Illinois Environmental Protection Agency

Final Stage III Report

Waukegan Harbor Remedial Action Plan

Waukegan, Illinois

July, 1999

CITIZENS ADVISORY GROUP · WAUKEGAN ·

WAUKEGAN HARBOR REMEDIAL ACTION PLAN

STAGE III

STATUS AND UPDATE - 1998

ACKNOWLEDGEMENTS

This report was accomplished in part with the assistance of Hey and Associates of Libertyville, Illinois. Photos were provided by the Waukegan Historical Society.

UPDATES AVAILABLE

Information pertinent to the Remedial Action Plan is continually becoming available for the Area of Concern and the Expanded Study Area. Updated information and documents are available through the Illinois Environmental Protection Agency, Office of Community Relations, Greg Michaud, P.O. Box 19276, 1021 North Grand Avenue (East), Springfield, Illinois 62794-9276. Additional information can be found on the **Waukegan Harbor Citizens' Advisory Group (CAG) Home Page** at:

http:// www.nsn.org/wkkhome/iepa

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I. INTRODUCTION

Waukegan Harbor, Illinois was designated an area of concern (or AOC) in 1981 by the International Joint Commission (IJC), the United States Environmental Protection Agency (USEPA), and the Illinois Environmental Protection Agency (IEPA). This designation as an AOC was prompted by the discovery of high levels of polychlorinated biphenyls (PCBs) in harbor sediments.

The Great Lakes Water Quality Agreement (GLWQA) required state and provincial governments to designate geographic Areas of Concern on the Great Lakes where conditions have caused or are likely to cause the impairment of beneficial uses. The GLWQA further required that a Remedial Action Plan (RAP) be submitted to the public and to the International Joint Commission (IJC) for review and comment at three stages:

1. When a definition of the problem at the AOC has been completed;
2. When remedial and regulatory measures are selected; and
3. When monitoring indicates that identified beneficial uses have been restored.

A Citizens Advisory Group (CAG) was formed by the IEPA in 1990 to provide recommendations on the development and implementation of the RAP. The Waukegan CAG is made up of business, civic, education, environment, government, industry, and recreation interests in the area. As part of the overall environmental assessment process, the CAG and the IEPA have worked together to identify potential pollution sources in the Waukegan area beyond PCB contamination in the harbor. The Stage I RAP identified an expanded study area (ESA) beyond the harbor proper (Fig. 1.1.).

The CAG currently consists of representatives from 28 organizations (Table 1.1.) plus unaffiliated individuals. The CAG has sponsored several activities aimed at heightening public awareness of the environmental conditions near the harbor and lakeshore areas. This group is a prime example of how public-private partnerships can resolve water quality problems. The CAG's active participation has accelerated the restoration of formerly impaired uses. A number of subcommittees and workgroups have been formed within the CAG to provide assistance with specific RAP topics or CAG activities.

This report serves as an update for the Remedial Action Plan process to meet local expectations in restoring environmental conditions leading to the de-listing of Waukegan Harbor as an Area of Concern (AOC). Previous Stage I and II documents provide extensive information on the Area of Concern (AOC) and Expanded Study Area (ESA). This Stage III report is presented to provide updated information on progress. Additional updates will be provided on the Waukegan Harbor Citizens Advisory Group Home Page at http://www.nsn.org/wkkhome/iepa and ocassional printed reports.

Figure 1.1 The Watershed Tributary to the Waukegan Expanded Study Area for the Waukegan Remedial Action Plan.

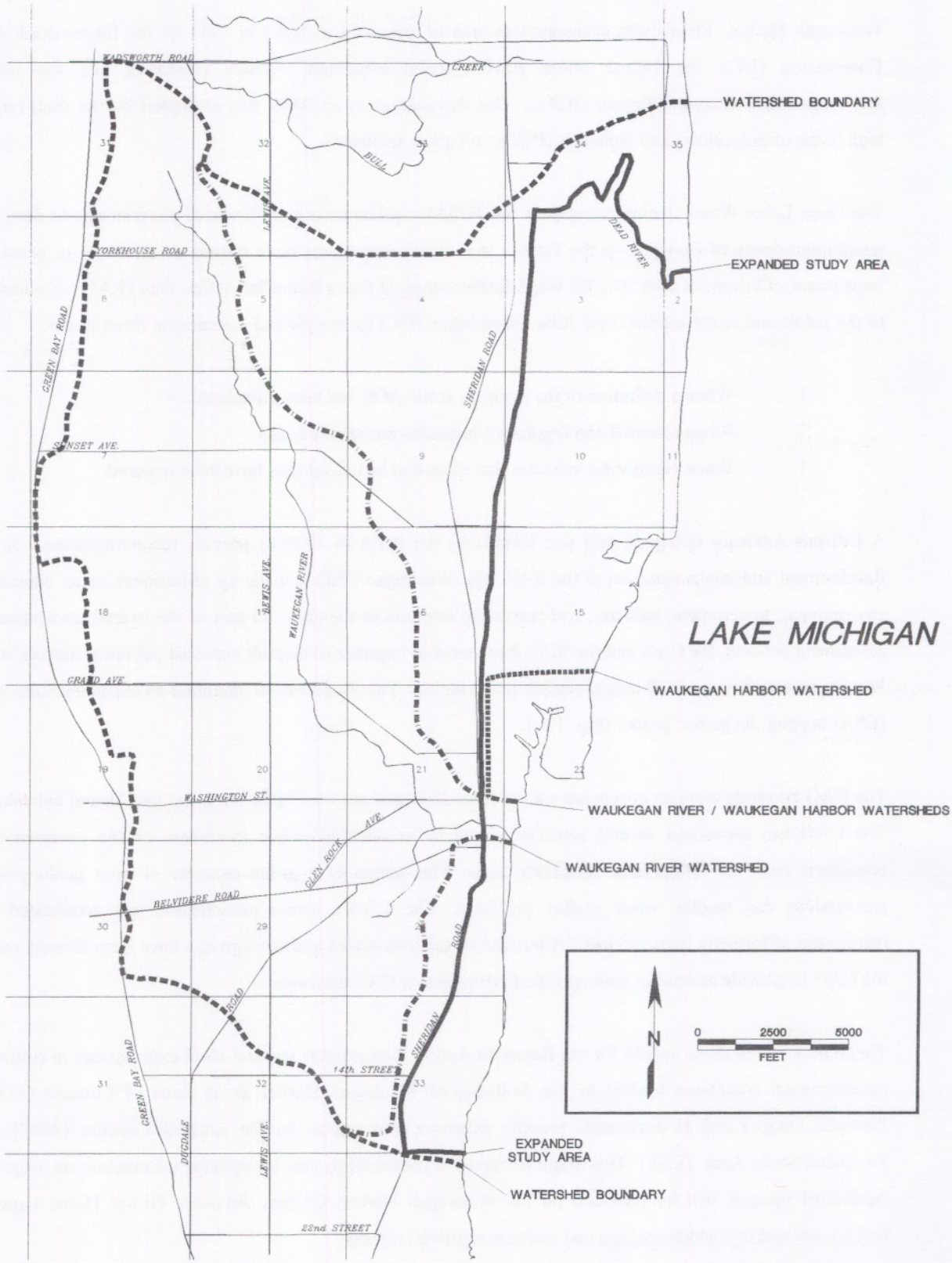
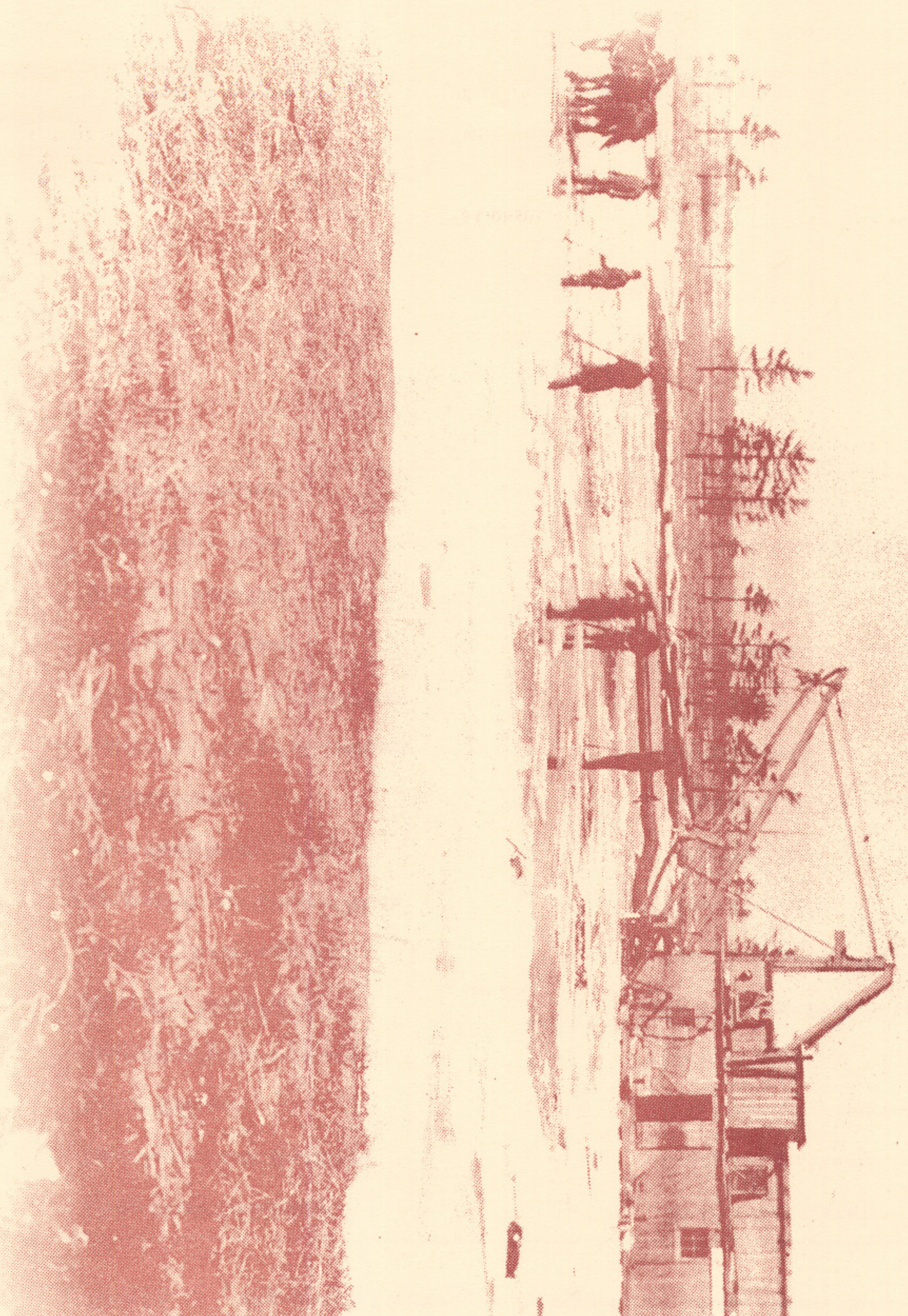


Table 1.1. Organizations Comprising the Waukegan Harbor Citizens Advisory Group - 1998

Liberty Prairie Conservancy	Illinois Audubon Society
Lake County Health Department	College of Lake County
City of Waukegan	Lake Michigan Federation
Great Lakes Sport Fishing Council	LaFarge Corporation
Sierra Club, Illinois Chapter	Waukegan Park District/Historical Society
Outboard Marine Corporation	Lake County Department of Planning
League of Women Voters of Illinois	Dexter Corporation
North Shore Sanitary District	North Shore Gas
Salmon Unlimited	Commonwealth Edison Company
Lake County Chamber of Commerce	City of North Chicago
Waukegan Charter Boat Association	Larsen Marine
Waukegan Port District	Northeastern Illinois Planning Commission
Waukegan Yacht Club	E.J. & E. Railroad
Levine, Fricke, Recon	Tanner Environmental Co.
Citizen Representatives	



2. ENVIRONMENTAL STATUS

This Remedial Action Plan (RAP) relies on an "ecosystem approach" for identifying remediation needs and plans within the Expanded Study Area (ESA). The ecosystem approach considers the impairment of beneficial water resource uses within the ESA as well as contaminant sources and loadings. The International Joint Commission has developed criteria for the identification of use impairments (Table 2.1.), and the current use impairments identified within the Waukegan ESA were determined through the application of these criteria weighed against local goals.

Once the use impairments were defined, the environmental condition of the harbor was identified using existing monitoring data. Data reviewed included water quality, sediment quality, biomonitoring, benthic community assessments, and environmental contaminant monitoring data for sediments and fish.

The organization of this chapter reflects the above described use impairment procedure. Section 2.1. Impaired Uses, describes use impairments identified through documented observations. Sections 2.2. through 2.4. discuss the nature and extent of contamination associated with the identified use impairments. Updated information has been included to reflect changes to conditions that have occurred since publication of the Stage I and II RAP report in December, 1994.

2.1. IMPAIRED USES

Five use impairments have been identified for the Waukegan ESA based on the listing criteria approved by the IJC (1991). These impairments are shown in Table 2.2. Impairments include benthos degradation, restrictions on dredging, beach closings, degradation of phytoplankton and zooplankton populations, and loss of fish and wildlife habitat.

2.1.1. Restrictions on Fish and Wildlife Consumption

Substantial progress has been made at Waukegan Harbor since 1981, when the Illinois Department of Public Health first recommended that fish caught in the harbor not be eaten. The Lake County Health Department thereafter had posted signs in the harbor area warning that consumption of fish taken from the north portion of Waukegan Harbor may be dangerous to human health. After cleanup of high-concentration PCBs in the North Harbor sediments in 1993, the Lake County Health Department updated the warning signs. Even as recently as 1993, IDOC Fishing Information regulations (IDOC, 1993) had noted that "the Department of Public Health advises that no fish from Waukegan Old North Harbor be consumed". However, by 1996, evidence of a dramatic turnaround in the condition of fish from North Harbor was noted. Levels of PCBs in fish taken

Table 2.1. Guidelines for Recommending the Listing and Delisting of Great Lakes Areas of Concern (IJC, 1991).

USE IMPAIRMENT	LISTING GUIDELINE	DELISTING GUIDELINE	RATIONALE	REFERENCES
RESTRICTIONS ON FISH AND WILDLIFE CONSUMPTION	When contaminant levels in fish or wildlife populations exceed current standards, objectives or guidelines, or public health advisories are in effect for human consumption of fish or wildlife. Contaminant levels in fish and wildlife must be due to contaminant input from the watershed.	When contaminant levels in fish and wildlife populations do not exceed current standards, objectives or guidelines, and no public health advisories are in effect for human consumption of fish or wildlife. Contaminant levels in fish and wildlife must be due to contaminant input from the watershed	Accounts for jurisdictional and federal standards; emphasizes local watershed sources.	Adapted from Mack1988.
TAINTING OF FISH AND WILDLIFE FLAVOR	When ambient water quality standards, objectives, and guidelines, for the anthropogenic substance(s) known to cause tainting, are being exceeded or survey results have identified tainting of fish or wildlife flavor.	When survey results confirm no tainting of fish or wildlife flavor	Sensitive to ambient water quality standards for tainting substances; emphasizes survey results.	See American Public Health Association(1980) for survey Methods.
DEGRADED FISH AND WILDLIFE POPULATIONS	When fish and wildlife management programs have identified degraded fish or wildlife populations due to a cause within the watershed. In addition, this use will be considered impaired when relevant, field-validated, fish or wildlife bioassays with appropriate quality assurance/quality controls confirm significant toxicity from water column or sediment contaminants.	When environmental conditions support healthy, self-sustaining communities of desired fish and wildlife at predetermined levels of abundance that would be expected from the amount and quality of suitable physical, chemical and biological habitat present. An effort must be made to ensure that fish and wildlife objectives for Areas of Concern are consistent with Great Lakes ecosystem objectives and Great Lakes Fishery Commission fish community goals. Further, in the absence of community structure data, this use will be considered restored when fish and wildlife bioassays confirm no significant toxicity from water column or sediment contaminants.	Emphasizes fish and wildlife management program goals; consistent with Agreement and Great Lakes Fishery Commission goals; accounts for toxicity bioassays.	Adapted from Manny and Pacific, 1988; Wisconsin DNR, 1987; United States and Canada, 1987; Great Lakes Fishery Commission, 1980.
FISH TUMORS OR OTHER DEFORMITIES	When the incidence rates of fish tumors or other deformities exceed rates at unimpacted control sites or when survey data confirm the presence of neoplastic or preneoplastic liver tumors in bullheads or suckers.	When the incidence rates of fish tumors or other deformities do not exceed rates at unimpacted control sites and when survey data confirm the absence of neoplastic or preneoplastic tumors in bullheads or suckers.	Consistent with expert opinion on tumors; acknowledges background incidence rates.	Adapted from Mack and Smith, 1988; Black 1983; Bauman et. al., 1982.
BIRD OR ANIMAL DEFORMITIES OR REPRODUCTIVE PROBLEMS	When wildlife survey data confirm the presence of deformities (e.g. cross-bill syndrome) or other reproductive problems(e.g. egg-shell thinning) in sentinel wildlife species.	When the incidence rates of deformities(e.g. cross-bill syndrome) or reproductive problems (e.g. egg-shell thinning) in sentinel wildlife species do not exceed background levels in inland control populations	Emphasizes confirmation through survey data; makes necessary control comparisons.	Adapted from Kubiak, 1988; Miller, 1988; Wiemeyer et. al., 1984.
DEGRADATION OF BENTHOS	When the benthic macroinvertebrate community structure significantly diverges from unimpacted control sites of comparable physical and chemical characteristics. In addition, this use will be considered impaired when toxicity (as defined by relevant, field-validated, bioassays with appropriate quality assurance/quality controls) of sediment- associated contaminants at a site is significantly higher than controls.	When the benthic macroinvertebrate community structure does not significantly diverge from unimpacted control sites of comparable physical and chemical characteristics. Further, in the absence of community structure data, this use will be considered restored when toxicity of sediment-associated contaminants is not significantly higher than controls.	Accounts for community structure and composition; recognizes sediment toxicity; uses appropriate control sites.	Adapted from Reynoldson, 1988; Henry, 1988; IJC, 1988.

