5 Nature and Extent of Detected Chemicals

The nature and extent of chemical compounds are presented in this section for the Lower Fox River, including PCBs, pesticides, SVOCs, metals (such as mercury and arsenic), and many other organic and inorganic parameters. In Green Bay, the discussion is limited to the nature and extent of PCBs and mercury, although a number of the same chemicals detected in the Lower Fox River have also been identified.

5.1 Detected Compound Sources

Potential sources of the compounds detected in the Lower Fox River and Green Bay include both point and non-point sources. Point sources are direct discharges or emissions from discrete sources, such as an outfall pipe, landfill, or spill. Sources of detected compounds that are not specifically characterized but which may encompass numerous individual discharges or emissions are non-point sources. Examples of non-point sources include agricultural and urban storm runoff as well as automobile emissions. Each of these types of sources contributes to the compounds found in the Lower Fox River and Green Bay sediments, as described below. Where sufficient information exist, the other Green Bay tributaries are discussed as non-point sources of PCBs and mercury.

5.1.1Point Sources

The watershed area draining into the Lower Fox River is locally urbanized, particularly in areas adjacent to the river. Point sources of pollution within these urbanized areas include industries and municipalities which discharge directly into the Lower Fox River as well as releases from chemical spills, leaking underground storage tanks (LUSTs), and landfills.

5.1.1.1 Industrial/Municipal Discharges

Lower Fox River Dischargers

Since the early 1970s, discharges to surface water require WPDES permits issued by the WDNR. The permit records indicate there were 44 major industrial and municipal WPDES dischargers in Brown, Outagamie, and Winnebago counties in 1990. Including both general and specific permittees, 99 industrial dischargers occur within the Fox/Wolf River System (WDNR, 1990a). In 1990, there were over 20 facilities that had a combined discharged of approximately 109 MGD to the Lower Fox River.

The major industrial/municipal discharges (exceeding 1 MGD) along each reach of the Lower Fox River include the following:

- **LLBdM Reach**: Badger Paper Mills; P.H. Glatfelter; Menasha Electric and Water Utility; Neenah/Menasha WWTP; Kimberly-Clark Neenah/Badger Globe; U.S. Paper Mills; Wisconsin Tissue Mills

- **Appleton to Little Rapids Reach**: Appleton Papers; Appleton WWTP; Riverside Paper; International Paper-Thilmany Division; Interlake Papers; Heart of the Valley WWTP, and the Village of Wrightstown Sewer and Water Utility

- **Little Rapids to De Pere Reach**: None

- **De Pere to Green Bay Reach**: Nicolet Paper; Fort James East; Fort James West; Procter & Gamble Paper; Green Bay Packaging; U.S. Paper Mills; De Pere WWTP; and GBMSD

Historically, specific discharges were identified as the main source for some of the chemical parameters detected in the Lower Fox River, especially with regard to PCBs. In 1999, WDNR completed a hindcast study to evaluate the source of PCBs in the Lower Fox River. Although numerous contributors were recognized, five entities are believed to have contributed over 99 percent of the PCBs discharged into the Lower Fox River between 1954 and 1971 (WDNR, 1999a). These PCB sources include the following: Appleton Papers-Coating Mill (38 percent); P.H. Glatfelter Co. and the associated Arrowhead Park Site (27 percent); Fort James-Green Bay West Mill (formerly Fort Howard) (23 percent); Wisconsin Tissue (10 percent); and Appleton Papers-Locks Mill (2 percent). PCB discharges from all other paper facilities during this time period were less than 1 percent (WDNR, 1999a).

Similarly, elevated levels of mercury identified in Fox River sediments have been attributed to mercuric slimicides (phenyl mercuric acetate) in paper manufacturing. This practice was discontinued in 1971 (Konrad, 1971). A 1970 study of river sediments from upstream of Little Rapids to Green Bay revealed elevated concentrations of mercury in sediments. Also, a number of studies completed in the late 1980s and 1990s indicated that mercury concentrations remained elevated in sediments and the water column more than 20 years after mercury use was discontinued. The studies are summarized in the WDNR Triad Assessment report (1996).

Overall, pollutant loading of PCBs and many other chemicals have been reduced by at least 85 percent since the 1970s, when effluent limits were imposed on facilities discharging more than 1 million gallons of wastewater per day. The discharge limits for many of the parameters discussed in this section, including the seven COPCs identified in the Screening Level Risk Assessment (SLRA), are listed in Wisconsin Administrative Code (W.A.C.) Chapter NR 105 "Surface Water Quality Criteria and Secondary Values for Toxic Substances" (1997). The COPCs include: PCBs, dioxin/furans, DDT, dieldrin, mercury, lead, and arsenic.
Although PCBs have not been used in the Lower Fox River valley in over 20 years, they are still detected in discharge at very low levels from previous point sources due to their ubiquitous nature and general persistence in the environment (WDNR, 1999a). Based on effluent discharge data from 1989/90, WDNR has estimated that current PCB discharge levels range from 3 to 5 kg annually and that there is little that can be done to reduce these sources further (Velleux and Endicott, 1994; WDNR, 1999a).

Few identifiable point sources exist for the other COPCs in the Lower Fox River. Dioxin is not a manufactured compound; rather it is a by-product associated with the manufacture, use, or incomplete combustion of various chlorinated organic compounds. Dioxin is often associated with bleaching activities conducted by the pulp and paper industry. The pesticides DDT and dieldrin had widespread use in agricultural applications but there is no point source associated with these compounds. Similarly, the metals lead and arsenic had widespread uses and are not associated with any specific point sources.

Besides the chemical compounds listed above, discharge limits have also been established for phosphorous, ammonia, and TSS. Compared with PCBs and other anthropogenic compounds detected within river and bay sediments/water, these parameters are not significant toxins for the fish and biota of the river or bay, although ammonia can be detrimental to aquatic species. Rather, these compounds were identified in the lower Green Bay RAP (WDNR, 1988) and subsequent RAP documents due to the role they play in eutrophication of the bay. Therefore, the brief discussion of these compounds is included to provide insight into continued eutrophic conditions within the bay, especially the hypertrophic conditions observed at the southern end of the bay which are associated with discharge from the Lower Fox River.

The 1990 Lower Fox River municipal and industrial discharges of phosphorous, ammonia, and TSS are summarized below and compared with the discharge estimates from the lower Green Bay RAP (WDNR, 1988). The percent of these parameters loads attributable to the industrial or municipal sources is also listed. The remaining percentages of phosphorous and TSS not accounted for in the table below are from non-point sources. Approximately 80 percent and 95 percent of the phosphorous and TSS loads result from non-point sources. An estimate for the total ammonia load into the Lower Fox River is not available.

1990 Industrial/Municipal Loading to the Lower Fox River

Parameters (kg/year)	Industrial (WDNR, 1990a)	Municipal (WDNR, 1990a)	Estimated Annual Discharge*
Total Phosphorous	73,326 (10.5%)	65,827 (9.4%)	700,000
Suspended Solids	3,150,658 (3.5%)	1,433,267 (1.6%)	136,077,000
Ammonia	146,248	743,120	Unknown

* Estimated values include non-point sources such as agricultural and urban areas (Harris, 1994).

Green Bay and Tributary Dischargers

Within Green Bay, considerably less phosphorous, ammonia or TSS are contributed by industrial or municipal sources. WDNR data (Mills, 2000; Oman, 2000) for Marinette, Oconto, Kewaunee, and Door counties, as well as EPA (2000b) discharge data for Delta and Menominee counties, Michigan, are summarized below.

1998/99 County Loading Estimates to Green Bay

Parameters (kg per year)	Door/Kewaunee Counties	Marinette/Oconto Counties	Menominee/Delta Counties
Total Phosphorous	82	14,870	38
TSS	1,130	246,820	382
Ammonia	1,846	905	0.5

The combined discharge data for the six counties listed above indicate that approximately 15,000 kg (3,300 pounds) of phosphorous, 248,300 kg (547,400 pounds) of TSS, and 2,750 kg (6,060 pounds) of ammonia are released into Green Bay annually from these areas. This phosphorous load is just under 11 percent of the combined Lower Fox River industrial and municipal loads. Similarly, this TSS load is only 5.4 percent and the ammonia load represents just over 0.3 percent of the combined Lower Fox River loads. Pollutant loading from these counties is negligible compared to the Lower Fox River levels. Data were not available for non-point contributions of these parameters (e.g., from agricultural practices, etc.) for these counties.

5.1.1.2 Landfills

There are 17 closed municipal and industrial landfills that lie within a quarter mile of the Lower Fox River (EDR, 1995). Sixteen of these landfills are located downstream of the De Pere dam in Brown County and within the lower Green Bay AOC. The other is the former P.H. Glatfelter-Arrowhead Park Landfill (Arrowhead Park) at the southern end of LLBdM. This site was identified by WDNR (1999a) as one of the potential PCB contributors.

Arrowhead Park and three of the other landfills were evaluated for potential contributions of PCBs, dieldrin, lead, and cadmium to the Lower Fox River, and eventually Green Bay, during the Green Bay Mass Balance Groundwater Monitoring Studies. These studies concluded that groundwater migration from these four landfills does not adversely impact surface water bodies adjacent to these waste sites, especially with respect to PCBs, lead, or cadmium (Stoll and Erdmann, 1990 and 1992). The total PCB load from Arrowhead Park is estimated not to exceed 12.8 grams per year (g/year). The PCB load from the other 16 former municipal/industrial landfills located within the Green Bay city limits is estimated to range from 0.005 to 0.02 g/year, indicating that these would not likely contribute more than 1 gram of PCBs annually, combined (Stoll and Erdmann, 1990 and 1992). Additionally, PCB attenuation by soils was not considered in the study and would likely further reduce projected PCB impacts to the river. The estimated daily PCB loads to groundwater from Arrowhead Park is 0.035 g/day (Stoll and Erdmann, 1992). This PCB load is minimal compared to the lowest winter daily PCB loading of 30 to 100 g/day as estimated from concentration data measured in the Lower Fox River downstream of the De Pere dam (Steuer, 1990; WDNR, 1995).

Numerous landfills are present in the vicinity of Green Bay (Plate 5-5) but only those listed below are still active.

Sanitary Landfills in the Green Bay Area

<table>
<tr><th>Landfill Name</th><th>Location</th><th>County</th><th>State</th></tr>
<tr><td>Door County Sanitary Landfill</td><td>Sturgeon Bay</td><td rowspan="2">Door</td><td rowspan="4">WI</td></tr>
<tr><td>Washington Island Landfill/Compost Site</td><td>Washington Island</td></tr>
<tr><td>Mar-Oco Landfill</td><td rowspan="2">Marinette</td><td rowspan="2">Marinette</td></tr>
<tr><td>Badger Paper Mills</td></tr>
<tr><td>United Waste Systems Landfill</td><td rowspan="2">Menominee</td><td rowspan="2">Menominee</td><td rowspan="4">MI</td></tr>
<tr><td>Great Lakes Pulp &Fibre Landfill</td></tr>
<tr><td>Mead Paper Industrial Landfill</td><td rowspan="2">Escanaba</td><td rowspan="2">Delta</td></tr>
<tr><td>Delta County Landfill</td></tr>
</table>

According to WDNR and Michigan Department of Environmental Quality records, these landfills have received both industrial and municipal wastes. Additionally, the Mead Paper, Badger Paper, United Waste Systems Landfill, and Great Lakes Pulp & Fibre landfills have all likely received industrial wastes that contain PCBs. Similar to the landfills located along the Lower Fox River in Brown County, the contribution of PCBs from these landfills to Green Bay is believed to be very low compared to the Lower Fox River sediments.

5.1.1.3 Spills

Spills include surface releases of chemicals as well as leakage from underground storage tanks, pipelines and other structures. Spills of substances reported to WDNR include used motor oil, diesel and gasoline fuel, ammonia, and numerous industrial chemicals. From 1987 to 1991, there were 437 spills reported in the Lower Fox River Basin and a response action was taken on 262 incidents. In 1992, there were 170 active cleanup cases for spills or leaking underground storage tanks (USTs) related to non-petroleum products in the Lower Fox River Basin.

While many spill and LUST incidents have occurred within the Lower Fox River watershed, their potential effect, if any, on the river has not been specifically evaluated. However, spills are limited in volume and duration and the vast majority occur at locations which would not reach the river. When compared with the chemical parameters discharged directly to the river via the municipal and industrial dischargers, recent point source spills likely have little impact, if any, and are not addressed further.

Outside of the Lower Fox River watershed the EPA Toxic Release Inventory (TRI) database was queried to evaluate the possibility of significant releases or spills in the Green Bay region. The database query results are summarized below.

EPA Toxic Release Inventory Sites in the Green Bay Area

City	Number of TRI sites	Total Number of TRI sites in County
Sturgeon Bay	5	5
Oconto/Oconto Falls	6	12
Peshtigo	1	16
Marinette	10	10
Menominee	12	13
Escanaba/Gladstone	3	3

Most of these sites are located in the cities which are either situated on the bay or on one of the Green Bay tributaries just upstream from the bay. Most of these sites are currently being investigated or remediated. Similar to spills in the Lower Fox River watershed, spills near the shores of Green Bay are unlikely to significantly impact water quality in the bay. The TRI database did not reveal that PCBs were a potential compound of concern at any of these sites.

The Lower Menominee River RAP indicates that spills are not significant source of impacts in the Menominee River. Rather, the most significant sources of impacts to the Menominee River resulted from direct discharge of process wastewater containing arsenic from the Ansul facility.

5.1.2 Non-Point Sources

The Lower Fox River Basin drains approximately 16,395 km^2 (6,330 mi^2). Due to the large size of the watershed, non-point sources have the potential to contribute significant pollutant loads from runoff and atmospheric deposition into the river. A general listing of the non-point sources applicable to the Lower Fox River are listed below.

Non-point Sources of Pollution (WDNR, 1990b)

Non-Point Sources	Typical Pollutants
Atmospheric deposition from automobiles and point sources	Heavy metals (from autos), carbon dioxide, sulfur dioxide, nitrates, and acids formed from these substances
Agricultural activities and runoff	Pesticides, VOCs, PAHs, inorganic and organic pollutants, BOD, COD, suspended solids, nutrients, and bacteria.
River and Bay Sediments and Green Bay Tributaries	PCBs, Pesticides, VOCs, PAHs, inorganic and organic pollutants, heavy metals, and suspended solids.
Urban Storm Sewer Outfalls	Heavy metals, pesticides, inorganic and organic pollutants, BOD, COD, suspended solids, nutrients, and bacteria.

These non-point sources are discussed below.

5.1.2.1 River and Bay Sediments

As previously cited, an estimated 313,600 kg of PCBs were discharged to the Lower Fox River between 1954 and 1971 (WDNR, 1999a). Based on the FRDB sediment sampling results, a significant percentage of this PCB mass has accumulated in river and bay sediments. Sediments containing elevated concentrations of PCB, as well as other compounds, are dispersed along the entire Lower Fox River and are a continuing source of non-point pollution. PCB modeling studies (Velleux and Endicott, 1994; WDNR, 1995; WDNR, 1999a) evaluated the sources, movement, and fate of PCBs in the Lower Fox River and Green Bay. It is estimated that over 99 percent of the PCB in the river water is due to resuspension, volatilization and/or dissolution of PCBs from the sediments (Fitzgerald and Steuer, 1996). These same processes also control the occurrence of other organic and inorganic compounds within the sediments and water.

In the Menominee River AOC, the main compound of concern was found to be arsenic, which was detected at concentrations as high as 32,300 mg/kg. PCBs and mercury were detected in Menominee River sediments at maximum concentrations of 2.0 mg/kg and 2.6 mg/kg, respectively. In comparison, the maximum detected concentrations of these two compounds in Lower Fox River sediments are 710 mg/kg and 9.82 mg/kg, respectively. PCB and mercury concentrations in the Menominee River are significantly lower than in Lower Fox River sediments.

In 1987 and 1988, the USGS evaluated the loading of PCBs, dieldrin, lead, and cadmium from Green Bay tributaries (House, 1990). The results of this study indicated that low concentrations of PCB and lead were present in bottom sediments of Duck Creek and that lead was found in other tributaries. Dieldrin and cadmium were not detected. Based on this study, the USGS completed an evaluation of PCB loading from the five major tributaries to Green Bay from 1988 to 1990 and these results are summarized below. More than 90 percent of the PCB load into Green Bay is attributable to the Lower Fox River (House, *et al.,* 1993). The Menominee River is the second most significant source of PCBs to Green Bay, accounting for 10 kg (22 pounds) or less of PCBs, which is only about 2 percent to 4.5 percent of total PCB load into the bay. The other Green Bay tributaries are insignificant compared with the Lower Fox River.

PCB Loads from Green Bay Tributaries, 1989-90 (House, 1990)

Tributary	Water Year 1989		Water Year 1990	
	Load (kg)	Percent	Load (kg)	Percent
Fox (De Pere dam)	119.45	54.2%	158.76	66.9%
Fox (Mouth)	201.04	91.2%	227.3	95.8%
Oconto (Mouth)	1.47	0.7%	1.42	0.6%
Peshtigo (Mouth)	4.04	1.8%	2.39	1.0%
Menominee (Mouth)	10.01	4.5%	4.79	2.0%
Escanaba (Mouth)	3.77	1.7%	1.39	0.6%
Total Load	220.33	---	237.29	---

No estimates of mercury loading into Green Bay are available.

Sediment transport within Green Bay was studied by a number of researchers and summarized by the USFWS (Stratus, 1999a). Based on Green Bay currents and flow dynamics, Hawley and Niester (1993) estimated that between 10 percent to 33 percent of the inner bay tributary sediment load, the majority of which is derived from the Lower Fox River, is transported to the outer bay (Stratus, 1999a). Transport of this sediment load mainly occurs between the east shore of Green Bay and Chambers Island.

5.1.2.2 Stormwater Runoff

Soil eroded from agricultural land, construction sites, and street runoff as well as erosion from unstable stream banks is estimated to contribute 100,000 tons of solids to the Lower Fox River each year (WDNR, 1988). Only 5 percent of the solids load results from municipal/industrial dischargers; the remaining 95 percent is from non-point sources, such as agricultural and urban run-off. As indicated above, approximately 150,000 tons of solids are transported into Green Bay annually (Harris, 1994), and these solids contribute significantly to water quality problems in the bay.

Within the Lower Fox River, a portion of these solids settle out and accumulate behind the dams and other areas of low water velocity. Subsequent storm and snow melt events can erode and resuspend particles which may contain nutrients and chemicals adsorbed onto their surfaces. These particles are a continuing non-point pollutant source to downstream reaches of the river, Green Bay, and Lake Michigan. Associated pollutants can be made accessible to the aquatic ecosystem through biological (i.e., algae or bottom feeding fish consumption), physical, (i.e., re-suspension) and chemical (i.e., volatilization or dissolution into the river water) mechanisms.

Previous nutrient loading studies have primarily focused on phosphorus from both agricultural (barnyard runoff, placement and tonnage of winter-spread manure) and urban stormwater sources. Phosphorous contributions to the Lower Fox River from Lake Winnebago comprised approximately 51 percent of the load in 1990 and non-point sources contributed an additional 33 percent (WDNR, 1993). As stated above, only 20 percent of the estimated phosphorous load and 5 percent of the TSS load to the river is accounted for from either industrial or municipal discharge sources. Therefore, it is estimated that the remaining phosphorous load results from non-point sources.

To evaluate the significance of urban areas as a source of PCBs, WDNR collected sediment samples from ten sewer catch basins in May 1989. The PCB residue concentrations were used to extrapolate from the catch basin drainage areas to the entire study area. The sediment load from urban areas within the study area was estimated from the PCB residue concentrations from the catch basins. The maximum PCB concentration in urban stormwater runoff, using the catch basin approach, resulted in an estimated loading of about 1 kg/yr (Konrad, 1992). Therefore, these levels do not appear to be a significant source of PCBs to the Lower Fox River.

Stormwater runoff from urban areas along the shores of Green Bay has not been studied in detail. The Lower Menominee River RAP (WDNR, 1990b) indicates that the AOC is susceptible to pollution from runoff but there is no estimate of the load contributed by the watershed. Similarly, other areas of the Green Bay watershed susceptible to runoff from both urban and agricultural areas have not been evaluated.

5.1.2.3 Atmospheric Deposition and Volatilization

A number of studies have found that PCB volatilization from the bay greatly exceeds the atmospheric deposition of PCBs into bay waters. Airborne concentrations of PCBs in lower Green Bay were as much as 2 to 3 times greater than concentrations in the outer bay and as great as 7 times higher than concentrations over land on the same day. Total PCBs over the water of southern Green Bay were 670 to 2,200 picograms per cubic meter [pg/m^3]. This enrichment of airborne PCB concentrations was attributed to volatilization of the most volatile PCB congeners from the water. Results suggested that volatilization from water can be an important source of atmospheric chemicals and that the magnitude of this release has likely been underestimated previously (Hornbuckle, *et al.,* 1993).

Data from the early 1980s estimated atmospheric deposition of PCBs into Lake Michigan of approximately 650 to 1,000 kg (1,430 to 2,200 pounds) annually (WDNR, 1988). For comparison, the surface area of Lake Michigan is approximately 57,800 km^2 (22,300 mi^2) while Green Bay only covers about 4,150 km^2 (1,600 mi^2). Therefore, the surface area of Green Bay represents only about 7.2 percent of the total Lake Michigan area. Similarly, due to the overall limited surface area of the Lower Fox River compared to the surface area of Green Bay, the direct atmospheric contributions of the PCBs to the river are limited. In the early 1990s the estimated atmospheric contributions of PCBs into Green Bay was approximately 2 to 16 kg (4.5 to 35 pounds) annually (Hornbuckle, *et al.,* 1993 and Achman, *et al.,* 1993). In 1993, Sweet, *et al.* estimated that approximately 35 kg (77 pounds) of PCB were deposited into the bay.

In 1993, Sweet, *et al.* estimated that Green Bay experienced a net loss of approximately 500 kg (1,100 pounds) of PCBs due to volatilization. Hornbuckle, *et al.*(1995), estimated that Lake Michigan, north of Milwaukee (above 43 N. Latitude), experienced a net loss of approximately 520 kg (1,150 pounds) of PCBs while Green Bay net losses were approximately 130 kg (286 pounds) of PCBs annually. Similarly, Hoff, *et al.*(1994) estimated that annual volatilization of PCBs from Lake Michigan decreased from 5,140 kg (11,330 pounds) in 1988 to 2,700 kg (5,950 pounds) in 1994 while annual PCB deposition into the lake fell from 400 kg (881 pounds) to 69 kg (152 pounds) over the same time period. Studies consistently indicate that PCB volatilization exceeds atmospheric deposition.

Atmospheric emissions of PAHs, lead and other compounds are also potential sources of these constituents in sediments. The fate of air emissions is dependent on many factors and their effects on the Lower Fox River are unknown. However, studies of Green Bay have evaluated DDT, benzo(a)pyrene (B[a]P), and lead, as well as the impacts of urban areas. Hoff, *et al.*(1994) found that approximately 99 kg (218 pounds) of DDT were introduced into Lake Michigan in 1994 through both gaseous and particulate deposition while particulate depositions of B[a]P and lead were 250 kg (551 pounds) and 72,000 kg (158,700 pounds), respectively. Levels for all of these compounds except B[a]P generally decreased over time. B[a]P deposition to Lake Michigan increased between 1988 and 1994 (as it did in the other 4 Great Lakes), suggesting that emissions of PAHs and other SVOCs are increasing (Hoff, *et al.,* 1994). Measured concentrations of PCBs, DDT, dieldrin, chromium, and lead at urban and rural sites along Lake Michigan indicated that levels in or near urban areas were as much as 40 times higher than at rural locations (EPA, 1997). However, the measurements of other pesticides, arsenic, and selenium were similar for urban and rural locations.

5.2 Summary of Detected Chemicals

5.2.1 Overview

Numerous chemical and physical parameters have been analyzed and detected in the sediment, water, and biota of the Lower Fox River and Green Bay. The SLRA (RETEC, 1998c) identified seven COPCs for the Lower Fox River which are discussed in this section. These compounds include: PCBs, dioxin/furan, DDT, dieldrin, mercury, lead, and arsenic. Only PCBs and mercury will be discussed for Green Bay. This section discusses the specific sediment and water-sampling chemical results in the FRDB. The FRDB biota results, for both the Lower Fox River and Green Bay, are discussed in detail in the RA. However, a summary of PCB concentration trends in select animal species of the river and bay is included herein.

Sediment samples included in the FRDB have been analyzed for over 206 different parameters in various chemical categories, including PCBs, dioxin/furans, pesticides, SVOCs (including the polynuclear aromatic hydrocarbons and pentachlorophenol), and inorganic compounds, including metals. The chemical parameters detected in Lower Fox River and Green Bay sediments are summarized on Table 5-1. The results are summarized for each reach and zone and include the number of samples analyzed for each parameter, as well as the number and percentage of detections (Table 5-1). Thirty-four (34) compounds were detected in less than four samples (Table 5-1) and are not discussed further.

Two arithmetic average values and the logarithmic mean have been calculated for each parameter sample group (Table 5-1). The two averages are labeled as the "RI Mean" and the "RA Mean" and each was calculated in the following way:

- The RI Mean was calculated using only the laboratory results for all samples in which the chemical was detected. Therefore, all samples that the laboratory labeled as "non-detect" were ignored in calculating the RI Mean.

- The RA Mean was calculated using the detected results. However, a value of one-half the detection limit was assigned to all samples that had "non-detect" results. Therefore, the RA Mean is always less than or equal to the RI Mean because these low concentrations increased the sample population without proportionally increasing the sum of all values.

The RA Mean provides a mechanism for evaluating sample points as though PCB or other chemical were present at concentrations below the laboratory method detection limit in that location. Both the RI Mean and RA Mean are included on Tables 5-1 and 5-2 to show the difference in the deposit/SMU/zone averages when both methods are used to calculate the value. However, the RA mean is the value that is used for discussion purposes in both this RI and the RA.

The logarithmic mean was also calculated for all parameter groups in addition to the two arithmetic averages. The PCB results for many of the deposit/SMU/zone groups exhibited a log-normal distribution. The logarithmic mean calculates an average value that is not skewed by a small number of extremely high values. The log-normal distribution is evidenced by the extreme differences (several orders of magnitude) between the minimum and maximum detected values for many data sets, such as deposits A, C, and POG in LLBdM (Table 5-2). The logarithmic mean was used to calculate an average value for each deposit/SMU/zone and the results are included on Table 5-2. Non-detect samples were assigned values of one-half the detection limit, similar to calculation of the RA mean. The distribution (normal, log-normal, or other) of each particular chemical compound data set is indicated in the FRDB.

Only post-dredging PCB data collected at Deposit N has been used in the PCB distribution evaluation and mapping effort. Also, post remediation data for SMU 56/57 has not been incorporated into the FRDB because dredging activities were not completed to the targeted dredging depths. Rather, pre-dredging sediment results have been used and the estimated PCB mass and sediment volume removed during the SRD project has been subtracted from the calculated totals for SMU 56-61.

5.2.2PCBs

Historically, PCBs were used for a variety of industrial purposes because of their desirable chemical properties, which included general inertness, resistance to both acids and alkalis, and thermal stability. PCBs were useful in a wide variety of applications, including dielectric fluids in transformers and capacitors, heat transfer liquids, and lubricants (Merck and Company, 1989). In general, PCBs are relatively insoluble in water and the solubility decreases with increased chlorination; however, they are also freely soluble in non-polar organic solvents and biological lipids (ATSDR, 1997a). In the Lower Fox River valley, PCBs were specifically used in the manufacture and recycling of carbonless copy paper (WDNR, 1999a).

PCBs are a class of chemical compounds in which 1-10 chlorine atoms are attached to the biphenyl molecule (two benzene rings, which are the basic PCB building blocks), with 209 variations. The 209 individual chlorinated compounds are called PCB congeners. Additionally, various configurations are possible as well since there can be free rotation between the benzene rings. The benzene rings can rotate around the bond connecting them and the two configurations are called planar (or coplanar) and non-planar. Coplanar PCBs have the two benzene rings in the same plane while non-planar PCBs have the benzene rings at an angle anywhere from 1 to 90 degrees of each other. The most toxic congeners with respect to human health and the environment are the coplanar congeners 77, 105, 118, 126, and 169 (ATSDR, 1997a). These coplanar congeners have been evaluated and analyzed as part of previous Lower Fox River and Green Bay sampling efforts. While the presence and distribution of total PCBs is the focus of this report overall, discussions of the PCB congeners herein will mainly focus on these five particular PCB congeners.

In addition to the five coplanar congeners listed above, the USFWS summarized the toxic effects of these and other PCB congeners with regards to birds (Stratus, 1999c). The toxicological effects of PCBs congeners are important because these compounds, especially the coplanars listed above, have a similar molecular configuration as dioxin 2,3,7,8-TCDD. Therefore, these PCBs have a dioxin-like affinity for the same cellular receptors as 2,3,7-8-TCDD (Stratus, 1999c). Congeners 77, 126, and 169 most resemble dioxin (ThermoRetec, 2000). In addition to the five coplanars listed above, congeners 81, 114, 123, 156, 157, 167, and 189 have all been assigned toxic equivalency factors (TEFs) by the

World Health Organization based on the dioxin-like effects that these compounds may have with respect to birds (Stratus, 1999c). PCB congeners also have phenobarbital-like, neurotoxic, and endocrine-disrupting toxicological effects in birds (Stratus, 1999c). Therefore, the presence of other congeners within the Lower Fox River and Green Bay system cannot be discounted. Rather, the presence of these various congeners within the system represent a possible threat to wildlife within the region that are evaluated further in the RA.

PCBs are also categorized by degree of chlorination. The term "homolog" is used for all of the PCB compounds with the same number of chlorines (e.g., dichlorophenyl means two chlorine atoms). The PCBs of a given homolog with different chlorine substitution patterns in the molecules are called isomers (e.g., the dichlorophenyl homolog has twelve isomers). Due to the large number of PCB congeners, homolog plots for particular sediment deposits are discussed in Section 6 to evaluate the movement, degradation, and loss of PCBs from the environment.

In the U.S., PCB mixtures were marketed under the trade name Aroclors by the Monsanto Corporation, the major U.S. producer of PCBs from 1930 to 1977. All the Aroclors, with the exception of Aroclor 1016, were identified by a four-digit numbering code in which the first two digits indicated that the parent molecule was biphenyl (12 carbons) and the last two digits indicated the chlorine content by weight percent. Thus, Aroclor 1242 was a chlorinated biphenyl mixture of varying amounts of mono-through heptachlorinated PCB congeners with an average chlorine content of 42 percent. This numbering system also indicated that the higher numbered Aroclors contained an increasingly greater percentage of higher chlorinated congeners.

PCBs have been detected in 2,332 of the 2,717 sediment samples analyzed (total PCB results, Table 5-1). Both congeners and Aroclors have been analyzed to evaluate the distribution of PCBs in Lower Fox River sediments. The individual PCB congeners have been analyzed in 282 samples in the Lower Fox River and in 818 samples in Green Bay. The various Aroclors have been analyzed in 2,260 samples in the Lower Fox River and in 61 samples from Green Bay (Table 5-1).

The number of samples in which the five coplanar congeners (77 [77/110], 105, 118, 126, and 169) were analyzed and detected are summarized on Table 5-1. Congener 169 was not detected in either Lower Fox River or Green Bay sediments (Table 5-1). According to studies completed on Aroclor mixtures, congener 169 was not found in Aroclors 1016, 1242, 1248, 1254, or 1260 (ATSDR, 1997a). When elevated concentrations of PCBs are present in a sample it becomes difficult for the laboratory to differentiate between congener 77 and 110 due to interference. Therefore, these results are often reported as congener 77/110 (Table 5-1). Although it is possible to evaluate the relationship and determine the percent of congener 77 to congener 110 in samples where each was identified individually, use of such a method in this case is questionable. The ratio determined for samples with lower PCB concentrations is may not be applicable to samples with elevated concentrations. Therefore, for use in this study, it has been assumed that all samples reported as congener 77/110 are congener 77.

In the Lower Fox River, 138 congeners have been detected in sediment samples. At least 253 samples were analyzed for PCB congeners, although not every sample was analyzed for the full list of congeners. Congeners 77/110 and 118 have been detected in 97 percent to 99 percent of the samples analyzed, respectively, while congeners 77 and 105 were detected in about 80 percent of the samples. (Table 5-1). The congeners 77/110 and 118 maximum and mean concentrations were the highest for the coplanar congeners (Table 5-1). Congener 105 is present at relatively low concentrations even though it was detected in about 80 percent of the analyzed samples (Table 5-1). Similarly, congener 126 was detected in less than 30 percent of the samples and had very low concentration results. Congeners 77 (77/110) and 118 are more widespread in sediments than the other coplanar PCBs (Table 5-1).

In Green Bay, at least 97 congeners have been detected in 797 of 818 sediment samples analyzed. Congeners 77/110 and 118 have been detected in well over 95 percent of the analyzed samples (Table 5-1). Maximum and mean concentrations indicate these congeners had the highest results for the coplanar congeners (Table 5-1). Similar to the Lower Fox River, congener 105 was present at relatively low concentrations even though it was detected in approximately 80 percent of the analyzed samples (Table 5-1). Congener 126 was detected in less than 30 percent of the samples and congener 169 was absent (Table 5-1), also similar to the Lower Fox River. Congeners 77 (77/110) and 118 are also more widespread in Green Bay sediments than the other coplanar PCBs. The PCB coplanar congeners are discussed further in the RA.

Aroclor 1242 was the PCB mixture used in the emulsion applied to the manufacture of carbonless copy paper. Approximately, 45 million pounds of this emulsion were reportedly used in the Lower Fox River valley between about 1954 and 1971 (WDNR, 1999a). In the Lower Fox River, Aroclor 1242 was detected in over 90 percent of the sediment samples tested by Aroclor analysis (Table 5-1). By comparison, Aroclors 1254, 1260, and 1268 were only detected in about 9 percent to 25 percent of all samples analyzed while the other five Aroclors (1016, 1221, 1232, 1248, and 1262,) were virtually undetected. Aroclor 1242 is also dominant in Green Bay, being one of only two Aroclors detected (Table 5-1). The Aroclor 1242 maximum and average concentrations are about one to two orders of magnitude higher than the results for the other three detected Aroclors (Table 5-1). Only 61 samples from Green Bay were tested by Aroclor analysis while 818 samples were analyzed for PCB congeners. Aroclor 1242 and 1260 were detected in more than 44 percent and 16 percent, respectively, of the 61 samples analyzed. Other than Aroclors 1242 and 1260, none of the other Aroclors were detected in Green Bay. Specific end-uses of PCB Aroclors 1242, 1254, 1260, and 1268, which are the dominant Aroclors present in the river, are listed below (ATSDR, 1997a).

Summary of Former End Uses for Select Aroclors (ATSDR, 1997a)

End Use	**Aroclors**			
	1242	1254	1260	1268
Capacitors	X	X		
Transformers	X	X	X	
Heat Transfer	X			
Hydraulics/Lubricants				
Hydraulic Fluids	X	X	X	
Vacuum Pumps		X		
Gas-Transmission Turbines	X			
Plasticizers				
Rubbers	X	X		X
Synthetic Resins		X	X	X
Carbonless Paper	X			
Miscellaneous				
Adhesives	X	X		
Wax Extenders	X	X		X
Dedusting Agents		X	X	
Inks		X		
Cutting Oils		X		
Pesticide Extenders		X		
Sealants/Caulking Compounds		X		

The PCB sample frequency distribution results for each sediment deposit/SMU group/zone have been plotted on Figure 5-1 which illustrate where sediment samples have been collected and where elevated PCB concentrations have been detected. A majority of the samples collected have focused on specific deposits/SMUs.

In the Lower Fox River, there are 12 deposits/SMU groups for which approximately 50 or more total PCB results have been reported and six areas with more than 100 results (Figure 5-1). Additionally, more than 100 samples had been collected from Deposit N prior to remediation, however, less than 50 post-remediation samples are included in the database. Following the 1989/90 sediment investigation, deposits/SMUs exhibiting large areal extent were the focus of subsequent investigations and areally smaller deposits were subject to very limited sampling. Distribution of total PCBs in the Lower Fox River sediments is described below for each reach of the river. Approximately 60 samples have been collected from Green Bay Zone 2 (2A and 2B) and over 150 samples were collected from zones 3A and 4. More than 400 samples have been collected in Green Bay Zone 3B (Figure 5-1).

5.2.3 Dioxin/Furan

Dioxin/furan compounds are a group of chlorinated organic compounds which have a large number of different congeners, similar to PCBs. Dioxin/furan compounds are not manufactured. Rather, they are typically generated through a number of manufacturing processes. Dioxin/furans are often associated with the wood treatment and pulp/paper industries as a by-product of the treatment and bleaching processes, respectively. Based on the production, recycling, and de-inking of carbonless copy paper at mills located along the Lower Fox River, bleaching activities within the valley were limited. Therefore, the formation of dioxin associated with paper bleaching was also limited. In addition, although low levels of polychlorinated dibenzofurans resulted from the processing and manufacture of Aroclors, dibenzo-p-dioxins were not typically produced or associated with Aroclor production (ATSDR, 1997a). Based on this information there are no known specific point sources for these compounds.

Although numerous congeners exist, dioxin 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) and furan 2,3,7,8-tetrachlorodibenzo-p-furan (2,3,7,8-TCDF) are the two most toxic congeners with respect to human health and the environment. These two congeners were analyzed in 21 sediment samples of the Lower Fox River during the GAS/SAIC RI (1996). No sediment samples from Green Bay were analyzed for either of these congeners. Therefore, the dioxin/furan data is very limited (Table 5-1).

Dioxin/furan samples were collected in locations where PCB concentrations were elevated (e.g., deposits D, E, POG, N, EE, HH, and SMU 56/57). 2,3,7,8-TCDD concentrations range from 0.23 to 10.0 nanograms per kilogram (ng/kg or part per trillion [ppt]) while 2,3,7,8-TCDF concentrations range from 31.78 and 170.0 ng/kg (ppt) (Table 5-3). Nine samples were collected upstream of the De Pere dam; seven were collected from the upper 60 cm (2 ft) of sediments, while the other two samples were collected deeper. All 12 samples downstream of the De Pere dam were collected from a single location to evaluate the vertical distribution of both parameters (Table 5-3). The results for Deposit N, collected prior to the SRD project are not discussed.

5.2.4 Pesticides

The chlorinated pesticides primarily result from non-point sources associated with agricultural activities, although other sources, such as parks, golf courses, and other institutional facilities where pest control is required, may contribute to the occurrence of some of these compounds in the sediments. Given the large percentage of agricultural land use in the vicinity of the Lower Fox River, agricultural uses contribute the majority of the chlorinated pesticides found in sediments. No pesticides were detected in sediment samples collected in Green Bay.

Ninety-eight sediment samples were analyzed for chlorinated pesticides that pose a risk to human health and the environment. At least 17 different chlorinated pesticide compounds were detected in sediment samples from the Lower Fox River and Lake Winnebago (Table 5-1). Pesticide samples were collected from deposits C, D, E, POG, W, X, EE, GG, HH, and downstream of the De Pere dam. The samples from Lake Winnebago were collected and analyzed for use in the RA and to establish background values. The pesticides DDT, DDD, DDE, endrin aldehyde, endrin ketone, gamma-BHC (lindane), and heptachlor were all detected in more than four samples.

Two pesticides were identified as chemicals of potential concern in the SLRA (RETEC, 1998c). DDT was detected in 16 samples and dieldrin was detected in only one river sediment sample (at a concentration of 5.9 μg/kg, Table 5-4). The manufacture and use of both DDT and dieldrin in the United States were discontinued in the early 1970s (ATSDR, 1993a and ATSDR, 1994).

5.2.5 Inorganic Compounds

Numerous inorganic parameters have been analyzed, all of which occur naturally within native soils and river sediments. Parameters analyzed reflect the Resource Conservation and Recovery Act (RCRA) list of heavy metals and include arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. It is sometimes difficult to distinguish between naturally occurring concentrations and those resulting from anthropogenic activities. The inorganic compounds were analyzed in approximately 3,200 samples (including the TCLP samples) and they were detected in approximately 85 percent of the samples, which is expected for naturally occurring compounds (Table 5-1).

Mercury, lead, and arsenic were identified as COPCs in the SLRA and concentrations detected in sediments are listed on Table 5-5. Mercury has been analyzed in almost 400 samples while the other RCRA metals were analyzed in approximately 100 to 150 samples (Table 5-1). In addition to the RCRA metals, copper, nickel, and zinc were also analyzed in a large number of samples. Other inorganic compounds have been analyzed in less than 100 samples (Table 5-1).

For comparison purposes, background or reference concentrations are listed at the bottom of the tables for inorganic compounds. These background concentration values were derived from the following:

- The reference results (and average of these results) for sediment samples collected as part of the USGS National Water Quality Assessment (NWQA) program

- The average value for sediment sample results collected from Lake Winnebago as part of this effort (discussed below)

- The WDNR Triad Assessment reference sample results from Lake Butte des Morts (WDNR, 1996)

- The average sediment concentrations for northern Wisconsin streams generated as part of the National Uranium Resources Evaluation (NURE) project (Mudrey and Bradbury, 1992)

- The EPA range of background concentrations for inorganic compounds in soils (EPA, 1983)

All barium values detected were below the NURE and EPA background levels and do not warrant specific discussion in individual river reaches (Table 5-6). Similarly, nickel, selenium and silver occurred within or near the cited ranges of background values, except at SMU 38 of the De Pere to Green Bay Reach, which exhibited the highest concentrations of these three parameters for all samples collected in the river or the bay (Table 5-6). Results from the other Fox River reaches indicate that concentrations are relatively low and stable compared with the De Pere to Green Bay Reach while levels in Green Bay seldom exceed background values. Therefore, nickel, selenium and silver are discussed only in the De Pere to Green Bay Reach.

Over 140 copper and zinc samples exceed the Lake Winnebago, NURE, and WDNR Triad Assessment background concentration values. There are no obvious trends to the occurrence of these elevated concentrations as they are widely distributed in the sediments and the average concentrations for each reach show no clear pattern (Table 5-6). Although concentrations within Green Bay are generally slightly lower, many still exceed these background values. Moreover, zinc values above 75 mg/kg are typically considered to be representative of soils. Due to the fact that these parameters are not significant environmental or human health concerns, especially when compared with PCBs and other organic compounds, copper and zinc are not addressed in the discussions of compounds detected in each reach of the river.

Other inorganic compounds (aluminum, antimony, beryllium, calcium, cobalt, iron, magnesium, manganese, potassium, sodium, thallium and vanadium) have been analyzed in 35 to 71 sediment samples and the results are listed on Table 5-7. Excluding antimony and thallium, the other compounds were detected in almost every sample analyzed. Many of these samples exceed the NURE background levels but do not necessarily exceed the EPA listed range of concentrations typical in natural soil (Table 5-7). These inorganic parameters were detected at relatively consistent levels, indicating that these parameters are widely distributed in the sediments due to background levels of these materials in the native soils of the region. Additionally, most of these parameters are not significant environmental or human health concerns. Due to these factors, these compounds are not addressed in the discussions of compounds detected in the river or bay.

Ammonia (as nitrogen) was detected in 97 samples in the Lower Fox River and in 19 samples in Green Bay (Table 5-8). In sediments, ammonia is usually generated during anaerobic breakdown of organic material; therefore, higher levels of ammonia suggest that anaerobic degradation of organic material is occurring. However, industries along the Lower Fox River also discharge ammonia and organic material into the system. Therefore, it is difficult to distinguish between production of ammonia from the breakdown of naturally occurring compounds or from anthropogenic sources of ammonia/organic material. Ammonia concentrations in Fox River sediments range from 25 to 700 μg/kg and 95 (98 percent) of these samples exceed the reference concentration of 31 μg/kg (Table 5-8). In Green Bay the ammonia concentrations range from 22 to 140 μg/kg and 17 (89 percent) of these samples exceed the reference concentration (Table 5-8). Due to the difficulty in determining the source of ammonia (naturally occurring vs. anthropogenic related) and that the SLRA did not identify ammonia as a compound of potential concern, discussion of ammonia in river and bay sediments is limited.

Cyanide was analyzed in 28 sediment samples but was only detected in three samples (11 percent) collected as part of the SMU 56/57 SRD project. These results ranged from 0.73 to 3 mg/kg. Cyanide was not identified a concern in the SLRA. Due to the low number of detected results and the fact that all three samples were collected from the same location, no further analysis of cyanide impacts will be discussed and these data are not included on any tables.

5.2.6 TCLP Results

Thirteen RCRA metal sediment samples collected upstream of the De Pere dam were analyzed by the Toxicity Characteristic Leaching Procedure (TCLP) (Tables 5-1 and 5-9). One additional sample was also analyzed only for TCLP silver. None of the samples had TCLP concentrations approaching the regulatory levels that would classify the sediments as characteristically hazardous.

5.2.7 Semi-Volatile Organic Compounds (SVOCs)

None of the SVOCs were identified as chemicals of potential concern in the SLRA (RETEC, 1998c) but are summarized below due to their ubiquitous occurrence in the environment. SVOCs are a class of approximately 10,000 compounds that are found in thousands of products ranging from fuels, paints, and adhesives to skin creams and shampoos. They also result from the burning of solid waste, coal, and other organic material (Wisconsin Division of Health, 1994). Numerous SVOCs have been analyzed in sediments, but only six (not including PAHs) were detected in more than four samples (Table 5-1). SVOC samples were collected from Lake Winnebago, deposits C, E, POG, W, X, EE, GG, HH, and downstream of De Pere dam within the Lower Fox River, and from Green Bay zones 2 through 4 (Table 5-1).

PAHs are a subgroup of SVOCs comprised of 18 different compounds. Some PAHs are compounds of concern in the environment because they are carcinogenic. All 18 PAHs were detected in Lower Fox River and Green Bay sediments and the results are listed on Table 5-10.

In addition to PAHs, PCP is another SVOC of potential concern with respect to human health and the environment. PCP samples, like dioxin/furan, were collected from Lake Winnebago, deposits C, D, E, POG, EE, and downstream of the De Pere dam in the Lower Fox River, and from Green Bay. PCP was detected in 19 samples from the Lower Fox River and Green Bay, with concentrations ranging up to 1,100 μg/kg (Table 5-11). During the GAS/SAIC (1996) investigation, 16 PCP samples were collected from locations to evaluate vertical distribution within sediments. However, the method detection limit was elevated to 176 μg/kg (likely due to laboratory interference) in 14 of these samples and PCP was not detected. Therefore, all but one of these previously collected PCP results are from the upper sediments. PCP results are listed on Table 5-11.

Almost 50 SVOCs were detected in sediments, including all of the PAHs and PCP (Table 5-1). Besides PAHs and PCP, only five other SVOCs were detected in more than four samples, and these generally belonged to the phthalate, chlorobenzene, or phenol groups (Table 5-11). Fourteen of the SVOC/PAH compounds (totaling 153 individual samples) have been detected at concentrations exceeding 1,000 μg/kg (1 ppm); 11 of these compounds are PAHs or PCP (Tables 5-10 and 5-11). Pyrene is the most prevalent PAH in river and bay sediments and typically has the highest concentration in any given sample. Total PAH and SVOC results were compared to total PCB and there is no direct correlation between these parameters.

5.3 Lake Winnebago (Background) Results

Sediment samples were collected from three locations within Lake Winnebago to provide background concentrations of compounds entering the Lower Fox River for use in the RA. The Lake Winnebago sediment samples collected from 0 to 5 cm (0 to 2 in) were analyzed for PCBs (both Aroclors and congeners), SVOCs, pesticides, and metals. Only Aroclors 1242 and 1254 were present at concentrations from 10 to 20 μg/kg, whereas the three detected PCB congeners were below 5.5 μg/kg (Table 5-12). The congener analyses were the same as those used for the Lower Fox River sediments. Therefore, the number of congeners detected at low concentrations suggest that PCBs in Lake Winnebago are not a concern and the PCB congener concentrations are low compared with concentrations observed in the Lower Fox River (Table 5-2). None of the coplanar congeners were detected in Lake Winnebago. Total PCB concentrations in Lake Winnebago sediments ranged as high as 36 μg/kg (Table 5-12).

Dioxin/furan samples were not collected in Lake Winnebago and PCP was not detected.

The pesticides DDE, alpha-BHC, and endosulfan sulfate were the only chlorinated pesticides detected in Lake Winnebago. The three pesticides detected in Lake Winnebago sediments were also less than 3.6 μg/kg (Table 5-12). Downstream of Lake Winnebago, DDE was detected in five samples and alpha-BHC was detected in one sample; endosulfan sulfate was not detected.

Detected SVOCs were limited to eight of the PAHs, 4-Methylphenol, and bis(2-ethylhexyl)phthalate (BEHP). These are some of the same SVOCs found at a number of locations throughout the Lower Fox River (Tables 5-5, 5-6, and 5-12). Background concentrations of these parameters range as high as 350 μg/kg (BEHP, Table 5-12). The detected SVOCs (and PAHs in particular) cannot be attributed to a specific point or non-point source within Lake Winnebago or from further upstream, because these compounds are so widely used in so many different products and purposes. Total PAHs in Lake Winnebago sediments averaged 575 μg/kg (0.575 mg/kg) and ranged up to 842 μg/kg (0.842 mg/kg).

Seven metals, including mercury, lead, and arsenic, were detected in Lake Winnebago sediments (Table 5-12). Concentrations ranged up to 0.17 mg/kg for mercury, up to 39 mg/kg for lead and up to 6 mg/kg for arsenic. These results have been averaged for comparison with results from Lower Fox River sediments.

Metal concentrations detected in Lake Winnebago sediment are approximately 2 to 3 times greater than the average NURE background concentrations listed on Tables 5-7 through 5-9. This difference is likely due to the fact that most of the NURE sediment samples were collected from smaller, more rural streams which have lower population density and less industrial/agricultural activity than the Lake Winnebago/Lower Fox River system.

5.4 Chemical Distribution in Sediments

5.4.1Overview

This section discusses the magnitude and distribution of the COPCs in the Lower Fox River and Green Bay as well as other selected organic and inorganic parameters that are widely distributed in river and bay sediments. The emphasis of this section is on the occurrence and distribution of PCBs, based on the SLRA findings that PCBs are the primary chemicals of concern (COCs) in the Lower Fox River and Green Bay sediments.

The availability of numerous data points encompassing years of studies enables a more rigorous discussion of PCB distribution relative to other parameters Computer modeling and analysis has been used to assist in compiling these data points into graphical interpretations (i.e., bed maps) which illustrate the PCB distribution in individual sediments deposits/SMUs, the river reechoes, and the bay zones. While sediments in river reaches below Lake Winnebago may be referred to as individual deposits or SMUs in the discussion below, the previously established sediment deposit boundaries are sometimes arbitrary. The large majority of the Lower Fox River bottom contains sediment accumulations of varying depth and the boundaries between identified deposits are not necessarily distinctive and isolated. Rather, some deposits are continuous and transition into others (e.g., deposits EE through HH and SMUs downstream of the De Pere dam), while other deposits are very distinct (e.g., deposits G, H, I, J, etc.). Therefore, individual deposits/SMUs are addressed where the sediments exhibit concentrations or distribution that are relevant to describing the occurrence of compounds in the Lower Fox River.

Given the size and continuity of sediment deposits in the bay, it was not appropriate to establish specific "deposits". Similar to the De Pere to Green Bay Reach, sediments within the bay are continuous and the previously introduced zone designations have been established to facilitate discussion of the distribution of PCBs. A limited number of samples were collected from each zone, due to the size of the bay and the relative consistency of depositional environments for sediments derived from the Lower Fox River.

5.4.2 PCB Distribution

A general breakdown of total PCB results for each deposit/SMU group/zone are listed on Table 5-2. PCB concentrations ranged as high as 710,000 μg/kg in the Lower Fox River while the maximum concentration in Green Bay was 17,000 μg/kg. Along with the minimum and maximum PCB concentration results for each deposit/SMU group/zone, the RI, RA, and logarithmic means have been calculated for each area as described above. The RA and logarithmic means are used herein to represent PCB concentrations within a given deposit/SMU group/zone and to compare these results with other areas of the river or bay. These results have been used to map PCB distribution in the river and bay, as well as to estimate both the PCB mass and volume of sediments containing PCBs.

The PCB maximum, minimum, RA Mean, and logarithmic mean results for each deposit/SMU group/zone are plotted to illustrate the general trends for sediment concentrations from Lake Winnebago into Green Bay (Figure 5-2). When viewed alongside Figure 1-3 through 1-6, the summary of total PCB concentrations (Figure 5-2) shows that higher average PCB concentrations are generally found either in the vicinity of where the PCB discharges occurred (LLBdM) and/or locations where significant volumes of sediment have accumulated (Deposit EE behind the De Pere dam).

5.4.2.1 Bed Maps and Sediment Data Interpolation Methods

Bed maps were prepared showing the sediment thickness and occurrence of PCBs in the Lower Fox River and Green Bay from data in the FRDB. The methods used to produce these maps were the same as those outlined in WDNR Technical Memorandum 2e, the addendum to Technical Memorandum 2e, and Technical Memorandum 2f (1999c, 2000e, and 2000c, respectively). In order to prepare these bed maps for the river and the bay, it was necessary to extrapolate PCB concentration and sediment thickness between specific data points. These data interpolations were conducted for PCB concentration, sediment thickness, and sediment bulk density. The sediment thickness and PCB concentration interpolations were used to construct the distribution maps. Bulk density data were interpolated only to compute the PCB mass in sediments, and consequently are not plotted.

The interpolation analyses were conducted using ArcView 3.0 and Spatial Analyst 1.0 (ESRI) in both the river and the bay. However, slightly different approaches were used in each water body due to the availability of data and the size of the water bodies. The following sections discuss the specific methods used in the interpolations in each water body.

PCB Concentration Interpolations for the Fox River

The interpolations for the Fox River are based on the results included in the FRDB as of March 1, 2000, consisting of about 900 sample results and locations in the Lower Fox River from the following FRDB studies:

- 1989/90 Fox River Mass Balance Study
- 1989/90 Green Bay Mass Balance Study (GLNPO)
- 1994 Woodward-Clyde Deposit A Sediment Data
- 1992-1993 BBL Deposit A Sediment Data
- 1994 GAS/SAIC Sediment Data
- 1995 WDNR Sediment Data
- 1996 FRG/BBL Sediment/Tissue Data
- 1997-1998 Demonstration Project Data - SMU 56/57
- 1998-1999 Deposit N Post-Dredge Sediment Data
- 1998 FRG/BBL Sediment/Tissue Data
- 1998 RETEC RI/FS Supplemental Data

The interpolation of data for the Fox River involved both a screening of historic data and interpolation of the data to each river reach. In order to use the most recent data available, the data were assigned to three different time periods: 1989-1992, 1993-1995, and 1996-1998. All of the data from the period 1996-1998 were considered sufficiently recent and were used in the interpolation. However, data collected prior to 1996 were screened to remove data points that were in close proximity to locations with recent data.

To determine an appropriate distance for deleting pre-1996 data points, a relationship was developed between similar ranges of PCB concentrations and the distances between data points in that range. From this analysis it was determined that pre-1996 sample points located less than 133 m (436 ft) from a more recent sample point should not be used in the interpolations. This analysis was conducted first on the 1993-1996 data set to make a new data set for the 1993-1998 period. The analysis was then repeated using the 1989-1992 data set. In this way, the entire data set from 1989-1998 was used, but older data were superceded by more recent data as appropriate.

The interpolation was then conducted using this revised 1989-1998 data set. The procedure used for the interpolation was to break down the entire area of the Fox

River into a square grid with point's 10 meters apart. The data were then used to interpolate the value at each grid point.

The interpolation was developed using the inverse distance method, which results in the value at a grid point being more strongly affected by the sampling location(s) closest to the grid point. The inverse distance method gives more weight to closer points by using an inverse distance to the fifth power, meaning that points farther way have significantly less effect on the interpolated value at a point. For instance, for two data points, where the first point is half as far from the grid point as the second point, the first point contributes 32 times more to the interpolation than does the second point.

In addition to the inverse weighting, a set distance was selected for which data points would influence grid point results. For example, if there are no data points close to the grid point, then the grid point value would be interpolated from data that may be located a significant distance away. This can lead to erroneous interpolations as the data have been extrapolated over a long distance. To prevent this condition, grid point values were computed using data within a certain distance or radius of the grid point location. Data points located further from the grid point than the established radius were not used in the interpolation. If there were no data points within the interpolation radius of a grid point, then no value (or a "null point") was interpolated for that grid point in Spatial Analyst and the program then ignored these points.

The interpolation radius for computing sediment thickness was set at 100 m. For PCB and bulk density the interpolation radius varied among the river reaches. In the LLBdM Reach, complete coverage of the river required that a radius of 400 m (1,312 ft) be used. For the Appleton to Little Rapids Reach, the river is more narrow and linear. For this reach, the interpolation radius was computed as one third of the average river width, or 79 m (259 ft), to minimize the influence of separate deposits on the interpolation. For the Little Rapids to De Pere and De Pere to Green Bay reaches, an interpolation radius of 1,000 m (3,280 ft) was used. This is specified in Technical Memorandum 2e and in the Technical Memorandum 2e addendum (WDNR, 1999c; WDNR, 2000e).

Data interpolations for the Fox River were conducted for nine different layers of sediment depth: 0-10 cm, 10-30 cm, 30-50 cm, 50-100 cm, 100-150 cm, 150-200 cm, 200-250 cm, 250-300 cm, and greater than 300 cm. These sediment depths were selected based on previous and current modeling efforts as well as being defined by WDNR (1999c).

PCB Concentration Interpolations for Green Bay

Interpolation of sediment data from Green Bay followed the same methods as used in the Fox River. The data set for the Green Bay interpolations included approximately 240 sample results and locations from the following FRDB studies:

- 1989/90 Fox River Mass Balance Study
- 1989/90 Green Bay Mass Balance Study (GLNPO)
- 1995 WDNR Sediment Data
- 1996 FRG/BBL Sediment/Tissue Data
- 1998 FRG/BBL Sediment/Tissue Data

Because the hydraulic and sediment deposition characteristics of Green Bay are more uniform over larger distances, compared to the Lower Fox River, sediment data interpolations were adjusted accordingly. The methods used are the same as those outlined in Technical Memorandum 2f (WDNR, 2000c). Green Bay was divided into a square grid with 100 m between points, as opposed to a 10 m grid on the Fox River. The same inverse distance approach was used on both the Fox River and Green Bay, but the analysis on Green Bay used the distance squared rather than the distance raised to the fifth power (WDNR, 2000c). Therefore, interpolated results in Green Bay are more affected by data points farther way from the grid point than in the Fox River interpolation. For instance, for two data points, where the first point is half as far from the grid point as the second point, the first point contributes 4 times more to the interpolation than does the second point.

The interpolation radius for Green Bay was set at 8,000 m (26,250 ft) (WDNR, 2000c). This means that data points more than 8,000 m (26,250 ft) from a grid point were not used in the interpolation for that grid point. Conversely, grid points more than 8,000 m (26,250 ft) from any data point have no interpolated value, and this is evidenced by the lack of data in some areas of the bay, particularly along the west shore of Zone 3A and in Zone 4 (Plates 3-5 and 5-5).

Data interpolations for Green Bay were conducted for four different layers of sediment depth: 0-2 cm, 2-10 cm, 10-30 cm, and greater than 30 cm. In addition to these four sediment layers, a composite sediment layer was developed for a thickness of 0-10 cm. This layer was computed as a thickness-weighted average of the 0-2 and 2-10 cm layers. The 0-10 cm composite layer was developed for use in the RA and food web modeling. The other two layers were selected to coincide with the layering developed for the river, as well as also supporting modeling efforts.

Sediment Thickness Interpolations

In addition to PCB and other environmental parameters discussed above, interpolated grids were also developed for the presence or absence of sediment in the Fox River and Green Bay. The Fox River grid showing the occurrence of sediment was developed from field measurements of sediment thickness. As discussed previously, the sediment distribution maps for each river reach were shown on Plates 3-1 through 3-4. The occurrence of sediment was interpolated separately for all nine layers on the Fox River. For each layer, if the thickness at a sampling location was less than half the layer thickness, then the area was identified as an absence of sediment in that layer. Using this approach, sediment was also identified as absent in deeper layers if the sample depth did not extend to the modeled depth (e.g., if a sample was collected from 0 to 50 cm, the interpolation results indicate that there is no sediment present in the 50 to 100 cm layer).

For Green Bay, the occurrence-of-sediment grid was developed from the Green Bay Mass Balance Study (Manchester-Neesvig, *et al*., 1996) using a 5,000 m (16,400 ft) by 5,000 m (16,400 ft) grid. Based on sampling results, each grid cell was determined to be either soft sediments or glacial till (no soft sediments present). Grid cells that were not sampled were assigned to either the soft sediment or glacial till categories based on professional judgement, which included consideration of adjacent cells where sampling occurred and the depositional environment. For instance, areas near the mouth of the Fox River that were not sampled were considered to contain soft sediment as this is a depositional zone for sediments from the river. The 5,000 m (16,400 ft) grid was translated into a 100 m (328 ft) grid to match the sediment interpolation grids and allow a direct overlaying of the different grids. The sediment distribution map was shown on Plate 3-5.

The occurrence-of-sediment grids were used to edit the PCB concentration grids. This is necessary due to limitations in the PCB interpolation analysis. The PCB concentration interpolations do not consider whether sediment is present or absent. Consequently, PCB concentrations can be interpolated into areas that do not contain sediment. By using the occurrence-of-sediment grids, the PCB interpolation was restricted to those areas where sediments are present.

PCB Bed Maps

Maps showing the distribution of PCBs in sediment were constructed directly from the interpolated grids using ArcView and Spatial Analyst. The interpolated grid was color contoured into different ranges based on PCB concentration. The PCB bed maps for the Lower Fox River are shown on Plates 5-1 through 5-4 and the Green Bay bed map is shown on Plate 5-5. Areas were sediment is absent or outside the interpolation radius are not included in the color contouring.

PCB Volume and Mass Estimates

The interpolated grids provide a means of computing the PCB mass and contaminated sediment volume in the Lower Fox River and Green Bay. Each grid point represents a grid cell with an area 10 m (33 ft) by 10 m (33 ft) in the Fox River and an area 100 m (330 ft) by 100 m (330 ft) in Green Bay. The sediment volume at each grid cell in a layer is computed as the grid cell area multiplied by the layer thickness. The volume within a layer above some PCB concentration can be estimated by summing the number of grid points above the PCB concentration and multiplying by the area of a grid cell and the thickness of the layer. The grid points can also be counted within a river reach, deposit/SMU area, or Green Bay zone to determine the volume of contaminated sediment within an area of the river or bay. The estimated volume of sediments with PCBs is discussed for each reach or zone below.

Mass calculations are computed in a manner similar to the volume calculation. The PCB mass is computed by multiplying the sediment volume by the bulk density and the PCB concentration at a grid cell. Summing the mass over the grid cells within a reach, deposit/SMU or zone yields the mass of PCB within that area of the river or bay. The estimated mass of PCBs is discussed for each reach or zone below.

The PCB mass and impacted sediment volume estimates obtained from the data interpolations are listed in Tables 5-13, 5-14, and 5-15. Estimated results for the Lower Fox River are listed by concentration range in Table 5-13 and by sediment depth interval in Table 5-14. Results for Green Bay are included in Table 5-15. Due to rounding and significant figure issues, there is a slight difference in the total PCB mass calculated as calculated by concentrations range or by depth for both the river and the bay. The total PCB mass difference in the river is just over 37 kg (81 pounds) or just 0.13 percent of the total estimated mass for the entire river (Tables 5-13 and 5-14). Similarly, in Green Bay the calculated difference in the total PCB mass between the mass by concentration range or by depth is just 3 kg (7 pounds), which is 0.004 percent of the total bay mass. The difference in Green Bay is likely due to the smaller, more intricate grids areas used to interpolate the data over the river bed. These calculated differences are extremely small compared with the total mass in both the river and may and are not of concern in the final evaluation of PCBs in sediments. Due to the fact that the sediment volumes results do not have any digits beyond the decimal, rounding and significant figure issues did not influence these calculations.

5.4.2.2 Lower Fox River and Green Bay PCB Results

Based on the PCB concentration and sediment thickness interpolations, the large majority of PCB mass and impacted sediments are located within Green Bay. The results calculations are summarized below:

	Lower Fox River	Green Bay
PCB Mass in Sediments	28,602 kg (63,060 pounds)	69,954 kg (152,850 pounds)
Volume of Impacted Sediments	9,348,480 m^3 (12,227,350 yd^3)	622,300,000 m^3 (813,937,700 yd^3)

Virtually all of the PCB mass is located within the De Pere to Green Bay Reach of the Lower Fox River and zones 2 and 3 in Green Bay, as shown in Figure 5-3.

The calculated PCB mass for each river reach deposit/SMU group and bay zone are listed on Tables 5-13 through 5-15. These data are also summarized graphically by concentration range on Figures 5-4 through 5-7. The mass and volume plots for Green Bay (Figures 5-6 and 5-7) also include the total mass and volume results for the Lower Fox River for comparison, respectively. In addition, the PCB mass for particular sediment depth intervals has been plotted (Figure 5-8). The depth intervals for the Lower Fox River are 50 cm and extend to 350 cm deep. Two depth intervals, 0 to 30 and below 30 cm, are plotted for Green Bay (Figure 5-8).

As noted above, the volume of sediments containing PCBs rises substantially from the Lower Fox River out into the Green Bay zones. The ratio of the PCB mass in each cubic meter (g/m^3) of sediment in the Lower Fox River and Green Bay has been calculated using the interpolated results. The mass/volume ratios were obtained for each concentration range by dividing the PCB mass by the sediment volume listed for the reach or zone (Tables 5-13 and 5-15, respectively). These ratios were calculated to evaluate which areas of the river or bay contain the highest PCB mass on a volume basis (Tables 5-13 and 5-15). These results are also plotted to facilitate evaluation and comparison of the river reaches and bay zones (Figure 5-9). The greatest ratio of PCB mass per cubic meter of sediment (g/m^3) occurs within the Lower Fox River, and the De Pere to Green Bay Reach in particular, as shown on Figure 5-10.

The PCB mass/sediment volume ratio is important to the consideration of remedial alternatives since it is desirable to treat/remove the greatest contaminant mass per unit volume of sediment. PCB within Green Bay is generally contained within large volumes of sediment at relatively lower concentrations.

The entire Lower Fox River has a PCB mass to sediment volume ratio of 3.32 g/m3 in sediments with concentrations exceeding 50 μg/kg (0.05 ppm) (Table 5-13). Based on the calculated estimates presented on Table 5-13, sediments with less than 50 μg/kg total PCBs account for less than 0.024 percent of the total calculated PCB mass. Similarly, in Green Bay sediments with concentrations exceeding 50 μg/kg (0.05 ppm), the PCB mass to sediment ratio is 0.22 g/m^3 (220 milligrams per m^3) (Table 5-15). Based on the calculated PCB mass estimates, sediments with less than 50 μg/kg PCBs account for less than 2.6 percent of the total PCB mass (Table 5-15). Further, Green Bay sediments with PCB concentrations exceeding 1,000 μg/kg are limited to zones 2A, 2B, and 3A while sediments with PCB concentrations exceeding 5,000 μg/kg are limited to zones 2A and 2B (Table 5-15).

The PCB mass and contaminated sediment volume exceeding the 50 μg/kg (0.05 ppm), 1,000 μg/kg (1 ppm), and 10,000 μg/kg (10 ppm) concentrations are summarized below for each reach or zone. The discussions below focus on those mass and volume results for sediments containing over 50 μg/kg PCB, which is slightly above total PCB concentrations observed in Lake Winnebago. These concentration ranges have been selected, along with Figures 5-4 through 5-7, to facilitate comparison between reaches/zones at given concentrations.

The USFWS reviewed the statistical similarities between PCB congeners in sediments of the Lower Fox River, Inner Green Bay, Outer Green Bay and Lake Michigan as part of the PCB pathway determination (Stratus, 1999a). The Principal Component Analysis of PCB congeners indicated that samples from within each one of these four regions tended to group together. USFWS concluded that the congener patterns tended to be similar within each region and that they could be used to discriminate between regions of the system. Further, the Principal Component Analysis identified the overall degree of congener chlorination was the most important factor in explaining variability between samples and regions (Stratus, 1999a).

5.4.2.3 LLBdM Reach PCB Results

The LLBdM Reach of the Lower Fox River includes nine sediment deposits, A through H and POG (Figure 1-3). A total of 661 PCB samples have been collected along this reach in the previously identified investigations and PCBs were detected in 539 of these samples. These samples were collected from 293 coring locations and many of these represent discrete sample depth intervals within the same core.

Total PCB concentrations for this reach ranged from non-detectable to 222,722 μg/kg (Table 5-2). The average concentrations for deposits in this reach range from 180.00 to 24,373.31 μg/kg while the logarithmic mean ranges from 90.75 to 3,723.42 μg/kg. The mean results for the reach reflect the influence of deposits A and POG. These are the only two areas where the deposit averages exceed the average values for the entire reach (Table 5-2), which shows the influence of deposits where the sediments contain elevated PCB concentration and significant work has been completed.

The PCB sample frequency distribution results for LLBdM indicate that much of the investigation within this reach has focused on sediment deposits A and E, where approximately 325 and 150 total PCB samples results are available (Figure 5-1). Deposits D, C, and POG include 39 to 57 sample results in these deposits (Table 5-2). Only 2 to 12 total PCB sample results were obtained from each of deposits B, F, G, and H (Table 5-2). Only five samples were collected from Deposit B, but there is no physical barrier between deposits A and B. These two deposits are essentially one large, continuous sediment unit. Therefore, the estimated PCB mass and sediment volumes obtained for these two deposits are combined in discussions below.

Large areas and volumes of sediment have accumulated in LLBdM. All seven of the deposits located within the lake (A through F and POG) have a surface area ranging from 12.36 hectares (30.5 acres) to 202.5 hectares (500.4 acres) (Table 5-13). The interpolated total PCB results at select depth intervals are shown on Plate 5-1. Areas of greatest surface (0 to 10 cm) concentrations occur within portions of deposits A, C, E, and POG where total PCB exceeds 10,000 μg/kg. These elevated concentrations continue to be detected at the 10 to 30 cm depth interval in deposits C and E, in the 30 to 50 cm interval in Deposit A, and at sediment depths up to 150 cm at Deposit POG. Elevated concentrations were also estimated to be present in Deposit B from the interpolated data, due to close proximity of upstream Deposit A and the lack of any physical barrier separating these two deposits. In some areas, concentrations increase with depth, such as deposits A and B, where concentrations in the 30 to 50 cm interval are higher in some areas than the surface sediment results (Plate 5-1).

The area with the highest PCB concentrations is located just outside of Deposit POG, where the surface sediments exhibit concentrations exceeding 50,000 μg/kg. However, these concentrations decrease rapidly and only a small area of sediments with such levels is present in the 30 to 50 cm interval (Plate 5-1).

Deposits D, E and F represent a broad section of the LLBdM Reach downstream of deposits A, C, and POG. One area of Deposit E (mentioned above) and a small part of Deposit D have surface sediment concentrations exceeding 5,000 or 10,000 μg/kg. Below a depth of 30 cm, total PCB concentrations exceed 1,000

μg/kg only in isolated areas, indicating that sediment impacts in these areas do not typically extend to great depths. Where sediments have been sampled in the 50 to 100 cm interval, concentrations tend to be less than 50 μg/kg (Plate 5-1).

Beyond the downstream deposits E and F, the LLBdM Reach exhibits little sediment accumulation, except for two relatively small, isolated areas (deposits G and H). Total PCB concentrations in Deposit G ranged up to 250 μg/kg, while concentrations in Deposit H ranged as high as 5,000 μg/kg range (Plate 5-1). However, PCB concentrations in these two deposits declined quickly, as indicated by the results from the 30 to 50 cm interval (Plate 5-1), similar to the results obtained for deposits D, E, and F.

The summary of total PCB concentrations, including the maximum, minimum, RA Mean, and logarithmic mean results for the LLBdM Reach, are plotted on Figure 5-2. Most significantly impacted deposits are located in the vicinity of former sources and/or locations where significant volumes of sediment have accumulated, both within this reach of the river and in downstream reaches as well. The PCB distribution in deposits A, B, and C reflect the influence of the Neenah Slough, the Arrowhead Park Site, and the Kimberly Clark/Badger joint WWTP, all located on the south side of LLBdM, where significant historical releases of PCBs were reported to occur to the Lower Fox River. Elevated PCB sediment concentrations in Deposit POG reflect the impact of discharges from the Neenah-Menasha WWTP, located near the south end of Deposit POG. The Neenah-Menasha WWTP received process wastewater from Wisconsin Tissue Mills which contained PCBs (WDNR, 1999a). The RA Mean PCB values in the upstream end of LLBdM, in the vicinity of deposits A, C, and POG, exceed 9,000 μg/kg, as well as having a logarithmic mean above 1,000 μg/kg. Moving downstream past Deposit POG, the values decline to about 300 g/kg in the vicinity of deposits E through H.

The PCB mass and sediment volume estimates within the LLBdM Reach for the 50 μg/kg, 1,000 μg/kg, and 10,000 μg/kg concentrations ranges is summarized below.

LLBdM PCB Mass and Contaminated Sediment Volume Percentages

Sediment Concentration Range	PCB Mass	Percent of PCB Mass in River	Contaminated Sediment Volume	Percent of Contaminated Sediment Volume in River
>50 ug/kg	1,540 kg (3,395 pounds)	5.38%	1,353,340 m^3 (1.77 mill. yd^3)	15.42%
>1,000 ug/kg	1,427 kg (3,146 pounds)	4.99%	493,480 m^3 (654,448 yd^3)	5.26%
>10,000 ug/kg	859 kg (1,894 pounds)	3.00%	95,140 m^3 (124,438 yd^3)	1.01%

The calculated PCB mass/sediment volume ratios for each of the deposits are included on Table 5-13 but the ratios for sediment with more than 50 μg/kg are summarized below.

LLBdM PCB Mass/Sediment Volume Ratios for Sediments with more than 50 µg/kg

Deposit	PCB Mass (kg)	Sediment Volume (m^3)	PCB Mass to Volume Ratio (g/m^3)
Deposit A	237.4	107,730	2.20
Deposit B	410.9	41,740	9.84
Deposit C	38.9	59,230	0.66
Deposit POG	303.4	103,030	2.95
Deposit D	82.6	66,710	1.24
Deposit E	452.8	869,910	0.52
Deposit F	10.9	95,920	0.11
Deposit G	0.7	8,380	0.09
Deposit H	0.7	690	1.00
Reach Total	1,538.3	1,353,340	1.14

Ignoring Deposit B, the mass/volume ratios indicate that deposits A and POG are the only two locations where there are more than 2.2 g/m^3 of PCB in sediments with concentrations exceeding both 50 μg/kg and 1,000 μg/kg (Table 5-13). In sediments with concentrations exceeding 10,000 μg/kg, deposits A and POG both exceed 7.1 g/m^3 (Table 5-13). Combining the results for deposits A and B, there is approximately 648 kg (1,430 pounds) of PCB in about 149,500 m^3 (195,540 yd^3) of sediment. These combined results yield ratios of about 4.3 g/m^3 and 5.0 g/m^3 of PCB in sediments with concentrations exceeding 50 μg/kg and 1,000 μg/kg, respectively (Table 5-13). In sediments with more than 50,000 μg/kg PCB, the mass/volume ratio is about 21 g/m^3 (Figure 5-9).

Deposits F and G represent very low PCB mass and high sediment volume areas of this reach while deposits G and H contain less than 1 kg of PCBs (Table 5-13). Overall, the most significant deposits within this reach, in order of PCB mass in each cubic meter of sediment, are A/B, POG, E, and C.

The PCB mass distribution in each sediment layer is plotted on Figure 5-8. About 1,080 kg (2,380 pounds)of PCBs are present in the upper 50 cm (Figure 5-8); 315 kg in the 0 to 10 cm layer, 535 kg in the 10 to 30 cm layer, and 411 kg in the 30 to 50 cm layer (Table 5-14). Approximately 70 percent of the PCB mass in LLBdM is located in the upper 50 cm of sediment.

The PCB mass and sediment volume in inter-deposit areas was also estimated as part of the data interpolation efforts. Based on the interpolated results, the LLBdM Reach contains approximately 1,849 kg (4,075 pounds) of PCBs in about 1.68 million m^3 (2.2 million yd^3) (Table 5-13). Almost 310 kg (681 pounds) of PCBs are contained within about 180,000 m^3 (235,430 million yd^3) outside of the deposits (Table 5-13). If the four deposits identified above (A/B, POG, E, and C) are addressed, an estimated 400 kg (880 pounds), or about 30 percent, of PCBs would remain within the river sediments.

5.4.2.4 Appleton to Little Rapids Reach PCB Results

The Appleton to Little Rapids Reach of the river includes 22 sediment deposits, I through DD (Figure 1-4). PCBs have been detected in 188 sediment samples collected along this reach in the previously identified investigations (Table 5-2). These samples were collected from 131 coring locations and many of these represent discrete sample depth intervals within the same core. Total PCB concentrations for this reach ranged from non-detectable to 77,444 μg/kg (Table 5-2). The RA Mean for deposits in this reach ranged from 25 to about 25,720 μg/kg, while the logarithmic mean ranges up to almost 2,300 μg/kg (Table 5-2).

PCBs were detected in more than 10 samples from only seven deposits (N, P, Q, T, W, X, and DD) in this reach (Figure 5-1 and Table 5-2). Of the other 15 sediment deposits, three deposits (O, S, and V) had five or six samples with detected PCBs while the other 12 deposits had two or less samples with PCBs.

Sediment deposits N and O were remediated as part of the SRD project (Section 2.1.8). Sediments in Deposit N were dredged to within approximately 7.5 cm (3 in) of the bedrock substrate. As discussed previously, F&VD estimated that approximately 31 kg (68 pounds) of PCB remain in this area. Calculations conducted for this RI using the PCB distribution results (Plate 5-2) indicate that approximately 29 kg (64 pounds) of PCBs remain. Due to the completion of dredging activities at deposits N and O, these deposits will not be included in the discussion below. In addition, due to the relatively low number of samples collected from deposits S and V, and because the estimated PCB mass in both is 0.12 kg (0.26 pound) or less, further discussion of these two deposits will be limited. Therefore, only the nature and extent of PCB impacts detected within deposits P, Q, T, W, X, and DD are discussed in detail below.

Deposits S, W, X, CC, and DD are the only deposits in this reach that have surface areas greater than 10 hectares (24.7 acres) (Table 5-13). All five of these deposits are either located immediately upstream of a dam or in a location where the river width increases significantly and the corresponding stream flow velocities decrease. In general, the greatest mass of PCBs present within this reach is associated with those deposits where the greatest volume of sediment has accumulated.

This reach exhibits a significant decrease in PCB mass with depth (Figure 5-8). About 95 percent of the PCB mass in this reach is located in the upper 50 cm (20 in) of sediment; about 65 percent is contained in the upper 30 cm (12 in) (Figure 5-8 and Table 5-14). Total PCB concentrations in this reach at select depth intervals are shown on Plate 5-2. Accumulations of PCB are very localized in this reach. Areas of greatest surface (0 to 10 cm) concentrations occur within portions of deposits P, Q, T, W, X, and DD. The PCB distribution map (Plate 5-2) shows that deposits P, Q, T, V, W, and DD were the only other areas where surface concentrations exceed 1,000 μg/kg (1 ppm). However, none of the areas with elevated PCB concentrations are very large and the concentrations decrease rapidly with depth. Only small areas of deposits P, T, W, X, and DD have detectable PCB concentrations in sediments at the 30 to 50 cm interval (Plate 5-2). No samples were collected below 100 cm in this reach of the river.

PCBs seem to accumulate in only a few portions of this reach where the river is slowed by dams or natural features. Specifically, the total PCB RA Mean for deposits N, Q, and DD are elevated compared with the rest of this reach, suggesting that these are favorable locations for the deposition of PCB impacted sediments (Figure 5-2). Excluding Deposit N because the SRD project has been completed, the RA means are below 1,000 μg/kg between deposits I through O. The RA mean at Deposit Q is about 2 to 100 times greater than the value for any other deposits within this reach (Figure 5-2 and Table 5-2). Between deposits Q and BB, the mean values show a decreasing trend but the mean values begin a steady upward trend approaching Deposit DD, which continues into the Little Rapids to De Pere Reach (Figure 5-2).

The Appleton to Little Rapids Reach contains an approximate PCB mass of 94 kg (207 pounds) within about 240,940 m^3 (315,140 yd^3) of impacted sediment

(Table 5-13; Figures 5-4 and 5-5). Excluding deposits N and O mass/volume results due to completion of the SRD project, the approximate percentage of PCB mass and contaminated sediment for the 50 μg/kg, 1,000 μg/kg, and 10,000 μg/kg concentrations ranges is summarized below.

Appleton to Little Rapids PCB Mass and Contaminated Sediment Volume Percentages

Sediment Concentration Range	PCB Mass	Percent of PCB Mass in River	Contaminated Sediment Volume	Percent of Contaminated Sediment Volume in River
>50 ug/kg	62 kg (137 pounds)	0.22%	177,480 m^3 (232,135 yd^3)	2.03%
>1,000 ug/kg	47 kg (104 pounds)	0.16%	19,950 m^3 (26,100 yd^3)	0.21%
>10,000 ug/kg	9.4 kg (20.7 pounds)	0.03%	1,300 m^3 (1,700 yd^3)	0.01%

The calculated PCB mass/sediment volume ratios for each of the deposits are included on Table 5-13 but the ratios for sediment with more than 50 μg/kg are summarized below.

Appleton to Little Rapids PCB Mass/Sediment Volume Ratios for Sediments with more than 50 µg/kg

Deposit	PCB Mass (kg)	Sediment Volume (m^3)	PCB Mass to Volume Ratio (g/m^3)
Deposit I	0.2	3,570	0.05
Deposit J	0.1	1,630	0.05
Deposit K	0.1	480	0.19
Deposit L	0.1	570	0.19
Deposit M	0.2	1,650	0.09
Deposit N	29.6	4,880	6.07
Deposit O	2.0	2,430	0.82
Deposit P	5.3	12,800	0.42
Deposit Q	0.2	210	0.81
Deposit R	0.0	990	0.05
Deposit S	0.1	12,550	0.01
Deposit T	11.3	8,360	1.36
Deposit U	0.2	600	0.25
Deposit V	0.0	60	0.26
Deposit W	6.8	53,490	0.13
Deposit X	2.5	30,820	0.08
Deposit Y	0.3	1,330	0.21
Deposit Z	0.4	4,280	0.10
Deposit AA	0.0	390	0.06
Deposit BB	0.1	780	0.08
Deposit CC	0.7	14,300	0.05
Deposit DD	33.5	28,620	1.17
Reach Total	93.7	184,790	0.51

Deposits Q, T, and DD are the only areas that have more than 1 g/m^3 of PCB in sediments containing more than either 50 µg/kg or 1,000 µg/kg (Table 5-13). In addition to these three deposits, only deposits P, U, V, and W have sediments with PCB concentrations exceeding 1,000 µg/kg (Table 5-13). Deposit DD is the only location where PCB concentrations exceed 10,000 µg/kg and the mass/volume ratio exceeds 7 g/m^3 (Table 5-13). Sediments with more than 50,000 µg/kg PCB have a mass/volume ratio exceeding 16 g/m^3 (Figure 5-9). Deposit DD contains almost 55 percent of the PCB in the reach while Deposit T contains slightly less than 19 percent. Deposits W/X and P have about 13 percent and just over 5 percent of the PCB mass, respectively (Table 5-14).

In addition to the mass and sediment contained with the identified deposits, the PCB mass and sediment volume in inter-deposit areas was also estimated. Based on the interpolated data, the Appleton to Little Rapids Reach contains approximately 77 kg (170 pounds) of PCBs in about 251,600 m^3 (329,100 yd^3). Almost 15 kg (33 pounds), about 20 percent of the PCB, is contained within about 18,000 m^3 (23,540 yd^3) outside of the deposits (Table 5-13). This mass is minor compared to the almost 30,000 kg of PCB present within the river.

5.4.2.5 Little Rapids to De Pere Reach PCB Results

The Little Rapids to De Pere Reach includes four sediment deposits, EE through HH (Figure 1-5). PCBs were detected in 542 of 652 sediment samples collected within this reach. These samples were collected from 224 coring locations and many of these represent discrete sample depth intervals within the same core. Total PCB concentrations for this reach ranged from non-detectable to 54,000 μg/kg. The RA mean results range from 4,578 μg/kg to 11,078 μg/kg while the logarithmic mean ranges from 433 μg/kg to 2,544 μg/kg.

The De Pere dam slows water velocities in the river and creates a favorable environment for the accumulation of sediments. The effect is an increase in the area and thickness of impacted sediments near the dam (Plate 5-3), with sediments being deposited over a distance of approximately 8.5 km (5.3 mi) (Plate 5-3). More total PCB sediment results have been obtained from Deposit EE (Figure 5-1) than any other deposit or SMU group in the river, due to its large areal extent and location immediately upstream of the De Pere dam. About 140 total PCB results were also obtained within deposits GG and HH, which are contiguous with Deposit EE (Figure 1-5). Due to the nature of sediments in this reach, all the deposits are discussed as a single unit, which has an areal extent exceeding 266 hectares (658 acres) (Table 5-13).

Interpolated sediment concentrations in these deposits generally range from 500 to 5,000 μg/kg (Plate 5-3). Surface sediment (0 to 10 cm) concentrations in the southern end of Deposit EE are generally below 5,000 μg/kg, except at the southern tip of the deposit where concentrations exceed 10,000 μg/kg (Plate 5-3). Within the De Pere city limits, concentrations generally exceed 1,000 μg/kg but increase moving downstream towards deposits GG and HH and the De Pere dam. Surface sediments at a number of locations in the northern half of Deposit EE and large portions of deposits GG and HH exceed 10,000 μg/kg.

In the 10 to 30 cm interval PCB concentrations have decreased to less than 50 μg/kg over large portions of Deposit EE. South of the city of De Pere limits, one location at the tip of the deposit has PCB concentrations ranging up to 5,000 μg/kg (5 ppm) and three areas have concentrations ranging up to 1,000 μg/kg (1 ppm) (Plate 5-3). In deposits GG/HH and at the north end of Deposit EE sediment concentrations still exceed 10,000 μg/kg (10 ppm) (Plate 5-3).

PCBs were largely confined to sediments in the north end of Deposit EE and in deposits GG/HH below 30 cm (Plate 5-3). In the central potion of Deposit EE the PCB concentrations range from 250 to 500 μg/kg but increase moving toward the dam. Sediment concentrations in deposits GG/HH still exceed 5,000 μg/kg to 10,000 μg/kg in isolated locations (Plate 5-3). Between 30 and 50 cm, sediments with concentrations above 10,000 μg/kg are confined to Deposit GG and isolated locations in the downstream portion of Deposit EE. Although PCB concentrations decrease with depth, the levels still exceed 1,000 μg/kg (1 ppm) over a large portion of this reach to a depth of 100 cm (1 m or 3.28 ft). Below 100 cm (3.28 ft), only isolated locations in deposits EE/GG/HH have PCB concentrations which range up to 500 μg/kg while over most of the area the concentrations decrease rapidly to less than 50 μg/kg (Plate 5-3).

This reach contains an approximate PCB mass of 985 kg (2,170 pounds) is present in about 2.1 million m^3 (2.7 million yd^3) of impacted sediment (Table 5-13; Figures 5-4 and 5-5). The approximate percentage of PCB mass and contaminated sediment for the 50 μg/kg, 1,000 μg/kg, and 10,000 μg/kg concentrations ranges is summarized below.

Little Rapids to De Pere PCB Mass and Contaminated Sediment Volume Percentages

Sediment Concentration Range	PCB Mass	Percent of PCB Mass in River	Contaminated Sediment Volume	Percent of Contaminated Sediment Volume in River
>50 ug/kg	980 kg (2,160 pounds)	3.48%	1,709,000 m^3 (2,235,300 yd^3)	19.52%
>1,000 ug/kg	858 kg (1,892 pounds)	3.00%	326,180 m^3 (426,627 yd^3)	3.48%
>10,000 ug/kg	408 kg (900 pounds)	1.43%	48,920 m^3 (63,985 yd^3)	0.52%

The calculated PCB mass/sediment volume ratios for each of the deposits are included on Table 5-13 but the ratios for sediment with more than 50 μg/kg are summarized below.

Little Rapids to De Pere PCB Mass/Sediment Volume Ratios for Sediments with more than 50 μg/kg

Deposit	PCB Mass (kg)	Sediment Volume (m^3)	PCB Mass to Volume Ratio (g/m^3)
Deposit EE	828.4	1,660,390	0.50
Deposit FF	0.1	700	0.12
Deposit GG	81.0	18,320	4.42
Deposit HH	70.2	29,550	2.38
Reach Total	979.8	1,708,960	0.57

The mass/volume ratio ranges from about 0.6 g/m^3 to almost 8.4 g/m^3 PCBs for sediments containing more than 50 $\mu g/kg$ and 10,000 $\mu g/kg$ total PCBs, respectively (Table 5-13). Sediments with more than 10,000 $\mu g/kg$ PCB have a mass/volume ratio exceeding 8 g/m^3 (Figure 5-9).

Almost 1,000 kg (2,200 pounds) of PCBs are present in this reach. Similar to the other two upstream reaches, the majority of the PCB mass in this reach is located in the upper 50 cm of sediment (Figure 5-8 and Table 5-14). Approximately 760 kg (1,675 pounds) of PCBs are present in the upper 50 cm; 530 kg (1,170 pounds) are present in the upper 30 cm. The remaining mass (about 220 kg/490 pounds) is present between 50 and 100 cm (Figure 5-8 and Table 5-14).

The PCB mass and sediment volume in inter-deposit areas was also estimated based on the interpolated data. Approximately 265 kg (585 pounds) of PCBs in about 223,730 m^3 (292,630 yd^3) are present outside of the identified deposits. This is about 20 percent of the mass within this reach but less than one percent of the almost 30,000 kg of PCB present within the river.

5.4.2.6 De Pere to Green Bay Reach PCB Results

The De Pere to Green Bay Reach includes the 11 km (7 mi) stretch of the river downstream of the De Pere dam where the 16 SMU groups (and 96 SMUs) are located (Figure 1-6). Over 1,000 sediment samples were collected within this reach and PCBs were detected in about 940 (Table 5-2). These samples were collected from 243 coring locations including many discrete sample depth intervals within the same core.

Total PCB concentrations in this reach range up to 710,000 $\mu g/kg$. The RA Mean for the 16 SMU groups range from about 450 $\mu g/kg$ to about 47,650 $\mu g/kg$, while the logarithmic mean ranges from 243 $\mu g/kg$ to almost 8,200 $\mu g/kg$ (Table 5-2). The RA and logarithmic mean values for the entire reach are approximately 20,270 $\mu g/kg$ and 4,100 $\mu g/kg$, respectively (Table 5-2). Over 310 sample results exceed 10,000 $\mu g/kg$ (10 ppm) and over 730 sample results exceed 1,000 $\mu g/kg$ (1 ppm) (Table 5-2). Approximately 33 percent and 78 percent of all samples exceeded the 10,000 $\mu g/kg$ and 1,000 $\mu g/kg$ threshold levels, respectively.

The PCB distribution analysis was completed for each SMU group due to the large number of SMUs. Sampling efforts in this reach have tended to focus on the upstream portion of the reach (Figure 5-1). This reflects the limited amount of soft sediment encountered at the downstream end of the reach resulting from historical dredging activities and maintenance of the navigation channel. Overall, sediments containing more than 50$\mu g/kg$ PCBs cover over 523.5 hectares (1,294 acres). Over 300 samples have been collected from SMU group 56-61, where

SMU 56/57 is located. Over 150 sediment samples were also collected from SMU groups 20-25 and 44-49, the two SMU groups with the largest areal extent. Five SMU groups, including 20-25, 32-37, 56-61, 62-67, 68-73, have samples exceeding 50,000 μg/kg PCB (Figure 5-1 and Table 5-2). The first two groups are located immediately below and just downstream of the De Pere dam. The other three SMU groups are located at or just downstream of the Fort James turning basin, the location where the SMU 56/57 SRD project was completed. The majority of samples had total PCB concentrations ranging between 1,000 and 10,000 μg/kg (1 and 10 ppm) (Figure 5-1). According to previously completed modeling results, the sediment load decreases between the De Pere dam and the mouth of the river but the PCB load increases over this same stretch (Velleux and Endicott, 1994).

