Health Consultation

Evaluation of per- and polyfluoroalkyl substances (PFAS) in private wells in the Wright-Kiles Blackhawk Subdivision

Beloit Corp.

Rockton, Winnebago County, Illinois

EPA FACILITY ID: ILD021440375

November 12, 2026

Final Release

Prepared by the Illinois Department of Public Health

Under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Office of Capacity Development and Applied Prevention Science
Atlanta, Georgia 3033

Health Consultation: A Note of Explanation

A health consultation is a verbal or written response from ATSDR or ATSDR's Cooperative Agreement Partners to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. To prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material. In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Table of Contents

1. Summary 1
2. Background 5
2.1 Statement of Issue and Purpose 5
2.2 Site Description and Timeline 6
3. Community Description and Concerns 7
4. Sampling Data 9
5. Scientific Evaluations 9
5.1 Exposure Pathway Analysis 10
5.1.1 Completed Pathways 12
5.2 Private Well Water Evaluation 12
5.2.1 Screening Analysis 13
5.2.2 Evaluation of Household Water Use 15
5.2.2.1 Exposure Point Concentrations and Exposure Calculations 15
5.2.2.2 Non-Cancer Health Effect Evaluation 17
5.2.2.3 PFAS Mixtures Evaluation 25
5.2.2.4 Cancer Health Effect Evaluation 26
5.3 Evaluation of Health Outcome Data 27
5.4 Summary of Limitations and Uncertainties 27
6. Conclusions 28
7. Recommendations and Public Health Action Plan 29
8. Authors, Site Team, and Contributors 30
9. References 31
Appendix A: Brief Summary of ATSDR's Public Health Assessment (PHA) Process 34
Appendix B: Figures 35
Appendix C: Glossary of Terms 36
Appendix D: Technical Information 45
C.1 ATSDR Screening Levels 45
C.2 Health Guidelines Used in this Report 45
C.3 Hazard Assessment Equations 45

C.4 PFAS Type Names 47

List of Tables

Table 1: Detected PFAS Types in WKBS Private Wells and Comparison Values in Nanograms per Liter (ng/L) 14
Table 2: Summary of Combined Ingestion and Skin Contact Exposure Doses for Chronic Exposure to PFHxS in Household Water including Noncancer Hazard Quotients* 16
Table 3: Summary of Combined Ingestion and Skin Contact Exposure Doses for Chronic Exposure to PFOA in Household Water including Noncancer Hazard Quotients* 16
Table 4: Summary of Combined Ingestion and Skin Contact Exposure Doses for Chronic Exposure to PFOS in Household Water including Noncancer Hazard Quotients* 16
Table 5: Number of Wells with CTE Exposure Doses Approaching or Exceeding Effect Level Doses for Health Effects Associated with Exposure to PFHxS in Drinking Water 19
Table 6: Number of Wells with RME Exposure Doses Approaching or Exceeding Effect Level Doses for Health Effects Associated with Exposure to PFHxS in Drinking Water 20
Table 7: Number of Wells with CTE Exposure Doses Approaching or Exceeding Effect Level Doses for Health Effects Associated with Exposure to PFOA in Drinking Water 22
Table 8: Number of Wells with RME Exposure Doses Approaching or Exceeding Effect Level Doses for Health Effects Associated with Exposure to PFOA in Drinking Water 22
Table 9: Number of Wells with CTE Exposure Doses Approaching or Exceeding Effect Level Doses for Health Effects Associated with Exposure to PFOS in Drinking Water 24
Table 10: Number of Wells with RME Exposure Doses Approaching or Exceeding Effect Level Doses for Health Effects Associated with Exposure to PFOS in Drinking Water 24
Table 11: Cancer Risk (CR) based on Exposure to PFOA and PFOS in Drinking Water 26

List of Figures

Figure 1: Satellite view of the Site and the WKBS. 6
Figure 2: Sampling Map (IEPA, 2023*)* 9
Figure 3: Topographical Map of Beloit Corp. and the Surrounding Area 11

Acronyms and Abbreviations

6:2 FTSA	6:2 Fluorotelomer Sulfonic Acid
95UCL	95th Percentile Upper Confidence Limit
ATSDR	Agency for Toxic Substances and Disease Registry
COC	Contaminant of Concern
CR	Cancer Risk

CSF	Cancer Slope Factor
CTE	Central Tendency Exposure
CV	Comparison Value
CWS	Community Water System
EPA	Environmental Protection Agency
EPC	Exposure Point Concentration
FOSA	Perfluorooctane sulfonamide
GRASP	Geospatial Research, Analysis, and Services Program
HC	Health Consultation
HEDs	Human Equivalent Dose
HQ	Hazard Quotient
LiDAR	Light Detection and Ranging
IDPH	Illinois Department of Public Health
LOAEL	Lowest Observed Adverse Effect Level
LUs	Limitations and Uncertainties
MCL	Maximum Contaminant Level
$(mg/kg/day)^{-1}$	Change per Milligram of Chemical per Kilogram Body Weight per Day
MRL	Minimal Risk Level
ng/kg/day	Nanograms of Chemical per Kilogram Body Weight per Day
ng/L	Nanograms per Liter
NOAEL	No Observed Adverse Effect Level
NPL	National Priorities List
PFAS	Per- and Polyfluoroalkyl Substances
PFBA	Perfluorobutanoic Acid
PFBS	Perfluorobutanesulfonic Acid
PFHpA	Perfluoroheptanoic Acid
PFHpS	Perfluoroheptane Sulfonic Acid
PFHxA	Perfluorohexanoic Acid
PFHxS	Perfluorohexane Sulfonic Acid
PFNA	Perfluorononanoic Acid
PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctane Sulfonic Acid
PFPeA	Perfluoropentanoic Acid
PFPeS	Perfluoropentane Sulfonic Acid
PHA	Public Health Assessment
PHAST	Public Health Site Assessment Tool
RME	Reasonable Maximum Exposure
SHOWER	Shower and Household Water-Use Exposure Model
RfD	Reference Dose
VOC	Volatile Organic Compound
WKBS	Wright-Kiles Blackhawk Subdivision

1. Summary

The Agency for Toxic Substances and Disease Registry (ATSDR) evaluates community exposures and makes recommendations to prevent harmful exposures to hazardous substances in the environment. As a state partner of ATSDR, the Illinois Department of Public Health (IDPH) assists ATSDR by producing public health assessments and health consultations for the same purpose. This health consultation (HC) evaluates past, present, and future exposures to per- and polyfluoroalkyl substances (PFAS) in private wells in the Wright-Kiles Blackhawk Subdivision (WKBS), which is immediately adjacent to the Beloit Corp. Site (the Site) in Rockton, Illinois.

In June 2021, there was a six-alarm fire at the Chemtool facility, which was then operating on the Site. US Fire Pump, a Chemtool contractor, used 3,200 gallons of fire-fighting foam containing per- and polyfluoroalkyl substances (PFAS) at the Site to aid in suppressing the fire. EnviroServe Inc. sampled the private wells in the WKBS for PFAS in December 2022 in response to this release. PFAS were detected at concentrations above ATSDR's health-based comparison values (CVs) throughout the WKBS. We used ATSDR's CVs to decide which PFAS to evaluate further.

Available sampling data from fire-fighting foam wastewater show that the mix of PFAS in the fire-fighting foam largely did not match the mix of PFAS compounds detected above CVs in WKBS private wells. Samples of firefighting foam wastewater contained high levels of 6:2 FTSA, PFHxA, PFPeA, and PFBA. All four PFAS were detected in WKBS private wells at much lower levels. In addition, 6:2 FTSA was only detected in 1 of 38 samples from the WKBS. Because PFAS were detected in private wells throughout the WKBS, IEPA and the local government of Rockton began pursuing connections to the community water system (CWS) for residents using private wells in the WKBS. This work was completed in the summer thru fall of 2025. As of writing this report, 68 properties have been connected to Rockton's community water supply and 12 properties had water main stubs installed but refused connection. Therefore, current and future residents at these 12 properties are potentially exposed to PFAS through drinking from their private well.

This report evaluates sampling data for PFAS in drinking water collected by EnviroServe Inc. in December 2022. The samples were taken from 34 private wells in the WKBS before efforts to connect properties to municipal water. Three types of PFAS were identified and evaluated as potential contaminants of concern (COCs): perfluorohexane sulfonic acid (PFHxS), perfluorooctanoic acid (PFOA), and perfluorooctane sulfonic acid (PFOS). Most of the wells sampled were later connected to the CWS during the summer and fall of 2025. Many of the properties that refused a CWS connection have not been sampled for PFAS. However, given the

close proximity of homes and the uniform well depths throughout the WKBS, the 12 remaining active private wells are likely contaminated with similar levels of PFHxS, PFOA, and PFOS.

IDPH estimated exposures to PFAS in drinking water from WKBS private wells and evaluated the potential risk of adverse health effects for affected residents.

IDPH considered ingestion and dermal exposures for this report. Most PFAS do not easily evaporate from water during bathing and showering (ATSDR, 2021). Therefore, inhalation exposures were not evaluated. IDPH reached the following conclusions concerning ingestion and dermal exposures:

Conclusion 1	Exposure to PFAS in household water through drinking and bathing/showering could have harmed or could harm the health of private well users in the WKBS, especially children. Exposures were mitigated for many homes in the WKBS following connection to the Rockton CWS. However, those continuing to use the 12 private wells that were not connected to the CWS could continue to be exposed to PFAS at levels that could harm their health at the current time and into the future. This is a public health hazard.
Basis for Conclusion	IDPH estimated exposure doses based on the concentrations of PFHxS, PFOA, and PFOS in each well. Most wells in the WKBS had doses of each PFAS which approached or exceeded the effect levels for the following adverse health effects: • Reduced vaccine effectiveness (PFHxS, PFOA, PFOS) • Increased total cholesterol (PFOA, PFOS) • Decreased infant birth weights (PFHxS, PFOA, PFOS) • Thyroid effects (PFHxS) • Liver damage (PFHxS, PFOA, PFOS) These exceedances indicated that the above adverse health effects are possible following long-term exposure to the concentrations of PFAS in WKBS private wells. IDPH also estimated cancer risks based on the concentration of PFAS in each well. IDPH found that exposure to concentrations of PFOA in

32 of 34 wells could cause an increased risk of kidney, testicular, liver, or pancreatic cancers.

Few residents treat their water or use alternative sources of water based on information gathered by IDPH during a townhall with WKBS residents. Daily exposures to these PFAS are expected due to lack of water treatment or alternative water use in the WKBS. Because PFAS are persistent in groundwater, IDPH assumed that exposure to the concentrations detected in sampling data are representative of past, present, and future exposure concentrations.

Next Steps

- IDPH recommends residents who declined CWS connections to reduce their exposure to PFAS by treating their water with granular activated carbon filters or reverse osmosis treatment systems before drinking or cooking. Treatment devices that meet National Sanitation Foundation Standards 53 or 58 and that are maintained and updated following the manufacturer's instructions are recommended.
- IDPH recommends residents to reduce exposure to other potential PFAS sources, including food packaging materials, stain resistant carpets, water resistant clothing, cleaning products, and some cosmetics.
- IDPH recommends nursing mothers to continue to breastfeed and contact their healthcare providers with specific concerns.
- To help protect formula-fed infants from potential exposure to PFAS, IDPH recommends caregivers to use pre-mixed formula or reconstitute dry formula with water sources that meet state and federal drinking water guidelines for PFAS.
- IDPH recommends residents concerned about past exposures to speak with their doctor about their PFAS exposure and ask about exposure reduction measures and health screenings.
- IDPH recommends local health providers consult ATSDR's current clinician guide at https://www.atsdr.cdc.gov/pfas/hcp/clinical-overview/clinical-evaluation-management.html as a resource to guide patient treatment.

