Chapter 11: 1,1,2,2-Tetrachloroethane

A chapter from:

Regulatory Determinations Support Document for Selected Contaminants from the Second Drinking Water Contaminant Candidate List (CCL 2)

EPA Report 815-D-06-007

Executive Summary

1,1,2,2-Tetrachloroethane, a volatile organic compound (VOC), is not known to occur naturally in the environment. Prior to the 1980s, 1,1,2,2-tetrachloroethane was synthesized for use in the production of other chemicals, primarily chlorinated ethylenes. 1,1,2,2-Tetrachloroethane was also once used as a solvent to clean and degrease metals, in paint removers, varnishes, lacquers, and photographic films, and for oil/fat extraction. Commercial production of 1,1,2,2-tetrachloroethane in the U.S. ceased in the 1980s when other processes to generate chlorinated ethylenes were developed.

Volatilization from water or soil surfaces to the atmosphere appears to be the primary dissipation route for 1,1,2,2-tetrachloroethane. In subsurface soils and ground water, 1,1,2,2-tetrachloroethane is subject to biodegradation by soil organisms and/or chemical hydrolysis.

Recent studies by the National Toxicology Program (NTP) provide a detailed evaluation of the short-term and subchronic oral toxicity of 1,1,2,2-tetrachloroethane. In rats and mice exposed orally, the liver appears to be the primary target organ. The reference dose (RfD) of 10 µg/kg/day for 1,1,2,2-tetrachloroethane was derived from the benchmark dose level (BMDL) for a 1 standard deviation change in relative liver weight, a biomarker for liver toxicity. A 1,000-fold uncertainty factor was applied in the RfD determination.

A National Cancer Institute (NCI) bioassay of 1,1,2,2-tetrachloroethane found clear evidence of carcinogenicity in male and female B6C3F1 mice based on a dose-related statistically significant increase in liver tumors. There was equivocal evidence for carcinogenicity in Osborn Mendel rats. The Agency used the slope factor of 8.5×10^{-2} for the tumors in female mice to derive the health reference level (HRL) of 0.4 µg/L for use in the analysis of the occurrence data for 1,1,2,2-tetrachloroethane.

Individuals with preexisting liver and kidney damage would likely be more sensitive to 1,1,2,2-tetrachloroethane exposure than the general public. Low intake of antioxidant nutrients (e.g., Vitamin E, Vitamin C, and selenium) could be a predisposing factor for liver damage. Individuals with a genetically low capacity to metabolize dichloroacetic acid (the primary metabolite of 1,1,2,2-tetrachloroethane) may also be at elevated risk.

Production of 1,1,2,2-tetrachloroethane in the U.S. declined from approximately 440 million pounds in 1967 to an estimated 34 million pounds by 1974. Although U.S. commercial production ceased in the 1980s, 1,1,2,2-tetrachloroethane is still generated as a byproduct and/or intermediate in the production of other chemicals. Toxic Release Inventory (TRI) data indicate that environmental releases have generally declined from a high of about 175,000 pounds in 1988 to a low of 3,500 pounds in 2003. Most releases took the form of air emissions, though surface water discharges were also documented nearly every year.

The United States Geological Survey's (USGS's) Random Source Water Survey and Focused Source Water Survey, both conducted between 1999 and 2001, provide an indication of ambient occurrence of 1,1,2,2-tetrachloroethane. The USGS did not detect 1,1,2,2-tetrachloroethane in either survey using a reporting limit of 0.2 µg/L (a level that is less than the

1,1,2,2-tetrachloroethane HRL). In addition, USGS found no indication at all of 1,1,2,2-tetrachloroethane contamination above the detection limit of 0.026 µg/L in the focused survey. Additional sources of information on ambient occurrence include a USGS stormwater study and a USGS compilation of historical VOC monitoring data.

To determine the extent of 1,1,2,2-tetrachloroethane contamination in drinking water, EPA included 1,1,2,2-tetrachloroethane as an analyte in the Unregulated Contaminant Monitoring (UCM) Round 1 and UCM Round 2 surveys. EPA evaluated the UCM Round 1 Cross-Section and the UCM Round 2 Cross-Section data at levels greater than 0.2 µg/L (½ the HRL) and greater than 0.4 µg/L (the HRL). The minimum reporting levels (MRLs) for UCM Round 1 ranged from 0.1 to 10 µg/L and the MRLs for UCM Round 2 ranged from 0.1 to 2.5 µg/L for UCM Round 2. Because some of the reporting limits exceeded the thresholds of interest, the occurrence analyses may result in an underestimate of systems affected.

Analysis of UCM Round 1 Cross-Section data indicates that approximately 0.22 percent (or 44) of the 20,407 public water systems (PWSs) sampled had detections of 1,1,2,2-tetrachloroethane at levels greater than 0.20 µg/L (½ the HRL), affecting approximately 1.69 percent of the population served (or 1.6 million of 95 million). The UCM Round 1 Cross-Section data indicate that approximately 0.20 percent (or 41) of the 20,407 PWSs sampled had detections of 1,1,2,2-tetrachloroethane at levels greater than 0.4 µg/L (the HRL), affecting approximately 1.63 percent of the population served (or 1.5 million of 95 million). The 99th percentile of all detects was 112 µg/L and the maximum reported value was 200 µg/L.

Analysis of the UCM Round 2 Cross-Section data indicate that approximately 0.07 percent (or 18) of the 24,800 PWSs sampled had detections of 1,1,2,2-tetrachloroethane at levels greater than 0.2 µg/L (½ the HRL), affecting approximately 0.51 percent of the population served (or 362,000 of 71 million). The UCM Round 2 Cross-Section data indicate that approximately the same percentage and number of the PWSs sampled (0.07 percent or 17 of the 24,800) had detections of 1,1,2,2-tetrachloroethane at levels greater than 0.4 µg/L (the HRL), affecting approximately 0.08 percent of the population served (or 56,000 of 71 million). The 99th percentile of all detects was 2 µg/L and the maximum reported value was 2 µg/L.

The Agency has made a preliminary determination not to regulate 1,1,2,2-tetrachloroethane with a national primary drinking water regulation (NPDWR). Because 1,1,2,2-tetrachloroethane appears to occur infrequently at health levels of concern in PWSs, the Agency believes that an NPDWR does not present a meaningful opportunity for health risk reduction.

EPA recognizes that 1,1,2,2-tetrachloroethane is listed as a likely human carcinogen. For this reason, the Agency encourages those States with public water systems that may have 1,1,2,2-tetrachloroethane above the HRL to evaluate site-specific protective measures and to consider whether State-level guidance (or some other type of action) is appropriate. The Agency also plans to update the Health Advisory document for 1,1,2,2-tetrachloroethane to provide more recent health information.

The Agency's preliminary regulatory determination for this contaminant is presented formally in the *Federal Register*.

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Abbreviations

BMDL	Benchmark Dose Level
CAS	Chemical Abstracts Service
CCL	Contaminant Candidate List
CCL 2	Second Contaminant Candidate List
ELCD	Electrolytic Conductivity Detector
GAC	Granular Activated Carbon
GC	Gas Chromatography
HRL	Health Reference Level
LOAEL	Lowest Observed Adverse Effect Level
MDL	Method Detection Limit
MRL	Minimum Reporting Level
MS	Mass Spectrometry
NAWQA	National Water Quality Assessment
NOAEL	No Observed Adverse Effect Level
NPDES	National Pollutant Discharge Elimination System
NPDWR	National Primary Drinking Water Regulation
NTP	National Toxicology Program
PCE	Tetrachloroethylene
PID	Photoionization Detector
PWS	Public Water System
RfD	Reference Dose
RL	Reporting Limit
TCE	Trichloroethylene
TRI	Toxics Release Inventory
UCM	Unregulated Contaminant Monitoring
USGS	United States Geological Survey
VOC	Volatile Organic Compound

11 1,1,2,2-Tetrachloroethane

11.1 Definition

1,1,2,2-Tetrachloroethane is a halogenated volatile organic compound (VOC) used in chemical synthesis. It is also given the following chemical names: acetosol, acetylene tetrachloride, symmetrical-tetrachloroethane, sym-tetrachloroethane, 1,1-dichloro-2,2-dichloroethane, and tetrachloroethane. 1,1,2,2-Tetrachloroethane goes by three registered trade names: Bonoform, Cellon, and Westron. The Chemical Abstracts Service (CAS) registry number for 1,1,2,2-tetrachloroethane is 79-34-5.

11.1.1 Properties and Sources

1,1,2,2-Tetrachloroethane is not known to occur naturally (IARC, 1979 as cited in ATSDR, 1996). At room temperature it is a dense, colorless liquid with a pungent, sweet, suffocating, chloroform-like smell. It is produced by the catalytic addition of chlorine to acetylene or through the direct chlorination or oxychlorination of ethylene (IARC, 1979; Archer, 1979 both as cited in ATSDR, 1996). Prior to the 1980s, the Specialty Materials Division of Eagle-Picher Industries synthesized this chemical for use in the production of other chemicals, primarily chlorinated ethylenes, as well as use as a solvent. Commercial production was discontinued in the 1980s when other methods to generate chlorinated ethylenes were discovered. The present use of 1,1,2,2-tetrachloroethane appears to be mostly as a chemical intermediate (ATSDR, 1996), although it is also produced as a by-product in the synthesis of other chlorinated hydrocarbons (Gerhartz, 1985 as cited in HSDB, 2004). Some physical and chemical properties of this VOC are summarized in Exhibit 11-1.

