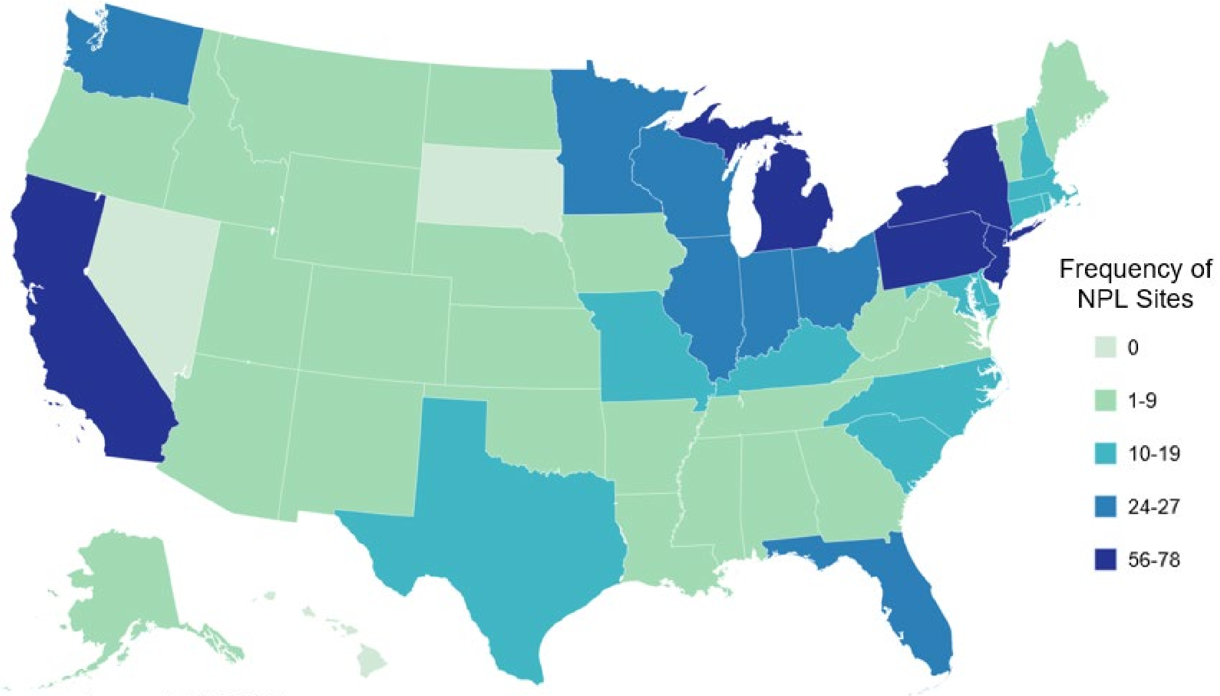
CHAPTER 5. POTENTIAL FOR HUMAN EXPOSURE

5.1 OVERVIEW

1,1,1-Trichloroethane has been identified in at least 797 of the 1,868 hazardous waste sites that have been proposed for inclusion on the EPA National Priorities List (NPL) (ATSDR 2022). However, the number of sites in which 1,1,1-trichloroethane has been evaluated is not known. The number of sites in each state is shown in Figure 5-1. Of these sites, 794 are located within the United States, 1 is located in the Virgin Islands, and 2 are located in Puerto Rico (not shown).

Figure 5-1. Number of NPL Sites with 1,1,1-Trichloroethane Contamination



Source: ATSDR 2022

- 1,1,1-Trichloroethane was primarily used in cold-cleaning, vapor degreasing, and ultrasonic cleaning before its use and production decreased due to the Clean Air Act and Montreal Protocol. It continues to be used as a raw material in the manufacture of chlorinated polymers.

- The dominant environmental fate process for 1,1,1-trichloroethane is volatilization to the atmosphere. In the atmosphere, 1,1,1-trichloroethane degrades via interaction with photochemically-produced hydroxyl radicals.

- Since the manufacture and use of 1,1,1-trichloroethane has been phased down, the exposure of most of the general population is expected to be low, but exposure to workers involved in its

> manufacture and use could occur. Any exposure that occurs is expected to primarily be through inhalation of contaminated air or ingestion of contaminated water.

1,1,1-Trichloroethane is a synthetic compound that continues to be released to the environment by human industrial activity. It is released to the environment by process and fugitive emissions during its manufacture, formulation, and use in industrial products. Because 1,1,1-trichloroethane is volatile and was used as a solvent in many products, it is most frequently found in the atmosphere due to volatilization during production and use. 1,1,1-Trichloroethane is an ozone depleting substance and has been listed as a class I substance under Section 602 of the Clean Air Act. Class I substances have an ozone depletion potential (ODP) of ≥0.2 and include chlorofluorocarbons (CFCs), halons, carbon tetrachloride, 1,1,1-trichloroethane, and methyl bromide. Although recent estimates have yielded an ODP of 0.12 for 1,1,1-trichloroethane, it is still listed as a class I substance. Under Section 604 of the Clean Air Act as amended in 1990, all production and use of 1,1,1-trichloroethane was scheduled to cease as of January 1, 2002. However, 1,1,1-trichloroethane could still be used for essential applications such as medical devices and aviation safety (for the testing of metal fatigue and corrosion of existing airplane engines and other parts susceptible to corrosion) until January 1, 2005. While the Montreal Protocol reduced the production of 1,1,1-trichloroethane, with a steady decline in the ambient air levels, some production does continue. 1,1,1-Trichloroethane (and other class I substances) could also be produced domestically for export to developing countries as specified in Section 604(e) of the Clean Air Act. This exception to the phase-out ended in 2012 for 1,1,1-trichloroethane (Kapp 2014).

The dominant environmental fate process for 1,1,1-trichloroethane is volatilization to the atmosphere. Once in the atmosphere, reaction with photochemically-produced hydroxyl radicals is expected to be the most important transformation process for 1,1,1-trichloroethane; the estimated atmospheric lifetime for this process is about 6 years. This long atmospheric lifetime allows about 15% of 1,1,1-trichloroethane to migrate to the stratosphere, where it may be degraded by lower wavelength ultraviolet light, not available in the troposphere, to produce atomic chlorine. The chlorine atoms produced in the stratosphere by this process may react with ozone causing the erosion of the ozone layer. However, direct photochemical degradation of 1,1,1-trichloroethane in the troposphere should not occur. The low water solubility of 1,1,1-trichloroethane suggests that rain washout can occur; however, 1,1,1-trichloroethane removed from the atmosphere by this process would be expected to re-volatilize. The lengthy half-life for 1,1,1-trichloroethane in the troposphere allows it to be carried great distances from its original point of release, and it has been found in remote places far from any known source of release.

If released to soil, 1,1,1-trichloroethane should display high mobility and the potential for leaching into groundwater. Volatilization from soil surfaces to the atmosphere is expected to be an important fate process. Although data regarding biodegradation of 1,1,1-trichloroethane in soil are lacking, it is not expected to be an important fate process. 1,1,1-Trichloroethane is not expected to undergo aerobic biodegradation, but there is some experimental evidence that biodegradation may slowly occur under anaerobic conditions.

