SEDIMENT ANALYSES
WINGRA CREEK
LAKE WINGRA
SPRING HARBOR

Prepared for
City of Madison
Engineering Division
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1.0
INTRODUCTION

The City of Madison received a grant from the Wisconsin Department of Natural Resources (DNR) for analyzing sediment quality along Wingra Creek and in Lake Wingra. At the same time, the City requested that two sediment samples be obtained and analyzed for quality at Spring Harbor on Lake Mendota. During meetings with the City, DNR, and Woodward-Clyde Consultants (WCC) six sites along the Creek, two sites in the Lake, and two sites at Spring Harbor were selected for sampling, and marked on 1"=200' aerial photographs. Subsequent to that meeting; the City requested WCC to collected an additional sediment sample for analysis in Lake Wingra. This site is near the Knickerbocker Street storm sewer outfall. Figures 1 and 2 show the locations of the sampling sites.

This report will:

- Describe the sampling procedures;
- Present field observations at each site;
- List the results of the laboratory analyses; and
- Discuss the results.

2.0
SAMPLING EQUIPMENT & PROCEDURES

WINGRA CREEK

A one-meter long, 5 cm. diameter, stainless steel, piston core sediment sampler was used to obtain sediment cores. Sampling sites were located using the 1" to 200' scale air photos provided by the City. Sites were probed with a 1" diameter metal rod for texture and sediment depth before sampling. At most sites more than one core sample was obtained to provide an adequate sample quantity for the analysis. At these sites, a metal pipe was inserted in the sediment to indicate the sampling site. Then one or more cores were obtained around the metal pipe.

At all sites, the sediment cores were divided into thirds for analysis. Each core was described as to color, texture, odor, presence of detritus, and macroinvertebrates. Each section was then mixed separately and thoroughly in a bucket and divided into two sample jars: one for metals analysis and another jar for pesticides analysis. Each jar was labelled and immediately placed in a cooler with ice. For sites where more than one core was obtained the corresponding layers from each core were thoroughly mixed before placement in the sample jar.

Because of sediment consolidation inside the sampler during the coring process, cores removed from the sampler were generally shorter than the sampler penetration distance. Because of this, when dividing up the core for sample analysis, the lengths were proportioned using the ratio of core length to penetration distance. If a sampler penetration of 3 feet resulted in a core sample of 2 feet, the core was segmented into thirds to for the lab analysis representing each 1-foot layer.

The sampler was cleaned with TSP and triple rinsed with deionized water between each sampling site. The samples remained on ice and were submitted to State Lab of Hygiene at 16:00 on March 24, 1992.

Photographs were taken of each sample and are in Appendix A.

LAKE WINGRA

The same basic procedures were used on the lake as in the creek except as described below.

Two sites were sampled near the middle of the lake (near the east and west ends), and one site was sampled at the Knickerbocker Street storm sewer outfall. At the Knickerbocker site two adjacent core samples were obtained to provide an adequate sample quantity for the analyses.

The east and west lake samples were placed into a sample container provided by the DNR for a series of metals analysis. Each container was labelled and kept on ice. The containers were delivered to the State Lab of Hygiene at 07:45 on April 2, 1992, the morning after sampling.

The east and west lake sampling sites were located using compass triangulation with identifiable landmarks on shore.

For the Knickerbocker site, the corresponding layers from each core were thoroughly mixed before placement in sample jars. Each layer of the Knickerbocker sediment was divided between 2 sample jars provided by Hazleton Labs. (one jar for metals and one jar for pesticide analysis). These samples were submitted to the Hazleton Labs at 08:30 on April 2, 1992.

SPRING HARBOR

The same basic procedures were used at Spring Harbor as in the Wingra Creek sites except as described below.

At site B, the soft sediment was 5.1 feet thick. A 6 foot PVC pipe with an inside diameter of 2.5 inches was inserted to a depth of 3 feet into the sediment. The piston core sampler was placed inside the PVC pipe to obtain a sample of the top 3.0 feet of

sediment. This sample was removed, and the sampler rinsed clear of sediment with lake water. The sampler was re-inserted into the PVC pipe to obtain a core of sediment from the 3-5 foot depth. The purpose of the PVC pipe was to prevent the hole from caving in so the bottom part of the core could be taken. In this manner a 6-foot core could be taken with a 3-foot sampler.

