RESEARCH BRIEF 2

FALL 2021

A Health Effects Institute Affiliate

Utility of the FracFocus Database for Understanding Water-Related Exposures from Unconventional Oil and Gas Development

This Research Brief is part of a series of periodic updates on the literature about potential human exposures and health effects associated with unconventional oil and natural gas development (UOGD) in the United States

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Trusted Science, Clean Environment, Better Health

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Health Effects Institute Energy

Boston, MA

TRUSTED SCIENCE, CLEAN ENVIRONMENT, BETTER HEALTH

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- HEI Energy staff and committees engage in open and extensive stakeholder engagement before, during,and after research, and communicate all results in the context of other relevant research;
- HEI Energy makes publicly available all literature reviews and original research that it funds and provides summaries written for a general audience; and
- Without advocating policy positions, HEI Energy provides impartial science, targeted to make better-informed decisions.

HEI Energy is a separately funded affiliate of the Health Effects Institute (*www.healtheffects.org*).

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PURPOSE OF THIS RESEARCH BRIEF

Since 2011, the Ground Water Protection Council and the Interstate Oil and Gas Compact Commission have jointly managed FracFocus, a public national registry for reporting the chemicals used in hydraulic fracturing fluid (HFF). HFF is commonly used in the process of fracturing shale to produce oil and natural gas. Hydraulic fracturing is just one phase in the development of oil and gas from shale and other unconventional resources, abbreviated in this document as UOGD.

The purpose of this brief is to describe the FracFocus database, summarize published reviews of the database (Konschnik and Dayalu 2016; U. S. Environmental Protection Agency 2015; Yost et al. 2016), supplement these reviews with an updated description of data posted to FracFocus from 2011 through 2019, and offer ideas for how the FracFocus database might be useful for research about potential human exposures associated with UOGD. Future Research Briefs will summarize other possible UOGD processes, such as produced water management, that might lead to water quality impacts.

EFFORTS TO UNDERSTAND WATER QUALITY IMPACTS OF UOGD

Onshore development of oil and natural gas from shale and other unconventional resources (UOGD) has expanded rapidly in the United States since the beginning of this century with technologies that have allowed for development in proximity to residential communities. This proximity has given rise to questions about the potential for human exposure to chemical and non-chemical agents associated with UOGD.

A growing body of research has focused on understanding potential exposure to chemicals associated with UOGD processes (HEI Energy Research Committee 2019), a subset of which examined water quality impacts and the potential for exposure to UOGD chemicals in groundwater or surface water (Cozzarelli et al. 2020; Hildenbrand et al. 2015; Orem et al. 2017; U.S. Environmental Protection Agency 2016; Wen et al. 2018).

The largest review to date on potential UOGD impacts on water in the United States was conducted by the U.S. Environmental Protection Agency (2016). The aim of the report was to investigate the likelihood and magnitude of impacts to drinking water from the hydraulic fracturing water cycle. A useful byproduct of the review was EPA's list of chemicals used in HFF, which was added to the Agency's web based CompTox Chemistry Dashboard (Grulke et al. 2019; Williams et al. 2017). The U.S. EPA's review concluded that impacts can arise from spills of HFF, chemicals, or produced water; injection of HFF directly into groundwater resources or into wells with inadequate integrity; and waste management issues, such as the discharge of inadequately treated wastewater to surface water and the use of unlined pits for wastewater storage. Researchers continue to study these and other potential pathways for exposure to UOGD chemicals in water. More recent research to understand these potential exposures have included reviews of the composition of HFF (Hu et al. 2018; Mumford et al. 2018; Rodriguez et al. 2020; Yost et al. 2016) and the composition of produced water (Gardiner et al. 2020; Ground Water Protection Council 2019; Shores et al. 2017; Stringfellow and Camarillo 2019; Torres et al. 2018; Varonka et al. 2020).

THE FRACFOCUS DATABASE

Hydraulic Fracturing Fluid Composition Data

When reporting through FracFocus, well operators and service companies upload hydraulic fracturing information to an online form, which is available for public viewing. There may be multiple entries per

well and multiple jobs for wells that are fractured more than one time. Each row in the database represents a chemical or group of chemicals used within a "frac job" when HFF is pumped into the well to create cracks in the oil- or gas-bearing shale or other resource. Operators report data describing the well (e.g., location, American Petroleum Institute [API] number, and vertical depth), the frac job (e.g., job start date, job end date, and total volume of water used), and the chemical composition (e.g., ingredient mass, supplier company, and function of the chemical). A full list of variables reported in FracFocus is provided in Appendix A. Companies may also label the ingredients as "proprietary," "confidential," "trade secret", or "not assigned" instead of providing a Chemical Abstract Service (CAS) number and ingredient name. However, the purpose of the withheld chemical must still be reported.

The Evolution of FracFocus

Konschnik and Dayalu (2016) explained how FracFocus was developed and has changed since its release in 2011. Briefly, in response to Congress exempting disclosure of HFF that did not contain diesel from the Safe Drinking Water Act (Energy Policy Act of 2005), individual states began requiring operators to report chemical use in 2010. FracFocus was launched as the largest online reporting system for HFF chemical use. Disclosure regulations regarding HFF vary across states, with some requiring reporting either through FracFocus or another reporting system, and some encouraging reporting on a voluntary basis.

After a set of reviews evaluating FracFocus for its accuracy, timeliness, accessibility, and efficacy as a reporting tool (Konschnik and Boling 2014; U. S. Environmental Protection Agency 2015; U.S Department of Energy 2014), FracFocus underwent a number of improvements within its reporting form and database management system. These improvements resulted in varying quantity and quality of data available in the FracFocus database over time. These staged improvements, titled FracFocus 1.0, 2.0, and 3.0, represent the periods 2011-2013, 2012-2016, and 2016-present, respectively. In FracFocus Form 1.0, limited chemical data are available because most of those data were not retained or are stored in PDF files making access challenging (Konschnik and Dayalu 2016). In November 2012, FracFocus began offering data entry through an XML system, and in June 2013 they eliminated the previous data entry methods; with these changes, FracFocus improved data accessibility (Savage 2013).

The second update of FracFocus included the introduction of the "systems approach" method for reporting chemicals. With the systems approach, operators can submit multiple ingredients in a single form instead of submitting a form for each chemical or chemical group. With the single form, operators do not report as much information about individual chemicals (e.g., their purpose or ingredient mass). In this way, the systems approach enables operators to disclose chemical constituent information without sharing proprietary information about the HFF mixture. Use of the systems approach increased in popularity with the latest update of FracFocus when it was changed from an opt-in alternative approach to a default setting (Trickey et al. 2020).

The FracFocus 3.0 update includes validity checks for many of the variables to prevent misspellings and entry of erroneous data, as well as improvements to the online form that simplify submission of data (Appendix A).

Previous Reviews of FracFocus Data

As a first step in understanding potential health effects from exposure to HFF or any other chemical mixture, investigators seek data on their chemical composition. Thus, investigators have previously reviewed the chemical data in FracFocus to identify potential health hazards (Elsner and Hoelzer 2016; Gradient Corporation 2013; Hu et al. 2018; Stringfellow et al. 2017; U. S. Environmental Protection Agency 2015; Wattenberg et al. 2015). Some have aimed to evaluate the characteristics of chemicals used in HFF, including their toxicity, physiochemical properties, and frequency of use. Most have analyzed

data for a specific reporting period and location instead of the database as a whole (Hu et al. 2018; Stringfellow et al. 2017; Wattenberg et al. 2015). Those conducting more comprehensive reviews of the database have primarily used data from the earlier years of FracFocus (2011- 2013) (Elsner and Hoelzer 2016; U. S. Environmental Protection Agency 2015) and may be missing changes in chemical use over time and by location. Other studies have used FracFocus data to examine chemical composition and policy efficacy (Stults 2018; U. S. Environmental Protection Agency 2015; Wang 2014), with some exploring FracFocus as a tool to guide exposure research (Elsner and Hoelzer 2016; Trickey et al. 2020; Yost et al. 2016).

FRACFOCUS DATA PREPARATION

Following methods described in "FracFocus Chemical Disclosure Registry 1.0 and 2.0 Data Conversion, Cleaning, and Standardization Methods Paper," (Konschnik and Dayalu 2015), we downloaded all available FracFocus disclosure forms from the website (http://fracfocus.org/data-download) on January 15, 2020. These data were reported on FracFocus form versions 1.0, 2.0 and 3.0 with the following variables: well API identification number, dates the job started and ended, location of the well, total vertical depth, operator's name, basic information on the quantity of fluids used in the fracturing job, chemical trade name, supplier, purpose of the ingredient, ingredient name, CAS number, and the maximum percentage of the chemical in the additive and fracturing job (descriptions of each variable are found in Appendix A).

Forms were excluded from analysis if (1) the reporting dates were left blank or fell outside our review period of 2011-2019, or (2) the well API number location code for state (the first two numbers in the API number) did not match the state where the well was reportedly drilled. We removed all duplicate forms as we could not distinguish the original from the updated form. The final data set includes 4,529,388 disclosure forms from 162,548 unique fracturing jobs between January 1, 2011 and December 31, 2019.

To assess chemical composition, we relied on CAS number reporting, as previous work (Konschnik and Dayalu 2015) found this variable to be more accurate and consistent than the ingredient name field in FracFocus 3.0. All versions of FracFocus allow both numeric and character entries in the CAS number field. First, numeric CAS number entries were checked for validity by comparing entries in the CAS number format to a standard algorithm (Check Digit Verification of CAS Registry Numbers). If an entry failed the algorithm check, it was labeled "Invalid". We also labeled CAS number entries "N/A" if a numeric CAS number entry was not in the CAS format. All character entries were labeled to match indicated status (trade secret, confidential, proprietary, N/A, systems approach). Other studies have cross-referenced the reported CAS numbers with chemical databases like U.S. EPA Substance Registry Services or US National Library of Medicine ChemIDplus to check the validity of the reported CAS numbers (Trickey et al. 2020). For our purposes, systems approach entries were excluded from analyses about chemical composition because the approach allows for the CAS field to be left blank and CAS numbers for each chemical in a mixture are not always retained in the form as separate single fields.

We then summarized the dataset to assess the frequency, makeup, and geographic distribution of chemical reporting, as well as how FracFocus can be used to understand potential human exposure to UOGD chemicals.

FINDINGS AND DISCUSSION

Overview of FracFocus dataset, 2011-2019

We assessed the number of forms submitted during periods when different versions of the FracFocus form were in use. FracFocus version 1.0 accounted for 1.9% of the total forms while 58.1% were version 2.0 and the remaining 39.9% were from version 3.0 (Table 1). Forms were submitted from wells located in 28 states. The ten states with the greatest number of submitted forms, in order of number of forms submitted, were Texas, Oklahoma, North Dakota, Colorado, New Mexico, Pennsylvania, Utah, Wyoming, California, and Ohio (Figure 1). The top seven states by number of submitted forms all require operators to use FracFocus to report chemical use (Trickey et al. 2020; See Table 1 for states requiring FracFocus submission). Texas began requiring reporting to FracFocus in 2011, while Oklahoma, North Dakota, Colorado, and Pennsylvania began requiring reporting in summer of 2012. Utah added the requirement a year later (About FracFocus - FracFocus 2016). In 2015, California began requiring reporting to FracFocus, however in the start of 2016 they switched mandatory reporting to their own

Table 1. Number of submitted forms to FracFocus by form version and state where the well was fractured.

