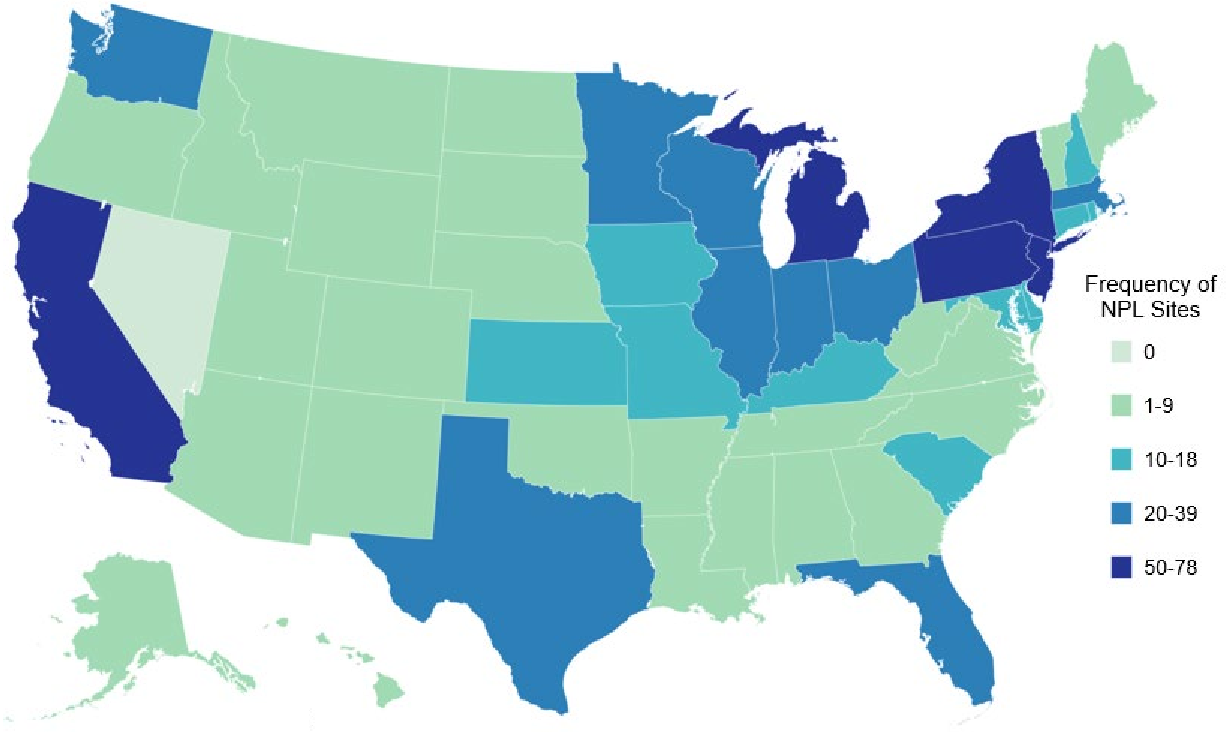
CHAPTER 5. POTENTIAL FOR HUMAN EXPOSURE

5.1 OVERVIEW

1,2-Dichloroethene has been identified in at least 816 of the 1,868 hazardous waste sites that have been proposed for inclusion on the EPA National Priorities List (NPL) (ATSDR 2022a). However, the number of sites in which 1,2-dichloroethene has been evaluated is not known. The number of sites in each state is shown in Figure 5-1. Of these sites, 810 are located within the United States, 1 is in the Virgin Islands, and 5 are in Puerto Rico (not shown).

Figure 5-1. Number of NPL Sites with 1,2-Dichloroethene Contamination



Source: ATSDR 2022a

- 1,2-Dichloroethene's manufacture and use as a solvent or its use as a chemical intermediate in the synthesis of other chlorinated solvents may result in exposure to both the general population and workers employed in occupations where it is produced and used.

- The general population may be exposed to 1,2-dichloroethene from inhalation of ambient air, dermal exposure, ingestion of drinking water, and ingestion of food items.

- 1,2-Dichloroethene is an anaerobic degradation product of other chlorinated solvents such as trichloroethylene (TCE) and tetrachloroethylene (PCE) and can be unintentionally released in environments that are contaminated with these substances. This may occur in contaminated subsurface soils and groundwater, which may lead to vapor intrusion of 1,2-dichloroethene into buildings or dwellings around the contaminated sites.

- 1,2-Dichlorethene is a volatile liquid and, when released, has been shown to volatilize from environmental matrices. It is degraded in the atmosphere by reaction with atmospheric oxidants such as hydroxyl radicals, ozone molecules, and nitrate radicals, with a half-life on the order of several days.

- 1,2-Dichloroethene is unlikely to bioconcentrate in fish and other aquatic organisms but possesses high mobility in soil and may, therefore, leach into groundwater.

5.2 PRODUCTION, IMPORT/EXPORT, USE, AND DISPOSAL

1,2-Dichloroethene is a compound produced by human industrial activities. It is a known byproduct of the reductive dehalogenation of other chlorinated solvents such as TCE and PCE; therefore, there will be unintentional releases of this substance from areas that are contaminated with TCE and PCE. Other sources of environmental exposure to 1,2-dichloroethene include: process and fugitive emissions from its production and use as a chemical intermediate; evaporation from wastewater streams, landfills, and solvents; and emissions from combustion or heating of polyvinyl chloride and some vinyl copolymers. Most of the 1,2-dichloroethene released in the environment will eventually enter the atmosphere or groundwater, where it may be subject to further biotic or abiotic degradation processes.

5.2.1 Production

trans-1,2-Dichloroethene may be produced by direct chlorination of acetylene at 40°C and it is frequently produced as a byproduct in the chlorination of chlorinated compounds and recycled as an intermediate for the synthesis of more useful chlorinated ethylenes (EPA 2020a). Another process to manufacture 1,2-dichloroethene is the thermal dehydrochlorination of 1,1,2-trichloroethane at 500°C (Dreher et al. 2012). This process produces both 1,1-dichloroethene and 1,2-dichloroethene. Production volume submissions for 2020 submitted to the EPA Chemical Data Reporting (CDR) system indicated that 1,2-dichloroethene had a production volume of 1,000,000–<20,000,000 pounds; however, more detailed facts were omitted since they were considered confidential business information (CBI) (EPA 2022a). Under the Toxic Substances Control Act (TSCA), the CDR requires manufacturers (including importers) to provide EPA with information on the production and use of chemicals like 1,2-dichloroethene in commerce. Table 5-1 summarizes information on companies that reported the production, import, or use of 1,2-dichloroethene for the Toxics Release Inventory (TRI) in 2023 (TRI23 2025). 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 1,2-Dichloroethene

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	9, 12
CA	1	10,000	99,999	9
CT	1	10,000	99,999	7, 9
IL	1	100,000	999,999	7
KY	1	10,000	99,999	1, 3, 6
LA	5	1,000	49,999,999	1, 4, 5, 13
NC	1	10,000	99,999	7
NE	1	10,000	99,999	11, 12
OH	1	10,000	99,999	12
TX	7	1,000 (or N/A)	999,999 (or N/A)	1, 2, 3, 5, 6, 7, 12, 13, 14

[a] Post office state abbreviations used.

[b] Amounts on site reported by facilities in each state. Facilities may report N/A (not applicable) instead of a numeric value "if the waste stream that contains or contained the EPCRA Section 313 chemical is not directed to the relevant environmental medium, or if leaks, spills, and fugitive emissions cannot occur" (EPA 2022c).

[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

Note: Facilities that report N/A for amounts on site do not report activities/uses.

EPCRA = Emergency Planning and Community Right-to-Know Act

Source: TRI23 2025 (Data are from 2023)

5.2.2 Import/Export

Little data are available regarding import or export volumes of 1,2-dichloroethene. In the 2016 CDR submissions, one company reported the importation of a formulated product containing <1% trans-1,2-dichloroethene (EPA 2020a).

