United States
Environmental Protection
Agency

INVENTORY OF SITES WITH THE POTENTIAL TO RELEASE CONTAMINANTS TO SOURCES OF DRINKING WATER

Office of Water EPA 817-R-23-001 August 2023

Disclaimer

The Water Infrastructure and Cyber Resilience Division of the Office of Groundwater and Drinking Water has reviewed and approved the report "Inventory of Sites with the Potential to Release Contaminants to Sources of Drinking Water" for publication. This document is intended for use by the drinking water sector to better understand the risk of potential threats to sources of drinking water. It may provide information useful for conducting risk and resilience assessments, as required under America's Water Infrastructure Act of 2018.

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Acknowledgements

The document was developed by the U.S. EPA Water Infrastructure and Cyber Resilience Division, with support provided under U.S. EPA contract EP-C-15-022. The following individuals contributed to the development of this document:

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Abbreviations

AST	Aboveground storage tank
AWIA	America's Water Infrastructure Act
CAFO	Concentrated animal feeding operation
CASRN	Chemical Abstracts Service Registry Number
CCR	Coal combustion residuals
CWA-HS	Clean Water Act Hazardous Substances
CWS	Community water system
EPCRA	Emergency Planning and Community Right-to-Know Act
ESRI	Environmental Systems Research Institute
FRP	Facility Response Plan
GIS	Geographic information system
GW	Groundwater
kgal	One thousand gallons
lat/long	Latitude and longitude
LUST	Leaking underground storage tank
NHD	National Hydrography Dataset
NPDES	National Pollutant Discharge Elimination System
NRC	National Response Center
PFAS	Perfluoroalkyl and polyfluoroalkyl substances
PWS	Public water system
RCRA	Resource Conservation and Recovery Act
SDWA	Safe Drinking Water Act
SDWIS	Safe Drinking Water Information System
STCM	Storage tank and contamination monitoring
SW	Surface water
SWAP	Source Water Assessment Program
SWCTI	Source water contamination threat inventory
TRI	Toxics Release Inventory
TSCA	Toxic Substances Control Act
U.S. EIA	United States Energy Information Administration
U.S. EPA	United States Environmental Protection Agency
UST	Underground storage tank
ZOC	Zone of concern

Section 1.0: Introduction

1.1 Introduction

Releases of hazardous substances into sources of drinking water can cause significant problems for public water systems (PWSs), such as process upsets, contaminated infrastructure, exposure of customers to harmful contaminants, and costs incurred to respond to the release. Note that throughout this report the terms "release" and "spill" are used interchangeably, and refer to the sudden, transient release of a contaminant into source water. Persistent, diffuse sources of contamination, such as agricultural runoff, are not covered in the scope of this report.

Congress recognized the importance of this risk to source water by enacting Section 2018 of America's Water Infrastructure Act (AWIA), which authorizes water systems to access chemical inventory data as well as receive prompt notification of spills contaminating their source water (U.S. Congress, 2018). Furthermore, Section 2013 of AWIA requires community water systems (CWSs) serving a population greater than 3,300 to conduct risk and resilience assessments every five years. One of the assets that must be considered in this assessment is source water.

An important step in preparing for releases to sources of drinking water is to develop an understanding of source water contamination threats in a PWS's source water protection area. This understanding can be acquired by conducting a source water contamination threat inventory (SWCTI), which is an inventory of potential sources of acute contamination (e.g., spills, untreated discharges) identified within a source water protection area. A source water contamination threat can be any site that manufactures, uses, stores, or discharges contaminants of concern that could enter a source of drinking water. Examples of source water contamination threats include aboveground storage tanks (ASTs), underground storage tanks (USTs), chemical facilities, mining operations, animal feeding operations, or facilities with National Pollutant Discharge Elimination System (NPDES) permits, among others. Contaminants of concern refer to any chemical or substance, which if released to a surface water or groundwater source would adversely impact drinking water operations or cause harm to the customers served by the drinking water system. Examples of contaminants of concern include gasoline, crude petroleum, benzene, styrene, coal combustion residuals (CCR), and untreated wastewater.

A SWCTI generally intends to capture two types of information, characteristics of a site and characteristics of contaminants of concern present at a site. In this document, the term site refers to any facility, storage container, outfall, plot of land, or other feature that produces, stores, handles, uses, or discharges a contaminant of concern. Note that a site (i.e., the physical location) may represent multiple threats (i.e., the specific contaminants of concern present at the site). Thus, a SWCTI will typically contain many more threats than sites. **Figure 1** shows an example of a site with multiple threats.

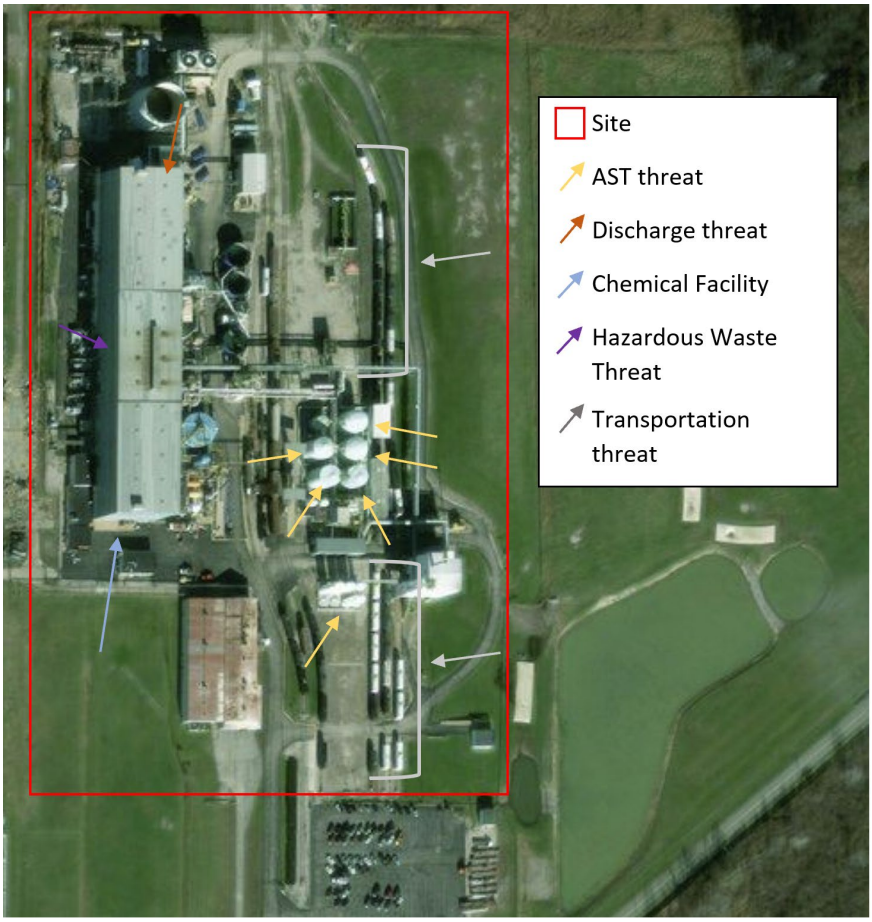


Figure 1. Example of a Site with Multiple Threats

1.2 Previous Efforts

Significant efforts previously conducted to inventory source water contamination threats are briefly described in this section. Most notably, source water assessments for PWSs often include a SWCTI, although scope and comprehensiveness can vary. The 1996 Safe Drinking Water Act (SDWA) Amendments required that states create a Source Water Assessment Program (SWAP) to inform source water protection activities (U.S. EPA, 2022a). Specifically, state drinking water programs were required to:

- Identify the land area(s) which provide source water to each PWS in their state;
- Complete an inventory of existing and potential sources of contamination in those areas;
- Determine the susceptibility of each PWS to contamination; and
- Distribute the results of the assessment to water users and other interested entities.

By the early 2000s, source water assessments were completed by all state drinking water programs. The 1996 SDWA Amendments do not require states to update their source water assessments, although some states do maintain and periodically update their SWCTIs. A brief description of the processes used to maintain contamination threat inventories in Idaho and Indiana is provided below.

The Idaho Department of Environmental Quality annually inventories facilities, land uses, and environmental conditions within delineated source water assessment areas that are potential sources of

contamination to groundwater or surface water (Idaho Department of Environmental Quality, 2022). Idaho's SWCTI involves searching electronic databases and other files to identify potential sources of contamination within the delineated area. Base maps detailing the delineated source water protection area(s) along with the potential contaminant sources are produced. This initial inventory is enhanced using on-the-ground surveys, local record review, and local knowledge to identify additional source water contamination threats not identified during the preliminary inventory (Idaho Department of Environmental Quality, 2007).

The Indiana Department of Environmental Management administers a Wellhead Protection Program, which requires all PWSs using groundwater sources to develop a plan to protect the areas around their wellheads, including development of a SWCTI. The inventory describes the location, nature, and status of identified threats. PWSs are required to update their management strategy, including updates to the SWCTI, if needed. PWSs are also required to perform ongoing maintenance to update the inventory and plan on a 5-year cycle as long as the PWS is operating (Indiana Department of Environmental Management, 2022).

The United States Environmental Protection Agency (U.S. EPA) hosts several databases and resources useful for developing a SWCTI. One such platform is the Drinking Water Mapping Application to Protect Source Waters, which provides a geographic information system (GIS) platform for accessing datasets important for source water protection activities. This application compiles information from national information resources, such as Toxic Substances Control Act (TSCA), NPDES, and Resource Conservation and Recovery Act (RCRA), but does not include information resources managed by individual states, such as Emergency Planning and Community Right-to-Know Act (EPCRA) Tier II chemical inventory systems (U.S. EPA, 2022c). Another U.S. EPA resource is the UST Finder Application, which compiles data from states and other jurisdictions about USTs. The database allows users to locate USTs in a specific area, with details on the material stored in the tanks, and indicates whether the tank is further categorized as a leaking underground storage tank (LUST) (U.S. EPA, 2022b).

Outside of the SDWA SWAP and other federal programs, several studies conducted contaminant threat inventories for specific contaminants or groups of contaminants. One example is a 2016 study to identify and compile information about facilities likely to store or handle substances containing per- and polyfluoroalkyl substances (PFAS) in order to examine the correlation of PFAS contamination to point sources (Hu et al., 2016) and identify water supplies that may be vulnerable to PFAS contamination (George & Dixit, 2021; McMahon et al., 2022; Xindi et al., 2021). EPA has also published PFAS Analytical Tools that provide location-specific information related to PFAS manufacture, release, and occurrence in the environment, as well as facilities potentially handling PFAS. Another example is an inventory conducted in the source water protection area for the City of Las Vegas to identify point and nonpoint sources of pollution. This study involved field work to identify possible sources of contamination, including facilities such as chemical manufacturers/warehouses, manufacturing sites, petroleum storage and distribution sites, research laboratories, airports, and dry-cleaning sites. The information collected included facility description and address, geographic coordinates, site pictures, and contaminants at the facility (Reginato, 2002).

The resources and studies described in this section are limited in geographic coverage, threat coverage, or information resources utilized. The authors were unable to identify a published multi-state SWCTI that uses both national and state information resources to document the full range of acute contamination threats to both surface water and groundwater sources of drinking water.

1.3 Objectives

The study described in this report characterized the occurrence of source water contamination threats within zones of concern (ZOCs) for CWSs located in the states included in this study. A ZOC is a portion of a source water protection area, typically in close proximity to an intake or wellhead, considered to be at greater risk from an acute contamination incident due to decreased opportunities for attenuation and mitigation. The objectives of this study were to evaluate the following:

- Distribution of the number of threats within ZOCs evaluated in this study
- Geographic occurrence of source water contamination threats
- Frequency of occurrence for classes of contaminants of concern
- Distribution of volumes of contaminants of concern
- Relationship between the number of source water contamination threats and the number of releases in a ZOC
- Relative value of different information resources in building a SWCTI and ease of accessing and using the information

1.4 Scope

The scope of this analysis was limited to the following:

- *Community water systems*. This analysis was limited to threats in source water ZOCs for CWSs, as defined in Section 1401(15) of the Safe Drinking Water Act. CWSs were considered in this analysis, rather than all PWSs, because the former serves established populations year-round.
- *Availability of detailed state-level data*. The study area included ten states (Florida, Illinois, Indiana, Iowa, Kentucky, Louisiana, New Jersey, New Hampshire, Ohio, and Texas) which were selected based on the availability of detailed state-level information resources that included statewide Tier II hazardous chemical inventories, oil and gas wells, discharge information, chemical facilities, ASTs, LUSTs, concentrated animal feeding operations (CAFOs), hazardous waste information, and releases.
- *Active sites*. This analysis was limited to active sites. Sites with inactive permits or wells that were not drilled were removed for this analysis.
- *Scope of information resources considered*. Potential sources of acute contamination were identified through national and state information resources in the study area; however, the analysis was limited to only those resources that were available to U.S. EPA. When possible, data were collected through publicly available resources (e.g., U.S. EPA, Texas Commission on Environmental Quality) or through a public records request. The data used in this study were reviewed and selected based on availability of specific information (e.g., site location, contaminant identity, contaminant mass or volume, container size) as well as the quality of that information.

Section 2.0: Methodology

2.1 Study Area

Ten states were selected for a statewide SWCTI: Florida, Illinois, Indiana, Iowa, Kentucky, Louisiana, New Jersey, New Hampshire, Ohio, and Texas. These states were selected to provide a diversified sample of source water contamination threats. For example, Louisiana and Texas have multiple industrial regions involved in chemical manufacturing; Ohio and Kentucky have a mix of mining operations, industrial regions, and agricultural areas; Iowa, Illinois, Indiana, and New Hampshire have extensive agricultural areas; and Florida and New Jersey have a mix of agricultural and large urbanized areas. The diversity of threat profiles provided by these ten states is intended to provide a reasonable representation of national trends in the occurrence of potential sources of contamination.

Furthermore, information resources considered essential to a SWCTI had to be available for selected states. Specifically, the study only considered states which were willing to provide a complete, statewide Tier II hazardous chemical storage dataset to U.S. EPA. Additionally, states were selected only if the available state-level information resources covered a significant portion of the threat types described in Section 2.3.

2.2 Zones of Concern

ZOCs were developed using the locations of drinking water intakes and groundwater wells, along with hydrography information. ZOCs extending into neighboring states not included in the assessment were clipped at the state boundary. For example, if the ZOC of a CWS in Kentucky (included in this study) extended into Tennessee (not included), the portion of the ZOC located in Tennessee was not included. Data sources used to develop ZOCs included:

- National Hydrography Dataset (NHD) served as the primary source of information about locations of surface waterbodies. The high-resolution NHD waterbody areas and flowlines were used when available; otherwise, medium resolution NHD flowlines and waterbody boundaries were used. **Figure 2** provides an example of NHD waterbody and flowline representations.
- Safe Drinking Water Information System (SDWIS) was used to identify CWSs from among the larger universe of PWSs and to obtain the population served and source water type (e.g., surface water, groundwater) for each CWS. The restricted access version of SDWIS was used to obtain the location of surface water intakes and groundwater wellheads for each CWS with a population served greater than 1,000.

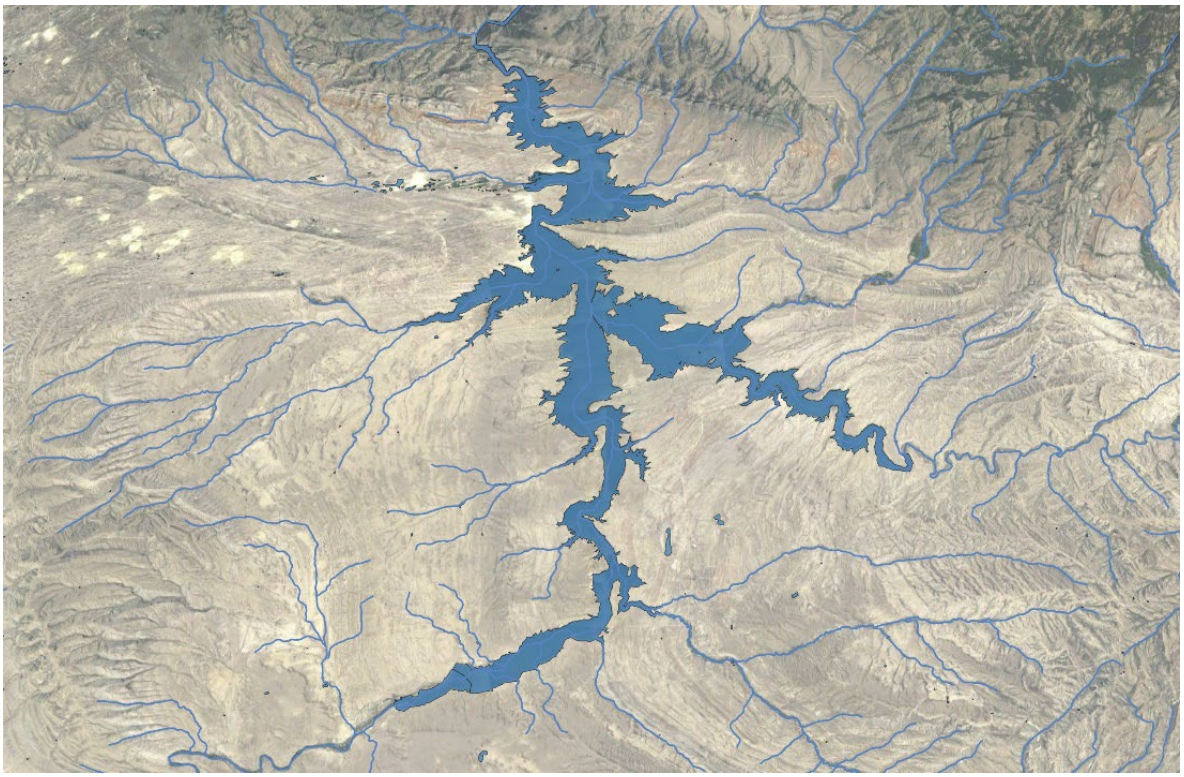


Figure 2. Example of NHD Flowline and Waterbody Representations

Surface water (SW) ZOCs extend 50 miles upstream, ¼ mile downstream, include all major tributaries, and include a ¼ mile buffer inland from the waterbody area boundary (see **Figure 3** for an example). This definition for a SW intake ZOC is consistent with the general principles for establishing source water area delineations for conducting a SWCTI, specifically in a targeted ZOC (U.S. EPA, 2006; ORSANCO, 2022). SW ZOCs were developed for 1,152 SW intakes in the study area.