	FracFocus 1.0 (Jan. 2011-June 2013)		**FracFocus 2.0** (Nov. 2012-June 2016)		**FracFocus 3.0** (June 2016-Present)		Total Submitted	% of Forms Submitted Nationally
State Name	Number Submitted	% of Total	Number Submitted	% of Total	Number Submitted	% of Total		
ALL	86,657	1.91	2,632,326	58.12	1,810,405	39.97	4,529,388	100.00
Alabama*	110	2.59	4,054	95.37	87	2.05	4,251	0.09
Alaska*	96	1.55	3,370	54.47	2,721	43.98	6,187	0.14
Arkansas	2,900	8.08	31,421	87.56	1,565	4.36	35,886	0.79
California	1,892	2.17	68,671	78.60	16,804	19.23	87,367	1.93
Colorado*	10,388	2.82	189,302	51.42	168,472	45.76	368,162	8.13
Illinois	0	0.00	70	100.00	0	0.00	70	0.00
Indiana	0	0.00	12	100.00	0	0.00	12	0.00
Kansas	426	2.80	12,279	80.83	2,487	16.37	15,192	0.34
Kentucky*	0	0.00	8	5.10	149	94.90	157	0.00
Louisiana	2,602	3.54	30,230	41.15	40,630	55.31	73,462	1.62
Maine	0	0.00	0	0.00	38	100.00	38	0.00
Michigan*	30	4.45	302	44.81	342	50.74	674	0.01
Minnesota	2	100.00	0	0.00	0	0.00	2	0.00
Mississippi	20	0.40	3,470	68.96	1,542	30.64	5,032	0.11
Missouri	2	100.00	0	0.00	0	0.00	2	0.00
Montana	554	3.71	12,337	82.68	2,031	13.61	14,922	0.33
Nebraska*	6	2.38	193	76.59	53	21.03	252	0.01
Nevada	0	0.00	389	100.00	0	0.00	389	0.01
New Mexico*	2,624	1.43	90,245	49.01	91,270	49.57	184,139	4.07
New York	0	0.00	0	0.00	98	100.00	98	0.00
North Dakota*	5,819	1.41	241,265	58.51	165,271	40.08	412,355	9.10
Ohio	338	0.40	46,547	54.64	38,304	44.96	85,189	1.88
Oklahoma*	4,466	0.95	256,943	54.65	208,729	44.40	470,138	10.38
Pennsylvania*	5,412	3.02	88,444	49.35	85,374	47.63	179,230	3.96
Texas*	41,504	1.87	1,335,143	60.07	845,822	38.06	2,222,469	49.07
Utah*	3,316	2.20	113,500	75.33	33,851	22.47	150,667	3.33
Virginia*	178	0.89	2,343	11.73	17,454	87.38	19,975	0.44
W. Virginia*	728	1.13	31,996	49.63	31,743	49.24	64,467	1.42
Wyoming	3,244	2.52	69,792	54.27	55,568	43.21	128,604	2.84

Notes: This table represents the analytical dataset.

*State requiring reporting to FracFocus (Trickey et al. 2020).

database (Trickey et al. 2020; About FracFocus - FracFocus 2016). New Mexico began requiring reporting to FracFocus in 2017 (EMNRD 2017). Neither Wyoming nor Ohio requires reporting to FracFocus, however reporting to FracFocus is one of the reporting options for Ohio operators.

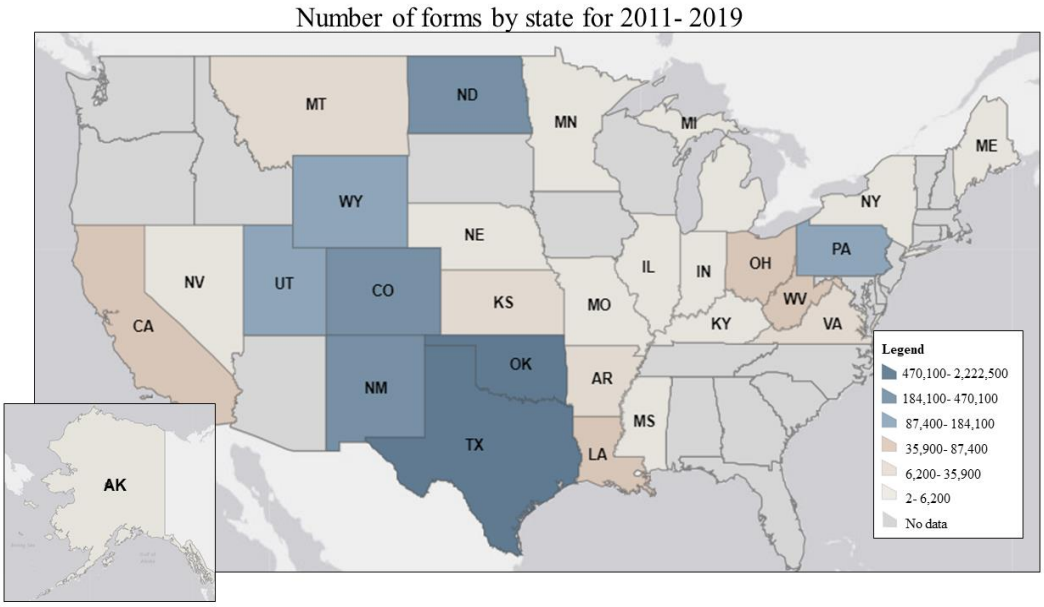

Figure 1. The number of FracFocus forms submitted in each state from 2011-2019

Chemical Information Availability

Availability of Forms with Valid CAS Numbers

Of the FracFocus forms submitted between 2011 and 2019, 74% included CAS numbers that could be validated for the chemicals reported (i.e., labeled as "valid" forms). Of the remaining forms, approximately 13% utilized the systems approach while approximately 12% withheld chemical information (Figure 2).

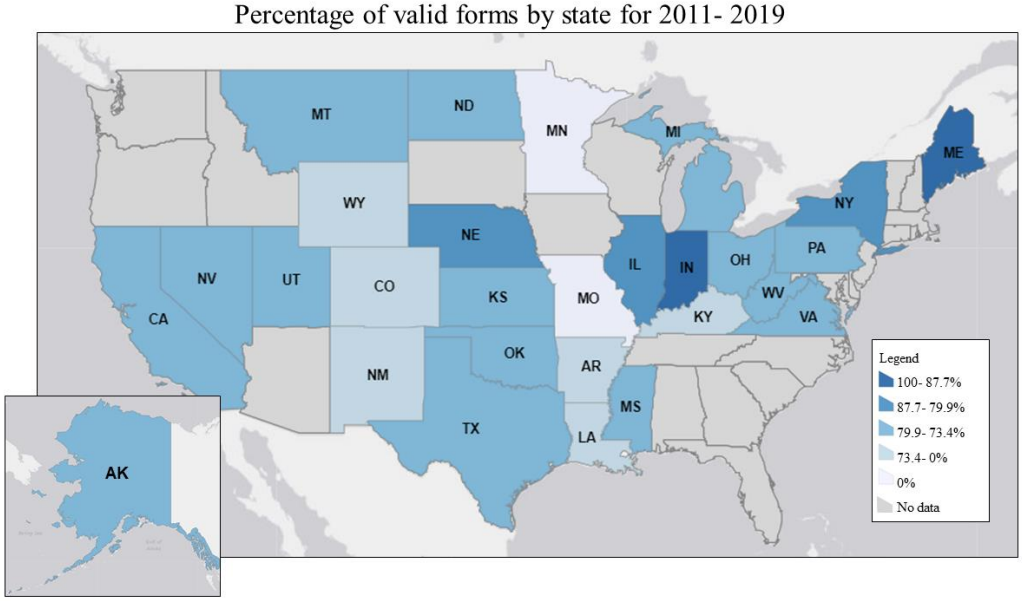

Figure 2. Percentage of forms submitted using systems approach from 2015-2019

About a quarter of the total entries in the database cannot be easily utilized to identify specific chemicals used in HFF because the information is not available or purposely withheld. The large number of unavailable records (denoted "N/A") between 2011 and 2012 reflects the missing data from entries where no chemical information was provided or retained.

As FracFocus evolved from version 1.0 to 3.0, the percent of invalid forms decreased (Figure 3). In general, the percentage of forms designated as proprietary or trade secret remained relatively unchanged after 2012 at approximately 9% and 2% of total forms, respectively. The percentage of forms entered as confidential has varied over time.

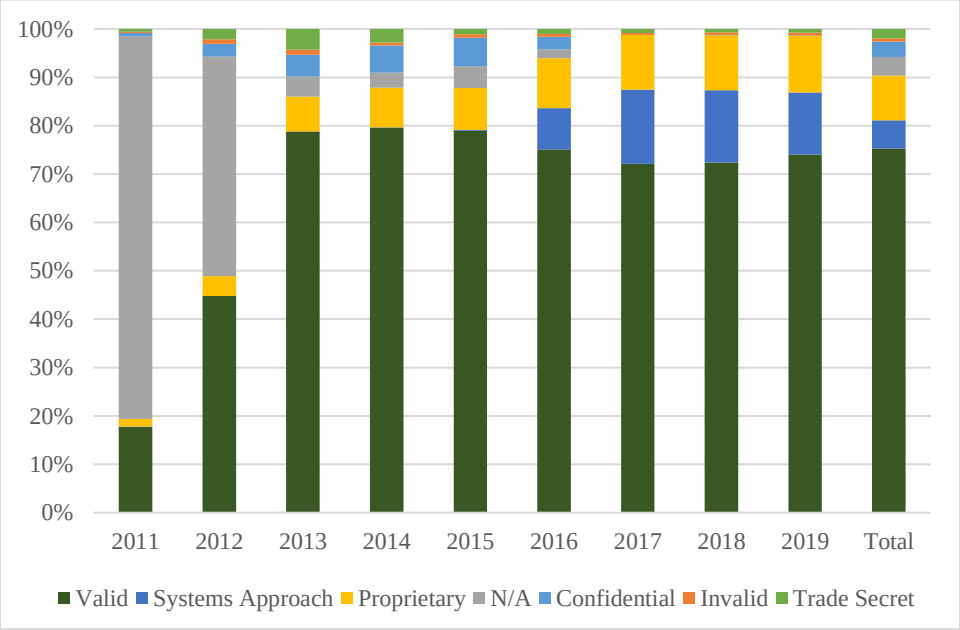

Figure 3. Category of chemical withholding trends over time. 'Valid' includes entries where the CAS number could be validated.