5.2.3 Use

1,2-Dichloroethene is used primarily as a chemical intermediate in the synthesis of chlorinated solvents and compounds. In many applications where 1,2-dichloroethene was previously used as an extraction solvent, methylene chloride is used instead, due to its higher ability to dissolve organics and its availability (Dreher et al. 2012). No information is available about how much, if any, 1,2-dichloroethene is currently used for solvent purposes. trans-1,2-Dichloroethene is more widely used in industry than either cis-1,2-dichloroethene or the commercial mixture (EPA 2020a; Gosselin et al. 1984). Other possible uses include refrigerant, pharmaceutical manufacture, artificial pearl manufacture, and extraction of fats from fish and meat (USGS 2006).

5.2.4 Disposal

No recent information regarding disposal of 1,2-dichloroethene was identified; however, current disposal methods are anticipated to be similar to those in the 1970s through the 1990s. 1,2-Dichloroethene and other chlorohydrocarbons may be released from industries in wastewater streams; however, these compounds can be removed from wastewater by air stripping (Marshall and Pottenger 2016). Improved wastewater treatment methods at publicly owned treatment works (POTWs) that employ air stripping processes will remove most 1,2-dichloroethene and other VOCs from final effluents and release them in air emissions (Marshall and Pottenger 2016). 1,2-Dichloroethene is a potential candidate for rotary kiln incineration at 820–1,600°C, with residence times of seconds for liquids and gases and longer for solids; fluidized bed incineration at 450–980°C, with residence times of seconds for liquids and gases, and longer for solids; and liquid injection incineration at 650–1,600°C, with residence times of 0.1–2 seconds (EPA 1981). Care must be exercised to assure complete combustion to prevent the formation of phosgene. Acid scrubbers are required to control air emissions. Information regarding the amount disposed of by each method is not available.

Experiments using a vacuum-ultraviolet excimer flow-through reactor to degrade chloro-organic compounds in water have had promising results (Baum and Oppenlander 1995). After 60 minutes of irradiation at 172 nm, the level of 1,2-dichloroethene in contaminated groundwater was reduced from 25 mg/L to below the detection limit of 0.1 mg/L. After 180 minutes of irradiation, >93% of the originally organic-bound chlorine atoms were converted to inorganic chloride ions.

trans-1,2-Dichloroethene is a hazardous substance under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Releases of trans-1,2-dichloroethene more than 1,000 pounds within a 24-hour period must be reported (EPA 2011a, 2011b). Release of trans-1,2-dichloroethene in wastewater is regulated under the Clean Water Act by the National Pollutant Discharge Elimination System (NPDES). Information regarding effluent guidelines and standards for trans-1,2-dichloroethene can be found in 40 CFR 122, 40 CFR 125, 40 CFR 413.02(i), 40 CFR 414, and 40 CFR 433.11(e) (EPA 2009, 2010a, 2010b, 2012a, 2021a).

Pursuant to RCRA Section 3004(g)(5), EPA has restricted the land disposal of trans-1,2-dichloroethene (EPA 1988). It may be disposed on land only if prior treatment standards have been met, or if disposal occurs in units that satisfy the statutory no-migration standard (EPA 1988). Proper guidelines and standards are outlined in the Code of Federal Regulations (EPA 1988).

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 2022c). 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) code(s) is (are) 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 2022c).

5.3.1 Air

Estimated releases of 40,977 pounds (~18.6 metric tons) of 1,2-dichloroethene to the atmosphere from 20 domestic manufacturing and processing facilities in 2023 accounted for about 68% of the estimated total environmental releases from facilities required to report to the TRI (TRI23 2025). These releases are summarized in Table 5-2.

Table 5-2. Releases to the Environment from Facilities that Produce, Process, or Use 1,2-Dichloroethene[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	0.2	0[l]	0	0	0	0.2	0	0.2
CA	1	12	0	0	0	0	12	0	12
CT	1	1,638	0	0	0	0	1,638	0	1,638
IL	1	2,780	0	0	0	6,855	2,780	6,855	9,635
KY	1	14	0	0	0	0	14	0	14

Table 5-2. Releases to the Environment from Facilities that Produce, Process, or Use 1,2-Dichloroethene[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
LA	5	5,313	0	0	0	0	5,313	0	5,313
NE	1	28,880	0	0	0	0	28,880	0	28,880
NC	1	1,404	0	0	0	1,194	1,404	1,194	2,598
OH	1	1	0	0	0	0	1	0	1
TX	7	935	0	0	10,910	0	935	10,910	11,845
Total	20	40,977	0	0	10,910	8,049	40,977	18,959	59,936

[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.
[l] Due to reporting guidelines, a zero may represent that the facility or facilities in each state's row reported "0," and "NA," or left the cell blank in their Form R submission.

RF = reporting facilities; UI = underground injection

Source: TRI23 2025 (Data are from 2023)

No air emissions data for 1,2-dichloroethene were provided in the 2017 National Emissions Inventory or any time since reporting began in 2008 (EPA 2021b). In 2020, the EPA released a risk evaluation of 1,2-dichloroethene that provided some quantitative emission data; however, these data were simply derived from the 2018 TRI database (EPA 2020a). This document cited potentially relevant Organisation for Economic Co-operation and Development (OECD) Emission Scenario Documents; however, a review of these documents did not contain data specifically related to 1,2-dichloroethene emissions (OECD 2011, 2015).

1,2-Dichloroethene may be released to the atmosphere in emissions from production facilities, contaminated wastewaters and waste disposal sites, and the pyrolysis and combustion of polyvinyl chloride and some vinyl copolymers. It may also be released during its use as a solvent and extractant, in organic synthesis, and in the manufacture of perfumes, lacquers, and thermoplastics but recent quantitative data are lacking (Michal 1976; Shen 1982b).

5.3.2 Water

There were no releases of 1,2-dichloroethene in 2023 to surface water from 20 domestic manufacturing and processing facilities required to report to the TRI (TRI23 2025).

No recent information on 1,2-dichloroethene emissions to water were identified. Older studies show that 1,2-dichloroethene may be released to surface waters via surface runoff from contaminated waste disposal sites, wastewater from a variety of industrial sources, and from some POTWs. 1,2-Dichloroethene has been found in effluents from manufacturing and processing sites and from industries involved in its use as a solvent and extractant, in organic synthesis, and in the manufacture of perfumes, lacquers, and thermoplastics (Hawley 1981). As part of a comprehensive EPA survey of industrial facilities and POTWs, 4,000 samples of wastewater were analyzed. The findings indicated that cis- or trans-1,2-dichloroethene are sometimes found in wastewater from petroleum refining; coal mining; foundries; nonferrous metal manufacture; POTWs; paint and ink formulation; rubber processing; steam electricity generation; leather tanning; iron and steel manufacture; textile mills; auto and other laundries; explosives factories; and production of inorganic chemicals, mechanical products, plastics and synthetics, electrical components and electronics, pharmaceuticals, organic chemicals and plastics, and transportation equipment (EPA 1980b).

1,2-Dichloroethene is a reductive dehalogenation degradation product of TCE and PCE (cis-1,2-dichloroethene is most commonly the main degradation product) and, therefore, can be released to water or soil where there is contamination with these solvents (U.S. Army 2018).

In addition to spills or leachates from waste disposal sites, groundwater may be contaminated by cracked sewer interceptors carrying industrial wastes. Especially after rains, substantial loadings may leave the interceptor system through infiltration and inflow processes and enter groundwater supplies. Such phenomena have been documented in Europe (Milde et al. 1988) and similar infiltration and inflow problems are common in most older U.S. cities.

5.3.3 Soil

Estimated releases of 10,910 pounds (~4.9 metric tons) of 1,2-dichloroethene to soil from 20 domestic manufacturing and processing facilities in 2023, accounted for 18% of the estimated total environmental releases from facilities required to report to the TRI (TRI23 2025). No 1,2-dichloroethene was released via underground injection (TRI23 2025). These releases are summarized in Table 5-2.

