# ENVIRONMENTAL EXPOSURES AND HEALTH RISKS

**Developed by**
**The Environmental Health Sciences Research Center**

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The EHSRC is funded by NIH P30 ES005605

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**The EHSRC would like to thank the development team (Lydia Johnson, Dr. Mary Charlton, Jackie Curnick, Dr. Brandi Janssen, and Dr. Hans Lehmler), and the expert reviewers who reviewed the content (Arsenic: Dr. Peter Thorne; Atrazine: Dr. Charles Lynch; Glyphosate: Dr. Charles Lynch; Nitrate: Dr. Mary Ward; PFAS: Dr. Jane Hoppin; Radon: Dr. Jong Sung Kim; and TCE: Dr. Rashmi Joglekar ).**

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# Introduction

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Iowa has the second-highest and fastest-growing rate of new cancer in the United States (1) as well as one of the greatest disparities in cancer mortality between Black and white populations (2). While many well-understood behavioral and genetic factors increase cancer risk, the role of exposures in the environment in increasing cancer risk is not as well documented. A chemical exposure can occur when a person's body comes into contact with a harmful substance in the air, water, or soil and has the potential to contribute to short-term and long-term illness.

A combination of natural and human activities contribute to environmental exposures to cancer-causing agents. Iowa has the largest percentage of homes that test at or above the EPA action level, as well as the highest average groundwater nitrate pollution from fertilizer use in the country. Thus, exposure to environmental carcinogens is an important consideration when examining the elevated cancer rates in the state (3, 4, 5). However, it should also be noted that higher than average red meat consumption, lower levels of activity, high alcohol consumption, UV exposure, some viruses, tobacco and nicotine exposure, lack of access to healthy fruits and vegetables, and more can further increase an individual's cancer risk, as highlighted by the Iowa Cancer Registry (1, 2). In line with priorities six and seven of Chapter 2 of the Iowa Cancer Plan, the goal of these fact sheets is to explain the current science about environmental contaminants and their relationship to cancer and other diseases to reduce the rates of potentially preventable diseases (6).

It is difficult to establish a causal relationship between one individual's exposure to an environmental carcinogen and cancer, so scientists use other ways to study these connections. In these fact sheets, risk, correlation, and association are all terms used to describe the relationship between an environmental contaminant and a health outcome (cancer, birth defects, etc.)

- Risk: explains the likelihood of an outcome in an exposed group compared to a lesser or unexposed group. A relative risk ratio of two indicates that the exposed group is two times more likely to experience the outcome than the comparison group.
- Correlation: measures the relationship between an exposure and a health outcome and how the two move together. A positive correlation indicates that when one variable increases, the other variable also increases. For example, when higher concentrations of radon are present in residential air, more people have lung cancer.
- Association: indicates there is a general relationship between an exposure and an outcome. A positive association means that an exposure is related to a higher probability of a health outcome.

In summary, relative risk ratio is the most specific indicator of a relationship, correlation shows a trend, and association is a more general relationship.

These fact sheets frequently reference Monographs produced by the International Agency for Research on Cancer (IARC). IARC evaluates carcinogenic risks by systematically reviewing and assessing studies published in peer-reviewed scientific literature. The evaluations consider evidence from human, animal, and mechanistic studies to ensure a rigorous and transparent review process. (8).

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# Arsenic & Health Fact sheet

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## Introduction

Inorganic arsenic is a toxic metalloid found naturally in Earth's crust. Arsenic can be detected in water, air, and soil globally and within the United States (1). While the metalloid can be found in many forms, inorganic arsenic is the environmental form that poses the greatest risk to public health (1). Arsenic is a colorless powder, with no smell or taste, making it imperceptible in water, food, air, and soil.

## Exposure Sources

Exposure to inorganic arsenic is associated with mining and smelting, proximity to hazardous waste sites, and its use as a pesticide, wood preservative, and alloy in semiconductors and batteries (1,2). While some exposure is attributable to the consumption of rice, the primary route of exposure to arsenic in the US is through drinking water where high concentrations of inorganic arsenic are present in the groundwater. Concentrations of inorganic arsenic may be high in groundwater used as a source of drinking water (3). Wells deeper than 100 feet have the highest risk of inorganic arsenic contamination.