There is variability in withholding trends across states (Figure 4). While the percent of valid forms was relatively similar across states (between 78.2% for Pennsylvania and 69.34% for Colorado), use of the various labels for withheld chemical information varied. The variability in withheld labeling may be because of state legislation. For example, some states allow withholding only trade secret claims, while others allow withholding on trade secret, confidential, and proprietary grounds (Konschnik and Dayalu 2016). Others do not offer guidance on proprietary designations, so designations are left to the discretion of the companies. Regardless of the label used for withholding chemical information, the option to withhold presents challenges for exposure research.

Use of Systems Approach

When looking at disclosure trends over time, we found an increased use of the systems approach after the introduction of FracFocus version 3.0 in 2016. This finding is similar to those reported in Trickey et al., (2020). While the systems approach option was available in FracFocus 2.0, it represented a very small percentage of forms (e.g., only 0.2% in 2015 and 12.9% in 2019).

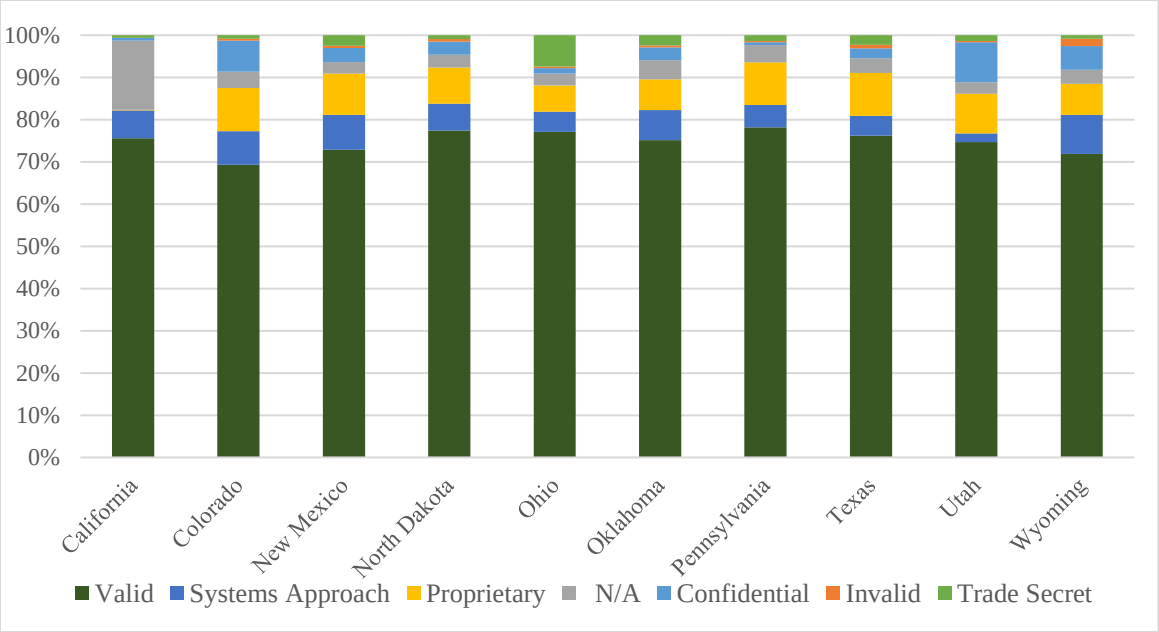

Figure 4. Data withholding by state for all years

We noted variation in the use of the systems approach across states and time (Figure 5), which may reflect differences in state regulation. For example, after California introduced its mandatory reporting system in 2016, use of the systems approach increased in the state. This could be attributed to the fact that the new California reporting structure was more like the systems approach than the traditional reporting method used in FracFocus (Trickey et al. 2020). As noted earlier, we omitted the data entered using the systems approach from this review because operators are not required to enter CAS numbers, which are important for confirming chemical identity. With the increasing use of the systems approach, it will be useful to identify ways to extract and process those data.

Some have argued that use of the systems approach would decrease the number of withheld chemicals (FracFocus Chemical Disclosure Registry 2015) because chemicals can be reported without their formulas or functions in the fracturing fluid, thereby offering protection for proprietary formulations. Trickey et al. (2020) investigated if the systems approach model affected the frequency of withholding between 2011-2018. They found that by 2018, a larger percentage of systems approach forms had a chemical withheld compared to traditional forms for a single fracturing job. However, both types of forms had a lower percentage of forms with at least one withheld chemical in 2018 compared to 2011.

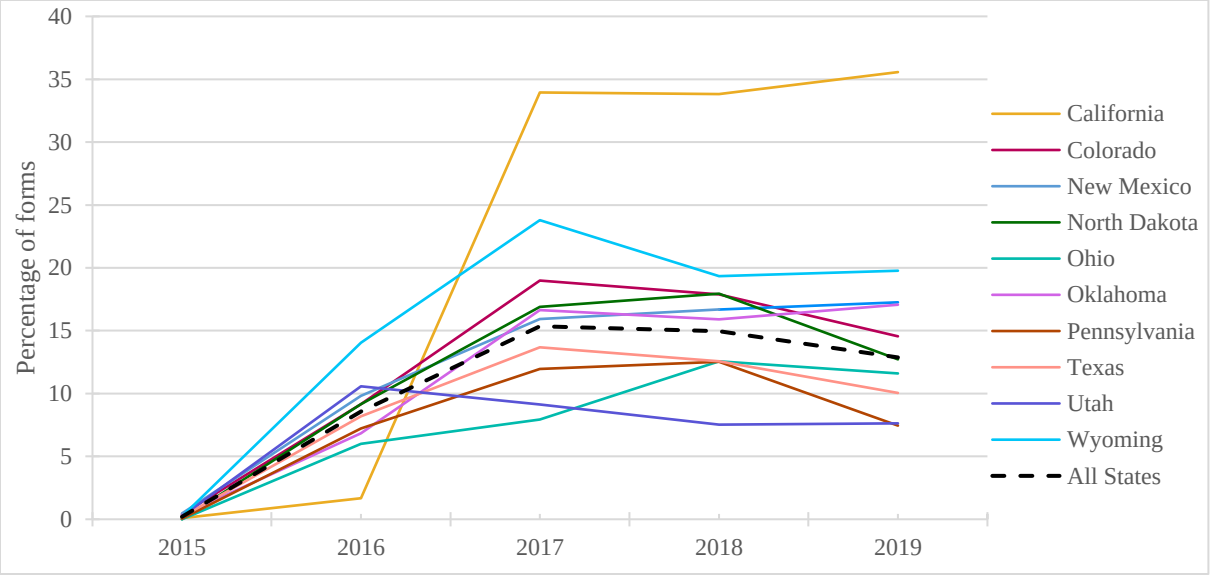

Figure 5. Percentage of forms submitted using systems approach from 2015-2019

Most Frequently Reported Chemicals

We examined the most frequently reported chemicals over time and across the 10 states with the greatest number of submitted forms (Table 2 and Appendix B). Water (CAS number: 7732-18-5) and quartz sand (CAS number: 14808-60-7) were the most frequently reported two CAS numbers each year and so were not included in Table 2. Otherwise, the chemical composition of hydraulic fracturing fluid varied between 2011 and 2019 and across locations.

Utility of FracFocus for Exposure Research

The HFF composition data reported in FracFocus presents a multitude of opportunities for exposure research. Investigators can identify potential study locations and target chemicals for analysis by examining trends in chemical use by purpose over time and across regions. The FracFocus database can help researchers identify the states with the most rigorous reporting requirements, understand how chemical composition varies among operators, and identify locations with the greatest number of fracturing jobs in specific periods. For our exploratory analysis on chemical use over time and across states, we omitted systems approach data. However, performing extensive data quality control will allow future research to utilize systems approach entries for a more complete picture of HFF chemical composition.

On the other hand, the data available from FracFocus are challenging to validate. Some fields can be compared to data submitted to other reporting databases (Elsner and Hoelzer 2016); however, this approach may present other data access issues and may not be an option for validating all data in FracFocus. Adding to the challenge of validation, operators can change form entries by re-submitting forms. In earlier versions of the FracFocus data entry form, submission dates were included with the form, allowing researchers to identify pairs of updated and original forms (Konschnik and Dayalu 2016). However, the form submission date was removed in FracFocus version 3.0.

FracFocus has the potential to be an important resource for assessment of exposure to chemicals in HFF, but users need to understand the regulatory context for the data, how the system has changed over time, and its utility and drawbacks for conducting exposure research.

Table 2. Top 20 most frequently reported CAS numbers over time and chemical names*

Rank	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total for All Years
1	Methanol 67-56-1	Methanol 67-56-1	Methanol 67-56-1	Methanol 67-56-1	Methanol 67-56-1	Distillates (petroleum), hydrotreated light 64742-47-8	Distillates (petroleum), hydrotreated light 64742-47-8	Distillates (petroleum), hydrotreated light 64742-47-8	Distillates (petroleum), hydrotreated light 64742-47-8	Methanol 67-56-1
2	Distillates (petroleum), hydrotreated light 64742-47-8	Distillates (petroleum), hydrotreated light 64742-47-8	Distillates (petroleum), hydrotreated light 64742-47-8	Distillates (petroleum), hydrotreated light 64742-47-8	Distillates (petroleum), hydrotreated light 64742-47-8	Methanol 67-56-1	Methanol 67-56-1	Methanol 67-56-1	Methanol 67-56-1	Distillates (petroleum), hydrotreated light 64742-47-8
3	Ethylene glycol 107-21-1	Hydrogen chloride 7647-01-0	Hydrogen chloride 7647-01-0	Hydrogen chloride 7647-01-0	Hydrogen chloride 7647-01-0	Hydrogen chloride 7647-01-0	Hydrogen chloride 7647-01-0	Hydrogen chloride 7647-01-0	Hydrogen chloride 7647-01-0	Hydrogen chloride 7647-01-0
4	Sodium chloride 7647-14-5	Isopropyl alcohol 67-63-0	Isopropyl alcohol 67-63-0	Isopropyl alcohol 67-63-0	Sodium chloride 7647-14-5	Sodium chloride 7647-14-5	Isopropyl alcohol 67-63-0	Isopropyl alcohol 67-63-0	Isopropyl alcohol 67-63-0	Isopropyl alcohol 67-63-0
5	Ethanol 64-17-5	Sodium chloride 7647-14-5	Ethylene glycol 107-21-1	Sodium chloride 7647-14-5	Isopropyl alcohol 67-63-0	Isopropyl alcohol 67-63-0	Sodium chloride 7647-14-5	Sodium chloride 7647-14-5	Ethylene glycol 107-21-1	Sodium chloride 7647-14-5
6	Hydrogen chloride 7647-01-0	Ethylene glycol 107-21-1	Sodium chloride 7647-14-5	Ethylene glycol 107-21-1	Ethylene glycol 107-21-1	Guar gum 9000-30-0	Ethylene glycol 107-21-1	Ethylene glycol 107-21-1	Sodium chloride 7647-14-5	Ethylene glycol 107-21-1
7	Guar gum 9000-30-0	Guar gum 9000-30-0	Diammonium peroxodisulphate 7727-54-0	Diammonium peroxodisulphate 7727-54-0	Sodium hydroxide 1310-73-2	Sodium hydroxide 1310-73-2	Guar gum 9000-30-0	Guar gum 9000-30-0	Ammonium chloride 12125-02-9	Guar gum 9000-30-0
8	Isopropyl alcohol 67-63-0	Ethanol 64-17-5	Guar gum 9000-30-0	Guar gum 9000-30-0	Guar gum 9000-30-0	Ethylene glycol 107-21-1	Sodium hydroxide 1310-73-2	Ethanol 64-17-5	Sodium hydroxide 1310-73-2	Sodium hydroxide 1310-73-2
9	Citric acid 77-92-9	Diammonium peroxodisulphate 7727-54-0	Sodium hydroxide 1310-73-2	Sodium hydroxide 1310-73-2	Diammonium peroxodisulphate 7727-54-0	Ethanol 64-17-5	Ethoxylated 68551-12-2	Sodium hydroxide 1310-73-2	Acetic acid 64-19-7	Diammonium peroxodisulphate 7727-54-0
10	Glutaral 111-30-8	Potassium hydroxide 1310-58-3	Potassium hydroxide 1310-58-3	Acetic acid 64-19-7	Acetic acid 64-19-7	Acetic acid 64-19-7	Ethanol 64-17-5	Glutaraldehyde 111-30-8	Glutaraldehyde 111-30-8	Acetic acid 64-19-7
11	Potassium hydroxide 1310-58-3	2-Butoxyethanol 111-76-2	Acetic acid 64-19-7	2-Butoxyethanol 111-76-2	Ethanol 64-17-5	Diammonium peroxodisulphate 7727-54-0	Glutaraldehyde 111-30-8	Ethoxylated 68551-12-2	Ethanol 64-17-5	Ethanol 64-17-5
12	Sodium hydroxide 1310-73-2	Sodium hydroxide 1310-73-2	Propargyl alcohol 107-19-7	Ammonium chloride 12125-02-9	Ammonium chloride 12125-02-9	Ethoxylated 68551-12-2	Acetic acid 64-19-7	Ammonium chloride 12125-02-9	Citric acid 77-92-9	Ammonium chloride 12125-02-9

