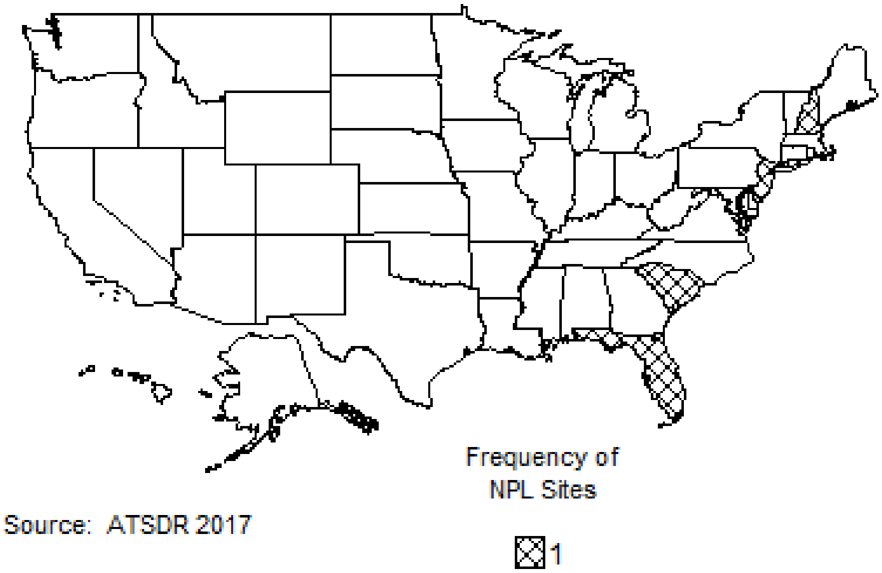
CHAPTER 5. POTENTIAL FOR HUMAN EXPOSURE

5.1 OVERVIEW

BCME has been identified in at least 4 of the 1,854 hazardous waste sites that have been proposed for inclusion on the EPA National Priorities List (NPL) (ATSDR 2017). However, the number of sites in which BCME has been evaluated is not known. The number of sites in each state is shown in Figure 5-1.

Figure 5-1. Number of NPL Sites with Bis(Chloromethyl)Ether Contamination



Source: ATSDR 2017

- Because BCME is not currently used as an isolated material in this country, and because it is rapidly degraded in the environment, the probability of human exposure to BCME is low. The most likely means of exposure is inhalation of BCME vapors in the workplace during the production and use of chemicals such as CME, in which BCME may occur as a contaminant or be formed inadvertently. Exposure through other media (water, food, soil) is unlikely to be significant.

- BCME in air is believed to be primarily degraded by reacting with photochemically-generated free hydroxyl radicals. BCME in the atmosphere can also undergo hydrolysis. In water, BCME is rapidly hydrolyzed.

5.2 PRODUCTION, IMPORT/EXPORT, USE, AND DISPOSAL

5.2.1 Production

Production of BCME in this country was curtailed in 1974 following stringent regulation by the Occupational Safety and Health Administration (EPA 1979; OSHA 1974). Table 5-1 summarizes information on U.S. companies that reported the manufacture or use of BCME in 2016 (TRI16 2017). Toxics Release Inventory (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 Bis-(Chloromethyl)Ether

State[a]	Number of facilities	Minimum amount on site in pounds[b]	Maximum amount on site in pounds[b]	Activities and uses[c]
LA	1	10,000	99,999	1, 5
TX	1	1,000	9,999	12

[a] Post office state abbreviations used.
[b] Amounts on site reported by facilities in each state.
[c] Activities/Uses:

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

Source: TRI16 2017 (Data are from 2016)

5.2.2 Import/Export

No data were located on imports of BCME.

5.2.3 Use

In the past, BCME was used for crosslinking of cellulose, preparation of styrene and other polymers, surface treatment of vulcanized rubber to increase adhesion, and in the manufacture of flame retardant fabrics (EPA 1980a). These applications have been discontinued, and no uses of BCME other than as a nonisolated intermediate were identified.

