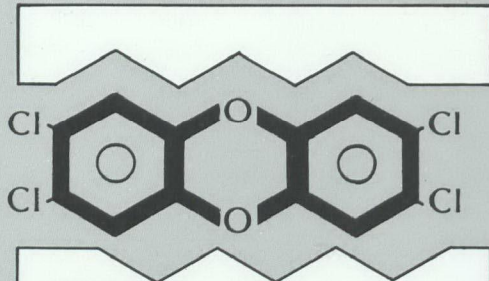


Study of

**DIOXIN & other
TOXIC POLLUTANTS**

Midland, Michigan

**U.S. EPA Region 5
April 1985**



DIOXIN

A generic term for a group of 75 related compounds known as polychlorinated dibenzo-p-dioxins. The most toxic compound of this group is 2,3,7,8-tetrachloro-dibenzo-p-dioxin (2378-TCDD). A number of the dioxins, including 2378-TCDD, are formed as inadvertent byproducts during the manufacture of organic chemicals, particularly chlorinated phenols. Certain combustion sources such as municipal and industrial waste incinerators and accidental electrical transformer fires have been shown to be sources of 2378-TCDD and other dioxins. The levels of 2378-TCDD from these sources have been relatively low compared to levels from chlorinated phenols production. 2378-TCDD is very persistent in the environment. It does not readily degrade into less toxic chemicals.

Tests on laboratory animals indicate 2378-TCDD is one of the most toxic chemicals made by man. Based on its estimated carcinogenic potency, cancer risks of individuals who consume fish contaminated with high levels of 2378-TCDD could be significant. Exposure to Dioxin contaminated soils could also significantly increase cancer risk.

As part of its National Dioxin Strategy, the U.S. EPA has begun a national dioxin study to determine the extent of dioxin contamination in the environment. The results of that study are expected by the end of 1985.

REPORT SUMMARY

At the State of Michigan's request, the U.S. Environmental Protection Agency has been conducting comprehensive environmental studies in the City of Midland, inside the Dow Chemical Midland plant, and at comparison sites across the Midwest. While the primary focus of the studies was on possible dioxin (2378-TCDD) contamination in the Midland area, EPA also sampled for other toxic chemicals. Results show that;

- Current dioxin levels in surface soils away from the Dow Chemical plant are well below one part per billion (ppb). According to the Centers for Disease Control, one ppb is the level at which some action must be considered to prevent human exposure to the dioxin-contaminated soil in residential areas. Current levels of dioxin in the Midland area, therefore, do not pose an unacceptable public health risk.
- Inside the Dow Chemical plant, EPA found concentrations as high as 36 ppb in surface soils. (Dow Chemical reported concentrations as high as 51 ppb.) Concentrations inside the plant are generally in the lower range of levels found at similar chemical manufacturing and disposal sites in other parts of the country. EPA, the State of Michigan, and Dow Chemical have entered into a proposed consent order to provide interim covering of surface areas that have high concentrations inside the plant. A public comment period on the consent order began on March 20, 1985 and will last until April 17, 1985.
- Concentrations of dioxin found in the City of Midland away from the Dow plant are significantly higher than the trace levels found in a few samples taken in other cities. Most samples from these comparison sites, and all samples from natural areas, did not contain dioxin at detectable levels.
- Air emissions from the Dow Chemical plant are the likely source of dioxin contamination in the Midland area.
- Current levels of toxic organic pollutants, other than dioxins, in Midland soils are at levels found elsewhere in the environment and do not pose an unacceptable public health risk.
- Because of high dioxin levels in fish taken from the Tittabawassee River, a warning on eating fish — particularly bottom-feeding fish such as carp and catfish — should be continued.

INTRODUCTION

This report presents a brief history of dioxin findings in the Midland area, a description of EPA's soil study, the soil study results, and conclusions from the Centers for Disease Control (CDC) and EPA about health risks from exposure to contaminated soils. In addition, data from other locations, including cities that also have chemical manufacturing plants and disposal sites, are compared to data from Midland. Results and conclusions from fish sampling in the Tittabawassee River are also presented.

The study in Midland has been incorporated into the National Dioxin Strategy. The National Dioxin Strategy is examining potential sources and risks of dioxin in the environment. It is organized into seven tiers or categories ranging from sites where dioxin was most likely to be found (Tiers 1 and 2) to sites where contamination is not suspected (Tier 7).

HISTORY OF DIOXIN FINDINGS

In June 1978, Dow Chemical advised the Michigan Department of Public Health (MDPH) that it had found dioxin (2378-TCDD) in fish caught from the Tittabawassee River. The MDPH immediately issued an advisory against eating fish from the river. That advisory is still in effect today. Subsequently, the Michigan Department of Natural Resources (MDNR), in cooperation with EPA, sampled fish from the Tittabawassee River and confirmed Dow's findings.

The agencies attempted to determine if Dow Chemical's wastewater discharges, which flow into the Tittabawassee River, contained the dioxin that was accumulating in the fish.

However, at that time, regulatory agencies could not detect dioxin at ultratrace levels in water because analytical methods had not yet been developed that were able to detect dioxin at very low levels.

In the fall of 1981, MDNR and EPA conducted a caged-fish study in the Tittabawassee River to determine if Dow Chemical was the source of the dioxin. Catfish were kept in cages for 28 days both upstream and downstream of Dow Chemical and directly in the plume of Dow's discharge in the river. An experimental method of ultratrace analysis for dioxin in water was also developed as part of that study.

The preliminary results released in March 1983 demonstrated that Dow Chemical's wastewater was the source of dioxin. Subsequent analyses by Dow Chemical have confirmed that finding.

In the spring of 1984, the State of Michigan, with EPA's concurrence, issued a wastewater discharge permit and an administrative order to Dow Chemical that limits the discharge of 2378-TCDD. The order also requires the construction of wastewater treatment systems as a first step in reducing dioxin discharges.