Table 2. Top 20 most frequently reported CAS numbers over time and chemical names*

Rank	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total for All Years
13	Heavy aromatic solvent naphtha 64742-94-5	Acetic acid 64-19-7	Glutaraldehyde 111-30-8	Propargyl alcohol 107-19-7	Propargyl alcohol 107-19-7	Ammonium chloride 12125-02-9	Diammonium peroxodisulphate 7727-54-0	Acetic acid 64-19-7	Benzyl-C12-16-alkyldimethyl 68424-85-1	Propargyl alcohol 107-19-7
14	Acetic acid 64-19-7	Citric acid 77-92-9	Ethanol 64-17-5	Potassium hydroxide 1310-58-3	2-Butoxyethanol 111-76-2	Propargyl alcohol 107-19-7	Ammonium chloride 12125-02-9	Benzyl-C12-16-alkyldimethyl 68424-85-1	Guar gum 9000-30-0	Glutaraldehyde 111-30-8
15	Sodium chlorite 7758-19-2	Ammonium chloride 12125-02-9	2-Butoxyethanol 111-76-2	Citric acid 77-92-9	Citric acid 77-92-9	Glutaraldehyde 111-30-8	Propargyl alcohol 107-19-7	Propargyl alcohol 107-19-7	Didecyl dimethyl ammonium chloride 7173-51-5	Ethoxylated 68551-12-2
16	Naphthalene 91-20-3	Glutaraldehyde 111-30-8	Citric acid 77-92-9	Ethanol 64-17-5	Ethoxylated 68551-12-2	Citric acid 77-92-9	Citric acid 77-92-9	Diammonium peroxodisulphate 7727-54-0	Ethoxylated 68551-12-2	Citric acid 77-92-9
17	2-Butoxyethanol 111-76-2	Propargyl alcohol 107-19-7	Ammonium chloride 12125-02-9	Sorbitan laurate 1338-43-8	Glutaraldehyde 111-30-8	2-Butoxyethanol 111-76-2	Benzyl-C12-16-alkyldimethyl 68424-85-1	Citric acid 77-92-9	Propargyl alcohol 107-19-7	2-Butoxyethanol 111-76-2
18	Potassium carbonate 584-08-7	Naphthalene 91-20-3	Sorbitan laurate 1338-43-8	Glutaraldehyde 111-30-8	Potassium hydroxide 1310-58-3	Benzyl-C12-16-alkyldimethyl 68424-85-1	Cinnamaldehyde 104-55-2	Alcohols, C11-14-iso-, C13-rich, ethoxylated 78330-21-9	Ammonium peroxydisulfate 7727-54-0	Potassium hydroxide 1310-58-3
19	Polyethylene glycol mono ether 127087-87-0	Ethoxylated 68551-12-2	Ethoxylated 68551-12-2	Ethoxylated 68551-12-2	Sorbitan laurate 1338-43-8	Ethoxylated C10-16 alcohols 68002-97-1	Ethoxylated C10-16 alcohols 68002-97-1	Cinnamaldehyde 104-55-2	Cinnamaldehyde 104-55-2	Sorbitan laurate 1338-43-8
20	1,2,4-Trimethylbenzene 95-63-6	Heavy aromatic solvent naphtha 64742-94-5	Thiourea 68527-49-1	Thiourea 68527-49-1	Thiourea 68527-49-1	Acrylamide 79-06-1	2-Butoxyethanol 111-76-2	Didecyl dimethyl ammonium chloride 7173-51-5	Polyethylene glycol mono ether 127087-87-0	Benzyl-C12-16-alkyldimethyl 68424-85-1

* The CAS numbers for water and quartz sand were the top 2 reported CAS numbers for all years and were removed from the table.

SUMMARY AND NEXT STEPS

Results from this review of FracFocus data represent an initial step in understanding the information available in the database and how the database might be useful to scientists conducting exposure research. Moving forward, it will be useful to further contextualize the information found in the database with changes in state regulations and reporting requirements and documentation to gain a better understanding of how and why HFF composition varies over time and across locations. For example, the database could be useful in tracking the introduction of new HFF mixtures over time as technology advances and regulations change.

In addition, Yost et al. (2016) used a decision framework based on toxicity, frequency of use, and physicochemical properties of HFF chemicals reported in FracFocus version 1.0 to identify chemicals of potential concern for human health. A continuation or expansion of this work to include data from later versions of FracFocus and other HFF repositories could expand understanding of the distribution and frequency of use of HFF chemicals across the country. This information could help exposure scientists select chemical analytes to include in their research.

Hydraulic fracturing processes are limited to well pads, so exposure beyond the worker population is not expected under typical operating conditions. However, U.S. EPA (2016) discussed the potential for releases during hydraulic fracturing associated with spills or leaks during fluid transport on or off the well pad. Spilled or leaked chemicals can be transported via subsurface and surface pathways and lead to contamination of drinking water resources (Vengosh et al., 2014). Combining FracFocus data with measurement and geochemical modeling approaches can further help define likelihood and pathways of potential groundwater and surface water contamination, and thus, the potential for human exposure.

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HEI ENERGY BOARD, RESEARCH COMMITTEE, AND STAFF

APPENDIX A: FRACFOCUS 3 FORM FIELDS AND DESCRIPTION

Variable[#]	Description	Validation check^[#]
JobStartDate	The date on which the hydraulic fracturing job was initiated. Does not include site preparation or setup.	Date must be less than or equal to JobEndDate
JobEndDate	The date on which the hydraulic fracturing job was completed. Does not include site teardown.	Date must be greater than or equal to JobStartDate
APINumber	The American Petroleum Institute well identification number formatted as follows xx-xxx-xxxxx0000 Where: First two digits represent the state, second three digits represent the county, third 5 digits represent the well.	-Must conform to State and County API Reference Combinations -14 Digit Number
StateNumber	The first two digits of the API number. Range is from 01-50.	
CountyNumber	The 3-digit county code.	
OperatorNumber*	The unique number corresponding to the name of the operator.	Must match assigned number provided by System to a Registered Operator
WellName	The name of the well.	Non-Null value
Latitude	Latitude is typically expressed in degrees North/South. In the FracFocus system these lines are shown in decimal degrees and must be between 15 and 75.	Cross reference with bounding coordinates of identified API County to determine if provided location matches provided State/County
Longitude	Longitude is typically expressed in degrees East/ West. In the FracFocus system the number representing these lines are shown in decimal degrees and must be between -180 and -163. Note: Longitude number must be preceded by a negative sign.	Cross reference with bounding coordinates of identified API County to determine if provided location matches provided State/County
Projection	The geographic coordinate system to which the latitude and longitude are related. In the FracFocus system the projection systems allowed are NAD (North American Datum) 27 or 83 and UTM (Universal Transverse Mercator).	
TVD	The vertical distance from a point in the well (usually the current or final depth) to a point at the surface, usually the elevation of the rotary kelly bushing (in feet).	Must be greater than or equal to 1
TotalBaseWaterVolume	The total volume of water used as a carrier fluid for the hydraulic fracturing job (in gallons).	Must be greater than or equal to zero
TotalBaseNonWaterVolume	The total volume of non-water components used as a carrier fluid for the hydraulic fracturing job (in gallons)	Must be greater than or equal to zero
StateName	The name of the state where the surface location of the well resides. Derived from the API number.	
CountyName	The name of the county where the surface location of the well occurs. Derived from the API number.	

FFVersion	A key which designates which version of FracFocus was used when the disclosure was submitted.	
FederalWell	True = Yes, False = No.	
TradeName	The name of the product as defined by the supplier	Non-Null value
Supplier	The name of the company that supplied the product for the hydraulic fracturing job (Usually the service company)	Non-Null value
Purpose*	The reason the product was used (e.g. Surfactant, Biocide, Proppant)	Non-Null value
IngredientName*	Name of the chemical or for Trade Secret chemicals the chemical family name	A Value is Required
CASNumber*	The Chemical Abstract Service identification number. Non-CAS Number values accepted are “Trade Secret”, ”CBI”, ”Proprietary”, ”CAS Not Assigned, ”Listed Below”, ”NA”	-If a numeric CAS Number is supplied (i.e., not CBI or Proprietary) it must conform to CAS Number Format -Verification Digit on CAS Number will be tested
PercentHighAdditive	The percent of the ingredient in the Trade Name product (Top of the range from MSDS)	Must be greater than or equal to zero
PercentHFJob	The amount of the ingredient in the total hydraulic fracturing volume in percent by Mass	Must be greater than or equal to zero
IngredientComment	Any comments related to the specific ingredient.	
MassIngredient	Mass of the ingredient used in job for the specific purpose listed, in pounds (Lbs). This information is only needed if a recalculation of Mass is to be performed.	
ClaimantCompany	Required when using Trade Secret, Proprietary, CBI, CAS Not Assigned or NA type ingredients.	