Table 2.1. (continued) Guidelines for Recommending the Listing and Delisting of Great Lakes Areas of Concern (IJC, 1991).

USE IMPAIRMENT	LISTING GUIDELINE	DELISTING GUIDELINE	RATIONALE	REFERENCE
RESTRICTIONS ON DREDGING ACTIVITIES	When contaminants in sediments exceed standards, criteria, or guidelines such that there are restrictions on dredging or disposal activities.	When contaminants in sediments do not exceed standards, criteria, or guidelines such that there are restrictions on dredging or disposal activities.	Accounts for jurisdictional and federal standards; emphasizes dredging and disposal activities.	Adapted from IJC, 1988
EUTROPHICATION OR UNDESIRABLE ALGAE	When there are persistent water quality problems (e.g. dissolved oxygen depletion of bottom waters, nuisance algal blooms or accumulation, decreased water clarity, etc.) attributed to cultural eutrophication.	When there are no persistent water quality problems (e.g. dissolved oxygen depletion of bottom waters, nuisance algal blooms or accumulation, decreased water clarity, etc.) attributed to cultural eutrophication.	Consistent with Annex 3 of the Agreement; accounts for persistence of problems.	United States and Canada, 1987
RESTRICTIONS ON DRINKING WATER CONSUMPTION OR TASTE AND ODOR PROBLEMS	When treated drinking water supplies are impacted to the extent that: 1) densities of disease-causing organisms or concentrations of hazardous or toxic chemicals or radioactive substances exceed human health standards, objectives or guidelines; 2) taste and odor problems are present; or 3) treatment needed to make raw water suitable for drinking is beyond the standard treatment used in comparable portions of the Great Lakes which are not degraded (i.e. settling, coagulation, disinfection).	For treated drinking water supplies: 1) when densities of disease-causing organisms or concentrations of hazardous or toxic chemicals or radioactive substances do not exceed human health objectives, standards or guidelines; 2) when taste and odor problems are absent; and 3) when treatment needed to make raw water suitable for drinking does not exceed the standard treatment used in comparable portions of the Great Lakes which are not degraded (i.e. settling, coagulation, disinfection).	Consistency with the Agreement; accounts for jurisdictional standards; practical; sensitive to increased cost as a measure of impairment.	Adapted from United States and Canada, 1987
BEACH CLOSINGS	When waters, which are commonly used for total-body contact or partial-body contact recreation, exceed standards, objectives, or guidelines for such use.	When water, which are commonly used for total-body contact of partial-body contact recreation, do not exceed standards, objectives, or guidelines for such use.	Accounts for use of waters; sensitive to jurisdictional standards; addresses water contact recreation; consistent with the Agreement.	Adapted from United States and Canada, 1987; Ontario Ministry of the Environment, 1984
DEGRADATION OF AESTHETICS	When any substance in water produces a persistent objectionable deposit, unnatural color or turbidity, or unnatural odor (e.g. oil slick, surface scum).	When the waters are devoid of any substance which produces a persistent objectable deposit, unnatural color or turbidity, or unnatural odor (e.g. oil slick, surface scum).	Emphasizes aesthetics in water; accounts for persistence.	Adapted from the Ontario Ministry of the Environment, 1984
ADDED COSTS TO AGRICULTURE OR INDUSTRY	When there are additional costs required to treat the water prior to use for agricultural purposes (i.e. including, but not limited to, livestock watering, irrigation and crop-spraying) or industrial purposes (i.e. intended for commercial or industrial applications and noncontact food processing).	When there are no additional costs required to treat the water prior to use for agricultural purposes (i.e. including, but not limited to, livestock watering, irrigation and crop-spraying) and industrial purposes (i.e. intended for commercial or industrial applications and noncontact food processing).	Sensitive to increased cost and a measure of impairment.	Adapted from Michigan DNR, 1977
DEGRADATION OF PHYTOPLANKTON AND ZOOPLANKTON POPULATIONS	When phytoplankton or zooplankton community structure significantly diverges from unimpacted control sites of comparable physical and chemical characteristics. In addition, this use will be considered impaired when relevant, field- validated, phytoplankton or zooplankton bioassays (e.g. Ceriodaphnia; algal fractionation bioassays) with appropriate quality assurance/quality controls confirm toxicity in ambient waters.	When phytoplankton and zooplankton community structure does not significantly diverge from unimpacted control sites of comparable physical and chemical characteristics. Further, in the absence of community structure data, this use will be considered restored when phytoplankton and zooplankton bioassays confirm no significant toxicity in ambient waters.	Accounts for community structure and composition; recognizes water column toxicity; uses appropriate control sites.	Adapted from IJC, 1987
LOSS OF FISH AND WILDLIFE HABITAT	When fish and wildlife management goals have not been met as a result of loss of fish and wildlife habitat due to a perturbation in the physical, chemical, or biological integrity of the Boundary Waters, including wetlands.	When the amount and quality of physical, chemical, and biological habitat required to meet fish and wildlife management goals have been achieved and protected.	Emphasizes fish and wildlife management program goals; emphasizes water component of Boundary Waters.	Adapted from Manny and Pacific, 1988

Table 2.2. Use Impairment Status within the Waukegan Expanded Study Area - 1998

		Use Is Impaired	Use Is Unimpaired	Unknown (1)
i.	Restriction on Fish and Wildlife Consumption Fish (2) Wildlife		X	 X
ii.	Tainting of Fish and Wildlife Flavor			X
iii.	Degradation of Fish and Wildlife (3) Populations (diversity and abundance, including reproduction problems			X
iv.	Fish Tumors and Other Deformities		X	
v.	Bird or Animal Deformities or Reproductive Problems			X
vi.	Degradation of Benthos	X		
vii.	Restrictions on Dredging Activities	X		
viii.	Eutrophication or Undesirable Algae		X	
ix.	Restrictions on Drinking Water Consumption or Taste and Odor Problems		X	
x.	Beach Closings	X		
xi.	Degraded Aesthetics		X	
xii.	Added Costs to Industry		X	
xiii.	Degradation of Phytoplankton and Zooplankton Populations	X		
xiv.	Loss of Fish and Wildlife Habitat	X		

(1) Additional data collection is require before a determination can be made.

(2) Specific fish consumption advisory signs at Waukegan Harbor were removed from the harbor in 1997; the lakewide fish consumption advisory remains in effect.

(3) Waukegan Harbor AOC did not contain the full compliment of expected marsh bird or amphibian species in the expected numbers. Overall the Waukegan AOC was rated as not impaired in terms of its ability to support healthy marsh bird and amphibian communities (Bird Studies Canada, 1998; Appendix 11).

from the harbor have declined significantly. Indeed, fish monitoring from both the Harbor and from Lake Michigan now show no appreciable difference in PCB concentrations in fish taken in the harbor area and in those taken from open waters of the Lake (Appendix 7).

Accordingly, in February, 1997 the signs warning anglers not to eat fish caught in the Waukegan North Harbor were removed (IEPA, 1997b). A copy of the Illinois Environmental Protection Agency news release on the sign removal is included as Appendix 1. Fish taken from the Harbor are now in the same consumption advisory categories as apply to fish caught elsewhere in Lake Michigan, and fish consumption is no longer considered an "impaired use" (see Table 2.2.). This is perhaps the most tangible measure to date of success in the clean-up of the harbor. Additional data on fish contaminant monitoring is given in Section 2.4, Fish Flesh Contamination.

Concurrent with the lifting of the warning to refrain from eating fish taken from the North Harbor, the Illinois Department of Public Health (IDPH) issued revised consumption advisories in 1997 for fish taken from Lake Michigan. The new advisories were jointly developed with five other Great Lakes states. Under the new health advisories, larger, older fish as well as bottom-feeding species are not to be eaten. For example, catfish, carp, and lake trout larger than 27″ are in the "Do Not Eat" category. Other common sport fish species have been placed in categories that range from one meal per week, to one meal per month, to one meal per every two months (Illinois Department of Health, 1997). A copy of the IDPH news release that details the current fish advisories is included as Appendix 2.

Carp have been identified as the target indicator species for the harbor since they are bottom feeders and are somewhat common in the harbor. With long term monitoring of contaminant levels over a range of sizes and particularly younger fish, an indication of overall environmental condition can be obtained. Over the years some difficulty has occurred in collecting a large number of samples.

Future fish monitoring will be directed toward obtaining a larger size range of carp to see the extent to which new generations are accumulating PCBs and to provide information on future fish consumption advisories. Each year the Illinois Department of Natural Resources publishes an update to fish consumption advisories in a booklet distributed when fishing licenses are purchased.

Hunting is not allowed in the ESA because of its urbanized nature. There have been no studies of contaminants in wildlife within the ESA.

2.1.2. Tainting of Fish Flavor

There have been no reports of tainted flavor in fish flesh in or near the area of concern. A fish flavor study using American Public Health Association (1980) methods has not been conducted.

2.1.3. Degradation of Fish and Wildlife Populations

Detailed fish and wildlife population impact studies have not been conducted in the Waukegan ESA. Detailed population studies in the area have been restricted to the annual collection of fish samples for contaminant analysis. The results of the most recent fish flesh analyses are presented in Section 2.4. Additional information may become available from a U.S. Fish and Wildlife Service (USFWS) national damage assessment of fish and wildlife impairments for Areas of Concern (AOCs) in the Great Lakes.

A number of lakewide impacts have been noted, which are likely associated with bioaccumulation, the uptake and retention of contaminants from food and the environment (Environment Canada, 1991a). Organochlorine compounds in the Great Lakes have been linked to reduced populations of double-crested cormorant and bald eagle (Environment Canada, 1991b). Double-crested cormorant populations in the Great Lakes declined in the 1970s as a result of eggshell thinning associated with DDT. Recovery of the double-crested cormorant began in the 1980s and, currently, Great Lakes cormorant populations are 20 times greater than at any other time this century. Bald eagles, as long-lived predators, are particularly susceptible to bioaccumulation and have suffered population declines in the Great Lakes starting in the 1940s (Environment Canada, 1991b). Other species which have experienced population declines associated with water and sediment contamination are otter, black-crowned night-heron, and possibly mink (Millar, personal communication, 1992). The Waukegan area is not in the natural range of the otter although it is for the bald eagle. Nesting black-crowned night-herons have been recently observed in Illinois Beach State Park. Both cormorants and mink are resident to the ESA while the bald eagle is not known to be.

Decline of native stocks of lake trout in Lake Michigan have been linked to sea lamprey predation, degradation of spawning habitat, overharvest, and changes in forage. Lake trout are currently stocked in Lake Michigan but the stocked trout do not reproduce successfully. Reasons for lack of successful reproduction by stocked fish are not well understood.

The decline of the yellow perch fishery is another problem which has come to the fore in recent years. The perch population has dwindled to the point that in 1997, Illinois authorities closed the recreational perch fishing season during the month of June, imposed stricter bag limits during other months of the year, and established a "slot" limit allowing only those fish between 8-10″ in length to be kept. An Illinois ban on

commercial and charterboat fishing for yellow perch in Illinois waters also was implemented beginning in April, 1997. Commercial harvest of yellow perch in Lake Michigan now has been banned by all the states.

The reasons for the decline are not yet understood, and research into the problem continues. Proliferation of the exotic zebra mussel is one possible cause that has been cited for the decline of the yellow perch population. Alewife predation and nutritional deficiencies are other possibilities. A multi-state, three-year project is now underway by the Lake Michigan Yellow Perch Task Group to investigate reasons for the yellow perch decline and to suggest solutions which will allow the long-term lakewide recovery of the species. The project includes research into the factors affecting the survival of young perch, as well as tagging approximately 40,000 fish in order to track their movements in the Lake. The Illinois DNR is also funding a two-year research project by an independent researcher to evaluate the potential influence of water depths and seasonal effects on the distribution of perch.

The possible natural reproduction of smallmouth bass in Waukegan Old North Harbor was observed by IEPA and IDNR during a fish collection conducted in August, 1997 (IDNR, 1997b; Appendix 3). These fish are believed to be a resident population, and are the IDNR's first observation of young of the year individuals of that gamefish species in North Harbor. Other species observed in the harbor in 1997 included northern pike, largemouth bass, smallmouth bass (yearlings), bluegill, pumpkinseed, black crappie, green sunfish, white suckers, and carp. Additional studies will be conducted to further verify the extent of natural smallmouth reproduction in the harbor.

Surveys of charter boat sport catch from the Illinois waters of Lake Michigan show greater total catch in Waukegan area waters than in Chicago area waters (Hess and Trudeau, 1990). In 1987 and 1988, overall charter boat sport catch near Waukegan was approximately 140 and 190 percent greater than that taken from near Chicago. Individual species of sport fish which were most commonly caught off Waukegan included coho salmon, chinook salmon, lake trout, rainbow trout, and brown trout.

As with charter boat fishing, pedestrian catch in the Waukegan area has been greater for many species than at other areas along the Lake Michigan shoreline in Illinois (Brofka,and Marsden, 1996). Pedestrian catch of brown trout, and chinook salmon from both the combined Commonwealth Edison Waukegan Generating Station and the Waukegan Harbor area were greater than from six other surveyed locations along the Illinois shoreline. Pedestrian catch of yellow perch in 1995 was greater at Waukegan than from all but one other Illinois location (Brofka and Marsden, 1996).

Efforts have also been underway to assess the status of marsh birds and amphibians in the AOC. A local volunteer effort Marsh Monitoring Program was initiated in 1995, coordinated through the Long Point Bird

Observatory (now Bird Studies Canada). The program was developed to monitor amphibians and marsh birds at Areas of Concern, with results being analyzed by Bird Studies Canada. This ongoing study is supported by the Great Lakes Protection Fund with local volunteer support provided through the Waukegan Harbor CAG.

Marsh bird data collected in 1995 and 1996 found thirteen species of marsh nesters, four water foragers, and five air foragers in the Waukegan AOC, indicating moderate species diversity. Densities of ten marsh nesting bird species were greater than the Great Lakes basin non-AOC averages. In total, three marsh bird indicators were present in the Waukegan AOC. Blue-winged teal abundance was above average while American Bittern and Sora were found in average abundance. Marsh nesting bird abundance was rated average overall. Amphibian diversity and amphibian indicator species were below average. Overall, the Waukegan Harbor AOC was rated as "not impaired" in terms of ability to support healthy marsh bird and amphibian communities (Appendix 11).

2.1.4. Fish Tumors or Other Deformities

There have been no reports of fish tumors or other abnormalities in Waukegan area fish. Since 1975, annual fall electrofishing surveys have been conducted either in the original harbor basin, off the mouth of the Waukegan River, or in the South Harbor south of government pier by the Illinois Department of Natural Resources to assess salmonid returns and collect fish for contaminant analysis. Collected samples do not represent bottom-feeding species. Examinations of subsamples of collected fish have not identified any internal or external tumors or abnormalities. It is not expected that fish tumors or other abnormalities are a problem in the ESA since no reports or observations have been documented.