Once released to surface water, 1,1,1-trichloroethane is expected to undergo volatilization to the atmosphere. Neither adsorption to sediment nor bioconcentration in aquatic organisms is recognized as an important removal process. Aerobic biodegradation of 1,1,1-trichloroethane can occur in the presence of methane-oxidizing bacteria. If released to groundwater, biodegradation of 1,1,1-trichloroethane under anaerobic conditions is known to occur; however, it appears to be a slow process under most environmental conditions.

1,1,1-Trichloroethane may very slowly undergo abiotic degradation in soil or water by elimination of hydrochloric acid (HCl) to form 1,1-dichloroethene, which also can be considered a pollutant, or it can undergo hydrolysis to form the naturally occurring acetic acid. Direct photochemical degradation is not expected to be an important fate process.

The current likelihood of exposure of the general population to 1,1,1-trichloroethane is low. Possible routes of exposure to 1,1,1-trichloroethane are inhalation, dermal contact, or through the ingestion of either contaminated water or food. Exposure by inhalation is expected to predominate. Occupational exposure to 1,1,1-trichloroethane could occur by inhalation or dermal contact during its manufacture and formulation, during its use as a raw material, and during waste handling. Near hazardous waste sites, inhalation is expected to be the predominant route of exposure; however, ingestion of contaminated water may also occur.

5.2 PRODUCTION, IMPORT/EXPORT, USE, AND DISPOSAL

5.2.1 Production

According to the 1990 amendments to the Clean Air Act and the Montreal Protocol, U.S. production of 1,1,1-trichloroethane was to be cut incrementally, eventually being completely phased out by January 2002. However, during the period beginning on January 1, 2002 and ending on January 1, 2005, production of limited amounts of 1,1,1-trichloroethane was authorized by the Administrator for use in essential applications, or for the export to developing countries (EPA 2004). Production of 1,1,1-trichloroethane in the United States was meant to end in 2012 as a result of ozone depletion agreements from the Montreal Protocol (Kapp 2014). While the Montreal Protocol reduced the production of 1,1,1-trichloroethane, production does continue. Some facilities still report quantities of 1,1,1-trichloroethane to EPA databases such as the Toxics Release Inventory (TRI) and Chemical Data Reporting (CDR).

Table 5-1 summarizes information on companies that reported the production, import, or use of 1,1,1-trichloroethane for the TRI in 2021 (TRI21 2023). TRI data should be used with caution since only certain types of industrial facilities are required to report. This is not an exhaustive list.

Table 5-1. Facilities that Produce, Process, or Use 1,1,1-Trichloroethane

State[a]	Number of facilities	Minimum amount on site in pounds[b]	Maximum amount on site in pounds[b]	Activities and uses[c]
AR	1	10,000	99,999	2, 3, 9, 12
IN	2	100	99,999	9, 12
KY	2	10,000	9,999,999	1, 3, 6
LA	2	100,000	9,999,999	1, 3, 4, 5, 6, 12, 13, 14
NE	1	10,000	99,999	9, 12
OH	3	1,000	99,999	12
PA	1	1,000	9,999	12
SC	1	1,000	9,999	12
TN	5	0	99	7
TX	5	100	999,999	1, 3, 4, 5, 6, 9, 12, 13, 14
UT	1	10,000	99,999	9, 12

[a] Post office state abbreviations used.

[b] Amounts on site reported by facilities in each state.

[c] Activities/uses:

1. Produce
2. Import
3. Used Processing
4. Sale/Distribution
5. Byproduct
6. Reactant
7. Formulation Component
8. Article Component
9. Repackaging
10. Chemical Processing Aid
11. Manufacture Aid
12. Ancillary
13. Manufacture Impurity
14. Process Impurity

Source: TRI21 2023 (Data are from 2021)

Although domestic production of 1,1,1-trichloroethane was scheduled to cease in 2012, according to EPA’s Chemical Data Reporting (CDR) database, nationally aggregated production volume of 1,1,1-trichloroethane ranged from 100,000,000 to <1,000,000,000 pounds between 2016 and 2019 (CDR

2020). Between 2012 and 2015, nationally aggregated production volumes at Axiall Corporation in Calcasieu, Louisiana ranged from 163,472,194 to 192,114,660 pounds (CDR 2016).

The most common method for industrial preparation of 1,1,1-trichloroethane is the reaction of hydrochloric acid with vinyl chloride (obtained from 1,2-dichloroethane) to obtain 1,1-dichloroethane, followed by either thermal or photochemical chlorination. Other methods include the catalyzed addition of hydrogen chloride to 1,1-dichloroethylene, and the direct chlorination of ethane itself, followed by separation from the other products produced (Mertens 2000). Commercial grades of 1,1,1-trichloroethane usually contain some inhibitor (Mertens 2000).

5.2.2 Import/Export

Data on the production volume of 1,1,1-trichloroethane imported at Eagle US 2 LLC in Calcasieu, Louisiana in 2019 is confidential in CDR (CDR 2020). 1,1,1-Tricholorethane was not imported or exported by Axiall Corporation from 2012 to 2015 or by PPG Industries, Inc. in 2011 (CDR 2012, 2016). Export volumes from 2016 to 2019 were listed as Confidential Business Information (CBI) (CDR 2020). The U.S. International Trade Commission (USITC) shows no imports or exports of 1,1,1-trichloroethane since 2014. In 2014, 321,924 kg of 1,1,1-trichloroethane was exported to developing countries (USITC 2023).

5.2.3 Use

1,1,1-Tricholoroethane was formerly widely used as a replacement for other chemicals in metal degreasing and cleaning applications (Doherty 2000). 1,1,1-Trichloroethane was primarily used in cold-cleaning, vapor degreasing, and ultrasonic cleaning to remove grease, oil, and wax from metal parts (Doherty 2000). In addition, 1,1,1-trichloroethane was used in pesticides, rodenticides, insecticides, drain cleaners, and carpet glue; for cleaning leather and suede garments; and for producing aerosols, adhesives, coatings, fluoropolymers, inks, textiles, and electronics (Doherty 2000).

According to EPA's CDR database, 1,1,1-trichloroethane was used as a reactant for industrial gas manufacturing and for plastics material and resin manufacturing at PPG Industries, Inc. in Calcasieu, Louisiana in 2010 and 2011, at Axiall Corporation in Calcasieu, Louisiana from 2012 to 2015, and at Eagle US 2 LLC in Calcasieu, Louisiana from 2016 to 2019 (CDR 2012, 2016, 2020). The database reported that 45,000 pounds were used onsite at Axiall Corporation (CDR 2016).

5.2.4 Disposal

1,1,1-Trichloroethane has been identified as a hazardous waste by EPA, and disposal of this waste is regulated under the Federal Resource Conservation and Recovery Act (RCRA). Specific information regarding federal regulations on 1,1,1-trichloroethane disposal on land, in municipal solid waste landfills, in incinerators, and during underground injection is available in the Code of Federal Regulations.

Disposal of 1,1,1-trichloroethane can be accomplished through its destruction in a high temperature incinerator equipped with a hydrochloric acid scrubber. The destruction and removal efficiency (DRE) for 1,1,1-trichloroethane in hazardous wastes must attain 99.99% (Carroll et al. 1992). During five tests to evaluate a rotary kiln incineration system under baseline conditions and failure conditions, the DRE for 1,1,1-trichloroethane ranged from 99.84 to 99.99982% (Carroll et al. 1992). Other methods that have shown promise for the destruction of 1,1,1-trichloroethane are homogeneous sonochemical treatment for aqueous wastes (Cheung et al. 1991) and a combination of ozonation and ultraviolet treatment for groundwater (Kusakabe et al. 1991). From a laboratory feasibility study, it was concluded that the *in situ* biodegradation of 1,1,1-trichloroethane in soils by methane-oxidizing bacteria was not a viable bioremediation method (Broholm et al. 1991).