## Health Risks Associated with Arsenic

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| **Cancer Health Risks** | The U. S. Environmental Protection Agency (EPA) classifies inorganic arsenic compounds as carcinogenic to humans (4). Hundreds of epidemiological studies conducted worldwide have shown the exposure to arsenic causes cancers of the skin, bladder, and lung. There is also evidence of association with cancers of the kidney, nasal passages, liver, and prostate. Recent research in the U.S. has provided evidence of a significantly elevated risk at levels below the current drinking water standard of 10 micrograms per liter (7). |
| **Non-Cancer Health Risks** | The EPA has conducted risk assessment on non-cancer effects of long-term exposure to inorganic arsenic including ischemic heart disease (IHD), Type II diabetes, adverse pregnancy and birth outcomes, and neurodevelopmental effects (7). Evidence demonstrates risk levels for IHD and Type 2 diabetes as high as 180 per 10,000 people with lifetime drinking water exposure to inorganic arsenic at the 10 micrograms per liter maximum contaminant level (MCL) (7). |

## How is Arsenic regulated?

- The EPA established the MCL to be 10 micrograms per liter to protect against the cancer and non-cancer health effects listed above (5).
- Under the Safe Drinking Water Act, the EPA requires public water suppliers to test for inorganic arsenic on an ongoing basis(1,3).
- Private wells are unregulated for arsenic (1,3).
- The Food and Drug Administration (FDA) and Occupational Safety and Health Administration (OSHA) regulate dietary and occupational exposures, respectively (5).

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## What can you do?

- If your water is supplied from a private well, you should get your water tested annually for arsenic by contacting your local health department.
- If you are on a public water supply, read your annual Consumer Confidence Report to see what levels of inorganic arsenic are in your drinking water. Arsenic is not reported if the concentration is below 5 micrograms per liter (3).
- Certain methods can be used to enhance the removal of arsenic from drinking water. These include anion exchange, reverse osmosis, activated alumina, pH adjustment, enhanced lime softening, and pre-oxidation (3,6).
- Using a Brita filter, refrigerator filter, and boiling water are not reliable methods of arsenic removal (6).
- Rice should be rinsed thoroughly prior to cooking.

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# Atrazine & Health Fact sheet

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## Introduction

Atrazine is a herbicide used to control broad-leaved weeds (1). Atrazine is used abundantly in Iowa, where it is applied to 65% of planted acres of corn (2). The herbicide is predominantly used in spring and summer (3). Atrazine is an odorless, white powder that dissolves in water; however, it breaks down slowly and persists in local water sources (4).

## Exposure Sources

People can be exposed to atrazine in many ways. While not detected in food sources, atrazine is found widely in lakes, rivers, estuaries and groundwater, leaving well water users at risk of exposure (1, 3). Most people are not exposed to atrazine regularly (1). However, well water users and those living on farms and in rural communities near areas where atrazine was applied to crops or manufactured may be exposed through contaminated dirt and water.(3,4). This exposure is particularly concerning for children who dig and play in outdoor spaces that may be contaminated. Further, occupational exposure from inhalation or absorption through the skin may occur (1).

## Health Risks Associated with Atrazine

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| **Cancer Health Risks** | When last reviewed in 1999, the International Agency for Research on Cancer (IARC) indicated atrazine as "not classifiable" as to its human carcinogenicity, meaning there was inadequate evidence of human and/or animal carcinogenitiy at the time. IARC will be releasing an updated evaluation in October of 2025. In an updated investigation of the Agricultural Health Study Cohort in 2024, atrazine exposure was associated with an increased risk of some cancers in farmers who were applying atrazine (5). Statistically significant associations were found for lung cancer, and for prostate cancer among those younger than sixty at diagnosis. Exposures to atrazine that occurred 25 years ago may lead to an elevated risk of pharyngeal and kidney cancer (5). |
| **Non-Cancer Health Risks** | Exposure to atrazine is associated with a range of adverse health problems, primarily cardiovascular and reproductive system effects (6). The Environmental Protection Agency (EPA) established the Maximum Contaminant Level (MCL) to protect against adverse health effects to the cardiovascular system and reproductive problems associated with long-term exposure to atrazine at levels above the MCL. Some of the reproductive problems associated with this long-term exposure include an increased risk of pre-term delivery, low fetal weight, and heart, urinary, and limb defects in infants (1). |

