PHASE II INVESTIGATION OF SEDIMENT CONTAMINATION IN WHITE LAKE

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Executive Summary

A Phase II investigation of the nature and extent of sediment contamination in White Lake was performed. Sediment chemistry, solid-phase toxicity, and benthic macroinvertebrates were examined at 21 locations. Since chromium was previously identified as the major contaminant in the sediments, experiments were conducted to determine the accumulation of the metal in zebra mussels, macrophytes, and chironomids. In addition, three core samples were evaluated using radiodating and stratigraphy to assess sediment stability and contaminant deposition. High levels of chromium were found to cover a majority of the lake bottom and to extend 8 km from Tannery Bay. All locations sampled west of Tannery Bay exceeded the Probable Effect Concentration (PEC). Most of the chromium was found in the top 51 cm of the core samples. High concentrations of PCBs were found near the outfall of the former Occidental/Hooker Chemical facility. These levels also exceeded PEC guidelines. Sediment toxicity was observed in the east bay area and at the Occidental/Hooker Chemical outfall. Toxicity near the Occidental/Hooker Chemical outfall was probably due to the presence of PCBs. No obvious toxicant was present in the sediments from the east bay. While no relationship was previously observed for total chromium and amphipod toxicity, a significant correlation was found for the organically bound fraction and the metal. Elevated levels of organic chromium were found in archived sediments from Tannery Bay. Benthic macroinvertebrate communities throughout White Lake were found to be indicative of organically enriched conditions. The locations in the east bay were significantly different than reference sites, as indicated by a shift to chironomids that were predators and sprawlers. Chironomid populations in the remainder of the lake were burrowers and detritivores. Higher densities of nematodes and reduced tubificids populations were associated with the stations with elevated chromium levels (> 400 mg/kg). The metal also was correlated with an increase in the trophic status of chironomid populations. Chromium accumulation was observed in chironomid populations throughout White Lake. In addition, macrophytes and zebra mussels in Tannery Bay were observed to accumulate the metal in their tissue.

All of the stratigraphy cores showed uniform levels of chromium deposition in the top 10 - 15 cm. This pattern suggested that a constant source of chromium was present in White Lake. A standard exponential decay pattern was absent in the lower sections of the cores, indicating that historical changes in sedimentation were caused by episodic events. These data coupled with chromium contour maps and the generalized circulation pattern of the lake were used to elucidate the fate and transport of the metal. The proximity to the drowned rivermouth currents at the Narrows and the wind induced resuspension in the bay provided conditions that facilitated the advection and dispersion of a sediment plume 8 km from its source. Higher concentrations of chromium were found in the three deep deposition basins (300-500 mg/kg). In contrast, the PCBs discharged by the Occidental/Hooker Chemical outfall remained within 100 m of the outfall pipe. The depth of the discharge (15 m) plus the depositional nature of the discharge zone acted to confine the contaminants to a small area. The removal of contaminated sediments in Tannery Bay and the Occidental/Hooker outfall were completed by October 2003. Both remedial actions are essential for the recovery of White Lake. Remediation at Tannery Bay removed the ongoing source of chromium contamination while dredging the Occidental/Hooker outfall reduced the amount of bioaccumulative compounds in the lake.

1.0 Introduction

White Lake, Michigan is a 10.2 km^2 (4,150 acres) drowned river mouth lake that is directly connected to Lake Michigan by a navigation channel. The lake has a mean depth of 7.3 m and an estimated volume of 7.6×10^7 m^3 (Freedman et al. 1979). Deep deposition zones are located at Dowies Point (17 m) and Long Point (21 m). The lake is part of the White River watershed, which has a drainage basin of 139,279 hectares (2,634 square miles). The White River originates in Newaygo County and flows through a large marsh/estuary complex before entering White Lake. A predominately western flow is maintained through the lake resulting in a residence time of 56 days. Strong currents are often noted in the region called the Narrows, where two peninsulas cause a restriction in the watercourse and produce riverine flow conditions through the passage. White Lake functions as a significant fishery and recreational area in this region of the Great Lakes and provides an important transition zone between the open waters of Lake Michigan and the estuary/riverine environments associated with the White River.

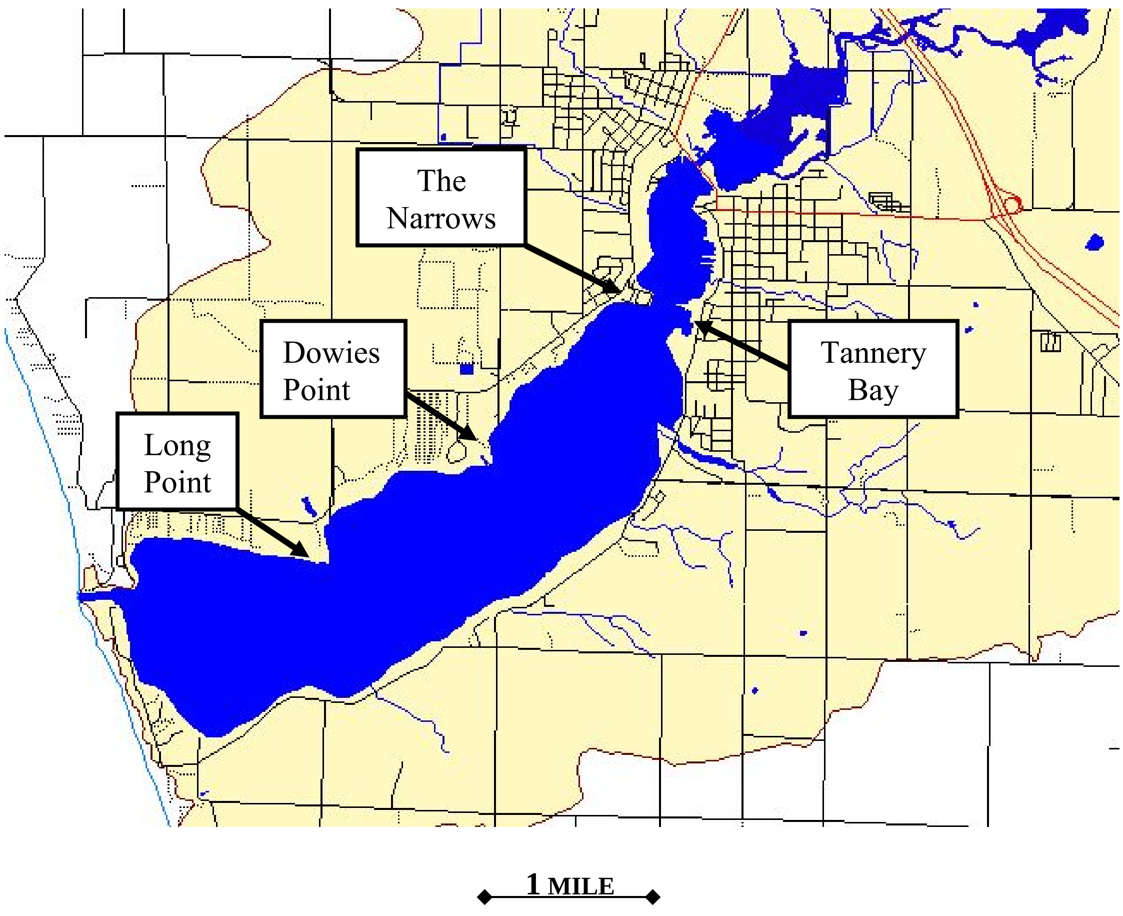

FIGURE 1.1 WHITE LAKE.

White Lake has a long history of environmental issues related to water quality and the discharge of toxic materials. The lake was impacted in the mid 1800s when saw mills were constructed on the shoreline during the lumbering era. During this period, a large portion of the littoral zone was filled with sawdust, wood chips, timber wastes, and bark. Large deposits of lumbering waste can still be found today in the nearshore zone of White Lake. The lumbering era was followed in the 1900s by an era of industrial expansion related to the construction of specialty chemical production facilities and a leather tanning operation. Tannery waste from Whitehall Leather was discharged directly into White Lake from 1890-1973. Effluents from Hooker Chemical's (now Occidental Chemical) chloralkali and pesticide production were discharged from the 1950-1986 (Evans 1992 and GLC 2000). Chlorinated organic chemicals from DuPont and Muskegon Chemical (now Koch Chemical) have also entered White Lake through groundwater and surface water discharges. As a result, degraded conditions were observed in much of the lake, as well as high sediment concentrations of heavy metals and pesticide related chemicals. Evans (1992) presented a review of studies that described extensive areas of oxygen depletion, high quantities of chromium in the sediments, thermal pollution, the discharge of industrial wastes with a high oxygen demand from the tannery (sulfide and organic matter), tainted fish, frequent algal blooms, and high nutrient concentrations. Generally, oligochaetes were the dominant benthic taxa and macroinvertebrate species richness and diversity were low across the lake (Evans 1976). These factors indicated that eutrophic conditions were prevalent in 1972, especially, the southeastern portion of the lake. The International Joint Commission designated White Lake as an Area of Concern (AOC) because of severe environmental impairments related to these discharges. The AOC boundary includes the lake and several small subwatersheds. In 1973, a state of the art wastewater treatment facility was constructed and the direct discharge of waste effluents and partially treated municipal sewage to White Lake was eliminated. The new facility was constructed near Silver Creek and utilized aeration, lagoon impoundment, spray irrigation and land treatment to remove nutrients, heavy metals, and organic chemicals. While the system was very effective in reducing the point source load of nutrients to White Lake, nonpoint contributions from upstream sources increased after construction and a net reduction in loading was not observed during 1974 and 1975 (Freedman et al. 1979).

Recent and historical studies have indicated extensive contamination of sediments in White Lake. Elevated levels of chromium, lead, arsenic, and mercury were detected in the northeastern section of the lake in 1982 during a U.S. Environmental Protection Agency (U.S.EPA) funded study conducted by the West Michigan Shoreline Regional Development Commission (WMSRDC 1982). This study also found evidence of heavy metal contamination in several locations along the northwest shore. In a more recent study conducted in the summer of 1994 by U.S.EPA/Michigan Department of Environmental Quality (MDEQ), elevated concentrations of these metals were detected in an area of the northeast shore of White Lake (Bolattino and Fox 1995). This area (Tannery Bay) was the historical discharge point for tannery effluent from Whitehall Leather. The chromium levels found in the sediments of this area (4,500 mg/kg) were some of the highest concentrations reported from any site in the Great Lakes. In a recent investigation, Rediske et al. (1998) determined the distribution of chromium in western White Lake and evaluated the toxicity

and stability of sediments in Tannery Bay. Key findings of the investigation were as follows:

- Sediments in Tannery Bay were acutely toxic to amphipods and midges.
- Chromium concentrations in Tannery Bay ranged from 1000 mg/kg to 4,500 mg/kg. No correlation was found between solid phase toxicity and total chromium concentrations.
- The highest degree of toxicity was found in the bay located to the east of Tannery Bay. Chromium levels were low (100 mg/kg - 200 mg/kg) at this location.
- Benthic macroinvertebrates in Tannery Bay and the east bay were lower in diversity and contained more pollution tolerant organisms than an uncontaminated control location.
- Profiles of ^{210}Pb showed that mixing was occurring in the top 20 cm of sediment in Tannery Bay.
- Chromium levels approaching 900 mg/kg were found 2.4 km (1.5 miles) down gradient of the discharge point.
- High levels of PCBs (100 mg/kg) were detected in the sediments near the discharge of the former Occidental Chemical facility (Dowies Point).

The extent of chromium and PCB contamination in western White Lake was not investigated in the previous study. While we know that high levels of chromium are present in the near surface zone in many areas of eastern White Lake, the toxicity of these sediments has not been evaluated. In addition, contaminant sediment profiles, toxicity evaluations, and an assessment of the macroinvertebrate community have not been performed in section of White Lake from Dowies Point to the Lake Michigan channel. The presence of contaminated sediments and ecological impairments in the eastern half of the lake coupled with westerly flow of water through the lake underscore the importance of conducting a more comprehensive assessment of the system.

This investigation expanded the historical data and addressed critical data gaps related to the distribution of chlorinated hydrocarbons and heavy metals in the western half of White Lake and the toxicity of sediments outside of Tannery Bay. The investigative sampling focused on regions of sediment contamination in areas near the shoreline and in deeper deposition zones. A series of 10 sediment cores and 20 PONAR samples were analyzed for heavy metals, semivolatiles, PCBs, and physical characteristics. PONAR samples were analyzed for benthic macroinvertebrates and sediment toxicity. Chromium levels in the benthic macroinvertebrates were also examined. In addition, three cores from deposition zones were dated using ^{210}Pb and ^{137}Cs. These cores were analyzed for chromium and radionuclides to determine the depositional patterns and contaminant flux in the lake. The study protocol followed the sediment quality triad approach (Canfield 1998) and focused on sediment chemistry, sediment toxicity, and the status of the *in situ* benthic macroinvertebrate community. The information from this investigation will be important in the determination of areas that may require further delineation and the prioritization of remedial action and habitat restoration activities. Additionally, these data will further our understanding of the ecological significance of sediments that are mobile and subject to resuspension in drowned river mouth systems.

1.1 Summary Of Anthropogenic Activities In White Lake

Areas and sources of contained sediments were recently inventoried as part of the Remedial Action Plan (RAP) update for White Lake (Rediske 2002). Locations and sources are shown in Figure 1.2. Wastes discharged by Whitehall Leather from 1890-1973 have impacted eastern White Lake. Wastewater and sludge from tanning operations based on a tree bark process were discharged into the east bay and Tannery Bay from 1890 to 1945. The process was changed to a chromium-based system in 1945 and wastewater containing heavy metals, hide fragments, and animal hair was discharged directly into the bay. Arsenic and mercury were added to the process as preservatives. In addition to heavy metals, the wastewater contained high levels of organic nitrogen, biological oxygen demand (BOD), and sulfide.

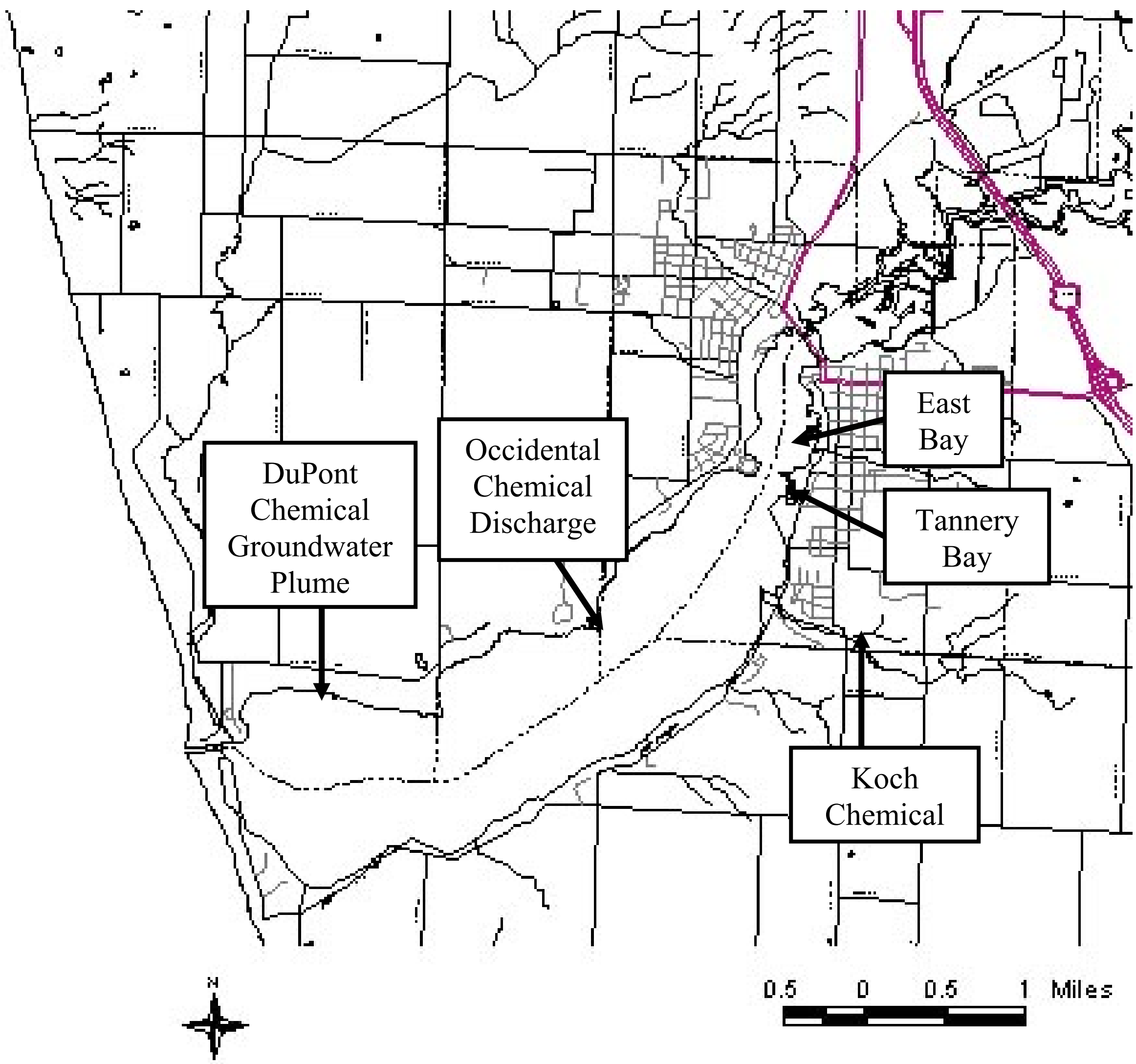

FIGURE 1.2 AREAS OF SEDIMENT CONTAMINATION IDENTIFIED IN WHITE LAKE

Solid wastes, dredged materials from the lagoons, and process sludge were disposed in landfill areas adjacent to the shore. Local residents frequently reported problems with the erosion of the solid waste materials. Recent and historical studies have indicated extensive contamination of sediments in this region of White Lake. High levels of chromium (4,000 - 60,000 mg/kg), mercury (1 -15 mg/kg), and arsenic (10 - 200 mg/kg) were reported (Bolattino and Fox 1995, Rediske et al. 1998). The sediments were found to be subject to a high degree of mixing in the bay and they also were toxic in laboratory bioassays. Internal resuspension plus the presence of high surface zone chromium concentrations 2.4 km from the discharge point suggested that the sediments were subject to transport by lake currents. Based on this information, the U.S. Army Corps of Engineers and the Michigan Department of Environmental Quality conducted a feasibility study and developed a remediation plan for Tannery Bay that involved the removal of 85,000 cubic yards of contaminated sediment. The dredging began in September 2002 and was completed in 2003. A contaminated groundwater plume exists on site and is currently being treated. The treatment system will have to remain in place to prevent future sediment contamination. A large amount of contaminated soils is also present on site and needs to stabilized or removed to prevent future sediment contamination by erosion and runoff.

The sediments in the bay area east of Tannery Bay were found to be contaminated with chromium slightly above the Probable Effect Concentration (PEC) in 1997 (Rediske et al. 1998). This location is on the shoreline of the Whitehall Leather facility and is also in the discharge zone of the former City of Whitehall wastewater treatment plant. Sediments were found to be highly toxic in laboratory bioassays and the diversity and total number of benthic macroinvertebrates were reduced. The toxicant in the sediments could not be identified. In consideration of the high toxicity and the degree of impact to the benthic community, further investigation and toxicity evaluations need to be performed in the east bay.

The Occidental Chemical facility discharge zone near Dowies Point received chemical production wastes from chloralkali and pesticide intermediate production operations from 1954 to 1977. Levels of chromium and lead that exceeded PEC values were found in the sediments at this location in previous investigations (West Michigan Shoreline Regional Development Commission 1982, Evans 1976). Rediske et al. (1998) determined that the deep water zone off Dowies Point functioned as a deposition area for contaminated sediments that were transported from Tannery Bay. This determination was based on the presence of high chromium concentrations and mats of animal hair in the surficial zone. A core sample collected from the area revealed the presence of high levels of PCBs (> 100 mg/kg) and chlorinated pesticide byproducts at sediment depths of 1-3 ft. Further investigations conducted by Earth Tech (2000) found a 30 x 100 m area that was contaminated with PCBs above the PEC value. The area was localized in the former effluent discharge zone and followed the prevailing lake currents to the west. The Earth Tech investigation also revealed an elliptical 30 m zone that was devoid of benthic macroinvertebrates. Because of the high level of PCBs present in the sediments and the potential for bioaccumulation in the local fish populations, Occidental Chemical and the EPA have agreed to remove the contaminated sediments by dredging. The removal operations were completed in the fall of 2003. A groundwater treatment system is in place that prevents a plume of contaminants from reaching White Lake. This system will remain in operation to protect the sediments after remediation.

The E.I. DuPont Chemical groundwater discharge zone is located between Long Point and the sand dunes on the Lake Michigan shore. The groundwater discharge is related to infiltration of lime wastes that contain low levels of heavy metals, high pH levels, and thiocyanate (EPA 2002). PCBs and chromium were detected at levels exceeding the PEC guidelines during an investigation in 1981 (West Michigan Shoreline Regional Development Commission 1982). These chemicals may have originated from Tannery Bay and/or Dowies Point since they are not related to the groundwater plume.

The Muskegon/Koch Chemical facility is located near Mill Pond Creek. The Creek drains into an impounded area, Mill Pond, and then discharges into White Lake on the southern shore. The Muskegon/Koch Chemical facility operated from 1975-1986 and produced a variety of specialty chemicals. The facility is a Superfund Site (EPA 2002) because the area groundwater and soil are contaminated with chlorinated solvents and chlorinated ethers (several compounds are classified as carcinogenic). As part of a consent agreement, a groundwater treatment system was installed 1995 that intercepts contaminants and prevents them from reaching Mill Pond Creek. The Creek passes through a residential area and there is no information available on the presence of contaminated sediments. In consideration that some of the groundwater contaminants are carcinogenic, a more detailed assessment of the area is ranked with a high priority. Chlorinated ethers were not observed in the discharge zone of Mill Pond Creek in White Lake (Rediske et al. 1998). Mill Pond Creek and the pond were not investigated in this project.

Evans (1992) summarized historical water quality and biological data for White Lake. Prior to the 1973 wastewater diversion, nuisance algal blooms, fish tainting problems, excessive macrophyte growth, winter fish kills, and oxygen depletion in the hypolimnion were common. Average sediment concentrations of total phosphorus and total nitrogen were 3,258 mg/kg and 7,180 mg/kg respectively. Benthic macroinvertebrate communities were dominated by pollution tolerant oligochaetes and chironomids. While ambient water quality improved significantly by the mid 1980s, the composition of the benthic community remained similar due to persistent sediment contamination. The only area where pollution intolerant organisms such as *Hexagenia* sp. were found was in the eastern section of White Lake near the river mouth (Evans 1992, Rediske et al. 1998).

1.2 Project Objectives And Task Elements

The objective of this investigation is to conduct a Category II assessment of sediment contamination in White Lake. Specific objectives and task elements are summarized below:

- Determine the nature and extent of sediment contamination in western White Lake.

  - A Phase II investigation was conducted to examine the nature and extent of sediment contamination in western White Lake. Core samples were collected to provide a historical perspective of sediment contamination. The investigation was directed at known sources of contamination in the lake and provided expanded coverage in the area of the old Occidental Chemical facility outfall and the DuPont lime pile groundwater plume. Arsenic, barium, cadmium, chromium, copper, lead, nickel, zinc, selenium, mercury, TOC, and grain size were analyzed in all core samples.
  - Surface sediments were collected from western White Lake with a PONAR to provide chemical data for the sediments used in the toxicity evaluations and for the analysis of the benthic macroinvertebrate communities. The PONAR samples were analyzed for the same parameters as the sediment cores in addition to PCBs and semivolatile organics.
  - Critical measurements were the concentration of arsenic, barium, cadmium, chromium, copper, lead, nickel, zinc, selenium, mercury, PCBs, and semivolatile organics in sediment samples. Non-critical measurements were total organic carbon, and grain size.

- Evaluate the toxicity of sediments from sites in White Lake.

  - Sediment toxicity evaluations were performed with *Hyalella azteca* and *Chironomus tentans*.
  - Toxicity measurements in White Lake sediments were evaluated and compared to control locations. These measurements determined the presence and degree of toxicity associated with sediments from White Lake.
  - Critical measurements were the determination of lethality during the toxicity tests and the monitoring of water quality indicators during exposure (ammonia, dissolved oxygen, temperature, conductivity, pH, and alkalinity).

- Determine the abundance and diversity of benthic invertebrates in White Lake.

  - Sediment samples were collected with a PONAR in White Lake
  - The abundance and diversity of the benthic invertebrate communities were evaluated and compared to control locations.
  - Critical measurements included the abundance and species composition of benthic macroinvertebrates.

- Determine the bioavailability of chromium in the sediments of eastern White Lake

  - Sediment samples were collected with a PONAR in White Lake
  - Benthic macroinvertebrates were removed from the sediment and analyzed for total chromium.
  - The sediment was analyzed for total and organic chromium.
  - Critical measurements were the determination of total and organic chromium.

- Determine the uptake of chromium by aquatic macrophytes and zebra mussels (*Dreissena polymorpha*) in Tannery Bay.

  - Benthic samples containing zebra mussels and macrophytes were collected from Tannery bay and a control location near the mouth of the White River.
  - Zebra mussels and macrophytes were removed from the sediment and washed thoroughly with lake water.
  - Critical measurements included the analysis of chromium in sediment and plant, and zebra mussel tissue.

- Determine the depositional history and stability of selected sediments in White Lake.

  - Sediment samples were collected with a piston core in White Lake.
  - The profiles of radioisotopes and chromium were determined in the sediment cores.
  - Critical measurements include the concentrations of total chromium and the radioisotopes (^{210}Pb, ^{214}Bi, and ^{137}Cs).

1.3 Experimental Design

This investigation was designed to examine specific sites of possible contamination as well as provide an overall assessment of the nature and extent of sediment contamination in White Lake. This bifurcated approach allowed the investigation to focus on specific sites based on historical information in addition to examining the broad-scale distribution of contamination. To determine the nature and extent of sediment contamination in western White Lake, 11 core samples were collected from locations that have been impacted by anthropogenic activity. Four cores were taken from deep depositional zones near Dowies Point, Long Point, Sylvan Beach, and Indian Bay. Seven additional cores were collected from shallow areas along the south shore (2), down gradient from Occidental Chemical (3), and the DuPont ground water plume (2). These core samples were analyzed for heavy metals (arsenic, barium, cadmium, chromium, copper, lead, selenium, and mercury), semivolatile organics, PCBs, and physical characteristics (grain size distribution, TOC, and percent solids). PONAR samples were collected at the same locations. An additional group of 10 PONARs were collected in areas of eastern White Lake. Two PONARs were collected from the cove area between Whitehall Leather and the White Lake Marina. This location had the highest level of amphipod toxicity in the NOAA/GVSU investigation (Rediske et al., 1998). Eight additional PONAR samples were collected from control sites (4) and locations outside of the Tannery Bay remediation area (4). The latter locations corresponded to Stations E-5, E-6, E-7, and E-9 in the Rediske et al. (1998) report. High levels of chromium were found in the near surface zone sediments at these locations. While we know that chromium contaminated sediments were exported from Tannery Bay, information on their toxicity was unknown. PONAR samples were analyzed for the same parameters as the cores plus sediment toxicity and organic chromium (Walsh and O'Holloran, 1996). Organic chromium complexes have been identified in sediments contaminated with tannery wastes and may exhibit a higher toxicity than inorganic chromium. Two sets of benthic macroinvertebrate samples were also collected at the PONAR sites. One set was analyzed for macroinvertebrate community composition and the second was analyzed for total chromium to assess the potential for bioaccumulation. A final series of four PONAR samples was used to evaluate the uptake of chromium by zebra mussels and aquatic macrophytes in Tannery Bay. Plant material and zebra mussels were removed from the PONAR and washed on site with lake water to remove attached sediment. Three locations in Tannery Bay and one location at the control site were examined. Sediment and tissue samples from the aquatic macrophytes and zebra mussels were lyophilized and analyzed for total chromium. A complete listing of locations and sample types is provided in Section 2.0

The final location of the core and PONAR samples was determined in cooperation with the MDEQ and USEPA. Core samples at the above locations were collected by VibraCore techniques using the R/V *Mudpuppy*. This part of the project provided both historical and current information related to the nature and extent of sediment contamination in White Lake. The benthic macroinvertebrate and toxicity evaluations were used to support this information and for the evaluation of ecological effects and the prioritization areas for remediation. Analytical methods were performed according to the protocols described in SW-846 3rd edition (EPA 1999a). Chemistry data were then supplemented by laboratory toxicity studies that utilized standardized exposure regimes to evaluate the effects of contaminated sediment on test organisms. Standard EPA methods (1999b) using *Chironomus tentans* and *Hyalella azteca* were used to determine the acute toxicity of sediments from the PONAR samples.

In addition to the above scope of work, an investigation of sediment deposition and stability was conducted using radiodating and detailed stratigraphy. Radiodating profiles were used to define annual deposition rates and directly reflect sediment stability (Appleby et al. 1983, Schelske et al. 1994). In consideration of the effluent diversions that occurred in the early 1970s, heavy metal flux into White Lake has changed dramatically over the last 25 years. If the sediments are stable and not subject to resuspension, lower levels of heavy metals should be encountered in the surface strata. To help assess the stability and deposition of sediments in White Lake, two box cores from deep deposition zones and one piston core from a near shore location were collected and dated using ^{210}Pb and ^{137}Cs. Each core was analyzed for a target list of heavy metals at 2 cm intervals in order to develop a detailed stratigraphic profile. Radionuclide and heavy metal profiles in the near shore areas were used to determine if the sediments are stable or mixed by wave action. Data from the deeper cores were used to assess the mobility of sediments in the lake. If the near shore sediments were subject to mixing, contaminated materials from historic discharges may be moved to the surface and result in a long term impairment of ecological conditions. These data along with the biological and toxicological studies discussed above will provide a technically sound basis for the development of remediation alternatives and restoration plans for White Lake. This project will also provide information on the fate and transport of contaminated sediments in drowned river mouth systems.

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2.0 Sampling Locations

Sampling locations for the assessment of contaminated sediments in White Lake were selected based on proximity to potential point and nonpoint sources of contamination. The locations of these sites were determined by review of historical records. Sediment samples were collected in areas of fine sediment deposition. Samples from areas containing rubble and sand were excluded. A total of 10 locations were selected for the collection of core samples and 24 locations were selected for PONAR samples. The sampling locations are listed below and displayed on Figure 2.1. GPS coordinates, depths, and visual descriptions are included in Tables 2.1, 2.2, and 2.3 respectively, for sediment core, stratigraphy core, and PONAR samples.

Core and PONAR Identification	Description
WL-1 and WL-2	DuPont Groundwater Plume
WL-3, WL-4, WL-10, WL-13	Western White Lake Deposition Basin
WL-5, WL-7,	Long Point Deposition Basin
WL-6, WL-8, WL-9, WL-13, WL-21	Occidental Chemical Outfall Area
WL-11, WL-12, WL-14, WL-15	Central White Lake Deposition Basin
WL-22, WL-23, WL-24	Tannery Bay
WL-16 and WL-17	East Bay
WL-18, WL-19, WL-20	Control Locations

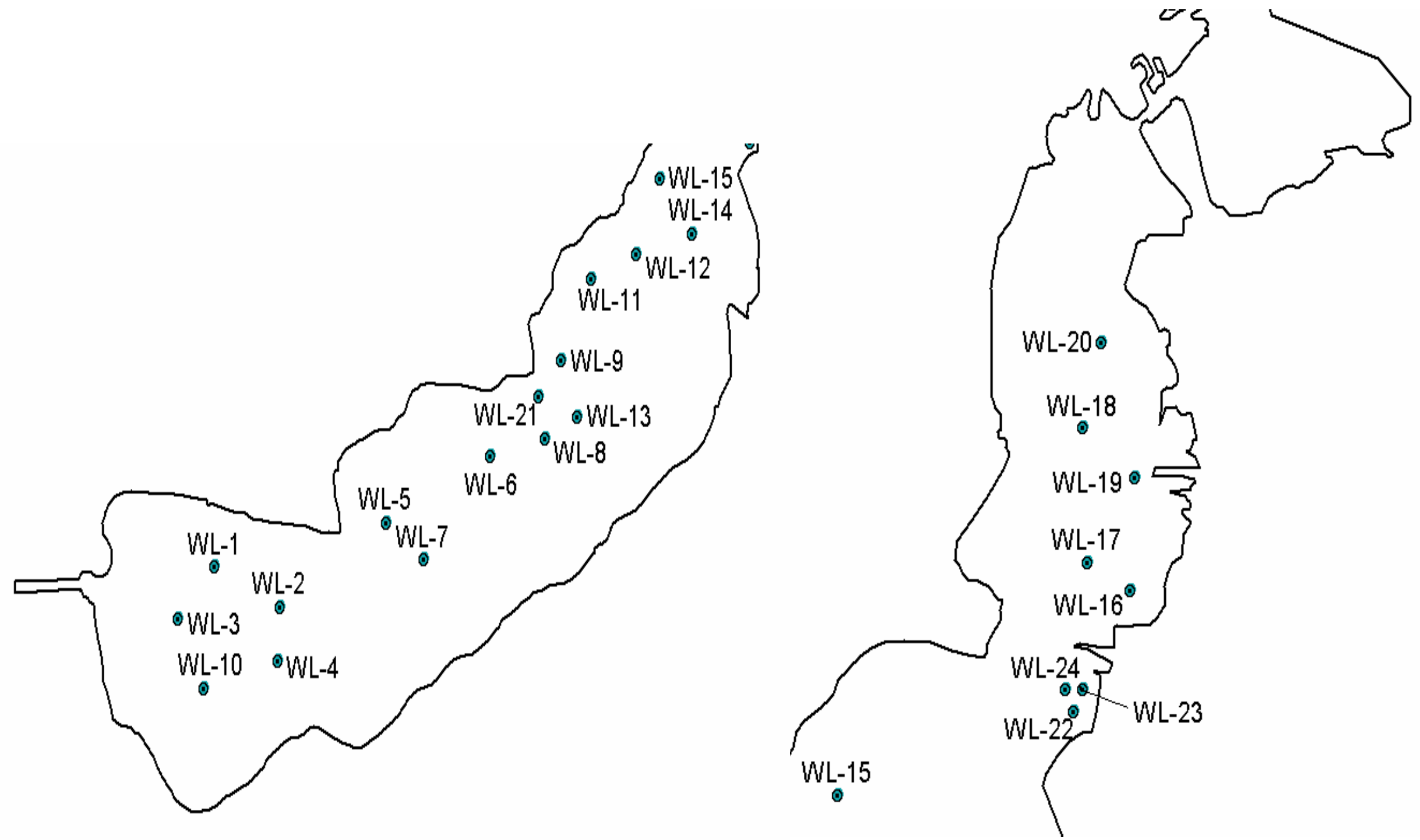

Figure 2.1 White Lake Core and PONAR Sampling Stations. (PONARs collected at all stations. Cores collected at stations WL-1 – WL-10 and WL-21.)

TABLE 2.1 WHITE LAKE CORE SAMPLING STATIONS.

Station	Sample ID	Date	Depth to Core	Depth of Core	Latitude	Longitude	Description
			m	cm	N	W	
WL-1		10/24/2000	15.0	183	43^o 22.58'	86^o 24.56'	
	White Lake 1 Top			0-51			Black silt
	White Lake 1 Middle			51-102			Black silt
	White Lake 1 Bottom			102-152			Brown clay
WL-1 Duplicate		10/24/2000	14.9	191	43^o 22.58'	86^o 24.56'	
	White Lake 1D Top			0-51			Black silt
	White Lake 1D Middle			51-102			Black silt
	White Lake 1D Bottom			102-152			Brown Black silt
WL-2		10/24/2000	20.3	229	43^o 22.46'	86^o 24.16'	
	White Lake 2 Top			0-51			Black silt
	White Lake 2 Middle			51-102			Black silt
	White Lake 2 Bottom			102-152			Black sand to Beach sand
WL-3		10/24/2000	16.5	188	43^o 22.41'	86^o 24.81'	
	White Lake 3 Top			0-51			Black silt
	White Lake 3 Middle			51-102			Black silt
	White Lake 3 Bottom			102-152			Brown silt
WL-4		10/23/2000	14.4	120	43^o 22.27'	86^o 24.16'	
	White Lake 4 Top			0-51			Sand Black Silt with Hydrocarbon odor
	White Lake 4 Bottom			51-102			Sandy Black silt
WL-5		10/23/2000	11.9	201	43^o 22.73'	86^o 23.50'	
	White Lake 5 Top			0-51			Fine Black silt
	White Lake 5 Middle			51-102			Black silt
	White Lake 5 Bottom			102-152			Brown silt
WL-6		10/24/2000	21.5	191	43^o 22.95'	86^o 22.88'	
	White Lake 6 Top			0-51			Black silt with clay
	White Lake 6 Middle			51-102			Black silt
	White Lake 6 Bottom			102-152			Grey clay
WL-7		10/23/2000	10.8	147	43^o 22.60'	86^o 23.28'	
	White Lake 7 Top			0-51			Black silt
	White Lake 7 Middle			51-102			Black silt
	White Lake 7 Bottom			102-152			Brown silt plastic
WL-8		10/23/2000	12.32	185	43^o 23.01'	86^o 22.53'	
	White Lake 8 Top			0-51			Fine Black silt no odor
	White Lake 8 Middle			51-102			Black silt Brown clay
	White Lake 8 Bottom			102-152			Black silt Brown clay
WL-9		10/23/2000	9.73	170	43^o 23.27'	86^o 22.44'	
	White Lake 9 Top			0-51			Fine Black silt
	White Lake 9 Middle			51-102			Fine Black silt
	White Lake 9 Bottom			102-152			Brown peat plastic
WL-10		10/23/2000	14.35	196	43^o 22.18'	86^o 24.61'	
	White Lake 10 Top			0-51			Fine Black silt
	White Lake 10 Middle			51-102			Fine Black silt
	White Lake 10 Bottom			102-152			Fine Black silt
WL-21		10/24/2000	15.11	155	43^o 23.16'	86^o 22.57'	
	White Lake 21 Top			0-51			Red, Yellow, Black chemical odor
	White Lake 21 Middle			51-102			Black silt no odor
	White Lake 21 Bottom			102-152			Black silt no odor

TABLE 2.2 WHITE LAKE STRATIGRAPHY SAMPLING STATIONS

Station	Date	Depth to Sediment	Latitude	Longitude
		M	N	W
WL-2S	10/25/00	20.32	43° 22.45'	86° 24.15'
WL-7S	10/25/00	21.46	43° 22.61'	86° 23.27'
WL-9S	10/25/00	15.11	43° 23.27'	86° 22.43'

TABLE 2.3 WHITE LAKE PONAR CORE SAMPLING STATIONS

Station	Date	Depth to Sediment	Latitude	Longitude	Description
		m	N	W	
WL-1-P	10/25/00	15.04	43° 22.58'	86° 24.55'	Fine Black silt
WL-2-P	10/25/00	20.32	43° 22.45'	86° 24.15'	Fine Black silt
WL-3-P	10/25/00	16.54	43° 22.41'	86° 24.77'	Fine Black silt
WL-4-P	10/25/00	14.35	43° 22.27'	86° 24.16'	Sand Black Silt with Hydrocarbon odor
WL-5-P	10/26/00	11.89	43° 22.73'	86° 23.50'	Fine Black silt
WL-6-P	10/26/00	21.46	43° 22.95'	86° 22.86'	Fine Black silt
WL-7-P	10/26/00	10.85	43° 22.61'	86° 23.27'	Fine Black silt
WL-8-P	10/26/00	12.32	43° 23.01'	86° 22.53'	Fine Black silt
WL-9-P	10/27/00	9.73	43° 23.27'	86° 22.43'	Fine Black silt
WL-10-P	10/27/00	14.35	43° 22.18'	86° 24.61'	Fine Black silt
WL-11-P	10/27/00	14.30	43° 23.54'	86° 22.25'	Fine Black silt
WL-12-P	10/27/00	16.15	43° 23.62'	86° 21.97'	Fine Black silt
WL-13-P	10/27/00	10.90	43° 23.08'	86° 22.33'	Fine Black silt
WL-14-P	10/27/00	8.76	43° 23.69'	86° 21.63'	Fine Black silt
WL-15-P	10/27/00	8.48	43° 23.87'	86° 21.83'	Fine Black silt
WL-16-P	10/24/00	3.43	43° 24.16'	86° 21.15'	Fine Black silt
WL-17-P	10/24/00	4.14	43° 24.20'	86° 21.25'	Fine Black silt
WL-18-P	10/24/00	3.18	43° 24.39'	86° 21.26'	Fine Black silt
WL-19-P	10/24/00	3.78	43° 24.32'	86° 21.14'	Fine Black silt
WL-20-P	10/24/00	2.74	43° 24.51'	86° 21.22'	Fine Black silt
WL-21-P	10/27/00	15.11	43° 23.15'	86° 22.57'	Fine Black silt
WL-22-P	10/27/00	3.66	43° 23.99'	86° 21.28'	Fine Black silt
WL-23-P	10/27/00	2.44	43° 24.02'	86° 21.26'	Fine Black silt
WL-24-P	10/27/00	3.20	43° 24.02'	86° 21.30'	Fine Black silt

3.0 Methods

3.1 Sampling Methods

Sediment and benthos samples were collected using the U.S. EPA Research Vessel *Mudpuppy*. VibraCore methods were used to collect sediment cores for chemical analysis. A 4-inch aluminum core tube with a butyrate liner was used for collection. A new core tube and liner were used at each location. The core samples were measured and sectioned into three equal segments corresponding to top, middle, and bottom. Each section was then homogenized in a polyethylene pan and split into sub-samples. The visual appearance of each segment was recorded along with the water depth and core depth.

PONAR samples were collected for toxicity testing, sediment chemistry, and benthic macroinvertebrates. For sediment chemistry and toxicity testing, a standard PONAR sample was deposited into a polyethylene pan and split into sub-samples. The PONAR was washed with water in between stations. A petite PONAR was used for the collection of benthic macroinvertebrates. Three replicate grabs were taken at each of the sites and treated as discrete samples. All material in the grab was washed through a Nitex screen with 500 μm openings and the residue preserved in buffered formalin containing rose bengal stain.

GPS system coordinates were used to record the position of the sampling locations. Since the core and PONAR samples were collected on different days, some variation in the location may have occurred.

3.1.2 Sample Containers, Preservatives, And Volume Requirements

Requirements for sample volumes, containers, and holding times are listed in Table 3.1.
All sample containers for sediment chemistry and toxicity testing were purchased, precleaned, and certified as Level II by I-CHEM Inc.

TABLE 3.1 SAMPLE CONTAINERS, PRESERVATIVES, AND HOLDING TIMES

Hold Times					
Matrix	***Parameter***	***Container***	***Preservation***	***Extraction***	***Analysis***
Sediment	Metals	250 mL Wide Mouth Plastic	Cool to 4°C	---	6 months, Mercury-28 Days
Sediment	TOC	250 mL Wide Mouth Plastic	Freeze -10°C	---	6 months
Sediment	Semi-Volatile Organics	500 mL Amber Glass	Cool to 4°C	14 days	40 days
Sediment	Grain Size	1 Quart Zip-Lock Plastic Bag	Cool to 4°C	---	6 months
Sediment	Toxicity	4 liter Wide Mouth Glass	Cool to 4°C	---	45 days
Water	Semi-Volatile Organics and Resin Acids	1000 mL Amber Glass	Cool to 4°C	14 days	40 days
Culture	Alkalinity	250 mL Wide Mouth Plastic	Cool to 4°C	---	24 hrs.
Water	Ammonia Hardness Conductivity pH	250 mL Wide Mouth Plastic	Cool to 4°C	---	24 hrs.

3.2 Chemical Analysis Methods For Sediment Analysis

A summary of analytical methods and detection limits is provided in Table 3.2.1. Instrument conditions and a summary of quality assurance procedures are provided in the following sections.

TABLE 3.2.1 ANALYTICAL METHODS AND DETECTION LIMITS

SEDIMENT MATRIX

Parameter	Method Description	Analytical Method	Detection Limit
Arsenic, Lead, Selenium, Cadmium	Arsenic-Graphite Furnace	7060[1] 3051[1] Digestion	0.10 mg/kg
Barium, Chromium, Copper, Nickel, Zinc	Inductively Coupled Plasma Atomic Emission Spectroscopy	6010[1], 3052[1] Digestion	2.0 mg/kg
Mercury	Mercury Analysis of Soils, Sludges and Wastes by Manual Cold Vapor Technique	7471[1], Prep Method in 7471[1]	0.10 mg/kg
Grain Size	Wet Sieve	WRI Method PHY-010	1 %
Total Organic Carbon	Combustion/IR	9060[1]	0.1%
USEPA Semivolatiles	Solvent Extraction and GC/MS analysis	8270[1], 3550[1] Extraction	Table 3.2.2

[1] - SW846 3rd. Ed. EPA 1994.

3.2.1 Sample Preparation For Metals Analysis

For aluminum, arsenic, barium, calcium, cadmium, chromium, copper, iron, magnesium, manganese, nickel, lead, selenium, and zinc analysis, sediment samples were digested according to a modified version of EPA SW-846 method 3052 "Microwave Assisted Acid Digestion of Sediments, Sludges, Soils and Oils". Samples were air-dried prior to digestion. A Questron (Mercerville, NJ) Q-4000 microwave system was used. The system provided a controlled temperature and pressure in each digestion vessel. Approximately 0.25 g of sediment was weighed into a Teflon liner. 4 mL Type 1 deionized water, 3 mL of concentrated nitric acid, 6 mL of concentrated hydrochloric acid, and 4 mL of hydrofluoric acid were added to each sample. Vessels were then capped and placed into the microwave cavity. The program was set to raise the temperature inside the vessels to 200°C for 20.0 minutes. After completion of the run, vessels were cooled and vented. Then 15 mL of saturated boric acid was added to each sample in place of hydrogen peroxide. The vessels were recapped and placed into the microwave cavity. The program was set to raise the temperature inside the vessels to 180°C for 15.0 minutes. After completion of the second run, the vessels were cooled and vented. The contents were transferred into 50 mL centrifuge tubes and brought up to 50 mL with Type I deionized water. Samples were centrifuged for 5 minutes at 3000 rpm before analysis. For every batch of 20 samples at least one set of the following quality control samples was prepared:

Method Blank (4 mL of Type 1 deionized water, 3 mL of nitric acid and 6 mL of hydrochloric acid);
Laboratory Control Spike (Blank Spike);
Matrix Spike;
Matrix Spike Duplicate.

For determining total mercury the samples were prepared by EPA SW-846 method 7471A, "Mercury in Solid and Semisolid Waste". Approximately 0.2 g of wet sediment was weighed into a 50 mL centrifuge tube. 2.5 mL of Type I deionized water and 2.5 mL of aqua regia were then added to the tube. Samples were heated in a water bath at 95°C for 2 minutes. After cooling, the volume of the samples was brought up to 30 mL with Type I deionized water. Then 7.5 mL of 5% potassium permanganate solution was added to each sample, the samples were mixed, and the centrifuge tubes were returned to the water bath for a period of 30 minutes. Three mL of 12% hydroxylamine chloride solution was added to each sample after cooling. Finally, the samples were mixed and centrifuged for 5 minutes at 3,000 rpm. Calibration standards were digested concurrent with the samples. Quality control samples were prepared as stated previously for every batch of 10 samples or less.

3.2.2 Arsenic Analysis By Furnace

Arsenic was analyzed in accordance with the EPA SW-846 method 7060A utilizing the Graphite Furnace technique. The instrument employed was a Perkin Elmer 4110ZL atomic absorption spectrophotometer. An arsenic EDL Lamp was used as a light source at a wavelength of 193.7 nm. The instrument utilized a Zeeman background correction that reduces the non-specific absorption caused by some matrix components. The temperature program is summarized below:

Step	Temp, °C	Time, sec.		Gas Flow, mL/min	Read
		Ramp	Hold		
1	110	1	35	250	
2	130	15	37	250	
3	1300	10	20	250	
4	2100	0	5	0	X
5	2500	1	3	250	

A Pd/Mg modifier was used to stabilize As during the pyrolysis step. The calibration curve was constructed from four standards and a blank. Validity of calibration was verified with a check standard prepared from a secondary source. This action was taken immediately after calibration, after every 20 samples, and at the end of each run. At least 1 post-digestion spike was performed for every analytical batch of 20 samples.

