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Investigation of Metal Distributions and Sedimentation Patterns in Lake DePue and Turner Lake

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ABBREVIATIONS AND SYMBOLS

AA	Atomic absorption
AAS	Atomic absorption spectrometry
Ag	Silver
Al	Aluminum
As	Arsenic
Au	Gold
Ba	Barium
Be	Beryllium
Br	Bromine
Ca	Calcium
Ce	Cerium
cm	Centimeter
Cd	Cadmium
Ch	Chlorine
Co	Cobalt
Cr	Chromium
Cs	Cesium
CI	Confidence interval
Cu	Copper
DDSDA	DePue Dredged Sediment Disposal Area
EDX	Energy-dispersive x-ray fluorescence spectrometry
Eu	Europium
Fe	Iron
Ga	Gallium
GPS	Global positioning system
Ha	Hectacre
Hf	Hafnium
Hg	Mercury
ICP	Inductively coupled plasma
ID	Identification
IDOC	Illinois Department of Conservation
IDNR	Illinois Department of Natural Resources
IEPA	Illinois Environmental Protection Agency
INAA	Instrumental neutron activation analysis
ISGS	Illinois State Geological Survey
ISWS	Illinois State Water Survey
K	Potassium
kg	Kilogram
km	Kilometer
La	Lanthanum
Li	Lithium

Lu	Lutetium
m	Meter
mB/q	millibecquerel
Mo	Molybdenum
mg	Milligram
Mg	Magnesium
mg/L	Milligrams per liter
ml	Milliliter
Mn	Manganese
mV	Millivolt
m^3	Cubic meter
Na	Sodium
Nb	Niobium
NGVD	National Geodetic Vertical Datum
Ni	Nickel
QA/QC	Quality assurance/quality control
P	Phosphorus
pH	Acidity/alkalinity
Pb	Lead
Rb	Rubidium
S	Sulfur
Sb	Antimony
Sc	Scandium
Se	Selenium
Si	Silicon
Sm	Samarium
Sn	Tin
Sr	Strontium
Ta	Tantalum
Tb	Terbium
Th	Thorium
Ti	Titanium
Tl	Thallium
V	Vanadium
U	Uranium
µg	Microgram
U.S. EPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
W	Tungsten
XRD	X-ray diffraction spectrometry
XRF	X-ray fluorescence spectrometry
Yb	Ytterbium
yr	Year

Zn	Zinc
Zr	Zirconium
^{137}Cs	Cesium-137

ABSTRACT

Sediments in Lake DePue have received contaminants from industries, particularly zinc smelting, in and near the Village of DePue, Illinois, since the early 1900s. Elevated zinc and cadmium concentrations in the sediments of Lake DePue were noted in 1976. Accumulated sediment was dredged in 1983 to accommodate recreational activities on Lake DePue. In the summer of 1998, a lake sedimentation survey and sediment and water quality sampling were done at Lake DePue to determine current conditions and evaluate the impact of dredging on the lake. A total of 148 sediment samples were collected and analyzed for zinc, cadmium, and organic carbon content. Turner Lake also was sampled to determine background concentrations. Up to 33 samples were analyzed for mineral content, grain size, and major, minor, and trace elements. Sedimentation rates in Lake DePue were estimated by measuring the cesium-137 content in 8 cores collected along 8 transects that had been surveyed by the Illinois State Water Survey (ISWS) in 1975 and 1998.

Zinc concentrations in sediment from Lake DePue ranged from 300 to 42,300 mg/kg compared with 155 to 427 mg/kg in Turner Lake.; cadmium concentrations in Lake DePue sediments ranged from 2 to 309 mg/kg compared with 2 to 8.5 mg/kg in Turner Lake sediments. Concentrations of zinc and cadmium were greatest in samples collected near the South Ditch. Copper and lead concentrations also were significantly greater in Lake DePue samples collected near the South Ditch than elsewhere in the lake. Concentrations of other metals were similar in Lake DePue, Turner Lake, and Peoria Lake. Long-term sedimentation rates from the lake survey (1903 to 1998) ranged from 1.4 to 2.6 centimeters per year (cm/yr). This is comparable to cesium-137 rates (1963 to 1998) of 1.6 to greater than 2.1 cm/yr. The area of the lake that was dredged has lost approximately one half of its water depth since dredging. The sedimentation rate is approximately 8 cm/yr in this area. The area of the lake that was dredged is trapping sediment that contains elevated level of metals coming from the South Ditch.

INTRODUCTION

Sediments in Lake DePue have received contaminants from industries, particularly zinc smelting, in and near the Village of DePue, Illinois, since the early 1900s. In 1976, Lee and Stall reported on sediment deposition in Lake DePue and its implication for future lake management. Cahill and Steele (1986) reported the results of metal analyses from 27 cores from 18 backwater lakes along the length of the Illinois River, including Lake DePue. Zinc was found in Lake DePue sediments at concentrations as great as 5,000 mg/kg of sediment.

To accommodate recreational activities on Lake DePue, the accumulated sediment was dredged in 1983 by the Village of DePue and the Illinois Department of Conservation (now the Illinois Department of Natural Resources). The dredge spoil was disposed of in a diked area on IDNR land adjacent to both the lake and the Illinois River.

This report is an update of previous work on the nature of the sediments of Lake DePue, including their depth of accumulation, chemical and mineralogical characteristics, and the distribution of metals in the lake sediments.

BACKGROUND

GEOLOGY AND HYDROLOGY OF THE LAKE DEPUE STUDY AREA

The study area is located in north-central Illinois in Bureau County in the Peoria Pool of the Illinois Waterway. The area is located just upstream from the "great bend" at Hennepin at about river mile 213. The Village of DePue and the former industrial site are located on a low-level outwash terrace between a bluff line and the edge of Lake DePue. The lake is in the floodplain of the Illinois River.

The geology of the Illinois Waterway was described by Willman (1973). The lake is located in recent alluvial deposits of the Illinois River. These deposits are generally less than 6 m thick, consisting largely of clayey silt and sandy silt with lenses of sand and gravel. In the Lake DePue area, the alluvium is as much as 12 m thick and overlies thick deposits of sand and gravel of the Henry Formation. Swamp and lake deposits assigned to the Grayslake peat, composed mostly of peat, peaty silt, and fine sand, occur on the northeast side of the lake. The Grayslake peat deposits have been modified by being drained and cultivated.

The nature of the deposits in Lake DePue also was described by Gibb and Cartwright (1982). They completed 6 shallow borings, starting on the western edge of the former industrial area and extending to the area east of the former lagoons and south of the railroad. No bedrock was encountered in any of the borings, so the exact thickness of the unconsolidated sediments was not determined. The Henry Formation varied in thickness and character across the site. Six meters of Grayslake peat overlay Henry Formation deposits at the easternmost boring. The boring across the railroad from the lagoons had 4.6 m of fill, overlying 3.7 m of Grayslake peat, over Henry Formation deposits. Golder Associates (1995) reported that 2 borings in unspecified locations in the industrial area encountered shale of the Pennsylvanian Age Modesto Formation at 16 and 23 m.

The hydrology of the industrial site was described by Gibb and Cartwright (1982) and by Golder Associates (1995). Gibb and Cartwright (1982) found a thick, permeable gravel deposit associated with the Illinois River lowland on the industrial site. They reported that 2 wells located on the industrial site were capable of yielding in excess of 500 gallons per minute each, and, based on piezometric surface maps, inferred the direction of groundwater flow to be southward toward the lake. Golder Associates (1995) interpreted the industrial site as at the distal end of a regional groundwater flow system with down-gradient discharge to Lake DePue and the Illinois River. They reported a shallow, water-bearing zone in the fill/residue that overlies the peat across the eastern part of the former plant site area. They also observed a series of groundwater discharge points or springs along the drainage ditch referred to as the South Ditch in this report.

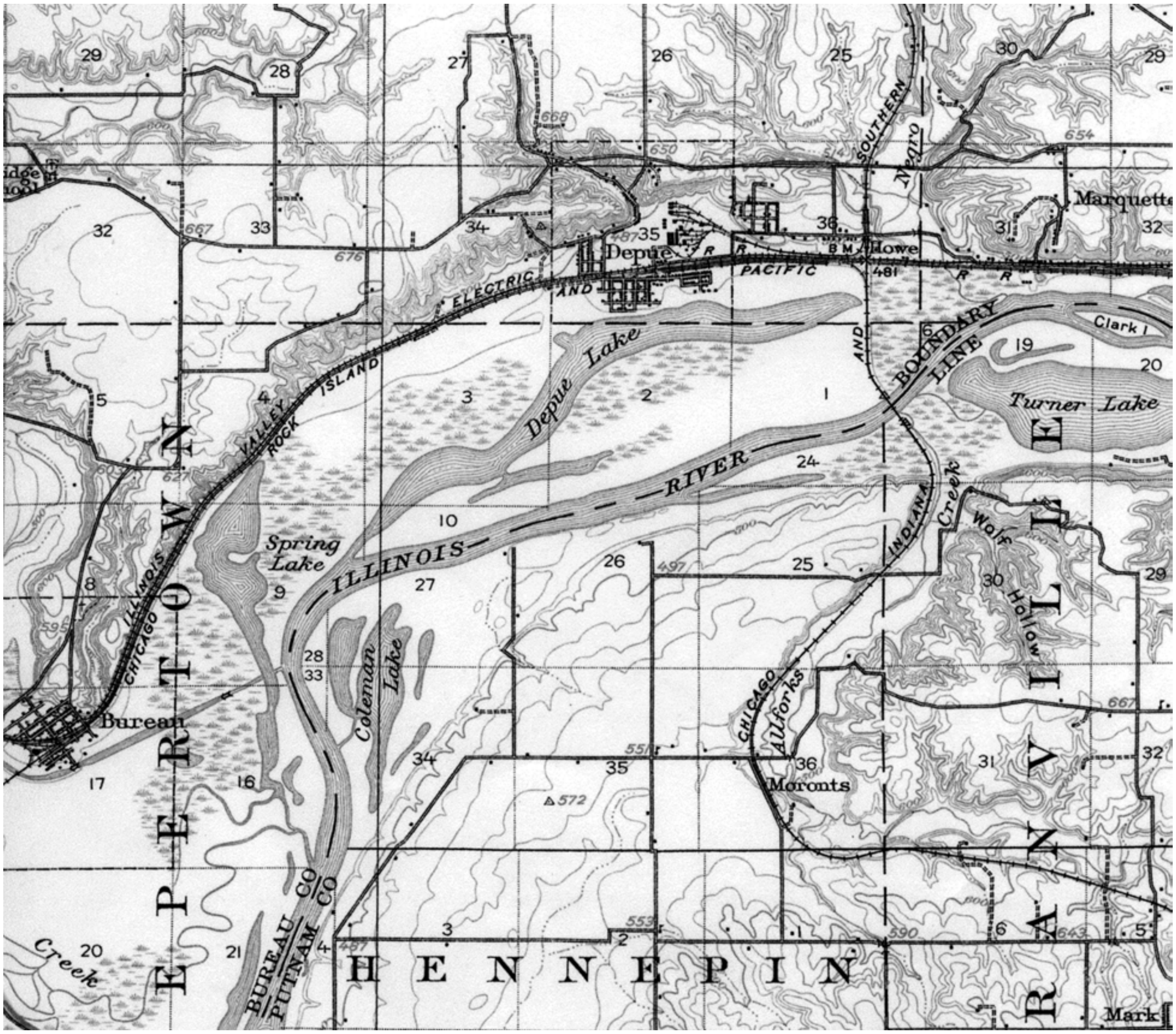

Figure 1. Portion of the 1909 Hennepin Quadrangle United States Geological Survey topographic map. Scale is 1:62,500. Contour interval is 20 feet.

INDUSTRIAL OPERATIONS IN DEPUE

The Village of DePue had been the site of continuous industrial operations from 1903 to 1989. The area was chosen for development in the late 1800s because of the abundance of local coal, railroad access, and the market demand for zinc products. Figure 1 is a topographic map of the Lake DePue area taken from surveys done in 1909. The industrial operation in the northeast part of the village is marked by several railroad spurs. During the height of operations, the zinc smelter was reported to employ approximately 300 workers and occupied an area of about 860 acres (Golder Associates, 1995). From 1903 to 1906, the primary zinc smelter produced slab zinc, zinc dust, and sulfuric acid. A plant producing lithopone (a white pigment consisting of zinc sulfide, barium sulfate, and zinc oxide used widely in paints) was in operation between 1923 and 1956. Diammonium phosphate fertilizer was produced between 1967 and 1987. A secondary zinc smelter operated between 1981 and 1989. Most of the buildings associated with the industrial operations were demolished by 1992.

Gibb and Cartwright studied the impact of the secondary zinc smelter located at DePue on water quality in 1982. They noted that a 40-foot-high pile of metal-rich cinders covered about 12 acres and a layer of cinder fill, 1 to 5 feet thick, also covered the remaining 90 acres of the main plant complex.

The U.S. Environmental Protection Agency (U.S. EPA) made preliminary assessments in 1980, 1983, 1984, and 1987 for putting the site on the National Priority List (NPL) of Superfund Sites. The site did not meet the existing criteria for Superfund Sites at that time (Illinois Environmental Protection Agency, 1995). The Illinois Environmental Protection Agency (IEPA) made an expanded site investigation in 1992 and submitted the results to the U.S. EPA. Using revised criteria, the U.S. EPA listed the site on the National Priorities List of Superfund Sites in May of 1999 (*Federal Register*, 1999). The site was noted as having several sources, including a residue pile, a waste pile, lagoons, cooling ponds, and gypsum stack ponds (U.S. EPA, 1999) that contained elevated levels of metals, including zinc, lead, arsenic, cadmium, chromium, and copper (U.S. EPA, 1999). Contamination was noted in residential soils and adjacent wetlands and at a state wildlife refuge area (U.S. EPA, 1999).

LAKE DEPUE

Lake DePue, a state-owned lake managed by the IDNR, is a shallow backwater lake associated with the Illinois River located between river miles 210.7 and 213.6 in Bureau County. In 1978 the surface area of Lake DePue was 266 ha, with a volume of 1,785,000 m^3 and an average depth of 0.7 m (Bellrose et al., 1983). Areas that had been wetlands are now part of the lake due to the diversion of water from Lake Michigan, effects of drainage and levee districts, and the effects of navigation dams (Bellrose et al., 1983). Currently the lake has a surface area of 212 ha with 18.2 km of shoreline (IEPA, 1996). The IEPA rated the overall resource quality of the lake as “fair” (IEPA, 1996). The primary sources of pollution were noted as agriculture, industrial and municipal point sources, and bank erosion, which added nutrients, suspended solids, and priority pollutants to the lake.

Figure 2. Composite of two 1994 infrared aerial photographs of Lake DePue (USGS, 1999). Note the white sediment plume from the South Ditch entering the northeast end of the lake. USGS Upper Midwest Environmental Science Center, Kewaunee, Wisconsin, images 161-011-pe-199i4 and 161-009-pe-1994, 1:24,000.

Historic aerial photographs from 1941, 1951, 1958, 1964, 1970, 1979, 1988, and 1994 were compiled and interpreted (Stohr, 1995). It was found that the northeast part of the lake had a considerable loss of surface area and that discharge of sediments from the South Ditch area has occurred since at least 1941 (Stohr, 1995).

Figure 2 is a composite of two 1994 USGS color infrared aerial photographs of Lake DePue (USGS, 1999). Most of the land around the lake is undeveloped, except for the Village of DePue beside the northeast portion of the lake. The large slag pile at the former industrial site is apparent, as is the white plume from the South Ditch entering the northeast corner of the lake.

TURNER LAKE

Turner Lake is a shallow backwater lake associated with the Illinois River located between river miles 214.2 and 216.6 in Putnam County. The lake is south of the river and is privately owned with no public access. Figure 3 is a USGS infrared aerial photograph of Turner Lake (USGS, 1999). The lake has no development and is bordered by woodlands on the south side and agricultural lands on the north side between the river and the lake. The surface area of Turner Lake changed from 158 ha in 1903 to 141 ha in 1969, an 11% decrease (Bellrose et

Figure 3. A 1994 infrared aerial photograph of Turner Lake (USGS, 1999). USGS Upper Midwest Environmental Science Center, Kewaunee, Wisconsin, image 160-011-pe-1994, 1:24,000 quadrangle.

al., 1983). This lake was included in the study to indicate background conditions of an undisturbed lake. The sediment quality of Turner Lake was evaluated by Cahill and Steele (1986). The toxicity of sediment pore waters from Turner Lake was tested by Sparks and Ross, (1992).

DREDGING OF LAKE DEPUE

A 1969 study of Lake DePue proposed raising the water level in the lake with control structures and pumps and reducing sedimentation in the lake with a soil conservation program (Illinois Department of Public Works, 1969). A 1974 report on the restoration of Lake DePue concluded that dredging would be costly, that silting-in within a short period of time was a certainty, and that doing nothing may be the best alternative (Illinois Department of Conservation, 1974). In 1977, the Village of DePue applied for a permit to dredge 43 ha of the lake and deposit the dredged material in a retention basin to be constructed on property owned by the IDOC (Chamlin & Associates, 1977). An average of 1 m of sediment was to be removed. The IDOC site, located on the Illinois River floodplain between the Illinois River and Lake DePue, is now known as the DePue Dredged Sediment Disposal Area (DDSDA).

Approximately 342,000 m^3 of sediment was dredged in 1982. According to the permit, the area proposed to be dredged was 915 m by 366 m wide, and material was to be dredged 1 m below the existing lake bottom to provide a 1.8 m depth of water. The amount of dredged material was originally expected to be 417,200 m^3 (Chamlin & Associates, 1977), but this amount was revised to 342,000 m^3. The diked area was built to hold 1,412,00 m^3 (37 ha to a depth of 2.4 m). The dredged material placed in the DDSDA was up to 1.2 m thick. Dikes were constructed with existing material in the DDSDA at an elevation of 452 feet mean sea level. The water from the dredge spoil was retained for 8.5 days before being released from the DDSDA into the Illinois River (Chamlin & Associates, 1977).

FIELD PROCEDURES

An Ekman® grab sampler was used to collect the surface sediment samples in Lake DePue and Turner Lake. A Wildco® gravity core sampler, with Lexan core tubes 5 cm in diameter and 120 cm long, was used to collect sediment cores. Surface sediment samples were placed in labeled polyethylene bags. Cores were labeled, stored upright, and kept on ice.

Surface water samples were collected from Lake DePue and Turner Lake by dipping a pre-cleaned, 500-ml-wide mouth, high-density polyethylene bottle just below the surface. In the dredged area, water samples were collected near the sediment-water interface using a 2.2 l PVC Van Dorn-style bottle sampler. Conductivity, pH, and temperature of the water were measured in the field using an Orion® Model 1230 pH/mV/ORP/conductivity/temperature meter. The instrument was calibrated with National Institute for Standards and Technology traceable solutions before and after returning from the field. Further details of the protocols used for the field sampling techniques are included in the quality assurance project plan (Cahill, 1998, unpublished).

SAMPLING LOCATIONS

Field data for the Lake DePue sedimentation survey were collected on June 8–9 and June 17–18, 1998. The first of these trips was made during a period of low water on the Illinois River, and access to areas outside the area that had been dredged in 1983 was limited by shallow water. During this trip, a reconnaissance of the lake was completed, and survey markers were found and relocated by the ISWS with a global positioning system (GPS). These GPS coordinates and the local grid controls from the 1975 ISWS lake sedimentation survey were used to calculate corrected GPS coordinates for the original monument sites (Lee and Stall, 1976). During the week of June 17, 1998, the Illinois River level had risen approximately 0.4 m, and surveying was repeated along the 8 transects surveyed in 1975. Eight additional survey lines were run to correspond to post-dredging survey lines.

Samples for sediment quality, sedimentation rates, and water quality were collected on July 22–23, 1998. Nine cores and 16 surface samples of bottom sediments from Lake DePue and 2 cores and 3 surface samples of bottom sediments from Turner Lake were collected. The sediment cores and grab samples collected from Lake DePue were at cross sections that had been established by the ISWS during its June 1998 sedimentation survey. Shallow water limited access to some areas of the lake, notably the entrance to the Illinois River. Eight water samples from Lake DePue, 3 water samples from Turner Lake, and 1 field duplicate sample were collected. Data for sediment samples collected for this project, including field identification (ID), GPS coordinates, length of the core recovered, and the type of sample collected are in Table 1. The GPS coordinates are given using Universal Transverse Mercator (UTM) projection. Sample locations in Lake DePue are shown in Figure 4. Included in the figure is the 1.2-m depth contour, which was the approximate area of the lake when it was dredged in1983.

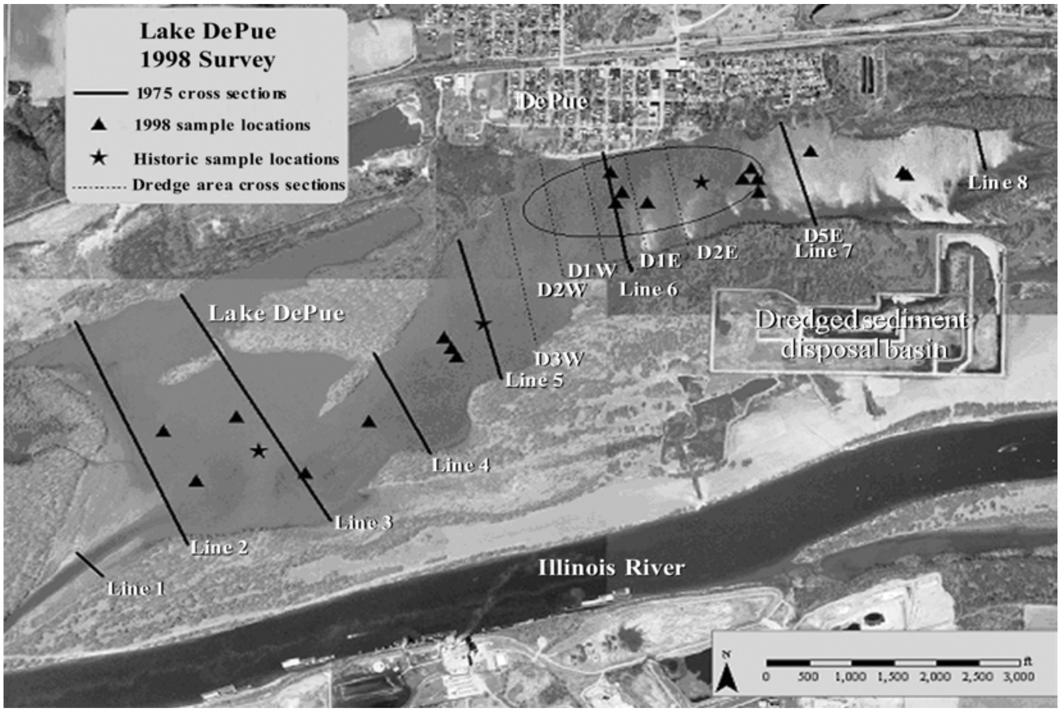

Figure 4. Transects surveyed for Lake DePue from 1975, 1983 (dredged area), and 1998 ISWS survey data.

Table 1. Field ID, cross section numbers, UTM coordinates, core length, and the type of samples collected from Lake DePue and Turner Lake on July 22 and 23, 1998.

Field ID	ISWS cross section	East (UTM) coordinates	North (UTM) coordinates	Core length (cm)	Samples taken
LD5a	2	1001114	15012678		Grab
LD5, WQ1	2	10011. .[A]	15012. . .[A]	60	Grab, core
LD4a	3	1001973	15012864		Grab
LD 4	3	1002783	15012133	66	Grab, core
LD6, WQ2	4	1003544	15012801	65	Grab, core
LD7a	5	1004434	15013895		Grab
LD7b	5	1004577	15013646		Grab
LD7	5	1004515	15013756	75	Grab, core
LD1a	6	1006838	15015665		Grab
LD1b	6	1006403	15016059		Grab
LD1	6	1006541	15015802	64	Grab, core
WQ6	6	1006456	15015664		Surface/btm.
LD2a	7	1008147	15015804		Grab
LD2b	7	1008064	15016119		Grab
LD2	7	1008146	15015978	70	Grab, core
WQ5	7	1007971	15015975		Surface/btm.
LD3	8	1009908	15016030	44	Grab, cores
WQ4	8	1009854	15016070		Surface
LD8, WQ3	South Ditch	1008763	15016339	79	Grab, core
TL1, WQT1		1018338	15013690	61	Grab, core
TL2, WQT2		1020105	15012967		Grab
TL3, WQT3		1022395	15013247	62	Grab, core

Notes: [A] No GPS reading taken. Position estimated based on field notes.
Water samples collected at the surface unless noted. Btm. is bottom, LD is Lake DePue, TL is Turner Lake, and WQ is water quality sample.

RESULTS AND DISCUSSION

SEDIMENT QUALITY RESULTS AND DISCUSSION

Initial Laboratory Procedures

Sediment cores and grab samples were returned to the ISGS laboratories in Champaign for extrusion and subsampling in preparation for analysis. The cores were extruded and subsampled at 5-cm intervals for cesium-137 analysis and metal analysis. Subsamples were air dried in a Class 100 laminar-flow clean bench. All dried core subsamples were stored in pre-cleaned 150-ml glass bottles from Quality environmental containers until further processing. The grab samples also were split into several subsamples. Approximately 20 grams of wet sediment were split for particle size analysis at the ISWS. About 150 grams of wet sediment were air dried in the Class 100 laminar-flow clean bench for metal analysis. All dried grab samples were stored in pre-cleaned 150-ml glass bottles from Quality environmental containers to await further processing. The remainder of the samples were retained in the original sample bags and refrigerated for possible future use.

Core Descriptions

Core LD5 was collected at the center of cross section 2 in Lake DePue in water approximately 0.3 m deep. The core was 60 cm long after extrusion and composed of a uniform silty clay.

Core LD4 was collected at the center of cross section 3 in Lake DePue in water approximately 0.3 m deep. The core was 66 cm in length after extrusion and composed of a uniform silty clay.

Core LD6 was collected at the center of cross section 4 in Lake DePue in water approximately 0.7 m deep. The core was 65 cm long after extrusion and composed of a uniform silty clay.

Core LD7 was collected at the center of cross section 5 in Lake DePue in water approximately 0.6 m deep. The core was 75 cm long after extrusion and composed of uniform silty clay.

Core LD1 was collected at the center of cross section 6 in the dredged area of Lake DePue in approximately 1.8 m of water. The core was 64 cm in length and composed of uniform silty clay.

Core LD2 was collected at the center of cross section 7 in the dredged area of Lake DePue at bench mark 472. The water depth was approximately 1.4 m. The core was 70 cm long after extrusion and composed of uniform silty clay.

Core LD8 was collected near the South Ditch outlet in Lake DePue in water approximately 0.2 m deep. The core was 79 cm long after extrusion. The upper 5 cm was a uniform silty clay. From 5 to 14 cm, the sediment had a somewhat grainy texture, and was crumbly. The rest of the core was uniform silty clay.

Core LD3 was collected at the center of cross section 8 in Lake DePue in water approximately 0.3 m deep. The core was 44 cm long after extrusion. The upper 5 cm was a uniform silty clay. From 5 to 15 cm the sediment had a somewhat grainy texture. The rest of the core was uniform silty clay.

The Field Duplicate Core also was collected at the center of cross section 8 in Lake DePue. The core was 34 cm long after extrusion. The upper 12 cm was a uniform silty clay. From 12 to 23 cm the sediment was silty clay with a grainy texture. The rest of the core was uniform silty clay.

Core TL1 was collected at the center of the upper end of Turner Lake. The water depth was approximately 0.6 m. The core was 61 cm long after extrusion and was composed of uniform silty clay.

Core TL3 was collected at the center of the lower end of Turner Lake. The water depth was approximately 0.7 m. The core was 62 cm long after extrusion and was composed of uniform silty clay.

Analytical Procedures Used for Sediment Analysis

All air-dried sediment samples were ground using a SPEX 8505 alumina ceramic grinding container in a SPEX 8500 Shatterbox. Samples were sieved to pass a 100-mesh stainless steel sieve. All ground and sieved samples were stored in pre-cleaned 150-ml glass bottles from Quality environmental containers.

The total number of sediment samples prepared for Lake DePue was 121, which included 16 surface grab samples and 105 sediment core subsamples. For Turner Lake, 3 surface grab samples and 24 core sediment subsamples were prepared. Fifteen additional samples were included for quality assurance/quality control (QA/QC).

Analytical splits of all 163 sediment samples were delivered to an IEPA-approved contract laboratory for determination of zinc and cadmium content. Of these samples, 25 also were analyzed for silver, aluminum, arsenic, barium, calcium, cobalt, chromium, copper, iron, mercury, potassium, lead, magnesium, manganese, sodium, nickel, antimony, selenium, thallium, and vanadium by the contract laboratory. Standard methods SW6010/700 Series were followed, and proper chain-of-custody forms were used.

Analytical splits of all 163 samples also were retained at the ISGS. The total carbon, inorganic carbon, and organic carbon contents were determined for all the samples. All core subsample intervals were tested for cesium-137 content. Additional analyses were made at the ISGS on approximately 20% of the total number of samples for a comprehensive list of metals. The intervals chosen for comprehensive analysis were normally the upper interval (0 to 5 cm or the grab sample collected at the same coring location), the 20- to 25-cm interval, the 40- to 45-cm interval, and the lowest interval sampled. The concentrations of iron, potassium, manganese, sodium, silver, arsenic, gold, barium, bromine, cerium, cobalt, chromium, cesium, europium, gallium, hafnium, lanthanum, lutetium, molybdenum, nickel, rubidium, antimony, scandium, selenium, samarium, tantalum, terbium, thorium, uranium, tungsten, ytterbium, and zinc were determined by instrumental neutron activation analysis (INNA) in 31 samples. The concentrations of silicon, aluminum, iron, calcium, magnesium, potassium, sodium, titanium, manganese, sulfur, barium, strontium, and zirconium were determined by x-ray fluorescence spectrometry (XRF) in 33 samples. Atomic absorption spectrometry (AAS) was used to determine the concentrations of copper, cadmium, nickel, lead, and zinc in 49 samples. Mercury concentrations were determined in 30 samples by cold-vapor AAS. Barium, tin, strontium, zinc, and zirconium concentrations were determined by energy-dispersive x-ray fluorescence spectrometry (EDX) in 68 samples. Thirty-three of the samples were analyzed by x-ray diffraction spectrometry (XRD) for bulk mineral composition. Twenty of the samples were tested for grain size distribution and 7 samples for their Atterberg Limit. The sample types, laboratory, and number of analyses performed for this project are summarized in Table 2.

Table 2. Summary of the analytes, the laboratory used, and number of analyses performed on sediment samples from Lake DePue and Turner Lake.

Analytes		Number of samples
Zinc and cadmium	Contract laboratory	163
Mercury	Contract laboratory	25
ICP (20 metals)	Contract laboratory	25
Total inorganic, organic carbon	ISGS	163
Zinc, cadmium, copper, lead, nickel (AAS)	ISGS	49
14 major elements (XRF)	ISGS	33
Barium, tin, strontium, zinc, zirconium (EDX)	ISGS	68
Mineral composition (XRD)	ISGS	33
32 trace metals (INAA)	ISGS	31
Mercury (cold-vapor AA)	ISGS	30
Sedimentation rates (cesium-137)	ISGS	11 cores
Grain size distribution (sieve and pipette)	ISWS	20
Atterberg Limit	ISGS	7

Notes: ICP means inductively coupled plasma.

Table 3. Laboratory number, ID, and description of samples that were included as QA/QC.

Laboratory number	ID	Notes
R21464	FDup0005[A]	Duplicate core collected at cross section 8 (R21396)
R21465	FDup0510	Duplicate core collected at cross section 8 (R21397)
R21466	FDup1015	Duplicate core collected at cross section 8 (R21398)
R21467	FDup1520	Duplicate core collected at cross section 8 (R21399)
R21468	FDup2025	Duplicate core collected at cross section 8 (R21400)
R21469	FDup2530	Duplicate core collected at cross section 8 (R21401)
R21470	FDup3034	Duplicate core collected at cross section 8 (R21402)
R21471	FDup2	Duplicate grab collected at cross section 7 (R21459)
R21472	QA/QC1	Lab duplicate of LD6C (R21456) split from sample bag.
R21473	QA/QC2	AC85–3 Turner Lake (R15032, R21274[B])
R21474	QA/QC3	Lake Peoria 1985 composite (R20103, R21273[B])
R21475	QA/QC4	Grand Calumet 1998 composite (R21994, R21272[B])
R21476	QA/QC5	NIST 2709 San Joaquin soil
R21477	QA/QC6	Lake Peoria 1998–Core 4B (R21229[B])
R21478	QA/QC7	1995 DePue sediment disposal (B7 30–45 cm) (R20537)

Notes: QA/QC means quality assurance/quality control.

[A]FDupXXX is a field duplicate in which XXX indicates depth interval; for example, 0005 represents 0–5 cm.

[B]Analysis number from sample previously analyzed by the same contract laboratory as part of the 1998 Peoria Pool Sediment Survey (Cahill, 2001).

The details of the analytical procedures used for this project were included in the Quality Assurance Project Plan (Cahill, 1998).

Quality Control Summary

Fifteen QA/QC samples were included with the 163 sediment samples prepared for this project. Eight of the samples were field duplicates, 1 sample was a laboratory duplicate, and 6 samples were primary or secondary reference samples. The QA/QC samples are identified in Table 3.

Included in the QA/QC samples are secondary reference sediment samples that have been used at ISGS for quality control. Four of the samples had been analyzed previously by the same contract laboratory. QA/QC no. 7 is a sample from the DePue Lake Sediment Disposal area that was collected in 1995. The results of analysis for the QA/QC samples are included in Appendices A to D.

The field duplicates commonly had a repeatability within 20%. The initial core collected at cross section 8 (LD3) was 45 cm long but the duplicate core was only 35 cm long. It is likely that the base of the duplicate core was not from a depth in the sediment equivalent to the 30 to 35-cm interval of core LD3.

The zinc and cadmium profiles for the duplicate cores collected at cross section 8 are included in Appendix B. The concentration profiles for the first 6 intervals were very similar. The concentrations for zinc and cadmium changed dramatically at the 30 to 35 cm interval in core LD3.

The complete quality control summary reports from the contract laboratory, including holding time and dilution summary report, QA/QC cross reference report, method blank, laboratory control sample, matrix spike/matrix spike duplicate, initial calibration and verification, post-digestion spike, and chain-of-custody documentation are available upon request.

Zinc and Cadmium Results and Discussion

The results of analyses for zinc and cadmium concentrations for all sediment samples are included in Appendix A. Results from analyses of the 15 QA/QC samples also are included in Appendix A. Zinc and cadmium were determined on all samples using method SW6010 by inductively coupled plasma (ICP) at a contract laboratory. Method SW6010 is not considered a complete digestion, and the concentrations are reported on a total-recoverable basis.

Zinc was also determined at ISGS on splits of up to 49 of the sediment samples by INAA, EDX, and AAS. All of these procedures report total concentration. Cadmium was determined at ISGS in splits of 49 of the samples by AAS. All of the results are reported on a moisture-free basis.

Comparison of Zinc and Cadmium Results by Different Techniques One way to evaluate the quality of analytical results is to use multiple techniques to determine the same element. Comparisons of total recoverable zinc and cadmium concentrations in Lake DePue sediment samples with total zinc and cadmium concentrations are shown in Figures 5 to 8. The line in the graphs represents equal concentration values. Total concentrations of metals would be expected to be somewhat greater than total recoverable or total extractable concentrations.

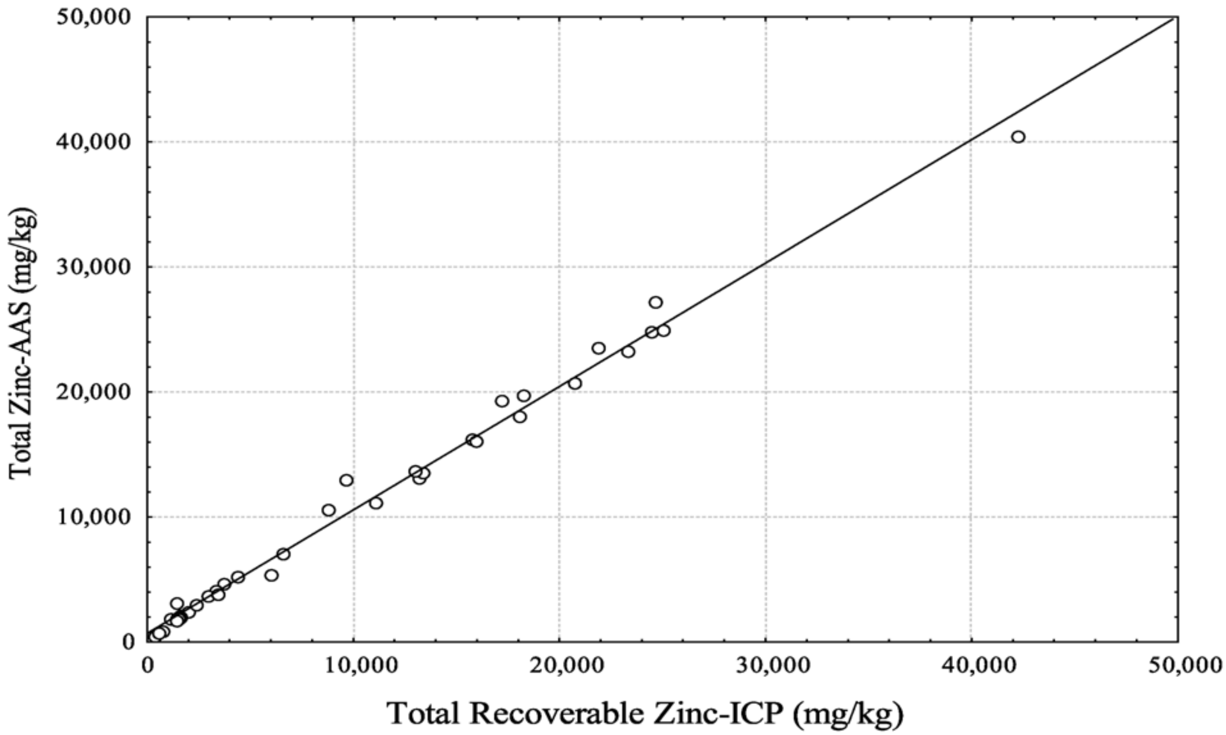

Figure 5. Comparison of zinc concentrations in Lake DePue sediments determined by ICP and AAS.

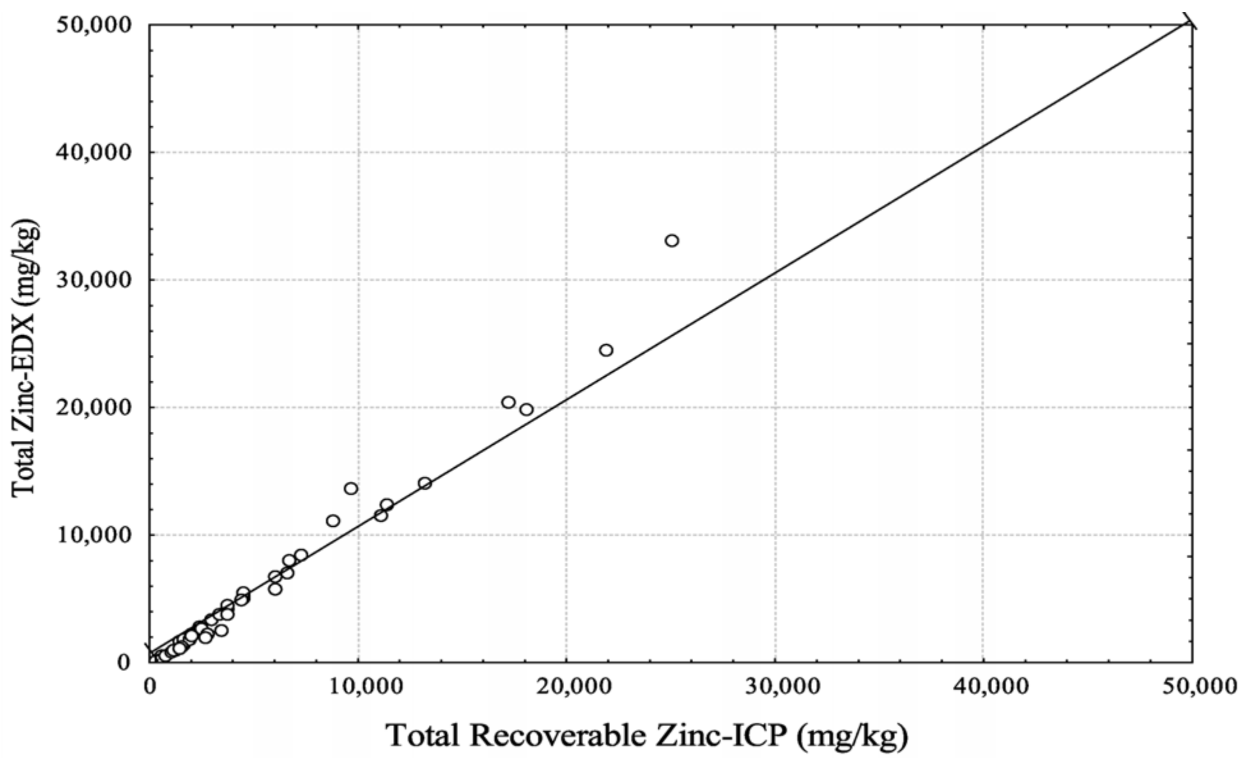

Figure 6. Comparison of zinc concentrations in Lake DePue sediments determined by ICP and EDX.

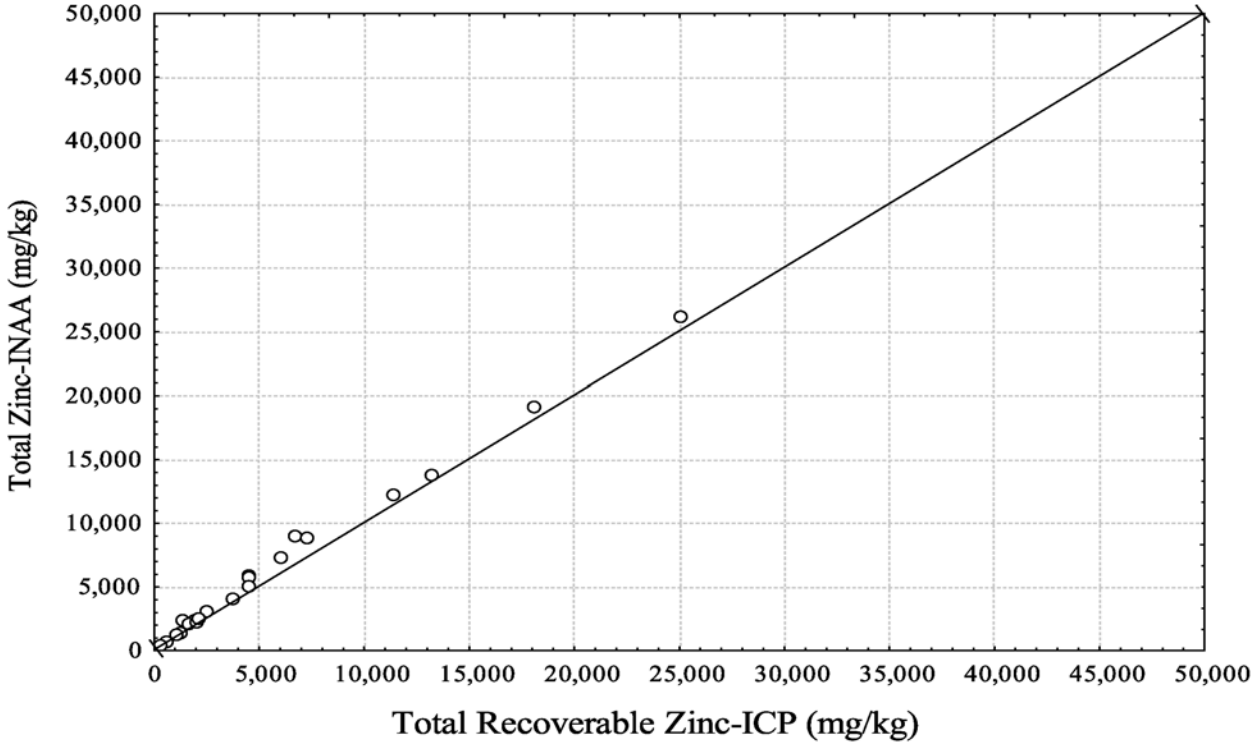

Figure 7. Comparison of zinc concentrations in Lake DePue sediments determined by ICP and INAA.

Table 4. Mean, median, minimum, maximum, lower quartile, and upper quartile concentrations and number of

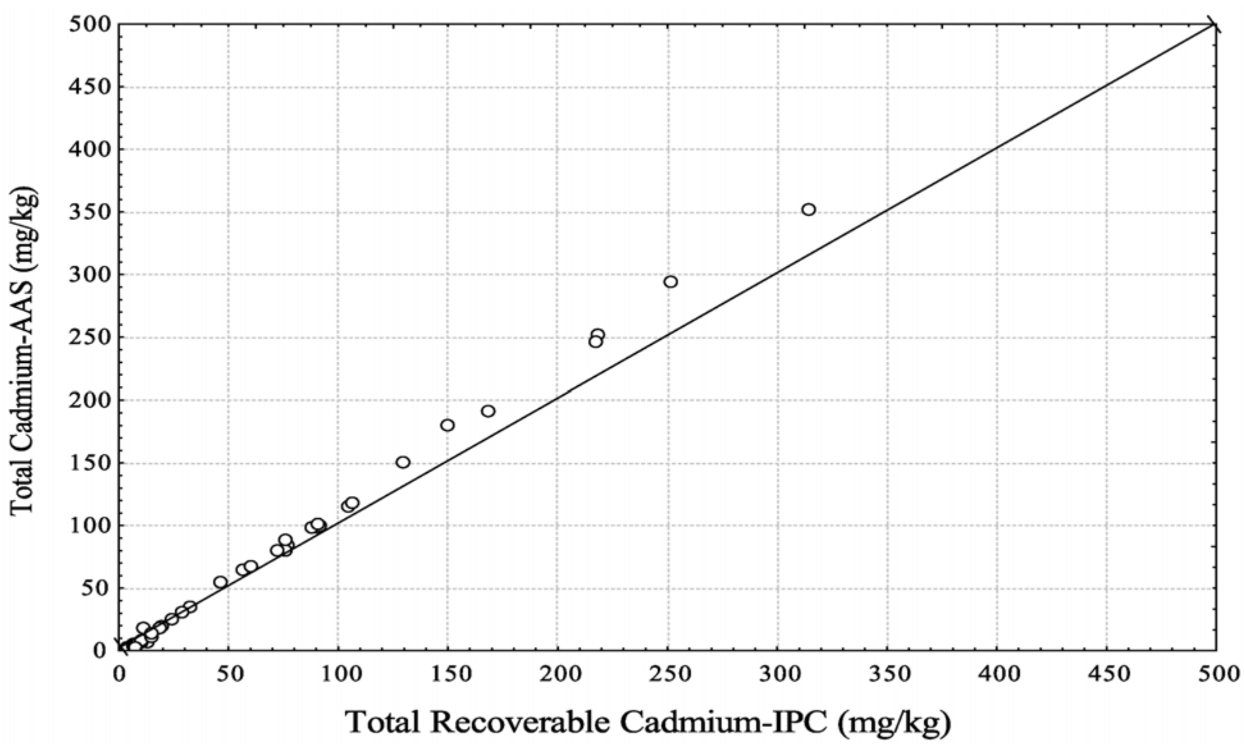

Figure 8. Comparison of cadmium concentrations in Lake DePue sediments determined by ICP and AAS.

values above detection limit for zinc and cadmium in sediment from Lake DePue, Turner Lake, and the Peoria Pool of the Illinois River. All values are in milligrams per kilogram, reported on a dry-weight basis.

Location	Number	Mean	Median	Minimum	Maximum	Lower quartile	Upper quartile
Lake DePue							
Zinc (ICP)[A]	121	5,724	3,400	304	42,300	1,450	7,280
Zinc (AAS)	38	10,831	7,534	390	43,300	2,470	18,100
Zinc (INAA)	22	6,263	3,364	391	26,214	2,075	8,845
Zinc (EDX)	46	5,904	3,818	120	33,150	1,670	7,095
Cadmium (ICP)[A]	121	36	17	2	309	7	45
Cadmium (AAS)	36	84	67	<2	352	13	110
Turner Lake							
Zinc (ICP)[A]	27	243	208	155	427	192	284
Zinc (AAS)	5	271	233	220	425	228	251
Zinc (INAA)	5	329	295	198	530	248	374
Zinc (EDX)	10	170	140	87	374	90	198
Cadmium (ICP)[A]	27	3.9	2.7	2.0	8.5	2.3	4.9
Cadmium (AAS)	1			<2	4		
Peoria Pool							
Zinc (ICP)[A]	46	303	311	120	500	244	378
Zinc (AAS)	23	324	324	104	531	263	388
Zinc (INAA)	54	327	323	73	637	269	417
Cadmium (ICP)[A]	46	4	3.7	0.6	10.3	2.4	5.6
Cadmium (AAS)	3			<2	9.1		

Note: [A]Total recoverable metal concentrations determined by contract laboratory.

Summary of Zinc and Cadmium Results Zinc and cadmium concentrations in sediments from Lake DePue and Turner Lake are summarized in Table 4. The mean, median, minimum, maximum, lower quartile, upper quartile, and the number of values above the detection limit are included. The concentrations of zinc and cadmium in sediments from the Peoria Pool of the Illinois River collected in April of 1998 (Cahill, 2001) also are shown. The statistics for the ISGS results cannot be compared directly with the contract laboratory results because not all of the samples were analyzed by the ISGS. In addition, comparisons among the various methods are not appropriate because of the different number and sites analyzed.

Box and whisker plots of zinc and cadmium concentration in sediments from Lake DePue are shown in Figures 9 and 10. The plots illustrate the wide range of the concentrations of zinc and cadmium in Lake DePue sediments.