In March 1983, the State of Michigan formally requested EPA to conduct a comprehensive study of dioxins and

other toxic pollutants at Dow Chemical's Midland plant, in the Tittabawassee River, and in the City of Midland. The state and EPA planned the study in the spring of 1983. Soil sampling was conducted in Midland, at Dow Chemical, and at the comparison sites during 1983 and 1984. Dow incinerator emissions, ambient air samples, Dow brine system and wastewater samples, drinking water well samples, and river sediment samples were also collected in 1984.

SOIL STUDY

Study Objectives

The principal objective of the soil study was to determine whether concentrations of dioxins and other toxic pollutants in Midland surface soils could pose unacceptable public health risks. The study was also conducted to determine the likely source or sources of ambient levels of dioxins in Midland; if levels found in Midland are comparable to levels found in other industrial areas with combustion sources and process operations different from those at Dow Chemical; and whether levels found in Midland are significantly different from background levels generally found in the environment.

Conduct of the Study

The investigation of dioxin and other toxic pollutants in the Midland area is one of the first and most comprehensive studies conducted by EPA in which laboratory methods capable of detecting 2378-TCDD at the low parts per trillion (ppt) range were used.

(One ppt is 1,000 times less than one part per billion (ppb) which is the level in residential soils at which CDC believes some action to limit human exposure needs to be considered.)

Throughout this study, elaborate quality assurance controls were used to ensure that accurate data were produced. Field work was thoroughly documented. Duplicate soil samples were obtained at certain locations. Clean, disposable sampling equipment was used for each sample. Each sample was coded with a unique identification number. The samples were thoroughly blended in a laboratory before extraction and analysis.

All samples were then analyzed on a blind basis, that is, EPA laboratories at Bay St. Louis, Mississippi, and Research Triangle Park, North Carolina, did not know where the samples had been taken or the identity of the samples they were analyzing. Control and blank samples were also submitted to the laboratories on a random, blind basis. In addition, EPA provided split samples to Dow Chemical on a blind basis for comparative analyses. Dow's analyses confirmed EPA's results.

EPA believes that the data obtained accurately reflect surface soil conditions in Midland, at Dow Chemical, and at the comparison sites. This set of high quality data is sufficient to evaluate health risks to Midland residents from exposure to current levels of 2378-TCDD and other pollutants in Midland soils.

NATURAL AREAS IN MINNESOTA

This site consists of the following four areas managed by the Minnesota Department of Natural Resources as scientific and natural areas:

- Kettle River Scientific and Natural Area
- Pembina Trail Scientific and Natural Area
- Itasca Wilderness
- Bluestem Prairie Scientific and Natural Area

Scientific and Natural Areas are established by the State of Minnesota to protect and perpetuate natural features that possess exceptional scientific or educational value. The Kettle River area is a 760-acre tract typical of the woodlands of eastern Minnesota. Pembina Trail is one of the largest remaining tracts (1,660 acres) of native prairie in Minnesota. Itasca Wilderness is a 2,000-acre tract of pine-dominated forest that has never been logged. Bluestem Prairie is another prairie that has not been affected by nearby pollution or combustion sources. These areas are considered Tier 7 sites, or background sites, for EPA's National Dioxin Strategy.

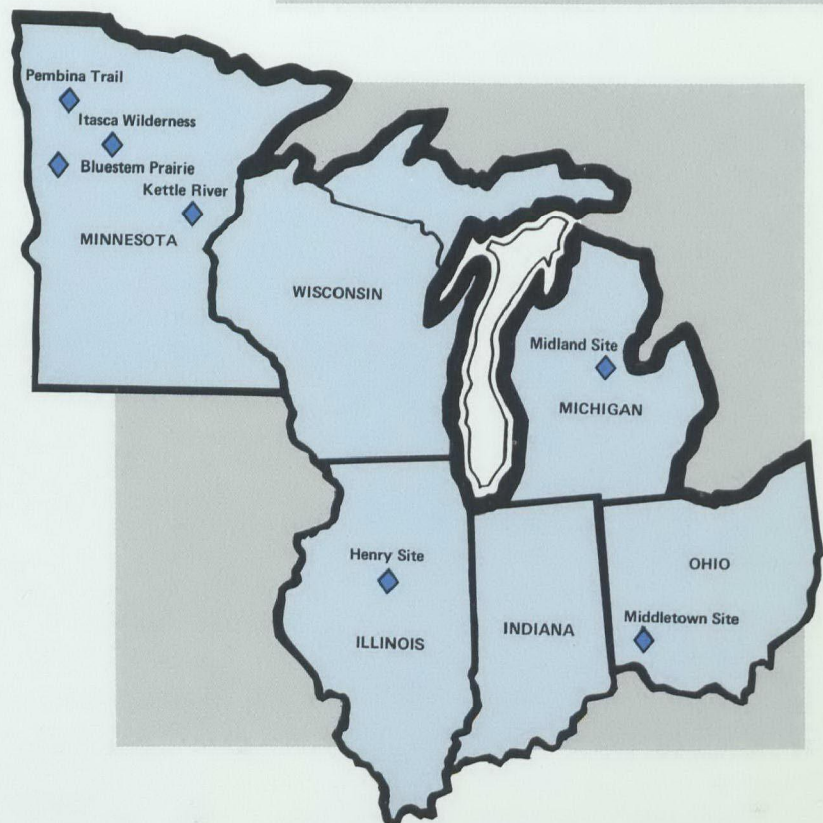
FIGURE 1
MAP OF EPA REGION 5
SHOWING LOCATIONS
OF SOIL STUDY SITES

HENRY, ILLINOIS

The principal industry near Henry, Illinois, is a polyvinyl chloride manufacturing plant operated by the B.F. Goodrich Chemical Company. The plant has numerous process vents and some combustion sources. There are no Tier 1 or Tier 2 sites as defined by EPA's National Dioxin Strategy in the Henry, Illinois area. Henry has a population of about 2,700.

