Michigan Department of Environmental Quality
Water Bureau
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Total Maximum Daily Load for Polychlorinated Biphenyls for the Pere Marquette River Watershed including Pere Marquette Lake Lake, Mason, Oceana, and Newaygo Counties

INTRODUCTION

Section 303(d) of the federal Clean Water Act and the United States Environmental Protection Agency's (USEPA's) Water Quality Planning and Management Regulations (Title 40 of the Code of Federal Regulations, Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for water bodies that are not meeting Water Quality Standards (WQS). The TMDL process establishes the allowable loadings of a pollutant to a water body based on the relationship between pollutant sources and in-stream water quality conditions. TMDLs provide states a basis for determining the pollutant reduction necessary from point and/or nonpoint sources to maintain and/or restore the quality of their water resources.

The purpose of this TMDL is to identify allowable levels of polychlorinated biphenyls (PCBs) that will result in the attainment of the applicable WQS in the Pere Marquette River watershed located in Lake, Mason, Oceana, and Newaygo Counties, Michigan.

PROBLEM STATEMENT

The PCB-related TMDL reaches for the Pere Marquette River watershed included in the 2008 Section 303(d) list are as follows:

Water body name: Pere Marquette Lake **AUID**: 040601010509-05
Impaired designated use: Fish Consumption
Cause: PCB in fish tissue
Size: 554 acres
Location Description: Vicinity of Ludington
TMDL Year(s): 2008

Water body name: Pere Marquette River watershed **AUID**: See Appendix A
Impaired designated use: Fish Consumption
Cause: PCB in fish tissue, PCB concentrations exceed WQS
Size: 513 miles
Location Description: Confluence with Pere Marquette Lake upstream, including all tributaries
TMDL Year(s): 2008

These reaches were addressed in the 2006 Section 303(d) list as water body identifiers 0821014, 082101E, and 082101A.

PCBs are a class of man-made, chlorinated, organic chemicals that include 209 congeners, or specific PCB compounds. PCBs are chemically inert, nonflammable, and do not transmit electrical current. They were most commonly used in electrical transformers and capacitors, plastics, rubber, paints, adhesives, and sealants. PCBs were produced for such industrial uses in the form of complex mixtures under the trade name "Aroclor" and were commercially available from 1930 through 1977, after which the USEPA banned their manufacture, sale, and

distribution in the United States due to environmental and public health concerns. PCBs are very stable and do not readily degrade and thus accumulate in water bodies and aquatic sediments. PCBs concentrate in fatty tissues of organisms and bioaccumulate in living tissues. PCBs are a probable human carcinogen and also have negative effects on reproduction and other endocrine functions (USEPA, 2004).

The entire Pere Marquette River watershed (i.e., 513 miles) was listed on the Section 303(d) list in 1998, as determined by fixed station chemical monitoring results of the water indicating PCB concentrations exceeded WQS. In 2000, 21 miles of the Pere Marquette River were listed as not attaining WQS due to fish consumption advisories for brown trout and suckers due to PCBs (LeSage and Smith, 2008). Additional data collected subsequent to the 21-mile listing, in 2004 and 2005, indicated that the fish consumption advisories for brown trout and suckers should be extended to the entire Pere Marquette River watershed (Bohr and Zbytowski, 2007). The 2008 Sections 303(d), 305(b), and 314 Integrated Report (LeSage and Smith, 2008) reflects this revised listing.

Pere Marquette Lake was placed on the Section 303(d) list in 2000, due to analysis of PCB concentrations in the fillets of northern pike and redhorse sucker captured in Pere Marquette Lake, by the Michigan Department of Environmental Quality (MDEQ), which indicated that fish consumption advisories were necessary.

This TMDL addresses the entire Pere Marquette River watershed, which covers approximately 755 square miles and travels through Lake, Mason, Newaygo, and Oceana Counties (Figure 1). Several townships and municipalities are within the watershed (Appendix B). Baldwin Creek, Little South Branch Pere Marquette, and Big South Branch Pere Marquette are all major tributaries of the mainstem of the Pere Marquette River. The majority of the land use in the Pere Marquette River watershed consists of forest (76 percent), followed by agriculture, including grass and pasture land (20 percent), water (4 percent), and commercial, industrial, and residential (<1 percent each) (Choi and Engel, 2005).

NUMERIC TARGET

The impaired designated use addressed by this TMDL is fish consumption. At a minimum, all surface waters of the state are designated and protected for all of the following designated uses: agriculture, navigation, industrial water supply, warmwater fishery, other indigenous aquatic life and wildlife, partial body contact recreation, and fish consumption (Rule 100 [R 323.1100], Designated Use, of the Part 4 rules, WQS, promulgated under Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended [NREPA]). Rule 57 (R 323.1057), Toxic Substances, of the WQS, states that toxic substances shall not be present in the surface waters of the state at levels that are or may become injurious to the public health, safety, or welfare; plant and animal life; or the designated uses of the waters.

Rule 57 was used to establish numeric WQS criteria for PCBs in water of 0.026 nanograms per liter (ng/L) as a human cancer value (HCV). The HCV is defined as the maximum ambient water concentration of a substance at which a lifetime of exposure from either drinking the water, consuming fish from the water, or conducting water-related recreation activities will represent a plausible upper bound risk of contracting cancer of 1 in 100,000 using the exposure assumptions and methodology specified in R 323.1057(4).

There are two approaches for assessing the attainment status of the fish consumption designated use: water chemistry and fish tissue analysis. For water chemistry, the ambient water column PCB concentration is compared to the HCV (0.026 ng/L) (R 323.1057). Water bodies with 1 or more ambient water column PCB sample results greater than the HCV are determined to not support the fish consumption designated use. The use of 1 sample is justified by the existence of a large PCB data set for the state as a whole, which shows virtually 100 percent exceedance of the WQS for total PCBs.

Fish are collected statewide by the MDEQ for tissue analysis as part of its Fish Contaminant Monitoring Program, and the results of that testing are used by the Michigan Department of Community Health (MDCH) to determine fish consumption advisories. If the MDCH has issued a site-specific fish consumption advisory for a water body, it is considered by the MDEQ to not support the fish consumption designated use. The MDCH uses the United States Food and Drug Administration's 2.0 parts per million (ppm) trigger level for total PCB (aroclor or congener) concentrations when developing advisories for the general population. The MDCH advises the general population to eat no more than 1 meal per week of a fish species when concentrations in more than 10 percent of the samples from that species of fish of a given length range exceed the trigger level. The general population is also advised to eat no fish when concentrations in 50 percent or more of the samples exceed the trigger level. In addition to general population advisories, the MDCH advises women and children to eat no more than 1 meal per week if total median PCB concentrations exceed 0.05 ppm, and no more than 1 meal per month if total PCB concentrations exceed 0.2 ppm (Bohr and Zbytowski, 2007).

The target for this TMDL is 0.026 ng/L expressed as a daily concentration throughout the year. This value is the most conservative value of the applicable WQS. A secondary target is the most conservative fish tissue contaminant advisory level of 0.05 ppm.

DATA DISCUSSION

Fish Collection Data

Pere Marquette Lake

The following data form the basis for the 2008 Section 303(d) listing under AUID 040601010509-05. In August 1989, 4 northern pike (*Esox lucius*) were collected in Pere Marquette Lake by the MDEQ and the edible portion fillets had an average total PCB Aroclor concentration of 0.433 milligrams per kilogram (mg/kg). Ten additional northern pike were collected by the MDEQ from the lake in May 2003 and the fillets had an average total PCB congener concentration of 0.0633 mg/kg. In June 1993, the MDEQ collected 5 redhorse suckers (*Moxostoma species*) at the confluence of the Pere Marquette River with Pere Marquette Lake and analysis of 1 composite sample of the fillets from these fish resulted in a total PCB Aroclor concentration of 0.247 mg/kg (Appendix C).

As a result of these fish tissue data for total PCBs, the MDCH has established a fish consumption advisory limiting fish consumption to 1 meal per month for women and children, applicable to suckers greater than 6 inches and northern pike greater than 22 inches (MDCH, 2007). Suckers is a general term for several species of fish in the *Catostomidae* genera, including both redhorse and white suckers (*Catostomus commersonii*).

Pere Marquette River Watershed

The following data form the basis for the listings in the Pere Marquette River watershed upstream of Pere Marquette Lake, as noted in Appendix A.

Wild Fish Data

Fish were collected from the Pere Marquette River watershed in 1993, 2003, 2004, and 2005 (Appendix C) for fish tissue contaminant analysis of edible portion fillets. Since 1993, a total of 35 brown trout have been collected from the Pere Marquette River watershed. The overall median total PCB concentration for all 35 trout fillets collected since 1993 is 0.18 ppm (Bohr and Zbytowski, 2006). As a result of the amount of total PCBs in the fillets, the Pere Marquette River has a fish consumption advisory for women and children, of 1 meal per month, for brown trout greater than 8 inches (MDCH, 2007).

There is also a fish consumption advisory for the Pere Marquette River watershed of 1 meal per month for women and children for suckers greater than 6 inches (MDCH, 2007). The basis for this consumption advisory is the 5 redhorse suckers that were collected at the confluence of the Pere Marquette River with Pere Marquette Lake in June 1993. Seven white suckers ranging in length from 9 to 15 inches were collected from the Little South Branch of the Pere Marquette River in 2004. Contaminant concentrations were below MDCH trigger levels in all 7 fish.