The maximum concentrations of zinc and cadmium in sediments from Lake DePue were found in the core collected near the South Ditch. The mean and median values of zinc determined by AAS are higher than those determined by the other techniques because all 17 samples from the core collected near the South Ditch were analyzed by AAS. The concentration of zinc and

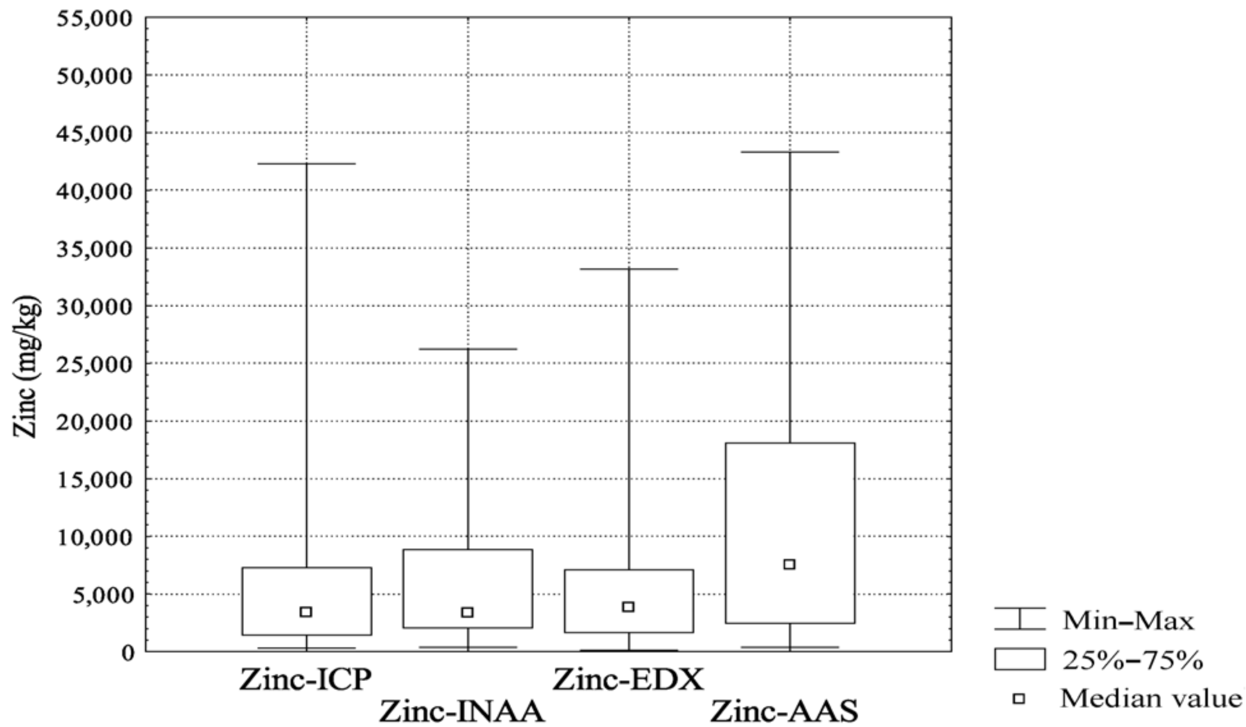

Figure 9. Box and whisker plots of zinc concentrations in sediments from Lake DePue.

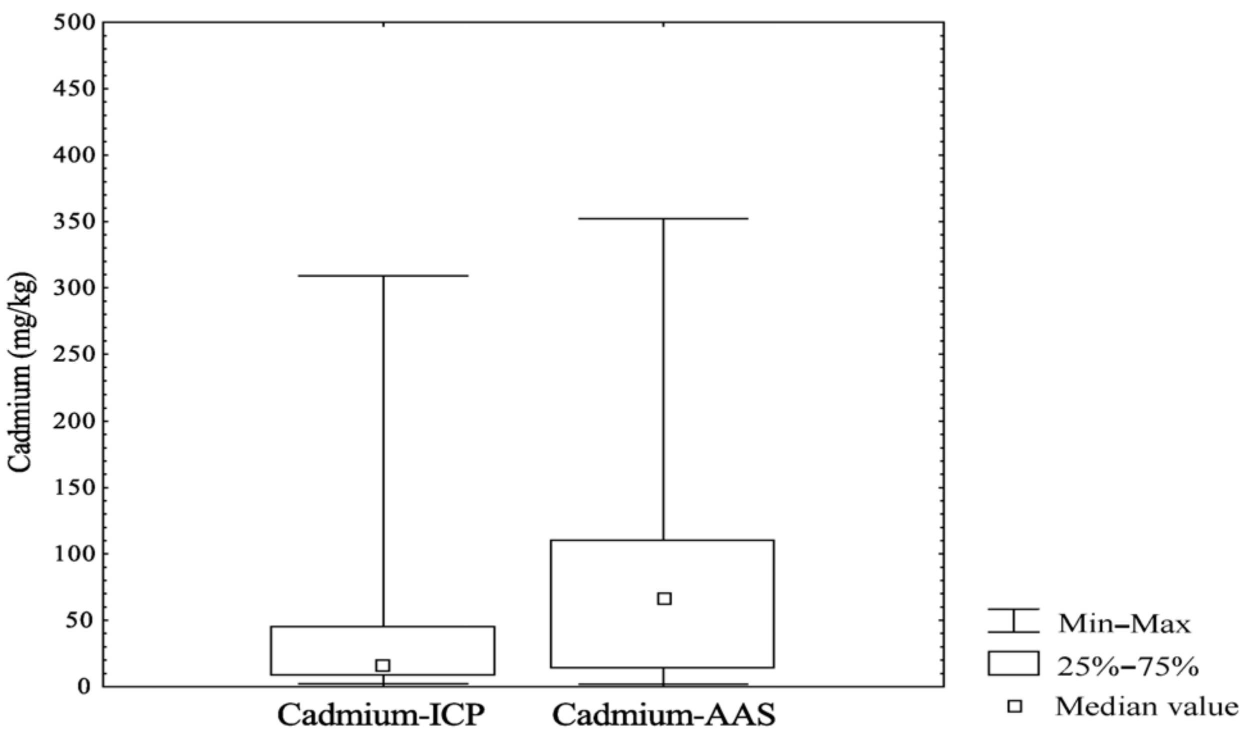

Figure 10. Box and whisker plots of cadmium concentrations in sediments from Lake DePue.

cadmium in sediments of Lake DePue are at least an order magnitude higher than in sediments from Turner Lake or the Peoria Pool of the Illinois River.

The results for zinc and cadmium for the 40- to 45-cm interval from core LD8 seem anomalous. Total recoverable zinc and cadmium concentrations are one fifth the amount in this interval compared with the samples from below or above this interval. Comparable results were obtained, however, in splits of the sample by AAS. The core collected at cross section 8 (LD3) exhibits a similar pattern in which the zinc and cadmium concentrations pass through minima. These intervals could represent sediments that were deposited during the dredging operation or a time when this section of the lake was dry.

Vertical Distribution of Zinc and Cadmium None of the cores collected in this study were of sufficient length to penetrate to the top of the original floodplain soils or to the sediment layers that were deposited in the early 1900s. It seems likely that higher concentrations of zinc and cadmium may be present in the deeper older sediments of Lake DePue, but these layers were not sampled because of limitations of the available equipment.

Concentrations of total recoverable zinc and cadmium are plotted versus depth in the cores in Appendix B. The concentration profiles for zinc exhibit various patterns. In several cores, the apparent maximum zinc concentrations occur at the base of the sediment cores (cross section 2 and Turner Lake cores), while in other cores the maximum concentrations occur near the surface (cross sections 6 and 7 and near the South Ditch). Some of the cores have 2 distinct zinc peaks (cross sections 5 and 8). The profiles for cadmium are similar to the patterns of zinc concentrations in most cores. However, in cores collected at cross sections 5 and 8 and near the South Ditch, the cadmium concentrations are greatest at the base of the cores, unlike zinc. The concentrations of total recoverable zinc and cadmium are grouped by depth in the Lake DePue sediment cores in Table 5.

Table 5. Total recoverable zinc and cadmium concentrations in Lake DePue sediments grouped by depth in sediment cores. All values are in milligrams per kilogram on a dry-weight basis.

Depth	Number	Mean	Median	Maximum	Minimum
0–5 cm					
Zinc	24	4,396	2,675	25,000	304
Cadmium	24	21	13	106	2
5–25 cm					
Zinc	32	6,738	3,470	42,300	416
Cadmium	32	28	16	168	3
25–50 cm					
Zinc	38	5,085	2,385	18,100	554
Cadmium	38	30	12	104	3
45–79 cm					
Zinc	26	6,754	4,430	24,700	1,040
Cadmium	26	69	28	309	7

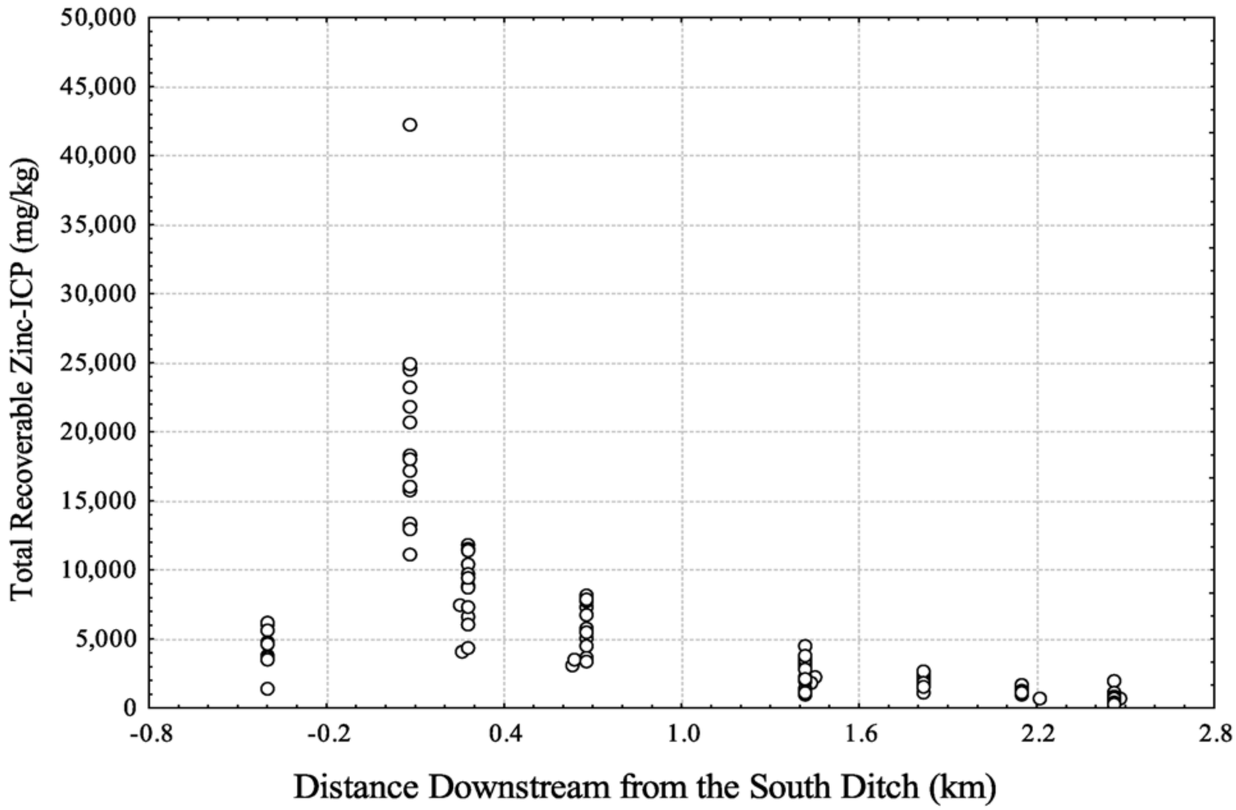

Figure 11. Total recoverable zinc concentrations in Lake DePue sediments relative to distance from the South Ditch.

The first grouping includes all of the grab samples and the 0- to 5-cm intervals from the sediment cores. This group represents sediments deposited in the last 2 to 3 years. The second group of sediment samples is from 5 to 25 cm in the cores and represents sediments deposited probably between 1988 and 1995. The third group of sediment samples is from 25 to 50 cm deep in the cores and represents sediments probably deposited between 1978 and 1988. The fourth group is from 50 cm to the base of the cores (about 65 cm) and represents sediments deposited probably between 1972 and 1978.

These sediment dates are based on sedimentation rates discussed later in the report. The maximum concentrations, as well as the greatest mean, median, and minimum concentrations of cadmium, occur in the deepest sediments. The vertical distribution of zinc is not as clear and appears to be bimodal. The most recent sediments still contain large concentrations of zinc and cadmium.

Concentrations of Zinc and Cadmium Relative to Distance from the South Ditch The concentrations of total recoverable zinc and cadmium are plotted as a function of distance downstream from the South Ditch in Figures 11 and 12.

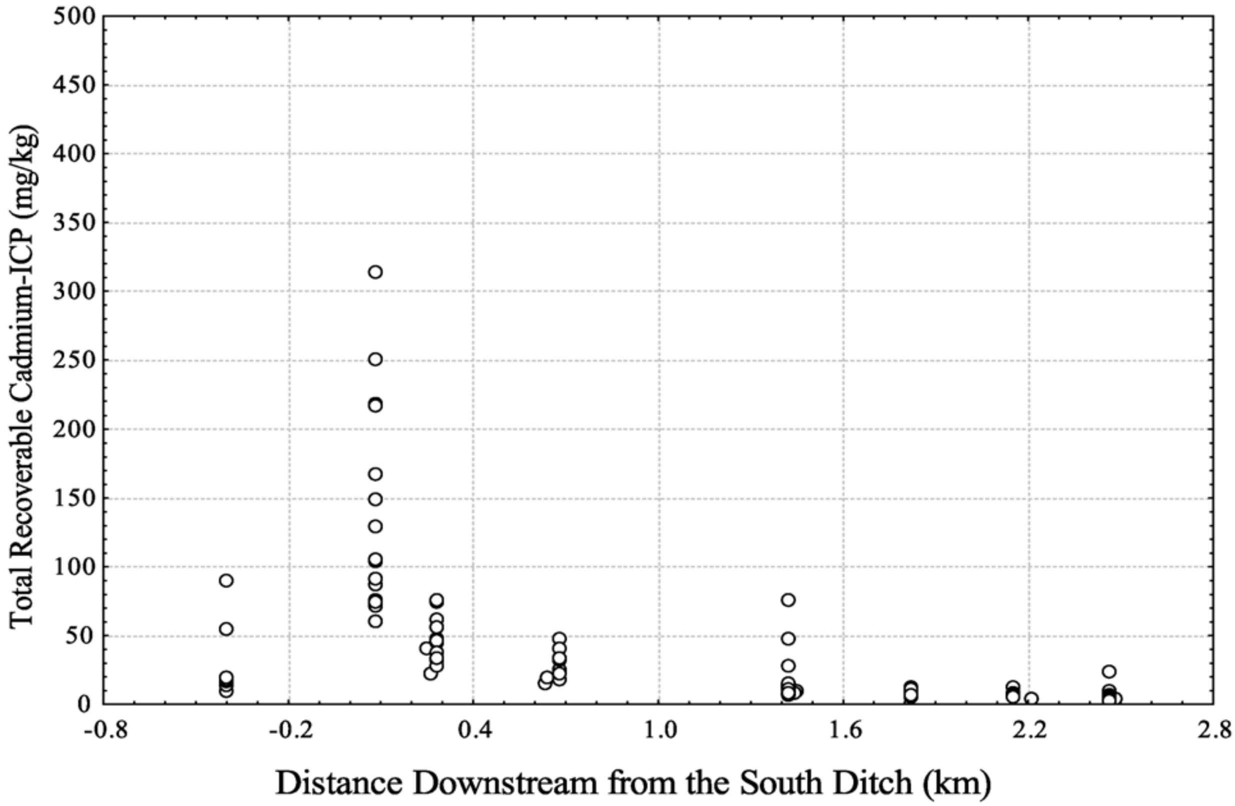

Figure 12. Total recoverable cadmium concentrations in Lake DePue sediments relative to distance from the South Ditch.

The South Ditch enters near the middle of the eastern arm of the lake and drains the large slag pile at the former industrial site.

Total recoverable zinc and cadmium concentrations decrease relative to distance from the South Ditch. The concentrations decreased with distance from the South Ditch probably by dilution with "clean" sediment. Also, since 1983, sediment containing elevated concentrations of zinc and cadmium coming from the South Ditch was being deposited in the dredged area and not moving into the lower section of Lake DePue or into the Illinois River.

Comparison of Zinc and Cadmium Results to Previous Work in Lake DePue Lake DePue was sampled in 1975, 1978, and 1982 (Cahill and Steele, 1986). Three intervals from a core collected in 1982 for cesium-137 analysis and one surface grab sample were analyzed as part of this project. Metal concentrations had not been determined previously on these samples. All of the results from cores collected in Lake DePue and Turner Lake and reported in Cahill and Steele 1986 are included in Appendix E.

Table 6. Zinc and cadmium concentrations in Lake DePue sediment cores collected in 1978 and 1982 near cross sections 3 and 5 compared with results from the cores collected at cross sections 3 and 5 in 1998 determined by AAS at ISGS. All values are in milligrams per kilogram on a dry-weight basis.

Year	Cross section	Depth (cm)	Zinc	Cadmium
1978	3	0–5	1,660	10
1978	3	5–15	1,120	6
1978	3	30–35	2,640	24
1978	3	60–65	1,200	30
1978	3	100–105	870	14
1998	3	20–25	1,770	4
1998	3	40–45	1,365	5
1982	5[A]	0–5	2,080	11
1982	5[A]	20–25	4,000	10
1982	5[A]	60–65	3,310	22
1982	5[A]	110–110	1,650	29
1982	5	0–5	2,090	12.6
1982	5	5–10	391	1.8
1982	5	20–27	1,120	6.0
1998	5	20–25	3,660	12
1998	5	40–45	1,700	3
1998	5	70–75	4,140	81

Note: [A] Results from a core collected in 1982 and analyzed as part of this project.

In Table 6, the zinc and cadmium concentrations determined by AAS near cross section 3 in 1978 and cross section 5 in 1982 are compared with results from cores collected in 1998 at the same cross sections. The 40- to 45-cm depth interval of the core collected in 1998 at cross section 3 is approximately equivalent to the surface units of the 1978 core. The zinc and cadmium concentrations in the 2 cores are similar. The upper units of the 1982 cores are approximately equivalent to the 25- to 40-cm intervals in the 1998 core. The zinc and cadmium concentrations are similar in these intervals, although there is wide range of concentrations. The cadmium concentration in the 70- to 75-cm interval of the 1998 core was 81 mg/kg. Levels of cadmium this great were not found in the intervals tested from the 1982 cores near cross section 5.

Zinc and Cadmium Elemental Ratios The terrestrial abundance of zinc in Earth's crust is 76 mg/kg and the abundance of cadmium is 0.16 mg/kg (Greenwood and Earnshaw, 1984). The geochemical cycles of zinc and cadmium are very closely related because they are in the same group in the periodic table and have similar arrangements of electrons in their outermost shells (O'Neill, 1985). The hydrated zinc ion is relatively more stable than the hydrated cadmium ion, and cadmium tends to bond more strongly than zinc in insoluble sulfur compounds (O'Neill, 1985). Cadmium generally has been found to be enriched in zones of reduction in preference to zinc (Rankama and Sahama, 1950). Zinc is biologically among the most important trace metals, but cadmium has no known biological role and is among the most toxic of the trace metals (Greenwood and Earnshaw, 1984).

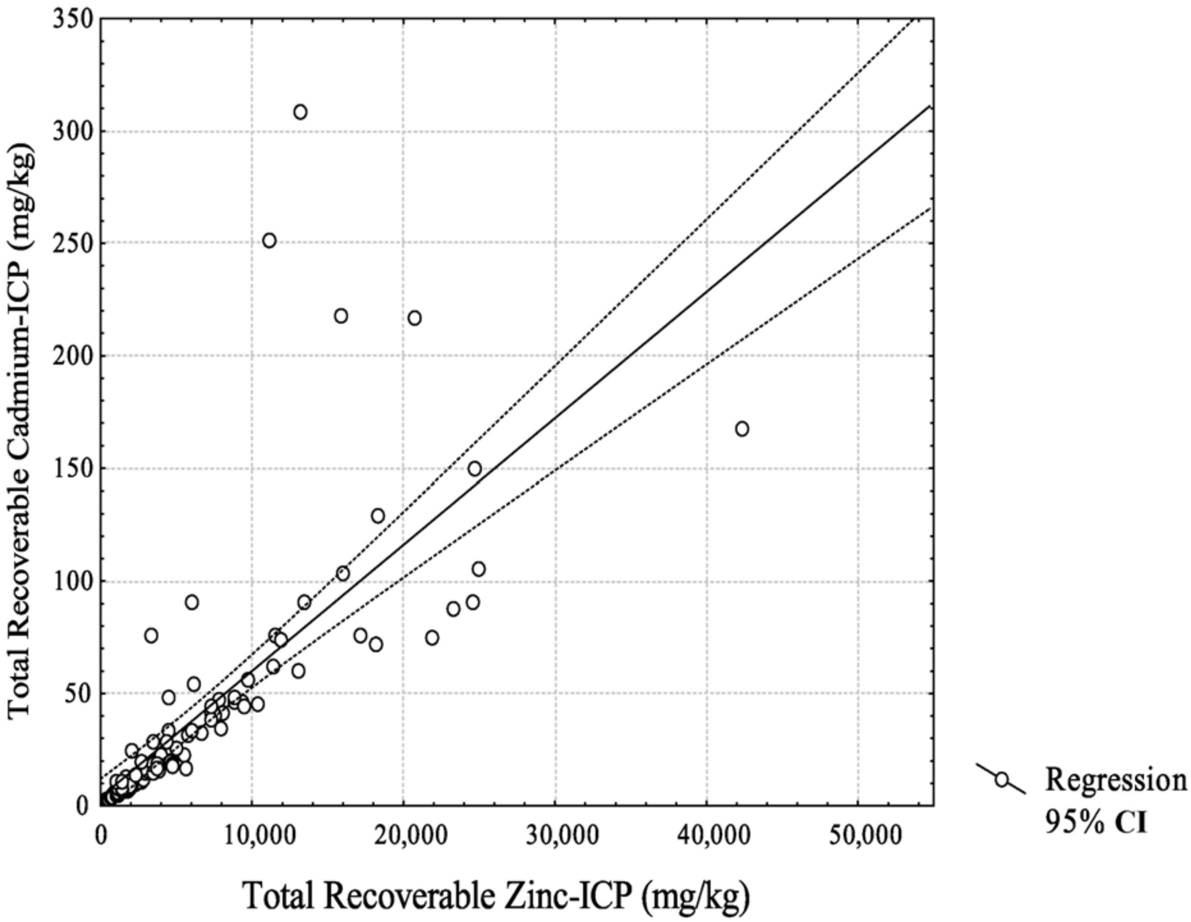

Figure 13. Correlations between zinc and cadmium concentrations in sediments from Lake DePue. All samples included. Correlation coefficient r^2 is 0.74. Closed circles are samples from the sediment core collected at the South Ditch.

The relationship between zinc and cadmium follows a linear trend for most of the sediment samples from Lake DePue. The average zinc-to-cadmium ratio is 186; range is 42 to 329. Figure 13 is a plot of total recoverable zinc versus total recoverable cadmium for Lake DePue sediment samples. The correlation coefficient is 0.74.

The points that fall above the trend line have large concentrations of cadmium relative to zinc. A number of the points that plotted above the trend line represent sediment intervals from the core collected near the South Ditch. Points that plot below the trend line have small concentrations of cadmium relative to zinc. Most of the points that plotted below the trend line also represent sediment intervals in the core collected near the South Ditch. The sediments in the South Ditch were noted as “unnatural” (IEPA, 1998), and the changing zinc-to-cadmium ratios in the core collected near the South Ditch may reflect changing industrial practices.

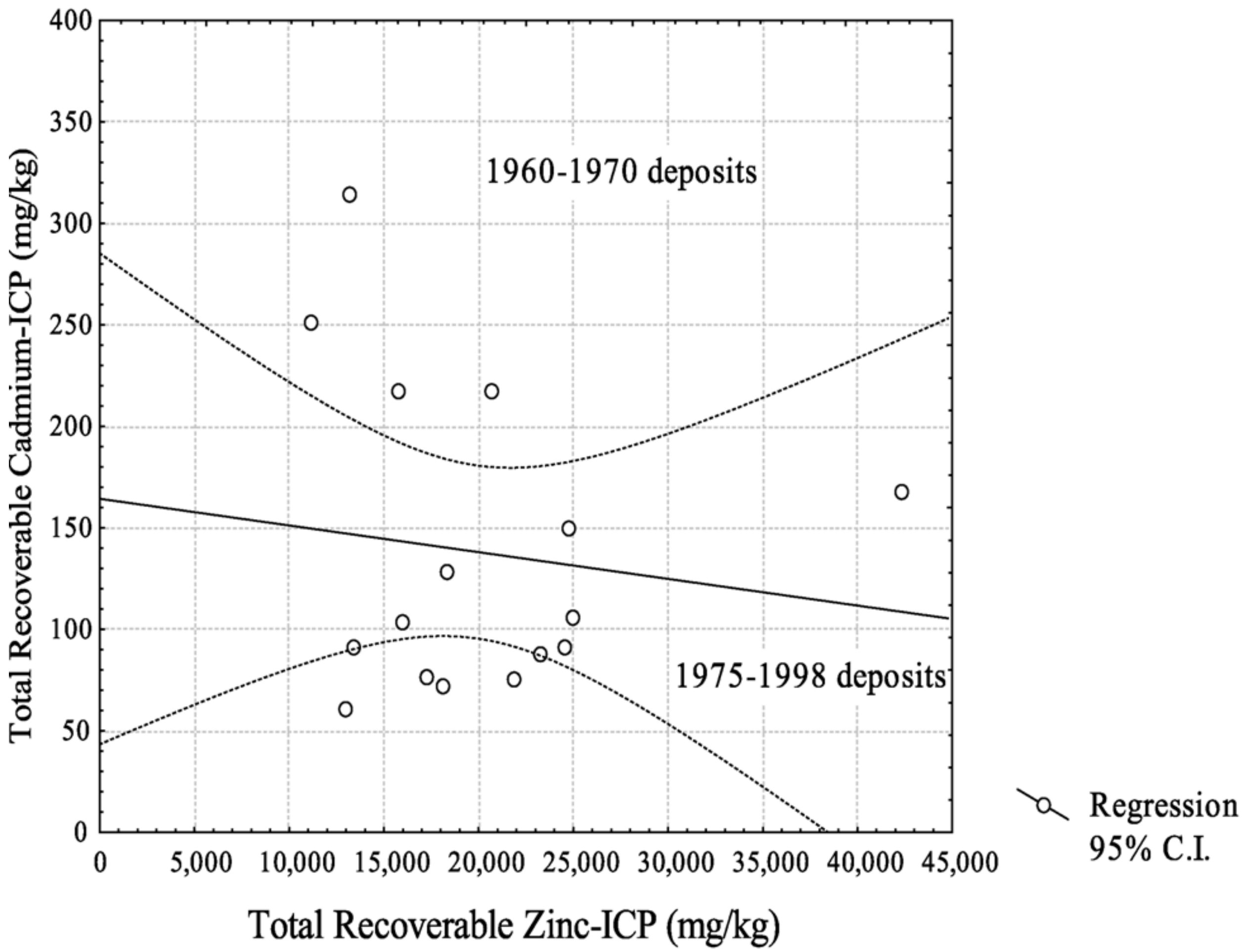

Figure 14. Correlations between zinc and cadmium concentrations in the sediment cores collected from near the South Ditch in Lake DePue only. The approximate date the sediments were deposited is given based on a cesium-137 sedimentation rate estimate. Correlation coefficient r^2 is 0.08.

Figure 14 is a plot of total recoverable zinc versus total recoverable cadmium for Lake DePue sediment samples collected from near the South Ditch. The approximate age of the deposits is included on the figure. The age is based on sedimentation rate estimates from cesium-137 results (Table 18). Sediments deposited in the period 1960 to 1970 plotted above the trend line; samples deposited since 1980 plotted below the trend line.

Organic Carbon

The concentrations of total carbon, inorganic carbon and organic carbon content are presented in Appendix A. Plots of the vertical distribution of organic carbon in the cores are shown in Appendix B. The distribution of organic carbon is nearly uniform within a narrow range of concentrations in both Lake DePue (2.3 to 4%) and Turner Lake (2.2 to 3.%). These concentrations are in contrast to those found in sediments from the Peoria Pool of the Illinois River, which range from 1.5 to 10.4% (Cahill and Steele, 1986).

Total Recoverable Metals (ICP Results)

The total recoverable metal concentrations are listed in Appendix C. The mean, median, minimum, maximum, lower quartile, and upper quartile concentrations and the number of values above the detection limit for total recoverable metals in sediments from Lake DePue, Turner Lake, and the Peoria Pool of the Illinois River determined by ICP are given in Tables 7 to 9. The same contract laboratory analyzed the samples from the Lake DePue, Turner Lake, and the Peoria Pool of the Illinois River.

The concentrations of most elements were similar in Lake DePue, Turner Lake, and the Peoria Pool of the Illinois River. Copper and lead were elevated in Lake DePue relative to Turner Lake or the Peoria Pool of the Illinois River. Barium, mercury, and sodium concentrations were elevated in some Lake DePue sediments.

Table 7. Mean, median, minimum, maximum, lower quartile, and upper quartile concentrations and number of values above detection limit of total recoverable metal concentrations in sediment from Lake DePue determined by ICP. A total of 19 sediment samples were analyzed. All values are in milligrams per kilograms unless noted, and are on a dry-weight basis.

Element	Number	Mean	Median	Minimum	Maximum	Lower quartile	Upper quartile
Aluminum (%)	19	1.69	1.67	1.22	2.56	1.46	1.82
Iron (%)	19	2.61	2.67	2.13	3.02	2.48	2.77
Calcium (%)	19	2.48	2.57	1.50	3.72	2.16	2.76
Magnesium (%)	19	1.08	1.07	0.80	1.49	1.00	1.13
Potassium (%)	19	0.24	0.22	0.18	0.40	0.20	0.26
Sodium	19	254	209	152	696	190	232
Manganese	19	687	716	505	887	596	746
Silver	5	1.6	1.6	<0.9	2.4	1.1	1.9
Arsenic	19	9.9	9.5	7.3	14.5	8.9	10.8
Barium	19	175	153	106	553	134	173
Cobalt	19	14	14	9	23	13	15
Chromium	19	46	39	31	88	36	51
Copper	19	175	100	38	838	62	182
Mercury	19	0.35	0.27	0.18	0.80	0.22	0.46
Nickel	19	35	33	23	54	29	40
Lead	19	81	61	35	282	47	97
Selenium	18	0.9	0.8	0.5	1.7	0.6	1.2
Thallium	0	<1					
Vanadium	19	31	31	24	47	27	32

Table 8. Mean, minimum and maximum concentrations and number of values above detection limit of total recoverable metal concentrations in sediment from Turner Lake determined by ICP. A total of 4 samples were analyzed. All values are in milligrams per kilogram unless noted, on a dry-weight basis.

Element	Number	Mean	Minimum	Maximum
Aluminum (%)	4	1.59	1.38	1.87
Iron (%)	4	2.56	2.34	2.72
Calcium (%)	4	2.67	2.22	2.90
Magnesium (%)	4	1.16	1.05	1.22
Potassium (%)	4	0.23	0.18	0.29
Sodium	4	153	134	169
Manganese	4	561	488	607
Silver	1		<0.9	1.0
Arsenic	4	8.8	8.4	9.7
Barium	4	130	120	144
Cobalt	4	9.4	9.2	9.8
Chromium	4	43	35	60
Copper	4	46	42	57
Mercury	4	0.21	0.16	0.33
Nickel	4	30	27	35
Lead	4	44	37	62
Selenium	2	0.6	<0.5	0.6
Titanium	0	<1		
Vanadium	4	30	27	35

Table 9. Mean, median, minimum, maximum, lower quartile, and upper quartile concentrations and number of values above detection limit of total recoverable metal concentrations in sediment from the Peoria Pool of the Illinois River determined by ICP (Cahill, 2001). Forty-six samples were analyzed; values are in milligrams per kilogram unless noted, on a dry-weight basis.

	Number	Mean	Median	Minimum	Maximum	Lower quartile	Upper quartile
Aluminum (%)	46	1.46	1.47	0.70	2.03	1.14	1.83
Iron (%)	46	2.51	2.63	1.33	3.18	2.13	2.93
Calcium (%)	46	2.76	2.66	0.89	4.28	2.39	3.26
Magnesium (%)	46	1.18	1.16	0.49	2.09	0.97	1.30
Potassium (%)	46	0.21	0.22	0.12	0.32	0.17	0.26
Sodium	46	432	434	328	517	401	459
Manganese	46	582	608	278	821	517	667
Silver	18	1.4	1.4	<0.9	1.8	1.1	1.5
Arsenic	46	9.1	9.1	4.8	16.6	7.6	10.4
Barium	46	225	231	138	270	203	250
Cobalt	46	10.4	11.0	6.7	12.2	9.4	11.5
Chromium	46	50	46	14	85	35	62
Copper	46	60	43	42	57	42	51
Mercury	46	0.32	0.28	0.07	0.78	0.21	0.43
Nickel	46	41	41	19	63	31	48
Lead	46	54	54	15	94	40	71
Selenium	5	1.3	1.0	<0.5	2.9	0.6	1.3
Titanium	0	<1					
Vanadium	46	29	30	18	39	25	35

Total Metal Concentration (ISGS Results)

The total concentrations of metals in sediments from Lake DePue and Turner Lake and in QA/QC samples determined by the ISGS are reported in Appendix D. The mean, median, minimum, maximum, lower quartile, and upper quartile concentrations and number of values above detection limits of total metal in sediments from Lake DePue and Turner Lake determined at ISGS are given in Tables 10 and 11.

The concentrations of most elements in the sediments from Lake DePue and Turner Lake were similar. Copper and lead are much higher in samples collected near the South Ditch. Phosphorus, sulfur, barium, arsenic, mercury, selenium, and uranium were also elevated in sediments near the South Ditch area relative to the rest of Lake DePue and Turner Lake.

Cadmium, Copper, Lead, Nickel, and Zinc Concentrations in Core Collected near the South Ditch Cadmium, copper, lead, nickel, and zinc concentrations were determined at the ISGS by AAS on all of the sediment intervals from the core collected near the South Ditch. The vertical distributions of zinc and cadmium are plotted in Figures 15 and 16. The vertical distribution of copper (Figure 17) was similar to that for zinc. The maximum concentration of copper was 1,561 mg/kg at a depth of 10 to 15 cm in the core. For comparison, background levels of copper ranged from 54 to 80 mg/kg in Turner Lake.

The vertical distribution of lead (Figure 18) was more similar to that of cadmium than zinc. The maximum lead concentration was 493 mg/kg at a core depth of 35 to 40 cm. For comparison, background levels of lead ranged from 58 to 118 mg/kg in Turner Lake sediments.

The concentrations of nickel (Figure 19) were relatively uniform, ranging from 32 to 73 mg/kg, except for an unusually large concentration in the depth interval 65 to 70 cm. The concentrations of nickel in this core were comparable with those observed throughout Lake DePue and to the background levels of nickel from Turner Lake, which ranged from 32 to 52 mg/kg. The South Ditch appears to have contributed primarily zinc, cadmium, copper, and lead to Lake DePue sediments.

Comparison of Concentrations in South Ditch Sediments with Other Results from This Study The ranges of concentrations for 15 metals from the South Ditch sediments (IEPA, 1998) are compared with the other results from this study in Table 12. Included in the table are results for total recoverable metals from the contract laboratory and total metals determined by ISGS. The methods used to determine concentrations in the South Ditch were not specified in the report from the IEPA (1998). The maximum concentrations of arsenic, barium, cadmium, copper, lead, mercury, silver, and zinc were much greater in the South Ditch sediments than in the Lake DePue sediments.

Table 10. Mean, median, minimum, maximum, lower quartile, and upper quartile concentrations and number of values above detection limit of total metal concentrations in sediments from Lake DePue determined by various techniques at ISGS. All values are in milligrams per kilogram unless noted, on a dry-weight basis. Method codes: no code indicates XRF, (1) is AAS, (2) is INAA, (3) is EDX.

	Number	Mean	Median	Minimum	Maximum	Lower quartile	Upper quartile
Total carbon (%)	121	4.16	4.18	3.46	5.25	3.91	4.38
Inorganic carbon (%)	121	1.04	1.03	0.50	2.09	0.77	1.24
Organic carbon (%)	121	3.12	3.16	2.28	4.04	2.97	3.30
Silicon dioxide (%)	25	53.89	53.78	49.85	57.83	53.07	55.16
Ferric oxide (%)	25	14.06	14.37	10.67	15.61	13.60	14.90
Ferric oxide (%)	25	5.92	6.01	4.48	6.45	5.80	6.22
Ferric oxide (%) 2	22	6.25	6.35	5.05	6.89	6.09	6.56
Calcium oxide (%)	25	4.16	4.20	2.79	6.70	3.41	4.88
Magnesium oxide (%)	25	2.74	2.74	2.38	3.28	2.58	2.82
Potassium oxide (%)	25	2.88	2.91	2.45	3.07	2.82	3.01
Potassium oxide (%) 2	22	3.07	3.10	2.6	3.45	2.99	3.16
Sodium oxide (%)	25	0.60	0.58	0.48	0.85	0.53	0.65
Sodium oxide (%) 2	22	0.56	0.52	0.46	0.73	0.51	0.60
Titanium dioxide (%)	25	0.71	0.71	0.61	0.75	0.69	0.74
Phosphorus pentoxide (%)	25	0.49	0.40	0.33	1.19	0.34	0.57
Manganous oxide (%)	25	0.11	0.11	0.08	0.15	0.09	0.12
Manganous oxide (%) 2	8	0.13	0.13	0.10	0.15	0.12	0.14
Sulfur oxide (%)	25	0.60	0.55	0.28	1.09	0.45	0.65
Silver 2	16	1.9	1.6	<0.5	6.3	1.0	2.0
Arsenic 2	22	13.3	13.0	9.5	32.0	11.3	13.9
Barium	25	539	516	400	954	481	580
Barium 2	22	715	699	552	1,091	596	783
Barium 3	47	574	562	432	894	535	607
Bromine 2	22	7.7	7.7	4.9	10.0	6.6	8.2
Cesium 2	22	81	81	68	92	78	85
Cobalt 2	22	25	25	18	37	22	28
Chromium 2	22	121	115	94	177	105	130
Cesium 2	22	7.1	7.1	5.5	8.6	6.9	7.6
Copper 1	38	375	192	52	1,560	88	520
Europium 2	22	1.4	1.3	1.0	1.8	1.3	1.4
Gallium 2	22	19	19	15	22	18	20
Hafnium 2	22	5.6	5.4	4.5	7.7	5.3	5.8
Mercury 1	25	0.38	0.28	0.16	0.89	0.23	0.47
Lanthanum 2	22	38	38	33	44	36	40
Lutetium 2	22	0.8	0.8	0.5	2.0	0.7	0.9
Molybdenum 2	3	12		<10	15		
Nickel 1	37	46	46	<15	73	41	53
Nickel 2	22	66	65	32	101	54	72
Lead 1	38	186	155	42	483	97	216
Rubidium 2	22	146	147	111	166	139	154
Antimony 2	22	1.7	1.6	1.3	3.0	1.5	1.8
Scandium 2	22	14.4	14.7	11.7	16.2	14.0	15.1
Selenium 2	17	2.1	1.4	<0.5	6.5	1.0	2.2
Samarium 2	22	7.3	7.1	6.3	9.2	6.8	7.6
Tin 3	47	9	9	5	18	8	9
Strontium	25	124	123	112	145	121	129
Strontium 3	47	115	116	104	134	110	120
Tantalum 2	22	1.0	1.0	0.8	1.1	0.9	1.0
Terbium 2	22	0.7	0.7	0.6	0.9	0.7	0.8
Thallium 2	22	11.3	11.5	10.0	12.6	10.8	12.0
Uranium 2	17	5.5	5.4	<2	9.3	4	6.6
Tungsten 2	20	1.9	1.8	<1	3.0	1.4	2.4
Ytterbium 2	22	2.8	2.7	2.2	4.4	2.5	2.8
Zirconium	25	107	101	87	177	93	112
Zirconium 3	47	205	196	173	349	188	207

Table 11. Mean, median, minimum, maximum, lower quartile, and upper quartile concentrations and number of values above detection limit of total metal concentrations in sediments from Turner Lake determined by various techniques at ISGS. All values are in milligrams per kilogram unless noted, on a dry-weight basis. Method codes: no code indicates XRF, (1) is AAS, (2) is INAA, (3) is EDX.

	Number	Mean	Median	Minimum	Maximum	Lower quartile	Upper quartile
Total carbon (%)	27	3.90	3.71	3.40	4.41	3.58	4.32
Inorganic C (%)	27	1.14	1.13	0.72	1.42	0.96	1.37
Organic carbon (%)	27	2.76	2.79	2.28	3.04	2.55	2.94
Silicon dioxide (%)	5	54.79	54.07	42.73	57.26	53.92	56.0
Aluminum oxide (%)	5	13.65	13.78	13.34	13.81	13.56	13.78
Ferric oxide (%)	5	5.61	5.57	5.52	5.82	5.53	5.63
Ferric oxide (%) 2	5	6.08	6.16	5.73	6.46	5.83	6.21
Calcium oxide (%)	5	4.43	4.75	3.55	5.09	4.22	5.08
Magnesium oxide (%)	5	2.88	2.93	2.65	3.03	2.85	2.94
Potassium oxide (%)	5	2.89	2.90	2.83	2.95	2.85	2.94
Potassium oxide (%) 2	5	2.79	2.83	2.53	3.02	2.59	2.99
Sodium oxide (%)	5	0.54	0.53	0.50	0.59	0.52	0.58
Sodium oxide (%) 2	5	0.57	0.57	0.53	0.60	0.56	0.59
Titanium dioxide (%)	5	0.70	0.70	0.68	0.73	0.69	0.72
Phosphorus pentoxide (%)	5	0.33	0.31	0.29	0.42	0.30	0.31
Manganous oxide (%)	5	0.09	0.09	0.08	0.10	0.09	0.09
Manganous oxide (%) 2	5	0.10	0.09	0.09	0.12	0.09	0.09
Sulfur oxide (%)	5	0.42	0.42	0.35	0.50	0.40	0.43
Silver 2	4	1.1	1.1	<0.5	1.4	0.9	1.3
Arsenic 2	5	10.5	11.2	6.0	12.9	10.2	12.2
Barium	5	482	497	414	516	469	515
Barium 2	5	631	636	564	705	594	658
Barium 3	10	559	566	474	617	523	601
Bromine 2	5	5.9	6.8	2.5	7.7	5.7	7.0
Cerium 2	5	81	81	71	91	80	83
Cobalt 2	5	18	17	16	19	17	19
Chromium 2	5	116	116	89	147	102	124
Cesium 2	5	6.8	6.7	6.0	7.5	6.5	7.2
Copper 1	5	63	59	54	80	57	64
Europium 2	5	1.3	1.3	1.2	1.5	1.2	1.4
Gallium 2	5	15	16	10	19	11	18
Hafnium 2	5	6.1	6.1	5.6	6.7	5.8	6.4
Mercury 1	5	0.21	0.19	0.15	0.32	0.19	0.20
Lanthanum 2	5	37	38	31	42	36	41
Lutetium 2	5	0.6	0.6	0.5	0.7	0.6	0.7
Molybdium 2	0	<20					
Nickel 1	5	40	38	32	52	36	41
Nickel 2	5	65	68	46	83	60	68
Lead 1	5	76	68	58	118	62	73
Rubidium 2	5	141	146	125	151	133	149
Antimony 2	5	1.6	1.6	1.1	2.4	1.3	1.8
Scandium 2	5	14.0	14.2	12.7	15.1	13.5	14.5
Selenium 2	5	1.4	1.5	0.4	2.4	1.0	1.7
Samarium 2	5	7.0	7.3	5.5	7.9	6.7	7.5
Tin 3	10	7	6	5	10	6	7
Strontium	5	121	122	113	128	120	123
Strontium 3	10	110	112	103	114	106	113
Tantalum 2	5	1.0	1.0	0.8	1.1	0.9	1.0
Terbium 2	5	0.8	0.8	0.7	0.9	0.7	0.8
Thallium 2	5	11.4	11.6	10.3	12.0	11.2	11.9
Uranium 2	3	3.0	3.2	<2	3.4		
Tungsten 2	4	2.3	2.5	<1	2.8	1.9	2.8
Ytterbium 2	5	2.8	2.7	2.4	3.6	2.7	2.8
Zirconium	5	120	119	114	131	115	120
Zirconium 3	10	224	221	210	247	213	235

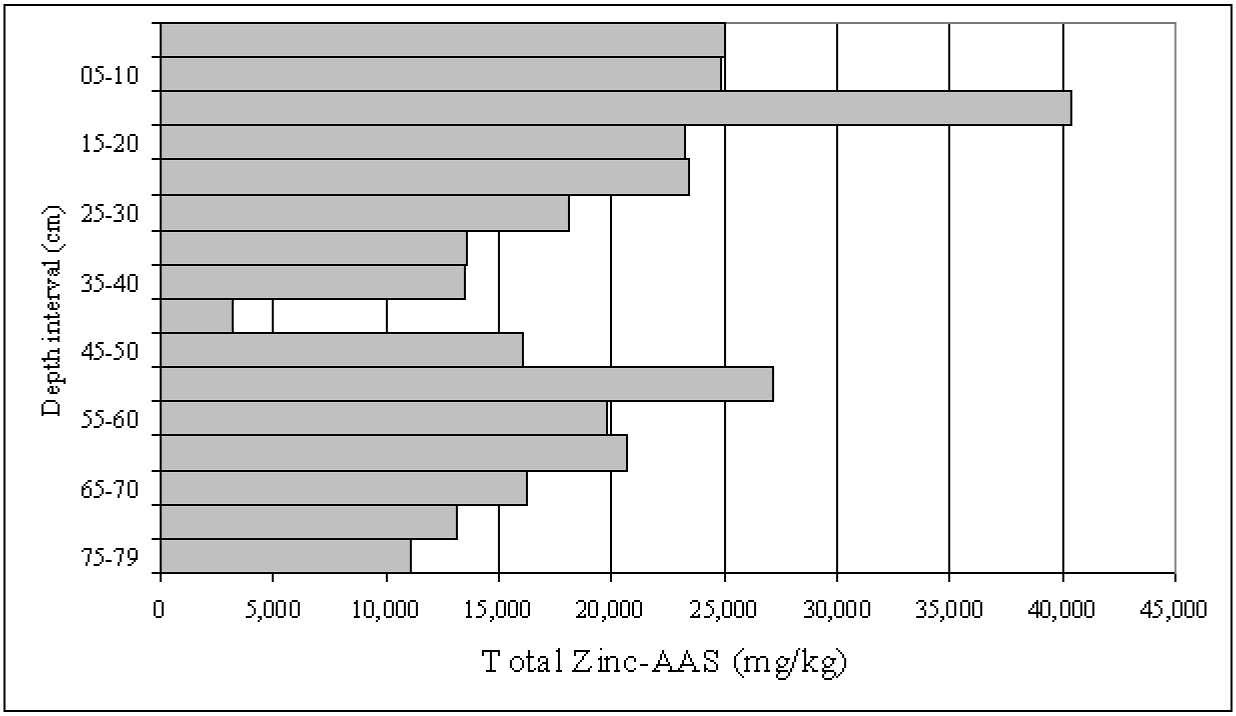

Figure 15. Total zinc concentrations in Lake DePue Sediment Core LD8, South Ditch area, determined by AAS. All values are in milligram per kilogram on a dry-weight basis.

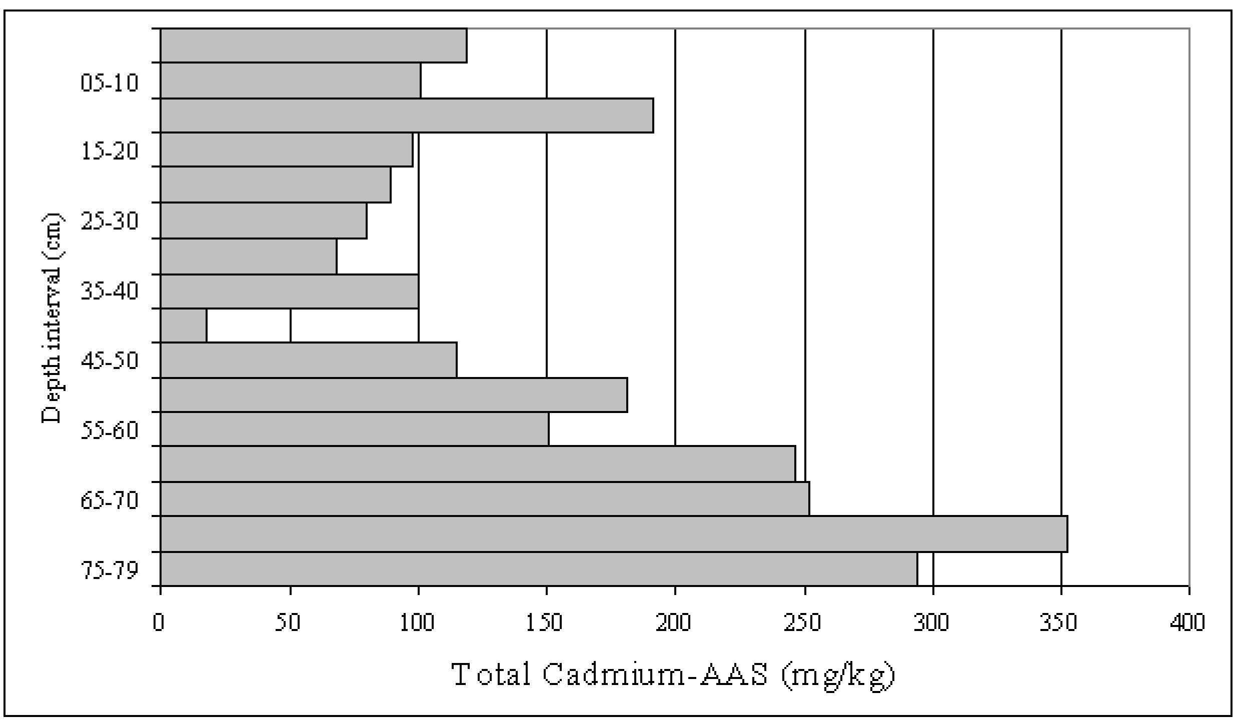

Figure 16. Total cadmium concentrations in Lake DePue Sediment Core LD8, South Ditch area, determined by AAS. All values are in milligram per kilogram on a dry-weight basis.