MIDLAND, MICHIGAN

The major industries in the City of Midland (population 37,250) are the Midland plant of the Michigan Division of Dow Chemical Company and the Dow-Corning Silicone Products plant. Dow Chemical's Midland plant falls within Tiers 1, 2, 3, and 4 or EPA's National Dioxin Strategy in that 2,4,5-trichlorophenol (2,4,5-TCP) was produced (Tier 1); 2,4,5-TCP was used to make pesticide products (Tier 2); 2,4,5-TCP and derivatives were formulated into pesticidal products (Tier 3); and the plant is also a combustion source (Tier 4).



MIDDLETOWN, OHIO

The City of Middletown (population 43,700) is in southwestern Ohio. The principal industries are the ARMCO, Inc. Middletown Works; Sorg Paper Company; and Crystal Tissue Company. The ARMCO, Inc. Middletown Works is a fully integrated steel plant that has cokemaking, iron-making, and steelmaking operations. Sorg Paper manufactures fine paper from purchased pulp, recycled paper, and paper wastes. Crystal Tissue manufactures fine tissue and wrapping papers from virgin pulp. There are no Tier 1 or Tier 2 facilities as defined by EPA's National Dioxin Strategy in the Middletown, Ohio, area.

Soil Study Results

The study results for 2378-TCDD for each site are summarized in Table 1. The Dow Chemical and City of Midland data are highlighted in the centerfold of this summary report.

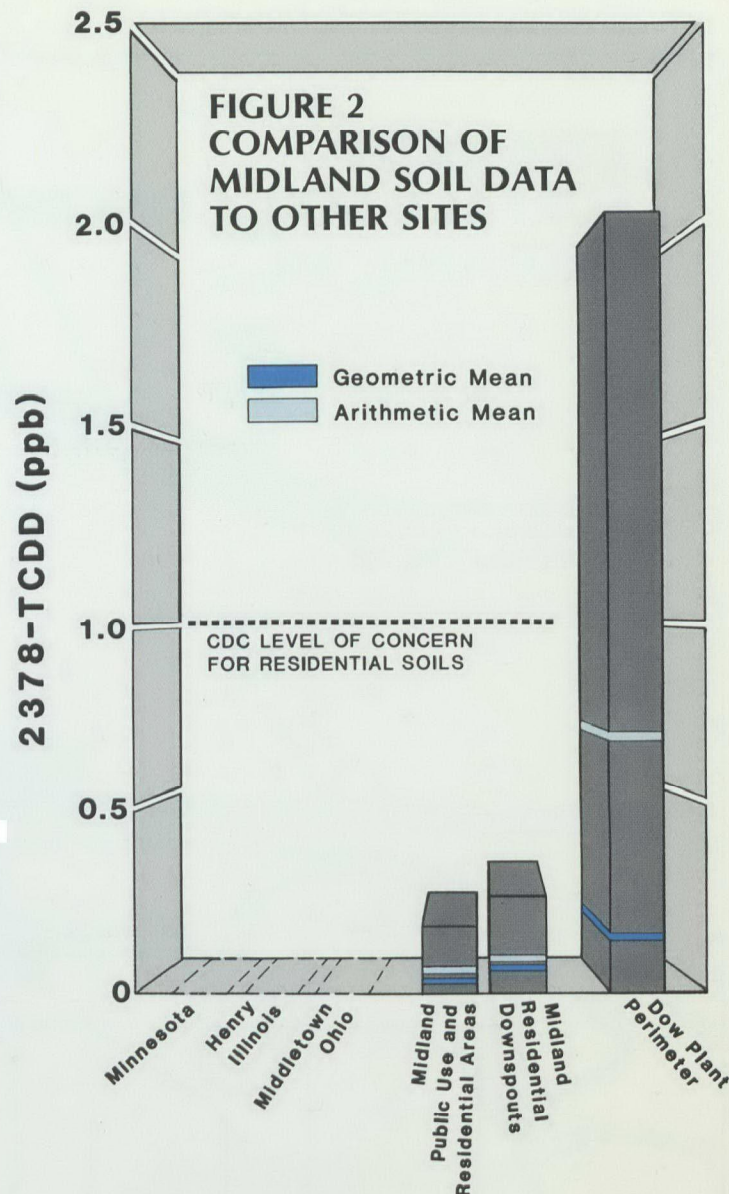
Figure 2 compares the ranges of dioxin levels found in surface soils at each of the comparison sites with levels found in Midland. The data show that levels of dioxin in Midland away from the Dow plant are well below the 1 ppb level of concern established by CDC for residential soils. One sample obtained near the east fence line of the Dow plant had a dioxin concentration of 2.03 ppb. Supplemental sampling conducted by Dow Chemical around the site showed the 2.03 ppb concentration to be isolated to a small area. Dow Chemical has extended its fencing around that site to prevent public access.

The next highest sample obtained near the perimeter of the Dow plant contained less than 0.55 ppb of dioxin. Frequent and prolonged exposure of the public to soils around the perimeter of the Dow plant is not likely.

Figure 2 also shows that, while levels of dioxin found in Midland are well below CDC's level of concern for residential areas, those levels are higher than found around other industrial sites and in natural areas.

Figures 3, 4 and 5 present the dioxin data for Midland public use and residential areas, the perimeter of the Dow plant, and inside the Dow plant. The data in Figure 3 show that most values of 2378-TCDD in Midland public use and residential areas are at or less than 0.10 ppb. All values were less than 0.30 ppb.

Four out of the five highest values in the city were found at residential downspouts, indicating that airborne emissions from Dow Chemical are the likely sources of dioxin. Downspouts can be good indicators of atmospheric contamination.