2.1.5. Bird or Animal Deformities or Reproduction Problems

There is no available information on bird or animal deformities or reproduction problems in the Waukegan ESA (Millar, 1991). Studies have shown that levels of toxicity similar to those levels formerly found in Waukegan Harbor have produced adverse effects, reproductive failure, and gross deformities on wildlife. Ranch raised mink experienced reproductive failure and elevated kit mortality when fed PCB-containing fish (Environment Canada, 1991a; Fitchko, 1986). Organochlorine compounds, especially DDT and DDE, are correlated with eggshell thinning and reproductive failure in double-crested cormorant and bald eagle (Environment Canada, 1991b). Contaminant-associated reproduction failure in herring gulls was attributed to altered egg incubation behavior in adult gulls. Deformities attributed to contaminant exposure include feminization of male herring gull embryos; bill deformities in common terns; tail, leg, and mouth deformities in snapping turtle; and, most notably, crossed bills in double-crested cormorants (Environment Canada, 1991b).

2.1.6. Degradation of Benthos

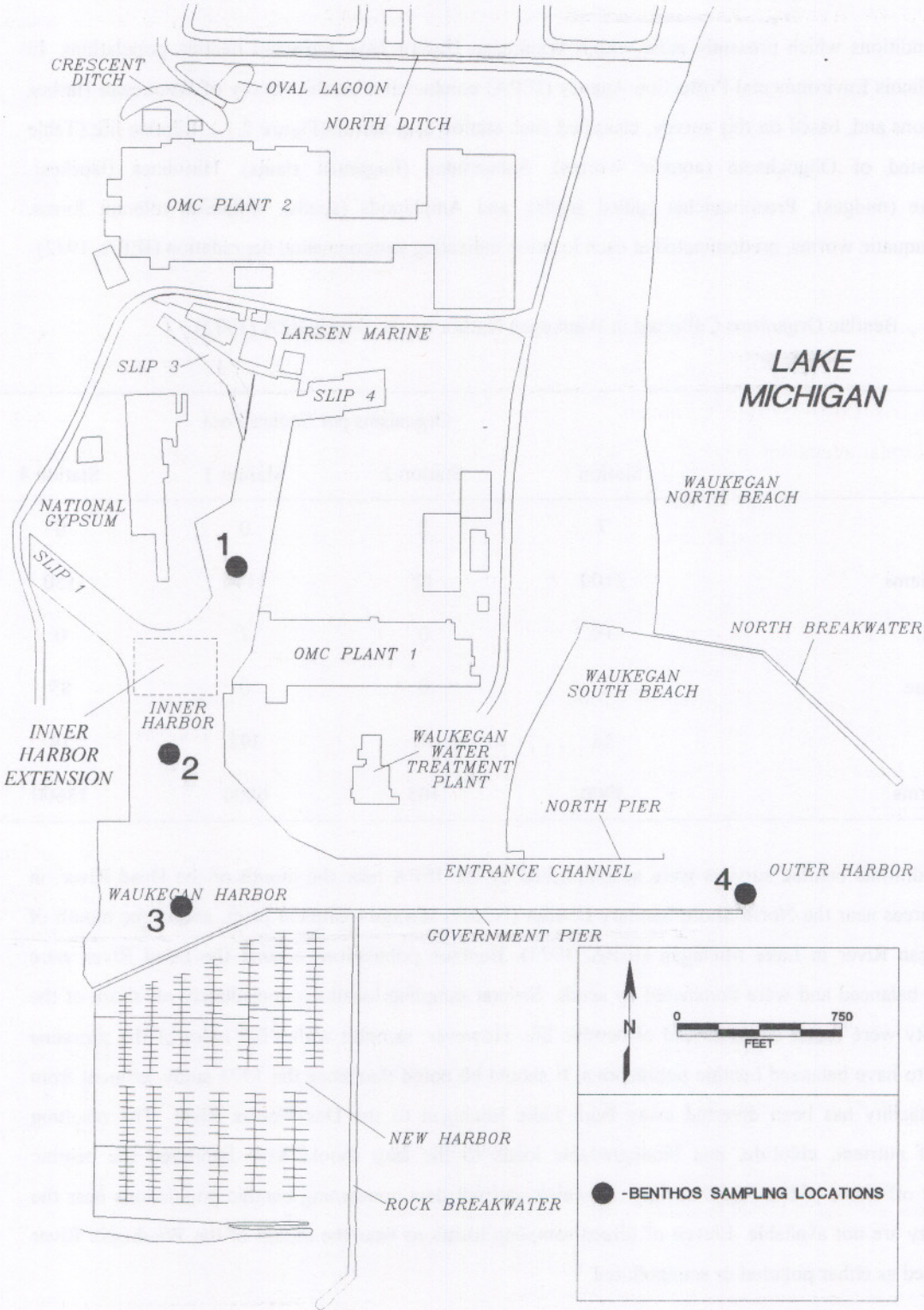
Polluted conditions which presently exist within Waukegan Harbor have impacted benthic populations. In 1972, the Illinois Environmental Protection Agency (IEPA) conducted a benthic survey of Waukegan Harbor at four stations and, based on this survey, classified each station as polluted (Figure 2.1.). Benthic life (Table 2.3.) consisted of Oligochaete (aquatic worms), Sphaeriidae (fingernail clams), Hirudinea (leeches), Chironimidae (midges), Prosobranchia (gilled snails), and Amphipods (scuds). Pollution tolerant forms, specifically aquatic worms, predominated at each location indicating environmental degradation (IEPA, 1972).

Table 2.3. Benthic Organisms Collected in Waukegan Harbor by the Illinois EPA (1972).

	Organisms per Square Foot			
Organism	Station 1	Station 2	Station 3	Station 4
Scuds	7	2	0	0
Fingernail clams	2100	12	1110	150
Gilled snails	14	0	7	0
Midge Larvae	7	0	0	85
Leeches	36	7	392	14
Aquatic worms	3900	105	6800	13600

In 1973, additional benthic surveys were accomplished by the IEPA near the mouth of the Dead River, in near-shore areas near the North Shore Sanitary District (NSSD) sewage treatment plant, and at the mouth of the Waukegan River in Lake Michigan (IEPA, 1973). Benthos populations around the Dead River were classified as balanced and were dominated by scuds. Several sampling locations immediately off-shore of the NSSD facility were found to be devoid of benthic life. However, samples within 0.5 miles of the shoreline were found to have balanced benthic populations. It should be noted that since the 1973 study, effluent from the NSSD facility has been diverted away from Lake Michigan to the Des Plaines River. The resulting reduction of nutrient, chloride, and biodegradable loads to the lake should have improved the benthic environment off-shore of the NSSD facility. However, current data concerning benthic populations near the NSSD facility are not available. Eleven of fifteen sampling locations near the mouth of the Waukegan River were classified as either polluted or semipolluted.

Figure 2.1 Stations Sampled for Benthic Organisms by the Illinois EPA in 1972 (IEPA, 1972).



Sediment samples for benthic invertebrate analysis were taken from nearshore Lake Michigan near the Commonwealth Edison Waukegan generating station in 1972 and 1973 (CEC, 1972; CEC, 1973). Sampling depths ranged from 10 to 40 feet. Samples were dominated by aquatic worms, scuds, and fingernail clams.

A 1987 benthic survey was conducted by the Illinois Natural History Survey (Ross et al., 1989) within Waukegan Harbor and in Lake Michigan immediately outside the harbor. As with earlier benthic studies, dominant species included aquatic worms and fingernail clams. Biomass, based on the dry weight of collected samples, was lower in areas of marked contamination.

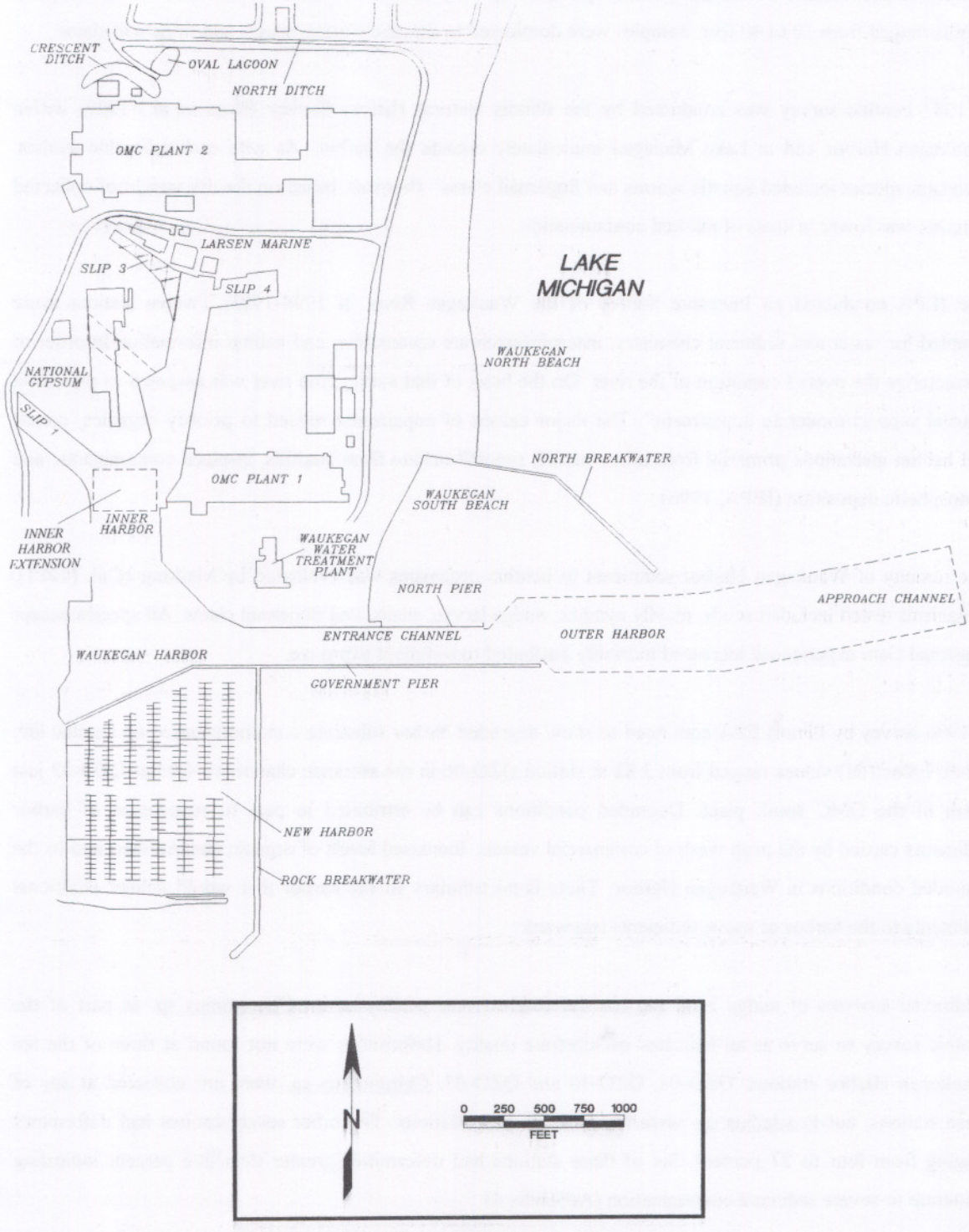
The IEPA conducted an Intensive Survey of the Waukegan River in 1994-1995. Twelve stations were sampled for water and sediment chemistry, macroinvertebrate community, and habitat information in order to characterize the overall condition of the river. On the basis of that survey, the river was assessed as providing "partial support/moderate impairment". The major causes of impairment related to priority organics, metals and habitat alterations primarily from urban runoff, runoff/leachate from landfills, in-place contaminants, and atmospheric deposition (IEPA, 1996).

The toxicity of Waukegan Harbor sediments to benthic organisms was evaluated by Marking et al. (1981). Organisms tested included scuds, mayfly nymphs, midge larvae, snails, and fingernail clams. All species except fingernail clam experienced increased mortality attributed to sediment exposure.

A 1996 survey by Illinois EPA continued to show degraded harbor substrate conditions based on benthic life. Biotic Index (BI) values ranged from 3.82 at station QZO-06 in the entrance channel to 4.03 at QZO-03 just north of the OMC south plant. Degraded conditions can be attributed in part to suspension of harbor sediments caused by the prop wash of commercial vessels. Increased levels of organic material also add to the degraded conditions in Waukegan Harbor. There is no tributary to the harbor that would deliver additional sediments to the harbor or move sediments lakeward.

Additional analyses of midge head capsule deformities were performed on Chironomus sp. as part of the benthic survey to serve as an indicator of substrate quality. Deformities were not found at three of the ten Waukegan Harbor stations, QZO-04, QZO-10 and QZO-03. Chironomus sp. were not collected at any of these stations, but Procladius sp. were found at all three stations. The other seven stations had deformities ranging from four to 27 percent. Six of these stations had deformities greater than five percent indicating moderate to severe sediment contamination (Appendix 4).

Figure 2.2 Waukegan Harbor Navigation Areas.



2.1.7. Restrictions on Dredging Activities

There has been an increased cost to industry due to restrictions on maintenance dredging in the harbor. The inner harbor area is authorized to be dredged to a depth of 23 feet and was last dredged to 18 feet in 1972. The inner harbor is now about 16 feet deep. Representatives of industries which rely on the harbor for transportation of raw and finished materials reported problems associated with lack of dredging to the Waukegan Citizens Advisory Group (CAG, 1991). Industries must alter normal shipping procedures to accommodate shallower water depths in the harbor, and thereby incur higher shipping costs. Since water depths in the harbor have been reduced by sedimentation, vessels may not safely navigate the harbor when fully loaded. Consequently, ships may only be loaded to approximately 70 percent of capacity requiring a greater number of dockages.

Both the inner and outer areas of Waukegan North Harbor (Figure 2.2.) are affected by sediment accumulation. Accumulated sediment in the inner harbor is estimated to be between 1 and 10 feet thick (Ross et al., 1989). The breakwaters and piers which define and protect the outer harbor trap sandy sediments which are eroded from the beaches at Illinois Beach State Park north of Waukegan and carried by the littoral drift (Norby, 1981). The U.S. Army USACE of Engineers (USACE) has dredged the outer areas of Waukegan Harbor as recently as 1991 and has instituted a program of annual dredging of the approach channel. Dredged materials removed from the outer harbor areas were clean sandy sediments which were suitable for unconfined lake disposal or use as nourishment materials for beaches. The most recently used disposal site for approach channel material is a near-shore site (water depths from 6 to 12 feet) approximately 2000 feet south of the South Harbor.

Dredging of the inner portions of Waukegan North Harbor was discontinued after 1972 because the sediments were classified as polluted (USACE, 1989). Since that time, the USACE has investigated alternatives for confined disposal facilities (CDFs) (USACE, 1986; USACE, 1989). None of the proposed CDF alternatives have been approved. An alternative that received serious consideration by the Chicago District, USACE, in an un-circulated 1989 draft report involved construction of an in-lake CDF with sufficient capacity to contain all the polluted, fine-grained soft sediment from the inner harbor (estimated to be 225,000 cubic yards) outside of the Outboard Marine Corporation (OMC) Superfund remediation site. This alternative, in conjunction with OMC's Superfund remediation, would have removed the vast majority of contaminated sediments in the harbor. However, after thorough review of existing federal law and USACE policy on dredging outside of designated channel limits, it was determined that federal funds were available only for dredging and disposal of sediments located within the physical boundaries of the authorized navigation project. The volume of sediment in the navigation project area is estimated to be 50,000 to 70,000 cubic yards.

Possibilities for future disposal options include transport and disposal of contaminated spoil at a landfill permitted for hazardous wastes, as well as a confined disposal facility located adjacent to or nearby the harbor. Based upon the results of sampling and analyses conducted by the USACE in 1995 (Appendix 5), the harbor sediment pollutant concentrations are within the limits of landfill acceptance criteria and could feasibly be disposed of in that manner (USACE, 1995).

To further define sediment contamination and the extent of PCBs remaining in harbor sediments after the Superfund cleanup, the Illinois EPA sampled 18 locations with the assistance of USEPA staff and a sampling vessel in 1996.

Generally, the vast majority of the analyses for organic constituents showed less than the applicable reporting value. Of the 1,458 analyses, less than four percent resulted in values greater than quantifiable reporting limits. All of the 18 harbor samples resulted in values less than 10 mg/kg of total PCBs. Concentrations ranged from 3.0 to 8.9 mg/kg with an average harbor wide concentration of 5.6 mg/kg (Appendix 6).

