QUANTITATIVE ESTIMATION OF THE ENTRY OF DIOXINS, FURANS AND HEXACHLOROBENZENE INTO THE GREAT LAKES FROM AIRBORNE AND WATERBORNE SOURCES

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

I. INTRODUCTION

This report covers the first phase of a two-year project to develop economically constructive ways of virtually eliminating the entry of several major toxic pollutants into the Great Lakes: polychlorinated dibenzo-dioxins (PCDD), polychlorinated dibenzo-furans (PCDF), and hexachlorobenzene (HCB). In this initial phase of the project we have identified the numerous sources of these pollutants and have estimated the amounts that each of them contributes to the Great Lakes annually. In the second phase of the project, we are evaluating economically constructive ways of virtually eliminating the impact of these pollutants on the Great Lakes by changing the responsible industrial and agricultural processes so that they do not produce the pollutants at all.

For many years, the Great Lakes have been recognized as a major testing ground of the effort to understand -- and to remedy -- modern environmental degradation. The lakes are embedded in a region of intense agricultural, industrial and urban activity and have been heavily affected by the resultant pollution. They have been the subject of extensive ecological analysis, earlier with respect to eutrophication, and more recently in order to understand the impact of toxic pollutants (Colburn et al., 1990; Environment Canada, 1991).

Since 1909, the environmental future of the Great Lakes has been the responsibility of a pioneering effort in international ecological collaboration. Mandated by a series of U.S.-Canadian treaties, the International Joint Commission (IJC) has evaluated detailed studies of the lakes' ecological status and has proposed ways of improving it.

Numerous studies have shown that the lakes are heavily burdened with a number of long-lasting, highly toxic pollutants that accumulate in the food chain, among them PCDD/PCDF and HCB. According to the IJC,

> Mounting evidence continues to reinforce concerns about the effects of persistent toxic substances. Long-term exposure of fish, wildlife and humans to these substances has been linked to reproductive, metabolical, neurological and behavioral abnormalities; to immunity suppression leading to susceptibility to infections and other life-threatening problems; and to increasing levels of breast and other cancers. Available evidence also points to long-term reproductive and intergenerational effects. (IJC, 1994)

The recent U.S. EPA dioxin risk assessment (U.S. EPA C) has recognized the serious implications of these results: that current exposure to PCDD, PCDF and related dioxin-like substances is sufficient to threaten the human population as a whole.

The IJC has concluded that only the strategy of pollution prevention can substantially reduce the lakes' burden of such substances. At present, efforts to reduce the environmental impact of toxic pollutants are almost entirely based on the strategy of control: a device is appended to the source with the aim of recapturing enough of the pollutant to bring the environmental emissions to some presumably acceptable level. In this case, the chief regulatory task is to specify a level of control device performance that is expected to reduce emissions to the acceptable environmental level.

The strategy adopted by the IJC calls for a different approach. Since the goal is the virtual elimination of the pollutant -- which experience shows is unattainable through control devices (Commoner, 1988, 1994) -- this must be achieved by altering the facilities or processes that generate the pollutant so that it is not produced to begin with. Thus, the goal is to appropriately redesign the individual facilities -- for example, incinerators, pulp and paper mills, or chemical plants -- that are collectively responsible for the pollutant loadings to the Great Lakes. Hence, in practice, the IJC strategy requires an evaluation of the degree to which such sources contribute to the pollutants that actually reach the Great Lakes. Then judgments can be made as to which of the classes of sources, and which individual ones, if properly redesigned, would bring the goal of virtually eliminating the entry of the pollutants into the Great Lakes within reach.

Thus, in contrast to the control-based strategy of remediation -- which involves the generic application of control devices and emission standards -- the IJC's remedial program requires a detailed evaluation of separate sources with respect to: their emissions; the fraction of the emitted material that reaches the Great Lakes; and the relative contribution that each source or class of sources makes to the level of pollution in the lakes. These considerations have guided the design of this project.

Recent studies of pollutants in the Great Lakes have identified a list of substances that appear to be responsible for the main toxic hazards. (For summaries, see IJC 1992; U.S. EPA 1993A.) Certain of these substances, for example polychlorinated-biphenyl (PCB), are no longer produced in the United States and Canada, so that the issue of eliminating their production is moot -- at least in these countries. The group of compounds that we have selected for this study are widely recognized as among the most serious continuing contributors to environmental hazards in the Great Lakes, and, indeed, more widely as well.

PCDDs and PCDFs are a group of 210 substances, similar in their molecular structure but which differ in the number and arrangement of their chlorine atoms. The individual members of the group, or congeners, have similar biological effects, which include increased incidence of cancer and damage to the development of the endocrine, immune and nervous systems. Only 17 of the 210 possible PCDD/PCDF congeners exhibit these toxic properties, and these differ considerably in their toxic potency. The toxic potency of the PCDD/PCDF congeners is commonly expressed in terms of Toxicity Equivalency Factors (TEF), i.e., the toxic potency of a given congener relative to that of 2,3,7,8-tetrachloro-dibenzo-p-dioxin (2,3,7,8-TCDD), which is the most toxic congener. The overall toxicity of a mixture of PCDD and PCDF congeners can be expressed quantitatively by using their respective TEFs to compute the amount of 2,3,7,8-TCDD that is equivalent in its toxicity to that of the mixture. This quantity is expressed as amount of toxic equivalents (TEQ).

PCDD and PCDF are not produced intentionally. However, they frequently occur as by-products in the manufacture of chlorinated organic substances. They are also produced when such substances are burned or when chlorine is present in any combustion process. They can also occur when chlorine or chlorine compounds are used for bleaching, as in the pulp and paper industry (Fiedler et al., 1990).

HCB produces a number of toxic effects in animals and people, including: abnormal fetal development, alteration of reproductive and development processes, and carcinogenicity (ATSDR, 1990, 1994; IARC, 1986). HCB has not been commercially produced in the United States since the 1970s; but it still occurs as a by-product in the chemical manufacturing of chlorinated organic compounds. As a result, certain pesticides are significantly contaminated with HCB. HCB also often occurs in the wastes from facilities that manufacture chlorinated organic compounds. Combustion processes that produce PCDD/PCDF are likely to produce HCB as well (U.S. EPA 1986A).

There is evidence that PCDD/PCDF and HCB enter the Great Lakes both from the air (see, for example, Eisenreich et al., 1981; Strachan & Eisenreich, 1988; Eisenreich & Strachan, 1992; Charles & Hites, 1987), and as the result of waterborne discharges (see, for example, Environment Canada and U.S. EPA 1988; Duran and Oliver, 1983; Onuska et al., 1983).

II. PROCEDURES

A. Approach:

In this first phase of the project, our overall aim was to identify those sources of PCDD/PCDF and HCB, which, if modified so as to no longer generate these pollutants, would virtually eliminate their entry into the Great Lakes. The general analytical problem is to determine, for each of the relevant sources (e.g. a particular municipal waste incinerator, or the HCB-containing pesticides used in a particular state or province), the amounts of their emitted PCDD/PCDF and/or HCB that enter the Great Lakes. To accomplish this purpose we have sought to identify and estimate the emissions of all of the U.S. and Canadian sources that are expected to emit the targeted pollutants. Then, for each source -- based on its location relative to the Great Lakes and the losses in transport -- we estimated the percent of the emitted material that actually enters the Great Lakes. In addition, we have analyzed the influence of the distance and geographic orientation of the sources relative to the lakes on the percent of the emissions deposited in them. Finally, by ranking the sources in descending order according to their contribution to the total amounts entering the Great Lakes, the most important classes of sources and individual ones were identified, as a guide to evaluating the economic implications of virtually eliminating their environmental impact.

B. Airborne Sources:

1. Identification of sources:

Ideally, this requires listing all of the U.S. and Canadian facilities (e.g. individual municipal waste incinerators or chemical plants) that are expected to emit PCDD/PCDF and HCB into the air. Given the limitations of the available data, this has been possible, to a reasonable degree of completeness, for only certain classes of sources: municipal waste incinerators, secondary copper refiners and smelters, sewage sludge incinerators, hazardous waste incinerators, cement kilns and iron sintering plants. In the case of several other classes -- medical waste incinerators, coal burning, wood burning, and mobile sources -- the individual sources are insufficiently documented and/or too numerous for individual characterization. They have therefore been characterized on a state-by-state (or province) basis by indirect means. This approach has also been used in the case of HCB from pesticides, which originates from non-point sources; given the available data, these can be localized only by the state or province in which the pesticides are applied. Table I summarizes the source classes and numbers of sources, totaling 1329, that we have identified in each of them.

In compiling the sources of PCDD/PCDF, we were guided initially by the list of classes published in the recent U.S. EPA dioxin risk assessment (U.S. EPA, 1994A). We have relied on several U.S. EPA and Environment Canada publications for the initial identification of the classes of HCB sources (Environment Canada/Health & Welfare Canada, 1993A and 1993B; U.S. EPA, 1986A and 1986B, 1993A, 1993B and 1994B). Lists of individual sources, specified by location, have been assembled from inquiries to industrial organizations and from a variety of publications available from U.S. EPA, Environment Canada, and state and provincial agencies.

2. Characterization of sources:

For the purpose of this project it was necessary to characterize the sources of PCDD/PCDF and HCB in two basic ways: by location, and by the amounts of these substances emitted annually. Since individual sources have only rarely been characterized with respect to emissions by means of actual measurements, these data must be acquired by determining, from the few actual measurements, the emissions produced per unit of facility operation. The latter is represented by the annual throughput, for example the amount of waste burned by an incinerator, or the number of vehicle-miles traveled by trucks. Then, using the data available from actual measurements of emissions, one can derive for a given source class an emission factor -- i.e., the amount of PCDD/PCDF or HCB that such a source emits per unit amount of throughput. The annual emission is then given by the product of the annual throughput and the emission factor.

In the case of individually identified sources (e.g. municipal waste incinerators), data on each facility's throughput (tons of waste burned per year) were available or could be

Table I. Characteristics of Airborne Sources

Class	Type	Air Pollution Control Equip. (1)	Number of Sources (2)			Annual Throughput (grams/year or veh-km/year) (3)		PCDD/PCDF Emissions Factors (grams TEQ emitted per gram or veh-km of throughput)			HCB Emissions Factors (grams HCB emitted per gram or veh-km of throughput)		
			USA	CAN	TOT	USA	CAN	MIN	AVG	MAX	MIN	AVG	MAX
Municipal Waste Incinerators	Mass Burn Refractory Wall	none	6	0	6	1.77e+11	0.00	1.3e-11	1.5e-11	1.7e-11	3.3e-09	1.0e-08	3.3e-08
		DS/FF	1	0	1	2.10e+10	0.00	5.0e-14	5.9e-13	2.1e-12	1.4e-08	4.4e-08	1.4e-07
		ESP	7	0	7	1.50e+12	0.00	1.7e-10	7.8e-10	1.6e-09	1.4e-08	4.4e-08	1.4e-07
		DS/ESP	1	0	1	1.05e+11	0.00	1.7e-10	7.8e-10	1.6e-09	1.4e-08	4.4e-08	1.4e-07
	Mass Burn Waterwall	none	2	1	3	1.54e+11	2.01e+10	1.3e-11	1.5e-11	1.7e-11	3.3e-09	1.0e-08	3.3e-08
		DS/FF	31	4	35	9.71e+12	6.25e+11	5.0e-14	5.9e-13	2.1e-12	1.4e-08	4.4e-08	1.4e-07
		ESP	16	1	17	4.64e+12	1.93e+11	2.6e-12	1.1e-11	4.0e-11	1.4e-08	4.4e-08	1.4e-07
		DS/ESP	9	0	9	2.98e+12	0.00	3.1e-12	8.8e-12	2.0e-11	1.4e-08	4.4e-08	1.4e-07
	Mass Burn Rotary Kiln	DS/FF	7	1	8	1.46e+12	7.27e+09	2.8e-13	8.8e-13	1.4e-12	1.4e-08	4.4e-08	1.4e-07
		ESP	3	0	3	3.01e+11	0.00	2.6e-12	1.1e-11	4.0e-11	1.4e-08	4.4e-08	1.4e-07
	Refuse Derived Fuel (RDF)	none	6	0	6	4.18e+11	0.00	1.3e-11	1.5e-11	1.7e-11	3.3e-09	1.0e-08	3.3e-08
		DS/FF	13	0	13	3.15e+12	0.00	4.5e-14	2.3e-13	3.9e-13	9.2e-09	2.9e-08	9.2e-08
		ESP	11	0	11	3.02e+12	0.00	5.9e-12	1.7e-10	4.1e-10	9.2e-09	2.9e-08	9.2e-08
		DS/ESP	4	0	4	1.75e+12	0.00	3.9e-13	8.2e-13	1.4e-12	9.2e-09	2.9e-08	9.2e-08
	Modular/ Starved Air	no apcd	28	7	35	2.79e+11	6.53e+10	1.3e-11	1.5e-11	1.7e-11	3.3e-09	1.0e-08	3.3e-08
		DS/FF	8	3	11	3.63e+11	1.47e+11	1.3e-11	1.5e-11	1.7e-11	3.3e-09	1.0e-08	3.3e-08
		ESP	16	0	16	6.58e+11	0.00	2.0e-11	2.9e-11	4.5e-11	3.3e-09	1.0e-08	3.3e-08
		DS/ESP	1	0	1	9.64e+10	0.00	2.0e-11	2.9e-11	4.5e-11	3.3e-09	1.0e-08	3.3e-08
	Modular/ Excess Air	none	2	0	2	1.25e+10	0.00	1.3e-11	1.5e-11	1.7e-11	3.3e-09	1.0e-08	3.3e-08
		ESP	3	0	3	2.36e+11	0.00	5.3e-12	2.1e-11	4.0e-11	3.3e-09	1.0e-08	3.3e-08
		DS/ESP	4	0	4	1.58e+11	0.00	5.3e-12	2.1e-11	4.0e-11	3.3e-09	1.0e-08	3.3e-08
	Total	Total	179	17	196	3.12e+13	1.06e+12						

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Class	Type	Air Pollution Control Equip. (1)	Number of Sources (2)			Annual Throughput (grams/year or veh-km/year) (3)		PCDD/PCDF Emissions Factors (grams TEQ emitted per gram or veh-km of throughput)			HCB Emissions Factors (grams HCB emitted per gram or veh-km of throughput)		
			USA	CAN	TOT	USA	CAN	MIN	AVG	MAX	MIN	AVG	MAX
Medical Waste Incin.	all types	none	51	12	63	3.71e+12	7.94e+10	4.4e-10	1.1e-09	3.7e-09	4.3e-09	1.9e-08	3.8e-08
Sec Copper Smelters	all types	typical	6	2	8	3.51e+11	1.12e+11	2.5e-10	7.8e-10	2.5e-09	3.9e-09	3.9e-08	3.9e-07
Sec Copper Refiners	all types	typical	7	0	7	3.71e+11	0.00	5.4e-12	1.7e-11	5.4e-11	3.3e-10	3.3e-09	3.3e-08
Sewage Sludge Incin.	all types	typical	208	9	217	8.65e+11	1.31e+11	1.9e-12	2.8e-11	7.4e-11	5.0e-08	5.0e-07	5.0e-06
Coal Combustion	all types	typical	51	12	63	8.13e+14	4.85e+13	4.9e-14	2.5e-13	4.9e-13	3.1e-12	1.6e-11	3.1e-11
Wood Combustion	all types	typical	51	12	63	2.41e+14	3.06e+13	3.0e-13	9.6e-13	3.0e-12	1.9e-11	6.0e-11	1.9e-10
Mobile Sources	Diesel Fuel	typical	50	12	62	2.43e+11	6.86e+09	1.6e-10	5.0e-10	1.6e-09	6.6e-09	2.1e-08	6.6e-08
Mobile Sources	Unleaded Gasoline	typical	50	12	62	3.49e+12	1.37e+11	1.1e-13	3.6e-13	1.1e-12	7.3e-12	2.4e-11	7.6e-11
Mobile Sources	Leaded Gasoline	typical	50	12	62	1.84e+11	7.23e+09	1.1e-12	1.1e-11	1.1e-10	8.7e-11	8.7e-10	8.6e-09
HCB-contam. pesticide use	all types	none	51	12	63	7.01e+06	5.82e+05	0.0	0.0	0.0	5.0e-01	7.5e-01	1.0e+00
Hazardous Waste Incin.	all types	typical	263	7	270	2.93e+12	3.61e+11	7.5e-12	2.4e-11	7.5e-11	1.0e-08	7.1e-08	5.0e-07
HCB waste incin.	from Prodn. of Carbon Tetrachloride	typical	5	1	6	7.91e+08	6.22e+07	4.7e-11	1.5e-10	4.7e-10	1.0e-05	1.0e-04	1.0e-03
HCB waste incin.	from Prodn. of Tetrachloroethylene	typical	4	0	4	1.39e+09	0.00	2.0e-11	6.4e-11	2.0e-10	1.0e-05	1.0e-04	1.0e-03
HCB waste incin	from Prodn. of Trichloroethylene	typical	2	0	2	1.18e+08	0.00	1.5e-10	4.7e-10	1.5e-09	1.0e-05	1.0e-04	1.0e-03
HCB waste incin	from Prodn. of Vinyl Chloride Monomer	typical	12	1	13	1.20e+10	3.59e+08	6.8e-11	2.1e-10	6.8e-10	1.0e-05	1.0e-04	1.0e-03
HCB waste incin	from Prodn. of Monochlorobenzene	typical	3	0	3	3.08e+08	0.00	6.0e-11	1.9e-10	6.0e-10	1.0e-05	1.0e-04	1.0e-03
HCB waste incin	from Prodn. of o-Dichlorobenzene	typical	3	0	3	7.53e+07	0.00	6.0e-11	1.9e-10	6.0e-10	1.0e-05	1.0e-04	1.0e-03
HCB waste incin	from Prodn. of p-Dichlorobenzene	typical	3	0	3	1.22e+08	0.00	6.0e-11	1.9e-10	6.0e-10	1.0e-05	1.0e-04	1.0e-03
HCB waste incin	from Prodn. of 1,2,4-Trichlorobenzene	typical	2	0	2	1.90e+08	0.00	6.0e-11	1.9e-10	6.0e-10	1.0e-05	1.0e-04	1.0e-03

Table I. Characteristics of Airborne Sources

Class	Type	Air Pollution Control Equip. (1)	Number of Sources (2)			Annual Throughput (grams/year or veh-km/year) (3)		PCDD/PCDF Emissions Factors (grams TEQ emitted per gram or veh-km of throughput)			HCB Emissions Factors (grams HCB emitted per gram or veh-km of throughput)		
			USA	CAN	TOT	USA	CAN	MIN	AVG	MAX	MIN	AVG	MAX
Cement and Aggregate Kilns	burning Hazardous Waste	typical	28	2	30	1.82e+13	2.03e+12	6.2e-12	2.0e-11	6.2e-11	7.2e-09	5.1e-08	3.6e-07
Cement and Aggregate Kilns	not burning Hazardous Waste	typical	97	18	115	5.79e+13	8.71e+12	7.9e-13	2.5e-12	7.9e-12	9.3e-10	6.6e-09	4.6e-08
Iron Sintering	all types	typical	10	2	12	8.69e+12	6.44e+11	7.6e-12	2.4e-11	7.6e-11	4.8e-10	1.5e-09	4.8e-09
TOTAL			1186	143	1329								

NOTES:

(1) "DS" = dry scrubber; "FF" = fabric filter; "ESP" = electrostatic precipitator

(2) The number of source locations presented in this table for certain of the "grouped" source categories (i.e., medical waste incin., mobile sources, and hcb-contaminated pesticide use) are the totals after they were re-aggregated back to "entire state" or "entire province" basis. In actuality, 80 additional locations were originally modeled for medical waste incineration and each of the types of mobile sources, corresponding to the addition of large metropolitan areas, and 8 additional locations were modeled for hcb-contaminated pesticide use, corresponding to certain agricultural regions in Canada. The results of these more localized calculations were then aggregated and have been expresseed uniformly on a state-wide or province-wide basis throughout this report.

(3) Regarding the throughput, the amounts expressed have the following meanings:

(a) for municipal waste, medical waste, sewage sludge, and hazardous waste incinerators, and for coal and wood combustion, it is the amount of material burned per year;

(b) for secondary copper refiners and smelters, iron sintering plants, and cement and aggregate kilns (incl. those burning haz. waste), it is the amount of product produced or processed per year;

(c) for mobile sources the "throughput" is the number of vehicle-kilometers traveled;

(d) for HCB-contaminated pesticide use, it is the application rate of HCB (estimated from the usage rate of significantly contaminated pesticides and amount of HCB contained in each of the pesticides);

(e) for HCB waste incineration, it is the estimated total amount of HCB in the wastes from the indicated chemical manufacturing process.

estimated from capacity information. As noted above, for certain classes of sources, throughput data on individual sources -- and often, even their locations -- are unavailable at present, and it was necessary to deal with them collectively, on a state-by-state (or province) basis.

Thus, the amount of medical waste incinerated in each state was estimated from the total U.S. value reported in the U.S. EPA risk assessment (U.S. EPA, 1994A, p. 3-111), divided according to each state's population. In a few states information about the number and/or capacity of medical waste incinerators was available. This information was used to modify the population-based estimate, and the remaining state values were adjusted so that our estimate of the total amount of medical waste burned nationally was equal to the U.S. EPA national estimate. The amounts of medical waste burned in the Canadian provinces was estimated from incinerator capacity data provided by the various provincial agencies, using the U.S. EPA's estimates of the usage of different types of facilities (i.e., usage as percent of capacity).

A similar approach was used to estimate the throughput of other non-localized sources. Pesticide use was estimated by state or province from agricultural statistics. For industrial burning of coal and wood, throughput was estimated from relevant state-by-state or provincial annual consumption data (e.g. tons of coal). For mobile sources (i.e., trucks), throughput was given by fuel consumption or vehicle-miles traveled.

For the purpose of estimating the fraction of the total national emissions that reach the Great Lakes, it is, of course, necessary to characterize each source by location, so that the effect of dispersion and transport between the source and the Great Lakes can be evaluated. Where it was possible to identify specific sources (e.g. individual municipal waste incinerators), each has been localized, from its address, by latitude and longitude. For the other source classes, the locality of the sources in a given state or province is defined as the latitude and longitude of the state or province geographic center, or in some cases of regional or metropolitan centers as well.

In sum, we have identified, located, and characterized a total of 1329 airborne sources, of which 954 are individual facilities and 375 are based on whole states or provinces, and -- in the case of medical waste incinerators and mobile sources -- on metropolitan areas within them as well. A complete list of all sources, their geographic location, and throughput can be found in the Appendix.

3. <u>Emission factors</u>:

In order to estimate the source's annual emissions of the targeted pollutants, the throughput is multiplied by an appropriate emission factor -- i.e., the amount of emitted material generated per unit throughput (e.g. grams of PCDD/PCDF emitted per ton of municipal solid waste burned). Emission factors were estimated from the relevant literature for each source class. In a few of the source classes -- for which detailed data were available -- emission factors were further specified for subclasses that differ with respect to the type of emission control device or process employed.

While such emissions factors are based on measured emissions from specific facilities, it is important to point out their limitations. First, for all source classes, actual measurements of PCDD/PCDF or HCB emissions have been made at only very few of the existing individual facilities. In addition, the few data that do exist show that there can be large differences in emissions factors between similar facilities, and from the same facility over time. Thus, for a given type of source, the actual data provide a wide range of values for the emission factor, and the reasons for such wide variations may be unknown or unreported. Thus, an average value may not accurately characterize the emissions from a specific individual facility. For example, two recent measurements of PCDD/PCDF emissions from the Columbus, Ohio, municipal waste incinerator yielded emissions of 1000 g TEQ/year and 200 g TEQ/year, apparently because of an originally unreported difference in the fuel input. Our use of the U.S. EPA emissions factors for this incinerator resulted in an estimate of about 100 g TEQ/year, with a range of 3-240 g TEQ/ year. Obviously, the actual emission factor might be much higher.

The range of variation and the mean values employed in our computations are reported in Table I for the different source classes. A comparison of the factors that we used with those of the U.S. EPA is tabulated in Table III. This shows that we relied on the U.S. EPA's recent estimates of PCDD/PCDF emissions factors (U.S. EPA, 1994A) for many source classes, although not for all of them. The uncertainties noted above apply to the U.S. EPA estimates despite their "official" origin. Clearly, there is an urgent need for more numerous and more frequently repeated measurements of emissions.

4. Total national emissions:

From the compiled lists of U.S. and Canadian sources, their estimated throughputs and emission factors, it is possible to estimate the total annual emissions of the targeted pollutants. The national emissions of PCDD/PCDF and HCB from the various classes of sources are shown in Tables IIA and IIB. The PCDD/PCDF values are similar to those recently reported in the U.S. EPA dioxin risk assessment, and in other assessments of PCDD/PCDF emissions (Schaum et al, 1993; Thomas and Spiro, 1994; Thornton, 1994). Table III compares the mid-point values of throughput, PCDD/PCDF emission factors, and national emissions used in the U.S. EPA dioxin risk assessment with our own, and briefly summarizes the differences between them.

Our estimates of national emissions from municipal and medical waste incinerators are significantly less than U.S. EPA's -- in the first case because different congener profiles were used, and in the second case because our source inventory was later than EPA's and took into account recently closed incinerators with high emissions. In other cases, our more recent information -- for example on throughput of cement kilns -- resulted in a larger emissions estimate than EPA's. In one case, iron sintering plants, which are not included in

Table II-A. Estimated Annual Air Emissions of PCDD/PCDF (TEQ) from Sources in the United States and Canada (1993)			
Source Class	**Midpoint Value of Emissions (g TEQ/yr)**	**Range of Emissions (low - high) (g TEQ/yr)**	**Percent of Total Midpoint Emissions**
Medical Waste Incinerators (*)	4,300	1,700 - 14,000	53%
Municipal Waste Incinerators	1,900	350 - 4,200	24%
Cement and Aggregate Kilns Burning Hazardous Waste	400	130 - 1,300	4.9%
Secondary Copper Smelters	360	110 - 1,100	4.5%
Wood Combustion	260	80 - 820	3.2%
Iron Sintering Plants	230	70 - 710	2.8%
Coal Combustion	210	40 - 430	2.6%
Cement and Aggregate Kilns Not Burning Hazardous Waste	170	50 - 530	2.1%
Heavy Duty Diesel Vehicles	120	40 - 390	1.5%
Hazardous Waste Incinerators, (not including haz. waste burned in cement/aggregate kilns or HCB waste incineration)	80	20 - 250	1.0%
Sewage Sludge Incinerators	30	2 - 70	0.3%
Secondary Copper Refiners	6	2 - 20	0.08%
Incineration of Waste from Chemical Manufacturing Contaminated with HCB	3	1 - 10	0.04%
Vehicles Using Leaded Gasoline	2	0.2 - 20	0.03%
Vehicles Using Unleaded Gasoline	1	0.4 - 4	0.02%
Total	8,100	2,600 - 24,000	100%

(*) The emissions estimates for medical waste incineration have been based, essentially, on the U.S. EPA's estimate of the amount of medical waste burned in the U.S. and their recommended emissions factors, which were based on their evaluation of emissions data (U.S. EPA 1994A). We used a slightly different emissions factor, representing a different emitted congener profile, which reduced our emissions estimate by 17.6% relative to the U.S. EPA estimate. The American Hospital Association (AHA) has submitted comments to the U.S. EPA in response to the Draft Dioxin Exposure Assessment claiming that the emissions from medical waste incinerators are substantially less than these estimates for two main reasons: (a) they claim that less medical waste is being burned than estimated by the U.S. EPA; and (b), that the average emissions factor used by the U.S. EPA (which was based on the assumption of no pollution control) is too high because they claim that a significant portion of the waste is now burned in incinerators with pollution control equipment. At this time, we are unable to evaluate the validity of the AHA's new estimates, since the primary data on which they are based are not yet accessible to us.

Table II-B. Estimated Annual Air Emissions of Hexachlorobenzene from Sources in the United States and Canada (1993)			
Source Class	**Midpoint Value of Emissions (kg/yr)**	**Range of Emissions (low-high) (kg/yr)**	**Percent of Total Midpoint Emissions**
Use of HCB-Contaminated Pesticides (*)	5,700	3,800 - 7,600	55%
Incineration of HCB-Contaminated Waste from Chemical Manufacturing	1,500	150 - 15,000	15%
Municipal Waste Incinerators	1,200	400 - 3,900	12%
Cement Kilns Burning Haz. Waste	1,000	140 - 7,200	10%
Cement Kilns Not Burning Haz Waste	440	60 - 3,100	4%
Other Hazardous Waste Incineration Processes	230	30 - 1,600	2%
Sewage Sludge Incinerators	80	8 - 800	0.8%
Medical Waste Incinerators	70	16 - 140	0.7%
Secondary Copper Smelters	18	2 - 180	0.2%
Wood Combustion	16	5 - 50	0.2%
Iron Sintering Plants	14	5 - 45	0.1%
Coal Combustion	13	3 - 27	0.1%
Heavy Duty Diesel Vehicles	5	2 - 17	0.05%
Secondary Copper Refiners	1	0.1 - 12	0.01%
Vehicles Using Leaded Gasoline	0.2	0.02 - 1.6	0.002%
Vehicles Using Unleaded Gasoline	0.1	0.03 - 0.3	0.001%
Total	10,400	4,600 - 40,000	100%

* The pesticides which are primarily responsible for these emissions, because of their hexachlorobenzene contamination, are the following (in order of importance): **Dimethyl Tetrachloroterephthalate (DCPA)**, an herbicide; **Chlorothalonil**, a fungicide; **Pentachloronitrobenzene** (PCNB), a fungicide; **Pentachlorophenol**, a wood preservative; **Picloram**, an herbicide; and **Atrazine** and **Simazine**, both herbicides.

SOURCE CLASS	Source Throughput (grams per year) (mobile: veh-km/yr)		Emissions Factor (g TEQ/g processed) (mobile: g TEQ/km)		Emissions (g TEQ/yr)		Explanation of Difference between EPA and CBNS Estimates
	CBNS	EPA	CBNS	EPA	CBNS	EPA	
Medical Waste Incin.	3.71e+12	3.72e+12	1.14e-09	1.36e-09	4,200	5,100	different congener profile used; also: see note on page 10
Municipal Solid Waste Incin.	3.12e+13	2.94e+13	5.92e-11	1.02e-10	1,900	3,000	CBNS inventory reflected closing of some of the most polluting incinerators
Wood Combustion	2.41e+14	1.24e+14	9.58e-13	2.93e-12	230	360	CBNS overall combustion total twice as high as EPA used; CBNS used lower overal emissions factor because EPA based their wood burning factor partly on the burning of saltwater-soaked wood.
Secondary Copper Smelting & Refining	7.22e+11	3.00e+11	4.40e-10	7.70e-10	280	230	CBNS divided category into smelting and refining, and used more recent data on throughput; CBNS used a lower emissions factor for the refining portion of the industry
Coal Combustion	8.13e+14	7.00e+14	2.47e-13	< 4.22e-13	200	< 300	EPA's estimate is an upper bound; thus the two estimates are consistent
Cement Kilns burning Hazardous Waste	1.82e+13	1.06e+13	1.95e-11	1.95e-11	360	210	CBNS used a higher, more up-to-date estimate of throughput, included aggregate kilns in its estimate, and did the estimate on a facility-by-facility basis; EPA assumed that all cement kilns were the same size, and thus did not account for the fact that the ones burning hazardous waste are larger than average.
Iron Sintering	8.69e+12		2.41e-11		210		EPA did not make an estimate for this source; CBNS used European emissions factor data and U.S. througput data to make an estimate for the U.S.
Cement Kilns not burning haz. waste	6.43e+13	5.54e+13	2.52e-12	2.52e-12	150	140	CBNS used a higher, more up-to-date estimate of throughput, included aggregate kilns in its estimate, and did the estimate on a facility-by-facility basis.
Mobile Sources: diesel fuel	2.40e+11	1.71e+11	5.00e-10	5.00e-10	120	85	CBNS had a higher throughput estimate
Forest Fires		8.60e+13		1.00e-12		86	CBNS did not include this "source"
Hazardous Waste Incineration	3.06e+12	1.30e+12	2.36e-11	2.71e-11	72	35	The amount of hazardous waste burned in the U.S. is not well characterized. The primary difference in the two estimates is that CBNS used a much higher throughput amount, which is believed to be based on more recent, more comprehensive data.
Sewage Sludge Incin.	8.65e+11	8.65e+11	2.78e-11	2.69e-11	24	23	The two estimates are essentially the same
Kraft Black Liq. Incin.		2.82e+13		9.71e-14		2.7	CBNS did not include this source, because it was so reportedly insignificant
Mobile Sources: leaded fuel	1.80e+11	1.74e+11	1.09e-11	1.09e-11	2.0	1.9	The two estimates are essentially the same
Drum and Barrel Incin.		1.09e+11		1.65e-11		1.7	CBNS did not include this source, because it was so reportedly insignificant
Sec. Lead Smelting & Ref.		8.60e+11		1.86e-12		1.6	CBNS did not include this source, because it was so reportedly insignificant
Mobile Sources: unleaded fuel	3.50e+12	3.29e+12	3.60e-13	3.60e-13	1.3	1.3	The two estimates are essentially the same
Tire Combustion		5.00e+11		5.42e-13		0.3	CBNS included these facility's emissions with municipal waste incinerator emissions
Carbon Reactivation Furnaces		4.80e+10		2.98e-12		0.1	CBNS did not include this source, because it was so reportedly insignificant
TOTAL					7,800	< 9500	The main difference arises from the differences, described above, in the emissions estimates for medical waste incinerators and municipal waste incinerators.

Table III. COMPARISON OF PCDD/PCDF EMISSIONS ESTIMATES for SOURCES in the UNITED STATES the U.S. EPA estimates, we used an emission estimate based on the throughput of U.S. plants and emission factors derived from tests of German plants (no U.S. plants have been tested as yet). These comparisons emphasize that, in the absence of sufficient direct measurements of PCDD/PCDF emissions, such estimates inevitably reflect uncertainties in the relevant data, especially regarding emission factors.

The major airborne sources of PCDD/PCDF are medical and municipal waste incinerators, which together account for 77% of our estimate of the total U.S. and Canadian airborne emissions. The major airborne sources of HCB are pesticides, incinerators that burn HCB, municipal waste incinerators, and cement kilns that burn hazardous waste, which together account for about 90% of the total emissions.

5. <u>Air transport/deposition model</u>:

The amounts of PCDD/PCDF or HCB generated by a source that reaches the Great Lakes is a function of the amount emitted at the source and the amount deposited or destroyed in transit. Transport, deposition and destruction of pollutants emitted into the air comprise a series of interacting processes: the path of transport (advection) of the material (in three dimensions) from its initial point of emission to each of the Great Lakes, as determined by weather conditions; the degree of dispersion (i.e. physical spread) of the material as it is transported; the amount of material deposited to ground level in the space between the point of emission and the Great Lakes (which will thereby diminish the amount available for deposition at the lake); the chemical or photochemical transformations that destroy the pollutant during transport; the influence of the physical state of the material (e.g. whether in the vapor phase or adsorbed on a particle) on its transport, dispersion, deposition and destruction; the weather conditions in the region traversed between the source and the Great Lakes that influence the material's physical state (e.g. the effect of ambient temperature on vapor/particle partitioning); the influence of terrain on transport and deposition.

All of these factors determine the proportion of the material emitted at the source that eventually arrives in the air over each of the Great Lakes and is therefore capable of being deposited there. At that point, several factors will govern the degree to which the material is actually deposited from the air into the lake. These include: the physical state of the material -- i.e., the extent to which it is in the vapor phase or associated with various-sized atmospheric particles (which differ in their rate of deposition); local weather conditions -- i.e., temperature and whether it is dry, raining or snowing; vertical and horizontal wind velocity.

We have employed the HYSPLIT (Hybrid Single Particle Lagrangian Integrated Trajectory) computer model developed by the National Oceanic and Atmospheric Administration (NOAA) as the basis for the analysis of transport, dispersion, deposition and destruction (Draxler 1992, 1994). The model was kindly provided by Dr. Roland Draxler, of the NOAA staff, who also helped a great deal in resolving difficulties that arose as we adapted the model to our purpose.

The HYSPLIT model incorporates, in considerable detail, actual weather data for the United States and southern Canada. It includes meteorological data for a three-dimensional grid of points 182.9 km apart horizontally, with six atmospheric layers vertically (up to 3000 meters), tabulated at two-hour intervals. NOAA has developed data for the years 1988-1993 for use with the program; we chose 1993 for our analysis. Consequently, all of the results on airborne PCDD/PCDF and HCB reported below reflect processes as they would have occurred in 1993.

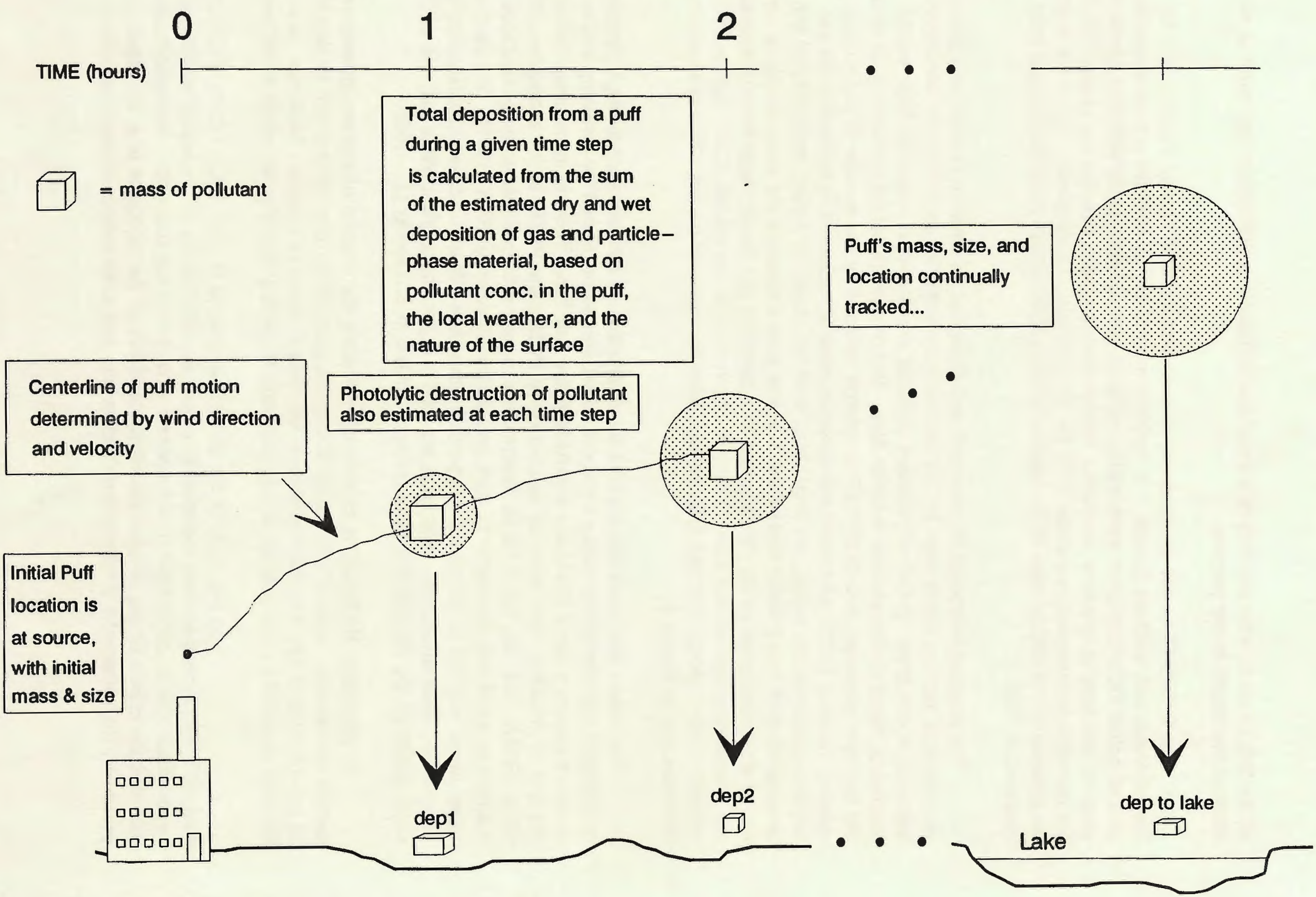
The program computes the transport and dispersion of material emitted at a given geographical location (designated by latitude and longitude), by estimating the atmospheric behavior of one gram "puffs" of pollution (injected into the air at intervals from source locations), based on the detailed weather data. The computational time necessary to model the transport processes with HYSPLIT is strongly affected by the number of puffs being tracked, for each puff's movement and behavior must be estimated individually. In our implementation of the model, we found that, over the course of a year, emissions of one seven-gram puff every seven hours from a source gave essentially the same results as hourly emissions of one-gram puffs. We adopted this approach and thereby significantly decreased the necessary computational time. Thus, in our version of the model, 1,250 such puffs were emitted at each source site, and then tracked, over the one-year period. This is shown schematically in Figure 1.

The model also takes into account the destruction of the substance through photolytic or chemical transformation during transport. This was accomplished by assigning to the modeled species a vapor phase and a particle-phase half-life. There is uncertainty concerning the rate of photolytic and chemical destruction of PCDD and PCDF in the atmosphere (U.S. EPA, 1994A, Vol. II), but there is, nevertheless, strong evidence that particle-associated material is much less vulnerable to such destruction (Koester & Hites, 1992). We used a vapor phase half-life of one day and a particle phase half-life of 10 days to characterize the behavior of these substances. For HCB we used a vapor and particle phase half-life of 700 days, based on the relevant literature (as summarized in Mackay et al., 1992).

In operation, HYSPLIT is capable of estimating the fraction of a given gaseous or particulate material, emitted into the air at a given geographic location that will be deposited to ground level at any specified location in the United States or Canada. However, to obtain the data required by this project, it was necessary to modify the original model as follows:

a) For each of the species considered (e.g. 2,3,7,8-TCDD, HCB), the basic HYSPLIT program was modified to reflect the distribution of the substance between the vapor phase and its attachment to atmospheric particles during transport. The modification included the effects of the physico-chemical properties of the substance (e.g. its vapor pressure), the nature of the atmospheric particulate, and temperature on vapor/particle

Figure 1. Air Transport and Deposition Model



partitioning. The different substances considered in our analysis have very different vapor/particle partitioning characteristics (Junge, 1977; Bidleman, 1988; U.S. EPA, 1994A). For example, at 63°F, 2,3,7,8-TCDD is about equally divided between the vapor phase and particles; 2,3,4,7,8-PeCDF is 20% in the vapor phase and 80% on particles; OCDD is almost entirely adsorbed on particles; and HCB is almost entirely in the vapor phase. In turn, the vapor/particle partitioning will influence the transport, deposition and destruction of the substances.

b) In order to estimate the deposition to the Great Lakes from sources in close proximity to them, it was necessary to modify HYSPLIT so that it determined the degree to which each puff of material overlapped with the area of a given lake.

The overall operation of the modified HYSPLIT model is diagrammed in Figure 2. Beginning with the emission of an initial 7 g puff of material, the program computes the transport, dispersion, and destruction of the material over a one-hour period, at the end of which the puff's new location, size and mass, and the amount of material deposited to the ground, are recorded. At the same time, the program determines the degree to which the area represented by the size of the puff overlaps with the area of the lake, and the amount of the material deposited into it is thereby computed and recorded. This cycle is repeated hourly over the entire year. Puffs are emitted at seven-hour intervals over the entire year, and all of them are tracked separately by the model.

The modified HYSPLIT program is therefore capable of the following basic operation: For a given substance (e.g. 2,3,7,8-TCDD or HCB), characterized with respect to its temperature-dependent vapor/particle partitioning, periodically emitted in the form of "puffs" into the air at any location, the model will compute the airborne concentration and the amount of the material deposited at any other location over time. The results of these calculations can be expressed as the percent of the emitted material that is deposited at a given second location over the one-year period; we use the term air transfer coefficient (ATC) to designate this value.

For the purpose of this project, the model was run initially for emissions of 2,3,7,8-TCDD and HCB at 25 locations in the United States and Canada. These "standard" emission locations were selected to reflect the expected importance of sources near them; they were therefore more concentrated near the Great Lakes and most were located at metropolitan areas, where two major sources -- municipal and medical waste incinerators -- are common. Each run computed the fraction of the material emitted at each of the 25 locations that was deposited over the area of each of the five Great Lakes -- i.e., the air transfer coefficient. The results of these runs are illustrated for Lake Michigan in Figures 3A and 3B. As expected, the lake receives a higher percentage of the emissions from nearby source sites than from distant ones. The values also reflect the general wind directions; i.e., west to east, and southwest to northeast. For the same site, the fraction of emitted HCB that is deposited in the lake is greater than that of 2,3,7,8-TCDD, which is more readily subject to photolytic destruction.

Figure 2. Modified HYSPLIT Program

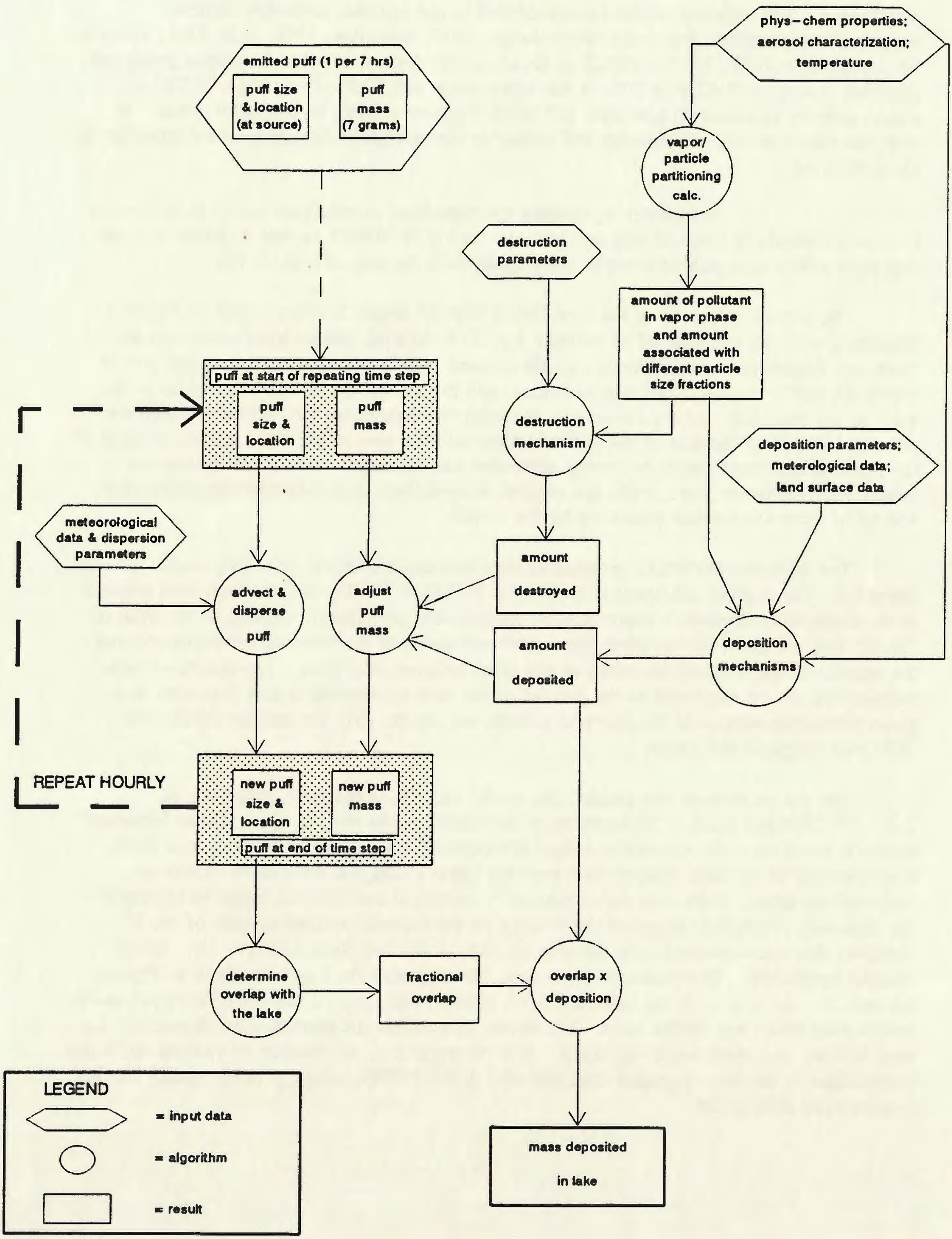


Fig. 3A:

AIR TRANSFER COEFFICIENTS DIRECTLY COMPUTED BY THE MODIFIED HYSPLIT PROGRAM

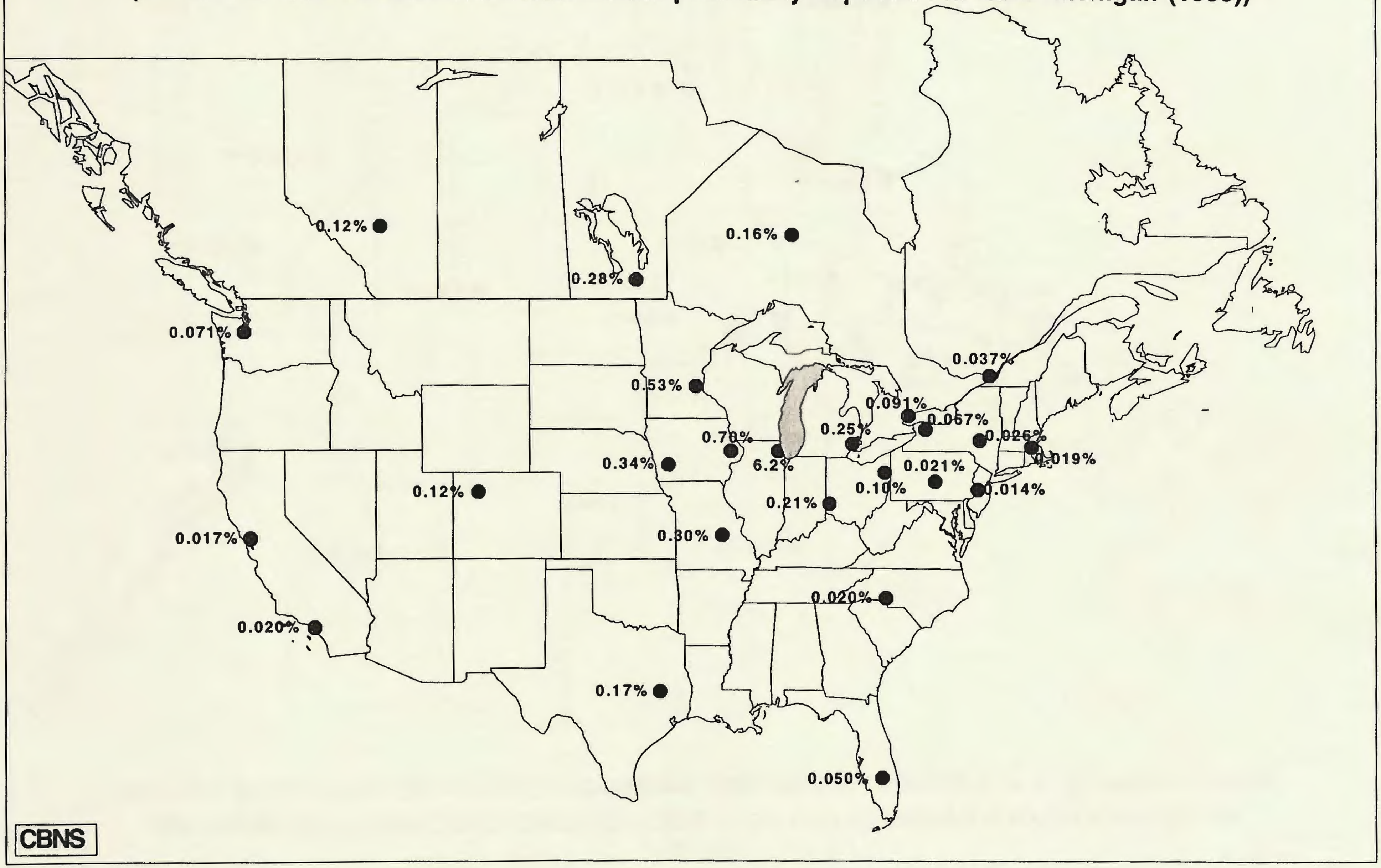
(Percent of 2,3,7,8-TCDD emitted at indicated sites that is deposited in L. Michigan (1993))

CBNS

Fig. 3B:

AIR TRANSFER COEFFICIENTS DIRECTLY COMPUTED BY THE MODIFIED HYSPLIT PROGRAM

(Percent of HCB emitted at indicated sites potentially deposited in Lake Michigan (1993))



Each such run required a significant amount of computational resources, so that without further development it would have been impractical to analyze the transport of the various substances from each of the 1329 source sites. In order to solve this problem, and at the same time carry out the computations needed to estimate source input data, a separate data-processing computer program was created: TRANSCO (Transfer Coefficient). This program, which is summarized in Figure 4, performs the following operations:

o **Generalized computation of air transfer coefficients**: An algorithm was developed that, using the ATC data from the 25 standard sites, computed the air transfer coefficient for any other emission site such as our identified sources. This was done by means of an interpolation that takes into account the relative distance between each of the four closest standard locations and the location of the identified source, and its angular orientation relative to the center-points of each of the five Great Lakes. This procedure enabled us to estimate the air transfer coefficients for each of the 1329 identified sources in the United States and southern Canada. Indeed, the interpolation procedure can be used to compute air transfer coefficients for <u>any</u> point of emission and <u>any</u> deposition site.

o **Computation of annual deposition**: Additional runs were made for 2,3,4,7,8-pentachloro-p-dibenzofuran (PeCDF), 1,2,3,4,7-pentachloro-dibenzo-p-dioxin (PeCDD), and octachloro-dibenzo-p-dioxin (OCDD) at a subset of the 25 standard points. The results showed that there was a systematic relationship between each congener's air transfer coefficient and its vapor/particle partitioning. This enabled us to enter factors for each of the PCDD and PCDF congeners into the TRANSCO program, so that it was then capable of estimating separate air transfer coefficients for each of them. In practice, the deposition of each of the 17 toxic PCDD/PCDF congeners and eight groups of non-toxic congeners was calculated separately for each source from data regarding the amounts emitted at the source and their separate air transfer coefficients.

