

Fox River NRDA/PCB Releases, Wisconsin

EPA Facility ID: WI0001954841

Basin: Lower Fox River

HUC: 04030204

Executive Summary

The Fox River NRDA/PCB Releases site is a zone of contaminated sediment that starts in the Lower Fox River and extends into the southern end of Green Bay. The site has been contaminated with PCBs and mercury as a result of discharged waste from paper mills and other sources. Four sediment deposits that contain concentrations of PCBs and mercury in excess of screening guidelines have been identified; one of the four was dredged and removed in 1998 to 1999. This site poses a risk to the numerous freshwater fish species in the Lower Fox River and Green Bay. These species and the supporting ecosystem are examples of NOAA trust resources of interest. The NOAA trust habitats of concern are the freshwater environments of the Fox River downstream of Lake Winnebago, Green Bay, and Lake Michigan.

Site Background

The Fox River Natural Resources Damage Assessment (NRDA)/PCB Releases site is a zone of sediment contamination encompassing 63 km (39 mi) of the Fox River, from the Neenah Channel and Menasha Channel downstream to Green Bay, as well as a minimum of 35 km (22 mi) into the bay (Figure 1).

The Lower Fox River area has one of the highest concentrations of paper mills in the world; operations at these mills resulted in the contamination of sediments, primarily with polychlorinated biphenyls (PCBs). Between 1957 and 1971, PCBs were used in the manufacture of carbonless copy paper. The primary sources of PCBs into the Fox River were facilities that recycled carbonless copy paper, although PCBs have also been detected in the effluents of paper mills that did not process carbonless copy paper and the effluents of publicly owned treatment works that received wastewater from paper mills (GASA and SAIC 1996). The Wisconsin Department of Natural Resources (WDNR) has estimated that nearly all of the PCBs released into the Lower Fox River were discharged before 1971 from five facilities: Appleton Papers-Coating Mill, P.H. Glatfelter Company and associated Arrowhead Park Landfill, Fort James-Green Bay West Mill (formerly Fort Howard), Wisconsin Tissue, and Appleton Papers-Locks Mill (WDNR 1999).

Four sediment deposits have been identified as the most contaminated; these deposits are referred to as POG, D/E, N, and EE/GG/HH (Figure 2) (GASA and SAIC 1996). Deposit N was dredged and removed from the river in a remediation effort that took place from 1998 to 1999 (Retec 2002). The remaining sediment deposits serve as continuing sources of contamination to downstream reaches of the Fox River, Green Bay, and Lake Michigan. During periods of high river flow, sediments behind the De Pere Dam may be carried over the dam, and the major source of PCBs in Green Bay is contaminated sediments of the Lower Fox River (USEPA 2000).