In order for a dredging project to proceed, it will be necessary for the USACE to first complete a feasibility study as a pre-requisite for congressional funding. Current costs of such a study are estimated at between $600,000 and $700,000, split evenly between the USACE and local sponsors. The Port District has indicated willingness to serve as the local sponsor provided the amount required for the local funding match can be raised. Current estimates of dredging project costs are on the order of $12 million split evenly between federal and local sources (Waukegan Harbor Citizens Advisory Group, 1997a).

Work has continued on the funding of the project. Local match funds of $147,000 were raised for work to begin on the USACE sampling program (Waukegan Harbor Citizens Advisory Group, 1997b). Future work includes the acquisition of funding, selection of the contained disposal facility site, and the preparation of reports and documents. The Waukegan Harbor Citizens Advisory Group (CAG) held public meetings in February of 1998 and 1999 to address the issue of additional dredging of the harbor. The US Army Corps of Engineers presented a plan which called for completion of additional dredging by the year 2002. The CAG continues to work closely with the USACE to work out final details for the additional harbor dredging.

The newer South Harbor also has been impacted by sediment that has accumulated since initial construction. Here, recreational vessels (particularly deeper-keeled sailboats) occasionally hit the channel bottom. In 1997, the Port District received USACE permission to dredge the South Harbor channel following sampling and analyses which showed that the South Harbor has not been subject to sediment contamination. The dredged

spoil, which consists mainly of sand, will be placed offshore southeast of Waukegan, which is the traditional form of spoil disposal for uncontaminated materials.

2.1.8. Eutrophication or Undesirable Algae

Eutrophication is the accumulation of nutrients in a water body and is commonly associated with increased high biotic productivity (Cole, 1979). Water quality constituents related to eutrophication are those which are required as macronutrients for production of plant material, particularly nitrogen and phosphorus.

The trophic status of the Illinois waters of Lake Michigan has improved substantially. Based on phosphate concentration, trophic status has improved from mesotrophic/eutrophic in the 1970s to oligotrophic (IEPA, 1996).

Water quality samples collected from within Waukegan Harbor in November, 1990 yielded a mean total phosphorus concentration of 0.018 mg/L and a mean total ammonia concentration of 0.37 mg/L (Table 2.4.). No undesirable algae growths have been reported or observed.

2.1.9. Restrictions on Drinking Water Consumption or Taste and Odor Problems

Two City of Waukegan raw water intakes (including an emergency intake) are located in the lake east of the harbor. The main intake is a 48-inch concrete pipe that runs in an east-southeast direction for 6,200 feet from south side of Government Pier. The emergency intake is a 24-inch line running approximately 1275 feet out from the pier. The location of the emergency intake is about 125 feet south of the eastern end Government Pier and 100 feet east. An additional emergency intake (15-inch line) is located in the entrance channel to the harbor (Consoer, Townsend and Associates, Inc., 1991). Currently, both emergency intakes are valved shut. Since an emergency intake which draws Lake Michigan water is available for use, it is quite unlikely that the City would ever utilize the emergency intake located in the harbor entrance channel.

There are no restrictions on drinking water for the City of Waukegan. Samples of finished water and raw water from the main intake are collected annually and tested for constituents identified in the Safe Drinking Water Act (USEPA, 1986). In addition, finished water is analyzed daily for bacteria, turbidity, residual chlorine, and fluoride and raw water is analyzed daily for turbidity and temperature. Tests for PCBs conducted in 1987 and 1988 showed no PCBs in the finished water. Annually, finished water is analyzed for 32 volatile compounds.

Table 2.4. Comparison of Mean Water Quality Concentrations from the Waukegan Harbor Area and Lake Michigan, 1990. Samples were collected and analyzed by the Illinois EPA.

Parameter	Standard	Waukegan Harbor Area (1)	Lake Michigan North Shore (2)
Water Temperature (C)	—	7.1	15
pH (units)	7.0 – 9.0	7	—
Dissolved Oxygen (mg/L)	5.0	8.3	—
DO Percent Saturation	90	70.4	—
Conductivity (uS/Cm) (3)	300	321*	287
Total Phosphorous (mg/L)	0.007	0.018*	0.004
Total Ammonia (mg/L)	0.02	0.37*	0.01
Un-ionized Ammonia (mg/L) (4)	0.04	0.000	—
Total Kjeldahl Nitrogen (mg/L)	—	0.6	0.2
Nitrite + Nitrate (mg/L)	—	0.29	0.24
COD (mg/L)	—	15	4
Turbidity (NTU)	—	11.7	2.0
Total Suspended Solids (mg/L)	—	12	2
Volatile Solids (mg/L)	—	4	2
Chloride (mg/L)	12	15*	11
Sulfate (mg/L)	24	30*	22
Cyanide (mg/L)	0.022	0.021	0.005K
Fluoride (mg/L)	1.4	0.13	0.09
Phenols (ug/L)	1.0	15*	3K
Fecal Coliform (No./100mL)	20	24*	8K

1 Seven Stations, November, 1990
2 Five Stations (1N, 3N, 5N, 7N, 9N), May and September, 1990
3 Conductivity x 0.6 = TDS (mg/L)
4 Calculated
K Less than
* Violated Standard

There have been no complaints reported regarding taste and odor since 1988 when harbor water entered the raw water intake due to drain and sump problems. Following reconstruction of the drain and sump and initiation of activated carbon treatment in 1988, no taste and odor complaints were reported. Use of granular activated carbon for treatment of drinking water is typical of public drinking water supplies in Cook and Lake counties which rely on surface water resources (IEPA, 1991a). In April, 1992 water sampled from the Waukegan water plant showed no organics in both raw and finished water. Sludge filtrate at the water treatment plant also had organics concentrations below detectable levels.

Other parameters were within expected ranges. In the harbor entrance channel, PCB levels in sediments were below 1.5 ppm. Highly elevated levels of arsenic in sediments were detected at 18.1 to 23.0 ppm. No additional parameters were rated as highly elevated.

Based on available information, harbor and open lake sediments do not pose a threat to the public water supply. Drinking water continues to meet standards set forth by the Safe Drinking Water Act after conventional treatment, and the IEPA reports that all 63 miles of Illinois shoreline "fully support" drinking water uses (IEPA, 1996).

2.1.10. Beach Closings

The Illinois Pollution Control Board (IPCB) and the Illinois Department of Public Health have set water quality standards for swimming based on fecal coliform counts. Fecal coliform is present in the feces of humans and other warm-blooded animals. Its presence in water indicates the possible presence of pathogenic organisms. The IPCB standard for full contact recreation is a geometric mean less than or equal to 200 counts per 100 mL and no more than 10 percent of the samples shall exceed 400 counts per 100 mL (35 Ill. Admin. Code 302). The IPCB Lake Michigan water quality standard of a geometric mean of 20 counts fecal coliform per 100 mL water (Table 2.4.) is applied for environmental evaluations rather than public health concerns related to beach closures.

In order to protect the health of swimmers, the North Shore Sanitary District and the Lake County Health Department conduct a daily (Monday through Friday) sampling program at Lake Michigan beaches in the county during the swimming season (June through August). The criteria used for closing a beach is two consecutive samples with fecal coliform counts greater than 500 per 100 mL water or total coliform counts greater than 5000 per 100 mL water (IDPH, 1987).

Two city beaches, Waukegan North and Waukegan South are located immediately north of the harbor entrance. These beaches have exceeded bacterial count swimming standards occasionally over the period reported (Table 2.5.). Over the past eleven years of record (1988 - 1998), combined North and South Beach closures averaged 7 days per season (Pfister, 1996, 1997, 1998). Total closures per year ranged from a high of 26 days in 1997, to a low of zero days in 1994. Both beaches also were placed on warning status for additional dates during the period, signifying conditions when coliform counts were high but not so high or prolonged as to warrant closure. During 1998 both Waukegan North and South beaches were closed for a total of eight days (Pfister, 1998).

An intensive reconnaissance of the area conducted in 1990 by the North Shore Sanitary District found that the Waukegan River was receiving fecal contamination, and further sampling was recommended to locate the source of contamination (NSSD, 1990). Subsequent inspections by the IEPA found stormwater and sanitary sewer cross-connections resulting in pollutional discharges to the Waukegan River. The City of Waukegan was requested by IEPA to correct any pollutional discharge in a 1991 compliance inquiry letter (IEPA, 1991b).

Follow-up monitoring by IEPA pinpointed additional problem sewers. The IEPA subsequently notified City officials of the problem and the need for repairs pending possible enforcement action (IEPA, 1993). The City of Waukegan has since taken remedial actions to correct a sanitary sewer overflow and storm/sanitary sewer cross-connections. The City of Waukegan also has a policy of correcting all connections of storm sewers with sanitary sewers when such connections are discovered (Trigg, 1997).

As noted in Table 2.5, beach closings were much higher in 1997 in comparison with other years since 1990. Given the fact that coliform problems related to local sewers have largely been eliminated, attention has focused on other sources of bacterial pollution. The Lake County Health Department attributes the increase in the number of days Waukegan beaches were closed in 1996 and 1997 to a burgeoning gull colony that has developed on OMC property near the harbor and beaches (Pfister, personal communication, 1997). High coliform counts were recorded on several days in 1996 and 1997 even though dry weather conditions prevailed and no stormwater discharges were occurring. During the 1997 beach season, the Department sampled for fecal streptococci in addition to fecal coliform in the hope of isolating the source of bacterial pollution (Pfister, 1997). (The ratio of fecal coliform to fecal streptococci can be used to roughly determine whether the source of contamination is human or animal in origin). However, sampling results during June, 1997 indicated no trends whatsoever, and the fecal streptococci sampling was therefore discontinued (Pfister, 1997). The Health Department is currently investigating the use of bio-tracers to more precisely identify the contaminant source. Both OMC and the Health Department are attempting to develop a strategy that will discourage the presence of excessive numbers of gulls in the area, which, if successful, should reduce coliform

Table 2.5. Summary of Beach Closings and Fecal Coliform Bacteria Counts at Lake Michigan Beaches in Waukegan, Illinois.

Year	Waukegan North Days Closed	Waukegan South Days Closed	Total Days Closed
1988	0	3	3
1989	3	2	5
1990	10	10	20
1991	2	0	2
1992	0	1	1
1993	0	6	6
1994	0	0	0
1995	0	3	3
1996	4	2	6
1997	6	20	26
1998	1	7	8

	Waukegan North (1)			Waukegan South (1)		
Year	Geo. Mean	% > 400	CS > 500	Geo. Mean	% > 400	CS > 500
1983	28	4	0	26	3	0
1984	44	8	1	24	7	0
1985	32	6	0	23	1	0
1986	66	18	4	42	8	0
1987	79	13	1	52	4	1
1988	76	8	0	82	10	3
1989	71	12	1	67	9	1
1990	91	20	5	67	10	4
1991	49	9	1	64	10	0
1992	49	6	1	55	10	1
1993	41	5	0	51	15	5
1994	53	12	5	116	10	4
1995	83	11	0	192	32	5
1996	142	22	2	220	37	2
1997	126	26	6	451	58	19
1998	62	2	0	134	12	1

Lake Michigan Standards (35 IL Adm Code 302.505) Applied to Beaches
Geometric Mean ≤ 20/100 mL and less than 10% of samples > 400/100 mL

Criterion for closing beaches (IDPH, 1987)
Consecutive Samples (CS) > 500/100 mL Fecal Coliform

(1) Data Based on Fecal Coliform No./100mL

problems at the beaches. Thus far, the experimental use of netting at the site frequented by the gulls appears only to have shifted the population to other locations in the immediate vicinity. Other techniques utilized to date include propane cannons and permitted lethal culling.

2.1.11. Degradation of Aesthetics

As defined by the IJC (1991), aesthetics within the ESA may be considered degraded when a "persistent objectionable deposit, unnatural color or turbidity, or unnatural odor" is observed in water. There is no known problem regarding degraded aesthetic conditions as defined by the IJC, in the Waukegan ESA. The City of Waukegan initiated a program in 1997 to clean-up debris among the Waukegan River in an attempt to upgrade aesthetic conditions along the course of this urban stream.

2.1.12. Added Costs to Agriculture or Industry

According to the IJC (1991), additional costs required to treat waters prior to agricultural or industrial use indicate an impaired use. There is no information available regarding any possible added costs for treatment of water from the Waukegan ESA for industry. There is no agricultural use of water within the Waukegan ESA.

2.1.13. Degradation of Phytoplankton and Zooplankton Populations

Phytoplankton communities in Lake Michigan near Waukegan were monitored by Commonwealth Edison between 1972 and 1974 (CEC, 1972; CEC, 1973; CEC, 1974). Overall, 349 genera representing six algal divisions were identified in samples taken from Lake Michigan between Zion and Waukegan. Dominant phytoplankton by number were *Stephanodiscus binderanus* and *S. hantzchii vel tenuis* and by volume was *Rhizosolenia eriensis*.

Zooplankton populations also were monitored by Commonwealth Edison (CEC, 1972; CEC, 1973; CEC, 1974). Generally, cladocera dominated zooplankton catch and the dominant species observed was *Bosmina longirostris*.

McNaught et al. (1980) investigated the effects of PCB concentrations on photosynthesis of phytoplankton. Photosynthesis was found to be inhibited 5.7 percent when phytoplankton was exposed to PCB concentrations of 5 ng/l/L. Likewise, photosynthesis inhibition was determined to be 8.9 percent and 18.9 percent for PCB concentrations of 100 ng/L and 500 ng/L, respectively. PCB concentrations of 5 ng/L are comparable to concentrations in open water areas of Lake Michigan.

Protozoan community response to Waukegan Harbor sediments was examined by Ross et al. (1988) in-situ and in laboratory tests. Sediment contamination within slip 3 was found to significantly alter the structure of indigenous protozoan communities. This result was confirmed through laboratory test results. Impacts to protozoan communities were found to be greater within lower portions of the water column where suspension of particles which carry toxic chemicals was probably greater.

The studies of Ross et al. (1988) and Risatti et al. (1990) show that the photosynthesis of the green alga *Selenastrum_capricornutum* was inhibited by sediment elutriates from several sampling sites within the harbor. Burton et al. (1989) reported toxicity to *Daphnia magna*, *Ceriodaphnia dubia*, and *S. capricornutum* when these organisms were exposed to sediments or sediment elutriates from the inner harbor. Also, Marking et al. (1981) observed water flea (probably *Daphnia magna*) mortalities of 100 percent from some sediment suspension samples taken from the harbor.

2.1.14. Loss of Fish and Wildlife Habitat

The urbanized and industrial nature of the Waukegan lakefront has significantly altered the potential for terrestrial wildlife habitat in the ESA. Industrial use of the ESA continues presently and provides an important economic base for the Waukegan area. The terrestrial habitat which remains is predominantly located in the northern portion of the ESA which intersects Illinois Beach State Park. Since the harbor is a man-made structure which was constructed for industrial purposes, its value for wildlife and fish habitat is limited (Hartig, 1993).

In nearshore Lake Michigan areas, both fish and wildlife habitat are impacted through sediment accumulation and contamination. Fish spawning and rearing habitat and avian foraging habitat have been adversely impacted according to the U.S. Department of the Interior Fish and Wildlife Service (Millar, 1991). Sediment accumulation may bury spawning and shelter areas used by small or immature fish.

2.2. LAKE MICHIGAN WATER QUALITY

The water quality of the Illinois shore of Lake Michigan has improved substantially since the 1970s. At that time, total phosphate and ammonia concentrations routinely violated above Lake Michigan water quality standards. The trophic status of the Illinois shore has improved from mesotrophic/eutrophic to oligotrophic conditions based on total phosphate (IEPA, 1996). Conductivity measurements and chloride and sulfate levels have fluctuated but have generally been within water quality standards. Toxic substances in the lake, including metals and organic compounds, have generally been below detection levels and in compliance with water quality standards (IEPA, 1990).

Water samples were collected at seven stations in the Waukegan ESA in November, 1990 (Figure 2.3.). Results, presented in Tables 2.6. and 2.7., were compared to then-current Illinois water quality standards including Lake Michigan, Public Water Supply and General Use Standards (35 Ill. Admin. Code 302). Water quality conditions were worse in the upper harbor and tended to improve towards the harbor mouth. A total of 48 standards violations involving 10 parameters were found in the Waukegan Harbor area. Ammonia, cyanide, phenols and dissolved oxygen were of most concern. Upper harbor (QZO01), slip 1 (QZP01), and central harbor (QZQ01) each had nine standards violations. Eight violations were found near the boat ramp (QZR01), five each at harbor channel (QZS01) and new harbor (QZT01), and three at North Beach (QZN01). Total phosphorus, total ammonia and sulfate were found to be in violation at all seven stations; dissolved oxygen percent saturation and conductivity at six stations; chloride and phenols at four stations; pH and cyanide at three stations and fecal coliform at one station.