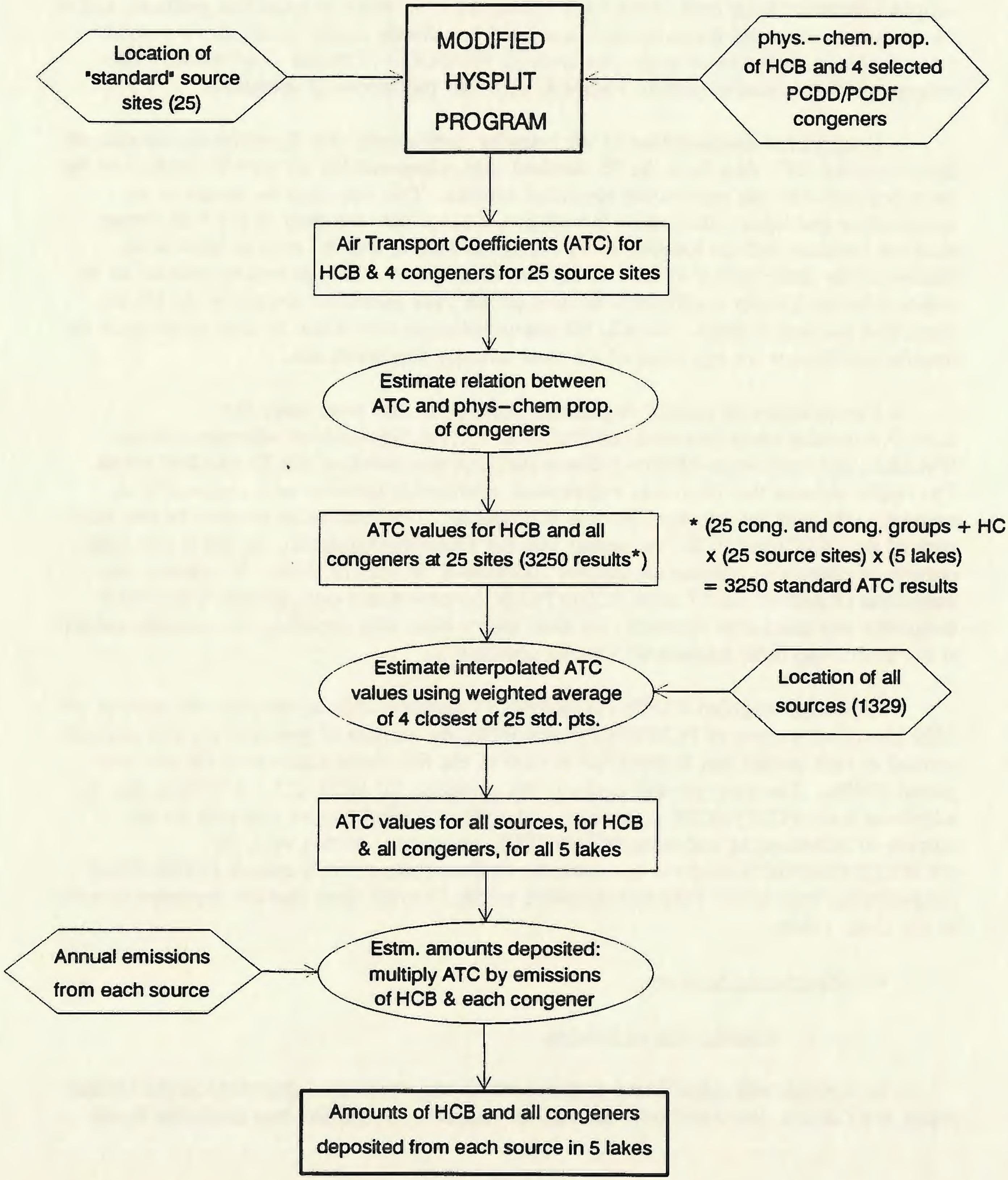
The entire modified HYSPLIT/TRANSCO system is able to compute, for each of the 1329 identified sources of PCDD/PCDF and HCB, the number of grams of a given material emitted at each source that is deposited in each of the five Great Lakes over the one-year period (1993). The program will perform this operation for HCB, 2,3,7,8-TCDD, the 16 additional toxic PCDD/PCDF congeners, and eight additional classes (grouped by the number of chlorines) of non-toxic PCDD/PCDF congeners. In this way, the HYSPLIT/TRANSCO program computes the total amounts of HCB and all PCDD/PCDF congeners (as well as the TEQ representative of the 17 toxic ones) that are deposited in each of the Great Lakes.

C. <u>Waterborne Sources</u>:

1. <u>Identification of sources</u>:

In contrast with the airborne sources, which may be located anywhere in the United States and Canada, the waterborne sources are restricted to facilities that discharge liquid

Figure 4. TRANSCO Program



effluent into the Great Lakes or into a river in the lakes' watersheds. The sources were identified from data regarding permits issued by the relevant U.S. and Canadian agencies. In the United States such facilities are subject to government permits from the U.S. EPA under the National Pollutant Discharge Elimination System (NPDES). Under this system, facilities are required to monitor the effluents and report the resulting data to state agencies and U.S. EPA. In Ontario, such facilities are regulated under the Environmental Protection Act of Ontario. As required by the Ontario Ministry of the Environment's Municipal-Industrial Strategy for Abatement (MISA) program, these facilities monitor their effluent streams.

The NPDES permits and MISA monitoring data provided us with an initial list of waterborne sources, including the following classes: pulp and paper mills; sewage treatment plants (generally abbreviated as "POTWs" for "publicly owned treatment works"); chemical plants; other industrial facilities. Data on pulp mills that discharge into the Great Lakes watershed were assembled from industry associations and state environmental agencies (see Table IV). Further information about the materials entering the Great Lakes can be obtained from measurements on the relevant rivers -- specifically the St. Clair/Detroit River system and the Niagara River/Welland Canal connecting channels -- where these are available.

2. Characterization of sources:

In the case of pulp and paper mills we estimated their contributions of PCDD/PCDF to the Great Lakes from measured concentrations in effluent and the water effluent flow rate for individual plants for 1993. These data were kindly provided to us by the National Council of the Paper Industry for Air and Stream Improvements for U.S. plants and the Ontario Forest Industries Association for Canadian plants. It was possible to estimate the loadings of PCDD/PCDF and HCB from POTWs by means of data on each facility's flow rate and emission factors derived from monitoring data on several POTWs in the Great Lakes watershed (Murray, 1994). Many industrial facilities discharge liquid effluents through POTWs.

Some monitoring data on the effluents from chemical and industrial facilities in Ontario are available, and were kindly supplied to us by the Ontario Ministry of Environment and Energy. Similar data for such sources in the United States are generally lacking. The few U.S. measurements for HCB and/or PCDD/PCDF that are available are for the most part reported as "not detected," with a relatively high detection limit. Aggregate data on the HCB loadings due to sources on the Niagara River (chiefly leachate from hazardous waste sites) and on the St. Clair/Detroit River system (chiefly chemical plants) can be roughly estimated from reported measurements of HCB concentrations in the river water (Environment Canada, 1994; Env. Canada and U.S. EPA, 1988). Data concerning PCDD/PCDF concentrations in the connecting channels are very limited.

The available data regarding the PCDD/PCDF and HCB content of the source effluents vary considerably either because tests for these substances were not made, or --

Table IV. Number of Quantified Sources of Waterborne PCDD/PCDF and HCB Entering the Great Lakes					
	Number of Sources Identified and Quantified				
Source Class	**Lake Superior**	**Lake Michigan**	**Lake Huron**	**Lake Erie**	**Lake Ontario**
Pulp and Paper Mills *	5	13	1	1	1
Chemical Manufacturers and other Industrial Plants **	1	1	2	14	6
Sewage Treatment Plants (POTWs)	105	347	257	578	272

* Only pulp and paper mills which use chlorine-containing chemicals (e.g., elemental chlorine, chlorine dioxide, sodium hypochlorite) in their processes have been included.

** Only facilities discharging directly to the lake or one of its tributaries for which data are available for <u>detected</u> levels of HCB and/or PCDD/PCDF in effluents have been included.

when they were -- they yielded non-detectable concentrations. However, non-detection cannot reasonably be regarded as evidence of zero concentration, for in some cases the reported detection limits appeared to be considerably above those characteristic of state-of-the-art methods.

These difficulties are often compounded by the effect of effluent water flow. In a number of instances, the flow rate was so high that pollutants present at levels just below the detection limit (hence reported as "non-detects") would nevertheless represent very significant amounts of material. As a result, the importance of many of the sources for which HCB and/or PCDD/PCDF were reported as non-detected is highly uncertain. If the actual concentration was at or near zero, then the source would truly be insignificant; if the concentration was in fact close to -- but below -- the detection limit, the source might be extremely important. Because of this problem and the apparent fact that no measurements of HCB or PCDD/PCDF discharges have been made at many potential sources, the assessment of waterborne loading of these chemicals to the Great Lakes is rather uncertain. These uncertainties apply as well to the data on PCDD/PCDF in the St. Clair/Detroit River and the Niagara River/Welland Canal systems.

3. Transport:

In the case of sources that emit effluent into a tributary river rather than directly into one of the Great Lakes, some of the emitted material is, of course, lost in transit. This may occur, for example, through the vaporization of HCB and the more volatile PCDDs/PCDFs. PCDD and PCDF are expected to be strongly associated with suspended sediments in water and hence correspondingly less available for volatilization. These substances are therefore likely to be carried downstream, with little loss. This view is supported by a recent Canadian study of biota contamination downstream of pulp and paper mills employing chlorine bleaching. Significant PCDD/PCDF concentrations were found in bottom-feeding fish at considerable distances (30 to 100 kilometers) downstream from the mills (Whittle et al., 1993).

In contrast, waterborne HCB is less likely to be adsorbed to sediment, and hence is available for volatilization. This fact, coupled with the relatively high vapor pressure and low water solubility of HCB, suggests that volatilization will result in a significant loss of HCB from rivers. One study estimated that the half-life of HCB in typical river systems was on the order of only 0.3 to 3 days (Zoeteman et al., 1980).

The fraction of HCB or PCDD/PCDF discharged from a given source into a tributary or connecting channel that is carried to a downstream lake (i.e., the water transfer coefficient) will, of course, depend on the distance between the two. It will also be influenced by certain characteristics of the river, e.g. water flow characteristics and the nature and quantity of suspended sediments. As a rough approximation, for screening purposes we have assumed that about 50% of HCB and 75% of PCDD/PCDF discharged into tributaries will be transported into the Great Lakes. While the accuracy of these assumed water transfer coefficients is obviously not very high, our analysis of the available data strongly suggests that in most cases the uncertainty in discharges from the facilities themselves is considerably greater. Thus, we believe that we have not greatly increased the level of uncertainty in loading to the Great Lakes by these rather simplified water transfer coefficient estimates.

III. RESULTS

A. Deposition of Airborne PCDD/PCDF and HCB:

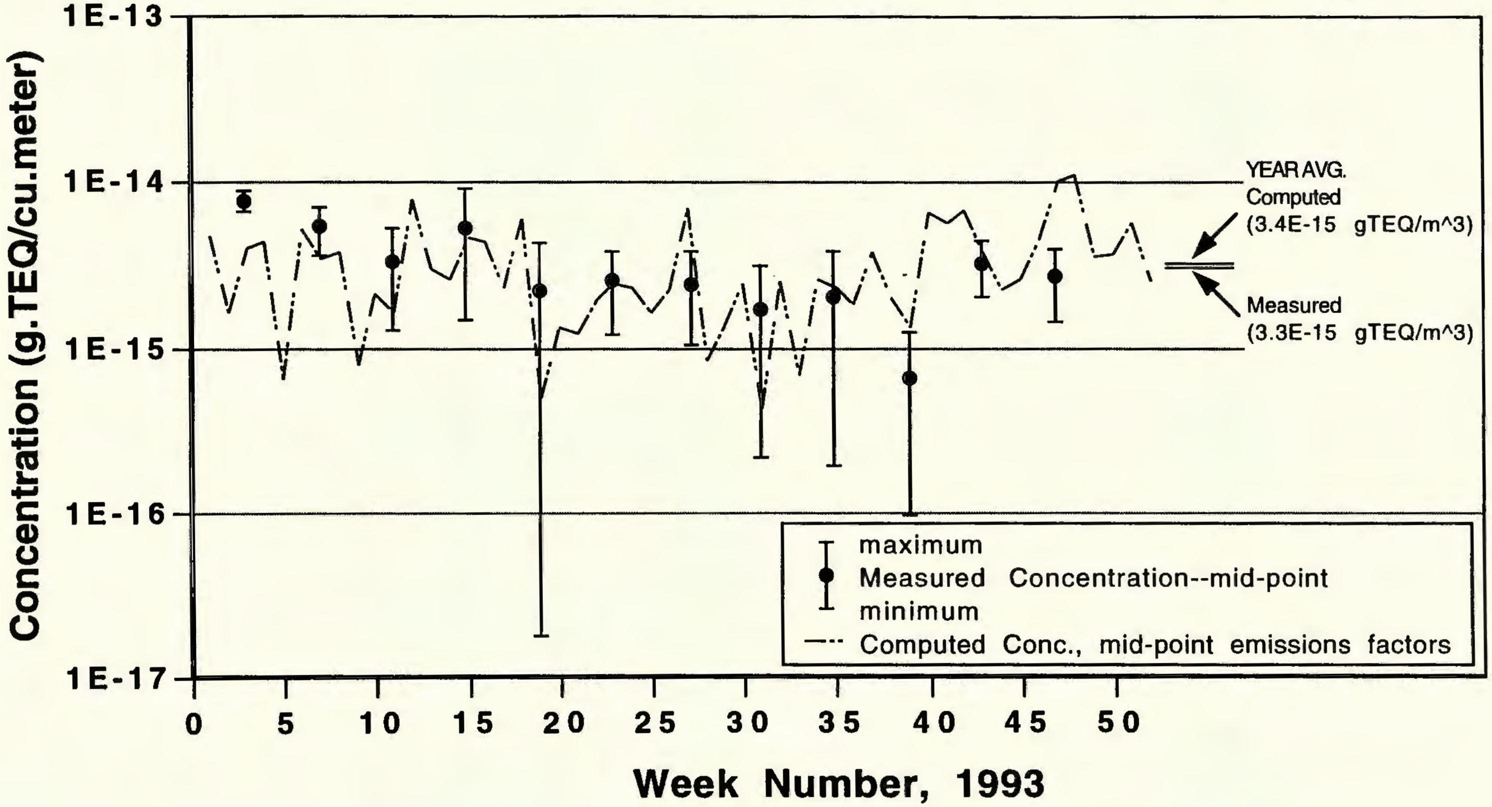
1. Comparison of computed and actual values:

The original HYSPLIT model has been validated by comparing its predictions with actual measurements of the movement of an experimental emission of a perfluorocarbon, as a tracer (Draxler 1992; Draxler et al., 1991A, 1991B). The model has also been successfully used to predict the dispersion and deposition of sulfur compounds emitted into the atmosphere from sources in the United States and Canada (Rolph et al., 1992, 1993). Given the modifications that we have made in the original model and the addition of the new data-processing operations, we have sought to assess the validity of the entire modified HYSPLIT/TRANSCO program. For this purpose the program was used to estimate the concentration (i.e., grams per m^3 of air) of the 17 toxic congeners of PCDD and PCDF, from all identified sources, expected at Dorset, Ontario, Canada, where ambient air concentrations of these congeners had been measured at monthly intervals throughout 1993 (OMOEE, 1994). This enabled us to compare the measured concentrations of the various congeners, expressed as total g TEQ per cubic meter of air, with those computed from the emissions of the 1329 sources by the HYSPLIT/TRANSCO programs.

As shown in Figure 5, the measured monthly values agree reasonably well with the concurrent weekly average concentrations computed by the model. When the average values for the entire year are compared, they are quite close: 3.28×10^{-15} g TEQ/m^3 for the actual measurements, and 3.40×10^{-15} g TEQ/m^3 for the HYSPLIT/TRANSCO computation.

This provides evidence that the HYSPLIT/TRANSCO system is capable of computing the concentration of PCDD/PCDF in the air with reasonable accuracy. However, a comparison of computed and measured concentrations in the air does not test the validity of the actual deposition of this material into the lakes. Nevertheless, the computed concentration of airborne PCDD/PCDF is itself dependent on the accuracy with which the HYSPLIT program predicts the deposition of these substances in the space between the point of emission and the Great Lakes. In this sense, therefore, the validity indicated by the comparison of actual and modeled concentrations of PCDD/PCDF extends to the estimates of the actual deposition into the lakes as well. In the same way, the agreement between the measured value and that computed by the HYSPLIT/TRANSCO program tends to confirm the validity of the emission factors used to compute each source's total emissions, and of the

Fig. 5: Measured vs. Computed Ambient Air Concentration of PCDD/PCDF (TEQ) at Dorset, Ontario (1993)



NOTE: The 12 measurement-based datapoints in this graph come from the ongoing ambient PCDD/PCDF monitoring program of the Ontario Ministry of Environment and Energy. The samples were collected over a 2-day period once per month and thus represent 2-day average values. In many of the samples, there were one or more of the toxic PCDD/PCDF congeners that were not detected. In order to estimate the TEQ associated with each of these samples, it is customary to assign a concentration value -- which could in actual fact range from zero to just below the detection limit -- to the congeners that were not detected. We have used the following procedure for this purpose: the minimum, maximum, and mid-point values of TEQ are computed by assuming that the true concentration of the non-detected congeners is, respectively, zero, at the detection limit, and at one-half the detection limit.

The computed values plotted are the medium-range estimates from the HYSPLIT/TRANSCO program, corresponding to medium-range emissions factors for the sources of PCDD/PCDF modeled. These predicted concentrations are weekly-average concentrations in the air at Dorset, Ontario, for 1993.

The concentration of PCDD/PCDF in the air appears to be highly variable, as suggested by both the computed and measured air concentrations. Thus, given the difference between the model-output averaging period and the measurement averaging period, the two data sets are not directly comparable at a given point in time. However, the yearly average concentrations can be compared.

emissions themselves. It should be noted that these considerations assume that all of the PCDD/PCDF in the air over the Great Lakes originates only in the sources that we have identified. Since these are all in the United States and Canada, the agreement between the computed and measured values suggests that no other sources -- for example, those in Mexico, South America, Europe or Asia -- contribute significantly to the PCDD/PCDF deposited in the Great Lakes. This conclusion does not apply to HCB, for there is evidence that HCB is distributed globally; for example, it is found in the Arctic, far from any sources of HCB (Bidleman et al., 1990). This is supported by evidence that the concentration of HCB in the air tends to be similar -- about 100-120 pg/m^3 -- in places as far apart as Norway, the Great Lakes region, and Bermuda (Wania and Mackay, 1993; Risebrough, 1990; Gatz et al., 1994).

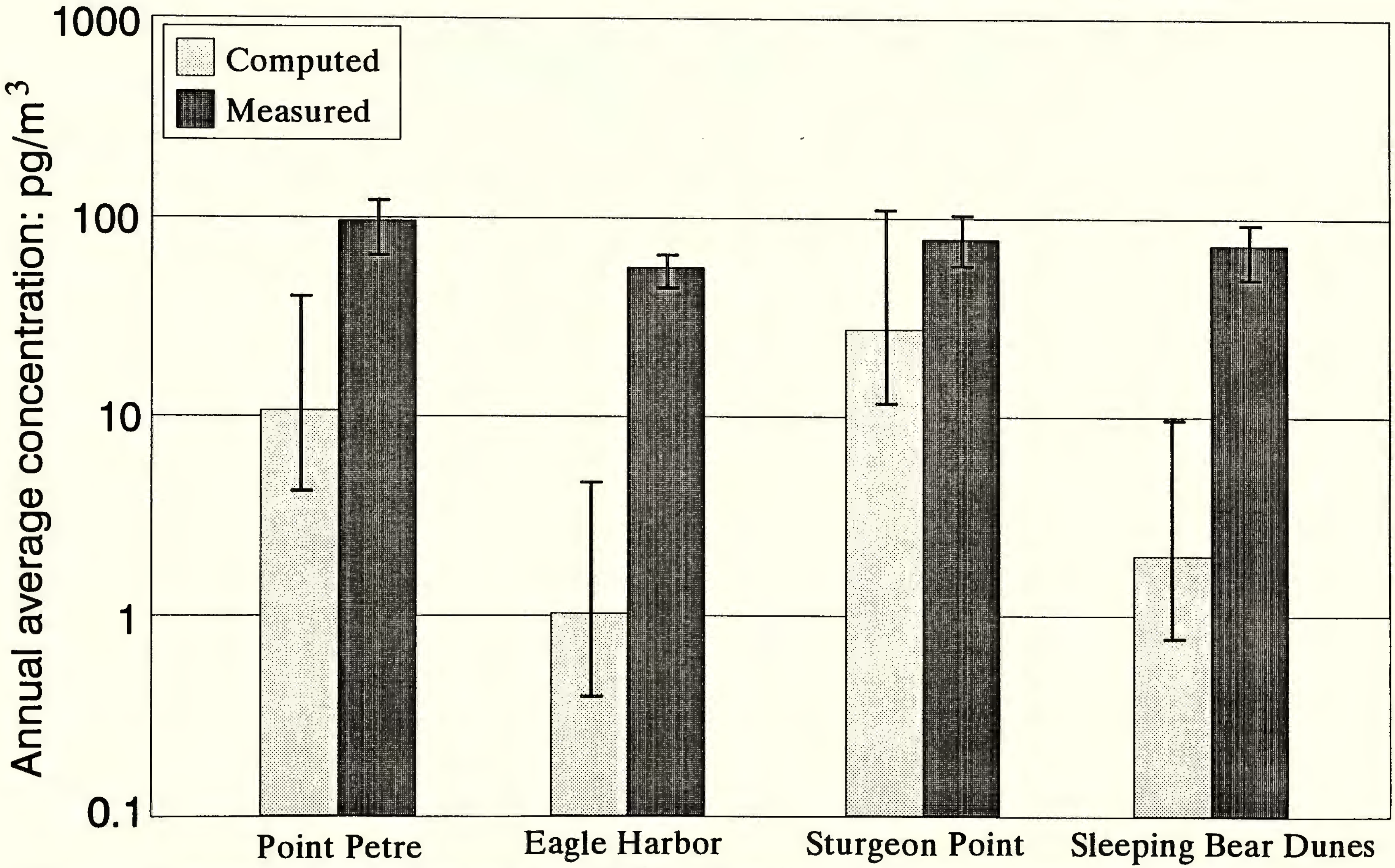
A comparison of the actual concentrations of HCB in the air at several sites in the Great Lakes, with the values computed by the HYSPLIT/TRANSCO system, tends to support this view. The Great Lakes Integrated Atmospheric Deposition Network (IADN) has monitored HCB concentrations in the air at ground level at four Great Lakes shoreline sites: Eagle Harbor (Lake Superior); Sleeping Bear Dunes (Lake Michigan); Sturgeon Point (Lake Erie); and Point Petre (Lake Ontario) at two-week intervals in 1993 (Sweet, 1994). The yearly average values are shown in Figure 6, together with the values computed by the model. The actual values at the several sites are quite similar, ranging from 56-95 pg/m^3. Such values are found ubiquitously, indicating that HCB in the air over the Great Lakes is part of the common global pool, and does not originate solely in U.S. and Canadian sources. As shown in Figure 6, the concentrations computed by the HYSPLIT/TRANSCO model, which reflect only these more localized sources, range from 1-27 pg/m^3, considerably below the measured concentrations.

Thus, the actual concentration of HCB in the air over the Great Lakes is apparently the result of a mixture of "foreign" HCB carried in from outside the U.S./Canadian area and of HCB emitted from the identified sites in the United States and Canada.

2. The total amounts of PCDD/PCDF and HCB deposited:

Table V reports the total amounts of PCDD/PCDF and HCB entering each of the Great Lakes annually from the air, computed from the sums of the amounts deposited from the airborne emissions of each of the 1329 sources. The amounts deposited depend, of course, on the area of the lake. It is of interest, therefore, to compute the flux of material deposited -- i.e., the amount per unit area -- as an index of pollution intensity. As shown in Table V, this value increases in the following order for PCDD/PCDF: Superior, Huron, Michigan, Erie, and Ontario; and in the order Superior, Michigan, Huron, Erie and Ontario in the case of HCB. These differences reflect the different levels of industrialization near each of the lakes, with Superior least affected by such airborne sources -- although subject to waterborne pollution from pulp and paper mills -- and Lakes Erie and Ontario most affected.

Fig. 6. Computed vs. Measured Ambient Air Concentrations of Hexachlorobenzene (1993)



For computed data, ranges shown are those due to range in emissions factors; For measured data, ranges are +/− one std. dev. from mean.

Table V. Amount Deposited and Flux of Airborne PCDD/PCDF and HCB from Sources in the United States and Canada (1993)

	Lake Superior	Lake Michigan	Lake Huron	Lake Erie	Lake Ontario	total for Great Lakes
Total PCDD/PCDF Deposition; g TEQ/yr	5.6	13.7	8.6	7.3	6.4	42
(range)	(2 - 17)	(5 - 43)	(3 - 25)	(2 - 21)	(2 - 18)	(13 - 124)
Average PCDD/PCDF Flux; ug/km^2/yr	69	238	145	284	337	172
Total Potential HCB Deposition; kg/yr	11	15	16	15	23	79
(range)	(4 - 49)	(5 - 73)	(6 - 74)	(6 - 65)	(9 - 101)	(30 - 362)
Average HCB Flux; g/km^2/yr	0.13	0.26	0.27	0.58	1.19	0.32

In interpreting these results, important distinctions must be made between PCDD/PCDF and HCB. For the reasons cited above, we regard the PCDD/PCDF results as reasonably reliable estimates of the total amounts of these substances that are deposited from the air into the Great Lakes. In contrast, the deposition of HCB computed by the HYSPLIT/TRANSCO model cannot be regarded as quantitatively equivalent to the amount that actually enters the Great Lakes from the air. This conclusion is based on the following considerations:

a) As shown in Figure 6, the HYSPLIT/TRANSCO model predicts concentrations of HCB at four lakeshore sites that are well below those actually measured, because it does not take into account the global origin of some of the HCB present in the air above the Great Lakes. Thus, the data generated by the HYSPLIT/TRANSCO model probably underestimate the amount of HCB available for deposition from the air over the Great Lakes.

b) Because of the volatility of HCB and its low solubility in water, it cannot be assumed that its presence in the air over the Great Lakes necessarily results in a net deposition into the lakes. This would only be true if the lakes were totally free of HCB. In fact, numerous measurements show that the lakes are significantly contaminated with dissolved HCB, which is capable of volatilizing and diffusing into the air above the lakes. (L'Italien, 1993; Stevens & Neilson, 1989) Depending on the relative concentrations of HCB in the lake and in the air over it, and the temperature, this "back pressure" may partially or completely counteract the deposition of HCB from the air to the lake. For at least two of the Great Lakes (Erie and Ontario) there is evidence that this relationship may result in a net flow of HCB from the lake into the air (Kelly et al., 1991; Oliver 1987). Nevertheless, even in this circumstance, the transport of HCB from the identified U.S./Canadian sources to the air over the Great Lakes will affect the HCB content of the water. By raising the HCB concentration in the air, the material transported from the U.S. and Canadian sources will reduce net upward flow and therefore tend to increase the amount in the lake.

As a result, it is difficult to precisely determine the net flux of HCB (see, for example, Hoff, 1994). Because our model is based on the simplifying assumption that the lakes are uncontaminated with HCB, our computed values of HCB deposition from the identified sources should be regarded as maxima. Accordingly, the HCB data generated by the HYSPLIT/TRANSCO model should be interpreted as representing HCB potentially capable of being deposited.

3. Ranking of sources with respect to total deposition:

Given the overall purpose of this project -- i.e., the development of economically constructive means of virtually eliminating the major sources of the PCDD/PCDF and HCB deposition in the Great Lakes -- it is useful to evaluate their relative importance as contributors to the total deposition. The data on the amounts of PCDD/PCDF and HCB deposited in each of the five Great Lakes annually by each of the 1329 sources have been used to rank them in accordance with their percentage contribution to the total amount deposited. (A tabulation of the results for all 1329 airborne sources is shown in the Appendix.)

The relationship between the source ranking and the cumulative percent of total deposition from all 1329 sources in Lake Michigan is shown in Figure 7A (for PCDD/PCDF) and Figure 7B (for HCB); the cumulative curves for the other lakes are quite similar. It is evident that only a relatively small fraction of the sources accounts for the bulk of the total amount of material deposited. Thus, as shown in Table VI, of the 1329 sources, only 106 account for 85% of the total amount of PCDD/PCDF toxicity deposited in any of the five lakes and only 148 account for 85% of the total potential deposition of HCB. Only 66 sources account for 75% of PCDD/PCDF deposits and 27 for 50% of them. The corresponding values for HCB are 93 and 42.

In Tables VIIA and VIIB, the foregoing data have been aggregated into the various source classes. The two dominant classes, which, depending on the lake, together account for 45-89% of the total deposition of PCDD/PCDF, are medical waste and municipal solid waste incinerators. Lesser but significant amounts are contributed by iron sintering plants and cement kilns that burn hazardous waste. Depending on the lake, these four source classes are responsible for 85-88% of the total PCDD/PCDF deposition.

The dominant source of HCB is the use of HCB-contaminated pesticides, accounting for 36-45% of potential deposition, depending on the lake. Four source classes -- pesticides, cement kilns burning hazardous waste, HCB-burning incinerators, and municipal solid waste incinerators -- account for 85-90% of the estimated potential deposition of HCB to the Great Lakes.

The source classes differ significantly in their relative contributions to the deposition of PCDD/PCDF and HCB. Thus, while medical waste incinerators are a significant source of PCDD/PCDF deposition to each of the Great Lakes, this source class accounts for only a small fraction of the potential deposits of HCB. On the other hand, HCB waste incineration is responsible for 4.2% to 19.4% of the potential deposition of HCB, but only 0.01% to 0.03% of the PCDD/PCDF deposition.

There are also significant differences among the five Great Lakes with respect to deposition. For example, PCDD/PCDF from iron sintering plants accounts for 22% of the total deposition to Lake Michigan, in comparison with only 4-6% to the other lakes. This arises from the proximity of such plants to Lake Michigan. Of the ten plants that contribute to the top 85% of the total deposition to the Great Lakes as a whole, four are in Indiana, close to Lake Michigan, and together contribute about 20% of the PCDD/PCDF deposited from the air into that lake.

Fig. 7A. Air Deposition of PCDD/PCDF (TEQ) to Lake Michigan from Sources in the U.S. and Canada

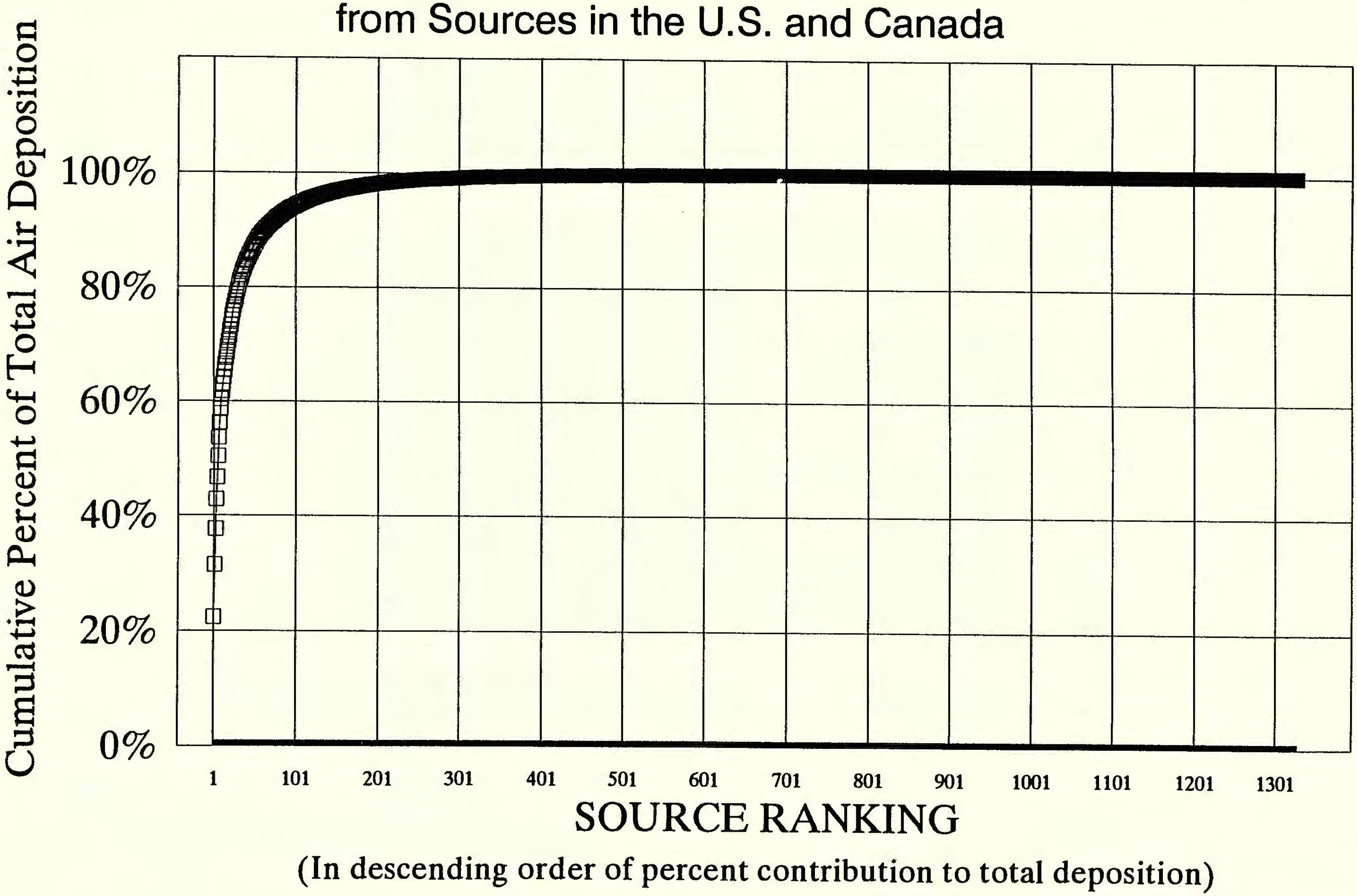


Fig. 7B. Potential Air Deposition of HCB to Lake Michigan from Sources in the U.S. and Canada

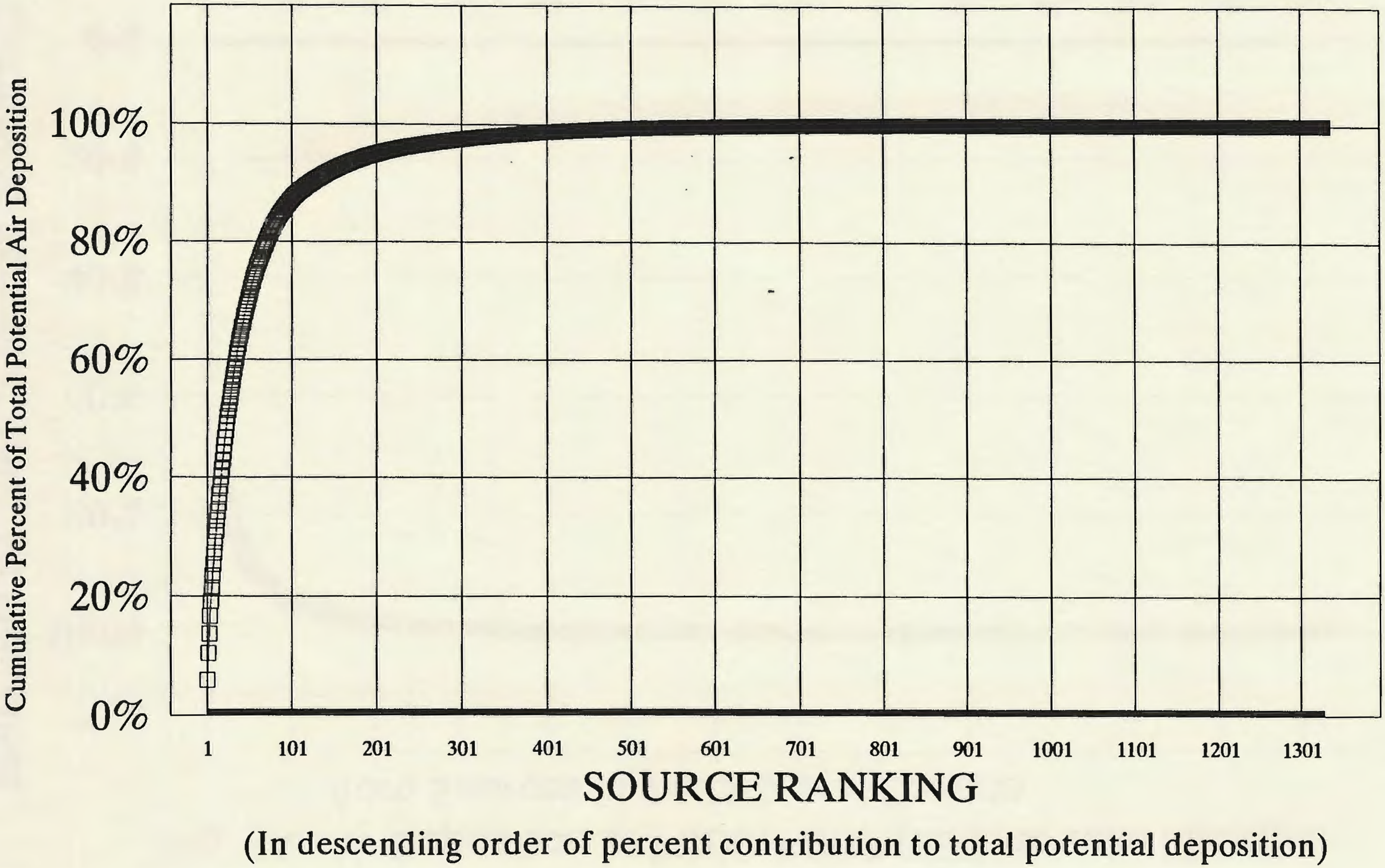


Table VI. Number of Sources that Comprise 50%, 75%, 85% and 100% of Total Potential Deposition of Airborne PCDD/PCDF and HCB to the Great Lakes

Cumulative Percentage of Total Potential Air Deposition	Lake Superior	Lake Michigan	Lake Huron	Lake Erie	Lake Ontario	Any Great Lake
PCDD/PCDF (TEQ)	**Number of Sources**					
100%	1329	1329	1329	1329	1329	1329
85%	72	42	71	62	59	106
75%	40	23	43	37	35	66
50%	14	5	14	11	12	27
Hexachlorobenzene	**Number of Sources**					
100%	1329	1329	1329	1329	1329	1329
85%	92	89	101	96	56	148
75%	59	58	62	56	18	93
50%	26	24	22	15	2	42

Table VII-A. Percentage Contribution of Total Deposition of Airborne PCDD/PCDF (TEQ) to the Great Lakes by Each Source Class (1993)							
Source Class	Lake Superior	Lake Michigan	Lake Huron	Lake Erie	Lake Ontario	total Great Lakes	average % for the 5 lakes
Medical Waste Incineration*	56.82%	53.90%	48.35%	43.45%	37.03%	48.73%	47.91%
Municipal Waste Incineration	16.44%	7.54%	24.42%	30.73%	32.17%	20.07%	22.26%
Iron Ore Sintering	5.54%	21.58%	5.42%	5.05%	4.57%	10.57%	8.43%
Cement Kilns burning Haz. Waste	6.64%	5.31%	7.30%	6.58%	12.18%	7.18%	7.60%
Secondary Copper Smelting	3.61%	3.73%	4.47%	4.00%	4.71%	4.06%	4.10%
Coal Combustion	3.38%	1.98%	2.81%	2.91%	1.96%	2.50%	2.61%
Wood Combustion	2.56%	1.45%	2.25%	2.10%	1.75%	1.93%	2.02%
Cement Kilns not burning Haz. Waste	2.03%	1.75%	1.98%	1.93%	2.32%	1.95%	2.00%
Heavy Duty Diesel Vehicles	1.58%	1.67%	1.37%	1.35%	1.07%	1.45%	1.41%
Hazardous Waste Incineration**	0.90%	0.75%	0.91%	0.92%	0.53%	0.80%	0.80%
Sewage Sludge Incineration	0.37%	0.18%	0.60%	0.87%	1.60%	0.63%	0.72%
Secondary Copper Refining	0.06%	0.07%	0.07%	0.06%	0.05%	0.06%	0.06%
HCB Waste Incineration	0.03%	0.03%	0.03%	0.02%	0.01%	0.03%	0.03%
Vehicles using Leaded Gasoline	0.02%	0.03%	0.02%	0.02%	0.02%	0.02%	0.02%
Vehicles using Unleaded Gasoline	0.02%	0.02%	0.01%	0.01%	0.01%	0.01%	0.01%
TOTAL	100%	100%	100%	100%	100%	100%	100%

Total Deposition; grams TEQ/yr	5.6	13.7	8.6	7.3	6.4	42
(range)	(2 - 17)	(5 - 43)	(3 - 25)	(2 - 21)	(2 - 18)	(13 - 124)

* See note on page 10.

** Not including HCB waste incineration or hazardous waste burned in Cement Kilns, which are reported separately in this table

(Note: the higher magnitude values in this table are reported with more significant figures than justified, for ease in comparison with the lower values)

Table VII-B. Percentage Contribution to Total Potential Deposition of Airborne HCB to the Great Lakes by Each Source Class (1993)

Source Class	Lake Superior	Lake Michigan	Lake Huron	Lake Erie	Lake Ontario	total Great Lakes	average % for the 5 lakes
Use of Pesticides Contaminated with HCB	44.77%	35.95%	44.04%	44.52%	42.11%	42.13%	42.28%
Cement Kilns burning Haz. Waste	15.67%	16.97%	19.67%	20.31%	34.32%	22.92%	21.39%
HCB Waste Incineration	19.43%	17.27%	15.18%	10.16%	4.22%	12.07%	13.25%
Municipal Waste Incineration	9.30%	14.44%	9.76%	11.33%	9.51%	10.81%	10.87%
Cement Kilns not burning Haz. Waste	5.16%	7.21%	5.31%	5.99%	5.26%	5.77%	5.79%
Hazardous Waste Incineration*	2.75%	2.94%	2.63%	3.42%	1.00%	2.39%	2.55%
Sewage Sludge Incineration	1.03%	0.89%	1.65%	2.47%	2.67%	1.87%	1.74%
Medical Waste Incineration	0.92%	1.41%	0.80%	0.83%	0.40%	0.83%	0.87%
Iron Ore Sintering	0.30%	2.26%	0.32%	0.35%	0.20%	0.66%	0.69%
Secondary Copper Smelting	0.19%	0.21%	0.22%	0.21%	0.15%	0.19%	0.20%
Coal Combustion	0.22%	0.19%	0.18%	0.19%	0.07%	0.16%	0.17%
Wood Combustion	0.18%	0.13%	0.15%	0.14%	0.06%	0.12%	0.13%
Heavy Duty Diesel Vehicles	0.07%	0.11%	0.06%	0.06%	0.03%	0.06%	0.06%
Secondary Copper Refining	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%
Vehicles using Leaded Gasoline	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Vehicles using Unleaded Gasoline	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL	100%	100%	100%	100%	100%	100%	100%

Total Potential Deposition in 1993, from sources in the United States and Canada (kg/year)	11	15	16	15	23	79
(range)	(4 - 49)	(5 - 73)	(6 - 74)	(6 - 65)	(9 - 101)	(30 - 362)

* Not including HCB waste incineration or hazardous waste burned in Cement Kilns, which are reported separately in this table.
(Note: the higher values in this table are reported with more significant figures than justified, for ease in comparison with the lower values)

4. The relation between deposition and the geographic distribution of the sources:

a. Location of the major sources:

It is of obvious interest to know where the sources that are responsible for the PCDD/PCDF and HCB deposited from the air into the Great Lakes are located, as a prelude to analyzing the effect of location on deposition. As noted earlier, we have identified all of the individual sources of the following classes: municipal waste, hazardous waste and sewage sludge-burning incinerators; iron sintering plants; secondary copper smelters and refiners; and cement kilns. These sources are mapped in Figures 8A-K, in which those facilities that, by their ranking, are responsible for the top 85% of the deposition of PCDD/PCDF and HCB in any of the five Great Lakes are separately identified.

The maps show that due to the special characteristics of the Great Lakes region, certain classes of sources play a more prominent role in that region than they do nationally. For example, the relative prominence of iron sintering plants in PCDD/PCDF deposition in the Great Lakes is largely due to the concentration of the steel industry in the region. The maps also show that although sources adjacent to the Great Lakes play a large role in generating the PCDD/PCDF and HCB that enter the Great Lakes, certain distant sources are significant as well. For example, although five hazardous waste incinerators adjacent to the lakes are among the sources that contribute 85% of the HCB entering the lakes, incinerators in Louisiana and Colorado also fall into this category. (See map, Figure 8B) Cement kilns burning hazardous waste that are as far from the Great Lakes as Texas contribute to the top 85% of PCDD/PCDF and HCB entering the lakes. (See map, Figure 8H) Although most of the municipal solid waste incinerators that are in this category of top contributors of PCDD/PCDF and HCB are located near the Great Lakes, two are in Florida, one is in Utah, and another is in Oklahoma. (See map, Figure 8A)

As noted earlier, medical waste incineration, coal burning, wood burning, mobile (especially diesel) sources, and pesticide application can be localized only by state or province. Their contributions to the average percent of the deposition of PCDD/ PCDF and HCB to the five lakes is shown, ranked by state or province, in Figures 9A-E. The relative contribution of different states to PCDD/PCDF deposition from medical waste incinerators reflects both the proximity of the states to the Great Lakes and their population (which influences the level of medical activity). Thus, the largest contributions are generated in states and provinces that border the Great Lakes. However, Texas is also included in the upper range of contributors, reflecting both its large population and the effect of weather patterns that tend to carry pollutants from that region to the Great Lakes. Similarly, while New York State borders the Great Lakes and also has a large population, its contribution of PCDD/PCDF from medical waste incineration is less than that of the other bordering states, apparently reflecting the prevailing eastward wind direction.