## How is Atrazine regulated?

- The EPA established the MCL for atrazine to be 0.003 mg/L in public drinking water to protect against cardiovascular or reproductive system effects (6).
- Atrazine is a restricted-use pesticide, meaning a person must be certified to purchase and apply this herbicide, due to its potential to contaminate the water and the environment (3).
- Public water suppliers are required to test for atrazine and present results to consumers and the state through consumer confidence reports (CCR). (Visit this link to find your local CCR: https://ordspub.epa.gov/ords/safewater/f?p=136:102::::::)

## What can you do?

- Avoid areas for 12 hours following atrazine application. Do not allow children to play in soil and water sources following the application of atrazine (3, 4).
- If living near agricultural fields, ask you local health department about testing your private well for atrazine (7).
- Avoid tracking contaminated soil into homes, especially into rooms where children live and play. Vacuum floors and dust surfaces to avoid exposure to low levels of atrazine (3).
- Granular activated carbon filtration is an effective method to remove atrazine from contaminated water (8). These filtration systems can be applied over the whole house plumbing system, or as point of use filters just before the faucet.

***Published March 2025***

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# Glyphosate & Health Fact sheet

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## Introduction

Glyphosate is a broad-spectrum herbicide, meaning it is toxic to a wide range of crop species. Glyphosate is used abundantly in agriculture to control the growth of broad-leaved weeds and grasses (1). Typically sold as Roundup or Ranger Pro, glyphosate is used in mixtures referred to as glyphosate-based herbicides (GBHs)(2,3). Not all Round Up contains glyphosate. To check whether a product contains glyphosate, check the product label. Glyphosate is colorless and odorless, making it imperceptible in the environment and on food, water, and dust(3). Due to the widespread use in agricultural and residential settings, exposure to glyphosate is very common. Glyphosate use increased substantially after 1996 with the innovation of glyphosate-resistant crops, which allowed the herbicide to be used throughout the growing season to manage weeds (3).

## Exposure Sources

Glyphosate residues have been detected in water, soil, food, and urine(3). In settings where glyphosate is applied, exposure to the chemical is highest. Still, outside of these settings, glyphosate is very common in the environment, contributing to long-term human exposure (3). Most non-occupational exposures occur through the consumption of contaminated foods, but may also be the result of contaminated soil, dust, and water (3). The food products that most commonly have detectable glyphosate residues include cereals and processed grain-based foods(1, 5). The herbicide enters surface water through a variety of routes, including run-off (5).

## Health Risks Associated with Glyphosate

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| **Cancer Health Risks** | The International Agency for Research on Cancer (IARC) classifies glyphosate as a probable human carcinogen, due to sufficient evidence of cancer risk in experimental animals (5). In animal models, exposure to glyphosate has been associated with DNA damage and implicated in a process called oxidative stress (5). This occurs when our bodies have too many free radicals, which cause damage to human cells (5). While there is limited evidence in humans as to the carcinogenicity of glyphosate, the strongest evidence was for a relationship with non-Hodgkin lymphoma (NHL) (5). The relationship with other types of cancer was not as strong. |
| **Non-Cancer Health Risks** | Glyphosate-based products can cause eye and skin irritation, and are potentially fatal when ingested (4). Because it is know that glyphosate interrupts cellular processes, more research is needed into adverse health outcomes associated with its use (5). Some studies have implicated glyphosate exposure in disease of the kidney, thyroid, and neurologic and reproductive systems; however, there is insufficient evidence to establish an association (6). |

## How is Glyphosate regulated?

- The EPA establishes the maximum amounts of glyphosate on food products to range from 0.1 to 400 parts per million depending on the food product (7).
- The FDA monitors food and animal feed products for compliance with the EPA-established tolerances (8).
- In 2020, the FDA detected glyphosate in 54 of 2,800 human food samples (8).
- Glyphosate is not a restricted use pesticide, so no application certification or training is required for its use (4).

## What can you do?

- Limit personal use of glyphosate.
- Follow all safety precautions indicated on the product label (4).
- Wear personal protective equipment including long sleeves and pants, close-toed shoes, eye protection, and chemical resistant gloves when applying glyphosate-based herbicides (4).
- Allow 12 hours after application of glyphosate before re-entering the area or field (4).