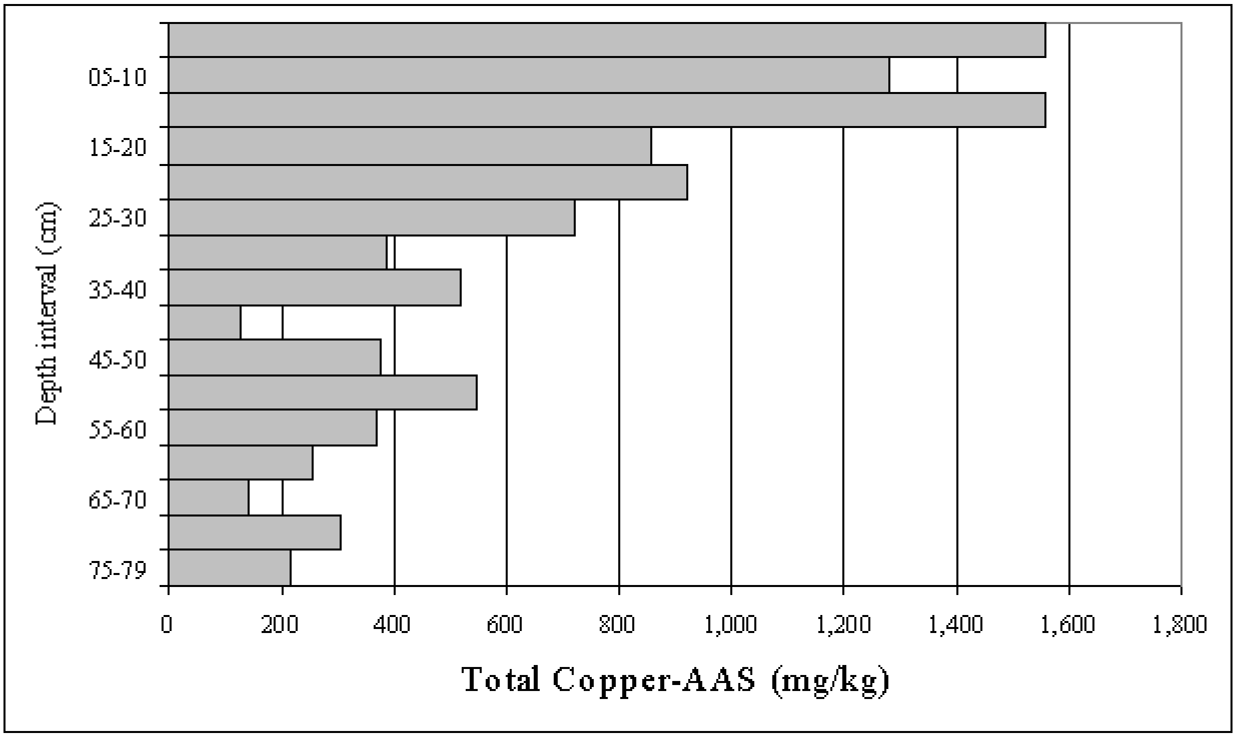

Figure 17. Total copper concentrations in Lake DePue Sediment Core LD8, South Ditch area determined by AAS. All values in milligrams per kilogram on dry-weight basis.

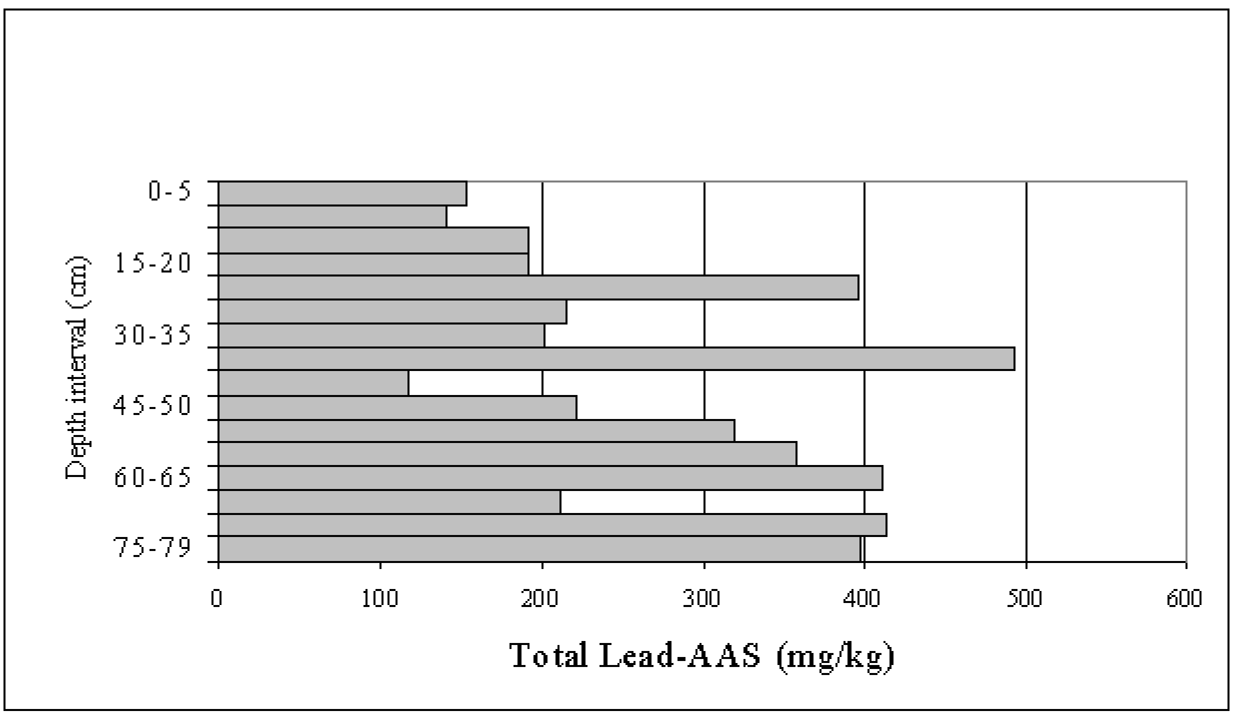

Figure 18. Total lead concentrations in Lake DePue Sediment Core LD8, South Ditch area, determined by AAS. All values are in milligrams per kilogram on a dry-weight basis.

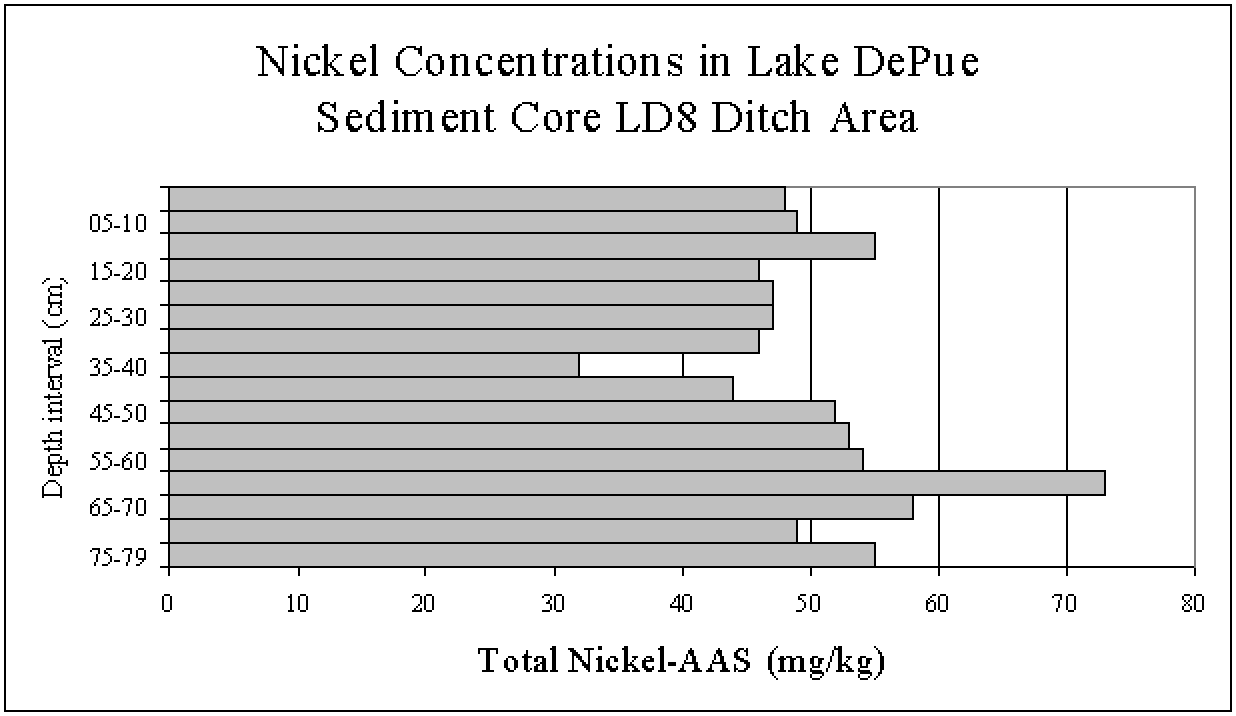

Figure 19. Total nickel concentrations in Lake DePue Sediment Core LD 8, South Ditch area, determined by AAS. All values are in mg/kg on a dry-weight basis.

Table 12. Comparison of ranges of metal concentrations of South Ditch sediments with results from this study of Lake De Pue samples. Concentrations are in milligrams per kilogram; the number of samples analyzed is in parentheses.

	South Ditch[A]	Total metals[B]	Total recoverable metals[C]
Arsenic	7.8–82.0	9.5–32.0 (25)	7.3–14.5 (19)
Barium	193–4,140	432–894 (51)	106–553 (19)
Beryllium	0.38–1.9		
Cadmium	32–910	<2–352 (38)	2.2–309 (121)
Chromium	<6–78	94–177 (25)	30.5–88.1 (19)
Cobalt	8.1–70.2	18.5–37.1 (25)	8.8–23.3 (19)
Copper	144–97,700	52–1,560 (40)	37.8–838 (19)
Lead	125–3,440	42–483 (40)	35–282 (19)
Manganese	433–3,130	619–1,160 (24)	505–887 (19)
Mercury	0.20–4.6	0.16–0.89 (25)	0.18–0.80 (19)
Nickel	11.6–60.3	22–73 (39)	23.3–54.0 (19)
Selenium	0.6–4.6	<0.5–6.5 (25)	<0.5–1.7 (19)
Silver	<1.4–144	<0.5–6.3 (25)	<1–2.4 (19)
Vanadium	<5–38		24–47 (19)
Zinc	3,840–204,000	390–43,300 (40)	304–42,300 (121)

Notes: [A]IEPA (1998).
[B]ISGS results.
[C]Contract laboratory results.

Table 13. Median, minimum, and maximum mineralogical compositions of sediments from Lake DePue and Turner Lake. All values are in percentages.

	Lake DePue			Turner Lake		
Mineral	Median	Minimum	Maximum	Median	Minimum	Maximum
Expandables-smectite	19.6	8.1	32.8	20.0	11.1	25.0
Illite	26.7	18.8	31.8	26.4	21.3	29.8
Kaolinite-chlorite	12.3	8.1	17.4	11.7	9.6	13.9
Total clay	56.8	43.2	67.4	55.9	53.0	58.7
Quartz	29.8	23.0	40.6	29.8	28.6	32.0
Potassium-feldspar	2.2	1.1	3.8	2.4	2.0	3.6
Plagioclase	3.5	2.2	5.6	3.3	2.7	4.0
Calcite	3.8	2.5	5.8	4.0	2.6	4.9
Dolomite	3.0	2.2	6.3	3.7	3.1	4.3
Total non-clay	43.0	32.6	56.8	44.1	41.2	46.9

Mineral Composition of Sediment Determined by XRD

The mineral composition of 27 sediment samples from Lake DePue and 5 samples from Turner Lake was determined by XRD analysis in combinations with acetic acid dissolution and ICP analysis. The results are included in Appendix F. The median, minimum, and maximum percentages of minerals present in the Lake DePue and Turner Lake sediment are summarized in Table 13.

The relative abundances of the minerals found are similar to those in typical glacial and recent sediments found in the area (Hughes, 1996). The approximate order of abundance is quartz, illite, expandable clay minerals, kaolinite, chlorite, plagioclase, calcite, dolomite, and potassium-feldspar. The calcite-to-dolomite ratios vary. The samples with the largest quartz content were, in general, closer to the Illinois River (cross section 2). The ratio of expandable clay minerals to illite varied markedly within the same core. No “unnatural” minerals were detected in the samples tested.

The large concentrations of clay minerals in the sediment, especially the expandable clay minerals, could absorb cations onto the clay structures and exchange them. Suspended sediment could quickly remove zinc, cadmium, copper, and lead from the water column.

Grain Size and Atterberg Limit Analysis Results from Surface Sediment Samples

All 16 surface grab samples, 1 field duplicate from Lake DePue, and 3 grab samples from Turner Lake were tested for particle size distribution. Particle size distributions were determined at the ISWS Sediment Laboratory. The grain size results are listed in Table 14.

Table 14. Sand, silt, and clay in surface sediments from Lake DePue and Turner Lake. Units are in percentages.

Grab sample ID	Cross section	% sand	% silt	% clay
Lake DePue				
LD5A	2	0.20	42.60	57.20
LD5B	2	4.70	50.80	44.50
LD4A	3	0.30	46.90	52.80
LD4C	3	0.10	41.70	58.20
LD6C	4	0.20	37.80	62.00
LD7A	5	0.20	31.80	68.00
LD7B	5	0.20	38.80	61.00
LD7C	5	0.10	32.10	67.80
LD1A	6	0.10	30.70	69.20
LD1B	6	0.10	25.70	74.20
LD1C	6	0.10	24.30	75.60
LD2A	7	0.10	36.10	63.80
LD2B	7	0.10	36.60	63.30
LD2C	7	0.20	38.3	61.50
LD3C	8	0.20	41.30	58.50
LD8	South Ditch	0.50	34.60	64.90
Field duplicate	(LD7C) 5	0.10	32.40	67.50
Turner Lake				
TL1		0.40	40.60	59.00
TL2		0.60	34.30	65.10
TL3		0.70	44.30	55.00

Figure 20 is a ternary plot of the percentages of the sand-, silt-, and clay-sized fractions in the surface sediments from Lake DePue. All samples plotted in the silty-clay region of the textural classification system according to Shepard (1954).

The liquid and plastic limits of 6 surface grab samples from Lake DePue and 1 grab sample from Turner Lake were tested at the ISGS Geotechnical Laboratory. The Atterberg Limits are used as part of an engineering classification system to characterize the engineering behaviors of fine-grain soils. Those engineering behaviors include compressibility, permeability, compatibility, shrink-swell, and shear strength (ASTM, 1984). The results are given in Table 15.

Five of the samples from Lake DePue were classified as inorganic silt with organic clays of medium to high plasticity. The sample from Turner Lake and at cross section 8 from Lake DePue was classified as an inorganic clay of high plasticity.

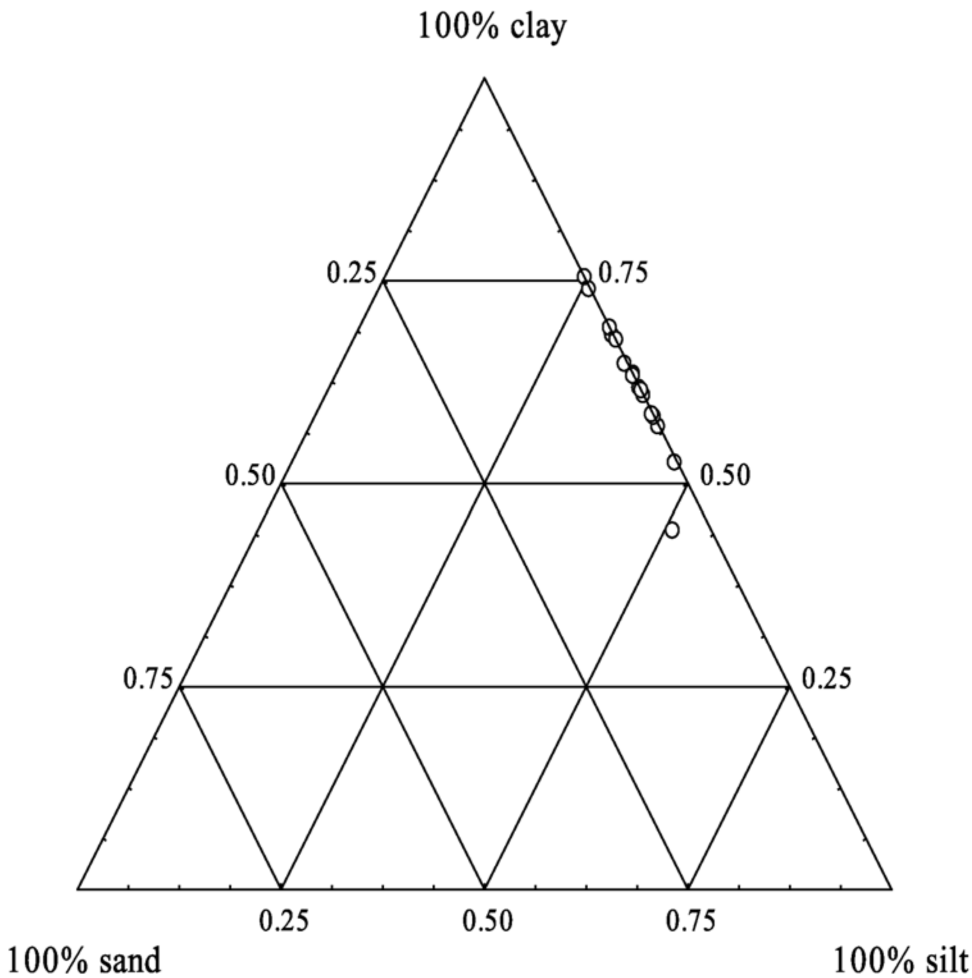

Figure 20. Ternary graph of percentages of sand, silt, and clay particle size fractions in Lake DePue surface sediment samples.

Table 15. Atterberg Limits of surface sediments from Lake DePue and Turner Lake: liquid limit, plastic limit, and plasticity index in percent water content.

Sample ID	Cross section	Liquid limit	Plastic limit	Plasticity index
Lake DePue				
LD5C	2	70.8	35.4	34.6
LD6C	4	101	46.1	54.9
LD7C	5	104.2	52.1	52.1
LD1C	6	107	45.5	61.5
LD2C	7	96.4	42.5	53.9
LD3C	8	91.5	38.4	53.1
Turner Lake				
Turner TL2C		104	42.1	61.7

WATER QUALITY RESULTS AND DISCUSSION

Eight water samples from Lake DePue and 3 water samples from Turner Lake were collected on July 22–23, 1998. In the dredged area of Lake DePue, samples were collected at the surface and also near the sediment-water interface. Conductivity, pH, and the temperature of the water were measured in the field. All samples were stored on ice until returned to the ISGS laboratory. Samples were filtered in the laboratory. Samples for ICP analysis were acidified with nitric acid to a pH of <2. Details of the analytical procedures used for water analysis are included in the Quality Assurance Project Plan (Cahill, 1998, unpublished).

The results for major cations, major anions, nutrients, trace metals, and field parameters are included in Appendix G. The accuracy of the analysis was checked by analyzing a field duplicate and by calculation of a anion-cation charge balances. Splits of 3 samples were analyzed for metals by the contract laboratory by the ICP method. The results are included in Appendix G. These water quality results represent a one-time snapshot of conditions in the lake. They cannot be construed as a long-term evaluation of lake water quality.

The median, maximum, and minimum concentrations and the number of samples above detection limit for water samples from Lake DePue and Turner Lake are summarized in Table 16. All concentrations are in milligrams per liter except mercury (micrograms per liter), specific conductance (micro-Siemens per centimeter), and pH.

The greatest zinc concentration was 0.17 mg/L. This value was confirmed by the contract laboratory, which reported 0.21 mg/L on a split of the original sample. The maximum value occurred in the water sample collected near the South Ditch. The concentration of zinc dropped to 0.02 mg/L in the sample from cross section 8 and in the surface and bottom water samples collected in the dredged area at cross section 7. Zinc concentrations were 0.01 mg/L in the surface water and bottom water collected in the dredged area at cross section 6. Zinc was not detected (<0.01 mg/L) elsewhere in Lake DePue or in Turner Lake. The concentration of zinc did not exceed the State of Illinois General Use Water Quality Standard for zinc (1.0 mg/L) in any of the water samples analyzed. Cadmium was not detected (<0.01 mg/L) in any of the water samples collected.

Copper, lead, and nickel were not detected in any of the water samples. Mercury was detected in 2 of the Lake DePue samples and in 2 samples from Turner Lake. The maximum was 7 µg/L in the bottom water sample at cross section 6 in the dredged area. The maximum concentration in Turner Lake was 1.8 µg/L. Ammonia nitrogen, nitrate nitrogen, chloride, sulfate, total alkalinity, calcium, magnesium, manganese, and sodium concentrations were greater in Lake DePue than in Turner Lake. Total phosphorus concentrations were greater in Turner Lake than in Lake DePue.

Table 16. Mean and minium concentrations and number of values above detection limit for water quality results for Lake DePue and Turner Lake. Method detection limits are given as minimum values. Three samples were tested for Turner Lake. All values are in milligrams per liter unless noted.

		Lake DePue			Turner		
	Number	Mean	Minimum	Maximum	Mean	Minimum	Maximum
Total carbon	8	66.1	59.6	86.9	54.5	53.3	56.7
Inorganic carbon	8	41.6	36.6	57.3	31.4	30.8	32.5
Organic carbon	8	24.5	22.3	29.6	23.1	22.4	24.2
Total nitrogen	8	3.0	1.5	4.0	1.6	1.5	1.7
Total phosphorus	8	0.20	0.20	0.27	0.34	0.30	0.39
Ammonia–nitrogen	8	1.3	0.4	1.6	0.5	0.3	0.7
Nitrate–nitrogen	8	1.5	0.9	1.7		<0.8	0.9
Sulfate	8	77.3	34.0	122.6	33.0	30.4	34.4
Fluoride	8	0.42	0.36	0.52	0.40	0.39	0.41
Chloride	8	42.7	38.3	44.1	34.4	30.8	36.8
Bromide	0		<0.9			<0.9	
Total alkalinity	8	241	204	334	180	173	188
Specific conductivity (µS/cm)	8	691	535	899	473	444	491
Acidity/alkalinity	6	7.5	6.9	8.1	8.6	8.3	8.8
Aluminum	2		<0.02	0.04		<0.02	
Arsenic	0		<0.1			<0.1	
Boron	8	0.11	0.08	0.14	0.09	0.08	0.10
Barium	8	0.06	0.04	0.07	0.04	0.04	0.04
Calcium	8	76.7	58.3	111.0	52.6	49.8	55.9
Cadmium	0		<0.01			<0.01	
Copper	0		<0.01			<0.01	
Iron	1		<0.01	0.02		<0.01	0.01
Potassium	8	4	3	4	4	3	6
Magnesium	8	28.9	22.9	41.0	21.1	19.7	22.3
Manganese	8	0.38	0.18	0.50	0.06	0.03	0.10
Mercury (µg/L)	2		<0.05	7.2	0.9	0.07	1.8
Sodium	8	29.7	23.1	37.2	19.0	16.5	20.6
Nickel	0		<0.03			<0.03	
Lead	0		<0.05			<0.05	
Silicon	8	4.55	4.1	5.5	4.51	4.4	4.6
Strontium	8	0.21	0.17	0.29	0.15	1.14	1.16
Zinc	6	0.04	<0.01	0.17		<0.01	

LAKE SEDIMENTATION SURVEY

Previous Work

The basin of Lake DePue has been comprehensively surveyed on three occasions since 1900. From 1902 to 1904, the lake was included in a survey of the entire Illinois River valley under the direction of J.W. Woermann, U.S. Assistant Engineer. The survey included topographic and water features including water depth (Woermann, 1905). The reference surface water elevation for Woermann's survey was the low lake level at Lake DePue, 445.1 feet (Memphis datum). Conversion of the Memphis datum to the National Geodetic Vertical Datum (NGVD) requires an adjustment of –7.3 feet. This adjustment includes an additional factor to correct for inaccuracies in the early leveling networks. With this adjustment, the low lake level for Lake DePue in 1903 was 437.8 feet NGVD.

In 1975, a survey of the lake was made by Daily and Associates, Engineers, Inc. under contract with the IDOC and the general direction of the ISWS (Lee and Stall, 1976). This survey included development of a precise horizontal and vertical control system. Eight cross sections of the lake were surveyed either by standard leveling or by water depth measurement. Survey results were analyzed by the ISWS and compared with cross section plots developed from the Woermann survey to estimate sedimentation rates for the lake (Lee and Stall, 1976).

In addition to these full-scale surveys, the area of the dredging operation of the early 1980s was surveyed both before and after dredging. For these surveys, a baseline was established along the north bank of the lake and centered on the monument that had been used to establish line end 62 for the 1975 survey. The pre-dredge survey included 16 surveyed cross sections. The post-dredge survey conducted in early 1983 included 5 of the original pre-dredge cross sections.

Field Procedures

For the 1998 survey of Lake DePue, the lake was resurveyed for the same 8 cross sections sampled in 1975. In addition, the cross sections surveyed for the 1983 post-dredge survey were resurveyed. The survey was conducted using an Odom Hydrographic Systems® MK II fathometer for depth measurement and a differentially corrected Pathfinder® GPS for horizontal control across the transect. The GPS unit controlled all navigation and data logging functions. The GPS positions were differentially corrected using Radio Technical Committee Menu correction signals broadcast by the U.S. Coast Guard from St. Louis, Missouri, or Rock Island, Illinois. The fathometer was calibrated daily prior to initiating measurements. Calibration checks at the end of each work day showed daily variations of 0.1 to 0.2 feet in a profile at 1-foot depth intervals. The positions of the measured cross sections are shown in Figure 21.

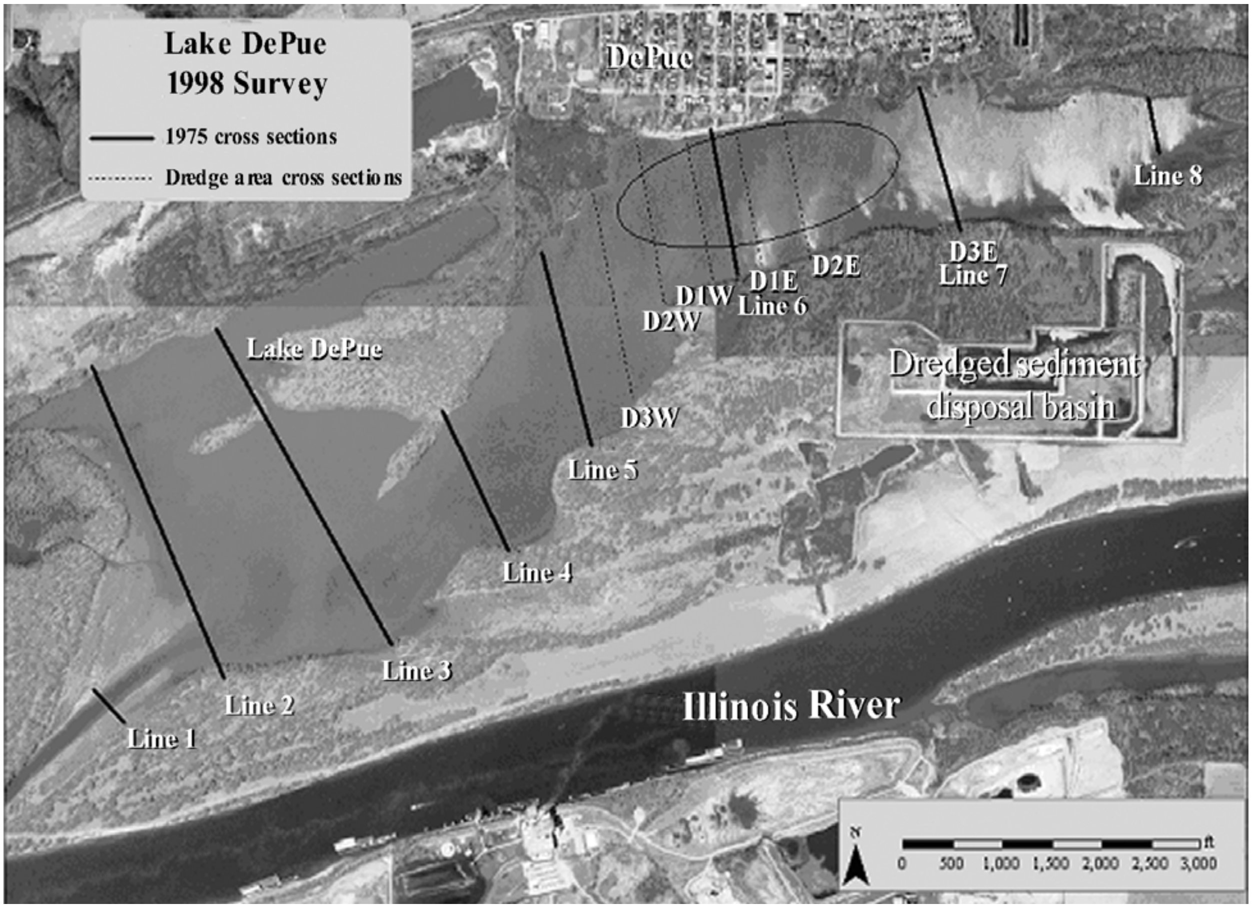

Figure 21. Cross section and sample locations in Lake DePue.

Results and Discussion of Sedimentation Survey

Plots of the surveyed cross sections from the 1902 to 1904 Woermann survey, the 1975 Daily and Associates survey, and the 1998 ISWS resurvey are presented in Appendix I. For cross section 6, a plot of the 1983 post-dredge survey transect has been added to the other 3 plots. Also included in Appendix I are plots of the dredge area plots made by combining the post-dredge plots with a corresponding plot from the 1998 survey.

An additional source of survey data was available for Lake DePue. In 1991, a reconnaissance survey of the lake was conducted by the ISWS (Demissie, 1991). Data collected for this survey were not consistent with the established survey lines and could not be used in this analysis.

Table 17. Average water depth and width of cross section profiles at Lake DePue (A) and adjusted average depth and sedimentation rates (B).

A.	1904		1975		1998	
Line	Depth (m)	Width (m)	Depth (m)	Width (m)	Depth (m)	Width (m)
1	1.91	982	0.37	243	0.42	61
2	1.46	881	0.69	976	0.19	943
3	1.40	1,201	0.60	1,183	0.32	1,058
4	1.28	992	1.20	420	0.64	447
5	1.70	931	1.02	594	0.67	589
6	2.06	565	1.02	436	1.53	429
7	1.61	674	0.54	387	0.50	392
8	1.38	713	0.12	335	0.30	166

B.	Adjusted depth (m)			Sedimentation rates (cm/yr)		
Line	1904	1975	1998	71 years 1904–1975	23 years 1975–1998	94 years 1904–1998
1	1.91	0.09	0.03	2.6	0.3	2.0
2	1.46	0.77	0.20	1.0	2.5	1.3
3	1.40	0.59	0.28	1.1	1.3	1.2
4	1.28	0.51	0.29	1.1	1.0	1.1
5	1.70	0.65	0.43	1.5	1.0	1.4
6	2.06	0.79	1.16	1.8	–1.6	1.0
7	1.61	0.31	0.29	1.8	0.1	1.4
8	1.38	0.06	0.07	1.9	–0.1	1.4

Note: Average depth and width determined for each surveyed cross section at a water level elevation of 442 feet NGVD.

Data collected during the 1998 field survey were processed and plotted using the ISWS' Geographic Information System and spreadsheet formats to compare the present (1998) conditions with those of the Woermann, Daily and Associates, and the post-dredge surveys.

The average depth below 442 feet NGVD for each of the analyzed survey cross sections for each survey date was calculated individually. These average water depths were re-referenced to the lake width determined from the Woermann survey for comparison of sediment accumulation rates. The changes in average depth were used to determine sediment depths. These sediment depths were divided by the time interval between surveys to derive apparent sedimentation rates.

Table 17A lists the average water depth below water level 442 feet, NGVD for each surveyed cross section and a corresponding lake width. Table 17B presents an average depth for each cross section that has been "normalized" to the 1904 lake width. Also shown in Table 17B are the sediment accumulation rates for each Lake DePue cross section surveyed in 1975 and 1998 within the original lake area. The average depths shown in Table 17 are referenced to 442 feet NGVD, 2 feet higher than the target pool level for the Peoria Pool of the Illinois River.

The sedimentation rates were determined relative to the actual depth of accumulation. Negative values in this case indicate a decrease in sediment thickness. The most prominent negative sedimentation is at cross section 6, the only cross section located in the dredged area.

The average depths and sedimentation rates in Table 17 show distinct differences in the sedimentation conditions in the west (cross sections 1 to 5) and east (cross sections 6 to 8) sections of the lake. In the west end of the lake, sedimentation rates appear to be fairly consistent between the 1902 to 1975 period and the 1975 to 1998 period, differing by a factor of 2 or less. These sedimentation rates range from 0.3 cm/yr to 2.6 cm/yr.

In the east end of the lake, the sedimentation process has been quite different, possibly affected by the 1980s dredging project. For line 6, in the dredged area, and lines 7 and 8, sedimentation from 1902 to 1975 fell in the general range of the western lines. For lines 7 and 8, sedimentation rates since 1975 are negligible or slightly negative, indicating possible consolidation of the sediments. For line 6, the rate of sedimentation since the dredging project has been 5.2 cm/yr and has filled about half of the depth increase from the dredging project. Based on the plots of the other dredge area cross sections, this rate of sedimentation seems to be consistent in the central dredged area.

The increase in the sediment accumulation rate for line 6 and the dredged area is most likely due to the general tendency of sediment to fill low areas at a faster rate than higher areas. The reduced sedimentation rates in other areas are probably due to a combination of factors, including sediment consolidation, changes in sediment inflows due to redirection of the local drainage system, and the deposition of Illinois River sediments in the deeper water of the dredged area.

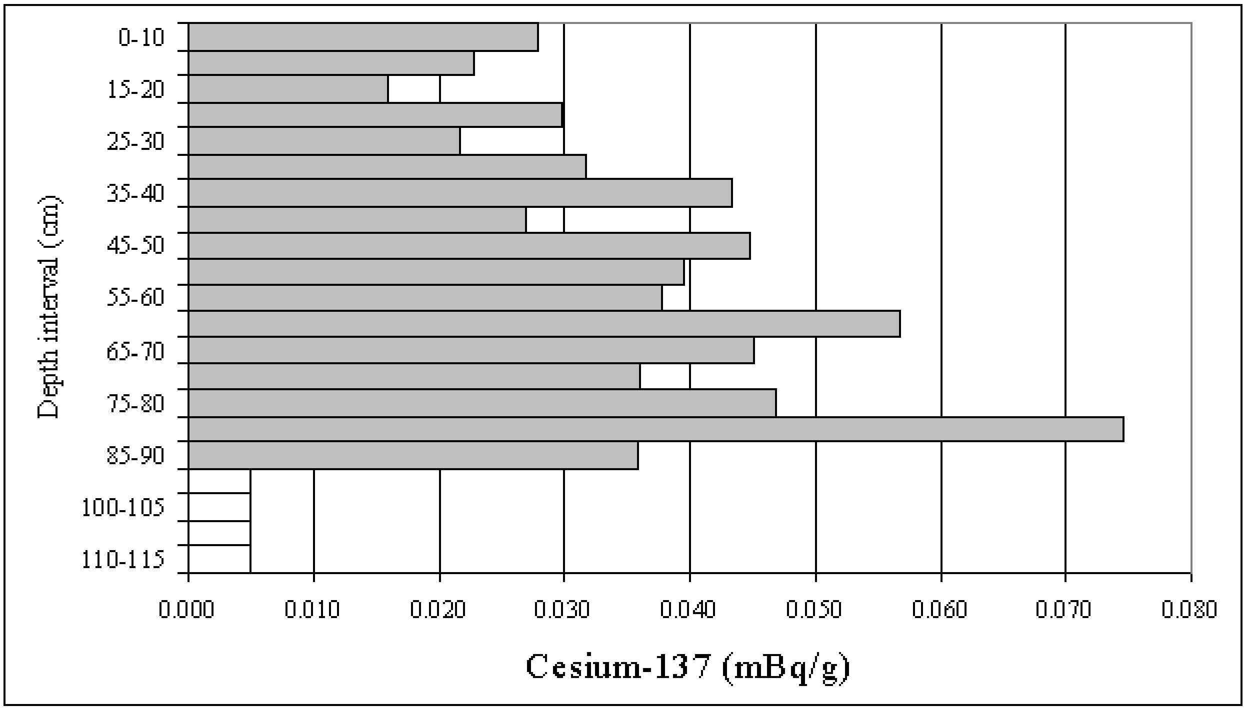

Figure 22. Cesium-137 profile from the 1982 core collected in Lake DePue near cross section 5. Open bars are intervals where no cesium-137 was detected.

CESIUM-137 SEDIMENTATION RATES RESULTS AND DISCUSSION

Sedimentation rate measurements are calculated based on estimate of the approximate year when sediments were deposited. The radioactive isotope cesium-137 is present in the sediment as a result of fallout from the atomospheric testing of nuclear weapons. The interval of maximum radioactivity from cesium-137 in a core corresponds to the period of maximum atmospheric nuclear testing, approximately 1963. The onset of activity from cesium-137 corresponds to the start of atmospheric nuclear testing in 1954. The positions of these 2 points can be used to calculate an average sedimentation rate for the overlying sediment layers in the core. Sedimentation rates were estimated by measuring the cesium-137 activities in 8 cores from Lake DePue and 2 cores from Turner Lake. The results are plotted in Appendix I.

The previous sedimentation rate measured in Lake DePue using cesium-137 was 3 to 4 cm/y (Cahill and Steele, 1986). Figure 22 is a plot of the cesium-137 profile for this core, which was collected near cross section 5. The core was 115 cm long. The maximum activity of cesium-137 occurred in the 80- to 85-cm interval. No cesium-137 was detected below 90 cm.

The cores collected for the present study would have to be approximately 70 cm long to reach the

1963 horizon of peak fallout with an assumed sedimentation rate of 2 cm/y, or about 1 meter in length if the sedimentation rate were 3 cm/yr. None of the cores were of sufficient length to reach depths of no detectable cesium-137 activity, which would represent the onset of deposition of radioactive fallout from atmospheric testing of thermonuclear weapons in 1954. Cores would have to be between 90 and 130 cm long to reach this event horizon. In several of the cores the profiles did not indicate a clear peak or maximum activity, which would represent the peak of radioactive fallout in 1963.

The profiles from Turner Lake indicate a peak of activity at the 50- to 55-cm interval. The position of this peak suggests a long-term sedimentation rate of 1.5 cm/yr since 1963. The Lake DePue core at cross section 5, which was used to estimate the sedimentation rate, was one of the longest cores collected in Lake DePue. However, peak cesium-137 activity still may not have been reached. If the radioactivity in the segment of the core from 65 to 70 cm was the maximum for this core, then sediment at this location in the lake has accumulated at a rate of at least 2 cm/yr since 1963. A summary of the sedimentation rates determined by cesium-137 is given in Table 18.

The sedimentation rates obtained by the sedimentation survey and by cesium-137 are in good agreement. The sedimentation rates between 1903 and 1998 from the lake survey ranged from 1.4 to 2.6 cm/yr. The sedimentation rates between 1963 and 1998 determined from the position in the core of peak activity from cesium-137 range from >1.2 to >2.1 cm/yr.

The cores collected in the dredged area were not of sufficient length to reach the "pre-dredged" sediment layers. Because of the rapid sedimentation in this area (8 cm/yr) between the 1975 and 1998 lake surveys, sediment cores would have to have been at least 1.2 m long to reach sediments that were not disturbed by the dredging operation.

Table 18. Summary of sedimentation rates determined by cesium-137 in DePue and Turner Lakes in 1998. None of the cores were of sufficient length to reach the pre-1954 no-activity event horizon.

Cross section	Core length (cm)	Depth to maximum cesium-137 activity (cm)	1963 to 1998 sedimentation rate (cm/yr)
Lake DePue			
2	60	55–60?	>1.6
3	66	60–65?	>1.8
4	65	50–55?	>1.5
5	75	65–70	1.9
6 (dredged area)	64	Not reached	>2
7 (dredged area)	70	Not reached	>2
8	44	40–45?	>1.2
South Ditch	79	70–75?	>2.1
Turner Lake			
1	61	50–55	1.5
3	62	60–65?	>1.8

CONCLUSIONS AND RECOMMENDATIONS

The concentrations of zinc and cadmium were found to be much greater in the sediments of Lake DePue than in Turner Lake or in sediment from elsewhere in the Peoria Pool of the Illinois River (Cahill, 2001). Zinc and cadmium concentrations were greatest near the South Ditch. Concentrations of copper and lead were also greater in sediments from Lake DePue compared with Turner Lake, and also were greater near the South Ditch. The concentrations of barium and mercury were greater in some sediment samples in Lake DePue than in Turner Lake. The concentrations of the other the metals analyzed were similar in Lake DePue and Turner Lake.

The long-term sedimentation rates in Lake DePue determined by previous surveys and by cesium-137 activity are 2 to 3 cm/yr. The area that was dredged in 1983 is filling at a rate of 8 cm/yr and about half of the dredged water depth already has been lost. The area of Lake DePue that was dredged appears to be trapping sediments with elevated metal concentrations that likely are coming from the South Ditch.

Long sediment cores should be collected in Lake DePue to confirm the concentration profiles, the anomalous zinc/cadmium ratios, and to obtain a complete cesium-137 record. A Vibra-coring technique would be required. A long core should also be collected in the area that was dredged to reach the "pre-dredged" layers. Pore water concentrations should be measured in the deep sediment cores. The physical and chemical limnology of Lake DePue should be investigated, especially in regard to sediment movement and water quality.

The upper end of Lake DePue should be posted with signs and buoys to restrict access to areas near the South Ditch that have highly contaminated sediments. Shore birds and fish should be tested for uptake of metals in the upper end of Lake DePue to establish whether there should be a fish advisory posted for the lake. The public should be made aware of the results of the research that IDNR is doing in the Lake DePue area.

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APPENDIX A

Table A1. Total carbon, inorganic carbon, organic carbon, zinc, and cadmium concentrations in Lake DePue, Turner Lake, and QA/QC samples.