The samples remained on ice and were submitted to Hazleton Labs (Madison) the next morning (March 18, 1992).

3.0
FIELD OBSERVATIONS

WINGRA CREEK OBSERVATIONS

DATE: March 24, 1992

CONDITIONS: Sunny; Air Temperature: 28° F @ 08:00; 58° F @ 14:00

SITE: Creek-1

Location: Wingra Creek; approximately 800' upstream from Fish Hatchery Road Bridge; Directly across from house at 1321 Wingra Drive; 8' off east shore.

Site Conditions: Water Depth = 3.0'; Soft Sediment Depth > 6.0'; very soft top layer; oil sheen rose to water surface after obtaining sample.

Sample: 3' core obtained at 08:15

Sample Description:

1-A: 0 - 10"; top 1" dark silt/sand; bottom 9" light brown silt; dark streaks within this layer; sewage odor; many small white snail shells (macroinvertebrates) throughout.

1-B: 10 - 22"; very homogeneous; light brown silt/fine sand; some snail shells (fewer than in 0-10" layer); some sewage odor.

1-C: 22 - 28" grey/brown; silt/clay
28 - 32"; dark gray to black; silt
32- 33"; light brown; fine sand;
white snail shells throughout; no odor.

SITE: Creek-2:

Location: Wingra Creek; approximately 250' downstream from Fish Hatchery Road Bridge; 15' from south shore; directly across from driveway of Wisconsin Bell Station on Plaenert Drive.

Site Conditions: Water Depth = 30"; Soft Sediment Depth > 6.0'; very soft top layer.

Sample: Two 3' cores obtained at 09:15

Sample Description:

2-A: 0 - 8"; fine sand in top 1"; few shells; very homogenous clay at 2 - 8" depth; dark gray, dense fine plant root material throughout; no odor; no macroinvertebrates.

2-B: 8 - 16"; very homogenous; dark gray color; very clayey (moldable); few roots; no odor, no macroinvertebrates.

2-C: 16 - 24"; same as 8 - 16" layer except bottom 0.5" is fine-medium sand texture; light brown color; no odor, no macroinvertebrates

SITE: Creek-3

Location: Wingra Creek; approximately 20' downstream from Beld Street Bridge; mid channel.

Site Conditions: Water Depth = 12"; Firm bottom; sandy; no soft sediment.

Sample: Four 1.5' cores obtained at 10:30

Sample Description:

3-A: 0 - 5"; very coarse sand and gravel; petroleum odor; black color; no macroinvertebrates.

3-B: 5 - 10"; sand texture, black color, no odor, no macroinvertebrates.

3-C: 10-15; sand, some silt, black color, some garbage (glass, plastic); no odor, no macroinvertebrates.

SITE: Creek-4

Location: Wingra Creek; Approximately 450' downstream from R.R. bridge; straight out from corner fence post of City Public Works drive entrance; 15' off north shore.

Site Conditions: Water Depth = 7"; Soft Sediment Depth > 6.0'.

Sample: Two 3' cores obtained at 11:45

Sample Description:

4-A: 0 - 2"; dark black/gray color; silt/fine sand texture;
2 - 9"; light gray color; clay texture, very homogenous; petroleum odor, no macroinvertebrates.

4-B: 9 - 12"; dark gray color; very clayey (moldable)
12 - 15"; sand texture; dark color
15 - 18"; clay texture; black/dark gray;
no odor, no macroinvertebrates throughout 4-B sample

4-C: 18 - 27"; dark gray; sandy/ silt/clay mix; streaks of light grey sand throughout; no odor, no macroinvertebrates.

SITE: Creek-5

Location: Wingra Creek; Approximately 450' downstream from footbridge; (700' downstream from site 4); Directly out from left field corner fence post of baseball diamond; 20' off north shore.

Site Conditions: Water Depth = 9"; Soft Sediment Depth > 6.0'. Cattail growth along north shore of creek.

Sample: Three 3' cores obtained at 13:15

Sample Description:

5-A: 0 - 2.5"; sand texture; dark gray/black;
2.5 - 5"; clay/silt/sand mix; dark gray/black color; some detritus; no odor, no macroinvertebrates.