Caged Fish Data

Due to the above noted fish contaminant advisories, starting June 18, 2003, a 28-day exposure caged fish study was conducted using channel catfish to assess PCB uptake and identify spatial trends in contaminant concentrations to determine if there are possible localized sources of PCBs in the Pere Marquette River watershed. Caged fish studies are a useful water quality monitoring tool because the test fish are exposed to the water column under relatively controlled conditions. Some contaminants accumulate in the test fish at levels that may be orders of magnitude above the concentrations in the ambient water. A cage containing approximately 35 catfish 4 to 6 inches in length was suspended off the bottom of the Pere Marquette River, at Stations 2, 3, 5, 7, and 8, and approximately 1500 feet upstream and downstream of the Ludington Wastewater Treatment Plant (WWTP) discharge location (Figure 1, Table 1). A control aliquot of approximately 35 fish was taken from the pool of fish used in the caged fish study.

At the end of the 28-day period, the fish were removed from the cages and divided into 4 composite samples of whole fish for each site. Each sample had a minimum total weight of 40 grams, and the number of fish per composite was determined by the size of the fish and the number surviving to the end of the 28-day test. PCBs were detected in all samples, including the control samples; however, net uptake of total lipid-normalized PCBs was only quantifiable at 5 sites when compared to the control, and the average net uptake was highest at the Little South Branch site (Station 2, Appendix D). The observed fish uptake levels did not indicate localized sources of PCBs and levels were consistent with results from other caged fish studies among Michigan rivers where sediment analytical results showed no localized PCB-contaminated sediments and PCB sources are considered to be primarily atmospheric.

Water Sampling Data

Water sample data collection began in 1994. Low level analysis of water samples from the Pere Marquette River at Scottville Road (Station 9, Figure 1) indicated PCBs were exceeding WQS (Appendix E). In both 2000 and 2001, samples from Station 9 indicated PCB concentrations continued to exceed WQS (Appendix F) (Aiello, 2002 and 2003).

In 2002, there was a cooperative effort between the United States Geological Survey (USGS) and the MDEQ to provide data in support of the MDEQ's TMDL development process (Aiello, 2004; USGS, 2004). A total of 36 water samples were taken at 9 stations throughout the Pere Marquette River watershed (Figure 1; Appendix F) from May through October 2002. Three samples were invalidated due to contamination, leaving a total of 33 samples. Additional sampling of these 9 stations continued in 2003 (Aiello, 2005), and 1 station was sampled in 2005 (Aiello, 2008). Total PCB concentrations for a total of 48 samples collected from 2000 through 2005 ranged from 0.083 to1.380 ng/L (Appendix F). All samples exceeded the Rule 57 water quality value of 0.026 ng/L. PCB samples were collected and analyzed according to protocols published by the USEPA (1997a and 1997b).

Table 1. Station locations for water quality sampling (all stations) and caged fish sampling (2, 3, 5, 7, 8, and 9) in the Pere Marquette River watershed.

Station #	Water body	Location
1	Middle Branch Pere Marquette River	Rosa Bridge
*2	Little South Branch Pere Marquette River	17-Mile Road
3	Baldwin River	Off M-37
4	Pere Marquette River	Peacock Road
*5	Pere Marquette River	South Branch Road
6	Big South Branch Pere Marquette River	Dickinson Road
*7	Big South Branch Pere Marquette River	Walhalla Road
8	Weldon Creek	Downstream Benson Road
9	Pere Marquette River	Scottville Road
*	Pere Marquette River	Upstream Ludington WWTP
*	Pere Marquette River	Downstream Ludington WWTP

* indicates net uptake of total PCBs in caged fish quantified (see Appendix D).

Sediment Sampling Data

Single sediment samples were collected from the Pere Marquette River in 2000 and 2001 near an abandoned municipal dump located just downstream of the Ludington WWTP discharge (Figure 1). This sampling was in response to a citizen's concern regarding historical use of the dump and its close proximity to the Pere Marquette River. PCB Aroclors were not detected (reporting limit = 430 micrograms/kilogram [µg/kg]) in the 2000 sample (Walker, 2000) but were detected in the 2001 sample collected by the MDEQ, Cadillac District Office (1900 µg/kg). A sample was taken again near this same location in May 2003 and PCB Aroclors were not detected (reporting limit = 120-590 µg/kg) (Taft, 2004). Sediment samples were collected by the USGS at the 9 water sampling stations in August 2002 and PCB Aroclors were not detected (reporting limit = 160-430 µg/kg) in any of the samples (USGS, 2004). The results suggest that there is no localized source of PCBs to the Pere Marquette River watershed. The 1 detectable sample collected in 2001 is an unconfirmed isolated result.

In May 2003, staff of the MDEQ and USEPA, Great Lakes National Program Office, took 13 sediment samples from Pere Marquette Lake (Taft, 2004). The purpose of the sampling was to determine if the lake sediments were contributing to elevated levels of PCBs found in fish tissues collected from the watershed. No PCB Aroclors were detected in any of the sediment samples collected (reporting limit = 120-590 µg/kg). The results suggest that there is no localized source of PCBs to Pere Marquette Lake.

SOURCE ASSESSMENT

The entire Pere Marquette River watershed is included in the 2008 Section 303(d) listing for PCBs. This includes approximately 513 miles of stream and the 554-acre Pere Marquette Lake.

As a result of the federal Toxic Substance Control Act of 1976, the continued manufacturing and discharge of PCBs has been banned; however, due to their historic widespread use, limited continued use and discharge, and persistence in the environment, PCBs are often detected at levels that exceed WQS in surface water samples using low level detection methods. The existence of a large PCB data set for the state of Michigan shows virtually 100 percent exceedance of the WQS for total PCBs (LeSage and Smith, 2008).

Historically, PCBs entered the environment from sites where they were used, through spills or leaks, or through improper disposal. Currently, PCB use is restricted to preexisting closed systems (such as transformers). PCBs may also be produced by combustion processes, including incineration, and can be found in stack emissions and ash from incinerators. A major source of PCBs today is the environmental cycling of PCBs that were historically introduced into the environment. PCBs are relatively insoluble in water and adsorb strongly to soil and organic matter. PCBs are very stable and the breakdown of PCBs in water and soil may take several years. Aquatic organisms can be exposed to PCBs via several routes, including: contaminated sediment, point source discharges, or the water itself. In addition, PCBs are highly fat soluble and are rapidly accumulated by aquatic organisms in their fat tissue and thus can bioaccumulate up the food chain. PCB concentrations in aquatic organisms can be 2,000 to >1,000,000 times higher than concentrations found in the surrounding waters (USEPA, 1999). PCBs also volatilize from the land and water into the atmosphere, which can, in turn, result in wet or dry deposition of PCBs back to the land and water.

Other common sources of PCBs include the unintentional production of PCBs in processes that involve chlorine, carbon, and high temperatures, and contaminated sediment from historic discharge or disposal sites (USEPA, 2000; USEPA, 2004). An example of the inadvertent production of PCBs is production of titanium dioxide. PCB 209 is a congener inadvertently generated during titanium dioxide production, which involves high temperatures and chlorine. A by-product of titanium dioxide production is ferric chloride (iron chloride), which is contaminated with PCB 209. Ferric chloride is marketed as a water treatment flocculent both for drinking water and wastewater (Panero et al., 2005). PCBs can also be produced in the de-inking of newspaper with chlorine, production of carbonless copy paper, and the production of chlorinated solvents, detergents, plastic materials, and agriculture chemicals (Panero et al., 2005).

The most likely source of PCBs to the Pere Marquette River watershed is air deposition. The USEPA, Great Lakes National Program Office, and its partners conducted a Lake Michigan Mass Balance study in 1994-1995 (USEPA, 2004). As part of this study, the concentrations of PCBs were measured in the atmosphere, several tributaries, lake water, sediments, and the food webs of Lake Michigan. The goal of the study was to develop a sound, scientific base of information to guide future toxic load reduction efforts within the Lake Michigan watershed. Results of the study estimate that 82 percent of the PCB loadings to Lake Michigan are from atmospheric deposition (through gas phase absorption from the atmosphere to the surface of the lake water and wet and dry atmospheric deposition). The remaining 18 percent is from tributary loadings to Lake Michigan, which would not be present within the Pere Marquette River watershed. There are no known point sources of PCBs within the Pere Marquette River watershed.

The MDEQ, Water Bureau's, National Pollutant Discharge Elimination System (NPDES) permit Management System (NMS) indicated there are 32 NPDES permitted discharges in the Pere Marquette River watershed (Tables 2 and 3; Figure 1) including 6 individual permits, 15 certificates of coverage (COCs) under 3 general permits, and 11 notices of coverage (NOCs) under 1 permit-by-rule (NMS, 2008).

None of the general storm water permittees are known sources of PCBs in the Pere Marquette River watershed. There are 2 permitted Concentrated Animal Feeding Operations (CAFO) in the Pere Marquette River watershed. They are not permitted to discharge to surface waters of the state and are not considered a source of PCBs. The 11 permit-by-rule (MIR100000) NOCs involve earthwork in the TMDL watershed and are not considered to be known sources of PCBs.

Of the 6 individual permits within the Pere Marquette River watershed, 3 are industrial discharges, 2 are treated sanitary wastewater discharges, and 1 is the Michigan Department of Transportation (MDOT) statewide Municipal Separate Storm Sewer System (MS4) permit. None of the individual permitted discharges are known to be sources of PCBs.

Table 2. NPDES individual permits and COCs with receiving waters in the Pere Marquette River watershed.

