

5. POTENTIAL FOR HUMAN EXPOSURE

5.1 OVERVIEW

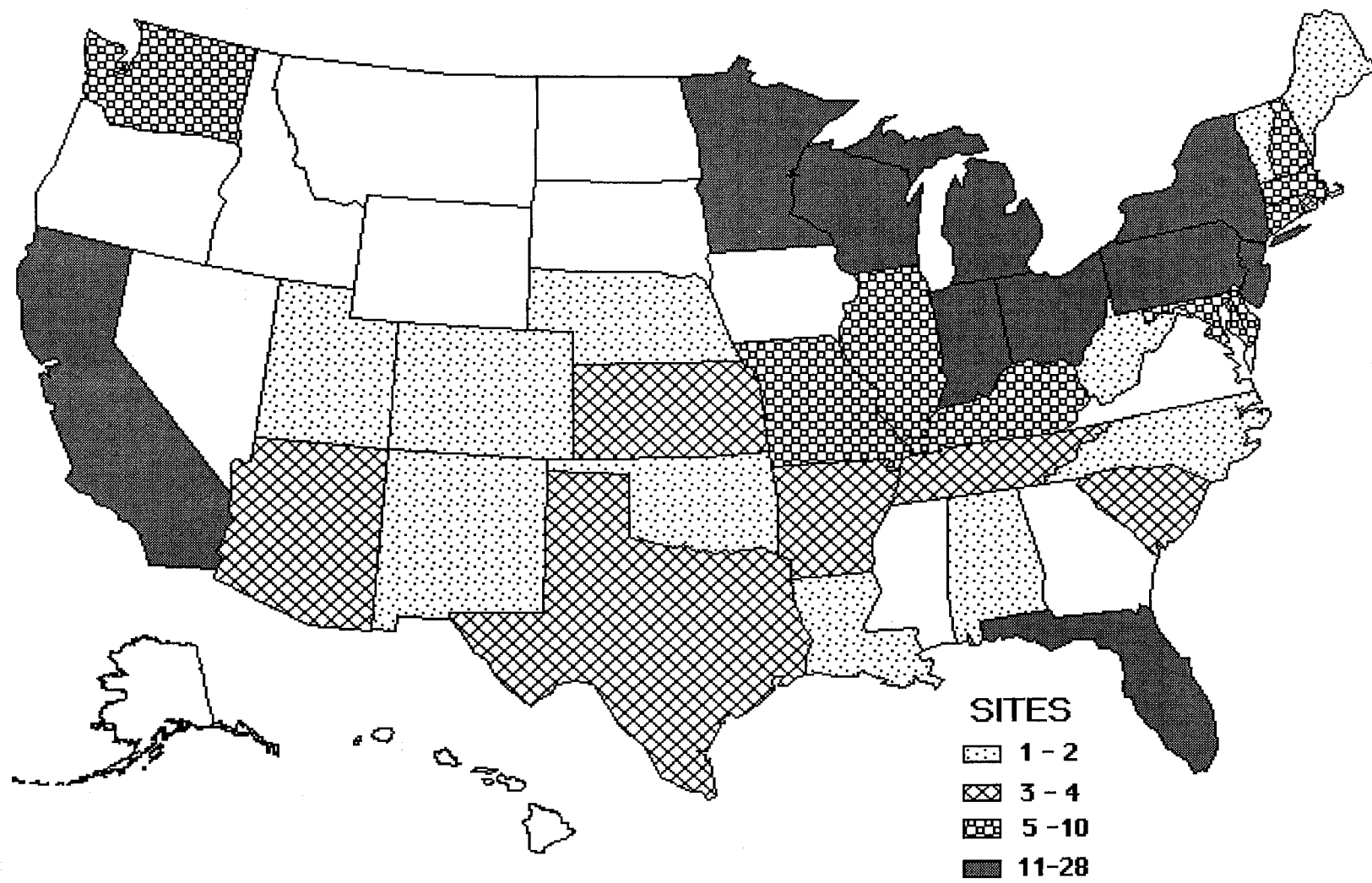
Chloroethane has been identified in at least 282 of the 1,467 current or former EPA National Priorities List (NPL) hazardous waste sites (HazDat 1998). However, the number of sites evaluated for chloroethane is not known. The frequency of these sites within the United States can be seen in Figure 5-1.