5-B: 5 - 10"; clay; black/dark gray color; no odor, no macroinvertebrates

5-C: 10-15"; sand/silt/clay mix; light gray/brown color; no odor, no macroinvertebrates; no detritus.

SITE: Creek-6

Location: Wingra Creek; Approximately 20' upstream of Olin Avenue Bridge; 8' off southwest shore.

Site Conditions: Water Depth = 2.0'; Very soft sediment, Depth > 6.0'; water very murky and black bottom.

Sample: Two 3' cores obtained at 14:00

Sample Description:

6-A: 0 - 2"; black color; detritus; clay
2 - 7"; clay texture; gray color; darker gray at 7" no odor, no macroinvertebrates throughout 6-A layer.

6-B: 7 - 10"; sandy texture, black color
10 - 15"; clay texture, gray color; no odor, no macroinvertebrates throughout 6-B layer.

6-C: 14 - 21"; clay texture, gray color; no odor, no macroinvertebrates.

LAKE WINGRA OBSERVATIONS

DATE: April 1, 1992

CONDITIONS: Overcast sky, winds 10-15 mph from the NW; Air Temperature: 30-35° F.; no ice on lake.

SITE: Lake-1

Location: Lake Wingra; Approximately 1,300' at 185° south from dock at Wingra Park.

Site Conditions: Water Depth = 9.5'; Very Soft Sediment, Sediment Depth > 10.0';

Sample: One core obtained at 12:00; Probe was pushed through 10' of sediment; no firm bottom was reached.

Sample Description:

1-A: 0 - 4"; dark gray; very soft; paste consistency; no clay/silt or sand; no odor; no macroinvertebrates.

1-B: 4 - 7"; very dark gray; very soft; paste consistency; no clay/silt or sand; no odor; no macroinvertebrates.

7 - 8"; light brown color; past consistency; many white shells (macroinvertebrates) throughout; slight humus/sewer odor.

1-C: 8 - 12"; light brown color; past consistency; many white shells throughout; humus/sewer odor.

SITE: Lake-2

Location: Lake Wingra; Approximately 1,900' at 125° south from bridge on Vilas Park Drive, in Vilas Park.

Site Conditions: Water Depth = 9.0'; Very Soft Sediment, Depth > 6.0';

Sample: One core obtained at 14:36; Probe was pushed through 6.0' of sediment; no firm bottom was reached.

Sample Description:

2-A: 0 - 4"; light brown color, paste consistency, not moldable; white shells throughout sample, some roots, no detritus, slight humus smell.

2-B 4 - 8"; same description as "2-A" layer

2-C 8 - 12"; somewhat firmer material than the 0 - 8" layer; no clay/silt/or sand present; paste consistency, not moldable; white shells throughout sample, some roots, no detritus, slight humus smell.

SITE: Lake-3

Location: Lake Wingra; Approximately 50' due south of Knickerbocker Street storm sewer outfall.

Site Conditions: Water Depth = 0.5'; Firm, sandy bottom; sand layer about 0.5 - 1.0' deep; then softer, silt layer below.

Sample: Two 3' cores obtained at 15:45; oil sheen on surface of water after sample obtained.

Sample Description:

3-A: 0 - 4"; black/dark gray color; sand texture, some small stones; some roots, no odor, no macroinvertebrates.

3-B: 4 - 8"; black/dark gray color, sand texture, faint oil smell; no macroinvertebrates.

3-C: 8 - 10"; light color sand; oil odor; no macroinvertebrates
10 - 12"; grey color; sand/silt/clay mix; oil odor; no macroinvertebrates.

SPRING HARBOR OBSERVATIONS

DATE: March 17, 1992

CONDITIONS: Sunny, Air temperature: 45 deg F.
Lake Mendota water level: 849.72 ft. March 17, 1992 @ 8:00 am
Open-water conditions; minor amount of shelf ice along east shore of Spring Harbor.

4.0
LABORATORY RESULTS

Sediment samples were analyzed and results are shown on tables 1, 2, and 3. The lab reports with the analyses results are found in Appendix B.