3.2.3 Cadmium Analysis By Furnace

Cadmium was analyzed in accordance with the EPA SW-846 method 7060A utilizing the Graphite Furnace technique. The instrument employed was a Perkin Elmer 4110ZL atomic absorption spectrophotometer. A hollow cathode lamp was used as a light source at a wavelength of 228.8 nm. The instrument utilized a Zeeman background correction that reduces the non-specific absorption caused by some matrix components. The temperature program is summarized below:

Step	Temp, °C	Time, sec.		Gas Flow, mL/min	Read
		Ramp	Hold		
1	110	1	40	250	
2	130	15	45	250	
3	500	10	20	250	
4	1550	0	5	0	X
5	2500	1	3	250	

A Pd/Mg modifier was used to stabilize Cd during the pyrolysis step. The calibration curve was constructed from four standards and a blank. Validity of calibration was verified with a check standard prepared from a secondary source. This action was taken immediately after calibration, after every 20 samples, and at the end of each run. At least 1 post-digestion spike was performed for every analytical batch of 20 samples.

3.2.4 Lead Analysis By Furnace

Lead was analyzed in accordance with the EPA SW-846 method 7060A utilizing the Graphite Furnace technique. The instrument employed was a Perkin Elmer 4110ZL atomic absorption spectrophotometer. A lead EDL Lamp was used as a light source at a wavelength of 283.3 nm. The instrument utilized a Zeeman background correction that reduces the non-specific absorption caused by some matrix components. The temperature program is summarized below:

Step	Temp, °C	Time, sec.		Gas Flow, mL/min	Read
		Ramp	Hold		
1	120	1	20	250	
2	140	5	40	250	
3	200	10	10	250	
4	850	10	20	250	
5	1900	0	5	0	X
6	2500	1	3	250	

A Pd/Mg modifier was used to stabilize Pb during the pyrolysis step. The calibration curve was constructed from four standards and a blank. Validity of calibration was verified with a check standard prepared from a secondary source. This action was taken immediately after calibration, after every 20 samples, and at the end of each run. At least 1 post-digestion spike was performed for every analytical batch of 20 samples.

3.2.5 Selenium Analysis By Furnace

Selenium was analyzed in accordance with the EPA SW-846 method 7060A utilizing the Graphite Furnace technique. The instrument employed was a Perkin Elmer 4110ZL atomic absorption spectrophotometer. An arsenic EDL Lamp was used as a light source at a wavelength of 196.0 nm. The instrument utilized a Zeeman background correction that reduces the non-specific absorption caused by some matrix components. The temperature program is summarized below:

Step	Temp, °C	Time, sec.		Gas Flow, mL/min	Read
		Ramp	Hold		
1	120	1	22	250	
2	140	5	42	250	
3	200	10	11	250	
4	1300	10	20	250	
5	2100	0	5	0	X
6	2450	1	3	250	

A Pd/Mg modifier was used to stabilize Se during the pyrolysis step. The calibration curve was constructed from four standards and a blank. Validity of calibration was verified with a check standard prepared from a secondary source. This action was taken immediately after calibration, after every 20 samples, and at the end of each run. At least 1 post-digestion spike was performed for every analytical batch of 20 samples.

3.2.6 Metal Analysis By ICP

Aluminum, barium, calcium, chromium, copper, iron, magnesium, manganese, nickel, and zinc were analyzed in accordance with EPA SW-846 method 6010A using Inductively Coupled Plasma Atomic Emission Spectroscopy. Samples were analyzed on a Perkin Elmer P-1000 ICP Spectrometer with Ebert monochromator and cross-flow nebulizer. The following settings were used:

Element Analyzed	Wavelength, nm
Al	308.2
Ba	233.5
Ca	315.9
Element Analyzed	Wavelength, nm
Cr	267.7
Cu	324.8
Fe	259.9

Mg	279.1
Mn	257.6
Ni	231.6
Zn	213.9

RF Power: 1300 W

Matrix interferences were suppressed with internal standardization utilizing Myers-Tracy signal compensation. Interelement interference check standards were analyzed in the beginning and at the end of every analytical run and indicated absence of this type of interference at the given wavelength. The calibration curve was constructed from four standards and a blank, and was verified with a check standard prepared from a secondary source.

3.2.7 Mercury

After the digestion procedure outlined in 3.2.1, sediment samples were analyzed for total mercury by cold vapor technique according to SW-846 Method 7471. A Perkin Elmer 5100ZL atomic absorption spectrophotometer with FIAS-200 flow injection accessory was used. Mercury was reduced to an elemental state using stannous chloride solution, and atomic absorption was measured in a quartz cell at an ambient temperature and a wavelength of 253.7 nm. A mercury electrodeless discharge lamp was used as a light source. The calibration curve consisted of four standards and a blank, and was verified with a check standard prepared from a secondary source.

3.2.8 Total Organic Carbon

Total Organic Carbon analysis of sediments was conducted on a Shimadzu TOC-5000 Total Organic Carbon Analyzer equipped with Solid Sample Accessory SSM-5000A. Samples were air dried and then reacted with phosphoric acid to remove inorganic carbonates. Prior to analysis, the samples were air dried a final time. Calibration curves for total carbon were constructed from three standards and a blank. Glucose was used as a standard compound for Total Carbon Analysis (44% carbon by weight).

3.2.9 Grain Size Analysis

Grain size was performed by wet sieving the sediments. The following mesh sizes were used: 2 mm (granule), 1 mm (very coarse sand), 0.85 mm (coarse sand), 0.25 mm (medium sand), 0.125 mm (fine sand), 0.063 (very fine sand), and 0.031 (coarse silt). After sieving, the fractions were dried at 105^{o}C and analyzed by gravimetric methods to determine weight percentages.

3.2.10 Semivolatiles Analysis

Sediment samples were extracted for analysis of semivolatiles using SW-846 Method 3050. The sediment samples were dried with anhydrous sodium sulfate to form a free flowing powder. The samples were then serially sonicated with 1:1 methylene chloride/acetone and concentrated to a volume of 1 mL.

The sample extracts were analyzed by GC/MS on a Hewlett Packard 5895 MSD Mass Spectrometer according to Method 8270. Instrumental conditions are itemized below:

MS operating conditions:

- Electron energy:	70 volts (nominal).
- Mass range:	40-450 amu.
- Scan time:	820 amu/second, 2 scans/sec.
- Source temperature:	190° C
- Transfer line temperature:	250°C

GC operating conditions:

- Column temperature program:	45°C for 6 min., then to 250°C at 10°C/min, then to 300°C at 20°C/min hold 300°C for 15 min.
- Injector temperature program:	250°C
- Sample volume:	1 µl

A list of analytes and detection limits is given in Table 3.2.2. Surrogate standards were utilized to monitor extraction efficiency. Acceptance criteria for surrogate standards are given in Table 3.2.3. The GC/MS was calibrated using a 5-point curve. Instrument tuning was performed by injecting 5 ng of decafluorotriphenylphosphine and then adjusting spectra to meet method acceptance criteria. The MS and MSD samples were analyzed at a 5% frequency.

TABLE 3.2.2 ORGANIC PARAMETERS AND DETECTION LIMITS

Semi-Volatile Organic Compounds (8270)	Sediment (mg/kg)

Phenol	0.33
Bis(2-chloroethyl)ether	0.33
2-Chlorophenol	0.33
1,3-Dichlorobenzene	0.33
1,4-Dichlorobenzene	0.33
1,2-Dichlorobenzene	0.33
2-Methylphenol	0.33
4-Methylphenol	0.33
Hexachloroethane	0.33
Isophorone	0.33
2,4-Dimethylphenol	0.33
Bis(2-chloroethoxy)methane	0.33
2,4-Dichlorophenol	0.33
1,2,4-Trichlorobenzene	0.33
Naphthalene	0.33
Hexachlorobutadiene	0.33
4-Chloro-3-methylphenol	0.33
2-Methylnaphthalene	0.33
Hexachlorocyclopentadiene	0.33
2,4,6-Trichlorophenol	0.33
2,4,5-Trichlorophenol	0.33
2-Chloronaphthalene	0.33
Dimethylphthalate	0.33
Acenaphthylene	0.33
Acenaphthene	0.33
Diethylphthalate	0.33
4-Chlorophenyl-phenyl ether	0.33
Fluorene	0.33
4,6-Dinitro-2-methylphenol	1.7
4-Bromophenyl-phenyl ether	0.33

TABLE 3.2.2 ORGANIC PARAMETERS AND DETECTION LIMITS (CONTINUED)

Semi-Volatile Organic Compounds (8270)	Sediment (mg/kg)
Hexachlorobenzene	0.33
Pentachlorophenol	1.7
Phenanthrene	0.33
Anthracene	0.33
Di-n-butylphthalate	0.33
Fluoranthene	0.33
Pyrene	0.33
Butylbenzylphthalate	0.33
Benzo(a)anthracene	0.33
Chrysene	0.33
Bis(2-ethylhexyl)phthalate	0.33
Di-n-octylphthalate	0.33
Benzo(b)fluoranthene	0.33
Benzo(k)fluoranthene	0.33
Benzo(a)pyrene	0.33
Indeno(1,2,3-cd)pyrene	0.33
Dibenzo(a,h)anthracene	0.33
Benzo(g,h,i)perylene	0.33
3-Methylphenol	0.33

TABLE 3.2.3 DATA QUALITY OBJECTIVES FOR SURROGATE STANDARDS CONTROL LIMITS FOR PERCENT RECOVERY

Parameter	Control Limit
Nitrobenzene-d_5	30%-97%
2-Fluorobiphenyl	42%-99%
o-Terphenyl	60%-101%
Phenol-d_6	43%-84%
2-Fluorophenol	33%-76%
2,4,6-Tribromophenol	58%-96%

3.2.11 PCB Analysis

The sediment samples were extracted for PCBs using SW-846 Method 3050. Sediment samples were air dried for 24 hours, and then equal weights of the dried soil and anhydrous sodium sulfate were mixed together. The samples were then extracted using 50 mL of methanol and 100 mL of hexane. The samples were sonicated for 3 minutes, and then the hexane layer was removed and filtered through anhydrous sodium sulfate. The process was repeated two more times, adding 50 mL of hexane each time. The hexane extract was concentrated to 1 mL in the Turbovap, and then run through a chromatography column packed with 2% deactivated florisil and anhydrous sodium sulfate. Copper turnings cleaned with 1 M hydrochloric acid were added to remove sulfur. The eluent was concentrated to 1 mL using the Turbovap, and concentrated sulfuric acid was added as a final clean-up step. Solvent transfer to iso-octane was achieved under a flow of nitrogen gas and condensed to a final volume of 1 mL.

Sample extracts were analyzed using gas chromatography with a Ni_{63} electron capture detector and RTX-5 capillary column. Helium and nitrogen were used as the carrier gas and makeup gas, respectively. Instrumental operating conditions were as follows:

- Column temperature program: 80°C for 2 min., 10°C/min to 160°C,
- 1.5°C/min to 190°C, 2°C/min to 256°C and hold at 256°C for 6 min.
- Injector temperature: 260°C
- Detector temperature: 330°C
- Sample volume: 1 µl

Table 3.2.4 presents a list of PCB congeners and their detection limits. Two surrogate standards, tetrachloro-m-xylene and decachlorobiphenyl were used to monitor extraction efficiency. Acceptance limits for the surrogates were ± 50% for precision and accuracy.

Table 3.2.4 Sediment Detection Limits for PCBs

PCB Formulation	Detection Limit (mg/kg)
Aroclor 1221	0.33
Aroclor 1232	0.33
Aroclor 1242	0.33
Aroclor 1248	0.33
Aroclor 1254	0.33
Aroclor 1260	0.33

3.2.12 Organic Chromium Analysis

The organic chromium fraction in sediment was extracted using 0.1 M $Na_2P_2O_7$ at a 10:1 (v/m) ratio by shaking for 18 hours (Walsh and O'Halloran 1996). Twenty grams of wet sediment were extracted. The extract was centrifuged, filtered with a 0.45 μm membrane and analyzed for total chromium as described previously. Sample results were converted to a dry weight basis for reporting.

3.2.13 Proton Induced X-Ray Emission Spectroscopy (PIXE)

Dried 2-cm-sections of sediment cores were homogenized by mechanical shaking. A sample of approximately 0.1 to 0.2 g of sediment was pressed into a self-supporting thin target by 10,000 psi of hydraulic pressure in a standard pellet press. The exact mass and thickness of the pellet was not critical as long as the resultant target remains thin with respect to the range of accelerated protons used in the irradiation. A current of approximately 10 nA of 2.3 MeV protons was used as an ion analysis probe for X-ray emission. The sediment samples were loaded on a target wheel in a vacuum chamber, which was subsequently evacuated to $<10^{-5}$ torr. Each sample was exposed to the beam for approximately 300 seconds, or a total accumulated charge of approximately 3 μCoulomb. The incident beam current was measured with a Faraday cup immediately before and after irradiation and an average current was used to calculate the exact charge collected on each target. The resultant X-rays emitted from the irradiation were detected with a 4 cm^2 Si(Li) detector located at 135° from the incident beam. There was a thin vacuum window and a piece of Be foil in front of the active detector, as well as an adjustable wheel of Kaptan® foils that was interspersed between the target and X-ray detector to attenuate the excess low-energy X-rays. A 2 mil (.002") of Kaptan® foil was used to suppress low energy X-rays on sediment sample irradiation. The X-ray energies were calibrated with a set of known metal standards (Si, Ti, In, Au) and for each run (up to a maximum of 36 samples per target wheel) a NIST standard mud pellet was used to standardize the X-ray yield calculations. We use both Buffalo River Sediment (NIST SRM 2704) and Trace Elements in Soil (NIST SRM 2586) as calibration standards for sediment samples. The X-ray spectra were acquired by standard NIM and CAMAC electronics and recorded onto a PC in binary format. The spectra were analyzed off-line by GUPIX II® a commercial PIXE analysis program1. The limits of detection vary from element to element, but typically range between the ppb - ppm level for most metals. A general review of the technique and examples of earth science applications are provided by Johanssen and Campbell (1988).

3.3 Chemical Analysis Methods For Water Analysis

The parameters, methods, and detection limits for the measurements performed on the culture water used in the sediment toxicity tests are listed in Table 3.3.1. All methods were performed according to procedures outlined in Standard Methods 14th Edition (1996).

TABLE 3.3.1 ANALYTICAL METHODS AND DETECTION LIMITS FOR CULTURE WATER

Parameter	Method	Detection Limit
Specific Conductance	Standard Methods 2510 B.	NA
Alkalinity	Standard Methods 2320	10 mg/l
Temperature	Standard Methods 2550	NA
Dissolved Oxygen	Standard Methods 4500-O G.	0.5 mg/l
Ammonia Electrode	Standard Methods 4500-NH_3 F.	0.05 mg/l
Hardness	Standard Methods 2340 C.	10 mg/l

3.4 Sediment Toxicity

The evaluation of the toxicity of the White Lake sediments was conducted using the ten-day survival test for the amphipod *Hyalella azteca* and the dipteran *Chironomus tentans*. The procedures followed are contained in EPA/600/R-94/024, Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Fresh Water Invertebrates. All sediments were stored at 4°C prior to analysis.

3.4.1 Laboratory Water Supply

Moderately hard well water was employed for the culture and maintenance of *H. azteca* and *C. tentans*.

3.4.2 Test Organisms

The original stock of *H. azteca* was obtained from the Great Lakes Environmental Research Laboratory in Ann Arbor, Michigan. The *H. azteca* culture was maintained in four 20 L glass aquaria using maple leaves as a substrate and as a food source. The food source was supplemented with a suspension of Tetramin® fish food. The original stock of *C. tentans* was obtained from the University of Michigan Department of Environmental Health in Ann Arbor, Michigan. The culture of *C. tentans* was maintained in 36 L glass aquaria using shredded paper toweling as a substrate and was fed a suspension of Tetrafin® goldfish food.

3.4.3 Experimental Design

For the November testing, eight replicates per sediment were set up for both *H. azteca* and *C. tentans* exposures, with the sediment from site M-15P designated as the control. In all tests, moderately hard well water was utilized as the overlying water. The experimental conditions outlined in Tables 3.4.1 and 3.4.2 were used for the toxicity evaluations.

One day prior to the start of the test (day –1), the sediment from each site was mixed thoroughly and a 100 mL aliquot was transferred to each of the eight test chambers. Additionally, visual observations of the sediments were made. Moderately hard well water also was added at this time. On day 0, the overlying water was renewed once before the test organisms were introduced into each of the glass beakers. Measurement of water quality parameters also was initiated on this day. Ten, 7-14 day old *H. azteca* and 10 third instar *C. tentans* larvae were randomly added to their respective test chambers. At this time the organisms were fed 1.5 mL of Tetrafin®. The glass beakers were placed in a rack and transferred to a temperature controlled room (23 ± 1°C). The light cycle was 16 hours on and 8 hours off. Temperature and dissolved oxygen measurements were taken from one randomly selected beaker for each sediment sample every 12 hours, after which the overlying water was renewed in all the beakers. Feeding with the Tetrafin® suspension occurred after the morning renewal. This procedure was repeated daily through day 10, at which point the test was terminated. On day 0, the overlying water from the beakers was composited from each sediment sample and 250 mL were retained for alkalinity, pH, conductance, hardness and ammonia analysis. On the last day the same procedure was carried out. On day 10, the sediments were sieved, and the surviving test organisms were removed and counted. The biological endpoint for these sediment tests was mortality. The validity of the test was based on EPA (1994) criteria of greater than 80% survival in the control treatment for *H. azteca* and greater than 70% survival in the control treatment for the *C. tentans*. In addition, EPA (1994) recommended that the hardness, alkalinity, pH, and ammonia in the overlying water within a treatment should not vary by more than 50% over the duration of the test.

3.4.4 Statistical Analysis

Survival data for the toxicity testing were analyzed first for normality with Chi Square and then for homogeneity using Bartlett's Test. All data passed the normality and homogeneity tests without transformation. The data were then examined using Dunnett's Procedure to determine whether there was a significant difference in survival between the designated control sediment and those sediments containing pollutants. The TOXSTAT® 3.5 Computer Program was used for the statistical evaluations.

TABLE 3.4.1 TEST CONDITIONS FOR CONDUCTING A TEN DAY SEDIMENT TOXICITY TEST WITH *HYALELLA AZTECA*.

1.	Test Type:	Whole-sediment toxicity test with renewal of overlying water
2.	Temperature (°C):	23 ± 1°C
3.	Light quality:	Wide-spectrum fluorescent lights
4.	Illuminance:	About 500 to 1000 lux
5.	Photoperiod:	16 h light, 8 h darkness
6.	Test chamber size:	300 mL high-form lipless beaker
7.	Sediment volume:	100 mL
8.	Overlying water volume:	175 mL
9.	Renewal of overlying water:	2 volume additions per day (i.e., one volume addition every 12 hours)
10.	Age of test organisms:	7 to 14 days old at the start of the test
11.	Number of organisms per chamber:	10
12.	Number of replicate chambers per treatment:	8
13.	Feeding:	Tetramin® fish food, fed 1.5 mL daily to each test chamber
14.	Aeration:	None, unless dissolved oxygen in overlying water drops below 40% of saturation
15.	Overlying water:	Reconstituted water
16.	Overlying water quality:	Hardness, alkalinity, conductivity, pH, and ammonia measured at the beginning and end of a test. Temperature and dissolved oxygen measured daily.
17.	Test duration:	10 days
18.	End point:	Survival, with greater than 80% in the control

Test Method 100.1. EPA Publication 600/R-94/024 (July 1994).

TABLE 3.4.2 RECOMMENDED TEST CONDITIONS FOR CONDUCTING A TEN DAY SEDIMENT TOXICITY TEST WITH *CHIRONOMUS TENTANS*.

1.	Test Type:	Whole-sediment toxicity test with renewal of overlying water
2.	Temperature (°C):	23 ± 1°C
3.	Light quality:	Wide-spectrum fluorescent lights
4.	Illuminance:	About 500 to 1000 lux
5.	Photoperiod:	16 h light, 8 h darkness
6.	Test chamber size:	300 mL high-form lipless beaker
7.	Sediment volume:	100 mL
8.	Overlying water volume:	175 mL
9.	Renewal of overlying water:	2 volume additions per day (i.e., one volume addition every 12 hours)
10.	Age of test organisms:	Third instar larvae (All organisms must be third instar or younger with at least 50% of the organisms at third instar)
11.	Number of organisms per chamber:	10
12.	Number of replicate chambers per treatment:	8
13.	Feeding:	Tetrafin® goldfish food, fed 1.5 mL daily to each test chamber (1.5 mL contains 4.0 mg of dry solids)
14.	Aeration:	None, unless dissolved oxygen in overlying water drops below 40% of saturation
15.	Overlying water:	Reconstituted water
16.	Overlying water quality:	Hardness, alkalinity, conductivity, pH, and ammonia measured at the beginning and end of a test. Temperature and dissolved oxygen measured daily.
17.	Test duration:	10 days
18.	End point:	Survival, with greater than 70% in the control. Weight > 0.6 mg per midge in the control

Test Method 100.2. EPA Publication 600/R-94/024 (July 1994).

3.5 Benthic Macroinvertebrate Analysis

Samples were washed with tap water to remove formalin and extraneous debris through a USGS #30 mesh screen. The retained portion was poured into a white enamel pan from which the organisms were picked into two groups. These were oligochaetes and "other". The worms were preserved with 4% formalin and later identified to the lowest practical level. The worms were mounted separately and examined under 100X and 400X. The "other" group was preserved in 70% ethanol. Midges were removed from this group and a head mount of each midge was made and examined under 100X and 400X. The number and taxa were reported. The remainder of the organisms were identified and enumerated utilizing a 60X dissecting microscope.

3.6 Radiometric Dating

Radiometric measurements were made using low-background gamma counting systems with well-type intrinsic germanium detectors (Schelske et al. 1994). Dry sediment from each section was packed to a nominal height of 30 mm in a tared polypropylene tube (84 mm high x 14.5 mm outside diameter, 12 mm inside diameter). Sample height was recorded and tubes were weighed to obtain sample mass. Samples in the tubes were then sealed with a layer of epoxy resin and polyamine hardener, capped, and stored before counting to ensure equilibrium between ^{226}Ra and ^{214}Bi. Activities for each radionuclide were calculated using empirically derived factors of variation in counting efficiency with sample mass and height (Schelske et al. 1994). Total ^{210}Pb activity was obtained from the 46.5 keV photon peak, and ^{226}Ra activity was obtained from the 609.2 keV peak of ^{214}Bi. ^{226}Ra activity was assumed to represent supported ^{210}Pb activity. Excess ^{210}Pb activity was determined from the difference between total and supported ^{210}Pb activity and then corrected for decay from the coring date. The 661.7 keV photon peak is used to measure ^{137}Cs activity.

Sediments were aged using activity measurements of the above radioisotopes in the sediment samples. The method was based on determining the activity of total ^{210}Pb (22.3 yr half-life), a decay product of ^{226}Ra (half-life 1622 yr) in the ^{238}U decay series. Total ^{210}Pb represents the sum of excess ^{210}Pb and supported ^{210}Pb activity in sediments. The ultimate source of excess ^{210}Pb is the outgassing of chemically inert ^{222}Rn (3.83 d half-life) from continents as ^{226}Ra incorporated in soils as rocks decay. In the atmosphere, ^{222}Rn decays to ^{210}Pb which is deposited at the earth's surface with atmospheric washout as unsupported or excess ^{210}Pb. Supported ^{210}Pb in lake sediments is produced by the decay of ^{226}Ra that is deposited as one fraction of erosional inputs. In the sediments, gaseous ^{222}Rn produced from ^{226}Ra is trapped and decays to ^{210}Pb. By definition, supported ^{210}Pb is in secular equilibrium (production rate matches decay rate) with sedimentary ^{226}Ra and is equal to total ^{210}Pb activity at depths where excess ^{210}Pb activity is not measurable due to decay. Because the decay of excess ^{210}Pb activity in sediments provides the basis for estimating sediment ages, it is necessary to make estimates of total and supported ^{210}Pb activities so excess ^{210}Pb activity can be determined by difference. Excess ^{210}Pb activity was calculated either by subtracting ^{226}Ra activity from total ^{210}Pb activity at each depth or by subtracting an estimate of supported ^{210}Pb activity based on measurements of total ^{210}Pb activity at depths where excess ^{210}Pb activity was negligible.

Sediment ages were calculated using a CRS model (Appleby and Oldfield 1983). This model calculates ages based on the assumption that the flux of excess ^{210}Pb to the lake was constant and therefore that variation in ^{210}Pb activity from a pattern of exponential decrease with depth depends on variation in rate of sedimentation. The age of sediments at depth x is given by:

$$t = (1/k)\ [\ln (A_0/A)]$$

where t is time in yr, k is 0.03114 (the ^{210}Pb decay constant), A_0 is the total residual excess ^{210}Pb activity in the sediment core, and A is the integrated excess ^{210}Pb activity below depth x. Calculations for each depth provide a continuous profile of ages as a function of depth. Mass sedimentation rate (MSR) at depth x was determined by:

$$MSR = m/t$$

where m is dry mass of sediment (g /cm^2) for the sampling interval. Errors in age and mass sedimentation rate were propagated using first-order approximations and calculated according to Binford (1990).

3.7 Statistical Analysis

Multivariate analyses were conducted using SAS version 8.0 (Cary, North Carolina). Principal Components Analysis (PCA) was conducted on the physical/chemical parameters. Correspondence Analysis (CA) was conducted on the benthic macroinvertebrate data using the individual taxa.

Spearman Rank Correlation was used to determine significant relationships between individual physical and chemical parameters and the trophic status indices. Pearson correlation analysis was conducted using SYSTAT version 5.0 (Evanston, Illinois).

3.8 Contaminant Mapping

ArcView GIS and Surfer were utilized for analyzing and mapping contaminant concentrations in White Lake. ArcView was primarily used for geographic projection and spatial distribution mapping while Surfer was used for creating contour maps of chromium and PCB concentrations, in which Kriging was selected as a gridding method.

The original GPS observation points were expressed in decimal degrees under the Geographic-Lat/Long system. To determine the coordinates of the station locations, ArcView GIS 3.3 and the MI DNR Projection Extension were used to project the station points to the Michigan GeoRef NAD 1983 system. Kriging was used for the interpolation of chromium concentrations at the grid points. Specific information concerning the range of X and Y coordinates, grid size, as well as the variogram model, drift type, and nugget effect are shown below:

X Coordinates	465255 - 471530 meters
Y Coordinates	312504 - 317754 meters
Grid Size	876 rows × 1047 columns
Variogram Model	Type: Linear
	Parameters: Scale: 671000; Length: 3310
Drift Type	No Drift
Nugget Effect	Error Variance: 0; Micro Variance: 0
Anisotropy	Ratio = 1; Angle = 0

3.9 References

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4.0 Results And Discussion

The results and discussion section is organized according to 6 sections that present and summarize the information related to the following topics:

Section 4.1	Sediment Chemistry Results
Section 4.2	Stratigraphy and Radiodating Results
Section 4.3	Toxicity Testing Results
Section 4.4	Benthic Macroinvertebrate Results
Section 4.5	Chromium Uptake In Aquatic Organisms
Section 4.6	Environmental Fate and Transport Analysis
Section 4.7	Sediment Quality Triad Assesment
Section 4.8	Summary and Conclusions

The sediment chemistry results are presented for the core and PONAR samples (Section 4.1) and include metals, semivolatiles, and physical parameters. A discussion is also included related to the comparison of the data with published sediment quality guidelines. The stratigraphy and radiodating results are presented in Section 4.2 and include the results of radioisotopes and the target list of metals (chromium and lead). Toxicity and Benthic Macroinvertebrate results are presented in Sections 4.3 and 4.4, respectively. Statistical analyses of the data and comparisons to related chemical and biological data are also discussed. Chromium accumulation in selected aquatic organisms and the results are summarized in Section 4.5. Section 4.6 provides a discussion of the environmental fate and transport of contaminants in White Lake using the results of this investigation plus studies by Rediske et al. (1998) and Earth Tech (2001). Finally, Section 4.7 presents the investigative data in the contex of the Sediment Quality Triad. The project summary and conclusions are provided in section 4.8.

The project data were reviewed for compliance with the Data Quality Objectives outlined in the Quality Assurance Project Plan. Low matrix spike recoveries were obtained on one sample for semivolatiles and one sample for metals. Acceptable recoveries were obtained in the laboratory control sample, indicating that the problem was matrix related. The data were not qualified due to the fact that the project was a preliminary investigation. The results of the Quality Assurance reviews are summarized in Appendix A.

4.1 Sediment Chemistry Results

The results of sediment grain size fractions, percent solids and TOC for the core and PONAR samples are presented in Tables 4.1.1 and 4.1.2, respectively. The sediments from most of the core samples can be characterized as having fine grain size (> 70% of particles < 63 *u*m) and moderate to high in total organic carbon (TOC 1% - 10%) in the top 51 cm. Grain size distributions changed to include a greater sand fraction (125-500 *u*m range) in the middle (51-102 cm) and bottom (102-152 cm) sections. This pattern is consistent with historical modification and development of the shoreline. Much of the lake shoreline was modified by

TABLE 4.1.1 RESULTS OF SEDIMENT GRAIN SIZE FRACTIONS, TOC, AND PERCENT SOLIDS FOR WHITE LAKE CORE SAMPLES, OCTOBER 2000. (TOP = 0-52 CM, MID = 52-102 CM, BOT = 102-152 CM)

Sample ID	>2000 *um* Weight %	2000-1000 *um* Weight%	1000-850 *um* Weight %	850-500 *um* Weight %	500-125 *um* Weight %	125-63 *um* Weight %	<63 *um* Weight %	TOC %	Solids %
WL-1 TOP	0	0	0	0	2	6	92	3.9	12
WL-1 MID	0	0	0	0	13	9	78	11	14
WL-1 BOT	0	0	0	0	7	9	84	9.5	15
WL-2 TOP	1	0	0	0	4	4	92	6.5	11
WL-2 MID	0	0	0	0	13	9	77	10	15
WL-2 BOT	0	0	0	2	90	2	5	<1.0	67
WL-3 TOP	0	0	0	0	4	8	87	2.2	13
WL-3 MID	0	0	0	1	23	11	65	4.8	18
WL-3 TOP	0	0	0	0	7	9	84	8.1	15
WL-4 TOP	0	0	0	0	10	14	76	2.9	13
WL-4 MID	0	0	0	3	80	3	13	<1.0	53
WL-5 TOP	0	0	0	0	7	12	81	5.8	12
WL-5 MID	0	0	0	0	9	12	79	8.9	15
WL-5 BOT	0	0	0	0	6	10	84	7.2	15
WL-6 TOP	0	0	0	0	2	5	93	3.0	17
WL-6 MID	1	0	0	2	43	8	46	10	38
WL-6 BOT	0	0	0	1	8	13	78	3.0	16
WL-7 TOP	0	0	0	0	8	12	80	3.6	12
WL7 MID	0	0	0	0	11	17	72	10	16
WL-7 BOT	0	0	0	0	8	18	75	10	15
WL-8 TOP	0	0	0	0	8	16	76	6.6	12
WL-8 MID	0	0	0	0	8	11	80	1.2	15
WL-8 BOT	0	1	0	0	6	12	83	1.3	16
WL-9 TOP	0	1	0	0	9	14	76	7.5	13
WL-9-MID	0	0	0	0	9	10	81	7.1	15
WL-9 BOT	0	0	0	0	7	11	81	8.1	16
WL-10 TOP	6	0	0	0	23	6	71	5.0	14
WL-10 MID	0	0	0	0	11	10	79	9.7	15
WL-10 BOT	0	0	0	0	6	7	87	8.9	14
WL-21 TOP	0	0	0	0	10	5	84	2.7	20
WL-21 MID	0	0	0	1	10	15	74	7.1	16
WL-21 BOT	0	0	0	1	6	6	86	3.4	13

TABLE 4.1.2 RESULTS OF SEDIMENT GRAIN SIZE FRACTIONS, TOC, AND PERCENT SOLIDS FOR WHITE LAKE PONAR SAMPLES, OCTOBER 2000.

Sample ID	>2000 *u*m Weight %	2000-1000 *u*m Weight%	1000-850 *u*m Weight %	850-500 *u*m Weight %	500-125 *u*m Weight %	125-63 *u*m Weight %	<63 *u*m Weight %	TOC %	Solids %
WL-1 P	0	0	0	0	4	5	91	8.0	7
WL-2 P	0	0	0	0	6	5	88	3.5	10
WL-3 P	0	0	0	0	4	5	90	3.0	10
WL-4 P	0	0	0	5	82	2	11	<1.0	61
WL-5 P	0	0	0	0	6	10	83	5.0	11
WL-6 P	0	0	0	0	5	7	88	4.4	10
WL-7 P	0	0	0	0	7	10	83	6.6	10
WL-8 P	0	0	0	0	8	10	82	5.5	11
WL-9 P	0	0	0	0	7	9	83	6.4	11
WL-10 P	0	0	0	0	5	5	89	2.2	10
WL-11 P	0	0	0	0	7	9	84	6.0	11
WL-12 P	1	0	0	0	6	9	84	7.1	11
WL-13 P	0	0	0	0	30	14	55	5.0	15
WL-14 P	1	0	0	0	13	10	76	18	13
WL-15 P	1	0	0	0	6	10	83	7.4	12
WL-16 P	0	0	0	0	3	7	90	10	14
WL-17 P	0	0	0	0	5	10	84	10	15
WL-18 P	0	0	0	0	8	8	84	11	16
WL-19 P	0	0	0	0	6	11	83	11	15
WL-20 P	0	0	0	0	11	17	70	8.5	16
WL-21 P	0	0	0	1	19	9	71	5.6	13
WL-22 P	6	2	0	1	12	13	65	4.6	11
WL-23 P	3	3	1	2	10	9	73	5.9	12
WL-24 P	3	1	0	1	12	7	76	8.2	15

logging in the 1800s and urban/industrial development in the 1900s. The subsequent erosion and runoff probably resulted in a sand layer being deposited throughout the near shore area. The presence of the finer grained material is consistent with the recent history of a more stable shoreline and eutrophic conditions present in the lake. Station WL-4 was different with respect to grain size distribution as it contained a higher sand fraction (80%) in the 52-102 cm core section. WL-4 was collected off a sloping contour with a public boat launch located to the south. Since the particle size and TOC characteristics of sediments will influence their ability to retain metals and organic chemicals, these data will be important in explaining the distribution of anthropogenic contaminants.

Very little difference was noted between the grain size and TOC content of the PONAR samples (Table 4.1.2) and the top core sections (Table 4.1.1) for all samples except WL-4. The PONAR collected at this location was very high in sand fraction sediments (80%) suggesting that sediment composition is variable at this location. The variability may be due to the landscape variables discussed above or depositional patterns. Since these samples were used for chemical analysis in addition to the assessment of sediment toxicity and benthic invertebrate diversity, the influence of particle size and TOC content will also be an important factor in the evaluation of the project data. Chemical and ecological results from W-4 will be influenced to a large extent by the physical characteristics of the substrate.

The results of sediment metals analyses are presented for the core and PONAR samples in Tables 4.1.3 and 4.1.4 respectively. The results of semivolatile and PCB analyses for the same sample groupings are given in Tables 4.1.5 and 4.1.6. Figures 4.1.1, 4.1.2, and 4.1.3 illustrate the distribution of arsenic, chromium, and lead respectively, in core samples collected from western White Lake. In general, arsenic concentrations in the three core sections showed little variation (±3 mg/kg) with depth (Figure 4.1.1). The same pattern was noted in the prior investigation (Rediske et al. 1998) for samples collected in eastern White Lake. These data suggest a relatively constant deposition rate of arsenic in the lake occurred over time. Uniform deposition rates over an extended period of time are usually related to regional geology and do not indicate anthropogenic pollution. Chromium and lead (Figures 4.1.2 and 4.1.3 respectively) did not follow this pattern as the highest levels of these elements were found in the top 51 cm of sediment. The sediment chemistry profiles of chromium and lead are indicative of recent anthropogenic pollution and cannot be attributed to background levels. A comparison of the results for arsenic, chromium and lead is provided in Figures 4.1.4, 4.1.5, and 4.1.6 respectively. The PONAR collects sediments to an approximate depth of 18 cm and can be used to estimate very recent deposition. The results for arsenic are again indicative of a relatively constant deposition rate, as there was little difference between PONAR and core sections (Figure 4.1.4). Chromium results follow a similar pattern indicating stable deposition rates in the more recent strata (Figure 4.1.5). In consideration that the deeper strata were considerably lower in chromium, these results suggest a relatively constant source is currently present in the lake. This is significant because the tannery ceased its discharge of chromium laden wastewater to White Lake in 1975. Chromium deposition in the western half of the lake reflects a constant loading of chromium after the wastewater diversion. These data support the hypothesis that the erosion and transport of sediments from Tannery Bay play an important role in the mobilization and deposition of contaminants in the western portion of White Lake (Rediske et al. 1998). Lead

TABLE 4.1.3 RESULTS OF SEDIMENT METAL ANALYSES FOR WHITE LAKE CORE SAMPLES (MG/KG DRY WEIGHT), OCTOBER 2000. (TOP = 0-52 CM, MID = 52-102 CM, BOT = 102-152 CM)

Sample	Arsenic (mg/kg)	Barium (mg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Mercury (mg/kg)	Nickel (mg/kg)	Lead (mg/kg)	Selenium (mg/kg)	Zinc (mg/kg)
WL-1 Top	9.1	130	1.3	270	29	0.42	23	140	2.8	140
WL-1 Mid	6.1	130	0.87	34	18	< 0.1	16	15	2.8	75
WL-1 Bot.	6.6	160	0.74	37	21	< 0.1	18	9.8	2.6	86
WL-2 Top	9.0	160	1.6	470	33	0.42	18	190	2.6	140
WL-2 Bot	7.5	150	0.97	34	18	0.14	12	24	2.7	87
WL-3 Top	7.9	120	1.5	290	33	0.39	24	190	2.7	150
WL-3 Mid	6.2	110	0.61	33	17	0.16	14	28	2.1	80
WL-3 Bot	5.7	130	0.48	28	16	< 0.1	13	8.2	2.6	65
WL-4 Top	9.0	130	1.9	440	34	0.49	27	180	2.5	160
WL-4 Mid	1.8	18	0.15	8.1	2.3	< 0.1	U	2.1	0.47	16
WL-5 Top	8.9	140	1.4	300	31	0.52	24	110	3.6	160
WL-5 Mid	6.3	130	0.53	34	18	0.10	15	16	2.9	82
WL-5 Bot	6.1	150	< 0.1	24	17	< 0.1	12	5.9	3.1	69
WL-6 Top	6.7	180	1.3	410	23	0.38	27	340	2.1	110
WL-6 Mid	12	88	0.26	19	12	< 0.1	13	13	0.86	46
WL-6 Bot	12	110	0.19	17	13	< 0.1	14	7.7	1.5	45
WL-7 Top	8.2	130	1.6	600	34	0.62	28	180	2.6	160
WL-7 Mid	6.5	110	0.65	40	19	0.13	16	22	1.9	90
WL-7 Bot	5.5	110	0.35	33	17	< 0.1	15	7.9	< 0.1	70
WL-8 Top	7.7	140	1.4	380	32	0.58	26	180	< 0.1	160
WL-8 Mid	7.7	120	0.42	34	18	< 0.1	15	9.6	< 0.1	76
WL-8 Bot	7.3	1470	0.49	40	18	< 0.1	16	8.9	1.7	78
WL-9 Top	9.6	140	1.5	500	34	0.63	26	120	5.1	170
WL-9 Mid	7.5	120	0.6	38	18	0.12	16	18	2.6	81
WL-9 Bot	7.0	120	0.51	35	17	< 0.1	14	8.0	2.6	69
WL-10 Top	6.5	92	1.1	210	23	0.34	18	97	< 0.1	120
WL-10 Mid	5.8	110	0.47	33	16	0.11	14	18	2.0	75
WL-10 Bot	6.5	110	0.36	30	16	< 0.1	14	6.9	2.7	64
WL-21 Top	9.5	162	1.2	430	23	0.51	28	290	1.5	160
WL-21Mid	7.8	120	0.78	99	12	0.11	19	170	1.8	85

TABLE 4.1.4 RESULTS OF SEDIMENT METAL ANALYSES FOR WHITE LAKE PONAR SAMPLES (MG/KG DRY WEIGHT), OCTOBER 2000.

Sample	Arsenic (mg/kg)	Barium (mg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Mercury (mg/kg)	Nickel mg/kg)	Lead (mg/kg)	Selenium (mg/kg)	Zinc (mg/kg)
WL-1 P	6.3	140	0.85	270	30	0.20	17	70	< 0.1	120
WL-2 P	7.5	150	0.85	300	34	0.20	18	76	< 0.1	120
WL-3 P	5.5	120	0.73	190	29	0.16	16	54	< 0.1	100
WL-4 P	1.4	12	< 0.1	18	2.2	< 0.1	1.6	8.3	< 0.1	33
WL-5 P	6.2	130	1.1	400	31	0.27	19	89	2.9	120
WL-6 P	8.4	130	1.0	360	28	0.25	18	73	3.0	120
WL-7 P	7.6	120	0.99	390	37	0.29	25	86	3.6	130
WL-8 P	8.8	130	0.93	380	27	0.25	20	75	3.7	120
WL-9 P	7.9	170	0.87	420	34	0.30	23	74	3.0	130
WL-10 P	7.0	120	0.91	270	31	0.34	19	75	< 0.1	120
WL-11 P	6.3	*	0.96	310	32	0.32	18	78	*	116
WL-12 P	5.9	*	1.03	510	30	0.28	17	70	*	118
WL-13 P	6.3	*	0.96	250	32	0.27	17	67	*	108
WL-14 P	6.3	*	1.10	480	31	0.25	17	72	*	95
WL-15 P	6.0	*	0.75	250	28	0.26	17	71	*	101
WL-16 P	5.8	*	0.84	190	27	0.27	18	75	*	105
WL-17 P	5.4	*	0.64	50	30	0.05	19	34	*	115
WL-18 P	5.3	*	0.51	29	32	0.05	20	22	*	125
WL-19 P	5.7	*	0.42	39	31	0.05	21	26	*	131
WL-20 P	6.2	*	0.61	28	28	0.05	19	21	*	124
WL-21P	6.5	*	1.00	450	31	0.24	18	65	*	132

* PONAR analyzed for target list metals. Barium and selenium not analyzed.

TABLE 4.1.5 RESULTS OF SEDIMENT PCB AND SEMIVOLATILE ANALYSES FOR WHITE LAKE CORE SAMPLES (MG/KG DRY WEIGHT), OCTOBER 2000. (SAMPLES AND PARAMETERS THAT WERE NOT DETECTED WERE OMITED.) (TOP = 0-52 CM, MID = 52-102 CM, BOT = 102-152 CM)

Sample ID	Aroclor 1248	1,3-DICHLORO BENZENE	1,4-DICHLORO BENZENE	BIS (2-ETHYLHEXYL)-PHTHALATE	DI-N-BUTYL PHTHALATE	FLUORANTHENE	HEXACHLORO BENZENE	HEXACHLORO BUTADIENE	HEXACHLOROCYCLO PENTADIENE	PYRENE
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
WL-1 Top	**0.22**	< 1.5	< 1.5	**0.38**	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5
WL-1 Top	**0.49**	< 1.7	< 1.7	< 1.5	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
WL-1 Mid	< 0.33	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1
WL-1 Mid	**0.07**	< 1.2	< 1.2	**0.42**	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2
WL-1 Bot	< 0.33	< 1.2	< 1.2	**.26**	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2
WL-1 Bot	**.061**	< 1.2	< 1.2	**0.32**	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2
WL-2 Top	**0.07**	< 1.7	< 1.7	**0.56**	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
WL-2 Mid	< 0.33	< 1.2	< 1.2	**0.35**	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2
WL-3 Top	**0.05**	< 1.4	< 1.4	**0.99**	< 1.4	< 1.4	< 1.4	< 1.4	< 1.4	< 1.4
WL-3 Mid	< 0.33	< 0.93	< 0.93	< 0.93	< 0.93	< 0.93	< 0.93	< 0.93	< 0.93	< 0.93
WL-3 Bot	**0.06**	< 1.0	< 1.0	**0.39**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
WL-4 Top	**0.17**	< 1.3	< 1.3	< 1.3	1	0.10	< 1.3	< 1.3	< 1.3	< 1.3
WL-4 Mid	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
WL-5 Top	0.17	< 1.3	< 1.3	< 1.3	< 1.3	0.097	< 1.3	< 1.3	< 1.3	< 1.3
WL-5 Mid	< 0.33	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2
WL-5 Bot	**0.06**	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1
WL-6 Top	**0.39**	< 1.1	< 1.1	**0.22**	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1
WL-6 Mid	< 0.33	< 0.46	< 0.46	**0.19**	< 0.46	< 0.46	< 0.46	< 0.46	< 0.46	< 0.46
WL-6 Bot	< 0.33	< 0.45	< 0.45	**0.14**	< 0.45	< 0.45	< 0.45	< 0.45	< 0.45	< 0.45
WL-7 Top	**0.24**	< 1.5	< 1.5	**0.28**	1.1	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5
WL-7 Mid	< 0.33	< 1.1	< 1.1	**0.25**	**0.99**	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1
WL-7 Bot	< 0.33	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1
WL-8 Top	0.27	< 1.3	< 1.3	**0.25**	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3
WL-8 Mid	**0.054**	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1
WL-8 Bot	< 0.33	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1
WL-9 Top	**0.07**	< 1.4	< 1.4	< 1.4	< 1.4	< 1.4	< 1.4	< 1.4	< 1.4	< 1.4
WL-9 Mid	**0.06**	< 1.1	< 1.1	< 1.1	**0.44**	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1
WL-9 Bot	< 0.33	< 1.1	< 1.1	**0.23**	**0.46**	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1
WL-10 Top	**0.06**	< 1.1	< 1.1	**0.25**	**0.98**	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1
WL-10 Mid	**0.06**	< 1.1	< 1.1	< 1.1	**1.1**	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1
WL-10 Bot	< 0.33	< 1.2	< 1.2	< 1.2	**0.84**	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2
WL-21 Top	**22**	**1.9**	**0.65**	**0.94**	< 1.2	< 1.2	**0.54**	< 0.33	< 0.33	< 1.2
WL-21 Mid	**0.84**	**0.29**	< 0.33	**0.54**	< 0.98	< 0.98	0.051	< 0.98	< 0.98	< 0.98

TABLE 4.1.6 RESULTS OF SEDIMENT PCB AND SEMIVOLATILE ANALYSES FOR WHITE LAKE PONAR SAMPLES (MG/KG DRY WEIGHT), OCTOBER 2000. (SAMPLES AND PARAMETERS THAT WERE NOT DETECTED WERE OMITED.)

Sample ID	Aroclor 1248	1,3-DICHLORO BENZENE	1,4-DICHLORO BENZENE	BIS (2-ETHYLHEXYL)-PHTHALATE	DI-N-BUTYL PHTHALATE	FLUORANTHENE	HEXACHLORO BENZENE	HEXACHLORO BUTADIENE	HEXACHLOROCYCLO PENTADIENE	PYRENE
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
WL-1 P	< 0.33	< 1.8	< 1.8	**0.92**	< 1.8	< 1.8	< 1.8	< 1.8	< 1.8	< 1.8
WL-2 P	**0.086**	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
WL-3 P	< 0.33	< 1.5	< 1.5	**0.31**	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5
WL-4 P	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
WL-5 P	< 0.33	< 1.7	< 1.7	**0.62**	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
WL-6 P	**0.071**	< 1.5	< 1.5	**0.25**	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5
WL-7 P	**0.084**	< 1.7	< 1.7	**0.32**	**0.3**	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
WL-8 P	**0.076**	< 1.7	< 1.7	**0.35**	**0.25**	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
WL-9 P	< 0.33	< 1.5	< 1.5	**1.3**	< 1.5	< 0.33	< 1.5	< 1.5	< 1.5	< 1.5
WL-10 P	< 0.33	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
WL-11 P	< 0.33	*	*	*	*	*	*	*	*	*
WL-12 P	< 0.33	*	*	*	*	*	*	*	*	*
WL-13 P	< 0.33	*	*	*	*	*	*	*	*	*
WL-14 P	< 0.33	*	*	*	*	*	*	*	*	*
WL-15 P	< 0.33	*	*	*	*	*	*	*	*	*
WL-16 P	< 0.33	< 1.2	< 1.2	**1.1**	< 1.2	**0.18**	< 1.2	< 1.2	< 1.2	**0.12**
WL-17 P	< 0.33	*	*	*	*	*	*	*	*	*
WL-18 P	< 0.33	*	*	*	*	*	*	*	*	*
WL-19 P	< 0.33	*	*	*	*	*	*	*	*	*
WL-20 P	< 0.33	*	*	*	*	*	*	*	*	*
WL-21 P	**21**	< 1.3	< 1.3	**0.4**	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3

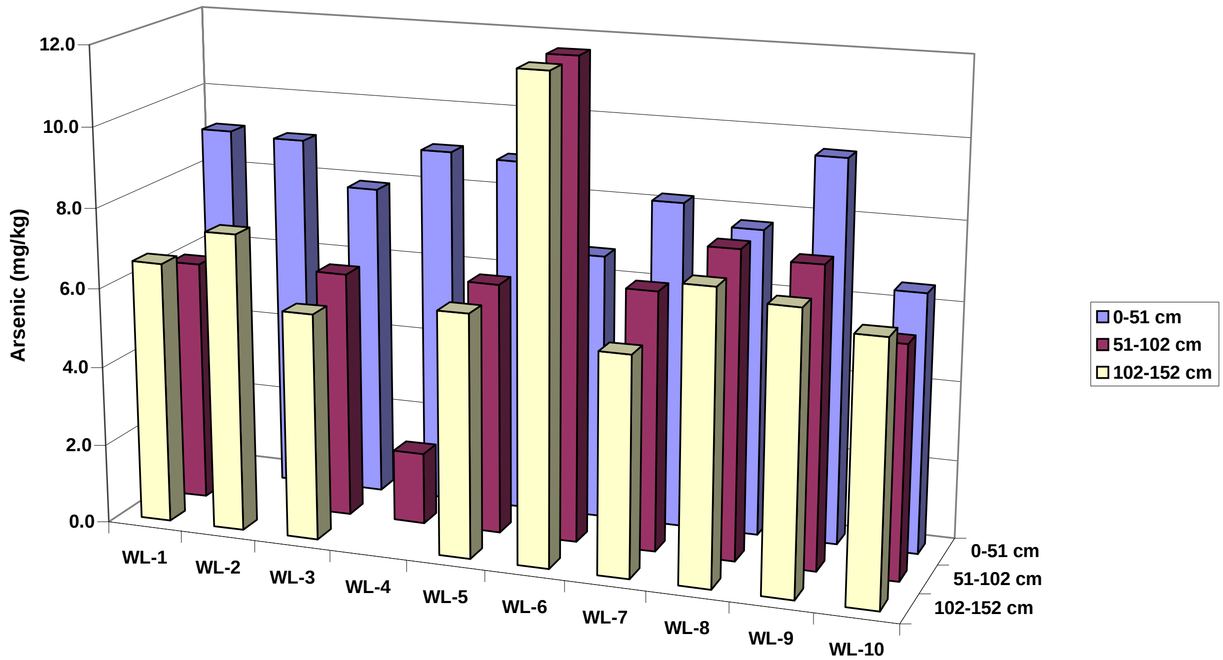


FIGURE 4.1.1 DISTRIBUTION OF ARSENIC IN CORE SAMPLES COLLECTED IN WESTERN WHITE LAKE, OCTOBER 2000.

