Barr
Engineering Company

COPY

September 1, 1998

Ms. Gail Tessman, President
Wapogasset and Bear Trap Lakes Association
1867 Jackson Street
Maplewood, Minnesota 55117

Re: Report on 1998 Lake Monitoring Activities

Dear Ms. Tessman:

This letter reports on the results of lake monitoring activities we conducted during 1998 as part of your Wisconsin Lake Planning Grant project (#LPL-519). Before discussing those new data, however, I will briefly recap the results of earlier phases of the project so it is clear why the 1998 work was done.

Earlier, in 1995, a program of intensive lake water quality monitoring was completed. Results of that work confirmed what was previously suspected—that poor lake water quality conditions encountered during late summer periods of each year were related to internal phosphorus loading of the lake by its seasonally anoxic bottom sediments. As the attached three figures clearly demonstrate, persistent summer thermal stratification of the lake's water column results in the formation of a strong thermocline (Figure 1) that, because of its associated density gradient, prevents diffusion of dissolved oxygen downward into the lake's hypolimnion. The deep hypolimnetic zone of the lake subsequently goes anaerobic (Figure 2) as the decomposing organic matter in the lake sediments consumes oxygen. Under these anaerobic conditions the phosphorus contained in the sediments is liberated into the overlying waters where it begins to diffuse upward (Figure 3). This upward migration of phosphorus continues until early-autumn when the lake circulates again as it did in early-spring when the water column was isothermal (i.e., the same temperature throughout). Fall circulation occurs each year after the surface waters, which were warmer and less dense than the underlying deep waters during summer, cool to a degree that the density differences within the water column (top-to-bottom) can be overcome by the winds that cause the lake to mix. At that time much of the phosphorus released from the anaerobic lake sediments is redistributed throughout the water column, including the upper photic zone where algae find sufficient sunlight to grow in abundance. There the added phosphorus causes increased growth of algae and corresponding reductions in the late-summer transparency levels of the lake's surface waters.

To prevent the annual internal phosphorus loading problem in Wapogasset and Bear Trap Lakes, it was suggested by Barr Engineering Company that an alum treatment be made to chemically seal phosphorus into the lake sediments. The WDNR evaluated our recommendation and

☑ 8300 Norman Center Drive
Minneapolis, MN 55437-1026
Phone: (612) 832-2600
Fax (612) 832-2601

☐ 555 West 27th Street
Hibbing, MN 55746
Phone: (218) 262-3465
Fax (218) 262-3460

☐ 332 West Superior Street
Duluth, MN 55802
Phone: (218) 727-5218
Fax (218) 727-6450

☐ 450 South Wagner Road
Ann Arbor, MI 48103
Phone: (734) 327-1200
Fax (734) 327-1212

☐ 219 East Dunklin
Jefferson City, MO 65101
Phone: (573) 636-5331
Fax (573) 636-5323

☑ 229 Quail Run Drive
St. Louis, MO 63341
Phone: (314) 398-8055
Fax (314) 398-8054

concurred that such a treatment was the appropriate remedy to the lakes' late-summer water quality problems. The chemical alum is aluminum sulfate. When added to water, it forms an insoluble precipitate in the form of a "floc" (i.e., feathery flake-like particles). This floc settles through the water column, "sweeping" particulate matter out of suspension as it descends, and deposits itself on the lake sediments. The resultant floc "blanket" prevents subsequent release of phosphorus from seasonally anaerobic sediments. Such an alum treatment is usually effective in this regard for a period of 10 to 15 years depending on both the initial alum dose and the rate at which watershed inflows and internal biological production within the lake produce new sediments that cover the alum floc blanket. We estimated that an alum treatment had the potential to reduce late-summer total phosphorus concentrations of your lakes significantly, to 37 µg/L (from 63 µg/L in 1995) for Lake Wapogasset and to 24 µg/L (from 60 µg/L in 1995) for Bear Trap Lake. The estimated costs of alum treatments of Wapogasset and Bear Trap Lakes are $278,500 and $67,500, respectively.

During 1998 additional lake monitoring was done to look at the status of the aquatic macrophyte (i.e, lake weed) populations in both lakes out of a concern that increased water clarity might result in aquatic plants growing to much deeper depths throughout the lake basins. To that end, we conducted two macrophyte surveys, one in late-June and the other in early-August, in order to document the distribution and abundance of the early-blooming exotic plant curlyleaf pondweed (*Potamogcton crispus*) and the later-blooming native species in relation to prevailing water transparencies. Results of those surveys indicated that plant growth was generally restricted to areas of the lakes that were less than 20-feet deep in Lake Wapogasset and 10-feet deep in Bear Trap Lake (See Figures 4 and 5). Curlyleaf pondweed was encountered only during our June survey, and then only in the north half of Lake Wapogasset and in one isolated spot near Hickory Point in Bear Trap Lake. By the time of our August survey, we were no longer able to locate any curlyleaf pondweed in either lake, presumably because it had died-back by that time and was present only as turions (reproductive bodies), not as leafy, adult plants. The depths to which other aquatic plants continued to grow was unchanged from the June survey, 20 feet in Wapogasset and 10 feet in Bear Trap Lake.

Because an alum treatment of these lakes could significantly reduce their total phosphorus concentrations and increase their water transparencies, the maximum depths to which aquatic plants could grow might also be expected to increase. The total phosphorus concentration reductions (from 63 to 37 µg/L in Lake Wapogasset and from 60 to 24 µg/L in Bear Trap Lake) expected to result from alum treatments are also expected to increase average summer water transparencies in both lakes. Using the predicted relationship between maximum rooting depth (Y) and water transparency (X) developed by P.A. Chambers and J. Kalff (1985. *Depth Distribution and Biomass of Submersed Aquatic Macrophyte Communities in Relation to Secchi Depth.* Can. J. Fish. Aquat. Sci. 42: 701-709.) for aquatic macrophytes in North America we predict that the maximum rooting depths of macrophytes in Lake Wapogasset would increase to about 9.5 meters (ca. 30 feet). For Bear Trap Lake, where suspended sediments, not algae, often control transparency, the increase in maximum rooting depth of aquatic macrophytes may be less than proportional to the expected change in total phosphorus concentration. We now estimate the maximum rooting depth in Bear Trap Lake would be approximately 15 feet after an alum treatment.