Chloroethane is a compound that occurs in the environment as the result of anthropogenic activity. Sources of chloroethane exposure include process and fugitive emissions from its production and use as a chemical intermediate; evaporation from waste-water streams, landfills, solvents, refrigerants, and anesthetics; emissions from plastics, refuse, and biomass combustion; formation during water chlorination; formation via anaerobic biodegradation of some chlorinated solvents; and evaporation and leaching from landfills. Most chloroethane released in the environment eventually enters the atmosphere.

When released to the atmosphere, the dominant removal mechanism is expected to be reaction with photochemically-generated hydroxyl radicals (half-life of 40 days). Potential exists for removal from the atmosphere in precipitation; however, most chloroethane removed by this mechanism is likely to reenter the atmosphere by volatilization. When released to surface water, volatilization is expected to be the primary fate process (half-life of 2.4 hours in a model river). When released to soil, chloroethane either volatilizes rapidly from soil surfaces or leaches through subsurface soil where it becomes a potential groundwater contaminant. In groundwater, chloroethane would probably be subject to chemical hydrolysis. Sufficient data are not available to establish the rate of chloroethane degradation in groundwater.

The general population may be exposed to low (ppt) levels of chloroethane through inhalation of contaminated ambient air and consumption of contaminated drinking water. Dermal contact can occur as a result of the intentional use of chloroethane as a topical anesthetic. Occupational exposure may occur by inhalation and/or dermal contact. According to a 1981-1983 NIOSH survey, an estimated 49,212 workers in the United States are potentially exposed to chloroethane in the workplace (NIOSH 1991).

Figure 5-1. Frequency of NPL Sites with Chloroethane Contamination*



* Derived from HazDat 1998
282 of 1,467 Sites

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5.2 RELEASES TO THE ENVIRONMENT

According to the Toxics Release Inventory (TRI), in 1996, a total of 3,242,710 pounds (1,470,617 kg) of chloroethane was released to the environment from 50 large processing facilities (TR196 1998). Table 5-1 lists amounts released from these facilities. In addition, an estimated 762 pounds (346 kg) were released by manufacturing and processing facilities to publicly owned treatment works (POTWs) and an estimated 688,311 pounds (312,159 kg) were transferred offsite (TR196 1998). The TRI data should be used with caution because only certain types of facilities are required to report. This is not an exhaustive list.

Chloroethane has been identified in a variety of environmental media (air, surface water, groundwater, soil, and sediment) collected at 282 of the 1,467 NPL hazardous waste sites.

5.2.1 Air

According to the Toxics Release Inventory (TRI), in 1996, the estimated releases of chloroethane of 2553,260 pounds (1,157,941 kg) to air from 50 large processing facilities accounted for about 79% of total environmental releases (TR196 1998). Table 5-1 lists amounts released from these facilities. The TRI data should be used with caution because only certain types of facilities are required to report. This is not an exhaustive list.

Chloroethane may be released to the environment through process and fugitive emissions related to its production and use as a chemical intermediate; through evaporative losses from waste-water streams, landfills, solvents, refrigerants, and anesthetics; and through emissions from combustion of plastics, refuse, and biomass (Graedel et al. 1986; Liepins et al. 1977; Vogt and Walsh 1985; Young and Parker 1984). Based on 1980 air monitoring data, it was estimated that 20 million pounds of chloroethane per year were being released into the atmosphere in the United States (Singh et al. 1981). Between 1980 and 1988, production levels of chloroethane in the United States decreased by approximately 62% (IARC 1991), and a proportional decrease in emissions related to its production and use as a chemical intermediate probably occurred.

Table 5-1. Releases to the Environment from Facilities That Manufacture or Process Chloroethane

State ^b	Number of Facilities	Air ^c	Total of reported amounts in pounds per year ^a					Total Environment ^d
			Water	Land	Underground Injection	POTW Transfer	Off-Site Waste Transfer	
AL	2	257	0	0	0	0	250	507
CA	1	122,000	0	0	0	0	0	122,000
CT	2	198,010	0	0	0	750	0	198,760
GA	2	180,300	0	0	0	0	0	180,300
IA	1	6,700	0	0	0	0	0	6,700
IL	2	199,356	0	0	0	0	0	199,356
KY	1	1	0	0	0	0	156,414	156,415
LA	10	106,691	4	0	0	0	4,705	111,400
MI	2	226,602	0	0	0	0	48,066	274,668
MO	2	345,106	0	0	0	0	0	345,106
NJ	4	30,875	27	0	0	2	24,620	55,524
OH	2	445,611	0	0	0	0	1,926	447,537
PA	1	1,895	0	0	0	0	0	1,895
PR	1	136,460	0	0	0	5	1,300	137,765
SC	2	8,473	0	0	0	0	447,430	455,903
TN	1	302	0	0	0	0	0	302
TX	10	126,408	0	0	92	0	0	126,500
VA	2	363,839	0	0	0	5	0	363,844
WI	1	314	0	0	0	0	3,600	3,914
WV	1	54,060	254	0	0	0	0	54,314