5.3 RELEASES TO THE ENVIRONMENT

The Toxics Release Inventory (TRI) data should be used with caution because only certain types of facilities are required to report (EPA 2022b). This is not an exhaustive list. Manufacturing and processing facilities are required to report information to the TRI only if they employ ≥10 full-time employees; if their facility's North American Industry Classification System (NAICS) codes is covered under EPCRA Section 313 or is a federal facility; and if their facility manufactures (defined to include importing) or processes any TRI chemical in excess of 25,000 pounds, or otherwise uses any TRI chemical in excess of 10,000 pounds, in a calendar year (EPA 2022b).

Table 5-2 shows the reported amounts of 1,1,1-trichloroethane released from facilities that produce, process, or use 1,1,1-trichloroethane.

Table 5-2. Releases to the Environment from Facilities that Produce, Process, or Use 1,1,1-Trichloroethane[a]

	Reported amounts released in pounds per year[b]								
							Total release		
State[c]	RF[d]	Air[e]	Water[f]	UI[g]	Land[h]	Other[i]	On-site[j]	Off-site[k]	On- and off-site
AR	1	1	0	0	0	0	1	0	1
IN	2	780	0	0	0	0	780	0	780
KY	2	4,792	14	0	0	11	4,806	11	4,817
LA	2	34,828	440	0	7	0	35,268	7	35,275
NE	1	72	0	0	21	0	72	21	93
OH	3	27	0	0	7	0	27	7	34
PA	1	500	0	0	0	5	500	5	505
AC	1	18	0	0	0	0	18	0	18
TE	5	50	0	0	0	0	50	0	50
TX	5	49	0	0	19	0	49	19	68
UT	1	0	0	0	0	2	0	2	2
Total	24	41,116	454	0	54	18	41,570	72	41,643

[a] The TRI data should be used with caution since only certain types of facilities are required to report. This is not an exhaustive list. Data are rounded to nearest whole number.
[b] Data in TRI are maximum amounts released by each facility.
[c] Post office state abbreviations are used.
[d] Number of reporting facilities.
[e] The sum of fugitive and point source releases are included in releases to air by a given facility.
[f] Surface water discharges, wastewater treatment (metals only), and publicly owned treatment works (POTWs) (metal and metal compounds).
[g] Class I wells, Class II-V wells, and underground injection.
[h] Resource Conservation and Recovery Act (RCRA) subtitle C landfills; other onsite landfills, land treatment, surface impoundments, other land disposal, other landfills.
[i] Storage only, solidification/stabilization (metals only), other off-site management, transfers to waste broker for disposal, unknown.
[j] The sum of all releases of the chemical to air, land, water, and underground injection wells.
[k] Total amount of chemical transferred off-site, including to POTWs.

RF = reporting facilities; UI = underground injection

Source: TRI21 2023 (Data are from 2021)

5.3.1 Air

Estimated releases of 41,116 pounds (~18.65 metric tons) of 1,1,1-trichloroethane to the atmosphere from 24 domestic manufacturing and processing facilities in 2021, accounted for about 99% of the estimated total environmental releases from facilities required to report to the TRI (TRI21 2023). These releases are summarized in Table 5-2.

EPA's National Emission Inventory (NEI) database contains information regarding sources that emit criteria air pollutants (CAPs) and their precursors, and hazardous air pollutants (HAPs) for the 50 United States, Washington DC, Puerto Rico, and the U.S. Virgin Islands. Emissions are estimated from multiple sources, including state and local environmental agencies; the TRI database; computer models for on- and off-road emissions; and databases related to EPA's Maximum Achievable Control Technology (MACT) programs to reduce emissions of HAPs. 1,1,1-Trichloroethane emissions estimated from the 2017 NEI are summarized in Table 5-3 (EPA 2021a).

Table 5-3. National Emission Inventory (NEI) Total National Emissions for 1,1,1-Trichloroethane Estimated by Sector 2017

Sector	Emissions (pounds)
Solvent, degreasing	18,364,705
Solvent, industrial surface coating and solvent use	1,787,213
Solvent, consumer and commercial solvent use	1,104,593
Solvent, non-industrial surface coating	95,397
Industrial processes, not elsewhere classified	77,598
Waste disposal	57,136
Industrial processes, pulp and paper	43,146
Industrial processes, chemical manufacturing	35,758
Fuel combustion, industrial boilers, internal combustion engines, biomass	17,045
Fuel combustion, industrial boilers, internal combustion engines, other	8,158
Fuel combustion, electric generation, coal	5,266
Fuel combustion, electric generation, biomass	3,542
Industrial processes, storage and transfer	2,351
Industrial processes, petroleum refineries	1,894
Fuel combustion, commercial/institutional, biomass	739
Fuel combustion, industrial boilers, internal combustion engines, coal	610
Fuel combustion, industrial boilers, internal combustion engines, natural gas	484
Solvent, graphic arts	402
Industrial processes, cement manufacturing	267
Fuel combustion, electric generation, other	266
Fuel combustion, industrial boilers, internal combustion engines, oil	174
Fuel combustion, commercial/institutional, other	123
Industrial processes, ferrous metals	112
Fuel combustion, electric generation, oil	47
Industrial processes, non-ferrous metals	26
Fuel combustion, commercial/institutional, coal	24
Fuel combustion, commercial/institutional, oil	19
Dust, construction dust	10
Fuel combustion, commercial/institutional, natural gas	3

Table 5-3. National Emission Inventory (NEI) Total National Emissions for 1,1,1-Trichloroethane Estimated by Sector 2017

Sector	Emissions (pounds)
Industrial processes, oil and gas production	3
Industrial processes, mining	3
Bulk gasoline terminals	2
Gas stations	1
Fuel combustion, electric generation, natural gas	1

Source: EPA 2021a

Since 1,1,1-trichloroethane use has declined and production has decreased in the United States, releases to the air from industrial sources are expected to be lower than historical measurements; there are no natural sources of 1,1,1-trichloroethane, but releases may occur from existing soil and water contamination. While data from three sites in the United States showed that emissions of 1,1,1-trichloroethane declined from 18.5 to 3.0 Gg/year from 1997 to 2002, 1,1,1-trichloroethane was still released to the atmosphere despite decreased production as established by the Montreal Protocol in 1996 (Millet and Goldstein 2004).

The only natural source of 1,1,1-trichloroethane emissions proposed is biomass burning, and global emissions from this source were estimated to be around 2 to 10 Gg/year (Simpson et al. 2007). However, field measurements from five continents collected for >10 years did not show that biomass burning is a significant source of 1,1,1-trichloroethane in the atmosphere, and global emissions from biomass burning are not expected to exceed 0.014 Gg/year (Simpson et al. 2007).