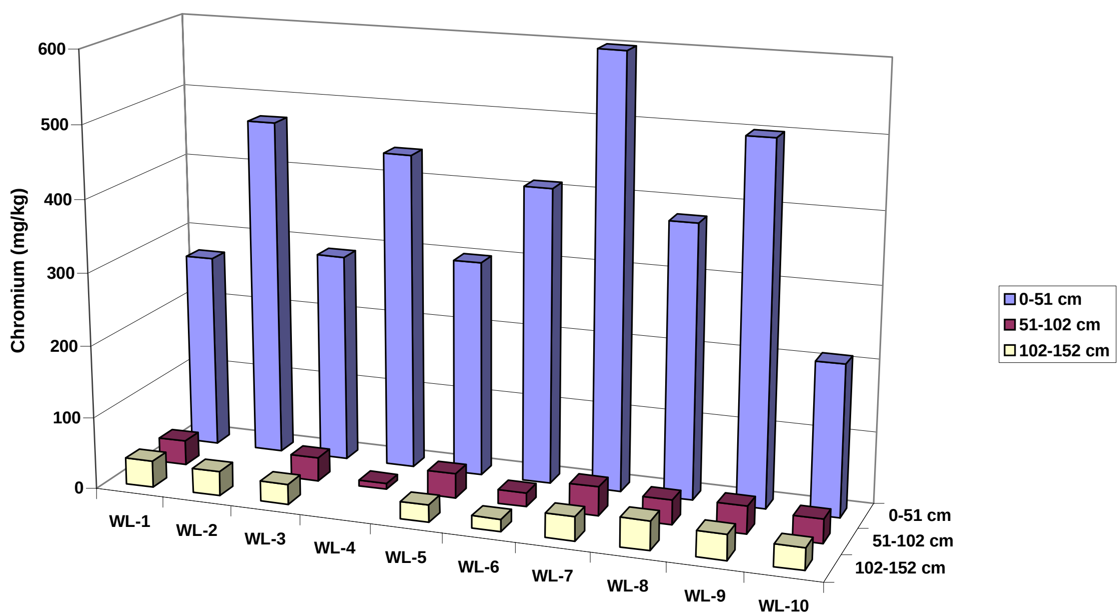


FIGURE 4.1.2 DISTRIBUTION OF CHROMIUM IN CORE SAMPLES COLLECTED IN WESTERN WHITE LAKE, OCTOBER 2000.

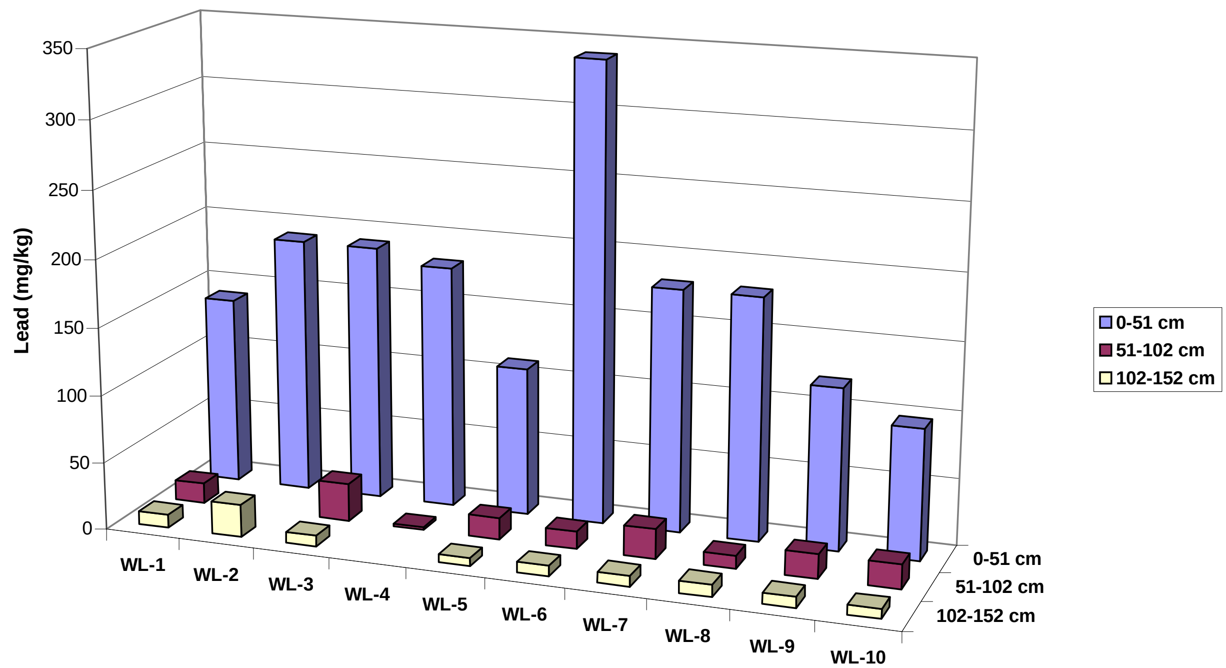


FIGURE 4.1.3 DISTRIBUTION OF LEAD IN CORE SAMPLES COLLECTED IN WESTERN WHITE LAKE, OCTOBER 2000.

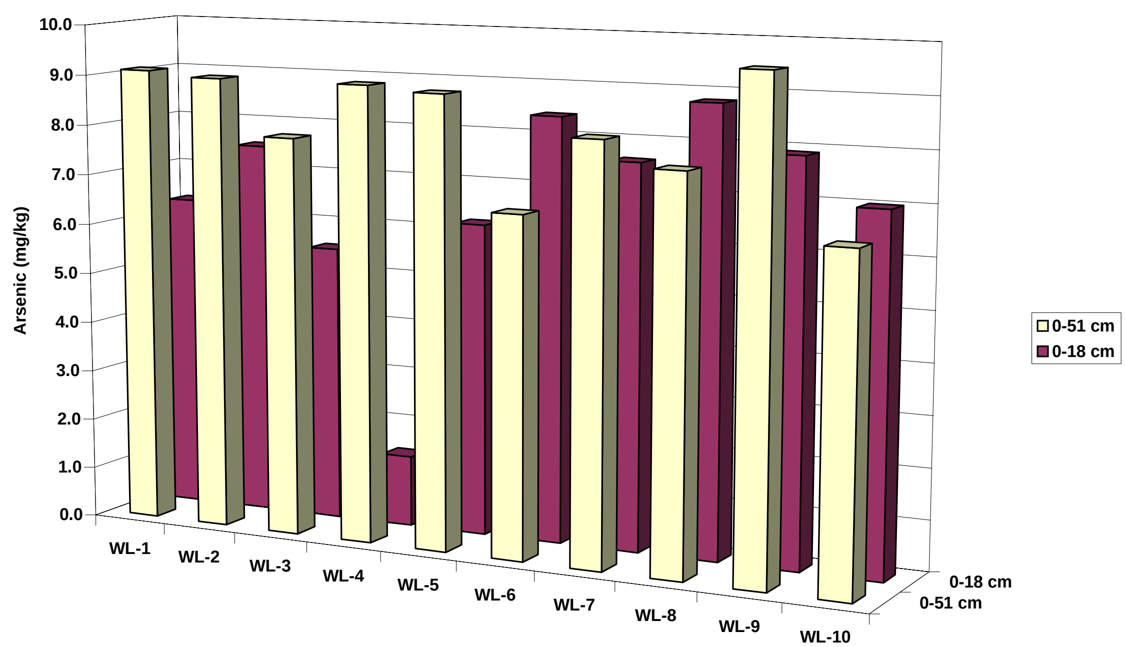


FIGURE 4.1.4 COMPARISON OF ARSENIC CONCENTRATIONS IN PONAR SAMPLES (0-18 CM) AND TOP CORE SECTIONS (0-51 CM) COLLECTED IN WHITE LAKE, OCTOBER 2000.

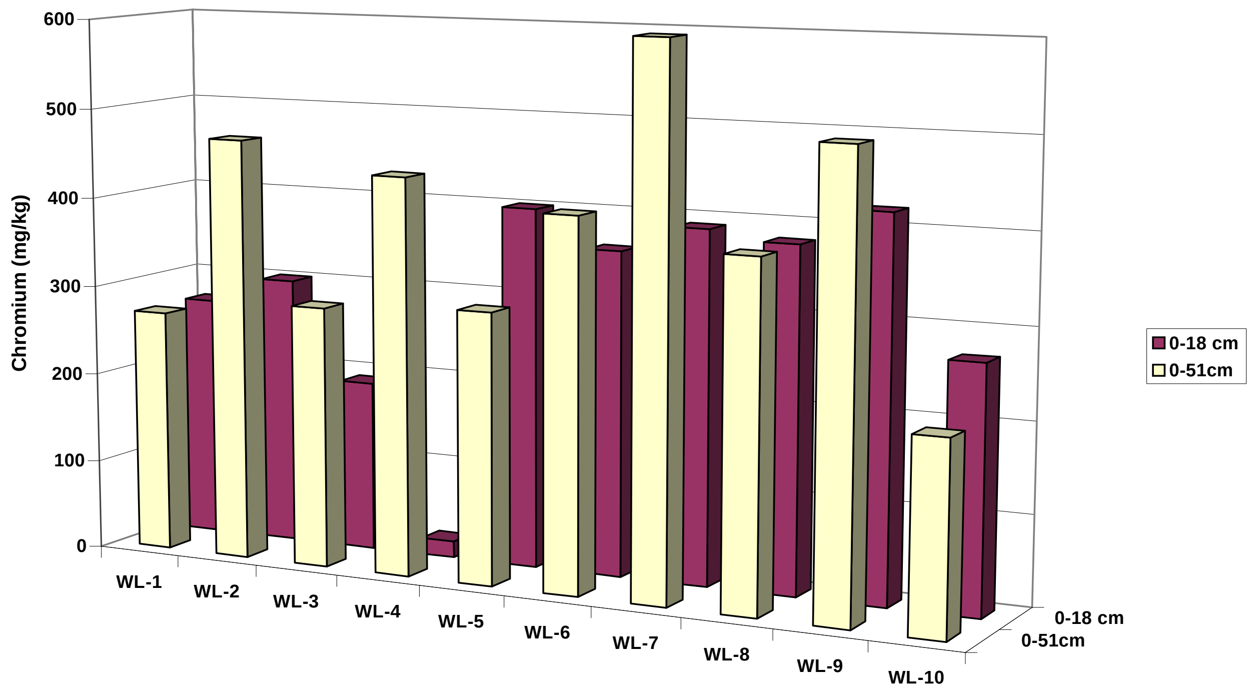


FIGURE 4.1.5 COMPARISON OF CHROMIUM CONCENTRATIONS IN PONAR SAMPLES (0-18 CM) AND TOP CORE SECTIONS (0-51 CM) COLLECTED IN WHITE LAKE, OCTOBER 2000.

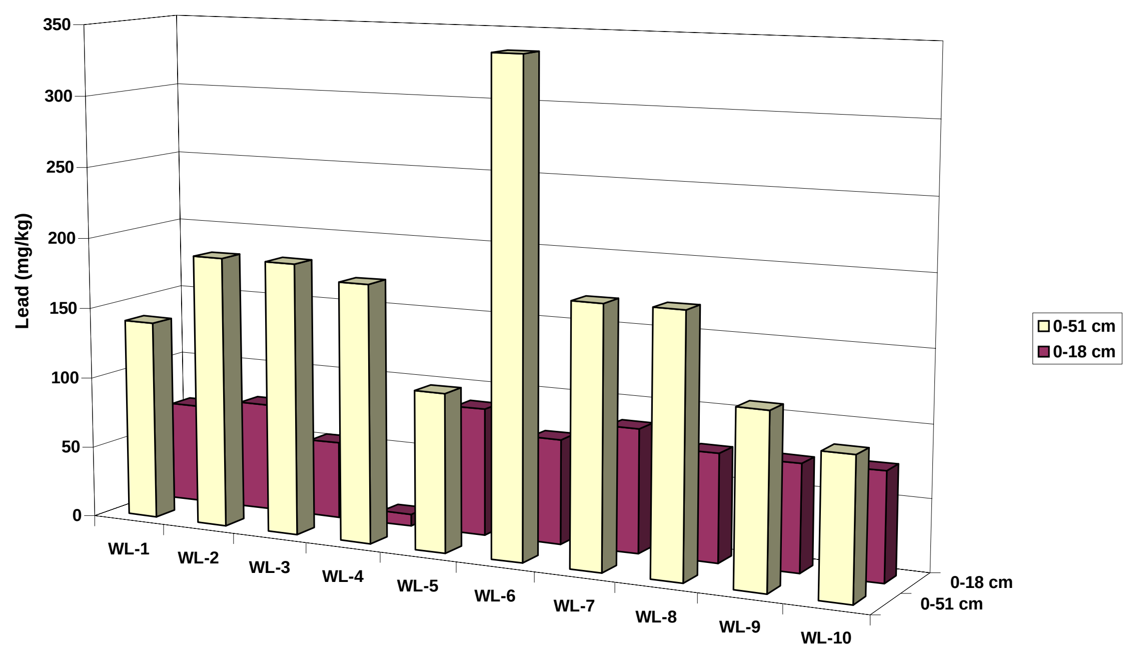


FIGURE 4.1.6 COMPARISON OF LEAD CONCENTRATIONS IN PONAR SAMPLES (0-18 CM) AND TOP CORE SECTIONS (0-51 CM) COLLECTED IN WHITE LAKE, OCTOBER 2000.

follows a different depositional pattern as the PONAR samples have lower contaminant concentrations than the 0-51 cm core sections (Figure 4.1.6). Lead was removed from fuel formulations during the 70s and lower deposition rates in the more recent sediments reflect this change.

With the exception of the sample collected at WL-21, high levels of PCBs and organic chemicals were not present in sediment cores (Table 4.1.5). Station WL-21 was collected near the outfall of the former Hooker/Occidental Chemical facility and contained similar PCB levels as previously reported (Rediske et al. 1998). Figure 4.1.7 shows the distribution of Aroclor 1248 in the three core sections. PCBs appear to be localized in the vicinity of the outfall and show minimal migration to areas in the western basin. Low levels of phthalate esters (bis ethylhexyl phthalate and di-n-butyl phthalate) were sporadically found in a number of core sections (Table 4.1.5). Phthalate esters are often found in plastic materials and are common laboratory contaminants. Their sporadic distribution in the samples does not point to a particular contaminant source or time period. PONAR samples (Table 4.1.6) reflect a similar deposition pattern for Aroclor 1248. The highest concentration was found at WL-21 and no significant migration of PCBs was noted in the western stations. Organic contaminants were not detected in the PONAR sample from WL-16. This station exhibited the highest degree of toxicity in the previous investigation (Rediske et al. 1998) and in this project (Section 4.3). These results strongly indicate that the heavy metals and/or the scan list of organic chemicals are not responsible for the toxicity observed at this WL-16.

Chromium concentrations were analyzed in a series of PONAR samples collected in the eastern section of White Lake to provide an indication of the distribution of this contaminant throughout the entire system. The results of the PONAR samples are summarized in Figure 4.1.8. While a decreasing trend in chromium concentration is noted moving downgradient from Tannery Bay to Long Point, it is significant to note that the lowest chromium value measured in the organic sediments was 190 mg/l. The low chromium concentration observed at station WL-4 can be attributed to the physical characteristics (80% sand). Since the PONAR collects samples from the biologically active zone of 0-18 cm, the results can be compared to sediment quality guidelines to evaluate ecological effects. For this purpose, the Probable Effect Concentration (PEC) (MacDonald et al. 2000) for chromium (111 mg/kg) can be used as a reference point. Stations with concentrations above the chromium PEC are identified on Figure 4.1.8. PECs are consensus based guidelines that indicate a >75% probability that adverse ecological effects may be observed when the concentrations are exceeded. The results suggest that a majority of the organic sediments in White Lake west of the Tannery are contaminated with chromium at levels exceeding the PEC. The bathymetric plot for White Lake (Figure 4.1.9) supports this conclusion as it shows a shallow zone with an approximate depth of 4 m that is present along the perimeter west of the Narrows (white and light green contours). This shelf area consists of sandy sediments related to the native soils and has physical characteristics that limit the accumulation of chromium. Depositional organic sediments are found in the deeper areas of the lake west of Tannery Bay and in the shallow zone extending from the rivermouth to the Narrows. All of the samples collected in this depositional zone were contaminated with chromium at levels significantly above the PEC and are representative of a majority of the lake bottom.

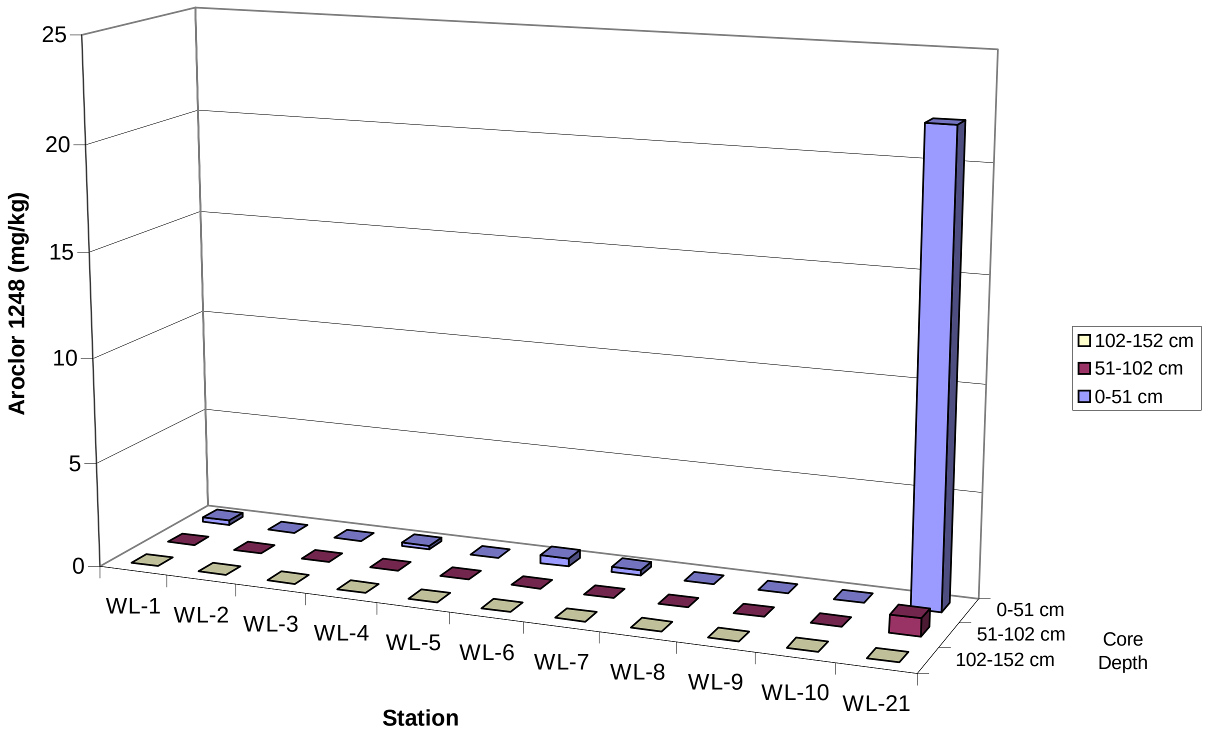


FIGURE 4.1.7 DISTRIBUTION OF AROCLOR 1248 IN CORE SAMPLES COLLECTED IN WESTERN WHITE LAKE, OCTOBER 2000.

In contrast to chromium, the pattern of PCB contamination shows that it is localized in the area near the Occidental/Hooker Chemical outfall near WL-21 (Figure 4.1.7). The discharge of PCBs occurred in a deep area near the Occidental/Hooker Chemical outfall (15 m) that was not subject to wave action and currents. The stability of the sediments plus the hydrophobic nature of PCBs limited the ability of this contaminant to be transported to areas downgradient from the outfall zone. In contrast, the discharge of chromium occurred in an area of shallow sediments (< 3 m) that were subject to shoreline erosion and currents related to the flow of the drowned rivermouth and wave action. Even though chromium is very insoluble in natural water due to the formation of $Cr(OH)_3$, the combination of resuspension by wave action and advection by lake currents resulted in contamination throughout the basin west of Tannery Bay. Factors influencing the spatial distribution of contaminants in White Lake will be discussed in Section 4.6.

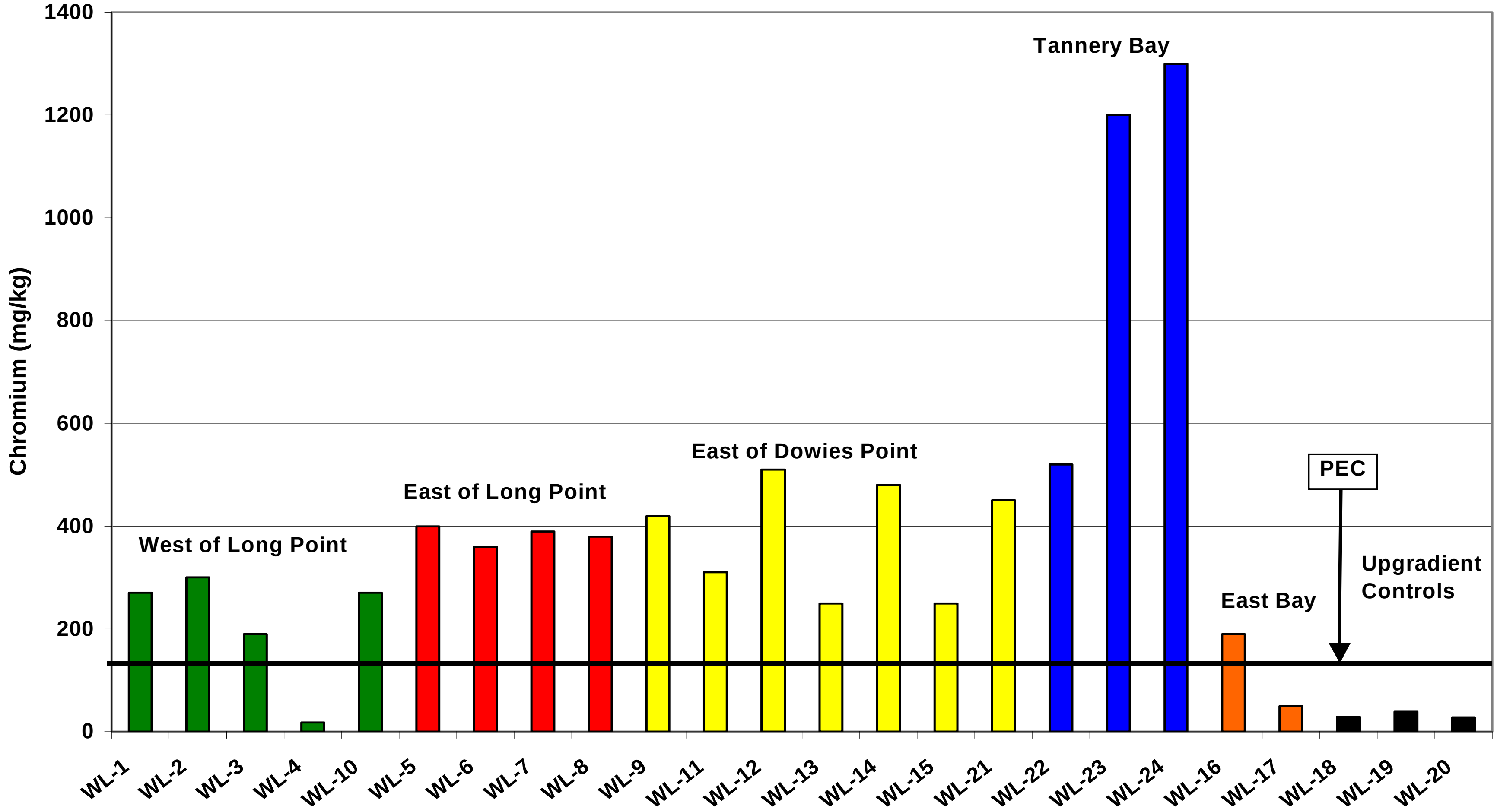


FIGURE 4.1.8 DISTRIBUTION OF CHROMIUM IN PONAR SAMPLES FOR WHITE LAKE, OCTOBER 2000. LINE DENOTES PROBABLE EFFECT CONCENTRATION (PEC) (MACDONALD ET AL. 2000).

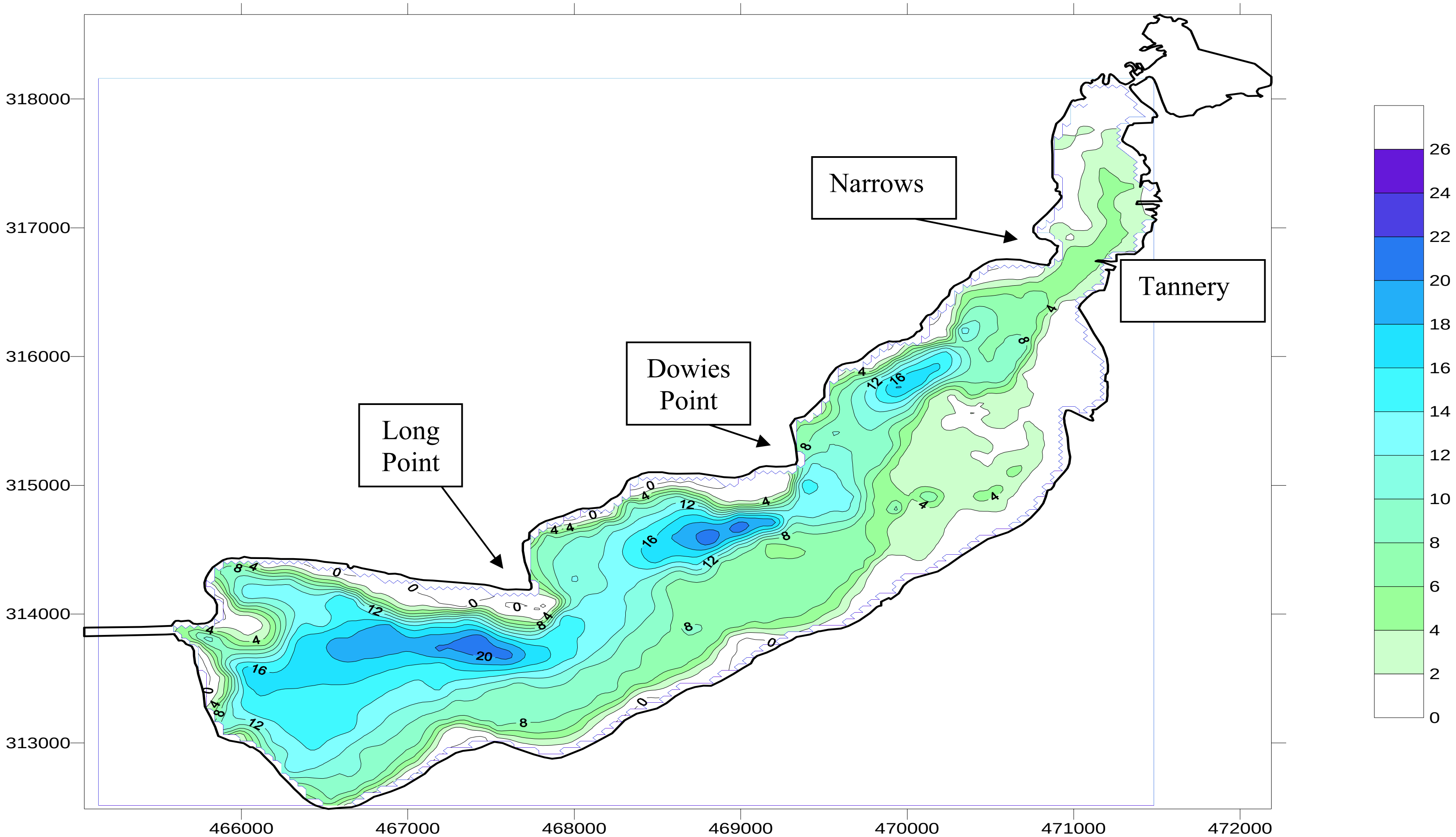


FIGURE 4.1.9 BATHYMETRIC PLOT OF WHITE LAKE.

Principal Component Analysis (PCA) was conducted on the physical and chemical parameters collected during this investigation (Figure 4.1.10). In the first two principal components

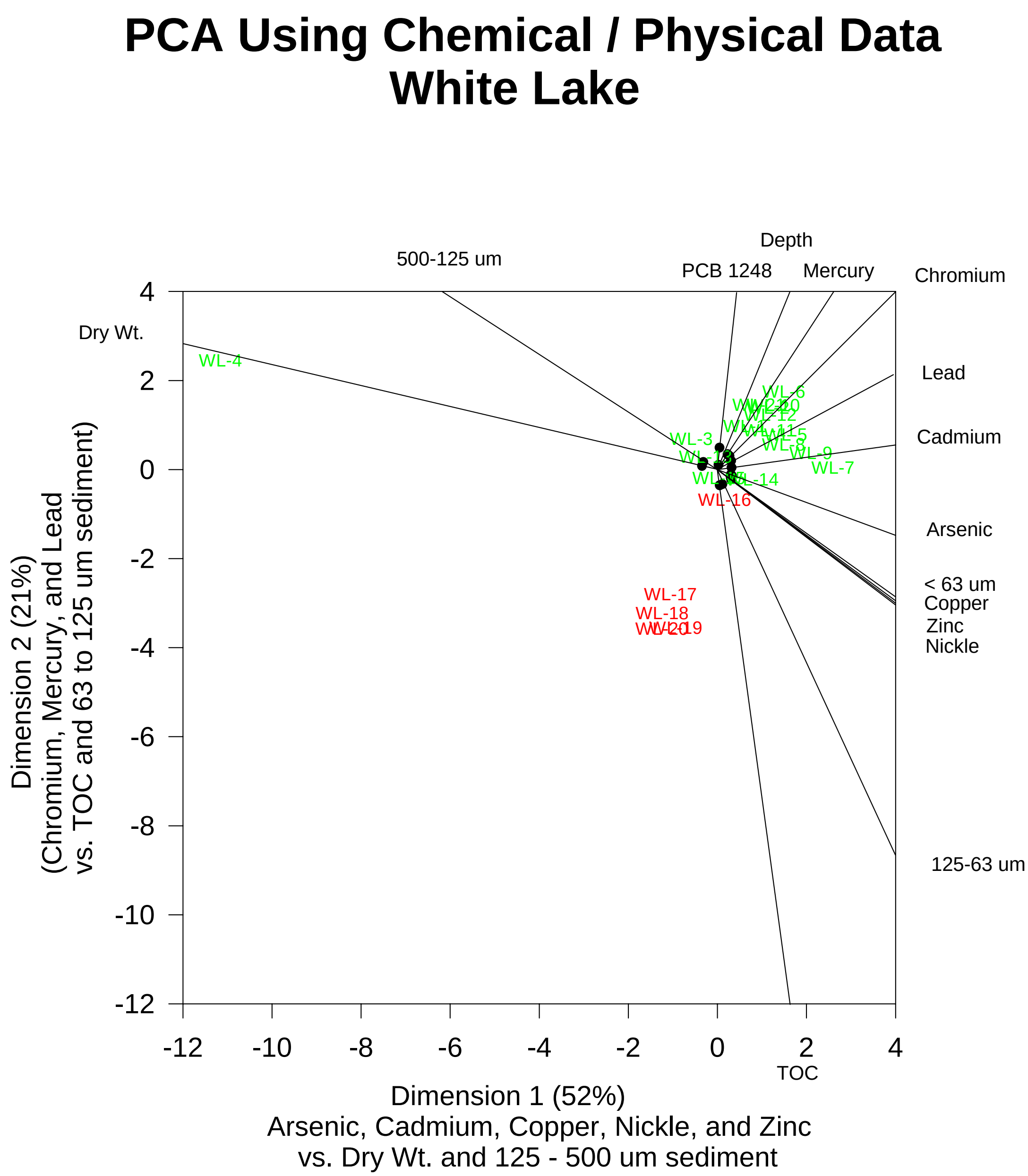


FIGURE 4.1.10 PCA ANALYSIS OF WHITE LAKE PHYSICAL AND CHEMICAL DATA.

(explaining 73.2% of the variation), the deep sites and the west bay were pulled away from the locations upgradient from the tannery (WL-17, WL-18, WL-19, and WL-20). The upgradient sites (WL-17, WL-18, WL-19, and WL-20) were pulled in the direction of physical parameters (TOC and grain size) while the remainder of the stations clustered around the contaminants chromium, mercury, and lead. Station WL-4 did not follow this pattern as it was pulled in the direction of the grain size (sand fraction) and % solids. This station had the greatest sand fraction, the highest dry weight (% solids), and was the only deep station that contained low contaminant concentrations. Spearman Rank Order Correlations were developed for chromium and the physical/chemical parameters measured in the investigation (Table 4.1.7) to further examine the relationship between the variables. Chromium showed a strong positive correlation with lead, arsenic, and mercury. In addition, chromium showed a negative correlation with % solids. Previous investigations (Bolattino and Fox. 1995, Rediske et al. 1998) established that arsenic, lead, and mercury were associated with the tannery discharge and found in high concentrations in Tannery Bay. The clustering of the deep stations in the PCA around these contaminants plus the Spearman Correlations indicate that the tannery is the predominant source of metal enrichment in western White Lake.

TABLE 4.1.7 SPEARMAN RANK ORDER CORRELATIONS FOR CHROMIUM, CHEMICAL, AND PHYSICAL PARAMETERS FOR WHITE LAKE SEDIMENTS. (VALUES IN BOLD DENOTE STATISTICALLY SIGNIFICANT CORRELATIONS)

Chromium with:	**r**
Arsenic	**0.644**
Cadmium	**0.906**
Copper	0.347
Mercury	**0.63**
Nickel	0.063
Lead	**0.616**
Zinc	0.189
Depth	0.459
<63um	-0.03
Total organic carbon	-0.03
% Solids	**-0.52**

Organic chromium was analyzed in the PONAR samples by extraction with sodium pyrophosphate (Walsh and O'Halloran 1996). This fraction contains chromium bound to alkaline extractable ligands such as humic and fulvic acids. Organically bound chromium was found in sediments contaminated with tannery wastes in New Zealand (Walsh and O'Halloran 1996). The results of organic chromium determinations are given in Table 4.1.8. No detectable organic chromium was found in the stations east of Tannery Bay (WL-17, WL-18, WL-19, and WL-20) and at WL-4. The high sand content and low organic carbon would prevent this fraction of chromium from accumulating at this location. Stations west of Tannery Bay had levels of organic chromium ranging from 23-55 mg/kg. A set of archived samples that had been collected from Tannery Bay (Rediske et al. 1998) were also analyzed (Table 4.1.8). Organic chromium in these samples ranged from 40-380 mg/kg. The location with the lowest organic chromium fraction (I-6) was similar to WL-4 in that it contained a high sand fraction. Samples that were previously noted to contain hide fragments, I-5 and I-3, exhibited the highest levels of organic chromium (380 and 160 mg/kg, respectively). The relationship between organic chromium and sediment toxicity will be discussed in Section 4.3.3.

TABLE 4.1.8 CONCENTRATION OF ORGANIC CHROMIUM IN WHITE LAKE SEDIMENTS.

Station	Organic Chromium (mg/kg)	Total Chromium (mg/kg)	Station	Organic Chromium (mg/kg)	Total Chromium (mg/kg)
WL 1 P	55	270	WL 15 P	27	250
WL 2 P	37	300	WL 16 P	24	190
WL 3 P	45	190	WL 17 P	0	50
WL 4 P	0	18	WL 18 P	0	29
WL 5 P	41	400	WL 19 P	0	39
WL 6 P	41	360	WL 20 P	0	28
WL 7 P	39	390	WL 21 P	39	450
WL 8 P	30	380	I-3*	155	934
WL 9 P	38	420	I-4*	120	1890
WL 10 P	31	270	I-5*	380	4100
WL 11 P	30	310	I-6*	40	2650
WL 12 P	54	510	I-7*	110	2560
WL 13 P	23	250	I-8*	160	515
WL 14 P	53	480			

* Collected in 1996 (Rediske et al. 1998)

While discharges from the tannery and Occidental/Hooker Chemical left large areas of contaminated sediment in White Lake, samples collected near the DuPont groundwater plume (WL-1 and WL-2) did not contain elevated levels of organic compounds. Chromium and other metals were at concentrations consistent with the tannery discharge. No obvious signature related to the DuPont groundwater plume was noted in the core or PONAR samples.

4.2 Stratigraphy and Radiodating Results

Three cores were collected for radiodating and the analysis of detailed stratigraphy for chromium. Stations were selected based on bathymetry and the chromium concentrations measured in the initial cores. One core was collected from a deep depositional area and the remaining two were collected at locations that showed high accumulations of chromium in the 0-51 cm section of the initial cores. The first core (WL-2S) was collected at station WL-2 and was located in the deep basin (20.3 m) west of Long Point (Figures 2.1 and 4.1.8) and near the channel to Lake Michigan. This station represented the deep depositional zone of the lake. The second core (WL-7S) was collected at WL-7 in a shallower zone (10.8 m) east of Long Point. This station had the highest level of chromium in the 0-51 cm zone of the initial set of cores (600 mg/kg). The final core (WL-9S) was collected at station WL-9 located west of Dowies Point at a depth of (9.7 m). This site is nearer to Tannery Bay than the previous cores and contained the second highest level of chromium (500 mg/kg). The results of each core are presented in the following sections.

4.2.1 Core WL-2S

Stratigraphy and radiodating results for WL-2S are presented in Table 4.2.1. Station WL-2S is located at the deep point in White Lake near Long Point and within the flow path of the old river channel (Figure 2.1). Profiles of depth and concentration for chromium, ^{210}Pb, and ^{137}Cs are shown on Figure 4.2.1. Elevated concentrations of chromium continue beyond the estimated date of 1894, which indicates that the CRS model did not yield credible results for the deeper strata. Depositional patterns for ^{210}Pb describe three regions in the core. The top 25 cm exhibits an exponential decay pattern for the radionuclide, which indicates stable deposition (Robbins and Herche 1993). Estimated dates within the top 19 cm of the core appear to be realistic as a peak in ^{137}Cs activity is noted at 15cm. This peak corresponds to

TABLE 4.2.1 STRATIGRAPHY AND RADIODATING RESULTS FOR CORE WL-2S COLLECTED FROM WHITE LAKE, OCTOBER 2001.

Depth (cm)	Total Chromium mg/kg	Ra-226 Activity (dpm/g)	Cs-137 Activity (dpm/g)	Excess Pb-210 Activity (dpm/g)	Date at Given Depth
3	340	1.797	0.992	17.667	1996
7	341	2.529	1.438	8.904	1986
11	317	2.384	1.992	7.538	1977
15	347	2.359	8.801	4.637	1966
19	415	2.980	5.181	2.198	1958
23	481	2.612	2.070	5.012	1954
27	625	2.612	2.055	2.318	1947
31	688	2.090	2.384	0.970	1935
35	793	2.342	2.904	3.385	1930
39	1137	2.187	2.466	2.598	1910
43	1915	2.205	0.932	0.000	1890
47	2046	2.737	0.209	0.000	
51	1846	3.260	0.437	0.000	
55	1400	3.093	0.759	0.000	
59	911	3.514	0.305	0.000	
61	679	2.446	-0.542	0.000	

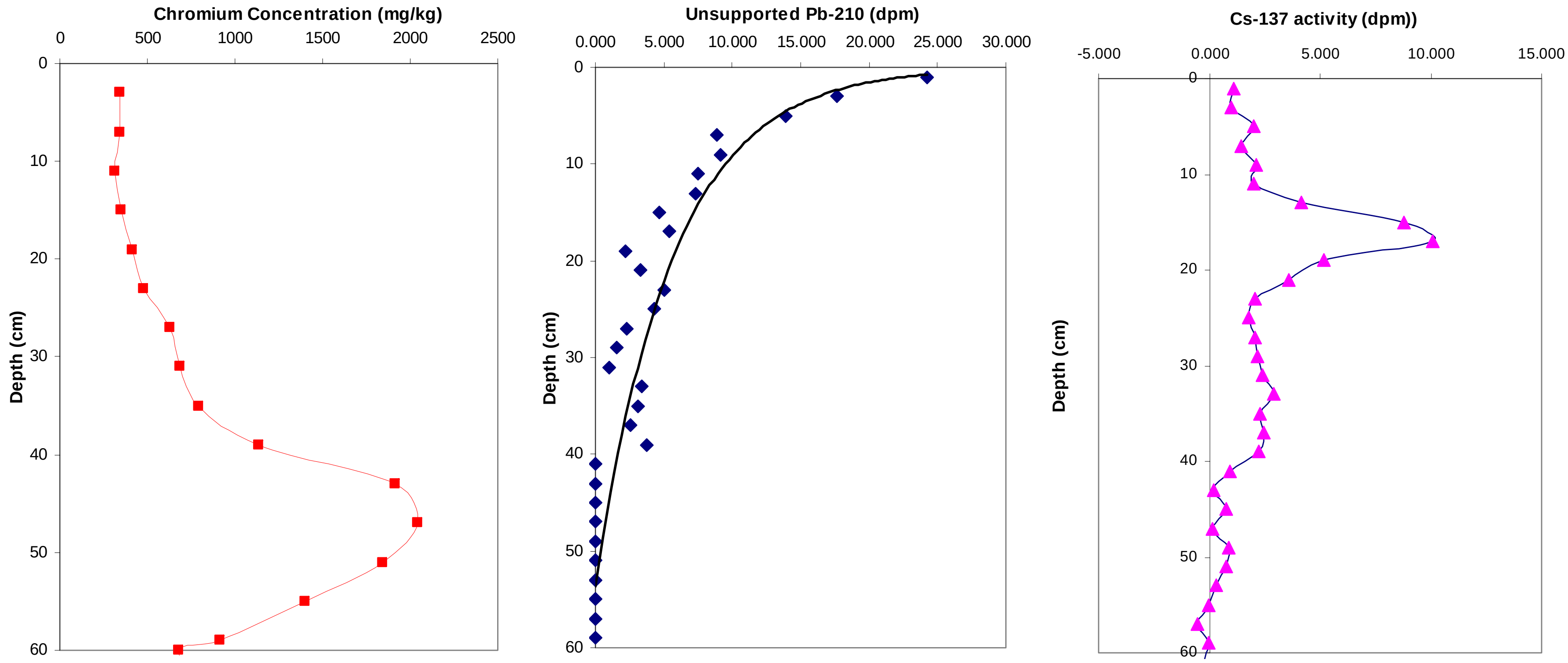


FIGURE 4.2.1 DEPTH AND CONCENTRATION PROFILES FOR CHROMIUM , LEAD-210, AND CESIUM-137 AT STATION WL-2S, WHITE LAKE, OCTOBER 2001.

the maximum deposition of the radionuclide that occurred during 1962 from atomic testing. The CRS model estimated the data of this interval to be 1966, indicating good agreement with the ^{137}Cs peak. Chromium deposition appears to be constant in the top 15 cm of the core, which indicates a relatively constant supply of the element. Since the tannery discharge ceased in the mid 70s, the continued deposition of chromium can be attributed to the transport of contaminated sediment from Tannery Bay by lake currents. From 19 cm to 39 cm, ^{210}Pb deposition is uniform. Chromium deposition increases from 415 mg/kg to 1915 mg/kg at the end of this interval. Excess ^{210}Pb activity is absent in the region below 43 cm. Chromium levels peak at 47 cm (2071 mg/kg) and then decrease to 795 mg/kg at the bottom of the core (81 cm). The results of the strata below 19 cm suggest that ^{210}Pb deposition was attenuated by dilution from excessive sedimentation. Since ^{226}Ra inventories were relatively consistent throughout the core, it is unlikely that sediments generated by the erosion of surficial soils were responsible for the dilution of the ^{210}Pb signal. A similar pattern of high chromium levels in strata with no ^{210}Pb inventories was noted for sediment cores taken in Tannery Bay (Rediske et al. 1989). Dilution by the discharge of industrial waste materials was thought to have attenuated the ^{210}Pb signal in Tannery Bay. In the deep basin where WL-2S is located, it is likely that the additional sedimentation was generated by primary productivity and/or the input of organic matter. This location is 8 km from Tannery Bay and no known source of industrial waste is present in the area. Since the historical tannery discharge also contained high levels of nitrogen and phosphorus from the processing of animal hides, the productivity of White Lake may have been greater during the years prior to 1960. Observations and data from Evans (1992) support this conclusion as the water quality in White Lake was significantly degraded during the 50s and early 60s. Excessive algal blooms, high turbidity, and degraded benthic populations were reported for this time period. A trend of increasing water quality was noted in the late 60s. The fact that a peak in chromium deposition is coupled with the absence of ^{210}Pb suggests that the tannery was discharging high levels of metal laden waste materials into White Lake prior to the early 1960s and that organic sedimentation was elevated by primary productivity.

4.2.2 Core WL-7S

Stratigraphy and radiodating results for WL-7S are presented in Table 4.2.2. Profiles of depth and concentration for chromium and lead are shown in Figure 4.2.2. This core was taken at a depth of 21.5 m in the deep basin near Dowies Point (Figure 2.1). The top 11 cm showed an exponential decay pattern for ^{210}Pb while the remainder of the core had variable radioisotope inventories. These data suggest a recent pattern of stable deposition followed by a period of mixing and excess sedimentation from advection within the lake. Since White Lake is a drowned rivermouth, storm events and currents are capable of transporting significant amounts of sediment on an episodic basis. The layer of uniform ^{210}Pb inventories

TABLE 4.2.2 STRATIGRAPHY AND RADIODATING RESULTS FOR CORE WL-7S COLLECTED FROM WHITE LAKE, OCTOBER 2001.