Analytical number	Sample ID	Depth interval (cm)	Total carbon (%)	Inorganic carbon (%)	Organic carbon (%)	Zinc[A] ICP (mg/k)g	Zinc INAA (mg/kg)	Zinc EDX (mg/kg)	Zinc AAS (mg/kg)	Cadmium[A] ICP (mg/kg)	Cadmium AAS (mg/kg)
Cross section 2											
R21454	LD5 A grab	0–5	4.37	1.38	2.99	763				4.6	
R21455	LD5 C grab	0–5	4.46	1.75	2.71	335		145	390	2.5	<2
R21316	LD5 core	0–5	4.65	1.71	2.94	304	391	120		2.2	
R21317	LD5 core	05–10	4.53	1.96	2.57	416				2.7	
R21318	LD5 core	10–15	4.37	2.09	2.28	487				2.8	
R21319	LD5 core	15–20	4.59	2.01	2.58	662				3.4	
R21320	LD5 core	20–25	4.54	1.85	2.69	596		510	705	3.4	3
R21321	LD5 core	25–30	4.51	1.75	2.76	554	675	235		3.3	
R21322	LD5 core	30–35	4.14	1.68	2.46	692				4.4	
R21323	LD5 core	35–40	3.65	1.26	2.39	756				5.2	
R21324	LD5 core	40–45	3.68	1.17	2.51	733		620	870	4.9	<2
R21325	LD5 core	45–50	3.85	1.23	2.62	842				6.4	
R21326	LD5 core	50–55	3.90	0.85	3.05	1,200	1,410	930		9.9	
R21327	LD5 core	55–60	3.98	0.97	3.01	2,010		2,240	2,470	24.3	25
Cross section 3											
R21452	LD4 A grab	0–5	4.42	1.40	3.02	725				4.1	
R21453	LD4 C grab	0–5	4.38	1.39	2.99	1,080				5.2	
R21328	LD4 core	0–5	4.45	1.38	3.07	1,070	1,325	845		5.2	
R21329	LD4 core	05–10	4.35	1.44	2.91	1,100				5.3	
R21330	LD4 core	10–15	4.37	1.49	2.88	1,310				5.7	
R21331	LD4 core	15–20	4.25	1.44	2.81	1,700				7.3	
R21332	LD4 core	20–25	3.95	1.24	2.71	1,450		1,690	1,770	6.8	4
R21333	LD4 core	25–30	3.91	1.11	2.80	1,660	2,165	1,800		8.0	
R21334	LD4 core	30–35	4.18	1.30	2.88	1,760				9.1	
R21335	LD4 core	35–40	3.75	0.99	2.86	1,440				7.2	
R21336	LD4 core	40–45	3.55	0.86	2.69	1,150		980	1,430	6.4	5
R21337	LD4 core	45–50	3.60	0.81	2.59	1,050				6.0	
R21338	LD4 core	50–55	3.65	0.67	2.98	1,270				7.0	
R21339	LD4 core	55–60	3.71	0.74	2.97	1,370				9.1	
R21340	LD4 core	60–66	3.72	0.52	3.20	1,670	1,987	1,670		12.5	
Cross section 4											
R21456	LD6 C grab	0–5	4.30	1.26	3.04	1,640		1,400	2,060	7.4	6
R21341	LD6 core	0–5	4.31	1.26	3.05	1,600	2,075	1,870		7.2	
R21342	LD6 core	05–10	4.35	1.24	3.11	1,540				6.9	
R21343	LD6 core	10–15	4.33	1.30	3.03	1,820				7.2	
R21344	LD6 core	15–20	4.18	1.28	2.90	2,680				11.3	
R21345	LD6 core	20–25	3.97	1.10	2.87	2,360		2,800	3,020	10.2	8
R21346	LD6 core	25–30	3.91	1.06	2.85	2,530	3,111	2,665		10.9	
R21347	LD6 core	30–35	4.08	1.15	2.93	2,720				13.2	

Table A1. (cont.) Analytical number	Sample ID	Depth interval (cm)	Total carbon (%)	Inorganic carbon (%)	Organic carbon (%)	Zinc[A] ICP (mg/kg)	Zinc INAA (mg/kg)	Zinc EDX (mg/kg)	Zinc AAS (mg/kg)	Cadmium[A] ICP (mg/kg)	Cadmium AAS (mg/kg)
R21348	LD6 core	35–40	3.88	0.91	2.97	2,230				9.9	
R21349	LD6 core	40–45	3.67	0.73	2.94	1,510		1,210	1,790	7.2	5
R21350	LD6 core	45–50	3.70	0.68	3.02	1,110				6.0	
R21351	LD6 core	50–55	3.66	0.65	3.01	2,100				9.5	
R21352	LD6 core	55–60	3.84	0.64	3.20	1,910	2,448	1,880		10.6	
R21353	LD6 core	60–66	3.68	0.57	3.11	1,550		1,240	1,920	10.0	7
Cross section 5											
R21457	LD7 A grab	0–5	4.34	1.17	3.17	2,310				10.3	
R21458	LD7 B grab	0–5	4.46	1.28	3.18	1,880				8.2	
R21459	LD7 C grab	0–5	4.37	1.18	3.19	2,090				9.4	
R21354	LD7 core	0–5	4.33	1.14	3.19	2,100	2,518	2,250		9.2	
R21355	LD7 core	05–10	4.48	1.29	3.19	2,810				11.4	
R21356	LD7 core	10–15	4.19	1.17	3.02	3,780				15.9	
R21357	LD7 core	15–20	4.09	1.13	2.96	3,460				15.5	
R21358	LD7 core	20–25	3.78	0.90	2.88	2,980		3,420	3,660	14.5	12
R21359	LD7 core	25–30	3.74	0.71	3.03	1,970	2,316	2,060		9.1	
R21360	LD7 core	30–35	3.99	0.76	3.23	1,190				7.5	
R21361	LD7 core	35–40	3.93	0.62	3.31	1,350				7.4	
R21362	LD7 core	40–45	3.71	0.57	3.14	1,420		1,110	1,700	7.5	3
R21363	LD7 core	45–50	3.87	0.71	3.16	2,240				13.4	
R21364	LD7 core	50–55	3.80	0.50	3.30	1,390				10.8	
R21365	LD7 core	55–60	4.30	0.60	3.70	1,040				10.7	
R21366	LD7 core	60–65	4.18	0.76	3.42	3,480				28.5	
R21367	LD7 core	65–70	4.00	0.61	3.39	4,530	5,854	5,350		48.1	
R21368	LD7 core	70–75	3.93	0.77	3.16	3,310		3,860	4,140	76.0	81
Cross section 6 (dredged area)											
R21445	LD1 A grab	0–5	4.53	1.11	3.42	3,040				15.6	
R21446	LD1 B grab	0–5	4.69	1.05	3.64	3,590				19.7	
R21447	LD1 C grab	0–5	4.39	1.03	3.36	3,680		4,300	4,610	19.0	20
R21369	LD1 core	0–5	4.42	1.01	3.41	4,530	5,062	5,140		22.3	
R21370	LD1 core	05–10	4.56	1.09	3.47	3,400				18.3	
R21371	LD1 core	10–15	4.32	1.01	3.31	5,470				22.8	
R21372	LD1 core	15–20	4.28	0.92	3.36	7,940				34.1	
R21373	LD1 core	20–25	4.18	0.77	3.41	6,700	8,975	8,075		32.1	
R21374	LD1 core	25–30	4.12	0.88	3.24	8,120				41.2	
R21375	LD1 core	30–35	4.14	0.81	3.33	5,770				31.8	
R21376	LD1 core	35–40	3.94	0.73	3.21	7,750				47.4	
R21377	LD1 core	40–45	3.78	0.70	3.08	7,330				41.5	
R21378	LD1 core	45–50	3.77	0.64	3.13	4,570				22.4	
R21379	LD1 core	50–55	3.46	0.66	2.80	4,490				25.9	
R21380	LD1 core	55–60	3.69	0.65	3.04	5,050				25.8	
R21381	LD1 core	60–64	3.79	0.60	3.19	4,510	5,813	5,560		34.0	
Cross section 7 (dredged area)											
R21448	LD2 A grab	0–5	5.25	1.21	4.04	4,020				22.4	
R21449	LD2 B grab	0–5	4.62	1.18	3.44	7,490				40.8	
R21450	LD2 C grab	0–5	4.46	1.25	3.21	6,620		7,095	7,030	32.6	35
R21382	LD2 core	0–5	4.53	1.18	3.35	6,030	7,336	6,825		33.5	
R21383	LD2 core	05–10	4.45	1.24	3.21	6,000				33.9	

Table A1. (cont.) Analytical number	Sample ID	Depth interval (cm)	Total carbon (%)	Inorganic carbon (%)	Organic carbon (%)	Zinc[A] ICP (mg/kg)	Zinc INAA (mg/kg)	Zinc EDX (mg/kg)	Zinc AAS (mg/kg)	Cadmium[A] ICP (mg/kg)	Cadmium AAS (mg/kg)
R21384	LD2 core	10–15	4.33	1.31	3.02	7,280				38.7	
R21385	LD2 core	15–20	4.64	1.21	3.43	9,380				46.1	
R21386	LD2 core	20–25	4.25	1.09	3.02	9,700		13,700	12,900	56.7	65
R21387	LD2 core	25–30	4.26	0.95	3.31	11,400	12,203	12,350		62.4	
R21388	LD2 core	30–35	4.33	1.09	3.24	11,500				76.4	
R21389	LD2 core	35–40	4.33	1.09	3.24	11,900				74.3	
R21390	LD2 core	40–45	4.01	0.84	3.17	8,790		11,150	10,600	45.9	55
R21391	LD2 core	45–50	4.27	0.78	3.49	9,450				44.8	
R21392	LD2 core	50–55	4.11	0.85	3.26	10,400				45.4	
R21393	LD2 core	55–60	4.18	0.91	3.27	8,880				48.6	
R21394	LD2 core	60–65	3.93	0.75	3.18	7,270	8,845	8,485		44.5	
R21395	LD2 core	65–70	3.84	0.61	3.23	4,370		4,950	5,260	28.4	31
Cross section 8											
R21451	LD3 C grab	0–5	4.37	1.31	3.06	3,750		4,450	4,700	18.7	19
R21396	LD3 core	0–5	4.53	1.30	3.23	4,650				19.6	
R21397	LD3 core	05–10	4.41	1.26	3.15	4,700				18.4	
R21398	LD3 core	10–15	4.28	1.05	3.23	4,790				17.3	
R21399	LD3 core	15–20	4.00	0.97	3.03	5,640				17.1	
R21400	LD3 core	20–25	3.57	0.63	2.94	3,480		2,520	3,770	14.8	14
R21401	LD3 core	25–30	3.74	0.62	3.12	3,680	4,119	3,755		16.8	
R21402	LD3 core	30–35	3.90	0.62	3.28	1,360				10.4	
R21403	LD3 core	35–40	4.27	0.98	3.29	6,160				54.4	
R21404	LD3 core	40–45	4.11	0.75	3.36	6,060		5,800	5,380	90.4	99
South Ditch area											
R21460	LD8 grab	0–5	4.42	1.09	3.33	17,200		20,450	19,300	76.3	84
R21405	LD8 core	0–5	4.59	0.94	3.65	25,000	26,214	33,150	25,000	106.0	119
R21406	LD8 core	05–10	4.33	0.96	3.37	24,500			25,600	91.0	99
R21407	LD8 core	10–15	4.56	1.15	3.41	42,300			43,300	168.0	190
R21408	LD8 core	15–20	4.51	1.09	3.42	23,300			23,200	87.7	98
R21409	LD8 core	20–25	4.49	1.20	3.29	21,900		24,500	23,500	75.4	89
R21410	LD8 core	25–30	4.31	1.11	3.20	18,100	19,093	19,800	18,100	72.3	80
R21411	LD8 core	30–35	4.33	0.87	3.46	13,000			12,700	60.4	69
R21412	LD8 core	35–40	4.07	1.19	2.88	13,400			13,500	91.1	100
R21413	LD8 core	40–45	4.42	1.33	3.09	2,670		2,010	3,100	19.7	19
R21414	LD8 core	45–50	4.17	0.86	3.31	16,000			16,100	104.0	119
R21415	LD8 core	50–55	4.11	0.68	3.43	24,700			27,200	150.0	182
R21416	LD8 core	55–60	4.18	0.91	3.27	18,300			19,700	129.0	152
R21417	LD8 core	60–65	4.50	1.02	3.48	2,0700			20,700	217.0	247
R21418	LD8 core	65–70	4.02	0.82	3.20	1,5800			16,200	218.0	252
R21419	LD8 core	70–75	4.26	0.79	3.47	1,3200	13,860	14,090	13,100	309.0	352
R21420	LD8 core	75–79	4.04	1.01	3.03	1,1100		11,500	11,100	251.0	294
Turner Lake											
R21461	TL1 grab	0–5	4.32	1.40	2.92	205				2.2	
R21421	TL1 core	0–5	4.36	1.33	3.03	187	198	87		2.5	
R21422	TL1 core	05–10	4.40	1.39	3.01	208				2.7	
R21423	TL1 core	10–15	4.35	1.42	2.93	185				2.3	
R21424	TL1 core	15–20	4.16	1.27	2.89	204				2.6	
R21425	TL1 core	20–25	3.54	1.06	2.48	213	295	95		2.1	

Table A1. (cont.) Analytical number	Sample ID	Depth interval (cm)	Total carbon (%)	Inorganic carbon (%)	Organic carbon (%)	Zinc[A] ICP (mg/kg)	Zinc INAA (mg/kg)	Zinc EDX (mg/kg)	Zinc AAS (mg/kg)	Cadmium[A] ICP (mg/kg)	Cadmium AAS (mg/kg)
R21426	TL1 core	25–30	3.58	0.89	2.67	217				3.2	
R21427	TL1 core	30–35	3.64	0.98	2.66	220				3.8	
R21428	TL1 core	35–40	3.70	0.91	2.79	266				5.0	
R1429	TL1 core	40–45	3.70	0.76	2.94	284				4.8	
R21430	TL1 core	45–50	3.68	0.72	2.96	288	374	134		4.9	
R21 431	TL1 core	50–55	3.74	0.88	2.86	427				8.3	
R21432	TL1 core	55–61	3.40	0.77	2.63	371				7.1	
R21462	TL2 grab	0–5	4.29	1.38	2.91	194		90	233	2.0	<2
R21463	TL3 grab	0–5	4.15	1.39	2.76	180		87	220	2.3	<2
R21433	TL3 core	0–5	4.34	1.36	2.98	186				2.1	
R21434	TL3 core	05–10	4.41	1.37	3.04	194				2.3	
R21435	TL3 core	10–15	4.39	1.42	2.97	155				2.1	
R21436	TL3 core	15–20	4.14	1.26	2.88	189				2.4	
R21437	TL3 core	20–25	3.93	1.26	2.67	192		100	228	2.4	<2
R21438	TL3 core	25–30	3.71	1.28	2.43	192	248	90		2.7	
R21439	TL3 core	30–35	3.53	1.09	2.44	208				3.3	
R21440	TL3 core	35–40	3.64	1.09	2.55	225				4.1	
R21441	TL3 core	40–45	3.44	0.96	2.48	252		110	251	4.4	<2
R21442	TL3 core	45–50	3.66	0.97	2.69	361				7.2	
R21443	TL3 core	50–55	3.54	0.99	2.55	412	530	185		8.4	
R21444	TL3 core	55–62	3.41	1.13	2.28	358		170	425	8.5	4
Field duplicates											
R21464	Core LD3	0–5	4.42	1.33	3.09	3,720	4,929	4,635		18.9	
R21396	LD3 core	0–5	4.53	1.30	3.23	4,650				19.6	
	% difference		–2%	2%	–4%	–20%				–4%	
R21465	Core LD3	05–10	4.44	1.31	3.13	4,020				19.7	
R21397	LD3 core	05–10	4.41	1.26	3.15	4,700				18.4	
	% difference		1%	4%	–1%	–14%				7%	
R21466	Core LD3	10–15	4.22	1.12	3.10	4,310				19.6	
R21398	LD3 core	10–15	4.28	1.05	3.23	4,790				17.3	
	% difference		–1%	7%	–4%	–10%				13%	
R21467	Core LD3	15–20	3.68	0.97	2.71	4790				16.4	
R21399	LD3 core	15–20	4.00	0.97	3.03	5640				17.1	
	% difference		–8%	0%	–11%	–15%				–4%	
R21468	Core LD3	20–25	3.71	0.79	2.92	2650	3338	2130		10.6	
R21400	LD3 core	20–25	3.57	0.63	2.94	3480			3770	14.8	14
	% difference		4%	25%	–1%	–24%				–28%	
R21469	Core LD3	25–30	3.72	0.73	2.99	3240		3775	4020	17.0	17
R21401	LD3 core	25–30	3.74	0.62	3.12	3680	4119			16.8	
	% difference		–1%	18%	–4%	–12%				1%	
R21470	Core LD3	30–34	3.77	0.67	3.10	2740	3338	2150		14.0	
R21402	LD3 core	30–35	3.90	0.62	3.28	1360				10.4	
	% difference		–3%	8%	–5%	101%				35%	
R21471	Grab at LD 7 C	0–5	4.37	1.18	3.19	2150			2660	9.5	9
R21459	LD7 C grab	0–5	4.37	1.18	3.19	2090				9.4	
	% difference		0%	0%	0%	3%				1%	

Table A1. (cont.) Analytical number	Sample ID	Depth interval (cm)	Total carbon (%)	Inorganic carbon (%)	Organic carbon (%)	Zinc[A] ICP (mg/kg)	Zinc INAA (mg/kg)	Zinc EDX (mg/kg)	Zinc AAS (mg/kg)	Cadmium[A] ICP (mg/kg)	Cadmium AAS (mg/kg)
Laboratory QA/QC samples											
R21472	QA/1		4.44	1.26	3.18	1,620		1240		7.3	
R21456	LD6 C grab	0–5	4.37	1.18	3.19	1640		1400		7.4	
	% difference		2%	7%	0%	–1%		–11%		–1%	
R21473	QA/2		3.91	0.93	2.98	232		95		4.1	340.92
	SecRef #2		3.92	0.9	3.02	274				2.7	
	% difference		0%	3%	–1%	–15%				52%	
R21474	QA/3		4.27	0.81	3.46	254		110		4.1	
	1985 Peoria		4.42	0.8	3.57	314					
	% difference		–3%	1%	–3%	–19%					
R21475	QA/4		5.22	2.33	2.89	237				1.0	
	Grd Cal 6		5.03	2.29	2.74	290				<5	
	% difference		4%	2%	5%	–18%					
R21476	QA/5		1.34	0.33	1.01	75.5	122	35	98	<0.47	<2
	Certified value										
	NIST 2709		*1.2*			*100*	106		106	*<1*	0.38
	Noncertified value										
	% difference		–12%			25%	–15%		8%		
R21477	QA/6		3.8	1.25	2.55	458		192		10.0	
	R21229		4.1	1.31	2.79	500				10.3	
	% difference		–7%	–5%	–9%	–8%				–3%	
R21478	QA/7		4.31	0.66	3.65	7320		9180		126.0	
	R20537		4.77	0.63	4.14	8660				147.0	
	% difference		–10%	5%	–12%	–15%				–14%	

Note: [A]Total recoverable concentrations.

APPENDIX B

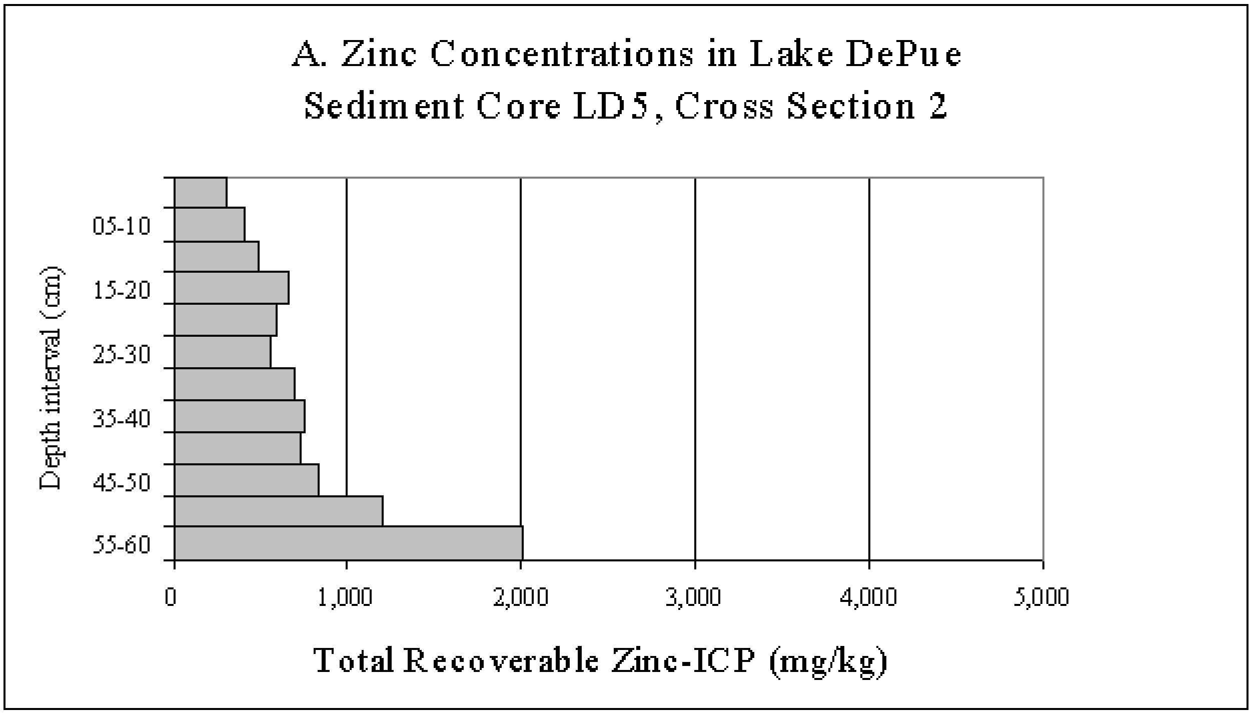
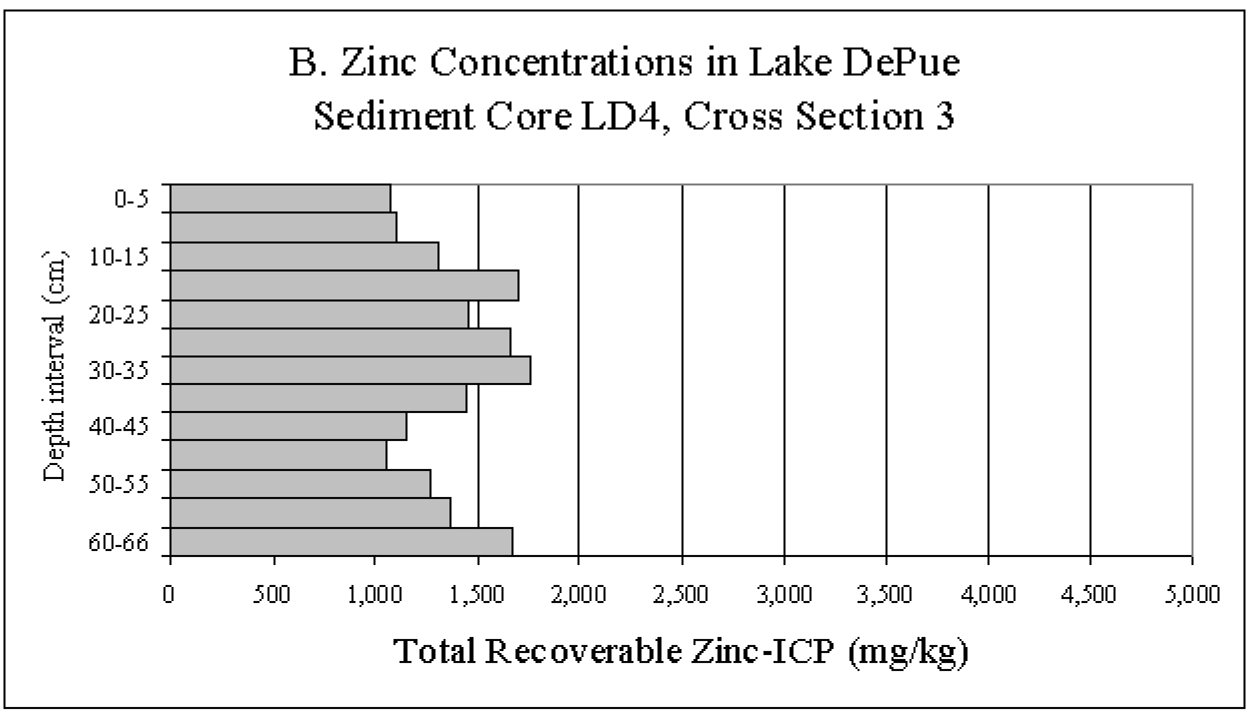
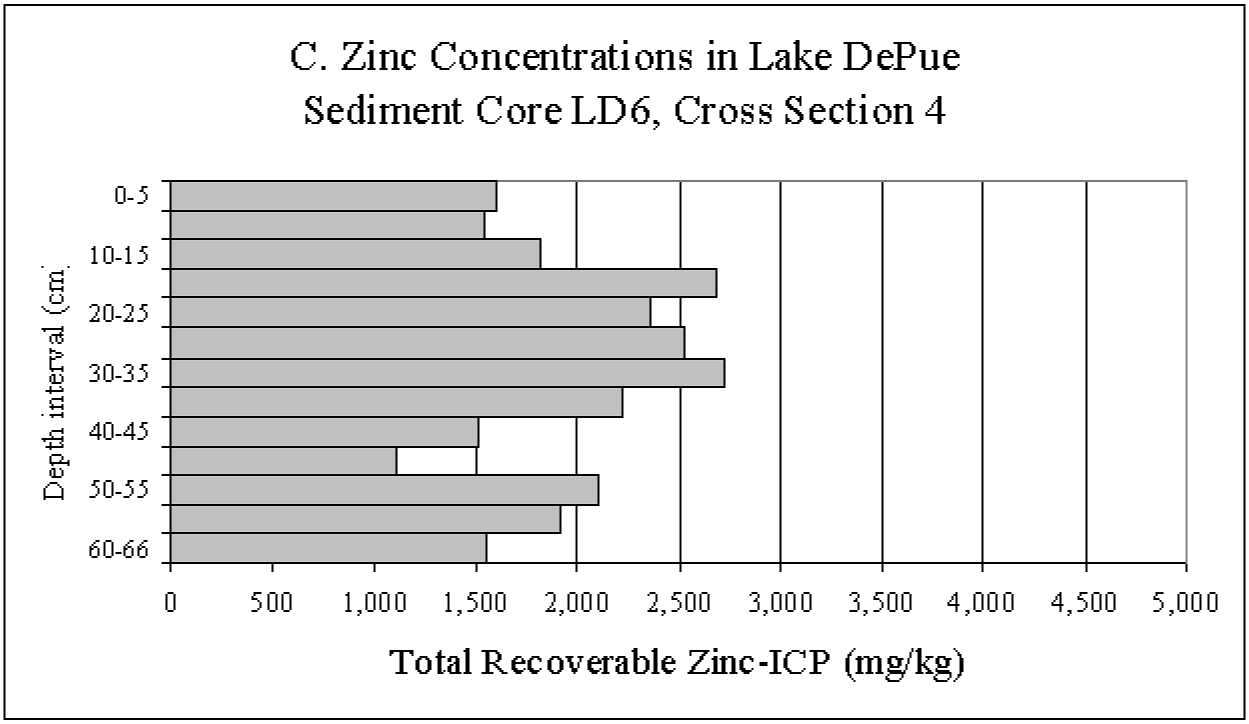
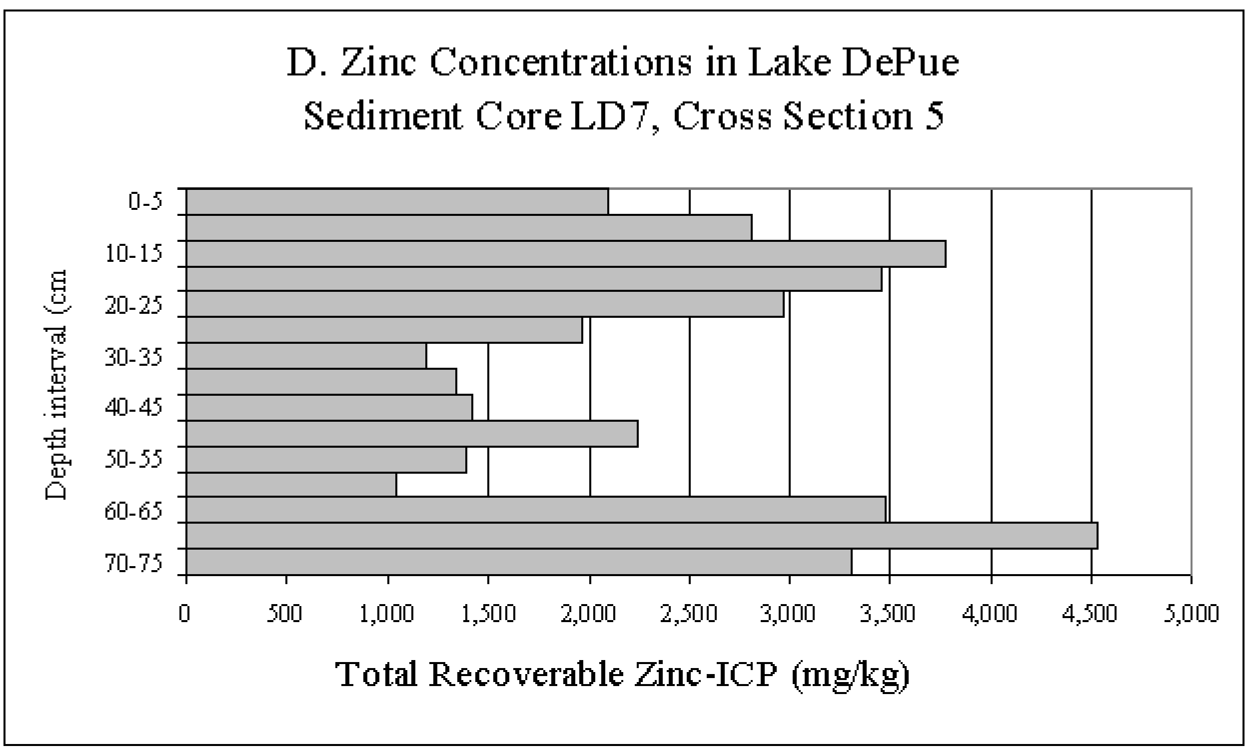
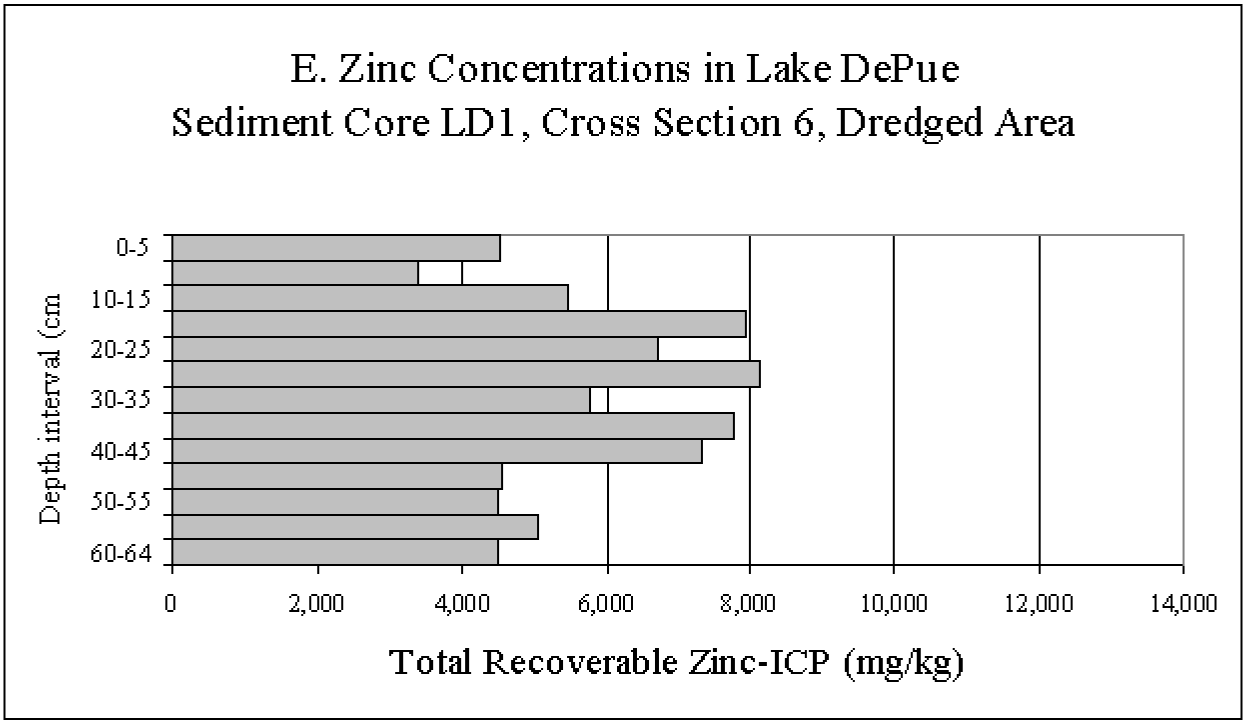


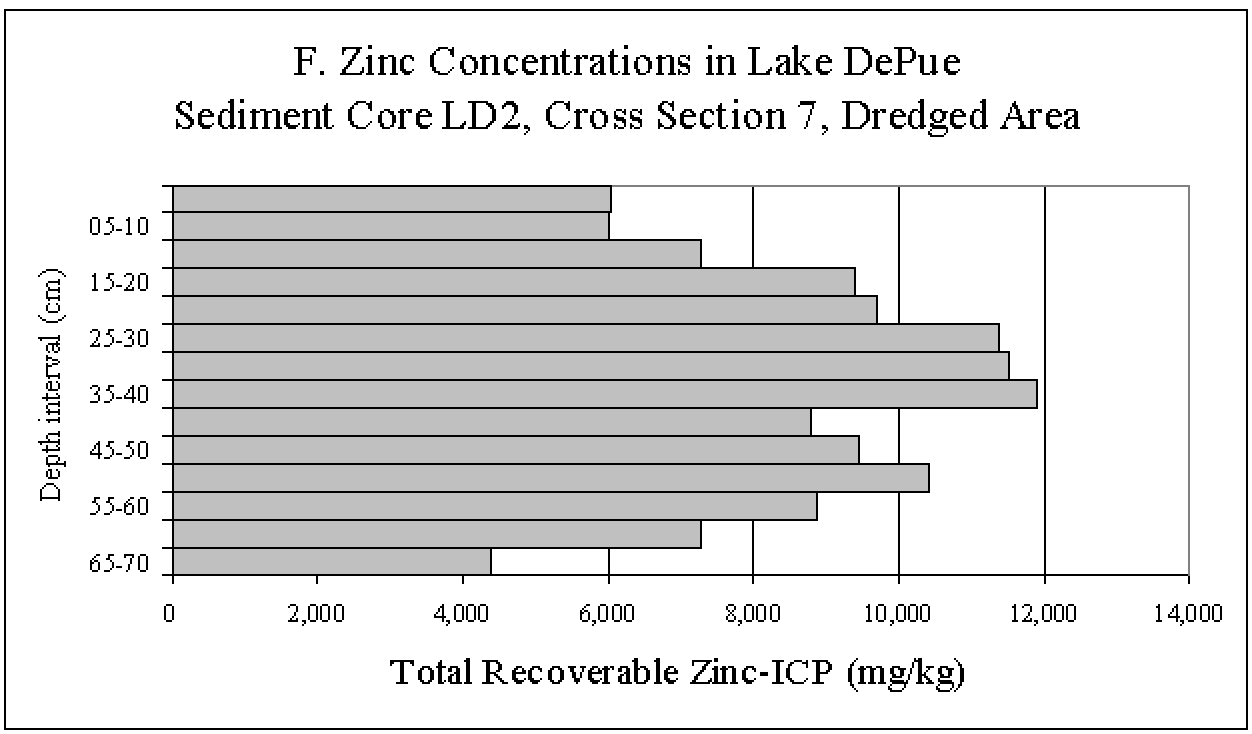
Figure B1. Total recoverable zinc concentrations in Lake DePue sediment cores. Note the changes in the concentration scale.

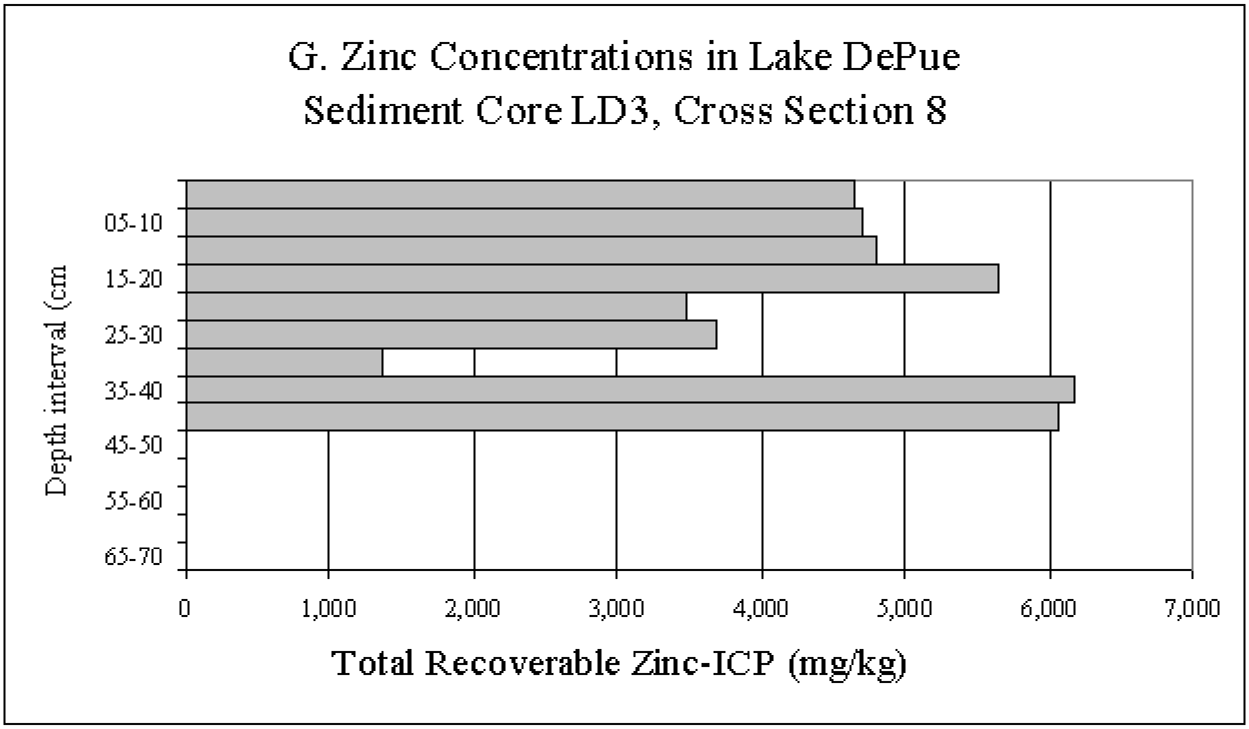


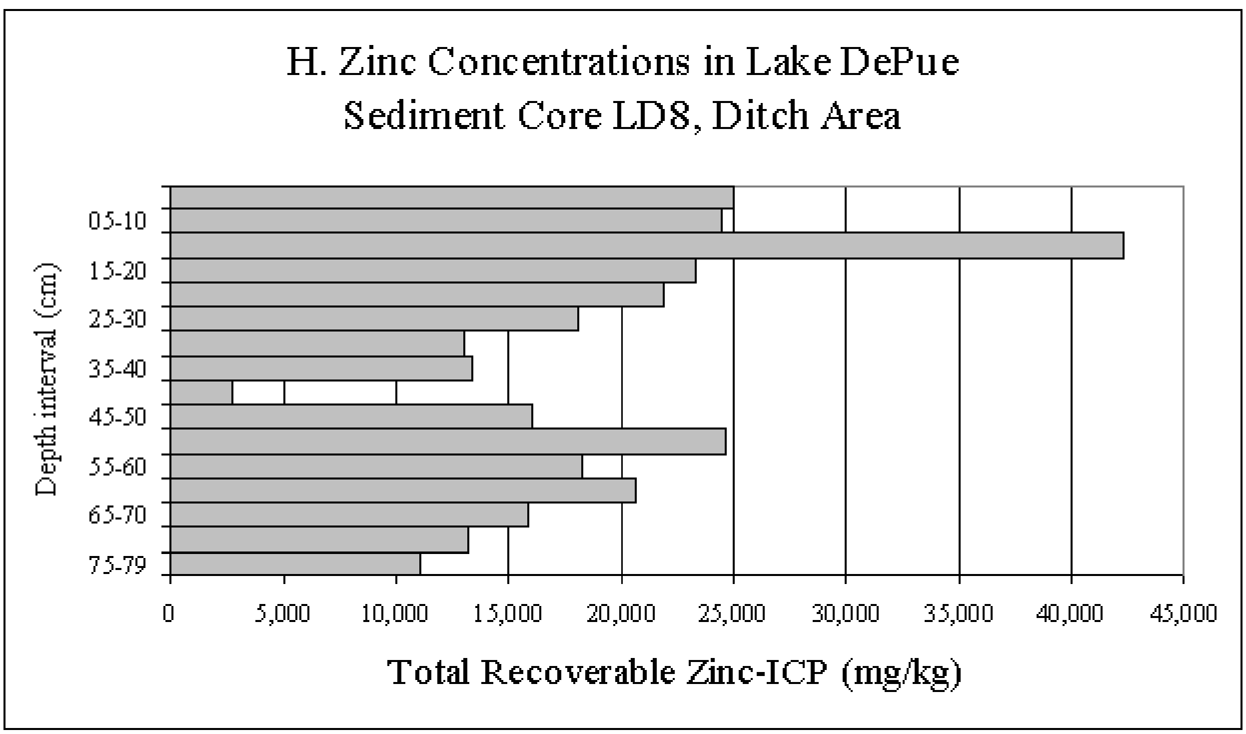

C. Zinc Concentrations in Lake DePue
Sediment Core LD6, Cross Section 4
Depth interval (cm)
0-5
10-15
20-25
30-35
40-45
50-55
60-66
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
5,000
Total Recoverable Zinc-ICP (mg/kg)

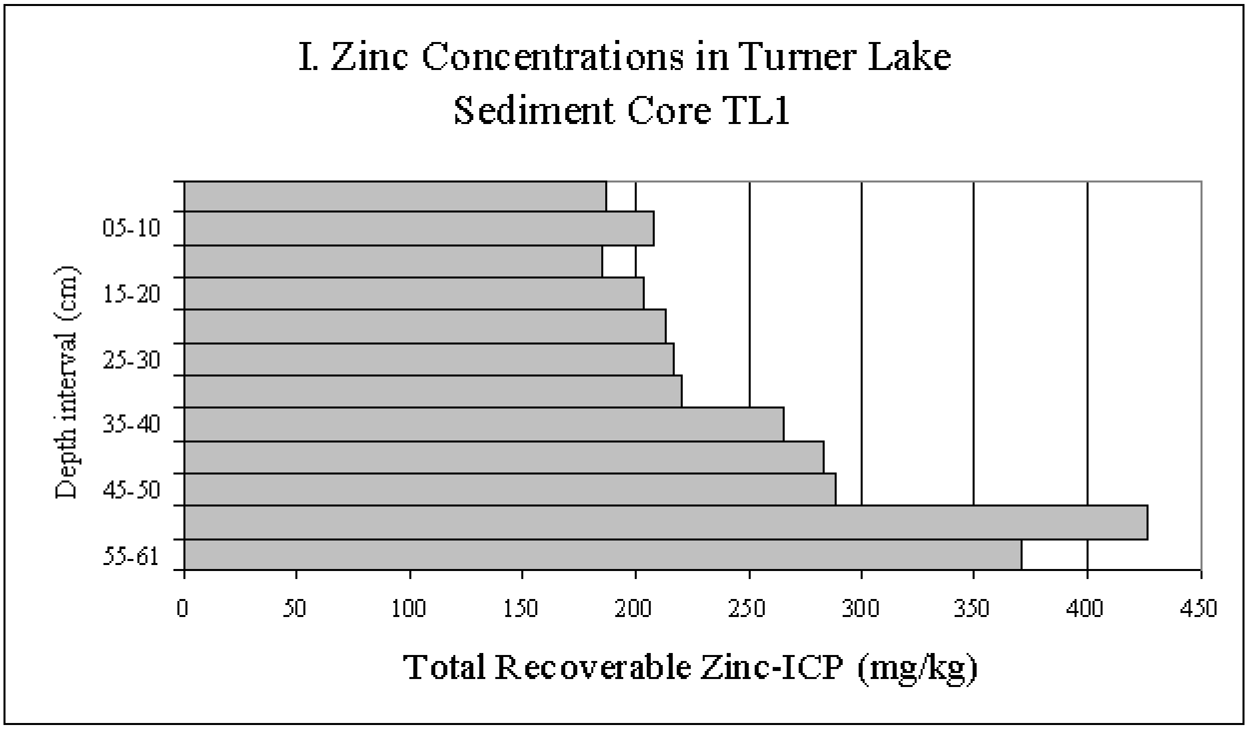

D. Zinc Concentrations in Lake DePue
Sediment Core LD7, Cross Section 5
Depth interval (cm
0-5
10-15
20-25
30-35
40-45
50-55
60-65
70-75
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
5,000
Total Recoverable Zinc-ICP (mg/kg)

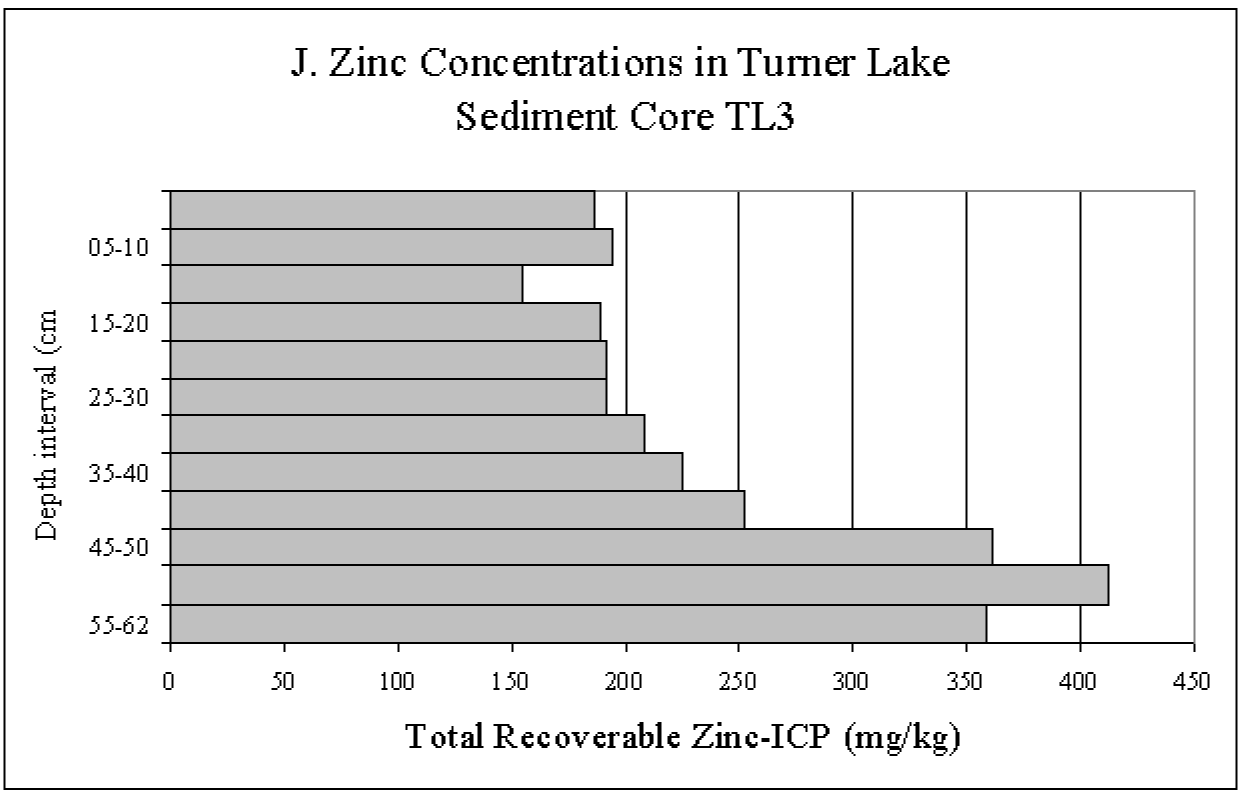

E. Zinc Concentrations in Lake DePue
Sediment Core LD1, Cross Section 6, Dredged Area
Depth interval (cm
0-5
10-15
20-25
30-35
40-45
50-55
60-64
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
Total Recoverable Zinc-ICP (mg/kg)

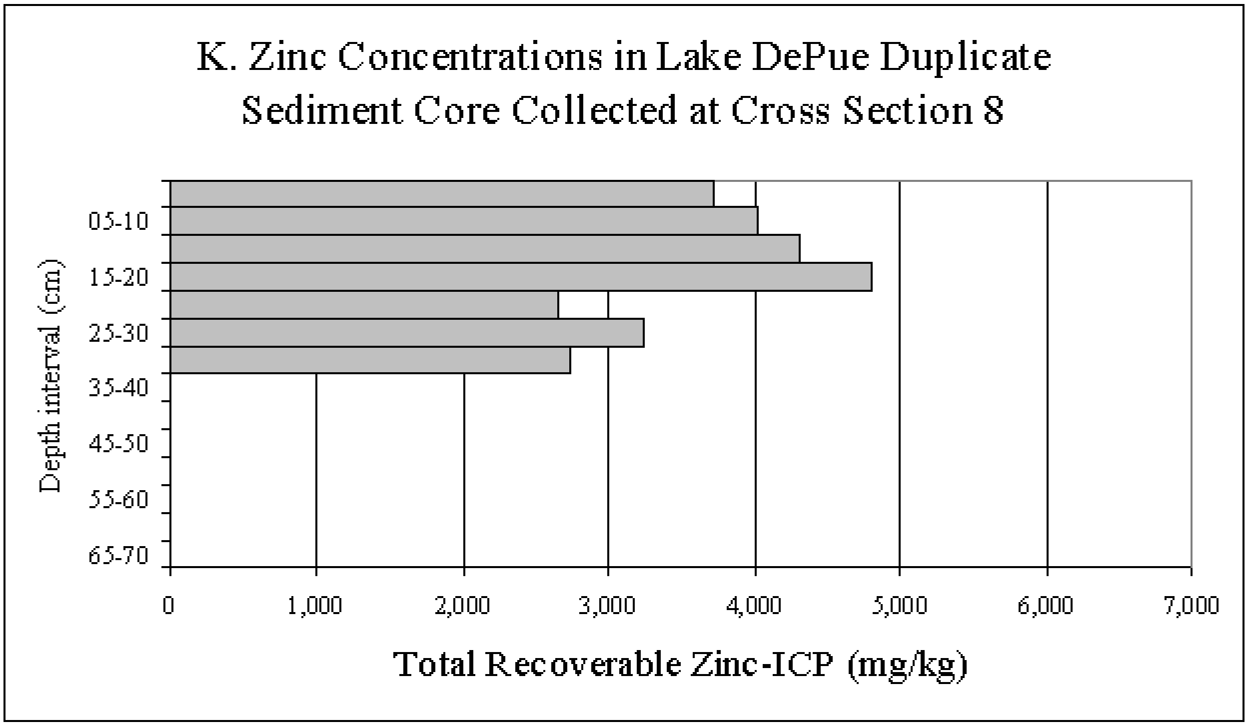

F. Zinc Concentrations in Lake DePue
Sediment Core LD2, Cross Section 7, Dredged Area
Depth interval (cm)
05-10
15-20
25-30
35-40
45-50
55-60
65-70
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
Total Recoverable Zinc-ICP (mg/kg)

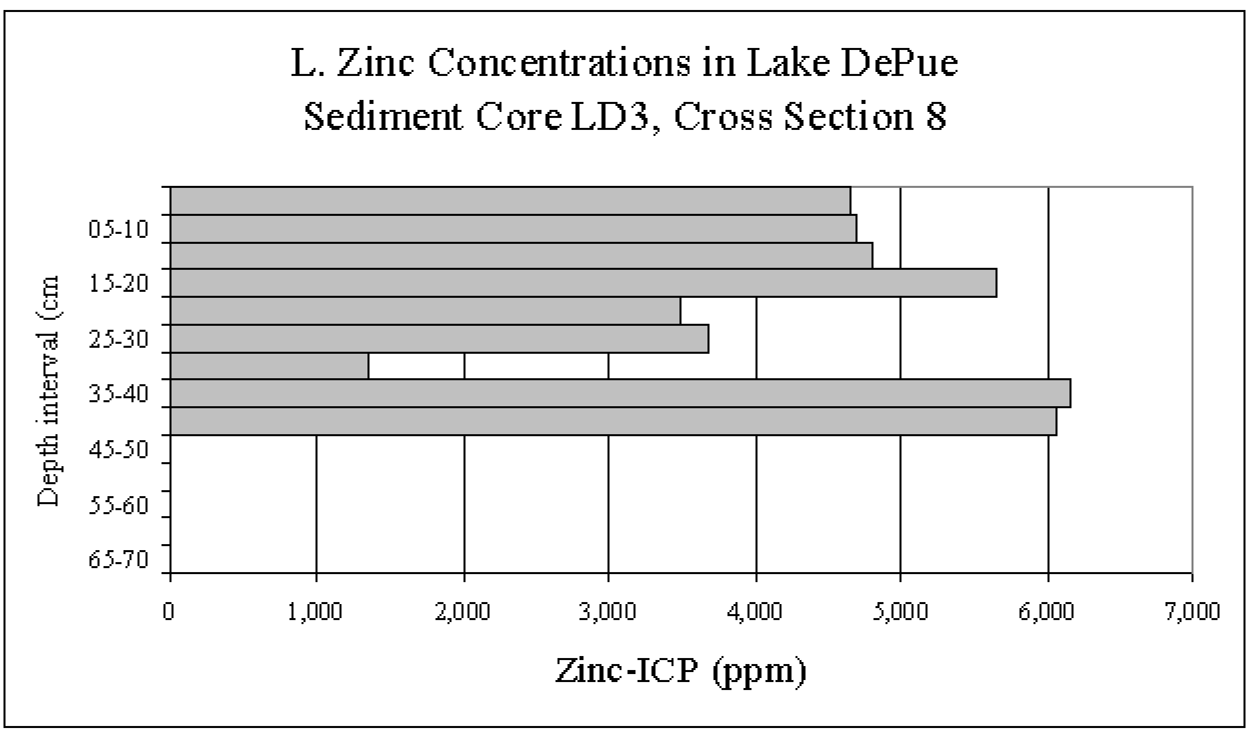

G. Zinc Concentrations in Lake DePue
Sediment Core LD3, Cross Section 8
Depth interval (cm
05-10
15-20
25-30
35-40
45-50
55-60
65-70
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
Total Recoverable Zinc-ICP (mg/kg)


H. Zinc Concentrations in Lake DePue
Sediment Core LD8, Ditch Area
Depth interval (cm)
05-10
15-20
25-30
35-40
45-50
55-60
65-70
75-79
0
5,000
10,000
15,000
20,000
25,000
30,000
35,000
40,000
45,000
Total Recoverable Zinc-ICP (mg/kg)


I. Zinc Concentrations in Turner Lake
Sediment Core TL1
Depth interval (cm)
05-10
15-20
25-30
35-40
45-50
55-61
0
50
100
150
200
250
300
350
400
450
Total Recoverable Zinc-ICP (mg/kg)


J. Zinc Concentrations in Turner Lake
Sediment Core TL3
Depth interval (cm
05-10
15-20
25-30
35-40
45-50
55-62
0
50
100
150
200
250
300
350
400
450
Total Recoverable Zinc-ICP (mg/kg)


K. Zinc Concentrations in Lake DePue Duplicate Sediment Core Collected at Cross Section 8
Depth interval (cm)
05-10
15-20
25-30
35-40
45-50
55-60
65-70
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
Total Recoverable Zinc-ICP (mg/kg)


L. Zinc Concentrations in Lake DePue Sediment Core LD3, Cross Section 8
Depth interval (cm
05-10
15-20
25-30
35-40
45-50
55-60
65-70
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
Zinc-ICP (ppm)