*Published March 2025*

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# Nitrate & Health Fact sheet

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## Introduction

Nitrate, a form of nitrogen, is a water-soluble chemical found at high concentrations in some Iowa waterways and private wells (1, 2, 3). Nitrate is colorless and has no smell, so it is unnoticeable in drinking water. Nitrate occurs naturally in the environment; however, applying nitrogen fertilizers to corn and other crop fields, and manure run-off from animal feeding operations can cause nitrate pollution in drinking water (2, 3). Nitrate can be reduced to nitrite and other compounds that have been shown to have negative health effects (1,5).

## Exposure Sources

People are primarily exposed to nitrate through contaminated drinking water and by eating certain nitrate-containing foods, like processed meats (1, 4). Drinking water contaminated with nitrate is a public health concern in Iowa due to the amount of nitrogen fertilizer used in agriculture (1, 2, 3), with shallow wells being most at risk of high nitrate concentrations (3). Nitrate is the most common form of nitrogen entering Iowa streams because of its stability and water-solubility, potentially contributing to downstream contamination of drinking water.

## Health Risks Associated with Nitrate

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| **Cancer Health Risks** | The International Agency for Research on Cancer (IARC) classifies nitrate in food and water as "probably carcinogenic to humans" (1, 5). Studies conducted in Iowa have shown a positive correlation between exposure to nitrate in the drinking water and some cancers (1). Some studies conducted in Iowa have analyzed cancer risk at or above levels one-half the maximimum contaminant level (MCL) over long periods of time. From these studies, consistent associations have been discovered for colorectal cancer. Cancers at other sites have been less studied, however, positive associations have been found at levels below the MCL for cancers of the thyroid, ovary, and kidney (6). |
| **Non-Cancer Health Risks** | Methemoglobinemia, or Blue Baby Syndrome, is a condition in which not enough oxygen is transported in the blood to the body's tissues (3). Blue Baby Syndrome can occur when infants are exposed to nitrate levels higher than 10 mg/L. Elevated prenatal nitrate exposure in Iowa has also been connected to increased risk of birth defects, including spina bifida, limb deficiencies, and cleft palate (7,8). |

## How is Nitrate regulated?

- The EPA established the maximum contaminant level for nitrate to be 10 mg/L in drinking water, to protect infants against methemoglobinemia, or Blue Baby Syndrome (7, 9).
- Public water suppliers must test for nitrate and present results to consumers and the state through consumer confidence reports (3).
- Private wells are not required to be tested for nitrate, and those with water sourced from a shallow well, less than 50 feet, face a disproportionate risk of high nitrate exposure (3,10).

## What can you do?

- Test well water for nitrate once a year if the well is privately-owned.
- Water purification methods that remove nitrate include reverse osmosis, ion exchange, and distillation. Using Brita filters, refrigerator filters, and boiling water are not effective at removing nitrate (7).
- Maintain a healthy diet rich in antioxidants and limited in processed, cured, and red meats (1).

***Published September 2024***

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# PFAS & Health Fact sheet

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## Introduction

Per- and polyfluoroalkyl substances, or PFAS, are a large group of compounds, sometimes referred to as "forever chemicals" because they do not degrade in the environment (1). PFAS contain a strong carbon -to-fluorine bond, which is why they persist. Perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) are the most widely studied chemicals in this group of compounds (1). PFAS can be broken into two categories to help understand their environmental and health impacts—short-chain PFAS and long-chain PFAS (2). Short-chain PFAS have less than seven fluorinated carbon atoms, while long-chain PFAS have seven or more fluorinated carbon atoms and persist longer in the environment and the human body (2).

## Exposure Sources

The public can be exposed to PFAS through diet, drinking water, household dust, consumer products, and contaminated air (1, 3). The highest exposures to PFAS occur among those who work in fluorochemical production processes or in industries that make products containing PFAS (1). Drinking water is the greatest source of exposure for the public when there is a specific pollution source, such as a nearby manufacturing plant (1). In the absence of a specific pollution source, diet is the primary source through food origins, packaging, and processing (1, 3). Plant- and animal-based foods, formula and baby food, and fish and seafood have all been noted as source of PFAS exposure (1, 3, 4). Consumer products that contain PFAS include textiles, outdoor clothing, cleaning products, paints, coatings, carpets, floor coverings, floor polish, leathers, cosmetics, printing inks, adhesives, ski wax, lubricants, and non-stick cookware. Aqueous Film Forming Foam (AFFF), a fire suppressant, contains high concentrations of PFAS (1, 3).