Conclusion 2

Exposure to a mixture of PFHxS, PFOA, and PFOS in household water through drinking and bathing/showering could have caused or could cause an increased risk of the harmful noncancer health effects listed

	in Conclusion 1, except for thyroid effects, for private well users in the WKBS. Exposures were mitigated for many homes in the WKBS following connection to the Rockton CWS. However, those continuing to use the 12 private wells that were not connected to the CWS could continue to be exposed to PFAS at levels that could harm their health at the current time and into the future. This is a public health hazard.
Basis for Conclusion	Of the 34 wells sampled, 27 had detections of PFHxS, PFOA, and PFOS. These three PFAS can cause several of the same health effects. Based on these shared health effects and the very low doses at which these health effects have been modeled to occur for each PFAS, it's reasonable to assume that exposure to a combination of these PFAS in one well could increase the overall risks of reduced vaccine effectiveness, increased total cholesterol, liver damage, and decreased infant birth weights.
Next Steps	• IDPH recommends following the steps described in Conclusion 1 to reduce PFAS exposure as much as possible. • IDPH will stay up to date on the latest PFAS research and update our assessment as needed.
Conclusion 3	There is not enough information to determine the public health hazard(s) due to exposure to other PFAS types detected in WKBS private wells. This is an indeterminant public hazard.
Basis for Conclusion	Health guidelines are currently unavailable due to lack of toxicological information for six of the 13 PFAS types detected in the WKBS: PFPeA, PFHpA, PFPeS, PFHpS, FOSA, and 6:2 FTSA. Epidemiological and toxicological data are limited for these types. Therefore, IDPH cannot make definitive public health conclusions regarding exposures at this time.
Next Steps	• IDPH recommends following the steps described in Conclusion 1 to reduce PFAS exposure as much as possible. • IDPH will stay up to date on the latest PFAS research and update our assessment as needed.
For More Information	If you have concerns about your health, you should contact your local health care provider.

Questions about this report, or exposures associated with this site can be directed to the IDPH Toxicology Section at 217-782-5830 or DPH.Tox@illinois.gov.

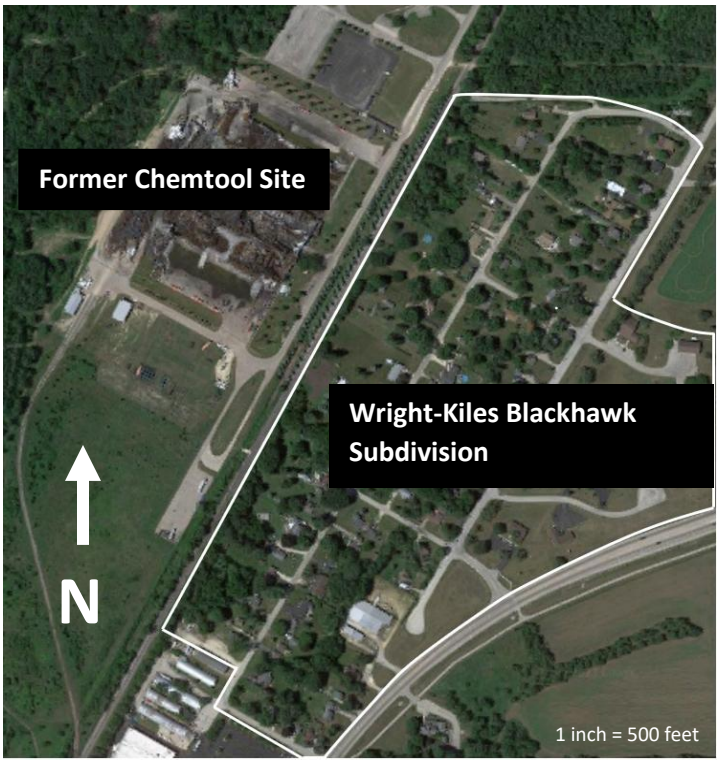
2. Background

2.1 Statement of Issue and Purpose

PFHxS, PFOA, or PFOS were detected in 33 of 34 private wells sampled in the WKBS. This indicates widespread PFAS contamination in the aquifer used by these private wells and the aforementioned PFAS types are considered potential contaminants of concern (COCs). However, as will be further discussed in this report, no plume has been identified nor has a contamination source been identified, so the extent of contamination in the aquifer has not been defined.

Based on information gathered by IDPH, very few residents treat their drinking water. IDPH cannot approximate the start of exposures due to the unknown source of contamination. Daily exposures are assumed and are expected to continue until treatment is installed or connections to a community water supply are established at the properties that refused connections. IDPH prepared this HC to evaluate the public health hazard posed by PFAS contamination in private wells in the WKBS and to identify next steps in reducing or preventing further exposures.

2.2 Site Description and Timeline



The 200-acre Beloit Corp. Superfund Site is located in the village of Rockton, Illinois. The Site includes the former Beloit Corp./Chemtool facility, several smaller industrial businesses, and the WKBS **(Figure 1)**. From 1961 until 1999, Beloit Corp. manufactured paper-making equipment and operated a research center on the property. Wastewater containing paper fibers was deposited into three unlined lagoons at the northern end of the Site along the Rock River from 1961 to 1986. Biosolids from the treatment lagoons were also applied to 10 acres of land near the southern end of the Site until 1984. Manufacturing and waste management activities throughout the contaminated onsite soil and area groundwater with volatile organic compounds (VOCs). The United States Environmental Protection Agency (EPA) placed the Site on the Superfund program's National Priorities List (NPL) of hazardous waste site in 1990.

The following provides a timeline of environmental investigations and remediation activities at the Site:

- Mid-late 1980s: Multiple environmental investigations discovered significant levels of contaminants in onsite groundwater and private wells in the WKBS.
- 1988: EPA proposed to list the Site on the NPL.
- 1990: Site is listed on the NPL.
- 1992: IDPH released an Interim Public Health Assessment (PHA) which concluded VOCs in site groundwater presented a public health hazard.
- 1993: IEPA installed point-of-use carbon filtration treatment units at four residences in the WKBS.
- 1994: IEPA began annual sampling of WKBS private wells for VOCs. IDPH continued to provide letters to residents with interpretations of results.
- 1996: Beloit Corp. installed a groundwater pump-and-treat system in the manufacturing area of the site to divert contaminated groundwater away from the Blackhawk Acres subdivision.
- 1998: IEPA installed additional treatment systems in homes on Watts Avenue and Blackhawk Avenue. IEPA found a private well impacted by VOCs and subsequently connected this residence to the Rockton community water supply (CWS) in 1999.

- 2004: IDPH published a PHA for the Site and concluded the Site posed no apparent public health hazard based on available data showing VOCs having decreased in WKBS private wells. A whole-house treatment system with carbon filters was installed at one home and is maintained by IEPA.
- 2021: A six-alarm fire at the Chemtool facility operating on the Site caused suspension of the pump-and-treat system. Fire-fighting foams containing PFAS were used early in the response. Fire-fighting wastewater contained high concentrations of 6:2 fluorotelomer sulfonic acid (6:2 FTSA) and perfluorohexanoic acid (PFHxA).
- 2022: Due to concerns about contamination from the Chemtool facility fire, new sampling for PFAS was conducted in private wells throughout the WKBS. PFHxS, PFOA, and PFOS were detected above CVs in most of the wells sampled. IEPA considered PFHxS, PFOA, and PFOS to be potential COCs.
- 2023: Winnebago County Health Department, IEPA, and IDPH held a public availability session in Rockton to answer health-related questions about PFAS exposure and provide well-water treatment recommendations to affected residents.
- 2025: The City of Rockton connected 49 new homes to the CWS. Sixty-eight of 80 homes have been connected to the CWS when including the 19 homes that were already connected to the CWS prior to the new connections being established.

3. Community Description and Concerns

Graphics were generated by ATSDR's Geospatial Research, Analysis, and Services Program (GRASP) to describe the local demographics (**Figure A1, Appendix A**).

Every person who uses a private well in this neighborhood is likely exposed to PFAS. Sixty-five people were estimated to have potentially been exposed prior to the connections made to the CWS. Sixteen people are estimated to still be potentially exposed. These estimates are based on the total estimated population of the WKBS (106), the total number of homes (80), the homes that were already connected to the CWS (19), the homes that used private wells prior to connections to the CWS (49), and the number of homes that refused connections (12).

The residents of WKBS have been well-aware of the Site over its long history. Because this HC addresses recently discovered PFAS contamination, community/political interest will only be discussed for concerns about PFAS contamination.

On March 30, 2023, IDPH attended a virtual meeting with IEPA, Winnebago County Health Department, and local government entities including the Rockton Township and the Village of Rockton. During the meeting, local government representatives asked questions about PFAS contamination in their community and approaches to address these concerns. When the mayor of Rockton asked what the best recommendation was to reduce exposures to PFAS, IDPH advised that connecting to the CWS and abandoning private wells would significantly reduce

exposure to PFAS, as the CWS monitors and treats for PFAS. The mayor, township supervisor, and other local government officials accepted the recommendation and verbally committed to pursuing residential connections to CWS.

On April 25, 2023, IDPH staff attended a townhall in Rockton to answer health-related questions about PFAS exposure. In speaking with residents, we learned that a few people have either treated their water or not drank their water for years, citing concerns about VOC contamination from the Site. However, most were not using any kind of treatment. Everyone we spoke to was concerned about the health risks and said they intended to treat their water or connect to the CWS. During the townhall, the mayor said he had secured funds to provide free connections to the CWS for anyone in Rockton. This work was projected to take place from May 2025 through May 2026. On April 18, 2024, the mayor of Rockton held a townhall discussing the offer for connections to the CWS with the affected residents of the WKBS. Most residents indicated they would accept the connections, but some indicated they would decline due to financial reasons (Rockton mayor, email communication, April 18, 2024). Daily exposures would remain for current and future residents at properties where these connections are refused.

4. Sampling Data

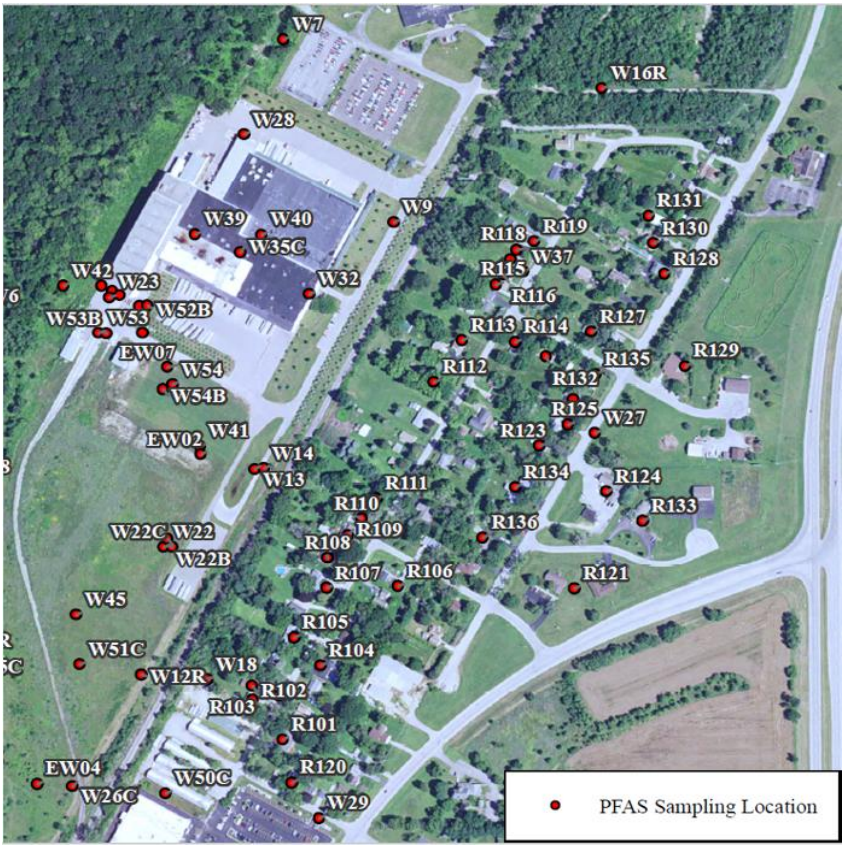


Figure 2: Zoomed-in sampling map from the Enviroserve Inc. sampling event on December 7-8, 2022. All private well samples are those with the sample ID format "R1XX". The results of these samples are the only ones reviewed in this HC. The image used for the sampling map is from prior to the fire which destroyed the Chemtool facility in June of 2021. (IEPA, 2023*)

Private wells in the WKBS were sampled by EnviroServe Inc. from December 7-8, 2022 **(Figure 2)**. Thirty-eight grab samples of untreated water were collected from 34 separate properties and analyzed by Eurofins using a modified EPA Method 537 for 40 different types of PFAS. Thirty-one of the properties sampled were single family homes, two properties were duplexes which used the same well but have two different residences on the property, and one was a local government building. Private wells were the main source of drinking water for WKBS residents and very few treated their water. These sampling data are therefore representative of current and future residential drinking water exposures for those properties that were not connected to the CWS because these residents drink untreated water. There is uncertainty as to how representative the private well data are for past exposures due to the lack of sampling data over time. However, due to the persistence of PFAS in groundwater, it is possible that the detected PFAS are from contamination by other PFAS sources which were present before the fire. Our assessment is based on the December 2022 data. These data are also considered high-quality because they used methods validated by EPA specifically for PFAS assays.