Cis- and trans-1,2-dichloroethene are released to soil from the disposal of waste materials containing these compounds (Barber et al. 1988; Fain et al. 1987). They also may be formed in landfills, aquifers, or sediments as anaerobic biodegradation products of tetrachloroethene, trichloroethene, 1,1,1-trichloroethane, and 1,1,2,2-tetrachloroethane, solvents commonly found in municipal and industrial landfills (Parsons et al. 1984; Smith and Dragun 1984). In muck and sediment microcosms, tetrachloroethylene is converted to 1,2-dichloroethene with a preponderance of cis-1,2-dichloroethene (Parsons et al. 1984). Because it is a priority pollutant, trans-1,2-dichloroethene is more commonly analyzed for, and the analytical procedures used generally do not distinguish between isomers (Cline and Viste 1985). Insufficient data are available to estimate the amount of 1,2-dichloroethene released to soil.

Available information for aquatic sediments is also very limited. Some researchers feel that the subsurface behavior of 1,2-dichloroethene would be similar in groundwater, soils, and sediments (Yeh and Kastenberg 1991). Most empirical information, however, comes from groundwater remediation studies, usually involving controlled laboratory microcosm studies. For some highly polluted waterbodies, for instance the Delaware and Raritan Canal, 1,2-dichloroethene detections in the water column probably reflect extensive contamination with chlorinated toxics in the sediments (Granstrom et al. 1984). Analyzing cause-source pathways in such complicated systems can be extremely difficult.

5.4 ENVIRONMENTAL FATE

5.4.1 Transport and Partitioning

Air. Occurrence of 1,2-dichloroethene in rainwater samples (Kawamura and Kaplan 1983) indicates that this compound may be removed from the atmosphere by precipitation; however, most of the 1,2-dichloroethene so removed is likely to reenter the atmosphere by volatilization. Organics with a vapor pressure of $>10^{-4}$ mmHg should exist almost entirely in the vapor phase in the atmosphere (Eisenreich et al. 1981). Thus, cis- and trans-1,2-dichloroethene, which have vapor pressures of 215 and

336 mmHg at 25°C, respectively (Stevens 1979), are not expected to partition from the vapor phase to particulates in the atmosphere.

Water. The dominant removal mechanism for 1,2-dichloroethene in surface waters is volatilization (EPA 1979a). Henry's Law constants are 4.08×10^{-3} atm-m^3/mol at 24.8°C for cis-1,2-dichloroethene and 9.38×10^{-3} atm-m^3/mol at 24.8°C for trans-1,2-dichloroethene (Gossett 1987). Based on these values, the volatilization half-life from a model river 1 m deep, flowing 1 m/second with a wind speed of 3 m/second is estimated to be 3 hours, using the method of Thomas (1982). Dilling (1977) experimentally determined that the volatilization half-life in an open beaker containing 1 ppm of test compound at a solution depth of 6.5 cm under continuous stirring (200 rpm) was 19 minutes for cis-1,2-dichloroethene and 24 minutes for trans-1,2-dichloroethene. These values correspond to volatilization half-lives of 5.0 and 6.2 hours, respectively, from a body of water 1 m deep. trans-1,2-Dichloroethene is sufficiently volatile that 50% evaporates from water in 22 minutes when stirred at 25°C; cis-1,2-dichloroethene is similarly volatile (Dilling 1977). Experiments have shown that the degradation of trans-1,2-dichloroethene is relatively slow due to ultraviolet irradiation, unless lamps of approximately 15–20 watts are used (Gürtler et al. 1994) to allow greater relative stability of the vapor form in the environment.

In fish, bioconcentration factors (BCFs) ranging between 5 and 23 have been estimated for the 1,2-dichloroethene isomers using linear regression equations based on log K_{ow} and water solubility data (Bysshe 1982; Horvath 1982; Lyman 1982). These estimates suggest that 1,2-dichloroethene does not bioconcentrate significantly in aquatic organisms. Based on this information, there is little potential for biomagnification within aquatic food chains.

Sediment and Soil. Soil adsorption coefficients (K_{oc}) of 32–49 were estimated for the 1,2-dichloroethene isomers using a linear regression equation based on water solubility data (Lyman 1982) and the structure-activity relationship developed by Sabljic (1984). These K_{oc} values suggest that adsorption of the 1,2-dichloroethene isomers to soil, sediment, and suspended solids in water is not a significant fate process. The presence of 1,2-dichloroethene in groundwater, especially under sandy soil (Barber et al. 1988), substantiates its leachability. The relatively low K_{oc} and high vapor pressure of 1,2-dichloroethene indicate that this compound should also readily volatilize from moist soil surfaces (Swann et al. 1983).

5.4.2 Transformation and Degradation

Air. The dominant atmospheric removal process for 1,2-dichloroethene is predicted to be reaction with photochemically generated oxygenated species (e.g., hydroxyl radicals) in the troposphere. The estimated atmospheric lifetimes for cis- and trans-1,2-dichloroethene due to this removal process are 12 and 5 days, respectively (Goodman et al. 1986). These estimates are based on experimentally determined hydroxyl reaction rate constants of 2.0×10^{-12} cm^3/molecules-second at 25°C for cis-1,2-dichloroethene and 4.5×10^{-12} cm^3/molecules-second at 25°C for trans-1,2-dichloroethene. Formyl chloride has been positively identified as a product of this reaction. Experimental data indicate that the reaction of cis- and trans-1,2-dichloroethene with ozone, nitrate radicals, or singlet oxygen in the troposphere is too slow to be environmentally significant (Atkinson and Carter 1984; Sanhueza and Heicklen 1975a, 1975b). The half-life resulting from ozone attack of the double bond is 44 days for trans-1,2-dichloroethene and 129 days for cis-1,2-dichloroethene (Tuazon et al. 1984).

The primary ultraviolet (UV) absorption band for cis-1,2-dichloroethene is at 190 nm, which extends to about 240 nm (Ausbel and Wijnen 1975). The primary ultraviolet (UV) absorption band for trans-1,2-dichloroethene also extends to about 240 nm (Dahlberg 1969). A minute amount of light is absorbed in the environmentally significant range (wavelengths >290–380 nm). However, such absorption is insufficient for direct photolysis to be a significant fate process in the atmosphere.

In polluted urban airsheds, photolytic processes are a major factor in generating free radicals. Several studies summarized in Hall et al. (1989) emphasize that 1,2-dichloroethene degradation will proceed 2–4 times faster in polluted urban air exposed to UV radiation than with "pure air" containing no free radical precursors. Tuazon et al. (1988) and Jeffers et al. (1989) provide other convenient summaries of the reaction chemistry of chloroethenes and hydroxyl radicals.

Water. There is relatively little literature dealing with 1,2-dichloroethene fate and transport in surface waters. Since 1,2-dichloroethene is appreciably volatile, the usual assumption is that 1,2-dichloroethene introduced into surface waters will volatilize to the atmosphere. Chemical hydrolysis and oxidation are probably not environmentally important fate processes for 1,2-dichloroethene (EPA 1979a, 1982a, 1984). Kinetic data pertaining specifically to the abiotic degradation of the 1,2-dichloroethene isomers in the environment were not located. Direct photolysis of 1,2-dichloroethene is also not likely to be important in sunlit natural waters (EPA 1979a).

When released to surface waters, 1,2-dichloroethene and other chlorinated ethenes generally resist biodegradation under aerobic conditions (Fogel et al. 1986; Mudder 1981; Mudder and Musterman 1982). However, in one study, the 1,2-dichloroethene isomers were susceptible to aerobic biodegradation. In this study (Tabak et al. 1981), settled domestic wastewater was used as the inoculum with 5 ppm each of the cis- and trans- isomers. Losses in 7 days were 54% of cis-1,2-dichloroethene and 67% of trans-1,2-dichloroethene. Losses due to volatilization over a 10-day period were 34 and 33% for cis- and trans-1,2-dichloroethene, respectively. The inoculum may have contained a facultative methanotroph capable of degrading the dichloroethenes (Fogel et al. 1986). No information was found regarding biodegradation in biological waste treatment plants.

