ENVIRONMENTAL CONTAMINANTS ENCYCLOPEDIA

DICHLOROETHYLENE-1,1 (1,1- DICHLOROETHYLENE) ENTRY

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Like a library or most large databases (such as EPA's national STORET water quality database), this document contains information of variable quality from very diverse sources. In compiling this document, mistakes were found in peer reviewed journal articles, as well as in databases with relatively elaborate quality control mechanisms [366,649,940]. A few of these were caught and marked with a "[sic]" notation, but undoubtedly others slipped through. The [sic] notation was inserted by the editors to indicate information or spelling that seemed wrong or misleading, but which was nevertheless cited verbatim rather than arbitrarily changing what the author said.

Most likely additional transcription errors and typos have been added in some of our efforts. Furthermore, with such complex subject matter, it is not always easy to determine what is correct and what is incorrect, especially with the "experts" often disagreeing. It is not uncommon in scientific research for two different researchers to come up with different results which lead them to different conclusions. In compiling the Encyclopedia, the editors did not try to resolve such conflicts, but rather simply reported it all.

It should be kept in mind that data comparability is a major problem in environmental toxicology since laboratory and field methods are constantly changing and since there are so many different "standard methods" published by EPA, other federal agencies, state agencies, and various private groups. What some laboratory and field investigators actually do for standard operating practice is often a unique combination of various standard protocols and impromptu "improvements." In fact, the interagency task force on water methods concluded that [1014]:

> It is the exception rather than the rule that water-quality monitoring data from different programs or time periods can be compared on a scientifically sound basis, and that...
>
> No nationally accepted standard definitions exist for water quality parameters. The different organizations may collect data using identical or standard methods, but identify them by different names, or use the same names for data collected by different methods [1014].

Differences in field and laboratory methods are also major issues related to (the lack of) data comparability from media other than water: soil, sediments, tissues, and air.

In spite of numerous problems and complexities, knowledge is often power in decisions related to chemical contamination. It is therefore often helpful to be aware of a broad universe of conflicting results or conflicting expert opinions rather than having a portion of this information arbitrarily censored by someone else. Frequently one wants to know of the existence of information, even if one later decides not to use it for a particular application. Many would like to see a high percentage of the information available and decide for themselves what to throw out, partly because they don't want to seem uniformed or be caught by surprise by potentially important information. They are in a better position if they can say: "I knew about that data, assessed it based on the following quality assurance criteria, and decided not to use it for this application." This is especially true for users near the end of long decision processes, such as hazardous site cleanups, lengthy ecological risk assessments, or complex natural resource damage assessments.

For some categories, the editors found no information and inserted the phrase "no information found." This does not necessarily mean that no information exists; it

simply means that during our efforts, the editors found none. For many topics, there is probably information "out there" that is not in the Encyclopedia. The more time that passes without encyclopedia updates (none are planned at the moment), the more true this statement will become. Still, the Encyclopedia is unique in that it contains broad ecotoxicology information from more sources than many other reference documents. No updates of this document are currently planned. However, it is hoped that most of the information in the encyclopedia will be useful for some time to come even with out updates, just as one can still find information in the 1972 EPA Blue Book [12] that does not seem well summarized anywhere else.

Although the editors of this document have done their best in the limited time available to insure accuracy of quotes or summaries as being "what the original author said," the proposed interagency funding of a bigger project with more elaborate peer review and quality control steps never materialized.

> The bottom line: The editors hope users find this document useful, but don't expect or depend on perfection herein. Neither the U.S. Government nor the National Park Service make any claims that this document is free of mistakes.

The following is one chemical topic entry (one file among 118). Before utilizing this entry, the reader is strongly encouraged to read the README file (in this subdirectory) for an introduction, an explanation of how to use this document in general, an explanation of how to search for power key section headings, an explanation of the organization of each entry, an information quality discussion, a discussion of copyright issues, and a listing of other entries (other topics) covered.

See the separate file entitled REFERENC for the identity of numbered references in brackets.

HOW TO CITE THIS DOCUMENT: As mentioned above, for critical applications it is better to obtain and cite the original publication after first verifying various data quality assurance concerns. For more routine applications, this document may be cited as:

> **Irwin, R.J., M. VanMouwerik, L. Stevens, M.D. Seese**, and **W. Basham.** 1997. Environmental Contaminants Encyclopedia. National Park Service, Water Resources Division, Fort Collins, Colorado. Distributed within the Federal Government as an Electronic Document (Projected public availability

on the internet or NTIS: 1998).

Dichloroethylene-1,1 (1,1- Dichloroethylene; DCE; 1,1-DCE; Vinylidene chloride; Dichloroethylene, 1,1-; 1,1-Dichloroethene; CAS number 75-35-4)

Brief Introduction:

Br.Class: General Introduction and Classification Information:

The compound 1,1-Dichloroethene is a volatile organic compound (VOC) [868] and chlorinated solvent [609] which eventually breaks down into vinyl chloride by undergoing reductive dechlorination [580]. Vinylidene chloride is structurally related to the known carcinogen, vinyl chloride [893]. Considered a purgeable halocarbon (40 CFR, Part 136, Appendix A, page 400, 1994) [1010].

The compound 1,1-Dichloroethene (1,1-dichloroethylene) is a chemical used to make certain plastics (such as packaging materials, flexible films like SARAN wrap) and flame-retardant coatings for fiber and carpet backing. It is a clear, colorless liquid that evaporates quickly at room temperature. It has a mild, sweet smell like chloroform and burns quickly [932].

The compound 1,1-Dichloroethene (1,1-dichloroethylene) is a man-made chemical and is not found naturally in the environment. Although 1,1-dichloroethene is manufactured in large quantities, most of it is used to make other substances or products such as polyvinylidene chloride [932].

The compound 1,1-Dichloroethene (1,1-dichloroethylene) can enter the environment when it is released to the air during its production or released to surface water or soil as a result of waste disposal. Most 1,1-dichloroethene evaporates quickly and mainly enters the environment through the air, although some enters into rivers or lakes. It may enter soil, water, and air in large amounts during an accidental spill. 1,1-Dichloroethene can also enter the environment as a breakdown product of other chemicals in the environment [932].

Dichloroethylene is a carcinogenic priority pollutant [446]. It is used in the manufacture of chemicals (plastics, dyes, perfumes paints and synthetic chemicals [658].

According to EPA's health advisories (available through the Office of Drinking Water, EPA, Washington, D.C. or through NTIS) on vinyl chloride and dichloroethylene, vinyl chloride is a degradation product of

trichloroethylene and tetrachloroethylene in groundwater, with dichloroethylene being an intermediate breakdown product. The common progression is tetrachloroethylene to trichloroethylene to dichloroethylene to vinyl chloride (Mario Fernandez, Jr., USGS, personal communication, 1994).

Designated as a hazardous substance under section 311(b)(2)(A) of the Federal Water Pollution Control Act and further regulated by the Clean Water Act Amendments of 1977 and 1978. These regulations apply to discharges of this substance (40 CFR 116.4, 7/1/88) [609].

Toxic pollutant designated pursuant to section 307(a)(1) of the Clean Water Act and is subject to effluent limitations (40 CFR 401.15, 7/1/88) [609].

Br.Haz: General Hazard/Toxicity Summary:

Potential Hazards to Fish, Wildlife, Invertebrates, Plants, and other Non-Human Biota:

There has been more publicity and attention given to this VOC as a potential hazard to humans than to fish or wildlife; thus there is more literature related to humans and the information found on other species is comparatively sparse compared to the more detailed human health literature. The imbalance in favor of human effects information (and information on human surrogates: rats and mice), as reflected in the sections below, will hopefully be corrected in the future as more ecological effects information becomes available.

Animals fed food that contained 1,1-dichloroethene or that had it placed experimentally in their stomachs developed liver and kidney disease, and some even died [932].

Effects of this volatile solvent to non-human biota could potentially result from high concentrations immediately after a spill (before the compound has volatilized into the atmosphere) or be the indirect result of contamination of groundwater. For example, if highly polluted groundwater water comes into surface or cave waters from springs or seeps, local effects may occur in the mixing zone where the groundwater enters surface water (Roy Irwin, National Park Service, Personal Commuication, 1997)..

Potential Hazards to Humans:

The ATSDR found no information on the health effects in humans who ate food or drank water that contained 1,1-dichloroethene. Although animals fed 1,1-dichloroethene developed liver and kidney disease and (some) died, the amount fed them were very much higher than those in drinking water supplies [932].

Humans are exposed to vinylidene chloride (synonym for 1,1-dichloroethylene) from ambient air, particularly near industrial sources and contaminated drinking water. Indoor air sometimes contains vinylidene chloride although its source is unknown. Exposure can also occur from ingestion of food wrapped in plastic with residue vinylidene chloride monomer (Fishbein L; Sci Total Environ 11: 111-61, 1979) [609].

In air around waste sites where it has been identified, the amount of 1,1-dichloroethene ranges from 0.39 to 97 parts 1,1-dichloroethene per billion parts of air (ppb, 1 ppb is 1,00 times more than 1 ppt) [932]. The levels of 1,1-dichloroethene in air around waste sites are usually much lower than those that have caused health effects in animals [932].

One potentially important aspect of the presence of dichloroethylene (DCE) is that it can breakdown into vinyl chloride; therefore, groundwater which has been polluted with DCE, once the DCE concentrations seem to be approaching acceptably low concentrations, often still needs to be checked for hazardous or toxic breakdown products.

A comprehensive toxicological profile for 1,1-dichloroethylene (1,1-dichloroethene), especially as it relates to human health, is available from ATSDR [932]. Due to lack of time, information highlights from this ATSDR document have not yet been completely incorporated into this entry. Also, EPA has a free and informative (several page) health advisory on this compound, available through the Office of Drinking Water, EPA, Washington, D.C. or through NTIS.

Br.Car: Brief Summary of Carcinogenicity/Cancer Information:

EPA 1996 IRIS Information [893]:

Evidence for classification as to human carcinogenicity; weight-of-evidence classification:

Classification: C; possible human carcinogen [893].

Basis: Tumors observed in one mouse strain after inhalation exposure is the basis for this classification. Other studies were of inadequate design. Vinylidene chloride is mutagenic, and a metabolite is known to alkylate and to bind covalently to DNA. It is structurally related to the known human carcinogen, vinyl chloride [893].

Human carcinogenicity data: Inadequate. An epidemiologic study of 138 workers showed no carcinogenic effect associated with vinylidene chloride exposure (Ott et al., 1976). Based on power considerations, this study is inadequate for assessing cancer risk in humans [893].

Animal carcinogenicity data: Limited. Eighteen animal studies have been reported, which provide information about the carcinogenic potential of vinylidene chloride. Eleven of the studies involved inhalation exposure, five were oral, and one each was by skin application and subcutaneous injection. Most were not designed for maximum sensitivity to detect carcinogenic effects [893].

Considered a carcinogen for EPA PRG and RBC modeling purposes [868,903].

The Human Health Assessment Group in EPA's Office of Health and Environmental Assessment has evaluated 1,1-dichloroethylene for carcinogenicity. According to their analysis, the weight-of-evidence for 1,1-dichloroethylene is group C, which is based on no evidence in humans and limited evidence in animals. As a group C chemical, 1,1-dichloroethylene is considered to be possibly carcinogenic to humans (USEPA; Methodology for Evaluating Potential Carcinogenicity in Support of Reportable Quantity Adjustments Pursuant to Cercla Section 102 (Final) p.39, 1988, EPA/600/8-89/053) [609].

IARC Summary and Evaluation [609]:

Inadequate evidence of carcinogenicity in humans. Limited evidence of carcinogenicity in animals. Overall evaluation: Group 3: The agent is not classifiable as to its carcinogenicity to humans. [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer,1972-present. (Multivolume work).,p. S7 73 (1987)].

Br.Dev: Brief Summary of Developmental, Reproductive, Endocrine, and Genotoxicity Information:

Based on studies in laboratory animals, it is prudent to consider that potential adverse maternal and developmental effects could occur in humans exposed to 1,1-dichlorethene [932].

Rats were given vinylidene chloride either as 200 mg/l in drinking water or as 80-640 mg/cu m (20-160 ppm) by inhalation for 7 hr/day on days 6-15 of gestation; rabbits were given the same dose by inhalation on days 6-18 of gestation. No teratogenic effect was seen in either rats or rabbits, although some evidence of embryotoxicity & fetotoxicity was observed in both species exposed by inhalation; these effects were associated with maternally toxic levels of exposure (IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer,1972-present. (Multivolume work).,p. V19 446, 1979) [609].

No studies were located by ATSDR regarding reproductive effects of 1,1-dichloroethene in humans [932]. Three rat studies (found in the literature by ATSDR) showed no reproductive effects to rats that were exposed by inhalation or by ingestion of contaminated water [932]. The biological significance of these findings in animals with regard to potential reproductive effects of 1,1-dichloroethene in humans is not known [932].

The available data suggest that 1,1-dichloroethene produces genotoxic effects in a number of test systems, including bacteria, yeast, plants, cultured mammalian cells (in vitro), and mice (in vivo) [932].

Vinylidene chloride is mutagenic to bacteria and this activity is largely dependent on microsomal activation. Vinylidene chloride gave positive results for gene reversion in yeast that was also dependent on metabolic activation, and was positive in Tradescantia. In mammalian systems, vinylidene chloride failed to induce gene mutations in V79 cells at two separate loci, failed to induce chromosomal aberrations in mouse bone marrow in vivo, and failed to induce dominant lethals in either mice or rats. Vinylidene chloride was found to alkylate DNA of mice exposed through inhalation and may have caused unscheduled DNA synthesis in kidneys of similarly exposed mice (Jacobson-Kram D; Environ Mutagen 8, 1: 161-69, 1986) [609].

Vinylidene chloride has been shown to be mutagenic for Salmonella typhimurium in multiple assays. This activity

is largely dependent on the presence of microsomal enzymes. It has been used as a positive control in studies of chemicals that are gases at or near room temperature. Both conventional and host-mediated assays of Saccharomyces cerevisiae have been positive for mitotic gene conversion [893].

Br.Fate: Brief Summary of Key Bioconcentration, Fate, Transport, Persistence, Pathway, and Chemical/Physical Information:

From water, 1,1-dichloroethene (1,1-dichloroethylene) evaporates into the air; it breaks down very slowly in water. It is not readily transferred to fish or birds and only very small amounts enter the food chain. It is not known exactly how long 1,1-dichloroethene stays in water, but it is known that it stays (persists) longer in lakes than in rivers [932].

In soil, 1,1-dichloroethene (1,1-dichloroethylene) either evaporates to the air or percolates down through soil with rainwater and enters underground water. Small living organisms in soil and groundwater may change it into other less harmful substances, although this happens slowly [932].

One potentially important aspect of the presence of dichloroethylene is that it can breakdown into vinyl chloride by undergoing reductive dechlorination [580]. According to EPA's health advisories (available through the Office of Drinking Water, EPA, Washington, D.C. or through NTIS) on vinyl chloride and dichloroethylene, vinyl chloride is a degradation product of trichloroethylene and tetrachloroethylene in groundwater, with dichloroethylene being an intermediate breakdown product. The common progression is tetrachloroethylene to trichloroethylene to dichloroethylene to vinyl chloride (Mario Fernandez, Jr., USGS, personal communication, 1994).

Although some vinyl chloride can result from the breakdown of the above-listed solvents, not 100% of the breakdown route is to vinyl chloride (some other breakdown pathways exist and different resultant breakdown products are sometimes produced) (Karl Ford, BLM, personal communication, 1994).