Designated Name	Permit No.	County	Latitude	Longitude	Receiving Water
Individual Permits					
Dow Chem-Ludington	MI0003026	Mason	43.93917	-86.43139	Pere Marquette River
Ludington WWTP	MI0021334	Mason	43.94167	-86.40639	Pere Marquette River
Walkerville WWTP	MI0046485	Oceana	43.72639	-86.12639	Beaver Creek
Mich Pwr LP	MI0053767	Mason	43.93583	-86.42583	Pere Marquette River
MDOT MS4	MI0057364				Statewide
Austin Tube Prod	MI0054224	Lake	43.90722	-85.81806	Little Leverentz Lake via a wetland
CAFO COC	**General Permit MIG019000**				
Valley View Pork	MIG010081	Oceana	43.74278	-86.03940	Freeman Creek
Hillside Farms-Riverton	MIG010135	Mason	43.89239	-86.33590	none listed
Industrial Storm Water COC	**General Permit MIS120000 Storm Water Discharges with Required Monitoring**				
Elmers Concrete of Ludington	MIS120608	Mason	43.95011	-86.34201	Pere Marquette River
Industrial Storm Water COCs	**General Permit MIS210000 Storm Water from Industrial Activities**				
Whitehall Industries-Ludington	MIS210084	Mason	43.94583	-86.43750	Pere Marquette Lake
Metalworks Inc-Ludington	MIS210085	Mason	43.95444	-86.42000	Pere Marquette Lake
Straits Steel & Wire	MIS210089	Mason	43.97167	-86.45194	Pere Marquette River
Quick Way-Ludington	MIS210091	Mason	43.94444	-86.42667	Pere Marquette River
Marek Auto Parts Inc	MIS210093	Mason	43.95444	-86.36611	Pere Marquette River
Carrom Company	MIS210095	Mason	43.94944	-86.44583	Pere Marquette Lake
Fair Salvage Co	MIS210096	Lake	43.88965	-85.63470	Pere Marquette River
Harsco Track Technologies	MIS210097	Mason	43.95417	-86.42694	Pere Marquette River
Quality Carriers Inc	MIS210100	Mason	43.94806	-86.42167	Pere Marquette Lake
Pallet Recycle-Ludington	MIS210679	Mason	43.90806	-86.39611	Pere Marquette River
Cone Drive Textron-Ludington	MIS210777	Mason	43.93972	-86.39222	Pere Marquette River
Cal Chlor Corp-Ludington	MIS210828	Mason	43.94190	-86.42390	Pere Marquette Lake

Table 3. NOCs covered under permit-by-rule #MIR100000 in the Pere Marquette River watershed.

Designated Name	Permit No.	County	Township
Hidden Forest Ph 4	MIR106654	Mason	Amber
Westwood-Ludington Crossing	MIR107222	Mason	Amber
Mason Co-Wastewater Imp	MIR107368	Mason	Custer
Casmar LLC	MIR108907	Mason	Custer
First St Bus/Ind Pk-Ludington	MIR109162	Mason	Pere Marquette
PerePointe Village Condos	MIR109321	Mason	Pere Marquette
Hidden Forest MHP Ph 4	MIR109665	Mason	Amber
Chase Farms Phase III	MIR109925	Oceana	Colfax
Mason Co Central Schools	MIR109974	Mason	Amber
Ludington St & Utility Imp	MIR110343	Mason	Pere Marquette
MDOT-M-82 Widening	MIR110419	Newaygo	Sheridan

Other sources of PCBs to the Pere Marquette River watershed, in addition to the atmospheric contributions, may be attributed to the upstream migration of several species of anadromous fish species from Lake Michigan (Merna, 1986; USEPA, 2004). The salmonids may contribute to the PCB budget via spawning (egg deposits), and decomposition process of spent (post spawning) adult salmon. These additional sources of PCBs are estimated to be minor compared to the atmospheric loadings.

As an additional tool in determining potential sources of PCBs to the Pere Marquette River watershed, a load duration curve analysis, as outlined by Cleland (2002), was developed for each sampling station. A load duration curve considers how flow conditions relate to a variety of potential pollutant sources (point and nonpoint sources). The load duration curves for each station sampled on the Pere Marquette River are included in Appendix G. All historical flows available from the USGS gage on the Pere Marquette River near Scottville, Michigan (Gage #04122500), were used to develop the load duration curves.

The data indicate that exceedances of the WQS are observed during wet and dry weather events (Appendix G). Note that dots above the curve on the left side of each figure are indicative of PCB WQS exceedances during wet weather conditions (higher flows) and dots above the curve to the right side of the figure indicate PCB WQS exceedances during dry weather conditions (lower flows). Exceedances of the WQS occurred during all flow conditions. This would be expected since the primary source of PCBs to the watershed is wet and dry atmospheric deposition, which occurs during all flow conditions. PCBs from atmospheric deposition enter the watershed via dry and wet deposition directly to the surface of the water. PCBs may also enter the watershed via atmospheric deposition to soil on the land that enters the water due to runoff during precipitation events or eroding streambanks.

LOADING CAPACITY DEVELOPMENT

The loading capacity (LC) represents the maximum daily loading that can be assimilated by the water body while still achieving WQS. As indicated in the Numeric Target section, the target for this PCB TMDL is the Rule 57 HCV of 0.026 ng/L, with a secondary target being the fish tissue contaminant advisory level of 0.05 ppm.

Concurrent with the selection of numeric concentration endpoints, development of the LC requires identification of the critical conditions. The "critical condition" is the set of environmental conditions (e.g., flow) used in developing the TMDL that result in attaining WQS and has an acceptably low frequency of occurrence. The critical conditions for the applicability of WQS in Michigan are given in Rule 90 (R 323.1090). For human health values, such as for PCBs, R 323.1090 specifies the harmonic mean flow as a design condition. MDEQ, Hydrologic Studies Unit, used the USGS gage near Scottville, Michigan, to estimate a harmonic mean flow for the Pere Marquette River of 620 cubic feet per second (cfs) (401 million gallons per day [mgd]). The WQS of 0.026 ng/l and the harmonic mean flow were used to derive the LC for the Pere Marquette River of 8.68×10^{-5} pounds per day of PCBs.

The LC is the sum of individual waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background levels to assure WQS are met. In addition, the LC must include a margin of safety (MOS), either implicitly within the WLA or LA, or explicitly, that accounts for uncertainty in the relation between pollutant loads and the quality of the receiving water body. Conceptually, this definition is denoted by the equation:

$$\mathbf{LC = \sum WLAs + \sum LAs + MOS}$$

Based on the geometric mean of all PCB water samples taken from 2000 to 2003 from the Pere Marquette River (Appendix E) and the harmonic mean flow of the Pere Marquette River at Station 9 (620 cfs), it is estimated that the current total load of PCBs in the river is 1.08×10^{-3} pounds per day. To meet the LC, a 92 percent reduction in PCB loading to the Pere Marquette River watershed is necessary.

WLAs

Queries of the MDEQ's NMS database yielded 6 individual NPDES permitted facilities in the Pere Marquette River watershed (NMS, 2008); 3 are industrial discharges, 2 are treated sanitary wastewater discharges, and 1 is the MDOT statewide MS4 permit, which applies to all state roadways. Although none of the facilities are known sources of PCBs, with the exception of the MDOT permit, a waste load was allocated to each of the 5 individual facilities based on the industry's permitted discharge rate or WWTP design flow and the numeric target for PCBs (Table 4). A WLA was calculated for the MDOT statewide permit using an estimate of approximately 600 acres of roadways that are addressed by the MDOT permit within the Pere Marquette River watershed, an average annual rainfall near Ludington from 2004 through 2007 of 2.7 feet (MSU, 2008), and the WQS of 0.026 ng/L for PCBs (Table 4).

Queries of the NMS database yielded 13 general industrial storm water permits (NMS, 2008). Based on 1992 land use information, 648 acres of the Pere Marquette River watershed are considered industrial (Choi and Engel, 2005). This acreage, the average annual rainfall (2.7 feet), and the WQS for PCBs of 0.026 ng/L were used to calculate a WLA for all industrial storm water permits combined. This value is likely an overestimation of the allocation necessary for the industrial permits since many of the industries covered in the land use acreage would not be required to have a storm water permit. Other than the MDOT statewide permit, there are no MS4 permits in the Pere Marquette River watershed. As noted in the Source Assessment section, the 2 CAFO and 11 permit-by-rule (MIR100000) NOCs involving earthwork are not considered to be a known sources of PCBs. No reduction in loads from point sources is required in this TMDL.

Table 4. WLA for facilities with individual permits within the Pere Marquette River watershed, 2008.

Designated Name	Permit No.	County	Latitude	Longitude	Receiving Water	Permitted Flow (mgd)	WLA (lbs/day)
Dow Chem-Ludington	MI0003026	Mason	43.93917	-86.43139	Pere Marquette River	40	8.6736E-06
Ludington WWTP	MI0021334	Mason	43.94167	-86.40639	Pere Marquette River	7.5	1.6263E-06
Walkerville WWTP	MI0046485	Oceana	43.72639	-86.12639	Beaver Creek	0.035	7.5894E-09
Mich Pwr LP	MI0053767	Mason	43.93583	-86.42583	Pere Marquette River	0.7752	1.6809E-07
Austin Tube Prod	MI0054224	Lake	43.90722	-85.81806	Little Leverentz Lake via a wetland	0.36	7.8062E-08
MDOT MS4	MI0057364	Statewide				estimated	3.14E-07
Total							**1.09E-05**

LAs

The LA component of the TMDL defines the fraction of the LC for PCBs from nonpoint sources. A 93 percent reduction in PCB loading from nonpoint sources is necessary to meet the TMDL. This results in an LA of 7.56 X 10^{-5} pounds per day (Table 5). All significant PCB load reductions are expected to come from atmospheric reductions that should occur over time. As atmospheric loading declines, the amount of PCBs coming from overland flow from nonpoint sources should decline as well, regardless of land use.

Table 5. Summary of WLA and LA for total PCBs for the Pere Marquette River watershed.