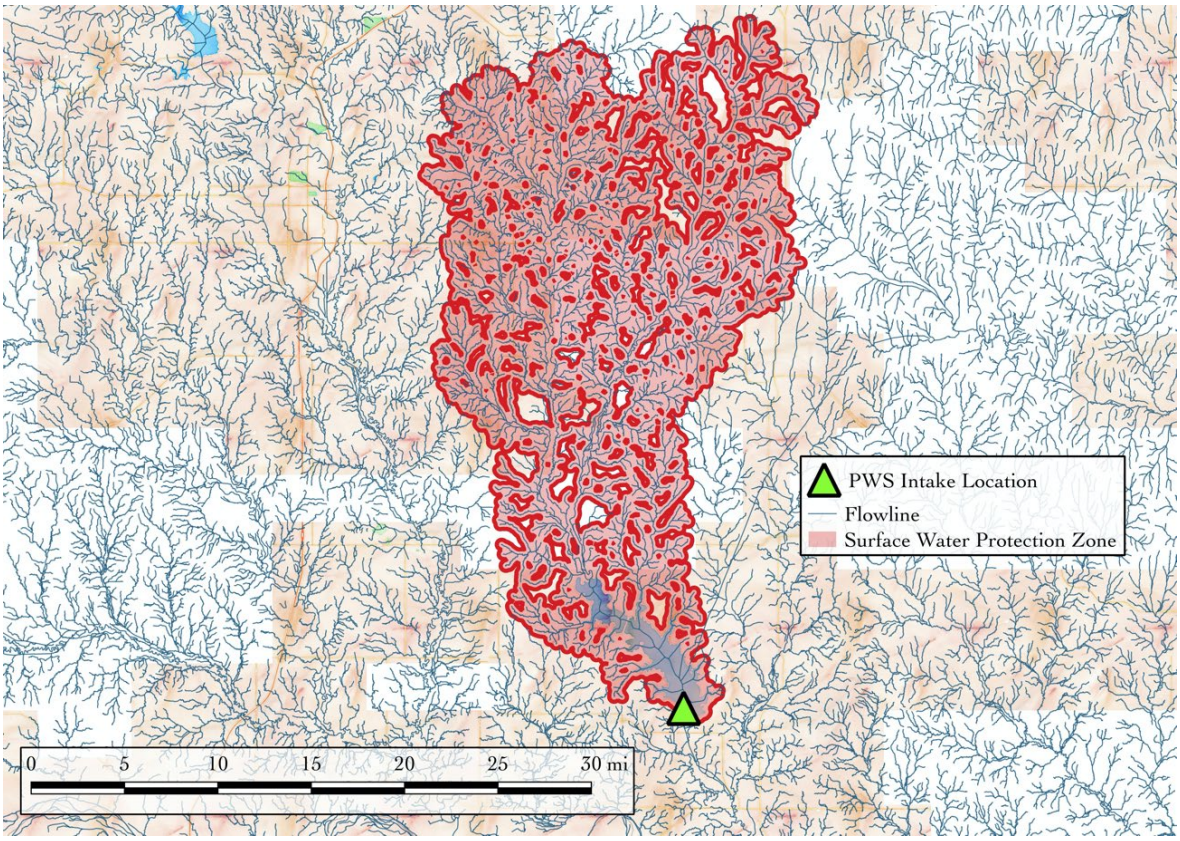


Figure 3. Example of a Surface Water Zone of Concern

Groundwater (GW) ZOCs are defined by a ½ mile radius around a wellhead (see **Figure 4** for an example). Guidance from U.S. EPA states that an "arbitrary fixed radius" can be used as a first approximation for a source water area delineation (U.S. EPA, 2006). GW ZOCs were developed for 31,441 GW wellheads in the study area.

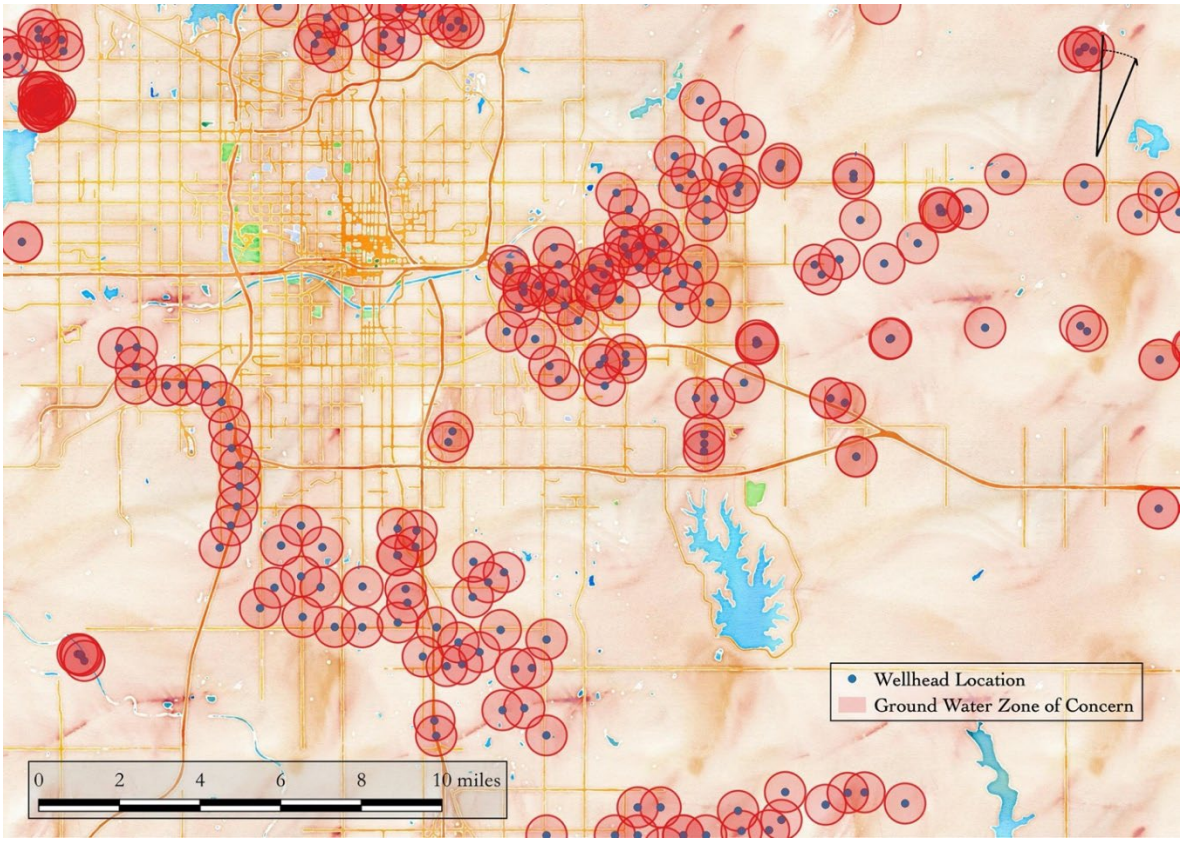


Figure 4. Example of Groundwater Zones of Concern

The SW ZOCs developed for this study were defined to be conservative, meaning they cover a large area in order to capture most threats that could impact water quality at the intake. Some SW ZOCs cross state boundaries, and when the neighboring state was included in this study, the threats from the neighboring state were included in the threat inventory for that SW ZOC. However, if a SW ZOC extended into a state that was not included in this study, the ZOC was clipped at the state border. **Table 1** presents a summary of ZOC statistics per state, including the distribution of ZOC areas for SW ZOCs. The area statistics are not included for GW ZOCs, because, with only a few exceptions, GW ZOCs have a uniform area of 0.78 sq mi, corresponding to a ½ mile radius.

Table 1. Statistics for SW ZOC Areas, per State

	OH	TX	NH	IA	IL	IN	FL	KY	LA	NJ	Total
Total No. of Zones	2,929	11,319	1,232	2,072	2,949	2,041	5,509	364	2,213	1,965	**32,593**
Total No. of SW Zones	231 (8%)	405 (4%)	39 (3%)	38 (2%)	137 (5%)	37 (2%)	31 (1%)	139 (38%)	52 (2%)	43 (2%)	**1,152**
Total No. of GW Zones	2,698 (92%)	10,914 (96%)	1,193 (97%)	2,034 (98%)	2,812 (95%)	2,004 (98%)	5,478 (99%)	225 (62%)	2,161 (98%)	1,922 (98%)	**31,441**
Mean SW Zone (sq mi)	78.09	148.94	45.76	149.80	101.99	37.21	146.87	165.74	171.29	39.52	**120.99**
Minimum SW Zone (sq mi)	0.30	0.14	0.18	0.70	0.20	0.34	0.43	0.20	0.19	0.44	**0.14**
10th Percentile SW Zone (sq mi)	1.03	0.36	0.65	1.81	2.52	1.21	0.44	0.82	13.71	1.71	**0.74**
50th Percentile SW Zone (sq mi)	24.36	61.89	4.01	30.19	32.78	27.04	47.27	46.72	39.08	25.08	**34.89**
90th Percentile SW Zone (sq mi)	243.78	408.39	102.86	454.13	307.98	82.55	552.34	452.51	496.93	80.17	**372.60**
Maximum SW Zone Area (sq mi)	828.56	912.76	718.41	785.02	786.30	218.42	725.45	759.01	1,517.59	259.01	**1,517.59**

2.3 Threat Type and Contaminant Class Definitions

Sites were classified according to the threat types defined in **Table 2** based on the nature of the site.

Table 2. Threat Types used to Classify Sites

Threat Type	Threat Type Description
Aboveground Storage Tanks (AST)	AST threats include sites with chemicals stored in ASTs. Most AST information resources acquired for this study tracked storage of petroleum products, including diesel and gasoline, as well as a few organic chemicals and trade name chemicals.
Chemical Facilities	Chemical facility threats include sites that handle, manufacture, use, or store toxic substances. These include sites reporting under the TSCA for chemicals that were determined to cause unreasonable risk to public health or the environment, and facilities required to develop a risk management plan (RMP) for handling, manufacturing, using, or storing certain flammable or toxic substances that exceed a threshold quantity.
Concentrated Animal Feeding Operation (CAFO)	CAFO threats include large-scale industrial agricultural facilities where animals are kept and raised in confined areas or facilities.
Energy Infrastructure	Energy infrastructure threats include refineries and processing plants.
Hazardous Waste	Hazardous waste threats include sites that handle and dispose of hazardous waste. Facilities with RCRA permits for large quantity (waste) generators are included, while small quantity were excluded. State regulated hazardous waste treatment, storage, and disposal sites were included.
Injection and Resource Extraction Wells	Injection and resource extraction well threats include waste injection wells as well as active oil and gas wells (including fracking sites). Dry and non-drilled wells were omitted from this analysis.
Leaking Underground Storage Tanks (LUST)	LUST threats include sites with leaking underground storage tanks.
National Pollutant Discharge Elimination System (NPDES)	NPDES threats include sites with a permit for discharging pollutants into nearby waters. Stormwater NPDES permits were omitted from this analysis.
Oil Storage Facilities	Oil storage facility threats include facilities required to submit an EPA Facility Response Plan (FRP) for storing and using oil. Facilities are required to develop an FRP if they have a total oil storage capacity of 1 million gallons or greater or if they have an oil storage capacity of 42,000 gallons or greater and transfer oil over water.
Resource Extraction	Resource extraction threats include sites involved in mining operations, natural gas market hubs, and natural gas underground storage.
Storage Tanks	Storage tank threats include sites storing petroleum in ASTs or USTs.
Tier II Hazardous Chemical Storage	Tier II threats include sites reporting tier II hazardous chemical inventory data under EPCRA. This includes facilities storing more than 10,000 pounds of a hazardous substance or more than a threshold quantity (between 1 and 500 pounds) of an extremely hazardous substance.
Toxic Release	Toxic release threats include releases reported to the National Response Center (NRC) of 100 gallons or more and sites reporting under the Toxic Release Inventory (TRI).

Sites were also characterized according to the types of chemicals stored or handled onsite. Given the very large number of unique materials identified in this study (16,827), it was necessary to group materials into classes to facilitate analysis of contaminant occurrence. The contaminant classes used in this study are listed in **Table 3**, along with examples of the most commonly occurring contaminant within each class. While these contaminant classes are useful for a high-level aggregate analysis, many

contaminants within the same class behave differently with respect to important characteristics, such as fate and transport, treatability, and toxicity.

Table 3. Contaminant Classes and Most Common Materials

Contaminant Class	Most Common Materials within these Categories
Acid	Sulfuric Acid, Hydrochloric Acid, Fluorosilicic Acid
Antifreeze/Ethylene Glycol	Ethylene Glycol, Propylene Glycol, Triethylene Glycol
Caustic Material	Sodium Hydroxide, Potassium Hydroxide, Calcium Hydroxide
Chlorine	Liquified Chlorine Gas, Sodium Hypochlorite
Coal Combustion Residuals (CCR)	Fly Ash, Carbon Black, Bottom Ash
Cyanide Compounds	Sodium Cyanide, Potassium Cyanide
Diesel or Gasoline	Diesel No 2 Fuels, Natural Gasoline, Diesel
Drilling Fluid	Produced Water, Brine
Fertilizer/Ammonia	Ammonia, Nitrogen, Ammonium Sulfate
Firefighting Foam	Ansul Purple K, Aer-O-Lite 3%, Buckeye 3% AFFF
Food Products	Soybean Oil, Xanthan Gum
Inorganic Chemical	Sodium Chloride, Aluminum Sulfate, Sodium Bisulfite
Organic Chemical	Methanol, Ethanol
Paint	Paint, C.I. Pigment Yellow 42, Pigment Blue 15
Pesticides or Herbicides	Acetochlor, Atrazine, S-Metachlor
Petroleum Products	Crude Oil, Fuel Oil Number 2. (Excludes Diesel and Gasoline, which are covered under a dedicated class.)
Radiological	Americium-141, Radioactive Material
Trade Name	Nettles P.E. Extract, Nalco Product. (Unidentified composition.)
Waste Material	Hazardous Waste N.O.S., Waste & Slop Polyols

Materials unlikely to change water quality due to the nature or form of the material were excluded from the analysis. The material categories, with examples, excluded from this study are listed in **Table 4**.

Table 4. Excluded Material Categories and Examples

Excluded Material Category	Material Examples
Abrasives	Blast Media - Mineral Sands, Blast Media (Almandine Garnet)
Ammunition/Explosives	1.1d Emulsion Explosives, Bulk Emulsion Explosives, High Explosives (Class A)
Batteries and Related Products	Lead Acid Batteries, Electrodes
Coal	CWS Charcoal
Construction Materials	Roofing Shingles, Cement, Concrete, Brick Rubble, Glass, Lumber
Earth/Mineral Products	Gravel, Gypsum, Limestone, Aggregate, Mica, Kaolin, Quartz, Bentonite, Clay, GMA Garnet
Food Products	Corn Dust, Corn Flour, Wheat Flour, Whole Grain, Corn Cob Grits, Corn Germ
Gaseous Products	Compressed Air, Argon, Carbon Dioxide, Helium, Oxygen, Landfill Gas, LP Gas
Metal and Scrap	Alloys, Aluminum, Carbon Steel, Brass, Iron, Metal Dust, Metal Shavings, Lead
Miscellaneous Waste	Waste Aerosol Cans, Waste Sandblasting Media, Metals Water Tank
Non-Hazardous	No Hazardous Ingredients, None Listed
Other	Molecular Sieve
Resin Products	Amberlite IR-120+ Industrial Resin, Dowex Monosphere 550a oh Anion Exchange Resin
Volatile Chemicals	Propane, Butane, Methane, Natural Gas, 1-Pentene, Aerosol, Refrigerants
Water	Water, Pond Water, Treated Freshwater

2.4 Information Resources for Building SWCTIs

To build the SWCTI, information about potential sources of acute contamination were collected from national and state information resources. Available resources were reviewed and selected based on the quality of data and amount of information available, such as site name, address, and contaminant information. A full list of information resource references used in this assessment is provided in the References section of this report. The national organizations that provided the greatest number of information resources were the U.S. EPA, U.S. Energy Information Administration (U.S. EIA), and Center for Effective Government Right-to-Know Network. Although these references were the top contributing information resources across the ten states, these datasets often provided only a site name and address, and lacked site attributes important to a SWCTI, such as the identity and quantity of material present at a site.

Based on their content, each information resource was classified according to the threat type (see Table 2) for which it was most relevant. These classifications are summarized in **Table 5**. The threat categories covered by the greatest number of state and national information resources include Resource Extraction (13), Hazardous Waste (12), and NPDES (11). At the state level, Ohio (9), Florida (9), and Kentucky (9) provided the greatest number of information resources, while Louisiana (5), Texas (5), New Hampshire (4), and New Jersey (3) provided the fewest.

Table 5. Threat Type Coverage by State and National Information Resources

Threat Type	National	FL	KY	OH	IN	IA	IL	TX	LA	NH	NJ	Total
Resource Extraction	3		2	3	1	1	1	1	1			13
Hazardous Waste	1	4	2				1	1	1	2		12
NPDES	1	1	1	1	2	1	1		1		2	11
Tier II		1	1	1	1	1	1	1	1	1	1	10
Injection and Resource Extraction Wells	2	1	3	2	1				1			10
Chemical Facilities	6	1										7
Energy Infrastructure	5				1							6
Toxic Release	5											5
CAFOs				1	1	1	1	1				5
AST				1		1		1		1		4
LUST	1					1	1					3
Oil Storage Facilities	1											1
Storage Tanks		1										1
Total	**25**	**9**	**9**	**9**	**7**	**6**	**6**	**5**	**5**	**4**	**3**	**88**

2.5 Data Processing

Data entry errors occurred in data fields within most of the information resources used in this study. Most of these errors involved inconsistent naming of record attributes, such as material names and location names. In many information resources, the material name and volume units were not standardized, which resulted in the use of synonymous or ambiguous names and various volumetric units. Other errors included missing latitude and longitude (lat/long) coordinates for site locations.