Exhibit 11-1: Physical and Chemical Properties of 1,1,2,2-Tetrachloroethane

Identification	
CAS number	79-34-5
Molecular Formula	$C_2H_2Cl_4$
Physical and Chemical Properties	
Boiling Point	146.5 °C at 760 mm Hg [1]
Melting Point	- 43.8 ° C [1]
Molecular Weight	167.85 g/mol [1]
Log K_{oc}	2.78 [2]
Log K_{ow}	2.39 [3]
Water Solubility	2,962 mg/L at 25 °C [4]
Vapor Pressure	6.1 mm Hg at 25 ° C [5]
Henry's Law Constant	4.55×10^{-4} atm-m^3/mole at 25 ° C [5] 0.012 mol/mol (dimensionless), predicted [6] 0.016 mol/mol (dimensionless), from literature [6]
Freundlich Isotherm Constant (K)	823 (µg/g)(L/µg)$^{1/n}$ [7]

[1] *Lide, 1995 as cited in HSDB, 2004*

[2] *ASTER, 1995 as cited in ATSDR, 1996*

[3] *Hansch et al., 1995 as cited in HSDB, 2004*

[4] *Horvath, 1982 as cited in HSDB, 2004*

[5] *Howard, 1990*

[6] *Speth et al., 2001*

[7] *Speth and Adams, 1993 (as cited in Speth et al., 2001)*

11.1.2 Environmental Fate and Behavior

The evaporation of 1,1,2,2-tetrachloroethane from soil surfaces is expected to be fairly rapid (HSDB, 2004). In silt loam, 1,1,2,2-tetrachloroethane has been found to be highly mobile, suggesting a potential for leaching to ground water (Howard, 1990). Experiments simulating degradation reactions under landfill conditions found 1,1,2,2-tetrachloroethane to transform to a number of products, including 1,1,2-trichloroethane, trichloroethene, 1,1-dichloroethene, and vinyl chloride (Hallen *et al.*, 1986 as cited in ATSDR, 1996).

A large percentage of 1,1,2,2-tetrachloroethane released to water will evaporate with a half-life of days to weeks depending on the water body (Howard, 1990). The remaining portion will degrade through hydrolysis. In ground water, 1,1,2,2-tetrachloroethane will degrade through anaerobic biodegradation or hydrolysis. Hydrolysis is pH-dependant - degradation will be faster under basic to neutral conditions. At a neutral pH, 1,1,2,2-tetrachloroethane hydrolysis half-lives range from 29 to 102 days (Haag and Mill, 1988; Cooper *et al.*, 1987 both as cited in

ATSDR, 1996). Trichloroethylene is the major product of 1,1,2,2-tetrachloroethane hydrolysis, while biodegradation is reported to produce 1,1,2-trichloroethane (Bouwer and McCarty, 1983 as cited in Howard, 1990). Adsorption of 1,1,2,2-tetrachloroethane to stream sediments and bioconcentration in fish is expected to be minimal (Howard, 1990).

As a highly volatile chemical with slow biodegradation in soil and water, most 1,1,2,2-tetrachloroethane releases to any medium will eventually enter the atmosphere. In the atmosphere, 1,1,2,2-tetrachloroethane will disperse and eventually degrade by reaction with photochemically produced hydroxyl radicals. The half-life for this process has been theoretically estimated to be 53 days (Atkinson, 1987 as cited in ATSDR, 1996). Older experimental data suggest that 1,1,2,2-tetrachlorethane may have a significantly longer residence time in the atmosphere, with a half-life of two years (Singh *et al.*, 1981 as cited in HSDB, 2004). Due to potentially long residence times in the atmosphere, a small percentage (~1 percent) of 1,1,2,2-tetrachloroethane is predicted to escape to the stratosphere where it will rapidly degrade through photodissociation (Howard, 1990).

11.2 Health Effects

Data on the toxicity of 1,1,2,2-tetrachloroethane in humans are limited, consisting of one experimental inhalation study, a few case reports of suicidal or accidental ingestion, and dated occupational studies. In most cases, there was no quantification of the exposure. Respiratory and mucosal effects, eye irritation, nausea, vomiting, and dizziness were reported by human volunteers exposed to 1,1,2,2-tetrachloroethane vapors under controlled chamber conditions (Lehmann and Schmidt-Kehl, 1936 as cited in ATSDR, 1996 and USEPA, 1989). Effects from non-lethal occupational exposures included gastric distress (i.e., pain, nausea, vomiting), headache, loss of appetite, an enlarged liver, and cirrhosis (Jeney *et al.*, 1957 as cited in USEPA 1989; Lobo-Mendonca, 1963 as cited in ATSDR, 1996 and USEPA, 1989; Minot and Smith 1921 as cited in ATSDR, 1996).

There have been a variety of animal studies in rats and mice using both the inhalation and oral exposure routes. Recent studies by the National Toxicology Program (NTP, 2004) provide a detailed evaluation of the short-term and subchronic oral toxicity of 1,1,2,2-tetrachloroethane and confirm many of the observations from earlier studies. In rats and mice exposed orally, the liver appears to be the primary target organ. The reference dose (RfD) (10 µg/kg/day) for 1,1,2,2-tetrachloroethane was derived from the benchmark dose level ($BMDL_{10}$) for a 1 standard deviation change in relative liver weight, a biomarker for liver toxicity. A 1,000-fold uncertainty factor was applied in the RfD determination.

A National Cancer Institute (1978 as cited in ATSDR, 1996) bioassay of 1,1,2,2-tetrachloroethane found clear evidence of carcinogenicity in male and female B6C3F1 mice based on a dose-related statistically significant increase in liver tumors. There was equivocal evidence for carcinogenicity in Osborn Mendel rats because of the occurrence of a small number of rare-for-the species neoplastic and preneoplastic lesions in the livers of the high dose animals. The Agency used the slope factor of 8.5×10^{-2} for the tumors in female mice to derive the health reference level (HRL) of 0.4 µg/L for use in the analysis of the occurrence data for 1,1,2,2-tetrachloroethane.

Information on the reproductive effects of 1,1,2,2-tetrachloroethane is limited. There is a single one-generation inhalation study that does not follow a standard methodology and examined a small number of rats (five females and seven males) exposed via inhalation to one dose (13.3 mg/m^3). There were no statistically significant differences in the percentage of females having offspring, number of pups per litter, average birth weight, sex ratio, or post natal offspring mortality (Schmidt *et al.*, 1972). Effects on sperm in male rats were seen after oral (27 mg/kg/day; NTP, 2004) and inhalation (13 mg/m^3; Schmidt *et al.*, 1972) exposures. Similar effects were seen in mice but at higher doses. Fetal toxicity did not occur in the absence of maternal toxicity.

Developmental range-finding studies conducted for NTP (1991a, 1991b) found that 1,1,2,2-tetrachloroethane was toxic to the dams and pups of Sprague Dawley rats and CD-1 Swiss mice. Rats were more sensitive than mice. The "no-observed-adverse-effect level" (NOAEL) in the rats for both maternal toxicity and associated fetal toxicity was 34 mg/kg/day with a "lowest-observed-adverse-effect level" (LOAEL) of 98 mg/kg/day. In mice, the NOAEL was 987 mg/kg/day and the LOAEL was 2,120 mg/kg/day.

EPA also evaluated whether health information is available regarding the potential effects on children and other sensitive populations. Individuals with preexisting liver and kidney damage would likely be sensitive to 1,1,2,2-tetrachloroethane exposure. Low intake of antioxidant nutrients (e.g., Vitamin E, Vitamin C, and selenium) could be a predisposing factor for liver damage. In addition, individuals with a genetically low capacity to metabolize dichloroacetic acid (the primary metabolite of 1,1,2,2-tetrachloroethane) may be at greater risk than the general population as a result of 1,1,2,2-tetrachloroethane exposure.

11.3 Occurrence and Exposure

11.3.1 Use and Environmental Release

Prior to the 1980s, 1,1,2,2-tetrachloroethane was commonly used in the production of other chemicals, primarily trichloroethylene (TCE), tetrachloroethylene (PCE), and 1,2-dichloroethylene (Archer, 1979 as cited in ATSDR, 1996). It was also used as a metal degreaser, an extractant for oils and fats, and a component of paint removers, varnishes and lacquers, and photographic films (Hawley, 1981 as cited in ATSDR, 1996). At one time the compound was also used as an insecticide, fumigant, weedkiller, and insect repellant, but it is not currently registered in the United States for such uses. Approximately 440 million pounds of 1,1,2,2-tetrachloroethane were produced in 1967 (Konietzko, 1984 as cited in ATSDR, 1996). Production fell to 34 million pounds in 1974, and production for commercial uses ceased in the United States by the late 1980s. Imports are also thought to be minimal (ATSDR, 1996).