Environmental Fate/Exposure Summary: Vinylidene chloride (1,1-dichloroethylene) enters the atmosphere from its production and use in the manufacture of plastics such as saran wrap. It is released in wastewater from plastics manufacturing and metal finishing. Releases to water will primarily be lost to the atmosphere through evaporation.

Once in the atmosphere it will degrade rapidly by photooxidation with a half-life of 11 hours in relatively clean air or under 2 hours in polluted air. If spilled on land, part of the vinylidene chloride will evaporate and part will leach into the groundwater where its fate is unknown, but degradation is expected to be slow based upon microcosm studies. Vinylidene chloride would not be expected to bioconcentrate into fish. Major human exposure is from occupational atmospheres. The general population may be exposed to low levels of vinylidene chloride in ambient air, indoor air, contaminated drinking water, and food which has come in contact with plastic wrap which contains residual monomer [609].

Low or moderate levels breathed in (25-200 ppm) or taken by mouth (up to 50 milligrams per kilogram of (human) body weight) leave the body mainly as breakdown products in the urine [932]. As the amount of 1,1-dichloroethene that enters the body increases, more and more 1,1-dichloroethene leaves the body in the exhaled breath [932]. Whether 1,1-dichloroethene is inhaled or taken by mouth it leaves the body in about the same way [932]. 1,1-Dichloroethene is not stored very much in the body when low-to-moderate amounts enter the body [932].

Synonyms/Substance Identification:

DCE [617]
Vinylidene chloride [617]
DICHLOROETHENE, 1,1- [617]
1,1-Dichloroethene [617]
1,1-DCE [609]
ASYM-DICHLOROETHYLENE [609]
CHLORURE DE VINYLIDENE (FRENCH) [609]
ETHENE, 1,1-DICHLORO- [609]
ETHYLENE, 1,1-DICHLORO- [609]
VDC [609]
VINYLIDENE CHLORIDE, MONOMER [609]
VINYLIDENE CHLORIDE (II) [609]
VINYLIDENE CHLORIDE (INHIBITED) [609]
VINYLIDENE DICHLORIDE [609]
VINYLIDINE CHLORIDE [609]
VC [609]
as-Dichloroethylene [609]
NCI-C54262 [609]

Molecular Formula [609]:
C2-H2-Cl2

Associated Chemicals or Topics (Includes Transformation Products):

See also individual entries:

Tetrachloroethylene
Trichloroethylene
Vinyl Chloride

Impurities [609]:

Water content (75 ppm), acetylene (25 ppm), acidity as hydrochloric acid (15 ppm), iron (0.5 ppm), methyl ether hydroquinone (180-220 ppm), trans-dichloroethylene (0.25%), 1,1-dichloroethane (0.25%), trichloroethylene (0.25%), ethylene dichloride (0.25%), peroxides (H2O2) (25 ppm). [Dow Chem Co; Vinylidene Chloride Methyl Ether Hydroquinone (MEHQ) Inhibited. Quality Assurance Sales Specification Sheet (1970) as cited in USEPA; Phase I Document: Vinylidene Chloride p.5 (1981) EPA No. 68-01-6030].

A typical analysis of commercial-grade vinylidene chloride monomer (excluding inhibitors) is as follows: vinylidene chloride 99.8%; trans-1,2-dichloroethylene 900 ppm; vinyl chloride 800 ppm; 1,1,1-trichloroethane 150 ppm; cis-1,2-dichloroethylene 10 ppm; and 1,1-dichloroethane, ethylene chloride, and trichloroethylene, each less than 10 ppm. [USEPA; Health Assessment Document: Vinylidene Chloride p.3-5 (1983) EPA-600/8-83-031A].

Dichloroacetylene has been reported to be an impurity in some commercial samples of vinylidene chloride. [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer,1972-PRESENT. (Multivolume work).,p. V39 196 (1986)].

Metabolism/Metabolites [609]:

Biotransformation of vinylidene chloride gives thiodihydroxyacetic acid & n-acetyl-s-cysteinylacetyl deriv as major urinary metabolites, together with substantial amt of chloroacetic acid, dithiohydroxyacetic acid (dithioglycolic acid) & thiohydroxyacetic acid (thioglycolic acid). [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer,1972-PRESENT. (Multivolume work).,p. V19 446 (1979)].

Following administration of a single oral dose of (14)C-vinylidene chloride by gavage to 180-to-220 g female Wistar rats, isolated 24 hr urinary metabolites /included/ n-acetyl-S-(2-carboxymethyl)cysteine and n-(hydroxyethyl)-methylthioacetamide. [Reichert D et al; Arch Toxicol 42: 159-69 (1979) as cited in USEPA; Phase I Document: Vinylidene Chloride p.50 (1981) EPA No. 68-01-6030].

Metabolic conversion of vinylidene chloride into an epoxide which can rearrange to corresponding acyl chloride has been

proposed. [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer,1972-PRESENT. (Multivolume work).,p. V19 446 (1979)].

Comparative studies in mice & rats have revealed that mice, which are more susceptible to vinylidene chloride than rats, biotransform the chemical to a greater extent than rats. [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer,1972-PRESENT. (Multivolume work).,p. V39 211 (1986)].

A gram- positive, strictly anaerobic, motile, endospore-forming rod, tentatively identified as a proteolytic Clostridium sp, was isolated from the effluent of an anaerobic suspended-growth bioreactor. The organism was able to biotransform 1,1,1-trichloroethane, trichloromethane, and tetrachloromethane. 1,1,1-Trichloroethane was completely transformed (99.5%) by reductive dehalogenation to 1,1-dichloroethane (30 to 40%) and, presumably by other mechanisms, to acetic acid (7%) and unidentified products. ... 1,1-Dichloroethene, and 1,1-dichloroethane, were not biotransformed significantly by the organism. [Galli R, McCarty PL; Appl Environ Microbiol 55 (4): 837-44 (1989)].

In vivo metabolic constants were determined in male Fischer rats for five chemicals: 1,1-dichloroethylene, diethyl ether, bromochloromethane, methyl chloroform, and carbon tetrachloride in a closed recirculated exposure system. Metabolism of both 1,1-dichloroethylene and carbon tetrachloride was represented by a single saturable process while methyl chloroform required only a first-order pathway. Bromochloromethane and diethyl ether exhibited a combination of both a saturable and a first-order process. Pyrazole, which blocks oxidative microsomal metabolism, inhibited the saturable pathways of 1,1-dichloroethylene, bromochloromethane, diethyl ether, and carbon tetrachloride metabolism and abolished the first-order pathway for methyl chloroform. The maximum velocity of metabolism for the saturable pathway with 1,1-dichloroethylene, bromochloromethane, diethyl ether, and carbon tetrachloride for a 225 g rat was 27.2, 19.9, 26.1, and 0.92 mol/hr, respectively. The simulation approach distinguishes between single and multiple metabolic pathways. [Gargas ML et al; Toxicol Appl Pham 86 (3): 341-52 (1986)].

The metabolic activation of 1,1-dichloroethylene by mouse lung and liver microsomes was studied in vitro. Lung and liver microsomes from CD-1-mice were incubated with (14)C-1,1-dichloroethylene. The effects on covalent binding of 1,1-dichloroethylene to microsomal macromolecules were determined. ... Phenobarbital pretreatment had no effect on 1,1-dichloroethylene microsomal binding. Pretreatment with 3-

methylcholanthrene had no effect on 1,1-dichloroethylene lung microsomal binding, but increased 1,1-dichloroethylene liver microsome binding. Piperonyl butoxide inhibited binding in both microsome preparations. SKF525A inhibited binding only in liver microsomes. Lung and liver can metabolize 1,1-dichloroethylene as indicated by covalent binding of 1,1-dichloroethylene. [Forhert PG et al; Can J Phys Pharm 65 (7): 1496-99 (1987)].

Water Data Interpretation, Concentrations and Toxicity (All Water Data Subsections Start with "W."):

W.Low (Water Concentrations Considered Low):

None detected in raw surface water in 105 U.S. cities in a 1980 study [932].

W.High (Water Concentrations Considered High):

Potential industrial sources of waste 1,1- dichloroethene in surface water are metal finishing and nonferrous metals manufacturing industries, soap and detergent manufacturers, electric coil coating and battery manufacturers, coal mines, laundries, and industries involving paint and ink formulation [932]. 1,1-Dichloroethene has been measured in raw waste water from these industries at mean concentrations of 3-760 ug/L [932].

The concentration of 1,1-dichloroethene in groundwater samples from hazardous waste sites ranged from 0.001 to 0.09 ppm [932].

Water 1,1-Dichloroethene concentrations: 5 mg/L have been measured in raw waste water from the metal finishing and nonferrous metals manufacturing industries [932]. Lower concentrations (<1 mg/L) have been measured in raw waste water from industries involving paint and ink formulation, soap and detergent manufacturing, coil coating, battery manufacturing, coal mining and laundries [932]. Treated waste waters from all these industries ranged from 1 to 4 mg/L [932]. According to the STORET database maintained by the EPA, 1,1-dichloroethene has been detected in 3.3% of 1,350 effluent samples monitored nationwide [932]. 1,1-Dichloroethene has been detected in surface waters sampled near industrial sites at concentrations ranging from less than 1 to 550 ug/L [932].

Effluents Concentrations [609]:

Detected, not quantified in effluent from USA latex and chemical manufacturing plants(1,2). 32 ppb -

discharged from a chemical manufacturing plant, the Netherlands(1,2). Samples from the 4 largest, publicly owned, treatment plants in Southern Calif were as follows: primary effluent, 3 of 4 pos, < 10 to 20 ppb, secondary effluent, 2 of 3 pos, < 10 ppb, 7 mile sludge and centrate, 2 of 3 pos, < 10 ppb(3). Detected in 1 of 2 municipal treatment plants(4). Industries with mean effluent conc > 100 ppb - metal finishing (760 ppb), non-ferrous metal mfg and organic chemicals mfg/plastics(5). 17% of 48 samples of influent to a sewage treatment plant in US pos, 5.0 ppb avg when found above detection limit(4). [(1) IARC; Monograph Some Monomers, Plastics and Synthetic Elastomers, and Acrolein 19: 439-59 (1979) (2) Fishbein L; Sci Total Environ 11: 111-61 (1979) (3) Young DR; Ann Rep Southern Calif Coastal Water Res Proj p 103-12 (1978) (4) Callahan MA et al; Proc Natl Conf Munic Sludge Manag 8th p 55-61 (1979) (5) USEPA; Treatability Manual page I.12.24-1 to I.12.24-5 USEPA 600/2-82-001a (1981)].

In a comprehensive survey of wastewater from 4000 industrial and publicly owned treatment works (POTWs) sponsored by the Effluent Guidelines Div of the U.S. EPA, vinylidene chloride was identified in discharges of the following industrial category (frequency of occurrence, median conc in ppb): timber products (2; 10.8), steam electric (2; 38.8), petroleum refining (1; 8.0), nonferrous metals (3; 2.9), paint and ink (1; 4.6), printing and publishing (1; 152.6), organics and plastics (31; 35.7), inorganic chemicals (2; 20.7), pulp and paper (4; 9.3), rubber processing (1; 137.7), auto and other laundries (6; 32.8), pesticides manufacture (2; 246.8), organic chemicals (2; 675.8), transportation equipment (1; 238.0), publicly owned treatment works (40; 23.0)(1). The highest effluent conc was 3,636 ppb in the auto and other laundries industry(1). [(1) Shackelford WM et al; Analyt Chim Acta 146: 157 (1983)].

W.Typical (Water Concentrations Considered Typical):

Mean concentration in the 3 % of surface waters where it was detected in 1985: 0.3 ug/l [932]. According to the STORET database maintained by the EPA, 1,1-dichloroethene has been detected in 6% of 8,714 surface water samples monitored nationwide [932]. However, no 1,1-dichloroethene was detected in raw surface water during a 105-city survey of U.S.cities [932]. 1,1-Dichloroethene has been detected infrequently at low concentrations in urban runoff that will contribute to surface water

concentrations [932]. The Nationwide Urban Runoff Program (NURP), initiated to evaluate the significance of priority pollutants in urban storm water runoff, report a detection frequency of only 3%, with a concentration range of 1.5-4 ug/L [932].

About 3% of the drinking water supplies in the United States have been found to contain 1,1-dichloroethene at 0.2-0.5 ug/L (estimated mean 0.3 ug/L) concentration in an EPA survey [932]. 1,1-Dichloroethene was also detected (quantification limit of 0.2 ppb) in 2.3% of the 945 samples of finished drinking water taken from community-based groundwater sources in a nationwide survey [932].

I,1-Dichloroethene was detected in 9 of 466 U.S.drinking water wells sampled in the 1982 Ground Water Supply Survey at a median concentration of 0.3 ug/L [932]. 1,1-Dichloroehtene has been detected in 25.2% of 178 contaminated sites monitored under the Comprehensive Emergency Response, Compensation, and Liability Act (CERCLA) making it the fifth most frequently detected [932].

Information from HSDB [609]:

> DRINKING WATER: In a nationwide survey, vinylidene chloride was detected in 7.1% of finished supplies from groundwater sources(4). In 1979, the highest reported concn was 0.1 ppb(1,3). Of 103 USA cities sampled, 1.9% pos, 0.36 mean ppb mean, 0.2-0.51 ppb range in finished surface water(5). 13 USA cities sampled, 7.7% pos, 0.2 ppb mean and max, in finished groundwater(2,5). In a screening of 1174 community wells and 617 private wells in Wisconsin, 1 community and 3 private wells had detectable levels of vinylidene chloride(6). USA Groundwater Supply Survey (945 supplies derived from groundwater chosen both randomly and on the basis that they may contain VOCs) - 24 samples positive for vinylidene chloride, max 6.3 ppb(7). Mean and max conc of vinylidene chloride in 2 New Jersey supplies serving roughly 100,000 persons each ranged from 0.1-0.2 and 0.9-2.5 ppb, respectively(8). [(1) IARC; Monograph. Some Monomers, Plastics and Synthetic Elastomers, and Acrolein. 19: 439-59 (1979) (2) Council on Environmental Quality Contamination of Groundwater by Toxic Organic Chemicals (1981) (3) Fishbein L; Sci Total Environ 11: 111-61 (1979) Arbor Sci p 305-27 (1976) (4) Dyksen JE, Hess AF III; J Amer Water Works Assoc 74:394-403 (1982) (5) Coniglio WA et al; The Occurrence of Volatile Organics in Drinking Water Exposure Assessment Project. Criteria and Standards Division, Science and

Technology Branch (1980) (6) Krill RM, Sonzogni WC; J Am Water Works Assoc 78: 70-5 (1986) (7) Westrick JJ et al; J Am Water Works Assoc 76: 52-9 (1984) (8) Wallace LA et al; Environ Res 43: 290-307 (1987)].

GROUNDWATER: Contaminated drinking water wells in New Jersey, Massachusetts and Maine had maximum vinylidene chloride concentrations of 280, 118, and 70 ppb, respectively(3). A 13-US city survey of raw groundwater supplies resulted in 15.4% pos, and 0.5 ppb avg and max(2). Miami, Florida had 0.1 ppb vinylidene chloride in their raw drinking water supply(1). As reported by Aerojet-General Corp, vinylidene chloride was detected in several domestic and industrial well water samples in Sacramento, CA(4). [(1) Coleman WE et al; p.305-27 in Analysis and Identification of Organic Substances in Water, Keith L ed Ann Arbor, MI: Ann Arbor Sci (1976) (2) Coniglio WA et al; The Occurrence of Volatile Organics in Drinking Water Exposure Assessment Project. Criteria and Standards Division, Science and Technology Branch (1980) (3) Burmaster DE; Environ 24: 6-13,33-6 (1982) (4) USEPA; Subst Risk Not, 8(e) 35 USEPA 560/11-80-020].