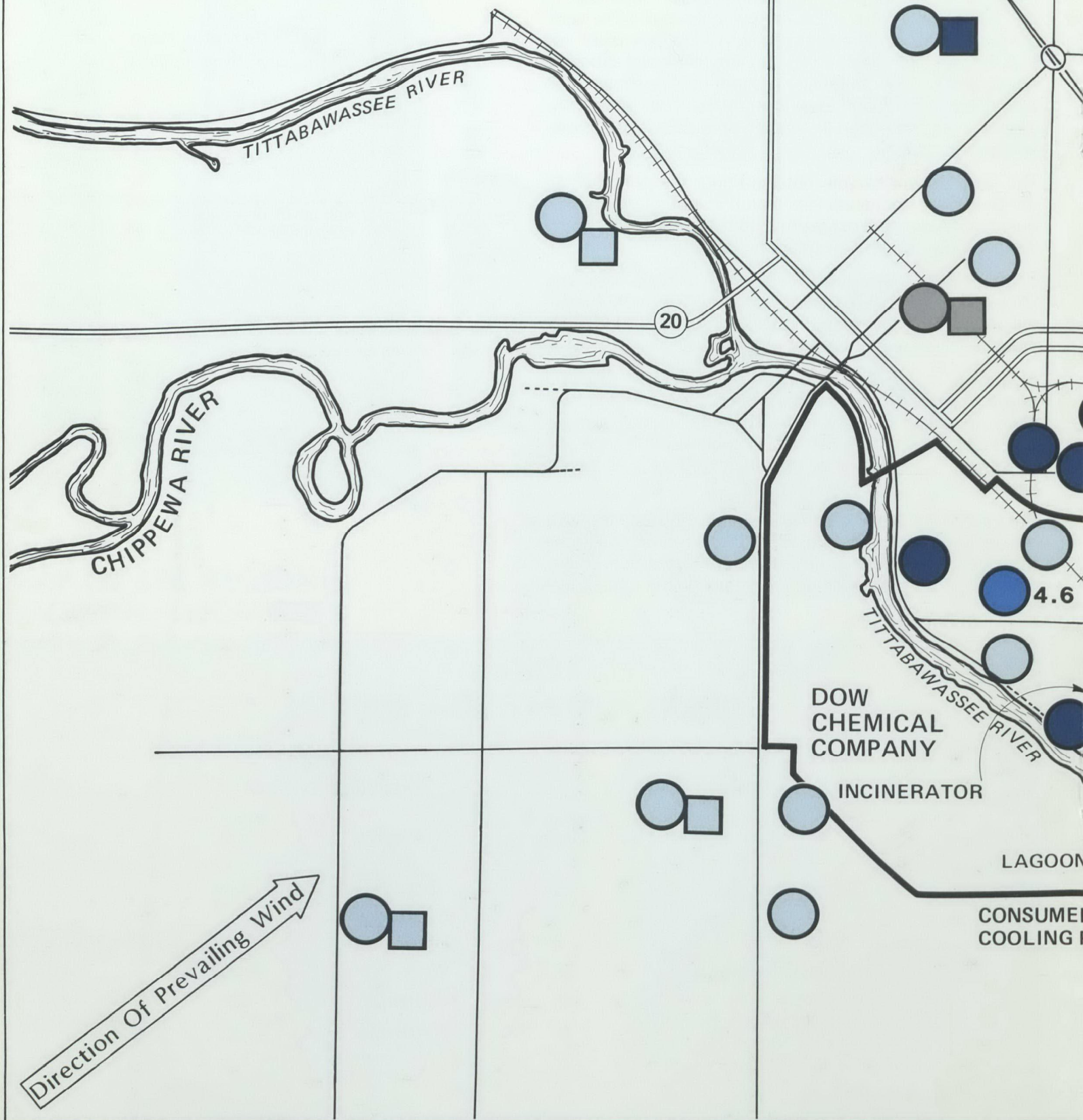


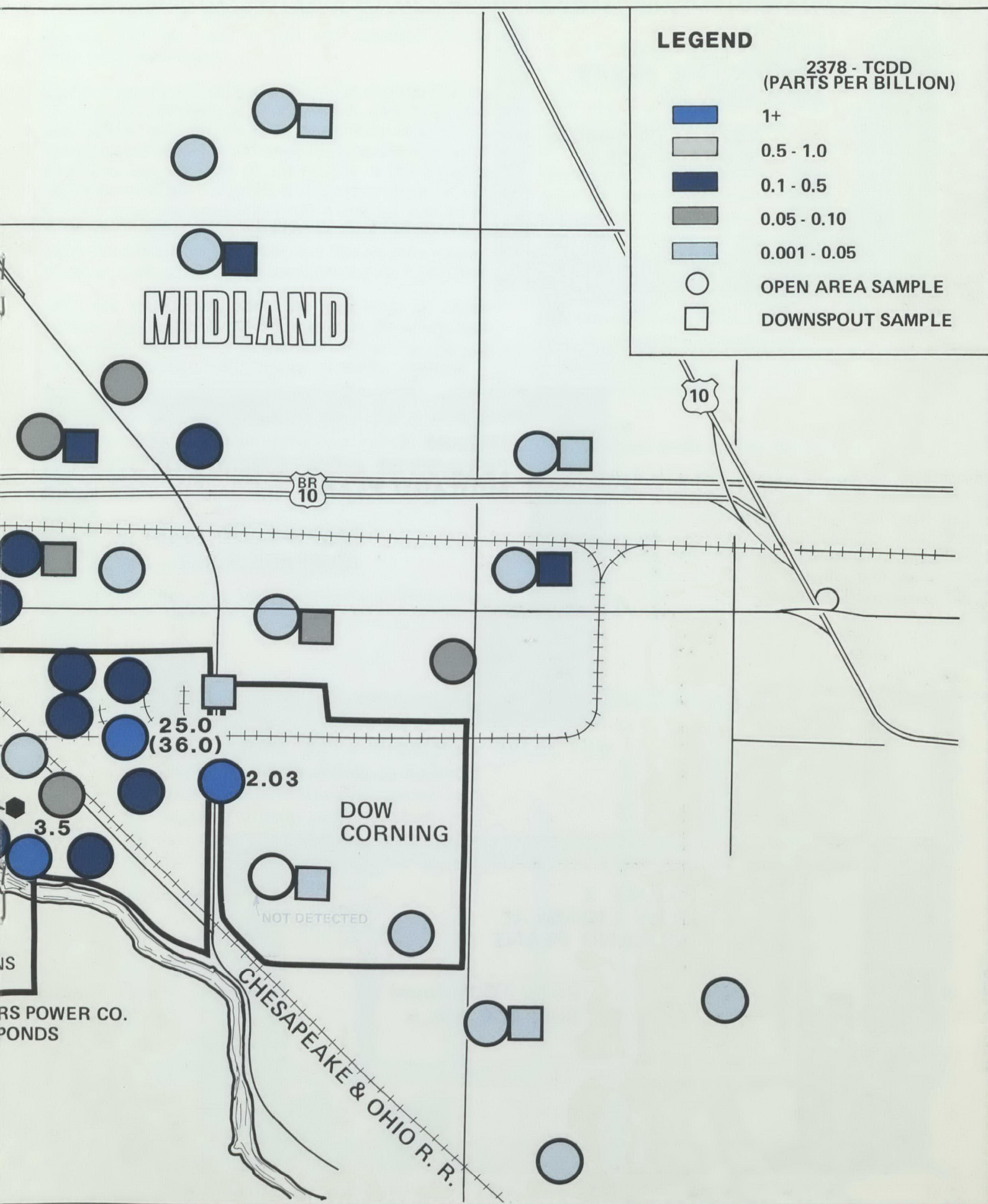
**TABLE 1
DIOXIN SURFACE SOIL RESULTS**

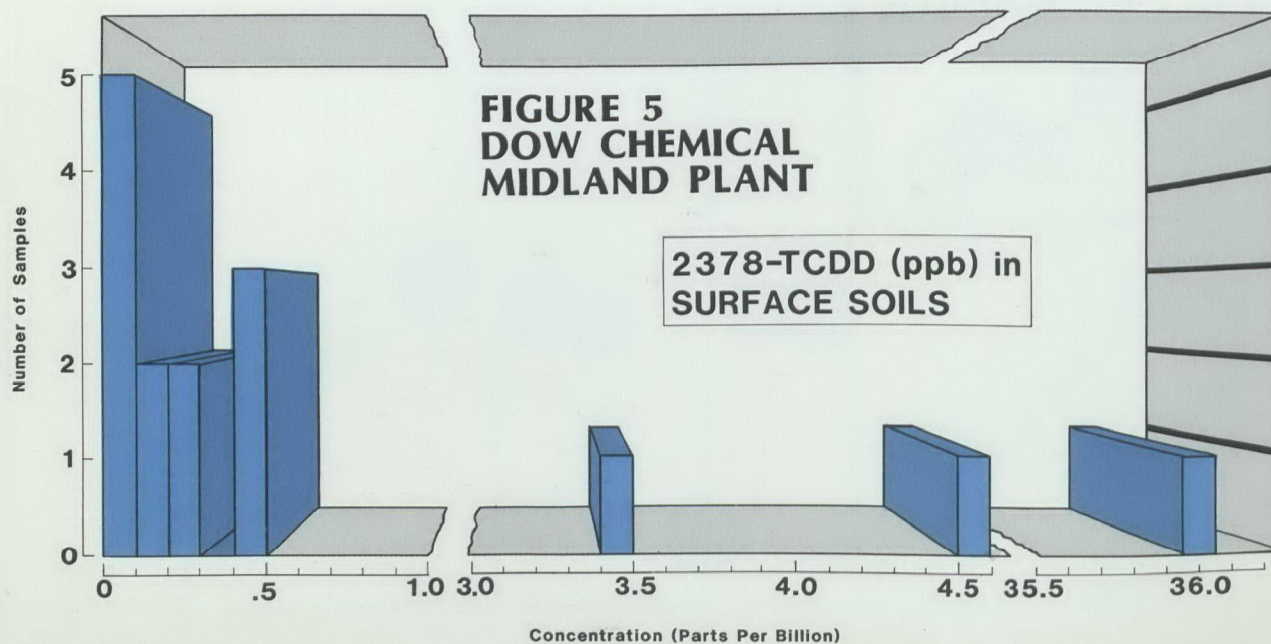
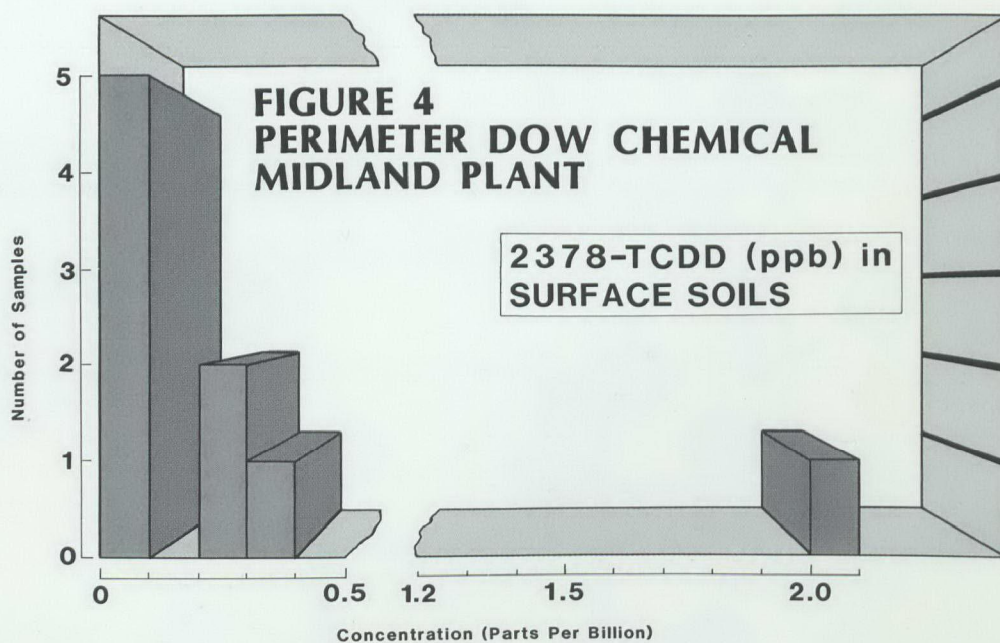
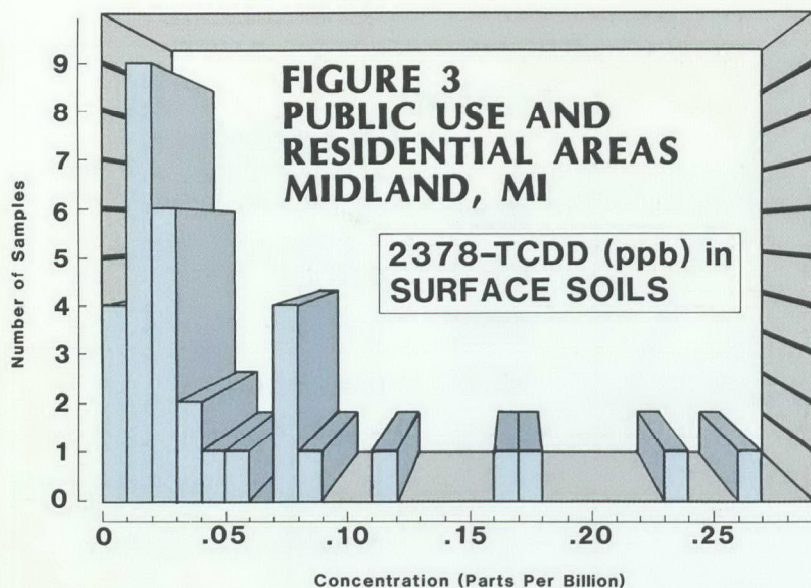
Location	Number of Samples	2378-TCDD (Results in Parts Per Billion)		
		Range	Arithmetic Mean	Geometric Mean
Midland, Michigan				
Dow Chemical-Midland Plant	15	0.01-36.0	3.09	0.24
City of Midland				
Dow Plant Perimeter	9	0.01-2.03	1.43	0.17
Public Use and Recreational Areas	33	0.003-0.27	0.06	0.03
Henry, Illinois	13	ND-0.002	<DL	—
Middletown, Ohio	20	ND-0.005	<DL	—
Minnesota Natural Areas	4	ND	—	—