Although 1,1,2,2-tetrachloroethane is no longer generated as an end product, it is still generated as an intermediate product and/or by-product in the manufacturing of other synthetic chemicals, including trichloroethylene, 1,1,2-trichloroethane, 1,2-dichloroethene, tetrachloroethylene, vinyl chloride, ethylene dichloride, and 1,1,1-trichloroethane. It can occur as a trace contaminant in these and other manufactured chemicals, and in the waste stream of facilities that produce them. ATSDR (1996) lists 15 facilities that produce 1,1,2,2-

tetrachloroethane as a by-product or use it as an intermediate product. (Note: The list is likely not exhaustive.)

1,1,2,2-Tetrachloroethane is listed as a Toxics Release Inventory (TRI) chemical. For a discussion of the nature and limitations of TRI data, see Chapter 2.

TRI data for 1,1,2,2-tetrachloroethane (see Exhibit 11-2) are reported for the years 1988 to 2003 (USEPA, 2006a). Air emissions constitute most of the on-site releases. Reported air releases peaked in 1991 and then generally declined. Surface water discharges ranged in the thousands of pounds until the mid-1990s, and then dropped off significantly until a sharp increase in 2002. There is no detectable pattern in on-site underground injections or releases to land. Reported off-site releases were most significant in the first year of reporting, and then generally declined, with an aberrant peak in 1998. These TRI data for 1,1,2,2-tetrachloroethane were reported from 20 States (AR, CA, CO, CT, FL, KS, KY, LA, MI, MO, NC, NE, NJ, NY, OH, PA, SC, TN, TX, VA), but no more than 11 States reported in a given year. Louisiana and Texas were the only States to report releases every year.

Exhibit 11-2: Environmental Releases (in pounds) of 1,1,2,2-Tetrachloroethane in the United States, 1988-2003

Year	On-Site Releases				Off-Site Releases	Total On- & Off-site Releases
	Air Emissions	Surface Water Discharges	Underground Injection	Releases to Land		
1988	43,865	1,903	0	29	128,750	174,547
1989	35,611	5,429	283	18	15,209	56,550
1990	44,796	3,529	80	495	771	49,671
1991	64,251	2,113	0	0	262	66,626
1992	48,899	5,164	0	0	273	54,336
1993	28,203	2,930	0	1	80	31,214
1994	12,484	1,517	26	0	52	14,079
1995	8,275	2,222	0	0	7	10,504
1996	15,488	130	0	0	7	15,625
1997	13,614	0	0	0	511	14,125
1998	7,299	269	5	0	6,503	14,076
1999	5,202	1	0	15	30	5,248
2000	4,461	13	5	0	631	5,110
2001	3,462	56	0	961	941	5,420
2002	7,879	1,464	0	1	108	9,452
2003	2,729	466	0	66	259	3,520

Source: USEPA, 2006a

11.3.2 Ambient Water Occurrence

Ambient lakes, rivers, and aquifers are sources of drinking water. Data on the occurrence of 1,1,2,2-tetrachloroethane in ambient surface and ground water are available from the National Water Quality Assessment (NAWQA) program of the United States Geological Survey (USGS). For further details on this program, see the discussion of NAWQA in Chapter 2. NAWQA data have been analyzed independently by USGS and EPA. USGS has also collected data on 1,1,2,2-tetrachloroethane occurrence in a review of stormwater studies.

NAWQA VOC National Synthesis

Random and Focused VOC Surveys

Using data collected from the NAWQA Study Units and other sources, USGS and collaborating institutions have recently completed a national synthesis assessment of VOC occurrence in the nation's drinking water supply. The assessment included a random survey (1999-2000) of VOC occurrence in ground and surface water resources used by geographically representative community water systems in different size categories (Grady, 2003) and a focused survey (1999-2001) of VOC occurrence patterns, including seasonal variability, in source waters considered particularly susceptible to MTBE contamination (Delzer and Ivahnenko, 2003). 1,1,2,2-Tetrachloroethane was included as an analyte in both surveys, with a reporting limit of 0.2 µg/L (Ivahnenko *et al.*, 2001).

The national random survey and focused survey both found no detections of 1,1,2,2-tetrachloroethane at the reporting level of 0.2 µg/L (Grady, 2003; Delzer and Ivahnenko, 2003). In addition, the focused survey provided results for 1,1,2,2-tetrachloroethane below the reporting level. At levels as low as the method detection limit (0.026 µg/L), no detections of 1,1,2,2-tetrachloroethane were found (Delzer and Ivahnenko, 2003).

Compilation of Historical VOC Monitoring Data

USGS assessed VOC occurrence in untreated ambient ground water samples collected between 1985 and 1995 by local, State, and federal agencies (Squillace *et al.*, 1999). The samples represented both urban and rural areas, and both drinking water and non-drinking water wells.

Multiple investigators collected 1,1,2,2-tetrachloroethane samples from 204 urban wells and 1,267 rural wells. At a reporting level of 0.2 µg/L, there were no detections of 1,1,2,2-tetrachloroethane.

EPA Summary Analysis of NAWQA Data

Whereas the NAWQA program often uses the most representative data for a site to calculate summary statistics, EPA, with the cooperation of USGS, has performed a summary analysis of all Cycle 1 water monitoring data from all study units (1991-2001) for many of the Second Contaminant Candidate List (CCL 2) contaminants being considered for regulatory determination, including 1,1,2,2-tetrachloroethane. Detection frequencies were simply computed as the percentage of samples and sites with detections (i.e., with at least one result equal to or greater than the reporting limit). Note that reporting limits were not uniform. Sample detections can be biased by frequent sampling in areas with high (or low) occurrence. Calculating the percentage of sites with detections can reduce this bias. For more details on the data set and the EPA analysis, see Chapter 2.

The results of the EPA analysis are presented in Exhibit 11-3. Overall, 1,1,2,2-tetrachloroethane was detected in 0.07% of samples and at 0.07% of sites. 1,1,2,2-Tetrachloroethane was detected more frequently in surface water but at higher concentrations (maximum of 0.38 µg/L) in ground water.

Exhibit 11-3: EPA Summary Analysis of 1,1,2,2-Tetrachloroethane Data from NAWQA Study Units, 1992-2001

	Detection Frequency (detections are results ≥ RL[1])				Concentration Values (of detections, in µg/L)				
	Number of Samples	% Samples with Detections	Number of Sites	% Sites with Detections	Minimum	Median	95th Percen-tile	99th Percen-tile	Maximum
surface water	1,408	0.21%	190	1.05%	0.02	0.08	0.20	0.20	0.20
ground water	4,544	0.02%	4,127	0.02%	0.38	0.38	0.38	0.38	0.38
all sites	5,952	0.07%	4,317	0.07%	0.02	0.14	0.38	0.38	0.38

[1] *RLs (Reporting Limits) for 1,1,2,2-tetrachloroethane varied but did not exceed 0.2 µg/L. For more information, see Chapter 2. Note that because this EPA analysis involves more data points than the USGS analyses presented above, a direct comparison is not possible.*

USGS Stormwater Studies

For the National Highway Runoff Data and Methodology Synthesis, USGS conducted a review of 44 highway and urban runoff studies implemented since 1970 (Lopes and Dionne, 1998). 1,1,2,2-Tetrachloroethane results are reported in four of these studies. For background information on this review, see Chapter 2.

Three of the studies were stormwater studies conducted in major metropolitan areas in connection with National Pollutant Discharge Elimination System (NPDES) permitting. In metropolitan Phoenix (Maricopa County), USGS collected 35 samples from 5 drainage basins and the City of Phoenix collected an additional 26 samples from 7 sites (Lopes *et al.*, 1995). In Colorado Springs, 35 samples were collected from 5 sites (von Guerard and Weiss, 1995). In Dallas-Fort Worth, 182 samples were collected from 26 stormwater drainage basins (Baldys *et al.*, 1998). The reporting limits were 0.2 µg/L in Phoenix and Colorado Springs, and they ranged from 0.2 to 10 µg/L in Dallas-Fort Worth. Not all samples were monitored for every contaminant. These three studies found no detections of 1,1,2,2-tetrachloroethane above the reporting limits.

The fourth study analyzed 86 urban runoff samples from 15 U.S. cities, collected between 1979 and 1982 in connection with the National Urban Runoff Program (Cole *et al.*, 1984). 1,1,2,2-Tetrachloroethane was detected in 2 percent of samples, in concentrations ranging from 2 µg/L to 3 µg/L. All detections were from Long Island, New York. A detection limit was not reported.

11.3.3 Drinking Water Occurrence

Nationally representative data on 1,1,2,2-tetrachloroethane occurrence in drinking water were collected by large and small public water systems under EPA's Unregulated Contaminant Monitoring (UCM) program (1987-1999).

UCM Program, Rounds 1 and 2

Round 1 of the UCM lasted from 1988 to 1992, and Round 2 lasted from 1993 to 1999. A geographical cross-section of States with the most complete and reliable data was chosen to provide a roughly representative picture of national occurrence in each round. For more details on the UCM program, see Chapter 2 and USEPA (2006b).

