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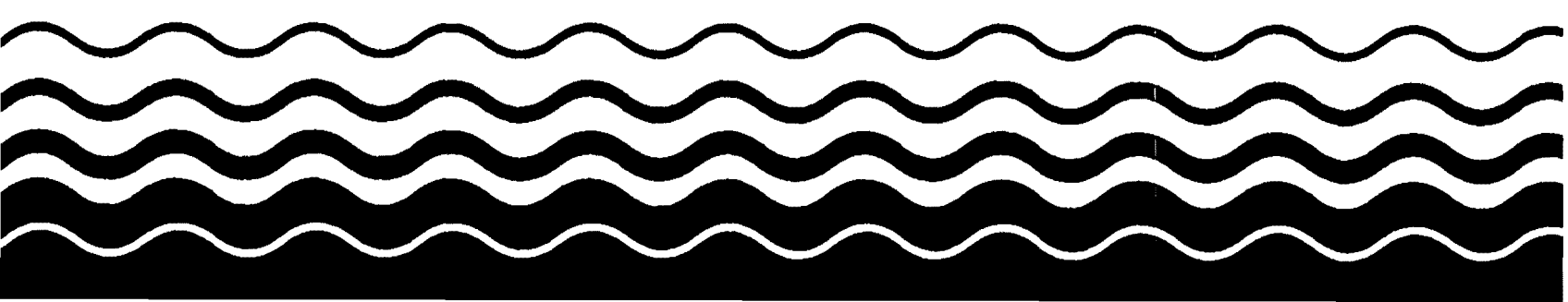
EPA

# Environmental Profiles and Hazard Indices for Constituents of Municipal Sludge: Tetrachloroethylene



## PREFACE

This document is one of a series of preliminary assessments dealing with chemicals of potential concern in municipal sewage sludge. The purpose of these documents is to: (a) summarize the available data for the constituents of potential concern, (b) identify the key environmental pathways for each constituent related to a reuse and disposal option (based on hazard indices), and (c) evaluate the conditions under which such a pollutant may pose a hazard. Each document provides a scientific basis for making an initial determination of whether a pollutant, at levels currently observed in sludges, poses a likely hazard to human health or the environment when sludge is disposed of by any of several methods. These methods include landspreading on food chain or nonfood chain crops, distribution and marketing programs, landfilling, incineration and ocean disposal.

These documents are intended to serve as a rapid screening tool to narrow an initial list of pollutants to those of concern. If a significant hazard is indicated by this preliminary analysis, a more detailed assessment will be undertaken to better quantify the risk from this chemical and to derive criteria if warranted. If a hazard is shown to be unlikely, no further assessment will be conducted at this time; however, a reassessment will be conducted after initial regulations are finalized. In no case, however, will criteria be derived solely on the basis of information presented in this document.

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# SECTION 1

## INTRODUCTION

This preliminary data profile is one of a series of profiles dealing with chemical pollutants potentially of concern in municipal sewage sludges. Tetrachloroethylene ($C_2Cl_4$) was initially identified as being of potential concern when sludge is incinerated.* This profile is a compilation of information that may be useful in determining whether $C_2Cl_4$ poses an actual hazard to human health or the environment when sludge is disposed of by this method.

The focus of this document is the calculation of "preliminary hazard indices" for selected potential exposure pathways, as shown in Section 3. Each index illustrates the hazard that could result from movement of a pollutant by a given pathway to cause a given effect (e.g., sludge → air → human toxicity). The values and assumptions employed in these calculations tend to represent a reasonable "worst case"; analysis of error or uncertainty has been conducted to a limited degree. The resulting value in most cases is indexed to unity; i.e., values >1 may indicate a potential hazard, depending upon the assumptions of the calculation.

The data used for index calculation have been selected or estimated based on information presented in the "preliminary data profile", Section 4. Information in the profile is based on a compilation of the recent literature. An attempt has been made to fill out the profile outline to the greatest extent possible. However, since this is a preliminary analysis, the literature has not been exhaustively perused.

The "preliminary conclusions" drawn from each index in Section 3 are summarized in Section 2. The preliminary hazard indices will be used as a screening tool to determine which pollutants and pathways may pose a hazard. Where a potential hazard is indicated by interpretation of these indices, further analysis will include a more detailed examination of potential risks as well as an examination of site-specific factors. These more rigorous evaluations may change the preliminary conclusions presented in Section 2, which are based on a reasonable "worst case" analysis.