Depth (cm)	Total Chromium mg/kg	Ra-226 Activity (dpm/g)	Cs-137 Activity (dpm/g)	Excess Pb-210 Activity (dpm/g)	Date at Given Depth
3	204	4.047	1.922	30.878	1999
7	242	3.773	2.184	27.848	1996
11	273	3.056	2.244	22.008	1992
15	330	2.947	2.348	16.646	1990
19	470	2.535	2.195	18.633	1983
23	462	3.356	2.828	20.804	1977
27	397	3.531	2.183	12.293	1971
31	702	3.083	3.247	16.398	1966
35	928	3.562	4.015	11.531	1964
39	893	3.018	3.695	13.742	1957
43	1052	3.398	4.611	11.814	1951
47	1230	3.734	3.515	14.954	1947
51	1848	3.404	3.434	13.294	1939
55	1779	3.126	3.877	11.450	1928
59	1418	3.357	4.282	13.387	1918
61	1072	2.639	3.467	9.901	1900

may be due to a combination of mixing and excess deposition by episodic events. The absence of a ^{137}Cs horizon (Figure 4.2.2) also supports the hypothesis of sediment mixing and transport, as the radionuclide profile shows a slightly increasing deposition pattern instead of the classic peak shape found in core WL-2S (Figure 4.2.1). In consideration of the atypical radioisotope at this location, the dates assigned by the constant supply model cannot be considered to be accurate. Chromium deposition patterns (Figure 4.2.2) also show the dates to be inaccurate as the highest levels of chromium were estimated to be deposited prior to the conversion of the tanning process in 1945. Chromium levels were relatively consistent in the top 11 cm and then increased to a maximum of 1848 mg/kg at 51 cm. This region of the core also contained ^{210}Pb inventories that were more representative of exponential decay, indicating stable sediments and a constant supply of chromium. Increasing chromium deposition is evident in the deeper region where the ^{210}Pb is variable. The presence of excess ^{210}Pb throughout this region of the core indicates a continuous influx of sediment and frequent movement out of the location. Based on the increasing and decreasing pattern, it appears that episodic events such as storms act to remove and deposit varying amounts of sediment at this location.

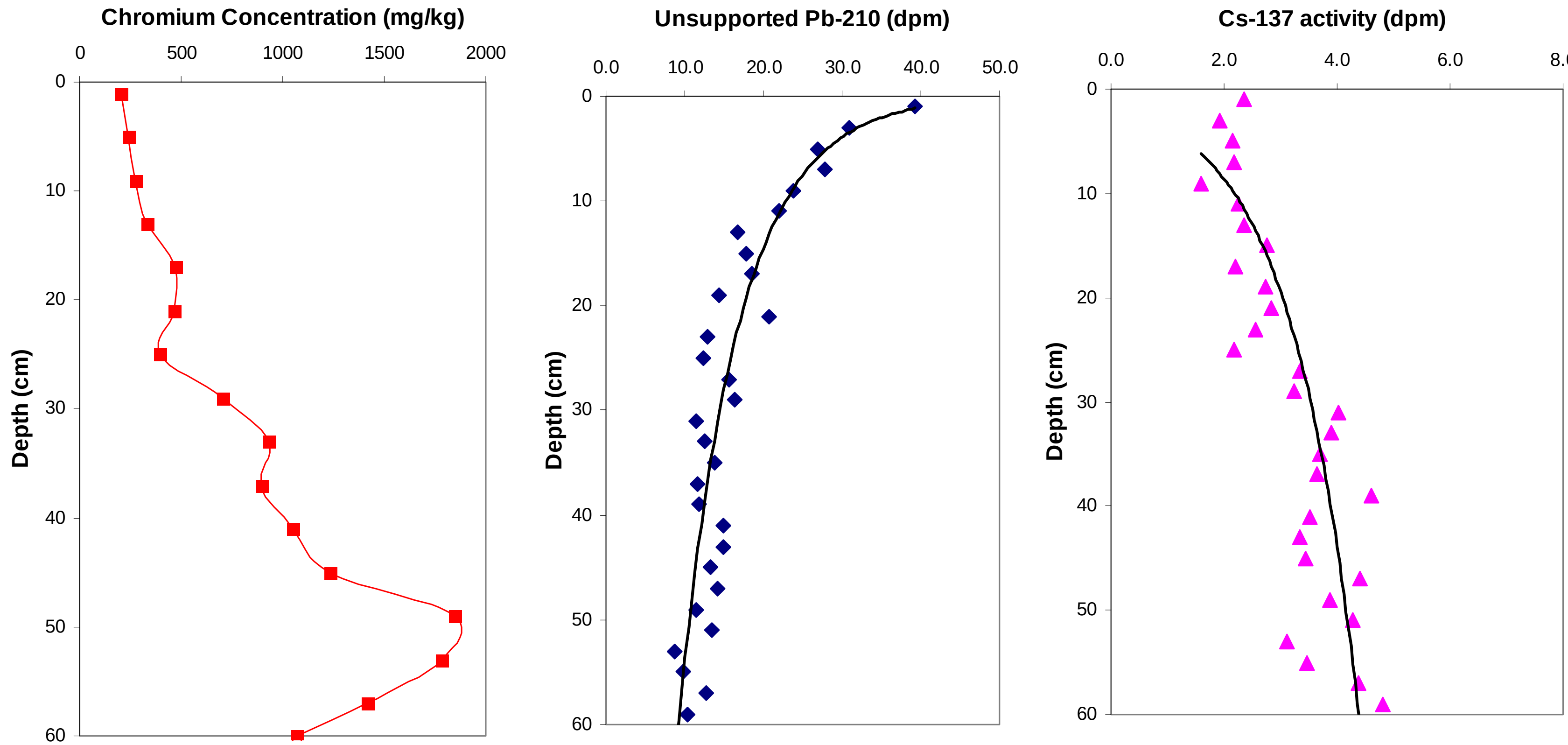


FIGURE 4.2.2 DEPTH AND CONCENTRATION PROFILES FOR CHROMIUM , LEAD-210, AND CESIUM-137 AT STATION WL-7S, WHITE LAKE, OCTOBER 2001.

4.2.3 Core WL-9S

Stratigraphy and radiodating results for WL-9S are presented in Table 4.2.3. Profiles of depth and concentration for chromium and lead are shown in Figure 4.2.3 along with the calculated dates from the ^{210}Pb deposition model. The radiodating results indicate that stable sediments are not accumulating at this location. The accumulation of stable sediments would result in a ^{210}Pb profile that exhibits an exponential decay of the radioisotope (Robbins and Herche 1993) similar to core WL-2S. No exponential decay pattern is visible in core WL-2S (Table 4.2.3). Instead, a mixed layer with uniform ^{210}Pb inventories was observed for the first 15 cm followed by a pattern of sections with increasing and decreasing ^{210}Pb concentrations ranging from ≈ 11 - 19 dpm. The presence of excess ^{210}Pb throughout the core indicates a continuous influx of sediment and frequent movement out of the location. Based on the increasing and decreasing pattern, it appears that episodic events such as storms act to remove varying amounts of sediment from the location. The depositional pattern of chromium also exhibits sporadic changes in concentration indicating the influence of episodic events. The relatively uniform concentrations of chromium noted in the top 11 cm correspond to a mixed sediment layer shown in the ^{210}Pb profile. Chromium concentrations peak at 31 cm and then decline to the base of the core. Station WL-9S is closer to Tannery Bay than the two previous cores and is also located in shallower water (15.2 m).

TABLE 4.2.3 STRATIGRAPHY AND RADIODATING RESULTS FOR CORE WL-9S COLLECTED FROM WHITE LAKE, OCTOBER 2001.

Depth (cm)	Total Chromium mg/kg	Ra-226 Activity (dpm/g)	Cs-137 Activity (dpm/g)	Excess Pb-210 Activity (dpm/g)	Date at Given Depth
3	454	1.797	0.992	24.098	1999
7	464	2.529	1.438	23.798	1996
11	488	2.384	1.992	23.858	1991
15	606	2.359	8.801	20.499	1989
19	643	2.980	5.181	17.389	1984
23	695	2.339	3.576	16.061	1978
27	917	2.612	2.070	14.196	1972
31	1201	2.612	2.055	14.602	1967
35	849	2.090	2.384	15.705	1963
39	778	1.839	2.261	10.988	1958
43	750	2.040	2.239	15.262	1955
47	732	2.205	1.932	12.225	1947
51	678	2.272	1.759	17.246	1932
55	722	3.326	0.851	18.967	1912
59	630	3.093	0.759	19.093	1890

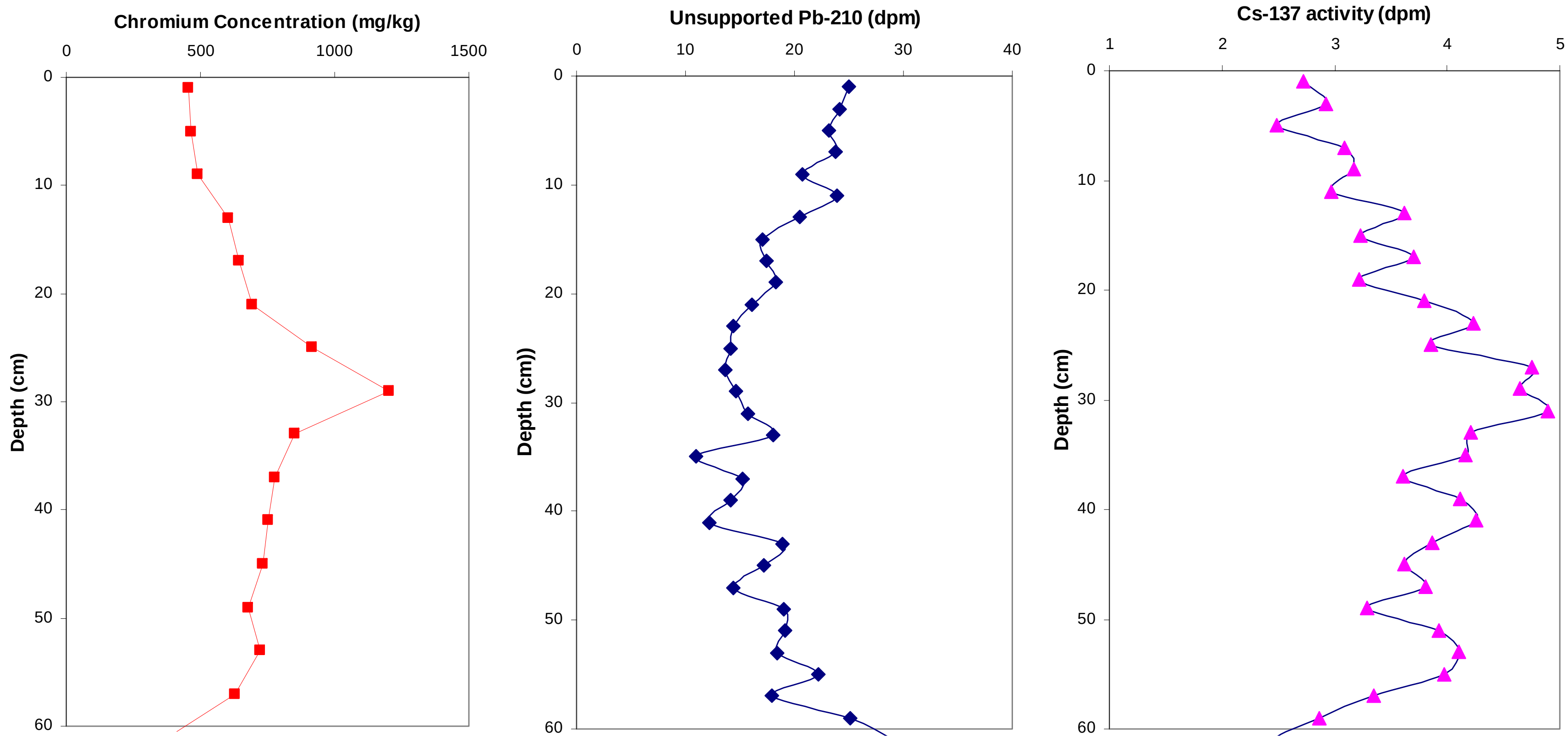


FIGURE 4.2.3 DEPTH AND CONCENTRATION PROFILES FOR CHROMIUM , LEAD-210, AND CESIUM-137 AT STATION WL-9S, WHITE LAKE, OCTOBER 2001.

4.2.4 Stratigraphy and Radiodating Summary

In examining the results of the three stratigraphy cores together, some important patterns in contaminant deposition are evident. All of the cores show uniform levels of chromium deposition in the top 10 - 15 cm. This pattern indicates that a relatively constant source of chromium is currently present in White Lake. These data coupled with the previous investigation (Rediske et al. 1998) suggest that the heavily contaminated sediments near the historic tannery discharge are being transported out of the bay by currents and then deposited throughout the lake. In addition, the lack of a standard exponential decay pattern in the lower sections of the core illustrates that sediments in the open waters of the lake are also mobile and influenced by currents and episodic events. Even when there is evidence of a distinct ^{137}Cs horizon as in WL-2S, the deeper sections of the core still contain atypical ^{210}Pb profiles that suggest mixed sediment layers.

The stratigraphy cores were analyzed by PIXE while the investigative samples were evaluated by ICP. The PIXE method is a form of elemental analysis based on the characteristics of X-rays and the nature of X-ray detection (Johansson et al. 1995). The method uses beams of energetic ions, produced by an accelerator to generate a beam of protons in the 2-5 MeV range, used to create inner electron shell vacancies. As these inner shell vacancies become filled by outer shell electrons, the characteristic X-rays emitted by this cascade effect can be detected by wavelength dispersion. PIXE techniques provide a rapid screening of the samples for metals without sample preparation. The PIXE results represent a total analysis of metals due to the interaction of the proton beam with all metallic forms (Rajander et al. 1999). In contrast, the microwave digestion used for the investigative samples provides data on acid extractable metals. Comparative studies of the two techniques found that acid extractable digestions underestimate chromium concentrations by up to 40% because of the stability of chromite (Ma et al. 1997, Chen and Ma 2001). Total metal digestions involving HF are necessary to dissolve the refractory chromite. In order to compare the results of the stratigraphy cores with the investigative samples, the core from WL-9S was analyzed by PIXE and ICP methods. The results of the comparison study are shown in Table 4.2.4. With respect to White Lake sediments, there appears to be a 21% difference between the two methods (based on grand mean). Since the soils in the White River watershed consist of glacial tills that originated in the Canadian Shield, background levels of chromite can be expected in the core samples. The results also indicate that some of the chromium originating in the tannery waste may be refractory to acid digestion. The results of the top core section from the investigative samples (0-51 cm) are compared to the same depth interval of the stratigraphy cores in Table 4.2.5. When a 21% factor is applied to the PIXE results to account for the difference between total and extractable metals, the results between the methods show good agreement. There appears to be some high bias associated with the stratigraphy results that is probably related to sample collection methods. The investigative samples were collected by VibraCore methods that tend to compress flocculent sediments. It is possible that some of the deeper strata were included in the VibraCore samples. It is also interesting to note that the middle core section of the investigative samples (51-102 cm) had chromium levels that ranged from 34-38 mg/kg (Table 4.1.3). These results suggest that anthropogenic chromium contamination does not extend down into this region of the core.

TABLE 4.2.4 RESULTS OF ICP AND PIXE ANALYSES FOR CHROMIUM IN CORE WL-9S COLLECTED FROM WHITE LAKE, OCTOBER 2001.

Depth (cm)	Chromium (ICP) mg/kg	Chromium (PIXE) mg/kg	% Difference
3	359	454	21
7	427	464	8
11	421	488	14
15	484	606	20
19	496	643	23
23	552	695	21
27	709	917	23
31	870	1200	28
35	678	849	20
39	627	778	19
43	611	750	19
47	540	732	26
51	564	678	17
55	564	712	20
59	359	454	21
Grand Mean	551	695	21

TABLE 4.2.5 AVERAGE AND CORRECTED DATA FOR STRATIGRAPHY CORES (OCTOBER 2001) COMPARED TO THE RESULTS OF THE TOP CORE SECTION FROM THE INVESTIGATIVE SURVEY (OCTOBER 2000) FOR WHITE LAKE SEDIMENTS.

Station	Stratigraphy Core Average Chromium (PIXE) mg/kg	Stratigraphy Core Corrected Average Chromium (PIXE) mg/kg*	Investigative Core Top Section Chromium (ICP) mg/kg**
3	695	549	470
7	869	686	600
11	712	574	500

* Corrected for 21% difference between PIXIE and ICP results
** Top Core Section Results (0-51 cm)

4.3 Toxicity Testing Results

The toxicity evaluations of the White Lake sediments were performed during November 2000. Grab sediment samples collected from 21 different sites were evaluated using the EPA (1994) solid phase testing protocol with *Hyalella azteca* and *Chironomus tentans*. Conductivity, hardness, alkalinity, ammonia, and pH were determined for the culture water at the beginning and on the tenth day of each test (Appendix E: Tables E-1, E-3). With the exception of ammonia in most of the sediments and conductivity and hardness in M10-P, these parameters remained relatively constant. Variations of less than 50% from initial to final measurements for both test species were observed. Based on the initial pH values (all < 8.00) and the fact that the overlying water was exchanged prior to adding the organisms, toxicity related to unionized ammonia was not anticipated to be a factor in these experiments. Temperature and dissolved oxygen measurements were recorded daily throughout the duration of the tests (Appendix E: Tables E-2, E-4). Very little variation was noted with respect to temperature. The dissolved oxygen remained above 40% saturation in all of the test beakers.

4.3.1 *Hyalella azteca*

Survival data for solid phase toxicity tests with *Hyalella azteca* are presented in Table 4.3.1.1. The survival in the control (WL-20P and WL-4P) treatments exceeded the required 80%. In order to group the samples based on depth, WL-20P was used as the control for the shallow locations east of the Narrows and WL-4P was used as the control for the deep stations. Separate statistical analyses also were performed on the two groups of data. Un-transformed survival data were evaluated to determine whether they were consistent with a normal distribution. The Chi-Squared distribution was used to compare the expected count of data values at the 10^{th}, 20^{th}, …, and 90^{th} percentiles with the observed count. The sample data from both groups were found to be consistent with those drawn from a normal population ($p > 0.01$). Dunnett's Test (Table 4.3.1.2) showed a statistically significant ($p < 0.05$) difference for the survival data compared to control site WL-20P in 1 out of 4 shallow stations. Sediments from site WL-16P had significantly reduced survival compared to WL-20P (66% vs 90% respectively). Dunnett's Test (Table 4.3.1.3) showed a statistically significant ($p < 0.05$) difference for the survival data compared to control site WL-4P in 1 out of 9 deep stations. Sediments from site WL-21P had significantly reduced survival compared to WL-4P (65% vs 88% respectively). All of the other deep and shallow locations had greater than 80% survival.

TABLE 4.3.1.1 SUMMARY OF *HYALELLA AZTECA* SURVIVAL DATA OBTAINED DURING THE 10 DAY TOXICITY TEST WITH WHITE LAKE SEDIMENTS. (WL-4 AND WL-20 ARE CONTROLS.)

Sample ID	Number of Organisms	Replicate A	B	C	D	E	F	G	H	Survival Mean	Std Dev	Variance
WL-1	Initial	10	10	10	10	10	10	10	10			
	Final	10	8	9	10	9	8	9	9	9.000	0.7559	0.571
WL-2	Initial	10	10	10	10	10	10	10	10			
	Final	10	10	10	10	9	10	7	10	9.500	1.0690	1.143
WL-3	Initial	10	10	10	10	10	10	10	10			
	Final	9	9	10	9	8	10	9	8	9.000	0.7559	0.571
WL-4	Initial	10	10	10	10	10	10	10	10			
	Final	9	7	9	9	8	10	10	9	8.875	0.9910	0.982
WL-5	Initial	10	10	10	10	10	10	10	10			
	Final	8	9	10	10	10	9	8	8	9.000	0.9258	0.857
WL-6	Initial	10	10	10	10	10	10	10	10			
	Final	8	9	8	10	10	10	7	8	8.750	1.1650	1.357
WL-7	Initial	10	10	10	10	10	10	10	10			
	Final	10	7	9	6	9	9	8	10	8.500	1.4142	2.000
WL-8	Initial	10	10	10	10	10	10	10	10			
	Final	9	9	10	8	7	10	8	8	8.625	1.0607	1.125
WL-9	Initial	10	10	10	10	10	10	10	10			
	Final	8	8	9	8	10	8	9	9	8.625	0.7440	0.554
WL-10	Initial	10	10	10	10	10	10	10	10			
	Final	7	9	8	8	9	8	7	9	8.125	0.8345	0.696
WL-11	Initial	10	10	10	10	10	10	10	10			
	Final	10	10	9	8	7	10	8	9	8.875	1.1260	1.268
WL-12	Initial	10	10	10	10	10	10	10	10			
	Final	8	9	9	9	8	10	9	8	8.750	0.7071	0.500
WL-13	Initial	10	10	10	10	10	10	10	10			
	Final	9	9	8	6	7	9	8	10	8.250	1.2817	1.643
WL-14	Initial	10	10	10	10	10	10	10	10			
	Final	10	9	8	7	10	6	10	7	8.375	1.5980	2.554
WL-15	Initial	10	10	10	10	10	10	10	10			
	Final	8	9	8	6	8	6	9	10	8.000	1.4142	2.000
WL-16	Initial	10	10	10	10	10	10	10	10			
	Final	6	7	6	5	6	8	7	8	6.625	1.0607	1.125
WL-17	Initial	10	10	10	10	10	10	10	10			
	Final	9	8	9	10	8	10	9	8	8.875	0.8345	0.696
WL-18	Initial	10	10	10	10	10	10	10	10			
	Final	9	10	8	9	7	10	9	8	8.750	1.0351	1.071
WL-19	Initial	10	10	10	10	10	10	10	10			
	Final	9	10	8	10	7	9	8	8	8.625	1.0607	1.125
WL-20	Initial	10	10	10	10	10	10	10	10			
	Final	9	10	10	9	8	9	8	9	9.000	0.7559	0.571
WL-21	Initial	10	10	10	10	10	10	10	10			
	Final	7	6	9	6	8	5	6	5	6.500	1.4142	2.000

TABLE 4.3.1.2 SUMMARY OF DUNNETT'S TEST ANALYSIS OF *HYALELLA AZTECA* SURVIVAL DATA OBTAINED DURING THE 10 DAY TOXICITY TEST WITH WHITE LAKE SEDIMENTS FROM SHALLOW STATIONS (< 4.5 M).

ID	MEAN	T STAT	SIG 0.05
WL-20P	9.0000	0.0000	
WL-19P	8.6250	0.7828	
WL-18P	8.7500	0.5219	
WL-17P	8.8750	0.2609	
WL-16P	6.6250	4.9580	*

Dunnett's critical value = 2.2500. 1 Tailed, alpha = 0.05.

TABLE 4.3.1.3 SUMMARY OF DUNNETT'S TEST ANALYSIS OF *HYALELLA AZTECA* SURVIVAL DATA OBTAINED DURING THE 10 DAY TOXICITY TEST WITH WHITE LAKE SEDIMENTS FROM DEEP STATIONS (> 4.5 M).

ID	MEAN	T STAT	SIG 0.05
WL-4P	8.8750	0.0000	
WL-2P	9.5000	-1.1832	
WL-3P	9.0000	-0.2366	
WL-1P	9.0000	-0.2366	
WL-5P	9.0000	-0.2366	
WL-6P	8.7500	0.2366	
WL-7P	8.5000	0.7099	
WL-8P	8.6250	0.4733	
WL-9P	8.6250	0.4733	
WL-21P	6.5000	4.4962	*

Dunnett's critical value = 2.4800. 1 Tailed, alpha = 0.05.

4.3.2 *Chironomus tentans*

Survival data for solid phase toxicity tests with *Chironomus tentans* are presented in Table 4.3.2.1. The survival in the control treatments (WL-4P and WL-20P) exceeded the required 70%. Un-transformed survival data were evaluated as described above with the Chi-Squared distribution. The sample data were found to be consistent with those drawn from a normal population ($p > 0.01$). Dunnett's Test (Table 4.3.2.2) showed a statistically significant ($p < 0.05$) difference for the survival data compared to control site WL-20P in 1 out of 4 shallow stations. Sediments from site WL-16P had significantly reduced survival compared to WL-20P (66% vs 90% respectively). Dunnett's Test (Table 4.3.2.3) showed a statistically significant ($p < 0.05$) difference for the survival data compared to control site WL-4P in 1 out of 9 deep stations. Sediments from site WL-21P had significantly reduced survival compared to WL-4P (65% vs 88% respectively). All of the other deep and shallow locations had greater than 80% survival.

Chironomus tentans growth data are presented in Table 4.3.2.4. Un-transformed growth data were found to be consistent with a Chi-Squared distribution at $p > 0.01$. Dunnett's Test (Table 4.3.2.5) showed a statistically significant ($p < 0.05$) difference for the growth data compared to control site WL-20P in 1 out of 4 shallow stations. Sediments from site WL-16P had significantly reduced growth compared to WL-20P (0.5375 mg/individual vs 1.1522 mg/individual respectively). Dunnett's Test (Table 4.3.2.6) showed a statistically significant ($p < 0.05$) difference for the growth data compared to control site WL-4P in 1 out of 9 deep stations. Sediments from site WL-21P had significantly reduced growth compared to WL-4P (0.6263 mg/individual vs 0.9834 mg/individual respectively). All of the other deep and shallow locations had average individual weights of >0.6 mg.

4.3.3 Sediment Toxicity Data Discussion

Statistically significant ($p < 0.05$) acute toxicity effects were observed in the sediments from sites WL-16 and WL-21 for the amphipod, *H. azteca*. In addition, statistically significant ($p < 0.05$) mortality and growth rates were noted for the midge, *C. tentans* in sediment from the same sites. Sediment from station located in the east bay, WL-16, contained no detectable organic compounds and metals that were above PEC guidelines (MacDonald et al. 2000). The toxic agent(s) present at this location were not identified in the current protocol. Given the high level of toxicity measured in this study and the previous investigation, a more detailed assessment of east bay area is warranted. A Toxicity Identification Evaluation (TIE) protocol needs to be performed to examine the classification of the toxicant. The east bay is located adjacent to the old storage reservoir for the tree bark tanning agent used from 1890-1940. Since tannins are known to be toxic to herbivores including insects (Cowan 1999, Bernays et al. 1989, and Kubanek et al. 2001), it is possible that this class of compounds is responsible for the amphipod and midge mortality. The dark, opaque color of pyrophosphate extract from

TABLE 4.3.2.1 SUMMARY OF *CHIRONOMUS TENTANS* SURVIVAL DATA OBTAINED DURING THE 10 DAY TOXICITY TEST WITH WHITE LAKE SEDIMENTS. (WL-4 AND W-20 ARE CONTROLS.)

Sample	Number of	Replicate								Survival		
ID	Organisms	A	B	C	D	E	F	G	H	Mean	Std Dev	Variance
WL-1	Initial	10	10	10	10	10	10	10	10			
	Final	7	6	8	8	8	9	9	8	7.875	0.9910	0.982
WL-2	Initial	10	10	10	10	10	10	10	10			
	Final	8	7	8	9	8	8	9	8	8.125	0.6409	0.411
WL-3	Initial	10	10	10	10	10	10	10	10			
	Final	8	9	8	7	8	9	8	8	8.125	0.6409	0.411
WL-4	Initial	10	10	10	10	10	10	10	10			
	Final	8	9	8	8	9	8	7	8	8.125	0.6409	0.411
WL-5	Initial	10	10	10	10	10	10	10	10			
	Final	9	8	7	8	9	8	8	7	8.000	0.7559	0.571
WL-6	Initial	10	10	10	10	10	10	10	10			
	Final	6	5	8	9	7	6	8	9	7.250	1.4880	2.214
WL-7	Initial	10	10	10	10	10	10	10	10			
	Final	8	9	7	8	6	7	9	9	7.875	1.1260	1.268
WL-8	Initial	10	10	10	10	10	10	10	10			
	Final	8	7	6	5	9	10	9	8	7.750	1.6690	2.786
WL-9	Initial	10	10	10	10	10	10	10	10			
	Final	8	6	7	6	8	6	9	6	7.000	1.1952	1.429
WL-10	Initial	10	10	10	10	10	10	10	10			
	Final	7	9	8	7	10	7	9	8	8.125	1.1260	1.268
WL-11	Initial	10	10	10	10	10	10	10	10			
	Final	7	8	10	7	11	8	11	7	8.625	1.7678	3.125
WL-12	Initial	10	10	10	10	10	10	10	10			
	Final	7	8	7	5	10	5	8	7	7.125	1.6421	2.696
WL-13	Initial	10	10	10	10	10	10	10	10			
	Final	6	8	5	8	5	7	10	7	7.000	1.6903	2.857
WL-14	Initial	10	10	10	10	10	10	10	10			
	Final	9	12	8	10	10	9	9	9	9.500	1.1952	1.429
WL-15	Initial	10	10	10	10	10	10	10	10			
	Final	10	8	8	8	4	4	8	6	7.000	2.1381	4.571
WL-16	Initial	10	10	10	10	10	10	10	10			
	Final	7	6	5	3	5	5	8	4	5.375	1.5980	2.554
WL-17	Initial	10	10	10	10	10	10	10	10			
	Final	10	8	8	8	7	6	8	7	7.750	1.1650	1.357
WL-18	Initial	10	10	10	10	10	10	10	10			
	Final	8	6	8	6	7	6	8	7	7.000	0.9258	0.857
WL-19	Initial	10	10	10	10	10	10	10	10			
	Final	7	8	7	6	9	9	7	8	7.625	1.0607	1.125
WL-20	Initial	10	10	10	10	10	10	10	10			
	Final	8	8	8	7	9	7	6	8	7.625	0.9161	0.839
WL-21	Initial	10	10	10	10	10	10	10	10			
	Final	6	5	6	5	6	5	7	5	5.625	0.7440	0.554

TABLE 4.3.2.2 SUMMARY OF DUNNETT'S TEST ANALYSIS OF *CHIRONOMUS TENTANS* SURVIVAL DATA OBTAINED DURING THE 10 DAY TOXICITY TEST WITH WHITE LAKE SEDIMENTS FROM SHALLOW STATIONS (<4.5 M).

ID	MEAN	T STAT	SIG 0.05
WL-20P	7.6250	0.0000	
WL-19P	7.6250	0.0000	
WL-18P	7.0000	1.0773	
WL-17P	7.7500	-0.2155	
WL-16P	5.3750	3.8781	*

Dunnett's critical value = 2.2500. 1 Tailed, alpha = 0.05.

TABLE 4.3.2.3 SUMMARY OF DUNNETT'S TEST ANALYSIS OF *CHIRONOMUS TENTANS* SURVIVAL DATA OBTAINED DURING THE 10 DAY TOXICITY TEST WITH WHITE LAKE SEDIMENTS FROM DEEP STATIONS (> 4.5 M).

ID	MEAN	T STAT	SIG 0.05
WL-4P	8.1250	0.0000	
WL-1P	7.8750	0.4585	
WL-2P	8.1250	0.0000	
WL-5P	8.0000	0.2292	
WL-6P	7.2500	1.6047	
WL-7P	7.8750	0.4585	
WL-8P	7.7500	0.6877	
WL-9P	7.0000	2.0632	
WL-10P	8.1250	0.0000	
WL-21P	5.6250	5.6250	*

Dunnett's critical value = 2.4800. 1 Tailed, alpha = 0.05.

TABLE 4.3.2.4 SUMMARY OF *CHIRONOMUS TENTANS* DRY WEIGHT DATA OBTAINED DURING THE 10 DAY TOXICITY TEST WITH WHITE LAKE SEDIMENTS. (WL-4 AND WL-20 ARE CONTROLS.)

Sample	Individual Weight (mg)	Average Individual Weight (mg)	Sample	Individual Weight (mg)	Average Individual Weight (mg)	Sample	Individual Weight (mg)	Average Individual Weight (mg)
WL-1 A	0.9714	1.0020	WL-8 A	1.0875	1.2592	WL-15 A	1.0700	1.3431
WL-1 B	1.2167		WL-8 B	1.4571		WL-15 B	1.1125	
WL-1 C	0.9500		WL-8 C	1.9000		WL-15 C	1.0625	
WL-1 D	0.9875		WL-8 D	1.5800		WL-15 D	1.1875	
WL-1 E	1.0500		WL-8 E	0.9556		WL-15 E	1.5250	
WL-1 F	0.8667		WL-8 F	1.0100		WL-15 F	1.9000	
WL-1 G	0.9111		WL-8 G	1.0333		WL-15 G	1.9875	
WL-1 H	1.0625		WL-8 H	1.0500		WL-15 H	0.9000	
WL-2 A	0.9500	0.9934	WL-9 A	1.0250	1.0069	WL-16 A	0.7857	0.5357
WL-2 B	1.0429		WL-9 B	1.0167		WL-16 B	0.6111	
WL-2 C	1.2000		WL-9 C	0.9429		WL-16 C	0.4625	
WL-2 D	0.8444		WL-9 D	1.2667		WL-16 D	0.3667	
WL-2 E	0.9500		WL-9 E	0.9375		WL-16 E	0.7250	
WL-2 F	1.0125		WL-9 F	1.0000		WL-16 F	0.2600	
WL-2 G	0.8222		WL-9 G	0.8667		WL-16 G	0.7500	
WL-2 H	1.1250		WL-9 H	1.0000		WL-16 H	0.3250	
WL-3 A	1.3750	1.4514	WL-10 A	0.9143	0.9266	WL-17 A	0.7636	1.0071
WL-3 B	1.0667		WL-10 B	0.7333		WL-17 B	1.0125	
WL-3 C	1.0500		WL-10 C	0.9000		WL-17 C	1.0500	
WL-3 D	1.3571		WL-10 D	1.0714		WL-17 D	0.9500	
WL-3 E	1.4000		WL-10 E	0.9900		WL-17 E	1.1429	
WL-3 F	2.1000		WL-10 F	1.0857		WL-17 F	1.1000	
WL-3 G	1.8250		WL-10 G	0.8556		WL-17 G	1.0375	
WL-3 H	1.4375		WL-10 H	0.8625		WL-17 H	1.0000	
WL-4 A	0.8250	0.9834	WL-11 A	0.9714	0.9803	WL-18 A	0.8625	0.9971
WL-4 B	0.8667		WL-11 B	0.9750		WL-18 B	1.0500	
WL-4 C	1.1125		WL-11 C	0.8600		WL-18 C	0.9000	
WL-4 D	0.7750		WL-11 D	0.9143		WL-18 D	1.1500	
WL-4 E	1.1111		WL-11 E	0.9364		WL-18 E	1.0714	
WL-4 F	1.0750		WL-11 F	1.1500		WL-18 F	1.0500	
WL-4 G	1.0143		WL-11 G	0.9636		WL-18 G	0.9500	
WL-4 H	1.0875		WL-11 H	1.0714		WL-18 H	0.9429	
WL-5 A	1.1333	0.9685	WL-12 A	0.9286	0.8900	WL-19 A	1.0857	0.9935
WL-5 B	1.1250		WL-12 B	0.8250		WL-19 B	1.1333	
WL-5 C	1.0857		WL-12 C	0.8714		WL-19 C	0.8857	
WL-5 D	1.0750		WL-12 D	0.9600		WL-19 D	0.9333	
WL-5 E	0.8111		WL-12 E	0.5800		WL-19 E	0.9556	
WL-5 F	0.8125		WL-12 F	1.0600		WL-19 F	0.8111	
WL-5 G	0.7625		WL-12 G	1.0375		WL-19 G	1.0714	
WL-5 H	0.9429		WL-12 H	0.8571		WL-19 H	1.0714	
WL-6 A	1.1833	1.0409	WL-13 A	1.9000	1.1978	WL-20 A	1.1429	1.1522
WL-6 B	0.9200		WL-13 B	1.3750		WL-20 B	0.9875	
WL-6 C	1.1000		WL-13 C	1.3200		WL-20 C	1.1000	
WL-6 D	1.1556		WL-13 D	1.3875		WL-20 D	0.9571	
WL-6 E	1.0571		WL-13 E	0.5400		WL-20 E	1.9667	
WL-6 F	0.8667		WL-13 F	1.1857		WL-20 F	0.7714	
WL-6 G	1.1000		WL-13 G	0.9600		WL-20 G	1.1667	
WL-6 H	0.9444		WL-13 H	0.9143		WL-20 H	1.1250	
WL-7 A	1.3000	1.0900	WL-14 A	1.1111	1.0124	WL-21 A	0.7000	0.6263
WL-7 B	0.9222		WL-14 B	0.8083		WL-21 B	0.5000	
WL-7 C	1.2000		WL-14 C	0.9750		WL-21 C	0.6000	
WL-7 D	0.9125		WL-14 D	0.9600		WL-21 D	0.6600	
WL-7 E	1.2833		WL-14 E	1.0000		WL-21 E	0.6333	
WL-7 F	1.1571		WL-14 F	0.9667		WL-21 F	0.6800	
WL-7 G	0.9778		WL-14 G	1.1333		WL-21 G	0.6571	
WL-7 H	0.9667		WL-14 H	1.1444		WL-21 H	0.5800	

TABLE 4.3.2.5 SUMMARY OF DUNNETT'S TEST ANALYSIS OF *CHIRONOMUS TENTANS* GROWTH DATA OBTAINED DURING THE 10 DAY TOXICITY TEST WITH WHITE LAKE SEDIMENTS FROM SHALLOW STATIONS (<4.5 M).

ID	MEAN	T STAT	SIG 0.05
WL-20P	1.1522	0.0000	
WL-19P	0.9935	1.6051	
WL-18P	0.9971	1.4816	
WL-17P	1.0071	1.4816	
WL-16P	0.5357	6.1733	*

Dunnett's critical value = 2.2500. 1 Tailed, alpha = 0.05.

TABLE 4.3.2.6 SUMMARY OF DUNNETT'S TEST ANALYSIS OF *CHIRONOMUS TENTANS* GROWTH DATA OBTAINED DURING THE 10 DAY TOXICITY TEST WITH WHITE LAKE SEDIMENTS FROM DEEP STATIONS (> 4.5 M).

ID	MEAN	T STAT	SIG 0.05
WL-4P	0.9834	0.0000	
WL-2P	0.9934	-0.2551	
WL-3P	1.4514	-4.7197	
WL-1P	1.0020	0.2551	
WL-5P	0.9685	-0.6378	
WL-6P	1.0409	-1.1480	
WL-7P	1.0900	-2.9339	
WL-8P	1.2592	-0.1276	
WL-9P	1.0069	0.5102	
WL-21P	0.6263	3.5717	*

Dunnett's critical value = 2.4800. 1 Tailed, alpha = 0.05.

WL-16 provides indirect evidence of the presence of high levels of tannins due to their solubility in alkaline conditions. The toxicity observed at WL-21 was most likely due to the presence of PCBs (22 mg/kg) and/or chlorinated hydrocarbons. This area was dredged in 2003 and further toxicity evaluations are not necessary.

No correlation was found between amphipod toxicity and chromium concentrations in Tannery Bay sediments in the previous investigation (Rediske et al. 1998). Table 4.3.3.1

contains the 1996 data for total chromium and amphipod toxicity plus the recently measured values of organic chromium. The correlation results for amphipod toxicity and total chromium and organic chromium are displayed in Figures 4.3.3.1 and 4.3.3.2, respectively. The results clearly show that a significant correlation exists between organic chromium and

TABLE 4.3.3.1 SUMMARY OF RESULTS OF TOTAL CHROMIUM, ORGANIC CHROMIUM, AND AMPHIPOD SURVIVAL FOR WHITE LAKE SEDIMENTS (REDISKE ET AL. 1998). (ORGANIC CHROMIUM ANALYSIS PERFORMED ON ARCHIVED SEDIMENT FROM 1996.)

Station	Total Cr (mg/kg)	% Survival *H. azteca*	Organic Cr (mg/kg)
E-1	35	84	160
I-1	212	9	120
I-2	259	1	380
I-3	934	20	40
I-4	1890	53	110
I-5	4100	9	155
I-6	2650	60	33
I-7	2560	41	58
I-8	515	23	27

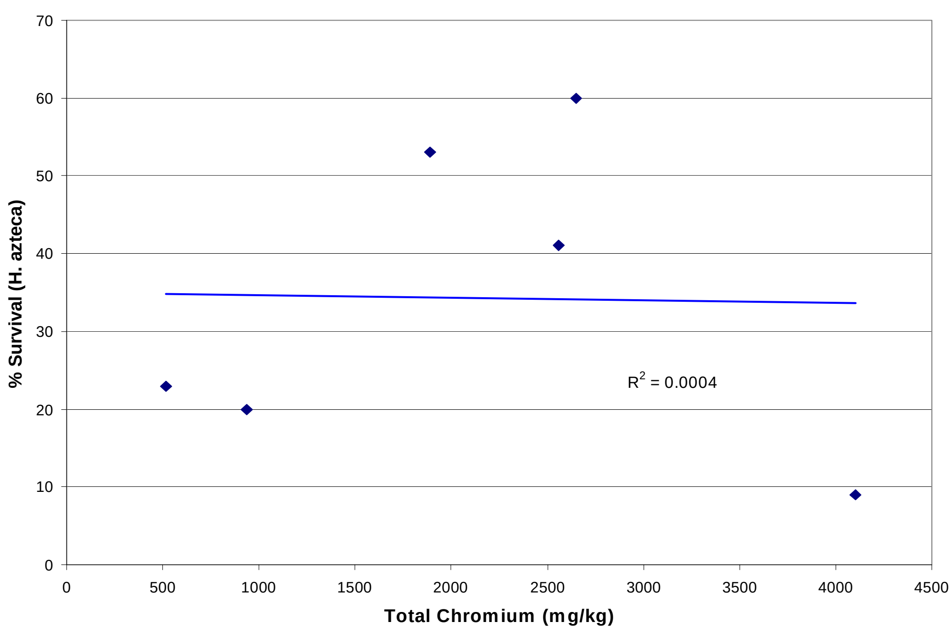


FIGURE 4.3.3.1 RELATIONSHIP BETWEEN TOTAL CHROMIUM AND AMPHIPOD SURVIVAL FOR TANNERY BAY SEDIMENTS (REDISKE ET AL. 1998).

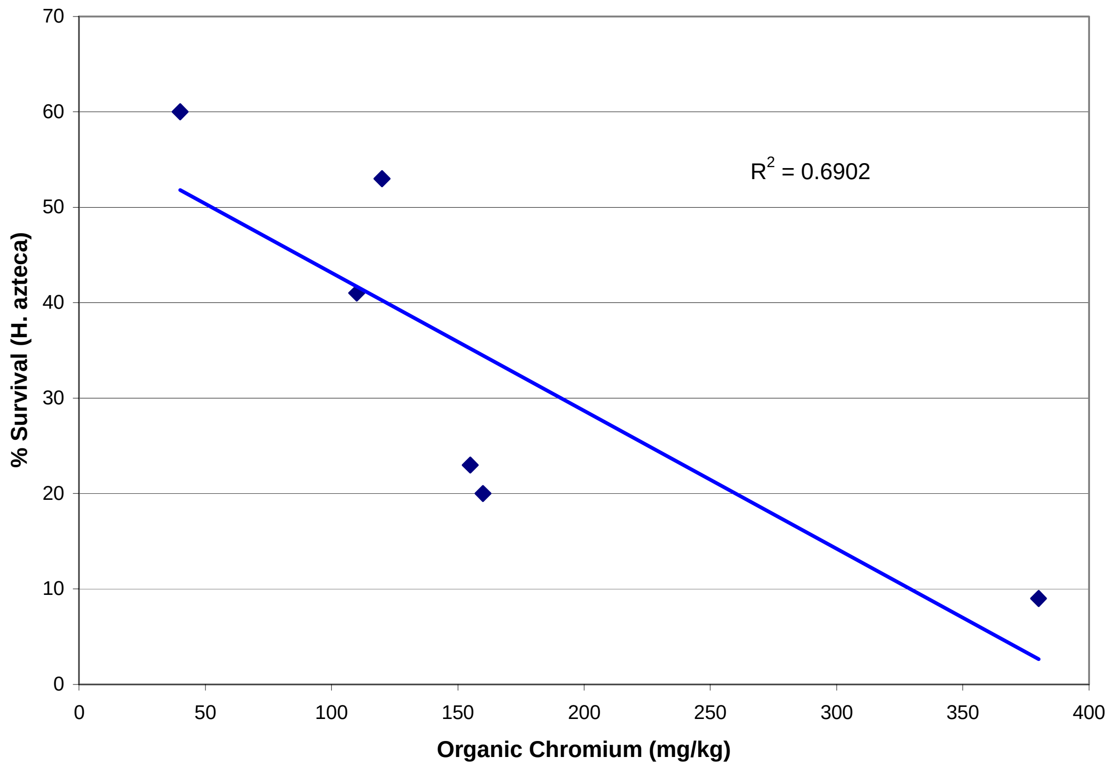


FIGURE 4.3.3.2 RELATIONSHIP BETWEEN ORGANIC CHROMIUM AND AMPHIPOD SURVIVAL FOR TANNERY BAY SEDIMENTS (REDISKE ET AL. 1998). (ORGANIC CHROMIUM ANALYSIS PERFORMED ON ARCHIVED SEDIMENT FROM 1996.)

amphipod toxicity (r^2=0.6902). No correlation was observed for total chromium and amphipod toxicity. Chromium (III) is anticipated to be the only form of the metal present in the sediments of White Lake due to their reducing nature (ENVCA 1994). While trivalent chromium compounds have low membrane permeabilities (Eisler 1986), organically bound metals exhibit increased absorption (Barnhart 1997). Once in the cell, chromium (III) has been shown to bind with DNA and induce conformational changes in bio molecules (Snow 1994). In consideration of these chemical properties and the correlation with amphipod mortality, it is possible that the organic chromium fraction in the sediments of Tannery Bay is responsible for the observed toxicity. More research would be required to link cause and effect with the organic chromium fraction. The presence of the decomposing animal hides in Tannery Bay may contribute a form of organic chromium that is more toxic than the material found in the remainder of the lake.

4.4 Benthic Macroinvertebrate Results

Triplicate PONAR grab samples were used to characterize the benthic macroinvertebrate populations at each of the investigative stations. The locations, depths, and physical characteristics of the sediments are given in Table 2.2. Benthic macroinvertebrate populations were assessed by three methods. These data were first analyzed for differences in taxa and total number of organisms and the results summarized in Section 4.4.1. A further analysis of these data using trophic indices and diversity metrics was then conducted and presented in Section 4.4.2. Finally, the community composition on an organismal level was statistically analyzed in Section 4.4.3 to determine if differences in community composition were associated with contaminant concentration and distribution.

4.4.1 Benthic Macroinvertebrate Results Of Individual Samples

The population composition and abundance data are summarized in Table 4.4.1.1 by mean and standard deviation for each station. The results for each replicate are presented in Appendix F, Table F-1. The general distribution of organisms is shown in Figure 4.4.1.1. Tubificids dominated the benthic macroinvertebrate assemblages at most stations. Nematodes were the dominant taxon at WL-12, WL-9, and WL-14. Chironomids also were abundant at most stations. Benthic populations show an increase in both total numbers and species compared to the historic data reported by Evans (1992) for the 1980s. A summary of total organisms and taxometric groups is presented in Table 4.4.1.2. Total density was generally high and ranged between 2,297/m^2 and 34,405/m^2 with 15 of 21 sites having >4000 organisms/m^2. Tubificidae were the most abundant group at all but three of the sites sampled, comprising between 1,880/m^2 and 30,171/m^2. Fifteen of the locations had tubificid populations that accounted for 75% of the total organisms. Four species, *Aulodrilus limnobius, Aulodrilus pigueti, Limnodrilus hoffmeisteri*, and *Ilyodrilus templetoni* were found at most sites (Table 4.4.1). One of the more pollution tolerant species, *L. hoffmeisteri*, was found at all sites and was the dominant tubificid taxon. Howmiller and Scott (1977) and Milbrink (1983) classified benthic macroinvertebrate assemblages dominated by these species as enriched with organic (nutrient) materials. Sites with the highest chromium levels (WL-9, WL-12, and WL-14) had lower tubificid densities (45%, 23%, and 37% respectively). WL-20, the control station, was also characterized by a lower percentage of these organisms (31%) and a slightly larger abundance of amphipods (35%). The shallow depth and presence of macrophytes at this station provided an environment more conducive to the growth of amphipods.

Nematoda were the second most abundant group in White Lake with densities that ranged from 0/m^2 to 7,780/ m^2 (Table 4.4.1.2). Stations WL-9, WL-12, and WL-14 had nematode densities of 47%, 72%, and 55% of the total population, respectively, and the organisms were found in greater abundance than tubificids. This taxon was not found in significant quantities in the shallow stations (WL-16 - WL20) and several of the deeper locations (WL-2, WL-3, WL-4, and WL-7). Nematodes are generally considered part of the microbenthos,

TABLE 4.4.1.1 BENTHIC MACROINVERTEBRATE DISTRIBUTION IN WHITE LAKE ($\#/M^2$), OCTOBER 2000. MEAN NUMBER OF ORGANISMS AND STANDARD DEVIATION REPORTED FOR EACH STATION.