Small amounts of 1,1,1-trichloroethane are also released to the atmosphere from coal-fired power plants (Garcia et al. 1992), incineration of hospital wastes (Green and Wagner 1992; Walker and Cooper 1992), incineration of military nerve agents (Mart and Henke 1992), incineration of industrial wastes containing certain plastics and waste solvents (Nishikawa et al. 1992, 1993), and incineration of municipal wastewater sludge (EPA 1991). 1,1,1-Trichloroethane contained in industrial products is released into the atmosphere during the manufacture and use of these products and during waste handling. 1,1,1-Trichloroethane can enter the atmosphere via the air-stripping treatment of wastewater. Volatilization, which accounts for ≈100% of removal in wastewater, occurs during this process (Kincannon et al. 1983a). Volatilization from waste lagoons is also likely (Shen 1982).

5.3.2 Water

Estimated releases of 454 pounds (~0.21 metric tons) of 1,1,1-trichloroethane to surface water from 24 domestic manufacturing and processing facilities in 2021, accounted for 1% of the estimated total environmental releases from facilities required to report to the TRI (TRI21 2023). This estimate includes releases to wastewater treatment and publicly owned treatment works (POTWs) (TRI21 2023). These releases are summarized in Table 5-2.

1,1,1-Trichloroethane can be released to surface water from the wastewater of industries in any of the industrial classifications that use or produce this compound. Higher concentrations of 1,1,1-trichloroethane have been found in surface waters near known industrial sources, such as effluent outfalls or disposal sites, compared to the levels found upstream from these sources (Hall 1984; Kaiser and Comba 1986; Kaiser et al. 1983; Wakeham et al. 1983).

1,1,1-Trichloroethane has been found in samples from four U.S. cities measured in the National Urban Runoff Program (Cole et al. 1984). 1,1,1-Trichloroethane has been found in the effluent from water treatment plants and municipal wastewater (Comba and Kaiser 1985; Corsi et al. 1987; EPA 1981, 1992; Feiler et al. 1979; Lue-Hing et al. 1980; McCarty and Reinhard 1980; Namkung and Rittmann 1987; Otson 1987; Pincince 1988; Rogers et al. 1987; Young 1978; Young et al. 1983).

1,1,1-Trichloroethane can enter groundwater from various sources. Contamination as a result of industrial activity has occurred (Dever 1986; Hall 1984). Leachate from landfills has percolated into groundwater (Barker 1987; Plumb 1987). The measured soil sorption coefficient (K_{oc}) value of 2.02 (Chiou et al. 1980; Gossett 1987) suggests that 1,1,1-trichloroethane released to soil can leach into groundwater. Measurements of 1,1,1-trichloroethane in drinking water from probability-based population studies (Wallace et al. 1984, 1987b, 1988) indicate the potential for exposure from drinking water.

5.3.3 Soil

Estimated releases of 54 pounds (~0.02 metric tons) of 1,1,1-trichloroethane to soil from 24 domestic manufacturing and processing facilities in 2021, accounted for about <1% of the estimated total environmental releases from facilities required to report to the TRI (TRI21 2023). These releases are summarized in Table 5-2.

Land application of sewage sludge that may contain minute amounts of 1,1,1-trichloroethane may slightly elevate the level of 1,1,1-trichloroethane in agricultural soil, but the level is not expected to be of environmental concern in the majority of cases (Wilson et al. 1994). The most likely routes for soil contamination are through accidental spills, contamination of soil by landfill leachates, leaching of contaminated surface waters from treatment/storage lagoons, wet deposition, and possibly the percolation of contaminated rainwater through soil.

5.4 ENVIRONMENTAL FATE

5.4.1 Transport and Partitioning

Air. 1,1,1-Trichloroethane has a vapor pressure of 124 mm Hg at 20°C, which means that it exists in the vapor phase in the atmosphere (Haynes et al. 2015). Since this compound has low water solubility, some vapor-phase 1,1,1-trichloroethane will be removed from the air via washout by rain and transported to the terrestrial surface. It has been identified in rainwater (Jung et al. 1992; Kawamura and Kaplan 1983; Plumacher and Renner 1993; Rasmussen et al. 1982). 1,1,1-Trichloroethane removed by rainwater would be expected to re-volatilize rapidly to the atmosphere. Because of its long half-life of 5–6.9 years, tropospheric 1,1,1-trichloroethane will be transported to the stratosphere, where it will participate in the destruction of the ozone layer. It will also undergo long-distance transport from its sources of emissions to other remote and rural sites. This is confirmed by the detection of this synthetic chemical in forest areas of Northern and Southern Europe and in remote sites (Ciccioli et al. 1993).

Water. 1,1,1-Trichloroethane is a VOC with low water solubility (1,290 mg/L at 25°C) (Haynes et al. 2015). The experimental Henry's law constant measured for this compound is 0.0163 atm-m^3/mole at 25°C (Warneck 2007); this suggests that volatilization from water should be the dominant fate process. Volatilization of 1,1,1-trichloroethane from water has readily occurred in the laboratory, in the field, and during wastewater treatment (Dilling 1977; Dilling et al. 1975; Kincannon et al. 1983b; Piwoni et al. 1986; Wakeham et al. 1983). Partitioning of 1,1,1-trichloroethane also has occurred from soil to air and from the groundwater of unconfined aquifers to soil (EPA 1983; Piwoni et al. 1986).

Sediment and Soil. Based on the experimental values for the log octanol/water partition coefficient (K_{ow}), 2.49 (Hansch and Leo 1985), and log K_{oc}, in the range of 2.02–2.03 (Chiou et al. 1979; Friesel et al. 1984), 1,1,1-trichloroethane would be expected to show high mobility in soil and readily leach into groundwater (Lyman et al. 1990; Swann et al. 1983). In surface waters, 1,1,1-trichloroethane would not be expected to show appreciable adsorption to sediment or suspended organic material.

Other Media. An experimental bioconcentration factor (BCF) of 9 (bluegill sunfish) has been determined for 1,1,1-trichloroethane (Barrows et al. 1980), suggesting that in fish and other aquatic organisms, uptake from water should not be an important fate process.

5.4.2 Transformation and Degradation

Air. The dominant atmospheric fate process for 1,1,1-trichloroethane is predicted to be degradation by interaction with photochemically-produced hydroxyl radicals. Rate constants for this gas-phase reaction range from 0.95×10^{-14} to 1.2×10^{-14} cm^3/mol-second (Finlayson-Pitts et al. 1992; Jiang et al. 1992; Lancar et al. 1993; Talukdar et al. 1992).

1,1,1-Trichloroethane is degraded via H-atom abstraction to $CCl_3 \cdot CH_2$ and reacts with O_2 to yield the peroxy radical ($CCl_3CH_2O_2$) (DeMore 1992; Spence and Hanst 1978). Using an estimated atmospheric hydroxyl ($\cdot OH$) radical concentration of 5.0×10^5 mol/cm^3 (Atkinson 1985), the more recent rate constants translate to a calculated lifetime or residence time of ~6 years. The estimated atmospheric lifetime of 1,1,1-trichloroethane, which incorporates all removal processes, was also estimated to be ~6 years (Prinn et al. 1987, 1992). This indicates that the predominant tropospheric sink of 1,1,1-trichloroethane is through its reaction with hydroxyl radicals.