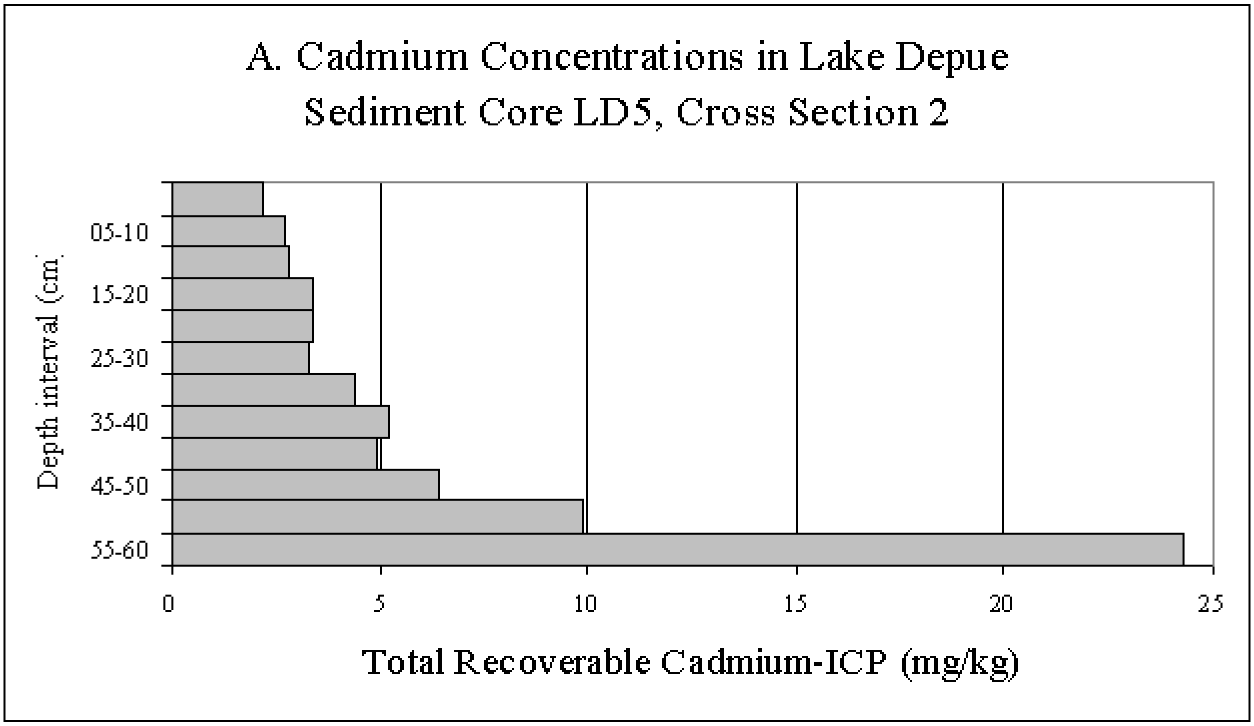
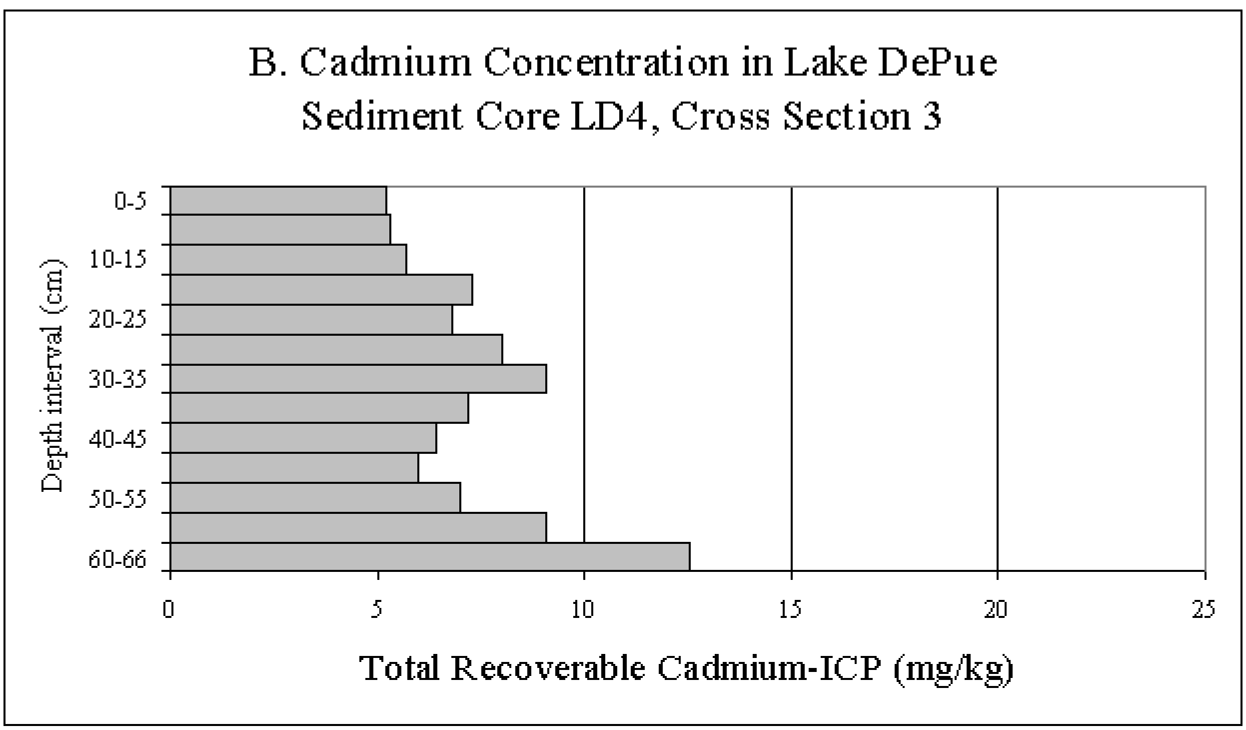
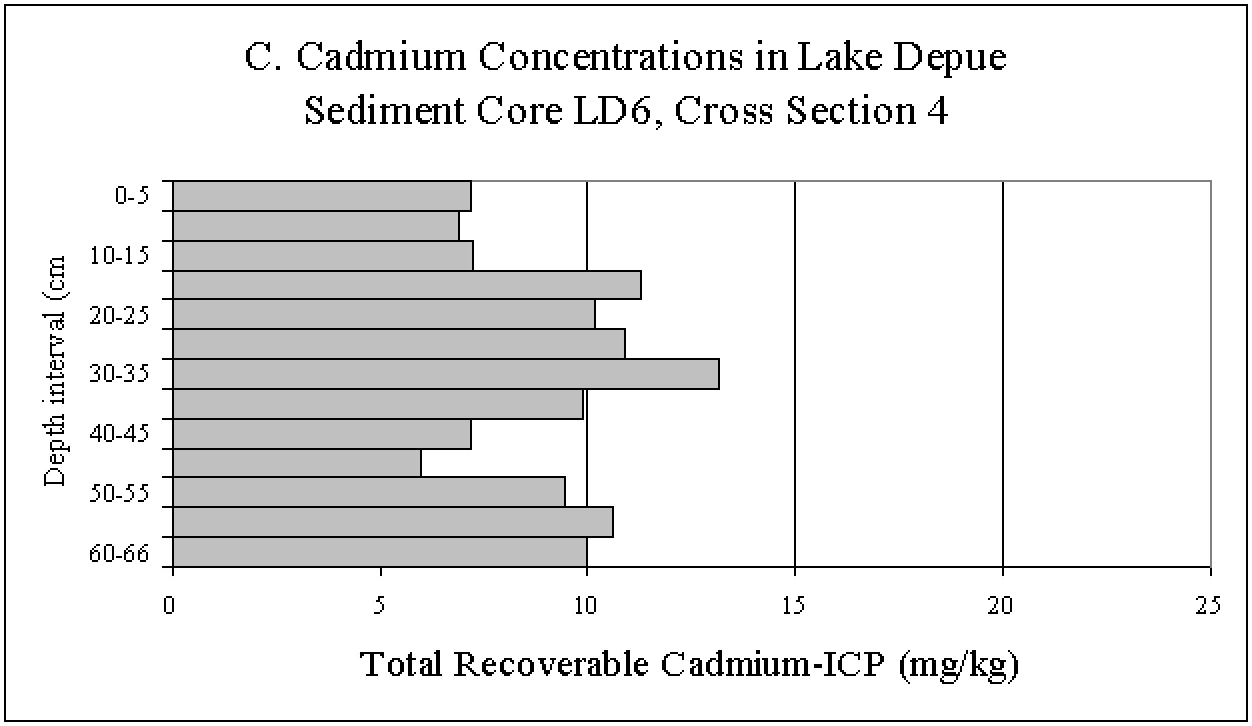
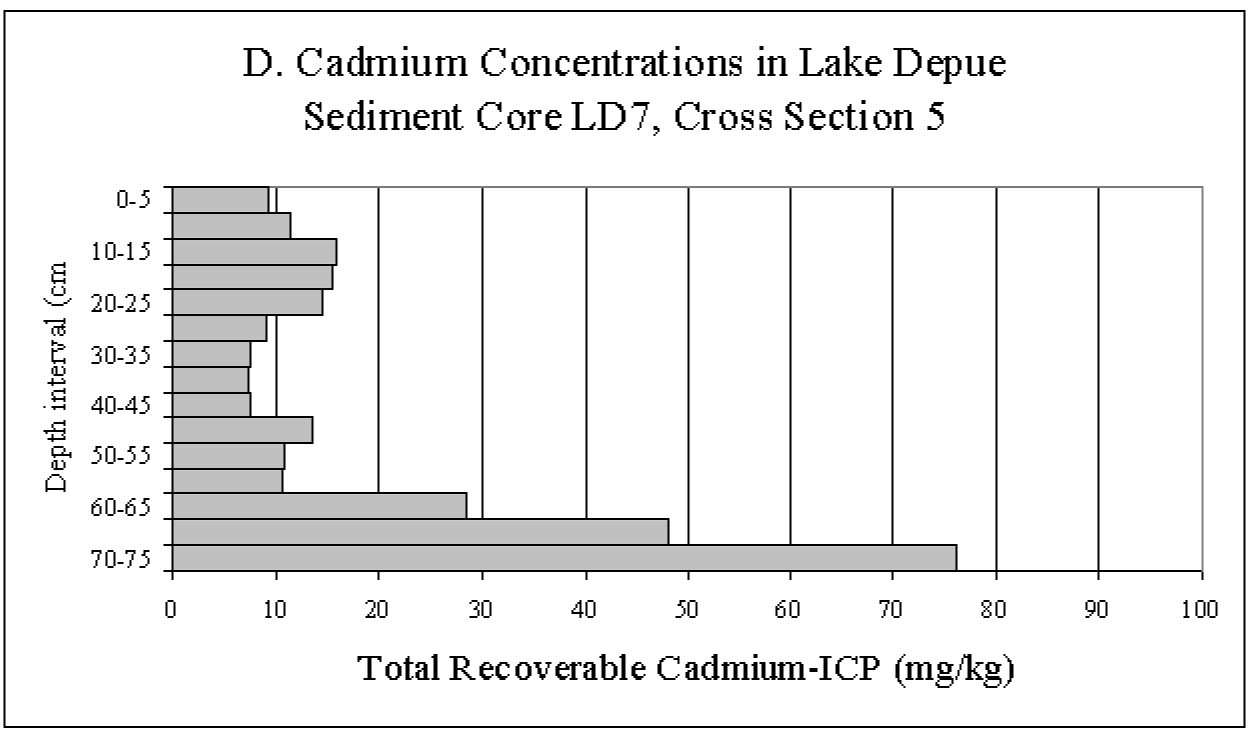
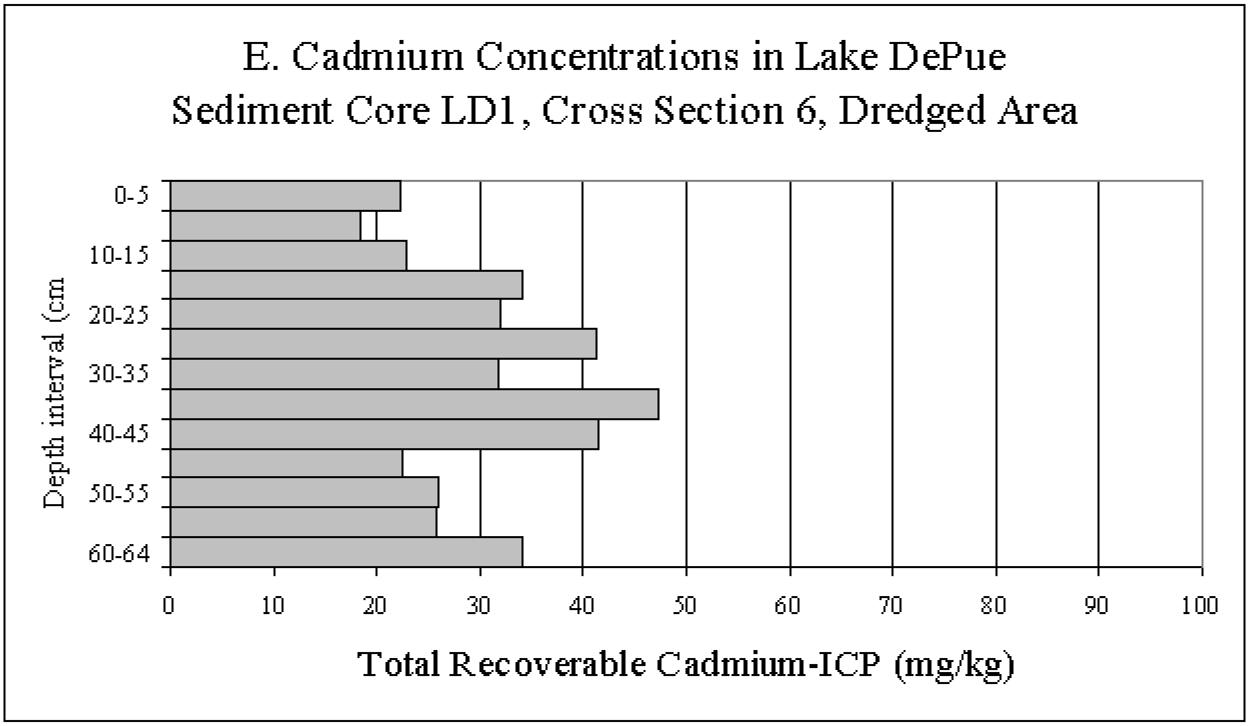


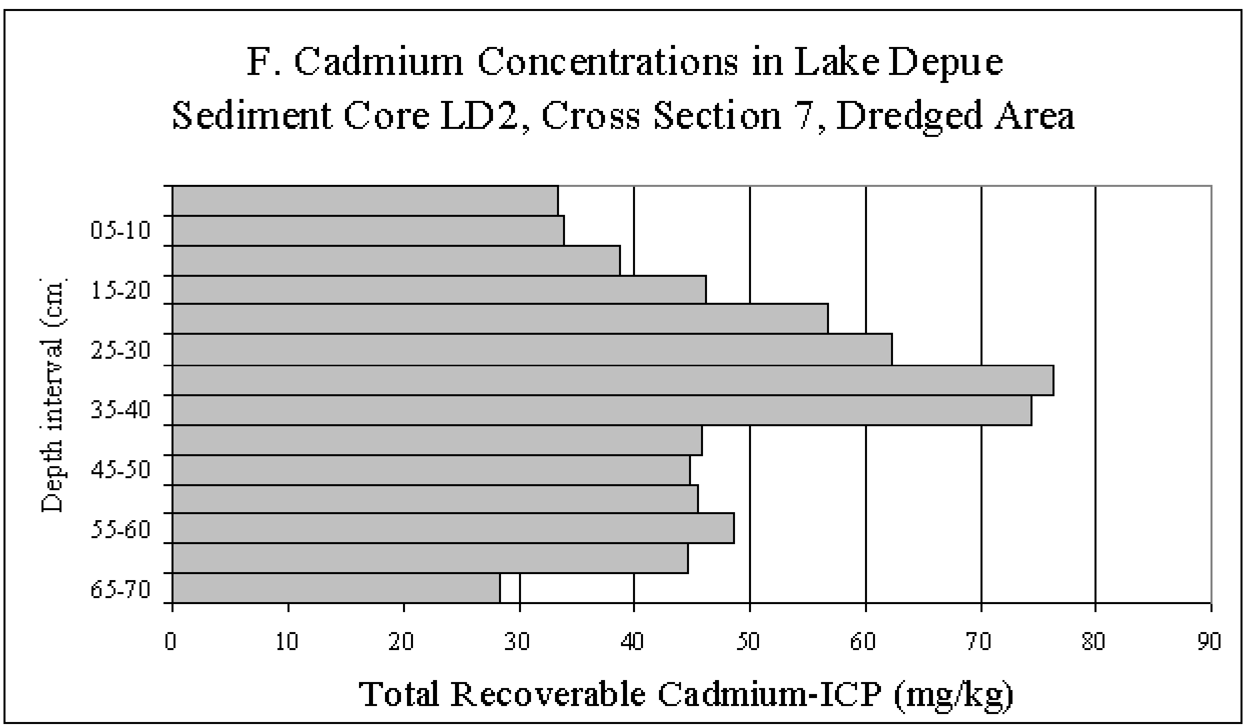
Figure B2. Total recoverable cadmium concentrations in sediment cores from Lake DePue.

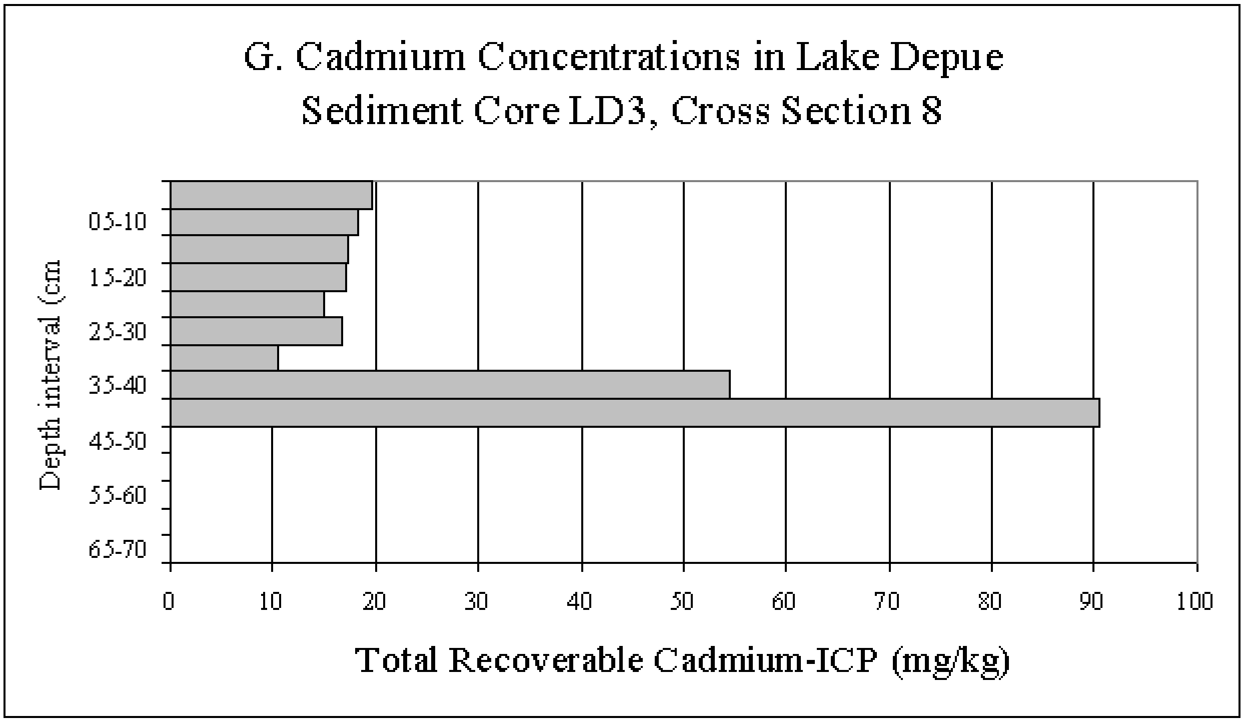


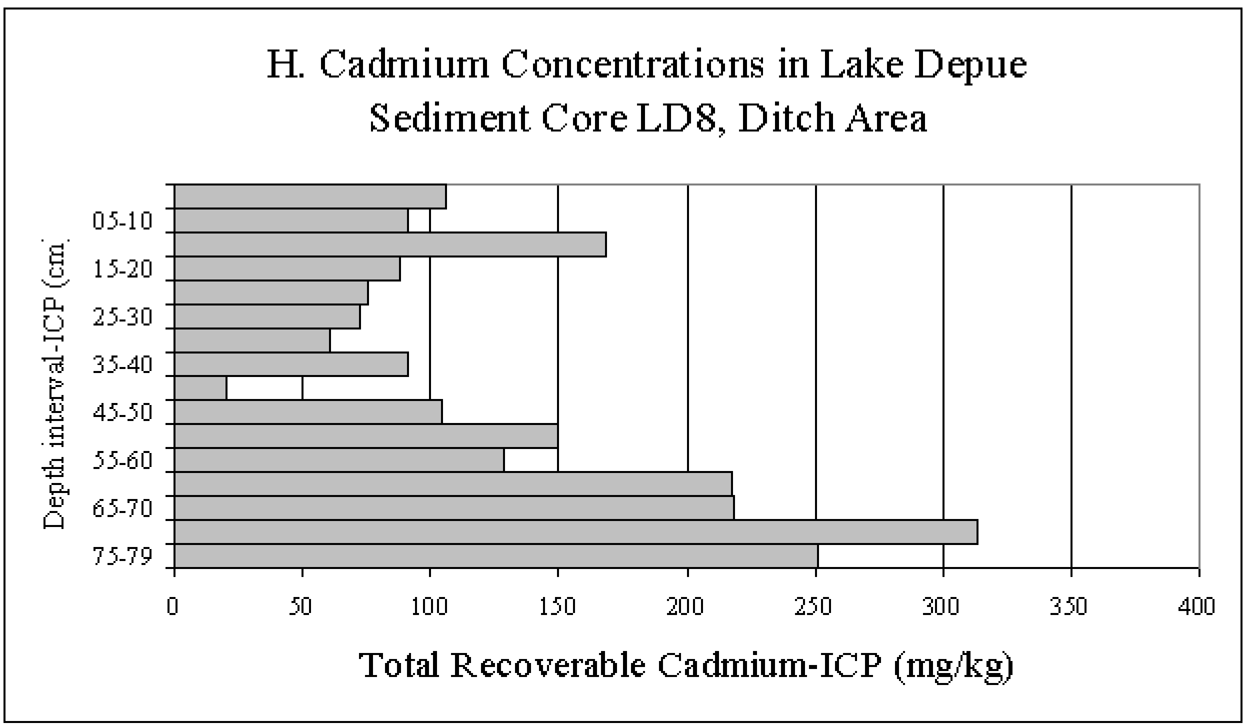

C. Cadmium Concentrations in Lake Depue
Sediment Core LD6, Cross Section 4
Depth interval (cm
0-5
10-15
20-25
30-35
40-45
50-55
60-66
0
5
10
15
20
25
Total Recoverable Cadmium-ICP (mg/kg)

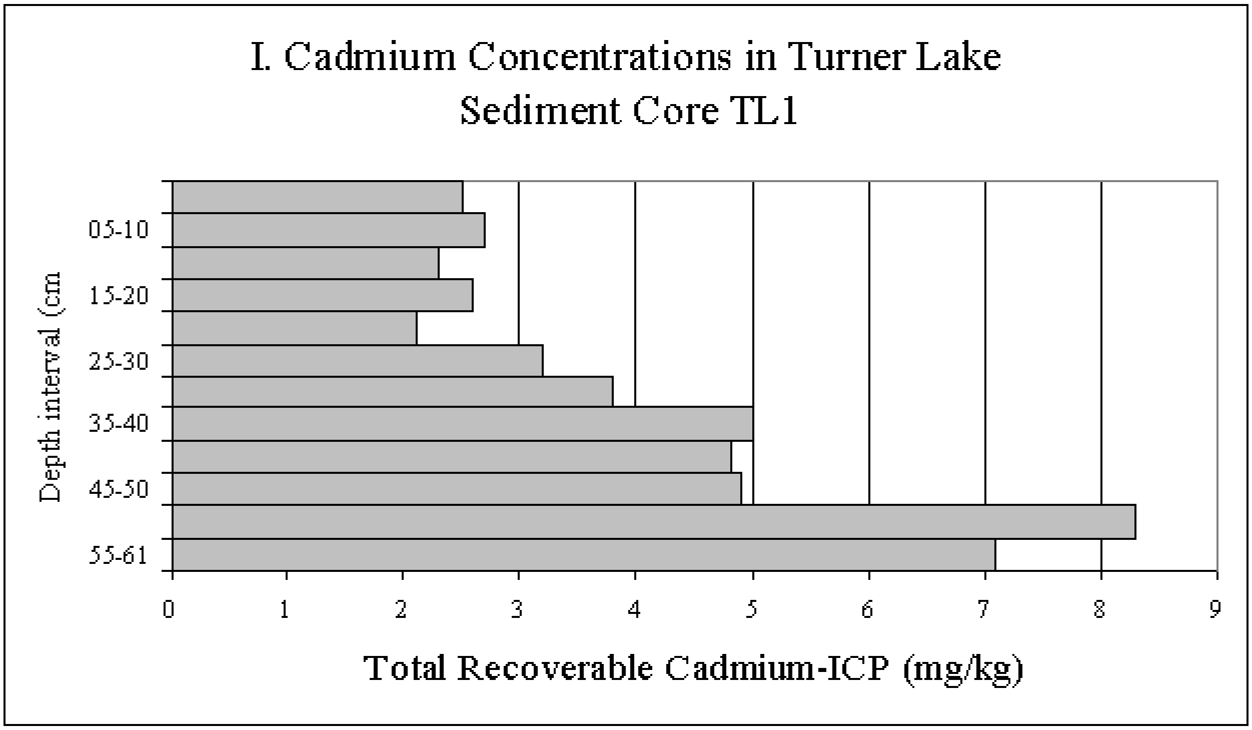

D. Cadmium Concentrations in Lake Depue
Sediment Core LD7, Cross Section 5
Depth interval (cm
0-5
10-15
20-25
30-35
40-45
50-55
60-65
70-75
0
10
20
30
40
50
60
70
80
90
100
Total Recoverable Cadmium-ICP (mg/kg)

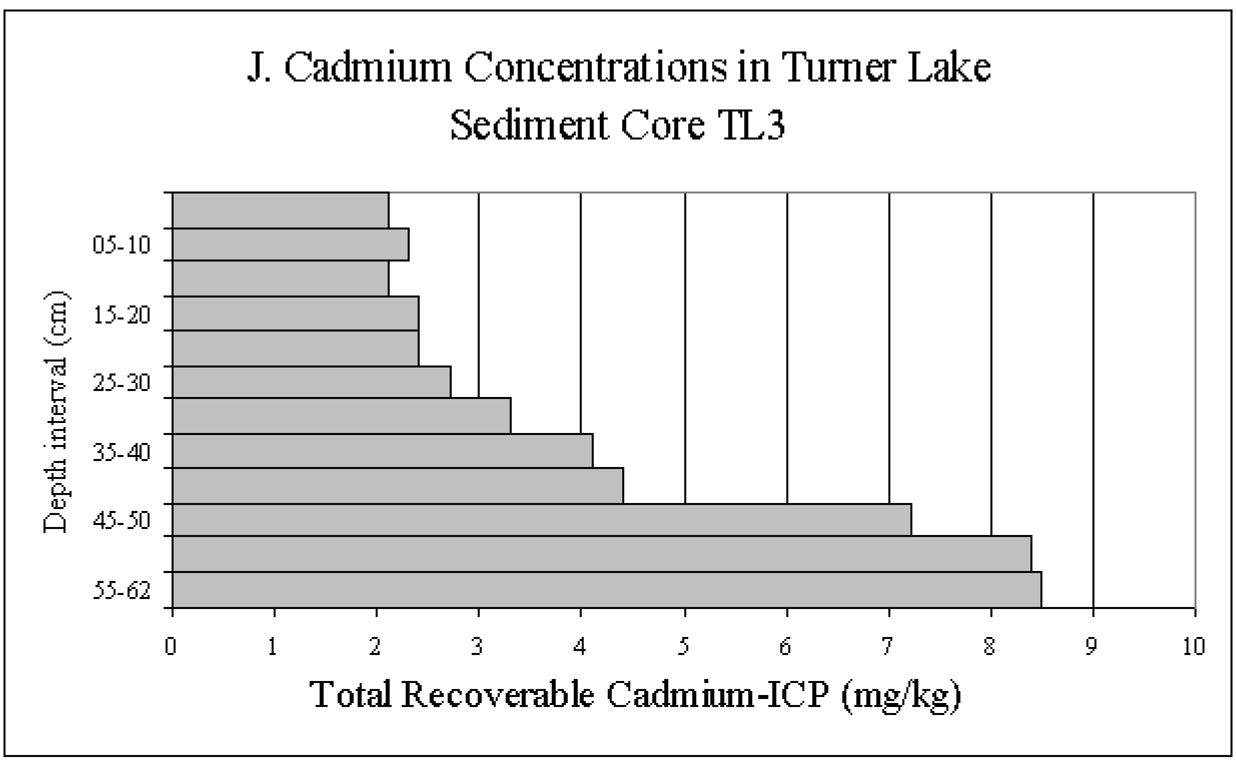

E. Cadmium Concentrations in Lake DePue
Sediment Core LD1, Cross Section 6, Dredged Area
Depth interval (cm
0-5
10-15
20-25
30-35
40-45
50-55
60-64
0
10
20
30
40
50
60
70
80
90
100
Total Recoverable Cadmium-ICP (mg/kg)

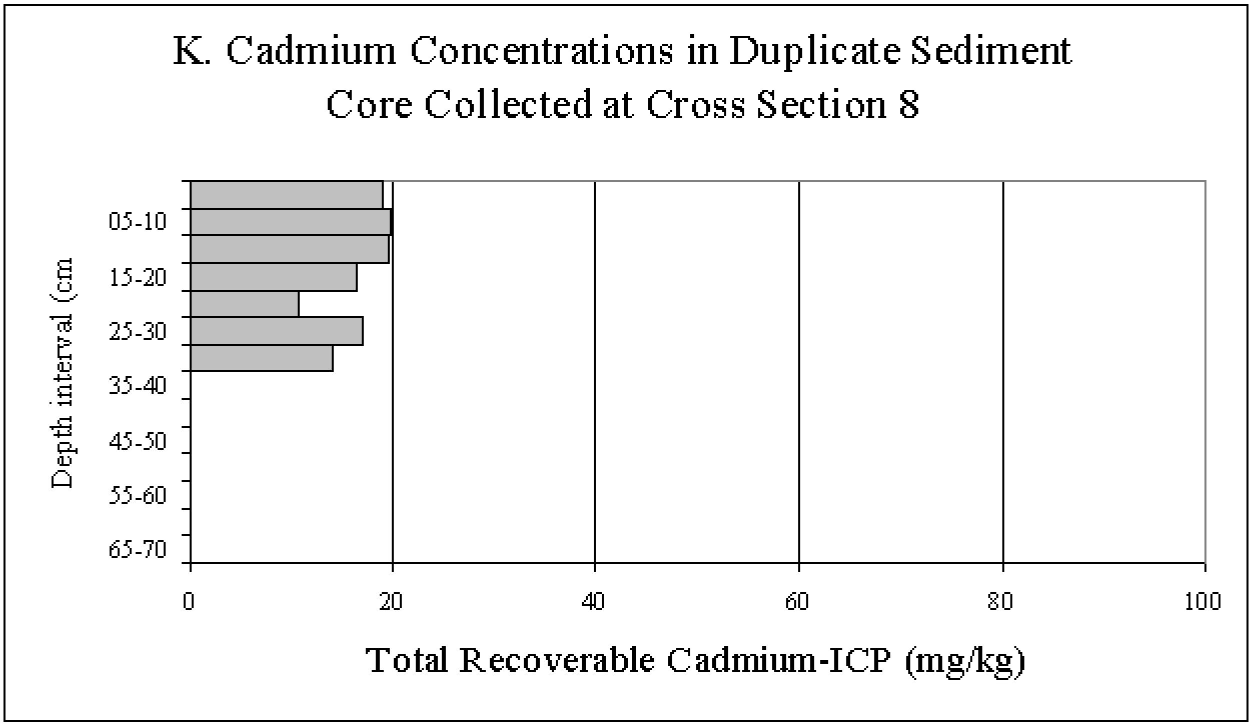

F. Cadmium Concentrations in Lake Depue
Sediment Core LD2, Cross Section 7, Dredged Area
Depth interval (cm
05-10
15-20
25-30
35-40
45-50
55-60
65-70
0
10
20
30
40
50
60
70
80
90
Total Recoverable Cadmium-ICP (mg/kg)

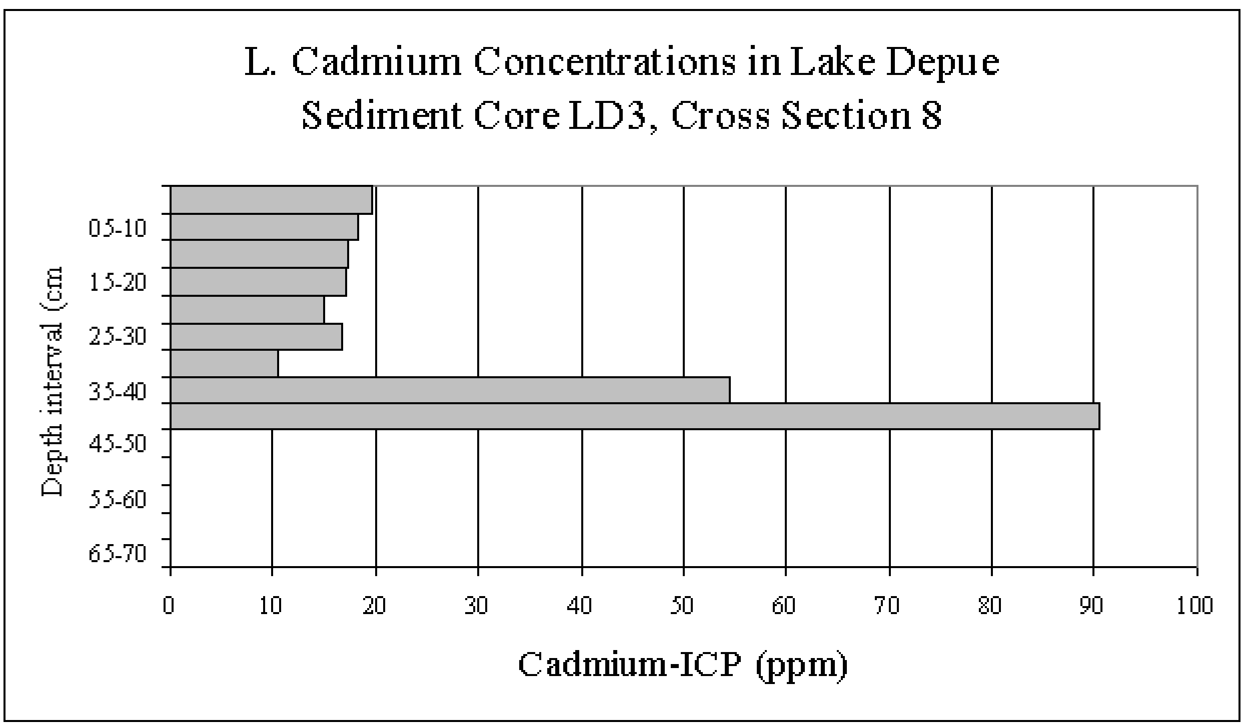

G. Cadmium Concentrations in Lake Depue
Sediment Core LD3, Cross Section 8
Depth interval (cm
05-10
15-20
25-30
35-40
45-50
55-60
65-70
0
10
20
30
40
50
60
70
80
90
100
Total Recoverable Cadmium-ICP (mg/kg)


H. Cadmium Concentrations in Lake Depue
Sediment Core LD8, Ditch Area
Depth interval-ICP (cm
05-10
15-20
25-30
35-40
45-50
55-60
65-70
75-79
0
50
100
150
200
250
300
350
400
Total Recoverable Cadmium-ICP (mg/kg)


I. Cadmium Concentrations in Turner Lake
Sediment Core TL1
Depth interval (cm
05-10
15-20
25-30
35-40
45-50
55-61
0
1
2
3
4
5
6
7
8
9
Total Recoverable Cadmium-ICP (mg/kg)


J. Cadmium Concentrations in Turner Lake
Sediment Core TL3
Depth interval (cm)
05-10
15-20
25-30
35-40
45-50
55-62
0
1
2
3
4
5
6
7
8
9
10
Total Recoverable Cadmium-ICP (mg/kg)


K. Cadmium Concentrations in Duplicate Sediment Core Collected at Cross Section 8
Depth interval (cm
05-10
15-20
25-30
35-40
45-50
55-60
65-70
0
20
40
60
80
100
Total Recoverable Cadmium-ICP (mg/kg)


L. Cadmium Concentrations in Lake Depue Sediment Core LD3, Cross Section 8
Depth interval (cm
05-10
15-20
25-30
35-40
45-50
55-60
65-70
0
10
20
30
40
50
60
70
80
90
100
Cadmium-ICP (ppm)

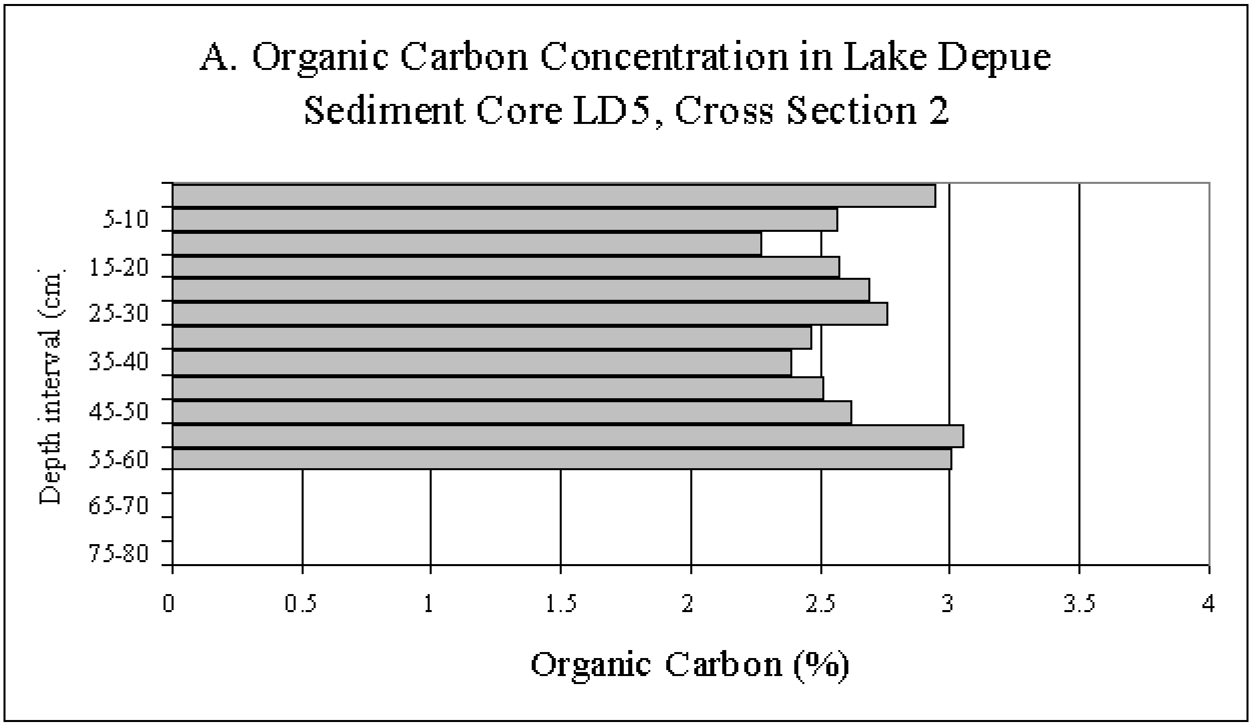
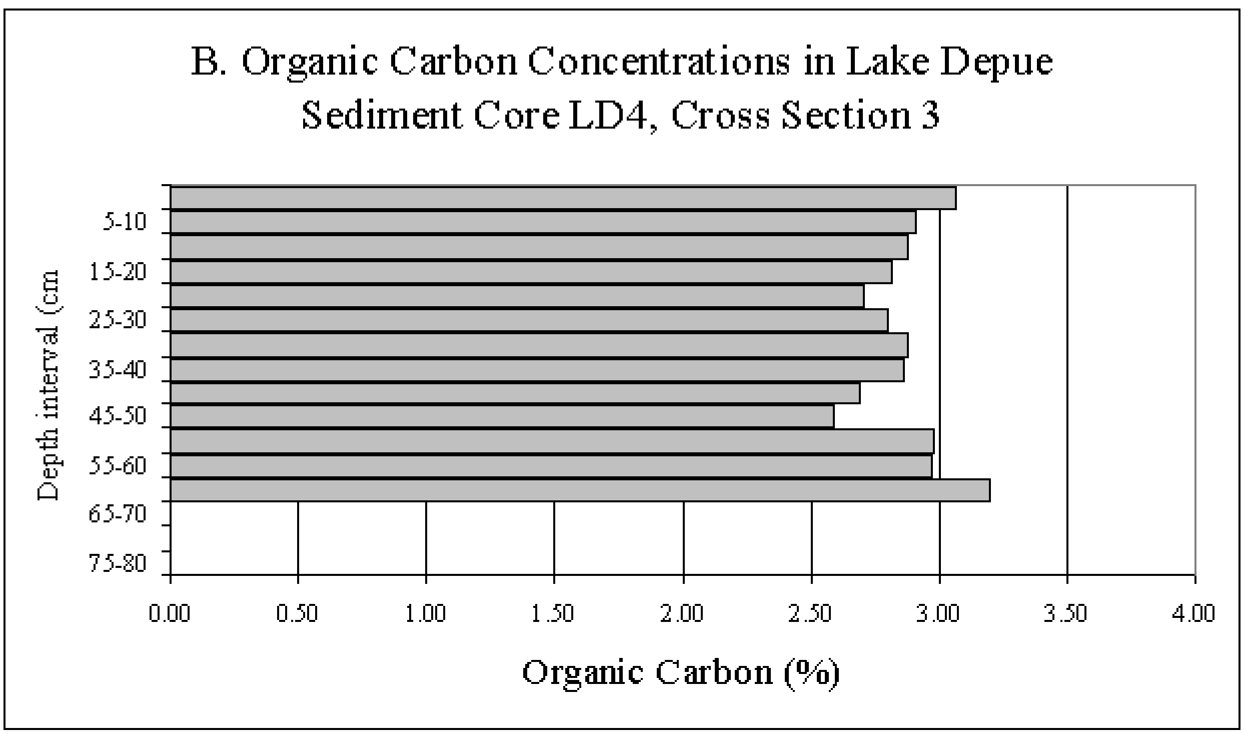
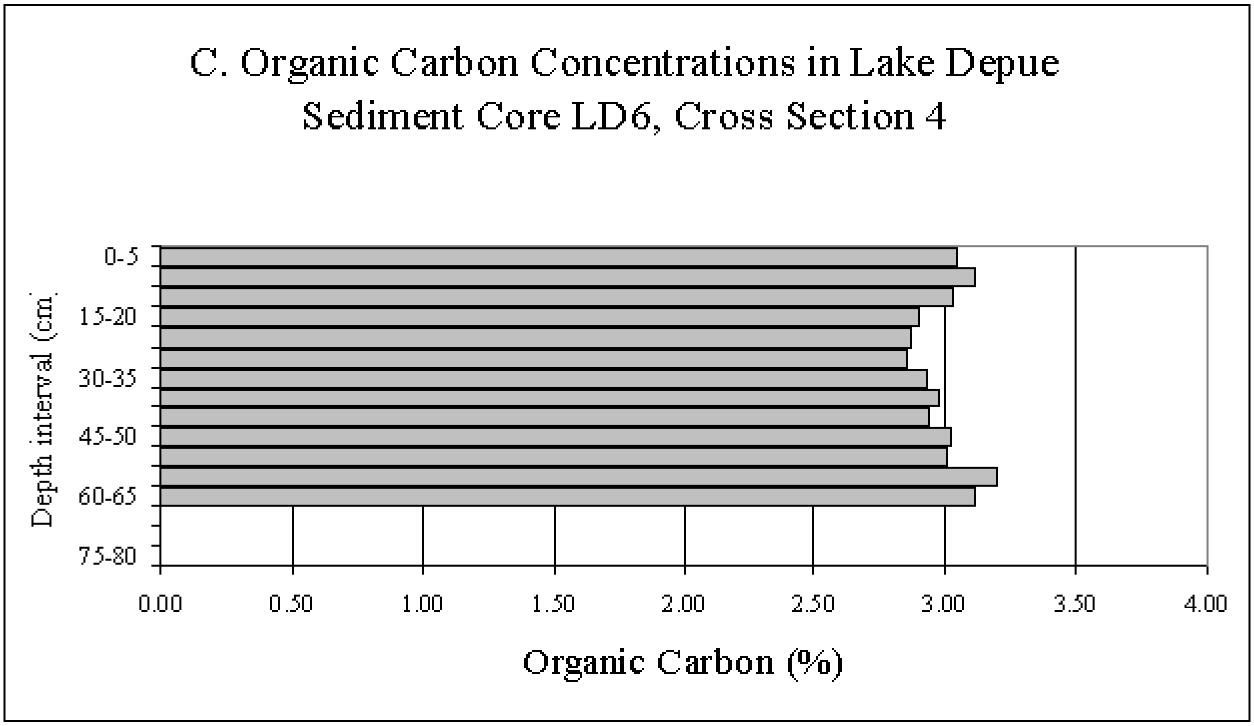
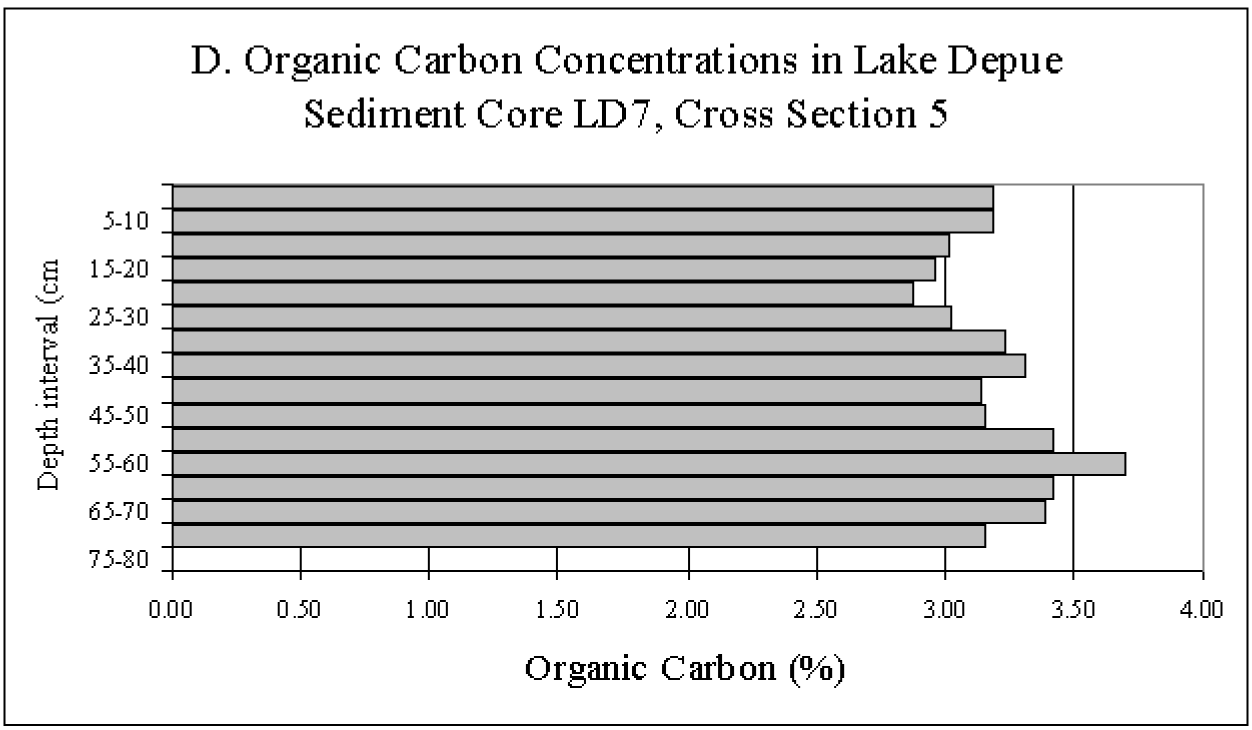
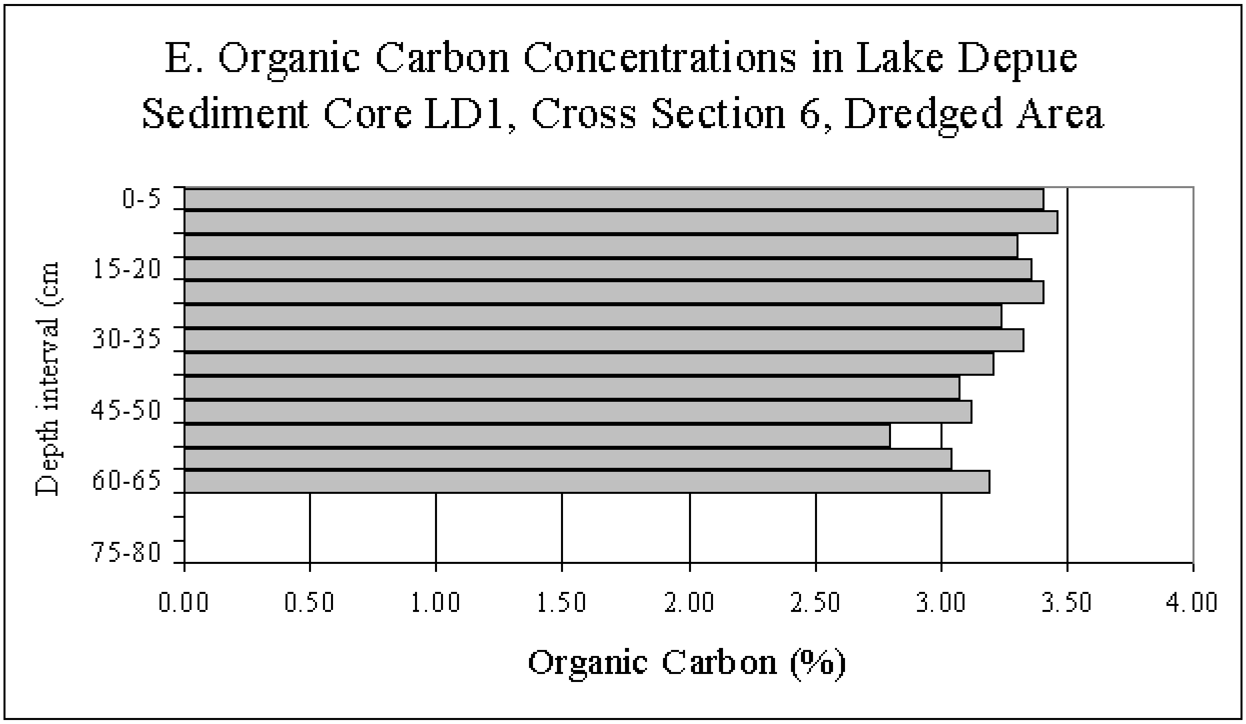


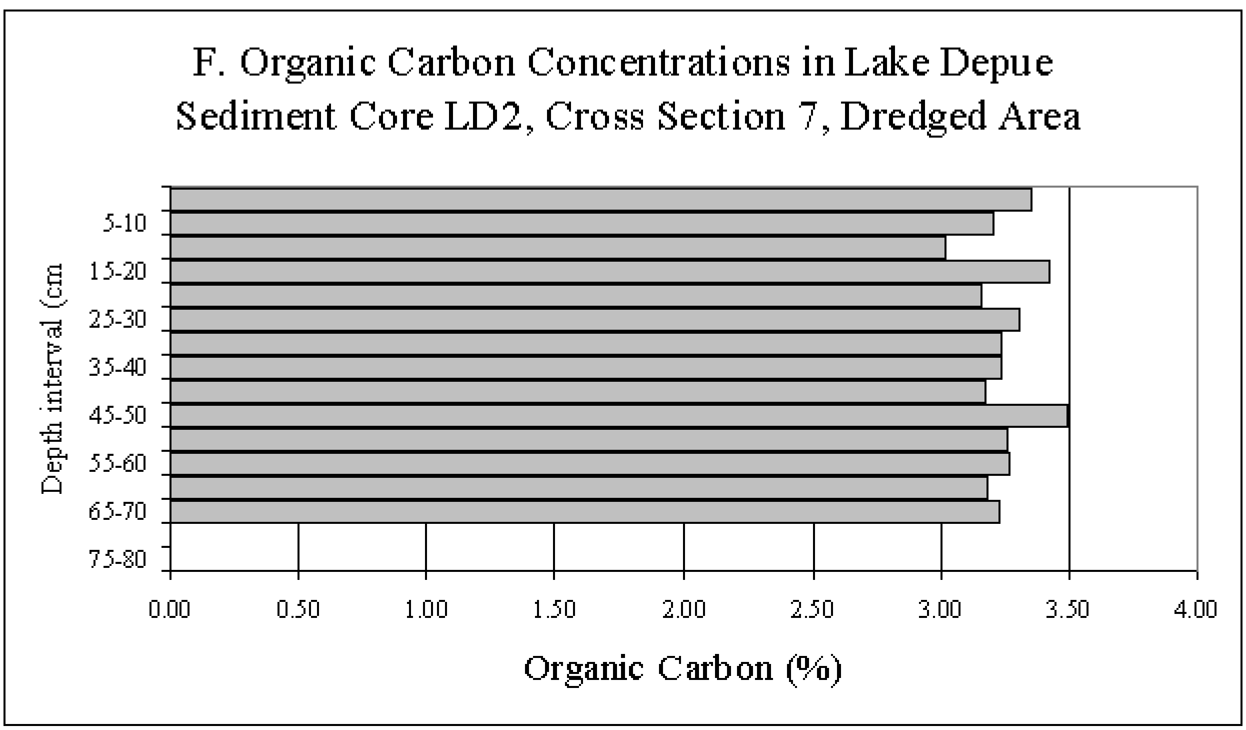
Figure B3. Organic carbon concentrations in sediment cores from Lake DePue.