Taxa	WL-1		WL-2		WL-3		WL-4		WL-5		WL-6		WL-7	
	$\#/m^2$	STDEV	$\#/m^2$	STDEV	$\#/m^2$	STDEV	$\#/m^2$	STDEV	$\#/m^2$	STDEV	$\#/m^2$	STDEV	$\#/m^2$	STDEV
Amphipoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gammarus	0	0	14	21	14	21	43	38	0	0	14	25	29	25
Hyallela	0	0	14	21	0	0	0	0	0	0	0	0	0	0
Isopoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mollusca	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gastropoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Amnicola	14	21	43	41	72	81	29	25	57	99	57	36	43	41
Physa	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Valvata tricarinata	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Viviparous	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bivalvia	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dreissena polymorpha	0	0	0	0	14	21	129	107	29	50	0	0	144	128
Pisidium	57	61	100	71	129	75	115	64	43	23	14	21	29	25
Sphaerium	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tubificidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aulodrilus limnobius	0	0	93	25	43	49	132	55	646	52	733	157	21	79
Aulodrilus pigueti	0	0	0	0	32	41	220	100	0	0	183	85	4	50
Ilyodrilus templetoni	703	55	926	128	54	124	265	183	517	36	504	235	4	50
Limnodrilus hoffmeisteri	2612	1668	2340	1647	1521	1182	569	895	6028	3908	2612	1880	1234	1109
Limnodrilus claparianus	0	0	0	0	0	0	178	120	0	0	0	0	0	0
Quistrodrillus	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Naididae	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Haemonais waldvogeli	0	0	0	0	0	0	14	21	0	0	0	0	0	0
Hirundinea - Glossiphoniidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helobdella	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nematoda	502	354	14	25	14	21	0	0	646	434	646	351	0	0
Tricladida	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Planaridae	0	0	0	0	0	0	0	0	0	0	14	21	0	0
Diptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chaoboridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chaoborus punctipennis	1292	745	2497	1422	1565	843	761	537	445	243	1077	597	330	229
Ceratapogonidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chironomidae	43	75	129	114	0	0	0	0	129	75	230	163	0	0
Ablabesmyia	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chironomus	57	35	646	366	72	60	29	25	330	192	1435	883	43	41
Clinotanypus	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coelotanypus	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cryptochironomus	0	0	0	0	0	0	0	0	0	0	14	21	14	25
Dicrotendipes	43	75	100	101	0	0	14	21	0	0	43	75	0	0
Heterotrissocladius	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paraphaenocladius	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paratendipes	0	0	0	0	14	21	0	0	0	0	14	21	0	0
Phaenopsectra	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polypedilum	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Procladius	0	0	14	25	0	0	57	36	86	70	29	43	14	25
Pseudochironomus	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tanypus	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ephemeroptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caenis	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ephemera	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hexagenia	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isonychia	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trichoptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polycentroapodidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pseudostenophylax	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Megaloptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sialis	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydracarina	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Odonata - Zygoptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 4.4.1.1 (CONTINUED) BENTHIC MACROINVERTEBRATE DISTRIBUTION IN WHITE LAKE (#/M^2), OCTOBER 2000. MEAN NUMBER OF ORGANISMS AND STANDARD DEVIATION REPORTED FOR EACH STATION.

Taxa	WL-8		WL-9		WL-10		WL-11		WL-12		WL-13		WL-14		WL-15	
	#/m^2	STDEV	#/m^2	STDEV	#/m^2	STDEV	#/m^2	STDEV	#/m^2	STDEV	#/m^2	STDEV	#/m^2	STDEV	#/m^2	STDEV
Amphipoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gammarus	0	0	29	25	29	43	14	25	0	0	43	23	57	85	14	21
Hyallela	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isopoda	0	0	0	0	0	0	0	0	0	0	0	0	14	21	0	0
Mollusca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gastropoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Amnicola	115	120	43	41	29	43	14	21	57	61	129	69	43	38	172	110
Physa	0	0	0	0	0	0	0	0	14	25	0	0	0	0	0	0
Valvata tricarinata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Viviparous	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bivalvia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dreissena polymorpha	0	0	86	101	43	41	0	0	43	64	29	43	72	74	57	35
Pisidium	57	85	100	101	86	70	0	0	0	0	0	0	0	0	0	0
Sphaerium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tubificidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aulodrilus limnobius	660	55	785	87	0	0	298	60	215	25	1837	742	0	0	514	156
Aulodrilus pigueti	110	21	0	0	112	49	119	25	0	0	0	0	0	0	73	21
Ilyodrilus templetoni	220	43	349	35	419	119	1491	536	431	150	0	0	675	321	73	25
Limnodrilus hoffmeisteri	3746	2541	1270	1363	1409	748	6967	1432	1421	675	2110	1247	2770	932	1852	760
Limnodrilus claparianus	0	0	423	88	328	148	0	0	0	0	0	0	0	0	0	0
Quistrodrillus	0	0	0	0	0	0	683	81	0	0	0	0	0	0	0	0
Naididae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Haemonais waldvogeli	0	0	0	0	14	21	14	21	0	0	0	0	0	0	0	0
Hirundinea - Glossiphoniidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helobdella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nematoda	1177	705	3804	2569	172	163	1277	697	7780	4390	574	440	5698	3620	617	592
Tricladida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Planaridae	0	0	0	0	0	0	0	0	0	0	0	0	14	21	0	0
Diptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chaoboridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chaoborus punctipennis	201	129	158	126	1077	598	416	242	129	76	201	139	0	0	0	0
Ceratapogonidae	14	21	0	0	0	0	0	0	14	21	0	0	14	21	43	41
Chironomidae	72	64	0	0	0	0	301	172	43	41	72	52	72	60	115	77
Ablabesmyia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chironomus	215	130	230	153	115	120	904	490	172	143	144	104	273	162	359	381
Clinotanypus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coelotanypus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43	38
Cryptochironomus	14	21	0	0	0	0	0	0	0	0	0	0	57	49	72	52
Dicrotendipes	0	0	0	0	0	0	29	25	0	0	0	0	0	0	0	0
Heterotrissocladius	14	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paraphaenocladius	0	0	0	0	0	0	0	0	0	0	0	0	14	25	0	0
Paratendipes	0	0	14	21	0	0	0	0	0	0	0	0	0	0	0	0
Phaenopsectra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polypedilum	14	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Procladius	115	107	144	89	29	25	0	0	115	105	115	89	158	97	172	130
Pseudochironomus	0	0	0	0	14	21	0	0	0	0	0	0	0	0	0	0
Tanypus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ephemeroptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caenis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ephemera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hexagenia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isonychia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trichoptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polycentroapodidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pseudostenophylax	0	0	14	21	0	0	0	0	0	0	0	0	0	0	0	0
Megaloptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sialis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydracarina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Odonata - Zygoptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 4.4.1.1 (CONTINUED) BENTHIC MACROINVERTEBRATE DISTRIBUTION IN WHITE LAKE (#/M^2), OCTOBER 2000. MEAN NUMBER OF ORGANISMS AND STANDARD DEVIATION REPORTED FOR EACH STATION.

Taxa	WL-16		WL-17		WL-18		WL-19		WL-20		WL-21		WL-21 Dup	
	#/m^2	STDEV	#/m^2	STDEV	#/m^2	STDEV	#/m^2	STDEV	#/m^2	STDEV	#/m^2	STDEV	#/m^2	STDEV
Amphipoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gammarus	29	25	57	36	43	23	43	41	2483	2312	100	88	244	132
Hyallela	0	0	0	0	0	0	0	0	230	290	0	0	0	0
Isopoda	0	0	0	0	0	0	0	0	100	101	0	0	0	0
Mollusca	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gastropoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Amnicola	43	38	72	42	14	25	57	49	144	142	86	74	43	41
Physa	0	0	29	43	0	0	0	0	14	25	0	0	0	0
Valvata tricarinata	0	0	0	0	0	0	0	0	14	21	0	0	0	0
Viviparous	0	0	0	0	14	25	0	0	0	0	0	0	0	0
Bivalvia	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dreissena polymorpha	244	226	72	81	86	82	0	0	201	247	43	38	14	25
Pisidium	0	0	43	41	0	0	0	0	0	0	144	99	100	88
Sphaerium	0	0	0	0	0	0	0	0	0	0	0	0	14	25
Annelida	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tubificidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aulodrilus limnobius	0	0	0	0	0	0	0	0	0	0	3986	1154	772	292
Aulodrilus pigueti	0	0	2411	83	115	0	165	0	0	0	996	281	114	45
Ilyodrilus templetoni	890	25	0	0	115	0	165	0	215	149	5381	1223	772	406
Limnodrilus hoffmeisteri	2225	110	1716	174	1306	0	1837	56	1521	136	18444	9279	5177	2644
Limnodrilus claparianus	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Quistrodrillus	0	0	322	64	0	0	0	0	0	0	0	0	0	0
Naididae	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Haemonais waldvogeli	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hirundinea - Glossiphoniidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helobdella	0	0	0	0	0	0	0	0	14	25	14	21	0	0
Nematoda	14	21	0	0	14	21	14	21	0	0	2268	1337	330	309
Tricladida	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Planaridae	29	43	0	0	0	0	0	0	431	590	0	0	0	0
Diptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chaoboridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chaoborus punctipennis	0	0	0	0	0	0	0	0	0	0	976	594	488	483
Ceratapogonidae	14	25	0	0	14	21	0	0	115	98	0	0	0	0
Chironomidae	86	81	0	0	187	137	172	230	560	422	258	281	187	161
Ablabesmyia	0	0	0	0	0	0	29	23	0	0	0	0	0	0
Chironomus	115	64	29	23	43	64	43	38	86	76	976	691	646	362
Clinotanypus	0	0	0	0	0	0	57	49	0	0	0	0	0	0
Coelotanypus	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cryptochironomus	0	0	144	123	0	0	129	76	57	56	14	25	14	21
Dicrotendipes	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heterotrissocladius	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paraphaenocladius	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paratendipes	0	0	0	0	0	0	0	0	0	0	0	0	14	21
Phaenopsectra	0	0	0	0	0	0	0	0	14	21	14	21	0	0
Polypedilum	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Procladius	57	60	43	41	57	85	57	60	301	164	316	192	244	136
Pseudochironomus	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tanypus	0	0	29	43	0	0	0	0	0	0	0	0	0	0
Ephemeroptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caenis	0	0	0	0	0	0	0	0	14	21	0	0	0	0
Ephemera	0	0	0	0	0	0	0	0	14	25	0	0	0	0
Hexagenia	0	0	0	0	29	23	29	43	129	129	0	0	0	0
Isonychia	0	0	0	0	0	0	0	0	14	25	0	0	0	0
Trichoptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polycentroapodidae	0	0	0	0	0	0	0	0	14	25	0	0	0	0
Pseudostenophylax	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Megaloptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sialis	14	25	0	0	0	0	0	0	0	0	0	0	0	0
Hydracarina	0	0	0	0	0	0	0	0	14	25	0	0	0	0
Odonata - Zygoptera	0	0	0	0	0	0	0	0	57	99	0	0	0	0

TABLE 4.4.1.2 MEAN ABUNDANCE (#/M^2) AND RELATIVE DENSITIES (%) OF MAJOR TAXONOMIC GROUPS IN WHITE LAKE, OCTOBER 2000.

Station	N	Tuberficidae	(%)	Nematoda	(%)	Chironomidae	(%)	Amphipoda	(%)	Other
WL-1	4521	3804	84	502	11	144	3	0	0	72
WL-2	4880	3804	78	14	0	890	18	14	0	158
WL-3	2713	2383	88	14	1	86	3	14	1	215
WL-4	2612	2182	84	0	0	100	4	43	2	287
WL-5	9287	7966	86	646	7	545	6	0	0	129
WL-6	7378	4866	66	646	9	1765	24	14	0	86
WL-7	2297	1981	86	0	0	72	3	29	1	215
WL-8	7119	5311	75	1177	17	445	6	0	0	187
WL-9	8067	3603	45	3804	47	388	5	29	0	244
WL-10	3660	3129	85	172	5	158	4	29	1	172
WL-11	12947	10392	80	1277	10	1234	10	14	0	29
WL-12	10736	2497	23	7780	72	330	3	0	0	129
WL-13	5569	4464	80	574	10	330	6	43	1	158
WL-14	10277	3804	37	5698	55	574	6	57	1	144
WL-15	4981	3316	67	617	12	761	15	14	0	273
WL-21	34405	30171	88	2268	7	1579	5	100	0	287
WL-16	4177	3531	85	14	0	258	6	29	1	344
WL-17	4196	3679	88	0	0	244	6	57	1	215
WL-18	2383	1880	79	14	1	287	12	43	2	158
WL-19	3172	2541	80	14	1	488	15	43	1	86
WL-20	7162	2253	31	0	0	1019	14	2483	35	1407

however it is evident that larger forms were retained by the screen during elutriation. Very little information is available on the pollution tolerance of these organisms.

Densities of Chironomidae ranged between 72/m^2 and 1,765/m^2 and this taxa group was the third most abundant group at 8 of 21 of the stations sampled (Table 4.4.1.2). A total of 15 taxa were identified (Table 4.4.1.1). *Chironomus* spp. was found at all sites and *Procladius* spp. was present at 18 of the 21 stations. Abundance of *Chironomus* spp. ranged from 29/m^2 to 1,435/m^2 and was generally the most common chironomid encountered. *Procladius* spp. abundance was low and did not exceed 301/m^2. With the exception of *Dicrotendipes* spp. and *Cryptochironomus* spp., the remaining species were found infrequently and were generally low in abundance. Organisms from these two genera are predatory in nature and do not exclusively feed on organic detritus like *Chironomus* spp. (Berg 1995). Sites with the highest levels of heavy metals (M-5, M-6, and M-7) had chironomid populations dominated by this organism, which may suggest an impact from contaminated sediments. *Chironomus* was the most abundant midge genus in the enriched stations with the highest oligochaete densities.

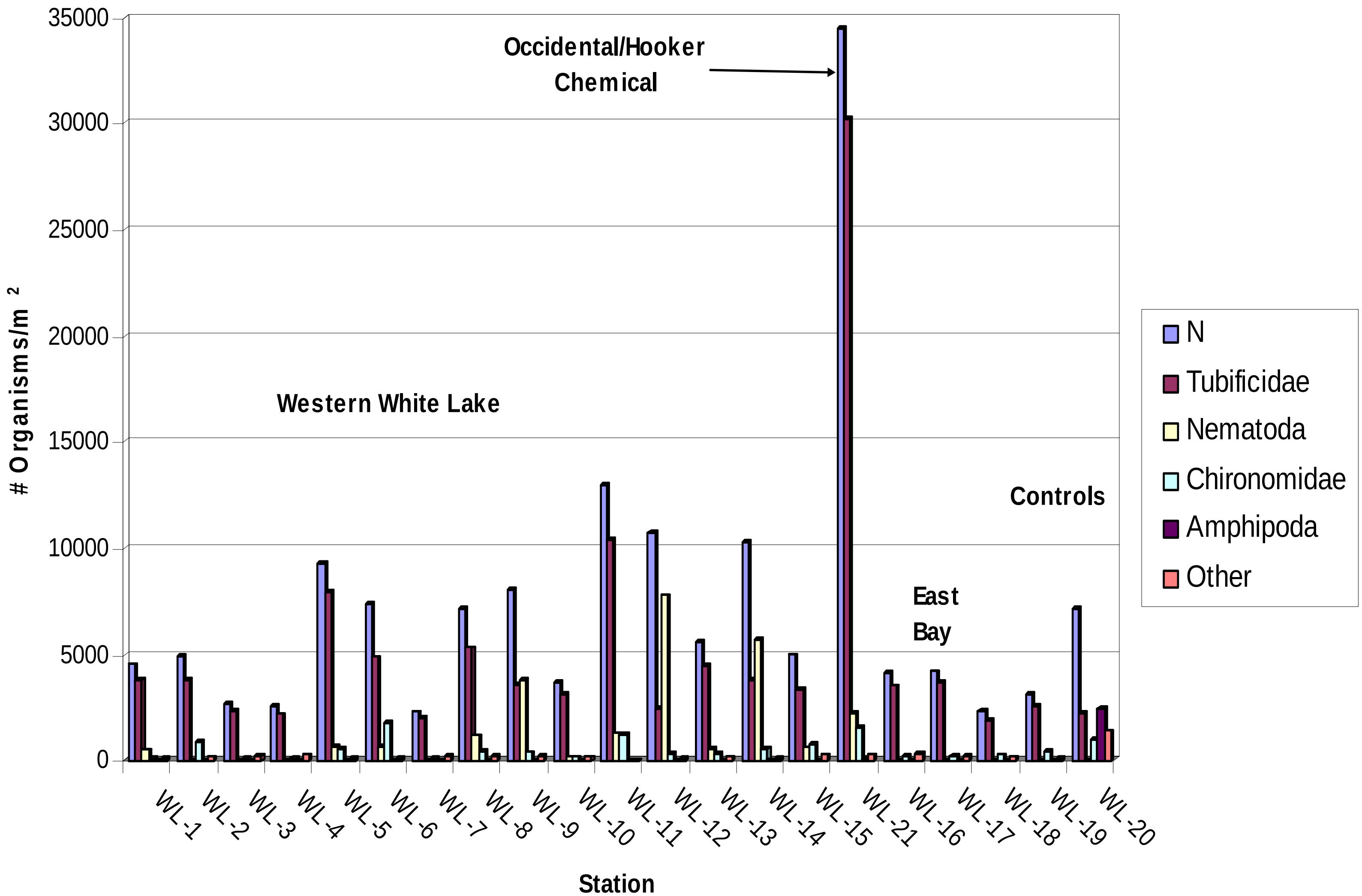


Figure 4.4.1.1 General Distribution of Benthic Macroinvertebrates in White Lake, October 2000.

Station WL-20 was very different than the other stations with respect to macroinvertebrate composition as amphipods were the dominant genera (35%) along with four mayfly taxa plus odonata and trichoptera species. The latter three groups were not present in the other shallow stations. WL-20 was located in closest proximity to the mouth of the White River and away from the marinas. The absence of both physical and chemical anthropogenic disturbance at this station influenced the quality of the macroinvertebrate population at this location.

4.4.2 Analysis of Macroinvertebrate Results Using Trophic Indices and Diversity Metrics

The benthic macroinvertebrate data were analyzed by a variety of trophic status indices and diversity metrics. The following indices and metrics were utilized:

- Shannon Weaver Diversity (Krebs 1989)
- Margalef's Richness (Krebs 1989)
- Evenness (Krebs 1989)
- Pielou's J (Krebs 1989)
- Oligochaete Index (Howmiller and Scott 1977, Hilsenhoff 1987)
- Chironomid Index (Hilsenhoff 1987)
- Oligochaete + Chironomid Index (*)
- Trophic Index (Hilsenhoff 1987)

* Modified from Howmiller and Scott (1977)

Tolerance values used to calculate the Trophic Index and the individual indices for Chironomids and Oligochaetes were taken from Winnell and White (1985), Lauritsen et al. (1985), Hilsenhoff (1987), Schloesser et al. (1995), and Barbour et al. (1999). The results of the population metrics are summarized in Table 4.4.2.1. Summaries of Trophic Indices for the benthic populations are shown in Figure 4.4.2.1. Shallow stations WL-20 and WL-17 had the most favorable trophic index scores for overall community structure (Hilsenhoff) and chironomids. All of the other shallow stations and the deep stations exhibited high scores for the Hilsenhoff index, indicating enriched conditions. Chironomid index values for the shallow stations WL-18, WL-19, and WL-20 were all <7.5. Deep stations had higher chironomid index values that were again representative of organic enrichment. It is interesting to note that the stations WL-4 and WL-20 had similar Shannon-Weaver scores, indicating a more balanced community structure (~2.1). Shannon-Weaver scores for the other stations ranged from 0.8-1.5, indicating a more limited diversity. The increased diversity at WL-4 appears to be related to the lower TOC and increased sand fraction.

TABLE 4.4.2.1 SUMMARY OF DIVERSITY AND TROPHIC STATUS METRICS FOR THE BENTHIC MACROINVERTEBRATES IN WHITE LAKE, OCTOBER 2000.

Station	N	Hilsenhoff Index	Oligochaete Index	Chironomid Index	Shannon-Weaver	Margalef's Richness	Evenness	J	Taxa Richness
WL-1	4521	9.573	9.715	7.860	0.808	0.734	0.321	0.415	7
WL-2	4880	9.282	9.563	8.819	1.402	1.191	0.370	0.585	11
WL-3	2713	9.153	9.567	9.333	0.976	1.187	0.265	0.424	10
WL-4	2612	8.162	8.426	8.943	2.100	1.602	0.628	0.819	13
WL-5	9287	9.258	9.358	8.653	0.923	0.892	0.280	0.420	9
WL-6	7378	8.723	8.682	9.034	1.588	1.497	0.350	0.602	14
WL-7	2297	9.231	9.707	8.960	0.925	1.358	0.229	0.386	11
WL-8	7119	8.859	9.022	8.506	1.182	1.397	0.251	0.461	13
WL-9	8067	8.388	8.444	9.319	1.833	1.349	0.521	0.738	12
WL-10	3660	9.201	9.446	9.073	1.542	1.397	0.390	0.621	12
WL-11	12947	9.431	9.545	8.670	1.229	1.076	0.311	0.512	11
WL-12	10736	9.051	9.238	8.922	1.442	1.149	0.423	0.626	10
WL-13	5569	7.616	7.659	8.609	1.170	0.833	0.403	0.563	8
WL-14	10277	9.377	9.722	8.610	1.248	1.437	0.268	0.487	13
WL-15	4981	8.406	8.699	8.483	1.689	1.467	0.416	0.658	13
WL-21	34405	8.869	8.912	8.844	1.264	1.258	0.253	0.479	14
WL-16	4177	9.303	9.686	8.267	1.255	1.215	0.319	0.523	11
WL-17	4196	7.049	7.051	8.012	1.343	1.293	0.319	0.541	12
WL-18	2383	8.758	9.388	7.140	1.393	1.445	0.336	0.561	12
WL-19	3172	8.757	9.381	7.059	1.387	1.387	0.334	0.558	12
WL-20	7162	6.413	9.750	7.262	2.086	2.495	0.350	0.665	23

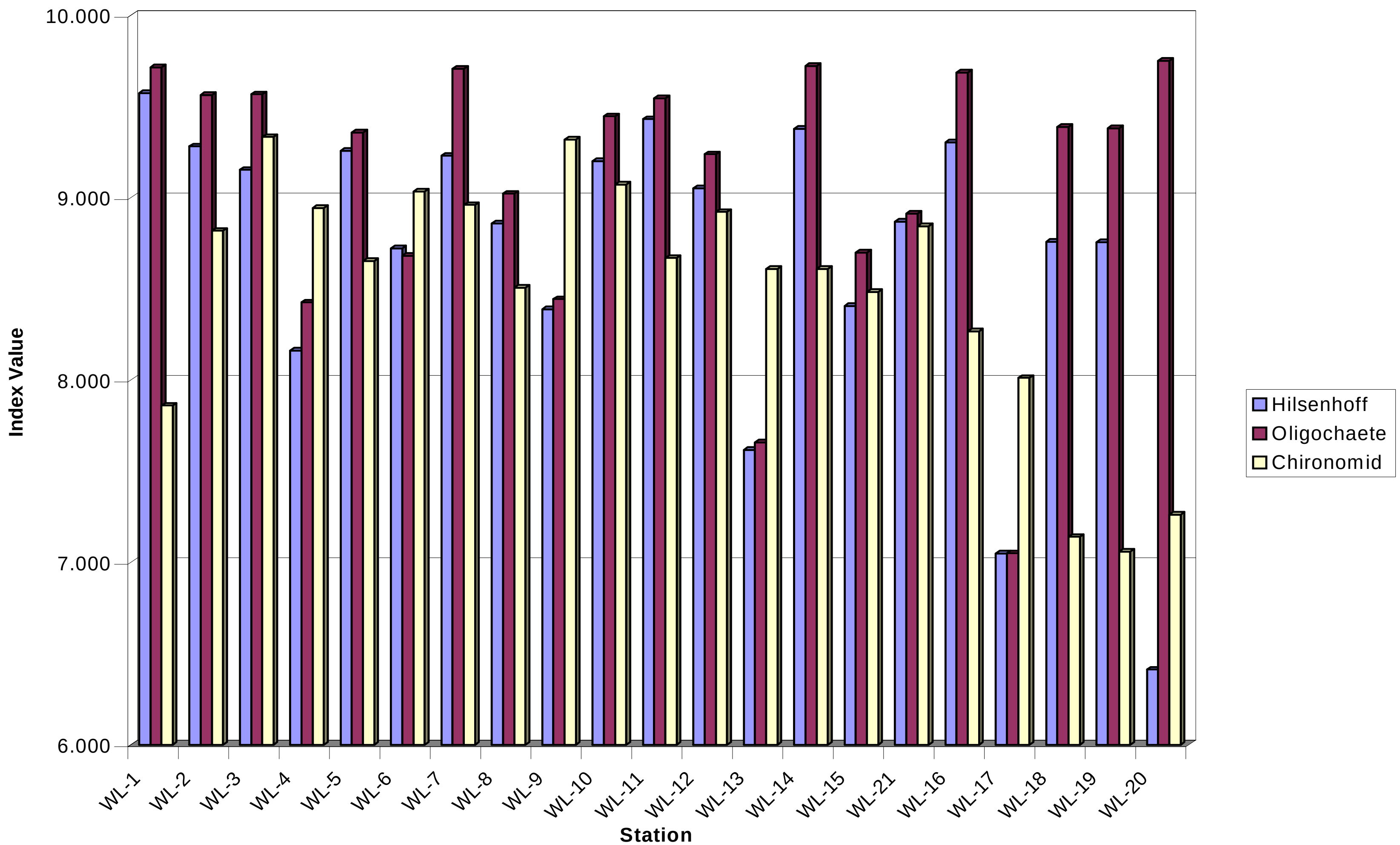


FIGURE 4.4.2.1 SUMMARY OF TROPHIC INDICES (POLLUTION TOLERANCE) FOR THE BENTHIC MACROINVERTEBRATES IN WHITE LAKE, OCTOBER 2000.

Spearman Rank Order Correlations were developed for the indices and physical/chemical parameters (Table 4.4.2.2) to determine variables that help define community structure. Chromium showed significant correlations with nematodes and the Chironomid index. Elevated levels of chromium were associated with increased abundance of nematodes and a decrease in the quality of the chironomid population. The chironomid index value was positively correlated with depth and negatively correlated with TOC. This pattern shows that increased pollution tolerance is associated with greater depth and more organic carbon in the sediments. A negative correlation was found between the Chironomid/Oligocheate ratio and TOC, indicating that chironomids are associated with lower organic enrichment in the sediments than oligochaetes. There is a strong relationship between Hilsenhoff index values and fine grain sediments, indicating that pollution tolerance is associated with soft, depositional sediments. Taxa richness and fine grain sediments were negatively correlated, indicating that the number of taxa decrease as sediments become more finely grained. The significant correlations with TOC, grain size, and depth all point to eutrophication related factors having the greatest influence on the benthic community. Increased nematodes were strongly linked with chromium enrichment. The positive correlation with the chironomid index may also be influenced by depth since the chromium was also linked to this variable (Table 4.1.7).

TABLE 4.4.2.2 SPEARMAN RANK ORDER CORRELATIONS FOR ECOLOGICAL, CHEMICAL, AND PHYSICAL PARAMETERS FOR WHITE LAKE. (SIGNIFICANT CORRELATION IN BOLD.)

Parameter	Cr	Depth	TOC	<63um
Total Organisms	0.241	0.029	0.047	-0.201
Total Tubificidae	0.455	0.226	-0.073	-0.039
Total Chironomidae	0.299	0.089	0.202	-0.253
Nematoda	**0.800**	0.380	-0.070	0.030
Hilsenhoff Index	0.445	0.305	-0.133	**0.518**
Oligochaete Index	0.015	-0.127	0.145	0.313
Chironomid Index	**0.509**	**0.714**	**-0.551**	0.109
Shannon-Weaver	-0.27	-0.049	0.096	-0.201
Margalef's Richness	-0.32	-0.336	0.259	-0.352
Evenness	-0.25	0.075	-0.165	-0.069
J	-0.29	-0.044	0.018	-0.229
Taxa Richness	-0.10	-0.190	0.255	**-0.513**
Chironomid/Oligochaete Ratio	-0.05	-0.227	**-0.510**	-0.201

4.4.3 Analysis of Macroinvertebrate Results Using Community Structure

The benthic macroinvertebrate taxa were further analyzed for associations with chromium by canonical correspondence analysis (Figure 4.4.3.1). A description of the taxa abbreviations are provided in Table 4.4.3.1. Dimensions 1 and 2 accounted for 55% of the variability in the data set (31% and 24%, respectively). Four data clusters are evident. The clean site, Station WL-20, was characterized by amphipods, mayflies, and isopods. This assemblage was not

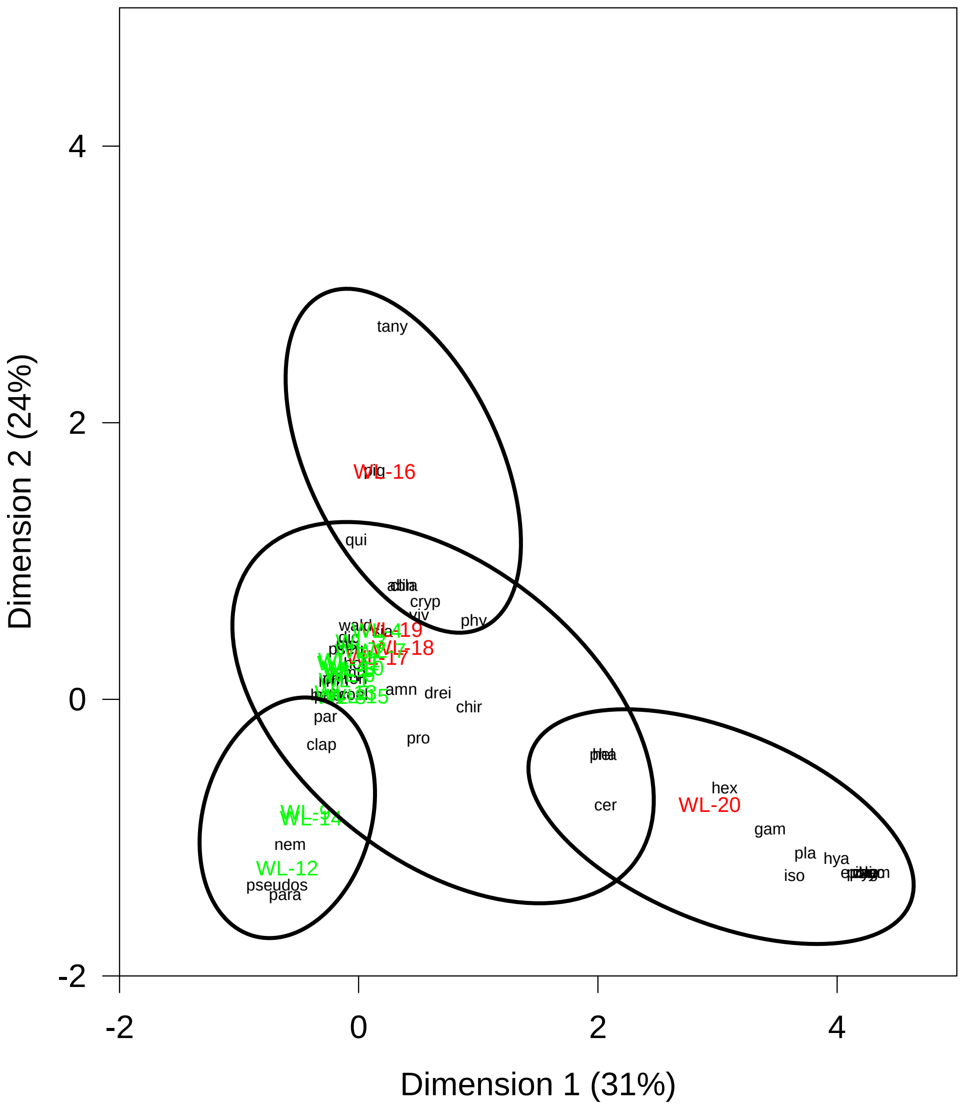


FIGURE 4.4.3.1 CANONICAL CORRESPONDENCE ANALYSIS OF BENTHIC MACRO-INVERTEBRATE TAXA FOR WHITE LAKE, OCTOBER 2000. (LABELS INDICATE SPECIFIC TAXA AND STATIONS. SHALLOW STATIONS LISTED IN RED AND DEEP STATIONS IN GREEN.)

TABLE 4.4.3.1 SUMMARY STATISTICS FOR THE ANALYSIS OF INDIVIDUAL BENTHIC MACROINVERTEBRATE SAMPLES FROM WHITE LAKE, OCTOBER 2000.

Taxa	Abbreviation	Taxa	Abbreviation
Gammarus	gam	*Chironomus*	chiron
Hyallela	hya	*Clinotanypus*	clin
Isopoda	iso	*Coelotanypus*	coel
Amnicola	amn	*Cryptochironomus*	cryp
Physa	phy	*Dicrotendipes*	dic
Valvata tricarinata	tri	*Heterotrissocladius*	heter
Viviparous	viv	*Paraphaenocladius*	para
Dreissena polymorpha	drei	*Paratendipes*	par
Pisidium	pis	*Phaenopsectra*	pha
Aulodrilus limnobius	limn	*Polypedilum*	poly
Aulodrilus pigueti	pig	*Procladius*	pro
Ilyodrilus templetoni	temp	*Pseudochironomus*	pseu
Limnodrilus hoffmeisteri	hof	*Tanypus*	tany
Limnodrilus claparianus	clap	*Caenis*	cae
Quistrodrillus	qui	*Ephemera*	ephem
Haemonais waldvogeli	wald	*Hexagenia*	hex
Helobdella	hel	*Isonychia*	iso
Nematoda	nem	*Polycentroapodidae*	polyc
Planaridae	pla	*Pseudostenophylax*	pseudos
Ceratapogonidae	cer	*Sialis*	sia
Chironomidae	Chir	Zygoptera	zyg
Ablabesmyia	Abla		

found in the other sites. WL-16, the site in the east bay with high solid phase toxicity, was grouped around the two tubificid taxa *Quistrodrillus* spp. and *Aulodrilus pigueti*, the gastropod *Physa* spp., and the midges *Tanytarsus* spp., *Ablabesmyia* spp., *Cryptochironomus* spp., and *Clinotanypus* spp. The tubificid taxa represent additional pollution tolerant organisms at this location. *Tanytarsus* spp. is classified as a "sprawler" because it resides on the surface and does not burrow in the sediment. *Ablabesmyia* spp., *Cryptochironomus* spp., and *Clinotanypus* spp. are predators and do not ingest sediment and/or detritus. The additional pollution tolerant tubificids and the shift to predatory and surface dwelling midges are indicative of adverse conditions in the sediment.

Stations WL-9, WL-12, and WL-14 cluster together around Nematoda, *Pseudostenophylax* spp., and *Paraphaenocladius* spp. The latter two organisms were found in very low numbers

(1 organism in the triplicate PONARS) and cannot be considered as important members of the benthic assemblage. Chromium concentrations and the order Nematoda showed a strong correlation (Table 4.4.2.2). Stations WL-9, WL-12, and WL-14 had the highest concentrations of chromium (420 mg/kg, 510 mg/kg, and 480 mg/kg, respectively). Nematodes have been reported to be tolerant of heavy metal pollution (Gyedu-Ababio et al. 1999, Fiscus and Neher 2002). Some are able to produce phytochelatins that are able to detoxify heavy metals (Cobbett 2000, Vatamaniuk et al. 2001). In addition to changes in the nematode population, this group of locations also had the lowest percentage of tubificids (Table 4.4.1.2). Samples at stations WL-9, WL-12, and WL-14 contained tubificid percentages of 45%, 23%, and 37%, respectively. The tubificid percentage range for the other deep stations was 66-85%. Based on these results, the benthic macroinvertebrate populations at these stations appear to be influenced by chromium.

The remainder of stations and organisms form a cluster in the middle of the CCA plot. Benthic macroinvertebrate assemblages of the remaining shallow stations (WL-17, WL-18, and WL-19) with low chromium levels are grouped with deep locations that contain high concentrations of the metal. These sites are characterized by similar TOC, % solid, and grain size values. This suggests that organic enrichment from eutrophication exerts the predominant influence on the benthic community for this cluster.

4.4.4. Benthic Macroinvertebrate Data Summary

The benthic macroinvertebrate community of White Lake is characterized by organisms that are tolerant of organic (nutrient) enrichment. The presence of organic deposition from the White River, the eutrophic conditions in the lake, and the historical anthropogenic enrichment from the lumbering operations, the Tannery, and the wastewater treatment plant all act to increase the densities of pollution tolerant organisms. To this extent, detritivores such as tubificids and chironomids from the genus *Chironomus* should dominate the benthic populations (Winnell and White 1985). While these conditions would indicate habitat degradation in a more pristine system, organic enrichment forms the basis for structuring the benthic community in White Lake. The only sites that did not fit this characterization were the locations with high chromium levels (WL-9, WL-12, and WL-14) and the east bay site, WL-16. The most notable difference with respect to the first group of stations was a change in benthic taxa from tubificids to nematodes. WL-16 was characterized by a change in chironomid species from detritivores to predators. A shift to more opportunistic organisms has previously been attributed to contaminant impact (Dauer 1991).

With respect to the influence of chromium on the benthic ecology in White Lake, a significant relationship exists between the metal and the macroinvertebrate community (Figure 4.4.4.1). When dimension 1 of the CCA (invertebrate taxa) is plotted against chromium, a strong relationship is noted ($r = -0.588$, $p < 0.017$). An increase in chromium concentration shifts the population from an assemblage dominated by tubificids to one dominated by nematodes. Changes in the benthic community in response to chromium have been previously reported (Leslie et al. 1999). The significance of this shift is unknown and would require further taxonomic resolution to identify and classify the nematode species with respect to pollution tolerance. In addition, a more detailed assessment of benthic biomass would be required to determine if this shift is significant with respect to ecological resources in White Lake. Finally, a more detailed evaluation of the nutrient and organic composition would need to be performed to determine if this shift was related to food quality or a response to sediment contamination.

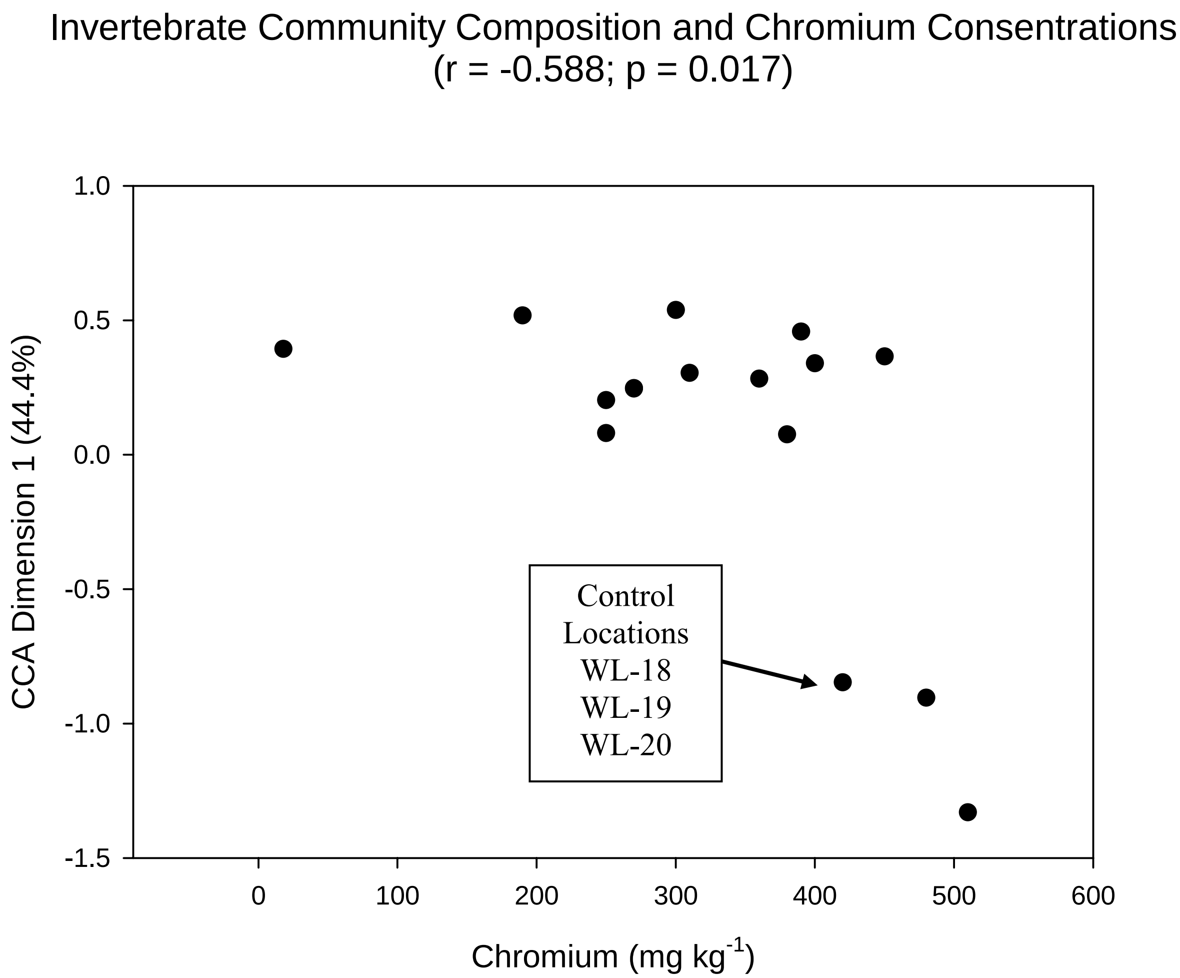


FIGURE 4.4.4.1 PLOT OF CCA DIMENSION 1 (MACROINVERTEBRATE TAXA) AND CHROMIUM FOR WHITE LAKE SEDIMENTS, OCTOBER 2000.

4.5 Chromium Uptake by Aquatic Organisms

The accumulation of chromium in several aquatic organisms was examined to determine the biological fate of the metal in White Lake. The contaminated sediments in Tannery Bay contained the highest levels of chromium (1,000-4,000 mg/kg) and supported dense macrophyte and zebra mussel populations (Rediske et al. 1998). For this project, triplicate collections of macrophytes (*Ceratophyllum* spp.) and zebra mussels (*Dreissena polymorpha)* were made at three sites in Tannery Bay and at WL-20. The results are shown in Table 4.5.1 and displayed in Figure 4.5.1. Only macrophyte shoots and the attached zebra mussels were analyzed to minimize the inclusion contact with the highly contaminated sediment. The *Ceratophyllum* spp. tissue found in Tannery Bay contained significantly higher chromium levels than the control location (13-35 mg/kg vs. 5 mg/kg respectively). Zebra mussel tissue followed a similar trend, however the difference between the chromium concentrations in samples from Tannery Bay (16-33 mg/kg) and from the control area (2 mg/kg) were greater. Chromium accumulation in macrophytes (Vajpayee et al. 1995) and zebra mussels (Redders and Bij de Vaate 1993, LaValle et al. 1999) has been previously reported. The results from this investigation demonstrate the bioavailability of chromium in the sediments of Tannery Bay. In consideration of the dense macrophyte growth in the bay and the level of chromium accumulation, translocation and senescence would not contribute significant concentrations of the metal to the sediment. While the macrophytes would contribute organic matter and nutrients to the sediments, mixing and resuspension provide the mechanism for maintaining the high chromium levels in the surficial layers. The accumulation of chromium in zebra mussels also supports the mixing and resuspension hypothesis as these organisms are filter feeders and ingest suspended particulates.

TABLE 4.5.1 CHROMIUM CONCENTRATION IN MACROPHYTES AND ZEBRA MUSSELS IN TANNERY BAY. (STATION 20 IS THE CONTROL SITE.)

Station	Chromium in Zebra Mussels (mg/kg)	Chromium in Plant Tissue (mg/kg)
22A	52	14
22B	12	11
22C	14	16
23A	16	36
23B	12	48
23C	23	23
24A	45	54
24B	16	36
24C	23	20
20A	0.84	6.9
20B	*	3.5

* Insufficient organisms present for replicates

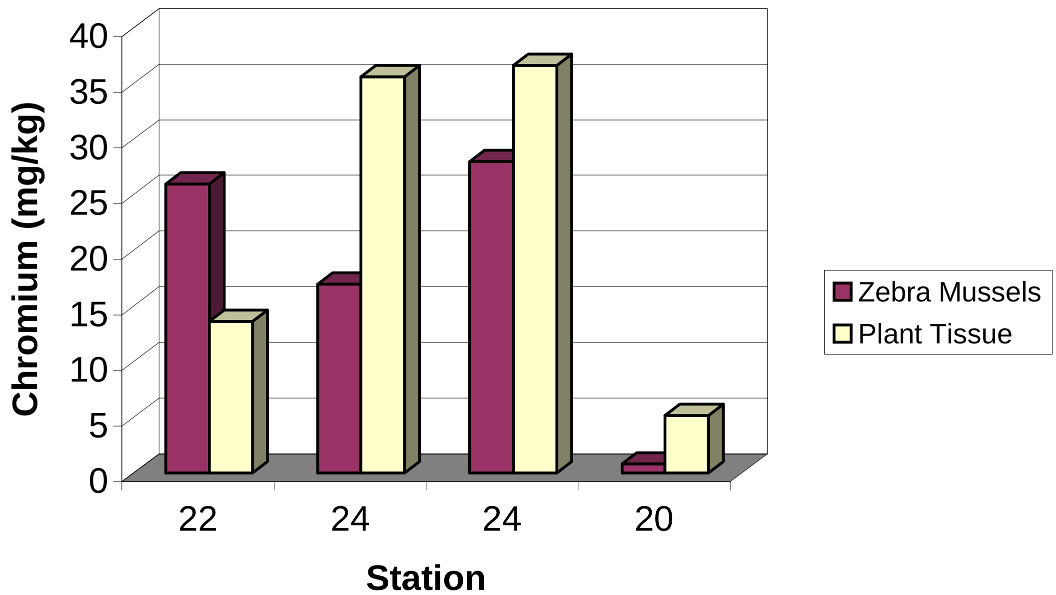


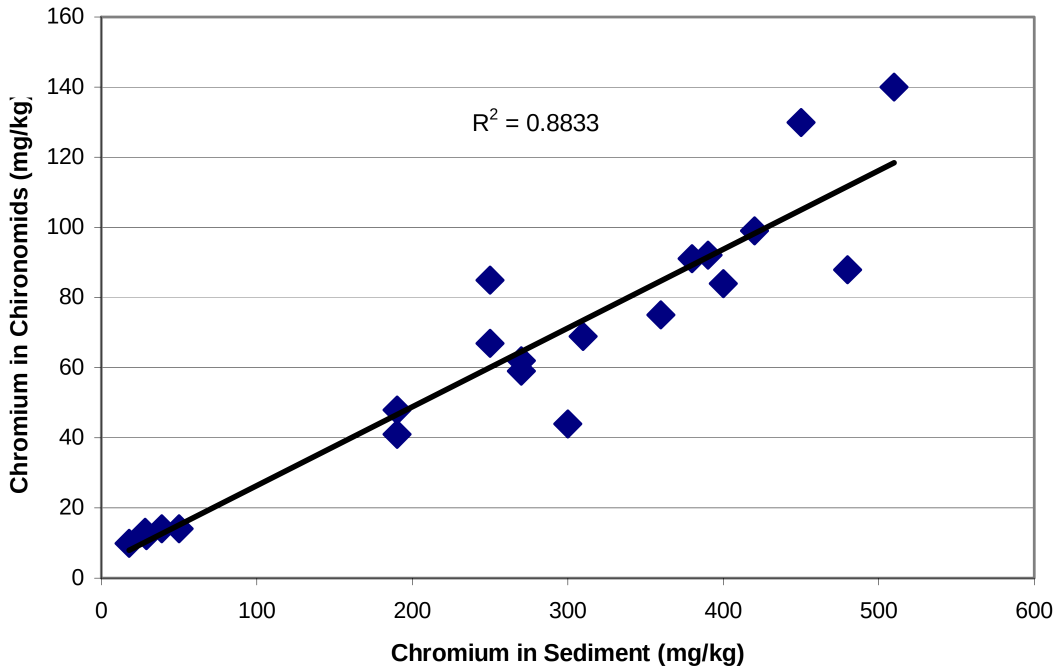
FIGURE 4.5.1 CHROMIUM ACCUMULATION IN MACROPHYTES AND ZEBRA MUSSELS IN TANNERY BAY.

The accumulation of chromium was evaluated at all of the PONAR locations. Chromium concentrations in the sediment and in chironomid tissue from each station are presented in Table 4.5.2 and displayed graphically in Figure 4.5.2. The results show a significant

TABLE 4.5.2 CHROMIUM CONCENTRATION IN CHIRONOMIDS FROM TANNERY BAY.