Source Category	Current PCB Estimated Load (lb/day)	Target PCB Load (lb/day)
WLA Components		
NPDES Individual Permits	1.09E-05	1.09E-05
NPDES Industrial Storm Water Permits	3.38E-07	3.38E-07
NPDES CAFOs	0	0
WLA Total	**1.12E-05**	**1.12E-05**
LA Components		
Forested, Agricultural, Residential, Commercial Land, Water	1.07E-03	7.56E-05
LA Total	**1.07E-03**	**7.56E-05**
Overall Total	1.08 E-03	8.68E-05

MOS

The MOS accounts for any uncertainty or lack of knowledge concerning the relationship between pollutant loading and water quality, including the pollutant decay rate if applicable. The MOS can be either implicit (i.e., incorporated into the WLA or LA through conservative assumptions) or explicit (i.e., expressed in the TMDL as a portion of the loadings). The MOS is implicit for this PCB TMDL because several conservative assumptions were made in the development of the LC. The WLA was developed using a conservative estimate of the amount of PCBs entering the watershed due to point sources (since no facilities are known sources of PCBs as supported by ambient monitoring). The estimated load from industrial storm water permits is also conservative due to the likely overestimation of the industrial acreage covered by storm water permits. Finally, in addition to the WQS target of 0.026 ng/L, the success of the TMDL will be based, in part, on the attainment of fish tissue target concentration of 0.05 ppm and the removal of fish contaminant advisories. Due to the bioaccumulative nature of PCBs, fish tissue concentrations are predicted to eventually meet target concentrations after water quality concentrations meet WQS, thus adding to the implicit MOS.

SEASONALITY

Seasonality in this TMDL is addressed using a numeric target that is equal to the WQS, which applies throughout the year. The WQS is targeted to be met at flows greater than or equal to the harmonic mean flow. In addition, PCBs accumulate in fish tissue throughout the year, thus sampling of fish tissue takes into account seasonal variation.

MONITORING

Future monitoring of the Pere Marquette River watershed fish community (fish tissue samples and caged fish studies) and water quality monitoring will take place as resources allow as part of the 5-year rotating basin monitoring.

REASONABLE ASSURANCE

As noted in the Source Assessment section, the USEPA, Lake Michigan Mass Balance study, estimated that 82 percent of the PCB loadings to Lake Michigan are from atmospheric deposition (USEPA, 2004). The Pere Marquette River was part of that study and was selected for sampling because it has a fairly large and pristine watershed in the Lake Michigan watershed and it was considered to be representative of background conditions. Results of the study indicate that PCB concentrations in the Pere Marquette River were the lowest (although still exceeded WQS) of the 11 rivers sampled in the Lake Michigan watershed.

There are several federal laws and regulations regarding the regulation of PCBs that are administered by the USEPA. These include The Resource Conservation and Recovery Act, the Clean Water Act, and the Toxic Substances Control Act, which regulates the manufacturing, processing, and distribution in commerce, marking, storage, and disposal of PCBs. Michigan operated a PCB program under a Toxic Substances Control Act Cooperative Agreement until the late 1980s. The program conducted compliance inspections of sites that were using or had historically used PCBs. This program no longer exists; instead, Michigan has integrated PCB regulation and cleanup into other state programs. The MDEQ's Water Bureau, Air Quality Division, Waste and Hazardous Materials Division, and Remediation and Redevelopment Division each regulate PCBs under several administrative rules of Michigan's NREPA (Lake Superior Binational Program, 2006). For example, attainment of WQS for PCBs is assisted by the use of NPDES discharge permits for point sources when there is reasonable potential for

the discharge of PCBs to exceed WQS. In this situation the permit contains a PCB water quality-based effluent limit and requires the development and implementation of a PCB minimization plan. In addition, the general storm water permittees in the watershed are required to develop a Storm Water Pollution Prevention Plan. The Storm Water Pollution Prevention Plan requires the permittee to complete an evaluation of the reasonable potential for the contribution of significant materials to run off. If a source of pollutant (PCBs) is found, the permittee is required to address the pollutant in their Storm Water Pollution Prevention Plan. This information is used by the permittee to estimate the annual load of pollutants to the water body and identify the level of control necessary to comply with any established TMDL.

The Great Lakes Binational Toxics Strategy report (USEPA/Canada, 2001) states that Environment Canada and the USEPA are committed to assessing atmospheric inputs of toxic substances, including PCBs, to the Great Lakes basins. The focus of this effort is to evaluate and report jointly on the contribution of atmospheric loadings ("long-range transport") from worldwide sources. If ongoing long-range sources are confirmed, work will commence within international frameworks to reduce releases of such substances. In support, the United States and Canada have maintained the Great Lakes Integrated Atmospheric and Deposition Monitoring Network program, improved the integration of monitoring networks and data management, and have continued research on the atmospheric science of toxic pollutant transport.

Due to the above regulations and initiatives, it is presumed that given time, levels of PCBs in the environment, including the Pere Marquette River watershed, will decrease with time. Although slow, biodegradation via dechlorination by bacteria under anaerobic conditions and via oxygenation by bacteria in aerobic conditions will reduce the amount of PCBs found in the environment. There is evidence that levels of PCBs in the air and water of the Great Lakes are decreasing (Hillery et al., 1998; USEPA, 2006; and Pearson et al., 1996). Studies have estimated that the half-life of PCBs in the air and water in the Great Lakes basin is 5 to 9 years (Hillery et al., 1998; Pearson et al., 1996). The Lake Michigan Mass Balance study estimates that lake trout PCB concentrations from Lake Michigan will be lower than the Great Lakes sport fish consumption advisory level of 0.05 ppm sometime between the year 2039 and 2055 (depending on how fast or slow rates of atmospheric declines) (USEPA, 2004). These predicted declines are reasonable assurance that LAs for PCBs in the Pere Marquette River as explained in this TMDL will be met in the future. If numeric targets are not met, the TMDL will be modified as appropriate.

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References

Aiello, Christine. 2008. Water Chemistry Monitoring Report, 1998-2005. Michigan Department of Environmental Quality, Water Division, Surface Water Quality Assessment Section, Lansing, MI. Report No. MI/DEQ/WD-08/014.

Aiello, Christine. 2005. Water Chemistry Monitoring Report, 2003. Michigan Department of Environmental Quality, Water Division, Surface Water Quality Assessment Section, Lansing, MI. Report No. MI/DEQ/WD-05/058.

Aiello, Christine. 2004. Water Chemistry Monitoring Report, 2002. Michigan Department of Environmental Quality, Water Division, Surface Water Quality Assessment Section, Lansing, MI. Report No. MI/DEQ/WD-04/049.

Aiello, Christine. 2003. Water Chemistry Monitoring Report, 2001. Michigan Department of Environmental Quality, Water Division, Surface Water Quality Assessment Section, Lansing, MI. Report No. MI/DEQ/WD-03/085.

Aiello, Christine. 2002. Water Chemistry Monitoring Report, 2000. Michigan Department of Environmental Quality, Water Division, Surface Water Quality Assessment Section, Lansing, MI. Report No. MI/DEQ/WD-02/092.

Bohr, J. and J. Zbytowski. 2007. Michigan Fish Contaminant Monitoring Program 2006. MDEQ Report No. MI/DEQ/WB-07/053. Michigan Department of Environmental Quality, Water Bureau, Lansing, Michigan

Bohr, J. and J. Zbytowski. 2006. Michigan Fish Contaminant Monitoring Program 2005. MDEQ Report No. MI/DEQ/WB-06/091. Michigan Department of Environmental Quality, Water Bureau, Lansing, Michigan.

Choi, J. and B. Engel. 2005. Watershed Delineation Program Agricultural & Biological Engineering Department, Purdue University, West Lafayette, Indiana. Web site: http://pasture.ecn.purdue.edu/~watergen/.

Cleland, B. 2002. TMDL Development from the “Bottom Up” – Part II. Using Duration Curves to Connect the Pieces. America’s Clean Water Foundation.

Hillery, B. R., M.F. Simcik, I. Basil, R.M. Hoff, W.M.J. Strachan, D. Burniston, C.H. Chan, K. A. Brice, C.W. Sweet, and R.A. Hites. 1998. Atmospheric Deposition of Toxic Pollutants to the Great Lakes as Measured by the Integrated Atmospheric Deposition Network. Environmental Science and Technology 32:2216-2221.

Lake Superior Binational Program. 2006. Lake Superior Lakewide Management Plan: 1990-2005 Critical Chemical Reduction Milestones. Appendix D. Prepared by the Superior Work Group-Chemical Committee. 209 pages. Toronto and Chicago.

LeSage, S.W. and J. Smith. 2008. Water Quality and Pollution Control in Michigan, 2008, Sections 303(d), 305(b), and 314 Integrated Report. MDEQ Report No. MI/DEQ/WB-08/007. Michigan Department of Environmental Quality, Water Bureau, Lansing, Michigan.

MDCH. 2007. Michigan Family Fish Consumption Guide. Michigan Department of Community Health, Division of Environmental Health, Lansing, Michigan.

Merna, J.W. 1986. Contamination of Stream Fishes with Chlorinated Hydrocarbons from Eggs of Great Lakes Salmon. Transactions of the American Fisheries Society 115:69-74.

MSU. 2008. Michigan State Climatologist's Office. Michigan State University Department of Geography, East Lansing, Michigan. http://climate.geo.msu.edu.

NMS. 2008. National Pollutant Discharge Elimination System Management System Database Query, MDEQ.

Panero, M., S. Boehme, and G. Munoz. 2005. Pollution Prevention and Management Strategies for Polychlorinated Biphenyls in the New York/New Jersey Harbor. New York Academy of Sciences, New York, New York.

Pearson, R.F., K.C. Hornbuckle, S.J. Eisenreich, and D.L. Swackhamer. 1996. PCBs in Lake Michigan Water Revisited. Environmental Science and Technology 30:1429-1436.

Taft, W. 2004. A Sediment Survey of Pere Marquette Lake and River Mouth, Mason County, Michigan, May 5-7, 2003. MDEQ Report No. MI/DEQ/WB-03/131. Michigan Department of Environmental Quality, Water Division, Lansing, Michigan.