The RA and logarithmic means increase in the vicinity and just downstream of the Fort James turning basin (Figure 5-2), which is an identified historical PCB source (WDNR, 1999a). Starting at the De Pere dam, the RA Mean levels decline from just above 9,000 μg/kg to slightly over 3,700 μg/kg (Figure 5-2). However, at SMU group 56-61, the RA Mean increases to almost 47,650 μg/kg and generally decline downstream. Both the RA and logarithmic means exceed 1,000 μg/kg in 14 of the 16 SMU groups (Figure 5-2 and Table 5-2).

Total PCB results at select depth intervals are shown on Plate 5-4. Areas of greatest surface (0 to 10 cm) concentrations occur in portions of SMU groups 20-25, 26-31, 44-49, 74-79, and 110-115, where total PCBs range from 5,000 μg/kg to 50,000 μg/kg (Plate 5-4). The first two SMU groups are located at and just downstream of the De Pere dam. SMUs 44-49 are located in a wide portion of the river just upstream of the Fort James turning basin while SMUs 74-79 are located downstream of the turning basin and SMUs 110-115 are located at the mouth of the river (Plate 5-4). Similar localized areas occur along the reach where concentrations in the surface sediments are below 1,000 μg/kg (1 ppm). The PCB distribution plot also reflects the impact of historic dredging in the downstream portion of the reach. Sediment deposits in the lower third of this reach are sporadically located and generally less than 100 cm thick (Plate 5-4)

Total PCB concentrations increase significantly below 10 cm between the De Pere dam and SMUs 74-79. Between 10 and 150 cm, large areas of sediment have PCB concentrations ranging from 5,000 to 50,000 μg/kg (5 ppm to 50 ppm) and five areas are present where concentrations exceed 50,000 μg/kg. These five areas are located in SMU groups 20-25, 32-37, 56-61, 62-67, and 68-73 and extend as deep as 300 cm (Plate 5-4). SMUs 56-61 have the largest areas with the greatest depths where total PCBs exceed 50,000 μg/kg (Plate 5-4). In addition to SMUs 56-61, localized areas of SMUs 20-25 have total PCBs exceeding 50,000 μg/kg from 50 to 100 cm while similar areas in SMUs 32-37 and 68-73 are present from 100 to 150 cm. Total PCBs exceeding 50,000 μg/kg are present from 100 to 200 cm in SMUs 62-67.

The highest percentages of PCB mass and contaminated sediment are present in this reach (Table 5-13; Figures 5-4 and 5-5). The approximate percentage of PCB mass and contaminated sediment for the 50 μg/kg, 1,000 μg/kg, and 10,000 μg/kg concentrations ranges is summarized below. The estimated totals for the remaining PCB mass and contaminated sediment volume have been adjusted to reflect the 636 kg of PCB and 31,000m^3 of contaminated sediment removed during the SMU 56/57 SRD project.

De Pere to Green Bay PCB Mass and Contaminated Sediment Volume Percentages

Sediment Concentration Range	PCB Mass	Percent of PCB Mass in River	Contaminated Sediment Volume	Percent of Contaminated Sediment Volume in River
>50 ug/kg	25,984 kg (57,285 pounds)	90.86%	5,550,000 m^3 (7,260,000 yd^3)	59.16%
>1,000 ug/kg	25,719 kg (56,700 pounds)	89.93%	4,181,400 m^3 (5,469,100 yd^3)	44.58%
>10,000 ug/kg	20,000 kg (44,090 pounds)	69.93%	1,857,100 m^3 (2,429,000 yd^3)	19.80%

Based on the above, focusing on sediments with PCB concentrations exceeding 10,000 μg/kg would address slightly more than 70 percent of all PCBs in the river.

De Pere to Green Bay PCB Mass/Sediment Volume Ratios for Sediments with more than 50 µg/kg

SMU Group	PCB Mass (kg)	Sediment Volume (m^3)	PCB Mass to Volume Ratio (g/m^3)
SMUs 20-25	5557.3	1,054,580	5.27
SMUs 26-31	761.2	166,230	4.58
SMUs 32-37	1172.9	233,230	5.03
SMUs 38-43	1149.5	402,360	2.86
SMUs 44-49	5211.2	1,379,690	3.78
SMUs 50-55	1829.7	405,280	4.51
SMUs 56-61A	5174.7	457,490	11.31
SMUs 62-67	861.3	190,570	4.52
SMUs 68-73	1858.2	337,250	5.51
SMUs 74-79	430.2	141,950	3.03
SMUs 80-85	385.3	164,650	2.34
SMUs 86-91	253.1	103,400	2.45
SMUs 92-97	254.8	118,500	2.15
SMUs 98-103	94.3	82,200	1.15
SMUs 104-109	151.1	74,550	2.03
SMUs 110-115	839.0	206,250	4.07
Reach Total	25983.6	5,518,180	4.71

With the exception of SMU group 56-61, PCBs in this reach are spread fairly consistently throughout the sediments. SMU group 56-61 has the highest mass/volume ratio of any group in the reach, even after subtracting the PCB mass and sediment volume removed during the SRD project. The SMU 56-61 mass/volume ratios range from 11 g/m^3 to over 17 g/m^3 for sediments with more than 50 μg/kg and 10,000 μg/kg, respectively (Table 5-13).

Ignoring SMU 56-61, the mass/volume ratio for SMU groups from the De Pere dam to just downstream of the Fort James turning basin (SMUs 20-25 through SMUs 68-73) range from about 3 to 5 g/m^3 (Table 5-13) in sediments with PCB concentrations above 50 μg/kg. Downstream of the Fort James turning basin, from SMU group 74-79 to the mouth of the river, the mass/volume ratios range from 1.15 g/m^3 to 4.07 g/m^3. It is assumed that historic dredging of the navigation channel in this downstream portion of the river has affected the PCB concentrations and mass compared to the other portions of this reach. Sediments with more than 10,000 μg/kg have an overall mass/volume ratio exceeding 11 g/m^3 (Table 5-13 and Figure 5-9), while those with more than 50,000 μg/kg have a ratio exceeding 36 g/m^3 (Figure 5-9).

The mass/volume ratios are fairly consistent in sediments with more than 1,000 μg/kg or 10,000 μg/kg PCBs. Nine of the 16 SMU groups have mass/volume ratios exceeding 10 g/m^3 for sediments with concentrations exceeding 10,000 μg/kg (Table 5-13). In addition to SMU group 56-61, the other three SMU groups with the highest mass/volume ratios are SMUs 62-67, 20-25, and 26-31 (Table 5-13).

Seven SMU groups (20-25, 32-37, 38-43, 56-61, 62-67, 68-73, and 80-85), with either the highest PCB concentrations or greatest mass/volume ratios, contain about 16,160 kg (35,630 pounds) of PCBs in sediments with more than 50 μg/kg PCB (Table 5-13), or about 57 percent of PCBs within the river. Additionally, this mass is contained in approximately 2.84 million m^3 (3.71 million yd^3), or about 32 percent of the total impacted sediment volume in the river.

Just over 7,500 kg (16,535 pounds) of PCBs are present in the upper 50 cm (20 in.) of sediment while approximately 8,600 kg (18,960 pounds) of PCB are present from 50 to 100 cm (20 to 40 in) (Figure 5-8 and Table 5-14). Approximately 10,600 kg (23,370 pounds) of PCBs, or about 36 percent of the PCBs in the entire river, are buried below 100 cm (40 in.).

5.4.2.7 Green Bay Zone 2 PCB Results

Green Bay Zone 2 (zones 2A and 2B) extends from the mouth of the river to a line approximately 12.2 km (7.6 mi) north of the mouth (Figure 1-2). A total of 49 sediment samples were collected from 22 coring locations within this zone and PCBs were detected in 48 (Table 5-2).

Total PCB concentrations in this reach range from 15 to 17,000 μg/kg. The RA Mean for the zone was about 1,110 μg/kg while the logarithmic mean was approximately 622 μg/kg (Table 5-2). PCB concentrations in Green Bay sediments decrease compared with the river (Figure 5-2). Zone 2 is the only area of Green Bay where the RA Mean exceeds 1,000 μg/kg (Table 5-2 and Figure 5-2), compared to the reach averages, which ranged from about 4,590 μg/kg to 20,270 μg/kg.

The interpolated total PCB results are shown on Plate 5-5. The highest PCB concentrations in surface sediments (0 to 2 cm and 2 to 10 cm) are found in one large area within Zone 2B and two isolated locations within Zone 2A (Plate 5-5). Sediments with PCB concentrations exceeding 5,000 μg/kg (5 ppm) are located just beyond the mouth of the Lower Fox River in Zone 2A. Sediments containing more than 1,000 μg/kg (1 ppm) are located in both zones 2A and 2B. In Zone 2A, sediments with PCB concentrations exceeding 1,000 μg/kg (1 ppm) are located near the navigation channel (Plate 5-5). In Zone 2B, sediments with PCB concentrations exceeding 1,000 μg/kg (1 ppm) extend from just north of Kidney Island to a point just south of Point Au Sable (Plate 5-5), where discharge from the Lower Fox River is directed by bay currents.

The Zone 2B sediments with PCB concentrations exceeding 1,000 μg/kg extend from the surface to a depth greater than 30 cm (Plate 5-5). These sediments generally cover the same area throughout the sediment column. In addition to the stability of PCB concentrations in this sediment, the PCB concentrations actually increased to concentrations above 5,000 μg/kg (5 ppm) in two locations below 30 cm (Plate 5-5). These two areas are located along the west side of the navigation channel (just off of the end of Long Tail point) in Zone 2A and on the south side of the sediment area described above in Zone 2B.

Sediment containing PCBs cover approximately 11,080 hectares (27,380 acres) (Table 5-15). Approximately about 14,400 kg (45 percent) of the PCBs in this zone are present in the upper 30 cm of sediment while about 17,600 kg (or 55 percent) are located below 30 cm (Figure 5-8 and Table 5-15). The PCBs in Zone 2 represent about 46 percent of the total bay mass. Therefore, the upper 30 cm of sediment in this zone contain about 21 percent of the total bay mass which are contained in about 30 million m^3 (39 million yd^3), which is slightly less than 5 percent of the total bay sediment volume (Table 5-15). Additionally, about 6,600 kg (14,550 pounds) and 7,900 kg (17,400 pounds) of PCBs are present in the upper 30 cm of sediments in zones 2A and 2B, respectively (Table 5-15).

Just over 32,000 kg (70,550 pounds) of PCB and 39.58 million m^3 (51.77 million yd^3) of impacted sediment are present in this zone (Table 5-15; Figures 5-6 and 5-7). The approximate percentage of PCB mass and contaminated sediment for the 50 μg/kg, 1,000 μg/kg, and 5,000 μg/kg concentration ranges is summarized below.

Green Bay Zone 2 PCB Mass and Contaminated Sediment Volume Percentages

Sediment Concentration Range	PCB Mass	Percent of PCB Mass in Bay	Contaminated Sediment Volume	Percent of Contaminated Sediment Volume in Bay
>50 μg/kg	32,010 kg (70,570 pounds)	46.95%	39,491,600 m^3 (51,653,060 yd^3)	6.35%
>1,000 μg/kg	28,090 kg (61,930 pounds)	41.20%	17,767,600 m^3 (23,239,140 yd^3)	2.86%
>5,000 μg/kg	5,110 kg (11,265 pounds)	7.50%	1,265,000 m^3 (1,654,560 yd^3)	0.20%

Almost one-half of the PCB mass in the bay is contained within Zone 2. Additionally, this PCB mass is contained within slightly more than 6 percent of the estimated contaminated sediment volume in the bay. Sediments with PCB concentrations exceeding 1,000 μg/kg represent slightly more than 40 percent of all PCBs in the bay within a contaminated sediment volume of less than 3 percent of the estimated total (Table 5-15; Figures 5-6 and 5-7).

The PCB mass/volume ratio in sediments with PCB concentrations above 50 μg/kg is approximately 0.80 g/m^3 (800 milligrams/m^3) (Table 5-15 and Figure 5-9). The mass/volume ratios are 1.55 g/m^3 and 3.55 g/m^3 in sediments with PCB concentrations above 1,000 μg/kg and 5,000 μg/kg, respectively (Table 5-15 and Figure 5-9). The calculated PCB mass/volume ratios for Zone 2 are the highest in Green Bay.

5.4.2.8 Green Bay Zone 3 PCB Results

Green Bay Zone 3 (zones 3A and 3B) extends from the east-west line marking the northern boundary of Zone 2 to a line just below Chambers Island (Figure 1-2). This is a distance of approximately 74.5 km (46.3 mi). This is the most heavily sampled zone of Green Bay, with 180 samples collected from Zone 3A and almost 420 samples collected from Zone 3B (Table 5-2). These samples were collected from 14 cores and 40 cores, respectively, and many represent discrete sample depth intervals within the same core. Sediments containing PCBs cover approximately 155,230 hectares (383,580 acres).

Total PCB concentrations in this zone range from 2 to 1,320 μg/kg. The RA Mean for Zone 3A was about 300 μg/kg while the logarithmic mean was approximately 190 μg/kg (Table 5-2). The RA and logarithmic means for Zone 3B were about 440 μg/kg and 320 μg/kg, respectively (Table 5-2). The mean values for subzones 3A and 3B, as well as the PCB distribution plots shown on Plate 5-5, reflect the influence of Green Bay currents in the overall distribution of sediment and PCBs.

PCB concentrations in zones 3A and 3B decreased compared with Zone 2 (Figure 5-2). In Zone 2, the RA Mean exceeded 1,000 μg/kg. However, the RA and logarithmic means for zones 3A, 3B, and 4 are all below 500 μg/kg, and significantly lower than the river reach means (Table 5-2 and Figure 5-2).

Total PCB results at select depth intervals are shown on Plate 5-5. PCBs are located through most of Green Bay Zone 3B, but are generally confined to the eastern half of Zone 3A. As indicated in the sediment distribution maps in Section 3 and the interpolation summary (Section 5.4.1.1) sediment was not present along the western shore of Green Bay; therefore, PCBs are largely absent for a distance of 3 to 8 km (1.9 to 5 mi) from the shore in Zone 3A. PCB concentrations in the surface sediments (0 to 2 cm and 2 to 10 cm) range up to 1,000 μg/kg (1 ppm) in Zone 3A, with the highest concentrations located immediately adjacent to the boundary between zones 3A and 3B in the central portion of the bay (Plate 5-5). PCB concentrations ranging from 500 to 1,000 μg/kg cover an area in Zone 3A of approximately 63 km^2 (24 mi^2). Surface sediment results in Zone 3B are more extensive, as the area where PCB concentrations range up to 1,000 μg/kg (1 ppm) is larger compared to Zone 3A. Sediments with PCB concentrations ranging from 500 to 1,000 μg/kg extend almost from the boundary with Zone 2 to Egg Harbor, a distance of approximately 65 km (40 mi) in the very upper layer of sediment (Plate 5-5). Considering sediment to a depth of 10 cm, the length of this area has decreased but these sediments still cover approximately 280 km^2 (108 mi^2). This is over 4 times as large an area than that estimated for Zone 3A (Plate 5-5).

PCB concentrations decrease in sediments located 10 to 30 cm below the surface (Plate 5-5). PCB concentrations in Zone 3A range only up to 250 μg/kg. Sediments containing PCB concentrations ranging up to 500 μg/kg (0.5 ppm) in Zone 3B are located adjacent to the east shore of Green Bay. These sediments extend from a point near the boundary with Zone 2 to a location just north of Sugar Creek County Park (Plate 5-5), a distance of approximately 28 km (18 mi). In addition, sediments with similar PCB concentrations are also located near Sand Bay, just north of Little Sturgeon Bay. Overall, sediments with PCB concentrations ranging up to 500 μg/kg (0.5 ppm) in Zone 3B cover approximately 140 km^2 (54 mi^2) (Plate 5-5).

Below 30 cm, PCB concentrations range up to 250 μg/kg (0.25 ppm) in the central portion of Zone 3 (Plate 5-5). These sediment cover approximately 400 km^2 (160 mi^2) in both zones 3A and 3B (Plate 5-5) and have an estimated PCB mass of 5,730 kg (12,630 pounds) (Table 5-15).

Almost 36,000 kg (79,370 pounds) of PCB and 436.17 million m^3 (570.50 million yd^3) of impacted sediment are present in this zone (Table 5-15; Figures 5-6 and 5-7). The approximate percentage of PCB mass and contaminated sediment for the 50 μg/kg, 1,000 μg/kg, and 5,000 μg/kg concentration ranges is summarized below.

Green Bay Zone 3 PCB Mass and Contaminated Sediment Volume Percentages

Sediment Concentration Range	PCB Mass	Percent of PCB Mass in Bay	Contaminated Sediment Volume	Percent of Contaminated Sediment Volume in Bay
>50 μg/kg	35,240 kg (77,690 pounds)	51.69%	396,983,200 m^3 (519,234,400 yd^3)	63.79%
>1,000 μg/kg	1.65 kg (3.64 pounds)	0.0024%	8,800 m^3 (11,510 yd^3)	0.0014%
>5,000 μg/kg	None	----	None	----

The PCBs in this zone are spread over a very large area at low concentrations so that less than 0.003 percent of the total bay mass and sediment volume are present in areas where PCB concentrations exceed 1,000 μg/kg (Table 5-15). The PCB mass is split about evenly between zones 3A and 3B (Table 5-15 and Figure 5-8). Compared to Zone 2, where the PCB mass was about equal between the upper 30 cm and deeper sediments, the largest percentage of the PCB mass in this reach is located in the upper sediments (Figure 5-8). Slightly more than 30,000 kg (66,140 pounds or 83 percent) of the PCBs in this zone are located within the upper 30 cm of sediment (Figure 5-8). Just under 6,000 kg (13,230 pounds or 17 percent) of the PCB mass in this zone is located below 30 cm (Figure 5-8).

There are approximately 0.09 g/m^3 (90 milligrams/m^3) and 0.19 g/m^3 (190 milligrams/m^3) in sediments with PCB concentrations above 50 μg/kg and 1,000 μg/kg, respectively (Table 5-15). Compared to the Zone 2 and Lower Fox River PCB mass/sediment volume ratios, these values are extremely low (Figure 5-9). Due to the lack of sediments with PCB concentrations exceeding 5,000 μg/kg, no mass/volume ratio could be determined for this concentration range.

5.4.2.9 Green Bay Zone 4 PCB Results

Green Bay Zone 4 extends from Chambers Island to Big and Little Bays de Noc in Michigan's Upper Peninsula (UP) (Figure 1-2). Just over 200 sediment samples were collected from 31 coring locations in this zone and PCBs were detected in over 98 percent (Table 5-2). Sediments containing PCBs cover approximately 255,000 hectares (630,100 acres).

Total PCB concentrations in this reach range up to 751 μg/kg. The RA Mean for the zone is about 54 μg/kg while the logarithmic mean is approximately 39 μg/kg (Table 5-2). Green Bay Zone 4 sediment PCB concentrations are almost as low as the concentrations in Lake Winnebago, lower than the SMU groups, the other bay zones, and most of the river deposits (Table 5-2 and Figure 5-2).

Five sediment sample results from Lake Michigan are included in the FRDB. The Lake Michigan PCB concentrations range from 18.2 to 271.23 μg/kg. However, the Lake Michigan RA and logarithmic means of almost 123 μg/kg and 77.1 μg/kg, respectively, are higher than the mean values for Zone 4. These results suggest PCB concentrations in Green Bay Zone 4 are approximately background concentrations for Lake Michigan.

PCB concentrations in the upper 2 cm of sediment range as high as 500 μg/kg (0.5 ppm) just north of Chambers Island (Plate 5-5). In general, Zone 4 PCB concentrations decrease to less than 125 μg/kg (0.125 ppm) in sediments from 2 to 10 cm below the surface. The only exceptions to this are in the area where concentrations in the upper sediments ranged up to 500 μg/kg (north of Chambers Island) and one area near the boundary with Zone 3 along the west shore of the bay (Plate 5-5). Sediments with PCBs concentrations less than 50 μg/kg (0.05 ppm) are randomly located throughout Zone 4 (Plate 5-5). PCB concentrations do not exceed 50 μg/kg (0.05 ppm) below 10 cm, and no PCBs were collected from sediment below 30 cm in this reach (Plate 5-5).

Less than 1,960 kg (4,320 pounds) of PCB are present in about 146.55 million m^3 (191.68 million yd^3) of impacted sediment in this zone (Table 5-15; Figures 5-6 and 5-7). The approximate percentage of PCB mass and contaminated sediment for the 50 μg/kg, 1,000 μg/kg, and 5,000 μg/kg concentration ranges is summarized below.

Green Bay Zone 4 PCB Mass and Contaminated Sediment Volume Percentages

Sediment Concentration Range	PCB Mass	Percent of PCB Mass in Bay	Contaminated Sediment Volume	Percent of Contaminated Sediment Volume in Bay
>50 μg/kg	925 kg (2,040 pounds)	1.36%	28,922,000 m^3 (37,828,550 yd^3)	6.21%
>1,000 μg/kg	None	----	None	----
>5,000 μg/kg	None	----	None	---

Only 1.3 percent of the total PCB mass and slightly over 6 percent of the total sediment volume are located in Zone 4. In addition, the PCB mass/volume ratio determined for these sediments is only 0.03 g/m^3 (or 30 milligrams/m^3) (Table 5-15). This is more that two orders of magnitude lower than the calculated ratios for the other bay zones or river reaches (Figure 5-9). No sediments were detected in this zone with concentrations exceeding 500 μg/kg, as indicated on Plate 5-5.

All of the detected PCBs are contained in the upper 30 cm of sediment (Figure 5-8) and a large percentage are concentrated in the upper 10 cm (Table 5-15). Considering all PCBs and sediments, the estimated mass is approximately 1,960 kg (4,320 pounds). About 1,550 kg (80 percent) of this mass is located in the upper 10 cm, with only 420 kg (925 pounds) of PCB located between 10 and 30 cm (Table 5-15).

5.4.2.10 General PCB Homolog Distribution

Overview

ThermoRetec (2000) completed a literature review evaluating the natural PCB degradation/weathering processes that occur in sediments. The USFWS (Stratus, 1999a) also evaluated degradation/weathering of PCBs in sediments of the Lower Fox River and Green Bay. These studies indicate that PCB congeners that belong to the lower chlorinated homolog groups degrade/weather, in general, more quickly than do the PCB congeners which belong to the higher chlorinated homolog groups. To assess the overall PCB degradation/weathering from Aroclor 1242 in the Fox River and Green Bay system, the general percentage of each PCB homolog group within a given reach or zone was analyzed.

As discussed in Section 5.2.2, PCB congeners can be grouped by homolog, which corresponds to the number of chlorine atoms present in a particular PCB molecule. The typical homolog plot for Aroclors 1242, 1254, and 1260 are presented on Figure 5-11. The tables from the ATSDR (1997a) toxicological profile used to construct these plots are included in Appendix H.

Figure 5-11 shows that Aroclor 1242 is predominantly a mixture of di-, tri-, and tetrachlorinated PCBs, whereas Aroclor 1254 is predominantly a mixture of tetra-, penta-, and hexachlorinated PCBs. Aroclor 1260 is comprised of almost equal portions penta- through heptachlorinated PCB with small amounts of tri-, tetra-, octa-, and nonachlorinated PCBs (Figure 5-11).

A listing of the PCB congeners and the homolog group to which each belongs was obtained from the toxicological profile for PCBs (ATSDR, 1997a) and is included in Appendix H. In general, the higher chlorinated homologs are more resilient to aerobic degradation in the environment than do are the lower chlorinated homologs. The higher chlorinated homologs (those with more than 5 or 6 chlorine molecules) are generally recalcitrant to aerobic degradation but, under appropriate conditions can undergo anaerobic dechlorination, which results in the loss of chlorine atoms and the formation of lower chlorinated homologs (ThermoRetec, 2000).

PCB homolog plots were constructed from the PCB congener data included in the FRDB. Because these sediment homolog plots were completed only for each reach or zone, all detected results were used in calculating the relative percentage, regardless of depth or location. The relative percentage of each PCB homolog in a reach or zone has been calculated by the following method:

1) The average PCB congener results (for congeners 1 through 209) were summed for each reach/zone. This summed result was the 100 percent value.

2) The average PCB congener results for each homolog group were then summed and this result was divided by the reach/zone total (the 100 percent value) to obtain the relative percent of the homolog in that reach.

This method was used because of the large number of detected PCB congener results for each reach and zone. The PCB congener data used and the summed values obtained by this method are included in Appendix I. The Aroclor 1242 homolog distribution is plotted with the reach/zone specific PCB homolog results to facilitate evaluation.

The water sample homolog results were determined by the laboratory. However, these results were only determined for the De Pere to Green Bay Reach and Green Bay zones 2, 3, and 4.

Sediment Homolog Distribution

The PCB congener results all the reaches and zones have been divided into the appropriate PCB homolog groups and plotted (Figure 5-12). Compared to Aroclor 1242, the LLBdM PCB homolog distribution suggests that lower chlorinated congeners (di- and trichlorinated) have been lost (degraded/weathered) from the sediment (Figure 5-12). Given that Aroclor 1242 was the PCB mixture used in carbonless paper production, it is assumed that these lower chlorinated congeners were present when the material was released to the environment. The percentage of tetrachlorinated PCBs is approximately the same for both LLBdM sediments and Aroclor 1242 while the percentage of the penta- through nonachlorinated PCBs in the sediments is more than twice as great as that found in Aroclor 1242. The presence of the higher chlorinated PCBs (hepta- through nona-) in sediments likely reflects both aerobic degradation, differential solubilization, and/or volatilization of lower chlorinated PCBs. Additionally, these higher chlorinated compounds may also indicate the presence of Aroclors 1254, 1260, or 1268, all of which were detected in river sediments. Compared with the other reach/zone homolog results, the LLBdM plot suggests that little degradation/weathering of Aroclor 1242 congeners has occurred, as might be expected in the vicinity of PCB source areas. In addition, the RA Mean total PCB concentration in LLBdM is higher than in the other two reaches upstream of the De Pere dam (Figure 5-12).

Compared with Aroclor 1242, the PCB homolog distribution for the Appleton to Little Rapids Reach contains similar percentages of tri- and pentachlorinated congeners in sediments, while containing slightly less dichlorinated and slightly more tetrachlorinated PCBs (Figure 5-12). These four homolog groups account for over 99 percent of Aroclor 1242 and over 98 percent of the PCBs detected in sediments in this reach. The homolog plot for this reach suggests that some of the lower chlorinated PCBs (di-, tri-, and tetrachlorinated PCB) may have been transported downstream from the LLBdM Reach, as the percentage of these homologs is greater in this reach than in LLBdM. The total PCB RA Mean for this reach is about 4,600 μg/kg, down from a concentration of about 12,300 μg/kg in the LLBdM Reach (Figure 5-12). This is the lowest RA Mean for any of the river reaches and may reflect the physical factors (i.e., increased velocities and river gradients, etc.) which inhibit sediment accumulation compared to the other reaches.

In the Little Rapids to De Pere Reach more of the mid- to heavy-end PCBs (tetra- through nonachlorinated) have accumulated, especially compared with Appleton to Little Rapids Reach (Figure 5-12). In addition, the RA Mean is just over 5,200 μg/kg, which is slightly higher than the Appleton to Little Rapids Reach (Figure 5-12). This increase may reflect the physical environment that facilitates accumulation of river sediments behind the De Pere dam.

The PCBs detected in the sediments of the De Pere to Green Bay Reach have a similar homolog plot as Aroclor 1242 (Figure 5-12). The relative percent of di- through pentachlorinated homologs for Aroclor 1242 and sediments in this reach differ by 4 percent or less, possibly reflecting the known PCB discharge location within this reach. Additionally, the total PCB RA Mean value increases to about 20,270 μg/kg (Figure 5-12). This increase in the total PCB RA Mean likely further reflects the presence of a historical PCB discharge location.

Within Green Bay Zone 2, the tetra- through hexachlorinated PCB homologs comprise about 55 percent of the PCBs in sediment compared with 30 percent for Aroclor 1242 (Figure 5-12). Similar decreases in the percentage of the lower chlorinated PCBs is evident in both this zone and the other portions of the bay compared to the Lower Fox River results. This likely reflects the fact that the lower chlorinated PCBs are generally more susceptible to degradation/weathering processes than are the higher chlorinated compounds. Therefore, the relative percentage increase in the penta- through decachlorinated PCBs moving from zones 2 through 4 in the bay reflect the overall general stability of the higher chlorinated PCBs (Figure 5-12).

The homolog plots for Zone 3 do not reflect the PCB composition of Aroclor 1242 (Figure 5-12). As indicated above, the homolog plots for zones 3A and 3B show a slight increase in the relative percentage of the penta- through decachlorinated PCBs compared with Zone 2 (Figure 5-12). Conversely, the relative percentage of mono- through tetrachlorinated PCBs decreased compared to Zone 2 (Figure 5-12). This decrease in the lower chlorinated PCBs likely reflects the fact that Zone 3 is further removed from PCB sources than Zone 2 or any of the river reaches.

In Zone 4, the relative percentage of mono- through tetrachlorinated PCB homologs comprise just over 55 percent of the PCBs detected; however, these same homologs comprised about 92 percent of the PCBs in Aroclor 1242 (Figure 5-12). The homolog plot shows there has been a significant decrease of the lower chlorinated congeners relative to the higher chlorinated homologs, reflecting that Zone 4 is located a significant distance from the nearest PCB source (Figure 5-12).

5.4.3Dioxin/Furans

Twenty-four sediment samples were collected in various locations throughout the Lower Fox River for analysis of 2,3,7,8-TCDD (dioxin) and 2,3,7,8-TCDF (furan). The SLRA (RETEC, 1998c) indicated that furan concentrations above 2,000 ng/kg are a potential concern; there is no established level for dioxins. Six surface samples were collected at deposits D, E, and POG in LLBdM. Concentrations of dioxin ranged up to 5.44 ng/kg (ppt) in deposits D and POG while concentrations of furan ranged up to 71.29 ng/kg (ppt) in all three deposits (Table 5-3). One sample from Deposit POG was collected to evaluate the vertical extent of impacts. Both dioxin and furan were approximately one-half to one-third lower in the deeper sediment sample (Table 5-3). Comparison of the dioxin/furan results with total PCB results indicates there is no a strong correlation between concentrations of these compounds. Regression analysis results for these data indicate a possible correlation between dioxin and PCBs(“R” = 0.65 to 0.68) but a poor correlation between furan and PCBs (“R” = 0.31 to 0.35). Further analysis of such correlations is included in the RA.

In the Appleton to Little Rapids Reach, three samples were collected from Deposit N for analysis of dioxin and furan prior to the 1998/99 sediment remediation activities and no post-dredging samples were collected for dioxin/furan.

In the Little Rapids to De Pere Reach, three samples were collected; one each from surface sediments in deposits EE and HH and one at depth in Deposit EE. Dioxin concentrations ranged up to 6.82 ng/kg (ppt) and furan concentrations ranged up to 117.09 ng/kg (ppt) (Table 5-3). In Deposit EE the dioxin and furan concentrations in the surface sediment were 24 times and four times greater than the subsurface results, respectively. These limited data suggest that dioxin/furan concentrations decrease with depth. Correlation of PCB with dioxin/furan is not appropriate based on the small data set.

As part of the SMU 56/57 SRD project, 12 sediment samples were collected at a single location to evaluate the vertical extent of dioxin/furan compounds. Dioxin was only detected at the base of the core, 3.35 to 3.65 m (11 to 12 ft) below the sediment surface, at a concentration of 10 ng/kg. Furan was present throughout the core at concentrations ranging from 20 to 170 ng/kg. The highest concentrations were detected 1.8 to 2.1 m (6 to 7 ft) below the sediment surface (Table 5-3).

No sediment samples were analyzed for dioxin/furan compounds in Green Bay.

5.4.4 Pesticides

Sixteen pesticides were detected in Lower Fox River sediments (Table 5-4). Only two pesticides, DDT and dieldrin, were identified in the SLRA (RETEC, 1998c) as chemicals of potential concern. Aldrin is also included on Table 5-4 because dieldrin is a degradation by-product of aldrin. Both dieldrin and aldrin were only detected in one sediment sample in the river (Table 5-4). None of the analyzed pesticides were detected in Green Bay.

Pesticide analyses indicate low level detections occur sporadically along the Lower Fox River. No pesticide compound exhibits an apparent trend with respect to occurrence or concentrations. Some pesticides are found at depth within the sediment column, suggesting their occurrence reflects long-term use within the watershed. These data are discussed for each reach below.

5.4.4.1 LLBdM Reach Results

Seven pesticides were detected in 11 samples collected in this reach. Deposit C is the only location in the river (or bay) where dieldrin and aldrin were detected, at concentrations of 5.9 μg/kg and 60 μg/kg, respectively (Table 5-4). The detected dieldrin may be the result of aldrin degradation and the extent of both these compounds appears to be very limited. According to the SLRA, dieldrin concentrations exceeding 11,000 μg/kg are a potential concern (RETEC, 1998c).

DDT was detected in deposits D and POG and, according to the SLRA (RETEC, 1998c), concentrations above 1.6 μg/kg are a potential concern. DDT concentrations ranged between 5.5 and 50 μg/kg, with the highest concentration detected in Deposit POG (Table 5-4). DDT concentrations decrease with depth in Deposit D. Along with the other pesticide results described below, the limited data suggest that pesticide concentrations, in this reach and throughout the remaining parts of the river, decrease with depth. In addition to the DDT, the degradation by-products DDD and DDE were also detected. DDD was detected in deposits C, E, and POG at concentrations below 10 μg/kg while DDE was present in Deposit A at concentrations ranging up to 25 μg/kg.

Other pesticides detected in this reach of the river include endrin ketone and heptachlor. Concentrations for these two pesticides range up to 19 μg/kg and the compounds are sporadically and inconsistently located throughout the deposits.

5.4.4.2 Appleton to Little Rapids Reach Results

DDT and DDD were the only pesticides detected in Deposit X and the concentrations are all below 3.4 μg/kg. These results are from surface samples so that pesticide concentrations at depth cannot be evaluated. Dieldrin was not detected in this reach.

5.4.4.3 Little Rapids to De Pere Reach Results

A number of different pesticides were detected in this reach and except for the two composite samples from deposits EE/GG (EG), all samples were collected from Deposit EE (Table 5-4).

DDT, DDD, and DDE were detected in either three or four samples. DDT concentrations ranged from 5.1 to 20 μg/kg while DDE concentrations ranged up to 22 μg/kg. The maximum DDD concentration was 2.8 μg/kg. Endrin ketone was the most prevalent pesticide in this reach, being detected in 9 samples from Deposit EE with concentrations ranging up to 23 μg/kg. All other pesticides were detected sporadically in only a few samples. Endrin aldehyde, gamma-BHC and heptachlor were all detected in a single sediment sample at concentrations below 9.8 μg/kg.

All but two of the pesticide samples analyzed for this reach of the river were collected during the supplemental data collection activities. Only surface sediment results are available for most of the samples. However, the composite samples were collected at a single location and suggest that DDT concentrations decrease with depth. Dieldrin was not detected in this reach of the river.

5.4.4.4 De Pere to Green Bay Reach Results

During the 1998 WDNR supplemental sampling effort, four surface sediment samples were collected for pesticide analysis from SMUs 20, 45, and 115. These three SMUs are located at each end of this reach and approximately one-third of the way downstream from the De Pere dam. DDD, endrin aldehyde, and endrin ketone were detected in three or four samples while DDE was only detected in one (Table 5-4). The results for these four pesticides were less than 7.2 μg/kg.

DDT and gamma-BHC were detected during SMU 56/57 SRD project sampling. DDT concentrations range from 19 to 28 μg/kg in two samples, collected from near surface (10-30 cm) and deeper (274 to 305 cm) sediments. Gamma-BHC was detected in seven samples collected between 10 and 366 cm (0.32 and 12 ft) deep. These concentrations ranged from 1 to 17 μg/kg, with the highest concentrations detected between 213 and 244 cm (7 and 8 ft) below the sediment surface (Table 5-4). These results are similar to the furan results, where the highest furan concentration was also detected at depth. Dieldrin was not detected in this reach.

5.4.5Inorganic Compounds

5.4.5.1 Mercury

Background mercury levels in Lake Winnebago averaged 0.14 mg/kg. Almost 87 percent of samples in which mercury was detected in the river and bay exceeded this value. Mercury concentrations exceeding 0.15 mg/kg were identified as a potential concern in the SLRA (RETEC, 1998c). Results for the 336 samples analyzed for mercury are summarized below.

Summary of Mercury Results (mg/kg)

River Reach	Number of Samples	Minimum Concentration	Maximum Concentration	Average
LLBdM	95	0.14	6.1	1.18
Appleton to Little Rapids	6	0.34	4.3	2.14
Little Rapids to De Pere	140	0.01	9.82	2.34
De Pere to Green Bay	84	0.1	7.7	1.15
Entire River	325	0.01	9.82	1.95
Green Bay Zone 2	9	0.11	1.5	0.593
Green Bay Zone 3A	0	---	---	---
Green Bay Zone 3B	1	0.19	0.19	0.19
Green Bay Zone 4	1	0.11	0.11	0.11

Mercury use in paper production was discontinued in 1971 (WDNR, 1996), approximately the same time that PCB use ceased. Mercury is present throughout the Lower Fox River and it is speculated its occurrence extends to depths similar to PCBs. Because the sediment sampling where mercury was analyzed focused on specific deposits along the river, it is difficult assess whether differences between reaches are meaningful.

Samples were collected at over 60 locations in deposits D, E, POG, and EE/GG/HH to evaluate vertical distribution of mercury (Table 5-5). With some exceptions, surface sediment concentrations exceeded those observed in deeper samples, typically by a factor of two to five times or more. The results for Deposit POG indicate that in three of the six locations where samples were collected at depth, the deeper sediment results are up to 2 times higher than the surface sediment results.

In the Little Rapids to De Pere Reach, a number of samples were collected from the same location within deposits EE/GG/HH. Almost 90 of the 140 samples from this reach had concentrations exceeding 1 mg/kg, which significantly raised the average concentration for this reach. The mercury samples from 45 locations in these deposits showed that upper sediment concentrations range from 1.5 to over 10 times greater than the deeper sediment results at 43 of these locations. Two locations, one in deposit EE and HH, have a surface sediment concentration lower than the concentration found in sediments below. Additionally, three or more samples were collected at 25 of these locations. At seven of these locations, the mercury concentration of the middle sample was the lowest of all the results (Table 5-5).

Mercury was analyzed and detected in only 11 samples in Green Bay (Table 5-5). Although mercury is a compound of concern within the river, there are insufficient data points to conclude that mercury is of concern in the bay. Seven of the 11 sample results exceed 0.14 mg/kg and six of these samples are located in Zone 2. However, only one sample exceeds any of the average concentrations determined for the four river reaches. Based on the limited amount of data and the relatively low mercury concentrations in bay sediments compared to the Lower Fox River levels, detected mercury concentrations are not considered significant.

Mercury concentrations do not have as wide a concentration range as PCBs; therefore, specific point sources (either recent or historical) are not readily identifiable from the mercury distribution. Compared to Lake Winnebago, the elevated concentrations suggest mercury inputs have occurred along the Lower Fox River. Hoff, *et al.* (1994) estimated atmospheric inputs of mercury to the Lake Superior to be approximately 800 kg (1,760 pounds) annually. Although not directly applicable to Green Bay and the Lower Fox River, atmospheric sources of mercury likely contribute some portion of the total mercury concentrations detected throughout the river and bay.

5.4.5.2 Lead

Lead background levels in Lake Winnebago averaged 35 mg/kg. Almost 78 percent of the 192 samples in which lead was detected in the river and bay exceeded this value. Lead concentrations above 47 mg/kg are a potential concern according to the SLRA (RETEC, 1998c). Lead results are summarized below.

Summary of Lead Results (mg/kg)

River Reach	Number of Samples	Minimum Concentration	Maximum Concentration	Average
LLBdM	30	3.54	549	167.8
Appleton to Little Rapids	10	44	130	75.6
Little Rapids to De Pere	24	2.25	1,400	138.7
De Pere to Green Bay	107	4.44	350	85.0
Entire River	171	2.25	1,400	106.7
Green Bay Zone 2	11	2	42	19.7
Green Bay Zone 3A	2	1.1	1.9	1.5
Green Bay Zone 3B	4	9.6	50	29.9
Green Bay Zone 4	4	2.1	4.5	3.1

Sixty-four sediment samples (37 percent) were collected upstream of the De Pere dam (Table 5-5). A number of samples in these upstream reaches have very high concentrations, ranging up to 1,400 mg/kg. The average lead concentrations upstream of the De Pere dam are approximately 2 to 5 times greater than the Lake Winnebago average (35 mg/kg). The overall distribution of elevated lead levels in the Lower Fox River is sporadic. No specific point sources were identified that can be attributed to elevated lead occurrences. Results for the Appleton to Little Rapids and Little Rapids to De Pere reaches suggest that lead from LLBdM has been transported downstream and accumulated behind the De Pere dam.

Composite sediment sample results, collected to evaluate vertical distribution, indicated that the deeper sediments in Deposit POG have higher concentrations than surface sediments (Table 5-5). However, in Deposit EE the vertical distribution results indicated surface sediments had higher concentrations and deeper sediment levels were well below Lake Winnebago background concentrations.

The large majority of samples were collected in the De Pere to Green Bay Reach. Lead was detected in all 107 samples and concentrations ranged from 4.44 and 350 mg/kg (Table 5-5). The reach average is 85 mg/kg. All but 13 of the samples exceed the background level of 35 mg/kg, indicating that elevated lead values are widespread in this reach. All the samples were collected from surface sediments so the vertical distribution of lead in this reach is unknown. The results do not suggest any distribution pattern for lead within the surface sediments.

Lead concentrations range up to 50 mg/kg in Green Bay (Table 5-5). Lead was detected in all 21 samples collected in the bay and only four samples exceed the

Lake Winnebago background levels. None of the average lead concentrations exceed 35 mg/kg (Table 5-5), suggesting that lead within the bay sediments reflect background values.

Based on the ubiquitous nature of lead in the environment and the fact that lead has historically been used in numerous household and industrial products from paint to gasoline to dishes, it is difficult to fully assess definitive sources. Possible historical and current sources of lead include atmospheric deposition, urban runoff, agricultural practices, and unknown point source discharges.

5.4.5.3 Arsenic

Arsenic background levels in Lake Winnebago averaged 5.33 mg/kg. Almost 42 percent of the samples in which arsenic was detected in the river and bay exceeded this value. According to the SLRA, arsenic concentrations above 8.2 mg/kg are a potential concern (RETEC, 1998c). Arsenic results are summarized below.

Summary of Arsenic Results (mg/kg)

River Reach	Number of Samples	Minimum Concentration	Maximum Concentration	Average
LLBdM	30	0.23	6.80	2.91
Appleton to Little Rapids	10	0.17	9.70	3.23
Little Rapids to De Pere	23	0.90	7.60	4.08
De Pere to Green Bay	89	0.23	385.57 (13.35)	10.19 (5.92)
Entire River	152 (151)	2.25	385.57 (13.35)*	7.37 (4.86)*
Green Bay Zone 2	10	1	3.2	2.25
Green Bay Zone 3A	2	1.4	1.6	1.5
Green Bay Zone 3B	4	3.6	15	8.58
Green Bay Zone 4	4	1.4	8.9	4.98

*excludes highest detected value

Similar to lead, arsenic was detected in 63 sediment samples (37 percent) collected upstream of the De Pere dam (Table 5-5). The average arsenic concentrations for the three reaches upstream of the De Pere dam were below 5.33 mg/kg, the Lake Winnebago average. Since arsenic is naturally occurring, sediments exhibiting higher values are likely within a normal range of variability for background and WDNR (1996) reached similar conclusion.

Arsenic was detected in 89 samples in the De Pere to Green Bay Reach and 56 of these samples exceed 5.3 mg/kg (Table 5-5). Arsenic concentrations ranged up to 385.57 mg/kg. The sample with 3785.57 mg/kg arsenic was collected in SMU 38 and is the same sample which exhibited the highest concentrations of cadmium, nickel, selenium, and silver. Based on the number and relatively high concentrations for parameters detected in this SMU, the results suggest possible point source impacts in this area. The remaining arsenic concentrations range between 0.8 and 13.35 mg/kg, and discarding the highest result, the average for this reach would be 5.92 mg/kg, which is just slightly above the Lake Winnebago average (Table 5-5). Similarly, discarding the SMU 38 results would also yield a river-wide average of 4.86 mg/kg instead of 7.37 mg/kg, thus making the entire river average lower than the Lake Winnebago value.

The arsenic results for Green Bay Zone 2 are below the Lake Winnebago average. However, arsenic concentrations and averages for zones 3B and 4 are higher, exceeding the Lake Winnebago average within Zone 3B. Arsenic at these locations within the bay may not be related to the Lower Fox River. Rather, these concentrations may reflect the influence of the Menominee River AOC, where arsenic was the main chemical of concern.

5.4.6 Other Organic Compounds

According to the SLRA (RETEC, 1998c), none of the SVOCs (including the PAHs) were chemicals of potential concern within sediments. However, the presence of PAHs and PCP in river sediments is briefly summarized below.

5.4.6.1 LLBdM Reach SVOC Results

Numerous SVOCs have been detected in sediments from deposits A, C, D, E, and POG (Tables 5-10 and 5-11). In most samples, pyrene was the PAH with the highest concentration. However, in a few samples, the SVOCs BEHP and 4-methylphenol had the highest concentrations. Total PAH results ranged from 148 μg/kg to 44,260 μg/kg and 13 of the 22 samples exceed the WDNR reference value of 4,000 μg/kg. WDNR has previously used a value of 4,000 μg/kg total PAHs as an indicator of impacted sediments that could warrant further evaluation (WDNR, 1992). The lowest and highest total PAH results were detected in Deposit POG (Table 5-10), with all the samples from Deposit C exceeding 4,000 μg/kg.

Overall, comparison of the total PAHs with total PCBs indicates that there is no general trend. Only four samples from deposits A, D, E and three from POG have total PCB results that exceed total PAH results. In the other 15 samples, the total PCBs are less than the total PAHs (Table 5-10). Similarly, there is no trend when comparing SVOC results with total PCBs (Table 5-11).

PCP was detected in seven samples in this reach from deposits C, E, and POG; six surface samples and one subsurface sample. PCP concentrations ranged from 350 to 860 μg/kg (Table 5-11). In Deposit POG, PCP was detected in only one sample (a subsurface sample) collected from 122 to 183 cm (4 to 6 feet) below the sediment surface. This sample had a concentration of 719 μg/kg; however PCP was not detected in either of the samples collected immediately above or below this sample (from 0-60 cm and from 60-120 cm). These results reflect similar findings for other compounds in Deposit POG where concentrations increase with depth.

5.4.6.2 Appleton to Little Rapids Reach SVOC Results

Almost all of the PAHs and a number of SVOCs have been detected in samples from deposits P, W, and X. Similar to LLBdM, pyrene often exhibited the highest concentration. Total PAHs in this reach range from 2,820 μg/kg to 13,920 μg/kg. and were typically one order of magnitude higher than the total PCB concentrations in these deposits. Only the inter-deposit sample had a total PCB result exceeding the total PAH value (Table 5-10). Again, there is no correlation between total PAH results and total PCB values.

PCP was detected in two surface sediment samples at concentrations of 280 to 290 μg/kg. These were generally the lowest PCP concentrations observed in the river and only one other sample, from the De Pere to Green Bay Reach, had a lower PCP result (Table 5-11).

5.4.6.3 Little Rapids to De Pere Reach SVOC Results

SVOCs were detected in up to 21 samples from this reach and the majority of these samples were collected from Deposit EE (Tables 5-10 and 5-11). Similar to the other reaches, pyrene concentrations were generally highest (Table 5-10).

Total PAHs range from 240 to 13,364.6 μg/kg, while total PCBs range from 143 to 18,671 μg/kg. Thirteen (13) of the 21 sample results exceed the WDNR reference standard of 4,000 μg/kg. PAHs appear to be pervasive in this and upstream reaches of the river and are not necessarily associated with PCB occurrences. All but two of the samples (from Deposit EE) have total PAHs values that exceed total PCB results.

PCP was only detected in four surface sediment samples from deposits EE and HH at concentrations from 500 to 1,100 μg/kg. These samples were collected from the downstream half of Deposit EE (water column segments EE/25 and EE/26). The PCP concentrations detected in EE/26 were the highest concentrations detected throughout the Lower Fox River.

5.4.6.4 De Pere to Green Bay Reach SVOC Results

Downstream of the De Pere dam, SVOCs and PAHs were detected in 25 samples. Total PAH concentrations range from 640 to 13,000 μg/kg and 17 of the 25 sample results exceeded 4,000 μg/kg. Additionally, 21 of 25 total PAHs results exceed the total PCB concentrations. Similar to other upstream reaches, PAHs appear to be pervasive in this reach of the river and are not associated with PCB occurrences.

PCP was detected in six surface sediment samples and concentrations range from 20 to 710 μg/kg (Table 5-11). Four of these samples are just downstream of the De Pere dam. The sample results suggest that PCP distribution is limited and sporadic in occurrence.

5.4.6.5 Green Bay SVOC Results

PAHs and SVOCs were only detected in six samples from Green Bay Zone 2 (Table 5-10 and 5-11). Only four PAHs were detected in this zone and pyrene was again the compound with the highest concentrations. Total PAHs in Zone 2 ranged from 98 to 1,310 μg/kg. The only SVOC detected was 4-methylphenol. No SVOCs were detected in Green Bay zones 3 or 4.

5.4.7Other Inorganic Compounds

5.4.7.1 Cadmium/Chromium

Cadmium was detected in 147 sediment samples collected from the river and in 13 samples from the bay (Table 5-6). Similar to lead and arsenic, a disproportionate number of samples were collected downstream of the De Pere dam. Cadmium was detected in 89 samples from the De Pere to Green Bay Reach (Table 5-6). In the Lower Fox River, the reach averages range from 0.97 to 3.48 mg/kg, indicating that all the averages are near or exceed the WDNR Triad Assessment reference background level of 1 mg/kg. Concentrations generally decline moving downstream; however, this may be due to the limited number of samples collected upstream of the De Pere dam. In the De Pere to Green Bay Reach, cadmium ranged up to 10.8 mg/kg at SMU-38, which also exhibited the highest arsenic, cadmium, silver, nickel and selenium concentrations.

The results suggest that cadmium in sediments are slightly elevated in the upstream portions of the Lower Fox River. The highest concentration (12.5 mg/kg) was detected in Deposit A (Table 5-6). No specific point source has been identified. Cadmium has widespread uses, including metal refining and plating, paint pigments, and plastics.

The Green Bay zone averages range up to 0.5625 mg/kg in Zone 3B (Table 5-6) and suggest that cadmium concentrations in the bay are not significant.

Chromium was detected in 171 samples from the river and in 21 samples from the bay (Table 5-6). Similar to cadmium, lead, and arsenic, a disproportionate number of samples (107 samples) were collected in the De Pere to Green Bay Reach. The reach averages range from 47.9 to 73.3 mg/kg (Table 5-6). The results for LLBdM, Appleton to Little Rapids, and De Pere to Green Bay reaches are within a normal range of variability near background while the Little Rapids to De Pere Reach average slightly exceeds the Lake Winnebago background level of 65 mg/kg. No specific point source has been identified and chromium also has widespread uses, including metal refining, finishing, and plating.

Chromium concentrations in Green Bay range up to 40 mg/kg, which is below the Lake Winnebago average and equal to the NURE average (Table 5-6). Like cadmium, these results indicate that chromium concentrations within Green Bay are not significant.

5.4.7.2 Ammonia

Ammonia was detected in 97 river samples and 19 bay samples. As mentioned above, all but four of the samples (two from the river and two from the bay) exceed the Triad Assessment reference concentration of 31 mg/kg (Table 5-8). The maximum concentrations generally increase moving downstream towards the De Pere dam, ranging from 300 mg/kg in LLBdM to 700 mg/kg in the Little Rapids to De Pere Reach (Table 5-8). The maximum concentration in the De Pere to Green Bay Reach declined to 590 mg/kg. However, only four samples were collected in this reach. In Green Bay, the maximum concentration decreased even further to 140 mg/kg (Table 5-8). Due to the formation of ammonia resulting from natural degradation of organic material in sediments, it is difficult to determine if these concentrations result from point source discharges to the river or from natural processes.

5.5 Surface Water Sampling Results

5.5.1Overview

The total number of water samples collected during previous investigations and the chemical compounds detected are summarized on Table 5-16. In both the river and the bay, the greatest number of samples have been collected and analyzed for PCBs, followed by the inorganic parameters. In addition to the PCBs detected in the waters of the Lower Fox River, 34 other parameters, including a number of pesticides and one SVOC, were also were detected in water in either the dissolved or particulate phase (Table 5-16). PCBs were the only parameters detected in particulate samples in Green Bay. In addition to PCBs, seven inorganic compounds and TOC were detected in dissolved phase (Table 5-16). No pesticides or SVOCs were detected in the bay.

Other than PCBs and mercury, none of the other parameters have been analyzed in more than 50 samples. Due to the limited number of chemical parameters analyzed, the focus of this section is PCBs, mercury, and DDT (and its derivatives DDD and DDE), the only chemicals identified in SLRA which were detected in water samples (Tables 5-17 through 5-19).

Approximately 650 water samples have been collected and analyzed for PCB in either the dissolved or particulate phase, but many difficulties exist in evaluating the water sampling results. Although the water samples can be identified as originating within a certain reach of the river, the exact sampling location may have changed from one investigation to another. Therefore, due to the dynamic nature of the flow system, comparison of the results from one investigation to another relies on the assumption that samples collected within a specific reach are comparable to one another.

Water samples were obtained from a limited number of investigations during specific time periods. Data from 1989/90 were collected by WDNR or the EPA Great Lakes National Program Office (GLNPO) as part of the GBMBS. The 1992/93 data were collected by BBL during sediment investigations of Deposit A on behalf of P.H. Glatfelter and due to the limited amount of this data, it will not be included in the following analysis. Data from 1994/95 were collected as part of the Lake Michigan Mass Balance study completed by EPA and USGS. During 1998, BBL collected a number of Fox River and Green Bay samples on behalf of the FRG and in 1998/99, WDNR collected a number of water samples in conjunction with the Deposit N SRD project.

5.5.2 PCB Distribution

PCB data were collected between 1989 and 1998 and the results for the Lower Fox River and Green Bay are listed on Tables 5-17 and 5-18, respectively. WDNR has evaluated the 1989/90 GBMBS data in previous reports. The analysis presented below evaluates trends for which reliable sample collection location/date information is available subsequent to the 1989/90 sampling event and the results will be discussed and compared to WDNR findings. The 1994/95 data are plotted to evaluate trends in PCB concentrations over a one-year period and to calculate the PCB load from the Lower Fox River into Green Bay. Data collected throughout the Lower Fox River by BBL during 1998 is plotted to evaluate how the PCB load changes from one reach to another. Available temperature data are also plotted with these data to facilitate analysis.

5.5.2.1 Distribution in the Lower Fox River

General Overview of the PCBs in the River

The Lower Fox River PCB concentrations and general results are summarized below.

Summary of the Lower Fox River PCB Water Sampling Results

PCB Concentrations (ng/L)	Dissolved PCB	Particulate PCB	Total PCB
Maximum	32.03	110.36	141.97
Minimum	2.52	1.6	10.15
Average	14.64	39.97	54.6

Approximately, 70 to 75 percent of the detected PCBs are particulate phase while the remaining 25 to 30 percent are dissolved phase (Table 5-16). The results are similar to the GBMBS results (Velleux and Endicott, 1994; WDNR, 1995), such that seasonal variations and ratios of dissolved to solid phase PCB appears consistent over time.

Seasonal PCB Trends

The 1994/95 PCB concentrations (Table 5-17) collected in the De Pere to Green Bay Reach are plotted on Figure 5-13, along with river temperature readings. Figure 5-13 shows the general relationship between the particulate and dissolved phase PCB concentrations and indicate a direct correlation between water temperature and total PCB concentrations. When water temperatures fall below 4°C (40°F), the total PCB concentrations also decline significantly (Figure 5-13). Additionally, during the winter months of December 1994 through February 1995, when total PCB levels decline to about 10 percent of the average concentration (Table 5-17), the concentration of particulate PCB falls below the concentration for the dissolved fraction (Figure 5-13).

WDNR (1995) concluded that this seasonal variation is related to the amount of algae present in the water, which appear to facilitate suspension of PCB in the water column. If water temperature were the only factor in the amount of total PCB suspended in the water column, the winter decline in PCB concentrations would be expected to be more gradual than observed (Figure 5-13). However, since algae populations are also dependent on water temperature and a number of other variables (such as sunlight, which is inhibited in winter by ice cover and overall shorter days), their presence would be expected to increase or decrease rapidly with changes in critical river conditions.

In addition to the decrease in particulate concentrations, significant increases in PCB concentrations are also evident (Figure 5-13). During 1994, total PCB concentrations increase by 2 to 4 times over concentrations observed in the first samples collected as part of this data set (Table 5-17 and Figure 5-13). Based on the historical increase in river discharge observed during this time of year, particulate concentrations are augmented by the large TSS load that would be expected to accompany the increased river discharge and velocities. USGS (1998f) data show that discharge increased from about 62.8 m^3/s (2,220 cfs) on July 1, 1994 to over 272 m^3/s (9,610 cfs) on July 17, 1994. This increased stream discharge correlates with the observed total and particulate PCB concentrations (Figure 5-13).

Downstream PCB Trends

PCB data for each river reach was collected by BBL during 1998 (Table 5-17) and are plotted on Figure 5-14. Total PCB concentrations in the LLBdM Reach are consistently the lowest in the river and the concentrations generally increased downstream from LLBdM to the De Pere to Green Bay Reach. After fluctuating in the spring of March 1998, PCB concentrations in the De Pere to Green Bay Reach begin a steady increase through the August before almost doubling to about 85 ng/L (Figure 5-14). Concentration trends in the other upstream reaches also increase to their maximum in August 1998 (Figure 5-14). However, by September 1998, PCB concentration trends decrease to levels near the reach averages (Figure 5-14), reflecting the seasonal component to PCB transport suggested by WDNR (1995).

PCB Homolog Distribution

Similar to the PCB sediment results, a homolog plot was constructed using data from the De Pere to Green Bay Reach and the Green Bay zones to evaluate the general fate of PCBs moving through the water column and from the river into the bay (Figure 5-15). Data for the LLBdM, Appleton to Little Rapids, and Little Rapids to De Pere river reaches were not in the same format as the data from De Pere to Green Bay and the Green Bay zones. Therefore, the upstream reaches of the river are not included in this analysis.

The PCB homolog data have been plotted for both the dissolved and particulate phase. The dissolved PCB results for the De Pere to Green Bay Reach are data which most closely resemble the plot for Aroclor 1242 (Figure 5-15). This data set exhibits less mono- and dichlorinated PCBs and more tetra- through octachlorinated PCBs than Aroclor 1242. In addition, the percentage of mono- through trichlorinated PCBs is greater in the dissolved samples than in the particulate results (Figure 5-15). Conversely, the percentage of tetra- though nonachlorinated PCBs is greater in particulate samples than in the dissolved samples. These results reflect the overall solubility each homolog group. The mono- trough trichlorinated PCBs are more soluble than are the mid- to higher chlorinated congeners. Additionally, the percentage of mid- and higher chlorinated PCBs increases moving from the river into the bay. This is indicated by the increasing percentage of hexa- through octachlorinated PCBs in each reach/zone moving further out into the bay.

Similar to the homolog results in sediments, the greatest percentage of any homolog groups are the tri- and tetrachlorinated PCBs, which typically comprise 50 percent or more of the detected PCBs (Figure 5-15). PCBs within these two homolog groups (the tri- and tetrachlorinated PCBs) are soluble enough to migrate within the system yet they degrade slow enough so that they comprise a significant portion of the total PCBs detected in the river and the bay.

5.5.2.2 PCB Distribution in Green Bay

PCB results for Green Bay are available from 1989/90 and 1998 (Table 5-18), and other authors previously summarized the 1989/90 data. While the 1989/90 samples were analyzed for PCBs in both a dissolved (filtrate) and particulate phase, the 1998 samples were apparently only analyzed for particulate phase PCBs (Table 5-18).

The 1989/90 and 1998 Green Bay results indicate similar trends. In 1989/90 total PCB concentrations in Zone 2 (zones 2A and 2B) were about 18.5 ng/L. PCB concentrations decreased with distance from the Lower Fox River mouth, from 4.48 ng/L and 3.56 ng/L in zones 3A and 3B, respectively, to 0.99 ng/L in Zone 4 (Table 5-18), suggesting the Fox River as the source.

Similar trends were observed for the 1998 particulate data. The average PCB concentration in Zone 2 (zones 2A and 2B) was about 6.2 ng/L but this value declined to about 1 ng/L in zones 3A and 3B and no PCBs were detected in Zone 4 (Table 5-18). The Green Bay PCB results also indicate that particulate phase PCBs account for approximately 74 percent of the PCBs detected in Zone 2. This is similar to the percentages observed in the Lower Fox River. However, the particulate phase PCB percentage decreases moving away from the mouth of the river and for zones 3A, 3B, and 4 are about 64 percent, 59 percent, and 42 percent, respectively.

5.5.2.3 PCB Distribution in Lake Michigan

The estimated PCB mass transported from Green Bay into Lake Michigan was derived in the early 1990s from modeling activities using water sample data from both the bay and the lake. Raghunathan (1994) concluded that approximately 122 kg (270 pounds) of PCB are transported annually through the water column from Green Bay to Lake Michigan.

5.5.3 Mercury Distribution

In the Lower Fox River, particulate phase mercury was detected in 32 samples from the De Pere to Green Bay Reach while dissolved mercury was detected in 46 samples between Appleton and the river mouth. Mercury was only detected in two samples in Green Bay Zone 2 and the concentrations ranged from 1.15 to 2.33 ng/L (Table 5-16).

The 1994/95 total, dissolved, and particulate phase mercury concentrations in water samples (Table 5-19) are plotted along with PCBs on Figure 5-13. Similar to the total PCB results, the particulate concentrations are usually significantly higher than the dissolved phase levels (about 80 to 90 percent of the total mercury result on Table 5-17). The total mercury concentrations also exhibit the same trends observed for PCBs. Concentrations decrease significantly during the winter months, when water temperatures decline, and increase during the spring/summer, with increased stream flow as well as possible increased biological activity. Seasonal variations in the chemical phase exist for both organic and inorganic compounds and may imply that biological activity related to algal growth cycles facilitate the transport of chemical parameters in the Lower Fox River, as well as TSS transport. Dissolved mercury, however, remained relatively constant over the monitoring period, indicating that only very low levels of mercury are transformed into a dissolved state.

5.5.4 Pesticide Distribution

DDT, DDD, and DDE were in analyzed in a number of samples from the Lower Fox River and Green Bay. DDT was only detected in seven samples while DDD and DDE were each detected in 38 and 43 samples, respectively. The Lower Fox River sampling results for these pesticides are listed on Table 5-19 and summarized below.

Summary of the Lower Fox River Pesticide Sampling Results

Detected Concentration Ranges (ng/L)	DDT	DDD	DDE
Dissolved	Not Detected	0.05 to 0.07	0.03 to 0.07
Particulate	0.05 to 0.21	0.05 to 0.27	0.03 to 0.41

None of these parameters were detected in samples collected in Green Bay.

5.6 Chemical Loading to Green Bay

5.6.1PCB Loading to Green Bay

Much of the data provided in Table 5-17 has been generated in association with two mass balance studies, the Green Bay Mass Balance Study (GBMBS) and Lake Michigan Mass Balance (LMMB). These studies have quantified the movement of PCBs within the Lower Fox River as well as Green Bay.

The Green Bay Mass Balance Study (GBMBS) was designed to identify the sources, transport pathways, and fate of PCBs within the Lower Fox River and Green Bay. The Lower Fox River portion of the GBMBS consisted of two components which separately evaluated the fate and transport of PCBs in the upper 32 river miles from Lake Winnebago to the DePere dam (WDNR, 1995) and the lower 7 river miles from the DePere dam to Green Bay (Velleux and Endicott 1994, Velleux, *et. al* 1995). PCB concentrations in the water entering the Lower Fox River from Lake Winnebago were negligible with measured concentrations often similar concentrations found in field equipment blank samples. This is confirmed by the minimal amount of transport, 4 kg, estimated at the railroad bridge in the southern portion of Little Lake Butte des Morts. Consistent with the previous observation that PCB concentration generally increases with distance downstream (Figure 3-17), PCB transport also increases downstream with an estimated 143 kg transported over the DePere dam. In the parallel effort downstream of the DePere dam it was estimated that 280 kg of PCB were transported into Green Bay during the same period, May 1989-April 1990. PCB transport fluxes throughout the river and bay are summarized in Table 5-20 and Figure 5-16 (WDNR 1995 and http://www.epa.gov/med/images/gb_massbal.gif).

Following the GBMBS, USEPA GLNPO undertook a similar effort for all of Lake Michigan. The Lake Michigan Mass Balance included quantifying PCB loadings from 11 tributaries around Lake Michigan, including the Lower Fox River, during 1994 and 1995. The LMMB estimated that the Lower Fox River contributed 186 kg of PCB to Lake Michigan (the LMMB considered Green Bay part of Lake Michigan), accounting for more that 60 percent of the total tributary PCB loading (EPA, 2000)

5.6.2Mercury and DDT Loading to Green Bay

Similar to the estimated PCB load into the bay, the annual loads for mercury and DDT were calculated using the 1994/95 water sampling results and the average stream flow discharge. The mercury load may range between approximately 10 and 300 kg (22 to 661 pounds) annually, with an average of about 100 kg (220 pounds). The mercury load may, at times, be as great as the PCB load. Conversely, the estimated DDT load ranges from 0.23 to 0.81 kg (0.51 to 1.8 pounds) annually, much lower than the estimated loads for either PCBs or mercury (Table 5-18). No recent data were available to include in the analysis of mercury and DDT in Green Bay.

5.7 Summary of PCBs in Biota

PCBs have been analyzed in a number of different fish and bird species, as well as fur-bearing mammals and insects/invertebrates. PCB concentrations in these creatures have been evaluated as part of the Human Health and Ecological Risk Assessments.

The number and type of biological samples collected in the Lower Fox River or Green Bay and analyzed for PCBs are listed on Tables 5-21 and 5-22, respectively. The first samples included in the FRDB were collected in 1971 in Green Bay (Table 5-22). Continuous sample collection from Green Bay and the Lower Fox River began in 1975 and 1976, respectively. The total PCB analytical results for all the animal groups listed on Tables 5-21 and 5-22 are used in the evaluation of human health and ecological risks in the RA.

In the Lower Fox River 1,405 fish samples, 154 bird samples, and one fur-bearing mammal sample have been analyzed for total PCBs (Table 5-21). In Green Bay 1,490 fish samples, 227 bird samples, and two mammal samples (one fur-bearing mammal and one deer) have been analyzed for total PCBs (Table 5-22). In addition, a small number of insect/invertebrate samples have been analyzed in both the Lower Fox River and Green Bay (Tables 5-21 and 5-22). These data are discussed in more detail in the RA.

5.8 Time Trends of Contaminants in Sediment and Fish

A time trends analysis was conducted on sediments and fish tissue within the Lower Fox River and Zone 2 of Green Bay in order to assess whether statistically significant changes in PCB concentrations were occurring. For the purposes of the BLRA, it was important to understand if apparent or implied decreases in PCB concentrations in sediments and fish tissue were real, and if so, determine if the rate of change could be estimated. A brief description of the methods and results is given below. The detailed analysis may be found as Appendix B.

5.8.1Sediment Methods

For sediments, the overall approach was to first review the data for usability, then explore relevant groupings of the data both horizontally and vertically to conduct regression-type analyses for increases or decreases in PCB concentrations over time. All data used in these analyses were from the Fox River Database.

Exploratory analysis demonstrated that PCB concentrations varied across locations in the river. To adequately conduct the analysis of time trends, it was necessary to undertake a separate evaluation of the spatial layout; a horizontal evaluation within the river bed and a vertical evaluation with each depth stratum. The deposit designations used in the RI/FS (e.g., A, POG, EE, or SMU 26) were found to be unsuited to defining spatially-cohesive subsets, as many samples had no deposit designation and some deposit designations spanned stretches of a river reach too long to allow adequate assessment and control of spatial structure. Based upon analysis of the spatial layout, 23 distinct geographic "deposit groups" were determined, forming data subsets with spatial structures far more amenable to statistical analysis. These were given designations that reflected the general deposit designations, with the added benefit that these groups designated non-overlapping spatial sets. The statistical groups analyzed are shown on Figures 5-17 through 5-19.

Depth strata within each deposit group were consistent with the depth used thoughout the RI: 0 to 10 cm, 10 to 30 cm, 30 to 50 cm, 50 to 100 cm and 100+ cm. Sample groups defined by a specific deposit and depth stratum were analyzed separately for the time trends. Depth strata within some deposits were excluded due to either inadequate sample size or lack of time variation. After averaging samples from a common sediment core within a particular stratum, 1,618 observations in 46 combinations of deposit and depth were included in the sediment time trends analysis. PCBs were analyzed as the logarithm of PCB concentration (in μg/kg) due to the approximately log normal distribution of these values.

Spatial correlation among observations was determined using semivariograms, a common technique in geostatistics. In order to avoid overstating statistical significance of time trends in the presence of spatially-correlated observations, the Window Subsampling Empirical Variance (WSEV) (Heagerty and Lumley, 2000) estimation method was used. WSEV is analogous to averaging observations within cells of a grid, where the grid size is specified such that sample subsets falling into different cells of the grid are approximately independent of each other. The WSEV method yields a proper estimate of variance that can be used to calculate statistical significance.

The WSEV method for handling spatial dependence was used in conjunction with a standard method for estimating time trends; regression analysis. Regression models for log PCB concentration versus time, depth, and linear and quadratic spatial coordinates were fitted using the method of maximum likelihood, which readily incorporates the observations below detection limit without imputation of a value such as half the detection limit. Throughout the analysis, significance levels of $p < 0.05$ from regression analysis or from any other analysis were designated as "statistically significant."

5.8.2 Fish Methods

Like sediments, the approach for examining time trends in fish tissue PCB concentrations was to first review the data, then explore relevant groupings of the data on which to conduct regression-type analyses. In addition to the four reaches of the Lower Fox River, fish time trends were examined in Green Bay Zone 2. This was undertaken to determine whether PCB exposure in Zone 1 and Zone 2 were identical (i.e., represent a single exposure unit), or if there were distinct trends in these two zones for the target fish species. Fish tissue data from those two zones were explored first to ascertain whether they represented a single or separate exposure units (i.e., have different for PCBs). This was conducted to determine whether the data should be combined for a single analysis, or to conduct separate time trends analyses for the two zones.

All data used in these analyses were from the Fox River Database. A total of 1,677 fish samples were available for analysis, divided into three main sample types: fillet without skin, fillet with skin, and whole body. Inadequate sample size presented the greatest obstacle to analysis. There were several cases where there were substantial data, but there was inadequate spread in the years between collections. It should be noted that within the Little Rapids to De Pere Reach, there with no fish groups with both sufficient sample size and time spread. There were over a hundred combinations of reach, species, and sample type with at least one observation, but only 19 of these had sufficient numbers of samples and a sufficient time spread for analysis of time trends. Carp and walleye provided the largest number of observations of any species. These 19 combinations represent 867 samples-over half of all samples of whole body, fillet with skin, and fillet without skin. In addition to the 19 combinations, there were four analyses which could statistically combine samples from the fillet and whole body categories (within a single reach and single species) to come up with a single time trend estimate.

Data on PCBs in fish were analyzed as the logarithm of PCB concentration in micrograms per kilogram. The percent lipid content of samples was significantly associated with PCB concentration in most species and sample types, and was thus used as a normalization term in all analyses.[1]

[1] Note that fish concentrations of PCBs were not normalized by dividing by lipid content of samples. Thus, the concentrations are expressed as log micrograms of PCBs per kilogram of tissue rather than per kilogram of lipid.

Regression models for PCB concentrations versus time were fitted using the logarithm of percent lipid content and time as independent variables. A linear spline function was included in some time trends analyses to accommodate different rates of change in PCB concentrations during earlier versus later periods. The maximum likelihood method was used to accommodate observations below detection limit. A test for changing trends was also carried out.

The difference in fish PCB concentrations between Green Bay Zone 1 (De Pere to Green Bay Reach) and Green Bay Zone 2 was analyzed using both cross-sectional data (five analyses) and time trends data (three analyses), again controlling for percent lipid content of samples in regression models. All regression models for the fish analysis were fitted using the maximum likelihood method to accommodate the small fraction of observations below the detection limit.

5.8.3 Results

Results of the sediment time trends are presented in Table 5-23, and are represented graphically on Figures 5-17 through 5-19. Seventy percent of all calculated slopes (32 out of 46) were negative. However, only 13 out of the 46 slopes were statistically significant, such that a hypothesis of no change in PCB concentration over time could be rejected. Of those, 10 were negative,[2] and within that subset eight were in the 0- to 10-cm segment.

Conducting a meta-analysis on the surface sediment data showed a negative trend in all reaches except Appleton to Little Rapids (Table 5-24). A meta-analysis of time trends in surface sediments yielded an average rate of decrease in PCB concentration per year of -18 percent in Little Lake Butte des Morts, +0.6 percent in the Appleton to Little Rapids Reach, -10 percent in the Little Rapids to De Pere Reach, and -15 percent in the De Pere to Green Bay Reach. These trends were statistically significant except for the Appleton Reach.

While those data suggest an overall decline in PCBs in the Lower Fox River, a more careful analysis of the subsurface data suggest that these declines are restricted to the upper 4 inches (0 to 10 cm). While 32 out of the 46 analyses were negative, there is a strong trend toward fewer and weaker negative slopes at increasing depth. Table 5-23 and Figures 5-17 through 5-19 show in general that the subsurface deposits do not show a significant decline in PCB concentrations. For Little Lake Butte des Morts, the figures suggest that there is a generally increasing trend in subsurface PCBs, and an indeterminate mixture of trends that is not distinguishable from zero in the Appleton to Little Rapids and De Pere to Green

[2] A negative slope indicates decreasing PCB concentrations; a positive slope indicates increasing PCB concentrations over time.

Bay reaches. For Little Rapids to De Pere, there are consistently negative trends in the 10- to 30-cm strata, but in the lower strata, the data are consistent with either zero trend (30 to 50 cm), or an increasing trend (50 to 100 cm).

These results suggest that over time, the surface sediment concentrations of PCBs have been steadily decreasing. However, numerically this was difficult to define, and depended upon the specific deposits or sediment management units. PCB concentrations in sediment suggest declines, but a large fraction of analyses provided little useful trend information. A large fraction of sediment analyses yielded imprecise or inconclusive trends such that positive, negative, or zero trends are consistent with the data.

Like sediment PCB concentrations, fish tissue PCB concentrations showed a significant but slow rate of change throughout the Lower Fox River and lower Green Bay (Table 5-25). Initial exploration of the data demonstrated that there were statistically significant declines in tissue PCB concentrations in all species in all reaches. More detailed analyses were then conducted to determine if there had been a constant linear rate of decline, or if significant changes in the rate of decline, or "breakpoints," could be identified. Among fish time trends analyzed, nine out of 19 combinations of reach, species, and sample type showed a statistically significant change in slope during earlier and later periods. In all of the reaches of the river, and in Zone 2, there were steep declines in fish tissue PCB concentrations from the 1970s, but with significant breakpoints in declines beginning around 1980. After the breakpoint, depending upon the fish species, the additional apparent declines were either not significantly different from zero, or were relatively low (5 to 7 percent annually). However, for two species there were increases in PCB concentrations after the breakpoint; walleye in Little lake Butte des Morts and carp in Green Bay Zone 1.

Most slopes were negative, and all statistically significant slopes were negative. Over the period of analyzed data, percentage rates of decrease were usually between -5 and -10 percent per year (compounded). Percent lipid content of tissue was significantly related to PCB concentration in 16 out of the 19 analyses. Specific trends in sediment and fish by reach are discussed below.

5.8.3.1 Little Lake Butte des Morts

Time trend results for sediments in Little Lake Butte des Morts are presented in Table 5-23 and on Figures 5-17 through 5-19. With the exception of two strata at 10 to 30 cm in two separate deposit groups, slopes are negative (9 out of 11 analyses). However, statistically significant negative slopes (decreasing PCB concentration over time) was found only in surface sediments (0 to 10 cm) of four deposit groups (AB, D, F, GH). The estimated rates of decrease ranged from 8 to

24 percent per year, with wide confidence intervals for these rates of change; a rate of decrease of as little as 1 to 5 percent and as much as 15 to 43 percent per year. While the slopes were negative, there were no significant trends at deposits C or POG. In fact, for POG the estimated annual slope was -18.6 percent per year, but the upper and lower confidence bound on the estimate ranged from -43.3 to +16.9 percent per year.

When pooled across all deposits, there was an estimated significant ($p < 0.001$) average annual decrease of -15 percent of surface concentrations (Table 5-24) within the period supported by the data. It is important to note that on a reach basis, the 95 percent confidence intervals around the estimated average were 22 percent, up to 8 percent annual rate of decrease.

The only statistically significant increasing trend of PCB concentrations occurs at 10 to 30 cm in Deposit Group D, where the rate of increase is 108 percent per year. The confidence interval for the significantly increasing slope at 10 to 30 cm in Deposit Group D indicates a rate as low as 59 percent and as high as 171 percent per year. The *Time Trends Analysis* report noted that this must represent a temporary positive trend because a projection of the PCB concentration even at the minimum of 59 percent per year would yield an absurd 10,000-fold increase in PCB concentration after 20 years.

Caution needs to be used in the interpretation of the estimated average decrease within this reach. As noted previously, there were wide confidence intervals around all estimates for the sediment deposit groups. While the mass-weighted time trend for surface sediments indicated a significant decrease, the fact that the estimate did not include Deposit E, the largest depositional area within the reach, must be considered. There were insufficient data to conduct the analysis for Deposit E, and thus the sediment time trend is somewhat skewed by the lack of inclusion here.

For the fish examined in this reach, an early rapid decline was observed until around 1987, followed by either a slower decline or a flattening without further decline, depending upon the species (Table 5-25). Within this reach, time trends were conducted on carp and walleye (skin-on fillet and whole body), and northern pike and perch (skin-on fillet). For carp, the breakpoints identified for the skin-on fillet and whole body were 1979 and 1987, respectively. Walleye data fillet and whole body data show that the breakpoint occurs between 1987 and 1990. The fillet data suggests no change in concentration after the breakpoint, while the whole body data showed a sharp rate of increase (22 percent per year). However, the latter analysis, when tested, was not significantly different from zero. For northern pike skin-on fillets, the analysis showed no breakpoint, but a constant rate of decline of 12 percent per year. By contrast, yellow perch skin-on fillets declined sharply until 1981, and have since remained at constant levels. A meta-analysis conducted on all fish data combined yields a statistically significant, but slow rate of decline of 4.9 percent (range 2.1 to 7.5 percent decrease) per year.

5.8.3.2 Appleton to Little Rapids

For this reach, there were only sufficient data to evaluate Deposit Group IMOR, Deposit N (pre-demonstration dredging), and Deposit Group VCC. For these three groupings, surface sediments at IMOR showed an estimated annual increase of 9.9 percent, while the other two showed decreases in total PCB concentrations. While Deposit N surface sediments were found to be significant, there were non-significant increases observed in the subsurface sediments. Again, confidence limits around the estimated mean for all deposits was wide. Meta-analysis for the reach showed a non-significant increase of 0.6 percent per year.

For fish in this reach, the only tissue type with sufficient numbers and time spread of data were walleye skin-on fillet. Analysis of those data showed a relatively constant rate of decline of 10 percent (range 5.6 to 17.9 percent decrease) per year.

5.8.3.3 Little Rapids to De Pere

Time trends in sediments for this reach have a majority of negative slopes; but two of only three significant slopes were negative and occur in the 0- to 10-cm and 10- to 30-cm depth strata. One large positive statistically significant slope occurs at the 30- to 50-cm depth (Table 5-23, Figure 5-18).

The surface sediment (0 to 10 cm) in the Lower EE Deposit Group has a significantly negative slope ($p = 0.04$), implying a rate of decrease of 15 percent per year with a 95 percent confidence interval of 2 to 26 percent rate of decrease per year. In the same deposit group, the deeper 30- to 50-cm stratum shows a significantly positive slope, indicating a rate of increase of 23 percent per year and a 95 percent confidence interval of 4 to 46 percent per year. In Deposit Group FF, the 10- to 30-cm layer has a significantly negative slope with a rate of PCB concentration decrease of 20 percent per year with a 95 percent confidence interval of 1 to 35 percent. Again, while the estimates speak to significant decreasing or increasing PCB concentrations over time in these strata and deposit group combinations, the analysis showed wide confidence intervals. For surface sediments, the annual change ranged from an increase of 19.1 percent per year to a decrease of 33 percent per year.

Although only one surface sediment has a statistically significant decline, the mass-based meta-analysis found an overall statistically significant combination of declining PCB concentrations in the reach, with a slope of -0.046 per year

($p = 0.01$), implying a 10 percent per year rate of decrease (95 percent confidence interval: -17 to -2 percent). While some uncertainty may persist in the individual surface deposits, the PCB mass in the surface of this reach appears to be generally declining as of the mass estimation date, 1989 through 1990.

As noted previously, there were not sufficient fish tissue data for analysis of time trends.

5.8.3.4 De Pere to Green Bay (Zone 1)

The time trends analysis for surface sediments in this reach showed primarily negative slopes (Table 5-23). Statistically significant negative slopes were found in only three combinations of deposit group and depth. SMU Group 2649 showed a significantly negative slope ($p < 0.001$) in the surface deposit (0 to 10 cm), with a rate of decrease of 13 percent per year (95 percent confidence interval of 8 to 17 percent decrease per year). SMU Group 5067, 0 to 10 cm, also has a significantly negative slope ($p = 0.01$) implying an annual rate of decrease of 21 percent (95 percent confidence interval of 5 to 33 percent). In the same SMU group (5067), at a greater depth of 50 to 100 cm, a significant ($p = 0.003$) and large positive slope with a rate of increase of 133 percent per year (95 percent confidence interval of 56 to 250 percent) was observed.

It is important to note that an exceptionally high value of PCB concentration in SMU Group 56/57 was excluded from the analysis. Sample A3_0-4 had a concentration of 99,000 ppb, whereas all other samples in the 0- to 10-cm stratum in this deposit ranged from 400 to 7,800 ppb. In a statistical sense, the sample is an “outlier,” but that does not imply error in the value of 99,000.

For fish, Green Bay Zone 1 and Zone 2 PCB exposures were found to be significantly different. This difference was determined using two methods: 1) cross-sectional analyses, which compared fish PCB concentrations within a single year (e.g., 1989 data only) between the zones; and 2) estimating the significant differences between time trend slopes calculated separately for the two zones. Four out of five cross-sectional analyses showed statistically significant differences, either in the relationship of lipid content and PCB concentration or in the mean PCB concentration, while controlling for lipid content. All three time trend analyses comparing the two zones showed significantly different trends in the two reaches. Thus, the time trends in the two zones were handled separately.

For Zone 1, there appears to be a significant but slow rate of decline for most fish species tested with no breakpoint identified. The exception to this pattern were carp, which showed a breakpoint in 1995, and steep significant increases in PCB concentrations of 22 percent per year. Other fish tested within the reach included gizzard shad, northern pike, walleye (fillet and whole body), white bass, and white sucker. With the exception noted for carp, all species showed a rate of decline in PCB concentrations of between 5 and 10 percent annually. Combining all data showed that there is an average rate of decline of 7 percent per year.

5.8.3.5 Green Bay Zone 2

Zone 2 shows decreasing trends with no significant breakpoints in most species tested, including carp. Significant decreases of between 4 and 15 percent annually were found in alewife, carp, and yellow perch. The exception to this was gizzard shad, which showed a significant increasing trend of 6 percent PCBs in tissues per year.

5.8.4 Conclusion

The objective of the time trends analysis was to determine if PCB concentrations in the Lower Fox River were decreasing over time. For PCB concentrations in surface sediment, the data suggest an overall decline. PCB concentrations in surface sediments in the Lower Fox River are generally decreasing over time, but apparent detectable loss is limited to the top 4 inches of sediment. The apparent declines observed in surface sediments is consistent with the continued observed transport of PCBs from the river to Green Bay, as discussed in Section 2.4. The rate of change in surface sediments is both reach- and deposit-specific. The change averages an annual decrease of 15 percent, but ranges from an increase of 17 percent to a decrease of 43 percent. A large fraction of analyses provided little useful information for projecting future trends because of the lack of statistical significance and the wide confidence limits observed. This is especially true for sediments below the top 4 inches; changes in the sediment PCB concentrations cannot be distinguished from zero, or no change.

PCB concentrations in fish are also generally decreasing over the analysis period. The changes in PCBs in the sediments are reflected in the significant but slow declines in fish tissue concentrations of between 5 and 7 percent annually. Exceptions to the general overall decline were noted with walleye in Little Lake Butte des Morts, carp in Green Bay Zone 1, and gizzard shad in Zone 2 where significant increases in PCB concentrations were observed. In all reaches, a breakpoint was observed in the fish tissue declines. The presence of an earlier slowing of rates of decrease in fish, along with a more recent phenomenon of changing trends in some species and sample types, suggests that fish time trends are changeable. Since PCBs in fish are derived from PCBs in sediment, the sediment rates of change may also be changeable.

It is important to note that the trends discussed are limited to the period of time for which data existed. These analyses are not suitable for projecting trends; the data do not provide the assurance of a future steady or rapid decline in PCB concentrations. Even though there are a number of negative time trends that suggest PCB declines, future projections of PCB concentrations in sediments and fish are highly uncertain. Over the period of data collection, surface sediments and fish species have, on the average, declined in PCB concentrations. Yet the presence of increases in PCB concentrations in deeper sediments, and of breakpoints and other non-linear phenomena in fish PCB time trends (on the log scale), suggest that the river, its sediment, and its species may be experiencing an arrest or reversal of such a decline. The analyzed data do not assure continued PCB decreases over time.

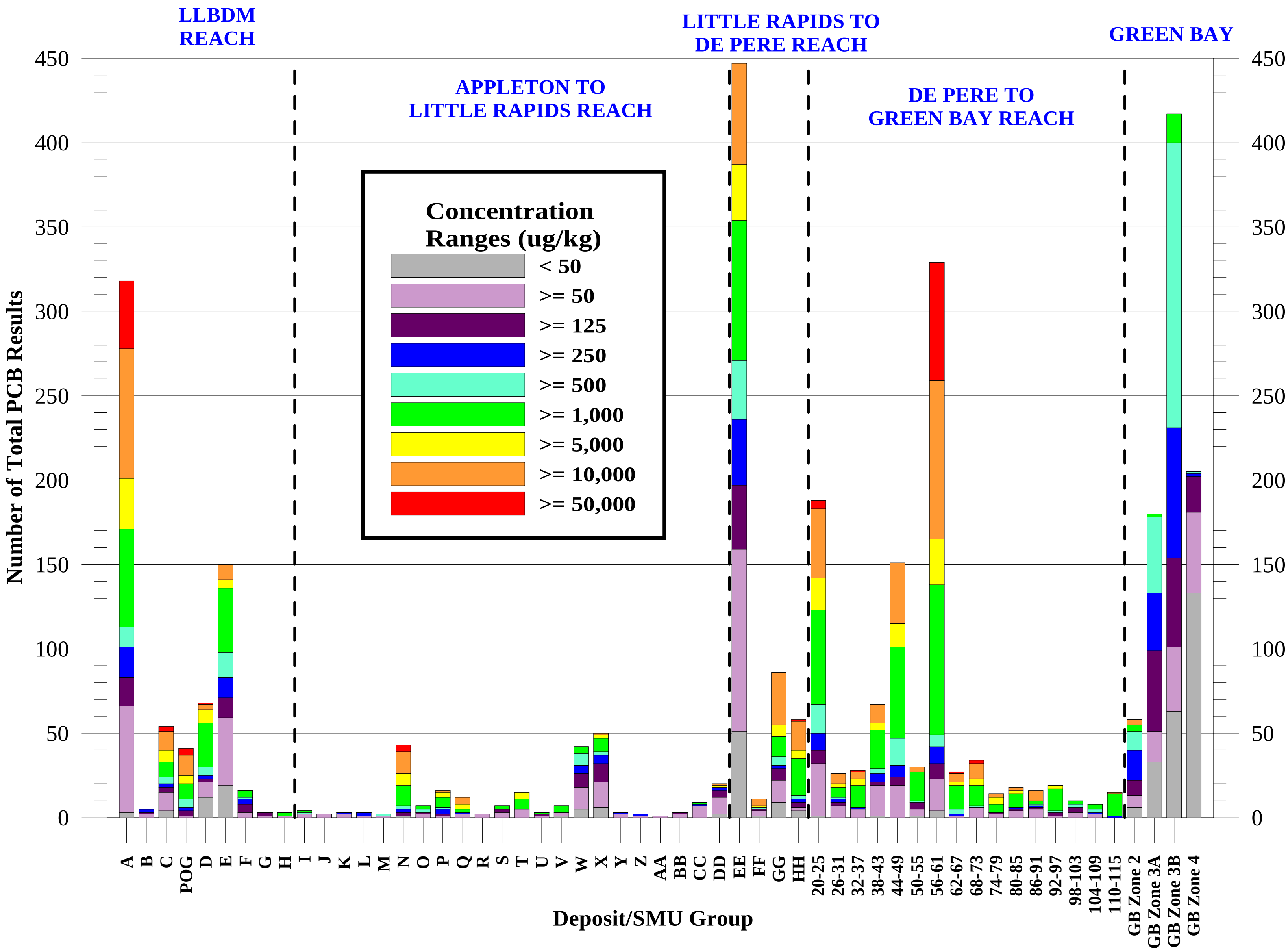
The time trends analysis dealt strictly with the testing of changes in PCB concentrations over time, and not with the mechanisms that could control changes in sediment and tissue loads. As discussed in Section 2.4, studies have shown that PCBs are being transported out of the Lower Fox River into Green Bay, while PCBs in Green Bay migrate into Lake Michigan. Therefore, PCB dispersal is one factor in the observed PCB declines. In addition, some of the variability observed in the data may be accounted for by changes in river profile, burial, scour by flood or ice, and propeller wash in the lower reaches of the river. As the analysis focused solely on the existing data, these potential mechanisms could not be adequately controlled or accounted for.

The conclusions of a general decrease in PCB burdens in sediments and fish of the Lower Fox River and in Zone 1 of Green Bay are consistent with findings by other researchers in the Great Lakes. Deceases in PCB concentrations have been observed in Lake Michigan (Offenberg and Baker, 2000; DeVault, *et al.*, 1996; Lamon, *et al.*, 1998), Lake Ontario (DeVault, *et al.*, 1996; Gobas, *et al.*, 1995) and Lake Superior (Smith, 2000). The yearly rate of decline for PCBs in biota and sediment of Lake Superior has been estimated at 5 to 10 percent per year (Smith, 2000), which is generally consistent with the trends observed in the Lower Fox River. However, several other researchers have also noted breakpoints, or constant levels of PCBs beginning in the mid- to late 1980s. Lake trout and smelt are reported to have been relatively constant in Lake Ontario since 1985 (Gobas, *et al.*, 1995). PCB body burdens in Lake Erie walleye were shown to be declining between the periods of 1977 and 1982, but after that period remained constant through 1990 (DeVault, *et al.*, 1996). Time tends analysis for salmonids in Lake Michigan showed generally decreasing tissue concentrations, but upper-bound forecast estimates for lake trout and chinook indicated that there would be a steady, or slightly increasing annual average PCB concentration. These findings are consistent with the time trends analysis for the Lower Fox River, and suggest that there may continue to be slow, gradual declines, or steady-state concentrations for many years to come.