Station	Chromium in Sediment (mg/kg)	Chromium in Chironomids (mg/kg)	Station	Chromium in Sediment (mg/kg)	Chromium in Chironomids (mg/kg)
WL-1	270	59	WL-12	510	140
WL-2	300	44	WL-13	250	85
WL-3	190	41	WL-14	480	88
WL-4	18	10	WL-15	250	67
WL-5	400	84	WL-16	190	48
WL-6	360	75	WL-17	50	14
WL-7	390	92	WL-18	29	12
WL-8	380	91	WL-19	39	14
WL-9	420	99	WL-20	28	13
WL-10	270	62	WL-21	450	130
WL-11	310	69			

FIGURE 4.5.2 CHROMIUM ACCUMULATION IN CHIRONOMIDS FROM TANNERY BAY.



relationship between chromium uptake and the concentration in the sediment. The Spearman Correlation coefficient was 0.92 ($p < 0.001$), indicating a strong relationship between sediment and chironomid concentrations. Locations with sediment concentrations < 50 mg/kg had chromium concentrations in the chironomid populations of 10-14 mg/kg. In contrast, locations with chromium concentrations > 100 mg/kg had accumulated metal levels of 48-140 mg/kg. These data coupled with the increased chironomid index value (Table 4.4.2.2) suggest that chromium is associated with an adverse impact to this group of organisms. A more detailed evaluation of physiological response to chromium would be necessary to establish a direct link between accumulation and the increased pollution tolerance.

The results of the tissue analyses showed that chromium in the sediment from White Lake was accumulated by macrophytes, chironomids, and zebra mussels. Based on the dense growth of macrophytes and the high numbers of zebra mussels in Tannery Bay, there was no obvious ecological effect apparent in these organisms. More research would be necessary to establish the linkage between chromium accumulation in chironomids and ecological impairment.

4.6 The Environmental Fate and Significance of Chromium and PCBs in White Lake

The results of this investigation coupled with previous studies (Rediske et al. 1998, Earth Tech 2001) provide an extensive sampling grid for chromium and PCBs in White Lake. The chromium sampling points are shown in Figure 4.6.1 for White Lake and in Figure 4.6.2 for the Tannery Bay area. Coordinates and chromium concentrations are listed in Table 4.6.1.

TABLE 4.6.1 WHITE LAKE CHROMIUM DATA. (PONAR SAMPLES FROM CURRENT INVESTIGATION AND REDISKE ET AL. 1998)

Station	Latitude N	Longitude W	Chromium mg/kg	Station	Latitude N	Longitude W	Chromium mg/kg
WL-1	43° 22.58'	86° 24.55'	270	WL-21	43° 23.15'	86° 22.57'	450
WL-2	43° 22.45'	86° 24.15'	300	WL-22	43° 23.99'	86° 21.28'	520
WL-3	43° 22.41'	86° 24.77'	190	WL-23	43° 24.02'	86° 21.26'	1200
WL-4	43° 22.27'	86° 24.16'	18	WL-24	43° 24.02'	86° 21.30'	1300
WL-5	43° 22.73'	86° 23.50'	400	I-1	43° 24.15'	86° 21.15'	212
WL-6	43° 22.95'	86° 22.86'	360	I-2	43° 24.11'	86° 21.27'	259
WL-7	43° 22.61'	86° 23.27'	390	I-3	43° 24.06'	86° 21.32'	934
WL-8	43° 23.01'	86° 22.53'	380	I-4	43° 24.05'	86° 21.31'	1890
WL-9	43° 23.27'	86° 22.43'	420	I-5M	43° 24.04'	86° 21.26'	4100
WL-10	43° 22.18'	86° 24.61'	270	I-6	43° 23.98'	86° 21.25'	2650
WL-11	43° 23.54'	86° 22.25'	310	I-7M	43° 23.97'	86° 21.22'	2560
WL-12	43° 23.62'	86° 21.97'	510	I-8	43° 23.97'	86° 21.36'	515
WL-13	43° 23.08'	86° 22.33'	250	E-1-P	43° 24.59'	86° 21.59'	23
WL-14	43° 23.69'	86° 21.63'	480	E-2-P	43° 21.10'	86° 21.38'	64
WL-15	43° 23.87'	86° 21.83'	250	E-3-P	43° 23.89'	86° 21.50'	43
WL-16	43° 24.16'	86° 21.15'	190	E-4-P	43° 23.93'	86° 21.69'	344
WL-17	43° 24.20'	86° 21.25'	50	E-5-P	43° 23.70'	86° 21.61'	492
WL-18	43° 24.39'	86° 21.26'	29	E-6-P	43° 23.70'	86° 21.95'	771
WL-19	43° 24.32'	86° 21.14'	39	E-7-P	43° 23.59'	86° 21.71'	541
WL-20	43° 24.51'	86° 21.22'	28	E-9-P	43° 23.13'	86° 21.59'	369

Chromium concentration contours plotted from the data using kriging are shown in Figure 4.6.3. Concentrations are plotted for the ≥ 4 m depth contours as shallower sediments in the lake are sandy and related to shoreline erosion. Organic depositional sediments are typically found at depths ≥ 4 m. The concentration map shows that the spatial extent of chromium contamination covers the area of the lake from Tannery Bay to the navigation channel. Advective transport and deposition are also evident from the reservoir of highly contaminated sediment in Tannery Bay. Moving westward from Tannery Bay, an area of low chromium concentration is present in the Narrows, where drowned rivermouth related currents would be highest. The maximum chromium concentration outside of Tannery Bay (771 mg/kg) occurs

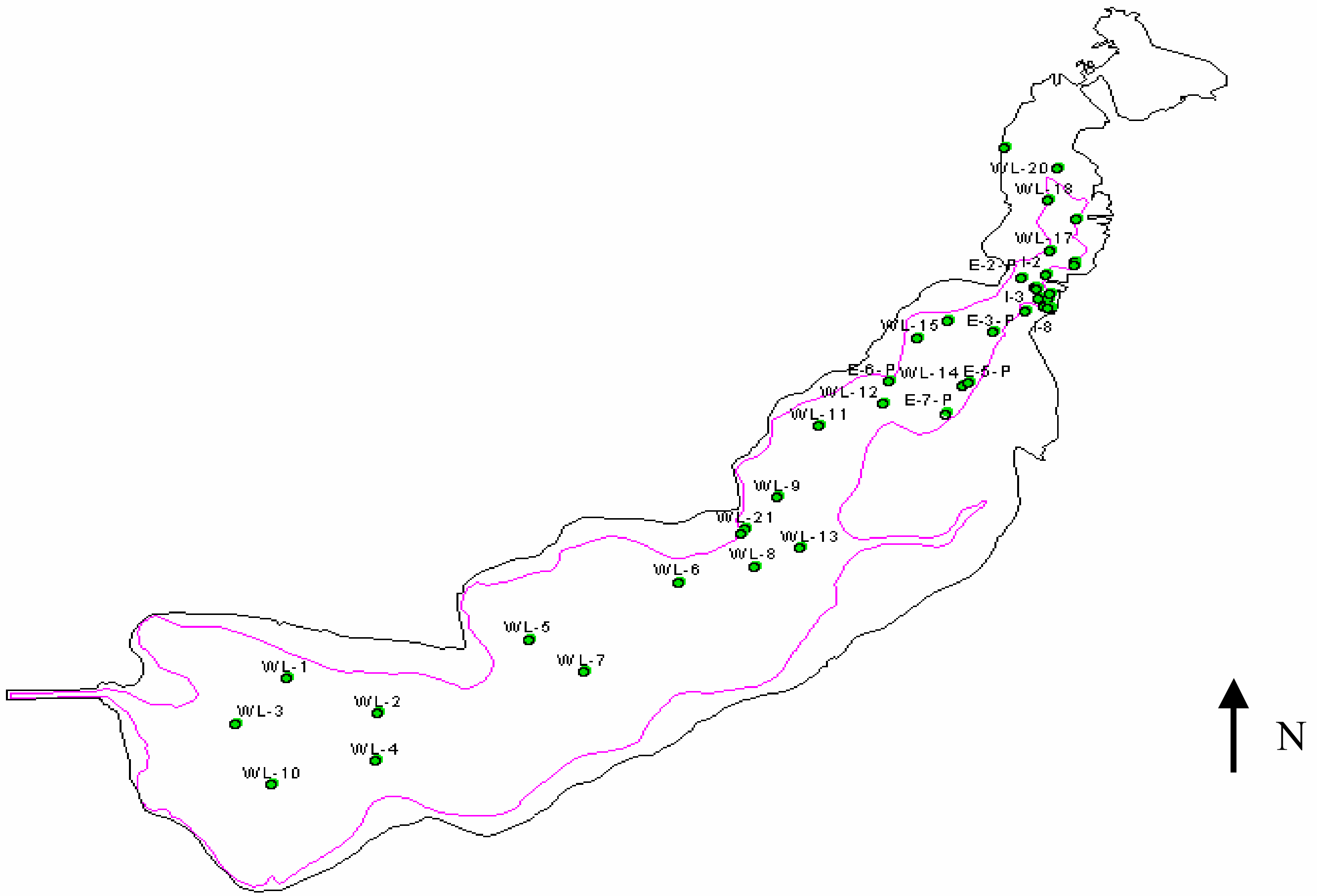


FIGURE 4.6.1 CHROMIUM SAMPLING POINTS IN WHITE LAKE (CURRENT INVESTIGATION AND REDISKE ET AL. 1998). (RED LINE DENOTES THE 4 M DEPTH CONTOUR.)

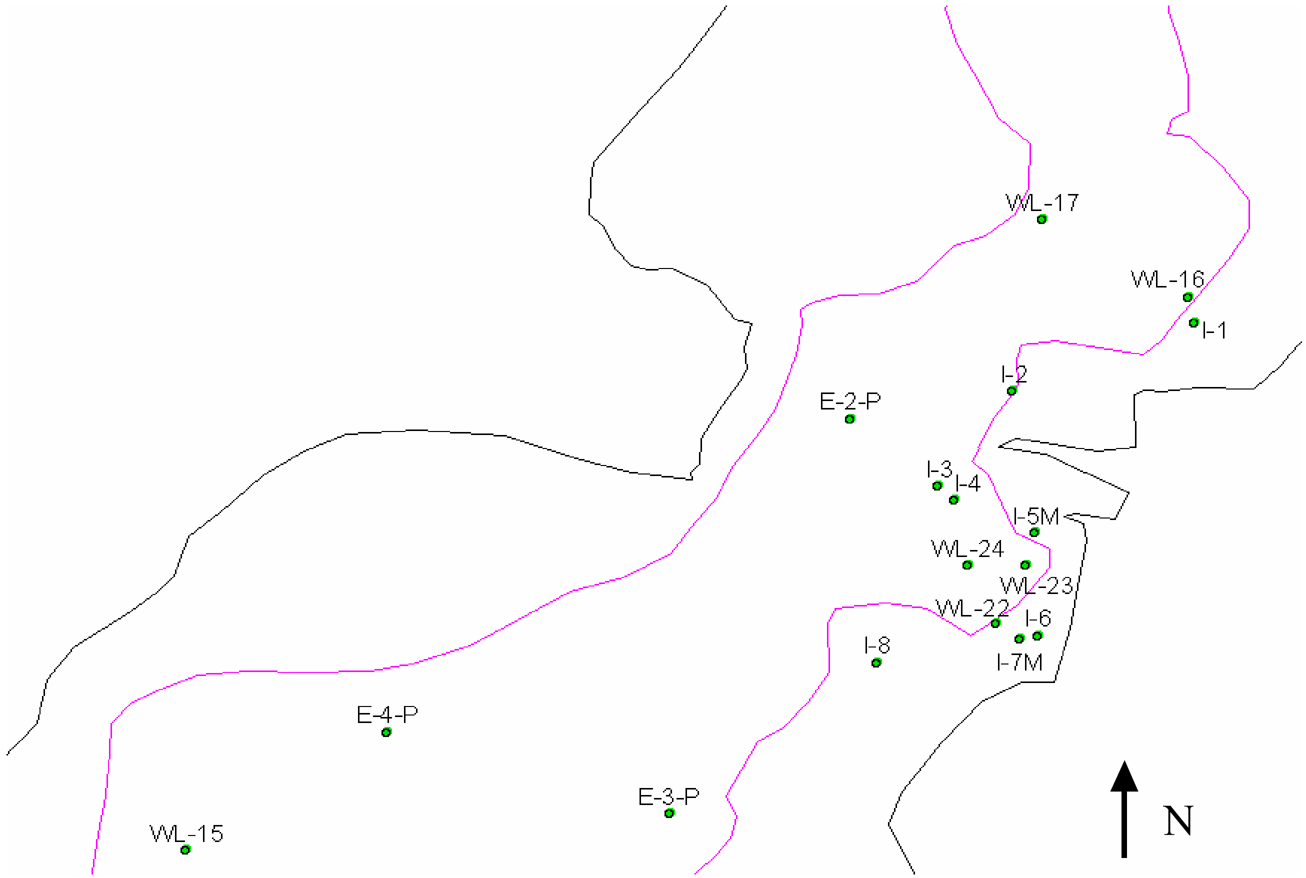


FIGURE 4.6.2 CHROMIUM SAMPLING POINTS IN THE VICINITY OF TANNERY BAY . (CURRENT INVESTIGATION AND REDISKE ET AL. 1998. RED LINE DENOTES THE 4 M DEPTH CONTOUR.)

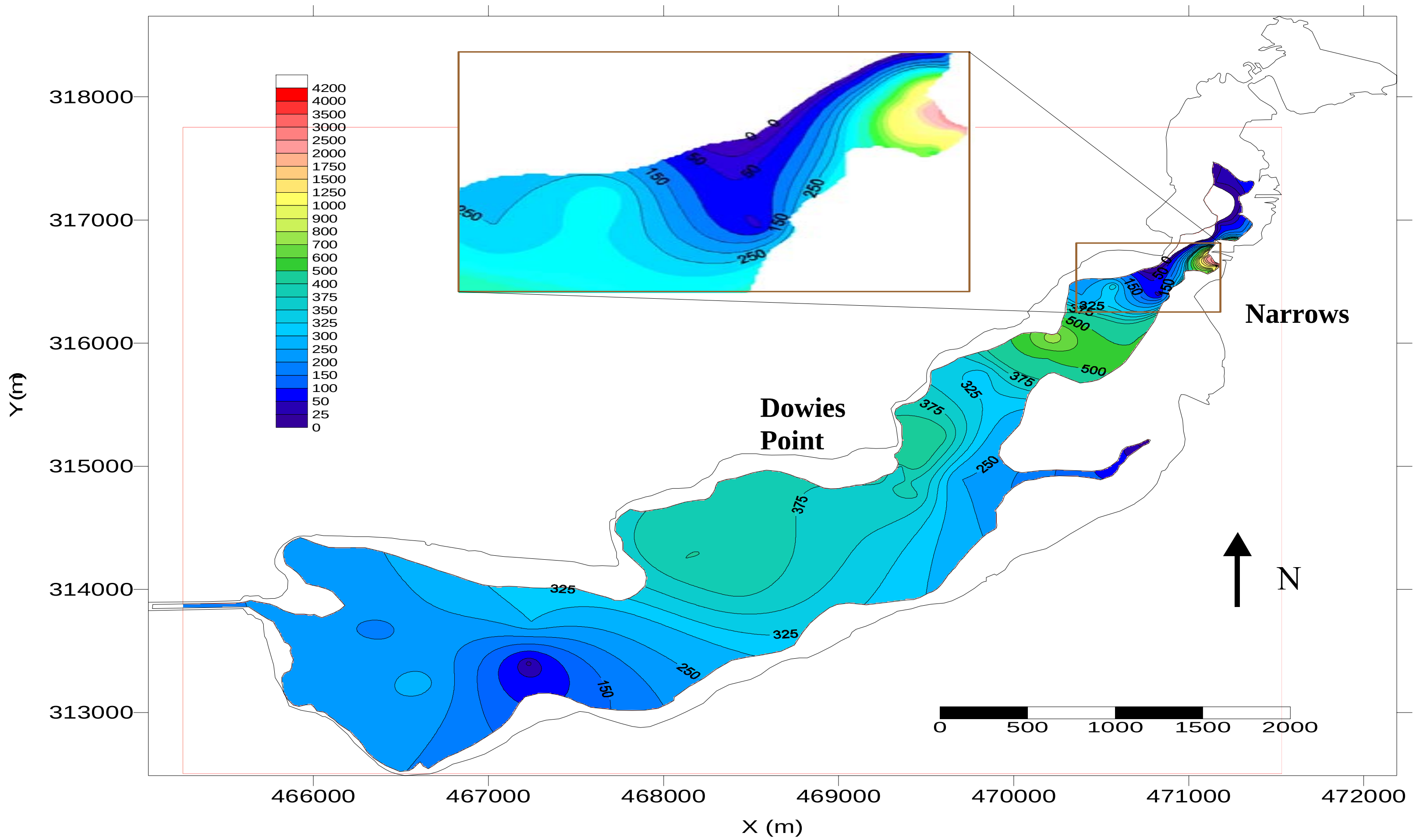


FIGURE 4.6.3 CHROMIUM CONCENTRATION CONTOURS FOR WHITE LAKE SURFICIAL SEDIMENTS. (CONCENTRATIONS PLOTTED FOR DEPTHS > 4 M. TANNERY BAY AREA SHOWN IN GREATER DETAIL)

in the first depositional basin (16 m) at the midpoint between Dowies Point and the Narrows (Figures 4.1.8 and 4.6.3). The next areas of high chromium concentration occur in the depositional basins to the east (420 mg/kg) and west (400 mg/kg) of Dowies Point (6 m and 20 m, respectively). In the depositional basin west of Long Point (22 m), chromium levels decrease to 300 mg/kg and continue to decline in concentration to the channel (190 mg/kg). The plume of contaminated sediment emanating from Tannery Bay extends ≈ 8 km from the source. Depositional contours also follow the generalized circulation pattern for White Lake. Lung (1975) described a westerly flow of water from the drowned rivermouth and a wind induced countercurrent along the southern shore (Figure 4.6.4). The predominant westerly wind results in a current moving eastward until it reaches the Narrows where it is nullified by the drowned rivermouth flow. The shallow depths and sandy nature of the sediments on the southern shore of the lake are indicative of the erosional character of this current and its effect on the shoreline. The extensive shallow zone along the southern shore is the result of the erosional effects on the shoreline and the rapid depositional process resultant from the interaction of the countercurrents. The northern shoreline is protected from the prevailing

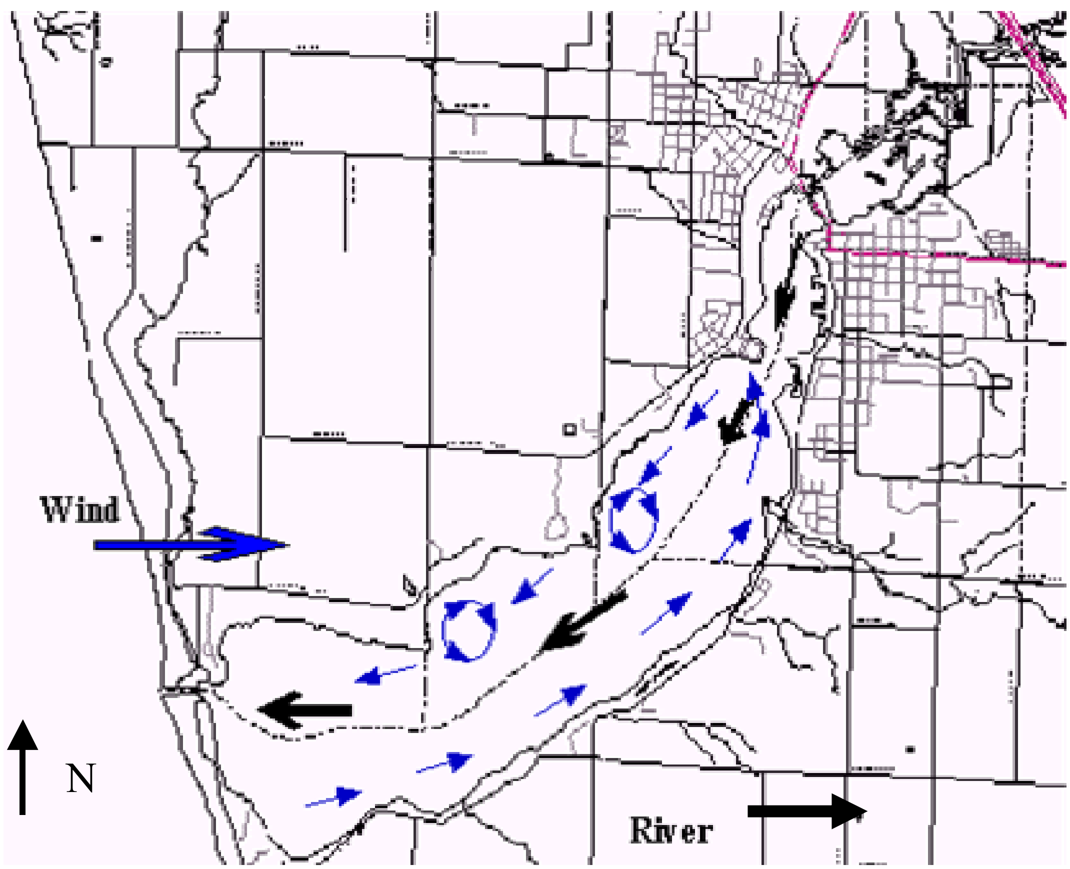


FIGURE 4.6.4 GENERALIZED CIRCULATION PATTERN FOR WHITE LAKE (LUNG 1975).

wind by the high banks and shows little evidence of erosion. The morphometry of the northern shore and the two points result in the formation of two gyres that enhance sediment and detrital deposition. Based on these flow characteristics, chromium deposition should be lower along the southern shore and higher to the north. The chromium concentration map fits the generalized flow pattern as the higher metal concentrations follow the northern shoreline of White Lake. The position of Tannery Bay in the eastern corner of the lake and morphometry associated with the Narrows would make this area a deposition and transport zone depending on the nature of the storm event. Small storm events and wind surges would cause sediment resuspension in the bay and result in a minor degree of transport out into the drowned rivermouth current. Larger storm events would result in considerable resuspension and transport as the increased wave action facilitates sediment advection out of the bay and into the main section of the lake. The 20 cm mixed layer previously reported in the Tannery Bay sediments (Rediske et al. 1998) and the influence of episodic events on chromium stratigraphy described in Section 4.2 are evidence of these phenomena.

The environmental fate and transport of the PCB discharge in White Lake from the former Occidental/Hooker Chemical facility is very different from the chromium release from the tannery. The data from the extensive sampling of the Occidental/Hooker Chemical discharge zone (Earth Tech 2001) plus the results of current and previous investigations of White Lake are given in Table 4.6.2. A map of the sampling locations is provided in Figure 4.6.5. Maps of PCB concentration contours for the discharge zone and for White Lake are shown in Figures 4.6.6 and 4.6.7, respectively. The effluent pipe was located at a depth ≈ 10 m and the maximum PCB concentration occurred at ≈ 11 m (390 mg/kg). Sediment contamination is confined to a 100 m^2 zone around the outfall. The discharge from this facility began in the mid 50s and the origin of the PCBs is not known. Occidental/Hooker Chemical manufactured chlorinated pesticide intermediates and the PCBs were either produced as byproducts or were released from the electrical systems on site. The discharge of chemical wastes was terminated in the mid 70s, however treated groundwater from an activated carbon system is currently released from the old outfall. Concentration contours follow the southwestern flow of the drowned rivermouth and the depth change from 10 m to 14 m. The affinity of PCBs for sediment coupled with the location of the outfall in the deep depositional basin resulted in conditions that limited the advective transport of the chemical outside the area around Dowies Point. This environment is in stark contrast to the shallow area of the tannery discharge and its proximity currents associated with the Narrows. The presence of PCBs in the surficial sediments is problematic because of the depositional nature of the discharge zone. If this location was a true depositional zone, the PCBs would have been covered by clean sediment over the last 20+ years. The groundwater treatment discharge (≈1.6 mgd) may cause turbulence in the local area and result in the resuspension and limited transport of PCBs. The complex flow pattern for this area (Figure 4.6.5) may also result in limited redistribution of sediments.

The highly contaminated sediment in Tannery bay and near the former Occidental/Hooker Chemical outfall will be removed by dredging in 2003. Removing the sediments from Tannery Bay will eliminate the source that has contaminated the depositional sediments in

TABLE 4.6.2 WHITE LAKE PCB DATA. (PONAR SAMPLES FROM EARTH TECH 2001 AND THE CURRENT AND PREVIOUS INVESTIGATION)

Sample	Aroclor 1248 (mg/kg)	X	Y	Sample	Aroclor 1248 (mg/kg)	N	W
SD-99-01	< 0.3	1456881.77	694618.72	WL-1	<0.05	43° 22.58'	86° 24.55'
SD-99-02	< 0.3	1456885.82	694617.08	WL-2	0.09	43° 22.45'	86° 24.15'
SD-99-03	6.3	1456882.99	694581.86	WL-3	<0.05	43° 22.41'	86° 24.77'
SD-99-05	0.55	1456903.31	694609.45	WL-4	<0.05	43° 22.27'	86° 24.16'
SD-99-06	< 0.3	1456813.09	694632.34	WL-5	<0.05	43° 22.73'	86° 23.50'
SD-99-07	< 0.3	1456928.34	694653.54	WL-6	0.07	43° 22.95'	86° 22.86'
SD-99-08	413	1456911.14	694532.07	WL-7	0.08	43° 22.61'	86° 23.27'
SD-99-09	390	1456915.93	694552.40	WL-8	<0.05	43° 23.01'	86° 22.53'
SD-99-10	110	1456934.64	694574.49	WL-9	<0.05	43° 23.27'	86° 22.43'
SD-99-11	0.58	1456959.40	694600.19	WL-10	<0.05	43° 22.18'	86° 24.61'
SD-99-12	< 0.3	1456978.93	694622.57	WL-11	<0.05	43° 23.54'	86° 22.25'
SD-99-13	0.47	1456931.41	694516.70	WL-12	<0.05	43° 23.62'	86° 21.97'
SD-99-14	9	145647.75	694562.27	WL-13	<0.05	43° 23.08'	86° 22.33'
SD-99-15	0.4	1456997.48	694604.88	WL-14	<0.05	43° 23.69'	86° 21.63'
SD-00-01	0.88	1456870.26	694582.65	WL-15	<0.05	43° 23.87'	86° 21.83'
SD-00-02	7.6	1456900.67	694552.86	WL-16	<0.05	43° 24.16'	86° 21.15'
SD-00-03	1.4	1456960.59	694507.16	WL-17	<0.05	43° 24.20'	86° 21.25'
SD-00-04	38	1456866.68	694540.53	WL-18	<0.05	43° 24.39'	86° 21.26'
SD-00-06	2.1	1456920.27	694492.04	WL-19	<0.05	43° 24.32'	86° 21.14'
SD-00-07	1.1	1456946.05	694475.87	WL-20	<0.05	43° 24.51'	86° 21.22'
SD-00-08	44	1456859.61	694495.57	WL-21	22	43° 23.15'	86° 22.57'
SD-00-09	27	1456896.51	694467.79	I-1	<0.05	43° 24.15'	86° 21.15'
SD-00-10	0.76	1456926.84	694445.57	I-2	<0.05	43° 24.11'	86° 21.27'
SD-00-11	0.35	1456801.24	694501.97	I-3	<0.05	43° 24.06'	86° 21.32'
SD-00-12	0.99	1456765.84	694363.00	I-4	<0.05	43° 24.05'	86° 21.31'
SD-00-13	0.47	1456699.94	694215.55	I-5M	<0.05	43° 24.04'	86° 21.25'
SD-00-17	< 0.3	1456969.63	694297.55	I-6	<0.05	43° 23.98'	86° 21.25'
SD-00-18	0.55	1456990.59	694393.18	I-7M	<0.05	43° 23.97'	86° 21.22'
SD-00-19	1.1	1456924.39	694410.49	I-8	<0.05	43° 23.97'	86° 21.36'
SD-00-20	1.3	1456868.38	694436.77	E-1-P	<0.05	43° 24.59'	86° 21.59'
SD-00-21	4.3	1456828.58	694468.79	E-2-P	<0.05	43° 24.10'	86° 21.38'
SD-00-22	< 0.3	1456891.26	694314.74	E-3-P	<0.05	43° 23.90'	86° 21.50'
SD-00-23	< 0.3	1456819.55	694335.65	E-4-P	<0.05	43° 23.93'	86° 21.69'
SD-00-34	34	1457055.22	694554.38	E-5-P	<0.05	43° 23 70'	86° 21.61'
SD-00-35	< 0.3	1456846.44	694564.03	E-6-P	<0.05	43° 23.70'	86° 21.95'
SD-00-38	76	1456697.60	694274.53	E-7-P	<0.05	43° 23.59'	86° 21.71'
SD-00-40	50	1456894.22	694487.45	E-9-P	5.5	43° 23.13'	86° 22.59'
SD-00-41	3.3	1456927.94	694543.62				
SD-00-46	< 0.3	1457097.29	694530.11				
SD-00-47	0.35	1457050.21	694584.42				
SD-00-48	1.5	1457022.73	694536.46				
SD-00-49	0.56	1456887.74	694386.30				
SD-00-50	0.82	1456822.38	694388.65				
SD-00-51	110	1456887.81	694593.90				

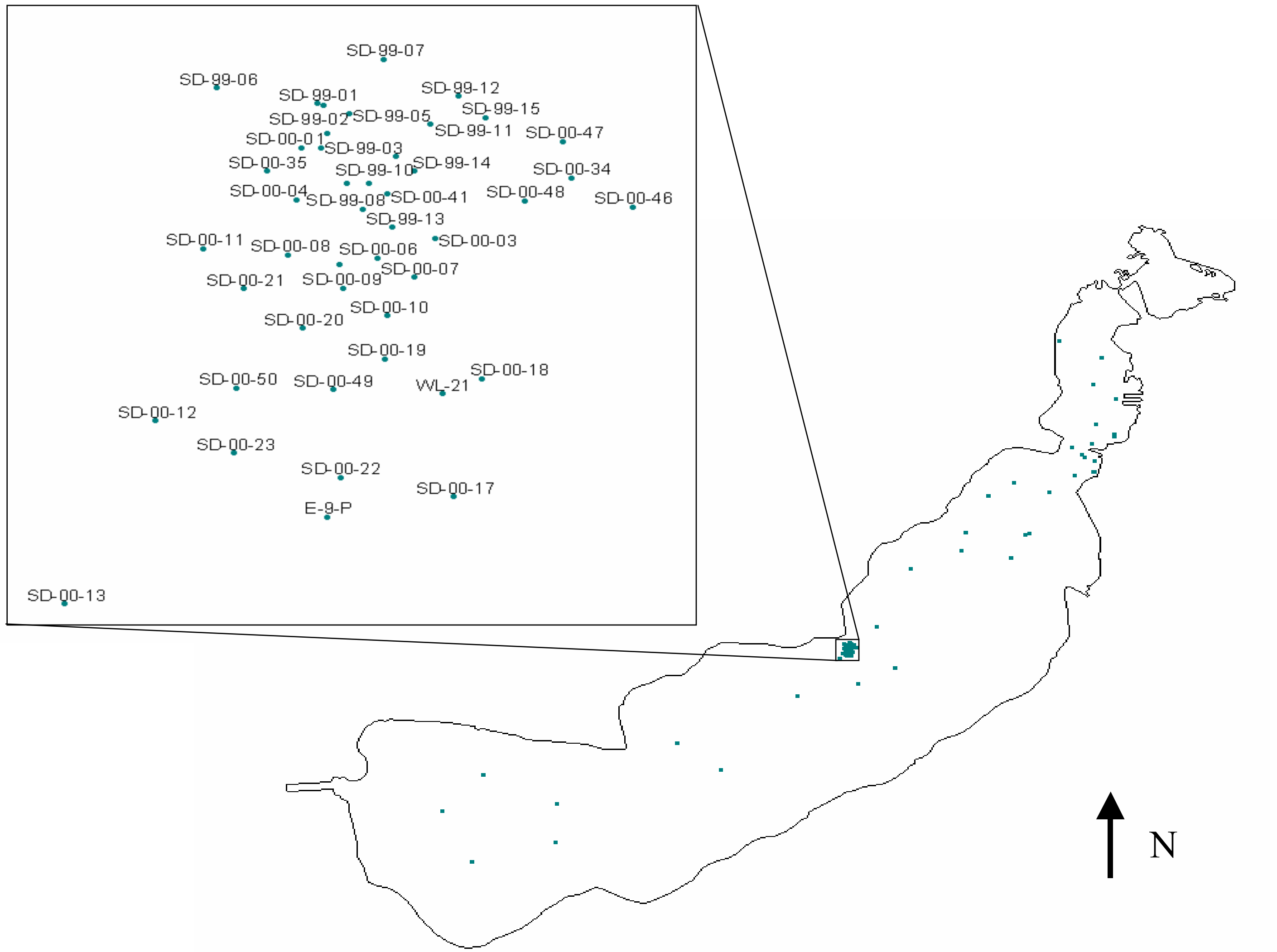


FIGURE 4.6.5 PCB SAMPLING POINTS IN WHITE LAKE (EARTH TECH 2001, CURRENT INVESTIGATION AND REDISKE ET AL. 1998. OCCIDENTAL/HOOKER CHEMICAL AREA SHOWN IN GREATER DETAIL)

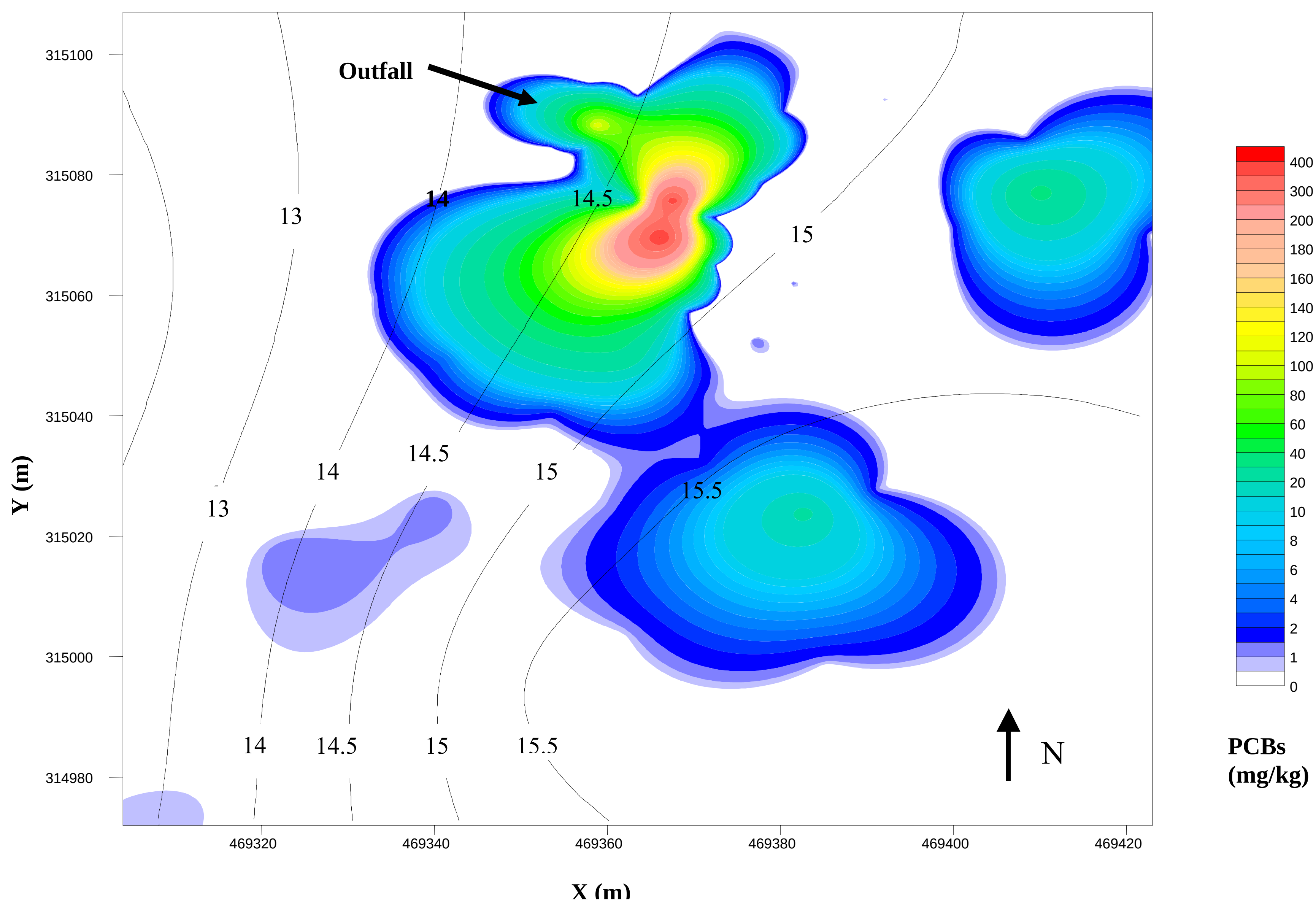


FIGURE 4.6.6 PCB CONCENTRATION CONTOURS IN THE SURFICIAL SEDIMENTS IN THE VICINITY OF THE FORMER OCCIDENTAL/HOOKER CHEMICAL DISCHARGE.

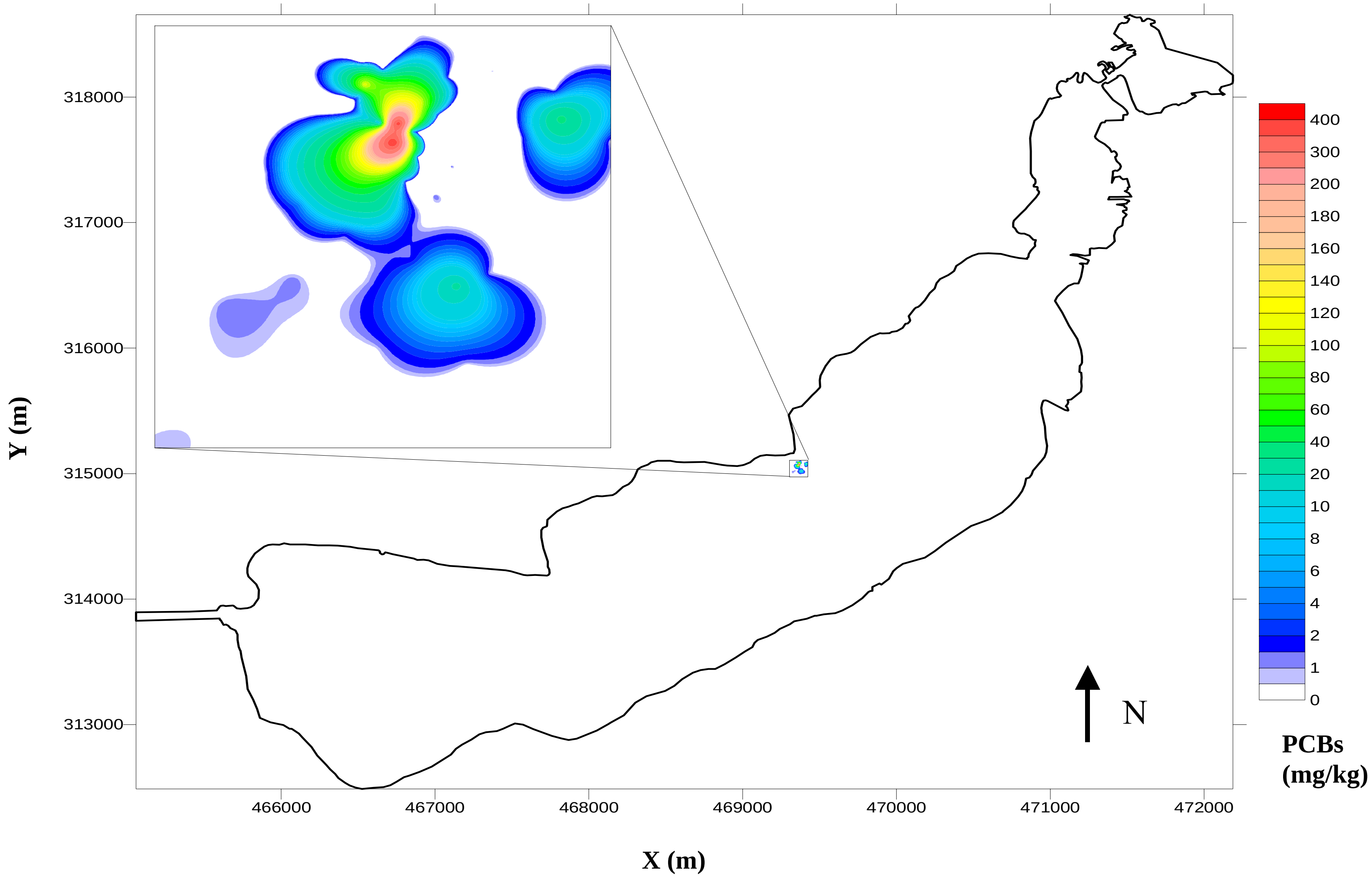


FIGURE 4.6.7 PCB CONCENTRATION CONTOURS IN THE SURFICIAL SEDIMENTS IN WHITE LAKE. (OCCIDENTAL/HOOKER CHEMICAL AREA SHOWN IN GREATER DETAIL.)

90% of White Lake. The complex flow pattern of the lake will continue to redistribute the remaining contaminated sediments throughout the western basins. Even though the source has been eliminated, it will take many years to observe a significant trend of reduced chromium deposition in the surficial zone. Dredging should have a more immediate impact on the ecosystem in Tannery Bay as the toxic sediments will be removed from the environment. The removal of PCB contaminated sediment from the Occidental/Hooker Chemical outfall will also have an immediate benefit to the local ecosystem through the elimination of toxic sediment. On a broader scale, the removal of PCBs will eliminate a major area of persistent bioaccumulative toxicants from White Lake.

4.7 Sediment Quality Triad Assessment of Contaminated sediments in White Lake

In order to determine the significance of the remaining areas of sediment contamination, an assessment matrix (Chapman 1992) can be used to examine the relationship between chemistry, toxicity, and benthic macroinvertebrate data. An assessment matrix for the White Lake data is presented in Table 4.6.3. Stations exceeding the PEC (MacDonald et al. 2000)

TABLE 4.7.1 SEDIMENT QUALITY ASSESSMENT MATRIX FOR WHITE LAKE DATA, OCTOBER 2000. ASSESSMENT MATRIX FROM CHAPMAN (1992).

Station	Sediment Chemistry	Toxicity Test	Benthic Community	Possible Conclusions
No stations fit the criteria	+	+	+	Impact highly likely; contaminant induced degradation of sediment dwelling organisms evident
WL-17, WL-18, WL-19, WL-20	-	-	-	Impact highly unlikely; contaminant degradation of sediment dwelling organisms not likely
WL-1, WL-2, WL-3, WL-4, WL-5, WL-6, WL-7, WL-8, WL-10, WL-11, WL-13. WL-15	+	-	-	Impact unlikely; contaminants unavailable to sediment dwelling organisms
No stations fit the criteria	-	+	-	Impacts possible; Unmeasured contaminants or conditions exist that have the potential to cause toxicity
No stations fit the criteria	-	-	+	Impacts unlikely; no degradation of sediment dwelling organisms in the field apparent relative to sediment contamination; physical factors may be influencing benthic community
WL-21	+	+	-	Impact likely; toxic chemicals probably stressing system
WL-16	-	+	+	Impact likely; unmeasured toxic chemicals contributing to the toxicity
WL-9, WL-12, WL-14	+	-	+	Impact likely; sediment dwelling organisms degraded by toxic chemical, but toxicity tests not sensitive to chemicals present

+ = Indicator classified as affected; as determined based on comparison to the PEC or control site

- = Indicator not classified as affected; as determined based on comparison to the PEC or control site were classified as having a potential impact from sediment chemistry. Toxicity and benthic community impacts were based on observing a statistically significant difference in mortality and diversity/trophic status metrics, respectively. Using this assessment methodology, the Occidental/Hooker Chemical Outfall (WL-21), the east bay (WL-16), and the high chromium sites (WL-9, WL-12, and WL-14) were likely to be impacted by contaminated sediments. None of the stations were positive for all three components of the triad. Station WL-21 had levels of chromium and PCBs that exceeded the PEC and solid phase toxicity. The benthic community at this location was not significantly different from the other deep stations in White Lake. Given the organically enriched conditions present in the sediment, it is difficult to detect a toxic response in the benthos above effects caused by eutrophication. Sediments from WL-16 exhibited solid phase toxicity and impacted benthic invertebrates. None of the chemicals however were at sufficient concentrations to produce the toxic effect. Stations WL-9, WL-12, and WL-14 had chromium levels above the PEC, no solid phase toxicity, and a marginally impacted benthic community. Nematodes were the most abundant organism at these locations while tubificids dominated the other stations. Based on the Assessment Matrix, ecological impairments exist at all of these sites due to contaminated sediments. Stations WL-17, WL-18, WL-19, and WL-20 did not exhibit solid phase toxicity, benthic impairment, or contaminant concentrations above the PEC. While the remaining stations exceeded the chromium PEC, solid phase toxicity was absent and the benthic community was similar to WL-17, WL-18, and WL-19. Because of these findings, impacts from contaminated sediments were not anticipated at these locations.

In consideration of the remediation of the sediments in Tannery Bay and near the Occidental/Hooker Chemical Outfall, the source of impairments due to chromium and PCBs in White Lake should be eliminated. While dredging should remove all of the sediment containing harmful levels of PCBs, the extent of chromium contamination throughout western White Lake and the cost of remediation make removal an unfeasible alternative. Natural attenuation by the redistribution and burial of contaminated sediments appears to be the most cost effective option.

4.8 Summary And Conclusions

A Phase II investigation of the nature and extent of sediment contamination in White Lake was performed. Sediment chemistry, solid-phase toxicity, and benthic macroinvertebrates were examined at 21 locations. Since chromium was previously identified as the major contaminant in the sediments, experiments were conducted to determine the accumulation of the metal in zebra mussels, macrophytes, and chironomids. In addition, three core samples were evaluated using radiodating and stratigraphy to assess sediment stability and contaminant deposition. High levels of chromium were found to cover a majority of the lake bottom and extend 8 km from the Tannery Bay. All locations sampled west of Tannery Bay exceeded the Probable Effect Concentration (PEC). Most of the chromium was found in the top 51 cm of the core samples. High concentrations of PCBs were found near the outfall of the former Occidental/Hooker Chemical facility. These levels also exceeded PEC guidelines. Sediment toxicity was observed in the east bay area and at the Occidental/Hooker Chemical outfall. Toxicity near the Occidental/Hooker Chemical outfall was probably due to the presence of PCBs. No obvious toxicant was present in the sediments from the east bay.

While no relationship was previously observed for total chromium and amphipod toxicity, a significant correlation was found for the organically bound fraction. Elevated levels of organic chromium were found in archived sediments from Tannery Bay. Benthic macroinvertebrate communities throughout White Lake were found to be indicative of organically enriched conditions. Invertebrate community structure of locations in the east bay were significantly different than reference sites, as indicated by a shift to chironomids that were predators and sprawlers. Chironomid populations in the remainder of the lake were burrowers and detritivores. Higher densities of nematodes and reduced tubificid populations were associated with the stations with elevated chromium levels (> 400 mg/kg). The metal also was correlated with an increase in the trophic status of chironomid populations. Chromium accumulation was observed in chironomid populations throughout White Lake. In addition, macrophytes and zebra mussels in Tannery Bay were observed to accumulate the metal in their tissue.

All of the stratigraphy cores showed uniform levels of chromium deposition in the top 10 - 15 cm. This pattern suggested that a constant source of chromium was present in White Lake. A standard exponential decay pattern was absent in the lower sections of the cores, indicating that historical changes in sedimentation were caused by episodic events. These data coupled with chromium contour maps and the generalized circulation pattern of the lake were used to elucidate the fate and transport of the metal. The proximity to the drowned rivermouth currents at the Narrows and the wind induced resuspension in the bay provided conditions that facilitated the advection and dispersion a sediment plume 8 km from its source. Higher concentrations of chromium were found in the three deep deposition basins (300-500 mg/kg). In contrast, the PCBs discharged by the Occidental/Hooker Chemical outfall remained within 100 m of the outfall pipe. The depth of the discharge (15 m) plus the depositional nature of the discharge zone acted to confine the contaminants to a small area. The removal of contaminated sediments in Tannery Bay and the Occidental/Hooker outfall was completed in October 2003. Both remedial actions were essential for the recovery of White Lake. Remediation at Tannery Bay removed the ongoing source of chromium contamination while dredging the Occidental/Hooker outfall reduced the amount of bioaccumulative compounds in the lake.

