRODUCT THAT CONSISTS OF ONE OR MORE CHEMICALS AND IS SOLD OR DISTRIBUTED FOR USE IN DOWNHOLE OPERATIONS IN THE STATE.

(II) "CHEMICAL PRODUCT" INCLUDES ADDITIVES, BASE FLUIDS, AND

HYDRAULIC FRACTURING FLUIDS.

(III) "CHEMICAL PRODUCT" DOES NOT INCLUDE THE STRUCTURAL AND MECHANICAL COMPONENTS OF A WELL SITE WHERE DOWNHOLE OPERATIONS ARE BEING CONDUCTED.

(i) (I) "DIRECT VENDOR" MEANS ANY DISTRIBUTOR, SUPPLIER, OR OTHER ENTITY THAT SELLS OR SUPPLIES ONE OR MORE CHEMICAL PRODUCTS DIRECTLY TO AN OPERATOR OR SERVICE PROVIDER FOR USE AT A WELL SITE.

(II) "DIRECT VENDOR" DOES NOT INCLUDE ENTITIES THAT MANUFACTURE, PRODUCE, OR FORMULATE CHEMICAL PRODUCTS FOR FURTHER MANUFACTURE, FORMULATION, SALE, OR DISTRIBUTION BY THIRD PARTIES PRIOR TO BEING SUPPLIED DIRECTLY TO OPERATORS OR SERVICE PROVIDERS.

(j) "DISCLOSER" MEANS AN OPERATOR, ANY SERVICE PROVIDER USING ONE OR MORE CHEMICAL PRODUCTS IN THE COURSE OF DOWNHOLE OPERATIONS, AND ANY DIRECT VENDOR THAT PROVIDES ONE OR MORE CHEMICAL PRODUCTS DIRECTLY TO THE OPERATOR OR SERVICE PROVIDER FOR USE AT A WELL SITE.

(k) "DIVISION" MEANS THE DIVISION OF PARKS AND WILDLIFE IN THE DEPARTMENT OF NATURAL RESOURCES.

(l) "DOWNHOLE OPERATIONS" MEANS OIL AND GAS PRODUCTION OPERATIONS THAT ARE CONDUCTED UNDERGROUND.

(m) "HEALTH-CARE PROFESSIONAL" MEANS A PHYSICIAN, PHYSICIAN ASSISTANT, NURSE PRACTITIONER, REGISTERED NURSE, OR EMERGENCY MEDICAL SERVICE PROVIDER LICENSED OR CERTIFIED BY THE STATE.

(n) "HIGH-PRIORITY HABITAT" MEANS HABITAT AREAS IDENTIFIED BY THE DIVISION WHERE MEASURES TO AVOID, MINIMIZE, AND MITIGATE ADVERSE IMPACTS TO WILDLIFE HAVE BEEN IDENTIFIED TO PROTECT BREEDING, NESTING, FORAGING, MIGRATING, OR OTHER USES BY WILDLIFE.

(o) "HYDRAULIC FRACTURING FLUID" MEANS THE FLUID, INCLUDING ANY BASE FLUID AND ADDITIVES, USED TO PERFORM A HYDRAULIC FRACTURING TREATMENT.

(p) "HYDRAULIC FRACTURING TREATMENT" MEANS ALL STAGES OF THE TREATMENT OF A WELL BY THE APPLICATION OF HYDRAULIC FRACTURING FLUID UNDER PRESSURE, WHICH TREATMENT IS EXPRESSLY DESIGNED TO INITIATE OR PROPAGATE FRACTURES IN AN UNDERGROUND GEOLOGIC FORMATION TO ENHANCE THE PRODUCTION OF OIL AND GAS.

(q) "MANUFACTURER" MEANS A PERSON OR ENTITY THAT MAKES, ASSEMBLES, OR OTHERWISE GENERATES A CHEMICAL PRODUCT OR WHOSE TRADE NAME IS AFFIXED TO A CHEMICAL PRODUCT.

(r) "PERFLUOROALKYL AND POLYFLUOROALKYL SUBSTANCES" OR "PFAS CHEMICALS" HAS THE MEANING SET FORTH IN SECTION 25-5-1302 (7).

(s) "PROPPANTS" MEANS MATERIALS INSERTED OR INJECTED INTO AN UNDERGROUND GEOLOGIC FORMATION DURING A HYDRAULIC FRACTURING TREATMENT THAT ARE INTENDED TO PREVENT FRACTURES FROM CLOSING.

(t) "PUBLIC WATER SYSTEMS" HAS THE MEANING SET FORTH IN SECTION 25-1.5-201 (1).

(u) "TRADE SECRET" HAS THE MEANING SET FORTH IN SECTION 7-74-102 (4).

(v) "TYPE III AQUIFER" MEANS AN AQUIFER THAT CONSISTS OF UNCONSOLIDATED GEOLOGIC MATERIAL, INCLUDING ALLUVIAL, COLLUVIAL, OR OTHER CONSOLIDATED MATERIALS.

(w) "WELL SITE" MEANS THE AREA THAT IS DIRECTLY DISTURBED DURING OIL AND GAS OPERATIONS.

(2) Discloser chemical disclosure information and declaration.

(a) ON AND AFTER JULY 31, 2023, AND SUBJECT TO SUBSECTION (2)(b) OF THIS SECTION, A DISCLOSER THAT SELLS OR DISTRIBUTES A CHEMICAL PRODUCT FOR USE IN DOWNHOLE OPERATIONS IN THE STATE OR THAT USES A CHEMICAL PRODUCT IN DOWNHOLE OPERATIONS IN THE STATE MUST:

(I) DISCLOSE TO THE COMMISSION:

(A) THE TRADE NAME OF THE CHEMICAL PRODUCT; AND

(B) A LIST OF THE NAMES AND CHEMICAL ABSTRACTS SERVICE NUMBERS OF EACH CHEMICAL USED IN THE CHEMICAL PRODUCT; AND

(C) IF A DISCLOSER BELIEVES THAT A CHEMICAL CONSTITUENT OF A CHEMICAL PRODUCT IS A TRADE SECRET OR IS PROPRIETARY INFORMATION, NEVERTHELESS DISCLOSE THE CHEMICAL CONSTITUENT; AND

(II) PROVIDE A WRITTEN DECLARATION TO THE COMMISSION THAT THE CHEMICAL PRODUCT CONTAINS NO INTENTIONALLY ADDED PFAS CHEMICALS.

(b) (I) (A) FOR DISCLOSERS THAT WERE ALREADY SELLING OR DISTRIBUTING A CHEMICAL PRODUCT FOR USE IN DOWNHOLE OPERATIONS IN THE STATE BEFORE JULY 31, 2023, OR THAT WERE USING THE CHEMICAL PRODUCT BEFORE JULY 31, 2023, THE INFORMATION AND DECLARATION REQUIRED TO BE PROVIDED PURSUANT TO SUBSECTION (2)(a) OF THIS SECTION MUST BE PROVIDED TO THE COMMISSION AT LEAST THIRTY DAYS BEFORE JULY 31, 2023.

(B) THIS SUBSECTION (2)(b)(I) IS REPEALED, EFFECTIVE JULY 1, 2024.

(II) FOR DISCLOSERS THAT BEGIN TO SELL, DISTRIBUTE, OR USE A CHEMICAL PRODUCT FOR USE IN DOWNHOLE OPERATIONS IN THE STATE ON OR AFTER JULY 31, 2023, THE INFORMATION AND DECLARATION REQUIRED TO BE PROVIDED PURSUANT TO SUBSECTION (2)(a) OF THIS SECTION MUST BE PROVIDED TO THE COMMISSION AT LEAST THIRTY DAYS BEFORE THE DISCLOSER BEGINS SELLING, DISTRIBUTING, OR USING THE CHEMICAL PRODUCT.

(c) THE COMMISSION SHALL ENSURE THAT THE INFORMATION AND DECLARATION REQUIRED TO BE PROVIDED UNDER SUBSECTION (2)(a) OF THIS SECTION IS PROVIDED TO THE COMMISSION.

(d) IF A MANUFACTURER DOES NOT PROVIDE THE INFORMATION DESCRIBED IN SUBSECTION (2)(a)(I) OF THIS SECTION FOR A CHEMICAL PRODUCT THAT IT SELLS OR DISTRIBUTES FOR USE IN DOWNHOLE OPERATIONS IN THE STATE TO A DISCLOSER UPON THE REQUEST OF THE DISCLOSER OR THE COMMISSION, THE MANUFACTURER MUST PROVIDE THE COMMISSION WITH A TRADE SECRET FORM OF ENTITLEMENT, AS DETERMINED BY THE COMMISSION

BY RULE, FOR THE CHEMICAL PRODUCT. AT A MINIMUM, THE MANUFACTURER MUST INCLUDE IN THE TRADE SECRET FORM OF ENTITLEMENT FOR THE CHEMICAL PRODUCT:

(I) THE NAME OF EACH CHEMICAL USED IN THE CHEMICAL PRODUCT;
AND

(II) THE CHEMICAL ABSTRACTS SERVICE NUMBER OF EACH CHEMICAL USED IN THE CHEMICAL PRODUCT.

(e) IF, AFTER MAKING A REQUEST TO THE MANUFACTURER OF THE CHEMICAL PRODUCT PURSUANT TO SUBSECTION (2)(d) OF THIS SECTION, A DISCLOSER IS UNABLE TO DISCLOSE THE INFORMATION DESCRIBED IN SUBSECTION (2)(a)(I) OF THIS SECTION, THE DISCLOSER SHALL DISCLOSE TO THE COMMISSION:

(I) THE NAME OF THE CHEMICAL PRODUCT'S MANUFACTURER;

(II) THE CHEMICAL PRODUCT'S TRADE NAME;

(III) THE AMOUNT OR WEIGHT OF THE CHEMICAL PRODUCT; AND

(IV) A SAFETY DATA SHEET FOR THE CHEMICAL PRODUCT, IF IT IS AVAILABLE FOR DISCLOSURE BY THE DISCLOSER AND PROVIDES THE INFORMATION DESCRIBED IN SUBSECTION (2)(a)(I) OF THIS SECTION.

(f) IN THE EVENT THAT THE DISCLOSER IS UNABLE TO DISCLOSE THE INFORMATION DESCRIBED IN SUBSECTION (2)(a)(I) OF THIS SECTION, THE COMMISSION SHALL OBTAIN THE INFORMATION DESCRIBED IN SUBSECTION (2)(a)(I) OF THIS SECTION FROM THE MANUFACTURER.

(3) Operator chemical disclosure information - declaration.

(a) ON AND AFTER JULY 31, 2023, AND SUBJECT TO SUBSECTION (3)(b) OF THIS SECTION, AN OPERATOR OF DOWNHOLE OPERATIONS USING A CHEMICAL PRODUCT MUST:

(I) DISCLOSE TO THE COMMISSION:

(A) THE DATE OF COMMENCEMENT OF DOWNHOLE OPERATIONS;

(B) THE COUNTY OF THE WELL SITE WHERE DOWNHOLE OPERATIONS ARE BEING OR WILL BE CONDUCTED;

(C) THE UNIQUE NUMERICAL IDENTIFIER ASSIGNED BY THE AMERICAN PETROLEUM INSTITUTE TO THE WELL WHERE DOWNHOLE OPERATIONS ARE BEING OR WILL BE CONDUCTED AND THE US WELL NUMBER ASSIGNED TO THE WELL WHERE DOWNHOLE OPERATIONS ARE BEING OR WILL BE CONDUCTED; AND

(D) THE TRADE NAMES AND QUANTITIES OF ANY CHEMICAL PRODUCTS THE OPERATOR USED IN DOWNHOLE OPERATIONS; AND

(II) PROVIDE A WRITTEN DECLARATION TO THE COMMISSION THAT THE CHEMICAL PRODUCT CONTAINS NO INTENTIONALLY ADDED PFAS CHEMICALS.

(b)(I)(A) FOR A DOWNHOLE OPERATION THAT COMMENCED BEFORE JULY 31, 2023, AND THAT WILL BE ONGOING ON JULY 31, 2023, THE INFORMATION AND DECLARATION REQUIRED TO BE PROVIDED PURSUANT TO SUBSECTION (3)(a) OF THIS SECTION MUST BE PROVIDED TO THE COMMISSION WITHIN ONE HUNDRED TWENTY DAYS AFTER JULY 31, 2023.

(B) THIS SUBSECTION (3)(b)(I) IS REPEALED, EFFECTIVE JULY 1, 2024.

(II) FOR A DOWNHOLE OPERATION THAT COMMENCES ON OR AFTER JULY 31, 2023, THE INFORMATION AND DECLARATION REQUIRED TO BE PROVIDED PURSUANT TO SUBSECTION (3)(a) OF THIS SECTION MUST BE PROVIDED TO THE COMMISSION WITHIN ONE HUNDRED TWENTY DAYS AFTER THE COMMENCEMENT OF THE DOWNHOLE OPERATION.

(c) THE COMMISSION SHALL ENSURE THAT THE INFORMATION AND DECLARATION REQUIRED TO BE PROVIDED UNDER SUBSECTION (3)(a) OF THIS SECTION IS PROVIDED TO THE COMMISSION.

(4) **Change in chemical disclosure information.** IF THERE IS A CHANGE IN THE INFORMATION PROVIDED UNDER SUBSECTION (2)(a)(I) OR (3)(a)(I) OF THIS SECTION, THE DISCLOSER OR OPERATOR, OR IN THE CASE OF DISCLOSURE UNDER SUBSECTION (2)(d) OF THIS SECTION, THE MANUFACTURER, MUST SUBMIT THE CHANGE TO THE COMMISSION WITHIN

THIRTY DAYS AFTER THE DATE THE DISCLOSER, MANUFACTURER, OR OPERATOR FIRST KNEW OF THE CHANGE.

(5) **Chemical disclosure lists.** (a) THE COMMISSION SHALL USE THE CHEMICAL DISCLOSURE INFORMATION TO CREATE A CHEMICAL DISCLOSURE LIST FOR EACH APPLICABLE WELL SITE.

(b) (I) THE COMMISSION SHALL INCLUDE IN THE CHEMICAL DISCLOSURE LIST AN ALPHABETICAL LIST OF THE NAMES AND CHEMICAL ABSTRACTS SERVICE REGISTRY NUMBERS OF EACH CHEMICAL USED IN DOWNHOLE OPERATIONS AT THE WELL SITE.

(II) NOTWITHSTANDING ANY LAW TO THE CONTRARY, THE COMMISSION SHALL INCLUDE THE NAMES AND CHEMICAL ABSTRACTS SERVICE REGISTRY NUMBERS OF ALL CHEMICALS USED IN DOWNHOLE OPERATIONS IN THE CHEMICAL DISCLOSURE LIST AND SHALL NOT PROTECT THE NAMES OR CHEMICAL ABSTRACTS SERVICE REGISTRY NUMBERS OF ANY CHEMICAL AS A TRADE SECRET OR PROPRIETARY INFORMATION. ANY FORMULAS AND PROCESSES CONTINUE TO HAVE TRADE SECRET PROTECTIONS.

(c) THE COMMISSION SHALL NOT INCLUDE IN THE CHEMICAL DISCLOSURE LIST:

(I) THE TRADE NAME OF A CHEMICAL PRODUCT USED IN DOWNHOLE OPERATIONS AT THE WELL SITE; OR

(II) THE TOTAL AMOUNT OF A CHEMICAL IN A CHEMICAL PRODUCT.

(d) NO LATER THAN THIRTY DAYS AFTER AN OPERATOR MAKES THE DISCLOSURES REQUIRED UNDER SUBSECTION (3) OF THIS SECTION, THE COMMISSION SHALL:

(I) POST THE CHEMICAL DISCLOSURE LIST ON THE CHEMICAL DISCLOSURE WEBSITE AND INCLUDE THE DATE OF THE SUBMISSION OF THE CHEMICAL DISCLOSURE LIST TO THE COMMISSION IN THE POST; AND

(II) PROVIDE THE CHEMICAL DISCLOSURE LIST TO THE OPERATOR OF THE APPLICABLE WELL.

(e) THE COMMISSION SHALL:

(I) POST AN UPDATED CHEMICAL DISCLOSURE LIST IF THERE ARE ANY NOTIFICATIONS RECEIVED FROM A DISCLOSER, MANUFACTURER, OR OPERATOR UNDER SUBSECTION (4) OF THIS SECTION AND INCLUDE THE DATE OF THE NOTIFICATION BY THE DISCLOSER, MANUFACTURER, OR OPERATOR IN THE POST; AND

(II) ENSURE THAT:

(A) ALL CHEMICAL DISCLOSURE LISTS AND UPDATED CHEMICAL DISCLOSURE LISTS REMAIN VIEWABLE BY THE PUBLIC;

(B) THE CHEMICAL DISCLOSURE WEBSITE IS SEARCHABLE BY CHEMICAL, DATE OF SUBMISSION OR UPDATE OF A CHEMICAL DISCLOSURE LIST, NAME AND ADDRESS OF THE OPERATOR, AND COUNTY OF THE WELL SITE; AND

(C) THE CHEMICAL DISCLOSURE WEBSITE ALLOWS MEMBERS OF THE PUBLIC TO DOWNLOAD CHEMICAL DISCLOSURE LISTS IN AN ELECTRONIC, DELIMITED FORMAT.

(6) **Community notification.** (a) ON OR BEFORE JULY 31, 2023, AND SUBJECT TO SUBSECTION (6)(b) OF THIS SECTION, AN OPERATOR SHALL PROVIDE THE CHEMICAL DISCLOSURE LIST TO:

(I) ALL OWNERS OF MINERALS THAT ARE BEING DEVELOPED AT THE WELL SITE;

(II) ALL SURFACE OWNERS, BUILDING UNIT OWNERS, AND RESIDENTS, INCLUDING TENANTS OF BOTH RESIDENTIAL AND COMMERCIAL PROPERTIES, THAT ARE WITHIN TWO THOUSAND SIX HUNDRED FORTY FEET OF THE WELL SITE;

(III) THE STATE LAND BOARD IF THE STATE OWNS MINERALS THAT ARE BEING DEVELOPED AT THE WELL SITE;

(IV) THE FEDERAL BUREAU OF LAND MANAGEMENT IF THE UNITED STATES OWNS THE MINERALS THAT ARE BEING DEVELOPED AT THE WELL SITE;

(V) THE SOUTHERN UTE INDIAN TRIBE IF THE MINERALS BEING DEVELOPED AT THE WELL SITE ARE WITHIN THE EXTERIOR BOUNDARY OF THE TRIBE'S RESERVATION AND ARE SUBJECT TO THE JURISDICTION OF THE COMMISSION;

(VI) ALL SCHOOLS, CHILD CARE CENTERS, AND SCHOOL GOVERNING BODIES WITHIN TWO THOUSAND SIX HUNDRED FORTY FEET OF THE WELL SITE;

(VII) POLICE DEPARTMENTS, FIRE DEPARTMENTS, EMERGENCY SERVICE AGENCIES, AND FIRST RESPONDER AGENCIES THAT HAVE A JURISDICTION THAT INCLUDES THE WELL SITE;

(VIII) LOCAL GOVERNMENTS THAT HAVE A JURISDICTION WITHIN TWO THOUSAND SIX HUNDRED FORTY FEET OF THE WELL SITE;

(IX) THE ADMINISTRATOR OF ANY PUBLIC WATER SYSTEM THAT OPERATES:

(A) A SURFACE WATER PUBLIC WATER SYSTEM INTAKE THAT IS LOCATED FIFTEEN STREAM MILES OR LESS DOWNSTREAM FROM THE WELL SITE;

(B) A GROUNDWATER UNDER THE DIRECT INFLUENCE OF A SURFACE WATER PUBLIC WATER SYSTEM SUPPLY WELL WITHIN TWO THOUSAND SIX HUNDRED FORTY FEET OF THE WELL SITE; AND

(C) A PUBLIC WATER SYSTEM SUPPLY WELL COMPLETED IN A TYPE III AQUIFER WITHIN TWO THOUSAND SIX HUNDRED FORTY FEET OF THE WELL SITE; AND

(X) THE DIVISION IF:

(A) THERE IS A HIGH-PRIORITY HABITAT AREA WITHIN ONE MILE OF THE WELL SITE; OR

(B) THERE IS A STATE WILDLIFE AREA, AS DEFINED IN SECTION 33-1-102 (42), OR A STATE PARK OR RECREATION AREA WITHIN TWO THOUSAND SIX HUNDRED FORTY FEET OF THE WELL SITE.

(b) THE CHEMICAL DISCLOSURE LIST MUST BE DISCLOSED IN

ACCORDANCE WITH SUBSECTION (6)(a) OF THIS SECTION WITHIN THIRTY DAYS AFTER THE OPERATOR'S RECEIPT OF THE CHEMICAL DISCLOSURE LIST FROM THE COMMISSION.

(7) Reporting to the general assembly. (a) (I) THE COMMISSION SHALL PREPARE AN ANNUAL REPORT THAT INCLUDES A LIST OF THE CHEMICALS USED IN DOWNHOLE OPERATIONS IN THE STATE IN THE PRIOR CALENDAR YEAR.

(II) THE COMMISSION SHALL PRESENT THE ANNUAL REPORT TO THE TRANSPORTATION AND ENERGY COMMITTEE OF THE SENATE AND THE ENERGY AND ENVIRONMENT COMMITTEE OF THE HOUSE OF REPRESENTATIVES, OR THEIR SUCCESSOR COMMITTEES, DURING THE COMMITTEES' HEARINGS HELD PRIOR TO THE 2026 REGULAR SESSION, AND EACH SESSION THEREAFTER, OF THE GENERAL ASSEMBLY UNDER THE "STATE MEASUREMENT FOR ACCOUNTABLE, RESPONSIVE, AND TRANSPARENT (SMART) GOVERNMENT ACT", PART 2 OF ARTICLE 7 OF TITLE 2. THE COMMISSION SHALL ALSO POST THE REPORT ON THE COMMISSION'S WEBSITE.

(b) NOTWITHSTANDING SECTION 24-1-136 (11)(a)(I), THE REQUIREMENT TO REPORT TO THE LEGISLATIVE COMMITTEES CONTINUES INDEFINITELY.

(8) Rules. THE COMMISSION MAY PROMULGATE RULES THAT ARE NECESSARY FOR THE IMPLEMENTATION AND ADMINISTRATION OF THIS SECTION.

(9) Local governments. NOTHING IN THIS SECTION OR THE RULES PROMULGATED BY THE COMMISSION PURSUANT TO THIS SECTION LIMITS A LOCAL GOVERNMENT FROM ENACTING OR ENFORCING ANY ORDINANCE, REGULATION, OR OTHER LAW RELATED TO THE DISCLOSURE OF ANY CHEMICAL PRODUCT.

(10) Collection of chemical disclosure information under other provisions of law. NOTWITHSTANDING ANY LAW TO THE CONTRARY, NOTHING IN THIS SECTION OR THE RULES PROMULGATED BY THE COMMISSION PURSUANT TO THIS SECTION PREVENTS THE COMMISSION, THE STATE, OR A LOCAL GOVERNMENT FROM COLLECTING CHEMICAL DISCLOSURE INFORMATION FROM DISCLOSERS, MANUFACTURERS, OR OPERATORS UNDER ANY OTHER PROVISION OF LAW.

SECTION 3. Appropriation. (1) For the 2022-23 state fiscal year, \$61,500 is appropriated to the department of natural resources. This appropriation is from the oil and gas conservation and environmental response fund created in section 34-60-122 (5)(a), C.R.S. To implement this act, the department may use this appropriation for the purchase of information technology services.

(2) For the 2022-23 state fiscal year, \$61,500 is appropriated to the office of the governor for use by the office of information technology. This appropriation is from reappropriated funds received from the department of natural resources under subsection (1) of this section. To implement this act, the office may use this appropriation to provide information technology services for the department of natural resources.

SECTION 4. Safety clause. The general assembly hereby finds,

determines, and declares that this act is necessary for the immediate preservation of the public peace, health, or safety.



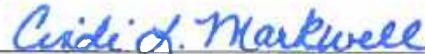
Alec Garnett
SPEAKER OF THE HOUSE
OF REPRESENTATIVES



Steve Fenberg
PRESIDENT OF
THE SENATE



Robin Jones
CHIEF CLERK OF THE HOUSE
OF REPRESENTATIVES

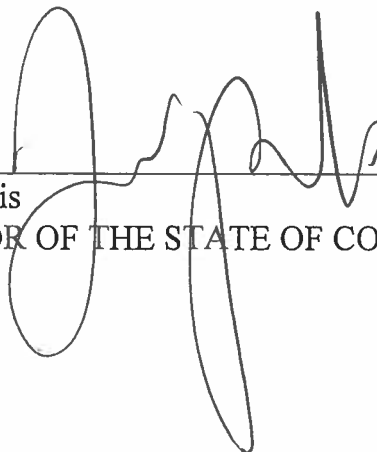


Cindi L. Markwell
SECRETARY OF
THE SENATE

APPROVED

June 8th at 1:33 p.m.

(Date and Time)



Jared S. Polis
GOVERNOR OF THE STATE OF COLORADO

Secretary of Energy Advisory Board

Task Force Report on FracFocus 2.0

March 28, 2014



U.S. Department of Energy

Executive Summary

This report presents the findings and recommendations for the Secretary of Energy Advisory Board (SEAB) Task Force on FracFocus. This Task Force report builds upon and extends the 2011 SEAB Subcommittee report on the environmental impacts of unconventional gas production.

The Task Force believes that the FracFocus experience to date demonstrates the ease of disclosure of chemicals added to fracturing fluid for companies, the value of this disclosure for the public, and the importance of public confidence in the quality and accessibility of the FracFocus chemical registry data. It has accomplished a good deal and shows the capacity to make improvements at modest additional cost. FracFocus has greatly improved public disclosure quickly and with a significant degree of uniformity.

The Task Force recommends a number of actions that will further improve the effectiveness of the FracFocus disclosure of chemical additives and improve transparency for regulators, operating companies, and the public. Recommendations are made for improving the accuracy and completeness of registry submissions. In addition, the Task Force believes that an independent audit to assess the accuracy and compliance of the process will be useful for all stakeholders.

A large fraction of reporting wells claim at least one trade secret exemption. The Task Force favors full disclosure of all known constituents added to fracturing fluid with few, if any exceptions. A “systems approach” that reports the chemicals added separately from the additive names and product names that contain them, generally should provide adequate protection of trade secrets. The Task Force further calls for state and federal regulators to adopt standards for making a trade secret claim and establish an accompanying compliance process and a challenge mechanism.

The Task Force also makes recommendations for improving data storage and retention collected by FracFocus, the budget required for FracFocus to operate and upgrade its

service and system, as well as for how these activities might be financed by a combination of DOE support and/or a user charge.

All members of the Task Force support this report.

Context for the Task Force Deliberations

On November 26, 2013 Secretary of Energy Moniz charged the SEAB to establish a Task Force to review FracFocus 2.0, the registry for public disclosure of chemical constituents added to hydraulic fracturing fluids used in unconventional oil and gas production. The Ground Water Protection Council (GWPC) and the Interstate Oil and Gas Compact Commission (IOGCC), two quasi-public organizations dedicated to conservation and environmental protection, operate the FracFocus registry.¹ The Secretary's charge to the Task Force included in Appendix A, instructs the Task Force to examine seven topics related to the operation of FracFocus. Task Force membership is given in Appendix B.

The Task Force was formed to respond to a request from Senator Wyden, chair of the Senate Energy Committee, to review FracFocus. The Secretary turned to SEAB because a subcommittee of the board had undertaken a study to identify measures to reduce the environmental impacts of unconventional gas production in 2011.² President Obama had directed former Secretary Chu to form this Subcommittee as part of the President's "Blueprint for a Secure Energy Future."³

The 2011 SEAB Subcommittee report made over twenty recommendations for reducing the environmental impact of unconventional gas operations.⁴ A central finding of the 2011 Subcommittee report was *the importance of a process of continuous improvement in various aspects of shale gas production that relies on best practices and is tied to*

¹ Information about FracFocus can be found on the web at <http://fracfocus.org/>.

² The Subcommittee's interim and final report in August and November 2011, respectively can be found at <http://www.shalegas.energy.gov/>.

³ Available at [Blueprint for a Secure Energy Future \(pdf\)](#), The White House, March 30, 2011.

⁴ Page 1, August 2011 Subcommittee report.

measurement and disclosure in order to achieve progressively lower levels of environmental impact.⁵ While the focus of the Subcommittee was unconventional shale gas production the Task Force believes that most, if not all, of its findings apply to both unconventional oil and gas exploration and production.

Several of the 2011 Subcommittee recommendations were directed at increasing transparency and disclosure in order to support state and national regulations and to meet public concerns about hydraulic fracturing. The Subcommittee specifically recommended DOE support for (1) the then new FracFocus website for voluntary disclosure of fracturing fluid composition; (2) STRONGER (the State Review of Oil and Natural Gas Environmental Regulation); and (3) the Groundwater Protection Council for expansion of the Risk Based Data Management System (RBDMS), so that similar projects might be expanded to other aspects of shale gas and oil development. As discussed below several additional suggestions were made bearing on the disclosure of fracturing fluid chemicals and on the operation of FracFocus. Accordingly, it was appropriate for Secretary Moniz to turn to SEAB to review and extend its findings on disclosure of fracturing fluid chemical composition and the operation of FracFocus in response to Chairman Wyden's request.

Questions for the Task Force to address

The terms of reference suggests the Task Force examine seven matters:

- (1) Evolution of the operation of FracFocus 2.0 toward timely, complete, and accurate data storage.
- (2) The extent to which state and federal regulatory bodies are using FracFocus to meet regulatory disclosure requirements.

⁵ Pages 1 to 5, August 2011 Subcommittee Report.

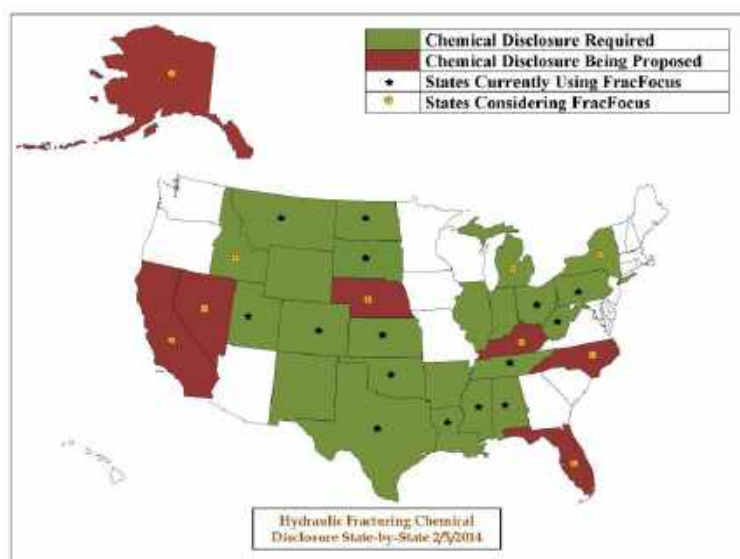
- (3) Understanding the breadth of data maintained by FracFocus, how frequently companies are using the proprietary exemption to avoid disclosure of fracturing fluid composition, and the standards for the use of this exemption.
- (4) Understanding the difference in federal data custody requirements and FracFocus practices.
- (5) Increasing the utility of FracFocus by maintaining it as a database with tools suitable for analysis by regulatory bodies, companies, and the public.
- (6) Expanding the scope of the FracFocus registry to other areas, such as the water quality data in neighboring water wells collected prior to well stimulation or postproduction.
- (7) Adequacy of funding for FracFocus activities and suggestion for possible alternative arrangements.

The 2011 Subcommittee addressed several of these issues, in particular, (2), (3), (5), and (7). The current report is informed by this work and, where noted, the 2011 findings have been confirmed and/or extended.

Addressing the Questions

- (1) **Evolution of the operation of FracFocus 2.0 toward timely, complete, and accurate data storage.** The following table summarizes the rapid growth of key FracFocus operating factors and the map below displays the states that require chemical disclosure. It is notable that between 2011 and 2013 the number of registered wells increased more than four fold.

Operating Factors	2011	2012	2013
States requiring FF disclosure	2	8	14
# of wells registered	14,246	24,570	62,410
FF budget ⁶ \$000	\$527	\$1,438	\$1,406



The two important trends are the growth in the number of wells entered into the registry and the increase in the number of states that use FracFocus as part of their disclosure requirement for the composition of fracturing fluids. The evolution of FracFocus from version 1.0 to 2.0 enables the system to respond to several of the 2011 Subcommittee recommendations. The registry's back end has also converted from spreadsheet based to a web-based data entry process.

Initially FracFocus directed those using the site to disclose all chemicals used in fracturing fluids that appear on Material Safety Data Sheets (by common name and, more importantly, by their Chemical Abstract Service, or CAS, identification number). Chemicals on these sheets are believed to be hazardous to workers in an occupational

⁶ Source: FracFocus. These funds come from the DOE, the American Petroleum Institute, American Natural Gas Alliance, Environmental Defense Fund and other organizations.

setting as determined by the Occupational Safety and Health Administration, (OSHA). MSDS reporting does not include other chemicals that might be hazardous to humans in an environmental setting or that might be harmful to the environment. Thus the 2011 Subcommittee recommended that disclosure include all chemicals intentionally added to fracturing fluid, not just those that appear on MSDS. FracFocus 2.0 follows this recommendation now asking for “additional ingredients not listed on MSDS.”

Full disclosure means the public reporting of all constituents added to fracturing fluid injected into a well. Constituents include both “chemicals” and “additives” such as surfactants, friction reduction agents, and tracers that are composite material composed of several, perhaps many, molecules. As discussed below this distinction is important because 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.” Most states currently require disclosure of both chemicals and additives.

Currently, disclosure does not require any information about the chemistry of the make-up water that is traditionally 90% by weight of the fracturing fluid. The water used to mix the fracturing fluid is normally fresh water taken from water wells, lakes or rivers. However, during the past few years, it is becoming increasingly common to recycle fracture fluid that is produced from wells that have recently experienced physical or chemical fracture treatment. In either case, the chemicals that are part of the make-up water are not always measured and usually not reported as part of FracFocus 2.0. Disclosure of the water analysis of the make-up water used in hydraulic fracturing would be appropriate, if data were available.

It is important to assess the accuracy of well data disclosed on FracFocus since transparency implies correct information has been filed. Examination of a limited sample of records from FracFocus 2.0 indicates a variety of errors, partly due to many different companies contributing data to an individual FracFocus record, besides the operator of the well. We recommend:

- (a) FracFocus should examine the entire data entry workflow and structure, looking for opportunities to simplify data structure and steps for data entry to reduce the probability of data entry errors, and assuring accuracy. Simple data entry reduces errors.
- (b) FracFocus should improve the quality of the data entered into the system, especially the accuracy and completeness of reported CAS numbers. CAS numbers are the unique and universal identifier of individual chemicals that might go under a variety of different names. FracFocus 2.0 has introduced basic error checking that alerts users if an entered CAS number is in the proper format, but not whether the CAS number matches the chemical name, or even if the CAS number is currently in use. While FracFocus does not assert authority to reject operator entries, the automatic validation system should be expanded and improved.
- (c) When FracFocus discovers an error in a company submission FracFocus should inform the company and indicate on the web site that the submitted data are in some doubt. Such a notice on the FracFocus web site would inform the regulatory authorities and the public that there is an issue and serve as incentive to the company to revise the submission. (The Task Force understands that the FracFocus variant in use in British Columbia contains this feature). This practice would also encourage operators to assure that CAS numbers received from manufacturers and suppliers are accurate.
- (d) FracFocus should make provisions for submissions to include more information about the water used as a base fluid, for example whether it is 100% fresh water or does it contain a percentage of recycled fracturing fluid. Such data in FracFocus would be available to EPA, state regulators and the public.
- (e) In some instances, the FracFocus disclosure form does not explicitly call for information required by state disclosure rules. For example, with respect to chemical concentrations, some states require actual concentrations, while the form only requests maximum concentrations. The Task Force recommends that

states be attentive to ensure compliance with more specific state disclosure requirements, especially where FracFocus requires less or different information.

FracFocus and the states that require disclosure, through FracFocus or more generally, have different ways of assessing compliance with respect to timing, accuracy, and substance of the disclosure. The Task Force believes that an understanding of how well this disclosure system is working would be enhanced if an independent audit were conducted to assess the accuracy and compliance of the process. This would benefit all stakeholders in FracFocus – regulators, companies, and the public. The audit should be sponsored by an independent entity with the objective of shedding light on FracFocus system operations in addition to the information it houses. Accordingly, the Task Force recommends that DOE’s Office of Fossil Energy contract with a suitable audit or consulting firm to perform this audit. The audit should include (1) the accuracy of the operator's field records; (2) a comparison of the operator's field records to the service company field tickets; (3) a comparison of the service company's field ticket to the service company final report; and (4) the accuracy of the data entry into FracFocus 2.0. The audit firm should consider sample size and diversity to ensure a meaningful review and should examine, among other factors, trade secret exemption claims.

(2) The extent to which state and federal regulatory bodies are using FracFocus to meet regulatory disclosure requirements. FracFocus has evolved beyond a strictly voluntary effort as state regulators and firms have recognized the level of public concern about possible health and environmental consequences of chemical constituents used in fracturing fluid to water supplies. Voluntary disclosure offered an immediate and practical response to growing public concern about chemical use for both industry and regulatory bodies.

As of November 1, 2013, over 20 states have adopted some level of disclosure requirements, of which 14 states require the use of FracFocus. Inspection and

enforcement will require increased effort on the part of state regulators.⁷ FracFocus makes an important contribution by facilitating the flow of information to states through the Risk Based Data Management System (RBDMS).

(3) Understanding the breadth of data housed in FracFocus, how frequently companies are invoking the trade secret exemption to avoid disclosure of fracturing fluid composition, and the standards for the use of this exemption. The Task Force believes that full disclosure of all known constituents added to fracturing fluids is desirable. It is desirable because transparent disclosure addresses the public concern, justified or not, about the risk these chemicals present to drinking water supplies. Trade secret claims that shield disclosure are made to protect perceived intellectual property value of the chemical treatment. The Task Force has no wish to constrain innovation for improved environmental characteristics or performance/cost attributes of chemical stimulation, or to limit the role of proprietary information as part of the innovation process. Indeed, as discussed below, the Task Force believes this disclosure can be accomplished with little or no risk to disclosing proprietary information. Regulatory bodies have the authority to adopt binding disclosure requirements. The Task Force is challenging FracFocus to operate in a manner that encourages full disclosure with few, in any trade secret exceptions.

The 2011 Subcommittee strongly endorsed full disclosure of the chemical composition of fracturing fluids:

Disclosure of fracturing fluid composition: The Subcommittee shares the prevailing view that the risk of fracturing fluid leakage into drinking water sources through fractures made in deep shale reservoirs is remote.⁸ Nevertheless the Subcommittee believes there is no economic or technical reason to prevent public disclosure of all chemicals in fracturing fluids, with an exception for genuinely proprietary information. While companies and

⁷ *Hydraulic Fracturing – Chemical Disclosure Requirements*, Congressional Research Service, Brandon Murrill & Adam Vann, June 19, 2012. R42461.