(ND — Not detected)
(<DL — Less than detection limit)

2378-TCDD SURFACE SOIL CONCENTRATIONS MIDLAND, MI







tion because airborne particles tend to collect on exposed surfaces such as building roofs. These particles are washed from the roofs by rain and deposited in soils around the downspouts.

Figure 4 shows that although one value of 2.03 ppb was found on the perimeter of the Dow plant, the next highest value is less than 0.50 ppb. Data presented in Figure 5 indicate that most values found inside the Dow Chemical plant have less than 0.50 ppb of 2378-TCDD. A few sampling locations inside the Dow plant had concentrations in the 3 to 5 ppb range and one location had a dioxin concentration of 36 ppb. Supplemental sampling by Dow Chemical indicates that most of the Dow plant had dioxin concentrations less than 1 ppb, although one sample had a value of 51 ppb.

CDC has stated that, based on experience at similar facilities, it is doubtful whether significant dioxin exposure to workers would occur at the plant unless the soil was disturbed because of construction or similar activities.

EPA, the State of Michigan, and Dow Chemical have entered into a proposed consent order by which Dow Chemical will provide interim covering of the two identified high concentration areas with asphalt to minimize exposure to plant workers and prevent migration of dioxin offsite.

Consideration of Health Risks

The data from this study were reviewed by CDC to determine whether levels of dioxin and other pollutants in

Midland soils might pose unacceptable health risks to Midland residents.

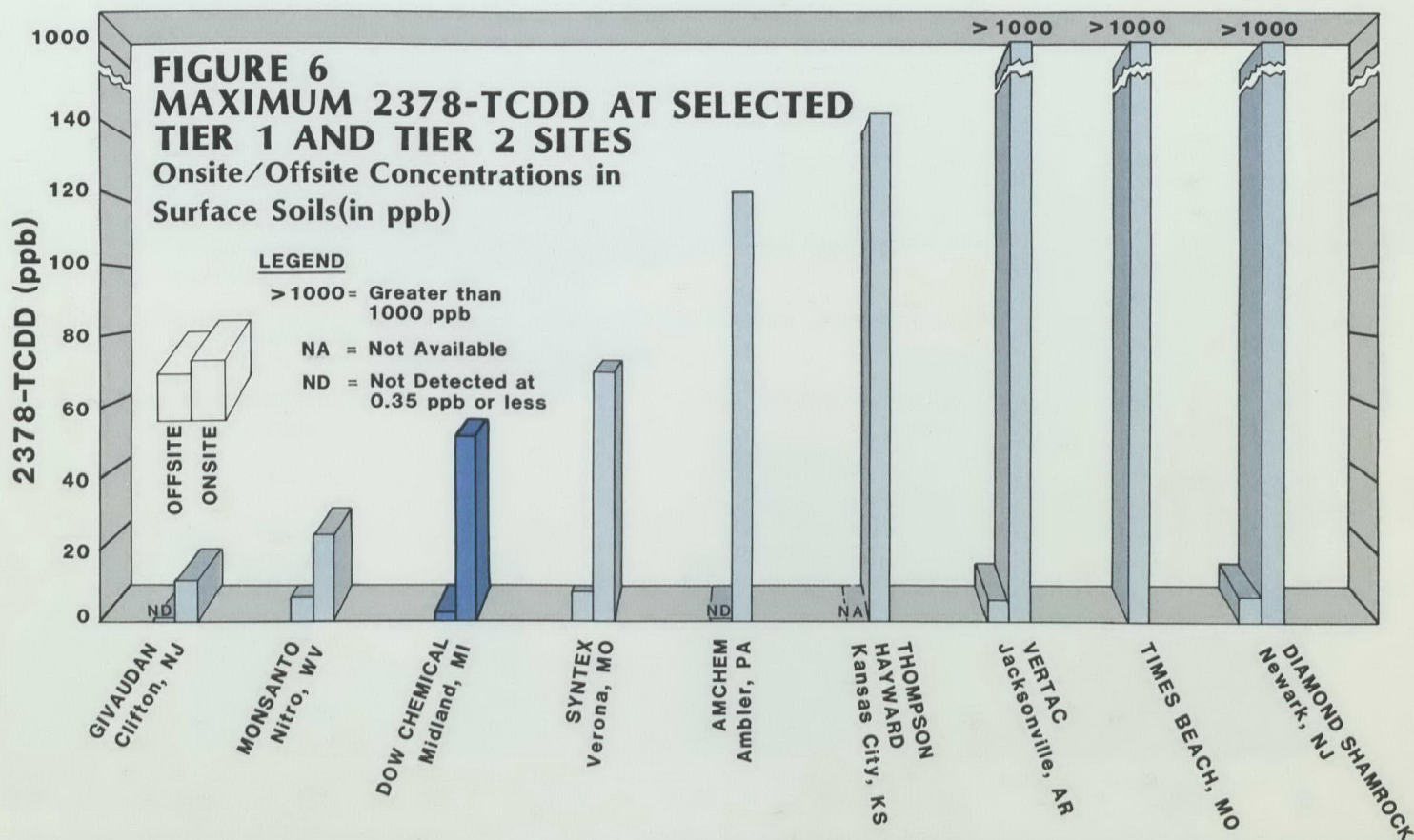
CDC concluded that levels of 2378-TCDD in Midland soils are well below the 1 ppb level at which some action to limit human exposure to residential soils needs to be considered; and, that levels found in residential soils, including downspout areas, do not represent a significant health risk to either the persons living there or the public at large.