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5.0 Recommendations

The remediation of contaminated sediments in Tannery Bay and in the vicinity of the Occidental/Hooker Chemical outfall provide a unique opportunity monitor the restoration of these areas and effects on the ecology of White Lake. The following recommendations are based on the results of this investigation and the completion of the above sediment remediation:

1. East Bay. Solid phase toxicity and an impaired benthic community were identified in the current and previous investigations. Conventional analyses for metals and organic compounds were unable to identify a toxicant. In consideration that the east bay contains one of the few undeveloped littoral zones, it is important to identify the source of the toxicity and the benthic impairment. A Toxicity Identification Evaluation (TIE) study should be conducted to evaluate the nature of the toxicant. Tannin levels in the sediments should also be evaluated. Once the toxic agent(s) have been identified, remediation and restoration options can be developed.
2. The removal of contaminated sediments from Tannery Bay and in the vicinity of the Occidental/Hooker Chemical outfall remediated the two major source areas responsible for the Area of Concern designation for White Lake. In order to prepare for future delisting activities, it is important to initiate a lake wide monitoring program to evaluate the effectiveness of the remediation. Annual monitoring of sediment chemistry, toxicity, benthic macroinvertebrates, and the macrophyte community should be conducted in the remediated areas to determine whether the influx of contaminants has ceased and a stable benthic community is established. In addition, sediment chemistry and benthic macroinvertebrates should be examined on a lake wide scale to evaluate the effects of reduced chromium loading on the ecosystem. The stations used in this investigation will provide a solid data set that describes the condition of the lake prior to remediation. Since the sampling locations reflect a broad range of chromium concentrations and depths, the data from this investigation will provide a baseline to evaluate changes in specific areas of elevated contamination and on a lake wide scale.
3. No sediment contamination related to the DuPont groundwater plume was detected in the investigation. Based on these results, questions related to contaminated sediments should not prevent the disposition of the DuPont property west of Long Point.
4. The only remaining site with potential sediment contamination is the Mill Pond area downstream from Koch Chemical. This site should be investigated since hazardous chemicals were discharged in the creek and the area is residential.

Appendices

Appendix A. Quality Assurance Review of the Project Data.

QA/QC Analysis Checklist for
SEDIMENT CHEMISTRY ANALYSIS

GRANT/IAG NUMBER: GL- GL975368-01-0
PROJECT NAME: Phase II Investigation of Sediment Contamination in White Lake
REVIEWER: Richard Rediske
DATE: 6-26-03

1. What sediment chemistry data has been collected (CHECK ALL THAT APPLY)?

   Total Metals ___X__ PCBs _____ pH _____ TOC _X____
   Dioxins/Furans _____ PAHs ___X__Pesticides ___X__ DO _____AVS _____
   SEM Metals _____ Particle Size _X____ Other Semivolatile Organics X

2. Were the target detection limits met for each parameter?

   YES ____
   NO X (UNACCEPTABLE) (Target Detection Limits were not met for semivolatile organics due to low % solids))

3. Were the Method Blanks less than the established MDL for each parameter?

   YES X
   NO _____ (UNACCEPTABLE)

4. Did the results of Field Duplicate Analysis vary by less than the % RPD specified in the QAPP?

   YES X
   NO _____ (UNACCEPTABLE)

5. Did the results of the Field Replicates Analysis vary by less than the % RPD specified in the QAPP?

   YES X Field replicates were not required in the QAPP
   NO _____ (UNACCEPTABLE)

6. Did the surrogate spike recoveries meet the limits set forth in the QAPP?

   YES X
   NO _____ (UNACCEPTABLE)

7. Did the MS/MSD recoveries meet the limits set forth in the QAPP?

YES ___X__
NO _____

8. Did the RPD (%) of the MS/MSD sample set meet the limits set forth in the QAPP?

YES __X___
NO _____

9. Did the initial calibration verification standards meet the requirements set forth in the QAPP?

YES X
NO _____ (UNACCEPTABLE)

10.. Were any level of contaminants detected above the MDL for the trip blanks and storage blanks?

YES _____ (UNACCEPTABLE)
NO X Trip and Storage blanks were not required in the QAPP

11. Did all required analysis take place within the required holding time protocols set forth in the QAPP?

YES X
NO _____ (UNACCEPTABLE)

12. Did the laboratory duplicates vary by less than the % RPD specified in the QAPP?

YES X
NO _____ (UNACCEPTABLE)

13. Are measured dry weight contaminant concentrations reported? (Note: Conversion from wet weight to dry weight concentration may occur ONLY if data on moisture or TOC are provided. Nominal concentrations are unacceptable.)

YES X
NO _____ (UNACCEPTABLE)

14. Please provide details for all of the "UNACCEPTABLE" marked above. Include details on the specific analytes affected by any QA/QC discrepancies, and recommendations regarding usability of data.

Sediment samples had very low % solids that resulted in raising the detection limits for semivolatiles. The results are listed in the data tables. A larger sample volume should be used at these locations if additional assessments are made. Target detection limits were achieved on all other samples.

QA/QC Analysis Checklist for
ACUTE AND CHRONIC WHOLE SEDIMENT TOXICITY TESTS
(10-day*C. tentans* and 10-day or 28-day *H. azteca*)

GRANT/IAG NUMBER: GL975368-01-0
PROJECT NAME: Phase II Investigation of Sediment Contamination in White Lake
REVIEWER: Richard Rediske
DATE: 2-26-02

1. Did toxicity tests employ appropriate procedures? [ASTM: E1367, E1611, E1706, USEPA (2000)]

YES X
NO _____ (UNACCEPTABLE)

2. Does sample storage time exceed the allowable storage time specified in the QAPP?

Allowable Storage Days Specified in QAPP 45
Number of Storage Days Prior to Testing 14 DYAS AND 30 DAYS

YES _____ (UNACCEPTABLE)
NO X

3. Was the age for H. azteca organisms between 7- to 14-days at the start of the test with an age range less than 2-days?

YES X
NO _____ (UNACCEPTABLE)

4A. Were all of the C. tentans organisms second- to third-stage larvae with at least 50% at the third instar?

YES X
NO _____ (UNACCEPTABLE)

4B. How was the developmental stage of the C. tentans larvae measured?

Head Capsule Width _____ (See Table 10.2 of EPA/600/R-99/064, March 2000)
Length X (Should fall between 4 mm to 6 mm)
Weight _____ (Should fall between 0.08 to 0.23 mg/individual)

5. Do flow rates through the different test chambers differ by more than 10% at any particular time during the test?

YES _____ (UNACCEPTABLE)
NO X (QAPP REQUIRED 2X DAILY RENEWAL OF OVERLYING WATER INSTEAD OF FLOW THROUGH)

6. Did Dissolved Oxygen remain above 2.5 mg/L?

YES X
NO _____ (Provide Explanation at end of Checklist)

7. Does daily mean Temperature remain at 23 ± 1°C?

YES X
NO _____ (UNACCEPTABLE)

8. Does the instantaneous Temperature remain in the range of 23 ± 3EC?

YES X
NO _____ (UNACCEPTABLE)

9. Do the Ranges of for Hardness, Alkalinity, pH, and Ammonia fluctuate more than 50% from the mean?

Maximum % Difference:

DO	30%	Alk	22%
pH	6%	NH_3	50%

YES _____ (UNACCEPTABLE)
NO _____

10. Was the Ammonia concentration ever greater than 20 mg/L?

YES _____ (See EPA/600/R-99/064, March 2000 to determine if ammonia contributed to toxicity of H. azteca.)
NO X

11. Was the Ammonia concentration greater than 82 mg/L?

YES _____ (See EPA/600/R-99/064, March 2000 to determine if ammonia contributed to toxicity of C. tentans)
NO X

12. Was the Mean Control Survival in the *H. azteca* Control Sediments greater than or equal to 80%?

YES X
NO _____ (UNACCEPTABLE)

13. Was the Mean Control Survival in the *C. tentans* Control Sediments greater than or eqaul to 70%?

YES X
NO _____ (UNACCEPTABLE)

14. Was the mean weight per surviving C. tentans control organism greater than 0.48 mg (ash-free dry weight)?

YES X QAPP used dry weight of 0.8 mg/ individual. This was achieved.
NO _____ (UNACCEPTABLE)

15. Was the overlying water renewed at a rate of 2 volumes per day?

YES X
NO _____ (UNACCEPTABLE)

16. Please provide details for all of the "UNACCEPTABLE" responses marked above. Include details on the specific results that potentially may be affected by any QA/QC discrepancies, and recommendations regarding usability of data.

All discrepancies were related to following methods approved in the project QAPP.

Appendix B. Results Physical Analyses On White Lake Sediments, October 2000

TABLE B-1. RESULTS OF GRAIN SIZE, TOC, AND % SOLIDS ANALYSES ON WHITE LAKE SEDIMENT CORE SAMPLES. OCTOBER 2000.

Sample ID	>2000 um Weight %	2000-1000 um Weight%	1000-850 um Weight %	850-500 um Weight %	500-125 um Weight %	125-63 um Weight %	<63 um Weight %	TOC %	Solids %
WL-1 TOP	0	0	0	0	2	6	92	3.9	12
WL-1 MID	0	0	0	0	13	9	78	11	14
WL-1 BOT	0	0	0	0	7	9	84	9.5	15
WL-1 TOP DUP	0	0	0	0	2	6	92	3.1	11
WL-1 MID DUP	0	0	0	0	6	9	86	1.5	15
WL-1 BOT DUP	0	0	0	0	12	12	75	9	14
WL-2 TOP	1	0	0	0	4	4	92	6.5	11
WL-2 MID	0	0	0	0	13	9	77	10	15
WL-2 BOT	0	0	0	2	90	2	5	<1.0	67
WL-3 TOP	0	0	0	0	4	8	87	2.2	13
WL-3 MID	0	0	0	1	23	11	65	4.8	18
WL-3 TOP	0	0	0	0	7	9	84	8.1	15
WL-4 TOP	0	0	0	0	10	14	76	2.9	13
WL-4MID	0	0	0	3	80	3	13	<1.0	53
WL-5 TOP	0	0	0	0	7	12	81	5.8	12
WL-5 MID	0	0	0	0	9	12	79	8.9	15
WL-5 BOT	0	0	0	0	6	10	84	7.2	15
WL-6 TOP	0	0	0	0	2	5	93	3.0	17
WL-6 MID	1	0	0	2	43	8	46	10	38
WL-6 BOT	0	0	0	1	8	13	78	3.0	16
WL-7 TOP	0	0	0	0	8	12	80	3.6	12
WL7 MID	0	0	0	0	11	17	72	10	16
WL-7 BOT	0	0	0	0	8	18	75	10	15
WL-8 TOP	0	0	0	0	8	16	76	6.6	12
WL-8 MID	0	0	0	0	8	11	80	1.2	15
WL-8 BOT	0	1	0	0	6	12	83	1.3	16
WL-9 TOP	0	1	0	0	9	14	76	7.5	13
WL-9-MID	0	0	0	0	9	10	81	7.1	15
WL-9 BOT	0	0	0	0	7	11	81	8.1	16
WL-10 TOP	6	0	0	0	23	6	71	<1.0	14
WL-10 MID	0	0	0	0	11	10	79	9.7	15
WL-10 BOT	0	0	0	0	6	7	87	8.9	14
WL-21 TOP	0	0	0	0	10	5	84	2.7	20
WL-21 MID	0	0	0	1	10	15	74	7.1	16
WL-21 BOT	0	0	0	1	6	6	86	3.4	13

TABLE B-2. RESULTS OF GRAIN SIZE, TOC, AND % SOLIDS ANALYSES ON WHITE LAKE SEDIMENT SAMPLES. OCTOBER 2000.

Sample ID	>2000 um Weight %	2000-1000 um Weight%	1000-850 um Weight %	850-500 um Weight %	500-125 um Weight %	125-63 um Weight %	<63 um Weight %	TOC %	Solids %
WL-1 P	0	0	0	0	4	5	91	<1.0	7
WL-2 P	0	0	0	0	6	5	88	3.5	10
WL-3 P	0	0	0	0	4	5	90	3.0	10
WL-4 P	0	0	0	5	82	2	11	<1.0	61
WL-5 P	0	0	0	0	6	10	83	5.0	11
WL-6 P	0	0	0	0	5	7	88	4.4	10
WL-7 P	0	0	0	0	7	10	83	6.6	10
WL-8 P	0	0	0	0	8	10	82	5.5	11
WL-9 P	0	0	0	0	7	9	83	6.4	11
WL-10 P	0	0	0	0	5	5	89	2.2	10
WL-11 P	0	0	0	0	7	9	84	6.0	11
WL-12 P	1	0	0	0	6	9	84	7.1	11
WL-13 P	0	0	0	0	30	14	55	5.0	15
WL-14 P	1	0	0	0	13	10	76	18	13
WL-15 P	1	0	0	0	6	10	83	7.4	12
WL-16 P	0	0	0	0	3	7	90	10	14
WL-17 P	0	0	0	0	5	10	84	10	15
WL-18 P	0	0	0	0	8	8	84	11	16
WL-19 P	0	0	0	0	6	11	83	11	15
WL-20 P	0	0	0	0	11	17	70	8.5	16
WL-21 P	0	0	0	1	19	9	71	5.6	13
WL-22 P	6	2	0	1	12	13	65	4.6	11
WL-23 P	3	3	1	2	10	9	73	5.9	12
WL-24 P	3	1	0	1	12	7	76	8.2	15

TABLE B-3. TOC MATRIX SPIKE AND MATRIX SPIKE DUPLICATE RESULTS FOR WHITE LAKE SEDIMENT SAMPLES. OCTOBER 2000.

Matrix Spike Data

Sample ID	Sample OC mg	MS OC mg	Matrix Spike Conc. mg	% Recovery
WL-5 Top	6.1	20.2	12.4	114
WL-6 Bot	2.6	56.9	52.9	103
WL-9 Top	8.0	28.7	21.0	98
WL-21 Top	2.7	22.3	18.6	106
WL-5 P	5.0	26.5	23.5	91
WL-14 P	7.2	31.8	25.1	98
WL-18 P	9.0	36.1	26.7	101

Matrix Spike Duplicate Data

Sample ID	Sample OC mg	MSD OC mg	Matrix Spike Conc. mg	% Recovery	RPD*
WL-5 Top	6.1	30.9	23.4	106	8
WL-6 Bot	2.6	33.1	29.1	105	2
WL-9 Top	8.0	41.5	34.1	98	0
WL-21 Top	2.7	19.9	18.6	92	13
WL-5 P	5.0	31.4	25.8	102	11
WL-14 P	7.2	29.8	22.7	99	8
WL-18 P	9.0	30.1	21.6	98	0

* RPD was calculated using the % recoveries for the ms and msd.
Different amounts (mg) of sample and spike were used for the ms and msc

TABLE B-4. QUALITY CONTROL RESULTS FOR GRAIN SIZE ANALYSES ON WHITE LAKE SEDIMENT SAMPLES. OCTOBER 2000.

Sample ID	>2000 um Weight %	2000-1000 um Weight%	1000-850 um Weight %	850-500 um Weight %	500-125 um Weight %	125-63 um Weight %	<63 um Weight %
WL-2 Bot	0	0	0	2	90	2	5
WL-2 Bot Dup	0	0	0	3	90	2	5
WL-4 Mid	0	0	0	3	81	2	12
WL-4 Mid Dup	0	0	0	3	81	3	12
Wl-6 Mid	1	0	0	2	43	8	46
WL-6 Mid Dup	0	1	0	2	42	7	47
WL-10 P	0	0	0	0	5	5	89
WL-10 P Dup	0	0	0	0	6	5	90
WL-15 P	1	0	0	0	6	11	83
WL-15 P Dup	0	0	0	0	6	10	83
WL-18 P	0	0	0	0	8	8	84
WL-18 P Dup	1	0	0	1	6	11	82
WL-21 P	0	0	0	1	19	9	71
WL-21 P Dup	0	0	0	1	17	9	73

Appendix C. Organic Analyses On White Lake Sediments, October 2000.

TABLE C-1. RESULTS OF SEMIVOLATILE ORGANIC ANALYSES ON WHITE LAKE SEDIMENTS, OCTOBER 2000. (MG/KG DRY WT)

	WL-1			WL-1 Dup			WL-2		WL-3			WL-4	
	Top	Middle	Bottom	Top	Middle	Bottom	Top	Middle	Top	Middle	Bottom	Top	Middle
PCB-1016	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
PCB-1221	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
PCB-1232	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
PCB-1242	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
PCB-1248	**0.22**	< 0.33	< 0.33	**0.44**	< 0.33	**0.06**	**0.06** **0.07**	< 0.33	**0.06**	< 0.33	**0.06**	< 0.33	< 0.33
PCB-1254	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
PCB-1260	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
1,2,4-TRICHLOROBENZENE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
1,2-DICHLOROBENZENE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
1,3-DICHLOROBENZENE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
1,4-DICHLOROBENZENE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
2,4,5-TRICHLOROPHENOL	< 8.6	< 6.1	< 6.1	< 8.6	< 6.1	< 6.1	< 8.6	< 6.1	< 7.2	< 4.8	< 5.4	< 6.6	< 1.7
2,4,6-TRICHLOROPHENOL	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
2,4-DICHLOROPHENOL	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
2,4-DIMETHYLPHENOL	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
2,4-DINITROPHENOL	< 8.6	< 6.1	< 6.1	< 8.6	< 6.1	< 6.1	< 8.6	< 6.1	< 7.2	< 4.8	< 5.4	< 6.6	< 1.7
2,4-DINITROTOLUENE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
2,6-DINITROTOLUENE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
2-CHLORONAPHTHALENE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
2-CHLOROPHENOL	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
2-METHYLNAPHTHALENE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
2-METHYLPHENOL	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
2-NITROANILINE	< 8.6	< 6.1	< 6.1	< 8.6	< 6.1	< 6.1	< 8.6	< 6.1	< 7.2	< 4.8	< 5.4	< 6.6	< 1.7
2-NITROPHENOL	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
3,3'-DICHLOROBENZIDINE	< 10	< 7.2	< 7.2	< 10	< 7.2	< 7.2	< 10	< 7.2	< 8.4	< 5.6	< 6.3	< 7.8	< 2.0
3-NITROANILINE	< 8.6	< 6.1	< 6.1	< 8.6	< 6.1	< 6.1	< 8.6	< 6.1	< 7.2	< 4.8	< 5.4	< 6.6	< 1.7
4,6-DINITRO- 2-METHYLPHENOL	< 8.6	< 6.1	< 6.1	< 8.6	< 6.1	< 6.1	< 8.6	< 6.1	< 7.2	< 4.8	< 5.4	< 6.6	< 1.7
4-BROMOPHENYL PHENYLETHER	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
4-CHLORO-3-METHYLPHENOL	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
4-CHLOROANILINE	< 6.6	< 4.7	< 4.7	< 6.6	< 4.7	< 4.7	< 6.6	< 4.7	< 5.5	< 3.7	< 4.1	< 5.1	< 1.3
4-CHLOROPHENYLPHENYL- ETHER	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
4-METHYLPHENOL	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
4-NITROANILINE	< 8.6	< 6.1	< 6.1	< 8.6	< 6.1	< 6.1	< 8.6	< 6.1	< 7.2	< 4.8	< 5.4	< 6.6	< 1.7
4-NITROPHENOL	< 8.6	< 6.1	< 6.1	< 8.6	< 6.1	< 6.1	< 8.6	< 6.1	< 7.2	< 4.8	< 5.4	< 6.6	< 1.7
ACENAPHTHENE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
ACENAPHTHYLENE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
ANTHRACENE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
BENZO (A) ANTHRACENE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
BENZO (A) PYRENE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
BENZO (B) FLUORANTHENE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
BENZO (G,H,I,) PERYLENE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
BENZO (K) FLUORANTHENE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
BIS (2-CHLOROETHOXY)- METHANE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
BIS (2-CHLOROETHYL) ETHER	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
BIS (2-CHLOROISOPROPYL)- ETHER	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
BIS (2-ETHYLHEXYL)- PHTHALATE	**0.38**	< 1.2	**0.26**	< 1.7	**0.42**	**0.32**	**0.56**	**0.35**	**0.99**	< 0.93	**0.06**	**0.17**	< 0.33
BUTYL BENZYL PHTHALATE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
CARBAZOLE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
CHRYSENE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
DI-N-BUTYLPHTHALATE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
DI-N-OCTYLPHTHALATE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
DIBENZO (A,H) ANTHRACENE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
DIBENZOFURAN	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
DIETHYLPHTHALATE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
DIMETHYLPHTHALATE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
FLUORANTHENE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
FLUORENE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
HEXACHLOROBENZENE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
HEXACHLOROBUTADIENE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
HEXACHLOROCYCLOPENTADIENE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
HEXACHLOROETHANE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
INDENO (1,2,3-CD) PYRENE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
ISOPHORONE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
N-NITROSO-DI-PHENYLAMINE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
N-NITROSODI-N-PROPYLAMINE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
NAPHTHALENE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
NITROBENZENE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
PENTACHLOROPHENOL	< 8.6	< 6.1	< 6.1	< 8.6	< 6.1	< 6.1	< 8.6	< 6.1	< 7.2	< 4.8	< 5.4	< 6.6	< 1.7
PHENANTHRENE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
PHENOL	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33
PYRENE	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.2	< 1.7	< 1.2	< 1.4	< 0.93	< 1.0	< 1.3	< 0.33

TABLE C-1 (CONTINUED). RESULTS OF SEMIVOLATILE ORGANIC ANALYSES ON WHITE LAKE SEDIMENTS, OCTOBER 2000.

	WL-5			WL-6			WL-7			WL-8			WL-9		
	Top	Middle	Bottom	Top	Middle	Bottom	Top	Middle	Botom	Top	Middle	Bottom	Top	Middle	Botom
PCB-1016	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
PCB-1221	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
PCB-1232	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
PCB-1242	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
PCB-1248	**0.17**	< 0.33	< 0.33	**0.39**	< 0.33	< 0.33	**0.24**	< 0.33	< 0.33	**0.27**	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
PCB-1254	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
PCB-1260	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
1,2,4-TRICHLOROBENZENE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
1,2-DICHLOROBENZENE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
1,3-DICHLOROBENZENE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
1,4-DICHLOROBENZENE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
2,4,5-TRICHLOROPHENOL	< 6.6	< 6.1	< 5.4	< 5.7	< 2.4	< 2.3	< 7.8	< 5.8	< 5.4	< 6.6	< 5.8	< 5.4	< 7.1	< 5.8	< 5.4
2,4,6-TRICHLOROPHENOL	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
2,4-DICHLOROPHENOL	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
2,4-DIMETHYLPHENOL	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
2,4-DINITROPHENOL	< 6.6	< 6.1	< 5.4	< 5.7	< 2.4	< 2.3	< 7.8	< 5.8	< 5.4	< 6.6	< 5.8	< 5.4	< 7.1	< 5.8	< 5.4
2,4-DINITROTOLUENE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
2,6-DINITROTOLUENE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
2-CHLORONAPHTHALENE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
2-CHLOROPHENOL	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
2-METHYLNAPHTHALENE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
2-METHYLPHENOL	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
2-NITROANILINE	< 6.6	< 6.1	< 5.4	< 5.7	< 2.4	< 2.3	< 7.8	< 5.8	< 5.4	< 6.6	< 5.8	< 5.4	< 7.1	< 5.8	< 5.4
2-NITROPHENOL	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
3,3'-DICHLOROBENZIDINE	< 7.8	< 7.2	< 6.4	< 6.7	< 2.8	< 2.7	< 9.2	< 6.8	< 6.4	< 7.8	< 6.8	< 6.4	< 8.4	< 6.8	< 6.4
3-NITROANILINE	< 6.6	< 6.1	< 5.4	< 5.7	< 2.4	< 2.3	< 7.8	< 5.8	< 5.4	< 6.6	< 5.8	< 5.4	< 7.1	< 5.8	< 5.4
4,6-DINITRO- 2-METHYLPHENOL	< 6.6	< 6.1	< 5.4	< 5.7	< 2.4	< 2.3	< 7.8	< 5.8	< 5.4	< 6.6	< 5.8	< 5.4	< 7.1	< 5.8	< 5.4
4-BROMOPHENYL PHENYLETHER	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
4-CHLORO-3-METHYLPHENOL	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
4-CHLOROANILINE	< 5.1	< 4.7	< 4.2	< 4.4	< 1.8	< 1.8	< 6.0	< 4.4	< 4.2	< 5.1	< 4.4	< 4.2	< 5.5	< 4.4	< 4.2
4-CHLOROPHENYLPHENYL- ETHER	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
4-METHYLPHENOL	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
4-NITROANILINE	< 6.6	< 6.1	< 5.4	< 5.7	< 2.4	< 2.3	< 7.8	< 5.8	< 5.4	< 6.6	< 5.8	< 5.4	< 7.1	< 5.8	< 5.4
4-NITROPHENOL	< 6.6	< 6.1	< 5.4	< 5.7	< 2.4	< 2.3	< 7.8	< 5.8	< 5.4	< 6.6	< 5.8	< 5.4	< 7.1	< 5.8	< 5.4
ACENAPHTHENE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
ACENAPHTHYLENE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
ANTHRACENE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
BENZO (A) ANTHRACENE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
BENZO (A) PYRENE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
BENZO (B) FLUORANTHENE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
BENZO (G,H,I,) PERYLENE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
BENZO (K) FLUORANTHENE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
BIS (2-CHLOROETHOXY)- METHANE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
BIS (2-CHLOROETHYL) ETHER	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
BIS (2-CHLOROISOPROPYL)- ETHER	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
BIS (2-ETHYLHEXYL)- PHTHALATE	< 1.3	< 1.2	< 1.1	**0.22**	**0.19**	**0.14**	**0.28**	**0.25**	< 1.1	**0.25**	< 1.1	< 1.1	< 1.4	< 1.1	**0.23**
BUTYL BENZYL PHTHALATE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
CARBAZOLE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
CHRYSENE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
DI-N-BUTYLPHTHALATE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	**0.99**	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
DI-N-OCTYLPHTHALATE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
DIBENZO (A,H) ANTHRACENE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
DIBENZOFURAN	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
DIETHYLPHTHALATE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
DIMETHYLPHTHALATE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
FLUORANTHENE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
FLUORENE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
HEXACHLOROBENZENE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
HEXACHLOROBUTADIENE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
HEXACHLOROCYCLOPENTADIENE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
HEXACHLOROETHANE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
INDENO (1,2,3-CD) PYRENE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
ISOPHORONE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
N-NITROSO-DI-PHENYLAMINE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
N-NITROSODI-N-PROPYLAMINE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
NAPHTHALENE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
NITROBENZENE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
PENTACHLOROPHENOL	< 6.6	< 6.1	< 5.4	< 5.7	< 2.4	< 2.3	< 7.8	< 5.8	< 5.4	< 6.6	< 5.8	< 5.4	< 7.1	< 5.8	< 5.4
PHENANTHRENE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
PHENOL	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1
PYRENE	< 1.3	< 1.2	< 1.1	< 1.1	< 0.46	< 0.45	< 1.5	< 1.1	< 1.1	< 1.3	< 1.1	< 1.1	< 1.4	< 1.1	< 1.1

TABLE C-1 (CONTINUED). RESULTS OF SEMIVOLATILE ORGANIC ANALYSES ON WHITE LAKE SEDIMENTS, OCTOBER 2000.

	WL-10			WL-21		WL-1P	WL-1P	WL-2P	WL-3P	WL-4P	WL-5P	WL-6P	WL-7P	WL-8P	WL-9P
	Top	Middle	Bottom	Top	Middle		Dup								
PCB-1016	< 0.33	< 0.33	< 0.33	< 0.33	< 0.98	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
PCB-1221	< 0.33	< 0.33	< 0.33	< 0.33	< 0.98	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
PCB-1232	< 0.34	< 0.34	< 0.33	< 0.33	< 0.99	< 0.33	< 0.33	0.34	< 0.34	< 0.34	< 0.34	< 0.34	< 0.34	< 0.34	< 0.33
PCB-1242	< 0.33	< 0.33	< 0.33	< 0.33	< 0.98	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
PCB-1248	**0.06**	**0.06**	< 0.33	**22**	**0.84**	< 0.33	< 0.33	**0/09**	< 0.33	< 0.33	< 0.33	**0.07**	**0.08**	**0.08**	< 0.33
PCB-1254	< 0.33	< 0.33	< 0.33	< 0.33	< 0.98	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
PCB-1260	< 0.33	< 0.33	< 0.33	< 0.33	< 0.98	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
					< 0.98										
1,2,4-TRICHLOROBENZENE	< 1.1	< 1.1	< 1.2	< 1.2	< 5.0	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
1,2-DICHLOROBENZENE	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
1,3-DICHLOROBENZENE	< 1.1	< 1.1	< 1.2	**1.9**	**0.29**	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
1,4-DICHLOROBENZENE	< 1.1	< 1.1	< 1.2	**0.65**	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
2,4,5-TRICHLOROPHENOL	< 5.8	< 5.8	< 6.1	< 6.1	< 0.98	< 9.2	< 8.6	< 7.8	< 1.7	< 8.8	< 7.8	< 8.6	< 8.6	< 7.8	< 8.6
2,4,6-TRICHLOROPHENOL	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
2,4-DICHLOROPHENOL	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
2,4-DIMETHYLPHENOL	< 1.1	< 1.1	< 1.2	< 1.2	< 5.0	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
2,4-DINITROPHENOL	< 5.8	< 5.8	< 6.1	< 6.1	< 0.98	< 9.2	< 8.6	< 7.8	< 1.7	< 8.8	< 7.8	< 8.6	< 8.6	< 7.8	< 8.6
2,4-DINITROTOLUENE	< 1.1	< 1.1	< 1.2	< 1.2	< 5.9	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
2,6-DINITROTOLUENE	< 1.1	< 1.1	< 1.2	< 1.2	< 5.0	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
2-CHLORONAPHTHALENE	< 1.1	< 1.1	< 1.2	< 1.2	< 5.0	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
2-CHLOROPHENOL	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
2-METHYLNAPHTHALENE	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
2-METHYLPHENOL	< 1.1	< 1.1	< 1.2	< 1.2	< 3.9	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
2-NITROANILINE	< 5.8	< 5.8	< 6.1	< 6.1	< 0.98	< 9.2	< 8.6	< 7.8	< 1.7	< 8.8	< 7.8	< 8.6	< 8.6	< 7.8	< 8.6
2-NITROPHENOL	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
3,3'-DICHLOROBENZIDINE	< 6.8	< 6.8	< 7.2	< 7.2	< 5.0	< 11	< 10	< 9.2	< 2.0	< 10	< 9.2	< 10	< 10	< 9.2	< 10
3-NITROANILINE	< 5.8	< 5.8	< 6.1	< 6.1	< 5.0	< 9.2	< 8.6	< 7.8	< 1.7	< 8.8	< 7.8	< 8.6	< 8.6	< 7.8	< 8.6
4,6-DINITRO- 2-METHYLPHENOL	< 5.8	< 5.8	< 6.1	< 6.1	< 0.98	< 9.2	< 8.6	< 7.8	< 1.7	< 8.8	< 7.8	< 8.6	< 8.6	< 7.8	< 8.6
4-BROMOPHENYL PHENYLETHER	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
4-CHLORO-3-METHYLPHENOL	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
4-CHLOROANILINE	< 4.4	< 4.4	< 4.7	< 4.7	< 0.98	< 7.1	< 6.6	< 6.0	< 1.3	< 6.7	< 6.0	< 6.6	< 6.6	< 6.0	< 6.6
4-CHLOROPHENYLPHENYL- ETHER	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
4-METHYLPHENOL	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
4-NITROANILINE	< 5.8	< 5.8	< 6.1	< 6.1	< 0.98	< 9.2	< 8.6	< 7.8	< 1.7	< 8.8	< 7.8	< 8.6	< 8.6	< 7.8	< 8.6
4-NITROPHENOL	< 5.8	< 5.8	< 6.1	< 6.1	< 0.98	< 9.2	< 8.6	< 7.8	< 1.7	< 8.8	< 7.8	< 8.6	< 8.6	< 7.8	< 8.6
ACENAPHTHENE	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
ACENAPHTHYLENE	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
ANTHRACENE	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
BENZO (A) ANTHRACENE	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
BENZO (A) PYRENE	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
BENZO (B) FLUORANTHENE	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
BENZO (G,H,I,) PERYLENE	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
BENZO (K) FLUORANTHENE	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
BIS (2-CHLOROETHOXY)- METHANE	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
BIS (2-CHLOROETHYL) ETHER	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
BIS (2-CHLOROISOPROPYL)- ETHER	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
BIS (2-ETHYLHEXYL)- PHTHALATE	**0.25**	< 1.1	< 1.2	**0.94**	**0.54**	**0.92**	< 1.7	< 1.5	**0.31**	< 1.7	**0.62**	**0.32**	**0.35**	**1.3**	< 1.7
BUTYL BENZYL PHTHALATE	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
CARBAZOLE	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
CHRYSENE	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
DI-N-BUTYLPHTHALATE	< 1.1	< 1.1	**0.84**	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	**0.30**	**0.25**	< 1.7
DI-N-OCTYLPHTHALATE	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
DIBENZO (A,H) ANTHRACENE	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
DIBENZOFURAN	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
DIETHYLPHTHALATE	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
DIMETHYLPHTHALATE	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
FLUORANTHENE	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
FLUORENE	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
HEXACHLOROBENZENE	< 1.1	< 1.1	< 1.2	**0.54**	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
HEXACHLOROBUTADIENE	< 1.1	< 1.1	< 1.2	**0.081**	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
HEXACHLOROCYCLOPENTADIENE	< 1.1	< 1.1	< 1.2	**0.036**	< 5.0	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
HEXACHLOROETHANE	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
INDENO (1,2,3-CD) PYRENE	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
ISOPHORONE	< 1.1	< 1.1	< 1.2	< 1.2	< 0.98	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
N-NITROSO-DI-PHENYLAMINE	< 1.1	< 1.1	< 1.2	< 1.2	< 0.46	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
N-NITROSODI-N-PROPYLAMINE	< 1.1	< 1.1	< 1.2	< 1.2	< 0.46	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
NAPHTHALENE	< 1.1	< 1.1	< 1.2	< 1.2	< 0.46	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
NITROBENZENE	< 1.1	< 1.1	< 1.2	< 1.2	< 0.46	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
PENTACHLOROPHENOL	< 5.8	< 5.8	< 6.1	< 6.1	< 2.4	< 9.2	< 8.6	< 7.8	< 1.7	< 8.8	< 7.8	< 8.6	< 8.6	< 7.8	< 8.6
PHENANTHRENE	< 1.1	< 1.1	< 1.2	< 1.2	< 0.46	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
PHENOL	< 1.1	< 1.1	< 1.2	< 1.2	< 0.46	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7
PYRENE	< 1.1	< 1.1	< 1.2	< 1.2	< 0.46	< 1.8	< 1.7	< 1.5	< 0.33	< 1.7	< 1.5	< 1.7	< 1.7	< 1.5	< 1.7

TABLE C-1 (CONTINUED). RESULTS OF SEMIVOLATILE ORGANIC ANALYSES ON WHITE LAKE SEDIMENTS, OCTOBER 2000.

	WL-10P	WL-11P	WL-12P	WL-13P	WL-14P	WL-15P	WL-16P	WL-17P	WL-18P	WL-19P	WL-20	WL-21
PCB-1016	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
PCB-1221	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
PCB-1232	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
PCB-1242	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	**21**
PCB-1248	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
PCB-1254	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
PCB-1260	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33	< 0.33
1,2,4-TRICHLOROBENZENE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
1,2-DICHLOROBENZENE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
1,3-DICHLOROBENZENE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
1,4-DICHLOROBENZENE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
2,4,5-TRICHLOROPHENOL	< 9.2	< 8.6	< 8.7	< 8.8	< 8.9	< 8.10	< 8.11	< 8.12	< 8.13	< 8.14	< 8.15	< 8.16
2,4,6-TRICHLOROPHENOL	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
2,4-DICHLOROPHENOL	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
2,4-DIMETHYLPHENOL	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
2,4-DINITROPHENOL	< 9.2	< 8.6	< 8.7	< 8.8	< 8.9	< 8.10	< 8.11	< 8.12	< 8.13	< 8.14	< 8.15	< 8.16
2,4-DINITROTOLUENE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
2,6-DINITROTOLUENE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
2-CHLORONAPHTHALENE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
2-CHLOROPHENOL	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
2-METHYLNAPHTHALENE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
2-METHYLPHENOL	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
2-NITROANILINE	< 9.2	< 8.6	< 8.7	< 8.8	< 8.9	< 8.10	< 8.11	< 8.12	< 8.13	< 8.14	< 8.15	< 8.16
2-NITROPHENOL	< 1.8	< 1.7	< 1.8	< 1.9	< 1.10	< 1.11	< 1.12	< 1.13	< 1.14	< 1.15	< 1.16	< 1.17
3,3'-DICHLOROBENZIDINE	< 11	< 10	< 11	< 12	< 13	< 14	< 15	< 16	< 17	< 18	< 19	< 20
3-NITROANILINE	< 9.2	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6
4,6-DINITRO- 2-METHYLPHENOL	< 9.2	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6
4-BROMOPHENYL PHENYLETHER	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
4-CHLORO-3-METHYLPHENOL	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
4-CHLOROANILINE	< 7.1	< 6.6	< 6.7	< 6.8	< 6.9	< 6.10	< 6.11	< 6.12	< 6.13	< 6.14	< 6.15	< 6.16
4-CHLOROPHENYLPHENYL- ETHER	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
4-METHYLPHENOL	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
4-NITROANILINE	< 9.2	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6
4-NITROPHENOL	< 9.2	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6
ACENAPHTHENE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
ACENAPHTHYLENE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
ANTHRACENE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
BENZO (A) ANTHRACENE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
BENZO (A) PYRENE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
BENZO (B) FLUORANTHENE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
BENZO (G,H,I,) PERYLENE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
BENZO (K) FLUORANTHENE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
BIS (2-CHLOROETHOXY)- METHANE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
BIS (2-CHLOROETHYL) ETHER	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
BIS (2-CHLOROISOPROPYL)- ETHER	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
BIS (2-ETHYLHEXYL)- PHTHALATE	**0.92**	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	**1.1**	< 1.7	< 1.7	< 1.7	< 1.7	**0.4**
BUTYL BENZYL PHTHALATE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
CARBAZOLE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
CHRYSENE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
DI-N-BUTYLPHTHALATE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
DI-N-OCTYLPHTHALATE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
DIBENZO (A,H) ANTHRACENE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
DIBENZOFURAN	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
DIETHYLPHTHALATE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
DIMETHYLPHTHALATE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
FLUORANTHENE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	**0.18**	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
FLUORENE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
HEXACHLOROBENZENE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
HEXACHLOROBUTADIENE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
HEXACHLOROCYCLOPENTADIENE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
HEXACHLOROETHANE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
INDENO (1,2,3-CD) PYRENE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
ISOPHORONE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
N-NITROSO-DI-PHENYLAMINE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
N-NITROSODI-N-PROPYLAMINE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
NAPHTHALENE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
NITROBENZENE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
PENTACHLOROPHENOL	< 9.2	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6	< 8.6
PHENANTHRENE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
PHENOL	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7
PYRENE	< 1.8	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7	**0.12**	< 1.7	< 1.7	< 1.7	< 1.7	< 1.7

TABLE C-2. SURROGATE STANDARD RECOVERIES FOR SEMIVOLATILE ORGANICS ANALYSES ON WHITE LAKE SEDIMENTS, OCTOBER 2000.

Sample	2-Fluoro biphenyl	2-Fluoro phenol	d5-Nitro benzene	d6-Phenol	o-Terphenyl	2,4,6-Tribromo phenol
WL-1 Top	77	79	61	72	66	59
WL-1 Middle	97	89	72	84	71	72
WL-1 Bottom	89	92	77	80	70	67
WL-1 Top Dup	84	82	72	76	68	63
WL-1 Middle Dup	83	82	80	79	66	63
WL-1 Bottom Dup	86	81	73	79	70	63
WL-2 Top	83	81	68	76	67	62
WL-2 Middle	72	70	64	68	61	48
WL-3 Top	89	79	73	78	69	63
WL-3 Middle	82	77	77	75	66	57
WL-3 Bottom	89	83	79	78	73	60
WL-4 Top	81	67	67	63	67	46
WL-4 Middle	90	74	61	72	65	58
WL-5 Top	63	52	49	53	52	53
WL-5 Middle	56	46	36	46	45	45
WL-5 Bottom	56	44	44	45	47	47
WL-6 Top	75	71	68	67	65	54
WL-6 Middle	77	73	34	73	70	58
WL-6 Bottom	83	66	73	65	71	56
WL-7 Top	91	71	54	68	64	73
WL-7 Middle	84	69	63	70	68	70
WL-7 Bottom	80	69	60	71	67	55
WL-8 Top	53	41	42	43	46	34
WL-8 Middle	70	57	58	56	57	56
WL-8 Bottom	65	53	46	52	55	52
WL-9 Top	63	52	51	52	52	51
WL-9 Middle	64	56	45	51	47	41
WL-9 Bottom	82	65	56	65	65	68
WL-10 Top	85	65	60	65	61	68
WL-10 Middle	86	65	70	66	65	61
WL-10 Bottom	81	70	61	69	62	65
WL-21 Top	94	78	70	72	70	72
WL-21 Middle	91	77	72	78	73	61
WL-1P	81	75	73	73	73	58
WL-2P	87	70	80	73	67	64
WL-3P	91	76	69	76	68	63
WL-5P	87	72	73	76	71	58
WL-6P	85	79	77	74	66	55
WL-7P	78	66	75	70	65	52
WL-8P	86	79	69	77	70	54
WL-9P	72	61	63	65	58	61
WL-10P	69	65	64	62	57	48
WL-16P	84	70	71	84	63	59
WL-21 P	94	86	85	64	65	52

TABLE C-3. RESULTS OF MATRIX SPIKE/MATRIX SPIKE DUPLICATE ANALYSES FOR SEMIVOLATILE ORGANICS ANALYSES ON WHITE LAKE SEDIMENTS, OCTOBER 2000.

WL-1 Bottom

Parameter	Sample Conc	Spike Quantity	Sample +Spike	Spike %Rec	Control Limits
Acenaphthene	<0.33	3.33	3.07	92	47-112
1,4-Dichlorobenzene	<0.33	3.33	2.87	86	43-122
2,4-Dinitrotoluene	<0.33	3.33	2.97	89	52-128
Naphthalene	<0.33	3.33	3.01	90	55-129
N-Nitrosodi-n-Propylamine	<0.33	3.33	3.55	107	48-120
Pyrene	<0.33	3.33	3.28	98	42-129
1,2,4-Trichlorobenzene	<0.33	3.33	2.82	85	57-116
4-Chloro-3-Methylphenol	<0.33	3.33	3.22	97	61-125
2-Chlorophenol	<0.33	3.33	3.09	93	51-126
4-Nitrophenol	<1.70	3.33	2.37	71	34-128
Pentachlorophenol	<1.70	3.33	2.71	81	20-143
Phenol	<0.33	3.33	3.20	96	58-126

Wl-10 Top

Parameter	Sample Conc	Spike Quantity	Sample +Spike	Spike %Rec	Control Limits
Acenaphthene	<0.33	3.33	2.97	89	47-112
1,4-Dichlorobenzene	<0.33	3.33	2.80	84	43-122
2,4-Dinitrotoluene	<0.33	3.33	2.96	89	52-128
Naphthalene	<0.33	3.33	2.90	87	55-129
N-Nitrosodi-n-Propylamine	<0.33	3.33	3.18	95	48-120
Pyrene	<0.33	3.33	3.14	94	42-129
1,2,4-Trichlorobenzene	<0.33	3.33	2.76	83	57-116
4-Chloro-3-Methylphenol	<0.33	3.33	3.01	90	61-125
2-Chlorophenol	<0.33	3.33	2.91	87	51-126
4-Nitrophenol	<1.70	3.33	2.62	79	34-128
Pentachlorophenol	<1.70	3.33	2.78	83	20-143
Phenol	<0.33	3.33	2.92	88	58-126

WL-2P

Parameter	Sample Conc	Spike Quantity	Sample +Spike	Spike %Rec	Control Limits
Phenol	<0.33	6.67	6.51	98	58-126
2-Chlorophenol	<0.33	6.67	6.11	92	51-126
1,4-Dichlorobenzene	<0.33	3.33	2.80	84	43-122
N-Nitrosodi-n-Propylamine	<0.33	3.33	2.72	82	48-120
1,2,4-Trichlorobenzene	<0.33	3.33	2.86	86	57-116
Naphthalene	<0.33	3.33	2.96	89	55-129
4-Chloro-3-Methylphenol	<0.33	6.67	5.90	88	61-125
Acenaphthene	<0.33	3.33	2.86	86	47-112
4-Nitrophenol	<1.70	6.67	3.99	60	34-128
2,4-Dinitrotoluene	<0.33	3.33	2.84	85	52-128
Pentachlorophenol	<1.70	6.67	5.38	81	20-143
Pyrene	<0.33	3.33	2.33	70	42-129

WL-9P

Parameter	Sample Conc	Spike Quantity	Sample +Spike	Spike %Rec	Control Limits
Phenol	<0.33	6.67	5.91	89	58-126
2-Chlorophenol	<0.33	6.67	5.49	82	51-126
1,4-Dichlorobenzene	<0.33	3.33	2.45	74	43-122
N-Nitrosodi-n-Propylamine	<0.33	3.33	2.64	79	48-120
1,2,4-Trichlorobenzene	<0.33	3.33	2.59	78	57-116
Naphthalene	<0.33	3.33	2.84	85	55-129
4-Chloro-3-Methylphenol	<0.33	6.67	5.79	87	61-125
Acenaphthene	<0.33	3.33	2.79	84	47-112
4-Nitrophenol	<1.70	6.67	3.80	57	34-128
2,4-Dinitrotoluene	<0.33	3.33	2.64	79	52-128
Pentachlorophenol	<1.70	6.67	4.47	67	20-143
Pyrene	<0.33	3.33	2.24	67	42-129

Table C-4. Surrogate Standard Recoveries For PCB Analyses On White Lake Sediments, October 2000.

Sample	Tetrachloro-M-xylene	Decachlorobiphenyl
WL-1 Top	84	91
WL-1 Middle	83	94
WL-1 Bottom	82	88
WL-1 Top duplicate	85	94
WL-1 Middle duplicate	91	100
WL-1 Bottom duplicate	94	99
WL-2 Top	90	95
WL-2 Middle	82	87
WL-3 Top	79	85
WL-3 Middle	79	86
WL-3 Bottom	75	85
WL-4 Top	84	90
WL-4 Middle	85	93
WL-5 Top	81	90
WL-5 Middle	83	89
WL-5 Bottom	83	91
WL-6 Top	81	93
WL-6 Middle	84	91
WL-6 Bottom	81	88
WL-7 Top	86	94
WL-7 Middle	84	89
WL-7 Bottom	87	92
WL-8 Top	82	90
WL-8 Middle	86	92
WL-8 Bottom	84	90
WL-9 Top	86	91
WL-9 Middle	83	90
WL-9 Bottom	88	94
WL-10 Top	90	94
WL-10 Middle	84	90
WL-10 Bottom	86	92
WL-21 Top	*	*
WL-21 Middle	83	96
WL-1P	79	86
WL-2P	78	81
WL-3P	81	88
WL-5P	76	88
WL-6P	81	91
WL-7P	80	91
WL-8P	84	92
WL-9P	84	90
WL-10P	83	91
WL-11P	81	86
WL-12P	80	89
WL-13P	82	99
WL-14P	73	89
WL-15P	71	75
WL-16P	70	87
WL-17P	81	86
WL-18P	80	90
WL-19P	80	93
WL-20P	89	97
WL-21 P	73	86
[illegible]	[illegible]	[illegible]

* Surrogates not available due to dilution

Appendix D. Results Of Metals Analyses For White Lake Sediments, October 2000.