Photolytic degradation experiments have been performed in the presence of NO and NO_2; 1,1,1-trichloroethane underwent <5% degradation in 24 hours in the presence of NO (Dilling et al. 1976). In a smog chamber experiment in the presence of NOx, 1,1,1-trichloroethane showed a disappearance rate of 0.1% per hour (Dimitriades and Joshi 1977). Other studies have also concluded that 1,1,1-trichloroethane has low potential to form ozone as a result of photochemical reaction in the presence of NOx (Andersson-Skold et al. 1992; Derwent and Jenkin 1991). Under laboratory conditions designed to mimic atmospheric smog conditions, direct photochemical irradiation of 1,1,1-trichloroethane in the presence of elemental chlorine was performed. 1,1,1-Trichloroethane was the least reactive and thus the most stable of all chloroethanes under these conditions (Spence and Hanst 1978).

Direct photochemical degradation of 1,1,1-trichloroethane in the troposphere is not expected to be an important fate process, because there is no chromophore for absorption of ultraviolet light (>290 nm) found in sunlight at tropospheric altitudes (Hubrich and Stuhl 1980; Vanlaethem-Meuree et al. 1979). A laboratory experiment performed in sealed Pyrex ampules showed loss of 1,1,1-trichloroethane in 2 weeks under the influence of sunlight; however, catalysis by the Pyrex surface was probably responsible for the enhanced reactivity (Buchardt and Manscher 1980).

The relatively long tropospheric residence time for 1,1,1-trichloroethane suggests that migration to the stratosphere should be important. An estimated 11–15% of 1,1,1-trichloroethane released to the atmosphere is expected to survive and migrate to the stratosphere (Prinn et al. 1987; Singh et al. 1992). In the stratosphere, chlorine atoms produced from 1,1,1-trichloroethane by ultraviolet light may interact with ozone contributing to the destruction of the stratospheric ozone layer. Compared to CFC-11 (trichlorofluoromethane), the steady-state ozone depletion potential of 1,1,1-trichloroethane has been estimated to be 0.1–0.16 (CARB 1992; Solomon and Albritton 1992).

Water. Slow biodegradation of 1,1,1-trichloroethane can occur under both anaerobic and aerobic conditions. Anaerobic degradation of 1,1,1-trichloroethane is thought to occur predominantly through reductive dechlorination by methane-producing bacteria (Vargas and Ahlert 1987; Vogel and McCarty 1987) and by sulfate-reducing organisms (Cobb and Bouwer 1991; Klecka et al. 1990). Determined experimental half-lives for anaerobic degradation using mixed culture bacteria ranged from 1 day to 16 weeks in the laboratory (Bouwer and McCarty 1983b, 1984; Hallen et al. 1986; Parsons et al. 1985; Vogel and McCarty 1987; Wood et al. 1985). *Desulfitobacterium sp.* strain PR reductively dechlorinated 1,1,1-trichloroethane to monochloroethane in 15 days (Ding et al. 2014). Based on a study from an injection well, after 3 months of injection, the predicted half-life of 1,1,1-trichloroethane in an aquifer was 200–300 days (Bouwer and McCarty 1984). Results obtained in a grab sample study of an aquifer suggest that anaerobic biodegradation of 1,1,1-trichloroethane will not occur (Wilson et al. 1983); however, the spiked concentration of 1,1,1-trichloroethane in the study, 1 mg/L, was in a range determined to be toxic to microorganisms (EPA 1979; Benson and Hunter 1976; Vargas and Ahlert 1987). Another grab sample study, performed using more realistic concentrations, indicates that 1,1,1-trichloroethane slowly degrades under anaerobic conditions to 1,1-dichloroethane in groundwater (Parsons and Lage 1985; Parsons et al. 1985). However, when mixed anaerobic cultures were provided with acetate as primary substrate, the biodegradation of secondary substrate 1,1,1-trichloroethane occurred even without acclimation at concentrations exceeding 1 mg/L (Hughes and Parkin 1992). A laboratory study showed that anaerobic biodegradation of 1,1,1-trichloroethane did not occur under denitrification conditions even after 8 weeks of incubation (Bouwer and McCarty 1983a).

Aerobic biodegradation in surface water and groundwater is not likely to be an important fate process since experimental studies did not indicate significant aerobic degradation of 1,1,1-trichloroethane (Klecka et al. 1990; Mudder and Musterman 1982; Wilson and Pogue 1987). One study showed that 1,1,1-trichloroethane underwent aerobic degradation in the presence of Fe^{+2}/porphyrin solution (82% in 21 days), thought to be a catalyzed reductive chlorination (Klecka and Gonsior 1984). It is difficult to interpret these results in terms of the potential for environmental significance. One study reported that 1,1,1-trichloroethane underwent moderate biodegradation with significant concomitant volatilization (Tabak et al. 1981); however, experimental details are not sufficient to rule out loss due solely to volatilization. Halogenated aliphatic hydrocarbons, including 1,1,1-trichloroethane, act as cometabolic substrates for certain aerobic chemotrophs. In such cases, the organisms grow on another substrate and the enzymes induced under the particular growth conditions fortuitously biodegrade the halogenated aliphatics (Leisinger 1992). Such aerobic biodegradation of 1,1,1-trichloroethane up to a concentration of 1.2 mg/L was observed with methane-oxidizing (methanotrophic) bacteria isolated from an aquifer (Arvin 1991). Aerobic biodegradation may occur in the presence of adapted organisms; in aerobic groundwater collected from seven sites contaminated with chlorinated hydrocarbons, degradation was observed in samples from five sites, with lag periods of 0–92 days (Willmann et al. 2023). Degradation typically stagnated after substantial reduction (residual levels of 0.0050–0.34 mg/L remaining), and only one site degraded to a level below the detection limit.

Anaerobic biodegradation proceeds via reductive dechlorination (Leisinger 1992; McCarty 1993). The major product from the anaerobic degradation of 1,1,1-trichloroethane has been identified as 1,1-dichloroethane, which slowly degrades to chloroethane in a secondary reaction (Hallen et al. 1986; Vogel and McCarty 1987). Therefore, total biodegradation of 1,1,1-trichloroethane is feasible by combining anaerobic dehalogenation with subsequent aerobic treatment (Leisinger 1992). Aerobic biodegradation of 1,1,1-trichloroethane, on the other hand, proceeds via substitutive and oxidative mechanisms with the production of trichloroethyl alcohol, which is further oxidized to chloride, carbon dioxide, and water (McCarty 1993).

Products from the abiotic degradation of 1,1,1-trichloroethane have also been identified. Acetic acid can arise from the hydrolysis of 1,1,1-trichloroethane (calculated half-life of 1.2 years at 25°C and pH 7). Elimination of HCl can produce 1,1-dichloroethene (Hallen et al. 1986; Parsons et al. 1985; Vogel and McCarty 1987). The calculated half-life for this reaction is 4.8 years at 25°C and pH 7 (Ellenrieder and Reinhard 1988). The half-lives of abiotic degradation of 1,1,1-trichloroethane by reaction with nucleophiles, such as HS^- and S_2O^{2-}, which might be present in water, should be insignificant compared to the other processes described (Haag and Mill 1988). A 2.8 mmol aqueous solution of 1,1,1-trichloroethane reacted with ozone (concentration 1 mg/L) with a half-life of >32 days at 22°C and a pH of 7 (Yao and Haag 1991). Therefore, reaction with ozone will not be an important process for the transformation of 1,1,1-trichloroethane present in natural bodies of water.

