

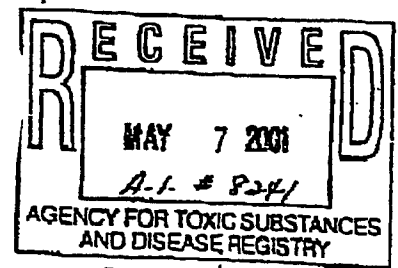
Attachment A

Petition Letter to ATSDR dated May 1, 2001

ATSDR/DHAC/OD

2001 MAY 10 PM 12:05

May 1, 2001



Dr. Henry Falk  
Assistant Administrator  
Agency for Toxic Substances and Disease Registry (ATSDR)  
1600 Clifton Road, NE (E28)  
Atlanta, GA 30333

*John Steward*  
*Draft response due*  
*DHAC 5/24/01*  
*Due OAA 5/30/01*

Dear Dr. Falk,

We are writing on behalf of our organizations to petition for a public health assessment of the population of Midland, Michigan, because of chronic and serious dioxin contamination. The primary source of this contamination is the Dow Chemical Company.

Our petition is prompted by the following facts, which have emerged over the last two decades:

- Results of soil sampling by the state Department of Environmental Quality (DEQ) in Midland have been surprising, and alarming. Although the state's residential cleanup criteria for dioxins in soil is 90 parts per trillion, of 37 samples taken in the community in 1996, almost a third had dioxin above that level. The areas that exceeded the residential cleanup standard included two elementary schools, an intermediate school, a high school and parks. **These are areas where the public has access and children play.** After release of these results, DEQ promised to resample community areas and determine potential human exposures.
- Instead of carrying through on its commitment, DEQ agreed with Dow's suggestion to use soils inside Dow's corporate center as a "surrogate" for the community. Levels found in 1998 sampling at the corporate center ranged from 66 to 476 parts per trillion, with an average of 136 parts per trillion. One particularly high dioxin hot spot was adjacent to a residential area east of the Dow facility.
- DEQ and Dow *still* refuse to keep commitments to characterize human exposures to dioxins and take appropriate protective actions – more than four years after the first sampling was done.
- There are other routes of exposure to dioxins in Midland. Dioxin contamination of fish in the Tittabawassee River below Midland is chronically high. According to the *Michigan Fish Contaminant Monitoring Program: 2000 Annual Report* issued by DEQ this winter, dioxin TEQ concentrations exceeded the "trigger level" for fish consumption warnings in all 10 carp collected in 1999 and in all 11 carp collected since 1992, and in 2 of 5 smallmouth bass. As a result, the state has tightened its advisory to warn against eating more than 1 meal per week

for smallmouth bass from the river due to dioxin, and advises that women and children eat no smallmouth bass from the river due to elevated levels of dioxins and PCBs.

This data is simply the latest in a long line of disclosures about dioxin contamination of the community. For example, a 1985 multi-media risk assessment by the U.S. Environmental Protection Agency pointed to birth defects and cancer data suggesting elevated health effects in the Midland community, noted that the highest levels of dioxin in the nation were found in Tittabawasee River fish, and called for a comprehensive health study. To date, no such study has ever been done. Further, rather than taking action to protect the public from the serious soil contamination documented in the two most recent rounds of soil testing, the State of Michigan has continued to engage in private discussions with Dow Chemical Company about how to manage public relations. Despite repeated requests from our organizations for an independently-funded, state-commissioned health study and a plan to protect citizens from exposure to excessive levels of dioxins, the state has taken no such action.

It is abundantly clear that significant levels of dioxins and other hazardous materials, including PCBs, are present in the Midland community and in adjacent communities, where contaminants are transported from Dow via water and air. These contaminants may be ingested through fish, consumed in other food, absorbed through dermal contact with soils, and inhaled. The science supporting the link between dioxins and human health effects is strong and growing. It is time for a public health assessment by ATSDR and appropriate protective actions by federal, state and local agencies to prevent further exposures to dioxin and to study health impacts in the community.

Sincerely,

**Attachment B**

**Petition Scoping Report for Dow Chemical Company Midland**

**Petition Scoping Report**  
**August 31, 2001**

**Site/City/State:** Dow Chemical Company/Midland/Michigan

**Region:** 5

**Scoping Team:**

**A. Petitioner's Concern(s)**

- Dioxins, reported as total equivalent concentrations (TEQs) of 2,3,7,8-TCDD, have been detected in soil in Midland at concentrations above the Michigan Department of Environmental Quality residential cleanup criterion. Levels of dioxins detected in soil adjacent to the eastern perimeter of the Dow plant site and along a road-way (haul route) in the community exceed 1 ppb.
- Dioxins have been detected in fish taken from the Tittabawassee River. Levels detected exceed the State of Michigan trigger levels for fish consumption warnings. In 1985, the U.S. EPA noted that the highest national levels of dioxins in fish were found in the Tittabawassee River.
- In 1985, the U.S. EPA "called for a comprehensive health study" of dioxin exposures and the resulting health effects in the Midland community. No such comprehensive study has ever been performed.