Water samples were scanned for thirty-eight VOCs, eighteen organochlorine pesticides, PCBs and pentachlorophenol. Pentachlorophenol and xylenes were the only compounds detected. There are no Illinois water quality standards for these two compounds. The concentrations of pentachlorophenol were at the detection level (0.01 mg/L) and well below USEPA's acute criterion of 55 mg/L (USEPA, 1986). Xylenes were detected in central harbor (39 mg/L), upper harbor (62 mg/L), and slip 1 (64 mg/L). Additional compounds were detected but could not be identified and were reported as aliphatic hydrocarbons (3 mg/L to 64 mg/L) and other organic compounds (4 mg/L to 50 mg/L). Highest levels of these compounds were found in slip 1 and upper harbor.

The 1990 sampling results from the ESA were compared with results from five Lake Michigan North Shore stations sampled in May and September, 1990 (Table 2.8.). These stations are located from one to six miles off-shore between Waukegan and Chicago. All of the Lake Michigan mean values were well within standards, but Waukegan Harbor mean values for dissolved oxygen, conductivity, total phosphorus, total ammonia, chloride, sulfate, phenols and fecal coliform were in violation. The most substantial difference was total ammonia which was 37 times higher in Waukegan Harbor than in Lake Michigan. Other parameters which were at least twice as high in Waukegan Harbor than in Lake Michigan were iron, aluminum, total suspended solids (TSS), turbidity, manganese, phenols, phosphorus, cyanide, chemical oxygen demand (COD), total Kjeldahl nitrogen (TKN), fecal coliform, sodium, and potassium. Organic compounds were not detected in offshore Lake Michigan waters

Figure 2.3 Water and Sediment Sampling Locations for Sampling Conducted for the Waukegan RAP on November 14, 1990. Samples were collected and analyzed by the IEPA.

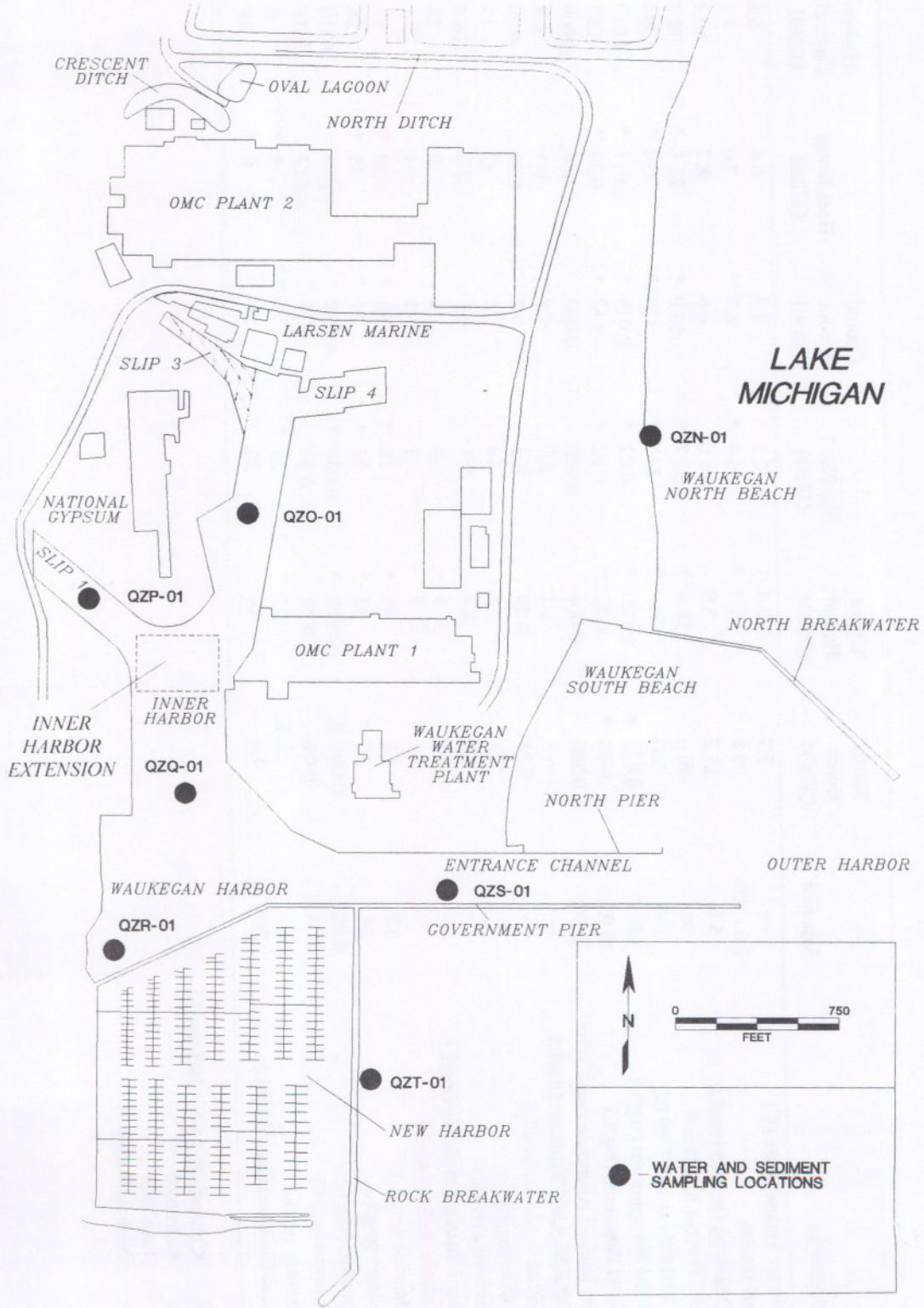


Table 2.6. Water Quality in the Waukegan Harbor Area, November 14, 1990. Concentrations are in Parts Per Million Unless Otherwise Noted. Samples were Collected and Analyzed by the Illinois EPA.

Parameter	Standard	North Beach QZN01	Upper Harbor QZO01	Slip No. 1 QZP01	Central Harbor QZQ01	Boat Ramp QZR01	Harbor Channel QZS01	New Harbor QZT01
Water Temperature (C)	—	7.7	7.4	7.3	7.3	6.4	6.8	6.5
pH (units)	7.0 - 9.0	7.8	6.7 *	6.6 *	6.7 *	7.0	7.1	7.4
Dissolved Oxygen (mg/L)	5.0	11.2	5.9	6.0	6.6	8.7	9.4	10.0
DO Percent Saturation	90	96.6	50.9 *	51.7 *	56.9 *	73.1 *	79.7 *	84.0 *
Conductivity (uS/Cm) (a)	300	265	349 *	347 *	339 *	339 *	304 *	306 *
Total Phosphorous (mg/L)	0.007	0.023 *	0.020 *	0.02 *	0.019 *	0.017 *	0.019 *	0.011 *
Total Ammonia (mg/L)	0.02	0.04 *	0.82 *	0.62 *	0.52 *	0.29 *	0.22 *	0.09 *
Un-ionized Ammonia (mg/L) (b)	0.04	0.000	0.001	0.000	0.000	0.000	0.000	0.000
Total Kjeldahl Nitrogen (mg/L)	—	0.3	1.1	0.9	0.8	0.5	0.4	0.3
Nitrite + Nitrate (mg/L)	—	0.26	0.29	0.3	0.3	0.31	0.29	0.31
COD (mg/L)	—	23	16	14	14	12	13	11
Turbidity (NTU)	—	22	8.4	9.1	9.1	7.3	16.4	9.5
Total Suspended Solids (mg/L)	—	34	5	4	6	8	18	6
Volatile Solids (mg/L)	—	6	2	3	3	3	6	4
Chloride (mg/L)	12	11	18 *	18 *	16 *	19 *	11	12
Sulfate (mg/L)	24	26 *	32 *	32 *	31 *	32 *	28 *	29 *
Cyanide (mg/L)	0.022	0.005 K	0.050 *	0.040 *	0.030 *	0.010	0.010	0.005 K
Fluoride (mg/L)	1.4	0.09	0.15	0.15	0.15	0.13	0.11	0.10
Phenols (ug/L)	1.0	5 K	43 *	26 *	19 *	5 *	5 K	5 K
Fecal Coliform (No./100mL)	20	10	18	20	20	6 *	18	50 K

(a) Conductivity x 0.6 = TDS (mg/L)
(b) Calculated
K Less Than
* Violated Standards

Table 2.7. Water Concentrations of Metals in the Waukegan Harbor Area, November 14, 1990. Concentrations are in Parts Per Million Unless Otherwise Noted. Samples were Collected and Analyzed by the Illinois EPA.

Parameter	Standard	North Beach QZN01	Upper Harbor QZO01	Slip No. 1 QZP01	Central Harbor QZQ01	Boat Ramp QZR01	Harbor Channel QZS01	New Harbor QZT01
Calcium (mg/L)	—	42	45	45	44	45	42	42
Magnesium (mg/L)	—	14	14	14	14	14.0	14	13
Potassium (mg/L)	—	1.3	2.9	2.7	2.1	2.7	1.2	3.0
Sodium (mg/L)	—	10.0	17.0	17.0	16.0	19.0	12.0	13.0
Hardness (mg/L) (a)	—	165	169	168	167	170	162	159
Aluminum (ug/L)	—	675	247	312	290	227	494	272
Arsenic (ug/L)	50	1 K	7	5	4	2	2	1
Barium (ug/L)	1000	25	27	27	27	27	25	24
Beryllium (ug/L)	—	0.5 K	0.5 K	0.5 K	0.5 K	0.5 K	0.5 K	0.5 K
Boron (ug/L)	1000	50 K	60	64	54	51	50 K	50 K
Cadmium (ug/L)	10	3 K	3 K	3 K	4	3 K	5	3 K
Chromium (ug/L)	50	5 K	5 K	5 K	5 K	5 K	5	5 K
Cobalt (ug/L)	—	5 K	5 K	5 K	7	5 K	5 K	5 K
Copper (ug/L)	(b)	6	5 K	5	5 K	5 K	5	6
Iron (ug/L)	—	1015	447	486	446	343	691	347
Lead (ug/L)	50	50 K	100 K	50 K	100 K	50 K	100 K	50 K
Manganese (ug/L)	150	25	42	42	39	22	23	9
Mercury (ug/L)	0.5	0.05 K	0.05 K	0.05 K	0.05 K	0.05 K	0.05 K	0.05 K
Nickel (ug/L)	1000	5 K	9	5 K	21	10 K	20	5 K
Silver (ug/L)	5	5 K	3 K	5 K	3 K	3 K	3 K	5 K
Strontium (ug/L)	—	129	148	147	145	147	134	134
Vanadium (ug/L)	—	6	5 K	5 K	5 K	5 K	5 K	5 K
Zinc (ug/L)	1000	136	50 K	100 K	130	50 K	100 K	50 K

(a) Calculated
(b) Depends on Hardness; Acute Copper = exp [0.94221n(Hardness)-1.464]
K Less Than

Table 2.8. Comparison of Mean Metals (Total) Concentration in Water from the Waukegan Harbor Area and Lake Michigan, 1990. Samples were collected and Analyzed by the IEPA.

Parameter	Standard	Waukegan Harbor Area (1)	Lake Michigan North Shore (2)
Calcium (mg/L)	—	44	36
Magnesium (mg/L)	—	14	11
Potassium (mg/L)	—	2.3	1
Sodium (mg/L)	—	14.9	5.6
Hardness (mg/L) (3)	—	166	134
Aluminum (ug/L)	—	360	53
Arsenic (ug/L)	50	3	1 K
Barium (ug/L)	1000	26	20
Beryllium (ug/L)	—	0.5 K	0.5 K
Boron (ug/L)	1000	54	50 K
Cadmium (ug/L)	10	3 K	3 K
Chromium (ug/L)	50	5 K	5 K
Cobalt (ug/L)	—	5 K	5 K
Copper (ug/L)	(a)	5	6 K
Iron (ug/L)	—	539	50 K
Lead (ug/L)	50	71 K	50 K
Manganese (ug/L)	150	29	5 K
Mercury (ug/L)	0.5	0.05 K	0.08 K
Nickel (ug/L)	1000	11	8 K
Silver (ug/L)	5	4 K	3 K
Strontium (ug/L)	—	141	124
Vanadium (ug/L)	—	5 K	5 K
Zinc (ug/L)	1000	88 K	50 K

(1) Seven Stations, November, 1990
(2) Five Stations (1N, 3N, 5N, 7N, 9N), May & September, 1990
(3) Calculated
(a) Depends on Hardness
K Less Than

2.3. SEDIMENT QUALITY

Sediment samples were collected for chemical analyses in November, 1990 at seven stations in the Waukegan ESA (Figure 2.3.). Results for metals, cyanide, nutrients, COD, and volatile solids are presented in Table 2.9. Sediment samples were scanned for seventy semi-volatile organic compounds, nineteen organochlorine pesticides, and PCBs. Organic compounds which were detected are listed in Table 2.10. This table includes compounds which were detected but could not be identified. These compounds were reported as aliphatic hydrocarbons, aliphatic ketones, or other organic compounds. Results in these tables were compared with guidelines for the pollution classification of Great Lakes harbor sediments (USEPA, 1977) and with sediment results from the Illinois/Indiana area of Lake Michigan.

The upper harbor (Station QZ001) had the highest number of parameters signifying "heavy pollution" with 11, followed by central harbor (QZQ01) with 8, slip 1 (QZP01) with 5, new harbor (QZQ01) with 3 and the harbor channel (QZS01) with 1. The area near the boat ramp (QZR01) had no parameters signifying heavily polluted conditions, but it did have 5 parameters showing moderately polluted conditions. North Beach (QZN01) was classified as nonpolluted for all parameters.

"Heavily polluted" levels of arsenic and lead were found at four stations; cadmium and copper at three stations; chromium, zinc, nickel, COD and volatile solids at two stations; and cyanide, iron, phosphorus and Kjeldahl nitrogen at one station. "Moderately polluted" levels of barium were found at six stations; and manganese and PCBs at three stations.

Waukegan Harbor sediment results were compared with results from Lake Michigan, Lake Calumet and five harbors in Illinois and Indiana collected between 1981 and 1990 (Table 2.11.). Seven parameters (Cd, Cr, Cu, Pb, Mn, Zn, PCBs) were analyzed at all six harbors and Lake Michigan. Waukegan Harbor had samples with the most parameters classified as heavily polluted with six (Cd, Cu, Pb, Mn, Zn, PCBs), followed by Indiana Harbor and Great Lakes Naval Training Center Harbor with four (Cu, Pb, Mn, Zn), Lake Calumet with four (Cr, Cu, Pb, Zn), Calumet Harbor with three (Pb, Mn, Zn), Chicago and Wilmette Harbors with one (Pb and Mn respectively) and none in Lake Michigan. The highest levels of PCBs, lead, and cadmium were found in Waukegan Harbor sediments.

Work done in 1985 and 1986 by Ross et al. (1988) found that the highest levels of PCBs in Waukegan Harbor are in slip 3 (maximum = 17,251 ppm), and that concentrations generally decreased towards the harbor mouth. Sampling by IEPA in 1990 also showed this decrease in PCB concentrations away from slip 3, although slip 3 was not sampled. A comprehensive discussion of the PCB contamination in Waukegan Harbor can be found in the settlement agreement between the United States of America and the People of the State of Illinois with

Outboard Marine Corporation (U.S. District Court, Northern District Eastern Division, Civil Action No. 78-C-1004, April 1989) and the Remedial Investigation Report.

A 1987 Waukegan Harbor study by Risatti et al. (1990) found the highest levels of lead (420 ppm) and cadmium (50 ppm) in slip 1. Much higher levels of lead were found in slip 1 (12,200 ppm) and the new harbor (10,000 ppm) by IEPA in 1990. The highest cadmium concentration (12 ppm) in 1990 was found at upper and central harbor stations.