USEPA. 2006. Lake Michigan Lakewide Management Plan 2006. USEPA, Great Lakes National Program Office, Chicago, Illinois.

USEPA. 2004. Results of the Lake Michigan Mass Balance Study: Polychlorinated Biphenyls and trans-nonachlor Data Report. USEPA Great Lakes National Program Office, Chicago.

USEPA. 2000. Lake Michigan Lakewide Management Plan 2000. USEPA, Great Lakes National Program Office, Chicago, Illinois.

USEPA. 1999. Polychlorinated Biphenyls (PCBs) Update: Impact on Fish Advisories. USEPA, Office of Water. EPA-823-F-99-019.

USEPA. 1997a. USGS Field Operation Plan: Tributary Monitoring. Lake Michigan Mass Balance Study Methods Compendium, Vol. 1: Sample Collection Techniques. EPA 905/R-97-012a.

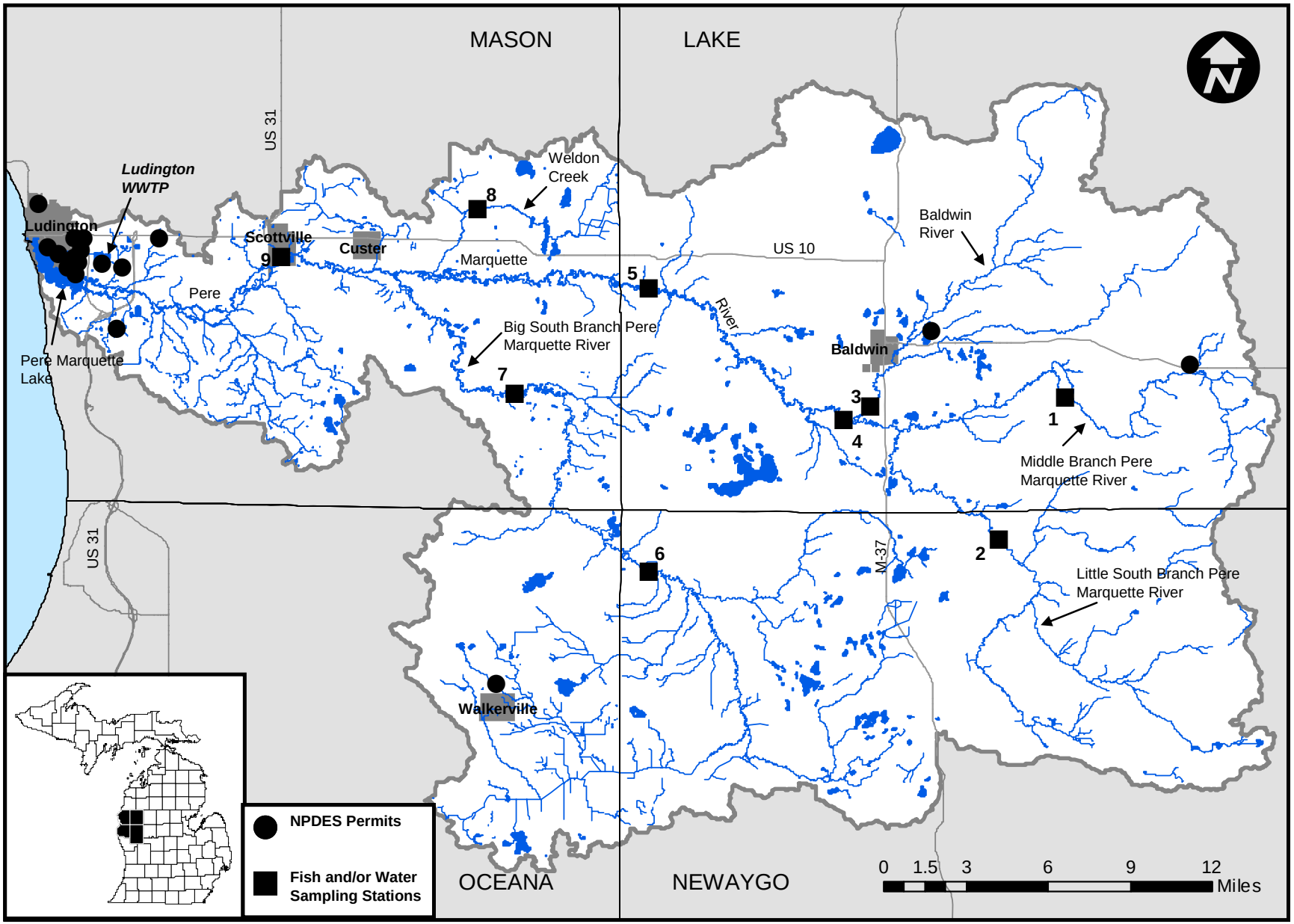
USEPA. 1997b. PCBs and Pesticides in Surface Water by XAD-2 Resin Extraction. Lake Michigan Mass Balance Study Methods Compendium, Vol. 2: Organic and Mercury Sample Analysis Techniques. EPA 905/R-97-012b.

USEPA/Canada. 2001. The Great Lakes Binational Toxics Strategy. Annual Progress Report. USEPA, Great Lakes National Program Office, Chicago, Illinois.

USGS. 2004. PCB Concentrations in Pere Marquette River and Muskegon River Watersheds, 2002. Report No. OF 2004-1088.

Walker, B. 2000. Preliminary Chemical Sampling of Water and Sediments in the Vicinity of an Old Dump Site Adjacent to the Pere Marquette River, Mason County, August 14, 2000. Michigan Department of Environmental Quality, Surface Water Quality Division, Lansing, Michigan.

Figure 1. Pere Marquette River watershed sampling stations and NPDES permits.



Appendix A. Assessment Unit ID (AUID) reaches found in Pere Marquette River watershed PCB TMDL.

AUID	AUID	AUID	AUID	AUID
040601010301-01	040601010402-02	040601010406-01	040601010505-02	040601010507-03
040601010302-01	040601010402-03	040601010406-02	040601010505-03	040601010508-01
040601010303-01	040601010402-04	040601010501-01	040601010505-04	040601010508-02
040601010303-02	040601010402-05	040601010502-01	040601010505-05	040601010508-03
040601010304-01	040601010403-01	040601010503-02	040601010506-01	040601010508-04
040601010304-02	040601010404-01	040601010503-03	040601010506-02	040601010509-01
040601010401-01	040601010404-02	040601010504-01	040601010506-03	040601010509-02
040601010401-02	040601010405-01	040601010504-02	040601010506-04	040601010509-03
040601010401-03	040601010405-02	040601010504-05	040601010507-01	040601010509-04
040601010402-01	040601010405-03	040601010505-01	040601010507-02	

Appendix B. Townships and municipalities located within the Pere Marquette River watershed.

Amber Township	Village of Custer	Merrill Township	Sable Township
City of Baldwin	Eden Township	Monroe Township	City of Scottville
Barton Township	Elbridge Township	New Field Township	Sheridan Township
Beaver Township	Ellsworth Township	Newkirk Township	Sherman Township
Branch Township	Home Township	Norwich Township	Summit Township
Chase Township	Lake Township	Peacock Township	Sweetwater Township
Cherry Valley Township	Leavitt Township	Pere Marquette Township	Troy Township
Colfax Township	Lilley Township	Pinora Township	Webber Township
Crystal Township	Logan Township	Pleasant Plains Township	Yates Township
Custer Township	City of Ludington	Riverton Township	Village of Walkerville

Appendix C. Pere Marquette River watershed fish tissue analytical results for PCBs collected from 1989 through 2005.

Water body Name	Date	Species	Total PCB - Aroclor (ppm)	Total PCB Congeners (ppm)	Mean Total PCB Congeners (ppm)
Baldwin River	8/18/2005	Brown Trout		0.101	
Baldwin River	8/18/2005	Brown Trout		0.153	
Baldwin River	8/18/2005	Brown Trout		0.118	
Baldwin River	8/18/2005	Brown Trout		0.171	
Baldwin River	8/18/2005	Brown Trout		0.217	
Baldwin River	8/18/2005	Brown Trout		0.025	
Baldwin River	8/18/2005	Brown Trout		0.017	
Baldwin River	8/18/2005	Brown Trout		0.006	
Baldwin River	8/18/2005	Brown Trout		0.27	
Baldwin River	8/18/2005	Brown Trout		0.04	0.1118
Pere Marquette Lake	8/23/1989	Largemouth Bass	0.154		
Pere Marquette Lake	8/23/1989	Northern Pike	0.155		
Pere Marquette Lake	8/23/1989	Northern Pike	0.282		
Pere Marquette Lake	8/23/1989	Northern Pike	0.504		
Pere Marquette Lake	8/23/1989	Northern Pike	0.791		
Pere Marquette Lake	5/5/2003	Northern Pike		0.03	
Pere Marquette Lake	5/5/2003	Northern Pike		0.078	
Pere Marquette Lake	5/5/2003	Northern Pike		0.016	
Pere Marquette Lake	5/5/2003	Northern Pike		0.048	
Pere Marquette Lake	5/5/2003	Northern Pike		0.081	
Pere Marquette Lake	5/5/2003	Northern Pike		0.101	
Pere Marquette Lake	5/5/2003	Northern Pike		0.052	
Pere Marquette Lake	5/5/2003	Northern Pike		0.084	
Pere Marquette Lake	5/5/2003	Northern Pike		0.078	
Pere Marquette Lake	5/5/2003	Northern Pike		0.065	0.0633
Pere Marquette Lake	5/5/2003	White Sucker		0.023	
Pere Marquette Lake	5/5/2003	White Sucker		0.11	
Pere Marquette Lake	5/5/2003	White Sucker		0.106	
Pere Marquette Lake	5/5/2003	White Sucker		0.024	
Pere Marquette Lake	5/5/2003	White Sucker		0.289	
Pere Marquette Lake	5/5/2003	White Sucker		0.102	
Pere Marquette Lake	5/5/2003	White Sucker		0.118	
Pere Marquette Lake	5/5/2003	White Sucker		0.406	
Pere Marquette Lake	5/5/2003	White Sucker		0.145	
Pere Marquette Lake	5/5/2003	White Sucker		0.13	0.1453
Pere Marquette River	9/3/2004	Brown Trout		0.037	
Pere Marquette River	9/3/2004	Brown Trout		0.117	
Pere Marquette River	9/3/2004	Brown Trout		0.186	
Pere Marquette River	9/3/2004	Brown Trout		0.083	
Pere Marquette River	9/3/2004	Brown Trout		0.302	
Pere Marquette River	9/3/2004	Brown Trout		0.254	
Pere Marquette River	9/3/2004	Brown Trout		0.321	
Pere Marquette River	9/3/2004	Brown Trout		0.547	
Pere Marquette River	9/3/2004	Brown Trout		0.375	
Pere Marquette River	9/3/2004	Brown Trout		0.459	0.2681
Pere Marquette River	6/9/1993	Redhorse Sucker	0.247		
Pere Marquette River	6/9/1993	Redhorse Sucker	0.247		
Pere Marquette River	6/9/1993	Redhorse Sucker	0.247		
Pere Marquette River	6/9/1993	Redhorse Sucker	0.247		
Pere Marquette River	6/9/1993	Redhorse Sucker	0.247		