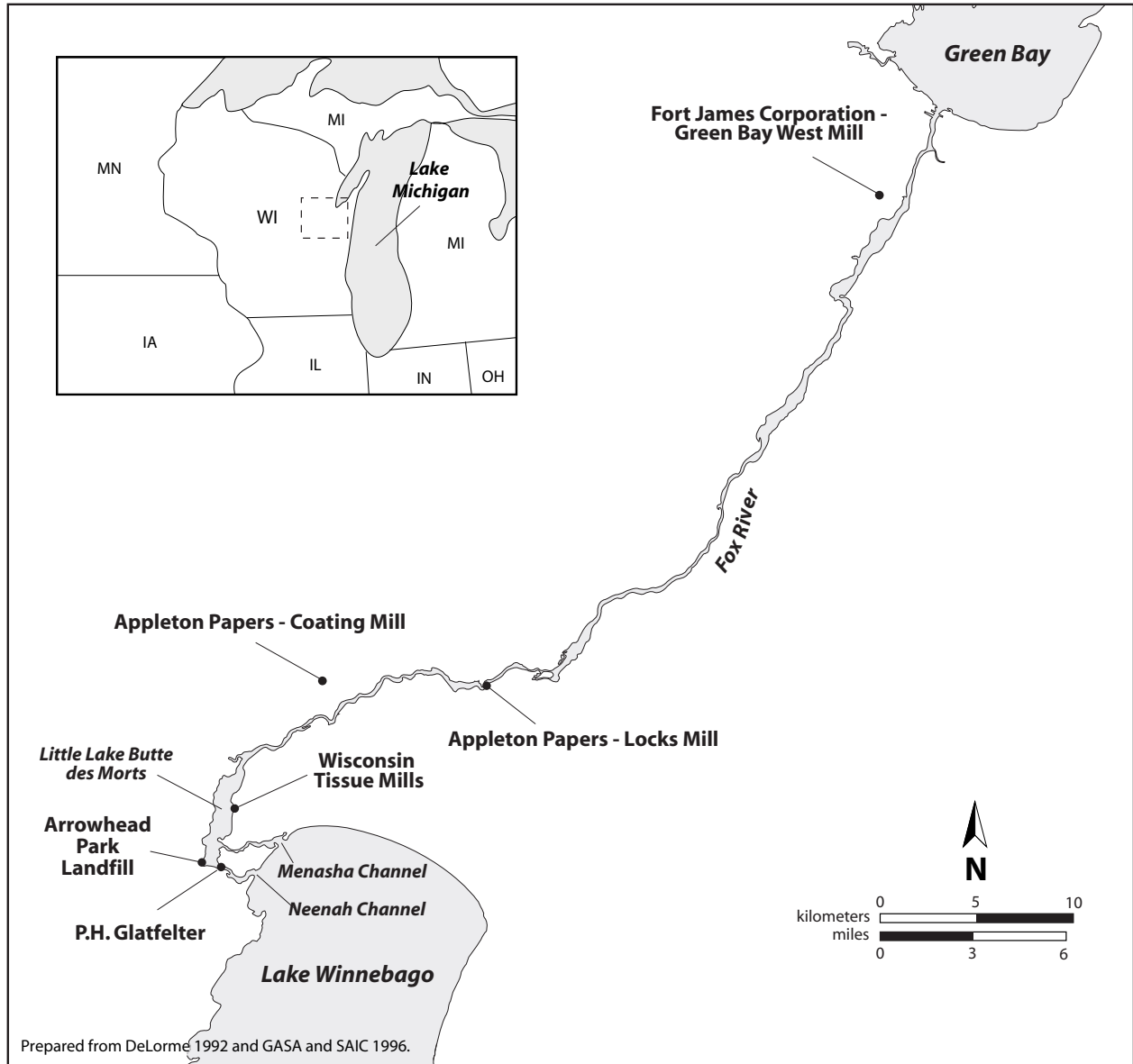


Figure 1. Locations of the Fox River NRDA/PCB releases site and major waste sources on the Lower Fox River, Wisconsin.

The Fox River NRDA/PCB Releases site is divided into five sections (Figure 2): the Little Lake Butte des Morts (LLBdM) Reach, the Appleton to Little Rapids Reach, the Little Rapids to De Pere Reach, the De Pere to Green Bay Reach, and Green Bay (Retec 2002).

The site was proposed for inclusion on the U.S. Environmental Protection Agency's (USEPA's) National Priorities List in July 1998 (USEPA 2000). A remedial investigation/feasibility study (RI/FS) of the contaminated sediment deposits was completed in 2002 (Retec 2002). A Record of Decision, which describes the cleanup decision, was signed for the LLBdM Reach and the Appleton to Little Rapids Reach of the site in December 2002 (USEPA 2003).