1,2-Dichloroethene undergoes slow reductive dechlorination under anaerobic conditions (Barrio-Lage et al. 1986; Fogel et al. 1986). In one study, anoxic microcosms containing uncontaminated organic sediment and water to simulate the groundwater environment were spiked with 5 mg/L of test compound. First-order rate constants were obtained that correspond to half-lives of 88–339 and 132–147 days for cis- and trans-1,2-dichloroethene, respectively. No degradation occurred in sterile microcosms; thus, loss of the compounds was assumed to be due entirely to anaerobic biodegradation. cis-1,2-Dichloroethene degraded to chloroethane and vinyl chloride (a human carcinogen), while trans-1,2-dichloroethene degraded to vinyl chloride only (Barrio-Lage et al. 1986). When cis- and trans-1,2-dichloroethene were incubated with methanogenic aquifer material from a site near a landfill, at least 16 weeks passed before trans-1,2-dichloroethene degradation began (Wilson et al. 1986). During the same time, cis-1,2-dichloroethene was reduced to <2% of the concentration in the autoclaved control, and vinyl chloride appeared after only 1–2 weeks of incubation; therefore, cis-1,2-dichloroethene degrades more rapidly. After 40 weeks, the trans-1,2-dichloroethene concentration fell to 18% of that in the autoclaved control containing trans-1,2-dichloroethene. Trace amounts of cis-1,2-dichloroethene remained in the unsterilized microcosm beyond 40 weeks. Tandoi et al. (1994) found that an anaerobic enrichment culture, using methanol as an electron donor, rapidly metabolized cis-1,2-dichloroethene to vinyl chloride with near zero-order kinetics and apparent inhibition of subsequent vinyl chloride dechlorination. trans-1,2-Dichloroethene was converted to vinyl chloride more slowly with first-order kinetics and an estimated half-life of 9.5 hours and did not inhibit vinyl chloride dechlorination.

Hopkins and McCarty (1995) performed an evaluation of the aerobic co-metabolism of dichloroethene isomers, using phenol and toluene as the primary substrates, in a shallow aquifer at a pilot test facility. In an earlier study, a methane substrate was highly successful at transforming trans-1,2-dichloroethene in groundwater, but removal efficiency was rather low for cis-1,2-dichloroethene. Phenol was found to be superior to methane for *in situ* degradation of cis-1,2-dichloroethene, providing up to 90% removal in one pass at concentrations up to 1 mg/L. Removal of trans-1,2-dichloroethene was 74% when phenol was used. Semprini (1995) also demonstrated in pilot scale field studies of aerobic co-metabolic transformations that indigenous microbes grown on phenol are more effective at degrading cis-1,2-dichloroethene than are microbes grown on methane.

A study was performed on a sand aquifer at an industrial site near the town of St. Joseph, Michigan, to improve the understanding of the distribution of chlorinated aliphatic hydrocarbons (CAHs) years after contamination occurred (Semprini 1995). Groundwater concentrations varied significantly with depth. Relatively high concentrations of CAHs existed at all locations within 20 m of the center of the plume. The dominant dichloroethene isomer present was cis-1,2-dichloroethene, with maximum concentrations of cis- and trans-1,2-dichloroethene of 133 and 3.9 mg/L, respectively. cis-1,2-Dichloroethene was observed in a transition zone between high and decreasing trichloroethene concentrations.

Anaerobic biotransformation by methanogenic bacteria was the earliest documented research on the biodegradation of 1,2-dichloroethene. In addition to studies in the United States (Barrio-Lage et al. 1986; Ehlke et al. 1992; Parsons et al. 1984; Silka and Wallen 1988), there has been good documentation of similar phenomena in sandy aquifers near Berlin, Germany (Kastner 1991; Leschber et al. 1990) and in groundwater supplies near a landfill in Ottawa, Canada (Lesage et al. 1990). In addition to anaerobic pathways, laboratory studies suggest that ammonia-oxidizing aerobic bacteria (Vannelli et al. 1990) and facultative sulfur-bacteria (Bagley and Gossett 1990) can biodegrade chlorinated aliphatic hydrocarbons. Burback and Perry (1993) demonstrated that 1,2-dichloroethene, when added singly to groundwater, is catabolized by *Mycobacterium vaccae*. At 100 ppm, 1,2-dichloroethene was catabolized <50%. A wide range of estimates for reaction rates and pollutant half-lives have been reported. The biodegradation processes appear to be highly site-specific, and influenced by the types of bacteria present, aerobic or anaerobic conditions, the presence of other substrates such as methane or sulfide, and the toxicity impacts from the various metabolites (Janssen et al. 1988).

Sediment and Soil. Studies showing that cis- and trans-1,2-dichloroethene degrade in nonsterile groundwater microcosms (Barrio-Lage et al. 1986; Wilson et al. 1986) suggest that these compounds undergo anaerobic biodegradation in soil and that this process may be the sole mechanism by which 1,2-dichloroethene degrades in soil. Hallen et al. (1986) found that when cis- and trans-1,2-dichloroethene were incubated in a system inoculated with anaerobic sludge from a municipal digester to simulate anaerobic conditions in a landfill, vinyl chloride appeared within 6 weeks. Biodegradation of trans-

1,2-dichloroethene was studied in microcosms containing uncontaminated organic sediment from the Everglades and allowed to stand to ensure oxygen depletion. Under these anoxic conditions, 50% of the chemical was lost within 6 months (Barrio-Lage et al. 1986). The fact that ethyl chloride as well as vinyl chloride are produced indicates that there are different pathways in the sequential dechlorination of cis-1,2-dichloroethene. In an aerobic environment that studied several soils from an aquifer in Oklahoma, biodegradation was shown to occur quite readily with 50% disappearance over 3 weeks for cis-1,2-dichloroethene and 4 weeks for trans-1,2-dichloroethene (Klier et al. 1999). In another study, the concentration of trans-1,2-dichloroethene was determined in soil in sealed ampules to prevent volatilization; concentrations remained constant over 20 days, suggesting that biodegradation in soil may not be a major pathway for trans-1,2-dichloroethene (U.S. Army 1994).

The aerobic biodegradation of *cis*-1,2-dichloroethene was studied in groundwater mixed with sediment obtained from two sites in Denmark (Broholm et al. 2005). The results of the experiments revealed 35% removal after 274 days and 50% removal after 204 days for the two different sites, with removal being dependent on the biodegradation of vinyl chloride.

There are no transformation and degradation studies dealing with sediments. 1,2-Dichloroethene does not show significant bioconcentration or bioaccumulation tendencies and in outside groundwater, would tend to volatilize and move to the atmosphere. Some researchers feel that the behavior of 1,2-dichloroethene in sediments would be similar to patterns documented for soils or groundwater (Yeh and Kastenberg 1991).

5.5 LEVELS IN THE ENVIRONMENT

Reliable evaluation of the potential for human exposure to 1,2-dichloroethene depends, in part, on the reliability of supporting analytical data from environmental samples and biological specimens. Concentrations of 1,2-dichloroethene 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 1,2-dichloroethene 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 5-3 shows the detection limits that are typically achieved by analytical analysis in environmental media.

Table 5-3. Lowest Limit of Detection for 1,2-Dichloroethene Based on Standards[a]

Media	Detection limit	Reference
Air	Generally, in the sub-ppbv in 1 L air samples using the GC/MS operated in the full SCAN mode	EPA 1999
Drinking water	0.06 ppb	EPA 1996
Surface water and groundwater	0.06 ppb	EPA 1996
Soil	1 ppb	EPA 2002
Sediment	1 ppb	EPA 2002
Whole blood	0.010 ng/mL	CDC 2021

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

GC = gas chromatography; MS = mass spectrometry

Detections of 1,2-dichloroethene in air, water, and soil at NPL sites are summarized in Table 5-4.

Table 5-4. 1,2-Dichloroethene, cis-1,2-Dichloroethene, and trans-1,2-Dichloroethene 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
1,2-Dichloroethene					
Water (ppb)	91	107	18.6	312	179
Soil (ppb)	750	799	82.0	69	53
Air (ppbv)	1.25	2.46	21.5	15	11
cis-1,2-Dichloroethene					
Water (ppb)	37.7	46.2	23.3	192	117
Soil (ppb)	1,900	1,380	67.9	17	15
Air (ppbv)	1.81	4.92	37.2	21	18
trans-1,2-Dichloroethene					
Water (ppb)	126	165	20.0	356	212
Soil (ppb)	707	1,240	66.0	62	56
Air (ppbv)	1.00	1.95	19.4	17	15

[a] Concentrations found in ATSDR site documents from 1981 to 2022 for 1,868 NPL sites (ATSDR 2022a). 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

1,2-Dichloroethene is a pollutant monitored in the national Air Quality System (AQS) database which contains ambient air pollution data collected by EPA, state, local, and tribal air pollution control agencies from thousands of monitoring stations throughout the country. Table 5-5 shows the range of yearly mean 24-hour concentrations and maximum concentrations measured of cis-1,2-dichloroethene at monitoring stations across the United States from 2016 to 2022.