SURFACE WATER: 3 tributaries and 7 of 8 sites on the Ohio River pos (4972 samples, 343 pos), 304 samples 0.1 to 1.0 ppb, 36 samples 1.0 to 10 ppb, and 3 samples >10 ppb(3). 2 of 4 cities with surface water contaminated with industrial, municipal, agricultural, and natural waste as a source of drinking water supply contained vinylidene chloride in the raw water; of the pos supplies one contained <0.1 ppb and one was not quantified(1). In a survey of 105 USA cities using surface water supplies, no vinylidene chloride was detected in the raw water(2). [(1) Coleman WE et al; p.305-27 in Analysis and Identification of Organic Substances in Water, Keith L ed Ann Arbor, MI: Ann Arbor Sci (1976) (2) Coniglio WA et al; The Occurrence of Volatile Organics in Drinking Water Exposure Assessment Project. Criteria and Standards Division, Science and Technology Branch (1980) (3) Ohio River Valley Water Sanit Comm; Assessment of water quality conditions, Ohio River Mainstream 1980-81 Cincinnati, OH (1982)].

W.Concern Levels, Water Quality Criteria, LC50 Values, Water Quality Standards, Screening Levels, Dose/Response Data, and Other Water Benchmarks:

W.General (General Water Quality Standards, Criteria, and Benchmarks Related to Protection of Aquatic Biota in General; Includes Water Concentrations Versus Mixed or General Aquatic Biota):

EPA 1996 IRIS information [893]:

Ambient Water Quality Criteria for Aquatic Organisms:

Acute Freshwater: 1.16E+4 ug/L LEC [893].

Chronic Freshwater: None Given. [893].

Acute Marine: 2.24E+5 ug/L LEC [893].

Chronic Marine: None Given. [893].

Reference: 45 FR 79318 (11/28/80) [893].

Contact: Criteria and Standards Division / OWRS / (202)260-1315 [893].

Discussion: The values that are indicated as "LEC" are not criteria, but are the lowest effect levels found in the literature. LECs are given when the minimum data required to derive water quality criteria are not available. The value given is for the class of dichloroethylenes, and not specifically for 1,1-dichlorolethylene. [893].

The Netherlands' Harmonized (between media) Maximum Permissible Concentration (MPC) for this compound in water is 3400 ug/L [655].

Note: Harmonization takes into account whether or not the MPC in one media (such as soil) would lead to exceeding the MPC in another media (such as air, water, or sediment) [655].

The Netherlands' Harmonized (between media) Negligible Concentration (NC) for this compound in water is 1% of the MPC, or 34 ug/L [655].

Oak Ridge National Lab, 1994: Ecological Risk Assessment Freshwater Screening Benchmarks for concentrations of contaminants in water [649]. To be considered unlikely to represent an ecological risk, field concentrations should be below all of

the following benchmarks [649]:

For CAS 75-35-4, DICHLOROETHENE, 1,1- (ug/L):

NATIONAL AMBIENT WATER QUALITY CRITERION - ACUTE: No information found

NATIONAL AMBIENT WATER QUALITY CRITERION - CHRONIC: No information found

SECONDARY ACUTE VALUE: 3520

SECONDARY CHRONIC VALUE: 196

LOWEST CHRONIC VALUE - FISH: > 2800

ESTIMATED LOWEST CHRONIC VALUE - DAPHNIDS: 4720

LOWEST CHRONIC VALUE - NON-DAPHNID INVERTEBRATES: No information found

LOWEST CHRONIC VALUE - AQUATIC PLANTS: > 798,000

LOWEST TEST EC20 - FISH: No information found

LOWEST TEST EC20 - DAPHNIDS: No information found

SENSITIVE SPECIES TEST EC20: No information found

POPULATION EC2O: 447

W.Plants (Water Concentrations vs. Plants):

EC50 Selenastrum capricornutum (green alga) > 798,000 ug/l/96 hr, Toxic effects: inhibition of chlorophyll synthesis; cell count. /Conditions of bioassay not specified (USEPA; In-Depth Studies on Health and Environmental Impacts of Selected Water Pollutants, 1978, Contract No. 68-01-4646 as cited in USEPA; Ambient Water Quality Criteria Doc: Dichloroethylenes p.B-7 (1980) EPA 440/5-80-041) [609].

EC50 Skeletonema costatum (alga) > 712,000 ug/l/96 hr, Toxic effects: Inhibition chlorophyll synthesis; reduced cell counts. /Conditions of bioassay not specified (USEPA; In-Depth Studies on Health and Environmental Impacts of Selected Water Pollutants. 1978. Contract No. 68-01-4646 as cited

in USEPA; Ambient Water Quality Criteria Doc: Dichloroethylenes p.B-7, 1980, EPA 440/5-80-041) [609].

W.Invertebrates (Water Concentrations vs. Invertebrates):

LC50 Mysidopsis bahia (mysid shrimp) > 798 mg/l/24 hr, 48 hr, 72 hr; 224 mg/l/96 hr in a static bioassay using seawater. [USEPA; In-Depth Studies on Health and Environmental Impacts of Selected Water Pollutants (1978) Contract No. 68-01-4646 as cited in USEPA; Health Assessment Document: Vinylidene chloride p.9-2 (1983) EPA-600/8-83-031A] [609].

LC50s for Daphnia magna (water flea) were 98 and 11.6 mg/L for a 24-hr exposure, and 79 and 11.6 mg/L for a 48-hr exposure [998].

W.Fish (Water Concentrations vs. Fish):

LC50 Pimephales promelas (fathead minnow) 169,000 ug/l/96 hr in a static bioassay; 108,000 ug/l/96 hr flow-through bioassay (USEPA; Ambient Water Quality Criteria Doc: 1,1-Dichloroethylene p.B-1, 1980. EPA 440/5-80-41) [609].

LC50s for Pimephales promelas (fathead minnow) were 175 and 116 mg/L for a 24-hr exposure, 169 and 108 mg/L for a 48-hr exposure, 97 mg/L for a 5-day exposure, 74 mg/L for a 6-day exposure, and 29 mg/L for a 7-, 8-, 9-, 10-, 11-, 12-, and 13-day exposures [998].

LC50 Lepomis macrochirus (bluegill) 74 mg/l @ 24 hr & 96 hr, temp @ 21-23 deg C, water hardness 32-48 mg/l (calcium carbonate), Ph 6.7-7.8, Dissolved oxygen concn 7.0-8.8 Mg/l (static bioassay). (Buccafusco RJ et al; Bull Environ Contam Toxicol 26: 446-52, 1981) [609].

LC50 Cyprinodon variegatus (sheepshead minnow) 249 mg/l/24 hr, 48 hr, 72 hr, 96 hr in a static bioassay using sea water (USEPA; In-Depth Studies on Health and Environmental Impacts of Selected Water Pollutants, 1978, Contract No. 68-01-4646 as cited in USEPA; Health Assessment Document: Vinylidene Chloride p.9-2, 1983, EPA-600/8-83-031A) [609].

No-observed-effect-concentration (NOEC) (with the effect being death) was 80 mg/L for a 96-hr exposure [998].

LC50 Lepomis macrochirus (bluegill) 220 ppm/96 hr in a static bioassay in fresh water at 23 deg C with mild aeration (Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983. 488) [609].

LC50 Menidia beryllina (inland silverside) 250 ppm/96 hr in a static bioassay in synthetic seawater at 23 deg C with mild aeration. (Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983. 488) [609].

W.Wildlife (Water Concentrations vs. Wildlife or Domestic Animals):

Oak Ridge National Lab, 1994: Risk Assessment Screening Benchmarks for Wildlife derived from No-Observed-Adverse-Effect (NOAEL) levels (see Tis.Wildlife, B) for these). To be considered unlikely to represent an ecological risk, water concentrations should be below the following benchmarks for each species present at the site [650]:

For CAS 75-35-4, 1,1-Dichloroethylene:

SPECIES	WATER CONCENTRATION (ppm)
Rat (test species)	0.00000
Short-tailed Shrew	385.59400
Little Brown Bat	666.45900
White-footed Mouse	249.19700
Meadow Vole	436.13900
Cottontail Rabbit	206.66200
Whitetail Deer	85.57500
Beagle Dog (test species)	0.00000
Mink	53.98900
Red Fox	38.53100

Comment: Actually, the number of significant figures for a benchmark value should never be more than one; even if these values have been taken directly from another report, they should be rounded; otherwise the impression is given of a level of accuracy that is simply unwarranted. The uncertainties are too large to justify such a fine distinction (Owen Hoffman, SENES Oak Ridge, Personal Communication, 1997).

Groups of 47-48 male & 48 female Sprague-Dawley rats, 6 to 7 wk of age, were admin 50, 100 or 200 mg/l vinylidene chloride (99.5% pure, with 1-5 mg/l hydroquinone monomethyl ether) in drinking water ad libitum for 2 yr (avg time-weighted daily doses: males, 7, 10, 20 mg/kg body wt; females, 9, 14 or 30 mg/kg body wt). A group of 80 males & 80 females received drinking water only. Mortality & body-wt gain were similar in the treated & control groups; no statistically significant increase in tumor incidence was found. [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer,1972-PRESENT, Multivolume work,.,p. V39 205, 1986) [609].

In Sprague-Dawley rats given 200 mg/ml vinylidene chloride in drinking water on gestation days 6-15, no adverse effect was observed. In a three generation study in which Sprague-Dawley rat received 50, 100 or 200 mg/l vinylidene chloride in drinking water, survival was comparable in 6 sets of litters over 3 generations in control & exposed groups. There was no evidence of adverse effects on the reproductive capacity of animals of either sex (IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer,1972-PRESENT, Multivolume work,.,p. V39 210, 1986) [609]

W.Human (Drinking Water and Other Human Concern Levels):

EPA 1996 IRIS information [893]:

Ambient Water Quality Criteria for Human Health:

Water & Fish: 3.3E-2 ug/liter [893].

Older references:

Published Criteria for Water and Organisms: 0.033 ug/L [446]. IRIS Recalculated (9/90) Criteria for Water and Organisms: 0.057 ug/L [446].

Fish Only: 1.85E+0 ug/liter [893].

Older references:

Published Criteria for Organisms Only: 1.85 ug/L [446].

IRIS Recalculated (9/90) Criteria for Organisms Only: 3.2 ug/L [446].

Reference: 45 FR 79318 (11/28/80) [893].

Contact: Criteria and Standards Division / OWRS / (202)260-1315 [893].

Discussion: For the maximum protection from the potential carcinogenic properties of this chemical, the ambient water concentration should be zero. However, zero may not be attainable at this time, so the recommended criteria represents a E-6 estimated incremental increase of cancer risk over a lifetime. [893].

Maximum Contaminant Level Goal:

Value: 0.007 mg/L [893,952].

Status/Year: Final 1985 Econ/Tech?: No, does not consider economic or technical feasibility Reference: 50 FR 46880 (11/13/85) [893].

Contact: Health and Ecological Criteria Division / (202)260-7571 Safe Drinking Water Hotline / (800)426-4791 [893].

Discussion: An MCLG of 0.007 mg/L for 1,1-dichloroethylene is proposed based on an RfD and an assumed drinking water contribution of 20%. The RfD was calculated based on the DWEL of 350 ug/L from an animal study in which liver effects were noted. An additional safety factor of 10 (for carcinogenicity) was applied. [893].

Maximum Contaminant Level (MCL):

Value: 0.007 mg/L [893,952].

Status/Year: Final 1987 Econ/Tech?: Yes, does consider economic or technical feasibility Reference: 52

FR 25690 (07/08/87); 56 FR 30266 (07/01/91) [893].

Contact: Drinking Water Standards Division / OGWDW / (202)260-7575 Safe Drinking Water Hotline / (800)426-4791 [893].

Discussion: EPA has set an MCL equal to the MCLG of 0.007 mg/L [893].

Note: Before citing a concentration as EPA's water quality criteria, it is prudent to make sure you have the latest one. Work on the replacement for the Gold Book [302] was underway in March of 1996, and IRIS is updated monthly [893].

Quantitative estimate of carcinogenic risk from oral exposure:

Cancer Slope Factor: 6E-1 per mg/(kg/day) [893,952].

Unit Risk: 1.7E-5 per ug/liter [868,893], Extrapolation Method: Linearized multistage procedure, extra risk [893].

Drinking Water Concentrations at Specified Risk Levels [893]:

Risk Level Concentration E-4 (1 in 10,000) 6E+0 ug/liter E-5 (1 in 100,000) 6E-1 ug/liter E-6 (1 in 1,000,000) 6E-2 ug/liter

Older Information from HSDB [609]:

The levels of 1,1-dichloroethylene in ambient water which may result in an incremental cancer risk of 1X10-5, 1X10-6, and 1X10-7 over an individual lifetime are estimated to be 0.33 ug/l, 0.033 ug/l, and 0.003 ug/l, respectively. On the basis of the consumption of aquatic organisms alone, the corresponding levels in ambient water are estimated to be 18.5 ug/l, 1.85 ug/l, and 0.185 ng/l, respectively. [USEPA; Ambient Water Quality Doc:

Dichloroethylenes (1980) EPA 440/5-80-041].

The national revised primary drinking water maximum contaminant level for 1,1-dichloroethylene for community water systems is 0.007 mg/l. [40 CFR 141.61 (7/1/88)].

EPA Region 9 tap water preliminary remediation goal (PRG): 4.6E-02 ug/L [868].

EPA has determined that drinking water containing 3.5 ppm of 1,1-dichloroethene for adults and 1 ppm for children is not expected to cause noncancerous harmful health effects [932].

State drinking water standards [932]:

NJ: 2 ug/L
Nine other states: 6-6 ug/L.

W.Misc. (Other Non-concentration Water Information):

1,1-Dichloroethene can enter the environment when it is released to the air during its production or released to surface water or soil as a result of waste disposal [932]. Most 1,1-dichloroethene evaporates quickly and mainly enters the environment through the air although some enters into rivers or lakes [932].

Sediment Data Interpretation, Concentrations and Toxicity (All Sediment Data Subsections Start with "Sed."):

Sed.Low (Sediment Concentrations Considered Low):

No information found.

Sed.High (Sediment Concentrations Considered High):

No information found.

Sed.Typical (Sediment Concentrations Considered Typical):

No information found.

Sed.Concern Levels, Sediment Quality Criteria, LC50 Values, Sediment Quality Standards, Screening Levels, Dose/Response Data and Other Sediment Benchmarks:

Sed.General (General Sediment Quality Standards, Criteria, and Benchmarks Related to Protection of Aquatic

Biota in General; Includes Sediment Concentrations Versus Mixed or General Aquatic Biota):

Oak Ridge National Lab, 1994: Risk Assessment Screening Benchmarks for Sediment Concentrations. To be considered unlikely to represent an ecological risk, field concentrations should be below all of the following benchmarks in mg/kg (ppm) dry weight [652]:

For CAS 75-35-4, Dichloroethylene, 1,1-:

Estimated equivalent sediment quality criterion at 1% Organic Carbon is 0.057 mg/kg (ppm).

Comment: Actually, the number of significant figures for a benchmark value should never be more than one; even if these values have been taken directly from another report, they should be rounded; otherwise the impression is given of a level of accuracy that is simply unwarranted. The uncertainties are too large to justify such a fine distinction (Owen Hoffman, SENES Oak Ridge, Personal Communication, 1997).