Fig. 8A: LOCATION OF MUNICIPAL SOLID WASTE INCINERATORS

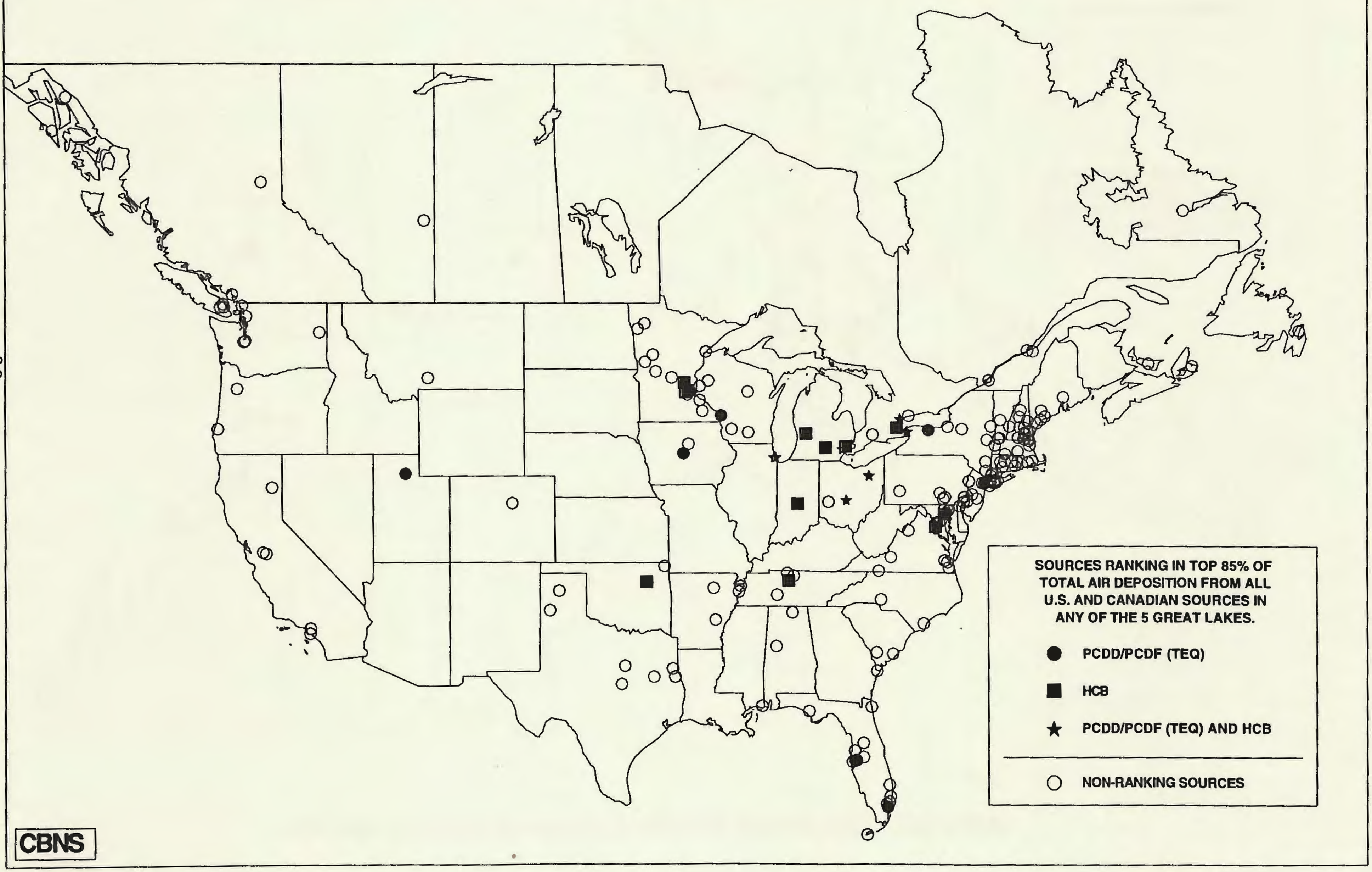


Fig. 8B: LOCATION OF HAZARDOUS WASTE INCINERATORS

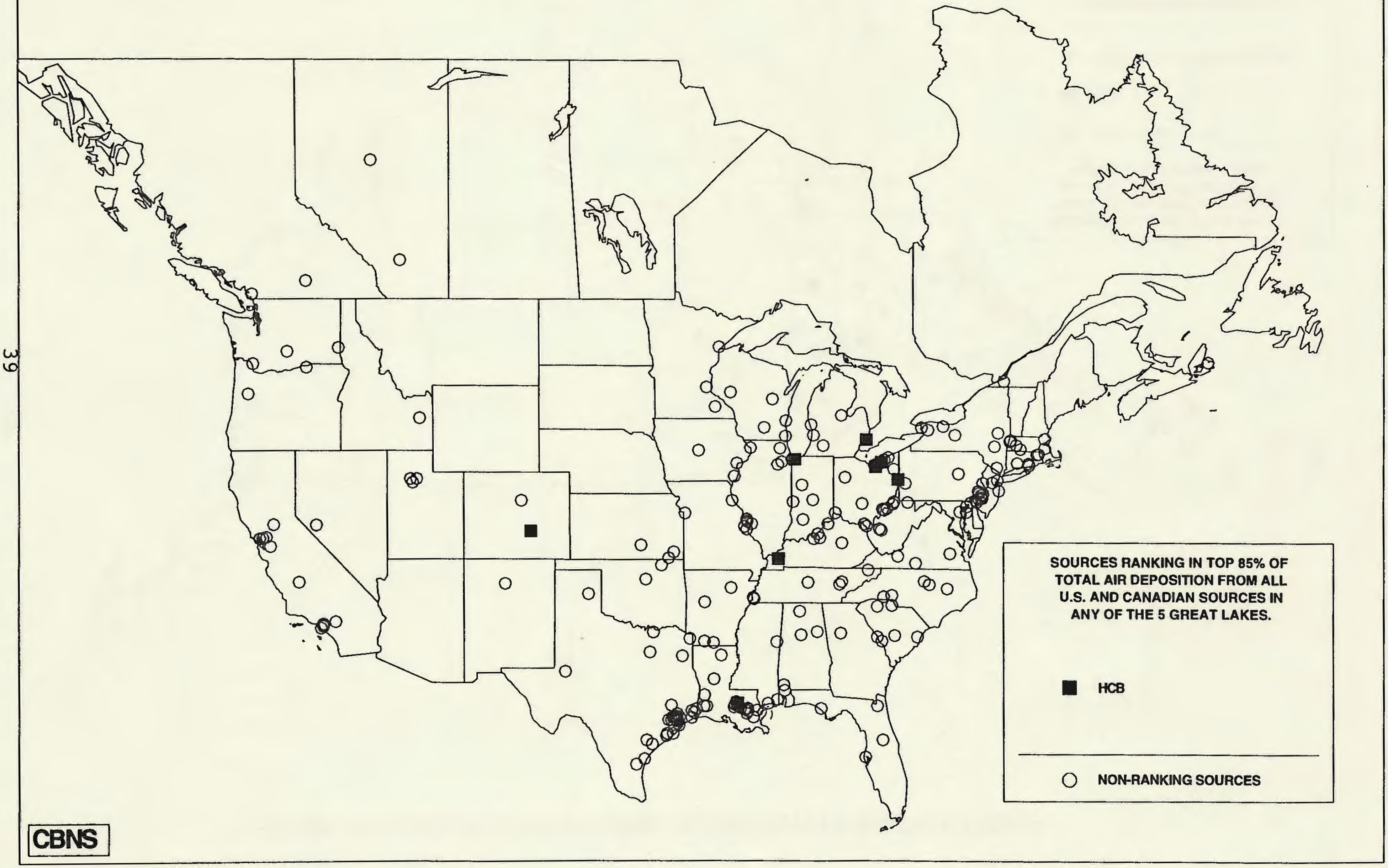


Fig. 8C: LOCATION OF SEWAGE SLUDGE INCINERATORS

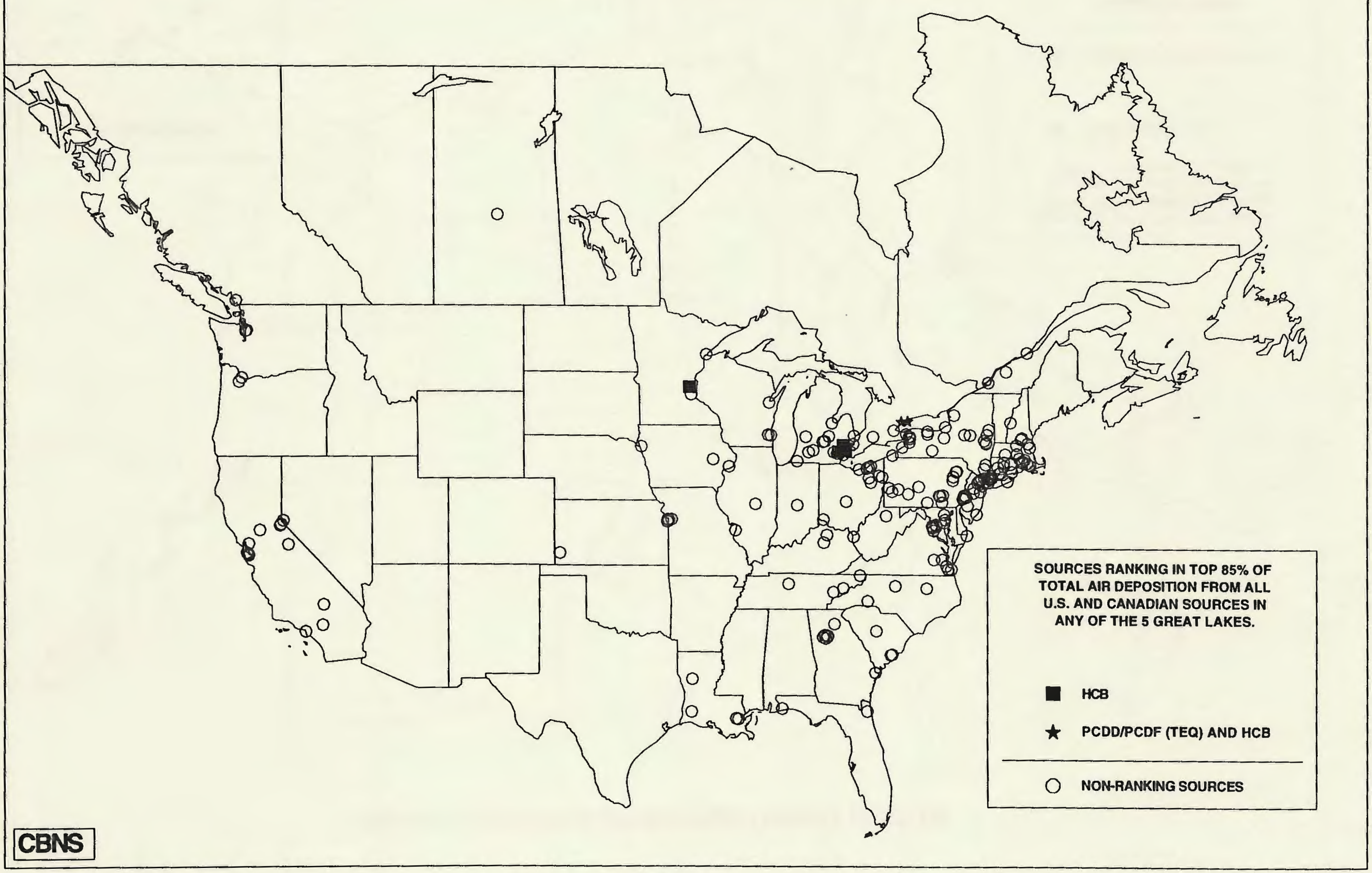


Fig. 8D: LOCATION OF IRON SINTERING PLANTS

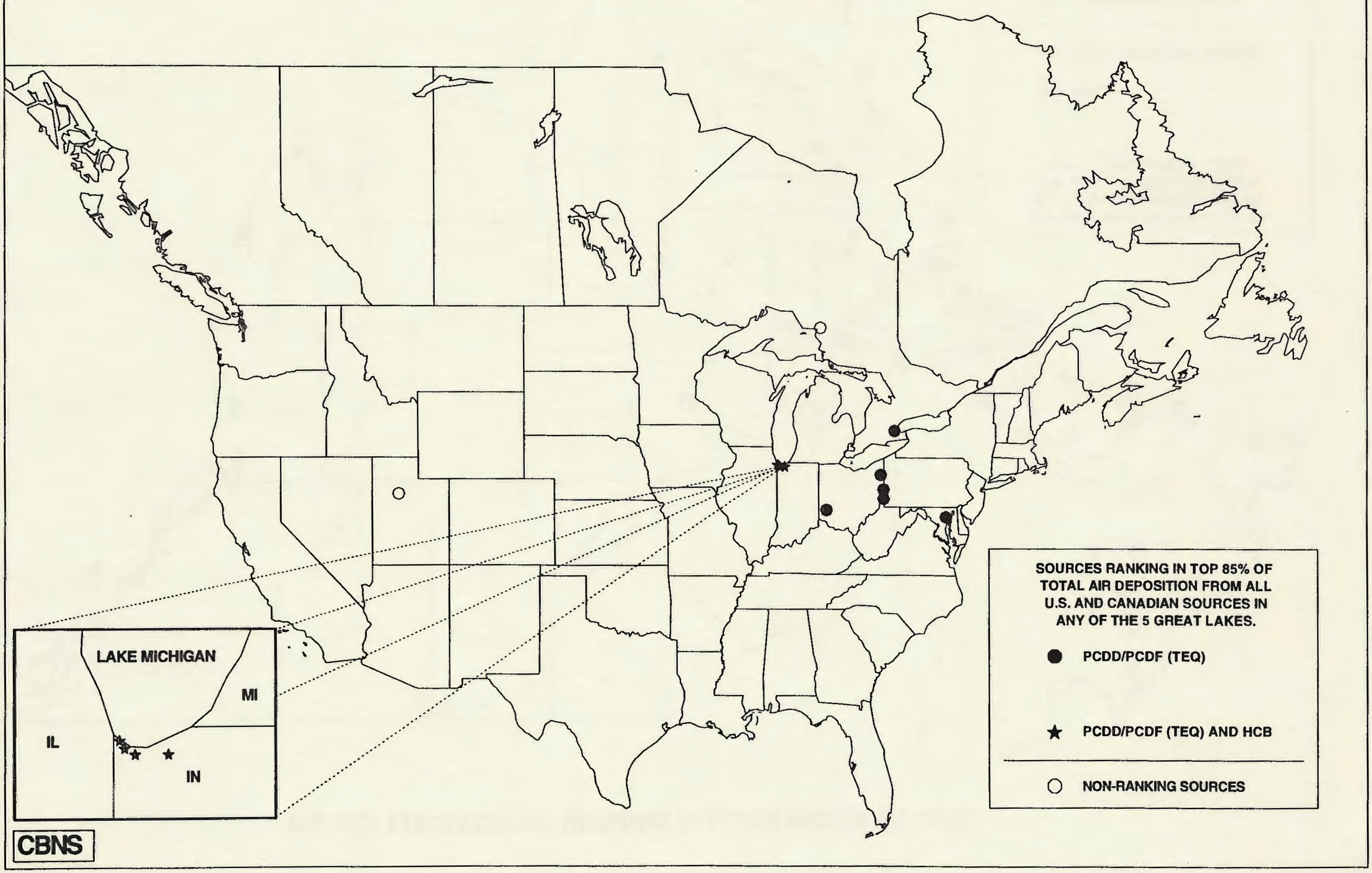


Fig. 8E: LOCATION OF SECONDARY COPPER SMELTERS

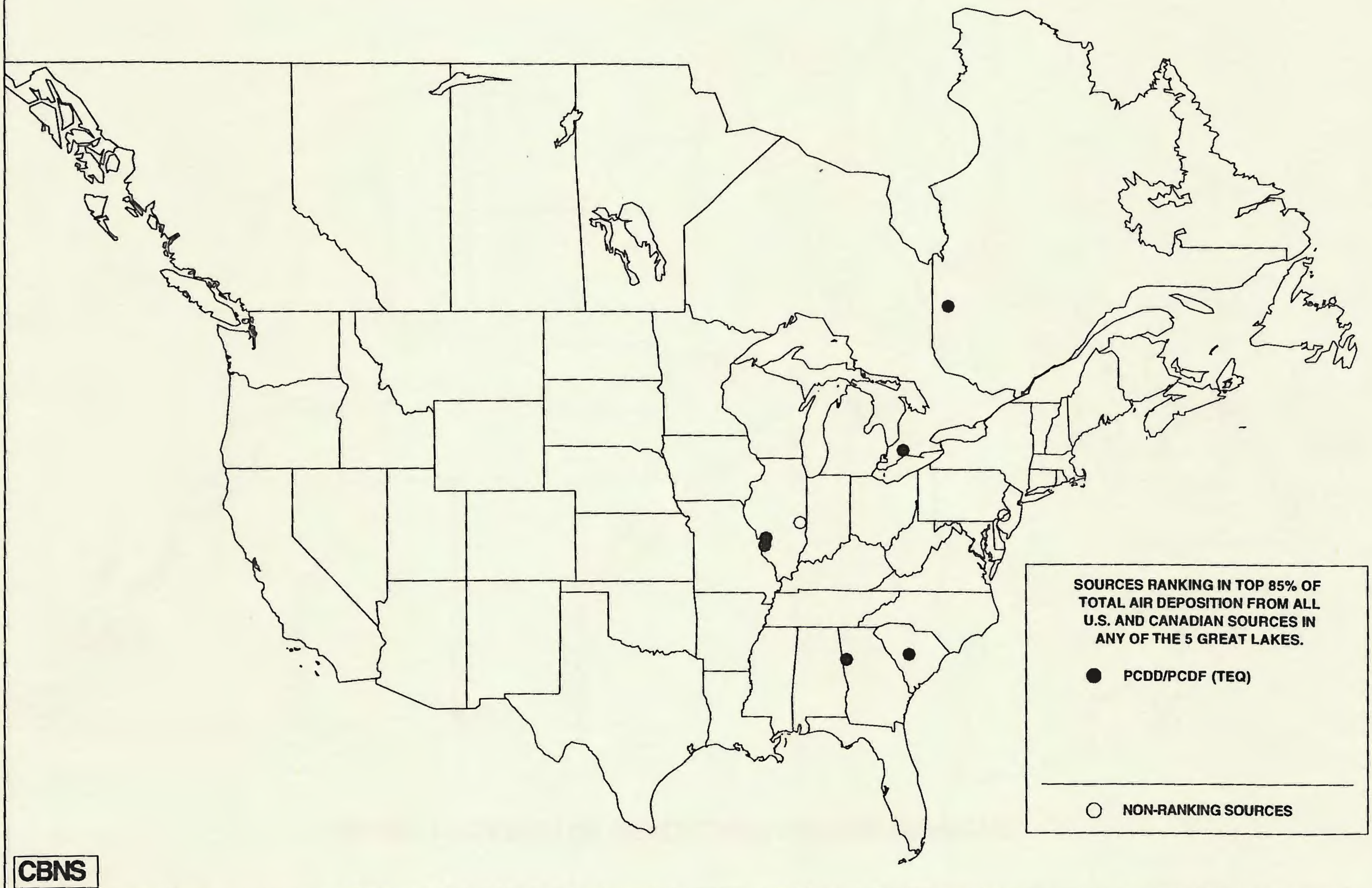


Fig. 8F: LOCATION OF SECONDARY COPPER REFINERS

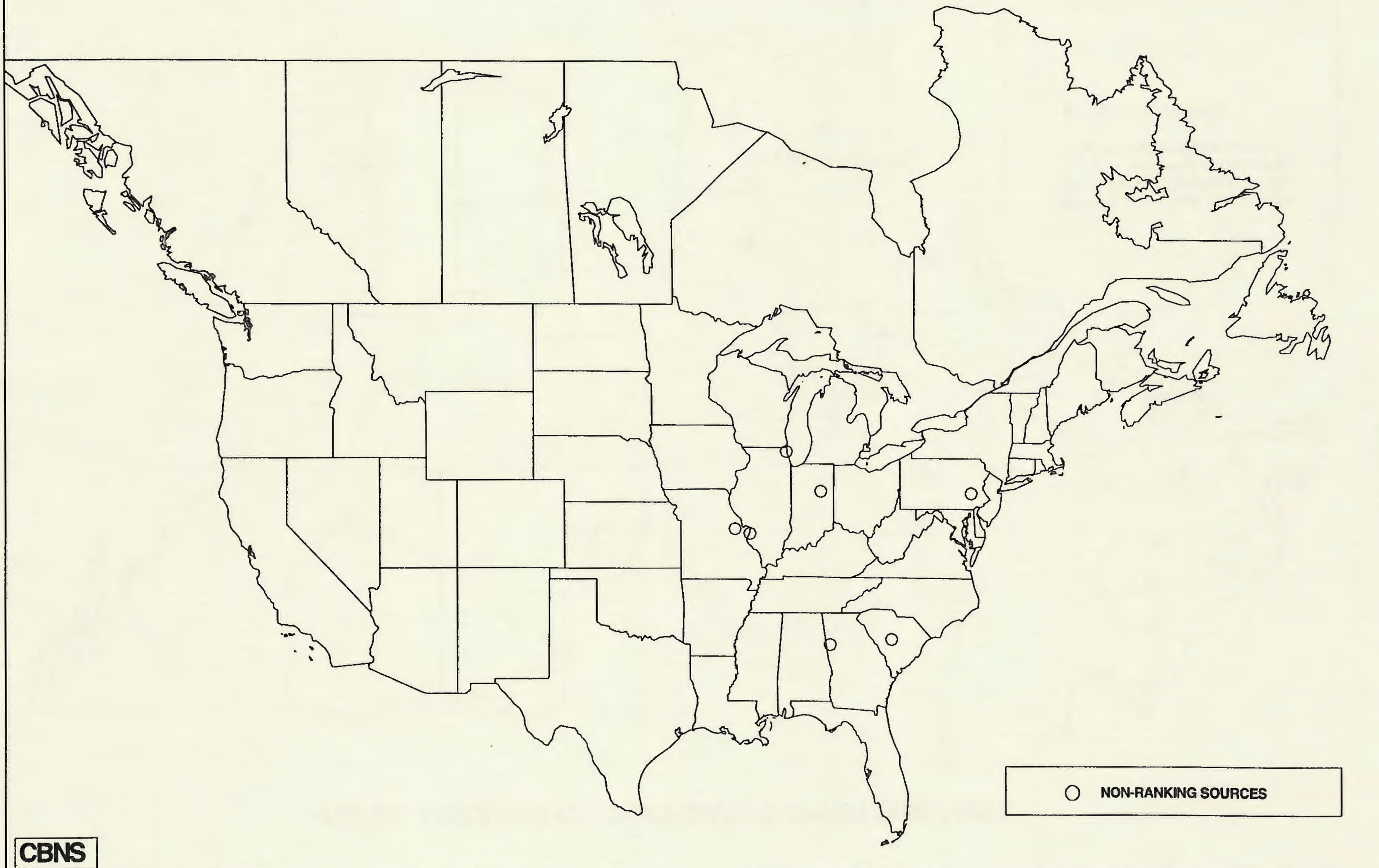


Fig. 8G: LOCATION OF HCB WASTE INCINERATORS

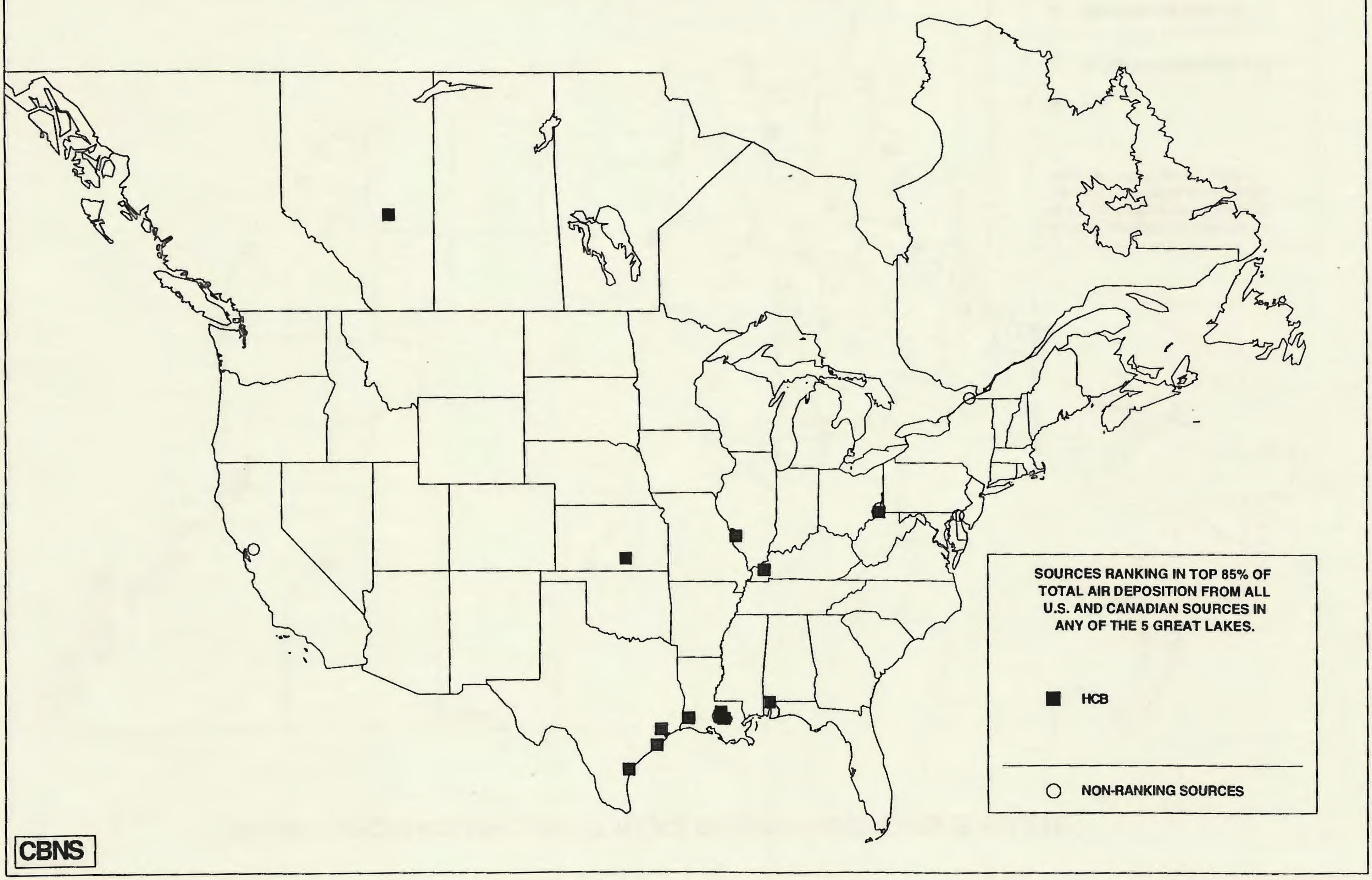


Fig. 8H: LOCATION OF CEMENT KILNS BURNING HAZARDOUS WASTE

Fig. 8I: LOCATION OF CEMENT KILNS NOT REPORTING HAZARDOUS WASTE COMBUSTION

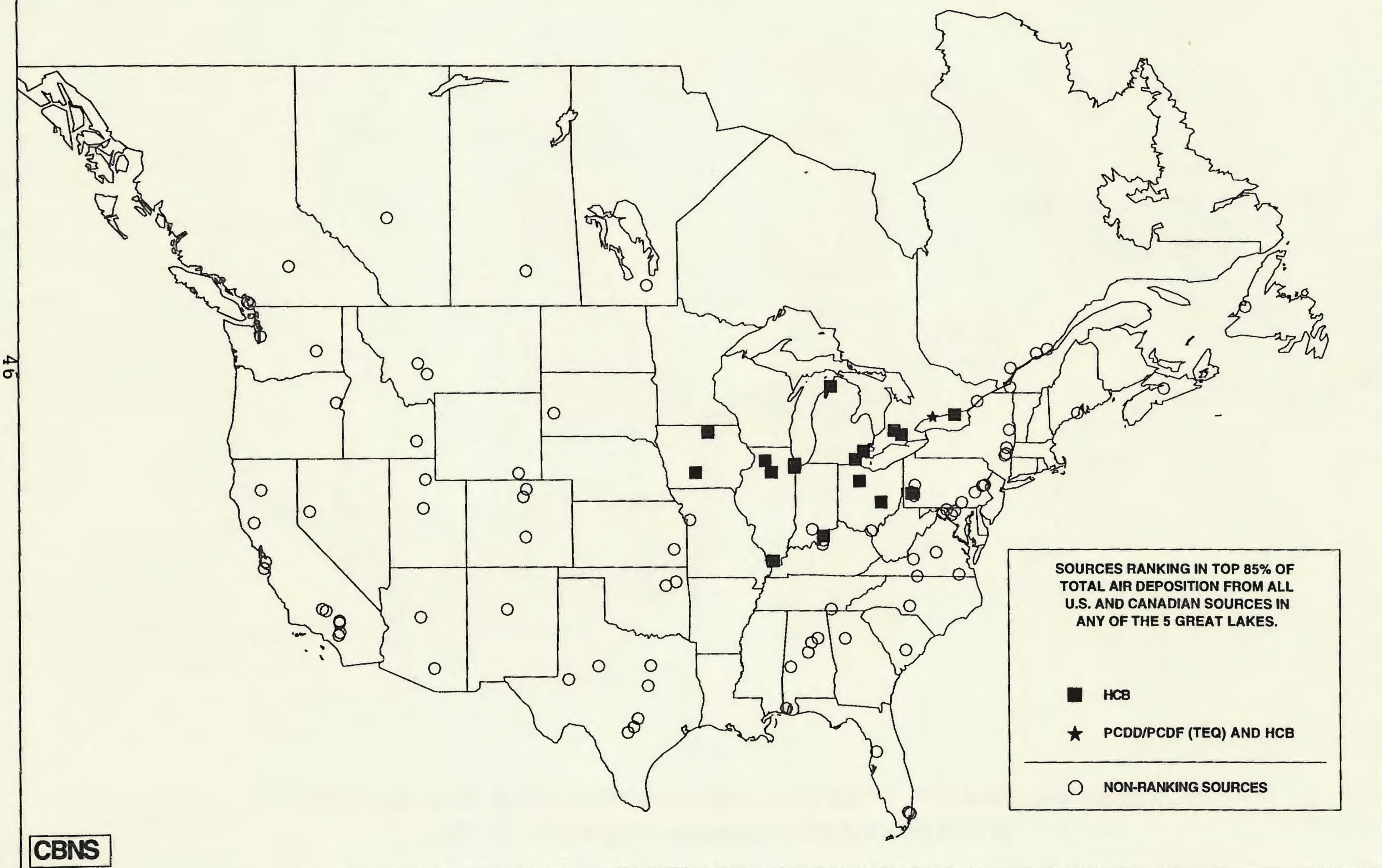
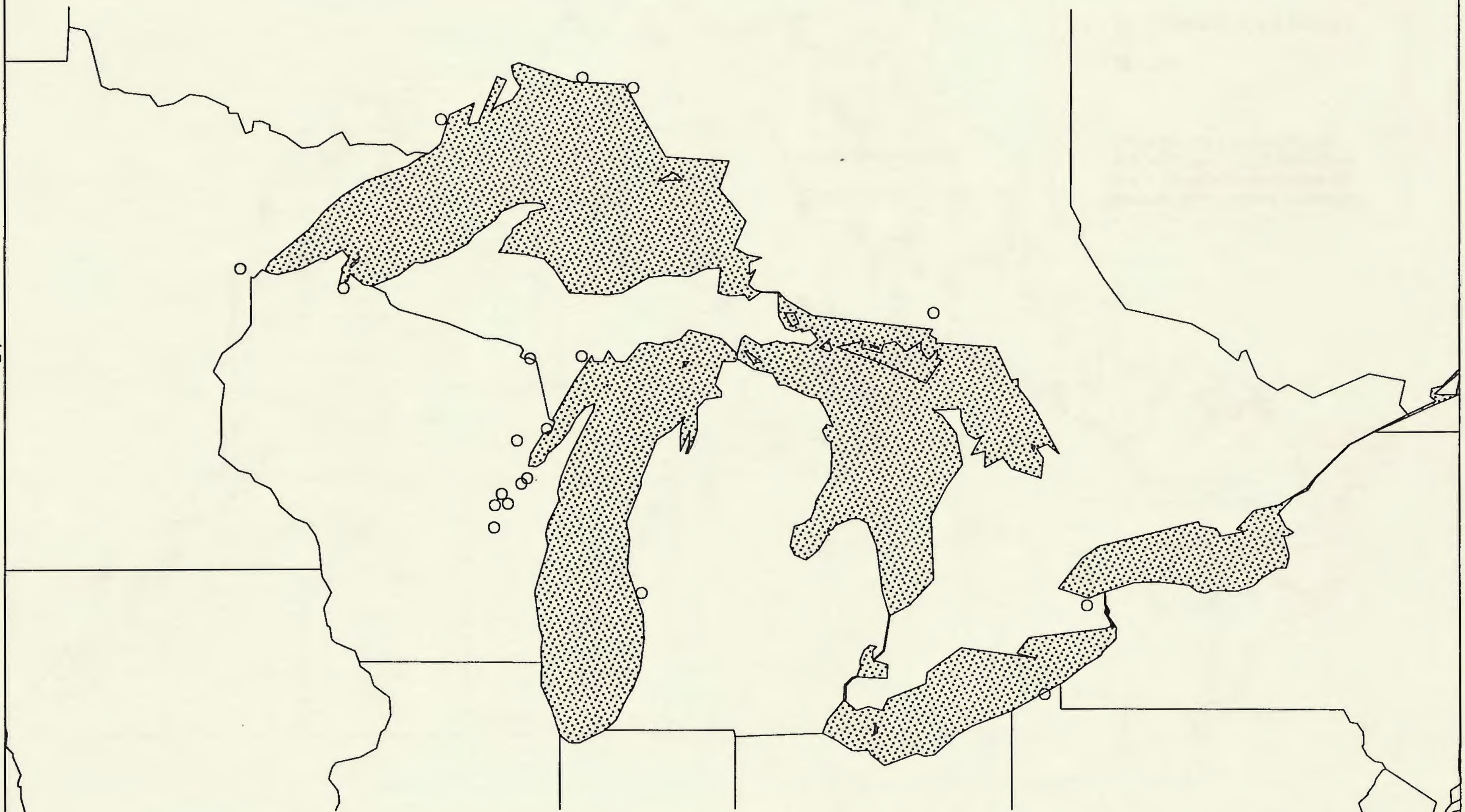


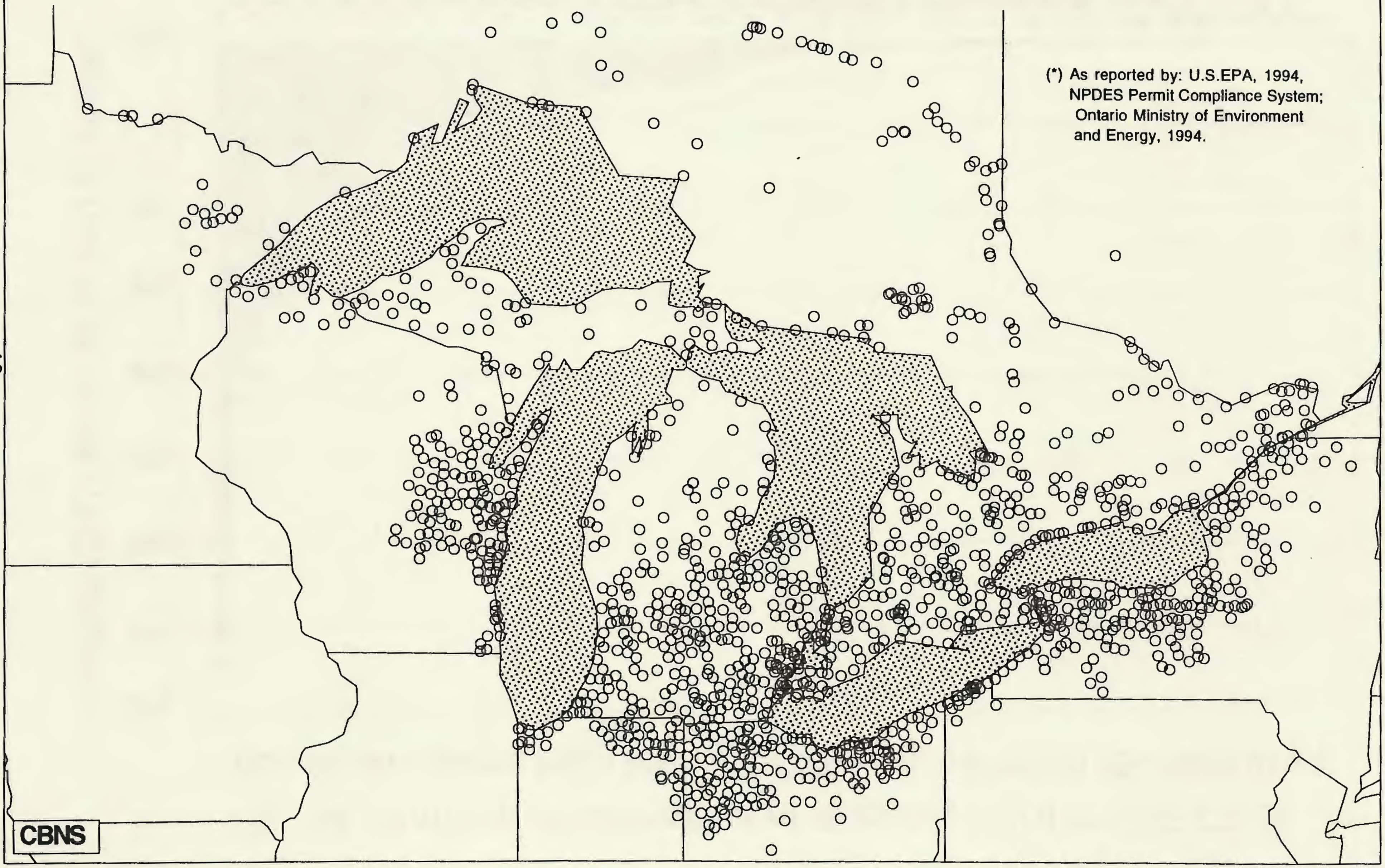
Fig. 8J: LOCATION OF PULP AND PAPER MILLS
which discharge liquid effluent to the Great Lakes and their Tributaries



CBNS

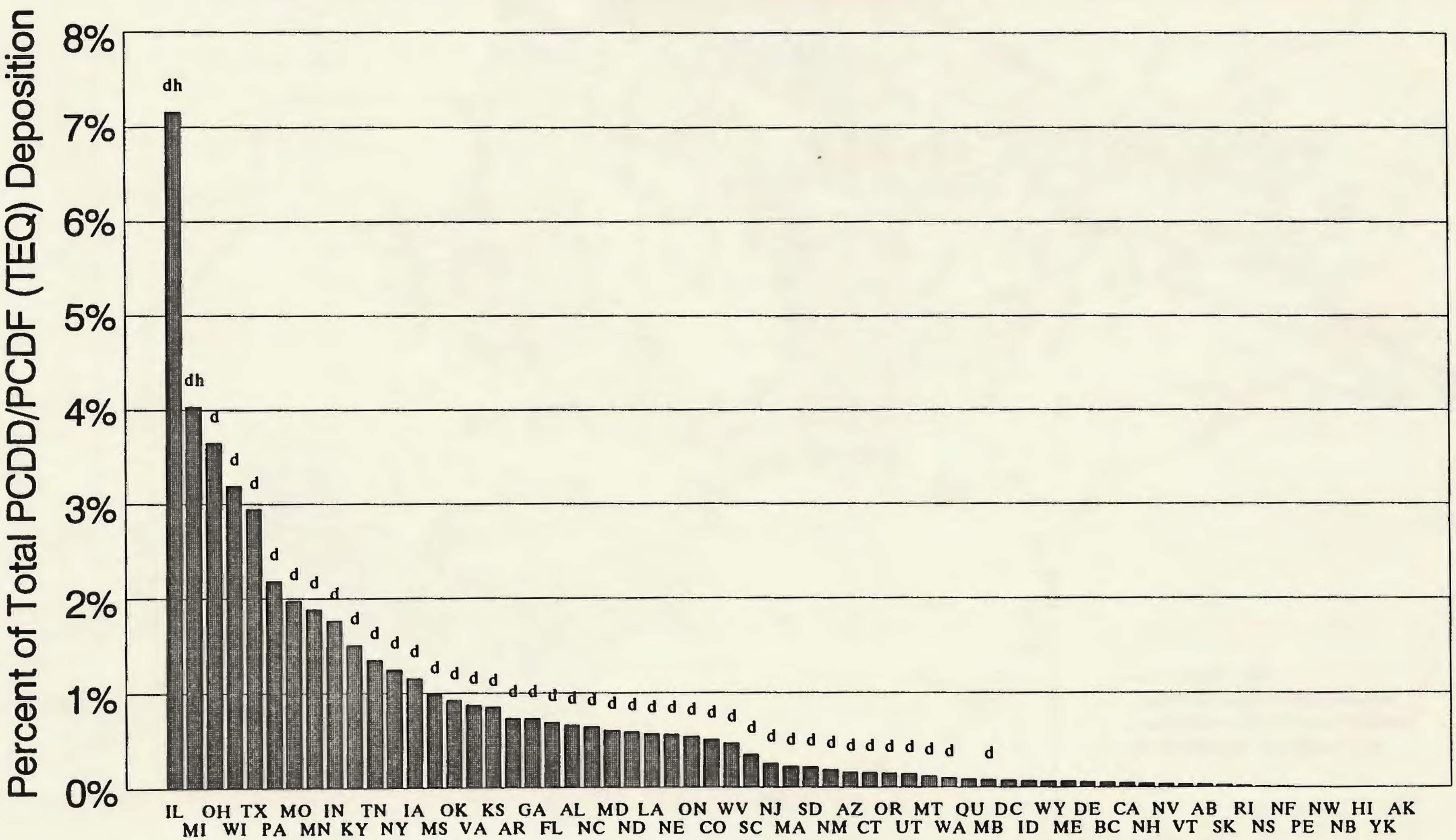
Only pulp and paper mills which use chlorine-containing chemicals (e.g., elemental chlorine, chlorine dioxide, sodium hypochlorite) in their processes are shown on this map.

Fig. 8K: LOCATION OF SEWAGE TREATMENT PLANTS
which discharge liquid effluent to the Great Lakes and their Tributaries (*)



(*) As reported by: U.S.EPA, 1994, NPDES Permit Compliance System; Ontario Ministry of Environment and Energy, 1994.

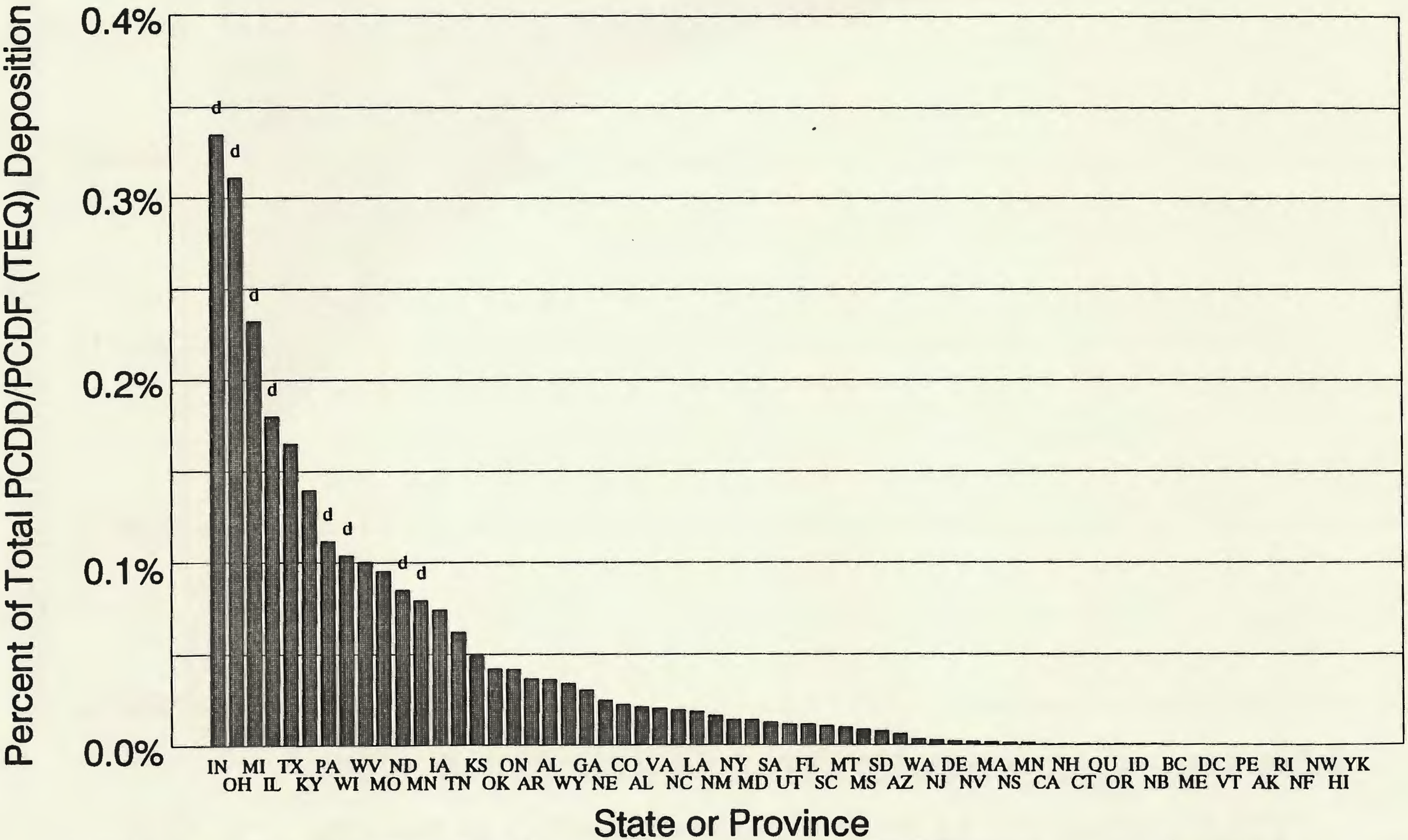
Fig. 9A. Percent of Deposition of Airborne PCDD/PCDF (TEQ) due to emissions from Medical Waste Incineration (5-lake avg.)



See note on page 10.

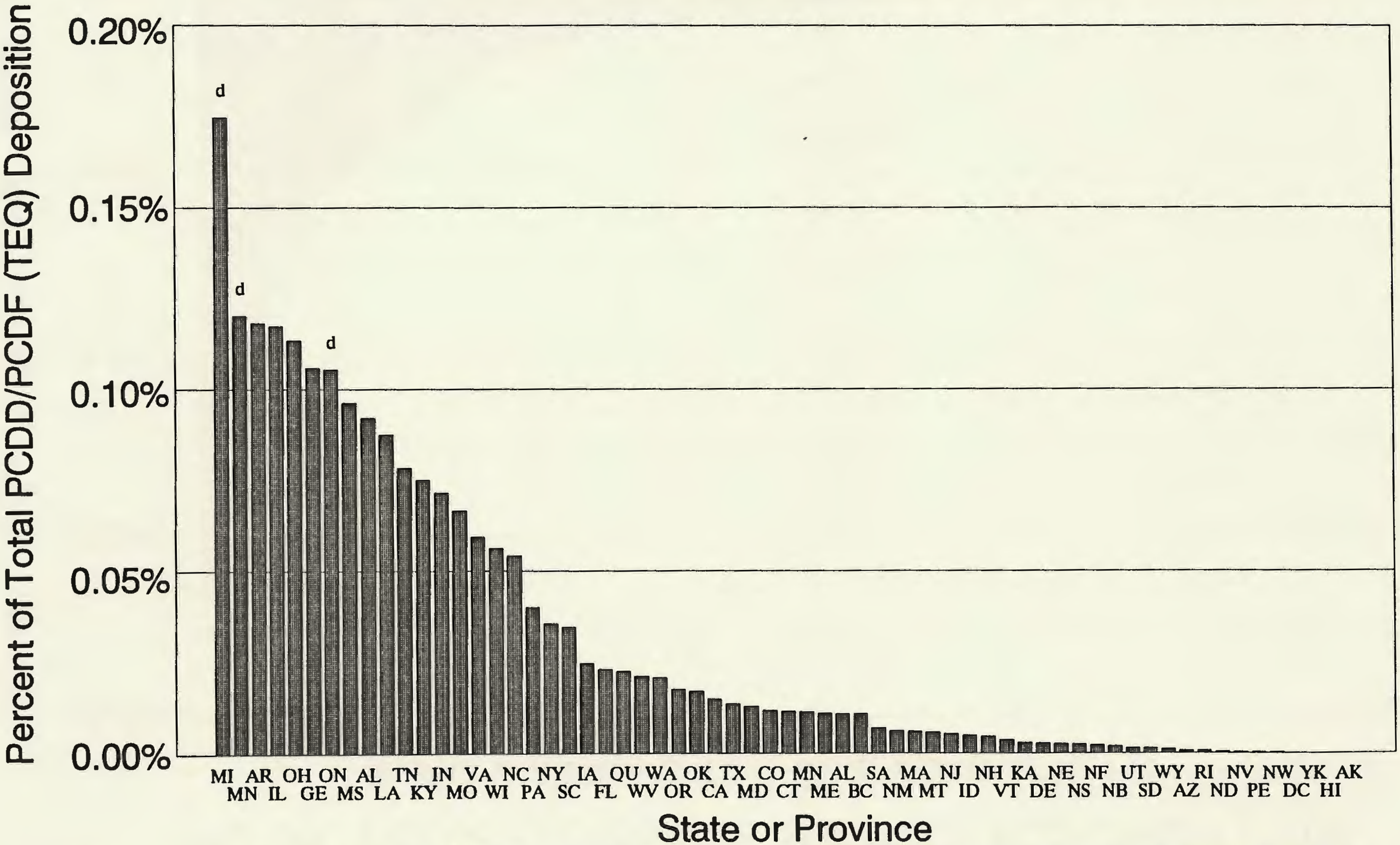
If state or province fell within the top 85% of air deposition contributors of PCDD/PCDF to any given lake, it is labeled with a "d";
If state or province fell within the top 85% of potential air deposition contributors of HCB to any given lake, it is labeled with an "h"

Fig. 9B. Percent of Deposition of Airborne PCDD/PCDF (TEQ) due to emissions from Coal Combustion (5-lake avg.)