Exhibits 11-4 and 11-5 show the results from the Round 1 and Round 2 cross-sections. Results from all States, including those with incomplete and less reliable data, are also presented for the sake of comparison. Results are analyzed at the level of simple detections (at or above the minimum reporting level, or ≥ MRL), exceedances of the health reference level (> HRL, or > 0.4 µg/L), and exceedances of one half the value of the HRL (> ½ HRL, or > 0.2 µg/L). MRLs for 1,1,2,2-tetrachloroethane were not uniform. They varied from 0.01 µg/L to 10 µg/L in the first round, and from 0.01 µg/L to 2.5 µg/L in the second round. The modal (most common) MRL in both rounds was 0.5 µg/L. Because the MRL was often higher than the HRL and ½ HRL, it is likely that the sampling failed to capture some HRL and ½ HRL exceedances at the participating systems, and that the HRL and ½ HRL analyses underestimate actual 1,1,2,2-tetrachloroethane occurrence. However, all MRLs fell within (or below) the risk range of 10^{-6} to 10^{-4} used by EPA to evaluate carcinogens (see Section 2.1.1).

In Round 1 cross-section States, 1,1,2,2-tetrachloroethane was detected at approximately 0.45% of public water systems (PWSs), affecting 1.86% of the population served, equivalent to approximately 4.0 million people nationally. Exceedances of one-half the value of the HRL were found at 0.22% of PWSs, affecting 1.69% of the population served, equivalent to approximately 3.6 million people nationally. HRL exceedances were found at 0.20% of PWSs, affecting 1.63% of the population served, equivalent to approximately 3.5 million people nationally.

When all Round 1 results are included in the analysis, including results from States with incomplete or less reliable data, 1,1,2,2-tetrachloroethane detection frequencies appear to be slightly higher than the cross-section data indicate. Detections affect 0.48% of PWSs and 2.16% of the population served; exceedances of the ½ HRL benchmark affect 0.26% of PWSs and 1.99% of the population served; and HRL exceedances affect 0.24% of PWSs and 1.90% of the population served.

In Round 2 cross-section States, 1,1,2,2-tetrachloroethane was detected at 0.08% of PWSs, affecting 2.61% of the population served, equivalent to approximately 5.6 million people nationally. The ½ HRL benchmark was exceeded in 0.07% of PWSs (18 of 24,800), affecting 0.51% of the population served, equivalent to approximately 1.1 million people nationally. The HRL benchmark was exceeded in 0.07% of PWSs (17 of 24,800—one fewer than the ½ HRL benchmark), affecting 0.08% of the population served, equivalent to approximately 0.2 million people nationally. Round 2 generally shows lower occurrence of 1,1,2,2-tetrachloroethane than Round 1. One apparently contradictory indicator, the strikingly high proportion of the population served by PWSs with detections in Round 2, is due to the unusually large size of one of the relatively few contaminated surface water systems.

Including Round 2 results from all reporting States in the analysis does not change the picture of 1,1,2,2-tetrachloroethane occurrence significantly. Detections affect 0.08% of PWSs and 2.23% of the population served; ½ HRL exceedances affect 0.07% of PWSs and 0.44% of the population served; and HRL exceedances affect 0.06% of PWSs and 0.08% of the population served.

Exhibit 11-4: Summary UCM Occurrence Statistics for 1,1,2,2-Tetrachloroethane (Round 1)

Frequency Factors	24-State Cross-Section[1]		All Reporting States[2]		National System & Population Numbers[3]	
Total Number of Samples	67,688		70,784		--	
Percent of Samples with Detections	0.16%		0.16%		--	
99th Percentile Concentration (all samples)	< MRL		< MRL		--	
Health Reference Level (HRL)	0.4 µg/L		0.4 µg/L		--	
Minimum Reporting Level (MRL) - Range - (modal value)[4]	0.01 - 10 µg/L (0.5 µg/L)		0.01 - 10 µg/L (0.5 µg/L)		--	
Maximum Concentration of Detections	200 µg/L		200 µg/L		--	
99th Percentile Concentration of Detections	112 µg/L		112 µg/L		--	
Median Concentration of Detections	0.5 µg/L		0.5 µg/L		--	
Total Number of PWSs Number of GW PWSs Number of SW PWSs	20,407 18,693 1,867		20,899 19,054 2,019		65,030 59,440 5,590	
Total Population Population of GW PWSs Population of SW PWSs	94,710,065 55,763,644 43,763,942		98,334,686 57,663,608 45,776,159		213,008,182 85,681,696 127,326,486	
Occurrence by System	**Number**	**Percentage**	**Number**	**Percentage**	**National Extrapolation[5]**	
					Cross-Section	**All States**
PWSs with detections (≥ MRL)	91	0.45%	101	0.48%	290	314
Range across States	0 - 39	0 - 11.64%	0 - 39	0 - 100%	N/A	N/A
GW PWSs with detections	72	0.39%	80	0.42%	229	250
SW PWSs with detections	19	1.02%	21	1.04%	57	58
PWSs > 1/2 HRL	44	0.22%	54	0.26%	140	168
Range across States	0 - 11	0 - 2.76%	0 - 11	0 - 100%	N/A	N/A
GW PWSs > 1/2 HRL	33	0.18%	41	0.22%	105	128
SW PWSs > 1/2 HRL	11	0.59%	13	0.64%	33	36
PWSs > HRL	41	0.20%	50	0.24%	131	156
Range across States	0 - 11	0 - 2.76%	0 - 11	0 - 100%	N/A	N/A
GW PWSs > HRL	32	0.17%	39	0.20%	102	122
SW PWSs > HRL	9	0.48%	11	0.54%	27	30
Occurrence by Population Served						
Population served by PWSs with detections	1,762,198	1.86%	2,119,844	2.16%	3,963,000	4,592,000
Range across States	0 - 616,019	0 - 25.48%	0 - 616,019	0 - 100%	N/A	N/A
Pop. Served by GW PWSs with detections	1,017,630	1.82%	1,365,976	2.37%	1,564,000	2,030,000
Pop. Served by SW PWSs with detections	744,568	1.70%	753,868	1.65%	2,166,000	2,097,000
Population served by PWSs > 1/2 HRL	1,597,140	1.69%	1,954,786	1.99%	3,592,000	4,234,000
Range across States	0 - 616,019	0 - 25.48%	0 - 616,019	0 - 100%	N/A	N/A
Pop. Served by GW PWSs > 1/2 HRL	864,770	1.55%	1,213,116	2.10%	1,329,000	1,803,000
Pop. Served by SW PWSs > 1/2 HRL	732,370	1.67%	741,670	1.62%	2,131,000	2,063,000
Population served by PWSs > HRL	1,543,647	1.63%	1,868,493	1.90%	3,472,000	4,047,000
Range across States	0 - 616,019	0 - 25.48%	0 - 616,019	0 - 100%	N/A	N/A
Pop. Served by GW PWSs > HRL	851,641	1.53%	1,167,187	2.02%	1,309,000	1,734,000
Pop. Served by SW PWSs > HRL	692,006	1.58%	701,306	1.53%	2,013,000	1,951,000

1. Summary Results based on 24-State Cross-Section, UCM Round 1 data.
2. Summary Results based on All Reporting States, UCM Round 1 data.
3. Total PWS and population numbers are from EPA March 2000 Water Industry Baseline Handbook, 2nd Edition.
4. Because several different analytical methods were used, MRLs were not uniform. The modal value is the most common MRL.
5. National extrapolations are generated by multiplying the system/population percentages and the national Baseline Handbook system/population numbers.

Abbreviations:
PWS = Public Water Systems; GW = Ground Water; SW = Surface Water; N/A = Not Applicable; Total Number of Samples = total number of samples on record for the contaminant; 99th Percentile Concentration = the concentration in the 99th percentile sample (out of either all samples or just samples with detections); Median Concentration of Detections = the concentration in the median sample (out of samples with detections); Total Number of PWSs = the total number of PWSs for which sampling results are available; Total Population Served = the total population served by PWSs for which sampling results are available; PWSs with Detections, PWSs > ½ HRL, or PWSs > HRL = PWSs with at least one sampling result greater than or equal to the MRL, exceeding the ½ HRL benchmark, or exceeding the HRL benchmark, respectively; Population Served by PWSs with Detections, by PWSs > ½ HRL, or by PWSs > HRL = population served by PWSs with at least one sampling result greater than or equal to the MRL, exceeding the ½ HRL benchmark, or exceeding the HRL benchmark, respectively.

Notes:
-Only results at or above the MRL were reported as detections. Concentrations below the MRL are considered non-detects.
-Because some systems were counted as both ground water and surface water systems and others could not be classified, GW and SW figures might not add up to totals.
-Due to differences between the ratios of GW and SW systems with monitoring results and the national ratio, extrapolated GW and SW figures might not add up to extrapolated totals.
-Due to MRL variability, it is likely that the sampling failed to capture some ½ HRL and HRL exceedances at the participating systems, and the ½ HRL and HRL analyses underestimate actual contaminant occurrence.
-The HRL used in this analysis is a draft value for working review only.