Over the past 50 (or more) years, chemicals have been used in Wapogasset and Bear Trap Lakes to control growths of algae and aquatic plants. Both copper sulfate and arsenic (in the form of arsenate) have been used extensively. While briefly effective, these chemicals only treat the symptoms of the water quality problems that relate to excesses of nutrients in both lakes, not their root causes. Also, the applied copper and arsenic ultimately end up in the lake sediments following application. High concentrations of copper and arsenic in sediment could pose a problem for bottom dwelling biota if concentrations exceed pollution thresholds contained in published guidelines on sediment quality criteria. To investigate this possibility, we collected intact sediment cores from three deep water areas (North, Center and South) of Lake Wapogasset and at one deep site in Bear Trap Lake (See Figure 6). The upper 10 centimeters (ca. 4 inches) of each core was segmented into three strata each: 0-2, 2-6, and 6-10 centimeters. Assuming an average annual sediment deposition rate of 0.2 cm/yr., which is typical of eutrophic lakes in the upper Midwest, these core strata represent the consecutive preceding 10-, 20- and 20-year time intervals, approximately. Results of the chemical analyses performed on these sediment core segments are graphed for copper, arsenic and phosphorus in Figures 7, 8 and 9, respectively. These same results plus results for additional analytes are also tabulated in the attached Laboratory Report from the Wisconsin State Laboratory of Hygiene (Appendix A).

Results of the sediment quality analyses all suggest that Wapogasset and Bear Trap Lake sediments are polluted. Concentrations of copper in surficial lake sediments from all sampling sites all exceed the 50 and 100 mg/kg thresholds generally associated with moderately and severely polluted sediment conditions, respectively, according to various regulatory agency rules (see Appendix B). Similarly, all sediment samples analyzed for arsenic content exceeded the 8-10 mg/kg threshold indicative of polluted conditions. All sediment samples also exceeded the 650 mg/kg phosphorus content threshold above which conditions are considered polluted. These data suggest that the recommended alum treatment is a preferable alternative to continued use of copper- and/or arsenic-based herbicides for the control of algae and aquatic plants in Wapogasset and Bear Trap Lakes.

Thank you again for giving us the opportunity to work with you on this very interesting study. Please contact me by telephone at Barr if you have any questions about the data reported here, or if you need additional assistance in preparing for an alum treatment project.

Sincerely,

BARR ENGINEERING CO.

Henry M. (Hal) Runke, Ph.D.
Limnologist

HMR/dsd
K:\4949022\60405_1.WPD

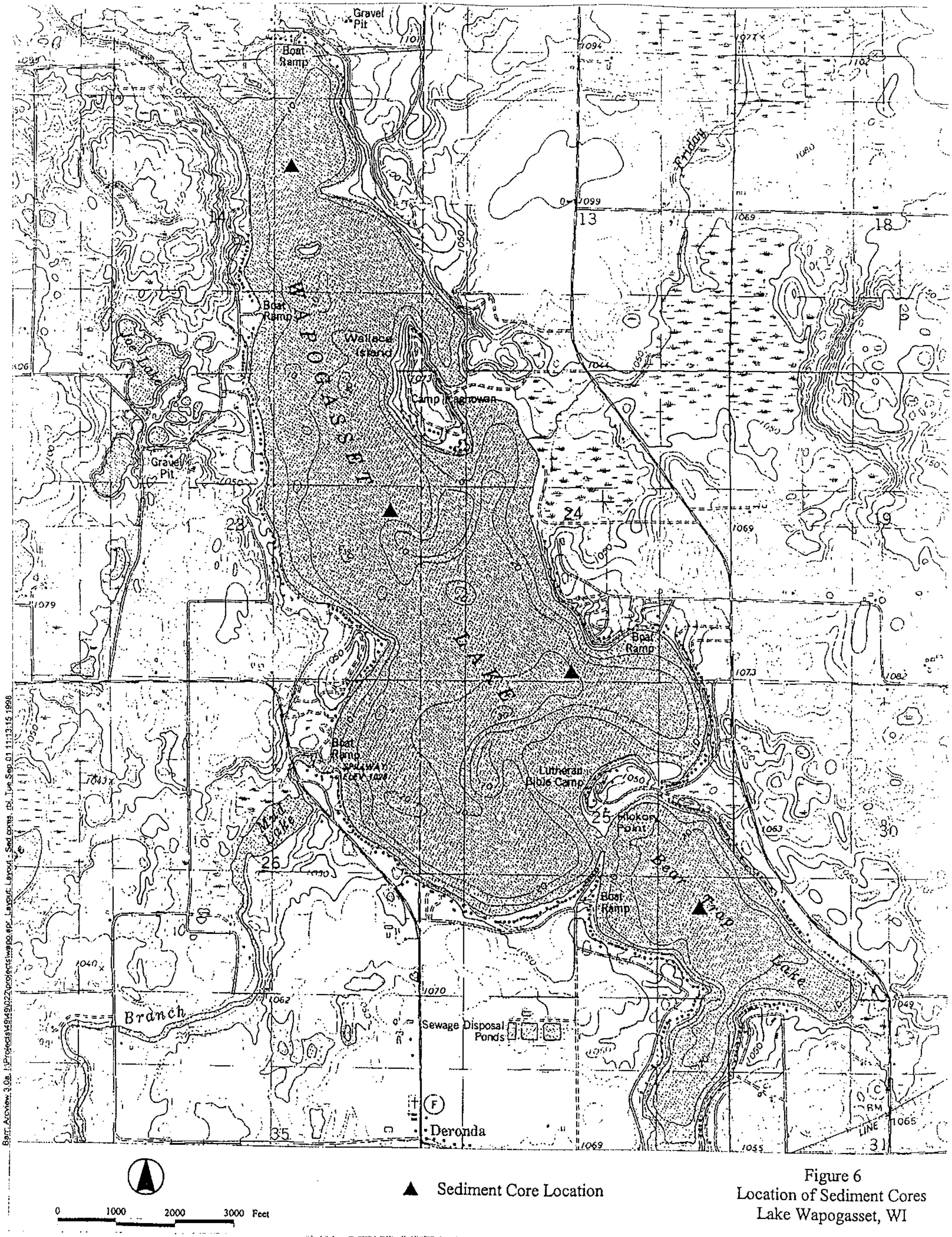
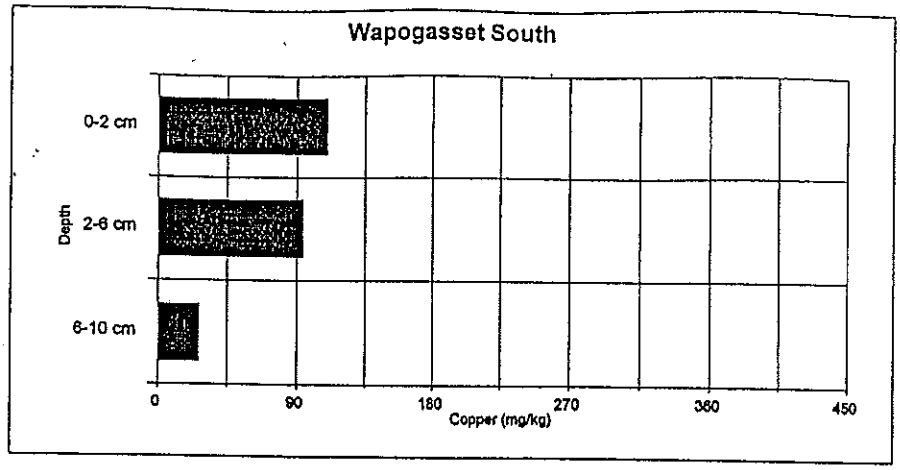
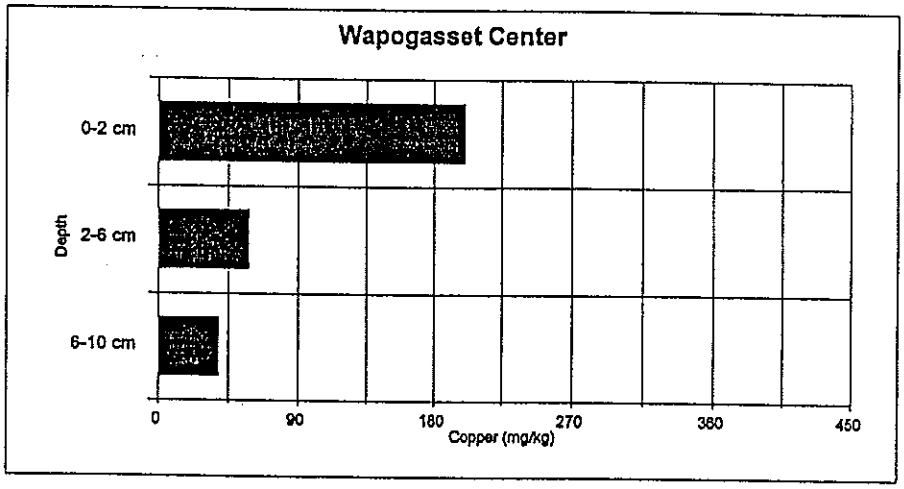
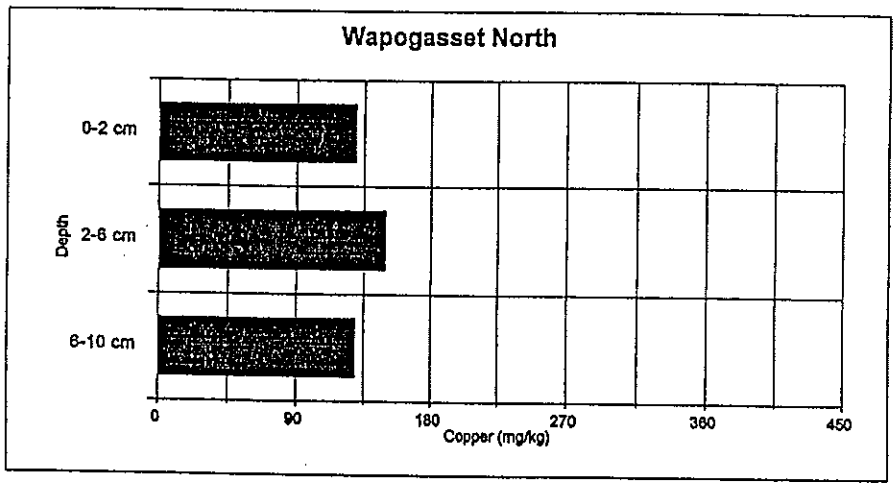