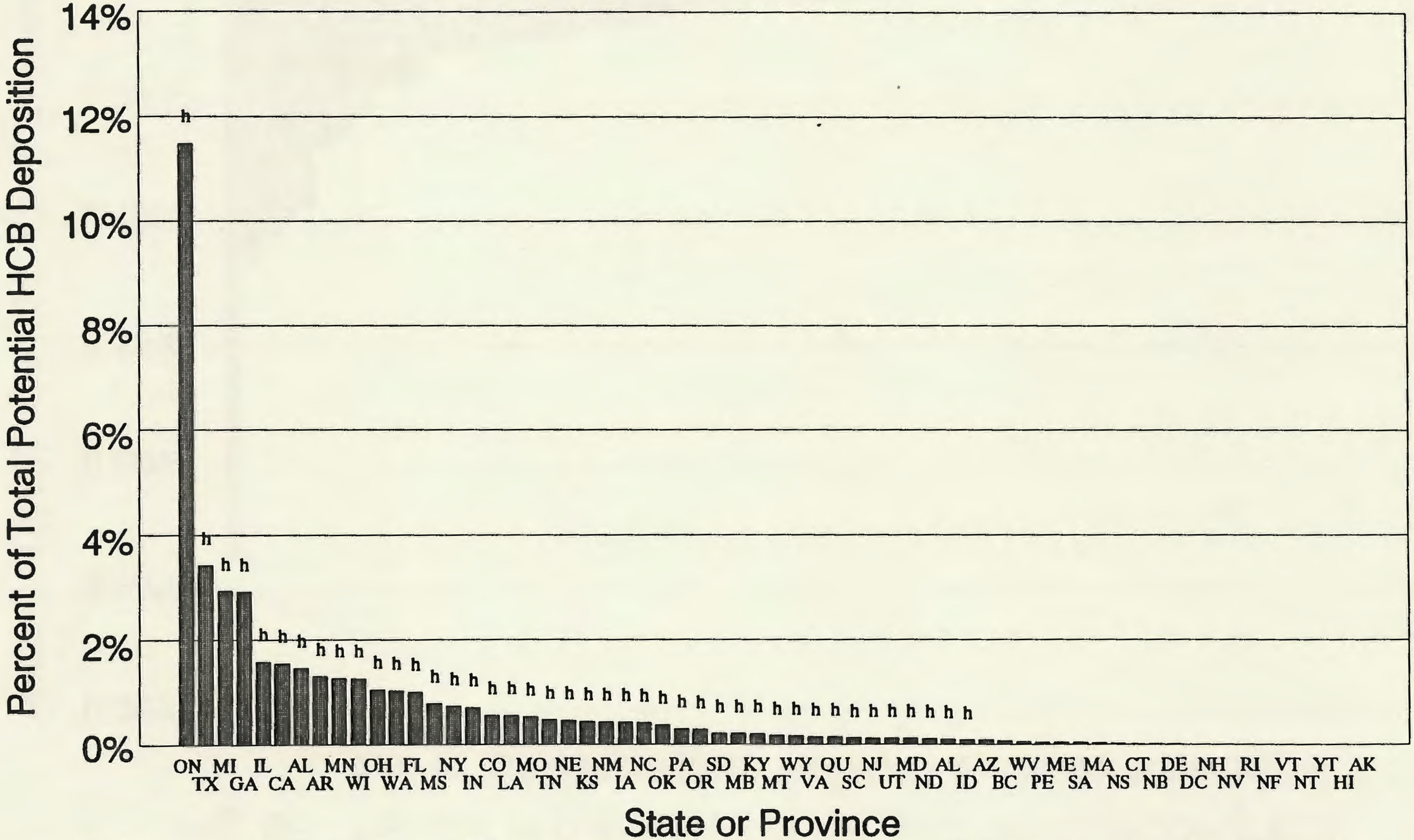
If state or province fell within the top 85% of air deposition contributors of PCDD/PCDF to any given lake, it is labeled with a "d";
None of the states or provinces fell within the top 85% of potential air deposition contributors of HCB to any given lake

Fig. 9C. Percent of Deposition of Airborne PCDD/PCDF (TEQ) due to emissions from Wood Combustion (5–lake avg.)



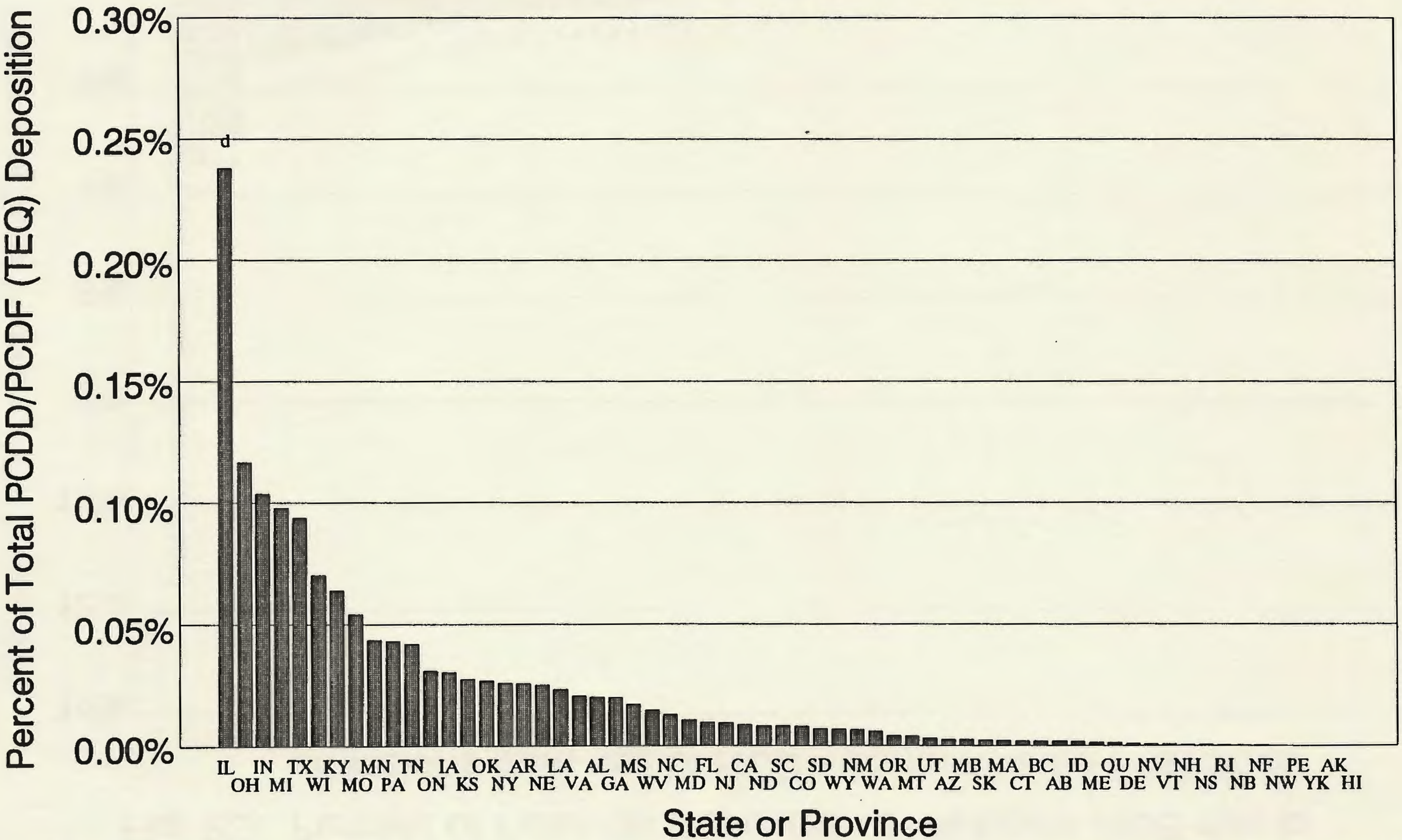
If state or province fell within the top 85% of air deposition contributors of PCDD/PCDF to any given lake, it is labeled with a "d"; None of the states or provinces fell within the top 85% of potential air deposition contributors of HCB to any given lake

Fig. 9D. Percent of Potential Deposition of Airborne HCB due to emissions from use of HCB–Contaminated Pesticides



If state or province fell within the top 85% of potential air deposition contributors of HCB to any given lake, it is labeled with an "h"; Emissions of PCDD/PCDF from pesticide use was assumed to be insignificant

Fig. 9E. Percent of Deposition of Airborne PCDD/PCDF (TEQ) due to emissions from Heavy Duty Diesel Vehicles



Only one state (Illinois) fell within the top 85% of air deposition contributors of PCDD/PCDF to any given lake; it is labeled with a "d";
None of the states fell within the top 85% of potential air deposition contributors of HCB to any given lake

The geographic distribution of the effect of coal burning on PCDD/PCDF deposition reflects both the proximity and the relatively high levels of coal consumption in Midwestern states. Thus, no Northeastern states are included in the states contributing to 85% of the PCDD/PCDF deposition, in part reflecting their relatively low consumption of coal, but also the prevailing wind direction. In the same way, the state-by-state contribution of wood burning to PCDD/PCDF deposition appears to reflect not only proximity to the Great Lakes but also the prevalence of wood burning. Thus, Washington and Oregon contribute significantly, despite their considerable distance from the Great Lakes, because of their relatively high level of wood burning as well as the direction of the prevailing wind.

In the case of HCB from pesticide application, the largest single source is the Province of Ontario, which contributes 11% of the total, followed, in order, by Texas, Michigan, Georgia, Illinois, and California, which together contribute 12%. The predominance of Ontario reflects both its proximity to the Great Lakes and the presence of types of crops that are treated with a high proportion of HCB-contaminated pesticides. That Texas, Georgia and California are also among the main contributors reflects in part their relatively heavy use of such pesticides.

b. The relation between deposition and the geographic orientation of the sources:

The orientation of a source relative to a given lake will determine in part the impact of the weather pattern on the transport of the source's emissions, and hence the fraction deposited in the lake. In order to investigate this relationship, we have divided the total sources of PCDD/PCDF into four groups according to their compass orientation relative to the geographic center of each of the five lakes. It is then possible to determine what percent of the total emissions and of the amount of PCDD/PCDF deposited in each lake is due to the sources located in each of the four quadrants centered on the lake.

The results are shown in Figure 10 (A-E). It is evident that the emissions of the sources in the NW and NE quadrants, as well as the amounts deposited in the lakes, are much less than the emissions (and deposits) from the sources in the SW and SE quadrants. As shown in Table VIII, the emissions from the sources in the two northern quadrants (NW and NE) represent only 2.8% to 22.8% of the total emissions, depending on the lake. This reflects the relative scarcity of sources north of the Great Lakes in comparison with the numerous sources south of them. The largest percentage of emissions originating from the northern sectors (22.8%) occurs in the most southern of the five lakes, Lake Erie, which has a number of sources at or near its northern border.

There is also a striking difference between the western and eastern quadrants with respect to the relationship between emissions and deposition. The effect is greatest in Lake Michigan. Although the emissions from sources in the two western quadrants (NW and SW) account for 85% of the PCDD/PCDF deposits in Lake Michigan, the sources in these quadrants generate only 40% of the total emissions. In contrast, in the eastern quadrants

Figure 10 (A–E).

The Relation Between the Geographic Orientation of PCDD/PCDF Sources and their Emissions and Deposition to the Great Lakes

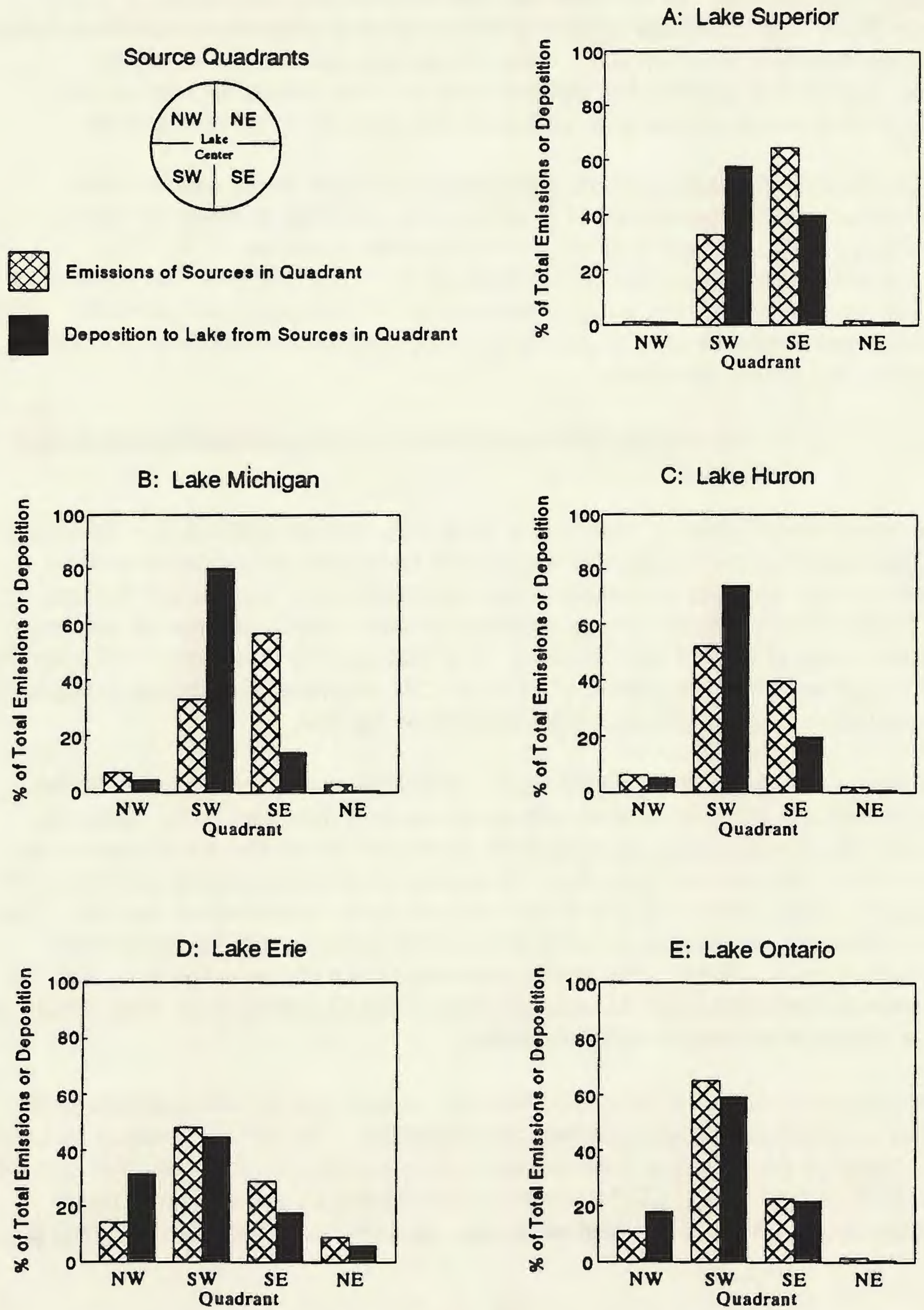


Table VIII
PERCENT OF TOTAL PCDD/PCDF (g TEQ) EMISSIONS

Lake	Quadrants	
	Northern (NW & NE)	Southern (SW & SE)
Superior	2.8	97.2
Huron	8.2	91.8
Michigan	10.0	90.0
Erie	22.8	76.2
Ontario	12.3	87.7

Table IX
EMISSION, DEPOSITION AND AIR TRANSFER COEFFICIENT (ATC)
IN WESTERN AND EASTERN QUADRANTS

Lake	Western Quadrants (NW & SW)			Eastern Quadrants (NE & SE)		
	Emission (% of Lake Total)	Deposition (% of Lake Total)	ATC (% of Emission Deposited)	Emission (% of Lake Total)	Deposition (% of Lake Total)	ATC (% of Emission Deposited)
Superior	34.1	59.1	.119	66.0	40.9	.043
Huron	58.5	79.3	.143	41.6	20.8	.053
Michigan	40.2	85.0	.355	59.8	15.0	.042
Erie	62.4	76.5	.109	37.6	23.5	.056
Ontario	75.8	77.3	.080	24.2	22.7	.073

(NE and SE), this relationship between emissions and deposition is reversed: 60% of the total emissions give rise to only 15% of the deposits. As shown in Table IX, this east/west difference in the relationship between emission and depositions occurs in all five lakes, although it is less pronounced in Lake Erie and Ontario.

Thus, in the western quadrants emissions are more effectively converted into deposits than they are in the eastern quadrants. This can be seen directly from Table IX, which also lists the average air transfer coefficients (percent of emissions that are deposited) for the five lakes. The air transfer coefficients range from 0.080% to 0.355% in the western quadrants and from 0.042% to 0.073% in the eastern quadrants. Thus, as expected from the direction of the prevailing wind, PCDD/PCDF is more effectively transported to the Great Lakes in the west-to-east direction than in the reverse direction. A directional effect on deposition may be involved as well if, for example, winds from the southwest tend to maximize rainfall -- which intensifies deposition -- at the lakes.

c. The relationship between deposition and transport distance:

In order to analyze the influence of the distance between the source and the lake on deposition, we have segmented the sources into annular sections of 250 km each, centered on the geographic center of each of the five lakes. Each annular section was further divided into the four compass quadrants. As shown in Figure 11 (A-E), it was then possible to plot, for each quadrant, the cumulative percentage of PCDD/PCDF deposition as a function of the distance between the sources and the lake.

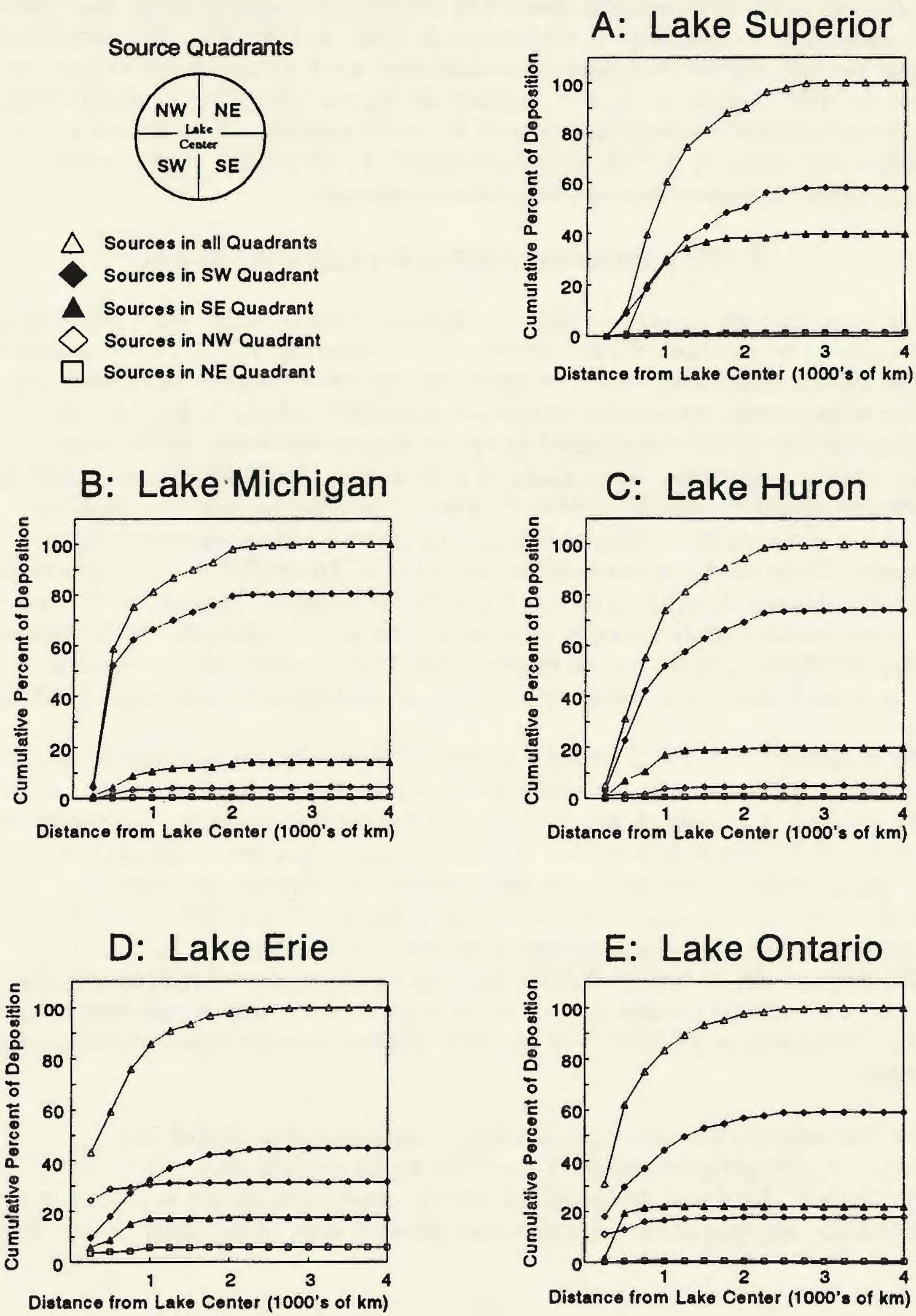
Several relationships are apparent. First, the cumulative deposition with distance follows a hyperbolic curve; sources contribute progressively less deposition as their distance from the lake center increases. This is expected, since as the distance between the source and the lake increases (and with it the time of transport), processes that reduce the amount of material reaching the lake also increase. Progressively more of the original material emitted at the source is lost through deposition to the ground; more of it is subject to destruction; and the remaining material becomes more diffuse.

It is also evident that the role of distance is very different in the SW and SE quadrants. This is shown in Table X by comparing the distances from the lake center at which sources in the SW and SE quadrants have the same average air transfer coefficients, in

Table X
AVERAGE DISTANCE FROM THE LAKE CENTER AT WHICH AIR TRANSFER COEFFICIENTS (ATC) ARE EQUALLY 0.1% IN THE SW AND SE QUADRANTS

Lake	Distance at Which ATC = 0.1% (km)	
	Quadrant	
	SW	SE
Superior	1,600	800
Huron	1,500	600
Michigan	2,000	500
Erie	800	400
Ontario	600	300

Figure 11 (A–E).
The Effect of Distance and Geographic Orientation of Sources on Cumulative Deposition of PCDD/PCDF in the Great Lakes



this case 0.1%. Lake Michigan is the extreme case of a relationship common to all the lakes: sources in the SW quadrant at a distance of 2000 km from Lake Michigan deposit the same percentage of their emissions in the lake as sources in the SE quadrant at a distance of 500 km. This differentiation between the SW and SE quadrants is also evident in Figure 11, which shows that in the SW quadrants, sources at increasing distances from the lake center continue to contribute to deposition in the lake out to 3,000 to 4,000 km. In contrast, in the SE quadrant the total amount deposited accumulates over much shorter distances from the lake center. In effect, sources in the SW quadrant can deposit PCDD/PCDF into the lakes from significantly greater distances than sources in the SE quadrant. This east-west differentiation also occurs in the two northern quadrants but on a much smaller scale, reflecting the lower emissions from sources in these quadrants.

d. The geographic distribution of air transfer coefficients:

The data described above show that the amount of PCDD/PCDF deposited in each of the Great Lakes is the resultant of three factors: (a) the amount of PCDD/PCDF emitted by the sources; (b) the distance between each source and the lake's geographical center; and (c) the location of the source, specifically its compass orientation relative to the lake center. Of these factors, (b) and (c) are encompassed by the air transfer coefficient (ATC), since: deposition = ATC x emission. Accordingly, it is of interest to identify the role played by the transfer and deposition process itself in the entry of airborne pollutants to the Great Lakes. We can visualize the interaction between this process and the sources in the following way: Each source injects a certain amount of PCDD/PCDF or HCB, at a certain point, into the complex, dynamic system that comprises the weather pattern. With time, this material is transported through changing weather patterns to new locations. In the process, the material diffuses and, depending on its properties, some is destroyed, and some is deposited to ground, eventually delivering a fraction of the original emission to a given lake.

The HYSPLIT/TRANSCO program enables us to describe this behavior of the weather system -- without reference to the specific sources that we have identified. As noted earlier, the program is capable of computing the air transfer coefficient that determines what fraction of PCDD/PCDF or HCB emitted by a source in any location is deposited in each of the Great Lakes. Such a computation can then describe the "effective proximity" of emissions from any point to each of the lakes -- so to speak, the ease with which the material is transported from that point and deposited in the lake. In this way, the HYSPLIT/TRANSCO program can be used to describe how the weather system extending over the United States and southern Canada in 1993 would influence the transport and deposition to each of the Great Lakes of PCDD/PCDF and HCB injected into that system from any point in its domain.

For this purpose, the entire U.S./southern Canada area was divided into approximately 20,000 polygons (squares), each 270 square miles in area. The HYSPLIT/TRANSCO program computed the transfer coefficients for the PCDD congener, 2,3,4,7,8-PeCDF, for each of the squares' center points to each of the Great Lakes. Thus, this computation gives rise to values of the percent of the 2,3,4,7,8-PeCDF that, if emitted at each of the approximately 20,000 locations, would be deposited in each of the Great Lakes over the year 1993.

The resultant values are mapped, using differential shading patterns to represent six ranges of transfer coefficient values, in Figures 12A-E. Thus, these maps depict the relative degree to which different locations, serving as the site of 2,3,4,7,8-PeCDF emission, will effectuate the transfer and deposition of this substance into one of the Great Lakes. Since the vapor/particle partitioning behavior of 2,3,4,7,8-PeCDF is similar to the average value for the group of 17 PCDD/PCDF congeners on which TEQ is based, these distribution patterns represent an approximate average for the transfer of PCDD/PCDF toxicity as a whole.

The maps clearly show how the weather system influences the transfer and deposition of PCDD/PCDF into each of the lakes from various geographic regions. While the distribution pattern of ATC values differs among the five lakes, they are all characterized by a pronounced extension of these values to the west and southwest. Thus, the ATC distribution map for Lake Superior shows that the Range 6, representing the highest ATC values, extends only westward from the lake center; the eastern edge of Range 2 is only 400 km from the center, while the western edge is at a distance of 2,400 km. In Lake Huron, the eastern edge of Range 2 is in New York State, about 600 km from the lake center, while the western edge is in Wyoming, 2,500 km from the lake. In Lake Michigan Range 2 extends only 700 km eastward from the lake center and 2,200 km westward. An extension of the ATC values toward the southwest is also evident, with the edge of Range 2 reaching the southern border of Texas, 2,400 km from the lake center, but only extending by 800 km in the opposite direction. Such a southwesterly extension of the range of ATC values is also evident in the maps for Lake Erie and Lake Ontario.

These results confirm the earlier conclusion, based on the data derived from the 1329 identified sources, that the weather system delivers to the Great Lakes a significantly greater fraction of PCDD/PCDF emitted from sources west and southwest of the lakes than from sources in the opposite directions. They also emphasize the importance of long-range transport. Thus, a source emitting PCDD/PCDF in Montana, about 2,400 km west of the center of Lake Superior, would deposit about a third as much of this material into the lake as a source of equal size at the western edge of the lake. Similarly, sources of equal size, one about 400 km south of Lake Michigan and the other in Corpus Christi, Texas, about an additional 1,600 km distant, would deposit PCDD/PCDF in Lake Michigan in the ratio 1:.36.

As indicated earlier, the air transfer coefficients are influenced by the physical characteristics of the specific substance, in particular its vapor/particle partitioning and its susceptibility to chemical or photolytic reactions. This is illustrated in Figures 13A, 13B and 13C. These map the air transfer coefficients of HCB and two PCDD congeners, 2,3,7,8-TCDD and OCDD, to Lake Michigan, and reflect the differences in their physical and chemical characteristics. Thus, source emissions of OCDD, which is predominantly

Fig. 12A: GEOGRAPHIC DISTRIBUTION OF AIR TRANSFER COEFFICIENTS FOR 2,3,4,7,8-PeCDF. Percent of Emissions Deposited in Lake Superior in 1993.

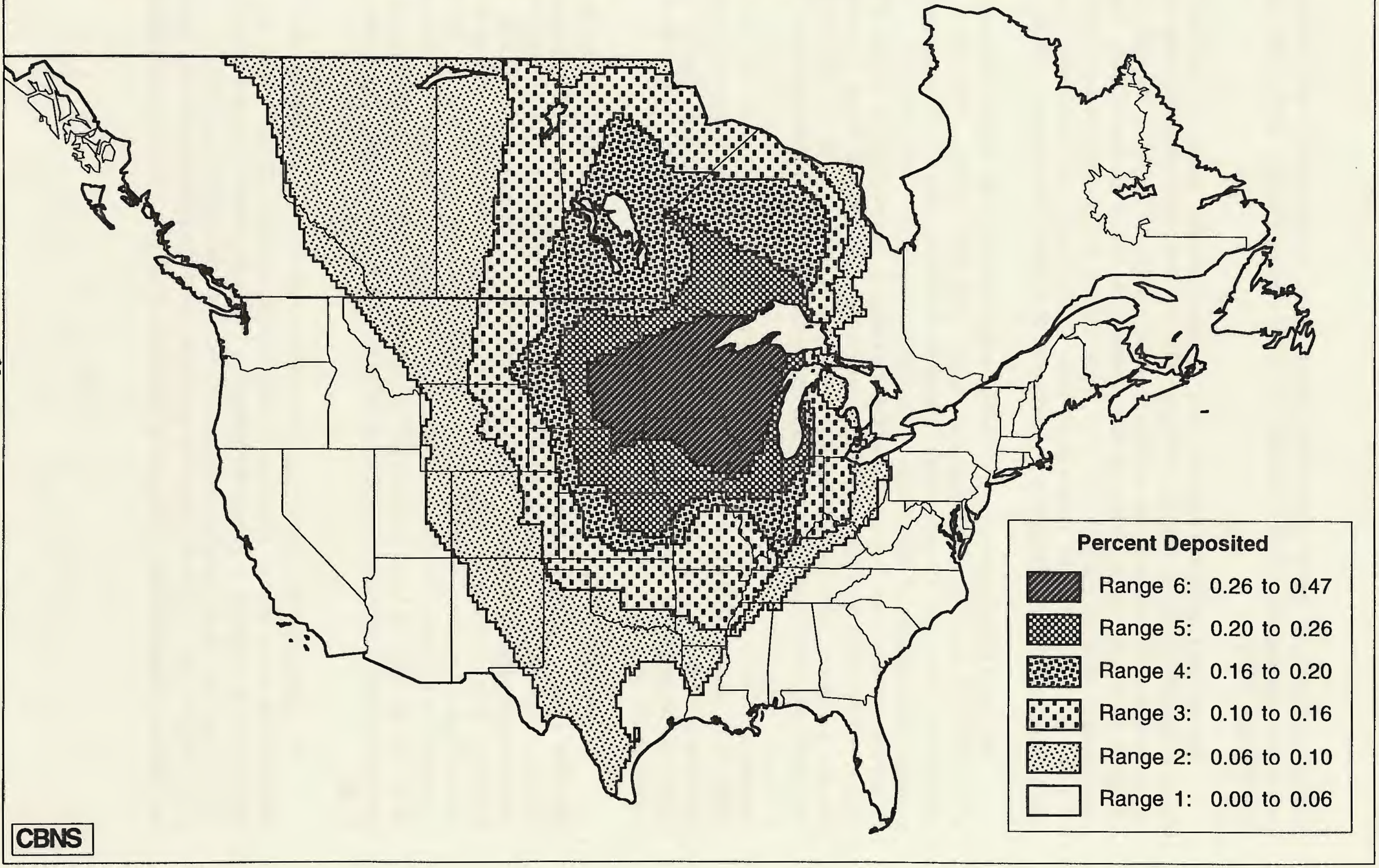


Fig. 12B: GEOGRAPHIC DISTRIBUTION OF AIR TRANSFER COEFFICIENTS FOR 2,3,4,7,8-PeCDF. Percent of Emissions Deposited in Lake Huron in 1993.

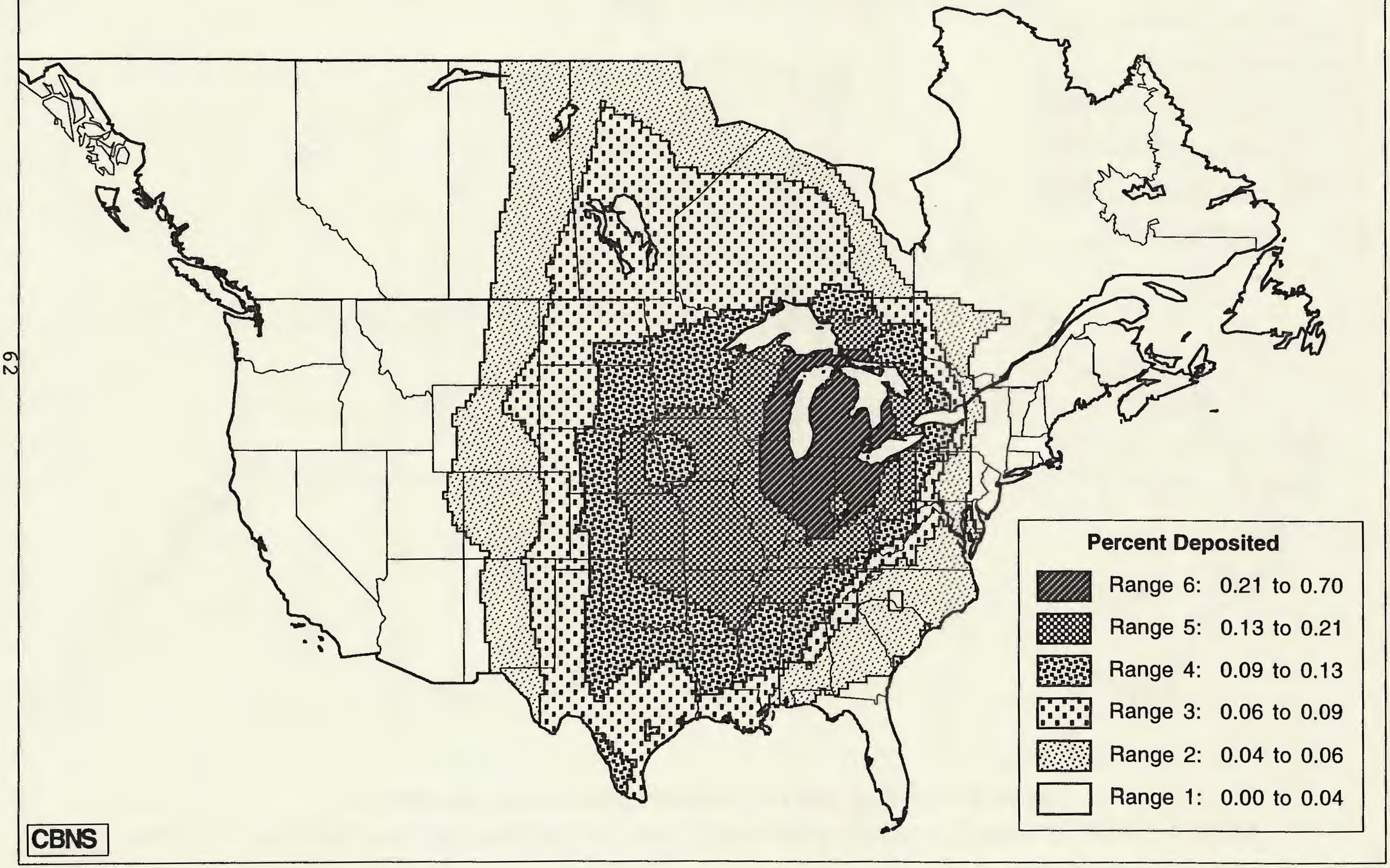


Fig. 12C: GEOGRAPHIC DISTRIBUTION OF AIR TRANSFER COEFFICIENTS FOR 2,3,4,7,8-PeCDF. Percent of Emissions Deposited in Lake Michigan in 1993.

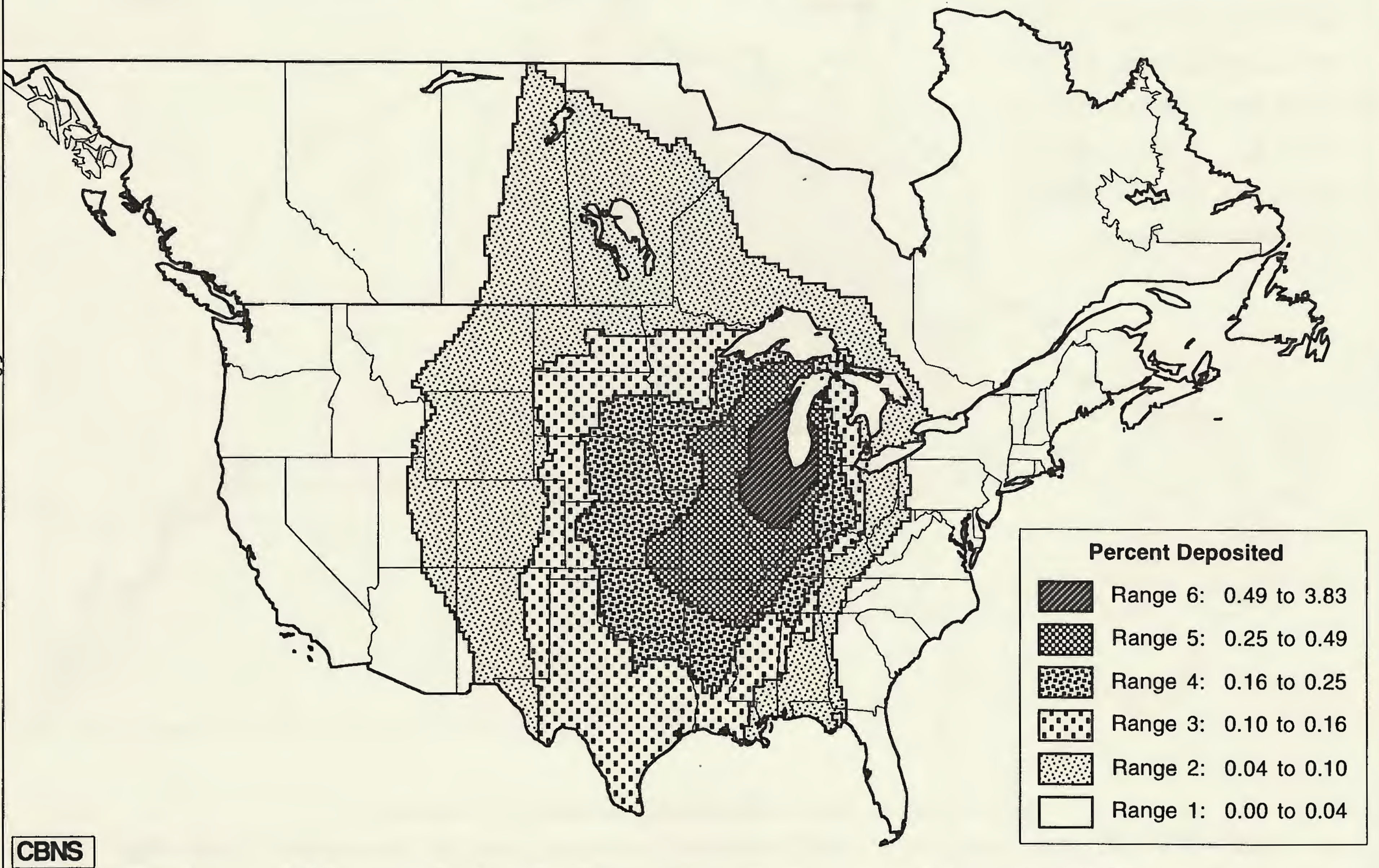


Fig. 12D: GEOGRAPHIC DISTRIBUTION OF AIR TRANSFER COEFFICIENTS FOR 2,3,4,7,8-PeCDF.
Percent of Emissions Deposited in Lake Erie in 1993.

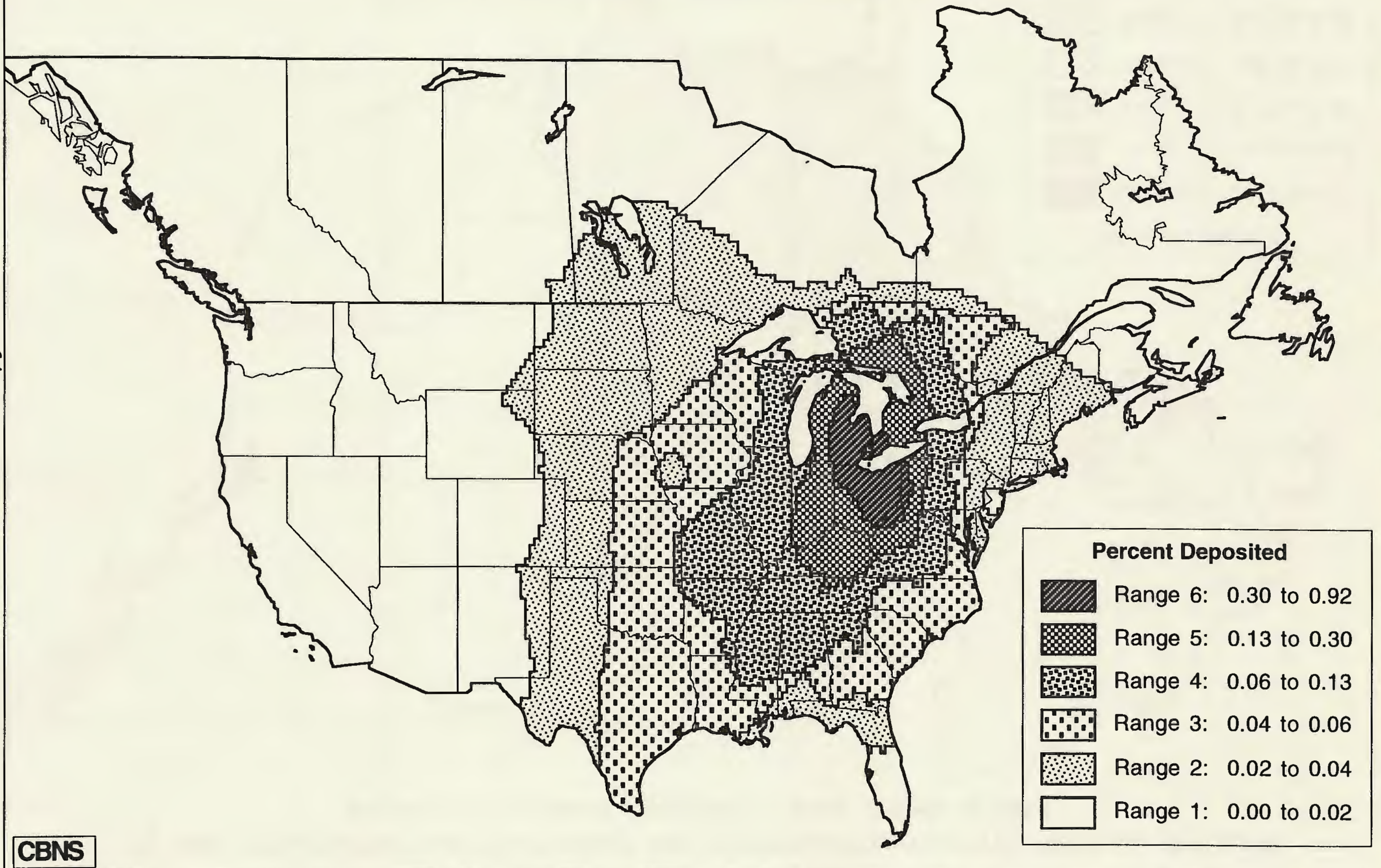


Fig. 12E: GEOGRAPHIC DISTRIBUTION OF AIR TRANSFER COEFFICIENTS FOR 2,3,4,7,8-PeCDF.
Percent of Emissions Deposited in Lake Ontario in 1993.

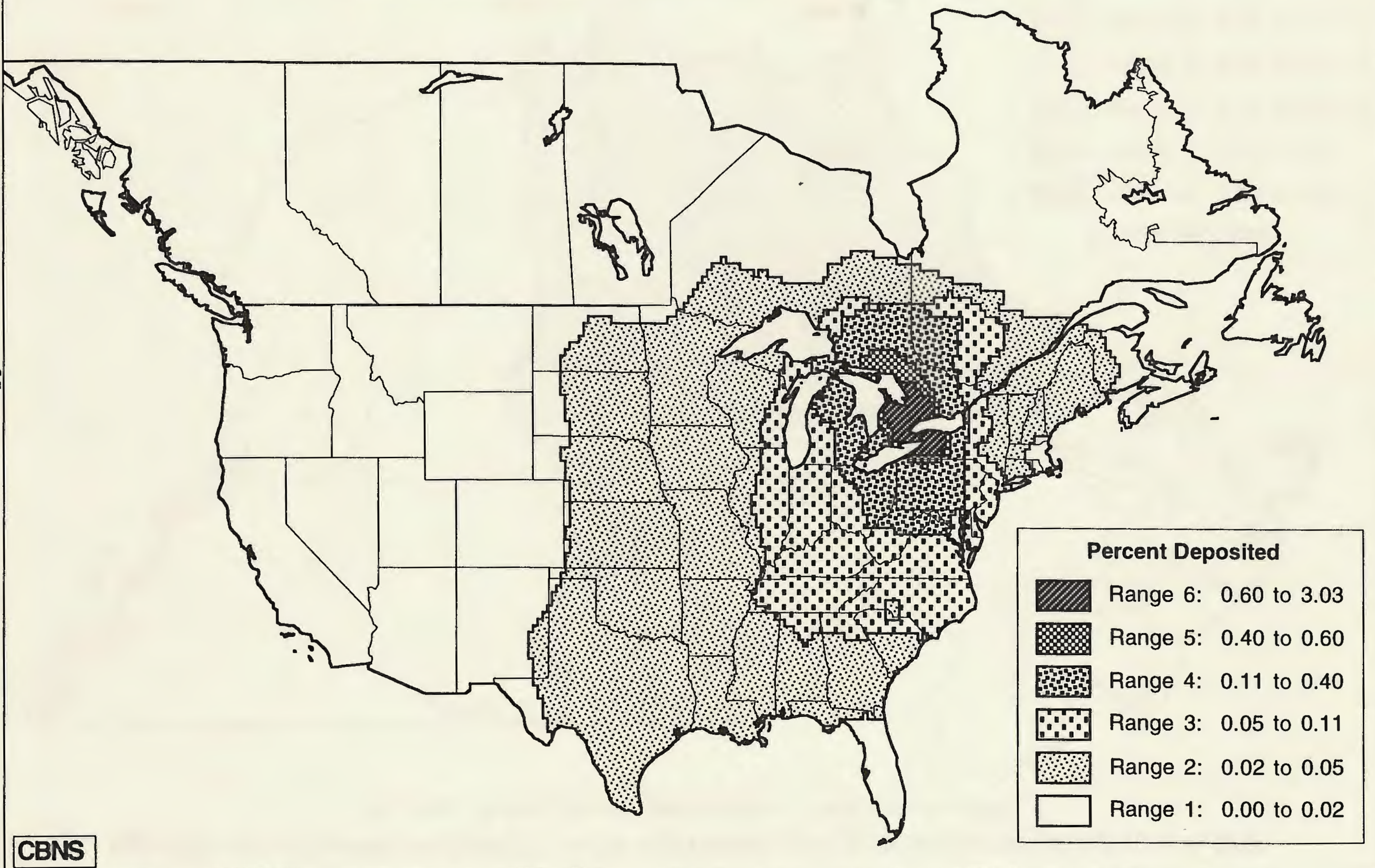


Fig. 13A: GEOGRAPHIC DISTRIBUTION OF AIR TRANSFER COEFFICIENTS FOR 2,3,7,8-TCDD. Percent of Emissions Deposited in Lake Michigan in 1993.

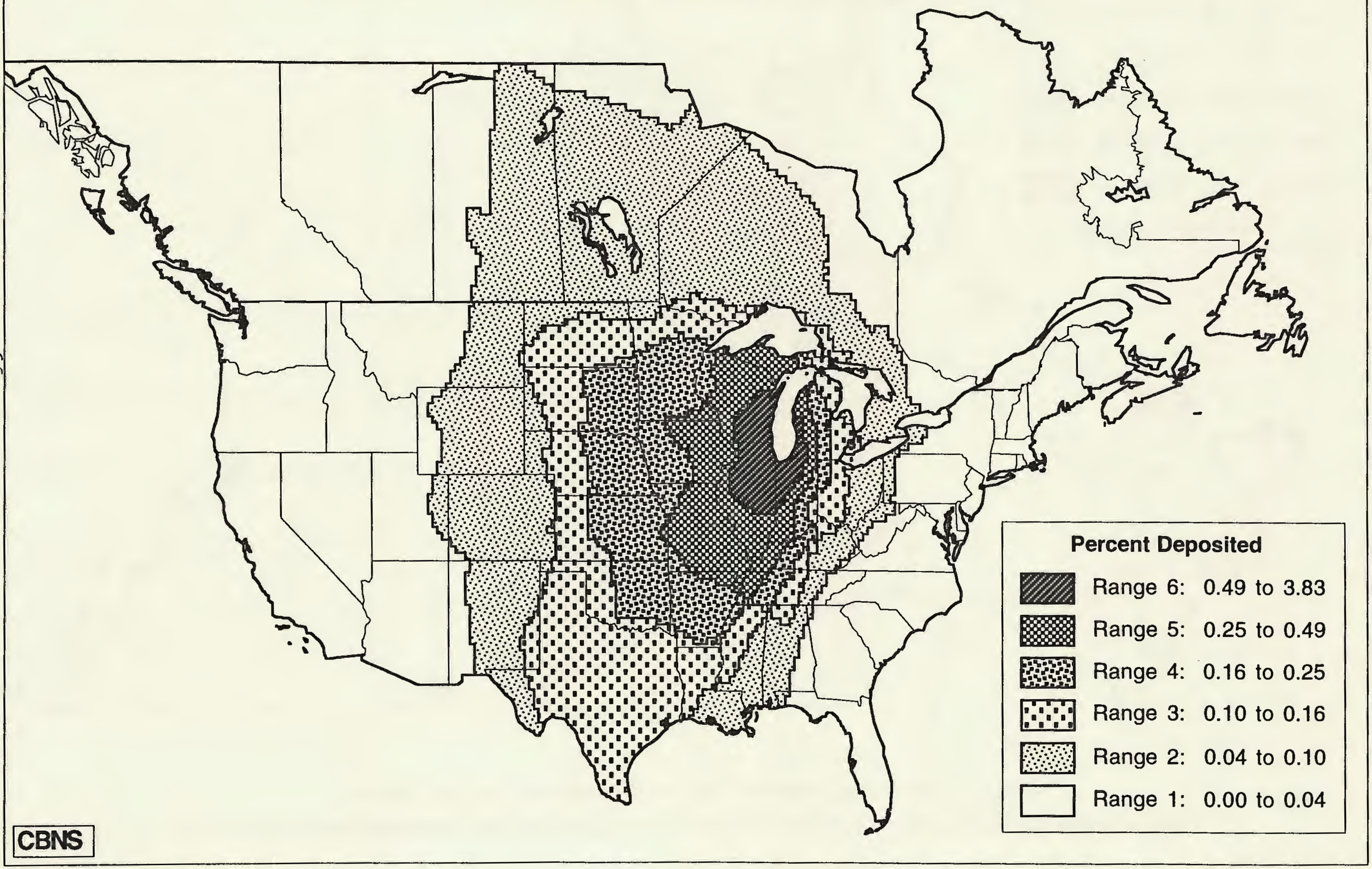


Fig. 13B: GEOGRAPHIC DISTRIBUTION OF AIR TRANSFER COEFFICIENTS FOR OCDD.
Percent of Emissions Deposited in Lake Michigan in 1993.