**B. Brief Site Background**

The Dow Chemical, founded in 1897, operates a chemical manufacturing facility in the city of Midland, Michigan. The facility encompasses approximately 1900 acres on the southern perimeter of the city. The Tittabawassee River forms the southern boundary of the facility and flows east to the Saginaw Bay of Lake Huron.

Chemicals produced at the Midland plant include; styrene, butadiene, picric acid, mustard gas, Saran wrap, Styrofoam, Agent Orange, napalm, and various pesticides including Dursban and 2,4,5-T. Chlorophenol production began in 1915. Wastes generated from this process were initially disposed of in 600 acres of on-site waste ponds. During high flow periods in the early 1900's, wastes from these ponds would be released to the Tittabawassee River. Dow currently operates it's own wastewater treatment plant on-site.

Two rotary kiln incinerators are used for treatment of liquid and solid hazardous and non-hazardous wastes generated from manufacturing activities at the facility. Ambient air dispersion modeling and monitoring indicates that the north-eastern quadrant of the city of Midland have been affected by emissions from the incinerators.

**C. Key Previous Actions Related To The Site**

The Dow property is currently part of the RCRA corrective action program delegated by the U.S. EPA to the MDEQ Waste Management Division. The EPA sampled soil in the city of Midland in the 1980's and found elevated concentrations of 2,3,7,8-TCDD. The EPA recommended additional sampling in the future to monitor levels of dioxins in the community. In 1996, the MDEQ took additional soil samples from public properties such as parks and school yards and found total dioxins (TEQ) at concentrations exceeding the Michigan residential cleanup criterion for soil. The Dow plant site, it's northeastern perimeter, and a community road-way leading from the Dow plant to a landfill were also sampled. Concentrations at the plant perimeter and on the road-way exceeded 1 ppb. In 1998, as a follow-up alternative to additional community sampling, the Dow Company and the DEQ agreed to sample the Dow Corporate Center property as a surrogate for the community. Levels of TEQs detected at the Corporate Center ranged from 77-583 parts per trillion (ppt).

No public health assessment has been conducted by either the MDCH or the ATSDR.

**D. Public Health Issue(s)**

**Table 1. Levels of total dioxins detected in soil in the city of Midland.**

Soil Samples Location	Range of TEQ detected in ppt	DEQ Cleanup Criterion in ppt	ATSDR Chronic Soil EMEMG for a Child in ppt	ATSDR Chronic Soil EMEMG for an Adult in ppt	ATSDR Action Level for TCDD
Northeast Plant Perimeter	6 - 1068	90	50	700	1000
Road-Way (Haul Route)	10 - 2663	90	50	700	1000
Dow Corporate Center	77 - 583	90	50	700	1000
Northeast Quadrant of Midland	22 - 598	90	50	700	1000

**Table 2. Levels of total dioxins (TEQ) detected in fish in the Tittabawassee River downstream of Midland.**

Date	Range of 2,3,7,8-TCDD in ppt	Range of TEQ in ppt	MDCH Advisory Trigger in ppt
1976 - 1980	3 - 695	NA	10
1983 - 1989	1.1 - 530	1.11 - 10.91	10
1990 - 1999	1 - 209	4.56 - 73.90	10
2000 -	Data pending	Data pending	10

**Demographics**

The city of Midland is the county seat of Midland County, Michigan and encompasses an area approximately 28 square miles. The population of Midland was approximately 38,090 in 1990. Twenty five percent of the population in 1990 were children under the age of 17 years.

**Previous Health Studies**

At the request of the MDEQ Air Quality Division (AQD) and in support of the AQD review of an application made by the Dow Company for an air quality permit for a new incinerator, the MDCH performed a statistical analysis of cancer incidence for zip codes 48640 and 48642, Midland County, and Bay County. This analysis showed that the 1994 through 1998 age-adjusted incidence rate for all cancers combined in zip code 48640, which includes the Dow plant site, was significantly higher than the corresponding rates for all white residents in Midland County, Bay County, and the State of Michigan. Incident rates were also elevated in this zip code for lung and prostate cancer. No elevations in cancer rates were indicated for zip code 48642. (see attachment)