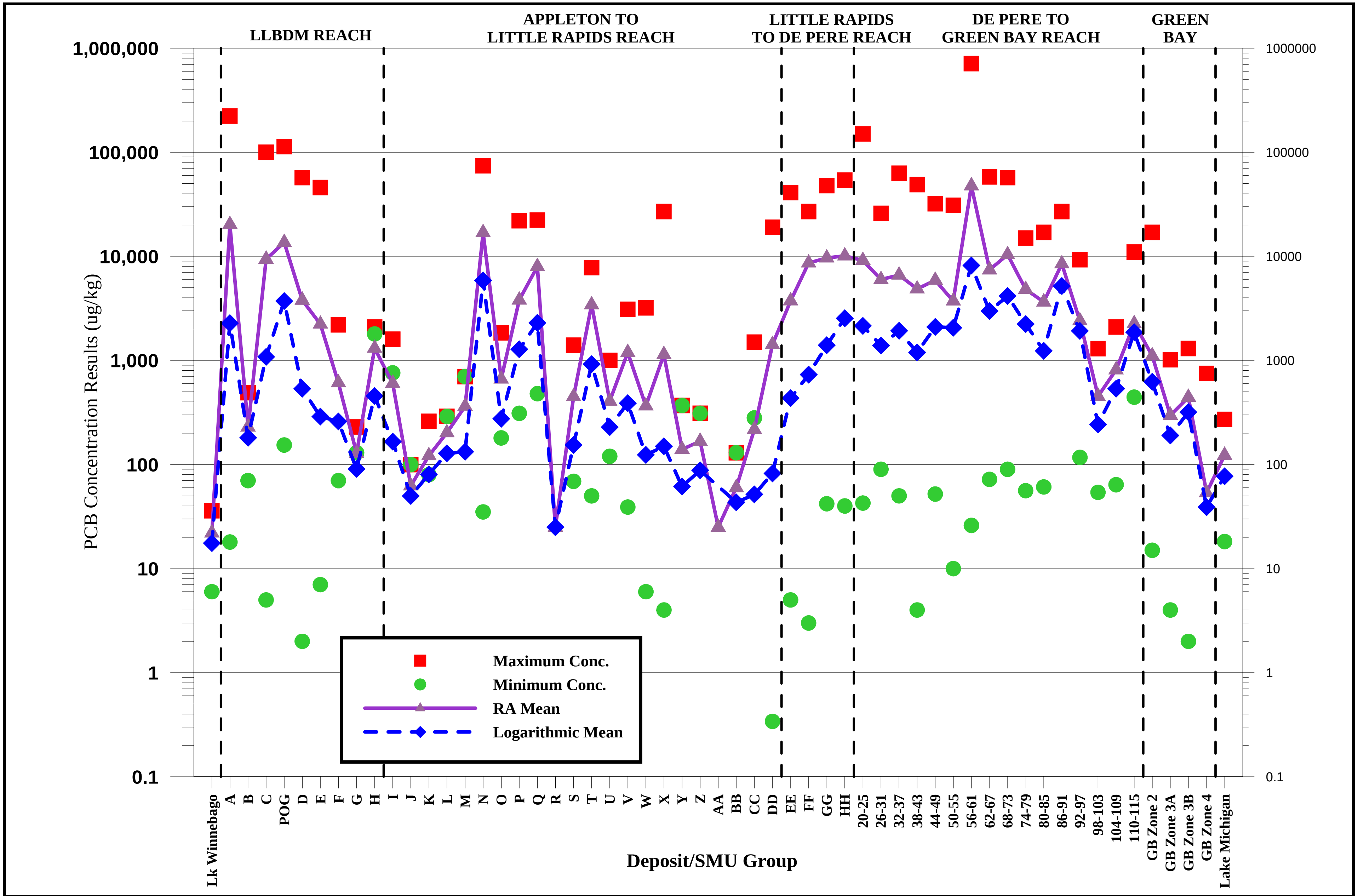
Given the potential for disturbance and redistribution of sediments, which has been observed in the past due to scouring, there is a high degree of uncertainty in projecting future PCB concentrations in sediments and fish. Given this, coupled with similar observations for sediments and fish on other Great Lakes systems, there is too much uncertainty to apply the information to human health or ecological risk analysis. The current Fox River data shows wide confidence limits on slopes. Some important game fish such as walleye or carp, as well as forage fish (gizzard shad) show increasing PCB levels.

5.9 Section 5 Figures, Tables, and Plates

Figures, tables, and plates for Section 5 follow this page, and include:



ThermoRetec Smart Solutions Positive Outcomes	Natural Resource Technology	Remedial Investigation Report	PCB Sampling Frequency Distribution in Lower Fox River and Green Bay Sediments FIGURE: 5-1	REF NO: CREATED BY: PRINT DATE: APPROVED:



ThermoRetec
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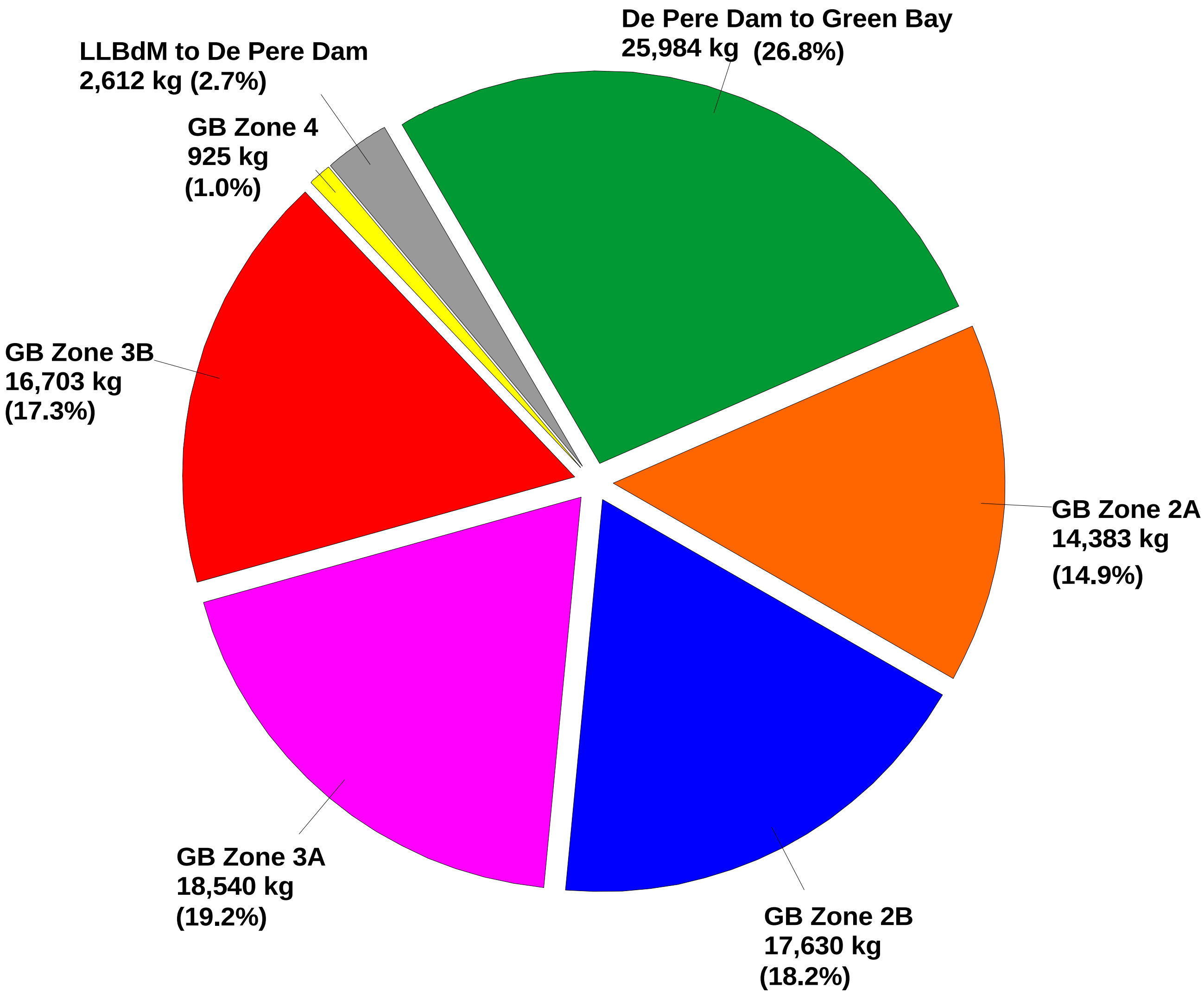
Natural Resource Technology

Remedial Investigation Report

Summary of Total PCB Concentrations in Lower Fox River and Green Bay Sediments

FIGURE: 5-2

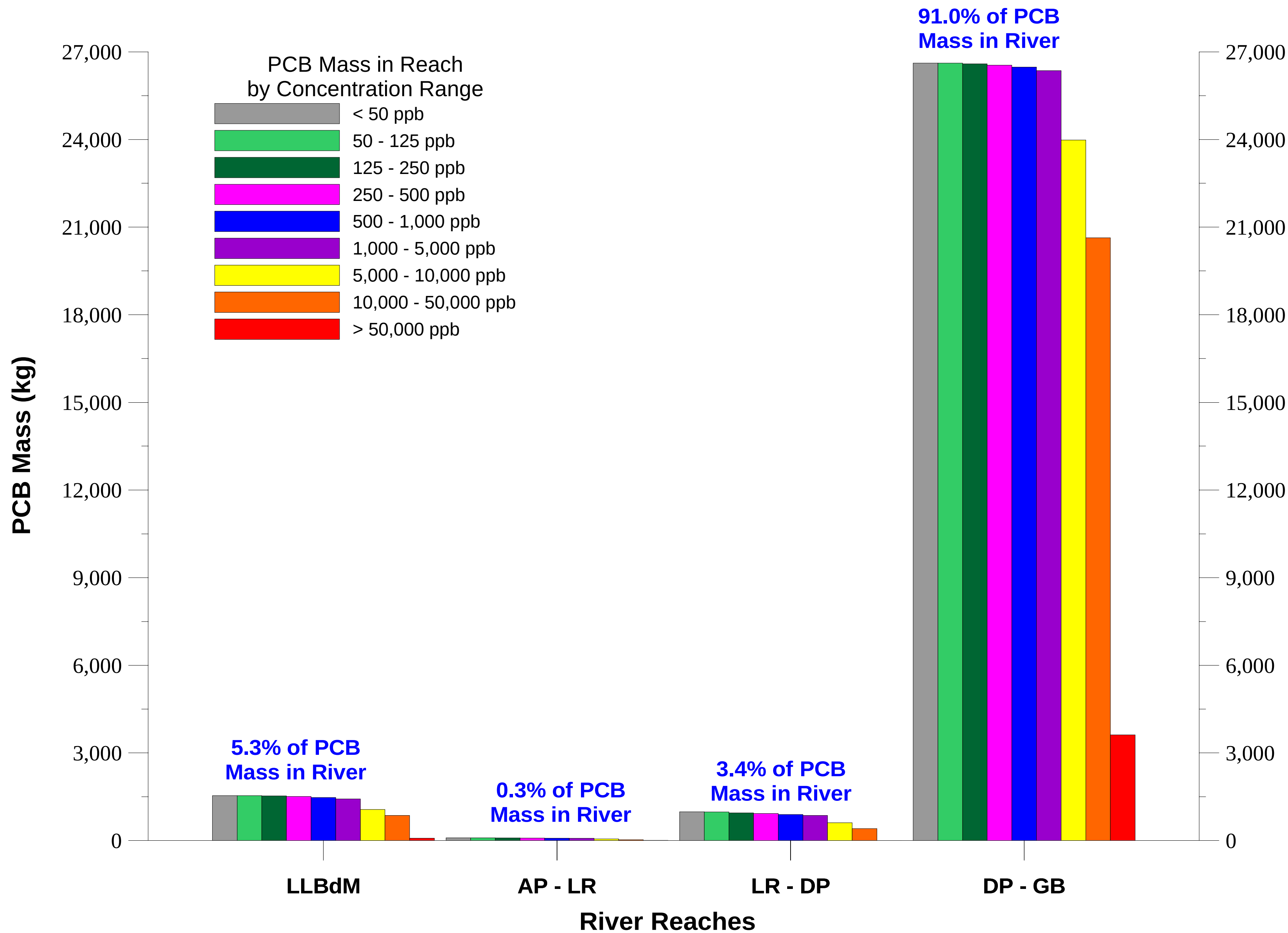
REF NO:
CREATED BY:
PRINT DATE:
APPROVED:



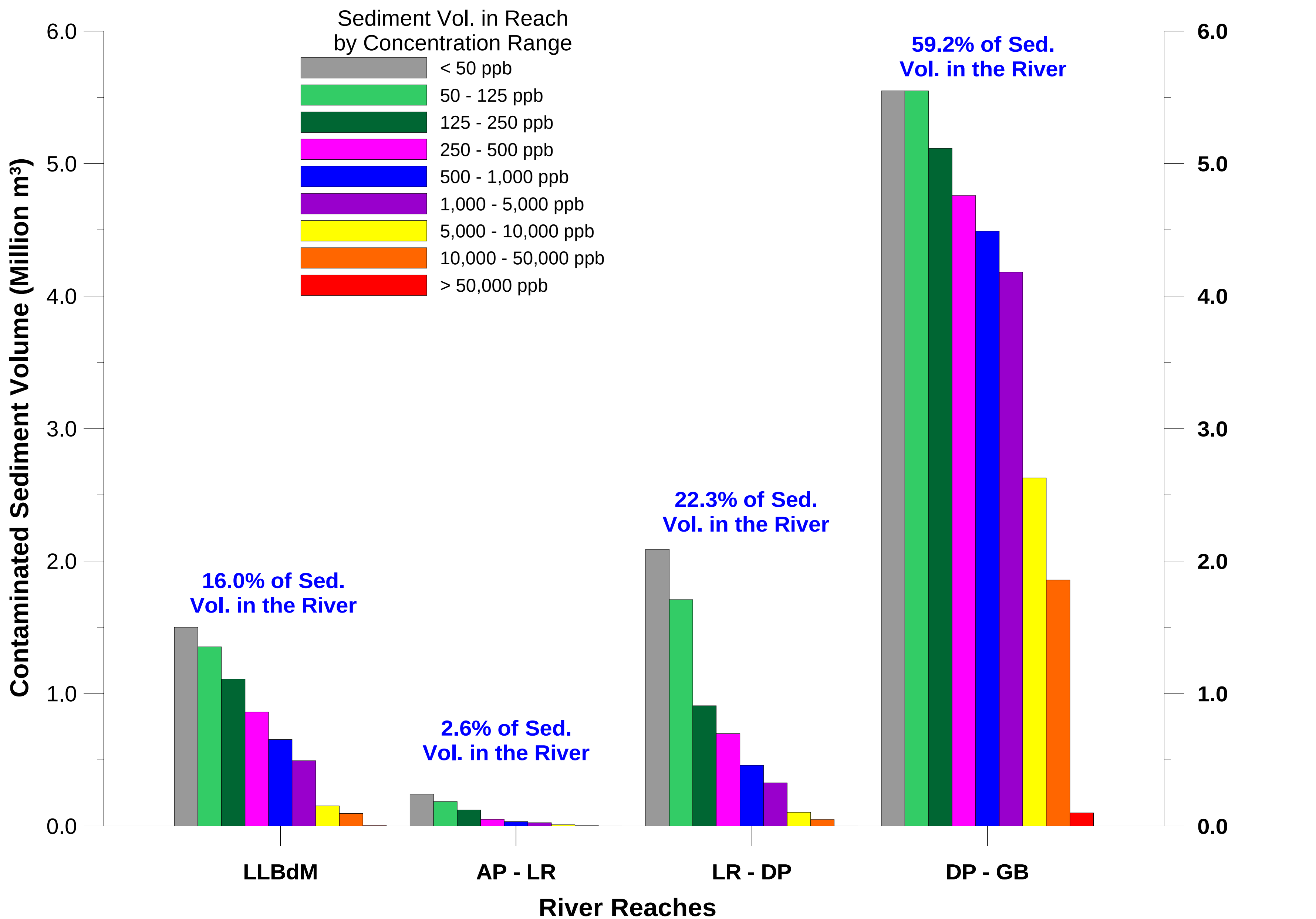
NOTES:

1) The upper 3 Reaches of the Lower Fox River, from LLBdM to the De Pere Dam, have been combined and contain 2.7% of the total PCB mass in sediments.
2) The combined mass of Zones 2A and 2B is 33.1% of the total PCB mass in sediments.
3) The combined mass of Zones 3A and 3B is 36.5% of the total PCB mass in sediments.

ThermoRetec Smart Solutions Positive Outcomes	Natural Resource Technology	Remedial Investigation Report	PCB Mass Distribution in Sediments for Each River Reach and Bay Zone	REF NO:
				CREATED BY:
				PRINT DATE:
			FIGURE: 5-3	APPROVED:



ThermoRetec Smart Solutions Positive Outcomes	Natural Resource Technology	Remedial Investigation Report	PCB Mass by Concentration Ranges in Lower Fox River Sediments	REF NO:
				CREATED BY:
				PRINT DATE:
			FIGURE: 5-4	APPROVED:



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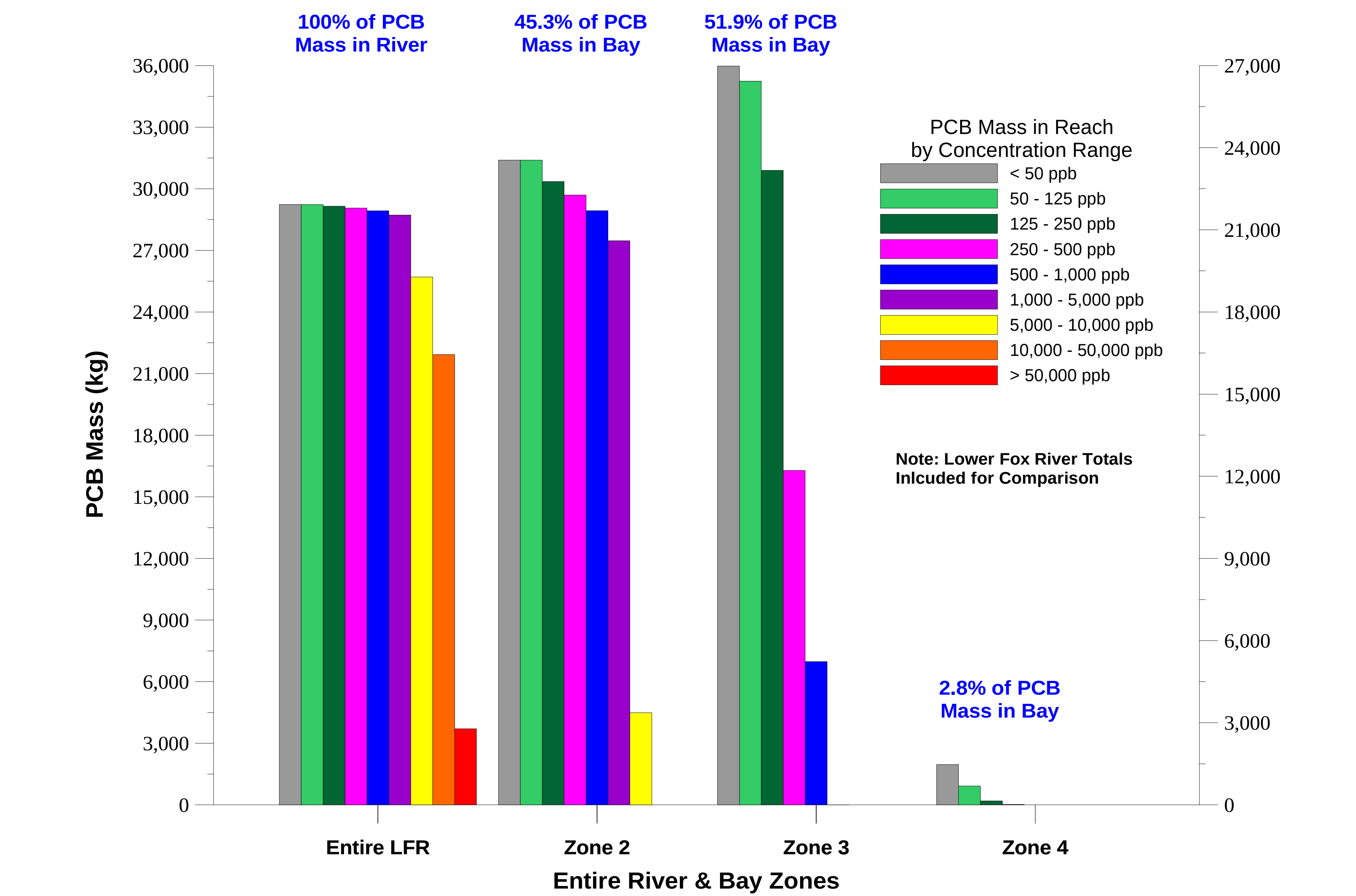
Natural Resource Technology	Remedial Investigation Report	Contaminated Sediment Volume by Concentration Ranges in the Lower Fox River	REF NO:
			CREATED BY:
			PRINT DATE:
		FIGURE: 5-5	APPROVED:



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Remedial Investigation Report

PCB Mass by Concentration Ranges in Green Bay Sediments

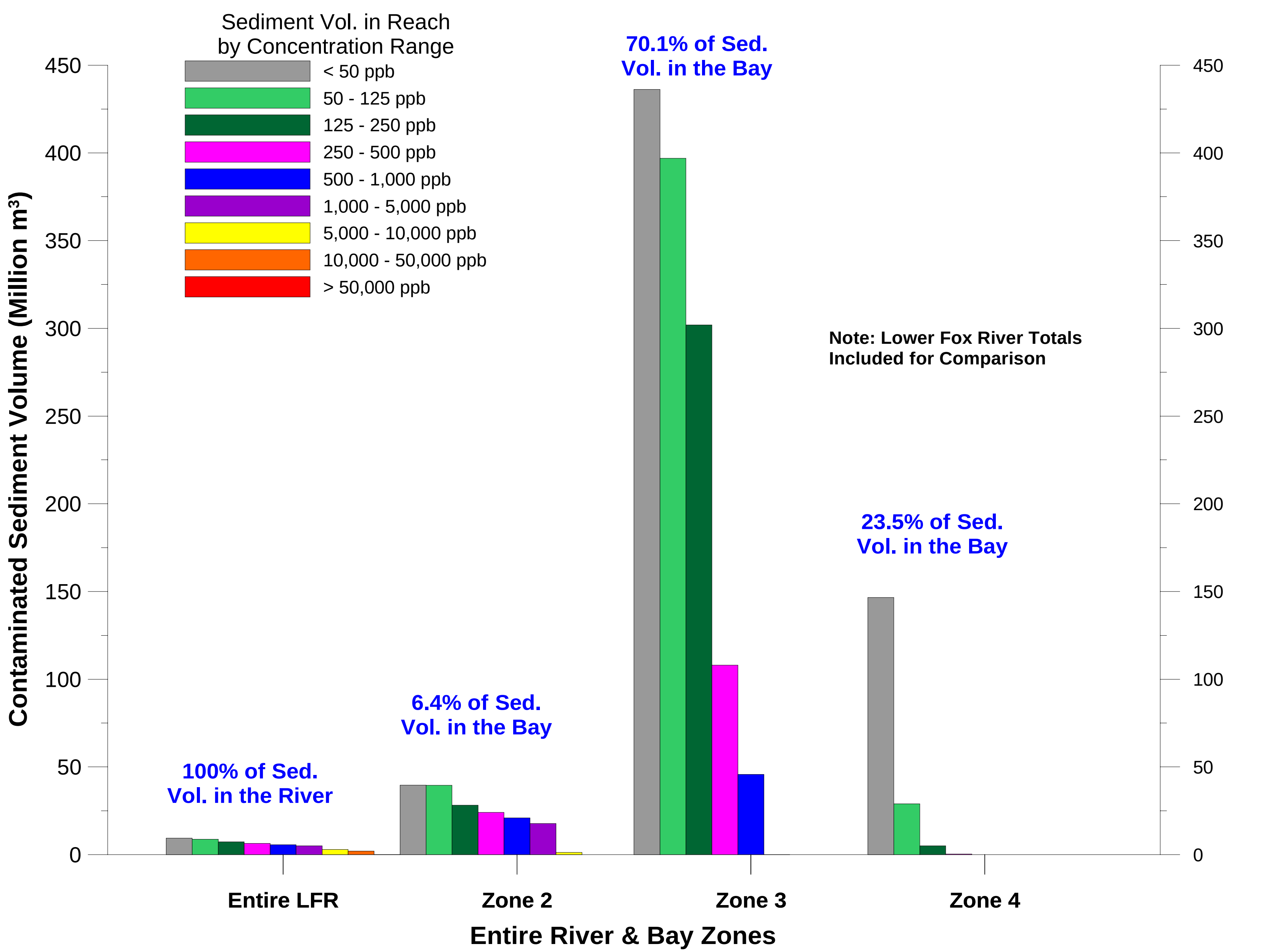
FIGURE: 5-6

REF NO:

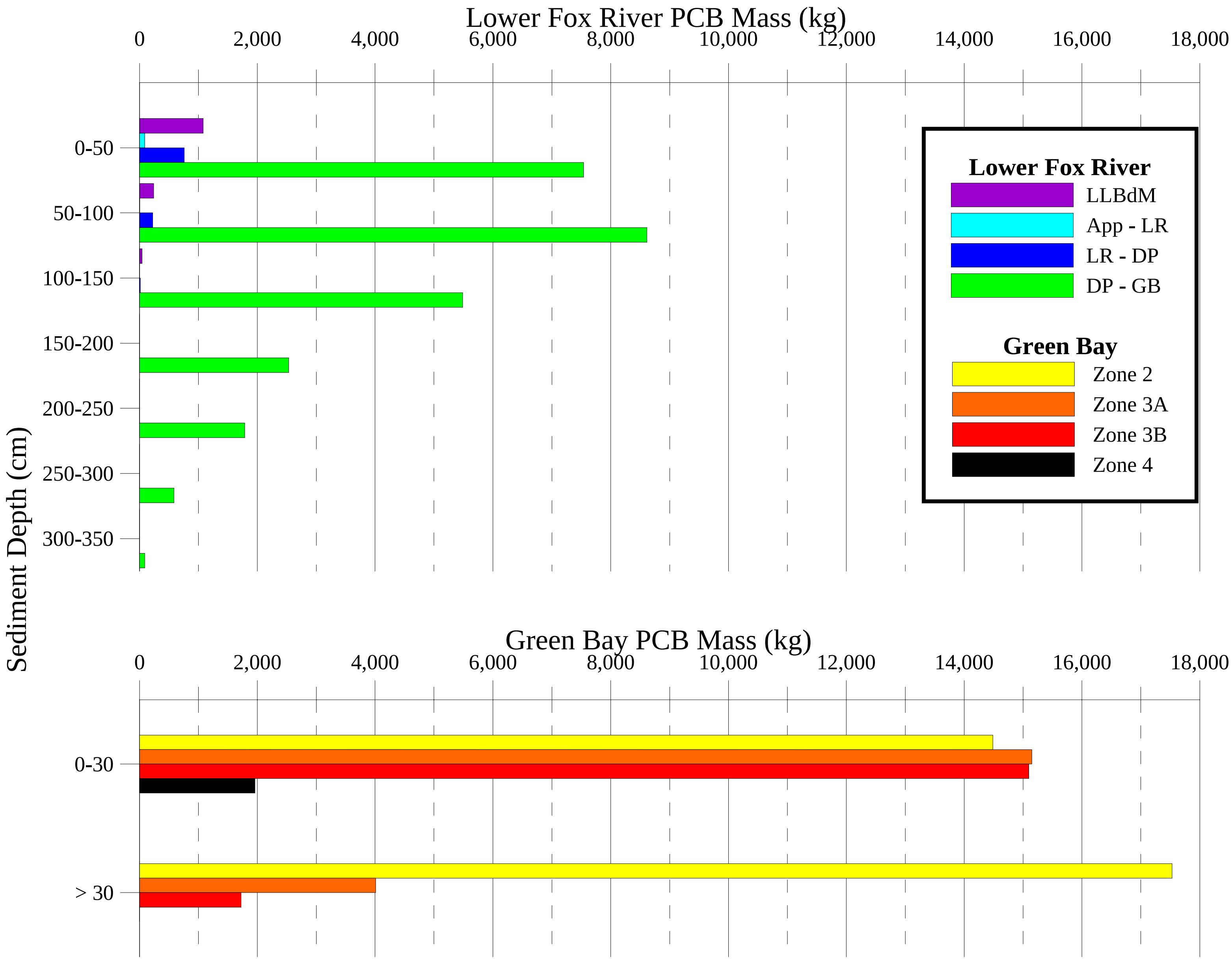
CREATED BY:

PRINT DATE:

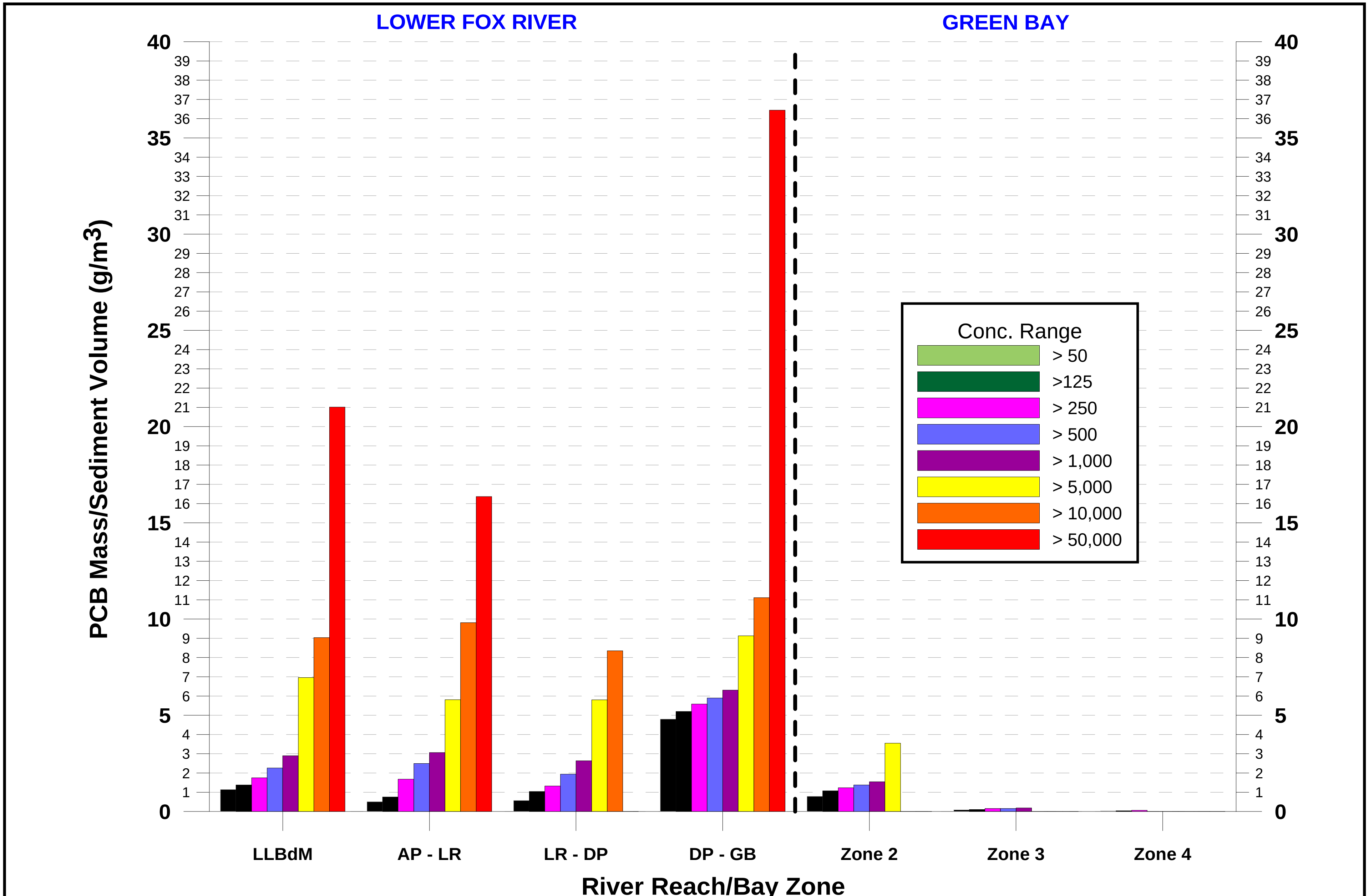
APPROVED:



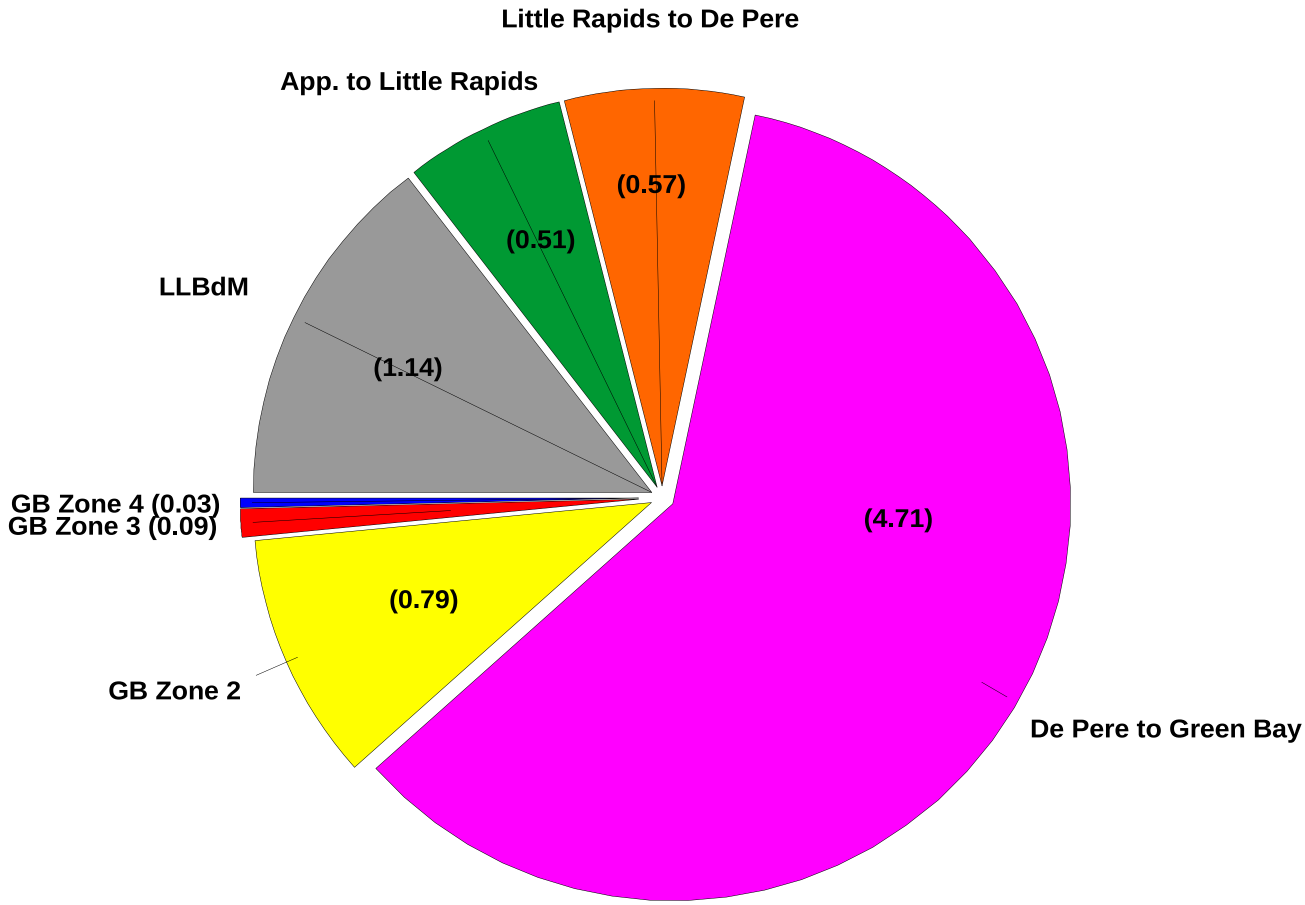
ThermoRetec Smart Solutions Positive Outcomes	Natural Resource Technology	Remedial Investigation Report	Contaminated Sediment Volume by Concentration Ranges in Green Bay	REF NO: CREATED BY: PRINT DATE:
			FIGURE: 5-7	APPROVED:



ThermoRetec Smart Solutions Positive Outcomes	Natural Resource Technology	Remedial Investigation Report	PCB Mass Distribution in Lower Fox River and Green Bay Sediments	REF NO:
				CREATED BY:
				PRINT DATE:
			FIGURE: 5-8	APPROVED:



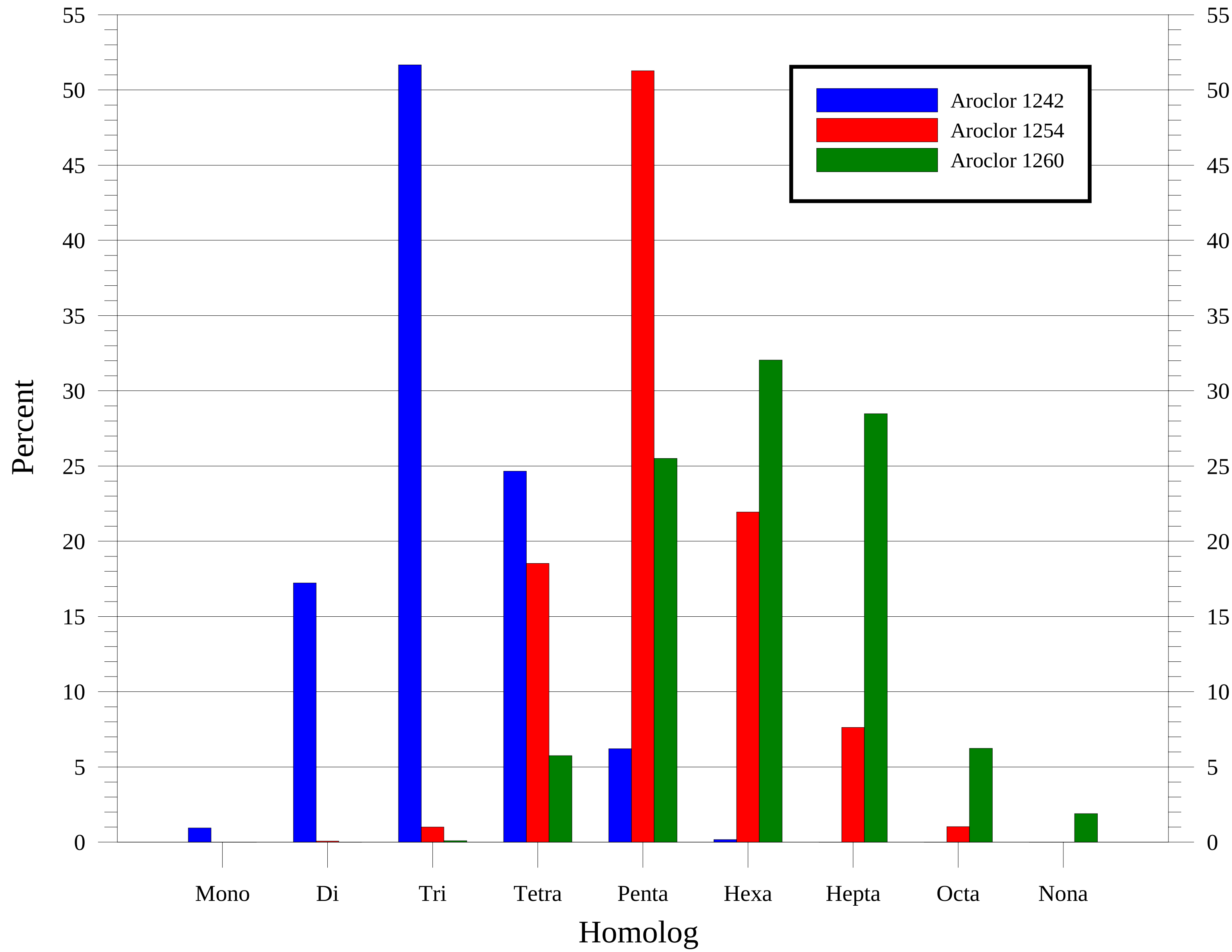
ThermoRetec Smart Solutions Positive Outcomes	Natural Resource Technology	Remedial Investigation Report	Ratios of PCB Mass/Sediment Volume In Lower Fox River and Green Bay Sediments	REF NO:
				CREATED BY:
				PRINT DATE:
			FIGURE: 5-9	APPROVED:



NOTES:

1) **Only includes sediments with more than 50 µg/kg PCBs.**

ThermoRetec Smart Solutions Positive Outcomes	Natural Resource Technology	Remedial Investigation Report	Distribution of PCB Mass/Sediment Volume Ratios in Sediments with More than 50 µg/kg PCBs	REF NO:
				CREATED BY:
				PRINT DATE:
			FIGURE: 5-10	APPROVED:



ThermoRetec
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Natural Resource Technology

Remedial Investigation Report

Aroclors 1242/1254/1260 PCB Homolog Plots

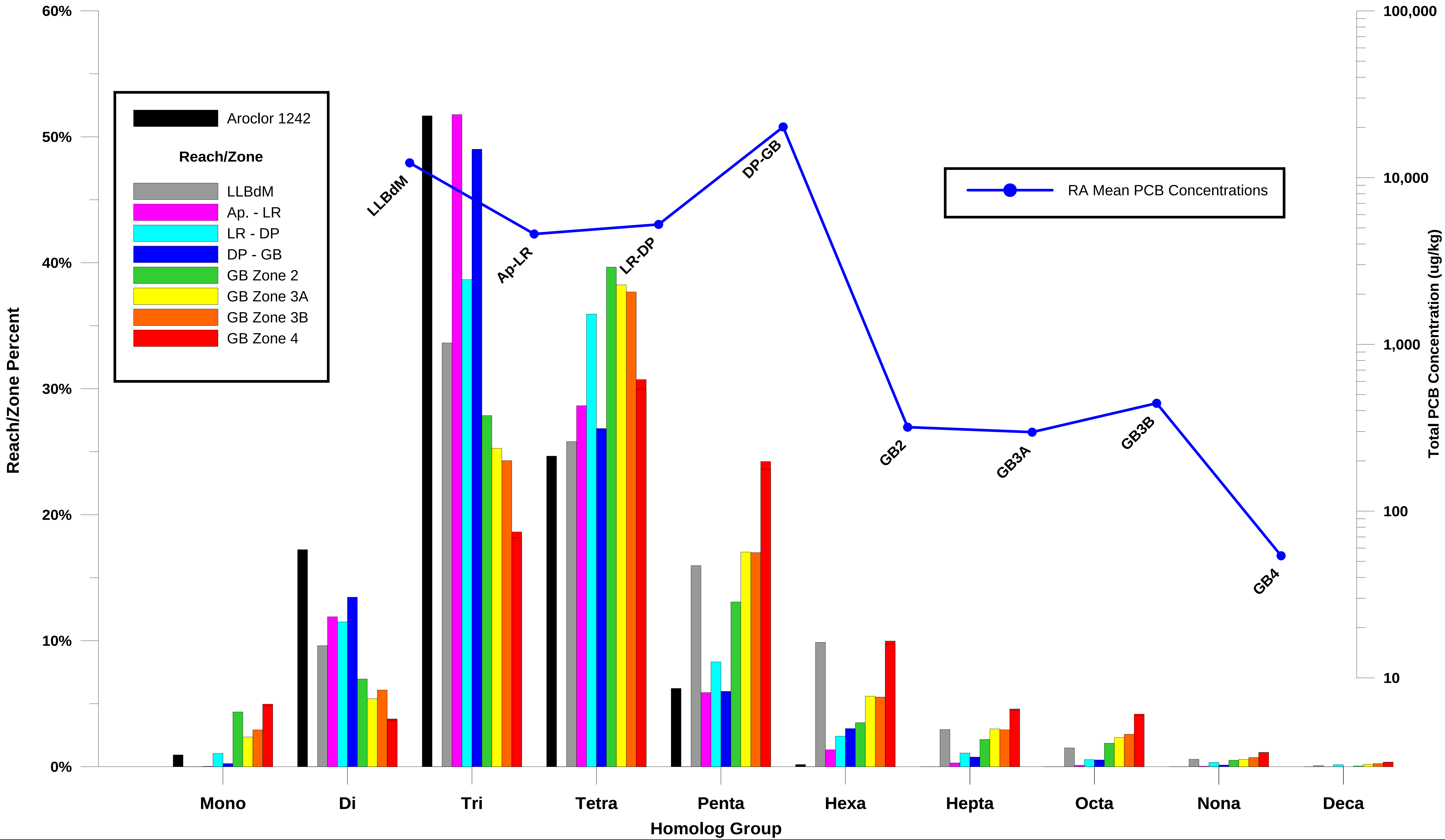
FIGURE: 5-11

REF NO:

CREATED BY:

PRINT DATE:

APPROVED:



ThermoRetec
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Natural Resource Technology

Remedial Investigation Report

PCB Homolog Distribution in Lower Fox River and Green Bay Sediments

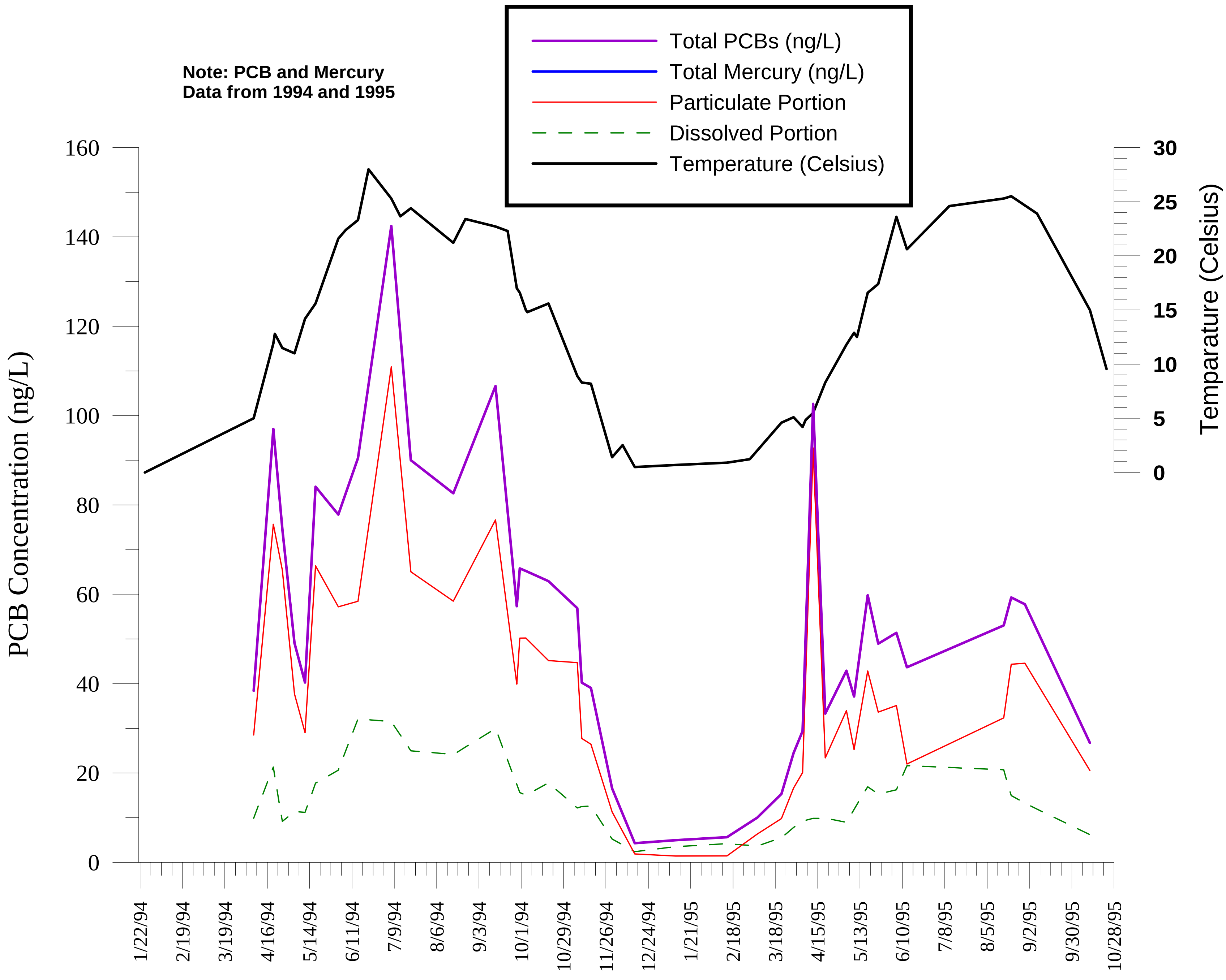
FIGURE: 5-12

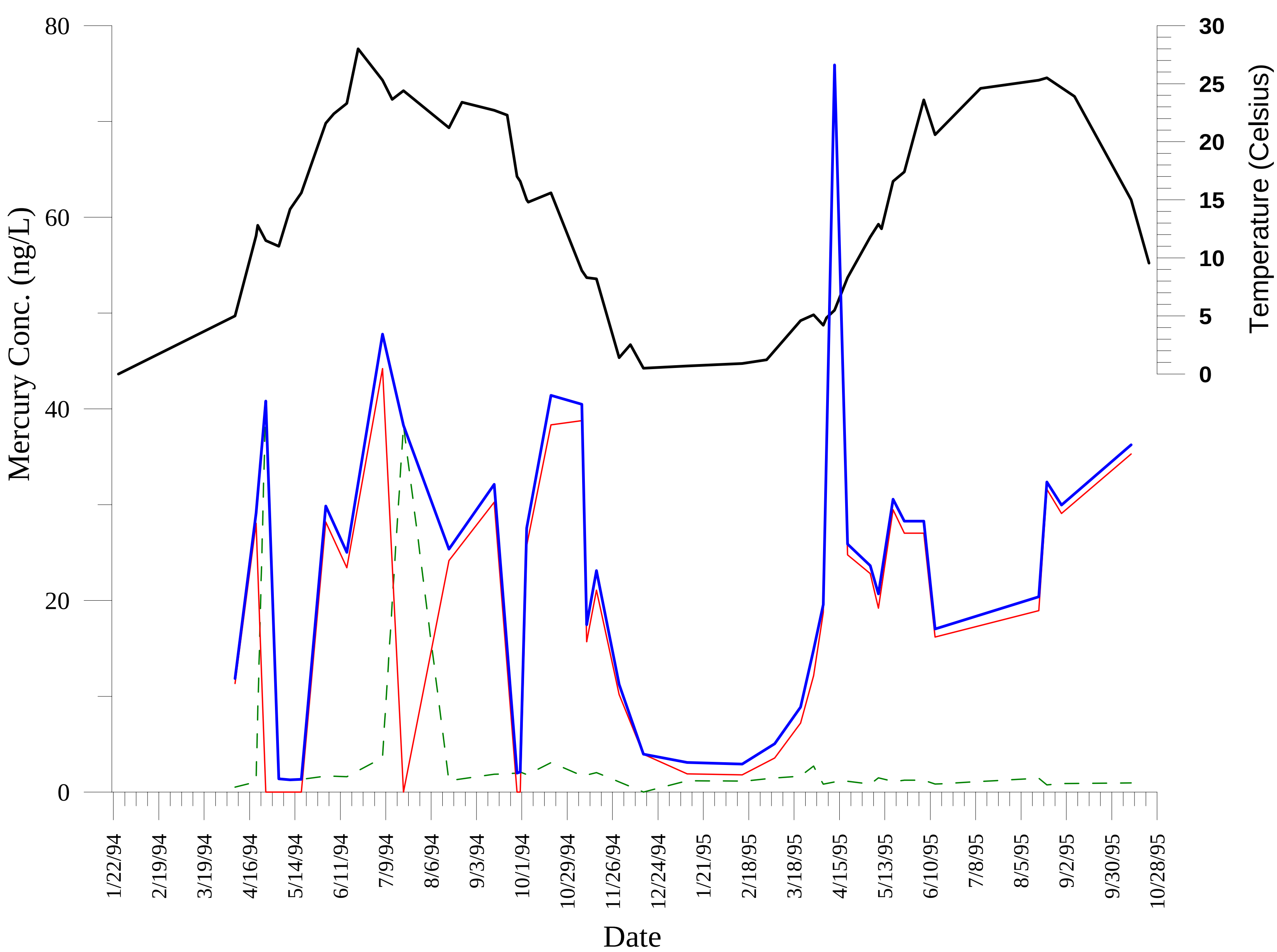
REF NO:

CREATED BY:

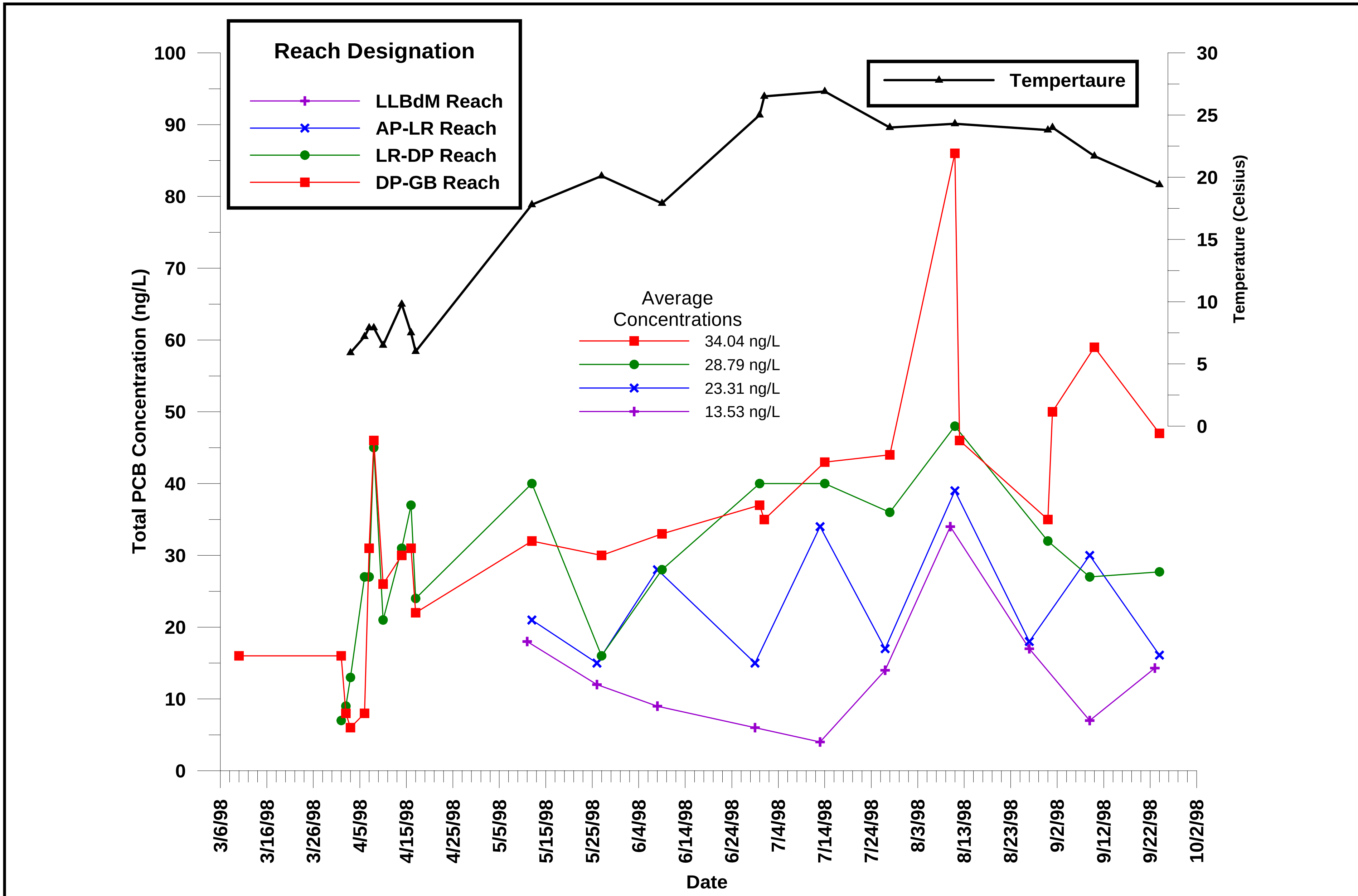
PRINT DATE:

APPROVED:

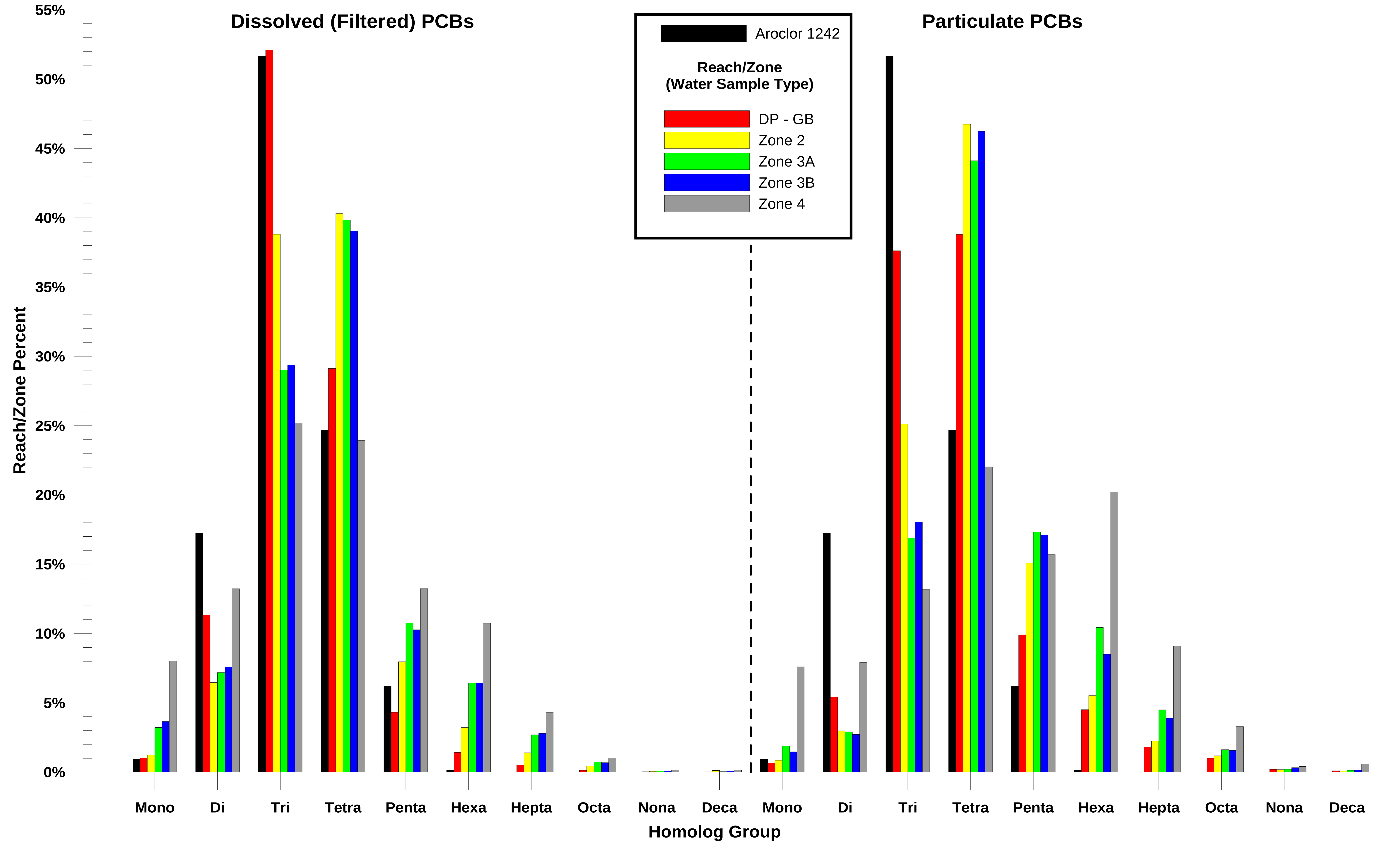




ThermoRetec Smart Solutions Positive Outcomes	Natural Resource Technology	Remedial Investigation Report	1994/95 Total PCB & Mercury Concentrations in Lower Fox River Water FIGURE: 5-13	REF NO: CREATED BY: PRINT DATE: APPROVED:



ThermoRetec *Smart Solutions Positive Outcomes*	Natural Resource Technology	Remedial Investigation Report	1998 Total PCB Concentration in Lower Fox River Water	REF NO:
				CREATED BY:
				PRINT DATE:
			FIGURE: 5-14	APPROVED:



ThermoRetec
Smart Solutions Positive Outcomes

Natural Resource Technology

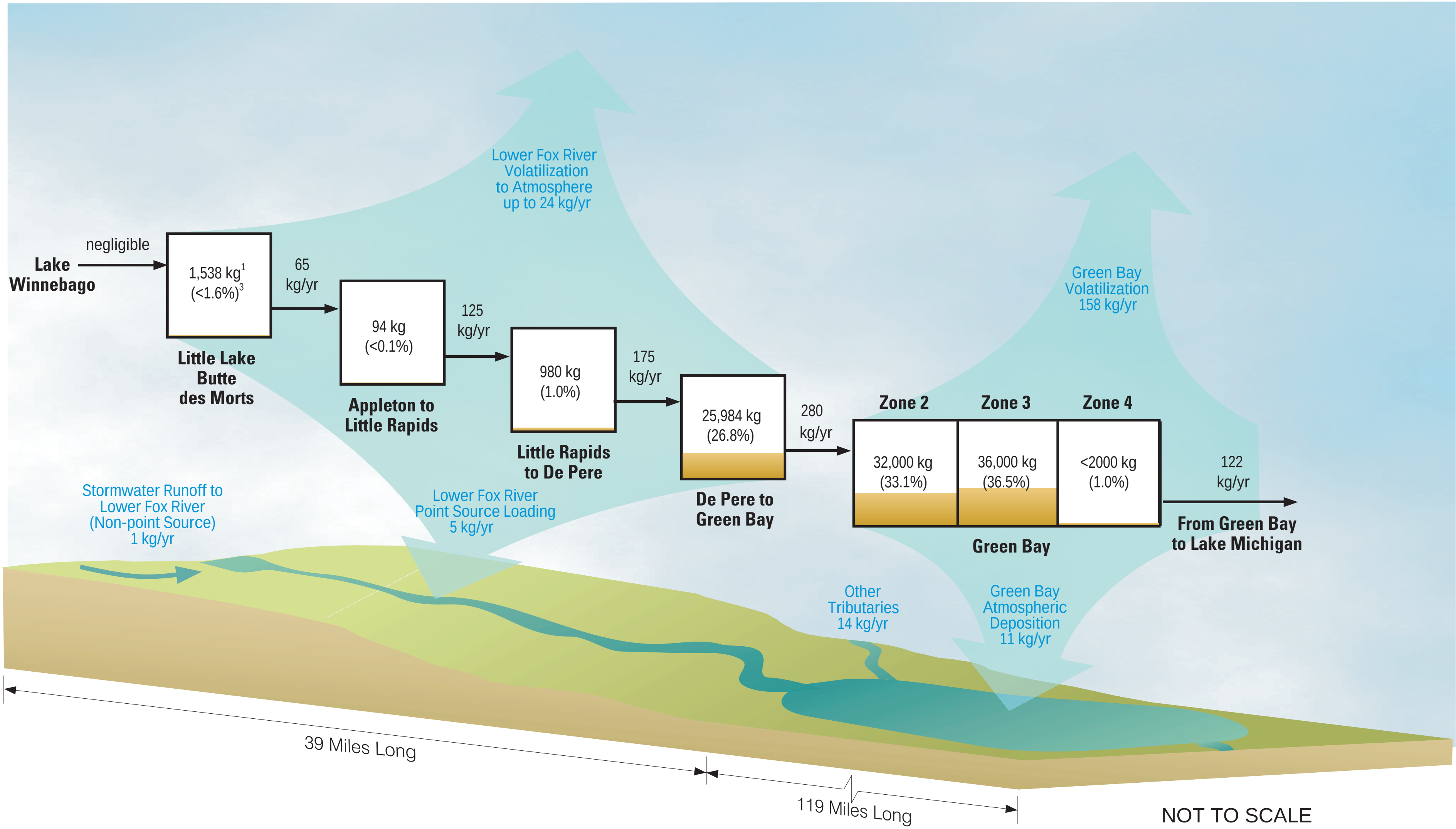
Remedial Investigation Report

PCB Homolog Distribution in Water:
De Pere Dam Through Green Bay

FIGURE: 5-15

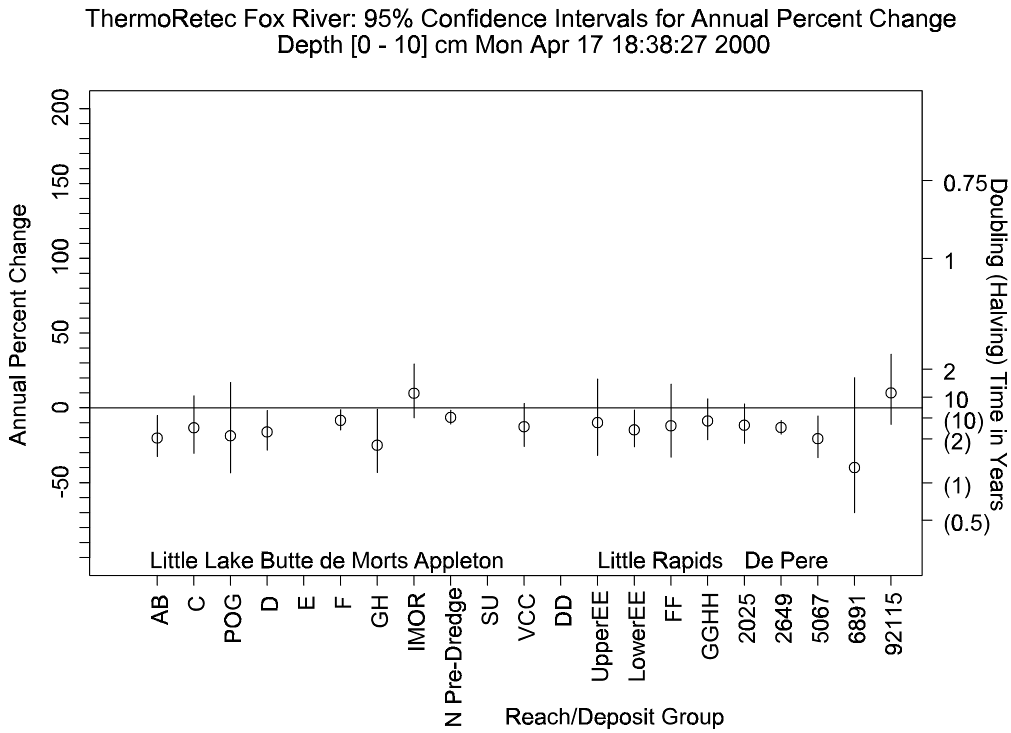
REF NO:
CREATED BY:
PRINT DATE:
APPROVED:

Figure 5-16. Lower Fox River and Green Bay System Estimated PCB Mass and Major PCB Flux Pathways



Notes: 1. PCB mass in sediments with PCB concentrations of 50 µg/kg or more.
2. Flux rates are average estimated loading rates per year.
3. Percentages correspond to fraction of total PCB mass in project area residing in each reach or zone. PCB mass estimates obtained from Tables 5-13, 5-14 and 5-15.
4. Estimate of PCB loads from WDNR 1995 and www.epa.gov/med/images/gbmassbal.gif

Figure 5-17 Time Trends of PCBs in Sediments for Depths from 0 to 10 cm and from 10 to 30 cm



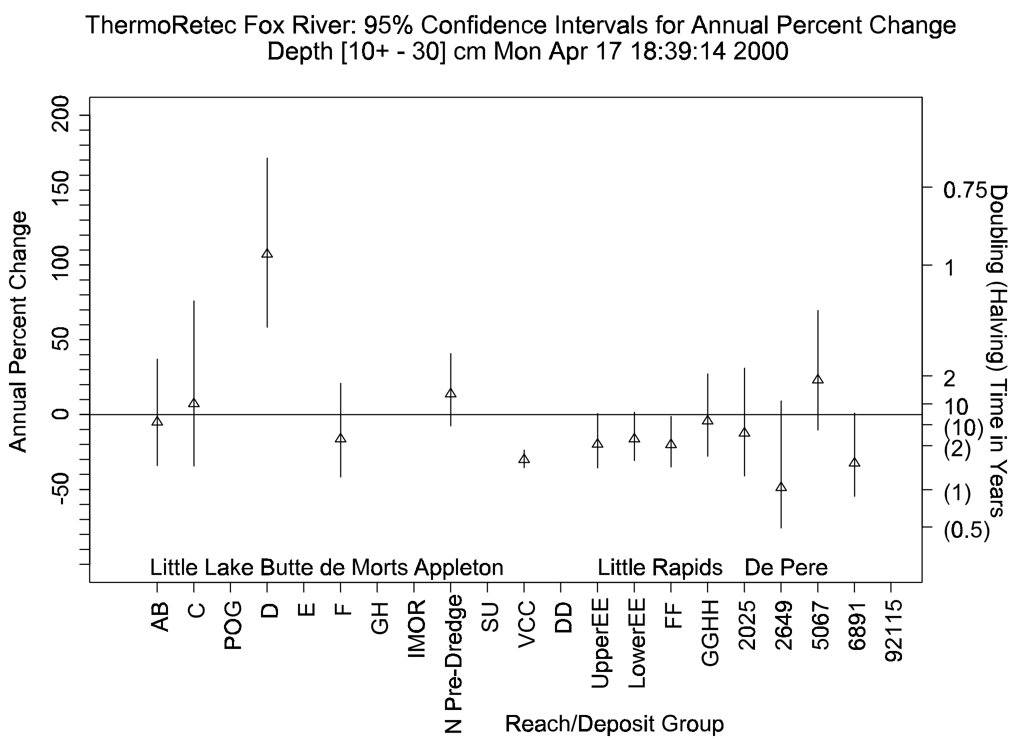
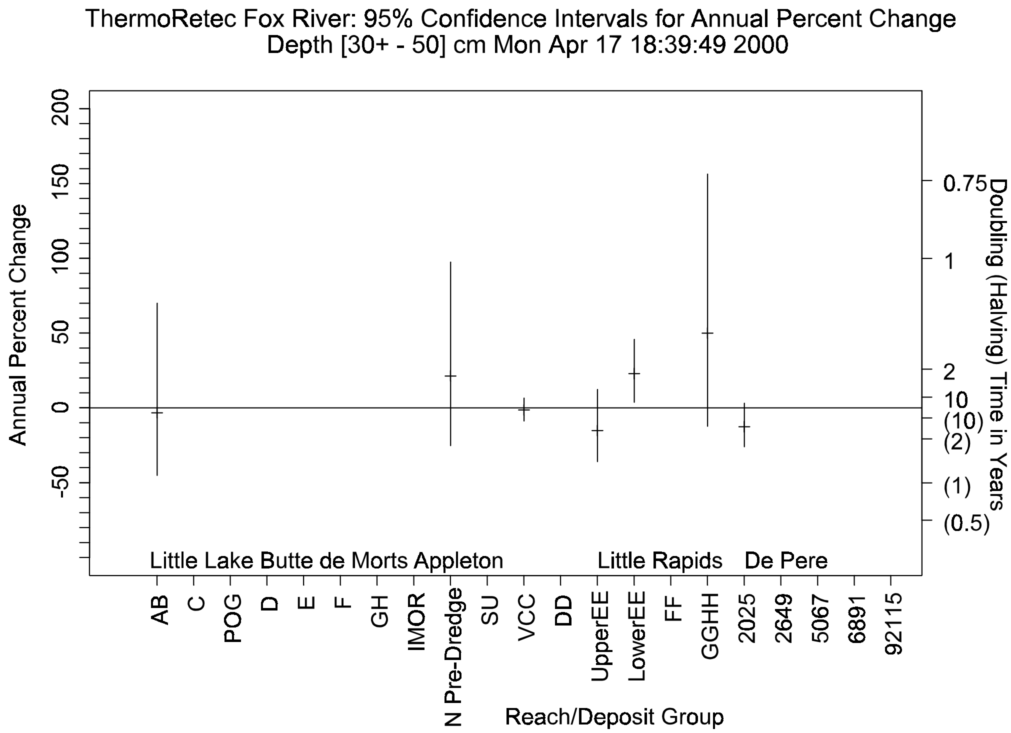


Figure 5-18 Time Trends of PCBs in Sediments for Depths from 30 to 50 cm and from 50 to 100 cm



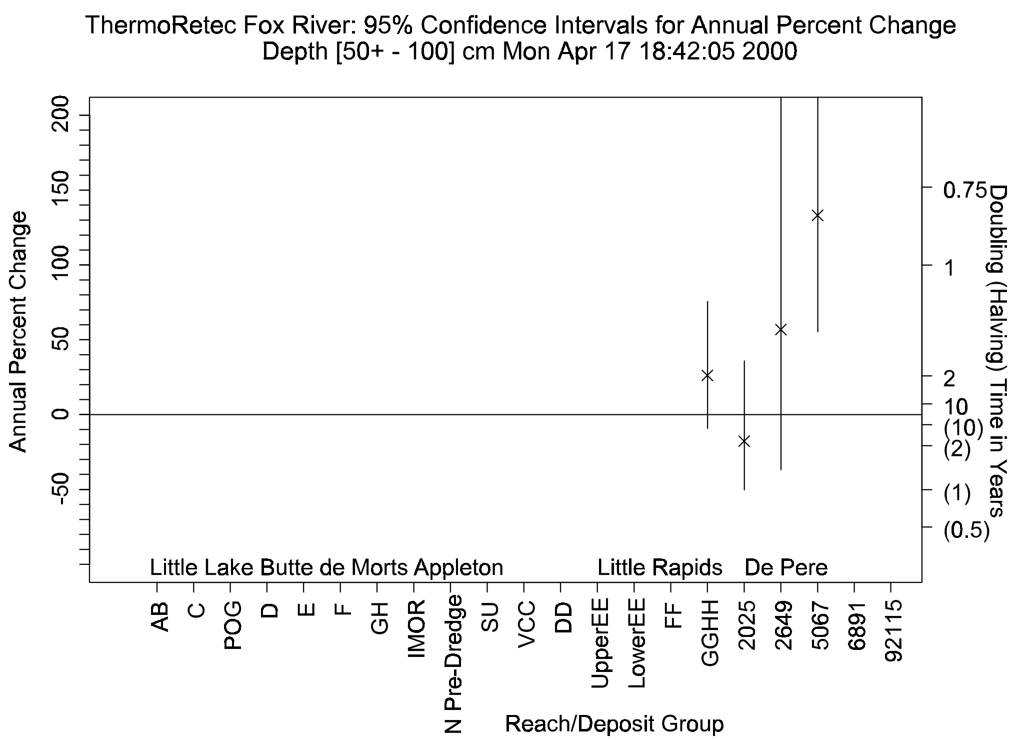


Figure 5-19 Time Trends of PCBs in Sediments for Depths over 100 cm

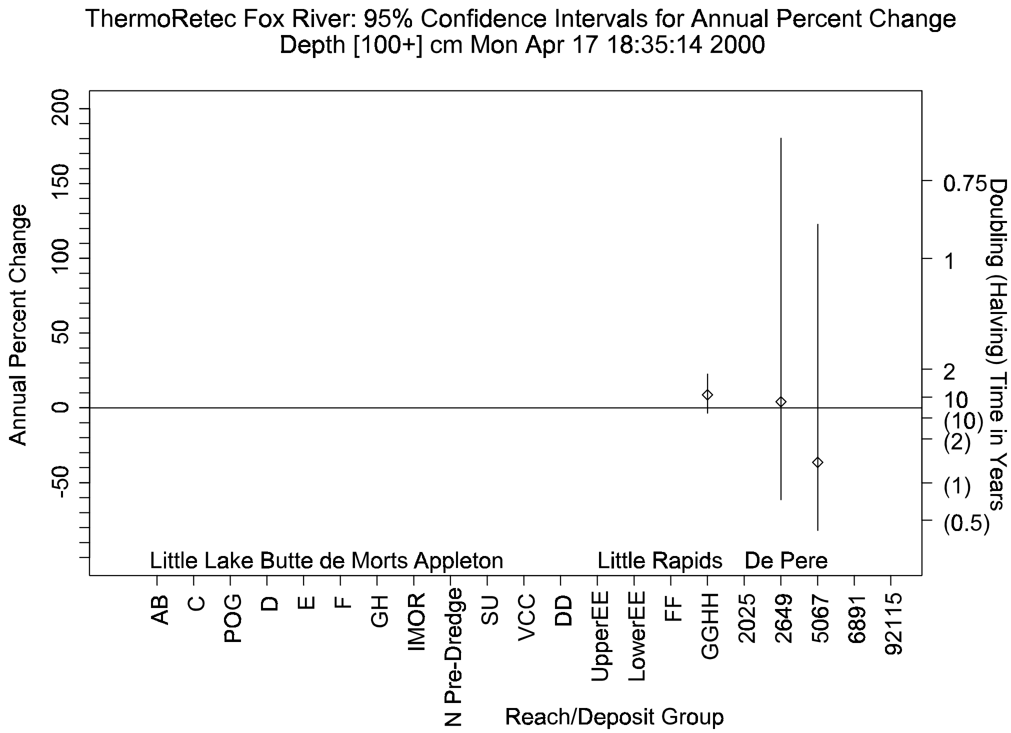


Table 5-1. Lower Fox River and Green Bay - Sediment Sampling Results: Summary of Detected Compounds

Location Reach/Zone	Parameter	Number of Samples	Number Detected	Percent Detected	Minimum Result	Maximum Result	RI Mean[A]	RA Mean[B]	Logarithmic Mean[C]	Units
Lake Winnebago Background Results										
Lake Winnebago	Total PCBs	5	5	100.00%	5.5	36	22.00	22.00	17.56	µg/kg
Lake Winnebago	Ar1242	3	3	100.00%	10	16	13.33	13.33	13.08	µg/kg
Lake Winnebago	Ar1254	3	3	100.00%	16	20	18.33	18.33	18.25	µg/kg
Lake Winnebago	p,p'-DDE	3	2	66.67%	2.4	3.5	2.95	2.68	2.62	µg/kg
Lake Winnebago	alpha-BHC	3	1	33.33%	3.6	3.6	3.60	1.70	1.25	µg/kg
Lake Winnebago	Endosulfan sulfate	3	1	33.33%	3.2	3.2	3.20	2.38	2.31	µg/kg
Lake Winnebago	4-Methylphenol	3	1	33.33%	59	59	59.00	42.50	41.06	µg/kg
Lake Winnebago	bis(2-Ethylhexyl)phthalate	3	3	100.00%	100	350	196.67	196.67	169.85	µg/kg
Lake Winnebago	Benzo(a)pyrene	3	1	33.33%	120	120	120.00	62.83	52.02	µg/kg
Lake Winnebago	Benzo(b)fluoranthene	3	1	33.33%	91	91	91.00	53.17	47.44	µg/kg
Lake Winnebago	Benzo(g,h,i)perylene	3	1	33.33%	100	100	100.00	56.17	48.95	µg/kg
Lake Winnebago	Benzo(k)fluoranthene	3	3	100.00%	87	140	115.67	115.67	113.49	µg/kg
Lake Winnebago	Chrysene	3	3	100.00%	84	140	114.67	114.67	112.17	µg/kg
Lake Winnebago	Fluoranthene	3	3	100.00%	100	120	110.00	110.00	109.70	µg/kg
Lake Winnebago	Indeno(1,2,3-cd)pyrene	3	1	33.33%	87	87	87.00	51.83	46.73	µg/kg
Lake Winnebago	Pyrene	3	3	100.00%	89	110	103.00	103.00	102.50	µg/kg
Lake Winnebago	Arsenic	3	3	100.00%	4	6	5.33	5.33	5.24	mg/kg
Lake Winnebago	Chromium	3	3	100.00%	51	75	65.00	65.00	64.14	mg/kg
Lake Winnebago	Copper	3	3	100.00%	23	33	28.67	28.67	28.34	mg/kg
Lake Winnebago	Lead	3	3	100.00%	30	39	35.00	35.00	34.79	mg/kg
Lake Winnebago	Mercury	3	3	100.00%	0.11	0.17	0.14	0.14	0.14	mg/kg
Lake Winnebago	Nickel	3	3	100.00%	22	30	27.00	27.00	26.75	mg/kg
Lake Winnebago	Zinc	3	3	100.00%	70	100	86.67	86.67	85.73	mg/kg
LOWER FOX RIVER RESULTS										
PCB Results										
LLBdM	Total PCBs	661	539	81.54%	2	222722	15,042.95	12,272.77	1,067.72	µg/kg
APP to LR	Total PCBs	263	188	71.48%	0.34	77444	6,405.94	4,589.09	362.20	µg/kg
LR to DP	Total PCBs	652	542	83.13%	3	54000	6,291.75	5,236.31	626.98	µg/kg
DP to GB	Total PCBs	1023	947	92.57%	0.4	710000	21,721.79	20,139.22	2,612.80	µg/kg
LR to DP	Ar1016	274	1	0.36%	1700	1700	1,700.00	139.53	17.35	µg/kg
LR to DP	Ar1221	274	1	0.36%	1700	1700	1,700.00	116.30	30.07	µg/kg
LR to DP	Ar1232	274	1	0.36%	1700	1700	1,700.00	138.63	17.11	µg/kg

Table 5-1. Lower Fox River and Green Bay - Sediment Sampling Results: Summary of Detected Compounds (Continued)

Location Reach/Zone	Parameter	Number of Samples	Number Detected	Percent Detected	Minimum Result	Maximum Result	RI Mean[A]	RA Mean[B]	Logarithmic Mean[C]	Units
LLBdM	Ar1242	483	416	86.13%	6.5	210000	13,255.69	11,436.46	1,196.91	µg/kg
APP to LR	Ar1242	171	145	84.80%	4.4	51000	4,633.98	3,937.22	495.12	µg/kg
LR to DP	Ar1242	498	440	88.35%	4.8	54000	5,836.52	5,159.64	624.92	µg/kg
DP to GB	Ar1242	1012	938	92.69%	26	710000	22,254.79	20,629.74	2,695.23	µg/kg
LLBdM	Ar1242/1254	2	2	100.00%	660	2500	1,580.00	1,580.00	1,284.52	µg/kg
APP to LR	Ar1242/1254	2	2	100.00%	900	3200	2,050.00	2,050.00	1,697.06	µg/kg
LR to DP	Ar1242/1254	1	1	100.00%	1600	1600	1,600.00	1,600.00	0.00	µg/kg
LR to DP	Ar1242/1254/1260	1	1	100.00%	520	520	520.00	520.00	0.00	µg/kg
DP to GB	Ar1242/1254/1260	1	1	100.00%	350	350	350.00	350.00	0.00	µg/kg
LLBdM	Ar1242/1268	1	1	100.00%	5900	5900	5,900.00	5,900.00	0.00	µg/kg
APP to LR	Ar1242/1268	3	3	100.00%	140	280	220.00	220.00	211.11	µg/kg
LR to DP	Ar1242/1268	6	6	100.00%	200	600	411.67	411.67	380.68	µg/kg
LLBdM	Ar1248	323	2	0.62%	1500	5100	3,300.00	612.55	78.46	µg/kg
LR to DP	Ar1248	274	1	0.36%	1700	1700	1,700.00	136.54	17.22	µg/kg
LLBdM	Ar1248/1254	1	1	100.00%	410	410	410.00	410.00	0.00	µg/kg
LLBdM	Ar1254	328	81	24.70%	4.6	60000	5,139.56	1,773.56	203.82	µg/kg
APP to LR	Ar1254	98	15	15.31%	4.6	340	87.11	377.71	82.78	µg/kg
LR to DP	Ar1254	275	61	22.18%	6	6600	557.26	233.56	39.97	µg/kg
DP to GB	Ar1254	914	41	4.49%	13	3300	465.34	455.56	74.07	µg/kg
LLBdM	Ar1254/1260	1	1	100.00%	80	80	80.00	80.00	0.00	µg/kg
LLBdM	Ar1260	319	13	4.08%	87	1400	615.92	609.21	112.31	µg/kg
APP to LR	Ar1260	97	2	2.06%	120	2100	1,110.00	391.00	68.64	µg/kg
LR to DP	Ar1260	274	49	17.88%	46	1600	552.22	139.33	31.12	µg/kg
DP to GB	Ar1260	914	81	8.86%	8.6	17000	696.64	488.52	78.55	µg/kg
LLBdM	Ar1262	91	1	1.10%	2200	2200	2,200.00	105.85	21.73	µg/kg
LLBdM	Ar1268	94	7	7.45%	32	530	168.00	38.26	14.72	µg/kg
APP to LR	Ar1268	4	4	100.00%	70	110	92.50	92.50	90.73	µg/kg
LR to DP	Ar1268	146	57	39.04%	9.2	270	75.67	40.28	19.23	µg/kg
DP to GB	Ar1268	48	6	12.50%	50	1100	236.83	118.72	43.14	µg/kg
LLBdM	PCB Congener 105	21	18	85.71%	1.2	48	6.72	6.27	3.20	µg/kg
APP to LR	PCB Congener 105	14	10	71.43%	0.44	180	34.60	27.00	4.07	µg/kg
LR to DP	PCB Congener 105	27	24	88.89%	0.94	54.4	15.27	13.78	6.22	µg/kg
DP to GB	PCB Congener 105	26	25	96.15%	0.79	23	5.85	5.65	3.12	µg/kg

Table 5-1. Lower Fox River and Green Bay - Sediment Sampling Results: Summary of Detected Compounds (Continued)

Location Reach/Zone	Parameter	Number of Samples	Number Detected	Percent Detected	Minimum Result	Maximum Result	RI Mean[A]	RA Mean[B]	Logarithmic Mean[C]	Units
LLBdM	PCB Congener 118	102	100	98.04%	0.48	3700	221.53	217.21	44.01	µg/kg
APP to LR	PCB Congener 118	39	37	94.87%	0.56	590	61.31	58.21	13.54	µg/kg
LR to DP	PCB Congener 118	86	82	95.35%	0.49	270	68.30	65.20	27.69	µg/kg
DP to GB	PCB Congener 118	26	26	100.00%	1.4	46	12.71	12.71	6.86	µg/kg
LLBdM	PCB Congener 126	21	8	38.10%	0.017	0.32	0.10	0.60	0.17	µg/kg
APP to LR	PCB Congener 126	10	3	30.00%	0.05	2.5	0.87	0.50	0.17	µg/kg
LR to DP	PCB Congener 126	27	7	25.93%	0.031	0.79	0.30	0.64	0.34	µg/kg
DP to GB	PCB Congener 126	26	5	19.23%	0.027	0.27	0.08	0.24	0.07	µg/kg
LLBdM	PCB Congener 126/129/178	4	1	25.00%	4.4	4.4	4.40	3.74	2.74	µg/kg
LR to DP	PCB Congener 126/129/178	12	2	16.67%	1.4	5.2	3.30	1.76	1.45	µg/kg
LLBdM	PCB Congener 77	21	14	66.67%	1.5	52	14.01	9.79	3.98	µg/kg
APP to LR	PCB Congener 77	10	6	60.00%	0.77	160	35.98	21.81	3.06	µg/kg
LR to DP	PCB Congener 77	27	19	70.37%	2.4	89.1	25.88	18.46	5.84	µg/kg
DP to GB	PCB Congener 77	26	24	92.31%	1.9	85	13.97	12.95	5.59	µg/kg
LLBdM	PCB Congener 77/110	91	91	100.00%	0.37	5900	491.59	491.59	84.34	µg/kg
APP to LR	PCB Congener 77/110	30	30	100.00%	0.73	1400	126.36	126.36	33.96	µg/kg
LR to DP	PCB Congener 77/110	73	72	98.63%	0.4	620	135.46	133.78	46.15	µg/kg
DP to GB	PCB Congener 77/110	8	8	100.00%	2.8	89	40.98	40.98	30.86	µg/kg
Dioxin/Furan Results										
LLBdM	2,3,7,8-TCDD	6	5	83.33%	0.00175	0.00544	0.00	0.00	0.00	µg/kg
LR to DP	2,3,7,8-TCDD	3	3	100.00%	0.00023	0.00682	0.00	0.00	0.00	µg/kg
DP to GB	2,3,7,8-TCDD	12	1	8.33%	0.01	0.01	0.01	0.01	0.01	µg/kg
LLBdM	2,3,7,8-TCDF	6	6	100.00%	0.03222	0.07129	0.06	0.06	0.06	µg/kg
LR to DP	2,3,7,8-TCDF	3	3	100.00%	0.03178	0.11709	0.06	0.06	0.06	µg/kg
DP to GB	2,3,7,8-TCDF	12	10	83.33%	0.02	0.17	0.06	0.05	0.03	µg/kg
Pesticide Results										
LLBdM	p,p'-DDT	24	4	16.67%	5.5	50	20.63	42.96	10.01	µg/kg
APP to LR	p,p'-DDT	10	1	10.00%	3.4	3.4	3.40	9.19	4.74	µg/kg
LR to DP	p,p'-DDT	17	3	17.65%	5.1	20	13.70	14.20	9.38	µg/kg
DP to GB	p,p'-DDT	35	2	5.71%	19	28	23.50	7.61	6.03	µg/kg
LLBdM	p,p'-DDD	27	4	14.81%	4.7	19	9.95	15.29	4.92	µg/kg
APP to LR	p,p'-DDD	10	2	20.00%	0.97	1.7	1.34	8.91	4.13	µg/kg
LR to DP	p,p'-DDD	23	5	21.74%	1.5	2.8	1.92	8.53	3.40	µg/kg
DP to GB	p,p'-DDD	24	3	12.50%	1.2	4.5	2.30	7.16	5.25	µg/kg
LR to DP	p,p'-DDE	22	4	18.18%	6.6	22	14.15	10.93	4.78	µg/kg
DP to GB	p,p'-DDE	34	1	2.94%	1.9	1.9	1.90	6.29	3.64	µg/kg
LLBdM	Aldrin	23	1	4.35%	60	60	60.00	10.53	3.65	ug/kg
LLBdM	Dieldrin	15	1	6.67%	5.9	5.9	5.90	32.06	12.60	ug/kg
LLBdM	Endrin aldehyde	24	1	4.17%	67	67	67.00	18.42	8.20	µg/kg

Table 5-1. Lower Fox River and Green Bay - Sediment Sampling Results: Summary of Detected Compounds (Continued)