Available information on biological effects of sediments is limited. Present guidelines used for the pollution classification of Great Lakes harbor sediments (USEPA, 1977) are not based on known toxic response but rather on deviations from "normal" concentrations. Sediment classifications in Illinois lakes and streams by Kelly and Hite (1981 and 1984) were developed much the same way. Ross (1991) reviewed a report by Long and Morgan (1990) who compiled data from all available studies that report a minimum sediment concentration of a contaminant required to produce a biological impact. Long and Morgan arranged sediment concentrations in order from lowest to highest and took the 10th percentile and 50th percentile and termed these points the Effects Range-Low (ER-L) and Effects Range-Median (ER-M). The ER-L indicates that adverse biological effects occur approximately one time out of ten at this level and above. This procedure was done for zinc, cadmium and lead.

Ross (1991) compared data from Long and Morgan (1990) with Waukegan Harbor sediment data from Risatti et al. (1990). Results are summarized in Table 2.12. According to Ross (1991) the greatest hazard to aquatic life is from lead. Zinc also presents a clear hazard, while there are possible hazards from cadmium. Ross (1991) also indicated that metals toxicity is additive. In order to approximate the relative additivity of toxic potential at each station, Ross calculated the ratio of zinc, cadmium, and lead concentration to the ER-M value for that metal at each of the 23 stations sampled by Risatti et al. These ratios were then summed to give an additive estimate of the hazard to aquatic life from those three metals. Based on these sums it appears that the most severe metal contamination is in the northern part of Waukegan Harbor and in slip 1. Data collected by IEPA in 1990 also suggests that lead is the greatest problem compared to zinc and cadmium (Table 2.12.), and that slip 1 and the new harbor have severe sediment contamination.

As noted in Section 2.1.7., additional sediment sampling was conducted by IEPA in 1996 to quantify improvements made by the Waukegan Harbor clean-up. The results of that sampling program are contained in Appendix 6.

Table 2.9. Unsieved Sediment Concentrations in the Waukegan Harbor Area, November 14, 1990.Concentrations are in Parts Per Million Unless Otherwise Noted. Samples were Collected and Analyzed by the IEPA.

Parameter	North Beach QZN01	Upper Harbor QZO01	Slip No. 1 QZP01	Central Harbor QZQ01	Boat Ramp QZR01	Harbor Channel QZS01	New Harbor QZT01
Arsenic	1 N	41 H	13 H	23 H	6 M	10 H	4 M
Barium	9 N	52 M	31 M	43 M	27.0 M	34 M	22 M
Cadmium	1 K	12 H	7.0 H	12 H	1 K	1 *	1.0 K
Chromium	4.0 N	90.0 H	47.0 M	88.0 H	22.0 N	34.0 M	15.0 N
COD	39200 N	117650 H	77648 M	91000 H	24900 N	62600 M	23600 N
Copper	2 N	160 H	53 H	86 H	26 M	50 M	30 M
Cyanide	0.52 K	1.2 K	2.4 K	3.3 K	0.65 K	0.87 K	9.3 H
Iron	3200 N	26000 H	14000 N	20000 M	9000 N	18000 M	12000 N
Kjeldahl Nitrogen	60 K	2500 H	900 N	1700 M	175 N	175 N	450 N
Lead	10 K	140 H	12000 H	120 H	39 N	60 M	10000 H
Manganese	96 N	460 M	91 N	450 M	220 N	480 M	24 N
Mercury	0.1 K	0.4 N	0.19 N	0.34 N	0.1 K	0.13 N	0.1 K
Nickel	5 K	26 M	340 H	21 M	9 N	16 N	400 H
Phosphorous	329 N	826 H	350 N	545 M	202 N	428 M	510 M
Potassium	1000 K	1900	1000	1500	1000 K	1300	1000
Silver	1 K	1 K	13	1 K	1 K	1 K	10
Volatile Solids	2.3 N	9.8 H	7.3 M	8.3 H	4.2 N	4.8 N	2.2 N
Zinc	20 N	280 H	15 N	210 H	100 M	130 M	15 N

Sediment Classifications (USEPA, 1977)
K = Less Than
N = Nonpolluted
M = Moderately Polluted
H = Heavily Polluted ; * = Lower Limits Not Established

Table 2.10. Unsieved Sediment Concentrations of Organic Compound Detected[1] in the Waukegan Harbor Area, November 14, 1990. Concentrations are in Parts Per Million Unless Otherwise Noted. Samples were Collected and Analyzed by the IEPA.

Parameter	North Beach QZN01	Upper Harbor QZO01	Slip No. 1 QZP01	Central Harbor QZQ01	Boat Ramp QZR01	Harbor Channel QZS01	New Harbor QZT01
PCBs	0.01 K	9.000 M	4.600 M	1.900 M	0.200 N	0.260 N	0.037 N
4-Methylpenol	0.5 K	0.5 K	0.5 K	0.62	0.5 K	0.5 K	0.5 K
Bis(2-Ethylhexyl)Phthalate	0.5 K	0.69	0.5 K	0.5 K	0.5 K	1.1	0.5 K
Flouranthene	0.5 K	0.5 K	0.62	0.5 K	0.66	0.5 K	0.5 K
Pyrene	0.5 K	0.58	0.65	0.5 K	0.63	0.5 K	0.5 K
Aliphatic Hydrocarbon **	ND	70 *	24 *	18 *	1.6 *	1.8 *	ND
Aliphatic Ketone **	ND	ND	ND	ND	0.55 *	ND	ND
C3-Substituted Benzene	ND	0.95 *	ND	ND	ND	ND	ND
C4-Substituted Benzene	ND	6.1 *	3.0 *	1.0 *	ND	ND	ND
C5-Substituted Benzene	ND	2.8 *	1.8 *	ND	ND	ND	ND
Dimethyl Naphthalene	ND	ND	0.78 *	ND	ND	ND	ND
Methyl Naphthalene #	ND	ND	0.71 *	ND	ND	ND	ND
Ethyl-Dimethyl-Pentane #	ND	1.5 *	ND	ND	ND	ND	ND
Methyl Pentane #	ND	0.60 *	0.59 *	ND	ND	ND	ND
Tetramethyl Pentane #	ND	15 *	7.2 *	ND	ND	ND	ND
Other Organics **	2.8	16 *	9.1 *	6.9 *	0.63 *	1.3 *	9.6 *

Approximated Quantitations
** Could Not Be Identified
# Tentatively Identified
K = Less Than
ND = Not Detected

Classification Guidelines (USEPA, 1977)
N = Nonpolluted
M = Moderately Polluted
H = Heavily Polluted

(1) A Priority Pollutant Scan was Done for 90 Organic Compounds.

Table 2.11. Comparison of Mean Concentrations of Various Parameters in Unsieved Sediments from the Illinois Area of Lake Michigan. Concentrations are in Parts Per Million Unless Otherwise Noted.

Parameter	Waukegan Harbor Area (1)	Waukegan Harbor (2)	Great Lakes Naval Training Center Harbor (3)	Wilmette Harbor (3)	Chicago Harbor (4)	Calumet Harbor (5)	Lake Calumet (6)	Indiana Harbor (7)	Lake Michigan (8)
Volatile Solids (%)	5.6 M	—	4.4 N	4.6 N	4.3 N	8.8 H	—	3.6 N	2.3 N
Kjeldahl Nitrogen	851 N	—	951 N	1060 M	760 N	872 N	—	946 N	592 N
Phosphorous	456 M	—	368 N	229 N	217 N	205 N	20.0 N	478 M	291 N
COD	62371 M	—	46000 M	48850 M	53333 M	72500 M	—	98000 H	47000 M
Arsenic	14 H	—	8 M	6 M	3.6 M	4.7 M	29.8 H	20 H	7.4 M
Barium	31 M	283 H	—	—	—	—	—	—	—
Cadmium	5.0 *	8.0 H	1.2 *	0.4 *	3.0 *	3.0 *	1.8 *	0.5 K	0.5 K
Chromium	43 M	5 N	23 N	13 N	28 M	41 M	76.7 H	58 M	12 N
Copper	58 H	104 H	87 H	30 M	35 M	38 M	57.5 H	110 H	23 N
Lead	3196 H	202 H	134 H	31 N	107 H	132 H	187.0 H	120 H	18 N
Manganese	260 N	531 H	589 H	537 H	490 H	710 H	—	970 H	430 M
Mercury	0.19 N	—	0.32 N	0.18 N	0.34 N	0.38 N	—	0.13 N	0.03 N
Nickel	117 H	18 N	—	—	—	—	23.6 M	—	—
PCBs	2.29 M	2426 H	0.225 N	0.070 N	0.133 N	0.585 N	—	0.400 N	0.017 N

(1) IEPA, 1990, Seven Samples, Includes Samples from Waukegan Harbor (except Slip No. 3), New Harbor and North Beach.
(2) Metals 23 Samples (Risatti et al., 1990); PCBs 18 Samples (Ross et al., 1988), (Includes Samples from Slip No. 3).
(3) Three Samples (City of Chicago and IEPA, 1985).
(4) Three Samples (Stations 15, 16, 17), (USACE, 1981).
(5) Four Samples (Stations 1,2,3,4), (USACE, 1981).
(6) Thirty-seven Samples (Ross et al., 1988).
(7) One Sample (City of Chicago and IEPA, 1981).
(8) Eight Samples (Stations 5A, 5H, 5J, 1N, 7N, 2S,5S,7S), (City of Chicago and IEPA, 1981).

Sediment Classification (USEPA, 1977)
N = Nonpolluted
M = Moderately Polluted
H = Heavily Polluted
* Lower Limits ; K = Less Than

Table 2.12. Comparison of Lead, Zinc and Cadmium Concentrations in Waukegan Harbor Sediments with Effects Range Levels from Long and Morgan (1990).

	Waukegan Harbor 23 Stations (1)	Waukegan Harbor Area 7 Stations (2)
Lead (mg/kg)		
Minimum	36	< 10
Maximum	420	12000
Mean	202	3196
Number > 35 (ER-L)	23	6
Number > 110 (ER-M)	18	4
Zinc (mg/kg)		
Minimum	81	15
Maximum	370	280
Mean	214	110
Number > 120 (ER-L)	12	3
Number > 270 (ER-M)	7	1
Cadmium (mg/kg)		
Minimum	< 1.3	< 1.0
Maximum	50.0	12.0
Mean	8.0	5.0
Number > 5.0 (ER-L)	7	3
Number > 9.0 (ER-M)	4	2

(1) Risatti et al. (1990)
(2) IEPA (1990)

ER-L = Effects Range-Low (biological effects 10% of the time).
ER-M = Effects Range-Median (biological effects 50% of the time).

2.4. FISH FLESH CONTAMINATION

PCBs and chlordane have been the two fish contaminants of greatest concern in Lake Michigan over time. During the 1980s, as discussed in detail in the Stage I and II RAP documents, U.S. Food and Drug Administration (USFDA) action levels for PCBs (2 ppm) and chlordane (0.3 ppm) were regularly exceeded in samples taken of Illinois Lake Michigan fish. This, in turn, led to the posting of signs warning that fish from Waukegan North Harbor not be consumed. Other consumption advisories were issued for different species taken elsewhere in Illinois waters of Lake Michigan.

Table 2.13. Summary Data, Mean Concentrations of PCBs in Fish Tissue from Illinois Waters of Lake Michigan, 1986, 1990, 1994 (IEPA, 1996).

	Mean PCB Concentrations (mg/kg)		
Species	1986	1990	1994
Lake Trout	3.81	2.27	1.12
Brown Trout	2.22	1.35	0.83
Rainbow Trout	0.72	1.33	0.66
Chinook Salmon	4.6	0.93	0.57
Coho Salmon	0.69	(a)	0.7
Yellow Perch	(a)	<0.1	<0.1

(a) no data

By the mid-1990s, the results of monitoring indicated a dramatic turnaround in the presence of PCBs and other organic compounds in the tissue of most species of fish taken from both Waukegan Harbor and elsewhere in Illinois waters of the Lake. Sampling since 1986 showed a reduction in PCB levels in trout and salmon (Table 2.13).

The fish consumption warning that had been previously applied to Waukegan Harbor was rescinded in 1997, and revised Lake Michigan fish consumption guidelines were promulgated by the Illinois Department of Public Health (Appendix 2).

Carp have been chosen as the target species for monitoring fish flesh contaminant levels for Waukegan Harbor since they are bottom feeders and harbor residents. It has been demonstrated that larger and older carp have higher levels of PCBs because of greater exposure time. Since it is important to look at fish contaminant data within age groups, special efforts are being made to collect fish from year classes after 1993.

Significant reductions of PCBs have been observed in carp and alewife since the 1993 harbor sediment removal. In 1991, PCBs in alewife and carp were 10 and 19 ppm, respectively. Recently, average concentrations of PCBs in carp have been shown to be less than half of levels found in 1991 with averages among all samples increasing somewhat in recent years. The long term average PCB level in all size groups of carp from 1993 through 1998 was 3.74 ppm. Average PCBs among all size groups were 4.17 ppm in 1996, 5.04 ppm in 1997, and 6.77 ppm in 1998. The last sample of alewife in 1996 showed 0.40 ppm PCBs. Sample size between years has remained relatively small due to availability during sampling and does not allow analysis by fish length groups (Appendix 7).

2.5. THREATENED AND ENDANGERED BIOTA

According to the 1997 Illinois Natural Resource Database, there are 37 species in the Waukegan ESA that are presently on the State endangered or threatened list. Most of these are found within Illinois Beach State Park, although Illinois' only nesting colony of Common Terns is found at the Commonwealth Edison Waukegan plant. Four additional species (3 plant and 1 reptile) have been observed near the northern boundary of the ESA. In addition, one state threatened fish, the longnose sucker, has been found near the Waukegan ESA between Waukegan and Zion, collected in 1995. Five additional species known or suspected to be present in the ESA are federally threatened or endangered and one additional species is a federal species of concern (Table 2.14).

There is no indication that contamination of Waukegan Harbor by PCBs or other chemicals has had an effect on these listed species, although no specific studies addressing such effects have been done. Within the Waukegan ESA it is likely that industrial and commercial development of the Lake Michigan shore has reduced the abundance of some of these endangered and threatened species by eliminating suitable habitats. Short of removing such developments from the area, it is unlikely that restoration of those habitats to any significant extent is possible.

2.6. MAJOR POLLUTANTS OF CONCERN (CAUSING THE IMPAIRED USES)

The USEPA recommends that the following yardsticks be used to designate critical pollutants for Lake Michigan as additional information becomes available:

Table 2.14. Threatened and Endangered Species Within the Waukegan ESA

State of Illinois Listing			
Scientific Name	Common Name	Last Observed	Status
Aflexia rubranura	Redveined Prairie Leafhopper	1992	T
Agalinis skinneriana	Pale False Foxglove	1992	T
Ammodramus henslowii	Henslow's Sparrow	1982	E
Ammophila breviligulata	Marram Grass	1989	E
Arctostaphylos uva-ursi	Bearberry	1993	E
Bartramia longicauda	Upland Sandpiper	1987	E
Cakile edentula	Sea Rocket	1993	T
Calopogon tuberosus	Grass Pink Orchid	1993	E
Carex crawei	Crawe Sedge	1988	T
Carex garberi	Elk Sedge	1987	E
Carex viridula	Little Green Sedge	1977	E
Castilleja sessiliflora	Downy Yellow Painted Cup	1993	E
Catharus fuscescens	Veery	1982	T
Ceanothus herbaceus	Redroot	1990	E
Chamaesyce polygonifolia	Seaside Spurge	1989	E
Drosera rotundifolia	Round-leaved Sundew	1992	E
Eleocharis olivacea	Capitate Spike Rush	1988	E
Hypericum kalmianum	Kalm St. John's-wort	1993	E
Incisalia polios	Hoary Elfin	1994	E
Juncus alpinus	Richardson's Rush	1975	E
Juniperus communis	Ground Juniper	1993	T
Juniperus horizontalis	Trailing Juniper	1993	E
Lechea intermedia	Pinweed	1974	E
Nycticorax nycticorax	Black-crowned Night-heron	1994	E
Orobanche fasciculata	Clustered Broomrape	1988	E
Paraphlepsius lupalus	Leafhopper	1991	E
Platanthera clavellata	Wood Orchid	1991	E
Platanthera flava var herbiola	Tubercled Orchid	1968	E
Platanthera psycodes	Purple-fringed Orchid	1993	E
Podilymbus podiceps	Pied-billed Grebe	1982	T
Populus balsamifera	Balsam Poplar	1990	E
Salix syrticola	Dune Willow	1989	E
Sterna hirundo	Common Tern	1993	E
Triglochin maritimum	Common Bog Arrow Grass	1977	E
Triglochin palustre	Slender Bog Arrow Grass	1977	E
Utricularia cornuta	Horned Bladderwort	1990	E
Utricularia minor	Small Bladderwort	1970	E

T = Threatened, E = Endangered

Table 2.14.(Continued) Threatened and Endangered Species Within the Waukegan ESA

Federal Listing Scientific Name	Common Name	Presence in ESA	Status
Cirsium pitcheri	Pitcher's thistle	K	T
Platanthara leucophaea	Eastern prairie fringed orchid	P	T
Sterna hirundo	Common tern	K	SC
Charadrius melodus	Piping plover	P	E
Falco peregrinus	Peregrine falcon	K	T
Myotis soladis	Indiana bat	P	E
Lycaeides melissa samuelis	Karner blue butterfly	P	E

K = Known presence, P = Possible presence
T = Threatened, E = Endangered, SC = Species of Concern

1. a pollutant bioaccumulates in fish or wildlife tissue, resulting in a lakewide fish or wildlife health advisory;
2. a pollutant exceeds an enforceable water or sediment quality standard;
3. the trend in a pollutant concentration in fish tissue, sediments, or ambient water suggests that safe concentrations, as established by State or Federal water or sediment quality standards, by the parties as specific objectives under the Great Lakes Water Quality Agreement (GLWQA), or by using accepted risk assessment procedures, will be exceeded; and/or
4. a pollutant is present at sufficient locations and at fish tissue, sediment, or water concentrations capable of violating State narrative quality standards prohibiting the presence of substance in toxic amounts.