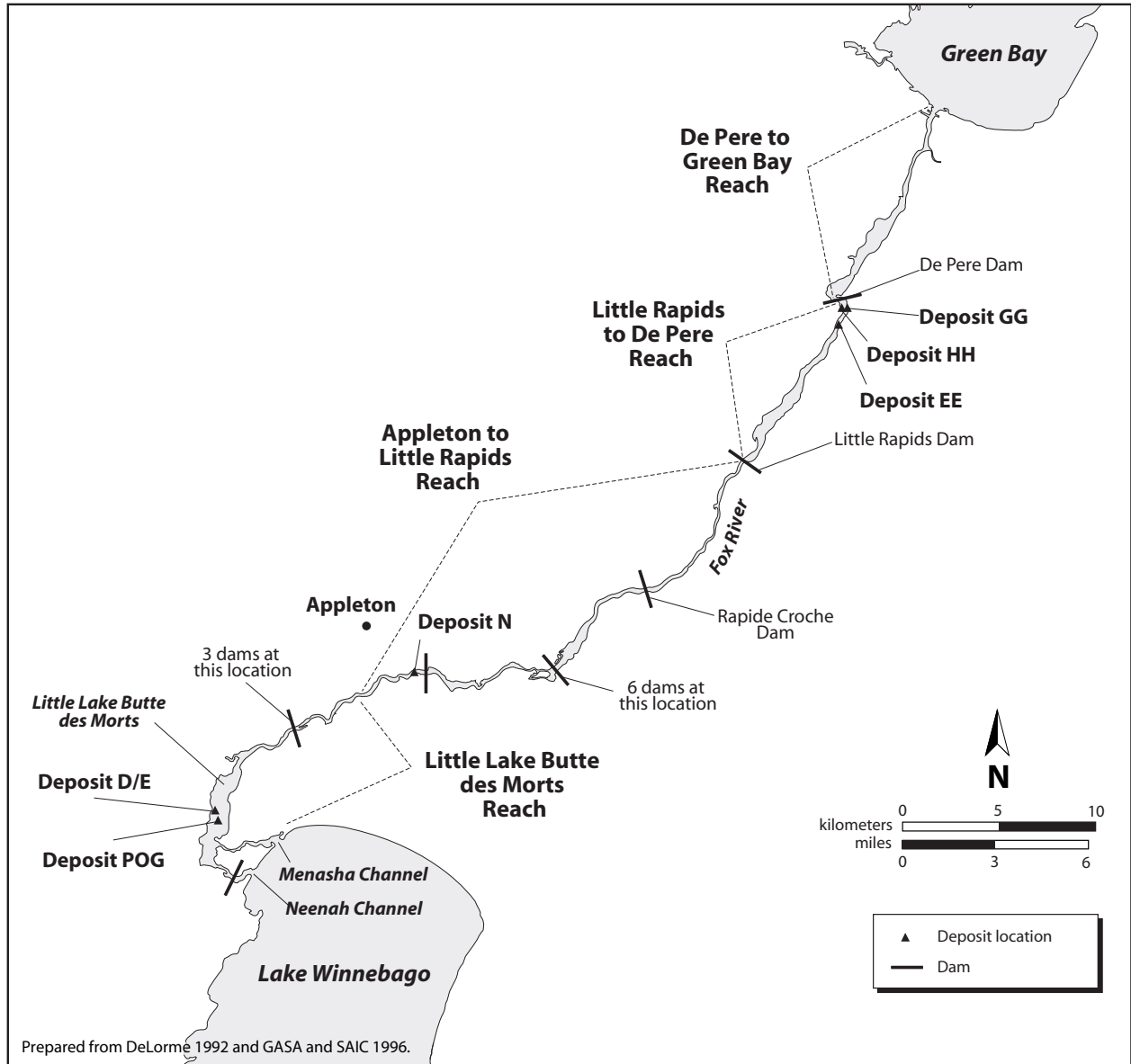


Figure 2. Locations of dams and contaminated sediment deposits on the Lower Fox River.

NOAA Trust Resources

The NOAA trust habitats of concern are the freshwater environments of the Fox River downstream of Lake Winnebago, Green Bay, and Lake Michigan. The Fox River is 322 km (200 mi) long; the area under investigation encompasses the lower 63 km (39 mi) of the river. The river ranges from 150 m (500 ft) to nearly 1,200 m (4,000 ft) in width and up to 8 m (26 ft) in depth, with substrates (bottom sediments) consisting of silts to sands (NOAA 1998). Fourteen dams are present on the river between Lake Winnebago and Green Bay; these dams modify the habitat into a series of slow-flowing impoundments (GASA and SAIC 1996). The Fox River flows into Green Bay, an embayment of Lake Michigan that measures approximately 190 km (119 mi) in length and 37 km (23 mi) in width and has an average depth of about 20 m (65 ft) (GASA and SAIC 1996).

44 EPA Region 5

Numerous freshwater fish species found in Lake Michigan are also present in the Fox River and Green Bay (Table 1). These species and the supporting ecosystem are examples of NOAA trust resources of interest. Periodic fish surveys conducted by the WDNR have identified at least 43 species of fish between Lake Winnebago and the De Pere Dam. These surveys indicate that the fish community in the Lower Fox River is dominated by only a few species. Carp is the most abundant fish species from LLBdM to the De Pere Dam. Other dominant fish species upstream of the De Pere Dam include walleye, white bass, yellow perch, and several species of bullhead. The most abundant fish species in the De Pere to Green Bay Reach of the river are carp, freshwater drum, quillback, and white sucker (Retec 2002).