Source: TRI96 1998

^aData in TRI are maximum amounts released by each facility^bPost office state abbreviations used^cThe sum of fugitive and stack releases are included in releases to air by a given facility^dThe sum of all releases of the chemical to air, land, and water, and underground injection wells; and transfers off-site by a given facility

POTW = publicly-owned treatment works

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5.2.2 Water

According to the Toxics Release Inventory (TRI), in 1996, the estimated releases of chloroethane of 285 pounds (129 kg) to water from 50 large processing facilities accounted for about 0.01% of total environmental releases (TR196 1998). Table 5-1 lists amounts released from these facilities. The TRI data should be used with caution because only certain types of facilities are required to report. This is not an exhaustive list.

Limited data are available regarding the release of chloroethane to water. This compound may be released to the environment as a constituent of waste-water streams from various industries, particularly those that use chloroethane as an intermediate. The following industries have been identified as potential sources of release of chloroethane: electroplating, organic chemicals, steam electric, asbestos, timber products processing, metal finishing, paving and roofing, paint and ink formulating, gum and wood, and carbon black (EPA 1988a). It is possible that chloroethane forms in some waste-water streams as a result of disinfection bychlorination (Gould et al. 1983; Liepins et al. 1977; Otson 1987). Because of its volatility, the majority of chloroethane released to surface water is expected to enter the atmosphere. This compound can leach into groundwater from waste disposal sites, and it may form in groundwater as an anaerobic biodegradation product of chlorinated solvents (e.g., 1,1,1-trichloroethane and *cis*-1,1-dichloroethylene) (Barrio-Lage et al. 1986; Vogel and McCarty 1987).

5.2.3 Soil

According to the Toxics Release Inventory (TRI), in 1996, there were no releases to soil from the 50 large processing facilities required to report (TR196 1998).

Chloroethane can occur in soil as a result of the disposal of waste products that contain this compound and as a result of formation as an anaerobic biodegradation product of various chlorinated compounds (e.g., 1,1,1-trichloroethane and *cis*-1,2-dichloroethylene) (Barrio-Lage et al. 1986; Vogel and McCarty 1987).

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5.3 ENVIRONMENTAL FATE**5.3.1 Transport and Partitioning**

The relatively high water solubility of chloroethane suggests that potential exists for removal of this compound from the atmosphere via washout. However, most chloroethane removed by this mechanism is likely to reenter the atmosphere by volatilization.

The dominant removal process for chloroethane in surface water is expected to be volatilization. Based on a measured Henry's Law constant of 1.11×10^{-2} atm-m³/mole at 24.8 °C, the volatilization half-life of chloroethane from a model river 1 m deep, flowing 1 m/second with a wind speed of 3 m/second was estimated to be 2.4 hours (Gessett 1987; Thomas 1982).

Bioconcentration factors (BCF) of 7 and 5 have been estimated for chloroethane using linear regression equations based on a log of the octanol-water partition coefficient (K_{ow}) of 1.43 and a water solubility of 5,678 mg/L at 20°C, respectively (Bysshe 1982; Hansch and Leo 1985; Horvath 1982). These BCF values indicate that this compound would not bioconcentrate significantly in aquatic organisms.

Adsorption coefficients (K_{oc}) of 143 and 33 were estimated for chloroethane using linear regression equations based on log K_{ow} and water solubility data, respectively (Lyman 1982). These &, values suggest that adsorption of chloroethane to suspended solids and sediments in water would not be a significant fate process.