The preliminary hazard indices for selected exposure routes pertinent to incineration are included in this profile. The calculation formulae for these indices are shown in the Appendix. The indices are rounded to two significant figures.

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* Listings were determined by a series of expert workshops convened during March-May, 1984 by the Office of Water Regulations and Standards (OWRS) to discuss landspreading, landfilling, incineration, and ocean disposal, respectively, of municipal sewage sludge.

## SECTION 2

## PRELIMINARY CONCLUSIONS FOR TETRACHLOROETHYLENE IN MUNICIPAL SEWAGE SLUDGE

The following preliminary conclusions have been derived from the calculation of "preliminary hazard indices", which represent conservative or "worst case" analyses of hazard. The indices and their basis and interpretation are explained in Section 3. Their calculation formulae are shown in the Appendix.

### I. LANDSPREADING AND DISTRIBUTION-AND-MARKETING

Based on the recommendations of the experts at the OWRS meetings (April-May, 1984), an assessment of this reuse/disposal option is not being conducted at this time. The U.S. EPA reserves the right to conduct such an assessment for this option in the future.

### II. LANDFILLING

Based on the recommendations of the experts at the OWRS meetings (April-May, 1984), an assessment of this reuse/disposal option is not being conducted at this time. The U.S. EPA reserves the right to conduct such an assessment for this option in the future.

### III. INCINERATION

Incineration of municipal sewage sludge is not expected to increase the amount of $C_2Cl_4$ contamination above background urban levels (see Index 1). Also, the incineration of municipal sewage sludge is not expected to increase the risk of human cancer, due to $C_2Cl_4$ inhalation, above the preexisting risk attributable to background levels in urban air (see Index 2).

### IV. OCEAN DISPOSAL

Based on the recommendations of the experts at the OWRS meetings (April-May, 1984), an assessment of this reuse/disposal option is not being conducted at this time. The U.S. EPA reserves the right to conduct such an assessment for this option in the future.

## SECTION 3

## PRELIMINARY HAZARD INDICES FOR TETRACHLOROETHYLENE IN MUNICIPAL SEWAGE SLUDGE

### I. LANDSPREADING AND DISTRIBUTION-AND-MARKETING

Based on the recommendations of the experts at the OWRS meetings (April-May, 1984), an assessment of this reuse/disposal option is not being conducted at this time. The U.S. EPA reserves the right to conduct such an assessment for this option in the future.

### II. LANDFILLING

Based on the recommendations of the experts at the OWRS meetings (April-May, 1984), an assessment of this reuse/disposal option is not being conducted at this time. The U.S. EPA reserves the right to conduct such an assessment for this option in the future.

### III. INCINERATION

#### A. Index of Air Concentration Increment Resulting from Incinerator Emissions (Index 1)

1. **Explanation** - Shows the degree of elevation of the pollutant concentration in the air due to the incineration of sludge. An input sludge with thermal properties defined by the energy parameter (EP) was analyzed using the BURN model (Camp Dresser and McKee, Inc., 1984). This model uses the thermodynamic and mass balance relationships appropriate for multiple hearth incinerators to relate the input sludge characteristics to the stack gas parameters. Dilution and dispersion of these stack gas releases were described by the U.S. EPA's Industrial Source Complex Long-Term (ISCLT) dispersion model from which normalized annual ground level concentrations were predicted (U.S. EPA, 1979). The predicted pollutant concentration can then be compared to a ground level concentration used to assess risk.

2. **Assumptions/Limitations** - The fluidized bed incinerator was not chosen due to a paucity of available data. Gradual plume rise, stack tip downwash, and building wake effects are appropriate for describing plume behavior. Maximum hourly impact values can be translated into annual average values.