Figure 6
Location of Sediment Cores
Lake Wapogasset, WI

Figure 7. Sediment Quality Data - Copper







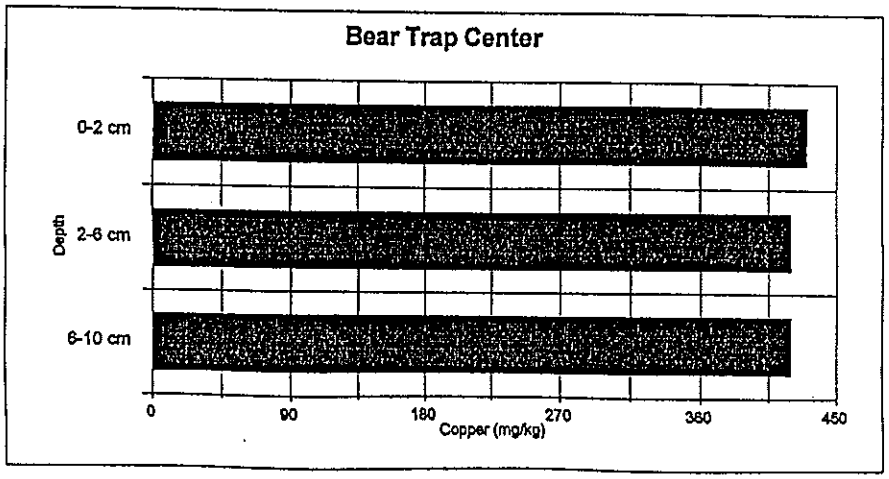
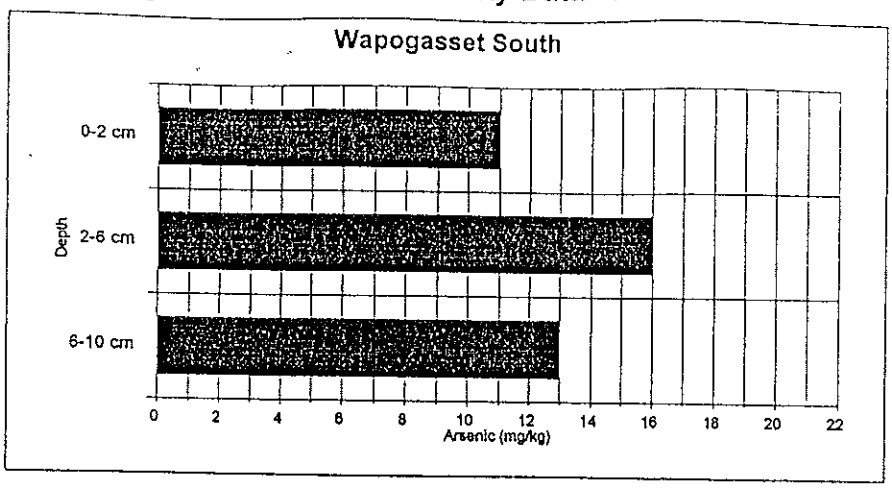
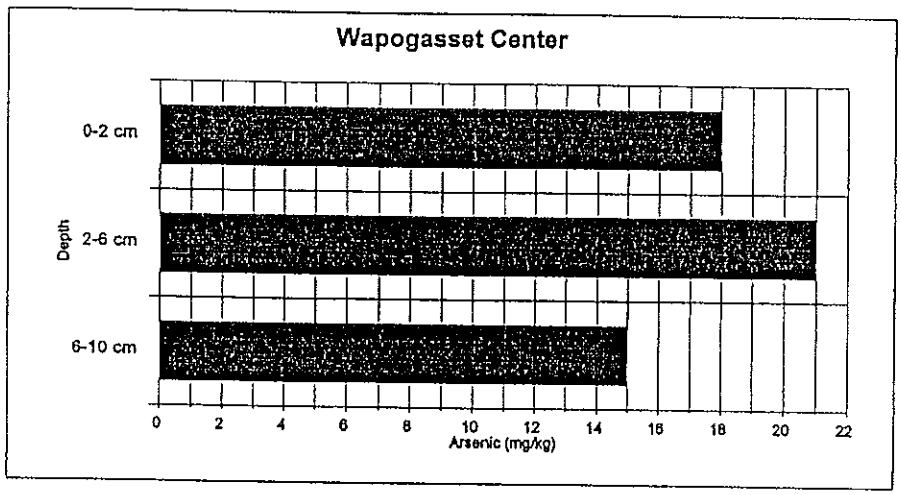
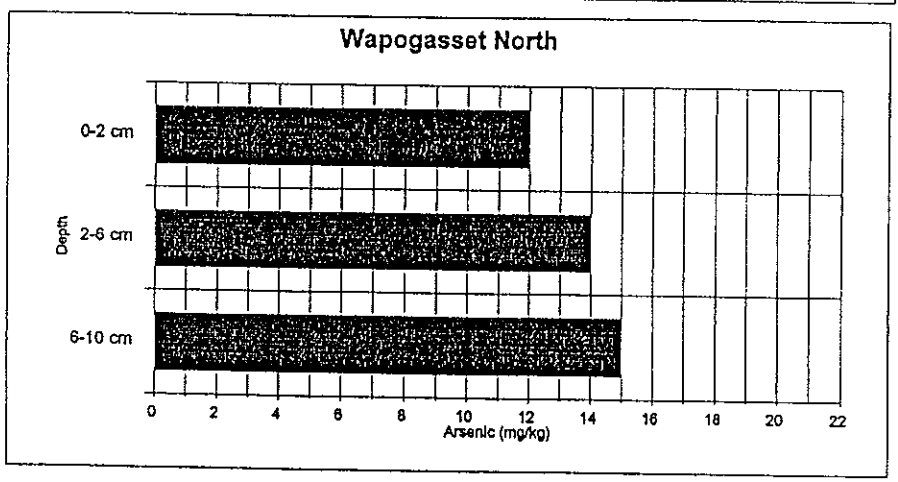