(FracFocus Chemical Disclosure Registry 2016)
^Describes the conditions for which the online system will return an “error” for the submissions. When an error occurs in the online submission of a form, the form cannot be submitted to the FracFocus database until the error is resolved. This is a feature introduced with FracFocus 3.0.
*Required field for submission to FracFocus database

APPENDIX B: TOP 20 CHEMICALS BY STATE

California

Table B1. Top 20 Chemicals used over time in California

Rank	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total	Chemical Names for Total
0	14808-60-7	14808-60-7	14808-60-7	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	Water
0	7732-18-5	67-56-1	7732-18-5	14808-60-7	14808-60-7	14808-60-7	14808-60-7	7647-14-5	7647-14-5	14808-60-7	Quartz
1	67-56-1	7727-54-0	91053-39-3	91053-39-3	9000-30-0	9000-30-0	9000-30-0	9000-30-0	9000-30-0	9000-30-0	Guar gum
2	9025-56-3	9003-35-4	9000-30-0	9000-30-0	7727-54-0	7647-14-5	7647-14-5	1310-73-2	1113-55-9	1310-73-2	Sodium hydroxide
3	7727-54-0	9000-30-0	1310-73-2	7727-54-0	91053-39-3	1310-73-2	1310-73-2	1113-55-9	10222-01-2	91053-39-3	Kieselguhr, calcined
4	91053-39-3	7631-86-9	7727-54-0	64742-47-8	14464-46-1	7727-54-0	1113-55-9	10222-01-2	1310-73-2	7727-54-0	Ammonium peroxydisulfate
5	5131-66-8	1303-96-4	107-21-1	64742-55-8	64742-47-8	91053-39-3	10222-01-2	14808-60-7	14808-60-7	64742-47-8	Hydrotreated light distillates (petroleum)
6	9003-35-4	56-81-5	64742-47-8	7647-14-5	64742-55-8	14464-46-1	9012-54-8	9012-54-8	9012-54-8	14464-46-1	Cristobalite
7	584-08-7	67-63-0	14464-46-1	14464-46-1	10377-60-3	64742-55-8	7757-82-6	63-42-3	63-42-3	9043-30-5	Polyethylene glycol monoisotridecyl ether
8	10043-35-3	78330-21-9	10377-60-3	10377-60-3	2682-20-4	10377-60-3	7775-27-1	12125-02-9	12125-02-9	10377-60-3	Magnesium nitrate
9	111-76-2	14807-96-6	26172-55-4	2682-20-4	7786-30-3	2682-20-4	26038-87-9	7757-82-6	7757-82-6	2682-20-4	2-Methyl-3(2H)-isothiazolone
10	9000-30-0	25038-72-6	2682-20-4	7786-30-3	26172-55-4	7786-30-3	63-42-3	7775-27-1	7775-27-1	7786-30-3	Magnesium chloride
11	107-21-1	78330-19-5	7786-30-3	26172-55-4	15821-83-7	26172-55-4	12125-02-9	26038-87-9	26062-79-3	26172-55-4	5-Chloro-2-methyl-4-isothiazolin-3-one
12	64742-47-8	7699-43-6	64742-55-8	15821-83-7	9043-30-5	15821-83-7	26062-79-3	26062-79-3	26038-87-9	64742-55-8	Hydrotreated light paraffinic petroleum distillates
13	14464-46-1	55566-30-8	15821-83-7	9043-30-5	1310-73-2	9043-30-5	7447-40-7	2594415	64-19-7	15821-83-7	1-Propanol, 2-butoxy-
14	10377-60-3	91-20-3	9043-30-5	1310-73-2	5131-66-8	5131-66-8	9003-35-4	7631-90-5	67-56-1	7647-14-5	Sodium chloride
15	26172-55-4	64742-94-5	5131-66-8	107-21-1	55636-09-4	55636-09-4	100-97-0	67-56-1	111-30-8	107-21-1	Ethylene glycol
16	2682-20-4	25322-68-3	138879-94-4	1303-96-4	1303-96-4	56-81-5	67-63-0	111-30-8	64-17-5	1303-96-4	Borax
17	7786-30-3	30846-35-6	9025-56-3	9025-56-3	107-21-1	37288-54-3	61791-12-6	64-17-5	68424-85-1	5131-66-8	1-Butoxy-2-propanol
18	64742-55-8	68989-00-4	1303-96-4	13598-36-2	13598-36-2	64742-47-8	1319-33-1	68424-85-1	7664-38-2	9025-56-3	Hemicellulase
19	15821-83-7	78330-20-8	13598-36-2	6419-19-8	6419-19-8	1303-96-4	7758-19-2	7664-38-2	2594415	13598-36-2	Phosphonic acid
20	9043-30-5	7722-84-1	67-56-1	138879-94-4	9025-56-3	107-21-1	68647-72-3	13197-76-7	7631-90-5	6419-19-8	Aminotri(methylene phosphonic acid)
Total Forms	65	26	14566	19411	17594	3552	2590	4367	3873	66044	
Total CAS #s	38	26	198	191	137	42	57	77	53	293	

Colorado

Table B2. Top 20 Chemicals used over time in Colorado											
Rank	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total	Chemical Names for Total
0	14808-60-7	14808-60-7	14808-60-7	14808-60-7	14808-60-7	64742-47-8	64742-47-8	64742-47-8	64742-47-8	14808-60-7	Quartz
0	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	Water
1	67-56-1	7647-14-5	7647-14-5	7647-14-5	64742-47-8	14808-60-7	14808-60-7	14808-60-7	7647-01-0	64742-47-8	Hydrotreated light distillates (petroleum)
2	64-17-5	64-17-5	64742-47-8	64742-47-8	7647-14-5	67-56-1	67-56-1	7647-01-0	14808-60-7	67-56-1	Methanol
3	7647-14-5	12125-02-9	67-56-1	12125-02-9	67-56-1	7647-01-0	7647-01-0	67-56-1	67-56-1	67-63-0	Isopropanol
4	12125-02-9	67-56-1	12125-02-9	67-56-1	7647-01-0	67-63-0	67-63-0	67-63-0	67-63-0	7647-14-5	Sodium chloride
5	127087-87-0	64742-47-8	64-17-5	67-63-0	67-63-0	7647-14-5	7647-14-5	107-21-1	1310-73-2	7647-01-0	Hydrochloric acid
6	64742-94-5	67-63-0	67-63-0	631-61-8	64-17-5	127087-87-0	64-17-5	64-17-5	64-17-5	64-17-5	Ethanol
7	67-63-0	631-61-8	631-61-8	64-17-5	64742-94-5	64-17-5	107-21-1	104-55-2	15619-48-4	12125-02-9	Ammonium chloride
8	7647-01-0	68909-34-2	1338-43-8	64-19-7	127087-87-0	95-63-6	127087-87-0	34590-94-8	127087-87-0	127087-87-0	Polyethylene glycol mono(branched p-nonylphenyl) ether
9	91-20-3	68647-72-3	9005-65-6	1338-43-8	91-20-3	64742-94-5	1310-73-2	64-18-6	12125-02-9	91-20-3	Naphthalene
10	95-63-6	7758-19-2	68551-12-2	9005-65-6	95-63-6	91-20-3	64742-94-5	68551-12-2	91-20-3	64742-94-5	Heavy aromatic solvent naphtha (petroleum)
11	1310-73-2	64-19-7	64-19-7	7647-01-0	12125-02-9	15619-48-4	91-20-3	7647-14-5	95-63-6	95-63-6	1,2,4-Trimethylbenzene
12	64742-47-8	1338-43-8	64742-94-5	91-20-3	631-61-8	12125-02-9	68551-12-2	72480-70-7	64742-94-5	68551-12-2	Ethoxylated C12-16 alcohols
13	7681-52-9	91-20-3	91-20-3	68551-12-2	64-19-7	68551-12-2	95-63-6	15619-48-4	61791-26-2	631-61-8	Ammonium acetate
14	100-97-0	64742-94-5	7647-01-0	64742-94-5	7758-19-2	10222-01-2	34590-94-8	12125-02-9	107-21-1	1338-43-8	Sorbitan monooleate
15	15619-48-4	7647-01-0	127087-87-0	127087-87-0	68909-34-2	68410-62-8	15619-48-4	127087-87-0	81741-28-8	64-19-7	Acetic acid
16	61791-26-2	95-63-6	95-63-6	95-63-6	68551-12-2	61791-26-2	104-55-2	81741-28-8	31512-74-0	107-21-1	Ethylene glycol
17	631-61-8	9003-35-4	7758-19-2	7758-19-2	7631-86-9	7681-82-5	10222-01-2	1310-73-2	104-55-2	1310-73-2	Sodium hydroxide
18	64-19-7	127087-87-0	7727-54-0	68909-34-2	144-55-8	7722-76-1	64-18-6	91-20-3	7647-14-5	9005-65-6	Polysorbate 80
19	68410-62-8	68551-12-2	68909-34-2	1310-73-2	15619-48-4	7758-19-2	72480-70-7	64742-94-5	34590-94-8	7758-19-2	Sodium chlorite
20	68551-12-2	9005-65-6	68647-72-3	7727-54-0	10222-01-2	64-19-7	61791-26-2	95-63-6	7681-82-5	15619-48-4	1-Benzylquinolinium chloride
Total # Forms	148	6366	42054	52816	31299	22242	34867	36409	29065	255266	
Total CAS #s	47	212	321	340	305	245	247	201	189	529	