Pollutants of concern (Table 2.15.) in Waukegan Harbor include those parameters which exceed Illinois water quality standards, are classified as heavily polluted according to USEPA sediment criteria (USEPA, 1977), or exceed USFDA action levels in fish. Those pollutants which have not been directly linked to impaired uses associated with the Waukegan ESA are considered possible potential causes, pending further investigation. Potential chronic health effects of selected pollutants of concern are presented in Table 2.16.

Table 2.15. Pollutants of Concern in the Waukegan Expanded Study Area.

Water	Sediment	Fish
Total Phosphorous	PCBs[1]	PCBs[1]
Total Ammonia	Arsenic[2]	
Chloride	Barium[2]	
Sulfate	Cadmium[2]	
Total Dissolved Solids	Chromium[2]	
Cyanide	Copper[2]	
Phenols	Iron	
Dissolved Oxygen	Lead[2]	
pH	Manganese	
Fecal Coliform	Nickel	
	Phosphorous	
	Kjeldahl Nitrogen	
	Chemical Oxygen Demand	
	Volatile Solids	
	Cyanide[2]	
	Zinc[2]	

1Targeted as a lakewide critical pollutant in the Draft Lake Michigan Lakewide Management Plan, Stage I (USEPA, 1993).
2Targeted as a lakewide pollutant of concern in the Draft Lake Michigan Lakewide Management Plan, Stage I (USEPA, 1993).

Table 2.16. Potential Chronic Human Health Effects of Selected Pollutants of Concern (Stewart et al., 1988).

Contaminant	Possible Chronic Human Health Effect
Arsenic	skin and lung cancer; liver and kidney damage
Barium	hypertension and heart damage
Cadmium	kidney damage
Chromium	liver, kidney, and lung damage
Copper	anemia; digestive disturbances; liver and kidney damage
Lead	brain and nerve damage, especially in children; kidney damage; digestive disturbances; blood disorders; hypertension
Nitrogen	Methemoglobinemia in infants
PCBs	cancer; liver damage; reproductive effects

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3. GOALS AND OBJECTIVES FOR RESTORATION OF BENEFICIAL USES

The Waukegan Expanded Study Area (ESA) is vital to the economic and environmental well-being ofWaukegan and Lake County, llIinois. The commercial and industrial facilities along the lakeshore provide employment. Recreational opportunities are diverse and include two public beaches on Lake Michigan, Illinois Beach State Park, parks along the
Waukegan River, marinas, and access to boat and pedestrian fishing. Restoration of impaired uses and enhancement of unimpaired uses in the ESA will support the further utilization of these amenities and may enhance the development potential of nearby urban areas.

3.1. PROCESS FOR ESTABLISHING GOALS AND OBJECTIVES

The goals and objectives presented in this chapter are the result of a cooperative process during the Stage II RAP process that involved both technical experts and the public. After initial d~velopment, the goals and objectives were sent to members of the IEPA's Interagency Workgroup, a consortium of representatives fTom U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, the llIinois Department of Natural Resources (formerly the Conservation Department), the Citadel, the Illinois Pollution Control Board, and the llIinois State Geological Survey, for review and comment. The goals and objectives were revised and submitted to the Waukegan CAG and its Technical, Habitat, and Site Review Subcommittees. The goals and objectives were revised again and were presented as part of the Stage II RAP document. Final updates to the goals and objectives were completed following a 60-day public comment period.

3.2. GOALS

Goals for each of the 14 beneficial uses identified by the UC (UC, 1989) are presented in Table 3.1. Generally, goals for the Waukegan RAP aim to restore, maintain, or enhance beneficial uses. In situations where the status of the beneficial use is currently unknown, additional study of the use is specified as the goal. Objectives for each goal are presented in section 3.3. Accomplishment of certain goals and objectives will require the determination of a responsible party for follow-up together with adequate funding to accomplish goals and objectives according to priority.

3.3 OBJECTIVES

3.3.1. Restrictions on Fish and Wildlife Consumption

- Reduce contaminant concentrations in the Waukegan ESA which may influence lake-wide fish flesh contamination.

Table 3.1. Goals for the Waukegan Remedial Action Plan

		Maintain/Enhance Current Quality	Provide Further Study	Provide Remedial Action
1.	Restriction on Fish Iilld Wildlife Consumption		X	X
Iii.	Tainting ofFish Iilld Wildlife Flavor		X	
111.	Degradation of Fish and Wildlife Populations		X	
IV.	Fish Tumors Iilld Other Deformities	X		
v.	Bird or Animal Deformities or Reproductive Problems		X	
VI.	Degradation of Benthos			X
vii.	Restrictions on Dredging Activities			X
viii.	Eutrophication or Undesirable Algae	X		
IX.	Restrictions on Drinking Water Consumption or Taste and Odor Problems	X		
x.	Beach Closings		X	X
xi.	Degraded Aesthetics	X		
xii.	Added Industrial Water Treatment Costs	X		
xiii.	Degradation of Phytoplankton and Zooplankton Populations			X
XIV.	Loss ofFih QItd Wildlife H&bitat		X	X

o Evaluate flesh contamination in fish and wildlife which inhabit or use the Waukegan ESA.

3.3.2. **Tainting of Fish and Wildlife Flavor**

o Evaluate the impact of water and sediment contamination in the Waukegan ESA on the flavor offish and wildlife.

o Evaluate ambient water and sediment concentrations of contaminants, such as phenols, which are associated with fish and wildlife tainting.

3.3.3. **Degradation of Fish and Wildlife Populations**

o Protect threatened and endangered species which inhabit or use the ESA.

o Protect the diversity of plant and animal life in the southern portions of Illinois Beach State Park.

o Evaluate and quantifY use of the Waukegan ESA by fish and wildlife.

3.3.4. **Fish Tumors and Other Deformities**

o Maintain ambient water and sediment quality such that occurrence of tumors and defonnities in **fish** do not appear.

3.3.5. **Bird or Animal Deformities or Reproductive Problems**

o Evaluate the impact of water and sediment contamination in the Waukegan ESA on defonnities and reproductive problems in birds and animals.

o Ifbird and animal defonnities and reproductive problems are discovered in the Waukegan ESA, studies would be needed to detennine the cause associated with these problems.

3.3.6. **Degradation of Benthos**

o Maintain conditions which promote the development of healthy and diverse benthic populations in the nearshore waters of Lake Michigan adjacent to Waukegan.

o Remove contaminated sediments with PCB concentrations greater than 50 mg/kg (ppm) ITom Waukegan Harbor to prevent the spread of contamination to the nearshore waters of Lake Michigan.

o Maintain water and sediment quality conditions in Waukegan Harbor. And, allow the development of diverse benthic communities consistent with industrial and commercial use of the harbor.

3.3.i~ ResmctioDsn ~ Aictiyuies

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3.3.'8. Eatt".Qpbicatioll.or Un4esirable A1gae

o Maintain water quality conditions, through!\Pprqpriate management practices such as monitoring of stormwater .and .inciustrial discharges ,and .inst8.Ilation of urban best I1}anagement practices.

o Reduce discharges OfllUtt:ient rich effiuent,such as those iTom sewer exfiltration -of cr.oss connections.

3.3.9. Restrictions .on Drink.iqg Water Consu~ption or Taste and Odor Problems

o Protectthe current.quality of raw 'Water as ail11uniajpalpublicwater **SUmllY.**

3.3.16. Beach Closings

o 'ldentif¥ ,and ,quantifY 'S0uroeSoflffecal.rolifonn,such lasCroSS .connections or extiltration trom ,se.wer :lines, which impact the quality of the Wauk~an River.

o R.educe£ec8.l,colifeml.contaminationoomithe W.auk~anRiver.

3.3.U. Degraded AShetia;

o :Maintain.and!pr.oteat ,the\ooIIDr .andlClatity .of'water ,in the '.haibor,and ,in iRearshore UtkeMichigan.

o !Bromate activities -which \Will iinyJro¥e:the ;ambiance 'oflthe :immediate :harbor 'W:inity and :thelakeftont 'such as jland8C&Pmg andtmaintenance,of;buildiQgs;andi8f.Qunds(c;jf industrial ;facilities.

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3.3.13. Degradation of Phytoplankton and Zooplankton Populations

a Provide water and sediment quality throughout the harbor and nearshore lake area which is not detrimental to the development and growth of phytoplankton and zooplankton populations.

3.3.14. Loss of Fish and Wildlife Habitat

a Protect the high quality habitat provided by the southern portion oflllinois Beach State Park.

a Maximize, to the greatest extent practicable in an industrial use situation, the habitat value of the Waukegan Harbor.

a Protect and enhance the habitat provided in the nearshore waters of Lake Michigan, especially through reduction of water and sediment contamination in the ESA.

3.4. APPLICABLE STANDARDS AND GUIDELINES

Goals and objectives for the Waukegan ESA were developed using the guidance of the Clean Water Act, the Great Lakes Water Quality Agreement, and state and federal water quality standards. In addition, these goals and objectives reflect the concerns of the public through input from the Waukegan CAG and its Technical, Habitat, and Site Review Subcommittees. Specific standards and guidelines which are especially applicable to the goals and objectives for the Waukegan ESA are discussed below.

3.4.1. Water Quality Standards and Guidelines

The Federal Clean Water Act establishes goals for water quality that support fishing and swimming. Attainment of the fishable goal requires water quality conditions which provide protection and propagation of balanced populations of shellfish, fish, and wildlife. Likewise, attainment of the swimmable goal requires water quality conditions which allow recreation activities in or on the water.

The Great Lakes Water Quality Agreement (Agreement) was developed with the purpose of restoring and maintaining "the chemical, physical, and biological integrity of the waters of the Great Lakes Basin Ecosystem" (IJC, 1989). The general objectives of the Agreement aim to protect the Great Lakes System from adverse impacts which may result from human activity. Adverse impacts include contamination of bottom sediments, concentration of floating materials at the water surface, degradation of the physical characteristics of water, and introduction of toxic contaminants and nutrients.

The State of lliinois updated its water quality standards for Lake Michigan on December 18, 1997. This update incorporates the standards and procedures of the Great Lake Initiative (GLI) and is being implemented in coordination with

the Great Lakes States md USEP A to provide consistent, enforceable long tenn protection from all types of pollutants. The Gq entp~is is on long Jasqug pollutants that accumulate in the fooq wep. The Gp includes water quality criteria, and anti-degradation policies and implementations procedures that provide an ecosystem approach consistent with State re~atory a,pproaches throughout the Great J-akes.

In the LaJce Mic1Ug~ regt$tions, new numerical standards for many parameters have been added. Numerical standards specifically protect human heaJth md wildlife from chronic adverse health effects that could occur from drinking water and fish consumption exposures. In addition these standards also protect aquatic life from both acute and chronic effects caused by contaminaqon exposures. There are also new procedures for deriving protective water quality criteria for substances in the Lake Mic1Ugan basin waters to protect aquatic life, wildlife, and human health.

3.4.2. Sediment Quality Standards and Guidelines

The USEP A has developed guidelines for the pollutional classification of Great Lakes harbor sediments (USEP A, 1977). These guidelines were developed to facilitate the identification of appropriate disposal locations for dredge spoils. Under these guidelines, sediments are classified as either nonpolluted, moderately polluted, or heavily polluted based on the concentration of the most prevalent sediment contaminants.

The IEP A has published pollutional classifications of inland lake sediments based on observed concentrations of samples coUected in lakes throughout the State of Dlinois (KeUy and Hite, 1981). The database used to develop these classifications included sediment samples from 63 lakes. Mean background contaminant concentrations were identified and the classifications were developed based on deviation from these background means.

3.4.3. Fish Consumption Guidelines

In 1997 the Great Lakes States adopted a new method for assessing the effect fish flesh consumption has on humans. Under the new Great Lakes ratings, consumption catagories have been expanded to five (no restrictions, one meal per week, one meal per month, one meal every two months, and do not eat). Species now include various size groups of chinook salmon, lake whitefish, rainbow trout, brown trout, lake trout, yellow perch, smelt, channel catfish, and carp. The new system builds upon the U.S. Food and Drug (USFDA) guidelines which were previousJy used.

3.4.4. Beneficial Use Guidelines

In defining the Remedial Action Plan process, the IJC identified 14 beneficial uses which could potentially be impaired as a result of contamination. These use impairments and the criteria used for their evaluation are listed in Chapter 2, Table 2.1.

3.5. SUMMARY

The goals and objectives presented in this chapter aim to maintain. enhance, and restore beneficial uses in the Waukegan ESA and were based on water, sediment, and fish and wildlife contamination standards and guidelines. After development, the goals and objectives were reviewed by representatives of federal and state agencies, the Waukegan CAG, and the general public. These goals and objectives are to be used to track progress and to prioritize future remedial actions to be conducted in the Waukegan ESA.

3.6. REFERENCES

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4. REMEDIAL ACTION STEPS

Attainment of the goals and objectives defined in Chapter 3 requires the completion of plans and successful remedial actions. Remedial actions recommended for the Waukegan ESA include: studies which will better define the status and extent of use impairments; specific remedial actions which will promote better environmental conditions in the ESA; and, maintenance and protective activities which will conserve natural resources and guard against future environmental degradation.

4.1. PLANS AND STUDIES

Although Waukegan Harbor has been the subject of numerous studies, additional investigations throughout the ESA may be required. These studies are needed to determine whether there may be other use impairments that have not been previously defined. Studies also may be needed to identify additional contaminated sites. Further, transport processes and exposure pathways which affect contaminant movement and bioaccumulation require greater definition. The plans and studies outlined in this chapter resulted from input provided by the Citizens Advisory Group, The Inter-Agency Workgroup, the International Joint Commission, and the USEPA among others.

City of Waukegan Brownfield Initiative

Responsible Parties: City of Waukegan
Estimated Cost: $200,000
Completion Date: 2002
Funding Source: USEPA

On July 16, 1998 the City of Waukegan was awarded a USEPA brownfield grant to bring abandoned and degraded properties back into full use. The city has been working closely with Illinois EPA on a brownfield pilot project as part of the Remedial Action Plan to restore Waukegan Harbor. The RAP process was the catalyst for the new project. The new project is titled – Brownfield Redevelopment for the City of Waukegan and Waterfront Revitalization Project. Since Waukegan's downtown and waterfront areas are separated by a number of brownfield sites, the new project will target five or six of these properties along the proposed Madison Street corridor that will eventually link the City's downtown and waterfront areas. Project funding will be used for site assessment activities, to compile a brownfield database, and for community outreach activities with the goal of building partnerships.

Waukegan Harbor (AOC) Sediment Toxicity

Responsible Parties: IEPA, USGS
Estimated Cost: $40,000
Completion Date: 1999
Funding Source: IEPA, USEPA

Surface sediments were collected in Waukegan Harbor with the assistance of USEPA in 1996. Toxicity tests were conducted on whole sediments using the Microtox acute testing protocol. A subset of these samples were tested using the 28 day bioaccumulation test using Lumbriculus variegatus. Additional whole sediment toxicity tests were accomplished using the 7 day Ceriodaphnia dubia or the 28 day Hyalla asteca test. Results are pending at the time of this report.