3. **Data Used and Rationale**

   a. **Coefficient to correct for mass and time units (C) =** $2.78 \times 10^{-7}$ hr/sec x g/mg

**b. Sludge feed rate (DS)**

**i. Typical** = 2660 kg/hr (dry solids input)

A feed rate of 2660 kg/hr DW represents an average dewatered sludge feed rate into the furnace. This feed rate would serve a community of approximately 400,000 people. This rate was incorporated into the U.S. EPA-ISCLT model based on the following input data:

EP = 360 lb $H_2O$/mm BTU
Combustion zone temperature - 1400°F
Solids content - 28%
Stack height - 20 m
Exit gas velocity - 20 m/s
Exit gas temperature - 356.9°K (183°F)
Stack diameter - 0.60 m

**ii. Worst** = 10,000 kg/hr (dry solids input)

A feed rate of 10,000 kg/hr DW represents a higher feed rate and would serve a major U.S. city. This rate was incorporated into the U.S. EPA-ISCLT model based on the following input data:

EP = 392 lb $H_2O$/mm BTU
Combustion zone temperature - 1400°F
Solids content - 26.6%
Stack height - 10 m
Exit gas velocity - 10 m/s
Exit gas temperature - 313.8°K (105°F)
Stack diameter - 0.80 m

**c. Sludge concentration of pollutant (SC)**

| | |
|---|---|
| Typical | 0.181 mg/kg DW |
| Worst | 13.707 mg/kg DW |

The typical and worst case sludge concentrations of the pollutant are the median and 95th percentile values statistically derived from data provided in a study of 40 publicly-owned treatment works (POTWs) (U.S. EPA, 1982). (See Section 4, p.4-1.)

**d. Fraction of pollutant emitted through stack (FM)**

| | |
|---|---|
| Typical | 0.05 (unitless) |
| Worst | 0.20 (unitless) |

These values were chosen as best approximations of the fraction of pollutant emitted through stacks (Farrell, 1984). No data was available to validate

these values; however, U.S. EPA is currently testing incinerators for organic emissions.

e. **Dispersion parameter for estimating maximum annual ground level concentration (DP)**

Typical 3.4 $\mu g/m^3$
Worst 16.0 $\mu g/m^3$

The dispersion parameter is derived from the U.S. EPA-ISCLT short-stack model.

f. **Background concentration of pollutant in urban air (BA) = 5.0 $\mu g/m^3$**

This value is the approximate average of urban air concentrations in the United States (U.S. EPA, 1985). (See Section 4, p.4-2.)

4. **Index 1 Values**

| Fraction of Pollutant Emitted Through Stack | Sludge Concentration | Sludge Feed Rate (kg/hr DW)[a] 0 | 2660 | 10,000 |
|---|---|---|---|---|
| Typical | Typical | 1.0 | 1.0 | 1.0 |
| | Worst | 1.0 | 1.0 | 1.0 |
| Worst | Typical | 1.0 | 1.0 | 1.0 |
| | Worst | 1.0 | 1.0 | 1.0 |

[a] The typical (3.4 $\mu g/m^3$) and worst (16.0 $\mu g/m^3$) dispersion parameters will always correspond, respectively, to the typical (2660 kg/hr DW) and worst (10,000 kg/hr DW) sludge feed rates.

5. **Value Interpretation** - Value equals factor by which expected air concentration exceeds background levels due to incinerator emissions.

6. **Preliminary Conclusion** - Incineration of municipal sewage sludge is not expected to increase the amount of $C_2Cl_4$ contamination above background urban levels.

B. **Index of Human Cancer Risk Resulting from Inhalation of Incinerator Emissions (Index 2)**

1. **Explanation** - Shows the increase in human intake expected to result from the incineration of sludge. Ground level concentrations for carcinogens typically were developed

based upon assessments published by the U.S. EPA Carcinogen Assessment Group (CAG). These ambient concentrations reflect a dose level which, for a lifetime exposure, increases the risk of cancer by $10^{-6}$. For non-carcinogens, levels typically were derived from the American Conference of Government Industrial Hygienists (ACGIH) threshold limit values (TLVs) for the workplace.

2. **Assumptions/Limitations** - The exposed population is assumed to reside within the impacted area for 24 hours/day. A respiratory volume of 20 $m^3$/day is assumed over a 70-year lifetime.