Appendix C. cont.

Water body Name	Date	Species	Total PCB - Aroclor (ppm)	Total PCB Congeners (ppm)	Mean Total PCB Congeners (ppm)
Little South Branch Pere Marquette River	8/17/1993	Brown Trout	0.039		
Little South Branch Pere Marquette River	8/17/1993	Brown Trout	0.039		
Little South Branch Pere Marquette River	8/17/1993	Brown Trout	0.05		
Little South Branch Pere Marquette River	8/17/1993	Brown Trout	0.163		
Little South Branch Pere Marquette River	8/17/1993	Brown Trout	0.414		
Little South Branch Pere Marquette River	8/24/2004	Brown Trout		0.292	
Little South Branch Pere Marquette River	8/24/2004	Brown Trout		0.139	
Little South Branch Pere Marquette River	8/24/2004	Brown Trout		0.16	
Little South Branch Pere Marquette River	8/24/2004	Brown Trout		0.147	
Little South Branch Pere Marquette River	8/24/2004	Brown Trout		0.226	
Little South Branch Pere Marquette River	8/24/2004	Brown Trout		0.196	
Little South Branch Pere Marquette River	8/24/2004	Brown Trout		0.313	
Little South Branch Pere Marquette River	8/24/2004	Brown Trout		0.231	
Little South Branch Pere Marquette River	8/24/2004	Brown Trout		0.259	
Little South Branch Pere Marquette River	8/24/2004	Brown Trout		0.437	0.24
Little South Branch Pere Marquette River	8/24/2004	White Sucker		0.002	
Little South Branch Pere Marquette River	8/24/2004	White Sucker		<0.001	
Little South Branch Pere Marquette River	8/24/2004	White Sucker		0.002	
Little South Branch Pere Marquette River	8/24/2004	White Sucker		<0.001	
Little South Branch Pere Marquette River	8/24/2004	White Sucker		0.005	
Little South Branch Pere Marquette River	8/24/2004	White Sucker		0.004	
Little South Branch Pere Marquette River	8/24/2004	White Sucker		0.015	0.0056

Appendix D. Pere Marquette River caged fish study results. Station number locations correlate to those in Figure 1. NQU = No Quantifiable Uptake.

Station #	Water body Name	Location	fat (%)	Total PCB Congeners (ppm)	Total PCB Congeners (ppm) Lipid Normalized	Mean Total PCB Congeners (ppm) Lipid Normalized	Mean Net Uptake Total PCBs (ppm)
2	Little S. Branch PM River	17 Mile Rd	3	0.017	0.0057		
	Little S. Branch PM River	17 Mile Rd	6	0.027	0.0045		
	Little S. Branch PM River	17 Mile Rd	4	0.011	0.0028		
	Little S. Branch PM River	17 Mile Rd	4	0.027	0.0068	0.0049	0.0046
3	Baldwin River	Near M-37	8	0.002	0.0003		
	Baldwin River	Near M-37	9	0.003	0.0003		
	Baldwin River	Near M-37	7	0.005	0.0007		
	Baldwin River	Near M-37	8	0.003	0.0004	0.0004	NQU
5	Pere Marquette River	South Branch Rd	5	0.015	0.0030		
	Pere Marquette River	South Branch Rd	5	0.022	0.0044		
	Pere Marquette River	South Branch Rd	6	0.032	0.0053		
	Pere Marquette River	South Branch Rd	7	0.017	0.0024	0.0038	0.0035
7	Big South Branch PM	Walhalla Road	6	0.004	0.0007		
	Big South Branch PM	Walhalla Road	5	0.003	0.0006		
	Big South Branch PM	Walhalla Road	4	0.005	0.0013		
	Big South Branch PM	Walhalla Road	7	0.006	0.0009	0.0008	0.0005
8	Weldon Creek	Benson Road	6	0.003	0.0005		
	Weldon Creek	Benson Road	6	0.002	0.0003		
	Weldon Creek	Benson Road	6	0.007	0.0012		
	Weldon Creek	Benson Road	7	0.006	0.0009	0.0007	NQU
9	Pere Marquette River	Scottville Rd	4	0.001	0.0003		
	Pere Marquette River	Scottville Rd	7	0.014	0.0020		
	Pere Marquette River	Scottville Rd	6	0.014	0.0023		
	Pere Marquette River	Scottville Rd	4	0.012	0.0030	0.0019	NQU
	Pere Marquette River	u/s Ludington WWTP	6	0.029	0.0048		
	Pere Marquette River	u/s Ludington WWTP	5	0.017	0.0034		
	Pere Marquette River	u/s Ludington WWTP	5	0.026	0.0052		
	Pere Marquette River	u/s Ludington WWTP	5	0.017	0.0034	0.0042	0.0039
	Pere Marquette River	d/s Ludington WWTP	2	0.011	0.0055		
	Pere Marquette River	d/s Ludington WWTP	7	0.021	0.0030		
	Pere Marquette River	d/s Ludington WWTP	6	0.017	0.0028		
	Pere Marquette River	d/s Ludington WWTP	6	0.01	0.0017	0.0033	0.0030
		CONTROL	7	0.002	0.0003		
		CONTROL	7	0.002	0.0003		
		CONTROL	7	0.002	0.0003		
		CONTROL	5	0.002	0.0004		

Appendix E. Total PCB results for water samples collected from the Pere Marquette River at Scottville Road for Lake Michigan Mass Balance Study, 1994 and 1995.

Station Number	EPA STORET ID	Sample Collection Date	Total Congener PCBs (ng/L)
9	4122500	04/05/94	0.068
		04/13/94	0.417
		04/25/94	0.839
		05/03/94	0.693
		05/10/94	1.007
		06/06/94	1.164
		06/28/94	1.283
		07/09/94	0.738
		08/23/94	0.796
		09/13/94	1.081
		05/10/94	0.385
		10/25/94	0.379
		11/08/94	0.844
		12/06/94	0.685
		01/25/95	0.436
		02/16/95	0.398
		03/14/95	0.941
		03/16/95	0.535
		03/18/95	0.663
		03/20/95	0.819
		03/26/95	1.072
		04/14/94	0.914
		05/09/95	0.857
		06/08/95	1.941
		07/18/95	1.821
		08/15/95	1.555
		08/19/95	1.849
		10/18/95	1.222

Appendix F. Total PCB results for water samples collected in the Pere Marquette River watershed 2000 through 2003.