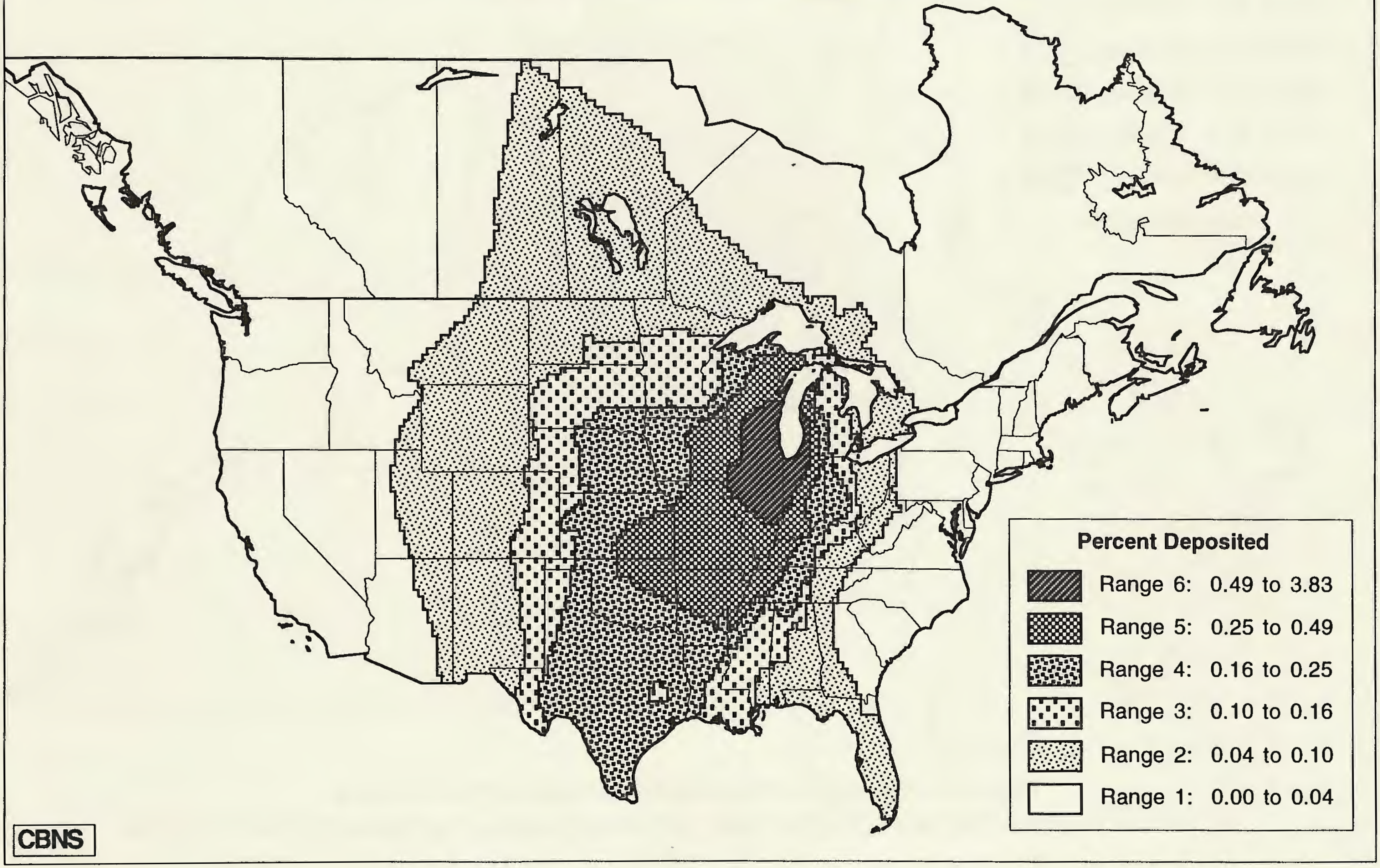
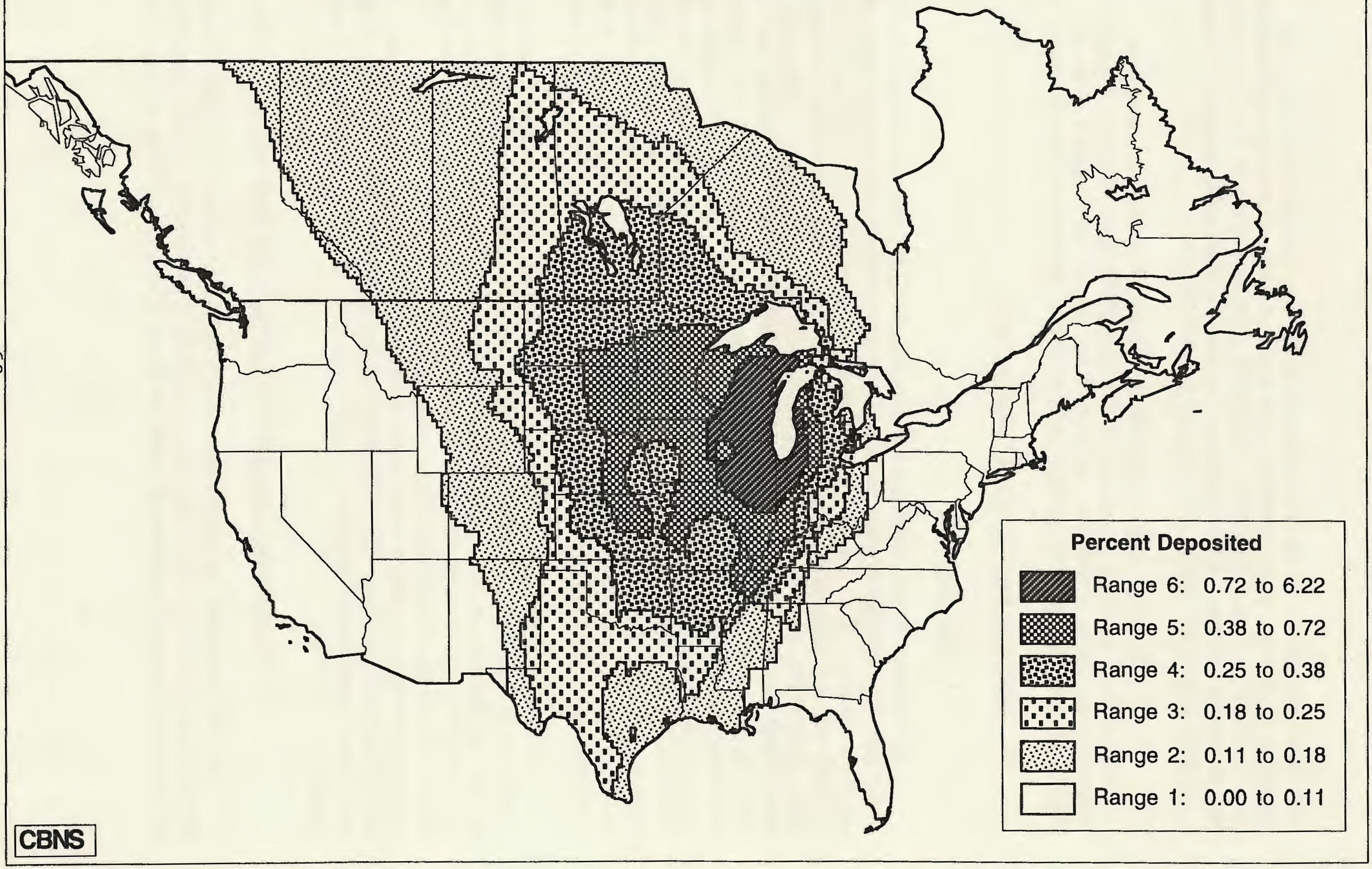


Fig. 13C: GEOGRAPHIC DISTRIBUTION OF AIR TRANSFER COEFFICIENTS FOR HCB.
Percent of Emissions Deposited in Lake Michigan in 1993.



associated with particles in the atmosphere and is therefore somewhat protected from photolytic destruction, have a relatively larger range of influence than source emissions of 2,3,7,8-TCDD or 2,3,4,7,8-PeCDF. While HCB exists predominantly in the gas phase in the atmosphere, its vulnerability to photolytic or chemical destruction is quite low, leading to a relatively large area of influence in comparison with TCDD.

In sum, these maps of the geographic distribution of air transfer coefficients demonstrate the general effectiveness of the HYSPLIT/TRANSCO system as a means of evaluating the transfer of airborne material from any location in the United States and southern Canada, to any other specified location, in this case each of the five Great Lakes.

B. Waterborne Entry of PCDD/PCDF and HCB:

1. The source data:

As indicated earlier, data about the amounts of PCDD/PCDF and HCB entering the Great Lakes from specific sources on the lakes or their tributaries are relatively scarce and usually incomplete. The classes of sources for which reasonably reliable data are available are only pulp and paper mills; some useful but more limited data are available for chemical plants and POTWs (more commonly known as sewage treatment plants). In these cases, the data include measured effluent concentrations of PCDD/PCDF and HCB and the flow rate, from which the load delivered to the lake per year can be estimated. These data, together with measurements of the concentrations and flow rate in the rivers on which certain sources (not necessarily separately evaluated) are located, represent the total waterborne entry of PCDD/PCDF and HCB into each lake. The range of uncertainty in the computed loads is quite large; the maximum value may be an order of magnitude greater than the mid-point estimate. The analyses described below are based on the mid-point values; the possibility that they might actually be considerably greater or significantly less must be kept in mind.

Another difficulty arises regarding the currency of the reported values. Ideally, we wish to know how much PCDD/PCDF and HCB entered the lakes from waterborne sources in 1993, so that these values can be compared with our airborne data. Unfortunately, some of the waterborne data are from the period 1985-86, and as noted below, there is evidence that the levels have declined since then. Moreover, it is possible that some of the measurements made in 1985-86 may reflect HCB and PCDD/PCDF actually emitted considerably earlier. Thus, material generated by sources in the 1970s -- generally at levels well above current ones -- may persist in sediments from which they are currently being eluted.

2. The amounts of waterborne PCDD/PCDF and HCB entering the Lakes:

Table XI summarizes the overall results regarding the amounts of PCDD/PCDF and HCB entering each of the lakes from the three classes of sources and from the connecting channels (the Niagara River/Welland Canal and the St. Clair/Detroit River system). Sources

Table XI. PCDD/PCDF and HCB Loadings to the Great Lakes from Liquid Effluents (1993)

	Hexachlorobenzene (kg/year) (midpoint value of estimates)					PCDD/PCDF (g TEQ/year) (midpoint value of estimates)				
Source Class	Lake Superior	Lake Ontario	Lake Erie	Lake Huron	Lake Michigan	Lake Superior	Lake Ontario	Lake Erie	Lake Huron	Lake Michigan
Pulp and Paper Mills	(a)	(a)	(a)	(a)	(a)	0.61	0.010	0.020	0.10	0.16
Chemical Manufacturers and Other Industrial Plants (b)	none identified	0.32	1.0	none identified	none identified	0.5	0.4	0.6	0.09	0.02
Sewage Treatment Plants (POTWs) (c)	0.1	1.7	2.2	0.6	0.8	0.3	3.5	4.8	1.2	1.7
Loading from connecting channel(s)		33 (Niagara River and Welland Canal)	less than 70 (d) (St. Clair/ Detroit River system)				unknown (Niagara River and Welland Canal)	8 (d) (St. Clair/ Detroit River system)		
Total for Liquid Discharges to Lake (e)	0.1	35 (f)	less than 72 (f)	0.6	0.8	1.4	greater than 3.9	11 (f)	1.4	1.9

(a) There are no reliable data that indicate that hexachlorobenzene is generated at and/or emitted from Pulp and Paper mills.
(b) Facilities discharging directly to the lake or one of its tributaries for which data are available for detected levels of HCB and/or PCDD/F in effluents
(c) The estimates of loading from POTWs are very uncertain, as they rely on emissions factors developed from measurements on only a few facilities.
(d) See text regarding uncertainty.
(e) Totals may not "appear" to be exact sums because each number in the table has been independently rounded off.
(f) A portion of the loading from POTWs and industrial facilities separately totalled in this table are due to facilities which discharge to the connecting channel; the total loading has been adjusted to eliminate double-counting.

on the connecting channels dominate waterborne HCB loading into Lakes Ontario and Erie. In these lakes direct discharge that can be ascribed to individual identified plants amounts to only a small fraction -- perhaps 1-2% -- of the total estimated waterborne loading of HCB; the PCDD/PCDF loading due to quantified emissions from individual plants is also only a small fraction of the total. As a result, the HCB loading to Lakes Erie and Ontario are nearly two orders of magnitude greater than the loading to the other lakes; the difference in PCDD/PCDF loading is much smaller and more uncertain.

3. The origin of PCDD/PCDF and HCB in connecting channels:

The waterway that connects Lake Huron to Lake Erie consists of the St. Clair River, Lake St. Clair, and the Detroit River (which leads into Lake Erie). The link between Lake Erie and Lake Ontario is the Niagara River, with the Welland Canal playing a much smaller role. Given the foregoing relationships, it is important to consider the significance of the loading originating in the connecting channels in more detail. There are in fact considerable difficulties in estimating the amounts of toxic materials entering Lakes Erie and Ontario from the channel systems.

a. HCB in the St. Clair/Detroit River system:

HCB in the effluents from individual sources (chiefly chemical plants) on the St. Clair River was studied in 1985-86 (the Upper Great Lakes Connecting Channel Study (UGLCCS), Environment Canada and U.S. EPA, 1988). This study reported a total of 12.5 kg of HCB per year entering the river from such sources, including 8.9 kg/year from the Dow Chemical manufacturing plant in Sarnia, Ontario. Four other studies (also in 1985-86) (summarized by Environment Canada (1993a)) reported effluent values for the Dow Sarnia plant ranging from 3 to 50 kg per year. In the same period of time, several studies were made to estimate the amount of HCB entering the St. Clair River by measuring concentrations at its inlet and outlet. The UGLCCS reported that 5 kg/year entered the river from Lake Huron and 131 kg/year was discharged by the river into Lake St. Clair, so that at least 126 kg of HCB was discharged to the river per year. Another study (Chan, 1986) yielded a value for the amount of HCB being carried by the St. Clair River at Port Lambton (near the downstream end of the river) ranging between 21 and 102 kg per year. A similar study (Lau, 1989) yielded the following results: 12 kg/year entered the river from Lake Huron, at least 35 kg/year was added by industrial sources, but only 17 kg/year remained at the end of the river as it emptied into Lake St. Clair. (Presumably this added HCB was lost through evaporation.) Thus, the net effect of sources along the river was the addition of 5 kg per year. Taking all these results into account, it seems reasonable to conclude that loadings from sources on the St. Clair River probably represented about 50 kg of HCB per year in 1985-86. We are aware of no later measurements.

There are very few data on the entry of HCB into Lake St. Clair. The UGLCCS found that three sewage treatment plants and storm drains from Canadian cities accounted for a total of 0.36 kg per year. The UGLCCS suggested that 95% of the HCB entering Lake St.

Clair would be lost, presumably through evaporation. However, elsewhere in the same report, the UGLCCS reports that 80 kg/year were entering the lake from the St. Clair River and 92 kg/year were discharged from the lake into the Detroit River, representing an addition of at least 12 kg of HCB per year to the lake. Considering the variability and uncertainty of these results, it is reasonable to conclude that there is no net increase of HCB attributable to sources on Lake St. Clair.

The UGLCCS report includes estimates of HCB in the effluent from sources on the Detroit River (chemical plants and sewage treatment plants). They represent a total of 0.87-4.4 kg of HCB per year. Measurements at the river inlet and outlet led to the conclusion that there was very little net addition of HCB to the Detroit River (0-3 kg/year). However, measurements at the outlet nevertheless indicated that between 44 and 95 kg/year of HCB were carried from the Detroit River into Lake Erie.

Overall, these data, while very uncertain, suggest that perhaps 70 kg of HCB per year entered Lake Erie from the St. Clair/Detroit River system in 1985-86. At the same time, studies of HCB in the eggs of the Herring Gull (a fish-eating bird) at Fighting Island in the Detroit River have declined since 1985-86, suggesting a reduced rate of entry into the river (Bishop et al., 1992A, 1992B; Hebert et al., 1994; Pettit et al., 1994A, 1994B). Further, the Dow Chemical plant in Sarnia, identified in previous studies as perhaps the largest source of HCB to this channel system, reportedly ceased the manufacture of chlorinated compounds in 1993. In sum, it would appear that the amount of HCB entering Lake Erie from sources on the St. Clair/Detroit River system in 1993 may be less than 70 kg per year. Given the uncertainties in the data, even this estimate must be regarded as unreliable. The need for more reliable current data is self-evident.

b. PCDD/PCDF in the St. Clair/Detroit River system:

We have found only one set of data regarding PCDD/PCDF in the effluent from sources on this river system, which has been kindly provided to us by the Ontario Ministry of Environment and Energy (OMOEE, 1992, 1994B). According to these measurements, in 1989-91 six chemical plants contributed a total of 0.749 g TEQ of PCDD/PCDF to the river system. Using recent measurements of effluents from several POTWs in other locations, we have estimated that POTWs contribute approximately 1.6 g TEQ per year to the connecting channel system. It would appear, therefore, that these sources contributed a total of about 2.4 g TEQ of PCDD/PCDF per year.

OMOEE (Jobb et al., 1990) has also studied the PCDD/PCDF concentration in drinking water taken from the river system at a series of points from Sarnia (near the inlet from Lake Huron) to Amherstburg (near the outlet to Lake Erie). These data, collected in 1985-86, lead to the conclusion that about 8 g TEQ of PCDD/PCDF leaves the channel system and is discharged into Lake Erie, with the largest additions probably occurring in the Sarnia region. However, given the actual measurements there is considerable uncertainty in this result. The only toxic PCDD/PCDF congener actually detected in these measurements was OCDD. All the other toxic congeners were below the detection limit, which was reported as "in the low ppq range" (parts per quadrillion, equivalent to picograms per liter). If we assume that the detection limit was 1 pg/lit and that in fact each of the 17 toxic congeners was present in concentrations just under this detection limit, then the corresponding flux of PCDD/PCDF leaving the river system would be 477 g TEQ per year. Thus, the actual number is very uncertain, but may be more than 8 g TEQ per year.

c. The entry of HCB and PCDD/PCDF to Lake Ontario through the Niagara River:

There is strong evidence that hazardous waste sites along the Niagara River have been significant contributors of PCDD/PCDF and HCB to Lake Ontario via the Niagara River (Elder et al., 1981; U.S. EPA, 1985; U.S. EPA/NYS DEC, 1993 and 1994; U.S. EPA et al., 1990).

To our knowledge, no current measurements of the effluents from specific sources have quantified HCB entering the Niagara River or the Welland Canal (a relatively small connecting channel between Lakes Erie and Ontario). However, an extensive sampling program undertaken jointly by Environment Canada, U.S. EPA, the New York State Dept. of Environmental Conservation, and OMOEE has been operating since 1984. Based on repeated measurements at the inlet to the Niagara River and the outlet to Lake Ontario, at most 7 kg/year entered the river from Lake Erie, at least 26 kg/year was added by sources to the river, and 33.2 kg of HCB per year was carried by the river into Lake Ontario.

There are very few data regarding the entry of PCDD/PCDF to the Niagara River, and these are insufficient to estimate the loading to Lake Ontario. There is evidence that the Niagara River was the principle source of PCDD/PCDF contamination in Lake Erie in the past, but that these sources have declined. As a result, we conclude that the amount of PCDD/PCDF entering Lake Ontario from the Niagara River is unknown.

C. The Relative Impact of Airborne and Waterborne PCDD/PCDF and HCB:

Table XII summarizes our computation of the amounts of PCDD/PCDF and HCB that enter the Great Lakes annually as deposition from the air and directly as liquid effluent. It is again important to take note of the relative reliability of the two sets of data. In general we regard the air deposition values (and especially those for PCDD/PCDF) as reasonably reliable. But the water values are much less reliable because they are relatively incomplete and affected by the frequency with which "non-detect" levels occur. Nevertheless, certain systematic relations are suggested by the data.

For Lakes Superior, Huron and Michigan, the loading of HCB from the air appears to be much greater than the entry from liquid effluent. For Lakes Ontario and Erie, the waterborne loading appears to be greater than the potential atmospheric loading. However, as noted earlier, our estimates of HCB deposition are based only on emissions from

Table XII. Summary of the Amounts of HCB and PCDD/PCDF Contributed to the Great Lakes from Air and Water Sources (1993)

Lake	HCB Loading to the Great Lakes (kg/year)		PCDD/PCDF Loading to the Great Lakes (g TEQ per year)	
	Air	Water	Air	Water
Lake Superior	11	0.1	5.6	1.4
Lake Ontario	23	35	6.4	greater than 3.9
Lake Erie	15	less than 72	7.3	11
Lake Huron	16	0.6	8.6	1.4
Lake Michigan	15	0.8	13.7	1.9

Note: As discussed in the text, the air loadings for HCB are somewhat uncertain, as they do not include sources outside of the U.S. and Canada, and, are the potential amount of HCB that would be deposited if the Lake were uncontaminated with HCB.

U.S./Canadian sources and do not reflect potential deposition of HCB that originates in the global circulation of this substance. Taking this global source into account might increase our HCB potential deposition estimate perhaps by as much as a factor of 10. This may be particularly important for Lakes Superior, Huron and Michigan, which appear to receive the bulk of their HCB from the air.

There are differences among the five lakes with respect to the relative entry of PCDD/PCDF from air and water sources. Except for Lake Erie and Lake Ontario, the airborne component is greater than the waterborne entry. In Lake Erie and Lake Ontario, the relative loading is more difficult to estimate due to the highly uncertain loadings from the inter-lake connecting channels.

Waterborne entry of PCDD/PCDF into Lake Ontario may in part reflect historically contaminated sediment in the Niagara River. Here, however, two additional factors appear to be involved: (a) that the numerous toxic dumps -- many of them known to contain high concentrations of PCDD/PCDF -- adjacent to the Niagara/ Welland system continue to leach these substances into the river; and (b) that Lake Ontario receives water from Lake Erie, which is itself elevated in PCDD/PCDF concentration.

IV. DISCUSSION

This study can be seen as a response to the distinctive policies developed by the International Joint Commission. As pointed out earlier, these policies call for an approach to the analysis and regulation of toxic pollutants that sharply differs from current practice. It is of interest, therefore, to review the results of this study in the light of the contrasting approaches of the IJC and the more conventional agencies such as U.S. EPA.

Conventional practice has been largely governed by the control strategy, which is directed toward achieving some, presumably acceptable, level of emissions into the environment. Attention is focused on the individual plant and on the degree to which its control device is suited to this purpose. Analysis of the plant's impact on the environment is based on risk assessment, which, in order to facilitate comparison, is usually evaluated in terms of the "maximum exposed individual." In turn, this requirement generally limits consideration of the transport of the plant's emissions to the determination of the region of highest concentration ("where the plume hits the ground"), which is naturally within a few kilometers of the source. Little attention is given to the more distant, widespread fate of the emissions -- an attitude that has left the way open to arguments that widespread pollution must be due to some ubiquitous source, such as "fires." This may explain why the observed widespread occurrence of PCDD/PCDF in the environment -- for example, in vacuum cleaner sweepings -- has been regarded as evidence that this pollutant originates in natural processes, such as forest fires, rather than in specific industrial operations.

The data presented in this report reflect the consequences of having oriented this study toward the IJC approach rather than the conventional one. To begin with, the IJC's concern with a large environmental domain -- the Great Lakes -- rather than a narrow region in the immediate neighborhood of an industrial plant dictated the scope of our analysis. We were required to analyze the impact, not of a few individual sources, but of thousands of them -- ranging in their design from cement kilns to paper mills. Then, given the wide geographic distribution of the airborne sources, it was necessary to develop the HYSPLIT/TRANSCO model in order to estimate, for each of the 1329 sources, the amount of their PCDD/PCDF and HCB emissions that actually reaches the Great Lakes. This created -- to our knowledge, for the first time -- an estimate of the cumulative impact of the numerous, varied sources of PCDD/PCDF and HCB on an environmental domain. Fortunately, despite the inadequacies of the basic data, the model appears to estimate the amount of at least the deposition of PCDD/PCDF in the lakes with a reasonable degree of accuracy, so that the numerous sources can be ranked with respect to their individual contributions to this process. In turn, this capability allowed us to identify types of sources, and individual ones, that -- if redesigned to remove the pollutant-generating process -- would make a start toward the goal of virtual elimination: the IJC goal.

An important outcome of our analysis is the evidence that the airborne emissions are transported over distances of continental dimensions. In the case of HCB -- which is both volatile and highly stable -- this was to be expected from the earlier evidence of its global distribution. However, in the case of PCDD/PCDF, despite evidence of its widespread occurrence, little consideration has been given thus far to the possibility that this phenomenon might be the result of long-range transport. The most critical evidence of the ubiquitous occurrence of PCDD/PCDF is the measurement of the body burdens in representative samples of the U.S. population (Stanley et al., 1985). As pointed out in an earlier CBNS study (Commoner et al., 1986), a pharmicokinetic analysis of the observed levels leads to an exposure estimate of 2-9 pg TEQ per day, which, as confirmed by the recent EPA dioxin reassessment, is sufficient to cause concern regarding the occurrence of the hazards now associated with PCDD/PCDF.

Our data provide a new factual basis for understanding the ubiquitous exposure of the population to PCDD/PCDF. Because of the long-range transport of PCDD/PCDF and its tendency to become adsorbed to airborne particulates, deposition is widespread and contaminates the environment generally. Therefore, PCDD/PCDF can be expected to contaminate not only the Great Lakes, but agricultural crops as well, leading to uptake by beef cattle and dairy cows; deposits will settle on forests, leading to the occurrence of PCDD/PCDF in forest fires; PCDD/PCDF-contaminated dust will settle in homes, eventually occurring in vacuum cleaner sweepings.

In effect, we must now regard the PCDD/PCDF emitted to the air by numerous industrial processes -- chiefly combustion -- as the source of the ubiquitous "background" exposure to these substances at levels sufficient to cause concern about the harmful effects on the general population. This is a conclusion that calls for urgent remedial action.

In this sense, the Great Lakes' regional problem might be seen as simply a part of a national problem that must be addressed as a whole -- and remedied -- for the benefit of every region. Viewed in this way, the task of sunsetting the sources is very large, complex, and potentially disruptive. It is no surprise that the first such proposal in the United States -- sunsetting the gasoline-driven automobile in favor of pollution-free electric vehicles -- has been resisted nationally, despite vigorous regional support from California and the Northeast states. What could be accomplished by addressing the Great Lakes problem regionally?

The data developed by the HYSPLIT/TRANSCO program help to resolve this issue. By ranking the contributions of the numerous airborne sources, we find that most of the environmental impact arises from relatively few of them. For example, only 10% or less of the sources are responsible for at least 85% of the PCDD/PCDF that enters the lakes from the air, greatly reducing what would otherwise be a formidable task of remediation.

The same analytical data further narrow this task. Thus, only 18 of the 196 municipal waste incinerators that deposit PCDD/PCDF in the Great Lakes contribute to 85% of the total amount deposited. In the same way, the data enable us to determine that ten of the 12 iron sintering plants and 16 of the 30 cement kilns that burn hazardous waste are among the sources that contribute to 85% of the total airborne PCDD/PCDF deposited in any of the five lakes. In sum, of the 1329 sources that contribute to the airborne deposition of PCDD/PCDF to the Great Lakes, only 106 account for 85% of the total.

Such data also allow us to rank the relative contribution of different sources by class. This singles out four classes -- municipal waste incineration, iron sintering, cement kilns burning hazardous waste, and medical waste incineration (see note, p. 10) -- as responsible for 85% or more of the total deposition of airborne PCDD/PCDF in the Great Lakes. Similar data identify four source classes as responsible for the deposition of 85% of the potential deposition of HCB: the use of HCB-contaminated pesticides, cement kilns burning hazardous waste, HCB waste incineration, and municipal solid waste incineration.

These data serve to greatly reduce the number of sources that merit the considerable effort that will be required to eliminate their generation of PCDD/PCDF and/or HCB. At the same time, the value of undertaking this task is enhanced by the similarity of the source classes that rank high in their impact on the Great Lakes and those that are major sources of PCDD/PCDF or HCB nationally. That is, the same sources that account for the deposition of the majority of the PCDD/PCDF in the Great Lakes also account for the majority of the U.S. and Canadian national emissions of these pollutants. Consequently, if, in keeping with the policy that the IJC has urged, the Great Lakes states were to develop a program for sunsetting these sources, that pioneering effort could serve as a model nationally as well.

The waterborne sources that are contributors of PCDD/PCDF and HCB to the Great Lakes are naturally more characteristic of that region than of the nation as a whole. Nevertheless, one of the contributors of these pollutants to the Great Lakes -- paper mills -- are sources of pollution in many other parts of the United States and Canada. Here, too, initiatives developed in the Great Lakes region to appropriately transform these facilities can serve as important, broadly applicable models.

Finally, it is useful to recall that the immediate purpose of this study has been the identification of sources of PCDD/PCDF and HCB that are suitable subjects of the second phase of our project: the development of economically constructive ways of eliminating the processes that generate these pollutants. Much of the necessary economic information can be acquired from generic sources, such as the U.S. Census of Manufacturers or Agricultural Statistics. However, for more detailed data about the technological and economic feasibility of replacing or modifying the process within a source that generates PCDD/PCDF or HCB, individual facilities must be examined as well. Accordingly, it would be useful to derive from our database of sources a list of those that not only rank highest in loadings to the Great Lakes, but might also be able to provide detailed technological and economic information regarding the feasibility and consequences of sunsetting. These sources would comprise useful initial subjects for the analysis of the technical and economic implications of transforming them in order to eliminate the generation of PCDD/ PCDF and HCB.

As noted earlier, the uncertainty inherent in the available data on sources of HCB makes ranking beyond the level of source class less informative. However, in the case of Lake Ontario, the use of HCB-contaminated pesticides and cement kilns burning hazardous waste comprise 76% of the airborne potential deposition of that pollutant from sources in the United States and Canada. Detailed analysis of sunset options focused on these two sources would therefore be particularly useful.

In sum, the analyses developed in the course of this study provide a useful basis for the second phase of this project: the evaluation of economically constructive ways of sunsetting the sources that contribute the bulk of the PCDD/PCDF and HCB that enter the Great Lakes. For the reasons cited earlier, the quantitative data on HCB are considerably less complete and more uncertain than those on PCDD/PCDF. In both cases there are also uncertainties about the emissions from specific individual sources, given that these are estimated not from direct measurements, but from reported throughput and generic emission factors.

While such uncertainties are unlikely to influence the ranking of source classes, they may affect the ranking of individual sources. The remedy is to considerably expand the effort -- which is very limited at present -- to determine the actual amounts of PCDD/PCDF and HCB in the emissions and effluents of the various sources. This would provide direct measurements of emissions of particularly important individual sources, as well as more reliable data on emission factors. It would be especially important to obtain such direct data on the individual highest-ranked sources as a means of confirming the ranking developed by our indirect model-based computations.

Indeed, a useful outcome of this study has been the identification of such gaps and inadequacies in the present information about PCDD/PCDF and HCB emissions and effluents. Particularly lacking are expanded analyses on emissions from combustion facilities; on the HCB content of pesticides; and on emissions from HCB waste incineration, especially that generated by the largest potential source -- the production of vinyl chloride monomer used to manufacture polyvinyl chloride (PVC) (no such data appear to be available at present). The actual emissions from U.S. iron sintering plants need to be determined as well; these are now lacking, so that it was necessary to use data from German plants for our estimates. Up-to-date data on the PCDD/PCDF and HCB content of the St. Clair/Detroit River system and the effluent from known sources are needed, as well as data on the PCDD/PCDF loading to Lake Ontario from sources contributing to the Niagara River. More measurements of the PCDD/PCDF and HCB content of the effluent from sewage treatment plants are needed. Much more monitoring of ambient air concentrations would also be useful for comparison with values computed by the HYSPLIT/TRANSCO program.

Finally, it is worth noting that the methods that we have developed to analyze the transport of pollutants from widely spread sources to the Great Lakes are also applicable to certain other environmental problems. For example, it is now apparent that the major route of human exposure to PCDD/PCDF, which has led to average body burdens high enough to affect the health of a significant part of the general population, is food -- beef and dairy products in particular (Schecter et al., 1994). It would be of considerable interest, therefore, to determine the origin of the PCDD/PCDF that contaminates the crops used to feed beef cattle and dairy cows. Much of this is likely to be from atmospheric deposition and could be traced, in the manner that we have used to evaluate the airborne sources to the Great Lakes, by the application of the HYSPLIT/TRANSCO program.

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APPENDIX

Table of 1329 individual sources, in the United States and Canada, that emit PCDD/PCDF and HCB to the air.

The table shows the results of computations, carried out by the HYSPLIT/TRANSCO program, of the percent of the materials emitted by each source that are deposited in each of the five Great Lakes. The table includes the name, location, and throughput of each source. The sources are separated by class, and within each class ranked in descending order by the average percent contribution of the source to the total amounts of PCDD/PCDF deposited in the five lakes.

The indicated codes are defined as follows:

(a) Type Codes:

Municipal Solid Waste Incineration:
1 = mass burn: refractory wall
2 = mass burn: waterwall
3 = mass burn: rotary kiln
4 = refused derived fuel
5 = modular: starved air
6 = modular: excess air

Hazardous Waste Incineration:
0 = commercial hazardous waste incinerator
1 = on-site hazardous waste incinerator
2 = boiler - industrial furnace burning hazardous waste
5 = mobile hazardous waste incinerator
6 = unclassified

Cement Kilns:
3 = facilities burning hazardous waste
4 = facilities not burning hazardous waste

Hexachlorobenzene Waste Incineration:
1 = production of carbon tetrachloride
2 = production of tetrachloroethylene
3 = production of trichloroethylene
4 = production of vinyl chloride monomer
5 = production of monochlorobenzene
6 = production of o-dichlorobenzene
7 = production of p-dichlorobenzene
8 = production of 1,2,4-trichlorobenzene

Mobile Sources:
1 = diesel-powered heavy duty vehicles
2 = unleaded gasoline vehicles
3 = leaded gasoline vehicles

Sewage Sludge Incineration, Iron Sintering Plants, Secondary Copper Smelters, Secondary Copper Refiners, Medical Waste Incineration, Coal Combustion, Wood Combustion, Pesticide Application:
1 = all types combined

(b) Air Pollution Control Devices (APCD):

Municipal Solid Waste Incineration:
0 = no apcd
1 = dry scrubber/fabric filter
2 = electrostatic precipitator
3 = dry scrubber/electrostatic precipitator

Hazardous Waste Incineration, HCB Waste Incineration, Sewage Sludge Incineration, Cement Kilns, Iron Sintering Plants, Secondary Copper Smelters, Secondary Copper Refiners, Coal Combustion, Wood Combustion:
1 = all types of apcd combined

Mobile Sources:
1 = standard apcd for each type

Medical Waste Incineration and Pesticide Application:
0 = no apcd

(c) Throughput Unit Codes:

1 = grams per hour burned or processed (unit for HCB waste incineration = grams HCB incinerated per hour; unit for pesticide application = grams HCB applied per hour)
2 = billions of vehicle kilometers per year
3 = tons/year bumed
3 = tons/year processed

Facility Name	City	State/ Province	Country	Type Code (a)	APCD (b)	Throughput	Unit (c)	5-Lake Average Percent of Total Deposition TEQ	HCB	Within Top 85% of Deposition to any Lake (1 = yes) TEQ	HCB
Municipal Solid Waste Incineration											
Clinton Grosse	Clinton	MI	USA	1	2	1.7E+07	1	4.67%	0.33%	1	1
Central Wayne C	Dearborn H	MI	USA	1	2	1.4E+07	1	3.89%	0.28%	1	1
Amer RefFuel Ni	Niagara Fa	NY	USA	4	2	6.1E+07	1	3.57%	0.68%	1	1
Columbus MWC	Columbus	OH	USA	4	2	6.6E+07	1	2.26%	0.36%	1	1
Pulaski MWC	Baltimore	MD	USA	1	2	3.5E+07	1	1.33%	0.05%	1	0
Ramsey Washingt	Newport	MN	USA	4	2	4.0E+07	1	1.28%	0.32%	1	1
Akron MWC	Akron	OH	USA	4	2	2.2E+07	1	0.81%	0.13%	1	1
McKay Bay MWC	Tampa	FL	USA	1	2	3.0E+07	1	0.46%	0.03%	1	0
Greenpoint MWC	Brooklyn	NY	USA	1	2	1.4E+07	1	0.34%	0.01%	1	0
Dade County MWC	Miami	FL	USA	4	2	9.7E+07	1	0.31%	0.07%	1	0
Davis County MW	Layton	UT	USA	1	3	1.2E+07	1	0.28%	0.02%	1	0
La Crosse N Sta	La Crosse	WI	USA	4	2	7.7E+06	1	0.25%	0.06%	1	0
Northwest MWC	Chicago	IL	USA	2	2	3.7E+07	1	0.25%	1.47%	1	1
Betts Avenue	Queens	NY	USA	1	2	8.4E+06	1	0.20%	0.01%	1	0
Kodak MWC	Rochester	NY	USA	4	2	4.1E+06	1	0.17%	0.03%	1	0
Ames RDF MWC	Ames	IA	USA	4	2	4.4E+06	1	0.12%	0.02%	1	0
Peel MWC	Brampton	ON	CAN	5	1	1.5E+07	1	0.12%	0.09%	1	1
East Chicago MW	Chicago	IL	USA	1	0	1.3E+07	1	0.11%	0.51%	1	1
Madison MWC	Madison	WI	USA	4	2	1.8E+06	1	0.07%	0.02%	0	0
Lawrence Haverh	Haverhill	MA	USA	4	2	2.8E+07	1	0.07%	0.01%	0	0
Albany Stm Gen	Albany	NY	USA	4	2	1.3E+07	1	0.06%	0.01%	0	0
Walter Hall MWC	Tulsa	OK	USA	2	2	3.6E+07	1	0.05%	0.20%	0	1
Nashville NTTC	Nashville	TN	USA	2	2	3.3E+07	1	0.04%	0.15%	0	1
Southwest BRESC	Baltimore	MD	USA	2	2	7.4E+07	1	0.04%	0.11%	0	1
Essex County MW	Newark	NJ	USA	2	3	9.0E+07	1	0.02%	0.08%	0	0
Alexandria Arli	Alexandria	VA	USA	2	2	3.6E+07	1	0.02%	0.06%	0	0
Westchester RES	Peekskill	NY	USA	2	2	6.8E+07	1	0.02%	0.06%	0	0
Montgomery Cnty	Dayton	OH	USA	3	2	9.7E+06	1	0.02%	0.07%	0	0
Wash DC MWC 1	Washington	DC	USA	2	3	4.3E+07	1	0.02%	0.07%	0	0
Tuscaloosa MWC	Tuscaloosa	AL	USA	5	2	9.3E+06	1	0.02%	0.01%	0	0
Pinellas MWC	St Ptrsbrg	FL	USA	2	2	8.6E+07	1	0.02%	0.09%	0	0
Wstrn Lk Sup Sa	Duluth	MN	USA	4	0	7.3E+06	1	0.02%	0.05%	0	0
Barron County M	Almena	WI	USA	5	2	3.3E+06	1	0.02%	0.01%	0	0
Harford MWC	Joppa	MD	USA	5	2	1.2E+07	1	0.02%	0.00%	0	0
Pigeon Point MW	Newcastle	DE	USA	6	2	2.1E+07	1	0.02%	0.01%	0	0
Harrisburg MWC	Harrisburg	PA	USA	2	2	2.3E+07	1	0.02%	0.04%	0	0
Marathon Cnty M	Ringle	WI	USA	4	0	5.2E+06	1	0.02%	0.04%	0	0
Oswego County M	Fulton Vol	NY	USA	5	2	6.8E+06	1	0.01%	0.00%	0	0
Baltimore Count	Cockeysvil	MD	USA	4	0	1.9E+07	1	0.01%	0.02%	0	0
Perham MWC	Perham	MN	USA	5	2	3.1E+06	1	0.01%	0.01%	0	0
Olmstead County	Rochester	MN	USA	2	2	6.1E+06	1	0.01%	0.07%	0	0
New Hanover Cnt	Wilmington	NC	USA	5	3	1.1E+07	1	0.01%	0.00%	0	0
Richards Asphal	Savage	MN	USA	5	2	2.3E+06	1	0.01%	0.01%	0	0
Red Wing MWC	Red Wing	MN	USA	5	2	2.3E+06	1	0.01%	0.01%	0	0
Camden MWC	Camden	NJ	USA	2	3	3.5E+07	1	0.01%	0.03%	0	0
Polk County MWC	Fosston	MN	USA	5	2	3.1E+06	1	0.010%	0.006%	0	0
Hillsborough Co	Brandon	FL	USA	2	2	4.4E+07	1	0.010%	0.045%	0	0
St Croix County	New Richmo	WI	USA	5	1	3.1E+06	1	0.009%	0.009%	0	0
Indianapolis MW	Indianapol	IN	USA	2	1	7.0E+07	1	0.008%	0.588%	0	1
Chambers Med Te	Hampton	SC	USA	5	2	7.5E+06	1	0.008%	0.002%	0	0
Haverhill MWC	Haverhill	MA	USA	2	3	5.8E+07	1	0.008%	0.035%	0	0
Sumner County M	Gallatin	TN	USA	3	2	5.7E+06	1	0.008%	0.027%	0	0
Pope Douglas MW	Alexandria	MN	USA	6	2	2.2E+06	1	0.008%	0.006%	0	0
Savannah MWC	Sanannah	GA	USA	2	2	1.8E+07	1	0.007%	0.023%	0	0
Oneida County M	Rome	NY	USA	5	2	6.0E+06	1	0.007%	0.002%	0	0
Montreal MWC	Montreal	QU	CAN	2	2	2.2E+07	1	0.007%	0.026%	0	0
Charleston MWC	Charleston	SC	USA	2	3	2.3E+07	1	0.007%	0.025%	0	0
Blytheville MWC	Blythevill	AR	USA	5	0	2.9E+06	1	0.007%	0.005%	0	0
North Andover R	North Ando	MA	USA	2	2	4.0E+07	1	0.007%	0.024%	0	0
County Energy S	Panama Cit	FL	USA	3	2	1.9E+07	1	0.007%	0.026%	0	0
Long Beach MWC	Long Beach	NY	USA	5	2	7.6E+06	1	0.006%	0.002%	0	0
Central Mass MW	Millbury	MA	USA	2	3	5.0E+07	1	0.006%	0.029%	0	0
Fergus Falls MW	Fergus Fal	MN	USA	5	0	2.8E+06	1	0.006%	0.007%	0	0

Facility Name	City	State/ Province	Country	Type Code (a)	APCD (b)	Throughput	Unit (c)	5-Lake Average Percent of Total Deposition		Within Top 85% of Deposition to any Lake (1 = yes)	
								TEQ	HCB	TEQ	HCB
Greater Detroit	Detroit	MI	USA	4	1	7.8E+07	1	0.006%	0.993%	0	1
Heartland Recyc	Iowa Falls	IA	USA	4	0	2.2E+06	1	0.006%	0.014%	0	0
Batesville MWC	Batesville	AR	USA	5	0	2.7E+06	1	0.005%	0.004%	0	0
Hampton NASA MW	Hampton	VA	USA	2	2	8.9E+06	1	0.005%	0.013%	0	0
Tacoma RDF MWC	Tacoma	WA	USA	4	0	1.3E+07	1	0.005%	0.016%	0	0
Westmoreland MW	Greensburg	PA	USA	5	2	1.2E+06	1	0.005%	0.001%	0	0
Harrisonburg MW	Harrisonbu	VA	USA	5	2	2.4E+06	1	0.005%	0.001%	0	0
Wallingford MWC	Wallingfor	CT	USA	5	1	1.4E+07	1	0.004%	0.002%	0	0
Hennepin Energy	Minneapoli	MN	USA	2	1	3.8E+07	1	0.004%	0.458%	0	1
Pittsfield MWC	Pittsfield	MA	USA	6	3	7.8E+06	1	0.004%	0.001%	0	0
Rutland MWC	Rutland	VT	USA	6	3	7.8E+06	1	0.004%	0.002%	0	0
I95 Fairfax Cnt	Lorton	VA	USA	2	1	1.1E+08	1	0.004%	0.180%	0	1
Pascagoula MWC	Moss Point	MS	USA	6	2	3.7E+06	1	0.003%	0.002%	0	0
Adirondack MWC	Hudson Fal	NY	USA	2	3	1.6E+07	1	0.003%	0.013%	0	0
Miami MWC	Miami	OK	USA	5	0	1.7E+06	1	0.003%	0.002%	0	0
Fall River MWC	Fall river	MA	USA	2	0	1.4E+07	1	0.003%	0.009%	0	0
Stamford MWC	Stamford	CT	USA	2	2	1.0E+07	1	0.003%	0.009%	0	0
Springfield MWC	Agawam	MA	USA	5	1	1.2E+07	1	0.003%	0.002%	0	0
Moore County MW	Moore Coun	TX	USA	1	0	2.6E+06	1	0.003%	0.010%	0	0
Osceola MWC	Osceola	AR	USA	5	1	1.2E+06	1	0.003%	0.002%	0	0
Hereford MWC	Hereford	TX	USA	1	0	2.6E+06	1	0.003%	0.010%	0	0
Univ City MWC	Charlotte	NC	USA	2	2	7.4E+06	1	0.003%	0.007%	0	0
Kent County MWC	Grand Rapi	MI	USA	2	1	2.0E+07	1	0.003%	0.251%	0	1
Hamilton MWC	Hamilton	ON	CAN	2	1	1.1E+07	1	0.003%	0.237%	0	1
Hohenwald Inc M	Hohenwald	TN	USA	5	0	1.7E+06	1	0.003%	0.002%	0	0
Greater Portlan	Portland	ME	USA	2	3	1.7E+07	1	0.003%	0.012%	0	0
Cleburne MWC	Cleburne	TX	USA	6	3	1.7E+06	1	0.003%	0.001%	0	0
Delaware County	Chester	PA	USA	3	1	8.6E+07	1	0.003%	0.076%	0	0
Stuttgart MWC	Stuttgart	AR	USA	5	0	1.4E+06	1	0.002%	0.002%	0	0
Key West MWC	Key West	FL	USA	5	2	4.1E+06	1	0.002%	0.001%	0	0
Salem MWC	Salem	VA	USA	5	0	2.4E+06	1	0.002%	0.001%	0	0
Anoka Cnty Elk	Elk River	MN	USA	4	1	4.8E+07	1	0.002%	0.381%	0	1
Glen Cove MWC	Glen Cove	NY	USA	2	3	8.2E+06	1	0.002%	0.007%	0	0
Lamprey Regiona	Durham	NH	USA	5	2	4.1E+06	1	0.002%	0.001%	0	0
St Johns Univ M	Collegevil	MN	USA	5	0	6.7E+05	1	0.002%	0.002%	0	0
York County MWC	York	PA	USA	3	1	3.6E+07	1	0.002%	0.060%	0	0
Center MWC	Center	TX	USA	5	0	1.5E+06	1	0.002%	0.001%	0	0
Hempstead MWC	Westbury	NY	USA	2	1	9.5E+07	1	0.002%	0.079%	0	0
Honolulu MWC	Honolulu	HA	USA	1	2	1.7E+07	1	0.002%	0.000%	0	0
Pennington Cnty	Thief Rive	MN	USA	4	0	1.0E+06	1	0.002%	0.006%	0	0
New Canaan MWC	New Canaan	CT	USA	2	0	3.6E+06	1	0.001%	0.003%	0	0
Recomp Washingt	Ferndale	WA	USA	5	1	3.6E+06	1	0.001%	0.002%	0	0
Carthage Panola	Carthage	TX	USA	5	0	1.1E+06	1	0.001%	0.001%	0	0
Lancaster Cnty	Marietta C	PA	USA	2	1	3.8E+07	1	0.001%	0.060%	0	0
Pentagon MWC	Arlington	VA	USA	1	0	1.4E+06	1	0.001%	0.002%	0	0
North County MW	West Palm	FL	USA	4	3	7.3E+07	1	0.001%	0.049%	0	0
Bridgeport RESC	Bridgeport	CT	USA	2	1	7.7E+07	1	0.001%	0.061%	0	0
Parkdale MWC	Parkdale	PE	CAN	5	0	3.4E+06	1	0.001%	0.001%	0	0
Huntsville MWC	Huntsville	AL	USA	2	1	2.0E+07	1	0.001%	0.074%	0	0
Jackson County	Jackson	MI	USA	2	1	6.2E+06	1	0.001%	0.091%	0	1
Wheelabrator Fa	Morrisvill	PA	USA	2	1	5.1E+07	1	0.001%	0.043%	0	0
St David Levis	St David Q	QU	CAN	2	0	2.3E+06	1	0.0010%	0.0026%	0	0
Park County MWC	Livingston	MT	USA	5	0	1.6E+06	1	0.0010%	0.0011%	0	0
Broward County	Fort Laude	FL	USA	2	1	7.7E+07	1	0.0009%	0.0797%	0	0
Broward County	Pompano Be	FL	USA	2	1	7.3E+07	1	0.0008%	0.0746%	0	0
Montgomery Cnty	Conshohock	PA	USA	2	1	4.0E+07	1	0.0008%	0.0333%	0	0
SEMASS MWC	Rochester	MA	USA	4	3	6.2E+07	1	0.0008%	0.0245%	0	0
Windham MWC	North Wind	CT	USA	5	1	3.1E+06	1	0.0008%	0.0005%	0	0
Fort Dix MWC	Wrightstow	NJ	USA	5	1	1.5E+06	1	0.0007%	0.0003%	0	0
Fort Eustis MWC	Fort Eusti	VA	USA	5	0	9.4E+05	1	0.0007%	0.0003%	0	0
Channel Sanit C	Juneau	AK	USA	2	2	2.0E+06	1	0.0006%	0.0042%	0	0
Beav Hill Coos	Coquille	OR	USA	5	0	2.9E+06	1	0.0006%	0.0007%	0	0
SE Tidewater MW	Portsmouth	VA	USA	4	1	4.9E+07	1	0.0006%	0.0455%	0	0
EPR Inc MWC	Eden Prair	MN	USA	4	1	1.2E+07	1	0.0005%	0.0996%	0	1
Quebec City MWC	City of Qu	QU	CAN	2	1	3.0E+07	1	0.0005%	0.0344%	0	0