3. **Data Used and Rationale**

   a. **Index of air concentration increment resulting from incinerator emissions (Index 1)**

      See Section 3, p. 3-3.

   b. **Background concentration of pollutant in urban air (BA) = 5.0 $\mu g/m^3$**

      See Section 3, p. 3-3.

   c. **Cancer potency = $5.8 \times 10^{-3}$ $(mg/kg/day)^{-1}$**

      The estimate of cancer potency for human inhalation of $C_2Cl_4$ has been derived from that for ingestion. However, evidence for carcinogenicity of this compound by the inhalation route is much weaker than for the oral route. This issue is under review by the U.S. EPA Carcinogen Assessment Group (U.S. EPA, 1983). (See Section 4, p. 4-4.)

   d. **Exposure criterion (EC) = 0.60 $\mu g/m^3$**

      A lifetime exposure level which would result in a $10^{-6}$ cancer risk was selected as ground level concentration against which incinerator emissions are compared. The risk estimates developed by CAG are defined as the lifetime incremental cancer risk in a hypothetical population exposed continuously throughout their lifetime to the stated concentration of the carcinogenic agent. The exposure criterion is calculated using the following formula:

$$EC = \frac{10^{-6} \times 10^3 \ \mu g/mg \times 70 \ kg}{\text{Cancer potency} \times 20 \ m^3/day}$$

4. **Index 2 Values**

| Fraction of Pollutant Emitted Through Stack | Sludge Concentration | Sludge Feed Rate (kg/hr DW)[a] 0 | 2660 | 10,000 |
|---|---|---|---|---|
| Typical | Typical | 8.3 | 8.3 | 8.3 |
| | Worst | 8.3 | 8.3 | 8.4 |
| Worst | Typical | 8.3 | 8.3 | 8.3 |
| | Worst | 8.3 | 8.3 | 8.5 |

[a] The typical (3.4 $\mu g/m^3$) and worst (16.0 $\mu g/m^3$) dispersion parameters will always correspond, respectively, to the typical (2660 kg/hr DW) and worst (10,000 kg/hr DW) sludge feed rates.

5. **Value Interpretation** - Value > 1 indicates a potential increase in cancer risk of > $10^{-6}$ (1 per 1,000,000). Comparison with the null index value at 0 kg/hr DW indicates the degree to which any hazard is due to sludge incineration, as opposed to background urban air concentration.

6. **Preliminary Conclusion** - The incineration of municipal sewage sludge is not expected to increase the risk of human cancer, due to the inhalation of $C_2Cl_4$, above the preexisting risk attributable to background levels in urban air.

## IV. OCEAN DISPOSAL

Based on the recommendations of the experts at the OWRS meetings (April-May, 1984), an assessment of this reuse/disposal option is not being conducted at this time. The U.S. EPA reserves the right to conduct such an assessment for this option in the future.

## SECTION 4

## PRELIMINARY DATA PROFILE FOR TETRACHLOROETHYLENE IN MUNICIPAL SEWAGE SLUDGE

### I. OCCURRENCE

#### A. Sludge

##### 1. Frequency of Detection

Data not immediately available.

##### 2. Concentration

Minimum--Data not immediately available.

| | |
|---|---|
| Maximum--42.109 µg/g (DW) | U.S. EPA, 1982 |
| Median--0.181 mg/kg (DW)<br>95th percentile--13.707 mg/kg (DW) | Statistically derived from sludge concentration data presented in U.S. EPA, 1982 |

#### B. Soil - Unpolluted

##### 1. Frequency of Detection

Data not immediately available.

##### 2. Concentration

Data not immediately available.

#### C. Water - Unpolluted

##### 1. Frequency of Detection

| | |
|---|---|
| $C_2Cl_4$ detected in 9 of 105 drinking water samples between November 1976 and January 1977 | U.S. EPA, 1980 (p. C-1) |

##### 2. Concentration

###### a. Freshwater

| | |
|---|---|
| Highest level reported = 45 µg/L. In all samples taken in California, Oregon, and Washington, $C_2Cl_4$ was either not detected or was found at a concentration of 1 µg/L or less. | U.S. EPA, 1985 (p. 3-16) |

b. **Seawater**

Liverpool Bay, England

| | | |
|---|---|---|
| Mean | 0.12 µg/L | U.S. EPA, 1980 |
| Maximum | 2.6 µg/L | (p. C-1) |

c. **Drinking water**

| | |
|---|---|
| Mean concentration 0.81 µg/L | U.S. EPA, 1980 (p. C-1) |

D. **Air**

1. **Frequency of Detection**

| | |
|---|---|
| Data available from a wide variety of urban and nonurban areas. | U.S. EPA, 1985 (p. 3-10) |

2. **Concentration**

| | |
|---|---|
| Survey of eight locations in the United States indicated concentrations up to 6.7 $\mu g/m^3$. | U.S. EPA, 1980 (p. C-3) |
| A measurement taken at Phoenix, Arizona in 1979 showed concentrations up to 3.7 $\mu g/m^3$. An approximate average urban value of 0.8 ppb ($\sim$ 5 $\mu g/m^3$) was estimated. | U.S. EPA, 1985 (p. 3-10,3-15) |

E. **Food**

Data not immediately available.