The results of the sediment analysis are compared to guideline levels used by the Great Lakes International Joint Commission and the WDNR. The "non-polluted" levels are used by the agencies to define what may be described as "clean" or "unpolluted" sediment. These levels approximate background concentrations in lake bed sediment unaffected by cultural activities. Table 4 shows results of metals in sediment from other sites around Wisconsin. This table helps to put the results from the Madison sites in perspective. The sites shown in Table 4 were specifically selected by DNR to represent relatively uncontaminated environmental conditions.

5.0
DISCUSSION

INTRODUCTION

The analysis of the sediment was for "total" concentration of each parameter. The sediments are subjected to a rigorous digestion process to extract all the possible metal or organic compound from the sediments. This test does not necessarily indicate how much of the material is available to the water in its environment.

A laboratory analysis known as the "Toxicity Characteristic Leaching Procedure" (TCLP) is used when determining the potential for a contaminant to leach out of a sediment during dredging and land disposal operations. The TCLP test can be required by regulatory agencies before dredging of severely contaminated sites is permitted.

The sediment in Spring Harbor, Lake Wingra, and Wingra Creek has been influenced by cultural activities. Spring Harbor receives the runoff from a large portion of west Madison including the commercial area around West Towne Mall. Runoff from lawns, streets, parking lots, and roof tops contain heavy metals and organic compounds. Wingra Creek runs through an industrial area of Madison, and through an old landfill near Olin Avenue.

WINGRA CREEK SEDIMENT

With a few exceptions, the metals concentrations in these samples are generally in the range of or below the comparative levels for "clean" sediment. Lead levels were elevated in six samples with one very high concentration at the middle level of site 6 (near the Olin Avenue bridge). Lead levels can be very high if the sediment sample contained a piece of metal containing lead. The digestion process in the analysis will dissolve the metal and result in a very high concentration. This is the likely explanation for the single very high lead concentration at this site. Also the proximity of the site to

the road and the old landfill support this explanation. If this becomes problematic, another sample in the immediate vicinity should be collected and analyzed.

The organic compound concentrations also were generally at low levels. With one exception (middle level of site 5) the PCB concentrations were below detection. Some detections were also made of op- and pp- DDD, DDT, and DDE. These detections were mostly at the sites along Franklin Field, which is the site of an old landfill. This material, if dredged, may have to be disposed of in a landfill if the DNR rules it a "designated hazardous waste product" (Rick Pager, Waste Management, verbal commun., 6 Aug 1992). However, if this material is mixed with "cleaner" dredge spoils from elsewhere, and thereby diluted, special disposal may not be required.

LAKE WINGRA SEDIMENT

Again, the metals concentrations are generally in the low range. Arsenic concentrations are slightly elevated in the western lake site. Lead concentrations are highest near the Knickerbocker storm sewer outfall. The likely reason for this is the deposition of street sediments during runoff periods at this site. These lead levels are commonly found in urban environments.

The detection limits for some organic compounds found near the Knickerbocker outfall were above the "clean" values provided by DNR. DDD concentrations were higher than any found in Wingra Creek. Because of the relatively high concentrations of Lead and DDD, special disposal methods may be required by the DNR. However, if this material is mixed with "cleaner" dredge spoils from elsewhere, and thereby diluted, special disposal may not be required.

SPRING HARBOR SEDIMENT

Lead levels in Spring Harbor are higher than "clean" levels, although this level is to be expected given the watershed above the harbor. Studies have shown that high volumes of automobile traffic and commercial land use commonly contribute high concentrations of lead in the runoff waters (NURP, 1983, and Roger Bannerman, DNR, personal communication). It is believed that the major source of this lead was the leaded

gasoline. Since the cessation of leaded gasoline, the lead concentrations in runoff waters is expected to decline.

Chlordane was detected well above background concentrations as was DDD at Site A near the storm sewer outfall. However, if this material is mixed with "cleaner" dredge spoils from the rest of Spring Harbor, special disposal may not be required.

6.0
REFERENCES

Bannerman, et al. 1983. Evaluation of Urban Nonpoint Source Polluting in Milwaukee County, Wisconsin, Volume I: Urban Stormwater Characteristics, Pollutant Sources, and Management ByStreet Sweeping. Wisconsin Department of Natural Resources, Madison, Wisconsin.