Sediment and Soil. Data are lacking on the degradation of 1,1,1-trichloroethane in soil. In a grab sample experiment, anaerobic degradation of 1,1,1-trichloroethane occurred slowly in soil (16% in 6 days) (Henson et al. 1988). If the microorganisms in the soil were first activated by using methane as a nutrient source, 46% of 1,1,1-trichloroethane degraded during the same period under aerobic conditions (Henson et al. 1988). Incubation of 1,1,1-trichloroethane in soil under aerobic conditions resulted in no measurable biodegradation (Klecka et al. 1990).

Other Media. Uptake of 1,1,1-trichloroethane has been observed in *Eucalyptus camaldulensis* seedlings and wood (Graber et al. 2007). Competition between 1,1,1-trichloroethane and trichloroethene for sorption sites occurred during both seedling uptake and wood sorption, indicating that uptake of compounds is impacted by the number of VOCs present and may be lower than expected when more contaminants are present.

5.5 LEVELS IN THE ENVIRONMENT

Reliable evaluation of the potential for human exposure to 1,1,1-trichloroethane depends, in part, on the reliability of supporting analytical data from environmental samples and biological specimens. Concentrations of 1,1,1-trichloroethane in unpolluted atmospheres and in pristine surface waters are often so low as to be near the limits of current analytical methods. In reviewing data on 1,1,1-trichloroethane levels monitored or estimated in the environment, it should also be noted that the amount of chemical identified analytically is not necessarily equivalent to the amount that is bioavailable.

Table 5-4 shows the limit of detections typically achieved by analytical analysis in environmental media. An overview summary of the range of concentrations detected in environmental media is presented in Table 5-5.

Table 5-4. Lowest Limit of Detection for 1,1,1-Trichloroethane Based on Standards[a]

Media	Detection limit	Reference
Blood	0.010 ng/mL	CDC 2018
Municipal and industrial wastewater	0.030 μg/L	EPA 2021b
Drinking water	0.005 μg/L	EPA 1995
Groundwater	5 μg/L	EPA 1986
Soil and sediment	0.275 μg/kg	EPA 2006b
Air	1 pptv	EPA 2019

[a] Detection limits based on using appropriate preparation and analytics. These limits may not be possible in all situations

Table 5-5. Summary of Environmental Levels of 1,1,1-Trichloroethane

Media	Low	High	For more information
Outdoor air (ppbv)	<0.015	0.48	Section 5.5.1
Indoor air (ppbv)	0.05	150	Section 5.5.1
Surface water (ppb)	ND	0.5	Section 5.5.2
Groundwater (ppb)	<0.05	390	Section 5.5.2
Drinking water (ppb)	0.0002	500	Section 5.5.2
Food (ppb)	–	–	Section 5.5.4
Soil and sediment (ppb)	ND	1,600	Section 5.5.3

ND = not detected

Presented in Table 5-6 is a summary of the range of concentrations detected in environmental media at NPL sites.

Table 5-6. 1,1,1-Trichloroethane Levels in Water, Soil, and Air of National Priorities List (NPL) Sites

Medium	Median[a]	Geometric mean[a]	Geometric standard deviation[a]	Number of quantitative measurements	NPL sites
Water (ppb)	93.5	112	27.7	626	322
Soil (ppb)	1,500	1,830	90.4	219	155
Air (ppbv)	3	5.17	35.2	106	71

[a] Concentrations found in ATSDR site documents from 1981 to 2022 for 1,868 NPL sites (ATSDR 2022). Maximum concentrations were abstracted for types of environmental media for which exposure is likely. Pathways do not necessarily involve exposure or levels of concern.

5.5.1 Air

Table 5-7 shows the mean ambient air 1,1,1-trichloroethane concentrations measured by EPA, state, local, and tribal air pollution control agencies for the Air Quality System (AQS). Mean ambient air concentrations are typically <0.015 ppbv, with a maximum mean concentration of 0.48 ppbv in the last 5 years (EPA 2022a).

Table 5-7. Percentile Distribution of Mean 1,1,1-Trichloroethane Concentrations (ppbv) Measured in Ambient Air at Locations Across the United States

		Percentile				
Year	Number of U.S. locations	25th	50th	75th	95th	Maximum
2017	201	0	0	0.0025	0.0085	0.11
2018	201	0	0	0.0016	0.0145	0.48
2019	151	0	0	0.0008	0.0170	0.16
2020	159	0	0	0.0002	0.0138	0.03
2021	164	0	0	0	0.0061	0.46
2022	120	0	0	0	0.0043	0.05

Source: EPA 2022a (data current as of August 2023)

The East Palestine, Ohio train derailment occurred on February 3, 2023, and involved several train cars containing hazardous materials. 1,1,1-Trichloroethane was below the reporting limits (<0.005–0.064 ppbv) in the majority of 1,190 air samples collected following the derailment to mid-July, 2023 (EPA 2023). An average of 0.027 ppbv 1,1,1-trichloroethane was detected in five samples collected on March 10, 2023.

EPA's compilation of 15 studies of background indoor air concentrations found a 4–100% detection rate for 1,1,1-trichloroethane in 2,658 U.S. resident samples between 1981 and 2004 (EPA 2011). The background medians ranged from 0.3 to 26 μg/m^3, 95th percentiles ranged from 3.4 to 130 μg/m^3, and maximum values ranged from 9.3 to 817 μg/m^3. One possible source of indoor air 1,1,1-trichloroethane is vapor intrusion from polluted soil or groundwater. Four sites included in the EPA Vapor Intrusion Database had reported indoor air concentrations of 0.27–34.00 μg/m^3 (EPA 2012). Indoor air concentrations of 0.03–200 μg/m^3 were detected at 15 vapor intrusion sites included in ATSDR public health assessments between 1994 and 2009. In indoor air of New Jersey suburban and rural homes, the maximum indoor air concentration of 1,1,1-trichloroethane was 9.3 μg/m^3 (Weisel et al. 2008). At the

National Aeronautics and Space Administration Research Park in San Francisco in 2003 and 2004, 513 samples of indoor air, 113 samples of outdoor air, and 68 samples of background outdoor air were analyzed for 1,1,1-trichloroethane and other VOCs (Brenner 2010). In indoor air, 1,1,1-trichloroethane was detected in 99.6% of the samples at a mean concentration of 0.212 μg/m^3 with a standard deviation of 0.258 μg/m^3 and a maximum concentration of 0.248 μg/m^3 (Brenner 2010). 1,1,1-Trichloroethane was detected in all outdoor air samples at a mean concentration of 0.185 μg/m^3, with a standard deviation of 0.073 μg/m^3 and a maximum concentration of 0.856 μg/m^3 (Brenner 2010). In background outdoor air, 1,1,1-trichloroethane was detected in all samples at a mean concentration of 0.182 μg/m^3, with a standard deviation of 0.0382 μg/m^3 and a maximum concentration of 0.307 μg/m^3 (Brenner 2010).