E. Exposure Pathways

Pathway	Source of Contaminant	Contaminant and Level	Environmental Media	Exposure Point	Exposure Route	Exposed Population	Time Frame
Direct Contact with Soil	Incinerator Emissions	Dioxins and Furans 6 - 2663 ppt	Soil	Soil in the city of Midland	Incidental Ingestion Dermal Contact Particulate Inhalation	Residents of Midland	Past
							Present
							Future
Fish Consumption	Release to Surface Water	Dioxins and Furans	Fish 1.1 - 73.9 ppt	Tittabawassee River	Ingestion	Anglers and their families	Past
							Present
							Future

**Level of Community Interest** (Difficult to gauge at this time. The Michigan Environmental Council, a well-organized environmental group is one of the petitioners. However, Midland is a corporate town and support for the company is high)

- High      Large numbers of inquiries about the site/release; well attended meetings about a site/release; the involvement of national, state, and local environmental activist groups, and community groups that are well-organized; extensive environmental, health and/or political interest and extensive national, state and local media coverage.
- Medium      Involvement of the petitioner and community groups without the involvement of national, and state environmental activist groups; some national or state environmental, health and/or political interest; only local media coverage.
- Low      Involvement of the petitioner; no community, environmental, health, or political interest; no media coverage.

F. Decision Criteria

2.1 Are the location, concentration, and toxicity of the hazardous substances related to the petition, site, or release possibly of public health concern?

Yes, levels of dioxins detected in soil in the city of Midland and in fish in the Tittabawassee River downstream of Midland exceed health-based comparison values. Dioxin and related compounds are believed to cause both carcinogenic and noncarcinogenic human health effects at extremely low levels of exposure.

2.2 Is there an exposed or potentially exposed population as indicated in the petition and as determined by evaluating the human exposure pathways for the hazardous substance release(s)?

Yes, dioxins are present in soil throughout the city of Midland. More than 38,000 people live in the city, 25% of which are children under the age of 17. The Tittabawassee River is a valuable State of Michigan fishery resource and is heavily utilized both by the residents of Midland and by other communities down river.

2.3 Is there a plausible relationship between possible human exposure to a release of hazardous substances and community health concerns or adverse health outcomes?\*

Yes, the U.S. EPA, the International Agency for Research on Cancer, and the National Toxicology Program have determined that exposure to dioxins is associated with elevated rates of all cancers combined as well as several particular cancers including lung and soft tissue sarcoma. Elevated incidence rates of all cancers combined, lung and prostate cancer have been detected in the city of Midland. Additional information is needed to determine if exposure to dioxins is related to other health effects in the population of Midland and the surrounding communities.

G. Recommendation:

The scoping team recommends:

<u>      </u>	No further action	<u>  X  </u>	Further characterization
<u>  X  </u>	Public Health Consultation/SRU	<u>  X  </u>	Public Health Assessment
<u>  X  </u>	Health Education	<u>  X  </u>	Exposure Investigation

       \*Refer as a Public Health Consultation to a toxicologist, epidemiologist or physician for determination of plausible relationship between possible human exposure to a release of hazardous substances and community health concerns or adverse health outcomes, if relationships are not readily available utilizing the tox. profiles.

       Referral to:



Attachment C

ATSDR Letter to Petitioners for Dow Midland site dated November 2, 2001



Agency for Toxic Substances  
and Disease Registry  
Atlanta GA 30333

November 2, 2001

In May 2001, you wrote to the Agency for Toxic Substances and Disease Registry (ATSDR), about the Dow Chemical Company, Midland, Michigan and dioxin contamination. ATSDR acknowledged your letter to be a petition for a public health assessment. The following outlines ATSDR's response to your petition.

After reviewing the public health issues and community concerns about potential dioxin contamination and the Dow Midland facility, ATSDR has found a reasonable basis to prepare public health consultations to address the concerns associated with the Dow facility. The public health consultations will review and summarize the existing environmental and health data for dioxin concentrations in soils in the Midland community and in fish found in community streams. The consultations will evaluate possible ways that people could be exposed to harmful substances, document and evaluate community health concerns, state health-based conclusions, and make recommendations. We believe that the health consultations will provide timely, appropriate responses to the concerns.

ATSDR maintains a cooperative agreement with the Michigan Department of Community Health (MDCH), under which MDCH conducts public health assessments and other environmental health activities in Michigan. ATSDR has requested that MDCH complete the public health consultations and release them for public review in fiscal year 2002, which began October 1, 2001. MDCH has a talented staff with a good track record for successfully conducting public health evaluations, and they understand the needs of Michigan communities. ATSDR will review MDCH's work and provide technical support as needed. We have enclosed a fact sheet about public health consultations.

Thank you for referring your concerns to ATSDR. We welcome your comments about this response and the planned public health consultations. If you have questions about our proposed plan of action, please contact Dr. Mark Johnson, ATSDR Senior Regional Representative, at telephone (312) 886-0840, or Alan Yarbrough, ATSDR Technical Project Officer, at telephone (404) 498-0427. Dr. Linda Larsen, MDOH, may be contacted at (517-335-8566). Community members may also contact ATSDR by calling our toll-free telephone number, 1-888-42-ATSDR (1-888-422-8737).