Exhibit 11-5: Summary UCM Occurrence Statistics for 1,1,2,2-Tetrachloroethane (Round 2)

Frequency Factors	20-State Cross-Section[1]		All Reporting States[2]		National System & Population Numbers[3]	
Total Number of Samples	98,911		112,480		--	
Percent of Samples with Detections	0.02%		0.03%		--	
99th Percentile Concentration (all samples)	< MRL		< MRL		--	
Health Reference Level (HRL)	0.4 µg/L		0.4 µg/L		--	
Minimum Reporting Level (MRL) - Range - (modal value)[4]	0.1 - 2.5 µg/L (0.5 µg/L)		0.1 - 2.5 µg/L (0.5 µg/L)		--	
Maximum Concentration of Detections	2 µg/L		3.9 µg/L		--	
99th Percentile Concentration of Detections	2 µg/L		3.9 µg/L		--	
Median Concentration of Detections	0.5 µg/L		0.5 µg/L		--	
Total Number of PWSs Number of GW PWSs Number of SW PWSs	24,800 22,106 2,694		28,209 25,152 3,057		65,030 59,440 5,590	
Total Population Population of GW PWSs Population of SW PWSs	71,294,263 25,978,359 45,315,904		84,692,367 31,069,576 53,622,791		213,008,182 85,681,696 127,326,486	
Occurrence by System	**Number**	**Percentage**	**Number**	**Percentage**	**National Extrapolation[5]**	
					Cross-Section	**All States**
PWSs with detections (≥ MRL)	19	0.08%	22	0.08%	50	51
Range across States	0 - 9	0 - 0.50%	0 - 9	0 - 3.49%	N/A	N/A
GW PWSs with detections	11	0.05%	13	0.05%	30	31
SW PWSs with detections	8	0.30%	9	0.29%	17	16
PWSs > 1/2 HRL	18	0.07%	19	0.07%	47	44
Range across States	0 - 9	0 - 0.50%	0 - 9	0 - 1.16%	N/A	N/A
GW PWSs > 1/2 HRL	11	0.05%	12	0.05%	30	28
SW PWSs > 1/2 HRL	7	0.26%	7	0.23%	15	13
PWSs > HRL	17	0.07%	18	0.06%	45	41
Range across States	0 - 9	0 - 0.50%	0 - 9	0 - 1.16%	N/A	N/A
GW PWSs > HRL	11	0.05%	12	0.05%	30	28
SW PWSs > HRL	6	0.22%	6	0.20%	12	11
Occurrence by Population Served						
Population served by PWSs with detections	1,862,105	2.61%	1,892,850	2.23%	5,563,000	4,761,000
Range across States	0 - 1,500,000	0 - 29.92%	0 - 1,500,000	0 - 29.92%	N/A	N/A
Pop. Served by GW PWSs with detections	24,115	0.09%	51,543	0.17%	80,000	142,000
Pop. Served by SW PWSs with detections	1,837,990	4.06%	1,841,307	3.43%	5,164,000	4,372,000
Population served by PWSs > 1/2 HRL	362,105	0.51%	371,980	0.44%	1,082,000	936,000
Range across States	0 - 306,000	0 - 7.12%	0 - 306,000	0 - 7.12%	N/A	N/A
Pop. Served by GW PWSs > 1/2 HRL	24,115	0.09%	33,990	0.11%	80,000	94,000
Pop. Served by SW PWSs > 1/2 HRL	337,990	0.75%	337,990	0.63%	950,000	803,000
Population served by PWSs > HRL	56,105	0.08%	65,980	0.08%	168,000	166,000
Range across States	0 - 26,550	0 - 0.54%	0 - 26,550	0 - 0.54%	N/A	N/A
Pop. Served by GW PWSs > HRL	24,115	0.09%	33,990	0.11%	80,000	94,000
Pop. Served by SW PWSs > HRL	31,990	0.07%	31,990	0.06%	90,000	76,000

1. Summary Results based on 20-State Cross-Section, UCM Round 2 data.
2. Summary Results based on All Reporting States, UCM Round 2 data.
3. Total PWS and population numbers are from EPA March 2000 Water Industry Baseline Handbook, 2nd Edition.
4. Because several different analytical methods were used, MRLs were not uniform. The modal value is the most common MRL.
5. National extrapolations are generated by multiplying the system/population percentages and the national Baseline Handbook system/population numbers.

Abbreviations:
PWS = Public Water Systems; GW = Ground Water; SW = Surface Water; N/A = Not Applicable; Total Number of Samples = total number of samples on record for the contaminant; 99th Percentile Concentration = the concentration in the 99th percentile sample (out of either all samples or just samples with detections); Median Concentration of Detections = the concentration in the median sample (out of samples with detections); Total Number of PWSs = the total number of PWSs for which sampling results are available; Total Population Served = the total population served by PWSs for which sampling results are available; PWSs with Detections, PWSs > ½ HRL, or PWSs > HRL = PWSs with at least one sampling result greater than or equal to the MRL, exceeding the ½ HRL benchmark, or exceeding the HRL benchmark, respectively; Population Served by PWSs with Detections, by PWSs > ½ HRL, or by PWSs > HRL = population served by PWSs with at least one sampling result greater than or equal to the MRL, exceeding the ½ HRL benchmark, or exceeding the HRL benchmark, respectively.

Notes:
-Only results at or above the MRL were reported as detections. Concentrations below the MRL are considered non-detects.
-Due to differences between the ratios of GW and SW systems with monitoring results and the national ratio, extrapolated GW and SW figures might not add up to extrapolated totals.
-Due to MRL variability, it is likely that the sampling failed to capture some ½ HRL and HRL exceedances at the participating systems, and the ½ HRL and HRL analyses underestimate actual contaminant occurrence.
-The HRL used in this analysis is a draft value for working review only.

Each of the following maps focuses on a somewhat different aspect of the geographical distribution of 1,1,2,2-tetrachloroethane occurrence. Exhibit 11-6 identifies all States with at least one PWS with a detection of 1,1,2,2-tetrachloroethane in Round 1 or Round 2. All States are included in this analysis, including both cross-section States with reliable data and non-cross-section States with less reliable data, in order to provide the broadest assessment of possible 1,1,2,2-tetrachloroethane occurrence. Exhibit 11-7 presents the same information (identifying States with detections, regardless of whether they were included in the cross-sections) separately for Round 1 (1988-1992) and Round 2 (1993-1999), to reveal temporal trends.

Exhibit 11-8 illustrates the geographic distribution of States with different detection frequencies (percentage of PWSs with at least one detection), and Exhibit 11-9 illustrates the geographic distribution of different HRL exceedance frequencies (percentage of PWSs with at least one HRL exceedance). Only cross-section States, which have the most complete and reliable occurrence data, are included in these two analyses. In each exhibit, Round 1 data are presented in the upper map and Round 2 data are presented in the lower map to reveal temporal trends.

In each map, two color categories represent States with no data. Those in white do not belong to the relevant Round or cross-section, and those in the lightest category of shading were included in the Round or cross-section but have no data for 1,1,2,2-tetrachloroethane. The darker shades are used to differentiate occurrence findings in States with 1,1,2,2-tetrachloroethane data.

The large number of Northeastern and Great Lakes States reporting at least one detection, especially in Round 1, suggests a possible regional problem. However, States with detections are distributed from the east to the west coast, and from the Canadian to the Mexican borders. Even the States with the highest proportion of PWSs with detections are generally distributed across the United States.

Exhibit 11-6: Geographic Distribution of 1,1,2,2-Tetrachloroethane Detections in Both Cross-Section and Non-Cross-Section States (Combined UCM Rounds 1 and 2)

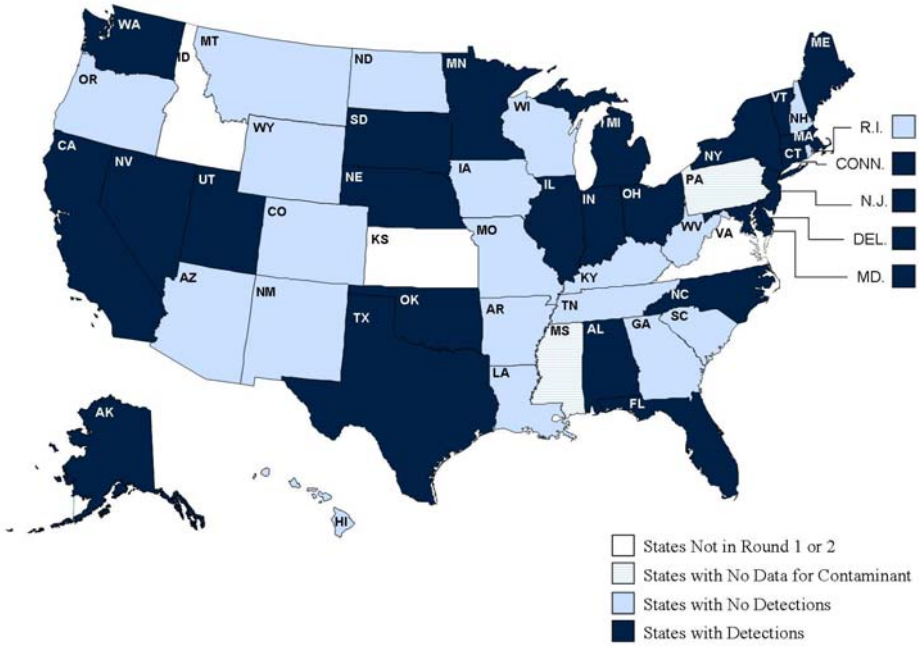
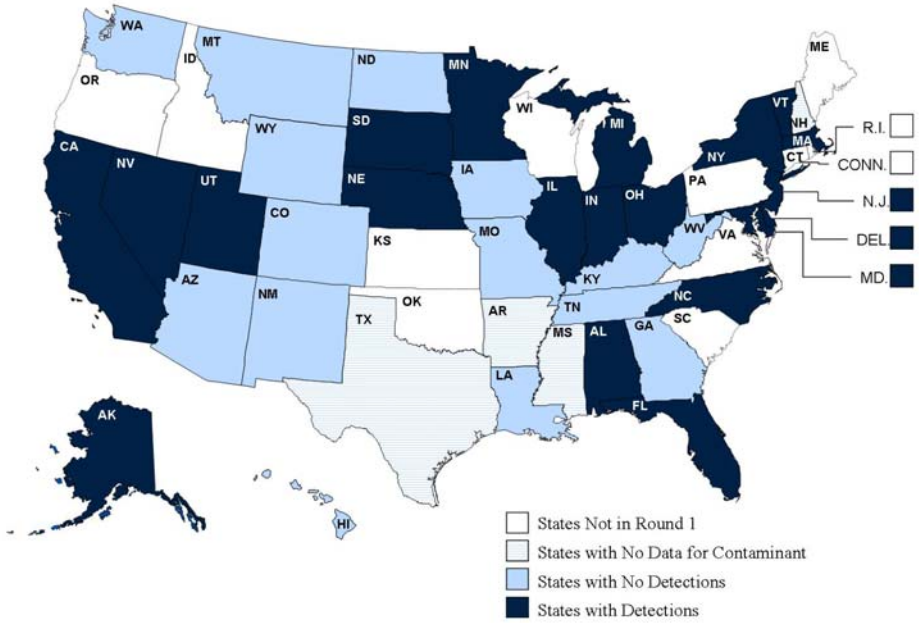