## II. HUMAN EFFECTS

### A. Ingestion

#### 1. Carcinogenicity

##### a. Qualitative Assessment

| | |
|---|---|
| No data found related to humans. NCI reports hepatocellular carcinoma in male and female mice, when exposed to oral doses of $C_2Cl_4$ in the range of 386 to 772 mg/kg/day. | U.S. EPA, 1983 (p. 9-39) |

##### b. Potency

| | |
|---|---|
| Cancer potency for mice is $3.5 \times 10^{-2}$ $(mg/kg/day)^{-1}$ | U.S. EPA, 1983 (p. 9-35) |

##### c. Effects

| | |
|---|---|
| Hepatocellular carcinoma in mice. | U.S. EPA, 1983 (p. 9-39) |

#### 2. Chronic Toxicity

Data not presented because cancer potency will be used to assess hazard.

#### 3. Absorption Factor

| | |
|---|---|
| $C_2Cl_4$ is rapidly and virtually completely absorbed into the body from the gastrointestinal tract, presumably because of its high lipid solubility. | U.S. EPA, 1985 (p. 5-2) |

#### 4. Existing Regulations

No regulations found pertaining to human ingestion of $C_2Cl_4$.

### B. Inhalation

#### 1. Carcinogenicity

##### a. Qualitative Assessment

| | |
|---|---|
| IARC classifies $C_2Cl_4$ as a group 3 compound. This rating is based on limited evidence for assessing human cancer risk associated with exposure to $C_2Cl_4$. | U.S. EPA, 1984 (p. 11) |

**b. Potency**

| | |
|---|---|
| The cancer potency for human inhalation is $5.8 \times 10^{-3}$ $(mg/kg/day)^{-1}$. This estimate has been derived from that for ingestion of $3.5 \times 10^{-2}$ $(mg/kg/day)^{-1}$, assuming that the effective dose by inhalation is 0.17 of that for ingestion. However, direct evidence for carcinogenicity of this compound by the inhalation route is much weaker than that for the oral route. This issue is currently undergoing review by the U.S. EPA Carcinogen Assessment Group. | Derived from U.S. EPA, 1983 (p. 9-35) |

**c. Effects**

| | |
|---|---|
| None demonstrated for inhalation route. | U.S. EPA, 1984 (p. 14) |

**2. Chronic Toxicity**

**a. Inhalation Threshold or MPIH**

Data not presented because cancer potency will be used to assess hazard.

**b. Effects**

Data not immediately available.

**3. Absorption Factor**

| | |
|---|---|
| The effective dose by inhalation is 0.17 of that by ingestion. | U.S. EPA, 1983 (p. 5) |

**4. Existing Regulations**

ACGIH

| | | |
|---|---|---|
| TWA-TLV | 50ppm | U.S. EPA, 1984 |
| STEL | 200ppm | (p. 12) |

OSHA 8 Hour

| | | |
|---|---|---|
| TWA | 100 ppm | U.S. EPA, 1984 (p. 12) |

## III. PLANT EFFECTS

### A. Phytotoxicity

No adverse effects on chlorophyll a or cell numbers of the freshwater alga, Selenastrum Capriconutum, were observed at exposure concentrations as high as 816,000 µg/L. — U.S. EPA, 1980 (p. B-3)

### B. Uptake

Data not immediately available.

## IV. DOMESTIC ANIMAL AND WILDLIFE EFFECTS

### A. Toxicity

See Table 4-1.

### B. Uptake

Data not immediately available.

## V. AQUATIC LIFE EFFECTS

### A. Toxicity

#### 1. Freshwater

##### a. Acute

See Table 4-2.

##### b. Chronic

See Table 4-3.

#### 2. Saltwater

Data not immediately available.

### B. Uptake

Bioconcentration factor for bluegills is 4.9. — U.S. EPA, 1980 (p. B-3)

Bioconcentration factor for rainbow trout is 39. — U.S. EPA, 1980 (p. B-4)

## VI. SOIL BIOTA EFFECTS

Data not immediately available.