To improve the quality of the analysis, the following data processing was performed:

- Location data was standardized to identify the best geospatial data for a supplied address if the lat/long coordinates were not given. When a street address was provided, this information was used to geocode the record.

- Names of materials were reviewed and standardized to a specific material name or general group if the material name was vague and lacking a Chemical Abstracts Service Registry Number (CASRN). For some information resources that did not provide a material name, the name could be inferred from the purpose or scope of that resource. For example, it was assumed that the information resource "Facilities with Anhydrous Ammonia" tracks sites that store ammonia.
- CASRNs were used to correct material names. Trade name materials that list the CASRN of the main component of the mixture were categorized according to the provided CASRN. Incorrect CASRNs or those with missing digits were also reviewed and standardized to a specific material name when the correct CASRN or material name could be inferred. Materials missing CASRNs were assigned a specific material name by using its synonym or other identifier.
- Units for amount of material were standardized to a common unit, gallons, using the conversion factors listed in Appendix A. In some cases, contextual information from the record was used to assign a unit of measure (e.g., EPCRA specifies Tier II reporting thresholds in pounds, thus it was assumed that values for Tier II storage quantities were provided in pounds unless otherwise noted).
- Sites considered to pose a minimal threat of rapidly releasing contaminants into drinking water sources were excluded from the analysis. Examples of excluded sites include those associated with inactive permits, wells that were not drilled, dry wells, small quantity generators (as designated under RCRA), and stormwater discharges. Additionally, sites that reported a material volume or mass of "0" were excluded from the analysis; however, sites with unreported volume or mass were retained.

2.6 Limitations of the Methodology

- Collected information resources may be incomplete and missing data essential to the analysis, such as site location, contaminant identity, and volume or mass.
- State information resources were sought for all threat types listed in Table 2, however, not all states track all sites of interest in publicly available resources.
- The criteria used to develop ZOCs were generic and there is a possibility that a release from a threat outside of a ZOC could significantly impact a source of drinking water. Conversely, it is possible that a release from threats within a ZOC may not significantly impact a source of drinking water.
- The analyses presented in this report focus on occurrence of threats in ZOCs, and each unique combination of a specific threat and specific ZOC constitute a unique occurrence record. An artifact of this approach is that a single threat is counted multiple times if it occurs in multiple ZOCs. Specifically, the occurrence of overlapping ZOCs results in inflated threat counts and cumulative volumes reported in aggregate analyses. Section 3.4 provides more details regarding analysis of threats in overlapping ZOCs.

Section 3.0: Results and Discussion

Results from the inventory of sites with the potential to rapidly release contaminants to sources of drinking water are presented in the following subsections:

- 3.1 provides a summary of the number of threats in each threat category and presents the geographic occurrence of threats involving different threat types
- 3.2 provides a summary of the number of threats in each contaminant class, presents the geographic occurrence of contaminant classes, and presents the relation between contamination threat occurrence and contaminant releases
- 3.3 provides a summary of the number and geographic occurrence of Clean Water Act Hazardous Substance (CWA-HS) threats
- 3.4 provides a summary of source water contamination threat occurrence by ZOC
- 3.5 presents the evaluation of information resources

3.1 Occurrence of Threats by Threat Type

After the records were processed according to the methodology described in Section 2, a total of 506,413 threats were identified in the SWCTI across the ten states. These 506,413 threats are associated with 110,745 unique sites, resulting in an average of 4.57 threats per site.

As shown in **Table 6** and **Figure 5**, the threat types with the largest counts in the SWCTI were Tier II with 234,040 threats (46%), followed by Injection and Resource Extraction Wells with 93,774 threats (19%), and NPDES with 71,086 threats (14%). Note that these trends are influenced by the availability of state-level resources that track occurrence of threats in each threat type category. Some threat type categories may be underrepresented because only a portion of the ten states included in this study had information resources that track sites relevant to those threat types, as shown in Table 5 of Section 2.4.

Table 6. Threat Type Counts for all Ten States

Threat Type	Percentage	Threat Count
Tier II	46.2%	234,040
Injection and Resource Extraction Wells	18.5%	93,774
NPDES	14.0%	71,086
LUST	6.7%	33,808
Chemical Facilities	5.3%	26,696
Storage Tanks	2.7%	13,656
Toxic Release	2.5%	12,561
Hazardous Waste	1.4%	7,084
AST	1.4%	6,858
Resource Extraction	0.8%	4,203
Energy Infrastructure	0.2%	1,230
CAFOs	0.2%	764
Oil Storage Facilities	0.1%	653
Total	**100%**	**506,413**

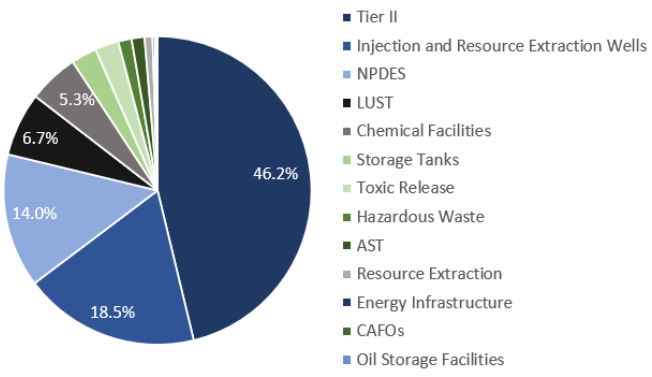


Figure 5. Threat Type Percentages for all Ten States

Figure 6 shows threat counts by state, including the total count, the threat count in SW ZOCs, and the threat count in GW ZOCs. The states with the largest number of threats in SW ZOCs include Louisiana (77,199), Ohio (58,330), and Texas (55,948). The states with the largest number of threats in GW zones include Florida (48,994), Louisiana (39,535), and Texas (29,428).

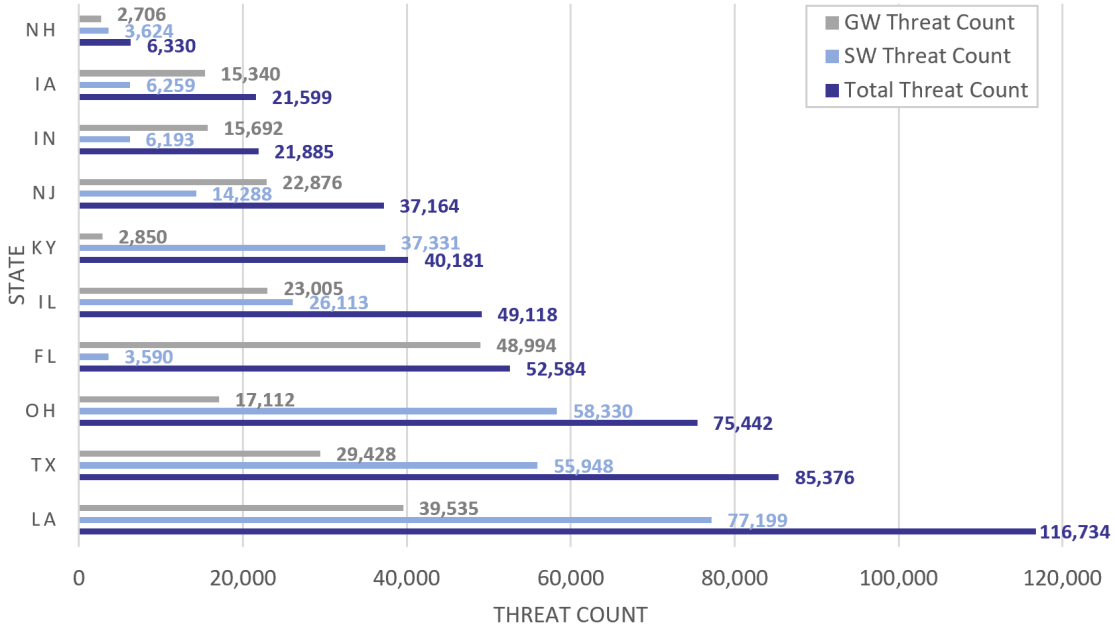


Figure 6. Total GW and SW Threat Counts per State

Further analysis of the geographic distribution of threats evaluated occurrence within the following types of designated regions: Environmental Systems Research Institute (ESRI) industrial areas, shale play areas, and census urban areas. This analysis included the following six threat types that occurred with high frequency or in high volume: Petroleum Products, Organic Chemical, Inorganic Chemical, Trade Name, Fertilizer/Ammonia, and Pesticides or Herbicides. Also, this analysis was limited to threats identified through the national information resources. State information resources were not included due to interstate variability in the availability of this data.

Figure 7 shows the relative percentage of threat counts in each of four categories located in ESRI industrial areas for the ten states included in this study. As can be seen in the figure, the majority of threats across all four categories were located outside of ESRI industrial areas. Oil Storage Facilities (77%) and Energy Infrastructure (83%) had the greatest percentage of threats falling outside of industrial areas. While more than half of the inventoried threats were located outside of ESRI industrial areas across the ten states, there were exceptions to this average trend for individual states. For example, in New Jersey between 73% and 100% of threats in each of the four categories were located within ESRI industrial areas.

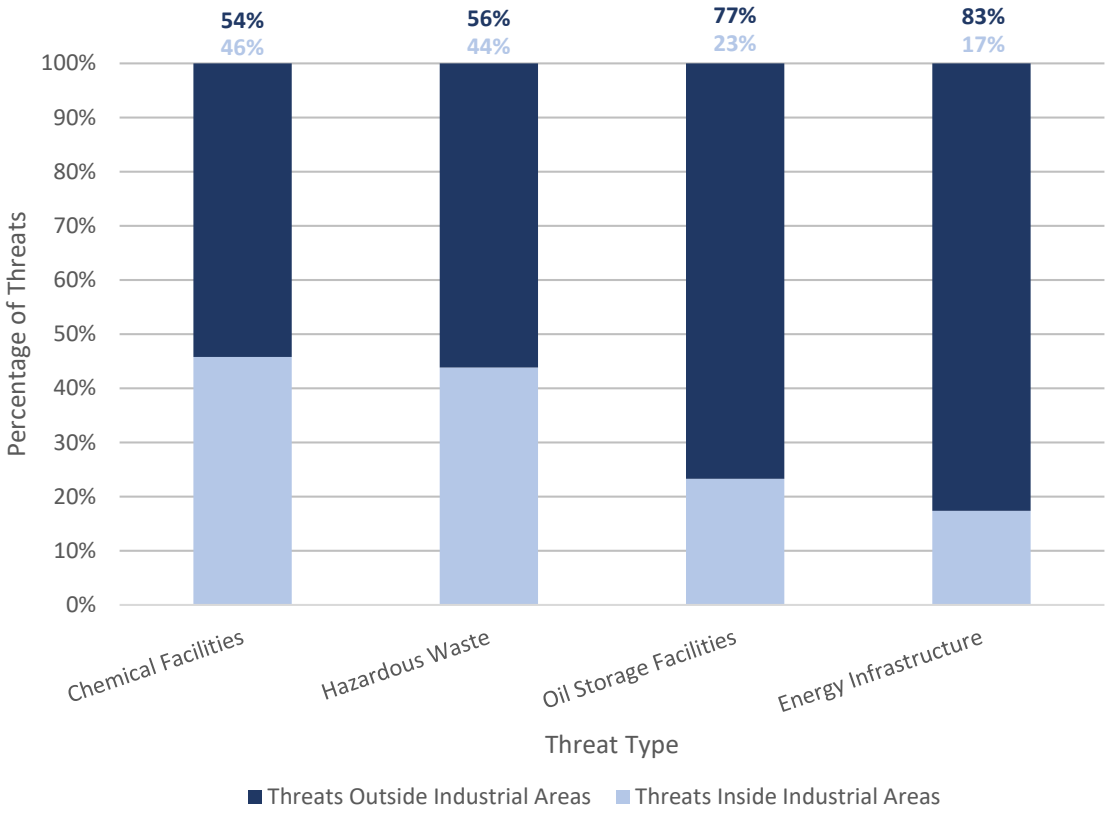


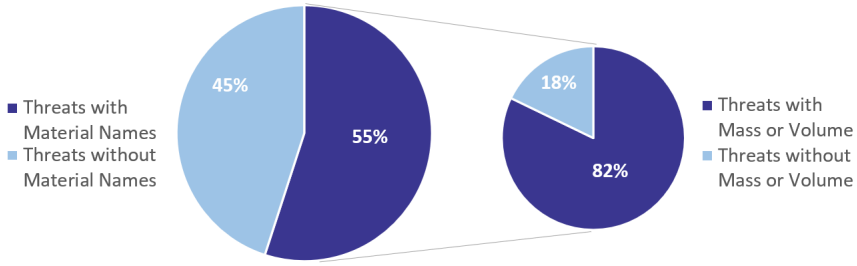
Figure 7. Percentage of Threats Located Inside and Outside of ESRI Industrial Areas

The geographic occurrence of Oil Storage Facilities threats was also evaluated relative to the locations of shale plays. Only 20% (130) of Oil Storage Facilities were located within the boundaries of shale plays. Similarly, the occurrence of NPDES permits was compared to census designated urban areas, and for the data evaluated in this study, 60% (27,690) of NPDES threats fell within the census designated urban areas.

Collectively, these results indicate that the designated regions evaluated in this study: ESRI industrial areas, shale play areas, and census designated urban areas, are not always reliable predictors of threat occurrence. However, they may serve as better predictors in some states relative to others.

3.2 Occurrence of Threats by Contaminant Classification

Of the 506,413 threats identified in the SWCTI, 276,816 (55%) threats reported a material name. These 276,816 threats included 16,827 unique materials, which were grouped into the contaminant classes listed in Table 3. A mass or volume was reported for 227,449 (82%) of the 276,816 threats with material names.



The threat count and average volume per threat by contaminant class is shown in **Figure 8**. Materials in the Organic Chemical class occurred at the greatest frequency, with 59,402 (21%), and the most commonly occurring materials in the Organic Chemical class were methanol, 5,472 (9%); ethanol, 2,003 (3%); and paraffinic petroleum distillates, 1,332 (2%). The next most commonly occurring contaminant class was Trade Name, with 45,991 (16%) threats, which includes proprietary chemical mixtures comprised of two or more components. The contaminant classes with the third and fourth highest threat counts were Petroleum Products, with 36,517 (13%), and Diesel or Gasoline, with 36,250 (13%). The Petroleum Products class had the highest average volume per threat across all contaminant classes, with 12,387 kgal.

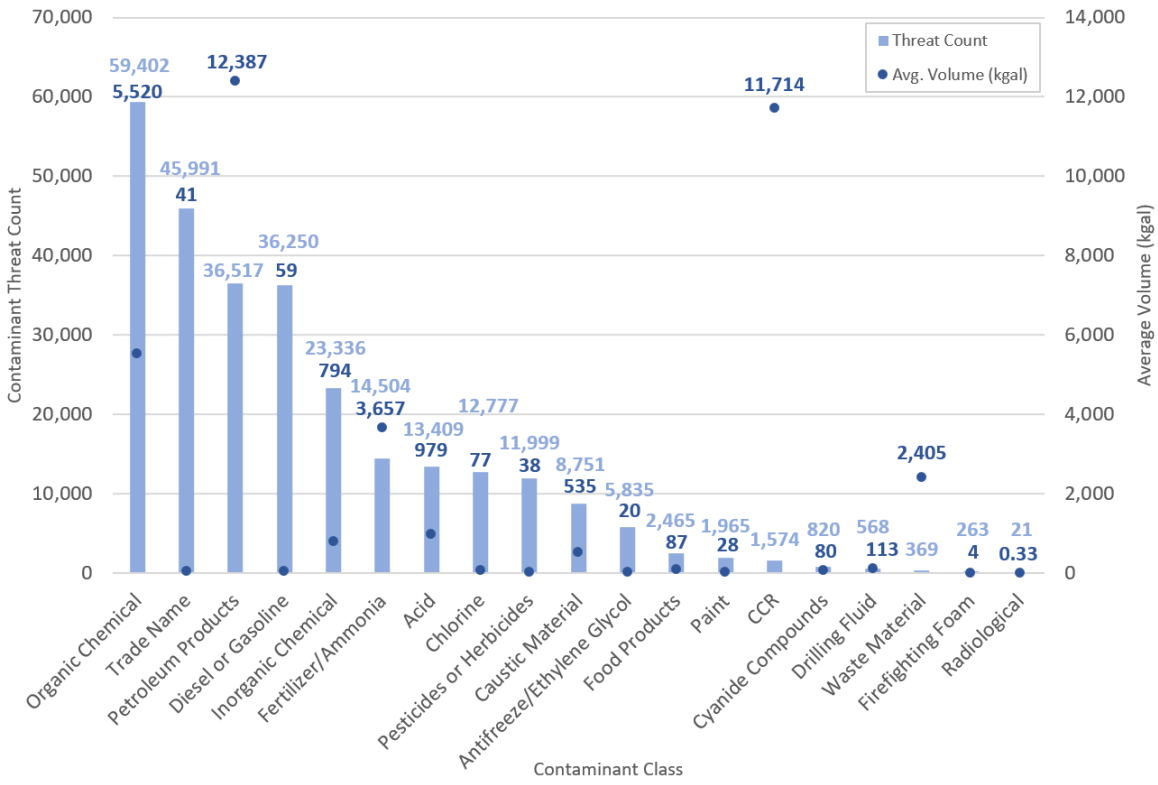


Figure 8. Total Number of Threats and Average Volume for Each Contaminant Class

Table 7 shows the total number of threats for each contaminant class by state. A red font gradient indicates the first (darkest red), second, and third (lightest red) most frequently occurring contaminant class in each state. The states with the largest total threat count include Louisiana, 73,583 (27%), Texas, 63,323 (23%), and Ohio, 26,442 (10%). The majority of threats in Louisiana fell into the Trade Name class, 24,616 (33%), followed by Organic Chemical, 15,850 (22%), and Petroleum Products, 6,750 (9%). The Organic Chemical contaminant class represented the largest threat count in Texas, Ohio, New Jersey, and Illinois.