5. Scientific Evaluations

IDPH assesses possible public health hazards from environmental contamination using a stepwise method from the ATSDR called the Public Health Assessment process. In general, the process involves:

1. Conducting an exposure pathway analysis to see how a person may be exposed to a substance,
2. Comparing concentrations in different environmental media (drinking water, soil, air, and food) to established CVs to select contaminants for further evaluation,
3. Calculating estimated doses based on the concentration of a substance and the expected amount of exposure to that substance,
4. Comparing that estimated dose to health guidelines which indicate the potential for certain adverse health effects, and
5. Conducting an in-depth toxicological analysis when doses exceed those guidelines to determine if a public health hazard is absent, indeterminate, or present.

5.1 Exposure Pathway Analysis

IDPH determines whether people may have come in contact with contaminants by examining *exposure pathways*. An exposure pathway is the route a contaminant takes from its source to its end point, and how people can contact it. An exposure pathway has five elements:

1. A source of contamination
2. Transport through an environmental medium like air, soil, water, or food
3. A point of exposure where people could contact the contaminant
4. A route of exposure for the contaminant to be taken in by individuals
5. A potentially exposed population (ATSDR, 2022)

Exposure pathways can be completed, potential, or eliminated.

Completed exposure pathways are those for which all five pathway elements are evident and indicate that exposure to site related contaminants has occurred in the past, is now occurring, or will occur in the future.

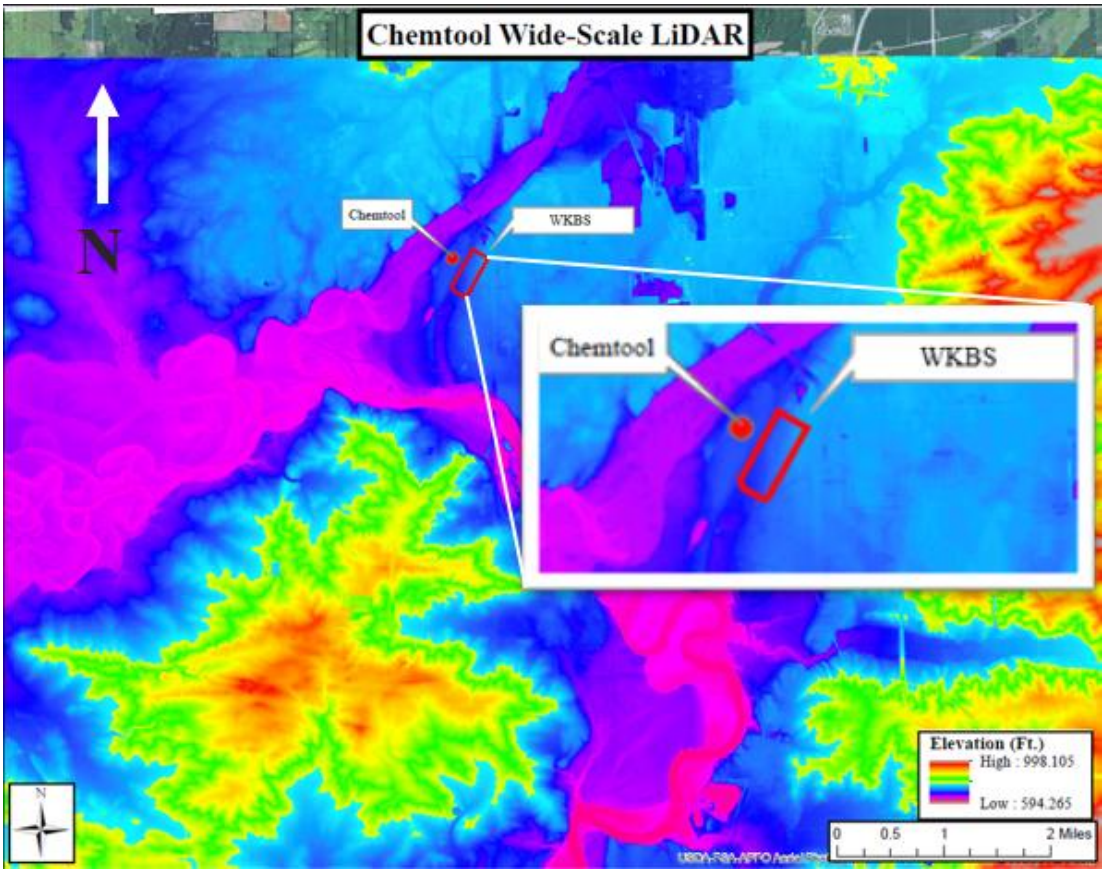
Potential exposure pathways are those for which one or more of the elements are missing, but information is insufficient to eliminate or exclude the element. Potential exposure pathways suggest that exposure to site-related contaminants could have occurred in the past, could be occurring now, or could occur in the future.

Eliminated exposure pathways are missing one or more elements that will never be present. Eliminated exposure pathways indicate that exposure to site-related contaminants has not or never will occur (ATSDR, 2022).

Contamination source: No source or groundwater plume of the PFAS contamination has been identified. PFAS do not occur naturally in the environment and have been used in many industrial processes and consumer products for several decades. This creates a wide variety of sources from which PFAS may enter the environment.

Transport through an environmental medium: Groundwater is usually contaminated by PFAS due to releases of PFAS at the surface during industrial processes. Because PFAS adsorb poorly to soil particles, PFAS released at the surface quickly migrate downward through soil to the water table and begin migrating through that aquifer because they are highly water soluble (ATSDR, 2021). The Light Detection and Ranging (LiDAR) scan map below **(Figure 3)** shows the topography of the area surrounding the Site and the WKBS. The red rectangle indicates the location of the WKBS. The light to dark blue color gradient inside this rectangle indicates a decrease in elevation. Groundwater flows from high to low elevation. Therefore, groundwater is believed to flow away from the WKBS and toward the Site. However, groundwater flow can deviate from suspected paths due to hydrogeologic factors; further study of local groundwater flow may help confirm the direction of groundwater. Groundwater beneath the Chemtool facility is expected to flow northwest away from WKBS and towards the nearby Rock River.

Figure 3: Topographical Map of Beloit Corp. and the Surrounding Area



(IEPA, 2023)

Point of exposure: When determining the third element of an exposure pathway, the point of exposure, it is common practice to designate the "exposure units" of a Site to delineate where exposures to potential COCs occur. Exposure units are a geographically defined point or area where a person is expected to contact a contaminated environmental medium, such as soil, surface water, groundwater, air, or food items (e.g., fruits, vegetables, fish, game).
For household water exposures, each point where one accesses their water is considered an

exposure unit. Therefore, each property sampled is an exposure unit.

Route of exposure: Ingestion of drinking water is the main route of exposure. People are also exposed to smaller amounts of PFAS in water when the water touches their skin during showering or other household water use. Most PFAS do not evaporate from water into indoor air during showering thus inhalation exposure is usually minimal. (ATSDR, 2021).

Potentially exposed population: Private well users in the WKBS.

IDPH has developed the following exposure pathways based on the above information:

5.1.1 Completed Pathways

Past, present, and future combined ingestion of and skin contact with PFAS in well water for private well users in the WKBS. – Past exposures are considered completed because sampling data collected in December 2022 showed widespread groundwater contamination beneath the WKBS area. This indicates the contamination having first impacted the aquifer before the time of sampling. Per ATSDR guidance (ATSDR, 2022), IDPH conservatively assumed that exposures began as long as 33 years ago. Given the lack of a known contamination source and the persistence of PFAS in groundwater, this time period was chosen to be the most protective. Present and future exposures are considered completed because IDPH learned that many people do not treat their water, nor do they use an alternative source of water. Furthermore, there are some private well users who did not accept connections to the CWS, because they do not want a water bill (Rockton Mayor, personal email communication, 2024). Therefore, daily exposures are expected to persist at these properties.

Past, present, and future inhalation of PFAS in indoor air during showering for private well users in the WKBS. – This pathway is considered complete based on the widespread groundwater contamination beneath the WKBS area, the few number of people to treat their water or use alternative water sources, and the homes that did not receive connections to the CWS. However, inhalation is not considered a significant exposure route for the potential COCs, because the amount of PFAS escaping to the air during showers and while bathing is negligible. Therefore, PFAS exposures for this pathway were not evaluated.

5.2 Private Well Water Evaluation

IDPH identified one completed exposure pathway for past, present, and future combined ingestion of and skin contact with PFAS in well water for private well users in the WKBS. Very few people in the WKBS treat their water or use an alternative source of water. Therefore, most residents were expected to have had daily exposures to the PFAS detected in the untreated water samples collected from their private wells prior to connections to the CWS. Private well water sampling data collected in December 2022 were evaluated to determine the magnitude of contamination by potential COCs and assess the potential for adverse health effects due to exposure. An additional completed exposure pathway for inhalation of PFAS volatilized to

indoor air during showering for private well users in the WKBS was also identified. However, as previously stated, this is not a significant exposure pathway and was not evaluated.

5.2.1 Screening Analysis

A screening analysis involves comparing the PFAS concentrations detected in the sampling data to CVs for specific types of PFAS in drinking water. There are currently CVs for PFHxS, PFOA, PFOS, perfluorononanoic acid (PFNA), perfluorobutanesulfonic acid (PFBS), perfluorohexanoic acid (PFHxA), and perfluorobutanoic acid (PFBA). There were six other PFAS types that were detected but which do not have CVs. Therefore, screening was limited to PFAS for which CVs exist.

ATSDR develops CVs for *noncancer* and *cancer* health effects. When developing noncancer CVs, ATSDR assumes that only noncancer health effects could occur while using appropriate noncancer health guidelines and standard default exposure assumptions. When developing cancer CVs, ATSDR assumes that only cancer health effects could occur while using EPA's cancer risk values. The cancer risk values identify estimated concentrations of cancer-causing contaminants that would be predicted to cause no more than one excess cancer in a million persons exposed during their lifetime (78 years). When a contaminant has both a cancer and noncancer CV, health assessors use the lowest of the two CVs for screening. An exceedance of a CV does not mean an adverse health effect will occur, but that the contaminant is selected for further evaluation. In addition to ATSDR CVs, IDPH may use non-ATSDR screening levels when ATSDR CVs are not available, or when they are more protective than available ATSDR CVs.

All but one of the properties sampled (33 of 34) had detections of PFHxS, PFOA, or PFOS above the applicable ATSDR CVs. PFHxS, PFOA, and PFOS were selected for further evaluation and are considered potential COCs because they exceeded their CVs in most wells. No other analytes exceeded their CVs and were not evaluated for individual exposures. A summary of the PFAS sampling data is provided below in **Table 1**. A list of full PFAS type names can be found in **Appendix B.** Further information on the CVs and health guidelines used in this report can be found in **Appendix C.**

Table 1: Detected PFAS Types in WKBS Private Wells and Comparison Values in Nanograms per Liter (ng/L)

PFAS	Number of Detections/Number of Samples	Detection Frequency (% of samples)	Maximum Concentration (ng/L)	Comparison Value (CV) (ng/L)	CV Source	Number Detections Exceeded CV/ % of All Detections
Perfluorohexane sulfonic acid (PFHxS)	37 / 38	97	89	0.0028	ATSDR child RMEG †	37 /100%
Perfluorooctanoic acid (PFOA)	34 / 38	89	130	0.21	ATSDR child RMEG	34 / 100%
Perfluorooctane sulfonic acid (PFOS)	31 / 38	82	29	0.71	ATSDR child RMEG	31 / 100%
Perfluorononanoic acid (PFNA)	6 / 38	16	0.45*	21	ATSDR intermediate child EMEG ‡	0 / 0%
Perfluorobutane sulfonic acid (PFBS)	38 / 38	100	89	2,100	ATSDR intermediate child EMEG	0 / 0%
Perfluorohexanoic acid (PFHxA)	38 / 38	100	5	3,500	ATSDR child RMEG	0 / 0%
Perfluorobutyric acid (PFBA)	38 / 38	100	29	7,100	ATSDR child RMEG	0 / 0%
Perfluoropentanoic acid (PFPeA)	36 / 38	95	69	None	N/A	N/A
Perfluoroheptanoic acid (PFHpA)	35 / 38	92	23	None	N/A	N/A
Perfluoropentane sulfonic acid (PFPeS)	26 / 38	68	13	None	N/A	N/A
Perfluoroheptane sulfonic acid (PFHpS)	17 / 38	45	1*	None	N/A	N/A
Perfluorooctane sulfonamide (FOSA)	6 / 38	16	2.3	None	N/A	N/A
6:2 fluorotelomer sulfonic acid (6:2 FTSA)	1 / 38	3	22	None	N/A	N/A

* Concentration estimated by laboratory

† Reference Dose Media Evaluation Guide - Represents the concentration in a specific medium (e.g., water, soil) at which daily human exposure for a chronic duration is unlikely to result in noncarcinogenic effect.