New Mexico

Table B3. Top 20 Chemicals used over time in New Mexico

Rank	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total	Chemical Names for Total
0	14808-60-7	7732-18-5	14808-60-7	14808-60-7	14808-60-7	14808-60-7	14808-60-7	14808-60-7	14808-60-7	14808-60-7	Quartz
0	7732-18-5	14808-60-7	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	Water
1	67-56-1	67-56-1	67-56-1	67-56-1	67-56-1	7647-01-0	64742-47-8	64742-47-8	67-56-1	67-56-1	Methanol
2	64-17-5	64742-47-8	7647-01-0	67-63-0	64742-47-8	64742-47-8	67-56-1	67-56-1	64742-47-8	64742-47-8	Hydrotreated light distillates (petroleum)
3	67-63-0	7647-14-5	107-21-1	64742-47-8	7647-14-5	67-56-1	7647-01-0	7647-01-0	7647-01-0	7647-01-0	Hydrochloric acid
4	68647-72-3	7647-01-0	64742-47-8	7727-54-0	7647-01-0	1310-73-2	111-30-8	111-30-8	111-30-8	67-63-0	Isopropanol
5	7647-01-0	9000-30-0	9000-30-0	107-21-1	67-63-0	107-21-1	68551-12-2	68551-12-2	68551-12-2	7647-14-5	Sodium chloride
6	77-92-9	1310-58-3	7727-54-0	9000-30-0	7727-54-0	64-19-7	7647-14-5	67-63-0	67-63-0	9000-30-0	Guar gum
7	108-24-7	7727-54-0	7647-14-5	7647-01-0	107-21-1	7647-14-5	12125-02-9	12125-02-9	68424-85-1	107-21-1	Ethylene glycol
8	64-19-7	107-21-1	67-63-0	7647-14-5	9000-30-0	9000-30-0	64-19-7	68424-85-1	12125-02-9	7727-54-0	Ammonium peroxydisulfate
9	64742-48-9	64-19-7	107-19-7	67-48-1	1310-73-2	68551-12-2	107-21-1	7647-14-5	68002-97-1	111-30-8	Glutaraldehyde
10	7727-37-9	67-63-0	68527-49-1	1310-73-2	1310-58-3	67-63-0	64-17-5	1310-73-2	7647-14-5	1310-73-2	Sodium hydroxide
11	107-19-7	12125-02-9	1310-73-2	9016-45-9	107-19-7	107-19-7	9000-30-0	64-17-5	1310-73-2	68551-12-2	Ethoxylated C12-16 alcohols
12	111-46-6	91053-39-3	50-00-0	107-19-7	68551-12-2	12125-02-9	68424-85-1	9000-30-0	107-19-7	107-19-7	Propargyl alcohol
13	111-76-2	107-19-7	111-30-8	1310-58-3	1338-43-8	7727-54-0	107-19-7	68002-97-1	64-19-7	12125-02-9	Ammonium chloride
14	9012-54-8	10043-52-4	67-48-1	64742-94-5	67-48-1	77-92-9	67-63-0	78330-21-9	68439-50-9	64-17-5	Ethanol
15	52-51-7	1338-43-8	9016-45-9	25322-68-3	64-02-8	64-17-5	1310-73-2	68439-50-9	78330-21-9	64-19-7	Acetic acid
16	7447-40-7	25322-68-3	8042-47-5	91-20-3	111-76-2	68527-49-1	7727-54-0	79-06-1	9000-30-0	68424-85-1	Quaternary ammonium compounds, benzyl-C12-16-alkyldimethyl, chlorides
17	9003-35-4	81741-28-8	1310-58-3	111-30-8	12125-02-9	56-81-5	68002-97-1	107-21-1	64-17-5	67-48-1	Choline chloride
18	107-21-1	64-17-5	64742-55-8	50-00-0	56-81-5	1338-43-8	68527-49-1	64-19-7	79-06-1	68527-49-1	Thiourea, polymer with formaldehyde and 1-phenylethanone
19	26038-87-9	7775-27-1	91053-39-3	9003-35-4	77-92-9	10486-00-7	68439-50-9	107-19-7	7173-51-5	1310-58-3	Potassium hydroxide
20	64742-94-5	111-30-8	57-55-6	68527-49-1	7757-82-6	64-02-8	1338-43-8	104-55-2	7727-54-0	77-92-9	Citric acid
Total # Forms	354	1505	19257	24745	20920	9984	13554	23937	19886	134142	
Total CAS #s	50	161	334	367	391	276	307	304	286	637	

North Dakota

Table B4. Top 20 Chemicals used over time in North Dakota

Rank	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total	Chemical Names for Total
0	14808-60-7	14808-60-7	14808-60-7	14808-60-7	14808-60-7	14808-60-7	14808-60-7	64742-47-8	14808-60-7	14808-60-7	Quartz
0	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	Water
1	7647-14-5	9000-30-0	67-56-1	67-56-1	64742-47-8	64742-47-8	64742-47-8	14808-60-7	67-56-1	64742-47-8	Hydrotreated light distillates (petroleum)
2	64-17-5	7647-14-5	64742-47-8	64742-47-8	67-56-1	67-56-1	67-56-1	7647-01-0	64742-47-8	67-56-1	Methanol
3	67-56-1	67-63-0	7647-14-5	7647-14-5	7647-14-5	7647-14-5	7647-01-0	67-56-1	7647-01-0	7647-14-5	Sodium chloride
4	1310-58-3	64742-47-8	67-63-0	1310-73-2	1310-73-2	1310-73-2	107-21-1	64-17-5	77-92-9	7647-01-0	Hydrochloric acid
5	9000-30-0	7631-86-9	9000-30-0	67-63-0	9000-30-0	7647-01-0	64-17-5	77-92-9	64-17-5	107-21-1	Ethylene glycol
6	127087-87-0	7727-54-0	107-21-1	9000-30-0	107-21-1	107-21-1	1310-73-2	67-63-0	67-63-0	1310-73-2	Sodium hydroxide
7	64742-94-5	1310-58-3	1310-73-2	1310-58-3	7647-01-0	9000-30-0	7647-14-5	107-21-1	111-30-8	67-63-0	Isopropanol
8	7631-86-9	1309-37-1	1310-58-3	107-21-1	67-63-0	64-17-5	9000-30-0	78330-21-9	107-21-1	9000-30-0	Guar gum
9	91-20-3	1344-28-1	7727-54-0	12125-02-9	64-17-5	77-92-9	77-92-9	68551-12-2	78330-21-9	64-17-5	Ethanol
10	95-63-6	13463-67-7	64-17-5	7647-01-0	1319-33-1	95-63-6	111-30-8	111-30-8	79-06-1	7727-54-0	Ammonium peroxydisulfate
11	13709-94-9	64-17-5	7631-86-9	7631-86-9	1310-58-3	7727-54-0	67-63-0	1338-43-8	1338-43-8	12125-02-9	Ammonium chloride
12	14464-46-1	107-21-1	91-20-3	7727-54-0	12125-02-9	68551-12-2	12125-02-9	7647-14-5	61791-26-2	1310-58-3	Potassium hydroxide
13	7758-19-2	91-20-3	64742-94-5	1338-43-8	7727-54-0	111-30-8	7727-54-0	104-55-2	68424-85-1	7631-86-9	Silica
14	584-08-7	68953-58-2	12125-02-9	104-76-7	7631-86-9	67-63-0	68551-12-2	1310-73-2	104-55-2	111-30-8	Glutaraldehyde
15	1302-93-8	64742-94-5	1338-43-8	91-20-3	91-20-3	1319-33-1	104-55-2	79-06-1	9051-89-2	77-92-9	Citric acid
16	590-29-4	10222-01-2	95-63-6	64742-94-5	64742-94-5	12125-02-9	7173-51-5	64742-94-5	34590-94-8	91-20-3	Naphthalene
17	1302-76-7	127087-87-0	7758-19-2	68551-12-2	95-63-6	7758-19-2	1319-33-1	91-20-3	12125-02-9	64742-94-5	Heavy aromatic solvent naphtha (petroleum)
18	68953-58-2	95-63-6	7647-01-0	7758-19-2	57-55-6	104-55-2	9051-89-2	68424-85-1	68551-12-2	68551-12-2	Ethoxylated C12-16 alcohols
19	2836-32-0	14464-46-1	64-19-7	64-17-5	104-76-7	1310-58-3	91-20-3	61791-26-2	7647-14-5	1338-43-8	Sorbitan monooleate
20	9004-32-4	7758-19-2	127087-87-0	1302-93-8	7758-19-2	107-19-7	64742-94-5	9051-89-2	64742-94-5	95-63-6	1,2,4-Trimethylbenzene
Total # Forms	1449	4266	55959	78795	51236	23141	35084	39076	30278	319284	
Total CAS #s	87	195	378	385	331	292	279	280	245	563	

Ohio

Table B5. Top 20 Chemicals used over time in Ohio											
Rank	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total	Chemical Names for Total
0	NA	14808-60-7	14808-60-7	14808-60-7	14808-60-7	14808-60-7	64742-47-8	64742-47-8	64742-47-8	14808-60-7	Quartz
0	NA	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	Water
1	NA	107-21-1	7727-54-0	7647-01-0	7647-01-0	64742-47-8	14808-60-7	14808-60-7	14808-60-7	64742-47-8	Hydrotreated light distillates (petroleum)
2	NA	67-56-1	64742-47-8	64742-47-8	64742-47-8	7647-01-0	67-56-1	67-56-1	67-56-1	7647-01-0	Hydrochloric acid
3	NA	7647-01-0	107-21-1	67-56-1	7727-54-0	67-56-1	7647-01-0	7647-01-0	7647-01-0	67-56-1	Methanol
4	NA	64742-47-8	7647-01-0	7727-54-0	7647-14-5	107-21-1	68551-12-2	107-19-7	12125-02-9	107-21-1	Ethylene glycol
5	NA	7727-54-0	9000-30-0	7647-14-5	67-56-1	68551-12-2	68424-85-1	68551-12-2	107-19-7	7727-54-0	Ammonium peroxydisulfate
6	NA	12125-02-9	67-56-1	9000-30-0	9000-30-0	68424-85-1	107-19-7	107-21-1	111-30-8	107-19-7	Propargyl alcohol
7	NA	9000-30-0	111-30-8	107-21-1	107-21-1	64-19-7	12125-02-9	12125-02-9	93-83-4	9000-30-0	Guar gum
8	NA	107-19-7	67-63-0	107-19-7	67-63-0	68002-97-1	64-17-5	68424-85-1	68424-85-1	111-30-8	Glutaraldehyde
9	NA	64-17-5	1310-73-2	12125-02-9	1310-73-2	107-19-7	64-19-7	93-83-4	107-21-1	12125-02-9	Ammonium chloride
10	NA	7647-14-5	64-02-8	111-30-8	111-30-8	64-17-5	107-21-1	77-92-9	61790-12-3	7647-14-5	Sodium chloride
11	NA	77-92-9	7647-14-5	77-92-9	64-02-8	9000-30-0	93-83-4	64-17-5	64-17-5	68551-12-2	Ethoxylated C12-16 alcohols
12	NA	10222-01-2	1310-58-3	67-63-0	6381-77-7	7727-54-0	7173-51-5	111-30-8	68551-12-2	68424-85-1	Quaternary ammonium compounds, benzyl-C12-16-alkyldimethyl, chlorides
13	NA	111-30-8	77-92-9	1310-73-2	7758-98-7	111-30-8	9000-30-0	61790-12-3	77-92-9	64-17-5	Ethanol
14	NA	1310-58-3	68-12-2	68527-49-1	64-17-5	67-63-0	111-30-8	68002-97-1	7647-14-5	77-92-9	Citric acid
15	NA	1310-73-2	107-19-7	64-02-8	10222-01-2	12125-02-9	61790-12-3	9000-30-0	104-76-7	1310-73-2	Sodium hydroxide
16	NA	67-63-0	111-46-6	68551-12-2	10049-04-4	10222-01-2	7727-54-0	104-76-7	68603-42-9	67-63-0	Isopropanol
17	NA	68527-49-1	68527-49-1	68951-67-7	68424-85-1	7647-14-5	77-92-9	7727-54-0	64-19-7	93-83-4	Oleic acid diethanolamide
18	NA	68551-12-2	64-17-5	1310-58-3	7173-51-5	68951-67-7	104-76-7	7173-51-5	7173-51-5	61790-12-3	Tall oil fatty acids
19	NA	68951-67-7	7758-98-7	6381-77-7	111-46-6	68439-50-9	68603-42-9	68603-42-9	68951-67-7	68951-67-7	Ethoxylated C14-15 alcohols
20	NA	7757-82-6	68951-67-7	1338-43-8	107-19-7	7173-51-5	1310-73-2	7647-14-5	50-00-0	64-19-7	Acetic acid
Total # Forms	0	448	8406	13191	10592	6483	10081	9281	7197	65679	
Total CAS #s	0	95	211	253	245	175	192	149	132	406	