5.5.2 Water

The Water Quality Portal (WQP) database compiles water quality data across the United States from EPA, the U.S. Geological Survey (USGS), and the U.S. Department of Agriculture (USDA). A summary of the data available for surface and groundwater is provided in Table 5-8 (WQP 2023). 1,1,1-Trichloroethane was not commonly detected in either media, although surface water sampling campaigns were more limited, and higher concentrations were reported in groundwater. In 21 samples of groundwater at the National Aeronautics and Space Administration (NASA) Research Park in San Francisco in 2003 and 2004, 1,1,1-trichloroethane was detected in 43% of the samples at a mean concentration of 3.622 μg/L, with a standard deviation of 2.91 μg/L and a maximum concentration of 10 μg/L (Brenner 2010). 1,1,1-Trichloroethane was <0.5 μg/L (the reporting limit) in 221 groundwater samples collected from 28 monitoring wells in Pennsylvania between 2015 and 2019 (USGS 2022). In water from principal aquifers in the United States surveyed between 1991 and 2010, 1,1,1-trichloroethane was detected in 0.88% of shallow groundwater beneath agricultural land (0.68% >0.2 μg/L) and 10.71% of shallow groundwater beneath urban land (3.51% >0.2 μg/L) (USGS 2014a, 2014b).

Table 5-8. Summary of Concentrations of 1,1,1-Trichloroethane (μg/L[a]) Measured in Surface and Groundwater Across the United States[b]

Year	Average	Maximum	Number of samples	Percent detected
Surface water				
2018	–	–	510	0%
2019	–	–	458	0%
2020	–	–	199	0%
2021	0.012	0.012	157	0.64%

Table 5-8. Summary of Concentrations of 1,1,1-Trichloroethane (µg/L[a]) Measured in Surface and Groundwater Across the United States[b]

Year	Average	Maximum	Number of samples	Percent detected
2022	0.5	0.5	43	2.3%
2023[b]	–	–	29	0%
Groundwater				
2018	0.25	0.7	1,303	1.7%
2019	0.21	0.6	2,009	1.8%
2020	0.32	1.4	1,708	2.5%
2021	26	390	2,264	1.7%
2022	43	305	2,962	1.5%
2023[b]	0.29	0.42	667	0.90%

[a] 1 µg/L = 1 ppb.
[b] As of August 2, 2023.

Source: WQP 2023

Under the Safe Drinking Water Act, the EPA conducts compliance monitoring data reviews across 6-year periods of drinking water monitoring data submitted by states and primary agencies. Between 2006 and 2011, 1,1,1-trichloroethane was reported in 1.3% of 374,181drinking water samples collected from across all 50 states (EPA 2016). Reported concentrations ranged from 0.0002 to 500 µg/L, with an average of 3.03 µg/L. During a survey of principal aquifers in the United States between 1991 and 2010, 1,1,1-trichloroethane was detected in 4.88% of all sampled areas of aquifers used for drinking water, or up to 19.35% of areas in a single aquifer (USGS 2014a, 2014b). Only 0.57% of the detections in all sample aquifers were >0.2 µg/L.

Due to waste-disposal activities at the Idaho National Laboratory, VOCs, including 1,1,1-trichloroethane, are present in water from the eastern Snake River Plain aquifer in Idaho (USGS 2019). 1,1,1-Trichloroethane was one of the primary VOCs detected in water samples collected from 15 aquifer wells between 2016 and 2018, with concentrations ranging from 0.3 to 0.4 µg/L (USGS 2019). 1,1,1-Trichloroethane was detected in one well at the Radioactive Waste Management Complex at the Idaho National Laboratory at concentrations ranging from 0.411 to 0.735 µg/L from 2016 to 2018 (USGS 2019). The concentration of 1,1,1-trichloroethane was greater than the MCL for drinking water in one well near Test Area North. 1,1,1-Trichloroethane was not detected in groundwater samples (n=82) collected from the Palermo Wellfield Superfund site between 2018 and 2020 (WQP 2023). 1,1,1-Trichloroethane was below the reporting limits (0.27–100 μg/L) in surface water samples collected in February 2023, after the East Palestine, Ohio train derailment (EPA 2023).

5.5.3 Sediment and Soil

Recent monitoring data on the occurrence of 1,1,1-trichloroethane in soil are lacking. In surface soil samples compiled by WQP in 2006, 1,1,1-trichloroethane was not detected (WQP 2023). In subsurface soil and sediment, the concentration of 1,1,1-trichloroethane ranged from 1.1 to 1,600 μg/kg in samples collected between 2006 and 2011 (WQP 2023). Recent data are limited to bed sediment samples (n=28) collected in 2019 in which 1,1,1-trichloroethane was not detected (WQP 2023). The limited data on the concentration of 1,1,1-trichloroethane in soil may be due to its rapid volatilization from soil, its ability to leach through soil, or both. Sub-slab soil gas detections of 160.00–5,251.64 μg/m^3 were reported across four sites in the EPA Vapor Intrusion Database (EPA 2012).

In two grab soil samples taken in 1980 from two former sludge lagoons of a solvent recovery operation at Southington, Connecticut, the measured concentrations of 1,1,1-trichloroethane were 23,000 and 120,000 ppb (Hall 1984). 1,1,1-Trichloroethane was not detected in five surface soil samples collected more recently at the Palermo Wellfield Superfund site (WQP 2023).

5.5.4 Other Media

Limited data on the occurrence of 1,1,1-trichloroethane in other media were identified. Samples of three different species of fish collected in Honolulu, Hawaii, between 2010 and 2014 did not contain 1,1,1-trichloroethane (WQP 2023). Previously, 1,1,1-trichloroethane has been detected in fish and shrimp taken from the Pacific Ocean at average concentrations of 2.7 and <0.3 ppm, respectively (Young et al. 1983), and in clams and oysters from Lake Pontchartrain, Louisiana, with mean concentrations ranging from 39 to 310 ppm (Ferrario et al. 1985). 1,1,1-Trichloroethane was previously detected in 2 of 265 table-ready foods of the Food and Drug Administration (FDA) Total Diet Study at an average concentration of 12.7 ppb (Heikes et al. 1995). The compound has not been included in the more recent FDA Total Diet Studies from 2003 to 2017.

1,1,1-Trichloroethane has been detected in four shoe and leather glues in Denmark in the concentration range 0.1–2.7% (wt/wt) (Rastogi 1992). Six samples of glues manufactured in the United States and

Europe, which were used for assembling various consumer goods and toys, contained 1,1,1-trichloroethane in the range of 0.002–97.5% (wt/wt) (Rastogi 1993). In various brands of imported typing correction fluids in Singapore, the equilibrium vapor phase concentration of 1,1,1-trichloroethane ranged from <1 to 95% (v/v) (Ong et al. 1993).

5.6 GENERAL POPULATION EXPOSURE

Since the manufacture and use of 1,1,1-trichloroethane has been reduced, the exposure of the general population should be insignificant. However, since there is some evidence of 1,1,1-trichloroethane releases to the water, air, and soil, the general population is potentially exposed to low levels of 1,1,1-trichloroethane through ingestion and inhalation of contaminated water and air, respectively. 1,1,1-Trichloroethane was used as a component of adhesives for food packaging, and this practice may have contributed to human exposure by ingestion (Miller and Uhler 1988). According to NHANES data from 2011 to 2018, the mean blood concentration of 1,1,1-trichloroethane in the total population is below the limit of detection (0.010 ng/mL) (CDC 2022).