The Netherlands' Harmonized (between media) Maximum Permissible Concentration (MPC) for this compound in sediments is 12 mg/kg [655].

Note: Harmonization takes into account whether or not the MPC in one media (such as soil) would lead to exceeding the MPC in another media (such as air, water, or sediment) [655].

The Netherlands' Harmonized (between media) Negligible Concentration (NC) for this compound in sediments is 1% of the MPC, or 0.12 mg/kg [655].

Sed.Plants (Sediment Concentrations vs. Plants):

No information found.

Sed.Invertebrates (Sediment Concentrations vs. Invertebrates):

No information found.

Sed.Fish (Sediment Concentrations vs. Fish):

No information found.

Sed.Wildlife (Sediment Concentrations vs. Wildlife or Domestic Animals):

No information found.

Sed.Human (Sediment Concentrations vs. Human):

No information found.

Sed.Misc. (Other Non-concentration Sediment Information):

Hydrolysis of 1,1,1-trichloroethane in water or water/sediment systems will result in the formation of 1,1-dichloroethene by elimination, although it is a very slow process [932].

A methane-utilizing culture isolated from lake sediment was able to degrade 600 ng/mL 1,1-dichloroethene to 200 ng/mL under aerobic conditions within 2 days [932]. The end products were nonvolatile and did not include vinyl chloride which is known to be formed under anaerobic conditions [932].

Soil Data Interpretation, Concentrations and Toxicity (All Soil Data Subsections Start with "Soil."):

Soil.Low (Soil Concentrations Considered Low):

No information found.

Soil.High (Soil Concentrations Considered High):

No information found.

Soil.Typical (Soil Concentrations Considered Typical):

No information found.

Soil.Concern Levels, Soil Quality Criteria, LC50 Values, Soil Quality Standards, Screening Levels, Dose/Response Data and Other Soil Benchmarks:

Soil.General (General Soil Quality Standards, Criteria, and Benchmarks Related to Protection of Soil-dwelling Biota in General; Includes Soil Concentrations Versus Mixed or General Soil-dwelling Biota):

The Netherlands' Harmonized (between media) Maximum Permissible Concentration (MPC) for this compound in soil is 12 mg/kg [655].

Note: Harmonization takes into account whether or not the MPC in one media (such as soil)

would lead to exceeding the MPC in another media (such as air, water, or sediment) [655].

The Netherlands' Harmonized (between media) Negligible Concentration (NC) for this compound in soil is 1% of the MPC, or 0.12 mg/kg [655].

Soil.Plants (Soil Concentrations vs. Plants):

No information found.

Soil.Invertebrates (Soil Concentrations vs. Invertebrates):

No information found.

Soil.Wildlife (Soil Concentrations vs. Wildlife or Domestic Animals):

No information found.

Soil.Human (Soil Concentrations vs. Human):

EPA 1996 National Generic Soil Screening Level (SSL) designed to be conservative and protective at the majority of sites in the U.S. but not necessarily protective of all known human exposure pathways, land uses, or ecological threats [952]:

SSL = 1 mg/kg for ingestion pathway [952].

SSL = 0.07 mg/kg for inhalation pathway [952].

SSL = 0.003 to 0.06 mg/kg for protection from migration to groundwater at 1 to 20 Dilution-Attenuation Factor (DAF) [952].

EPA 1995 Region 9 Preliminary remediation goals (PRGs), 1995 [868]:

Residential Soil: 3.8E-02 mg/kg wet wt.
Industrial Soil: 8.2E-02 mg/kg wet wt.

NOTE:
1) PRGs focus on the human exposure pathways of ingestion, inhalation of particulates and volatiles, and dermal absorption. Values do not consider impact to groundwater or ecological receptors.
2) Values are based on a non-carcinogenic hazard quotient of one.
3) PRGs for residential and industrial landuses are slightly lower concentrations

than EPA Region III RBCs, which consider fewer aspects [903].

EPA 1995 Region 3 Risk based concentration (RBC) to protect from transfers to groundwater:

0.03 mg/Kg dry weight [903].

Soil.Misc. (Other Non-concentration Soil Information):

1,1-Dichloroethene spilled onto surface soil will also tend to partition to the atmosphere, while some of the chemical may percolate into the subsurface soil [932]. Once in the subsurface soil, 1,1- dichloroethene will partition between soil, 1,1-Dichloroethene has high water solubility and a small log soil organic carbon sorption coefficient (Koc) value of 1.81 (EPA 1982), indicating that 1,1-dichloroethene will migrate through soil without significant retardation by adsorption to organic carbon [932].

Tissue and Food Concentrations (All Tissue Data Interpretation Subsections Start with "Tis."):

Tis.Plants:

A) As Food: Concentrations or Doses of Concern to Living Things Which Eat Plants:

No information found.

B) Body Burden Residues in Plants: Typical, Elevated, or of Concern Related to the Well-being of the Organism Itself:

No information found.

Tis.Invertebrates:

A) As Food: Concentrations or Doses of Concern to Living Things Which Eat Invertebrates:

No information found.

B) Concentrations or Doses of Concern in Food Items Eaten by Invertebrates:

No information found.

C) Body Burden Residues in Invertebrates: Typical, Elevated, or of Concern Related to the Well-being of the Organism Itself:

No information found.

Tis.Fish:

A) As Food: Concentrations or Doses of Concern to Living Things Which Eat Fish (Includes FDA Action Levels for Fish and Similar Benchmark Levels From Other Countries):

EPA Region III Risk Based Concentration (RBC) for fish tissues: 0.0053 mg/kg based on carcinogenic risk [903].

B) Concentrations or Doses of Concern in Food Items Eaten by Fish:

No information found.

C) Body Burden Residues in Fish: Typical, Elevated, or of Concern Related to the Well-being of the Organism Itself:

No information found.

Tis.Wildlife: Terrestrial and Aquatic Wildlife, Domestic Animals and all Birds Whether Aquatic or not:

A) As Food: Concentrations or Doses of Concern to Living Things Which Eat Wildlife, Domestic Animals, or Birds:

No information found.

B) Concentrations or Doses of Concern in Food Items Eaten by Wildlife, Birds, or Domestic Animals (Includes LD50 Values Which do not Fit Well into Other Categories, Includes Oral Doses Administered in Laboratory Experiments):

Oak Ridge National Lab, 1994: Risk Assessment Screening Benchmarks for Wildlife derived from No-Observed-Adverse-Effect (NOAEL) levels (mg contaminant per kg body weight per day). To be considered unlikely to represent an ecological risk, wet-weight field concentrations should be below the following (right column) benchmarks for each species present at the site [650]:

For CAS 75-35-4, 1,1-Dichloroethylene:

SPECIES	NOAEL (mg/kg/day)	FOOD CONCEN-TRATION (ppm)
Rat (test species)	30.00000	0.00000
Short-tailed Shrew	84.83100	141.38500
Little Brown Bat	106.63400	319.90100
White-footed Mouse	74.75900	483.73500

Meadow Vole	59.47400	523.36700
Cottontail Rabbit	19.97700	101.15100
Whitetail Deer	5.60400	181.96900
Beagle Dog (test species)	2.50000	0.00000
Mink	5.34500	39.01400
Red Fox	3.25400	32.53700

Comment: Actually, the number of significant figures for a benchmark value should never be more than one; even if these values have been taken directly from another report, they should be rounded; otherwise the impression is given of a level of accuracy that is simply unwarranted. The uncertainties are too large to justify such a fine distinction (Owen Hoffman, SENES Oak Ridge, Personal Communication, 1997).

Information from HSDB [609]:

LD50 Mouse oral approx 200 mg/kg [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer,1972-PRESENT. (Multivolume work).,p. V39 209 (1986)].

LD50 Rat oral 1500 mg/kg [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer,1972-PRESENT. (Multivolume work).,p. V39 209 (1986)].

LD50 Rat (adrenalectomized) oral 80 mg/kg body wt [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer,1972-PRESENT. (Multivolume work).,p. V39 209 (1986)].

Dogs were admin vdc in peanut oil in a gelatin capsule at concn which provided 6.25, 12.5, Or 25 mg vdc/kg/day for 97 days. No exposure-related changes were present in tissues taken from dogs at termination of the study. [QUAST JF ET AL; FUNDAM APPL TOXICOL 3 (1): 55-62 (1983)].

C) Body Burden Residues in Wildlife, Birds, or Domestic Animals: Typical, Elevated, or of Concern Related to the Well-being of the Organism Itself:

No information found.

Tis.Human:

A) Typical Concentrations in Human Food Survey Items:

The estimated average amount of 1,1-dichloroethene in plastic food-packaging films ranged from 0.02 to 1.26 ppm [932]. The measured average amount in food wrapped in these films was less than 0.01 ppm [932]. Not every tested food sample contained 1,1-dichloroethene, so these numbers only reflect the levels found in food samples tested that did contain 1,1-dichloroethene [932]. The FDA has determined that the films can contain no more than 10 ppm 1,1-dichloroethene and that the low levels of 1,1-dichloroethene found in food wrapped in these films present no health risk to the consumer [932].

Although no monitoring data could be found, vinylidene chloride is a known contaminant in plastic wrap made from this monomer; the maximum amount possible that could be adsorbed by food from such food wraps has been estimated to be less than or equal to the detection limit (<10 ppb)(1). [(1) Fishbein L; Sci Total Environ 11: 111-61 (1979)] [609].

B) Concentrations or Doses of Concern in Food Items Eaten by Humans (Includes Allowable Tolerances in Human Food, FDA, State and Standards of Other Countries):

EPA 1996 IRIS information [893]:

Crit. Dose: 9 mg/kg-day [Study 1 LOAEL(adj)] UF: 1000 MF: 1

RfD: 9E-3 mg/kg-day [893,952].

Confidence: Medium [893].

RfD: 9.0E-03 mg/kg/day [868].

Cancer Slope Factor: 6E-1 per mg/(kg/day) [893,952].

Slope Factor: 1.8E-01 mg/kg/day [868].

EPA Region III Risk Based Concentration (RBC) for fish tissues: 0.0053 mg/kg based on carcinogenic risk [903].

C) Body Burden Residues in Humans: Typical, Elevated, or of Concern Related to the Well-being of Humans:

12% of approximately 300 breath samples from Elizabeth and Bayonne New Jersey contained quantifiable levels (0.2-2 ug/cu m) of vinylidene chloride (Wallace L et al; J Occu Med 28: 603-7, 986) [609].

Tis.Misc. (Other Tissue Information):

No information found.

Bio.Detail: Detailed Information on Bioconcentration, Biomagnification, or Bioavailability:

Although measured bioconcentration factors were not located in the available literature, partitioning of 1,1-dichloroethene from water into aquatic organisms can be predicted in part by the magnitude of the octanol/water partition coefficient (Kow) value [932]. The chemicals with a log Kow of less than 4.0 are unlikely to bioaccumulate to hazardous levels in human food chains [932]. The log Kow is 2.13, and based upon this calculation, bioaccumulation in the human food chain is not expected to be significant for this compound [932].

No experimental data could be found on the bioconcentration of vinylidene chloride in fish or aquatic invertebrates. Based on its low octanol/water partition coefficient (log Kow= 1.48(1)) one would not expect any significant bioconcentration(SRC). [(1) Tute MS; Adv Drug Res 6: 1-77 (1971)] [609]

In male Sprague-Dawley rats, the t1/2 (after dose of 10 to 100 mg/kg) was 46-55 min after iv admin in fasted rats, 62-69 min after oral admin in fasted rats, 42-63 min after iv admin in nonfasted rats, and 78-138 min after oral admin in nonfasted rats (Putcha L et al; Fundam Appl Toxicol 6, 2: 240-50, 1986) [609].

Interactions:

Information from HSDB [609]:

In vivo ... pretreatment of rats with phenobarbital protected against the hepatotoxicity of vinylidene chloride. [Jaeger RJ et al; Environ Health Perspect 21: 113-19 (1977)].

Treatment of rats with 3-methylcholanthrene incr the liver microsome-mediated mutagenicity of vinylidene chloride in Salmonella typhimurium TA1530 approx two-fold. [Bartsch H et al; Arch Toxicol 41 (4): 249-78 (1979)].

Pretreatment with deferrioxamine (125-500 mg/kg ip) protected male mice against CC14- or CBrCl3- induced hepatotoxicity which is closely related to an inhibition of iron- dependent lipid peroxidation monitored by ethane exhalation. For 1,1-

dichloroethene, ... no hepatoprotection was achieved with deferrioxamine indicating that lipid peroxidation is not involved as a primary mechanism of toxicity. [Siegers CP et al; Pharmacol Res Commun 20 (4): 337-43 (1988)].

To determine if L-2-oxothiazolidine-4-carboxylate protects rats from the hepatoxicity of 1,1-dichloroethylene, fasted male Sprague-Dawley-rats were treated with 10 mm/kg of L-2-oxothiazolidine-4-carboxylate sc, or an equivalent amount of saline, 1 hour prior to the peritoneal administration of 50 mg/kg 1,1-dichloroethylene. Serum alanine-aminotransferase was used to monitor onset, peak, and extent of liver damage. L-2-oxothiazolidine-4- carboxylate pretreated rats showed consistently lower serum alanine- aminotransferase activities 2 to 24 hr after 1,1-dichloroethylene. Alanine-aminotransferase activities in L-2-oxothiazolidine-4-carboxylate pretreated rats exceeded control levels at about 4 hr after 1,1-dichloroethylene treatment compared to only 2 hr in the saline pretreated group. Peak alanine-aminotransferase values were approximately ten fold lower in the L-2-oxothiazolidine-4-carboxylate treated animals indicating a protective effect of L-2-oxothiazolidine-4-carboxylate on 1,1-dichloroethylene hepatotoxicity. This protection was associated with about 50% less total, acid soluble and acid precipitable 1,1-dichloroethylene in serum, 30% less in urine and at 24 hr 30 to 68% less covalently bound in the liver, kidney and lung. Peak liver injury correlated well with the amount of 1,1-dichloroethylene in serum at early times and with the amount covalently bound to liver at 24 hr. There was only a poor correlation with 1,1-dichloroethylene in the urine. Fasted rats demonstrated a persistent loss of hepatic cytochrome p450 at 3 and 6 hr whereas their hepatic and renal reduced glutathione contents were transiently diminished at 3 hr. The L-2-oxothiazolidine-4-carboxylate induced loss of hepatic cytochrome p450 which converted 1,1-dichloroethylene to reactive intermediates, contributed to the apparent decrease in toxin metabolism and therefore to the L-2-oxothiazolidine-4-carboxylate protection against 1,1-dichloroethylene induced liver injury. [Moslen MT et al; J Pharmacol Exp Ther 248 (1): 157-63 (1989)].

Pretreatment of rodents with diethyldithiocarbamate, carbon disulfide, ... thiram or disulfiram resulted in different degrees of protection against the acute toxicity of vinylidene chloride. [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer,1972-PRESENT. (Multivolume work).,p. V39 210 (1986)].

The inhibitor of mixed-function oxidase, SKF-525A, had no effect on mortality in immature rats (80-100 g), but markedly exacerbated 1,1-dichloroethylene toxicity in rats weighing 260-270 g. Pretreatment with 3-aminotriazole or carbon tetrachloride protected fasted, male rats of all sizes tested

from lethal effects of doses of 1,1-dichloroethylene below 700 mg/kg. [Anderson ME et al; Toxicol Appl Pharmacol 46: 227-34 (1978)].