## VII. PHYSICOCHEMICAL DATA FOR ESTIMATING FATE AND TRANSPORT

| | | |
|---|---|---|
| Chemical Class: | Halogenated aliphatic hydrocarbon | U.S. EPA, 1984 (p. 1) |
| Vapor Pressure: | 17.8 mm Hg at 25°C | |
| Water Solubility: | 150 mg/L at 25°C | |
| Octanol/Water Partition coefficient: | 398 | |
| Soil Mobility: (predicted as retardation factor for soil depth of 140cm and organic carbon content of 0.087%) | 2.5 | |
| Half-life in air: | 47 days | |
| Half-lives in water: | 1 to 30 days. | |

TABLE 4-1. SUMMARY OF THE ANIMAL EFFECTS OF SUBCHRONIC INHALATION EXPOSURE TO TETRACHLOROETHYLENE

| Species | Dose (Concentration) | Exposure Period | Effects | References |
|---|---|---|---|---|
| Rats | 15 ppm | 4 hours/day for 5 months | EEG changes and protoplasmal swelling of cerebral cortical cells, some vacuolated cells and signs of karyolysis. | U.S. EPA, 1984 (p. 4) |
| Rats | 70, 230 or 470 ppm | 8 hours/day 5 days/week, for 150 exposures (7 months) | 70 ppm = No pathological findings. 230 ppm = Similar, but less severe pathological findings as with higher dose; congestion and light granular swelling of kidneys. 400 ppm = Congested livers with cloudy swelling; no evidence of fatty degeneration or necrosis; evidence of kidney injury including increased secretion, cloudy swelling and desquamation; congestion of spleen. | U.S. EPA, 1984 (p. 4) |
| Rats | 100-400 ppm | 7 hours/day, 5 days/week, for 6 months | No abnormal growth, organ function or histopathologic findings. | U.S. EPA, 1984 (p. 4) |
| Mice | 15-74 ppm | 5 hours/day for 3 months | Decreased electroconductance of muscle and "amplitude" of muscular contraction. | U.S. EPA, 1984 (p. 4) |
| Rabbits | 15 ppm | 3-4 hours/day for 7-11 months | Depressed agglutinin formation. | U.S. EPA, 1984 (p. 4) |
| Rabbits | 15 ppm | 3-4 hours/day for 7-11 months | Moderately increased urinary urobilinogen, pathomorphological changes in the parenchyma of liver and kidneys. | U.S. EPA, 1984 (p. 5) |

TABLE 4-1. (continued)

| Species | Dose (Concentration) | Exposure Period | Effects | References |
|---|---|---|---|---|
| Rabbits | 100-400 ppm | 7 hours/day, 5 days/week, for 6 months | No abnormal growth, organ function or histopathologic findings. | U.S. EPA, 1984 (p. 5) |
| Guinea pigs | 0, 100, 200 or 400 ppm | 7 hours/day, 5 days/week, for 132 or 169 exposures | 100 ppm: Increased liver weights in females.<br>200 ppm: Increased liver weights with some fatty degeneration in both sexes; slight increase in hepatic lipid content; several small fat vacuoles in liver<br>400 ppm: More pronounced liver changes than at 200 ppm; cirrhosis; increased liver weight; increase in neutral fat and esterified cholesterol in the liver; moderate central fatty degernation. | U.S. EPA, 1984 (p. 5) |
| Monkeys | 100-400 ppm | 7 hours/day, 5 days/week, for 6 months | No abnormal growth, organ function or histopathologic findings | U.S. EPA, 1984 (p. 5) |

TABLE 4-2. ACUTE VALUES FOR TETRACHLOROETHYLENE

| Species | Method[a] | LC50/EC50 (µg/L) | Species Acute Value (µg/L) | References |
|---|---|---|---|---|
| FRESHWATER SPECIES | | | | |
| Cladoceran, *Daphnia magna* | S, U | 17,700 | 17,700 | U.S. EPA, 1980 (p. B-6) |
| Midge, *Tanytarsus dissimills* | S, M | 30,840 | 30,840 | U.S. EPA, 1980 (p. B-6) |
| Rainbow trout, *Salmo gairdneri* | FT, M | 4,800 | - | U.S. EPA, 1980 (p. B-6) |
| Rainbow trout *Salmo gairdneri* | FT, M | 5,800 | 5,280 | U.S. EPA, 1980 (p. B-6) |
| Fathead minnow, *Pimephales promelas* | FT, M | 13,460 | - | U.S. EPA, 1980 (p. B-6) |
| Fathead minnow, *Pimephales promelas* | FT, M | 18,400 | - | U.S. EPA, 1980 (p. B-6) |
| Fathead minnow, *Pimephales promelas* | S, U | 21,400 | 15,700 | U.S. EPA, 1980 (p. B-6) |
| Bluegill, *Lepomis macrochirus* | S, U | 12,900 | 12,900 | U.S. EPA, 1980 (p. B-6) |
| SALTWATER SPECIES | | | | |
| Mysid Shrimp, *Mysidopsis bahia* | S, U | 10,200 | 10,200 | U.S. EPA, 1980 (p. B-6) |