Sincerely yours,

Robert C. Williams, P.E., DEE  
Assistant Surgeon General  
Director, Division of Health Assessment and Consultation

Enclosure

cc:  
Linda D. Larsen, Ph.D.  
Michigan Department of Community Health

MICHIGAN DEPARTMENT  
OF COMMUNITY HEALTH

NOV 3 - 2001

ENVIRONMENTAL EPIDEMIOLOGY  
DIVISION

Attachment D

Dioxin and Dioxin-Like Compounds in Soil,  
Part 1: ATSDR Interim Policy Guideline



## DIOXIN AND DIOXIN-LIKE COMPOUNDS IN SOIL, PART I: ATSDR INTERIM POLICY GUIDELINE

CHRISTOPHER T. DE ROSA, DAVID BROWN,\* ROSALINE DHARA,  
WOODROW GARRETT, HUGH HANSEN, JAMES HOLLER, DENNIS JONES,  
DENISE JORDAN-IZAGUIRRE, RALPH O'CONNOR, HANA POHL, AND  
CHARLES XINTARAS

Agency for Toxic Substances and Disease Registry  
U.S. Department of Health and Human Services  
Atlanta, Georgia

### PURPOSE

The Agency for Toxic Substances and Disease Registry (ATSDR) has adopted this interim policy guideline to assess the public health implications of dioxin and dioxin-like compounds in residential soils near or on hazardous waste sites. These compounds include

- 2,3,7,8-Tetrachlorodibenzo-*p*-dioxin (TCDD)
- Related chlorinated dibenzo-*p*-dioxins (CDDs)
- Chlorinated dibenzofurans (CDFs)
- Other structurally related groups of chemicals from the family of halogenated aromatic hydrocarbons.

These substances are defined under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended, commonly known as Superfund. This interim policy guideline will provide a clear and consistent understanding of ATSDR's current approaches and judgments regarding hazards posed by the presence of TCDD and its less toxic dioxin-like congeners, the CDDs and CDFs, in residential soils. Likely users of this interim policy guideline include:

- ATSDR and state-based health assessors
- ATSDR partners including relevant federal, state, and local health and environmental entities
- Concerned community groups.

1. Address all correspondence to: Christopher T. De Rosa, Ph.D., Director, Division of Toxicology, Agency for Toxic Substances and Disease Registry, Mailstop E-29, 1600 Clifton Road, NE, Atlanta, GA 30333. Tel.: (404)639-6300. Fax: (404)639-6315. E-mail: cyd0@cdc.gov.

2. Abbreviations: ATSDR, Agency for Toxic Substances and Disease Registry; CDDs, chlorinated dibenzo-*p*-dioxins; CDFs, chlorinated dibenzofurans; CERCLA, Comprehensive Environmental Response, Compensation, and Liability Act of 1980; EMEG, environmental media evaluation guide; FDA, U.S. Food and Drug Administration; MRL, minimal risk level; TCDD, 2,3,7,8-tetrachlorodibenzo-*p*-dioxin; TEF, toxicity equivalency factor; TEQs, toxicity equivalents.

3. Key words: dioxin, human exposure, risk assessment, soil levels, TCDD, TEQs.

4. Note: \*65 Bulkley Avenue North, Westport, CT 06880.

5. Reprinted from the *Journal of Clean Technology, Environmental Toxicology and Occupational Medicine*, Vol. 6, No. 2, 1997.

## INTERIM POLICY GUIDELINE

This interim policy guideline is based on a current understanding of the toxicology and epidemiology associated with TCDD and its congeners (see "Background" section) and on exposure potential when soil is the primary medium of interest.

This guidance is consistent with the Dioxin and Dioxin-Like Compounds in Soil, Part II: Technical Support Document for ATSDR Interim Policy Guideline (De Rosa et al., 1997) and with the ATSDR Public Health Assessment Guidance Manual (ATSDR, 1992). They explain how to use comparison values to select contaminants for further evaluation and then draw conclusions about the public health implications of the contaminants. Assessments of public health implications are based on considerations of site-specific factors affecting the extent and characteristics of exposure and on the toxicology and epidemiology of the compounds selected for evaluation.

This guidance for dioxin and dioxin-like compounds is unique because of the potency of TCDD itself, and the need to consider the total potency of all dioxin and dioxin-like compounds detected in soil. The toxicity of a dioxin-like compound is commonly referred to in terms of its dioxin toxicity equivalency factor (TEF). See "Background" section for further information.