Pyrrazole, a cytochrome p450 antagonist, was found to inhibit the uptake and toxic effects of vinylidene chloride in a perfused rat liver system. [Reichert D, Henschler D; Int Arch Occup Envir Health 41: 169-78 (1978)].

Treatment with the glutathione depleting agent ... vinylidene chloride dose dependently inhibited paw edema induced by carrageenan in rats. This effect was accompanied by a decrease in the glutathione concn of the target tissue ... and may result in an inhibition of prostaglandin biosynthesis. ... [Strubelt O, Youngs M; Agents Actions 14 (5-6): 680-3 (1984)].

Vinylidene chloride was tested for carcinogenicity by chronic admin by one or more routes in ha:icr swiss mice. It was active a skin tumor initiator in 2 stage carcinogenesis assays; phorbol myristate acetate was used as a promoter. [VAN DURREN BL ET AL; JNCI 63 (6): 1433-9 (1979)].

Simultaneous admin of vinyl chloride with vinylidene chloride prevented the hepatotoxicity associated with vinylidene chloride inhalation in fasted rats. [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer,1972-PRESENT. (Multivolume work).,p. V39 210 (1986)].

Male Fischer- 344 rats were tested to determine kinetic constants for trichloroethylene and 1,1-dichloroethylene and to develop a linked model for examing the pattern of the pharmacokinetic interactions between the two agents, using gas uptake simulation methods. The respective allometrically scaled maximum velocities for trichloroethylene and 1,1-dichloroethylene equalled 11 and 7.5 mg/hr. Mixtures of the two products were used to determine uptake curves described by equations based on pharmacokinetic models in which each product was regarded as the metabolic inhibitor of the other. ... Good correlation between predicted and observed behavior was obtained whe inhibition was considered to be competitive for binding contants of 0.25 and 0.10 mg/l of trichloroethylene and 1,1-dichloroethylene, respectively. This model to predict conditions of 1,1-dichloroethylene induced hepatotoxicity during exposure to a constant concentration of the agents tested was compared with the activity of liver enzymes in the plasma of animals exposed to 1,1-dichloroethylene alone or in combination with trichloroethylene. [Andersen ME et al; Toxicol Appl Pharm 89 (2): 149-57 (1987)].

Uses/Sources:

The estimated average amount of 1,1-dichloroethene in plastic food-packaging films ranged from 0.02 to 1.26 ppm [932].

Major Uses [609]:

Used as comonomer, primarily with vinyl chloride. [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer,1972-PRESENT. (Multivolume work).,p. V39 197 (1986)].

In adhesives; component of synthetic fibers. [Sax, N.I. and R.J. Lewis, Sr. (eds.). Hawley's Condensed Chemical Dictionary. 11th ed. New York: Van Nostrand Reinhold Co., 1987. 1224].

In the synthesis of the refrigerant 142b, 1-chloro-1,1-difluoroethane, is synthesized from 1,1-difluoroethane, vinylidene chloride & 1,1,1-trichloroethane. [Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. 11(80) 65].

A monomeric intermediate in the production of plastics, particularly the saran types. [De Serres FJ, Hollaender A; Chemical Mutagens Vol 4 p.261 (1976)].

Comonomer, esp for food packaging & coating resins. [SRI].

Comonomer for modacrylic fibers; unisolated chemical intermediate for 1,1,1-trichloroethane. [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer,1972-PRESENT. (Multivolume work).,p. V19 441 (1979)].

Chemical intermediate in production of chloracetyl chloride. [USEPA; Health Assessment Document: Vinylidene Chloride p.5-15 (1983) EPA-600/8-83-031A].

Natural Sources [609]:

Vinylidene chloride is not known to occur as a natural product(1). [(1) IARC; Monograph on the Evaluation of the Carcinogenic Risk of Chemicals to Humans 39: 195-226 (1986)].

Artificial Sources [609]:

A source of 1,1-dichloroethylene is the decomposition of 1,1,1-trichloroethylene. [McConnell G et al; Endeavour 34: 13 (1975) as cited in USEPA; Ambient Water Quality Criteria Doc: Dichloroethylenes p.C-1 (1980) EPA 440/5-80-041].

Vinylidene chloride may be released into the environment as emissions or in wastewater during its production and use in

the manufacture of plastic wrap, adhesives, and synthetic fiber(1). Vinylidene chloride is formed by a minor pathway during the anaerobic biodegradation of trichloroethylene and also by the hydrolysis of 1,1,1-trichloroethane(3). Therefore there is a potential for it to form in groundwater that has been contaminated by chlorinated solvents. Vinylidene chloride is also produced by the thermal decomposition of 1,1,1-trichloroethane, a reaction that is catalyzed by copper(2). 1,1,1-Trichloroethane is used as a degreasing agent in welding shops so there is a potential for vinylidene chloride to be formed in these shops as well as in other industrial environments where 1,1,1-trichloroethane is used near sources of heat(2). [(1) Hawley GG; Condensed Chem Dict 10th ed Von Nostrand Reinhold NY (1981) (2) Glisson BT; Am Ind Hyg Assoc J 47: 427-35 (1986) (3) Cline PV, Delfino JJ; Am Chem Soc Div Environ Chem Natl Mtg, New Orleans LA 27: 577-9 (1987)].

Forms/Preparations/Formulations:

No information found.

Chem.Detail: Detailed Information on Chemical/Physical Properties:

Solubilities [609]:

Sol in chloroform [Weast, R.C. (ed.) Handbook of Chemistry and Physics. 69th ed. Boca Raton, FL: CRC Press Inc., 1988-1989.,p. C-272].

0.63 g/100 g water at 50 deg C (solubility at saturation vapor pressure) [Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. 14(81) 83].

In water: 3.5 g/l at 4 deg C; 3.0 g/l at 16 deg C; 2.5 g/l at 25 deg C. [Dow Chem Co; Vinylidene Chloride Monomer: Safe Handling Guide (1980)].

> 10% in acetone [Weast, R.C. and M.J. Astle. CRC Handbook of Data on Organic Compounds. Volumes I and II. Boca Raton, FL: CRC Press Inc. 1985.,p. V1 623].

> 10% in benzene [Weast, R.C. and M.J. Astle. CRC Handbook of Data on Organic Compounds. Volumes I and II. Boca Raton, FL: CRC Press Inc. 1985.,p. V1 623].

> 10% in ether [Weast, R.C. and M.J. Astle. CRC Handbook of Data on Organic Compounds. Volumes I and II. Boca Raton, FL: CRC Press Inc. 1985.,p. V1 623].

> 10% in ethanol [Weast, R.C. and M.J. Astle. CRC Handbook of Data on Organic Compounds. Volumes I and II. Boca Raton, FL: CRC Press Inc. 1985.,p. V1 623].

Vapor Pressure [609]:

591 MM HG @ 25 DEG C [Clayton, G. D. and F. E. Clayton (eds.). Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology. 3rd ed. New York: John Wiley Sons, 1981-1982. 3545].

Molecular Weight [609]:

96.94 [Weast, R.C. (ed.) Handbook of Chemistry and Physics. 69th ed. Boca Raton, FL: CRC Press Inc., 1988-1989.,p. C-272].

Density/Specific Gravity [609]:

1.2129 @ 20 DEG C/4 DEG C [The Merck Index. 10th ed. Rahway, New Jersey: Merck Co., Inc., 1983. 1430].

Octanol/Water Partition Coefficient [609]:

log Kow= 1.32 (est) [Leo A et al; Chem Rev 71 (6): 552-8 (1971) as cited in USEPA; Phase I Document: Vinylidene Chloride p.22 (1981) EPA No. 68-01-6030].

Boiling Point [609]:

31.7 DEG C @ 760 MM HG [The Merck Index. 10th ed. Rahway, New Jersey: Merck Co., Inc., 1983. 1430].

Melting Point [609]:

-122.5 DEG C [The Merck Index. 10th ed. Rahway, New Jersey: Merck Co., Inc., 1983. 1430].

Color/Form [609]:

Colorless liquid [Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983. 487].

Odor [609]:

Mild, sweet odor resembling that of chloroform [The Merck Index. 10th ed. Rahway, New Jersey: Merck Co., Inc., 1983. 1430].

Surface Tension [609]:

24 DYNES/CM @ 15 DEG C (INHIBITED) [U.S. Coast Guard, Department of Transportation. CHRIS - Hazardous Chemical Data. Volume II. Washington, D.C.: U.S. Government Printing Office, 1984-5.].

Vapor Density [609]:

3.25 (air= 1) [National Fire Protection Association. Fire Protection Guide on Hazardous Materials. 9th ed. Boston, MA: National Fire Protection Association, 1986.,p. 49-38].

Viscosity [609]:

0.3302 cP at 20 deg C [USEPA; Health Assessment Document: Vinylidene Chloride p.3-3 (1983) EPA-600/8-83-031A].

Other Chemical/Physical Properties [609]:

Heat of polymerization: -185 CAL/G; VAPOR SPECIFIC GRAVITY: 3.3 [U.S. Coast Guard, Department of Transportation. CHRIS - Hazardous Chemical Data. Volume II. Washington, D.C.: U.S. Government Printing Office, 1984-5.].

The water/air partition coefficient at 20 deg C is 0.16. [Pearson CR, McConnell G; Proc R Soc London Ser B 189: 305-32 (1975)].

Heat of combustion: -4860 BTU/lb= -2700 cal/g [U.S. Coast Guard, Department of Transportation. CHRIS - Hazardous Chemical Data. Volume II. Washington, D.C.: U.S. Government Printing Office, 1984-5.].

Liquid density at 0 deg C: 1.2517 g/cu m [USEPA; Health Assessment Document: Vinylidene Chloride p.3-2 (1983) EPA-600/8-83-031A].

Latent heat of vaporization at 25 deg C: 6328 cal/mol [USEPA; Health Assessment Document: Vinylidene Chloride p.3-3 (1983) EPA-600/8-83-031A].

Latent heat of vaporization at boiling point: 6257 cal/mol. [USEPA; Health Assessment Document: Vinylidene Chloride p.3-3 (1983) EPA-600/8-83-031A].

Latent heat of fusion: 1557 cal/mol. [USEPA; Health Assessment Document: Vinylidene Chloride p.3-3 (1983) EPA-600/8-83-031A].

Specific heat: 0.275 cal/g. [USEPA; Health Assessment Document: Vinylidene Chloride p.3-3 (1983) EPA-600/8-83-031A].

Dielectric constant 4.67 at 16 deg C. [USEPA; Health Assessment Document: Vinylidene Chloride p.3-3 (1983) EPA-600/8-83-031A].

Heat of polymerization: -18.0 Kcal/mol. [USEPA; Health Assessment Document: Vinylidene Chloride p.3-3 (1983) EPA-600/8-83-031A].

Heat of formation (liquid monomer): -6 Kcal/mol; Heat of formation (gaseous monomer): 0.3 Kcal/mol [USEPA; Health Assessment Document: Vinylidene Chloride p.3-3 (1983) EPA-

600/8-83-031A].

Heat capacity at 25.15 deg C (liquid monomer): 26.745 cal/mol/deg. [USEPA; Health Assessment Document: Vinylidene Chloride p.3-3 (1983) EPA-600/8-83-031A].

Heat capacity @ 25 deg C: 111.3 J/mole-K @ 1 atmosphere (liq); 67.4 J/mole-K @ 1 atmosphere (gas) [Weast, R.C. (ed.) Handbook of Chemistry and Physics. 69th ed. Boca Raton, FL: CRC Press Inc., 1988-1989.,p. D-174].

Saturated concn in air: 2,640 g/cu m @ 20 deg C, 3,675 g/cu m @ 30 deg C [Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983. 487].

Solubility of water in monomer, @ 25 deg C, 0.035 wt%; critical vol: 218 cu m/mole [Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. 23(83) 765].

1 mg/cu m= 0.25 ppm, 1 ppm= 3.97 mg/cu m [Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983. 487].

Dipole moment: 1.30 @ 25 deg C in benzene [Dean, J.A. Handbook of Organic Chemistry. New York, NY: McGraw-Hill Book Co., 1987.,p. 4-55].

Gibbs energy of formation: 5.85 kcal/mole (liq), 5.78 kcal/mole (gas) [Dean, J.A. Handbook of Organic Chemistry. New York, NY: McGraw-Hill Book Co., 1987.,p. 5-13].

Enthalpy of melting: 1.557 kcal/mole @ mp; enthalpy of sublimation: 6.328 kcal/mole @ 298 K [Dean, J.A. Handbook of Organic Chemistry. New York, NY: McGraw-Hill Book Co., 1987.,p. 5-52].

Fate.Detail: Detailed Information on Fate, Transport, Persistence, and/or Pathways:

1,1-Dichloroethene evaporates to the air very quickly from soil and water [932]. In the air, 1,1-dichloroethene is broken down by reactive compounds formed by sunlight [932]. 1,1-Dichloroethene remains in the air for about 4 days [932]. From water, 1,1-dichloroethene evaporates into the air; it breaks down very slowly in water [932]. We do not know exactly how long 1,1 dichloroethene stays in water [932]. It is not readily transferred to fish or birds, and only very small amounts enter the food chain [932]. In soil, 1,1-dichloroethene either evaporates to the air or percolates down through soil with rainwater and enters underground water [932]. Small living organisms in soil and groundwater may transform it into other less harmful substances, although this happens slowly

[932].

Biotransformation in soil has not been studied extensively, but it has been shown to occur by methanogenic organisms [932]. Biotransformation will be more important in subsurface soils, because 1,1-dichloroethene in surface soils will volatilize to the atmosphere [932].

As the magnitude of the Henry's law constant for 1,1-dichloroethene, 0.19 atmospheres m 3 /mole indicates, 1,1-dichloroethene is likely to partition readily into the atmosphere from water [932]. Because of this, 1,1-dichloroethene is generally not found in surface water in high concentrations [932]. Studies on atmospheric removal process indicate that once in the atmosphere, 1,1-dichloroethene is unlikely to be removed by physical processes such as wet deposition (e.g., rain) or by adsorption to atmospheric particulates [932]. 1,1-Dichloroethene spilled onto surface soil will also tend to partition to the atmosphere, while some of the chemical may percolate into the subsurface soil [932]. Once in the subsurface soil, 1,1- dichloroethene will partition between soil, 1,1-Dichloroethene has high water solubility and a small log soil organic carbon sorption coefficient (Koc) value of 1.81, indicating that 1,1-dichloroethene will migrate through soil without significant retardation by adsorption to organic carbon [932]. Similarly, 1,1-dichloroethene will migrate relatively freely within groundwater [932]. 1,1-Dichloroethene in surface water is unlikely to partition significantly into aquatic organisms [932].

Information from HSDB [609]:

> Terrestrial fate: When spilled on land, vinylidene chloride will be lost partially by evaporation and partially by percolation into the groundwater. Under anaerobic conditions, such as may occur in groundwater degradation to vinylidene chloride may occur after many months. (SRC)].
>
> Aquatic fate: When released into water, vinylidene chloride will primarily be lost by evaporation into the atmosphere with a half-life of 1-6 days. Little of the chemical would be lost by adsorption onto the sediment. (SRC)].
>
> Atmospheric fate: Vinylidene chloride is a photochemically reactive compound and when released to the atmosphere, it will degrade by reaction with hydroxyl radicals with a half-life of 11 hours. Under photochemical smog conditions, its half-life is much shorter (<2 hr). (SRC)].