The likely insignificant sorption of chloroethane to soil, indicated by the relatively low K_{oc} value for the compound, suggests that it would be highly mobile in soil and might undergo significant leaching (Swann et al. 1983). The relatively high vapor pressure of chloroethane and its volatility from water suggest that it would evaporate rapidly from soil surfaces, and that volatilization would probably be a major removal process. Washington (1996) has calculated a K_c value for chloroethane. This value is the ratio of the concentration of the compound in the gas phase relative to the water phase and indicates the mobility of the compound from water in saturated soils to vapor. The calculated value of K_c , 0.347 at 17.5 °C, indicates that chloroethane in soil has a propensity to become dissolved in soil water and will then enter soil gas. The concentrations of chloroethane in soil water and the vapor phase will approach equilibrium (Washington 1996).

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5.3.2 Transformation and Degradation**5.3.2.1 Air**

The dominant atmospheric removal process for chloroethane is predicted to be removal by reaction with photochemically-generated hydroxyl radicals in the troposphere. This reaction is believed to proceed via hydrogen abstraction (Atkinson 1985; Howard and Evenson 1976). The half-life for this reaction has been estimated to be 40 days based on a reaction rate constant of 4.0×10^{-13} m³/molecule-second at 25 °C and a typical hydroxyl radical concentration of 5.0×10^5 molecules/m³ (Atkinson 1985; Howard and Evenson 1976). This tropospheric half-life suggests that less than 1% of the chloroethane released to the atmosphere would diffuse into the stratosphere, where it would be destroyed by photolysis (Callahan et al. 1979). Chloroethane is not expected to photolyze in the atmosphere below the ozone layer since it contains no chromophores that absorb light in the visible part of the spectrum (wavelengths about 400-700 nm) (Hubrich and Stuhl 1980; Jaffe and Orchin 1962; Mabey et al. 1981).

5.3.2.2 Water

Chloroethane is susceptible to slow chemical hydrolysis and forms ethanol and hydrochloric acid as reaction products. The hydrochloric acid formed dissociates at the neutral pH of most natural waters and forms a chloride salt. The hydrolytic half-life of chloroethane is not known with certainty. The hydrolytic half-life in water at 25 °C and pH 7 was estimated to be 38 days based on a reaction rate constant extrapolated from experimental data at 100°C (Laughton and Robertson 1959; Mabey and Mill 1978). However, in another study, the hydrolytic half-life was estimated to be approximately 1.9 years based on an estimated first-order rate constant of 1.18×10^{-8} s⁻¹ obtained from the analysis of chloroethane in a batch fermented at 20°C (Vogel and McCarty 1987). Both the neutral and alkaline reaction rates for the hydrolysis of chloroethane were determined by Jeffers and Wolf (1996). The neutral reaction measured in 0.01 M hydrochloric acid at 25 °C was found to predominate, with a rate constant of 5.1×10^{-7} , resulting in an estimated half-life for chloroethane of 2.6 years. Despite these conflicting data, chemical hydrolysis may be an important fate process in groundwater when losses from other degradation and transport processes are expected to be negligible.

The high volatility of chloroethane indicates that this compound will volatilize from groundwater and enter soil as a gas. In addition, chloroethane is susceptible to biodegradation in groundwater and other media. Vogel and McCarty (1987) have shown that chloroethane, formed by the anaerobic biodegradation of

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trichloroethylene in a batch fermenter, was further dechlorinated by methanogenic bacteria. This study, however, provided no rate constant for this reaction that could be compared to the rate for hydrolysis. Oxidation of chloroethane in water via reaction with singlet oxygen or peroxy radicals is too slow to be environmentally relevant (Mabey et al. 1981). Direct photolysis in surface waters is not expected to be an environmentally relevant fate process (Mabey et al 1981).

5.3.2.3 Sediment and Soil

In moist subsurface soils, chloroethane is expected to be susceptible to chemical hydrolysis. However, this pathway is expected to be slow and other fate and transport processes may predominate. A large body of data exists on the biodegradation of chlorinated alkenes and alkanes under anaerobic or aerobic conditions. The majority of this data, however, deals with polychlorinated compounds that are biodegraded to chloroethane or a structurally similar alkane or alkene (Ahlert and Enzinger 1992; Barrio-Lage et al. 1986; Chang and Alvarez-Cohen 1996; Tabak et al. 1981; Vogel and McCarty 1987).