Bowman, G. 1992. Personal communication, Wisconsin State Laboratory of Hygiene. Madison, Wisconsin.

International Joint Commission, 1988. Procedures for the assessment of contaminated sediment problems in the Great Lakes by the Sediment Subcommittee and its Assessment Work Group. Great Lakes Regional Office, Windsor, Ontario.

Wis. Department of Natural Resources, Bureau of Water Resources Management, 1990 and 1991. Unpublished results from Low Level Metals Study, and CMP Background Concentrations.

FIGURES

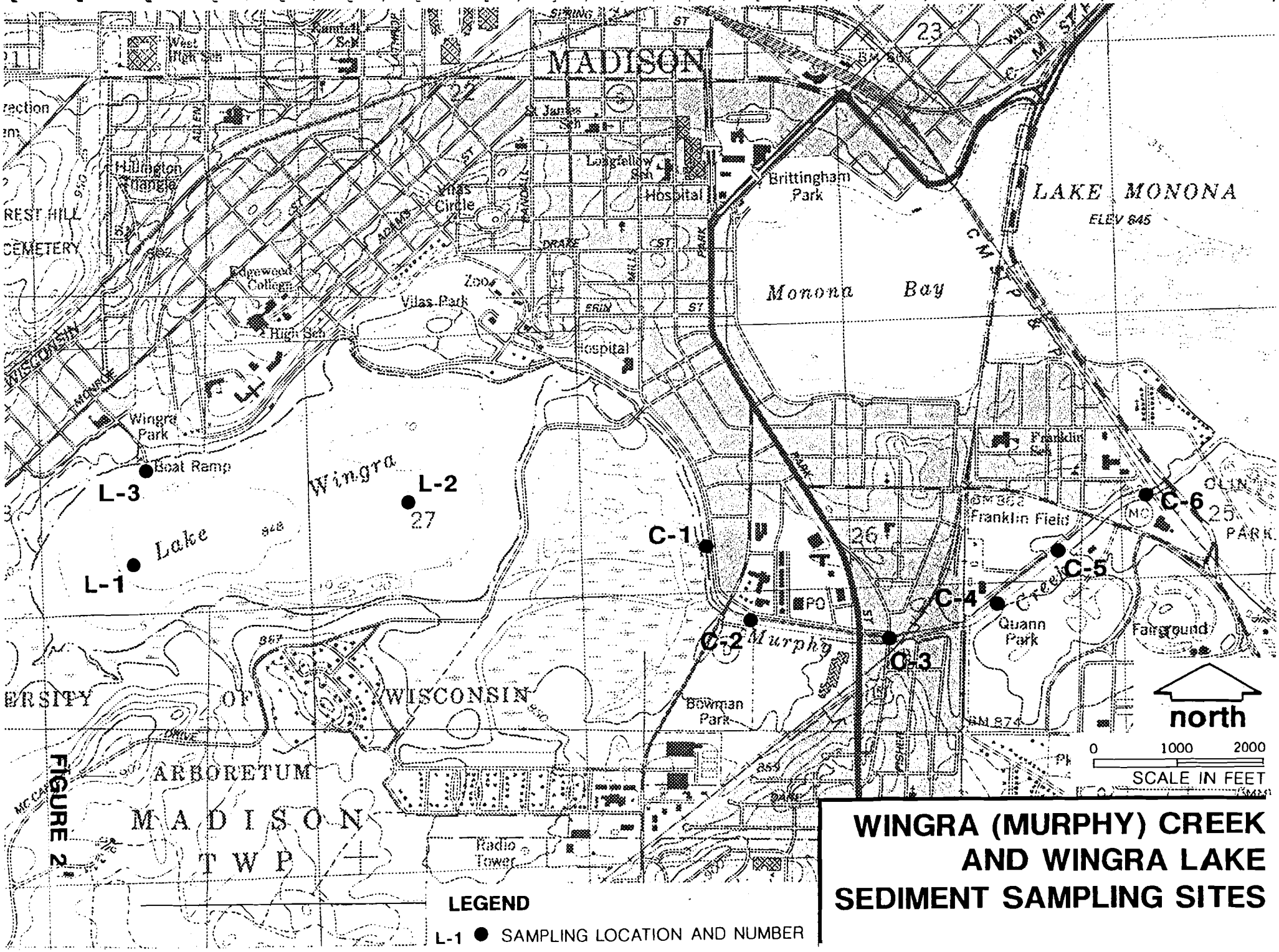

FIGURE 2

WINGRA (MURPHY) CREEK AND WINGRA LAKE SEDIMENT SAMPLING SITES

TABLES

Parameter	Site #:	1			2			3			4			5			6			"C
	Dept	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	Le
METALS																				
Arsenic		4.8	1.37	3.12	5.88	6.92	7.02	2.00	1.84	3.44	3.76	4.34	4.54	1.86	4.80	1.16	4.17	6.42	5.52	
Cadmium		< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	1	< 1	< 1	< 1	1	
Chromium		< 5	< 5	8	13	17	13	11	12	9	11	12	5	6	11	6	12	14	20	
Copper		26	5	11	17	20	17	13	13	18	19	15	7	8	12	5	24	24	17	
Mercury (3)		<.02	<.02	<.02	.02	0.03	<.02	.02	0.03	0.04	0.04	0.26	0.03	0.02	0.07	<.02	0.04	0.04	0.03	
Nickel		7	< 5	9	16	16	13	36	6	< 5	9	7	< 5	< 5	6	< 5	14	12	16	
Lead		< 5	< 5	< 5	< 5	< 5	< 5	57	61	140	22	50	9	20	37	< 5	51	63,000	< 5	
Zinc		14	9	24	43	49	39	81	71	73	61	79	32	35	53	12	65	46	50	
ORGANICS																				
Arochlor (4) (PCB)		<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	0.07	<.05	<.05	<.05	<.05	
Cis-Chlordane		<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	
Trans-Chlordane		<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	
op DDT		<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	