The levels of other dioxins, furans, and other toxic chemicals, which are all less toxic than 2378-TCDD, do not represent an unacceptable public health risk. CDC also concluded that levels of other toxic chemicals are within the range of levels found generally in the environment. CDC also states that its assessment is based upon current environmental data, and no comment can be made about past environmental levels and potential risks.

EPA's Chlorinated Dioxins Work Group at EPA Headquarters in Washington, D.C., also evaluated the data and came to the same conclusions as CDC.

Comparison with Other Dioxin Sites

Figure 6 compares data obtained at Dow Chemical and in Midland with data from other chemical manufacturing sites and disposal sites where dioxin has been found. These are Tier 1 and Tier 2 sites for EPA's National Dioxin Strategy. These data show that the levels of 2378-TCDD found at Dow Chemical are, for the most part, in the range of, or lower than, levels found at other Tier 1 and Tier 2 sites.



FISH STUDY

During the summer of 1983, MDNR collected fish from the Tittabawassee River and several other Michigan rivers for dioxin analyses.

For most rivers, samples of bottom-feeding fish such as carp and catfish were collected along with samples of game fish including walleye and bass. The fish were analyzed by U.S. EPA's Environmental Research Laboratory in Duluth, Minnesota. The results for the Tittabawassee River, which are summarized in Table 2, were originally released to the public by MDNR in October 1984:

Whole fish composite samples of carp from 11 other Michigan rivers had levels of 2378-TCDD ranging from none detected to 8.6 ppt.

Figure 7 presents data obtained for the 25 carp fillets and 5 walleye fillets from the Tittabawassee River. The concentrations of 2378-TCDD in carp are much higher than concentrations in walleye. As shown in Table 2, the average

carp fillet concentration is about 50 ppt, while the average for walleye is about 4 ppt.

The Food and Drug Administration recommends that fish with more than 50 ppt of 2378-TCDD not be eaten and fish in the range of 25 to 50 ppt be consumed only on a limited basis. Based upon the data obtained from this study, both CDC and EPA recommend that the MDPH warning on consumption of fish from the Tittabawassee River be maintained.

As a result of a March 1984 consent decree with EPA, Dow Chemical has agreed to analyze dioxin levels in fish from the Tittabawassee River every 2 years beginning in 1985 and lasting until 1991. This program has been approved by EPA and MDNR and will be monitored by the agencies. The purpose of the program is to determine whether wastewater treatment systems now being installed by Dow Chemical to control dioxin are having a beneficial impact on dioxin levels in Tittabawassee River fish.