⁸ Fracturing fluids can reach surface and near-surface water supplies, for example, if there is poor well completion or surface accidents during production.

regulators are moving in this direction, progress needs to be accelerated in light of public concern.⁹

The Subcommittee believes that the high level of public concern about the nature of fracturing chemicals suggests that the benefit of immediate and complete disclosure of all chemical components and composition of fracturing fluid completely outweighs the restriction on company action, the cost of reporting, and any intellectual property value of proprietary chemicals. The Subcommittee believes that public confidence in the safety of fracturing would be significantly improved by complete disclosure and that the barrier to shield chemicals based on trade secret should be set very high. Therefore the Subcommittee recommends that regulatory entities immediately develop rules to require disclosure of all chemicals used in hydraulic fracturing fluids on both public and private lands.¹⁰

The Task Force endorses this finding.

The FracFocus disclosure exemption is based on “trade secret” as defined in OSHA regulation 1910.1200(i)(1).¹¹ The Task Force has learned from FracFocus that 84% of the registered wells invoked a trade secret exemption for at least one chemical, with the range by state extending from 57% to 100%, since FracFocus 2.0 went operational in June of 2013. On average, trade secret exemptions were claimed for 16% of the chemical entries recorded in the FracFocus database between June and December 2013.¹² (See Appendix C). While there are many different ways to assess the incidence of the trade secret exemption claim (for example, by well, by chemical, by mass, by state, or by operating company) this data does not suggest the level of transparency and disclosure urged by this Task Force or by the 2011 Subcommittee and supported by this Task Force. More can be done.

⁹ Page 3, August, 2011 Subcommittee Report.

¹⁰ Page 24, August 2011 Subcommittee Report.

¹¹ This report uses the narrower “trade secret” term rather than “proprietary information” or “confidential business information” because it is more consistent with the call for a “high bar” for disclosure.

¹² A chemical entry occurs each time that a chemical is disclosed in an individual well. The percentage of chemical entries is not the same as the percentage of unique chemicals claimed as a trade secret, but it is one of the more useful metrics for understanding the incidence of trade secret claims. But, recall the reporting complications mentioned on page 11.

There may be reporting complications that can be masking, to some extent, the number of trade secret exemptions on FracFocus and the number of trade secrets claimed. If a submission leaves the CAS field blank or reports zero concentration of uses the “less than” symbol, the FracFocus users may interpret such instances as a trade secret claim. One company reviewed for the Task Force their internal records of the 1500+ disclosures made to FracFocus after 6/1/2013 and found 120 separate trade secret claims, involving 400 chemicals from almost 58,000 chemicals reported in all the disclosures. The company was unable to determine from the FracFocus database the chemical agent claims attributed to this particular 1500+ sample. There seems to be a discrepancy between the trade secret claims data indicated by FracFocus and the internal records of some companies that suggest a much lower incidence of trade secret claims for those companies. The work recommended by this Task Force should shed light on this important issue.

This Task Force believes that the goal should be to have very few trade secret exemption claims from disclosure. The public is clearly concerned about the nature of the chemicals used in hydraulic fracturing. It is much to industry’s advantage to meet this concern.

The federal Emergency Planning and Community Right to Know Act¹³ and laws enacted in several states give officials access to chemical trade secret information in times of crisis in order to give emergency first responders and health officials access to information they need. So the impression that trade secrets bar public access to information in all circumstances is incorrect. The Task Force endorses strong provisions to provide access to trade secret information in emergency situations but goes further in advocating disclosure.

¹³ The objective of the Emergency Planning and Community Right-To-Know Act (EPCRA) is to: (1) allow state and local planning for chemical emergencies, (2) provide for notification of emergency releases of chemicals, and (3) address communities' right-to-know about toxic and hazardous chemicals. However, the access formally is only to chemicals that appear on Materials Safety Data Sheets (MSDS) See <http://www.epa.gov/oecaagct/lcra.html>

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. In sum, the Task Force recommendation for chemical disclosure is

- No trade secret disclaimers unless documented and attested as they do in Wyoming or Arkansas - but the fewer the better.
- Report the complete list of chemical by their CAS numbers and quantities added.
- Report a complete list of products without linking to the list of chemicals¹⁴

Operators report that chemical suppliers or pumping services demand trade secret protection for their products. The Task Force believes that if the leading operators and oil field service companies establish practical protocols for data transfer across the supply chain, and clear requirements for their suppliers, then supplier insistence of trade secrets will be greatly reduced and possibly disappear.

The Task Force believes three steps should be taken to further explore way to reduce the use of the trade secret exemption:

- (a). Assemble accurate data about the nature and extent of trade secrecy claims across chemical, states, operators, suppliers and time. Under the auspices of DOE

¹⁴ The reporting by disaggregated chemicals is known in industry practice as the “systems approach” and it is used by at least one large oil field service supplier.

Fossil Energy and with the cooperation of FracFocus, it should be possible to complete this study within four to six months.

The study should include: (1) trends in trade secret claims; (2) the percentage of wells with one or more hydraulic fracturing chemicals that are claimed to be trade secret; (3) for wells with trade secret claims, the average number of claims, the average percentage of chemicals used in such wells that have been claimed as trade secret, and the percentage by mass of chemicals used in such wells that have been claimed as trade secret; (4) the degree to which the incidence of trade secret claims varies by operator and supplier; (5) the overall percentage of hydraulic fracturing chemicals, on a state and national basis, that are claimed to be trade secret; and (6) how commonly particular chemicals claimed as trade secret are used.

- (b). States and federal regulators should establish a standard for claiming the exemption. The Task Force notes the criticism that has been raised that while trade secret law is generally standardized across the country, there is no accepted standard for asserting a trade secret exemption in the hydraulic fracturing context and no standardized compliance procedure to verify the claim for protection.¹⁵ The Task Force believes the standard for disclosure exemption should be very high. We recommend that states use the State Review of Oil and Gas Regulations, (STRONGER) mechanism to craft and adopt stringent criteria for trade secret exemption to disclosure and a process for validating compliance. STRONGER should begin by reviewing the practices in different states to determine the effectiveness of different approaches and, when available, draw on the results of the DOE Fossil Energy review in subsection (a) above and the independent audit we recommend above of the FracFocus disclosure system, in particular the data collected on trade secret claims.

¹⁵ K. Konschnik, M. Holden, and A. Shasteen, *Legal Fractures in Chemical Disclosure Laws*, Harvard Law School, Environmental Law Program, April 23, 2013.

- (c). State and federal regulators should establish compliance of trade secret claims and challenge mechanisms once a procedure is in place. Every trade secret exemption procedure adopted by a state should be accompanied by mechanisms for determining compliance (including certification by the company invoking exemption that the procedure has been followed) and for interested parties from the public to raise challenges.

This work and its results will be of interest to the U.S. Environmental Protection Agency and the Bureau of Land Management (BLM) of the Department of Interior. Therefore the study and work recommended on trade secrets should be coordinated with these federal agencies. The BLM recently proposed disclosure policy regulations.¹⁶ These proposed disclosure regulations do not yet meet the high disclosure standards that the 2011 Subcommittee recommended that BLM adopt.¹⁷ Therefore, the Task Force recommends that any trade secret exemptions permitted by BLM in its regulations for hydraulic fracturing on federal lands include a rigorous process of claiming trade secret exemptions and robust trade secret verification and challenge mechanisms.

(4) Understanding the difference in federal data custody requirements and FracFocus practices. The Task Force understands that there are differences in the data custody practices of FracFocus and the more stringent and comprehensive federal data custody standards. It is not unusual to find private sector data practices different from and/or below federal standards with respect to security, storage, and retention. The Task Force would encourage and welcome improvements in FracFocus data custody practices.

¹⁶ Department of Interior, BLM, 43 CFR Part 3160 , [WO-300-L13100000.FJ0000] RIN 1004-AE26, *Oil and Gas; Well Stimulation, Including Hydraulic Fracturing, on Federal and Indian Lands*. The BLM proposed rule allows companies to identify confidential information that is exempt from public disclosure under the Trade Secrets Act or other Federal law. However, if BLM determines that the asserted confidential information is not prohibited from disclosure by Federal law, BLM may make that information available to the public. The rule does not specify the process by which the BLM would assess or deny the protection, nor a procedure for public challenge of the claim.

¹⁷ Page 6, November 2011 Subcommittee Report.

FracFocus has an informal policy for permanent data retention. The Task Force recommends that FracFocus formalize a more robust policy for its public data custody, data management, security, storage and retention practices and adopt an explicit policy of long-term data retention. This policy should include provision for data custody if the organizations that currently sponsor FracFocus decide in the future to drop the activity.

The Task Force is aware of discussions underway between FracFocus and DOE's Energy Information Administration to include FracFocus as an element of EIA's contemplated National Oil and Gas Information Gateway. This relationship should prove productive for FracFocus, and the RBDMS with which it is now integrated, as a means to identify further opportunities for improvement of data management.

Standards that are important for FracFocus to adopt include: protections against unauthorized alteration or deletion of data; long-term data retention policy including both original and any updated submissions, and audit trails. Additionally, FracFocus should amend its "terms of use" to eliminate restrictions on sharing and aggregation of data on the site.

To ensure that data will be subject to government open records policies that apply to publicly held data, the Task Force also recommends that any state or federal agency that adopts FracFocus as a reporting venue should explicitly adopt a policy to download data or otherwise take possession of information from FracFocus on a regular basis (e.g., weekly).

The Task Force recognizes that the RBDMS program, the oil and gas regulatory agency database used by the majority of oil and gas producing states to manage and analyze oil and gas program data and water resources information, has developed a module to interface with the FracFocus website. This module will allow regulators to automatically download and parse raw data submitted to FracFocus, streamlining the data transfer process and permitting statistical analyses and auditing functions. Putting this module to work in individual states can be done quickly but requires certain additional

programming. GWPC should accelerate the rollout of this RBDMS module to states that receive chemical disclosure data through FracFocus.

(5) Increasing the utility of FracFocus by maintaining it as a database with tools suitable for analysis by regulatory bodies, companies, and the public. The 2011 Subcommittee report noted that the FracFocus registry was not maintained as a database and tools were not available to analyze the information to answer questions of interest to regulators, operating companies, and public interest groups.

By 2013, FracFocus had made important progress in upgrading the registry to act as a database, with varying levels of access for the public and for state regulators. The Task Force recommends that DOE fund FracFocus to upgrade its website to be a more usable interactive database.¹⁸ DOE's Office of Fossil Energy should commission an independent cost estimate of a project to construct a fully interactive database.

The following are a non-exhaustive list of improvements that FracFocus should consider making:

- a. Allow for searching by any field included in a FracFocus submission record (including additive trade name, additive purpose, chemical supplier, date submitted, etc.).
- b. Eliminate the 2000 record display limit, or allow a "next" function. FracFocus currently returns a maximum of 2000 records for any search, without indicating which 2000 are being presented. FracFocus should either return all results, or allow for a "next 2000" functionality.
- c. Solve the CAS number concatenation problem. To the extent that the public is using data scrapers in order to transfer information from FracFocus PDFs to private databases (an activity that promotes better understanding of the FracFocus data in the absence of raw database availability), researchers are

¹⁸ Pages 13 – 15, August 2011, Subcommittee Report

running into problems that arise from how CAS numbers are sometimes entered in batch instead of separately, resulting in CAS numbers appearing together on one line in an unbroken string. FracFocus should modify how the PDFs are created to eliminate this problem.

- d. Allow batch downloads of PDFs. Currently, the system only permits the downloading of a single well's chemical disclosure PDF at a time.
- e. Address the SEAB 2011 report recommendation that the system "include tools for searching and aggregating data by chemical, well, by company, and by geography."¹⁹ One way to do so would be to release the full contents of the FracFocus database in raw, machine-readable form on the FracFocus website.

There is interest in understanding the value of FracFocus and who is using this resource. The Task Force recommends that FracFocus include on its website a dropdown menu requiring the user when entering the system to identify their affiliation or perspective:

- ☐ State government official
- ☐ Federal government official
- ☐ Local government official
- ☐ Non-Governmental Organization
- ☐ Operating company
- ☐ Service company
- ☐ Landowner
- ☐ Mineral owner
- ☐ Educator
- ☐ Research Organization
- ☐ General public
- ☐ Other

(6) Potential for broadening the scope of FracFocus to include any water quality data regarding surrounding water sources both before and after hydraulic fracturing drilling activity. There have been several other proposals for broadening the scope of FracFocus as well. Examples of these suggestions are to require disclosure at the registry of (a) the

chemical composition of flow back and produced water from hydraulically fractured wells; (c) concentration of radioactive elements in the flow back water from the geological formation; (d) disclosure of pre-fracturing information such as chemicals planned for use; and (e) “master lists” of chemicals used by particular companies in a state in a given year.

Each of these suggestions (and others) is of potential interest as part of the regulatory process. But each of these measures also poses challenges for a registry for which companies’ disclosure submissions remain – in many instances – voluntary. Some of these suggestions would require, for example, definitions that respect highly variable geologies, quality control of data submitted by producers with different technical sophistication, and the necessary complex rules for inclusion. The exploration of possible extensions of the concept of the registry to a wider range of use may indeed be productive but we note that the success of FracFocus to date is very much a consequence of its narrow focus and therefore we do not endorse any specific extensions at the present time.

However, within the scope of hydraulic fracturing chemical disclosure, the Task Force notes that the current functionality of FracFocus 2.0 does not meet all of the state requirements, such as pre-fracturing disclosure in Wyoming and “master list” requirements in Arkansas. These are matters that need to be addressed by the RBDMS mechanism of the Groundwater Protection Council and the Interstate Oil and Gas Compact.

The 2011 Subcommittee recommended the creation of a web portal that would aggregate a wide range of public information on shale gas development.²⁰ This Task Force supports this recommendation, and stresses the importance of making data from state and federal regulatory agencies and other sources public -- including statistics regarding methane emission measurements, enforcement information, and other

²⁰ Pages 13 – 15, August 2011 Subcommittee Report.

material – as part of a comprehensive national database. The portal should be open to the public for use to study and analyze oil and gas operations and results.

(7) Stable funding for FracFocus activities. The Task Force like the 2011 Subcommittee, is concerned that FracFocus have a stable source of funding. Up to the present, support has come from a combination of sources: the DOE, the API, and other organizations. The current level of funding is about \$700,000 per year. Currently, the annual cost of maintaining FracFocus is approximately \$1 million. Measured initiatives to update the FracFocus 2.0 website, provide training for the use of the FracFocus system, and to increase capability, (e.g., well finder emergency response, implementation of integration between FracFocus and RBDMS), are programmed for an additional expenditure level of \$500,000 per year for the period 2014 to 2016.

The Task Force believes that a funding level of about \$1.5 million per year is justified to cover the current FracFocus 2.0 activities mentioned above and the additional work recommended in this report: (a) making the website a user-friendly database; (b) carrying out some audits of the accuracy of data deposited in the registry; and (c) coordinating with STRONGER to craft and adopt stringent criteria for trade secret exemption and a process for validating compliance. Additional initiatives put forward by FracFocus could well justify a higher budget especially projects that are integrated into the RBDMS.

At present the modest (< \$1 million) budget for FracFocus is covered by a DOE grant, occasional contributions from a state, and from two oil and gas industry associations. The Task Force believes that the importance of FracFocus justifies a stable source of funding. There are two options for accomplishing this: (a) a higher multi-year grant or contract from DOE or (b) a modest user fee assessed on each well registered. For every 10,000 wells registered each year, a \$50 registration fee per well would produce a revenue stream of \$0.5 million for FracFocus. A combination of DOE support and use fee will comfortably provide for FracFocus. Accordingly, The Task Force recommends that DOE move to establish a stable multi-year budget for FracFocus employing one or

both of these mechanisms. To ensure public confidence in the integrity of FracFocus, it should take steps to make clear that any industry contributions do not appear to influence FracFocus operations in any way.

Appendix A – Secretary Moniz charge to SEAB for the Frac Focus Task Force



The Secretary of Energy
Washington, DC 20585

November 26, 2013

MEMORANDUM FOR THE CO-CHAIRS
SECRETARY OF ENERGY ADVISORY BOARD

FROM: ERNEST J. MONIZ

A handwritten signature in black ink, appearing to be "Ernest J. Moniz".

SUBJECT: Establishing a Task Force on FracFocus 2.0

I request that you form a Secretary of Energy Advisory Board (SEAB) Task Force composed of individuals with expertise and experience required to review how FracFocus 2.0 houses the information Federal and State regulatory agencies require as part of their regulatory functions with regard to disclosure of the composition and quantities of fracturing fluids injected into unconventional oil and gas wells.

Purpose of the Task Force: The SEAB FracFocus 2.0 Task Force will examine the following:

- Operating procedures of FracFocus 2.0.
- How procedures and interfaces allow for timely, complete, and accurate data storage in accordance with regulatory requirements.
- Understanding of the breadth of data housed in FracFocus 2.0 and the extent of exemption of information as being proprietary.
- Data handling and retention practices compared to Federal standards.
- Usefulness to regulatory officials and interested members of the public to access information contained in the FracFocus 2.0 database.
- Potential to expand FracFocus to include any well-water quality data collected prior to well stimulation and post-production.
- The adequacy of existing funding mechanism and suggestion of possible alternative arrangements.

Designated Federal Officer: Amy Bodette, Deputy Director, Office of Secretarial Boards and Councils

Schedule: The Task Force should complete its work, submit a report of its activities to SEAB by March 2014, and make a presentation at SEAB's March 27-28, 2014 meeting. This Task Force is expected to carry out most of its work in sessions open to the public.



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Appendix B – Task Force membership

Organization affiliations are listed for identification purposes only. The Task Force report integrates the contributions of individual members and should not be associated with the view of any of the listed organizations.

***Frances Beinecke** President, Natural Resources Defense Council

***Rafael L. Bras** Provost and Executive Vice President for Academic Affairs, Georgia Institute of Technology

***John Deutch** MIT Chemist and Former Under Secretary of Energy – Task Force Chair

***Persis Drell** Professor of Physics, Stanford University and Former Director, SLAC National Accelerator Laboratory – Ex Officio SEAB Co-chair

Stephen Holditch Professor of Petroleum Engineering, Texas A&M

Fred Krupp President, Environmental Defense Fund

***Dan W. Reicher** Executive Director, Steyer-Taylor Center for Energy Policy and Finance, Stanford University and faculty member, Stanford Law School and Graduate School of Business

***Ram Shenoy** Chief Technology Officer, ConocoPhillips

Susan Tierney Managing Principal, Analysis Group; Former DOE Assistant Secretary for Policy

***Daniel Yergin** Vice Chairman, IHS and Founder of IHS Cambridge Energy Research Associates

* SEAB member

Appendix C - Data from FracFocus2

Disclosures Submitted to FracFocus Version 2.0			
State	Disclosures Since 6/1/2013	Disclosures With Trade Secret	Percent of Chemicals
Alabama	17	17	21
Alaska	1	1	13
Arkansas	246	246	17
California	401	269	6
Colorado	1026	995	25
Kansas	91	52	4
Louisiana	100	68	15
Michigan	1	1	23
Mississippi	6	4	10
Montana	78	51	11
New Mexico	343	336	22
North Dakota	1190	988	13
Ohio	154	128	23
Oklahoma	1158	764	15
Pennsylvania	565	356	15
Texas	6406	5509	17
Utah	609	591	22
Virginia	4	4	22
West Virginia	102	86	15
Wyoming	470	432	17
Total	12968	10898	
Average		84.04%	15.80%

March 17, 2014

U.S. Environmental Protection Agency
Agency Freedom of Information Office (2822T)
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Re: Freedom of Information Act Request

Dear Freedom of Information Officer:

Pursuant to the Freedom of Information Act, 5 U.S.C. § 552, and corresponding U.S. Environmental Protection Agency regulations, Earthworks, a 501 (c)(3) nonprofit environmental organization, requests copies of the following records located within the EPA's Office of Pollution Prevention and Toxics (EPA OPPT):

EPA's initial health assessments, initial determinations, final health assessments and final regulatory determinations for all chemicals assessed under the premanufacture program (TSCA Section 5 notices) that are used for enhanced hydrocarbon recovery, also known as hydraulic fracturing or acid fracturing and all chemicals assessed under the premanufacture program that are used as drilling mud additives and drilling lubricants in oil and natural gas drilling. In conducting your search for chemicals used for such purposes, we request that you use at least the following search terms. Please note that 'AND' refers to the Boolean search term such that both terms should appear in the use field. An '*' means a search in which all the variations of a term are covered. For example, "drill*" would include "drills," "drilling," etc. Here are the search terms:

Oil* AND Drill*
Oil* AND Gel*
Oil* AND Well*
Oil* AND Recover*
Oil* AND Field*

Gas* AND drill*
Gas* AND gel*
Gas* AND well*
Gas* AND recover*
Gas* AND field*

Hydraulic* AND fractur*
Fractur* AND fluid*
Coal* AND dewater*

We request that you provide EPA's initial health assessments (Structure Activity Team reports), initial regulatory determinations (FOCUS reports), final health assessments (final health and/or risk assessments and final regulatory determinations (disposition meeting reports) for each notice without identifying the premanufacture notice case numbers for the chemicals or any other information associated with the records that might be considered confidential business information. We request, however, that EPA keep a key related to the health assessments and determinations responsive to this request (e.g. by numbering the responsive records 1, 2, 3, 4, etc.) so that EPA can easily locate documents if we make additional freedom of information requests related to particular records. We also request that you characterize each chemical record as relating to "hydraulic fracturing," "acid fracturing," "drilling mud," "drilling lubricant" or other use in drilling operations if such use can be determined from your records.

For cases that were dropped from further review or regulated at the FOCUS meeting or another disposition meeting, Earthworks understands that the initial assessments serve as the basis for the final Agency determination and any subsequent action. Further, Earthworks understands that under TSCA Sec. 14(b), EPA may not deny the disclosure of the results of health and safety studies when they are related to chemical substances distributed in commerce as a trade secret. The assessments of EPA staff that rely, in part or whole, upon these studies may also not be denied as trade secrets. In filing this request, Earthworks is not interested in manufacturing or processing information that may be claimed confidential.

Request for Fee Waiver

Earthworks requests that the EPA waive any and all fees associated with this FOIA request in accordance with 5 U.S.C. § 552 (a)(4)(A)(iii) and 40 C.F.R. § 2.107 (l). Earthworks should qualify for a fee waiver because our request "is likely to contribute significantly to public understanding of the operations or activities of the government and is not primarily in the commercial interest of the requester."

Below we address each of the criteria that the EPA shall use in determining whether fees should be waived:

1) *The records requested concern the operations or activities of the government.*

The records Earthworks seeks are produced by EPA, an agency of the federal government and are generated as part of EPA's mission to protect the public from chemical risks.

2) *Disclosure of the records requested is likely to contribute to public understanding of those operations or activities.*

The records are likely to contribute to the public's understanding of how EPA evaluates and regulates chemicals used in oil and natural gas drilling and hydraulic fracturing. The records are also likely to contribute to the public's understanding of the characteristics of the chemicals submitted for review and what, if any, risks the EPA foresees due to the use of such chemicals. It is not widely known that EPA reviews new chemicals used for

oil and natural gas drilling and hydraulic fracturing and EPA's analyses and determinations are not widely known, either.

3) *Disclosure of the records will contribute to the understanding of a reasonably broad audience of people interested in the issue.*

Disclosure of the requested information will contribute to the understanding of a reasonably broad audience of people interested in the issue because oil and gas drilling is occurring in more than 30 states. Regulation of this activity is a hotly debated topic, and drilling and hydraulic fracturing have been featured recently in many prominent news stories as well as in books, movies and at least one popular television show, CSI. Earthworks has worked for twenty-five years protecting communities and the environment from the negative impacts of resource extraction. Our Oil & Gas Accountability Project program has played an instrumental role in highlighting the inadequacies of state and federal oversight since the onset of widespread use of horizontal hydraulic fracturing. Local, state and national media, legislators and regulatory agencies routinely seek our expertise on drilling and fracturing issues as they pertain to public health and regulatory oversight.

After obtaining and analyzing the records sought by this FOIA request, Earthworks intends to incorporate the information the records contain into a report and to disseminate the information to media outlets, public officials and the general public. We will publicize this information in the same fashion as our previous research, which has received wide coverage from local, regional, and national media. For example, *Breaking All the Rules*¹, a recent Earthworks report on state oversight of oil and gas development, received extensive coverage from the *Los Angeles Times*,² *Huffington Post*,³ *Bloomberg News*,⁴ *Columbus Dispatch*,⁵ *Houston Chronicle*,⁶ and *Associated Press*.⁷

4) *The disclosure of the information is likely to contribute significantly to public understanding.*

Disclosure of the information is likely to significantly enhance the public's understanding of the characteristics of chemicals EPA regulates for use in oil and natural gas drilling operations, the agency's analyses of these chemicals and the agency's regulatory determinations because, to our

¹ Earthworks, *Breaking All the Rules* (2012), <http://enforcement.earthworksaction.org>

² Neela Banerjee, *Watchdog group faults states' inspections of oil, gas wells* (Sep 25, 2012), <http://articles.latimes.com/2012/sep/25/nation/la-na-nn-oil-gas-regulator-report-20120925>

³ Tom Zeller Jr, *Fracking regulations in states leave wells without inspection, environmental groups says* (Sep 25, 2012), http://www.huffingtonpost.com/2012/09/25/fracking-regulations-states-wells_n_1914527.html

⁴ Kasia Klimasinska, *States fail to oversee fracking, environmental groups says* (Sep 25, 2012), <http://www.bloomberg.com/news/2012-09-25/states-fail-to-oversee-u-s-fracking-environmental-group-says.html>

⁵ Spencer Hunt, *Report: Oil well inspections lagging in Ohio* (Sep 25, 2012), <http://www.dispatch.com/content/blogs/science-environment/2012/09/inspectors.html>

⁶ Jeannie Kever, *Group says many Texas wells aren't inspected* (Sep 26, 2012), http://www.google.com/url?q=http%3A%2F%2Fwww.chron.com%2Fbusiness%2Fenergy%2Farticle%2FGroup-says-many-Texas-wells-aren-t-inspected-3893881.php&sa=D&ntz=1&usg=AFQjCNGWRXPTj_CVvXhyXQ1SKpP7DJGGWg

⁷ Kevin Begos, *Environmental group says DEP is slack on gas well inspections*, (Sep 27, 2012), <http://www.poonorecord.com/apps/pbcs.dll/article?AID=/20120927/NEWS90/209270338/-1/NEWS>

knowledge, these records have not previously been made public and the existence of the review process for these chemicals is not widely known.

5) *Disclosure of the requested records is not primarily in the commercial interest of the requester.*

Disclosure of the requested records would not be in Earthworks' commercial interest, because Earthworks is a 501(c)(3) nonprofit organization. Earthworks has no intention of using these records or the information they contain in a manner that furthers a commercial, trade, or profit interest. Any analysis of this information would be conducted to educate the public about this issue.

For the foregoing reasons, it is clear that the disclosure of the information requested is in the public interest. Please waive processing and copying fees pursuant to 40 C.F.R. 2.107. If the EPA cannot grant a fee waiver, Earthworks is willing pay up to \$100 so that the agency may conduct the requested search in a timely fashion. This request for a fee waiver should not be construed as an extension of time in which to reply to this FOIA request.

Earthworks respectfully requests that the EPA make every effort to respond to this request within the 20-day limit required by your regulations, 40 C.F.R. 2.104. If you determine that portions of the records requested are exempt from disclosure, please segregate the exempt portions and send the remaining records within the statutory time limits. For any records or portions of records that you determine to be exempt, please provide a specific description of the record or portion of the record exempted, as well as a justification of the exemption.

Finally, Earthworks requests that the agency send all responsive records in an electronic format (e.g., .xls, .doc, .pdf, .jpeg, .mp3, and/or .mp4). If honoring this request would incur prohibitive additional costs for the agency, or substantially delay the time in which the agency is able to honor this FOIA request, Earthworks will accept records in hard copy or other format more expedient and economical for the agency to produce.

Sincerely,

Lauren Pagel
Policy Director
Earthworks
1612 K St., NW; Suite 808
Washington, DC 20006
202-887-1872 x117

Focus Report

New Chemicals Program

PMN Number: **P-11-0091**

Focus Date: 01/03/2011 12:00:00 AM Report Status: Completed
 Consolidated Set: P-11-0091; P-11-0092; P-11-0093
 Focus Chair: Jim Alwood Contractor: Christina Stanley

I. Notice Information

Submitter: [REDACTED] CAS Number: [REDACTED]
 Chemical Name: [REDACTED]

Use: [REDACTED]

Other Uses: [REDACTED]

PV-Max: [REDACTED]

Manufacture: [REDACTED]

Import: X

II. SAT Results

(1) Health Rating:	1-2	Eco Rating:	2	Comments:	PMN;mitigation of toxicity expected i.e., ~17x
(2) Health Rating:	2	Eco Rating:	3	Comments:	Potential Incineration/degradation p concern for toxicity of incomplete incineration products to terrestrial organisms

Occupational: 2-3D

Non-Occupational:

Environmental: 2

(1) PBT: 3	1	1	Comments: PMN
(2) PBT: 3	2	2	Comments: Incin Pdt
(3) PBT: 3	2	2	Comments:
(4) PBT: 3	2	2	Comments:
(5) PBT: 3	2	2	Comments:

III. OTHER FACTORS

Categories:

Health Chemical Category:	Perfluoro Containing Chemicals	Ecotox SAR and Category:	polycationic polymers; Polycationic Polymers

Related Cases/Regulatory History:

Health related Cases: [REDACTED]
 Ecotox Related Cases: Analogs: [REDACTED]
 Regulatory History: [REDACTED]: GRANTED WITH CONDITION

MSDS/Label Information:

MSDS: Yes Label: No
 General Equipment: impervious gloves/ safety glasses or coverall chemical splash goggles / Use only in area provided with appropriate exhaust ventilation. [REDACTED]

Respirator: In case of mist, spray or aerosol exposure wear suitable personal respiratory protection and protective suit.

Health Effects: Inhalation of aerosol or fine spray mist may cause serious respiratory problems / No skin or eye irritation.

TLV/PEL (PMN or raw material): - none established.

Exposure Based Information:

Exposure Based Review:	N	Exposure Based Review (Health):	N
Exposure Based Review (Eco):	N	Exposure Based (Occupational):	No
Exposure Based Review (Non Occupational):	N	Exposure Based (Environmental):	

Exposure Parameter	Exposure-Based	Persistent/Bioaccum	Exposure Value
Surface DW:			
Fish Ingestion:			
Ground DW:		Yes	
Inhalation:			
Water Releases:		Yes	
Total Releases:		Yes	
Consumer Exposure:			

IV. Summary of SAT Assessment**Fate:**

Fate Summary: P-11-0091-93
 FATE: MW = 

 S = Disp.
 VP < 1.0E-6 torr at 25 C (E)
 BP > 400 C (E)
 H < 1.00E-8 (E)
 POTW removal (%) = 90 via sorption
 Time for complete ultimate aerobic biodeg > mo
 Sorption to soils/sediments = v.strong
 PBT Potential: PMN P3B1; Incin Pdt P3B2
 *CEB FATE: Migration to ground water = negl

Health:

Health Summary: Absorption is nil all routes based on physical/chemical properties. There is concern for lung toxicity from cationic binding to lung membranes.

For the potential incomplete incineration/environmental degradation product, based on test data for the analogue  concerns are liver toxicity, blood toxicity, and male reproductive toxicity [rat 28-day oral NOAEL = 50 mg/kg, LOAEL = 150 mg/kg with liver toxicity; rat 90-day oral LOAEL = 10 mg/kg based on decreased body weight in males at all doses and liver toxicity and anemia at 200 mg/kg; there were toxic effects on the testes in 2 males in the 90-day oral study that were judged by the reviewer to be indicative of the potential for male reproductive toxicity. There is also concern for immunosuppression and oncogenicity based on data for .

Test Data: (-) Salmonella with and without activation; (-) E. coli with and without activation; rat oral LD0 = 5000 mg/kg; slight eye irritation in rabbits, cleared by 48 h; slight skin irritation in rabbits, cleared by 24 h; (-) for skin sensitization in a mouse local lymph node assay at 20% ai

Ecotox:

Ecotox Values:

Fish 96-h LC50:	3.5(P)	
Daphnid 48-h LC50:	13(P)	>120(M)
Green algal 96-h EC50:	1.5(P)	
Fish Chronic Value:	0.19(P)	
Daphnid ChV:	0.92(P)	

Algal ChV: 0.40(P)

Ecotox values comments: Predictions are based on SARs for polycationic polymers with [REDACTED] amine-N; SAR chemical class = polymer-cationic-[REDACTED] amine-N; MW [REDACTED]; [REDACTED] effective concentrations based on 100% active ingredients and nominal concentrations; hardness <180.0 mg/L as CaCO₃; and TOC <2.0 mg/L; significant mitigation of toxicity expected in the presence of 10 mg TOC/L, i.e., ~17 times;

high concern for the [REDACTED] to wild mammals and birds based on mammalian test data for mammals for [REDACTED]

Ecotoxicity Study Review for [REDACTED]
[REDACTED]

PMN P11-0091

A single daphnid acute ecotoxicity study, conducted in [REDACTED], accompanied this PMN submission. In this study, the test substance, designated [REDACTED] " was tested. This designation was stipulated as identical to the PMN substance by personal communication with [REDACTED], technical contact for [REDACTED]. The PMN is marketed as various [REDACTED]. The PMN is a polycationic polymer with [REDACTED] amine nitrogen and thus having toxicity mitigated by a factor of 17 for adsorption to organic carbon. The combination [REDACTED] salt was tested in daphnia and results are considered to apply to all 3 forms of the PMN. The substance was described as a [REDACTED] consisting of [REDACTED] and was introduced into the reconstituted aqueous test media at a nominal concentration of 600 mg product formulation per liter (or 120 mg a.i./L). Dilutions were made of this highest concentration, consisting of 60 (12 mg a.i./L), 6 (1.2 mg a.i./L) or 0.6 (0.12 mg a.i./L). All test solutions were then stirred again for an additional 15 minutes. Solutions were clear with no observable precipitate. These concentrations, along with a control consisting of only aqueous test media, were tested with daphnia. The PMN was not measured analytically and all reported concentrations are nominal.

In a static immobilization test, fasted *Daphnia magna* (10 daphnids/replicate x 1 replicate) were exposed to nominal concentrations of 0, 0.12, 1.2, 12, or 120 mg a.i./L for 48 hours under static conditions. Over the course of the study, water temperature was 19.8-21.0°C, pH ranged from 8.0 to 8.2, O₂ levels ranged from 8.7 to 9.1 mg O₂/L, water hardness of the dilution water 100-140 mg/L as CaCO₃ and electrical conductivity was not reported. Thus, study parameters complied with OCSPP and OECD guidelines for: 1) O₂, pH, temperature, water hardness values and other water quality parameters; 2) species, age, number of organisms per replicate, and biomass loading rates; and, 3) replicate and overall variability.

No immobilization or abnormal response was observed in the control or treated groups. The daphnia 48-hour EC₅₀ for immobilization was determined to be >120 mg a.i./L with no 95% confidence limits determinable. The LOAEC was not determined and the NOAEC was 120 mg a.i./L.

Results from this acute daphnid aquatic ecotoxicity study show lower toxicity than the ECOSAR-predicted daphnid acute value of 13 mg/L. *Daphnia* was the only species tested. ECOSAR predicts that algae will have a 96-hr EC₅₀ of 1.5 mg/L and that fish will have a 96-hr LC₅₀ of 3.5 mg/L.

Even though the daphnia test is considered valid, because ECOSAR predicts higher toxicity for fish and algae, the predictions from ECOSAR for algae will supersede the *Daphnia* test results for setting the COC to err on the side of protecting the environment. Based on algae, the most sensitive species predicted by ECOSAR, the existing COC of 320 ppb will not be changed based on the test results for daphnia.

Reviewer: S. Cragg
20 December 2010

Ecotox Factors:

Assessment Factor: 10
Concern Concentration: 320
- Chronic Value

V. Summary of Exposures/Releases

Engineering Summary: P-11-0091

Exposures/Releases	Release	Release	Release
Scenario			
Sites			
Media			
Descriptor A	High End	Conservative	High End
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

Engineering Summary: Exposures/Releases	Release	Release	Release
Scenario			
Sites			
Media			
Descriptor A	High End	High End	Output 2
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

V. Summary of Exposures/Releases

Engineering Summary: P-11-0091

Exposures/Releases	Release	Release	Release
Scenario			
Sites			
Media			
Descriptor A	Conservative	High End	Conservative
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

Engineering Summary: Exposures/Releases	Release	Release	Release
Scenario			
Sites			
Media			
Descriptor A	High End	Conservative	Output 2
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

V. Summary of Exposures/Releases

Engineering Summary: P-11-0091

Exposures/Releases	Release	Release	Release
Scenario			
Sites			
Media			
Descriptor A	Output 2	Output 2	High End
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

Engineering Summary: Exposures/Releases	Release	Release	Release
Scenario			
Sites			
Media			
Descriptor A	Conservative	Output 2	High End
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

V. Summary of Exposures/Releases

Engineering Summary: P-11-0091

Exposures/Releases	Release	Release	Release
Scenario			
Sites			
Media			
Descriptor A	Conservative	High End	Output 2
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

Engineering Summary: Exposures/Releases	Release	Release	Exposure
Scenario			
Sites			
Media			
Descriptor A	Output 2	Conservative	High End
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

V. Summary of Exposures/Releases

Engineering Summary: P-11-0091

Exposures/Releases	Exposure	Exposure	Exposure
Scenario			
Sites			
Media			
Descriptor A	High End	High End	Upper Bound
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

Engineering Summary: Exposures/Releases	Exposure	Exposure	Exposure
Scenario			
Sites			
Media			
Descriptor A	High End	High End	Upper Bound
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

V. Summary of Exposures/Releases

Engineering Summary: P-11-0091

Exposures/Releases	Exposure	Exposure	Exposure
Scenario			
Sites			
Media			
Descriptor A	High End	High End	High End
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

Engineering Summary: Exposures/Releases	Exposure	Exposure	Exposure
Scenario			
Sites			
Media			
Descriptor A	High End	High End	High End
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

V. Summary of Exposures/Releases

Engineering Summary: P-11-0091

Exposures/Releases	Exposure		
Scenario			
Sites			
Media			
Descriptor A	Upper Bound		
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

VI. Focus Decision and Rationale

Regulatory Actions

Regulatory Decision: PMN Standard Review

Decision Date: 01/03/2011

Type of Decision:

Rationale:

P11-0091-0093 will be placed in standard review to examine potential human health risks to workers and consumers from [REDACTED], polymers with [REDACTED], and PBT concerns for they hydrolysis product. Human health concerns were low-moderate for the PMN substances and moderate for the degradation product. Human health risks from [REDACTED] include immunotoxicity and developmental/reproductive effects. Ecotoxicity concerns were moderate for the PMN substance and high for the hydrolysis product for terrestrial species. These risks were mitigated due to no chronic exceedance for the 320 ppb chronic COC and no exceedance of the 6,375 ppb acute COC. The standard review will consist of a team, schedule and TI. The PBT score for the PMN substances is P3B2T1 and P3B2T2 for they hydrolysis product.