5.2.4 Disposal

Any products, residues, or container liners contaminated with BCME are considered acute hazardous waste under the Resource Conservation and Recovery Act (RCRA) (40 CFR 261.33 (c)), and must be disposed of by transport to a RCRA waste storage and disposal facility. The preferred method of disposal is incineration (OSHA 1974; Sittig 1985).

5.3 RELEASES TO THE ENVIRONMENT

The Toxics Release Inventory (TRI) data for BCME, summarized in Table 5-2, should be used with caution because only certain types of facilities are required to report (EPA 2005). 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 is included in Standard Industrial Classification (SIC) Codes 10 (except 1011, 1081, and 1094), 12 (except 1241), 20–39, 4911 (limited to facilities that combust coal and/or oil for the purpose of generating electricity for distribution in commerce), 4931 (limited to facilities that combust coal and/or oil for the purpose of generating electricity for distribution in commerce), 4939 (limited to facilities that combust coal and/or oil for the purpose of generating electricity for distribution in commerce), 4953 (limited to facilities regulated under RCRA Subtitle C, 42 U.S.C. section 6921 et seq.), 5169, 5171, and 7389 (limited S.C. section 6921 et seq.), 5169, 5171, and 7389 (limited to facilities primarily engaged in solvents recovery services on a contract or fee basis); and if their facility produces, imports, or processes ≥25,000 pounds of any TRI chemical or otherwise uses >10,000 pounds of a TRI chemical in a calendar year (EPA 2005).

Table 5-2. Releases to the Environment from Facilities that Produce, Process, or Use Bis(Chloromethyl)Ether[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	1	No data	No data	No data	No data	No data	No data	No data	No data
TX	1	13	0	0	0	No data	13	No data	13
Total	2	13	0	0	0	0	13	0	13

[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, waste water treatment-(metals only), and publicly owned treatment works (POTWs) (metal and metal compounds).
[g] Class I wells, Class II-V wells, and underground injection.
[h] Resource Conservation and Recovery Act (RCRA) subtitle C landfills; other onsite landfills, land treatment, surface impoundments, other land disposal, other landfills.
[i] Storage only, solidification/stabilization (metals only), other off-site management, transfers to waste broker for disposal, unknown
[j] The sum of all releases of the chemical to air, land, water, and underground injection wells.
[k] Total amount of chemical transferred off-site, including to POTWs.

RF = reporting facilities; UI = underground injection

Source: TRI16 2017 (Data are from 2016)

5.3.1 Air

Estimated releases of 13 pounds (~0.006 metric tons) of BCME to the atmosphere from 2 domestic manufacturing and processing facilities in 2016, accounted for about 100% of the estimated total environmental releases from facilities required to report to the TRI (TRI16 2017). These releases are summarized in Table 5-2.

5.3.2 Water

No releases of BCME to surface water or publicly owned treatment works (POTWs) were reported from facilities required to report to the TRI (TRI16 2017), see Table 5-2.

5.3.3 Soil

No releases of BCME to soils were reported from facilities required to report to the TRI (TRI16 2017), see Table 5-2.

5.4 ENVIRONMENTAL FATE

5.4.1 Transport and Partitioning

No information was located on the transport and partitioning of BCME in the environment. Due to the relatively short half-life in both air and water, it is unlikely that significant transport or partitioning between media occurs.

5.4.2 Transformation and Degradation

Air. The primary process for BCME degradation in air is believed to be reaction with photochemically-generated hydroxyl radicals. Reaction products are believed to include chloromethyl formate, ClHCO, formaldehyde, and HCl (Cupitt 1980; EPA 1987a). The atmospheric half-life due to reaction with hydroxyl radicals is estimated to be 1.36 hours. Hydrolysis in the vapor phase is slower, with an estimated half-life of 25 hours in moist air (80% relative humidity at 25°C) (Tou and Kallos 1974). Reaction of BCME with molecular oxygen may also occur, but the rate of this reaction is not known. Other calculations suggest an atmospheric residence time of 0.2–2.9 days (Cupitt 1980).