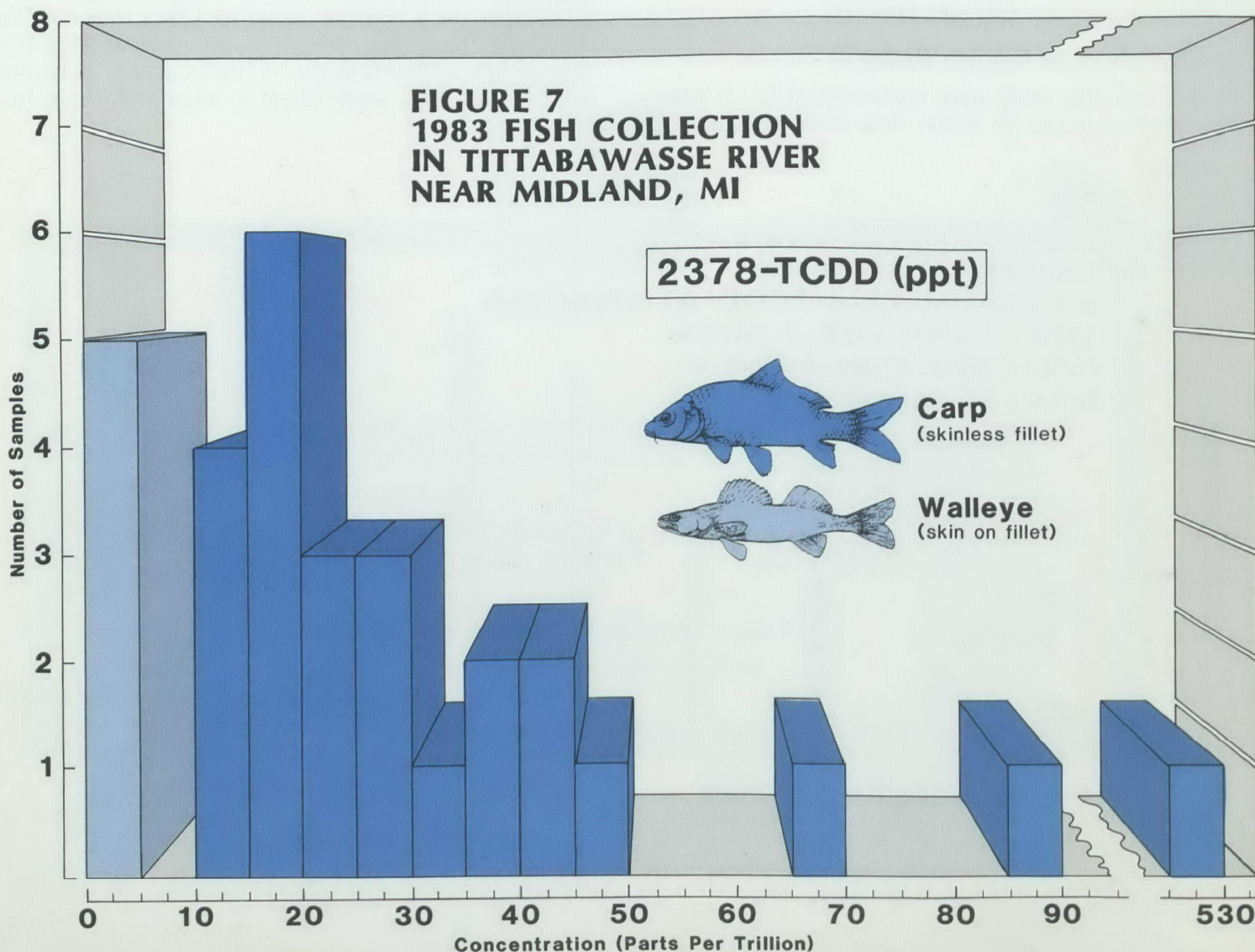


TABLE 2 FISH STUDY RESULTS

2378-TCDD
(Results in Parts Per Trillion)

Tittabawassee River Fish (August-September 1983)	Number of Measurements	Range	Mean
Carp — whole fish composite (5 fish)	1	190 ppt	
Carp — individual skinless fillets	25	12-530 ppt	50 ppt
Catfish — skinless fillet composite (5 fish)	1	75 ppt	
Smallmouth Bass — skin-on fillet composite (5 fish)	1	5.1 ppt	
Walleye — individual skin-on fillets	5	2.8-5.1 ppt	3.9 ppt

Note: A composite fish sample is made up of a number of individual fish blended together prior to analyses.
Bottom-feeding fish were sampled because they are more likely to pick up contamination in river sediment.

ACRONYMS

EPA — U.S. Environmental Protection Agency
 CDC — Centers for Disease Control
 MDNR — Michigan Department of Natural Resources
 MDPH — Michigan Department of Public Health
 PPB — Parts Per Billion
 PPT — Parts Per Trillion
 2378-TCDD — dioxin or 2,3,7,8 tetrachlorodibenzo-p-dioxin

GLOSSARY

Ambient Air — Air outside the property limits of industrial or other types of facilities.

Administrative Order — An order issued by an EPA administrator in accordance with congressional authorization that requires a party to correct environmental problems.

Background Levels — Concentrations of chemicals that are found in the environment away from manmade pollution sources.

Carcinogen — A substance or agent that produces or incites cancer.

National Dioxin Strategy — In December 1983, EPA announced a National Dioxin Strategy to determine the extent of dioxin contamination throughout the country. The strategy provides a framework under which the Agency will:

- Study the nature of dioxin contamination throughout the United States and the risks to people and the environment

- Clean up dioxin-contaminated sites that threaten public health
- Find ways to prevent future contamination
- Find ways to destroy or dispose of existing dioxin.

To carry out its dioxin strategy, EPA established seven categories or tiers of sites for investigation and study. These sites range from those that are most probably contaminated (Tiers 1 and 2) to those where there is no expectation of contamination (Tier 7). EPA believes more than 80 percent of the dioxin in the environment is associated with the Tier 1 and 2 sites. The other tiers are being evaluated in EPA's National Dioxin Study, which was started in the summer of 1984, and is scheduled for completion by the end of 1985.

Parts Per Billion, Trillion — One part per billion, the level at which CDC says action must be considered to prevent human exposure to 2378-TCDD in residential soils, is equivalent to one inch in about 16,000 miles. A part per trillion is one thousand times less than one part per billion.

Split Samples — To ensure the accuracy of laboratory analyses, samples are often divided and sent to different laboratories for comparative analyses.

Toxic Chemical — Any of a number of chemicals considered by EPA for special regulatory attention because of the adverse impacts these chemicals can have on man, animal life, or the environment in general. Many are lethal in single high doses or cause long term illness if administered at low doses over longer periods of time.

AVAILABLE INFORMATION

For more information about EPA's dioxin studies in the Midland area, please review the information repositories at the following locations:

Grace A. Dow Memorial Public Library

1710 W. St. Andrews Drive
 Midland, MI 48640
 (517) 835-7151

Dr. Winifred Oyen, Director
 Midland Health Department
 125 W. Main Street
 Midland, MI 48640
 (517) 832-6655

Ingersoll Township Hall
 c/o Kurt Shaffner, Supervisor
 4400 Brooks Road
 Midland, MI 48640
 (517) 835-5289

For additional information, please contact:

Vanessa Musgrave

U.S. EPA Community Relations Coordinator
 230 South Dearborn Street
 Chicago, IL 60604
 (312) 886-4359
 1-800-621-8431 (toll free, 8:30 a.m.-4:30 p.m., Central Time)

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