Exhibit 11-7: Geographic Distribution of 1,1,2,2-Tetrachloroethane Detections in Both Cross-Section and Non-Cross-Section States (Above: UCM Round 1; Below: UCM Round 2)



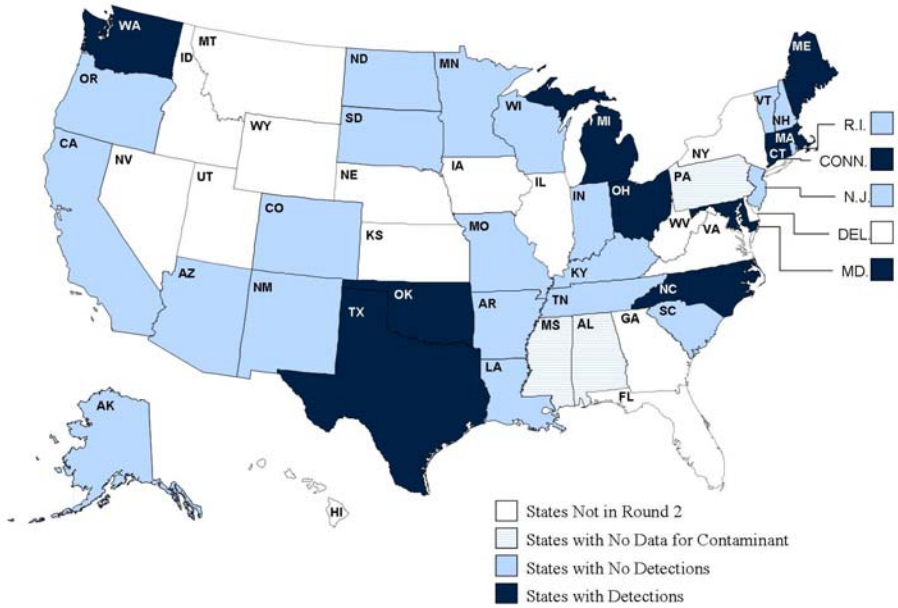
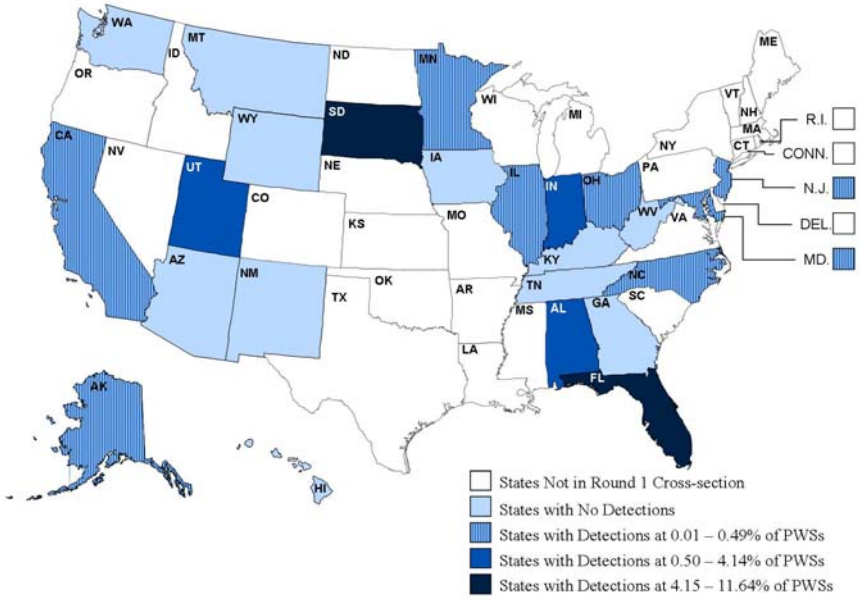


Exhibit 11-8: Geographic Distribution of 1,1,2,2-Tetrachloroethane Detection Frequencies in Cross-Section States (Above: UCM Round 1; Below: UCM Round 2)



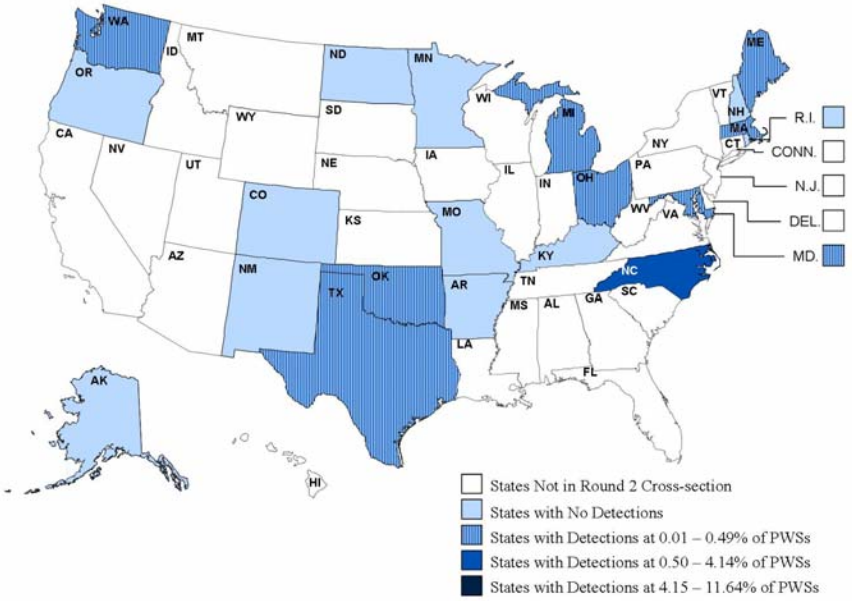
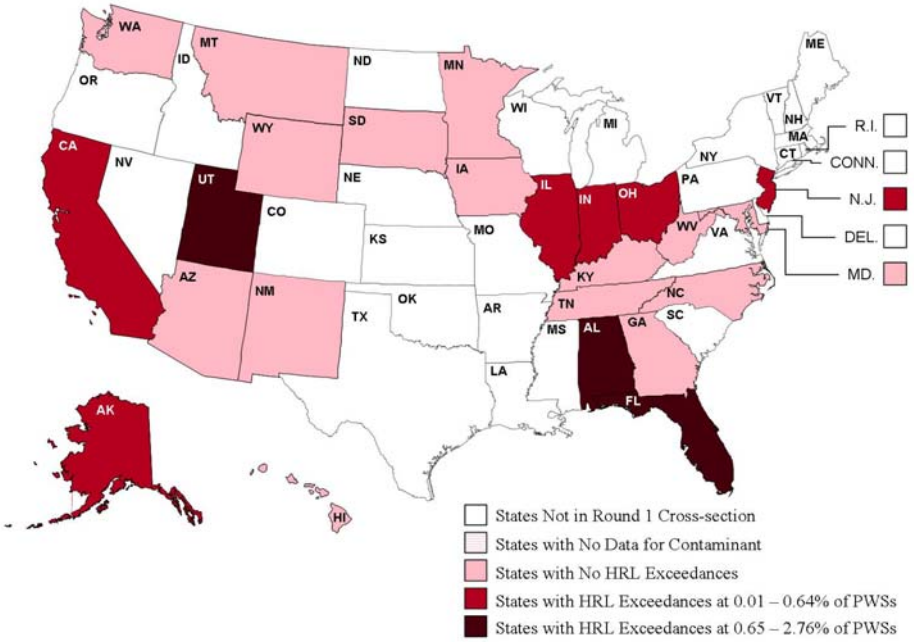
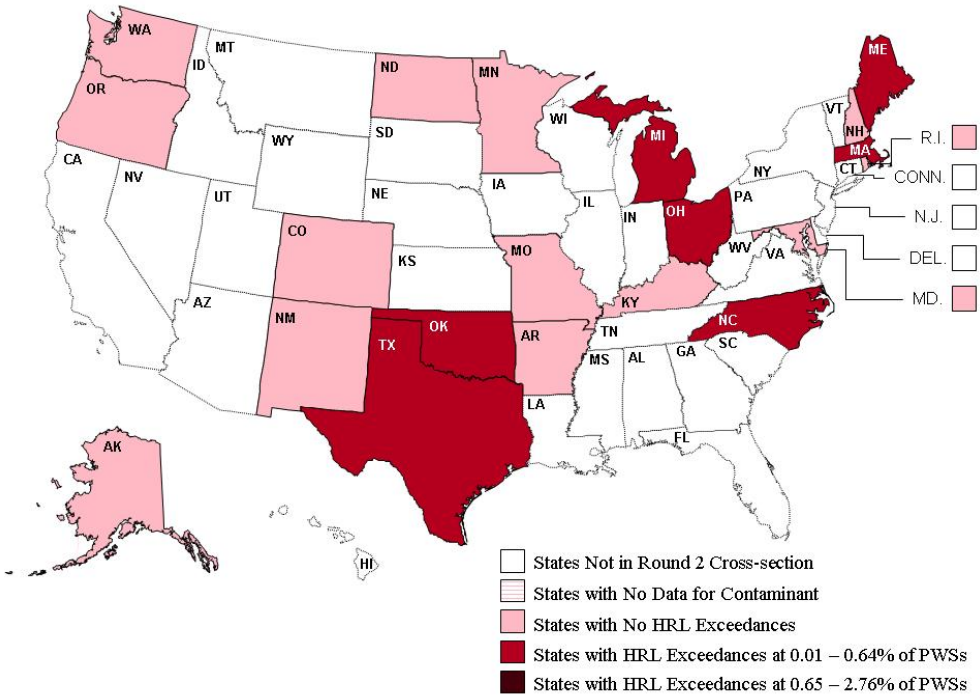