Facility Name	City	State/ Province	Country	Type Code (a)	APCD (b)	Throughput	Unit (c)	5-Lake Average Percent of Total Deposition TEQ	HCB	Within Top 85% of Deposition to any Lake (1 = yes) TEQ	HCB
Victoria Hospit	London	ON	CAN	2	1	3.4E+06	1	0.0005%	0.0389%	0	0
Koksilah MWC	Duncan	BC	CAN	5	0	1.3E+06	1	0.0005%	0.0006%	0	0
Mayport Naval S	Mayport	FL	USA	6	0	1.2E+06	1	0.0005%	0.0003%	0	0
Spokane MWC	Spokane	WA	USA	2	1	3.0E+07	1	0.0004%	0.0560%	0	0
Huntington MWC	East North	NY	USA	2	1	2.8E+07	1	0.0004%	0.0227%	0	0
Sitka MWC	Sitka	AK	USA	6	3	7.5E+05	1	0.0004%	0.0004%	0	0
Sidney MWC	Sidney	NS	CAN	5	1	1.2E+06	1	0.0004%	0.0002%	0	0
Saugus RESCO MW	Saugus	MA	USA	2	1	4.5E+07	1	0.0004%	0.0262%	0	0
Burnaby MWC	Burnaby	BC	CAN	2	1	2.7E+07	1	0.0004%	0.0481%	0	0
Babylon MWC	West Babyl	NY	USA	2	1	2.4E+07	1	0.0004%	0.0196%	0	0
Gen Motors MWC	Oshawa	ON	CAN	3	1	8.3E+05	1	0.0004%	0.0217%	0	0
MacArthur MWC	Ronkonkoma	NY	USA	3	1	1.7E+07	1	0.0004%	0.0133%	0	0
Gloucester Cnty	West Deptf	NJ	USA	2	1	1.8E+07	1	0.0004%	0.0151%	0	0
Dutchess County	Poughkeeps	NY	USA	3	1	1.5E+07	1	0.0004%	0.0131%	0	0
Lassen Com Coll	Susanville	CA	USA	5	1	2.9E+06	1	0.0004%	0.0003%	0	0
Pittsfield NH M	Pittsfield	NH	USA	5	0	1.4E+06	1	0.0003%	0.0002%	0	0
Pasco County MW	Spring Hil	FL	USA	2	1	2.8E+07	1	0.0003%	0.0299%	0	0
Harbour Grace M	Harbour Gr	NF	CAN	5	0	9.8E+05	1	0.0003%	0.0002%	0	0
Wainright MWC	Wainright	AL	CAN	5	1	6.1E+05	1	0.0003%	0.0004%	0	0
Muscoda MWC	Muscoda	WI	USA	1	1	2.4E+06	1	0.0003%	0.0280%	0	0
Warren MWC	Oxford Tow	NJ	USA	2	1	1.5E+07	1	0.0003%	0.0134%	0	0
Southeast SERRF	Long Beach	CA	USA	2	1	4.6E+07	1	0.0003%	0.0193%	0	0
Mid Connecticut	Hartford	CT	USA	4	1	6.4E+07	1	0.0003%	0.0292%	0	0
Bristol MWC	Bristol	CT	USA	2	1	2.0E+07	1	0.0002%	0.0145%	0	0
Marion County M	Brooks	OR	USA	2	1	1.9E+07	1	0.0002%	0.0278%	0	0
Labrador City M	Labrador C	NF	CAN	5	0	4.9E+05	1	0.0002%	0.0001%	0	0
Southeast MWC	Preston	CT	USA	2	1	2.3E+07	1	0.0002%	0.0142%	0	0
Lincoln MWC	Lincoln	NH	USA	5	0	6.9E+05	1	0.0002%	0.0001%	0	0
Delaware MWC	Newcastle	DE	USA	4	1	2.4E+07	1	0.0002%	0.0163%	0	0
Wilton MWC	Wilton	NH	USA	5	0	8.6E+05	1	0.0002%	0.0001%	0	0
Beto 1 Unit MWC	Palestine	TX	USA	5	0	1.9E+05	1	0.0002%	0.0002%	0	0
Tumbler Ridge M	Tumbler Ri	BC	CAN	5	0	4.3E+05	1	0.0002%	0.0003%	0	0
Lake County MWC	Okahumpka	FL	USA	2	1	1.6E+07	1	0.0002%	0.0163%	0	0
Concord Regiona	Penacook	NH	USA	2	1	1.7E+07	1	0.0002%	0.0118%	0	0
Ladysmith MWC	Ladysmith	BC	CAN	5	0	4.3E+05	1	0.0002%	0.0002%	0	0
Lake Cowichan M	Lake Cowic	BC	CAN	5	0	4.3E+05	1	0.0002%	0.0002%	0	0
Pelham MWC	Pelham	NH	USA	5	0	6.9E+05	1	0.0002%	0.0001%	0	0
Stapleton Intl	Denver	CO	USA	5	0	1.7E+05	1	0.0001%	0.0001%	0	0
Litchfield MWC	Litchfield	NH	USA	5	0	6.3E+05	1	0.0001%	0.0001%	0	0
Saltaire MWC	Saltaire F	NY	USA	5	0	3.5E+05	1	0.0001%	0.0001%	0	0
Plymouth MWC	Plymouth	NH	USA	5	0	4.6E+05	1	0.0001%	0.0001%	0	0
Wolfeboro MWC	Wolfeboro	NH	USA	5	0	4.6E+05	1	0.0001%	0.0001%	0	0
Readsboro MWC	Readsboro	VT	USA	1	0	3.7E+05	1	0.0001%	0.0003%	0	0
Skagit County M	Mount Vern	WA	USA	3	1	5.2E+06	1	0.0001%	0.0094%	0	0
Mid Maine MWC	Auburn	ME	USA	3	1	6.7E+06	1	0.0001%	0.0050%	0	0
Harpswell MWC	Harpswell	ME	USA	5	0	4.0E+05	1	0.0001%	0.0001%	0	0
Stanislaus Cnty	Crows Land	CA	USA	2	1	3.0E+07	1	0.0001%	0.0112%	0	0
Penobscot MWC	Orrington	ME	USA	4	1	2.3E+07	1	0.0001%	0.0121%	0	0
Candia MWC	Candia	NH	USA	5	0	4.3E+05	1	0.0001%	0.0001%	0	0
ANSWERS MWC	Albany	NY	USA	4	1	1.6E+07	1	0.0001%	0.0096%	0	0
Stamford MWC	Stamford	VT	USA	1	0	2.9E+05	1	0.00009%	0.00022%	0	0
Gatesville MWC	Gatesville	TX	USA	5	0	8.6E+04	1	0.00009%	0.00007%	0	0
Maine Energy Re	Biddeford	ME	USA	4	1	2.3E+07	1	0.00009%	0.01025%	0	0
Exeter Energy M	Sterling	CT	USA	2	1	9.6E+06	1	0.00009%	0.00584%	0	0
New Hamp Vermon	Claremont	NH	USA	2	1	7.3E+06	1	0.00008%	0.00529%	0	0
Commerce MWC	Commerce	CA	USA	2	1	1.1E+07	1	0.00007%	0.00484%	0	0
Reuter of Flori	Pembroke P	FL	USA	4	1	1.3E+07	1	0.00006%	0.00891%	0	0
Nottingham MWC	Nottingham	NH	USA	6	0	2.3E+05	1	0.00006%	0.00003%	0	0
City of Lakelan	Lakeland	FL	USA	4	3	3.1E+06	1	0.00005%	0.00213%	0	0
Galax City MWC	Galax	VA	USA	3	1	1.1E+06	1	0.00004%	0.00153%	0	0
Tacoma Stm Plnt	Tacoma	WA	USA	4	1	7.8E+06	1	0.00004%	0.00920%	0	0
Auburn MWC	Auburn	NH	USA	5	0	1.4E+05	1	0.00003%	0.00002%	0	0
Modesto Tire In	Westley	CA	USA	2	1	5.5E+06	1	0.00002%	0.00200%	0	0
Robertson Count	Springfiel	TN	USA	4	1	4.0E+05	1	0.00001%	0.00133%	0	0
H Power MWC	Ewa Honolu	HI	USA	4	3	6.2E+07	1	0.00001%	0.00011%	0	0

Facility Name	City	State/ Province	Country	Type Code (a)	APCD (b)	Throughput	Unit (c)	5-Lake Average Percent of Total Deposition TEQ	HCB	Within Top 85% of Deposition to any Lake (1 = yes) TEQ	HCB
Shemya AFB MWC	Shemya	AK	USA	5	0	5.8E+05	1	0.000001%	0.000000%	0	0
North Slope Bor	Prudhoe Ba	AK	USA	5	2	2.1E+04	1	0.000000%	0.000000%	0	0
Alaska Solid Wa	Fairbanks	AK	USA	4	1	9.3E+05	1	0.000000%	0.000002%	0	0

Facility Name	City	State/ Province	Country	Type Code (a)	APCD (b)	Throughput	Unit (c)	5-Lake Average Percent of Total Deposition		Within Top 85% of Deposition to any Lake (1 = yes)	
								TEQ	HCB	TEQ	HCB
Hazardous Waste Incineration											
HWI:LWD	Calvert Ci	KY	USA	0	1	1.7E+05	3	0.07%	0.21%	0	1
HWI:Laidlaw	Sarnia	ON	CAN	1	1	7.2E+04	3	0.06%	0.23%	0	1
HWI:Rollins Env	Baton Roug	LA	USA	0	1	3.5E+05	3	0.05%	0.16%	0	1
HWI:Waste Techn	East Liver	OH	USA	0	1	9.5E+04	3	0.05%	0.14%	0	1
HWI:US Army Pue	Pueblo	CO	USA	1	1	3.0E+05	3	0.04%	0.15%	0	1
HWI:Ross Incine	Grafton	OH	USA	0	1	7.6E+04	3	0.04%	0.13%	0	1
HWI:Chemical Wa	Sauget	IL	USA	0	1	7.6E+04	3	0.03%	0.09%	0	0
HWI:BP American	Cleveland	OH	USA	2	1	5.0E+04	3	0.03%	0.08%	0	1
HWI:Dow Chemica	Freeport	TX	USA	2	1	1.5E+05	3	0.03%	0.08%	0	0
HWI:Rhone-Poule	Houston	TX	USA	0	1	1.3E+05	3	0.02%	0.07%	0	0
HWI:ENSCO	El Dorado	AR	USA	0	1	8.7E+04	3	0.02%	0.06%	0	0
HWI:Rhone Poule	Baton Roug	LA	USA	0	1	1.1E+05	3	0.02%	0.05%	0	0
HWI:Ninth Avenu	Gary	IN	USA	5	1	1.3E+04	3	0.02%	0.07%	0	1
HWI:Rollins Env	Deer Park	TX	USA	0	1	8.9E+04	3	0.02%	0.05%	0	0
HWI:Parke Davis	Holland	MI	USA	2	1	2.2E+04	3	0.02%	0.06%	0	0
HWI:US Anniston	Anniston	AL	USA	1	1	9.9E+04	3	0.01%	0.03%	0	0
HWI:Lubrizol Co	Wickliffe	OH	USA	2	1	2.1E+04	3	0.01%	0.03%	0	0
HWI:Chemical Wa	Port Arthu	TX	USA	0	1	5.3E+04	3	0.009%	0.029%	0	0
HWI:Aptus	Coffeyvill	KS	USA	0	1	2.7E+04	3	0.009%	0.027%	0	0
HWI:Bofos Nobel	Muskegon	MI	USA	5	1	1.3E+04	3	0.009%	0.033%	0	0
HWI:Catalyst Re	Elyria	OH	USA	6	1	1.5E+04	3	0.009%	0.028%	0	0
HWI:Atochem	Carrollton	KY	USA	0	1	1.7E+04	3	0.008%	0.021%	0	0
HWI:Rollins Env	Bridgeport	NJ	USA	0	1	9.5E+04	3	0.008%	0.014%	0	0
HWI:Rohm and Ha	Louisville	KY	USA	2	1	1.5E+04	3	0.007%	0.019%	0	0
HWI:Dupont	Victoria	TX	USA	2	1	3.8E+04	3	0.007%	0.021%	0	0
HWI:Smiths Farm	Sheperdsvi	KY	USA	5	1	1.3E+04	3	0.006%	0.016%	0	0
HWI:Ohio Techno	Cleveland	OH	USA	2	1	1.1E+04	3	0.006%	0.017%	0	0
HWI:US Army Uma	Hermiston	OR	USA	1	1	9.6E+04	3	0.006%	0.027%	0	0
HWI:Canadian Cr	Calgary	AL	CAN	1	1	6.5E+04	3	0.006%	0.032%	0	0
HWI:Arrowhead R	Hermantown	MN	USA	5	1	1.3E+04	3	0.005%	0.025%	0	0
HWI:Times Beach	Times Beac	MO	USA	5	1	1.3E+04	3	0.005%	0.014%	0	0
HWI:Arco Chemic	Channelvie	TX	USA	2	1	2.8E+04	3	0.005%	0.015%	0	0
HWI:USS Gary Wo	Gary	IN	USA	2	1	4.0E+03	3	0.005%	0.022%	0	0
HWI:Ordnance Wo	Morgantown	WV	USA	5	1	1.3E+04	3	0.005%	0.012%	0	0
HWI:BP Chemical	Lima	OH	USA	2	1	8.7E+03	3	0.005%	0.014%	0	0
HWI:Sidney Tarp	Sidney	NS	CAN	1	1	8.3E+04	3	0.004%	0.011%	0	0
HWI:Canadian Oi	Kelowna	BC	CAN	1	1	6.5E+04	3	0.004%	0.022%	0	0
HWI:Alberta Spe	Swan Hills	AL	CAN	1	1	5.0E+04	3	0.004%	0.025%	0	0
HWI:Laidlaw Env	Mercier	QU	CAN	1	1	6.1E+04	3	0.004%	0.012%	0	0
HWI:Rhone Poule	Hammond	IN	USA	1	1	3.4E+03	3	0.004%	0.019%	0	0
HWI:Midland Pro	Ola	AR	USA	5	1	1.3E+04	3	0.004%	0.012%	0	0
HWI:Aptus	Aragonite	UT	USA	0	1	5.3E+04	3	0.004%	0.013%	0	0
HWI:Huntsman Co	Port Neche	TX	USA	2	1	2.1E+04	3	0.004%	0.011%	0	0
HWI:US Red Rive	Texarkana	TX	USA	1	1	1.7E+04	3	0.004%	0.011%	0	0
HWI:Eastman Ark	Magness	AR	USA	2	1	1.1E+04	3	0.004%	0.010%	0	0
HWI:Waste Tech	Lake Charl	LA	USA	1	1	1.7E+04	3	0.003%	0.009%	0	0
HWI:Shell Chemi	Belpre	OH	USA	2	1	6.7E+03	3	0.003%	0.008%	0	0
HWI:Laidlaw Env	Roebuck	SC	USA	0	1	3.0E+04	3	0.003%	0.005%	0	0
HWI:Eli Lilly C	Clinton	IN	USA	2	1	5.2E+03	3	0.003%	0.009%	0	0
HWI:American Cy	Hannibal	MO	USA	2	1	6.5E+03	3	0.003%	0.008%	0	0
HWI:Sterling Ch	Texas City	TX	USA	2	1	1.5E+04	3	0.003%	0.008%	0	0
HWI:American Cy	Kalamazoo	MI	USA	2	1	4.4E+03	3	0.003%	0.009%	0	0
HWI:Albemarle C	Magnolia	AR	USA	6	1	1.1E+04	3	0.002%	0.007%	0	0
HWI:Sikes Dispo	Crosby	TX	USA	5	1	1.3E+04	3	0.002%	0.007%	0	0
HWI:Union Carbi	South Char	WV	USA	2	1	8.9E+03	3	0.002%	0.005%	0	0
HWI:US Aberdeen	Aberdeen	MD	USA	1	1	2.0E+04	3	0.002%	0.004%	0	0
HWI:LTV Steel	Cleveland	OH	USA	2	1	4.0E+03	3	0.002%	0.007%	0	0
HWI:LTV Steel	Cleveland	OH	USA	2	1	4.0E+03	3	0.002%	0.007%	0	0
HWI:LTV Steel	Warren	OH	USA	2	1	4.0E+03	3	0.002%	0.006%	0	0
HWI:PPG Industr	Westlake	LA	USA	2	1	1.2E+04	3	0.002%	0.006%	0	0
HWI:US Army Too	Tooele	UT	USA	1	1	2.8E+04	3	0.002%	0.007%	0	0
HWI:Cleve Reber	Sorrento	LA	USA	5	1	1.3E+04	3	0.002%	0.006%	0	0
HWI:US Army Haw	Hawthorne	NV	USA	1	1	8.4E+04	3	0.002%	0.007%	0	0

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								TEQ	HCB	TEQ	HCB
HWI:US Radford	Radford	VA	USA	1	1	1.3E+04	3	0.002%	0.004%	0	0
HWI:Hoechst Cel	Pasadena	TX	USA	6	1	1.0E+04	3	0.002%	0.005%	0	0
HWI:Ciba Geigy	St Gabriel	LA	USA	2	1	1.1E+04	3	0.002%	0.005%	0	0
HWI:ThermalKem	Rock Hill	SC	USA	0	1	1.9E+04	3	0.002%	0.003%	0	0
HWI:Fina Oil	Deer Park	TX	USA	2	1	8.9E+03	3	0.002%	0.005%	0	0
HWI:Shell Chemi	Norco	LA	USA	2	1	1.1E+04	3	0.002%	0.005%	0	0
HWI:Dupont	Orange	TX	USA	2	1	7.9E+03	3	0.001%	0.004%	0	0
HWI:Rhone Poule	Institute	WV	USA	2	1	5.1E+03	3	0.001%	0.003%	0	0
HWI:Miles	New Martin	WV	USA	2	1	3.2E+03	3	0.001%	0.004%	0	0
HWI:Eastman Kod	Rochester	NY	USA	2	1	2.5E+03	3	0.001%	0.005%	0	0
HWI:US Army Sav	Savanna	IL	USA	1	1	2.4E+03	3	0.001%	0.004%	0	0
HWI:Dow Chemica	Torrance	CA	USA	2	1	4.2E+04	3	0.001%	0.003%	0	0
HWI:Celanese Co	Shelby	NC	USA	5	1	1.3E+04	3	0.001%	0.002%	0	0
HWI:US DOE Los	Los Alamos	NM	USA	1	1	9.8E+03	3	0.001%	0.004%	0	0
HWI:Dow Chemica	Midland	MI	USA	2	1	1.9E+03	3	0.001%	0.004%	0	0
HWI:Monsanto	Nitro	WV	USA	2	1	4.3E+03	3	0.001%	0.003%	0	0
HWI:US Seneca A	Romulus	NY	USA	1	1	3.7E+03	3	0.001%	0.003%	0	0
HWI:De Rewal Ch	Frenchtown	NJ	USA	5	1	1.3E+04	3	0.001%	0.002%	0	0
HWI:Eli Lilly T	Lafayette	IN	USA	2	1	1.7E+03	3	0.001%	0.004%	0	0
HWI:US DOE Sava	Jackson	SC	USA	1	1	1.1E+04	3	0.001%	0.002%	0	0
HWI:Waldick Aer	Wall Twp.	NJ	USA	5	1	1.3E+04	3	0.001%	0.002%	0	0
HWI:Houston Che	Houston	TX	USA	2	1	5.4E+03	3	0.0009%	0.0029%	0	0
HWI:Yellow Wate	Baldwin	FL	USA	5	1	1.3E+04	3	0.0009%	0.0026%	0	0
HWI:Union Carbi	Taft	LA	USA	2	1	6.4E+03	3	0.0009%	0.0026%	0	0
HWI:Waste Resea	Eau Claire	WI	USA	0	1	1.9E+03	3	0.0009%	0.0037%	0	0
HWI:Laidlaw Env	Colfax	LA	USA	1	1	4.2E+03	3	0.0009%	0.0026%	0	0
HWI:Eastman Ten	Kingsport	TN	USA	2	1	6.0E+03	3	0.0008%	0.0018%	0	0
HWI:Olin Corp	Lake Charl	LA	USA	2	1	4.7E+03	3	0.0008%	0.0026%	0	0
HWI:FMC Yakima	Yakima	WA	USA	5	1	1.3E+04	3	0.0008%	0.0039%	0	0
HWI:BASF	Freeport	TX	USA	2	1	4.6E+03	3	0.0008%	0.0025%	0	0
HWI:Georgia Gul	Plaquemine	LA	USA	2	1	5.4E+03	3	0.0008%	0.0024%	0	0
HWI:Eastman Tex	Longview	TX	USA	2	1	4.0E+03	3	0.0008%	0.0023%	0	0
HWI:BP Chemical	Port Lavac	TX	USA	2	1	4.2E+03	3	0.0007%	0.0023%	0	0
HWI:Rose Dispos	Lanesborou	MA	USA	5	1	1.3E+04	3	0.0007%	0.0017%	0	0
HWI:Nepera Chem	Harriman	NY	USA	2	1	1.1E+03	3	0.0007%	0.0027%	0	0
HWI:Upjohn	Kalamazoo	MI	USA	2	1	1.2E+03	3	0.0007%	0.0025%	0	0
HWI:Zellwood Gr	Zellwood	FL	USA	5	1	1.3E+04	3	0.0007%	0.0023%	0	0
HWI:Ciba-Geigy	McIntosh	AL	USA	2	1	6.1E+03	3	0.0007%	0.0020%	0	0
HWI:SC Johnson	Sturtevant	WI	USA	2	1	6.0E+02	3	0.0007%	0.0030%	0	0
HWI:Dow Chemica	Plaquemine	LA	USA	2	1	4.5E+03	3	0.0007%	0.0020%	0	0
HWI:3M Company	Decatur	AL	USA	2	1	2.7E+03	3	0.0007%	0.0018%	0	0
HWI:Rexene Prod	Odessa	TX	USA	2	1	3.0E+03	3	0.0006%	0.0019%	0	0
HWI:UT Southwes	Dallas	TX	USA	1	1	3.0E+03	3	0.0006%	0.0018%	0	0
HWI:US Navy Sur	Crane	IN	USA	1	1	1.2E+03	3	0.0006%	0.0016%	0	0
HWI:American Cy	Willow Isl	WV	USA	2	1	1.3E+03	3	0.0006%	0.0015%	0	0
HWI:US Lexingto	Richmond	KY	USA	1	1	1.5E+03	3	0.0005%	0.0014%	0	0
HWI:BASF	Geismar	LA	USA	2	1	3.6E+03	3	0.0005%	0.0016%	0	0
HWI:Dupont	LaPorte	TX	USA	2	1	3.0E+03	3	0.0005%	0.0016%	0	0
HWI:Vulcan Chem	Geismar	LA	USA	1	1	3.6E+03	3	0.0005%	0.0016%	0	0
HWI:Chemical Wa	Kettleman	CA	USA	1	1	2.2E+04	3	0.0005%	0.0016%	0	0
HWI:Georgia Gul	Pasadena	TX	USA	2	1	2.9E+03	3	0.0005%	0.0016%	0	0
HWI:Aristech Ch	Pasadena	TX	USA	2	1	2.8E+03	3	0.0005%	0.0015%	0	0
HWI:Baird and M	Holbrook	MA	USA	5	1	1.3E+04	3	0.0005%	0.0013%	0	0
HWI:Davis Liqui	Smithfield	RI	USA	5	1	1.3E+04	3	0.0005%	0.0013%	0	0
HWI:Chemolite	ST. Paul	MN	USA	2	1	1.1E+03	3	0.0005%	0.0021%	0	0
HWI:Union Carbi	Texas City	TX	USA	2	1	2.7E+03	3	0.0005%	0.0014%	0	0
HWI:Aristech Ha	Haverhill	OH	USA	2	1	1.2E+03	3	0.0005%	0.0013%	0	0
HWI:Occidental	Niagara Fa	NY	USA	2	1	6.0E+02	3	0.0005%	0.0017%	0	0
HWI:Angus Chemi	Sterlingto	LA	USA	2	1	2.0E+03	3	0.0005%	0.0014%	0	0
HWI:OSI Special	Sistervill	WV	USA	2	1	1.0E+03	3	0.0004%	0.0012%	0	0
HWI:Occidental	Deer Park	TX	USA	2	1	2.4E+03	3	0.0004%	0.0013%	0	0
HWI:Merck Chemi	Riverside	PA	USA	2	1	2.9E+03	3	0.0004%	0.0009%	0	0
HWI:US Kansas A	Parsons	KS	USA	1	1	1.2E+03	3	0.0004%	0.0012%	0	0
HWI:General Ele	Selkirk	NY	USA	2	1	5.6E+03	3	0.0004%	0.0008%	0	0
HWI:VVV Chemica	Georgetown	SC	USA	2	1	4.1E+03	3	0.0004%	0.0007%	0	0

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								TEQ	HCB	TEQ	HCB
HWI:Miles	Kansas Cit	MO	USA	6	1	9.9E+02	3	0.0004%	0.0012%	0	0
HWI:Shell Chemi	Deer Park	TX	USA	2	1	2.0E+03	3	0.0004%	0.0011%	0	0
HWI:Atochem	Beaumont	TX	USA	1	1	2.0E+03	3	0.0003%	0.0011%	0	0
HWI:Olin Corp	Brandonbur	KY	USA	2	1	7.2E+02	3	0.0003%	0.0010%	0	0
HWI:Idaho Natio	Idaho Fall	ID	USA	2	1	4.4E+03	3	0.0003%	0.0014%	0	0
HWI:US Army Too	Tooele	UT	USA	1	1	4.6E+03	3	0.0003%	0.0011%	0	0
HWI:Chevron Che	Belle Chas	LA	USA	2	1	2.5E+03	3	0.0003%	0.0010%	0	0
HWI:Allied Sign	Birmingham	AL	USA	0	1	1.7E+03	3	0.0003%	0.0008%	0	0
HWI:BASF	Geismar	LA	USA	2	1	2.0E+03	3	0.0003%	0.0009%	0	0
HWI:Dupont	Beaumont	TX	USA	2	1	1.6E+03	3	0.0003%	0.0009%	0	0
HWI:Dupont Expe	Wilmington	DE	USA	2	1	3.1E+03	3	0.0003%	0.0005%	0	0
HWI:Federated T	Brooksvill	MS	USA	2	1	1.4E+03	3	0.0003%	0.0008%	0	0
HWI:Olin Corp	Beaumont	TX	USA	2	1	1.5E+03	3	0.0003%	0.0008%	0	0
HWI:Nutrasweet	Augusta	GA	USA	2	1	2.7E+03	3	0.0003%	0.0005%	0	0
HWI:Cargill Che	Carpenters	IL	USA	2	1	1.8E+02	3	0.0003%	0.0012%	0	0
HWI:Vulcan Mate	Witchita	KS	USA	1	1	7.6E+02	3	0.0003%	0.0008%	0	0
HWI:Westvaco	Deridder	LA	USA	2	1	1.4E+03	3	0.0003%	0.0008%	0	0
HWI:Dupont Park	Parkersbur	WV	USA	2	1	5.8E+02	3	0.0002%	0.0007%	0	0
HWI:Hoechst Cel	Bay City	TX	USA	2	1	1.2E+03	3	0.0002%	0.0007%	0	0
HWI:Chevron USA	Philadelph	PA	USA	2	1	2.3E+03	3	0.0002%	0.0003%	0	0
HWI:Dupont	Louisville	KY	USA	2	1	3.5E+02	3	0.0002%	0.0005%	0	0
HWI:US NASA Mar	New Orlean	LA	USA	1	1	1.3E+03	3	0.0002%	0.0005%	0	0
HWI:Borden Chem	Geismar	LA	USA	2	1	1.2E+03	3	0.0002%	0.0005%	0	0
HWI:Dupont	LaPlace	LA	USA	2	1	1.2E+03	3	0.0002%	0.0005%	0	0
HWI:Occidental	Niagara Fa	NY	USA	2	1	2.1E+02	3	0.0002%	0.0006%	0	0
HWI:Arizona Che	Panama Cit	FL	USA	2	1	2.0E+03	3	0.0002%	0.0005%	0	0
HWI:Phillips Re	Bartlesvil	OK	USA	2	1	5.0E+02	3	0.0002%	0.0005%	0	0
HWI:Occidental	Ingleside	TX	USA	2	1	8.5E+02	3	0.0002%	0.0005%	0	0
HWI:General Ele	Pittsfield	MA	USA	0	1	2.5E+03	3	0.0001%	0.0003%	0	0
HWI:Polyrez Com	Woodbury	NJ	USA	2	1	1.7E+03	3	0.0001%	0.0002%	0	0
HWI:Cook Compos	Port Washi	WI	USA	6	1	1.7E+02	3	0.0001%	0.0006%	0	0
HWI:Rhone Poule	Martinez	CA	USA	2	1	8.4E+03	3	0.0001%	0.0005%	0	0
HWI:Quantum Che	Deer Park	TX	USA	2	1	7.2E+02	3	0.0001%	0.0004%	0	0
HWI:Celanese Ch	Bishop	TX	USA	2	1	7.0E+02	3	0.0001%	0.0004%	0	0
HWI:Smithkline	Conshohock	PA	USA	2	1	1.4E+03	3	0.0001%	0.0002%	0	0
HWI:US Lake Cit	Independen	MO	USA	1	1	3.0E+02	3	0.0001%	0.0003%	0	0
HWI:Allied Sign	Hopewell	VA	USA	2	1	8.6E+02	3	0.0001%	0.0002%	0	0
HWI:Huntsman Co	Conroe	TX	USA	2	1	6.0E+02	3	0.0001%	0.0003%	0	0
HWI:Rubicon	Geismar	LA	USA	2	1	7.2E+02	3	0.0001%	0.0003%	0	0
HWI:Phillips	Sweeny	TX	USA	2	1	5.8E+02	3	0.0001%	0.0003%	0	0
HWI:Monsanto	Springfiel	MA	USA	2	1	2.3E+03	3	0.0001%	0.0003%	0	0
HWI:Monsanto	Alvin	TX	USA	2	1	5.7E+02	3	0.0001%	0.0003%	0	0
HWI:Phillip Ent	Burnaby	BC	CAN	1	1	1.4E+03	3	0.00009%	0.00042%	0	0
HWI:Mobil Chem	Beaumont	TX	USA	2	1	4.7E+02	3	0.00008%	0.00025%	0	0
HWI:Kalama Chem	Kalama	WA	USA	2	1	1.3E+03	3	0.00008%	0.00037%	0	0
HWI:Merck and C	West Point	PA	USA	2	1	9.7E+02	3	0.00008%	0.00013%	0	0
HWI:Texas Instr	Sherman	TX	USA	2	1	3.5E+02	3	0.00008%	0.00023%	0	0
HWI:Iowa State	Ames	IA	USA	2	1	1.9E+02	3	0.00007%	0.00026%	0	0
HWI:Celanese Ch	Seabrook	TX	USA	2	1	3.9E+02	3	0.00007%	0.00021%	0	0
HWI:Pfizer	Groton	CT	USA	2	1	1.5E+03	3	0.00007%	0.00017%	0	0
HWI:Dow Chemica	La Porte	TX	USA	2	1	3.8E+02	3	0.00007%	0.00020%	0	0
HWI:PPG Industr	Circlevill	OH	USA	2	1	1.5E+02	3	0.00007%	0.00018%	0	0
HWI:Shell Oil	Martinez	CA	USA	2	1	4.3E+03	3	0.00007%	0.00025%	0	0
HWI:FMC Corp	Baltimore	MD	USA	2	1	5.3E+02	3	0.00006%	0.00012%	0	0
HWI:Schenectady	Freeport	TX	USA	2	1	3.4E+02	3	0.00006%	0.00018%	0	0
HWI:Novacor Che	Decatur	AL	USA	2	1	2.3E+02	3	0.00006%	0.00015%	0	0
HWI:Lyondell	Channelvie	TX	USA	6	1	3.2E+02	3	0.00006%	0.00017%	0	0
HWI:DSM Chemica	Augusta	GA	USA	2	1	5.4E+02	3	0.00005%	0.00011%	0	0
HWI:Schenectady	Rotterdam	NY	USA	2	1	7.6E+02	3	0.00005%	0.00011%	0	0
HWI:Mayo Clinic	Rochester	MN	USA	2	1	1.2E+02	3	0.00005%	0.00022%	0	0
HWI:Reilly Indu	Indianapol	IN	USA	6	1	1.0E+02	3	0.00005%	0.00014%	0	0
HWI:Advanced Te	Los Angele	CA	USA	1	1	1.7E+03	3	0.00005%	0.00012%	0	0
HWI:Huls Americ	Chestertow	MD	USA	2	1	4.1E+02	3	0.00005%	0.00009%	0	0
HWI:Marathon Oi	Garyville	LA	USA	2	1	3.1E+02	3	0.00004%	0.00013%	0	0
HWI:Searle Phar	Augusta	GA	USA	2	1	4.3E+02	3	0.00004%	0.00009%	0	0

Facility Name	City	State/ Province	Country	Type Code (a)	APCD (b)	Throughput	Unit (c)	5-Lake Average Percent of Total Deposition TEQ	HCB	Within Top 85% of Deposition to any Lake (1 = yes) TEQ	HCB
HWI:Nalco Chemi	Sugar Land	TX	USA	2	1	2.3E+02	3	0.00004%	0.00013%	0	0
HWI:Merichem	Houston	TX	USA	2	1	2.3E+02	3	0.00004%	0.00012%	0	0
HWI:Parkens Int	Houston	TX	USA	2	1	2.1E+02	3	0.00004%	0.00011%	0	0
HWI:Dupont	Memphis	TN	USA	2	1	1.1E+02	3	0.00004%	0.00010%	0	0
HWI:First Chemi	Pascagoula	MS	USA	2	1	3.2E+02	3	0.00004%	0.00011%	0	0
HWI:Ethyl Corpo	Orangeburg	SC	USA	2	1	3.8E+02	3	0.00004%	0.00007%	0	0
HWI:Burroughs W	Greenville	NC	USA	2	1	3.0E+02	3	0.00003%	0.00006%	0	0
HWI:WR Grace	Deer Park	TX	USA	2	1	1.9E+02	3	0.00003%	0.00010%	0	0
HWI:Diversified	Kingston	TN	USA	2	1	1.7E+02	3	0.00003%	0.00008%	0	0
HWI:Cook Compos	Chatham	VA	USA	2	1	2.4E+02	3	0.00003%	0.00006%	0	0
HWI:Velsicol	Memphis	TN	USA	2	1	9.2E+01	3	0.00003%	0.00009%	0	0
HWI:Sandoz Agro	Beaumont	TX	USA	6	1	1.8E+02	3	0.00003%	0.00009%	0	0
HWI:Neville Che	Pittsburgh	PA	USA	2	1	7.1E+01	3	0.00003%	0.00008%	0	0
HWI:Laidlaw Env	Clarence	NY	USA	0	1	4.1E+02	3	0.00003%	0.00006%	0	0
HWI:Atochem	Calvert Ci	KY	USA	2	1	6.3E+01	3	0.00003%	0.00008%	0	0
HWI:University	Madison	WI	USA	2	1	4.5E+01	3	0.00003%	0.00011%	0	0
HWI:California	Vernon	CA	USA	6	1	9.0E+02	3	0.00003%	0.00006%	0	0
HWI:Dow Chemica	Joliet	IL	USA	2	1	2.3E+01	3	0.00003%	0.00011%	0	0
HWI:Morton Thio	Elkton	MD	USA	2	1	2.5E+02	3	0.00003%	0.00005%	0	0
HWI:US Iowa Arm	Middletown	IA	USA	1	1	4.8E+01	3	0.00002%	0.00008%	0	0
HWI:Arizona Che	Gulfport	MS	USA	2	1	2.0E+02	3	0.00002%	0.00007%	0	0
HWI:Dupont Shel	Axis	AL	USA	2	1	2.1E+02	3	0.00002%	0.00007%	0	0
HWI:Copolymer	Addis	LA	USA	2	1	1.5E+02	3	0.00002%	0.00007%	0	0
HWI:Atochem	Houston	TX	USA	2	1	1.3E+02	3	0.00002%	0.00007%	0	0
HWI:McDonnel Do	St. Charle	MO	USA	2	1	5.0E+01	3	0.00002%	0.00006%	0	0
HWI:Huntsman Po	Woodbury	NJ	USA	2	1	2.4E+02	3	0.00002%	0.00003%	0	0
HWI:Uniroyal	Geismar	LA	USA	2	1	1.3E+02	3	0.00002%	0.00005%	0	0
HWI:Teledyne Wa	Albany	OR	USA	2	1	3.5E+02	3	0.00002%	0.00008%	0	0
HWI:Monsanto	Addyston	OH	USA	2	1	3.5E+01	3	0.00002%	0.00004%	0	0
HWI:Glaxo	RTP	NC	USA	2	1	1.6E+02	3	0.00002%	0.00003%	0	0
HWI:Curwood	New London	WI	USA	2	1	3.0E+01	3	0.00002%	0.00007%	0	0
HWI:Dow Chemica	Ironton	OH	USA	2	1	3.6E+01	3	0.00001%	0.00004%	0	0
HWI:US DOE Sand	Livermore	CA	USA	1	1	8.5E+02	3	0.00001%	0.00005%	0	0
HWI:Mallinckrod	Raleigh	NC	USA	2	1	1.2E+02	3	0.00001%	0.00002%	0	0
HWI:Monsanto	Muscatine	IA	USA	2	1	2.4E+01	3	0.00001%	0.00004%	0	0
HWI:Chevron Che	Richmond	CA	USA	2	1	8.0E+02	3	0.00001%	0.00005%	0	0
HWI:Atochem	Thorofare	NJ	USA	2	1	1.5E+02	3	0.00001%	0.00002%	0	0
HWI:Quantum Che	Morris	IL	USA	2	1	1.1E+01	3	0.00001%	0.00005%	0	0
HWI:American Cy	Wallingfor	CT	USA	2	1	2.1E+02	3	0.00001%	0.00003%	0	0
HWI:Halterman	Houston	TX	USA	2	1	6.0E+01	3	0.00001%	0.00003%	0	0
HWI:Texaco Petr	Port Neche	TX	USA	2	1	5.6E+01	3	0.00001%	0.00003%	0	0
HWI:Novacor Che	Indian Orc	MA	USA	2	1	1.8E+02	3	0.000008%	0.000021%	0	0
HWI:Nissan	Smyrna	TN	USA	2	1	2.7E+01	3	0.000007%	0.000019%	0	0
HWI:Broco Envir	Rialto	CA	USA	1	1	2.5E+02	3	0.000007%	0.000018%	0	0
HWI:Waste Tech	Golden	CO	USA	1	1	5.0E+01	3	0.000007%	0.000024%	0	0
HWI:Dupont	Deepwater	NJ	USA	2	1	7.3E+01	3	0.000007%	0.000012%	0	0
HWI:T Thermal I	Conshohock	PA	USA	2	1	8.1E+01	3	0.000007%	0.000011%	0	0
HWI:NIEHS	RTP	NC	USA	2	1	6.1E+01	3	0.000006%	0.000012%	0	0
HWI:Rohm and Ha	Philadelph	PA	USA	2	1	7.3E+01	3	0.000006%	0.000010%	0	0
HWI:Cargill	Forest Par	GA	USA	2	1	5.0E+01	3	0.000006%	0.000013%	0	0
HWI:Goodyear	Beaumont	TX	USA	2	1	2.9E+01	3	0.000005%	0.000016%	0	0
HWI:Dow Chemica	Gales Ferr	CT	USA	2	1	1.1E+02	3	0.000005%	0.000011%	0	0
HWI:Ashland Che	Commerce	CA	USA	2	1	1.3E+02	3	0.000004%	0.000009%	0	0
HWI:Allied Sign	Philadelph	PA	USA	2	1	4.2E+01	3	0.000003%	0.000006%	0	0
HWI:Zeneca	Bayonne	NJ	USA	2	1	4.2E+01	3	0.000003%	0.000006%	0	0
HWI:Union Carbi	Piscataway	NJ	USA	2	1	2.9E+01	3	0.000002%	0.000004%	0	0
HWI:Bostik	Middleton	MA	USA	2	1	5.8E+01	3	0.000002%	0.000006%	0	0
HWI:Providence	Pawtucket	RI	USA	2	1	5.3E+01	3	0.000002%	0.000005%	0	0
HWI:Honeywell	Clearwater	FL	USA	2	1	3.6E+01	3	0.000002%	0.000006%	0	0
HWI:BP Oil	Belle Chas	LA	USA	2	1	1.4E+01	3	0.000002%	0.000005%	0	0
HWI:Cargill Res	Lynwood	CA	USA	2	1	6.0E+01	3	0.000002%	0.000004%	0	0
HWI:Lubrizol Co	Painesvill	OH	USA	2	1	2.5E+00	3	0.000001%	0.000004%	0	0
HWI:Hoechst Cel	Mt. Holly	NC	USA	2	1	7.0E+00	3	0.000001%	0.000001%	0	0
HWI:Moore Busin	Stillwater	OK	USA	2	1	8.4E-01	3	0.000000%	0.000001%	0	0
HWI:US DOE K-25	Oak Ridge	TN	USA	1	1	1.2E+00	3	0.000000%	0.000001%	0	0

Facility Name	City	State/ Province	Country	Type Code (a)	APCD (b)	Throughput	Unit (c)	5-Lake Average Percent of Total Deposition TEQ	HCB	Within Top 85% of Deposition to any Lake (1 = yes) TEQ	HCB
HWI:Purina Mill	Bridgeton	MO	USA	2	1	4.4E-01	3	0.000000%	0.000000%	0	0
HWI:Dow Chemica	Pittsburg	CA	USA	2	1	6.9E+00	3	0.000000%	0.000000%	0	0
HWI:Hoechst Cel	Pampa	TX	USA	2	1	3.5E-01	3	0.000000%	0.000000%	0	0
HWI:Washington	Pullman	WA	USA	2	1	1.0E+00	3	0.000000%	0.000000%	0	0
HWI:Air Product	Pasadena	TX	USA	2	1	1.7E-01	3	0.000000%	0.000000%	0	0
HWI:Exxon Chemi	Baton Roug	LA	USA	2	1	1.5E-01	3	0.000000%	0.000000%	0	0
HWI:Lonza	Pasadena B	TX	USA	6	1	1.2E-01	3	0.000000%	0.000000%	0	0
HWI:Hercules Ae	Magna	UT	USA	2	1	2.4E-01	3	0.000000%	0.000000%	0	0
HWI:Rohm and Ha	Deer Park	TX	USA	2	1	4.7E-02	3	0.000000%	0.000000%	0	0
HWI:Natural Gas	Baytown	TX	USA	2	1	1.2E-02	3	0.000000%	0.000000%	0	0
HWI:Goodyear	La Port	TX	USA	2	1	9.0E-03	3	0.000000%	0.000000%	0	0
HWI:Aerojet	Sacramento	CA	USA	2	1	4.0E-02	3	0.000000%	0.000000%	0	0

Facility Name	City	State/ Province	Country	Type Code (a)	APCD (b)	Throughput	Unit (c)	5-Lake Average Percent of Total Deposition		Within Top 85% of Deposition to any Lake (1 = yes)	
								TEQ	HCB	TEQ	HCB
Sewage Sludge Incineration											
Ashbridges Bay	Toronto	ON	CAN	1	1	4.1E+06	1	0.10%	0.20%	1	1
Highland Creek	Toronto	ON	CAN	1	1	3.0E+06	1	0.08%	0.14%	1	1
Detroit 2	Detroit	MI	USA	1	1	6.0E+06	1	0.07%	0.21%	0	1
Detroit 1	Detroit	MI	USA	1	1	3.6E+06	1	0.04%	0.13%	0	1
Metropolitan TP	St Paul	MN	USA	1	1	6.9E+06	1	0.04%	0.15%	0	1
Wyandotte STP	Wayne Coun	MI	USA	1	1	2.2E+06	1	0.03%	0.08%	0	1
Birds Island ST	Buffalo	NY	USA	1	1	1.6E+06	1	0.02%	0.05%	0	0
Hamilton	Hamilton	ON	CAN	1	1	1.2E+06	1	0.02%	0.04%	0	0
Indianapolis Be	Indianapol	IN	USA	1	1	3.2E+06	1	0.02%	0.05%	0	0
Southerly WWTP	Cleveland	OH	USA	1	1	2.3E+06	1	0.02%	0.04%	0	0
London	London	ON	CAN	1	1	2.0E+06	1	0.02%	0.04%	0	0
Westerly STP	Cleveland	OH	USA	1	1	1.7E+06	1	0.01%	0.03%	0	0
Bissel Point ST	St Louis	MO	USA	1	1	2.9E+06	1	0.01%	0.03%	0	0
Erie	Erie	PA	USA	1	1	1.2E+06	1	0.01%	0.02%	0	0
Millcreek	Cincinnati	OH	USA	1	1	1.5E+06	1	0.008%	0.019%	0	0
Frank E Van Ler	Rochester	NY	USA	1	1	6.4E+05	1	0.007%	0.014%	0	0
Pontiac STP	Pontiac	MI	USA	1	1	5.8E+05	1	0.007%	0.018%	0	0
Ypsilanti WWTP	Ypsilanti	MI	USA	1	1	4.8E+05	1	0.006%	0.017%	0	0
Kiski Valley WP	Appolo	PA	USA	1	1	1.2E+06	1	0.006%	0.011%	0	0
Southtowns Adva	Buffalo	NY	USA	1	1	3.8E+05	1	0.006%	0.011%	0	0
Ann Arbor	Ann Arbor	MI	USA	1	1	4.8E+05	1	0.005%	0.015%	0	0
Green Bay WWTP	Green BAy	WI	USA	1	1	7.8E+05	1	0.005%	0.019%	0	0
Lenay STP	St Louis	MO	USA	1	1	1.3E+06	1	0.005%	0.016%	0	0
Niagra County	Niagrra Co	NY	USA	1	1	3.1E+05	1	0.005%	0.009%	0	0
NW Quad STP	Rochester	NY	USA	1	1	4.3E+05	1	0.005%	0.009%	0	0
Two Mile Creek	Tonawanda	NY	USA	1	1	3.1E+05	1	0.005%	0.009%	0	0
Amherst	Amherst	NY	USA	1	1	3.1E+05	1	0.005%	0.009%	0	0
Hamburg	Erie Count	NY	USA	1	1	3.1E+05	1	0.004%	0.008%	0	0
Trenton WWTP	Trenton	MI	USA	1	1	3.1E+05	1	0.004%	0.011%	0	0
Gates Chile Ogd	Rochester	NY	USA	1	1	3.2E+05	1	0.004%	0.007%	0	0
Dunkirk STP	Dunkirk	NY	USA	1	1	3.1E+05	1	0.004%	0.007%	0	0
Canton WWTP	Canton	OH	USA	1	1	4.4E+05	1	0.003%	0.007%	0	0
NW Quadrant TP	Greece	NY	USA	1	1	3.1E+05	1	0.003%	0.006%	0	0
Kalamzoo WWTP	Kalamazoo	MI	USA	1	1	4.3E+05	1	0.003%	0.010%	0	0
Owosso WWTP	Owosso	MI	USA	1	1	3.1E+05	1	0.003%	0.008%	0	0
Commun Urb de M	Montreal	QU	CAN	1	1	3.6E+06	1	0.003%	0.008%	0	0
Niles WWTP	Niles	MI	USA	1	1	3.1E+05	1	0.003%	0.010%	0	0
Warren	Warren	MI	USA	1	1	2.3E+05	1	0.003%	0.008%	0	0
Lansing WWTP	Lansing	MI	USA	1	1	3.1E+05	1	0.003%	0.008%	0	0
Bay County STP	Bay County	MI	USA	1	1	3.1E+05	1	0.003%	0.008%	0	0
Youngstown WWTP	Youngstown	OH	USA	1	1	3.6E+05	1	0.003%	0.006%	0	0
East Lansing	East Lansi	MI	USA	1	1	2.9E+05	1	0.003%	0.008%	0	0
Lorain	Lorain	OH	USA	1	1	3.1E+05	1	0.003%	0.006%	0	0
Adron WWTP	Akron	OH	USA	1	1	3.5E+05	1	0.003%	0.006%	0	0
Columbus South	Columbus	OH	USA	1	1	4.0E+05	1	0.003%	0.006%	0	0
Central WWTP	Nashville	TN	USA	1	1	8.2E+05	1	0.002%	0.007%	0	0
Battle Creek	Battle Cre	MI	USA	1	1	3.1E+05	1	0.002%	0.007%	0	0
Warren County	Franklin	OH	USA	1	1	3.1E+05	1	0.002%	0.005%	0	0
Jackson Pike WW	Columbus	OH	USA	1	1	3.5E+05	1	0.002%	0.005%	0	0
Grand Rapids	Grand Rapi	MI	USA	1	1	2.9E+05	1	0.002%	0.006%	0	0
Bath	Bath	NY	USA	1	1	3.1E+05	1	0.002%	0.004%	0	0
Ambridge STP	Ambridge	PA	USA	1	1	3.1E+05	1	0.002%	0.004%	0	0
Dubuque	Dubuque	IA	USA	1	1	5.0E+05	1	0.002%	0.007%	0	0
Decatur STP	Decatur	IL	USA	1	1	3.1E+05	1	0.002%	0.006%	0	0
Davenport	Davenport	IA	USA	1	1	3.2E+05	1	0.002%	0.006%	0	0
Alcosan WWTP	Pittsburgh	PA	USA	1	1	3.1E+05	1	0.002%	0.004%	0	0
Little Miami WW	Cincinnati	OH	USA	1	1	3.1E+05	1	0.002%	0.004%	0	0
Duluth	Duluth	MN	USA	1	1	3.0E+05	1	0.002%	0.006%	0	0
Clarksburg STP	Clarksburg	WV	USA	1	1	3.1E+05	1	0.002%	0.003%	0	0
Cynthiana	Cynthiana	KY	USA	1	1	3.1E+05	1	0.002%	0.004%	0	0
Euclid WWTP	Euclid	OH	USA	1	1	1.9E+05	1	0.002%	0.003%	0	0
Kansas City	Kansas Cit	MO	USA	1	1	4.0E+05	1	0.002%	0.005%	0	0
Willoughby East	Willoughby	OH	USA	1	1	1.9E+05	1	0.001%	0.003%	0	0