These guidelines and procedures apply to human exposure for direct ingestion of soils contaminated with dioxin and dioxin-like compounds in residential areas and may not be appropriate for other exposure scenarios. The guidance will be evaluated in view of new data that may become available. The science basis for the guidance is outlined in the "Background" discussion.

**Step 1. Screening for contaminants of concern**

Review soil sampling data and compare levels against dioxin comparison values (environmental media evaluation guide or EMEG for children) that are not site-specific. If one or more soil sampling values exceed the screening value of 50 parts per trillion (ppt) of toxicity equivalents (TEQs), further site-specific evaluations are needed as described next and in Table 1.

If samples exceed this screening value, then ATSDR generally assumes that further evaluation is required. However, even if samples are below these values, ATSDR policy states that it may still be necessary to conduct a more detailed site-specific evaluation under the following conditions:

- community health concerns
- health assessor's concerns about other combinations of contaminants.

## Step 2. Evaluating potential exposure pathways

Further evaluation includes the most critical aspect of health hazard evaluations, that is, the determination of likelihood, extent, and duration of exposure of populations. Thus, the health assessor uses the following to determine the existence of a potential or completed exposure pathway—past, present, or future:

- site visits and observations
- detailed review of data packages for land use scenarios, contaminant locations, and site locations
- evaluation of receptor populations and potential points of contact.

If a completed or potentially completed exposure pathway is identified, then the extent of exposure and public health implications are further evaluated.

Site-specific exposure scenarios based on site-specific factors are evaluated in conjunction with relevant toxicologic, epidemiologic, and medical information. This involves assessing site-specific information about the likelihood, frequency, routes, and levels of exposure to contaminants, and the populations that are likely to be exposed.

Where estimated levels of exposure in soil fall in the range of greater than 50 ppt to less than 1 part per billion (ppb) TEQs (Table 1), a weight-of-evidence approach is recommended to evaluate the exposure and the public health implications of the exposure.

Health assessors must ask the following questions:

- How extensive is the contamination?
- Is the contamination isolated or widespread?
- Is the contamination in surface soils or areas easily accessible to children or adults? Is it in areas with no vegetation or in any other areas?
- At this site, how often (daily, weekly, monthly) and for what length of time (months, years, lifetimes) would exposures be likely to occur?

Many of these estimates depend on professional judgment and experience regarding the likelihood of exposures from soils in different kinds of sites. For further information on the evaluation process see ATSDR (1992).

### *Interpretation of Health Guidance Values*

The policy incorporates information on exposure potential from residential soils and residential exposure scenarios. It should be noted that the levels (in TEQs)  $\leq 50$  ppt (0.05 ppb),  $> 0.05$  ppb but  $< 1$  ppb, and  $\geq 1$  ppb in residential soils are guidance values and should not be construed to indicate that actual health effects will occur. The policy provides a protective framework for evaluating the health implications of exposures to dioxin and dioxin-like compounds in residential soils on a site-specific basis.

TABLE 1. ATSDR's Decision Framework for Sites Contaminated with Dioxin and Dioxin-Like Compounds

Because the toxicity of dioxin and dioxin-like compounds is assumed to be elaborated through a common receptor-mediated mechanism, levels greater than 50 ppt (0.05 ppb) TEQs\* are used to determine whether further site-specific evaluation for dioxins is to occur based on the maximum soil concentrations identified at the site. A level of 1 ppb TEQs is used to determine the potential need for public health actions on a site-specific basis and on the basis of adequate sampling and measured or projected human exposure—past, present, or future—as determined by the health assessor.

SCREENING LEVEL	EVALUATION LEVELS	ACTION LEVEL**
≤ 50 ppt (0.05 ppb) TEQs	> 0.05 ppb but < 1 ppb TEQs	≥ 1 ppb TEQs
<ul style="list-style-type: none"> <li>• The EMEG for TCDD is 50 ppt</li> <li>• This is based on an MRL of 1 pg/kg/day for TCDD (ATSDR, 1989).</li> <li>• For screening purposes 50 ppt TCDD is assumed to be equivalent to 50 ppt TEQs</li> </ul>	Evaluation of site-specific factors, such as: <ul style="list-style-type: none"> <li>• Bioavailability</li> <li>• Ingestion rates</li> <li>• Pathway analysis</li> <li>• Soil cover</li> <li>• Climate</li> <li>• Other contaminants</li> <li>• Community concerns</li> <li>• Demographics</li> <li>• Background Exposures</li> </ul>	Potential public health actions considered, such as: <ul style="list-style-type: none"> <li>• Surveillance</li> <li>• Research</li> <li>• Health studies</li> <li>• Community education</li> <li>• Physician education</li> <li>• Exposure investigations</li> </ul>

\*The toxicity equivalent (TEQ) of TCDD is calculated by multiplying the exposure level of a particular dioxin-like compound by its toxicity equivalency factor (TEF). TEFs are based on congener-specific data and the assumption that Ah receptor-mediated toxicity of dioxin-like chemicals is additive. The TEF scheme compares the relative toxicity of individual dioxin-like compounds to that of TCDD, which is the most toxic halogenated aromatic hydrocarbon.