Exhibit 11-9: Geographic Distribution of 1,1,2,2-Tetrachloroethane HRL Exceedance Frequencies in Cross-Section States (Above: UCM Round 1; Below: UCM Round 2)

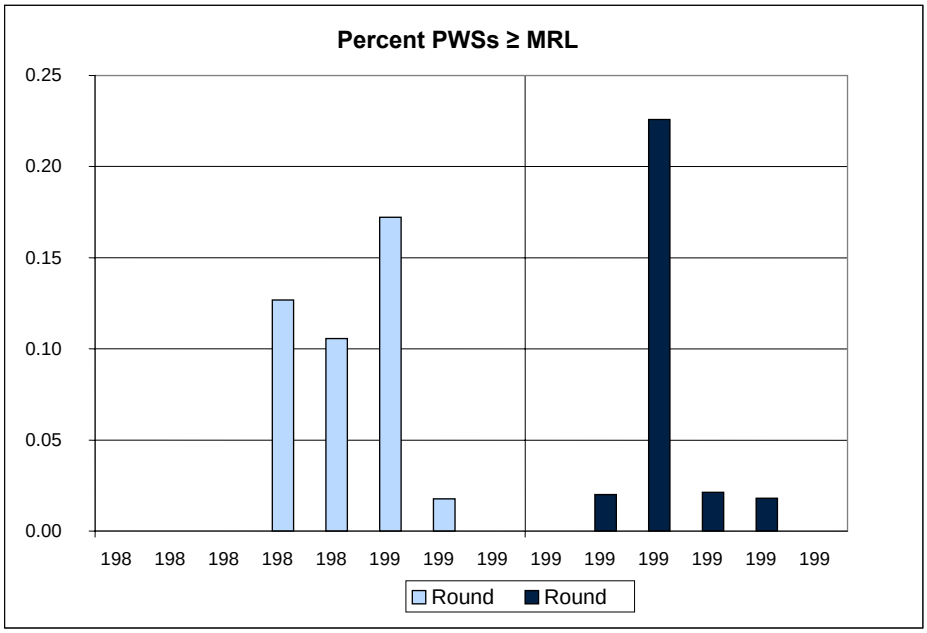


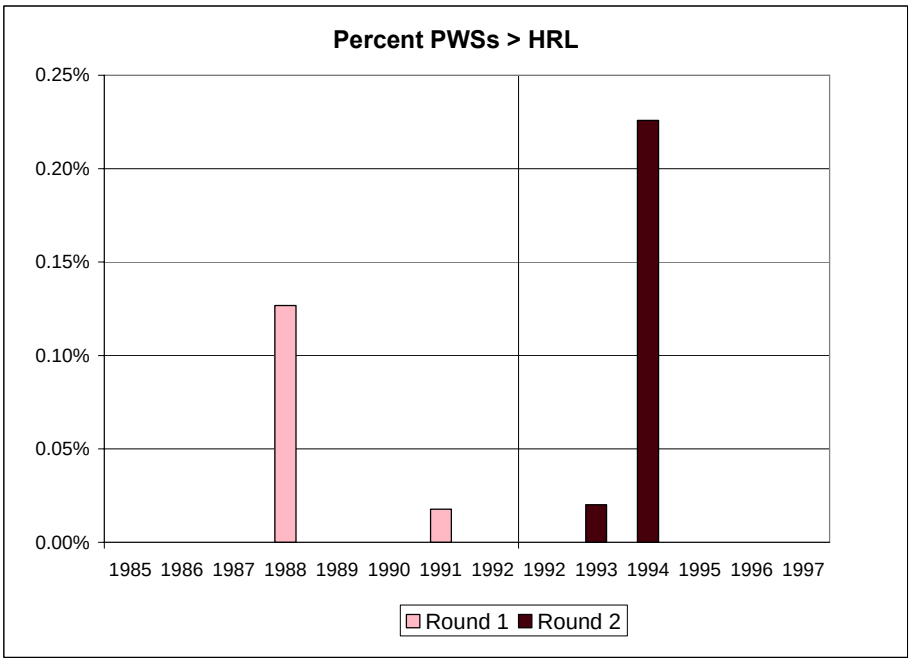


Eight States (AK, KY, MD, MN, NM, NC, OH, and WA) contributed 1,1,2,2-tetrachloroethane data to both the Round 1 and Round 2 cross-sections. While these States are

not necessarily nationally representative, they enable a preliminary assessment of temporal trends in 1,1,2,2-tetrachloroethane occurrence. Exhibits 11-10 and 11-11 suggest that detections in those States were most common in 1988-1990, and again in 1994. HRL exceedances were also most common in 1988 and 1994. Only three of the eight States had detections in both Rounds, and only one State (Ohio) had HRL exceedances in both Rounds.

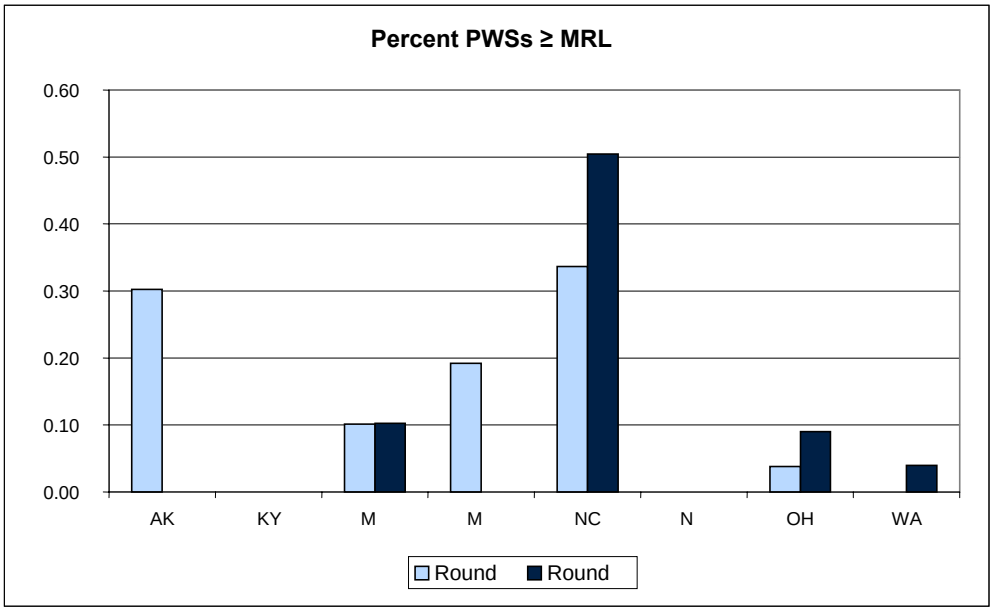
Exhibit 11-10: Annual Frequency of 1,1,2,2-Tetrachloroethane Detections (above) and HRL Exceedances (below), 1985 - 1997, in Select Cross-Section States