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								TEQ	HCB	TEQ	HCB
Kenton County	Kenton Cou	KY	USA	1	1	3.1E+05	1	0.001%	0.003%	0	0
Hartford WPCF	Hartford	CT	USA	1	1	3.0E+06	1	0.001%	0.004%	0	0
Lower Potomac S	Fairfax	VA	USA	1	1	8.1E+05	1	0.001%	0.002%	0	0
New Point	Kansas Cit	KA	USA	1	1	3.6E+05	1	0.001%	0.005%	0	0
Huntington	Huntington	WV	USA	1	1	3.1E+05	1	0.001%	0.003%	0	0
Patapsco	Baltimore	MD	USA	1	1	8.8E+05	1	0.001%	0.002%	0	0
Auburn	Auburn	NY	USA	1	1	3.6E+05	1	0.001%	0.002%	0	0
Atlanta Bolton	Atlanta	GA	USA	1	1	1.2E+06	1	0.001%	0.003%	0	0
Cedar Rapids WP	Cedar Rapi	IA	USA	1	1	2.2E+05	1	0.001%	0.004%	0	0
Seneca TP	St Paul	MN	USA	1	1	1.7E+05	1	0.001%	0.004%	0	0
Fairfax	Fairfax	VA	USA	1	1	5.8E+05	1	0.001%	0.002%	0	0
Schenectady STP	Schenectad	NY	USA	1	1	1.2E+06	1	0.0010%	0.0020%	0	0
Albany North	Albany	NY	USA	1	1	1.2E+06	1	0.0009%	0.0018%	0	0
West STP	Oswego	NY	USA	1	1	3.1E+05	1	0.0009%	0.0018%	0	0
East STP	Oswego	NY	USA	1	1	3.1E+05	1	0.0009%	0.0018%	0	0
Milwaukee	Milwaukee	WI	USA	1	1	6.3E+04	1	0.0008%	0.0029%	0	0
Wayne	Wayne	NJ	USA	1	1	8.5E+05	1	0.0007%	0.0013%	0	0
Lamberts Point	Norfolk	VA	USA	1	1	5.1E+05	1	0.0007%	0.0013%	0	0
Williamsburg WP	Williamsbu	VA	USA	1	1	5.0E+05	1	0.0007%	0.0013%	0	0
Trout Run WPCC	Upper Mari	PA	USA	1	1	3.1E+05	1	0.0007%	0.0012%	0	0
Port Huron	Port Huron	MI	USA	1	1	6.8E+04	1	0.0007%	0.0019%	0	0
Hershey	Hershey	PA	USA	1	1	3.6E+05	1	0.0007%	0.0011%	0	0
Stamford	Stamford	CT	USA	1	1	8.4E+05	1	0.0006%	0.0013%	0	0
Albany South	Albany	NY	USA	1	1	8.2E+05	1	0.0006%	0.0013%	0	0
Watertown	Watertown	NY	USA	1	1	3.1E+05	1	0.0006%	0.0013%	0	0
Parsippany	Parsippany	NJ	USA	1	1	6.9E+05	1	0.0006%	0.0011%	0	0
York	York	PA	USA	1	1	3.5E+05	1	0.0006%	0.0010%	0	0
Cumberland City	Lemoyne Bo	PA	USA	1	1	3.1E+05	1	0.0006%	0.0010%	0	0
Kansas City	Kansas Cit	KA	USA	1	1	1.6E+05	1	0.0006%	0.0021%	0	0
Turkey Creek	Shawnee Mi	KA	USA	1	1	1.6E+05	1	0.0006%	0.0020%	0	0
Natchitoches	Natchitoch	LA	USA	1	1	3.1E+05	1	0.0006%	0.0021%	0	0
Mission Townshi	Johnson Co	KA	USA	1	1	3.1E+05	1	0.0006%	0.0022%	0	0
Utica	Oneida Cou	NY	USA	1	1	5.3E+05	1	0.0005%	0.0011%	0	0
Potomac River S	Woodbridge	VA	USA	1	1	3.1E+05	1	0.0005%	0.0009%	0	0
Two Bridges	Lincoln Pa	NJ	USA	1	1	5.9E+05	1	0.0005%	0.0009%	0	0
Arlington COWPC	Arlington	VA	USA	1	1	3.1E+05	1	0.0005%	0.0009%	0	0
Alexandria STP	Alexandria	VA	USA	1	1	3.1E+05	1	0.0005%	0.0009%	0	0
Lake Charles Pl	Lake Charl	LA	USA	1	1	3.1E+05	1	0.0005%	0.0018%	0	0
Lake Charles Pl	Lake Charl	LA	USA	1	1	3.1E+05	1	0.0005%	0.0018%	0	0
Annapolis City	Annapolis	MD	USA	1	1	3.1E+05	1	0.0005%	0.0008%	0	0
Cox Creek WWTP	Riviera Be	MD	USA	1	1	3.1E+05	1	0.0005%	0.0008%	0	0
Harrisburg	Harrisburg	RI	USA	1	1	1.2E+06	1	0.0004%	0.0013%	0	0
Lower Lackawann	Old Forge	PA	USA	1	1	3.1E+05	1	0.0004%	0.0007%	0	0
Wyoming Valley	Wilkes Bar	PA	USA	1	1	2.9E+05	1	0.0004%	0.0007%	0	0
First Bank STP	New Orlean	LA	USA	1	1	3.6E+05	1	0.0004%	0.0016%	0	0
Decatur	Decatur	GA	USA	1	1	4.0E+05	1	0.0004%	0.0011%	0	0
Boat Harbor WPC	Newport Ne	VA	USA	1	1	3.0E+05	1	0.0004%	0.0008%	0	0
Commun Urb de Q	Quebec Cit	QU	CAN	1	1	4.9E+05	1	0.0004%	0.0010%	0	0
Greensboro	Greensboro	NC	USA	1	1	4.0E+05	1	0.0004%	0.0009%	0	0
Brookfield STP	Brookfield	WI	USA	1	1	3.5E+04	1	0.0004%	0.0015%	0	0
Watertown	Watertown	NY	USA	1	1	1.9E+05	1	0.0004%	0.0008%	0	0
New Orleans W B	Algiers	LA	USA	1	1	3.1E+05	1	0.0004%	0.0013%	0	0
Independence	Independen	MO	USA	1	1	8.6E+04	1	0.0003%	0.0012%	0	0
Hyperion WWTP	Playa Del	CA	USA	1	1	2.4E+06	1	0.0003%	0.0018%	0	0
Delcora Chester	Chester	PA	USA	1	1	1.7E+05	1	0.0003%	0.0006%	0	0
RM Clayton WWTP	Atlanta	GA	USA	1	1	3.1E+05	1	0.0003%	0.0009%	0	0
Stony Brook RSA	Princeton	NJ	USA	1	1	3.5E+05	1	0.0003%	0.0005%	0	0
Duryea	Duryea	PA	USA	1	1	2.3E+05	1	0.0003%	0.0006%	0	0
Army Base WWTP	Norfolk	VA	USA	1	1	2.3E+05	1	0.0003%	0.0006%	0	0
Centre Rive Sud	unknown	QU	CAN	1	1	3.7E+05	1	0.0003%	0.0008%	0	0
First Bank STP	New Orlean	LA	USA	1	1	2.7E+05	1	0.0003%	0.0012%	0	0
Thtr Lawrence S	North Ando	MA	USA	1	1	8.1E+05	1	0.0003%	0.0009%	0	0
E Norristown Pl	Norristown	PA	USA	1	1	3.1E+05	1	0.0003%	0.0005%	0	0
Upper Moreland	Willow Gro	PA	USA	1	1	3.1E+05	1	0.0003%	0.0005%	0	0
Bridgeport STP	Bridgeport	PA	USA	1	1	3.1E+05	1	0.0003%	0.0005%	0	0

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Chesapeake Eliz	Virginia B	VA	USA	1	1	2.0E+05	1	0.0003%	0.0005%	0	0
Rockaway Valley	Parsippany	NJ	USA	1	1	3.1E+05	1	0.0003%	0.0005%	0	0
Mountain View S	Wayne Town	NJ	USA	1	1	3.1E+05	1	0.0003%	0.0005%	0	0
Bay City STP	Bay City	MI	USA	1	1	2.8E+04	1	0.0003%	0.0007%	0	0
New Canaan	New Canaan	CT	USA	1	1	3.5E+05	1	0.0003%	0.0005%	0	0
North Charlesto	North Char	SC	USA	1	1	3.1E+05	1	0.0003%	0.0006%	0	0
New Rochelle SD	New Rochel	NY	USA	1	1	3.1E+05	1	0.0003%	0.0005%	0	0
Pensacola WWTP	Pensacola	FL	USA	1	1	3.1E+05	1	0.0003%	0.0009%	0	0
Port Washington	Port Washi	NY	USA	1	1	3.1E+05	1	0.0003%	0.0005%	0	0
Port Chester SD	Port Chest	NY	USA	1	1	3.1E+05	1	0.0002%	0.0005%	0	0
Bayshore Region	Union Beac	NJ	USA	1	1	2.7E+05	1	0.0002%	0.0004%	0	0
Charleston	Charleston	SC	USA	1	1	2.9E+05	1	0.0002%	0.0006%	0	0
Norwalk	Norwalk	CT	USA	1	1	3.2E+05	1	0.0002%	0.0005%	0	0
Saratoga	Saratoga	NY	USA	1	1	3.1E+05	1	0.0002%	0.0005%	0	0
Glens Falls	Glens fall	NY	USA	1	1	3.1E+05	1	0.0002%	0.0005%	0	0
Atlantic City	Atlantic C	NJ	USA	1	1	2.3E+05	1	0.0002%	0.0004%	0	0
New London WPCF	New London	CT	USA	1	1	4.6E+05	1	0.0002%	0.0006%	0	0
City of Johnsto	Johnstown	PA	USA	1	1	7.2E+04	1	0.0002%	0.0004%	0	0
Maryville Regio	Maryville	TN	USA	1	1	1.2E+05	1	0.0002%	0.0005%	0	0
West Haven	West Haven	CT	USA	1	1	3.1E+05	1	0.0002%	0.0004%	0	0
Bristol	Bristol	TN	USA	1	1	1.4E+05	1	0.0002%	0.0004%	0	0
Cobb County	Marietta	GA	USA	1	1	1.8E+05	1	0.0002%	0.0005%	0	0
Disposal Distri	Southampto	NY	USA	1	1	3.1E+05	1	0.0002%	0.0004%	0	0
Glen Cove	New York	NY	USA	1	1	2.2E+05	1	0.0002%	0.0003%	0	0
Mattabassett	Cromwell	CT	USA	1	1	3.1E+05	1	0.0002%	0.0004%	0	0
East Shore WPCF	New Haven	CT	USA	1	1	2.6E+05	1	0.0002%	0.0004%	0	0
Jacksonville	Jacksonvil	FL	USA	1	1	2.5E+05	1	0.0001%	0.0005%	0	0
Vancouver	Vancouver	WA	USA	1	1	3.0E+05	1	0.0001%	0.0009%	0	0
New Bergen Cnty	Waldwick	NJ	USA	1	1	1.6E+05	1	0.0001%	0.0002%	0	0
Fitchburg East	Fitchburg	MA	USA	1	1	3.5E+05	1	0.0001%	0.0004%	0	0
Willimantic WPC	Willimanti	CT	USA	1	1	3.1E+05	1	0.0001%	0.0004%	0	0
Manchester WWTP	Manchester	NH	USA	1	1	3.1E+05	1	0.0001%	0.0003%	0	0
Shelby	Shelby	NC	USA	1	1	1.4E+05	1	0.0001%	0.0003%	0	0
Orangetown DPW	Orangetown	NY	USA	1	1	1.5E+05	1	0.0001%	0.0002%	0	0
Merrimack WWTP	Merrimack	NH	USA	1	1	3.1E+05	1	0.0001%	0.0003%	0	0
Somerset Rarita	Bridgewate	NJ	USA	1	1	1.2E+05	1	0.0001%	0.0002%	0	0
Fall River	Fall River	MA	USA	1	1	3.1E+05	1	0.0001%	0.0003%	0	0
Upper Blackston	Millbury	MA	USA	1	1	3.1E+05	1	0.0001%	0.0003%	0	0
Providence	Providence	RI	USA	1	1	3.1E+05	1	0.0001%	0.0003%	0	0
Attleboro Advan	Attleboro	MA	USA	1	1	3.1E+05	1	0.0001%	0.0003%	0	0
Lynn	Lynn	MA	USA	1	1	3.1E+05	1	0.0001%	0.0003%	0	0
Newport	Newport	TN	USA	1	1	6.9E+04	1	0.0001%	0.0003%	0	0
West Side STP	Jersey Cit	NJ	USA	1	1	1.2E+05	1	0.0001%	0.0002%	0	0
Prince Albert	Prince Alb	SK	CAN	1	1	6.4E+04	1	0.0001%	0.0006%	0	0
Tyrone	Tyrone	PA	USA	1	1	4.5E+04	1	0.0001%	0.0002%	0	0
Hopewell	Hopewell	VA	USA	1	1	7.2E+04	1	0.0001%	0.0002%	0	0
Savannah	Savannah	GA	USA	1	1	1.1E+05	1	0.00009%	0.00024%	0	0
Lake Charles	Lake Charl	LA	USA	1	1	5.3E+04	1	0.00008%	0.00032%	0	0
Gloucester Town	Blackwood	NJ	USA	1	1	8.5E+04	1	0.00008%	0.00013%	0	0
Rocky Mount	Rocky Moun	NC	USA	1	1	6.7E+04	1	0.00008%	0.00016%	0	0
Atlanta Utoy	Atlanta	GA	USA	1	1	7.2E+04	1	0.00008%	0.00021%	0	0
Ocean City	Ocean City	MD	USA	1	1	7.1E+04	1	0.00007%	0.00013%	0	0
Beacon WPCP	Beacon	NY	USA	1	1	8.6E+04	1	0.00007%	0.00013%	0	0
Gainesville	Gainesvill	GA	USA	1	1	4.9E+04	1	0.00007%	0.00016%	0	0
Cranston	Cranston	RI	USA	1	1	1.8E+05	1	0.00007%	0.00019%	0	0
LuLu Island	LuLu Islan	BC	CAN	1	1	1.3E+05	1	0.00006%	0.00041%	0	0
Columbia	Columbia	SC	USA	1	1	7.3E+04	1	0.00006%	0.00014%	0	0
Tigard	Tigard	OR	USA	1	1	1.3E+05	1	0.00006%	0.00038%	0	0
Hazelton	West Hazel	PA	USA	1	1	4.0E+04	1	0.00006%	0.00010%	0	0
Arlington	Arlington	NY	USA	1	1	7.5E+04	1	0.00006%	0.00012%	0	0
Mattabassett	Cromwell	CT	USA	1	1	1.1E+05	1	0.00006%	0.00014%	0	0
New Bedford WWT	New Bedfor	MA	USA	1	1	1.4E+05	1	0.00006%	0.00016%	0	0
Hatfield Townsh	Colmar	PA	USA	1	1	5.1E+04	1	0.00005%	0.00008%	0	0
Central Contra	Martinez	CA	USA	1	1	3.9E+05	1	0.00004%	0.00025%	0	0
Waterbury WPCF	Waterbury	CT	USA	1	1	5.8E+04	1	0.00004%	0.00008%	0	0

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Lebanon WWTP	Lebanon	NH	USA	1	1	6.4E+04	1	0.00003%	0.00009%	0	0
Tahoe Truckee	Truckee	CA	USA	1	1	3.1E+05	1	0.00003%	0.00023%	0	0
Little Falls	Little Fal	NY	USA	1	1	3.5E+04	1	0.00003%	0.00006%	0	0
Redwood City	Redwood Ci	CA	USA	1	1	3.1E+05	1	0.00003%	0.00020%	0	0
Martinez	Martinez	CA	USA	1	1	3.1E+05	1	0.00003%	0.00020%	0	0
Chicopee	Chicopee	MA	USA	1	1	6.4E+04	1	0.00003%	0.00008%	0	0
Round Hill	Douglas Co	NV	USA	1	1	8.0E+04	1	0.000009%	0.000061%	0	0
Upper Gwynedd	North Wale	PA	USA	1	1	9.8E+03	1	0.000009%	0.000015%	0	0
Edmonds	Edmonds	WA	USA	1	1	1.4E+04	1	0.000007%	0.000046%	0	0
Sacramento	Sacramento	CA	USA	1	1	6.4E+04	1	0.000006%	0.000043%	0	0
Lake Arrowhead	Lake Arrow	CA	USA	1	1	4.3E+04	1	0.000006%	0.000033%	0	0
Douglas County	Zephyr Cov	NV	USA	1	1	4.4E+04	1	0.000005%	0.000034%	0	0
Palo Alto	Palo Alto	CA	USA	1	1	5.3E+04	1	0.000005%	0.000035%	0	0
San Mateo	San Mateo	CA	USA	1	1	4.4E+04	1	0.000004%	0.000028%	0	0
Yosemite	Yosemite N	CA	USA	1	1	3.0E+04	1	0.000003%	0.000023%	0	0
Barstow	Barstow	CA	USA	1	1	2.2E+04	1	0.000003%	0.000018%	0	0
Lynnwood	LYnnwood	WA	USA	1	1	6.2E+03	1	0.000003%	0.000020%	0	0
Petersburg	Petersburg	AK	USA	1	1	3.1E+05	1	0.000001%	0.000001%	0	0
Honolulu	Honolulu	HI	USA	1	1	3.1E+05	1	0.000001%	0.000001%	0	0
Oahu	Oahu	HI	USA	1	1	3.1E+05	1	0.000001%	0.000001%	0	0
South Lake Taho	Lake Tahoe	CA	USA	1	1	7.1E+03	1	0.000001%	0.000005%	0	0
Main Island WWT	Honolulu	HI	USA	1	1	2.3E+05	1	0.000001%	0.000001%	0	0
Anchorage	Anchorage	AK	USA	1	1	9.8E+03	1	0.000000%	0.000000%	0	0
Wrangell	Wrangell	AK	USA	1	1	1.8E+03	1	0.000000%	0.000000%	0	0

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Iron Sintering Plants											
FeS:USS Div of	Gary	IN	USA	1	1	2.2E+06	4	2.79%	0.25%	1	1
FeS:Bethlehem S	Chesterton	IN	USA	1	1	1.5E+06	4	1.70%	0.15%	1	1
FeS:LTV Steel	East Chica	IN	USA	1	1	7.0E+05	4	1.06%	0.10%	1	1
FeS:Inland Stee	East Chica	IN	USA	1	1	6.0E+05	4	0.91%	0.08%	1	1
FeS:WCI Steel	Warren	OH	USA	1	1	8.4E+05	4	0.50%	0.03%	1	0
FeS:Stalco Stee	Hamilton	ON	CAN	1	1	3.1E+05	4	0.38%	0.02%	1	0
FeS:Weirton Ste	Wierton	WV	USA	1	1	6.5E+05	4	0.36%	0.02%	1	0
FeS:Bethlehem S	Baltimore	MD	USA	1	1	2.0E+06	4	0.25%	0.01%	1	0
FeS:AK Steel Co	Middletown	OH	USA	1	1	4.6E+05	4	0.22%	0.01%	1	0
FeS:Wheeling Pi	East Steub	WV	USA	1	1	2.4E+05	4	0.13%	0.01%	1	0
FeS:Algomo Inc	Wawa	ON	CAN	2	1	4.0E+05	4	0.12%	0.01%	0	0
FeS:Geneva Stee	Orem	UT	USA	1	1	3.9E+05	4	0.02%	0.00%	0	0
Secondary Copper Smelters											
CHEMETCO	HARTFORD	IL	USA	1	1	1.2E+07	1	1.51%	0.08%	1	0
CERRO COPPER PR	SAUGET	IL	USA	1	1	5.5E+06	1	0.65%	0.03%	1	0
NORANDA	ROUYN-NORA	QU	CAN	1	1	1.0E+07	1	0.64%	0.03%	1	0
WOOLVERINE	LONDON	ON	CAN	1	1	2.8E+06	1	0.62%	0.03%	1	0
SOUTHWIRE COPPE	CARROLLTON	GA	USA	1	1	1.1E+07	1	0.36%	0.02%	1	0
GASTON NASSAU C	GASTON	SC	USA	1	1	1.0E+07	1	0.27%	0.01%	1	0
FRANKLIN CORP	PHILADELPH	PA	USA	1	1	1.5E+06	1	0.04%	0.00%	0	0
RECONTEK	NEWMAN	IL	USA	1	1	8.3E+04	1	0.01%	0.00%	0	0
Secondary Copper Refiners											
CERRO COPPER PR	SAUGET	IL	USA	1	1	9.5E+06	1	0.027%	0.005%	0	0
SOUTHWIRE COPPE	CARROLLTON	GA	USA	1	1	1.1E+07	1	0.010%	0.001%	0	0
WARRENTON	WARRENTON	MO	USA	1	1	2.9E+06	1	0.008%	0.001%	0	0
GASTON NASSAU C	GASTON	SC	USA	1	1	1.1E+07	1	0.007%	0.001%	0	0
ESSEX GROUP	MARION	IN	USA	1	1	1.6E+06	1	0.006%	0.001%	0	0
READING TUBE CO	READING	PA	USA	1	1	6.3E+06	1	0.004%	0.001%	0	0
N CHICAGO REF &	NORTH CHIC	IL	USA	1	1	4.5E+04	1	0.000%	0.000%	0	0

Facility Name	City	State/ Province	Country	Type Code (a)	APCD (b)	Throughput	Unit (c)	5-Lake Average Percent of Total Deposition		Within Top 85% of Deposition to any Lake (1 = yes)	
								TEQ	HCB	TEQ	HCB
Hexachlorobenzene Waste Incineration											
Westlake Monome	Calvert Ci	KY	USA	4	1	1.1E+05	1	0.00%	1.82%	0	1
DuPont Corpus C	Ingleside	TX	USA	4	1	1.5E+05	1	0.00%	1.10%	0	1
BF Goodrich Co	La Porte	TX	USA	4	1	1.5E+05	1	0.00%	1.08%	0	1
Occidental Chem	Deer Park	TX	USA	4	1	1.2E+05	1	0.00%	0.85%	0	1
Dow Chemical Co	Plaquemine	LA	USA	4	1	1.4E+05	1	0.00%	0.84%	0	1
Georgia Gulf	Plaquemine	LA	USA	4	1	1.3E+05	1	0.00%	0.80%	0	1
Formosa	Baton Roug	LA	USA	4	1	1.3E+05	1	0.00%	0.77%	0	1
Formosa	Point Comf	TX	USA	4	1	8.5E+04	1	0.00%	0.73%	0	1
Dow Chemical Co	Freeport	TX	USA	4	1	9.6E+04	1	0.00%	0.70%	0	1
Vista	Lake Charl	LA	USA	4	1	8.9E+04	1	0.00%	0.66%	0	1
Borden Chemical	Geismar	LA	USA	4	1	9.8E+04	1	0.00%	0.58%	0	1
PPG	Lake Charl	LA	USA	4	1	7.7E+04	1	0.00%	0.57%	0	1
PPG Industries	Lake Charl	LA	USA	2	1	6.5E+04	1	0.00%	0.48%	0	1
Vulcan Chemical	Geismar	LA	USA	2	1	4.9E+04	1	0.00%	0.29%	0	1
Dow Chemical Ca	Fort Saska	AL	CAN	4	1	4.1E+04	1	0.00%	0.28%	0	1
Monsanto	Sauget	IL	USA	5	1	1.7E+04	1	0.00%	0.25%	0	1
Vulcan Chemical	Wichita	KS	USA	2	1	1.6E+04	1	0.00%	0.23%	0	1
Vulcan	Wichita	KS	USA	8	1	1.3E+04	1	0.00%	0.18%	0	1
AKZO	Lemoyne	AL	USA	1	1	4.2E+04	1	0.00%	0.18%	0	1
Dow	Plaquemine	LA	USA	2	1	2.9E+04	1	0.00%	0.18%	0	1
PPG	New Martin	WV	USA	5	1	4.2E+03	1	0.00%	0.07%	0	1
Dow	Plaquemine	LA	USA	1	1	2.0E+04	1	0.00%	0.12%	0	0
Vulcan	Geismar	LA	USA	1	1	1.4E+04	1	0.00%	0.09%	0	0
PPG Industries	Lake Charl	LA	USA	3	1	8.4E+03	1	0.00%	0.06%	0	0
Monsanto	Sauget	IL	USA	7	1	3.3E+03	1	0.00%	0.05%	0	0
PPG	New Martin	WV	USA	7	1	3.0E+03	1	0.00%	0.05%	0	0
Dow	Freeport	TX	USA	3	1	5.1E+03	1	0.00%	0.04%	0	0
Standard Chlori	Delaware C	DE	USA	5	1	1.4E+04	1	0.00%	0.03%	0	0
PPG	New Martin	WV	USA	6	1	2.1E+03	1	0.00%	0.03%	0	0
Cornwall Chemic	Cornwall	ON	CAN	1	1	7.1E+03	1	0.00%	0.02%	0	0
LCP Chemicals	Moundsvill	WV	USA	1	1	1.3E+03	1	0.00%	0.02%	0	0
Standard Chlori	Delaware C	DE	USA	8	1	8.7E+03	1	0.00%	0.02%	0	0
Standard Chlori	Delaware C	DE	USA	7	1	7.6E+03	1	0.00%	0.02%	0	0
Monsanto	Sauget	IL	USA	6	1	1.2E+03	1	0.00%	0.02%	0	0
Standard Chlori	Delaware C	DE	USA	6	1	5.3E+03	1	0.00%	0.01%	0	0
Dow	Pittsburg	CA	USA	1	1	1.3E+04	1	0.00%	0.01%	0	0

Facility Name	City	State/ Province	Country	Type Code (a)	APCD (b)	Throughput	Unit (c)	5-Lake Average Percent of Total Deposition TEQ	HCB	Within Top 85% of Deposition to any Lake (1 = yes) TEQ	HCB
Cement Kilns Burning Hazardous Waste											
CAK:Saint Lawre	Mississaug	ON	CAN	3	1	1.5E+06	4	1.32%	4.52%	1	1
CAK:Systech Env	Alpena	MI	USA	3	1	1.8E+06	4	0.83%	2.56%	1	1
CAK:Holnam	Clarkville	MO	USA	3	1	1.2E+06	4	0.39%	1.01%	1	1
CAK:Lone Star I	Cape Girar	MO	USA	3	1	9.9E+05	4	0.33%	0.81%	1	1
CAK:Cemtech LP	Festus	MO	USA	3	1	1.1E+06	4	0.32%	0.77%	1	1
CAK:Systech Env	Greencastl	IN	USA	3	1	6.5E+05	4	0.29%	0.77%	1	1
CAK:Cadence Env	Louisville	NE	USA	3	1	8.8E+05	4	0.26%	0.76%	1	1
CAK:Solite Kent	Brooks	KY	USA	3	1	6.8E+05	4	0.27%	0.64%	1	1
CAK:Cemtech LP	Wampum	PA	USA	3	1	6.3E+05	4	0.26%	0.62%	1	1
CAK:Essroc Mate	Logansport	IN	USA	3	1	4.1E+05	4	0.21%	0.60%	1	1
CAK:Systech Env	Paulding	OH	USA	3	1	4.4E+05	4	0.20%	0.55%	1	1
CAK:MFR Inc	Hannibal	MO	USA	3	1	5.4E+05	4	0.19%	0.50%	1	1
CAK:Southdown I	Fairborn	OH	USA	3	1	5.5E+05	4	0.21%	0.48%	1	1
CAK:Texas Indus	Midlothian	TX	USA	3	1	1.2E+06	4	0.18%	0.48%	1	1
CAK:Cadence Env	Foreman	AR	USA	3	1	8.6E+05	4	0.16%	0.43%	1	1
CAK:Cadence Env	Chanute	KS	USA	3	1	4.5E+05	4	0.13%	0.33%	1	1
CAK:Lafarge Can	Exshaw	AL	CAN	3	1	7.7E+05	4	0.06%	0.28%	0	1
CAK:Medusa	Demopolis	AL	USA	3	1	7.3E+05	4	0.11%	0.26%	0	1
CAK:Lafarge Cor	Fredonia	KS	USA	3	1	3.3E+05	4	0.09%	0.25%	0	1
CAK:Systech Env	Independen	KS	USA	3	1	3.0E+05	4	0.08%	0.22%	0	1
CAK:Chemtech LP	Artesia	MS	USA	3	1	4.5E+05	4	0.08%	0.18%	0	1
CAK:Southdown I	Knoxville	TN	USA	3	1	5.4E+05	4	0.08%	0.16%	0	1
CAK:Solite Corp	Arvonia	VA	USA	3	1	6.8E+05	4	0.08%	0.13%	0	1
CAK:Safety Klee	Holly Hill	SC	USA	3	1	9.9E+05	4	0.07%	0.12%	0	1
CAK:Solite Virg	Cascade	VA	USA	3	1	6.8E+05	4	0.07%	0.11%	0	1
CAK:Solite Flor	Green Cove	FL	USA	3	1	6.8E+05	4	0.03%	0.09%	0	0
CAK:Solite Caro	Norwood	NC	USA	3	1	6.8E+05	4	0.05%	0.08%	0	0
CAK:Norlite Cor	Cohoes	NY	USA	3	1	6.8E+05	4	0.04%	0.07%	0	0
CAK:Keystone Ce	Bath	PA	USA	3	1	5.4E+05	4	0.04%	0.07%	0	0
CAK:National Ce	Lebec	CA	USA	3	1	5.9E+05	4	0.01%	0.03%	0	0

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								TEQ	HCB	TEQ	HCB
Cement Kilns Not Reporting Hazardous Waste Combustion											
CAK:St Marys Ce	Bowmanvill	ON	CAN	4	1	1.2E+06	4	0.11%	0.37%	1	1
CAK:Marblehead	Thornton	IL	USA	4	1	6.8E+05	4	0.09%	0.35%	0	1
CAK:Lone Star I	Oglesby	IL	USA	4	1	4.9E+05	4	0.07%	0.29%	0	1
CAK:Holnam	Dundee	MI	USA	4	1	9.0E+05	4	0.07%	0.24%	0	1
CAK:Medusa	Charlevoix	MI	USA	4	1	1.3E+06	4	0.06%	0.21%	0	1
CAK:St Marys Pe	Detroit	MI	USA	4	1	5.9E+05	4	0.05%	0.17%	0	1
CAK:Lafarge	Grand Chai	IL	USA	4	1	1.1E+06	4	0.05%	0.12%	0	1
CAK:Essroc Mate	Speed	IN	USA	4	1	9.0E+05	4	0.05%	0.12%	0	1
CAK:St Marys Ce	St Marys	ON	CAN	4	1	5.0E+05	4	0.03%	0.10%	0	1
CAK:National Li	Carey	OH	USA	4	1	6.8E+05	4	0.04%	0.11%	0	1
CAK:Lafarge Can	Woodstock	ON	CAN	4	1	4.3E+05	4	0.03%	0.09%	0	1
CAK:Holnam	Mason City	IA	USA	4	1	7.7E+05	4	0.04%	0.12%	0	1
CAK:Lehigh Port	Mitchell	IN	USA	4	1	6.8E+05	4	0.04%	0.09%	0	0
CAK:Environment	Brooks	KY	USA	4	1	6.8E+05	4	0.03%	0.08%	0	0
CAK:Lafarge	Whitehall	PA	USA	4	1	7.8E+05	4	0.03%	0.08%	0	1
CAK:Lehigh Port	Mason City	IA	USA	4	1	6.8E+05	4	0.03%	0.11%	0	1
CAK:Komos Cemen	Kosmosdale	KY	USA	4	1	6.3E+05	4	0.03%	0.08%	0	0
CAK:Dixon Marqu	Dixon	IL	USA	4	1	4.7E+05	4	0.03%	0.11%	0	1
CAK:Centex	La Salle	IL	USA	4	1	4.1E+05	4	0.03%	0.11%	0	1
CAK:Lafarge	Buffalo	IA	USA	4	1	8.0E+05	4	0.03%	0.09%	0	1
CAK:Essroc Cana	Picton	ON	CAN	4	1	8.4E+05	4	0.02%	0.06%	0	1
CAK:Lone Star I	Pedro	OH	USA	4	1	6.8E+05	4	0.03%	0.06%	0	0
CAK:Carlow Grou	East Fulto	OH	USA	4	1	5.5E+05	4	0.03%	0.07%	0	1
CAK:Hercules	West Eliza	PA	USA	4	1	6.8E+05	4	0.03%	0.06%	0	0
CAK:Monarch Cem	Humboldt	KS	USA	4	1	6.0E+05	4	0.02%	0.06%	0	0
CAK:Lone Star I	Pryor	OK	USA	4	1	6.2E+05	4	0.02%	0.05%	0	0
CAK:Essroc Mate	Bessemer	PA	USA	4	1	5.0E+05	4	0.02%	0.05%	0	0
CAK:Lafarge	Sugar Cree	MO	USA	4	1	4.8E+05	4	0.02%	0.05%	0	0
CAK:Lehigh Texa	Buda	TX	USA	4	1	9.9E+05	4	0.02%	0.05%	0	0
CAK:Boxcrow Cem	Midlothian	TX	USA	4	1	9.0E+05	4	0.02%	0.05%	0	0
CAK:Blue Circle	Tulsa	OK	USA	4	1	5.4E+05	4	0.02%	0.05%	0	0
CAK:Capitol Cem	Martinsbur	WV	USA	4	1	8.6E+05	4	0.02%	0.03%	0	0
CAK:Dacotah Cem	Rapid City	SD	USA	4	1	6.8E+05	4	0.02%	0.06%	0	0
CAK:Lafarge	New Braunf	TX	USA	4	1	7.9E+05	4	0.02%	0.04%	0	0
CAK:Holnam	Theodore	AL	USA	4	1	1.3E+06	4	0.02%	0.04%	0	0
CAK:Capitol Agg	San Antoni	TX	USA	4	1	7.7E+05	4	0.02%	0.04%	0	0
CAK:Roanoke Cem	Cloverdale	VA	USA	4	1	8.9E+05	4	0.01%	0.03%	0	0
CAK:Kosmos Ceme	Pittsburgh	PA	USA	4	1	3.5E+05	4	0.01%	0.03%	0	0
CAK:Lehigh Port	Union Brid	MD	USA	4	1	8.9E+05	4	0.01%	0.02%	0	0
CAK:Texas Indus	New Braunf	TX	USA	4	1	6.8E+05	4	0.01%	0.04%	0	0
CAK:Systech Env	Demopolis	AL	USA	4	1	6.8E+05	4	0.01%	0.03%	0	0
CAK:Alamo Cemen	San Antoni	TX	USA	4	1	6.8E+05	4	0.01%	0.04%	0	0
CAK:Lafarge Can	Bath	ON	CAN	4	1	8.4E+05	4	0.01%	0.02%	0	0
CAK:National Ce	Ragland	AL	USA	4	1	8.0E+05	4	0.01%	0.03%	0	0
CAK:Armstrong C	Cabot	PA	USA	4	1	2.9E+05	4	0.01%	0.03%	0	0
CAK:Holnam	Florence	CO	USA	4	1	7.3E+05	4	0.01%	0.03%	0	0
CAK:Federal Whi	Woodstock	ON	CAN	4	1	1.2E+05	4	0.01%	0.02%	0	0
CAK:Blue Circle	Ravena	NY	USA	4	1	1.4E+06	4	0.01%	0.02%	0	0
CAK:Oldover Cor	Arvonia	VA	USA	4	1	6.8E+05	4	0.010%	0.017%	0	0
CAK:Southdown	Odessa	TX	USA	4	1	4.8E+05	4	0.010%	0.027%	0	0
CAK:Essroc Mate	Nazareth	PA	USA	4	1	9.9E+05	4	0.010%	0.015%	0	0
CAK:Lone Star I	Sweetwater	TX	USA	4	1	4.5E+05	4	0.009%	0.026%	0	0
CAK:Lehigh Port	Leeds	AL	USA	4	1	5.9E+05	4	0.009%	0.020%	0	0
CAK:Allentown C	Blandon	PA	USA	4	1	8.1E+05	4	0.009%	0.014%	0	0
CAK:Hercules Fr	Franklin	VA	USA	4	1	6.8E+05	4	0.009%	0.014%	0	0
CAK:Oldover Cor	Cascade	VA	USA	4	1	6.8E+05	4	0.009%	0.015%	0	0
CAK:Independent	Hagerstown	MD	USA	4	1	4.7E+05	4	0.008%	0.016%	0	0
CAK:Blue Circle	Calera	AL	USA	4	1	5.4E+05	4	0.008%	0.018%	0	0
CAK:Ciment Queb	St Basile	QU	CAN	4	1	8.4E+05	4	0.006%	0.015%	0	0
CAK:RC Cement	Chattanoog	TN	USA	4	1	3.9E+05	4	0.008%	0.016%	0	0
CAK:St Lawrence	Joliette	QU	CAN	4	1	7.7E+05	4	0.006%	0.014%	0	0
CAK:Lafarge Can	St Constan	QU	CAN	4	1	7.7E+05	4	0.006%	0.014%	0	0
CAK:Inland Ceme	Winnipeg	MB	CAN	4	1	2.7E+05	4	0.006%	0.032%	0	0

Facility Name	City	State/ Province	Country	Type Code (a)	APCD (b)	Throughput	Unit (c)	5-Lake Average Percent of Total Deposition TEQ	HCB	Within Top 85% of Deposition to any Lake (1 = yes) TEQ	HCB
CAK:Tilbury Cem	Delta	BC	CAN	4	1	8.4E+05	4	0.005%	0.022%	0	0
CAK:Blue Circle	Atlanta	GA	USA	4	1	5.4E+05	4	0.007%	0.013%	0	0
CAK:Inland Ceme	Edmonton	AL	CAN	4	1	5.6E+05	4	0.005%	0.026%	0	0
CAK:RC Cement	Stockertow	PA	USA	4	1	6.8E+05	4	0.006%	0.010%	0	0
CAK:Holnam	Fort Colli	CO	USA	4	1	4.2E+05	4	0.006%	0.019%	0	0
CAK:Oldover Cor	Albemarle	NC	USA	4	1	6.8E+05	4	0.006%	0.010%	0	0
CAK:Southdown	Brooksvill	FL	USA	4	1	1.1E+06	4	0.006%	0.018%	0	0
CAK:Essroc Mate	Frederick	MD	USA	4	1	3.4E+05	4	0.006%	0.011%	0	0
CAK:Blue Circle	Harleyvill	SC	USA	4	1	6.3E+05	4	0.006%	0.010%	0	0
CAK:Centex	Laramie	WY	USA	4	1	3.9E+05	4	0.006%	0.018%	0	0
CAK:California	Rillito	AZ	USA	4	1	1.2E+06	4	0.006%	0.015%	0	0
CAK:Southdown	Lyons	CO	USA	4	1	3.8E+05	4	0.006%	0.017%	0	0
CAK:Lone Star I	Nazareth	PA	USA	4	1	5.7E+05	4	0.005%	0.009%	0	0
CAK:Holnam	Tijeras	NM	USA	4	1	4.3E+05	4	0.005%	0.015%	0	0
CAK:Keystone Ce	Bath	PA	USA	4	1	5.4E+05	4	0.005%	0.008%	0	0
CAK:Lehigh Port	Waco	TX	USA	4	1	2.6E+05	4	0.005%	0.014%	0	0
CAK:Pennsuco Ce	Medley	FL	USA	4	1	9.0E+05	4	0.005%	0.014%	0	0
CAK:Ash Grove	Nephi	UT	USA	4	1	5.8E+05	4	0.005%	0.014%	0	0
CAK:St Lawrence	Quebec Cit	QU	CAN	4	1	4.7E+05	4	0.004%	0.008%	0	0
CAK:Grant Count	Lind	WA	USA	4	1	6.8E+05	4	0.004%	0.018%	0	0
CAK:Southdown	Victorvill	CA	USA	4	1	1.4E+06	4	0.004%	0.010%	0	0
CAK:Ash Grove C	Seattle	WA	USA	4	1	6.1E+05	4	0.004%	0.017%	0	0
CAK:Inland Ceme	Regina	SK	CAN	4	1	1.8E+05	4	0.003%	0.014%	0	0
CAK:Lehigh Port	Cementon	NY	USA	4	1	5.0E+05	4	0.004%	0.007%	0	0
CAK:California	Mojave	CA	USA	4	1	1.2E+06	4	0.003%	0.008%	0	0
CAK:Independent	Catskill	NY	USA	4	1	4.7E+05	4	0.003%	0.006%	0	0
CAK:Riverside C	Oro Grande	CA	USA	4	1	1.1E+06	4	0.003%	0.007%	0	0
CAK:Lafarge Can	Richmond	BC	CAN	4	1	3.6E+05	4	0.002%	0.010%	0	0
CAK:Phoenix Cem	Clarkdale	AZ	USA	4	1	6.4E+05	4	0.003%	0.008%	0	0
CAK:Glens Falls	Glens Fall	NY	USA	4	1	4.6E+05	4	0.003%	0.006%	0	0
CAK:Lafarge Can	Brookfield	NS	CAN	4	1	4.1E+05	4	0.002%	0.005%	0	0
CAK:Florida Cru	Brooksvill	FL	USA	4	1	5.1E+05	4	0.003%	0.008%	0	0
CAK:Holnam	Three Fork	MT	USA	4	1	2.7E+05	4	0.003%	0.012%	0	0
CAK:Ash Grove	Montana Ci	MT	USA	4	1	2.7E+05	4	0.003%	0.012%	0	0
CAK:Holnam	Seattle	WA	USA	4	1	4.0E+05	4	0.003%	0.011%	0	0
CAK:Mitsubishi	Lucerne Va	CA	USA	4	1	1.5E+06	4	0.003%	0.009%	0	0
CAK:Rinker Port	Miami	FL	USA	4	1	5.0E+05	4	0.003%	0.008%	0	0
CAK:Ash Grove	Durkee	OR	USA	4	1	4.4E+05	4	0.003%	0.010%	0	0
CAK:Holnam	Morgan	UT	USA	4	1	2.9E+05	4	0.002%	0.007%	0	0
CAK:Kaiser Ceme	Permanente	CA	USA	4	1	1.4E+06	4	0.002%	0.008%	0	0
CAK:California	Colton	CA	USA	4	1	6.8E+05	4	0.002%	0.004%	0	0
CAK:Dragon Prod	Thomaston	ME	USA	4	1	3.9E+05	4	0.002%	0.004%	0	0
CAK:Calaveras C	Tehachapi	CA	USA	4	1	6.7E+05	4	0.002%	0.004%	0	0
CAK:Ash Grove	Inkom	ID	USA	4	1	2.1E+05	4	0.002%	0.006%	0	0
CAK:Lafarge Can	Kamloops	BC	CAN	4	1	1.5E+05	4	0.001%	0.005%	0	0
CAK:Lehigh Port	York	PA	USA	4	1	8.9E+04	4	0.001%	0.002%	0	0
CAK:Calaveras C	Redding	CA	USA	4	1	5.7E+05	4	0.001%	0.004%	0	0
CAK:RMC Lonesta	Davenport	CA	USA	4	1	7.2E+05	4	0.001%	0.004%	0	0
CAK:Centex	Fernley	NV	USA	4	1	3.9E+05	4	0.0009%	0.0028%	0	0
CAK:North Star	Corner Bro	NF	CAN	4	1	1.2E+05	4	0.0007%	0.0015%	0	0
CAK:Riverside C	Riverside	CA	USA	4	1	9.9E+04	4	0.0003%	0.0007%	0	0
CAK:Hawaiian	Ewa Beach	HI	USA	4	1	2.3E+05	4	0.0000%	0.0000%	0	0

Facility Name	City	State/ Province	Country	Type Code (a)	APCD (b)	Throughput	Unit (c)	5-Lake Average Percent of Total Deposition TEQ	HCB	Within Top 85% of Deposition to any Lake (1 = yes) TEQ	HCB
Medical Waste Incineration											
MWI:IL	entire state	IL	USA	1	0	1.5E+07	1	7.16%	0.17%	1	1
MWI:MI	entire state	MI	USA	1	0	1.3E+07	1	4.03%	0.09%	1	1
MWI:OH	entire state	OH	USA	1	0	1.6E+07	1	3.65%	0.06%	1	0
MWI:WI	entire state	WI	USA	1	0	1.1E+07	1	3.19%	0.07%	1	0
MWI:TX	entire state	TX	USA	1	0	3.3E+07	1	2.94%	0.05%	1	0
MWI:PA	entire state	PA	USA	1	0	2.6E+07	1	2.18%	0.03%	1	0
MWI:MO	entire state	MO	USA	1	0	1.1E+07	1	1.97%	0.03%	1	0
MWI:MN	entire state	MN	USA	1	0	9.6E+06	1	1.89%	0.05%	1	0
MWI:IN	entire state	IN	USA	1	0	7.3E+06	1	1.77%	0.03%	1	0
MWI:KY	entire state	KY	USA	1	0	8.1E+06	1	1.51%	0.02%	1	0
MWI:TN	entire state	TN	USA	1	0	1.1E+07	1	1.35%	0.02%	1	0
MWI:NY	entire state	NY	USA	1	0	2.3E+07	1	1.25%	0.02%	1	0
MWI:IA	entire state	IA	USA	1	0	6.0E+06	1	1.16%	0.02%	1	0
MWI:MS	entire state	MS	USA	1	0	1.0E+07	1	0.99%	0.01%	1	0
MWI:OK	entire state	OK	USA	1	0	6.9E+06	1	0.92%	0.02%	1	0
MWI:VA	entire state	VA	USA	1	0	1.4E+07	1	0.88%	0.01%	1	0
MWI:KS	entire state	KS	USA	1	0	5.3E+06	1	0.86%	0.01%	1	0
MWI:AR	entire state	AR	USA	1	0	5.2E+06	1	0.74%	0.01%	1	0
MWI:GA	entire state	GA	USA	1	0	1.5E+07	1	0.74%	0.01%	1	0
MWI:FL	entire state	FL	USA	1	0	2.9E+07	1	0.69%	0.01%	1	0
MWI:AL	entire state	AL	USA	1	0	1.0E+07	1	0.66%	0.01%	1	0
MWI:NC	entire state	NC	USA	1	0	1.5E+07	1	0.65%	0.01%	1	0
MWI:MD	entire state	MD	USA	1	0	1.1E+07	1	0.61%	0.01%	1	0
MWI:ND	entire state	ND	USA	1	0	4.6E+06	1	0.59%	0.02%	1	0
MWI:LA	entire state	LA	USA	1	0	7.9E+06	1	0.57%	0.01%	1	0
MWI:NE	entire state	NE	USA	1	0	3.5E+06	1	0.56%	0.01%	1	0
MWI:ON	entire prov	ON	CAN	1	0	2.1E+06	1	0.54%	0.01%	1	0
MWI:CO	entire state	CO	USA	1	0	7.4E+06	1	0.51%	0.01%	1	0
MWI:WV	entire state	WV	USA	1	0	3.9E+06	1	0.47%	0.01%	1	0
MWI:SC	entire state	SC	USA	1	0	7.7E+06	1	0.35%	0.00%	1	0
MWI:NJ	entire state	NJ	USA	1	0	7.0E+06	1	0.25%	0.00%	1	0
MWI:MA	entire state	MA	USA	1	0	1.3E+07	1	0.22%	0.00%	1	0
MWI:SD	entire state	SD	USA	1	0	1.6E+06	1	0.22%	0.00%	1	0
MWI:NM	entire state	NM	USA	1	0	3.5E+06	1	0.19%	0.00%	1	0
MWI:AZ	entire state	AZ	USA	1	0	8.3E+06	1	0.17%	0.00%	1	0
MWI:CT	entire state	CT	USA	1	0	7.0E+06	1	0.16%	0.00%	1	0
MWI:OR	entire state	OR	USA	1	0	6.4E+06	1	0.15%	0.00%	1	0
MWI:UT	entire state	UT	USA	1	0	3.9E+06	1	0.15%	0.00%	1	0
MWI:MT	entire state	MT	USA	1	0	2.4E+06	1	0.12%	0.00%	1	0
MWI:WA	entire state	WA	USA	1	0	3.3E+06	1	0.10%	0.00%	1	0
MWI:MB	entire prov	MB	CAN	1	0	8.8E+05	1	0.08%	0.00%	1	0
MWI:QU	entire prov	QU	CAN	1	0	2.7E+06	1	0.08%	0.00%	0	0
MWI:DC	entire state	DC	USA	1	0	1.3E+06	1	0.08%	0.00%	0	0
MWI:ID	entire state	ID	USA	1	0	2.3E+06	1	0.07%	0.00%	0	0
MWI:WY	entire state	WY	USA	1	0	1.0E+06	1	0.07%	0.00%	0	0
MWI:ME	entire state	ME	USA	1	0	2.7E+06	1	0.06%	0.00%	0	0
MWI:DE	entire state	DE	USA	1	0	1.5E+06	1	0.06%	0.00%	0	0
MWI:BC	entire prov	BC	CAN	1	0	1.7E+06	1	0.05%	0.00%	0	0
MWI:CA	entire state	CA	USA	1	0	4.0E+06	1	0.05%	0.00%	0	0
MWI:NH	entire state	NH	USA	1	0	2.0E+06	1	0.04%	0.00%	0	0
MWI:NV	entire state	NV	USA	1	0	2.9E+06	1	0.04%	0.00%	0	0
MWI:VT	entire state	VT	USA	1	0	1.2E+06	1	0.03%	0.00%	0	0
MWI:AB	entire prov	AB	CAN	1	0	7.0E+05	1	0.03%	0.00%	0	0
MWI:SK	entire prov	SK	CAN	1	0	4.3E+05	1	0.03%	0.00%	0	0
MWI:RI	entire state	RI	USA	1	0	1.1E+06	1	0.02%	0.00%	0	0
MWI:NS	entire prov	NS	CAN	1	0	3.1E+05	1	0.008%	0.000%	0	0
MWI:NF	entire prov	NF	CAN	1	0	1.7E+05	1	0.006%	0.000%	0	0
MWI:PE	entire prov	PE	CAN	1	0	7.4E+04	1	0.002%	0.000%	0	0
MWI:NW	entire prov	NW	CAN	1	0	2.2E+04	1	0.001%	0.000%	0	0
MWI:NB	entire prov	NB	CAN	1	0	1.4E+04	1	0.0004%	0.0000%	0	0
MWI:HI	entire state	HI	USA	1	0	2.5E+06	1	0.0003%	0.0000%	0	0
MWI:YK	entire prov	YK	CAN	1	0	6.9E+03	1	0.0002%	0.0000%	0	0
MWI:AK	entire state	AK	USA	1	0	1.3E+06	1	0.0002%	0.0000%	0	0