Biodegradation [609]:

> Few studies on the biodegradation of vinylidene could be found In one study, 45-78% of the chemical was lost in 7 days when incubated with a wastewater inoculum; however, a sizeable fraction of the loss was due to volatilization(1). 97% of vinylidene chloride was reported to be removed in a municipal wastewater plant but again the fraction lost by evaporation is unknown(2,SRC). Under anaerobic conditions in microcosms designed to simulate the anaerobic conditions in

groundwater(3) and landfills(4), vinylidene chloride undergoes reductive dechlorination to vinyl chloride. In the microcosms designed to simulate a groundwater environment, 50% of the vinylidene chloride disappeared in 5-6 mo(3). Under the simulated landfill conditions, degradation occurred in 1-3 weeks(4). In another anaerobic biodegradation study that used materials from an aquifer that receive municipal landfill leachate and is known to support methanogenesis, the vinylidene chloride disappeared in 40 weeks(5). However, no significant degradation occurred for 16 weeks. Vinylidene chloride was formed as a degradation product(SRC). [(1) Tabak HH et al; J Water Pollut Control Fed 53: 1503-18 (1981) (2) Patterso JW, Kodukala PS; Chem Eng Prog 77: 48-55 (1981) (3) Barrio-Lage G et al; Enviro Sci Technol 20: 96-9 (1986) (4) Hallen RT et al; Am Chem Soc Div Environ Chem 26th Natl Mtg 26: 344-6 (1986) (5) Wilson BH et al; Environ Sci Technol 20: 997-1002 (1986)].

Abiotic Degradation [609]:

Vinylidene chloride reacts with photochemically produced hydroxyl radicals with an atmospheric half-life of 11 hr(1). Under photochemical smog situations, when nitrogen dioxide present vinylidene chloride decomposes more rapidly (half-life < 2 hr)(2). Products which are formed in the photooxidation of vinylidene chloride in the presence of nitrogen oxides include chloracetyl chloride, phosgene, formaldehyde, formic acid, hydrochloric acid, carbon monoxide and nitric acid(1,2). When adsorbed on silica gel, vinylidene chloride undergoes photolysis; approximately 72% of it degrading on exposure to 170 hr of sunlight(5). In water, the photooxidation of vinylidene chloride is insignificant(3,4). A hydrolysis half-life of 6-9 months has been observed with no significant difference in hydrolysis rate between pH 4.5 and 8.5(6). This value differs markedly from the estimated hydrolytic half-life of 2 yr at pH 7(7). [(1) Edney E et al; Atmospheric Chemistry of Several Toxic Compounds USEPA-600/53-82-092 (1983) (2) Gay BW et al; Environ Sci Technol 10: 58-67 (1976) (3) Mabey WB et al; Aquatic Fate Process Data for Organic Priority Pollutants p 157 USEPA 440/4-81-014 (1981) (4) Callahan MA et al; Water-Related Environmental Fate of 129 Priority Pollutants p. 50-1 to 50-10 USEPA 440/4-79-029a (1979) (5) Parlar H; Fresenius Z Anal Chem 319: 114-8 (1984) (6) Cline PV, Delfino JJ; Am Chem Soc Div Environ Chem Preprint New Orleans LA 27: 577-9 (1987) (7) Schmidt-Bleek F et al; Chemosphere 11: 383-415 (1982)].

Soil Adsorption/Mobility [609]:

No experimental data is available on the adsorption of vinylidene chloride. A low Koc of 150 are calculated from a regression equation based on its octanol/water partition coefficient (log Kow= 1.48(1))(2,SRC). [(1) Tute M; Adv Drug Res 6: 1-77 (1971) (2) Kenaga EE, Goring CAI; Aquatic Toxicology 3rd Annual Symp on Aquatic Toxicology Philadelphia,

PA ASTM (1980)].

Volatilization from Water/Soil [609]:

The mass transfer coefficient between water and the atmosphere of vinylidene chloride relative to oxygen has been measured to be 0.62(1). Using data for the oxygen reaeration rate of typical bodies of water(2), one can calculate the half-life for evaporation of vinylidene chloride to be 5.9, 1.2 and 4.7 days from a pond, river and lake, respectively(SRC). [(1) Matter-Mueller C et al; Water Res 15: 1271-9 (1981) (2) Mill T et al; Aquatic Fate Process Data for Organic Priority Pollutants p 255 USEPA-440/4-80-014 (1982)].

Absorption, Distribution and Excretion [609]:

As dose level of radioactive vinylidene chloride is incr in rats from 1-50 mg/kg body wt orally, or from 40-800 mg/cu m (10-200 ppm) by inhalation, the metabolic pathway becomes saturated, so that smaller percentage of dose admin is metabolized & more is eliminated via lung as vinylidene chloride. With the 1 mg/kg body wt oral dose & the 10 ppm inhalation dose, there was no difference in elimination by fed versus fasted rats. At 50 mg/kg body wt orally or 200 ppm by inhalation, there was significant incr in excretion of vinylidene chloride via lung & decr in urinary excretion of radioactivity in fed versus fasted rats. The main excretory route for (14)c-vinylidene chloride after intragastric, iv, or ip admin to rats is pulmonary: both unchanged vinylidene chloride & related carbon dioxide are excreted by that route; other vdc metabolites are eliminated via kidneys. [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer,1972-PRESENT. (Multivolume work).,p. V19 446 (1979)].

Seventy-two hr after dose of 0.5, 5.0 & 50.0 Mg/kg, 1.26, 9.70, 16.47% Respectively, are exhaled as unchanged vinylidene chloride, & 13.64, 11.35, 6.13% As (14)c-carbon dioxide. Main pathway of elimination is through renal excretion with 43.55, 53.88, 42.11% Of the admin radioactivity. Through the biliary system, 15.74, 14.54, 7.65% Of the activity are eliminated. [REICHERT D ET AL; ARCH TOXICOL 42 (3): 159-69 (1979)].

Single oral doses of (14)C-VDC /were administered/ by gavage to groups of four 200 g male Alderley Park rats; excretion of radioactivity was followed for 72 hr: at 0.5 mg/kg, 0.7% was exhaled in the air as unchanged vinylidene chloride, 4.8% as (14)CO2; 80.2% was excreted in the urine. At 350 mg/kg, however, 67.3% was exhaled as unchanged vinylidene chloride and 1.0% as (14)CO2; 29.5% was excreted in the urine. [Jones BK, Hathway DE; Chem Biol Interact 20: 27-41 (1978) as cited in USEPA; Phase I Document: Vinylidene Chloride (VDC) p.47 (1981) EPA No. 68-01-6030].

The absorption kinetics of 1,1-dichloroethylene (DCE) was studied in male Fischer 344 rats exposed to DCE atmosphere exposure system. Initial concentrations ranged up to 4000 ppm. The atmosphere of the exposure systems was analyzed every 10 minutes by gas/liquid chromatography. Chemical to air and tissue to air coeffiecients were estimated by a vital equilibration method. Tissues utilized in the partition experiments included blood, liver, muscle, and fat. The data were used to investigate metabolism kinetics of the compounds. Uptake was adequately described by a single saturable metabolic pathway, and the metabolism was essentially abolished by pyrazole pretreatment. Maximum velocities of metabolism for the saturable pathways for 1,1-dichloroethylene was 27.2 moles per hour, calculated for a 225 gram rat. [Gargas ML et al; Toxicol Appl Pharmacol 86 (3): 341-52 (1986)].

A study of 1,1-dichloroethylene (1,1-DCE), was undertaken to contrast the kinetics of the chemical following iv injection with that following oral administration. Four dosage-levels of 1,1-dichloroethylene (10, 25, 50, and 100 mg/kg bw) in 50% aqueous polyethylene glycol 400 were given iv and po to fasted and nonfasted male Sprague-Dawley rats. Serial blood samples were taken from the tail artery of the lightly etherized animals for up to 490 min after dosing. The iv data revealed that disappearance of 1,1-dichloroethylene from the systemic circulation followed a triexponential pattern. Light ether anesthesia did not appear to alter the pharmacokinetics of iv injected 1,1-dichloroethylene. There was no difference between nonfasted and fasted iv rats in biological half-life or in any other pharmacokinetic parameter. Total body clearance, half-life, apparent volume of distribution and volume of distribution in the central compartment did show increases with increasing dose in these animals. Oral dosing experiments revealed that 1,1-dichloroethylene was absorbed very rapidly and completely from the gastrointestinal tract. Peak blood levels were reached 2 to 8 min following oral administration of 1,1-dichloroethylene as an aqueous suspension. The half-life of 1,1-dichloroethylene in orally dosed rats was somewhat longer than in their iv counterparts. The half-life values for nonfasted, orally dosed rats were longer than for their fasted counterparts, suggesting delayed absorption due to the presence of food. [Putcha L et al; Fundam Appl Toxicol 6 (2): 240-50 (1986)].

A physiologically based pharmacokinetic model has been developed for vinylidene chloride in the rat based on oxidative metabolism of vinylidene chloride and subsequent glutathione detoxification of metabolite. The model offers insight into the complex interrelationship between the processes of absorption, metabolism, and glutathione conjugation, and simulates the manner in which these factors operate in regulating vinylidene chloride toxicity. The physiologically based pharmacokinetics model successfully

predicts blood, tissue, and exhaled air concentrations of vinylidene chloride, and liver glutathione levels as a function of dose and route of administration. The model also explains the complex dose-response mortality curves seen with vinylidene chloride. Because of the low blood:air partition coefficient of vinylidene chloride and its saturable metabolism, the amount of vinylidene chloride dose that is metabolized is sensitive to the rate of absorption. After an intravenous bolus dose, most of the administered vinylidene chloride is exhaled unchanged within a few minutes. Blood vinylidene chloride half-life is not representative of metabolism rates but to reequilibration of vinylidene chloride from fat. Rats with greater fat content, therefore, display longer vinylidene chloride blood half-lives. [D'Souza RW, Anderson ME; Toxicol Appl Pharmacol 95 (2): 230-40 (1988)].

Laboratory and/or Field Analyses:

Detection Limits: For optimum risk or hazard assessment work, volatile compound lab methods with very low detection limits [such as EPA Method 8260 modified for Selective Ion Mode (SIM) Enhanced Detection Limits] or other advanced methods should be used. In concert with need to compare values with low benchmark concentrations and avoid false negatives, detection limits should be as low as possible and in all cases no higher than comparison benchmarks and criteria. Ideally, the detection limit should be at least 10 times higher than the comparison benchmark or criteria [676]. The following should be considered for default detection limits when living things are of a concern or benchmarks are veru low, or one is trying to minimize false negatives:

Water Detection Limits: Water detection limits of 0.13 ug/L can be achieved with GC/HECD (Hall Electolyte Conductivity Detector) methods [932]. For routine NPDES permit applications using EPA method 601 for purgeable halocarbons, EPA also specifies a water detection limit of 0.13 ug/L for this compound (40 CFR, Part 136, Appendix A, Table 1) [1010]. This should probably be the default detection limit in many situations, However, in certain applications, higher detection limits are sufficient:

Wisconsin requires a water detection limit of 0.5 ug/L for all VOCs in water [923]. The USGS routinely uses 0.10 ug/L as a detection limit (Brooke Connor, USGS Water Quality Lab, Denver, Personal Communication, 1996). Some EPA Superfund CLP methods call for detection limits of 1 ug/L (AOC/Contract Laboratory Program, Routine Analytical Services, Summary on EPA Home Page under Superfund Subdirectory, EPA Office of Remedial and Emergency Response, 1997, Internet).

Detection Limits for Solids: Soil, sediment, and tissue detection limits of 5 ppb can be achieved with GC/ECD methods [932]. In certain applications, higher detection limits are sufficient:

> Detection limits could be 25 ppb in soil, sediment, or tissue [913]. Some EPA Superfund CLP soil methods call for detection limits of 10 ug/kg (AOC/Contract Laboratory Program, Routine Analytical Services, Summary on EPA Home Page under Superfund Subdirectory, EPA Office of Remedial and Emergency Response, 1997, Internet).

In the past, many methods have been used to analyze for this compound [861,1010,1011,1013]. EPA methods for NPDES permits are specified in 40 CFR Part 136 [1010]. EPA methods for drinking water are specified in 40 CFR Part 141 [1011].

EPA (RCRA Group) publishes requirements for solid waste methods in 40 CFR Part 261, Appendix III, with details in the following periodically updated publication [1013]:

> Environmental Protection Agency. 1995. Test methods for evaluating solid waste, physical/chemical methods, SW-846, EPA Office of Solid Waste and Emergency Response, EPA, Washington, D.C. Available from NTIS [1013].

RCRA (SW-846) methods tend to include provisions for using the specified method or something better, whereas the CERCLA CLP methods tend to require things done exactly per contract specifications. RCRA SW-846 methods typically require instrument calibration before analyses, but some labs don't do it, and many labs actually use some kind of hybrid between RCRA, CERCLA, or other "standard protocols" (Roy Irwin, Park Service, Personal Communication, 1997, based on conversations with various EPA and private lab staff members). The guidance in SW-846 must be used in some states, but is considered "guidance of acceptable but not required methods" in most federal applications.

In the past, EPA has also published separate (not SW-846) guidance documents with suggestions on field sampling and data quality assurance related to sampling of sediments [1016] and soils [1017,1018,1019].

Since they are designed for highly contaminated superfund sites, the CERCLA (CLP) methods typically have higher detection limits than many other EPA standard methods and are thus less appropriate for use in baseline assessments of very clean areas or for use in analyzing environmental concentrations for comparison with low-concentration criteria or benchmarks. EPA (CERCLA) publishes various Contract Laboratory Program (CLP) methods documents periodically, with information available from EPA, NTIS, and the internet. A few past examples (this list is not complete) [861]:

> User's Guide CLP CERCLA User's Guide to the Contract Laboratory Program. USEPA - Office of Emergency and Remedial

Response. Dec 1988

9240_0-0XFS Multi-Media/Conc Superfund OSWER CERCLA Multi-Media, Multi-Concentration Organic/Inorganic Analytical Service for Superfund, Quick Reference Fact Sheets, 9240.0-08FS (organic) and 9240-0-09FS (inorganic), August 1991. The organic/inorganic analytical service provides a technical and contractual framework for laboratories to apply EPA/Contract Laboratory Program (CLP) analytical methods for the isolation, detection and quantitative measurement of 33 volatile, 64 semi-volatile, 28 pesticide/Aroclor, and 24 inorganic target analytes in water and soil/ sediment environmental samples.

AOC/Contract Laboratory Program, Routine Analytical Services, Summary on EPA Home Page under Superfund Subdirectory, EPA Office of Remedial and Emergency Response, 1997, Internet.

When dichloroethylene is present in environmental samples, the investigator should also consider looking for its breakdown product vinyl chloride.

Holding Times for water samples: According to EPA protocols for NPDES permits [1010] and for RCRA [1013], the maximum holding time for all volatile organics is 14 days; samples should be kept at 4 degrees C, with no headspace or bubbles in the container [1010,1013].

Holding Times for samples of solids: The same as for water. EPA RCRA methods for volatiles in solids in SW-846 call for holding times of 14 days; samples should be kept at 4 degrees C, with no headspace or bubbles in the container [1013].