\*\*A concentration of chemicals at which consideration of action to interdict/prevent exposure occurs, such as surveillance, research, health studies, community education, physician education, or exposure investigations. Alternatively, based on the evaluation by the health assessor, none of these actions may be necessary.

### Step 3. Defining public health implications/actions

Where exposures to concentrations in residential soils exceeding 1 ppb TEQs are significant, ATSDR health assessors should consider judging the site a public health hazard and consider site-specific public health recommendations/actions to prevent or interdict exposures (Table 1).

## BACKGROUND FOR INTERIM POLICY GUIDELINE

### *Dioxin and Dioxin-Like Compounds*

Dioxin and dioxin-like compounds are structurally related groups of chemicals from the family of halogenated aromatic hydrocarbons. Depending on the number of chlorine-substituted positions, there are several congeners in each group. The most toxic and the most studied congener is TCDD.

TEFs were developed to compare the relative toxicity of individual dioxin-like compounds to that of TCDD (Tables 2 and 3). This comparison is based on the assumption that dioxin and dioxin-like compounds act through the same mechanism of action. The TEF for TCDD is defined as one, whereas TEF values for all other dioxin-like compounds are less than one. TEQs are used to assess the risk of exposure to a mixture of dioxin-like compounds. A TEQ is defined as the product of the concentration,  $C_i$ , of an individual "dioxin-like compound" in a complex environmental mixture and the corresponding TCDD TEF<sub>i</sub> for that compound. The total TEQs is the sum of the TEQs for each of the congeners in a given mixture:

$$\text{Total TEQs} = \sum_{i=1}^n (C_i \cdot \text{TEF}_i)$$

*Adverse Health Effects*

Studies in animals demonstrated a wide range of effects associated with dioxin exposure including death, cancer, and wasting, as well as hepatic, immunologic, neurologic, reproductive, and developmental effects. In contrast to laboratory results, direct exposure information is not available in human studies; therefore, body burden is used as a surrogate. Body burdens in some animal studies were in the same range as those associated with adverse health effects in human studies. For more information, see Technical Support Document for ATSDR Interim Policy Guideline: Dioxin and Dioxin-Like Compounds in Soil (ATSDR, 1997). These results underscore the need for research to elucidate the toxicity at low doses to human populations and to evaluate exposures in at-risk populations (see Appendix 1) in view of total body burdens of dioxin and dioxin-like compounds.

TABLE 2. Recommended Toxicity Equivalency Factors (TEFs) for CDDs and CDFs

CDDs	EPA current recommended values	CDFs	EPA current recommended values
monoCDDs	0	monoCDFs	0
diCDDs	0	diCDFs	0
triCDDs	0	triCDFs	0
2,3,7,8-TCDD	1	2,3,7,8-tetraCDF	0.1
other tetraCDDs	0	other tetraCDFs	0
2,3,7,8-pentaCDD <sup>a</sup>	0.5	1,2,3,7,8-pentaCDF	0.05
other pentaCDDs	0	2,3,4,7,8-pentaCDF	0.5
2,3,7,8-hexaCDD <sup>a</sup>	0.1	other pentaCDFs	0
other hexaCDDs	0	2,3,7,8-hexaCDF <sup>a</sup>	0.1
2,3,7,8-heptaCDD <sup>a</sup>	0.01	other hexaCDFs	0
other heptaCDDs	0	2,3,7,8-heptaCDF <sup>a</sup>	0.01
octaCDD	0.001	other heptaCDFs	0
		octaCDF	0.001

<sup>a</sup>Any isomer that contains chlorine in the 2,3,7,8-positions  
 CDDs = chlorinated dibenzo-*p*-dioxins; CDFs = chlorinated dibenzofurans;  
 TCDD = tetrachlorodibenzo-*p*-dioxins.  
 Source: derived from EPA (1989).



