



Background Levels of Dioxin in Soil Stephen Lester Science Director January 1998

The USEPA has estimated the background level for dioxin in soil to be 8 parts per trillion (ppt) of Total Dioxin Equivalents (TEQ). This estimate was made in the 1994 draft reassessment document and is based on 95 samples "selected as representing background conditions in the United States." EPA did not, however, define or identify the specific locations of the samples they used to derive their background estimate. Upon reviewing the actual studies and the individual data cited by EPA, it appears that EPA's estimate of "background" dioxin in soil included data from testing conducted in urban and industrial areas where there are known dioxin sources.

The following is an analysis of EPA's data on dioxin levels in soil. This analysis is subject to several limitations: 1) It is not clear what specific data EPA used to generate the 8 ppt national background level in soil; and 2) Some data are reported as 2378-TCDD, some as "TCDD", and some as TEQ (Total Equivalent value which is the sum total of all forms of dioxin including the most toxic form - 2378-TCDD). This inconsistency makes direct comparisons of the data more difficult.

Given these limitations, a number of conclusions/observations can be made:

- Dioxin was not found in areas defined as pristine.
- Background is not defined by EPA in the 1994 reassessment document. EPA uses the term to indicate levels of dioxin currently found in soil and defined as "representative." EPA makes no effort to consider the contribution of dioxin from fallout over time from emission sources.
- A reasonable definition of background can be found in the 1987 National Dioxin Study where background is defined as "an area where you would not expect to find any dioxin."
- "Background" levels of dioxin in soil as described by EPA varied from one community type to another with a clear trend: Dioxin levels were highest in industrial areas and lowest in pristine areas with a clear gradient in between (see summary chart below).

Table 1 - Summary of "Background" Levels of Dioxin in Soil

<u>Type of Area</u>	<u>Dioxin Level</u>	<u>Form of Dioxin Measured</u>
PRISTINE	ND (1.0 ppt)	2378-TCDD
AGRICULTURAL	ND (3.75 ppt)	2378-TCDD
RURAL	<1 - 24 ppt	2378-TCDD/TEQ
RESIDENTIAL	6 ppt	TEQ
	158 ppt *	TEQ *
URBAN	22-67 ppt	TEQ
INDUSTRIAL	2,192 ppt	TEQ

* Samples from Midland, MI

ND = Not Detected (detection level)

- In EPA's estimate of "background," they included data from studies in communities where there are known dioxin sources. For example, residential samples included data collected from Midland, MI, home of Dow Chemical Corp., a significant source of dioxin. In addition, the National Dioxin Study, conducted by EPA in the mid 1980's, only found positive urban background samples in Tacoma, WA, Lake Charles, LA, Gary IN, Pittsburgh, PA, Evansville, IN, San Francisco, CA and Washington, DC. Most of these areas are urban communities that contain significant industrial areas with known producers/sources of dioxin and thus are likely contaminated with dioxin.
- The highest numbers recorded in the "background" samples came from Midland, MI, the home of Dow Chemical, a significant source of dioxin in the U.S.
- The National Dioxin Study found an average mean value of 2.83 ppt of 2378-TCDD in 17 of 221 urban soil samples. When non detect values are included (204 of 221 samples), the average mean dioxin soil level is less than 1 ppt. Only 1 positive dioxin value was found in 138 samples taken in rural soil with an average mean value of less than 0.5 ppt 2378-TCDD (the limit of detection used on the sampling).
- Because "background" dioxin soil levels vary substantially from one community type to another, it may be difficult to define a single national background level.

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- Because EPA has included data from communities with known dioxin sources, EPA has biased the data upwards. Their national background estimate of 8 ppt is therefore likely to be high.
- The true estimate of "background" dioxin in soil is likely to be less than 1 ppt.

More information on the specific studies and data used by EPA is needed in order to assess and determine an accurate and true background level of dioxin.