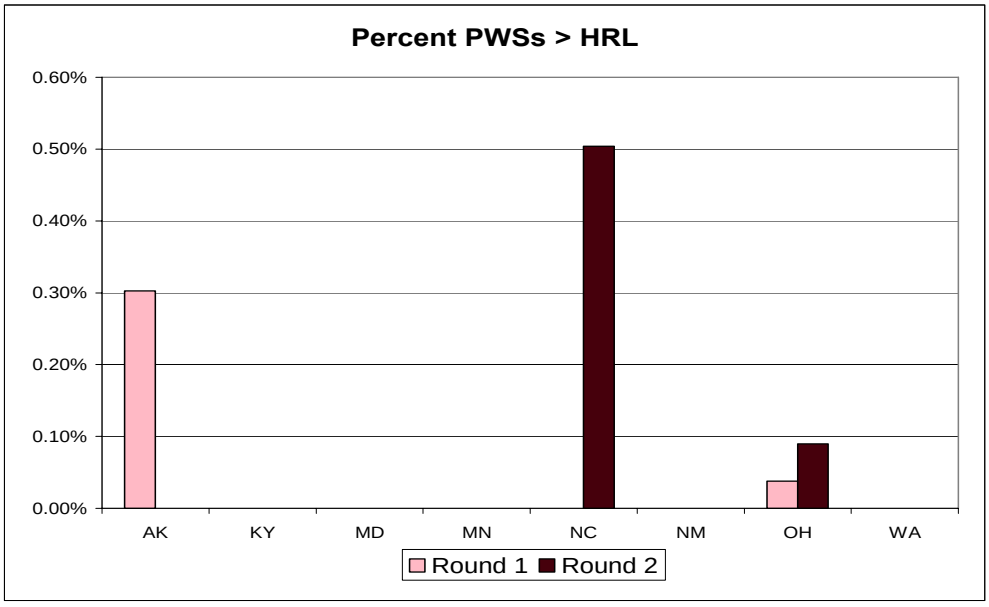




Notes: Data are from AK, KY, MD, MN, NC, NM, OH, and WA. (These eight States are the only States in both the Round 1 and Round 2 cross-sections.) Both Round 1 and Round 2 have data for 1992; 1992 results from each Round are presented separately. The HRL for 1,1,2,2-tetrachloroethane is 0.4 µg/L.

Exhibit 11-11: Distribution of 1,1,2,2-Tetrachloroethane Detections (above) and HRL Exceedances (below) Among Select Cross-Section States





Notes: These eight States are the only States in both the Round 1 cross-section and the Round 2 cross-section. The HRL for 1,1,2,2-tetrachloroethane is 0.4 µg/L.

11.4 Technology Assessment

11.4.1 Analytical Methods

Two analytical methods are available for detecting 1,1,2,2-tetrachloroethane in drinking water. EPA Methods 502.2 and 524.2 rely on purge and trap gas chromatography (GC) followed by either electrolytic conductivity detection (ELCD) or mass spectrometry (MS). A description of these methods can be found in EPA's *Methods for the Determination of Organic Compounds in Drinking Water, Supplement III,* available from the Drinking Water Public Docket or the National Technical Information Service (USEPA, 1995a). Historically, Methods 502.1 and 524.1 were also used to collect occurrence data for 1,1,2,2-tetrachloroethane. These methods are based on similar technology to Methods 502.2 and 524.2, but are now considered obsolete. Their approval for use for compliance monitoring of VOCs was withdrawn as of July 1, 1996.

The MDL and the average recovery for each analytical method that can be used for the analysis of 1,1,2,2-tetrachloroethane are included in the method descriptions below.[1]

EPA Method 502.2

EPA Method 502.2 (Revision 2.1), entitled "*Volatile Organic Compounds in Water by Purge and Trap Capillary Column Gas Chromatography with Photoionization and Electrolytic Conductivity Detectors in Series*," determines the presence of VOCs in water samples using GC with ELCD or photoionization (PID). However, only ELCD can be used for 1,1,2,2-tetrachloroethane analysis, as this compound does not respond to PIDs.

The method detection limit (MDL) for 1,1,2,2-tetrachloroethane using this method is reported to range from 0.01 to 0.02 µg/L, and the average recovery is reported to range from 99 to 100 percent, depending on the method option used (USEPA, 1995b).

EPA Method 524.2

EPA Method 524.2 (Revision 4.1), "*Measurement of Purgeable Organic Compounds in Water by Capillary Column Gas Chromatography/Mass Spectrometry,*" is used to detect VOCs, including 1,1,2,2-tetrachloroethane, in finished drinking water, raw source water, or drinking water in any treatment stage.

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[1] The Method Detection Limit (MDL) is a statistical estimate of the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero, *i.e.*, greater than the background signal. The calculation of the MDL is based upon the precision of a series of replicate measurements of the analyte at low concentrations. The MDL incorporates estimates of the accuracy of the determination. The MDL is not a concentration that can typically be measured by the method on a routine basis. Detection limits may vary between analysts and laboratories under various laboratory conditions.

The average recovery is the fraction or percent concentration of a target analyte determined relative to the true or expected concentration from a sample containing a known amount of the target analyte. (This can result in apparent recovery values greater than 100 percent.)

VOCs such as 1,1,2,2-tetrachloroethane are extracted by bubbling an inert gas through the aqueous sample. Purged sample components are trapped in a tube containing suitable sorbent materials. When purging is complete, the sorbent tube is heated and backflushed with helium to thermally desorb trapped sample components onto a capillary GC column. The column is temperature-programmed to separate the method analytes, which are then detected with a mass spectrometer. Analytes are identified and quantitated by comparison to standard materials (USEPA, 1995c).

The MDL for 1,1,2,2-tetrachloroethane using this method is reported to range from 0.04 to 0.2 µg/L, and the average recovery is reported to range from 91 to 100 percent, depending on the method option used (USEPA, 1995c).

11.4.2 Treatment Technologies

Treatment technology status does not influence the determination of whether or not a contaminant should be regulated. However, treatment technologies must be readily available before a contaminant can be regulated with a national primary drinking water regulation (NPDWR). Potential treatment technologies for removing 1,1,2,2-tetrachloroethane include air stripping and activated carbon.

Air stripping involves the continuous contact of air with the water being treated, allowing dissolved volatile contaminants to transfer from the source water to the air. Systems often consist of a large column (or tower) filled with molded plastic or ceramic packing material. As the water flows along the column, air is forced counter-current through the water. The packing material increases the area of air-liquid interface, enhancing mass transfer. After contact, the air is vented to an additional treatment device that safely contains or destroys the contaminant.

The Henry's Law constant is commonly used to indicate the tendency of a contaminant to partition from water to air. A larger Henry's constant indicates a greater equilibrium concentration of the contaminant in the air. A compound is generally considered amenable to air stripping if it has a Henry's constant above that of dibromochloropropane (0.003 mol/mol) or ethylene dibromide (0.013 mol/mol) (Speth *et al.*, 2001). Speth *et al.* (2001) compiled Henry's Law constants, both calculated by the authors and reported in the literature, for Contaminant Candidate List (CCL) compounds. These authors report Henry's Law constants of 0.012 mol/mol and 0.016 mol/mol for 1,1,2,2-tetrachloroethane, suggesting that air stripping might be a viable treatment option (Speth *et al.*, 2001).

Granular activated carbon (GAC) treatment removes contaminants via the physical and chemical process of sorption: the contaminants attach to the carbon surface as water passes through the carbon bed. Activated carbon has a large sorption capacity for many water impurities, including synthetic organic chemicals, taste- and odor-causing compounds, and some species of mercury.

Adsorption capacity is typically represented by the Freundlich isotherm constant, with higher Freundlich (K) values indicating greater sorption potential. Activated carbon is considered to be cost-effective for removing a particular contaminant if the Freundlich (K) value of the contaminant is above 200 µg/g $(L/\mu g)^{1/n}$ (Speth *et al.*, 2001). Speth and Adams (1993 as

cited in Speth *et al.*, 2001) report that the Freundlich (K) value for 1,1,2,2-tetrachloroethane is 823 μg/g $(L/\mu g)^{1/n}$, which indicates that GAC might be a viable treatment option.

11.5 Regulatory Determination

The Agency has made a preliminary determination not to regulate 1,1,2,2-tetrachloroethane with an NPDWR. Because 1,1,2,2-tetrachloroethane appears to occur infrequently at health levels of concern in PWSs, the Agency believes that an NPDWR does not present a meaningful opportunity for health risk reduction. While 1,1,2,2-tetrachloroethane was detected in both the UCM Round 1 and the UCM Round 2 surveys, the percentage of detections had decreased by the time the UCM Round 2 survey was performed in the mid-1990's. In addition, the USGS did not detect 1,1,2,2-tetrachloroethane in two subsequent monitoring surveys of source waters that supply community water systems using a reporting limit that is less than the 1,1,2,2-tetrachloroethane HRL. The Agency believes that this decrease in detections occurred because commercial production of 1,1,2,2-tetrachloroethane ceased in the mid-1980's. Hence, the Agency does not expect 1,1,2,2-tetrachloroethane to occur in many public water systems today.

EPA recognizes that 1,1,2,2-tetrachloroethane is listed as a likely human carcinogen. For this reason, the Agency encourages those States with public water systems that may have 1,1,2,2-tetrachloroethane above the HRL to evaluate site-specific protective measures and to consider whether State-level guidance (or some other type of action) is appropriate. The Agency also plans to update the Health Advisory document for 1,1,2,2-tetrachloroethane to provide more recent health information. The updated Health Advisory will provide information to any States with public water systems that may have 1,1,2,2-tetrachloroethane at levels above the HRL.

The Agency's preliminary regulatory determination for this contaminant is presented formally in the *Federal Register*.

11.6 References

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