Location Reach/Zone	Parameter	Number of Samples	Number Detected	Percent Detected	Minimum Result	Maximum Result	RI Mean[A]	RA Mean[B]	Logarithmic Mean[C]	Units
LR to DP	Endrin aldehyde	23	1	4.35%	4.9	4.9	4.90	10.43	6.38	µg/kg
DP to GB	Endrin aldehyde	23	4	17.39%	5.1	12	7.70	8.88	8.07	µg/kg
LLBdM	Endrin ketone	23	3	13.04%	4.3	17	12.43	17.22	7.75	µg/kg
LR to DP	Endrin ketone	22	9	40.91%	3.2	23	7.98	11.75	7.43	µg/kg
DP to GB	Endrin ketone	21	3	14.29%	1.4	3.4	2.40	7.85	6.51	µg/kg
LR to DP	gamma-BHC (Lindane)	23	1	4.35%	9.8	9.8	9.80	5.29	2.41	µg/kg
DP to GB	gamma-BHC (Lindane)	36	7	19.44%	1	17	6.60	6.35	3.81	µg/kg
LLBdM	Heptachlor	23	4	17.39%	4.4	8.4	5.83	9.71	4.82	µg/kg
LR to DP	Heptachlor	22	1	4.55%	3.1	3.1	3.10	9.76	5.11	µg/kg
Semi-Volatile Organic Compound (SVOC) Results										
LLBdM	1,2-Dichlorobenzene	22	2	9.09%	120	130	125.00	1,705.23	417.95	µg/kg
LR to DP	1,2-Dichlorobenzene	22	8	36.36%	63	370	146.50	1,027.57	287.46	µg/kg
DP to GB	1,2-Dichlorobenzene	22	3	13.64%	79	150	119.67	2,329.73	1,022.55	µg/kg
LLBdM	1,4-Dichlorobenzene	22	4	18.18%	62	282	144.88	1,712.48	429.20	µg/kg
LR to DP	1,4-Dichlorobenzene	22	1	4.55%	60	60	60.00	988.64	187.17	µg/kg
DP to GB	1,4-Dichlorobenzene	22	3	13.64%	36	69	53.00	2,320.64	915.16	µg/kg
LLBdM	4-Methylphenol	26	11	42.31%	75	1530	567.23	1,664.60	645.02	µg/kg
APP to LR	4-Methylphenol	9	6	66.67%	110	1500	510.00	817.78	481.70	µg/kg
LR to DP	4-Methylphenol	22	11	50.00%	210	880	551.27	1,245.82	693.20	µg/kg
DP to GB	4-Methylphenol	20	3	15.00%	29	540	236.33	2,577.63	1,539.62	µg/kg
LLBdM	bis(2-Ethylhexyl)phthalate	26	13	50.00%	87	25000	2,973.69	2,662.23	715.63	µg/kg
APP to LR	bis(2-Ethylhexyl)phthalate	9	9	100.00%	100	1300	531.11	531.11	394.57	µg/kg
LR to DP	bis(2-Ethylhexyl)phthalate	22	12	54.55%	120	803	364.42	1,092.55	404.48	µg/kg
DP to GB	bis(2-Ethylhexyl)phthalate	23	8	34.78%	63	1400	477.88	2,229.26	1,430.39	µg/kg
LLBdM	Carbazole	22	4	18.18%	30	2700	749.25	1,737.82	590.37	µg/kg
APP to LR	Carbazole	9	3	33.33%	64	180	109.33	634.11	269.14	µg/kg
DP to GB	Carbazole	20	2	10.00%	50	1300	675.00	2,485.03	1,205.33	µg/kg
LLBdM	Pentachlorophenol	25	7	28.00%	350	860	612.71	3,742.32	801.77	µg/kg
APP to LR	Pentachlorophenol	9	2	22.22%	280	290	285.00	1,317.78	434.94	µg/kg
LR to DP	Pentachlorophenol	22	4	18.18%	300	1100	725.00	2,502.59	584.46	µg/kg
DP to GB	Pentachlorophenol	24	5	20.83%	20	710	398.00	5,396.42	2,262.03	µg/kg
LLBdM	Phenol	22	1	4.55%	71	71	71.00	1,694.64	367.98	µg/kg
DP to GB	Phenol	22	2	9.09%	46	94	70.00	2,321.61	943.34	µg/kg
Polynuclear Aromatic Hydrocarbons (PAHs)										
LLBdM	Acenaphthene	28	5	17.86%	9.25	580	134.35	1,303.33	234.98	µg/kg
APP to LR	Acenaphthene	10	3	30.00%	66	130	105.33	572.45	217.09	µg/kg
LR to DP	Acenaphthene	23	1	4.35%	9.25	9.25	9.25	948.23	165.96	µg/kg
DP to GB	Acenaphthene	26	7	26.92%	9.25	210	45.71	1,970.02	471.78	µg/kg
LLBdM	Acenaphthylene	28	6	21.43%	9.25	71	29.29	1,385.81	261.37	µg/kg

Table 5-1. Lower Fox River and Green Bay - Sediment Sampling Results: Summary of Detected Compounds (Continued)

Location Reach/Zone	Parameter	Number of Samples	Number Detected	Percent Detected	Minimum Result	Maximum Result	RI Mean[A]	RA Mean[B]	Logarithmic Mean[C]	Units
APP to LR	Acenaphthylene	10	4	40.00%	110	170	127.50	541.85	201.71	µg/kg
LR to DP	Acenaphthylene	23	3	13.04%	9.25	77	53.75	952.23	179.93	µg/kg
DP to GB	Acenaphthylene	26	7	26.92%	9.25	100	33.29	1,966.67	467.08	µg/kg
LLBdM	Anthracene	28	8	28.57%	30	1400	245.95	1,347.41	345.21	µg/kg
APP to LR	Anthracene	10	7	70.00%	58	360	198.29	568.80	288.92	µg/kg
LR to DP	Anthracene	23	6	26.09%	64	210	135.67	975.70	252.56	µg/kg
DP to GB	Anthracene	26	8	30.77%	3.06	640	134.00	1,998.34	651.91	µg/kg
LLBdM	Benzo(a)anthracene	29	13	44.83%	113	3300	645.77	1,384.31	481.59	µg/kg
APP to LR	Benzo(a)anthracene	10	10	100.00%	380	1300	737.00	737.00	670.42	µg/kg
LR to DP	Benzo(a)anthracene	23	14	60.87%	170	1200	417.86	963.04	407.84	µg/kg
DP to GB	Benzo(a)anthracene	27	14	51.85%	135	870	382.14	1,725.93	964.38	µg/kg
LLBdM	Benzo(a)pyrene	29	15	51.72%	77	2900	827.80	1,482.31	534.96	µg/kg
APP to LR	Benzo(a)pyrene	10	8	80.00%	410	1200	823.75	1,039.00	854.12	µg/kg
LR to DP	Benzo(a)pyrene	23	13	56.52%	74	1400	540.38	1,223.61	598.93	µg/kg
DP to GB	Benzo(a)pyrene	27	11	40.74%	134	1700	504.09	2,086.85	1,314.61	µg/kg
LLBdM	Benzo(b)fluoranthene	29	18	62.07%	156	4400	1,389.00	1,470.83	504.58	µg/kg
APP to LR	Benzo(b)fluoranthene	10	7	70.00%	350	900	642.86	885.00	707.97	µg/kg
LR to DP	Benzo(b)fluoranthene	23	16	69.57%	101	3600	995.69	1,095.96	504.31	µg/kg
DP to GB	Benzo(b)fluoranthene	27	24	88.89%	83.5	3300	1,589.31	1,838.65	1,146.81	µg/kg
LLBdM	Benzo(g,h,i)perylene	29	17	58.62%	104	3700	1,311.47	1,345.28	414.30	µg/kg
APP to LR	Benzo(g,h,i)perylene	10	9	90.00%	250	660	446.67	722.00	514.69	µg/kg
LR to DP	Benzo(g,h,i)perylene	23	17	73.91%	200	3000	832.35	953.65	431.98	µg/kg
DP to GB	Benzo(g,h,i)perylene	27	21	77.78%	80	8330	1,629.24	2,039.41	1,158.73	µg/kg
LLBdM	Benzo(k)fluoranthene	26	9	34.62%	76.9	2600	908.88	1,492.46	379.01	µg/kg
APP to LR	Benzo(k)fluoranthene	10	8	80.00%	420	1600	818.75	1,025.00	823.76	µg/kg
LR to DP	Benzo(k)fluoranthene	23	13	56.52%	200	1200	481.54	1,084.96	452.66	µg/kg
DP to GB	Benzo(k)fluoranthene	27	11	40.74%	50.7	800	361.25	2,028.66	1,111.06	µg/kg
LLBdM	Chrysene	29	17	58.62%	71	3800	858.76	1,281.69	478.92	µg/kg
APP to LR	Chrysene	10	10	100.00%	540	2100	972.00	972.00	887.36	µg/kg
LR to DP	Chrysene	23	21	91.30%	79	1400	530.48	487.30	363.20	µg/kg
DP to GB	Chrysene	27	20	74.07%	194	1200	582.00	1,303.33	838.54	µg/kg
LLBdM	Dibenz(a,h)anthracene	26	8	30.77%	30.9	320	129.08	1,457.79	292.69	µg/kg
APP to LR	Dibenz(a,h)anthracene	10	5	50.00%	95	260	165.00	617.50	342.03	µg/kg
LR to DP	Dibenz(a,h)anthracene	23	10	43.48%	66.1	210	116.11	975.92	257.09	µg/kg
DP to GB	Dibenz(a,h)anthracene	26	7	26.92%	12.9	150	77.04	1,978.84	637.81	µg/kg
LLBdM	Fluoranthene	29	15	51.72%	174	6500	1,174.53	1,632.07	613.32	µg/kg
APP to LR	Fluoranthene	10	10	100.00%	580	2300	1,225.00	1,225.00	1,100.44	µg/kg
LR to DP	Fluoranthene	23	15	65.22%	240	2400	670.67	1,114.09	543.69	µg/kg
DP to GB	Fluoranthene	27	20	74.07%	274	1600	731.95	1,332.93	975.27	µg/kg

Table 5-1. Lower Fox River and Green Bay - Sediment Sampling Results: Summary of Detected Compounds (Continued)

Location Reach/Zone	Parameter	Number of Samples	Number Detected	Percent Detected	Minimum Result	Maximum Result	RI Mean[A]	RA Mean[B]	Logarithmic Mean[C]	Units
LLBdM	Fluorene	28	7	25.00%	15.25	580	119.11	1,308.81	272.01	µg/kg
APP to LR	Fluorene	10	3	30.00%	90	190	146.67	584.85	239.38	µg/kg
LR to DP	Fluorene	23	5	21.74%	64	110	81.00	960.96	217.73	µg/kg
DP to GB	Fluorene	24	6	25.00%	15.25	56.3	37.24	2,129.52	693.91	µg/kg
LLBdM	Indeno(1,2,3-cd)pyrene	29	12	41.38%	68.6	3400	811.72	1,378.23	358.60	µg/kg
APP to LR	Indeno(1,2,3-cd)pyrene	10	9	90.00%	240	660	433.33	710.00	499.33	µg/kg
LR to DP	Indeno(1,2,3-cd)pyrene	23	14	60.87%	140	2900	635.00	943.83	373.52	µg/kg
DP to GB	Indeno(1,2,3-cd)pyrene	27	19	70.37%	125	2600	1,145.63	1,709.89	935.84	µg/kg
LLBdM	Naphthalene	27	5	18.52%	9.5	280	96.80	1,444.04	323.22	µg/kg
APP to LR	Naphthalene	9	4	44.44%	87	180	131.75	653.00	343.25	µg/kg
LR to DP	Naphthalene	22	9	40.91%	73	190	147.56	1,036.59	340.42	µg/kg
DP to GB	Naphthalene	25	7	28.00%	9.5	790	199.94	2,091.38	796.58	µg/kg
LLBdM	1-Methylnaphthalene	2	2	100.00%	24.5	24.5	24.50	24.50	24.50	µg/kg
DP to GB	1-Methylnaphthalene	3	3	100.00%	15.3	84.4	53.60	53.60	42.89	µg/kg
LLBdM	2-Methylnaphthalene	27	5	18.52%	18.35	200	136.67	1,480.09	474.51	µg/kg
APP to LR	2-Methylnaphthalene	9	4	44.44%	66	190	129.00	651.78	334.88	µg/kg
LR to DP	2-Methylnaphthalene	22	9	40.91%	84	430	190.00	1,069.59	409.74	µg/kg
DP to GB	2-Methylnaphthalene	23	4	17.39%	14.4	134	80.10	2,226.76	832.71	µg/kg
LLBdM	Phenanthrene	29	13	44.83%	220	4700	835.31	1,412.24	504.14	µg/kg
APP to LR	Phenanthrene	10	9	90.00%	280	1700	794.44	1,035.00	762.34	µg/kg
LR to DP	Phenanthrene	23	14	60.87%	200	1100	427.14	1,048.09	482.09	µg/kg
DP to GB	Phenanthrene	27	12	44.44%	157	1600	550.17	2,031.56	1,261.49	µg/kg
LLBdM	Pyrene	29	20	68.97%	162	7000	1,251.45	1,346.38	517.08	µg/kg
APP to LR	Pyrene	10	10	100.00%	810	3000	1,572.00	1,572.00	1,383.42	µg/kg
LR to DP	Pyrene	23	21	91.30%	80	1800	848.14	777.52	539.41	µg/kg
DP to GB	Pyrene	27	22	81.48%	335	1400	745.32	1,098.04	886.67	µg/kg
Inorganic Compounds										
LLBdM	Aluminum	24	24	100.00%	10860	22900	10,596.25	10,596.25	7,306.10	mg/kg
APP to LR	Aluminum	5	5	100.00%	5600	7500	6,700.00	6,700.00	6,637.13	mg/kg
LR to DP	Aluminum	12	12	100.00%	4500	23300	12,619.17	12,619.17	11,552.90	mg/kg
DP to GB	Aluminum	18	18	100.00%	3200	57000	13,422.22	13,422.22	9,621.52	mg/kg
LLBdM	Ammonia	33	33	100.00%	25	282	95.00	95.00	76.38	mg-N/kg
APP to LR	Ammonia	1	1	100.00%	340	340	340.00	340.00	0.00	mg/kg
LR to DP	Ammonia	21	21	100.00%	96.4	700	315.83	315.83	288.33	mg-N/kg
DP to GB	Ammonia	4	4	100.00%	68.5	590	276.13	276.13	189.30	mg/kg
LLBdM	Ammonia as N	10	10	100.00%	160	300	239.00	239.00	233.36	mg/kg
APP to LR	Ammonia as N	5	5	100.00%	87	180	124.00	124.00	119.17	mg/kg
LR to DP	Ammonia as N	8	8	100.00%	63	410	241.63	241.63	212.76	mg/kg
DP to GB	Ammonia as N	16	15	93.75%	80	390	168.67	160.13	141.32	mg/kg

Table 5-1. Lower Fox River and Green Bay - Sediment Sampling Results: Summary of Detected Compounds (Continued)

Location Reach/Zone	Parameter	Number of Samples	Number Detected	Percent Detected	Minimum Result	Maximum Result	RI Mean[A]	RA Mean[B]	Logarithmic Mean[C]	Units
LLBdM	Antimony	27	8	29.63%	0.562	25	6.57	4.13	1.41	mg/kg
APP to LR	Antimony	6	1	16.67%	25	25	25.00	5.00	1.70	mg/kg
LR to DP	Antimony	13	3	23.08%	0.308	25	9.84	2.94	0.78	mg/kg
DP to GB	Antimony	22	7	31.82%	1	25	8.73	3.55	1.82	mg/kg
LLBdM	Arsenic	31	28	90.32%	1.27	6.8	4.75	4.58	4.21	mg/kg
APP to LR	Arsenic	10	6	60.00%	2.8	9.7	5.36	4.44	3.95	mg/kg
LR to DP	Arsenic	23	21	91.30%	2.17	7.6	4.76	4.64	4.42	mg/kg
DP to GB	Arsenic	107	81	75.70%	0.8	385.567	11.66	9.47	5.35	mg/kg
LLBdM	Barium	24	23	95.83%	14.2	590	105.63	101.23	61.52	mg/kg
APP to LR	Barium	5	5	100.00%	51	73	58.20	58.20	57.74	mg/kg
LR to DP	Barium	12	12	100.00%	35	128	81.86	81.86	76.98	mg/kg
DP to GB	Barium	30	30	100.00%	24	400	109.87	109.87	86.23	mg/kg
LLBdM	Beryllium	27	27	100.00%	0.22	1.31	0.70	0.70	0.62	mg/kg
APP to LR	Beryllium	6	6	100.00%	0.31	0.64	0.52	0.52	0.50	mg/kg
LR to DP	Beryllium	13	12	92.31%	0.17	1.38	0.67	0.64	0.53	mg/kg
DP to GB	Beryllium	23	23	100.00%	0.25	1	0.61	0.61	0.57	mg/kg
LLBdM	Cadmium	31	26	83.87%	0.51	12.5	3.48	3.07	2.04	mg/kg
APP to LR	Cadmium	10	9	90.00%	0.5	2	0.97	0.90	0.79	mg/kg
LR to DP	Cadmium	23	23	100.00%	0.5	7.54	2.44	2.44	1.75	mg/kg
DP to GB	Cadmium	107	89	83.18%	0.43	10.8	1.42	1.22	0.96	mg/kg
LLBdM	Calcium	24	24	100.00%	75300	92700	56,286.46	56,286.46	42,145.83	mg/kg
APP to LR	Calcium	5	5	100.00%	28000	140000	58,400.00	58,400.00	48,669.17	mg/kg
LR to DP	Calcium	12	12	100.00%	47000	50000	29,839.17	29,839.17	7,644.91	mg/kg
DP to GB	Calcium	18	18	100.00%	24000	62000	40,111.11	40,111.11	39,084.03	mg/kg
DP to GB	Cerium	2	2	100.00%	51	62	56.50	56.50	56.23	mg/kg
LLBdM	Chromium	31	31	100.00%	5.12	89	47.86	47.86	42.49	mg/kg
APP to LR	Chromium	10	10	100.00%	20	95	50.40	50.40	44.59	mg/kg
LR to DP	Chromium	23	23	100.00%	21.7	420	73.25	73.25	58.19	mg/kg
DP to GB	Chromium	107	107	100.00%	4.6	220	63.03	63.03	51.36	mg/kg
LLBdM	Cobalt	24	24	100.00%	4.32	12	7.85	7.85	7.57	mg/kg
APP to LR	Cobalt	5	5	100.00%	3.8	8.9	6.20	6.20	5.82	mg/kg
LR to DP	Cobalt	12	12	100.00%	4.8	8.7	6.56	6.56	6.44	mg/kg
DP to GB	Cobalt	18	18	100.00%	4.2	12	5.84	5.84	5.58	mg/kg
LLBdM	Copper	31	31	100.00%	3.5	210	73.85	73.85	58.75	mg/kg
APP to LR	Copper	10	10	100.00%	28	119	63.50	63.50	58.58	mg/kg
LR to DP	Copper	23	23	100.00%	26.9	149	81.47	81.47	76.53	mg/kg
DP to GB	Copper	107	107	100.00%	4.1	160	60.98	60.98	51.80	mg/kg
LLBdM	Iron	24	24	100.00%	23200	32900	17,695.13	17,695.13	13,002.37	mg/kg
APP to LR	Iron	5	5	100.00%	9400	15000	11,880.00	11,880.00	11,707.62	mg/kg

Table 5-1. Lower Fox River and Green Bay - Sediment Sampling Results: Summary of Detected Compounds (Continued)

Location Reach/Zone	Parameter	Number of Samples	Number Detected	Percent Detected	Minimum Result	Maximum Result	RI Mean[A]	RA Mean[B]	Logarithmic Mean[C]	Units
LR to DP	Iron	12	12	100.00%	14400	25000	12,098.17	12,098.17	3,101.06	mg/kg
DP to GB	Iron	30	30	100.00%	7000	29000	16,023.33	16,023.33	15,175.69	mg/kg
LLBdM	Lead	31	31	100.00%	3.54	549	167.83	167.83	70.78	mg/kg
APP to LR	Lead	10	10	100.00%	44	130	75.60	75.60	72.80	mg/kg
LR to DP	Lead	23	23	100.00%	2.25	1400	138.65	138.65	58.76	mg/kg
DP to GB	Lead	107	107	100.00%	4.44	350	85.04	85.04	70.56	mg/kg
LLBdM	Magnesium	24	24	100.00%	38500	71500	27,322.42	27,322.42	19,627.28	mg/kg
APP to LR	Magnesium	5	5	100.00%	12000	18000	15,400.00	15,400.00	15,200.54	mg/kg
LR to DP	Magnesium	12	12	100.00%	28700	24000	13,783.25	13,783.25	3,733.98	mg/kg
DP to GB	Magnesium	18	18	100.00%	11000	26000	17,111.11	17,111.11	16,752.96	mg/kg
LLBdM	Manganese	24	24	100.00%	210	1390	410.42	410.42	373.78	mg/kg
APP to LR	Manganese	5	5	100.00%	200	290	242.00	242.00	240.00	mg/kg
LR to DP	Manganese	12	12	100.00%	220	465	340.33	340.33	333.01	mg/kg
DP to GB	Manganese	30	30	100.00%	150	670	302.67	302.67	288.36	mg/kg
LLBdM	Mercury	117	99	84.62%	0.00275	5.43	1.14	0.99	0.59	mg/kg
APP to LR	Mercury	10	10	100.00%	0.17	2.1	0.77	0.77	0.56	mg/kg
LR to DP	Mercury	146	142	97.26%	0.0109	9.82	2.34	2.28	1.28	mg/kg
DP to GB	Mercury	95	92	96.84%	0.1	7.7	1.07	1.04	0.79	mg/kg
LLBdM	Nickel	31	31	100.00%	4.07	29.1	17.93	17.93	16.91	mg/kg
APP to LR	Nickel	10	10	100.00%	9	21	15.10	15.10	14.73	mg/kg
LR to DP	Nickel	23	23	100.00%	8.9	28	18.55	18.55	17.93	mg/kg
DP to GB	Nickel	107	107	100.00%	3.2	112.113	18.13	18.13	16.43	mg/kg
DP to GB	Nitrogen, NO3 + NO2	12	11	91.67%	0.41	100	9.77	8.99	0.89	mg/L
LLBdM	Potassium	24	24	100.00%	620	4710	1,866.50	1,866.50	1,650.36	mg/kg
APP to LR	Potassium	5	5	100.00%	780	1200	1,034.00	1,034.00	1,019.17	mg/kg
LR to DP	Potassium	12	12	100.00%	760	3590	1,970.00	1,970.00	1,826.38	mg/kg
DP to GB	Potassium	18	18	100.00%	460	22000	3,660.56	3,660.56	1,784.29	mg/kg
LLBdM	Selenium	27	12	44.44%	0.149	3	0.92	0.95	0.61	mg/kg
APP to LR	Selenium	6	5	83.33%	0.83	3.2	2.23	1.98	1.70	mg/kg
LR to DP	Selenium	13	4	30.77%	0.119	2.3	0.95	0.93	0.54	mg/kg
DP to GB	Selenium	102	16	15.69%	0.14	391.592	26.26	6.28	2.22	mg/kg
LLBdM	Silver	27	9	33.33%	0.7	1.7	1.34	1.04	0.81	mg/kg
LR to DP	Silver	13	2	15.38%	0.66	1.12	0.89	0.55	0.48	mg/kg
DP to GB	Silver	89	30	33.71%	0.54	9.6	1.17	0.64	0.47	mg/kg
LLBdM	Sodium	24	23	95.83%	200	2470	1,035.74	1,004.25	780.82	mg/kg
APP to LR	Sodium	5	5	100.00%	220	2200	704.00	704.00	468.11	mg/kg
LR to DP	Sodium	12	12	100.00%	32.3	590	320.63	320.63	244.46	mg/kg
DP to GB	Sodium	18	18	100.00%	62	5200	984.06	984.06	500.53	mg/kg
LLBdM	Thallium	27	3	11.11%	25	25	25.00	3.36	0.61	mg/kg

Table 5-1. Lower Fox River and Green Bay - Sediment Sampling Results: Summary of Detected Compounds (Continued)

Location Reach/Zone	Parameter	Number of Samples	Number Detected	Percent Detected	Minimum Result	Maximum Result	RI Mean[A]	RA Mean[B]	Logarithmic Mean[C]	Units
APP to LR	Thallium	6	1	16.67%	25	25	25.00	4.85	1.44	mg/kg
LR to DP	Thallium	13	3	23.08%	0.193	25	9.13	2.70	0.71	mg/kg
DP to GB	Thallium	21	6	28.57%	2	25	17.43	6.20	2.09	mg/kg
DP to GB	Total Phosphorus	12	12	100.00%	2000	6300	3,866.67	3,866.67	3,676.33	mg/kg
LLBdM	Vanadium	24	24	100.00%	7.04	39.4	25.11	25.11	23.63	mg/kg
APP to LR	Vanadium	5	5	100.00%	16	23	19.60	19.60	19.41	mg/kg
LR to DP	Vanadium	12	12	100.00%	14	36.9	27.17	27.17	26.42	mg/kg
DP to GB	Vanadium	18	18	100.00%	9.6	61	25.09	25.09	22.33	mg/kg
LLBdM	Zinc	28	28	100.00%	11.2	2050	421.00	421.00	244.58	mg/kg
APP to LR	Zinc	10	10	100.00%	83	180	122.80	122.80	119.10	mg/kg
LR to DP	Zinc	23	23	100.00%	56.8	330	162.12	162.12	150.37	mg/kg
DP to GB	Zinc	103	103	100.00%	11.2	485	162.46	162.46	138.43	mg/kg
Toxicity Characteristic Leaching Procedure (TCLP) Results - Inorganic Compounds										
LLBdM	Arsenic, TCLP	9	9	100.00%	0.003	0.012	0.01	0.01	0.01	mg/L
LR to DP	Arsenic, TCLP	4	4	100.00%	0.007	0.031	0.02	0.02	0.02	mg/L
LLBdM	Barium, TCLP	9	9	100.00%	0.357	0.936	0.68	0.68	0.66	mg/L
LR to DP	Barium, TCLP	4	4	100.00%	0.255	0.789	0.54	0.54	0.50	mg/L
LLBdM	Cadmium, TCLP	9	2	22.22%	0.01	0.01	0.01	0.01	0.01	mg/L
LR to DP	Cadmium, TCLP	4	3	75.00%	0.01	0.01	0.01	0.01	0.01	mg/L
LLBdM	Chromium, TCLP	9	5	55.56%	0.01	0.2	0.07	0.04	0.01	mg/L
LR to DP	Chromium, TCLP	4	3	75.00%	0.01	0.01	0.01	0.01	0.01	mg/L
LLBdM	Lead, TCLP	9	6	66.67%	0.06	0.27	0.16	0.11	0.08	mg/L
LR to DP	Lead, TCLP	4	3	75.00%	0.07	0.16	0.11	0.09	0.07	mg/L
LLBdM	Mercury, TCLP	9	2	22.22%	0.0005	0.0005	0.00	0.00	0.00	mg/L
LLBdM	Silver, TCLP	9	9	100.00%	0.02	0.03	0.02	0.02	0.02	mg/L
LR to DP	Silver, TCLP	4	3	75.00%	0.02	0.03	0.02	0.02	0.02	mg/L
Cyanide Results										
LLBdM	Cyanide	14	2	14.29%	0.35	0.64	0.50	0.32	0.24	mg/kg
DP to GB	Cyanide	12	3	25.00%	0.73	3	1.64	1.12	1.03	mg/kg
Miscellaneous Parameters Detected in Less than 4 Samples (These parameters are not included on other Tables)										
DP to GB	1,2,4-Trichlorobenzene	22	1	4.55%	14	14	14.00	2,315.89	790.99	ug/kg
LR to DP	1,2,4-Trichlorobenzene	22	1	4.55%	120	120	120.00	991.73	194.07	ug/kg
DP to GB	1,2-Dimethylnaphthalene	2	2	100.00%	23	220	121.50	121.50	71.13	ug/kg
DP to GB	1,6-Dimethylnaphthalene	2	2	100.00%	160	650	405.00	405.00	322.49	ug/kg
DP to GB	1-Methyl-9H-fluorene	2	1	50.00%	210	210	210.00	117.50	72.46	ug/kg
DP to GB	1-Methylphenanthrene	2	2	100.00%	59	620	339.50	339.50	191.26	ug/kg
DP to GB	1-Methylpyrene	2	2	100.00%	51	630	340.50	340.50	179.25	ug/kg
DP to GB	2,3,6-Trimethylnaphthalene	2	2	100.00%	32	260	146.00	146.00	91.21	ug/kg
DP to GB	2,6-Dimethylnaphthalene	2	2	100.00%	190	560	375.00	375.00	326.19	ug/kg

Table 5-1. Lower Fox River and Green Bay - Sediment Sampling Results: Summary of Detected Compounds (Continued)

Location Reach/Zone	Parameter	Number of Samples	Number Detected	Percent Detected	Minimum Result	Maximum Result	RI Mean[A]	RA Mean[B]	Logarithmic Mean[C]	Units
LLBdM	2-Butanone	3	3	100.00%	26	71	44.33	44.33	40.51	ug/kg
DP to GB	2-Methylanthracene	2	2	100.00%	26	490	258.00	258.00	112.87	ug/kg
DP to GB	4,5-Methylenephenanthrene	2	1	50.00%	55	55	55.00	40.00	37.08	ug/kg
DP to GB	9H-Fluorene	2	2	100.00%	68	270	169.00	169.00	135.50	ug/kg
LLBdM	Acetone	3	1	33.33%	450	450	450.00	169.00	63.61	ug/kg
LR to DP	alpha-BHC	23	1	4.35%	2.2	2.2	2.20	4.53	2.00	ug/kg
LLBdM	alpha-Chlordane	26	2	7.69%	9	25	17.00	8.46	3.36	ug/kg
LR to DP	alpha-Chlordane	22	1	4.55%	2.3	2.3	2.30	4.67	2.20	ug/kg
APP to LR	Benzo(e)pyrene	1	1	100.00%	980	980	980.00	980.00	0.00	ug/kg
DP to GB	Benzo(e)pyrene	1	1	100.00%	720	720	720.00	720.00	0.00	ug/kg
LLBdM	Benzo(e)pyrene	1	1	100.00%	480	480	480.00	480.00	0.00	ug/kg
LR to DP	Benzo(e)pyrene	1	1	100.00%	1600	1600	1,600.00	1,600.00	0.00	ug/kg
LLBdM	beta-BHC	27	2	7.41%	5.8	22	13.90	7.96	3.09	ug/kg
LLBdM	Butylbenzylphthalate	22	1	4.55%	81	81	81.00	1,673.50	201.42	ug/kg
DP to GB	C8-Alkylphenol	2	1	50.00%	11	11	11.00	18.00	16.58	ug/kg
LLBdM	Carbon Disulfide	3	1	33.33%	69	69	69.00	33.50	25.51	ug/kg
APP to LR	Dibenzofuran	9	1	11.11%	120	120	120.00	617.56	210.15	ug/kg
DP to GB	Dibenzofuran	20	1	5.00%	31	31	31.00	2,546.30	1,190.80	ug/kg
LLBdM	Dibenzofuran	25	1	4.00%	86	86	86.00	1,579.98	471.87	ug/kg
DP to GB	Dibenzothiophene	2	2	100.00%	38	110	74.00	74.00	64.65	ug/kg
DP to GB	Diethylphthalate	22	1	4.55%	480	480	480.00	2,337.50	949.27	ug/kg
LLBdM	Diethylphthalate	23	2	8.70%	120	540	330.00	1,629.15	249.40	ug/kg
LLBdM	di-n-Butylphthalate	22	2	9.09%	240	890	565.00	1,608.02	320.93	ug/kg
LLBdM	Endrin	19	2	10.53%	16	44	30.00	42.11	11.54	ug/kg
DP to GB	Gallium	2	2	100.00%	15	25	20.00	20.00	19.36	mg/kg
LLBdM	gamma-Chlordane	26	3	11.54%	7.4	46	20.87	10.48	4.77	ug/kg
LLBdM	Heptachlor epoxide	24	1	4.17%	4.3	4.3	4.30	8.03	3.14	ug/kg
DP to GB	Isoquinoline	2	1	50.00%	20	20	20.00	22.50	22.36	ug/kg
DP to GB	Lanthanum	2	2	100.00%	26	32	29.00	29.00	28.84	mg/kg
DP to GB	Lithium	2	2	100.00%	30	30	30.00	30.00	30.00	mg/kg
DP to GB	Methoxychlor	21	1	4.76%	11	11	11.00	38.77	29.37	ug/kg
LR to DP	Methoxychlor	22	2	9.09%	6.1	98	52.05	47.38	17.59	ug/kg
DP to GB	Neodymium	2	2	100.00%	24	25	24.50	24.50	24.49	mg/kg
DP to GB	p-Cresol	2	2	100.00%	440	550	495.00	495.00	491.93	ug/kg
APP to LR	Perylene	1	1	100.00%	230	230	230.00	230.00	0.00	ug/kg
DP to GB	Perylene	1	1	100.00%	50	50	50.00	50.00	0.00	ug/kg
LLBdM	Perylene	1	1	100.00%	140	140	140.00	140.00	0.00	ug/kg
LR to DP	Perylene	1	1	100.00%	290	290	290.00	290.00	0.00	ug/kg
DP to GB	Phosphorus	2	2	100.00%	0.15	0.15	0.15	0.15	0.15	percent

Table 5-1. Lower Fox River and Green Bay - Sediment Sampling Results: Summary of Detected Compounds (Continued)

Location Reach/Zone	Parameter	Number of Samples	Number Detected	Percent Detected	Minimum Result	Maximum Result	RI Mean[A]	RA Mean[B]	Logarithmic Mean[C]	Units
DP to GB	Quinoline	2	1	50.00%	18	18	18.00	21.50	21.21	ug/kg
DP to GB	Quinoline	2	1	50.00%	18	18	18.00	21.50	21.21	ug/kg
DP to GB	Scandium	2	2	100.00%	9	10	9.50	9.50	9.49	mg/kg
DP to GB	Strontium	2	2	100.00%	150	150	150.00	150.00	150.00	mg/kg
LLBdM	Tetrachloroethene	3	1	33.33%	0.6	0.6	0.60	10.70	5.25	ug/kg
DP to GB	Titanium	2	2	100.00%	0.3	0.32	0.31	0.31	0.31	mg/kg
DP to GB	Ytterbium	2	2	100.00%	2	2	2.00	2.00	2.00	mg/kg
DP to GB	Yttrium	2	2	100.00%	16	19	17.50	17.50	17.44	mg/kg
GREEN BAY RESULTS										
PCB Results										
GB Zone 2	Total PCBs	49	48	97.96%	15	799	324.47	318.54	216.67	ug/kg
GB Zone 3A	Total PCBs	180	157	87.22%	4	1017	322.20	297.50	156.25	ug/kg
GB Zone 3B	Total PCBs	424	418	98.58%	2	1302	447.77	442.99	257.12	ug/kg
GB Zone 4	Total PCBs	203	199	98.03%	1	751	54.31	53.92	25.71	ug/kg
GB Zone 2	Ar1242	11	10	90.91%	26	460	190.30	176.09	116.17	ug/kg
GB Zone 3A	Ar1242	26	3	11.54%	38	990	432.67	163.94	104.24	ug/kg
GB Zone 3B	Ar1242	20	14	70.00%	50	220	134.36	127.05	117.02	ug/kg
GB Zone 3B	Ar1260	20	10	50.00%	21	93	55.20	76.20	67.07	ug/kg
GB Zone 2	PCB Congener 105	11	10	90.91%	0.072	5.2	2.02	1.88	0.94	ug/kg
GB Zone 3A	PCB Congener 105	2	1	50.00%	1.6	1.6	1.60	0.81	0.20	ug/kg
GB Zone 3B	PCB Congener 105	4	4	100.00%	0.31	1.1	0.57	0.57	0.50	ug/kg
GB Zone 4	PCB Congener 105	4	2	50.00%	0.017	0.079	0.05	0.05	0.04	ug/kg
GB Zone 2	PCB Congener 118	49	48	97.96%	0.12	16.887	6.16	6.04	3.52	ug/kg
GB Zone 3A	PCB Congener 118	156	152	97.44%	0.013	32.032	6.29	6.18	2.73	ug/kg
GB Zone 3B	PCB Congener 118	408	401	98.28%	0.04	45.486	11.28	11.09	5.19	ug/kg
GB Zone 4	PCB Congener 118	205	178	86.83%	0.008	25.712	1.93	1.69	0.60	ug/kg
GB Zone 2	PCB Congener 126	11	5	45.45%	0.012	0.082	0.05	0.04	0.04	ug/kg
GB Zone 2	PCB Congener 132/153/105	38	38	100.00%	0.465	21.658	9.00	9.00	6.21	ug/kg
GB Zone 3A	PCB Congener 132/153/105	154	153	99.35%	0.111	36.182	9.15	9.09	4.53	ug/kg
GB Zone 3B	PCB Congener 132/153/105	404	398	98.51%	0.048	52.187	15.00	14.78	7.90	ug/kg
GB Zone 4	PCB Congener 132/153/105	201	180	89.55%	0.027	30.381	2.76	2.50	1.02	ug/kg
GB Zone 2	PCB Congener 77	11	11	100.00%	0.078	9.2	3.23	3.23	1.45	ug/kg
GB Zone 3A	PCB Congener 77	2	2	100.00%	0.017	0.067	0.04	0.04	0.03	ug/kg
GB Zone 3B	PCB Congener 77	4	4	100.00%	0.33	1.4	0.61	0.61	0.49	ug/kg
GB Zone 4	PCB Congener 77	4	2	50.00%	0.013	0.037	0.03	0.04	0.03	ug/kg
GB Zone 2	PCB Congener 77/110	38	38	100.00%	0.546	24.886	10.38	10.38	7.42	ug/kg
GB Zone 3A	PCB Congener 77/110	154	154	100.00%	0.132	42.259	9.94	9.94	4.95	ug/kg
GB Zone 3B	PCB Congener 77/110	404	403	99.75%	0.02	57.987	16.08	16.04	8.42	ug/kg
GB Zone 4	PCB Congener 77/110	201	197	98.01%	0.016	27.29	2.05	2.03	0.93	ug/kg

Table 5-1. Lower Fox River and Green Bay - Sediment Sampling Results: Summary of Detected Compounds (Continued)

Location Reach/Zone	Parameter	Number of Samples	Number Detected	Percent Detected	Minimum Result	Maximum Result	RI Mean[A]	RA Mean[B]	Logarithmic Mean[C]	Units
Semi-Volatile Organic Compound (SVOC) Results										
GB Zone 2	4-Methylphenol	11	1	9.09%	96	96	96.00	1,525.55	1,086.24	ug/kg
Polynuclear Aromatic Hydrocarbons (PAHs)										
GB Zone 2	Benzo(a)anthracene	11	1	9.09%	260	260	260.00	1,420.00	997.86	ug/kg
GB Zone 2	Chrysene	11	4	36.36%	280	440	355.00	880.00	609.86	ug/kg
GB Zone 2	Fluoranthene	11	3	27.27%	370	440	403.33	1,106.36	762.38	ug/kg
GB Zone 2	Pyrene	11	5	45.45%	98	520	377.60	872.55	568.76	ug/kg
Inorganic Compounds										
GB Zone 2	Aluminum	11	11	100.00%	680	7600	3,880.00	3,880.00	3,212.27	mg/kg
GB Zone 3A	Aluminum	2	2	100.00%	460	540	500.00	500.00	498.40	mg/kg
GB Zone 3B	Aluminum	4	4	100.00%	2500	13000	6,075.00	6,075.00	5,008.38	mg/kg
GB Zone 4	Aluminum	4	4	100.00%	410	840	647.50	647.50	621.96	mg/kg
GB Zone 2	Ammonia as N	11	10	90.91%	32	130	74.30	69.23	59.44	mg/kg
GB Zone 3A	Ammonia as N	2	2	100.00%	69	77	73.00	73.00	72.89	mg/kg
GB Zone 3B	Ammonia as N	4	3	75.00%	43	140	90.33	75.13	62.87	mg/kg
GB Zone 4	Ammonia as N	4	4	100.00%	22	62	40.50	40.50	37.44	mg/kg
GB Zone 3B	Antimony	4	1	25.00%	1.5	1.5	1.50	1.49	1.46	mg/kg
GB Zone 4	Antimony	4	1	25.00%	1	1	1.00	0.56	0.51	mg/kg
GB Zone 2	Arsenic	11	10	90.91%	1	3.2	2.25	2.07	1.78	mg/kg
GB Zone 3A	Arsenic	2	2	100.00%	1.4	1.6	1.50	1.50	1.50	mg/kg
GB Zone 3B	Arsenic	4	4	100.00%	3.6	15	8.58	8.58	7.59	mg/kg
GB Zone 4	Arsenic	4	4	100.00%	1.4	8.9	4.98	4.98	4.11	mg/kg
GB Zone 2	Barium	11	11	100.00%	4.9	40	23.32	23.32	19.75	mg/kg
GB Zone 3A	Barium	2	2	100.00%	3.4	5.3	4.35	4.35	4.24	mg/kg
GB Zone 3B	Barium	4	4	100.00%	14	120	52.75	52.75	39.72	mg/kg
GB Zone 4	Barium	4	4	100.00%	4.2	7.2	5.83	5.83	5.72	mg/kg
GB Zone 2	Beryllium	11	10	90.91%	0.048	0.33	0.20	0.19	0.13	mg/kg
GB Zone 3A	Beryllium	2	1	50.00%	0.065	0.065	0.07	0.05	0.05	mg/kg
GB Zone 3B	Beryllium	4	4	100.00%	0.18	0.83	0.42	0.42	0.36	mg/kg
GB Zone 4	Beryllium	4	1	25.00%	0.1	0.1	0.10	0.04	0.03	mg/kg
GB Zone 2	Cadmium	11	8	72.73%	0.097	0.79	0.40	0.30	0.18	mg/kg
GB Zone 3B	Cadmium	4	4	100.00%	0.18	0.81	0.56	0.56	0.49	mg/kg
GB Zone 4	Cadmium	4	1	25.00%	0.067	0.067	0.07	0.03	0.03	mg/kg
GB Zone 2	Calcium	11	11	100.00%	1500	54000	24,863.64	24,863.64	18,880.18	mg/kg
GB Zone 3A	Calcium	2	2	100.00%	3400	4300	3,850.00	3,850.00	3,823.61	mg/kg
GB Zone 3B	Calcium	4	4	100.00%	15000	93000	51,000.00	51,000.00	42,322.91	mg/kg
GB Zone 4	Calcium	4	4	100.00%	2300	23000	11,625.00	11,625.00	8,545.33	mg/kg
GB Zone 2	Chromium	11	11	100.00%	2.4	36	17.83	17.83	13.81	mg/kg
GB Zone 3A	Chromium	2	2	100.00%	1.6	2.7	2.15	2.15	2.08	mg/kg

Table 5-1. Lower Fox River and Green Bay - Sediment Sampling Results: Summary of Detected Compounds (Continued)

Location Reach/Zone	Parameter	Number of Samples	Number Detected	Percent Detected	Minimum Result	Maximum Result	RI Mean[A]	RA Mean[B]	Logarithmic Mean[C]	Units
GB Zone 3B	Chromium	4	4	100.00%	8.4	40	22.35	22.35	19.38	mg/kg
GB Zone 4	Chromium	4	4	100.00%	2.6	4.9	3.88	3.88	3.76	mg/kg
GB Zone 2	Cobalt	11	11	100.00%	0.41	5.1	3.12	3.12	2.62	mg/kg
GB Zone 3A	Cobalt	2	2	100.00%	0.5	0.62	0.56	0.56	0.56	mg/kg
GB Zone 3B	Cobalt	4	4	100.00%	2.3	7.8	4.15	4.15	3.71	mg/kg
GB Zone 4	Cobalt	4	4	100.00%	0.48	1.3	0.76	0.76	0.70	mg/kg
GB Zone 2	Copper	11	10	90.91%	7.9	35	18.96	17.30	12.55	mg/kg
GB Zone 3A	Copper	2	2	100.00%	1.1	1.3	1.20	1.20	1.20	mg/kg
GB Zone 3B	Copper	4	4	100.00%	5.9	36	17.23	17.23	14.02	mg/kg
GB Zone 4	Copper	4	4	100.00%	1.2	3.2	1.88	1.88	1.74	mg/kg
GB Zone 2	Iron	11	11	100.00%	1200	12000	6,954.55	6,954.55	5,894.39	mg/kg
GB Zone 3A	Iron	2	2	100.00%	1600	1900	1,750.00	1,750.00	1,743.56	mg/kg
GB Zone 3B	Iron	4	4	100.00%	5600	26000	15,400.00	15,400.00	13,453.52	mg/kg
GB Zone 4	Iron	4	4	100.00%	2300	7500	4,650.00	4,650.00	4,272.67	mg/kg
GB Zone 2	Lead	11	11	100.00%	2	42	19.73	19.73	13.80	mg/kg
GB Zone 3A	Lead	2	2	100.00%	1.1	1.9	1.50	1.50	1.45	mg/kg
GB Zone 3B	Lead	4	4	100.00%	9.6	50	29.90	29.90	25.61	mg/kg
GB Zone 4	Lead	4	4	100.00%	2.1	4.5	3.10	3.10	2.93	mg/kg
GB Zone 2	Magnesium	11	11	100.00%	670	30000	13,197.27	13,197.27	9,673.11	mg/kg
GB Zone 3A	Magnesium	2	2	100.00%	1700	2300	2,000.00	2,000.00	1,977.37	mg/kg
GB Zone 3B	Magnesium	4	4	100.00%	9800	54000	29,950.00	29,950.00	25,371.46	mg/kg
GB Zone 4	Magnesium	4	4	100.00%	1200	13000	6,325.00	6,325.00	4,546.11	mg/kg
GB Zone 2	Manganese	11	11	100.00%	26	300	177.82	177.82	153.10	mg/kg
GB Zone 3A	Manganese	2	2	100.00%	31	77	54.00	54.00	48.86	mg/kg
GB Zone 3B	Manganese	4	4	100.00%	400	1900	830.00	830.00	666.79	mg/kg
GB Zone 4	Manganese	4	4	100.00%	65	150	108.75	108.75	104.22	mg/kg
GB Zone 2	Mercury	11	9	81.82%	0.11	1.5	0.59	0.49	0.24	mg/kg
GB Zone 3B	Mercury	4	1	25.00%	0.19	0.19	0.19	0.11	0.09	mg/kg
GB Zone 4	Mercury	4	1	25.00%	0.11	0.11	0.11	0.05	0.04	mg/kg
GB Zone 2	Nickel	11	11	100.00%	1.4	12	7.08	7.08	6.07	mg/kg
GB Zone 3A	Nickel	2	2	100.00%	1.3	1.4	1.35	1.35	1.35	mg/kg
GB Zone 3B	Nickel	4	4	100.00%	4.6	23	12.15	12.15	10.39	mg/kg
GB Zone 4	Nickel	4	4	100.00%	1.6	2.3	2.00	2.00	1.98	mg/kg
GB Zone 2	Potassium	11	11	100.00%	90	1600	650.00	650.00	495.42	mg/kg
GB Zone 3A	Potassium	2	2	100.00%	71	79	75.00	75.00	74.89	mg/kg
GB Zone 3B	Potassium	4	4	100.00%	610	2400	1,155.00	1,155.00	986.91	mg/kg
GB Zone 4	Potassium	4	4	100.00%	60	170	105.50	105.50	95.22	mg/kg
GB Zone 3B	Selenium	4	1	25.00%	0.87	0.87	0.87	1.01	0.98	mg/kg
GB Zone 2	Sodium	11	11	100.00%	87	670	256.09	256.09	203.60	mg/kg

Table 5-1. Lower Fox River and Green Bay - Sediment Sampling Results: Summary of Detected Compounds (Continued)

Location Reach/Zone	Parameter	Number of Samples	Number Detected	Percent Detected	Minimum Result	Maximum Result	RI Mean[A]	RA Mean[B]	Logarithmic Mean[C]	Units
GB Zone 3A	Sodium	2	2	100.00%	130	160	145.00	145.00	144.22	mg/kg
GB Zone 3B	Sodium	4	4	100.00%	210	740	382.50	382.50	335.57	mg/kg
GB Zone 4	Sodium	4	4	100.00%	60	160	112.25	112.25	104.58	mg/kg
GB Zone 2	Vanadium	11	11	100.00%	2.8	20	12.22	12.22	10.83	mg/kg
GB Zone 3A	Vanadium	2	2	100.00%	4.4	5.2	4.80	4.80	4.78	mg/kg
GB Zone 3B	Vanadium	4	4	100.00%	8.2	41	21.30	21.30	18.17	mg/kg
GB Zone 4	Vanadium	4	4	100.00%	6.4	10	7.80	7.80	7.66	mg/kg
GB Zone 2	Zinc	11	11	100.00%	4	110	49.73	49.73	34.97	mg/kg
GB Zone 3A	Zinc	2	2	100.00%	3.9	7.7	5.80	5.80	5.48	mg/kg
GB Zone 3B	Zinc	4	4	100.00%	20	110	63.50	63.50	53.92	mg/kg
GB Zone 4	Zinc	4	4	100.00%	7.2	15	10.00	10.00	9.62	mg/kg

Notes: This table only contains parameters which were sampled and detected in Lower Fox River or Green Bay sediment samples.

A) The RI Mean is the average of all detected sample results.

B) The RA Mean is the average of all detected sample results plus 1/2 the detection limit for samples flagged as non-detect by the laboratory.

C) The Logarithmic Mean was calculated using the RA Mean sample data - this was done because not all sample populations, have a normal distribution. This is especially true for PCBs.

LLBdM - This is the Little Lake Butte des Morts Reach
APP to LR - This is the Appleton to Little Rapids Reach
LR to DP - This is the Little Rapids to DePere
DP to GB - This is the DePere to Green Bay Reach

GB Zone 2 - This is Green Bay Zones 2A & 2B
GB Zone 3A - This is Green Bay Zone 3A
GB Zone 3B - This is Green Bay Zone 3B
GB Zone 4 - This is Green Bay Zone 4

Table 5-2. Lower Fox River and Green Bay - Distribution of Total PCBs in Sediment

Deposit, SMU or Zone	Number of Samples in Selected Concentration Ranges - Total PCBs (µg/kg)									Total Number of		Percent Detected	Detected Values (µg/kg)		Averages (µg/kg)		Logarithmic Mean[C]
	Greater Than or Equal to								Below 50	Samples	Detects		Min.	Max.	RI Mean[A]	RA Mean[B]	
	50,000	10,000	5,000	1,000	500	250	125	50									
Lake Winnebago																	
Reach Totals	0	0	0	0	0	0	0	0	5	5	5	100.00%	6	36	22.00	22.00	17.56
Little Lake Butte des Morts																	
Reach Totals	48	112	55	146	42	41	46	133	38	661	539	81.54%	0	222,722	15,042.95	12,272.77	1,547.92
Deposit A	40	77	30	58	12	18	17	63	3	318	264	83.02%	18	222,722	24,373.31	20,241.28	2,281.54
Deposit B	0	0	0	0	0	2	1	2	0	5	5	100.00%	70	490	229.01	229.01	180.63
Deposit C	3	11	7	9	4	2	3	11	4	54	45	83.33%	5	100,000	11,284.36	9,408.91	1,081.91
Deposit D	1	3	8	26	5	2	2	9	12	68	57	83.82%	2	56,990	4,522.18	3,793.59	535.97
Deposit E	0	9	5	38	15	12	12	40	19	150	113	75.33%	7	45,850	2,962.19	2,237.75	288.28
Deposit F	0	0	0	4	1	3	5	3	0	16	11	68.75%	70	2,200	861.82	610.94	258.95
Deposit G	0	0	0	0	0	0	2	1	0	3	2	66.67%	130	230	180.00	128.33	90.75
Deposit H	0	0	0	2	0	0	0	1	0	3	2	66.67%	1,800	2,100	1,950.00	1,308.33	455.49
Deposit POG	4	12	5	9	5	2	3	1	0	41	39	95.12%	154	113,640	14,312.59	13,618.01	3,723.42
Interdeposit	0	0	0	0	0	0	1	1	0	2	1	50.00%	230	230	230.00	134.00	93.49
Creek Trib.	0	0	0	0	0	0	0	1	0	1	0	0.00%	0	0	0.00	25.00	0.00
Appleton to Little Rapids																	
Reach Totals	6	21	20	49	16	25	31	80	15	263	188	71.48%	0	77,444	6,405.94	4,589.09	1,302.38
Deposit I	0	0	0	1	1	0	0	2	0	4	2	50.00%	760	1,600	1,180.00	602.50	166.04
Deposit J	0	0	0	0	0	0	0	2	0	2	1	50.00%	100	100	100.00	62.50	50.00
Deposit K	0	0	0	0	0	1	0	2	0	3	2	66.67%	80	260	170.00	121.67	80.41
Deposit L	0	0	0	0	0	2	0	1	0	3	2	66.67%	290	290	290.00	201.67	128.11
Deposit M	0	0	0	0	1	0	0	1	0	2	1	50.00%	700	700	700.00	362.50	132.29
Deposit N	4	13	7	12	2	2	2	0	1	43	43	100.00%	35	74,200	16,897.05	16,897.05	5,880.11
Deposit O	0	0	0	2	2	0	1	2	0	7	5	71.43%	180	1,840	920.00	664.29	274.97
Deposit P	0	1	3	6	1	3	1	1	0	16	14	87.50%	310	22,000	4,338.57	3,801.88	1,277.29
Deposit Q	0	4	3	2	0	1	0	2	0	12	10	83.33%	480	22,335	9,576.50	7,984.58	2,298.92
Deposit R	0	0	0	0	0	0	0	2	0	2	0	0.00%	0	0	0.00	25.00	25.00
Deposit S	0	0	0	2	0	0	2	3	0	7	5	71.43%	69	1,400	619.80	449.86	153.85
Deposit T	0	0	4	6	0	0	0	5	0	15	12	80.00%	50	7,800	4,281.67	3,430.33	921.85
Deposit U	0	0	0	1	0	0	1	1	0	3	2	66.67%	120	1,000	560.00	406.67	228.94
Deposit V	0	0	0	4	0	0	0	2	1	7	6	85.71%	39	3,100	1,386.50	1,192.00	388.84
Deposit W	0	0	0	4	7	5	8	13	5	42	28	66.67%	6	3,200	527.07	365.67	123.81
Deposit X	0	1	2	8	2	5	11	15	6	50	33	66.00%	4	27,000	1,701.94	1,138.28	149.95
Deposit Y	0	0	0	0	0	1	0	2	0	3	1	33.33%	370	370	370.00	140.00	61.38
Deposit Z	0	0	0	0	0	1	0	1	0	2	1	50.00%	310	310	310.00	167.50	88.03
Deposit AA	0	0	0	0	0	0	0	1	0	1	0	0.00%	0	0	0.00	25.00	0.00
Deposit BB	0	0	0	0	0	0	1	2	0	3	1	33.33%	130	130	130.00	60.00	43.31
Deposit CC	0	0	0	1	0	1	0	7	0	9	2	22.22%	280	1,500	890.00	217.22	51.53
Deposit DD	0	1	1	0	0	2	4	10	2	20	12	60.00%	0.34	19,000	2,357.45	1,424.47	82.02
Unknowns	2	0	0	0	0	0	0	3	0	5	3	60.00%	56	77,444	42,833.33	25,719.80	884.67
Creek Trib.	0	0	0	0	0	1	0	0	0	1	1	100.00%	340	340	340.00	340.00	0.00
Interdeposit	0	1	0	0	0	0	0	0	0	1	1	100.00%	18,000	18,000	18,000.00	18,000.00	0.00

Notes:

A) Th RI Mean is the average value calculated using all laboratory detected values.

B) The RA Mean is the average value calculated using all laboratory detected results plus 1/2 the detection limit for samples flagged as non-detect by the laboratory.

C) The Logarithmic Mean was calculated using the RA Mean sample data - this was done because not all sample populations have a normal distribution.

Table 5-2. Lower Fox River and Green Bay - Distribution of Total PCBs in Sediment (Continued)

Deposit, SMU or Zone	Number of Samples in Selected Concentration Ranges - Total PCBs (µg/kg)									Total Number of		Percent Detected	Detected Values (µg/kg)		Averages (µg/kg)		Logarithmic Mean[C]
	Greater Than or Equal to								Below 50	Samples	Detects		Min.	Max.	RI Mean[A]	RA Mean[B]	
	50,000	10,000	5,000	1,000	500	250	125	50									
Little Rapids to DePere																	
Reach Totals	1	122	48	128	51	47	58	132	65	652	542	83.13%	0	54,000	6,291.75	5,236.31	797.05
Deposit EE	0	60	33	83	35	39	38	108	51	447	364	81.43%	5	41,000	4,578.62	3,735.19	433.77
Deposit FF	0	4	1	0	1	0	1	3	1	11	9	81.82%	3	27,000	10,560.33	8,647.09	731.80
Deposit GG	0	31	7	12	5	2	7	13	9	86	76	88.37%	42	47,800	10,925.12	9,656.97	1,401.23
Deposit HH	1	17	5	22	2	2	3	2	4	58	53	91.38%	40	54,000	11,078.60	10,126.14	2,544.59
Unknowns	0	2	0	1	0	2	3	3	0	11	9	81.82%	90	25,590	5,067.78	4,150.91	363.66
Creek Trib.	0	0	0	0	0	0	0	2	0	2	0	0.00%	0	0	0.00	25.00	25.00
Interdeposit	0	8	2	10	8	2	6	1	0	37	31	83.78%	216	22,600	5,980.06	5,021.68	1,232.26
DePere to Green Bay																	
Reach Totals	84	228	87	336	58	42	39	129	11	1014	938	92.50%	0	710,000	21,878.20	20,269.87	4,083.00
SMUs 20-25	5	41	19	56	17	10	8	31	1	188	162	86.17%	42.6	150,000	10,573.84	9,122.14	2,146.22
SMUs 26-31	0	6	2	6	1	2	2	7	0	26	22	84.62%	90	26,000	7,082.86	5,997.08	1,390.46
SMUs 32-37	1	4	4	13	0	1	0	5	0	28	26	92.86%	50	63,000	7,123.00	6,616.04	1,926.10
SMUs 38-43	0	11	4	23	3	5	2	18	1	67	56	83.58%	4	49,000	5,572.93	4,872.00	1,192.92
SMUs 44-49	0	36	14	54	16	7	5	19	0	151	142	94.04%	52	32,000	6,168.22	5,898.25	2,101.34
SMUs 50-55	0	3	0	17	1	0	4	4	1	30	28	93.33%	10	31,000	3,985.43	3,721.42	2,064.75
SMUs 56-61	70	94	27	89	7	10	9	19	4	329	319	96.96%	26	710,000	49,142.49	47,649.56	8,175.35
SMUs 62-67	1	5	2	14	3	1	0	1	0	27	27	100.00%	72	58,000	7,421.19	7,421.19	2,987.93
SMUs 68-73	2	9	4	12	1	0	0	6	0	34	31	91.18%	90	57,000	11,398.71	10,396.56	4,164.14
SMUs 74-79	0	2	4	5	0	0	1	2	0	14	14	100.00%	56	15,000	4,820.43	4,820.43	2,240.00
SMUs 80-85	0	2	2	8	0	1	1	4	0	18	16	88.89%	61	17,000	4,092.12	3,640.25	1,237.38
SMUs 86-91	0	6	0	2	1	1	1	5	0	16	12	75.00%	0	27,000	11,282.58	8,468.22	5,198.74
SMUs 92-97	0	0	2	13	1	0	2	1	0	19	19	100.00%	117	9,300	2,400.42	2,400.42	1,925.32
SMUs 98-103	0	0	0	2	2	0	3	3	0	10	9	90.00%	54	1,300	500.33	452.80	243.36
SMUs 104-109	0	0	0	3	2	1	0	2	0	8	7	87.50%	64	2,100	924.86	812.38	534.99
SMUs 110-115	0	1	0	13	0	1	0	0	0	15	15	100.00%	444	11,000	2,260.80	2,260.80	1,869.12
Unknowns	5	8	3	6	3	2	1	2	4	34	33	97.06%	0.4	90,000	17,550.68	17,035.21	1,980.10
Green Bay Zone 2 (2A & 2B)																	
Zone Totals	0	3	0	4	11	18	9	7	6	58	57	98.28%	15	17,000	1,129.02	1,110.14	622.34
Green Bay Zone 3A																	
Zone Totals	0	0	0	2	45	34	48	18	33	180	157	87.22%	4	1,017	322.20	297.50	190.52
Green Bay Zone 3B																	
Zone Totals	0	0	0	17	169	77	53	38	63	417	411	98.56%	2	1,302	447.75	442.89	319.03
Green Bay Zone 4																	
Zone Totals	0	0	0	0	1	2	21	48	133	205	201	98.05%	0	751	54.31	53.92	38.89

Notes:
A) Th RI Mean is the average value calculated using all laboratory detected values.
B) The RA Mean is the average value calculated using all laboratory detected results plus 1/2 the detection limit for samples flagged as non-detect by the laboratory.
C) The Logarithmic Mean was calculated using the RA Mean sample data - this was done because not all sample populations have a normal distribution.

Table 5-3. Lower Fox River - Dioxin/Furan (2,3,7,8-TCDD/F) Results

Deposit/SMU	Sample Identification	Depth (cm)	2,3,7,8-TCDD (ng/kg)	2,3,7,8-TCDF (ng/kg)	Total PCBs (mg/kg)
Little Lake Butte des Morts Reach					
D	D-RI-13(0-2)	0 - 61	1.75	67.81	2,017
D	D-RI-6(0-0.5)	0 - 15	3.00	60.80	5,460
E	E-RI-3(0-2)	0 - 61	ND	71.29	157
POG	P-RI-15(0-2)	0 - 61	1.90	50.20	6,297
POG	P-RI-4(0-2)	0 - 61	5.44	69.93	11,761
POG	P-RI-4(2-3.4)	61 - 104	3.59	32.22	13,870
Little Rapids to DePere Reach					
EE	EE-RI-24(0-2)	0 - 61	6.82	117.09	9,875
EE	EE-RI-24(2-4)	61 - 122	0.23	31.78	96
HH	HH-RI-5(0-2)	0 - 61	3.70	45.70	3,678
DePere to Green Bay Reach					
SMU 56/57	B2 4-12"	10 - 30	ND	20.00	NA
SMU 56/57	B2 1-2'	30 - 61	ND	20.00	NA
SMU 56/57	B2 2-3'	61 - 91	ND	ND	NA
SMU 56/57	B2 3-4'	91 - 122	ND	80.00	NA
SMU 56/57	B2 4-5'	122 - 152	ND	ND	NA
SMU 56/57	B2 5-6'	152 - 183	ND	80.00	NA
SMU 56/57	B2 6-7'	183 - 213	ND	170.00	NA
SMU 56/57	B2 7-8'	213 - 244	ND	20.00	NA
SMU 56/57	B2 8-9'	244 - 274	ND	40.00	NA
SMU 56/57	B2 9-10'	274 - 305	ND	60.00	NA
SMU 56/57	B2 10-11'	305 - 335	ND	30.00	NA
SMU 56/57	B2 11-12'	335 - 366	10.00	80.00	NA

Note: No Green Bay sediment samples were collected/analyzed for dioxin/furan.

Table 5-4. Lower Fox River and Green Bay - Pesticide Results

Deposit, SMU, or Zone	Sample Identification	Depth (cm)	DDT (µg/kg)	DDD (µg/kg)	DDE (µg/kg)	Aldrin (µg/kg)	Dieldrin (µg/kg)	Endrin Aldehyde (µg/kg)	Endrin Ketone (µg/kg)	gamma-BHC (Lindane) (µg/kg)	Heptachlor (µg/kg)
LOWER FOX RIVER											
Little Lake Butte des Morts Reach											
A	BA-SD01comp	0 - 61	na	na	25	na	na	na	7	na	19
A	BA-SD04comp	0 - 43	na	na	9	na	na	na	ND	na	ND
C	SDC-C-1-P-S	0 - 5	ND	ND	ND	ND	5.9	ND	4.3	ND	ND
C	SDC-C-3-P-S	0 - 5	ND	5	ND	60	ND	ND	16	ND	ND
D	D-RI-Comp1(0-2)	0 - 61	13	ND	ND	ND	na	ND	ND	ND	5
D	D-RI-Comp1(2-4)	61 - 122	5.5	ND	ND	ND	na	ND	ND	ND	ND
D	D-RI-Comp2(0-2)	0 - 61	ND	ND	ND	ND	na	ND	ND	ND	4.4
E	E-RI-Comp2(0-2)	0 - 61	ND	ND	ND	ND	na	ND	ND	ND	5.5
E	SDC-E-1-P-S	0 - 5	ND	6	ND	ND	ND	ND	17	ND	ND
POG	P-RI-Comp1(2-4)	61 - 122	14	ND	ND	ND	na	ND	ND	ND	8.4
POG	POG (Tr)	"0"	50	10	ND	na	ND	ND	na	ND	na
Appleton to Little Rapids Reach											
X	SDC-X-1-P-S	0 - 5	ND	1.5	ND	ND	ND	ND	ND	ND	ND
X	SDC-X-3-P-S	0 - 5	3.4	2.8	ND	ND	ND	ND	ND	ND	ND
Little Rapids to DePere Reach											
EE	SDC-EE22-2-P-S	0 - 5	ND	1.5	ND	ND	ND	4.9	7.1	ND	ND
EE	SDC-EE22-3-P-S	0 - 5	ND	2.8	21	ND	ND	ND	7.4	ND	ND
EE	SDC-EE23-2-P-S	0 - 5	ND	ND	ND	ND	ND	ND	7.6	ND	ND
EE	SDC-EE23-3-P-S	0 - 5	ND	1.6	ND	ND	ND	ND	6.6	ND	ND
EE	SDC-EE24-1-P-S	0 - 5	ND	1.9	ND	ND	ND	ND	3.2	ND	ND
EE	SDC-EE24-3-P-S	0 - 5	5.1	ND	6.6	ND	ND	ND	ND	ND	ND
EE	SDC-EE25-1-P-S	0 - 5	ND	ND	ND	ND	ND	ND	4.5	ND	ND
EE	SDC-EE25-3-P-S	0 - 5	ND	1.8	ND	ND	ND	ND	4.8	ND	ND
EE	SDC-EE26-1-P-S	0 - 5	ND	ND	7	ND	ND	ND	7.6	ND	ND
EE	SDC-EE26-5-P-S	0 - 5	20	ND	22	ND	ND	ND	23	9.8	ND
EG	EGH-RI-Comp1(0-2)	0 - 61	16	ND	ND	ND	na	ND	ND	ND	ND
EG	EGH-RI-Comp1(2-4)	61 - 122	ND	ND	ND	ND	na	ND	ND	ND	3.1
DePere to Green Bay Reach											
20	SDC-DPD-1-P-S	0 - 5	ND	4.5	ND	ND	ND	12	ND	ND	ND
20	SDC-DPD-2-P-S	0 - 5	ND	1.2	ND	ND	ND	5.1	2.4	ND	ND
45	SDC-DPD-3-P-S	0 - 5	ND	1.2	ND	ND	ND	6.5	3.4	ND	ND
56/57	B2 4-12"	10 - 30	19	na	ND	ND	ND	na	na	1	ND
56/57	B2 1-2'	30 - 61	ND	na	ND	ND	ND	na	na	4	ND
56/57	B2 2-3'	61 - 91	ND	na	ND	ND	ND	na	na	5	ND
56/57	B2 7-8'	213 - 244	ND	na	ND	ND	ND	na	na	17	ND
56/57	B2 8-9'	244 - 274	ND	na	ND	ND	ND	na	na	3	ND
56/57	B2 9-10'	274 - 305	28	na	ND	ND	ND	na	na	6	ND
56/57	B2 10-11'	305 - 366	ND	na	ND	ND	ND	na	na	10	ND
115	SDC-DPD-5-P-S	0 - 5	ND	ND	1.9	ND	ND	7.2	1.4	ND	ND

Table 5-4. Lower Fox River and Green Bay - Pesticide Results (Continued)

Deposit, SMU, or Zone	Sample Identification	Depth (cm)	DDT (µg/kg)	DDD (µg/kg)	DDE (µg/kg)	Aldrin (µg/kg)	Dieldrin (µg/kg)	Endrin Aldehyde (µg/kg)	Endrin Ketone (µg/kg)	gamma-BHC (Lindane) (µg/kg)	Heptachlor (µg/kg)
GREEN BAY											
Green Bay Zone 2 (2A & 2B)											
	S00030	0 - 10	ND	ND	ND	ND	ND	ND	ND	ND	ND
	S00031	0 - 10	ND	ND	ND	ND	ND	ND	ND	ND	ND
	S00032	0 - 10	ND	ND	ND	ND	ND	ND	ND	ND	ND
	S00037	0 - 10	ND	ND	ND	ND	ND	ND	ND	ND	ND
	S00038	0 - 10	ND	ND	ND	ND	ND	ND	ND	ND	ND
	S00039	0 - 10	ND	ND	ND	ND	ND	ND	ND	ND	ND
	S00040	0 - 10	ND	ND	ND	ND	ND	ND	ND	ND	ND
	S00056	0 - 10	ND	ND	ND	ND	ND	ND	ND	ND	ND
	S00057	0 - 10	ND	ND	ND	ND	ND	ND	ND	ND	ND
	S00058	0 - 10	ND	ND	ND	ND	ND	ND	ND	ND	ND
	S00063	0 - 10	ND	ND	ND	ND	ND	ND	ND	ND	ND
Green Bay Zone 3A											
	S00042	0 - 10	ND	ND	ND	ND	ND	ND	ND	ND	ND
	S00043	0 - 10	ND	ND	ND	ND	ND	ND	ND	ND	ND
Green Bay Zone 3B											
	S00041	0 - 10	ND	ND	ND	ND	ND	ND	ND	ND	ND
	S00047	0 - 10	ND	ND	ND	ND	ND	ND	ND	ND	ND
	S00048	0 - 10	ND	ND	ND	ND	ND	ND	ND	ND	ND
	S00054	0 - 10	ND	ND	ND	ND	ND	ND	ND	ND	ND
Green Bay Zone 4											
	S00044	0 - 10	ND	ND	ND	ND	ND	ND	ND	ND	ND
	S00045	0 - 10	ND	ND	ND	ND	ND	ND	ND	ND	ND
	S00046	0 - 10	ND	ND	ND	ND	ND	ND	ND	ND	ND
	S00055	0 - 10	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:
1) Sample results are in micrograms per kilogram (mg/kg).
2) Only samples with detected parameters are listed on table.
3) "0" depth indicates sample was collected from surface sediments.
4) ND = parameter not detected in sample.
5) na = parameter not analyzed in sample.

Table 5-5. Lower Fox River and Green Bay - Mercury, Lead, and Arsenic Results

Deposit, SMU, or Zone	Sample Identification	Depth (cm)	Mercury (mg/kg)	Lead (mg/kg)	Arsenic (mg/kg)
LOWER FOX RIVER					
Little Lake Butte des Morts Reach					
A	BA-SD01comp	0 - 61	4.90	497.00	1.40
A	BA-SD04comp	0 - 43	6.10	447.00	1.90
A	BA-SD08comp	0 - 46	5.60	314.00	1.60
A	BA-SD34	0 - 61	6.10	522.00	0.23
A	BA-SD35	0 - 34	ND	3.80	ND
A	S00009	0 - 10	ND	320.00	0.97
C	2C2 (Tr)	"0"	1.50	300.00	6.57
C	SDC-C-1-P-S	0 - 5	1.17	262.00	6.00
C	SDC-C-3-P-S	0 - 5	0.72	162.00	3.80
C	S00003	0 - 10	ND	230.00	1.10
D	D-RI-1(0-0.5)	0 - 15	ND	na	na
D	D-RI-10(0-2.2)	0 - 67	0.85	na	na
D	D-RI-11(0-1.3)	0 - 40	0.18	na	na
D	D-RI-12(0-2)	0 - 61	1.25	na	na
D	D-RI-12(2-3.5)	61 - 107	0.58	na	na
D	D-RI-13(0-2)	0 - 61	1.14	na	na
D	D-RI-13(2-3.6)	61 - 110	ND	na	na
D	D-RI-14(0-0.75)	0 - 23	ND	na	na
D	D-RI-15(0-2)	0 - 61	1.31	na	na
D	D-RI-15(2-3.7)	61 - 113	0.26	na	na
D	D-RI-16(0-1.6)	0 - 49	ND	na	na
D	D-RI-17(0-1.1)	0 - 34	ND	na	na
D	D-RI-18(0-1.5)	0 - 46	1.29	na	na
D	D-RI-19(0-0.5)	0 - 15	ND	na	na
D	D-RI-20(0-2)	0 - 61	0.42	na	na
D	D-RI-20(2-3)	61 - 91	ND	na	na
D	D-RI-21(0-2)	0 - 61	0.42	na	na
D	D-RI-21(2-4)	61 - 122	ND	na	na
D	D-RI-2(0-0.5)	0 - 15	0.51	na	na
D	D-RI-3(0-0.5)	0 - 15	ND	na	na
D	D-RI-4(0-0.5)	0 - 15	0.60	na	na
D	D-RI-5(0-0.5)	0 - 15	ND	na	na
D	D-RI-6(0-0.5)	0 - 15	0.51	na	na
D	D-RI-7(0-1.3)	0 - 40	0.34	na	na
D	D-RI-8(0-1.7)	0 - 52	0.98	na	na
D	D-RI-9(0-2)	0 - 61	0.92	na	na
D	D-RI-9(2-2.8)	61 - 85	0.41	na	na
D	D-RI-Comp1(0-2)	0 - 61	ND	3.99	4.88
D	D-RI-Comp1(2-4)	61 - 122	0.30	3.54	1.27
D	D-RI-Comp2(0-2)	0 - 61	2.60	160.00	4.56
D	S00025	0 - 10	5.00	90.00	0.35
D	S00026	0 - 10	3.80	97.00	0.79
D	S00049	0 - 10	2.60	65.00	0.34
E	2E8 (Tr)	"0"	2.20	99.00	3.70
E	E-RI-1(0-0.5)	0 - 15	0.75	na	na
E	E-RI-10(0-1.5)	0 - 46	0.28	na	na
E	E-RI-11(0-2)	0 - 61	0.52	na	na
E	E-RI-11(2-3.6)	61 - 110	0.61	na	na
E	E-RI-12(0-2)	0 - 61	2.76	na	na
E	E-RI-12(2-4.2)	61 - 128	0.23	na	na
E	E-RI-13(0-2)	0 - 61	1.48	na	na
E	E-RI-13(2-3.75)	61 - 114	0.23	na	na
E	E-RI-14(0-2)	0 - 61	0.72	na	na
E	E-RI-15(0-2)	0 - 61	0.93	na	na
E	E-RI-16(0-2)	0 - 61	2.58	na	na
E	E-RI-16(2-3)	61 - 91	2.25	na	na
E	E-RI-17(0-2)	0 - 61	2.19	na	na
E	E-RI-17(2-4)	61 - 122	3.72	na	na
E	E-RI-2(0-2)	0 - 61	2.69	na	na
E	E-RI-2(2-4)	61 - 122	0.14	na	na
E	E-RI-2(4-4.7)	122 - 143	0.14	na	na
E	E-RI-3(0-2)	0 - 61	0.84	na	na
E	E-RI-3(2-2.8)	61 - 85	1.91	na	na
E	E-RI-4(0-2)	0 - 61	1.25	na	na

Deposit, SMU, or Zone	Sample Identification	Depth (cm)	Mercury (mg/kg)	Lead (mg/kg)	Arsenic (mg/kg)
Lower Fox River - Little Rapids to De Pere Continued					
EE	SDC-EE26-5-P-S	0 - 5	9.7	297	5.7
EE	S00021	0 - 10	3.2	68	1.2
EE	S00023	0 - 10	3	45	0.9
EE	S00036	0 - 10	6.1	97	4
EG	EGH-RI-Comp1(0-2)	0 - 61	1.23	6.15	5.08
EG	EGH-RI-Comp1(2-4)	61 - 122	2.75	4.55	7.5
EG	EGH-RI-Comp1(4-6)	122 - 183	1.71	5.04	5.07
EG	EGH-RI-Comp1(6-8)	183 - 244	0.98	2.25	2.17
GG	GG-RI-1(0-2)	0 - 61	6.69	na	na
GG	GG-RI-1(2-4.2)	61 - 128	1.2	na	na
GG	GG-RI-10(0-0.9)	0 - 27	1.27	na	na
GG	GG-RI-11(0-2)	0 - 61	2.57	na	na
GG	GG-RI-11(2-3.7)	61 - 113	0.38	na	na
GG	GG-RI-12(0-2)	0 - 61	0.34	na	na
GG	GG-RI-12(2-2.5)	61 - 76	ND	na	na
GG	GG-RI-13(0-2)	0 - 61	1.45	na	na
GG	GG-RI-13(2-4.1)	61 - 125	0.83	na	na
GG	GG-RI-14(0-1.1)	0 - 34	5.57	na	na
GG	GG-RI-15(0-2)	0 - 61	1.2	na	na
GG	GG-RI-15(2-4.2)	61 - 128	0.78	na	na
GG	GG-RI-2(0-2)	0 - 61	2.23	na	na
GG	GG-RI-2(2-2.9)	61 - 88	0.21	na	na
GG	GG-RI-3(0-2)	0 - 61	0.64	na	na
GG	GG-RI-3(2-3.7)	61 - 113	0.45	na	na
GG	GG-RI-4(0-2)	0 - 61	8.21	na	na
GG	GG-RI-4(2-4)	61 - 122	1.86	na	na
GG	GG-RI-4(4.5-5.2)	122 - 158	1.2	na	na
GG	GG-RI-5(0-2.2)	0 - 67	0.56	na	na
GG	GG-RI-6(0-2)	0 - 61	7.98	na	na
GG	GG-RI-6(2-4)	61 - 122	1.56	na	na
GG	GG-RI-6(4.5-5.2)	122 - 158	1.33	na	na
GG	GG-RI-7(0-2)	0 - 61	0.89	na	na
GG	GG-RI-8(0-2)	0 - 61	9.1	na	na
GG	GG-RI-8(2-4)	61 - 122	1.42	na	na
GG	GG-RI-8(4-5.1)	122 - 155	0.69	na	na
GG	GG-RI-9(0-2)	0 - 61	2.41	na	na
GG	GG-RI-9(2-4.2)	61 - 128	0.38	na	na
HH	HH (Tr)	"0"	5.69	1400	5.46
HH	HH-RI-1(0-2)	0 - 61	1.8	na	na
HH	HH-RI-1(2-3)	61 - 91	0.15	na	na
HH	HH-RI-10(0-0.7)	0 - 21	2.04	na	na
HH	HH-RI-2(0-2)	0 - 61	1.64	na	na
HH	HH-RI-2(2-3.25)	61 - 99	0.19	na	na
HH	HH-RI-3(0-2)	0 - 61	6.27	na	na
HH	HH-RI-3(2-4)	61 - 122	5.16	na	na
HH	HH-RI-3(4-6)	122 - 183	0.96	na	na
HH	HH-RI-3(6-6.7)	183 - 204	0.65	na	na
HH	HH-RI-4(0-1.2)	0 - 37	7.9	na	na
HH	HH-RI-5(0-2)	0 - 61	3.79	na	na
HH	HH-RI-5(2-4)	61 - 122	0.54	na	na
HH	HH-RI-5(4.5-5.1)	122 - 155	0.66	na	na
HH	HH-RI-6(0-2)	0 - 61	0.01	na	na
HH	HH-RI-6(2-4)	61 - 122	7.71	na	na
HH	HH-RI-6(4.5-5.2)	122 - 158	1.19	na	na
HH	HH-RI-7(0-0.5)	0 - 15	1.47	na	na
HH	HH-RI-8(0-2)	0 - 61	9.82	na	na
HH	HH-RI-8(2-2.9)	61 - 88	1.75	na	na
HH	HH-RI-9(0-2)	0 - 61	8.63	na	na
HH	HH-RI-9(2-3.7)	61 - 113	1.43	na	na
HH	S00001	0 - 10	ND	130	1.3
HH	S00034	0 - 10	3.2	110	4.7
Interdeposit	S00002	0 - 10	ND	76	3
Interdeposit	S00033	0 - 10	5.4	66	1.5
Interdeposit	S00035	0 - 10	4.1	71	2.3
Mean Concentrations Little Rapids-De Pere			2.417	138.652	4.077

Table 5-5. Lower Fox River and Green Bay - Mercury, Lead, and Arsenic Results (Continued)

Deposit, SMU, or Zone	Sample Identification	Depth (cm)	Mercury (mg/kg)	Lead (mg/kg)	Arsenic (mg/kg)
E	E-RI-4(2-3)	61 - 91	1.18	na	na
E	E-RI-5(0-2)	0 - 61	1.12	na	na
E	E-RI-6(0-2)	0 - 61	0.67	na	na
E	E-RI-6(2-4)	61 - 122	0.29	na	na
E	E-RI-7(0-2)	0 - 61	0.64	na	na
E	E-RI-7(2-2.8)	61 - 85	0.17	na	na
E	E-RI-8(0-2)	0 - 61	1.21	na	na
E	E-RI-8(2-3.25)	61 - 99	0.38	na	na
E	E-RI-9(0-2)	0 - 61	0.81	na	na
E	E-RI-9(2-4)	61 - 122	0.38	na	na
E	E-RI-9(4-5.7)	122 - 174	0.26	na	na
E	E-RI-Comp1(0-2)	0 - 61	1.92	7.10	3.57
E	E-RI-Comp1(2-4)	61 - 122	0.62	6.99	2.22
E	E-RI-Comp2(0-2)	0 - 61	2.14	7.79	3.93
E	SDC-E-1-P-S	0 - 5	1.92	289.00	6.80
E	SDC-E-3-P-S	0 - 5	0.23	39.00	4.40
E	S00027	0 - 10	5.00	88.00	0.63
E	S00029	0 - 10	3.20	81.00	0.71
F	S00028	0 - 10	5.70	140.00	1.30
POG	P-RI-1(0-2)	0 - 61	0.68	na	na
POG	P-RI-10(0-0.5)	0 - 15	0.55	na	na
POG	P-RI-11(0-2)	0 - 61	0.96	na	na
POG	P-RI-11(2-4)	61 - 122	1.94	na	na
POG	P-RI-11(4-6.2)	122 - 189	1.91	na	na
POG	P-RI-12(0-1.4)	0 - 43	ND	na	na
POG	P-RI-13(0-1.1)	0 - 34	0.47	na	na
POG	P-RI-14(0-1.2)	0 - 37	ND	na	na
POG	P-RI-15(0-2)	0 - 61	0.98	na	na
POG	P-RI-15(2-4)	61 - 122	1.65	na	na
POG	P-RI-15(4-6)	122 - 183	1.85	na	na
POG	P-RI-16(0-1.3)	0 - 40	1.39	na	na
POG	P-RI-17(0-1.2)	0 - 37	0.51	na	na
POG	P-RI-18(0-1.4)	0 - 43	ND	na	na
POG	P-RI-19(0-0.5)	0 - 15	0.46	na	na
POG	P-RI-2(0-1)	0 - 30	0.40	na	na
POG	P-RI-20(0-2)	0 - 61	1.27	na	na
POG	P-RI-20(2-4.3)	61 - 131	1.34	na	na
POG	P-RI-21(0-1.8)	0 - 55	0.69	na	na
POG	P-RI-22(0-0.4)	0 - 12	0.50	na	na
POG	P-RI-3(0-1.0)	0 - 30	0.69	na	na
POG	P-RI-4(0-2)	0 - 61	3.06	na	na
POG	P-RI-4(2-3.4)	61 - 104	2.29	na	na
POG	P-RI-5(0-0.9)	0 - 27	ND	na	na
POG	P-RI-6(0-2.2)	0 - 67	ND	na	na
POG	P-RI-7(0-2)	0 - 61	2.34	na	na
POG	P-RI-7(2-2.7)	61 - 82	5.43	na	na
POG	P-RI-8(0-1.7)	0 - 52	ND	na	na
POG	P-RI-Comp1(0-2)	0 - 61	2.25	6.08	4.69
POG	P-RI-Comp1(2-4)	61 - 122	ND	549.00	6.51
POG	P-RI-Comp1(4-6)	122 - 183	2.54	5.50	6.40
POG	POG (Tr)	"0"	3.30	110.00	5.14
POG	S00024	0 - 10	4.50	230.00	1.00
Interdeposit	S00022	0 - 10	6.00	67.00	0.49
Mean Concentrations - LLBdM			1.652	167.832	2.908
Appleton to Little Rapids Reach					
P	S00007	0 - 10	ND	75	0.17
P	S00008	0 - 10	ND	44	0.33
W	SDC-W-2-P-S	0 - 5	0.39	60	2.8
W	SDC-W-3-P-S	0 - 5	0.58	57	2.8
W	SDC-X-1-P-S	0 - 5	0.34	84	4.7
W	SDC-X-3-P-S	0 - 5	0.43	71	9.7
W	S00005	0 - 10	ND	73	2.1
X	X (Tr)	"0"	1.5	130	7.88
X	S00004	0 - 10	ND	85	0.32
Interdeposit	S00060	0 - 10	4.3	77	1.5
Mean Concentrations Appleton-Little Rapids			1.257	75.600	3.230

Deposit, SMU, or Zone	Sample Identification	Depth (cm)	Mercury (mg/kg)	Lead (mg/kg)	Arsenic (mg/kg)
DePere to Green Bay Reach					
20	95004-01	0 - 10	1.4	90.64	7.95
20	95008-01	0 - 10	1.7	96.24	7.35
20	S00010	0 - 10	ND	64	0.96
20	SDC-DPD-1-P-S	0 - 5	2	113	4.6
20	SDC-DPD-2-P-S	0 - 5	1.22	89	4.6
21	95018-01	0 - 10	1.6	85.04	10.45
21	95020-01	0 - 10	2.2	140.43	8.15
21	S00013	0 - 10	ND	77	1.1
21	S00014	0 - 10	5.4	74	1.8
22	95002-01	0 - 10	1.7	104.43	7.75
22	95006-01	0 - 10	0.97	39.64	ND
23	95016-01	0 - 10	0.3	38.24	ND
23	95022-01	0 - 10	ND	4.44	ND
24	95007-01	0 - 10	0.5	75.44	7.55
24	S00011	0 - 10	ND	67	0.87
25	95013-01	0 - 10	0.96	76.84	9.15
25	S00012	0 - 10	ND	33	0.38
29	95025-01	0 - 10	0.95	80.64	7.05
29	95028-01	0 - 10	0.98	80.54	7.95
35	95030-01	0 - 10	1.7	77.94	8.65
38	95035-01	0 - 10	1.1	166.43	385.57
38	S00015	0 - 10	ND	23	0.32
41	95038-01	0 - 10	2.3	110.43	ND
41	S00016	0 - 10	ND	62	0.75
43	S00018	0 - 10	3.3	32	0.35
44	S00017	0 - 10	ND	49	0.47
44	S00051	0 - 10	5	56	0.6
45	95054-01	0 - 10	1.1	76.74	5.75
45	S00052	0 - 10	ND	61	0.7
45	SDC-DPD-3-P-S	0 - 5	0.81	72	3
46	95041-01	0 - 10	6.1	73.8	1
46	95044-01	0 - 10	1	69.74	8.85
47	95047-01	0 - 10	1.3	85.64	9.65
47	95051-01	0 - 10	1.1	84.1	9.3
47	95058-01	0 - 10	0.91	73.3	ND
47	95109-01	0 - 10	1.1	83.5	9.9
48	95049-01	0 - 10	1.2	77.9	7.8
48	S00061	0 - 10	6.1	60	0.81
48	S00062	0 - 10	6.3	57	0.71
49	95052-01	0 - 10	0.96	65.4	8.5
49	95056-01	0 - 10	0.99	88.4	13
50	95060-01	0 - 10	0.39	29.6	ND
52	95061-01	0 - 10	1.6	83.2	8.1
53	95062-01	0 - 10	0.46	47.8	7.9
54	S00019	0 - 10	3.7	27	0.23
56	95066-01	0 - 10	2.1	108	10.6
56	95068-01	0 - 10	1	76.2	9.9
56/57	B2 4-12"	10 - 30	na	100	2.9
56/57	B2 1-2'	30 - 61	na	120	7.3
56/57	B2 2-3'	61 - 91	na	110	4.5
56/57	B2 3-4'	91 - 122	na	130	5.1
56/57	B2 4-5'	122 - 152	na	170	8.8
56/57	B2 5-6'	152 - 183	na	190	7.3
56/57	B2 6-7'	183 - 213	na	140	5.3
56/57	B2 7-8'	213 - 244	na	180	6.9
56/57	B2 8-9'	244 - 274	na	190	8.9
56/57	B2 9-10'	274 - 305	na	150	7.5
56/57	B2 10-11'	305 - 366	na	180	5.1
56/57	B2 11-12'	335 - 366	na	230	5.3
57	95070-01	0 - 10	1.1	77.2	9.5
57	95071-01	0 - 10	1.2	80.8	6.6
57	95074-01	0 - 10	1.3	88.5	9
61	95072-01	0 - 10	1	78.2	6.8
62	95076-01	0 - 10	1	91.1	7.2
62	S00053	0 - 10	4.4	48	1

Table 5-5. Lower Fox River and Green Bay - Mercury, Lead, and Arsenic Results (Continued)

Deposit, SMU, or Zone	Sample Identification	Depth (cm)	Mercury (mg/kg)	Lead (mg/kg)	Arsenic (mg/kg)
Little Rapids to DePere Reach					
EE	EE-RI-1(0-2)	0 - 61	1.66	na	na
EE	EE-RI-1(2-4)	61 - 122	0.8	na	na
EE	EE-RI-1(6-7.8)	183 - 238	ND	na	na
EE	EE-RI-10(0-2)	0 - 61	7.7	na	na
EE	EE-RI-10(2-4)	61 - 122	1.02	na	na
EE	EE-RI-10(6-7.1)	183 - 216	2.06	na	na
EE	EE-RI-11(0-2)	0 - 61	2.28	na	na
EE	EE-RI-11(2-4)	61 - 122	0.8	na	na
EE	EE-RI-11(4-4.5)	122 - 137	0.19	na	na
EE	EE-RI-12(0-2)	0 - 61	8.06	na	na
EE	EE-RI-12(2-4)	61 - 122	0.43	na	na
EE	EE-RI-12(4-4.7)	122 - 143	ND	na	na
EE	EE-RI-13(0-2)	0 - 61	5.29	na	na
EE	EE-RI-13(4-6)	122 - 183	1.47	na	na
EE	EE-RI-13(6-6.9)	183 - 210	ND	na	na
EE	EE-RI-14(0-0.7)	0 - 21	1.49	na	na
EE	EE-RI-15(0-2)	0 - 61	8.33	na	na
EE	EE-RI-15(2-4)	61 - 122	1.51	na	na
EE	EE-RI-15(6-7.3)	183 - 223	0.77	na	na
EE	EE-RI-16(0-1.8)	0 - 55	1.69	na	na
EE	EE-RI-17(0-2)	0 - 61	6.97	na	na
EE	EE-RI-17(2-3.1)	61 - 94	0.41	na	na
EE	EE-RI-18(0-2)	0 - 61	2.67	na	na
EE	EE-RI-18(2-3.3)	61 - 101	0.25	na	na
EE	EE-RI-19(0-2)	0 - 61	1.48	na	na
EE	EE-RI-19(2-4.1)	61 - 125	0.67	na	na
EE	EE-RI-2(0-2)	0 - 61	3.57	na	na
EE	EE-RI-2(2-4)	61 - 122	1.03	na	na
EE	EE-RI-2(4-5)	122 - 152	0.32	na	na
EE	EE-RI-20(0-2)	0 - 61	3.58	na	na
EE	EE-RI-20(2-4.2)	61 - 128	0.93	na	na
EE	EE-RI-21(0-2)	0 - 61	1.74	na	na
EE	EE-RI-21(2-4)	61 - 122	1.09	na	na
EE	EE-RI-21(4-5.7)	122 - 174	0.38	na	na
EE	EE-RI-22(0-2)	0 - 61	0.65	na	na
EE	EE-RI-22(2-3.2)	61 - 98	0.33	na	na
EE	EE-RI-23(0-2)	0 - 61	2.49	na	na
EE	EE-RI-23(2-4.1)	61 - 125	0.69	na	na
EE	EE-RI-24(0-2)	0 - 61	2.65	na	na
EE	EE-RI-24(2-4)	61 - 122	0.71	na	na
EE	EE-RI-24(6-7.3)	183 - 223	0.84	na	na
EE	EE-RI-25(0-1.6)	0 - 49	0.73	na	na
EE	EE-RI-26(0-2)	0 - 61	0.52	na	na
EE	EE-RI-26(2-4)	61 - 122	1.31	na	na
EE	EE-RI-26(6-6.9)	183 - 210	0.15	na	na
EE	EE-RI-27(0-2)	0 - 61	4.62	na	na
EE	EE-RI-27(2-4)	61 - 122	1.04	na	na
EE	EE-RI-27(4-6.2)	122 - 189	1.01	na	na
EE	EE-RI-28(0-2)	0 - 61	5.67	na	na
EE	EE-RI-28(2-3.4)	61 - 104	1.32	na	na
EE	EE-RI-29(0-2)	0 - 61	1.85	na	na
EE	EE-RI-29(2-2.75)	61 - 84	0.65	na	na
EE	EE-RI-3(0-2)	0 - 61	5.23	na	na
EE	EE-RI-3(2-4)	61 - 122	0.83	na	na
EE	EE-RI-3(6-7)	183 - 213	1.39	na	na
EE	EE-RI-4(0-2)	0 - 61	5.82	na	na
EE	EE-RI-4(2-4)	61 - 122	0.89	na	na
EE	EE-RI-4(4-6.1)	122 - 186	0.27	na	na
EE	EE-RI-5(0-2)	0 - 61	4.15	na	na
EE	EE-RI-5(4-6)	122 - 183	1.02	na	na
EE	EE-RI-5(6-8)	183 - 244	1.81	na	na
EE	EE-RI-6(0-2)	0 - 61	7.18	na	na
EE	EE-RI-6(2-4)	61 - 122	0.54	na	na
EE	EE-RI-6(4-5.7)	122 - 174	0.4	na	na
EE	EE-RI-7(0-2)	0 - 61	4.58	na	na
EE	EE-RI-7(2-4)	61 - 122	0.59	na	na
EE	EE-RI-7(6-6.7)	183 - 204	1.04	na	na

Deposit, SMU, or Zone	Sample Identification	Depth (cm)	Mercury (mg/kg)	Lead (mg/kg)	Arsenic (mg/kg)
65	95077-01	0 - 10	1	85.4	11.4
65	95079-01	0 - 10	0.91	74.9	6.1
70	95078-01	0 - 10	1.2	93.8	9.3
70	95080-01	0 - 10	1.1	84.7	8.3
70	95081-01	0 - 10	1.3	98.5	9
71	95082-01	0 - 10	1	71.4	7.2
72	S00020	0 - 10	4.2	51	0.56
76	95084-01	0 - 10	1.1	83.8	8.2
77	95085-01	0 - 10	0.73	121	8
82	95086-01	0 - 10	0.81	85.6	7.2
82	95087-01	0 - 10	1.4	80.4	6.8
82	95088-01	0 - 10	1.4	89.8	ND
83	95089-01	0 - 10	0.92	73.1	ND
88	95090-01	0 - 10	1.1	128	10.6
88	95091-01	0 - 10	1.5	218	ND
89	95092-01	0 - 10	0.64	96.5	10.1
94	95093-01	0 - 10	0.93	71.9	6.5
94	95094-01	0 - 10	0.53	52.1	6.1
95	95095-01	0 - 10	0.37	41.6	7.6
95	95096-01	0 - 10	ND	17.2	ND
96	SDC-DPD-4-P-S	0 - 5	0.52	20	0.8
100	95097-01	0 - 10	0.26	59.6	ND
100	95098-01	0 - 10	0.6	41.9	6.4
101	95099-01	0 - 10	ND	5.3	ND
101	95101-01	0 - 10	0.11	20.2	ND
106	95100-01	0 - 10	0.55	40	7.5
107	95102-01	0 - 10	1.2	79.6	ND
109	95103-01	0 - 10	0.18	49	6.6
112	95104-01	0 - 10	0.61	19.1	ND
112	95105-01	0 - 10	0.85	62.1	8.3
113	95106-01	0 - 10	0.64	62.1	ND
115	SDC-DPD-5-P-S	0 - 5	0.59	58	3.2
	2FRB1 (Tr)	"0"	2.1	99	2.8
	2FRB17 (Tr)	"0"	0.4	27	1.57
	2FRB22 (Tr)	"0"	7.7	180	5.56
	4085139AB	-	4.4	84	1
	4085139B	-	3.8	66	1
	FRB (Tr)	"0"	2.2	350	7.58
	FRB1	-	2.1	99	2.8
?	95010-01	0 - 10	0.95	104.41	13.35
?	95011-01	0 - 10	1.4	84.24	ND
???	95064-01	0 - 10	0.1	9.3	ND
Mean Concentrations De Pere-Green Bay			1.630	85.038	10.185
Mean Concentrations DP - GB (w/o high concentration of 385.57 mg/kg)					*5.920*
GREEN BAY					
Green Bay Zone 2 (2A & 2B)					
	S00030	0 - 10	0.12	8.1	1
	S00031	0 - 10	0.11	10	1.4
	S00032	0 - 10	ND	2	ND
	S00037	0 - 10	0.97	42	2.9
	S00038	0 - 10	0.58	24	2.7
	S00039	0 - 10	1.3	40	3.2
	S00040	0 - 10	1.5	42	2.5
	S00056	0 - 10	ND	4.8	1.8
	S00057	0 - 10	0.43	17	1.9
	S00058	0 - 10	0.2	19	2.5
	S00063	0 - 10	0.13	8.1	2.6
Mean Concentrations Green Bay 2A & 2B			0.593	19.727	2.250
Green Bay Zone 3A					
	S00042	0 - 10	ND	1.1	1.4
	S00043	0 - 10	ND	1.9	1.6
Mean Concentrations Green Bay 3A			0	1.5	1.5
Green Bay Zone 3B					
	S00041	0 - 10	ND	9.6	3.6
	S00047	0 - 10	ND	32	8
	S00048	0 - 10	0.19	28	7.7
	S00054	0 - 10	ND	50	15
Mean Concentrations Green Bay 3B			0.190	29.900	8.575

Table 5-5. Lower Fox River and Green Bay - Mercury, Lead, and Arsenic Results (Continued)

Deposit, SMU, or Zone	Sample Identification	Depth (cm)	Mercury (mg/kg)	Lead (mg/kg)	Arsenic (mg/kg)
EE	EE-RI-8(0-2)	0 - 61	7.47	na	na
EE	EE-RI-8(4-6)	122 - 183	1.04	na	na
EE	EE-RI-8(6-7.7)	183 - 235	1.42	na	na
EE	EE-RI-9(0-2)	0 - 61	9.14	na	na
EE	EE-RI-9(2-4)	61 - 122	1.05	na	na
EE	EE-RI-9(4-5.6)	122 - 171	1.01	na	na
EE	SDC-EE22-2-P-S	0 - 5	0.55	68	4.3
EE	SDC-EE22-3-P-S	0 - 5	3.1	126	4.7
EE	SDC-EE23-2-P-S	0 - 5	0.6	74	6.7
EE	SDC-EE23-3-P-S	0 - 5	0.82	68	4.7
EE	SDC-EE24-1-P-S	0 - 5	0.69	62	3.1
EE	SDC-EE24-3-P-S	0 - 5	0.8	70	3
EE	SDC-EE25-1-P-S	0 - 5	0.58	148	7.6
EE	SDC-EE25-3-P-S	0 - 5	1.58	72	5
EE	SDC-EE26-1-P-S	0 - 5	0.73	123	4.8

Deposit, SMU, or Zone	Sample Identification	Depth (cm)	Mercury (mg/kg)	Lead (mg/kg)	Arsenic (mg/kg)
Green Bay Zone 4					
	S00044	0 - 10	0.11	2.1	8.9
	S00045	0 - 10	ND	3.7	1.4
	S00046	0 - 10	ND	4.5	4.4
	S00055	0 - 10	ND	2.1	5.2
Mean Concentrations Green Bay Zone 4			0.110	3.100	4.975
Reference					
	4072050AW	-	4.4	19	0.06
	4072050B	-	3.7	17	0.05
	4072050BO	-	8.9	14	ND
	4072050BR	-	3	19	0.05
	4085109Q	-	3.3	16	0.04
	4085110B	-	26	18	0.13
	REF (Tr)(2)	0	2.78	20	0.18
Mean Concentrations Refs			7.440	17.571	0.085

AVERAGE VALUES AND BACKGROUND CONCENTRATIONS

Comparison of Reach/Zone Averages	Mercury	Lead	Arsenic
Mean Concentrations LLBdM	1.652	167.832	2.908
Mean Concentrations AP - LR	1.257	75.600	3.230
Mean Concentrations LR - DP	2.417	138.652	4.077
Mean Concentrations DP - GB	1.630	85.038	10.185
Mean Concentrations DP - GB (w/o high concentration of 385 mg/kg).			*5.920*
NURE Average Background Conc.	**---**	**11.57**	**2.07**
WDNR Triad Asses. Ref. Conc.	**0.18**	**20.0**	**2.78**

Comparison of Reach/Zone Averages	Mercury	Lead	Arsenic
Mean Concentrations Green Bay Zone 2	0.593	19.727	2.250
Mean Concentrations Green Bay Zone 3A	0.000	1.500	1.500
Mean Concentrations Green Bay Zone 3B	0.190	29.900	8.575
Mean Concentrations Green Bay Zone 4	0.110	3.100	4.975
Mean Concentrations References	7.440	17.571	0.085
Lake Winnebago Average Conc.	**0.14**	**35.0**	**5.33**
EPA Background Levels (1986)	**0.01-0.3**	**2-200**	**1-50**

Notes: 1) ND = parameter not detected in sample.
2) "0" depth indicates sample was collected from surface sediments.
3) na = parameter not analyzed in sample.