Although hydrolysis of BCME to formaldehyde and HCl is highly favored thermodynamically, low levels of BCME may form by the reverse reaction when high concentrations of formaldehyde and HCl are mixed. Frankel et al. (1974) studied this reaction, and found that although BCME levels increased exponentially in proportion to reactant concentrations, yields were only 0.002–0.01 mol% at reactant concentrations ranging from 20 to 1,000 ppm. For example, the BCME concentration was 3 ppb in a mixture of 100 ppm formaldehyde and 100 ppm HCl. Based on the data of Frankel et al. (1974), Travenius (1982) proposed the empirical equation:

$$\log(\mathrm{BCME})_{\mathrm{ppb}} = -2.25 + 0.67 \bullet \log(\mathrm{HCHO})_{\mathrm{ppm}} + 0.77 \bullet \log(\mathrm{HCl})_{\mathrm{ppm}}$$

Employing this equation, the concentration of BCME likely to form from any mixture of formaldehyde and HCl may be calculated. In the workplace, assuming that exposure occurred at the Threshold Limit

Values for each (1 ppm for formaldehyde and 5 ppm for HCl), the resulting BCME concentration would be 0.02 ppb. Concentrations in the home and the ambient environment are likely to be significantly lower for one or both reactants, and concentrations of BCME would be expected to be essentially negligible.

Water. BCME is rapidly hydrolyzed in water to yield formaldehyde and HCl, with a hydrolysis rate constant of 0.018 second^{-1} at 20°C (Tou et al. 1974). This corresponds to a half-life of approximately 38 seconds. Under laboratory conditions (a sealed vessel from which formaldehyde and HCl cannot escape), an equilibrium is established in which about 80% of the BCME is rapidly hydrolyzed, with about 20% of the BCME remaining (Van Duuren et al. 1972). In the environment, formaldehyde and HCl formed by hydrolysis of BCME would be expected to dissipate by diffusion or volatilization, and BCME hydrolysis would rapidly proceed to completion.

Sediment and Soil. No information was located on the fate of BCME in soil. However, it is probable that BCME would rapidly hydrolyze upon contact with moisture in soil or would react with soil constituents. Consequently, it is not expected that BCME would persist for significant periods in soil.

5.5 LEVELS IN THE ENVIRONMENT

Reliable evaluation of the potential for human exposure to BCME depends, in part, on the reliability of supporting analytical data from environmental samples and biological specimens. Concentrations of BCME 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 BCME 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 lowest limit of detections that are achieved by analytical analysis in environmental media.

Table 5-3. Lowest Limit of Detection Based on Standards[a]

Media	Detection limit	Reference
Air	0.1 ppb	Collier 1972
Drinking water	No data	
Surface water and groundwater	No data	
Soil	No data	
Sediment	No data	

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

No data are available on levels of BCME in air, water, and soil at NPL sites (ATSDR 2017).

5.5.1 Air

BCME has not been detected in ambient air. Some early reported industrial air concentrations ranged from 0.7 to 5.2 ppm, but increased care in the handling of this compound has reduced workplace levels to the sub-ppb range (NIOSH 1972a). No other quantitative data on BCME levels in air were located.

5.5.2 Water

BCME has not been detected in ambient waters, but has been reported to be present in groundwater at one chemical waste site being investigated under Superfund (CLPSD 1988). Because BCME hydrolyzes so quickly in water, this observation must be considered with skepticism.

5.5.3 Sediment and Soil

BCME was reported to be present at 0.5% of the waste sites being investigated under Superfund (CLPSD 1988), but quantitative data were not available. As with the data regarding occurrence in water, these data must be considered with caution, since BCME is unlikely to endure at measurable levels in soil.

5.5.4 Other Media

No studies were located regarding the occurrence of BCME in other media.

5.6 GENERAL POPULATION EXPOSURE

The most likely route of human exposure to BCME is by inhalation, but available data are not adequate to estimate typical dose levels. Doses are likely to be close to zero for the general population, but could be of concern inside or close by industrial sites where chloromethylation processes occur (Roe 1985).

5.7 POPULATIONS WITH POTENTIALLY HIGH EXPOSURES

As discussed above, the individuals most likely to have potential exposure to BCME are industrial workers who manufacture or use chemicals such as CME that might contain BCME as a contaminant. The possibility exists that residents near a facility or a waste site that permits escape of BCME could also be exposed, but there are no data to establish whether or not this occurs or is of concern.