Chloroethane can undergo reductive dehalogenation by methanogenic bacteria in an anaerobic cell suspension or packed column environment (Baek et al. 1990; Holliger et al. 1990). Ethane and hydrochloric acid are formed by the reductive dechlorination of chloroethane (Holliger et al. 1990). In addition, chloroethane can be oxidized by aerobic nitrifying bacteria (Rasche et al. 1990). Both acetaldehyde and 2-chloroethanol are produced from the oxidation of chloroethane, with acetaldehyde predominating at more than 98% of the total product (Rasche et al. 1990).

Although these studies provided maximum product formation rates, first-order rate constants were not estimated; therefore, no comparisons could be made to determine which biodegradation pathway would more rapidly clear chloroethane from a contaminated environment. The pathways do not directly compete, because they occur in different environments, one in an oxygen-deficient environment and the other in an oxygen-rich environment. For example, methanogenic environments are found at landfills and deep aquifers rich in carbohydrate-like compounds. Denitrifying environments are common to agricultural land use as well as areas that have on-site wastewater treatment systems (Ahlert and Enzinger 1992).

Further, optimal biodegradation of chloroethane in aquifers or saturated sediments or soils is highly dependent on the presence of appropriate metabolizing bacteria, the migration of the contaminant to the bacteria, and the availability and concentration of necessary reactants such as carbon sources, reducers,

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and/or oxidizers. While laboratory studies indicate that biodegradation can be a significant pathway for clearance of chloroethane and other contaminants from affected media, the importance of this pathway in the environment is still unknown.

5.4 LEVELS MONITORED OR ESTIMATED IN THE ENVIRONMENT

Reliable evaluation of the potential for human exposure to chloroethane depends in part on the reliability of supporting analytical data from environmental samples and biological specimens. In reviewing data on chloroethane 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.

5.4.1 Air

Limited data are available regarding the detection of chloroethane in air. Monitoring data from the early 1980s indicate that levels of chloroethane in ambient air at various urban/suburban locations in the United States ranged from 10 to 1,248 ppt with average concentrations ranging from 41 to 140 ppt (Shepson et al. 1987; Singh et al. 1981). Marine air samples collected in the Northern Hemisphere during 1981 contained an average concentration of 19 ppt (Singh et al. 1983). Rural air samples collected in 1974-1975 in the northwest United States contained less than 5 ppt chloroethane (Grimsrud and Rasmussen 1975). Current ambient levels of chloroethane are believed to be markedly lower than levels found during the mid 1970s and early 1980s because of a substantial decrease in the production of chloroethane in the United States. Chloroethane has been detected in the air samples of landfill gas collected from a municipal/industrial landfill in the United Kingdom and a municipal landfill simulator (Young and Parker 1984; Vogt and Walsh 1985). These data indicate that chloroethane may be found in the air above some landfills. However, sufficient data are not available to determine whether elevated levels of chloroethane typically occur at or in the vicinity of waste disposal sites.

5.4.2 Water

Limited data are available regarding the detection of chloroethane in surface water, groundwater, drinking water, and waste water. Analysis of data input into the EPA STORET database during the early 1980s indicates that chloroethane is not a common surface water pollutant and that levels in unfiltered surface water samples typically fall below the detection limit (<10 mg/L) (Staples et al. 1985). Chloroethane

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contamination of groundwater has occurred at various waste disposal sites throughout the United States (ATSDR 1989,1991; Cline and Viste 1985; EPA 1986a, 1987; Myers 1983; Sabel and Clark 1984). Groundwater and landfill leachate were the media in which chloroethane was most frequently found at NPL hazardous waste sites (HazDat 1998). Chloroethane was found in groundwater at 218 sites and in leachate at 43 NPL sites. Results of a 1982-1983 survey of 10 Canadian drinking water supplies suggest that trace levels (<0.1 mg/L) of chloroethane may occur in some finished drinking water supplies as a result of formation during the chlorination process (Otson 1987). During the 1975 EPA National Organics Reconnaissance Survey (NORS), chloroethane was qualitatively identified in drinking water samples from three of five finished drinking water supplies in the United States (EPA 1975). Without more recent or comprehensive data, the average daily intake of chloroethane by ingestion of drinking water cannot be estimated. Chloroethane is not a common constituent of treated waste water (EPA 1981; Perry et al. 1979; Staples et al. 1985; Young et al. 1983). The maximum reported concentration for chloroethane in a waste stream was 10 mg/L in treated waste water from a paint and ink formulation industry (EPA 1981). A survey of storm water runoff samples collected from 15 cities located across the United States revealed that chloroethane is not a typical contaminant of stormwater runoff (Cole et al. 1984).