## Health Risks Associated with PFAS

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| **Cancer Health Risks** | PFAS are a large category of chemicals and two have been evaluated the International Agency for Research on Cancer for carcinogenicity (1, 5). IARC classifies PFOA as carcinogenic to humans and PFOS as possibly carcinogenic to humans (1, 5). The strongest evidence for an association between PFOA exposure and human cancer risk was for cancer of the kidney and testis (1). There was also limited evidence of an association between PFOA and breast cancer (1). IARC reported suggestive and inconsistent evidence of a relationship between PFOS exposure and cancer of the testis, thyroid gland, and breast (1). |
| **Non-Cancer Health Risks** | The National Academy of Sciences (NAS) has conducted reviews on PFAS exposure and various health effects (6). The NAS found sufficient evidence of an association between PFAS exposure and decreased antibody response, dyslipidemia, decreased infant and fetal growth, and increased risk of kidney cancer in adults (6). They found limited evidence of an association between PFAS exposure and liver enzyme alterations, increased risk of pregnancy-induced hypertension, increased risk of thyroid disease and dysfunction in adults, and increased risk of ulcerative colitis in adults (6). |

## How are PFAS regulated?

- The EPA regulates six PFAS in public drinking water, including PFOA and PFOS. Each have maximum contaminant levels that public water supplier must stay below (7).
- PFOA and PFOS are hazardous substances under the Superfund Act, ensuring that polluters pay to clean up environmental contamination (8).
- The FDA allows some food contact products to contain PFAS, if there is demonstrated, reasonable certainty that the use causes no harm (4).

## What can you do?

- Read your water source's Community Confidence Report to learn the PFAS concentration in your drinking water.
- Activated carbon and reverse osmosis filtration will remove some PFAS from drinking water. For more information, click here (10).
- If you are on a private well, contact your state environmental health agency for a list of state-certified laboratories testing for PFAS (9).
- Avoid eating fish from PFAS contaminated waterways (9).

*Published September 2025*

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# Radon & Health Fact sheet

environmental health sciences research center

IOWA College of Public Health

## Introduction

Radon is a naturally occurring gas that originates from the breakdown of uranium and is present in air, water, and soil (1). It is odorless, colorless, tasteless, and imperceptible to the senses. Radon is radioactive, forming other radioactive products called decay products over time. Higher radon concentration in the ground in Iowa results from historical glacial activity that carried rock containing uranium to Iowa (2). The uranium in this rock naturally decays to form radon. Because the glaciers deposited this rock unevenly, uranium and, as a result, radon levels in the ground vary from site to site.

## Exposure Sources

Unstable radon decays into radioactive products and emits alpha particle radiation (1). These radioactive products can be inhaled and damage lungs the DNA in our lung cells. This damage can lead to genetic mutations, which may eventually cause lung cancer. Many people are exposed to radon by breathing in indoor air. The amount of radon in the air is measured in pCi/L (picocuries per liter of air). Radon gas can infiltrate homes from soil through small cracks in the foundation or openings around pipes, sump pumps, crawl spaces, drains, and other structures (2). Building materials, water supply, and natural gas are also sources of radon in the home.

Radon levels will increase in homes with poor ventilation and lower floors near the foundation, such as a basement or ground floor. Indoor radon levels are often higher than outdoors levels (1). Because of its unique glacial rock deposits, Iowa has the highest average indoor radon levels in the nation (2,3). Radon levels can vary from home to home because of the uneven distribution of radon in the ground (2). Radon testing is the only way to determine indoor radon concentrations (1,2,3).

## Health Risks Associated with Radon

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|---|---|
| **Cancer Health Risks** | Radon causes cancer in humans (4,5) and, after smoking, is the second leading cause of lung cancer in the nation (1). For example, the Iowa Radon Lung Cancer Study concluded that “cumulative radon exposure in the residential environment is significantly associated with lung cancer risk” (5). The chances of getting lung cancer from radon increase with the indoor level of radon and the time spent in the home. People who smoke that are exposed to radon are at a 10 to 20 times higher risk of developing lung cancer than non-smokers (1). Moreover, with their different lung shapes and sizes and higher breathing rates, children are exposed to higher radon doses than adults. No consistent relationship has been found between elevated radon exposure and cancer at other sites. |
| **Non-Cancer Health Risks** | Lung cancer is the only established adverse health effect associated with exposure to elevated radon levels (1). Some studies are being conducted in examination of a potential association between radon exposure and risk of stroke and clonal hematopoiesis of indeterminate potential (CHIP) (6). |

## How is Radon regulated?

- There are no enforceable federal regulations for acceptable radon levels in indoor environments, such as individual residences or schools (1).
- The EPA recommends taking action to reduce radon levels if they are at or above 4 pCi/L to limit the risk of developing lung cancer (1).
- Radon levels below 4 pCi/L still carry risk and, in many cases, should be further reduced, especially for inhabited or heavily used areas (1).