Table 5-6. Lower Fox River and Green Bay - Other RCRA Metals, Copper, Nickel, and Zinc

Deposit, SMU, or Zone	Sample Identification	Depth (cm)	Barium (mg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Nickel (mg/kg)	Selenium (mg/kg)	Silver (mg/kg)	Zinc (mg/kg)
LOWER FOX RIVER										
Little Lake Butte des Morts Reach										
A	BA-SD01comp	0 - 61	109	9.8	85.6	73.5	29.1	1.3	ND	2050
A	BA-SD04comp	0 - 43	136	ND	69.9	97.4	26.4	1.5	ND	357
A	BA-SD08comp	0 - 46	127	ND	72.3	108	21.1	ND	ND	271
A	BA-SD34	0 - 61	148	12.5	56.4	75.5	25.5	3	1.7	1720
A	BA-SD35	0 - 34	24.3	ND	13	11.2	16.3	ND	ND	20.1
A	S00009	0 - 10	79	4.9	57	69	19	ND	1.3	1200
C	2C2 (Tr)	"0"	na	2	48	110	13	0.64	ND	na
C	SDC-C-1-P-S	0 - 5	na	4	64	154	24	na	na	460
C	SDC-C-3-P-S	0 - 5	na	2.2	39	77	18	na	na	420
C	S00003	0 - 10	85	3	53	110	18	ND	1.5	480
D	D-RI-Comp1(0-2)	0 - 61	63.1	4.98	41.8	59.6	16.2	0.34	ND	224
D	D-RI-Comp1(2-4)	61 - 122	14.2	1.06	5.12	3.5	4.07	ND	ND	11.2
D	D-RI-Comp2(0-2)	0 - 61	ND	ND	53.1	69	14.7	0.46	0.7	244
D	S00025	0 - 10	58	1.7	34	38	15	ND	ND	230
D	S00026	0 - 10	70	1.2	39	57	17	ND	ND	230
D	S00049	0 - 10	53	0.74	29	30	12	ND	ND	160
E	2E8 (Tr)	"0"	na	1	60	49	17	0.98	ND	na
E	E-RI-Comp1(0-2)	0 - 61	101	4.7	35.2	34.5	12.5	0.15	ND	na
E	E-RI-Comp1(2-4)	61 - 122	51.2	2.8	15.4	14.2	9.84	ND	ND	35.8
E	E-RI-Comp2(0-2)	0 - 61	78.8	4.2	42.9	47	12.8	ND	1.5	143
E	S00027	0 - 10	81	0.78	41	53	21	ND	ND	230
E	S00029	0 - 10	64	0.51	45	58	19	ND	1.2	180
E	SDC-E-1-P-S	0 - 5	na	3.1	89	127	25	na	na	390
E	SDC-E-3-P-S	0 - 5	na	ND	36	48	24	na	na	110
F	S00028	0 - 10	110	1.6	67	65	25	ND	ND	900
POG	P-RI-Comp1(0-2)	0 - 61	77.9	5.09	55.6	93.9	16.7	0.52	1	236
POG	P-RI-Comp1(2-4)	61 - 122	124	6.15	61.2	117	20.45	0.72	1.55	292
POG	P-RI-Comp1(4-6)	122 - 183	131	8.3	64.2	120	22.1	0.7	1.6	294
POG	POG (Tr)	"0"	na	2	43	60	13	0.71	ND	140
POG	S00024	0 - 10	590	1.2	32	210	13	ND	ND	630
Interdeposit	S00022	0 - 10	54	0.95	36	50	15	ND	ND	130
Reach Average			105.63	3.48	47.86	73.85	17.93	0.92	1.34	421.00

Table 5-6. Lower Fox River and Green Bay - Other RCRA Metals, Copper, Nickel, & Zinc (Continued)

Deposit, SMU, or Zone	Sample Identification	Depth (cm)	Barium (mg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Nickel (mg/kg)	Selenium (mg/kg)	Silver (mg/kg)	Zinc (mg/kg)
Appleton to Little Rapids Reach										
P	S00007	0 - 10	55	0.93	40	28	18	ND	ND	170
P	S00008	0 - 10	51	ND	29	43	15	2.4	ND	140
W	S00005	0 - 10	57	0.69	39	54	15	3	ND	110
W	SDC-W-2-P-S	0 - 5	na	0.6	26	57	15	na	na	91
W	SDC-W-3-P-S	0 - 5	na	0.5	20	54	9	na	na	83
W	SDC-X-1-P-S	0 - 5	na	1.5	57	90	21	na	na	130
W	SDC-X-3-P-S	0 - 5	na	0.8	40	119	16	na	na	94
X	S00004	0 - 10	73	1	91	43	14	1.7	ND	120
X	X (Tr)	"0"	na	2	95	89	17	0.83	ND	180
Interdeposit	S00060	0 - 10	55	0.74	67	58	11	3.2	ND	110
Reach Average			58.2	0.97	50.40	63.50	15.10	2.23	ND	122.80
Little Rapids to DePere Reach										
EE	S00021	0 - 10	67	1.2	40	67	14	ND	ND	140
EE	S00023	0 - 10	35	0.51	26	49	8.9	ND	ND	74
EE	S00036	0 - 10	94	1.5	65	75	18	ND	ND	160
EE	SDC-EE22-2-P-S	0 - 5	na	0.7	39	61	17	na	na	120
EE	SDC-EE22-3-P-S	0 - 5	na	1.6	88	99	22	na	na	180
EE	SDC-EE23-2-P-S	0 - 5	na	1.5	36	80	17	na	na	116
EE	SDC-EE23-3-P-S	0 - 5	na	1.2	42	88	17	na	na	120
EE	SDC-EE24-1-P-S	0 - 5	na	0.5	40	56	14	na	na	91
EE	SDC-EE24-3-P-S	0 - 5	na	2	46	53	19	na	na	120
EE	SDC-EE25-1-P-S	0 - 5	na	4	83	124	26	na	na	220
EE	SDC-EE25-3-P-S	0 - 5	na	0.9	49	59	18	na	na	130
EE	SDC-EE26-1-P-S	0 - 5	na	6	90	104	27	na	na	210
EE	SDC-EE26-5-P-S	0 - 5	na	3.1	108	149	28	na	na	330
EG	EGH-RI-Comp1(0-2)	0 - 61	128	7.54	92.7	115	21.5	0.39	1.12	276
EG	EGH-RI-Comp1(2-4)	61 - 122	118	7.4	62.2	110	21.8	0.12	0.66	221
EG	EGH-RI-Comp1(4-6)	122 - 183	98.7	5.3	48.2	72.8	20	ND	ND	144
EG	EGH-RI-Comp1(6-8)	183 - 244	40.67	2.89	21.7	26.9	9.54	ND	ND	56.8
HH	HH (Tr)	"0"	na	3	420	95	19	1.01	ND	230
HH	S00001	0 - 10	83	1.1	55	61	20	2.3	ND	160
HH	S00034	0 - 10	94	1.3	74	98	19	ND	ND	180
Interdeposit	S00002	0 - 10	72	1	51	100	16	ND	ND	140
Interdeposit	S00033	0 - 10	73	0.83	52	66	17	ND	ND	140
Interdeposit	S00035	0 - 10	79	1.1	56	65	17	ND	ND	170
Reach Average			81.86	2.44	73.25	81.47	18.55	0.96	0.89	162.12

Table 5-6. Lower Fox River and Green Bay - Other RCRA Metals, Copper, Nickel, & Zinc (Continued)

Deposit, SMU, or Zone	Sample Identification	Depth (cm)	Barium (mg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Nickel (mg/kg)	Selenium (mg/kg)	Silver (mg/kg)	Zinc (mg/kg)
DePere to Green Bay Reach										
20	95004-01	0 - 10	na	1.6	70	71.7	18.21	ND	0.84	196.08
20	95008-01	0 - 10	na	1.8	73.5	73.1	19.51	ND	0.69	206.07
20	S00010	0 - 10	48	0.81	43	49	12	ND	ND	110
20	SDC-DPD-1-P-S	0 - 5	na	1.6	80	84	22	na	na	190
20	SDC-DPD-2-P-S	0 - 5	na	1.3	65	78	22	na	na	160
21	95018-01	0 - 10	na	1.2	62.3	70.2	17.11	ND	ND	164.08
21	95020-01	0 - 10	na	0.78	26.9	33.8	8.41	ND	ND	143.08
21	S00013	0 - 10	79	1.1	70	80	17	ND	ND	150
21	S00014	0 - 10	71	1.1	63	59	16	ND	ND	150
22	95002-01	0 - 10	na	1.7	75.6	72.1	16.41	ND	0.6	187.08
22	95006-01	0 - 10	na	ND	44	27.1	21.01	ND	ND	68.6
23	95016-01	0 - 10	na	ND	18.7	30.4	6.51	ND	ND	54.7
23	95022-01	0 - 10	na	ND	6.6	5	3.71	ND	ND	13.8
24	95007-01	0 - 10	na	0.66	49.3	56.6	13.51	ND	ND	145.08
24	S00011	0 - 10	59	ND	48	54	13	2.9	ND	130
25	95013-01	0 - 10	na	0.57	54.5	52.7	13.61	ND	ND	124.08
25	S00012	0 - 10	43	ND	31	41	11	ND	ND	72
29	95025-01	0 - 10	na	0.95	64.9	62.9	18.01	ND	ND	184.08
29	95028-01	0 - 10	na	1.3	63.2	63.9	14.31	ND	ND	165.08
35	95030-01	0 - 10	na	1.2	56.1	64.3	17.11	ND	ND	161.08
38	95035-01	0 - 10	na	10.8	102.08	108.05	112.11	391.59	9.6	276.08
38	S00015	0 - 10	29	ND	22	18	10	ND	ND	49
41	95038-01	0 - 10	na	1.8	119.08	75.8	20.81	ND	0.84	255.08
41	S00016	0 - 10	66	1.2	55	54	18	ND	1.4	140
43	S00018	0 - 10	24	0.43	21	18	9	ND	ND	60
44	S00017	0 - 10	54	0.73	43	35	15	ND	ND	120
44	S00051	0 - 10	67	0.69	50	52	16	ND	ND	140
45	95054-01	0 - 10	na	1.4	59.7	59.6	18.71	ND	ND	174.08
45	S00052	0 - 10	61	0.82	49	58	16	ND	ND	140
45	SDC-DPD-3-P-S	0 - 5	na	1.2	58	61	24	na	na	160
46	95041-01	0 - 10	na	1.2	59.7	53.8	19.4	ND	ND	164
46	95044-01	0 - 10	na	0.96	55.9	52.2	16.81	ND	ND	156.07
47	95047-01	0 - 10	na	1.5	64.8	66.8	19.11	ND	1.2	189.07
47	95051-01	0 - 10	na	1.8	64.9	67.3	19.7	ND	0.65	190
47	95058-01	0 - 10	na	1.6	51	57.2	14.4	ND	ND	137
47	95109-01	0 - 10	na	1.4	63	60.4	17.2	ND	ND	162

Table 5-6. Lower Fox River and Green Bay - Other RCRA Metals, Copper, Nickel, & Zinc (Continued)

Deposit, SMU, or Zone	Sample Identification	Depth (cm)	Barium (mg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Nickel (mg/kg)	Selenium (mg/kg)	Silver (mg/kg)	Zinc (mg/kg)
48	95049-01	0 - 10	na	0.9	56.5	55.7	13.1	ND	ND	129
48	S00061	0 - 10	68	0.93	48	54	16	ND	ND	120
48	S00062	0 - 10	63	0.86	51	50	16	ND	ND	130
49	95052-01	0 - 10	na	0.73	45.8	59.4	14.1	ND	ND	123
49	95056-01	0 - 10	na	0.8	59.2	65.6	16.7	ND	ND	157
50	95060-01	0 - 10	na	0.91	25	21.2	9.3	ND	ND	67.2
52	95061-01	0 - 10	na	1.3	58.5	64.2	17.1	ND	ND	165
53	95062-01	0 - 10	na	1.3	36.3	40.7	12.2	ND	ND	93.7
54	S00019	0 - 10	26	ND	22	19	8.4	ND	ND	55
56	95066-01	0 - 10	na	1.6	72.8	71.1	19.7	ND	0.59	485
56	95068-01	0 - 10	na	1.5	59.9	64.2	18.7	ND	ND	183
56/57	B2 4-12"	10 - 30	81	1.3	78	63	18	ND	na	190
56/57	B2 1-2'	30 - 61	120	2	110	86	23	2	na	270
56/57	B2 2-3'	61 - 91	110	1.5	120	81	21	ND	na	260
56/57	B2 3-4'	91 - 122	110	1.7	160	92	21	1.7	na	310
56/57	B2 4-5'	122 - 152	130	1.5	210	110	22	ND	na	320
56/57	B2 5-6'	152 - 183	140	1.7	220	120	22	ND	na	280
56/57	B2 6-7'	183 - 213	140	1.7	130	110	21	ND	na	250
56/57	B2 7-8'	213 - 244	150	2.3	150	160	23	2.5	na	310
56/57	B2 8-9'	244 - 274	160	3.1	130	140	26	3.9	na	360
56/57	B2 9-10'	274 - 305	210	1.7	130	100	18	2.2	na	240
56/57	B2 10-11'	305 - 366	140	2.2	100	130	23	ND	na	270
56/57	B2 11-12'	335 - 366	170	3.5	89	130	21	1.6	na	280
57	95070-01	0 - 10	na	1.2	60.6	62.8	19.8	ND	ND	178
57	95071-01	0 - 10	na	1.6	64.9	69.2	19.4	ND	ND	178
57	95074-01	0 - 10	na	1.8	73.5	72	22.4	ND	ND	204
61	95072-01	0 - 10	na	1.2	64.2	64	20.2	ND	ND	180
62	95076-01	0 - 10	na	1.2	66.7	69.5	21.2	ND	ND	193
62	S00053	0 - 10	52	0.77	37	44	14	ND	ND	110
65	95077-01	0 - 10	na	1.6	70.5	70.5	22.6	7.8	0.62	196
65	95079-01	0 - 10	na	0.99	67	56.2	18.5	ND	0.77	162
70	95078-01	0 - 10	na	1.8	72.7	74.3	23.6	ND	ND	212
70	95080-01	0 - 10	na	1.3	73.4	74.5	23.4	ND	1	206
70	95081-01	0 - 10	na	1.5	91.2	75.8	19.6	ND	0.98	223
71	95082-01	0 - 10	na	1.2	59.8	57.2	18	ND	0.7	161
72	S00020	0 - 10	55	ND	38	43	13	ND	2.1	110

Table 5-6. Lower Fox River and Green Bay - Other RCRA Metals, Copper, Nickel, & Zinc (Continued)

Deposit, SMU, or Zone	Sample Identification	Depth (cm)	Barium (mg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Nickel (mg/kg)	Selenium (mg/kg)	Silver (mg/kg)	Zinc (mg/kg)
76	95084-01	0 - 10	na	0.85	66.2	66.1	20.3	ND	0.9	184
77	95085-01	0 - 10	na	0.59	56.7	38.3	14.5	ND	ND	194
82	95086-01	0 - 10	na	1.3	61.2	65.1	28.3	ND	0.98	209
82	95087-01	0 - 10	na	0.63	46.4	46.8	9.5	ND	ND	123
82	95088-01	0 - 10	na	1.4	66	59.7	17.4	ND	0.83	176
83	95089-01	0 - 10	na	1.1	59.3	61.1	19.7	ND	0.79	175
88	95090-01	0 - 10	na	1.5	85.6	65.6	19.9	ND	1.1	220
88	95091-01	0 - 10	na	0.76	18.5	28.2	12	ND	1.1	93.5
89	95092-01	0 - 10	na	0.75	31.1	68.4	23	ND	0.86	169
94	95093-01	0 - 10	na	1.1	57.2	62.6	19.7	ND	1	174
94	95094-01	0 - 10	na	ND	42.1	43.6	15.3	ND	0.62	117
95	95095-01	0 - 10	na	ND	28.2	27.5	15.6	ND	ND	90.2
95	95096-01	0 - 10	na	ND	5.2	6.2	16.2	ND	ND	20.2
96	SDC-DPD-4-P-S	0 - 5	na	ND	8	8	5	na	na	23
100	95097-01	0 - 10	na	0.84	22.2	30.3	16.6	ND	ND	164
100	95098-01	0 - 10	na	ND	15.5	108	10.9	ND	ND	48.1
101	95099-01	0 - 10	na	ND	4.6	4.1	9.2	ND	ND	11.2
101	95101-01	0 - 10	na	ND	9.6	8.7	3.5	ND	ND	28.5
106	95100-01	0 - 10	na	ND	35	39.7	18.6	ND	ND	97.8
107	95102-01	0 - 10	na	1.3	65.3	71.5	28.9	ND	0.93	190
109	95103-01	0 - 10	na	0.65	41.5	41.5	21.3	ND	0.65	113
112	95104-01	0 - 10	na	ND	15	19.6	27.2	ND	ND	51.5
112	95105-01	0 - 10	na	0.88	48.9	52.5	18.3	ND	0.88	143
113	95106-01	0 - 10	na	1.4	50.9	58.1	17.4	ND	ND	152
115	SDC-DPD-5-P-S	0 - 5	na	0.9	50	56	24	na	na	130
unknown	2FRB1 (Tr)	"0"	na	2	66	72	15	0.14	ND	na
unknown	2FRB17 (Tr)	"0"	na	1	17	26	9	0.94	ND	na
unknown	2FRB22 (Tr)	"0"	na	2	100	120	16	0.25	ND	na
unknown	4085139AB	-	400	1.3	100	62	27	0.8	0.6	190
unknown	4085139B	-	370	1.3	99	64	28	0.8	0.6	180
unknown	FRB (Tr)	"0"	na	2	160	87	19	0.84	ND	250
unknown	FRB1	-	na	2	66	72	15	0.14	na	na
unknown	95010-01	0 - 10	na	1.2	69	64	15.61	ND	ND	175.07
unknown	95011-01	0 - 10	na	1	63.6	69.4	16.81	ND	0.54	174.07
unknown	95064-01	0 - 10	na	ND	8.2	5	3.2	ND	ND	19
Reach Average			109.87	1.42	63.03	60.98	18.13	26.26	1.17	162.46

Table 5-6. Lower Fox River and Green Bay - Other RCRA Metals, Copper, Nickel, & Zinc (Continued)

Deposit, SMU, or Zone	Sample Identification	Depth (cm)	Barium (mg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Nickel (mg/kg)	Selenium (mg/kg)	Silver (mg/kg)	Zinc (mg/kg)
GREEN BAY										
Green Bay Zone 2 (2A & 2B)										
	S00030	0 - 10	15	0.11	8.6	7.9	4.7	ND	ND	22
	S00031	0 - 10	13	ND	8.9	8.7	4.4	ND	ND	26
	S00032	0 - 10	4.9	ND	2.4	ND	1.4	ND	ND	4
	S00037	0 - 10	40	0.72	34	29	12	ND	ND	99
	S00038	0 - 10	23	0.45	19	21	7.2	ND	ND	63
	S00039	0 - 10	37	0.58	32	31	11	ND	ND	95
	S00040	0 - 10	38	0.79	36	35	12	ND	ND	110
	S00056	0 - 10	8.6	0.1	6.2	15	3.4	ND	ND	12
	S00057	0 - 10	23	0.16	15	16	6.9	ND	ND	43
	S00058	0 - 10	27	0.26	21	16	9.1	ND	ND	46
	S00063	0 - 10	27	ND	13	10	5.8	ND	ND	27
Zone Average			23.32	0.40	17.83	18.96	7.08	ND	ND	49.73
Green Bay Zone 3A										
	S00042	0 - 10	3.4	ND	1.6	1.3	1.3	ND	ND	3.9
	S00043	0 - 10	5.3	ND	2.7	1.1	1.4	ND	ND	7.7
Zone Average			4.35	ND	2.15	1.20	1.35	ND	ND	5.80
Green Bay Zone 3B										
	S00041	0 - 10	14	0.18	8.4	5.9	4.6	0.87	ND	20
	S00047	0 - 10	39	0.59	21	14	10	ND	ND	63
	S00048	0 - 10	38	0.67	20	13	11	ND	ND	61
	S00054	0 - 10	120	0.81	40	36	23	ND	ND	110
Zone Average			52.75	0.5625	22.35	17.225	12.15	0.87	ND	63.5
Green Bay Zone 4										
	S00044	0 - 10	6.2	ND	4.5	1.5	2.2	ND	ND	15
	S00045	0 - 10	5.7	0.07	3.5	3.2	2.3	ND	ND	8.7
	S00046	0 - 10	7.2	ND	4.9	1.6	1.9	ND	ND	9.1
	S00055	0 - 10	4.2	ND	2.6	1.2	1.6	ND	ND	7.2
Zone Average			5.825	0.07	3.875	1.875	2	ND	ND	10

Table 5-6. Lower Fox River and Green Bay - Other RCRA Metals, Copper, Nickel, & Zinc (Continued)

Deposit, SMU, or Zone	Sample Identification	Depth (cm)	Barium (mg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Nickel (mg/kg)	Selenium (mg/kg)	Silver (mg/kg)	Zinc (mg/kg)
Reference										
	4072050AW	-	500.00	0.40	64.00	31.00	30.00	0.80	0.20	96.00
	4072050B	-	450.00	0.50	61.00	23.00	26.00	0.90	0.20	87.00
	4072050BO	-	220.00	0.30	55.00	19.00	31.00	0.80	ND	96.00
	4072050BR	-	490.00	0.40	57.00	23.00	25.00	0.68	0.10	89.00
	4085109Q	-	530.00	0.20	69.00	30.00	34.00	0.50	0.10	78.00
	4085110B	-	na	1.10	57.00	11.00	14.00	1.20	0.20	150.00
	REF (Tr)(2)	"0"	na	1.00	20.00	23.00	12.00	1.56	ND	na
Reference Average			370.00	0.56	54.71	22.86	24.57	0.92	57.54	113.71
NURE Average Background Concentration			455.70	None	40.29	12.84	14.20	0.57	2.13	91.84
WDNR Triad Reference Background Conc.			na	1.00	20.00	23.00	12.00	1.56	ND	34.00
Lake Winnebago Avergae Conc.			na	ND	65.00	28.70	27.00	ND	ND	86.70
EPA Background Level (1986)			100 - 3,000	0.01 - 0.7	1 - 1,000	2 - 100	5 - 500	0.1 - 2	0.01 - 5	10 - 300

Notes: 1) ND = parameter not detected in sample.
2) "0" depth indicates sample was collected from surface sediments.
3) na = parameter not analyzed in sample.

Table 5-7. Lower Fox River and Green Bay - Miscellaneous Inorganic Compounds

Deposit, SMU, or Zone	Sample Identification	Depth (cm)	Aluminum (mg/kg)	Antimony (mg/kg)	Beryllium (mg/kg)	Calcium (mg/kg)	Cobalt (mg/kg)	Iron (mg/kg)	Magnesium (mg/kg)	Manganese (mg/kg)	Potassium (mg/kg)	Sodium (mg/kg)	Thallium (mg/kg)	Vanadium (mg/kg)
LOWER FOX RIVER														
Little Lake Butte des Morts Reach														
A	BA-SD01comp	0 - 61	14800.00	ND	0.84	62900.00	11.30	23400.00	17800.00	484.00	2140.00	624.00	ND	34.40
A	BA-SD04comp	0 - 43	14500.00	ND	0.74	33000.00	11.30	19200.00	14300.00	231.00	2220.00	ND	ND	32.60
A	BA-SD08comp	0 - 46	22900.00	ND	0.77	55700.00	9.40	19100.00	22400.00	326.00	3230.00	521.00	ND	37.20
A	BA-SD34	0 - 61	18400.00	ND	1.10	67400.00	8.60	25700.00	22100.00	1390.00	2350.00	688.00	ND	34.30
A	BA-SD35	0 - 34	5720.00	ND	0.25	90600.00	4.80	14100.00	52400.00	332.00	969.00	319.00	ND	30.90
A	S00009	0 - 10	8500.00	ND	0.75	64000.00	8.50	15000.00	25000.00	350.00	1200.00	560.00	ND	21.00
C	2C2 (Tr)	"0"	na	10.00	0.70	na	na	na	na	na	na	na	25.00	na
C	S00003	0 - 10	11000.00	ND	0.76	54000.00	6.60	16000.00	18000.00	310.00	1300.00	490.00	ND	21.00
D	D-RI-Comp1(0-2)	0 - 61	10.00	ND	1.08	75.00	8.65	23.00	38.00	386.00	1750.00	2470.00	ND	23.10
D	D-RI-Comp1(2-4)	61 - 122	2570.00	ND	0.33	57100.00	4.32	2860.00	30400.00	233.00	737.00	1040.00	ND	7.04
D	D-RI-Comp2(0-2)	0 - 61	6880.00	ND	0.48	86900.00	8.10	21500.00	45800.00	416.00	2140.00	1870.00	ND	20.80
D	S00025	0 - 10	7300.00	2.90	0.32	50000.00	6.40	17000.00	19000.00	310.00	1000.00	730.00	ND	19.00
D	S00026	0 - 10	8600.00	ND	0.40	50000.00	7.20	15000.00	20000.00	350.00	1100.00	200.00	ND	20.00
D	S00049	0 - 10	7200.00	ND	0.51	31000.00	4.90	12000.00	11000.00	260.00	950.00	500.00	ND	16.00
E	2E8 (Tr)	"0"	na	10.00	0.70	na	na	na	na	na	na	na	25.00	na
E	E-RI-Comp1(0-2)	0 - 61	10400.00	ND	1.05	57000.00	5.60	14800.00	28300.00	312.00	1750.00	1570.00	ND	20.50
E	E-RI-Comp1(2-4)	61 - 122	9600.00	ND	0.67	16400.00	7.30	19400.00	71500.00	809.00	1520.00	1100.00	ND	17.70
E	E-RI-Comp2(0-2)	0 - 61	7380.00	2.87	1.14	78000.00	7.20	16500.00	40300.00	366.00	1730.00	1720.00	ND	20.00
E	S00027	0 - 10	11000.00	ND	0.44	51000.00	8.10	18000.00	16000.00	370.00	1500.00	350.00	ND	27.00
E	S00029	0 - 10	8100.00	ND	0.22	63000.00	11.00	18000.00	24000.00	370.00	1500.00	880.00	ND	24.00
F	S00028	0 - 10	15000.00	ND	0.61	52000.00	12.00	25000.00	18000.00	450.00	2500.00	880.00	ND	35.00
POG	P-RI-Comp1(0-2)	0 - 61	15800.00	0.66	1.21	92700.00	7.55	25000.00	46700.00	455.00	3480.00	2210.00	ND	29.60
POG	P-RI-Comp1(2-4)	61 - 122	21450.00	0.59	1.30	64100.00	8.15	32900.00	33100.00	421.00	4710.00	2140.00	ND	39.40
POG	P-RI-Comp1(4-6)	122 - 183	16700.00	0.56	1.31	53000.00	8.80	24200.00	27600.00	369.00	3100.00	2120.00	ND	34.00
POG	POG (Tr)	"0"	na	25.00	0.50	na	na	na	na	na	na	na	25.00	na
POG	S00024	0 - 10	3600.00	ND	0.32	58000.00	5.40	13000.00	26000.00	210.00	620.00	340.00	ND	16.00
Interdeposit	S00022	0 - 10	6900.00	ND	0.39	63000.00	7.20	17000.00	26000.00	340.00	1300.00	500.00	ND	22.00
Appleton to Little Rapids Reach														
P	S00007	0 - 10	7400.00	ND	0.64	45000.00	8.90	15000.00	18000.00	260.00	1200.00	430.00	ND	22.00
P	S00008	0 - 10	7400.00	ND	0.54	43000.00	6.40	12000.00	17000.00	240.00	1200.00	220.00	ND	20.00
W	S00005	0 - 10	7500.00	ND	0.59	36000.00	8.10	13000.00	17000.00	220.00	1100.00	270.00	ND	23.00
X	S00004	0 - 10	5600.00	ND	0.43	140000.00	3.80	10000.00	13000.00	290.00	780.00	2200.00	ND	16.00
X	X (Tr)	"0"	na	25.00	0.60	na	na	na	na	na	na	na	25.00	na
Interdeposit	S00060	0 - 10	5600.00	ND	0.31	28000.00	3.80	9400.00	12000.00	200.00	890.00	400.00	ND	17.00

Table 5-7. Lower Fox River and Green Bay - Miscellaneous Inorganic Compounds (Continued)

Deposit, SMU, or Zone	Sample Identification	Depth (cm)	Aluminum (mg/kg)	Antimony (mg/kg)	Beryllium (mg/kg)	Calcium (mg/kg)	Cobalt (mg/kg)	Iron (mg/kg)	Magnesium (mg/kg)	Manganese (mg/kg)	Potassium (mg/kg)	Sodium (mg/kg)	Thallium (mg/kg)	Vanadium (mg/kg)
Little Rapids to DePere Reach														
EE	S00021	0 - 10	8300.00	ND	0.31	42000.00	6.50	13000.00	21000.00	270.00	1400.00	420.00	2.20	23.00
EE	S00023	0 - 10	4500.00	ND	0.17	45000.00	4.80	9100.00	24000.00	220.00	760.00	430.00	ND	14.00
EE	S00036	0 - 10	13000.00	ND	0.36	34000.00	6.90	17000.00	15000.00	310.00	2000.00	590.00	ND	28.00
EG	EGH-RI-Comp1(0-2	0 - 61	19800.00	0.31	1.38	32900.00	8.31	25000.00	18300.00	367.00	2770.00	32.30	ND	34.10
EG	EGH-RI-Comp1(2-4	61 - 122	23300.00	ND	1.28	47.00	8.70	34.00	28.00	456.00	2490.00	68.20	0.19	34.50
EG	EGH-RI-Comp1(4-6	122 - 183	18400.00	ND	1.11	53.00	8.34	30.00	31.00	465.00	3590.00	270.00	ND	36.90
EG	EGH-RI-Comp1(6-8	183 - 244	7730.00	ND	ND	70.00	4.80	14.00	40.00	346.00	1330.00	107.00	ND	23.50
HH	HH (Tr)	"0"	na	25.00	0.70	na	na	na	na	na	na	na	25.00	na
HH	S00001	0 - 10	12000.00	ND	0.89	50000.00	7.00	18000.00	21000.00	380.00	2000.00	480.00	ND	29.00
HH	S00034	0 - 10	11000.00	4.20	0.36	35000.00	5.90	15000.00	17000.00	260.00	1500.00	240.00	ND	25.00
Interdeposit	S00002	0 - 10	9400.00	ND	0.65	44000.00	5.80	15000.00	18000.00	350.00	1400.00	270.00	ND	23.00
Interdeposit	S00033	0 - 10	11000.00	ND	0.31	36000.00	5.60	16000.00	14000.00	350.00	1800.00	400.00	ND	26.00
Interdeposit	S00035	0 - 10	13000.00	ND	0.52	39000.00	6.10	17000.00	17000.00	310.00	2600.00	540.00	ND	29.00
DePere to Green Bay Reach														
	2FRB1 (Tr)	"0"	na	10.00	0.60	na	na	na	na	na	na	na	25.00	na
	2FRB17 (Tr)	"0"	na	10.00	0.40	na	na	na	na	na	na	na	25.00	na
	2FRB22 (Tr)	"0"	na	10.00	0.70	na	na	na	na	na	na	na	25.00	na
	4085139AB	-	57000.00	2.00	1.00	59000.00	11.00	29000.00	26000.00	670.00	22000.00	5200.00	na	61.00
	4085139B	-	52000.00	1.00	1.00	62000.00	12.00	29000.00	23000.00	630.00	21000.00	4900.00	na	61.00
	FRB (Tr)	"0"	na	25.00	0.90	na	na	na	na	na	na	na	25.00	na
	FRB1	-	na	10.00	0.60	na	na	na	na	na	na	na	ND	na
20	S00010	0 - 10	6400.00	ND	0.51	36000.00	4.20	11000.00	16000.00	230.00	920.00	230.00	ND	16.00
21	95015-01	0 - 10	na	na	na	na	na	na	na	na	na	na	na	na
21	S00013	0 - 10	14000.00	ND	0.90	42000.00	5.40	17000.00	18000.00	310.00	2700.00	420.00	ND	30.00
21	S00014	0 - 10	11000.00	ND	0.76	43000.00	5.50	16000.00	18000.00	300.00	1800.00	460.00	ND	25.00
24	S00011	0 - 10	7800.00	ND	0.61	39000.00	4.90	14000.00	17000.00	300.00	1400.00	870.00	2.00	23.00
25	S00012	0 - 10	7600.00	ND	0.49	39000.00	4.30	10000.00	17000.00	240.00	1500.00	770.00	ND	19.00
38	S00015	0 - 10	5800.00	ND	0.37	24000.00	4.20	8000.00	12000.00	150.00	1100.00	550.00	ND	14.00
41	S00016	0 - 10	10000.00	ND	0.69	43000.00	6.20	16000.00	18000.00	320.00	1700.00	460.00	ND	26.00
43	S00018	0 - 10	3200.00	ND	0.25	24000.00	5.20	7000.00	11000.00	150.00	460.00	62.00	ND	9.60
44	S00017	0 - 10	8600.00	ND	0.56	39000.00	5.60	13000.00	17000.00	270.00	1400.00	500.00	ND	21.00
44	S00051	0 - 10	11000.00	ND	0.63	38000.00	5.10	14000.00	16000.00	290.00	2100.00	930.00	ND	25.00
45	S00052	0 - 10	9300.00	ND	0.57	38000.00	5.20	14000.00	16000.00	290.00	1500.00	580.00	2.60	23.00
48	95049-01	0 - 10	na	na	na	na	na	na	na	na	na	na	na	na
48	S00061	0 - 10	11000.00	ND	0.62	43000.00	6.00	15000.00	18000.00	340.00	2000.00	850.00	ND	27.00
48	S00062	0 - 10	8700.00	3.10	0.48	43000.00	5.90	14000.00	18000.00	340.00	1400.00	250.00	ND	23.00

Table 5-7. Lower Fox River and Green Bay - Miscellaneous Inorganic Compounds (Continued)

Deposit, SMU, or Zone	Sample Identification	Depth (cm)	Aluminum (mg/kg)	Antimony (mg/kg)	Beryllium (mg/kg)	Calcium (mg/kg)	Cobalt (mg/kg)	Iron (mg/kg)	Magnesium (mg/kg)	Manganese (mg/kg)	Potassium (mg/kg)	Sodium (mg/kg)	Thallium (mg/kg)	Vanadium (mg/kg)
54	S00019	0 - 10	3400.00	ND	0.29	41000.00	5.60	7700.00	20000.00	210.00	510.00	81.00	ND	11.00
56/57	B2 1-2'	30 - 61	na	na	na	na	na	20000.00	na	410.00	na	na	na	na
56/57	B2 10-11'	305 - 366	na	na	na	na	na	20000.00	na	300.00	na	na	na	na
56/57	B2 11-12'	335 - 366	na	na	na	na	na	19000.00	na	240.00	na	na	na	na
56/57	B2 2-3'	61 - 91	na	na	na	na	na	19000.00	na	320.00	na	na	na	na
56/57	B2 3-4'	91 - 122	na	na	na	na	na	18000.00	na	290.00	na	na	na	na
56/57	B2 4-12"	10 - 30	na	na	na	na	na	15000.00	na	330.00	na	na	na	na
56/57	B2 4-5'	122 - 152	na	na	na	na	na	18000.00	na	270.00	na	na	na	na
56/57	B2 5-6'	152 - 183	na	na	na	na	na	19000.00	na	270.00	na	na	na	na
56/57	B2 6-7'	183 - 213	na	na	na	na	na	18000.00	na	250.00	na	na	na	na
56/57	B2 7-8'	213 - 244	na	na	na	na	na	20000.00	na	260.00	na	na	na	na
56/57	B2 8-9'	244 - 274	na	na	na	na	na	22000.00	na	290.00	na	na	na	na
56/57	B2 9-10'	274 - 305	na	na	na	na	na	15000.00	na	250.00	na	na	na	na
62	S00053	0 - 10	6700.00	ND	0.46	32000.00	4.50	11000.00	12000.00	280.00	1100.00	440.00	ND	17.00
72	S00020	0 - 10	8100.00	ND	0.57	37000.00	4.40	12000.00	15000.00	280.00	1300.00	160.00	ND	20.00
GREEN BAY														
Green Bay Zone 2 (2A & 2B)														
	S00030	0 - 10	2400.00	ND	0.10	15000.00	2.20	4400.00	7800.00	110.00	290.00	170.00	ND	8.90
	S00031	0 - 10	2100.00	ND	0.05	15000.00	2.50	4100.00	7500.00	120.00	310.00	120.00	ND	6.90
	S00032	0 - 10	680.00	ND	ND	1500.00	0.41	1200.00	670.00	26.00	90.00	160.00	ND	2.80
	S00037	0 - 10	7600.00	ND	0.24	54000.00	4.90	12000.00	30000.00	300.00	1600.00	660.00	ND	20.00
	S00038	0 - 10	3500.00	ND	0.11	29000.00	4.40	7200.00	15000.00	180.00	550.00	210.00	ND	11.00
	S00039	0 - 10	6700.00	ND	0.32	52000.00	5.10	12000.00	29000.00	290.00	1300.00	670.00	ND	19.00
	S00040	0 - 10	5800.00	ND	0.26	27000.00	4.60	11000.00	14000.00	250.00	960.00	180.00	ND	17.00
	S00056	0 - 10	1600.00	ND	0.11	22000.00	1.40	3500.00	12000.00	140.00	230.00	100.00	ND	7.80
	S00057	0 - 10	3300.00	ND	0.23	26000.00	3.20	6900.00	14000.00	180.00	510.00	250.00	ND	12.00
	S00058	0 - 10	4900.00	ND	0.33	16000.00	3.20	7700.00	7900.00	200.00	730.00	210.00	ND	14.00
	S00063	0 - 10	4100.00	ND	0.30	16000.00	2.40	6500.00	7300.00	160.00	580.00	87.00	ND	15.00
Green Bay Zone 3A														
	S00042	0 - 10	460.00	ND	ND	3400.00	0.50	1600.00	1700.00	31.00	79.00	130.00	ND	4.40
	S00043	0 - 10	540.00	ND	0.07	4300.00	0.62	1900.00	2300.00	77.00	71.00	160.00	ND	5.20
Green Bay Zone 3B														
	S00041	0 - 10	2500.00	1.50	0.18	93000.00	2.30	5600.00	54000.00	400.00	610.00	210.00	ND	8.20
	S00047	0 - 10	4400.00	ND	0.36	50000.00	3.30	15000.00	29000.00	510.00	810.00	340.00	ND	18.00
	S00048	0 - 10	4400.00	ND	0.30	46000.00	3.20	15000.00	27000.00	510.00	800.00	240.00	ND	18.00
	S00054	0 - 10	13000.00	ND	0.83	15000.00	7.80	26000.00	9800.00	1900.00	2400.00	740.00	ND	41.00

Table 5-7. Lower Fox River and Green Bay - Miscellaneous Inorganic Compounds (Continued)

Deposit, SMU, or Zone	Sample Identification	Depth (cm)	Aluminum (mg/kg)	Antimony (mg/kg)	Beryllium (mg/kg)	Calcium (mg/kg)	Cobalt (mg/kg)	Iron (mg/kg)	Magnesium (mg/kg)	Manganese (mg/kg)	Potassium (mg/kg)	Sodium (mg/kg)	Thallium (mg/kg)	Vanadium (mg/kg)
Green Bay Zone 4														
	S00044	0 - 10	550.00	ND	ND	7200.00	1.30	7500.00	3700.00	150.00	60.00	140.00	ND	6.40
	S00045	0 - 10	790.00	1.00	0.10	14000.00	0.67	2300.00	7400.00	110.00	130.00	60.00	ND	6.40
	S00046	0 - 10	840.00	ND	ND	23000.00	0.48	4600.00	13000.00	110.00	170.00	160.00	ND	8.40
	S00055	0 - 10	410.00	ND	ND	2300.00	0.57	4200.00	1200.00	65.00	62.00	89.00	ND	10.00
Reference														
	4072050AW	-	60000	0.5	1	30000	16	36000	17000	860	29000	7000	na	74
	4072050B	-	53000	0.7	1	32000	14	33000	17000	780	25000	6600	na	69
	4072050BO	-	58000	1	2	160000	12	25000	5700	790	12000	1300	na	120
	4072050BR	-	57000	0.38	1	34000	13	32000	18000	750	28000	7600	na	73
	4085109Q	-	66000	0.3	2	27000	16	36000	20000	560	31000	7200	na	80
	4085110B	-	35000	0.9	ND	12000	10	41000	5400	3100	12000	6600	na	56
	REF (Tr)(2)	"0"	na	10	0.5	na	na	na	na	na	na	na	25	na
Reference Averages			54,833.33	1.97	1.25	49,166.67	13.50	33,833.33	13,850.00	1,140.00	22,833.33	6,050.00	25.00	78.67
NURE Average Background Concentratio			3,399	---	1.49	1138.05	13.19	2006.30	669.40	733.74	1.63	744.9	na	60.94
WDNR Triad Reference Background Con			---	10	0.5	---	---	---	---	---	---	---	25	---
Lake Winnebago Avergae Conc.			na	na	na	na	na	na	na	na	na	na	na	na
EPA Background Level (1986)			10,000 to 300,000	2-10	0.1-40	---	1-40	---	600-6,000	20-3,000	---	---	---	20-500

Notes: 1) ND = parameter not detected in sample.
2) "0" depth indicates sample was collected from surface sediments.
3) na = parameter not analyzed in sample.

Table 5-8. Lower Fox River and Green Bay - Ammonia Results

Deposit, SMU, or Zone	Sample Identification	Depth (cm)	Ammonia (mg/kg)
LOWER FOX RIVER			
Little Lake Butte des Morts Reach			
A	S00009	0 - 10	160
C	2C2 (Tr)	"0"	141
C	S00003	0 - 10	220
D	D-RI-12(0-2)	0 - 61	101.4
D	D-RI-15(0-2)	0 - 61	52.3
D	D-RI-15(2-3.7)	61 - 113	45.1
D	D-RI-16(0-1.6)	0 - 49	47.6
D	D-RI-18(0-1.5)	0 - 46	55.0
D	D-RI-19(0-0.5)	0 - 15	25.0
D	D-RI-2(0-0.5)	0 - 15	41.7
D	D-RI-21(0-2)	0 - 61	97.3
D	D-RI-4(0-0.5)	0 - 15	37.6
D	D-RI-9(0-2)	0 - 61	128.7
D	S00025	0 - 10	160
D	S00026	0 - 10	230
D	S00049	0 - 10	290
E	2E8 (Tr)	"0"	68.5
E	E-RI-10(0-1.5)	0 - 46	59.2
E	E-RI-12(0-2)	0 - 61	155
E	E-RI-13(0-2)	0 - 61	73
E	E-RI-13(2-3.75)	61 - 114	70
E	E-RI-15(0-2)	0 - 61	75
E	E-RI-16(0-2)	0 - 61	200
E	E-RI-17(0-2)	0 - 61	213
E	E-RI-2(0-2)	0 - 61	54.7
E	E-RI-4(0-2)	0 - 61	69.4
E	E-RI-7(0-2)	0 - 61	167.2
E	E-RI-9(0-2)	0 - 61	135.9
E	S00027	0 - 10	220
E	S00029	0 - 10	280
F	S00028	0 - 10	300
POG	P-RI-12(0-1.4)	0 - 43	37
POG	P-RI-15(0-2)	0 - 61	282
POG	P-RI-17(0-1.2)	0 - 37	35
POG	P-RI-19(0-0.5)	0 - 15	29.05
POG	P-RI-2(0-1)	0 - 30	62.1
POG	P-RI-21(0-1.8)	0 - 55	87.2
POG	P-RI-22(0-0.4)	0 - 12	36.95
POG	P-RI-5(0-0.9)	0 - 27	41.2
POG	P-RI-7(0-2)	0 - 61	171
POG	POG (Tr)	"0"	240
POG	S00024	0 - 10	230
Interdeposit	S00022	0 - 10	300
Little Rapids to DePere Reach - cont.			
GG	GG-RI-1(0-2)	0 - 61	361
GG	GG-RI-10(0-0.9)	0 - 27	113
GG	GG-RI-13(0-2)	0 - 61	341.5
GG	GG-RI-4(0-2)	0 - 61	272
GG	GG-RI-6(0-2)	0 - 61	341
GG	GG-RI-8(0-2)	0 - 61	370
GG	GG-RI-9(0-2)	0 - 61	421
HH	HH (Tr)	"0"	700
HH	HH-RI-2(0-2)	0 - 61	276
HH	HH-RI-3(0-2)	0 - 61	336
HH	HH-RI-5(0-2)	0 - 61	160
HH	HH-RI-7(0-0.5)	0 - 15	96.4
HH	HH-RI-9(0-2)	0 - 61	323
HH	S00001	0 - 10	410
HH	S00034	0 - 10	280
Interdeposit	S00002	0 - 10	300
Interdeposit	S00033	0 - 10	280
Interdeposit	S00035	0 - 10	240
DePere to Green Bay Reach			
	2FRB1 (Tr)	"0"	89
	2FRB17 (Tr)	"0"	68.5
	2FRB22 (Tr)	"0"	357
	FRB (Tr)	"0"	590
20	S00010	0 - 10	150
21	S00013	0 - 10	170
21	S00014	0 - 10	170
24	S00011	0 - 10	170
25	S00012	0 - 10	130
38	S00015	0 - 10	80
41	S00016	0 - 10	390
43	S00018	0 - 10	150
44	S00017	0 - 10	180
44	S00051	0 - 10	120
45	S00052	0 - 10	150
48	S00061	0 - 10	90
54	S00019	0 - 10	120
62	S00053	0 - 10	180
72	S00020	0 - 10	280
GREEN BAY			
Green Bay Zone 2 (2A & 2B)			
	S00030	0 - 10	98
	S00031	0 - 10	83
	S00032	0 - 10	33
	S00037	0 - 10	65

Notes: 1) "0" depth indicates sample was collected from surface sediments.

Table 5-8. Lower Fox River and Green Bay - Ammonia Results (Continued)

Deposit, SMU, or Zone	Sample Identification	Depth (cm)	Ammonia (mg/kg)
Appleton to Little Rapids Reach			
P	S00007	0 - 10	180
P	S00008	0 - 10	150
W	S00005	0 - 10	110
X	S00004	0 - 10	93
X	X (Tr)	"0"	340
Interdeposit	S00060	0 - 10	87
Little Rapids to DePere Reach			
EE	EE-RI-1(0-2)	0 - 61	191
EE	EE-RI-12(0-2)	0 - 61	280
EE	EE-RI-19(0-2)	0 - 61	464.5
EE	EE-RI-24(0-2)	0 - 61	412
EE	EE-RI-29(0-2)	0 - 61	347
EE	EE-RI-4(0-2)	0 - 61	206
EE	EE-RI-5(0-2)	0 - 61	280
EE	EE-RI-8(0-2)	0 - 61	341
EE	S00021	0 - 10	63
EE	S00023	0 - 10	120
EE	S00036	0 - 10	240
	S00038	0 - 10	59
	S00039	0 - 10	80
	S00040	0 - 10	130
	S00056	0 - 10	32
	S00057	0 - 10	43
	S00058	0 - 10	120
Green Bay Zone 3A			
	S00042	0 - 10	69
	S00043	0 - 10	77
Green Bay Zone 3B			
	S00041	0 - 10	43
	S00048	0 - 10	88
	S00054	0 - 10	140
Green Bay Zone 4			
	S00044	0 - 10	48
	S00045	0 - 10	62
	S00046	0 - 10	22
	S00055	0 - 10	30
Reference	**REF (Tr)(2)**	**"0"**	**31**

Notes: 1) "0" depth indicates sample was collected from surface sediments.

Table 5-9. Lower Fox River - Toxicity Characteristic Leaching Procedure (TCLP) Results

Deposit	Sample Identification	Depth (cm)	Arsenic (mg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Lead (mg/L)	Mercury (mg/L)	Selenium (mg/L)	Silver (mg/L)
Little Lake Butte des Morts Reach										
Deposit D	D-RI-Comp1(0-2)	0 - 61	0.009	0.936	ND	0.20	0.11	0.0005	ND	0.02
Deposit D	D-RI-Comp1(2-4)	61 - 122	0.003	0.591	ND	ND	ND	ND	ND	0.03
Deposit D	D-RI-Comp2(0-2)	0 - 61	0.0011	0.794	ND	0.12	0.11	ND	ND	0.02
Deposit E	E-RI-Comp1(0-2)	0 - 61	0.005	0.684	ND	0.01	ND	ND	ND	0.03
Deposit E	E-RI-Comp1(2-4)	61 - 122	0.003	0.789	ND	0.01	ND	ND	ND	0.02
Deposit E	E-RI-Comp2(0-2)	0 - 61	0.007	0.697	ND	0.01	0.06	ND	ND	0.02
Deposit POG	P-RI-Comp1(0-2)	0 - 61	0.006	0.588	0.01	ND	0.27	ND	ND	0.02
Deposit POG	P-RI-Comp1(2-4)	61 - 122	0.012	0.710	0.01	ND	0.27	0.0005	ND	0.02
Deposit POG	P-RI-Comp1(4-6)	122 - 183	0.011	0.357	ND	ND	0.11	ND	ND	0.02
Little Rapids to DePere Reach										
Deposit EG	EGH-RI-Comp1(0-2)	0 - 61	0.020	0.255	0.01	0.01	0.16	ND	ND	0.02
Deposit EG	EGH-RI-Comp1(2-4)	61 - 122	0.031	0.629	0.01	0.01	0.09	ND	ND	ND
Deposit EG	EGH-RI-Comp1(4-6)	122 - 183	0.029	0.503	0.01	ND	0.07	ND	ND	0.02
Deposit EG	EGH-RI-Comp1(6-8)	183 - 244	0.007	0.789	ND	0.01	ND	ND	ND	0.03
DePere to Green Bay Reach										
	FRB1	0	na	na	na	na	na	na	na	ND
Regulatory Levels			**5**	**100**	**1**	**5**	**5**	**0.2**	**1**	**5**

Notes: 1) ND = parameter not detected in sample.
2) na = parameter not analyzed in sample.

Table 5-10. Lower Fox River and Green Bay - Semi-Volatile Organic Compound Results (PAHs).

Deposit, SMU, or Zone	Sample Identification	Depth (cm)	Acenaphthene (µg/kg)	Acenaphthylene (µg/kg)	Anthracene (µg/kg)	Benzo(a)anthracene (µg/kg)	Benzo(a)pyrene (µg/kg)	Benzo(b)fluoranthene (µg/kg)	Benzo(ghi)perylene (µg/kg)	Benzo(k)fluoranthene (µg/kg)	Chrysene (µg/kg)	Dibenz(a,h)anthracene (µg/kg)
LOWER FOX RIVER												
Little Lake Butte des Morts Reach												
A	BA-SD01comp	0 - 61	64	ND	ND	390	440	920	150	na	ND	na
A	BA-SD04comp	0 - 43	ND	ND	ND	ND	ND	370	120	na	ND	na
A	BA-SD08comp	0 - 46	ND	54	48	ND	ND	620	230	na	270	na
A	S00009	0 - 10	ND	ND	ND	1300	2500	4100	3700	2300	2200	ND
C	S00003	0 - 10	ND	ND	ND	ND	1000	ND	1400	ND	1200	ND
C	2C2 (Tr)	"0"	9.25	9.25	116	573	691	446	684	243	1240	45.6
C	SDC-C-1-P-S	0 - 5	110	110	110	470	910	430	780	590	920	170
C	SDC-C-3-P-S	0 - 5	ND	71	160	710	1300	910	620	1100	1100	210
D	S00025	0 - 10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
D	S00026	0 - 10	ND	ND	ND	ND	ND	2900	2600	ND	590	ND
D	S00049	0 - 10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
E	2E8 (Tr)	"0"	9.25	9.25	47.6	236	289	175	317	76.9	341	30.9
E	E-RI-Comp2(0-2)	0 - 61	ND	ND	ND	113	142	156	ND	ND	143	90
E	SDC-E-1-P-S	0 - 5	ND	23	56	490	980	470	850	560	810	320
E	SDC-E-3-P-S	0 - 5	ND	ND	30	230	450	480	240	420	410	100
E	S00029	0 - 10	ND	ND	ND	ND	ND	3900	3200	ND	680	ND
F	S00028	0 - 10	ND	ND	ND	ND	ND	4100	3600	ND	ND	ND
POG	P-RI-Comp1(0-2)	0 - 61	ND	ND	ND	148	148	174	ND	ND	192	ND
POG	P-RI-Comp1(2-4)	61 - 122	ND	ND	ND	ND	77	ND	ND	ND	71	ND
POG	P-RI-Comp1(4-6)	122 - 183	ND	ND	ND	125	200	161	104	ND	182	ND
POG	S00024	0 - 10	580	ND	1400	3300	2900	4400	3400	2600	3800	ND
POG	POG (Tr)	"0"	9.25	9.25	110	310	390	290	300	290	450	66.1
Appleton to Little Rapids Reach												
P	S00007	0 - 10	ND	ND	ND	440	ND	ND	250	550	690	ND
P	S00008	0 - 10	ND	ND	180	1300	1200	ND	440	1600	2100	ND
W	SDC-W-2-P-S	0 - 5	ND	ND	100	380	410	360	280	440	540	100
W	SDC-W-3-P-S	0 - 5	130	110	360	980	950	810	530	800	1000	210
X	SDC-X-1-P-S	0 - 5	ND	ND	58	390	410	350	260	420	550	95
X	SDC-X-3-P-S	0 - 5	66	110	260	1000	1,100.00	810	660	1200	1200	260
W	S00005	0 - 10	ND	ND	ND	540	510	660	450	ND	660	ND
X	X (Tr)	"0"	120	120	270	1000	1100	900	660	900	1300	160
X	S00004	0 - 10	ND	170	160	870	910	610	490	640	990	ND
Interdeposit	S00060	0 - 10	ND	ND	ND	470	ND	ND	ND	ND	690	ND
Little Rapids to DePere Reach												
EE	SDC-EE22-2-P-S	0 - 5	ND	75	140	540.00	910	780	480	840	710	210
EE	SDC-EE22-3-P-S	0 - 5	ND	ND	64	250.00	330	220	200	300	350	70
EE	SDC-EE23-2-P-S	0 - 5	ND	ND	130	410.00	440	380	260	370	520	110
EE	SDC-EE23-3-P-S	0 - 5	ND	77	120	480.00	660	750	400	480	620	120
EE	SDC-EE24-1-P-S	0 - 5	ND	ND	150	530.00	690	660	340	500	650	130
EE	SDC-EE24-3-P-S	0 - 5	ND	ND	ND	170.00	310.00	190	250	310	280	85
EE	SDC-EE25-1-P-S	0 - 5	ND	ND	ND	290.00	410	220	370	380	470	100
EE	SDC-EE25-3-P-S	0 - 5	ND	ND	ND	280.00	520	470	290	440	420	130
EE	SDC-EE26-1-P-S	0 - 5	ND	ND	ND	340.00	600	250	540	570	600	140
EE	SDC-EE26-5-P-S	0 - 5	ND	ND	ND	310.00	600	310	690	200	620	ND
EE	S00021	0 - 10	ND	ND	ND	380	ND	2200	2000	ND	580	ND
EE	S00023	0 - 10	ND	ND	ND	300	ND	1600	1300	280	400	ND
EE	S00036	0 - 10	ND	ND	ND	ND	ND	ND	ND	ND	570	ND

Notes:
1) Sample results are in micrograms per kilogram (mg/kg).
2) ND = parameter not detected in sample.
3) na = parameter not analyzed in sample.
4) "0" depth indicates sample was collected from surface sediments.

Table 5-10. Lower Fox River and Green Bay - Semi-Volatile Organic Compound Results (PAHs) (Continued)

Deposit, SMU, or Zone	Sample Identification	Depth (cm)	Acenaphthene (µg/kg)	Acenaphthylene (µg/kg)	Anthracene (µg/kg)	Benzo(a)anthracene (µg/kg)	Benzo(a)pyrene (µg/kg)	Benzo(b)fluoranthene (µg/kg)	Benzo(ghi)perylene (µg/kg)	Benzo(k)fluoranthene (µg/kg)	Chrysene (µg/kg)	Dibenz(a,h)anthracene (µg/kg)
EG	EGH-RI-Comp1(0-2)	0 - 61	ND	ND	ND	ND	81	ND	ND	ND	79	ND
EG	EGH-RI-Comp1(2-4)	61 - 122	ND	ND	ND	ND	74	101	ND	ND	81	ND
HH	HH (Tr)	"0"	9.25	9.25	210	1200.00	1400	1200	700	1200	1400	66.1
HH	S00001	0 - 10	ND	ND	ND	ND	ND	ND	340	ND	530	ND
HH	S00034	0 - 10	ND	ND	ND	ND	ND	3000	2600	ND	540	ND
Interdeposit	S00002	0 - 10	ND	ND	ND	370	ND	ND	390	390	460	ND
Interdeposit	S00033	0 - 10	ND	ND	ND	ND	ND	3600	3000	ND	660	ND
Interdeposit	S00035	0 - 10	ND	ND	ND	ND	ND	ND	ND	ND	600	ND
DePere to Green Bay Reach												
20	SDC-DPD-1-P-S	0 - 5	ND	ND	56	400	910	650	640	730	630	150
20	SDC-DPD-2-P-S	0 - 5	ND	ND	ND	190	280	300	180	390	380	ND
20	S00010	0 - 10	ND	ND	ND	ND	ND	2700	2400	ND	650	ND
21	S00013	0 - 10	ND	ND	ND	540	ND	3300	2800	ND	800	ND
21	S00014	0 - 10	ND	ND	ND	ND	ND	3200	2800	ND	740	ND
24	S00011	0 - 10	ND	ND	ND	510	ND	3000	2600	ND	770	ND
25	S00012	0 - 10	ND	ND	ND	ND	ND	2300	1900	ND	ND	ND
38	S00015	0 - 10	ND	ND	ND	ND	ND	1400	1200	ND	240	ND
41	S00016	0 - 10	ND	ND	ND	ND	ND	3100	2700	ND	ND	ND
43	S00018	0 - 10	ND	ND	ND	ND	ND	1500	ND	ND	ND	ND
44	S00017	0 - 10	ND	ND	ND	610	ND	2500	2200	ND	960	ND
44	S00051	0 - 10	ND	ND	ND	ND	ND	2900	ND	ND	680	ND
45	SDC-DPD-3-P-S	0 - 5	ND	ND	ND	270	450	420	280	800	660	ND
45	S00052	0 - 10	ND	ND	ND	ND	ND	3000	ND	ND	ND	ND
54	S00019	0 - 10	ND	ND	ND	ND	ND	1600	1300	ND	280	ND
62	S00053	0 - 10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
72	S00020	0 - 10	ND	ND	ND	ND	ND	3300	2700	ND	640	ND
96	SDC-DPD-4-P-S	0 - 5	31	34	92	360	420	310	180	320	420	77
115	SDC-DPD-5-P-S	0 - 5	85	85	85	150	240	240	170	300	330	85
unknown	2FRB1 (Tr)	"0"	9.25	9.25	52.3	217	277	223	377	126	350	51.3
unknown	2FRB17 (Tr)	"0"	9.25	9.25	25.6	135	134	83.5	8330	50.7	194	12.9
unknown	2FRB22 (Tr)	"0"	9.25	9.25	103	398	444	367	707	124	706	137
unknown	FRB (Tr)	"0"	9.25	9.25	3.06	480	530	710	190	400	710	66.1
unknown	4085139A	-	42	62	100	220	160	200	80	63	300	45
unknown	4085139AC	-	210	100	640	870	1700	840	480	670	1200	ND
GREEN BAY												
Green Bay Zone 2 (2A & 2B)												
	S00030	0 - 10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	S00037	0 - 10	ND	ND	ND	ND	ND	ND	ND	ND	350	ND
	S00039	0 - 10	ND	ND	ND	ND	ND	ND	ND	ND	350	ND
	S00040	0 - 10	ND	ND	ND	ND	ND	ND	ND	ND	440	ND
	S00057	0 - 10	ND	ND	ND	260	ND	ND	ND	ND	280	ND
None of the listed PAHs were detectedin Green Bay Zone 3												
None of the listed PAHs were detectedin Green Bay Zone 4												
Reference												
	REF (Tr)(2)	"0"	9.25	9.25	3.06	18.2	24.1	23.5	40.4	11	20.8	66.1
	4072050BS	-	ND	ND	ND	ND	ND	ND	18.9	ND	ND	ND
	4085110A	-	ND	ND	ND	14	57	24	6	ND	13	ND

Notes:
1) Sample results are in micrograms per kilogram (mg/kg).
2) ND = parameter not detected in sample.
3) na = parameter not analyzed in sample.
4) "0" depth indicates sample was collected from surface sediments.

Table 5-10. Lower Fox River and Green Bay - Semi-Volatile Organic Compound Results (PAHs) (Continued)

Deposit, SMU, or Zone	Sample Identification	Depth (cm)	1-Methylnaphthalene (µg/kg)	2-Methylnaphthalene (µg/kg)	Fluoranthene (µg/kg)	Fluorene (µg/kg)	Indeno(1,2,3-cd)pyrene (µg/kg)	Naphthalene (µg/kg)	Phenanthrene (µg/kg)	Pyrene (µg/kg)	Total PAHs (µg/kg)	Total PCBs (µg/kg)
LOWER FOX RIVER												
Little Lake Butte des Morts Reach												
A	BA-SD01comp	0 - 61	na	140	990	99	260	120	640	1400	5,613	7,500
A	BA-SD04comp	0 - 43	na	ND	390	ND	ND	ND	220	580	1,680	2,300
A	BA-SD08comp	0 - 46	na	ND	390	ND	190	ND	230	580	2,612	120
A	S00009	0 - 10	na	ND	2900	ND	3400	ND	1400	2800	26,600	15,000
C	S00003	0 - 10	na	ND	1100	ND	760	ND	390	1400	7,250	4,400
C	2C2 (Tr)	"0"	24.5	165	1190	15.25	222	9.5	752	1330	7,765.35	500
C	SDC-C-1-P-S	0 - 5	na	110	540	110	350	110	370	1200	7,390	6,146
C	SDC-C-3-P-S	0 - 5	na	200	1100	82	490	280	760	2400	11,493	1,782
D	S00025	0 - 10	na	ND	ND	ND	ND	ND	ND	580	580	740
D	S00026	0 - 10	na	ND	ND	ND	ND	ND	ND	690	6,780	1,000
D	S00049	0 - 10	na	ND	ND	ND	ND	ND	ND	500	500	1,100
E	2E8 (Tr)	"0"	24.5	18.35	437	15.25	68.6	9.5	287	482	2,874.1	350
E	E-RI-Comp2(0-2)	0 - 61	na	ND	174	ND	ND	ND	ND	162	980	1,070
E	SDC-E-1-P-S	0 - 5	na	160	450	27	440	65	300	1200	7,201	1,070
E	SDC-E-3-P-S	0 - 5	na	ND	580	ND	260	ND	220	710	4,130	324
E	S00029	0 - 10	na	ND	ND	ND	ND	ND	ND	870	8,650	290
F	S00028	0 - 10	na	ND	ND	ND	ND	ND	ND	ND	7,700	1,100
POG	P-RI-Comp1(0-2)	0 - 61	na	ND	ND	ND	ND	ND	ND	242	904	9,630
POG	P-RI-Comp1(2-4)	61 - 122	na	ND	ND	ND	ND	ND	ND	ND	148	na
POG	P-RI-Comp1(4-6)	122 - 183	na	ND	207	ND	ND	ND	ND	263	1,242	na
POG	S00024	0 - 10	na	ND	6500	580	3100	ND	4700	7000	44,260	60,000
POG	POG (Tr)	"0"	na	na	670	15.25	200	na	590	640	4,339.85	16,000
Appleton to Little Rapids Reach												
P	S00007	0 - 10	na	ND	930	ND	350	ND	320	840	4,370	370
P	S00008	0 - 10	na	ND	2300	ND	600	ND	1200	3000	13,920	1,100
W	SDC-W-2-P-S	0 - 5	na	100	670	ND	260	100	470	1000	5,210	338
W	SDC-W-3-P-S	0 - 5	na	190	1800	160	480	180	1700	2700	13,090	347
X	SDC-X-1-P-S	0 - 5	na	66	580	ND	240	87	350	900	4,756	150
X	SDC-X-3-P-S	0 - 5	na	160	1500	90	660	160	1000	2500	12,736	434
W	S00005	0 - 10	na	ND	680	ND	290	ND	280	810	4,880	1,800
X	X (Tr)	"0"	na	na	1800	190	610	na	1300	1700	12,130	1,600
X	S00004	0 - 10	na	ND	1200	ND	410	ND	530	1400	8,380	140
Interdeposit	S00060	0 - 10	na	ND	790	ND	ND	ND	ND	870	2,820	18,000
Little Rapids to DePere Reach												
EE	SDC-EE22-2-P-S	0 - 5	na	140	830	87	380	150	580	1600	8,452	655
EE	SDC-EE22-3-P-S	0 - 5	na	95	310	ND	140	100	280	680	3,389	18,671
EE	SDC-EE23-2-P-S	0 - 5	na	210	640	64	210	190	540	1200	5,674	332
EE	SDC-EE23-3-P-S	0 - 5	na	170	710	70	340	170	570	1400	7,137	599
EE	SDC-EE24-1-P-S	0 - 5	na	150	900	74	320	170	630	1300	7,194	1,166
EE	SDC-EE24-3-P-S	0 - 5	na	84	270	ND	150	73	200	610	2,982	613
EE	SDC-EE25-1-P-S	0 - 5	na	430	470	ND	210	190	360	800	4,700	143
EE	SDC-EE25-3-P-S	0 - 5	na	91	470	ND	230	95	300	780	4,516	1,192
EE	SDC-EE26-1-P-S	0 - 5	na	340	490	ND	250	190	390	1100	5,800	510
EE	SDC-EE26-5-P-S	0 - 5	na	ND	240	ND	200	ND	240	1000	4,410	4,303
EE	S00021	0 - 10	na	ND	610	ND	1800	ND	ND	790	8,360	450
EE	S00023	0 - 10	na	ND	550	ND	1200	ND	290	640	6,560	280
EE	S00036	0 - 10	na	ND	ND	ND	ND	ND	ND	530	1,100	7,300

Notes:
1) Sample results are in micrograms per kilogram (mg/kg).
2) ND = parameter not detected in sample.
3) na = parameter not analyzed in sample.
4) "0" depth indicates sample was collected from surface sediments.

Table 5-10. Lower Fox River and Green Bay - Semi-Volatile Organic Compound Results (PAHs) (Continued)

Deposit, SMU, or Zone	Sample Identification	Depth (cm)	1-Methylnaphthalene (µg/kg)	2-Methylnaphthalene (µg/kg)	Fluoranthene (µg/kg)	Fluorene (µg/kg)	Indeno(1,2,3-cd)pyrene (µg/kg)	Naphthalene (µg/kg)	Phenanthrene (µg/kg)	Pyrene (µg/kg)	Total PAHs (µg/kg)	Total PCBs (µg/kg)
EG	EGH-RI-Comp1(0-2)	0 - 61	na	ND	ND	ND	ND	ND	ND	80	240	na
EG	EGH-RI-Comp1(2-4)	61 - 122	na	ND	ND	ND	ND	ND	ND	101	357	na
HH	HH (Tr)	"0"	na	na	2400	110	560	na	1100	1800	13,365	11,000
HH	S00001	0 - 10	na	ND	590	ND	ND	ND	250	580	2,290	810
HH	S00034	0 - 10	na	ND	ND	ND	ND	ND	ND	720	6,860	6,400
Interdeposit	S00002	0 - 10	na	ND	580	ND	ND	ND	250	560	3,000	1,000
Interdeposit	S00033	0 - 10	na	ND	ND	ND	2900	ND	ND	880	11,040	780
Interdeposit	S00035	0 - 10	na	ND	ND	ND	ND	ND	ND	660	1,260	1,100
DePere to Green Bay Reach												
20	SDC-DPD-1-P-S	0 - 5	na	98	540	55	440	90	400	970	6,759	5,057
20	SDC-DPD-2-P-S	0 - 5	na	ND	490	ND	150	ND	190	620	3,170	2,360
20	S00010	0 - 10	na	ND	660	ND	2200	ND	ND	680	9,290	1,300
21	S00013	0 - 10	na	ND	800	ND	2600	ND	ND	800	11,640	1,700
21	S00014	0 - 10	na	ND	760	ND	2600	ND	ND	800	10,900	1,600
24	S00011	0 - 10	na	ND	820	ND	2400	ND	ND	870	10,970	780
25	S00012	0 - 10	na	ND	ND	ND	1800	ND	ND	ND	6,000	350
38	S00015	0 - 10	na	ND	ND	ND	ND	ND	ND	ND	2,840	280
41	S00016	0 - 10	na	ND	ND	ND	2500	ND	ND	610	8,910	730
43	S00018	0 - 10	na	ND	ND	ND	ND	ND	ND	ND	1,500	200
44	S00017	0 - 10	na	ND	1500	ND	2100	ND	680	1300	11,850	480
44	S00051	0 - 10	na	ND	920	ND	ND	ND	ND	880	5,380	630
45	SDC-DPD-3-P-S	0 - 5	na	ND	650	ND	240	ND	260	1000	5,030	1,691
45	S00052	0 - 10	na	ND	740	ND	ND	ND	ND	690	4,430	680
54	S00019	0 - 10	na	ND	380	ND	ND	ND	ND	380	3,940	220
62	S00053	0 - 10	ND	ND	ND	ND	ND	ND	ND	640.00	640	670
72	S00020	0 - 10	na	ND	680	ND	2600	ND	ND	710	10,630	930
96	SDC-DPD-4-P-S	0 - 5	na	ND	700	34	200	34	340	630	4,182	117
115	SDC-DPD-5-P-S	0 - 5	na	85	360	85	140	85	200	460	3,185	1,468
unknown	2FRB1 (Tr)	"0"	61.1	74	429	40.2	125	45	265	488	3,219.4	5,000
unknown	2FRB17 (Tr)	"0"	15.3	14.4	274	22.7	135	9.5	157	335	9,947.1	310
unknown	2FRB22 (Tr)	"0"	84.4	134	806	56.3	207	91.1	560	934	5,877.3	21,000
unknown	FRB (Tr)	"0"	na	na	1000	15.25	170	na	1600	800	6,692.91	51,000
unknown	4085139A	-	na	na	530	na	160	340	450	400	3,152	na
unknown	4085139AC	-	na	na	1600	na	1000	790	1500	1400	13,000	1,400
GREEN BAY												
Green Bay Zone 2 (2A & 2B)												
	S00030	0 - 10	na	ND	ND	ND	ND	ND	ND	98	98	57
	S00037	0 - 10	na	ND	440	ND	ND	ND	ND	450	1,240	390
	S00039	0 - 10	na	ND	400	ND	ND	ND	ND	420	1,170	340
	S00040	0 - 10	na	ND	ND	ND	ND	ND	ND	520	960	460
	S00057	0 - 10	na	ND	370	ND	ND	ND	ND	400	1,310	180
None of the listed PAHs were detectedin Green Bay Zone 3												
None of the listed PAHs were detectedin Green Bay Zone 4												
Reference												
	REF (Tr)(2)	"0"	24.45	18.35	56.4	15.25	50	9.25	31.5	45	475.86	50
	4072050BS	-	na	na	13.2	na	ND	ND	ND	10.2	42.3	50
	4085110A	-	na	na	25	na	ND	ND	14	20	173	100

Notes:
1) Sample results are in micrograms per kilogram (mg/kg).
2) ND = parameter not detected in sample.
3) na = parameter not analyzed in sample.
4) "0" depth indicates sample was collected from surface sediments.

Table 5-11. Lower Fox River and Green Bay - Miscellaneous SVOC Results

Deposit, SMU, or Zone	Sample Identification	Depth (cm)	1,2-Dichlorobenzene (µg/kg)	1,4-Dichlorobenzene (µg/kg)	bis(2-Ethylhexyl)phthalate (BEHP) (µg/kg)	4-Methylphenol (µg/kg)	Pentachlorophenol (PCP) (µg/kg)	Carbazole (µg/kg)
LOWER FOX RIVER								
Little Lake Butte des Morts Reach								
A	BA-SD01comp	0 - 61	na	na	1300.00	120.00	na	0.00
A	BA-SD04comp	0 - 43	na	na	ND	110.00	na	0.00
A	BA-SD08comp	0 - 46	na	na	ND	75.00	na	0.00
A	S00009	0 - 10	ND	ND	2100.00	ND	ND	ND
C	2C2 (Tr)	"0"	na	na	na	na	410.00	0.00
C	S00003	0 - 10	ND	ND	970.00	ND	850.00	ND
C	SDC-C-1-P-S	0 - 5	110.00	110.00	25000.00	280.00	500.00	110.00
C	SDC-C-3-P-S	0 - 5	130.00	71.00	1700.00	1400.00	350.00	170.00
D	D-RI-Comp1(2-4)	61 - 122	ND	ND	113.00	ND	ND	ND
E	2E8 (Tr)	"0"	na	na	na	na	600.00	0.00
E	E-RI-Comp2(0-2)	0 - 61	ND	ND	87.00	442.00	ND	ND
E	SDC-E-1-P-S	0 - 5	120.00	62.00	2800.00	340.00	860.00	30.00
E	SDC-E-3-P-S	0 - 5	ND	ND	210.00	75.00	ND	97.00
POG	P-RI-Comp1(0-2)	0 - 61	ND	282.00	137.00	869.00	ND	ND
POG	P-RI-Comp1(2-4)	61 - 122	ND	164.50	125.00	998.50	ND	ND
POG	P-RI-Comp1(4-6)	122 - 183	ND	ND	216.00	1530.00	719.00	ND
POG	S00024	0 - 10	ND	ND	3900.00	ND	ND	2700.00
Appleton to Little Rapids Reach								
P	S00007	0 - 10	ND	ND	460.00	ND	ND	ND
P	S00008	0 - 10	ND	ND	1300.00	170.00	280.00	ND
W	SDC-W-2-P-S	0 - 5	ND	ND	300.00	610.00	ND	ND
W	SDC-W-3-P-S	0 - 5	ND	ND	240.00	110.00	ND	180.00
W	S00005	0 - 10	ND	ND	290.00	170.00	290.00	ND
X	S00004	0 - 10	ND	ND	280.00	ND	ND	ND
X	SDC-X-1-P-S	0 - 5	ND	ND	100.00	500.00	ND	64.00
X	SDC-X-3-P-S	0 - 5	ND	ND	510.00	1500.00	ND	84.00
Interdeposit	S00060	0 - 10	ND	ND	1300.00	ND	ND	ND
Little Rapids to DePere Reach								
EE	SDC-EE22-2-P-S	0 - 5	63.00	ND	530.00	400.00	ND	ND
EE	SDC-EE22-3-P-S	0 - 5	210.00	60.00	380.00	880.00	ND	ND
EE	SDC-EE23-2-P-S	0 - 5	ND	ND	200.00	580.00	ND	ND
EE	SDC-EE23-3-P-S	0 - 5	66.00	ND	540.00	600.00	ND	ND
EE	SDC-EE24-1-P-S	0 - 5	63.00	ND	300.00	490.00	ND	ND
EE	SDC-EE24-3-P-S	0 - 5	120.00	ND	160.00	210.00	ND	ND
EE	SDC-EE25-1-P-S	0 - 5	ND	ND	ND	750.00	500.00	ND
EE	SDC-EE25-3-P-S	0 - 5	140.00	ND	300.00	320.00	ND	ND
EE	SDC-EE26-1-P-S	0 - 5	140.00	ND	120.00	750.00	1000.00	ND
EE	SDC-EE26-5-P-S	0 - 5	370.00	ND	180.00	390.00	1100.00	ND
EG	EGH-RI-Comp1(0-2	0 - 61	ND	ND	803.00	ND	ND	ND
EG	EGH-RI-Comp1(2-4	61 - 122	ND	ND	ND	694.00	ND	ND
HH	S00001	0 - 10	ND	ND	570.00	ND	300.00	ND
Interdeposit	S00002	0 - 10	ND	ND	290.00	ND	ND	ND

Table 5-11. Lower Fox River and Green Bay - Miscellaneous SVOC Results (Continued)

Deposit, SMU, or Zone	Sample Identification	Depth (cm)	1,2-Dichlorobenzene (µg/kg)	1,4-Dichlorobenzene (µg/kg)	bis(2-Ethylhexyl)phthalate (BEHP) (µg/kg)	4-Methylphenol (µg/kg)	Pentachlorophenol (PCP) (µg/kg)	Carbazole (µg/kg)
DePere to Green Bay Reach								
20	SDC-DPD-1-P-S	0 - 5	150.00	54.00	550.00	540.00	460.00	ND
20	SDC-DPD-2-P-S	0 - 5	ND	ND	240.00	ND	ND	ND
24	S00011	0 - 10	ND	ND	1400.00	ND	ND	ND
44	S00017	0 - 10	ND	ND	ND	ND	ND	1300.00
45	SDC-DPD-3-P-S	0 - 5	ND	ND	320.00	140.00	ND	ND
96	SDC-DPD-4-P-S	0 - 5	ND	ND	63.00	29.00	ND	50.00
115	SDC-DPD-5-P-S	0 - 5	85.00	85.00	360.00	85.00	420.00	85.00
unknown	FRB (Tr)	-	na	na	na	na	400.00	0.00
unknown	2FRB1 (Tr)	"0"	na	na	na	na	400.00	0.00
unknown	2FRB17 (Tr)	"0"	na	na	na	na	20.00	0.00
unknown	2FRB22 (Tr)	"0"	na	na	na	na	710.00	0.00
unknown	4085139A	-	79.00	36.00	250.00	na	na	0.00
unknown	4085139AC	-	130.00	69.00	640.00	na	na	0.00
GREEN BAY								
Green Bay Zone 2 (2A & 2B)								
	S00032	0 - 10	ND	ND	ND	96.00	ND	ND
None of the listed SVOCs were detected in Green Bay Zone 3								
None of the listed SVOCs were detected in Green Bay Zone 4								
Reference								
	REF (Tr)(2)	"0"	na	na	na	na	10.00	0.00
	4072050A	-	ND	ND	210.00	na	na	0.00
	4072050BS	-	ND	ND	21.60	na	na	0.00
	4085110A	-	ND	ND	22.00	na	na	0.00

Notes:
1) Sample results are in micrograms per kilogram (mg/kg).
2) ND = parameter not detected in sample.
3) "0" depth indicates sample was collected from surface sediments.
4) na = parameter not analyzed in sample.