‡ Environmental Media Evaluation Guide - Represents estimated contaminant concentrations below which humans exposed during a specific timeframe (acute, intermediate, or chronic) are not expected to experience noncarcinogenic health effect

5.2.2 Evaluation of Household Water Use

The next step is to evaluate the potential public health hazards from drinking or otherwise using the water which has PFAS detections above CVs. This is done by estimating exposure doses based on the concentration of a specific PFAS type, the amount of exposure, and the timeframe of exposure. These doses are then compared to noncancer health guidelines and cancer risk factors are applied to assess the potential for adverse noncancer and cancer health effects.

As previously mentioned, 38 total samples were collected from 34 separate wells in the WKBS. IDPH estimated exposure doses for PFHxS, PFOA, and PFOA in each well. Exposures were evaluated for 33 wells because one well had no detections of the potential COCs. Appendix C, section **C.4** shows the equations used to estimate noncancer doses, hazard quotients (see Section 5.2.2.2), and cancer risk estimates.

5.2.2.1 Exposure Point Concentrations and Exposure Calculations

ATSDR's Public Health Assessment Guidance Manual instructs that an *exposure point concentration* (EPC) be used to estimate an exposure calculation, or dose, for each potential COC. An EPC is the concentration of a contaminant at a point or over an area to which a person may be exposed. Several different methods can be used to determine the EPC. The maximum amount of each contaminant in each private well was used to estimate exposure for each household. Other possible EPCs include the 95 percent upper confidence limit (95UCL) of the mean calculated for each contaminant at the site, the arithmetic mean of the contaminant, or the geometric mean of the contaminant (ATSDR, 2022). Per ATSDR guidance, IDPH used the maximum detected concentration of each contaminant in each well as the EPC because only one or at most sometimes two samples were available for each well. (ATSDR, 2022).

IDPH used the ATSDR Shower and Household Water-use Exposure (SHOWER) Model and the ATSDR Public Health Site Assessment Tool (PHAST) to estimate exposure doses for affected populations in completed exposure pathways. A *central tendency exposure* (CTE) scenario, which used average intake rates for tap water, was used to estimate average exposures. A *reasonable maximum exposure* (RME) scenario, which used above average intake rates for tap water, was used to estimate above average exposure. A RME scenario, which approximates exposure at the 95th percentile, refers to exposures which are higher than average but are still realistic.

Past, present, and future combined ingestion of and skin contact with PFAS in private well water for private well users in the WKBS. – CTE and RME exposures were estimated for numerous age groups ranging from birth to adult (21 years and older). IDPH used default residential exposure assumptions, which assume daily ingestion of and skin contact with water by all age groups for

a chronic duration (1 year and longer). This assumption was used to be health-protective of all residents with PFAS-contaminated private wells. **Tables 2-4** summarize the estimated exposure doses for PFHxS, PFOA, and PFOS for each household with a contaminated private well. The exposure doses of children aged birth to less than 1 year are included because they have the highest exposure among children. Adult exposure scenarios are also included to illustrate the magnitude of exposure across all exposure groups. See Section 5.2.2.2 for more details about the health effects evaluation.

Table 2: Summary of Combined Ingestion and Skin Contact Exposure Doses for Chronic Exposure to PFHxS in Household Water including Noncancer Hazard Quotients*

Exposure Group	Range of PFHxS Concentrations ng/L	CTE Doses (ng/kg/day)	CTE Noncancer Hazard Quotients	RME Doses (ng/kg/day)	RME Noncancer Hazard Quotients	Exposure Duration (yrs)
Birth to < 1 year	0.83 – 89	0.064 – 6.8	160 – 17,000†	0.12 – 13	300 – 32,000†	1
Adults	0.83 – 89	0.014 – 1.5	34 – 3,700†	0.034 – 3.6	84 – 9,000†	33

Source: [Eurofins Chicago, 2022]
Abbreviations: CTE = central tendency exposure (average); ng/kg/day = nanogram of chemical per kilogram body weight per day; ng/L = nanogram chemical per liter water; RME = reasonable maximum exposure (higher than average); yrs = years
* The calculations in this table were generated using ATSDR's SHOWER Model v4.0.1 and ATSDR's PHAST v2.5.1.0. The noncancer hazard quotients were calculated using the chronic (lifetime) reference dose of 0.0004 ng/kg/day.
† Indicates the hazard quotient is greater than 1, which ATSDR evaluates further.

Table 3: Summary of Combined Ingestion and Skin Contact Exposure Doses for Chronic Exposure to PFOA in Household Water including Noncancer Hazard Quotients*

Exposure Group	Range of PFOA Concentrations ng/L	CTE Doses (ng/kg/day)	CTE Noncancer Hazard Quotients	RME Doses (ng/kg/day)	RME Noncancer Hazard Quotients	Exposure Duration (yrs)
Birth to < 1 year	0.85 – 130	0.065 – 10	2 – 330†	0.12 – 18	4 – 610†	1
Adults	0.85 – 130	0.014 – 2.1	0.5 – 71†	0.034 – 5.3	1 – 170†	33

Source: [Eurofins Chicago, 2022]
Abbreviations: CTE = central tendency exposure (average); ng/kg/day = nanogram chemical per kilogram body weight per day; ng/L =nanogram chemical per liter water; RME = reasonable maximum exposure (higher than average); yrs = years
* The calculations in this table were generated using ATSDR's SHOWER Model v4.0.1 and ATSDR's PHAST v2.5.0.0. The noncancer hazard quotients were calculated using the chronic (lifetime) reference dose of 0.038 ng/kg/day.
† Indicates the hazard quotient is greater than 1, which ATSDR evaluates further.

Table 4: Summary of Combined Ingestion and Skin Contact Exposure Doses for Chronic Exposure to PFOS in Household Water including Noncancer Hazard Quotients*

Exposure Group	Range of PFOS Concentrations ng/L	CTE Doses (ng/kg/day)	CTE Noncancer Hazard Quotients	RME Doses (ng/kg/day)	RME Noncancer Hazard Quotients	Exposure Duration (yrs)
Birth to < 1 year	0.6 – 29	0.086 – 2.2	0.5 – 22†	0.14 – 4.1	1 – 41†	1

Exposure Group	Range of PFOS Concentrations ng/L	CTE Doses (ng/kg/day)	CTE Noncancer Hazard Quotients	RME Doses (ng/kg/day)	RME Noncancer Hazard Quotients	Exposure Duration (yrs)
Adults	0.6 – 29	0.001 – 0.48	0.1 – 4.8[†]	0.024 – 1.2	0.24 – 12[†]	33

Source: [Eurofins Chicago, 2022]
Abbreviations: CTE = central tendency exposure (average); ng/kg/day = nanogram chemical per kilogram body weight per day; ng/L = nanogram chemical per liter water; RME = reasonable maximum exposure (higher than average); yrs = years
[*] The calculations in this table were generated using ATSDR's SHOWER Model v4.0.1 and ATSDR's PHAST v2.5.0.0. The noncancer hazard quotients were calculated using the chronic (lifetime) reference dose of 0.1 ng/kg/day.
[†] Indicates the hazard quotient is greater than 1, which ATSDR evaluates further.

5.2.2.2 Non-Cancer Health Effect Evaluation

IDPH compares estimated doses to an applicable health guideline, such as a reference dose (RfD). EPA develops these health guidelines for contaminants that are commonly found at hazardous waste sites or contaminants with which people may come in frequent contact. An RfD is an estimate of the daily human exposure dose to a hazardous substance at or below which it is unlikely to pose an appreciable risk of adverse non-cancer health effects. RfDs are developed for three routes of exposure (ingestion, inhalation, or skin contact) for chronic (up to lifetime) exposure durations. RfDs are based on human epidemiological data or experimental animal studies. They are derived from studies that identified NOAELs (no-observed-adverse-effect levels) or LOAELs (lowest-observed-adverse-effect levels) and adjusted with a series of uncertainty factors or using statistical models. When possible, EPA applies benchmark dose modeling and converts animal doses to human equivalent doses as intermediate steps in deriving the RfD.

The comparison between an estimated exposure dose and a RfD is quantified using a ratio known as the "hazard quotient" (HQ). The HQ is defined as: HQ = Exposure Dose/RfD. Potential COCs with a hazard quotient exceeding a value of 1 are further evaluated to identify possible health effects and to determine whether those contaminants pose a health threat to exposed populations (ATSDR, 2022).

IDPH evaluates the potential for adverse health effects based on the most highly exposed and sensitive population group. In this case, that group is children aged birth to less than one year with RME intake rates. Estimated exposure doses to PFHxS, PFOA, and PFOS all yielded HQs which exceeded a value of 1 when compared to their respective RfDs in every well where these PFAS were detected. Older children and adults and those who consume more typical amounts of water will have less exposure than those aged birth to less than one year, and thus less risk. However, given the conservative nature of PFAS health guidelines the potential health risks described for children from birth to 1 year also apply to older children and adults for many private wells. The estimated doses, HQs, adverse effect levels, and potential adverse health effects are evaluated for each potential COC for the exposure pathway below.

Past, present, and future combined ingestion of and skin contact with PFAS in private well water for private well users in the WKBS.

PFHxS Exposure

PFHxS was detected in 33 private wells with concentrations ranging from 0.83 ng/L to 89 ng/L. Here are some important highlights from **Table 2** about PFHxS doses and HQs in children and adults:

- Children
  - Children aged birth to less than 1 year old had the highest exposure of all children.
  - For children aged birth to less than 1 year with typical tap water intake, CTE doses ranged from 0.064 to 6.8 ng/kg/day, and HQs ranged from 160 to 17,000.
  - For children aged birth to less than 1 year with higher-than-average tap water intake, RME doses ranged from 0.12 to 13 ng/kg/day, and HQs ranged from 300 to 32,000.
  - Doses and HQs for older children are similar but slightly lower.

- Adults
  - CTE doses in adults were slightly lower than the CTE doses in children and ranged from 0.014 to 1.5 ng/kg/day. CTE HQs in adults ranged from 34 to 3,700.
  - RME doses in adults were slightly lower than the RME doses in children and ranged from 0.034 to 3.6 ng/kg/day. RME HQs ranged from 84 to 9,000.

There is a greater risk that those exposed could experience adverse non-cancer health effects because HQs greatly exceeded 1. The high HQs for children and adults indicate that the doses are far above EPA's RfD for PFHxS and require further evaluation to determine if children and adults might experience harmful effects.

IDPH reviewed the *IRIS Toxicological Review of Perfluorohexanesulfonic Acid and Related Salts* (EPA, 2025) for summaries of the latest toxicological information used to evaluate associations between PFHxS exposure and adverse health effects in humans. Using human and experimental animal evidence, EPA's toxicological review found that, given sufficient exposure conditions, PFHxS exposure likely causes reduced vaccine effectiveness and thyroid effects, such as decreased thyroid hormone levels, abnormal histopathology results, and possibly changes in thyroid organ weight.

Additional evidence from epidemiological studies also suggests associations between PFHxS exposure and decreased birth weights and changes in liver enzymes at exposures similar to those that cause immune effects.

EPA developed their RfD for PFHxS based on the human equivalent doses (HEDs) of 0.0116 and 0.0123 ng/kg/day for effects to immune system function. These HEDs were modeled from the serum concentrations of PFHxS at which decreased antibody concentrations were observed in children after receiving the tetanus and diphtheria vaccines. To evaluate the health risks to private well users in the WKBS, IDPH compared maximum CTE and RME doses of PFHxS from each well to the lowest HED for reduced vaccine effectiveness: 0.0116 ng/kg/day. This value was chosen because it is the lowest of the HEDs that EPA considered when deriving their RfD, making it the most health protective.

IDPH also compared CTE and RME doses to effect level doses for other health effects associated with PFHxS exposure which have been derived in animal and human studies. Other possible health effects include decreased birth weights in infants born to mothers who drank PFHxS contaminated water during pregnancy, mild liver damage, and thyroid effects (decreased thyroid hormone levels, abnormal histopathology results, and possibly changes in thyroid organ weight).