Oklahoma

Table B6. Top 20 Chemicals used over time in Oklahoma

Rank	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total	Chemical Names for Total
0	67-56-1	14808-60-7	67-56-1	67-56-1	67-56-1	67-56-1	67-56-1	67-56-1	67-56-1	67-56-1	Methanol
0	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	Water
1	14808-60-7	67-56-1	14808-60-7	14808-60-7	14808-60-7	14808-60-7	14808-60-7	64742-47-8	14808-60-7	14808-60-7	Quartz
2	64742-47-8	64742-47-8	67-63-0	67-63-0	64742-47-8	64742-47-8	64742-47-8	14808-60-7	64742-47-8	64742-47-8	Hydrotreated light distillates (petroleum)
3	107-19-7	7647-01-0	64742-47-8	64742-47-8	67-63-0	7647-01-0	7647-01-0	7647-01-0	7647-01-0	67-63-0	Isopropanol
4	64-17-5	67-63-0	7647-01-0	7647-01-0	7647-01-0	67-63-0	7647-14-5	67-63-0	7647-14-5	7647-01-0	Hydrochloric acid
5	64-19-7	77-92-9	7647-14-5	7647-14-5	7647-14-5	7647-14-5	67-63-0	7647-14-5	67-63-0	7647-14-5	Sodium chloride
6	64742-94-5	7647-14-5	107-21-1	107-21-1	107-21-1	9000-30-0	9000-30-0	127087-87-0	107-19-7	9000-30-0	Guar gum
7	77-92-9	64-19-7	77-92-9	77-92-9	77-92-9	111-76-2	77-92-9	9000-30-0	64-17-5	107-21-1	Ethylene glycol
8	1310-73-2	64-17-5	64-19-7	64-19-7	111-76-2	107-21-1	111-76-2	111-76-2	9000-30-0	77-92-9	Citric acid
9	7647-01-0	10486-00-7	9000-30-0	111-76-2	9000-30-0	77-92-9	64-17-5	107-19-7	64-19-7	111-76-2	Ethylene glycol monobutyl ether
10	10486-00-7	107-19-7	1338-43-8	9000-30-0	64-19-7	7727-54-0	7727-54-0	77-92-9	77-92-9	64-19-7	Acetic acid
11	108-24-7	9000-30-0	64-17-5	107-19-7	107-19-7	64-17-5	107-21-1	7727-54-0	7173-51-5	107-19-7	Propargyl alcohol
12	91-20-3	9043-30-5	68551-12-2	64-17-5	68527-49-1	1310-73-2	12125-02-9	64-17-5	7727-54-0	64-17-5	Ethanol
13	127087-87-0	107-21-1	111-30-8	7727-54-0	12125-02-9	64-19-7	68551-12-2	64-19-7	111-76-2	7727-54-0	Ammonium peroxydisulfate
14	67-63-0	12125-02-9	107-19-7	68527-49-1	64-17-5	111-30-8	107-19-7	107-21-1	12125-02-9	12125-02-9	Ammonium chloride
15	7727-54-0	111-76-2	12125-02-9	111-30-8	1310-73-2	10486-00-7	111-30-8	12125-02-9	111-30-8	111-30-8	Glutaraldehyde
16	95-63-6	64742-94-5	111-76-2	104-55-2	7727-54-0	12125-02-9	64-19-7	104-55-2	68424-85-1	68551-12-2	Ethoxylated C12-16 alcohols
17	107-21-1	7727-54-0	68527-49-1	12125-02-9	68551-12-2	107-19-7	68424-85-1	68-12-2	107-21-1	1310-73-2	Sodium hydroxide
18	7681-52-9	111-30-8	7727-54-0	1338-43-8	10486-00-7	68-12-2	127087-87-0	78-40-0	10486-00-7	68002-97-1	Ethoxylated C10-16 alcohols
19	68424-85-1	25322-68-3	68002-97-1	68551-12-2	64-02-8	68551-12-2	1310-73-2	111-30-8	68002-97-1	68527-49-1	Thiourea, polymer with formaldehyde and 1-phenylethanone
20	7647-14-5	91-20-3	64742-94-5	1310-73-2	10049-04-4	68424-85-1	68002-97-1	72480-70-7	1310-73-2	68424-85-1	Quaternary ammonium compounds, benzyl-C12-16-alkyldimethyl, chlorides
Total # Forms	268	2217	54390	85830	48557	32711	44997	50116	34185	353271	
Total CAS #s	80	228	421	494	439	383	379	363	318	705	

Pennsylvania

Table B7. Top 20 Chemicals used over time in Pennsylvania

Rank	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total	Chemical Names for Total
0	67-56-1	67-56-1	14808-60-7	14808-60-7	14808-60-7	14808-60-7	64742-47-8	64742-47-8	64742-47-8	14808-60-7	Quartz
0	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	Water
1	14808-60-7	7647-01-0	7647-01-0	7647-01-0	7647-01-0	64742-47-8	14808-60-7	14808-60-7	14808-60-7	64742-47-8	Hydrotreated light distillates (petroleum)
2	7647-01-0	14808-60-7	64742-47-8	64742-47-8	64742-47-8	7647-01-0	67-56-1	7647-01-0	7647-01-0	7647-01-0	Hydrochloric acid
3	64742-47-8	64742-47-8	107-21-1	107-21-1	107-21-1	7647-14-5	7647-01-0	67-56-1	67-56-1	107-21-1	Ethylene glycol
4	107-19-7	107-19-7	67-56-1	67-63-0	67-63-0	107-21-1	107-21-1	107-21-1	12125-02-9	67-56-1	Methanol
5	107-21-1	9000-30-0	107-19-7	67-56-1	67-56-1	67-56-1	68551-12-2	68551-12-2	107-21-1	67-63-0	Isopropanol
6	12125-02-9	12125-02-9	67-63-0	107-19-7	107-19-7	68551-12-2	12125-02-9	111-30-8	111-30-8	107-19-7	Propargyl alcohol
7	67-63-0	107-21-1	10222-01-2	10222-01-2	77-92-9	12125-02-9	67-63-0	68424-85-1	77-92-9	12125-02-9	Ammonium chloride
8	7775-27-1	7775-27-1	25322-68-3	25322-68-3	111-76-2	107-19-7	7647-14-5	67-63-0	64-17-5	77-92-9	Citric acid
9	81741-28-8	81741-28-8	111-30-8	77-92-9	12125-02-9	68002-97-1	68002-97-1	93-83-4	93-83-4	68551-12-2	Ethoxylated C12-16 alcohols
10	9000-30-0	67-63-0	77-92-9	111-76-2	10222-01-2	68424-85-1	111-30-8	64-17-5	68551-12-2	111-30-8	Glutaraldehyde
11	9012-54-8	7647-14-5	111-76-2	7647-14-5	68-12-2	111-30-8	93-83-4	77-92-9	68424-85-1	7647-14-5	Sodium chloride
12	77-92-9	77-92-9	12125-02-9	12125-02-9	7647-14-5	64-17-5	68424-85-1	107-19-7	7173-51-5	68424-85-1	Quaternary ammonium compounds, benzyl-C12-16-alkyldimethyl, chlorides
13	111-30-8	111-30-8	9000-30-0	111-30-8	25322-68-3	93-83-4	69418-26-4	7173-51-5	67-63-0	64-17-5	Ethanol
14	111-76-2	25322-68-3	7647-14-5	50-00-0	10124-37-5	50-00-0	107-19-7	12125-02-9	64-18-6	7173-51-5	Didecyl dimethyl ammonium chloride
15	25322-68-3	10222-01-2	68527-49-1	68-12-2	64-19-7	68527-49-1	77-92-9	50-00-0	107-19-7	10222-01-2	2,2-Dibromo-3-nitrilopropionamide
16	68-12-2	50-00-0	64-17-5	68424-85-1	111-30-8	67-63-0	64-17-5	104-55-2	104-55-2	25322-68-3	Polyethylene glycol
17	7647-14-5	68527-49-1	68424-85-1	1338-43-8	68551-12-2	69418-26-4	7173-51-5	68002-97-1	7647-14-5	93-83-4	Oleic acid diethanolamide
18	111-46-6	7727-54-0	68551-12-2	68527-49-1	50-00-0	13477-34-4	104-55-2	64-18-6	72480-70-7	50-00-0	Formaldehyde
19	124-68-5	68951-67-7	50-00-0	64-19-7	631-61-8	7631-99-4	64-18-6	100-41-4	50-00-0	68002-97-1	Ethoxylated C10-16 alcohols
20	1762-95-4	61790-12-3	1310-73-2	631-61-8	72480-70-7	7173-51-5	13477-34-4	68526-83-0	34590-94-8	111-76-2	Ethylene glycol monobutyl ether
Total # Forms	324	1272	21350	26500	17369	13503	19808	22445	17577	140148	
Total CAS #s	51	128	262	236	233	198	182	177	153	409	