Table 5-12. Lake Winnebago Background Sediment Results

Parameter	Units	Sampling Locations			Average Concentration
		SDC-LW-1	SDC-LW-2	SDC-LW-3	
PCBs					
Ar1242	µg/kg	10.0	16.0	14.0	13.3
Ar1254	µg/kg	16.0	20.0	19.0	18.3
PCB Congener 170	µg/kg	2.8	nd	nd	0.9
PCB Congener 194	µg/kg	3.1	nd	nd	1.0
PCB Congener 20/33/53	µg/kg	3.4	5.5	nd	3.0
Calculated Total PCB Results					
Total PCBs (Aroclors)	µg/kg	26.0	36.0	33.0	NA
Total PCBs (Congeners)	µg/kg	9.3	5.5	0.0	NA
Pesticides					
DDE	µg/kg	2.4	nd	3.5	2.0
alpha-BHC	µg/kg	nd	3.6	nd	1.2
Endosulfan Sulfate	µg/kg	3.2	nd	nd	1.1
SVOCs					
Benzo(a)pyrene	µg/kg	120.0	nd	nd	40.0
Benzo(b)fluoranthene	µg/kg	91.0	nd	nd	30.3
Benzo(g,h,i)perylene	µg/kg	100.0	nd	nd	33.3
Benzo(k)fluoranthene	µg/kg	140.0	87.0	120.0	115.7
Chrysene	µg/kg	84.0	120.0	140.0	114.7
Fluoranthene	µg/kg	110.0	100.0	120.0	110.0
Indeno(1,2,3-cd)pyrene	µg/kg	87.0	nd	nd	29.0
Pyrene	µg/kg	110.0	89.0	110.0	103.0
4-Methylphenol	µg/kg	59.0	nd	nd	19.7
bis(2-Ethylhexyl)phthalate	µg/kg	100.0	140.0	350.0	196.7
Metals					
Arsenic	mg/kg	4.0	6.0	6.0	5.3
Cadmium	mg/kg	nd	nd	nd	nd
Chromium	mg/kg	51.0	69.0	75.0	65.0
Copper	mg/kg	23.0	30.0	33.0	28.7
Lead	mg/kg	30.0	36.0	39.0	35.0
Mercury	mg/kg	0.11	0.14	0.17	0.14
Nickel	mg/kg	22.0	29.0	30.0	27.0
Zinc	mg/kg	70.0	90.0	100.0	86.7

Table 5-13. Lower Fox River - PCB Mass and Sediment Volume by Concentration Range

Deposit or SMU Group	PCB Mass (kg) by Concentration Range									Total PCB Mass (kg)
	< = 50 µg/kg	50-125 µg/kg	125-250 µg/kg	250-500 µg/kg	500-1,000 µg/kg	1,000-5,000 µg/kg	5,000-10,000 µg/kg	10,000-50,000 µg/kg	>50,000 µg/kg	
LLBdM Reach										
Deposit A	-	0.01	0.04	0.07	0.56	103.01	21.98	111.70	-	237.37
Deposit B	-	0.71	1.25	2.23	2.86	31.75	48.81	312.29	10.96	410.87
Deposit C	0.04	0.10	0.24	3.14	0.41	14.79	17.25	2.98	-	38.96
Deposit POG	-	0.03	0.38	1.89	3.00	26.38	15.90	183.62	72.25	303.46
Deposit D	0.00	0.01	0.25	1.89	3.30	56.04	21.11	-	-	82.60
Deposit E	1.65	8.19	18.26	16.40	37.14	130.29	77.18	165.34	-	454.46
Deposit F	-	0.13	0.94	5.41	1.89	2.51	-	-	-	10.87
Deposit G	-	0.40	0.32	-	-	-	-	-	-	0.72
Deposit H	-	-	-	-	0.27	0.42	-	-	-	0.69
Reach Total	**1.70**	**9.58**	**21.69**	**31.03**	**49.44**	**365.19**	**202.23**	**775.93**	**83.21**	**1,540.00**
Appleton to Little Rapids Reach										
Deposit I	-	0.04	0.14	-	-	-	-	-	-	0.18
Deposit J	-	0.08	-	-	-	-	-	-	-	0.08
Deposit K	-	0.02	-	0.03	0.03	-	-	-	-	0.09
Deposit L	-	0.03	-	0.04	0.04	-	-	-	-	0.11
Deposit M	-	0.01	-	0.14	-	-	-	-	-	0.15
Deposit N	-	-	-	-	0.19	8.02	2.44	13.71	5.24	29.61
Deposit O	-	0.00	0.01	0.01	1.08	0.90	-	-	-	2.00
Deposit P	-	-	-	1.06	0.04	4.22	-	-	-	5.32
Deposit Q	-	-	-	0.00	0.01	0.16	-	-	-	0.17
Deposit R	-	0.05	-	-	-	-	-	-	-	0.05
Deposit S	-	0.12	-	-	-	-	-	-	-	0.12
Deposit T	-	0.07	-	-	-	4.65	6.63	-	-	11.35
Deposit U	-	-	-	0.06	-	0.09	-	-	-	0.15
Deposit V	-	-	-	0.00	-	0.01	-	-	-	0.02
Deposit W	0.24	0.88	2.56	1.46	1.46	0.47	-	-	-	7.07
Deposit X	0.20	0.04	1.95	0.23	0.23	-	-	-	-	2.65
Deposit Y	-	0.07	-	0.11	0.11	-	-	-	-	0.28
Deposit Z	-	0.14	-	0.16	0.16	-	-	-	-	0.45
Deposit AA	-	0.02	-	-	-	-	-	-	-	0.02
Deposit BB	-	0.03	0.03	-	-	-	-	-	-	0.06
Deposit CC	-	0.48	0.17	0.03	0.03	-	-	-	-	0.69
Deposit DD	0.05	0.39	1.22	0.50	0.58	2.68	18.74	9.42	-	33.58
Reach Total	**0.49**	**2.46**	**6.07**	**3.84**	**3.95**	**21.20**	**27.81**	**23.13**	**5.24**	**94.18**
Little Rapids to De Pere Reach										
Deposit EE	4.73	35.56	17.31	34.54	33.24	219.45	180.87	307.43	-	833.14
Deposit FF	0.00	0.01	-	0.04	0.04	-	-	-	-	0.09
Deposit GG	-	-	0.04	0.04	0.05	9.14	5.08	66.68	-	81.03
Deposit HH	0.01	0.00	0.10	-	0.57	24.19	10.81	34.56	-	70.25
Reach Total	**4.74**	**35.57**	**17.45**	**34.62**	**33.90**	**252.78**	**196.76**	**408.68**	**-**	**984.51**
De Pere to Green Bay Reach										
SMUs 20-25	-	6.30	9.09	14.91	31.80	386.67	431.18	4,361.45	315.89	5,557.29
SMUs 26-31	-	1.32	2.76	1.36	2.56	128.20	192.17	432.87	-	761.24
SMUs 32-37	-	1.03	0.99	6.21	2.93	121.94	390.17	551.62	97.99	1,172.86
SMUs 38-43	-	3.41	4.01	9.12	12.17	200.83	208.19	703.85	7.92	1,149.49
SMUs 44-49	-	3.06	4.79	13.55	30.88	487.74	1,023.15	3,647.99	-	5,211.15
SMUs 50-55	-	1.50	3.76	4.85	10.17	223.58	201.32	1,383.28	1.21	1,829.66
SMUs 56-61 [A]	0.00	0.22	0.28	0.62	6.96	128.52	178.48	2,881.26	2,614.38	5,174.71
SMUs 62-67	-	1.31	1.07	1.62	2.99	115.37	93.61	288.73	356.56	861.25
SMUs 68-73	-	0.90	2.29	2.12	3.53	105.65	112.02	1,405.55	226.11	1,858.16
SMUs 74-79	-	1.66	1.16	1.26	1.50	110.31	108.66	205.63	-	430.18
SMUs 80-85	-	2.03	3.66	5.56	2.44	63.52	85.99	222.13	-	385.33
SMUs 86-91	-	1.10	3.72	0.77	0.83	20.65	145.88	80.15	-	253.10
SMUs 92-97	-	0.86	2.54	1.82	3.77	137.10	108.75	-	-	254.84
SMUs 98-103	-	2.21	4.83	1.05	3.25	11.57	-	71.34	-	94.25
SMUs 104-109	-	0.62	0.32	0.79	3.89	51.72	-	93.73	-	151.08
SMUs 110-115	-	-	0.49	1.51	2.36	83.57	63.91	687.19	-	839.02
Reach Total	**0.00**	**27.53**	**45.77**	**67.10**	**122.03**	**2,376.92**	**3,343.47**	**17,016.77**	**3,620.04**	**25,983.63**
RIVER TOTALS	**6.93**	**75.15**	**90.98**	**136.59**	**209.32**	**3,016.09**	**3,770.28**	**18,224.51**	**3,708.48**	**28,602.32**

Table 5-13. Lower Fox River - PCB Mass and Sediment Volume by Concentration Range (Continued)

Deposit or SMU Group	Impacted Sediment Volume (m^3) by Concentration Range									Total Volume (m^3)
	< = 50 µg/kg	50-125 µg/kg	125-250 µg/kg	250-500 µg/kg	500-1,000 µg/kg	1,000-5,000 µg/kg	5,000-10,000 µg/kg	10,000-50,000 µg/kg	>50,000 µg/kg	
LLBdM Reach										
Deposit A	-	180	450	470	1,840	81,650	7,420	15,720	-	107,730
Deposit B	-	6,520	5,280	3,660	3,260	7,190	4,570	11,100	160	41,740
Deposit C	3,900	2,780	3,560	29,820	3,200	14,160	4,750	960	-	63,130
Deposit POG	-	470	3,240	9,590	13,680	37,540	5,500	29,210	3,800	103,030
Deposit D	150	90	1,460	5,660	7,780	45,690	6,030	-	-	66,860
Deposit E	142,460	222,040	215,830	102,630	118,180	147,990	29,050	34,190	-	1,012,370
Deposit F	-	6,100	17,410	54,270	11,570	6,570	-	-	-	95,920
Deposit G	-	5,580	2,800	-	-	-	-	-	-	8,380
Deposit H	-	-	-	-	460	230	-	-	-	690
Reach Total	**146,510**	**243,760**	**250,030**	**206,100**	**159,970**	**341,020**	**57,320**	**91,180**	**3,960**	**1,499,850**
Appleton to Little Rapids Reach										
Deposit I	-	1,530	1,360	-	680	-	-	-	-	3,570
Deposit J	-	1,630	-	-	-	-	-	-	-	1,630
Deposit K	-	320	-	160	-	-	-	-	-	480
Deposit L	-	380	-	190	-	-	-	-	-	570
Deposit M	-	240	-	940	470	-	-	-	-	1,650
Deposit N	-	-	-	10	370	2,300	610	1,270	320	4,880
Deposit O	-	60	60	60	1,440	810	-	-	-	2,430
Deposit P	-	-	-	5,330	400	7,070	-	-	-	12,800
Deposit Q	-	-	-	20	40	150	-	-	-	210
Deposit R	-	990	-	-	-	-	-	-	-	990
Deposit S	-	7,510	2,960	-	2,080	-	-	-	-	12,550
Deposit T	-	3,520	-	-	-	2,870	1,970	-	-	8,360
Deposit U	-	-	-	400	-	200	-	-	-	600
Deposit V	-	-	-	40	-	20	-	-	-	60
Deposit W	26,170	20,720	25,910	5,900	210	750	-	-	-	79,660
Deposit X	26,580	1,000	28,230	1,590	-	-	-	-	-	57,400
Deposit Y	-	900	-	430	-	-	-	-	-	1,330
Deposit Z	-	3,550	-	730	-	-	-	-	-	4,280
Deposit AA	-	390	-	-	-	-	-	-	-	390
Deposit BB	-	520	260	-	-	-	-	-	-	780
Deposit CC	-	10,890	2,200	90	1,120	-	-	-	-	14,300
Deposit DD	3,400	9,330	9,660	2,190	520	1,410	4,210	1,300	-	32,020
Reach Total	**56,150**	**63,480**	**70,640**	**18,080**	**7,330**	**15,580**	**6,790**	**2,570**	**320**	**240,940**
Little Rapids to De Pere Reach										
Deposit EE	379,050	800,070	207,970	237,700	130,330	201,520	48,720	34,080	-	2,039,440
Deposit FF	700	340	-	360	-	-	-	-	-	1,400
Deposit GG	-	-	500	250	100	5,810	1,790	9,870	-	18,320
Deposit HH	650	100	2,450	-	2,610	14,460	4,960	4,970	-	30,200
Reach Total	**380,400**	**800,510**	**210,920**	**238,310**	**133,040**	**221,790**	**55,470**	**48,920**	**-**	**2,089,360**
De Pere to Green Bay Reach										
SMUs 20-25	-	98,170	78,040	65,090	78,140	266,670	113,590	340,880	14,000	1,054,580
SMUs 26-31	-	17,820	20,770	4,650	5,310	46,470	33,740	37,470	-	166,230
SMUs 32-37	-	15,810	6,590	19,180	7,450	60,400	61,470	59,430	2,900	233,230
SMUs 38-43	-	56,650	28,050	33,830	31,550	123,590	44,250	84,190	250	402,360
SMUs 44-49	-	50,940	44,220	62,070	93,520	378,170	268,850	481,920	-	1,379,690
SMUs 50-55	-	21,070	29,180	18,920	24,600	135,130	42,030	134,290	60	405,280
SMUs 56-61 [A]	150	4,650	3,200	3,550	15,190	98,000	53,850	253,670	56,380	457,640
SMUs 62-67	-	17,100	8,330	7,810	9,240	79,250	22,120	31,570	15,150	190,570
SMUs 68-73	-	16,210	23,080	10,980	9,630	70,760	28,150	167,840	10,600	337,250
SMUs 74-79	-	25,720	9,770	4,590	2,750	54,900	24,660	19,560	-	141,950
SMUs 80-85	-	37,950	32,610	19,830	4,460	32,510	17,500	19,790	-	164,650
SMUs 86-91	-	23,430	30,330	2,630	640	10,810	26,310	9,250	-	103,400
SMUs 92-97	-	6,890	13,890	3,430	5,330	69,620	19,340	-	-	118,500
SMUs 98-103	-	33,250	23,690	2,720	6,710	9,530	-	6,300	-	82,200
SMUs 104-109	-	8,940	1,790	2,580	7,610	43,930	-	9,700	-	74,550
SMUs 110-115	-	-	2,530	6,490	6,610	75,090	13,630	101,900	-	206,250
Reach Total	**150**	**434,600**	**356,070**	**268,350**	**308,740**	**1,554,830**	**769,490**	**1,757,760**	**99,340**	**5,518,330**
RIVER TOTALS	**583,210**	**1,542,350**	**887,660**	**730,840**	**609,080**	**2,133,220**	**889,070**	**1,900,430**	**103,620**	**9,348,480**

Table 5-13. Lower Fox River - PCB Mass and Sediment Volume by Concentration Range (Continued)

Deposit or SMU Group	Impacted Sediment Volume (m^3) by Concentration Range			PCB Mass (kg) by Concentration Range			PCB Mass to Impacted Sediment Volume (g/m^3)		
	> 50 µg/kg	> 1,000 µg/kg	> 10,000 µg/kg	> 50 µg/kg	> 1,000 µg/kg	> 10,000 µg/kg	> 50 µg/kg	> 1,000 µg/kg	> 10,000 µg/kg
LLBdM Reach									
Deposit A	107,730	104,790	15,720	237.37	236.69	111.70	2.20	2.26	7.11
Deposit B	41,740	23,020	11,260	410.87	403.81	323.25	9.84	17.54	28.71
Deposit C	59,230	19,870	960	38.92	35.02	2.98	0.66	1.76	3.11
Deposit POG	103,030	76,050	33,010	303.46	298.15	255.86	2.95	3.92	7.75
Deposit D	66,710	51,720	-	82.60	77.15	-	1.24	1.49	-
Deposit E	869,910	211,230	34,190	452.80	372.81	165.34	0.52	1.76	4.84
Deposit F	95,920	6,570	-	10.87	2.51	-	0.11	0.38	-
Deposit G	8,380	-	-	0.72	-	-	0.09	-	-
Deposit H	690	230	-	0.69	0.42	-	1.00	1.82	-
Reach Total	**1,353,340**	**493,480**	**95,140**	**1,538.30**	**1,426.55**	**859.13**	**1.14**	**2.89**	**9.03**
Appleton to Little Rapids Reach									
Deposit I	3,570	-	-	0.18	-	-	0.05	-	-
Deposit J	1,630	-	-	0.08	-	-	0.05	-	-
Deposit K	480	-	-	0.09	-	-	0.19	-	-
Deposit L	570	-	-	0.11	-	-	0.19	-	-
Deposit M	1,650	-	-	0.15	-	-	0.09	-	-
Deposit N	4,880	4,500	1,590	29.61	29.42	18.95	6.07	6.54	11.92
Deposit O	2,430	810	-	2.00	0.90	-	0.82	1.11	-
Deposit P	12,800	7,070	-	5.32	4.22	-	0.42	0.60	-
Deposit Q	210	150	-	0.17	0.16	-	0.81	1.04	-
Deposit R	990	-	-	0.05	-	-	0.05	-	-
Deposit S	12,550	-	-	0.12	-	-	0.01	-	-
Deposit T	8,360	4,840	-	11.35	11.28	-	1.36	2.33	-
Deposit U	600	200	-	0.15	0.09	-	0.25	0.47	-
Deposit V	60	20	-	0.02	0.01	-	0.26	0.61	-
Deposit W	53,490	750	-	6.83	0.47	-	0.13	0.62	-
Deposit X	30,820	-	-	2.45	(0.00)	-	0.08	-	-
Deposit Y	1,330	-	-	0.28	-	-	0.21	-	-
Deposit Z	4,280	-	-	0.45	-	-	0.10	-	-
Deposit AA	390	-	-	0.02	-	-	0.06	-	-
Deposit BB	780	-	-	0.06	-	-	0.08	-	-
Deposit CC	14,300	-	-	0.69	-	-	0.05	-	-
Deposit DD	28,620	6,920	1,300	33.53	30.84	9.42	1.17	4.46	7.24
Reach Total	**184,790**	**25,260**	**2,890**	**93.69**	**77.37**	**28.37**	**0.51**	**3.06**	**9.82**
Little Rapids to De Pere Reach									
Deposit EE	1,660,390	284,320	34,080	828.41	707.75	307.43	0.50	2.49	9.02
Deposit FF	700	-	-	0.08	-	-	0.12	-	-
Deposit GG	18,320	17,470	9,870	81.03	80.90	66.68	4.42	4.63	6.76
Deposit HH	29,550	24,390	4,970	70.24	69.57	34.56	2.38	2.85	6.95
Reach Total	**1,708,960**	**326,180**	**48,920**	**979.77**	**858.22**	**408.68**	**0.57**	**2.63**	**8.35**
De Pere to Green Bay Reach									
SMUs 20-25	1,054,580	735,140	354,880	5,557.29	5,495.19	4,677.34	5.27	7.48	13.18
SMUs 26-31	166,230	117,680	37,470	761.24	753.24	432.87	4.58	6.40	11.55
SMUs 32-37	233,230	184,200	62,330	1,172.86	1,161.72	649.61	5.03	6.31	10.42
SMUs 38-43	402,360	252,280	84,440	1,149.49	1,120.78	711.77	2.86	4.44	8.43
SMUs 44-49	1,379,690	1,128,940	481,920	5,211.15	5,158.88	3,647.99	3.78	4.57	7.57
SMUs 50-55	405,280	311,510	134,350	1,829.66	1,809.39	1,384.49	4.51	5.81	10.31
SMUs 56-61 [A]	457,490	430,900	279,050	5,174.71	5,166.63	4,859.64	11.31	11.99	17.41
SMUs 62-67	190,570	148,090	46,720	861.25	854.26	645.29	4.52	5.77	13.81
SMUs 68-73	337,250	277,350	178,440	1,858.16	1,849.32	1,631.65	5.51	6.67	9.14
SMUs 74-79	141,950	99,120	19,560	430.18	424.59	205.63	3.03	4.28	10.51
SMUs 80-85	164,650	69,800	19,790	385.33	371.63	222.13	2.34	5.32	11.22
SMUs 86-91	103,400	46,370	9,250	253.10	246.69	80.15	2.45	5.32	8.66
SMUs 92-97	118,500	88,960	-	254.84	245.85	-	2.15	2.76	-
SMUs 98-103	82,200	15,830	6,300	94.25	82.91	71.34	1.15	5.24	11.32
SMUs 104-109	74,550	53,630	9,700	151.08	145.46	93.73	2.03	2.71	9.66
SMUs 110-115	206,250	190,620	101,900	839.02	834.66	687.19	4.07	4.38	6.74
Reach Total	**5,518,180**	**4,150,420**	**1,826,100**	**25,983.63**	**25,721.20**	**20,000.82**	4.71	6.20	10.95
RIVER TOTALS	**8,765,270**	**4,995,340**	**1,973,050**	**28,595.39**	**28,083.35**	**21,296.99**	**3.26**	**5.62**	**10.79**

Table 5-13. Lower Fox River - PCB Mass and Sediment Volume by Concentration Range (Continued)

Mass and Volume Total for Deposit and Interdeposit Areas in Each Reach						
Reach	Mass (kg)			Volume (m^3)		
	Deposits	All Areas	Difference[B]	Deposits	All Areas	Difference[B]
LLBdM	1,540.00	1,849.00	309.00	1,499,850	1,679,715	179,865
App-LR	94.18	108.95	14.77	240,940	258,905	17,965
LR-DP	984.51	1,250.31	265.80	2,089,360	2,313,090	223,730
DP-GB	26,619.63	26,647.63	28.00	5,549,330	6,481,960	932,630
Totals	**29,238.32**	**29,855.89**	**617.57**	**9,379,480**	**10,733,670**	**1,354,190**

Deposit/SMU Area (hectares[C])					
Dep. A	15.26	Dep. Q	0.42	Dep. HH	4.46
Dep. B	14.74	Dep. R	0.77	SMU 20-25	113.39
Dep. C	12.36	Dep. S	16.64	SMU 26-31	22.04
Dep. POG	21.32	Dep. T	2.08	SMU 32-37	26.78
Dep. D	25.24	Dep. U	1.74	SMU 38-43	46.46
Dep. E	202.51	Dep. V	2.41	SMU 44-49	107.15
Dep. F	16.91	Dep. W	56.41	SMU 50-55	32.91
Dep. G	4.11	Dep. X	25.60	SMU 56-61	29.66
Dep. H	1.08	Dep. Y	3.19	SMU 62-67	18.22
Dep. I	2.98	Dep. Z	2.44	SMU 68-73	21.58
Dep. J	2.51	Dep. AA	0.81	SMU 74-79	11.81
Dep. K	0.53	Dep. BB	1.58	SMU 80-85	10.62
Dep. L	1.06	Dep. CC	8.47	SMU 86-91	11.27
Dep. M	1.33	Dep. DD	14.92	SMU 92-97	19.76
Dep. N	2.25	Dep. EE	258.81	SMU 98-103	14.00
Dep. O	1.85	Dep. FF	0.49	SMU 104-109	17.02
Dep. P	3.14	Dep. GG	2.40	SMU 110-115	20.82

Table Notes:

A: Total PCB Mass and Total Sediment Volume results for SMU Group 56-61 reflect the subtraction of 636 kg of PCBs and 31,000 m^3 of sediment removed as part of the Demonstration Project.

B: The PCB mass and sediment volumes for the Interdeposit Areas are represented by the difference between the totals for the deposit and all areas in each reach.

C: 1 Hectare = 10,000 m^2

Table 5-14. Lower Fox River - PCB Mass and Sediment Volume by Deposit/SMU Layer

Deposit or SMU Group	PCB Mass (kg) by Depth Range									Total PCB Mass (kg)
	0-10 cm	10-30 cm	30-50 cm	50-100 cm	100-150 cm	150-200 cm	200-250 cm	250-300 cm	300-350 cm	
LLBdM Reach										
Deposit A	45.05	88.63	35.39	68.44	-	-	-	-	-	237.51
Deposit B	12.02	110.63	282.59	6.12	-	-	-	-	-	411.36
Deposit C	22.23	13.73	0.91	2.22	-	-	-	-	-	39.09
Deposit POG	35.79	56.34	40.59	128.85	43.03	-	-	-	-	304.59
Deposit D	19.80	35.20	20.00	8.23	0.00	-	-	-	-	83.23
Deposit E	176.64	227.45	30.81	22.99	1.60	0.00	-	-	-	459.48
Deposit F	3.26	2.88	1.19	3.57	-	-	-	-	-	10.89
Deposit G	0.32	0.40	-	-	-	-	-	-	-	0.72
Deposit H	0.42	0.27	-	-	-	-	-	-	-	0.69
Reach Total	**315.52**	**535.52**	**411.47**	**240.41**	**44.63**	**0.00**	**-**	**-**	**-**	**1,547.56**
Appleton to Little Rapids Reach										
Deposit I	0.27	0.14	0.02	0.02	-	-	-	-	-	0.45
Deposit J	0.03	0.05	0.00	-	-	-	-	-	-	0.08
Deposit K	0.03	0.02	-	-	-	-	-	-	-	0.06
Deposit L	0.04	0.03	-	-	-	-	-	-	-	0.07
Deposit M	0.15	0.14	0.01	-	-	-	-	-	-	0.30
Deposit N	6.93	14.86	7.32	0.67	-	-	-	-	-	29.78
Deposit O	0.90	1.11	-	-	-	-	-	-	-	2.00
Deposit P	1.06	1.72	1.59	1.03	-	-	-	-	-	5.40
Deposit Q	0.06	0.11	-	-	-	-	-	-	-	0.17
Deposit R	0.02	0.03	-	-	-	-	-	-	-	0.05
Deposit S	0.05	0.06	-	-	-	-	-	-	-	0.12
Deposit T	4.36	6.92	0.04	0.03	-	-	-	-	-	11.35
Deposit U	0.09	0.06	-	-	-	-	-	-	-	0.15
Deposit V	0.01	0.00	-	-	-	-	-	-	-	0.02
Deposit W	2.64	1.58	0.43	1.00	-	-	-	-	-	5.66
Deposit X	0.87	0.45	0.38	0.73	-	-	-	-	-	2.42
Deposit Y	0.11	0.06	0.00	-	-	-	-	-	-	0.17
Deposit Z	0.16	0.06	0.03	0.04	-	-	-	-	-	0.29
Deposit AA	0.01	0.01	-	-	-	-	-	-	-	0.02
Deposit BB	0.03	0.03	-	-	-	-	-	-	-	0.06
Deposit CC	0.61	0.44	0.06	-	-	-	-	-	-	1.12
Deposit DD	3.91	14.13	14.79	0.51	-	-	-	-	-	33.34
Reach Total	**22.33**	**42.03**	**24.68**	**4.02**	**-**	**-**	**-**	**-**	**-**	**93.06**
Little Rapids to De Pere Reach										
Deposit EE	225.48	247.46	184.16	182.58	3.97	0.70	0.08	-	-	844.44
Deposit FF	0.04	0.00	0.01	-	-	-	-	-	-	0.05
Deposit GG	8.46	23.59	22.89	20.03	5.98	0.08	-	-	-	81.03
Deposit HH	10.02	19.68	17.89	19.22	3.34	0.10	0.01	-	-	70.25
Reach Total	**244.00**	**290.73**	**224.95**	**221.83**	**13.29**	**0.89**	**0.09**	**-**	**-**	**995.78**
De Pere to Green Bay Reach										
SMUs 20-25	225.60	813.62	950.30	1,569.27	935.71	430.01	637.88	-	-	5,562.39
SMUs 26-31	57.40	271.18	180.75	247.42	3.90	0.85	0.18	-	-	761.68
SMUs 32-37	56.81	324.13	199.43	382.77	176.70	16.93	13.84	4.07	-	1,174.68
SMUs 38-43	53.43	264.65	300.18	435.82	57.25	5.86	6.43	11.44	16.45	1,151.52
SMUs 44-49	189.20	696.55	856.47	2,069.46	1,020.76	274.63	71.78	33.36	3.17	5,215.39
SMUs 50-55	48.61	121.37	280.75	583.52	345.12	256.37	142.65	50.80	2.33	1,831.52
SMUs 56-61	31.91	207.06	553.26	2,060.71	1,439.05	874.27	494.50	102.99	48.20	5,175.95
SMUs 62-67	11.84	25.27	34.16	120.62	232.86	209.17	189.63	16.00	22.05	861.59
SMUs 68-73	23.81	108.91	166.85	425.02	460.19	234.92	200.03	238.67	-	1,858.41
SMUs 74-79	22.30	93.32	37.51	80.72	20.47	20.41	27.13	128.32	-	430.18
SMUs 80-85	21.25	30.45	70.59	183.25	73.26	4.14	2.38	-	-	385.33
SMUs 86-91	4.75	14.00	17.41	98.49	114.71	2.58	0.76	-	-	252.71
SMUs 92-97	7.30	34.43	34.44	118.61	60.34	0.91	-	-	-	256.03
SMUs 98-103	4.08	3.58	4.67	11.67	71.34	-	-	-	-	95.35
SMUs 104-109	9.11	7.77	14.53	25.72	93.73	-	-	-	-	150.85
SMUs 110-115	16.61	23.91	14.27	200.58	382.50	201.87	-	-	-	839.73
Reach Total	**783.99**	**3,040.22**	**3,715.57**	**8,613.66**	**5,487.89**	**2,532.92**	**1,787.20**	**585.65**	**92.20**	**26,003.30**
RIVER TOTALS	**1,365.85**	**3,908.51**	**4,376.68**	**9,079.92**	**5,545.80**	**2,533.81**	**1,787.29**	**585.65**	**92.20**	**28,639.70**

Table 5-14. Lower Fox River - PCB Mass and Sediment Volume by Deposit/SMU Layer (Continued)

Deposit or SMU Group	Impacted Sediment Volume (m3) by Depth Range									Total Volume (m^3)
	0-10 cm	10-30 cm	30-50 cm	50-100 cm	100-150 cm	150-200 cm	200-250 cm	250-300 cm	300-350 cm	
LLBdM Reach										
Deposit A	12,110	24,160	21,960	49,500	-	-	-	-	-	107,730
Deposit B	9,690	19,380	11,120	1,550	-	-	-	-	-	41,740
Deposit C	9,710	19,080	13,740	20,600	-	-	-	-	-	63,130
Deposit POG	20,290	29,100	18,040	24,800	10,800	-	-	-	-	103,030
Deposit D	18,990	24,800	12,120	10,800	150	-	-	-	-	66,860
Deposit E	154,940	303,920	271,960	265,800	15,450	300	-	-	-	1,012,370
Deposit F	12,620	25,180	20,220	37,900	-	-	-	-	-	95,920
Deposit G	2,800	5,580	-	-	-	-	-	-	-	8,380
Deposit H	230	460	-	-	-	-	-	-	-	690
Reach Total	**241,380**	**451,660**	**369,160**	**410,950**	**26,400**	**300**	**-**	**-**	**-**	**1,499,850**
Appleton to Little Rapids Reach										
Deposit I	680	1,360	780	750	-	-	-	-	-	3,570
Deposit J	530	1,060	40	-	-	-	-	-	-	1,630
Deposit K	160	320	-	-	-	-	-	-	-	480
Deposit L	190	380	-	-	-	-	-	-	-	570
Deposit M	470	940	240	-	-	-	-	-	-	1,650
Deposit N	1,680	1,940	1,060	200	-	-	-	-	-	4,880
Deposit O	810	1,620	-	-	-	-	-	-	-	2,430
Deposit P	2,440	2,740	2,520	5,100	-	-	-	-	-	12,800
Deposit Q	70	140	-	-	-	-	-	-	-	210
Deposit R	330	660	-	-	-	-	-	-	-	990
Deposit S	3,090	6,180	3,280	-	-	-	-	-	-	12,550
Deposit T	1,620	3,220	2,020	1,500	-	-	-	-	-	8,360
Deposit U	200	400	-	-	-	-	-	-	-	600
Deposit V	20	40	-	-	-	-	-	-	-	60
Deposit W	15,060	29,860	17,740	17,000	-	-	-	-	-	79,660
Deposit X	11,230	21,740	13,280	11,150	-	-	-	-	-	57,400
Deposit Y	430	860	40	-	-	-	-	-	-	1,330
Deposit Z	730	1,460	940	1,150	-	-	-	-	-	4,280
Deposit AA	130	260	-	-	-	-	-	-	-	390
Deposit BB	260	520	-	-	-	-	-	-	-	780
Deposit CC	4,020	8,020	2,260	-	-	-	-	-	-	14,300
Deposit DD	7,480	14,820	5,820	3,900	-	-	-	-	-	32,020
Reach Total	**51,630**	**98,540**	**50,020**	**40,750**	**-**	**-**	**-**	**-**	**-**	**240,940**
Little Rapids to De Pere Reach										
Deposit EE	229,110	456,700	414,580	844,950	54,150	33,150	6,800	-	-	2,039,440
Deposit FF	360	700	340	-	-	-	-	-	-	1,400
Deposit GG	2,180	3,720	3,120	5,500	3,050	750	-	-	-	18,320
Deposit HH	3,560	5,300	4,740	8,100	5,300	2,550	650	-	-	30,200
Reach Total	**235,210**	**466,420**	**422,780**	**858,550**	**62,500**	**36,450**	**7,450**	**-**	**-**	**2,089,360**
De Pere to Green Bay Reach										
SMUs 20-25	98,050	175,280	154,500	291,200	192,150	94,850	48,550	-	-	1,054,580
SMUs 26-31	20,100	34,460	26,820	49,550	24,600	8,700	2,000	-	-	166,230
SMUs 32-37	26,080	45,620	32,880	63,650	39,050	16,250	7,300	2,400	-	233,230
SMUs 38-43	43,280	72,400	63,280	124,350	63,850	23,400	8,300	2,400	1,100	402,360
SMUs 44-49	104,730	198,500	181,860	389,300	284,350	150,100	62,350	7,300	1,200	1,379,690
SMUs 50-55	30,930	54,940	51,360	113,050	83,900	49,100	17,750	4,000	250	405,280
SMUs 56-61	27,910	52,340	49,540	114,650	98,750	75,450	42,800	18,400	8,800	457,640
SMUs 62-67	11,700	17,720	16,900	39,650	35,650	33,700	22,850	6,600	5,800	190,570
SMUs 68-73	13,390	26,780	26,780	66,950	66,950	66,950	41,150	28,300	-	337,250
SMUs 74-79	7,350	14,700	14,700	36,750	22,850	22,600	12,200	10,800	-	141,950
SMUs 80-85	8,050	16,100	16,100	40,250	38,200	23,700	22,250	-	-	164,650
SMUs 86-91	6,170	12,340	12,340	22,750	21,950	18,600	9,250	-	-	103,400
SMUs 92-97	9,960	19,920	19,920	49,800	11,550	7,350	-	-	-	118,500
SMUs 98-103	7,590	15,180	15,180	37,950	6,300	-	-	-	-	82,200
SMUs 104-109	9,860	19,720	13,820	21,450	9,700	-	-	-	-	74,550
SMUs 110-115	13,000	24,680	24,020	58,650	55,900	30,000	-	-	-	206,250
Reach Total	**438,150**	**800,680**	**720,000**	**1,519,950**	**1,055,700**	**620,750**	**296,750**	**80,200**	**17,150**	**5,518,330**
RIVER TOTALS	**966,370**	**1,817,300**	**1,561,960**	**2,830,200**	**1,144,600**	**657,500**	**304,200**	**80,200**	**17,150**	**9,348,480**

Table 5-15. Green Bay - PCB Mass and Sediment Volume by Concentration Range and Layer

PCB Mass (kg) and Sediment Volume (m^3) by Concentration Range

	PCB Mass (kg) by Concentration Range (µg/kg)							Total Mass (kg)
ZONE	0-50	50-125	125-250	250-500	500-1,000	1,000-5,000	> 5,000	
2A	3.28	832.75	438.95	310.86	288.67	8,558.35	3,953.23	14,386.09
2B	0.04	203.82	221.97	451.80	1,173.96	14,419.39	1,159.49	17,630.47
Zone 2	*3.33*	*1,036.58*	*660.92*	*762.66*	*1,462.63*	*22,977.74*	*5,112.71*	*32,016.57*
3A	619.32	3,298.71	9,766.72	3,316.07	2,156.97	1.65	0.00	19,159.44
3B	119.64	1,045.95	4,843.46	5,997.05	4,816.45	0.00	0.00	16,822.55
Zone 3	*738.96*	*4,344.67*	*14,610.18*	*9,313.12*	*6,973.42*	*1.65*	*0.00*	*35,981.99*
4	1,034.55	730.25	172.15	22.18	0.00	0.00	0.00	1,959.13
Entire Bay	**1,776.84**	**6,111.50**	**15,443.25**	**10,097.95**	**8,436.06**	**22,979.38**	**5,112.71**	**69,957.69**

	Sediment Volume (m^3) by Concentration Range (µg/kg)							Total Volume (m^3)
ZONE	0-50	50-125	125-250	250-500	500-1,000	1,000-5,000	> 5,000	
2A	87,400	8,692,600	2,753,000	1,373,800	645,800	5,535,400	1,033,000	20,121,000
2B	1,000	2,570,000	1,375,000	1,808,800	2,505,000	10,967,200	232,000	19,459,000
Zone 2	*88,400*	*11,262,600*	*4,128,000*	*3,182,600*	*3,150,800*	*16,502,600*	*1,265,000*	*39,580,000*
3A	30,398,200	50,100,800	101,372,200	17,355,800	12,464,200	8,800	0	211,700,000
3B	8,787,600	44,952,400	92,554,800	44,910,000	33,264,200	0	0	224,469,000
Zone 3	*39,185,800*	*95,053,200*	*193,927,000*	*62,265,800*	*45,728,400*	*8,800*	*0*	*436,169,000*
4	117,629,000	23,866,600	4,668,400	387,000	0	0	0	146,551,000
Entire Bay	**156,903,200**	**130,182,400**	**202,723,400**	**65,835,400**	**48,879,200**	**16,511,400**	**1,265,000**	**622,300,000**

	PCB Mass to Impacted Sediment Volume (grams/m^3)			
ZONE	> 50	> 500	> 1,000	> 5,000
2A	0.72	1.77	1.90	3.83
2B	0.91	1.22	1.39	5.00
Zone 2	*0.81*	*1.41*	*1.58*	*4.04*
3A	0.10	0.17	0.19	na
3B	0.08	0.14	na	na
Zone 3	*0.09*	*0.15*	*0.19*	*na*
4	0.03	na	na	na
Entire Bay	**0.15**	**0.55**	**1.58**	**4.04**

Notes: na - Not Applicable.

Table 5-15. Green Bay - PCB Mass and Sediment Volume by Concentration Range and Layer (Continued)

PCB Mass (kg) and Sediment Volume (m^3) by Layer

PCB Mass (kg) by Layer (cm)					
ZONE	**0-2**	**2-10**	**10-30**	**> 30**	**Total Mass (kg)**
2A	616.13	2,411.29	3,557.13	7,801.55	14,386.09
2B	853.03	3,348.01	3,702.21	9,727.22	17,630.47
Zone 2	*1,469.16*	*5,759.29*	*7,259.34*	*17,528.77*	*32,016.56*
3A	1,933.85	6,084.29	7,130.75	4,007.55	19,156.44
3B	1,523.76	5,820.64	7,753.49	1,724.66	16,822.55
Zone 3	*3,457.61*	*11,904.93*	*14,884.24*	*5,732.21*	*35,978.99*
4	391.17	1,147.11	420.85	0.00	1,959.13
Entire Bay	**5,317.95**	**18,811.33**	**22,564.43**	**23,260.97**	**69,954.68**

Sediment Volume (m^3) by Layer (cm)					
ZONE	**0-2**	**2-10**	**10-30**	**> 30**	**Total Volume (m^3)**
2A	1,099,800	4,399,200	10,784,000	3,838,000	20,121,000
2B	929,000	3,716,000	8,876,000	5,938,000	19,459,000
Zone 2	*2,028,800*	*8,115,200*	*19,660,000*	*9,776,000*	*39,580,000*
3A	13,112,400	52,449,600	100,036,000	46,102,000	211,700,000
3B	12,891,400	51,565,600	125,844,000	34,168,000	224,469,000
Zone 3	*26,003,800*	*104,015,200*	*225,880,000*	*80,270,000*	*436,169,000*
4	14,017,800	56,071,200	76,462,000	0	146,551,000
Entire Bay	**42,050,400**	**168,201,600**	**322,002,000**	**90,046,000**	**622,300,000**

PCB Mass to Impacted Sediment Volume (grams/m^3)				
ZONE	**0-2**	**2-10**	**10-30**	**> 30**
2A	0.56	0.55	0.33	2.03
2B	1.58	1.55	0.82	2.95
Zone 2	*1.03*	*1.01*	*0.55*	*2.59*
3A	0.15	0.12	0.07	0.09
3B	0.27	0.23	0.12	0.17
Zone 3	*0.21*	*0.17*	*0.10*	*0.12*
4	0.03	0.02	0.01	0.00
Entire Bay	**0.13**	**0.11**	**0.07**	**0.26**

Notes: na - Not Applicable.

Table 5-16. Lower Fox River and Green Bay - Water Sampling Results: Summary of Detected Compounds

Reach/Zone	Type	Parameter	Number of Samples	Number Detected	Percent Detected	Minimum Result	Maximum Result	RI Mean[A]	RA Mean[B]	Log-Normal Mean[C]	Units
Lake Winnebago - Filtered Water Results											
Lake Winnebago	filtered	Total PCBs	10	2	20.00%	5	7	6	11.2	10.7488	ng/L
Lake Winnebago	filtered	Ar1242	10	2	20.00%	5	7	6	4.6	4.4762	ng/L
Lake Winnebago	filtered	Mercury	1	0	0.00%	0	0	0	40	0.0000	ng/L
Lake Winnebago - Particulate Results											
Lake Winnebago	particulate	Total PCBs	10	3	30.00%	3.2	6	4.4	9.87	8.8776	ng/L
Lake Winnebago	particulate	Ar1242	10	3	30.00%	3.2	6	4.4	4.52	4.4231	ng/L
PCB Particulate Results											
Little Lake Butte des Morts	particulate	Total PCBs	41	34	82.93%	0.13	40.16	17.4424	16.5863	9.1379	ng/L
Appleton to Little Rapids	particulate	Total PCBs	86	82	95.35%	0.01	52.17	11.9519	11.9483	4.0719	ng/L
Little Rapids to DePere	particulate	Total PCBs	98	94	95.92%	0.17	96.3	30.5349	29.8753	20.8616	ng/L
DePere to Green Bay	particulate	Total PCBs	143	129	90.21%	1.433	149.0546	47.5894	44.2450	33.6712	ng/L
Green Bay Zone 2 (2A & 2B)	particulate	Total PCBs	71	71	100.00%	1.2702	91.7033	12.9643	12.9643	8.8221	ng/L
Green Bay Zone 3A	particulate	Total PCBs	66	61	92.42%	0.2181	16.9315	2.8102	2.7867	1.8689	ng/L
Green Bay Zone 3B	particulate	Total PCBs	45	40	88.89%	0.2528	9.4496	2.1790	2.2146	1.3947	ng/L
Green Bay Zone 4	particulate	Total PCBs	86	66	76.74%	0.1237	2.3816	0.4226	0.9057	0.5303	ng/L
Little Lake Butte des Morts	particulate	Ar1242	12	5	41.67%	5	15	9.2000	6.5000	5.8777	ng/L
Appleton to Little Rapids	particulate	Ar1242	13	9	69.23%	6	15	9.3333	8.0000	7.3670	ng/L
Little Rapids to DePere	particulate	Ar1242	24	20	83.33%	9	28	19.7000	18.0833	17.0671	ng/L
Little Rapids to DePere	particulate	Ar1254	24	1	4.17%	20	20	20.0000	6.8542	6.5639	ng/L
DePere to Green Bay	particulate	Ar1242	46	32	69.57%	12	45	22.2500	17.7935	15.2527	ng/L
Green Bay Zone 2 (2A & 2B)	particulate	Ar1242	9	9	100.00%	2.5	9.6	6.1889	6.1889	5.8004	ng/L
Green Bay Zone 3A	particulate	Ar1242	6	1	16.67%	0.66	0.66	0.6600	0.8600	0.8547	ng/L
Green Bay Zone 3B	particulate	Ar1242	7	2	28.57%	0.65	1.8	1.2250	0.9929	0.9485	ng/L
Green Bay Zone 4	particulate	Ar1242	20	0	0.00%	0	0	0.0000	0.9000	0.9000	ng/L
Little Lake Butte des Morts	particulate	PCB Congener 77/110	29	29	100.00%	0.04	1.3	0.5997	0.5997	0.3992	ng/L
Appleton to Little Rapids	particulate	PCB Congener 77/110	74	63	85.14%	0.023	1.5	0.3818	0.3705	0.1633	ng/L
Little Rapids to DePere	particulate	PCB Congener 77/110	74	74	100.00%	0.04	2.9	0.7661	0.7661	0.5302	ng/L
DePere to Green Bay	particulate	PCB Congener 77/110	86	86	100.00%	0.0486	2.5934	1.0373	1.0373	0.8672	ng/L
Green Bay Zone 2 (2A & 2B)	particulate	PCB Congener 77/110	61	61	100.00%	0.043	2.4525	0.3797	0.3797	0.2553	ng/L
Green Bay Zone 3A	particulate	PCB Congener 77/110	60	60	100.00%	0.007	0.4559	0.0824	0.0824	0.0526	ng/L
Green Bay Zone 3B	particulate	PCB Congener 77/110	38	38	100.00%	0.0074	0.2725	0.0633	0.0633	0.0370	ng/L
Green Bay Zone 4	particulate	PCB Congener 77/110	66	66	100.00%	0.0025	0.0283	0.0084	0.0084	0.0074	ng/L
Green Bay Zone 2 (2A & 2B)	particulate	PCB Congener 77/110	61	61	100.00%	0.043	2.4525	0.3797	0.3797	0.2553	ng/L

Table 5-16. Lower Fox River and Green Bay - Water Sampling Results: Summary of Detected Compounds (Continued)

Reach/Zone	Type	Parameter	Number of Samples	Number Detected	Percent Detected	Minimum Result	Maximum Result	RI MeanA	RA MeanB	Log-Normal MeanC	Units
Appleton to Little Rapids	particulate	PCB Congener 132/153/105	50	37	74.00%	0.026	0.49	0.1105	0.1428	0.0742	ng/L
DePere to Green Bay	particulate	PCB Congener 132/153/105	78	75	96.15%	0.08038	2.3348	0.7472	0.7193	0.5542	ng/L
Green Bay Zone 2 (2A & 2B)	particulate	PCB Congener 132/153/105	61	52	85.25%	0.0537	0.7381	0.2669	0.2276	0.0865	ng/L
Green Bay Zone 3A	particulate	PCB Congener 132/153/105	60	58	96.67%	0.0134	0.3031	0.0820	0.0793	0.0513	ng/L
Green Bay Zone 3B	particulate	PCB Congener 132/153/105	38	35	92.11%	0.0063	0.204	0.0585	0.0539	0.0287	ng/L
Green Bay Zone 4	particulate	PCB Congener 132/153/105	66	65	98.48%	0.0021	0.046	0.0144	0.0142	0.0115	ng/L
Little Lake Butte des Morts	particulate	PCB Congener 118	27	27	100.00%	0.03	0.65	0.3100	0.3100	0.2188	ng/L
Appleton to Little Rapids	particulate	PCB Congener 118	71	56	78.87%	0.016	0.8	0.2176	0.2072	0.0927	ng/L
Little Rapids to DePere	particulate	PCB Congener 118	72	72	100.00%	0.0203	1.2	0.4133	0.4133	0.3040	ng/L
DePere to Green Bay	particulate	PCB Congener 118	86	85	98.84%	0.01894	1.5584	0.5552	0.5488	0.4510	ng/L
Green Bay Zone 2 (2A & 2B)	particulate	PCB Congener 118	61	61	100.00%	0.0263	2.5922	0.2300	0.2300	0.1470	ng/L
Green Bay Zone 3A	particulate	PCB Congener 118	60	59	98.33%	0.0048	0.2406	0.0492	0.0484	0.0309	ng/L
Green Bay Zone 3B	particulate	PCB Congener 118	38	38	100.00%	0.0043	0.1703	0.0374	0.0374	0.0224	ng/L
Green Bay Zone 4	particulate	PCB Congener 118	66	66	100.00%	0.001	0.1021	0.0075	0.0075	0.0050	ng/L
Pesticide Particulate Results											
DePere to Green Bay	particulate	alpha-Chlordane	27	26	96.30%	0.022	0.2	0.0402	0.0391	0.0328	ng/L
DePere to Green Bay	particulate	cis-Nonachlor	3	3	100.00%	0.025	0.047	0.0327	0.0327	0.0313	ng/L
DePere to Green Bay	particulate	gamma-Chlordane	9	8	88.89%	0.028	0.24	0.0739	0.0669	0.0456	ng/L
DePere to Green Bay	particulate	p,p'-DDD	40	38	95.00%	0.054	0.27	0.1164	0.1119	0.0988	ng/L
DePere to Green Bay	particulate	p,p'-DDE	42	41	97.62%	0.032	0.41	0.1763	0.1725	0.1472	ng/L
DePere to Green Bay	particulate	p,p'-DDT	8	7	87.50%	0.05	0.21	0.0799	0.0730	0.0613	ng/L
DePere to Green Bay	particulate	trans-Nonachlor	45	18	40.00%	0.018	0.17	0.0306	0.0157	0.0096	ng/L
SVOC Particulate Results											
DePere to Green Bay	particulate	Hexachlorobenzene	42	40	95.24%	0.0073	0.0300	0.0151	0.0146	0.0131	ng/L
Inorganic Compound Particulate Results											
DePere to Green Bay	particulate	Mercury	32	32	100.00%	0.0018	0.0748	0.0230	0.0230	0.0177	µg/L
PCB Filtered Water Results											
Little Lake Butte des Morts	filtered	Total PCBs	46	40	86.96%	1.4	19	8.9708	11.0615	8.3044	ng/L
Appleton to Little Rapids	filtered	Total PCBs	85	84	98.82%	0.026	18.86	4.7567	4.8420	2.3967	ng/L
Little Rapids to DePere	filtered	Total PCBs	98	97	98.98%	0.185	27.6	11.2496	11.2726	9.2104	ng/L
DePere to Green Bay	filtered	Total PCBs	143	142	99.30%	2.414	45	16.6654	16.6397	14.7317	ng/L
Green Bay Zone 2 (2A & 2B)	filtered	Total PCBs	63	63	100.00%	0.9962	13.6814	4.8232	4.8232	3.9619	ng/L
Green Bay Zone 3A	filtered	Total PCBs	60	60	100.00%	0.4749	5.136	1.6307	1.6307	1.3759	ng/L
Green Bay Zone 3B	filtered	Total PCBs	40	40	100.00%	0.5181	3.9201	1.4468	1.4468	1.2250	ng/L
Green Bay Zone 4	filtered	Total PCBs	66	66	100.00%	0.315	1.323	0.5840	0.5840	0.5556	ng/L

Table 5-16. Lower Fox River and Green Bay - Water Sampling Results: Summary of Detected Compounds (Continued)

Reach/Zone	Type	Parameter	Number of Samples	Number Detected	Percent Detected	Minimum Result	Maximum Result	RI MeanA	RA MeanB	Log-Normal MeanC	Units
Little Lake Butte des Morts	filtered	Ar1242	18	12	66.67%	4	19	8.4417	13.9611	11.3055	ng/L
Appleton to Little Rapids	filtered	Ar1242	13	12	92.31%	4.6	10	7.2250	7.2077	7.0177	ng/L
Little Rapids to DePere	filtered	Ar1242	24	23	95.83%	7	25	12.2043	11.9667	10.9744	ng/L
DePere to Green Bay	filtered	Ar1242	46	43	93.48%	5	45	12.5349	12.1630	10.6920	ng/L
Little Lake Butte des Morts	filtered	PCB Congener 77/110	28	28	100.00%	0.08	0.54	0.1982	0.1982	0.1763	ng/L
Appleton to Little Rapids	filtered	PCB Congener 77/110	73	34	46.58%	0.022	0.3	0.1396	0.1251	0.0641	ng/L
Little Rapids to DePere	filtered	PCB Congener 77/110	72	72	100.00%	0.0236	0.34	0.1469	0.1469	0.1255	ng/L
DePere to Green Bay	filtered	PCB Congener 77/110	86	86	100.00%	0.0437	0.41648	0.1606	0.1606	0.1501	ng/L
Green Bay Zone 2 (2A & 2B)	filtered	PCB Congener 77/110	62	62	100.00%	0.002	0.1842	0.0735	0.0735	0.0606	ng/L
Green Bay Zone 3A	filtered	PCB Congener 77/110	60	60	100.00%	0.0079	0.1055	0.0309	0.0309	0.0255	ng/L
Green Bay Zone 3B	filtered	PCB Congener 77/110	40	39	97.50%	0.0068	0.0791	0.0271	0.0265	0.0202	ng/L
Green Bay Zone 4	filtered	PCB Congener 77/110	66	66	100.00%	0.0052	0.0234	0.0117	0.0117	0.0112	ng/L
Appleton to Little Rapids	filtered	PCB Congener 132/153/105	50	3	6.00%	0.026	0.043	0.0343	0.0859	0.0366	ng/L
DePere to Green Bay	filtered	PCB Congener 132/153/105	77	52	67.53%	0.04156	0.175	0.0895	0.0665	0.0511	ng/L
Green Bay Zone 2 (2A & 2B)	filtered	PCB Congener 132/153/105	62	62	100.00%	0.013	0.1549	0.0481	0.0481	0.0414	ng/L
Green Bay Zone 3A	filtered	PCB Congener 132/153/105	60	60	100.00%	0.0075	0.0847	0.0300	0.0300	0.0245	ng/L
Green Bay Zone 3B	filtered	PCB Congener 132/153/105	40	39	97.50%	0.0097	0.1119	0.0290	0.0283	0.0202	ng/L
Green Bay Zone 4	filtered	PCB Congener 132/153/105	66	66	100.00%	0.0075	0.0792	0.0143	0.0143	0.0131	ng/L
Little Lake Butte des Morts	filtered	PCB Congener 118	28	28	100.00%	0.03	0.12	0.0746	0.0746	0.0690	ng/L
Appleton to Little Rapids	filtered	PCB Congener 118	71	24	33.80%	0.021	0.5	0.0988	0.0808	0.0409	ng/L
Little Rapids to DePere	filtered	PCB Congener 118	70	70	100.00%	0.007	0.1939	0.0554	0.0554	0.0437	ng/L
DePere to Green Bay	filtered	PCB Congener 118	86	83	96.51%	0.01881	0.14079	0.0507	0.0494	0.0455	ng/L
Green Bay Zone 2 (2A & 2B)	filtered	PCB Congener 118	62	62	100.00%	0.0053	0.0583	0.0225	0.0225	0.0193	ng/L
Green Bay Zone 3A	filtered	PCB Congener 118	60	60	100.00%	0.0029	0.0339	0.0104	0.0104	0.0088	ng/L
Green Bay Zone 3B	filtered	PCB Congener 118	40	40	100.00%	0.003	0.026	0.0091	0.0091	0.0078	ng/L
Green Bay Zone 4	filtered	PCB Congener 118	66	66	100.00%	0.002	0.0084	0.0038	0.0038	0.0036	ng/L
Pesticide Filtered Water Results											
DePere to Green Bay	filtered	alpha-BHC	31	30	96.77%	0.058	1.1	0.2101	0.2042	0.1502	ng/L
DePere to Green Bay	filtered	alpha-Chlordane	14	12	85.71%	0.022	0.039	0.0263	0.0240	0.0227	ng/L
DePere to Green Bay	filtered	Atrazine	13	13	100.00%	40.6	81.07	58.8308	58.8308	57.5880	ng/L
DePere to Green Bay	filtered	Desethylatrazine	13	13	100.00%	36.5	62.49	46.5208	46.5208	46.1231	ng/L
DePere to Green Bay	filtered	Desisopropylatrazine	13	13	100.00%	14.1	33.9	22.5638	22.5638	21.8316	ng/L
DePere to Green Bay	filtered	gamma-BHC (Lindane)	31	28	90.32%	0.053	0.83	0.2035	0.1864	0.1301	ng/L
DePere to Green Bay	filtered	gamma-Chlordane	8	8	100.00%	0.024	0.053	0.0328	0.0328	0.0317	ng/L
DePere to Green Bay	filtered	p,p'-DDD	7	5	71.43%	0.05	0.067	0.0560	0.0474	0.0447	ng/L
DePere to Green Bay	filtered	p,p'-DDE	19	19	100.00%	0.034	0.072	0.0407	0.0407	0.0401	ng/L
DePere to Green Bay	filtered	trans-Nonachlor	36	9	25.00%	0.006	0.019	0.0094	0.0050	0.0042	ng/L
DePere to Green Bay	filtered	Hexachlorobenzene	44	44	100.00%	0.0074	0.026	0.0123	0.0123	0.0118	ng/L

Table 5-16. Lower Fox River and Green Bay - Water Sampling Results: Summary of Detected Compounds (Continued)

Reach/Zone	Type	Parameter	Number of Samples	Number Detected	Percent Detected	Minimum Result	Maximum Result	RI MeanA	RA MeanB	Log-Normal MeanC	Units
Inorganic Compound Filtered Water Results											
Little Lake Butte des Morts	filtered	Aluminum	1	1	100.00%	20.70	20.70	20.7000	20.7000	0.0000	µg/L
Little Rapids to DePere	filtered	Aluminum	2	2	100.00%	12.70	15.64	14.1700	14.1700	14.0935	µg/L
Green Bay Zone 2 (2A & 2B)	filtered	Aluminum	2	2	100.00%	5.56	12.40	8.9800	8.9800	8.3033	µg/L
Little Lake Butte des Morts	filtered	Cadmium	1	1	100.00%	0.0057	0.0057	0.0057	0.0057	0.0000	µg/L
Little Rapids to DePere	filtered	Cadmium	2	2	100.00%	0.0107	0.0182	0.0145	0.0145	0.0140	µg/L
Green Bay Zone 2 (2A & 2B)	filtered	Cadmium	2	2	100.00%	0.0124	0.0187	0.0156	0.0156	0.0152	µg/L
DePere to Green Bay	filtered	Calcium, dissolved	29	29	100.00%	31,700	48,770	38,657.59	38,657.59	38,357.98	µg/L
Little Rapids to DePere	filtered	Chromium	1	1	100.00%	0.3310	0.3310	0.3310	0.3310	0.0000	µg/L
Green Bay Zone 2 (2A & 2B)	filtered	Chromium	2	2	100.00%	0.1910	0.3730	0.2820	0.2820	0.2669	µg/L
Little Lake Butte des Morts	filtered	Copper	1	1	100.00%	1	1	1	1	0.0000	µg/L
Little Rapids to DePere	filtered	Copper	2	2	100.00%	0.8580	0.8910	0.8745	0.8745	0.8743	µg/L
Green Bay Zone 2 (2A & 2B)	filtered	Copper	2	2	100.00%	1.9200	2.0100	1.9650	1.9650	1.9645	µg/L
Little Lake Butte des Morts	filtered	Lead	1	1	100.00%	0.1170	0.1170	0.1170	0.1170	0.0000	µg/L
Little Rapids to DePere	filtered	Lead	2	2	100.00%	0.1180	0.1240	0.1210	0.1210	0.1210	µg/L
Green Bay Zone 2 (2A & 2B)	filtered	Lead	2	2	100.00%	0.0440	0.0442	0.0441	0.0441	0.0441	µg/L
DePere to Green Bay	filtered	Magnesium, dissolved	29	29	100.00%	17,290	24,500	20,970.66	20,970.66	20,892.48	µg/L
Little Lake Butte des Morts	filtered	Mercury	2	0	0.00%	0	0	0	0.0400	0.0400	µg/L
Appleton to Little Rapids	filtered	Mercury	2	1	50.00%	0.09	0.09	0.09	0.0650	0.0600	µg/L
Little Rapids to DePere	filtered	Mercury	3	2	66.67%	1.26	2.52	1.89	1.2733	0.5027	µg/L
DePere to Green Bay	filtered	Mercury	45	43	95.56%	0.00053	0.04081	0.00323	0.00487	0.00182	µg/L
Green Bay Zone 2 (2A & 2B)	filtered	Mercury	10	2	20.00%	1.15	2.33	1.74	0.3910	0.1035	µg/L
Green Bay Zone 3A	filtered	Mercury	6	0	0.00%	0	0	0	0.0508	0.0496	µg/L
Green Bay Zone 3B	filtered	Mercury	7	0	0.00%	0	0	0	0.0543	0.0528	µg/L
Green Bay Zone 4	filtered	Mercury	20	0	0.00%	0	0	0	0.0523	0.0504	µg/L
DePere to Green Bay	filtered	Potassium, dissolved	29	29	100.00%	2,233.00	4,530.00	2,861.38	2,861.38	2,824.25	µg/L
DePere to Green Bay	filtered	Sodium	29	29	100.00%	9,419	28,900	15,752.34	15,752.34	15,191.06	µg/L
Little Lake Butte des Morts	filtered	Zinc	1	1	100.00%	0.438	0.438	0.438	0.438	0.0000	µg/L
Little Rapids to DePere	filtered	Zinc	2	2	100.00%	1.24	2.59	1.915	1.915	1.7921	µg/L
Green Bay Zone 2 (2A & 2B)	filtered	Zinc	2	2	100.00%	1.2	1.81	1.505	1.505	1.4738	µg/L

Notes: This table only contains parameters which were sampled and detected in Lower Fox River or Green Bay water/particulate samples.

A) The RI Mean is the average of all detected sample results.

B) The RA Mean is the average of all detected sample results plus 1/2 the detection limit for samples flagged as non-detect by the lab.

C) The Log-Normal Mean was calculated using the RA Mean sample data - this was done because not all sample populations have a normal distribution.

Table 5-17. Lower Fox River - Total PCB Results in Water

Sample Idenifcation	Sample Date	Dissolved (ng/L)	Particulate (ng/L)	Total (ng/L)	Percent Particulate	Temp. (°C)	Sample Idenifcation	Sample Date	Dissolved (ng/L)	Particulate (ng/L)	Total (ng/L)	Percent Particulate	Temp. (°C)
LLBdM Reach							#46	4/11/90	4.710	11.390	16.100	70.75%	NA
9003244	4/20/89	NA	17.090	17.090	100.0%	NA	#47	4/17/90	6.730	16.540	23.270	71.08%	NA
9003450	5/2/89	13.270	34.810	48.080	72.4%	NA	OB004149	4/19/90	5.470	13.620	19.090	71.35%	NA
9003619	5/17/89	11.930	35.610	47.540	74.9%	NA	OB004150	4/19/90	6.350	13.360	19.710	67.78%	NA
9003621	5/17/89	13.150	36.160	49.310	73.3%	NA	#48	4/24/90	10.970	29.910	40.880	73.17%	NA
9003777	5/31/89	3.660	14.460	18.120	79.8%	NA	#49	4/24/90	11.100	30.950	42.050	73.60%	NA
9004429	6/27/89	16.610	38.930	55.540	70.1%	NA	#50	5/1/90	15.030	39.390	54.420	72.38%	NA
A	6/14/89	8.510	24.070	32.580	73.9%	NA	4085000AU	6/16/92	NA	NA	NA	NA	22.5
AO001179	7/26/89	14.610	33.660	48.270	69.7%	NA	4085000BU	8/13/92	NA	NA	NA	NA	20.5
BA-SW01	11/18/92	50.000	NA	50.000	0.0%	2.0	4085000CU	10/21/92	NA	NA	NA	NA	7.0
BA-SW04	11/18/92	50.000	NA	50.000	0.0%	2.0	4085000DU	3/12/93	NA	NA	NA	NA	2.0
BA-SW05a	12/16/92	50.000	NA	50.000	0.0%	0.5	4085000EU	5/13/93	NA	NA	NA	NA	15.0
BA-SW05b	3/9/93	50.000	NA	50.000	0.0%	3.0	4085000FU	8/24/93	NA	NA	NA	NA	25.0
BA-SW08a	12/16/92	50.000	NA	50.000	0.0%	2.0	4085000GU	10/19/93	NA	NA	NA	NA	12.0
BA-SW08b	3/9/93	50.000	NA	50.000	0.0%	3.0	4085000HU	3/29/94	NA	NA	NA	NA	4.5
OA001183	7/12/89	18.950	40.160	59.110	67.9%	NA	4085000IU	5/19/94	NA	NA	NA	NA	17.0
OA001626	8/22/89	16.200	33.060	49.260	67.1%	NA	4085000JU	8/24/94	NA	NA	NA	NA	25.0
OA001633	8/8/89	16.230	39.180	55.410	70.7%	NA	SW4-F1	4/1/98	7.000	ND	7.000	0.00%	NA
OA002394	10/3/89	12.580	24.940	37.520	66.5%	NA	SW4-F2	4/2/98	9.000	ND	9.000	0.00%	NA
OA003238	9/20/89	16.170	26.330	42.500	62.0%	NA	SW4-F3	4/3/98	13.000	ND	13.000	0.00%	5.9
OA003239	9/20/89	15.780	22.560	38.340	58.8%	NA	SW4-F4	4/6/98	27.000	ND	27.000	0.00%	6.7
OA003243	9/5/89	17.910	27.830	45.740	60.8%	NA	SW4-F5	4/7/98	7.000	20.000	27.000	74.07%	7.0
OA004474	10/17/89	14.610	28.490	43.100	66.1%	NA	SW4-F6	4/8/98	7.000	38.000	45.000	84.44%	7.6
OA004478	10/31/89	9.590	27.160	36.750	73.9%	NA	SW4-F7	4/10/98	8.000	13.000	21.000	61.90%	6.4
OB000378	11/14/89	4.140	0.470	4.610	10.2%	NA	SW4-F8	4/14/98	8.000	23.000	31.000	74.19%	9.0
OB000379	11/15/89	2.690	5.200	7.890	65.9%	NA	SW4-F9	4/16/98	13.000	24.000	37.000	64.86%	7.1
OB000387	12/5/89	2.350	1.050	3.400	30.9%	NA	SW4-F10	4/17/98	8.000	16.000	24.000	66.67%	6.6
OB001106	1/18/90	2.450	0.220	2.670	8.2%	NA	SW4-F11	5/12/98	12.000	28.000	40.000	70.00%	17.1
OB001112	2/13/90	2.710	0.810	3.520	23.0%	NA	SW4-F12	5/27/98	7.000	9.000	16.000	56.25%	19.3
OB001115	3/13/90	2.120	0.860	2.980	28.9%	NA	W00005	6/9/98	9.000	19.000	28.000	67.86%	16.9
OB001116	3/23/90	1.400	0.130	1.530	8.5%	NA	W00014	6/30/98	13.000	27.000	40.000	67.50%	24.5
OB002900	3/13/90	7.630	13.300	20.930	63.5%	NA	W00032	7/14/98	18.000	22.000	40.000	55.00%	26.6
OB002901	3/19/90	2.930	2.820	5.750	49.0%	NA	W00035	7/14/98	15.000	24.000	39.000	61.54%	26.6
OB002902	3/23/90	2.600	1.950	4.550	42.9%	NA	W00047	7/28/98	17.000	14.000	31.000	45.16%	23.8
OB002904	4/2/90	3.020	4.920	7.940	62.0%	NA	W00048	7/28/98	20.000	16.000	36.000	44.44%	23.8
OB002905	4/18/90	3.730	10.810	14.540	74.3%	NA	SW00066	8/11/98	25.000	23.000	48.000	47.92%	24.3

Table 5-17. Lower Fox River - Total PCB Results in Water (Continued)

Sample Idenifcation	Sample Date	Dissolved (ng/L)	Particulate (ng/L)	Total (ng/L)	Percent Particulate	Temp. (°C)
SW00064	8/10/98	19.000	15.000	34.000	44.1%	25.6
SW2-F11	5/11/98	11.000	7.000	18.000	38.9%	15.9
SW2-F12	5/26/98	7.000	5.000	12.000	41.7%	19.2
W00002	6/8/98	9.000	ND	9.000	0.0%	16.4
W00012	6/29/98	5.000	ND	5.000	0.0%	25.1
W00017	6/29/98	6.000	ND	6.000	0.0%	25.1
W00030	7/13/98	4.000	ND	4.000	0.0%	24.9
W00045	7/27/98	14.000	ND	14.000	0.0%	24.3
W00090	8/27/98	8.000	9.000	17.000	52.9%	24.0
W00099	9/9/98	7.000	ND	7.000	0.0%	19.3
W00100	9/9/98	7.000	ND	7.000	0.0%	19.3
W00124	9/23/98	4.300	10.000	14.300	69.9%	17.9
Appleton to Little Rapids						
9003241	4/19/89	7.540	29.000	36.540	79.4%	NA
9003452	5/3/89	11.040	42.640	53.680	79.4%	NA
9003620	5/16/89	13.570	51.610	65.180	79.2%	NA
9003778	6/1/89	6.020	35.910	41.930	85.6%	NA
B	6/14/89	9.660	29.690	39.350	75.5%	NA
9004428	6/27/89	18.860	46.180	65.040	71.0%	NA
9004430	6/27/89	17.460	32.880	50.340	65.3%	NA
OA001184	7/11/89	17.820	41.200	59.020	69.8%	NA
OA001178	7/26/89	14.920	44.100	59.020	74.7%	NA
OA001632	8/9/89	15.930	52.170	68.100	76.6%	NA
OA001625	8/23/89	15.020	46.940	61.960	75.8%	NA
OA003244	9/6/89	11.480	27.110	38.590	70.3%	NA
OA003237	9/20/89	13.510	27.330	40.840	66.9%	NA
OA002395	10/3/89	16.490	31.390	47.880	65.6%	NA
OA004473	10/17/89	8.380	32.000	40.380	79.2%	NA
OA004476	11/1/89	8.780	31.390	40.170	78.1%	NA
OB000380	11/15/89	2.820	4.850	7.670	63.2%	NA
OB000383	12/6/89	1.960	0.450	2.410	18.7%	NA
OB000385	12/6/89	2.810	0.550	3.360	16.4%	NA
OB001108	1/18/90	0.780	0.500	1.280	39.1%	NA
OB001114	2/14/90	NA	2.480	NA	NA	NA
OB004144	3/13/90	4.310	10.140	14.450	70.2%	NA
OB004146	4/2/90	3.400	3.670	7.070	51.9%	NA
OB004148	4/18/90	5.170	12.660	17.830	71.0%	NA
SW3-F11	5/12/98	10.000	11.000	21.000	52.4%	16.5

Sample Idenifcation	Sample Date	Dissolved (ng/L)	Particulate (ng/L)	Total (ng/L)	Percent Particulate	Temp. (°C)
SW00067	8/11/98	24.000	22.000	46.000	47.83%	24.3
W00092	8/31/98	11.000	19.000	30.000	63.33%	24.2
W00093	8/31/98	13.000	19.000	32.000	59.38%	24.2
W00103	9/9/98	9.000	18.000	27.000	66.67%	21.2
W00127	9/24/98	7.700	20.000	27.700	72.20%	19.0
DePere to Green Bay						
89GG25S70	5/4/89	19.725	116.812	136.532	85.56%	NA
89GG25S61	5/4/89	19.725	116.835	136.560	85.56%	NA
89GG25S90	5/5/89	27.607	149.052	176.659	84.37%	NA
89GG26D10	5/5/89	24.500	84.486	108.986	77.52%	NA
89GG26S01	5/5/89	23.832	95.007	118.839	79.95%	NA
89GG26S10	5/5/89	23.088	105.363	128.451	82.03%	NA
89GG26S30	5/5/89	25.449	86.668	112.117	77.30%	NA
89GG26S50	5/5/89	25.816	82.140	107.956	76.09%	NA
89GG25S81	5/5/89	27.628	149.055	176.682	84.36%	NA
89GG26S21	5/5/89	25.457	86.676	112.133	77.30%	NA
89GG26S41	5/5/89	25.879	82.153	108.032	76.04%	NA
89GG26S70	5/6/89	25.128	103.808	128.936	80.51%	NA
89GG26S41(2)	5/6/89	25.138	103.911	129.048	80.52%	NA
89GG31S01	6/7/89	11.112	55.073	66.185	83.21%	NA
89GG31S41	6/7/89	18.476	37.250	55.726	66.85%	NA
89GG31S61	6/7/89	12.607	27.543	40.150	68.60%	NA
89GG31D81	6/8/89	16.775	55.267	72.042	76.71%	NA
89GG31S81	6/8/89	17.021	30.954	47.975	64.52%	NA
89GG31S21	6/8/89	14.416	47.912	62.328	76.87%	NA
89GG32S01	6/8/89	16.095	56.626	72.721	77.87%	NA
89GG41S01	7/27/89	20.660	29.276	49.936	58.63%	NA
89GG41S21	7/27/89	25.961	46.474	72.436	64.16%	NA
89GG41S41	7/27/89	31.230	78.100	109.330	71.43%	NA
89GG41S61	7/27/89	24.313	41.177	65.490	62.88%	NA
89GG41S81	7/27/89	29.582	70.632	100.214	70.48%	NA
89GG42S01	7/27/89	25.280	77.837	103.117	75.48%	NA
89GG56D61	9/20/89	17.747	36.163	53.910	67.08%	NA
89GG56S61	9/20/89	17.078	28.538	45.616	62.56%	NA
89GG56S01	9/20/89	18.507	37.570	56.077	67.00%	NA
89GG56S21	9/20/89	23.396	55.882	79.278	70.49%	NA
89GG56S41	9/20/89	26.960	38.234	65.194	58.65%	NA
89GG56S81	9/20/89	25.588	44.956	70.544	63.73%	NA

Table 5-17. Lower Fox River - Total PCB Results in Water (Continued)

Sample Idenifcation	Sample Date	Dissolved (ng/L)	Particulate (ng/L)	Total (ng/L)	Percent Particulate	Temp. (°C)	Sample Idenifcation	Sample Date	Dissolved (ng/L)	Particulate (ng/L)	Total (ng/L)	Percent Particulate	Temp. (°C)
SW-D4-F	5/26/98	9.000	6.000	15.000	40.0%	19.9	89GG57S01	9/20/89	21.200	39.011	60.211	64.79%	NA
SW3-F12	5/26/98	8.000	6.000	14.000	42.9%	19.9	90GG01S01	10/17/89	15.851	48.207	64.058	75.26%	NA
W00003	6/8/98	6.000	22.000	28.000	78.6%	17.7	90GG01S21	10/17/89	16.360	86.972	103.332	84.17%	NA
W00004	6/8/98	6.000	22.000	28.000	78.6%	17.7	90GG01D61	10/18/89	26.137	75.326	101.463	74.24%	NA
W00013	6/29/98	7.000	8.000	15.000	53.3%	16.0	90GG01S61	10/18/89	25.021	97.590	122.611	79.59%	NA
W00031	7/13/98	7.000	27.000	34.000	79.4%	26.2	90GG01S41	10/18/89	20.492	72.636	93.128	78.00%	NA
W00046	7/27/98	10.000	7.000	17.000	41.2%	25.4	90GG01S81	10/18/89	23.791	78.765	102.557	76.80%	NA
SW00065	8/11/98	24.000	15.000	39.000	38.5%	24.5	90GG02S01	10/18/89	25.067	100.037	125.104	79.96%	NA
W00091	8/27/98	8.000	10.000	18.000	55.6%	25.1	90GG26S10	4/30/90	17.424	47.710	65.134	73.25%	NA
W00101	9/9/98	6.000	24.000	30.000	80.0%	21.4	90GG26S01	4/30/90	17.433	47.749	65.182	73.25%	NA
W00125	9/24/98	4.600	10.000	14.600	68.5%	19.2	90GG26S50	5/1/90	21.969	92.734	114.703	80.85%	NA
W00126	9/24/98	5.100	11.000	16.100	68.3%	19.2	90GG26S70	5/1/90	20.565	43.288	63.853	67.79%	NA
D-1	10/21/98	0.044	0.011	0.055	20.0%	NA	90GG26S90	5/1/90	25.042	49.271	74.313	66.30%	NA
U-1	10/21/98	0.026	0.010	0.036	27.8%	NA	90GG27S10	5/1/90	18.858	60.028	78.886	76.09%	NA
D-03	11/12/98	4.117	25.881	29.998	86.3%	NA	90GG26S41	5/1/90	22.067	92.895	114.962	80.80%	NA
U-03	11/12/98	4.925	32.733	37.658	86.9%	NA	90GG26S61	5/1/90	20.670	43.409	64.079	67.74%	NA
D-04	11/18/98	1.089	5.077	6.166	82.3%	NA	90GG26S81	5/1/90	25.142	49.380	74.522	66.26%	NA
U-04	11/18/98	0.658	4.317	4.975	86.8%	NA	90GG27S01	5/1/90	18.929	60.161	79.090	76.07%	NA
D-05	11/25/98	0.389	3.506	3.895	90.0%	NA	4085139CU	11/24/93	NA	NA	NA	NA	2.9
U-05	11/25/98	0.367	3.082	3.449	89.4%	NA	4085139DU	12/8/93	NA	NA	NA	NA	1.5
D-06	11/27/98	5.399	6.201	11.600	53.5%	NA	4085139EU	1/25/94	NA	NA	NA	NA	0.0
U-06	11/27/98	0.256	3.346	3.602	92.9%	NA	TFOXRB01	4/7/94	9.898	28.504	38.402	74.23%	5.0
D-07	11/30/98	1.510	7.072	8.582	82.4%	NA	TFOXRB02	4/20/94	21.356	75.664	97.020	77.99%	11.9
U-07	11/30/98	0.781	4.663	5.444	85.7%	NA	4085139FU	4/21/94	NA	NA	NA	NA	12.8
D-08	12/1/98	5.294	8.513	13.807	61.7%	NA	TFOXRB03	4/26/94	9.201	65.382	74.583	87.66%	11.5
U-08	12/1/98	1.322	5.477	6.799	80.6%	NA	TFOXRB04	5/4/94	11.380	37.707	49.087	76.82%	11.0
D-09	12/3/98	5.399	21.643	27.042	80.0%	NA	TFOXRB05	5/11/94	11.196	29.060	40.256	72.19%	14.2
U-09	12/3/98	1.556	5.039	6.595	76.4%	NA	TFOXRB06	5/18/94	17.731	66.348	84.079	78.91%	NA
D-10	12/4/98	3.380	13.543	16.923	80.0%	NA	TFOXRB06R1	5/18/94	17.723	66.207	83.930	78.88%	15.6
U-10	12/4/98	1.049	3.845	4.894	78.6%	NA	TFOXRB06R2	5/18/94	19.060	52.458	71.518	73.35%	15.6
D-11	12/8/98	3.976	11.166	15.142	73.7%	NA	TFOXRB06U	5/18/94	NA	NA	NA	NA	15.6
U-11	12/8/98	1.482	2.262	3.744	60.4%	NA	TFOXRB07	6/2/94	20.665	57.182	77.847	73.45%	21.6
U-12	12/8/98	1.781	2.159	3.940	54.8%	NA	4085139IU	6/7/94	NA	NA	NA	NA	22.4
D-12	12/9/98	5.320	14.583	19.903	73.3%	NA	TFOXRB08	6/15/94	32.074	58.430	90.504	64.56%	23.3
D-13	12/9/98	6.252	12.490	18.742	66.6%	NA	4085139JU	6/22/94	NA	NA	NA	NA	28.0
U-13	12/9/98	1.039	1.261	2.300	54.8%	NA	TFOXRB09	7/7/94	31.532	110.918	142.450	77.86%	25.3
PE-15	12/10/98	2.666	2.319	4.985	46.5%	NA	4085139KU	7/13/94	NA	NA	NA	NA	23.7
D-14	12/13/98	3.580	14.649	18.229	80.4%	NA	TFOXRB10	7/20/94	24.949	65.061	90.010	72.28%	24.4

Table 5-17. Lower Fox River - Total PCB Results in Water (Continued)

Sample Idenifcation	Sample Date	Dissolved (ng/L)	Particulate (ng/L)	Total (ng/L)	Percent Particulate	Temp. (°C)	Sample Idenifcation	Sample Date	Dissolved (ng/L)	Particulate (ng/L)	Total (ng/L)	Percent Particulate	Temp. (°C)
U-14	12/13/98	0.493	0.982	1.475	66.6%	NA	TFOXRB10R1	7/20/94	24.795	65.075	89.870	72.41%	24.4
D-15	12/14/98	1.308	5.436	6.744	80.6%	NA	TFOXRB11R2	7/20/94	26.563	78.404	104.967	74.69%	24.4
U-15	12/14/98	0.446	1.063	1.509	70.4%	NA	TFOXRB12	8/17/94	24.157	58.466	82.623	70.76%	21.2
PE-21	12/16/98	2.544	1.455	3.999	36.4%	NA	4085139NU	8/25/94	NA	NA	NA	NA	23.4
D-16	12/18/98	0.777	2.919	3.696	79.0%	NA	TFOXRB13	9/14/94	29.970	76.644	106.614	71.89%	22.7
U-16	12/18/98	0.433	1.025	1.458	70.3%	NA	4085139OU	9/22/94	NA	NA	NA	NA	22.3
D-17	12/19/98	0.784	2.521	3.305	76.3%	NA	TFOXRB14	9/28/94	17.460	39.890	57.350	69.56%	17.0
U-17	12/19/98	0.612	1.626	2.238	72.7%	NA	TFOXRB15	9/30/94	15.616	50.188	65.804	76.27%	16.6
D-18	12/22/98	1.173	2.643	3.816	69.3%	NA	TFOXRB16	10/4/94	15.027	50.203	65.230	76.96%	15.0
D-19	12/29/98	0.734	0.481	1.215	39.6%	NA	TFOXRB16R1	10/4/94	15.166	50.227	65.393	76.81%	15.0
U-18	12/29/98	0.442	0.036	0.478	7.5%	NA	TFOXRB17R2	10/4/94	15.846	50.744	66.590	76.20%	15.0
D-20	12/30/98	1.229	1.594	2.823	56.5%	NA	4085139PU	10/5/94	NA	NA	NA	NA	14.8
U-19	12/30/98	0.488	0.058	0.546	10.6%	NA	TFOXRB18	10/19/94	17.790	45.173	62.963	71.75%	15.6
D-21	1/6/99	1.092	2.299	3.391	67.8%	NA	TFOXRB19	11/7/94	12.177	44.714	56.891	78.60%	8.9
D-22	1/6/99	2.699	1.584	4.283	37.0%	NA	TFOXRB20	11/10/94	12.511	27.713	40.224	68.90%	8.3
U-20	1/6/99	0.370	0.063	0.433	14.5%	NA	TFOXRB21	11/16/94	12.603	26.448	39.051	67.73%	8.2
D-23	1/7/99	0.617	0.775	1.392	55.7%	NA	TFOXRB22	11/30/94	5.238	11.310	16.548	68.35%	1.4
U-21	1/7/99	0.633	0.212	0.845	25.1%	NA	4085139RU	12/7/94	NA	NA	NA	NA	2.5
D-24	1/19/99	1.858	7.360	9.218	79.8%	NA	TFOXRB23	12/15/94	2.414	1.896	4.310	43.99%	0.5
U-22	1/19/99	0.385	0.077	0.462	16.7%	NA	TFOXRB24	1/11/95	3.554	1.433	4.987	28.73%	0.7
D-25	1/20/99	1.661	10.045	11.706	85.8%	NA	TFOXRB25	2/14/95	4.187	1.457	5.644	25.82%	0.9
U-23	1/20/99	0.289	0.063	0.352	17.9%	NA	4085139TU	3/1/95	NA	NA	NA	NA	1.2
U-24	1/20/99	0.412	0.052	0.464	11.2%	NA	TFOXRB26	3/6/95	3.679	6.329	10.008	63.24%	NA
Little Rapids to DePere							TFOXRB27	3/22/95	5.516	9.816	15.332	64.02%	4.6
#1	1/19/89	25.910	3.450	29.360	11.75%	NA	TFOXRB28	3/30/95	7.822	16.640	24.462	68.02%	5.1
#2	4/13/89	4.240	7.230	11.470	63.03%	NA	TFOXRB29	4/5/95	9.273	20.108	29.381	68.44%	4.2
#3	4/19/89	1.330	30.490	31.820	95.82%	NA	4085139VU	4/7/95	NA	NA	NA	NA	4.9
#4	4/19/89	27.600	42.430	70.030	60.59%	NA	TFOXRB30	4/12/95	9.873	92.754	102.627	90.38%	5.5
9003240	4/19/89	8.000	23.720	31.720	74.78%	NA	TFOXRB31	4/20/95	9.917	23.389	33.306	70.22%	8.3
#5	4/26/89	12.860	48.660	61.520	79.10%	NA	TFOXRB32	5/4/95	8.922	33.973	42.895	79.20%	11.8
#6	5/3/89	18.300	96.300	114.600	84.03%	NA	TFOXRB33	5/9/95	11.851	25.276	37.127	68.08%	12.9
9003449	5/3/89	15.950	35.630	51.580	69.08%	NA	4085139WU	5/11/95	NA	NA	NA	NA	12.5
#7	5/11/89	15.660	72.410	88.070	82.22%	NA	TFOXRB34	5/18/95	16.936	42.855	59.791	71.67%	16.6
#8	5/17/89	18.720	56.360	75.080	75.07%	NA	TFOXRB35	5/25/95	15.327	33.627	48.954	68.69%	17.4
9003622	5/17/89	14.660	40.600	55.260	73.47%	NA	TFOXRB36	5/25/95	16.261	35.103	51.364	68.34%	17.4
#9	5/24/89	15.460	31.660	47.120	67.19%	NA	TFOXRB36	6/6/95	16.261	35.103	51.364	68.34%	23.6
#10	6/1/89	9.110	50.870	59.980	84.81%	NA	TFOXRB37	6/13/95	21.643	22.010	43.653	50.42%	20.6
9003779	6/1/89	10.440	83.520	93.960	88.89%	NA	4085139XU	7/11/95	NA	NA	NA	NA	24.6

Table 5-17. Lower Fox River - Total PCB Results in Water (Continued)

Sample Idenifcation	Sample Date	Dissolved (ng/L)	Particulate (ng/L)	Total (ng/L)	Percent Particulate	Temp. (°C)	Sample Idenifcation	Sample Date	Dissolved (ng/L)	Particulate (ng/L)	Total (ng/L)	Percent Particulate	Temp. (°C)
#11	6/6/89	9.990	63.660	73.650	86.44%	NA	TFOXRB38	8/16/95	20.703	32.342	53.045	60.97%	25.3
#12	6/13/89	14.950	54.290	69.240	78.41%	NA	TFOXRB39	8/21/95	14.961	44.337	59.298	74.77%	25.5
C	6/15/89	12.440	71.910	84.350	85.25%	NA	TFOXRB40	8/30/95	13.223	44.557	57.780	77.11%	NA
#12(2)	6/21/89	0.185	ND	0.185	0.00%	NA	TFOXRB40R1	8/30/95	13.321	44.564	57.885	76.99%	NA
#13	6/21/89	17.200	63.420	80.620	78.67%	NA	TFOXRB41R2	8/30/95	14.444	43.282	57.726	74.98%	NA
#14	6/28/89	21.740	63.520	85.260	74.50%	NA	4085139ADU	9/7/95	NA	NA	NA	NA	23.9
9004431	6/28/89	17.560	32.700	50.260	65.06%	NA	TFOXRB42	10/12/95	6.183	20.567	26.750	76.89%	15.0
#15	7/5/89	14.550	36.790	51.340	71.66%	NA	4085139AEU	10/23/95	NA	NA	NA	NA	9.6
OA001176	7/11/89	13.700	36.110	49.810	72.50%	NA	SW5-F1Pa	3/10/98	8.000	ND	8.000	0.00%	NA
#16	7/12/89	17.190	35.480	52.670	67.36%	NA	SW5-F2Pa	3/10/98	6.000	ND	6.000	0.00%	NA
#17	7/20/89	17.010	45.310	62.320	72.71%	NA	SW5-F3Pa	3/10/98	16.000	ND	16.000	0.00%	NA
#18	7/25/89	16.420	39.340	55.760	70.55%	NA	SW5-F1Pb	4/1/98	9.000	ND	9.000	0.00%	NA
OA001181	7/27/89	13.670	39.940	53.610	74.50%	NA	SW6-F1	4/1/98	16.000	ND	16.000	0.00%	NA
OA001182	7/27/89	14.180	40.950	55.130	74.28%	NA	SW-D1-F	4/2/98	8.000	ND	8.000	0.00%	NA
#19	7/31/89	19.660	53.380	73.040	73.08%	NA	SW5-F2Pb	4/2/98	8.000	ND	8.000	0.00%	NA
#20	8/9/89	17.180	60.330	77.510	77.84%	NA	SW6-F2	4/2/98	6.000	ND	6.000	0.00%	NA
OA001630	8/9/89	15.170	45.150	60.320	74.85%	NA	SW5-F3Pb	4/3/98	6.000	ND	6.000	0.00%	5.9
#21	8/14/89	18.220	64.930	83.150	78.09%	NA	SW6-F3	4/3/98	6.000	ND	6.000	0.00%	5.9
#22	8/23/89	17.880	51.040	68.920	74.06%	NA	SW5-F4	4/6/98	8.000	ND	8.000	0.00%	7.2
OA001627	8/23/89	12.750	39.050	51.800	75.39%	NA	SW6-F4	4/6/98	ND	ND	0.000	0.00%	7.2
#23	8/29/89	16.780	43.870	60.650	72.33%	NA	SW5-F5	4/7/98	9.000	12.000	21.000	57.14%	NA
#24	9/6/89	14.830	31.470	46.300	67.97%	NA	SW6-F5	4/7/98	8.000	23.000	31.000	74.19%	7.9
OA003246	9/7/89	10.750	25.530	36.280	70.37%	NA	SW-D2-F	4/8/98	8.000	19.000	27.000	70.37%	7.9
#25	9/13/89	15.230	38.720	53.950	71.77%	NA	SW5-F6	4/8/98	6.000	40.000	46.000	86.96%	7.9
OA003240	9/19/89	13.930	26.540	40.470	65.58%	NA	SW6-F6	4/8/98	8.000	18.000	26.000	69.23%	7.9
#26	9/20/89	13.930	34.460	48.390	71.21%	NA	SW5-F7	4/10/98	11.000	14.000	25.000	56.00%	6.5
#27	9/27/89	10.970	24.070	35.040	68.69%	NA	SW6-F7	4/10/98	7.000	19.000	26.000	73.08%	6.5
OA002397	10/3/89	10.450	22.750	33.200	68.52%	NA	SW5-F8	4/14/98	10.000	18.000	28.000	64.29%	9.8
#28	10/4/89	12.920	32.800	45.720	71.74%	NA	SW6-F8	4/14/98	11.000	19.000	30.000	63.33%	9.8
#29	10/12/89	11.880	33.080	44.960	73.58%	NA	SW5-F9	4/16/98	9.000	22.000	31.000	70.97%	7.5
OA004475	10/17/89	9.380	26.400	35.780	73.78%	NA	SW6-F9	4/16/98	5.000	25.000	30.000	83.33%	7.5
#30	10/18/89	12.130	43.330	55.460	78.13%	NA	SW5-F10	4/17/98	8.000	14.000	22.000	63.64%	6.0
#31	10/24/89	NA	28.790	28.790	100.00%	NA	SW6-F10	4/17/98	7.000	15.000	22.000	68.18%	6.0
#32	10/31/89	12.320	43.270	55.590	77.84%	NA	SW-D3-F	5/12/98	11.000	14.000	25.000	56.00%	17.8
OA004477	11/1/89	10.880	40.970	51.850	79.02%	NA	SW5-F11	5/12/98	13.000	17.000	30.000	56.67%	17.8
#33	11/7/89	6.810	20.710	27.520	75.25%	NA	SW6-F11	5/12/98	14.000	18.000	32.000	56.25%	17.8
#34	11/14/89	4.000	11.100	15.100	73.51%	NA	SW5-F12	5/27/98	9.000	15.000	24.000	62.50%	20.1
OB000382	11/15/89	4.410	8.750	13.160	66.49%	NA	SW6-F12	5/27/98	13.000	17.000	30.000	56.67%	20.1

Table 5-17. Lower Fox River - Total PCB Results in Water (Continued)

Sample Idenifcation	Sample Date	Dissolved (ng/L)	Particulate (ng/L)	Total (ng/L)	Percent Particulate	Temp. (°C)	Sample Idenifcation	Sample Date	Dissolved (ng/L)	Particulate (ng/L)	Total (ng/L)	Percent Particulate	Temp. (°C)
#35	11/30/89	2.630	5.170	7.800	66.28%	NA	W00006	6/9/98	10.000	23.000	33.000	69.70%	17.9
#36	11/30/89	2.680	4.520	7.200	62.78%	NA	W00009	6/9/98	14.000	19.000	33.000	57.58%	17.9
OB000384	12/6/89	3.810	0.990	4.800	20.63%	NA	W00015	6/30/98	17.000	20.000	37.000	54.05%	25.0
#37	12/13/89	5.920	6.040	11.960	50.50%	NA	W00018	7/1/98	17.000	18.000	35.000	51.43%	26.5
#38	1/11/90	2.460	2.810	5.270	53.32%	NA	W00033	7/14/98	15.000	24.000	39.000	61.54%	26.9
OB001109	1/17/90	2.570	0.170	2.740	6.20%	NA	W00036	7/14/98	17.000	26.000	43.000	60.47%	26.9
#39	1/25/90	3.360	3.260	6.620	49.24%	NA	W00050	7/28/98	24.000	18.000	42.000	42.86%	24.0
#40	2/6/90	2.710	3.510	6.220	56.43%	NA	W00052	7/28/98	24.000	20.000	44.000	45.45%	24.0
OB001113	2/14/90	3.500	0.570	4.070	14.00%	NA	SW00068	8/11/98	45.000	41.000	86.000	47.67%	24.3
#41	2/21/90	3.260	3.920	7.180	54.60%	NA	SW00072	8/12/98	33.000	13.000	46.000	28.26%	NA
#42	3/6/90	3.460	4.400	7.860	55.98%	NA	W00094	8/31/98	15.000	20.000	35.000	57.14%	23.8
OB004145	3/14/90	5.050	69.750	74.800	93.25%	NA	W00096	9/1/98	18.000	32.000	50.000	64.00%	24.0
#43	3/21/90	5.270	17.580	22.850	76.94%	NA	W00104	9/10/98	14.000	45.000	59.000	76.27%	21.7
#44	3/28/90	2.180	4.740	6.920	68.50%	NA	W00107	9/10/98	17.000	39.000	56.000	69.64%	21.7
#45	4/4/90	3.550	6.700	10.250	65.37%	NA	W00130	9/24/98	13.000	34.000	47.000	72.34%	19.4
OB004147	4/4/90	6.260	69.750	76.010	91.76%	NA	W00132	9/24/98	14.000	31.000	45.000	68.89%	19.4

Notes:

NA = not analyzed or not applicable.

ND = parameter not detected.