Tables 5 and 6 summarize the number of wells with CTE and RME exposure doses that approached or exceeded effect level doses for health effects associated with PFHxS exposure derived from human and animal studies.

Table 5: Number of Wells with CTE Exposure Doses Approaching or Exceeding Effect Level Doses for Health Effects Associated with Exposure to PFHxS in Drinking Water

Exposure Group	Health Effect	Effect Level Dose (ng/kg/day)	CTE Doses (ng/kg/day)	Number of Wells Approaching or Exceeding Effect Level Dose
Birth to < 1 year	Reduced Vaccine Effectiveness	0.0116	0.064 – 6.8	33/34
Adults	Reduced Vaccine Effectiveness	0.0116	0.014 – 2.1	33/34
Birth to <1 year	Liver Damage	0.09	0.065 – 10	33/34
Adults	Liver Damage	0.09	0.014 – 2.1	33/34
Adults	Decreased Birth Weights*	0.08	0.014 – 2.1	33/34
Birth to < 1 year	Thyroid Effects†	1,420‡	0.065 – 10	10/34

Abbreviations: CTE = central tendency exposure (average); PFHxS = perfluorohexane sulfonic acid; ng/kg/day = nanogram chemical, per kilogram body weight, per day

* Risk of this health effect only applies to females of child-bearing age

† Decreased thyroid hormone levels, abnormal histopathology results, and possibly changes in thyroid organ weight

‡ Doses of 10 ng/kg/day or greater were considered approaching the effect level dose.

Table 6: Number of Wells with RME Exposure Doses Approaching or Exceeding Effect Level Doses for Health Effects Associated with Exposure to PFHxS in Drinking Water

Exposure Group	Health Effect	Effect Level Dose (ng/kg/day)	RME Doses (ng/kg/day)	Number of Wells Approaching or Exceeding Effect Level Dose
Birth to < 1 year	Reduced Vaccine Effectiveness	0.0116	0.12 – 13	33/34
Adults	Reduced Vaccine Effectiveness	0.0116	0.034 – 3.6	33/34
Birth to < 1 year	Liver Damage	0.09	0.12 – 13	33/34
Adults	Liver Damage	0.09	0.034 – 3.6	33/34
Adults	Decreased Birth Weights*	0.08	0.034 – 3.6	33/34
Birth to < 1 year	Thyroid Effects†	1,420‡	0.12 – 13	1/34

Abbreviations: RME = reasonable maximum exposure (higher than average); PFHxS = perfluorohexane sulfonic acid; ng/kg/day = nanogram chemical, per kilogram body weight, per day

* Risk of this health effect only applies to females of child-bearing age

† Decreased thyroid hormone levels, abnormal histopathology results, and possibly changes in thyroid organ weight

‡ Doses of 10 ng/kg/day or greater were considered approaching the effect level dose.

IDPH found that reduced vaccine effectiveness, liver damage, and decreased birth weights (for females of childbearing age) are possible for nearly all private well users in the WKBS because all wells with PFHxS detections had CTE and RME exposure doses that approached or exceeded effect level doses derived from human and animal studies. Thyroid effects are also possible for children at one property because one well had RME doses for children which exceeded approached effect levels.

PFOA Exposure

PFOA was detected in 30 private wells with concentrations ranging from 0.85 ng/L to 130 ng/L. Here are some important highlights from Table 3 about PFOA doses and HQs in children and adults:

- Children
  - Children aged birth to less than 1 year old had the highest exposure of all children.
  - For children aged birth to less than 1 year with typical tap water intake, CTE doses ranged from 0.065 to 10 ng/kg/day, and HQs ranged from 2 to 330.
  - For children aged birth to less than 1 year with higher-than-average tap water intake, RME doses ranged from 0.12 to 18 ng/kg/day, and HQs ranged from 4 to 610.
  - Doses and HQs for older children are similar but slightly lower.

- Adults
  - CTE doses in adults were slightly lower than the CTE doses in children and ranged from 0.014 to 2.1 ng/kg/day. CTE HQs in adults ranged from 0.5 to 71.

- RME doses in adults were slightly lower than the RME doses in children and ranged from 0.034 to 5.3 ng/kg/day. RME HQs ranged from 1 to 170.

There is a greater risk that those exposed could experience adverse non-cancer health effects because HQs greatly exceeded 1. The high HQs for children and adults indicate that the doses are far above EPA's RfD for PFOA and require further evaluation to determine if children and adults might experience harmful effects.

IDPH reviewed the *Final Human Health Toxicity Assessment for Perfluorooctanoic Acid (PFOA) and Related Salts* (EPA, 2024a) for summaries of the latest toxicological information to evaluate associations between PFOA exposure and adverse health effects in humans. Using human and experimental animal evidence, EPA's PFOA toxicity review found that, given sufficient exposure conditions, PFOA exposure likely causes reduced vaccine effectiveness, increased total cholesterol, decreased birth weights, and liver damage.

EPA developed their RfD for PFOA based on multiple human studies examining adverse health effects including reduced vaccine effectiveness, increased total cholesterol, and decreased birth weights in infants. The doses of PFOA which cause each of these health effects were found to be very similar, thus making one RfD being protective for all three health effects, as well as other health effects which occur at higher doses.

Therefore, to evaluate health risks of private well users in the WKBS, IDPH compared the maximum CTE and RME doses for children and adults from each well to the HED from the study which examined increased total cholesterol: 0.28 ng/kg/day. This value was chosen because it is the lowest among all doses that were used to derive the RfD, making it the most health protective. IDPH also compared CTE and RME doses to the HED for liver damage associated with PFOA exposure. Other health effects such as liver necrosis and decreased offspring survival were not evaluated because these health effects occur at doses much higher than the estimated doses for private well users of the WKBS.

Tables 7 and 8 summarize the number of wells with CTE and RME exposure doses that approached or exceeded effect level doses for health effects associated with PFOA exposure derived from human and animal studies.

Table 7: Number of Wells with CTE Exposure Doses Approaching or Exceeding Effect Level Doses for Health Effects Associated with Exposure to PFOA in Drinking Water

Exposure Group	Health Effect	Effect Level Dose (ng/kg/day)	CTE Doses (ng/kg/day)	Number of Wells Approaching or Exceeding Effect Level Dose
Birth to < 1 year	Co-Critical Effects*	0.28	0.065 – 10	28/34
Adults	Co-Critical Effects*	0.28	0.014 – 2.1	22/34
Birth to < 1 year	Liver Damage	0.44	0.065 – 10	26/34
Adults	Liver Damage	0.44	0.014 – 2.1	16/34

Abbreviations: CTE = central tendency exposure (average); PFOA = perfluorooctanoic acid; ng/kg/day = nanogram chemical, per kilogram body weight, per day

* Co-critical effects are health effects that can occur at similar exposure doses. For PFOA, those health effects are reduced vaccine effectiveness, increased total cholesterol, and decreased birth weights (only applicable to females of child-bearing age)

Table 8: Number of Wells with RME Exposure Doses Approaching or Exceeding Effect Level Doses for Health Effects Associated with Exposure to PFOA in Drinking Water

Exposure Group	Health Effect	Effect Level Dose (ng/kg/day)	RME Doses (ng/kg/day)	Number of Wells Approaching or Exceeding Effect Level Dose
Birth to < 1 year	Co-Critical Effects*	0.28	0.12 – 18	30/34
Adults	Co-Critical Effects*	0.28	0.034 – 5.3	26/34
Birth to < 1 year	Liver Damage	0.44	0.12 – 18	30/34
Adults	Liver Damage	0.44	0.034 – 5.3	25/34

Abbreviations: RME = reasonable maximum exposure (higher than average); PFOA = perfluorooctanoic acid; ng/kg/day = nanogram chemical, per kilogram body weight, per day

* Co-critical effects are health effects that can occur at similar exposure doses. For PFOA, those health effects are reduced vaccine effectiveness, increased total cholesterol, and decreased birth weights (only applicable to females of child-bearing age)

IDPH found that the co-critical effects of increased total cholesterol and reduced vaccine effectiveness as well as liver damage are possible for most private well users in the WKBS because most wells had CTE and RME exposure doses that approached or exceeded effect level doses for these health effects. Decreased birth weights is also possible for most females of child-bearing age because most wells had CTE and RME exposure doses for adults that approached or exceeded the effect level dose for the co-critical effects.

PFOS Exposure

PFOS was detected in 27 private wells with concentrations ranging from 0.6 ng/L to 29 ng/L. Here are some important highlights from Table 4 about PFOS doses and HQs in children and adults:

- Children
  - Children aged birth to less than 1 year old had the highest exposure of all children.

  - For children aged birth to less than 1 year with typical tap water intake, CTE doses ranged from 0.086 to 2.2 ng/kg/day, and HQs ranged from 0.5 to 22.
  - For children aged birth to less than 1 year with higher-than-average tap water intake, RME doses ranged from 0.14 to 4.1 ng/kg/day, and HQs ranged from 1 to 41.
  - Doses and HQs for older children are similar but slightly lower.

- Adults
  - CTE doses in adults were slightly lower than the CTE doses in children and ranged from 0.001 to 0.48 ng/kg/day. CTE HQs in adults ranged from 0.1 to 4.8.
  - RME doses in adults were slightly lower than the RME doses in children and ranged from 0.024 to 1.2 ng/kg/day. RME HQs ranged from 0.24 to 12.

There is a greater risk that those exposed could experience adverse non-cancer health effects because HQs exceeded 1. The high HQs for children and adults indicate that the doses are far above EPA's RfD for PFOS and require further evaluation to determine if children and adults might experience harmful effects.

IDPH reviewed the *Final Human Health Toxicity Assessment for Perfluorooctanesulfonic Acid (PFOS) and Related Salts* (EPA, 2024b) for summaries of the latest toxicological data to evaluate associations between PFOS exposure and adverse health effects in humans. EPA's PFOS toxicity review found that, given sufficient exposure conditions, PFOS exposure can cause reduced vaccine effectiveness, increased total cholesterol, decreased birth weights in infants, and liver damage based on epidemiological studies.

EPA developed their RfD for PFOS using the most sensitive effects from two human studies examining adverse health effects including increased total cholesterol and decreased birth weights. The doses of PFOS which cause each of these health effects were found to be very similar, thus making one RfD being protective for both health effects, as well as other health effects which occur at higher doses.

Therefore, to evaluate health risks of private well users in the WKBS, IDPH compared the maximum CTE and RME doses from each well to the HED from the study which examined increased cholesterol (1.2 ng/kg/day). To evaluate the risk of reduced birth weight, we compared maximum CTE and RME doses in adults to the HED from the study which examined decreased birth weights in infants (1.12 ng/kg/day). These values were chosen because they are the lowest of the HEDs used to derive the RfD, making them the most health protective. IDPH also compared CTE and RME doses to the HED for reduced vaccine effectiveness associated with PFOS exposure. Other health effects such as liver cell death and formation of red blood cells in the spleen were not evaluated because these health effects occur at doses much higher than the estimated doses for private well users of the WKBS

Tables 9 and 10 summarize the number of wells with CTE and RME exposure doses that approached or exceeded effect level doses for health effects associated with PFOS exposure derived from human and animal studies.