Figure 8. Sediment Quality Data - Arsenic







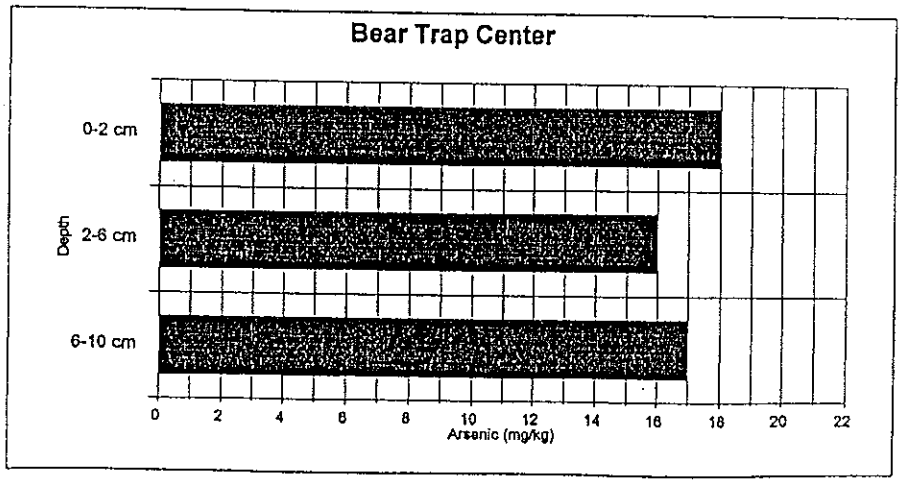
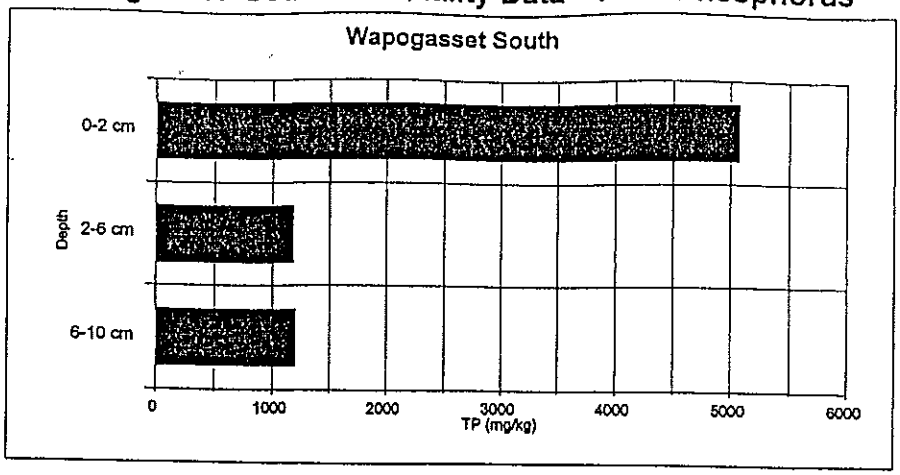
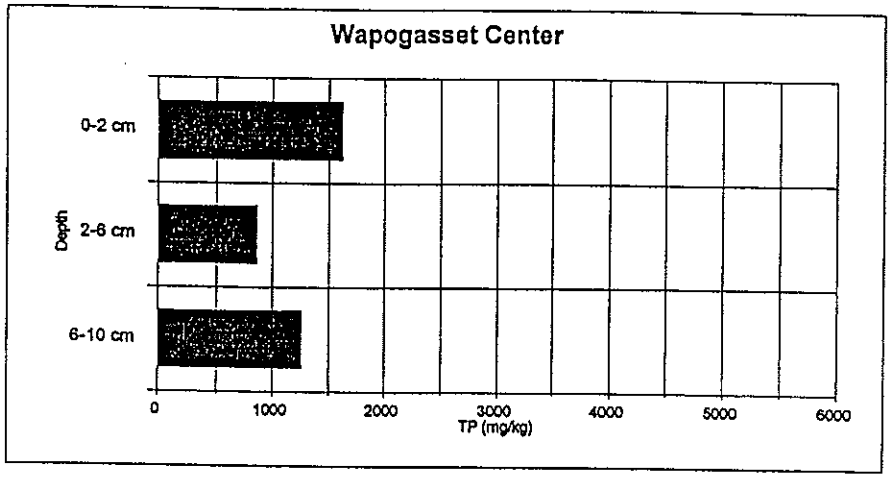
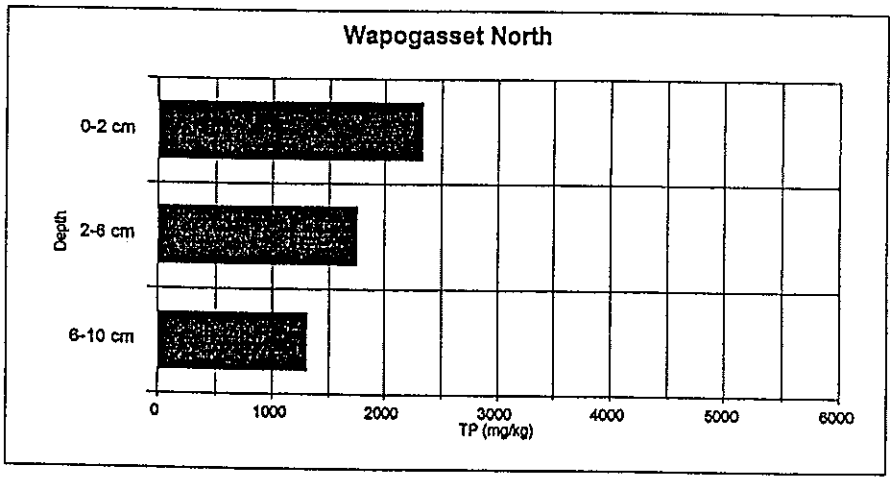
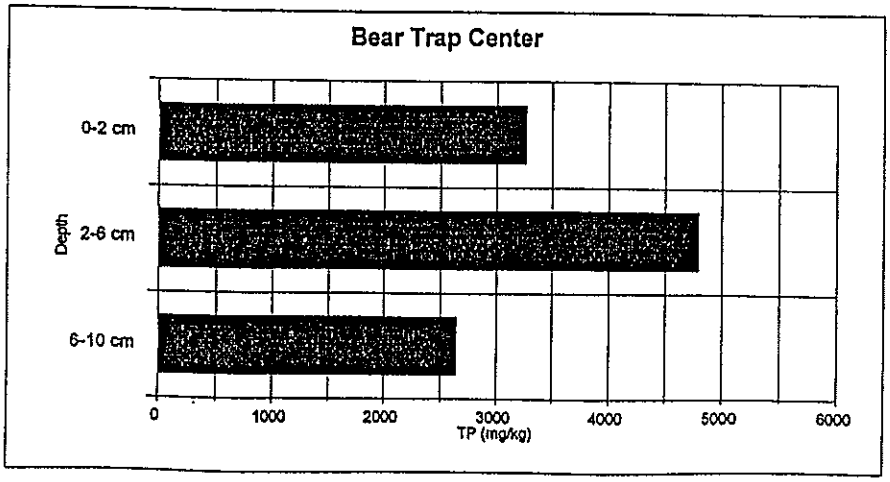