COC's: 320 ppb chronic, 6,375 ppb acute

Summary of Exposures and Releases:

[illegible]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

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[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

P2 Rec Comments:

Testing:

Final Recommended:

Health:
Eco:
Fate:
Other:

SAT ReportPMN Number: **P-11-0091**SAT Date: **12/17/2010**Print Date: **3/13/2015****Related cases:**

Health related cases: [REDACTED]

Ecotox related cases: Analogs: [REDACTED]

Concern levels:

Type of Concern:	<u>Health</u>	<u>Eco</u>	<u>Comments</u>
Level of Concern:	1-2	2	Health: PMN ; Eco: mitigation of toxicity expected, i.e., ~17x
	2	3	Health: Potential Incineration/degradation product ; Eco: concern for toxic incomplete incineration products to terrestrial organisms
	<u>Persistence</u>	<u>Bioaccum</u>	<u>Toxicity</u> <u>Comments</u>
	3	1	PMN
	3	2	Inciner Pdt

Exposure Based Review:**Health:** No**Ecotox:** No**Routes of exposure:****Health:** Dermal Inhalation**Ecotox:** All releases to water**Fate:** ;**Keywords:****Keywords:** LUNG**Summary of Assessment:****Fate:****Fate Summary:** P-11-0091-93

FATE: MW = [REDACTED] < 500 and [REDACTED] < 1000

S = Disp.

VP < 1.0E-6 torr at 25 C (E)

BP > 400 C (E)

H < 1.00E-8 (E)

POTW removal (%) = 90 via sorption

Time for complete ultimate aerobic biodeg > mo

Sorption to soils/sediments = v.strong
 PBT Potential: PMN P3B1; Incin Pdt P3B2
 *CEB FATE: Migration to ground water = negl

Health:

Health Summary: Absorption is nil all routes based on physical/chemical properties. There is concern for lung toxicity from cationic binding to lung membranes.

For the potential incomplete incineration/environmental degradation product, based on test data for the analogue [REDACTED] concerns are liver toxicity, blood toxicity, and male reproductive toxicity [rat 28-day oral NOAEL = 50 mg/kg, LOAEL = 150 mg/kg with liver toxicity; rat 90-day oral LOAEL = 10 mg/kg based on decreased body weight in males at all doses and liver toxicity and anemia at 200 mg/kg; there were toxic effects on the testes in 2 males in the 90-day oral study that were judged by the reviewer to be indicative of the potential for male reproductive toxicity. There is also concern for immunosuppression and oncogenicity based on data for [REDACTED].

Test Data: (-) Salmonella with and without activation; (-) E. coli with and without activation; rat oral LD0 = 5000 mg/kg; slight eye irritation in rabbits, cleared by 48 h; slight skin irritation in rabbits, cleared by 24 h; (-) for skin sensitization in a mouse local lymph node assay at 20% ai

Ecotox:

Test Organism	Test Type	Test End Point	Predicted	Measured	Comments
fish	96-h	LC50	3.5		
daphnid	48-h	LC50	13	>120	
green algal	96-h	EC50	1.5		
fish	–	chronic value	0.19		
daphnid	–	chronic value	0.92		
algal	–	chronic value	0.40		
Sewage Sludge	3-h	EC50	–		
Sewage Sludge	–	Chronic Value	–		

Ecotox Values Comments: Predictions are based on SARs for polycationic polymers with [REDACTED] amine-N; SAR chemical class = polymer-cationic [REDACTED] amine-N; MW [REDACTED] < 1000 and [REDACTED] < 500; pH7; effective concentrations based on 100% active ingredients and nominal concentrations; hardness <180.0 mg/L as CaCO₃; and TOC <2.0 mg/L; significant mitigation of toxicity expected in the presence of 10 mg TOC/L, i.e., ~17 times;

high concern for the [REDACTED] to wild mammals and birds based on mammalian test data for mammals for [REDACTED].

Ecotoxicity Study Review for [REDACTED]
[REDACTED]

PMN P11-0091

A single daphnid acute ecotoxicity study, conducted in [REDACTED], accompanied this PMN submission. In this study, the test substance, designated [REDACTED], was tested. This designation was stipulated as identical to the PMN substance by personal communication with [REDACTED], technical contact for [REDACTED]. The PMN is marketed as various salts of the polymer: [REDACTED]

[REDACTED] The PMN is a polycationic polymer with [REDACTED] amine nitrogen and thus having toxicity mitigated by a factor of 17 for adsorption to organic carbon. The combination [REDACTED] was tested in daphnia and results are considered to apply to all 3 forms of the PMN. The substance was described as a [REDACTED] and was introduced into the reconstituted aqueous test media at a nominal concentration of 600 mg product formulation per liter (or 120 mg a.i./L). Dilutions were made of this highest concentration, consisting of 60 (12 mg a.i./L), 6 (1.2 mg a.i./L) or 0.6 (0.12 mg a.i./L). All test solutions were then stirred again for an additional 15 minutes. Solutions were clear with no observable precipitate. These concentrations, along with a control consisting of only aqueous test media, were tested with daphnia. The PMN was not measured analytically and all reported concentrations are nominal.

In a static immobilization test, fasted *Daphnia magna* (10 daphnids/replicate x 1 replicate) were exposed to nominal concentrations of 0, 0.12, 1.2, 12, or 120 mg a.i./L for 48 hours under static conditions. Over the course of the study, water temperature was 19.8-21.0°C, pH ranged from 8.0 to 8.2, O₂ levels ranged from 8.7 to 9.1 mg O₂/L, water hardness of the dilution water 100-140 mg/L as CaCO₃ and electrical conductivity was not reported. Thus, study parameters complied with OCSPP and OECD guidelines for: 1) O₂, pH, temperature, water hardness values and other water quality parameters; 2) species, age, number of organisms per replicate, and biomass loading rates; and, 3) replicate and overall variability.

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Results from this acute daphnid aquatic ecotoxicity study show lower toxicity than the ECOSAR-predicted daphnid acute value of 13 mg/L. *Daphnia* was the only species tested. ECOSAR predicts that algae will have a 96-hr EC₅₀ of 1.5 mg/L and that fish will have a 96-hr LC₅₀ of 3.5 mg/L.

Even though the daphnia test is considered valid, because ECOSAR predicts higher toxicity for fish and algae, the predictions from ECOSAR for algae will supersede the *Daphnia* test results for setting the COC to err on the side of protecting the environment. Based on algae, the most

sensitive species predicted by ECOSAR, the existing COC of 320 ppb will not be changed based on the test results for daphnia.

Reviewer: S. Cragg
20 December 2010

Factors	Values	Comments
Assessment Factor	10	
Concentration of Concern (ppb)	320	with mitigation
SARs	polycationic polymers	
SAR Class	polymer-cationic-amine nitrogen-	new chemicals category: polycationic polymers
Ecotox Category		

Ecotox Factors Comments:

SAT Chair: L Keifer 564-8916

Focus Report
New Chemicals Program
 PMN Number: **P-11-0092**

Focus Date: 01/03/2011 12:00:00 AM Report Status: Completed
 Consolidated Set: P-11-0091; P-11-0092; P-11-0093
 Focus Chair: Jim Alwood Contractor: Christina Stanley

I. Notice Information

Submitter: [REDACTED] CAS Number: [REDACTED]
 Chemical Name: [REDACTED]

Use: [REDACTED]

Other Uses: [REDACTED]

PV-Max: [REDACTED]

Manufacture: [REDACTED]

Import: X

II. SAT Results

(1) Health Rating:	1-2	Eco Rating:	2	Comments:	PMN;mitigation of toxicity expected i.e., ~17x
(2) Health Rating:	2	Eco Rating:	3	Comments:	Potential Incineration/degradation p concern for toxicity of incomplete incineration products to terrestrial organisms

Occupational: 2-3D

Non-Occupational:

Environmental: 2

(1) PBT: 3	1	1	Comments: PMN
(2) PBT: 3	2	2	Comments: Incin Pdt
(3) PBT: 3	2	2	Comments:
(4) PBT: 3	2	2	Comments:
(5) PBT: 3	2	2	Comments:

III. OTHER FACTORS**Categories:**

Health Chemical Category:	Perfluoro Containing Chemicals	Ecotox SAR and Category:	polycationic polymers; Polycationic Polymers

Related Cases/Regulatory History:

Health related Cases: [REDACTED]

Ecotox Related Cases: [REDACTED]

Regulatory History: [REDACTED]

[REDACTED]: GRANTED WITH CONDITION

MSDS/Label Information:

MSDS:	Yes	Label:	No
General Equipment:	impervious gloves/ safety glasses or coverall chemical splash goggles / Use only in area provided with appropriate exhaust ventilation. [REDACTED]		

Respirator: In case of mist, spray or aerosol exposure wear suitable personal respiratory protection and protective suit.

Health Effects: Inhalation of aerosol or fine spray mist may cause serious respiratory problems / No skin or eye irritation.

TLV/PEL (PMN or raw material): - none established.

Exposure Based Information:

Exposure Based Review: N
 Exposure Based Review (Eco): N
 Exposure Based Review (Non Occupational):

Exposure Based Review (Health): N
 Exposure Based (Occupational): No
 Exposure Based (Environmental):

IV. Summary of SAT Assessment**Fate:****Fate Summary:**

P-11-0091-93
 FATE: MW = [REDACTED] < 500 and [REDACTED] < 1000
 [REDACTED]
 S = Disp.
 VP < 1.0E-6 torr at 25 C (E)
 BP > 400 C (E)
 H < 1.00E-8 (E)
 POTW removal (%) = 90 via sorption
 Time for complete ultimate aerobic biodeg > mo
 Sorption to soils/sediments = v.strong
 PBT Potential: PMN P3B1; Incin Pdt P3B2
 *CEB FATE: Migration to ground water = negl

Health:**Health Summary:**

Absorption is nil all routes based on physical/chemical properties. There is concern for lung toxicity from cationic binding to lung membranes.

For the potential incomplete incineration/environmental degradation product, based on test data for the analogue [REDACTED] concerns are liver toxicity, blood toxicity, and male reproductive toxicity [rat 28-day oral NOAEL = 50 mg/kg, LOAEL = 150 mg/kg with liver toxicity; rat 90-day oral LOAEL = 10 mg/kg based on decreased body weight in males at all doses and liver toxicity and anemia at 200 mg/kg; there were toxic effects on the testes in 2 males in the 90-day oral study that were judged by the reviewer to be indicative of the potential for male reproductive toxicity. There is also concern for immunosuppression and oncogenicity based on data for [REDACTED].

Test Data:

P11-0091: (-) Salmonella with and without activation; (-) E. coli with and without activation; rat oral LD0 = 5000 mg/kg; slight eye irritation in rabbits, cleared by 48 h; slight skin irritation in rabbits, cleared by 24 h; (-) for skin sensitization in a mouse local lymph node assay at 20% ai

Ecotox:**Ecotox Values:**

Fish 96-h LC50: 3.6(P)
 Daphnid 48-h LC50: 14(P)
 Green algal 96-h EC50: 1.6(P)
 Fish Chronic Value: 0.20(P)
 Daphnid ChV: 0.99(P)
 Algal ChV: 0.43(P)

Ecotox values comments:

Predictions are based on SARs for polycationic polymers with [REDACTED] amine-N; SAR chemical class = polymer-cationic [REDACTED] amine-N; MW [REDACTED] < 1000 and [REDACTED] < 500; [REDACTED]; effective concentrations based on 100% active ingredients and nominal concentrations; hardness <180.0 mg/L as CaCO3; and TOC <2.0 mg/L; significant mitigation of toxicity expected in the presence of 10 mg TOC/L, i.e., ~17 times;

high concern for the [REDACTED] to wild mammals and birds based on mammalian test data for mammals for [REDACTED].

Ecotox Factors:

Assessment Factor: 10
Concern Concentration: 340
- Chronic Value

V. Summary of Exposures/Releases

Engineering Summary: P-11-0092

Exposures/Releases	Release	Release	Release
Scenario			
Sites			
Media			
Descriptor A	High End	Conservative	High End
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

Engineering Summary: Exposures/Releases	Release	Release	Release
Scenario			
Sites			
Media			
Descriptor A	High End	High End	Output 2
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

V. Summary of Exposures/Releases

Engineering Summary: P-11-0092

Exposures/Releases	Release	Release	Release
Scenario			
Sites			
Media			
Descriptor A	Conservative	High End	Conservative
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

Engineering Summary: Exposures/Releases	Release	Release	Release
Scenario			
Sites			
Media			
Descriptor A	High End	Conservative	Output 2
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

V. Summary of Exposures/Releases

Engineering Summary: P-11-0092

Exposures/Releases	Release	Release	Release
Scenario			
Sites			
Media			
Descriptor A	Output 2	Output 2	High End
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

Engineering Summary: Exposures/Releases	Release	Release	Release
Scenario			
Sites			
Media			
Descriptor A	Conservative	Output 2	High End
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

V. Summary of Exposures/Releases

Engineering Summary: P-11-0092

Exposures/Releases	Release	Release	Release
Scenario			
Sites			
Media			
Descriptor A	Conservative	High End	Output 2
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

Engineering Summary: Exposures/Releases	Release	Release	Exposure
Scenario			
Sites			
Media			
Descriptor A	Output 2	Conservative	High End
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

V. Summary of Exposures/Releases

Engineering Summary: P-11-0092

Exposures/Releases	Exposure	Exposure	Exposure
Scenario			
Sites			
Media			
Descriptor A	High End	High End	Upper Bound
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

Engineering Summary: Exposures/Releases	Exposure	Exposure	Exposure
Scenario			
Sites			
Media			
Descriptor A	High End	High End	Upper Bound
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

V. Summary of Exposures/Releases

Engineering Summary: P-11-0092

Exposures/Releases	Exposure	Exposure	Exposure
Scenario			
Sites			
Media			
Descriptor A	High End	High End	High End
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

Engineering Summary: Exposures/Releases	Exposure	Exposure	Exposure
Scenario			
Sites			
Media			
Descriptor A	High End	High End	High End
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

V. Summary of Exposures/Releases

Engineering Summary: P-11-0092

Exposures/Releases	Exposure		
Scenario			
Sites			
Media			
Descriptor A	Upper Bound		
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

VI. Focus Decision and Rationale

Regulatory Actions

Regulatory Decision: PMN Standard Review

Decision Date: 01/03/2011

Type of Decision:

Rationale:

P11-0091-0093 will be placed in standard review to examine potential human health risks to workers and consumers from [REDACTED], polymers with [REDACTED], and PBT concerns for they hydrolysis product. Human health concerns were low-moderate for the PMN substances and moderate for the degradation product. Human health risks from [REDACTED] include immunotoxicity and developmental/reproductive effects. Ecotoxicity concerns were moderate for the PMN substance and high for the hydrolysis product for terrestrial species. These risks were mitigated due to no chronic exceedance for the 320 ppb chronic COC and no exceedance of the 6,375 ppb acute COC. The standard review will consist of a team, schedule and TL. The PBT score for the PMN substances is P3B2T1 and P3B2T2 for they hydrolysis product.

COC's: 320 ppb chronic, 6,375 ppb acute

Summary of Exposures and Releases:

Proc #1:

[illegible]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

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[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

P2 Rec Comments:

Testing:

Final Recommended:

Health:

Eco:

Fate:

Other:

SAT ReportPMN Number: **P-11-0092**SAT Date: **12/17/2010**Print Date: **3/13/2015****Related cases:**

Health related cases: [REDACTED]

Ecotox related cases: Analogs: [REDACTED]

Concern levels:

Type of Concern:	<u>Health</u>	<u>Eco</u>	<u>Comments</u>
Level of Concern:	1-2	2	Health: PMN ; Eco: mitigation of toxicity expected, i.e., ~17x
	2	3	Health: Potential Incineration/degradation product ; Eco: concern for toxic incomplete incineration products to terrestrial organisms
	<u>Persistence</u>	<u>Bioaccum</u>	<u>Toxicity</u> <u>Comments</u>
	3	1	PMN
	3	2	Inciner Pdt

Exposure Based Review:**Health:** No**Ecotox:** No**Routes of exposure:****Health:** Dermal Inhalation**Ecotox:** All releases to water**Fate:** ;**Keywords:****Keywords:** LUNG**Summary of Assessment:****Fate:****Fate Summary:** P-11-0091-93

FATE: MW = [REDACTED] < 500 and [REDACTED] < 1000

S = Disp.

VP < 1.0E-6 torr at 25 C (E)

BP > 400 C (E)

H < 1.00E-8 (E)

POTW removal (%) = 90 via sorption

Time for complete ultimate aerobic biodeg > mo

Sorption to soils/sediments = v.strong
 PBT Potential: PMN P3B1; Incin Pdt P3B2
 *CEB FATE: Migration to ground water = negl

Health:

Health Summary: Absorption is nil all routes based on physical/chemical properties. There is concern for lung toxicity from cationic binding to lung membranes.

For the potential incomplete incineration/environmental degradation product, based on test data for the analogue [REDACTED] concerns are liver toxicity, blood toxicity, and male reproductive toxicity [rat 28-day oral NOAEL = 50 mg/kg, LOAEL = 150 mg/kg with liver toxicity; rat 90-day oral LOAEL = 10 mg/kg based on decreased body weight in males at all doses and liver toxicity and anemia at 200 mg/kg; there were toxic effects on the testes in 2 males in the 90-day oral study that were judged by the reviewer to be indicative of the potential for male reproductive toxicity. There is also concern for immunosuppression and oncogenicity based on data for [REDACTED].

Test Data: P11-0091: (-) Salmonella with and without activation; (-) E. coli with and without activation; rat oral LD0 = 5000 mg/kg; slight eye irritation in rabbits, cleared by 48 h; slight skin irritation in rabbits, cleared by 24 h; (-) for skin sensitization in a mouse local lymph node assay at 20% ai

Ecotox:

Test Organism	Test Type	Test End Point	Predicted	Measured	Comments
fish	96-h	LC50	3.6		
daphnid	48-h	LC50	14		
green algal	96-h	EC50	1.6		
fish	–	chronic value	0.20		
daphnid	–	chronic value	0.99		
algal	–	chronic value	0.43		
Sewage Sludge	3-h	EC50	–		
Sewage Sludge	–	Chronic Value	–		

Ecotox Values Comments: Predictions are based on SARs for polycationic polymers with [REDACTED] amine-N; SAR chemical class = polymer-cationic-[REDACTED] amine-N; MW [REDACTED] < 1000 and [REDACTED] < 500; [REDACTED]; effective concentrations based on 100% active ingredients and nominal concentrations; hardness <180.0 mg/L as CaCO₃; and TOC <2.0 mg/L; significant mitigation of toxicity expected in the presence of 10 mg TOC/L, i.e., ~17 times;

high concern for the [REDACTED] to wild mammals and birds based on mammalian test data for mammals for [REDACTED]

Factors	Values	Comments
Assessment Factor	10	
Concentration of Concern (ppb)	340	with mitigation
SARs	polycationic polymers	
SAR Class	polymer-cationic- [REDACTED] amine nitrogen- [REDACTED]	new chemicals category: polycationic polymers
Ecotox Category		

Ecotox Factors Comments:

SAT Chair: L Keifer 564-8916

Focus Report
New Chemicals Program
 PMN Number: **P-11-0093**

Focus Date: 01/03/2011 12:00:00 AM Report Status: Completed
 Consolidated Set: P-11-0091; P-11-0092; P-11-0093
 Focus Chair: Jim Alwood Contractor: Christina Stanley

I. Notice Information

Submitter: [REDACTED] CAS Number: [REDACTED]
 Chemical Name: [REDACTED]

Use: [REDACTED]

Other Uses: [REDACTED]

PV-Max: [REDACTED]

Manufacture: [REDACTED]

Import: X

II. SAT Results

(1) Health Rating:	1-2	Eco Rating:	2	Comments:	PMN;mitigation of toxicity expected i.e., ~17x
(2) Health Rating:	2	Eco Rating:	3	Comments:	Potential Incineration/degradation p concern for toxicity of incomplete incineration products to terrestrial organisms

Occupational: 2-3D

Non-Occupational:

Environmental: 2

(1) PBT: 3	1	1	Comments: PMN
(2) PBT: 3	2	2	Comments: Incin Pdt
(3) PBT: 3	2	2	Comments:
(4) PBT: 3	2	2	Comments:
(5) PBT: 3	2	2	Comments:

III. OTHER FACTORS**Categories:**

Health Chemical Category:	Perfluoro Containing Chemicals	Ecotox SAR and Category:	polycationic polymers; Polycationic Polymers

Related Cases/Regulatory History:

Health related Cases: [REDACTED]
 Ecotox Related Cases: Analogs: [REDACTED]
 Regulatory History: [REDACTED] GRANTED WITH CONDITION

MSDS/Label Information:

MSDS: Yes Label: No
 General Equipment: impervious gloves/ safety glasses or coverall chemical splash goggles / Use only in area provided with appropriate exhaust ventilation. [REDACTED]

Respirator: In case of mist, spray or aerosol exposure wear suitable personal respiratory protection and protective suit.

Health Effects: Inhalation of aerosol or fine spray mist may cause serious respiratory problems / No skin or eye irritation.

TLV/PEL (PMN or raw material): - none established.

Exposure Based Information:

Exposure Based Review: N
 Exposure Based Review (Eco): N
 Exposure Based Review (Non Occupational):

Exposure Based Review (Health): N
 Exposure Based (Occupational): No
 Exposure Based (Environmental):

IV. Summary of SAT Assessment**Fate:****Fate Summary:**

P-11-0091-93
 FATE: MW = [REDACTED] < 500 and [REDACTED] < 1000
 [REDACTED]
 S = Disp.
 VP < 1.0E-6 torr at 25 C (E)
 BP > 400 C (E)
 H < 1.00E-8 (E)
 POTW removal (%) = 90 via sorption
 Time for complete ultimate aerobic biodeg > mo
 Sorption to soils/sediments = v.strong
 PBT Potential: PMN P3B1; Incin Pdt P3B2
 *CEB FATE: Migration to ground water = negl

Health:**Health Summary:**

Absorption is nil all routes based on physical/chemical properties. There is concern for lung toxicity from cationic binding to lung membranes.

For the potential incomplete incineration/environmental degradation product, based on test data for the analogue [REDACTED] concerns are liver toxicity, blood toxicity, and male reproductive toxicity [rat 28-day oral NOAEL = 50 mg/kg, LOAEL = 150 mg/kg with liver toxicity; rat 90-day oral LOAEL = 10 mg/kg based on decreased body weight in males at all doses and liver toxicity and anemia at 200 mg/kg; there were toxic effects on the testes in 2 males in the 90-day oral study that were judged by the reviewer to be indicative of the potential for male reproductive toxicity. There is also concern for immunosuppression and oncogenicity based on data for [REDACTED].

Test Data:

P11-0091: (-) Salmonella with and without activation; (-) E. coli with and without activation; rat oral LD0 = 5000 mg/kg; slight eye irritation in rabbits, cleared by 48 h; slight skin irritation in rabbits, cleared by 24 h; (-) for skin sensitization in a mouse local lymph node assay at 20% ai

Ecotox:**Ecotox Values:**

Fish 96-h LC50: 3.6(P)
 Daphnid 48-h LC50: 14(P)
 Green algal 96-h EC50: 1.6(P)
 Fish Chronic Value: 0.20(P)
 Daphnid ChV: 0.99(P)
 Algal ChV: 0.43(P)

Ecotox values comments:

Predictions are based on SARs for polycationic polymers with [REDACTED] amine-N; SAR chemical class = polymer-cationic-[REDACTED] amine-N; MW [REDACTED] < 1000 and [REDACTED] < 500; [REDACTED]; effective concentrations based on 100% active ingredients and nominal concentrations; hardness <180.0 mg/L as CaCO3; and TOC <2.0 mg/L; significant mitigation of toxicity expected in the presence of 10 mg TOC/L, i.e., ~17 times;

high concern for the [REDACTED] to wild mammals and birds based on mammalian test data for mammals for [REDACTED].

Ecotox Factors:

Assessment Factor: 10
Concern Concentration: 340
- Chronic Value

V. Summary of Exposures/Releases

Engineering Summary: P-11-0093

Exposures/Releases	Release	Release	Release
Scenario			
Sites			
Media			
Descriptor A	High End	Conservative	High End
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			1
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

Engineering Summary: Exposures/Releases	Release	Release	Release
Scenario			
Sites			
Media			
Descriptor A	High End	High End	Output 2
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

V. Summary of Exposures/Releases

Engineering Summary: P-11-0093

Exposures/Releases	Release	Release	Release
Scenario			
Sites			
Media			
Descriptor A	Conservative	High End	Conservative
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

Engineering Summary: Exposures/Releases	Release	Release	Release
Scenario			
Sites			
Media			
Descriptor A	High End	Conservative	Output 2
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

V. Summary of Exposures/Releases

Engineering Summary: P-11-0093

Exposures/Releases	Release	Release	Release
Scenario			
Sites			
Media			
Descriptor A	Output 2	Output 2	High End
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

Engineering Summary: Exposures/Releases	Release	Release	Release
Scenario			
Sites			
Media			
Descriptor A	Conservative	Output 2	High End
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

V. Summary of Exposures/Releases

Engineering Summary: P-11-0093

Exposures/Releases	Release	Release	Release
Scenario			
Sites			
Media			
Descriptor A	Conservative	High End	Output 2
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

Engineering Summary: Exposures/Releases	Release	Release	Exposure
Scenario			
Sites			
Media			
Descriptor A	Output 2	Conservative	High End
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

V. Summary of Exposures/Releases

Engineering Summary: P-11-0093

Exposures/Releases	Exposure	Exposure	Exposure
Scenario			
Sites			
Media			
Descriptor A	High End	High End	Upper Bound
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

Engineering Summary: Exposures/Releases	Exposure	Exposure	Exposure
Scenario			
Sites			
Media			
Descriptor A	High End	High End	Upper Bound
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

V. Summary of Exposures/Releases

Engineering Summary: P-11-0093

Exposures/Releases	Exposure	Exposure	Exposure
Scenario			
Sites			
Media			
Descriptor A	High End	High End	High End
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

Engineering Summary: Exposures/Releases	Exposure	Exposure	Exposure
Scenario			
Sites			
Media			
Descriptor A	High End	High End	High End
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

V. Summary of Exposures/Releases

Engineering Summary: P-11-0093

Exposures/Releases	Exposure		
Scenario			
Sites			
Media			
Descriptor A	Upper Bound		
Quantity A (Release = kg/site/day; Exposure = mg/day)			
Frequency A (day/year)			
Descriptor B			
Quantity B (Release = kg/site/day; Exposure = mg/day)			
Frequency B (day/year)			
From			
Workers			
Exposure Type			

VI. Focus Decision and Rationale

Regulatory Actions

Regulatory Decision: PMN Standard Review

Decision Date: 01/03/2011

Type of Decision:

Rationale:

P11-0091-0093 will be placed in standard review to examine potential human health risks to workers and consumers from [REDACTED], polymers with [REDACTED], and PBT concerns for they hydrolysis product. Human health concerns were low-moderate for the PMN substances and moderate for the degradation product. Human health risks from [REDACTED] include immunotoxicity and developmental/reproductive effects. Ecotoxicity concerns were moderate for the PMN substance and high for the hydrolysis product for terrestrial species. These risks were mitigated due to no chronic exceedance for the 320 ppb chronic COC and no exceedance of the 6,375 ppb acute COC. The standard review will consist of a team, schedule and TI. The PBT score for the PMN substances is P3B2T1 and P3B2T2 for they hydrolysis product.

COC's: 320 ppb chronic, 6,375 ppb acute

Summary of Exposures and Releases:

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

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P2 Rec Comments:

Testing:

Final Recommended:

Health:

Eco:

Fate:

Other:

SAT ReportPMN Number: **P-11-0093**SAT Date: **12/17/2010**Print Date: **3/13/2015****Related cases:**

Health related cases: [REDACTED]

Ecotox related cases: Analogs: [REDACTED]

Concern levels:

Type of Concern:	<u>Health</u>	<u>Eco</u>	<u>Comments</u>
Level of Concern:	1-2	2	Health: PMN ; Eco: mitigation of toxicity expected, i.e., ~17x
	2	3	Health: Potential Incineration/degradation product ; Eco: concern for toxic incomplete incineration products to terrestrial organisms
	<u>Persistence</u>	<u>Bioaccum</u>	<u>Toxicity</u> <u>Comments</u>
	3	1	PMN
	3	2	Inciner Pdt

Exposure Based Review:**Health:** No**Ecotox:** No**Routes of exposure:****Health:** Dermal Inhalation**Ecotox:** All releases to water**Fate:** ;**Keywords:****Keywords:** LUNG**Summary of Assessment:****Fate:****Fate Summary:** P-11-0091-93

FATE: MW = [REDACTED] < 500 and [REDACTED] < 1000

S = Disp.

VP < 1.0E-6 torr at 25 C (E)

BP > 400 C (E)

H < 1.00E-8 (E)

POTW removal (%) = 90 via sorption

Time for complete ultimate aerobic biodeg > mo

Sorption to soils/sediments = v.strong
 PBT Potential: PMN P3B1; Incin Pdt P3B2
 *CEB FATE: Migration to ground water = negl

Health:

Health Summary: Absorption is nil all routes based on physical/chemical properties. There is concern for lung toxicity from cationic binding to lung membranes.

For the potential incomplete incineration/environmental degradation product, based on test data for the analogue [REDACTED] concerns are liver toxicity, blood toxicity, and male reproductive toxicity [rat 28-day oral NOAEL = 50 mg/kg, LOAEL = 150 mg/kg with liver toxicity; rat 90-day oral LOAEL = 10 mg/kg based on decreased body weight in males at all doses and liver toxicity and anemia at 200 mg/kg; there were toxic effects on the testes in 2 males in the 90-day oral study that were judged by the reviewer to be indicative of the potential for male reproductive toxicity. There is also concern for immunosuppression and oncogenicity based on data for [REDACTED]

Test Data: P11-0091: (-) Salmonella with and without activation; (-)

E. coli with and without activation; rat oral LD0 = 5000 mg/kg; slight eye irritation in rabbits, cleared by 48 h; slight skin irritation in rabbits, cleared by 24 h; (-) for skin sensitization in a mouse local lymph node assay at 20% ai

Ecotox:

Test Organism	Test Type	Test End Point	Predicted	Measured	Comments
fish	96-h	LC50	3.6		
daphnid	48-h	LC50	14		
green algal	96-h	EC50	1.6		
fish	–	chronic value	0.20		
daphnid	–	chronic value	0.99		
algal	–	chronic value	0.43		
Sewage Sludge	3-h	EC50	–		
Sewage Sludge	–	Chronic Value	–		

Ecotox Values Comments: Predictions are based on SARs for polycationic polymers with [REDACTED] amine-N; SAR chemical class = polymer-cationic-[REDACTED] amine-N; MW [REDACTED] < 1000 and [REDACTED] < 500; [REDACTED]; effective concentrations based on 100% active ingredients and nominal concentrations; hardness <180.0 mg/L as CaCO₃; and TOC <2.0 mg/L; significant mitigation of toxicity expected in the presence of 10 mg TOC/L, i.e., ~17 times;

high concern for the [REDACTED] to wild mammals and birds based on mammalian test data for mammals for [REDACTED].

Factors	Values	Comments
Assessment Factor	10	
Concentration of Concern (ppb)	340	with mitigation
SARs	polycationic polymers	
SAR Class	polymer-cationic [REDACTED] amine nitrogen-[REDACTED]	new chemicals category: polycationic polymers
Ecotox Category		

Ecotox Factors Comments:

SAT Chair: L Keifer 564-8916

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- II. Summary of Terms of the Order
- III. Contents of PMNs
- IV. EPA's Assessment of Exposure and Risk
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- I. Scope of Applicability and Exemptions
- II. Terms of Manufacture, Import, Processing, Distribution in Commerce, Use, and Disposal Pending Submission and Evaluation of Information
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- IV. Requests for Pre-Inspection Information
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Attachment A - Definitions

Attachment B - Notice of Transfer of Consent Order

I. INTRODUCTION

Under the authority of § 5(e) of the Toxic Substances Control Act ("TSCA") (15 U.S.C. 2604(e)), the Environmental Protection Agency ("EPA" or "the Agency") issues the attached Order, regarding three premanufacture notices ("PMNs") P-11-91, 92, and 93 for the chemical substances P-11-91-- [

]; P-11-92--[

]; and P-11-93--[

] (the "PMN substances") submitted by [

] ("the Company"), to take effect upon expiration of the PMN review period. The Company submitted the PMNs to EPA pursuant to § 5(a)(1) of TSCA and 40 CFR Part 720.

Under § 15 of TSCA, it is unlawful for any person to fail or refuse to comply with any provision of § 5 or any order issued under § 5. Violators may be subject to various penalties and to both criminal and civil liability pursuant to § 16, and to specific enforcement and seizure pursuant to § 17. In addition, chemical substances subject to an Order issued under § 5 of TSCA, such as this one, are subject to the § 12(b) export notice requirement.

II. SUMMARY OF TERMS OF THE ORDER

The Consent Order for these three PMN substances requires the Company to:

- (a) submit to EPA certain tiered environmental fate and physical/chemical testing on the PMN substance, P-11-91 at least [] weeks before manufacturing or importing a total of [] kilograms (kgs), [] kgs, and [] kgs of the PMN substances;
- (b) analyze and report to EPA []* impurities;
- (c) not exceed the maximum established levels of [] impurities; and
- (d) maintain certain records.

Although a Consent Order for Contract Manufacturer is not attached to extend the requirements in this Order to an identified Contract Manufacturer, the Company may use a Contract Manufacturer in the future, if a modification of this Order to add a Consent Order for a Contract Manufacturer is approved and signed by EPA and signed by the Contract Manufacturer. This Consent Order establishes the requirements for the Company if a Contract Manufacturer manufactures the PMN substances. Prior to using a Contract Manufacturer, the Company must submit to EPA the Contract Manufacturer identity and other manufacturing process, and exposure, and release information concerning the Contract Manufacturer. The Contract Manufacturer would be required to keep records of quantities manufactured, but the Company must submit to EPA the required testing.

*As used in both the Preamble and Consent Order of this document, the terms [] mean []

III. CONTENTS OF PMNS

By signing this Order, the Company represents that it has carefully reviewed this document and agrees that all information herein that is claimed as confidential by the Company is correctly identified within brackets and that any information that is not bracketed is not claimed as confidential. To make this document available for public viewing, EPA will remove only information contained within the brackets.

Confidential Business Information Claims (Bracketed in the Preamble and Order): company identity, specific chemical identity, production volumes, manufacturing process, processing, and use information, and other information.

Chemical Identities:

Specific: P-11-91-- [

]; P-11-92--

]; and P-11-93--|

]

Generic: Fluorinated Acrylic Alkylamino Copolymer

Use: Specific: [

]

Generic use: Oil and water repellent and release agent

Maximum 12-Month Production Volume: [] kgs

Test Data Submitted with PMN and During the Review Period and previously by this Company

(many acronyms are subsequently explained more fully in section IV below where the results of the studies are discussed):

P-11-91: [] numbers refer to different formulations that include the PMN substance: acute inhalation and acute inhalation study with histopathy (Approximate Lethal Concentration, ALC); rat acute oral LD50, eye and skin irritation; skin sensitization-Local Lymph Node Assay (LLNA); mutagenicity in Salmonella and E. Coli; and acute 48-hr Daphnia study.

Toxicity Studies on []:

[]-11560 []-24748: [] Screening 10-Dose Oral Gavage Study in Rats;
[]-18510 []: Repeated Dose Oral Toxicity Two-Week Gavage Study 3 volumes; Repeated dose, 90-day Study with Reproductive Screen

IV. EPA'S ASSESSMENT OF EXPOSURE AND RISK

The following are EPA's predictions regarding the probable toxicity, human exposure and environmental release of the PMN substances, based on the information currently available to the Agency.

Human Health Effects and Fate Summary: EPA has concerns for potential incineration or other decomposition products of the PMN substances. EPA also has concerns for the PMN substances that under some conditions of use-- particularly non-industrial, commercial, or consumer use-- could cause lung effects, based on limited data on some perfluorinated compounds. EPA required the Company to perform an Acute Inhalation study before manufacture to test whether these substances caused lung effects. An Acute Inhalation study in rats on a formulation of P-11-91 was conducted over a 4-hour exposure period. The doses for the study were 1.2 and 2.0 mg/L. No deaths were seen at these concentrations. The approximate lethal concentration (ALC) was estimated to be greater than 2.0 mg/L (2000 mg/m3). The ALC is consistent with a low concern for acute inhalation toxicity.

EPA expects that the PMN substances will degrade based on []. The PMN substances may degrade to [].

Based on information submitted to EPA during the PMN review period, the PMN substances have []. EPA has agreed that for routine analysis, the Company may analyze the starting material, the [] for the following analytes: [].

[]. The Company will also annually analyze the starting material, [] for perfluorooctanoic acid (PFOA), including establishing calibration curves where the LOQ is []. However, at initial manufacture and at least annually thereafter, the Company has agreed to analyze representative samples of the "Initially Isolated Formulations" of the final formulation of the PMN substances. "Initially Isolated Formulations" is defined in the Definitions section of this Consent Order (Attachment A).

The Company will continue to work towards reducing the maximum amount of impurities []. During commercial production, these impurities are produced partly by []

[] The Company has agreed to seek ways to minimize these impurities. The Company, in consultation with EPA, has agreed to []

[]. The Company is also evaluating other chemical management steps, which include []

[]. To further document and control the actual contamination and efforts to reduce the impurity levels, the Company will limit the maximum impurity levels in the starting material, [] not to exceed the currently attainable levels (see Tables 1 and 2 in the Chemical Synthesis and Composition section of the attached Consent Order), and will report the various impurities [] annually.

EPA is concerned that these perfluorinated degradation products may be released to the environment from incomplete incineration of the PMN substances at low temperatures. EPA has preliminary evidence, including data on other [], that suggests that, under some conditions, the PMN substances could degrade in the environment. EPA has concerns that these degradation products will persist in the environment, could bioaccumulate or biomagnify, and could be toxic (PBT) to people, wild mammals, and birds based on data on analog chemicals,

including PFOA and []. The presumed perfluorinated degradants for these PMN substances include []. There is limited toxicological data in animals on [] or precursors, which is summarized below.

PFOA is expected to persist for years in the environment. Biodegradation and photolysis tests of analogous substances indicate little or no biodegradation or photolysis of perfluoroalkyl compounds. Bioaccumulation concerns are based on the measured presence of certain perfluoroalkyl compounds, including PFOA, in wildlife and in human blood samples. Toxicity studies on PFOA indicate developmental, reproductive and systemic toxicity in various species. Cancer may also be of concern. These factors, taken together, raise concerns for potential adverse chronic effects in humans and wildlife. For additional information about PFOA, consult the EPA regulatory docket at OPPT-2003-0012. Additional information about PFOA, [], and other perfluorinated substances may also be found in the *Administrative Record for PFOS, PFOA, and Telomers and Related Chemicals (AR-226)*. *Administrative Record (AR-226)* is not currently available online, but copies can be requested on CD-ROM from the EPA Docket office by calling 202/566-0280 or sending an email request to oppt.ncic@epa.gov.