Table 7. Total Number of Threats in Each Contaminant Class by State

	LA	TX	OH	NJ	FL	IL	IA	KY	IN	NH	Total
Organic Chemical	**15,850**	**14,169**	**5,437**	**13,406**	1,783	**4,258**	1,686	**1,675**	922	216	**59,402**
Trade Name	**24,616**	**8,826**	**4,237**	892	1,085	**2,518**	1,228	1,283	**1,041**	**265**	**45,991**
Petroleum Products	**6,750**	**13,651**	**4,645**	1,515	1,926	1,870	1,373	**2,036**	939	**1,812**	**36,517**
Diesel or Gasoline	4,277	8,536	2,459	**2,972**	**9,960**	**3,754**	**1,865**	782	715	**930**	**36,250**
Inorganic Chemical	5,262	4,227	3,709	**2,181**	1,324	2,499	1,477	**1,411**	**1,110**	136	**23,336**
Fertilizer/Ammonia	2,834	2,404	1,177	635	1,522	2,241	**2,060**	655	747	229	**14,504**
Acid	2,830	1,777	1,220	738	**2,085**	1,692	1,158	730	**1,048**	131	**13,409**
Chlorine	2,023	5,051	784	128	**2,775**	434	707	265	573	37	**12,777**
Pesticides or Herbicides	2,704	1,063	472	434	910	2,449	**2,833**	418	714	2	**11,999**
Caustic Material	2,560	1,154	1,309	555	1,359	668	547	288	199	112	**8,751**
Antifreeze/Ethylene Glycol	1,765	1,202	377	1,161	275	487	261	145	119	43	**5,835**
Food Products	448	317	203	823	19	304	200	87	49	15	**2,465**
Paint	777	157	99	600	8	97	66	108	49	4	**1,965**
CCR	143	388	199	63	219	174	202	106	69	11	**1,574**
Cyanide Compounds	128	149	59	175	32	60	42	23	135	17	**820**
Drilling Fluid	338	195	19	1	0	2	10	1	2	0	**568**
Waste Material	98	33	33	121	10	20	15	31	7	1	**369**
Firefighting Foam	179	24	4	23	13	7	0	9	4	0	**263**
Radiological	1	0	0	0	1	0	0	19	0	0	**21**
Total	**73,583**	**63,323**	**26,442**	**26,423**	**25,306**	**23,534**	**15,730**	**10,072**	**8,442**	**3,961**	**276,816**

Table 8 shows the number of threats within a specified range of volumes for each contaminant class. A red font gradient indicates the first (darkest red), second, and third (lightest red) most frequently occurring contaminant class in each volume range. Four volume ranges were considered: less than 1 kgal; between 1 and 10 kgal; between 10 and 100 kgal; and greater than 100 kgal. Most threats, 86,784 (31%), reported volumes within the range of 1 and 10 kgal, followed by those reporting volumes less than 1 kgal, 73,022 (26%). With the exception of Cyanide Compounds and Waste Material, all other classes had significantly fewer threats in the greater than 100 kgal volume range compared with the other three volume ranges. The contaminant classes with the largest number of threats in the greater than 100 kgal volume range include: Organic Chemical, 5,161 (26%); Trade Name, 4,071 (21%); and Petroleum Products, 2,523 (13%). The contaminant classes with the greatest total volume include Petroleum Products, 452,352,011 kgal (51%); Organic Chemical, 327,924,764 kgal (37%); Fertilizer/Ammonia, 53,036,862 kgal (6%); and Inorganic Chemical, 18,527,671 kgal (2%). Note that percentages are calculated relative to the total count or volume in the corresponding volume range.

The threat counts in Table 7 show that Organic Chemical, Trade Name, and Petroleum Products classes make up 51% of the total number of threats, and the values for total volume in **Table 8** show that Petroleum Products, Organic Chemical, Fertilizer/Ammonia, and Inorganic Chemical are responsible for 95% of the total material volume.

Table 8. Total Number of Threats Containing a Volume within the Indicated Range for Each Contaminant Class

Contaminant Class	No. of Threats	Total Volume (kgal)	Avg. Volume (kgal)	Number of Threats in Volume Range					Largest Volume (kgal)
				Not Reported	< 1 (kgal)	1 - 10 (kgal)	10 - 100 (kgal)	> 100 (kgal)	
TOTAL	**276,816**	**894,972,878**	**3,233**	**49,367**	**73,022**	**86,784**	**47,992**	**19,651**	**N/A**
Petroleum Products	36,517	452,352,011	12,387	7,133	9,216	11,087	6,558	2,523	9,113,000
Organic Chemical	59,402	327,924,764	5,520	20,794	12,157	13,949	7,341	5,161	13,000,000
Fertilizer/Ammonia	14,504	53,036,862	3,657	1,562	3,198	5,063	3,220	1,461	793,248
Inorganic Chemical	23,336	18,527,671	794	3,955	5,335	7,776	4,181	2,089	1,200,000
CCR	1,574	18,437,595	11,714	335	84	352	597	206	1,009,115
Acid	13,409	13,122,004	979	967	6,295	3,688	1,548	911	1,092,000
Caustic Material	8,751	4,685,280	535	661	1,788	3,187	2,152	963	230,000
Diesel or Gasoline	36,250	2,138,227	59	3,891	6,749	13,421	11,145	1,044	60,000
Trade Name	45,991	1,904,139	41	5,797	13,615	15,014	7,494	4,071	33,225
Chlorine	12,777	986,800	77	907	8,027	2,894	841	108	48,446
Waste Material	369	887,598	2,405	62	118	89	46	54	114,002
Pesticides or Herbicides	11,999	454,717	38	528	2,777	7,125	1,166	403	36,183
Food Products	2,465	214,874	87	958	246	564	470	227	9,274
Antifreeze/Ethylene Glycol	5,835	114,867	20	854	2,289	1,735	766	191	1,200
Cyanide Compounds	820	65,528	80	225	179	219	75	122	1,200
Drilling Fluid	568	64,297	113	37	103	124	235	69	1,200
Paint	1,965	54,692	28	686	781	322	128	48	6,055
Firefighting Foam	263	944	4	13	46	175	29	-	60
Radiological	21	7	0	2	19	-	-	-	0.4

Table 9 shows the most frequently occurring material in each contaminant class, displaying the threat count for the listed material and percentage relative to the total threat count in the corresponding contaminant class.

Table 9. Most Commonly Occurring Material in each Contaminant Class

Contaminant Class	Material Name	CASRN	Threat Count for Material Name	% of Total Class Count
Diesel or Gasoline	Fuels, diesel no. 2	068476-34-6	13,491	37%
Acid	Sulfuric acid	007664-93-9	6,698	50%
Chlorine	Liquified Chlorine Gas	007782-50-5	6,669	52%
Petroleum Products	Crude oil	148002-05-9	5,887	16%
Caustic Material	Sodium hydroxide	001310-73-2	5,508	63%
Organic Chemical	Methanol	000067-56-1	5,472	9%
Fertilizer/Ammonia	Ammonia	007664-41-7	3,678	25%
Antifreeze/Ethylene Glycol	Ethylene glycol	000107-21-1	2,422	42%
Pesticides or Herbicides	Acetochlor	034256-82-1	1,616	13%
Inorganic Chemical	Sodium chloride	007647-14-5	1,260	5%
CCR	Fly ash	068131-74-8	959	61%
Trade Name	Water-based hydraulic fluid	-	178	0.4%
Drilling Fluid	Produced water	007782-44-7	157	28%
Paint	Paint	-	157	8%
Food Products	Soybean oil, me ester	067784-80-9	148	6%
Cyanide Compounds	Polymeric Diphenylmethane diisocyanate	009016-87-9	114	14%
Waste Material	Haz Waste, N.O.S. (Only if EHS RPTD) liq	-	101	27%
Firefighting Foam	Ansul Purple K	-	32	12%
Radiological	Americium-241	014596-10-2	19	90%

The Organic Chemical class had the greatest number of threats across all contaminant classes. Contaminant occurrence within this category was further evaluated to identify the ten most commonly occurring organic chemicals, which are shown in **Table 10**.

Table 10. Ten Most Commonly Occurring Materials in the Organic Chemical Class

Material Name	CASRN	Threat Count for Material Name	% of Total Class Count
Methanol	000067-56-1	5,472	9%
Ethanol	000064-17-5	2,003	3%
Paraffinic petroleum distillates	064742-65-0	1,332	2%
Isopropyl alcohol	000067-63-0	1,127	2%
Toluene	000108-88-3	952	2%
Heavy paraffinic petroleum distillates	064741-88-4	814	1%
Naphthalene	000091-20-3	781	1%
Xylene	001330-20-7	751	1%
2-Butoxyethanol	000111-76-2	667	1%
Acetone	000067-64-1	643	1%

Table 11 lists the most frequently occurring materials in the Inorganic Chemical class. Notably, several of these inorganic chemicals are used in water treatment, including sodium chloride, aluminum sulfate, sodium bisulfite, hydrogen peroxide, and ferric chloride.

Table 11. Ten Most Commonly Occurring Materials in the Inorganic Chemical Class

Material Name	CASRN	Threat Count for Material Name	% of Total Class Count
Sodium chloride	007647-14-5	1,260	5%
Aluminum sulfate	010043-01-3	956	4%
Sodium bisulfite	007631-90-5	809	3%
Calcium chloride	010043-52-4	761	3%
Hydrogen peroxide	007722-84-1	657	3%
Ferric chloride	007705-08-0	491	2%
Titanium dioxide	013463-67-7	471	2%
Aluminum oxide	001344-28-1	470	2%
Lead compounds	007439-92-1	449	2%
Potassium chloride	007447-40-7	437	2%

Table 12 shows the ten most frequently occurring materials across all contaminant classes. Out of the ten most frequently occurring materials, three are in the Diesel or Gasoline contaminant class and two are in the Chlorine contaminant class. Again, several chemicals used in water treatment are on this top ten list: chlorine, sodium hypochlorite, sodium hydroxide, ammonia, and sulfuric acid.

Table 12. Ten Most Commonly Occurring Materials Across All Contaminant Classes

Contaminant Class	Material Name	CASRN	Threat Count for Material Name	% of Total Class Count
Diesel or Gasoline	Fuels, diesel no. 2	068476-34-6	13,491	37%
Diesel or Gasoline	Gasoline, natural	008006-61-9	6,954	19%
Diesel or Gasoline	Diesel	-	6,809	19%
Acid	Sulfuric acid	007664-93-9	6,698	50%
Chlorine	Liquified Chlorine Gas	007782-50-5	6,669	52%
Petroleum Products	Crude oil	148002-05-9	5,887	16%
Caustic Material	Sodium hydroxide	001310-73-2	5,508	63%
Organic Chemical	Methanol	000067-56-1	5,472	9%
Chlorine	Sodium hypochlorite	007681-52-9	4,039	32%
Fertilizer/Ammonia	Ammonia	007664-41-7	3,678	25%

3.3 Occurrence of CWA-HS Threats

The SWCTI developed for this study includes Clean Water Act Hazardous Substances (CWA-HS). The Clean Water Act, Section 311 (b)(2)(A) requires U.S. EPA to compile a list of hazardous substances which pose a threat to the public health or welfare when discharged into navigable waters or adjoining shorelines (U.S. EPA, 2021a). The CWA-HS list was published in 1978 and includes 296 substances. A complete listing of CWA-HS can be found at 40 CFR 116. Of the 506,413 threats identified in the SWCTI, 46,281 (9%) threats were identified as a CWA-HS.

The frequency of CWA-HS threats and average volume by contaminant class is shown in **Figure 9**. CWA-HS materials in the Chlorine class occur at the greatest frequency, with 11,271 threats (24%). This CWA-HS contaminant class includes liquified chlorine gas (59%), sodium hypochlorite (36%), and calcium hypochlorite (5%). The total volume of material in the CWA-HS Chlorine class is 818,102 kgal, most of which is liquified chlorine gas, 778,795 kgal (95%). The average volume of material in the Chlorine class is 73 kgal per threat (i.e., {total Chlorine volume 818,102 kgal} / {total Chlorine threat count 11,271}).

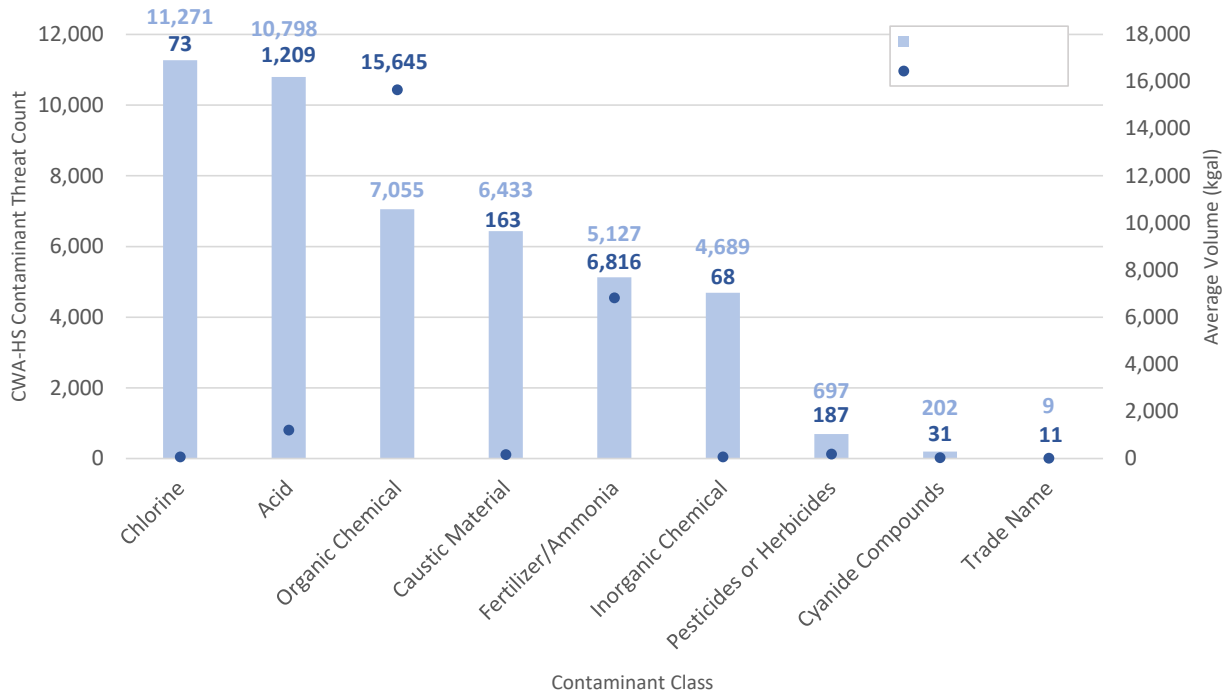


Figure 9. Total Number of Threats and Average Volume for Each CWA-HS Contaminant Class

The next most commonly occurring CWA-HS contaminant class is Acid, with 10,798 (23%) threats. Sulfuric acid is the most common CWA-HS material in the Acid class with 6,698 (62%) threats. The total CWA-HS Acid class volume is 13,059,473 kgal, and nitric acid is the material in this class with the greatest total volume at 7,484,673 kgal (57%). The average volume within the Acid class is 1,209 kgal per threat.

The third most commonly occurring CWA-HS contaminant class is Caustic, with 6,433 (14%) threats. Within the Caustic class, sodium hydroxide is the most common CWA-HS material with 5,508 (86%) threats, followed by potassium hydroxide with 925 (14%) threats. The total CWA-HS Caustic class volume is 1,047,819 kgal, and potassium hydroxide is the material in this class with the greatest total volume at 604,353 kgal (58%). The average volume within the Caustic class is 163 kgal per threat.

The fourth most commonly occurring contaminant class for CWA-HS materials is Organic Chemical, with 7,055 (15%) threats. Within the Organic Chemical class, the most commonly occurring material is toluene with 952 (13%) threats followed by naphthalene with 781 (11%) threats. The total CWA-HS Organic Chemical class volume is 110,377,573 kgal, most of which is ethylbenzene, 105,795,963 kgal (96%). The Organic Chemical class had the highest average volume of all contaminant classes at 15,645 kgal per threat.

Table 13 shows the total number of CWA-HS threats for each contaminant class by state. The dark red font color indicates the most frequently occurring contaminant class for each state followed by lighter shades of red highlighting the second and third most frequently occurring contaminant class. The states with the most CWA-HS threats include Louisiana, 11,309 (24%); Texas, 9,802 (21%); and Florida, 6,430 (14%).