Table 9: Number of Wells with CTE Exposure Doses Approaching or Exceeding Effect Level Doses for Health Effects Associated with Exposure to PFOS in Drinking Water

Exposure Group	Health Effect	Effect Level Dose (ng/kg/day)	CTE Doses (ng/kg/day)	Number of Wells Approaching or Exceeding Effect Level Dose
Birth to < 1 year	Increased Total Cholesterol	1.1	0.086 – 2.2	16/34
Adults	Co-Critical Effects*	1.1	0.001 – 0.48	1/34
Birth to < 1 year	Reduced Vaccine Effectiveness	1.8	0.086 – 2.2	13/34
Adults	Reduced Vaccine Effectiveness	1.8	0.001 – 0.48	1/34
Birth to < 1 year	Liver Damage	2	0.086 – 2.2	13/34
Adults	Liver Damage	2	0.001 – 0.48	1/34

Abbreviations: CTE = central tendency exposure (average); PFOS = perfluorooctane sulfonic acid; ng/kg/day = nanogram chemical, per kilogram body weight, per day

* Co-critical effects are health effects that can occur at similar exposure doses. For PFOS, those health effects are increased total cholesterol and decreased birth weights (only applicable to females of child-bearing age)

Table 10: Number of Wells with RME Exposure Doses Approaching or Exceeding Effect Level Doses for Health Effects Associated with Exposure to PFOS in Drinking Water

Exposure Group	Health Effect	Effect Level Dose (ng/kg/day)	RME Doses (ng/kg/day)	Number of Wells Approaching or Exceeding Effect Level Dose
Birth to < 1 year	Increased Total Cholesterol	1.1	0.14 – 4.1	23/34
Adults	Co-Critical Effects*	1.1	0.024 – 1.2	10/34
Birth to < 1 year	Reduced Vaccine Effectiveness	1.8	0.14 – 4.1	21/34
Adults	Reduced Vaccine Effectiveness	1.8	0.024 – 1.2	7/34
Birth to < 1 year	Liver Damage	2	0.14 – 4.1	21/34
Adults	Liver Damage	2	0.024 – 1.2	7/34

Abbreviations: RME = reasonable maximum exposure (higher than average); PFOS = perfluorooctane sulfonic acid; ng/kg/day = nanogram chemical, per kilogram body weight, per day

* Co-critical effects are health effects that can occur at similar exposure doses. For PFOS, those health effects are increased total cholesterol and decreased birth weights (only applicable to females of child-bearing age)

IDPH found that increased total cholesterol is possible for many children in the WKBS because as many as 23 of 34 wells had RME doses which approached or exceed the effect level dose. The co-critical effects of increased total cholesterol and decreased birth weights are possible for some adults in the WKBS, the latter health effect being of particular concern for females of child-bearing age. This is because RME exposure doses at 10 of 34 wells approached or exceeded the effect level dose. Reduced vaccine effectiveness and liver damage are also possible for many children in the WKBS because most wells had RME doses that approached or exceeded effect level doses. These health effects are also possible for some adults in the WKBS because 7 of 34 wells had RME doses that approached or exceeded effect level doses.

Exposures to Detected PFAS without Health Guidelines
Health guidelines are currently unavailable due to lack of toxicological information for 6 of the 13 PFAS types detected in the WKBS: PFPeA, PFHpA, PFPeS, PFHpS, FOSA, and 6:2 FTSA. PFPeA, PFHpA, PFPeS, PFHpS, and 6:2 FTSA are considered *short-chain* PFAS, which are generally understood to accumulate less in the body and are therefore believed to be less toxic than *long-chain* PFAS such as PFHxS, PFOA, and PFOS (ATSDR, 2021). However, as toxicological data are limited for these PFAS, IDPH cannot make definitive public health conclusions regarding possible health effects at this time.

FOSA is the sole detected long-chain PFAS for which health guidelines have not been developed. Epidemiological data show possible associations between FOSA exposure and increased risk of cardiovascular disease (ATSDR, 2021). However, too few studies have been conducted to assess the toxicity of FOSA. Therefore, IDPH cannot make definitive public health conclusions regarding FOSA exposure and harmful effects at this time.

5.2.2.3 PFAS Mixtures Evaluation

Table 1 indicates that most wells had detections of PFHxS, PFOA, and PFOS. These PFAS share the adverse health effects of reduced vaccine effectiveness, liver effects, and decreased birth weight in infants. These health effects have been modeled to occur at very low doses for each PFAS. Considering this, it logically follows that exposure to a combination of these PFAS in one well could increase the overall risk of these health effects compared to the risk from exposure to each individual PFAS. Therefore, exposure to PFHxS, PFOA, and PFOS as a mixture further increases the risks of reduced vaccine effectiveness, liver effects, and decreased birth weight in infants for private well users in the WKBS. In addition, exposure to PFOA and PFOS could interact to increase total cholesterol.

5.2.2.4 Cancer Health Effect Evaluation

EPA has classified PFOA and PFOS as "likely to be carcinogenic to humans" (EPA, 2024a; EPA, 2024b) and there is currently inadequate information to assess the carcinogenic potential of PFHxS (EPA, 2025). IDPH therefore evaluated the risk of cancer health effects due to PFAS exposure in the WKBS.

IDPH used the concentrations of PFOA and PFOS in each well and EPA's oral cancer slope factors (CSFs) to quantify cancer risks (CRs) due to exposure to PFOA and PFOS. CRs are calculated based on exposure occurring for either 12 years or 33 years. Twelve years is the average duration that someone lives at a residence while 33 years represents the 95th percentile of residential occupancy. Therefore, CTE cancer risks represents people of typical tap water intake with exposures lasting 12 years. RME cancer risks represents people with above average tap water intake with exposures lasting 33 years. An example of the CR equation can be found in **Appendix C**. **Table 11** summarizes CR estimates for PFOA and PFOS exposure in drinking water. When assessing the potential for cancer health effects, IDPH generally considers CR less than 1E-6 (1 in 1,000,000) as negligible and CR greater than 1E-4 (1 in 10,000) to be of concern for increased CR. Note that estimated CRs are indicators of risk and do not predict the number of cancer cases in an exposed population.

Table 11: Cancer Risk (CR) based on Exposure to PFOA and PFOS in Drinking Water

Population Group	PFAS	Concentration Range (ng/L)	CSF $(mg/kg/day)^{-1}$	Maximum CTE CRs	Maximum RME CRs
Children (Birth to >21 years)	PFOA	0.85 – 130	29,300	9E-5 – 1E-2	3E-4 – >1E-2
Adult (21 years and older)	PFOA	0.85 – 130	29,300	6E-5 – 9E-3	4E-4 – >1E-2
Children (Birth to >21 years)	PFOS	0.6 – 29	39.5	8E-8 – 4E-6	3E-7 – 1E-5
Adult (21 years and older)	PFOS	0.6 – 29	39.5	6E-8 – 3E-6	4E-7 – 2E-5

PFOA Exposure

CTE CRs ranged from 9E-5 (9 in 100,000) to 1E-2 (1 in 100) for children and 6E-5 (t in 100,000) to 9E-3 (9 in 1,000) for adults. RME CRs ranged from 3E-4 (3 in 10,000) to >1E-2 (1 in 100) for children and 4E-4 (4 in 10,000) to >1E-02 (1 in 100) for adults. Evidence from human studies indicates increased instances of kidney and testicular cancer and some evidence of breast cancer due to chronic oral PFOA exposure. Experimental animal studies in rats reported testicular, pancreatic, and liver cell tumors. IDPH found that 30 of 34 wells had CRs above 1E-4. IDPH concluded there is increased risks of kidney, testicular, liver, or pancreatic cancers for private well users of the WKBS because nearly all wells sampled had RME CRs greater than 1E-4.

PFOS Exposure

Cancer risk estimates from PFOS exposure were significantly lower than the CR estimates from PFOA. CTE CRs ranged from 8E-8 (8 in 100 million) to 4E-6 (4 in 1 million) for children and 6E-8 (6 in 100 million) to 3E-6 (3 in 1 million) for adults. RME CRs ranged from 3E-7 (3 in 10 million) to 1E-5 (1 in 100,000) for children and 4E-7 (4 in 10 million) to 2E-5 (2 in 100,000) for adults. Epidemiological data show elevated risk of liver, bladder, kidney, prostate, and breast cancers after chronic PFOS exposure in some studies, but these do not definitively provide causal evidence of a relationship between PFOS exposure and these cancers. Experimental animal studies provided additional evidence for the association between PFOS exposure and liver and pancreatic cancers (EPA, 2025). However, IDPH did not identify a significant increase in CR from PFOS exposure as all estimate cancer risks were below 2 in 100,000.

When looking at the combined cancer risk from exposure to PFOA and PFOS, PFOS does not contribute significantly to the overall cancer risk. Almost all the cancer risk comes from PFOA in private wells.

5.3 Evaluation of Health Outcome Data

IDPH queried our Department's Division of Epidemiological Studies for cancer incidence data in Rockton due to the identified long-term health hazard of increased risk of kidney, testicular, liver, and pancreatic cancers from PFOA exposure. Per ATSDR guidance for conducting reviews of health outcome data, IDPH queried the availability of data at a demographic scale similar to the size of the exposed population (ATSDR, 2022). Cancer incidence data were available for areas as small as the census tract. The population for the census tract in which the WKBS is located is 6,613. (United States Census Bureau, 2020). The estimated exposed population is 78 people. Because the available cancer data are at a demographic scale much larger than the exposed population (78 people), there is a chance that cancer cases in the WKBS neighborhood would be obscured by the larger population (6,613) in the census tract who are likely not exposed to PFOA and PFOS (ATSDR, 2021). IDPH did not evaluate health outcome data for this report due to the potential of this bias in exposure misclassification.

5.4 Summary of Limitations and Uncertainties

The limitations and uncertainties (LUs) in this report concern the sampling data and the ability to fully characterize the public health hazards presented by PFAS in private wells. Each of these LUs are listed below:

- No source of PFAS contamination has been identified. This makes it difficult to determine when PFAS contamination started and to determine whether other possible wells may have been impacted based on the direction groundwater flow and extent of groundwater contamination.

- There are a limited number of samples from each private well, so temporal variations in PFAS contamination are unknown.
- PFAS research into their health effects is ongoing. Therefore, the health guidelines used in this HC may be found to be over or under-protective in the future.
- There is limited or no epidemiological and toxicological data for 6 of the 13 PFAS detected in WKBS private wells. Exposures to these types of PFAS could not be evaluated.
- The effects of PFAS mixtures on carcinogenicity is unknown.

These types of LUs are commonly encountered in the public health assessment process, particularly in the evolving field of PFAS research and toxicity. IDPH employs professional judgment to make public health determinations which are as health protective and realistic as possible in response to these LUs.

6. Conclusions

Based on the above information, IDPH reached the following conclusions regarding exposure to PFAS in the WKBS private wells:

1. *Exposure to PFAS in household water in the WKBS could have harmed or could harm the health of private well users in the WKBS, especially children. Exposures were mitigated for many homes in the WKBS following connection to the Rockton CWS. However, those continuing to use the 12 private wells that were not connected to the CWS could continue to be exposed to PFAS at levels that could harm their health at the current time and into the future. This is a public health hazard.*

   IDPH estimated exposure doses based on the concentrations of PFHxS, PFOA, and PFOS in each well. Most wells in the WKBS had doses of each PFAS which approached or exceeded the effect levels for the following adverse health effects:

   - Reduced vaccine effectiveness (PFHxS, PFOA, PFOS)
   - Increased total cholesterol (PFOA, PFOS)
   - Reduced birth weights (PFHxS, PFOA, PFOS)
   - Thyroid effects (PFHxS)
   - Liver damage (PFHxS, PFOA, PFOS)

   These exceedances indicated that the above adverse health effects are possible following long-term exposure to the concentrations of PFAS in WKBS private wells.

IDPH also estimated cancer risks based on the concentration of PFAS in each well. IDPH found that exposure to concentrations of PFOA in 32 of 34 wells could cause an increased risk of kidney, testicular, liver, or pancreatic cancers.

Few residents treat their water or use alternative sources of water based on information gathered by IDPH during a townhall with WKBS residents. Daily exposures to these PFAS are expected due to lack of treatment or alternative water use in the WKBS. Because PFAS are persistent in groundwater, IDPH assumed that exposure to the concentrations detected in sampling data are representative of past, present, and future exposure concentrations.

2. *Exposure to a mixture of PFHxS, PFOA, and PFOS in household water through drinking and bathing/showering could have caused or could cause an increased risk of harmful noncancer health effects listed in Conclusion 1, except for thyroid effects, for private well users of the WKBS. Exposures were mitigated for many homes in the WKBS following connection to the Rockton CWS. However, those continuing to use the 12 private wells that were not connected to the CWS could continue to be exposed to PFAS at levels that could harm their health at the current time and into the future. This is a public health hazard.*

   Of the 34 wells sampled, 27 had detections of PFHxS, PFOA, and PFOS. These three PFAS can cause several of the same health effects. Based on these shared health effects and the very low doses at which these health effects have been modeled to occur for each PFAS, it's reasonable to assume that exposure to all three of these PFAS in one well would increase the overall risks of reduced vaccine effectiveness, increased total cholesterol, liver damage, and decreased infant birth weights.

3. *There is not enough information to determine the public health hazard(s) due to exposure to other PFAS types detected in WKBS private wells. This is an indeterminant public health hazard.*

   Health guidelines are currently unavailable due to lack of toxicological information for 6 of the 13 PFAS types detected in the WKBS: PFPeA, PFHpA, PFPeS, PFHpS, FOSA, and 6:2 FTSA. Therefore, IDPH cannot make definitive public health conclusions regarding exposures at this time.