Table 5-18. Green Bay - Total PCB Results in Water

Sample Label	Sample Date	Dissolved (ng/L)	Particulate (ng/L)	Total (ng/L)	Percent Particulate	Sample Label	Sample Date	Dissolved (ng/L)	Particulate (ng/L)	Total (ng/L)	Percent Particulate
Green Bay Zone 2 (2A & 2B)						**Green Bay Zone 3B**					
89GG23S23	5/4/89	4.2591	13.4858	17.7449	76.00%	89GG22S03	5/2/89	1.6678	1.6818	3.3496	50.21%
89GG24S43	5/4/89	1.5192	3.1478	4.6670	67.45%	89GG22S23	5/3/89	2.3824	4.0211	6.4035	62.80%
89GG24S63	5/4/89	1.2662	4.4715	5.7377	77.93%	89GG22S63	5/3/89	2.0548	3.3630	5.4178	62.07%
89GG24D83	5/7/89	2.0170	7.5630	9.5800	78.95%	89GG23S43	5/4/89	2.4047	4.4670	6.8717	65.01%
89GG24S83	5/7/89	2.5490	6.3840	8.9330	71.47%	89GG34S23	6/11/89	0.5926	0.4923	1.0849	45.38%
89GG24S23	5/7/89	5.7575	24.5617	30.3192	81.01%	89GG34S43	6/11/89	0.7703	0.5436	1.3139	41.37%
89GG25S03	5/7/89	8.5871	34.6872	43.2743	80.16%	89GG34S83	6/11/89	1.7502	4.1919	5.9421	70.55%
89GG25S23	5/7/89	11.7412	nd	NA	NA	89GG35S03	6/12/89	2.1651	5.1126	7.2777	70.25%
89GG30S23	6/6/89	4.2494	17.2158	21.4652	80.20%	89GG36S03	6/12/89	2.5723	4.6485	7.2208	64.38%
89GG30S43	6/6/89	7.9892	19.0331	27.0223	70.43%	89GG44D23	7/30/89	0.7630	0.3330	1.0960	30.38%
89GG30S63	6/7/89	7.3719	24.1046	31.4765	76.58%	89GG44S23	7/30/89	0.7150	0.3570	1.0720	33.30%
89GG30S83	6/7/89	10.6050	15.3509	25.9559	59.14%	89GG44S43	7/30/89	0.6358	0.3283	0.9641	34.05%
89GG36D23	6/12/89	3.3350	8.9610	12.2960	72.88%	89GG44S45	7/30/89	0.9569	0.7594	1.7163	44.25%
89GG36S23	6/12/89	3.5460	10.0400	13.5860	73.90%	89GG44S83	7/30/89	1.4562	nd	NA	NA
89GG36S63	6/12/89	1.6878	7.2942	8.9820	81.21%	89GG45S03	7/31/89	1.1743	0.7890	1.9633	40.19%
89GG36S83	6/13/89	2.4347	7.7539	10.1886	76.10%	89GG46S03	7/31/89	3.9201	4.8777	8.7978	55.44%
89GG37S03	6/13/89	4.0294	15.5546	19.5840	79.43%	89GG52S03	9/15/89	0.5520	0.2528	0.8048	31.41%
89GG40S23	7/25/89	3.0374	3.8066	6.8440	55.62%	89GG52S23	9/15/89	0.5181	0.3101	0.8282	37.44%
89GG40D83	7/26/89	9.7520	12.7330	22.4850	56.63%	89GG52S25	9/15/89	0.8785	0.4101	1.2886	31.83%
89GG40S83	7/26/89	10.5420	16.7230	27.2650	61.34%	89GG52S63	9/16/89	0.6920	0.3541	1.0461	33.85%
89GG40S43	7/26/89	6.2045	8.8988	15.1033	58.92%	89GG52S65	9/16/89	0.6295	0.4813	1.1108	43.33%
89GG40S63	7/26/89	10.2613	18.2040	28.4653	63.95%	89GG52S83	9/16/89	0.8172	0.5422	1.3594	39.89%
89GG46S23	7/31/89	5.5478	7.5313	13.0791	57.58%	89GG52S85	9/16/89	1.0042	0.8345	1.8387	45.39%
89GG46S63	7/31/89	2.3196	3.5235	5.8431	60.30%	89GG53S83	9/17/89	2.1602	4.2145	6.3747	66.11%
89GG46S83	8/1/89	4.9369	9.2617	14.1986	65.23%	90GG04S23	10/22/89	0.7135	1.1884	1.9019	62.48%
89GG47S03	8/1/89	7.0899	16.0486	23.1385	69.36%	90GG04S43	10/22/89	1.2857	2.3768	3.6625	64.90%
89GG54D83	9/17/89	3.2580	6.6070	9.8650	66.97%	90GG04S83	10/23/89	1.1825	2.4696	3.6521	67.62%
89GG54S83	9/17/89	2.9450	6.4430	9.3880	68.63%	90GG05S03	10/23/89	2.1452	7.0119	9.1571	76.57%
89GG54S03	9/17/89	2.6925	7.7311	10.4236	74.17%	90GG06S03	10/23/89	3.0102	9.4496	12.4598	75.84%
89GG54S43	9/17/89	2.8475	8.9130	11.7605	75.79%	90GG14S03	2/8/90	2.2230	1.2903	3.5133	36.73%
89GG54S63	9/17/89	3.7449	10.1071	13.8520	72.96%	90GG11S23	2/10/90	3.8697	1.9230	5.7927	33.20%
89GG55S23	9/18/89	2.9977	7.9842	10.9819	72.70%	90GG10D83	2/14/90	1.2270	0.4090	1.6360	25.00%
89GG55S43	9/18/89	6.5528	18.1046	24.6574	73.42%	90GG10S83	2/14/90	1.3420	0.3370	1.6790	20.07%
89GG55S63	9/18/89	6.9258	16.3010	23.2268	70.18%	90GG12S63	2/15/90	0.9679	0.6161	1.5840	38.90%
89GG55S83	9/18/89	9.9293	30.4949	40.4242	75.44%	90GG13S63	2/17/90	2.2210	1.7075	3.9285	43.46%
90GG06S23	10/23/89	2.3468	4.9780	7.3248	67.96%	90GG22S03	4/28/90	0.6111	nd	NA	NA

Table 5-18. Green Bay - Total PCB Results in Water (Continued)

Sample Label	Sample Date	Dissolved (ng/L)	Particulate (ng/L)	Total (ng/L)	Percent Particulate	Sample Label	Sample Date	Dissolved (ng/L)	Particulate (ng/L)	Total (ng/L)	Percent Particulate
90GG07D03	10/24/89	3.8690	18.4450	22.3140	82.66%	90GG22S23	4/28/90	0.5218	0.9117	1.4335	63.60%
90GG07S03	10/24/89	3.6820	21.8410	25.5230	85.57%	90GG22S63	4/28/90	1.0839	3.2187	4.3026	74.81%
90GG06S63	10/24/89	1.3106	4.8875	6.1981	78.85%	90GG22S83	4/29/90	1.3308	4.6207	5.9515	77.64%
90GG06S83	10/24/89	2.1391	7.6522	9.7913	78.15%	90GG23S83	4/29/90	0.9051	3.8128	4.7179	80.82%
90GG00S23	10/25/89	1.8380	8.5205	10.3585	82.26%	W00057	7/30/98	na/nf	1.800	NA	NA
90GG00S43	10/25/89	7.1645	37.0277	44.1922	83.79%	W00058	7/30/98	na/nf	nd	NA	NA
90GG00S63	10/25/89	5.5142	26.0140	31.5282	82.51%	W00059	7/30/98	na/nf	nd	NA	NA
90GG00S83	10/25/89	9.0273	38.7390	47.7663	81.10%	W00084	8/26/98	na/nf	nd	NA	NA
90GG14S43	2/10/90	4.3581	2.0272	6.3853	31.75%	W00085	8/26/98	na/nf	nd	NA	NA
90GG15S03	2/11/90	2.2379	1.2702	3.5081	36.21%	W00120	9/23/98	na/nf	nd	NA	NA
90GG16S43	2/11/90	4.1655	4.9257	9.0912	54.18%	W00121	9/23/98	na/nf	0.6500	NA	NA
90GG14D83	2/12/90	4.4750	3.4440	7.9190	43.49%	**Green Bay Zone 4**					
90GG14S83	2/12/90	4.5140	3.1730	7.6870	41.28%	89GG20S23	4/30/89	0.9549	0.9912	1.9461	50.93%
90GG11S63	2/12/90	6.0247	7.4375	13.4622	55.25%	89GG20S83	4/30/89	0.832	0.5691	1.4011	40.62%
90GG11S83	2/12/90	3.9445	3.5032	7.4477	47.04%	89GG21S03	4/30/89	0.7005	2.0739	2.7744	74.75%
90GG12D23	2/13/90	4.1110	4.3830	8.4940	51.60%	89GG21D23	5/1/89	1.323	1.148	2.4710	46.46%
90GG12S03	2/13/90	5.2700	5.3020	10.5720	50.15%	89GG21S23	5/1/89	0.624	1.452	2.0760	69.94%
90GG12S23	2/13/90	4.1060	4.7310	8.8370	53.54%	89GG20S43	5/1/89	0.7316	2.3816	3.1132	76.50%
90GG12S01	2/13/90	5.3070	5.3278	10.6348	50.10%	89GG20S63	5/1/89	0.8123	0.4399	1.2522	35.13%
90GG24S03	4/29/90	1.1582	6.0120	7.1702	83.85%	89GG32S83	6/8/89	0.7967	0.1864	0.9831	18.96%
90GG24S43	4/29/90	0.9962	3.3693	4.3655	77.18%	89GG32D63	6/9/89	1.155	0.372	1.5270	24.36%
90GG24S63	4/30/90	1.3058	5.6180	6.9238	81.14%	89GG32S63	6/9/89	0.751	0.372	1.1230	33.13%
90GG24S83	4/30/90	3.4651	14.7202	18.1853	80.95%	89GG32S65	6/9/89	0.5051	0.2393	0.7444	32.15%
90GG25S23	4/30/90	1.2463	4.5023	5.7486	78.32%	89GG33S03	6/9/89	0.656	0.3533	1.0093	35.00%
90GG25S43	4/30/90	2.2155	7.1608	9.3763	76.37%	89GG33D05	6/10/89	0.51	0.212	0.7220	29.36%
90GG25S83	4/30/90	13.6814	89.0234	102.7048	86.68%	89GG33S05	6/10/89	0.408	0.226	0.6340	35.65%
90GG25S63	5/1/90	9.8610	91.7033	101.5643	90.29%	89GG33S23	6/10/89	0.4485	0.27	0.7185	37.58%
W00039	7/28/98	na/nf	7.2	NA	NA	89GG33S43	6/10/89	0.4947	0.2702	0.7649	35.32%
W00040	7/28/98	na/nf	5.3	NA	NA	89GG33S63	6/10/89	0.5715	0.3731	0.9446	39.50%
W00027	7/30/98	na/nf	2.5	NA	NA	89GG33S65	6/10/89	0.5724	0.4676	1.0400	44.96%
W00073	8/24/98	na/nf	7.3	NA	NA	89GG33S83	6/11/89	0.531	0.3485	0.8795	39.62%
W00074	8/24/98	na/nf	4.2	NA	NA	89GG33S85	6/11/89	0.5756	0.3837	0.9593	40.00%
W00075	8/24/98	na/nf	4.9	NA	NA	89GG42D83	7/28/89	0.375	0.291	0.6660	43.69%
W00108	9/21/98	na/nf	7.4	NA	NA	89GG42S83	7/28/89	0.494	0.252	0.7460	33.78%
W00109	9/21/98	na/nf	9.6	NA	NA	89GG42S63	7/28/89	0.4402	0.2394	0.6796	35.23%
W00122	9/23/98	na/nf	7.3	NA	NA	89GG42S65	7/28/89	0.3851	0.2373	0.6224	38.13%

Table 5-18. Green Bay - Total PCB Results in Water (Continued)

Sample Label	Sample Date	Dissolved (ng/L)	Particulate (ng/L)	Total (ng/L)	Percent Particulate	Sample Label	Sample Date	Dissolved (ng/L)	Particulate (ng/L)	Total (ng/L)	Percent Particulate
Green Bay Zone 3A						89GG43D05	7/29/89	0.461	0.231	0.6920	33.38%
89GG21S83	5/1/89	0.7689	1.0032	1.7721	56.6%	89GG43S05	7/29/89	0.504	0.21	0.7140	29.41%
89GG23D03	5/3/89	1.2750	4.7520	6.0270	78.8%	89GG43S65	7/29/89	nd	0.2792	na	na
89GG23S03	5/3/89	3.1700	3.1830	6.3530	50.1%	89GG43S03	7/29/89	0.4544	0.286	0.7404	38.63%
89GG22S43	5/3/89	1.4587	1.3621	2.8208	48.3%	89GG43S23	7/29/89	0.3995	0.2096	0.6091	34.41%
89GG22S83	5/3/89	1.6969	1.8752	3.5721	0.0%	89GG43S25	7/29/89	0.3788	0.2963	0.6751	43.89%
89GG23S63	5/4/89	1.7689	2.5277	4.2966	58.8%	89GG43S43	7/29/89	0.3488	0.2208	0.5696	38.76%
89GG23S83	5/4/89	1.3557	2.0317	3.3874	60.0%	89GG43S45	7/29/89	0.5094	0.2979	0.8073	36.90%
89GG24S03	5/4/89	1.8877	6.6734	8.5611	78.0%	89GG43S63	7/29/89	0.4119	0.2319	0.6438	36.02%
89GG34S03	6/11/89	0.5580	0.3517	0.9097	38.7%	89GG43S83	7/30/89	0.4968	nd	na	na
89GG34S63	6/11/89	0.6461	0.5130	1.1591	44.3%	89GG50S43	9/13/89	0.4488	0.1668	0.6156	27.10%
89GG35D43	6/12/89	1.1800	1.7950	2.9750	60.3%	89GG50S45	9/13/89	0.69	0.1237	0.8137	15.20%
89GG35S43	6/12/89	1.1270	1.6930	2.8200	60.0%	89GG50S63	9/13/89	0.4795	0.1638	0.6433	25.46%
89GG35S23	6/12/89	1.0520	1.0316	2.0836	49.5%	89GG50D85	9/14/89	0.549	0.316	0.8650	36.53%
89GG35S63	6/12/89	1.2592	2.6778	3.9370	68.0%	89GG51D23	9/14/89	0.967	0.137	1.1040	12.41%
89GG35S83	6/12/89	1.9399	2.9471	4.8870	60.3%	89GG50S85	9/14/89	0.424	0.226	0.6500	34.77%
89GG36S43	6/12/89	1.6512	2.9827	4.6339	64.4%	89GG51S23	9/14/89	0.454	0.149	0.6030	24.71%
89GG44S03	7/30/89	0.7645	0.3448	1.1093	31.1%	89GG50S83	9/14/89	0.5503	0.1844	0.7347	25.10%
89GG44S63	7/30/89	0.7867	0.5217	1.3084	39.9%	89GG51S03	9/14/89	0.3768	0.1858	0.5626	33.03%
89GG45D83	7/31/89	4.2190	6.7440	10.9630	61.5%	89GG51S05	9/14/89	0.4788	0.1877	0.6665	28.16%
89GG46D43	7/31/89	2.8570	8.7780	11.6350	75.4%	89GG51S25	9/14/89	0.6567	0.3848	1.0415	36.95%
89GG45S83	7/31/89	4.1630	7.1080	11.2710	63.1%	89GG51S43	9/15/89	0.6275	0.1982	0.8257	24.00%
89GG46S43	7/31/89	5.1360	7.1440	12.2800	58.2%	89GG51S45	9/15/89	0.607	0.3336	0.9406	35.47%
89GG45S23	7/31/89	1.4747	1.8647	3.3394	55.8%	89GG51S63	9/15/89	0.5457	0.2135	0.7592	28.12%
89GG45S43	7/31/89	1.3766	1.5784	2.9550	53.4%	89GG51S65	9/15/89	0.4869	0.236	0.7229	32.65%
89GG45S63	7/31/89	1.7533	2.8136	4.5669	61.6%	90GG02S63	10/20/89	0.7347	0.3665	1.1012	33.28%
89GG51S83	9/15/89	0.4749	0.2181	0.6930	31.5%	90GG02D83	10/21/89	0.484	0.31	0.7940	39.04%
89GG51S85	9/15/89	0.6852	0.5754	1.2606	45.6%	90GG03D03	10/21/89	0.63	0.27	0.9000	30.00%
89GG53D23	9/16/89	1.2380	1.7300	2.9680	58.3%	90GG02S83	10/21/89	0.675	1.051	1.7260	60.89%
89GG53S23	9/16/89	1.3210	1.7970	3.1180	57.6%	90GG03S03	10/21/89	0.638	0.357	0.9950	35.88%
89GG52S43	9/16/89	0.6974	0.4725	1.1699	40.4%	90GG03S23	10/21/89	0.6541	0.426	1.0801	39.44%
89GG52S45	9/16/89	0.9148	0.3982	1.3130	30.3%	90GG03S43	10/21/89	0.8833	0.5134	1.3967	36.76%
89GG53S03	9/16/89	1.1371	0.4354	1.5725	27.7%	90GG03S63	10/21/89	0.8871	0.593	1.4801	40.06%
89GG53S43	9/16/89	2.3149	4.0736	6.3885	63.8%	90GG03S83	10/22/89	0.8308	1.2295	2.0603	59.68%
89GG53S63	9/17/89	1.8531	2.8194	4.6725	60.3%	90GG10S63	2/17/90	0.8311	0.5155	1.3466	38.28%
89GG54S23	9/17/89	2.6680	5.3212	7.9892	66.6%	90GG20S43	4/26/90	0.4508	0.2474	0.6982	35.43%

Table 5-18. Green Bay - Total PCB Results in Water (Continued)

Sample Label	Sample Date	Dissolved (ng/L)	Particulate (ng/L)	Total (ng/L)	Percent Particulate	Sample Label	Sample Date	Dissolved (ng/L)	Particulate (ng/L)	Total (ng/L)	Percent Particulate
90GG04S03	10/22/89	1.1422	1.6604	2.8026	59.2%	90GG21D23	4/27/90	0.32	0.178	0.4980	35.74%
90GG04S63	10/22/89	1.0737	1.1126	2.1863	50.9%	90GG21S23	4/27/90	0.315	0.312	0.6270	49.76%
90GG05D43	10/23/89	1.2720	2.5770	3.8490	67.0%	90GG20S63	4/27/90	0.4171	0.3183	0.7354	43.28%
90GG05S43	10/23/89	1.4360	2.4120	3.8480	62.7%	90GG20S83	4/27/90	0.5233	0.3217	0.8450	38.07%
90GG05S23	10/23/89	2.7463	6.5042	9.2505	70.3%	90GG21S03	4/27/90	0.4085	0.4611	0.8696	53.02%
90GG05S63	10/23/89	1.1955	4.3856	5.5811	78.6%	90GG21S43	4/27/90	0.5558	0.4019	0.9577	41.97%
90GG05S83	10/23/89	3.0853	12.0662	15.1515	79.6%	90GG21S63	4/28/90	0.3532	0.3993	0.7525	53.06%
90GG06S43	10/24/89	3.7436	16.9315	20.6751	81.9%	W00041	7/29/98	na/nf	nd	NA	NA
90GG11S03	2/9/90	2.3735	0.8352	3.2087	26.0%	W00042	7/29/98	na/nf	nd	NA	NA
90GG14S23	2/9/90	1.9557	1.1348	3.0905	36.7%	W00043	7/29/98	na/nf	nd	NA	NA
90GG11S43	2/10/90	3.1821	1.7872	4.9693	36.0%	W00054	7/29/98	na/nf	nd	NA	NA
90GG14S63	2/10/90	2.2468	1.9353	4.1821	46.3%	W00055	7/29/98	na/nf	nd	NA	NA
90GG16S23	2/11/90	2.7744	2.2326	5.0070	44.6%	W00056	7/29/98	na/nf	nd	NA	NA
90GG13S23	2/15/90	1.1663	0.5011	1.6674	30.1%	W00076	8/25/98	na/nf	nd	NA	NA
90GG16D03	2/18/90	1.4480	0.7750	2.2230	34.9%	W00077	8/25/98	na/nf	nd	NA	NA
90GG16S03	2/18/90	1.4730	0.6330	2.1060	30.1%	W00079	8/25/98	na/nf	nd	NA	NA
90GG21S83	4/28/90	0.4971	1.0251	1.5222	67.3%	W00080	8/25/98	na/nf	nd	NA	NA
90GG22S43	4/28/90	0.6564	1.1386	1.7950	63.4%	W00081	8/26/98	na/nf	nd	NA	NA
90GG23D03	4/29/90	0.6780	1.6640	2.3420	71.1%	W00082	8/26/98	na/nf	nd	NA	NA
90GG23D63	4/29/90	0.7360	2.2670	3.0030	75.5%	W00083	8/26/98	na/nf	nd	NA	NA
90GG23S03	4/29/90	0.6750	1.9290	2.6040	74.1%	W00111	9/22/98	na/nf	nd	NA	NA
90GG23S63	4/29/90	0.5910	1.8070	2.3980	75.4%	W00112	9/22/98	na/nf	nd	NA	NA
90GG23S23	4/29/90	0.8127	2.8370	3.6497	77.7%	W00113	9/22/98	na/nf	nd	NA	NA
90GG23S43	4/29/90	0.8063	2.8786	3.6849	78.1%	W00114	9/22/98	na/nf	nd	NA	NA
90GG24S23	4/29/90	1.4425	5.5950	7.0375	79.5%	W00115	9/22/98	na/nf	nd	NA	NA
W00060	7/30/98	na/nf	nd	NA	NA	W00116	9/22/98	na/nf	nd	NA	NA
W00061	7/30/98	na/nf	nd	NA	NA	W00117	9/22/98	na/nf	nd	NA	NA
W00086	8/26/98	na/nf	0.6600	NA	NA						
W00087	8/26/98	na/nf	nd	NA	NA						
W00118	9/23/98	na/nf	nd	NA	NA						
W00119	9/23/98	na/nf	nd	NA	NA						

Notes: na/nf - indicates that a sample results was either not available of found within the FRDB for this sample.
nd - indciates that the analyte was not detected.
NA - Not Applicable because one of the two results was either na/nf or nd.

Table 5-19. Lower Fox River and Green Bay - Mercury & DDT (DDD/DDE) Water Sampling Results

Reach or Zone	Sample Identification	Sample Date	Mercury (ng/L)			DDT (ng/L)		
			Dissolved	Particulate	Particulate Percent	Dissolved	Particulate	Particulate Percent
Fall 1992/Spring 1993 Results								
Little Rapids to DePere	Wrightstown	Fall 1992	2520.00	na	0.0%	na	na	na
Little Rapids to DePere	Wrightstown(2)	Spring 1993	1260.00	na	0.0%	na	na	na
Green Bay Zone 2 (2A & 2B)	Oneida	Fall 1992	1.15	na	0.0%	na	na	na
Green Bay Zone 2 (2A & 2B)	Oneida(2)	Spring 1993	2.33	na	0.0%	na	na	na
April 1994 through October 1995 Results								
DePere to Green Bay	TFOXRB01	07-Apr-94	0.53	11.33	95.5%	ND	ND	na
DePere to Green Bay	TFOXRB02	20-Apr-94	1.07	28.06	96.3%	ND	ND	na
DePere to Green Bay	TFOXRB03	26-Apr-94	40.81	na	0.0%	ND	0.21	100%
DePere to Green Bay	TFOXRB04A	04-May-94	1.38	na	0.0%	na	na	na
DePere to Green Bay	TFOXRB04	04-May-94	na	na	na	ND	ND	na
DePere to Green Bay	TFOXRB05A	11-May-94	1.28	na	0.0%	na	na	na
DePere to Green Bay	TFOXRB05	11-May-94	na	na	na	ND	ND	na
DePere to Green Bay	TFOXRB06	18-May-94	1.33	na	0.0%	ND	ND	na
DePere to Green Bay	TFOXRB06R1	18-May-94	na	na	na	na	na	na
DePere to Green Bay	TFOXRB06R2	18-May-94	na	na	na	na	na	na
DePere to Green Bay	TFOXRB07	02-Jun-94	1.67	28.19	94.4%	ND	ND	na
DePere to Green Bay	TFOXRB08	15-Jun-94	1.60	23.42	93.6%	ND	ND	na
DePere to Green Bay	TFOXRB09	07-Jul-94	3.59	44.21	92.5%	ND	ND	na
DePere to Green Bay	TFOXRB10	20-Jul-94	38.29	na	0.0%	ND	ND	na
DePere to Green Bay	TFOXRB10R1	20-Jul-94	na	na	na	na	na	na
DePere to Green Bay	TFOXRB11R2	20-Jul-94	na	na	na	na	0.05	100%
DePere to Green Bay	TFOXRB12	17-Aug-94	1.19	24.16	95.3%	ND	ND	na
DePere to Green Bay	TFOXRB13	14-Sep-94	1.86	30.26	94.2%	ND	ND	na
DePere to Green Bay	TFOXRB14	28-Sep-94	1.97	na	0.0%	ND	ND	na
DePere to Green Bay	TFOXRB15	30-Sep-94	2.09	na	0.0%	ND	ND	na
DePere to Green Bay	TFOXRB16R1	04-Oct-94	1.83	25.73	93.4%	na	na	na
DePere to Green Bay	TFOXRB16A	04-Oct-94	2.17	na	0.0%	na	na	na
DePere to Green Bay	TFOXRB16	04-Oct-94	na	na	na	ND	ND	na
DePere to Green Bay	TFOXRB17R2	04-Oct-94	na	na	na	na	na	na
DePere to Green Bay	TFOXRB18	19-Oct-94	3.08	38.33	92.6%	ND	ND	na
DePere to Green Bay	TFOXRB19	07-Nov-94	1.72	38.76	95.8%	ND	ND	na

Table 5-19. Lower Fox River and Green Bay - Mercury & DDT (DDD/DDE) Water Sampling Results (Continued)

Reach or Zone	Sample Identification	Sample Date	Mercury (ng/L)			DDT (ng/L)		
			Dissolved	Particulate	Particulate Percent	Dissolved	Particulate	Particulate Percent
DePere to Green Bay	TFOXRB20	10-Nov-94	1.77	15.70	89.9%	ND	ND	na
DePere to Green Bay	TFOXRB21	16-Nov-94	2.04	21.07	91.2%	ND	ND	na
DePere to Green Bay	TFOXRB22	30-Nov-94	1.06	10.18	90.6%	ND	ND	na
DePere to Green Bay	TFOXRB23	14-Dec-94	na	3.95	100.0%	ND	ND	na
DePere to Green Bay	TFOXRB23	15-Dec-94	na	3.95	100.0%	ND	ND	na
DePere to Green Bay	TFOXRB24	11-Jan-95	1.18	1.91	61.7%	ND	ND	na
DePere to Green Bay	TFOXRB25	14-Feb-95	1.13	1.80	61.5%	ND	ND	na
DePere to Green Bay	TFOXRB26	06-Mar-95	1.48	3.57	70.7%	ND	ND	na
DePere to Green Bay	TFOXRB27	22-Mar-95	1.66	7.20	81.2%	ND	0.06	100%
DePere to Green Bay	TFOXRB26	26-Mar-95	1.48	3.57	70.7%	ND	ND	na
DePere to Green Bay	TFOXRB28	30-Mar-95	2.72	12.14	81.7%	ND	ND	na
DePere to Green Bay	TFOXRB29	05-Apr-95	0.83	18.75	95.8%	ND	ND	na
DePere to Green Bay	TFOXRB30	12-Apr-95	1.06	74.85	98.6%	ND	0.06	100%
DePere to Green Bay	TFOXRB31	20-Apr-95	1.12	24.76	95.7%	ND	ND	na
DePere to Green Bay	TFOXRB32	04-May-95	0.83	22.81	96.5%	ND	ND	na
DePere to Green Bay	TFOXRB33A	09-May-95	1.44	na	0.0%	na	na	na
DePere to Green Bay	TFOXRB33	09-May-95	1.49	19.20	92.8%	ND	ND	na
DePere to Green Bay	TFOXRB34	18-May-95	1.10	29.47	96.4%	ND	ND	na
DePere to Green Bay	TFOXRB36	25-May-95	1.24	27.03	95.6%	ND	ND	na
DePere to Green Bay	TFOXRB36(2)	25-May-95	1.25	19.44	93.9%	na	na	na
DePere to Green Bay	TFOXRB35	25-May-95	1.29	na	0.0%	ND	ND	na
DePere to Green Bay	TFOXRB36	06-Jun-95	1.24	27.03	95.6%	ND	ND	na
DePere to Green Bay	TFOXRB37	13-Jun-95	0.84	16.19	95.1%	ND	ND	na
DePere to Green Bay	TFOXRB38	16-Aug-95	1.45	18.94	92.9%	na	ND	na
DePere to Green Bay	TFOXRB39	21-Aug-95	0.76	31.61	97.7%	ND	ND	na
DePere to Green Bay	TFOXRB40R1	30-Aug-95	0.89	29.08	97.0%	na	0.06	100%
DePere to Green Bay	TFOXRB40A	30-Aug-95	0.89	na	0.0%	na	na	na
DePere to Green Bay	TFOXRB40	30-Aug-95	na	na	na	ND	0.06	100%
DePere to Green Bay	TFOXRB41R2	30-Aug-95	na	na	na	na	0.05	100%
DePere to Green Bay	TFOXRB42	12-Oct-95	0.97	35.29	97.3%	ND	ND	na
DePere to Green Bay	TFOXRB42A	12-Oct-95	1.00	na	0.0%	na	na	na
May 1998 Results								
Appleton to Little Rapids	SW3-FW12	26-May-98	90.00	na	0.0%	na	na	na

Table 5-19. Lower Fox River and Green Bay - Mercury & DDT (DDD/DDE) Water Sampling Results (Continued)

Reach or Zone	Sample Identification	Sample Date	DDD (ng/L)			DDE (ng/L)		
			Dissolved	Particulate	Particulate Percent	Dissolved	Particulate	Particulate Percent
Fall 1992/Spring 1993 Results								
Little Rapids to DePere	Wrightstown	Fall 1992	na	na	na	na	na	na
Little Rapids to DePere	Wrightstown(2)	Spring 1993	na	na	na	na	na	na
Green Bay Zone 2 (2A & 2B)	Oneida	Fall 1992	na	na	na	na	na	na
Green Bay Zone 2 (2A & 2B)	Oneida(2)	Spring 1993	na	na	na	na	na	na
April 1994 through October 1995 Results								
DePere to Green Bay	TFOXRB01	07-Apr-94	ND	0.06	100%	ND	na	na
DePere to Green Bay	TFOXRB02	20-Apr-94	ND	0.19	100%	na	na	na
DePere to Green Bay	TFOXRB03	26-Apr-94	ND	0.22	100%	0.04	0.23	86.1%
DePere to Green Bay	TFOXRB04A	04-May-94	na	na	na	na	na	na
DePere to Green Bay	TFOXRB04	04-May-94	ND	0.10	100%	ND	na	na
DePere to Green Bay	TFOXRB05A	11-May-94	na	na	na	na	na	na
DePere to Green Bay	TFOXRB05	11-May-94	ND	0.07	100%	0.04	0.15	79.4%
DePere to Green Bay	TFOXRB06	18-May-94	ND	0.11	100%	ND	0.21	100%
DePere to Green Bay	TFOXRB06R1	18-May-94	na	0.11	100%	na	0.21	100%
DePere to Green Bay	TFOXRB06R2	18-May-94	na	0.15	100%	0.07	0.23	76.2%
DePere to Green Bay	TFOXRB07	02-Jun-94	ND	0.25	100%	0.04	0.30	89.0%
DePere to Green Bay	TFOXRB08	15-Jun-94	0.06	0.07	54.1%	0.04	0.24	87.3%
DePere to Green Bay	TFOXRB09	07-Jul-94	0.07	0.27	80.1%	0.04	0.41	90.7%
DePere to Green Bay	TFOXRB10	20-Jul-94	0.05	0.14	73.7%	0.04	0.25	85.9%
DePere to Green Bay	TFOXRB10R1	20-Jul-94	0.05	0.14	73.7%	0.04	0.25	85.9%
DePere to Green Bay	TFOXRB11R2	20-Jul-94	0.06	0.14	71.1%	0.04	0.26	87.5%
DePere to Green Bay	TFOXRB12	17-Aug-94	ND	0.14	100%	0.03	0.23	87.1%
DePere to Green Bay	TFOXRB13	14-Sep-94	ND	0.17	100%	0.04	0.26	86.4%
DePere to Green Bay	TFOXRB14	28-Sep-94	ND	0.12	100%	0.04	0.19	82.3%
DePere to Green Bay	TFOXRB15	30-Sep-94	ND	0.08	100%	ND	0.18	100%
DePere to Green Bay	TFOXRB16R1	04-Oct-94	na	0.14	100%	0.04	0.26	85.5%
DePere to Green Bay	TFOXRB16A	04-Oct-94	na	na	na	na	na	na
DePere to Green Bay	TFOXRB16	04-Oct-94	ND	0.14	100%	0.04	0.26	85.5%
DePere to Green Bay	TFOXRB17R2	04-Oct-94	na	0.12	100%	0.05	0.23	82.7%
DePere to Green Bay	TFOXRB18	19-Oct-94	ND	0.10	100%	ND	0.14	100%
DePere to Green Bay	TFOXRB19	07-Nov-94	ND	0.09	100%	ND	0.15	100%

Table 5-19. Lower Fox River and Green Bay - Mercury & DDT (DDD/DDE) Water Sampling Results (Continued)

Reach or Zone	Sample Identification	Sample Date	DDD (ng/L)			DDE (ng/L)		
			Dissolved	Particulate	Particulate Percent	Dissolved	Particulate	Particulate Percent
DePere to Green Bay	TFOXRB20	10-Nov-94	ND	0.08	100%	ND	0.14	100%
DePere to Green Bay	TFOXRB21	16-Nov-94	ND	0.05	100%	ND	0.10	100%
DePere to Green Bay	TFOXRB22	30-Nov-94	ND	ND	na	ND	0.07	100%
DePere to Green Bay	TFOXRB23	14-Dec-94	ND	ND	na	ND	ND	na
DePere to Green Bay	TFOXRB23	15-Dec-94	ND	ND	na	ND	ND	na
DePere to Green Bay	TFOXRB24	11-Jan-95	ND	ND	na	ND	ND	na
DePere to Green Bay	TFOXRB25	14-Feb-95	ND	ND	na	ND	ND	na
DePere to Green Bay	TFOXRB26	06-Mar-95	ND	ND	na	ND	0.03	100%
DePere to Green Bay	TFOXRB27	22-Mar-95	ND	ND	na	ND	0.05	100%
DePere to Green Bay	TFOXRB26	26-Mar-95	ND	ND	na	ND	0.03	100%
DePere to Green Bay	TFOXRB28	30-Mar-95	ND	ND	na	ND	0.07	100%
DePere to Green Bay	TFOXRB29	05-Apr-95	ND	ND	na	ND	0.08	100%
DePere to Green Bay	TFOXRB30	12-Apr-95	ND	0.19	100%	ND	0.24	100%
DePere to Green Bay	TFOXRB31	20-Apr-95	ND	0.08	100%	ND	0.11	100%
DePere to Green Bay	TFOXRB32	04-May-95	ND	0.06	100%	ND	0.10	100%
DePere to Green Bay	TFOXRB33A	09-May-95	na	na	na	na	na	na
DePere to Green Bay	TFOXRB33	09-May-95	ND	ND	na	ND	0.08	100%
DePere to Green Bay	TFOXRB34	18-May-95	ND	0.08	100%	ND	0.12	100%
DePere to Green Bay	TFOXRB36	25-May-95	ND	0.08	100%	ND	0.11	100%
DePere to Green Bay	TFOXRB36(2)	25-May-95	na	na	na	na	na	na
DePere to Green Bay	TFOXRB35	25-May-95	ND	0.07	100%	ND	0.12	100%
DePere to Green Bay	TFOXRB36	06-Jun-95	ND	0.08	100%	ND	0.11	100%
DePere to Green Bay	TFOXRB37	13-Jun-95	ND	0.06	100%	ND	0.08	100%
DePere to Green Bay	TFOXRB38	16-Aug-95	na	0.08	100%	ND	0.13	100%
DePere to Green Bay	TFOXRB39	21-Aug-95	ND	0.11	100%	0.04	0.20	84.7%
DePere to Green Bay	TFOXRB40R1	30-Aug-95	na	0.11	100%	0.04	0.22	86.3%
DePere to Green Bay	TFOXRB40A	30-Aug-95	na	na	na	na	na	na
DePere to Green Bay	TFOXRB40	30-Aug-95	ND	0.11	100%	0.04	0.22	86.3%
DePere to Green Bay	TFOXRB41R2	30-Aug-95	na	0.11	100%	0.04	0.21	85.7%
DePere to Green Bay	TFOXRB42	12-Oct-95	ND	0.06	100%	ND	0.11	100%
DePere to Green Bay	TFOXRB42A	12-Oct-95	na	na	na	na	na	na
May 1998 Results								
Appleton to Little Rapids	SW3-FW12	26-May-98	na	na	na	na	na	na

Notes: 1) ND: Parameter not detected

2) na: Sample not analyzed for parameter.

Table 5-20. PCP Transport within the Lower Fox River and Green Bay System

Reach	Transported PCB (kg)
Lake Winnebag	Negligible[1]
LLBdM Railroad Bridge	4 kg[1]
Appleton Dam	65 kg[1]
Little Rapids Dam	125 kg[1]
DePere Dam	175 kg[1]
River Mouth	280 kg[2]
To Lake Michigan	122 kg[3]

Note:

1 = From WDNR 1995

2 = From Velleux and Edicott 1994 and Velleux et al 1995

3 = From Raghunathan 1994

Table 5-21 Distribution of Resident Tissue Samples over Time in the Lower Fox River - Total PCBs Only

Year	Fish																Birds					Mammals	Other
	Benthic Fish				Game Fish				Pelagic Fish				Trout				Raptors	Swallow	Upland Game Bird	Waterfowl		Fur Bearer	Insect/ Invertebrate
	No. of Samples	No. of Species	No. of Fillet Samples	No. of Whole Fish Samples	No. of Samples	No. of Species	No. of Fillet Samples	No. of Whole Fish Samples	No. of Samples	No. of Species	No. of Fillet Samples	No. of Whole Fish Samples	No. of Samples	No. of Species	No. of Fillet Samples	No. of Whole Fish Samples	No. of Samples	No. of Samples	No. of Samples	No. of Samples	No. of Species	No. of Samples	No. of Samples
1971	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1976	6	2	7	0	11	4	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	24	3	18	6	12	3	10	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	24	3	10	9	14	3	5	8	0	0	0	0	4	1	3	0	0	0	0	0	0	0	0
1979	12	3	0	8	16	3	9	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1980	36	4	16	11	25	5	10	9	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0
1981	23	3	4	14	18	3	7	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1982	28	3	13	5	24	6	12	3	2	1	2	0	0	0	0	0	0	0	0	0	0	0	0
1983	8	3	3	2	10	5	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1984	8	2	5	2	14	7	7	0	0	0	0	0	0	0	0	0	0	0	1	3	1	1	1
1985	15	3	12	0	35	4	24	0	0	0	0	0	0	0	0	0	1	0	0	12	1	0	0
1986	16	4	9	2	18	3	12	2	1	1	0	1	0	0	0	0	0	0	0	28	1	0	0
1987	34	5	33	1	43	7	42	1	1	1	0	1	0	0	0	0	0	0	0	22	1	0	0
1988	7	2	7	0	6	2	6	0	0	0	0	0	0	0	0	0	0	0	0	6	1	0	0
1989	42	3	5	24	38	1	12	26	20	2	0	20	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
1991	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	20	2	12	8	111	9	103	9	4	1	0	4	0	0	0	0	0	0	0	0	0	0	0
1993	15	1	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	51	0	0	0	0	1
1994	10	2	0	5	13	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1996	109	6	20	84	185	7	131	34	13	3	0	13	0	0	0	0	0	0	0	0	0	0	0
1997	3	1	0	3	17	1	0	0	0	0	0	0	0	0	0	0	0	0	0	22	2	0	0
1998	93	4	75	48	198	7	163	59	17	3	0	17	0	0	0	0	0	0	0	0	0	0	10
1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes:

1. No piscivorous birds were collected in the Lower Fox River.
2. No cormorants were collected in the Lower Fox River.

Table 5-22 Distribution of Resident Tissue Samples over Time in Green Bay - Total PCBs Only

Year	Fish															
	Benthic Fish				Game Fish				Pelagic Fish				Trout			
	No. of Samples	No. of Species	No. of Fillet Samples	No. of Whole Fish Samples	No. of Samples	No. of Species	No. of Fillet Samples	No. of Whole Fish Samples	No. of Samples	No. of Species	No. of Fillet Samples	No. of Whole Fish Samples	No. of Samples	No. of Species	No. of Fillet Samples	No. of Whole Fish Samples
1971	0	0	0	0	0	0	0	0	0	0	0	0	14	1	0	0
1975	7	1	0	0	18	1	0	0	0	0	0	0	1	1	0	0
1976	15	3	20	0	20	8	28	0	1	1	3	0	0	0	0	0
1977	5	2	11	0	21	3	36	0	0	0	0	0	0	0	0	0
1978	7	2	6	1	9	2	7	2	7	3	4	1	5	1	5	1
1979	8	4	0	8	17	4	8	9	9	3	0	9	5	3	0	5
1980	3	1	3	0	4	3	4	0	0	0	0	0	0	0	0	0
1981	15	1	0	15	13	2	12	0	0	0	0	0	4	1	4	0
1982	5	1	5	0	4	1	4	0	0	0	0	0	5	1	5	0
1983	12	3	10	2	13	4	13	0	4	1	2	2	4	2	4	0
1984	8	3	8	0	23	6	23	0	9	4	4	4	20	4	20	0
1985	0	0	0	0	3	2	2	0	4	3	0	3	125	5	120	0
1986	5	1	5	0	9	3	9	0	2	1	0	2	3	2	3	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1988	20	2	20	0	11	2	11	0	10	1	11	0	0	0	0	0
1989	166	1	28	77	101	2	35	66	169	3	0	169	68	3	29	39
1990	0	0	0	0	22	3	22	0	9	2	0	9	22	2	22	0
1991	5	1	5	0	16	2	10	0	18	3	12	6	0	0	0	0
1992	10	1	0	10	35	3	25	10	7	2	0	7	46	5	43	3
1993	6	2	2	4	0	0	0	0	2	1	0	2	16	2	16	0
1994	0	0	0	0	19	2	19	0	4	1	0	4	16	3	16	0
1995	0	0	0	0	1	1	0	0	4	1	0	4	0	0	0	0
1996	0	0	0	0	60	3	20	24	0	0	0	0	29	4	10	19
1997	0	0	0	0	71	2	0	15	0	0	0	0	1	1	0	0
1998	12	2	0	12	32	4	10	22	8	2	0	8	0	0	0	0
1999	0	0	0	0	8	1	8	0	0	0	0	0	0	0	0	0

Notes:

1. No reptiles were collected in Green Bay.
2. No upland game birds were collected in Green Bay.
3. Date query included all sample body types. The number of whole samples included whole fish and whole fish composites for fish, and whole body for birds.

Table 5-22 Distribution of Resident Tissue Samples over Time in Green Bay - Total PCBs Only (Continued)

Year	Birds									Mammals		Other
	Cormorant		Piscivorous Birds		Raptors	Swallow		Waterfowl		Deer	Fur Bearer	
	No. of Samples	No. of Species	No. of Samples	No. of Species	No. of Samples	No. of Samples	No. of Species	No. of Samples	No. of Species	No. of Samples	No. of Samples	No. of Samples
1971	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	4	2	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	1	1	0	0	0	13	1	0	0	1
1987	0	0	0	0	1	0	0	16	3	1	0	0
1988	0	0	0	0	0	0	0	10	2	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	15	1	0	0	0	0	0
1994	60	1	0	0	0	0	0	0	0	0	0	0
1995	80	1	0	0	0	0	0	0	0	0	0	1
1996	0	0	15	2	0	0	0	5	1	0	0	0
1997	0	0	5	1	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	2	1	0	0	3
1999	0	0	0	0	0	0	0	0	0	0	1	0

Notes:

1. No reptiles were collected in Green Bay.
2. No upland game birds were collected in Green Bay.
3. Date query included all sample body types. The number of whole samples included whole fish and whole fish composites for fish, and whole body for birds.

Table 5-23. Results of Sediment Time Trends Analysis for the Lower Fox River

Deposit Group	Depth Range (cm)	Log_{10} (PCB) Time Trend Slope Estimate	WSEV Standard Error	WSEV *p*-Value	Statistically Significant Slopes	Estimated Annual Compound Percent Increase in PCB Level	Estimated Annual Compound Percent Increase in PCB Level: 95% Confidence Interval Lower-bound	Estimated Annual Compound Percent Increase in PCB Level: 95% Confidence Interval Upper-bound
Little Lake Butte des Morts								
AB	0–10	-0.0970	0.0348	0.0131	*	-20.03	-32.52	-5.22
	10–30	-0.0213	0.0647	0.7535		-4.78	-33.86	37.09
	30–50	-0.0144	0.1113	0.8995		-3.26	-44.95	70.02
C	0–10	-0.0612	0.0342	0.1481		-13.15	-30.22	8.09
	10–30	0.0317	0.0770	0.7018		7.57	-34.24	75.95
POG	0–10	-0.0893	0.0567	0.1900		-18.59	-43.33	16.95
D	0–10	-0.0755	0.0317	0.0307	*	-15.96	-28.06	-1.83
	10–30	0.3168	0.0454	0.0009	***	107.39	58.51	171.33
F	0–10	-0.0373	0.0136	0.0252	*	-8.23	-14.62	-1.37
	10–30	-0.0760	0.0749	0.3246		-16.06	-41.67	20.81
GH	0–10	-0.1244	0.0541	0.0443	*	-24.91	-43.12	-0.88
Appleton								
IMOR	0–10	0.0412	0.0255	0.1810		9.95	-6.57	29.38
N Pre-dredge	0–10	-0.0281	0.0065	0.0233	*	-6.26	-10.64	-1.65
	10–30	0.0572	0.0440	0.2061		14.08	-7.48	40.67
	30–50	0.0846	0.0932	0.3877		21.50	-25.22	97.40
VCC	0–10	-0.0582	0.0275	0.0878		-12.53	-25.65	2.90
	10–30	-0.1537	0.0164	0.000001	***	-29.81	-35.42	-23.72
	30–50	-0.0060	0.0151	0.6984		-1.37	-8.71	6.55

Table 5-23. Results of Sediment Time Trends Analysis for the Lower Fox River

Deposit Group	Depth Range (cm)	Log_{10} (PCB) Time Trend Slope Estimate	WSEV Standard Error	WSEV *p*-Value	Statistically Significant Slopes	Estimated Annual Compound Percent Increase in PCB Level	Estimated Annual Compound Percent Increase in PCB Level	
							95% Confidence Interval Lower-bound	95% Confidence Interval Upper-bound
Little Rapids								
Upper EE	0–10	-0.0447	0.0435	0.3618		-9.79	-31.68	19.13
	10–30	-0.0944	0.0429	0.0554		-19.53	-35.64	0.62
	30–50	-0.0712	0.0536	0.2173		-15.11	-35.80	12.25
Lower EE	0–10	-0.0682	0.0193	0.0387	*	-14.53	-25.81	-1.53
	10–30	-0.0759	0.0390	0.0695		-16.03	-30.58	1.58
	30–50	0.0900	0.0330	0.0213	*	23.02	3.86	45.72
FF	0–10	-0.0549	0.0557	0.3400		-11.87	-32.94	15.82
	10–30	-0.0962	0.0390	0.0389	*	-19.87	-34.86	-1.43
GGHH	0–10	-0.0394	0.0231	0.1643		-8.66	-21.23	5.90
	10–30	-0.0182	0.0596	0.7631		-4.10	-27.73	27.25
	30–50	0.1762	0.1008	0.1188		50.02	-12.18	156.27
	50–100	0.1012	0.0700	0.1586		26.23	-9.16	75.42
	100+	0.0365	0.0249	0.1587		8.76	-3.50	22.57

Table 5-23. Results of Sediment Time Trends Analysis for the Lower Fox River

Deposit Group	Depth Range (cm)	Log10 (PCB) Time Trend Slope Estimate	WSEV Standard Error	WSEV *p*-Value	Statistically Significant Slopes	Estimated Annual Compound Percent Increase in PCB Level	Estimated Annual Compound Percent Increase in PCB Level: 95% Confidence Interval Lower-bound	Estimated Annual Compound Percent Increase in PCB Level: 95% Confidence Interval Upper-bound
De Pere								
SMU Group 2025	0–10	-0.0528	0.0231	0.0838		-11.45	-23.58	2.61
	10–30	-0.0556	0.0750	0.4796		-12.02	-40.91	31.01
	30–50	-0.0580	0.0322	0.1016		-12.50	-25.81	3.20
	50–100	-0.0847	0.1058	0.4306		-17.72	-50.17	35.85
2649	0–10	-0.0608	0.0109	0.00001	***	-13.06	-17.41	-8.48
	10–30	-0.2882	0.1440	0.0764		-48.50	-75.68	9.04
	50–100	0.1957	0.1419	0.2399		56.93	-36.65	288.69
	100+	0.0177	0.1548	0.9146		4.15	-61.29	180.26
5067	0–10	-0.0998	0.0345	0.0136	*	-20.53	-33.17	-5.49
	10–30	0.0912	0.0649	0.1800		23.37	-10.26	69.61
	50–100	0.3677	0.0684	0.0030	**	133.17	55.54	249.55
	100+	-0.1963	0.2223	0.4112		-36.36	-81.81	122.65
6891	0–10	-0.2208	0.0944	0.1013		-39.86	-69.89	20.11
	10–30	-0.1685	0.0765	0.0550		-32.16	-54.45	1.03
92115	0–10	0.0413	0.0426	0.3493		9.97	-10.91	35.75

Notes:

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

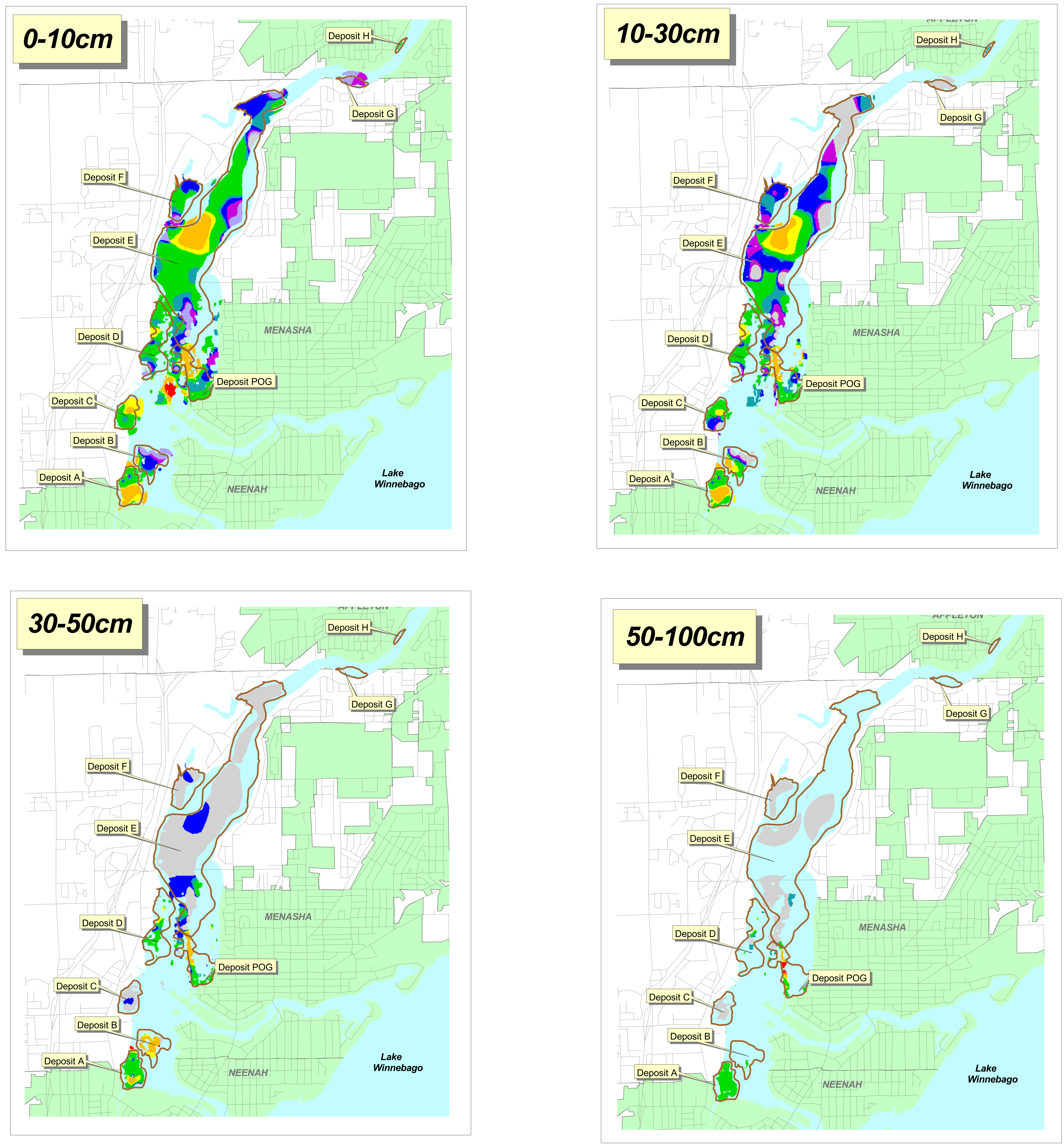
Table 5-24. Mass-weighted Combined Time Trend for 0 to 10 cm Depth by Reach

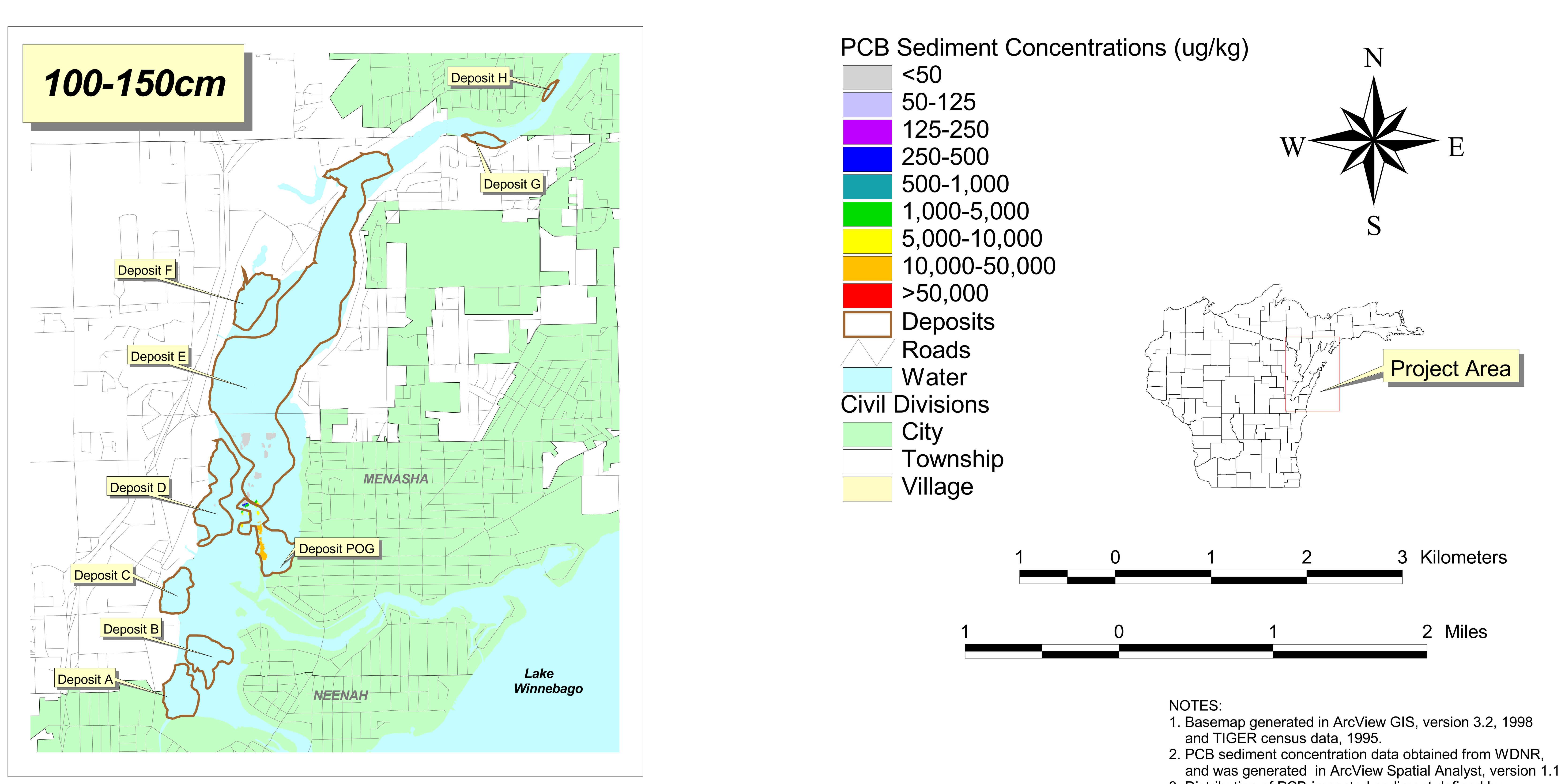
Deposit Group	Log_{10}(PCB) Time Trend Slope Estimate	WSEV Standard Error	PCB Mass (kg)	*p*-value	Annual Percent Change in PCB Concen-tration	Percent Change 95% Lower-bound	Percent Change 95% Upper-bound
Little Lake Butte des Morts							
AB	**-0.09705**	**0.034798**	**71.7**				
C	**-0.06124**	**0.03423**	**25.4**				
POG	**-0.08935**	**0.056669**	**113.5**				
D	**-0.07554**	**0.031669**	**32.1**				
F	**-0.0373**	**0.013582**	**142.5**				
GH	**-0.12443**	**0.054119**	**15.7**				
Reach, Combined	**-0.07071**	**0.01831**	**400.9**	**0.0001*** **	**-15.0**	**-21.8**	**-7.7**
Appleton							
IMOR	**0.041186**	**0.025457**	**13.7**				
N Pre-dredge	**-0.02805**	**0.006544**	**6.9**				
VCC	**-0.05816**	**0.02746**	**5.2**				
Reach, Combined	**-0.01135**	**0.01217**	**25.9**	**0.9**	**0.6**	**-5.9**	**7.5**
Little Rapids							
Upper EE	**-0.04473**	**0.043487**	**85.0**				
Lower EE	**-0.06819**	**0.019322**	**25.4**				
FF	**-0.05486**	**0.055669**	**36.7**				
GGHH	**-0.03936**	**0.023149**	**131.6**				
Reach, Combined	**-0.04567**	**0.018764**	**278.7**	**0.01***	**-10.0**	**-17.3**	**-2.0**
De Pere							
SMU Group 2025	**-0.05279**	**0.02305**	**225.6**				
SMU Group 2649	**-0.06078**	**0.010894**	**356.8**				
SMU Group 5067	**-0.09978**	**0.034549**	**92.4**				
SMU Group 6891	**-0.22081**	**0.094396**	**72.1**				
SMU Group 92115	**0.041293**	**0.042639**	**37.1**				
Reach, Combined	**-0.07296**	**0.012829**	**784.0**	**<0.0001*** **	**-15.5**	**-20.2**	**-10.4**

Notes:
* $p < 0.05$
** $p < 0.01$
*** $p < 0.001$

Table 5-25. Results of Fish Time Trends Analysis on the Lower Fox River

Species	Type	Sample Size	Year of Breakpoint	Percent Change per Year	95% Confidence Interval LCL	95% Confidence Interval UCL	*p*-Value
Little Lake Butte des Morts							
Carp	**fillet on skin**	**55**	**1979**	**-6.15**	**-10.9**	**-1.1**	**0.0177**
Carp	**whole fish**	**40**	**1987**	**0.71**	**-12.3**	**15.6**	**0.9172**
Northern Pike	**fillet on skin**	**19**		**-11.83**	**-16.7**	**-6.7**	**0.0003**
Walleye	**fillet on skin**	**63**	**1990**	**3.44**	**-7.8**	**16.0**	**0.5576**
Walleye	**whole fish**	**18**	**1987**	**21.47**	**-3.5**	**52.9**	**0.0874**
Yellow Perch	**fillet on skin**	**34**	**1981**	**0.73**	**-5.0**	**6.8**	**0.8025**
Combined				**-4.86**			**0.0055**
Appleton to Little Rapids							
Walleye	**fillet on skin**	**30**		**-9.97**	**-15.7**	**-3.9**	**0.0028**
De Pere to Green Bay (Zone 1)							
Carp	**whole fish**	**90**	**1995**	**21.76**	**2.2**	**45.0**	**0.0277**
Gizzard Shad	**whole fish**	**19**		**-5.07**	**-7.2**	**-2.9**	**0.0002**
Northern Pike	**fillet on skin**	**40**		**-9.95**	**-13.0**	**-6.8**	**<0.0001**
Walleye	**fillet on skin**	**120**		**-7.19**	**-8.7**	**-5.6**	**<0.0001**
Walleye	**whole fish**	**58**		**-8.11**	**-10.4**	**-5.8**	**<0.0001**
White Bass	**fillet on skin**	**58**		**-4.72**	**-7.5**	**-1.8**	**<0.0001**
White Sucker	**fillet on skin**	**44**		**-7.90**	**-10.3**	**-5.5**	**<0.0001**
Combined				**-6.89**			**<0.0001**
Green Bay Zone 2							
Alewife	**whole fish**	**44**		**-3.96**	**-7.8**	**0.0**	**0.0497**
Carp	**fillet on skin**	**28**		**-5.06**	**-11.8**	**2.2**	**0.1557**
Carp	**whole fish**	**57**	**1983**	**-15.54**	**-19.5**	**-11.4**	**0.0000**
Gizzard Shad	**whole fish**	**32**		**5.91**	**1.2**	**10.8**	**0.0144**
Yellow Perch	**fillet on skin**	**19**		**-10.75**	**-16.8**	**-4.2**	**0.0038**
Combined				**-5.11**			**0.0000**





NOTES:
1. Basemap generated in ArcView GIS, version 3.2, 1998 and TIGER census data, 1995.
2. PCB sediment concentration data obtained from WDNR, and was generated in ArcView Spatial Analyst, version 1.1.
3. Distribution of PCB-impacted sediment defined by interpolated depth intervals (layers) below surfaces greater than 300 cm depths. Assume no exceedences beyond depths shown.
4. The less than 50 ug/kg layer implies the presence of soft sediment with detectable PCB concentrations.

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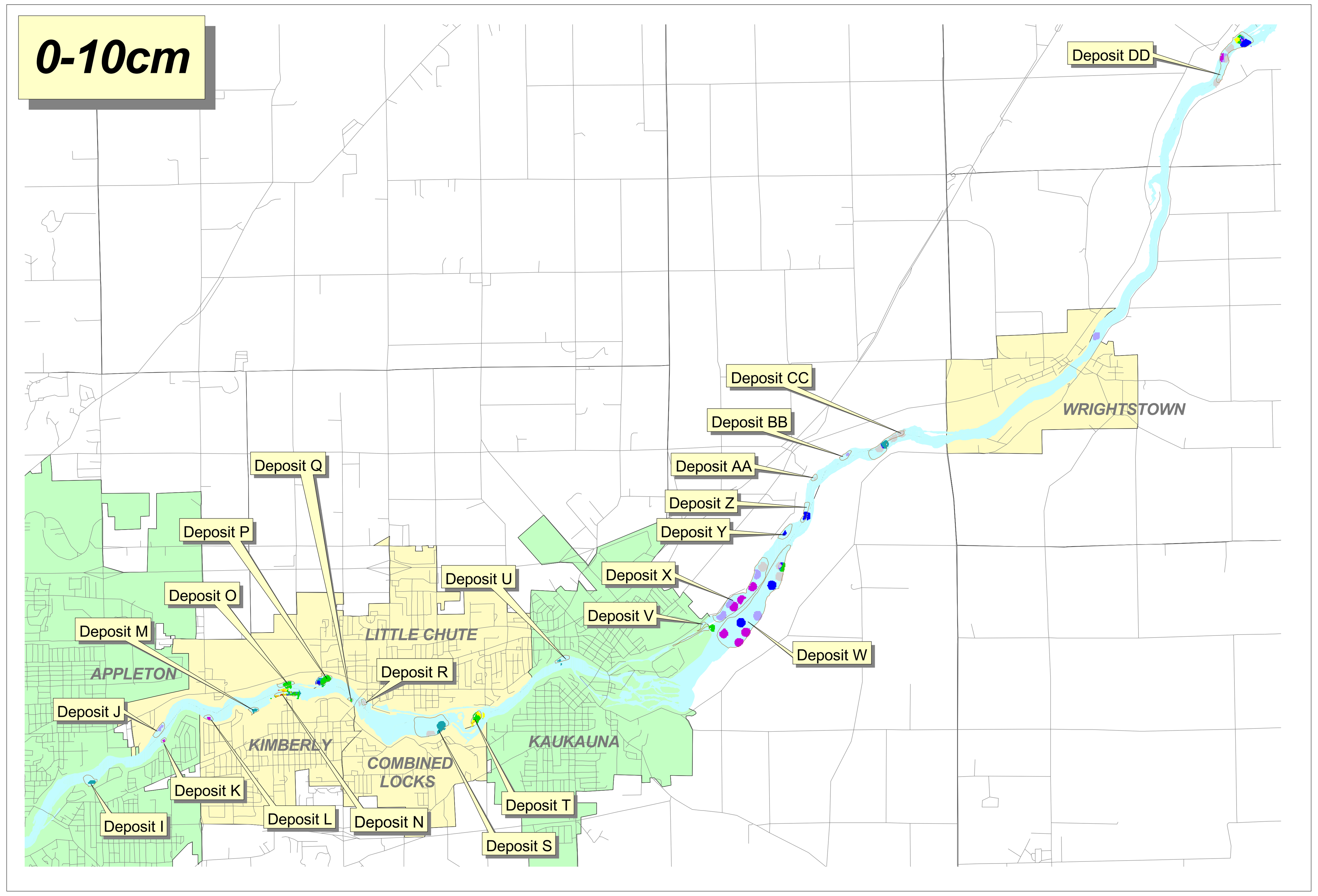
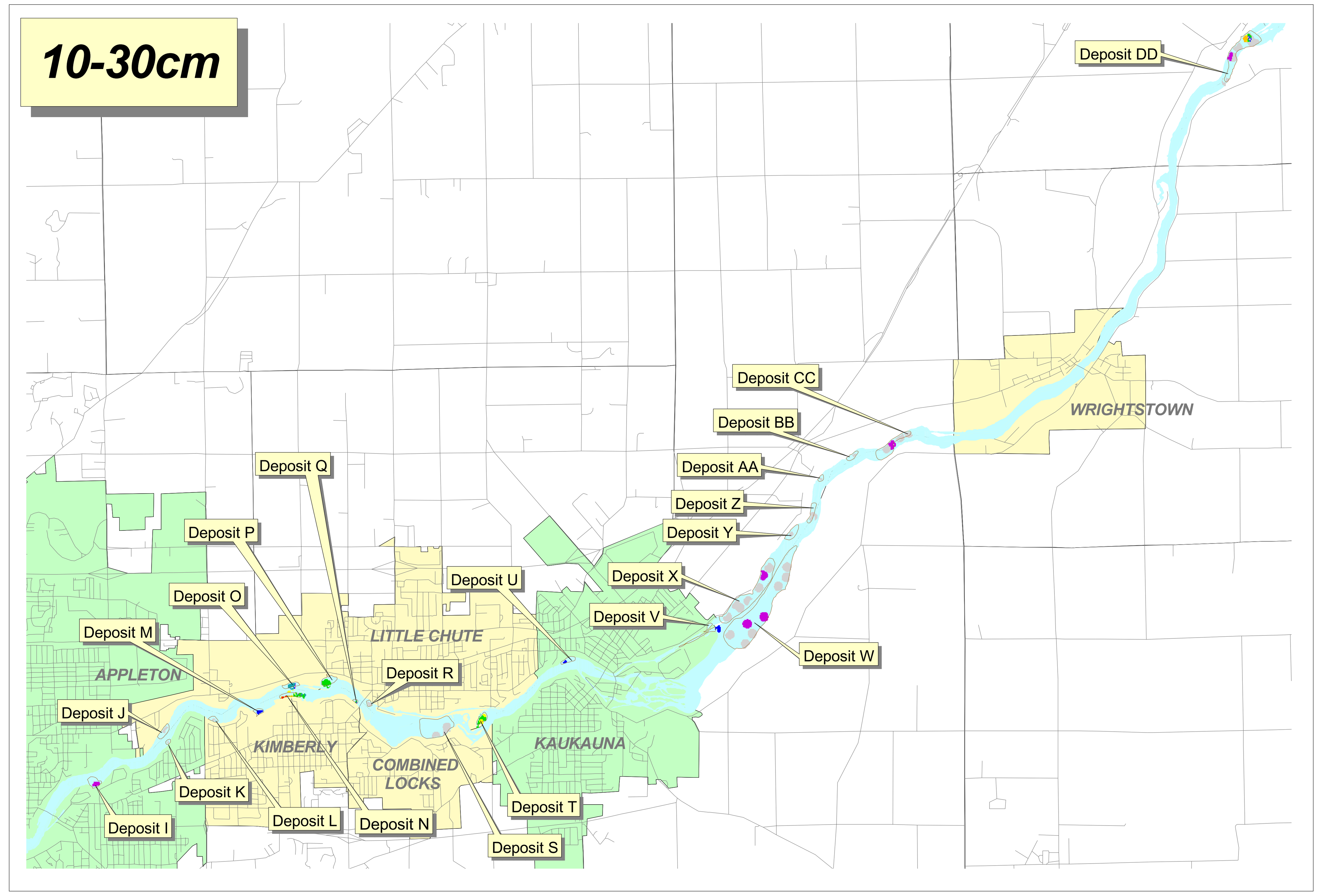
				PRINT DATE: 3/8/01
				CREATED BY: SCJ
			PLATE 5-1	APPROVED: AGF





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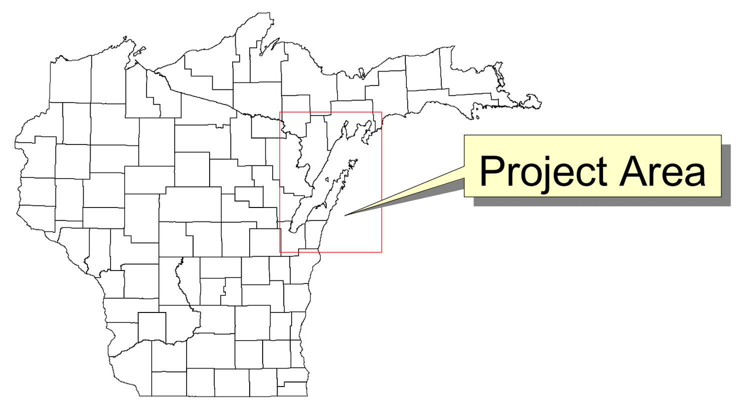

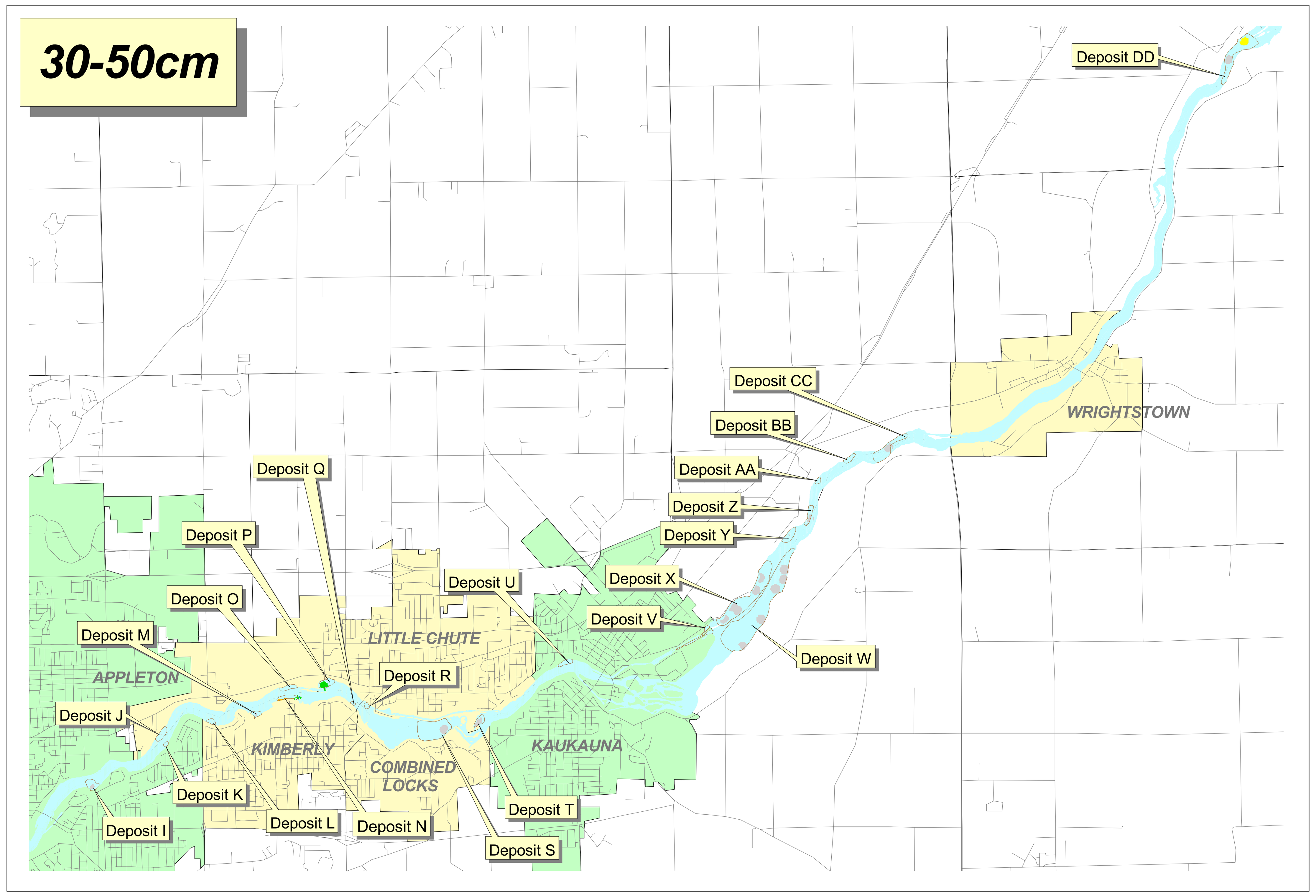

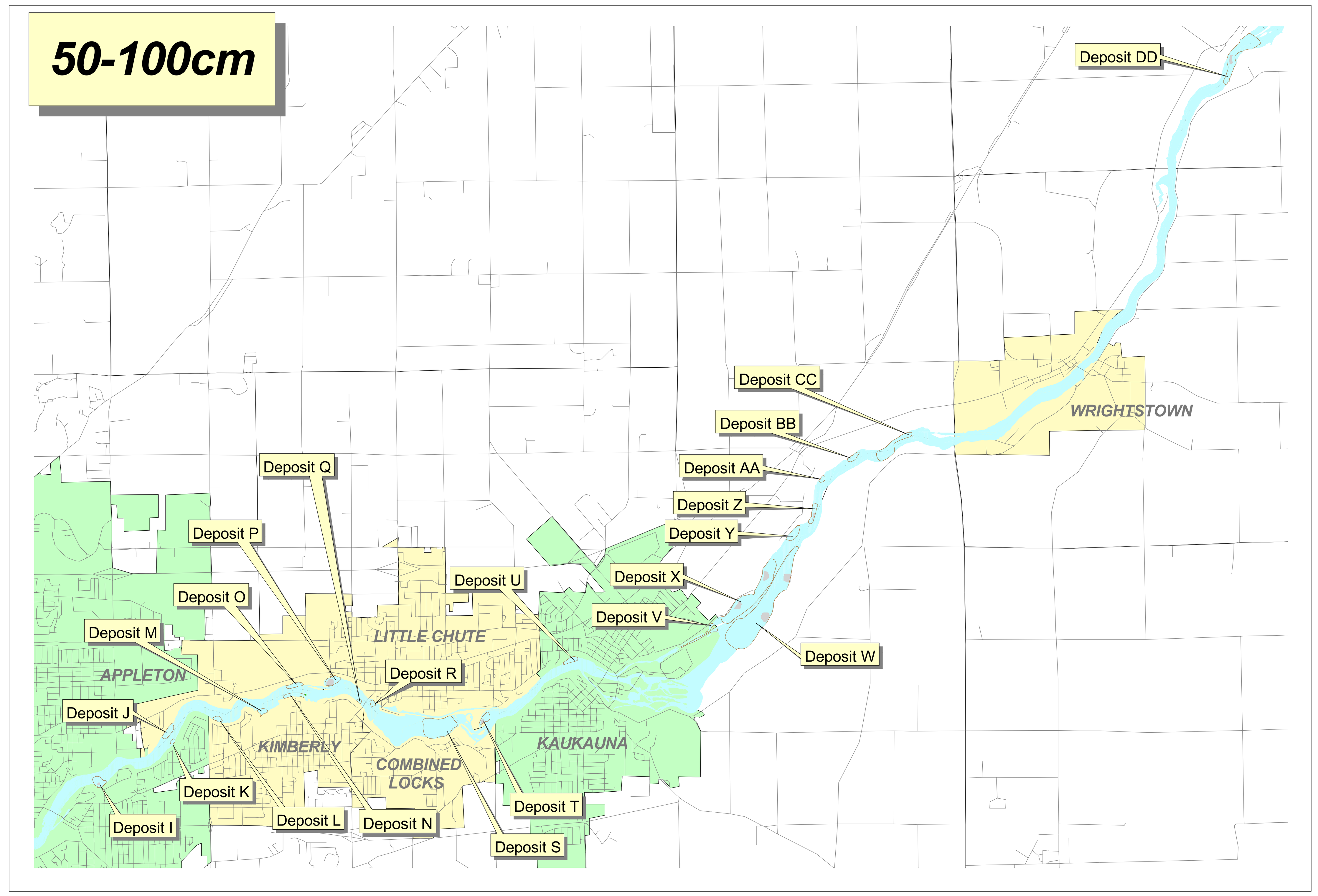

PCB Sediment Concentrations (ug/kg)
- <50
- 50-125
- 125-250
- 250-500
- 500-1,000
- 1,000-5,000
- 5,000-10,000
- 10,000-50,000
- >50,000
- Deposits
- Roads
- Water

Civil Divisions
- City
- Township
- Village

NOTES:
1. Basemap generated in ArcView GIS, version 3.2, 1998 and TIGER census data, 1995.
2. PCB sediment concentration data obtained from WDNR, and was generated in ArcView Spatial Analyst, version 1.1.
3. Distribution of PCB-impacted sediment defined by interpolated depth intervals (layers) below surfaces greater than 300 cm depths. Assume no exceedences beyond depths shown.
4. The less than 50 ug/kg layer implies the presence of soft sediment with detectable PCB concentrations.

2 0 2 4 6 Kilometers

2 0 2 4 Miles

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Remedial Investigation Report

Interpolated PCB Distribution in Sediments: Appleton to Little Rapids Reach

PLATE 5-2

DRAWING NO:	RI-14414-340-5-2
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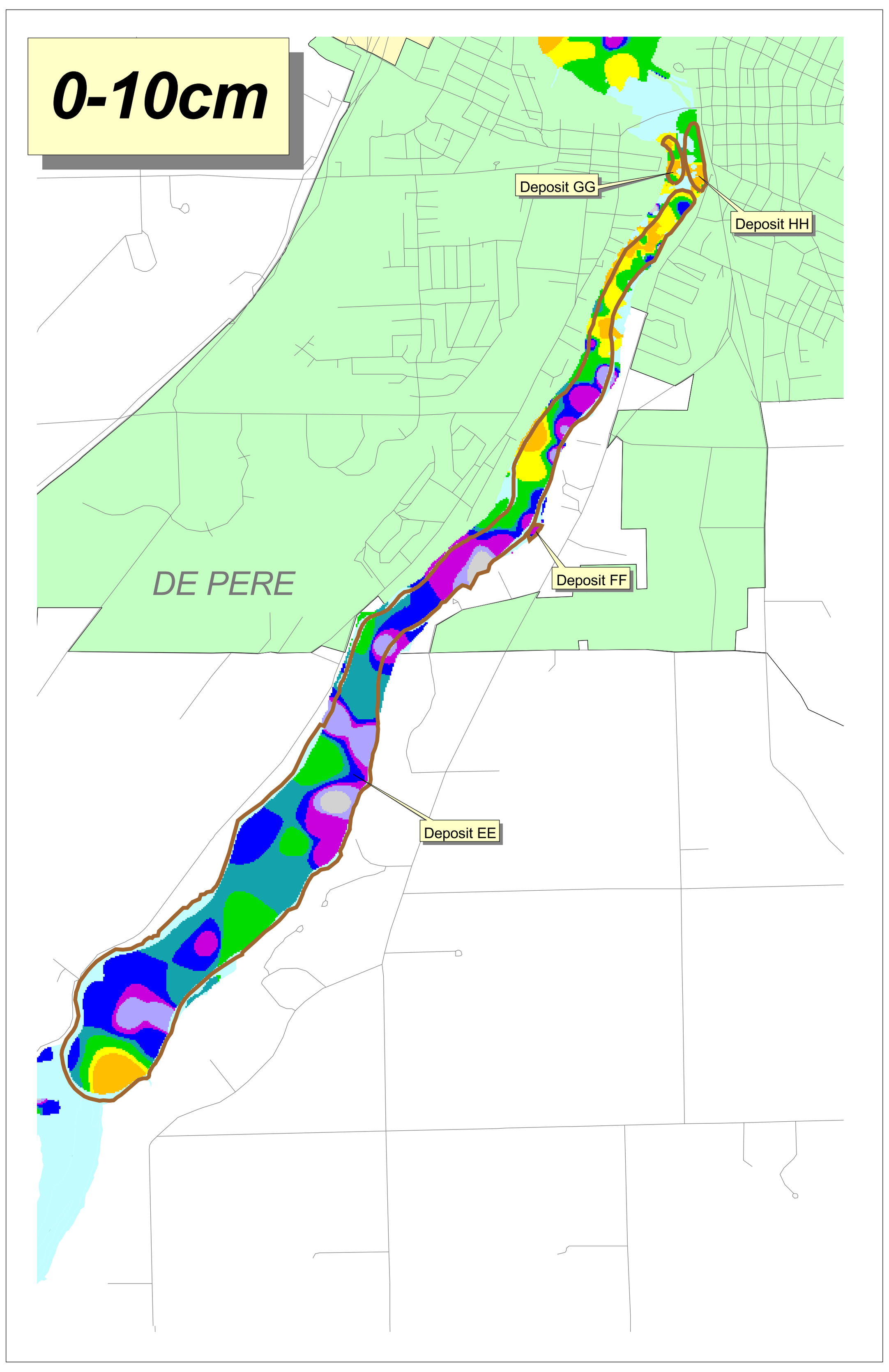

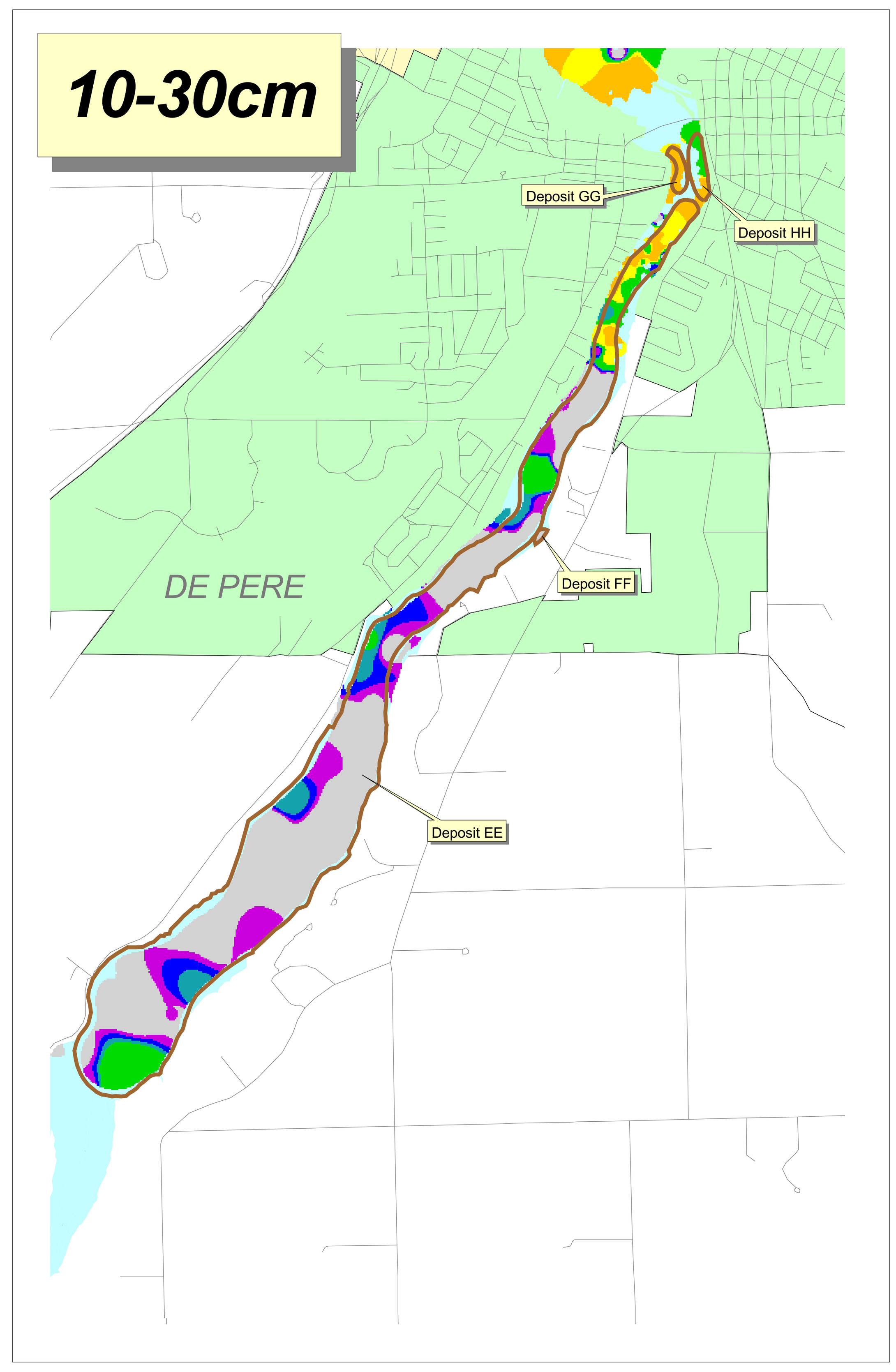

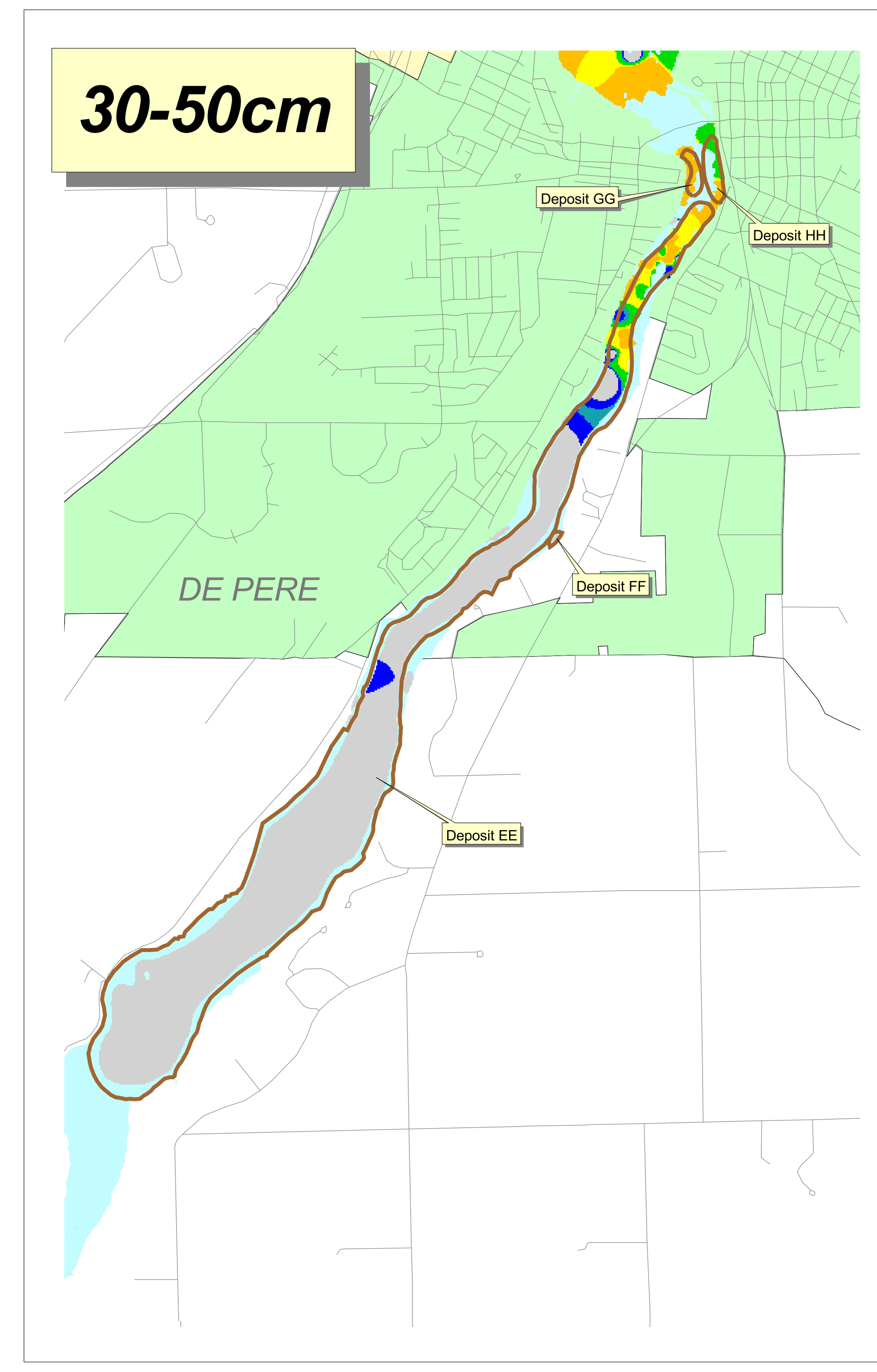

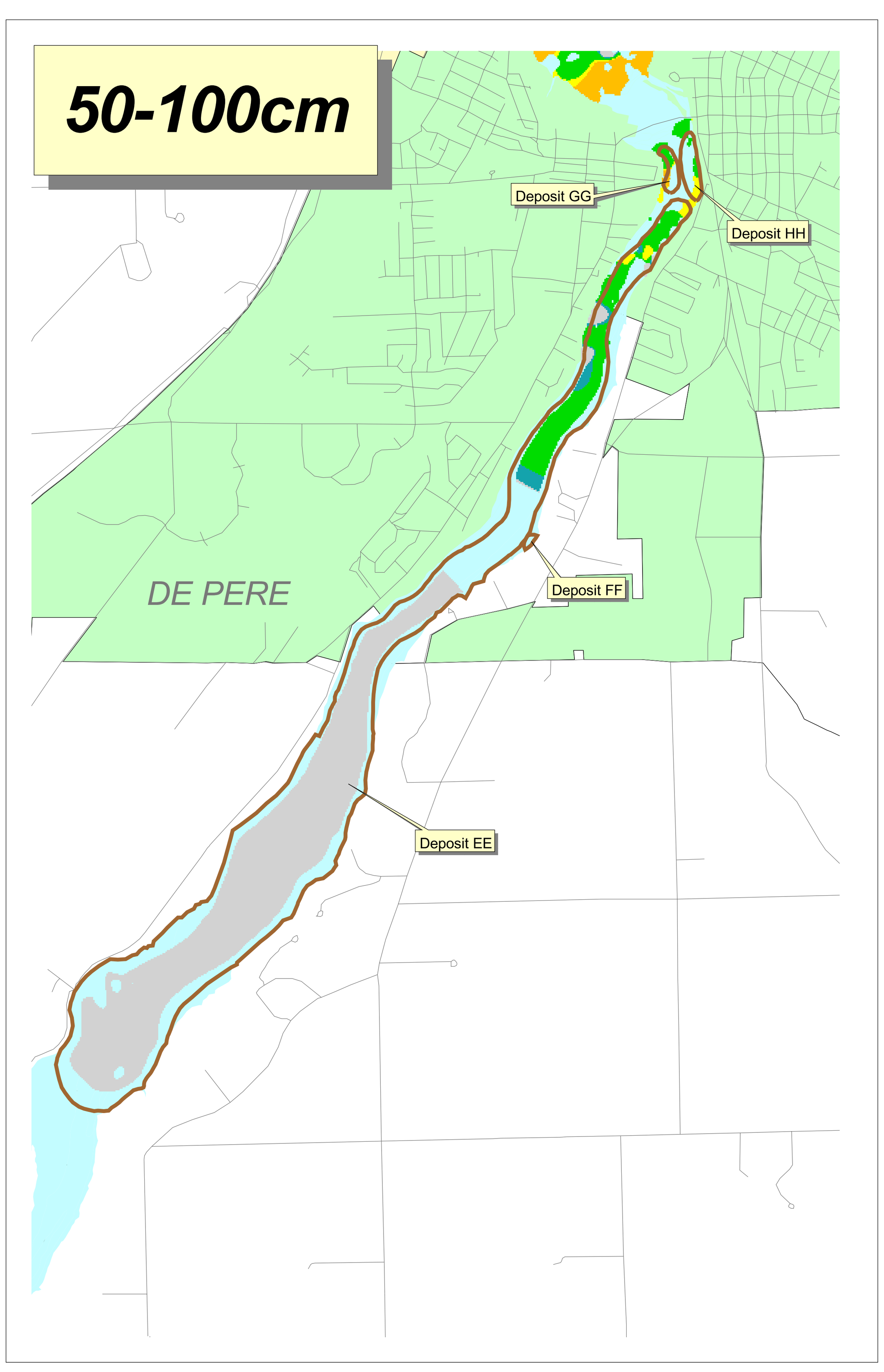

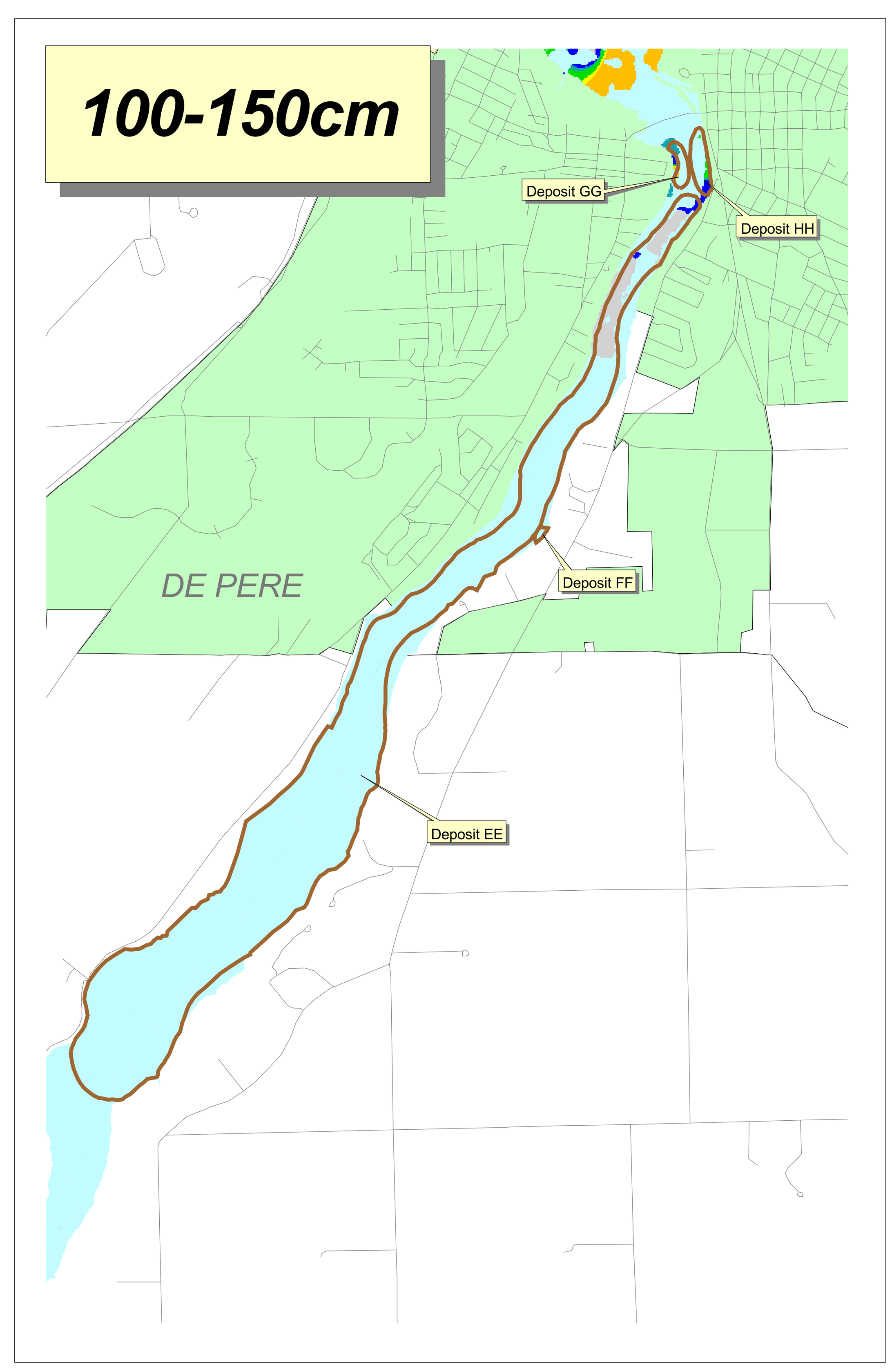

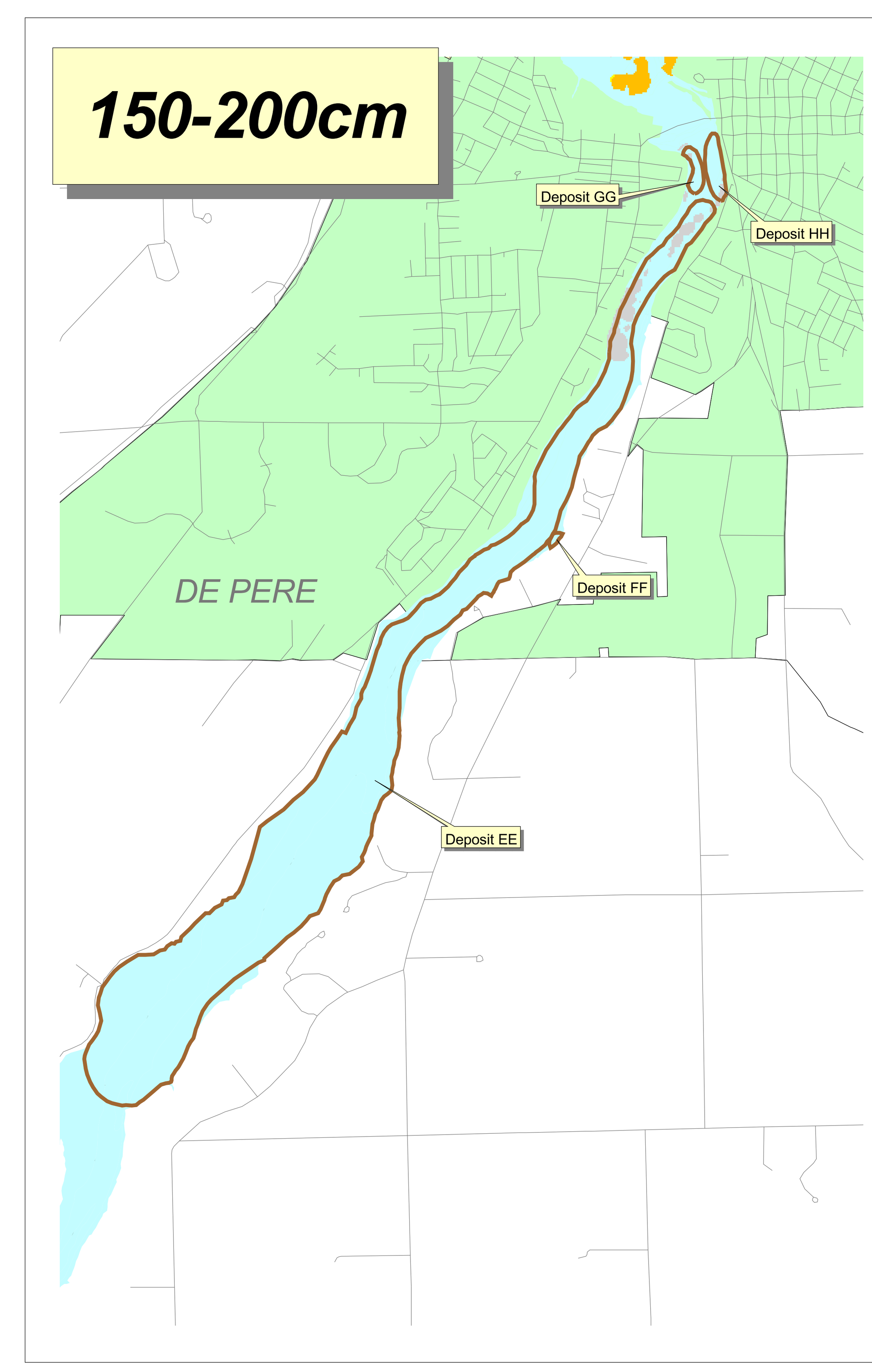

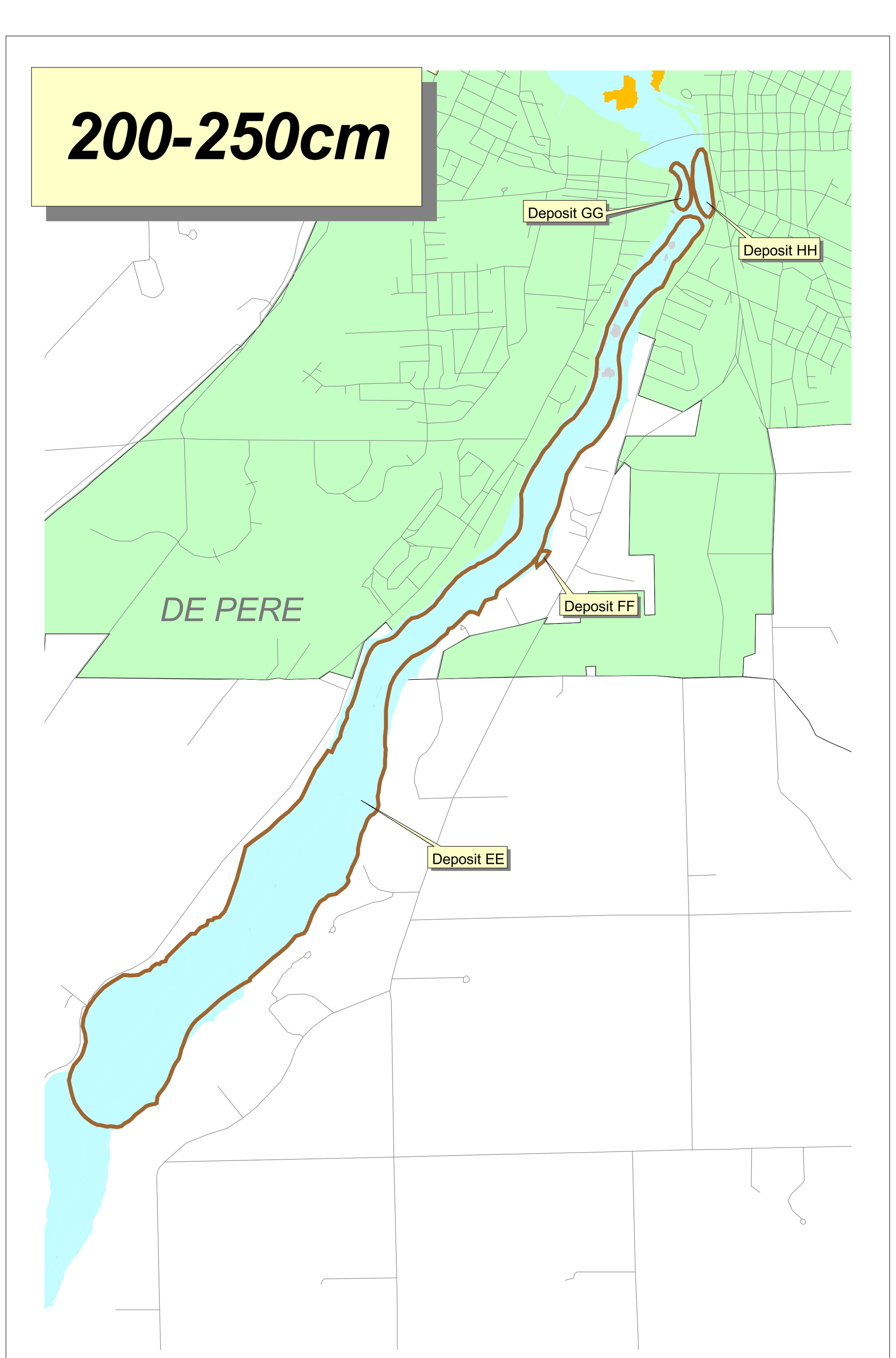

PCB Sediment Concentrations (ug/kg)
- <50
- 50-125
- 125-250
- 250-500
- 500-1,000
- 1,000-5,000
- 5,000-10,000
- 10,000-50,000
- >50,000
- Deposits
- Roads
- Water

Civil Divisions
- City
- Township
- Village

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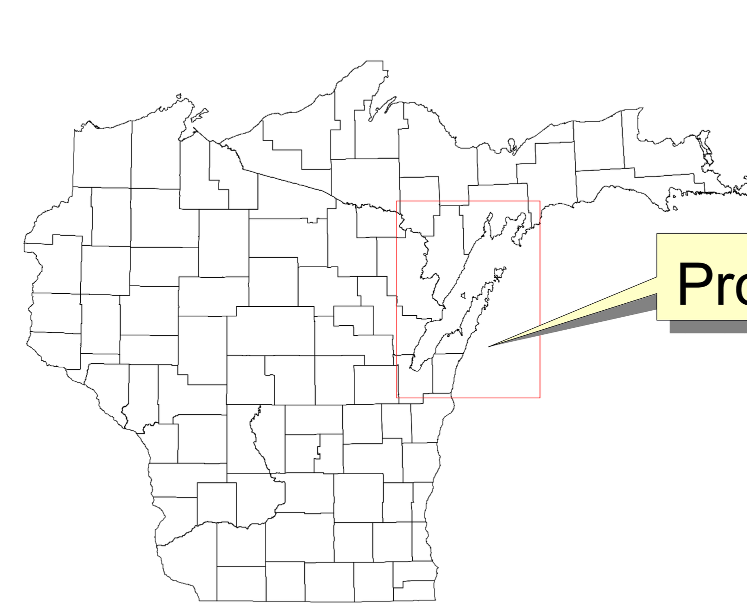

1 0 1 2 3 Kilometers

1 0 1 2 Miles

NOTES:
1. Basemap generated in ArcView GIS, version 3.2, 1998 and TIGER census data, 1995.
2. PCB sediment concentration data obtained from WDNR, and was generated in ArcView Spatial Analyst, version 1.1.
3. Distribution of PCB-impacted sediment defined by interpolated depth intervals (layers) below surfaces greater than 300 cm depths. Assume no exceedences beyond depths shown.
4. The less than 50 ug/kg layer implies the presence of soft sediment with detectable PCB concentrations.