Table 5-5. Summary of Annual Concentration of cis-1,2-Dichloroethene (ppbv) Measured in Ambient Air at Locations Across the United States[a]

Year	Number of samples	Range of arithmetic mean at all locations	Maximum concentration
2016	6,722	ND–0.0485	0.89
2017	6,659	ND–0.0833	0.98
2018	6,477	ND–0.594	8.80
2019	4,856	ND–0.083	4.05
2020	4,197	ND–0.034	0.82
2021	6,152	ND–0.073	1.29
2022	3,881	ND – 0.014	0.39

[a]Values were originally reported in parts per billion carbon (ppbC) and converted to ppbv; 24-hour sampling period.

Source: EPA (2022b)

Data from the EPA Water Quality Portal (WQP) reported levels of cis-1,2-dichloroethene ranging from 0.038 to 0.053 μg/m^3 (0.010–0.013 ppbv) from 2022 to 2024 (WQP 2024). Over the same reporting period, levels of trans-1,2-dichloroethene were 0.020–0.11 μg/m^3 (0.010–0.028 ppbv).

Pratt et al. (2000) reported the results of ambient air monitoring collected at 25 sites throughout the state of Minnesota over an 8-year period (1991–1998). The mean and maximum concentration of 1,2-dichloroethene in 3,650 samples (119 positive detections) were 0.02 and 2.18 μg/m^3 (0.005 and 0.550 ppbv), respectively. Levels of 1,2-dichloroethene were monitored near a residential area around a large-scale petrochemical complex in central Taiwan (Hsu et al, 2018). A relatively higher concentration was observed during the summer as compared to the spring and winter months, but the levels did not vary greatly depending upon the distance of the sampling location (<5 or 10–50 km away from the complex) with mean levels ranging from 0.010 to 0.091 ppbv.

Historical air monitoring data from the 1970s and 1980s is shown in Table 5-6. Maximum 1,2-dichloroethene concentrations were detected in landfill gas and ranged from 3,260 ppbv (Vogt and Walsh 1985) in a municipal landfill simulator to 75,600 ppbv at two Long Island landfills (Lipsky and Jacot 1985).

A predecessor to the AQS system was the National Ambient Database, which compiled indoor and outdoor air monitoring data on VOCs in the United States (Shah and Singh 1988). Based on information from 161 data points collected in the 1980s, outdoor 1,2-dichloroethene daily ambient air concentrations averaged 0.326 ppbv, with a median of 0.037 ppbv and with 75% of the values falling below a concentration of 0.113 ppbv.

5.5.2 Water

1,2-Dichloroethene has been detected in surface water, groundwater, and drinking water, as well as in industrial and municipal effluents, urban runoff, and leachate from landfills throughout the United States. Table 5-7 summarizes some historical monitoring data for 1,2-dichloroethene in these media. In some of the studies, only one of the 1,2-dichloroethene isomers was monitored; in several of the studies, the authors did not mention the specific isomer monitored. 1,2-Dichloroethene is often found in the groundwater at Superfund sites along with other halogenated organic compounds, such as 1,2-dibromoethane, vinyl chloride, 1,1,2,2-tetrachloroethane, 1,1,2-trichloroethane, trichloroethene, and tetrachloroethene (ATSDR 2022a; EPA 2012b).

Current monitoring data are available from the EPA WQP database, which aggregates environmental monitoring data from the National Water Information System (NWIS) and STORage and RETrieval (STORET) system, providing data for assessment of current conditions and trends in chemical concentrations in waters of the United States. Data from 2022 to 2024 reported that cis-1,2-dichloroethene concentrations ranged from not detected to 961 μg/L in groundwater and from not detected to 0.5 μg/L in surface waters (WQP 2024). For trans-1,2-dichloroethene, the levels ranged from not detected to 1,000 μg/L (groundwater) and from not detected to 2 μg/L (surface water).

The 1996 Safe Drinking Water Act (SDWA) amendments require that, once every 5 years, EPA issue a new list of no more than 30 unregulated contaminants to be monitored by public water systems (PWSs). 1,2-Dichloroethene was tested for in the first two rounds of the Unregulated Contaminant Monitoring Rule (UCMR). A total of 16,705 PWS were tested for cis-1,2-dichloroethene and 19,945 PWS were tested for trans-1,2-dichloroethene (EPA 2001). A total of 1.47% of the systems tested had at least one

Table 5-6. Historical Air Monitoring Data for 1,2-Dichloroethene in the United States

Media	Location	Sampling date	Isomer	Concentration (ppbv)	Comments	Reference
Ambient air	Houston, Texas		cis	0.071 (mean)	General urban atmosphere	EPA 1983
	St. Louis, Missouri	May 1980		0.039 (mean		
	Denver, Colorado	May–June 1980		0.076 (mean)		
	Riverside, California	June 1980		0.060 mean)		
	Staten Island, New York	July 1980		0.018 (mean)		
	Pittsburgh, Pennsylvania	March–April 1981		0.013 (mean)		
	Chicago, Illinois	April–May 1981		0.019 (mean)		
	Edison, New Jersey	NS	NS	1.3 (maximum)	Kin-Buc disposal site	EPA 1978
	Tulsa, Oklahoma	NS	NS	<0.1		EPA 1978
	Kanawha Valley, West Virginia			0.08		
	Front Royal, Virginia			0.1		
	South Charleston, West Virginia			<0.08		
	Birmingham, Alabama			<0.1		
	Baton Rouge, Louisiana			<0.1		
	Upland, California			<0.1		
	Magna, Vermont			0.08		
	Grand Canyon, Arizona			0.065		
	Geismar, Louisiana			2.6 (maximum)		
	Niagara Falls, New York	1978	NS	Trace	Detected in air outside three homes in Old Love Canal hazardous waste site (detection limit not stated)	Barkley et al. 1980
	New Jersey	NS	NS	NS	Four NPL sites and one municipal landfill; detected in air samples collected at three of five sites; occurred in 75–100% of samples collected at these sites (detection limit ≥0.1 ppb)	LaRegina et al. 1986

Table 5-6. Historical Air Monitoring Data for 1,2-Dichloroethene in the United States

Media	Location	Sampling date	Isomer	Concentration (ppbv)	Comments	Reference
	Edison, New Jersey	NS	trans	0.093		EPA 1982b
	Urban/suburban (669 sites)	NS	cis	0.068 (median) 3.5 (maximum)		
	Source areas (101 sites)	NS	cis	0.3 (median) 6.7 (maximum)		
	Pullman, Washington (rural area)	December 1974–February 1975	NS	ND	Detection limit 5 ppt	Grimsrud and Rasmussen 1975
Indoor air	Niagara Falls, New York	1978	NS	0.015	Air in basement of a home in Old Love Canal	Barkley et al. 1980
Landfill gas	Selected U.S. landfills	NS	NS	70 (mean) 3,600 (maximum)	Secondary source	Vogt and Walsh 1985
	Municipal landfill simulator	February 1983–February 1984	NS	210 (mean) 3,260 (maximum)	Simulation	Vogt and Walsh 1985
	Long Island, New York	NS	trans	75,600 (maximum)	Air samples collected from methane vents at two sanitary landfills	Lipsky and Jacot 1985
	California	NS	trans	59,000 (maximum)	20 class II landfills	Wood and Porter 1987