Table 13. Total Number of CWA-HS Threats for Each Contaminant Class by State

	LA	TX	FL	OH	IL	IA	NJ	IN	KY	NH	Total
Chlorine	1,837	**3,964**	**2,696**	745	408	**657**	117	**567**	**243**	37	**11,271**
Acid	**2,369**	**1,407**	**1,371**	**1,029**	**1,527**	**951**	**616**	**797**	**608**	**123**	**10,798**
Caustic Material	**2,023**	901	**1,045**	**831**	**425**	343	**416**	149	**197**	**103**	**6,433**
Organic Chemical	**2,336**	**1,891**	145	**859**	380	191	**954**	130	156	13	**7,055**
Fertilizer	1,191	609	728	442	**584**	**817**	153	261	164	**178**	**5,127**
Inorganic Chemical	1,296	981	346	663	378	262	212	**330**	195	26	**4,689**
Pesticides or Herbicides	238	38	93	26	114	83	51	37	17	0	**697**
Cyanide Compounds	19	11	6	10	18	1	41	76	5	15	**202**
Trade Name	0	0	0	6	0	0	3	0	0	0	**9**
Total	**11,309**	**9,802**	**6,430**	**4,611**	**3,834**	**3,305**	**2,563**	**2,347**	**1,585**	**495**	**46,281**

Table 14 shows the number of CWA-HS threats in each contaminant class that fall within a specified volume range. Similar to Table 8, four volume ranges are shown: less than 1 kgal; between 1 and 10 kgal; between 10 and 100 kgal; and greater than 100 kgal. With the exception of Cyanide Compounds and Organic Chemical classes, all other contaminant classes had significantly fewer CWA-HS threats in the greater than 100 kgal volume range compared with the lower volume ranges. The contaminant classes with the most CWA-HS threats in the greater than 100 kgal volume range include Organic Chemical, 1,261 (35%); Acid, 845 (24%); and Caustic Material, 618 (17%). The contaminant classes with the largest CWA-HS total volumes include Organic Chemical, 110,377,573 kgal (69%); Fertilizer/Ammonia, 34,945,388 kgal (22%); and Acid, 13,059,474 kgal (8%). Note that percentages are calculated relative to the total count or volume in the corresponding volume range.

Table 14. Total Number of CWA-HS Threats Containing a Volume within the Indicated Range for Each Contaminant Class

Contaminant Class	No. of Threats	Total Volume (kgal)	Avg. Volume (kgal)	Number of Threats in Volume Range					Largest Volume (kgal)
				Not Reported	< 1 (kgal)	1 - 10 (kgal)	10 - 100 (kgal)	> 100 (kgal)	
TOTAL	**46,281**	**160,704,144**	**3,472**	**4,745**	**18,767**	**12,483**	**6,701**	**3,585**	**N/A**
Organic Chemical	**7,055**	**110,377,573**	**15,645**	**1,912**	**1,698**	1,368	816	**1,261**	**2,958,030**
Fertilizer/Ammonia	5,127	**34,945,388**	**6,816**	483	1,694	1,437	1,140	373	**793,248**
Acid	**10,798**	**13,059,474**	**1,209**	**725**	**5,421**	**2,483**	**1,324**	**845**	**1,092,000**
Caustic Material	6,433	1,047,819	163	332	1,593	**2,554**	**1,336**	**618**	16,900
Chlorine	**11,271**	818,103	73	587	**7,072**	**2,737**	788	87	48,446
Inorganic Chemical	4,689	318,948	68	**630**	980	1,604	**1,173**	302	25,972
Pesticides or Herbicides	697	130,441	187	41	223	279	110	44	36,183
Cyanide Compounds	202	6,298	31	35	84	16	12	55	120
Trade Name	9	101	11	0	2	5	2	-	44

To investigate the geographic distribution of CWA-HS threats and releases, the threat locations were mapped in **Figure 10**. The states with the most CWA-HS threats and releases include Louisiana, 11,309 (24%); Texas, 9,802 (21%); and Florida, 6,430 (14%). The map shows a high density of CWA-HS threats in southeastern Louisiana, northern New Jersey, eastern Texas, and northeastern Illinois. As expected, occurrence of CWA-HS threats and releases was greater in more industrialized areas, including the following cities: Newark, NJ; Baton Rouge, LA; Dallas, TX; Houston, TX; and Chicago, IL. However, CWA-HS threats are widely distributed across many of the states, and dense occurrence of CWA-HS threats can occur outside industrialized areas.

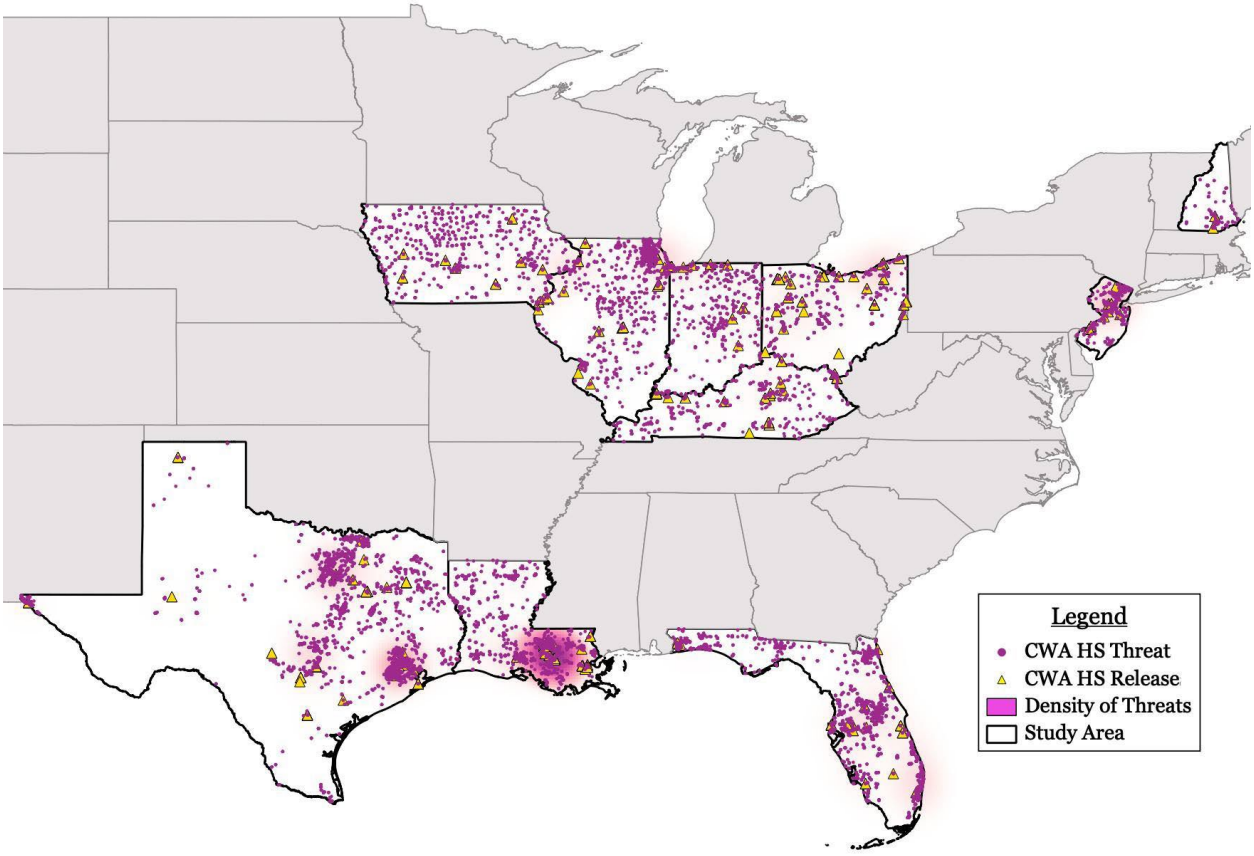


Figure 10. Geographic Distribution of CWA-HS Threats and Releases

(The total number of threats and releases displayed on this map is 46,281, which are associated with only 6,838 unique sites. This results in significant overlap of symbols on this map.)

The threat counts in Table 13 show Chlorine, Acid, and Caustic Material classes make up 62% of the CWA-HS contaminant threats in the SWCTI. These three contaminant classes contain only a few specific CWA-HS materials. The most frequently occurring materials in these three classes are: liquified chlorine gas (Chlorine), sulfuric acid (Acid), and sodium hydroxide (Caustic).

There are significantly more CWA-HS materials in the Organic Chemical (62) and Inorganic Chemical (49) classes. Thus, these two important contaminant classes were selected for a more detailed assessment.

Table 15 shows the ten most commonly occurring CWA-HS materials in the Organic Chemical class, displaying the count for the listed material and percentage relative to the total count in the Organic Chemical class. The most commonly occurring CWA-HS material in the Organic Chemical class was toluene, 952 (13%); followed by naphthalene, 781 (11%); and xylene, 751 (11%).

Table 15. Ten Most Commonly Occurring CWA-HS Materials in the Organic Chemical Class

Material Name	CASRN	Threat Count for Material Name	% of Total Class Count
Toluene	000108-88-3	952	13%
Naphthalene	000091-20-3	781	11%
Xylene	001330-20-7	751	11%
Formaldehyde	000050-00-0	438	6%
Styrene	000100-42-5	431	6%
Acetic acid	000064-19-7	349	5%
Ethylbenzene	000100-41-4	294	4%
Phenol	000108-95-2	281	4%
Benzene	000071-43-2	243	3%
Aniline	000062-53-3	205	3%

Table 16 lists the most frequently occurring CWA-HS materials in the Inorganic Chemical class, with the top three commonly used in water treatment: aluminum sulfate, 956 (20%); sodium bisulfite, 809 (17%); and ferric chloride, 491 (10%).

Table 16. Ten Most Commonly Occurring CWA-HS Materials in the Inorganic Chemical Class

Material Name	CASRN	Threat Count for Material Name	% of Total Class Count
Aluminum sulfate	010043-01-3	956	20%
Sodium bisulfite	007631-90-5	809	17%
Ferric chloride	007705-08-0	491	10%
Lead acetate	000301-04-2	435	9%
Potassium permanganate	007722-64-7	272	6%
Sodium nitrite	007632-00-0	261	6%
Ferric sulfate	010028-22-5	231	5%
Ferrous sulphate	007720-78-7	120	3%
Zinc sulfate	007733-02-0	114	2%
Zinc chloride	007646-85-7	105	2%

3.4 Threat Occurrence by ZOC

The results presented in Sections 3.1 through 3.3 aggregated threat occurrence within each state and across all ten states in the study area. This section provides details on the occurrence of threats within a source water ZOC for the CWS intakes and wells included in this study. It is important to consider that multiple intakes located in close proximity to each other have overlapping ZOCs, which results in the same threat impacting multiple ZOCs. Examples of SW and GW overlapping ZOCs are displayed in **Figures 11** and **12**. Both figures show the intake or wellhead location as a blue triangle, one ZOC as light pink, the second ZOC as orange, and the overlapping ZOC areas as red.

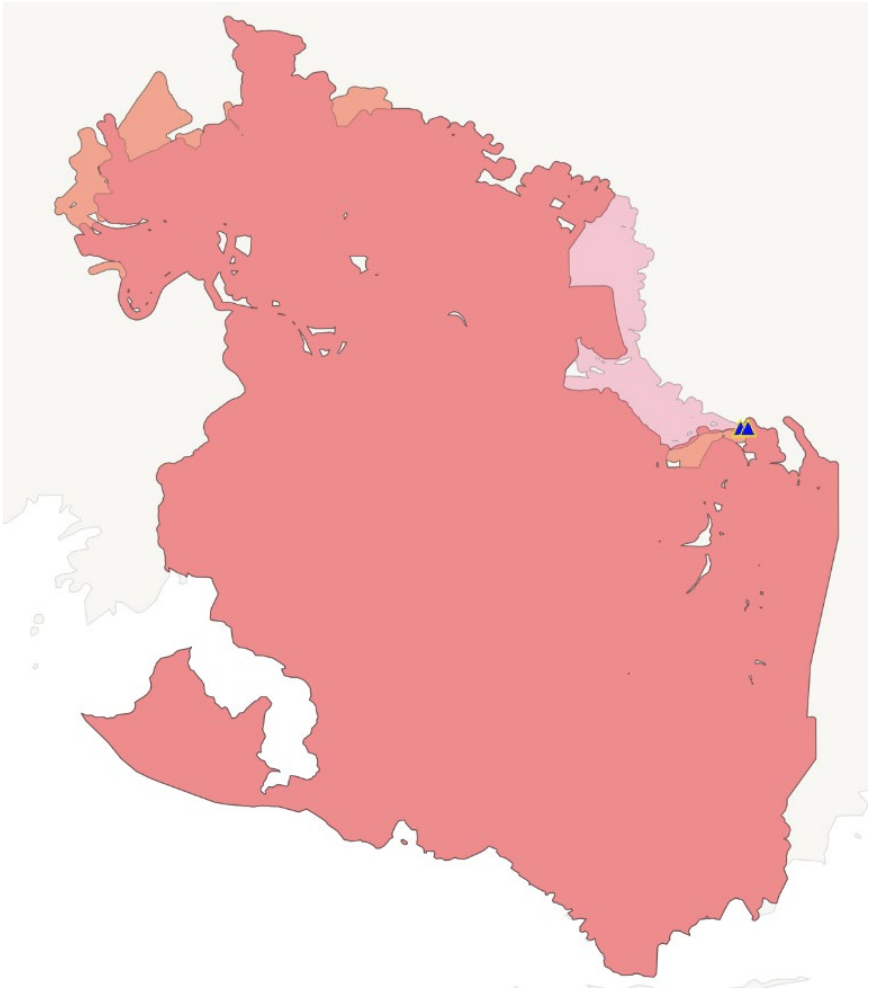


Figure 11. Example of Overlapping SW ZOCs

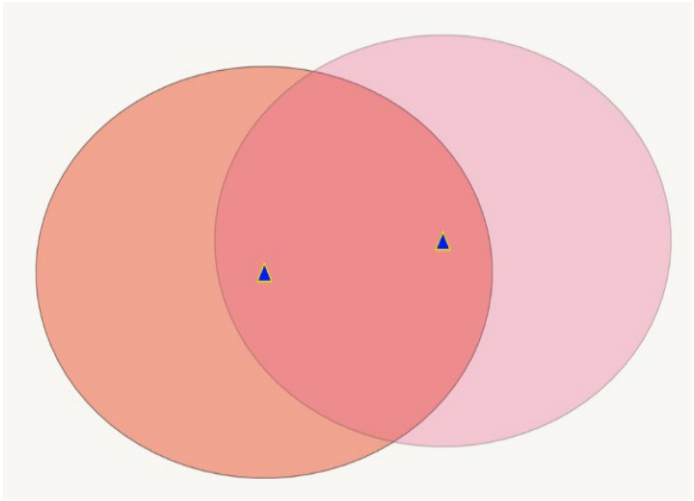


Figure 12. Example of Overlapping GW ZOCs

Table 17 shows the total number of SW and GW ZOCs delineated for each state and the total number of ZOCs with and without threats for each state. Of the 32,593 ZOCs delineated for this analysis, 1,152 are SW ZOCs, with 1,003 (87%) containing at least 1 threat; and 31,441 are GW ZOCs, with 19,955 (63%) containing at least 1 threat. The states with the highest percentage of SW ZOCs containing at least 1 threat include Illinois, 131 (96%); Texas, 343 (85%); and Ohio, 196 (85%). The states with the highest percentage of GW ZOCs containing at least 1 threat include Florida, 4,358 (80%); Ohio, 2,090 (77%); and Texas, 4,582 (42%).

Table 17. Total Number of SW and GW ZOCs Delineated for Each State

	OH	TX	NH	IA	IL	IN	FL	KY	LA	NJ	Total
Total No. of SW Zones	231	405	39	38	137	37	31	139	52	43	**1,152**
Total No. of SW Zones with 0 Threats	35	62	18	4	6	1	1	14	0	8	**149**
Total No. of SW Zones with >0 Threats	196	343	21	34	131	36	30	125	52	35	**1,003**
Total No. of GW Zones	2,698	10,914	1,193	2,034	2,812	2,004	5,478	225	2,161	1,922	**31,441**
Total No. of GW Zones with 0 Threats	608	6,332	669	614	760	439	1,120	49	441	454	**11,486**
Total No. of GW Zones with >0 Threats	2,090	4,582	524	1,420	2,052	1,565	4,358	176	1,720	1,468	**19,955**

Figure 13 shows the total threat count per state (blue shading and number within state boundary) as well as the average threat count per ZOC (black circles) in the state. The average ZOC threat count is computed as the total number of threats in the state divided by the total number of ZOCs with at least one threat in the state.

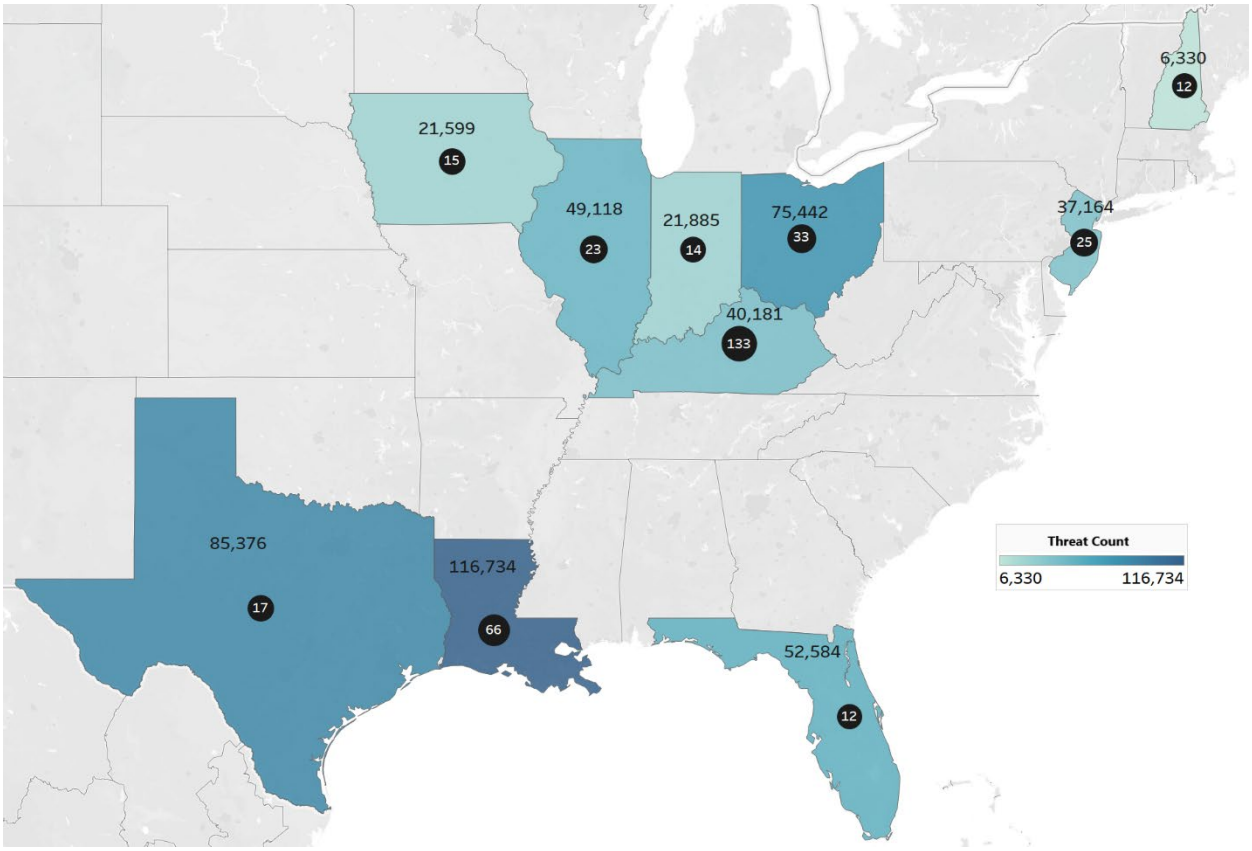


Figure 13. Total and Average ZOC Threat Count in Each State

The states with the highest average ZOC threat counts include Kentucky (133), Louisiana (66), and Ohio (33). The large average ZOC threat counts in Kentucky were driven by a small number of ZOCs covering

large resource extraction wellfields where individual wells are represented as a single threat. Out of the 301 ZOCs with at least 1 threat in Kentucky, 8 of the SW ZOCs contained more than 1,000 threats, and the total number of threats in these 8 SW ZOCs was 12,259, of which 6,706 (55%) were Injection and Resource Extraction Wells.