7. Recommendations and Public Health Action Plan

- IDPH recommends residents who refused CWS connections to reduce their exposure to PFAS by treating their water with granular activated carbon filters or reverse osmosis

treatment systems before drinking or cooking. Treatment devices that meet National Sanitation Foundation Standards 53 or 58 and are maintained and updated following the manufacturer's instructions are recommended.

- IDPH recommends residents to reduce exposure to other potential PFAS sources, including food packaging materials, stain resistant carpets, water resistant clothing, cleaning products, and some cosmetics.
- IDPH recommends nursing mothers to continue to breastfeed, and contact their healthcare providers with specific concerns.
- To help protect formula-fed infants from potential exposure, IDPH recommends caregivers to use pre-mixed formula or reconstitute dry formula with water sources that meet state and federal drinking water guidelines for PFAS.
- IDPH recommends residents concerned about past exposures to speak with their doctor about their PFAS exposure and ask about exposure reduction measures and health screenings.
- IDPH recommends local health providers consult ATSDR's current clinician guide at https://www.atsdr.cdc.gov/pfas/hcp/clinical-overview/clinical-evaluation-management.html as a resource to guide patient treatment.

IDPH will conduct a public availability session upon release of this report to answer health-related questions from WKBS residents. In particular, IDPH will seek to communicate the health hazards to those residents who did not accept a CWS connection. IDPH will coordinate with appropriate partner agencies regarding participation at the town hall. Additionally, IDPH will continue to be available to work with the local government of Rockton on approaches to educate its affected residents on the risks of PFAS exposure and how to reduce their exposure. IDPH will stay apprised of PFAS research and update our assessment as needed.

8. Authors, Site Team, and Contributors

The Illinois Department of Public Health (IDPH) prepared this Health Consultation for the Beloit Corp site, located in Rockton, Winnebago County, Illinois. This publication was made possible by a cooperative agreement CDC-RFA-TS-23-0001 with the federal Agency for Toxic Substances and Disease Registry (ATSDR). IDPH evaluated data of known quality using approved methods, policies, and procedures existing at the date of publication. ATSDR reviewed this document and concurs with its findings based on the information presented by IDPH.

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Appendices

Appendix A: Brief Summary of ATSDR's Public Health Assessment (PHA) Process

ATSDR follows the PHA process to find out:

- Whether people living near a hazardous waste site are being exposed to toxic substances.
- Whether that exposure is harmful.
- What must be done to stop or reduce exposure.

The PHA process is a step-by-step consistent approach during which ATSDR:

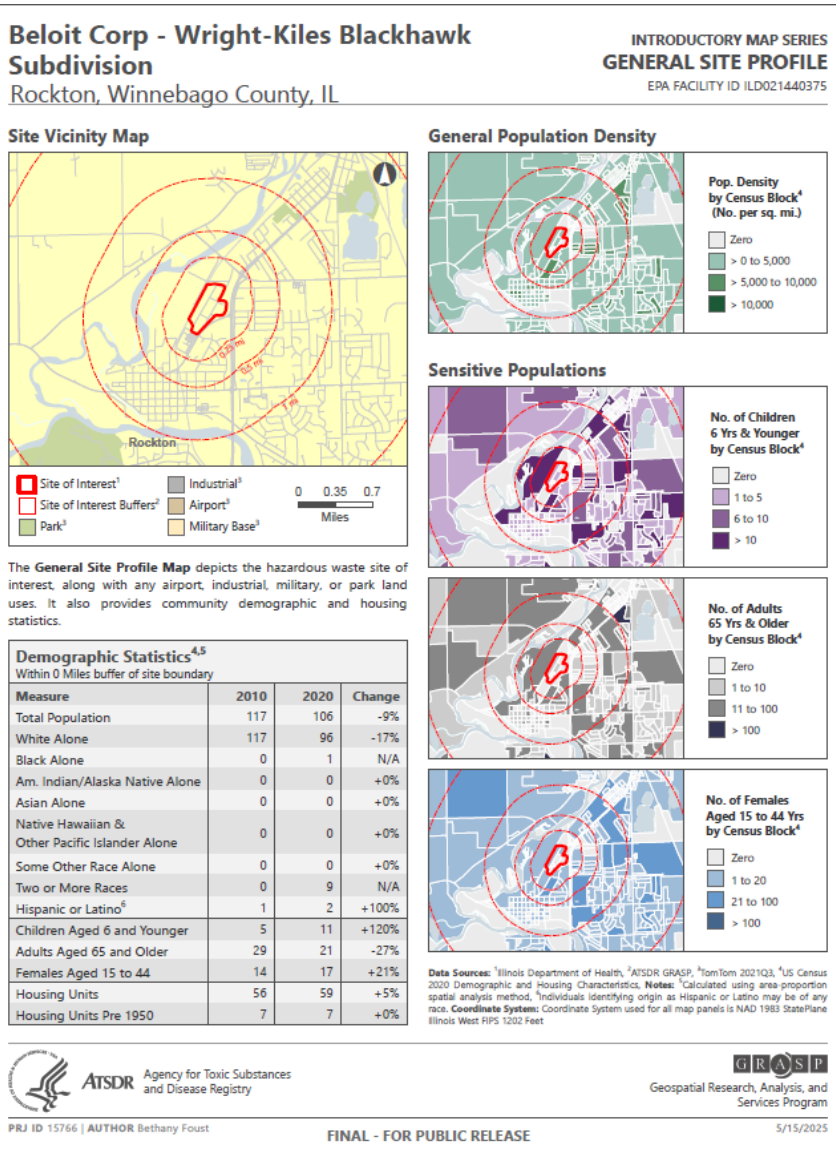
- Establishes communication mechanisms, including engaging communities at the beginning of site activities and involves them throughout the process to respond to their health concerns. Collects many different kinds of site information.
- Obtains, compiles, and evaluates the usability and quality of environmental and biological sampling data (and sometimes modeling data) to examine environmental contamination at a site.
- Conducts four main, sequential scientific evaluations.
    - Exposure pathways evaluation to identify past, present, and future site-specific exposure situations, and categorize them as completed, potential, or eliminated.
    - Screening analysis to compare the available sampling data to media-specific environmental screening levels (ATSDR comparison values [CVs] and non-ATSDR screening levels). This identifies potential contaminants of concern that require further evaluation for completed and potential exposure pathways.
    - Exposure Point Concentrations (EPCs) and exposure calculations for contaminants flagged as requiring further evaluation in completed and potential exposure pathways. It involves calculating EPCs, using the estimated EPCs to perform exposure calculations, and determining which site-specific scenarios requires an in-depth toxicological effects analysis.
    - In-depth toxicological effects evaluation, if necessary, based on the three previous scientific evaluations. This step looks more closely at contaminant-specific information in the context of site exposures. This evaluation can also help determine if there is a potential for non-cancer or cancer health effects.
- Summarizes findings and next steps, while acknowledging uncertainties and limitations.
- Provides recommendations to site-related entities, partner agencies, and communities to prevent and minimize harmful exposures.

The sequence of steps can differ based on site-specific factors. For instance, health assessors might define an exposure unit before or after the screening analysis. Readers can refer to

ATSDR's Public Health Assessment Guidance Manual for all information related to the stepwise PHA process.

Appendix B: Figures

Figure A1: GRASP Map – General Site Profile



Beloit Corp - Wright-Kiles Blackhawk Subdivision
Rockton, Winnebago County, IL

INTRODUCTORY MAP SERIES
GENERAL SITE PROFILE
EPA FACILITY ID ILD021440375

Site Vicinity Map

General Population Density

Sensitive Populations

The **General Site Profile Map** depicts the hazardous waste site of interest, along with any airport, industrial, military, or park land uses. It also provides community demographic and housing statistics.

Demographic Statistics[4,5]
Within 0 Miles buffer of site boundary

Measure	2010	2020	Change
Total Population	117	106	-9%
White Alone	117	96	-17%
Black Alone	0	1	N/A
Am. Indian/Alaska Native Alone	0	0	+0%
Asian Alone	0	0	+0%
Native Hawaiian & Other Pacific Islander Alone	0	0	+0%
Some Other Race Alone	0	0	+0%
Two or More Races	0	9	N/A
Hispanic or Latino[6]	1	2	+100%
Children Aged 6 and Younger	5	11	+120%
Adults Aged 65 and Older	29	21	-27%
Females Aged 15 to 44	14	17	+21%
Housing Units	56	59	+5%
Housing Units Pre 1950	7	7	+0%

Data Sources: [1]Illinois Department of Health, [2]ATSDR GRASP, [3]TomTom 2021Q3, [4]US Census 2020 Demographic and Housing Characteristics. **Notes:** [5]Calculated using area-proportion spatial analysis method, [6]Individuals identifying origin as Hispanic or Latino may be of any race. **Coordinate System:** Coordinate System used for all map panels is NAD 1983 StatePlane Illinois West FIPS 1202 Feet

ATSDR Agency for Toxic Substances and Disease Registry

GRASP Geospatial Research, Analysis, and Services Program

PRJ ID 15766 | AUTHOR Bethany Foust

FINAL - FOR PUBLIC RELEASE

5/15/2025

Appendix C: Glossary of Terms

The glossary in this appendix defines the various terms that were used in this Public Health Assessment. This glossary defines words used by ATSDR and IDPH in communications with the public. It is not a complete dictionary of environmental health terms. For additional questions or comments, call 1-800-CDC-INFO.

Acute (duration of exposure)

Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with intermediate duration exposure and chronic exposure].

Adverse health effect

A change in body function or cell structure that might lead to disease or health problems.

Agency for Toxic Substances and Disease Registry (ATSDR)

A federal public health agency in Atlanta, Georgia, with 10 regional offices in the United States. ATSDR serves the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent adverse exposures and diseases from toxic substances. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (EPA), which is the federal agency that develops and enforces laws to protect the environment and human health.

Analyte

A substance measured in the laboratory. A chemical for which a sample (such as water, air, or blood) is tested in a laboratory. For example, if the analyte is mercury, the laboratory test will determine the amount of mercury in the sample.

Cancer

Any one of a group of diseases that occur when cells in the body become abnormal and grow or multiply out of control.

Cancer risk (CR)

A theoretical risk for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

Carcinogen

A substance that causes cancer.

Central tendency exposure (CTE)

Refers to individuals who have average or typical exposure to a contaminant. For instance, at an example site where children < 21 years old are exposed to a chemical via incidental surface water ingestion, the estimated CTE lifetime cancer risk is 1.6E-6 – based on the average surface water intake rate of 0.049 liter per hour (L/hour) while swimming and exposure duration of 12 years. This can be compared to a reasonable maximum exposure (RME) lifetime cancer risk for the same population of 5E-5, which is based on the 95th percentile surface water intake rate of 0.12 L/hour while swimming and exposure duration of 33 years.

Chronic

Occurring over a long time [compare with acute].

Community

People who may be directly affected by site contamination because they currently live near the site or have lived near the site in the past. Community members may include, for example, residents, members of local action groups, local officials, tribal members, health professionals, and local media. The community is at the heart of all public health process activities.

Community water supply

A community water supply is a public water system that supplies water to the same population year-round.

Comparison value (CV)

Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause adverse health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.

Completed exposure pathway

All five elements of a pathway are present: contaminant source, environmental fate and transport, exposure point, exposure route, and potentially exposed population. A completed exposure pathway exists when there is direct evidence or, in the judgment of the health assessor, a strong likelihood that people have in the past, are presently, or in the future could come into contact with site-related contaminants.

Concentration

The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.

Contaminant

A substance that is either present in an environment where it does not belong or is present at levels that might cause adverse health effects.

Chronic (duration of exposure)

Contact with a substance that occurs over a long time (365 or more days) [compare with acute exposure and intermediate exposure].

Dermal

Referring to the skin. For example, dermal absorption means passing through the skin.

Dermal contact

Contact with (touching) the skin [see route of exposure].

Dose

The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

Effect

Any change in physiologic function or cellular structure because of an exposure to an environmental contaminant.

Effect Level

A toxicological term that refers to specific doses of a substance that are determined in experimental studies to cause a certain health effect or are at a level low enough that that health effect does not occur. They are used to assess risk and establish safety guidelines. The most common terms are the no-observed-adverse-effect level (NOAEL) and the lowest-observed-adverse-effect level (LOAEL)

Eliminated exposure pathway

At least one of the five elements of a pathway is not present and either will never be present or is extremely unlikely to ever be present: contaminant source, environmental fate and transport, exposure point, exposure route, and potentially exposed population. Health assessors classify an exposure pathway as eliminated after determining that exposure has not occurred in the past, is not occurring currently, and is extremely unlikely to occur in the future.