ND = not detected; NPL = National Priorities List; NS = not stated

Table 5-7. Water Monitoring Data for 1,2-Dichloroethene

Media	Location	Sampling date	Isomer	Concentration (ppb)	Comments	Reference
Surface water	Hylebos Waterway in the Puget Sound	1979	NS	0.8–2.4		NOAA 1980
	Potomac River in Quantico, Virginia	Spring 1986	trans	<2	One sample analyzed (detection limit not reported)	Hall et al. 1987
	12 sites in the Delaware and Raritan Canal in New Jersey	August 1979–January 1980	NS	ND	Detection limit not reported	Granstrom et al. 1984
	Indian River in Vero Beach, Florida	May 1981–May 1982	NS	ND	13 samples (detection limit 4.0 μg/L)	Wang et al. 1985b
	Drainage canal discharging into the Indian River in Vero Beach, Florida	May 1981–May 1982	NS	4.0–48.1; 15.7 (mean)	Canal receiving contaminated groundwater; detected in 23 of 39 samples (detection limit 4.0 μg/L)	Wang et al. 1985b
	New Jersey	1977–1979	trans	1,307.5 (maximum)	Detected in 172 of 273 samples (detection limit not reported)	Page 1981
	Wilson Creek (adjacent to hazardous waste site) in Bullitt County, Kentucky	February 1979	NS	75 (maximum)		Stonebraker and Smith 1980
Ground-water	178 CERCLA sites	1981–1984	trans	NS	Frequency of detection 29/1%	Plumb 1987
	3,498 aquifer samples from around the United States	NS	trans	100 (maximum)		USGS 2006
	New Jersey	1977–1979	trans	818.6 (maximum)	Detected in 193 of 378 samples	Page 1981
	Fort Bragg, NC	October 2017	cis	19.4 – 65.6		U.S. Army 2018
	Camp Lejeune, NC	1985-1995	cis and trans	>6,000 (maximum)	Multiple groundwater wells monitored throughout the site for 1,2-dichloroethene produced as a degradation product of TCE and PCE	ATSDR 2010

Table 5-7. Water Monitoring Data for 1,2-Dichloroethene

Media	Location	Sampling date	Isomer	Concentration (ppb)	Comments	Reference
	Colorado	1993	cis	6.1 (maximum)		Bruce and McMahon 1996
	208 wells located in urban areas in the United States	NS	cis	82 (maximum)		Kolpin et al, 1997
	Wisconsin	Sampling results as of June 30, 1984	NS	NS	Detected in 5 of 1,174 community wells and 12 of 617 private wells (detection limit 1.0–5.0 μg/L)	Krill and Sonzogni 1986
	Wausau, Wisconsin	NS	cis	83.3	Raw well water	Hand et al. 1986
	Wisconsin	1985–1987	NS	3,900 (maximum)	Detected at 5 of 26 sites	Wisconsin DNR 1988
	Montgomery County, Missouri	1983	trans	27–320; 158 (mean)	Detected in four samples	Dever 1986
	Potomac-Raritan-Magothy aquifer system (adjacent to the Delaware River)	1980–1982	trans	NS	Detected in 12 of 179 wells in the outcrop area and not detected in 115 wells in the downdip of the outcrop (detection limit 1 μg/L)	Fusillo et al. 1985
	Nebraska	Summer 1982	NS	2.1 (maximum); 0.50 (median)	Detected in 3 of 63 samples (detection limit 0.2 μg/L); private wells	Goodenkauf and Atkinson 1986
	Nebraska	1983–1984	NS	2.9	Detected in 1 of 97 samples; sources for public water system	Goodenkauf and Atkinson 1986
	Western Connecticut manufacturing plant	NS	trans	1.2–320.9	Detected in seven of nine monitoring wells	DOI 1983
	Biscayne aquifer, Miami, Florida	November 1982 and March 1983	trans	0.25–28 (range of average concentration from the mix areas)	12 total samples from six geographical areas defined within the study area	Singh and Organ 198

Table 5-7. Water Monitoring Data for 1,2-Dichloroethene

Media	Location	Sampling date	Isomer	Concentration (ppb)	Comments	Reference
	Miami Drum Services in Miami, Florida	1981	cis	839 (maximum)	Hazardous waste site	Myers 1983
	Biscayne aquifer in vicinity of Miami Drum Site	1983	NS	19 (mean)	Detected in two of three samples (detection limit not reported)	Myers 1983
	Piper Aircraft Corporation in Vero Beach, Florida	April 19811983–December 1983	NS	1,000–4,000	At site of a leaking subsurface trichloroethylene storage tank	Wang et al. 1985a
	Lakewood, Washington	December 1983	trans	250–435; 330 (mean)	Detected in 11 of 11 samples; in the vicinity of an NPL site	Wolf and Gorelik 1984
	Western Processing, Kings Country, Washington	November 1982	trans	Qualitatively identified	Hazardous waste site	Aldis et al. 1983
	Marshall landfill in Boulder County, Colorado	NS	trans	530 (onsite); 66 (offsite)	NPL site	EPA 1986a
	Minnesota	NS	cis	0.5–20,000	Detected in contaminated groundwater from 7 of 13 sites	Sabel and Clark 1984
			trans	0.6–98	Detected in contaminated groundwater from 3 of 13 sites	
	Forest Waste Disposal Site in Otisville, Michigan	NS	trans	100 (maximum)	NPL site	EPA 1986b
	Lang Property site in Pemberton Township, New Jersey	NS	trans	943 (mean); 2,500 (maximum)	NPL site	EPA 1986c
	Vega Alta Public Supply Wells in Puerto Rico	NS	NS	74 (maximum)	NPL site; detected in 89 of 168 samples (detection limit not reported)	EPA 1987
	Ponders Corner in Pierce County, Washington	1984–1985	trans	85 (maximum)	NPL site	EPA 1985
	Hollinsworth Solderless Terminal Co. in Fort Lauderdale, Florida	1983	NS	2,160 (maximum)	NPL site; level of dichloroethene (there was no indication whether this was 1,1- or 1,2-dichloroethene)	EPA 1986d

Table 5-7. Water Monitoring Data for 1,2-Dichloroethene

Media	Location	Sampling date	Isomer	Concentration (ppb)	Comments	Reference
	Lake wood Utility District near Tacoma, Washington	NS	trans	200	Production wells near a commercial facility	Boateng et al. 1984
Drinking water public wells	United States	1999-2002	Cis and trans	0.02-1.0 (cis); 0.02-10.0 trans	Detection frequency of 1-5%	USGS 2006
Drinking water (using ground-water sources)	United States	NS	NS	2.0 (maximum)	Detected in samples collected from 16 of 466 randomly selected sites using groundwater as a raw water source (detection limit 0.2 μg/L)	Westrick et al. 1984
Drinking water	Miami, Florida	NS	trans	1		EPA 198d
Drinking water	United States	1988 to 1992; 1993 to 1997	cis and trans	213 cis; 190 trans (maximums)		EPA 2001
Drinking water (private wells)	Winnebago County, Illinois	NS	trans	ND–64; 8 (median)	Five homes tested	Illinois ENR 1984
	Philadelphia, Pennsylvania	February 1975–January 1977	NS	NS	Detected in 1 of 17 samples (detection limit not reported)	Suffet et al. 1980
	Five U.S. cities	1975	cis and trans	NS	EPA National Organics Reconnaissance Survey; cis-1,2-dichloroethene positively identified in samples from Miami, Florida; Philadelphia, Pennsylvania; and Cincinnati, Ohio; trans-1,2-dichloroethene positively identified in samples from Miami, Florida	EPA 1975

Table 5-7. Water Monitoring Data for 1,2-Dichloroethene

Media	Location	Sampling date	Isomer	Concentration (ppb)	Comments	Reference
Raw and treated drinking water	10 potable water treatment plants in Canada	July 1982–July 1983	NS	trace	Positively identified in three raw and three treated water samples (detection limit not reported)	Otson 1987
Leachate	30 potable water treatment plants in Canada	August 1979–December 1979	NS	Raw water: 23 (maximum); treated water: 32 (maximum)	Positively identified in 2 raw and 11 treated water samples	Otson et al. 1982
	NS (landfill containing mixed industrial waste)	NS	trans	45–800 (average concentration of leachates)	Detected in two of eight leachates (detection limit not reported)	Ghassemi et al. 1984
	Minnesota	NS	cis	1.4–470	Detected in leachate from five of six sites (detection limit not reported)	Sabel and Clark 1984
			trans	3.8–88	Detected in leachate from three of six sites (detection limit not reported)	Sabel and Clark 1984
	Lyon, Minnesota, municipal landfill	NS	trans	3.8 (mean)		Brown and Donnelly 1988
	Meeker, Minnesota, municipal landfill	NS	cis	190 (mean)		Brown and Donnelly 1988
			trans	170 (mean)		
	Rochester, Minnesota, municipal landfill	NS	cis	470 (mean)		Brown and Donnelly 1988
			trans	88 (mean)		
	Wisconsin, 20 municipal and industrial landfills	1985–1987	NS	310	Detected in leachate from 8 of 26 sites	Wisconsin DNR 1988
Aqueous lagoon	Forest Waste Disposal site in Otisville, Michigan	NS	trans	50	NPL site; estimate level (compound detected below quantification limit)	EPA 1986b