Containers:

Both EPA and APHA (Standards Methods Book) recommend glass containers for the collection of organic compounds [141,1010]. Guidance from other federal agencies (USGS, FWS, NOAA) also recommends glass containers for organics, and discourages the use of plastic containers for a variety of reasons (Roy Irwin, National Park Service, Personal Communication, 1997, based on a glance through recent internal guidance of several agencies). EPA specifies the use of teflon lined caps and teflon lined cap septums in glass vial containers for water samples of volatiles (VOCs and purgeable halocarbons such as the common organic solvents) [1010]. No headspace is allowed [1010,1013]. Actually, vials are not the best choice for avoiding false negatives in soil samples through volatilization losses, since the use of brass liners for collection resulted in 19 fold higher VOCs than when 40 mL vials were used [798] (see Wisconsin protocol discussion below). The third update of EPA's SW-846 RCRA guidance authorizes the storage of soil samples of volatiles in EnCore TM (or equivalent, no government endorsement implied) samplers as long the sample is analyzed within 48 hours after collection [1013].

Several states also authorize the use of EnCore TM or equivalent containers (Donalea Dinsmore, State of Wisconsin DNR, personal communication, 1997).

Some federal agency quality control procedures call for voiding or red-flagging the results of organic analyses if the lab receives the sample in plastic containers (Roy Irwin, National Park Service, Personal Communication, 1997). The APHA pointed out some the potential hazards of the use of certain plastic containers for storing organic samples [141]:

A) Potential contamination of the sample via leaching of compounds from the plastic, and/or

B) The plastic container walls can sometimes be attacked by certain organics and fail, and/or

C) The possibility that some of organic compound will dissolve into the walls of the plastic container, reducing the concentration of the compound in the container [141].

Certain plastic polymers present less of a problem related to potential losses of volatiles than others. Some plastic is found in the latest approved EnCore TM samplers. Some states also give the reader the option of using plastic in collecting devices. For example, related to methods for gasoline range petroleum hydrocarbons, Wisconsin states that organics can be collected using a 30 ml plastic syringe with the end sliced off, a brass tube, an EnCore TM sampler or other appropriate devices (Donalea Dinsmore, State of Wisconsin DNR, personal communication, 1997). A plastic syrine is also mentioned as an option in SW-846 [1013]. The thinking appears to be that plastic is less of a threat in a collecting device, with momentary contact, than in a storage container where contact times are longer.

Typical "standard method" protocols recommend proper cleaning of glass containers before use. Some collectors simply use pre-cleaned jars from I-Chem or Eagle Pitcher (no government endorsement implied) or equivalent suppliers. EPA [1010], USGS, and most other federal agencies recommend cleaning procedures for the glass containers, usually involving detergent rinsing, baking, and sometimes HCL rinses (Roy Irwin, National Park Service, Personal Communication, 1997).

Field Protocols:

Standard field collection method protocols are published by various parts of EPA, and by groups such as ASTM, for public use. Different protocols are distributed for

internal use by the Fish and Wildlife Service, the USGS, NOAA, DOE, and various other agencies. These recommendations change over time, with the newest recommendations sometimes being quite different than the old, thereby producing different results. The Fish and Wildlife Service methods are similar in many ways to NOAA field protocols [676].

Many recommended EPA field methods for organics are not very detailed, and some EPA methods refer the user to ASTM methods. Thus the EPA-recommended field methods are scattered through various EPA and ASTM publications. The 3rd update of SW-846 for RCRA solid waste applications has more detail than some previous versions [1013].

The various EPA methods for organics are different from each other, with the selection of the appropriate method depending upon the specific application (RCRA vs. CERCLA vs. NPDES permits, vs. Drinking Water, etc.) [861,1010,1013].

EPA methods typically include recommendations that grab samples rather than composites be utilized for organics, and require the proper cleaning of collection bottles and collecting gear for both volatile and semi-volatile organics [1010,1013]. In other publications, EPA recommends caution in the use of composite soil samples whether organic or inorganic, citing statistical complications and stating that the compositing of samples cannot, in general, be justified unless for a stated specific purpose and unless a justification is provided [1017].

ASTM publishes standard method guidance for numerous very specific applications, like sampling from pipes (D 3370-95a) and sampling for VOCs in soils (ASTM method D 4547].

Regardless of what lab methods are used, the investigator must take special precautions to prevent the escape of volatiles during sample shipment, storage, extraction, and cleanup [798]. This is especially true for soil and sediment sampling. The results of analyses of volatiles can be dramatically effected by small details such as how the samples are collected, stored, held, and analyzed in the lab, since volatile compounds can readily volatilize from samples in both field and lab procedures.

The realization that better methods were needed began when the lab results of EPA methods 8020 and 8240 were negative even when contamination by volatiles was obvious in the field, in other words, when investigators began seeing clearly false negative results [798]. In one study, the use of brass liners for collection of soil samples resulted in 19 fold higher VOCs than when 40 mL

vials were used [798].

National guidance for minimizing loss of volatiles in field sampling is found in EPA RCRA method 5035 as described in update 3 of SW-846 [1013,1018]. Several states (WI,MN,NJ, and MI) have developed their own detailed guidance, often including the use of methanol as a preservative.

After researching various papers which documented volatile losses of 9 to 99% during sampling and then finding 100% losses in samples held over 14 days in their own facilities, the Wisconsin DNR requires the following for soil sampling of volatiles [913]:

1) Concentrated (1:1 by weight of preservative vs soil) methanol preservation be used for all samples [913], and

2) samples stored in brass tubes must be preserved in methanol within 2 hours and samples stored in EnCore TM samplers must be preserved in 48 hours [913].

3) Detection limits should be no higher than 25 ug/Kg (ppb) dry weight for VOCs or petroleum volatiles in soil samples [913].

Note: The use of methanol for soil sample preservation can make lower detection limits difficult, but the tradeoff can be worth it since otherwise high percentages of volatiles can be lost in very short periods of time, for example in 2 hours for benzene. In other words, low detection limits do not help much if you are losing all the volatiles from the soil sample before analysis. A possible alternative to using methanol for soil samples of volatiles would be to use the EnCore TM sampler and to analyze as soon as possible (no later than 48 hours) after collection using the methods that give lower detection limits (Donalea Dinsmore, State of Wisconsin DNR, personal communication, 1997).

The USGS NAWQA program also recognized the problem of potential losses of volatile compounds, and recommends the use of strong (1:1) HCL as preservative material. Some SW-846 methods for volatiles call for the use of sulfuric acid [1013].

Variation in concentrations of organic contaminants may sometimes be due to the typically great differences in how individual investigators treat samples in the field and in the lab

rather than true differences in environmental concentrations. This is particularly true for volatiles, which are so easily lost at various steps along the way. Contaminants data from different labs, different states, and different agencies, collected by different people, are often not very comparable. In fact, as mentioned in the disclaimer section above, the interagency task force on water methods concluded that [1014]:

> It is the exception rather than the rule that water-quality monitoring data from different programs or time periods can be compared on a scientifically sound basis, and that...
>
> No nationally accepted standard definitions exist for water quality parameters. The different organizations may collect data using identical or standard methods, but identify them by different names, or use the same names for data collected by different methods [1014].

As of 1997, the problem of lack of data comparability (not only for water methods but also for soil, sediment, and tissue methods) between different "standard methods" recommended by different agencies seemed to be getting worse, if anything, rather than better. The trend in quality assurance seemed to be for various agencies, including the EPA and others, to insist on quality assurance plans for each project. In addition to field and lab quality control steps (blanks, duplicates, spikes, etc.), these quality assurance plans call for a step of insuring data comparability [1015,1017]. However, the data comparability step is often not given sufficient consideration. The tendency of agency guidance (such as EPA SW-846 methods and some other new EPA methods for bio-concentratable substances) to allow more and more flexibility to select options at various points along the way, makes it harder in insure data comparability or method validity.

Even volunteer monitoring programs are now strongly encouraged to develop and use quality assurance project plans [1015]. The basics of these quality assurance plans for chemical analyses should include the following quality control steps:

> At minimum, before using contaminants data from diverse sources, one should determine that field collection methods, detection limits, and lab quality control techniques were acceptable and comparable. The goal is that the analysis in the concentration range of the comparison benchmark concentration should be very precise and accurate. Typical lab quality control techniques should have included the following considerations (condensed from various EPA recommendations [1015] and from various guidance materials distributed the Fish and Wildlife Service):
>
> > Procedural Blanks should be analyzed to assure that no contaminants are added during the processing of the samples. The standards for adequacy depend on the method and the media being measured. Different federal agencies publish different acceptable limits. For one program,

NOAA stated that at least 8% of samples should be blanks, reference or control materials [676]. The basic idea is that neither samples nor blanks should be contaminated. Because the only way to measure the performance of the modified procedures is through the collection and analysis of uncontaminated blank samples in accordance with this guidance and the referenced methods, it is highly recommended that any modifications be thoroughly evaluated and demonstrated to be effective before field samples are collected [1003].

Duplicate samples are analyzed to provide a measure of precision of the methods. The standards for adequacy depend on the method and the media being measured. Different federal agencies publish different acceptable limits. There appears to be an inverse relationship between precision and sensitivity [676]. Some EPA methods state that a field duplicate must be collected at each sampling site, or one field duplicate per every ten samples, whichever is more frequent [1003]. Some protocols call for the preparation of one Ongoing precision and recovery (OPR) standard for every ten or fewer field samples. Great care should be taken in preparing ongoing precision and recovery standards [1003].

Spiked samples are analyzed to provide a measure of the accuracy of the analysis methods. The standards for adequacy depend on the method and the media being measured. Different federal agencies publish different acceptable limits.

For water and waste water analyses of this compound, EPA in the past has recommended methods 601,624, and 1624, as well as method 8240 [932].

For drinking water, in the past, EPA has recommended the following methods for analyses of certain volatiles. The following was recommended for this compound [893]:

Monitoring Requirements

All systems to be monitored for four consecutive quarters; repeat monitoring dependent upon detection, vulnerability status and system size.

Analytical Methods

Gas chromatography (EPA 502.1, 502.2, 503.1); gas chromatographic/mass spectrometry (EPA 524.1, 524.2).

Variation in concentrations of organic contaminants may sometimes be due to the typically great differences in how individual investigators treat samples in the field and in the lab rather than true differences in environmental concentrations.

Contaminants data from different labs, different states, and different agencies, collected by different people, are often not very comparable.

At minimum, before using contaminants data from diverse sources, one should determine that field collection methods, detection limits, and lab quality control techniques were acceptable and comparable. The goal is that the analysis in the concentration range of the comparison benchmark concentration should be very precise and accurate. Typical lab quality control techniques should have included the following considerations (John Moore, Fish and Wildlife Service, Personal Communication, 1997):

Procedural Blanks should be analyzed to assure that no contaminants are added during the processing of the samples. The standards for adequacy depend on the method and the media being measured.

Different federal agencies publish different acceptable limits. For one program, NOAA stated that at least 8% of samples should be blanks, reference or control materials [676].

The basic idea is that neither samples nor blanks should be contaminated. Because the only way to measure the performance of the modified procedures is through the collection and analysis of uncontaminated blank samples in accordance with this guidance and the referenced methods, it is highly recommended that any modifications be thoroughly evaluated and demonstrated to be effective before field samples are collected [1003].

Duplicate samples are analyzed to provide a measure of precision of the methods. The standards for adequacy depend on the method and the media being measured.

Different federal agencies publish different acceptable limits. For one program, NOAA stated that acceptable limits of precision are plus or minus 30% on average for all analytes [676]. There appears to be an inverse relationship between precision and sensitivity [676].

Some EPA methods state that a field duplicate must be collected at each sampling site, or one field duplicate per every ten samples, whichever is more frequent [1003]. Some protocols call for the preparation of one Ongoing precision and recovery (OPR) standard for every ten or fewer field samples. Great care should be taken in preparing ongoing precision and recovery standards [1003].

Spiked samples are analyzed to provide a measure of the accuracy of the analysis methods. The standards for adequacy depend on the method and the media being measured.

Different federal agencies publish different acceptable limits. For one program, NOAA stated that acceptable limits of accuracy are plus or minus 30% of known certified concentrations [676].

Description of EPA standard methods 8240 (old method) and 8260 (replacement method) from EPA EMMI Database on Lab methods [861]:

EPA Method 8240 for Volatile Organics [861]:

Note: Method 8260 is replacing 8240 in the third update of SW-846 [1013].

OSW 8240A S Volatile Organics - Soil, GCMS 73 SW-846 GCMS ug/kg EQL Method 8240A "Volatile Organics by Gas Chromatography/Mass Spectrometry (GC/MS): Packed Column Technique" The volatile compounds are introduced into the gas chromatograph by the purge and trap method or by direct injection (in limited applications) [861]. The components are separated via the gas chromatograph and detected using a mass spectrometer, which is used to provide both qualitative and quantitative information [861]. The chromatographic conditions, as well as typical mass spectrometer operating parameters, are given [861]. If the above sample introduction techniques are not applicable, a portion of the sample is dispersed in methanol to dissolve the volatile organic constituents [861]. A portion of the methanolic solution is combined with organic-free reagent water in a specially designed purging chamber [861]. It is then analyzed by purge and trap GC/MS following the normal water method [861]. The purge and trap process - An inert gas is bubbled through the solution at ambient temperature, and the volatile components are efficiently transferred from the aqueous phase to the vapor phase [861]. The vapor is swept through a sorbent column where the volatile components are trapped [861]. After purging is complete, the sorbent column is heated and backflushed with inert gas to desorb the components, which are detected with a mass spectrometer [861].

OSW 8240A W Volatile Organics - Water, GCMS 73 SW-846 GCMS ug/L EQL Method 8240A "Volatile Organics by Gas Chromatography/Mass Spectrometry (GC/MS): Packed Column Technique" The volatile compounds are introduced into the gas chromatograph by the purge and trap method or by direct injection (in limited applications) [861]. The components are separated via the gas chromatograph and detected using a mass

spectrometer, which is used to provide both qualitative and quantitative information [861]. The chromatographic conditions, as well as typical mass spectrometer operating parameters, are given [861]. If the above sample introduction techniques are not applicable, a portion of the sample is dispersed in methanol to dissolve the volatile organic constituents [861]. A portion of the methanolic solution is combined with organic-free reagent water in a specially designed purging chamber [861]. It is then analyzed by purge and trap GC/MS following the normal water method [861]. The purge and trap process - An inert gas is bubbled through the solution at ambient temperature, and the volatile components are efficiently transferred from the aqueous phase to the vapor phase [861]. The vapor is swept through a sorbent column where the volatile components are trapped [861]. After purging is complete, the sorbent column is heated and backflushed with inert gas to desorb the components, which are detected with a mass spectrometer [861]. Note: Method 8260 is replacing 8240 in the third update of SW-846 [1013].

EPA Method 8260 (for GC/MS Volatile Organics):

Note: Method 8260 is replacing 8240 in the third update of SW-846 [1013].

EPA description [861]:

OSW 8260 Volatile Organics - CGCMS 58 SW-846 CGCMS ug/L MDL Method 8260 "Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS): Capillary Column Technique" The volatile compounds are introduced into the gas chromatograph by the purge and trap method or by direct injection (in limited applications) [861]. Purged sample components are trapped in a tube containing suitable sorbent materials [861]. When purging is complete, the sorbent tube is heated and backflushed with helium to desorb trapped sample components [861]. The analytes are desorbed directly to a large bore capillary or cryofocussed on a capillary precolumn before being flash evaporated to a narrow bore capillary for analysis [861]. The column is temperature programmed to separate the analytes which are then detected with a mass spectrometer interfaced to the gas chromatograph [861]. Wide capillary columns

require a jet separator, whereas narrow bore capillary columns can be directly interfaced to the ion source [861]. If the above sample introduction techniques are not applicable, a portion of the sample is dispersed in solvent to dissolve the volatile organic constituents [861]. A portion of the solution is combined with organic- free reagent water in the purge chamber [861]. It is then analyzed by purge and trap GC/MS following the normal water method [861]. Qualitative identifications are confirmed by analyzing standards under the same conditions used for samples and comparing resultant mass spectra and GC retention times [861]. Each identified component is quantified by relating the MS response for an appropriate selected ion produced by that compound to the MS response for another ion produced by an internal standard [861].