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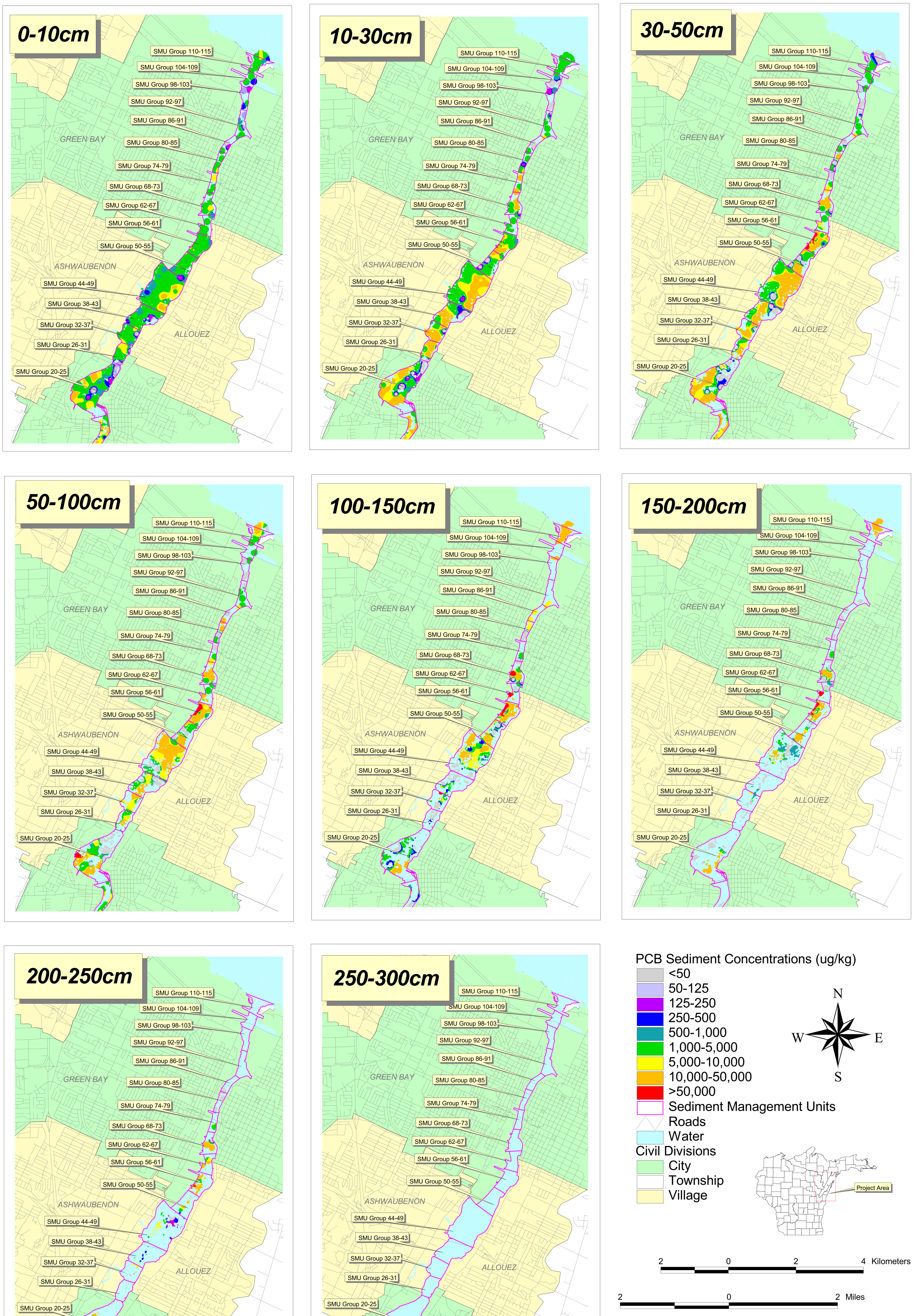
				PRINT DATE: 3/8/01
				CREATED BY: SCJ
			PLATE 5-3	APPROVED: AGF



NOTES:
1. Basemap generated in ArcView GIS, version 3.2, 1998 and TIGER census data, 1995.
2. PCB sediment concentration data obtained from WDNR, and was generated in ArcView Spatial Analyst, version 1.1.
3. Distribution of PCB-impacted sediment defined by interpolated depth intervals (layers) below surfaces greater than 300 cm depths. Assume no exceedences beyond depths shown.
4. The less than 50 ug/kg layer implies the presence of soft sediment with detectable PCB concentrations.

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Remedial Investigation Report

Interpolated PCB Distribution in Sediments: De Pere to Green Bay Reach

PLATE 5-4

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PRINT DATE: 3/8/01
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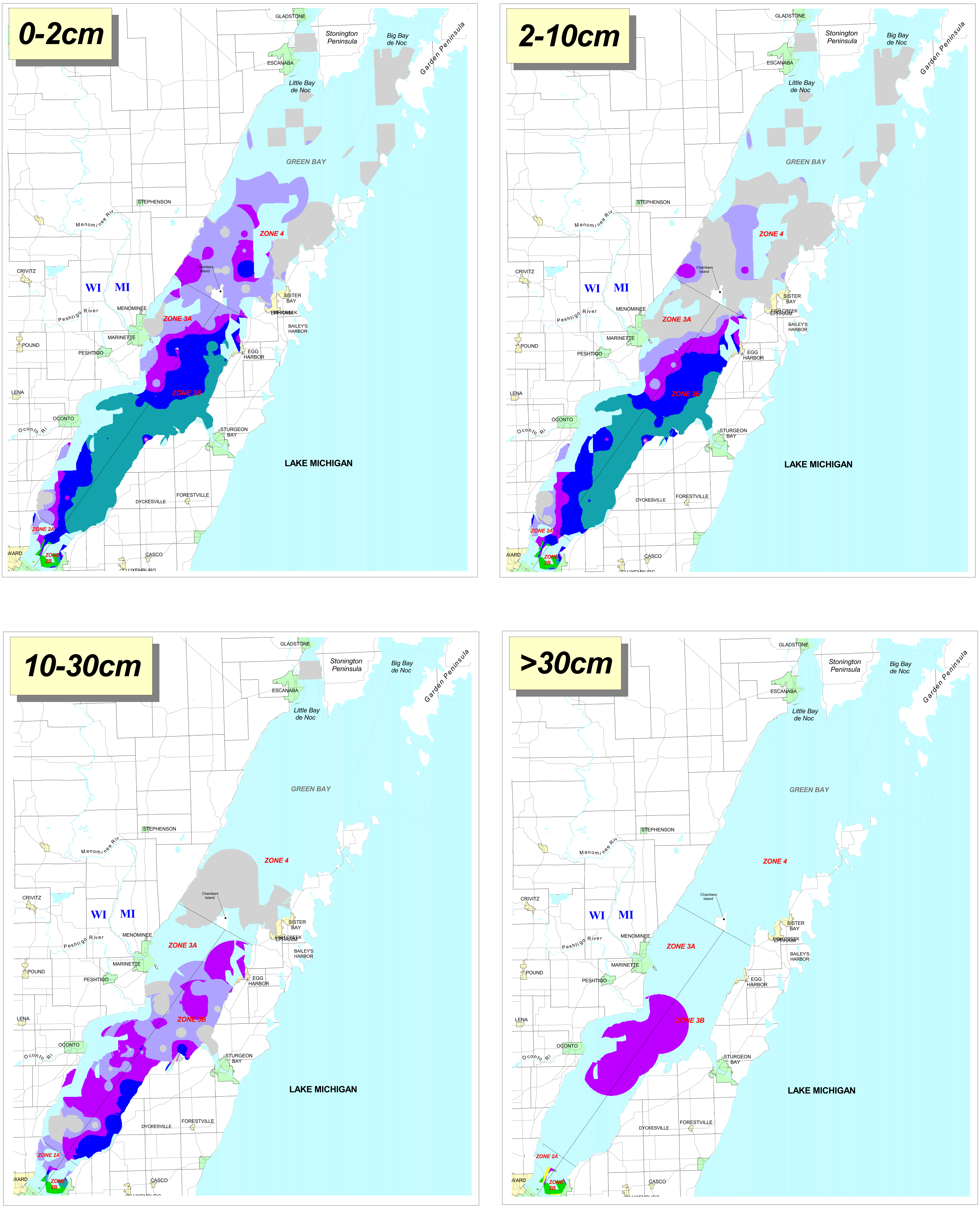
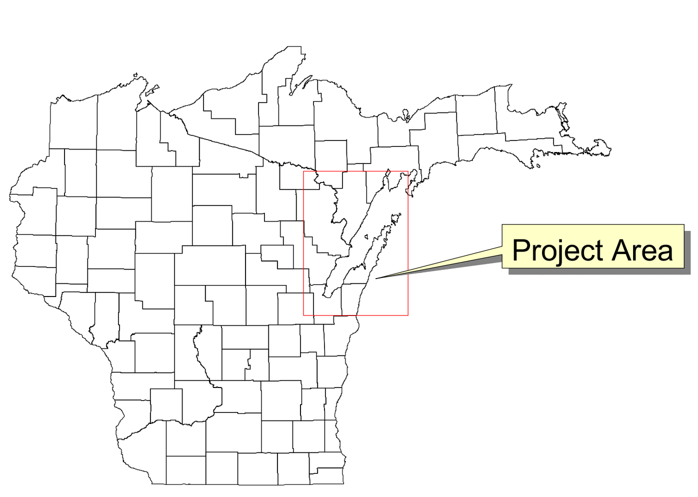


PCB Sediment Concentrations (ug/kg)

- <50
- 50-125
- 125-250
- 250-500
- 500-1,000
- 1,000-5,000
- >5,000
- Roads
- Water

Civil Divisions

- City
- Township
- Village



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20 0 20 40 Kilometers

20 0 20 Miles

NOTES:
1. Basemap generated in ArcView GIS, version 3.2, 1998 and TIGER census data, 1995.
2. PCB sediment concentration data obtained from WDNR, and was generated in ArcView Spatial Analyst, version 1.1.
3. Distribution of PCB-impacted sediment defined by interpolated depth intervals (layers) below surfaces up tp >30 cm depths.
4. The less than 50 ug/kg layer implies the presence of soft sediment with detectable PCB concentrations.

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				PRINT DATE: 3/8/01
				CREATED BY: SCJ
			PLATE 5-5	APPROVED: AGF

6 Chemical Transport and Fate

6.1 Introduction

This section summarizes the physical and chemical properties of the chemicals of concern (COCs) that influence their transport and fate in the Lower Fox River and Green Bay. Transport and fate processes affect how these compounds behave in the natural environment and move from source areas to potential human and environmental receptors. The discussion addresses PCBs, dioxin, dieldrin, DDT, arsenic, lead, and mercury, which were identified in the SLRA as chemicals of potential concern. In addition, the models to be used for the evaluation of PCB fate/transport and bioaccumulation are introduced and summarized. However, the results are not presented herein but can be found within the documentation report for each model.

A number of important physical and chemical processes affect contaminant fate and transport:

- Wind and stream flow/water movement
- Chemical-specific factors affecting partitioning between solid and dissolved phases
- Interactions between the dissolved and particulate phase of each compound (or compound group) within sediment, water column or biota
- Chemical partitioning or transformation in sediment, water, or biota

Once discharged into the environment, all of the chemicals discussed herein partition to sediment particles to some degree. Chemicals adsorbed onto the sediments are predominantly transported within the river system by physical processes. Important chemical and biological processes which facilitate uptake within the food chain include partitioning coefficients, metabolic processes, and species-specific bioaccumulation or bioconcentration factors. These processes are discussed in greater detail below.

6.2 Transport and Fate Processes

6.2.1 Chemical Transport Interactions

Chemical transport occurs through a variety of processes, including the following:

- Dissolution in the water column
- Volatilization into the atmosphere
- Adsorption to sediment (which may be deposited or suspended in the water column) and/or
- Incorporation into the food chain

In general, the chemicals of potential concern (COPC) tend to sorb to sediment particles, are resistant to biodegradation, volatilize slowly and bioaccumulate in aquatic organisms. Some chemical-specific measures, which are generally interrelated, that affect these tendencies include the following:

- Water solubility
- Organic carbon partitioning coefficient (K_{oc})
- Octanol-water partitioning coefficient (K_{ow})
- Vapor pressure
- Henrys Law constant (H_c) vapor: water partitioning coefficient
- Biodegradation rate
- Bioaccumulation factor

The water solubility of a chemical partly determines the extent to which a substance can partition between sediments and pore water/surface water. Because water is a polar solvent, polar covalent and ionic compounds are more likely to dissolve than non-polar compounds. Dissolution of non-polar organic chemicals are further controlled by their affinity for organic carbon phases in sediments or water. Both the K_{oc} and K_{ow} partitioning coefficients may be used to predict the degree of chemical sorption to organics in soil, sediment and particulate matter. The higher the K_{ow}, the greater affinity for partitioning to organic carbon. Vapor pressure and the Henrys Law constant are an indication of how readily a compound will volatilize from water into the atmosphere. The biodegradation rate, when known, provides the rate at which microbial processes may be expected to break down a chemical. Although the bioaccumulation factor is not a specific chemical property, it is a function of K_{oc} and can enable estimates of the degree to which a given chemical may be expected to be incorporated into tissues of aquatic organisms.

These are usually the most important factors effecting the overall fate of a chemical in the environment and they can be used to predict the mechanisms by which each contaminant (or group of contaminants) will move through or transform in the environment. Typical values for some of these chemical factors are included on Table 6-1 to enable general comparison with the other chemicals in the system.

6.2.2Physical Transport

Flowing water is the primary transport mechanisms for movement of contaminated sediment in the Lower Fox River downstream to Green Bay. Additionally, bay currents move sediments from southern Green Bay along the east shore, as discussed in Sections 3 and 5. Sediment transport is the primary mechanism for chemical movement in the Lower Fox River and Green Bay.

Surface water transport mechanisms depend on the type of water body present. In the Lower Fox River, the water velocity and sediment particle characteristics are the two main factors which influence the physical movement of sediment and the chemicals adsorbed onto their surfaces. The stream flow characteristics and physical movement of sediment particles as TSS in the Lower Fox River and Green Bay were discussed in detail in Section 3.

Chemicals sorbed to sediments and organic matter may be transported in suspension or as bed load by river currents. Fine-grained material, such as silts and clays, will generally be entrained in the water column and migrate downstream as suspended solids. As water velocities increase due to storm events or seasonal runoff, coarser-grained material (medium to coarse-grained sand or larger particles) will become suspended and/or move along the river bottom as bed load. Chemicals may accumulate as deposits as river velocities decrease. After deposition, bottom sediments are subject to resuspension.

In the case of larger water bodies, such as lakes (e.g., LLBdM and Green Bay), chemical/sediment transport occurs through wind and water driven currents as well as wave action. In general, currents are relatively slow and transport only fine-grained material. Large waves along near shore areas of Green Bay and Lake Michigan are capable of moving boulder size particles along the shoreline.

If a chemical dissolves in surface water, its chemical transport properties will be identical to those of water. Compounds present as an immiscible liquid phase will either sink or float on water depending on the compound's specific gravity.

Nonaqueous-phase liquids with a specific gravity of less than one will tend to remain close to, or float on the surface and may become susceptible to attenuation by volatilization and photolysis. Immiscible liquids more dense than water will move along the river bottom and/or become absorbed onto sediment particles.

Substances dissolved in surface waters can also partition out of the dissolved phase to a liquid phase or adsorb onto particles suspended in the water or onto bottom sediment. The latter process transfers the substances from the water to the sediment matrix. Conversely, chemicals may desorb from sediment back into the water.

Dispersion is a rapid process because of turbulent eddying (advection) and diffusion along concentration gradients. The amount of dilution can be approximated by comparing rates of chemical introduction to river flow discharge rates. In stagnant water bodies, such as marshes, advective forces are less important, and primary attenuation may be through diffusion.

6.2.3 Biological Interactions

Other important processes that affect long-term chemical persistence include bioturbation of sediments and bioaccumulation. Sediment bioturbation will generally improve degradation rates of organic compounds through oxygenation of surface sediments. Although bioturbation can have an effect on the anaerobic dechlorination of PCBs, it has little impact on the degradation rates of inorganic metals.

Bioaccumulation occurs in an organism when the uptake rate exceeds the organisms ability to remove the chemical through metabolic functions, dilution, or excretion, so that the excess chemical is stored in the body of the organism. One result of bioaccumulation may be biomagnification of the chemical up the food chain. Biomagnification occurs at the upper end of the food chain when the chemicals are passed from one organism to another through consumption (e.g., phytoplankton contain low levels of PCBs which are passed to the fish and ultimately to piscivorous birds or humans).

Benthic infauna occur in the upper strata of sediment in the Lower Fox River and Green Bay. Sediment is mixed by these organisms throughout their life cycles. The depth of sediment that is susceptible to mixing by various infaunal organisms varies with the sediment grain size, density, sediment chemistry, bottom current velocity, and type of habitat available. Benthic insect larvae, ingest bulk sediment and strip detritus from the surface of the particles. PCBs (and other chlorinated compounds) partitioned to sediments may enter into the food web principally from uptake of sediment solids (Capel and Eisenrich, 1990). Various oligochaetes (worms) and chironomid larvae (insects) were observed to depths up to 2 feet in the Lower Fox River deposits (GAS/SAIC, 1996), suggesting that bioturbation in the system may occur in the upper 2 feet of the river and bay sediments.

6.3 Compounds of Potential Concern

The following summaries were largely derived from the Agency for Toxic Substances and Disease Registry (ATSDR) Toxicological Profiles for each compounds or group of compounds discussed.

6.3.1 Organic Constituents

6.3.1.1 PCBs

PCBs exhibit low water solubility, are moderately volatile, strongly adsorb to organics, and preferentially partition to soil and sediment. The major fate process for PCBs in water is adsorption to sediment or other organic matter. Consequently, PCB concentrations in sediment and suspended matter are generally higher than in the associated water column (ATSDR, 1997a). The more highly chlorinated Aroclors sorb more strongly than the less chlorinated Aroclors, reflecting their differences in water solubilities and octanol-water partition coefficients. Adsorption and subsequent sedimentation may immobilize PCBs for relatively long periods of time in aquatic systems. However, redissolution into the water column may occur. PCBs contained in layers nearest the sediment surface may be slowly released over a long period of time. PCBs present in the lower layers of sedimentary deposits may be effectively sequestered from environmental distribution (ATSDR, 1997a).

The estimated Henry's law constants for individual Aroclors indicate that volatilization may be a significant environmental transport process for PCBs dissolved in natural water. However, adsorption to sediment significantly decreases the volatilization rate of highly chlorinated Aroclors from the aquatic phase. The redissolution rate of PCBs from sediment to water is greater in the summer than in the winter because of more rapid volatilization from water at higher temperatures.

The ability of PCBs to bioaccumulate has been related to corresponding octanol-water partition coefficients (K_{ow}). Compounds with high K_{ow} values more readily bind to sediments (particularly sediments with elevated organic carbon) and are more readily bioaccumulated by organisms. Experimentally determined bioconcentration factors (BCFs) in freshwater aquatic animals range from 600 to 274,000 (ATSDR, 1997a). The BCFs in aquatic animals may depend on the water depth in which they predominantly feed. Certain benthic organisms accumulate PCBs from water at the water/sediment interface and via intake of phytoplankton and zooplankton which contain higher levels of PCBs than the surrounding water (ATSDR, 1997a). In addition, the bioconcentration of PCBs in bottom-feeding species is also expected to be high because the PCB concentrations in sediment are several orders of magnitude higher than those in water.

PCBs also biomagnify within the food chain, as indicated by the PCB concentrations in higher trophic levels of aquatic organisms and in several species of piscivorous birds and seals (ATSDR, 1997a). The biotransfer factors of Aroclor 1254 were estimated to be 0.052 and 0.011 kg/day, "respectively, while the estimated mean BCF value for PCBs in human fat was 128 (ATSDR, 1997a). The BCF value is the PCB concentration in tissue over the PCB concentration in the diet."

The ability of PCBs to be degraded or transformed in the environment depends on the degree of chlorination of the biphenyl molecule in addition to the isomeric substitution pattern (ATSDR, 1997a). Aroclor 1242 appears to be persistent in this aquatic environment, given that it was the PCB mixture used by the PRPs in the production/recycling of carbonless copy paper and due to the detected concentrations and predominance of this mixture in both river and bay sediments.

Analysis of the movement of PCBs in the Lower Fox River was evaluated in several investigations. Studies indicate that suspended solids are the most important factor in the transport and fate of PCBs (Gailani, 1991; Velleux and Endicott, 1994; WDNR, 1995; and Velleux, *et al.,* 1995). WDNR (1995) found a strong correlation and dependency between total PCB (dissolved and particulate) and suspended solids concentrations in the water column. This PCB-suspended solids correlation was not observed at the upstream boundary where PCB concentrations leaving Lake Winnebago were low, ranging from 1 to 3 ng/L.

6.3.1.2 Dioxins and Furans

Chlorinated dioxins are a group of over 75 different compounds, and chlorinated dibenzofurans comprise over 135 compounds (ATSDR, 1989). These compounds have been found to be very persistent in the environment due to their low solubility in water and affinity for organic matter in sediments. The fate of 2,3,7,8-TCDD is not understood with certainty. According to some studies, surface water sediments are the ultimate environmental sink of airborne particulate 2,3,7,8-TCDD (ATSDR, 1997a).

2,3,7,8-TCDD is expected to be immobile in most soils. A rate of transport of 10 cm in 12 years has been observed with soils from Elgin Air Force Base. Leaching is possible, but very unlikely, in soils with a very low organic carbon content. Bacterial degradation of dioxins and furans is possible but it is a very slow process and is usually limited by the populations of organisms in the native material. However, both volatilization and photolysis will remove 2,3,7,8-TCDD from surface soils. Therefore, the half-life in surface soils may range from 1 to 3 years but for contaminants buried a few inches below the surface the half-life may be 10 to 12 years or more (ATSDR, 1989). In surface and groundwater, degradation of

2,3,7,8-TCDD is similar to that in soils, and volatilization and photolysis are again the two most significant processes (ATSDR, 1989).

Dioxins and furans have been found to highly bioconcentrated in aquatic organisms and wildlife. Experiments with fathead minnows (Pimephales promelas) have yielded a BCF of 7,900 to 9,300 on a wet weight basis. Similarly, studies completed on rainbow trout (Salmo gairdneri) have been extrapolated to yield a BCF of approximately 39,000 (ATSDR, 1989).

6.3.1.3 DDT

DDT, and its principal metabolites DDD and DDE, are organochlorine compounds that were used as insecticides until 1972, when their use in the United States was banned because of adverse toxicity to wildlife. These compounds may be transported from one medium to another by adsorption, bioaccumulation, dissolution, or volatilization. The major fate process for DDT in water is adsorption to sediment or other organic matter and the primary loss route is the transportation of the particulates to which the compound is bound (ATSDR, 1994). Studies have shown that in soils/sediments, DDT transformations have prolonged persistence. These compounds undergo extensive adsorption to soil particles, especially those with high TOC levels.

Photo-oxidation of DDT is known to occur on soil surfaces; however, it is not known to hydrolyze (ATSDR, 1994). Biodegradation may occur under both aerobic and anaerobic conditions by microorganisms including fungi, algae and mixed microbial populations. Under aerobic conditions DDT slowly converts to DDE whereas under anaerobic conditions it converts to DDD much more rapidly. However, the estimated DDT half-life ranges from 2 to more than 15 years (ATSDR, 1994; Stewart and Chisolm, 1971).

Studies have found that plants, fish, mammals, and birds, as well as phytoplankton and zooplankton in an aquatic environment, bioaccumulate DDT. DDT has a high potential to bioaccumulate and the BCF for rainbow trout has been estimated to be 12,000 while the estimated human BCF is above 1,650, primarily from the consumption of fish (ATSDR, 1994). A study completed in northern Canada found that biota living in the bottom of the sea had much higher levels of total DDT than biota living in the open sea (ATSDR, 1994). This is likely a result of DDT adsorption onto particulates which settled into bottom sediments. Additionally, the ring necked seal apparently biomagnified DDT, indicating that biomagnification is possible in other species as well (ATSDR, 1994). Others have also found DDT biomagnification from soil sediment to mosquito fish, and a study completed in Lake Michigan indicated that DDE biomagnified 28.7 times from phytoplankton to fish and 21 times from sediments to amphipods (ATSDR, 1994).

In sediments, DDE is the major metabolite formed (Montgomery, 2000). Both DDD and DDE are stable and biologically active, but DDE is non-insecticidal (Montgomery, 2000). DDT has a low solubility and preferentially binds to sediments. If consumed, DDT and metabolites are stored in fat and, as shown above, biomagnify up the food chain.

6.3.1.4 Dieldrin

Dieldrin is both a manufactured pesticide and a breakdown product of the pesticide aldrin. Therefore, the presence of dieldrin in the environment may result from either the application and use of dieldrin or aldrin. The use of both products has been banned in the United States since 1974. Therefore, the presence of dieldrin in river sediments is due to their continued persistence in the environment.

Dieldrin is extremely non-polar, has a low volatility, sorbs readily to sediment organic matter and has a high potential for bioaccumulation with a BCF of 4,670 (ATSDR, 1993a). Dieldrin is persistent in sediments and surface water with a half-life of 3 and 6 years, respectively (Howard, 1991). Direct photolysis of dieldrin can occur creating a half-life of about 2 months (ATSDR, 1993a). Dieldrin degradation is unaffected by aerobic or anaerobic conditions (Montgomery, 2000), but dieldrin can be biotransformed by soil microbes to a substance more toxic to insects. The persistence of dieldrin within soil and sediment is exemplified by a study in soil plots which had been treated with dieldrin for 15 years. The dieldrin concentrations were the same 4 years after treatment stopped (ATSDR, 1993a).

Volatilization is the principle route of loss from soil; however, the process is slow due to the low vapor pressure. Once in the atmosphere, dieldrin can travel great distances. Studies in the Northwest Territories of Canada have found mean concentrations of 0.75 ng/L in arctic snow. There were no known local sources.

Experimental evidence has shown that aldrin converts rapidly to dieldrin, which readily bioaccumulates and biomagnifies (ATSDR, 1993a). Radiolabeled aldrin was added to an ecosystem and was converted to dieldrin. Sampling results indicate that of the radiolabeled aldrin, approximately 96 percent of the total stored in fish, 92 percent of the total found in snails, and about 86 percent of the total found in algae was in the form of dieldrin (ATSDR, 1993a). Measured BCFs are approximately 2,700 in fish and 61,657 in snails. In rainbow trout, a biomagnification factor of 1.0 has been determined on a lipid weight basis and 2.3

for the wet weight. Additionally, biotransfer factors evaluated for beef and cow milk were estimated to be 0.008 and 0.011, respectively (ATSDR, 1993a). These results all indicate the strong affinity of dieldrin for organic matter and the increased likelihood of biomagnification to higher trophic levels of the food chain.

6.3.2Inorganic Constituents

The primary factor influencing the fate and transport of heavy metals is their speciation and adsorption capacity, which are affected by and change with the geochemistry of the environment. The transport of metals via surface water is affected by adsorption of metals to soil or other organic matter. The degree to which a metal will adsorb depends on the presence of competing ions, water chemistry, and metal speciation, which is, in turn affected by such factors as pH and reduction/oxidation (redox) potential. The interaction among these factors is complex.

In instances where metals are present in solution with other ions, competition for sorption sites on soil particles or on organic material may enhance the mobility of weakly sorbed metals such as cadmium. Adsorption of metals is also strongly influenced by pH, due in part to increased competition between protons ($H+$) and metal ions for the same binding sites. Furthermore, pH affects the speciation and solubility of metals through the formation of hydroxide complexes. Speciation of metals is also controlled by the redox potential of the environment, which determines the oxidation state of the metal. The fate and transport of individual metals of concern are discussed below.

6.3.2.1 Mercury

The transport and partitioning of mercury in surface waters and soil is influenced by the particular form of the compound. Volatile forms (e.g., metallic mercury and dimethylmercury) evaporate to the atmosphere, whereas solid forms partition to particulates or are transported in the water column, depending upon their solubility. However, the dominant process controlling the distribution of mercury compounds in the environment is the sorption of non-volatile forms to soil and sediment particulates. The sorption process is related to the organic matter content of the soil or sediment; the pH of the medium apparently does not affect the process. Inorganic mercury sorbed to particulate material forms stable complexes with organic compounds and is not readily desorbed or removed from sediment (ATSDR, 1997b). Consequently, freshwater and marine sediment are repositories for inorganic forms of mercury. Mobilization of sorbed mercury from particulates can occur through chemical or biological reduction to elemental mercury and bioconversion to volatile organic forms (ATSDR, 1997b).

Methylmercury produced from biotransformation processes is soluble and mobile, and quickly enters aquatic food chains. Methylmercury is not only the most biologically available form of mercury, it is also the most toxic. Mercury bioaccumulation and biomagnification have been demonstrated in the aquatic food chain by the elevated levels found in piscivorous fish compared with organisms lower on the food chain. Almost all mercury accumulated is in the methylated form, primarily as a result of the consumption of prey containing methylmercury. Methylmercury accumulates in carnivorous fish to levels of 10,000 to 100,000 times those found in ambient water (ATSDR, 1997b). Bioaccumulation of methylmercury in aquatic food chains is of interest because it is generally the most important source of nonoccupational human exposure to the compound (EPA, 1984). Mercury methylation in ecosystems depends on mercury loadings, microbial activity, nutrient content, pH, redox conditions, suspended sediment load, sedimentation rates, and other variables (ATSDR, 1997b). Conversion of inorganic mercury to methylmercury is favored by low pH and low dissolved organic carbon levels.

6.3.2.2 Lead

The primary sources of lead in the environment are anthropogenic emissions to the atmosphere. A significant fraction of lead carried by river water is in an undissolved form, consisting of colloidal particles or larger undissolved particles of metallic lead, lead carbonate, lead oxide, lead hydroxide, or other lead compounds incorporated in other components of surface particulate matter from runoff. Lead may occur either as sorbed ions or surface coatings on sediment particles, or it may be carried as a part of suspended living or nonliving organic matter in water. Lead in aquatic environments often precipitates out of solution by binding to carbonate or phosphate ions or it can be readily sorbed to either organic or inorganic components in sediments.

Factors affecting the degree of sorption include: the sediment type, pH, organic carbon content, cation exchange capacity, the form of the lead and other constituents in the sediment such as metal oxides, aluminum silicates, and carbonates. Sorption is high in sediments containing clay and lower in sediments containing a higher percentage of sand or sand and loam (ATSDR, 1993c). Lead can bioaccumulate but does not biomagnify.

Plants and animals may bioconcentrate lead. In general, the highest lead concentrations are found in organisms near lead mining, smelting, and refining facilities; storage battery recycling plants; areas affected by high automobile and truck traffic; sewage sludge and spoil disposal areas; sites where dredging has occurred; areas of heavy hunting (from spent shot); and in urban and industrialized areas. Lead is not biomagnified in aquatic or terrestrial food chains.

Older organisms tend to contain the greatest body burdens of lead. In aquatic organisms, lead concentrations are usually highest in benthic organisms and algae, and lowest in upper trophic level predators (e.g., carnivorous fish). High BCFs were determined in studies using oysters (6,600 for Crassostrea virginica), freshwater algae (92,000 for Selenastrum capricornitim), and rainbow trout (726 for Oncorhynchus mykiss), although most median BCF values for aquatic biota are significantly lower: 42 for fish, 536 for oysters, 500 for insects, 725 for algae, and 2,570 for mussels (ATSDR, 1993c). Lead is toxic to all aquatic biota, and organisms higher on the food chain may experience lead poisoning as a result of eating lead-contaminated food.

6.3.2.3 Arsenic

Most naturally occurring arsenic in the environment exists in soil or rock. This material may be transported by wind or water erosion of small particles. Arsenic can also leach from soil or rock into rainfall or snow melt (ATSDR, 1993b). However, because many arsenic compounds tend to absorb to soil or sediment, leaching usually results in transportation only over short distances (EPA, 1982; Welch, *et al.,* 1988).

Transport and partitioning of arsenic in water depend upon its chemical species, oxidation state, and on interactions with other materials present. Soluble forms may be carried long distances through rivers (ATSDR, 1993b). However, arsenic may be adsorbed from water onto sediment or soil, especially clays, iron oxides, aluminum hydroxides, manganese compounds, and organic material (Callahan, 1979; EPA, 1982; Welch, *et al.,* 1988). Sediment-bound arsenic may be released back into the water by chemical or biological interconversions of arsenic species. In an oxidized environment, arsenic is generally present as arsenate (As^{5+}), an immobilized form that will be ionically bound to soil. However, under reduced conditions, arsenate is transformed to arsenite (As^{3+}), which is water soluble and, therefore, more mobile.

Arsenic present in Lower Fox River sediment may be associated with agricultural chemicals such as pesticide and herbicides and with wood treatment facilities. Arsenic in this form is tightly bound and generally not as bioavailable as soil- or sediment-bound arsenic. Bioconcentration of arsenic occurs in aquatic organisms, primarily in algae and lower invertebrates. BCFs measured in freshwater invertebrates and fish for several arsenic compounds ranged from 0 to 17 (EPA, 1980) and biomagnification in the aquatic food chain does not appear to be significant (ATSDR, 1993b; EPA, 1982).

6.4 Lower Fox River/Green Bay Modeling

Computer models have been employed in the RI/FS/RA to assist in the evaluation PCB fate and transport, historically and into the future. These models also enable the evaluation of various remedial scenarios on future PCB distribution in various environmental media as well as the food web in the Lower Fox River and Green Bay. These models are briefly described below and additional information is included in the documentation report for each specific model.

6.4.1GBTOXe Model

The enhanced Green Bay toxics model (GBTOXe) was developed by HydroQual to simulate the fate and transport of PCBs in Green Bay for the RI/FS. GBTOXe is an enhanced version of an existing WASP4 based toxics model developed as part of the GBMBS by Bierman, *et al.* (1992) and updated by De Pinto, *et al.* (1993). Enhancements include a higher spatial resolution and linkage to a hydrodynamics model (GBHYDRO) and a sediment transport model (GBSED) of Green Bay. GBTOXe was calibrated against 1989-90 GLNPO PCB and carbon data. GBTOXe was used to run 100-year simulations of PCB fate and transport for several management scenarios, including no action.

GBTOXe is used to model total PCBs and three phases of carbon in the water column and sediments. The carbon phases considered are dissolved, biotic, and particulate detritus. The model domain consists of 1490 water column and 596 sediment segments. The water column consists of 10 layers of 149 horizontal segments. Segment volumes vary to maintain a water balance. The layers represent biologically active sediments, and deeper biologically inactive sediments. The volume of the segments in the upper 10cm of the sediment are assumed to be constant in time, while the fourth sediment layer changes in volume in response to deposition and resuspension. PCB transport mechanisms include advection, dispersion, volatilization, deposition and resuspension of sorbed phase, and pore water exchange. GBTOXe accounts for sediment bed armoring.

The GBTOXe results are published as a separate document which supplements this RI/FS/RA.

6.4.2GBFood Model

The GBFood bioaccumulation model is a mathematical description of contaminant transfer within the food web of Green Bay zones 2 through 4. The food web is comprised of the primary energy transfer pathways from the exposure sources (sediment and water) to the fish species of interest, described in Section 4.4. These pathways include: chemical uptake across the gill surface, chemical uptake from food and chemical losses due to excretion and growth dilution. The mathematical descriptions are generic (common to all aquatic food webs) and were updated as part of the FS.

GBFood was used in the RI/FS to estimate PCB concentrations in the food webs leading to brown trout and walleye in the Lower Fox River (from the dam at De Pere to the mouth) and Green Bay. This was accomplished by specifying values for the various physiological, bioenergetic and toxicokinetic parameters in the model and the PCB exposure levels in sediments and water. The parameter values were derived from peer reviewed studies published in the literature and/or site-specific data. The sediment and water column PCB concentrations were provided by the whole Lower Fox River Model (wLFRM) and GBTOXe model outputs. The calibrated GBFood was used to evaluate the efficacy of several remedial alternatives in reducing PCB levels in fish of the Lower Fox River and Green Bay.

The GBFood results are published as a separate document which supplements this RI/FS/RA.

6.4.3 Fox River Food (FRFood) Model

The Fox River Food (FRFood) bioaccumulation model, based on the Gobas model (1993), is a mathematical description of PCB transfer within the food web of the Lower Fox River and Green Bay (Zone 2). The model is designed to take the output of sediment and water concentrations of PCBs from wLFRM and GBTOXe to estimate concentrations in multiple trophic levels in the aquatic food web (i.e., benthic insects, phytoplankton, zooplankton, and fish). This food web model is functionally similar to, and spatially overlaps with, the food web model for Green Bay (GBFood), with the exception that the FRFood model can be run in reverse where the inputs are fish concentrations and the outputs are predicted sediment concentrations.

FRFood is based upon the algorithms originally developed for Lake Ontario PCBs (Gobas, 1993). Since then, the model has been used extensively throughout the Great Lakes, including derivation of bioaccumulation factors, bioconcentration factors, and food chain multipliers in the development of the Great Lakes Water Quality Initiative (GLWQI) criteria (EPA, 1993b; EPA, 1994). The model was first used for projecting sediment quality thresholds in the 1996 RI/FS for the Upper Fox River (GAS and SAIC, 1996), and has since been used for setting action levels at the Sheboygan River (EVS, 1998), and for predicting long-term effects on biota at the Hudson River, New York (EPA, 2000c).

The primary objectives in using the FRFood model was to 1) estimate potential risk-based remedial clean-up levels called sediment quality thresholds (SQTs), and

2) project fish tissue concentrations that would be associated with a specific remedy. To facilitate the selection of a remedy that will result in a decrease in human and ecological risks, it is necessary to establish a link between levels of PCBs toxic to human and ecological receptors, and the principle source of those PCBs, the Lower Fox River and Green Bay sediment. The FRFood model defines this link.

6.4.4 Whole Lower Fox River Model

The whole Lower Fox River Model (wLFRM) was developed from the two models developed for analysis of flow in the Lower Fox River: the Upper Fox River (UFR), which covered the river between Lake Winnebago and the De Pere dam, and the Lower Fox River model, which extended from the De Pere dam to the mouth of the river. The wLFRM retains the spatial resolution of the UFR/LFR models, but allows the simulation of the entire Lower Fox River from Lake Winnebago to the mouth of the river using a single model. The wLFRM is calibrated to data collected between 1989 and 1995. Calibration consisted of comparisons between the data and model results for total suspended solids and dissolved/particulate PCB in water, sediment bed elevation, and net sediment burial rate.

The wLFRM is used to simulate the fate and transport of solids and PCBs in the water and sediments in the Fox River. The model area is divided into 40 water column segments, 165 surficial sediment segments, and 330 subsurface sediment segments. The model predicts the movement of solids and PCBs among these various model segments. In addition, the model simulates the concentration of organic carbon in the water column. Transport mechanisms in wLFRM include advection, dispersion, volatilization, deposition, and resuspension. Deposition is a function of particle size or density with different settling rates to represent sand, silt and clay-size particles. The settling rate for clay-size particles can also be used to simulate the settling of low-density organic matter. Resuspension is based on surface water velocity and the effect of sediment bed armoring over time.

The results from the wLFRM are used as input to other modeling efforts being conducted for the Fox River/Green Bay RIFS. The wLFRM results from reaches above the De Pere dam are used as input to the FRFood model. Results from below De Pere dam to the mouth of the river are used as input to the GBFood model. Finally, the predicted solids and PCB discharges at the mouth of the river are used as inputs to the GBTOXe model.

The wLFRM results are published as a separate document which supplements this RI/FS/RA.

6.5 Section 6 Tables

Tables for Section 6 follow this page, and include:

Table 6-1. Lower Fox River - Fate and Transport Chemical Factors

Chemical Name	Water Solubility (mg/L)	Vapor Pressure (mm Hg)	Henry's Law Constant (atm-m^3/mol)	Koc (ml/g)	Kow (ml/g)
Polychlorinated Biphenyls (PCBs)					
PCBs (General values)	3.10E-02	7.70E-05	1.07E-03	5.30E+05	1.10E+06
Aroclor 1016	4.20E-01	4.00E-04	2.90E-04	NA	2.40E+04
Aroclor 1221	1.50E+01	6.70E-03	3.50E-03	NA	1.23E+04
Aroclor 1232	1.45E+00	4.06E-03	NA	NA	1.58E+03
Aroclor 1242	2.40E-01	4.10E-04	5.60E-04	NA	1.29E+04
Aroclor 1248	5.40E-02	4.90E-04	3.50E-03	NA	5.62E+05
Aroclor 1254	1.20E-02	7.70E-05	2.70E-03	4.25E+04	1.07E+06
Aroclor 1260	2.70E-03	4.10E-05	7.10E-03	NA	1.38E+07
Dioxin					
2,3,7,8-TCDD	2.00E-04	1.70E-06	3.60E-03	3.30E+06	5.25E+06
Pesticides					
DDT	5.00E-03	5.50E-06	5.13E-04	2.43E+05	1.55E+06
Dieldrin	1.95E-01	1.78E-07	4.58E-07	1.70E+03	3.16E+03
SVOCs/PAHs					
Acenaphthylene	3.93E+00	2.90E-02	1.48E-03	2.50E+03	5.01E+03
Acenaphthene	3.42E+00	1.55E-03	9.20E-05	4.60E+03	1.00E+04
Anthracene	4.50E-02	1.95E-04	1.02E-03	1.40E+04	2.82E+04
Benzo(a)anthracene	5.70E-03	2.20E-08	1.16E-06	1.38E+06	3.98E+05
Benzo(a)pyrene	1.20E-03	5.60E-09	1.55E-06	5.50E+06	1.15E+06
Benzo (b)fluoranthene	1.40E-02	5.00E-07	1.19E-05	5.50E+05	1.15E+06
Benzo(ghi)perylene	7.00E-04	1.03-E-10	5.34E-08	1.60E+06	3.24E+06
Benzo(k)fluoranthene	4.30E-03	5.10E-07	3.94E-05	5.50E+05	1.15E+06
Chrysene	1.80E-03	6.30E-09	1.05E-06	2.00E+05	4.07E+05
Dibenz(a,h)anthracene	5.00E-04	1.00E-10	7.33E-08	3.30E+06	6.31E+06
Fluoranthene	2.06E-01	5.00E-06	6.46E-06	3.80E+04	7.94E+04
Fluorene	1.69E+00	7.10E-04	6.42E-05	7.30E+03	1.58E+04
Indeno(1,2,3-cd)pyrene	5.30E-04	1.00E-10	6.86E-08	1.60E+06	3.16E+06
2-Methylnapthalene	2.54E+01	NA	NA	8.50E+03	1.30E+04
Naphthalene	3.17E+01	2.30E-01	1.15E-03	1.30E+03	2.76E+03
Phenanthrene	1.00E+00	6.80E-04	1.59E-04	1.40E+04	2.88E+04
Pyrene	1.32E-01	2.50E-06	5.04E-06	3.80E+04	7.59E+04
Pentachlorophenol	1.40E+01	1.10E-04	2.75E-06	5.30E+04	1.00E+05
Bis(2-ethylhexyl) phthalate	2.85E-01	2.00E-07	3.61E-07	5.90E+03	9.50E+03
Inorganic Compounds					
Ammonia	5.30E+05	7.60E+03	3.21E-04	3.10E.00	1.00E+00
Arsenic and Compounds	NA	0.00E+00	NA	NA	NA
Barium and Compounds	NA	NA	NA	NA	NA
Cadmium and Compounds	NA	0.00E+00	NA	NA	NA
Chromium III and Compounds	NA	0.00E+00	NA	NA	NA
Chromium VI and Compounds	NA	0.00E+00	NA	NA	NA
Copper and Compounds	NA	0.00E+00	NA	NA	NA
Lead and Compounds	NA	0.00E+00	NA	NA	NA
Mercury and Compounds	3.00E-02	2.00E-03	1.10E-02	NA	NA
Nickel and Compounds	NA	0.00E+00	NA	NA	NA
Selenium and Compounds	NA	0.00E+00	NA	NA	NA
Silver and Compounds	NA	0.00E+00	NA	NA	NA
Zinc and Compounds	NA	0.00E+00	NA	NA	NA

Notes: 1) Values obtained from "Basics of Pump-and-Treat Ground-Water Remediation Technology"
EPA document EPA-600/8-90/003 or from the specific ATSDR Toxicological Profile.
2) NA - Vaule not available.

7 Summary of Findings

7.1 Introduction

The RI study area includes the Lower Fox River, extending 63 km (39 mi) from the outlet of Lake Winnebago to its mouth, as well as Green Bay, from the city of Green Bay and extending 190 km (119 mi), to Michigan's Big and Little Bay de Nocs. Both the Lower Fox River, and to a lesser extent, Green Bay were historically used as general discharge points for municipal, industrial, and agricultural entities located within the watershed. Many of the historical discharge practices occurred with minimal treatment of wastes during an era of little environmental regulation and without an adequate understanding of the fate and effects the chemicals posed to the environment. As a result, numerous compounds have been detected in the sediments and water of the Lower Fox River and Green Bay, as well as in the aquatic and wildlife species living in or frequenting the system.

The data evaluated in this RI report include selected sediment and water sample analytical results collected between 1989 and 1999 along the entire 63 km (39 mi) stretch of the river as well as all of Green Bay. Sediment samples were analyzed for over 200 different chemical parameters. In addition, biological sampling data has been collected since the 1970s. Data that was used in preparing the RI report was derived from the FRDB. The FRDB was developed following quality assurance review and acceptance of data gathered during previous investigations (EcoChem, 2000). Further, the conclusions of an EPA authorized peer review included the following:

- The quantity and quality of data are good enough to support the need for cleanup action
- The data are adequate to determine the distribution of contaminants within the system and direct where cleanup actions should focus
- The data are adequate to support identification and selection of possible remedy technologies (Weston, 1999)

The FRDB was used in this RI to evaluate the distribution of select compounds in the sediment and water of both the Lower Fox River and Green Bay. Information pertaining to the distribution of chemical compounds within fish and wildlife evaluated along the Lower Fox River and Green Bay, as well as other potential risks to human health and the environment, are addressed in the SLRA (RETEC, 1998c) and the RA (RETEC, 2002), performed in conjunction with this RI.

Compounds of potential concern, representing potential risks to human and ecological health, were identified in the SLRA (RETEC, 1998c) based on conservative risk screening procedures. These compounds include the chlorinated organic compound (PCBs and dioxins/furans), the chlorinated pesticides (DDT and dieldrin), and the inorganic compounds (mercury, lead, and arsenic). Of the substances evaluated in the SLRA, PCBs are the primary compounds of concern within the Lower Fox River and Green Bay.

Between the mid 1950s and the early 1970s, PCBs were used and released to the environment through carbonless copy paper production and recycling by a number of facilities along the Lower Fox River. During this time period, PCB use was unregulated. The WDNR estimated that between about 1954 and the early 1970s the cumulative mass of PCBs discharged into the Lower Fox River was about 313,600 kg (691,370 pounds), with a possible range between 126,450 and 399,450 kg (278,775 and 880,640 pounds) (WDNR, 1999a). According to WDNR estimates, approximately 98 percent of the total PCBs were released by the end of 1971. Five point sources are estimated to have contributed over 99 percent of the PCBs detected in the river sediments (WDNR, 1999a).

Point source discharges of the compounds of potential concern (COPC) have decreased significantly since the Clean Water Act and other environmental regulations were implemented in the early 1970s. As a result, additional input of PCB into the Lower Fox River from regulated discharges has now been essentially eliminated (WDNR, 1999a). However, residual sources for PCBs and other detected compounds remain in river and bay sediments, which continue to affect water quality, fish, wildlife, and potentially humans. The RA (RETEC, 2002) identified total PCB concentrations in sediments above 250 μg/kg as a potential concern for at least 50 percent of all potential receptors. Some of the documented adverse effects associated with PCBs include altered benthic community structure and reproductive impairments in fish-eating birds (WDNR, 1996; Matteson, 1998). The WDNR issued consumption advisories for fish in both the river and the bay as early as 1976, and waterfowl advisories were issued in 1987 due to continuing elevated levels of PCBs in tissue samples. The MDNR issued a fish consumption advisory for Green Bay fish in 1977.

7.2 Physical and Ecological Characteristics

The average annual discharge rate from the Lower Fox River into Green Bay is approximately 122 m^3/s (4,300 cfs). The locations of sediment deposits are related to flow characteristics along the river channel and typically occur where water velocities decrease, such as behind dams or where the river widens. The most significant sediment accumulation in the Lower Fox River occurs downstream of the De Pere dam, partially due to the water level and seiche effect of Green Bay where streamflow direction frequently reverses in this reach.

Water currents within Green Bay are more complex than the Lower Fox River and are affected by wind speed and direction, river discharge, thermal gradients, and ice cover. These currents generally move counter-clockwise and water from the Lower Fox River moves north along the east side of the bay while water from Lake Michigan moves south along the west side. These currents also control the distribution of sediments discharged from the Lower Fox River into Green Bay. Because the mouth of the Lower Fox River is located at the southern end of Green Bay, most of the river discharge, associated sediment load, and PCBs are directed along the east shore of Green Bay.

The bay bathymetry is also influenced by water currents and, in turn, affects the distribution of sediments. Regionally, bedrock dips to the east and river tributaries to Green Bay are more prevalent along the west side of the bay. Based on current patterns, a number of spits and shallows have formed near these tributaries mouths. These spits and shallows direct the currents towards the center of the bay, thereby establishing areas within the bay where lower velocity circular currents occur. Both Long Tail Point and Little Tail Point extend at least 3.4 km (2.1 mi) into the bay. Significant sediment accumulations occur between the mouth of the Lower Fox River and a line between Long Tail Point (on the west) and Point Au Sable (on the east). Bathymetry measurements are typically less than 3.7 m (12 ft) within this area. Moving north from the mouth of the Lower Fox River, the water depth in the bay increases and the influence of the spits and shallow areas on current movement decreases.

The southern end of Green Bay is a lacustrine estuary with hypereutrophic conditions. Water quality on the south end of the bay reflects the influence of runoff and the sediment load from the Lower Fox River and other tributaries. The hypereutrophic conditions of the southern bay support a large and diverse population of fish species due to the availability of nutrients. Due to the shallow water depths, this portion of the bay warms rapidly during summer months, supporting extensive biological activity. Historically, fish dies-offs occurred during periods of extremely warm water or extended ice cover because of reduced dissolved oxygen levels from biological and chemical processes. No significant die-offs have been recorded since the 1960s or early 1970s (Lychwick, 2000c).

Water quality conditions in the northern part of the bay, especially near the passage connecting with Lake Michigan are generally oligotrophic, except in the northern portion of Big Bay de Noc or near the tributary mouths on the west side where mesotrophic or eutrophic conditions may exist.

Significant habitat areas present within the river and bay include wetlands and associated submerged SAV. Wetlands offer nesting, feeding, and refuge opportunities for birds and terrestrial animals of the region. The SAV typically associated with wetlands provide spawning, feeding and refuge habitat for a variety of forage and game fish in the river and bay. Wading birds, shorebirds, and waterfowl feed on the SAV or fish that frequent these areas, as well as nesting in these areas. Wetland habitat are preferred by mink, although these animals will also live and feed in grassland and agricultural areas, if necessary.

In addition to wetland/SAV habitat, islands offer nesting and feeding opportunities to birds and terrestrial animals, while cuts/coves offer quiet water areas where fish will congregate, birds will feed, and terrestrial animals will seek refuge or food. Eagles, double-crested cormorants, gulls/terns, and numerous other birds nest in the vicinity of the river and bay and these birds feed on the fish of the system.

Exposure of biota to PCB-impacted sediments fosters uptake of PCBs into the food chain. Therefore, the presence of PCB impacted sediments in locations near wetlands/SAV, islands, quiet water cuts/coves, and other habitat areas within or along the shores of the Lower Fox River and Green Bay are of concern and described in this report.

7.3 Nature and Extent of Sediment Impacts

7.3.1Overview

Sediment and water samples collected from Lake Winnebago reflect relatively low background concentrations of most constituent groups compared with those observed in Lower Fox River. The sources of PCBs, and most other COPC, are located downstream of Lake Winnebago. Water samples collected from both the river and bay indicate that PCBs and the other chemical compounds are continuing to migrate through the system as particulates absorbed to river/bay sediments and in a dissolved phase.

Below Lake Winnebago and upstream of the De Pere dam, PCB impacted sediments have accumulated in specific deposit areas that reflect the dynamics of the river hydrology. Downstream of the De Pere dam and out into Green Bay, sediments and PCBs have accumulated over large continuous areas. The highest total PCB concentrations in sediments within the Lower Fox River are typically found in the vicinity of historical point source discharges, including deposits in LLBdM and SMUs 56/57. Although a number of PCB discharge points were located in LLBdM, sediment transport has since dispersed the PCBs throughout the river and over large areas downstream of the De Pere dam, especially within the bay.

Approximately 96,800 kg of PCBs are distributed in sediments with PCB concentrations greater than 50 ug/kg. This PCB mass is contained in about 474 million m^3 of sediment. The results are summarized below and indicate that the De Pere to Green Bay Reach and Green Bay Zone 2, combined, contain almost 60 percent of the total PCB mass in the system in less than 10 percent of the total contaminated sediment volume. The PCB mass and volume of contaminated sediment for each river reach and bay zone are listed below.

Location	PCB Mass and Percent in System*	Contaminated Sediment Volume and Percent in System*
Little Lake Butte des Morts Reach	1,540 kg (1.6%)	1.35 million m^3 (0.29%)
Appleton to Little Rapids Reach	94 kg (0.1%)	0.18 million m^3 (0.04%)
Little Rapids to De Pere Reach	980 kg (1.0%)	1.71 million m^3 (0.36%)
De Pere to Green Bay Reach	25,984 kg (26.8%)	5.52 million m^3 (1.16%)
Green Bay Zone 2	32,013 kg (33.1%)	39.5 million m^3 (8.33%)
Green Bay Zone 3	35,243 kg (36.4%)	397 million m^3 (83.72%)
Green Bay Zone 4	925 kg (1.0%)	28.9 million m^3 (6.10%)
TOTAL	**96,779 kg**	**474.16 million m^3**

* Includes sediments containing PCB concentrations greater than 50 μg/kg.

Because PCBs are no longer discharged, more recent sediment loading into the river is gradually mixing with and accumulating over PCB impacted deposits. The vertical distribution of PCB concentrations within river and bay sediments frequently increase with depth. As noted previously, the river stage and discharge rate significantly affect resuspension, mixing, transport, and redeposition of impacted sediments in the system.

PCB concentrations in surface sediments in the Lower Fox River and Green Bay are generally decreasing over time, but apparent detectable loss is limited to the top 4 inches of sediment. The rate of change in surface sediments is both reach- and deposit-specific. The change averages an annual decrease of 15 percent, but ranges from an increase of 17 percent to a decrease of 43 percent. Just below the top 4 inches, there is no distinguishable change in the sediment PCB concentrations constant. The changes in PCBs in the sediments are reflected in the significant, but slow declines in fish tissue concentrations of between 5 and 7 percent annually. Exceptions to the general overall decline were noted with walleye in Little Lake

Butte des Morts and carp in Green Bay Zone 1, where steep significant increases in PCB concentrations were observed.

7.3.2 Lower Fox River PCB Impacts

7.3.2.1 Overview

Large volumes of soft sediment have accumulated at a number of locations throughout the Lower Fox River. Upstream of the De Pere dam there are 35 previously identified sediment deposits, exhibiting total PCB concentrations greater than 50 μg/kg. As indicated above, these deposits comprise approximately 2.7 percent of the total PCB mass in the system. A large majority of the PCBs in the upper three reaches of the river occur within several specific sediment deposits. Approximately 1,932 kg (4,260 pounds) of PCBs (74 percent of the total PCB mass upstream of the De Pere dam) is contained within sediment deposits A, B, POG, and EE/FF/GG/HH. The mass of PCB associated with Deposit N is not included in these estimates due to completion of the SRD project.

In the De Pere to Green Bay Reach there is one large, continuous sediment deposit between the dam and just downstream of the Fort James turning basin. Small sediment deposits are located downstream of the turning basin due to navigation channel dredging activities. Approximately 27 percent of the total estimated PCB mass in the river/bay system is located in this reach. Further, the estimated 25,984 kg (57,285 pounds) of PCB in this reach represents almost 91 percent of the total mass in the river.

The following summarizes the magnitude and extent of impacted sediments and PCBs for each reach of the river.

7.3.2.2 Little Lake Butte des Morts Reach

Deposits A through H and POG contain about 1,540 kg (3,395 pounds) of PCBs in about 1.35 million m^3 (1.77 million yd^3) of sediment with concentrations greater than 50 μg/kg PCB. RI findings for this reach include the following:

- These deposits cover about 314 hectares (775 acres) and the deposits range up to approximately 1.9 m (6.2 ft) thick.

- The highest total PCB concentration was 222,722 μg/kg.

- Upstream deposits A, B, and POG have the highest PCB mass to volume ratios in this reach. These three deposits contain 952 kg (2,100 pounds) of the PCBs in about 252,000 m^3 (329,600 yd^3) of sediment. Also, about 910 kg (2,000 pounds) of the PCBs in these three deposits is present in the upper 100 cm (3.28 ft) of sediment.

- Deposit E contains about 454 kg (1,000 pounds) of PCBs. However, the mass to sediment volume ratios for this deposit is much lower than deposits A, B, and POG.

Habitat associated with this reach include Stroebe Island, located on the northeast side of Deposit E. The wetlands located between Stroebe Island and the river bank are the largest in-river wetlands in this reach. Also, an eagle nest has been observed in this area. Smaller wetland areas are located in the vicinity of deposits A, C, and POG and SAV are present in the shallow waters nearby, including near Deposit B. Two large areas of cuts/coves are present on the west side of Deposit C and just south of Deposit POG. Most of the shoreline in the LLBdM Reach is characterized as either poor or unsuitable for mink.

7.3.2.3 Appleton to Little Rapids Reach

Sediment accumulation in the Appleton to Little Rapids Reach is more localized compared with the other three reaches. Deposits I through DD contain about 94 kg (207 pounds) of PCBs in about 184,790 m^3 (241,700 yd^3) of sediment with concentrations greater than 50 μg/kg PCB. RI findings for this reach include the following:

- Deposits I through DD cover approximately 153 hectares (378 acres) and these deposits generally occur in areas of slower stream flow velocities (e.g., where the river widens, in the vicinity of dams/locks, eddy pools along the banks, etc.).

- The highest total PCB concentration was 77,444 μg/kg.

- Only deposits W, X, and DD have a volume exceeding 30,000 m^3 (39,240 yd^3) of sediment and these are located where the river widens and/or upstream of a dam.

- The average sediment volume in each of the remaining 19 deposits in this reach is about 3,780 m^3 (4,944 yd^3) and sediments range up to approximately 100 cm (3.28 ft) thick.

- Deposits T and DD contain a combined mass of about 45 kg (100 pounds) of PCBs, and these PCBs are located at depths less than 100 cm (3.28 ft).

- Approximately 32 kg (71 pounds) of PCBs remain in deposits N and O following completion of the SRD project and no future attempt to remove this mass is currently under consideration.

The Thousand-Islands Nature Conservancy, located near the city of Kaukauna and just upstream of deposits W and X, is an important habitat area in this reach. The nature conservancy is protected island habitat in which eagles nest and other birds and terrestrial animals nest and feed. The wetland and SAV habitat associated with the shores of the conservancy are the largest in the reach. Additional wetlands and SAV areas are located near the Little Rapids dam, which is in the vicinity of Deposit DD. Mink habitat in this reach varies. Between Appleton and Kaukauna the mink habitat is generally characterized as either poor or unsuitable. However, between Kaukauna and Little Rapids, the shoreline habitat is characterized as moderate to good.

7.3.2.4 Little Rapids to De Pere Reach

Sediment accumulation in this reach extends over a long distance and large area. Deposits EE through HH contain 980 kg (2,160 pounds) of PCBs in approximately 1.71 million m^3 (2.24 million yd^3) of sediment with concentrations greater than 50 μg/kg PCB. The four deposits in this reach are essentially a single sediment unit. RI findings for this reach include the following:

- These sediments cover about 266 hectares (657 acres) and are up to 2.3 m (7.5 ft) thick in select areas, especially near the De Pere dam.

- The highest total PCB concentration was 54,000 μg/kg. Further, PCB concentrations are lowest at the upstream end of Deposit EE and increase near the De Pere dam.
- Almost all of the PCB are contained in the upper 100 cm (3.28 ft) of sediments.

No significant wetland or SAV areas are located in this reach. However, this reach is generally less developed than the other three reaches and large expanses of the shoreline are characterized as marginal to good for mink habitat.

7.3.2.5 De Pere to Green Bay Reach

This reach exhibits the largest volume and areal extent of impacted sediments found in the Lower Fox River. The 96 SMUs in this reach contain 25,984 kg (57,285 pounds) of PCBs in over 5.5 million m^3 (7.2 million yd^3) of sediments with concentrations greater than 50 μg/kg PCB. RI findings for this reach include the following:

- Sediments cover about 524 hectares (1,295 acres) and range in thickness up to 4 m (13 ft).

- The highest total PCB concentration was 710,000 μg/kg.

- The mass of PCB decreases significantly with depth. Approximately 16,150 kg (35,530 pounds) of PCBs, or about 55 percent of the total PCB mass in the Lower Fox River, are located in the upper 100 cm (3.28 ft) of sediments in this reach. Approximately 10,600 kg (23,370 pounds) of PCBs (36 percent of the PCBs in the river) are buried below 100 cm (3.28 ft).

- Approximately 636 kg (1,400 pounds) of PCB and 31,000 m^3 (40,550 yd^3) of sediment were removed from SMUs 56-61 during the SMU 56/57 SRD project. Further, removal of additional sediment and PCB from SMU 56/57 started in August 2000 but the final mass and volume estimates are not expected to be known until early 2001.

- Excluding SMUs 56-61, six SMU groups (SMUs 20-25, 32-37, 38-43, 62-67, 68-73, and 80-85) contain almost 11,000 kg (24,250 pounds) of PCB, or about 37 percent of the total mass in the Lower Fox River. These SMU groups also exhibit the highest PCB concentrations or greatest PCB mass to sediment volume ratios in the river.

Both banks of the river in this reach are extensively developed. Therefore, significant habitat locations within this reach are largely confined to submerged wetland areas associated with the mouth of the river. Only 16 hectares (40 acres) of wetlands and SAV were identified in this reach. Additionally, two large areas of cuts/coves are located in SMUs 20-25, just downstream of the De Pere dam, and in SMUs 44-49. These are both areas with elevated PCB concentrations in surface sediments. Mink habitat in this reach is generally characterized as unsuitable.

7.3.3Green Bay PCB Impacts

7.3.3.1 Overview

The PCB mass and impacted sediment volume in Green Bay are much larger than in the Lower Fox River. Considering sediments with concentrations greater than 50 μg/kg PCB, the estimated mass in Green Bay exceeds 68,180 kg (150,310 pounds) and the volume exceeds 465 million m^3 (608 million yd^3). This represents almost 71 percent of the PCB mass and over 98 percent of the contaminated sediment volume in the system.

Estimates of the PCB load transported from the Lower Fox River into Green Bay were completed using data from 1994/95 and 1998. Approximately 220 kg (485 pounds) of PCBs were transported from the river into the bay during 1994/95. Based on water samples collected during 1998, this load decreased to about 125 kg (275 pounds). The PCB load from the river into the bay is affected by the seasonal and yearly changes in stream flow as well as the declining finite source of PCBs located within the river.

Total PCB concentrations in sediment are highest, and the mass/volume ratios greatest, near the mouth of the Lower Fox River and decrease with distance. The presence and distribution of PCBs within Green Bay reflect the influence of discharge from the Lower Fox River as well as the predominantly counter-clockwise current patterns in Green Bay. Sediments with the highest PCB concentrations are located in the immediate vicinity of the river mouth or along the east shore of the bay.

7.3.3.2 Green Bay Zone 2

This zone contains approximately 32,000 kg (70,550 pounds) of PCBs in 39.5 million m^3 (51.6 million yd^3) of sediment. Sediments with the highest PCB concentrations have accumulated adjacent to the navigation channel and between the mouth of the river and Point Au Sable. The PCB distribution reflects the influence of Green Bay current patterns, as higher concentrations are located along the east side of the bay. RI findings for this zone include the following:

- Sediments in Zone 2A cover about 5,930 hectares (14,650 acres) and have an average thickness of about 0.34 m (1.1 ft). In Zone 2B the sediments cover about 5,150 hectares (12,725 acres) and have an average thickness of about 0.38 m (1.25 ft).

- The highest total PCB concentration was 17,000 μg/kg.

- Considering only sediments with PCB concentrations greater than 1,000 μg/kg reduces the mass and volume estimates to 28,100 kg (61,950 pounds) and 17.8 million m^3 (23.3 million yd^3), respectively. This represents slightly more than 29 percent of the PCBs in the system but less than 5 percent of the total estimated contaminated sediment volume.

- Considering only the upper 30 cm (1 ft) of sediments, approximately 14,5000 kg (31,900 pounds) of PCBs are contained within about 29.8 million m^3 (39 million yd^3) of sediment. This represents about 15 percent of the total PCB mass and 6 percent of the contaminated sediment volume in the system.

The most significant habitat types within Green Bay are wetlands and islands. A number of wetland areas are located within Zone 2. The Point Au Sable and Whitney Slough wetland areas are located along the east shore of Green Bay (Zone 2B). Atkinson Marsh, Long Tail Point, Dead Horse Bay, and portions of the Little Tail Point wetland areas are all located along the west shore of the bay (Zone 2A).

Fish spawn and feed throughout Zone 2 due to the shallow water depths and abundant nutrients available in this hypereutrophic environment. Although sediment impacts are greater in Zone 2B than in Zone 2A, the discharge of the Lower Fox River and the seiche effect both contribute to the dispersal of PCB-impacted sediments throughout this entire zone.

In addition to the wetland areas, both Bay Port and Kidney Island CDFs are located in this zone. Both CDFs have received PCB impacted sediments removed during navigation channel dredging activities and gulls/terns nest on Kidney Island while waterfowl and other birds nest and feed in the vicinity of Bay Port. Mink habitat associated with the two CDFs are generally marginal. Mink habitat in Zone 2B is generally poor to unsuitable, although moderate to good habitat is present with increasing distance from the mouth of the Lower Fox River. Zone 2A mink habitat is generally marginal or better north of the mouth of Duck Creek.

7.3.3.3 Green Bay Zone 3

This zone contains approximately 35,240 kg (77,700 pounds) of PCBs in approximately 397 million m^3 (519 million yd^3) of sediment. PCB distribution results show that sediments with the highest concentrations have accumulated along the east shore of Green Bay, extending from Dyckesville to Egg Harbor, reflecting the influence of Green Bay current patterns. RI findings for this zone include the following:

- Sediments in Zone 3A cover about 85,890 hectares (212,240 acres) and have an average thickness of just 0.21 m (0.7 ft). In Zone 3B, the sediments cover about 69,340 hectares (171,340 acres) and have an average thickness of about 0.31 m (1 ft).

- The highest total PCB concentration was 1,320 μg/kg.

- Considering only sediments with concentrations greater than 1,000 μg/kg PCB reduces the mass and volume estimates to 1.65 kg (3.64 pounds) and 8,800 m^3 (11,510 yd^3), respectively. This zone represents very small percentages of the estimated total PCB mass and contaminated sediment volume in the system.

- Considering only the upper 30 cm (1 ft) of sediments, approximately 30,000 kg (66,000 pounds) of PCBs are contained within about 355.9 million m^3 (465.5 million yd^3) of sediment. However, a large majority of this mass is located in sediments which have less than 1,000 μg/kg PCBs.

Similar to Zone 2, wetlands and islands are the main habitat located along or within the bay. Extensive wetland areas are located along the west shore of Green Bay and fish spawn and feed throughout this area. However, sediments with the highest PCB concentrations in Zone 3 are located along the east shore of Green Bay. Only two large wetland areas, the Little Sturgeon Bay and Sand Bay wetlands, are located along the east shore. Also, on the east side of the bay, fish spawn and feed within a very narrow band of shallow water located near the shore as well as in the vicinity of Little Sturgeon Bay and the islands located in this area. In addition to the wetlands, a number of small islands are located along the east shore of Green Bay, extending from Little Sturgeon Bay to the tip of the Door Peninsula. These islands offer secure nesting locations for numerous types of birds.

Mink habitat was only characterized only as far north as the city of Marinette on the west side of the bay and just north of the city of Sturgeon Bay on the east side. The Zone 3 shoreline is generally characterized as marginal to good, except in areas where development has occurred, such as the cities of Dyckesville and Sturgeon Bay.

7.3.3.4 Green Bay Zone 4

Based on the estimates of the PCB mass and sediment volume, Zone 4 is relatively unaffected compared to zones 2 and 3. Zone 4 contains less than 925 kg (2,040 pounds) of PCBs, or only about one percent of the total mass in the system. Total PCB concentrations in sediment within Zone 4 are all less than 500 μg/kg except for one sample which had a concentration of 751 μg/kg.

Habitat present in this zone includes wetlands, SAV, islands, and other areas which support fish, birds, and wildlife. Based on the small mass of PCBs and the low concentrations (compared with the other river reaches and bay zones), habitat within this zone is relatively unimpacted.

7.3.4 Other Chemical Compounds

Elevated concentrations of the other six COPCs are typically widespread in river and bay sediments with little or no spatial relation to specific discharge sources.

The distribution of these chemicals reflects the dynamic nature of the river and bay environments, the effect of downstream transport of sediments in the system, and/or non-point pollution sources.

The RI findings with respect to other chemical parameters in sediments include the following:

- Mercury was used in a number of pulp and paper production activities to reduce organic slime (Konrad, 1971). The SLRA identified mercury concentrations exceeding 0.15 mg/kg as a potential concern. Mercury concentrations in Lake Winnebago sediments averaged 0.14 mg/kg while average concentrations in each reach of the Lower Fox River ranged from 1.26 to 2.42 mg/kg. The elevated mercury concentrations are widespread in the Lower Fox River sediments and are not associated with any specific deposit or point source discharge. Mercury concentrations in Green Bay are much lower than levels in the river. The average concentration in Zone 2 was 0.593 mg/kg but averages in zones 3 and 4 range only up to 0.19 mg/kg, which is just above the Lake Winnebago background concentration.

- Except for PCB and mercury, no specific existing or historical discharge sources were identified for the other COPCs.

- The spatial distribution of dioxin/furan compounds cannot be evaluated because only 22 samples were collected from deposits D/E/POG, deposits EE/HH, and SMUs 56/57. Concentrations of 2,3,7,8 TCDD/F detected in sediments ranged from 0.23 to 170 ng/kg (ppt). The SLRA identified furan concentrations above 2,000 ng/kg as a potential concern.

- Sixteen chlorinated pesticides, which are generally associated with agricultural non-point source activities, were detected in river sediments at concentrations up to 67 μg/kg. Additional non-point pesticide sources may include atmospheric deposition and stormwater run-off from pesticides used at parks, golf courses, and other institutional facilities; however, these sources are likely to be small compared with agricultural activities. Only seven compounds were detected in more than four sediment samples. These included DDT, and its derivatives DDD and DDE, endrin aldehyde, endrin ketone, gamma-BHC (lindane), and heptachlor. Distribution of these compounds was generally sporadic. Only DDT and dieldrin were identified by the SLRA as being COPCs. The SLRA identified DDT (total) concentrations above 1.6 μg/kg as a potential concern. DDT was detected at 10 widely distributed locations within the Lower Fox River above this concentration. There is no established concentration of concern for dieldrin, which was detected in only one sample from LLBdM, suggesting that dieldrin distribution is very limited. Neither DDT nor dieldrin were detected within Green Bay.

- Lead is a naturally occurring element in soil and sediment. Background lead concentrations in Lake Winnebago sediments averaged 35 mg/kg while average concentrations in each reach of the Lower Fox River ranged from 75.6 to 167.8 mg/kg. However, a disproportionately large number of samples for these two compounds were collected in the De Pere to Green Bay Reach. The SLRA identified lead concentrations above 47 mg/kg as a potential concern. While some deposits exhibit concentrations as high as 1,400 mg/kg, lead occurrence is widespread in the Lower Fox River sediments and cannot be related to any specific point source discharge. In Green Bay, the average lead concentration ranged from 1.5 to 29.9 mg/kg, which is lower than the Lake Winnebago background concentration.

- Arsenic is also naturally occurring and background concentrations in Lake Winnebago sediments averaged 5.33 mg/kg. The SLRA identified arsenic concentrations above 8.2 mg/kg as a potential concern. An elevated arsenic concentration was detected in only one location (SMU 38) at 385 mg/kg. Excluding this arsenic detection, average concentrations in both the river and the bay were below either the Lake Winnebago background concentration or the SLRA level of 8.2 mg/kg.

- SVOCs, which result from both point and non-point sources in urban and rural areas, were detected throughout the Lower Fox River at concentrations exceeding the background levels observed in Lake Winnebago. The SVOCs detected at higher concentrations included PAHs and also occurred in widespread areas of the river. Total PAH concentrations below 4,000 μg/kg typically do not warrant further assessment. Total PAH concentrations along the Lower Fox River ranged from non-detectable to 60,000 μg/kg. A number of locations from LLBdM to the mouth of the river exceeded 4,000 μg/kg with the highest values frequently observed downstream of more urbanized areas. None of the sediment samples collected within Green Bay Zone 2 exceeded 4,000 μg/kg, and PAHs were not detected in zones 3 or 4.

7.4 Chemical Transport and Fate

The organic COPCs, including PCBs, dioxin/furan, pesticides, and PAHs, exhibit strong affinities for organic material in the sediments. The suspension and transport of these compounds absorbed onto the sediments is largely controlled by moving water in the Lower Fox River and Green Bay. Greater volumes of sediments become suspended and are transported during high flow events (such as storms and spring snow melt). The Lower Fox River has an average discharge of 122 m^3/s (4,300 cfs). Data from Water Years 1989-99 indicate that river discharge exceeds both 272 m^3/s (9,605 cfs) 10 percent of the time. Previous investigators have estimated that these high flow events transport more than 50 to 60 percent of the PCB mass which moves over the De Pere dam and into Green Bay (Velleux and Endicott, 1994; WDNR, 1995).

Water samples collected during 1994/95, confirm these results as well as the estimate of the PCB mass transported into Green Bay. Particulate PCB concentrations suspended in the water column increase moving downstream. Also, downstream of LLBdM, the particulate PCB concentration is approximately three times greater than the dissolved PCB concentration. Particulate PCB concentrations are related to water temperatures and flow whereas the dissolved PCB concentrations are generally constant and never exceeded 33 μg/kg. Particulate PCB concentrations decline dramatically during the winter months, when water temperatures are below 4°C (40°F), and increase in response to high flow events during the summer. WDNR (1995) concluded that this seasonal variation is related to the amount of algae present in the water, which appear to facilitate suspension and transport of PCB in the water column. Similar results were found for mercury in samples collected at the mouth of the river.

The overall PCB flux through the Lower Fox River and Green Bay system is estimated to be as follows:

- Approximately 125 kg (275 pounds) to 220 kg (485 pounds) of PCB are annually transported from the Lower Fox River into Green Bay as part of the suspended sediment load. According to some estimates, this load may have ranged as high 550 kg (1,210 pounds) annually in the past.

- The estimated annual PCB load into Green Bay from tributaries other than the Lower Fox River is estimated to be approximately 10 kg (22 pounds).

- The estimated annual stormwater runoff from non-point sources into the Lower Fox River is estimated to be 1 kg (2.2 pounds).

- Estimates for annual atmospheric deposition of PCB into the Lower Fox River range from 3 kg (6.6 pounds) to 5 kg (11 pounds) while deposition into Green Bay ranges from 2 kg (4.4 pounds) to 35 kg (77 pounds).

- Estimates for annual volatilization of PCBs from surface waters into the atmosphere range up to 5 kg (11 pounds) for the Lower Fox River while volatilization from Green Bay ranges from 130 kg (287 pounds) to 500 kg (1,100 pounds).

- Approximately 122 kg (270 pounds) of PCB are transported annually from Green Bay into Lake Michigan.

At present, roughly 0.4 percent to 1 percent of the PCB mass within the river was discharged into the bay annually. Atmospheric contributions and losses of PCBs are minimal compared to the mass in the river and bay and the amount of PCB transported in dissolved or particulate phase.

7.5 Investigative Assumptions/Uncertainties

Due to the heterogeneity and dynamic nature of the river and bay sediments, various assumptions are necessary in evaluating and interpreting the data and results. These assumptions are discussed below:

- The data used in this RI includes results from numerous investigations performed over an extended period of time. Sediment data were collected over a 10 year period while tissue samples date from 1971. In sediments, temporal changes in the magnitude and extent of the compounds of concern will occur over this time period, particularly at the sediment/water interface. In general, however, sediment mobility decreases with depth and the occurrence and mass of the compounds of concern as described herein is not likely to have appreciably changed over the period of these investigations. Although surface sediment concentrations decrease over time, once sediments are buried, the PCBs tend to remain in place and increase concentrations with depth (The Mountain-Whisper-Light, 2001). The PCB mass exported from the river into Green Bay (estimated to be 1 percent or less annually) is far less than the amount that remains in place. Although shallower PCB sediment concentrations may vary more significantly over the short term, declining PCB concentrations in the sediment and water column on a large scale are a long-term phenomena. Temporal variability in PCB occurrence and mass is believed to be less significant than its spatial heterogeneity. Therefore, the Fox River Database considered all usable analytical results over the period of these investigations, subject to the specified acceptance criteria. In tissue samples, decreasing concentration trends have been observed but the rate of decrease has slowed significantly since the 1980s. Also, some fish species show stable or increasing tissue concentration trends. Therefore, the analyses completed as part of this effort are not suitable for predicting future trends.

- The density of sediment sampling points in the river and bay affects the accuracy of the interpolated distribution of PCBs and the general distribution of the other COPCs described in this report. Some sediment locations (deposits/SMUs/zones) have been sampled extensively while others have been characterized by relatively few samples. However, it is believed that sufficient sampling has been conducted to characterize the compounds present and areas of the Lower Fox River and Green Bay of greatest concern.

- The precision and accuracy of laboratory analytical results for specific sediment samples can be affected by factors such as sampling methods, the representativeness of the sample at a specific location, matrix interferences and analytical protocols. Total PCBs were either analyzed and reported by the laboratory or were calculated from Aroclor or PCB congener results for a given sample. However, the analytical results in the FRDB are assumed to reasonably reflect sediment and water quality, based on the independent quality assurance review and acceptance criteria.

- Sediment bed properties (grain size, cohesion, water content, etc.) generally change more rapidly with depth than horizontally over a large area. It is possible that there is compaction of the sediments when sediment cores are collected. Sample core lengths and the corresponding analytical results have not been adjusted to correct for possible sediment compaction or the percentage of core length recovered, which may tend to underestimate PCB distribution and mass at depth.

Based on the data contained within the FRDB, sufficient sampling and analysis has been conducted to characterize the magnitude and distribution of COPCs in the Lower Fox River and Green Bay as well as allow development of the Baseline Risk Assessment and Feasibility Study.

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