5.4.3 Sediment and Soil

Chloroethane was found in sediment at 10 NPL sites and in soil at 42 NPL sites (HazDat 1998). In a survey of U.S. waste-water treatment plants receiving both municipal and industrial waste streams, chloroethane was found in undigested sewage sludge from 2 of 13 plants at concentrations ranging from 14.5 to 24 mg/kg dry weight. Assuming that the sludge was disposed of by land application, the application rate of chloroethane to soil was projected to be 0.16-0.17 kg/hectare (dry weight), and the resulting concentration of chloroethane in the top 15 cm of soil was predicted to be 0.08-0.085 mg/kg (Naylor and Loehr 1982).

5.4.4 Other Environmental Media

Few reports are available concerning the identification of chloroethane in other media. Traces of chloroethane were found in two of eight human milk samples taken from women in four urban areas of the United States (Pellizzari et al. 1982). Chloroethane at a mean concentration of 7.6 ng/g was found in oysters collected from Lake Pontchartrain, LA (Ferrario et al. 1985).

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5.5 GENERAL POPULATION AND OCCUPATIONAL EXPOSURE

According to a National Occupational Exposure Survey (NOES) conducted by NIOSH between 1981 and 1983, an estimated 49,212 workers in the United States are potentially exposed to chloroethane (NIOSH 1991). This was a tentative estimate and extrapolating to the present, such estimates are subject to change depending upon whether further information on trade name compounds containing chloroethane becomes available. Workers may be exposed to chloroethane by inhalation and/or dermal exposure. Chloroethane exposure can occur in several occupational environments including: chemical manufacturing industries; medical and health facilities; automotive dealerships and service stations; wholesale trade, electric, gas and sanitary services; companies manufacturing or using machinery (except electrical); metal production facilities; printing and publishing companies; paint manufacturers and painting companies; companies manufacturing rubber and plastic products not elsewhere classified; and companies manufacturing food and kindred products (Fidler et al. 1987; Parker et al. 1979). Workers who may potentially be exposed include physicians, nurses, and other medical workers, automobile mechanics, office machine mechanics, household appliance and accessory installers, assemblers, professional painters, heavy-equipment mechanics (including diesel mechanics), and plumbers and pipe fitters (Fidler et al. 1987; Parker et al. 1979). Limited data indicate that the general population is exposed to very low (ppt) levels of chloroethane by inhalation of contaminated air and ingestion of contaminated drinking water. Apparently, people residing in urban/suburban areas are exposed to somewhat higher levels of chloroethane in air than people living in rural areas (Grimsrud and Rasmussen 1975; Shepson et al. 1987; Singh et al. 1983). Medical use of chloroethane as a topical anesthetic results in direct dermal exposure of the general population to this compound. The general population is also exposed to chloroethane by dermal contact with consumer products that contain this compound (i.e., various paints, solvents, refrigerants) (HSDB 1997).

5.6 EXPOSURES OF CHILDREN

This section focuses on exposures from conception to maturity at 18 years in humans and briefly considers potential pre-conception exposure to germ cells. Differences from adults in susceptibility to hazardous substances are discussed in 2.6 Children's Susceptibility.

Children are not small adults. A child's exposure may differ from an adult's exposure in many ways. Children drink more fluids, eat more food, and breathe more air per kilogram of body weight, and have a larger skin surface in proportion to their body volume. A child's diet often differs from that of adults. The

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developing humans source of nutrition changes with age: from placental nourishment to breast milk or formula to the diet of older children who eat more of certain types of foods than adults. A child's behavior and lifestyle also influence exposure. Children crawl on the floor; they put things in their mouths; they may ingest inappropriate things such as dirt or paint chips; they spend more time outdoors. Children also are closer to the ground, and they do not have the judgement of adults in avoiding hazards (NRC 1993).

Children can be exposed inadvertently to chloroethane via household products such as paints, solvents, air fresheners, and refrigerants. However, children are unlikely to be exposed to a significant amount of chloroethane during normal use of these products by adults. Children can be exposed to chloroethane by intentionally sniffing household products containing the compound or sniffing packaged chloroethane that is sold specifically for misuse as an inhalant (Hersh 1991; Walker 1993).