The composition of fish species in Green Bay is similar to that in the Lower Fox River; additional species in Green Bay include several species of salmonids. WDNR fish surveys conducted in the Wisconsin waters of Green Bay from 1990 to 1998 indicate that walleye and yellow perch are the two most abundant fish species (Stratus Consulting 1999a).

The majority of fish species in the Lower Fox River spend their entire lives within or near the Fox River/Green Bay watershed. Although there is little migration outside of the watershed, several fish species, including lake sturgeon, northern pike, smallmouth bass, walleye, and yellow perch, have been documented to migrate between the waters of Green Bay and tributaries to Green Bay. Fish migration has also been documented between Green Bay and Lake Michigan and within Green Bay itself (Stratus Consulting 1999a).

When commercial fishing began in Green Bay in the 1800s, the important species in the north end of the bay were lake trout and lake whitefish. In the southern bay, prevalent species were lake herring, lake sturgeon, lake trout, lake whitefish, perch, pickerel, suckers, and walleye. Catfish and suckers, along with carp, crappies, muskellunge, shad, sunfish, and white bass, were also harvested in the southern bay and the Fox River. Data on average commercial fish harvests from the Wisconsin waters of Lake Michigan and Green Bay in 1998 showed a change in the fish species important in the Green Bay area. Chubs and lake whitefish made up the greatest portion of the harvest by weight (Stratus Consulting 1999a). Other important commercial fish species include alewife, rainbow smelt, and yellow perch (Retec 2002).

There is recreational fishing on the Lower Fox River; the most widely fished recreational species is walleye. Recreational fishing of northern pike, spotted muskellunge, walleye, and yellow perch occurs in southern Green Bay. Popular recreational species in northern Green Bay include lake whitefish, rainbow smelt, and walleye (Retec 2002). The most frequently caught recreational species in the Wisconsin waters of Green Bay from 1990 to 1998 was yellow perch (Stratus Consulting 1999b).

Fish consumption advisories are in effect for Green Bay and the Lower Fox River because of elevated concentrations of PCBs in edible fish tissue. Table 1 indicates which species are included in these advisories (Stratus Consulting 1999b; WDNR 2002).

Site-Related Contamination

The RI completed in 2002 compiled analytical data for samples collected from the Lower Fox River and Green Bay from 1989 to 2001. During that time, more than 18,000 combined sediment, tissue, surface water, pore water, and air samples were collected. This report focuses on test results for the sediment and surface water samples (Retec 2002).

Fox River NRDA/PCB Releases, Wisconsin 45

Table 1. Fish and invertebrate species found in the Lower Fox River and Green Bay (Stratus 1999b; Retec 2002; WDNR 2002)