Table 5-7. Water Monitoring Data for 1,2-Dichloroethene

Media	Location	Sampling date	Isomer	Concentration (ppb)	Comments	Reference
Urban storm water runoff	15 U.S. cities	As of July 1982	trans	1–3 (in positive samples)	Detected in runoff from Little Rock, Arkansas and Eugene, Oregon	Cole et al. 1984
Waste-water	Los Angeles, California	NS	NS	5.2 (mean)	Effluent from a county sewage treatment plant	Gossett et al. 1983
	NS	1980/1981	Trans	Untreated: 52–60; effluent: 31–43	Municipal sewage treatment plant; detected in five of five samples	Lao et al. 1982
	Chicago, Illinois	NS	Trans	<50	Effluent from a municipal sewage treatment plant	Lue-Hing et al. 1981
	NS	NS	Trans	20 (maximum)	Treated effluent from a petroleum refinery	Snider and Manning 1982
	Owensboro, Kentucky	August 1975	Cis	NS	Chemical plant effluent	EPA 1976
	Calvert City, Kentucky	October 1975	Cis	NS	Chemical plant effluent	EPA 1976
					Industry:	
	United States	NS	trans	10 (maximum)	Coal mining	EPA 1980a
			trans	46 (maximum)	Electrical electronic components	
			trans	10 (maximum)	Foundries	
			trans	10 (maximum)	Pharmaceutical manufacturing	
			trans	75 (maximum)	Nonferrous metals manufacturing	
			trans	12 (mean)	Organic chemicals and plastics manufacturing	
			trans	190 (maximum)	Paint and ink formulation	
			trans	<10 (maximum)	Petroleum refining	
			trans	290 (maximum)	Rubber processing	

Table 5-7. Water Monitoring Data for 1,2-Dichloroethene

Media	Location	Sampling date	Isomer	Concentration (ppb)	Comments	Reference
	NS	NS	trans	260 (mean); 1,700 (maximum)	Metal finishing	EPA 1980b
			trans	2,200 (maximum)	Photographic equipment/ supplies	
			trans	75 (mean); 260 (maximum)	Nonferrous metal manufacturing	
			trans	150 (mean); 290 (maximum)	Rubber processing	
Rain-water	UCLA campus, Los Angeles, California	March 26, 1982	NS	0.230	One sample	Kawamura and Kaplan 1983

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act; EPA = Environmental Protection Agency; ND = not detected; NPL = National Priorities List; NS = not stated; POTW = public owned treatment works; UCLA = University of California at Los Angeles positive detection for cis-1,2-dichloroethene and 0.64% of the systems having at least one positive detection for trans-1,2-dichloroethene. The Maximum Contaminant Level (MCL) was reported as 70 µg/L (cis-1,2-dichloroethene) and 100 µg/L (trans-1,2-dichloroethene). It was reported that 0.03% of the systems had a level greater than the MCL for the cis-1,2-dichloroethene and 0.01% of the systems had a level that exceeded the MCL for trans-1,2-dichloroethene. The maximum level of cis-1,2-dichloroethene was 213 µg/L for a system in the state of Ohio and the maximum level of trans-1,2-dichloroethene was 190 µg/L for a system in California. In a four-city study (Cincinnati, Ohio; St. Louis, Missouri; Atlanta, Georgia; Hartford, Connecticut) to determine the major source type of priority pollutants in tap water and POTW influents, it was found that 43, 38, and 28% of commercial sources, industrial sources, and POTW influents, respectively, contained trans-1,2-dichloroethene (EPA 1979b).

In a survey of 3,498 aquifer samples from around the United States; trans-1,2-dichloroethene was detected in 0.74% of samples with levels as low as 0.2 ppb and levels as high as 100 ppb (µg/L) (USGS 2006). Older water sampling studies detected 1,2-dichloroethene in groundwater in several states and U.S. territories including Colorado, Connecticut, Florida, Maryland, Michigan, Nebraska, New Jersey, Pennsylvania, Puerto Rico, Washington, and Wisconsin (Table 5-7). In a survey of shallow groundwater from 208 wells located in urban areas in the United States, cis-1,2-dichloroethene was detected in 5.3% of wells with a maximum concentration 82 ppb (µg/L) (Kolpin et al. 1997). A survey of 2,721 drinking water wells in California, detected 1,2-dichloroethene (isomers not distinguished) in 36 wells, with a maximum contamination level of 10 ppb (µg/L) (Lam et al. 1994). A survey of chemical quality of groundwater in the unconsolidated alluvial aquifer beneath Denver Colorado was performed in 1993, which detected cis-1,2-dichloroethene in 20% of samples with a high of 6.1 ppb (µg/L) (Bruce and McMahon 1996). Concentrations of 1,2-dichloroethene isomers detected in groundwater ranged from 0.25 to 0.28 ppb (µg/L) (range of average concentrations) in six areas near Miami, Florida (Singh and Orban 1987). Groundwater contamination has been reported at numerous waste disposal sites in the United States. In a detailed study, the Wisconsin Department of Natural Resources sampled groundwater at 20 municipal and 6 industrial landfills in Wisconsin. 1,2-Dichloroethene was detected in samples from 5 of 26 landfills at a maximum concentration of 3,900 ppb (µg/L), and in leachate from 8 of 26 landfills at a maximum concentration of 310 ppb (µg/L) (Wisconsin DNR 1988).

Since 1,2-dichloroethene can be produced from biodegradation of a variety of VOCs, screening tests for VOCs or tests for such widely used solvents as TCE or PCE can provide useful screening tools for follow-up testing for 1,2-dichloroethene. For instance, a study of 19 landfill sites in Wisconsin showed that while the incidence of 1,2-dichloroethene in all test wells was 19%, approximately two-thirds of the wells showing detectable VOCs also showed detectable 1,2-dichloroethene (Wisconsin DNR 1989). In a study of a western Connecticut manufacturing plant that used large quantities of high-quality trichloroethylene for degreasing, it was found that seven of nine monitoring wells contained 1.2–320.9 ppb (μg/L) of trans-1,2-dichloroethene (DOI 1983). More localized problems from leaking underground storage tanks or chemical spills may also show up in screens for VOCs (Stenzel and Gupta 1985). Where pollution levels are not excessive, remediation or permanent treatment technologies involving combinations of granular activated carbon or air stripping can remove over 96% of VOCs such as cis-1,2-dichloroethene (Clark et al. 1988; Lee et al. 1988; Stenzel and Gupta 1985). Cis- and trans-1,2-dichloroethene are contaminants in groundwater at Camp Lejeune, North Carolina, due to high levels of TCE and PCE that were released to groundwater from a dry-cleaning facility (ATSDR 2010). Monitoring studies that have occurred since the 1980s show typical concentrations in the low ppb range; however, some sampling wells have had levels of several thousand ppb.

5.5.3 Sediment and Soil

Since 1,2-dichloroethene is volatile, soil and sediment monitoring data are typically limited to those obtained through hazardous waste site monitoring (Aldis et al. 1983; ATSDR 2022a; EPA 1985, 1986c). A soil sample collected from a monitoring location in Camp Lejeune, North Carolina, had a cis-1,2-dichloroethene level of 21 μg/kg (ATSDR 2010). Soil gas pollutants in a shallow, unconfined aquifer receiving wastewater from metal-plating operations at Picatinny Arsenal in Morris County, New Jersey, were found to have a maximum cis-1,2-dichloroethene concentration of 33 ppb in the vadose zone (Smith 1988). The WQP reported levels of cis-1,2-dichloroethene ranging from 0.00045 to 0.0012 mg/kg in subsurface soil/sediment for sampling dates 2022–2024 (WQP 2024); trans-1,2-dichloroethene levels were 0.00045–0.0013 mg/kg.