Figures 14 and **15** represent each ZOC containing at least one threat as a point on the map. The symbology on these two figures uses a color designation to indicate the threat count bin into which each ZOC falls. The five threat count bins used in these figures are: 1; 2 to 25; 26 to 100; 101 to 1,000; and greater than 1,000.

Figure 14 shows the geographic distribution of SW ZOCs containing at least 1 threat. There were 327 (33%) SW ZOCs with threat counts that fell within the 101 to 1,000 bin, followed by 308 (31%) in the 2 to 25 bin. Only 78 (7%) SW ZOCs had threat counts that fell in the greater than 1,000 bin. The states with the most SW ZOCs containing more than 1,000 threats include: Louisiana, 28 (36%); Ohio, 16 (21%); and Texas, 12 (15%) – percentages are calculated relative to the 78 SW ZOCs that had threat counts in the greater than 1,000 range.

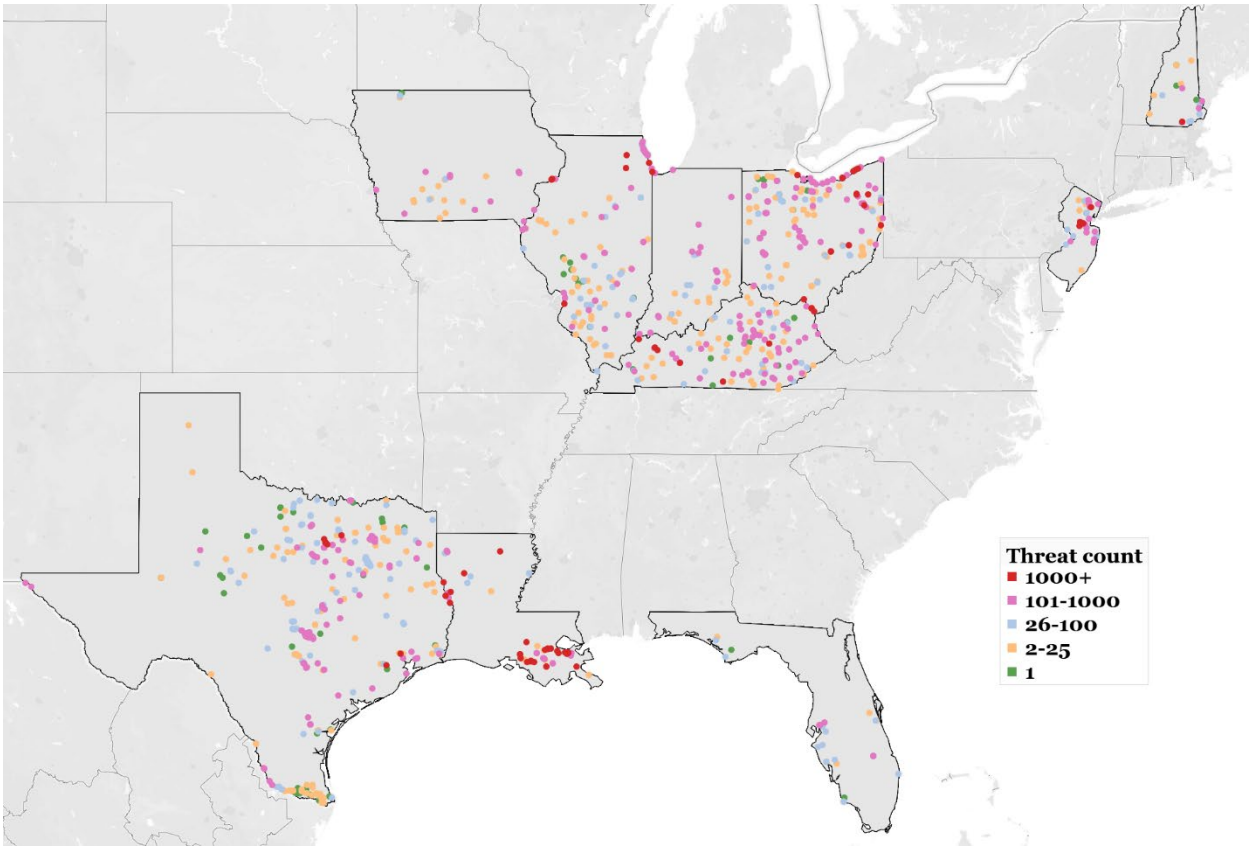


Figure 14. Geographic Distribution of SW ZOCs Containing Threat Counts Within the Indicated Range

Figure 15 shows the geographic distribution of GW ZOCs containing at least 1 threat. There were 14,577 (73%) GW ZOCs containing 2 to 25 threats, followed by 3,835 (19%) containing 1 threat. Only 2 GW ZOCs, one located in New Jersey and the other in Texas, contained more than 1,000 threats. The states with the most GW ZOCs containing at least 1 threat include Texas, 4,582 (23%); Florida, 4,358 (22%); and Ohio, 2,090 (10%).

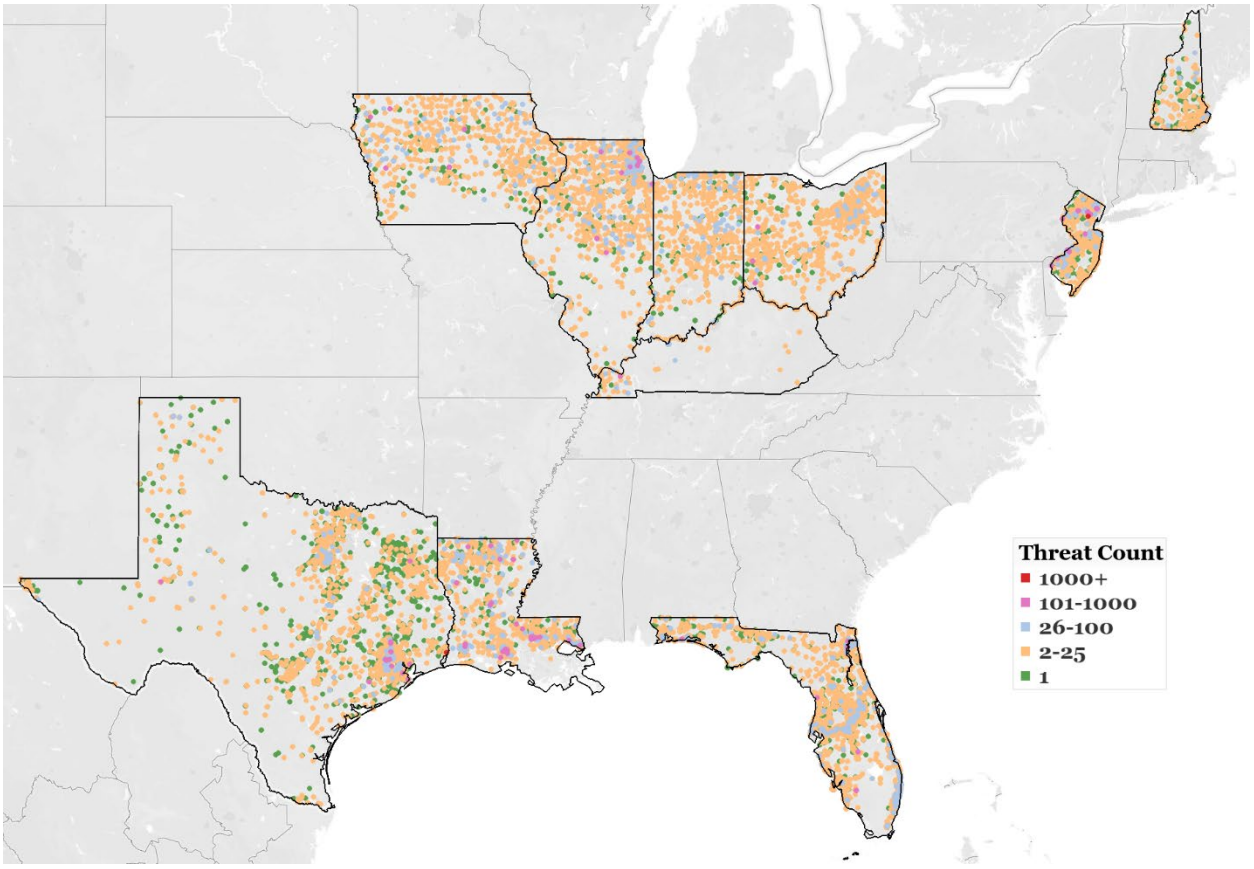


Figure 15. Geographic Distribution of GW ZOCs Containing Threat Counts Within the Indicated Range

Comparison of distribution of threat counts between SW and GW ZOCs displayed in Figures 14 and 15 clearly show that a greater proportion of SW ZOCs fall into the higher threat count bins compared with GW ZOCs. These differences in threat occurrence between SW and GW ZOCs are explored further in the following analysis.

Figure 16 presents the distribution of threat counts for SW and GW ZOCs using thirteen threat count bins: 1; 2; 3; 4; 5; 6–24; 25–49; 50–99; 100–299; 300–499; 500–999; 1,000–2,999; and greater than or equal to 3,000. Of the 1,003 SW ZOCs containing a least one threat, 17% (173) had threat counts that fell into the 6–24 bin, followed by 17% (172) in the 100–299 bin. Of the 19,955 GW ZOCs containing a least one threat, 36% (7,148) had threat counts that fell into the 6–24 bin, followed by 19% (3,835) in the 1 bin. The distribution of threats in Figure 16 show that threat counts in SW ZOCs skew towards higher threat count bins compared to GW ZOCs. Using 25 threats per zone as a reference, 62% (624) of SW ZOCs contain 25 or more threats compared to 8% (1,671) of GW ZOCs that contain 25 or more threats. At the upper end of the distribution, 8% (78) of SW ZOCs contain more than 1,000 threats while only 0.01% (2) of GW ZOCs contain more than 1,000 threats.

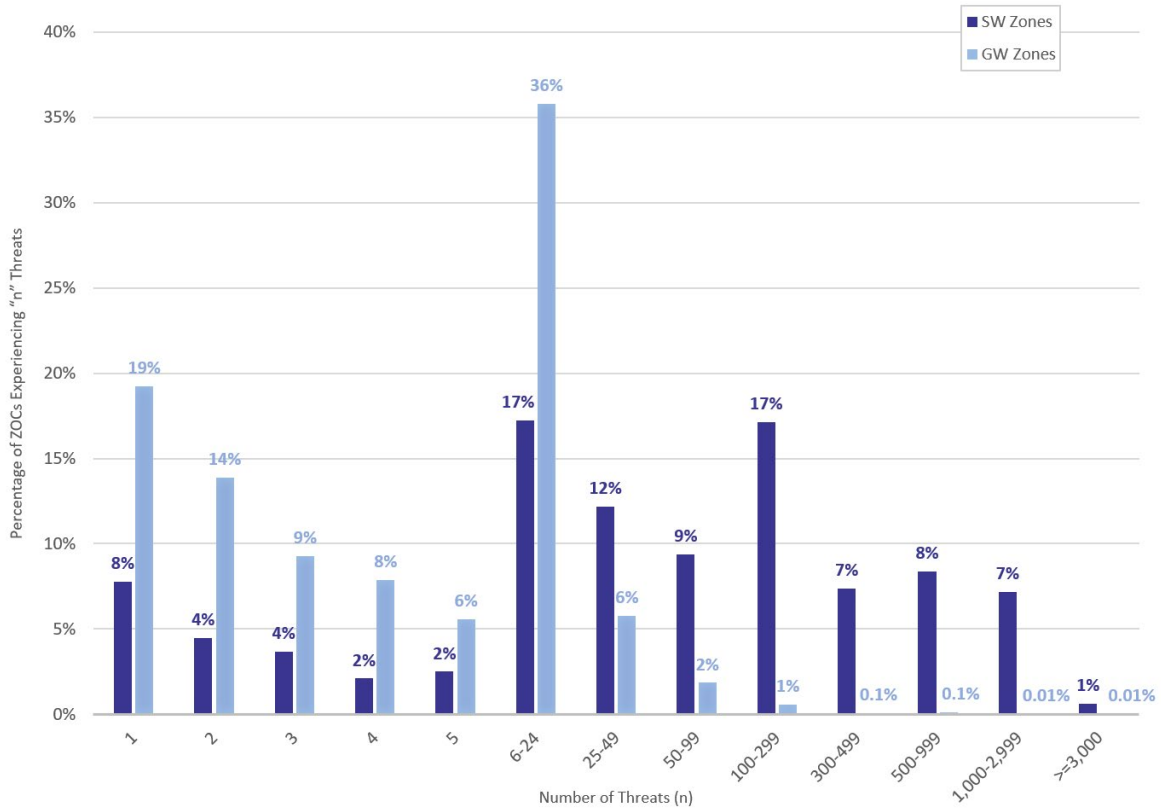


Figure 16. Percentage of SW and GW ZOCs Containing "n" Total Threats Within the Indicated Range

Table 18 shows the SW and GW ZOC threat count statistics per state, including minimum, mean, maximum, 10th percentile, 50th percentile, and 90th percentile. States that had the highest 50th percentile SW ZOC threat counts include Louisiana (1,218), New Jersey (224), and Kentucky (90). States that had the highest 50th percentile GW ZOC threat counts include Kentucky (11), Florida (7), Illinois (6), Indiana (6), and Louisiana (6).

Table 18. Threat Count Statistics for SW and GW ZOCs per State

	OH	TX	NH	IA	IL	IN	FL	KY	LA	NJ	Overall
Mean Zonal Threats	33	17	12	15	23	14	12	133	66	25	**24**
Minimum Zonal Threats	1	1	1	1	1	1	1	1	1	1	**1**
10th Percentile Zonal Threats	1	1	1	1	1	1	1	2	1	1	**1**
50th Percentile Zonal Threats	5	2	2	5	6	6	7	17	6	5	**5**
90th Percentile Zonal Threats	23	16	13	26	31	25	25	440	55	24	**26**
Maximum Zonal Threats	4,027	2,393	2,417	1,563	2,137	1,666	932	2,894	6,779	3,309	**6,779**
Mean SW Zonal Threats	298	163	173	184	199	172	120	299	1,485	408	**288**
Minimum SW Zonal Threats	1	1	1	1	1	2	1	1	4	1	**1**
10th Percentile SW Zonal Threats	3	1	1	3	2	4	1	2	14	6	**2**
50th Percentile SW Zonal Threats	60	40	34	31	43	63	47	90	1,218	224	**50**
90th Percentile SW Zonal Threats	843	384	129	459	578	359	194	791	2,898	1,129	**764**
Maximum SW Zonal Threats	4,027	2,393	2,417	1,563	2,137	1,666	932	2,894	6,779	2,322	**6,779**
Mean GW Zonal Threats	8	6	5	11	11	10	11	16	23	16	**11**
Minimum GW Zonal Threats	1	1	1	1	1	1	1	1	1	1	**1**
10th Percentile GW Zonal Threats	1	1	1	1	1	1	1	2	1	1	**1**
50th Percentile GW Zonal Threats	5	2	2	5	6	6	7	11	6	5	**4**
90th Percentile GW Zonal Threats	18	11	12	24	26	23	25	39	45	21	**22**
Maximum GW Zonal Threats	226	2,293	78	207	184	99	310	105	889	3,309	**3,309**

The ten SW ZOCs that had the maximum threat counts in each state collectively contained a total of 27,130 (9%) threats. The ten GW ZOCs that had the maximum threat counts in each state collectively contained a total of 7,700 (4%) threats. Additional analyses of SW and GW ZOCs with the largest threat counts can be found in Appendix B.

Throughout Section 3.4, attention has been drawn to ZOCs that contain a large number of threats, working from the hypothesis that ZOCs that contain a large number of threats are at greater risk of experiencing a release. A 2021 study evaluated the occurrence of releases between 2010 and 2019 that had the potential to impact sources of drinking water (U.S. EPA, 2021b). The 2021 study used the same ZOC definitions as are used in this SWCTI study, thus it was possible to compare the number of threats in a ZOC with the number of releases that occurred in the same ZOC between 2010 and 2019. **Figure 17** presents a scatter plot of the number of releases versus the number of threats in SW ZOCs included in this study. No correlation was observed between the number of threats and number of releases in a SW ZOC. In fact, there were a number of SW ZOCs with fewer than 100 threats which experienced more than ten releases over the 10-year period. Conversely, there were several SW ZOCs that contained more than 1,000 threats but experienced fewer than ten releases.