Limited toxicological, ecological, and fate data now exist on [] and some of the []-derived polymers and other substances; see the PMN docket for data for these specific PMNs. A pharmacokinetics study on [] and for comparison perfluorobutane sulfonate (PFBS) in the cynomolgus monkey was submitted previously. This study indicates that the serum half-life of [] in these monkeys is less than 24 hours, whereas the half-life of PFOA in monkeys is 20.9 days in female monkeys, 32.6 days in male monkeys, and 3.8 years in humans. Another company also conducted a pharmacokinetics study on [] in rats that

x

showed a serum half-life of one hour or less. These data and assessments support the assessment of reduced bioaccumulation of [] relative to PFOA.

The Company subject to this Consent Order has conducted a 90-day study with a reproductive screen on []. Dose levels for this study were 0, 20, 100, and 500 mg/kg/day. EPA received this study at the end of July 2007. EPA review of this study concluded that a no-observed adverse effect level (NOAEL) was not established in this study for systemic effects. There were numerous effects at 100 and 500 mg/kg/day on nasal tissue, liver, and thyroid, and at 500 mg/kg/day on body weight, the red blood cell system, clotting, and the kidney. The EPA reviewer concluded that although not clearly dose related, the elevation of two markers for liver toxicity across all treated groups of males in clinical chemistry, and the finding of focal necrosis in the liver across all treated groups of males, as well as, in treated recovery males, and the absence of this result in the controls, leads to the conclusion that no NOAEL was achieved.

For the one-generation reproductive toxicity study component of this study, the reproductive toxicity NOAEL is 500 mg/kg/day (the highest dose tested). The systemic toxicity NOAEL for P1 rats was 20 mg/kg/day based on decreased body weights/body weight gains at 100 and 500 mg/kg/day. The systemic toxicity NOAEL for F1 adults is 100 mg/kg/day based on reduced body weights/body weight gains and reduced food consumption at 500 mg/kg/day. The developmental toxicity NOAEL for F1 pups was 100 mg/kg/day based on decreased pup weights at 500 mg/kg/day. The rats (P1 generation; 20/sex/group) were administered gavage doses of 0, 20, 100 or 500 mg/kg/day for 70 days pre-mating, and then mated for a maximum of 2 weeks to produce 1 litter. Dosing was continued during mating, gestation, and lactation.

In addition, in 2005, another company conducted a Combined Repeated-Dose Toxicity Study with Reproduction/Developmental Screening Test, (OECD 422) in rats for [] and the []. The EPA review of these subchronic and reproductive data on [] and the [] concluded that for [] no reproductive effects were seen at any dose. Dose levels were 50, 150, and 450/300 mg/kg/day (450 was reduced to 300 in the study on day 4 because of toxicity). However, systemic effects—primarily liver effects—were seen. EPA review places the NOAEL for [] at 50 mg/kg/day. For the [], the doses were 25, 75, and 225 mg/kg/day. For systemic effects, no NOAEL was achieved with the Lowest-Observed Adverse Effect Level (LOAEL) at 25 mg/kg/day. For reproductive or developmental effects, the NOAEL is 75 mg/kg/day and the LOAEL is 225 mg/kg/day.

In 2006, another company submitted a 90-day Oral Repeated Dose Toxicity Study (OECD 408) for []. Dose levels for this study were 0 (vehicle control), 10, 50, or 200 mg/kg/day and were based on the previous Combined Study (OECD 422). EPA review set the Lowest-Effect Level (LOEL) or LOAEL at 10 mg/kg/day, based on the body weight gain being lower in all treated groups of males. There was treatment-related toxicity in the liver and the red blood cell system (anemia) in males at 200 mg/kg/day. There was also increased peroxisomal beta oxidation activity at this dose level. Hepatotoxicity and peroxisomal beta oxidation activity have also been seen in studies on PFOA.

The significance of the finding of a benign brain tumor (astrocytoma) in one male rat in the high dose group is not clear. It is not the type of tumor normally associated with PFOA-type compounds, is not a rare tumor, and may be incidental. Abnormal histopathology was observed in the testes (2 males) and epididymides (1 male) at 200 mg/kg/day and is a sign of concern for

male reproductive toxicity. Further testing should investigate male reproductive effects. From this study, the potential for immunotoxic effects is low. There have been some studies showing immunotoxic effects from PFOA. Any investigation of immunotoxic effects should await the corroborative testing now being conducted by EPA, Office of Research and Development. There were no clinical signs of neurotoxicity and there were no treatment-related effects in the functional observation battery or motor behavior.

Another 90-day study has been submitted to EPA on []. EPA review of that study concluded that blood and liver effects were seen at the highest dose. This study had comparable doses with the other studies.

EPA received a Chronic Toxicity/Carcinogenicity study on PFHxA in 2011.

These and other data indicate a different and less toxic profile for [] (a presumed environmental degradant of the PMN substances) than for PFOA. However, based on: (1) the persistence of []; (2) potential intermediate fate products; and, (3) the possibility or likelihood that this substance may be used as a major substitute for some uses of PFOA, EPA believes that more information is needed on the toxicity of [] and possibly other environmental degradants, and the fate and physical/chemical properties of []-derived or related polymers in the environment.

EPA also believes that additional reproductive and long-term toxicological testing on [] in animals is warranted. To this end, the Company has conducted a 90-day Repeated Dose Study With Reproductive Screen. EPA expects that a modified reproductive test (OECD 421, modified) will be conducted by another company. The modifications for the reproductive test include: (1) increase the parental sample size to 20; (2) the duration of the study should be

extended to until the pups have reached sexual maturation; (3) parental males should be dosed for 10 weeks prior to mating; (4) dosing of the parental animals should be continued through lactation and then the pups should be directly dosed until they reach sexual maturation; (5) pup body weight should be recorded on lactation days 0, 4, 7, 14, and 21, and then at weekly intervals; (6) litter size can be standardized to 4 pups/litter on lactation day 4 (optional); (7) at weaning one pup/sex/litter can be randomly selected to follow until sexual maturation; and (8) the time of sexual maturation should be recorded (i.e. vaginal opening and preputial separation). EPA expects that another company will also conduct a Combined Carcinogenicity/Chronic Toxicity test (OPPTS 870.4300/OECD 453). An avian reproduction test (bobwhite quail) (OECD 206) will also be conducted by another company. EPA may still seek additional avian reproduction testing (OECD 206) in mallard ducks. In addition, comparative data, especially on the pharmacokinetics of [] and other perfluorinated substances will be developed by testing of the National Toxicology Program (NTP) in the so-called Perfluorinated Compounds Class Study.

Environmental Effects Summary: EPA expects the PMN substances or the degradants to be highly persistent.

The Company conducted testing on daphnia on a formulation of P-11-91 []. EPA reviewed the study. No effects were seen at the highest dose tested. Based on ECOSAR predictions for [] polymers with a certain percentage of amine nitrogen, EPA determined a concentration of concern (COC) at 320 ppb. No release predictions exceeded this COC.

In addition, there is high concern for possible environmental effects from the potential persistent degradation product []. As stated previously, the analog PFOA is persistent in the environment and has a long bioretention time in various species. It has been detected in a number of species of wildlife, including marine mammals. It is toxic to mammalian and other species. The presence in the environment and toxicological properties of PFOA continue to be investigated. Some limited acute ecotoxicological effects data exist on [] in fish, daphnia, and algae. EPA believes development of additional chronic data on [] is warranted. These studies are being conducted by other companies.

Exposure and Environmental Release Summary: Thermal and simulated incineration testing exists on some related polymers. This testing indicates that incomplete incineration products are formed at lower incineration temperatures. Modified Zahn-Wellens and Semi-Continuous Activated Sludge (SCAS) biodegradation tests have been conducted on some related polymers. EPA has determined that some related polymers degrade, while another did not show signs of degradation during the time frame of the test. EPA has received and reviewed test data showing that certain polymers with perfluoroalkyl substituents degrade to form perfluoroalkyl containing intermediates and perfluoroalkyl containing organic acids. EPA expects that these PMN substances will degrade.

The PMN substances are expected to be imported. The PMN substances will be used as
a []

During use at many sites, releases could be to water or landfill or to air via incineration.

Commercial use could be by []. Occupational exposures are dermal and inhalation. The Company Material Safety Data Sheet (MSDS) recommends impervious gloves and NIOSH-certified respirators where there is potential for airborne exposures.

Consumer exposure will be dermal, except there is a possibility of commercial and consumer spray use. EPA does not expect a significant risk from spray use of the tested formulation.

V. EPA'S CONCLUSIONS OF LAW

The following findings constitute the basis of the Consent Order:

- (a) EPA is unable to determine the potential for human health and environmental effects from exposure to the PMN substances and potential degradation products. EPA therefore concludes, pursuant to § 5(e)(1)(A)(i) of TSCA, that the information available to the Agency is insufficient to permit a reasoned evaluation of the human health and environmental effects of the PMN substances and potential degradation products.
- (b) In light of the potential risk of human health and environmental effects posed by the uncontrolled manufacture, import, processing, distribution in commerce, use, and disposal of the PMN substances, EPA has concluded, pursuant to § 5(e)(1)(A)(ii)(I) of TSCA, that uncontrolled manufacture, import, processing, distribution in commerce, use, and disposal of the PMN substances may present an unreasonable risk of injury to human health and the environment.

(c) In light of the estimated production volume of, and human exposure to the PMN substances and potential degradation products, EPA has further concluded, pursuant to § 5(e)(1)(A)(ii)(II) of TSCA, that the PMN substances will be produced in substantial quantities and may reasonably be anticipated to enter the environment in substantial quantities, and there may be significant (or substantial) human exposure to the substance and potential degradation products.

VI. INFORMATION REQUIRED TO EVALUATE HUMAN HEALTH AND ENVIRONMENTAL EFFECTS

Triggered Testing. The Order prohibits the Company from exceeding specified production volumes unless the Company submits the information described in the Testing section of this Order in accordance with the conditions and test substance specified in the Testing section. The physical properties of the PMN substances and target analytes present technical challenges in conducting the required testing. EPA will review submitted protocols in a timely fashion as stated in the Consent Order and provide additional relevant information and input to the extent that it is known and not claimed confidential by other companies.

Pending Testing. The Order does not require submission of the following information at any specified time or production volume. However, the Order's restrictions on manufacture, import, processing, distribution in commerce, use, and disposal of the PMN substances will remain in effect until the Order is modified or revoked by EPA based on submission of the following or other relevant information.

EPA expects that protocols would be submitted prior to any additional toxicological testing required under this Consent Order. Due to the limited water solubility of some of these substances and consequent analytical difficulties, some modification of the protocols may be necessary. These and other modifications will be agreed upon between EPA and the Company.

(1) Because some concerns for the PMN substances are based on analogy between [] and PFOA, and because [] is a potential ultimate degradation product of the PMN substances, the following additional information on [] would be necessary to evaluate the human health and environmental effects which may be caused by the PMN substances: a modified 1-generation reproduction study in rats or mice (OECD Guideline 421 modified as stated earlier in the Preamble) or other reproduction testing in animals that addresses concerns raised in other testing on []; a combined chronic toxicity/carcinogenicity test in Sprague Dawley rats (OECD Guideline 453); and an avian reproduction test (OECD Guideline 206) in mallard ducks.

(2) Information on inhalation toxicology if the substance were to be sprayed by [] or sold for spray application use by consumers where use might be typically repeated in a chronic manner. This could include a repeated dose inhalation study with a bronchoalveolar lavage component and special attention to histopathology (inflammation and cell proliferation) or other relevant information. Based on current expected use, no additional mammalian toxicology testing is recommended for this exposure via inhalation.



CONSENT ORDER

I. SCOPE OF APPLICABILITY AND EXEMPTIONS

(a) Scope. The requirements of this Order apply to all commercial manufacturing, processing, distribution in commerce, use and disposal of the following three chemical substances: [-

] P-11-91; [

] P-

11-92; and [-

] P-11-93, (the "PMN substances") in the United States by [

] ("the Company"), except to the extent that those activities are exempted by paragraph

(b).

(b) Exemptions. Manufacturing of the PMN substances is exempt from the requirements of this Order (except the requirements in the Recordkeeping and Successor Liability Upon Transfer Of Consent Order sections) only to the extent that (1) these activities are conducted in full

compliance with all applicable requirements of the following exemptions, and (2) such compliance is documented by appropriate record keeping as required in the Recordkeeping section of this Order.

(1) Export. Until the Company begins commercial manufacture of the PMN substances for use in the United States, the requirements of this Order do not apply to manufacture, processing or distribution in commerce of the PMN substances solely for export in accordance with TSCA §12(a) and (b), 40 CFR 720.3(s) and 40 CFR Part 707. However, once the Company begins to manufacture the PMN substances for use in the United States, no further activity by the Company involving the PMN substances is exempt as "solely for export" even if some amount of the PMN substances is later exported. At that point, the requirements of this Order apply to all activities associated with the PMN substances while in the territory of the United States. Prior to leaving U.S. territory, even those quantities or batches of the PMN substances that are destined for export are subject to terms of the Order, and count towards any production volume test triggers in the Testing section of this Order.

(2) Research & Development ("R&D"). The requirements of this Order do not apply to manufacturing, processing, distribution in commerce, use and disposal of the PMN substances in small quantities solely for research and development in accordance with TSCA §5(h)(3), 40 CFR 720.3(cc), and 40 CFR 720.36. The requirements of this Order also do not apply to manufacturing, processing, distribution in commerce, use and disposal of the PMN substances when they are manufactured solely for non-commercial research and development per 40 CFR 720.30(i) and TSCA §5(i).

(3) Byproducts. The requirements of this Order do not apply to the PMN substances when they are produced, without separate commercial intent, only as a "byproduct" as defined at

40 CFR 720.3(d) and in compliance with 40 CFR 720.30(g).

(4) No Separate Commercial Purpose. The requirements of this Order do not apply to the PMN substances when they are manufactured, pursuant to any of the exemptions in 40 CFR 720.30(h), with no commercial purpose separate from the substance, mixture, or article of which they are a part.

(5) Imported Articles. The requirements of this Order do not apply to the PMN substances when they are imported as part of an "article" as defined at 40 CFR 720.3(c) and in compliance with 40 CFR 720.22(b)(1).

(c) Automatic Sunset. If the Company has obtained for the PMN substances a Test Market Exemption ("TME") under TSCA §5(h)(1) and 40 CFR 720.38 or a Low Volume Exemption ("LVE") or Low Release and Exposure Exemption ("LoREX") under TSCA §5(h)(4) and 40 CFR 723.50(c)(1) and (2) respectively, any such exemption is automatically rendered null and void as of the effective date of this Consent Order.

II. TERMS OF MANUFACTURE, IMPORT, PROCESSING, DISTRIBUTION IN COMMERCE, USE, AND DISPOSAL PENDING SUBMISSION AND EVALUATION OF INFORMATION

PROHIBITION

The Company is prohibited from manufacturing the PMN substances in the United States, for any nonexempt commercial purpose, pending the development of information necessary for a reasoned evaluation of the human health and environmental effects of the substances, and the completion of EPA's review of, and regulatory action based on, that information, in accordance with the conditions described in this Order.

CHEMICAL SYNTHESIS AND COMPOSITION

(a) Restriction. The Company shall not manufacture the PMN substances, P-11-91, 92 and 93 unless the [] starting material is in compliance with and does not exceed the limits specified in Table 1 and Table 2. The Company shall analyze the Initially Isolated Formulations of the PMN substances for the analytes specified in Table 3 upon initial commencement of manufacture, and at least annually analyze and report thereafter, until one year after the date of the last joint manufacture or processing of a product that contains [] products at the facility. The Company shall report to the Agency the levels of impurities [] associated with the PMN substances, P-11-91, 92, and 93 manufactured by the Company, as specified below. For routine analysis, the Company shall analyze the starting material, [] for the following analytes shown in Table 1 below: []

[]. The Company will also annually analyze the starting material, [], for the analyte [] shown in Table 2, below. The Company shall make its best effort to minimize these impurities and to seek to eliminate them.

(b) Analysis and Reporting. The Company shall analyze representative samples of the Initially Isolated Formulations of the PMN substances, P-11-91, 92, and 93 manufactured or imported by the Company to determine compliance with the requirements in paragraph (a). The Company shall also analyze the Initially Isolated Formulations of the PMN substances at each manufacturing facility both (1) at the initial commencement of non-exempt manufacture of the PMN substances at that facility, and (2) at least annually thereafter during every year in which the

PMN substances are manufactured at that facility or imported. If any new facility of manufacture is added or if the process of manufacture of the PMN substances are significantly altered, then the Initially Isolated Formulation of the PMN substances must be analyzed at commencement, and annually thereafter as set forth above. If the PMN substances are imported, the Company shall obtain from the foreign manufacturer written documentation to certify that representative samples of the imported form of the PMN substances have been analyzed, consistent with the requirements of this paragraph (b), and determined to comply with the requirements of paragraph (a). The Company shall report the above analysis to EPA at initial commencement of manufacture or import and again if any new manufacturing facility is added or if the process of manufacture of the PMN substances or any intermediate thereof is significantly altered. The Company shall continue to report these impurity levels to EPA annually, in a cycle complementary to the [

]. In addition to the reporting for the Initially Isolated Formulations of the PMN substances themselves, the Company shall, for the [] starting material, annually report (1) the average values and the range of values, including outlying data, for the routine analysis for the analytes specified in Table 1 and (2) the results of the annual analysis for the analyte specified in Table 2.

TABLE 1:

TO BE ROUTINELY ANALYZED IN [] STARTING MATERIAL

Analyte	CAS Number	Limit in []
[]	[]	[]
[] []	[] []	[] (combined)
[]	[]	[]
[] []	[] []	[] (combined)
[]	[]	[]
[] []	[] []	[] (combined)

TABLE 2:

TO BE ANALYZED AT LEAST ANNUALLY IN [] STARTING MATERIAL

Analyte	CAS Number	Limit in []
[]	[]	[]

TABLE 3:

TO BE ANALYZED AT START-UP AND AT LEAST ANNUALLY THEREAFTER
IN THE INITIALLY ISOLATED FORMULATIONS OF THE
PMN SUBSTANCES

Analyte	CAS Number	Estimated Maximum in Initially Isolated Formulations of the PMN substances
[] []	[] []	[] (combined)
[] []	[] []	[] (combined)
[]	[]	[]

MANUFACTURING

(a)(1) Prohibition. The Company shall not cause, encourage, or suggest the manufacture or import of the PMN substances by any other person. However, the Company may communicate to any other person the existence of the 5(e) Consent Order and TSCA Inventory status for the PMN substances.

(2) Sunset Following SNUR. Subparagraph (a)(1) shall expire 75 days after promulgation of a final significant new use rule ("SNUR") governing the PMN substances under section 5(a)(2) of TSCA unless the Company is notified on or before that day of an action in a Federal Court seeking judicial review of the SNUR. If the Company is so notified, subparagraph (a)(1) shall not expire until EPA notifies the Company in writing that all Federal Court actions involving the SNUR have been resolved and the validity of the SNUR affirmed.

(3) Notice of SNUR. When EPA promulgates a final SNUR for the PMN substances and subparagraph (a)(1) expires in accordance with subparagraph (a)(2), the Company shall notify each person whom it causes, encourages or suggests to manufacture or import the PMN substances of the existence of the SNUR.

(b) Contract Manufacturer. Notwithstanding paragraph (a), the Company may cause a "Contract Manufacturer" outside the Company to manufacture or import the PMN substances according to the following conditions:

(1) The Contract Manufacturer must be under contract to the Company to manufacture or import the PMN substances solely for the Company. The contract must specify the identity of the PMN substances, the total quantities to be manufactured, and the basic technology to be used for manufacturing.

(2) The Company shall obtain from each Contract Manufacturer a signed copy of the

Consent Order for Contract Manufacturer (to be attached to this Order as Attachment C) and submit the copy to EPA along with the name, address, and telephone number of a responsible official of the Contract Manufacturer. The Contract Manufacturer or Company must receive a fully executed copy of the Consent Order for Contract Manufacturer from EPA before the Contract Manufacturer may begin manufacture or import.

(3) If at any time, the Company learns that the Contract Manufacturer has failed to comply with any of the conditions specified in the Consent Order for Contract Manufacturer, the Company shall immediately cease to cause the Contract Manufacturer to manufacture or import the PMN substances, unless the Contract Manufacturer is in compliance with a SNUR for the PMN substances, or unless the Company is able to document each of the following:

(i) That the Company has, within 5 working days, notified the Contract Manufacturer in writing that the Contract Manufacturer has failed to comply with any of the conditions specified in the Consent Order for Contract manufacturer.

(ii) That, within 15 working days of notifying the Contract Manufacturer of the noncompliance, the Company received from the Contract Manufacturer, in writing, a statement of assurance that the Contract Manufacturer is aware of the terms of the Consent Order for Contract Manufacturer and will comply with those terms.

(iii) If, after receiving a statement of assurance from the Contract Manufacturer under subparagraph (b)(ii) of this Section, the Company has notice or knowledge that the Contract Manufacturer has failed to comply with any of the conditions specified in the Consent Order for Contract Manufacturer, the Company shall immediately cease to cause the Contract Manufacturer to manufacture or import the PMN substances, shall notify EPA of the failure to comply, and shall resume causing the Contract Manufacturer to manufacture or import the PMN substances only

upon written notification from the Agency.

DISTRIBUTION

(a) Export Notice Requirement. No later than the date of distribution, the Company shall notify in writing any person to whom it distributes the PMN substances for "commercial use" or "industrial use" that, due to the issuance of this Consent Order under section 5(e) of TSCA, the PMN substances are subject to the export notification requirements of TSCA section 12(b) and 40 CFR Part 707 Subpart D. Such notice shall contain, in the form in which it appears in this Consent Order, the following information: (1) the PMN number, and (2) either (A) the specific chemical identity of the PMN substance, or (B) if the specific chemical identity is confidential, the generic chemical identity.

TESTING

(a) Section 8(e) Reporting. Reports of information on the PMN substances which reasonably supports the conclusion that the PMN substances present a substantial risk of injury to health or the environment, which is required to be reported under TSCA section 8(e) shall reference the appropriate PMN identification number for these substances and contain a statement that the substances are subject to this Consent Order. Additional information regarding section 8(e) reporting requirements can be found at www.epa.gov/oppt/tsca8e.

(b) Notice of Study Scheduling. The Company shall notify, in writing, the EPA Laboratory Data Integrity Branch (2225A), Office of Enforcement and Compliance Assurance, U.S. Environmental Protection Agency, 1200 Pennsylvania Avenue, N.W., Washington, D.C. 20460, of the following information within 10 days of scheduling any study required to be performed pursuant to this

Order, or within 15 days after the effective date of this Order, whichever is later:

- (1) The date when the study is scheduled to commence;
- (2) The name and address of the laboratory which will conduct the study; and
- (3) The name and telephone number of a person at the Company or the laboratory whom EPA may contact regarding the study.
- (4) The appropriate PMN identification number for each substance and a statement that the substance is subject to this Consent Order.

(c) Good Laboratory Practice Standards and Test Protocols. Each study required to be performed pursuant to this Order must be conducted according to TSCA Good Laboratory Practice Standards at 40 CFR Part 792 and using methodologies generally accepted in the relevant scientific community at the time the study is initiated. Before starting to conduct any study, the Company must obtain approval of test protocols from EPA by submitting written protocols. EPA will respond to the Company within 4 weeks of receiving the written protocols. Published test guidelines specified in paragraph (d) provide general guidance for development of test protocols, but are not themselves acceptable protocols. Approval of the test protocol does not mean pre-acceptance of test results.

(d) Triggered Testing Requirements. (i) The Company is prohibited from manufacturing or importing the PMN substances, beyond aggregate manufacture and import volumes of [] kilograms, [] kilograms, and [] kilograms ("the production limits"), unless the Company conducts the following studies and submits final reports and underlying data in accordance with the conditions specified in this Testing section.

<u>Production Limit</u>	<u>Study</u>	<u>Guideline</u>
[] kgs	Modified Semi-Continuous Activated Sludge (SCAS) with Analysis for degradation products	OPPTS 835.5045; OECD 302A
	UV visible light absorption	OPPTS 830.7050, OECD 101
	Direct Photolysis, if wavelengths greater than 290 nm are absorbed in the previous test (OPPTS 830.7050)	OPPTS 835.2210
	Indirect Photolysis Screening Test	OPPTS 835.5270
	Hydrolysis as a function of pH and temperature	OPPTS 835.2130, OECD 111
	Aerobic Transformation in Soil	OECD 307
	Anaerobic Biodegradability of Organic Compounds in Digested Sludge	OECD 311
[] kgs	Phototransformation of Chemicals On Soil Surfaces—2 soils	Draft OECD guideline Jan. 2002
	Aerobic Sewage Treatment Plant (STP) (Activated Sludge Units)	OECD 303A
	Aerobic and Anaerobic Transformation in Aquatic Sediment Systems	OECD 308
[] kgs	Anaerobic Transformation in Soil	OECD 307

(ii) The test substance shall be the PMN substance described in P-11-91. Chemical composition of the test substance shall be verified and a certificate of analysis submitted to EPA.

(iii) Chemical composition of the test substance must be fully characterized. For polymers, characterization includes all information required on pages 5 and 6 of the PMN form (i.e. EPA Form 7710-25), except that data on residuals are only required for fluorinated.

substances. Although EPA understands that complete mass balance may not be achievable for the specified analytes, the Company shall attempt mass balance to the greatest extent practicable. EPA prefers that the Company test the commercial substance.

(iv) The Company must test for the following analytes in the Biodegradation Tests (OECD 307, OECD 308, OECD 311, OPPTS 835.5045 or OECD 302A, and OECD 303A) : [

].

(v) Because the environmental fate pathway for photolysis may be different than for biodegradation, the Company must test for the following analytes in the Abiotic Tests: identify the major fluorinated fragments and volatiles including: [

].

(e) Test Reports. The Company shall: (1) conduct each study in good faith, with due care, and in a scientifically valid manner; (2) promptly furnish to EPA the results of any interim phase of each study; and (3) submit, in triplicate (with an additional sanitized copy, if confidential business information is involved), the final report of each study and all underlying data ("the report and data") to EPA no later than 14 weeks prior to exceeding the applicable production limit. The final report shall contain the contents specified in 40 CFR 792.185. Underlying data shall be submitted to EPA in accordance with the applicable "Reporting," "Data and Reporting," and "Test Report" subparagraphs in the applicable test guidelines. However, for purposes of this Consent Order, the

word "should" in those subparagraphs shall be interpreted to mean "shall" to make clear that the submission of such information is mandatory. EPA will require the submission of raw data such as slides and laboratory notebooks only if EPA finds, on the basis of professional judgment, that an adequate evaluation of the study cannot take place in the absence of these items.

(f) Testing Waivers. The Company is not required to conduct a study specified in paragraph (d) of this Testing section if notified in writing by EPA that it is unnecessary to conduct that study.

(g) Equivocal Data. If EPA finds that the data generated by a study are scientifically equivocal, the Company may continue to manufacture and import the PMN substances beyond the applicable production limit. To seek relief from any other restrictions of this Order, the Company may make a second attempt to obtain unequivocal data by reconducting the study under the conditions specified in paragraphs (b), (c), and (e)(1) and (e)(2). The testing requirements may be modified, as necessary to permit a reasoned evaluation of the risks presented by the PMN substances, only by mutual consent of EPA and the Company.

(h) EPA Determination of Invalid Data.

(1) Except as described in subparagraph (h)(2), if, within 6 weeks of EPA's receipt of a test report and data, the Company receives written notice that EPA finds that the data generated by a study are scientifically invalid, the Company is prohibited from further manufacture and import of the PMN substances beyond the applicable production limit.

(2) The Company may continue to manufacture and import the PMN substances beyond the applicable production limit only if so notified, in writing, by EPA in response to the

Company's compliance with either of the following subparagraphs (h)(2)(i) or (h)(2)(ii).

(i) The Company may reconduct the study in compliance with paragraphs (b), (c), and (e)(1) and (e)(2). If there is sufficient time to reconduct the study and submit the report and data to EPA at least 14 weeks before exceeding the production limit as required by subparagraph (e)(3), the Company shall comply with subparagraph (e)(3). If there is insufficient time for the Company to comply with subparagraph (e)(3), the Company may exceed the production limit and shall submit the report and data in triplicate to EPA within a reasonable period of time, all as specified by EPA in the notice described in subparagraph (h)(1). EPA will respond to the Company, in writing, within 6 weeks of receiving the Company's report and data.

(ii) The Company may, within 4 weeks of receiving from EPA the notice described in subparagraph (h)(1), submit to EPA a written report refuting EPA's finding. EPA will respond to the Company, in writing, within 4 weeks of receiving the Company's report.

(i) Company Determination of Invalid Data.

(1) Except as described in subparagraph (i)(2), if the Company becomes aware that circumstances clearly beyond the control of the Company or laboratory will prevent, or have prevented, development of scientifically valid data under the conditions specified in paragraphs (c) and (e), the Company remains prohibited from further manufacture and import of the PMN substances beyond the applicable production limit.

(2) The Company may submit to EPA, within 2 weeks of first becoming aware of such circumstances, a written statement explaining why circumstances clearly beyond the control of the Company or laboratory will cause or have caused development of scientifically invalid data. EPA will notify the Company of its response, in writing, within 4 weeks of receiving the Company's

report. EPA's written response may either:

(i) allow the Company to continue to manufacture and import the PMN substances beyond the applicable production limit, or

(ii) require the Company to continue to conduct, or to reconduct, the study in compliance with paragraphs (b), (c), and (e)(1) and (e)(2). If there is sufficient time to conduct or reconduct the study and submit the report and data to EPA at least 14 weeks before exceeding the production limit as required by subparagraph (e)(3), the Company shall comply with subparagraph (e)(3). If there is insufficient time for the Company to comply with subparagraph (e)(3), the Company may exceed the production limit and shall submit the report and data in triplicate to EPA within a reasonable period of time, all as specified by EPA in the notice described in subparagraph (i)(2). EPA will respond to the Company, in writing, within 6 weeks of receiving the Company's report and data, as to whether the Company may continue to manufacture and import beyond the applicable production limit.

(j) Unreasonable Risk.

(1) EPA may notify the Company in writing that EPA finds that the data generated by a study are scientifically valid and unequivocal and indicate that, despite the terms of this Order, the PMN substances will or may present an unreasonable risk of injury to human health or the environment. EPA's notice may specify that the Company undertake certain actions concerning further testing, manufacture, import, processing, distribution, use and/or disposal of the PMN substances to mitigate exposures to or to better characterize the risks presented by the PMN substances. Within 2 weeks from receipt of such a notice, the Company must cease all manufacture, import, processing, distribution, use and disposal of the PMN substances, unless

either:

(2) within 2 weeks from receipt of the notice described in subparagraph (j)(1), the Company complies with such requirements as EPA's notice specifies; or

(3) within 4 weeks from receipt of the notice described in subparagraph (j)(1), the Company submits to EPA a written report refuting EPA's finding and/or the appropriateness of any additional requirements imposed by EPA. The Company may continue to manufacture, import, process, distribute, use and dispose of the PMN substances in accordance with the terms of this Order pending EPA's response to the Company's written report. EPA will respond to the Company, in writing, within 4 weeks of receiving the Company's report. Within 2 weeks of receipt of EPA's written response, the Company shall comply with any requirements imposed by EPA's response or cease all manufacture, import, processing, distribution, use and disposal of the PMN substances.

(k) Other Requirements. Regardless of the satisfaction of any other conditions in this Testing section, the Company must continue to obey all the terms of this Consent Order until otherwise notified in writing by EPA. The Company may, based upon submitted test data or other relevant information, petition EPA to modify or revoke provisions of this Consent Order pursuant to Part VI. of this Consent Order.

RISK NOTIFICATION

(a) If as a result of the test data required under the terms of this Order, the Company becomes aware that any of the PMN substances may present a risk of injury to human health or the environment (or is so notified by EPA), the Company must incorporate this new information, and

any information on methods for protecting against such risk, into a Material Safety Data Sheet ("MSDS") for those PMN substances, as described in 40 CFR section 721.72(c), within 90 days from the time the Company becomes aware of the new information. If the PMN substances are not being manufactured, imported, processed, or used in the Company's workplace, the Company must add the new information to an MSDS before the PMN substances are reintroduced into the workplace.

(b) The Company must ensure that persons who will receive the PMN substances from the Company for either commercial or industrial use, or who have received the PMN substances from the Company for either commercial or industrial use, within 5 years from the date the Company becomes aware of the new information described in paragraph (a) of this section, are provided an MSDS containing the information required under paragraph (a) within 90 days from the time the Company becomes aware of the new information.

III. RECORDKEEPING

(a) Records. The Company shall maintain the following records until 5 years after the date they are created and shall make them available for inspection and copying by EPA in accordance with section 11 of TSCA:

(1) Exemptions. Records documenting that the PMN substances did in fact qualify for any one or more of the exemptions described in Section I, Paragraph (b) of this Order. Such records must satisfy all the statutory and regulatory recordkeeping requirements applicable to the exemption being claimed by the Company. Any amounts or batches of the PMN substances eligible for the Export exemption in Section I, Paragraph (b)(1) of this Order, are exempt from all

the requirements in this Recordkeeping section, if the Company maintains, for 5 years from the date of their creation, copies of the export label and export notice to EPA, required by TSCA sections 12(a)(1)(B) and 12(b), respectively. Any amounts or batches of the PMN substances eligible for the Research and Development exemption in Section I, Paragraph (b)(2) of this Order, are exempt from all the requirements in this Recordkeeping section, if the Company maintains, for 5 years from the date of their creation, the records required by 40 CFR 720.78(b). For any amounts or batches of the PMN substances claimed to be eligible for any other exemption described in Section I, Paragraph (b) of this Order, the Company shall keep records demonstrating qualification for that exemption as well as the records specified in paragraphs (2) and (3) below, but is exempt from the other record keeping requirements in this Record keeping section;

(2) Records documenting compliance with the Chemical Synthesis and Composition section of this Order, including the results from routine analysis of representative samples of the starting material, [], and at start-up and annually thereafter of the Initially Isolated Formulations of the PMN substances.

(3) Records documenting compliance with the Manufacturing, Distribution, and Testing sections of this Order.

(4) Records documenting the manufacture and importation volume of the PMN substances and the corresponding dates of manufacture and import.

(5) Records documenting the names and addresses (including shipment destination address, if different) of all persons outside the site of manufacture or import to whom the Company directly sells or transfers the PMN substances, the date of each sale or transfer, and the quantity of the substance sold or transferred on such date, wherein transfer does not include the distribution of small sample quantities (less than [] kilograms annually) of the PMN substances

without charge.

(6) Records documenting the address of all sites of manufacture, import, processing, and use;

(7) Copies of material safety data sheets required by the Risk Notification section of this Order;

(8) Copies of any Transfer Documents and notices required by the Successor Liability section of this Order, if applicable; and

(9) The Company shall keep a copy of this Order at each of its sites where the PMN substances are manufactured, imported, processed, or used.

(b) Applicability. The provisions of this Record keeping Section are applicable only to activities of the Company and its Contract Manufacturer, if applicable, and not to activities of the Company's customers.

(c) OMB Control Number. Under the Paperwork Reduction Act and its regulations at 5 CFR Part 1320, particularly 5 CFR 1320.5(b), the Company is not required to respond to this "collection of information" unless this Order displays a currently valid control number from the Office of Management and Budget (OMB), and EPA so informs the Company. The "collection of information" required in this TSCA §5(e) Consent Orders has been approved under currently valid OMB Control Number 2070-0012.

IV. REQUESTS FOR PRE-INSPECTION INFORMATION

(a) EPA's Request for Information. Pursuant to section 11 of TSCA and 40 CFR 720.122, EPA

may occasionally conduct on-site compliance inspections of Company facilities and conveyances associated with the PMN substances. To facilitate such inspections, EPA personnel may contact the Company in advance to request information pertinent to the scheduling and conduct of such inspections. Such requests may be written or oral. The types of information that EPA may request may include, but are not limited to, the following:

- (i) Expected dates and times when the PMN substances will be in production within the subsequent 12 months;
- (ii) Current workshift schedules for workers who are involved in activities associated with the PMN substances and may reasonably be exposed to the PMN substances;
- (iii) Current job titles or categories for workers who are involved in activities associated with the PMN substances and may reasonably be exposed to the PMN substances;
- (iv) Existing exposure monitoring data for workers who are involved in activities associated with the PMN substances and may reasonably be exposed to the PMN substances;
- (v) Records required by the Record keeping section of this Order; and/or
- (vi) Any other information reasonably related to determining compliance with this Order or conducting an inspection for that purpose.

(b) Company's Response. The Company shall respond to such requests within a reasonable period of time, but in no event later than 30 days after receiving EPA's request. When requested in writing by EPA, the Company's response shall be in writing. To the extent the information is known to or reasonably ascertainable to the Company at the time of the request, the Company's response shall demonstrate a good faith effort to provide reasonably accurate and detailed answers to all of EPA's requests.

(c) Confidential Business Information. Any Confidential Business Information (CBI) that the Company submits to EPA pursuant to paragraph (b) shall be protected in accordance with §14 of TSCA and 40 CFR Part 2.

V. SUCCESSOR LIABILITY UPON TRANSFER OF CONSENT ORDER

(a) Scope. This section sets forth the procedures by which the Company's rights and obligations under this Order may be transferred when the Company transfers its interests in the PMN substances, including the right to manufacture the PMN substances, to another person outside the Company (the "Successor in Interest").

(b) Relation of Transfer Date to Notice of Commencement ("NOC").

(1) Before NOC. If the transfer from the Company to the Successor in Interest is effective before EPA receives a notice of commencement of manufacture or import ("NOC") for the PMN substances from the Company pursuant to 40 CFR 720.102, the Successor in Interest must submit new PMNs to EPA and comply fully with Section 5(a)(1) of TSCA and 40 CFR part 720 before commencing manufacture or import of the PMN substances.

(2) After NOC. If the transfer from the Company to the Successor in Interest is effective after EPA receives a NOC, the Successor in Interest shall comply with the terms of this Order and shall not be required to submit new PMNs to EPA.

(c) Definitions. The following definitions apply to this Successor Liability section of the Order:

(1) "Successor in Interest" means a person outside the Company who has acquired the Company's full interest in the rights to manufacture the PMN substances, including all ownership

rights and legal liabilities, through a transfer document signed by the Company, as transferor, and the Successor in Interest, as transferee. The term excludes persons who acquire less than the full interest of the Company in the PMN substances, such as a licensee who has acquired a limited license to the patent or manufacturing rights associated with the PMN substances. A Successor in Interest must be incorporated, licensed, or doing business in the United States in accordance with 40 CFR 720.22(3).

(2) "Transfer Document" means the legal instrument(s) used to convey the interests in the PMN substances, including the right to manufacture the PMN substances, from the Company to the Successor in Interest.

(d) Notices.

(1) Notice to Successor in Interest. On or before the effective date of the transfer, the Company shall provide to the Successor in Interest, by registered mail, a copy of the Consent Order and the "Notice of Transfer" document which is incorporated by reference as Attachment B to this Order.

(2) Notice to EPA. Within 10 business days of the effective date of the transfer, the Company shall, by registered mail, submit the fully executed Notice of Transfer document to: U.S. Environmental Protection Agency, New Chemicals Branch (7405), 1200 Pennsylvania Avenue, N.W., Washington, D.C. 20460.