Figure 9. Sediment Quality Data - Total Phosphorus









Appendix A

Lake Wapogasset and Bear Trap Lake Sediment Quality Data— WI Laboratory of Hygiene

State Laboratory of Hygiene
University of Wisconsin Center for Health Sciences
465 Henry Mall, Madison, WI 53706
R.H. Laessig, Ph.D., Director S.L. Inhorn, M.D., Medical Director

---

Environmental Science Section (608) 262-3458 DNR LAB ID 113133790
Inorganic chemistry (#1 of 85 on 08/17/98, unseen)

Id: 493131 Point/Well/..: Field #: WS:0-2 Route: WR80
Collection Date: 05/11/98 Time: 00:00 County: 49 (Polk)
From: LAKE WAPOGASSET SOUTH BASIN SEDIMENT SAMPLE 2-6CM
To: D J RYAN
DNR Source: Sediment
SPOONER
Account number: LM004 Collected by: HUDER/JENSEN
Waterbody/permit/..: 2618000
L, P, L, 5, 1, 9
Date Received: 05/14/98 Labslip #: II022384 Reported: 08/14/98

Comment: Corrected version

ALUMINUM, ICP, DRY WT (SW846 6010B)	6900.	MG/KG
ARSENIC, ICP, DRY WT (SW846 6010B)	11.	MG/KG
COPPER, ICP, DRY WT (SW846 6010B)	110.	MG/KG
DIG 750.1, ICP, SOLIDS (SW846 3050B)	DIG MET	
IRON, ICP, DRY WT (SW846 6010B)	35000.	MG/KG
SAMPLE PREP/HANDLING I	DRIED	
TOTAL PHOSPHORUS, DRY WT (EPA 365.1)	5070.	MG/KG
PERCENT SOLIDS (SM 2540G)	7.8	%
TEMPERATURE ON RECEIPT	ICED	C

State Laboratory of Hygiene
University of Wisconsin Center for Health Sciences
465 Henry Mall, Madison, WI 53706
R.H. Laessig, Ph.D., Director S.L. Inhorn, M.D., Medical Director

---

Environmental Science Section (608) 262-3458 DNR LAB ID 113133790
Inorganic chemistry (#2 of 85 on 08/17/98, unseen)

Id: 493131 Point/Well/..: Field #: WS:2-6 Route: WR80
Collection Date: 05/11/98 Time: 00:00 County: 49 (Polk)
From: LAKE WAPOGASSET SOUTH BASIN SEDIMENT SAMPLE 2-6CM
To: D J RYAN
DNR Source: Sediment
SPOONER
Account number: LM004 Collected by: HUDER/JENSEN
Waterbody/permit/..: 2618000
L, P, L, 5, 1, 9
Date Received: 05/14/98 Labslip #: II022385 Reported: 08/14/98

ALUMINUM, ICP, DRY WT (SW846 6010B)	6300.	MG/KG
ARSENIC, ICP, DRY WT (SW846 6010B)	16.	MG/KG
COPPER, ICP, DRY WT (SW846 6010B)	94.	MG/KG
DIG 750.1, ICP, SOLIDS (SW846 3050B)	DIG MET	
IRON, ICP, DRY WT (SW846 6010B)	32000.	MG/KG
SAMPLE PREP/HANDLING I	DRIED	
TOTAL PHOSPHORUS, DRY WT (EPA 365.1)	1180.	MG/KG
PERCENT SOLIDS (SM 2540G)	7.9	%
TEMPERATURE ON RECEIPT	ICED	C