Texas

Table B8. Top 20 Chemicals used over time in Texas											
Rank	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total	Chemical Names for Total
0	14808-60-7	14808-60-7	14808-60-7	14808-60-7	14808-60-7	14808-60-7	14808-60-7	14808-60-7	14808-60-7	14808-60-7	Quartz
0	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	Water
1	67-56-1	67-56-1	67-56-1	67-56-1	67-56-1	67-56-1	64742-47-8	64742-47-8	64742-47-8	67-56-1	Methanol
2	64742-47-8	64742-47-8	64742-47-8	64742-47-8	7647-01-0	64742-47-8	67-56-1	67-56-1	67-56-1	64742-47-8	Hydrotreated light distillates (petroleum)
3	107-21-1	7647-01-0	7647-01-0	7647-01-0	64742-47-8	7647-01-0	7647-01-0	7647-01-0	7647-01-0	7647-01-0	Hydrochloric acid
4	7647-01-0	67-63-0	67-63-0	67-63-0	67-63-0	1310-73-2	67-63-0	67-63-0	67-63-0	67-63-0	Isopropanol
5	64-17-5	107-21-1	107-21-1	7647-14-5	1310-73-2	67-63-0	9000-30-0	7647-14-5	64-19-7	7647-14-5	Sodium chloride
6	67-63-0	9000-30-0	7647-14-5	107-21-1	7647-14-5	9000-30-0	1310-73-2	107-21-1	1310-73-2	1310-73-2	Sodium hydroxide
7	77-92-9	7647-14-5	1310-73-2	7727-54-0	9000-30-0	7647-14-5	7647-14-5	9000-30-0	107-21-1	107-21-1	Ethylene glycol
8	111-30-8	111-76-2	7727-54-0	1310-73-2	107-21-1	64-19-7	107-21-1	64-19-7	7647-14-5	9000-30-0	Guar gum
9	9000-30-0	7727-54-0	9000-30-0	9000-30-0	7727-54-0	7727-54-0	64-19-7	1310-73-2	77-92-9	7727-54-0	Ammonium peroxydisulfate
10	68424-85-1	1310-58-3	1310-58-3	64-19-7	64-19-7	107-21-1	7727-54-0	7727-54-0	111-30-8	64-19-7	Acetic acid
11	7647-14-5	77-92-9	107-19-7	1310-58-3	107-19-7	64-17-5	68551-12-2	111-30-8	7173-51-5	107-19-7	Propargyl alcohol
12	64-19-7	1310-73-2	64-19-7	107-19-7	111-76-2	68551-12-2	64-17-5	68424-85-1	111-42-2	111-30-8	Glutaraldehyde
13	1310-73-2	111-30-8	111-30-8	111-76-2	111-30-8	107-19-7	111-30-8	107-19-7	9000-30-0	111-76-2	Ethylene glycol monobutyl ether
14	1310-58-3	64-17-5	111-76-2	111-30-8	64-17-5	111-30-8	107-19-7	64-17-5	7727-54-0	1310-58-3	Potassium hydroxide
15	111-76-2	107-19-7	77-92-9	77-92-9	1310-58-3	111-76-2	68424-85-1	78330-21-9	68424-85-1	77-92-9	Citric acid
16	7758-19-2	64-19-7	64-17-5	1338-43-8	77-92-9	12125-02-9	77-92-9	68551-12-2	12125-02-9	64-17-5	Ethanol
17	7727-54-0	68551-12-2	68527-49-1	68527-49-1	12125-02-9	77-92-9	12125-02-9	12125-02-9	64-17-5	68551-12-2	Ethoxylated C12-16 alcohols
18	9003-35-4	9043-30-5	9003-35-4	64-17-5	68527-49-1	68424-85-1	68002-97-1	7173-51-5	107-19-7	12125-02-9	Ammonium chloride
19	64-18-6	9003-35-4	1338-43-8	12125-02-9	68551-12-2	79-06-1	78330-21-9	79-06-1	104-55-2	68424-85-1	Quaternary ammonium compounds, benzyl-C12-16-alkyldimethyl, chlorides
20	108-24-7	68527-49-1	9016-45-9	68551-12-2	1338-43-8	68002-97-1	111-42-2	77-92-9	68551-12-2	1338-43-8	Sorbitan monooleate
Total # Forms	3190	24974	324357	430172	231369	133766	184517	193075	167514	1692934	
Total CAS #s	242	443	676	732	651	591	573	576	509	1074	

Utah

Table B9. Top 20 Chemicals used over time in Utah											
Rank	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total	Chemical Names for Total
0	7732-18-5	107-21-1	14808-60-7	14808-60-7	14808-60-7	67-56-1	67-56-1	67-56-1	67-56-1	14808-60-7	Quartz
0	14808-60-7	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	Water
1	107-21-1	67-63-0	67-56-1	67-56-1	67-63-0	14808-60-7	7647-14-5	64742-47-8	7647-14-5	67-56-1	Methanol
2	67-56-1	111-76-2	107-21-1	107-21-1	67-56-1	64742-47-8	64742-47-8	7647-14-5	64742-47-8	107-21-1	Ethylene glycol
3	55566-30-8	14808-60-7	7647-01-0	67-63-0	107-21-1	7647-14-5	9000-30-0	67-63-0	14808-60-7	67-63-0	Isopropanol
4	111-76-2	67-56-1	67-63-0	7647-01-0	111-76-2	7647-01-0	14808-60-7	107-19-7	67-63-0	64742-47-8	Hydrotreated light distillates (petroleum)
5	67-63-0	7647-01-0	64742-47-8	111-76-2	7647-01-0	67-63-0	107-19-7	68514-95-4	107-19-7	7647-01-0	Hydrochloric acid
6	9003-35-4	1309-37-1	7647-14-5	64-19-7	64742-47-8	9000-30-0	1310-58-3	14808-60-7	9003-06-9	7647-14-5	Sodium chloride
7	100-97-0	1344-28-1	111-76-2	9000-30-0	7647-14-5	1310-58-3	107-21-1	107-21-1	7647-01-0	111-76-2	Ethylene glycol monobutyl ether
8	1762-95-4	13463-67-7	7727-54-0	64742-47-8	127087-87-0	7727-54-0	9003-06-9	9000-30-0	68514-95-4	9000-30-0	Guar gum
9	25322-68-3	91-20-3	9000-30-0	7647-14-5	77-92-9	64-17-5	67-63-0	9003-06-9	67-48-1	64-19-7	Acetic acid
10	27176-87-0	64742-47-8	64-19-7	95-63-6	64742-94-5	127087-87-0	7647-01-0	7727-54-0	7727-54-0	7727-54-0	Ammonium peroxydisulfate
11	70750-07-1	55566-30-8	91-20-3	64-17-5	91-20-3	68551-12-2	7727-54-0	1310-58-3	64-17-5	77-92-9	Citric acid
12	7647-14-5	104-55-2	77-92-9	77-92-9	64-19-7	77-92-9	31512-74-0	7647-01-0	1310-73-2	91-20-3	Naphthalene
13	7647-01-0	68-12-2	55566-30-8	91-20-3	64-17-5	64742-94-5	68514-95-4	77-92-9	9000-30-0	1310-58-3	Potassium hydroxide
14	77-92-9	25322-68-3	68551-12-2	68551-12-2	9000-30-0	91-20-3	25322-68-3	67-48-1	77-92-9	95-63-6	1,2,4-Trimethylbenzene
15	84133-50-6	77-92-9	64742-94-5	64742-94-5	95-63-6	64-19-7	67-48-1	31512-74-0	25322-68-3	64742-94-5	Heavy aromatic solvent naphtha (petroleum)
16	9016-45-9	106-89-8	64-17-5	68-12-2	68551-12-2	107-21-1	77-92-9	61791-12-6	68424-85-1	64-17-5	Ethanol
17	107-19-7	109-55-7	25322-68-3	104-55-2	108-24-7	107-19-7	1310-73-2	81741-28-8	10043-52-4	68551-12-2	Ethoxylated C12-16 alcohols
18	1303-96-4	64741-67-9	95-63-6	1310-58-3	15619-48-4	95-63-6	13709-94-9	1310-73-2	12125-02-9	25322-68-3	Polyethylene glycol
19	1310-73-2	68139-30-0	127087-87-0	127087-87-0	68410-62-8	61791-26-2	100-41-4	69011-36-5	107-21-1	127087-87-0	Polyethylene glycol mono(branched p-nonylphenyl) ether
20	13598-36-2	68140-01-2	68-12-2	108-24-7	61791-26-2	1310-73-2	81741-28-8	25322-68-3	1310-58-3	104-55-2	Cinnamaldehyde
Total # Forms	124	1713	32017	39715	10373	5412	9765	9049	4314	112482	
Total CAS #s	29	102	225	196	180	196	170	201	140	422	

Wyoming

Table B10. Top 20 Chemicals used over time in Wyoming

Rank	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total	Chemical Names for Total
0	7732-18-5	14808-60-7	14808-60-7	7732-18-5	14808-60-7	7647-14-5	14808-60-7	14808-60-7	67-56-1	14808-60-7	Quartz
0	14808-60-7	7732-18-5	7732-18-5	14808-60-7	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	7732-18-5	Water
1	7647-14-5	67-56-1	7727-54-0	1310-73-2	7647-14-5	14808-60-7	64742-47-8	64742-47-8	14808-60-7	64742-47-8	Hydrotreated light distillates (petroleum)
2	67-56-1	7647-14-5	67-63-0	7727-54-0	64742-47-8	64742-47-8	7647-14-5	67-56-1	107-21-1	7647-14-5	Sodium chloride
3	12125-02-9	64742-47-8	1310-73-2	7647-14-5	7727-54-0	7681-52-9	67-56-1	7647-14-5	64742-47-8	1310-73-2	Sodium hydroxide
4	64-17-5	64-17-5	9000-30-0	64742-47-8	1310-73-2	1310-73-2	1310-73-2	1310-73-2	1310-73-2	67-56-1	Methanol
5	7727-54-0	91-20-3	64742-47-8	9000-30-0	9000-30-0	7757-82-6	7681-52-9	67-63-0	7647-01-0	7727-54-0	Ammonium peroxydisulfate
6	64742-47-8	1310-73-2	67-56-1	67-63-0	67-56-1	95-63-6	67-63-0	7727-54-0	12125-02-9	9000-30-0	Guar gum
7	14464-46-1	64742-94-5	7647-14-5	67-56-1	95-63-6	67-56-1	7647-01-0	7647-01-0	7647-14-5	67-63-0	Isopropanol
8	52-51-7	9000-30-0	67-48-1	111-30-8	7757-82-6	9000-30-0	9000-30-0	12125-02-9	7727-54-0	7647-01-0	Hydrochloric acid
9	68647-72-3	1338-43-8	7647-01-0	64-17-5	64742-94-5	91-20-3	7757-82-6	111-30-8	111-30-8	107-21-1	Ethylene glycol
10	108-10-1	7647-01-0	107-21-1	12125-02-9	7647-01-0	64742-94-5	7727-54-0	64-17-5	9000-30-0	12125-02-9	Ammonium chloride
11	1302-76-7	1310-58-3	25322-68-3	590-29-4	91-20-3	111-30-8	10486-00-7	9000-30-0	67-63-0	111-30-8	Glutaraldehyde
12	1310-73-2	7727-54-0	64-19-7	7758-19-2	12125-02-9	12125-02-9	7775-27-1	10486-00-7	81741-28-8	64-17-5	Ethanol
13	1338-43-8	64-19-7	590-29-4	64-19-7	7631-86-9	7727-54-0	68551-12-2	91-20-3	7681-52-9	7757-82-6	Sodium sulfate
14	64742-48-9	13709-94-9	111-30-8	9004-32-4	67-63-0	7775-27-1	590-29-4	107-21-1	68551-12-2	7681-52-9	Sodium hypochlorite
15	68551-12-2	12125-02-9	1310-58-3	7647-01-0	107-21-1	7647-01-0	9004-32-4	7681-52-9	10486-00-7	10486-00-7	Sodium perborate tetrahydrate
16	7647-01-0	67-63-0	10222-01-2	2836-32-0	10486-00-7	67-63-0	91-20-3	64742-94-5	1338-43-8	68551-12-2	Ethoxylated C12-16 alcohols
17	7775-27-1	2836-32-0	55566-30-8	68551-12-2	64-17-5	68551-12-2	2836-32-0	68551-12-2	64-17-5	91-20-3	Naphthalene
18	9000-30-0	590-29-4	56-81-5	7631-86-9	7681-52-9	10486-00-7	64-17-5	54841-71-3	1319-33-1	64742-94-5	Heavy aromatic solvent naphtha (petroleum)
19	9005-65-6	78330-21-9	1338-43-8	7775-27-1	590-29-4	590-29-4	64742-94-5	1344-28-1	9051-89-2	64-19-7	Acetic acid
20	1310-58-3	9004-32-4	1330-43-4	7757-82-6	9004-32-4	2836-32-0	107-21-1	1309-37-1	7173-51-5	590-29-4	Formic acid, potassium salt
Total # Forms	331	2166	19435	15953	13186	9136	12763	11767	7666	92403	
Total CAS #s	95	135	264	277	181	218	221	241	213	501	