(3) Transfer Document. Copies of the Transfer Document must be maintained by the Successor in Interest at its principal place of business, and at all sites where the PMN substances are manufactured or imported. Copies of the Transfer Document must also be made available for inspection pursuant to Section 11 of TSCA, must state the effective date and time of transfer, and

must contain provisions which expressly transfer liability for the PMN substances under the terms of this Order from the Company to the Successor in Interest.

(e) Liability.

(1) The Company shall be liable for compliance with the requirements of this Order until the effective date and time of the transfer described above.

(2) The Successor in Interest shall be liable for compliance with the requirements of this Order effective as of the date and time of transfer.

(3) Nothing in this section shall be construed to prohibit the Agency from taking enforcement action against the Company after the effective date of the transfer for actions taken, or omissions made, during the time in which the Company manufactured, processed, used, distributed in commerce, or disposed of the PMN substances pursuant to the terms of this Consent Order.

(f) Obligations to Submit Test Data under Consent Order. If paragraph (d) of the Testing section of this Consent Order requires the Company to submit test data to EPA at a specified production volume ("test trigger"), the aggregate volume of the PMN substances manufactured and imported by the Company up to the date of transfer shall count towards the test trigger applicable to the Successor in Interest.

VI. MODIFICATION AND REVOCATION OF CONSENT ORDER

The Company may petition EPA at any time, based upon new information on the health effects of, or human exposure to, the PMN substances, to modify or revoke substantive provisions

of this Order. The exposures and risks identified by EPA during its review of the PMN substances and the information EPA determined to be necessary to evaluate those exposures and risks are described in the preamble to this Order. However, in determining whether to amend or revoke this Order, EPA will consider all relevant information available at the time the Agency makes that determination, including, where appropriate, any reassessment of the test data or other information that supports the findings in this Order, an examination of new test data or other information or analysis, and any other relevant information.

EPA will issue a modification or revocation if EPA determines that the activities proposed therein will not present an unreasonable risk of injury to health or the environment and will not result in significant or substantial human exposure or substantial environmental release in the absence of data sufficient to permit a reasoned evaluation of the health or environmental effects of the PMN substances.

In addition, the Company may petition EPA at any time to make other modifications to the language of this Order, including modifications to production volume limits and time periods for submission of reports and data which are necessary due to no fault of, or circumstances beyond the control of, the Company. EPA in its sole discretion, may issue such a modification if EPA determines that the modification is useful, appropriate, and consistent with the structure and intent of this Order as issued.

VII. EFFECT OF CONSENT ORDER

(a) Waiver. This Order is effective when signed below by both parties and received by EPA. By consenting to the entry of this Order, the Company waives its rights to file objections to this Order pursuant to section 5(e)(1)(C) of TSCA, to receive service of this Order no later than 45 days before the end of the review period pursuant to section 5(e)(1)(B) of TSCA, and to challenge the validity of this Order in any subsequent action. Consenting to the entry of this Order, and agreeing to be bound by its terms, do not constitute an admission by the Company as to, the facts or conclusions underlying the Agency's determinations in this proceeding. This waiver does not affect any other rights that the Company may have under TSCA.

(b) CBI Brackets. By signing this Order, the Company represents that it has carefully reviewed this document and hereby agrees that all information herein claimed as confidential by the Company (per section 14 of TSCA, 40 CFR Part 720 Subpart E, and 40 CFR Part 2) is correctly identified within brackets and that any information that is not bracketed is not claimed as confidential. To make this document available for public viewing, EPA will remove only the information contained within the brackets.

24 OCTOBER 2011

Date

Maria J. Doe

Maria J. Doe, Ph.D.

Director

Chemical Control Division

Office of Pollution Prevention and Toxics

26 Oct 2011

Date

Name: []

Title:

Company: []

DEFINITIONS

[Note: The attached Order may not contain some of the terms defined below.]

"Chemical name" means the scientific designation of a chemical substance in accordance with the nomenclature system developed by the Chemical Abstracts Service's rules of nomenclature, or a name which will clearly identify a chemical substance for the purpose of conducting a hazard evaluation.

"Company" means the person or persons subject to this Order.

"Commercial use" means the use of a chemical substance or any mixture containing the chemical substance in a commercial enterprise providing saleable goods or a service to consumers (e.g., a commercial dry cleaning establishment or painting contractor).

"Common name" means any designation or identification such as code name, code number, trade name, brand name, or generic chemical name used to identify a chemical substance other than by its chemical name.

"Consumer" means a private individual who uses a chemical substance or any product containing the chemical substance in or around a permanent or temporary household or residence, during recreation, or for any personal use or enjoyment.

"Consumer product" means a chemical substance that is directly, or as part of a mixture, sold or made available to consumers for their use in or around a permanent or temporary household or residence, in or around a school, or in recreation.

"Container" means any bag, barrel, bottle, box, can, cylinder, drum, reaction vessel, storage tank, or the like that contains a hazardous chemical. For purposes of this section, pipes or piping systems, and engines, fuel tanks, or other operating systems in a vehicle, are not considered to be containers.

"Contract Manufacturer" means a person, outside the Company, who is authorized to manufacture and import the PMN substance under the conditions specified in Part II. of this Consent Order and in the Consent Order for Contract Manufacturer.

"Final Formulation of the PMN substances" means the formulated dispersion or solution of the PMN substances in the form in which it is sold to customers outside the Company or transferred to a different business unit within the Company. The term does not include intermediate dilutions of the PMN substances that are intended only for use within the Company for further dilution prior to sale.

"Identity" means any chemical or common name used to identify a chemical substance or a mixture containing that substance.

"Immediate use." A chemical substance is for the "immediate use" of a person if it is under the control of, and used only by, the person who transferred it from a labeled container and will only be used by that person within the work shift in which it is transferred from the labelled container.

"Industrial use." An industrial use is a use at a site at which one or more chemical substances or mixtures are manufactured (including imported) or processed.

"Initially Isolated Formulations of the PMN substances" means a common intermediate PMN formulation, as it exists when first produced and isolated after the polymer manufacturing process, that can be further processed or repackaged at the direction of the Company to result ultimately in one or more final formulations of the PMN substances.

"Manufacturing stream" means all reasonably anticipated transfer, flow, or disposal of a chemical substance, regardless of physical state or concentration, through all intended operations of manufacture, including the cleaning of equipment.

"MSDS" means material safety data sheet, the written listing of data for the chemical substance.

"NIOSH" means the National Institute for Occupational Safety and Health of the U.S. Department of Health and Human Services.

"Non-enclosed process" means any equipment system (such as an open-top reactor, storage tank, or mixing vessel) in which a chemical substance is manufactured, processed, or otherwise used where significant direct contact of the bulk chemical substance and the workplace air may occur.

"Non-industrial use" means use other than at a facility where chemical substances or mixtures are manufactured, imported, or processed.

"PMN substances" means the chemical substance (see TSCA s. 3(2)) described in the Premanufacture notices submitted by the Company relevant to this Order.

"Process stream" means all reasonably anticipated transfer, flow, or disposal of a chemical substance, regardless of physical state or concentration, through all intended operations of processing, including the cleaning of equipment.

"Scientifically invalid" means any significant departure from the EPA-approved protocol or the Good Laboratory Practice Standards at 40 CFR Part 792 without prior or subsequent Agency approval that prevents a reasoned evaluation of the health or environmental effects of the PMN substances.

"Scientifically equivocal data" means data which, although developed in apparent conformity with the Good Laboratory Practice Standards and EPA-approved protocols, are inconclusive, internally inconsistent, or otherwise insufficient to permit a reasoned evaluation of

the potential risk of injury to human health or the environment of the PMN substances.

"Sealed container" means a closed container that is physically and chemically suitable for long-term containment of the PMN substances, and from which there will be no human exposure to, nor environmental release of, the PMN substances during transport and storage.

"Use stream" means all reasonably anticipated transfer, flow, or disposal of a chemical substance, regardless of physical state or concentration, through all intended operations of industrial, commercial, or consumer use.

"Workplace" means an establishment at one geographic location containing one or more work areas.

NOTICE OF TRANSFER
OF
TOXIC SUBSTANCES CONTROL ACT
SECTION 5(e) CONSENT ORDER

Company (Transferor)

PMN Number

1. Transfer of Manufacture Rights. Effective on _____, the Company did sell or otherwise transfer to _____, ("Successor in Interest") the rights and liabilities associated with manufacture of the above-referenced chemical substance, which was the subject of a premanufacture notice (PMN) and is governed by a Consent Order issued by the U.S. Environmental Protection Agency (EPA) under the authority of §5(e) of the Toxic Substances Control Act (TSCA, 15 U.S.C. §2604(e)).

2. Assumption of Liability. The Successor in Interest hereby certifies that, as of the effective date of transfer, all actions or omissions governed by the applicable Consent Order limiting manufacture, processing, use, distribution in commerce and disposal of the PMN substance, shall be the responsibility of the Successor in Interest. Successor in Interest also certifies that it is incorporated, licensed, or doing business in the United States in accordance with 40 CFR 720.22(3).

3. Confidential Business Information. The Successor in Interest hereby:

___ reasserts,

___ relinquishes, or

___ modifies

all Confidential Business Information (CBI) claims made by the Company, pursuant to Section 14 of TSCA and 40 CFR part 2, for the PMN substance(s). Where "reasserts" or "relinquishes" is indicated, that designation shall be deemed to apply to all such claims. Where "modifies" is indicated, such modification shall be explained in detail in an attachment to this Notice of Transfer. Information which has been previously disclosed to the public (e.g., a chemical identity that was not claimed as CBI by the original submitter) would not subsequently be eligible for confidential treatment under this Notice of Transfer.

TOXIC SUBSTANCES CONTROL ACT
SECTION 5(e) CONSENT ORDER

NOTICE OF TRANSFER
(continued)

Company (Transferor)

PMN Number

Signature of Authorized Official

Date

Printed Name of Authorized Official

Title of Authorized Official

Successor in Interest

Signature of Authorized Official

Date

Printed Name of Authorized Official

Title of Authorized Official

Address

City, State, Zip Code

TOXIC SUBSTANCES CONTROL ACT
SECTION 5(e) CONSENT ORDER

NOTICE OF TRANSFER
(continued)

Successor's Technical Contact

Address

City, State, Zip Code

Phone

Cover Letter

{XXX}



PMN2010P1

PMN Page 1

WG Ex. 23

SANITIZED SUBMISSION

Form Approved. O.M.B. Nos. 2070-0012 and 2070-0038

U.S. ENVIRONMENTAL PROTECTION AGENCY		AGENCY USE ONLY											
EPA PREMANUFACTURE NOTICE FOR NEW CHEMICAL SUBSTANCES	Date of receipt:												
When completed, send this form to:	If sending by Courier: Office of Pollution Prevention and Toxics Document Control Office (7407M) US EPA, 1201 Constitution Ave NW WASHINGTON, D.C. 20460 Contact Numbers: 202-564-8930/8940	If sending by US Mail: Office of Pollution Prevention and Toxics Document Control Office (7407M) US EPA, 1200 Pennsylvania Ave NW WASHINGTON, D.C. 20460	Submission Report Number ST-5101203535628222										
Total Number of Pages	User Fee Payment ID Number		TS Number										
308	74150444984		D1469P										
GENERAL INSTRUCTIONS													
- You must provide all information requested in this form to the extent that it is known to or reasonably ascertainable by you. Make reasonable estimates if you do not have actual data. - Before you complete this form, you should read the "Instructions Manual for Premanufacture Notification" (the Instructions Manual is available from the Toxic Substances Control Act (TSCA) Information Service by calling 202-554-1404, or faxing 202-554-5603). - If a user fee has been remitted for this notice (40 CFR 700.45), indicate in the boxes above the TS-user fee identification number you have generated. Remember, your user fee ID number must also appear on your corresponding fee remittance. For mailing address information see the Help instructions in the e-PMN tool.													
Part I – GENERAL INFORMATION You must provide the currently correct Chemical Abstracts (CA) Name of the new chemical substance, even if you claim the identity as confidential. You may authorize another person to submit chemical identity information for you, but your submission will not be complete and the review will not begin until EPA receives this information. A letter in support of your submission should reference your TS user fee identification number. For all Section 5 Notice submissions (paper or electronic) you must submit an original notice including all test data; if you claimed any information as confidential, an original sanitized copy must also be submitted.		TEST DATA AND OTHER DATA You are required to submit all test data in your possession or control and to provide a description of all other data known to or reasonably ascertainable by you, if these data are related to the health and environmental effects on the manufacture, processing, distribution in commerce, use, or disposal of the new chemical substance. Standard literature citations may be submitted for data in the open scientific literature. <u>Complete test data (written in English), not summaries of data, must be submitted if they do not appear in the open literature.</u> You should clearly identify whether test data is on the substance or on an analog. Also, the chemical composition of the tested material should be characterized. Following are examples of test data and other data. Data should be submitted according to the requirements of §720.50 of the Premanufacture Notification Rule (40 CFR Part 720).											
Part II – HUMAN EXPOSURE AND ENVIRONMENTAL RELEASE If there are several manufacture, processing, or use operations to be described in Part II, sections A and B of this notice, reproduce the sections as needed.		Test Data (Check Below any included in this notice) <table style="width:100%"><tr><td>☐ Environmental fate data</td><td>☐ Other Data</td></tr><tr><td>☒ Health effects data</td><td>☐ Risk Assessments</td></tr><tr><td>☐ Environmental effects data</td><td>☐ Structure/activity relationships</td></tr><tr><td>☒ Physical/Chemical Properties (A physical and chemical properties worksheet is located on the last page of this form.)</td><td></td></tr><tr><td>☐ Test data not in the possession or control of the submitter</td><td></td></tr></table>		☐ Environmental fate data	☐ Other Data	☒ Health effects data	☐ Risk Assessments	☐ Environmental effects data	☐ Structure/activity relationships	☒ Physical/Chemical Properties (A physical and chemical properties worksheet is located on the last page of this form.)		☐ Test data not in the possession or control of the submitter	
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☒ Physical/Chemical Properties (A physical and chemical properties worksheet is located on the last page of this form.)													
☐ Test data not in the possession or control of the submitter													
Part III – LIST OF ATTACHMENTS For paper submissions, attach additional sheets if there is not enough space to answer a question fully. Label each continuation sheet with the corresponding section heading. In Part III, list these attachments, any test data or other data and any optional information included in the notice.													
OPTIONAL INFORMATION You may include any information that you want EPA to consider in evaluating the new substance. On page 11 of this form, space has been provided for you to describe pollution prevention and recycling information you may have regarding the new substance. "Binding" boxes are included throughout this form for you to indicate your willingness to be bound to certain statements you make in this section, such as use, production volume, protective equipment . . . The intention is to reduce delays that routinely accompany the development of consent orders or Significant New Use Rules. Checking a "binding" box in a PMN does not by itself prohibit the submitter from later deviating from the information (except chemical identity) reported in the form; however, in the case of exemption applications (such as TMEA, LVE, LOREX) certain information provided in such notifications is binding on the submitter when the Agency approves the exemption application, especially if the production volume "binding" box is chosen in a LVE.		TYPE OF NOTICE (Check Only One) <table style="width:100%"><tr><td>☒ PMN (Premanufacture Notice)</td></tr><tr><td>☐ SNUN (Significant New Use Notice)</td></tr><tr><td>☐ TMEA (Test Marketing Exemption Application)</td></tr><tr><td>☐ LVE (Low Volume Exemption) @ 40 CFR 723.50(c)(1)</td></tr><tr><td>☐ LOREX (Low Release/Low Exposure Exemption) @ 40 CFR 723.50(c)(2)</td></tr><tr><td>☐ LVE Modification</td></tr><tr><td>☐ LOREX Modification</td></tr><tr><td>☐ Mock Submission</td></tr><tr><td>☐ Mark (X) if pending Letter of Support</td></tr></table>		☒ PMN (Premanufacture Notice)	☐ SNUN (Significant New Use Notice)	☐ TMEA (Test Marketing Exemption Application)	☐ LVE (Low Volume Exemption) @ 40 CFR 723.50(c)(1)	☐ LOREX (Low Release/Low Exposure Exemption) @ 40 CFR 723.50(c)(2)	☐ LVE Modification	☐ LOREX Modification	☐ Mock Submission	☐ Mark (X) if pending Letter of Support	
☒ PMN (Premanufacture Notice)													
☐ SNUN (Significant New Use Notice)													
☐ TMEA (Test Marketing Exemption Application)													
☐ LVE (Low Volume Exemption) @ 40 CFR 723.50(c)(1)													
☐ LOREX (Low Release/Low Exposure Exemption) @ 40 CFR 723.50(c)(2)													
☐ LVE Modification													
☐ LOREX Modification													
☐ Mock Submission													
☐ Mark (X) if pending Letter of Support													
CONFIDENTIALITY CLAIMS You may claim any information in this notice as confidential. To assert a claim on the form, mark (X) the confidential box next to the information that you claim as confidential. To assert a claim in an attachment, circle or bracket the information you claim as confidential. <u>If you claim information in the notices as confidential, you must also provide a sanitized version of the notice, (including attachments).</u> For additional instructions on claiming information as confidential, read the Instructions Manual.		X IS THIS A CONSOLIDATED PMN (Y/N)? 3 # of chemicals or polymers (Prenotice Communication # required, enter # on p. 3). X Mark (X) if any information in this notice is claimed as confidential.											



PMN Page 2

The public reporting and recordkeeping burden for this collection of information is estimated to average 93 hours per response. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including through the use of automated collection techniques to the Director, Collection Strategies Division, U.S. Environmental Protection Agency (2822T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460. Include the OMB control number in any correspondence. Do not send the completed EPA Form 7710-25 to this address.

CERTIFICATION -- A printed copy of this signature page, with original signature, must be submitted with CD or paper submission.

I certify that to the best of my knowledge and belief:

1. The company named in Part I, section A, subsection 1a of this notice form intends to manufacture, import or process for a commercial purpose, other than in small quantities solely for research and development, the substance identified in Part I, Section B.
2. All information provided in this notice is complete and truthful as of the date of submission.
3. I am submitting with this notice all test data in my possession or control and a description of all other data known to or reasonably ascertainable by me as required by §720.50 of the Premanufacture Notification Rule.

Additional Certification Statements:

If you are submitting a PMN, Intermediate PMN, Consolidated PMN, or SNUN, check the following **user fee** certification statement that applies:



The Company named in Part I, Section A has remitted the fee of \$2500 specified in 40 CFR 700.45(b), or



The Company named in Part I, Section A has remitted the fee of \$1000 for an Intermediate PMN (defined @ 40 CFR 700.43) in accordance with 40 CFR 700.45(b), or



The Company named in Part I Section A is a small business concern under 40 CFR 700.43 and has remitted a fee of \$100 in accordance with 40 CFR 700.45(b).

If you are submitting a **Low Volume Exemption (LVE)** application in accordance with 40 CFR 723.50(c)(1) or a **Low Release and Low Exposure Exemption (LoRex)** application in accordance with 40 CFR 723.50(c)(2), check the following certification statements:



The manufacturer submitting this notice intends to manufacture or import the new chemical substance for commercial purposes, other than in small quantities solely for research and development, under the terms of 40 CFR 723.50.



The manufacturer is familiar with the terms of this section and will comply with those terms; and



The new chemical substance for which the notice is submitted meets all applicable exemption conditions.



If this application is for an LVE in accordance with 40 CFR 723.50(c)(1), the manufacturer intends to commence manufacture of the exempted substance for commercial purposes within 1 year of the date of the expiration of the 30 day review period.

The accuracy of the statements you make in this notice should reflect your best prediction of the anticipated facts regarding the chemical substance described herein. Any knowing and willful misrepresentation is subject to criminal penalty pursuant to 18 USC 1001.

Confidential

Signature and title of
Authorized Official (Original
Signature Required)

Date





PMN2010P3

PMN Page 3

WG Ex. 23
SANITIZED SUBMISSION

Part I -- GENERAL INFORMATION

Section A – SUBMITTER IDENTIFICATION

Mark (X) the "Confidential" box next to any subsection you claim as confidential

1a.	Person Submitting Notice (in U.S.)	Confidential			
Name of Authorized Official	(first) XXX (last) XXX	☒			
Position	XXX				
Company	XXX				
Mailing Address (number & street)	XXX				
City	XXX State Postal Code XXX				
email	XXX				
b.	Agent (if Applicable)	Confidential			
Name of Authorized Official	(first) (last)	☐			
Position					
Company					
Mailing Address (number & street)					
City	State Postal Code				
e-mail	Telephone (include area code)				
c.	Joint Submitter (if applicable)	Confidential			
If you are submitting this notice as part of a joint submission, mark (X)		☐			
Name of Authorized Official	(first) (last)	☐			
Position					
Company					
Mailing Address (number & street)					
City	State Postal Code				
e-mail	Telephone (include area code)				
2.	Technical Contact (in U.S.)	Confidential			
Name of Authorized Official	(first) XXX (last) XXX	☒			
Position	XXX				
Company	XXX				
Mailing Address (number & street)	XXX				
City	XXX State Postal Code XXX				
e-mail	XXX Telephone (include area code) XXX				
3.	If you have had a prenotice communication (PC) concerning this notice and EPA assigned a PC Number to the notice, enter the number.	XXX	Mark (X) if none	Confidential	
			☐	☒	
4.	If you previously submitted an exemption application for the chemical substance covered by this notice, enter the exemption number assigned by EPA. If you previously submitted a PMN for this substance enter the PMN number assigned by EPA (i.e. withdrawn or incomplete).	XXX	Mark (X) if none	Confidential	
			☐	☒	
5.	If you have submitted a notice of Bona fide intent to manufacture or import for the chemical substance covered by this notice, enter the notice number assigned by EPA.	XXX	Mark (X) if none	Confidential	
			☐	☒	
6.	Type of Notice – Mark (X)				
1.	Manufacture Only ☐	2.	Import Only ☒	3.	Both ☐
	Binding Option ☐		Binding Option ☐		



PMN Page 4

Part I – GENERAL INFORMATION -- Continued

Section B – CHEMICAL IDENTITY INFORMATION:		You must provide a currently correct Chemical Abstracts (CA) name of the substance based on current CA index nomenclature rules and conventions.	
Mark (X) the "Confidential" box next to any item you claim as confidential			
Complete either item 1 (Class 1 or 2 substances) or 2 (Polymers) as appropriate. Complete all other items.			
If another person will submit chemical identity information for you (for either Item 1 or 2), mark (X) the box at the right. Identify the name, company, and address of that person in a continuation sheet.			☐
1. Class 1 or 2 chemical substances (for definitions of class 1 and class 2 substances, see the Instructions Manual)		Class 1	Class 2
a. Class of substance - Mark (X)		☐	☐
b. Chemical name (Currently correct Chemical Abstracts (CA) Name that is consistent with TSCA Inventory listings for similar substances. For Class 1 substances a CA Index Name must be provided. For Class 2 substances either a CA Index Name or CA Preferred Name must be provided, which ever is appropriate based on current CA index nomenclature rules and conventions).		☐	
CAS Registry Number (if a number already exists for the substance)			
c. Please identify which method you used to develop or obtain the specified chemical identity information reported in this notice: (check one).			
Method 1 (CAS Inventory Expert Service - a copy of the Identification report obtained from the CAS Inventory Expert Services must be submitted as an attachment to this notice)		IES Order Number	Method 2 (Other Source)
☐			☐
Enter Attachment filename for Part I, Section B, 1. c.		☐	
d. Molecular formula	☐		
e. For a class 1 substance, provide a complete and correct chemical structure diagram. For a class 2 substance, provide a correct representative or partial chemical structure diagram, as complete as can be known, if one can be reasonably ascertained.			☐
Enter Attachment filename for Part I, Section B, 1. e.		☐	



PMN2010P4A

PMN Page 4a

WG Ex. 23
SANITIZED SUBMISSION

For a class 2 substance - (1) List the immediate precursor substances with their respective CAS Registry Numbers. (2) Describe the nature of the reaction or process. (3) Indicate the range of composition and the typical composition (where appropriate).

Confidential

e. (1) List the immediate precursor substance names with their respective CAS Registry Numbers.

☐

Enter Attachment filename for Part I, Section B, 1. e. (1)

☐

e. (2) Describe the nature of the reaction or process.

☐

Enter Attachment filename for Part I, Section B, 1. e. (2)

☐

e. (3) Indicate the range of composition and the typical composition (where appropriate).

☐

Enter Attachment filename for Part I, Section B, 1. e. (3)

☐



PMN2010P5

PMN Page 5

WG Ex 23
SANITIZED SUBMISSION

Part I -- GENERAL INFORMATION -- Continued

Section B -- CHEMICAL IDENTITY INFORMATION -- Continued

2. Polymers (For a definition of polymer, see the Instructions Manual.)

Confidential

a. Indicate the number-average weight of the lowest molecular weight composition of the polymer you intend to manufacture. Indicate maximum weight percent of low molecular weight species (not including residual monomers, reactants, or solvents) below 500 and below 1,000 absolute molecular weight of that composition.

☒

Describe the methods of measurement or the basis for your estimates:

GPC

☐

Other (Specify Below)

☐

Specify Other:

(i) lowest number average molecular weight:

(ii) maximum weight % below 500 molecular weight:

(iii) maximum weight % below 1000 molecular weight:

XXX

XXX

XXX

Enter Attachment filename for Part I, Section B, 2. a.

Analytical Report for Low MW (also see pg.12, attachment #16)_public.pdf

b. You must make separate confidentiality claims for monomer or other reactant identity, composition information, and residual information. Mark (X) the "Confidential" box next to any item you claim as confidential

- (1) - Provide the specific chemical name and CAS Registry Number (if a number exists) of each monomer or other reactant used in the manufacture of the polymer.
- (2) - Mark (X) this column if entry in column (1) is confidential.
- (3) - Indicate the typical weight percent of each monomer or other reactant in the polymer.
- (4) - Choose "yes" from drop down menu if you want a monomer or other reactant used at two weight percent or less to be listed as part of the polymer description on the TSCA Chemical Substance Inventory.
- (5) - Mark (X) this column if entries in columns (3) and (4) are confidential.
- (6) - Indicate the maximum weight percent of each monomer or other reactant that may be present as a residual in the polymer as manufactured for commercial purposes.
- (7) - Mark (X) this column if entry in column (6) is confidential.

Monomer or other reactant specific chemical name
(1)CBI
(2)Typical
composition
(3)Include in
identity
(4)CBI
(5)Max
residual
(6)CBI
(7)

XXX

X

xxx

X

xxx

X

CAS Registry Number (1)

XXX

XXX

X

xxx

X

xxx

X

CAS Registry Number (1)

XXX

XXX

X

xxx

X

xxx

X

CAS Registry Number (1)

XXX

XXX

X

xxx

X

xxx

X

CAS Registry Number (1)

XXX

XXX

X

xxx

X

xxx

X

Mark (X) this box if the data continues on the next page.

☐



PMN2010P5A

PMN Page 5a

WG Ex 23
SANITIZED SUBMISSION

c. Please identify which method you used to develop or obtain the specified chemical identity information reported in this notice (check one).				CBI
Method 1 (CAS Inventory Expert Service - a copy of the identification report obtained from CAS Inventory Expert Service must be submitted as an attachment to this notice) ☒	IES Order Number	152725-1	Method 2 (other source) ☐	
Enter Attachment filename for Part I, Section B, 2. c.		CAS - Inventory Expert Service (2010) #1 (public).pdf		☐
d. The currently correct Chemical Abstracts (CA) name for the polymer that is consistent with TSCA Inventory listings for similar polymers.				☒
XXX				
CAS Registry Number (if a number already exists for the substance)		XXX		
e. Provide a correct representative or partial chemical structure diagram, as complete as can be known, if one can be reasonably ascertained.				☐
See Attachment 001 (Structure #1 _(public)_.pdf)				
Enter Attachment filename for Part I, Section B, 2. e.		Structure #1 _(public)_.pdf		☐



PMN2010P6

PMN Page 6

WG Ex 23
SANITIZED SUBMISSION

Part I -- GENERAL INFORMATION -- Continued

Section B -- CHEMICAL IDENTITY INFORMATION -- Continued

3. Impurities

- (a) - Identify each impurity that may be reasonably anticipated to be present in the chemical substance as manufactured for commercial purpose. Provide the CAS Registry Number if available. If there are unidentified impurities, enter "unidentified."
(b) - Estimate the maximum weight % of each impurity. If there are unidentified impurities, estimate their total weight %.

Impurity (a)	CAS Registry Number (a)	Maximum Percent % (b)	Confidential
XXX	XXX	XXX	X
XXX	XXX	XXX	X
XXX	XXX	XXX	X
XXX	XXX	XXX	X
XXX	XXX	XXX	X
XXX	XXX	XXX	X

Mark (X) this box if the data continues on the next page.



Enter Attachment filename for Part I, Section B, 3.



4. Synonyms - Enter any chemical synonyms for the new chemical identified in subsection 1 or 2.

XXX



Enter Attachment filename for Part I, Section B, 4.



5. Trade identification - List trade names for the new chemical substance identified in subsection 1 or 2.

XXX



Enter Attachment filename for Part I, Section B, 5.



6. Generic chemical name - If you claim chemical identify as confidential, you must provide a generic name for your substance that reveals the specific chemical identity of the new chemical substance to the maximum extent possible. Refer to the TSCA Chemical Substance Inventory, 1985 Edition, Appendix B for guidance on developing generic names.

Fluorinated Acrylic Alkylamino Copolymer

Enter Attachment filename for Part I, Section B, 6.

7. Byproducts - Describe any byproducts resulting from the manufacture, processing, use, or disposal of the new chemical substance. Provide the CAS Registry Number if available.

Byproduct (1)	CAS Registry Number (2)	Confidential

Mark (X) this box if the data continues on the next page.





PMN2010P6-1

PMN Page 6 (1)

WG Ex 23
SANITIZED SUBMISSION

Part I -- GENERAL INFORMATION -- Continued

Section B -- CHEMICAL IDENTITY INFORMATION -- Continued

3. Impurities

- (a) - Identify each impurity that may be reasonably anticipated to be present in the chemical substance as manufactured for commercial purpose. Provide the CAS Registry Number if available. If there are unidentified impurities, enter "unidentified."
(b) - Estimate the maximum weight % of each impurity. If there are unidentified impurities, estimate their total weight %.

Impurity (a)	CAS Registry Number (a)	Maximum Percent % (b)	Confidential
XXX	XXX	XXX	X
XXX	XXX	XXX	X
XXX	XXX	XXX	X
XXX	XXX	XXX	X
XXX	XXX	XXX	X
XXX	XXX	XXX	X

Mark (X) this box if the data continues on the next page.



Enter Attachment filename for Part I, Section B, 3.



4. Synonyms - Enter any chemical synonyms for the new chemical identified in subsection 1 or 2.



Enter Attachment filename for Part I, Section B, 4.



5. Trade identification - List trade names for the new chemical substance identified in subsection 1 or 2.



Enter Attachment filename for Part I, Section B, 5.



6. Generic chemical name - If you claim chemical identify as confidential, you must provide a generic name for your substance that reveals the specific chemical identity of the new chemical substance to the maximum extent possible. Refer to the TSCA Chemical Substance Inventory, 1985 Edition, Appendix B for guidance on developing generic names.

Enter Attachment filename for Part I, Section B, 6.

7. Byproducts - Describe any byproducts resulting from the manufacture, processing, use, or disposal of the new chemical substance. Provide the CAS Registry Number if available.

Byproduct (1)	CAS Registry Number (2)	Confidential

Mark (X) this box if the data continues on the next page.





PMN2010P6-2

PMN Page 6 (2)

WG Ex 23
SANITIZED SUBMISSION

Part I -- GENERAL INFORMATION -- Continued

Section B -- CHEMICAL IDENTITY INFORMATION -- Continued

3. Impurities

- (a) - Identify each impurity that may be reasonably anticipated to be present in the chemical substance as manufactured for commercial purpose. Provide the CAS Registry Number if available. If there are unidentified impurities, enter "unidentified."
(b) - Estimate the maximum weight % of each impurity. If there are unidentified impurities, estimate their total weight %.

Impurity (a)	CAS Registry Number (a)	Maximum Percent % (b)	Confidential
XXX	XXX	XXX	X
XXX	XXX	XXX	X

Mark (X) this box if the data continues on the next page.

☐

Enter Attachment filename for Part I, Section B, 3.

☐

4. Synonyms - Enter any chemical synonyms for the new chemical identified in subsection 1 or 2.

☐

Enter Attachment filename for Part I, Section B, 4.

☐

5. Trade identification - List trade names for the new chemical substance identified in subsection 1 or 2.

☐

Enter Attachment filename for Part I, Section B, 5.

☐

6. Generic chemical name - If you claim chemical identify as confidential, you must provide a generic name for your substance that reveals the specific chemical identity of the new chemical substance to the maximum extent possible. Refer to the TSCA Chemical Substance Inventory, 1985 Edition, Appendix B for guidance on developing generic names.

Enter Attachment filename for Part I, Section B, 6.

7. Byproducts - Describe any byproducts resulting from the manufacture, processing, use, or disposal of the new chemical substance. Provide the CAS Registry Number if available.

Byproduct (1)	CAS Registry Number (2)	Confidential

Mark (X) this box if the data continues on the next page.

☐



PMN2010P4X1

PMN Page 4

WG Ex 23
SANITIZED SUBMISSION

Part I – GENERAL INFORMATION -- Continued

Section B – CHEMICAL IDENTITY INFORMATION:		You must provide a currently correct Chemical Abstracts (CA) name of the substance based on current CA index nomenclature rules and conventions.	
Mark (X) the "Confidential" box next to any item you claim as confidential			
Complete either item 1 (Class 1 or 2 substances) or 2 (Polymers) as appropriate. Complete all other items.			
If another person will submit chemical identity information for you (for either Item 1 or 2), mark (X) the box at the right. Identify the name, company, and address of that person in a continuation sheet.		☐	
1. Class 1 or 2 chemical substances (for definitions of class 1 and class 2 substances, see the Instructions Manual)	Class 1	Class 2	CBI
a. Class of substance - Mark (X)	☐	☐	☐
b. Chemical name (Currently correct Chemical Abstracts (CA) Name that is consistent with TSCA Inventory listings for similar substances. For Class 1 substances a CA Index Name must be provided. For Class 2 substances either a CA Index Name or CA Preferred Name must be provided, which ever is appropriate based on current CA index nomenclature rules and conventions).			☐
CAS Registry Number (if a number already exists for the substance)			
c. Please identify which method you used to develop or obtain the specified chemical identity information reported in this notice: (check one).			
Method 1 (CAS Inventory Expert Service - a copy of the Identification report obtained from the CAS Inventory Expert Services must be submitted as an attachment to this notice)	☐	IES Order Number	Method 2 (Other Source)
			☐
Enter Attachment filename for Part I, Section B, 1. c.		☐	
d. Molecular formula			☐
e. For a class 1 substance, provide a complete and correct chemical structure diagram. For a class 2 substance, provide a correct representative or partial chemical structure diagram, as complete as can be known, if one can be reasonably ascertained.			☐
Enter Attachment filename for Part I, Section B, 1. e.		☐	



PMN2010P4AX1

PMN Page 4a

WG Ex. 23
SANITIZED SUBMISSION

For a class 2 substance - (1) List the immediate precursor substances with their respective CAS Registry Numbers. (2) Describe the nature of the reaction or process. (3) Indicate the range of composition and the typical composition (where appropriate).

Confidential

e. (1) List the immediate precursor substance names with their respective CAS Registry Numbers.

☐

Enter Attachment filename for Part I, Section B, 1. e. (1)

☐

e. (2) Describe the nature of the reaction or process.

☐

Enter Attachment filename for Part I, Section B, 1. e. (2)

☐

e. (3) Indicate the range of composition and the typical composition (where appropriate).

☐

Enter Attachment filename for Part I, Section B, 1. e. (3)

☐



PMN2010P5X1

PMN Page 5

WG Ex. 23
SANITIZED SUBMISSION

Part I -- GENERAL INFORMATION -- Continued

Section B -- CHEMICAL IDENTITY INFORMATION -- Continued

2. Polymers (For a definition of polymer, see the Instructions Manual.)

Confidential

- a. Indicate the number-average weight of the lowest molecular weight composition of the polymer you intend to manufacture. Indicate maximum weight percent of low molecular weight species (not including residual monomers, reactants, or solvents) below 500 and below 1,000 absolute molecular weight of that composition.

☒

Describe the methods of measurement or the basis for your estimates:

GPC

☐

Other (Specify Below)

☐

Specify Other:

(i) lowest number average molecular weight:

(ii) maximum weight % below 500 molecular weight:

(iii) maximum weight % below 1000 molecular weight:

XXX

XXX

XXX

Enter Attachment filename for Part I, Section B, 2. a.

Analytical Report for Low MW (also see pg.12, attachment #19)_public.pdf

- b. You must make separate confidentiality claims for monomer or other reactant identity, composition information, and residual information. Mark (X) the "Confidential" box next to any item you claim as confidential

- (1) - Provide the specific chemical name and CAS Registry Number (if a number exists) of each monomer or other reactant used in the manufacture of the polymer.
- (2) - Mark (X) this column if entry in column (1) is confidential.
- (3) - Indicate the typical weight percent of each monomer or other reactant in the polymer.
- (4) - Choose "yes" from drop down menu if you want a monomer or other reactant used at two weight percent or less to be listed as part of the polymer description on the TSCA Chemical Substance Inventory.
- (5) - Mark (X) this column if entries in columns (3) and (4) are confidential.
- (6) - Indicate the maximum weight percent of each monomer or other reactant that may be present as a residual in the polymer as manufactured for commercial purposes.
- (7) - Mark (X) this column if entry in column (6) is confidential.

Monomer or other reactant specific chemical name
(1)CBI
(2)Typical
composition
(3)Include in
identity
(4)CBI
(5)Max
residual
(6)CBI
(7)

XXX

X

xxx

X

xxx

X

CAS Registry Number (1)

XXX

XXX

X

xxx

X

xxx

X

CAS Registry Number (1)

XXX

XXX

X

xxx

X

xxx

X

CAS Registry Number (1)

XXX

XXX

X

xxx

X

xxx

X

CAS Registry Number (1)

XXX

XXX

X

xxx

X

xxx

X

CAS Registry Number (1)

XXX

Mark (X) this box if the data continues on the next page.

☒



PMN2010P5X1-1

PMN Page 5 (1)

WG Ex. 23
SANITIZED SUBMISSION

Part I -- GENERAL INFORMATION -- Continued

Section B -- CHEMICAL IDENTITY INFORMATION -- Continued

2. Polymers (For a definition of polymer, see the Instructions Manual.)

Confidential

- a. Indicate the number-average weight of the lowest molecular weight composition of the polymer you intend to manufacture. Indicate maximum weight percent of low molecular weight species (not including residual monomers, reactants, or solvents) below 500 and below 1,000 absolute molecular weight of that composition.

☐

Describe the methods of measurement or the basis for your estimates:

GPC

☐

Other (Specify Below)

☐

Specify Other:

(i) lowest number average molecular weight:

(ii) maximum weight % below 500 molecular weight:

(iii) maximum weight % below 1000 molecular weight:

Enter Attachment filename for Part I, Section B, 2. a.