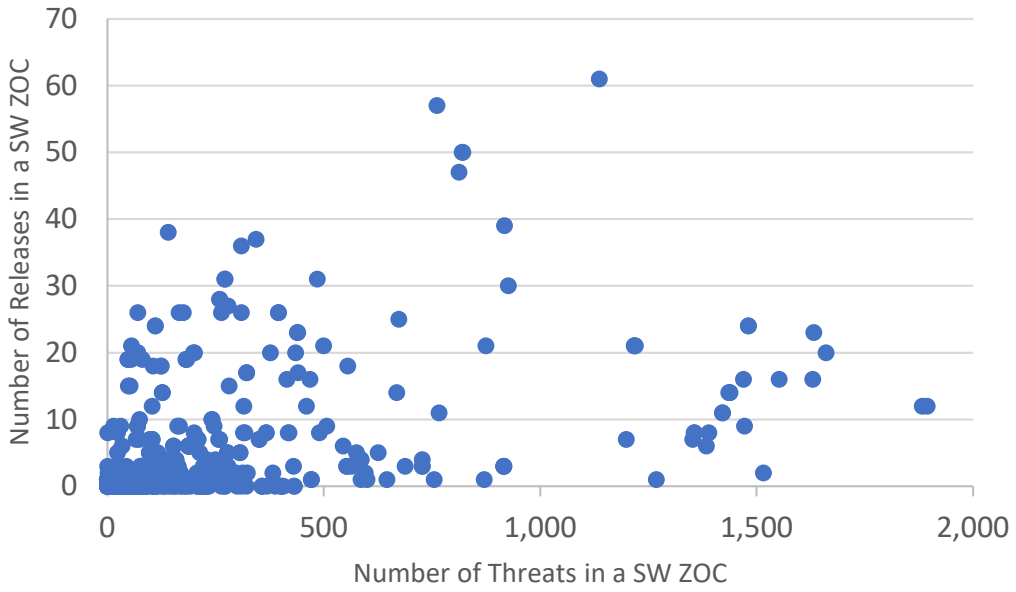
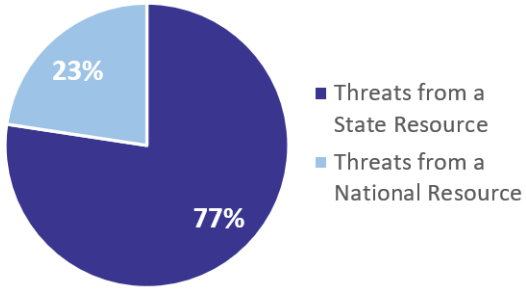


Figure 17. Correlation between Number of Threats and Number of Releases in SW ZOCs

The reasons for the lack of a correlation between threat count and release occurrence is unclear. However, the release report shows that the most frequent known cause of releases to source waters is equipment failure (U.S. EPA, 2021b). Thus, it may be that the characteristics of individual sites that store or handle chemicals and other materials is a more important factor in the risk of a release than is the number of threats in a ZOC. Another factor to consider is that some sites (i.e., specific facilities) are associated with more than 100 threats. Such large facilities may have more resources and incentive to invest in spill prevention and response. And while the presence of such large facilities with 100s of threats in a ZOC may elevate a water system's raw threat count, the results in this study suggest that this does not necessarily translate into a greater risk of releases. However, this is only a hypothesis based on the data available from these two studies, and more research is needed to gain a better understanding of the factors that increase the risk of releases into sources of drinking water.

3.5 Evaluation of Information Resources



As discussed in Section 2, it was necessary to utilize both state and national information resources to build a comprehensive SWCTI because no single resource covers all threat types. A total of 88 information resources were collected, consisting of 25 (28%) national information resources and 63 (72%) state information resources. State information resources proved to be more valuable than national information resources because the state information resources generally contained more complete information and fewer data gaps, however, national resources provided more uniform data for interstate SWCTIs. **Table 19** and **Table 20** show the national and state information resources that were collected for each threat type.

Table 19. National Information Resources used in this Study, Organized by Threat Type

Threat Type Covered	Number of Resources	Names of Resources
Chemical Facilities	6	EPA RMP Facilities RMP Facilities with Anhydrous Ammonia Facilities with Anhydrous Ammonia TSCA Consumer and Commercial Use Information TSCA Industrial Processing and Use Information TSCA Manufacturing Information
Energy Infrastructure	5	Coal Power Plants Ethylene Crackers Natural Gas Processing Plants Petroleum Refineries Power Plants
Toxic Release	5	NRC Incident Reports Toxic Release Inventory System TRI - Releases to Land TRI - Releases to Underground TRI - Releases to Water & POTW
Resource Extraction	3	Coal Mines Natural Gas Market Hubs Natural Gas Underground Storage
Injection and Resource Extraction Wells	2	Hydraulic Fracturing Wells by Type of Toxin - Gas Hydraulic Fracturing Wells by Type of Toxin - Oil
LUST	1	UST Finder App
Oil Storage Facilities	1	EPA FRP Facilities
Hazardous Waste	1	RCRA
NPDES	1	National Pollutant Discharge Elimination System
Storage Tanks	0	-
AST	0	-
CAFOs	0	-
Tier II	0	-

Table 20. State Information Resources used in this Study, Organized by Threat Type

Threat Type Covered	Number of Resources	Names of Resources
Hazardous Waste	11	FL - Hazardous Waste Transfer Facilities FL - Hazardous Waste Transport Facilities FL - HAZWASTE FL - Waste Cleanup Open Responsible Party Sites IL - IEPA Coal Ash Ponds KY - Hazardous Waste Large Quantity Generators KY - Solid Waste Landfills Points LA - Hazardous Waste Permits NH - Hazardous Waste Generators NH - Solid Waste Facilities TX - Industrial and Hazardous Waste
Tier II	10	Statewide Tier II Dataset
Resource Extraction	10	IA - Coal Mines Points IL - All Mine Points IN - Active Industrial Mineral Operations KY - Active Coal Mines KY - Mineral Operations LA - Coal Mines OH - Coal Mines Current OH - Coal Mines Locations OH - Industrial Mineral Locations TX - Historical Coal Sites
NPDES	10	FL - NPDES Facilities (both Domestic and Industrial) IA - Wastewater NPDES Facility IL - NPDES Permits IN - Water NPDES Facilities IN - Water NPDES Pipe Locations KY - KPDES Permitted Facilities LA - LPDES NJ - NJPDES Active Permit List with Contacts NJ - Surface Water Discharge OH - NPDES Individual Permits
Injection and Resource Extraction Wells	8	FL - Permitted Oil and Gas Wells IN - Petroleum Wells KY - Class I Wells, Waste Injection KY - Class II Wells, Injection Wells Associated with Oil and Gas Production KY - Oil & Gas Wells LA - Well Information OH - Active Oil and Gas Wells OH - Oil and Gas Wells
CAFOs	5	Statewide CAFOs Dataset (IA, IL, IN, OH, TX)
AST	4	Statewide AST Dataset (IA, OH, NH, TX)
LUST	2	Statewide LUST Dataset (IA, IL)
Chemical Facilities	1	FL - Fuel Facilities
Storage Tanks	1	FL - Registered Tanks from Storage Tank and Contamination Monitoring (STCM)
Energy Infrastructure	1	IN - Ethanol Production Facilities
Oil Storage Facilities	0	-
Toxic Release	0	-

The national and state information resources used in this study were selected in an effort to obtain specific threat attributes, including material identification (name/CASRN), material volume/mass, discharge flow information, and facility/tank operation status. **Table 21** shows the number of national or state information resources that included information about each of the listed attributes. Key findings from the evaluation of information resources include:

- State information resources generally had more complete reporting of material identity and volume/mass stored on-site compared with national information resources.

- Tier II was the most valuable information resource due to broad coverage of facilities that handle or store chemicals, the consistent availability of the identity and mass of material on-site, and the annual updating of Tier II chemical inventories. This valuable dataset is only available from state information resources.

Table 21. Threat Attributes Available in National and State Information Resources

Attribute	National Threat Type (Count)	Total National Resources	State Threat Type (Count)	Total State Resources
Material Identification (Name/CASRN)	Energy Infrastructure (1) Chemical Facilities (5) Injection and Resource Extraction Wells (2) LUST (1) Toxic Release (4)	13 (52%)	AST (4) Chemical Facilities (1) Resource Extraction (2) Energy Infrastructure (1) Tier II (10)	18 (29%)
Material Volume/Mass	Chemical Facilities (3) Toxic Release (3)	6 (24%)	AST (4) Chemical Facilities (1) Resource Extraction (1) Tier II (10)	16 (25%)
Discharge Flow Information	-	0 (0%)	NPDES (3)	3 (5%)
Facility/Tank/Operation Status	-	0 (0%)	Injection and Resource Extration Wells (3) Storage Tanks (1) AST (2) LUST (1) NPDES (1) CAFOs (1) Hazardous Waste (1)	10 (16%)

Of the 506,413 threats identified in the SWCTI, 391,880 (77%) threats were identified through a state information resource and 114,533 (23%) threats were identified through a national information resource. **Table 22** shows the number of threats, categorized by threat type, identified using national and state information resources. All except the following four threat type categories are represented in national information resources: Tier II, Storage Tanks, AST, and CAFOs. State information resources covered all threat types except Toxic Release and Oil Storage Facilities (i.e., EPA Facility Response Plan [FRP] Facilities), although this coverage varied widely across the ten states. Information resources for some threat types were identified in only one or two of the ten states (e.g., information resources covering Energy Infrastructure were identified only in KY and IN).

Comparing the total threat counts across all threat type categories shows that the number of threats identified using state information resources exceeds the number identified using national resources, with the following five exceptions: LUSTs, Toxic Release, Oil Storage Facilities, Energy Infrastructure, and NPDES. The national LUST information resource is a compilation of state and national databases, and thus would be expected to provide a comprehensive inventory of LUSTs. Toxic releases are tracked through EPA's Toxics Release Inventory (TRI) and the National Response Center (NRC) Spill Reporting Hotline. Large Oil Storage Facilities are tracked through EPA's FRP regulation. Thus, while state information resources may collectively provide a larger raw threat count, there are gaps in threat type coverage by state resources, and some states (e.g., NJ, NH) lack information resources for several of the listed threat types.

Table 22. Count of Threats (by Threat Type Category) Identified through National and State Information Resources

	LA	TX	OH	FL	IL	KY	NJ	IN	IA	NH	Total
Tier II - National	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**
Tier II - State	71,354	50,840	23,191	20,181	19,492	8,981	15,685	7,855	14,335	2,126	**234,040**
Injection and Resource Extraction Wells - National	42	7,886	14	0	0	0	0	0	0	0	**7,942**
Injection and Resource Extraction Wells - State	27,866	8,759	31,873	29	39	12,732	N/A	4,534	N/A	N/A	**85,832**
NPDES - National	8,277	5,742	6,875	7,962	5,437	4,264	2,333	3,579	1,343	661	**46,473**
NPDES - State	5,444	242	4,035	1,006	3,332	2,461	4,318	2,848	927	N/A	**24,613**
LUST - National	362	862	1,565	3,020	2,953	7,047	2,411	814	409	310	**19,753**
LUST - State	N/A	N/A	N/A	N/A	12,652	N/A	N/A	182	1,221	N/A	**14,055**
Chemical Facilities - National	1,903	2,994	2,441	649	1,361	701	10,649	546	921	49	**22,214**
Chemical Facilities - State	N/A	N/A	N/A	4,482	N/A	N/A	N/A	N/A	N/A	N/A	**4,482**
Storage Tanks - National	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**
Storage Tanks - State	N/A	N/A	N/A	13,656	N/A	N/A	N/A	N/A	N/A	N/A	**13,656**
Toxic Release - National	882	2,213	2,925	820	1,938	1,011	904	1,003	686	179	**12,561**
Toxic Release - State	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**
Hazardous Waste - National	360	125	810	226	529	201	772	255	72	62	**3,412**
Hazardous Waste - State	37	1,332	76	482	29	535	14	3	3	1,161	**3,672**
AST - National	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**
AST - State	2	3,668	588	N/A	103	8	N/A	N/A	736	1,753	**6,858**
Resource Extraction - National	10	25	20	0	18	219	0	4	2	0	**298**
Resource Extraction - State	0	122	653	N/A	831	1,883	N/A	2	414	N/A	**3,905**
Energy Infrastructure - National	49	304	240	46	214	95	66	52	132	29	**1,227**
Energy Infrastructure - State	N/A	N/A	N/A	N/A	N/A	2	N/A	1	N/A	N/A	**3**
CAFOs - National	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**
CAFOs - State	N/A	64	42	N/A	94	2	N/A	178	384	N/A	**764**
Oil Storage Facilities - National	146	198	94	25	96	39	12	29	14	0	**653**
Oil Storage Facilities - State	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**
Total - National	**12,031**	**20,349**	**14,984**	**12,748**	**12,546**	**13,577**	**17,147**	**6,282**	**3,579**	**1,290**	**114,533**
Total - State	**104,703**	**65,027**	**60,458**	**39,836**	**36,572**	**26,604**	**20,017**	**15,603**	**18,020**	**5,040**	**391,880**

The results of this analysis demonstrate that under the current paradigm of fractured data collection for potential sources of source water contamination, a comprehensive SWCTI can only be developed through use of multiple information resources from both national and state information resources. National information resources were found to be important for identifying threat types including Toxic Release, Energy Infrastructure, Oil Storage Facilities, Hazardous Waste, and NPDES. State information resources were found to be important for identifying threat types including Tier II, Resource Extraction sites (including wells), Storage Tanks (including ASTs and LUSTs), Hazardous Waste sites, NPDES, and CAFOs. Notably, the single most valuable information resource, in terms of both threat coverage and availability of important threat attributes, were the Tier II datasets, which are only available through State Emergency Response Commissions or Local Emergency Planning Committees. Fortunately, amendments to the EPCRA, enacted under Section 2018 of AWIA, provide CWSs with the legal authority to access this important dataset (U.S. EPA, 2019).

Section 4.0: Summary and Conclusions

A SWCTI conducted for ten states (Florida, Illinois, Indiana, Iowa, Kentucky, Louisiana, New Jersey, New Hampshire, Ohio, and Texas) identified 506,413 threats and 110,745 unique sites within the ZOCs delineated for CWSs that serve a population of 1,000 customers or more. Threats identified in this SWCTI include any material that is manufactured, used, stored, or discharged at an active site that fell within a ZOC. Regardless of their proximity to intakes or wellheads, threats considered to pose a minimal risk of releasing a significant volume of a contaminant to drinking water sources over a short duration were excluded, such as dry wells, wells that were not drilled, small quantity generators as designated under RCRA, stormwater discharges, and threats reporting a material volume or mass of "0." Additionally, materials unlikely to change water quality (e.g., lead acid batteries, limestone, propane) were excluded from the analysis (see Table 4 in Section 2.3 for additional materials excluded from the analysis). Finally, this analysis did not consider releases that can occur during transportation accidents.

Of the 506,413 threats, 288,875 (57%) threats were within 1,003 SW ZOCs and 217,538 (43%) were within 19,955 GW ZOCs. Threats in the SWCTI existed across all ten states, with the highest density of threats near industrial areas, resource extraction hubs, and urban areas. States with the greatest number of threats included Louisiana, 116,734 (23%); Texas, 85,376 (17%); and Ohio, 75,442 (15%). Of the 506,413 threats, the threat types with the largest threat counts in the SWCTI included Tier II, 234,040 (45%); Injection and Resource Extraction Wells, 93,774 (19%); and NPDES, 71,086 (14%).

Material names were reported for 276,816 (55%) of the 506,413 threats identified in the SWCTI. A mass or volume was reported for 227,449 (82%) of the 276,816 threats with material names. The most commonly occurring contaminant class was Organic Chemical with 59,402 (21%) threats, followed by Trade Name with 45,991 (16%) threats, Petroleum Products with 36,517 (13%) threats, and Diesel or Gasoline with 36,250 (13%) threats. The contaminant categories with the largest total volumes were Petroleum Products with 452,352,011 kgal (51%), Organic Chemical with 327,924,764 kgal (37%), and Fertilizer/Ammonia with 53,036,862 kgal (6%). Within the Organic Chemical class, the most commonly occurring materials were methanol, 5,472 (9%); ethanol, 2,003 (3%); and paraffinic petroleum distillates, 1,332 (2%).

Of the 506,413 threats identified in the SWCTI, 46,281 (9%) were identified as a CWA-HS. The most commonly occurring contaminant classes for CWA-HS were Chlorine with 11,271 (24%) threats, Acid with 10,798 (23%) threats, and Caustic Material with 6,433 (14%) threats. The contaminant categories with the largest total volumes of CWA-HS were: Organic Chemical, 110,377,573 kgal (69%); Fertilizer/Ammonia, 34,945,388 kgal (22%); and Acid, 13,059,474 kgal (8%). Within the Organic Chemical class, the most commonly occurring CWA-HS threats were toluene, 952 (13%); naphthalene, 781 (11%); and xylene, 751 (11%). CWA-HS threats were widely distributed across all ten states, with a high density of CWA-HS threats in more industrialized areas including southeastern Louisiana, northern New Jersey, northeastern/southeastern Texas, and northeastern Illinois.

A total of 32,593 ZOCs were delineated for this analysis, including 1,152 SW ZOCs and 31,441 GW ZOCs. Of the 1,152 SW ZOCs, 1,003 (87%) contained at least 1 threat. There were 327 (33%) SW ZOCs with threat counts between 101 and 1,000, and 78 (7%) SW ZOCs with threat counts greater than 1,000. Of the 31,441 GW ZOCs, 19,955 (63%) contained at least 1 threat. Of these, 14,577 (73%) had a threat count between 2 and 25, while only 2 (<1%) contained more than 1,000 threats: one GW ZOC located in NJ and the other in Texas.

The study identified 12,561 releases of a substance, but there was not a statistically significant correlation between the number of threats and number of releases in a SW ZOC. The reasons for this lack of correlation are unclear and warrant further research.