pp DDT		<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	0.08	0.22	0.34	<.01	<.01	<.01	<.01	<.01	<.01	
op DDD		<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	0.09	0.06	<.01	0.02	<.01	<.01	<.01	<.01	
pp DDD		<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	0.04	0.09	0.48	0.37	<.01	0.08	<.01	<.01	<.01	<.01	
op DDE		<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	
pp DDE		<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	0.01	0.04	0.04	.01	.01	<.01	<.01	<.01	<.01	
Dieldrin		<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	

[1] All analyses conducted at the State Laboratory of Hygiene; Madison WI

[2] These concentrations are the maximum allowable concentrations of contaminants in Great Lakes Sediments for beach nourishment and in-water disopsal - Wis. Source: Procedures for the assessment of contaminated sediment problems in the Great Lakes by the Sediment Subcommittee and its Assessment Work Group, International Joint Commission, Great Lakes Regional Office, Windsor, Ontario, December 1988.

These levels were also proposed as sediment quality guidelines in 1988 by the WDNR Bureau of Water Resources Mgmt.

[3] Mercury detection limit is 0.02 MG/KG; values between 0.02 - 0.07 are considered approximations

[4] Arochlor reported is the total PCB concentrations
Materials with PCB > 50 mg/kg must be disposed of through incineration or special permit
(USEPA: 40CFR 761.60(a)(4));
Materials with levels < 1 mg/kg may be landfilled with DNR and landfill operator permission

[5] Equivalent TCLP concentration estimate using a dilution factor of 20.

Table 2: Wingra Lake Sediment Analysis Results

(Dry Weight; mg/kg) (1)