☐

- b. You must make separate confidentiality claims for monomer or other reactant identity, composition information, and residual information. Mark (X) the "Confidential" box next to any item you claim as confidential

- (1) - Provide the specific chemical name and CAS Registry Number (if a number exists) of each monomer or other reactant used in the manufacture of the polymer.
- (2) - Mark (X) this column if entry in column (1) is confidential.
- (3) - Indicate the typical weight percent of each monomer or other reactant in the polymer.
- (4) - Choose "yes" from drop down menu if you want a monomer or other reactant used at two weight percent or less to be listed as part of the polymer description on the TSCA Chemical Substance Inventory.
- (5) - Mark (X) this column if entries in columns (3) and (4) are confidential.
- (6) - Indicate the maximum weight percent of each monomer or other reactant that may be present as a residual in the polymer as manufactured for commercial purposes.
- (7) - Mark (X) this column if entry in column (6) is confidential.

Monomer or other reactant specific chemical name
(1)CBI
(2)Typical
composition
(3)Include in
identity
(4)CBI
(5)Max
residual
(6)CBI
(7)

XXX

X

xxx

X

xxx

X

CAS Registry Number (1) xxx

CAS Registry Number (1)

CAS Registry Number (1)

CAS Registry Number (1)

CAS Registry Number (1)

Mark (X) this box if the data continues on the next page.

☐



PMN2010P5AX1

PMN Page 5a

WG Ex 23
SANITIZED SUBMISSION

c. Please identify which method you used to develop or obtain the specified chemical identity information reported in this notice (check one).				CBI
Method 1 (CAS Inventory Expert Service - a copy of the identification report obtained from CAS Inventory Expert Service must be submitted as an attachment to this notice) ☒	IES Order Number	152725-2	Method 2 (other source) ☐	
Enter Attachment filename for Part I, Section B, 2. c.		CAS - Inventory Expert Service (2010) #2 (public).pdf		☐
d. The currently correct Chemical Abstracts (CA) name for the polymer that is consistent with TSCA Inventory listings for similar polymers.				☒
XXX				
CAS Registry Number (if a number already exists for the substance)		XXX		
e. Provide a correct representative or partial chemical structure diagram, as complete as can be known, if one can be reasonably ascertained.				☐
See Attachment 004 (Structure #2 _(public)_.pdf)				
Enter Attachment filename for Part I, Section B, 2. e.		Structure #2 _(public)_.pdf		☐



PMN2010P6X1

PMN Page 6

WG Ex. 23
SANITIZED SUBMISSION

Part I -- GENERAL INFORMATION -- Continued

Section B -- CHEMICAL IDENTITY INFORMATION -- Continued

3. Impurities

- (a) - Identify each impurity that may be reasonably anticipated to be present in the chemical substance as manufactured for commercial purpose. Provide the CAS Registry Number if available. If there are unidentified impurities, enter "unidentified."
(b) - Estimate the maximum weight % of each impurity. If there are unidentified impurities, estimate their total weight %.

Impurity (a)	CAS Registry Number (a)	Maximum Percent % (b)	Confidential
XXX	XXX	XXX	X
XXX	XXX	XXX	X
XXX	XXX	XXX	X
XXX	XXX	XXX	X
XXX	XXX	XXX	X
XXX	XXX	XXX	X

Mark (X) this box if the data continues on the next page.



Enter Attachment filename for Part I, Section B, 3.



4. Synonyms - Enter any chemical synonyms for the new chemical identified in subsection 1 or 2.

XXX



Enter Attachment filename for Part I, Section B, 4.



5. Trade identification - List trade names for the new chemical substance identified in subsection 1 or 2.

XXX



Enter Attachment filename for Part I, Section B, 5.



6. Generic chemical name - If you claim chemical identify as confidential, you must provide a generic name for your substance that reveals the specific chemical identity of the new chemical substance to the maximum extent possible. Refer to the TSCA Chemical Substance Inventory, 1985 Edition, Appendix B for guidance on developing generic names.

Fluorinated Acrylic Alkylamino Copolymer

Enter Attachment filename for Part I, Section B, 6.

7. Byproducts - Describe any byproducts resulting from the manufacture, processing, use, or disposal of the new chemical substance. Provide the CAS Registry Number if available.

Byproduct (1)	CAS Registry Number (2)	Confidential

Mark (X) this box if the data continues on the next page.





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PMN Page 6 (1)

WG Ex 23
SANITIZED SUBMISSION

Part I -- GENERAL INFORMATION -- Continued

Section B -- CHEMICAL IDENTITY INFORMATION -- Continued

3. Impurities

- (a) - Identify each impurity that may be reasonably anticipated to be present in the chemical substance as manufactured for commercial purpose. Provide the CAS Registry Number if available. If there are unidentified impurities, enter "unidentified."
(b) - Estimate the maximum weight % of each impurity. If there are unidentified impurities, estimate their total weight %.

Impurity (a)	CAS Registry Number (a)	Maximum Percent % (b)	Confidential
XXX	XXX	XXX	X
XXX	XXX	XXX	X
XXX	XXX	XXX	X
XXX	XXX	XXX	X
XXX	XXX	XXX	X
XXX	XXX	XXX	X

Mark (X) this box if the data continues on the next page.



Enter Attachment filename for Part I, Section B, 3.



4. Synonyms - Enter any chemical synonyms for the new chemical identified in subsection 1 or 2.



Enter Attachment filename for Part I, Section B, 4.



5. Trade identification - List trade names for the new chemical substance identified in subsection 1 or 2.



Enter Attachment filename for Part I, Section B, 5.



6. Generic chemical name - If you claim chemical identify as confidential, you must provide a generic name for your substance that reveals the specific chemical identity of the new chemical substance to the maximum extent possible. Refer to the TSCA Chemical Substance Inventory, 1985 Edition, Appendix B for guidance on developing generic names.

Enter Attachment filename for Part I, Section B, 6.

7. Byproducts - Describe any byproducts resulting from the manufacture, processing, use, or disposal of the new chemical substance. Provide the CAS Registry Number if available.

Byproduct (1)	CAS Registry Number (2)	Confidential

Mark (X) this box if the data continues on the next page.





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PMN Page 6 (2)

WG Ex 23
SANITIZED SUBMISSION

Part I -- GENERAL INFORMATION -- Continued

Section B -- CHEMICAL IDENTITY INFORMATION -- Continued

3. Impurities

- (a) - Identify each impurity that may be reasonably anticipated to be present in the chemical substance as manufactured for commercial purpose. Provide the CAS Registry Number if available. If there are unidentified impurities, enter "unidentified."
(b) - Estimate the maximum weight % of each impurity. If there are unidentified impurities, estimate their total weight %.

Impurity (a)	CAS Registry Number (a)	Maximum Percent % (b)	Confidential
XXX	XXX	XXX	X
XXX	XXX	XXX	X

Mark (X) this box if the data continues on the next page.

☐

Enter Attachment filename for Part I, Section B, 3.

☐

4. Synonyms - Enter any chemical synonyms for the new chemical identified in subsection 1 or 2.

☐

Enter Attachment filename for Part I, Section B, 4.

☐

5. Trade identification - List trade names for the new chemical substance identified in subsection 1 or 2.

☐

Enter Attachment filename for Part I, Section B, 5.

☐

6. Generic chemical name - If you claim chemical identify as confidential, you must provide a generic name for your substance that reveals the specific chemical identity of the new chemical substance to the maximum extent possible. Refer to the TSCA Chemical Substance Inventory, 1985 Edition, Appendix B for guidance on developing generic names.

Enter Attachment filename for Part I, Section B, 6.

7. Byproducts - Describe any byproducts resulting from the manufacture, processing, use, or disposal of the new chemical substance. Provide the CAS Registry Number if available.

Byproduct (1)	CAS Registry Number (2)	Confidential

Mark (X) this box if the data continues on the next page.

☐



PMN Page 4

Part I – GENERAL INFORMATION -- Continued

Section B – CHEMICAL IDENTITY INFORMATION:		You must provide a currently correct Chemical Abstracts (CA) name of the substance based on current CA index nomenclature rules and conventions.	
Mark (X) the "Confidential" box next to any item you claim as confidential			
Complete either item 1 (Class 1 or 2 substances) or 2 (Polymers) as appropriate. Complete all other items.			
If another person will submit chemical identity information for you (for either Item 1 or 2), mark (X) the box at the right. Identify the name, company, and address of that person in a continuation sheet.			☐
1. Class 1 or 2 chemical substances (for definitions of class 1 and class 2 substances, see the Instructions Manual)	Class 1	Class 2	CBI
a. Class of substance - Mark (X)	☐	☐	☐
b. Chemical name (Currently correct Chemical Abstracts (CA) Name that is consistent with TSCA Inventory listings for similar substances. For Class 1 substances a CA Index Name must be provided. For Class 2 substances either a CA Index Name or CA Preferred Name must be provided, which ever is appropriate based on current CA index nomenclature rules and conventions).			☐
CAS Registry Number (if a number already exists for the substance)			
c. Please identify which method you used to develop or obtain the specified chemical identity information reported in this notice: (check one).			
Method 1 (CAS Inventory Expert Service - a copy of the Identification report obtained from the CAS Inventory Expert Services must be submitted as an attachment to this notice)	☐	IES Order Number	Method 2 (Other Source) ☐
Enter Attachment filename for Part I, Section B, 1. c.			☐
d. Molecular formula			☐
e. For a class 1 substance, provide a complete and correct chemical structure diagram. For a class 2 substance, provide a correct representative or partial chemical structure diagram, as complete as can be known, if one can be reasonably ascertained.			☐
Enter Attachment filename for Part I, Section B, 1. e.			☐



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SANITIZED SUBMISSION

For a class 2 substance - (1) List the immediate precursor substances with their respective CAS Registry Numbers. (2) Describe the nature of the reaction or process. (3) Indicate the range of composition and the typical composition (where appropriate).

Confidential

e. (1) List the immediate precursor substance names with their respective CAS Registry Numbers.

☐

Enter Attachment filename for Part I, Section B, 1. e. (1)

☐

e. (2) Describe the nature of the reaction or process.

☐

Enter Attachment filename for Part I, Section B, 1. e. (2)

☐

e. (3) Indicate the range of composition and the typical composition (where appropriate).

☐

Enter Attachment filename for Part I, Section B, 1. e. (3)

☐



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WG Ex 23
SANITIZED SUBMISSION

Part I -- GENERAL INFORMATION -- Continued

Section B -- CHEMICAL IDENTITY INFORMATION -- Continued

2. Polymers (For a definition of polymer, see the Instructions Manual.)

Confidential

a. Indicate the number-average weight of the lowest molecular weight composition of the polymer you intend to manufacture. Indicate maximum weight percent of low molecular weight species (not including residual monomers, reactants, or solvents) below 500 and below 1,000 absolute molecular weight of that composition.

☒

Describe the methods of measurement or the basis for your estimates:

GPC

☐

Other (Specify Below)

☐

Specify Other:

(i) lowest number average molecular weight:

(ii) maximum weight % below 500 molecular weight:

(iii) maximum weight % below 1000 molecular weight:

XXX

XXX

XXX

Enter Attachment filename for Part I, Section B, 2. a.

Analytical Report for Low MW (also see pg.12, attachment #22)_public.pdf

b. You must make separate confidentiality claims for monomer or other reactant identity, composition information, and residual information. Mark (X) the "Confidential" box next to any item you claim as confidential

- (1) - Provide the specific chemical name and CAS Registry Number (if a number exists) of each monomer or other reactant used in the manufacture of the polymer.
- (2) - Mark (X) this column if entry in column (1) is confidential.
- (3) - Indicate the typical weight percent of each monomer or other reactant in the polymer.
- (4) - Choose "yes" from drop down menu if you want a monomer or other reactant used at two weight percent or less to be listed as part of the polymer description on the TSCA Chemical Substance Inventory.
- (5) - Mark (X) this column if entries in columns (3) and (4) are confidential.
- (6) - Indicate the maximum weight percent of each monomer or other reactant that may be present as a residual in the polymer as manufactured for commercial purposes.
- (7) - Mark (X) this column if entry in column (6) is confidential.

Monomer or other reactant specific chemical name
(1)CBI
(2)Typical
composition
(3)Include in
identity
(4)CBI
(5)Max
residual
(6)CBI
(7)

XXX

X

xxx

X

xxx

X

CAS Registry Number (1) XXX

XXX

X

xxx

X

xxx

X

CAS Registry Number (1) XXX

XXX

X

xxx

X

xxx

X

CAS Registry Number (1) XXX

XXX

X

xxx

X

xxx

X

CAS Registry Number (1) XXX

XXX

X

xxx

X

xxx

X

Mark (X) this box if the data continues on the next page.

☐



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SANITIZED SUBMISSION

c. Please identify which method you used to develop or obtain the specified chemical identity information reported in this notice (check one).				CBI
Method 1 (CAS Inventory Expert Service - a copy of the identification report obtained from CAS Inventory Expert Service must be submitted as an attachment to this notice) ☒	IES Order Number	152725-3	Method 2 (other source) ☐	
Enter Attachment filename for Part I, Section B, 2. c.		CAS - Inventory Expert Service (2010) #3 (public).pdf		☐
d. The currently correct Chemical Abstracts (CA) name for the polymer that is consistent with TSCA Inventory listings for similar polymers.				☒
XXX				
CAS Registry Number (if a number already exists for the substance)		XXX		
e. Provide a correct representative or partial chemical structure diagram, as complete as can be known, if one can be reasonably ascertained.				☐
See Attachment 005 (Structure #3 _(public)_.pdf)				
Enter Attachment filename for Part I, Section B, 2. e.		Structure #3 _(public)_.pdf		☐



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PMN Page 6

WG Ex. 23
SANITIZED SUBMISSION

Part I -- GENERAL INFORMATION -- Continued

Section B -- CHEMICAL IDENTITY INFORMATION -- Continued

3. Impurities

- (a) - Identify each impurity that may be reasonably anticipated to be present in the chemical substance as manufactured for commercial purpose. Provide the CAS Registry Number if available. If there are unidentified impurities, enter "unidentified."
(b) - Estimate the maximum weight % of each impurity. If there are unidentified impurities, estimate their total weight %.

Impurity (a)	CAS Registry Number (a)	Maximum Percent % (b)	Confidential
XXX	XXX	XXX	X
XXX	XXX	XXX	X
XXX	XXX	XXX	X
XXX	XXX	XXX	X
XXX	XXX	XXX	X
XXX	XXX	XXX	X

Mark (X) this box if the data continues on the next page.



Enter Attachment filename for Part I, Section B, 3.



4. Synonyms - Enter any chemical synonyms for the new chemical identified in subsection 1 or 2.

XXX



Enter Attachment filename for Part I, Section B, 4.



5. Trade identification - List trade names for the new chemical substance identified in subsection 1 or 2.

XXX



Enter Attachment filename for Part I, Section B, 5.



6. Generic chemical name - If you claim chemical identify as confidential, you must provide a generic name for your substance that reveals the specific chemical identity of the new chemical substance to the maximum extent possible. Refer to the TSCA Chemical Substance Inventory, 1985 Edition, Appendix B for guidance on developing generic names.

Fluorinated Acrylic Alkylamino Copolymer

Enter Attachment filename for Part I, Section B, 6.

7. Byproducts - Describe any byproducts resulting from the manufacture, processing, use, or disposal of the new chemical substance. Provide the CAS Registry Number if available.

Byproduct (1)	CAS Registry Number (2)	Confidential

Mark (X) this box if the data continues on the next page.





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PMN Page 6 (1)

WG Ex. 23
SANITIZED SUBMISSION

Part I -- GENERAL INFORMATION -- Continued

Section B -- CHEMICAL IDENTITY INFORMATION -- Continued

3. Impurities

- (a) - Identify each impurity that may be reasonably anticipated to be present in the chemical substance as manufactured for commercial purpose. Provide the CAS Registry Number if available. If there are unidentified impurities, enter "unidentified."
(b) - Estimate the maximum weight % of each impurity. If there are unidentified impurities, estimate their total weight %.

Impurity (a)	CAS Registry Number (a)	Maximum Percent % (b)	Confidential
XXX	XXX	XXX	X
XXX	XXX	XXX	X
XXX	XXX	XXX	X
XXX	XXX	XXX	X
XXX	XXX	XXX	X
XXX	XXX	XXX	X

Mark (X) this box if the data continues on the next page.



Enter Attachment filename for Part I, Section B, 3.



4. Synonyms - Enter any chemical synonyms for the new chemical identified in subsection 1 or 2.



Enter Attachment filename for Part I, Section B, 4.



5. Trade identification - List trade names for the new chemical substance identified in subsection 1 or 2.



Enter Attachment filename for Part I, Section B, 5.



6. Generic chemical name - If you claim chemical identity as confidential, you must provide a generic name for your substance that reveals the specific chemical identity of the new chemical substance to the maximum extent possible. Refer to the TSCA Chemical Substance Inventory, 1985 Edition, Appendix B for guidance on developing generic names.

Enter Attachment filename for Part I, Section B, 6.

7. Byproducts - Describe any byproducts resulting from the manufacture, processing, use, or disposal of the new chemical substance. Provide the CAS Registry Number if available.

Byproduct (1)	CAS Registry Number (2)	Confidential

Mark (X) this box if the data continues on the next page.





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PMN Page 6 (2)

WG Ex. 23
SANITIZED SUBMISSION

Part I -- GENERAL INFORMATION -- Continued

Section B -- CHEMICAL IDENTITY INFORMATION -- Continued

3. Impurities

- (a) - Identify each impurity that may be reasonably anticipated to be present in the chemical substance as manufactured for commercial purpose. Provide the CAS Registry Number if available. If there are unidentified impurities, enter "unidentified."
(b) - Estimate the maximum weight % of each impurity. If there are unidentified impurities, estimate their total weight %.

Impurity (a)	CAS Registry Number (a)	Maximum Percent % (b)	Confidential
XXX	XXX	XXX	X
XXX	XXX	XXX	X

Mark (X) this box if the data continues on the next page.

☐

Enter Attachment filename for Part I, Section B, 3.

☐

4. Synonyms - Enter any chemical synonyms for the new chemical identified in subsection 1 or 2.

☐

Enter Attachment filename for Part I, Section B, 4.

☐

5. Trade identification - List trade names for the new chemical substance identified in subsection 1 or 2.

☐

Enter Attachment filename for Part I, Section B, 5.

☐

6. Generic chemical name - If you claim chemical identify as confidential, you must provide a generic name for your substance that reveals the specific chemical identity of the new chemical substance to the maximum extent possible. Refer to the TSCA Chemical Substance Inventory, 1985 Edition, Appendix B for guidance on developing generic names.

Enter Attachment filename for Part I, Section B, 6.

7. Byproducts - Describe any byproducts resulting from the manufacture, processing, use, or disposal of the new chemical substance. Provide the CAS Registry Number if available.

Byproduct (1)	CAS Registry Number (2)	Confidential

Mark (X) this box if the data continues on the next page.

☐



PMN2010P7

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WG Ex 23
SANITIZED SUBMISSION

Part I -- GENERAL INFORMATION -- Continued

Section C -- PRODUCTION, IMPORT, AND USE INFORMATION:

The information on this page refers to consolidated chemical number(s): ☒ 1 ☒ 2 ☒ 3 ☐ 4 ☐ 5 ☐ 6

Mark (X) the "Confidential" box next to any item you claim as confidential.

1. Production volume -- Estimate the **maximum** production volume during the first 12 months of production. Also estimate the maximum production volume for any consecutive 12-month period during the first three years of production. Estimates should be on 100% new chemical substance basis. For a Low Volume Exemption application, if you choose to have your notice reviewed at a lower production volume than 10,000 kg/yr, specify the volume and mark (x) in the binding box. If granted, you are bound to this volume.

Maximum first 12-month production (kg/yr) (100% new chemical substance basis)	Maximum 12-month production (kg/yr) (100% new chemical substance basis)	Confidential	Binding Option Mark (X)
XXX	XXX	☒	☐
Enter Attachment filename for Part I, Section C, 1.		Use Diagram (public).pdf	CBI ☐

2. Use Information -- You must make separate confidentiality claims for the description of the category of use, the percent of production volume devoted to each category, the formulation of the new substance, and other use information. Mark (X) the "Confidential" Box next to any item you claim as confidential.

- a. (1) --Describe each intended category of use of the new chemical substance by function and application.
(2) --Mark (X) this column if entry column (1) is confidential business information (CBI).
(3) --Indicate your willingness to have the information provided in column (1) binding.
(4) --Estimate the percent of total production for the first three years devoted to each category of use.
(5) --Mark (X) this column if entry in column (4) is confidential business information (CBI).
(6) --Estimate the percent of the new substance as formulated in mixtures, suspensions, emulsions, solutions, or gels as manufactured for commercial purposes at sites under your control associated with each category of use.
(7) --Mark (X) this column if entry in column (6) is confidential business information (CBI).
(8) --Indicate % of product volume expected for the listed "use" sectors. Mark more than one box if appropriate. Mark (X) to indicate your willingness to have the use type provided in (8) binding.
(9) --Mark (X) this column if entry(ies) in column (8) is (are) confidential business information (CBI).

Category of use (1) (by function and application i.e. a dispersive dye for finishing polyester fibers)	CBI (2)	Binding Option Mark (X) (3)	Prod uction % (4)	CBI (5)	% in Form- ulation (6)	CBI (7)	% of substance expected per use (8)					CBI (9)
							Site- limited	Con- sumer*	Industrial	Com- mercial	Binding Option	
XXX	X		XXX	X	XXX	X	XXX	XXX	XXX	XXX		X
XXX	X		XXX	X	XXX	X	XXX	XXX	XXX	XXX		X
XXX	X		XXX	X	XXX	X	XXX	XXX	XXX	XXX		X
XXX	X		XXX	X	XXX	X	XXX	XXX	XXX	XXX		X

* If you have identified a "consumer" use, please provide on a continuation sheet a detailed description of the use(s) of this chemical substance in consumer products. In addition include estimates of the concentration of the new chemical substance as expected in consumer products and describe the chemical reactions by which this substance loses its identity in the consumer product.

Mark (X) this box if the data continues on the next page.



- b. Generic use description If you claim any category of use description in subsection 2a as confidential, enter a generic description of that category. Read the Instruction Manual for examples of generic use descriptions.

Oil and water repellent and release agent

Enter Attachment filename for Part I, Section C, 2. b.	CBI ☐
3. Hazard Information -- Include in the notice a copy of reasonable facsimile of any hazard warning statement, label, material safety data sheet, or other information which will be provided to any person who is reasonably likely to be exposed to this substance regarding protective equipment or practices for the safe handling, transport, use, or disposal of the new substance. List in part III hazard information you include.	Binding Option Mark (X)
Mark (X) this box if you attach hazard information.	☒



PMN2010P7-1

PMN Page 7 (1)

WG Ex 23
SANITIZED SUBMISSION

Part I -- GENERAL INFORMATION -- Continued

Section C -- PRODUCTION, IMPORT, AND USE INFORMATION:

The information on this page refers to consolidated chemical number(s): ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6

Mark (X) the "Confidential" box next to any item you claim as confidential.

1. Production volume -- Estimate the **maximum** production volume during the first 12 months of production. Also estimate the maximum production volume for any consecutive 12-month period during the first three years of production. Estimates should be on 100% new chemical substance basis. For a Low Volume Exemption application, if you choose to have your notice reviewed at a lower production volume than 10,000 kg/yr, specify the volume and mark (x) in the binding box. If granted, you are bound to this volume.

Maximum first 12-month production (kg/yr) (100% new chemical substance basis)	Maximum 12-month production (kg/yr) (100% new chemical substance basis)	Confidential	Binding Option Mark (X)
		☐	☐
Enter Attachment filename for Part I, Section C, 1.		CBI	☐

2. Use Information -- You must make separate confidentiality claims for the description of the category of use, the percent of production volume devoted to each category, the formulation of the new substance, and other use information. Mark (X) the "Confidential" Box next to any item you claim as confidential.

- a. (1) --Describe each intended category of use of the new chemical substance by function and application.
(2) --Mark (X) this column if entry column (1) is confidential business information (CBI).
(3) --Indicate your willingness to have the information provided in column (1) binding.
(4) --Estimate the percent of total production for the first three years devoted to each category of use.
(5) --Mark (X) this column if entry in column (4) is confidential business information (CBI).
(6) --Estimate the percent of the new substance as formulated in mixtures, suspensions, emulsions, solutions, or gels as manufactured for commercial purposes at sites under your control associated with each category of use.
(7) --Mark (X) this column if entry in column (6) is confidential business information (CBI).
(8) --Indicate % of product volume expected for the listed "use" sectors. Mark more than one box if appropriate. Mark (X) to indicate your willingness to have the use type provided in (8) binding.
(9) --Mark (X) this column if entry(ies) in column (8) is (are) confidential business information (CBI).

Category of use (1) (by function and application i.e. a dispersive dye for finishing polyester fibers)	CBI (2)	Binding Option Mark (X) (3)	Prod uction % (4)	CBI (5)	% in Form- ulation (6)	CBI (7)	% of substance expected per use (8)					CBI (9)
							Site- limited	Con- sumer*	Industrial	Com- mercial	Binding Option	
XXX	X		XXX	X	XXX	X	XXX	XXX	XXX	XXX		X
XXX	X		XXX	X	XXX	X	XXX	XXX	XXX	XXX		X
XXX	X		XXX	X	XXX	X	XXX	XXX	XXX	XXX		X

* If you have identified a "consumer" use, please provide on a continuation sheet a detailed description of the use(s) of this chemical substance in consumer products. In addition include estimates of the concentration of the new chemical substance as expected in consumer products and describe the chemical reactions by which this substance loses its identity in the consumer product.

Mark (X) this box if the data continues on the next page. ☐

- b. Generic use description If you claim any category of use description in subsection 2a as confidential, enter a generic description of that category. Read the Instruction Manual for examples of generic use descriptions.

Enter Attachment filename for Part I, Section C, 2. b.	CBI	☐

3. Hazard Information -- Include in the notice a copy of reasonable facsimile of any hazard warning statement, label, material safety data sheet, or other information which will be provided to any person who is reasonably likely to be exposed to this substance regarding protective equipment or practices for the safe handling, transport, use, or disposal of the new substance. List in part III hazard information you include.

Mark (X) this box if you attach hazard information. ☐



PMN2010P8

PMN Page 8

WG Ex. 23
SANITIZED SUBMISSION

Part II-- HUMAN EXPOSURE AND ENVIRONMENTAL RELEASE

Section A -- INDUSTRIAL SITES CONTROLLED BY THE SUBMITTER

Mark (X) the "Confidential" box next to any item you claim as confidential

The information on pages 8 and 8a refer to consolidated chemical number(s): ☒ 1 ☒ 2 ☒ 3 ☐ 4 ☐ 5 ☐ 6

Complete section A for each type of manufacture, processing, or use operation involving the new chemical substance at industrial sites you control. Importers do not have to complete this section for operations outside the U.S.; however, you may still have reporting requirements if there are further industrial processing or use operations after import. You must describe these operations. See instructions manual

1. Operation description

Confidential

a. Identity -- Enter the identity of the site at which the operation will occur.

Name

Site address (number and street)

City

County

State

ZIP code

☐

If the same operation will occur at more than one site, enter the number of sites. Identify the additional sites on a continuation sheet, and if any of the sites have significantly different production rates or operations, include all the information requested in this section for those sites as attachments. →

☐

Mark (X) this box if the data continues on the next page.

☐b. Type --
Mark (X)Manufacturing ☐Processing ☐Use ☐☐

c. Amount and Duration -- Complete 1 or 2 as appropriate

Confidential

1. Batch

Maximum kg/batch
(100% new chemical substance)

Hours/batch

Batches/year

☐

2. Continuous

Maximum kg/day
(100% new chemical substance)

Hours/day

Days/year

☐

d. Process description

Mark (X) to indicate your willingness to have your process description binding.
→ ☐

- (1) Diagram the major unit operation steps and chemical conversions. Include interim storage and transport containers (specify- e.g. 5 gallon pails, 55 gallon drum, rail car, tank truck, etc.).
- (2) Provide the identity, the approximate weight (by kg/day or kg/batch on a 100% new chemical substance basis), and entry point of all starting materials and feedstocks (including reactants, solvents, catalysts, etc.), and of all products, recycle streams, and wastes. Include cleaning chemicals (note frequency if not used daily or per batch.).
- (3) Identify by number the points of release, including small or intermittent releases, to the environment of the new chemical substance. If releasing to two media at the same step, assign a second release number for the second medium.

☐



PMN2010P8A

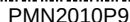
Diagram of the major unit operation steps.

Confidential

☐

Enter Attachment filename for Part II, Section A, 1. d.

☐



PMN Page 9

Part II-- HUMAN EXPOSURE AND ENVIRONMENTAL RELEASE -- Continued

Section A -- INDUSTRIAL SITES CONTROLLED BY THE SUBMITTER -- Continued

The information on pages 9 and 9a refer to consolidated chemical number(s): ☒ 1 ☒ 2 ☒ 3 ☐ 4 ☐ 5 ☐ 6

2. Occupational Exposure -- You must make separate confidentiality claims for the description of worker activity, physical form of the new chemical substance, number of workers exposed, and duration of activity. Mark (X) the "Confidential" box next to any item you claim as confidential.

- (1) -- Describe the activities (i.e. bag dumping, tote filling, unloading drums, sampling, cleaning, etc.) in which workers may be exposed to the substance.
- (2) -- Mark (X) this column if entry in column (1) is confidential business information (CBI).
- (3) -- Describe any protective equipment and engineering controls used to protect workers.
- (4) and (6) -- Indicate your willingness to have the information provided in column (3) or (5) binding.
- (5) -- Indicate the physical form(s) of the new chemical substance (e.g., solid: crystal, granule, powder, or dust) and % new chemical substance (if part of a mixture) at the time of exposure.
- (7) -- Mark (X) this column if entries in columns (3) and (5) are confidential business information (CBI).
- (8) -- Estimate the maximum number of workers involved in each activity for all sites combined.
- (9) -- Mark (X) this column if entry in column (8) is confidential business information (CBI).
- (10) and (11) -- Estimate the maximum duration of the activity for any worker in hours per day and days per year.
- (12) -- Mark (X) this column if entries in columns (10) and (11) are confidential business information (CBI).

[illegible]

Mark (X) this box if the data continues on the next page.

Enter Attachment filename for Part II, Section A on the bottom of page 9a.



3. Environmental Release and Disposal -- You must make separate confidentiality claims for the release number and the amount of the new chemical substance released and other release and disposal information. Mark (X) the "Confidential" box next to each item you claim as confidential.

- (1) -- Enter the number of each release point identified in the process description, part II, section A, subsection 1d(3).
- (2) -- Estimate the amount of the new substance released (a) directly to the environment or (b) into control technology (in kg/day or kg/batch).
- (3) -- Mark (X) this column if entries in columns (1) and (2) are confidential business information (CBI).
- (4) -- Identify the media (stack air, fugitive air (optional-see Instruction Manual), surface water, on-site or off-site land or incineration, POTW, or other (specify)) to which the new substance will be released from that release point.
- (5) -- a. Describe control technology, if any, and control efficiency that will be used to limit the release of the new substance to the environment. For releases disposed of on land, characterize the disposal method and state whether it is approved for disposal of RCRA hazardous waste. On a continuation sheet, for each site describe any additional disposal methods that will be used and whether the waste is subject to secondary or tertiary on-site treatment. b. Estimate the amount released to the environment after control technology (in kg/day).
- (6) -- Mark (X) this column if entries in columns (4) and (5) are confidential business information (CBI).
- (7) -- Identify the destination(s) of releases to water. Please supply NPDES (National Pollutant Discharge Elimination System) numbers for direct discharges or NPDES numbers of the POTW (Publicly Owned Treatment Works). Mark (X) if the POTW name or NPDES # is confidential business information (CBI).

Release Number (1)	Amount of New Substance Released		CBI (3)	Medium of release e.g. Stack air (4)	Control technology and efficiency (you may wish to optionally attach efficiency data)			CBI (6)
	(2a)	(2b)			(5a)	Binding Mark (X)	(5b)	

Mark (X) this box if the data continues on the next page.

☐

(7) Mark (X) the destination(s) of releases to water.				NPDES#	CBI
☐	POTW--provide name(s)				☐
☐	Navigable waterway- - provide name(s)				☐
☐	Other--Specify				☐

Enter Attachment filename for Part II, Section A.

☐



PMN2010P10

PMN Page 10

WG Ex. 23
SANITIZED SUBMISSION

Part II-- HUMAN EXPOSURE AND ENVIRONMENTAL RELEASE -- Continued

Section B -- INDUSTRIAL SITES CONTROLLED BY OTHERS

The information on pages 10 and 10a refer to consolidated chemical number(s): ☒ 1 ☒ 2 ☒ 3 ☐ 4 ☐ 5 ☐ 6

Complete section B for typical processing or use operations involving the new chemical substance at sites you do not control. Importers do not have to complete this section for operations outside the U.S.; however, you must report any processing or use activities after import. See the Instructions Manual. *Complete a separate section B for each type of processing, or use operation involving the new chemical substance.* If the same operation is performed at more than one site describe the typical operation common to these sites. Identify additional sites on a continuation sheet.

1(a). Operation Description -- To claim information in this section as confidential, bracket (e.g. {}) the specific information that you claim as confidential.

- (1) -- Diagram the major unit operation steps and chemical conversions, including interim storage and transport containers (specify - e.g. 5 gallon pails, 55 gallon drums, rail cars, tank trucks, etc). On the diagram, identify by letter and briefly describe each worker activity.
- (2) -- Either in the diagram or in the text field 1(b) below, provide the identity, the approximate weight (by kg/day or kg/batch, on an 100% new chemical substance basis), and entry point of all feedstocks (including reactants, solvents and catalysts, etc) and all products, recycle streams, and wastes. Include cleaning chemicals (note frequency if not used daily or per batch).
- (3) -- Either in the diagram or in the text field 1(b) below, identify by number the points of release, including small or intermittent releases, to the environment of the new chemical substance.
- (4) -- Please enter the # of sites (remember to identify the locations of these sites on a continuation sheet):

Number of Sites

Confidential

☒

See Attachment 002 (Operation Description #1_public.pdf)

1(b). (Optional) This space is for a text description to clarify the diagram above.

Confidential

☒

XXX

Enter Attachment filename for Part II, Section B on the bottom of page 10a.

Operation Description #1_public.pdf

☐



Continuation Sheet

ID	P10SB1(a)(4)1	Field	Part II, Section B, 1(a)(4). Operation Site Locations
XXX			

**2. Worker Exposure/Environmental Release**

- (1) -- From the diagram above, provide the letter for each worker activity. Complete 2-8 for each worker activity described.
- (2) -- Estimate the number of workers exposed for all sites combined.
- (4) -- Estimate the typical duration of exposure per worker in (a) hours per day and (b) days per year.
- (6) -- Describe physical form of exposure and % new chemical substance (if in mixture), and any protective equipment and engineering controls, if any, used to protect workers.
- (7) -- Estimate the percent of the new substance as formulated when packaged or used as a final product.
- (9) -- From the process diagram above, enter the number of each release point. Complete 9-13 for each release point identified.
- (10) -- Estimate the amount of the new substance released (a) directly to the environment or (b) into control technology to the environment (in kg/day or kg/batch).
- (12) -- Describe media of release i.e. stack air, fugitive air (optional-see Instructions Manual), surface water, on-site or off-site land or incineration, POTW, or other (specify) and control technology, if any, that will be used to limit the release of the new substance to the environment.
- (14) -- Identify byproducts which may result from the operation.
- (3), (5), (8), (11), (13) and (15) -- Mark (X) this column if any of the proceeding entries are confidential business information (CBI).

Letter of Activity	# of Workers Exposed	CBI	Duration of Exposure		CBI	Protective Equip./Engineering Controls/Physical Form	% new substance	% in Formulation	CBI
(1)	(2)	(3)	(4a)	(4b)	(5)	(6)	(6)	(7)	(8)
XXX	XXX	X	XXX	XXX	X	XXX	XXX	XXX	X
XXX	XXX	X	XXX	XXX	X	XXX	XXX	XXX	X
XXX	XXX	X	XXX	XXX	X	XXX	XXX	XXX	X
XXX	XXX	X	XXX	XXX	X	XXX	XXX	XXX	X

Release Number	Amount of New Substance Released		CBI	Media of Release & Control Technology	CBI
(9)	(10a)	(10b)	(11)	(12)	(13)
XXX	XXX	XXX	X	XXX	X
XXX	XXX	XXX	X	XXX	X

Mark (X) this box if the data continues on the next page.

☐

(14) Byproducts:

(15) CBI

☐

Enter Attachment filename for Part II, Section B.

☐



PMN2010P10X1

PMN Page 10

WG Ex. 23
SANITIZED SUBMISSION

Part II-- HUMAN EXPOSURE AND ENVIRONMENTAL RELEASE -- Continued

Section B -- INDUSTRIAL SITES CONTROLLED BY OTHERS

The information on pages 10 and 10a refer to consolidated chemical number(s): ☒ 1 ☒ 2 ☒ 3 ☐ 4 ☐ 5 ☐ 6

Complete section B for typical processing or use operations involving the new chemical substance at sites you do not control. Importers do not have to complete this section for operations outside the U.S.; however, you must report any processing or use activities after import. See the Instructions Manual. *Complete a separate section B for each type of processing, or use operation involving the new chemical substance.* If the same operation is performed at more than one site describe the typical operation common to these sites. Identify additional sites on a continuation sheet.

1(a). Operation Description -- To claim information in this section as confidential, bracket (e.g. {}) the specific information that you claim as confidential.

- (1) -- Diagram the major unit operation steps and chemical conversions, including interim storage and transport containers (specify - e.g. 5 gallon pails, 55 gallon drums, rail cars, tank trucks, etc). On the diagram, identify by letter and briefly describe each worker activity.
- (2) -- Either in the diagram or in the text field 1(b) below, provide the identity, the approximate weight (by kg/day or kg/batch, on an 100% new chemical substance basis), and entry point of all feedstocks (including reactants, solvents and catalysts, etc) and all products, recycle streams, and wastes. Include cleaning chemicals (note frequency if not used daily or per batch).
- (3) -- Either in the diagram or in the text field 1(b) below, identify by number the points of release, including small or intermittent releases, to the environment of the new chemical substance.
- (4) -- Please enter the # of sites (remember to identify the locations of these sites on a continuation sheet):

Number of Sites

Confidential

☒

See Attachment 003 (Operation Description #2_public.pdf)

1(b). (Optional) This space is for a text description to clarify the diagram above.

Confidential

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XXX

Enter Attachment filename for Part II, Section B on the bottom of page 10a.

Operation Description #2_public.pdf

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PMN2010P10X1-1

Continuation Sheet

ID	P10SB1(a)(4)2	Field	Part II, Section B, 1(a)(4). Operation Site Locations
XXX			



PMN2010P10AX1

PMN Page 10a

WG Ex. 23
SANITIZED SUBMISSION**2. Worker Exposure/Environmental Release**

- (1) -- From the diagram above, provide the letter for each worker activity. Complete 2-8 for each worker activity described.
- (2) -- Estimate the number of workers exposed for all sites combined.
- (4) -- Estimate the typical duration of exposure per worker in (a) hours per day and (b) days per year.
- (6) -- Describe physical form of exposure and % new chemical substance (if in mixture), and any protective equipment and engineering controls, if any, used to protect workers.
- (7) -- Estimate the percent of the new substance as formulated when packaged or used as a final product.
- (9) -- From the process diagram above, enter the number of each release point. Complete 9-13 for each release point identified.
- (10) -- Estimate the amount of the new substance released (a) directly to the environment or (b) into control technology to the environment (in kg/day or kg/batch).
- (12) -- Describe media of release i.e. stack air, fugitive air (optional-see Instructions Manual), surface water, on-site or off-site land or incineration, POTW, or other (specify) and control technology, if any, that will be used to limit the release of the new substance to the environment.
- (14) -- Identify byproducts which may result from the operation.
- (3), (5), (8), (11), (13) and (15) -- Mark (X) this column if any of the proceeding entries are confidential business information (CBI).