The data that EPA used to derive the 8 ppt background level of dioxin came from the following studies (full citations are listed at the end):

- 1) The 1987 National Dioxin Study which collected samples from all over the United States. These samples were analyzed primarily for 2378-TCDD (USEPA, 1987).
- 2) Samples collected from four Midwestern sites including Westlake, OH that were analyzed for a full range of dioxin congeners (USEPA, 1985).
- 3) Samples collected from industrialized areas in cities from Midwestern and Mid-Atlantic states (MI, IL, OH, TN, PA, NY, WV) that were analyzed for 2,3,7,8-TCDD only (Nestrick, 1986).
- 4) Samples collected from the vicinity of the Elk River, MN "generating station" that were analyzed for a full range of dioxin congeners (Reed, 1990).
- 5) Samples collected from around a sludge incinerator that were analyzed for full range of dioxin congeners (Pearson, 1990).
- 6) Samples collected from industrial, urban and rural sites in Ontario and some U.S. Midwestern states that were analyzed for full range of dioxin congeners (Birmingham, 1990).

The National Dioxin Study (EPA, 1987) reported the following summary of dioxin levels in soil (all data are reported as 2378-TCDD):

- 17 of 221 urban soil samples were positive with results ranging from 0.2 to 11.2 ppt
- 1 of 138 rural soil samples were positive with a result of 0.5 ppt

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The 17 positive urban soil samples were broken out as follows (all results in ppt):

Washington DC	- 3.0	San Francisco, CA	- 2.0
	- 2.0	Tacoma, WA	- 0.4
	- 4.0		- 0.5
Pittsburgh, PA	- 5.0		- 0.6
	- 2.0		- 0.8
Evansville, IN	- 1.3		- 1.9
Gary, IN	- 0.5		- 8.7
	- 4.1		- 11.2
Lake Charles, LA	- 0.2		

- Average 2378-TCDD in urban soil: 2.83 ppt based on 17 positive samples
- Average 2378-TCDD in urban soil: 0.88 ppt when the 221 non-detect values are given a value of 0.5 ppt and combined with the 17 positive values.
- Average 2378-TCDD in rural soil: 0.50 ppt based on 1 positive sample
- Average 2378-TCDD in rural soil: 0.50 ppt when the 138 non detect values are given a value of 0.5 ppt and combined with the one positive value.

Combining rural and urban together:

- Average 2378-TCDD in soil: 2.70 ppt based on 18 positive samples
- Average 2378-TCDD in soil: 0.74 ppt based on 359 sample samples

Additional studies of dioxin in soil are discussed in the 1994 EPA reassessment document. The data from these studies are summarized in Table 2. The different forms of dioxin shown in this table are combined in Table 3 to show a single TEQ value for the same set of samples.

Table 2 - Data on Dioxin Levels in Soil from 1994 Reassessment

	Midland, MI		Middleton, OH		Elk River, MN		Ont/MW		MN	
2378-TCDD	59/62	55	6/22	<1	0/4	ND *	-	-	-	-
TCDD	5/7	109	0/5	ND	0/4	NA *	11/47	40	0/3	ND
PeCDD	2/6	37	0/5	NA	0/4	NA *	0/3	NA	0/3	ND
					1/4	10				
HxCDD	5/7	172	1/5	14	0/4	NA *	0/3	NA	0/3	ND
HeCDD	7/7	930	5/5	113	4/4	346	25/47	212	3/3	54
					1/4	4	3/30	5.4		
					2/4	9				
					4/4	48				
OCDD	7/7	4473	5/5	2418	4/4	1655	38/47	1599	3/3	54
							17/30	67		

Note: For each sample location:

First column - Number of positive samples/total number of samples

Second column - mean concentration in parts per trillion (ppt)

ND = Not detected; detection limit = 1.0 ppt unless marked with * which indicates detection limit = 3.75 ppt.

NA = No data available

Other data: Henry, IL (Ref 5) 1/13 samples found 2378-TCDD at <1 ppt

References for Table 2:

Midland, MI - USEPA, 1985 (2)

Middletown, OH - USEPA, 1985 (2)

Elk River, MN - Reed, 1990 (4)

Ontario, Canada/Midwestern States - Birmingham, 1990 (6)

Minnesota - USEPA, 1985 (2)

Note: numbers in "()" refer to reference number at end of report.