Both state and national information resources were necessary to build a comprehensive SWCTI due to gaps in information available from any single information resource. Of the 88 information resources collected, 25 (28%) were national information resources and 63 (72%) were state information resources. Some threat types were better covered by national resources, such as Energy Infrastructure, Oil Storage Facilities, and Toxic Release, while others were better covered by state resources, such as Tier II Hazardous Chemical Storage, Storage Tanks, and Resource Extraction. Tier II datasets were found to be the single most valuable information resource, in terms of both threat coverage and availability of important threat attributes. Tier II datasets are only available through states or Local Emergency Planning Committees; however, the amendments to EPCRA under AWIA, Section 2018 explicitly grant CWSs with access to Tier II data for facilities located in a corresponding source water protection area.

The results of this SWCTI indicate that threats are prevalent across all industrial, agricultural, urban, and resource extraction regions that fall within SW and GW ZOCs. Although 11,635 (36%) ZOCs out of 32,593 did not have a threat present within the ZOC, there is a possibility that a release from a threat outside of a ZOC could significantly impact a source of drinking water. The following section provides recommendations to help CWSs develop a SWCTI and use it to understand risk and prepare for releases.

Section 5.0: Recommendations

The findings from this SWCTI demonstrate a variety of threat types occurring in SW and GW ZOCs across the ten states inventoried. However, the analysis of threat occurrence within individual ZOCs showed that threat occurrence varied by as much as three orders of magnitude and that the specific types of threats in a ZOC depend on local conditions, such as land use, characteristics of the drainage area, and the prevalence of industry, resource extraction, or agriculture in the region. Thus, for a water system to understand its unique risk of acute source water contamination incidents, it is necessary to develop a system-specific SWCTI. Once a SWCTI is developed, it should be analyzed to characterize and prioritize those threats identified in the inventory that present the greatest risk, considering factors such as:

- The identity and quantity of a material stored at the site
- Overland flow distance from the site to the waterbody, including consideration of direct conveyance that may occur through waste or storm water collection systems, or other infrastructure
- Flowpath within the waterbody from the site to the drinking water intake or wellhead
- Groundwater fate and transport modeling through an aquifer
- History of releases in the ZOC, including those that reached the waterbody

If the results of the SWCTI indicate the risk of releases to source water is significant, the following actions should be considered to prepare for and mitigate that risk:

- Identify the materials stored, used, or released at sites that pose the greatest risk to a source water
- Identify methods and laboratories that can analyze for these materials
- Evaluate the ability of current treatment processes, including intermittent pretreatment, such as addition of powdered activated carbon, to remove or neutralize these materials
- Reach out to site owners to share contact information and coordinate communications in the event of a release from that site
- Ensure that notifications of releases that are reported under EPCRA are promptly reported to CWSs that could be impacted (U.S. EPA, 2019)
- Create relationships with first responders and Local Emergency Planning Committees to coordinate communications for notification of releases that could impact a source water
- Consider methods for monitoring and early detection of releases
- Update emergency response plans to include procedures to respond to releases from threats identified in the SWCTI
- Periodically update the SWCTI to capture new threats and update information about previously identified threats

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Glossary

Census Designated Urban Areas. An area that encompasses at least 5,000 people or at least 2,000 housing units.

Clean Water Act Hazardous Substances. A list of substances defined under authorities of Section 311(b)(2) of the Clean Water Act (Title 40 of the CFR, Part 116).

Community Water System. A system that provides water for human consumption through pipes or other constructed conveyances and has at least fifteen service connections or regularly serves at least twenty-five individuals, and which serves the same population year-round (SDWA section 1401(15)).

Contaminants of Concern. Any contaminant that enters a body of water and is likely to cause adverse human health effects, impact water system operations, or damage water system infrastructure.

ESRI Industrial Areas. Geographical areas zoned for industrial use by a government jurisdiction.

National Hydrography Dataset. A dataset maintained by the United States Geological Survey that represents the water drainage network of the United States with features such as rivers, streams, canals, lakes, ponds, coastline, dams, and stream gages.

National Response Center. The designated federal point of contact for reporting all oil, chemical, radiological, biological, and etiological discharges into the environment, anywhere in the United States and its territories. The National Response Center is part of the federally established National Response System and staffed 24 hours a day by the U.S. Coast Guard.

Safe Drinking Water Information System. A system maintained by U.S. EPA that contains basic information about each public water system, violation information for each public water system, and enforcement information.

Shale Plays. A set of discovered, undiscovered, or possible natural gas accumulations that exhibit similar geological characteristics. Shale plays are located within basins, which are large scale geologic depressions, often hundreds of miles across, which may contain oil and natural gas resources.

Source Water Contamination Threat Inventory. A record of sites (e.g., facilities) that store or handle materials, which if suddenly released, could contaminate a source of drinking water. A source water contamination threat inventory (SWCTI) can be developed for systems using either surface water or groundwater. The scope of a SWCTI is generally defined by threat types of most concern to a system (e.g., above ground storage tanks, waste storage facilities) and a *zone of concern* (defined below).

Toxic Release Inventory. A program created under the Emergency Planning and Community Right-to-Know Act that requires certain industries to file an annual report documenting releases of certain toxic chemicals that may pose a threat to human health and to the environment. Reporting is limited to a list of approximately 755 individual chemicals and 33 chemical categories.

Zone of Concern. For surface water intakes, an area that extends 50 miles upstream, ¼ mile downstream, includes all major tributaries, and includes a ¼ mile buffer inland from the waterbody area boundary. For groundwater wells, an area defined by a ½ mile radius around the well location. This definition was used solely for the purposes of the study presented in this report.

Appendix A: Unit Conversion Multipliers

For each unit of measure below, multiply the available value by the multiplier to convert to gallons (U.S., liquid).

- Barrels (petroleum) = 42.0
- Barrels (not petroleum) = 31.5
- Cubic Meters = 264.172
- Cubic Yards = 201.974
- Cups = 0.0625
- Drops = 0.0000132086
- Gallons = 1.0
- Liters = 0.264
- Ounces = 0.0078125
- Pints = 0.125
- Pounds = 0.12 (assuming a density of water of 8.345 pounds/gallon)
- Quarts = 0.25
- Tablespoons = 0.00390625
- Tons = 269.0 (assuming a density of water of 8.345 pounds/gallon)

Appendix B: Supplemental Analyses of Threat Occurrence in Specific ZOCs

Table 23 presents attributes of the ten SW ZOCs that contain the greatest number of threats. The threat count for these ten SW ZOCs ranged from 2,775 to 6,779 threats, and the most common contaminant classes occurring were the Organic and Inorganic Chemical classes. Note that the ZOCs with the following IDs partially overlapped adjacent zones: 1, 2, 79, and 80. The two SW ZOCs (1 and 2) with the greatest number of threats, 6,753 and 6,779, represent multiple intakes located near one another and thus overlap almost completely, resulting in the two zones containing a nearly identical inventory of threats. These two SW ZOCs are located south of Baton Rouge, LA, and most threats in these ZOCs are Injection and Resource Extraction Wells: 3,931 (58%) and 4,131 (61%), for zones 1 and 2, respectively.

Table 23. SW ZOCs Containing the Greatest Number of Contamination Threats. (Unique sites are discrete locations that manufacture, use, store, or discharge contaminants of concern. Threat counts reflect the individual contamination threats located at these discrete locations.)

ID	Threat Count	Zone Area (sq mi)	Normalized Threat Count	Unique Sites	Threat Type with Highest Threat Count	Contaminant Class with Highest Threat Count
1, 2	6,753 & 6,779	1,505 & 1,518	4.50	4,276 & 4,308	Injection and Resource Extraction Wells (3,931 & 4,131)	Organic Chemical (371 & 389)
3	6,141	562	11	2,088	Tier II (3,593)	Organic Chemical (1,194)
4	5,575	52	108	274	Tier II (5,265)	Organic Chemical (1,588)
5	4,027	243	17	2,041	Injection and Resource Extraction Wells (3,789)	Organic Chemical (36)
35	3,908	40	98	200	Tier II (3,651)	Organic Chemical (1,159)
79, 80	2,898	45	64 & 65	206	Tier II (2,639)	Organic Chemical (973)
30	2,894	291	10	2,103	Injection and Resource Extraction Wells (1,590)	Organic Chemical (218)
47	2,877	386	7	1,277	Injection and Resource Extraction Wells (1,469)	Inorganic Chemical (218)
48	2,788	297	9	1,407	Injection and Resource Extraction Wells (2,431)	Organic Chemical (66)
49	2,775	356	8	1,233	Injection and Resource Extraction Wells (1,346)	Inorganic Chemical (224)

Table 24 presents attributes of the ten GW ZOCs that contain the greatest number of threats. Note that the ZOCs with the following IDs partially overlapped adjacent zones: 138, 139, 140, 141, 132, and 155. The threat count for these ten GW ZOCs ranged from 560 to 3,309 threats, and the most common contaminant class was the Organic Chemical class. The GW ZOC (ID-95) with the greatest number of threats was located near Madison, NJ and contained 3,309 threats, which are associated with five unique sites (i.e., one or more of these five sites handle a very large number of chemicals). Of the 3,309 threats within this GW ZOC, 3,304 (99.8%) were chemical facility threats.

Table 24. GW ZOCs Containing the Greatest Number of Contamination Threats. (Unique sites are discrete locations that manufacture, use, store, or discharges contaminants of concern. Threat counts reflect the individual contamination threats located at these discrete locations.)

ID	Threat Count	Zone Area (sq mi)	Normalized Threat Count	Unique Sites	Threat Type with Highest Threat Count	Contaminant Class with Highest Threat Count
95	3,309	0.78	4,217	5	Chemical Facilities (3,304)	Organic Chemical (2,339)
96	2,293	0.78	2,923	8	Tier II (2,265)	Organic Chemical (51)
97	889	0.78	1,133	47	Tier II (849)	Organic Chemical (257)
98	765	0.78	975	26	Tier II (741)	Organic Chemical (128)
99	714	0.78	910	16	Tier II (625)	Organic Chemical (142)
138, 139	708	0.78	902	12	Chemical Facilities (660)	Organic Chemical (609)
140, 141	684	0.78	872	13	Chemical Facilities (660)	Organic Chemical (588)
131	683	0.78	871	42	Tier II (646)	Organic Chemical (167)
132, 155	614 & 666	0.78	783 & 849	34 & 35	Tier II (554 & 606)	Organic Chemical (46 & 58)
142	560	0.78	714	9	Chemical Facilities (552)	Organic Chemical (324)

The ten SW ZOCs that had the maximum threat counts in each state collectively contained a total of 27,130 (9%) threats. The ten GW ZOCs that had the maximum threat counts in each state collectively contained a total of 7,700 (4%) threats. The characteristics of these ten SW ZOCs and ten GW ZOCs are presented in Tables 25 and 26, respectively.

Table 25 presents attributes of the SW ZOC that contains the largest number of threats in each state. Note that the ZOCs with the following IDs partially overlapped adjacent zones: 6 and 7; 1 and 2; 51 and 52. The states containing the SW ZOCs with the largest threat counts include Louisiana (largest SW ZOC threat count = 6,779), Ohio (largest SW ZOC threat count = 4,027), and Kentucky (largest SW ZOC threat count = 2,894). The two SW ZOCs in Louisiana with the largest threat count were previously described in Table 23. The SW ZOC with the second largest threat count was in Ohio with 4,027 threats. This SW ZOC was located near Alliance, OH, and the threats in this SW ZOC consisted mostly of resource extraction wells, 3,789 (94%). The most commonly occurring contaminant classes in these SW ZOCs are the Organic Chemical, Petroleum Products, Diesel or Gasoline, and Inorganic Chemical classes.

Table 25. SW ZOCs Containing the Greatest Number of Threats in each State. (Unique sites are discrete locations that manufacture, use, store, or discharges contaminants of concern. Threat counts reflect the individual contamination threats located at these discrete locations.)

State	ID	Threat Count	Zone Area (sq mi)	Normalized Threat Count	Unique Sites	Threat Type with Highest Threat Count	Contaminant Class with Highest Threat Count
FL	6,7	918 & 932	358 & 387	2 & 3	463 & 464	Tier II (408 & 427)	Diesel or Gasoline (123 & 131)
IA	14	1,563	463	3	363	Tier II (1,178)	Organic Chemical (302)
IL	20	2,137	72	30	876	Tier II (996)	Organic Chemical (182)
IN	25	1,666	109	15	648	Tier II (861)	Inorganic Chemical (128)
KY	30	2,894	291	10	2,103	Injection and Resource Extraction Wells (1,590)	Organic Chemical (218)
LA	1, 2	6,753 & 6,779	1,505 & 1,518	5	4,276 & 4,308	Injection and Resource Extraction Wells (3,931 & 4,131)	Organic Chemical (371 & 389)
NH	36	2,417	718	3	1,097	Tier II (984)	Petroleum Products (657)
NJ	42	2,322	126	18	706	Tier II (1,639)	Organic Chemical (705)
OH	5	4,027	243	17	2,041	Injection and Resource Extraction Wells (3,789)	Organic Chemical (36)
TX	51, 52	2,393	751	3	2,108	Injection and Resource Extraction Wells (2,059)	Organic Chemical (54)

Table 26 presents attributes of the GW ZOC in each state that contains the largest number of threats. Note that the ZOCs with the following IDs partially overlapped adjacent zones: 118, 119, and 120; and 144 and 145. The states containing the GW ZOCs with the largest threat counts include New Jersey (largest GW ZOC threat count = 3,309), Texas (largest GW ZOC threat count = 2,293), and Louisiana (largest GW ZOC threat count = 889). The GW ZOC in New Jersey with the largest threat count was previously described in Table 24. The GW ZOC with the second largest threat count was located near Orange, TX, and the threats consisted mostly of Tier II threats, 2,265 (99%). The most commonly occurring contaminant classes in these GW ZOCs are the Organic Chemical, Pesticides or Herbicides, and Fertilizer/Ammonia classes.

Table 26. GW ZOCs Containing the Greatest Number of Threats in each State. (Unique sites are discrete locations that manufacture, use, store, or discharges contaminants of concern. Threat counts reflect the individual contamination threats located at these discrete locations.)

State	ID	Threat Count	Zone Area (sq mi)	Normalized Threat Count	Unique Sites	Threat Type with Highest Threat Count	Contaminant Class with Highest Threat Count
FL	100	310	0.78	395	21	Tier II (183)	Organic Chemical (209)
IA	105	207	0.78	264	6	Tier II (204)	Pesticides or Herbicides (40)
IL	112	184	0.78	235	71	Tier II (121)	Organic Chemical (30)
IN	118, 119, 120	99	0.78	126	5	Tier II (96)	Pesticides or Herbicides (45)
KY	126	105	0.78	134	13	Tier II (94)	Organic Chemical (19)
LA	97	889	0.78	1,133	47	Tier II (849)	Organic Chemical (257)
NH	133	78	0.78	99	13	Tier II (57)	Fertilizer (43)
NJ	95	3,309	0.78	4,217	5	Chemical Facilities (3,304)	Organic Chemical (2,339)
OH	144, 145	225 & 226	0.78	287 & 288	2 & 3	Tier II (221)	Organic Chemical (179)
TX	96	2,293	0.78	2,923	8	Tier II (2,265)	Organic Chemical (51)

Two major rivers in the ten-state study area, Mississippi River and Ohio River, intersected fifty-two SW ZOCs. All SW ZOCs that intersected these rivers contained at least one threat. **Table 27** presents attributes of the five SW ZOCs containing the greatest number of threats that intersect each of these two rivers. The five SW ZOCs that intersect the Mississippi River with the greatest number of threats were all located along the river between Baton Rouge and New Orleans, LA. Note that the SW ZOCs with the following IDs partially overlapped adjacent zones: 4, 35, 79, 80, and 155. Two SW ZOCs (79 and 80) represent multiple intakes located near one another and thus overlap almost completely, resulting in the two zones containing the same 2,898 threats. The threat count for these five SW ZOCs ranged from 1,738 to 6,141 threats. The most common contaminant class occurring in these five SW ZOCs along the Mississippi River was Organic Chemicals.

The five SW ZOCs containing the greatest number of threats that intersect the Ohio River were mostly located along the river near Ashland, KY, although one was located near Evansville, IN. Note that the SW ZOCs with the following IDs partially overlapped adjacent zones: 31, 157, 156, and 158. The threat count for these five SW ZOCs ranged from 1,305 to 2,894 threats. The most common contaminant classes occurring in these five SW ZOCs along the Ohio River was Petroleum Products and Organic Chemical.

Table 27. SW ZOCs Containing the Most Threats Along the Mississippi and Ohio Rivers. (Unique sites are discrete locations that manufacture, use, store, or discharges contaminants of concern. Threat counts reflect the individual contamination threats located at these discrete locations.)

ID	State	Potentially Impacted Waterbody	Threat Count	Zone Area (sq mi)	Normalized Threat Count	Unique Sites	Threat Type with Highest Threat Count	Contaminant Class with Highest Threat Count
3	LA	Mississippi River	6,141	562	11	2,088	Tier II (3,593)	Organic Chemical (1,194)
4	LA	Mississippi River	5,575	52	108	274	Tier II (5,265)	Organic Chemical (1,588)
35	LA	Mississippi River	3,908	40	98	200	Tier II (3,651)	Organic Chemical (1,159)
79, 80	LA	Mississippi River	2,898	45	64 & 65	206	Tier II (2,369)	Organic Chemical (973)
155	LA	Mississippi River	1,738	32	55	91	Tier II (1,599)	Organic Chemical (327)
30	KY	Ohio River	2,894	291	10	2103	Injection and Resource Extraction Wells (1,590)	Organic Chemical (218)
156	OH	Ohio River	1,595	829	2	758	Tier II (625)	Petroleum Products (181)
31	KY	Ohio River	1,516	493	3	692	Injection and Resource Extraction Wells (614)	Petroleum Products (158)
157	KY	Ohio River	1,313	443	3	675	Tier II (427)	Petroleum Products (164)
158	OH	Ohio River	1,305	452	3	667	Tier II (426)	Petroleum Products (164)