Letter of Activity	# of Workers Exposed	CBI	Duration of Exposure		CBI	Protective Equip./Engineering Controls/Physical Form	% new substance	% in Formulation	CBI
(1)	(2)	(3)	(4a)	(4b)	(5)	(6)	(6)	(7)	(8)
XXX	XXX	X	XXX	XXX	X	XXX	XXX	XXX	X
XXX	XXX	X	XXX	XXX	X	XXX	XXX	XXX	X
XXX	XXX	X	XXX	XXX	X	XXX	XXX	XXX	X
XXX	XXX	X	XXX	XXX	X	XXX	XXX	XXX	X

Release Number	Amount of New Substance Released		CBI	Media of Release & Control Technology	CBI
(9)	(10a)	(10b)	(11)	(12)	(13)
XXX	XXX	XXX	X	XXX	X
XXX	XXX	XXX	X	XXX	X
XXX	XXX	XXX	X	XXX	X

Mark (X) this box if the data continues on the next page.

☐

(14) Byproducts:

(15) CBI

☐

Enter Attachment filename for Part II, Section B.

☐



PMN2010P10X2

PMN Page 10

WG Ex. 23
SANITIZED SUBMISSION

Part II-- HUMAN EXPOSURE AND ENVIRONMENTAL RELEASE – Continued

Section B -- INDUSTRIAL SITES CONTROLLED BY OTHERS

The information on pages 10 and 10a refer to consolidated chemical number(s): ☒ 1 ☒ 2 ☒ 3 ☐ 4 ☐ 5 ☐ 6

Complete section B for typical processing or use operations involving the new chemical substance at sites you do not control. Importers do not have to complete this section for operations outside the U.S.; however, you must report any processing or use activities after import. See the Instructions Manual. *Complete a separate section B for each type of processing, or use operation involving the new chemical substance.* If the same operation is performed at more than one site describe the typical operation common to these sites. Identify additional sites on a continuation sheet.

1(a). Operation Description -- To claim information in this section as confidential, bracket (e.g. {}) the specific information that you claim as confidential.

- (1) -- Diagram the major unit operation steps and chemical conversions, including interim storage and transport containers (specify - e.g. 5 gallon pails, 55 gallon drums, rail cars, tank trucks, etc). On the diagram, identify by letter and briefly describe each worker activity.
- (2) -- Either in the diagram or in the text field 1(b) below, provide the identity, the approximate weight (by kg/day or kg/batch, on an 100% new chemical substance basis), and entry point of all feedstocks (including reactants, solvents and catalysts, etc) and all products, recycle streams, and wastes. Include cleaning chemicals (note frequency if not used daily or per batch).
- (3) -- Either in the diagram or in the text field 1(b) below, identify by number the points of release, including small or intermittent releases, to the environment of the new chemical substance.
- (4) -- Please enter the # of sites (remember to identify the locations of these sites on a continuation sheet):

Number of Sites

Confidential



See Attachment 017 (Operation Description #3 _public.pdf)

1(b). (Optional) This space is for a text description to clarify the diagram above.

Confidential



XXX

Enter Attachment filename for Part II, Section B on the bottom of page 10a.

Operation Description #3 _public.pdf





PMN2010P10X2-1

Continuation Sheet

ID	P10SB1(a)(4)3	Field	Part II, Section B, 1(a)(4). Operation Site Locations
XXX			

**2. Worker Exposure/Environmental Release**

- (1) -- From the diagram above, provide the letter for each worker activity. Complete 2-8 for each worker activity described.
- (2) -- Estimate the number of workers exposed for all sites combined.
- (4) -- Estimate the typical duration of exposure per worker in (a) hours per day and (b) days per year.
- (6) -- Describe physical form of exposure and % new chemical substance (if in mixture), and any protective equipment and engineering controls, if any, used to protect workers.
- (7) -- Estimate the percent of the new substance as formulated when packaged or used as a final product.
- (9) -- From the process diagram above, enter the number of each release point. Complete 9-13 for each release point identified.
- (10) -- Estimate the amount of the new substance released (a) directly to the environment or (b) into control technology to the environment (in kg/day or kg/batch).
- (12) -- Describe media of release i.e. stack air, fugitive air (optional-see Instructions Manual), surface water, on-site or off-site land or incineration, POTW, or other (specify) and control technology, if any, that will be used to limit the release of the new substance to the environment.
- (14) -- Identify byproducts which may result from the operation.
- (3), (5), (8), (11), (13) and (15) -- Mark (X) this column if any of the proceeding entries are confidential business information (CBI).

Letter of Activity	# of Workers Exposed	CBI	Duration of Exposure		CBI	Protective Equip./Engineering Controls/Physical Form	% new substance	% in Formulation	CBI
(1)	(2)	(3)	(4a)	(4b)	(5)	(6)	(6)	(7)	(8)
XXX	XXX	X	XXX	XXX	X	XXX	XXX	XXX	X
XXX	XXX	X	XXX	XXX	X	XXX	XXX	XXX	X
XXX	XXX	X	XXX	XXX	X	XXX	XXX	XXX	X
XXX	XXX	X	XXX	XXX	X	XXX	XXX	XXX	X

Release Number	Amount of New Substance Released		CBI	Media of Release & Control Technology	CBI
(9)	(10a)	(10b)	(11)	(12)	(13)
XXX	XXX	XXX	X	XXX	X
XXX	XXX	XXX	X	XXX	X
XXX	XXX	XXX	X	XXX	X

Mark (X) this box if the data continues on the next page.

☐

(14) Byproducts:

(15) CBI

☐

Enter Attachment filename for Part II, Section B.

☐



PMN2010P10X3

PMN Page 10

WG Ex. 23
SANITIZED SUBMISSION

Part II-- HUMAN EXPOSURE AND ENVIRONMENTAL RELEASE -- Continued

Section B -- INDUSTRIAL SITES CONTROLLED BY OTHERS

The information on pages 10 and 10a refer to consolidated chemical number(s): ☒ 1 ☒ 2 ☒ 3 ☐ 4 ☐ 5 ☐ 6

Complete section B for typical processing or use operations involving the new chemical substance at sites you do not control. Importers do not have to complete this section for operations outside the U.S.; however, you must report any processing or use activities after import. See the Instructions Manual. *Complete a separate section B for each type of processing, or use operation involving the new chemical substance.* If the same operation is performed at more than one site describe the typical operation common to these sites. Identify additional sites on a continuation sheet.

1(a). Operation Description -- To claim information in this section as confidential, bracket (e.g. {}) the specific information that you claim as confidential.

- (1) -- Diagram the major unit operation steps and chemical conversions, including interim storage and transport containers (specify - e.g. 5 gallon pails, 55 gallon drums, rail cars, tank trucks, etc). On the diagram, identify by letter and briefly describe each worker activity.
- (2) -- Either in the diagram or in the text field 1(b) below, provide the identity, the approximate weight (by kg/day or kg/batch, on an 100% new chemical substance basis), and entry point of all feedstocks (including reactants, solvents and catalysts, etc) and all products, recycle streams, and wastes. Include cleaning chemicals (note frequency if not used daily or per batch).
- (3) -- Either in the diagram or in the text field 1(b) below, identify by number the points of release, including small or intermittent releases, to the environment of the new chemical substance.
- (4) -- Please enter the # of sites (remember to identify the locations of these sites on a continuation sheet):

Number of Sites

Confidential



See Attachment 018 (Operation Description #4_public.pdf)

1(b). (Optional) This space is for a text description to clarify the diagram above.

Confidential



XXX

Enter Attachment filename for Part II, Section B on the bottom of page 10a.

Operation Description #4_public.pdf





PMN2010P10X3-1

Continuation Sheet

ID	P10SB1(a)(4)4	Field	Part II, Section B, 1(a)(4). Operation Site Locations
XXX			

**2. Worker Exposure/Environmental Release**

- (1) -- From the diagram above, provide the letter for each worker activity. Complete 2-8 for each worker activity described.
- (2) -- Estimate the number of workers exposed for all sites combined.
- (4) -- Estimate the typical duration of exposure per worker in (a) hours per day and (b) days per year.
- (6) -- Describe physical form of exposure and % new chemical substance (if in mixture), and any protective equipment and engineering controls, if any, used to protect workers.
- (7) -- Estimate the percent of the new substance as formulated when packaged or used as a final product.
- (9) -- From the process diagram above, enter the number of each release point. Complete 9-13 for each release point identified.
- (10) -- Estimate the amount of the new substance released (a) directly to the environment or (b) into control technology to the environment (in kg/day or kg/batch).
- (12) -- Describe media of release i.e. stack air, fugitive air (optional-see Instructions Manual), surface water, on-site or off-site land or incineration, POTW, or other (specify) and control technology, if any, that will be used to limit the release of the new substance to the environment.
- (14) -- Identify byproducts which may result from the operation.
- (3), (5), (8), (11), (13) and (15) -- Mark (X) this column if any of the proceeding entries are confidential business information (CBI).

Letter of Activity	# of Workers Exposed	CBI	Duration of Exposure		CBI	Protective Equip./Engineering Controls/Physical Form	% new substance	% in Formulation	CBI
(1)	(2)	(3)	(4a)	(4b)	(5)	(6)	(6)	(7)	(8)
XXX	XXX	X	XXX	XXX	X	XXX	XXX	XXX	X
XXX	XXX	X	XXX	XXX	X	XXX	XXX	XXX	X
XXX	XXX	X	XXX	XXX	X	XXX	XXX	XXX	X
XXX	XXX	X	XXX	XXX	X	XXX	XXX	XXX	X
XXX	XXX	X	XXX	XXX	X	XXX	XXX	XXX	X

Release Number	Amount of New Substance Released		CBI	Media of Release & Control Technology	CBI
(9)	(10a)	(10b)	(11)	(12)	(13)
XXX	XXX	XXX	X	XXX	X
XXX	XXX	XXX	X	XXX	X
XXX	XXX	XXX	X	XXX	X
XXX	XXX	XXX	X	XXX	X

Mark (X) this box if the data continues on the next page.

☐

(14) Byproducts:

(15) CBI

☐

Enter Attachment filename for Part II, Section B.

☐



PMN2010P10X4

PMN Page 10

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SANITIZED SUBMISSION

Part II-- HUMAN EXPOSURE AND ENVIRONMENTAL RELEASE -- Continued

Section B -- INDUSTRIAL SITES CONTROLLED BY OTHERS

The information on pages 10 and 10a refer to consolidated chemical number(s): ☒ 1 ☒ 2 ☒ 3 ☐ 4 ☐ 5 ☐ 6

Complete section B for typical processing or use operations involving the new chemical substance at sites you do not control. Importers do not have to complete this section for operations outside the U.S.; however, you must report any processing or use activities after import. See the Instructions Manual. Complete a separate section B for each type of processing, or use operation involving the new chemical substance. If the same operation is performed at more than one site describe the typical operation common to these sites. Identify additional sites on a continuation sheet.

1(a). Operation Description -- To claim information in this section as confidential, bracket (e.g. {}) the specific information that you claim as confidential.

- (1) -- Diagram the major unit operation steps and chemical conversions, including interim storage and transport containers (specify - e.g. 5 gallon pails, 55 gallon drums, rail cars, tank trucks, etc). On the diagram, identify by letter and briefly describe each worker activity.
- (2) -- Either in the diagram or in the text field 1(b) below, provide the identity, the approximate weight (by kg/day or kg/batch, on an 100% new chemical substance basis), and entry point of all feedstocks (including reactants, solvents and catalysts, etc) and all products, recycle streams, and wastes. Include cleaning chemicals (note frequency if not used daily or per batch).
- (3) -- Either in the diagram or in the text field 1(b) below, identify by number the points of release, including small or intermittent releases, to the environment of the new chemical substance.
- (4) -- Please enter the # of sites (remember to identify the locations of these sites on a continuation sheet):

Number of Sites

Confidential

☒

See Attachment 006 (Operation Description #5_public.pdf)

1(b). (Optional) This space is for a text description to clarify the diagram above.

Confidential

☒

XXX

Enter Attachment filename for Part II, Section B on the bottom of page 10a.

Operation Description #5_public.pdf

☐



Continuation Sheet

ID	P10SB1(a)(4)5	Field	Part II, Section B, 1(a)(4). Operation Site Locations
XXX			

**2. Worker Exposure/Environmental Release**

- (1) -- From the diagram above, provide the letter for each worker activity. Complete 2-8 for each worker activity described.
- (2) -- Estimate the number of workers exposed for all sites combined.
- (4) -- Estimate the typical duration of exposure per worker in (a) hours per day and (b) days per year.
- (6) -- Describe physical form of exposure and % new chemical substance (if in mixture), and any protective equipment and engineering controls, if any, used to protect workers.
- (7) -- Estimate the percent of the new substance as formulated when packaged or used as a final product.
- (9) -- From the process diagram above, enter the number of each release point. Complete 9-13 for each release point identified.
- (10) -- Estimate the amount of the new substance released (a) directly to the environment or (b) into control technology to the environment (in kg/day or kg/batch).
- (12) -- Describe media of release i.e. stack air, fugitive air (optional-see Instructions Manual), surface water, on-site or off-site land or incineration, POTW, or other (specify) and control technology, if any, that will be used to limit the release of the new substance to the environment.
- (14) -- Identify byproducts which may result from the operation.
- (3), (5), (8), (11), (13) and (15) -- Mark (X) this column if any of the proceeding entries are confidential business information (CBI).

Letter of Activity	# of Workers Exposed	CBI	Duration of Exposure		CBI	Protective Equip./Engineering Controls/Physical Form	% new substance	% in Formulation	CBI
(1)	(2)	(3)	(4a)	(4b)	(5)	(6)	(6)	(7)	(8)
XXX	XXX	X	XXX	XXX	X	XXX	XXX	XXX	X
XXX	XXX	X	XXX	XXX	X	XXX	XXX	XXX	X
XXX	XXX	X	XXX	XXX	X	XXX	XXX	XXX	X

Release Number	Amount of New Substance Released		CBI	Media of Release & Control Technology	CBI
(9)	(10a)	(10b)	(11)	(12)	(13)
XXX	XXX	XXX	X	XXX	X

Mark (X) this box if the data continues on the next page.

☐

(14) Byproducts:

(15) CBI

☐

Enter Attachment filename for Part II, Section B.

☐



PMN2010P10X5

PMN Page 10

WG Ex. 23
SANITIZED SUBMISSION

Part II-- HUMAN EXPOSURE AND ENVIRONMENTAL RELEASE -- Continued

Section B -- INDUSTRIAL SITES CONTROLLED BY OTHERS

The information on pages 10 and 10a refer to consolidated chemical number(s): ☒ 1 ☒ 2 ☒ 3 ☐ 4 ☐ 5 ☐ 6

Complete section B for typical processing or use operations involving the new chemical substance at sites you do not control. Importers do not have to complete this section for operations outside the U.S.; however, you must report any processing or use activities after import. See the Instructions Manual. *Complete a separate section B for each type of processing, or use operation involving the new chemical substance.* If the same operation is performed at more than one site describe the typical operation common to these sites. Identify additional sites on a continuation sheet.

1(a). Operation Description -- To claim information in this section as confidential, bracket (e.g. {}) the specific information that you claim as confidential.

- (1) -- Diagram the major unit operation steps and chemical conversions, including interim storage and transport containers (specify - e.g. 5 gallon pails, 55 gallon drums, rail cars, tank trucks, etc). On the diagram, identify by letter and briefly describe each worker activity.
- (2) -- Either in the diagram or in the text field 1(b) below, provide the identity, the approximate weight (by kg/day or kg/batch, on an 100% new chemical substance basis), and entry point of all feedstocks (including reactants, solvents and catalysts, etc) and all products, recycle streams, and wastes. Include cleaning chemicals (note frequency if not used daily or per batch).
- (3) -- Either in the diagram or in the text field 1(b) below, identify by number the points of release, including small or intermittent releases, to the environment of the new chemical substance.
- (4) -- Please enter the # of sites (remember to identify the locations of these sites on a continuation sheet):

Number of Sites

Confidential

☒

See Attachment 020 (Operation Description #6_public.pdf)

1(b). (Optional) This space is for a text description to clarify the diagram above.

Confidential

☒

XXX

Enter Attachment filename for Part II, Section B on the bottom of page 10a.

Operation Description #6_public.pdf

☐



PMN2010P10X5-1

Continuation Sheet

ID	P10SB1(a)(4)6	Field	Part II, Section B, 1(a)(4). Operation Site Locations
XXX			

**2. Worker Exposure/Environmental Release**

- (1) -- From the diagram above, provide the letter for each worker activity. Complete 2-8 for each worker activity described.
- (2) -- Estimate the number of workers exposed for all sites combined.
- (4) -- Estimate the typical duration of exposure per worker in (a) hours per day and (b) days per year.
- (6) -- Describe physical form of exposure and % new chemical substance (if in mixture), and any protective equipment and engineering controls, if any, used to protect workers.
- (7) -- Estimate the percent of the new substance as formulated when packaged or used as a final product.
- (9) -- From the process diagram above, enter the number of each release point. Complete 9-13 for each release point identified.
- (10) -- Estimate the amount of the new substance released (a) directly to the environment or (b) into control technology to the environment (in kg/day or kg/batch).
- (12) -- Describe media of release i.e. stack air, fugitive air (optional-see Instructions Manual), surface water, on-site or off-site land or incineration, POTW, or other (specify) and control technology, if any, that will be used to limit the release of the new substance to the environment.
- (14) -- Identify byproducts which may result from the operation.
- (3), (5), (8), (11), (13) and (15) -- Mark (X) this column if any of the proceeding entries are confidential business information (CBI).

Letter of Activity	# of Workers Exposed	CBI	Duration of Exposure		CBI	Protective Equip./Engineering Controls/Physical Form	% new substance	% in Formulation	CBI
(1)	(2)	(3)	(4a)	(4b)	(5)	(6)	(6)	(7)	(8)
XXX	XXX	X	XXX	XXX	X	XXX	XXX	XXX	X
XXX	XXX	X	XXX	XXX	X	XXX	XXX	XXX	X
XXX	XXX	X	XXX	XXX	X	XXX	XXX	XXX	X

Release Number	Amount of New Substance Released		CBI	Media of Release & Control Technology	CBI
(9)	(10a)	(10b)	(11)	(12)	(13)
XXX	XXX	XXX	X	XXX	X
XXX	XXX	XXX	X	XXX	X

Mark (X) this box if the data continues on the next page.

☐

(14) Byproducts:

(15) CBI

☐

Enter Attachment filename for Part II, Section B.

☐



PMN2010P10X6

PMN Page 10

WG Ex. 23
SANITIZED SUBMISSION

Part II-- HUMAN EXPOSURE AND ENVIRONMENTAL RELEASE -- Continued

Section B -- INDUSTRIAL SITES CONTROLLED BY OTHERS

The information on pages 10 and 10a refer to consolidated chemical number(s): ☒ 1 ☒ 2 ☒ 3 ☐ 4 ☐ 5 ☐ 6

Complete section B for typical processing or use operations involving the new chemical substance at sites you do not control. Importers do not have to complete this section for operations outside the U.S.; however, you must report any processing or use activities after import. See the Instructions Manual. *Complete a separate section B for each type of processing, or use operation involving the new chemical substance.* If the same operation is performed at more than one site describe the typical operation common to these sites. Identify additional sites on a continuation sheet.

1(a). Operation Description -- To claim information in this section as confidential, bracket (e.g. {}) the specific information that you claim as confidential.

- (1) -- Diagram the major unit operation steps and chemical conversions, including interim storage and transport containers (specify - e.g. 5 gallon pails, 55 gallon drums, rail cars, tank trucks, etc). On the diagram, identify by letter and briefly describe each worker activity.
- (2) -- Either in the diagram or in the text field 1(b) below, provide the identity, the approximate weight (by kg/day or kg/batch, on an 100% new chemical substance basis), and entry point of all feedstocks (including reactants, solvents and catalysts, etc) and all products, recycle streams, and wastes. Include cleaning chemicals (note frequency if not used daily or per batch).
- (3) -- Either in the diagram or in the text field 1(b) below, identify by number the points of release, including small or intermittent releases, to the environment of the new chemical substance.
- (4) -- Please enter the # of sites (remember to identify the locations of these sites on a continuation sheet):

Number of Sites

Confidential



See Attachment 021 (Operation Description #7_ public.pdf)

1(b). (Optional) This space is for a text description to clarify the diagram above.

Confidential



XXX

Enter Attachment filename for Part II, Section B on the bottom of page 10a.

Operation Description #7_ public.pdf





PMN2010P10X6-1

Continuation Sheet

ID	P10SB1(a)(4)7	Field	Part II, Section B, 1(a)(4). Operation Site Locations
XXX			

**2. Worker Exposure/Environmental Release**

- (1) -- From the diagram above, provide the letter for each worker activity. Complete 2-8 for each worker activity described.
- (2) -- Estimate the number of workers exposed for all sites combined.
- (4) -- Estimate the typical duration of exposure per worker in (a) hours per day and (b) days per year.
- (6) -- Describe physical form of exposure and % new chemical substance (if in mixture), and any protective equipment and engineering controls, if any, used to protect workers.
- (7) -- Estimate the percent of the new substance as formulated when packaged or used as a final product.
- (9) -- From the process diagram above, enter the number of each release point. Complete 9-13 for each release point identified.
- (10) -- Estimate the amount of the new substance released (a) directly to the environment or (b) into control technology to the environment (in kg/day or kg/batch).
- (12) -- Describe media of release i.e. stack air, fugitive air (optional-see Instructions Manual), surface water, on-site or off-site land or incineration, POTW, or other (specify) and control technology, if any, that will be used to limit the release of the new substance to the environment.
- (14) -- Identify byproducts which may result from the operation.
- (3), (5), (8), (11), (13) and (15) -- Mark (X) this column if any of the proceeding entries are confidential business information (CBI).

Letter of Activity	# of Workers Exposed	CBI	Duration of Exposure		CBI	Protective Equip./Engineering Controls/Physical Form	% new substance	% in Formulation	CBI
(1)	(2)	(3)	(4a)	(4b)	(5)	(6)	(6)	(7)	(8)
XXX	XXX	X	XXX	XXX	X	XXX	XXX	XXX	X
XXX	XXX	X	XXX	XXX	X	XXX	XXX	XXX	X
XXX	XXX	X	XXX	XXX	X	XXX	XXX	XXX	X

Release Number	Amount of New Substance Released		CBI	Media of Release & Control Technology	CBI
(9)	(10a)	(10b)	(11)	(12)	(13)
XXX	XXX	XXX	X	XXX	X
XXX	XXX	XXX	X	XXX	X

Mark (X) this box if the data continues on the next page.

☐

(14) Byproducts:

(15) CBI

☐

Enter Attachment filename for Part II, Section B.

☐

**OPTIONAL POLLUTION PREVENTION INFORMATION**

To claim information in the following section as confidential, bracket (e.g. {}) the specific information that you claim as confidential.

In this section you may provide information not reported elsewhere in this form regarding your efforts to reduce or minimize potential risks associated with activities surrounding manufacturing, processing, use and disposal of the PMN substance. Please include new information pertinent to pollution prevention, including source reduction, recycling activities and safer processes or products available due to the new chemical substance. Source reduction includes the reduction in the amount or toxicity of chemical wastes by technological modification, process and procedure modification, product reformulation, and/or raw materials substitution. Recycling refers to the reclamation of useful chemical components from wastes that would otherwise be treated or released as air emissions or water discharges, or land disposal. Quantitative or qualitative descriptions of pollution prevention, source reduction and recycling should emphasize potential risk reduction in addition to compliance with existing regulatory requirements. The EPA is interested in the information to assess overall net reductions in toxicity or environmental releases and exposures, not the shifting of risks to other media (e.g., air to water) or nonenvironmental areas (e.g., occupational or consumer exposure). To the extent known, information about the technology being replaced will assist EPA in its relative risk determination. In addition, information on the relative cost or performance characteristics of the PMN substance to potential alternatives may be provided.

Describe the expected net benefits, such as

- (1) an overall reduction in risk to human health or the environment;
- (2) a reduction in the generation of waste materials through recycling, source reduction or other means;
- (3) a reduction in the use of hazardous starting materials, reagents, or feedstocks;
- (4) a reduction in potential toxicity, human exposure and/or environmental release; or
- (5) the extent to which the new chemical substance may be a substitute for an existing substance that poses a greater overall risk to human health or the environment.

Information provided in this section will be taken into consideration during the review of this substance. See PMN Instructions Manual and Pollution Prevention Guidance manual for guidance and examples.

{XXX} will manufacture the fluorinated acrylic alkylamino copolymer (PMN substance) for {XXX} use. In {XXX}, the PMN substance will be used {XXX}. The {XXX} of the PMN substance in the {XXX}. In some applications the {XXX}.

{XXX} of the PMN substance on {XXX} indicates that the use levels of the PMN substance by {XXX}.

Furthermore, the PMN substance demonstrates a high degree of {XXX}. Based on {XXX}, it is anticipated that the use of the PMN substance on {XXX}.

The PMN substance will also be used as an {XXX} to impart {XXX}. {XXX} application will use {XXX} of PMN substance in an {XXX}.

This PMN substance is more environmentally-benign because less {XXX} process (current technology in place) and the use of the PMN substance allows for a {XXX}. The addition of the PMN substance to the {XXX} process will allow for less overall {XXX}.

Monitoring and testing of {XXX} is performed to check for {XXX}. Strict rules and regulations are in place by each state to ensure that {XXX}. In addition, the {XXX} are added, as well as must meet construction standards to help further prevent any potential {XXX}.

This PMN substance contains {XXX}. It is a {XXX} for fluorinated acrylic copolymers of {XXX} presently in {XXX}. The fluorinated acrylic copolymers presently {XXX} which will be {XXX} are {XXX} percentages. A {XXX} is the {XXX} in the new PMN substance.

The fluorinated {XXX} the PMN substance is a {XXX}. The fluorinated {XXX} fluorinated acrylic copolymers is a {XXX} and must be {XXX}. The manufacture of the PMN substance will not {XXX} and will therefore {XXX}.

Enter Attachment filename for Pollution Prevention Page 11.





PMN2010P12

PMN Page 12

WG Ex. 23
SANITIZED SUBMISSION**Part III -- LIST OF ATTACHMENTS**

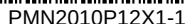
Attach continuation sheets for sections of the form, test data and other data (including physical/chemical properties and structure/activity information), and optional information after this page. Clearly identify the attachment and the section of the form to which it relates, if appropriate. Number consecutively the pages of any paper attachments. In the Number of Pages column below, enter the inclusive page numbers of each attachment for paper submissions or enter the total number of pages for each attachment for electronic submissions. Electronic attachments can be identified by filename.

Mark (X) the "Confidential" box next to any attachment name or filename you claim as confidential. Read the Instructions Manual for guidance on how to claim any information in an attachment as confidential. You must include with the sanitized copy of the notice form a sanitized version of any attachment in which you claim information as confidential.

#	Attachment Name	Attachment Filename	Number of Pages	Associated PMN Section Number	CBI
001	Structure #1	Structure #1_(public).pdf	1	Pt.I, Sec.B, 2e.	
002	Operation Description #1	Operation Description #1_public.pdf	1	Pt.2, Sec.B, 1a.	
003	Operation Description #2	Operation Description #2_public.pdf	1	Pt.2, Sec.B, 1a. (#2)	
004	Structure #2	Structure #2_(public).pdf	1	Pt.I, Sec.B, 2e. (Chem 2)	
005	Structure #3	Structure #3_(public).pdf	1	Pt.I, Sec.B, 2e. (Chem 3)	
006	Operation Description #5	Operation Description #5_public.pdf	1	Pt.2, Sec.B, 1a. (#5)	
007	Use Diagram	Use Diagram (public).pdf	1	Pt.I, Sec.C, 1.	
008	CAS - Inventory Expert Service (2010) #1	CAS - Inventory Expert Service (2010) #1 (public).pdf	1	Pt.I, Sec.B, 2c.	
009	MSDS #1	MSDS #1_public.pdf	6		
010	CAS - Inventory Expert Service (2010) #2	CAS - Inventory Expert Service (2010) #2 (public).pdf	1	Pt.I, Sec.B, 2c. (Chem 2)	
011	CAS - Inventory Expert Service (2010) #3	CAS - Inventory Expert Service (2010) #3 (public).pdf	1	Pt.I, Sec.B, 2c. (Chem 3)	
012	NMR Spectrum	NMR Spectrum_public.pdf	1		
013	IR #1	IR #1_public_.pdf	1		
014	IR #2	IR #2_public_.pdf	1		
015	IR #3	IR #3_public_.pdf	1		
016	Analytical Report for #1	Analytical Report for #1_public.pdf	6		
017	Operation Description #3	Operation Description #3_public.pdf	1	Pt.2, Sec.B, 1a. (#3)	
018	Operation Description #4	Operation Description #4_public.pdf	1	Pt.2, Sec.B, 1a. (#4)	
019	Analytical Report for #2	Analytical Report for	6		
020	Operation Description #6	Operation Description #6_public.pdf	1	Pt.2, Sec.B, 1a. (#6)	
021	Operation Description #7	Operation Description #7_	1	Pt.2, Sec.B, 1a. (#7)	

Mark (X) this box if the data continues on the next page.





Attach continuation sheets for sections of the form, test data and other data (including physical/chemical properties and structure/activity information), and optional information after this page. Clearly identify the attachment and the section of the form to which it relates, if appropriate. Number consecutively the pages of any paper attachments. In the Number of Pages column below, enter the inclusive page numbers of each attachment for paper submissions or enter the total number of pages for each attachment for electronic submissions. Electronic attachments can be identified by filename.

Mark (X) the "Confidential" box next to any attachment name or filename you claim as confidential. Read the Instructions Manual for guidance on how to claim any information in an attachment as confidential. You must include with the sanitized copy of the notice form a sanitized version of any attachment in which you claim information as confidential.

Mark (X) this box if the data continues on the next page.



PMN2010P13

WG Ex. 23
SANITIZED SUBMISSION

PMN Page 13

PHYSICAL AND CHEMICAL PROPERTIES WORKSHEET

The information on this page refers to chemical number(s): ☒ 1 ☒ 2 ☒ 3 ☐ 4 ☐ 5 ☐ 6

To assist EPA's review of physical and chemical properties data, please complete the following worksheet for data you provide and include it in the notice. Identify the property measured, the value of the property, the units in which the property is measured (as necessary), and whether or not the property is claimed as confidential. Give the attachment number (found on page 12) in column (b). The physical state of the neat substance should be provided. These measured properties should be for the neat (100% pure) chemical substance. Properties that are measured for mixtures or formulations should be so noted (% PMN substance in ____). You are not required to submit this worksheet; however, EPA strongly recommends that you do so, as it will simplify the review and ensure that confidential information is properly protected. You should submit this worksheet as a supplement to your submission of test data. This worksheet is not a substitute for submission of test data.

Property (a)	Unit	Mark X if Provided	Attachment Number (b)	Value (c)			Measured or Estimate (M or E)	CBI Mark (X) (d)
				(solid)	(liquid)	(gas)		
Physical state of neat substance		☐		☐	☐	☐		X
Vapor Pressure @ Temperature	°C	☐				Torr		
Density/relative density		☐				g/cm3		
Solubility								
@ Temperature	°C	☐				g/L		
Solvent								
Solubility in Water @ Temperature	°C	☐				g/L		
Melting Temperature		☐				°C		
Boiling / Sublimation temperature @	Torr	☐				°C		
Spectra		☐	xxx	xxx				X
Dissociation constant		☐						
Octanol / water partition coefficient		☐						
Henry's Law constant		☐						
Volatilization from water		☐						
Volatilization from soil		☐						
pH@ concentration	xxx	☐		xxx				X
Flammability		☐						
Explosability		☐						
Adsorption / Coefficient		☐						
Particle Size Distribution		☐		xxx			xxx	X
Other – Specify	xxx	☐	xxx	xxx				X



Continuation Sheet

ID	Field					
PHYSICAL AND CHEMICAL PROPERTIES WORKSHEET						
Property (a)		Mark X if Provided	Attachment Number (b)	Value (c)	Measured or Estimate (M or E)	CBI Mark (X) (d)
Other – Specify	XXX	☐		XXX		X
Other – Specify	XXX	☐		XXX		X
Other – Specify		☐				
Other – Specify		☐				
Other – Specify		☐				
Other – Specify		☐				
Other – Specify		☐				
Other – Specify		☐				
Other – Specify		☐				
Other – Specify		☐				
Other – Specify		☐				
Other – Specify		☐				
Other – Specify		☐				
Other – Specify		☐				
Other – Specify		☐				
Other – Specify		☐				
Other – Specify		☐				

ATTACHMENT HEADER SHEET

Attachment Number 001

Attachment Name

Structure #1

Associated PMN Section Number

Pt.I, Sec.B, 2e.

Does not contain CBI

Report Number

ST-5101203535628222

ATTACHMENT HEADER SHEET

Attachment Number 002

Attachment Name

Operation Description #1

Associated PMN Section Number

Pt.2, Sec.B, 1a.

Does not contain CBI

Report Number

ST-5101203535628222

ATTACHMENT HEADER SHEET

Attachment Number 003

Attachment Name

Operation Description #2

Associated PMN Section Number

Pt.2, Sec.B, 1a. (#2)

Does not contain CBI

Report Number

ST-5101203535628222

ATTACHMENT HEADER SHEET

Attachment Number 004

Attachment Name

Structure #2

Associated PMN Section Number

Pt.I, Sec.B, 2e. (Chem 2)

Does not contain CBI

Report Number

ST-5101203535628222

ATTACHMENT HEADER SHEET

Attachment Number 005

Attachment Name

Structure #3

Associated PMN Section Number

Pt.I, Sec.B, 2e. (Chem 3)

Does not contain CBI

Report Number

ST-5101203535628222

ATTACHMENT HEADER SHEET

Attachment Number 006

Attachment Name

Operation Description #5

Associated PMN Section Number

Pt.2, Sec.B, 1a. (#5)

Does not contain CBI

Report Number

ST-5101203535628222

ATTACHMENT HEADER SHEET

Attachment Number 007

Attachment Name

Use Diagram

Associated PMN Section Number

Pt.I, Sec.C, 1.

Does not contain CBI

Report Number

ST-5101203535628222

ATTACHMENT HEADER SHEET

Attachment Number 008

Attachment Name

CAS - Inventory Expert Service (2010) #1

Associated PMN Section Number

Pt.I, Sec.B, 2c.

Does not contain CBI

Report Number

ST-5101203535628222

ATTACHMENT HEADER SHEET

Attachment Number 009

Attachment Name

MSDS #1

Associated PMN Section Number

N/A

Does not contain CBI

Report Number

ST-5101203535628222

ATTACHMENT HEADER SHEET

Attachment Number 010

Attachment Name

CAS - Inventory Expert Service (2010) #2

Associated PMN Section Number

Pt.I, Sec.B, 2c. (Chem 2)

Does not contain CBI

Report Number

ST-5101203535628222

ATTACHMENT HEADER SHEET

Attachment Number 011

Attachment Name

CAS - Inventory Expert Service (2010) #3

Associated PMN Section Number

Pt.I, Sec.B, 2c. (Chem 3)

Does not contain CBI

Report Number

ST-5101203535628222

ATTACHMENT HEADER SHEET

Attachment Number 012

Attachment Name

NMR Spectrum

Associated PMN Section Number

N/A

Does not contain CBI

Report Number

ST-5101203535628222

ATTACHMENT HEADER SHEET

Attachment Number 013

Attachment Name

IR #1

Associated PMN Section Number

N/A

Does not contain CBI

Report Number

ST-5101203535628222

ATTACHMENT HEADER SHEET

Attachment Number 014

Attachment Name

IR #2

Associated PMN Section Number

N/A

Does not contain CBI

Report Number

ST-5101203535628222

ATTACHMENT HEADER SHEET

Attachment Number 015

Attachment Name

IR #3

Associated PMN Section Number

N/A

Does not contain CBI

Report Number

ST-5101203535628222

ATTACHMENT HEADER SHEET

Attachment Number 016

Attachment Name

Analytical Report for #1

Associated PMN Section Number

N/A

Does not contain CBI

Report Number

ST-5101203535628222

ATTACHMENT HEADER SHEET

Attachment Number 017

Attachment Name

Operation Description #3

Associated PMN Section Number

Pt.2, Sec.B, 1a. (#3)

Does not contain CBI

Report Number

ST-5101203535628222

ATTACHMENT HEADER SHEET

Attachment Number 018

Attachment Name

Operation Description #4

Associated PMN Section Number

Pt.2, Sec.B, 1a. (#4)

Does not contain CBI

Report Number

ST-5101203535628222

ATTACHMENT HEADER SHEET

Attachment Number 019

Attachment Name

Analytical Report for #2

Associated PMN Section Number

N/A

Does not contain CBI

Report Number

ST-5101203535628222

ATTACHMENT HEADER SHEET

Attachment Number 020

Attachment Name

Operation Description #6

Associated PMN Section Number

Pt.2, Sec.B, 1a. (#6)

Does not contain CBI

Report Number

ST-5101203535628222

ATTACHMENT HEADER SHEET

Attachment Number 021

Attachment Name

Operation Description #7

Associated PMN Section Number

Pt.2, Sec.B, 1a. (#7)

Does not contain CBI

Report Number

ST-5101203535628222

ATTACHMENT HEADER SHEET

Attachment Number 022

Attachment Name

Analytical Report for #3

Associated PMN Section Number

N/A

Does not contain CBI

Report Number

ST-5101203535628222

ATTACHMENT HEADER SHEET

Attachment Number 023

Attachment Name

Analytical Report for Low MW (also see pg.12, attachment #16)

Associated PMN Section Number

Pt.I, Sec.B, 2a.