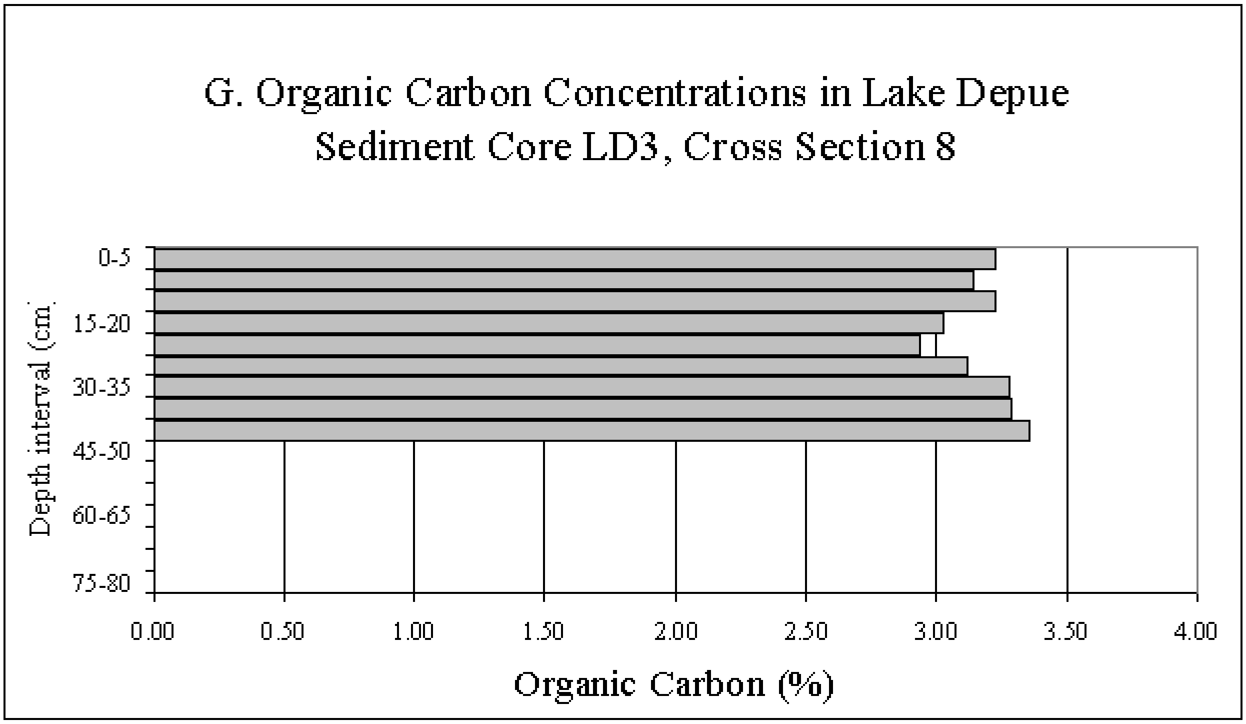


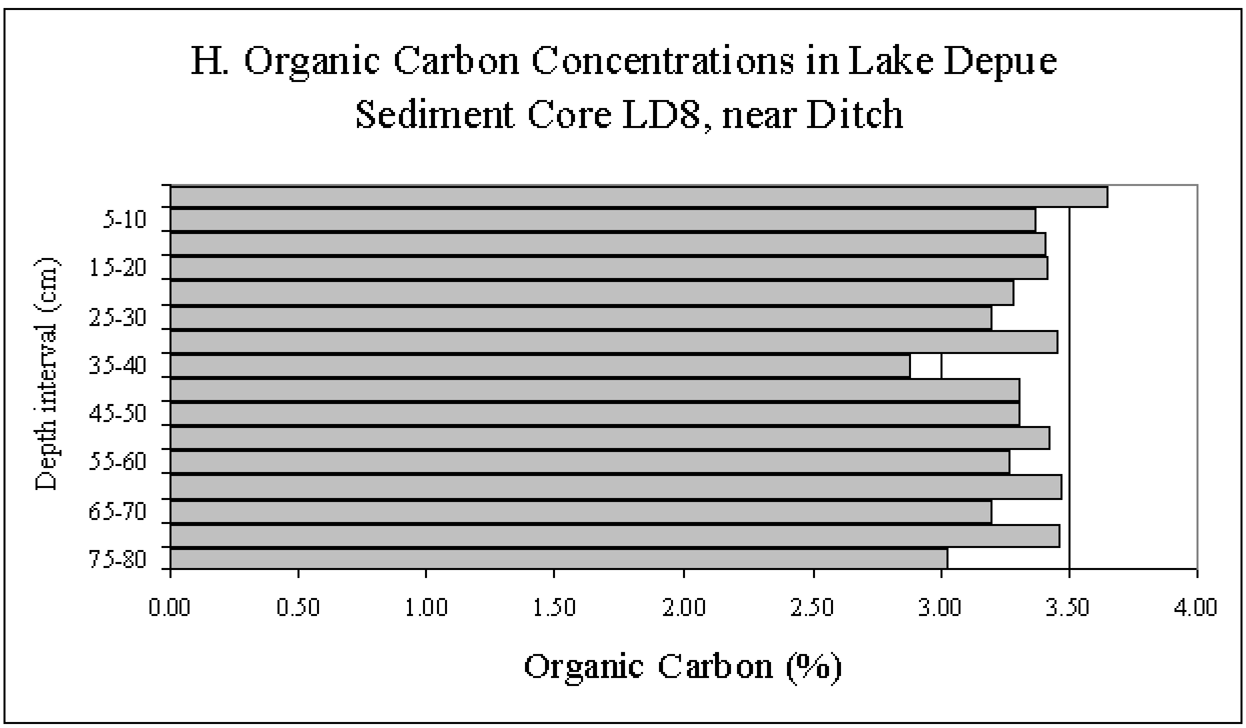

C. Organic Carbon Concentrations in Lake Depue
Sediment Core LD6, Cross Section 4
Depth interval (cm)
0-5
15-20
30-35
45-50
60-65
75-80
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
Organic Carbon (%)

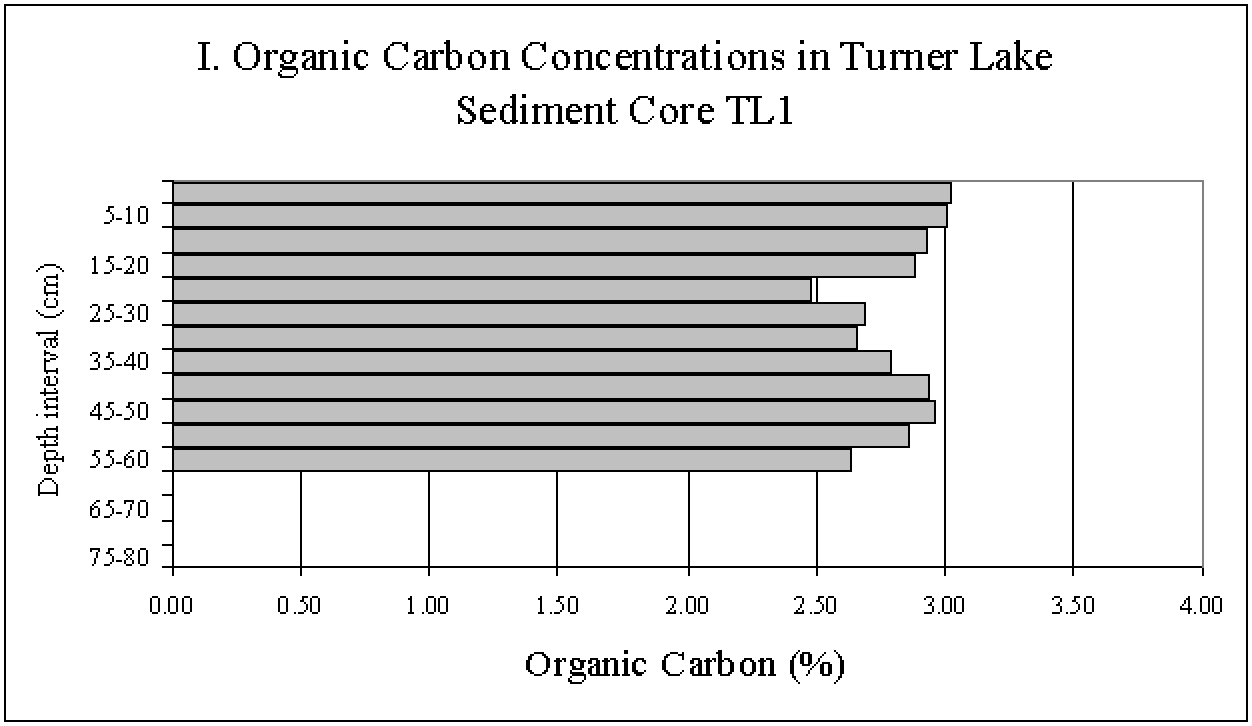

D. Organic Carbon Concentrations in Lake Depue
Sediment Core LD7, Cross Section 5
Depth interval (cm
5-10
15-20
25-30
35-40
45-50
55-60
65-70
75-80
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
Organic Carbon (%)

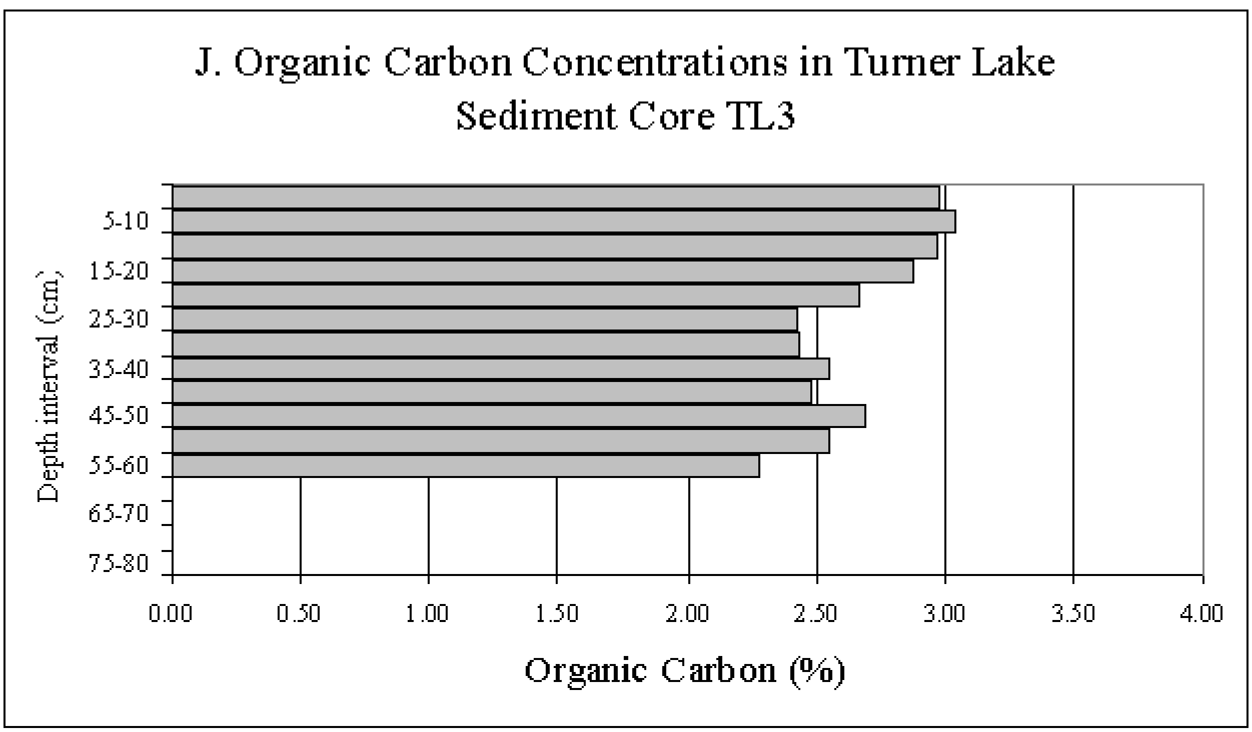

E. Organic Carbon Concentrations in Lake Depue
Sediment Core LD1, Cross Section 6, Dredged Area
Depth interval (cm
0-5
15-20
30-35
45-50
60-65
75-80
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
Organic Carbon (%)

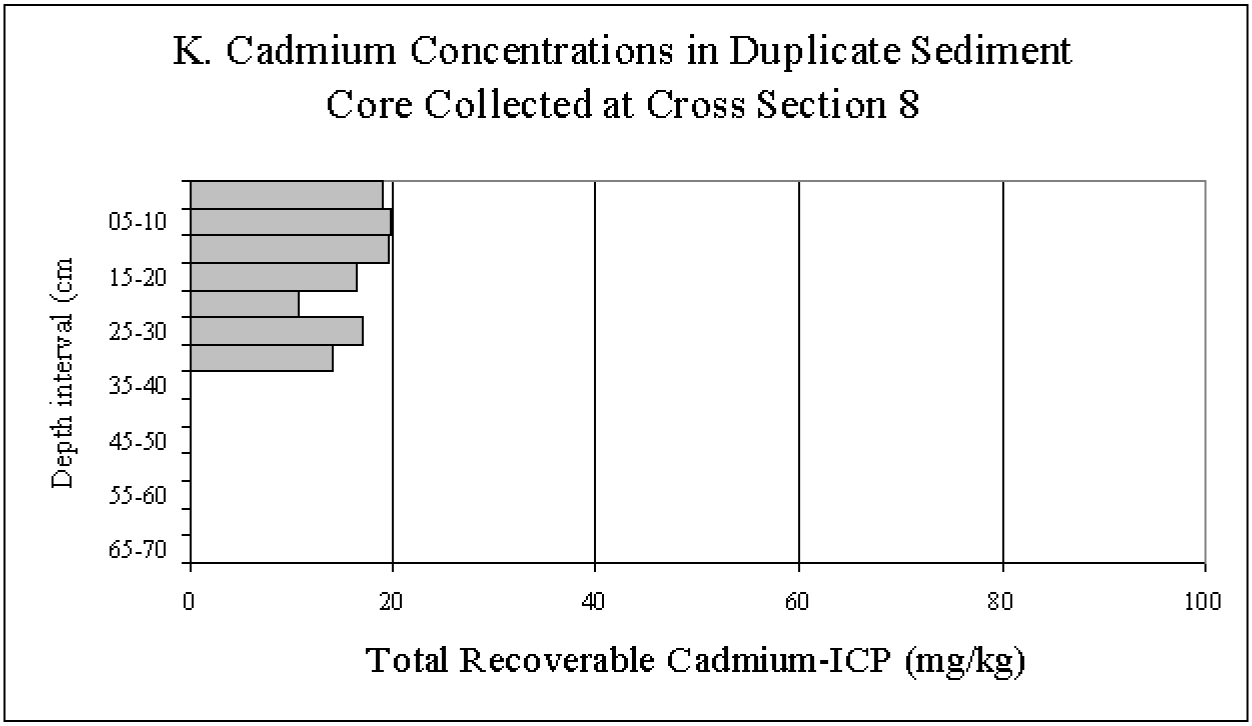

F. Organic Carbon Concentrations in Lake Depue
Sediment Core LD2, Cross Section 7, Dredged Area
Depth interval (cm
5-10
15-20
25-30
35-40
45-50
55-60
65-70
75-80
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
Organic Carbon (%)

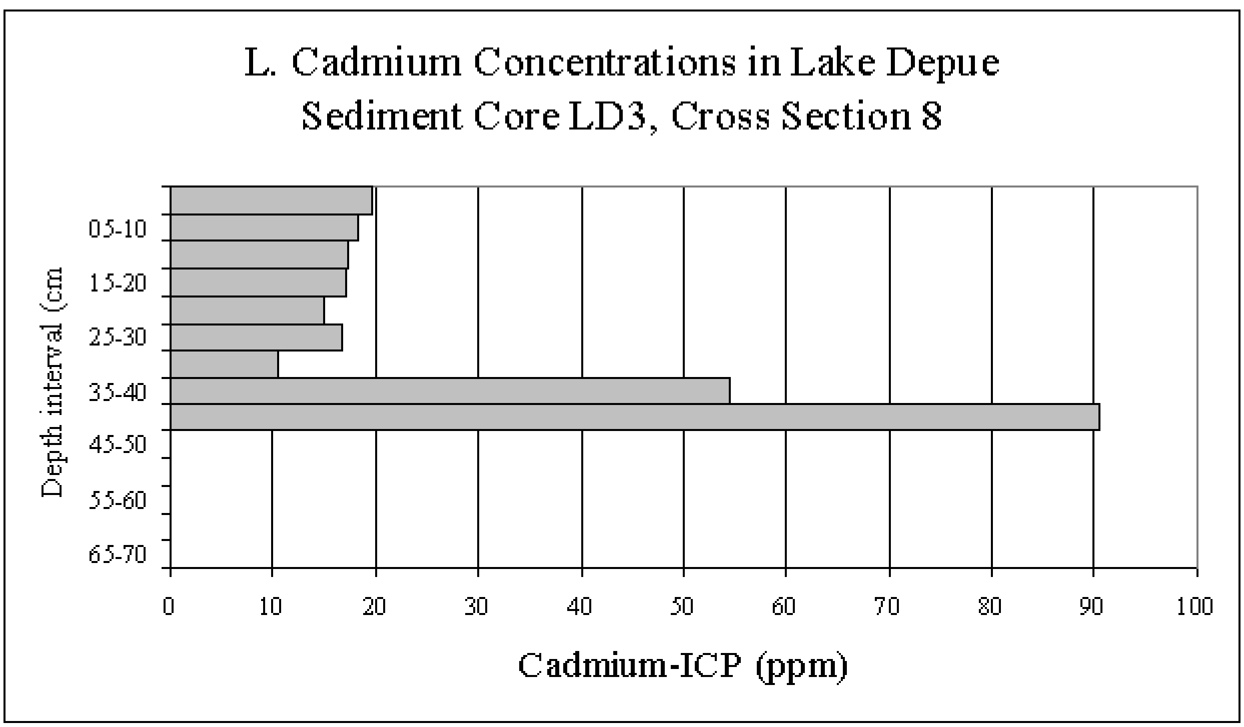

G. Organic Carbon Concentrations in Lake Depue
Sediment Core LD3, Cross Section 8
Depth interval (cm)
0-5
15-20
30-35
45-50
60-65
75-80
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
Organic Carbon (%)


H. Organic Carbon Concentrations in Lake Depue
Sediment Core LD8, near Ditch
Depth interval (cm)
5-10
15-20
25-30
35-40
45-50
55-60
65-70
75-80
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
Organic Carbon (%)


I. Organic Carbon Concentrations in Turner Lake
Sediment Core TL1
Depth interval (cm)
5-10
15-20
25-30
35-40
45-50
55-60
65-70
75-80
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
Organic Carbon (%)


J. Organic Carbon Concentrations in Turner Lake
Sediment Core TL3
Depth interval (cm)
5-10
15-20
25-30
35-40
45-50
55-60
65-70
75-80
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
Organic Carbon (%)


K. Cadmium Concentrations in Duplicate Sediment Core Collected at Cross Section 8
Depth interval (cm
05-10
15-20
25-30
35-40
45-50
55-60
65-70
0
20
40
60
80
100
Total Recoverable Cadmium-ICP (mg/kg)


L. Cadmium Concentrations in Lake Depue Sediment Core LD3, Cross Section 8
Depth interval (cm
05-10
15-20
25-30
35-40
45-50
55-60
65-70
0
10
20
30
40
50
60
70
80
90
100
Cadmium-ICP (ppm)

APPENDIX C

Table C1. Total recoverable metal concentrations in sediments from Lake DePue, Turner Lake, and QA/QC samples.

		Depth interval (cm)	Al ICP (%)	Fe ICP (%)	Ca ICP (%)	Mg ICP (%)	K ICP (mg/kg)	Na ICP (mg/kg)	Mn ICP (mg/kg)	Zn ICP (mg/kg)	Cd ICP (mg/kg)	Ag ICP (mg/kg)	As ICP (mg/kg)	Ba ICP (mg/kg)
Lake DePue														
Cross section 2														
R21455	LD5 grab	0–5	1.25	2.20	3.44	1.43	1,990	152	569	335	2.5	<0.90	7.5	108
R21320	LD5 core	20–25	1.22	2.13	3.72	1.49	2,050	178	596	596	3.4	<0.99	7.3	106
R21327	LD5 core	55–60	1.58	2.67	2.16	1.03	2,010	197	785	2,010	24.3	1.6	10.8	177
Cross section 3														
R21453	LD4 grab	0–5	1.57	2.48	3.06	1.19	2,500	190	675	1,080	5.2	<0.92	8.2	123
R21332	LD4 core	20–25	1.82	2.70	2.74	1.13	2,780	209	693	1,450	6.8	<0.99	8.9	137
Cross section 4														
R21456	LD6 grab	0–5	1.38	2.43	2.78	1.07	1,900	188	722	1,640	7.4	<0.84	8.5	123
R21345	LD6 core	20–25	1.92	2.78	2.57	1.07	2,870	232	733	2,360	10.2	<1.0	9.6	141
R21353	LD6 core	60–65	1.82	2.73	1.52	0.85	2,180	185	538	1,550	10.0	<1.0	10.0	160
Cross section 5														
R21459	LD7 grab	0–5	1.53	2.61	2.71	1.07	2,200	205	774	2,090	9.4	<0.92	9.0	134
R21358	LD7 core	20–25	1.77	2.70	2.34	1.01	2,340	230	739	2,980	14.5	<0.90	14.5	153
R21368	LD7 core	70–75	1.71	2.77	1.98	0.91	2,210	214	740	3,310	76.0	1.9	13.0	226
Cross section 6 (dredged area)														
R21447	LD1 grab	0–5	1.76	2.81	2.28	1.02	2,550	229	756	3,680	19.0	<0.92	9.7	149
Cross section 7 (dredged area)														
R21450	LD2 grab	0–5	1.62	2.58	2.68	1.08	2,380	261	691	6,620	32.6	0.9	9.5	158
R21386	LD2 core	20–25	1.45	2.44	2.20	0.97	1,990	328	716	9,700	56.7	1.1	9.5	169
R21395	LD2 core	65–70	1.67	2.51	1.50	0.80	1,840	197	505	4,370	28.4	<.90	10.3	173
Cross section 8														
R21451	LD3 grab	0–5	1.46	2.49	2.76	1.10	2,030	198	664	3,750	18.7	<0.97	9.0	141
R21400	LD3 core	20–25	2.56	3.02	1.65	1.00	3,970	225	525	3,480	14.8	<0.99	9.1	165
Ditch Area														
R21460	LD8 grab	0–5	1.68	2.72	2.39	1.05	2,370	510	746	17,200	76.3	<0.97	11.6	225
R21409	LD8 core	20–25	2.32	2.92	2.65	1.18	3,910	696	887	21,900	75.4	2.4	12.1	553
Turner Lake														
R21462	TL2 grab	0–5	1.64	2.66	2.84	1.15	2,420	161	607	194	2.0	<0.93	8.6	126
R21463	TL3 grab	0–5	1.47	2.53	2.90	1.22	2,120	148	586	180	2.3	<0.94	8.4	120
R21437	TL3 core	20–25	1.87	2.72	2.70	1.20	2,890	169	564	192	2.4	<0.99	8.6	131
R21444	TL3 core	55–62	1.38	2.34	2.22	1.05	1,830	134	488	358	8.5	1.0	9.7	144
R21472	QA/QC2 SecRef 2		1.87	2.76	2.15	1.12	2,610	147	502	232	4.1	<1.0	9.9	149
	Noncertified value		–36%	–20%	–21%	–24%	–17%	–8%	–17%	–25%				24%
	Certified value		*2.60*	*3.00*	*1.50*	*1.40*	*3200*	*680*	*470*	*100*	<1	*0.4*	*<20*	*398*
R21476	QA/5 (NIST 2709)		1.67	2.41	1.18	1.07	2740	624	392	76	<0.47	<0.93	14.0	320

		Depth interval (cm)	Co ICP (%)	Cr ICP (%)	Cu ICP (%)	Hg ICP (%)	Ni ICP (mg/kg)	Pb ICP (mg/kg)	Se ICP (mg/kg)	Tl ICP (mg/kg)	V ICP (mg/kg)
Lake DePue											
Cross section 2											
R21455	LD5 grab	0–5	8.8	30.5	37.8	0.18	23.3	35	0.8	<1	25.0
R21320	LD5 core	20–25	9.3	33.0	42.6	0.29	24.1	37	0.7	<1	24.3
R21327	LD5 core	55–60	13.9	84.5	82.6	0.44	54.0	96	1.1	<1	28.7
Cross section 3											
R21453	LD4 grab	0–5	11.0	35.6	51.1	0.20	26.8	41	<0.46	<1	28.4
R21332	LD4 core	20–25	12.5	42.5	59.0	0.22	31.8	47	0.6	<1	32.6
Cross section 4											
R21456	LD6 grab	0–5	12.2	33.6	61.8	0.21	27.5	46	0.5	<1	25.6
R21345	LD6 core	20–25	14.4	42.7	72.7	0.22	33.2	50	0.8	<1	33.9
R21353	LD6 core	60–65	12.7	60.6	67.7	0.27	44.2	70	0.7	<1	32.4
Cross section 5											
R21459	LD7 grab	0–5	13.3	36.4	71.7	0.22	29.3	53	0.6	<1	28.0
R21358	LD7 core	20–25	15.4	45.1	120.0	0.22	37.8	61	0.5	<1	31.3
R21368	LD7 core	70–75	14.7	88.1	100.0	0.49	53.6	136	1.7	<1	30.9
Cross section 6 (dredged area)											
R21447	LD1 grab	0–5	14.9	38.2	128	0.29	31.8	75	1.2	<1	31.6
Cross section 7 (dredged area)											
R21450	LD2 grab	0–5	15.0	37.3	197	0.61	30.7	97	1.3	<1	29.1
R21386	LD2 core	20–25	18.9	38.6	207.0	0.76	34.4	104	1.1	<1	27.1
R21395	LD2 core	65–70	12.6	44.8	182.0	0.28	35.4	76	0.7	<1	32.0
Cross section 8											
R21451	LD3 grab	0–5	14.4	35.8	140	0.24	30.0	52	0.8	<1	26.2
R21400	LD3 core	20–25	13.6	56.2	103.0	0.21	40.4	60	0.6	<1	47.0
Ditch Area											
R21460	LD8 grab	0–5	23.3	34.8	838	0.80	36.3	112	1.7	<1	31.2
R21409	LD8 core	20–25	20.6	50.6	764	0.46	40.8	282	1.5	<1	43.7
Turner Lake											
R21462	TL2 grab	0–5	9.5	36.0	41.9	0.17	27.9	37	0.6	<1	30.5
R21463	TL3 grab	0–5	9.3	35.2	41.7	0.18	27.2	38	0.6	<1	28.5
R21437	TL3 core	20–25	9.8	39.6	43.7	0.16	30.0	38	<.050	<1	35.0
R21444	TL3 core	55–62	9.2	60.3	57.3	0.33	35.4	62	<0.46	<1	27.4
R21472	QA/QC2 SecRef 2		10.2	54.2	61.2	0.39	38.0	58	0.5	<1	36.1
	Noncertified value		20%	54%	19%	1.64%	28%	26%			21%
	Certified value		*12*	*79*	*32*	1.40	*78*	*13*	*<0.2*	*<1*	*62*
R21476	QA/5 (NIST 2709)		10.0	51.4	26.9	0.53	60.8	10	1.1	<1	51.1

APPENDIX D

Table D1. Total metal concentrations in sediments from Lake DePue, Turner Lake, and QA/QC samples by various techniques at ISGS.

		Depth (cm)	SiO_2 (XRF) (%)	Al_2O_3 (XRF) (%)	Fe_2O_3 (XRF) (%)	Fe_2O_3 (INAA) (%)	CaO (XRF) (%)	MgO (XRF) (%)	K_2O (XRF) (%)	K_2O (INAA) (%)	Na_2O (XRF) (%)	Na_2O (INAA) (%)	TiO_2 (XRF) (%)	P_2O_5 (XRF) (%)	MnO (INAA) (%)	SO_3 (XRF) (%)
Lake DePue																
Cross section 2																
R21455	LD5 grab	0–5	55.49	11.16	4.64		6.16	3.24	2.49		0.65		0.62	0.33		0.44
R21316	LD5 core	0–5				5.13				2.65		0.71				
R21320	LD5 core	20–25	56.48	10.67	4.48		6.70	3.28	2.45		0.68		0.61	0.36		0.48
R21321	LD5 core	25–30				5.05				2.60		0.73				
R21324	LD5 core	40–45	57.83	12.92	5.15		4.23	2.74	2.76		0.65		0.70	0.34		0.46
R21326	LD5 core	50–55				6.33				3.01		0.59				
R21327	LD5 core	55–60	55.16	13.65	5.87		3.96	2.70	2.81		0.61		0.71	0.75		0.64
Cross section 3																
R21328	LD4 core	0–5				5.68				3.24		0.65				
R21332	LD4 core	20–25	53.78	13.84	5.70		4.88	2.82	2.91		0.53		0.70	0.34		0.56
R21333	LD4 core	25–30				6.19				3.25		0.61				
R21336	LD4 core	40–45	54.89	14.80	6.07		3.41	2.67	3.01		0.51		0.73	0.34		0.48
R21340	LD4 core	60–66				6.69				3.45		0.54				
Cross section 4																
R21456	LD6 grab	0–5	52.79	13.80	5.73		5.14	2.90	2.88		0.55		0.69	0.33		0.53
R21341	LD6 core	0–5				6.29				3.31		0.60				
R21345	LD6 core	20–25	53.07	14.37	5.91		4.65	2.75	2.97		0.54		0.71	0.37		0.62
R21346	LD6 core	25–30				6.41				3.16		0.55			0.14	
R21349	LD6 core	40–45	54.06	15.31	6.31		3.18	2.66	3.06		0.50		0.74	0.33		0.45
R21352	LD6 core	55–60				6.76				3.11		0.52			0.11	
R21353	LD6 core	60–65	54.20	15.52	6.36		2.86	2.53	3.06		0.48		0.75	0.46		0.44
Cross section 5																
R21354	LD7 core	0–5				6.26				3.01		0.51				
R21358	LD7 core	20–25	53.71	14.49	6.01		4.16	2.69	2.93		0.55		0.72	0.44		0.72
R21359	LD7 core	25–30				6.56				3.12		0.51				
R21362	LD7 core	40–45	54.46	15.61	6.36		2.79	2.57	3.07		0.49		0.75	0.34		0.36
R21367	LD7 core	65–70				6.69				3.08		0.48				
R21368	LD7 core	70–75	53.20	14.90	6.45		3.70	2.62	3.06		0.53		0.74	0.65		0.64
Cross section 6 (dredged area)																
R21447	LD1 grab	0–5	51.76	14.92	6.36		4.20	2.85	3.04		0.51		0.70	0.40		0.55
R21369	LD1 core	0–5				5.72				3.02		0.46			0.13	
R21373	LD1 core	20–25				6.89				3.12		0.48			0.15	
R21381	LD1 core	60–64				6.44				3.11		0.49			0.10	
Cross section 7 (dredged area)																
R21450	LD2 grab	0–5	52.60	13.52	5.80		4.99	2.87	2.83		0.62		0.68	0.39		0.86
R21382	LD2 core	0–5				6.09				2.89		0.53			0.13	
R21386	LD2 core	20–25	52.86	14.11	6.01		4.40	2.76	2.93		0.70		0.70	0.42		1.01
R21387	LD2 core	25–30				6.37				3.01		0.51			0.14	
R21390	LD2 core	40–45	53.18	14.58	6.22		3.81	2.75	2.92		0.65		0.72	0.66		0.65
R21394	LD2 core	60–65				6.38				2.99		0.51				
R21395	LD2 core	65–70	53.39	14.77	6.10		2.95	2.43	2.87		0.59		0.74	0.56		0.44
Cross section 8																
R21451	LD3 grab	0–5	53.29	13.35	5.71		5.07	2.90	2.82		0.59		0.69	0.38		0.63
R21400	LD3 core	20–25	55.25	15.01	6.21		3.07	2.57	3.01		0.54		0.75	0.39		0.29
R21401	LD3 core	25–30				6.56				2.98		0.54			0.13	
R21404	LD3 core	40–45	54.05	14.85	6.30		3.41	2.58	3.01		0.58		0.74	0.49		0.55
South Ditch area																
R21460	LD8 grab	0–5	51.22	13.60	6.00		4.36	2.75	2.81		0.75		0.67	0.57		1.02
R21405	LD8 core	0–5				6.26				3.12		0.54				
R21406	LD8 core	5–10														
R21407	LD8 core	10–15														

Table D1 . (cont.)		Depth (cm)	SiO_2 (XRF) (%)	Al_2O_3 (XRF) (%)	Fe_2O_3 (XRF) (%)	Fe_2O_3 (INAA) (%)	CaO (XRF) (%)	MgO (XRF) (%)	K_2O (XRF) (%)	K_2O (INAA) (%)	Na_2O (XRF) (%)	Na_2O (INAA) (%)	TiO_2 (XRF) (%)	P_2O_5 (XRF) (%)	MnO (INAA) (%)	SO_3 (XRF) (%)
R21408	LD8 core	15–20														
R21409	LD8 core	20–25	49.85	12.73	5.98		4.97	2.81	2.59		0.85		0.64	1.19		0.90
R21410	LD8 core	25–30				6.00				2.94		0.61				
R21411	LD8 core	30–35														
R21412	LD8 core	35–40														
R21413	LD8 core	40–45	55.40	15.13	6.14		2.84	2.38	2.90		0.58		0.73	0.77		0.28
R21414	LD8 core	45–50														
R21415	LD8 core	50–55														
R21416	LD8 core	55–60														
R21417	LD8 core	60–65														
R21478	LD8 core	65–70														
R21419	LD8 core	70–75				6.72				3.31		0.55				
R21420	LD8 core	75–79	55.29	13.89	6.20		4.21	2.57	2.90		0.66		0.70	0.60		1.09
Turner Lake																
R21421	TL1 core	0–5				5.73				2.83		0.56			0.12	
R21425	TL1 core	20–25				6.21				2.99		0.60			0.09	
R21430	TL1 core	45–50				6.46				3.02		0.53			0.09	
R21462	TL2 grab	0–5	52.73	13.78	5.82		5.09	2.93	2.94		0.53		0.69	0.31		0.42
R21463	TL3 grab	0–5	53.92	13.34	5.52		5.08	3.03	2.83		0.50		0.68	0.30		0.40
R21437	TL3 core	20–25	54.07	13.78	5.63		4.75	2.94	2.90		0.52		0.70	0.29		0.50
R21438	TL3 core	25–30				5.83				2.59		0.59			0.09	
R21441	TL3 core	40–45	57.26	13.81	5.53		3.55	2.65	2.85		0.59		0.73	0.31		0.35
R21443	TL3 core	50–55				6.16				2.53		0.57			0.09	
R21444	TL3 core	55–62	56.00	13.56	5.57		4.22	2.85	2.95		0.58		0.72	0.42		0.43
Field duplicates																
R21464	Core LD3	0–5				5.93				2.87		0.55			0.12	
R21468	Core LD3	20–25				6.32				2.93		0.51			0.10	
R21469	Core LD3	25–30	54.99	15.12	6.22		3.17	2.59	3.01		0.54		0.74	0.43		0.36
R21470	Core LD3	30–34				6.36				2.88		0.55			0.10	
R21471	Grab LD7	0–5	52.33	14.12	6.01		4.94	2.87	2.96		0.51		0.70	0.36		0.59
Laboratory QA/QC samples																
	Noncertified value		–1.9%	9.8%	2.8%	10.8%	4.4%	7.0%	–1.1%	2.9%	–6.6%	0.0%	–0.1%	12.5%		–5.6%
	Certified value		63.50	14.18	5.01	5.01	2.64	2.50	2.45	2.45	1.56	1.56	0.57	0.14		0.22
	QA/5 (NIST 2709)		62.29	15.56	5.15	5.55	2.76	2.68	2.42	2.52	1.46	1.56	0.57	0.16		0.21

Table D1 . (cont.)		Depth (cm)	Ag (INAA) (mg/kg)	As (INAA) (mg/kg)	Au (INAA) (mg/kg)	Ba (XRF) (mg/kg)	Ba (EDX) (mg/kg)	Ba (INAA) (mg/kg)	Br (INAA) (mg/kg)	Ce (INAA) (mg/kg)	Co (INAA) (mg/kg)	Cr (INAA) (mg/kg)	Cs (INAA) (mg/kg)	Cu (AAS) (mg/kg)	Eu (INAA) (mg/kg)
Lake DePue															
Cross section 2															
R21455	LD5 grab	0–5				400	483							52	
R21316	LD5 core	0–5	<0.4	9.8	<0.02		508	552	8.1	78.1	18.8	98	5.6		1.3
R21320	LD5 core	20–25				407	480							52	
R21321	LD5 core	25–30	<1	10.3	<0.02		502	591	6.7	76.5	18.5	100	5.5		1.0
R21324	LD5 core	40–45				511	567							71	
R21326	LD5 core	50–55	2.2	13.2	0.02		601	704	5.8	87.0	22.5	150	7.0		1.8
R21327	LD5 core	55–60				558	600							105	
Cross section 3															
R21328	LD4 core	0–5	0.9	11.6	0.03		518	600	7.8	68.6	19.1	94	6.2		1.3
R21332	LD4 core	20–25				497	535							73	
R21333	LD4 core	25–30	1.1	13.0	<0.02		555	587	7.4	80.6	22.4	110	7.6		1.4
R21336	LD4 core	40–45				478	564							79	
R21340	LD4 core	60–66	1.5	14.8	<0.02		626	911	10.0	83.2	22.7	130	7.6		1.3
Cross section 4															
R21456	LD6 grab	0–5				434	516							83	
R21341	LD6 core	0–5	1.7	11.3	<0.02		432	670	9.2	77.9	22.1	105	6.8		1.3
R21345	LD6 core	20–25				446	542							88	
R21346	LD6 core	25–30	<0.5	10.0	<0.03		547	596	10.0	81.0	25.3	106	7.9		1.4
R21349	LD6 core	40–45				532	563							86	
R21352	LD6 core	55–60	1.0	9.5	<0.03		592	749	5.5	80.1	22.5	129	7.4		1.5

Table D1 . (cont.)		Depth (cm)	Ag (INAA) (mg/kg)	As (INAA) (mg/kg)	Au (INAA) (mg/kg)	Ba (XRF) (mg/kg)	Ba (EDX) (mg/kg)	Ba (INAA) (mg/kg)	Br (INAA) (mg/kg)	Ce (INAA) (mg/kg)	Co (INAA) (mg/kg)	Cr (INAA) (mg/kg)	Cs (INAA) (mg/kg)	Cu (AAS) (mg/kg)	Eu (INAA) (mg/kg)
R21353	LD6 core	60–65				519	560							85	
Cross section 5															
R21354	LD7 core	0–5	<0.5	12.3	0.02		493	572	7.6	82.6	23.8	115	7.4		1.3
R21358	LD7 core	20–25				516	527							143	
R21359	LD7 core	25–30	1.0	13.9	0.02		538	818	6.3	89.7	24.1	130	7.9		1.4
R21362	LD7 core	40–45				510	562							80	
R21367	LD7 core	65–70	2.0	14.9	0.04		597	783	7.7	91.7	28.2	177	8.1		1.5
R21368	LD7 core	70–75				616	640							128	
Cross section 6 (dredged area)															
R21447	LD1 grab	0–5				481	560							157	
R21369	LD1 core	0–5	0.9	12.8	<0.02		537	563	8.2	72.3	25.0	103	7.1		1.3
R21373	LD1 core	20–25	<1	14.5	0.04		607	640	9.0	85.0	34.8	111	8.6		1.5
R21381	LD1 core	60–64	<1	12.2	0.03		631	728	6.6	78.0	26.3	111	7.6		1.3
Cross section 7 (dredged area)															
R21450	LD2 grab	0–5				451	556							238	
R21382	LD2 core	0–5	1.7	13.0	<0.02		510	714	7.6	81.2	26.0	115	6.9		1.4
R21386	LD2 core	20–25				509	556							266	
R21387	LD2 core	25–30	1.4	13.5	<0.02		572	722	7.7	82.5	33.6	125	7.1		1.2
R21390	LD2 core	40–45				624	642							689	
R21394	LD2 core	60–65	2.1	14.1	0.03		614	1091	7.9	87.1	25.0	145	7.4		1.4
R21395	LD2 core	65–70				580	594							226	
Cross section 8															
R21451	LD3 grab	0–5				486	531							170	
R21400	LD3 core	20–25				518	549							128	
R21401	LD3 core	25–30	1.1	10.2	<0.02		566	693	6.4	85.6	22.2	130	7.1		1.4
R21404	LD3 core	40–45				612	574							143	
South Ditch area															
R21460	LD8 grab	0–5				543	617							969	
R21405	LD8 core	0–5	2.0	13.5	<0.03		701	652	10.0	74.9	37.1	95	6.9	1,560	1.1
R21406	LD8 core	5–10												1,280	
R21407	LD8 core	10–15												1,560	
R21408	LD8 core	15–20												856	
R21409	LD8 core	20–25				954	894							924	
R21410	LD8 core	25–30	3.1	13.1	<0.02		651	934	6.4	68.0	28.0	123	6.4	721	1.3
R21411	LD8 core	30–35												385	
R21412	LD8 core	35–40												520	
R21413	LD8 core	40–45				586	562							126	
R21414	LD8 core	45–50												382	
R21415	LD8 core	50–55												548	
R21416	LD8 core	55–60												373	
R21417	LD8 core	60–65												255	
R21478	LD8 core	65–70												139	
R21419	LD8 core	70–75	6.3	32.0	0.03		611	865	6.7	82.2	31.7	150	7.2	303	1.3
R21420	LD8 core	75–79				696	682							214	
Turner Lake															
R21421	TL1 core	0–5	0.8	10.2	<0.02		486	564	7.7	70.6	15.9	89	6.0		1.3
R21425	TL1 core	20–25	1.3	11.2	<0.02		474	636	7.0	91.0	18.8	116	7.5		1.5
R21430	TL1 core	45–50	1.0	12.2	<0.02		601	658	6.8	80.8	19.3	124	7.2		1.4
R21462	TL2 grab	0–5				469	617							59	
R21463	TL3 grab	0–5				414	523							54	
R21437	TL3 core	20–25				497	539							57	
R21438	TL3 core	25–30	<2	6.0	<0.03		548	594	2.5	80.3	16.7	102	6.5		1.2
R21441	TL3 core	40–45				515	585							64	
R21443	TL3 core	50–55	1.4	12.9	<0.02		616	705	5.7	83.1	17.4	147	6.7		1.2
R21444	TL3 core	55–62				516	601							80	
Field Duplicates															
R21464	Core LD3	0–5	1.2	12.1	<0.02		537	683	6.2	81.3	25.0	105	6.9		1.3
R21468	Core LD3	20–25	1.0	11.2	0.03		587	726	4.9	85.7	22.0	117	7.3		1.7
R21469	Core LD3	25–30				584	590							119	
R21470	Core LD3	30–34	1.3	15.9	0.05		612	710	8.0	70.7	23.3	122	6.9		1.2
R21471	Grab LD7	0–5				447								92	
Laboratory QA/QC Samples															
	Noncertified value			10.2%	–33.3%	–9.7%	–10%	18.4%		26.2%	32.1%	12.3%	22.6%	6.9%	12.2%
	Noncertified value		0.40	17.7	*0.30*	968	968	968		*42.0*	13.4	130	*5.3*	35	*0.9*
R21476	QA/5 (NIST 2709)		<1	19.5	0.20	874	874	1146	10.0	53.0	17.7	146	6.5	37	1.0

Table D1. (cont.)		Depth (cm)	Ga (INAA) (mg/kg)	Hf (INAA) (mg/kg)	Hg (CVAA) (mg/kg)	Hg (INAA) (mg/kg)	La (INAA) (mg/kg)	Lu (INAA) (mg/kg)	Mo (INAA) (mg/kg)	Ni (INAA) (mg/kg)	Ni (AAS) (mg/kg)	Pb (AAS) (mg/kg)	Rb (INAA) (mg/kg)	Sb (INAA) (mg/kg)	Sc (INAA) (mg/kg)
Lake DePue															
Cross section 2															
R21455	LD5 grab	0–5			0.16						28	70			
R21316	LD5 core	0–5	16.4	7.6		<0.5	34.0	0.6	<15	77			117	1.5	12.1
R21320	LD5 core	20–25			0.27						<13	86			
R21321	LD5 core	25–30	17.5	7.7		<0.5	33.2	0.8	<12	57			111	1.7	11.7
R21324	LD5 core	40–45			0.47						22	97			
R21326	LD5 core	50–55	18.9	6.3		<0.5	39.6	0.8	<14	79			144	1.8	14.8
R21327	LD5 core	55–60			0.45						64	164			
Cross section 3															
R21328	LD4 core	0–5	18.9	5.8		<0.5	37.2	0.6	<10	32			138	1.5	12.7
R21332	LD4 core	20–25			0.21						36	45			
R21333	LD4 core	25–30	21.1	5.7		<0.5	40.3	0.5	<15	69			149	1.6	14.3
R21336	LD4 core	40–45			0.28						42	42			
R21340	LD4 core	60–66	22.3	5.2		<0.5	44.0	0.9	<15	97			161	2.0	15.4
Cross section 4															
R21456	LD6 grab	0–5			0.20						42	83			
R21341	LD6 core	0–5	18.4	5.8		<0.5	36.0	0.6	<16	56			156	1.4	14.2
R21345	LD6 core	20–25			0.20						33	84			
R21346	LD6 core	25–30	15.0	5.2		<0.5	35.6	0.9	<19	54			154	1.5	14.8
R21349	LD6 core	40–45			0.27						45	91			
R21352	LD6 core	55–60	16.2	5.3		<0.5	35.8	0.8	<18	72			162	1.7	15.7
R21353	LD6 core	60–65			0.25						49	125			
Cross section 5															
R21354	LD7 core	0–5	18.2	5.3		<0.5	36.8	0.9	<12	51			146	1.3	14.7
R21358	LD7 core	20–25			0.23						45	120			
R21359	LD7 core	25–30	20.6	5.3		<0.5	40.6	0.8	9	54			150	1.6	16.2
R21362	LD7 core	40–45			0.21						42	94			
R21367	LD7 core	65–70	21.2	4.5		<0.5	41.6	0.8	<10	81			147	2.3	16.2
R21368	LD7 core	70–75			0.54						62	216			
Cross section 6 (dredged area)															
R21447	LD1 grab	0–5			0.30						35	131			
R21369	LD1 core	0–5	19.1	4.7		<0.8	36.4	0.7	<20	48			134	1.4	13.6
R21373	LD1 core	20–25	19.0	5.3		<0.3	37.9	0.7	12	68			155	1.4	16.2
R21381	LD1 core	60–64	19.3	4.8		<0.7	40.3	0.6	<17	65			140	1.3	14.9
Cross section 7 (dredged area)															
R21450	LD2 grab	0–5			0.60						37	154			
R21382	LD2 core	0–5	17.1	5.4		0.5	35.3	0.9	<10	101			147	2.1	14.3
R21386	LD2 core	20–25			0.85						36	181			
R21387	LD2 core	25–30	19.5	5.3		1.1	38.5	0.9	<15	56			139	1.6	14.8
R21390	LD2 core	40–45			0.39						41	164			
R21394	LD2 core	60–65	18.0	5.4		<0.5	40.4	1.1	<12	67			153	1.7	15.3
R21395	LD2 core	65–70			0.31						45	118			
Cross section 8															
R21451	LD3 grab	0–5			0.23						31	85			
R21400	LD3 core	20–25			0.21						43	104			
R21401	LD3 core	25–30	19.6	5.8		<0.5	40.7	0.8	<15	90			156	1.9	14.8
R21404	LD3 core	40–45			0.42						58	215			
South Ditch area		0–5													
R21460	LD8 grab				0.89						45	156			
R21405	LD8 core	0–5	21.1	5.4		0.9	36.8	2.0	<17	66	48	154	143	1.7	13.2
R21406	LD8 core	5–10									49	123			
R21407	LD8 core	10–15									55	186			
R21408	LD8 core	15–20									46	192			
R21409	LD8 core	20–25			0.51						47	396			
R21410	LD8 core	25–30	19.0	5.9		<0.5	36.4	0.8	<18	51	47	230	147	2.0	12.6
R21411	LD8 core	30–35									46	215			
R21412	LD8 core	35–40									32	474			
R21413	LD8 core	40–45			0.25						46	120			
R21414	LD8 core	45–50									52	238			
R21415	LD8 core	50–55									53	321			
R21416	LD8 core	55–60									54	359			
R21417	LD8 core	60–65									73	412			
R21478	LD8 core	65–70									58	211			
R21419	LD8 core	70–75	19.8	5.0		1.6	40.0	1.1	<20	68	68	415	166	3.0	14.6
R21420	LD8 core	75–79			0.78						55	397			
Turner Lake															
R21421	TL1 core	0–5	15.9	6.4		<0.5	36.0	0.5	<11	46			125	1.1	12.7