TABLE 3. Recommended Toxicity Equivalency Factors (TEFs) for Dioxin-Like PCBs

PCB	WHO proposed interim values <sup>a</sup>	PCB	WHO proposed interim values <sup>a</sup>
3,3',4,4'-TCB	0.0005	2,3,3',4,4',5-HxCB	0.0005
3,3',4,4',5-PeCB	0.1	2,2,3',4,4',5'-HxCB	0.0005
3,3',4,4',5,5'-HxCB	0.01	2,3',4,4',5,5'-HxCB	0.00001
2,3,3',4,4'-PeCB	0.0001	2,3,3',4,4',5,5'-HpCB	0.0001
2,3,4,4',5-PeCB	0.0005	2,2',3,3',4,4',5-HpCB	0.0001
2,3',4,4',5-PeCB	0.0001	2,2',3,4,4',5,5'-HpCB	0.00001
2',3,4,4',4-PeCB	0.0001		

<sup>a</sup>Interim values proposed by World Health Organization/International Programme on Chemical Safety  
 PCB = polychlorinated biphenyl; TCB = tetrachlorinated biphenyl; PeCB = pentachlorinated biphenyl;  
 HxCB = hexachlorinated biphenyl; HpCB = heptachlorinated biphenyl  
 Source: derived from Ahlberg et al. (1994).

#### *Screening Level for Dioxin and Dioxin-Like Compounds in Soil*

While identifying levels of potential concern to human health, ATSDR considers a spectrum of contaminant concentrations. In general, *screening levels* are concentrations used to select contaminants of concern at hazardous waste sites that are taken forward in the health assessment process for further evaluation (screening levels are also called comparison values; see Appendix 1 - Glossary).

A minimal risk level (MRL) is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse noncancer health effects over a specified duration and route of exposure. These substance-specific estimates, which are intended to serve as screening levels, are used by ATSDR health assessors and others to identify contaminants and potential health effects that may be of concern at hazardous waste sites. The intermediate-duration oral MRL of 1 picogram/kilogram/day or  $\mu\text{g}/\text{kg}/\text{day}$  for TCDD (ATSDR, 1989) was based on reproductive effects in rats. The intermediate-duration oral MRL was also adopted as a chronic oral MRL. Based on this value, an EMEG of 50 ppt (0.05 ppb) TCDD, which is equivalent to 50 ppt (0.05 ppb) TEQs, was derived for exposure from contaminated soil. Uncertainty factors of 1000 (total) were used in the calculations of the MRL (for further details, see Appendix 3 of the Technical Support Document). Based on a review of more recent literature, ATSDR scientists conclude that the MRL of 1  $\mu\text{g}/\text{kg}/\text{day}$  is approximately two orders of magnitude below the noncancer health effect levels observed in recent studies. This is also true for cancer effect levels.

#### *Evaluation Levels for Dioxin and Dioxin-Like Compounds in Soil*

*Evaluation levels* are concentrations > 50 ppt (0.05 ppb) but < 1 ppb TEQs at which site-specific factors, including, but not limited to, bioavailability, ingestion rates, pathway analysis, soil cover, climate, other contaminants, community concerns, demographics, and background exposure, are considered in a deliberative process to assess the nature and extent of contamination and its impact on the community. Such an evaluation process may prompt further assessment at the next level where actions are considered. The evaluation levels are to be used as a framework to guide procedures for that judgment process. Thus, judgments in the evaluative phase are linked to actions where consideration is given to interventions from a public health perspective.

*Action Level for Dioxin and Dioxin-Like Compounds in Soil*

Action levels are concentrations of chemicals at which consideration of action to interdict exposure occurs; 1 ppb TCDD in residential soil was identified by Kimbrough et al. (1984) as a "level of concern," and recommended as "a reasonable level to begin consideration of action to limit exposure." Kimbrough et al.'s (1984) conclusions were derived in part from an evaluation of the carcinogenic potential of TCDD, based on a 2-year oral chronic toxicity and oncogenicity study in rats (Kociba et al., 1978). With the advancement of knowledge about dioxin-like chemicals and their assumed common mechanism of toxicity, the TEQs were introduced into the risk assessment process. Since then, 1 ppb of total dioxins (expressed as TEQs) in soil has been used as an action level by ATSDR.

The Kociba et al. (1978) study also served as the basis for the Food and Drug Administration's (FDA's) derivation of a risk-specific dose of 0.057 pg/kg/day dioxin for a 1 in a million ( $10^{-6}$ ) upper-bound risk estimate for cancer (FDA, 1990). Using a typical default value of 70 kg for average body weight and 100 milligrams/day (mg/day) for soil consumption, FDA's 0.057 pg/kg/day risk-specific dose corresponds to a soil concentration of 40 ppt. This value is marginally lower, but from a risk assessment perspective, it is essentially equivalent to the ATSDR media-specific screening level/comparison value (EMEG) of 50 ppt.