Children can also be exposed to chloroethane via contaminated drinking water or foods. Chloroethane concentrations in drinking water are expected to be low. One study was identified that reported chloroethane in small amounts (7.6 ng/g) in oysters in Lake Pontchartrain, LA (Ferrario et al. 1985). Because children drink more fluids and eat more food per kilogram of body weight than adults, they are expected to be disproportionately affected by exposure to chloroethane. However, because of the low concentrations of chloroethane detected in food and water, dietary exposures are not expected to be significant in children.

Chloroethane has been detected in human breast milk (Pellizari et al. 1982). However, the concentrations of chloroethane were not determined, nor was the exposure dose. Therefore, it is not possible to determine how much of an absorbed chloroethane dose would be excreted in the milk and ingested by a nursing infant. In addition, the number of women with detectable levels of chloroethane in their milk was low; data do not exist that could indicate what percentage of an exposed female population could be expected to excrete chloroethane in their breast milk.

Parents' work clothes, skin, hair, tools, or other objects removed from the workplace are not likely to be a source of exposure to children. Chloroethane is a gas at room temperature and pressure; thus, it will not remain on parents' clothes, hair, skin or other items, even for those who work with liquid chloroethane. Therefore, secondary exposure to children is unlikely.

It is unknown whether children are different in their weight-adjusted intake of chloroethane.

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5.7 POPULATIONS WITH POTENTIALLY HIGH EXPOSURES

Humans are typically exposed to very low levels of chloroethane. Nonetheless, potentially high levels could result from occupational exposure, exposure at or near hazardous waste sites, and frequent contact with consumer products that contain chloroethane (i.e., solvents, paints, refrigerants). Inhalation and dermal contact are expected to be the primary routes of exposure, although ingestion via indirect contact (e.g., eating foods that come in contact with contaminated surfaces or swallowing mucus that becomes contaminated as the result of breathing air containing chloroethane) is also possible.

5.8 ADEQUACY OF THE DATABASE

Section 104(I)(5) of CERCLA, as amended, directs the Administrator of ATSDR (in consultation with the Administrator of EPA and agencies and programs of the Public Health Service) to assess whether adequate information on the health effects of chloroethane is available. Where adequate information is not available, ATSDR, in conjunction with the NTP, is required to assure the initiation of a program of research designed to determine the health effects (and techniques for developing methods to determine such health effects) of chloroethane.

The following categories of possible data needs have been identified by a joint team of scientists from ATSDR, NTP, and EPA. They are defined as substance-specific informational needs that if met would reduce the uncertainties of human health assessment. This definition should not be interpreted to mean that all data needs discussed in this section must be filled. In the future, the identified data needs will be evaluated and prioritized, and a substance-specific research agenda will be proposed.

5.8.1 Identification of Data Needs

Physical and Chemical Properties. Data on the physical and chemical properties of chloroethane are available (Budavari 1989; HSDB 1997). A K_{oc} value provides a means for predicting whether a compound will partition significantly into suspended solids and sediments in water or adsorb strongly to soil. A K_{oc} for chloroethane was estimated using regression equations based on $\log K_{ow}$ and water solubility data (Lyman 1982). This estimation technique is believed to provide a reasonable approximation of K_{oc} . However, additional studies are needed in which the soil adsorption coefficient of chloroethane is measured in order to remove any doubt concerning the reliability of the K_{oc} .

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Production, Import/Export, Use, Release, and Disposal. According to the Emergency Planning and Community Right-to-Know Act of 1986, 42 U.S.C. Section 11023, industries are required to submit chemical release and off-site transfer information to the EPA. The Toxics Release Inventory (TRI), which contains this information for 1996, became available in May of 1998. This database will be updated yearly and should provide a list of industrial production facilities and emissions.

Data are adequate for the production and disposal of chloroethane (IARC 1991; TR196 1998). Information on the pattern of use of chloroethane is not available after 1988. Information would have to be supplied by the chemical industry in order to establish the percentage breakdown of the current chloroethane uses. This type of information is needed to establish the sources of chloroethane release and the potential for general population and occupational exposure.