Table D1 . (cont.)		Depth (cm)	Ga (INAA) (mg/kg)	Hf (INAA) (mg/kg)	Hg (CVAA) (mg/kg)	Hg (INAA) (mg/kg)	La (INAA) (mg/kg)	Lu (INAA) (mg/kg)	Mo (INAA) (mg/kg)	Ni (INAA) (mg/kg)	Ni (AAS) (mg/kg)	Pb (AAS) (mg/kg)	Rb (INAA) (mg/kg)	Sb (INAA) (mg/kg)	Sc (INAA) (mg/kg)
R21425	TL1 core	20–25	18.2	6.7		<0.3	38.5	0.7	<13	60			133	1.6	15.1
R21430	TL1 core	45–50	19.3	5.6		<0.9	40.8	0.6	<19	69			146	1.8	14.5
R21462	TL2 grab	0–5			0.19						32	68			
R21463	TL3 grab	0–5			0.20						36	58			
R21437	TL3 core	20–25			0.15						38	62			
R21438	TL3 core	25–30	11.4	6.1		<0.5	30.6	0.6	<20	83			151	1.3	13.5
R21441	TL3 core	40–45			0.19						41	73			
R21443	TL3 core	50–55	10.3	5.8		<0.5	42.0	0.7	<25	68			149	2.4	14.2
R21444	TL3 core	55–62			0.32						52	118			
Field Duplicates															
R21464	Core LD3	0–5	17.5	5.8		<0.5	36.8	0.7	<19	56			137	1.3	14.0
R21468	Core LD3	20–25	19.1	5.6		<0.3	38.6	0.6	<13	65			140	1.5	15.1
R21469	Core LD3	25–30									55	91			
R21470	Core LD3	30–34	18.2	5.7		<0.7	39.7	0.7	15	39		84	138	1.8	14.3
R21471	Grab LD7	0–5									48				
Laboratory QA/QC samples															
	Noncertified value		57.1%	32.4%		7.1%	–0.9%			8.0%	–14.8%		14.6%	20.3%	8.3%
	Certified value		*14*	*3.7*	1.40	1.4	*23*		*2*	88	88	18.9	*96*	7.9	*12*
R21476	QA/5 (NIST 2709)		22.0	4.9		1.5	22.8	0.5	<20	95	75	<50	110	9.5	13.0

Table D1 . (cont.)		Depth (cm)	Se (INAA) (mg/kg)	Sm (INAA) (mg/kg)	Sn (EDX) (mg/kg)	Sr (EDX) (mg/kg)	Sr (XRF) (mg/kg)	Ta (INAA) (mg/kg)	Tb (INAA) (mg/kg)	Th (INAA) (mg/kg)	U (INAA) (mg/kg)	W (INAA) (mg/kg)	Yb (INAA) (mg/kg)	Zr (EDX) (mg/kg)	Zr (XRF) (mg/kg)
Lake DePue															
Cross section 2															
R21455	LD5 grab	0–5			7	126	134							266	162
R21316	LD5 core	0–5	1.2	6.5	6	122		0.9	0.8	10.1	6.0	1.2	2.7	266	
R21320	LD5 core	20–25			7	134	145							286	177
R21321	LD5 core	25–30	1.3	6.5	7	134		0.9	0.7	10.1	3.4	1.4	2.6	277	
R21324	LD5 core	40–45			7	121	134							252	147
R21326	LD5 core	50–55	<0.5	7.2	9	120		1.0	0.8	11.8	4.0	1.3	2.8	225	
R21327	LD5 core	55–60			12	124	128							219	122
Cross section 3															
R21328	LD4 core	0–5	1.5	7.0	8	122		0.8	0.7	10.4	6.5	1.2	3.6	215	
R21332	LD4 core	20–25			8	122	132							208	112
R21333	LD4 core	25–30	1.4	7.0	9	118		1.1	0.8	11.4	5.5	2.3	2.2	200	
R21336	LD4 core	40–45			9	107	123							206	113
R21340	LD4 core	60–66	0.5	8.2	9	115		1.0	0.8	12.1	6.6	2.5	4.4	181	
Cross section 4															
R21456	LD6 grab	0–5			5	124	130							205	102
R21341	LD6 core	0–5	0.9	7.8	18	117		0.9	0.7	11.0	5.7	2.5	4.0	174	
R21345	LD6 core	20–25			9	115	129							191	93
R21346	LD6 core	25–30	<0.5	7.0	9	116		1.0	0.8	11.6	<3	1.7	2.5	189	
R21349	LD6 core	40–45			9	105	115							349	101
R21352	LD6 core	55–60	2.4	6.8	10	109		1.0	0.8	12.4	<3	<1	2.4	189	
R21353	LD6 core	60–65			9	109	123							186	90
Cross section 5															
R21354	LD7 core	0–5	<0.5	6.7	8	115		1.0	0.8	11.2	4.2	1.5	2.6	190	
R21358	LD7 core	20–25			9	116	121							198	101
R21359	LD7 core	25–30	<0.5	7.4	9	108		0.9	0.8	12.6	5.0	1.8	2.7	205	
R21362	LD7 core	40–45			7	109	118							189	100
R21367	LD7 core	65–70	1.6	7.6	11	113		1.1	0.9	12.0	5.4	1.7	2.6	187	
R21368	LD7 core	70–75			13	116	123							179	92
Cross section 6 (dredged area)															
R21447	LD1 grab	0–5			8	110	122							173	87
R21369	LD1 core	0–5	<0.5	6.6	9	110		0.8	0.7	10.0	<3	2.4	2.3	183	
R21373	LD1 core	20–25	3.0	8.2	7	105		1.0	0.7	12.0	7.0	1.3	2.4	173	
R21381	LD1 core	60–64	1.3	9.2	9	104		0.9	0.8	11.4	7.0	1.9	2.5	183	
Cross section 7 (dredged area)															
R21450	LD2 grab	0–5			8	116	124							200	104
R21382	LD2 core	0–5	1.4	6.3	9	117		1.0	0.6	10.9	<5	1.8	2.7	196	
R21386	LD2 core	20–25			8	110	122							182	92
R21387	LD2 core	25–30	6.2	7.0	9	112		1.1	0.7	11.7	<2	1.9	2.7	193	
R21390	LD2 core	40–45			10	120	127							184	92

Table D1 . (cont.)		Depth (cm)	Se (INAA) (mg/kg)	Sm (INAA) (mg/kg)	Sn (EDX) (mg/kg)	Sr (EDX) (mg/kg)	Sr (XRF) (mg/kg)	Ta (INAA) (mg/kg)	Tb (INAA) (mg/kg)	Th (INAA) (mg/kg)	U (INAA) (mg/kg)	W (INAA) (mg/kg)	Yb (INAA) (mg/kg)	Zr (EDX) (mg/kg)	Zr (XRF) (mg/kg)
R21394	LD2 core	60–65	1.7	7.5	9	116		0.9	0.7	12.1	5.4	2.0	2.5	184	
R21395	LD2 core	65–70			7	111	123							196	107
Cross section 8															
R21451	LD3 grab	0–5			7	120	125							212	118
R21400	LD3 core	20–25			8	107	112							194	100
R21401	LD3 core	25–30	1.0	7.6	9	114		0.9	0.9	11.7	4.0	1.9	3.8	200	
R21404	LD3 core	40–45			12	112	114							189	99
South Ditch Area															
R21460	LD8 grab	0–5			7	107	112							194	96
R21405	LD8 core	0–5	1.1	6.8	9	112		0.9	0.6	10.3	5.0	<1	2.4	211	
R21406	LD8 core	5–10													
R21407	LD8 core	10–15													
R21408	LD8 core	15–20													
R21409	LD8 core	20–25			15	120	124							196	94
R21410	LD8 core	25–30	2.6	7.6	13	121		0.9	0.7	10.4	9.3	2.6	3.3	206	
R21411	LD8 core	30–35													
R21412	LD8 core	35–40													
R21413	LD8 core	40–45			8	126	129							192	99
R21414	LD8 core	45–50													
R21415	LD8 core	50–55													
R21416	LD8 core	55–60													
R21417	LD8 core	60–65													
R21478	LD8 core	65–70													
R21419	LD8 core	70–75	6.5	8.6	17	116		1.0	0.6	11.5	9.0	2.5	2.5	187	
R21420	LD8 core	75–79			15	115	129							193	93
Turner Lake															
R21421	TL1 core	0–5	1.7	6.7	6	113		0.9	0.7	10.3	3.2	1.6	2.7	237	
R21425	TL1 core	20–25	1.5	7.3	6	104		1.0	0.8	12.0	3.4	2.8	2.8	247	
R21430	TL1 core	45–50	2.4	7.5	7	103		1.0	0.8	11.9	2.4	2.2	3.6	216	
R21462	TL2 grab	0–5			5	114	128							210	115
R21463	TL3 grab	0–5			6	112	123							213	120
R21437	TL3 core	20–25			6	106	120							218	114
R21438	TL3 core	25–30	1.0	5.5	7	108		0.8	0.7	11.2	<6	<1	2.7	229	
R21441	TL3 core	40–45			7	111	122							235	131
R21443	TL3 core	50–55	0.4	7.9	9	113		1.1	0.9	11.6	<5	2.8	2.4	213	
R21444	TL3 core	55–62			10	114	113							224	119
Field duplicates															
R21464	Core LD3	0–5	0.5	6.8	6	115		0.9	0.7	10.8	<2	1.0	2.8	211	
R21468	Core LD3	20–25	1.0	7.2	8	107		0.9	0.7	12.0	2.8	1.6	2.8	207	
R21469	Core LD3	25–30			8	110	117							200	103
R21470	Core LD3	30–34	2.0	7.4	7	105		1.0	0.8	11.9	3.4	3.0	2.8	207	
R21471	grab LD7	0–5					123							205	102
Laboratory QA/QC samples															
	Noncertified value		1.9%	13.2%		0.4%	0.4%		11.1%	2.7%		20.0%	12.5%	6.9%	–45.0%
	Certified value		1.57	*3.8*	*<5*	231	231		*0.9*	*11*	3	*2*	*1.6*	*160*	*160*
R21476	QA/5 (NIST 2709)		1.6	4.3		232	232	0.8	1.0	11.3	<4	2.4	1.8	171	88

APPENDIX E

Table E1. Updated concentrations of inorganic elements in sediments from Lake DePue in 1975, 1978, and 1982 (Cahill and Steele, 1986).

	Analysis	Depth	R12433	R12434	R12435	R12436	R12437	R14164	R14165	R14166	R14167	R14168
		(cm)	00–08	08–15	15–23	23–30	30–38	00–05	05–15	30–35	60–65	100–105
			1975	1975	1975	1975	1975	1978	1978	1978	1978	1978
Total carbon		%	5.08	4.35	4.54	4.14	3.95	3.27	3.47	3.74	3.69	3.27
Inorganic carbon		%	0.76	0.99	0.82	0.68	0.45	0.86	0.62	0.81	0.87	0.60
Organic carbon		%	4.32	3.36	3.72	3.46	3.50	2.41	2.85	2.93	2.82	2.67
Sodium oxide	XRF	%	0.50	0.50	0.50	0.57	0.57					
Sodium oxide	INAA	%						0.51	0.51	0.53	0.50	0.50
Magnesium oxide	XRF	%	2.71	2.56	2.65	2.47	2.29	2.27	2.37	2.37	2.52	2.16
Aluminum oxide	XRF	%	16.03	14.73	15.66	15.84	16.32	13.93	13.55	13.36	14.08	14.19
Silicon dioxide	XRF	%	59.69	57.29	60.10	61.00	61.98	56.63	57.29	55.92	56.95	56.95
Phosporus pentoxide	XRF	%	0.90	1.10	0.82	0.55	0.37	0.80	0.64	0.89	0.69	0.39
Sulfur oxide	XRF	%	0.50	0.48	0.53	0.50	0.18	0.10	0.07	0.23	0.18	0.20
Potassium oxide	XRF	%	2.73	2.66	2.75	2.85	2.94	2.75	2.61	2.60	2.65	2.73
Potassium oxide	INAA	%						2.65	2.65	2.53	2.41	2.53
Calcium oxide	XRF	%	3.38	3.66	3.93	3.86	2.56	3.79	3.05	3.51	4.06	3.05
Titanium dioxide	XRF	%	0.84	0.80	0.83	0.78	0.82	0.77	0.78	0.73	0.75	0.78
Manganous oxide	XRF	%	0.10	0.10	0.10	0.11	0.09					
Maganous oxide	INAA	%						0.15	0.09	0.11	0.09	0.07
Ferric oxide	XRF	%	6.56	6.35	6.56	6.41	6.31	5.69	5.65	5.73	5.75	5.70
Ferric oxide	INAA	%						5.43	5.56	5.43	5.15	5.01
Zinc	XRF	mg/kg										
Zinc	AA	mg/kg						1,660	1,120	2,640	1,200	870
Zinc	OEP	mg/kg	5,000	5,000	4,100	3,400	348					
Zinc	INAA	mg/kg						2,250	1,510	3,411	1,500	1,080
Cadmium	OED	mg/kg	52	34	104	116	5.5					
Cadmium	XRF	mg/kg										
Cadmium	AA	mg/kg						10	6	24	30	14
Antimony	INAA	mg/kg	3.9	2.7	3.3	2.8	2.1	2.4	2.1	2.4	2.8	2.3
Arsenic	INAA	mg/kg	19	14	16	20	12	12	14	14	16	14
Barium	OEP	mg/kg	54	53	48	55	55					
Barium	XRF	mg/kg										
Barium	EDX	mg/kg										
Boron	INAA	mg/kg	730	690	790	800	690	600	700	650	700	600
Beryllium	OEP	mg/kg	3.4	3.8	3.3	3.7	3.0					
Bromine	INAA	mg/kg	5.9	8.1	6.8	5.7	6.0	7.6	5.5	6.0	4.1	4.3
Cesium	INAA	mg/kg	9.8	10.0	11.0	10.0	11.0	8.0	8.0	7.0	7.5	7.3
Cerium	INAA	mg/kg	84	91	95	96	99	73	75	72	72	70
Chlorine	XRF	mg/kg	157	229	143	77	108	260	240	179	155	220
Chromium	XRF	mg/kg										
Chromium	INAA	mg/kg	170	180	210	170	130	200	183	217	208	160
Cobalt	INAA	mg/kg	18	18	13	12	9.3	19.0	19.0	22.0	16.0	15.0
Copper	XRF	mg/kg										
Copper	AA	mg/kg	128	119	130	107	47	79	63	90	81	63
Europium	INAA	mg/kg	1.8	1.7	1.7	1.7	1.8	1.4	1.4	1.4	1.4	1.3
Gallium	INAA	mg/kg	20.0	19.0	19.0	22.0	20.0	18.0	19.0	19.0	17.0	17.0
Hafnium	INAA	mg/kg	6.6	7.3	7.7	7.8	8.2	6.0	6.0	6.0	6.0	5.5
Mercury	AA	mg/kg	0.60	0.52	0.76	0.73	0.31	0.33	0.31	0.40	0.47	0.20
Lanthanum	INAA	mg/kg	60	55	55	59	59	44.0	46.0	45.0	46.0	42.0
Lead	XRF	mg/kg										
Lead	AA	mg/kg						78	74	93	98	93
Lead	OEP	mg/kg	141	119	183	211	42					

Table E1. (cont.)	Analysis	Depth	R12433	R12434	R12435	R12436	R12437	R14164	R14165	R14166	R14167	R14168
		(cm)	00–08	08–15	15–23	23–30	30–38	00–05	05–15	30–35	60–65	100–105
		collection	1975	1975	1975	1975	1975	1978	1978	1978	1978	1978
Lithium	AA	mg/kg										
Lutetium	INAA	mg/kg						0.7	0.8	0.7	0.7	0.6
Molybdenum	OEP	mg/kg	4.8	7.5	5.2	6.9	4.3					
Molybdenum	EDX	mg/kg										
Nickel	XRF	mg/kg										
Nickel	AA	mg/kg										
Nickel	OEP	mg/kg	61	53	61	44	38	46	41	54	47	<32
Nickel	INAA	mg/kg										
Niobium	XRF	mg/kg										
Rubidium	XRF	mg/kg										
Rubidium	INAA	mg/kg	200	210	220	220	240	192	200	180	160	200
Samarium	INAA	mg/kg	7.6	7.4	8.4	9.0	9.0	7.5	7.6	7.6	7.8	6.9
Scandium	INAA	mg/kg	16	17	17	17	18	17	18	17	16	17
Silver	OEP	mg/kg										
Silver	INAA	mg/kg						2.8	2.3	<1	3.0	2.0
Strontium	XRF	mg/kg										
Strontium	XES	mg/kg										
Tantalum	INAA	mg/kg	0.67	0.72	0.67	0.73	0.80	1.10	1.00	1.10	1.00	1.10
Terbium	INAA	mg/kg	2.1	1.8	2.3	2.5	2.5	1.1	1.1	1.1	1.1	1.1
Thorium	INAA	mg/kg	15.0	16.0	16.0	16.0	17.0	12.0	13.0	12.0	12.0	12.0
Tin	XRF	mg/kg										
Tin	XES	mg/kg										
Tungsten	INAA	mg/kg						2.7		1.5		1.8
Uranium	INAA	mg/kg						<2	<2	<2	<2	<2
Vanadium	XRF	mg/kg	102	142	98	137	103					
Ytterbium	INAA	mg/kg	2.0	3.0	3.0	3.0	2.0	4.2	3.8	3.8	3.6	3.4
Zirconium	XRF	mg/kg										
Zirconium	XES	mg/kg										

Table E1. (cont.)								**(New Data)**				
	Analysis		R15037	R15038	R15039	R20807	R20808	R20809	R20810	15031	15032	15033
		Depth	0–5	5–10	20–27	Ponar	20–25	60–65	110–115	00–05	07–22	30–45
		(cm)	1982	1982	1982	1982	1982	1982	1982	1982	1982	1982
Total carbon		%	3.96	4.08	4.20	4.10	4.11	4.22	4.20	3.96	3.87	3.92
Inorganic carbon		%	0.57	0.48	0.77	0.60	0.52	0.75	0.62	1.05	0.85	0.69
Organic carbon		%	3.39	3.60	3.43	3.50	3.59	3.47	3.58	2.91	3.02	3.23
Sodium oxide	XRF	%				0.47	0.48	0.52	0.49			
Sodium oxide	INAA	%	0.51	0.46	0.54	0.47	0.43	0.49	0.45	0.65	0.54	0.56
Magnesium oxide	XRF	%	2.34	2.34	2.44	2.43	2.46	2.62	2.39	2.74	2.52	2.35
Aluminum oxide	XRF	%	16.2	17.1	15.9	15.27	15.76	14.89	15.43	57.2	57.5	58.4
Silicon dioxide	XRF	%	56.5	55.9	56.9	54.93	54.67	53.94	54.30	14.30	15.30	16.30
Phosporus pentoxide	XRF	%	0.53	0.31	0.42	0.47	0.37	0.76	0.39	0.34	0.36	0.37
Sulfur	XRF	%				0.36	0.39	0.57	0.53			
Potassium oxide	XRF	%	3.15	3.25	3.12	3.02	3.13	3.02	3.15	2.95	3.06	3.14
Potassium oxide	INAA	%	3.74	3.78	3.42	3.02	3.10	2.94	2.99	3.40	3.37	3.46
Calcium oxide	XRF	%	2.9	2.7	3.3	2.84	2.61	3.35	2.97	4.1	3.6	3
Titanium dioxide	XRF	%	0.79	0.79	0.79	0.74	0.76	0.73	0.77	0.75	0.77	0.78
Manganous oxide	XRF	%				0.10	0.09	0.12	0.09			
Manganous oxide	INAA	%	0.10	0.08	0.08	0.11	0.10	0.12	0.09	0.08	0.08	0.07
Ferric oxide	XRF	%	5.90	6.20	5.70	6.33	6.43	6.34	6.47	5.20	5.50	5.70
Ferric oxide	INAA	%				6.46	6.54	6.43	6.34	5.46	5.03	5.58
Zinc	XRF	mg/kg				2,212	3,289	3,513	1,737			
Zinc	AA	mg/kg	2,090	391	1,120	2,080	4,000	3,310	1,650	241	275	332
Zinc	OEP	mg/kg										

Table E1. (cont.)

Analysis			R15037	R15038	R15039	R20807	R20808	R20809	R20810	15031	15032	15033
						(New Data)						
		Depth (cm)	0–5	5–10	20–27	Ponar	20–25	60–65	110–115	00–05	07–22	30–45
		collection	1982	1982	1982	1982	1982	1982	1982	1982	1982	1982
Zinc	INAA	mg/kg	2,130	395	966	2,700	3,811	4,028	1,927	244	255	325
Cadmium	OED	mg/kg										
Cadmium	XRF	mg/kg				10	7	25	31			
Cadmium	AA	mg/kg	12.6	1.8	6.0	11	10	22	29	1.6	2.5	4.3
Antimony	INAA	mg/kg	2.2	1.2	1.2	1.5	1.5	203.0	3.1	1.50	1.40	1.70
Arsenic	INAA	mg/kg	13.6	12.7	11.1	12.7	10.5	12.4	16.9	10.6	11.2	10.6
Boron	OEP	mg/kg										
Barium	XRF	mg/kg				521	549	571	748			
Barium	EDX	mg/kg	666	644	641	641	582	525	856	608	637	658
Barium	INAA	mg/kg	853	525	442	658	628	743	919	480	430	470
Beryllium	OEP	mg/kg	4.0	4.2	3.0					4.5	4.3	2.6
Bromine	INAA	mg/kg	6.6	10.8	8.2	6.4	7.2	4.3	5	6.5	5.0	5.8
Cesium	INAA	mg/kg	12.0	8.4	6.0	7.9	7.7	8.0	7.5	6.0	6.0	8.4
Cerium	INAA	mg/kg	106	71	61	82	85	64	64	54	48	54
Chlorine	XRF	mg/kg				236	284	247	218			
Chromium	XRF	mg/kg				117	108	146	164			
Chromium	INAA	mg/kg	192	98	98	131	106	155	162	112	110	135
Cobalt	INAA	mg/kg	28.0	14.0	14.0	18.7	19.6	22.8	16.1	15.0	14.0	16.0
Copper	XRF	mg/kg				85	88	110	117			
Copper	AA	mg/kg	87	57	81	65	65	140	92			
Europium	INAA	mg/kg	1.4	1.3	1.3	1.4	1.4	1.3	1.5	1.3	1.3	1.4
Gallium	INAA	mg/kg	19.0	20.0	16.0	18.3	18.8	16.4	19.6	16.0	18.0	18.0
Hafnium	INAA	mg/kg	8.3	5.2	5.3	5.0	4.8	5.1	4.9	6.6	5.6	6.0
Mercury	AA	mg/kg	0.28	0.13	0.22					0.21	0.22	0.27
Lanthanum	INAA	mg/kg	43.0	44.0	40.0	38.2	37.5	38.6	38.9	40.0	41.0	42.0
Lead	XRF	mg/kg				92	76	123	295			
Lead	AA	mg/kg	86	53	65	56	84	99	240	60	65	80
Lead	OEP	mg/kg	130	38	37					47	60	60
Lithium	AA	mg/kg				32	39	37	39			
Lutetium	INAA	mg/kg	0.80	0.47	0.38	0.7	0.7	0.7	0.7	0.50	0.44	0.50
Molybdenum	OEP	mg/kg										
Molybdenum	EDX	mg/kg				11	8	8	12			
Nickel	XRF	mg/kg				58	58	64	51			
Nickel	AA	mg/kg	47	35	38	46	38	42	25			
Nickel	OEP	mg/kg										
Nickel	INAA	mg/kg				24	48	95	78	30	40	41
Niobium	XRF	mg/kg				15	15	15	16			
Rubidium	XRF	mg/kg				154	161	150	158			
Rubidium	INAA	mg/kg	211	151	111	136	157	146	158	136	136	147
Samarium	INAA	mg/kg	7.3	7.2	6.7	6.7	6.8	6.5	7.2	6.9	6.7	7.1
Scandium	INAA	mg/kg	20.0	14.0	11.0	14.9	15.7	14.8	14.9	13.0	12.0	13.0
Silver	OEP	mg/kg	1.9	0.3	1.0					0.8	0.7	0.5
Silver	INAA	mg/kg				2.0	<0.6	<2	<2			
Strontium	XRF	mg/kg				120	118	126	120			
Strontium	XES	mg/kg	85	78	91	102	101	119	102	89	87	87
Tantalum	INAA	mg/kg	1.7	1.0	1.0	0.80	1.1	1.2	1.1	1.0	0.9	1.0
Terbium	INAA	mg/kg	1.1	1.1	0.9	0.50	1.5	0.7	1.1	0.8	0.7	1.0
Thorium	INAA	mg/kg	16.0	11.0	9.0	12.0	12.2	11.8	11.6	7.5	7.1	9.2
Tin	XRF	mg/kg				10	12	13	17			
Tin	XES	mg/kg	<5	<5	6	7	7	9	12	<5	<5	<5
Tungsten	INAA	mg/kg				1.8	2.4	<1	1.5			
Uranium	INAA	mg/kg				3.9	<2	<2	7			
Vanadium	XRF	mg/kg				121	123	116	125			
Ytterbium	INAA	mg/kg	4.0	2.7	2.3	3.5	1.9	3.2	2.2	3.0	2.8	2.6
Zirconium	XRF	mg/kg				100	93	103	99			
Zirconium	XES	mg/kg	142	145	171	192	180	185	191	196	180	169

APPENDIX F

Table F1. Mineralogical composition of sediments from Lake DePue and Turner Lake determined by XRD.

Analytical number	Core ID	Depth interval (cm)	Expandables: Smectite (%)	Expandables: Illite (%)	Kaolinite-chlorite (% K+C)	Total clay (%)	Quartz (%)	Potassium-feldspar (%)	Plagioclase (%)	Calcite (%)	Dolomite (%)	Total non-clay (%)
Cross section 2												
R21455	LD5C	0–5	8.7	28.5	13.6	50.8	32.9	2.2	4.1	4.6	5.3	49
R21320	LD5	20–25	8.1	24.1	11.1	43.2	36.1	3.1	5.6	5.7	6.3	57
R21324	LD5	40–45	11.5	22.5	10.9	44.9	40.6	2.1	4.6	3.8	4.2	55
R21327	LD5	55–60	17.3	27.5	9.7	54.5	33.5	1.8	3.1	3.5	3.5	45
Cross section 3												
R21332	LD4	20–25	15.5	29.4	11.8	56.7	28.1	2.5	4.2	4.8	3.4	43
R21336	LD4	40–45	27.5	22.6	12.8	62.9	27.4	1.4	2.7	2.8	2.9	37
Cross section 4												
R21456	LD6C	0–5	9.9	30.6	16.0	56.5	28.9	2.0	3.7	5.2	3.8	44
R21345	LD6	20–25	23.3	26.7	12.4	62.4	25.1	2.2	3.1	4.2	3.0	38
R21349	LD6	40–45	24.4	21.1	10.4	55.9	31.2	3.3	4.0	2.8	2.7	44
R21353	LD6	60–66	21.8	25.1	8.1	55.0	32.4	3.8	3.5	2.9	2.3	45
Cross section 5												
R21471	LD7C	0–5	14.6	20.7	10.3	45.6	37.1	3.3	3.9	5.8	4.2	54
R21358	LD7	20–25	22.6	24.2	12.4	59.2	28.7	1.8	3.5	3.9	2.9	41
R21362	LD7	40–45	29.8	27.6	10.1	67.4	23.2	2.0	2.6	2.5	2.3	33
R21368	LD7	70–75	19.6	28.2	11.2	59.0	29.7	2.3	2.3	4.0	2.8	41
Cross section 6 (dredged area)												
R21447	LD1C	0–5	26.2	27.0	14.2	67.4	23.0	1.1	2.2	3.5	2.8	33
Cross section 7 dredged area												
R21450	LD2C	0–5	21.3	28.1	12.3	61.7	25.9	1.7	2.7	4.4	3.5	38
R21386	LD2	20–25	18.1	25.5	13.7	57.3	29.8	1.5	3.7	4.3	3.4	43
R21390	LD2	40–45	11.7	30.3	13.9	55.9	31.7	2.3	3.2	3.6	3.3	44
R21395	LD2	65–70	25.2	19.1	10.0	54.3	34.6	2.3	3.6	2.9	2.4	46
Cross section 8												
R21451	LD3C	0–5	20.5	25.3	10.7	56.5	29.7	2.6	3.1	4.5	3.7	43
R21400	LD3	20–25	11.0	21.7	17.4	50.0	37.3	2.7	4.0	3.1	2.8	50
R21469	LD3	25–30	32.4	18.8	10.4	61.6	28.4	1.7	2.8	2.9	2.7	38
R21404	LD3	40–45	20.0	27.2	11.2	58.4	30.6	2.2	2.9	3.2	2.7	42
Ditch Area												
R21460	LD8C	0–5	12.2	28.3	16.2	56.8	28.7	2.5	4.7	3.9	3.4	43
R21409	LD8	20–25	20.6	24.9	12.7	58.2	27.6	1.9	4.4	4.3	3.8	42
R21413	LD8	40–45	16.9	27.8	13.8	58.5	30.9	1.7	4.2	2.5	2.2	42
R21420	LD8	75–79	11.4	31.8	14.7	57.9	30.3	2.7	2.4	3.8	3.0	42
Turner Lake												
R21462	TL1C	0–5	11.1	29.8	13.9	54.9	29.8	3.4	3.3	4.9	3.8	45.1
R21463	TL3C	0–5	17.9	22.6	12.5	53.0	31.7	2.8	3.3	4.8	4.3	46.9
R21437	TL3	20–25	20.3	28.4	10.1	58.7	28.6	2.2	2.7	4.0	3.7	41.2
R21441	TL3	40–45	25.0	21.3	9.6	55.9	32.0	2.4	4.0	2.6	3.2	44.1
R21444	TL3	55–62	20.0	26.4	11.7	58.2	29.8	2.0	3.2	3.2	3.5	41.8
QA/QC												
R21476	NIST	2,709	39.7	2.4	4.4	46.5	29.4	7.2	11.7	3.5	1.6	53.5

APPENDIX G

Table G1. Water quality results from Lake DePue and Turner Lake. All values are in milligrams per liter unless noted.

	Lake DePue								Turner Lake			Lake DePue
Lab number:	W03668	W03670	W03675	W03676	W03673	W03674	W03671	W03672	W03677	W03678	W03679	W03669
Sample type:	Surface	Surface	Surface	Bottom	Surface	Bottom	Surface	Surface	Surface	Surface	Surface	Field duplicate
Cross section number:	2	6	6	6	7	7	South Ditch	8	Downstream	Center	Upstream	4
Total dissolved carbon	62.8	59.6	63.0	62.3	65.0	63.7	65.8	86.9	53.3	53.6	56.7	70.5
Inorganic dissolved carbon	36.6	37.3	39.5	39.2	40.8	40.8	41.5	57.3	30.9	30.8	32.5	47.5
Dissolved organic carbon	26.2	22.3	23.5	23.1	24.2	22.9	24.3	29.6	22.4	22.8	24.2	23.0
Total nitrogen	1.54	3.36	3.46	3.38	3.37	3.43	3.99	2.26	1.62	1.72	1.54	3.18
Total kjeldahl nitrogen	0.61	1.62	1.85	1.77	1.77	1.88	2.37	1.20	0.73	<0.1	<0.1	1.45
Ammonia nitrogen	0.40	1.19	1.51	1.59	1.44	1.42	2.02	.78	0.53	0.69	0.34	1.21
Nitrite nitrogen	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrate nitrogen	0.9	1.7	1.6	1.6	1.6	1.6	1.6	1.1	0.89	<0.8	<0.8	1.73
Ortho phosphorus	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
Total phosphorus	0.24	0.20	0.24	0.20	0.25	0.27	0.24	0.20	0.30	0.34	0.39	0.20
Sulfate	34.0	67.0	70.3	71.5	75.7	79.1	98.1	122.6	30.4	34.3	34.4	66.3
Fluoride	0.36	0.44	0.38	0.4	0.45	0.39	0.52	0.47	0.41	0.39	0.4	0.42
Chloride	38.3	44.1	43.4	44	43.2	43.1	44	41.4	30.8	36.8	35.7	43.6
Bromide	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
Total alkalinity	204	216	233	228	233	238	243	334	173	178	188	214
Hardness by calculation	240	284	294	292	303	306	321	446	206	218	232	285
Specific conductivity	535	642	676	676	697	700	703	899	444	483	491	
Conductivity (uS)	555	670	696		720		760	865	463	498	595	
Acidity/alkalinity	7.3	7.6	8.1		7.9		7.1	6.9	8.8	8.6	8.3	
Temperature (C)	28.7	29.1	28.5		27.8		27.1	25.9	28	28.3	28.2	
Aluminium	<0.02	<0.02	<0.02	0.03	<0.02	<0.02	0.04	<0.02	<0.02	<0.02	<0.02	<0.02
Arsenic	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Boron	0.08	0.10	0.11	0.11	0.12	0.13	0.12	0.14	0.08	0.08	0.10	0.10
Barium	0.04	0.05	0.06	0.06	0.06	0.05	0.06	0.07	0.04	0.04	0.04	0.06
Beryllium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Calcium	58.3	69.9	72.5	72.1	74.4	75.8	79.6	111.0	49.8	52.1	55.9	70.30
Cadmium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	0.01	<0.01	<0.01	0.04
Potassium	3	4	3	4	4	3	4	4	3	6	4	3
Lanthanum	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Lithium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Magnesium	22.9	26.4	27.3	27.2	28.4	28.3	29.7	41.0	19.7	21.3	22.3	26.6
Manganese	0.18	0.36	0.40	0.49	0.35	0.30	0.44	0.50	0.06	0.03	0.10	0.37
Mercury (ug/L)	<0.05	0.08	<0.05	7.2	<0.05	<0.05	<0.05	<0.05	0.07	1.80		0.08
Molybdenum	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Sodium	23.1	28.6	29	28.8	29.7	29.6	31.4	37.2	16.5	20.6	19.9	28.9
Nickel	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Lead	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Antimony	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Scandium	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Selenium	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Silicon	4.37	4.14	4.34	4.44	4.39	4.42	4.73	5.53	4.58	4.58	4.37	4.27
Strontium	0.17	0.20	0.21	0.21	0.21	0.21	0.21	0.29	0.14	0.15	0.16	0.20
Titanium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Thallium	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Vanadium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	<0.01	<0.01	0.01	0.01	0.02	0.02	0.17	0.02	<0.01	<0.01	<0.01	<0.01

APPENDIX H

Table H1. Comparison of metal results on water collected in Lake DePue and Turner Lake. All values are in milligrams per liter.

		Lake Depue		Lake Depue		Turner Lake
Lab number	W03671	W03671	W03676	W03676	W03678	W03678
Location		Near the South Ditch		Bottom water Cross section 6	Center of lake	
	ISGS	Contract lab	ISGS	Contract lab	ISGS	Contract lab
Aluminium	0.04	<0.02	0.03	<0.02	<0.02	<0.02
Arsenic	<0.1	<0.01	<0.1	<0.01	<0.1	<0.01
Barium	0.06	0.06	0.06	0.06	0.04	0.04
Calcium	79.6	75.2	72.1	69.1	52.1	48.3
Cadmium	<0.01	<0.01	<0.01	<0.05	<0.01	<0.05
Cobalt	<0.01	<0.02	<0.01	<0.02	<0.01	<0.02
Chromium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	<0.01	<0.02	<0.01	<0.02	<0.01	<0.02
Iron	0.02	<0.01	<0.01	<0.01	<0.01	<0.01
Potassium	4	4.3	4.0	4.2	6.0	3.7
Magnesium	29.7	29.1	27.2	27.1	21.3	20.7
Manganese	0.44	0.42	0.49	0.48	0.03	0.03
Sodium	31.4	28.7	28.8	26.7	20.6	18.2
Nickel	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Lead	<0.05	<0.003	<0.05	<0.003	<0.05	<0.003
Selenium	<0.2	<0.005	<0.2	<0.005	<0.2	<0.005
Silver		<0.005		<0.005		<0.005
Vanadium	<0.01	<0.02	<0.01	<0.02	<0.01	<0.02
Zinc	0.17	0.21	0.01	0.03	<0.01	<0.02

APPENDIX I

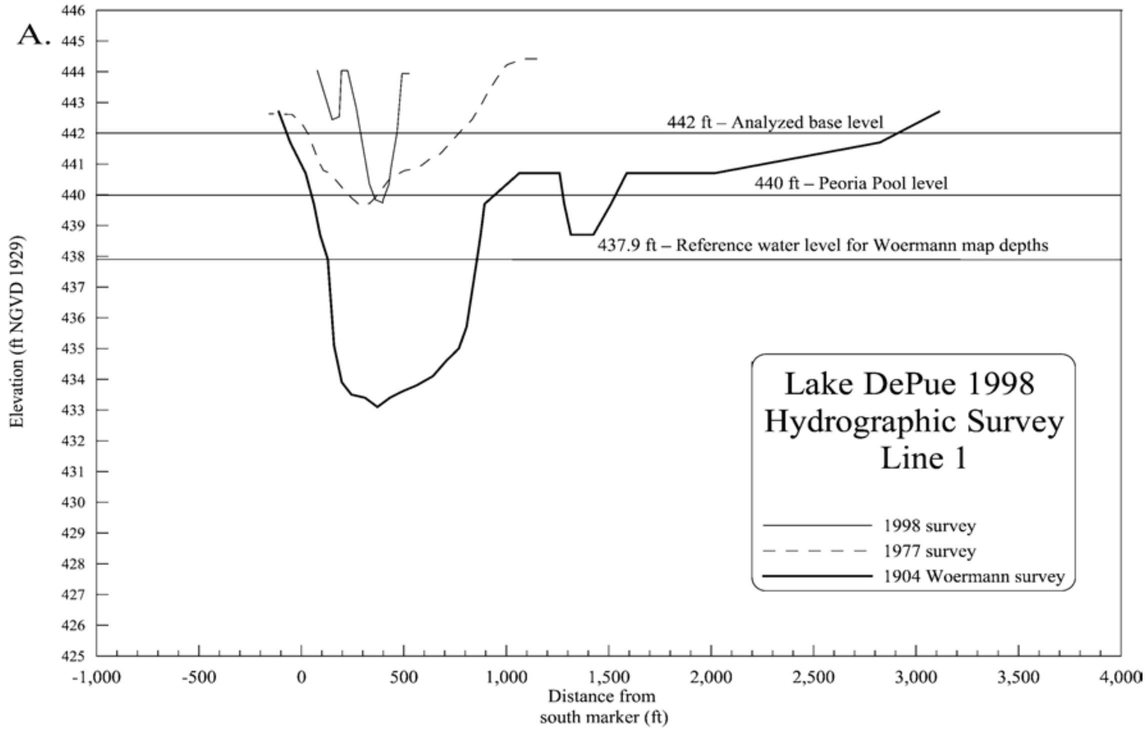
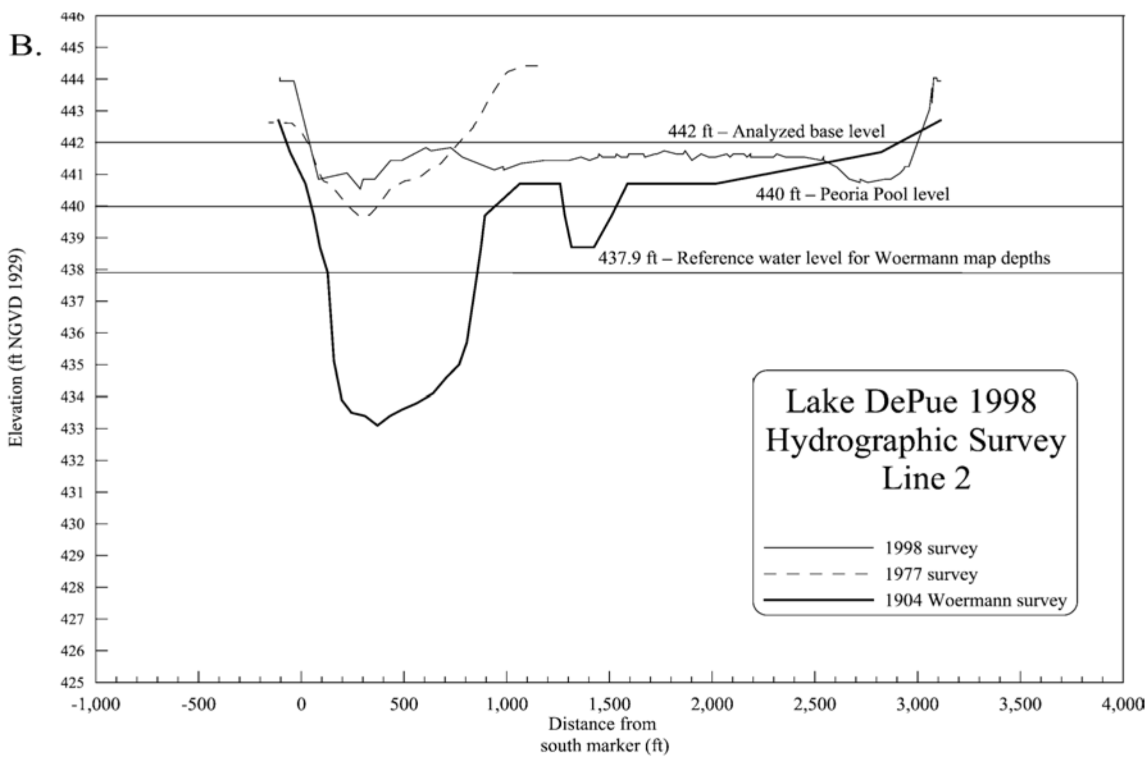


Figure I1. Comparison of 1998 and 1977 hydrographic surveys and the 1904 Woermann Survey.



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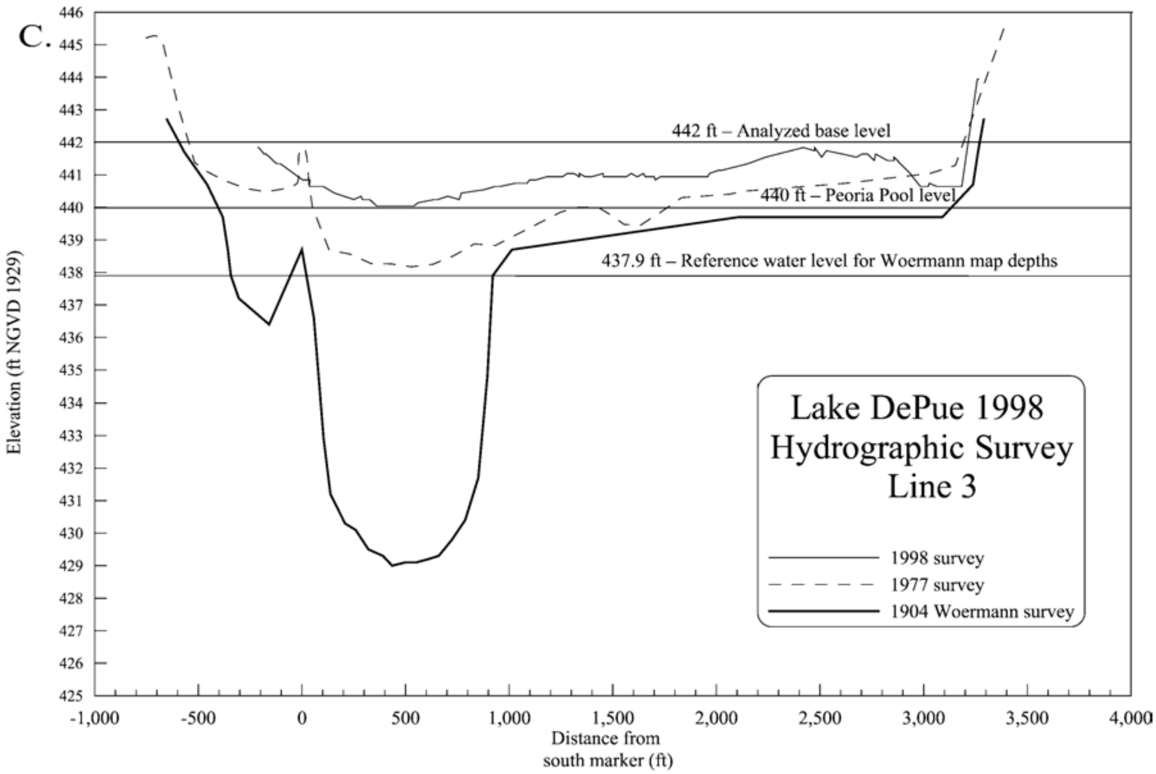
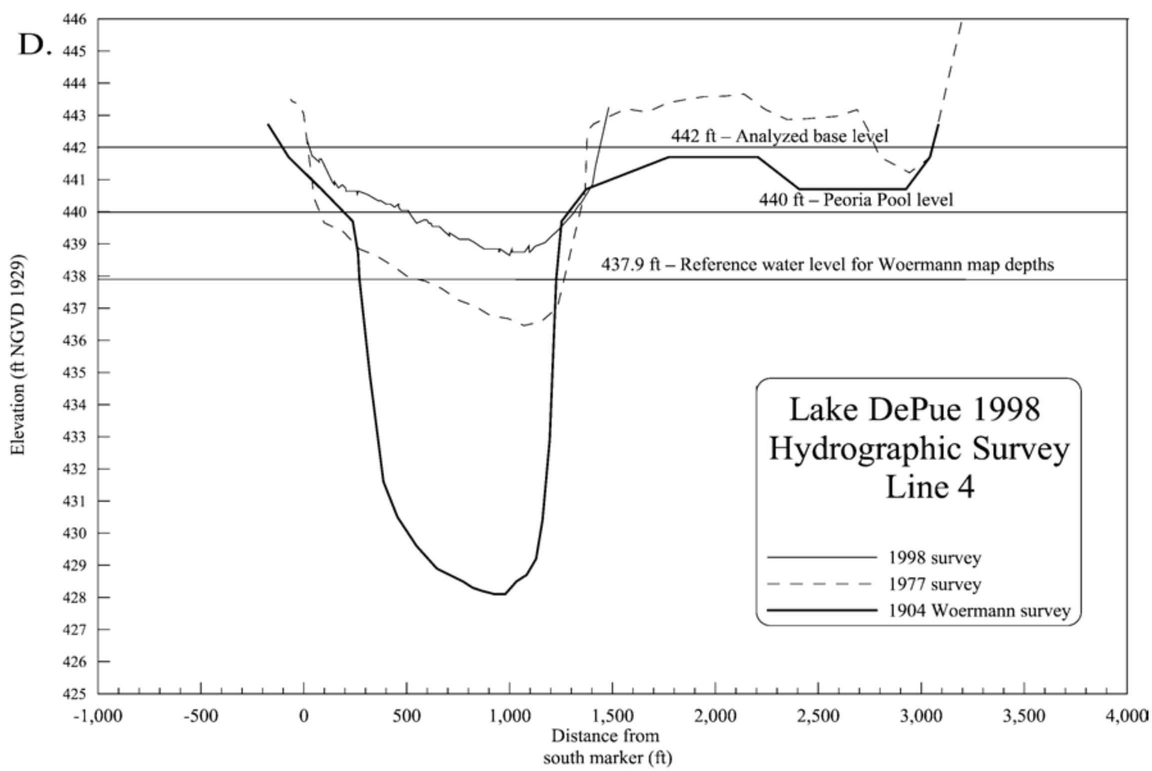


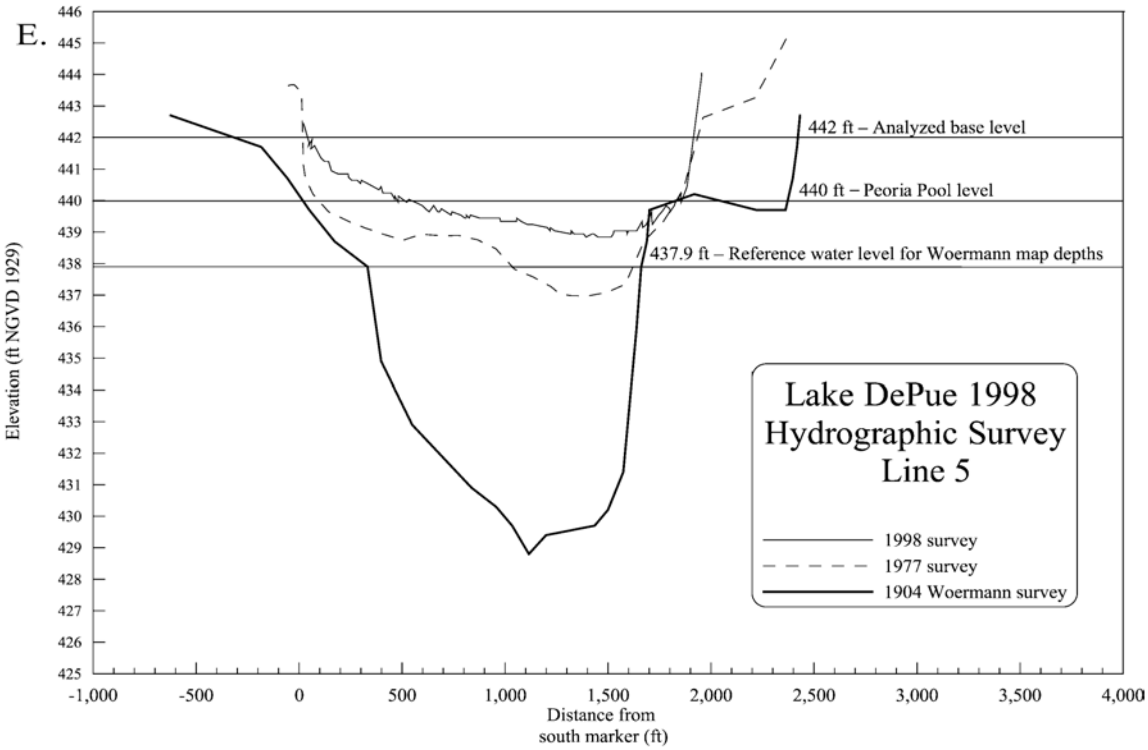
442 ft – Analyzed base level
440 ft – Peoria Pool level
437.9 ft – Reference water level for Woermann map depths
Lake DePue 1998
Hydrographic Survey
Line 3
1998 survey
1977 survey
1904 Woermann survey
Elevation (ft NGVD 1929)
Distance from south marker (ft)

D.