State Laboratory of Hygiene
University of Wisconsin Center for Health Sciences
465 Henry Mall, Madison, WI 53706
R.H. Laessig, Ph.D., Director S.L. Inhorn, M.D., Medical Director

---

Environmental Science Section (608) 262-3458 DNR LAB ID 113133790
Inorganic chemistry (#3 of 85 on 08/17/98, unseen)

Id: 493131 Point/Well/..: Field #: WS:6-10 Route: WR80
Collection Date: 05/11/98 Time: 00:00 County: 49 (Polk)
From: LAKE WAPOGASSET SOUTH BASIN SEDIMENT SAMPLE 6-10CM
To: D J RYAN
DNR Source: Sediment
SPOONER
Account number: LM004 Collected by: HUDER/JENSEN
Waterbody/permit/..: 2618000
L, P, L, 5, 1, 9
Date Received: 05/14/98 Labslip #: II022386 Reported: 08/14/98

ALUMINUM, ICP, DRY WT (SW846 6010B)	4200.	MG/KG
ARSENIC, ICP, DRY WT (SW846 6010B)	13.	MG/KG
COPPER, ICP, DRY WT (SW846 6010B)	27.	MG/KG
DIG 750.1, ICP, SOLIDS (SW846 3050B)	DIG MET	
IRON, ICP, DRY WT (SW846 6010B)	26000.	MG/KG
SAMPLE PREP/HANDLING I	DRIED	
TOTAL PHOSPHORUS, DRY WT (EPA 365.1)	1200.	MG/KG
PERCENT SOLIDS (SM 2540G)	7.9	%
TEMPERATURE ON RECEIPT	ICED	C

State Laboratory of Hygiene
University of Wisconsin Center for Health Sciences
465 Henry Mall, Madison, WI 53706
R.H. Laessig, Ph.D., Director S.L. Inhorn, M.D., Medical Director

---

Environmental Science Section (608) 262-3458 DNR LAB ID 113133790
Inorganic chemistry (#4 of 85 on 08/17/98, unseen)

Id: Point/Well/..: Field #: WN:0-2 Route: WR80
Collection Date: 05/11/98 Time: 00:00 County: 49 (Polk)
From: LAKE WAPOGASSET/POLK CTY NORTH BASIN LAKE SEDIMENT 0-2CM
To: D J RYAN
DNR Source: Sediment
SPOONER
Account number: LM004 Collected by: HUDER/JENSEN
Waterbody/permit/..: 2618000
L, P, L, 5, 1, 9
Date Received: 05/14/98 Labslip #: II022387 Reported: 08/14/98

ALUMINUM, ICP, DRY WT (SW846 6010B)	11000.	MG/KG
ARSENIC, ICP, DRY WT (SW846 6010B)	12.	MG/KG
COPPER, ICP, DRY WT (SW846 6010B)	130.	MG/KG
DIG 750.1, ICP, SOLIDS (SW846 3050B)	DIG MET	
IRON, ICP, DRY WT (SW846 6010B)	44000.	MG/KG
SAMPLE PREP/HANDLING I	DRIED	
TOTAL PHOSPHORUS, DRY WT (EPA 365.1)	2330.	MG/KG
PERCENT SOLIDS (SM 2540G)	7.8	%
TEMPERATURE ON RECEIPT	ICED	C

State Laboratory of Hygiene
University of Wisconsin Center for Health Sciences
465 Henry Mall, Madison, WI 53706
R.H. Laessig, Ph.D., Director S.L. Inhorn, M.D., Medical Director

---

Environmental Science Section (608) 262-3458 DNR LAB ID 113133790
Inorganic chemistry (#5 of 85 on 08/17/98, unseen)

Id: Point/Well/..: Field #: WN:2-6 Route: WR80
Collection Date: 05/11/98 Time: 00:00 County: 49 (Polk)
From: LAKE WAPOGASSET NORTH BASIN SEDIMENT SAMPLE 2-6CM
To: D J RYAN
DNR Source: Sediment
SPOONER
Account number: LM004 Collected by: HUDER/JENSEN
Waterbody/permit/..: 2618000
L, P, L, 5, 1, 9
Date Received: 05/14/98 Labslip #: II022388 Reported: 08/14/98

ALUMINUM, ICP, DRY WT (SW846 6010B)	11000.	MG/KG
ARSENIC, ICP, DRY WT (SW846 6010B)	14.	MG/KG
COPPER, ICP, DRY WT (SW846 6010B)	150.	MG/KG
DIG 750.1, ICP, SOLIDS (SW846 3050B)	DIG MET	
IRON, ICP, DRY WT (SW846 6010B)	42000.	MG/KG
SAMPLE PREP/HANDLING I	DRIED	
TOTAL PHOSPHORUS, DRY WT (EPA 365.1)	1750.	MG/KG
PERCENT SOLIDS (SM 2540G)	9.0	%
TEMPERATURE ON RECEIPT	ICED	C

State Laboratory of Hygiene
University of Wisconsin Center for Health Sciences
465 Henry Mall, Madison, WI 53706
R.H. Laessig, Ph.D., Director S.L. Inhorn, M.D., Medical Director

---

Environmental Science Section (608) 262-3458 DNR LAB ID 113133790
Inorganic chemistry (#6 of 85 on 08/17/98, unseen)

Id: Point/Well/..: Field #: WN:6-10 Route: WR80
Collection Date: 05/11/98 Time: 00:00 County: 49 (Polk)
From: LAKE WAPOGASSET NORTH BASIN SEDIMENT SAMPLE 6-10CM
To: D J RYAN
DNR Source: Sediment
SPOONER
Account number: LM004 Collected by: HUDER/JENSEN
Waterbody/permit/..: 2618000
L, P, L, 5, 1, 9
Date Received: 05/14/98 Labslip #: II022389 Reported: 08/14/98

ALUMINUM, ICP, DRY WT (SW846 6010B)	13000.	MG/KG
ARSENIC, ICP, DRY WT (SW846 6010B)	15.	MG/KG
COPPER, ICP, DRY WT (SW846 6010B)	130.	MG/KG
DIG 750.1, ICP, SOLIDS (SW846 3050B)	DIG MET	
IRON, ICP, DRY WT (SW846 6010B)	43000.	MG/KG
SAMPLE PREP/HANDLING I	DRIED	
TOTAL PHOSPHORUS, DRY WT (EPA 365.1)	1310.	MG/KG
PERCENT SOLIDS (SM 2540G)	9.7	%
TEMPERATURE ON RECEIPT	ICED	C