Environmental media

Soil, water, air, biota (plants and animals), or any other parts of the environment that can contain contaminants.

Environmental Media Evaluation Guides (EMEGs)

EMEGs are estimated contaminant concentrations that are not expected to result in adverse noncarcinogenic health effects based on ATSDR evaluation. EMEGs are calculated from ATSDR minimal risk levels (MRLs) for chronic or intermediate exposures (those occurring longer than 365 days or from between 14-365 days, respectively), as well as acute time frames (14 days of exposure or less). There are specific EMEGs for adults and children. Not all contaminants have chronic, intermediate, or acute EMEGs.

EPA (U.S. Environmental Protection Agency)

The primary federal agency responsible for environmental issues, including research, monitoring, enforcement, and cleanup functions. ATSDR (using its public health assessment process) and EPA (using its risk assessment process) evaluate spills or releases of hazardous substances in the environment at Superfund sites to protect public health

Epidemiologic study

A study that evaluates the association between exposure to hazardous substances and disease by testing scientific hypotheses.

Exposure

Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [acute exposure], of intermediate duration, or long-term [chronic exposure].

Exposure dose

The estimate of how much of a contaminant a person might contact based on his or her actions and habits. It is generally expressed as milligrams of contaminant per kilogram of body weight per day (mg/kg/day). Estimating an exposure dose requires identifying how much, how often, and how long a person or population might come in contact with some concentration of a contaminant (i.e., the exposure point concentration) in a specific medium. ATSDR calculates exposure doses based on acute, intermediate, and chronic exposure durations. For example, the exposure dose formula for drinking water is the concentration x the intake rate x the exposure factor divided by the body weight. Let's say the birth to <1 year exposure group (weighing 7.8 kilograms) on a daily chronic basis (exposure factor of 1) drank 1.113 liters per day (the reasonable maximum exposure intake rate) of water with an EPC of 3.5 milligrams per liter (mg/L) for a chemical. Using this drinking water equation, this example results in an exposure dose of 0.50 mg/kg/day.

Exposure pathway

The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a source of contamination (such as an abandoned business); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed).When all five parts are present, the exposure pathway is termed a completed exposure pathway.

Exposure point concentration (EPC)

A representative contaminant concentration. When appropriate, ATSDR calculates an EPC for each exposure unit or area, individual completed and potential exposure pathway, and exposure duration: acute (0-14 days), intermediate (15-364 days), or chronic (365 or more days) durations.

Exposure unit

A geographically defined point or area where a person is expected to contact an environmental medium, such as soil, surface water, groundwater, air, or food items (e.g., fruits, vegetables, fish, game). Health assessors define exposure units for each potential contaminant of concern identified in a completed exposure pathway or potential exposure pathway.

Groundwater

Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with surface water.

Hazard

A source of potential harm from past, current, or future exposures.

Hazard quotient (HQ)

A calculation to evaluate the potential for noncancer health hazards to occur from exposure to a contaminant with available noncancer health guidelines (MRLs, RfDs, RfCs). Typically, the hazard quotient is obtained by dividing the duration-specific (acute, intermediate, or chronic) exposure dose or concentration by the noncancer health guideline for the same duration for your exposure groups of interest.

Hazardous substance

Potentially adverse substances that have been released or discarded into the environment.

Health advisory

Health advisories serve as informal technical guidance, intended to provide information about

contaminant exposures and potential public health impacts. The guidance level represents concentrations in drinking water at which no adverse health effects are expected to occur. Guidance levels are not enforceable or intended to be used as drinking water standards, also known as maximum contaminant levels (MCLs).

Health assessor

Often the leader of the site team, coordinating the PHA process activities and working with subject matter experts (SMEs) as needed to gather and evaluate data. Usually, they are also responsible for writing the document that summarizes the findings of the PHA process.

Health consultation (HC)

An ATSDR document that presents a review of available information or collection of new data that generally responds to a specific public health issue or question, contaminant, health condition, or technical interpretation. HCs are typically focused on a specific exposure issue.

Health education

Any planned combination of learning experiences designed to predispose, enable, and reinforce voluntary behavior conducive to health in individuals, groups, or communities.

Health guidelines

Values that serve as the basis for ATSDR's non-cancer comparison values. They consist of oral human doses and air concentrations developed from toxicology or epidemiology studies (with safety factors applied) that are protective of human health.

Health outcome data

Information from private and public institutions on the health status of populations. Health outcome data can include morbidity and mortality statistics, birth statistics, tumor and disease registries, or public health surveillance data.

Ingestion

The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see **Route of exposure**].

Intermediate (duration of exposure)

Contact with a substance that occurs for more than 14 days and less than a year [compare with acute exposure and chronic exposure].

Limitation

Missing, unknown, or assumed information, as part of the public health assessment process, that can be critical to make a public health call, help you understand what contaminants, and at

what concentrations, people could be exposed to, and lend uncertainty to the public health conclusions.

Lowest-observed-adverse-effect level (LOAEL)

The lowest tested dose of a substance that has been reported to cause adverse health effects in people or animals. For example, mice exposed to an air concentration of 250 parts per million (ppm) experienced shallow breathing, and the study reported 250 ppm as a LOAEL.

Maximum Contaminant Levels (MCLs)

MCLs are derived by EPA as enforceable standards for municipal water systems. These standards are not strictly health-based but are set as close to the maximum contaminant level goals (MCLGs) (Health Goals) as is feasible and are based upon treatment technologies, costs (affordability) and other feasibility factors, such as the availability of analytical methods, treatment technology and costs for achieving various levels of removal.

National Priorities List for Uncontrolled Hazardous Waste Sites (National Priorities List or NPL)

EPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis.

Per- and polyfluoroalkyl substances (PFAS)

Man-made chemicals that have been used in industry and consumer products worldwide since the 1940s. They have been used to make nonstick cookware, water-repellent clothing, stain resistant fabrics and carpets, some cosmetics, some firefighting foams, and products that resist grease, water, and oil.

Point of exposure

The place where someone can come into contact with a substance present in the environment [see exposure pathway].

Population

A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

Potentially exposed population

The fifth part of an exposure pathway. This represents the people who potentially have, do, or could come in contact with environmental contaminants.

Potential contaminant of concern

A label given to a contaminant if its concentration meets or exceed screening levels, or its estimated exposure dose or cancer risk levels exceed acceptable levels. It is important to note

that chemicals flagged as potential contaminants of concern do not necessarily pose a health threat. Further evaluation is needed to evaluate contaminants flagged as potential contaminants of concern. For example, trichloroethylene detected in air above the ATSDR comparison value would represent a potential contaminant of concern and require further evaluation.

Prevention

Actions that reduce exposure or other risks, keep people from getting sick, or keep disease from getting worse.

Public health assessment (PHA)

An ATSDR document that examines hazardous substances, health outcomes, and community concerns at a hazardous waste site to determine whether people could be harmed from coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health.

Reference Dose Media Evaluation Guide (RMEG)

An ATSDR-derived comparison value based on non-cancer health effects for chronic exposure duration only. RMEGs represent the concentration in a specific medium (e.g., water or soil) at which daily human exposure is unlikely to result in adverse noncarcinogenic effects. ATSDR derives RMEGs from EPA's reference doses (RfDs) and reference concentrations (RfCs). For air, RMEGs are the same as corresponding inhalation RfCs. For drinking water and soil, RMEGs are derived from the corresponding oral RfDs using conservative assumptions of intake rate and body weight.

Risk

The probability that something will cause injury or harm.

Route of exposure

The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].

Reasonable maximum exposure (RME)

Refers to people who are at the high end of the exposure distribution (approximately the 95th percentile), a scenario intended to assess exposures that are higher than average, but still within a realistic exposure range. For instance, at an example site where children < 21 years old are exposed to a chemical via incidental surface water ingestion, the estimated RME lifetime cancer risk is 5.4E-05, which is based on the 95th percentile swimming ingestion intake rate of 0.12 liter per hour (L/hour) and exposure duration of 33 years. This can be compared to the

central tendency exposure (CTE) lifetime cancer risk for this population of 1.6E-06 – based on the average swimming ingestion intake rate of 0.049 L/hour and exposure duration of 12 years.

Sample

A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population [see population]. An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.

Sample size

The number of units chosen from a population or an environment.

Source of contamination

The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A source of contamination is the first part of an exposure pathway.

Substance

A chemical.

Superfund [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Superfund Amendments and Reauthorization Act (SARA)]*Dorado Well Groundwater Contamination Site Public Health Assessment– Public Comment Release*

Surface water
Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with groundwater].

Toxicological profile

An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine adverse levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.

Toxicology

The study of the adverse effects of substances on humans or animals.

Transport mechanism

Environmental media include water, air, soil, and biota (plants and animals). Transport mechanisms move contaminants from the source to points where human exposure can occur. The environmental media and transport mechanism is the second part of an exposure pathway.

95UCL

95 percent upper confidence limit of the arithmetic mean. Health assessors use statistical tools such as EPA's ProUCL and R to calculate the 95UCL for the exposure point concentration (EPC).

Appendix D: Technical Information

D.1 ATSDR Screening Levels

The screening levels described below were used in preparing this document.

Environmental Media Evaluation Guides (EMEGs) are ATSDR CVs. EMEGs are concentrations of contaminants in a specific medium (e.g., water, soil) that represent estimated contaminant concentrations below which humans exposed during a specific timeframe (acute, intermediate, or chronic) are not expected to experience noncancer health effects. EMEGs are based on ATSDR's oral and inhalation MRLs.

Reference Media Evaluation Guides (RMEGs) are ATSDR CVs. RMEGs represent the concentration in a specific medium (e.g., water, soil) at which daily human exposure for a chronic duration is unlikely to result in noncarcinogenic effects. RMEGs are derived from EPA's oral RfDs for ingestion and RfCs for inhalation.

D.2 Health Guidelines Used in this Report

Minimal risk level (MRL)

An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of adverse, noncancerous effects.

MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs are not used as predictors of adverse health effects [see reference dose].

Reference dose (RfD)

An EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

D.3 Hazard Assessment Equations

Water Ingestion Exposure Dose Equation

$$D_{noncancer} = (C \times IR \times EF_{noncancer}) \div BW \qquad \text{Equation 1}$$

$D_{noncancer}$ = dose (mg/kg/day), C = contaminant concentration (mg/L), IR = intake rate (L/day), $EF_{noncancer}$ = exposure factor (unitless), BW = body weight (kg)

SHOWER Model Dermal Exposure Dose Equation

$D_{noncancer} = ADD \times EF\ noncancer$ Equation 2

$D_{noncancer}$ = dermal exposure dose (mg/kg/day), ADD = SHOWER Model administered dermal dose (mg/kg/day),

$EF_{noncancer}$ = exposure factor (unitless)

Hazard Quotient

$HQ = D_{noncancer} \div HG$ Equation 3

HQ = hazard quotient, $D_{noncancer}$ = dose (mg/kg/day), HG = health guideline (e.g., oral MRL, RfD)

Cancer Risk Equations

$CR = D_{noncancer} \times CSF \times (ED \div LY)$ Equation 4

$ADAF\text{-adjusted } CR = (D_{noncancer} \times CSF) \times (ED \div LY) \times ADAF$ Equation 5

Total CR = Sum of the CR for all exposure groups Equation 6

CR = cancer risk (unitless), $D_{noncancer}$ = dose, CSF = oral cancer slope factor [$(mg/kg/day)^{-1}$], EF (cancer) = exposure factor (cancer)
calculated as follows: EF (noncancer; unitless) x exposure group specific exposure duration (years) ÷ lifetime of 78 years,
ADAF = age-dependent adjustment factor (unitless), ED = exposure duration (years), LY = lifetime years (78 years)

D.4 Full PFAS Congener Names

Full PFAS Congener Name	Abbreviation
Perfluorooctanoic acid	PFOA
Perfluorooctane sulfonic acid	PFOS
Perfluorononanoic acid	PFNA
Perfluorohexane sulfonic acid	PFHxS
Perfluorobutane sulfonic acid	PFBS
Perfluorohexanoic acid	PFHxA
Perfluorobutyric acid	PFBA
Perfluoropentanoic acid	PFPeA
Perfluoroheptanoic acid	PFHpA
Perfluoropentane sulfonic acid	PFPeS
Perfluoroheptane sulfonic acid	PFHpS
Perfluorooctane sulfonamide	FOSA
6:2 fluorotelomer sulfonic acid	6:2 FTSA