Does not contain CBI

Report Number

ST-5101203535628222

ATTACHMENT HEADER SHEET

Attachment Number 024

Attachment Name

Analytical Report for Low MW (also see pg.12, attachment #19)

Associated PMN Section Number

Pt.I, Sec.B, 2a. (Chem 2)

Does not contain CBI

Report Number

ST-5101203535628222

ATTACHMENT HEADER SHEET

Attachment Number 025

Attachment Name

Analytical Report for Low MW (also see pg.12, attachment #22)

Associated PMN Section Number

Pt.I, Sec.B, 2a. (Chem 3)

Does not contain CBI

Report Number

ST-5101203535628222

ATTACHMENT HEADER SHEET

Attachment Number 026

Attachment Name

Ongoing Studies for PMN Substance #1

Associated PMN Section Number

N/A

Does not contain CBI

Report Number

ST-5101203535628222

ATTACHMENT HEADER SHEET

Attachment Number 027

Attachment Name

MSDS #2

Associated PMN Section Number

N/A

Does not contain CBI

Report Number

ST-5101203535628222

ATTACHMENT HEADER SHEET

Attachment Number 028

Attachment Name

Acute Oral Toxicity Study

Associated PMN Section Number

N/A

Does not contain CBI

Report Number

ST-5101203535628222

ATTACHMENT HEADER SHEET

Attachment Number 029

Attachment Name

Bacterial Reverse Mutation Assay

Associated PMN Section Number

N/A

Does not contain CBI

Report Number

ST-5101203535628222

ATTACHMENT HEADER SHEET

Attachment Number 030

Attachment Name

Daphnia Toxicity Test

Associated PMN Section Number

N/A

Does not contain CBI

Report Number

ST-5101203535628222

ATTACHMENT HEADER SHEET

Attachment Number 031

Attachment Name

Eye Irritation Study

Associated PMN Section Number

N/A

Does not contain CBI

Report Number

ST-5101203535628222

ATTACHMENT HEADER SHEET

Attachment Number 032

Attachment Name

Local Lymph Node Assay

Associated PMN Section Number

N/A

Does not contain CBI

Report Number

ST-5101203535628222

ATTACHMENT HEADER SHEET

Attachment Number 033

Attachment Name

Skin Irritation Study

Associated PMN Section Number

N/A

Does not contain CBI

Report Number

ST-5101203535628222

ATTACHMENT HEADER SHEET

Attachment Number 034

Attachment Name

MSDS #3

Associated PMN Section Number

N/A

Does not contain CBI

Report Number

ST-5101203535628222

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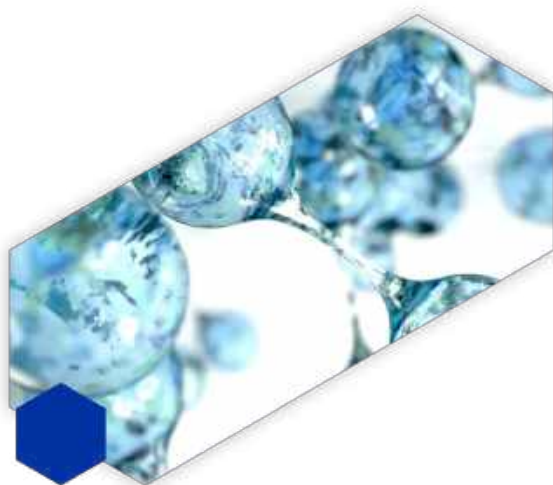
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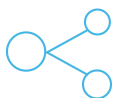


219 million organic substances, alloys, coordination compounds, minerals, mixtures, polymers, and salts disclosed in publications since the early 1800s.



WG Ex. 24

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Why do regulatory agencies rely on CAS Registry Numbers? ▾

Where can I find CAS REGISTRY Numbers? ▾

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EXPLORE

Chemical Names & CAS Registry Numbers

Home > Explore > Chemical Names & CAS Registry Numbers



Searching chemicals by CAS number can help eliminate the confusion of searching by name. Because many chemicals have multiple names, you can narrow your search more quickly using the CAS number method – the search result will include every name associated with a particular chemical.

You can find the CAS number for a chemical through a variety of resources:

- FracFocus includes the CAS numbers in our Find a Well form.
- An alphabetical list, organized by the chemical's function, is included below.
- Several websites include a CAS number database:
 - [National Institute of Standards and Technology \(NIST\)](#) »
 - [OSHA Occupational Chemical Database](#) »
 - [EPA Chemical Fact Sheets](#) »

(Please note that when you click these links, you will leave the FracFocus website. The listed websites are not controlled by or affiliated with FracFocus.)

CAS Registry Numbers

+ ACIDS

+ BIOCIDES

+ BREAKERS

+ CLAY STABILIZERS

+ CORROSION INHIBITORS

+ CROSSLINKERS

+ FRICTION REDUCERS

+ GELLING AGENTS

+ IRON CONTROLLERS

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Assessing and Managing Chemicals under TSCA

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Fact Sheet: 2010/2015 PFOA Stewardship Program

On this page:

- Q1. What is the 2010/2015 PFOA Stewardship Program?
- Q2. Why did EPA launch the PFOA Stewardship Program?
- Q3. What were the goals of the program?
- Q4. What companies participated in the PFOA Stewardship Program?
- Q5. What was the baseline that companies used for reductions?
- Q6. Did the companies meet the PFOA Stewardship Program goals?
- Q7. How did the companies meet the PFOA Stewardship Program goals?
- Q8. Are perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), and other long-chain PFASs still being manufactured or imported into United States?
- Q9. What other actions is EPA taking on PFASs?

Q1. What is the 2010/2015 PFOA Stewardship Program?

In 2006, EPA invited eight major leading companies in the per- and polyfluoroalkyl substances (PFASs) industry to join in a global stewardship program with two goals:

- To commit to achieve, no later than 2010, a 95 percent reduction, measured from a year 2000 baseline, in both facility emissions to all media of perfluorooctanoic acid (PFOA), precursor chemicals that can break down to PFOA, and related higher homologue chemicals, and product content levels of these chemicals.
- To commit to working toward the elimination of these chemicals from emissions and products by 2015.

Participating companies:

- Submitted baseline data on emissions and product content at the end of October 2006.
- Reported annual progress toward goals each succeeding October and report progress in terms of both U.S. and global operations. Final reports were submitted in early 2016.
- Companies also agreed to work cooperatively with EPA and establish scientifically credible analytical standards and laboratory methods to ensure comparability of reporting.

All public documents from the PFOA Stewardship Program are available in EPA Docket EPA-HQ-OPPT-2006-0621 [↗](#).

Q2. Why did EPA launch the PFOA Stewardship Program?

EPA launched the PFOA Stewardship Program in January 2006 because of concerns about the impact of PFOA and long-chain PFASs on human health and the environment, including concerns about their persistence, presence in the environment and in the blood of the general U.S. population, long half-life in people, and developmental and other adverse effects in laboratory animals.

Q3. What were the goals of the program?

EPA asked the eight major companies in the PFASs industry <<https://epa.gov/assessing-and-managing-chemicals-under-tsca/letter-inviting-participation-pfoa-stewardship-program>> to commit to reducing PFOA from facility emissions and product content by 95 percent no later than 2010, and to work toward eliminating PFOA from emissions and product content no later than 2015. Each of the eight companies expressed support for a global stewardship program addressing reductions in PFOA and related chemicals from both emissions and product content. Companies also noted their willingness to make a general commitment to continue to pursue research into the sources, pathways of exposure, and potential risks of these chemicals. All eight of the invited companies submitted commitments <<https://epa.gov/assessing-and-managing-chemicals-under-tsca/letters-committing-participation-pfoa-stewardship>> to the PFOA Stewardship Program by March 1, 2006.

Q4. What companies participated in the PFOA Stewardship Program?

Participating companies included:

- Arkema
- Asahi
- BASF Corporation (successor to Ciba)
- Clariant
- Daikin
- 3M/Dyneon
- DuPont
- Solvay Solexis

The companies participating in the PFOA Stewardship Program were global companies with business operations in United States and other countries. Under the PFOA Stewardship Program, each of the companies committed to work toward a global phaseout of PFOA and related chemicals, both for U.S. operations and for the company's global business.

Q5. What was the baseline that companies used for reductions?

As a means of measuring reductions, the PFOA Stewardship Program Reporting Guidance suggested that individual companies use year 2000 data as the baseline for their company's emissions and product content information. Companies that did not have year 2000 data available were to use as a baseline the nearest year for which data were available. Read the PFOA Stewardship Program Guidance document. <<https://epa.gov/assessing-and-managing-chemicals-under-tsca/201015-pfoa-stewardship-program-guidance-reporting>>

In addition, to account for all of their operations or products, some companies used more than a single baseline year. Read the PFOA Stewardship Program Baseline Summary Tables. <<https://epa.gov/assessing-and-managing-chemicals-under-tsca/pfoa-stewardship-program-baseline-year-summary-report>>

Q6. Did the companies meet the PFOA Stewardship Program goals?

All participating companies state that they met the PFOA Stewardship Program goals. Read the latest progress reports. <<https://epa.gov/assessing-and-managing-chemicals-under-tsca/20102015-pfoa-stewardship-program-2014-annual-progress>>

Q7. How did the companies meet the PFOA Stewardship Program goals?

To meet the program goals, most companies stopped manufacture and import of long-chain PFASs, and then transitioned to alternative chemicals. Other companies exited the PFASs industry altogether.

Companies submitted annual public reports on their progress toward the goals in October of each successive year, expressing their progress in terms of company-wide percentage achievements both for U.S. operations and for the company's global business. Companies also provided to EPA detailed, confidential business information (CBI) on their progress in support of their public reports.

Q8. Are perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), and other long-chain PFASs still being manufactured or imported into United States?

PFOS was not reported as manufactured (including imported) into the U.S. as part of the 2012 Chemical Data Reporting (CDR) effort or the previous collection effort in 2006. CDR requires manufacturers (including importers) to report if they meet certain production volume thresholds, generally 25,000 lbs at a single site. The last time PFOS manufacture was reported to EPA as part of this collection effort was 2002. There are some limited ongoing uses of PFOS (see 40 CFR §721.9582 [🔗](https://www.gpo.gov/fdsys/pkg/cfr-2014-title40-vol31/xml/cfr-2014-title40-vol31-sec721-9582.xml)). <<https://www.gpo.gov/fdsys/pkg/cfr-2014-title40-vol31/xml/cfr-2014-title40-vol31-sec721-9582.xml>>.

The manufacture and import of PFOA has also been phased out in United States as part of the PFOA Stewardship program. Existing stocks of PFOA might still be used and there might be PFOA in some imported articles.

Q9. What other actions is EPA taking on PFASs?

To complement the PFOA Stewardship Program, EPA has issued regulations, known as Significant New Use Rules (SNURs), requiring manufacturers and processors of these chemicals to notify EPA of new uses of these chemicals before they are commercialized. Specifically, the regulations require that anyone who intends to manufacture (including import) or process any chemicals for uses contained in the SNUR must submit a notification to EPA at least 90 days before beginning the activity. This provides EPA with an opportunity to review and, if necessary, place limits on manufacturers or processors who intend to reintroduce or import products with these chemicals. Learn more about EPA's actions on PFASs and other perfluorinated chemicals <<https://epa.gov/assessing-and-managing-chemicals-under-tsca/risk-management-and-polyfluoroalkyl-substances-pfas>>.

Since 2000, EPA has published SNURs impacting several hundred perfluoroalkyl carboxylic acid (PFCA) and perfluoroalkane sulfonate (PFSA) chemicals.

EPA anticipates finalizing a separate SNUR later this year to ensure that PFASs phased out as part of the PFOA Stewardship Program do not re-enter the marketplace without review (see 80 FR 2885 [↗](https://www.regulations.gov/document/epa-hq-oppt-2013-0225-0001) <<https://www.regulations.gov/document/epa-hq-oppt-2013-0225-0001>>)

Contact Us <<https://epa.gov/assessing-and-managing-chemicals-under-tsca/forms/assessing-and-managing-chemicals-under-tsca>> to ask a question, provide feedback, or report a problem.

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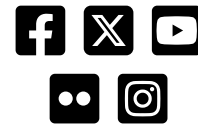
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NOC2011P1

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CBI SUBMISSION

 EPA		U.S. Environmental Protection Agency NOTICE OF COMMENCEMENT OF MANUFACTURE OR IMPORT (40CFR§720.102)		Report Number PMNX111201885885575	
Part I - SUBMITTER IDENTIFICATION			Document Control #:		
Manu- facturer/ Importer (in U.S.)	Name of Authorized Official		Mailing Address (number and street)		
	(first)	(last)			
	Company Name		City	State	Zip
Technical Contact (in U.S.)	Name		Telephone Number		
	(first)	(last)			
Part II - Premanufacture Notice (PMN) "P" Case Number:				P110091	
Part III - Check the appropriate box and provide the exact date of manufacture or importation:					
	First Commercial Manufacture**	X	First Commercial Importation***		
Date:		Date:	Nov 29, 2011		
Date of commencement is the date of completion of non-exempt manufacture of the first amount (batch, drum, etc.) *For importees, the date of commencement is the date that the new chemical substance clears U.S. customs.					
Part IV - Manufacturing Plant Site(s) or Importing Site(s): (Importers, provide street address of destination)					
					X
Part V - Specific Chemical Identity: (For Consolidated submissions, each substance must have a separate NOC form with the specific identity of each chemical substance.)					
					X
Part VI - Generic Chemical Name (if chemical identity is claimed CBI*):					
Fluorinated Acrylic Alkylamino Copolymer					
Part VII - Substance Identity Confidentiality Status:					
X	I wish to continue to claim the substance identity confidential and the substantiation to support this claim is attached. Failure to submit the required substantiation in accordance with 40 CFR 720.85(b) will result in a waiver of your claim.				
	I previously claimed the substance identity as confidential and hereby relinquish that claim.				
	I did not claim the substance identity as confidential in my original PMN submission.				
The public reporting and recordkeeping burden for this collection of information is estimated to average 0.8 hours per response. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including through the use of automated collection techniques to the Director, Collection Strategies Division, U.S. Environmental Protection Agency (2822T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460. Include the OMB control number in any correspondence. Do not send the completed EPA Form 7710-56 to this address. You must submit your completed notice no later than 30 calendar days after the first date of commercial manufacture/importation to the address shown below:					
U.S. Environmental Protection Agency OPPT Document Control Office (7407M) 1200 Pennsylvania Ave., NW Washington, D.C. 20460 ATTN: Notice of Commencement					
Signature of authorized official			Date		

Note: CBI* - refers to the term "Confidential Business Information". Mark (X) in the box if the information is to be held Confidential.



NOC2011P2

CBI Substantiation

Entire CBI substantiation claimed as CBI.

**Analysis of Initially Isolated Formulations of PMN Substance Required
Under Consent Order PMN P-11-0091, P-11-0092, and P-11-0093**

Annual Report

August 11, 2018 – August 10, 2019 Analytical Summary

Prepared by:

October 2019

Report P-10-19-10

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Objective

Consent order P-11-0091, P-11-0092, P-11-0093 requires the Company to analyze representative samples of the initially isolated formulation(s) of the PMN substance at each manufacturing facility for the analytes specified in Table 3 of the consent order and report the results at initial commencement of manufacture or import and again if any new manufacturing facility is added or if the process of manufacture of the PMN substance or any intermediate thereof is significantly altered. The Company is also required to annually analyze the initially isolated formulation(s) and report these results to EPA, in a cycle complementary to the

In addition to the annual reporting for the initially isolated formulation(s) of the PMN substance, the Company must annually report for the starting material: (1) the average values and range of values, including outlying data, from the routine analyses for the analytes specified in Table 1 of the consent order and (2) the results of the annual analysis for the analyte specified in Table 2 of the consent order. This report covers the annual reporting requirements for the initially isolated formulations of the PMN substance only. The starting material results are provided in a separate report because the starting material is common to PMN substances manufactured under several different consent orders. The starting material results can be found in Report P-10-19-02 entitled, "Analysis of Under Consent Orders: P-07-0087; P-08-0200; P-08-0643, P-08-0642, P-08-0644, and P-08-0664; P-08-0748 and P-08-0751; P-09-0245 and P-09-0246; P-09-0293 and P-09-0294; P-10-0058, P-10-0059, and P-10-0060; P-10-0148; P-11-0091, P-11-0092, P-11-0093, and P-12-0450"

Materials and Methods

A. Samples Analyzed

Initially Isolated Formulations of the PMN Substance

In this reporting period for the manufacture of the PMN substances covered under the subject consent order, there have been one (1) initially isolated formulations of the P-11-0091 substance manufactured. They are as follows:

The initially isolated formulations of the PMN substance listed above were packed out between August 11, 2018 and August 10, 2019. As per the consent order P-11-0091, P-11-0092, P-11-0093, representative samples of these formulations were analyzed for the substances specified in Table 3 of the consent order and reported to EPA at the time of first commercial manufacture or import, and again if any new manufacturing facility was added or if the process of manufacture of the PMN substance or any intermediate thereof was significantly altered, or at least annually in this report.

B. Analytical Methods

Analytical Methods for Initially Isolated Formulations of the PMN Substance

Representative samples of the initially isolated formulations of the PMN substance were analyzed for the analytes specified in Table 3 of the P-11-0091, P-11-0092, P-11-0093 consent order using methods described in detail in Report P-10-19-01 entitled: “Analytical Methods for the Analysis of _____ and Initially Isolated Formulations of the PMN Substances Required Under Consent Orders: P-07-0087; P-08-0200; P-08-0643, P-08-0642, P-08-0644, and P-08-0664; P-08-0748 and P-08-0751; P-09-0245 and P-09-0246; P-09-0293 and P-09-0294; P-

10-0058, P-10-0059, and P-10-0060; P-10-0148; P-11-0091, P-11-0092, P-11-0093, and P-12-0450.”

Results

Analysis of Initially Isolated Formulations of the PMN Substance

The results for analytes specified in Table 3 of the consent order are presented in Table 1 below.

LOT #	Product	conc (%)	conc (%)	conc (ppm)
	(estimated Max)	0.7% max combined	0.1% max combined	2 ppm max
13J		<0.0002	<0.0002	<0.5
S81.18J		<0.0002	<0.0002	<0.5
L09.19J		<0.0002	<0.0002	<0.5
S43.19J		<0.0002	<0.0002	<0.5
Avg		<0.0002	<0.0002	<0.5
Range		<0.0002 -- <0.0002	<0.0002 -- <0.0002	<0.5 -- <0.5

Table 1

Conclusion

The analyses specified in the consent order P-11-0091, P-11-0092, P-11-0093 have been completed for representative samples of the initially isolated formulations of the PMN substance manufactured between August 11, 2018 and August 10, 2019. The Company is required to annually analyze representative samples of the initially isolated formulation(s) and report these results to EPA, in a cycle complementary to the

This report fulfills this requirement.



About Us

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FracFocus is the national hydraulic fracturing chemical registry. It is managed by the Ground Water Protection Council (GWPC) an organization whose members are state government officials. GWPC's mission is focused on conservation and environmental protection.

This site was created to provide the general public with access to information about chemicals used in hydraulic fracturing. To help provide a comprehensive picture of this information and how it corresponds to related factors, the site also provides objective information on hydraulic fracturing, the purposes these chemicals serve, and the steps individual companies and regulatory agencies are taking to protect groundwater.

The primary purpose of this site is to provide factual information about hydraulic fracturing chemical use. We do not argue for or against the use of hydraulic fracturing as a technology, nor do we provide a scientific analysis of risks associated with it. Although FracFocus is not intended to replace or supplant any state

government information systems, it is being used by a number of states as a means of official chemical disclosure.

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About the Ground Water Protection Council

The Ground Water Protection Council (GWPC) is a nonprofit 501(c)6 organization whose members consist of state ground water regulatory agencies which come together within the GWPC organization to mutually work toward the protection of the nation's ground water supplies. The purpose of the GWPC is to promote and ensure the use of best management practices and fair but effective laws regarding comprehensive ground water protection.

Our Mission

The Ground Water Protection Council (GWPC) is a nonprofit 501(c)6 organization whose members consist of state groundwater regulatory agencies that come together within the GWPC organization to mutually work toward the protection of the nation's groundwater supplies. The purpose of the GWPC is to promote and ensure the use of best management practices and fair but effective laws regarding comprehensive groundwater protection, with a specific focus on three categories:

Water/Energy

Water Quality

Water Availability & Sustainability

Our mission is to promote the protection and conservation of groundwater resources for all beneficial uses, recognizing ground water as a critical component of the ecosystem. We provide an important

forum for stakeholder communication and research in order to improve governments' role in the protection and conservation of groundwater.

GWPC History

Chartered by the states in 1983, the GWPC was incorporated as a nonprofit national association, headquartered in the State of Oklahoma.

It was initially incorporated by five states who wanted to form an organization that would serve as a forum to bring together technical and regulatory experts to discuss underground injection control (UIC) issues and overall groundwater protection. The founders also sought to develop a strong public outreach/education program to inform the public about the safety of the national UIC program and to develop information that could be used by the states to enhance this effort.

Since then the Board of Directors have enhanced GWPC's overall commitment to broader groundwater issues as a recognition that the UIC program is one piece of a much larger effort to effectively protect groundwater as an essential component of the ecosystem.

The GWPC was founded upon a sound principle from which it has never wavered. It has matured into a respected national association of state groundwater and UIC agencies. Along the way, GWPC has had a significant impact in affecting national policy in underground injection and groundwater protection.

OUR MISSION IS TO PROMOTE THE PROTECTION AND CONSERVATION OF GROUND WATER RESOURCES.

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As of 3/1/2022:

FracFocus was created in 2011 with a single purpose in mind: to simplify the search for chemicals used in hydraulic fracturing operations by location. This goal extended not just to providing a one-stop resource for all relevant information, but also to ensuring the information is clear, easy to understand, and not simply a download of industry terminology.

The original vision began in 2010 through a partnership between the [Ground Water Protection Council](#) and the [Interstate Oil and Gas Compact Commission](#) and supported by US DOE, which were aware of and concerned about the time-consuming and inefficient processes in place for consumers who wanted to search for this information. In a joint effort, they began planning and seeking input from states, academia, and technology and industry experts to place chemical reporting data at the general public's fingertips.

Today, what began as a voluntary reporting site with 37 participating companies now receives reports from more than 1,600 companies reporting chemicals for more than 189,000 hydraulic fracturing operations nationwide. Because of the system's success from both operator and consumer perspectives, 27 states now either require or allow companies to disclose chemical data via FracFocus.

"We're extremely proud of FracFocus and how it has revolutionized the standard for hydraulic fracturing chemical disclosure," said Mike Paque, GWPC executive director. "We're excited about the future as we continue to grow and evolve, allowing us to improve the user and reporting company experiences, and to further improve public transparency."

In 2015, FracFocus began releasing disclosure data to the public in machine-readable SQL format, which allows users to more easily search and aggregate data. Site upgrades continued into 2016, based on combined response and feedback from the reporting companies, consumers and researchers. In 2017 FracFocus began offering data in Comma Separated Value (CSV) format which can be imported into MS Excel®.

The release of FracFocus 3.0 in 2016 included the following improvements:

- Stronger validation processes to improve data integrity and accuracy
- A new format for reporting chemical data that protects proprietary information while still allowing the chemicals used to be disclosed
- Newly designed forms to improve the company and regulatory agency user experiences when checking and completing disclosures

As a public resource, FracFocus is always interested in your feedback and input about your search experience on the site. We welcome your comments.

FracFocus Timeline

As of 4/10/2022:

- April 11, 2011 – FracFocus goes live. The site begins with 37 participating companies voluntarily submitting 444 hydraulic fracturing disclosures.
- June 2011 – FracFocus reaches 1,000 disclosures.
- July 2011 – Montana issues a rule allowing operators to meet state reporting requirements by submitting chemical information through FracFocus. Texas passes a law to the same effect, while Louisiana begins discussion.
- September 2011 – FracFocus begins using GIS interfaces for disclosure search.
- Jan. 1, 2012 – FracFocus goes international with FracFocus Canada deployed in British Columbia and Alberta.
- Summer 2012 – North Dakota, Colorado, Oklahoma, Louisiana and Pennsylvania begin requiring disclosure to FracFocus, bringing the total to seven states.
- Fall 2012 - US DOE begins providing funding for FracFocus expansion and support, Initial funding used specifically for the upgrade of FracFocus to version 2.0.
- June 2013 – FracFocus 2.0 is released, allowing users to more efficiently search for well site chemical information. A new and improved XML platform gives users the option to search and pull reports by date ranges, chemical names or CAS numbers. Additional improvements in data validation and error trapping are made to the system.
- September 2013 – Eight more states now require chemical disclosure through FracFocus: South Dakota, Utah, Nebraska, Alabama, Mississippi, Ohio, Tennessee and West Virginia.
- April 2015 – Another eight states now require chemical disclosures to FracFocus: California, Nevada, Idaho, Kansas, Kentucky, North Carolina, Michigan and Alaska.
- July 2015 – Due to public demand, FracFocus begins releasing disclosure data to the public in machine-readable

(SQL) format, allowing FracFocus users and researchers to more easily search and aggregate data.

- October 2015 – The number of disclosures for hydraulic fracturing operations surpasses 100,000 – in all, FracFocus sees 106,132 disclosures from operations nationwide with 974 reporting companies.
- June 2016 – FracFocus 3.0 goes live, providing stronger validation processes to improve data integrity, which in turn makes data more valuable for researchers and the public; a new format for reporting company data entry, which should decrease the use of trade secrets in disclosures, thereby providing more public transparency; and newly designed forms to improve the company and regulatory agency user experiences when checking and completing disclosures. Additional data downloaded also provided for public transparency.
- June 2020 - FracFocus launches new public website (this site)
- July 2020 - Milestone of 175,000 disclosures submitted reached
- May 2021 - Updated Website Hardware and Security Frameworks updates on FracFocus servers
- August 2021 - FracFocus is used as the only national regulatory reporting system for 27 Oil and Gas States. It contains over 184,000 disclosures with over 5 million chemicals records coming from more than 1,600 registered companies.
- December 2021 - FracFocus design for the next version is ongoing with expected development of FracFocus 4.0 in 2022.
- 2023 - FracFocus 4.0 slated for release, enabling reporting of water used in hydraulic fracturing jobs by source and quality.

“FracFocus is a victory for transparency and good governance, and an example of what is possible when the industry works with state regulators and environmental groups to solve urgent challenges in managing the local impacts of hydraulic fracturing. FracFocus remains one of the best national repositories of oil and gas data, and paves the way for a new era of open data in this field.”

– **Adam Peltz**, Environmental Defense Fund

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Disclosure(s) for Corral Canyon Federal #16H

Operated by XTO Energy/ExxonMobil

API: 30-015-42928-00-00

State	County	Indian Well	Federal Well
New Mexico	Eddy	No	Yes



Job Completed: 6/2/2018

Total Base Water Volume: 23,193,912

Total Base Non-Water Volume: 0

True Vertical Depth: 8,602

Hydraulic Fracturing Fluid Composition

[PDF Disclosure Form](#)

Ingredient	CAS Number	% HF Fluid
Water	7732-18-5	86.94200
Crystalline Silica, quartz	14808-60-7	9.81299
Crystalline Silica, quartz	14808-60-7	1.56375
*Quartz (SiO ₂)	14808-60-7	1.23286
Water	7732-18-5	0.20147
Aluminum Oxide	1344-28-1	0.10805
Castor Oil	8001-79-4	0.06290
Distillates (Petroleum), Hydrotreated Light	64742-47-8	0.04869
Guar Gum	9000-30-0	0.04869
Ammonium Persulfate	7727-54-0	0.03537
Water	7732-18-5	0.03233
Hydrochloric Acid	7647-01-0	0.02239
2-Propenoic acid, polymer with 2-propenamide, sodium salt	25987-30-8	0.02064
Distillates (Petroleum), Hydrotreated Light	64742-47-8	0.02064
Aluminum Oxide	1344-28-1	0.01722
Buffering agents	Proprietary	0.01513
Iron Oxide	1309-37-1	0.01258
vinylidene chloride- methyl acrylate copolymer	25038-72-6	0.01061

Ingredient	CAS Number	% HF Fluid
Iron Oxide	1309-37-1	0.00982
Titanium Oxide	13463-67-7	0.00982
Bentonite	1302-78-9	0.00406
Alcohols, C11-14-iso-, C13-rich, ethoxylated	78330-21-9	0.00344
Alcohols, C9-11-iso-, C10-rich, ethoxylated propoxylated	68002-97-1	0.00244
Proprietary	Proprietary	0.00206
Iron Oxide	1309-37-1	0.00157
Titanium Oxide	13463-67-7	0.00157
Water	7732-18-5	0.00094
Trisodium Nitrilotriacetate	5064-31-3	0.00078
Hydrated magnesium silicate	14807-96-6	0.00035
Ethylene Glycol	107-21-1	0.00031
Water	7732-18-5	0.00024
Glycerin	56-81-5	0.00021
Poly(tetrafluoroethylene)	9002-84-0	0.00018
Dimethylformamide	68-12-2	0.00016
2-Butoxyethanol	111-76-2	0.00012
Cinnamaldehyde	104-55-2	0.00012
Tar bases, quinoline derivs, benzyl chloride- quaternized	72480-70-7	0.00012
Alkyl (C10-16) dimethyl amine oxide	70592-80-2	0.00010
Diethylene glycol monomethyl ether	111-77-3	0.00010
Sodium dioctyl sulfosuccinate	577-11-7	0.00010
Acrylamide as residual	79-06-1	0.00007
1-DECANOL	112-30-1	0.00004

Ingredient

CAS Number

WG Ex. 32-A
% HF Fluid

Poly(oxy-1,2-ethanediyl),alpha-(4-nonylphenyl)-omega hydroxy-, branched 1-OCTANOL
Isopropanol
Triethyl Phosphate
Alcohols, C10-14, ethoxylated
CRYSTALLINE QUARTZ
Tar Bases, Quinoline Derivs.

127087-87-00.00004

111-87-5 0.00002
67-63-0 0.00002
78-40-0 0.00002

66455-15-0 0.00002

14808-60-7 0.00001

68513-87-1 0.00001

Total Water Volume sources may include various types of water including fresh water, produced water, and recycled water. Information is based on the maximum potential for concentration and thus the total may be over 100%.

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Disclosure(s) for FRAZIER 34 STATE COM #501H

Operated by EOG Resources, Inc.
API: 30-025-42386-00-00

State	County	Indian Well	Federal Well
New Mexico	Lea	No	No



Job Completed: 5/8/2015

Total Base Water Volume: 7,568,389.08

Total Base Non-Water Volume: 0

True Vertical Depth: 11,167.906

Hydraulic Fracturing Fluid Composition

[PDF Disclosure Form](#)

Ingredient	CAS Number	% HF Fluid
Water	7732-18-5	89.26440
Crystalline Silica	14808-60-7	9.77915
Water	7732-18-5	0.68496
Hydrochloric Acid	7647-01-0	0.05137
Diethanolamide	NA	0.01620
Methanol	67-56-1	0.01620
Isopropyl Alcohol	67-63-0	0.01368
Polyoxyalkylene glycol butyl ether	9004-77-7	0.01157
Hydrotreated Light Distillates	64742-47-8	0.00839
Water	7732-18-5	0.00769
Poly (acrylamide-co- acrylic acid), partial sodium salt	62649-23-4	0.00673
Paraffinic, Naphthenic Solvent	64742-47-8	0.00577
Ammonium Chloride	12125-02-9	0.00360
Nonionic Surfactants	Trade Secret	0.00192
Ethoxylated Nonyl Phenol-Formaldehyde Resin	30846-35-6	0.00171
Polymers Derived from Fatty Acids	Trade Secret	0.00171

Ingredient	CAS Number	% HF Fluid
C10-C16 Ethoxylated Alcohols	Mixture	0.00120
Ammonium Chloride	12125-02-9	0.00096
Sodium Chloride	7647-14-5	0.00096
Heavy Aromatic Naptha	64742-94-5	0.00085
Water	7732-18-5	0.00066
Trisodium Nitrilotriacetate	5064-31-3	0.00044
Benzyl alkyl pyridinyl quaternary ammonium chloride	68909-18-2	0.00036
Methyl Alcohol	67-56-1	0.00031
Methyl Alcohol	67-56-1	0.00029
Charcoal	7440-44-0	0.00028
Citric Acid	77-92-9	0.00025
Water	7732-18-5	0.00023
Dimer Fatty Acids	Proprietary	0.00017
Fluoroalkyl Alcohol Substituted	65545-80-4	0.00017
Polyethylene Glycol Naphthalene	91-20-3	0.00017
Polyethylene Glycol	25322-68-3	0.00017
Vegetable Oil	Proprietary	0.00017
Polyethoxylated Alcohol Surfactant	68951-67-7	0.00015
Thiourea/Formaldehyde Copolymer	68527-49-1	0.00015
Propargyl Alcohol	107-19-7	0.00005
Inert Ingredients	Trade Secret	0.00003
Sulfamic Acid	5329-14-6	0.00003
1,4-Dioxane	123-91-1	0.00002
C-14 to C-16 Alpha Olefins	64743-02-8	0.00002

Ingredient	CAS Number	
Dipropylene Glycol Methyl Ether	34590-94-8	0.00002
Sodium Sulfate Anhydrous	7757-82-6	0.00002
Water	7732-18-5	0.00002
Sodium Hydroxide	1310-73-2	0.00001
No Hazardous Ingredients	NA	0.00000
No Hazardous Ingredients	NA	0.00000

Total Water Volume sources may include various types of water including fresh water, produced water, and recycled water. Information is based on the maximum potential for concentration and thus the total may be over 100%.

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PFAS Master List of PFAS Substances (RETIRED)



Polytetrafluoroethylene

9002-84-0 | DTXSID7047724

Searched by DTXSID7047724.

Chemical Details

Wikipedia

Polytetrafluoroethylene (PTFE) is a synthetic fluoropolymer of tetrafluoroethylene, and has numerous applications because it is chemically inert. The commonly known brand name of PTFE-based composition is **Teflon** by Chemours, a spin-off from DuPont, which originally discovered the compound in 1938. Polytetrafluoroethylene is a fluorocarbon solid, as it is a high-molecular-weight polymer consisting wholly of carbon and fluorine. PTFE is hydrophobic: neither water

[Read more](#)

Quality Control Notes

(C2F4)x; Polymer type: Fluoropolymer, Polyvinyl; Record was reviewed with Common Chemi:

Intrinsic Properties

MOL FILE

Presence in Lists

Federal

- EPA|CHEMINV: EPA Chemical Inventory for ToxCast (20170203)
- EPA|CHEMINV: EPA ToxCast ChemInventory DMSO Insolubles at 20mM
- Chemical and Products Database v1
- EPA|ENDOCRINE: EDSP Universe of Chemicals
- WATER|EPA; Chemicals associated with hydraulic fracturing
- WATER|EPA; Chemicals in hydraulic fracturing fluids Table H-2
- EPA|EPA Substance Registry Service (January 2023)
- FDA Orange Book: Approved Drug Products with Therapeutic Equivalence Evaluations
- LIST: FDA UNII List April 12th 2021 Download
- PESTICIDES: InertFinder
- EPA: Toxicity Values Version 5 (Aug 2018)
- TSCA Active Inventory non-confidential portion (updated February 3rd 2021)
- TSCA Active Inventory non-confidential portion (updated March 23rd 2022)
- TSCA Active Inventory non-confidential portion (Updated February 17th 2023)
- TSCA Active Inventory non-confidential portion (Updated February 26th 2024)
- TSCA Active Inventory non-confidential portion (updated March 20th 2020).
- TSCA Active Inventory non-confidential portion (updated August 20th 2021)
- TSCA Active Inventory non-confidential portion (Updated August 16th 2023)

International

Canadian Domestic Substances List 2019

IARC: Group 3: Not classifiable as to its carcinogenicity to humans

PFAS: List from the Swedish Chemicals Agency (KEMI) Report

PFAS: Listed in OECD Global Database

Other

ARTICLE: Collaborative Modeling Project for Androgen Receptor Activity (COMPARA)

Navigation Panel to CPDat Versioned Structure Lists

Chemical and Products Database v2

PLASTICS|NORMAN: Database of Chemicals possibly (List B) associated with Plastic Packaging (CPPdb)

EPA Substance Registry Service (October 2022)

EPA|EPA Substance Registry Service (November 2023)

CATEGORY: Flame Retardants

Food Contact Chemicals database (FCCdb) - version 5

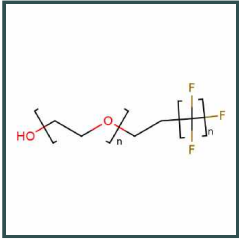
Record Information

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Ask.
Follow.



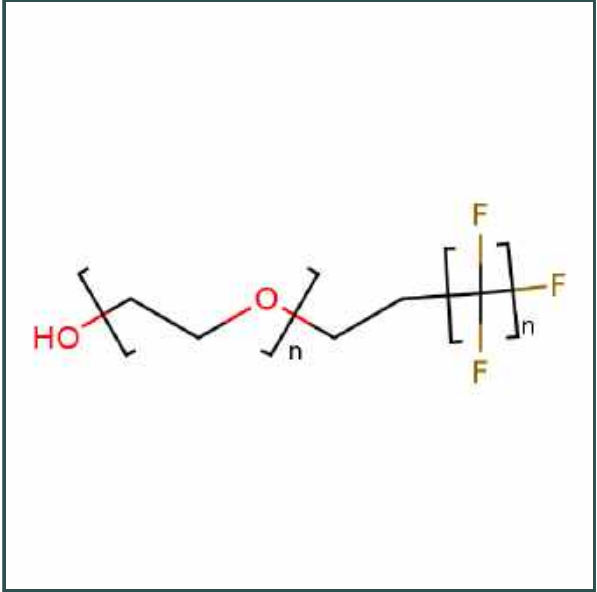


Poly(oxy-1,2-ethanediyl), alpha-hydr...

65545-80-4 | DTXSID6049727

Searched by DTXSID6049727.

Chemical Details



Quality Control Notes

No Quality Control notes

Intrinsic Properties

MOL FILE

Presence in Lists

Federal

CDR: Chemical Data Reporting 2016

CDR: Chemical Data Reporting 2020

Chemical and Products Database v1

EPA|ENDOCRINE: EDSP Universe of Chemicals

WATER|EPA; Chemicals associated with hydraulic fracturing

WATER|EPA; Chemicals in hydraulic fracturing fluids Table H-2

EPA|EPA Substance Registry Service (January 2023)

PESTICIDES: InertFinder

PFAS: Navigation Panel to PFAS Toxics Release Inventory Lists

PFAS: PFAS to the Toxics Release Inventory (TRI) Program by the National Defense Authorization Act (Version 1)

EPA: Toxicity Values Version 5 (Aug 2018)

EPA: Toxics Release Inventory

TSCA Active Inventory non-confidential portion (updated February 3rd 2021)

TSCA Active Inventory non-confidential portion (updated March 23rd 2022)

TSCA Active Inventory non-confidential portion (Updated February 17th 2023)

TSCA Active Inventory non-confidential portion (Updated February 26th 2024)

TSCA Active Inventory non-confidential portion (updated March 20th 2020).

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PFAS: Listed in OECD Global Database

Other

Navigation Panel to CPDat Versioned Structure Lists

Chemical and Products Database v2

EPA Substance Registry Service (October 2022)

EPA|EPA Substance Registry Service (November 2023)



Food Contact Chemicals database (FCCdb) - version 5

WATER|NORMAN: Wastewater Suspect List based on Swedish Product Data

Record Information

Citation: U.S. Environmental Protection Agency. Comptox Chemicals Dashboard. <https://comptox.epa.gov/dashboard/chemical/details/DTXSID6049727> (accessed October 17, 2024) Poly(oxy-1,2-ethanediyl), alpha-hydro-omega-hydroxy-, ether with alpha-fluoro-omega-(2-hydroxyethyl)poly(difluoromethylene) (1:1)

Data Quality:

Level 1: Expert curated, highest confidence in accuracy and consistency of unique chemical identifiers

Level 2: Expert curated, unique chemical identifiers using multiple sources

Level 3: Programmatically curated from high quality EPA source, unique chemical identifiers have no conflicts in ChemID and PubChem

Level 4: Programmatically curated from ChemID, unique chemical identifiers have no conflicts in PubChem

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