Sediment samples from Wallace Creek at Camp Lejeune, North Carolina, had total 1,2-dichloroethene levels of 31 μg/kg (ATSDR 2010). In the early 1980s, 1,2-dichloroethene was found at a concentration of >5 ppb (wet weight) in sediment at 4% of 361 stations reported in EPA's STOrage and RETrieval (STORET) database (Staples et al. 1985). No further summary information was located on the occurrence of 1,2-dichloroethene in sediments.

5.5.4 Other Media

trans-1,2-Dichloroethene concentrations ranging from 22 to 55 g/L have been detected in municipal sludge from various treatment plants throughout the United States (Feiler et al. 1980; Naylor and Loehr

1982). Few reports exist of 1,2-dichloroethene in biota from U.S. waters. This is because 1,2-dichloroethene is not a typical biota contaminant (Staples et al. 1985). Nicola et al. (1987) reported mean and maximum 1,2-dichloroethene levels of 0.04 and 0.05 ppm, respectively, in fish tissue from Commencement Bay in Tacoma, Washington. No fish obtained at the 95 stations in EPA's STORET database contained detectable levels of 1,2-dichloroethene (Staples et al. 1985).

The results of the U.S. Food and Drug Administration's (FDA) Total Diet Study for 1,2-dichloroethene (trans) from 1991–2002 and 2003–2017 are shown in Table 5-8. For these studies, the FDA purchases samples of food at retail outlets throughout the United States and prepares the foods as they would be consumed and analyzes them for specific compounds.

Table 5-8. Levels of trans-1,2-Dichloroethene in FDA Total Diet Studies[a]

Year	Food item	Concentration (ppb)
1998	Cheddar cheese	10
1999	Cheddar cheese	24
2000	Cheddar cheese	16
	Cheddar cheese	42
2001	Frankfurters, beef, boiled	11
	Frankfurters, beef, boiled	2
	Cheddar cheese	13
	Cheddar cheese	14
	Swiss cheese	2
	Chicken, fried (breast, leg, and thigh), fast-food	2
2002	Cheddar cheese	6
	Cheddar cheese	19
	Cheddar cheese	11
	Meatloaf, homemade	2
	Margarine, stick, regular (salted)	2
	Butter, regular	2
2003	Cheese, cheddar, natural (sharp/mild)	13

[a] There were no detections in years 1991–1997 or 2004–2017.

Source: FDA 2022

5.6 GENERAL POPULATION EXPOSURE

The general population may be exposed to 1,2-dichloroethene in urban air and drinking water, with higher possibilities of exposure in community systems relying on groundwater supplies. Contaminated tap water can cause exposure via ingestion, inhalation, and dermal contact during showering, bathing, cooking, and laundering clothing. Inhalation is the most probable route of exposure.

1,2-Dichloroethene in water is expected to rapidly volatilize; thus, there is potential for inhalation exposure during showering, bathing, cooking, and laundering clothing. 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. For a 15-minute exposure time, the SHOWER model predicts 63% exposure from showering, 35% from usage of the main house, and 2% from bathroom use after showering (ATSDR 2022b).

Vapor intrusion into indoor air may also be a potential source of 1,2-dichloroethene exposure, as vapor intrusion has been observed for several VOCs with similar properties. EPA has reported that 1,2-dichloroethene is rarely detected in indoor air; however, when it is detected, it most likely occurs because of vapor intrusion from contaminated groundwater or subsurface soil (EPA 2015). A review of vapor intrusion data from 148 ATSDR public health assessments completed between 1994 and 2009 identified 14 sites with detected concentrations of dichloroethene in groundwater, soil gas, or air (Burk and Zarus 2013). Indoor air was sampled at nine of the sites with dichloroethene and detected at levels of 0.08–55 ppb, which is below ATSDR's acute-duration inhalation MRL. Dichloroethene was detected in groundwater at 12 of the sites ranging from 0.33 to 6,500 μg/L, and none of the sites had dichloroethene groundwater concentrations at levels of concern from vapor intrusion based on the acute-duration MRL and assuming attenuation of concentrations by a factor of 1,000 as the soil gas moves from the groundwater to indoor air.

Both cis- and trans-1,2-dichloroethene were detected in soil gas samples obtained from the Palermo Wellfield Superfund Site located in Tumwater, Washington for sampling periods from 2022 to 2024 (WQP 2024). This location is contaminated with chlorinated hydrocarbons, particularly TCE and PCE from industrial operations from the Washington Department of Transportation and a dry-cleaning facility. Levels of cis-1,2-dichloroethene were reaching 4.56 μg/m^3 (1.15 ppbv) and levels of trans-1,2-dichloroethene were reaching 2.19 μg/m^3 (0.553 ppbv).

Brenner (2010) studied four large buildings at the National Aeronautics and Space Administration (NASA) Ames Research Center in Moffett Field, California and determined that the presence of cis-1,2-dichloroethene in indoor air samples arose due to contamination of groundwater with TCE and the subsequent degradation to 1,2-dichloroethene followed by vapor intrusion into the buildings. The Michigan Department of Health in consultation with ATSDR performed a vapor intrusion assessment of a chlorinated solvent groundwater plume that had migrated from a former General Motors facility under a residential neighborhood in Livonia (Wayne County), Michigan (ATSDR 2012). Ten residences were tested, and cis-1,2-dichloroethene was detected in soil gas at two locations while trans-1,2-dichloroethene was detected at five locations. There were detections of trans-1,2-dichloroethene in the soil gas at two properties that exceeded the air screening level of 630 $\mu g/m^3$ (174 ppbv). The two homes which exceeded the soil gas screening level for trans-1,2-dichloroethene, had levels of 1,300 and 70,000 $\mu g/m^3$ (328–17,677 ppbv). Analyzing the data further, the Michigan Department of Health and the EPA could not determine if vapor intrusion was the source of these anomalously high levels as previous sampling studies showed low or no detections in these residences.

Ashley et al. (1994) determined the internal dose of 32 VOCs in 600 or more people in the United States who participated in the Third National Health and Nutrition Examination Survey (NHANES III). Detectable concentrations of cis- and trans-1,2-dichloroethene were found in <10% of the blood samples examined. Their detection limits were 0.013 and 0.014 ppb, respectively. The most recent NHANES data compiled for 1,2-dichloroethene from the 2011–2012 sampling period reported that 1,2-dichloroethene (both cis- and trans- isomers) blood levels were below the detection limit of 0.010 ng/mL for all age and demographic groups studied (CDC 2021).

No specific data were reported for 1,2-dichloroethene; however, certain cooking practices release VOCs to air so inhalation exposures could result for occupations such as chefs or other workers in restaurant settings (Wang et al. 2018). It was reported that VOCs such as 1,2-dichloroethene are emitted from additive manufacturing and 3D printing machines (Zisook et al. 2020); therefore, workers in these emerging technologies could be occupationally exposed to 1,2-dichloroethene.

5.7 POPULATIONS WITH POTENTIALLY HIGH EXPOSURES

Other than individuals who are occupationally exposed, populations with potentially high exposure include those living near production and processing facilities, hazardous waste sites, municipal wastewater treatment plants, and municipal landfills. Near production and processing facilities, certain hazardous waste sites, and municipal landfills, potential exists for exposure to elevated levels of 1,2-dichloroethene in air downwind of the sites and in contaminated drinking water from groundwater downgradient of the sites. Sites that are contaminated with TCE and PCE can have high levels of 1,2-dichloroethene since this is a degradation product of these substances. As an example, people stationed and living at Camp Lejeune, North Carolina, were potentially exposed to high levels of 1,2-dichloroethene in the water supply due to high levels of TCE and PCE that were released from a dry-cleaning facility that operated from 1964 until 2005 (ATSDR 2010).