TABLE D-1. RESULTS OF METALS ANALYSES IN WHITE LAKE SEDIMENT, OCTOBER 2000. (MG/KG DRY WT)

Sample	Arsenic	Barium	Cadmium	Chromium	Copper	Mercury	Nickel)	Lead	Selenium	Zinc
WL-1 Top	9.1	130	1.3	270	29	0.42	23	140	2.8	140
WL-1 Mid	6.1	130	0.87	34	18	< 0.1	16	15	2.8	75
WL-1 Bot.	6.6	160	0.74	37	21	< 0.1	18	9.8	2.6	86
WL-2 Top	9.0	160	1.6	470	33	0.42	18	190	2.6	140
WL-2 Bot	7.5	150	0.97	34	18	0.14	12	24	2.7	87
WL-3 Top	7.9	120	1.5	290	33	0.39	24	190	2.7	150
WL-3 Mid	6.2	110	0.61	33	17	0.16	14	28	2.1	80
WL-3 Bot	5.7	130	0.48	28	16	< 0.1	13	8.2	2.6	65
WL-4 Top	9.0	130	1.9	440	34	0.49	27	180	2.5	160
WL-4 Mid	1.8	18	0.15	8.1	2.3	< 0.1	U	2.1	0.47	16
WL-5 Top	8.9	140	1.4	300	31	0.52	24	110	3.6	160
WL-5 Mid	6.3	130	0.53	34	18	0.10	15	16	2.9	82
WL-5 Bot	6.1	150	< 0.1	24	17	< 0.1	12	5.9	3.1	69
WL-6 Top	6.7	180	1.3	410	23	0.38	27	340	2.1	110
WL-6 Mid	12	88	0.26	19	12	< 0.1	13	13	0.86	46
WL-6 Bot	12	110	0.19	17	13	< 0.1	14	7.7	1.5	45
WL-7 Top	8.2	130	1.6	600	34	0.62	28	180	2.6	160
WL-7 Mid	6.5	110	0.65	40	19	0.13	16	22	1.9	90
WL-7 Bot	5.5	110	0.35	33	17	< 0.1	15	7.9	< 0.1	70
WL-8 Top	7.7	140	1.4	380	32	0.58	26	180	< 0.1	160
WL-8 Mid	7.7	120	0.42	34	18	< 0.1	15	9.6	< 0.1	76
WL-8 Bot	7.3	1470	0.49	40	18	< 0.1	16	8.9	1.7	78
WL-9 Top	9.6	140	1.5	500	34	0.63	26	120	5.1	170
WL-9 Mid	7.5	120	0.6	38	18	0.12	16	18	2.6	81
WL-9 Bot	7.0	120	0.51	35	17	< 0.1	14	8.0	2.6	69
WL-10 Top	6.5	92	1.1	210	23	0.34	18	97	< 0.1	120
WL-10 Mid	5.8	110	0.47	33	16	0.11	14	18	2.0	75
WL-10 Bot	6.5	110	0.36	30	16	< 0.1	14	6.9	2.7	64
WL-21 Top	9.5	162	1.2	430	23	0.51	28	290	1.5	160
WL-21Mid	7.8	120	0.78	99	12	0.11	19	170	1.8	85

TABLE D-1 (CONTINUED). RESULTS OF METALS ANALYSES IN WHITE LAKE SEDIMENT, OCTOBER 2000. (MG/KG DRY WT)

Sample	Arsenic (mg/kg)	Barium (mg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Mercury (mg/kg)	Nickel mg/kg)	Lead (mg/kg)	Selenium (mg/kg)	Zinc (mg/kg)
WL-1 P	6.3	140	0.85	270	30	0.20	17	70	< 0.1	120
WL-2 P	7.5	150	0.85	300	34	0.20	18	76	< 0.1	120
WL-3 P	5.5	120	0.73	190	29	0.16	16	54	< 0.1	100
WL-4 P	1.4	12	< 0.1	18	2.2	< 0.1	1.6	8.3	< 0.1	33
WL-5 P	6.2	130	1.1	400	31	0.27	19	89	2.9	120
WL-6 P	8.4	130	1.0	360	28	0.25	18	73	3.0	120
WL-7 P	7.6	120	0.99	390	37	0.29	25	86	3.6	130
WL-8 P	8.8	130	0.93	380	27	0.25	20	75	3.7	120
WL-9 P	7.9	170	0.87	420	34	0.30	23	74	3.0	130
WL-10 P	7.0	120	0.91	270	31	0.34	19	75	< 0.1	120
WL-11 P	6.3	*	0.96	310	32	0.32	18	78	*	116
WL-12 P	5.9	*	1.03	510	30	0.28	17	70	*	118
WL-13 P	6.3	*	0.96	250	32	0.27	17	67	*	108
WL-14 P	6.3	*	1.10	480	31	0.25	17	72	*	95
WL-15 P	6.0	*	0.75	250	28	0.26	17	71	*	101
WL-16 P	5.8	*	0.84	190	27	0.27	18	75	*	105
WL-17 P	5.4	*	0.64	50	30	0.05	19	34	*	115
WL-18 P	5.3	*	0.51	29	32	0.05	20	22	*	125
WL-19 P	5.7	*	0.42	39	31	0.05	21	26	*	131
WL-20 P	6.2	*	0.61	28	28	0.05	19	21	*	124
WL-21P	6.5	*	1.00	450	31	0.24	18	65	*	132

* PONAR analyzed for target list metals. Barium and selenium not analyzed.

TABLE D-2. RESULTS OF QUALITY CONTROL ANALYSES FOR METALS IN WHITE LAKE SEDIMENT, OCTOBER 2000.

WL-1 Top

Analyte	Sample Concentration (mg/ml)	MS Spk Added (mg/ml)	MSD Spk Added (mg/ml)	MS Results (mg/ml)	MSD Results (mg/ml)	MS %Rec	MSD %Rec	RPD	QC RPD	QC %REC
Arsenic	9.08	798	768	728.3	691.8	90	89	1.1	20	75-125
Barium	133	319	307	462.9	451.6	103	104	0.97	20	75-125
Cadmium	1.339	319	307	365.4	300.3	114	97	16	20	75-125
Chromium	267	319	307	650.2	547.7	120	91	27*	20	75-125
Copper	29.0	319	307	368.5	353.2	106	106	0	20	75-125
Lead	135	319	307	495.5	421.8	113	93	19	20	75-125
Mercury	0.419	0.813	0.844	1.159	1.194	91	92	1.1	23	65-131
Nickel	23.1	319	307	359.7	338.7	105	103	1.9	20	75-125
Selenium	2.80	798	768	677.8	644.3	85	84	1.2	20	75-125
Zinc	140	319	307	475.8	459.7	105	104	0.96	20	75-125

*No qualificarion of data is necessary

WL-7 Mid

Analyte	Sample Concentration (mg/ml)	MS Spk Added (mg/ml)	MSD Spk Added (mg/ml)	MS Results (mg/ml)	MSD Results (mg/ml)	MS %Rec	MSD %Rec	RPD	QC RPD	QC %REC
Arsenic	6.48	522	637	431.1	523.0	81	81	0	20	75-125
Barium	113	209	255	303.8	351.6	92	94	2.2	20	75-125
Cadmium	0.648	209	255	186.9	238.5	89	93	4.4	20	75-125
Chromium	40.3	209	255	218.4	270.7	85	90	5.7	20	75-125
Copper	18.9	209	255	219.1	270.7	96	99	3.1	20	75-125
Lead	22.3	209	255	206.5	260.4	88	93	5.5	20	75-125
Mercury	0.1338	0.667	0.667	0.8019	0.7809	100	97	3.0	23	65-131
Nickel	15.5	209	255	214.0	265.0	95	98	3.1	20	75-125
Selenium	1.91	522	637	406.1	491.0	77	77	0	20	75-125
Zinc	89.8	209	255	282.8	345.2	92	100	8.3	20	75-125

WL-5 P

Analyte	Sample Concentration (mg/ml)	MS Spk Added (mg/ml)	MSD Spk Added (mg/ml)	MS Results (mg/ml)	MSD Results (mg/ml)	MS %Rec	MSD %Rec	RPD	QC RPD	QC %REC
Arsenic	6.24	934	952	863.8	825.2	92	86	6.7	20	75-125
Barium	133.7	373	381	526.9	538.5	105	106	0.95	20	75-125
Cadmium	1.11	373	381	380.0	363.0	101	95	6.1	20	75-125
Chromium	401.8	373	381	769.9	737.0	99	88	12	20	75-125
Copper	30.9	373	381	419.6	406.9	104	99	4.9	20	75-125
Lead	88.7	373	381	465.8	441.0	101	93	8.2	20	75-125
Mercury	0.268	0.960	0.942	1.28	1.24	105	103	1.9	23	65-131
Nickel	19.0	373	381	400.0	414.4	102	104	1.9	20	75-125
Selenium	2.91	934	952	796.4	763.9	85	80	6.1	20	75-125
Zinc	125	373	381	523.1	529.8	107	106	0.94	20	75-125

TABLE D-3. RESULTS OF STANDARD REFERENCE MATERIAL ANALYSES FOR METALS (RESULTS IN MG/KG EXCEPT WHERE NOTED).

Sample ID	As	Hg	Cd	Cr	Cu	Pb	Ni	Zn
ERA-1	190	1.8	120	180	90	72	71	200
% RSD	95%	90%	86%	95%	82%	80%	89%	89%
ERA-2	160	1.8	110	150	76	58	60	170
% RSD	80%	90%	79%	79%	69%	64%	75%	76%
ERA-3	200	1.6	120	180	89	72	70	200
% RSD	100%	80%	86%	95%	81%	80%	88%	89%

Appendix E. Summary Of Chemical Measurements For The Toxicity Test With Sediments From White Lake, October 2000.

TABLE E-1. SUMMARY OF INITIAL AND FINAL CHEMICAL MEASUREMENTS FOR *HYALELLA AZTECA* IN WHITE LAKE SEDIMENTS

		Day		Difference
Sample	Parameter	0	10	(%)
WL-1	pH	8.06	8.13	1
	Conductivity (umhos/cm)	550	530	4
	Alkalinity (mg/l $CaCO_3$)	160	160	0
	Hardness (mg/l $CaCO_3$)	160	130	19
	Ammonia (mg/l NH_3)	0.3	<0.1	#VALUE!
WL-2	pH	8.06	8.46	5
	Conductivity (umhos/cm)	560	488	13
	Alkalinity (mg/l $CaCO_3$)	180	160	11
	Hardness (mg/l $CaCO_3$)	150	120	20
	Ammonia (mg/l NH_3)	0.6	<0.1	#VALUE!
WL-3	pH	8.05	8.68	8
	Conductivity (umhos/cm)	510	499	2
	Alkalinity (mg/l $CaCO_3$)	160	140	13
	Hardness (mg/l $CaCO_3$)	140	120	14
	Ammonia (mg/l NH_3)	0.8	<0.1	#VALUE!
WL-4	pH	8.11	8.45	4
	Conductivity (umhos/cm)	570	494	13
	Alkalinity (mg/l $CaCO_3$)	170	170	0
	Hardness (mg/l $CaCO_3$)	140	120	14
	Ammonia (mg/l NH_3)	0.4	<0.1	29900
WL-5	pH	8.04	8.40	4
	Conductivity (umhos/cm)	610	520	15
	Alkalinity (mg/l $CaCO_3$)	160	160	0
	Hardness (mg/l $CaCO_3$)	140	120	14
	Ammonia (mg/l NH_3)	0.3	<0.1	39900
WL-6	pH	8.08	8.21	2
	Conductivity (umhos/cm)	660	514	22
	Alkalinity (mg/l $CaCO_3$)	160	150	6
	Hardness (mg/l $CaCO_3$)	140	120	14
	Ammonia (mg/l NH_3)	0.3	<0.1	#VALUE!
WL-7	pH	8.10	8.36	3
	Conductivity (umhos/cm)	660	530	20
	Alkalinity (mg/l $CaCO_3$)	160	170	6
	Hardness (mg/l $CaCO_3$)	150	130	13
	Ammonia (mg/l NH_3)	0.6	<0.1	#VALUE!
WL-8	pH	8.10	8.55	6
	Conductivity (umhos/cm)	660	510	23
	Alkalinity (mg/l $CaCO_3$)	170	150	12
	Hardness (mg/l $CaCO_3$)	140	120	7
	Ammonia (mg/l $NH_{3\text{-}N}$)	0.2	<0.1	#VALUE!
WL-9	pH	8.13	8.85	9
	Conductivity (umhos/cm)	660	530	20
	Alkalinity (mg/l $CaCO_3$)	150	170	13
	Hardness (mg/l $CaCO_3$)	140	130	7
	Ammonia (mg/l NH_3)	1.3	<0.1	#VALUE!

Table E-1 (continued). Summary of Initial and Final Chemical Measurements for *Hyalella azteca* in White Lake Sediments

Sample	Parameter	Day 650	170 10	Difference (%)
WL-10	pH	8.02	8.27	3
	Conductivity (umhos/cm)	660	499	24
	Alkalinity (mg/l $CaCO_3$)	170	160	6
	Hardness (mg/l $CaCO_3$)	140	130	7
	Ammonia (mg/l NH_3)	0.6	0.1	77
WL-11	pH	8.06	7.97	1
	Conductivity (umhos/cm)	650	477	27
	Alkalinity (mg/l $CaCO_3$)	160	160	0
	Hardness (mg/l $CaCO_3$)	140	120	14
	Ammonia (mg/l NH_3)	0.3	0.2	47
WL-12	pH	8.11	8.27	2
	Conductivity (umhos/cm)	650	520	20
	Alkalinity (mg/l $CaCO_3$)	180	160	11
	Hardness (mg/l $CaCO_3$)	150	130	13
	Ammonia (mg/l NH_3)	0.4	<0.1	#VALUE!
WL-13	pH	8.11	8.96	10
	Conductivity (umhos/cm)	650	520	20
	Alkalinity (mg/l $CaCO_3$)	160	150	6
	Hardness (mg/l $CaCO_3$)	140	130	7
	Ammonia (mg/l NH_3)	0.3	<0.1	#VALUE!
WL-14	pH	8.09	8.64	7
	Conductivity (umhos/cm)	610	520	99
	Alkalinity (mg/l $CaCO_3$)	160	160	0
	Hardness (mg/l $CaCO_3$)	150	140	7
	Ammonia (mg/l NH_3)	0.2	<0.1	#VALUE!
WL-15	pH	7.98	8.87	11
	Conductivity (umhos/cm)	480	560	17
	Alkalinity (mg/l $CaCO_3$)	160	210	31
	Hardness (mg/l $CaCO_3$)	140	160	14
	Ammonia (mg/l NH_3)	1.9	0.2	89
WL-16	pH	7.97	8.05	1
	Conductivity (umhos/cm)	480	520	8
	Alkalinity (mg/l $CaCO_3$)	190	160	16
	Hardness (mg/l $CaCO_3$)	140	130	7
	Ammonia (mg/l NH_3)	3.0	<0.1	176
WL-17	pH	7.97	8.27	4
	Conductivity (umhos/cm)	540	525	3
	Alkalinity (mg/l $CaCO_3$)	180	180	0
	Hardness (mg/l $CaCO_3$)	150	130	13
	Ammonia (mg/l NH_3)	4.5	0.1	97
WL-18	pH	8.00	8.66	8
	Conductivity (umhos/cm)	430	540	26
	Alkalinity (mg/l $CaCO_3$)	160	190	19
	Hardness (mg/l $CaCO_3$)	130	140	8
	Ammonia (mg/l NH_3)	2.1	0.1	93

Table E-1 (continued). Summary of Initial and Final Chemical Measurements for *Hyalella azteca* in White Lake Sediments

		Day	140	Difference
Sample	**Parameter**	**0**	**10**	**(%)**
WL-19	pH	8.05	9.16	14
	Conductivity (umhos/cm)	420	530	26
	Alkalinity (mg/l $CaCO_3$)	160	190	19
	Hardness (mg/l $CaCO_3$)	130	140	8
	Ammonia (mg/l NH_3)	1.6	<0.1	#VALUE!
WL-20	pH	7.98	8.97	12
	Conductivity (umhos/cm)	480	552	15
	Alkalinity (mg/l $CaCO_3$)	170	170	0
	Hardness (mg/l $CaCO_3$)	150	140	7
	Ammonia (mg/l NH_3)	2.3	<0.1	#VALUE!
WL-21	pH	8.10	8.50	5
	Conductivity (umhos/cm)	490	541	10
	Alkalinity (mg/l $CaCO_3$)	160	180	13
	Hardness (mg/l $CaCO_3$)	140	130	7
	Ammonia (mg/l NH_3)	0.6	0.15	75

Table E-2. Summary Of Daily Temperature And Dissolved Oxygen Measurements For Hyallela azteca In The Solid Phase Toxicity Tests For White Lake Sediments

Sample:	Day																					
WL-1	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%
	22.2	99.80	22.7	86.30	22.0	73.50	22.5	79.40	22.4	64.10	22.4	72.40	22.8	69.30	22.4	62.40	22.7	61.20	22.1	65.30	22.4	43.50

Sample:	Day																					
WL-2	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%
	22.4	99.70	22.4	88.60	22.5	72.50	22.5	76.90	22.6	66.10	22.6	75.70	22.7	62.70	22.7	63.10	22.9	53.40	22.9	65.50	22.8	47.40

Sample:	Day																					
WL-3	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%
	22.2	96.70	22.2	85.70	22.7	77.00	22.6	76.70	22.5	60.80	22.6	68.80	22.6	51.30	22.7	64.50	22.9	50.10	22.9	59.20	22.6	47.50

Sample:	Day																					
WL-4	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%
	22.3	99.30	22.6	83.90	22.4	71.80	22.8	71.30	22.4	63.00	22.0	70.40	22.1	56.50	22.8	68.50	22.7	46.60	22.5	48.10	22.4	45.50

Sample:	Day																					
WL-5	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%
	22.1	96.20	22.3	85.00	22.6	61.30	22.6	74.40	22.6	62.10	22.3	71.60	22.4	64.30	22.6	59.90	22.7	55.60	22.8	64.00	22.6	51.60

Table E-2 (Cont). Summary of Daily Temperature and Dissolved Oxygen Measurements for Hyallela azteca in the Solid Phase Toxicity Tests for White Lake Sediments

Sample:	Day																					
WL-6	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%
	22.8	98.50	22.1	90.30	22.5	79.50	22.3	80.40	22.5	62.50	22.5	71.70	22.1	76.10	22.3	70.30	22.8	59.60	22.8	63.50	22.5	44.20

Sample:	Day																					
WL-7	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%
	22.8	82.60	22.9	76.60	22.3	67.80	22.3	70.80	22.9	62.90	22.0	72.30	22.2	61.70	22.5	63.30	22.5	52.50	22.0	60.90	22.2	48.30

Sample:	Day																					
WL-8	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%
	22.8	93.00	22.1	84.70	22.3	75.90	22.5	76.60	22.2	76.20	22.0	77.20	22.3	64.60	22.5	69.40	22.8	57.30	22.1	61.00	22.3	53.90

Sample:	Day																					
WL-9	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%
	22.9	93.70	22.2	88.10	22.4	80.30	22.4	77.50	22.3	66.60	22.9	73.30	22.2	57.90	22.6	63.50	22.6	59.60	22.2	65.80	22.3	53.20

Sample:	Day																					
WL-10	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%
	22.7	94.20	22.0	87.90	22.2	75.80	22.3	79.60	22.1	70.20	22.0	76.20	22.2	51.80	22.3	74.70	22.6	60.10	22.0	67.50	22.2	54.20

Table E-2 (Cont). Summary of Daily Temperature and Dissolved Oxygen Measurements for Hyallela azteca in the Solid Phase Toxicity Tests for White Lake Sediments

Sample:	Day																					
WL-11	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%
	22.1	98.40	22.1	85.50	22.2	56.90	22.0	76.20	22.8	69.30	22.3	80.00	22.1	82.30	22.0	69.70	22.2	66.40	22.2	80.10	22.0	49.70

Sample:	Day																					
WL-12	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%
	22.1	96.90	22.4	85.60	22.1	62.00	22.3	77.10	22.0	65.70	22.3	79.40	22.1	84.90	22.3	70.60	22.8	81.50	22.7	62.50	22.7	58.10

Sample:	Day																					
WL-13	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%
	22.1	95.70	22.1	92.30	23.2	70.40	22.8	85.40	22.3	74.60	23.2	84.40	23.0	83.50	22.7	83.10	22.2	73.60	22.9	72.70	22.5	61.80

Sample:	Day																					
WL-14	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%
	22.8	98.30	22.3	81.70	22.5	74.50	22.5	74.40	22.4	65.50	22.2	70.50	22.3	59.60	22.3	59.90	22.6	63.80	22.4	61.40	22.4	52.80

Sample:	Day																					
WL-15	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%	ºC	%
	22.5	91.20	22.8	86.30	22.0	75.80	22.9	75.90	22.1	69.40	22.3	75.00	22.3	58.90	22.5	69.00	22.6	63.60	22.3	70.60	22.4	49.70

Table E-2 (Cont). Summary of Daily Temperature and Dissolved Oxygen Measurements for Hyallela azteca in the Solid Phase Toxicity Tests for White Lake Sediments

Sample:	Day																					
WL-16	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%
	20.8	86.10	20.8	79.00	22.2	66.30	22.9	72.60	22.3	68.10	22.2	76.00	22.0	86.00	22.5	78.30	22.6	79.70	22.0	65.30	22.2	61.70

Sample:	Day																					
WL-17	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%
	22.1	84.70	22.2	78.20	22.4	62.80	22.2	72.60	22.4	72.70	22.5	80.00	22.9	73.90	22.9	83.40	22.2	68.90	22.2	78.10	22.9	62.90

Sample:	Day																					
WL-18	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%
	22.2	88.30	22.3	77.10	22.5	70.70	22.4	68.50	22.3	62.80	22.2	73.00	22.3	65.40	22.4	71.40	22.7	69.00	22.1	65.50	22.2	52.00

Sample:	Day																					
WL-19	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%
	20.9	96.60	20.8	84.70	22.1	64.10	22.8	74.00	22.1	72.00	22.2	76.10	22.9	82.20	22.8	78.40	22.8	68.60	22.0	77.50	22.2	61.90

Sample:	Day																					
WL-20	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%
	22.9	89.00	22.9	83.70	22.3	70.20	22.3	70.70	22.2	59.40	22.1	72.30	22.0	68.90	22.4	60.20	22.5	57.90	22.2	60.90	22.0	47.50

Table E-2 (Cont). Summary of Daily Temperature and Dissolved Oxygen Measurements for Hyallela azteca in the Solid Phase Toxicity Tests for White Lake Sediments

Sample:	Day																				
WL-21	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%
	22.7	93.50	22.8	84.30	22.8	65.50	22.9	74.10	23.2	70.90	23.1	83.10	22.8	88.90	22.6	74.40	22.1	78.10	22.5	79.60	22.2	63.80

TABLE E-3. SUMMARY OF INITIAL AND FINAL CHEMICAL MEASUREMENTS FOR *CHIRONOMUS TENTANS* IN WHITE LAKE SEDIMENTS

		Day		Difference
Sample	Parameter	0	10	(%)
WL-1	pH	8.05	8.07	0
	Conductivity (umhos/cm)	530	482	9
	Alkalinity (mg/l $CaCO_3$)	150	170	13
	Hardness (mg/l $CaCO_3$)	150	130	13
	Ammonia (mg/l NH_3)	0.3	0.2	50
WL-2	pH	7.90	8.30	5
	Conductivity (umhos/cm)	477	562	18
	Alkalinity (mg/l $CaCO_3$)	150	180	20
	Hardness (mg/l $CaCO_3$)	140	130	7
	Ammonia (mg/l NH_3)	0.6	<0.1	#VALUE!
WL-3	pH	8.05	8.50	6
	Conductivity (umhos/cm)	519	562	8
	Alkalinity (mg/l $CaCO_3$)	150	180	20
	Hardness (mg/l $CaCO_3$)	140	130	7
	Ammonia (mg/l NH_3)	0.6	<0.1	#VALUE!
WL-4	pH	7.98	8.03	1
	Conductivity (umhos/cm)	509	583	15
	Alkalinity (mg/l $CaCO_3$)	150	170	13
	Hardness (mg/l $CaCO_3$)	150	130	13
	Ammonia (mg/l NH_3)	1.2	0.4	63
WL-5	pH	8.05	8.06	6484
	Conductivity (umhos/cm)	477	530	64
	Alkalinity (mg/l $CaCO_3$)	150	170	13
	Hardness (mg/l $CaCO_3$)	140	130	100
	Ammonia (mg/l NH_3)	0.2	0.2	15
WL-6	pH	7.95	8.03	1
	Conductivity (umhos/cm)	514	530	3
	Alkalinity (mg/l $CaCO_3$)	140	170	21
	Hardness (mg/l $CaCO_3$)	150	130	13
	Ammonia (mg/l NH_3)	0.3	0.2	40
WL-7	pH	8.01	8.05	0
	Conductivity (umhos/cm)	474	583	23
	Alkalinity (mg/l $CaCO_3$)	140	170	21
	Hardness (mg/l $CaCO_3$)	150	130	13
	Ammonia (mg/l NH_3)	0.3	0.2	43
WL-8	pH	7.98	8.18	3
	Conductivity (umhos/cm)	517	530	3
	Alkalinity (mg/l $CaCO_3$)	140	180	29
	Hardness (mg/l $CaCO_3$)	150	130	20
	Ammonia (mg/l NH_{3-N})	0.1	<0.1	#VALUE!
WL-9	pH	8.01	8.39	5
	Conductivity (umhos/cm)	489	583	19
	Alkalinity (mg/l $CaCO_3$)	150	180	20
	Hardness (mg/l $CaCO_3$)	150	130	13
	Ammonia (mg/l NH_3)	0.7	<0.1	#VALUE!

TABLE E-3 (CONTINUED). SUMMARY OF INITIAL AND FINAL CHEMICAL MEASUREMENTS FOR *CHIRONOMUS TENTANS* IN WHITE LAKE SEDIMENTS

		Day		Difference
Sample	**Parameter**	**8**	**10**	**(%)**
WL-10	pH	8.06	8.02	0
	Conductivity (umhos/cm)	483	552	14
	Alkalinity (mg/l $CaCO_3$)	140	180	29
	Hardness (mg/l $CaCO_3$)	150	130	13
	Ammonia (mg/l NH_3)	0.5	0.3	34
WL-11	pH	7.92	7.86	1
	Conductivity (umhos/cm)	490	530	8
	Alkalinity (mg/l $CaCO_3$)	150	180	20
	Hardness (mg/l $CaCO_3$)	150	120	20
	Ammonia (mg/l NH_3)	0.3	0.3	17
WL-12	pH	8.00	8.15	2
	Conductivity (umhos/cm)	525	594	13
	Alkalinity (mg/l $CaCO_3$)	150	180	20
	Hardness (mg/l $CaCO_3$)	150	130	13
	Ammonia (mg/l NH_3)	<0.1	<0.1	#VALUE!
WL-13	pH	8.06	8.46	5
	Conductivity (umhos/cm)	522	583	12
	Alkalinity (mg/l $CaCO_3$)	150	180	20
	Hardness (mg/l $CaCO_3$)	140	130	7
	Ammonia (mg/l NH_3)	0.3	<0.1	#VALUE!
WL-14	pH	8.10	8.04	1
	Conductivity (umhos/cm)	525	595	98
	Alkalinity (mg/l $CaCO_3$)	150	180	20
	Hardness (mg/l $CaCO_3$)	140	130	7
	Ammonia (mg/l NH_3)	0.2	<0.1	#VALUE!
WL-15	pH	7.94	8.14	3
	Conductivity (umhos/cm)	525	585	11
	Alkalinity (mg/l $CaCO_3$)	140	180	29
	Hardness (mg/l $CaCO_3$)	150	140	7
	Ammonia (mg/l NH_3)	1.7	0.1	92
WL-16	pH	7.88	8.10	3
	Conductivity (umhos/cm)	530	569	7
	Alkalinity (mg/l $CaCO_3$)	160	180	13
	Hardness (mg/l $CaCO_3$)	140	120	14
	Ammonia (mg/l NH_3)	2.5	<0.1	221
WL-17	pH	7.81	8.03	3
	Conductivity (umhos/cm)	519	563	8
	Alkalinity (mg/l $CaCO_3$)	170	190	12
	Hardness (mg/l $CaCO_3$)	150	130	13
	Ammonia (mg/l NH_3)	4.7	<0.1	#VALUE!
WL-18	pH	8.11	8.12	0
	Conductivity (umhos/cm)	512	563	10
	Alkalinity (mg/l $CaCO_3$)	160	180	13
	Hardness (mg/l $CaCO_3$)	140	130	7
	Ammonia (mg/l NH_3)	2.3	<0.1	#VALUE!

TABLE E-3 (CONTINUED). SUMMARY OF INITIAL AND FINAL CHEMICAL MEASUREMENTS FOR *CHIRONOMUS TENTANS* IN WHITE LAKE SEDIMENTS

		Day		Difference
Sample	**Parameter**	**0**	**10**	**(%)**
WL-19	pH	8.02	8.63	8
	Conductivity (umhos/cm)	532	597	12
	Alkalinity (mg/l $CaCO_3$)	160	180	13
	Hardness (mg/l $CaCO_3$)	150	130	13
	Ammonia (mg/l NH_3)	1.7	<0.1	#VALUE!
WL-20	pH	7.98	8.26	4
	Conductivity (umhos/cm)	505	528	5
	Alkalinity (mg/l $CaCO_3$)	170	180	6
	Hardness (mg/l $CaCO_3$)	140	130	7
	Ammonia (mg/l NH_3)	2.6	0.1	96
WL-21	pH	8.12	7.97	2
	Conductivity (umhos/cm)	546	630	15
	Alkalinity (mg/l $CaCO_3$)	160	180	13
	Hardness (mg/l $CaCO_3$)	170	140	18
	Ammonia (mg/l NH_3)	0.6	0.3	55

TABLE E-4. SUMMARY OF DAILY TEMPERATURE AND DISSOLVED OXYGEN MEASUREMENTS FOR CHIRONOMUS TENTANS IN THE SOLID PHASE TOXICITY TESTS FOR WHITE LAKE SEDIMENTS.

Sample:	Day																					
WL-1	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%
	22.3	91.90	22.5	82.20	22.5	42.70	22.3	62.10	22.3	52.70	22.0	59.30	22.7	49.10	22.9	62.60	19.2	55.20	22.1	50.90	23.4	31.70

Sample:	Day																					
WL-2	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%
	22.4	90.90	22.2	86.80	22.5	60.90	22.7	89.30	22.1	60.50	22.1	61.70	22.6	51.30	23.4	63.50	18.8	65.20	22.2	57.40	23.1	37.10

Sample:	Day																					
WL-3	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%
	23.3	88.90	23.0	84.40	23.2	65.40	23.0	82.20	22.8	63.40	22.8	73.90	22.6	40.70	23.6	61.20	19.3	51.60	22.5	43.60	22.2	41.80

Sample:	Day																					
WL-4	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%
	22.5	81.40	22.6	75.10	22.7	44.40	22.7	59.30	22.6	41.80	22.3	47.70	22.7	41.20	22.7	58.20	22.7	40.20	22.5	63.50	22.7	54.40

Sample:	Day																					
WL5	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%
	22.4	83.70	22.6	73.70	22.7	43.60	22.7	59.80	22.7	41.30	22.6	47.70	22.6	41.10	22.5	59.90	22.8	44.80	22.9	52.00	22.8	41.90

TABLE E-4. (CONT). SUMMARY OF DAILY TEMPERATURE AND DISSOLVED OXYGEN MEASUREMENTS FOR CHIRONOMUS TENTANS IN THE SOLID PHASE TOXICITY TESTS FOR WHITE LAKE SEDIMENTS.

Sample:	Day																					
WL-6	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%
	22.5	73.70	22.9	59.60	22.7	53.00	22.7	55.30	22.6	41.00	23.0	60.00	22.8	44.90	22.5	40.30	22.0	40.20	22.2	47.10	22.9	47.80

Sample:	Day																					
WL-7	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%
	22.9	79.50	22.2	80.10	22.3	62.00	22.2	77.90	22.5	58.60	22.6	58.60	22.4	40.00	22.3	57.10	19.3	47.20	22.1	40.10	22.6	39.70

Sample:	Day																					
WL-8	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%
	22.3	75.80	22.5	71.60	22.4	48.80	22.7	70.20	22.3	40.00	22.4	43.10	22.6	52.90	22.8	48.60	22.0	44.20	22.7	61.20	23.1	40.80

Sample:	Day																					
WL-9	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%
	22.8	84.70	22.8	80.00	22.9	59.50	22.8	74.30	22.6	44.50	22.8	53.10	22.6	50.70	23.0	61.60	22.2	40.20	22.2	52.10	23.2	51.00

Sample:	Day																					
WL-10	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%
	22.0	80.00	22.1	71.80	22.6	53.60	22.4	63.10	22.4	44.30	22.3	43.50	22.5	52.20	22.7	44.80	22.3	39.60	22.3	43.70	22.8	41.40

TABLE E-4. (CONT). SUMMARY OF DAILY TEMPERATURE AND DISSOLVED OXYGEN MEASUREMENTS FOR CHIRONOMUS TENTANS IN THE SOLID PHASE TOXICITY TESTS FOR WHITE LAKE SEDIMENTS.

Sample:	Day																					
WL-11	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l
	22.0	81.40	22.2	77.20	22.0	57.80	22.3	68.20	22.4	49.00	22.8	42.40	22.7	59.10	22.6	53.10	22.1	51.50	22.3	65.70	23.1	50.10

Sample:	Day																					
WL-12	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l
	22.8	86.90	22.7	84.40	22.7	60.20	22.9	62.80	22.5	53.90	23.0	60.60	22.8	70.10	23.1	55.90	22.3	43.50	21.9	59.80	23.4	40.50

Sample:	Day																					
WL-13	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l
	22.7	85.10	22.8	75.10	22.6	56.10	22.8	49.60	22.5	53.10	22.8	58.70	22.8	55.80	22.9	61.40	22.1	53.80	22.0	60.00	23.3	48.00

Sample:	Day																					
WL-14	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l
	22.2	78.80	22.4	76.40	22.6	55.00	22.6	60.00	22.5	43.70	22.5	44.60	22.6	47.90	22.7	40.80	22.6	49.70	22.4	62.50	23.0	41.30

Sample:	Day																					
WL-15	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l
	22.4	81.60	22.7	72.90	22.7	56.00	22.6	64.40	22.3	47.90	22.7	51.30	22.7	44.10	22.8	41.50	22.3	46.60	21.5	49.90	23.2	41.80

TABLE E-4. (CONT). SUMMARY OF DAILY TEMPERATURE AND DISSOLVED OXYGEN MEASUREMENTS FOR CHIRONOMUS TENTANS IN THE SOLID PHASE TOXICITY TESTS FOR WHITE LAKE SEDIMENTS.

Sample:	Day																					
WL-16	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l
	22.7	89.40	22.5	77.10	22.9	59.50	22.6	72.70	22.6	56.50	23.0	53.90	22.3	42.40	22.9	57.40	22.3	43.90	22.0	51.70	23.3	41.10

Sample:	Day																					
WL-17	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l
	22.6	72.70	22.3	68.80	22.5	46.30	22.6	59.80	22.6	40.90	22.7	51.30	22.6	47.70	22.6	51.70	22.3	38.70	21.9	55.80	23.1	39.80

Sample:	Day																					
WL-18	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l
	22.2	86.00	22.3	75.50	22.3	53.90	22.3	57.50	22.3	44.40	22.7	59.70	22.8	56.50	22.8	55.60	22.4	46.20	22.2	51.30	23.2	39.20

Sample:	Day																					
WL-19	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l
	22.2	83.30	22.5	76.50	22.5	56.10	22.6	61.40	22.5	46.50	22.6	57.10	22.4	43.00	22.6	42.30	21.9	38.10	21.9	51.50	22.7	43.70

Sample:	Day																					
WL-20	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l	°C	mg/l
	21.8	84.80	22.4	79.10	22.4	66.50	22.4	78.80	22.3	51.20	22.7	55.70	22.5	42.90	22.4	51.50	21.5	50.30	21.5	53.50	22.3	47.90

TABLE E-4. (CONT). SUMMARY OF DAILY TEMPERATURE AND DISSOLVED OXYGEN MEASUREMENTS FOR CHIRONOMUS TENTANS IN THE SOLID PHASE TOXICITY TESTS FOR WHITE LAKE SEDIMENTS.

Sample: WL-21	Day																					
	0		1		2		3		4		5		6		7		8		9		10	
	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO	Temp	DO
	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%
	22.0	87.90	22.1	81.80	22.2	63.20	22.9	72.80	22.2	56.20	22.6	59.00	22.3	52.40	22.2	71.30	19.1	52.10	22.9	59.80	22.7	42.10

Appendix F. Summary Of Benthic Macroinvertebrate Results For White Lake, October 2000

TABLE F-1. BENTHIC MACROINVERTEBRATE RESULTS FOR WHITE LAKE, OCTOBER 2000

	WL			WL			WL			WL			WL			WL			WL			WL		
	1a	1b	1c	2a	2b	2c	3a	3b	3c	4a	4b	4c	5a	5b	5c	6a	6b	6c	7a	7b	7c	8a	8b	8c
Amphipoda																								
Gammarus	0	0	0	0	43.1	0	0	43.1	0	0	43.1	86.1	0	0	0	43.1	0	0	43.1	43.1	0	0	0	0
Hyallela	0	0	0	0	43.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isopoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mollusca																								
Gastropoda																								
Amnicola	0	0	43.1	86.1	0	43.1	172	43.1	0	43.1	43.1	0	172	0	0	86.1	43.1	43.1	86.1	0	43.1	86.1	0	258
Physa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Valvata tricarinata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Viviparous	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bivalvia																								
Dreissena polymorpha	0	0	0	0	0	0	0	43.1	0	258	86.1	43.1	86.1	0	0	0	0	0	258	0	172	0	0	0
Pisidium	129	0	43.1	172	86.1	43.1	86.1	129	172	129	129	86.1	43.1	43.1	43.1	0	43.1	0	43.1	0	43.1	0	0	172
Sphaerium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida																								
Tubificidae																								
Aulodrilus limnobius	0	0	0	43.1	0	0	86.1	0	86.1	43.1	86.1	129	43.1	129	43.1	129	388	172	129	129	172	129	86.1	43.1
Aulodrilus pigueti	0	0	0	0	0	0	43.1	0	86.1	172	215	43.1	0	0	0	0	172	0	86.1	0	0	0	43.1	0
Ilyodrilus templetoni	129	43.1	86.1	172	258	0	215	0	0	43.1	431	43.1	86.1	43.1	43.1	0	474	0	86.1	0	0	0	0	86.1
Limnodrilus hoffmeisteri	301	388	517	86.1	258	301	646	431	603	258	904	215	990	646	947	603	1120	646	517	344	603	388	301	301
Limnodrilus claparianus	0	0	0	0	0	0	0	0	0	0	258	172	0	0	0	0	0	0	0	0	0	0	0	0
Quistrodrillus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Immature w/ hair	904	560	646	861	1550	646	172	172	43.1	172	1033	646	1550	603	1335	689	2239	1335	0	0	86.1	947	1120	904
Immature w/o hair	2325	2627	2885	1421	1981	3617	1593	1120	1852	560	1292	388	6760	4521	6803	2282	2454	3100	258	1679	1765	2153	5641	3445
Naididae																								
Haemonais waldvogeli	0	0	0	0	0	0	0	0	0	0	43.1	0	0	0	0	0	0	0	0	0	0	0	0	0
Hirundinea - Glossiphoniidae																								
Helobdella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nematoda	818	517	172	43.1	0	0	0	43.1	0	0	0	0	990	689	258	732	646	560	0	0	0	1550	1292	689
Tricladida																								
Planaridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43.1	0	0	0	0	0	0
Diptera																								
Chaoboridae																								
Chaoborus punctipennis	1206	1722	947	2971	2799	1722	1679	1421	1593	775	1249	258	517	431	388	904	1335	990	560	258	172	258	258	86.1
Ceratapogonidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43.1	0
Chironomidae	129	0	0	0	129	258	0	0	0	0	0	0	86.1	172	129	215	388	86.1	0	0	0	129	86.1	0
Ablabesmyia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chironomus	43.1	86.1	43.1	646	474	818	0	86.1	129	43.1	43.1	0	215	431	344	1722	732	1852	43.1	0	86.1	215	129	301
Clinotanypus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coelotanypus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cryptochironomus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43.1	43.1	0	0	0	43.1	0
Dicrotendipes	129	0	0	215	0	86.1	0	0	0	0	43.1	0	0	0	0	129	0	0	0	0	0	0	0	0
Heterotrissocladius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43.1	0	0
Paraphaenocladius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paratendipes	0	0	0	0	0	0	0	0	43.1	0	0	0	0	0	0	0	0	43.1	0	0	0	0	0	0
Phaenopsectra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polypedilum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43.1	0
Procladius	0	0	0	43.1	0	0	0	0	0	86.1	43.1	43.1	172	43.1	43.1	0	86.1	0	43.1	0	0	43.1	258	43.1
Pseudochironomus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tanypus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ephemeroptera																								
Caenis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ephemera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hexagenia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isonychia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tricoptera																								
Polycentroapodidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pseudostenophylax	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Megaloptera																								
Sialis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Odonata - Zygoptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE F-1 (CONTINUED). BENTHIC MACROINVERTEBRATE RESULTS FOR WHITE LAKE, OCTOBER 2000

	WL			WL			WL			WL			WL			WL			WL			WL		
	9a	9b	9c	10a	10b	10c	11a	11b	11c	12a	12b	12c	13a	13b	13c	14a	14b	14c	15a	15b	15c	16a	16b	16c
Amphipoda																								
Gammarus	43.1	0	43.1	0	86.1	0	43.1	0	0	0	0	0	43.1	43.1	43.1	0	172	0	0	0	43.1	43.1	43.1	0
Hyallela	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isopoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43.1	0	0	0	0	0	0
Mollusca																								
Gastropoda																								
Amnicola	86.1	43.1	0	0	0	86.1	0	0	43.1	129	0	43.1	129	129	129	0	86.1	43.1	86.1	258	172	0	86.1	43.1
Physa	0	0	0	0	0	0	0	0	0	43.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Valvata tricarinata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Viviparous	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bivalvia																								
Dreissena polymorpha	43.1	215	0	86.1	0	43.1	0	0	0	0	0	129	0	86.1	0	0	172	43.1	43.1	86.1	43.1	258	474	0
Pisidium	86.1	215	0	0	129	129	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sphaerium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida																								
Tubificidae																								
Aulodrilus limnobius	215	86.1	86.1	0	0	0	0	129	86.1	43.1	0	0	86.1	43.1	86.1	0	0	0	86.1	86.1	129	0	0	0
Aulodrilus pigueti	0	0	0	86.1	0	86.1	43.1	43.1	0	0	0	0	0	0	0	0	0	0	0	43.1	0	0	0	0
Ilyodrilus templetoni	43.1	43.1	86.1	172	258	215	344	172	560	86.1	0	0	0	0	0	0	43.1	0	43.1	0	0	43.1	0	0
Limnodrilus hoffmeisteri	560	129	215	775	603	474	603	560	1033	129	0	0	301	301	603	43.1	258	258	990	603	861	172	258	86.1
Limnodrilus claparianus	172	0	129	0	86.1	344	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Quistrodrillus	0	0	0	0	0	0	172	43.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Immature w/ hair	990	301	2110	344	861	388	1593	1033	3100	603	301	1033	1981	1636	1895	732	775	517	215	1163	603	2067	560	43.1
Immature w/o hair	2756	1033	1292	1033	2110	2067	6545	6890	9516	1636	689	1938	2325	2110	1895	1722	4435	2153	1292	2282	1981	1033	3660	1981
Naididae																								
Haemonais waldvogeli	0	0	0	0	0	43.1	0	0	43.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hirundinea - Glossiphoniidae																								
Helobdella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nematoda	1938	3186	6287	172	0	344	1120	1507	1206	9387	5641	8311	215	431	1077	8784	3660	4650	172	1421	258	0	0	43.1
Tricladida																								
Planaridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43.1	0	0	0	0	86.1	0
Diptera																								
Chaoboridae																								
Chaoborus punctipennis	129	301	43.1	990	1335	904	560	388	301	129	172	86.1	129	344	129	0	0	0	0	0	0	0	0	0
Ceratapogonidae	0	0	0	0	0	0	0	0	0	0	0	43.1	0	0	0	0	43.1	0	86.1	0	43.1	43.1	0	0
Chironomidae	0	0	0	0	0	0	215	388	301	43.1	0	86.1	43.1	43.1	129	0	129	86.1	172	43.1	129	86.1	172	0
Ablabesmyia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chironomus	86.1	258	344	86.1	258	0	861	818	1033	43.1	344	129	86.1	258	86.1	215	215	388	258	0	818	86.1	129	129
Clinotanypus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coelotanypus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43.1	86.1	0	0	0
Cryptochironomus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	86.1	0	86.1	43.1	43.1	129	0	0	0
Dicrotendipes	0	0	0	0	0	0	43.1	43.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heterotrissocladius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paraphaenocladius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43.1	0	0	0	0	0	0	0	0
Paratendipes	0	0	43.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phaenopsectra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polypedilum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Procladius	86.1	215	129	43.1	43.1	0	0	0	0	215	0	129	215	86.1	43.1	215	86.1	172	301	43.1	172	43.1	129	0
Pseudochironomus	0	0	0	0	0	43.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tanypus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ephemeroptera																								
Caenis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ephemera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hexagenia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isonychia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tricoptera																								
Polycentroapodidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pseudostenophylax	0	0	43.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Megaloptera																								
Sialis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43.1	0	0
Odonata - Zygoptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE F-1 (CONTINUED). BENTHIC MACROINVERTEBRATE RESULTS FOR WHITE LAKE, OCTOBER 2000

	WL			WL			WL			WL			WL			WL		
	17a	17b	17c	18a	18b	18c	19a	19b	19c	20a	20b	20c	21a	21b	21c	21a1	21b1	21c1
Amphipoda																		
Gammarus	86.1	43.1	43.1	43.1	43.1	43.1	43.1	86.1	0	5426	258	1765	43.1	215	43.1	258	215	258
Hyallela	0	0	0	0	0	0	0	0	0	603	0	86.1	0	0	0	0	0	0
Isopoda	0	0	0	0	0	0	0	0	0	215	0	86.1	0	0	0	0	0	0
Mollusca																		
Gastropoda																		
Amnicola	86.1	43.1	86.1	43.1	0	0	86.1	86.1	0	301	0	129	129	129	0	86.1	0	43.1
Physa	0	86.1	0	0	0	0	0	0	0	43.1	0	0	0	0	0	0	0	0
Valvata tricarinata	0	0	0	0	0	0	0	0	0	0	0	43.1	0	0	0	0	0	0
Viviparous	0	0	0	43.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bivalvia																		
Dreissena polymorpha	43.1	172	0	172	0	86.1	0	0	0	517	0	86.1	0	86.1	43.1	43.1	0	0
Pisidium	43.1	86.1	0	0	0	0	0	0	0	0	0	0	43.1	215	172	43.1	43.1	215
Sphaerium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43.1	0	0
Annelida																		
Tubificidae																		
Aulodrilus limnobius	0	0	0	0	0	0	0	0	0	0	0	0	258	301	301	172	172	172
Aulodrilus pigueti	0	129	172	0	0	0	0	0	0	0	0	0	43.1	172	0	43.1	0	0
Ilyodrilus templetoni	0	0	0	0	0	0	0	0	0	258	0	0	431	258	474	215	215	86.1
Limnodrilus hoffmeisteri	258	43.1	388	0	0	0	86.1	129	86.1	258	215	0	1550	2325	2842	947	1335	1249
Limnodrilus claparianus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Quistrodrillus	0	0	129	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Immature w/ hair	732	388	6115	344	215	129	474	215	301	43.1	301	301	9645	####	9301	7622	2497	4005
Immature w/o hair	4177	1852	86.1	1852	1077	990	2368	1593	1550	1163	2024	1378	####	####	####	3273	2454	2928
Naididae																		
Haemonais waldvogeli	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hirundinea - Glossiphoniidae																		
Helobdella	0	0	0	0	0	0	0	0	0	43.1	0	0	0	43.1	0	0	0	0
Nematoda	0	0	0	0	43.1	0	0	0	43.1	0	0	0	1378	2971	2454	646	0	344
Tricladida																		
Planaridae	0	0	0	0	0	0	0	0	0	1206	0	86.1	0	0	0	0	0	0
Diptera																		
Chaoboridae																		
Chaoborus punctipennis	0	0	0	0	0	0	0	0	0	0	0	0	517	1120	1292	431	0	1033
Ceratapogonidae	0	0	0	0	43.1	0	0	0	0	0	215	129	0	0	0	0	0	0
Chironomidae	0	0	0	301	43.1	215	474	43.1	0	215	1033	431	172	603	0	258	0	301
Ablabesmyia	0	0	0	0	0	0	0	43.1	43.1	0	0	0	0	0	0	0	0	0
Chironomus	0	43.1	43.1	0	129	0	0	43.1	86.1	0	86.1	172	301	1593	1033	474	775	689
Clinotanypus	0	0	0	0	0	0	86.1	0	86.1	0	0	0	0	0	0	0	0	0
Coelotanypus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cryptochironomus	215	0	215	0	0	0	129	86.1	172	0	129	43.1	43.1	0	0	0	43.1	0
Dicrotendipes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heterotrissocladius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paraphaenocladius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paratendipes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43.1
Phaenopsectra	0	0	0	0	0	0	0	0	0	0	43.1	0	0	0	43.1	0	0	0
Polypedilum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Procladius	43.1	0	86.1	0	172	0	43.1	0	129	301	344	258	172	344	431	301	215	215
Pseudochironomus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tanypus	0	86.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ephemeroptera																		
Caenis	0	0	0	0	0	0	0	0	0	0	43.1	0	0	0	0	0	0	0
Ephemera	0	0	0	0	0	0	0	0	0	43.1	0	0	0	0	0	0	0	0
Hexagenia	0	0	0	0	43.1	43.1	0	86.1	0	0	301	86.1	0	0	0	0	0	0
Isonychia	0	0	0	0	0	0	0	0	0	43.1	0	0	0	0	0	0	0	0
Tricoptera																		
Polycentroapodidae	0	0	0	0	0	0	0	0	0	43.1	0	0	0	0	0	0	0	0
Pseudostenophylax	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Megaloptera																		
Sialis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Odonata - Zygoptera	0	0	0	0	0	0	0	0	0	172	0	0	0	0	0	0	0	0