As noted previously, ATSDR's EMEG is based on the MRL of 1 pg/kg/day TCDD, which is approximately two orders of magnitude below any health effect levels demonstrated either experimentally or in epidemiologic studies for both cancer and noncancer health end points. The conservative (i.e., protective) nature of both the MRL and the EMEG reflects adjustments made for recognized areas of uncertainty, perhaps spanning two to three orders of magnitude. As such, the EMEG and the MRL, on which the EMEG is based, are below levels of exposures associated with demonstrated health effects and are therefore considered to be protective of human health. The EMEG of 50 ppt (0.05 ppb) is at the low end of the range reflecting currently recognized areas of scientific uncertainty; this range is 50–50 000 ppt (or 0.05–50 ppb), which is based on the 1000-fold uncertainty factor used to derive the MRL.

## CONCLUSIONS

ATSDR concludes that the action level of 1 ppb (TEQ) for dioxin and dioxin-like compounds, when coupled to a site-specific context of evaluation for the range > 50 ppt (0.05 ppb) to < 1 ppb TEQs in residential soil, is protective of public health and continues to represent a level at which consideration of health action to interdict exposure, including cleanup, should occur. This conclusion is based on ATSDR's review and evaluation of

- more recent experimental and epidemiologic research findings
- ATSDR's historical use of the term "action level"
- the range of health guidance values developed by ATSDR including the MRL and EMEG
- the limitations and uncertainties of ATSDR's health guidance values and the scientific data on which these values are based.

ATSDR considers this action level to be both reasonable and protective for the following reasons:

- ATSDR's MRL is approximately two orders of magnitude below effect levels in experimental and epidemiologic studies.
- Cancer risk-specific doses and screening values for end points other than cancer are essentially equivalent from a risk assessment perspective.

### WHERE TO FIND MORE INFORMATION

For more information on the historical and scientific background of dioxin in soil values, their proper use, and data on limitations associated with these numbers, please refer to *Dioxin and Dioxin-Like Compounds in Soil, Part II: Technical Support Document for ATSDR Interim Policy Guideline* (De Rosa et al., 1997).

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### APPENDIX 1 - GLOSSARY

Action level	A concentration of chemicals at which consideration of action to interdict/prevent exposure occurs, such as surveillance, research, health studies, community education, physician education, or exposure investigations. Alternatively, based on the evaluation by the health assessor, none of these actions may be necessary.
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"At-risk" population	A population at a potentially elevated risk due to physiological sensitivity and/or increased exposure to a hazardous chemical.
BDDs	Brominated dibenzo- <i>p</i> -dioxins
BDFs	Brominated dibenzofurans
CDDs	Chlorinated dibenzo- <i>p</i> -dioxins
CDFs	Chlorinated dibenzofurans
Comparison value	A concentration used to select contaminants of concern at hazardous waste sites that are taken forward in the health assessment process for further evaluation (The terms comparison value and screening level are often used synonymously.)
Dioxin	A term used interchangeably with 2,3,7,8-tetrachlorodibenzo- <i>p</i> -dioxin or TCDD
Dioxin-like compounds	Compounds from a group of halogenated aromatic hydrocarbons that have molecules shaped like TCDD and produce similar toxic effects, such as certain other chlorinated dibenzo- <i>p</i> -dioxins (CDDs) and certain chlorinated dibenzofurans (CDFs), polychlorinated biphenyls (PCBs), polybrominated biphenyls (PBBs), brominated dibenzo- <i>p</i> -dioxins (BDDs), and brominated dibenzofurans (BDFs).
Dioxins	A term used interchangeably with chlorinated dibenzo- <i>p</i> -dioxins
EMEG	An environmental media evaluation guide (EMEG) is a media-specific comparison value that is used to select contaminants of concern at hazardous waste sites.
HazDat	ATSDR's Hazardous Substance Release/Health Effects Database
MRL	A minimal risk level (MRL) is an estimate of the daily human exposure to a hazardous substance that is likely to be without an appreciable risk of adverse noncancer health effects over a specified route and duration of exposure.
PBBs	Polybrominated biphenyls
PCBs	Polychlorinated biphenyls

Screening The process of initially identifying potentially important chemical contaminants and exposure pathways by eliminating those of known lesser significance.

TCDD 2,3,7,8-Tetrachlorodibenzo-*p*-dioxin

TEFs Toxicity equivalency factors (TEFs) are based on congener-specific data and the assumption that the toxicity of dioxin and dioxin-like compounds is mediated by the Ah receptor and is additive. The TEF scheme compares the relative toxicity of individual dioxin-like compounds to that of TCDD, which is the most toxic halogenated aromatic hydrocarbon.

TEQs Toxicity equivalent (TEQ) is defined as the product of the concentration,  $C_i$ , of an individual "dioxin-like compound" in a complex environmental mixture and the corresponding TCDD toxicity equivalency factor (TEF<sub>*i*</sub>) for that compound. The total TEQs is the sum of the TEQs for each of the congeners in a given mixture:

$$\text{Total TEQs} = \sum_{i=1}^n (C_i \cdot \text{TEF}_i).$$