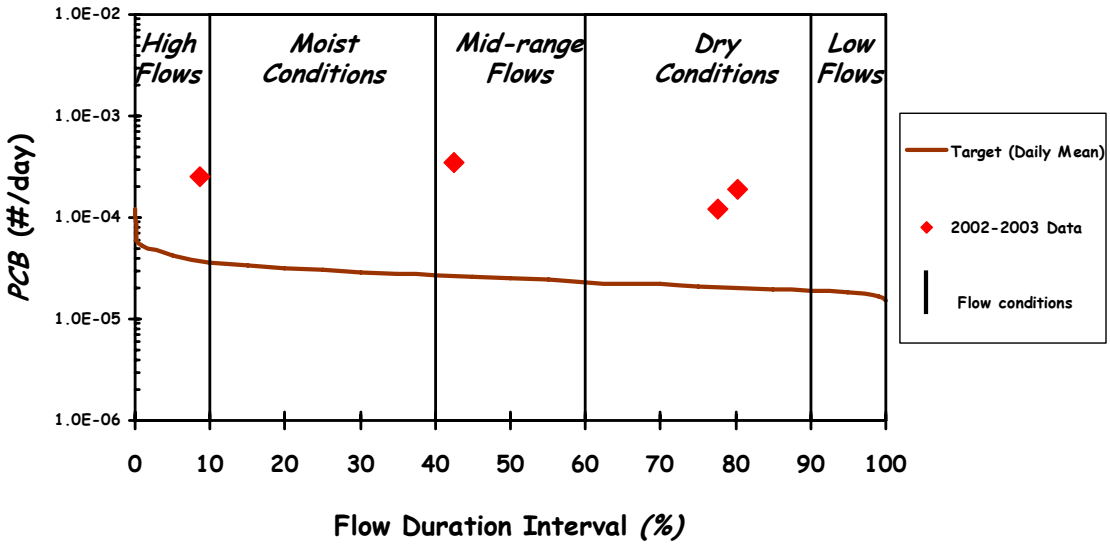
Station Number	MDEQ STORET ID	Latitude	Longitude	Sample Collection Date	Total PCB Congeners (ng/L)
1	430575	43.87306	-85.72379	05/14/02	0.177
				06/25/02	0.337
				08/06/02	0.237
				10/08/02	0.150
2	620249	43.80034	-85.77093	05/14/02	0.118
				06/25/02	0.332
				08/06/02	0.898
				06/26/03	0.112
				07/10/03	0.169
3	430592	43.86838	-85.86206	05/14/02	0.103
				06/25/02	0.318
				08/06/02	0.843
				10/08/02	0.148
				06/24/03	0.135
				07/08/03	0.222
4	430578	43.86187	-85.88087	05/15/02	0.191
				06/25/02	0.416
				08/06/02	0.333
				10/08/02	0.721
				09/06/05	0.303
5	430591	43.92916	-86.0191	05/15/02	0.467
				06/26/02	0.546
				08/07/02	0.422
				10/09/02	0.835
				06/26/03	0.469
				07/10/03	0.415
6	620248	43.78438	-86.01869	05/15/02	0.163
				06/26/02	0.315
				08/07/02	0.220
7	530235	43.87566	-86.11352	05/16/02	0.359
				06/27/02	0.390
				08/07/02	0.352
				10/09/02	0.532
				06/25/03	0.475
				07/09/03	0.633
8	530227	43.96977	-86.14007	05/15/02	0.117
				06/26/02	0.211
				08/07/02	0.110
				10/09/02	0.117
				06/25/03	0.083
				07/10/03	1.380
9	530027	43.94494	-86.27938	09/26/00	0.761
				07/30/01	0.551
				05/15/02	0.262
				06/26/02	0.699
				08/07/02	0.806
				06/25/03	0.876
				07/09/03	0.745

Appendix G. Load Durations Curves for Stations 1-9. Load duration curves based on HCV WQS of 0.026 ng/L.