Facility Name	City	State/ Province	Country	Type Code (a)	APCD (b)	Throughput	Unit (c)	5-Lake Average Percent of Total Deposition TEQ	HCB	Within Top 85% of Deposition to any Lake (1 = yes) TEQ	HCB
Coal Combustion											
coal:IN	entire sta	IN	USA	1	1	6.3E+09	1	0.33%	0.02%	1	0
coal:OH	entire sta	OH	USA	1	1	6.1E+09	1	0.31%	0.02%	1	0
coal:MI	entire sta	MI	USA	1	1	3.6E+09	1	0.23%	0.02%	1	0
coal:IL	entire sta	IL	USA	1	1	3.5E+09	1	0.18%	0.01%	1	0
coal:PA	entire sta	PA	USA	1	1	6.4E+09	1	0.11%	0.00%	1	0
coal:WI	entire sta	WI	USA	1	1	2.1E+09	1	0.10%	0.01%	1	0
coal:ND	entire sta	ND	USA	1	1	2.9E+09	1	0.08%	0.01%	1	0
coal:MN	entire sta	MN	USA	1	1	1.9E+09	1	0.08%	0.01%	1	0
coal:TX	entire sta	TX	USA	1	1	9.3E+09	1	0.16%	0.01%	0	0
coal:KY	entire sta	KY	USA	1	1	3.6E+09	1	0.14%	0.01%	0	0
coal:WV	entire sta	WV	USA	1	1	3.6E+09	1	0.10%	0.00%	0	0
coal:MO	entire sta	MO	USA	1	1	2.7E+09	1	0.10%	0.01%	0	0
coal:IA	entire sta	IA	USA	1	1	1.9E+09	1	0.07%	0.01%	0	0
coal:TN	entire sta	TN	USA	1	1	2.6E+09	1	0.06%	0.00%	0	0
coal:KS	entire sta	KS	USA	1	1	1.6E+09	1	0.05%	0.00%	0	0
coal:OK	entire sta	OK	USA	1	1	1.6E+09	1	0.04%	0.00%	0	0
coal:ON	entire sta	ON	CAN	1	1	1.8E+09	1	0.04%	0.00%	0	0
coal:AR	entire sta	AR	USA	1	1	1.3E+09	1	0.04%	0.00%	0	0
coal:AL	entire sta	AL	USA	1	1	2.9E+09	1	0.04%	0.00%	0	0
coal:WY	entire sta	WY	USA	1	1	2.6E+09	1	0.03%	0.00%	0	0
coal:GA	entire sta	GA	USA	1	1	3.1E+09	1	0.03%	0.00%	0	0
coal:NE	entire sta	NE	USA	1	1	7.7E+08	1	0.02%	0.00%	0	0
coal:CO	entire sta	CO	USA	1	1	1.7E+09	1	0.02%	0.00%	0	0
coal:AL	entire sta	AL	CAN	1	1	2.4E+09	1	0.02%	0.00%	0	0
coal:VA	entire sta	VA	USA	1	1	1.4E+09	1	0.02%	0.00%	0	0
coal:NC	entire sta	NC	USA	1	1	2.2E+09	1	0.02%	0.00%	0	0
coal:LA	entire sta	LA	USA	1	1	1.3E+09	1	0.02%	0.00%	0	0
coal:NM	entire sta	NM	USA	1	1	1.6E+09	1	0.02%	0.00%	0	0
coal:NY	entire sta	NY	USA	1	1	1.3E+09	1	0.01%	0.00%	0	0
coal:MD	entire sta	MD	USA	1	1	1.0E+09	1	0.01%	0.00%	0	0
coal:SA	entire sta	SA	CAN	1	1	8.7E+08	1	0.01%	0.00%	0	0
coal:UT	entire sta	UT	USA	1	1	1.6E+09	1	0.01%	0.00%	0	0
coal:FL	entire sta	FL	USA	1	1	2.6E+09	1	0.01%	0.00%	0	0
coal:SC	entire sta	SC	USA	1	1	1.2E+09	1	0.01%	0.00%	0	0
coal:MT	entire sta	MT	USA	1	1	1.0E+09	1	0.010%	0.001%	0	0
coal:MS	entire sta	MS	USA	1	1	4.3E+08	1	0.008%	0.001%	0	0
coal:SD	entire sta	SD	USA	1	1	2.7E+08	1	0.008%	0.001%	0	0
coal:AZ	entire sta	AZ	USA	1	1	1.7E+09	1	0.006%	0.000%	0	0
coal:WA	entire sta	WA	USA	1	1	5.3E+08	1	0.003%	0.000%	0	0
coal:NJ	entire sta	NJ	USA	1	1	3.1E+08	1	0.003%	0.000%	0	0
coal:DE	entire sta	DE	USA	1	1	2.4E+08	1	0.002%	0.000%	0	0
coal:NV	entire sta	NV	USA	1	1	8.6E+08	1	0.002%	0.000%	0	0
coal:MA	entire sta	MA	USA	1	1	4.5E+08	1	0.002%	0.000%	0	0
coal:NS	entire sta	NS	CAN	1	1	2.5E+08	1	0.001%	0.000%	0	0
coal:MN	entire sta	MN	CAN	1	1	5.3E+07	1	0.001%	0.000%	0	0
coal:CA	entire sta	CA	USA	1	1	3.0E+08	1	0.0006%	0.0000%	0	0
coal:NH	entire sta	NH	USA	1	1	1.2E+08	1	0.0005%	0.0000%	0	0
coal:CT	entire sta	CT	USA	1	1	1.0E+08	1	0.0005%	0.0000%	0	0
coal:QU	entire sta	QU	CAN	1	1	7.5E+07	1	0.0005%	0.0000%	0	0
coal:OR	entire sta	OR	USA	1	1	9.7E+07	1	0.0004%	0.0000%	0	0
coal:ID	entire sta	ID	USA	1	1	5.7E+07	1	0.0003%	0.0000%	0	0
coal:NB	entire sta	NB	CAN	1	1	5.7E+07	1	0.0003%	0.0000%	0	0
coal:BC	entire sta	BC	CAN	1	1	2.7E+07	1	0.0002%	0.0000%	0	0
coal:ME	entire sta	ME	USA	1	1	2.8E+07	1	0.0001%	0.0000%	0	0
coal:DC	entire sta	DC	USA	1	1	7.2E+06	1	0.0001%	0.0000%	0	0
coal:VT	entire sta	VT	USA	1	1	8.3E+05	1	0.000004%	0.000000%	0	0
coal:PE	entire sta	PE	CAN	1	1	8.1E+05	1	0.000004%	0.000000%	0	0
coal:AK	entire sta	AK	USA	1	1	8.1E+07	1	0.000002%	0.000000%	0	0
coal:RI	entire sta	RI	USA	1	1	5.2E+05	1	0.000002%	0.000000%	0	0
coal:NF	entire sta	NF	CAN	1	1	1.8E+05	1	0.000001%	0.000000%	0	0
coal:NW	entire sta	NW	CAN	1	1	1.2E+04	1	0.000000%	0.000000%	0	0
coal:HI	entire sta	HI	USA	1	1	2.9E+06	1	0.000000%	0.000000%	0	0
coal:YK	entire sta	YK	CAN	1	1	1.2E+04	1	0.000000%	0.000000%	0	0

Facility Name	City	State/ Province	Country	Type Code (a)	APCD (b)	Throughput	Unit (c)	5-Lake Average Percent of Total Deposition TEQ	HCB	Within Top 85% of Deposition to any Lake (1 = yes) TEQ	HCB
Wood Combustion											
wood:MI	entire sta	MI	USA	1	1	7.6E+08	1	0.17%	0.01%	1	0
wood:MN	entire sta	MN	USA	1	1	7.8E+08	1	0.12%	0.01%	1	0
wood:ON	entire sta	ON	CAN	1	1	1.3E+09	1	0.11%	0.01%	1	0
wood:AR	entire sta	AR	USA	1	1	1.0E+09	1	0.12%	0.01%	0	0
wood:IL	entire sta	IL	USA	1	1	5.9E+08	1	0.12%	0.01%	0	0
wood:OH	entire sta	OH	USA	1	1	6.1E+08	1	0.11%	0.01%	0	0
wood:GE	entire sta	GE	USA	1	1	2.7E+09	1	0.11%	0.00%	0	0
wood:MS	entire sta	MS	USA	1	1	1.2E+09	1	0.10%	0.01%	0	0
wood:AL	entire sta	AL	USA	1	1	1.8E+09	1	0.09%	0.00%	0	0
wood:LA	entire sta	LA	USA	1	1	1.5E+09	1	0.09%	0.01%	0	0
wood:TN	entire sta	TN	USA	1	1	8.3E+08	1	0.08%	0.00%	0	0
wood:KY	entire sta	KY	USA	1	1	5.1E+08	1	0.08%	0.00%	0	0
wood:IN	entire sta	IN	USA	1	1	3.5E+08	1	0.07%	0.00%	0	0
wood:MO	entire sta	MO	USA	1	1	4.7E+08	1	0.07%	0.00%	0	0
wood:VA	entire sta	VA	USA	1	1	1.0E+09	1	0.06%	0.00%	0	0
wood:WI	entire sta	WI	USA	1	1	3.0E+08	1	0.06%	0.00%	0	0
wood:NC	entire sta	NC	USA	1	1	1.5E+09	1	0.05%	0.00%	0	0
wood:PA	entire sta	PA	USA	1	1	6.3E+08	1	0.04%	0.00%	0	0
wood:NY	entire sta	NY	USA	1	1	9.0E+08	1	0.04%	0.00%	0	0
wood:SC	entire sta	SC	USA	1	1	9.5E+08	1	0.03%	0.00%	0	0
wood:IA	entire sta	IA	USA	1	1	1.6E+08	1	0.02%	0.00%	0	0
wood:FL	entire sta	FL	USA	1	1	1.2E+09	1	0.02%	0.00%	0	0
wood:QU	entire sta	QU	CAN	1	1	8.8E+08	1	0.02%	0.00%	0	0
wood:WV	entire sta	WV	USA	1	1	2.1E+08	1	0.02%	0.00%	0	0
wood:WA	entire sta	WA	USA	1	1	8.5E+08	1	0.02%	0.00%	0	0
wood:OR	entire sta	OR	USA	1	1	1.0E+09	1	0.02%	0.00%	0	0
wood:OK	entire sta	OK	USA	1	1	1.6E+08	1	0.02%	0.00%	0	0
wood:CA	entire sta	CA	USA	1	1	1.7E+09	1	0.01%	0.00%	0	0
wood:TX	entire sta	TX	USA	1	1	1.8E+08	1	0.01%	0.00%	0	0
wood:MD	entire sta	MD	USA	1	1	2.6E+08	1	0.01%	0.00%	0	0
wood:CO	entire sta	CO	USA	1	1	2.2E+08	1	0.01%	0.00%	0	0
wood:CT	entire sta	CT	USA	1	1	5.9E+08	1	0.01%	0.00%	0	0
wood:MN	entire sta	MN	CAN	1	1	1.4E+08	1	0.01%	0.00%	0	0
wood:ME	entire sta	ME	USA	1	1	5.3E+08	1	0.01%	0.00%	0	0
wood:AL	entire sta	AL	CAN	1	1	3.2E+08	1	0.01%	0.00%	0	0
wood:BC	entire sta	BC	CAN	1	1	4.1E+08	1	0.01%	0.00%	0	0
wood:SA	entire sta	SA	CAN	1	1	1.3E+08	1	0.007%	0.001%	0	0
wood:NM	entire sta	NM	USA	1	1	1.4E+08	1	0.006%	0.000%	0	0
wood:MA	entire sta	MA	USA	1	1	4.3E+08	1	0.006%	0.000%	0	0
wood:MT	entire sta	MT	USA	1	1	1.4E+08	1	0.006%	0.001%	0	0
wood:NJ	entire sta	NJ	USA	1	1	1.6E+08	1	0.005%	0.000%	0	0
wood:ID	entire sta	ID	USA	1	1	2.0E+08	1	0.005%	0.000%	0	0
wood:NH	entire sta	NH	USA	1	1	2.8E+08	1	0.005%	0.000%	0	0
wood:VT	entire sta	VT	USA	1	1	1.8E+08	1	0.004%	0.000%	0	0
wood:KA	entire sta	KA	USA	1	1	2.3E+07	1	0.003%	0.000%	0	0
wood:DE	entire sta	DE	USA	1	1	8.1E+07	1	0.003%	0.000%	0	0
wood:NE	entire sta	NE	USA	1	1	2.1E+07	1	0.003%	0.000%	0	0
wood:NS	entire sta	NS	CAN	1	1	1.2E+08	1	0.002%	0.000%	0	0
wood:NF	entire sta	NF	CAN	1	1	7.4E+07	1	0.002%	0.000%	0	0
wood:NB	entire sta	NB	CAN	1	1	9.4E+07	1	0.002%	0.000%	0	0
wood:UT	entire sta	UT	USA	1	1	4.4E+07	1	0.001%	0.000%	0	0
wood:SD	entire sta	SD	USA	1	1	1.2E+07	1	0.001%	0.000%	0	0
wood:WY	entire sta	WY	USA	1	1	2.2E+07	1	0.001%	0.000%	0	0
wood:AZ	entire sta	AZ	USA	1	1	4.5E+07	1	0.0007%	0.0000%	0	0
wood:RI	entire sta	RI	USA	1	1	4.9E+07	1	0.0007%	0.0000%	0	0
wood:ND	entire sta	ND	USA	1	1	5.1E+06	1	0.0005%	0.0001%	0	0
wood:NV	entire sta	NV	USA	1	1	4.0E+07	1	0.0004%	0.0000%	0	0
wood:PE	entire sta	PE	CAN	1	1	1.7E+07	1	0.0004%	0.0000%	0	0
wood:NW	entire sta	NW	CAN	1	1	7.0E+06	1	0.0003%	0.0000%	0	0
wood:DC	entire sta	DC	USA	1	1	2.6E+06	1	0.0001%	0.0000%	0	0
wood:YK	entire sta	YK	CAN	1	1	3.4E+06	1	0.0001%	0.0000%	0	0
wood:HI	entire sta	HI	USA	1	1	1.5E+08	1	0.00002%	0.00000%	0	0
wood:AK	entire sta	AK	USA	1	1	3.4E+07	1	0.000004%	0.000000%	0	0

Facility Name	City	State/ Province	Country	Type Code (a)	APCD (b)	Throughput	Unit (c)	5-Lake Average Percent of Total Deposition		Within Top 85% of Deposition to any Lake (1 = yes)	
								TEQ	HCB	TEQ	HCB
Mobile Sources (diesel-powered heavy duty vehicles)											
HDD:IL	entire state	IL	USA	1	1	9.2E+00	2	0.24%	0.01%	1	0
HDD:OH	entire state	OH	USA	1	1	9.3E+00	2	0.12%	0.00%	0	0
HDD:IN	entire state	IN	USA	1	1	8.5E+00	2	0.10%	0.00%	0	0
HDD:MI	entire state	MI	USA	1	1	5.3E+00	2	0.10%	0.00%	0	0
HDD:TX	entire state	TX	USA	1	1	2.4E+01	2	0.09%	0.00%	0	0
HDD:WI	entire state	WI	USA	1	1	4.5E+00	2	0.07%	0.00%	0	0
HDD:KY	entire state	KY	USA	1	1	6.7E+00	2	0.06%	0.00%	0	0
HDD:MO	entire state	MO	USA	1	1	6.5E+00	2	0.05%	0.00%	0	0
HDD:MN	entire state	MN	USA	1	1	4.2E+00	2	0.04%	0.00%	0	0
HDD:PA	entire state	PA	USA	1	1	9.3E+00	2	0.04%	0.00%	0	0
HDD:TN	entire state	TN	USA	1	1	7.0E+00	2	0.04%	0.00%	0	0
HDD:ON	entire prov	ON	CAN	1	1	1.6E+00	2	0.03%	0.00%	0	0
HDD:IA	entire state	IA	USA	1	1	3.3E+00	2	0.03%	0.00%	0	0
HDD:KS	entire state	KS	USA	1	1	3.7E+00	2	0.03%	0.00%	0	0
HDD:OK	entire state	OK	USA	1	1	4.3E+00	2	0.03%	0.00%	0	0
HDD:NY	entire state	NY	USA	1	1	7.5E+00	2	0.03%	0.00%	0	0
HDD:AR	entire state	AR	USA	1	1	3.9E+00	2	0.03%	0.00%	0	0
HDD:NE	entire state	NE	USA	1	1	3.3E+00	2	0.02%	0.00%	0	0
HDD:LA	entire state	LA	USA	1	1	7.2E+00	2	0.02%	0.00%	0	0
HDD:VA	entire state	VA	USA	1	1	6.3E+00	2	0.02%	0.00%	0	0
HDD:AL	entire state	AL	USA	1	1	6.7E+00	2	0.02%	0.00%	0	0
HDD:GA	entire state	GA	USA	1	1	8.5E+00	2	0.02%	0.00%	0	0
HDD:MS	entire state	MS	USA	1	1	3.9E+00	2	0.02%	0.00%	0	0
HDD:WV	entire state	WV	USA	1	1	2.3E+00	2	0.01%	0.00%	0	0
HDD:NC	entire state	NC	USA	1	1	6.3E+00	2	0.01%	0.00%	0	0
HDD:MD	entire state	MD	USA	1	1	3.5E+00	2	0.01%	0.00%	0	0
HDD:FL	entire state	FL	USA	1	1	9.9E+00	2	0.010%	0.001%	0	0
HDD:NJ	entire state	NJ	USA	1	1	5.1E+00	2	0.009%	0.000%	0	0
HDD:CA	entire state	CA	USA	1	1	2.0E+01	2	0.009%	0.000%	0	0
HDD:ND	entire state	ND	USA	1	1	1.2E+00	2	0.008%	0.001%	0	0
HDD:SC	entire state	SC	USA	1	1	3.9E+00	2	0.008%	0.000%	0	0
HDD:CO	entire state	CO	USA	1	1	2.6E+00	2	0.008%	0.000%	0	0
HDD:SD	entire state	SD	USA	1	1	9.9E-01	2	0.007%	0.000%	0	0
HDD:WY	entire state	WY	USA	1	1	2.3E+00	2	0.007%	0.000%	0	0
HDD:NM	entire state	NM	USA	1	1	2.9E+00	2	0.007%	0.000%	0	0
HDD:WA	entire state	WA	USA	1	1	4.6E+00	2	0.006%	0.000%	0	0
HDD:OR	entire state	OR	USA	1	1	4.2E+00	2	0.004%	0.000%	0	0
HDD:MT	entire state	MT	USA	1	1	1.7E+00	2	0.004%	0.000%	0	0
HDD:UT	entire state	UT	USA	1	1	2.0E+00	2	0.003%	0.000%	0	0
HDD:AZ	entire state	AZ	USA	1	1	3.2E+00	2	0.002%	0.000%	0	0
HDD:MB	entire prov	MB	CAN	1	1	4.7E-01	2	0.002%	0.000%	0	0
HDD:SK	entire prov	SK	CAN	1	1	7.0E-01	2	0.002%	0.000%	0	0
HDD:MA	entire state	MA	USA	1	1	2.7E+00	2	0.002%	0.000%	0	0
HDD:CT	entire state	CT	USA	1	1	1.8E+00	2	0.002%	0.000%	0	0
HDD:BC	entire prov	BC	CAN	1	1	1.4E+00	2	0.002%	0.000%	0	0
HDD:AB	entire prov	AB	CAN	1	1	9.7E-01	2	0.002%	0.000%	0	0
HDD:ID	entire state	ID	USA	1	1	1.4E+00	2	0.002%	0.000%	0	0
HDD:ME	entire state	ME	USA	1	1	1.2E+00	2	0.001%	0.000%	0	0
HDD:QU	entire prov	QU	CAN	1	1	8.3E-01	2	0.001%	0.000%	0	0
HDD:DE	entire state	DE	USA	1	1	5.1E-01	2	0.001%	0.000%	0	0
HDD:NV	entire state	NV	USA	1	1	1.4E+00	2	0.0007%	0.0000%	0	0
HDD:VT	entire state	VT	USA	1	1	5.5E-01	2	0.0007%	0.0000%	0	0
HDD:NH	entire state	NH	USA	1	1	4.7E-01	2	0.0005%	0.0000%	0	0
HDD:NS	entire prov	NS	CAN	1	1	3.7E-01	2	0.0005%	0.0000%	0	0
HDD:RI	entire state	RI	USA	1	1	4.2E-01	2	0.0004%	0.0000%	0	0
HDD:NB	entire prov	NB	CAN	1	1	2.5E-01	2	0.0003%	0.0000%	0	0
HDD:NF	entire prov	NF	CAN	1	1	1.6E-01	2	0.0003%	0.0000%	0	0
HDD:NW	entire prov	NW	CAN	1	1	3.2E-02	2	0.00009%	0.00001%	0	0
HDD:PE	entire prov	PE	CAN	1	1	4.3E-02	2	0.00005%	0.00000%	0	0
HDD:YK	entire prov	YK	CAN	1	1	3.4E-02	2	0.00005%	0.00000%	0	0
HDD:AK	entire state	AK	USA	1	1	1.8E+00	2	0.00001%	0.00000%	0	0
HDD:HI	entire state	HI	USA	1	1	9.6E-01	2	0.000006%	0.000000%	0	0

Facility Name	City	State/ Province	Country	Type Code (a)	APCD (b)	Throughput	Unit (c)	5-Lake Average Percent of Total Deposition TEQ	HCB	Within Top 85% of Deposition to any Lake (1 = yes) TEQ	HCB
Mobile Sources (unleaded gasoline vehicles)											
UNL:IL	entire state	IL	USA	2	1	1.4E+02	2	0.003%	0.000%	0	0
UNL:MI	entire state	MI	USA	2	1	1.3E+02	2	0.002%	0.000%	0	0
UNL:OH	entire state	OH	USA	2	1	1.4E+02	2	0.001%	0.000%	0	0
UNL:TX	entire state	TX	USA	2	1	2.6E+02	2	0.0008%	0.0001%	0	0
UNL:WI	entire state	WI	USA	2	1	6.6E+01	2	0.0007%	0.0001%	0	0
UNL:IN	entire state	IN	USA	2	1	8.2E+01	2	0.0007%	0.0000%	0	0
UNL:ON	entire prov	ON	CAN	2	1	5.5E+01	2	0.0007%	0.0001%	0	0
UNL:MO	entire state	MO	USA	2	1	8.7E+01	2	0.0005%	0.0000%	0	0
UNL:MN	entire state	MN	USA	2	1	6.4E+01	2	0.0005%	0.0000%	0	0
UNL:PA	entire state	PA	USA	2	1	1.4E+02	2	0.0005%	0.0000%	0	0
UNL:KY	entire state	KY	USA	2	1	5.8E+01	2	0.0004%	0.0000%	0	0
UNL:NY	entire state	NY	USA	2	1	1.7E+02	2	0.0004%	0.0000%	0	0
UNL:TN	entire state	TN	USA	2	1	7.8E+01	2	0.0003%	0.0000%	0	0
UNL:IA	entire state	IA	USA	2	1	4.0E+01	2	0.0003%	0.0000%	0	0
UNL:OK	entire state	OK	USA	2	1	5.3E+01	2	0.0002%	0.0000%	0	0
UNL:VA	entire state	VA	USA	2	1	9.5E+01	2	0.0002%	0.0000%	0	0
UNL:KS	entire state	KS	USA	2	1	3.6E+01	2	0.0002%	0.0000%	0	0
UNL:GA	entire state	GA	USA	2	1	1.1E+02	2	0.0002%	0.0000%	0	0
UNL:AR	entire state	AR	USA	2	1	3.9E+01	2	0.0002%	0.0000%	0	0
UNL:NC	entire state	NC	USA	2	1	1.0E+02	2	0.0002%	0.0000%	0	0
UNL:AL	entire state	AL	USA	2	1	6.7E+01	2	0.0002%	0.0000%	0	0
UNL:CA	entire state	CA	USA	2	1	4.2E+02	2	0.0001%	0.0000%	0	0
UNL:FL	entire state	FL	USA	2	1	1.9E+02	2	0.0001%	0.0000%	0	0
UNL:LA	entire state	LA	USA	2	1	6.0E+01	2	0.0001%	0.0000%	0	0
UNL:MD	entire state	MD	USA	2	1	6.5E+01	2	0.0001%	0.0000%	0	0
UNL:NJ	entire state	NJ	USA	2	1	1.0E+02	2	0.0001%	0.0000%	0	0
UNL:MS	entire state	MS	USA	2	1	4.0E+01	2	0.0001%	0.0000%	0	0
UNL:NE	entire state	NE	USA	2	1	2.3E+01	2	0.0001%	0.0000%	0	0
UNL:WV	entire state	WV	USA	2	1	2.6E+01	2	0.0001%	0.0000%	0	0
UNL:CO	entire state	CO	USA	2	1	4.7E+01	2	0.0001%	0.0000%	0	0
UNL:SC	entire state	SC	USA	2	1	5.7E+01	2	0.00009%	0.00000%	0	0
UNL:WA	entire state	WA	USA	2	1	7.3E+01	2	0.00007%	0.00001%	0	0
UNL:SD	entire state	SD	USA	2	1	1.2E+01	2	0.00006%	0.00001%	0	0
UNL:ND	entire state	ND	USA	2	1	1.0E+01	2	0.00005%	0.00001%	0	0
UNL:NM	entire state	NM	USA	2	1	2.6E+01	2	0.00005%	0.00000%	0	0
UNL:MA	entire state	MA	USA	2	1	7.4E+01	2	0.00004%	0.00000%	0	0
UNL:QU	entire prov	QU	CAN	2	1	3.2E+01	2	0.00004%	0.00000%	0	0
UNL:AZ	entire state	AZ	USA	2	1	5.5E+01	2	0.00003%	0.00000%	0	0
UNL:CT	entire state	CT	USA	2	1	4.2E+01	2	0.00003%	0.00000%	0	0
UNL:OR	entire state	OR	USA	2	1	4.2E+01	2	0.00003%	0.00000%	0	0
UNL:UT	entire state	UT	USA	2	1	2.4E+01	2	0.00003%	0.00000%	0	0
UNL:MT	entire state	MT	USA	2	1	1.4E+01	2	0.00002%	0.00000%	0	0
UNL:MB	entire prov	MB	CAN	2	1	6.0E+00	2	0.00002%	0.00000%	0	0
UNL:WY	entire state	WY	USA	2	1	9.2E+00	2	0.00002%	0.00000%	0	0
UNL:AB	entire prov	AB	CAN	2	1	1.4E+01	2	0.00002%	0.00000%	0	0
UNL:ME	entire state	ME	USA	2	1	1.9E+01	2	0.00002%	0.00000%	0	0
UNL:DE	entire state	DE	USA	2	1	1.1E+01	2	0.00002%	0.00000%	0	0
UNL:ID	entire state	ID	USA	2	1	1.5E+01	2	0.00001%	0.00000%	0	0
UNL:BC	entire prov	BC	CAN	2	1	1.4E+01	2	0.00001%	0.00000%	0	0
UNL:NH	entire state	NH	USA	2	1	1.6E+01	2	0.00001%	0.00000%	0	0
UNL:SK	entire prov	SK	CAN	2	1	4.5E+00	2	0.00001%	0.00000%	0	0
UNL:NV	entire state	NV	USA	2	1	2.1E+01	2	0.000009%	0.000001%	0	0
UNL:VT	entire state	VT	USA	2	1	9.1E+00	2	0.000008%	0.000000%	0	0
UNL:RI	entire state	RI	USA	2	1	1.2E+01	2	0.000007%	0.000000%	0	0
UNL:NB	entire prov	NB	CAN	2	1	4.1E+00	2	0.000004%	0.000000%	0	0
UNL:NS	entire prov	NS	CAN	2	1	4.0E+00	2	0.000003%	0.000000%	0	0
UNL:NF	entire prov	NF	CAN	2	1	2.2E+00	2	0.000003%	0.000000%	0	0
UNL:PE	entire prov	PE	CAN	2	1	8.1E-01	2	0.000001%	0.000000%	0	0
UNL:NW	entire prov	NW	CAN	2	1	2.6E-01	2	0.000001%	0.000000%	0	0
UNL:YK	entire prov	YK	CAN	2	1	1.3E-01	2	0.000000%	0.000000%	0	0
UNL:HI	entire state	HI	USA	2	1	1.2E+01	2	0.000000%	0.000000%	0	0
UNL:AK	entire state	AK	USA	2	1	7.7E+00	2	0.000000%	0.000000%	0	0

Facility Name	City	State/ Province	Country	Type Code (a)	APCD (b)	Throughput	Unit (c)	5-Lake Average Percent of Total Deposition TEQ	5-Lake Average Percent of Total Deposition HCB	Within Top 85% of Deposition to any Lake (1 = yes) TEQ	Within Top 85% of Deposition to any Lake (1 = yes) HCB
Mobile Sources (leaded gasoline vehicles)											
LEAD:IL	entire state	IL	USA	3	1	7.4E+00	2	0.004%	0.000%	0	0
LEAD:MI	entire state	MI	USA	3	1	7.1E+00	2	0.003%	0.000%	0	0
LEAD:OH	entire state	OH	USA	3	1	7.5E+00	2	0.002%	0.000%	0	0
LEAD:TX	entire state	TX	USA	3	1	1.4E+01	2	0.001%	0.000%	0	0
LEAD:WI	entire state	WI	USA	3	1	3.5E+00	2	0.001%	0.000%	0	0
LEAD:IN	entire state	IN	USA	3	1	4.4E+00	2	0.001%	0.000%	0	0
LEAD:ON	entire prov	ON	CAN	3	1	2.9E+00	2	0.001%	0.000%	0	0
LEAD:MO	entire state	MO	USA	3	1	4.5E+00	2	0.0008%	0.0001%	0	0
LEAD:MN	entire state	MN	USA	3	1	3.4E+00	2	0.0008%	0.0001%	0	0
LEAD:PA	entire state	PA	USA	3	1	7.4E+00	2	0.0007%	0.0000%	0	0
LEAD:KY	entire state	KY	USA	3	1	3.0E+00	2	0.0006%	0.0000%	0	0
LEAD:NY	entire state	NY	USA	3	1	9.0E+00	2	0.0006%	0.0000%	0	0
LEAD:TN	entire state	TN	USA	3	1	4.1E+00	2	0.0005%	0.0000%	0	0
LEAD:IA	entire state	IA	USA	3	1	2.1E+00	2	0.0004%	0.0000%	0	0
LEAD:OK	entire state	OK	USA	3	1	2.8E+00	2	0.0004%	0.0000%	0	0
LEAD:VA	entire state	VA	USA	3	1	5.0E+00	2	0.0004%	0.0000%	0	0
LEAD:KS	entire state	KS	USA	3	1	1.9E+00	2	0.0003%	0.0000%	0	0
LEAD:GA	entire state	GA	USA	3	1	5.8E+00	2	0.0003%	0.0000%	0	0
LEAD:AR	entire state	AR	USA	3	1	2.0E+00	2	0.0003%	0.0000%	0	0
LEAD:NC	entire state	NC	USA	3	1	5.4E+00	2	0.0002%	0.0000%	0	0
LEAD:AL	entire state	AL	USA	3	1	3.5E+00	2	0.0002%	0.0000%	0	0
LEAD:LA	entire state	LA	USA	3	1	3.1E+00	2	0.0002%	0.0000%	0	0
LEAD:FL	entire state	FL	USA	3	1	1.0E+01	2	0.0002%	0.0000%	0	0
LEAD:CA	entire state	CA	USA	3	1	2.2E+01	2	0.0002%	0.0000%	0	0
LEAD:MD	entire state	MD	USA	3	1	3.4E+00	2	0.0002%	0.0000%	0	0
LEAD:NJ	entire state	NJ	USA	3	1	5.3E+00	2	0.0002%	0.0000%	0	0
LEAD:MS	entire state	MS	USA	3	1	2.1E+00	2	0.0002%	0.0000%	0	0
LEAD:NE	entire state	NE	USA	3	1	1.2E+00	2	0.0002%	0.0000%	0	0
LEAD:WV	entire state	WV	USA	3	1	1.4E+00	2	0.0002%	0.0000%	0	0
LEAD:CO	entire state	CO	USA	3	1	2.4E+00	2	0.0002%	0.0000%	0	0
LEAD:SC	entire state	SC	USA	3	1	3.0E+00	2	0.0001%	0.0000%	0	0
LEAD:WA	entire state	WA	USA	3	1	3.9E+00	2	0.0001%	0.0000%	0	0
LEAD:SD	entire state	SD	USA	3	1	6.2E-01	2	0.00010%	0.00001%	0	0
LEAD:ND	entire state	ND	USA	3	1	5.3E-01	2	0.00008%	0.00001%	0	0
LEAD:NM	entire state	NM	USA	3	1	1.4E+00	2	0.00007%	0.00001%	0	0
LEAD:MA	entire state	MA	USA	3	1	3.8E+00	2	0.00007%	0.00001%	0	0
LEAD:QU	entire prov	QU	CAN	3	1	1.7E+00	2	0.00006%	0.00000%	0	0
LEAD:AZ	entire state	AZ	USA	3	1	2.9E+00	2	0.00005%	0.00000%	0	0
LEAD:CT	entire state	CT	USA	3	1	2.2E+00	2	0.00005%	0.00000%	0	0
LEAD:OR	entire state	OR	USA	3	1	2.3E+00	2	0.00005%	0.00001%	0	0
LEAD:UT	entire state	UT	USA	3	1	1.3E+00	2	0.00005%	0.00000%	0	0
LEAD:MT	entire state	MT	USA	3	1	7.1E-01	2	0.00004%	0.00000%	0	0
LEAD:MB	entire prov	MB	CAN	3	1	3.2E-01	2	0.00003%	0.00001%	0	0
LEAD:WY	entire state	WY	USA	3	1	4.8E-01	2	0.00003%	0.00000%	0	0
LEAD:AB	entire prov	AB	CAN	3	1	7.3E-01	2	0.00003%	0.00000%	0	0
LEAD:ME	entire state	ME	USA	3	1	9.9E-01	2	0.00003%	0.00000%	0	0
LEAD:DE	entire state	DE	USA	3	1	5.7E-01	2	0.00003%	0.00000%	0	0
LEAD:ID	entire state	ID	USA	3	1	7.9E-01	2	0.00002%	0.00000%	0	0
LEAD:BC	entire prov	BC	CAN	3	1	7.2E-01	2	0.00002%	0.00000%	0	0
LEAD:NH	entire state	NH	USA	3	1	8.5E-01	2	0.00002%	0.00000%	0	0
LEAD:SK	entire prov	SK	CAN	3	1	2.4E-01	2	0.00002%	0.00000%	0	0
LEAD:NV	entire state	NV	USA	3	1	1.1E+00	2	0.00001%	0.00000%	0	0
LEAD:VT	entire state	VT	USA	3	1	4.8E-01	2	0.00001%	0.00000%	0	0
LEAD:RI	entire state	RI	USA	3	1	6.1E-01	2	0.00001%	0.00000%	0	0
LEAD:NB	entire prov	NB	CAN	3	1	2.1E-01	2	0.000006%	0.000000%	0	0
LEAD:NS	entire prov	NS	CAN	3	1	2.1E-01	2	0.000006%	0.000000%	0	0
LEAD:NF	entire prov	NF	CAN	3	1	1.2E-01	2	0.000005%	0.000000%	0	0
LEAD:PE	entire prov	PE	CAN	3	1	4.3E-02	2	0.000001%	0.000000%	0	0
LEAD:NW	entire prov	NW	CAN	3	1	1.4E-02	2	0.000001%	0.000000%	0	0
LEAD:YK	entire prov	YK	CAN	3	1	7.0E-03	2	0.000000%	0.000000%	0	0
LEAD:HI	entire state	HI	USA	3	1	6.1E-01	2	0.000000%	0.000000%	0	0
LEAD:AK	entire state	AK	USA	3	1	4.1E-01	2	0.000000%	0.000000%	0	0

Facility Name	City	State/ Province	Country	Type Code (a)	APCD (b)	Throughput	Unit (c)	5-Lake Average Percent of Total Deposition TEQ	5-Lake Average Percent of Total Deposition HCB	Within Top 85% of Deposition to any Lake (1 = yes) TEQ	Within Top 85% of Deposition to any Lake (1 = yes) HCB
Pesticide Application											
PEST:ON	entire prov	ON	CAN	1	0	4.6E+01	1	0.00%	11.49%	0	1
PEST:TX	entire state	TX	USA	1	0	5.7E+01	1	0.00%	3.42%	0	1
PEST:MI	entire state	MI	USA	1	0	1.4E+01	1	0.00%	2.93%	0	1
PEST:GA	entire state	GA	USA	1	0	1.2E+02	1	0.00%	2.91%	0	1
PEST:IL	entire state	IL	USA	1	0	9.6E+00	1	0.00%	1.58%	0	1
PEST:CA	entire state	CA	USA	1	0	2.1E+02	1	0.00%	1.55%	0	1
PEST:AL	entire state	AL	USA	1	0	4.1E+01	1	0.00%	1.45%	0	1
PEST:AR	entire state	AR	USA	1	0	1.4E+01	1	0.00%	1.30%	0	1
PEST:MN	entire state	MN	USA	1	0	7.0E+00	1	0.00%	1.26%	0	1
PEST:WI	entire state	WI	USA	1	0	6.3E+00	1	0.00%	1.26%	0	1
PEST:OH	entire state	OH	USA	1	0	7.9E+00	1	0.00%	1.05%	0	1
PEST:WA	entire state	WA	USA	1	0	3.4E+01	1	0.00%	1.03%	0	1
PEST:FL	entire state	FL	USA	1	0	5.7E+01	1	0.00%	1.00%	0	1
PEST:MS	entire state	MS	USA	1	0	1.4E+01	1	0.00%	0.78%	0	1
PEST:NY	entire state	NY	USA	1	0	3.2E+01	1	0.00%	0.74%	0	1
PEST:IN	entire state	IN	USA	1	0	4.7E+00	1	0.00%	0.72%	0	1
PEST:CO	entire state	CO	USA	1	0	1.2E+01	1	0.00%	0.56%	0	1
PEST:LA	entire state	LA	USA	1	0	1.2E+01	1	0.00%	0.56%	0	1
PEST:MO	entire state	MO	USA	1	0	5.2E+00	1	0.00%	0.54%	0	1
PEST:TN	entire state	TN	USA	1	0	7.2E+00	1	0.00%	0.47%	0	1
PEST:NE	entire state	NE	USA	1	0	3.9E+00	1	0.00%	0.46%	0	1
PEST:KS	entire state	KS	USA	1	0	4.1E+00	1	0.00%	0.44%	0	1
PEST:NM	entire state	NM	USA	1	0	1.1E+01	1	0.00%	0.43%	0	1
PEST:IA	entire state	IA	USA	1	0	3.0E+00	1	0.00%	0.43%	0	1
PEST:NC	entire state	NC	USA	1	0	2.4E+01	1	0.00%	0.42%	0	1
PEST:OK	entire state	OK	USA	1	0	4.3E+00	1	0.00%	0.37%	0	1
PEST:PA	entire state	PA	USA	1	0	8.8E+00	1	0.00%	0.30%	0	1
PEST:OR	entire state	OR	USA	1	0	1.4E+01	1	0.00%	0.29%	0	1
PEST:SD	entire state	SD	USA	1	0	1.8E+00	1	0.00%	0.22%	0	1
PEST:MN	entire prov	MN	CAN	1	0	1.6E+00	1	0.00%	0.21%	0	1
PEST:KY	entire state	KY	USA	1	0	2.0E+00	1	0.00%	0.21%	0	1
PEST:MT	entire state	MT	USA	1	0	3.3E+00	1	0.00%	0.17%	0	1
PEST:WY	entire state	WY	USA	1	0	3.2E+00	1	0.00%	0.16%	0	1
PEST:VA	entire state	VA	USA	1	0	5.2E+00	1	0.00%	0.15%	0	1
PEST:QU	entire prov	QU	CAN	1	0	7.2E+00	1	0.00%	0.14%	0	1
PEST:SC	entire state	SC	USA	1	0	6.6E+00	1	0.00%	0.13%	0	1
PEST:NJ	entire state	NJ	USA	1	0	8.7E+00	1	0.00%	0.12%	0	1
PEST:UT	entire state	UT	USA	1	0	4.3E+00	1	0.00%	0.12%	0	1
PEST:MD	entire state	MD	USA	1	0	4.7E+00	1	0.00%	0.12%	0	1
PEST:ND	entire state	ND	USA	1	0	7.7E-01	1	0.00%	0.11%	0	1
PEST:AL	entire prov	AL	CAN	1	0	2.0E+00	1	0.00%	0.10%	0	1
PEST:ID	entire state	ID	USA	1	0	3.2E+00	1	0.00%	0.09%	0	1
PEST:AZ	entire state	AZ	USA	1	0	6.5E+00	1	0.00%	0.08%	0	0
PEST:BC	entire prov	BC	CAN	1	0	2.0E+00	1	0.00%	0.07%	0	0
PEST:WV	entire state	WV	USA	1	0	8.1E-01	1	0.00%	0.05%	0	0
PEST:PE	entire pro	PE	CAN	1	0	3.3E+00	1	0.00%	0.05%	0	0
PEST:ME	entire state	ME	USA	1	0	3.2E+00	1	0.00%	0.04%	0	0
PEST:SA	Saskatoon	SA	CAN	1	0	6.1E-01	1	0.00%	0.04%	0	0
PEST:MA	entire state	MA	USA	1	0	3.0E+00	1	0.00%	0.03%	0	0
PEST:NS	entire prov	NS	CAN	1	0	2.0E+00	1	0.00%	0.03%	0	0
PEST:CT	entire state	CT	USA	1	0	1.4E+00	1	0.00%	0.02%	0	0
PEST:NB	entire prov	NB	CAN	1	0	9.3E-01	1	0.00%	0.01%	0	0
PEST:DE	entire state	DE	USA	1	0	7.9E-01	1	0.00%	0.01%	0	0
PEST:DC	entire state	DC	USA	1	0	2.1E-01	1	0.000%	0.006%	0	0
PEST:NH	entire state	NH	USA	1	0	4.8E-01	1	0.000%	0.005%	0	0
PEST:NV	entire state	NV	USA	1	0	5.4E-01	1	0.000%	0.005%	0	0
PEST:RI	entire state	RI	USA	1	0	4.7E-01	1	0.000%	0.005%	0	0
PEST:NF	entire prov	NF	CAN	1	0	3.0E-01	1	0.000%	0.004%	0	0
PEST:VT	entire state	VT	USA	1	0	2.7E-01	1	0.000%	0.004%	0	0
PEST:NT	entire prov	NT	CAN	1	0	2.9E-02	1	0.000%	0.002%	0	0
PEST:YT	entire pro	YT	CAN	1	0	1.4E-02	1	0.0000%	0.0005%	0	0
PEST:HI	entire state	HI	USA	1	0	4.8E-01	1	0.00000%	0.00002%	0	0
PEST:AK	entire state	AK	USA	1	0	2.4E-01	1	0.00000%	0.00001%	0	0

Summary of Estimated Contributions of PCDD/PCDF to the Great Lakes in 1993 from liquid effluents from Pulp and Paper Mills										
Company	City	State or Prov	Cntry	LAKE	Estimated Water Transfer Coefficient for PCDD/F (see note a)	Estimated contribution of PCDD/PCDF to Lake (grams TEQ per year) (see notes b and c) minimum	medium	maximum	notes	# of actual samples on which estimate is based
International Paper	Erie	PA	USA	erie	75%	0.0082	0.0195	0.0308	d,o	1
E.B. Eddy	Espanola	ON	CAN	huron	100%	0.0560	0.1010	0.1460	d	7
Thorold Specialty Papers	Thorold	ON	CAN	ontario	75%	0.0004	0.0104	0.0205	e	5
S.D. Warren (Scott Paper)	Muskegon	MI	USA	michigan	25%	0.0000	0.0286	0.0571	d,f	1
Mead	Escanaba	MI	USA	michigan	100%	0.0133	0.0368	0.0629	d,g	6
Champion International	Quinnesec	MI	USA	michigan	75%	0.0119	0.0237	0.0475	h	0
Badger Paper Mills	Peshtigo	WI	USA	michigan	100%	0.0000	0.0041	0.0083	d,i	2
Ponderosa Pulp Products	Oshkosh	WI	USA	michigan	50%	0.0000	0.0004	0.0007	d,j,o	0
Wisconsin Tissue Mills	Menasha	WI	USA	michigan	75%	0.0000	0.0064	0.0127	d	1
James River	Green Bay	WI	USA	michigan	75%	0.0000	0.0142	0.0285	d,o	2
Fort Howard	Green Bay	WI	USA	michigan	100%	0.0012	0.0211	0.0409	d	4
Fox River Fiber	DePere	WI	USA	michigan	50%	0.0000	0.0008	0.0016	h,o	0
EcoFibre	De Pere	WI	USA	michigan	75%	0.0000	0.0006	0.0013	h	0
P.H. Glatfelter	Neenah	WI	USA	michigan	75%	0.0000	0.0042	0.0084	d	1
Scott Paper	Oconto Falls	WI	USA	michigan	75%	0.0000	0.0009	0.0019	d,k	1
Kerwin Paper	Appleton	WI	USA	michigan	50%	0.0000	0.0098	0.0197	d,o	1
Potlatch	Cloquet	MN	USA	superior	75%	0.0000	0.0284	0.0568	d,o	3
James River	Ashland	WI	USA	superior	100%	0.0000	0.0029	0.0058	d,l	1
Avenor	Thunder Bay	ON	CAN	superior	100%	0.0551	0.1281	0.2011	e	11
James River	Marathon	ON	CAN	superior	100%	0.0016	0.0356	0.0696	e	9
Kimberly-Clark	Terrace Bay	ON	CAN	superior	100%	0.3372	0.4174	0.4977	e,m	12
TOTAL for Great Lakes						0.4847	0.8950	1.3197	n	68

(a) The water transfer coefficient (WTC) is the fraction of the PCDD/F discharged from the plant that is estimated to make it to one of the Great Lakes. For direct discharge to one of the lakes or to a tributary within a few miles of the lake, the WTC is assumed to be 100%. If the discharge is treated by a POTW, we have reduced the WTC by 25%. If the effluent is discharged to a tributary more than a few miles from the lake, the WTC is assumed to be reduced by 25%.

(b) For all estimates, the basic methodology was to multiply the appropriate flow rate of the liquid effluent stream (e.g., in units of liters per day) by the measured or estimated concentration of PCDD/F in the effluent (e.g., in units of grams per liter). The minimum estimated discharge amount was estimated by assuming that all non-detects were zero; the medium estimated discharge amount was estimated by assuming all non-detects were at one-half the detection limit; and the maximum estimated discharge amount was estimated by assuming that all non-detects were at the reported detection limit of the measurement.

(c) The estimates of PCDD/F discharge were calculated using only the available data for 2,3,7,8-TCDD (with a toxic equivalency of 1) and 2,3,7,8-TCDF (with an assumed toxic equivalency of 0.1). These were the only two congeners for which data were available for the U.S. pulp and paper mills, and these two congeners are believed to contribute the majority of the PCDD/F toxic equivalents in mill effluents. Data from Canadian mills showed that other congeners were occasionally detected in effluents, and did add somewhat to the toxic equivalents in the discharge.

(d) The estimate of PCDD/F discharged from the mill was based on data supplied to CBNS by the National Council of the Paper Industry for Air and Stream Improvement, Inc. (NCASI).

(e) The estimate of PCDD/F discharged from the mill was based on data supplied to CBNS by the Ontario Forest Industries Association.

(f) This mill's effluent is applied to the land, and so only a small fraction of the dioxin in its effluent would make it to the Great Lakes. The estimate water transfer coefficient is highly uncertain, and the value of 25% chosen may be an overestimate.

(g) The measured concentrations of PCDD/F and the flow rate of the bleach plant effluent were used to make the discharge estimate, rather than the comparable parameters in the final effluent. When the final effluent has concentrations of dioxins and furans that are less than the detection limit, this may be a more accurate procedure to estimate the plant's emissions.

(h) Estimated by CBNS based on data from similar plants

(i) No data for 1993 were available; data from 1992 and 1994 were averaged to estimate the 1993 discharge amount.

(j) No data for 1993 were available; 1989 data which showed concentrations less than a probable detection limit of 10 pg/lit were used for the estimate.

(k) 2,3,7,8-TCDF was not measured; it was assumed to be present at less than the detection limit of 1.6 pg/lit which was reported for the measurement of 2,3,7,8-TCDD at this plant.

(l) No data for 1993 were available; data from 1991 were used.

(m) The company has stated that their research identified a contaminated sewage pipe as the primary source of PCDD/F in their discharge. They replaced the pipe in April 1994, and effluent samples taken since then have indeed shown decreased levels of PCDD/F. In 8 samples taken from May 1994 to Dec 1994, the PCDD/F levels in the effluent (considering only 2,3,7,8 TCDD and 2,3,7,8 TCDF as with all the other plants) correspond to an annual medium-estimate loading of approximately 0.096 grams TEQ/year.

(n) Only pulp and paper mills which use chlorine-containing compounds in their processes (e.g., chlorine, chlorine dioxide, sodium hypochlorite) have been included in this list. Some of the facilities on this list have reported process changes and/or effluent data which suggest that PCDD/F discharges have decreased since 1993.

(o) The effluent from the plant is treated at a POTW; the estimated water transfer coefficient reflects this fact, in an approximate way.

Summary of Contributions of HCB and PCDD/F to the Great Lakes from Chemical Manufacturing and Other Industrial Sources (a)

							estimated amount of pollutant discharged			Estimated Water Transfer Coefficients		estimated pollutant load to Lake	
COMPANY	CITY	STATE or PROV	CNTRY	LAKE	Source of Data	date of discharge data	HCB kg/yr	PCDD/F g TEQ/yr	notes	for HCB	for PCDD/F	HCB kg/yr	PCDD/F g TEQ/yr
Murphy Oil	Superior	WI	USA	superior	1	1993 (?)		0.7045	e	50%	75%		0.5284
Celanese	Millhaven	ON	CAN	ontario	2	1989–90		0	b	100%	100%		0
Cyanamid Canada	Niagara Falls	ON	CAN	ontario	3	1989–91		0	b	50%	75%		0
DuPont	Kingston	ON	CAN	ontario	2	1989–90		0.3988		100%	100%		0.3988
Geon	Thorold	ON	CAN	ontario	2	1989–90		0.000061		50%	75%		0.000046
Occidental Chemical Durez Div.	N. Tonawanda	NY	USA	ontario	4	1992–93	0.4		c,d	50%	75%	0.2196	
Petro Canada	Oakville	ON	CAN	ontario	5	1988–89	0.100	0.0002		100%	100%	0.1004	0.0002
UCAR Carbon	Welland	ON	CAN	ontario	3	1989–91		0.0001		50%	75%		0.0001
Allied Chem	Amherstburg	ON	CAN	erie	3	1989–91		0.0002		50%	75%		0.0002
Chinook	Sombra	ON	CAN	erie	2	1989–90		0.0002		50%	75%		0.0001
Dow Chemical	Sarnia	ON	CAN	erie	2	1989–90	1.282	0.2772	f	50%	75%	0.6411	0.2079
DuPont	Corunna	ON	CAN	erie	2	1989–90	0.050	0.0012		50%	75%	0.0250	0.0009
General Chemical	Amherstburg	ON	CAN	erie	3	1989–91		0.4973		50%	75%		0.3730
IMC	Port Maitland	ON	CAN	erie	3	1989–91		0.000043		100%	100%		0.000043
Imperial Oil Chemicals Div.	Sarnia	ON	CAN	erie	2	1989–90		0	b	50%	75%		0
Linde	Moore Township	ON	CAN	erie	3	1989–91		0.0000005		50%	75%		0.0000004
Linde	Sarnia	ON	CAN	erie	3	1989–91		0.0002		50%	75%		0.0001
Polysar	Sarnia	ON	CAN	erie	2	1989–90	0.635			50%	75%	0.3173	
SCM Corp	Huron	OH	USA	erie	4	1992	0.023		d	100%	100%	0.0230	
Sun Refining & Marketing	Toledo	OH	USA	erie	4	1992–93			d	100%	100%		
Suncor Inc.	Sarnia	ON	CAN	erie	5	1988–89		0.0008		50%	75%		0.0006
Uniroyal Chemical	Elmira	ON	CAN	erie	2	1989–90		0.0086		50%	75%		0.0064
Dow Chemical	Midland	MI	USA	huron	4	1992–93		0.1190		50%	75%		0.0893
Linde	Sault Ste. Marie	ON	CAN	huron	3	1989–91		0.0076		50%	75%		0.0057
American Oil Company	Whiting	IN	USA	michigan	4	1992–93		0.0164		100%	100%		0.0164
TOTAL for Lake Superior							0.0000	0.7045				0.0000	0.5284
TOTAL for Lake Ontario							0.5395	0.3991				0.3200	0.3991
TOTAL for Lake Erie							1.9895	0.7857				1.0062	0.5893
TOTAL for Lake Huron							0.0000	0.1266				0.0000	0.0950
TOTAL for Lake Michigan							0.0000	0.0164				0.0000	0.0164
TOTAL for ALL LAKES							2.5291	2.0324				1.3262	1.6282

Data Sources

1. USEPA: Freedom of Information Act request
2. OMOEE: MISA Organic Chem. Manuf. Sector
3. OMOEE: MISA Inorganic Chem. Manuf. Sector
4. USEPA: Permit Compliance System
5. OMOEE: MISA Petroleum Refining Sector

"OMOEE" = the Ontario Ministry of Environment and Energy

NOTES

(a) In general, only sources with detected levels of HCB or PCDD/F in their effluents were considered. There have been very few tests of industrial effluents for these compounds for sources in the Unites States and thus this list is almost certainly not complete for U.S. sources. The monitoring program in Canada is far more comprehensive, extensive and precise, and so the Canadian facilities in this table are probably much closer to being a complete list of facilities discharging HCB and/or PCDD/F.

(b) The effluent loading was less than the influent loading, and so the facility was assumed to not be adding PCDD/F to its effluent

(c) HCB was below the detection limit and was assigned a value corresponding to 10% of the detection limit.

(d) This facility may be a potential source of PCDD/F, but test data for PCDD/F in the effluent from this facility, if they exist, were not included in the Permit Compliance System data we received from the U.S. EPA.

(e) This company is reported to have ceased direct discharge of a waste stream heavily contaminated with PCDD/F; this may have substantially lowered its discharge of PCDD/F.

(f) This company reportedly ceased production of chlorinated compounds after these tests were conducted; their discharge of HCB and PCDD/F may have been significantly reduced by this action.