State Laboratory of Hygiene
University of Wisconsin Center for Health Sciences
465 Henry Mall, Madison, WI 53706
R.H. Laessig, Ph.D., Director S.L. Inhorn, M.D., Medical Director

---

Environmental Science Section (608) 262-3458 DNR LAB ID 113133790
Inorganic chemistry (#7 of 85 on 08/17/98, unseen)

Id: Point/Well/..: Field #: WC:0-2 Route: WR80
Collection Date: 05/11/98 Time: 00:00 County: 49 (Polk)
From: LAKE WAPOGASSET CENTER BASIN SEDIMENT SAMPLE 0-2CM
To: D J RYAN
DNR
SPOONER
Source: Sediment
Account number: LM004 Collected by: HUDER/JENSEN
Waterbody/permit/..: 2618000
L, P, L, 5, 1, 9
Date Received: 05/14/98 Labslip #: II022390 Reported: 08/14/98

ALUMINUM, ICP, DRY WT (SW846 6010B)	9300.	MG/KG
ARSENIC, ICP, DRY WT (SW846 6010B)	18.	MG/KG
COPPER, ICP, DRY WT (SW846 6010B)	200.	MG/KG
DIG 750.1, ICP, SOLIDS (SW846 3050B)	DIG MET	
IRON, ICP, DRY WT (SW846 6010B)	52000.	MG/KG
SAMPLE PREP/HANDLING I	DRIED	
TOTAL PHOSPHORUS, DRY WT (EPA 365.1)	1620.	MG/KG
PERCENT SOLIDS (SM 2540G)	11.4	%
TEMPERATURE ON RECEIPT	ICED	C

State Laboratory of Hygiene
University of Wisconsin Center for Health Sciences
465 Henry Mall, Madison, WI 53706
R.H. Laessig, Ph.D., Director S.L. Inhorn, M.D., Medical Director

---

Environmental Science Section (608) 262-3458 DNR LAB ID 113133790
Inorganic chemistry (#8 of 85 on 08/17/98, unseen)

Id: Point/Well/..: Field #: WC:2-6 Route: WR80
Collection Date: 05/11/98 Time: 00:00 County: 49 (Polk)
From: LAKE WAPOGASSET CENTER BASIN SEDIMENT SAMPLE 2-6CM
To: D J RYAN
DNR Source: Sediment
SPOONER
Account number: LM004 Collected by: HUDER/JENSEN
Waterbody/permit/..: 2618000
L, P, L, 5, 1, 9
Date Received: 05/14/98 Labslip #: II022391 Reported: 08/14/98

ALUMINUM, ICP, DRY WT (SW846 6010B)	9600.	MG/KG
ARSENIC, ICP, DRY WT (SW846 6010B)	21.	MG/KG
COPPER, ICP, DRY WT (SW846 6010B)	58.	MG/KG
DIG 750.1, ICP, SOLIDS (SW846 3050B)	DIG MET	
IRON, ICP, DRY WT (SW846 6010B)	36000.	MG/KG
SAMPLE PREP/HANDLING I	DRIED	
TOTAL PHOSPHORUS, DRY WT (EPA 365.1)	855.	MG/KG
PERCENT SOLIDS (SM 2540G)	10.8	%
TEMPERATURE ON RECEIPT	ICED	C

State Laboratory of Hygiene
University of Wisconsin Center for Health Sciences
465 Henry Mall, Madison, WI 53706
R.H. Laessig, Ph.D., Director S.L. Inhorn, M.D., Medical Director

---

Environmental Science Section (608) 262-3458 DNR LAB ID 113133790
Inorganic chemistry (#9 of 85 on 08/17/98, unseen)

Id: Point/Well/..: Field #: WC:6-10 Route: WR80
Collection Date: 05/11/98 Time: 00:00 County: 49 (Polk)
From: LAKE WAPOGASSET CENTER BASIN SEDIMENT SAMPLE 6-10CM
To: D J RYAN
DNR
SPOONER
Source: Sediment
Account number: LM004 Collected by: HUDER/JENSEN
Waterbody/permit/..: 2618000
L, P, L, 5, 1, 9
Date Received: 05/14/98 Labslip #: II022392 Reported: 08/14/98

ALUMINUM, ICP, DRY WT (SW846 6010B)	6900.	MG/KG
ARSENIC, ICP, DRY WT (SW846 6010B)	15.	MG/KG
COPPER, ICP, DRY WT (SW846 6010B)	39.	MG/KG
DIG 750.1, ICP, SOLIDS (SW846 3050B)	DIG MET	
IRON, ICP, DRY WT (SW846 6010B)	38000.	MG/KG
SAMPLE PREP/HANDLING I	DRIED	
TOTAL PHOSPHORUS, DRY WT (EPA 365.1)	1260.	MG/KG
PERCENT SOLIDS (SM 2540G)	9.5	%
TEMPERATURE ON RECEIPT	ICED	C

State Laboratory of Hygiene
University of Wisconsin Center for Health Sciences
465 Henry Mall, Madison, WI 53706
R.H. Laessig, Ph.D., Director S.L. Inhorn, M.D., Medical Director

---

Environmental Science Section (608) 262-3458 DNR LAB ID 113133790
Inorganic chemistry (#10 of 85 on 08/17/98, unseen)

Id: 493122 Point/Well/..: Field #: BC:0-2 Route: WR80
Collection Date: 05/11/98 Time: 00:00 County: 49 (Polk)
From: BEAR TRAP LAKE CENTER BASIN SEDIMENT SAMPLE 0-2CM
To: D J RYAN
DNR
SPOONER
Source: Sediment
Account number: LM004 Collected by: HUDER/JENSEN
Waterbody/permit/..: 2618100
L, P, L, 5, 1, 9
Date Received: 05/14/98 Labslip #: II022393 Reported: 08/14/98

ALUMINUM, ICP, DRY WT (SW846 6010B)	7100.	MG/KG
ARSENIC, ICP, DRY WT (SW846 6010B)	18.	MG/KG
COPPER, ICP, DRY WT (SW846 6010B)	430.	MG/KG
DIG 750.1, ICP, SOLIDS (SW846 3050B)	DIG MET	
IRON, ICP, DRY WT (SW846 6010B)	44000.	MG/KG
SAMPLE PREP/HANDLING I	DRIED	
TOTAL PHOSPHORUS, DRY WT (EPA 365.1)	3270.	MG/KG
PERCENT SOLIDS (SM 2540G)	5.2	%
TEMPERATURE ON RECEIPT	ICED	C

State Laboratory of Hygiene
University of Wisconsin Center for Health Sciences
465 Henry Mall, Madison, WI 53706
R.H. Laessig, Ph.D., Director S.L. Inhorn, M.D., Medical Director