Other Misc. (mostly less rigorous) lab methods which have been used in the past in media such as drinking water for volatiles [893] (lab method description from EPA [861]):

EMSLC 502.2 ELCD VOA's - P&T/CGCELCD/CGCPID 44 DRINKING_WATER CGCELD ug/L MDL "Volatile Organic Compounds in Water by Purge and Trap Capillary Column Gas Chromatography with Photoionization and Electrolytic Conductivity Detectors in Series" This method is used for the identification and measurement of purgeable volatile organic compounds in finished drinking water, raw source water, or drinking water in any treatment stage [861]. The method is applicable to a wide range of organic compounds, including the four trihalomethane disinfection by-products, that have sufficiently high volatility and low water solubility to be efficiently removed from water samples with purge and trap procedures [861]. An inert gas is bubbled through a 5 mL water sample [861]. The volatile compounds with low water solubility are purged from the sample and trapped in a tube containing suitable sorbent materials [861]. When purging is complete, the tube is heated and backflushed with helium to desorb trapped sample components onto a capillary gas chromatography (GC) column [861]. The column is temperature programmed to separate the analytes which are then detected with photoionization detector (PID) and halogen specific detectors in series [861]. Analytes are identified by comparing retention times with authentic standards and by comparing relative responses from the two detectors [861]. A GC/MS may be used for further

confirmation [861].

EMSLC 502.2 PID VOA's - P&T/CGCELCD/CGCPID 33 DRINKING_WATER CGCPID ug/L MDL "Volatile Organic Compounds in Water by Purge and Trap Capillary Column Gas Chromatography with Photoionization and Electrolytic Conductivity Detectors in Series" This method is used for the identification and measurement of purgeable volatile organic compounds in finished drinking water, raw source water, or drinking water in any treatment stage [861]. The method is applicable to a wide range of organic compounds, including the four trihalomethane disinfection by-products, that have sufficiently high volatility and low water solubility to be efficiently removed from water samples with purge and trap procedures [861]. An inert gas is bubbled through a 5 mL water sample [861]. The volatile compounds with low water solubility are purged from the sample and trapped in a tube containing suitable sorbent materials [861]. When purging is complete, the tube is heated and backflushed with helium to desorb trapped sample components onto a capillary gas chromatography (GC) column [861]. The column is temperature programmed to separate the analytes which are then detected with photoionization detector (PID) and halogen specific detectors in series [861]. Analytes are identified by comparing retention times with authentic standards and by comparing relative responses from the two detectors [861]. A GC/MS may be used for further confirmation [861].

EMSLC 503.1 Volatile Aromatics in Water 28 DRINKING_WATER GCPID ug/L MDL "Volatile Aromatic and Unsaturated Organic Compounds in Water by Purge and Trap Gas Chromatography" This method is applicable for the determination of various volatile aromatic and unsaturated compounds in finished drinking water, raw source water, or drinking water in any treatment stage [861]. Highly volatile organic compounds with low water solubility are extracted (purged) from a 5-ml sample by bubbling an inert gas through the aqueous sample [861]. Purged sample components are trapped in a tube containing a suitable sorbent material [861]. When purging is complete, the sorbent tube is heated and backflushed with an inert gas to desorb trapped sample components onto a gas chromatography (GC) column [861]. The gas chromatograph is temperature programmed to separate

the method analytes which are then detected with a photoionization detector [861]. A second chromatographic column is described that can be used to help confirm GC identifications or resolve coeluting compounds [861]. Confirmation may be performed by gas chromatography/mass spectrometry (GC/MS) [861].

APHA 6230 D Volatile Halocarbons - CGCELCD STD_METHODS GCELCD "6230 Volatile Halocarbons" GCPID 6230 D [861]. Purge and Trap Capillary-Column Gas Chromatographic Method: This method is similar to Method 6230 C., except it uses a wide-bore capillary column, and requires a high-temperature photoionization detector in series with either an electrolytic conductivity or microcoulometric detector [861]. This method is equivalent to EPA method 502.2; see EMSLC\502.2 [861]. Detection limit data are not presented in this method, but the method is identical to 502.2; therefore, see EMSLC\502.2 for detection limit data [861]. Method 6230 B., 17th edition, corresponds to Method 514, 16th edition [861]. The other methods listed do not have a cross-reference in the 16th edition [861].

EMSLC 524.1 Purgeable Organics - GCMS 48 DRINKING_WATER GCMS ug/L MDL "Measurement of Purgeable Organic Compounds in Water by Packed Column Gas Chromatography/Mass Spectrometry" This is a general purpose method for the identification and simultaneous measurement of purgeable volatile organic compounds in finished drinking water, raw source water, or drinking water in any treatment stage [861]. Volatile organic compounds and surrogates with low water solubility are extracted (purged) from the sample matrix by bubbling an inert gas through the aqueous sample [861]. Purged sample components are trapped in a tube containing suitable sorbent materials [861]. When purging is complete, the trap is backflushed with helium to desorb the trapped sample components into a packed gas chromatography (GC) column interfaced to a mass spectrometer (MS) [861]. The column is temperature programmed to separate the method analytes which are then detected with the MS [861]. Compounds eluting from the GC column are identified by comparing their measured mass spectra and retention times to reference spectra and retention times in a data base [861]. Reference spectra and retention times for analytes are obtained by the measurement of calibration standards under the same conditions used for samples [861]. The concentration of each identified component is measured by relating the MS

response of the quantitation ion produced by that compound to the MS response of the quantitation ion produced by a compound that is used as an internal standard [861]. Surrogate analytes, whose concentrations are known in every sample, are measured with the same internal standard calibration procedure [861].

EMSLC 524.2 Purgeable Organics - CGCMS 60 DRINKING_WATER CGCMS ug/L MDL "Measurement of Purgeable Organic Compounds in Water by Capillary Column Gas Chromatography/Mass Spectrometry" This is a general purpose method for the identification and simultaneous measurement of purgeable volatile organic compounds in finished drinking water, raw source water, or drinking water in any treatment stage [861]. Volatile organic compounds and surrogates with low water solubility are extracted (purged) from the sample matrix by bubbling an inert gas through the aqueous sample [861]. Purged sample components are trapped in a tube containing suitable sorbent materials [861]. When purging is complete, the sorbent tube is heated and backflushed with helium to desorb the trapped sample components into a capillary gas chromatography (GC) column interfaced to a mass spectrometer (MS) [861]. The column is temperature programmed to separate the method analytes which are then detected with the MS [861]. Compounds eluting from the GC column are identified by comparing their measured mass spectra and retention times to reference spectra and retention times in a data base [861]. Reference spectra and retention times for analytes are obtained by the measurement of calibration standards under the same conditions used for samples [861]. The concentration of each identified component is measured by relating the MS response of the quantitation ion produced by that compound to the MS response of the quantitation ion produced by a compound that is used as an internal standard [861]. Surrogate analytes, whose concentrations are known in every sample, are measured with the same internal standard calibration procedure [861].

USGS 1996 Method for VOC analyses (Brooke Connor, USGS Water Quality Lab, Denver, Personal Communication, 1996, distributed on the intenet):

Subject: Custom Method 9090: Basic Description of the Method and more Date: Tue, 14 May 1996 From: "John S Zogorski, Supervisory Hydrologist, Rapid City, SD" Custom Method 9090: Basic Description of the Method, Identification and Quantification Strategy, and Data Transfer The purpose of

this memo is to provide additional details on the new VOC method -- Custom Method 9090. Information included in this memo includes: (1) general description of the method; (2) identification and quantitation strategy; and (3) data transfer to study units. A. General Description of the Method Custom method 9090 uses capillary column gas chromatography / mass spectrometry (GC/MS) to identify and quantitate 87 analytes, and to tentatively identify unknowns. The method is intended to identify and measure low concentrations of VOCs that may occur in the environmental settings sampled in the NAWQA program, and which may be associated with either point and non-point sources, especially in urban areas. Fifty-five of the analytes included on 9090 are referred to as NAWQA VOC target analytes and were selected because of their known human health concern (A or B carcinogens), aquatic toxicity, frequency of occurrence, and/or emerging chemicals with a potential for wide-scale use and significance. Custom method 9090 builds on the same VOC analytical technology, GC/MS, that has been used at the NWQL and elsewhere for many years, and which is considered the conventional approach for high-quality analysis of VOCs in water....Persons unfamiliar with the GC/MS method for VOCs may wish to refer to 2 recent reports: Rose, D.L., and M.P. Schroeder, 1995, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory -- Determination of volatile organic compounds in water by purge and trap capillary gas chromatography/mass spectrometry: U.S. Geological Survey Open-File Report 94-708, 26 p. Raese, J.W., D.L Rose, and M.W. Sandstrom, 1995, U.S. Geological Survey Laboratory Method for Methyl tert-Butyl Ether and Other Fuel Oxygenates: U.S. Geological Survey Fact Sheet 219-95, 4 p..... Questions on this EDOC should be directed to Brooke Connor (303-467-8170) at the NWQL or John Zogorski of VOC National Synthesis (605-394-1780 x.214), or both.

Detailed Information from ATSDR:

BIOLOGICAL MATERIALS: The analytical methods used to quantify 1,1-dichloroethene in biological samples are summarized below [932]. Table 6-1 lists the applicable analytical methods for determining 1,1-dichloroethene in biological specimens [932]. 1,1-Dichloroethene exposure can be monitored by measuring the levels in blood, expired air and urine [932]. 1,1-Dichloroethene also distributes preferentially to liver, kidney, and to a lesser extent, adipose tissue [932]. Methods are available to measure 1,1-dichloroethene and/or its metabolites in these tissues as well [932]. Purge-and-trap gas chromatography/mass spectrometry (GC/MS) is the most commonly used method to detect 1,1-dichloroethene in biological samples [932]. The purge-and-trap technique involves bubbling an inert gas through the sample to purge the volatile compounds out of solution [932]. The compounds are then trapped in a cold trap (cryotrapping) or adsorbed on a suitable adsorbent such as

Tenax [932]. The next step is thermal desorption of the trapped solutes and their subsequent transfer to an analytical column [932]. GC/MS allows the detection of compound at the ppb level [932]. Capillary GC affords the highest resolution of complex mixtures, even when other volatile organic compounds are present that could conceivably mask or interfere with the detection of 1,1-dichloroethene [932]. Furthermore, specific GC-detectors, as well as mass selective detectors, enable the quantitation of 1,1-dichloroethene even when it is not fully separated from other compounds [932]. It is difficult to accurately measure biological concentrations of 1,1-dichloroethene and correlate these measurements to actual exposure concentrations because of the chemical's short half-life and conversion into metabolites [932]. The concentration of 1,1-dichloroethene in biological media is continually changing by virtue of its rapid release into the air or biotransformation into other compounds [932]. More information on methods for the analysis of 1,1-dichloroethene in biological materials, including sample preparation techniques, can be found in the references cited in Table 6- l [932]. Environmental exposure to 1,1-dichloroethene at hazardous waste sites may often include exposure to other chlorinated hydrocarbons [932]. 1,1-Dichloroethene exposure can be monitored by direct measurement of the parent compound or its metabolites [932]. It is difficult to distinguish metabolites of 1,1-dichloroethene in the body because some of the same metabolites may be formed as a result of exposure to other chlorinated hydrocarbons [932]. Determination of 1,1-dichloroethene in breath samples by GC/MS is the most commonly used method of monitoring exposure to 1,1-dichloroethene [932]. Sensitivity is in the low ppb range [932]. Recovery is adequate [932]. Various other techniques are being studied and developed to monitor 1,1-dichloroethene in expired air using reversible adsorption and impregnated tape methods for continuous monitoring [932]. Recently, a portable device for measuring 1,1-dichloroethene in alveolar breath was described [932]. 1,1-Dichloroethene has been measured in whole blood samples using purge-and-trap GC/MS [932]. ...The reason for the high recoveries was not clear but was suggested to be due to the inability to accurately assess the levels of the volatile compounds in the unspiked blood which served as a baseline for recovery calculation [932]. The measurement of 1,1-dichloroethene adducts with DNA in lymphocytes or hemoglobin may also be useful in monitoring exposure to 1,1-dichloroethene [932]. Such a method has been established in hemoglobin for another volatile organic compound, ethylene oxide [932]. Because human hemoglobin has a half-life of 60 days (although half-lives of hemoglobin adducts are somewhat reduced), monitoring of 1,1-dichloroethene adducts with hemoglobin can be a valuable tool for estimating exposure over longer periods [932].

ENVIRONMENTAL SAMPLES: The analytical methods used to quantify 1,1-dichloroethene in environmental samples are listed Table

6-2 [932]. The analytical methods required by EPA for the analysis of 1,1- dichloroethene in water and waste water are described in procedures 601 (GC/ECD), 624 (GC/MS), and 1624 (GC/MS) [932]. The sensitivity for these methods is in the ppb range [932]. These are testing procedures required under the Clean Water Act for sites discharging municipal and industrial waste water [932]. The method required by the EPA Contract Laboratory Program (CLP) for analysis of 1,1- dichloroethene and other volatile organic compounds is hexadecane extraction, followed by determination of approximate concentration using GC and flame ionization detection (FID), and final quantitative analysis using GC/MS [932]. GC/FID is used to detect 1,1-dichloroethene in air samples [932]. The sensitivity of this procedure is in the low ppm range [932]. Recovery is good [932]. GC/MS is used to determine 1,1-dichloroethene in water, waste water discharges, and soil samples with sensitivities in the ppb-range [932]. DeLeon et al in 1980 measured levels of 1,1-dichloroethene in soil and chemical waste; this method had a limit of detection of 10 ppm [932]. In addition, GC/MS is used to determine levels of 1,1-dichloroethene in fish tissue [932]. GC/ion trap detection (ITD) is used for drinking water [932]. Sensitivity is in the ppb range and recovery is good [932]. Purge-and-trap GC/MS is used for measuring volatile chlorinated hydrocarbons in ground water [932]. The detection limit for this method is 0.2 ug/L [932]. At concentrations 1,1-dichloroethene ranging from 0.2 to 100 ug/L, recoveries were good, ranging from 85% to 142% [932]. The high recoveries were the result of using a calibration curve that spanned more than three orders of magnitude [932]. Precision was excellent (3-8% RSD) [932]. Purgeable organic chloride (POCI) analysis can be used as a complimentary method for use with GC/MS [932]. Purge-and-trap GC/MS and POCI analysis gave data of similar accuracy and precision at spiked concentrations [932]. ... POCI analysis is useful for screening samples for volatile chlorinated hydrocarbons; however, it is not suitable as an independent method of analysis [932]. Purge-and-trap GC/flame ionization detector (ECD) has also been used to measure 1,1-dichloroethene in tap water [932]. Recovery (76.6%) and precision (1.6% RSD) for this method were good [932]. The detection limit was not reported [932]. Gilbert et al [932]. in 1980 detected 1,1-dichloroethene in food at levels 5 ppm using headspace GC/ECD [932]. These food products were packaged in polyvinylchloride films [932]. Birkel et al in 1977. using GSC/MS, detected levels of between 6.5 and 10.4 ppm of 1,1-dichloroethene in Saran food packaging films [932].