Environmental Fate. Conflicting data are available concerning the hydrolytic half-life of chloroethane in water (Jeffers and Wolf 1996; Laughton and Robertson 1959; Mabey and Mill 1978; Vogel and McCarty 1987). Experimental data obtained from a hydrolysis study carried out in distilled water under environmental conditions (at 25 °C and pH 5-9) are needed to predict the half-life of chloroethane (Haider 1980; Kobayashi and Rittmann 1982) in natural water and moist soil. Available data regarding biodegradation of chloroethane are insufficient for predicting the importance of biodegradation as a removal process for chloroethane. Natural water grab sample biodegradation studies and soil metabolism studies carried out under both aerobic and anaerobic conditions are needed to estimate the biodegradation half-life of chloroethane. Although volatilization from soil is expected to be an important fate process (Washington 1996), data pertaining to the rate of volatilization from soil surfaces were not located in the available literature. Studies involving the measurement of the volatilization rate of chloroethane from soil surfaces are needed to evaluate the persistence of this compound upon release to soil. The dominant removal mechanism for chloroethane in air is expected to be reaction with photochemically-generated hydroxyl radicals (Atkinson 1985; Howard and Evenson 1976). However, no data are available concerning the products of this reaction. These data are needed to understand the mechanism by which this compound degrades in the atmosphere.

Bioavailability from Environmental Media. Chloroethane is readily absorbed following inhalation exposure, the major route of exposure (Konietzko 1984; Lehman and Flury 1943; Torkelson and Rowe 1981). Data regarding the bioavailability of chloroethane from different media for other routes of exposure were not identified. Studies examining the absorption of chloroethane from various media following oral and dermal exposure are needed to predict exposure to chloroethane at hazardous waste sites.

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Food Chain Bioaccumuiation. Based on bioconcentration factors of 7 and 5 estimated from log K_{ow} and water solubility (Bysshe 1982; Hansch and Leo 1985; Horvath 1982), chloroethane is not expected to bioconcentrate significantly in aquatic organisms. Studies in which chloroethane is measured in biota and environmental media are needed to determine if the predictions are correct.

Exposure Levels in Environmental Media. Relatively large amounts of chloroethane are released to the environment on an annual basis (TR196 1998). However, limited data were available concerning the detection of chloroethane in the environment, particularly in ambient air (Shepson et al. 1987; Singh et al. 1981), air in the vicinity of waste disposal sites (Vogt and Walsh 1985; Young and Parker 1984), drinking water, groundwater downgradient from waste disposal sites (HazDat 1998), and soil at waste disposal sites (HazDat 1998; Otson 1987). Reliable monitoring data for the levels of chloroethane in contaminated media at hazardous waste sites are needed so that the information obtained on levels of chloroethane in the environment can be used in combination with the known body burdens of chloroethane to assess the potential risk of adverse health effects in populations living in the vicinity of hazardous waste sites.

Exposure Levels in Humans. Despite the fact that chloroethane is a fairly large volume commercial compound, limited data are available concerning occupational exposure. Tentative results of the National Occupational Exposure Survey are indicative of the number of workers potentially exposed to chloroethane in industry (NIOSH 1991). However, there are no quantitative data relating type of occupation to level and route of exposure. Available data indicate that the general population may be exposed to chloroethane by inhalation, ingestion of drinking water, and dermal contact (HSDB 1997). However, data were insufficient for estimating average daily intake by these routes. Up-to-date comprehensive monitoring data for air, water, and soil are needed to determine the typical amount of chloroethane to which the general population is exposed.

This information is necessary for assessing the need to conduct health studies on these populations.

Exposures of Children. Children are exposed to chloroethane via many different exposure pathways. However, to date no studies have provided information on adverse effects observed in children as a result of exposure to a specific dose of the compound. Reliable exposure and body burden studies in children are needed to relieve this data gap. In addition, because many older children may be exposed to chloroethane through sniffing the compound directly, there is a need to explore the prevalence of this behavior, the frequency of the abuse, and resulting exposure doses.

5. POTENTIAL FOR HUMAN EXPOSURE

It is currently unknown whether children differ from adults in their weight-adjusted intake of chloroethane. Therefore, studies investigating this issue are needed.

Exposure Registries. No exposure registries for chloroethane were located. This substance is not currently one of the compounds for which a subregistry has been established in the National Exposure Registry. The substance will be considered in the future when chemical selection is made for subregistries to be established. The information that is amassed in the National Exposure Registry facilitates the epidemiological research needed to assess adverse health outcomes that may be related to exposure to this substance.

5.8.2 Ongoing Studies

Ongoing studies regarding the environmental fate of chloroethane were not identified in the CRISP (1996), PEDRIP (1998), or CRIS/USDA (1998) databases.