---

Environmental Science Section (608) 262-3458 DNR LAB ID 113133790
Inorganic chemistry (#11 of 85 on 08/17/98, unseen)

Id: 493122 Point/Well/..: Field #: BC:2-6 Route: WR80
Collection Date: 05/11/98 Time: 00:00 County: 49 (Polk)
From: BEAR TRAP LAKE CENTER BASIN SEDIMENT SAMPLE 2-6CM
To: D J RYAN
DNR
SPOONER
Source: Sediment
Account number: LM004 Collected by: HUDER/JENSEN
Waterbody/permit/..: 2618100
L, P, L, 5, 1, 9
Date Received: 05/14/98 Labslip #: II022394 Reported: 08/14/98

ALUMINUM, ICP, DRY WT (SW846 6010B)	7600.	MG/KG
ARSENIC, ICP, DRY WT (SW846 6010B)	16.	MG/KG
COPPER, ICP, DRY WT (SW846 6010B)	420.	MG/KG
DIG 750.1, ICP, SOLIDS (SW846 3050B)	DIG MET	
IRON, ICP, DRY WT (SW846 6010B)	43000.	MG/KG
SAMPLE PREP/HANDLING I	DRIED	
TOTAL PHOSPHORUS, DRY WT (EPA 365.1)	4800.	MG/KG
PERCENT SOLIDS (SM 2540G)	5.7	%
TEMPERATURE ON RECEIPT	ICED	C

State Laboratory of Hygiene
University of Wisconsin Center for Health Sciences
465 Henry Mall, Madison, WI 53706
R.H. Laessig, Ph.D., Director S.L. Inhorn, M.D., Medical Director

---

Environmental Science Section (608) 262-3458 DNR LAB ID 113133790
Inorganic chemistry (#12 of 85 on 08/17/98, unseen)

Id: 493122 Point/Well/..: Field #: BC:6-10 Route: WR80
Collection Date: 05/11/98 Time: 00:00 County: 49 (Polk)
From: BEAR TRAP LAKE CENTER BASIN SEDIMENT SAMPLE 6-10CM
To: D J RYAN
DNR Source: Sediment
SPOONER
Account number: LM004 Collected by: HUDER/JENSEN
Waterbody/permit/..: 2618100
L, P, L, 5, 1, 9
Date Received: 05/14/98 Labslip #: II022395 Reported: 08/14/98

ALUMINUM, ICP, DRY WT (SW846 6010B)	8500.	MG/KG
ARSENIC, ICP, DRY WT (SW846 6010B)	17.	MG/KG
COPPER, ICP, DRY WT (SW846 6010B)	420.	MG/KG
DIG 750.1, ICP, SOLIDS (SW846 3050B)	DIG MET	
IRON, ICP, DRY WT (SW846 6010B)	43000.	MG/KG
SAMPLE PREP/HANDLING I	DRIED	
TOTAL PHOSPHORUS, DRY WT (EPA 365.1)	*2650	MG/KG #1
PERCENT SOLIDS (SM 2540G)	6.0	%
TEMPERATURE ON RECEIPT	ICED	C

--- Footnotes ---
Remark #1: MATRIX DUPLICATE QC EXCEEDED

Appendix B

Sediment Quality Guidelines:

U.S. Environmental Protection Agency
WI Department of Natural Resources
Ontario Ministry of Environment

Sediment Guidelines
Ontario

Dreading Subcommittee. 1986. A forum to review confined disposal facilities for dredged materials in the Great Lakes. Submitted to the Great Lakes Water Quality Board, 31 October 1986.

Ontario Ministry of the Environmental guidelines for open lake disposal of sediments.

Contaminant or Measurement	Guideline (ppm[a])
Arsenic	8
Cadmium	1
Chromium	25
Copper	25
Lead	50
Mercury	0.3
Nickel	25
PCBs	0.05
Zinc	100
Total phosphorus	1,000
Oil and grease	1,500
Kjeldahl nitrogen	2,000
Loss on ignition	6%[a]
Chemical oxygen demand	5%[a]

[a] Guidelines for loss on ignition and chemical oxygen demand are expressed as percentages.

Sediment Guidelines
Wisconsin

Wisconsin Department of Natural Resources. 1985. Report of the technical subcommittee on determination of dredge material suitability for in-water disposal. Madison, Wisconsin 53707

Disposal of sediments in water is prohibited if concentrations of any of the contaminants are more than 125 percent of the criteria or if the concentrations of three or more contaminants are more than 110 percent of the criteria. If one or two contaminants are found at concentrations in the range of 110-125 percent of the criteria then a decision will be made for that particular case.

Wisconsin interim criteria for sediments from Great Lakes harbors for disposal in water (from Wisconsin Department of Natural Resources 1985).

Contaminant Category	Criteria not to be exceeded (ppm: dry weight)
Pesticides	
Aldrin	0.01
Chlordane	0.01
DDT	0.01
Dieldrin	0.01
Endrin	0.05
Heptachlor	0.05
Lindane	0.05
Toxaphene	0.05
Other organics	
PCBs	0.05
2,3,7,8 TCDD	1.0 pg/g[a]
2,3,7,8 TCDF	1.0 pg/g
Metals	
Arsenic	10
Barium	500
Cadmium	1.0
Chromium	100
Copper	100
Lead	50
Mercury	0.1
Nickel	
Zinc	
Oil and grease	1,000

[a] Picograms per gram.

Sediment Guidelines
United States

Great Lakes Harbors
U.S. Environmental Protection Agency, 1977. Unpublished guidelines. Region 5. 230 S. Dearborn, Chicago, Illinois 60604.

Guidelines for the pollutional classification of Great Lakes harbor sediments (from U.S. Environmental Protection Agency 1977).

Contaminant	Nonpolluted (ppm: dry weight)	Moderately Polluted (ppm: dry weight)	Heavily Polluted (ppm: dry weight)
Ammonia	<75	75-200	>200
Arsenic	<3	3-8	>8
Barium	<20	20-60	>60
Cadmium	NE[a]	NE[a]	>75
Chemical oxygen demand	<40,000	40,000-80,000	>80,000
Chromium	<25	25-75	>75
Copper	<25	25-50	>50
Cyanide	<0.10	0.1-0.25	>0.25
Iron	<17,000	17,000-25,000	>25,000
Lead	<40	40-60	>60
Manganese	<300	300-500	>500
Mercury	<1	1	>1
Nickel	<20	20-50	>50
Phosphorus	<420	420-650	>650
PCBs	<1	1-10	>10
Volatile solids	<50,000	50,000-80,000	>80,000
Zinc	<90	90-200	>200

[a] NE = guidelines not established.