Species Common Name	Scientific Name	Fish Consumption Advisories		Fisheries	
		Lower Fox River	Green Bay	Comm.	Rec.
FISH					
Alewife	<i>Alosa pseudoharengus</i>			◆	
Atlantic salmon ^a	<i>Salmo salar</i>				◆
Black bullhead	<i>Ameiurus melas</i>				
Black crappie	<i>Pomoxis nigromaculatus</i>	◆		◆	◆
Bluegill	<i>Lepomis macrochirus</i>			◆	◆
Brook trout ^a	<i>Salvelinus fontinalis</i>				
Brown bullhead	<i>Ameiurus nebulosus</i>				◆
Brown trout ^a	<i>Salmo trutta</i>		◆		◆
Burbot	<i>Lota lota</i>				◆
Carp	<i>Cyprinus carpio</i>	◆	◆		◆
Channel catfish	<i>Ictalurus punctatus</i>	◆	◆		◆
Chinook salmon ^a	<i>Oncorhynchus tshawytscha</i>		◆		◆
Chubs ^a	Unknown			◆	
Coho salmon ^a	<i>Oncorhynchus kisutch</i>				◆
Emerald shiner	<i>Notropis atherinoides</i>				
Flathead catfish	<i>Pylodictis olivaris</i>				◆
Freshwater drum	<i>Aplodinotus grunniens</i>				◆
Gizzard shad	<i>Dorosoma cepedianum</i>				
Green sunfish	<i>Lepomis cyanellus</i>				◆
Lake sturgeon ^a	<i>Acipenser fulvescens</i>		◆		
Lake trout ^a	<i>Salvelinus namaycush</i>				
Lake whitefish ^a	<i>Coregonus clupeaformis</i>		◆	◆	◆
Longnose gar	<i>Lepisosteus osseus</i>				
Northern pike	<i>Esox lucius</i>	◆	◆	◆	◆
Pink salmon ^a	<i>Oncorhynchus gorbuscha</i>				◆
Quillback carpsucker	<i>Carpoides cyprinus</i>				
Rainbow smelt ^a	<i>Osmerus mordax dentex</i>			◆	◆
Rainbow trout ^a	<i>Salmo gairdneri</i>		◆		◆
Redhorses	<i>Moxostoma spp.</i>				
Rock bass	<i>Ambloplites rupestris</i>	◆		◆	◆
Sauger	<i>Stizostedion canadense</i>			◆	◆
Shortnose gar	<i>Lepisosteus platostomus</i>				
Smallmouth bass	<i>Micropterus dolomieu</i>	◆	◆	◆	◆
Splake ^b	<i>Merone americana</i>		◆	◆	
Spottail shiners	<i>Notropis hudsonius</i>				
Spotted muskellunge ^a	<i>Esox masquinongy</i>			◆	◆
Trout perch	<i>Percopsis omiscomaycus</i>				
Walleye	<i>Stizostedion vitreum</i>	◆	◆	◆	◆
White bass	<i>Morone chrysops</i>	◆	◆	◆	◆
White perch	<i>Morone americana</i>	◆	◆		
White sucker	<i>Catostomus commersoni</i>	◆	◆		
Yellow perch	<i>Perca flavescens</i>	◆	◆	◆	◆
INVERTEBRATES					
Chironomids	<i>Chironomid diptera spp.</i>				
Oligochaets	<i>Oligochacter spp.</i>				

a: These species are present in Green Bay but are not present in the lower Fox River according to fish surveys conducted from 1975 through 1998.

b: A hybrid fish produced in a hatchery by crossing a true lake trout female (*S. namaycush*) and a true brook trout male (*S. fontinalis*).

46 EPA Region 5

The primary contaminants of concern to NOAA in the Lower Fox River are PCBs and mercury, which were detected at maximum concentrations that exceeded screening guidelines. Several other inorganic and organic compounds exceeded guidelines to a lesser extent and are of secondary concern. Maximum concentrations of contaminants of concern in surface water and sediment samples are presented in Table 2.

Several inorganic compounds (metals), total PCBs, and the pesticide DDT were detected in surface water samples collected from the site. Mercury was detected in 71 percent of the surface water samples analyzed for mercury. The maximum mercury concentration was detected in a sample collected from the Little Rapids to De Pere Reach and exceeded the ambient water quality criteria (AWQC) screening guideline by a factor of three. Other inorganic compounds detected in surface water included cadmium, chromium, copper, lead, and zinc; maximum concentrations of these metals did not exceed the AWQC. Total PCBs were detected in 91 percent of the surface water samples analyzed for PCBs. The maximum total PCB concentration, which was detected in a sample from the De Pere to Green Bay Reach, exceeded the AWQC screening guideline by one order of magnitude. The maximum concentration of DDT detected in surface water did not exceed the AWQC.

Several inorganic compounds were detected at elevated concentrations in sediment samples collected from the site. Maximum concentrations of arsenic, cadmium, chromium, lead, mercury, and zinc exceeded the threshold effects level (TEL) screening guidelines by one order of magnitude. The maximum concentration of copper exceeded the TEL by a factor of six. The maximum concentration of arsenic was detected in sediment from the De Pere to Green Bay Reach. The maximum concentrations of chromium, lead, and mercury were detected in sediment samples from the Little Rapids to De Pere Reach. The maximum concentrations of cadmium, copper, and zinc were detected in sediment samples from the LLBdM Reach.