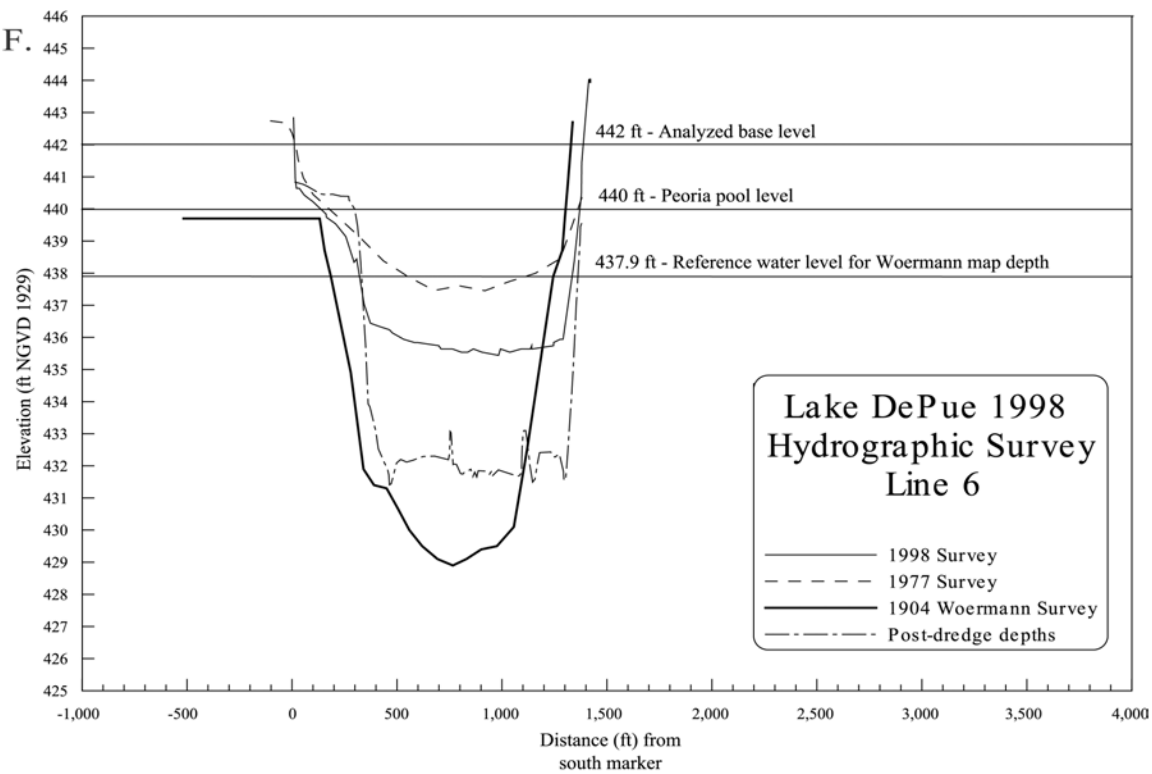


442 ft – Analyzed base level
440 ft – Peoria Pool level
437.9 ft – Reference water level for Woermann map depths
Lake DePue 1998
Hydrographic Survey
Line 4
1998 survey
1977 survey
1904 Woermann survey
Elevation (ft NGVD 1929)
Distance from south marker (ft)

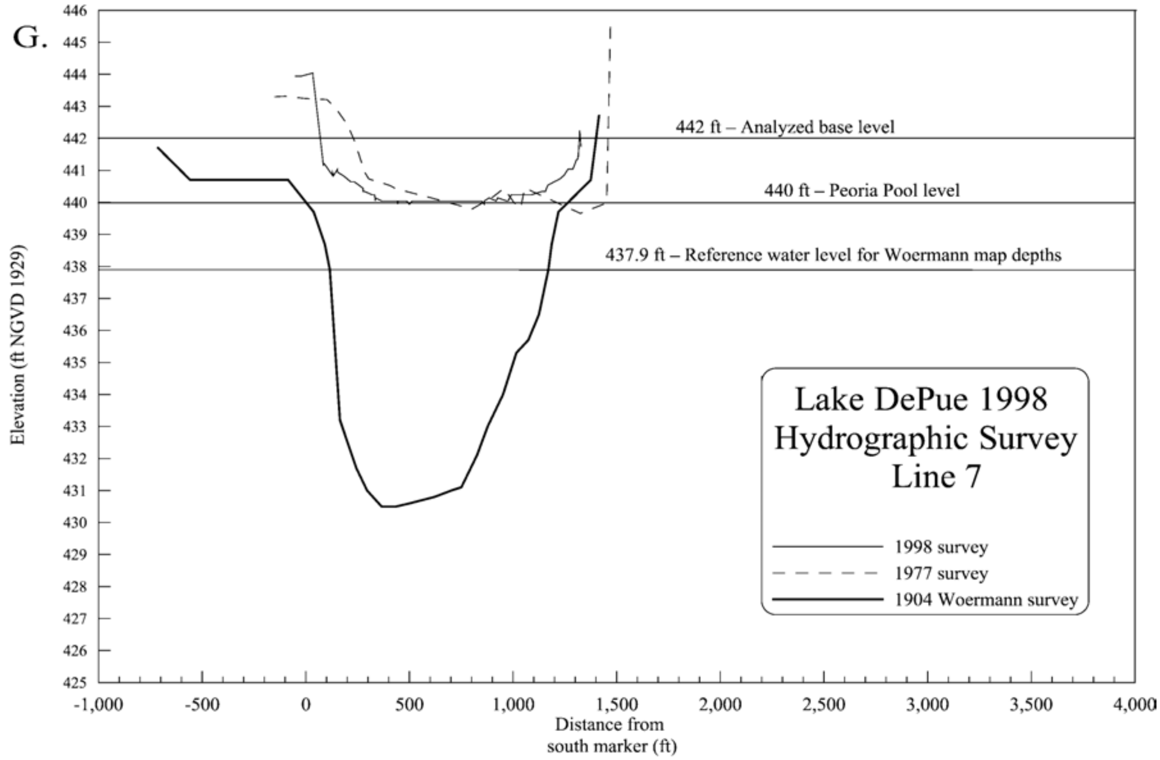
E.


Lake DePue 1998
Hydrographic Survey
Line 5
442 ft – Analyzed base level
440 ft – Peoria Pool level
437.9 ft – Reference water level for Woermann map depths
1998 survey
1977 survey
1904 Woermann survey
Elevation (ft NGVD 1929)
Distance from south marker (ft)

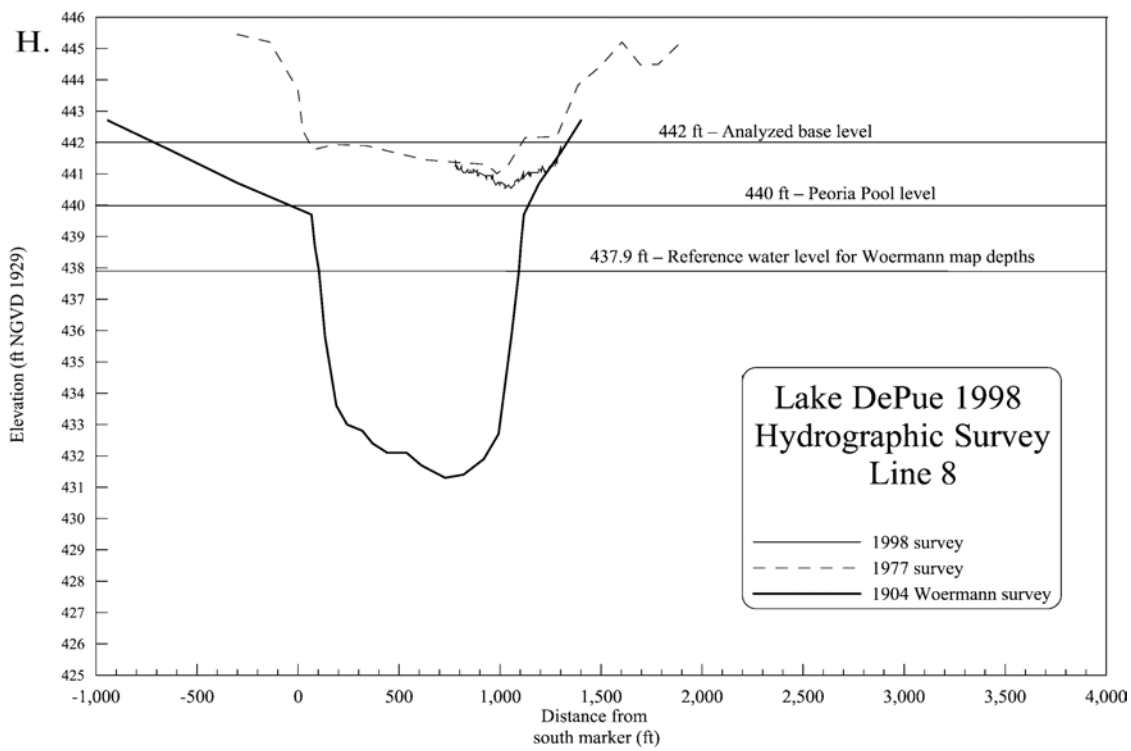
F.


Lake DePue 1998
Hydrographic Survey
Line 6
442 ft - Analyzed base level
440 ft - Peoria pool level
437.9 ft - Reference water level for Woermann map depth
1998 Survey
1977 Survey
1904 Woermann Survey
Post-dredge depths
Elevation (ft NGVD 1929)
Distance (ft) from south marker

G.


442 ft – Analyzed base level
440 ft – Peoria Pool level
437.9 ft – Reference water level for Woermann map depths
Lake DePue 1998
Hydrographic Survey
Line 7
1998 survey
1977 survey
1904 Woermann survey
Elevation (ft NGVD 1929)
Distance from
south marker (ft)

H.


442 ft – Analyzed base level
440 ft – Peoria Pool level
437.9 ft – Reference water level for Woermann map depths
Lake DePue 1998
Hydrographic Survey
Line 8
1998 survey
1977 survey
1904 Woermann survey
Elevation (ft NGVD 1929)
Distance from
south marker (ft)

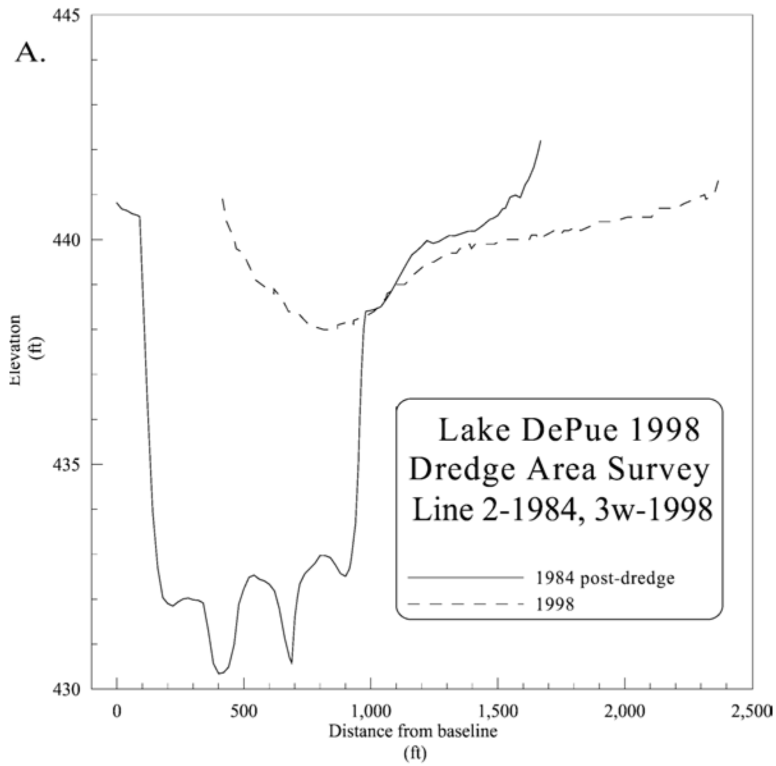
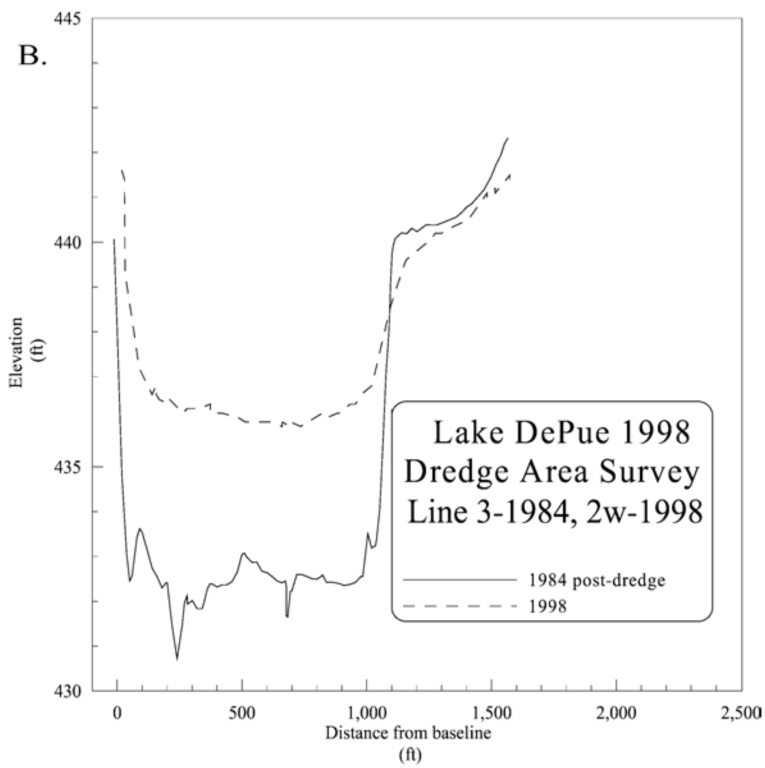
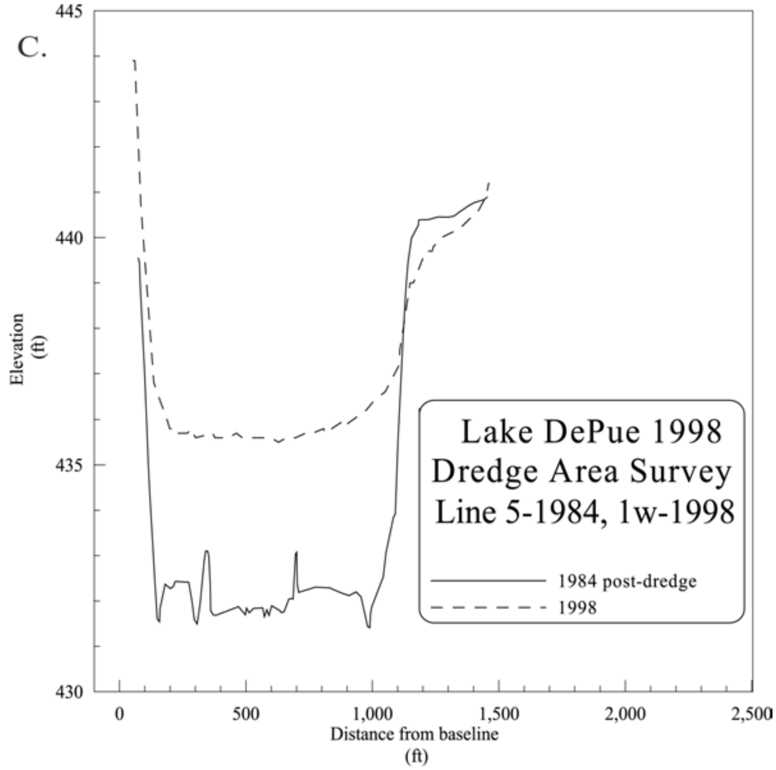
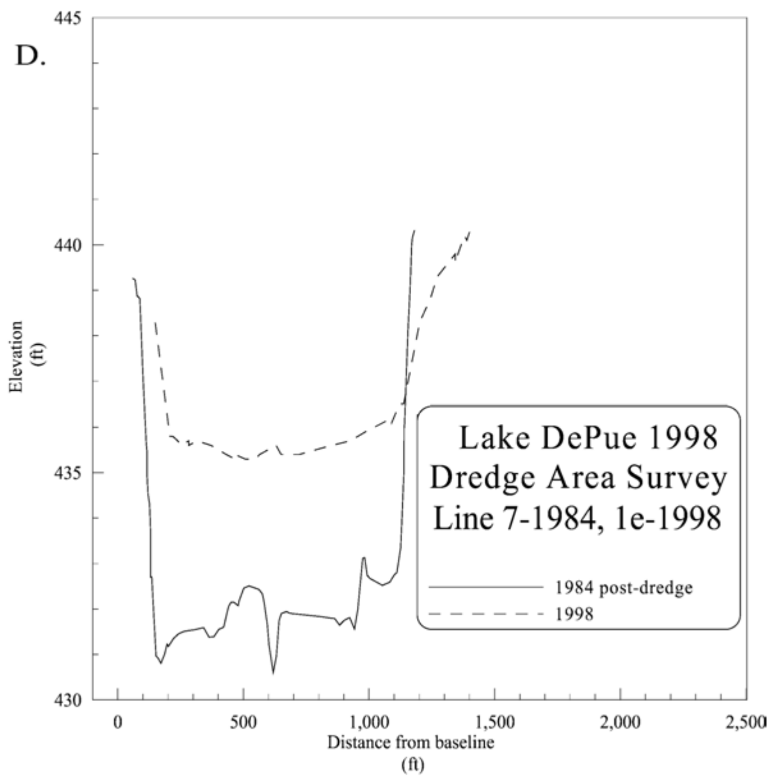
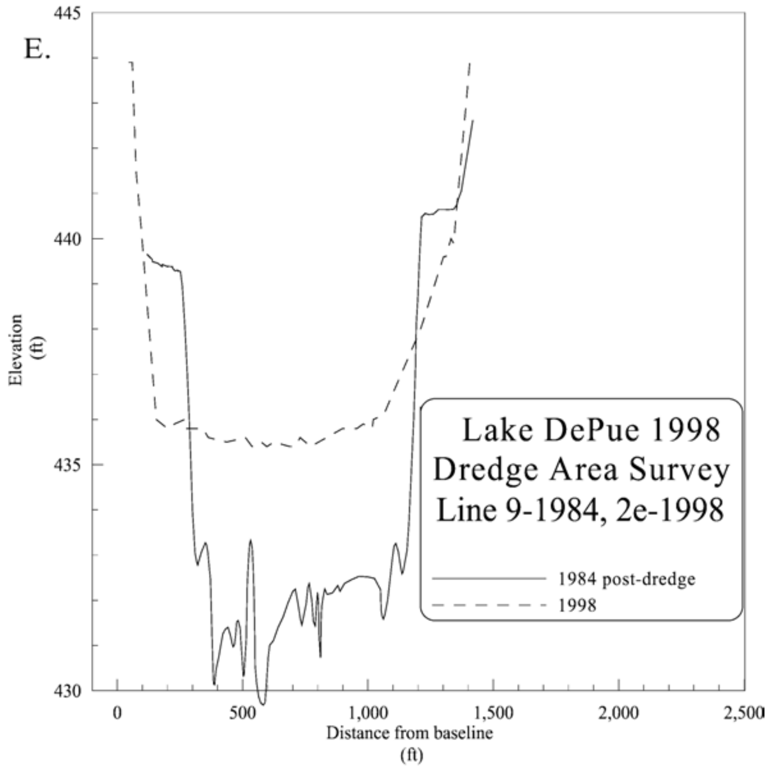


Figure I2. Comparison of 1984 and 1998 dredge area surveys.




C.
Lake DePue 1998
Dredge Area Survey
Line 5-1984, 1w-1998
1984 post-dredge
1998
Elevation (ft)
Distance from baseline (ft)
445
440
435
430
0
500
1,000
1,500
2,000
2,500


D.
Lake DePue 1998
Dredge Area Survey
Line 7-1984, 1e-1998
1984 post-dredge
1998
Elevation (ft)
Distance from baseline (ft)
445
440
435
430
0
500
1,000
1,500
2,000
2,500


E.
445
440
435
430
Elevation
(ft)
Lake DePue 1998
Dredge Area Survey
Line 9-1984, 2e-1998
1984 post-dredge
1998
0
500
1,000
1,500
2,000
2,500
Distance from baseline
(ft)

APPENDIX J

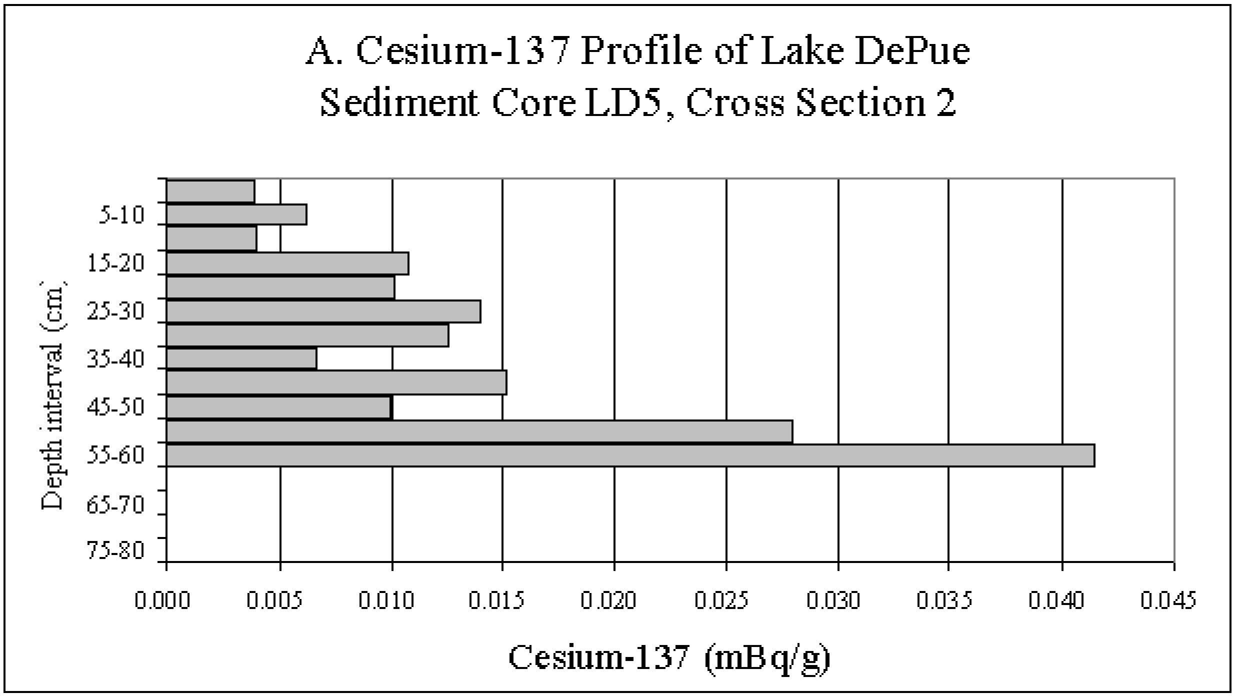
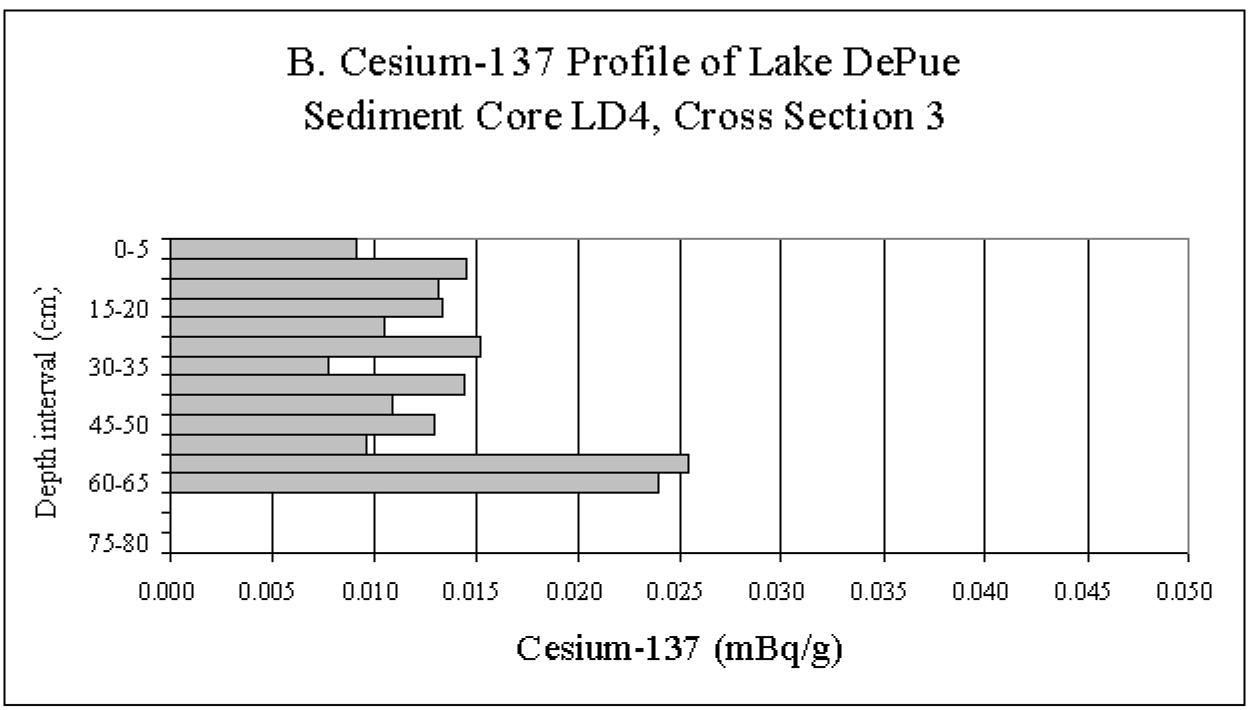
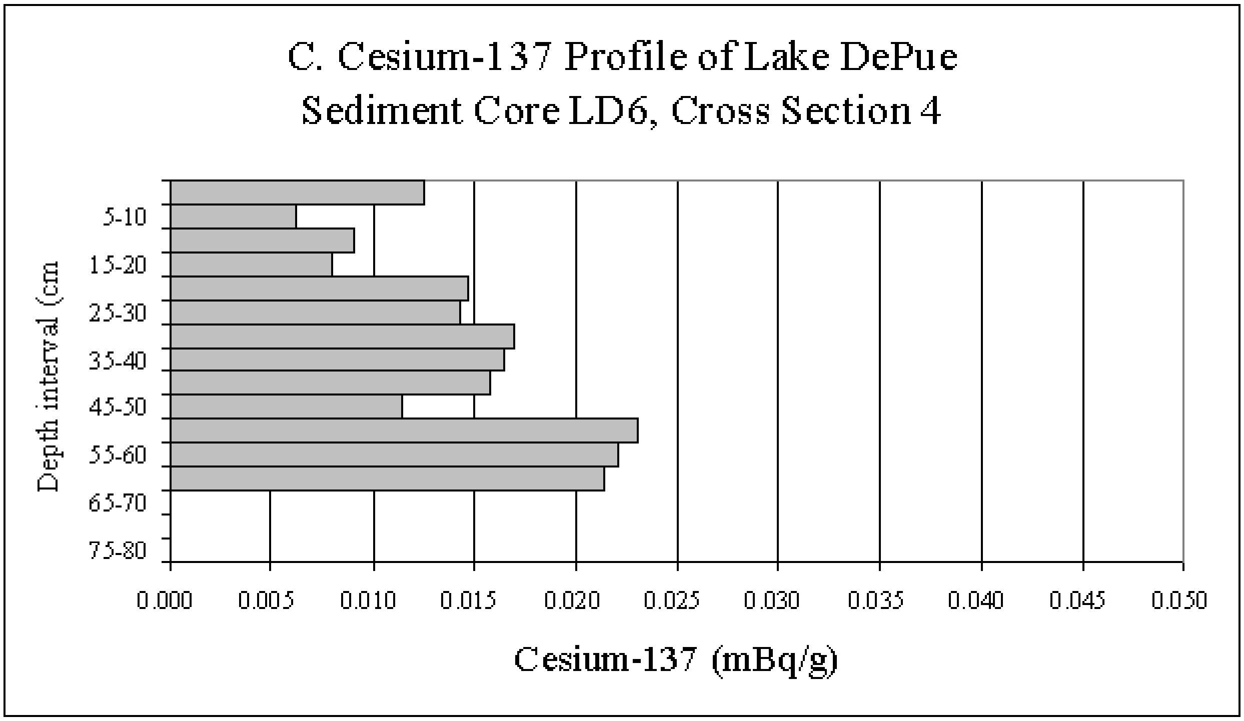
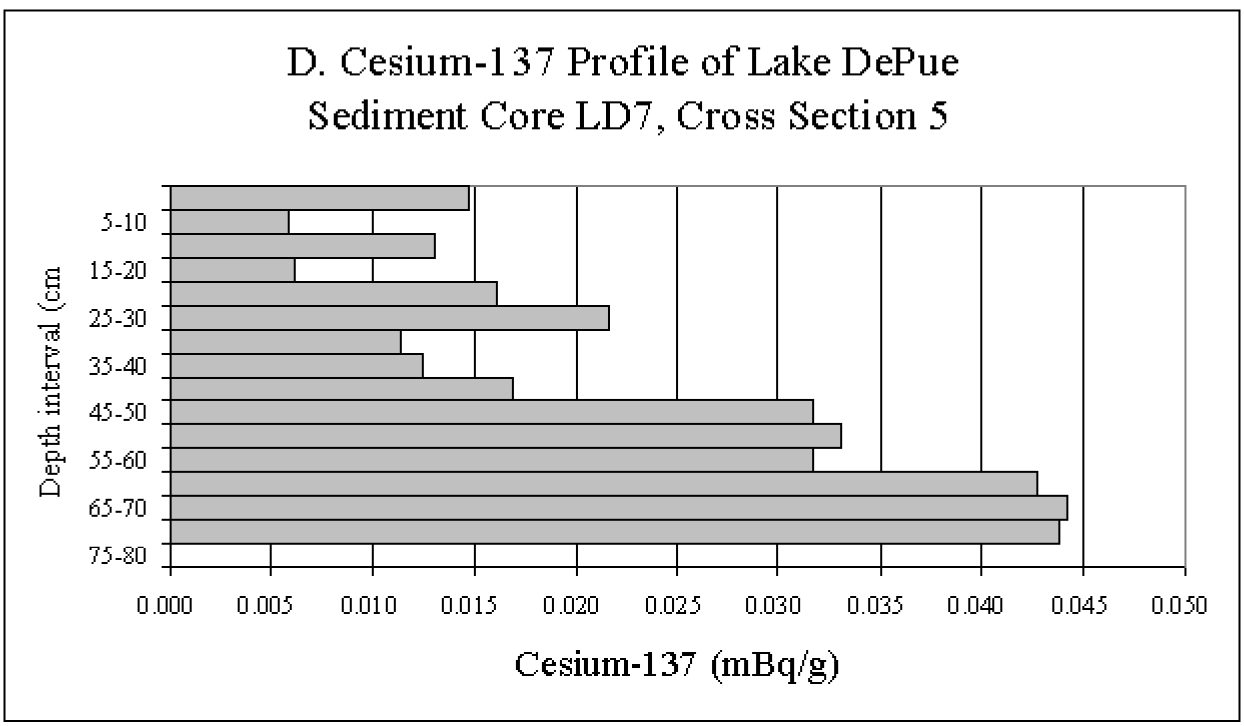
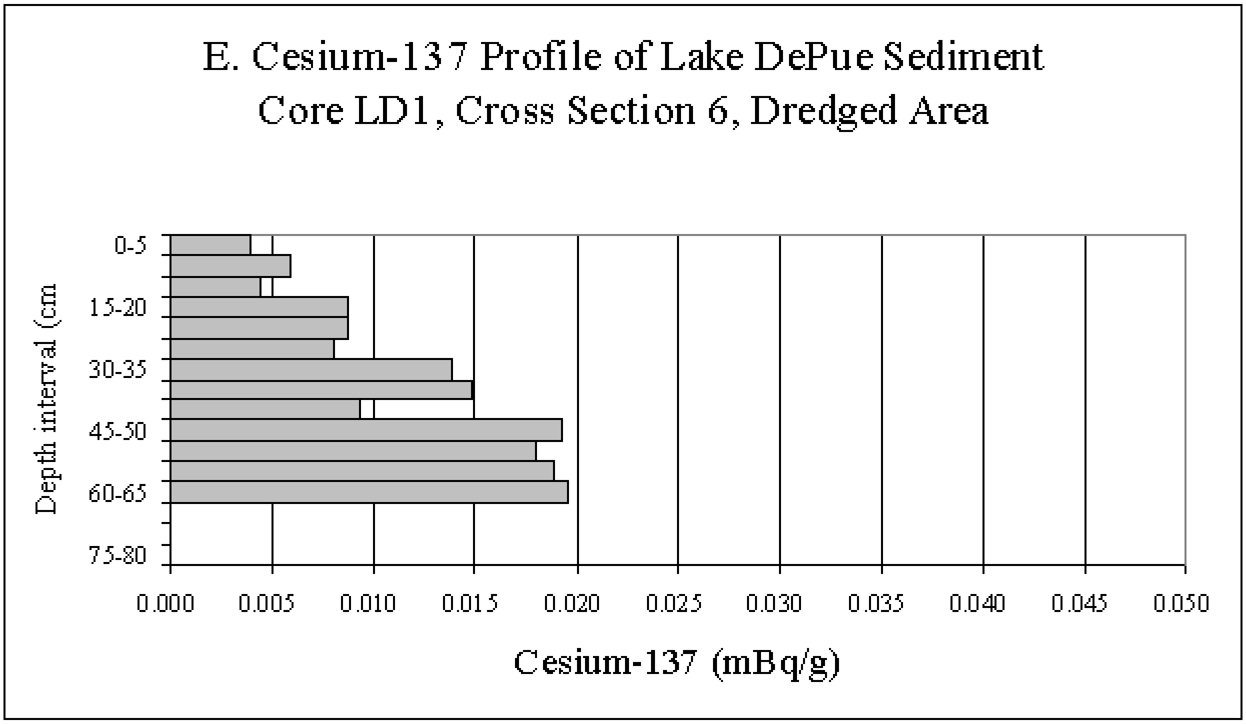


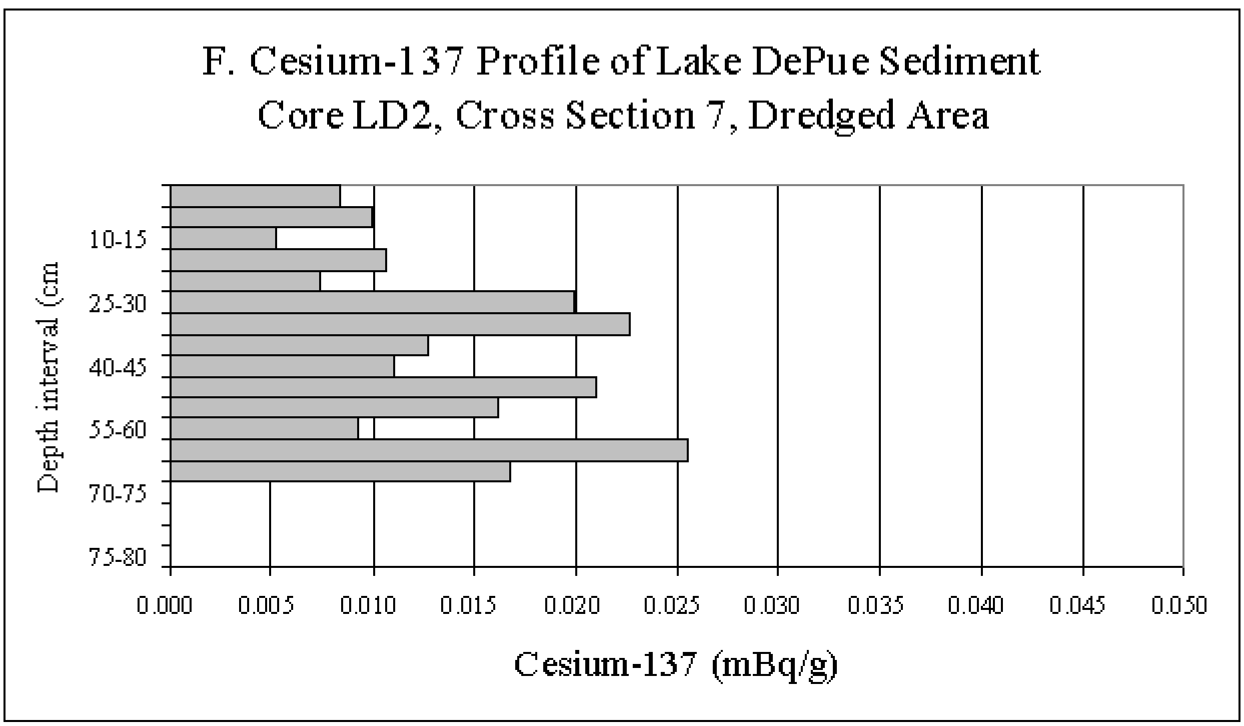
Figure J1. Cesium-137 profiles for Lake DePue and Turner Lake.

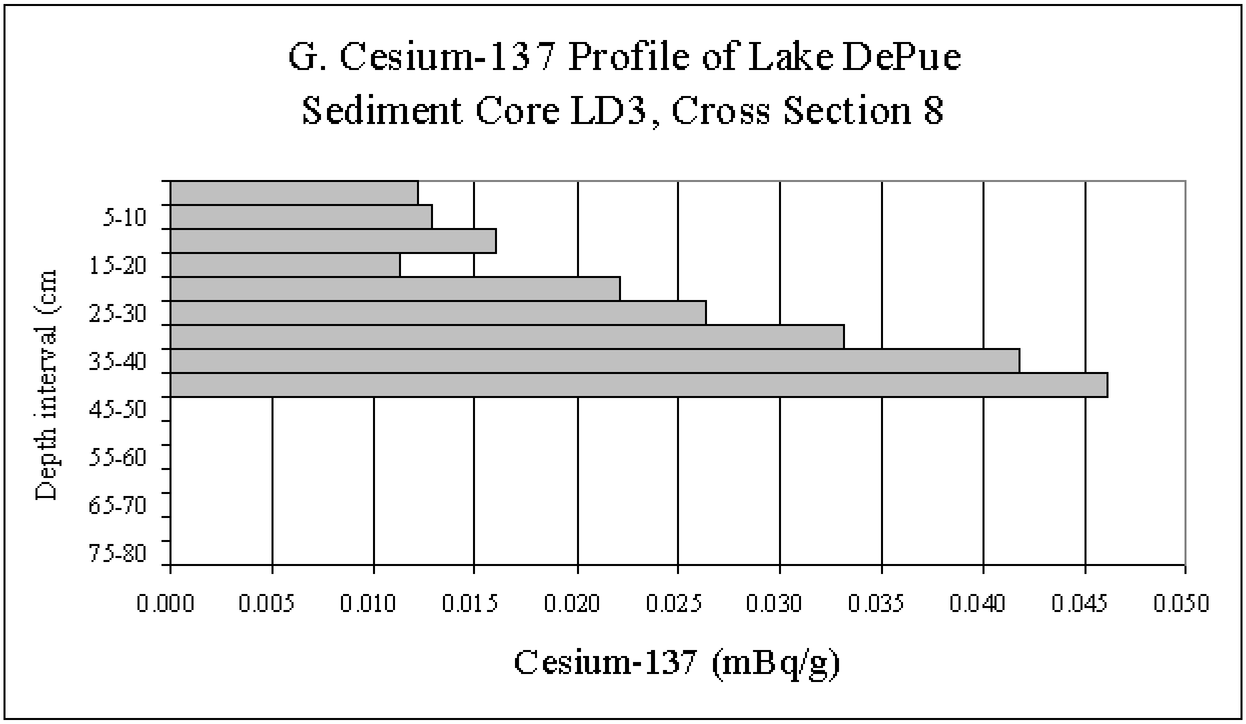


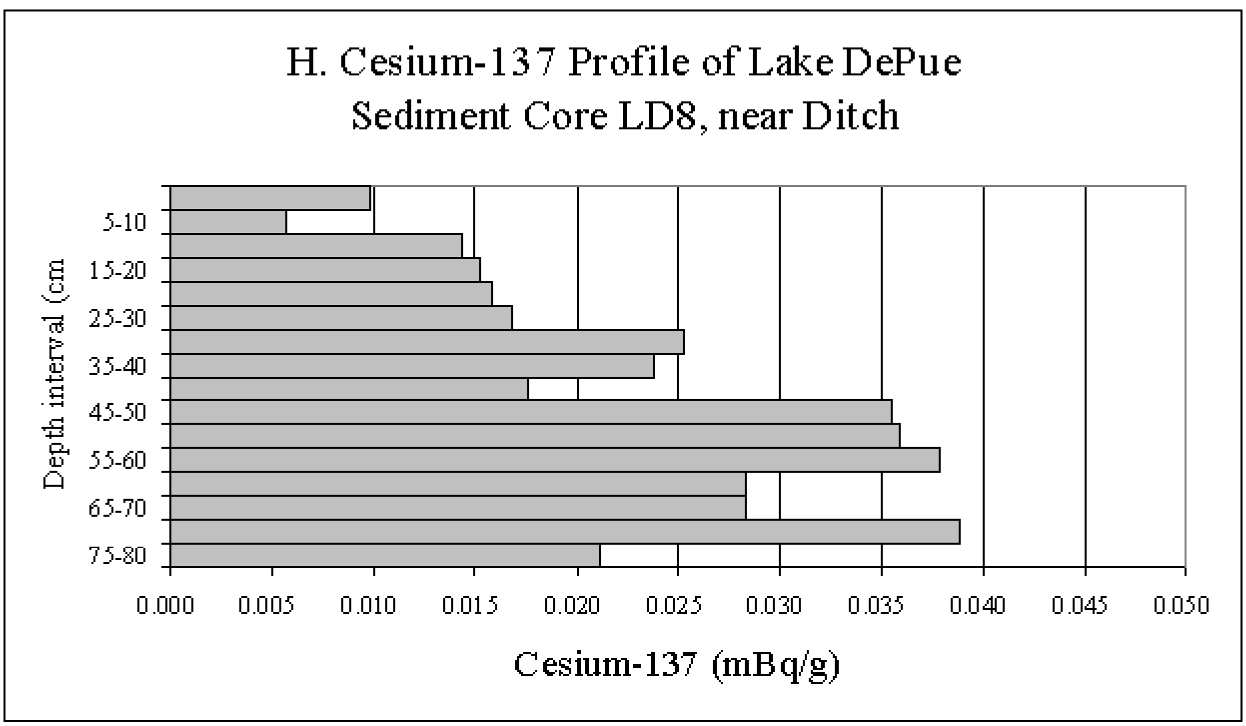

C. Cesium-137 Profile of Lake DePue
Sediment Core LD6, Cross Section 4
Depth interval (cm
5-10
15-20
25-30
35-40
45-50
55-60
65-70
75-80
0.000
0.005
0.010
0.015
0.020
0.025
0.030
0.035
0.040
0.045
0.050
Cesium-137 (mBq/g)

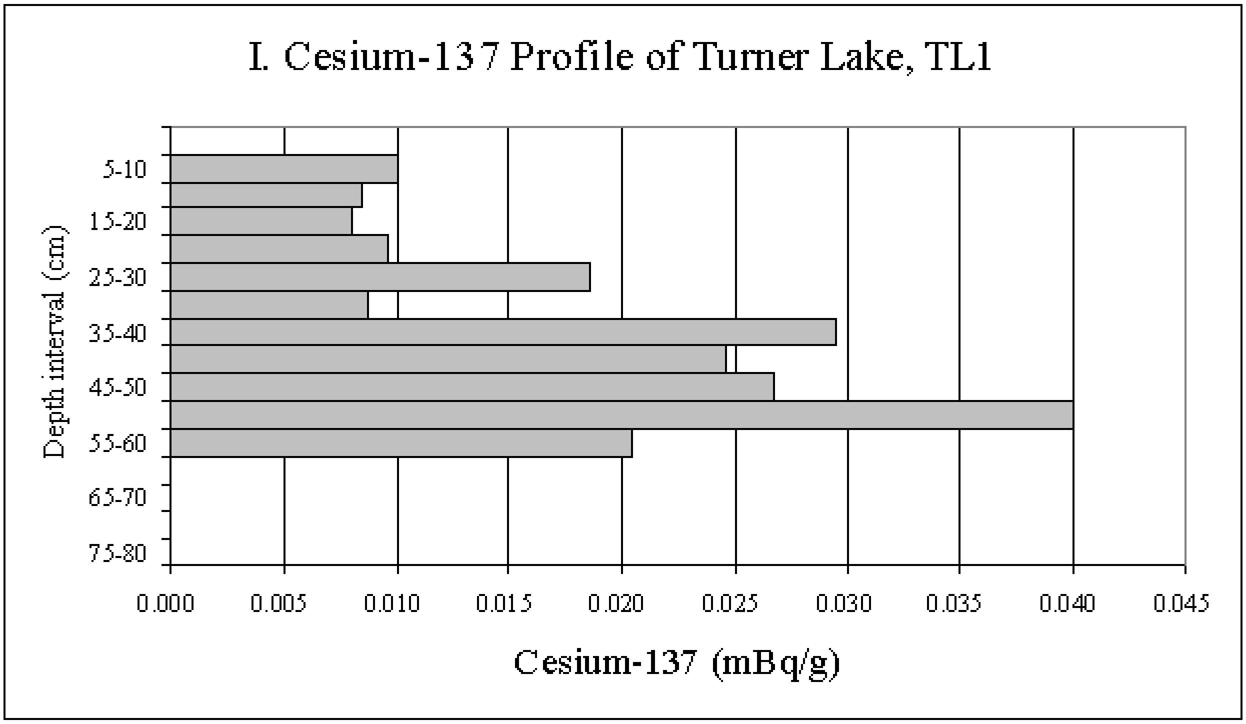

D. Cesium-137 Profile of Lake DePue
Sediment Core LD7, Cross Section 5
Depth interval (cm
5-10
15-20
25-30
35-40
45-50
55-60
65-70
75-80
0.000
0.005
0.010
0.015
0.020
0.025
0.030
0.035
0.040
0.045
0.050
Cesium-137 (mBq/g)


E. Cesium-137 Profile of Lake DePue Sediment
Core LD1, Cross Section 6, Dredged Area
Depth interval (cm
0-5
15-20
30-35
45-50
60-65
75-80
0.000
0.005
0.010
0.015
0.020
0.025
0.030
0.035
0.040
0.045
0.050
Cesium-137 (mBq/g)


F. Cesium-137 Profile of Lake DePue Sediment
Core LD2, Cross Section 7, Dredged Area
Depth interval (cm
10-15
25-30
40-45
55-60
70-75
75-80
0.000
0.005
0.010
0.015
0.020
0.025
0.030
0.035
0.040
0.045
0.050
Cesium-137 (mBq/g)


G. Cesium-137 Profile of Lake DePue
Sediment Core LD3, Cross Section 8
Depth interval (cm
5-10
15-20
25-30
35-40
45-50
55-60
65-70
75-80
0.000
0.005
0.010
0.015
0.020
0.025
0.030
0.035
0.040
0.045
0.050
Cesium-137 (mBq/g)


H. Cesium-137 Profile of Lake DePue
Sediment Core LD8, near Ditch
Depth interval (cm
5-10
15-20
25-30
35-40
45-50
55-60
65-70
75-80
0.000
0.005
0.010
0.015
0.020
0.025
0.030
0.035
0.040
0.045
0.050
Cesium-137 (mBq/g)



I. Cesium-137 Profile of Turner Lake, TL1
Depth interval (cm)
5-10
15-20
25-30
35-40
45-50
55-60
65-70
75-80
0.000
0.005
0.010
0.015
0.020
0.025
0.030
0.035
0.040
0.045
Cesium-137 (mBq/g)

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