Parameter	Site #:	1 - West			2 - East			3 - Knickerbocker			"Clean"	TCLP
	Dept	A	B	C	A	B	C	A	B	C	Level (2)	Factor(6)
METALS												
Arsenic		17.14	17.30	1.58	1.89	1.42	1.11	1.16	1.32	15.3	10	100
Cadmium		<1	<1	<1	<1	<1	<1	<1.18	<1.20	<1.22	1.0	20
Chromium		21	22	27	18	15	12	8.15	71.8	8.58	75	100
Copper		12	9	4	3	5	2	6.65	8.49	8.32	50	2000
Mercury (3)		0.07	0.04	<.02	<.02	<.02	<.02	0.021	0.026	0.018	0.1	4
Nickel		8	8	<5	<5	<5	<5	<9.45	<9.59	<9.80	50	700
Lead		43	17	<5	5	<5	<5	**110**	**182**	**187**	50	100
Zinc		63	44	14	11	11	10	95.0	61.6	49	100	4000
ORGANICS (5)												
Arochlor (4) (PCB)								<1.3	<1.2	<1.3	0.5 (4)	
Cis-Chlordane								<.044	0.047	<.044	0.01	0.20
Trans-Chlordane								<.044	<.042	<.044	0.01	0.20
op DDT								<.084	<.082	<.084	0.01	
pp DDT								<.084	<.082	<.084	0.01	
op DDD								**0.27**	<.082	<.084		
pp DDD								**2.30**	**0.73**	<.084		
op DDE								<.084	<.082	<.084	0.01	
pp DDE								<.084	<.082	<.084	0.01	
Dieldrin								<.084	<.082	<.084	0.01	

(1) Analysis for sites 1 and 2 conducted at the State Laboratory of Hygiene; analysis for site 3 conducted at Hazleton Laboratories, Madison, Wisconsin. Reported as dry weight

(2) These concentrations are the maximum allowable concentrations of contaminants in Great Lakes Sediments for beach nourishment and in-water disopsal - Wis. Source: Procedures for the assessment of contaminated sediment problems in the Great Lakes by the Sediment Subcommittee and its Assessment Work Group, International Joint Commission, Great Lakes Regional Office, Windsor, Ontario, December 1988.

The levels were also proposed as sediment quality guidelines in 1988 by the WDNR Bureau of Water Resources Management

(3) Mercury detection limit for sites 1 and 2 is 0.02 MG/KG; values between 0.02 - 0.07 are considered approximations

(4) Arochlor reported is the total PCB concentrations

Materials with PCB > 50 mg/kg must be disposed of through incineration or special permit (USEPA: 40CFR 761.60(a)(4));
Materials with levels < 1 mg/kg may be landfilled with DNR and landfill operator permission

(5) Per request of the City, organics analyses were conducted only for the sample at the Knickerbocker storm sewer outfall

Table 4: Sediment Metal Concentrations from Wisconsin Sites

(Dry Weight, mg/kg)

Site	Arsenic	Cadmium	Chromium	Copper	Mercury	Nickel	Lead	Zinc
Upper Eau Claire	15.5	1.48	40	36	0.14	14	72	93
Mecan Springs	2.13	0.20	65	6	0.04	<5	7.6	18
Black R. (Medford)	1.73	0.66	19	10	0.07	13	5	98
Wolf R. (Hwy 52)	3.56	0.30	16	6	0.05	6	6	48
Flambeau R.	4.82	1.16	30	17	0.16	17	16	120
Bit Carr Lake	15.57	2.90	25	37	0.21	18	150	180
Namekogan r.	13.39	1.76	45	35	0.19	16	76	140
Nemadji R.	3.41	0.20	16	17	0.03	17	9.2	38
Port Wing	3.9	<1	13	14	0.03	8	<5	24
L. Winnebago	6.1	<1	30	20	0.03	13	40	66
(Northeast bay)								
Port Washington Bluff	1.6	<1	<5	8	<.02	6	<5	28
Pensaukee R.	1.2	<1	5	5	0.02	<5	<5	18
Peshtigo R. (Hwy 41)	6.9	<1	17	11	0.06	7	12	58
Menominee R.	12	<1	26	80	2.40	22	33	130
(at Hwy 8)								
Menominee R.	5	<1	14	12	0.08	13	7	66
(above Niagra)								
Bois Brule Bluff	5.4	<1	32	38	0.07	29	<5	57
Mink R.	1.9	<1	8	7	0.03	5	100	16
Spring Harbor	2.0	<1.3	9.0	13.6	0.03	<12	109	62
Wingra Creek	7.0	1.0	20	26	0.26	36	63000	81
Lake Wingra	17.3	<1.2	72	12	0.07	8	187	95

Source: WDNR Bureau of Water Resources Management: 1991 Low Level Metals Study; and 1990, CMP Background Concentrations