Total PCBs were detected in sediment samples from throughout the site at concentrations exceeding the TEL screening guideline. The maximum concentrations of total PCBs detected in sediment from each of the site's five sections ranged from 0.75 mg/kg in Green Bay to 710 mg/kg, which exceeded the TEL screening guideline by four orders of magnitude, in the De Pere to Green Bay Reach. Total PCBs were detected in 88 percent of the sediment samples analyzed for PCBs.

Several polynuclear aromatic hydrocarbons (PAHs) and pentachlorophenol were also detected in sediment samples. The maximum concentrations of benz(a)anthracene, phenanthrene, and pyrene exceeded the TEL screening guidelines by two orders of magnitude. Chrysene and fluoranthene were detected at maximum concentrations that exceeded the screening guidelines by one order of magnitude. Other PAHs were detected, but TELs are not available for comparison to the maximum concentrations of those compounds. The majority of the maximum PAH concentrations were detected in sediment from the LLBdM Reach. The maximum concentration of pentachlorophenol was detected in sediment from the Little Rapids to De Pere Reach.

DDT, heptachlor, and dioxins/furans were detected in sediment from the site. The maximum concentration of DDT exceeded the TEL screening guideline by a factor of seven. There is no TEL for heptachlor. The maximum concentrations of DDT and heptachlor were detected in sediment from the LLBdM Reach. The maximum concentrations of dioxins/furans were detected in sediment from the De Pere to Green Bay Reach. The maximum concentration of 2,3,7,8-TCDD in sediment was slightly less than twice the screening guideline.

Table 2. Maximum concentrations of the primary contaminants of concern detected in sediment and surface water in the Lower Fox River (GASA and SAIC 1996; Retec 2002).

Contaminant	Water (µg/L)		Sediment (mg/kg)	
	Surface Water	AWQC ^a	Sediment	TEL ^b
INORGANIC COMPOUNDS				
Arsenic	ND	150	390	5.9
Cadmium	0.019	2.2 ^c	13	0.596
Chromium ^h	0.37	11	420	37.3
Copper	1.0	9 ^c	210	35.7
Lead	0.12	2.5 ^c	1400	35
Mercury	2.5	0.77 ^d	11	0.174
Zinc	2.6	120 ^c	2100	123.1
PAHs/PHENOLS				
Acenaphthylene	ND	NA	0.17	NA
Anthracene	ND	NA	1.4	NA
Benz(a)anthracene	ND	NA	3.3	0.0317
Chrysene	ND	NA	3.8	0.0571
Dibenz(a,h)anthracene	ND	NA	0.32	NA
Fluoranthene	ND	NA	6.5	0.111
Fluorene	ND	NA	0.58	NA
2-Methylnaphthalene	ND	NA	0.43	NA
Naphthalene	ND	620 ^g	0.79	NA
Pentachlorophenol	ND	15 ^e	1.1	NA
Phenanthrene	ND	NA	4.7	0.0419
Pyrene	ND	NA	7.0	0.053
PESTICIDES/PCBs				
DDT	0.00021	0.001	0.050	0.00698 ^f
Heptachlor	ND	0.0038	0.0084	NA
PCBs (as Aroclors)	0.15	0.014	710	0.0341
DIOXINS/FURANS				
2,3,7,8-TCDD	ND	NA	1 x 10 ⁻⁵	8.8 x 10 ⁻⁶ ⁱ
2,3,7,8-TCDF	ND	NA	1.7 x 10 ⁻⁴	NA

- a: Ambient water quality criteria for the protection of aquatic organisms (USEPA 1993, 1999). Freshwater chronic criteria presented.
 - b: Threshold effects level is the geometric mean of the 15th percentile of the effects data and the 50th percentile of the no-effects data. The TEL is intended to represent the concentration below which adverse biological effects rarely occurred (Smith et al. 1996).
 - c: Criterion expressed as a function of total hardness; concentrations shown correspond to hardness of 100 mg/L.
 - d: Criterion expressed as total recoverable metal.
 - e: Chronic is pH dependent; concentration shown above corresponds to pH of 7.8.
 - f: Expressed as total DDT.
 - g: Lowest Observable Effects Level (LOEL).
 - h: Screening guidelines represent concentrations for Cr.⁺⁶
 - i: TEL not available; the freshwater upper effects threshold (UET) value is presented.
- NA: Screening guidelines not available.
 ND: Not detected.

48 EPA Region 5

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