Pere Marquette River at Rosa Bridge

Load Duration Curve *(2002 Monitoring Data)*

Site: Station 1

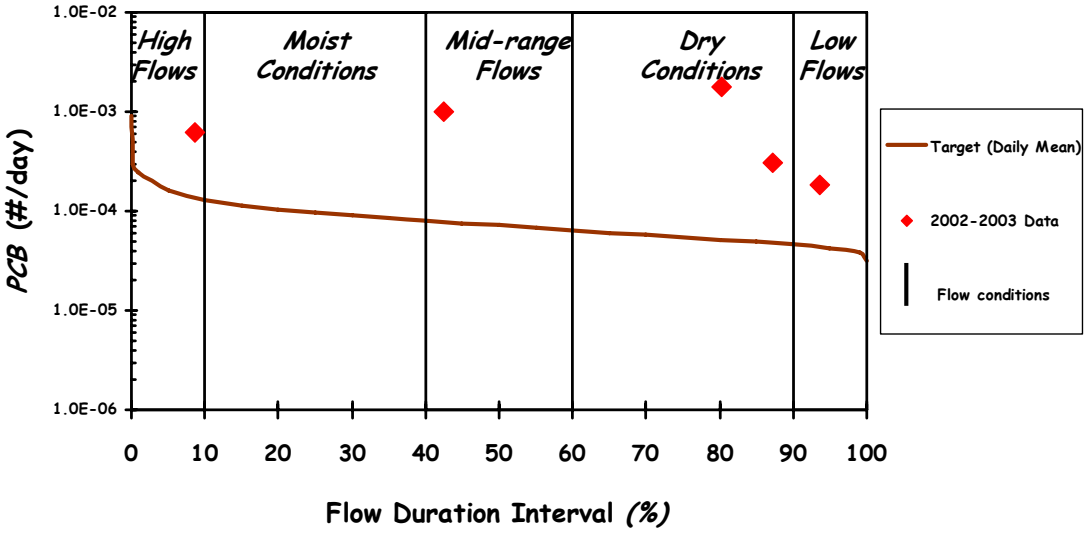


PCB Data & USGS Gage Duration Interval 04122500 *31.0 square miles*

Little S. Branch Pere Marquette River at 17-mile Road

Load Duration Curve *(2002-2003 Monitoring Data)*

Site: Station 2

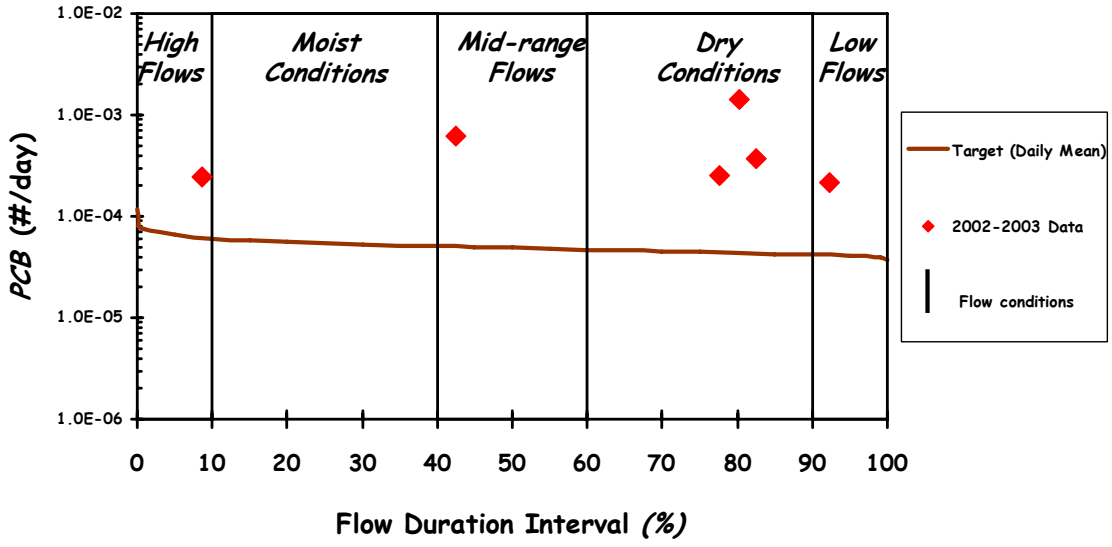


PCB Data & USGS Gage Duration Interval 04122500 *103.0 square miles*

Baldwin Creek off M-37

Load Duration Curve *(2002-2003 Monitoring Data)*

Site: Station 3

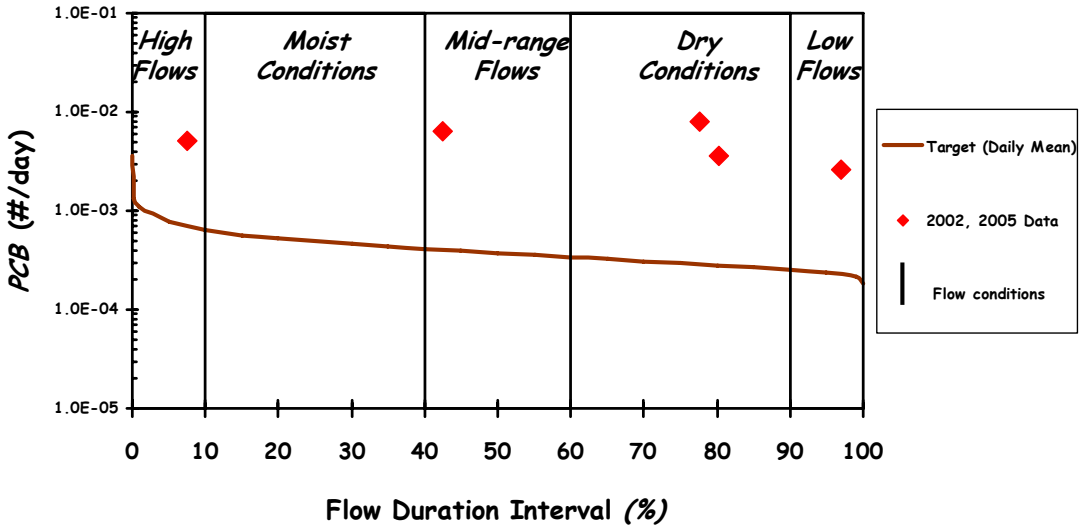


PCB Data & USGS Gage Duration Interval 04122500 *117.0 square miles*

Pere Marquette River at Peacock Road

Load Duration Curve *(2002, 2005 Monitoring Data)*

Site: Station 4

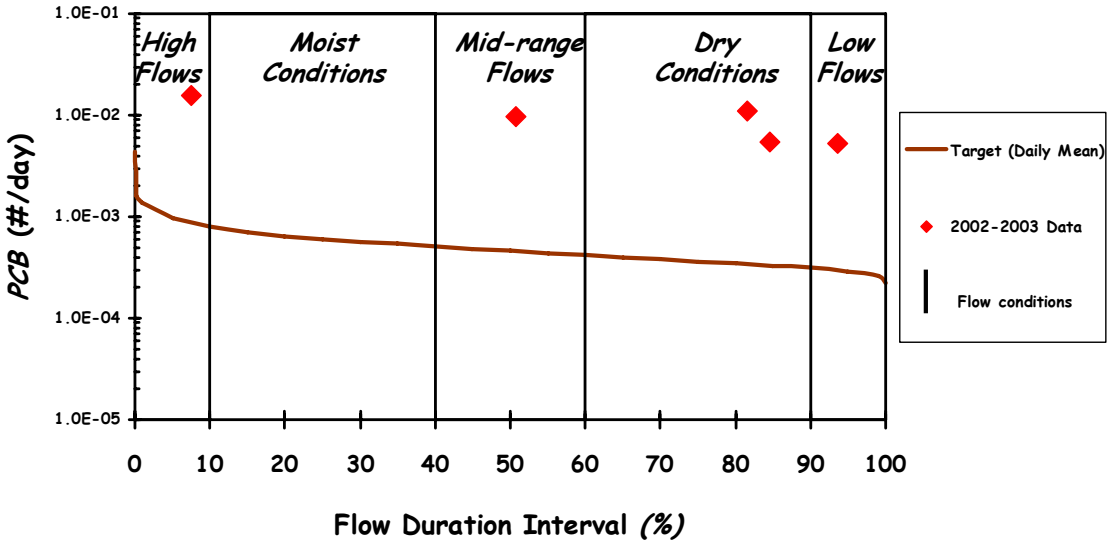


PCB Data & USGS Gage Duration Interval 04122500 *290.0 square miles*

Pere Marquette River at South Branch Road

Load Duration Curve *(2002-2003 Monitoring Data)*

Site: Station 5

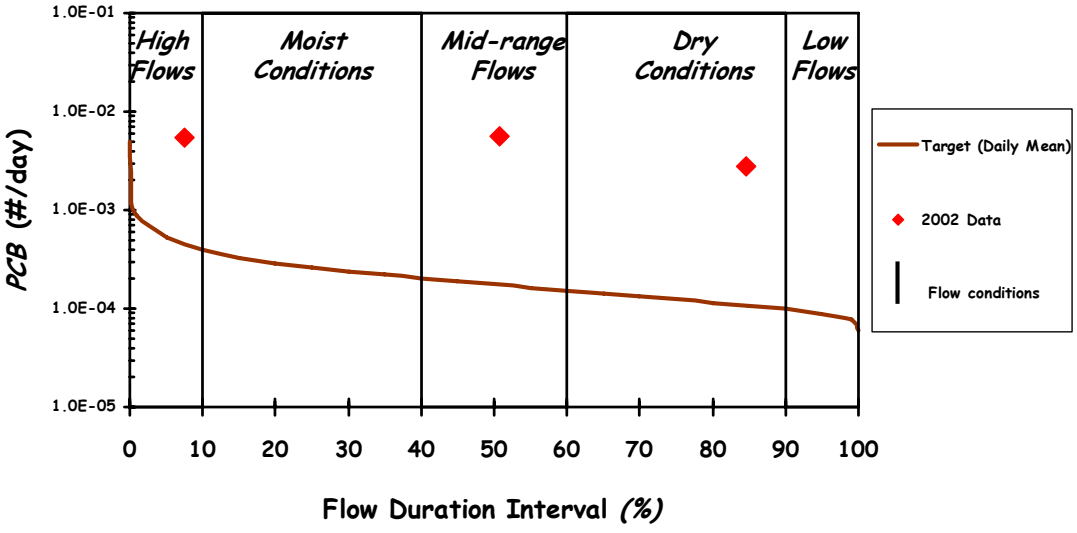


PCB Data & USGS Gage Duration Interval 04122500 *358.0 square miles*

Big South Branch Pere Marquette River at Dickinson Road

Load Duration Curve *(2002 Monitoring Data)*

Site: Station 6

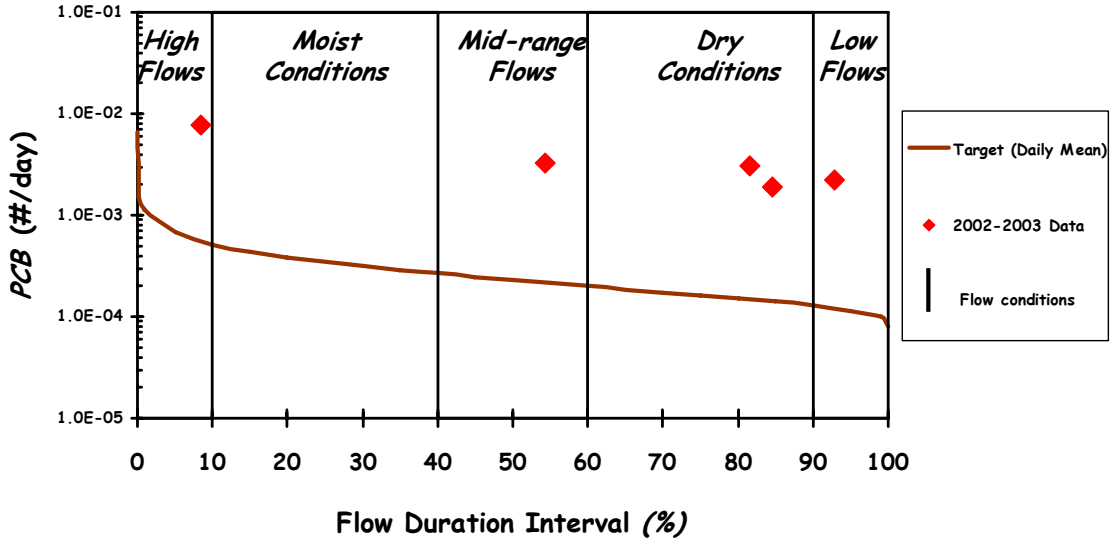


PCB Data & USGS Gage Duration Interval 04122500 *184.0 square miles*

Big South Branch Pere Marquette River at Walhalla Road

Load Duration Curve *(2002-2003 Monitoring Data)*

Station 7

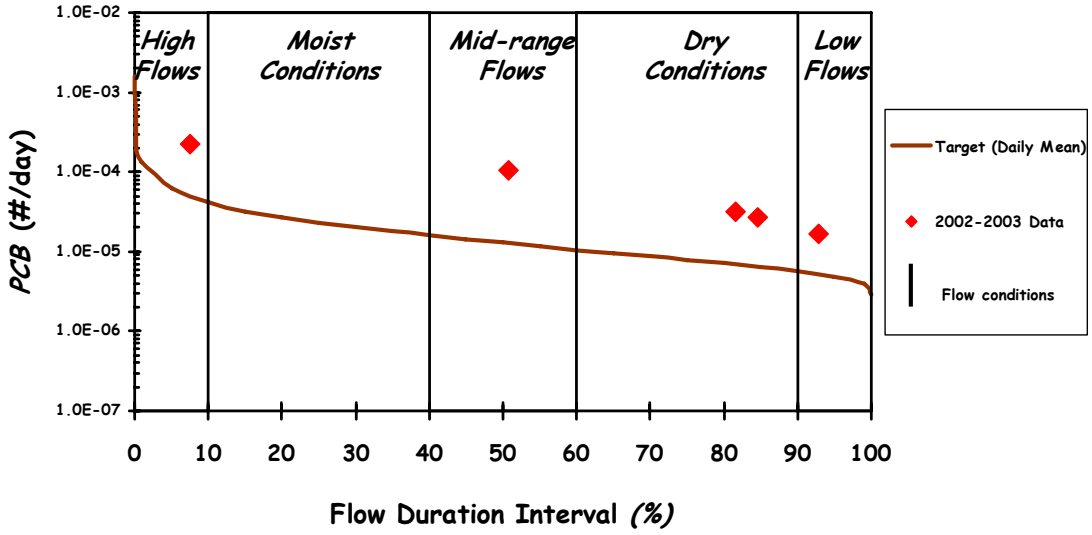


PCB Data & USGS Gage Duration Interval 04122500 *241.0 square miles*

Weldon Creek downstream of Benson Road

Load Duration Curve *(2002-2003 Monitoring Data)*

Site: Station 8



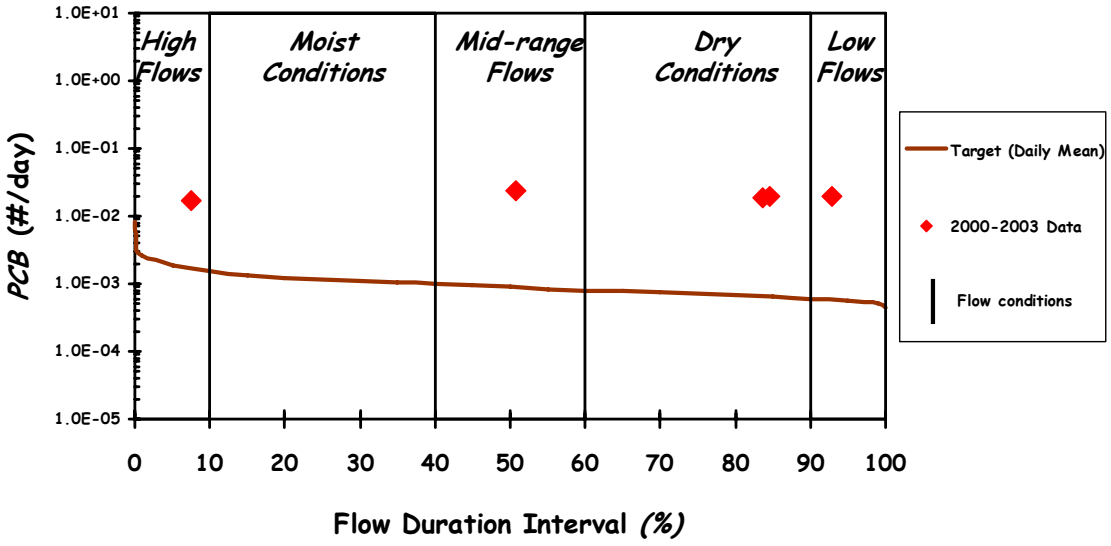
PCB Data & USGS Gage Duration Interval 04122500 *20.7 square miles*

Appendix G. cont.

Pere Marquette River at Scottville Rd.

Load Duration Curve *(2000-2003 Monitoring Data)*

Site: Station 9



PCB Data & USGS Gage Duration Interval 04122500 *689.0 square miles*