Although it is unclear what 95 samples EPA selected as "representing background conditions in the United States," several points jump out at you when you look at the data in Table 2:

- Data from Midland, Michigan dominate the numbers. The highest numbers recorded in these "background" samples come from Midland, MI, the home of Dow Chemical, a large producer/source of dioxin in the U.S.
- One study looked only at industrialized areas (Ref 3) and another at soil from around an incinerator (Ref 5); neither area represent true background conditions.
- Some studies looked at all dioxin congeners (Refs 2,4,5,6), several looked only at 2378-TCDD (Refs 1,3) and others looked at "TCDD" (Refs 2,4,6). As a result, the data were collected using different methods and are difficult to compare.

If you take out the Midland, MI samples as not being "representative of background," the overall average dioxin level in soil drops substantially to less than 1 ppt TEQ (non detects reported in the data equal half the detection limit, which in most cases was 1 ppt). It is unclear, however, how many of the Midland samples were actually used by EPA to determine their background value of 8 ppt.

This estimate of less than 1 ppt is consistent with the estimate of the combined studies shown in Table 2 which separate the data from Midland from other areas. In addition, the average 2378-TCDD in 221 urban soil samples as determined in the National Dioxin Study which looked at "background sites that were not expected to have contamination" was less than 1 ppt. Based on these observations, it seems that background dioxin levels in soil, where background is defined to be "an area that is not expected to have contamination," is likely to be less than 1 ppt.

Table 3 - Summary of Data Reported by EPA in the 1994 Reassessment Document

	# Samples	Level (ppt) mean conc.	Form of Dioxin	Location
Pristine	4	ND (1.0) 0.6	2378-TCDD TEQ	Minnesota (2) Minnesota (2)
Agricultural	4	ND (3.75)	2378-TCDD	Elk River, MN (4)
Rural	4	24	TEQ	Elk River, MN (4)

Table 3 - Summary of Data Reported by EPA in the 1994 Reassessment Document (cont'd)

Residential	7	158	TEQ	Midland, MI (2)
	5	6	TEQ	Middletown, OH (2)
	1	<1	2378-TCDD	Henry, IL (2)
Urban	62	55	2378-TCDD	Midland, MI (2)
	47	67	TEQ	Ontario and Midwestern US (6)
	20	22	TEQ	Canada/US (3,6)
Industrial	67	2192	2378-TCDD	Midland, MI (3)
	1	1965	TEQ	Midland, MI (2)

References:

(1) National Dioxin Study, USEPA, Office of Solid Waste and Emergency Response, EPA/530-SW- 87-025, Washington, DC, August, 1987.

(2) Soil Screening Survey at Four Midwestern Sites, USEPA, Westlake, Ohio: Region V. Environmental Services Division, Eastern District Office, EPA-905/4-805-005, June, 1985.

(3) "Perspectives of a large scale environmental survey of chlorinated dioxins: overview and soil data. Nestruck, TJ, Lamparski, LL, Frawley, NN, Hummel, RA, Kocher, CW, Mahle, NH, McCoy, JW, Miller, DL, Peters, TL, Pillepich, JL, Smith WE, Tobey, SW, *Chemosphere* 15: 1453-1460 (1986).

(4) "Baseline assessment of PCDDs/PCDFs in the vicinity of the Elk River, Minnesota generating station," Reed, LW, Hunt, GT, Maisel, BE, Hoyt, M, Keefe, D, Hackney, P, *Chemosphere* 21 (1-2): 159-171 (1990).

(5) "Concentrations of PCDD and PCDF in Ontario soils from the vicinity of refuse and sewage sludge incinerators and remote rural and urban locations," Pearson, RG, McLaughlin, DL and McIlveen, WD, *Chemosphere* 20:1543-1548 (1990).

(6) "Analysis of PCDD and PCDF patterns in soil samples: use in the estimation of the risk of exposure," Biringham, B. *Chemosphere* 20 (7-9): 807-814 (1990).

(7) "Estimating Exposure to Dioxin-Like Compounds, Volume II: Properties, Sources, Occurrence and Background Exposures," USEPA, Office of Research and Development, EPA/600/6-88/005Cb, External Review Draft, June