ATSDR’s three-compartment Shower and Household-Use Exposure (SHOWER) model predicts air concentrations in the shower stall, bathroom, and main house throughout the day by estimating the contribution from showering or bathing and the contribution from other water sources in the house, such as the dishwasher, clothes washer, and faucets. This information along with human activity patterns are used to calculate a daily time-weighted average exposure concentration via inhalation exposure and from dermal uptake from skin contact. ATSDR’s SHOWER model is available by sending a request to showermodel@cdc.gov. Using average drinking water concentrations (EPA 2016; see Section 5.5.2) and the reporting level for AQS detections, as 1,1,1-trichloroethane is typically not detected in average outdoor air (EPA 2022a; see Section 5.5.1), Reasonable Maximum Exposure (RME) levels were calculated for different exposure groups and are reported in Table 5-9 (ATSDR 2023).

Table 5-9. RME Daily Inhalation Dose (μg/m^3) and Administered Dermal Dose (μg/kg/day) for the Target Person

Exposure group	Inhalation	Dermal
Birth to < 1 year	2.4	0.023
1–<2 years	2.4	0.021
2–<6 years	2.4	0.018
6–<11 years	2.4	0.015
11–<16 years	2.4	0.012

Table 5-9. RME Daily Inhalation Dose (μg/m^3) and Administered Dermal Dose (μg/kg/day) for the Target Person

16–<21 years	2.4	0.011
Adult	2.4	0.011
Pregnant and breastfeeding women	2.4	0.011

RME = Reasonable Maximum Exposure

Source: ATSDR 2023

Vapor intrusion may also be a potential source of 1,1,1-trichloroethane exposure, as vapor intrusion has been observed for several VOCs with similar properties. EPA's compilation of 15 studies of background indoor air concentrations found a 4–100% detection rate for 1,1,1-trichloroethane in 2,658 U.S. resident samples between 1981 and 2004 (EPA 2011). The background medians ranged from 0.3 to 26 μg/m^3, 95th percentiles ranged from 3.4 to 130 μg/m^3, and maximum values ranged from 9.3 to 817 μg/m^3. EPA's Vapor Intrusion Database reported indoor air concentrations of 0.27–34.00 μg/m^3 and sub-slab soil gas concentrations of 160.00–5,251.64 μg/m^3; attenuation factors ranged from 2.6x10^{-4} to 0.079 (EPA 2012). A long-term study of vapor intrusion at the NASA Ames Research Center in San Francisco detected 1,1,1-trichloroethane in 43% of groundwater samples below the research park at a mean concentration of 3.622 μg/L and maximum concentration of 10 μg/L (Brenner 2010). 1,1,1-Trichloroethane was not detected at elevated concentrations or at a high frequency, and its degradation products were found at lower concentrations in the groundwater and thus was not used as vapor intrusion tracers. 1,1,1-Trichloroethane was detected in 99.6% of samples of indoor ambient air and in all samples of outdoor ambient air and outdoor background air (Brenner 2010). The mean concentrations of 1,1,1-trichloroethane were 0.212 μg/m^3 in indoor air, 0.185 μg/m^3 in outdoor air, and 0.182 μg/m^3 in outdoor background air (Brenner 2010).

A review of vapor intrusion data from 148 ATSDR public health assessments completed between 1994 and 2009 identified 36 sites with detected concentrations of 1,1,1-trichloroethane in groundwater, soil gas, or air (Burk and Zarus 2013). Indoor air was sampled at 15 of the sites with 1,1,1-trichloroethane detected from 0.03 to 200 μg/m^3, which are all below levels of health concern. Groundwater was sampled at 23 of the sites, and 3 of the sites had 1,1,1-trichloroethane concentrations at levels of concern for vapor intrusion. Two of the sites with elevated groundwater data (628,000 and 13,000 μg/L) did not have indoor air data, but the health assessments included recommendations to address exposures (ATSDR 2005a, 2006). The third site with elevated groundwater data (71,000 μg/L) had low indoor air detections up to 0.444 μg/m^3 in spring and summer, but ATSDR recommended follow-up sampling in winter

(ATSDR 2005b). None of the 36 sites were determined to be a public health hazard as a result of breathing 1,1,1-trichloroethane in indoor air from vapor intrusion.

5.7 POPULATIONS WITH POTENTIALLY HIGH EXPOSURES

Since most applications and uses of 1,1,1-trichloroethane have been or are currently being discontinued, human exposure, while possible, is steadily decreasing. Airtight, highly-insulated houses are likely to have high indoor concentrations from use of household products containing 1,1,1-trichloroethane. However, the concentration of 1,1,1-trichloroethane has been shown to be higher in older homes, which may be less airtight and have higher rates of air exchange (Weisel et al. 2008). Very high levels of exposure are expected to occur for those who intentionally inhale 1,1,1-trichloroethane for its euphoric/ narcotic properties.

Workers who are still involved in processes using or disposing of this compound may encounter exposure to 1,1,1-trichlorethane. However, most occupational exposures are less likely to occur today as the production and use of 1,1,1-trichloroethane in the United States has been significantly reduced. A study of the association between kidney cancer and occupational exposure in individuals in Detroit and Chicago from 2002 to 2007 focused on solvent exposure found that 47 (4.4%) controls and 48 (4%) individuals with kidney cancer had a probability of exposure to 1,1,1-trichloroethane greater than 50% (Purdue et al. 2017). The most common task involving 1,1,1-trichloroehthane was degreasing, with 80% of participants involved in degreasing having at least 50% exposure probability (Purdue et al. 2017). Hein et al. (2010) used a database of air concentrations and associated exposure determinants in the United States to estimate the intensity of occupational exposure to 1,1,1-trichloroethane and two other solvents from 1940 to 2001. 1,1,1-Trichloroethane was most frequently released to the air via evaporation (Hein et al. 2010). Industrial mechanical dilution ventilation (mixing indoor air using fans or recirculation) decreased levels of 1,1,1-trichloroethane by 50%, and working outdoors was associated with 1,1,1-trichloroethane levels 90–95% lower than working indoors (Hein et al. 2010). Thus, people who worked indoors with 1,1,1-trichloroethane without ventilation were at higher risk of exposure. The 947 reported levels from the measurement database for 1,1,1-trichloroethane ranged from 0.0004 to 1,500 ppm, with a median of 0.95 ppm (Hein et al. 2010).

Workers in the iron and steel industry may be at higher risk of 1,1,1-trichloroethane exposure. Workplace air samples from sintering, coke making, and hot and cold forming processes were analyzed for VOCs (Chang et al. 2010). In the sintering process, 1,1,1-trichloroethane was detected at concentrations ranging from 5.6 to 50 ppb (Chang et al. 2010). Small amounts of 1,1,1-trichloroethane were detected in the cakemaking process (Chang et al. 2010).

1,1,1-Trichloroethane was used in some adhesive remover pads of incubators in intensive care nurseries, and there is evidence that infants in incubators were exposed to high concentrations of 1,1,1-trichloroethane (Gallagher and Kurt 1990). This use of 1,1,1-trichloroethane has been discontinued. There are no existing studies that have monitored the level of exposure from 1,1,1-trichloroethane to children. Most uses of 1,1,1-trichloroethane are associated with occupational purposes, so it is unlikely that children will receive significant doses. Children may be exposed to 1,1,1-trichloroethane by playing near sources or through accidental ingestion or inhalation of the chemical.