[a] S = Static
FT = Flow-through
U = Unmeasured
M = Measured

TABLE 4-3. CHRONIC VALUES FOR TETRACHLOROETHYLENE

| Species | Method[a] | Limits (µg/L) | Chronic Value (µg/L) | Acute/Chronic Ratio[b] | References |
|---|---|---|---|---|---|
| FRESHWATER SPECIES | | | | | |
| Fathead minnow, *Pimephales promelas* | E-L | 500-1,400 | 840 | 16 | U.S. EPA, 1980 (p. B-7) |
| SALTWATER SPECIES | | | | | |
| Mysid Shrimp, *Mysidopsis bahia* | LC | 300-670 | 450 | 23 | U.S. EPA, 1980 (p. B-7) |

[a] E-L = Embryo-larval
LC = Life cycle or partial life cycle

[b] Acute values used to calculate ratio are those presented in Table 4-2.

# SECTION 5

## REFERENCES


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## APPENDIX

## PRELIMINARY HAZARD INDEX CALCULATIONS FOR TETRACHLOROETHYLENE IN MUNICIPAL SEWAGE SLUDGE

### I. LANDSPREADING AND DISTRIBUTION-AND-MARKETING

Based on the recommendations of the experts at the OWRS meetings (April-May, 1984), an assessment of this reuse/disposal option is not being conducted at this time. The U.S. EPA reserves the right to conduct such an assessment for this option in the future.

### II. LANDFILLING

Based on the recommendations of the experts at the OWRS meetings (April-May, 1984), an assessment of this reuse/disposal option is not being conducted at this time. The U.S. EPA reserves the right to conduct such an assessment for this option in the future.

### III. INCINERATION

#### A. Index of Air Concentration Increment Resulting from Incinerator Emissions (Index 1)

##### 1. Formula

$$\text{Index 1} = \frac{(C \times DS \times SC \times FM \times DP) + BA}{BA}$$

where:

C = Coefficient to correct for mass and time units (hr/sec x g/mg)
DS = Sludge feed rate (kg/hr DW)
SC = Sludge concentration of pollutant (mg/kg DW)
FM = Fraction of pollutant emitted through stack (unitless)
DP = Dispersion parameter for estimating maximum annual ground level concentration ($\mu g/m^3$)
BA = Background concentration of pollutant in urban air ($\mu g/m^3$)

##### 2. Sample Calculation

$$1.000004 = [(2.78 \times 10^{-7} \text{ hr/sec} \times \text{g/mg} \times 2660 \text{ kg/hr DW} \times 0.181 \text{ mg/kg DW} \times 0.05 \times 3.4 \ \mu g/m^3) + 5.0 \ \mu g/m^3] \div 5.0 \ \mu g/m^3$$

### B. Index of Human Cancer Risk Resulting from Inhalation of Incinerator Emissions (Index 2)

#### 1. Formula

$$\text{Index 2} = \frac{[(I_1 - 1) \times BA] + BA}{EC}$$

where:

$I_1$ = Index 1 = Index of air concentration increment resulting from incinerator emissions (unitless)
BA = Background concentration of pollutant in urban air ($\mu g/m^3$)
EC = Exposure criterion ($\mu g/m^3$)

#### 2. Sample Calculation

$$8.33337125 = \frac{[(1.000004 - 1) \times 5.0\ \mu g/m^3] + 5.0\ \mu g/m^3}{0.6\ \mu g/m^3}$$

## IV. OCEAN DISPOSAL

Based on the recommendations of the experts at the OWRS meetings (April-May, 1984), an assessment of this reuse/disposal option is not being conducted at this time. The U.S. EPA reserves the right to conduct such an assessment for this option in the future.