## What can you do?

- Because the entire state of Iowa is at high risk of radon in homes and other buildings, the Iowa Department of Health and Human Services recommends testing every two years or after renovating your home (3). Radon testing is inexpensive and reliable.
- If the results from radon testing are greater than or equal to 2 pCi/L, installing a radon mitigation system can range from $800 to $2,500 (3).

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# TCE & Health Fact sheet

environmental health sciences research center

IOWA College of Public Health

## Introduction

Trichloroethylene (TCE) is a volatile chemical created by chemical synthesis (1, 2). It is colorless, nonflammable, and produces a somewhat sweet odor (1). When ingested, the chemical has a sweet, burning taste (3). TCE is used in adhesives, lubricants, paints, varnishes, pesticides, cleaning wipes, carpet cleaners, and other products, but mainly as a degreasing solvent for metal equipment, and as a refrigerant (2, 3). TCE breaks down slowly and persists in the environment for long periods of time (2).

## Exposure Sources

People can be exposed to TCE in a variety of ways. Workers who manufacture and repair aircraft and automobiles, cut screws, or are involved in degreasing are exposed to high concentrations of the chemical (3, 4). TCE has been detected in outdoor and indoor air, water, soil, food, and animal tissues (4). Exposure from environmental sources, like hazardous waste sites and contaminated water, is common in the US (4). When spilled or improperly stored, TCE can pass through soil and accumulate in groundwater, making drinking water an important exposure source (2, 3). In 2023, 101 of the 103 Iowa public water systems contained no detectable TCE. The two remaining public water systems contained concentrations below the maximum contaminant level (5). People can also be exposed to TCE when vapor intrusion occurs at Superfund sites. This is the process by which harmful vapors seep into homes near the foundation through cracks, and pipes. Iowa hosts two TCE superfund site in the southwest of downtown Des Moines and the Lot 46 Valley Gardens TCE site (6).

## Health Risks Associated withTCE

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| **Cancer Health Risks** | The International Agency for Research on Cancer (IARC) considers TCE a known human carcinogen. Exposure to TCE increases the risk of kidney cancer and is also linked to liver cancer and non-Hodgkin lymphoma (4). There is insufficient evidence to support an association between TCE and other cancers (4). |
| **Non-Cancer Health Risks** | TCE causes damage to the central nervous system, liver, kidneys, immune system, and reproductive organs (1). The chemical also causes fetal heart defects (1). Acute exposure to high concentrations can cause a dizziness or sleeping and can lead to unconsciousness and death if the exposure is very high. Chronic exposure to small amounts of TCE may cause headaches, dizziness, difficulty concentrating, and lung irritation, in addition to cancer and organ damage (1, 3). |

## How is TCE regulated?

- The maximum contaminant level (MCL) for drinking water for TCE is 0.005 mg/L (7).
- The manufacturing, processing, and distribution of TCE for consumer uses was prohibited in 2025; however, the final ruling allows exemptions that extend up to several decades (1).
- In locations where phase-out will take longer, the Workplace Chemical Protection Program reduces exposure through enforceable safety measures(1)
- Products cannot contain greater than 0.1% TCE by weight (1).
- TCE is listed as a hazardous substance under CERCLA authorizing it's clean-up at contaminated sites.

## What can you do?

- If you work with or near TCE, wear proper protective equipment to minimize exposure (2).
- Avoid drinking water contaminated with TCE (2).
- Do not allow children to play in areas where TCE has been detected in the soil, for example, in and around Superfund sites (2, 8).
- Follow instructions on product labels to reduce your exposure to TCE and other toxic chemicals (2).
- To learn more about potential exposures in your area, visit the environmental working groups page here to discover drinking water exceedances and the EPA here to find Superfund sites near you.

***Published September 2025***

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