Waukegan Harbor (AOC) Brownfield Initiative

Responsible Parties: IEPA
Estimated Cost: $100,000
Completion Date: 1998
Funding Source: IEPA, USEPA

The long range goal of Brownfields planning initiatives is to bring old abandoned industrial property along the lake shore in the Waukegan Area of Concern (AOC) into full use with no risk to the health of the public or the environment. This project will provide the initial planning and phase I investigations at priority sites identified by the Waukegan Citizens Advisory Group (CAG) of Waukegan Harbor.

Literature reviews and site sampling were completed in the Spring, 1998, for three parcels of land that the Waukegan Citizens Advisory Group selected for the Illinois EPA. The first parcel, a former gas station located at the corner of Sheridan Road and Clayton, was sampled in November, 1997. Redevelopment of this parcel as an annex to the Genesee Theater appears likely as a result of this Brownfields assessment. The other two parcels are adjacent properties on South Genesee Street where a commercial dry cleaner formerly operated. Sampling on these two parcels was conducted in April, 1998. Discussions with municipal officials indicate an interest in constructing an apartment complex on this property. An Illinois EPA status report on the Brownfield assessment is included as Appendix 10. Local partnerships have been developed serving as a catalyst for followup by the local community for additional implementation.

Waukegan Harbor Citizen Advisory Group Linkage to the Great Lakes Information Network/Administrative Support

Responsible Parties: IEPA, Waukegan Citizens Advisory Group (CAG)
Estimated Cost: $17,000
Completion Date: 1998
Funding Source: USEPA, IEPA

Access to Great Lakes environmental information at the Waukegan Public Library and administrative support to the Waukegan Citizens Advisory Group (CAG) provides active participation, communication and coordination between the local community and other Great Lakes partners. The necessary hardware and software was purchased to establish access to the Great Lakes Information Network (GLIN). An Internet computer was purchased and donated to the Waukegan Public Library in 1997 and a home page was established for the CAG (http://www.nsn.org/wkkhome/iepa). Administrative support for the Waukegan Citizens Advisory Group (CAG) will cover expenses related to preparation of monthly meeting notes, postage, xeroxing, and mailings of related CAG business. Attendance at meetings related to Great Lakes Remedial Action Plans and the Lake Michigan Lakewide Management Plan may also be provided at the request of the CAG. A September 5, 1997 news release and fact sheet describing implementation of the Internet public access project is reproduced as Appendix 9.

Stage III Report Update and De-Listing Guidelines for the Waukegan Harbor (AOC)

Responsible Parties: IEPA, Hey & Associates, Inc.
Estimated Cost: $35,000
Completion Date: 1998
Funding Source: IEPA, USEPA

A major revision and updating of the Waukegan Harbor Remedial Action Plan (RAP) is required in order to de-list this Area of Concern (AOC). De-listing of the AOC provides for a statement of environmental progress and improvement through implementation of the Remedial Action Plan and removal from the list of highest priority cleanup concerns in the Great Lakes. A multitude of activities and improvements have taken place in the Waukegan Harbor AOC are now documented in this final Stage III report. De-listing discussions with the Citizens Advisory Group are documented in a separate report.

Interim Measures Contingency Plan for Asbestos Mitigation at Illinois Beach State Park

Responsible Parties: IEPA, IDNR, IDPH, USEPA, Johns Manville
Estimated Cost: Indeterminate
Completion Date: 1998
Funding Source: IEPA, IDNR, IDPH

A comprehensive plan was developed in early 1998 to deal with increased concerns regarding asbestos material found along the beaches of Illinois Beach State Park. The plan includes awareness training for staff, a health and safety plan, a detailed monitoring and problem assessment, and a public information effort. A monitoring effort included sampling of beach sand, waste pile areas, lake water, public drinking water, and ambient air. After completion of the monitoring effort in Spring, 1998, the Illinois Department of Public Health announced that there was no threat to the public health that would affect normal park operation. Additional investigation will be undertaken as appropriate.

Bird Census at Illinois Beach State Park - Zion

Responsible Parties: Chicago Ornithological Society
Estimated Cost: Indeterminate
Completion Date: Ongoing
Funding Source: Volunteer

The Chicago Ornithological Society initiated volunteer bird census activities at Illinois Beach State Park in 1995 to provide bird population information. Census continues to provide data on bird migrations and use of habitats in the park.

Examine Waukegan's Sewer System and Identify Sanitary Sewer Problems and Illegal Connections to Storm Sewers

Responsible Parties: City of Waukegan
Estimated Cost: Indeterminate
Completion Date: Ongoing
Funding Source: IEPA, USEPA, City of Waukegan

The City of Waukegan conducts ongoing work to identify sanitary sewer problems. Identification and correction of sewer infiltration problems could aid in reducing the frequency and magnitude of excess flow discharges from the North Shore Sanitary District's Waukegan Sewage Treatment Plant. Identification of sanitary sewer problems and cross-connections to

storm sewers has also helped to target remedial actions necessary to reduce the fecal coliform concentrations in the Waukegan River that were associated with the periodic closing of Waukegan beaches (NSSD, 1990).

Investigate Contamination of Fish Flesh

Responsible Parties: IDNR, IEPA
Estimated Cost: $ 25,000/year
Completion Date: Ongoing
Funding Source: IDNR, IEPA, USEPA

Fish tissue sampling is conducted annually within the old north harbor to monitor contaminant levels for fish taken by electrofishing gear. Both sport and bottom feeding species will be targeted for whole fish or fillet samples as appropriate.

Evaluate Use of the Waukegan ESA by Fish and Wildlife

Responsible Parties: IDNR, USFWS, Volunteers
Estimated Cost: $ 100,000
Completion Date: Indeterminate
Potential Funding Source: IEPA, USEPA

While use of the Waukegan ESA water resources by several species of fish has been fairly well documented, use by bird and animal species, especially outside the boundaries of Illinois Beach State Park, is not well defined. Use of the ESA by bird and animal species for habitat and foraging will be observed and recorded. If possible, observed usage will be compared to available records to assess historical changes in bird and animal populations. Fish and wildlife will be monitored to aid the evaluation of remediation success and to document re-establishment of impaired uses.

Monitoring of fish and wildlife in the ESA will provide an opportunity to further document the lack of tumors and deformities in fish and to investigate the occurrence of tumors and deformities in birds and animals. Population monitoring over an extended period also could indicate the existence or nonexistence of any fish and wildlife reproductive problems.

The USEPA has sponsored a study of the use of the Lake Michigan shoreline wetlands by birds. The study began in Spring, 1992. Study locations within the ESA are all located in the Illinois Beach State Park and include one transect along the lakeshore and two sites on the Dead River. As much as possible, new studies of bird populations in the ESA should build upon the results of this study. In 1995 and 1996, volunteer bird and amphibian monitoring showed the Waukegan AOC as not impaired in terms of its ability to support healthy marsh bird and amphibian communities (Appendix 11).

Investigate Possible Contamination at the Diamond Scrap Yard

Responsible Parties: Bank of Waukegan
Estimated Cost: Indeterminate
Completion Date: Indeterminate
Potential Funding Source: Diamond Scrap Yard, IEPA, USEPA

The nature and extent of contamination at the Diamond Scrap Yard was investigated through site inspection, soil borings, and groundwater sampling. The Bank of Waukegan funded a preliminary site survey, conducted by Roy F. Weston, Inc., that involved soil and asbestos sampling from buildings on-site. The results of the preliminary site survey indicated the presence of metals, VOCs, and PCBs. Further investigation is needed to determine the extent of contamination. Study results should be used to determine potential threats posed by contamination to human health and the possibility for transport of contaminants to Lake Michigan. Study results also should identify any required remedial actions.

Investigate Potential Tainting of Fish and Wildlife Flavor

Responsible Parties: USFWS, IDNR
Estimated Cost: Indeterminate
Completion Date: Indeterminate
Potential Funding Source: USFWS, IDNR

Anglers fishing in the waters of the ESA should be surveyed about any past experiences with tainted fish taken from the Waukegan area. Results of this study and survey should provide a better indication of the status of possible use impairment. Water samples collected throughout Waukegan Harbor and the Waukegan nearshore areas of Lake Michigan should be analyzed for substances such as volatile organic carbons and phenols which are associated with tainting of fish and wildlife flavor.

Great Lakes Charterboat Captain Fish Consumption Health Study

Responsible Parties: IDPH
Estimated Cost: Indeterminate
Completion Date: Indeterminate
Funding Source: IL, MI, IN, WS, OH

The Health Departments from the states of Ohio, Michigan, Indiana, Illinois and Wisconsin are working together to study

the possible health effects of Great Lakes fish consumption. The focus of the study is on charter boat captains and their families from Lakes Michigan, Huron and Erie. Past studies have suggested that charter captains may eat more Great Lakes fish than the general public and it is hoped that they can provide an accurate assessment of human exposure to fish contaminants.

Phase One of the study, which began in the fall of 1993, used a telephone survey to gather information on the consumption of Great Lakes fish among charter captain families and to determine the health status of children born to charter captains since 1970. Phase Two of the study involved checking the chemical contaminants in the blood of approximately 600 individuals.

Investigate Possible Contamination at Abbott Laboratories (formerly U.S. Steel)

Responsible Parties: Abbott Laboratories, MCL Development, IEPA, USEPA
Estimated Cost: Indeterminate
Completion Date: Indeterminate
Potential Funding Source: Abbott Laboratories, MCL Development, IEPA, USEPA

The Abbott Laboratory property (formerly U.S. Steel) adjacent to Waukegan Paint and Lacquer along the southern boundary of the ESA, should be investigated for the presence of soil and groundwater contamination. The site should be examined to determine the presence of underground storage tanks and to better define the location of the stormwater drainage system and its outfalls to the lake. Study results should be used to determine any potential health threats from contamination and potential contaminant transport. If necessary, appropriate remedial activities will be identified based on study results.

Investigate Contamination of Wildlife Flesh

Responsible Parties: IDNR, IEPA, USFWS
Estimated Cost: Indeterminate
Completion Date: Indeterminate
Potential Funding Source: IDNR, USFWS

Tissue from resident wildlife will be collected and analyzed for concentrations of constituents commonly found within the Waukegan ESA, such as PCBs and PAHs. Concentrations of these constituents in wildlife flesh will provide an indication of the exposure of wildlife to hazardous substances in the ESA. Constituent concentrations also may indicate a need for wildlife consumption restrictions; however, since hunting is not allowed in the ESA due to its urban location, the need for wildlife consumption restrictions is questionable.

Sport Fishing Creel Survey on the Illinois Portion of Lake Michigan

Responsible Parties: INHS, IDNR, USFWS
Estimated Cost: $ 324,000
Completion Date: 1996
Funding Source: USFWS, IDNR

This study estimated total summer (April 1 to September 30) sport harvest of yellow perch, brown trout, rainbow trout, lake trout, coho salmon and chinook salmon for the years 1993, 1994, and 1995. Estimates covered harvests by pedestrian anglers, anglers using launched boats, anglers using boats kept at moorings, and excluded harvest by charter fishing boats, winter fishing, and smelt fishing. Snagging from October 1 through November 15 was included. Estimates of the number of man hours fished and the number of angler trips was made. Records also were made of fish lengths, weights, and markings (especially fin clips) for fish in the possession of anglers.

Waukegan River National Monitoring Strategy

Responsible Parties: ISWS, Waukegan Park District, IEPA
Estimated Cost: $ 50,000
Completion Date: 1996
Funding Source: IEPA, USEPA

A monitoring program plan for the Waukegan River was developed as part of a national non-point pollution monitoring strategy. The study included data collection for macroinvertebrate sampling, physical habitat, fisheries, and stream flow during Spring, Summer and Fall. A monitoring plan was prepared to describe the effectiveness of biotechnical stream stabilization techniques. The study area included Washington and Powell Parks in the city of Waukegan. A final report, video, and brochure were completed.

Waukegan River Intensive Survey

Responsible Parties: IEPA
Estimated Cost: $ 50,000
Completion Date: 1995
Funding Source: USEPA, IEPA

An intensive survey of the Waukegan River Basin to determine overall stream condition was completed in 1995. Twelve

stations were sample for water chemistry, sediment chemistry, macroinvertebrate community and instream habitat. Ecological health of the Waukegan River was rated as poor to very poor based on the data collected.

Waukegan River Wetland Demonstration

Responsible Parties: Wetlands Research Inc.
Estimated Cost: $ 166,000
Completion Date: 1995
Funding Source: Great Lakes Protection Fund

The Illinois Environmental Protection Agency and the Lake County Stormwater Management Commission have both identified the Waukegan River watershed for intensive study and development of controls for urban stormwater runoff. A large area of degraded wetlands exists in the upper part of the watershed. Wetlands Research Inc. studied the feasibility of restoring the wetlands in the watershed to manage stormwater, reduce stream bank erosion, and to improve water quality, and worked with the Citizens Advisory Committee to evaluate the plan. The study shows the potential water quality improvements from three different types of wetland restoration projects (one each in Illinois, Wisconsin, and Michigan).

Investigate the Nature and Extent of Sediment Contamination in the Inner Harbor Extension

Responsible Parties: USACE
Estimated Cost: Indeterminate
Completion Date: 1995
Potential Funding Source: USACE

Sediment core samples collected from Waukegan Harbor between slip 1 and the area dredged as part of OMC Superfund remediation and the entrance channel were analyzed for various contaminants, including PCBs. Contaminant analysis will help to determine actions necessary to allow dredging of sediments from this portion of the harbor (Appendix 5).

Public Health Site Review and Update of Johns Manville

Responsible Parties: ATSDR, IDPH
Estimated Cost: Indeterminate
Completion Date: 1994
Funding Source: USEPA

The Agency for Toxic Substances and Disease Registry (ATSDR) completed a Site Review and Update (SRU). The

purpose of a SRU is to discuss the current status of a hazardous waste site and to identify future ATSDR activities planned for the site. The Illinois Department of Public Health concluded that this site had levels of contamination in on-site soil samples that exceed background levels for asbestos, lead, and chromium. There is no evidence that contaminants are migrating off-site. Future contamination of Lake Michigan, air, groundwater, or soils is not likely. Site access is restricted, and there are no residential dwellings located within 0.5 miles of the site. Since the site has been capped to reduce contaminant migration, future exposures are not likely. Although the data and information used in developing the Site Review and Update determined that no further public health actions were needed additional studies were conducted in 1998 directed at asbestos found at the Illinois Beach State Park. The 1998 study reaffirmed that there was no threat to the public health (See Interim Measures Contingency Plan for Asbestos Mitigation at Illinois Beach State Park in this section).

Lake Michigan Ozone Study (LMOS)/Lake Michigan Ozone Project (LMOP)

Responsible Parties: IEPA, MDNR, IDEM, WDNR, USEPA
Estimated Cost: $ 12,000,000
Completion Date: 1994
Funding Source: IEPA, MDNR, IDEM,WDNR, USEPA

The Lake Michigan Ozone Study is a comprehensive investigation of the formation and transport of smog in the Lake Michigan airshed. The study is a joint effort involving the states of Illinois, Michigan, Wisconsin, and Indiana, along with the USEPA. The project has been the subject of discussion and planning since 1987. The study represents a coordinated approach to a regional problem - ozone formation and transport in the Lake Michigan region. State-of-the-art computer modeling will help planners organize and interpret data. The purpose of the study is to gather the information needed to develop improved ozone control strategies for each of the four participating states.

Public Health Assessment of Outboard Marine Corporation

Responsible Parties: ATSDR, IDPH
Estimated Cost: Indeterminate
Completion Date: 1998
Funding Source: USEPA

The Agency for Toxic Substances and Disease Registry (ATSDR) collected relevant health data, environmental data, and community health concerns for public health assessment at the Outboard Marine Corporation. The aim of this evaluation was to find out if people are being exposed to hazardous substances, and if so, whether that exposure is harmful and should be stopped or reduced. The Illinois Department of Public Health (IDPH) concluded that this site posed a public health hazard because humans have probably been exposed to PCBs via consumption of contaminated fish, which could result in

adverse health effects. An additional update will be prepared after completion of the Waukegan Manufactured Gas and Coke Plant remedy.

Characterize Groundwater Quality and Flow in the Waukegan ESA

Responsible Parties: IEPA
Estimated Cost: $ 105,000
Completion Date: 1994
Funding Source: IEPA, USEPA

Eight groundwater monitoring wells were installed south of Waukegan Harbor along the lake front and water level readings were taken between October, 1992 and December, 1993. Water samples from each well were drawn twice and analyzed for various constituents including volatile organic compounds (VOC), semi-volatile compounds, metals, pesticides, and PCBs.

Results from the groundwater study show lead and VOCs to be the contaminants of concern south of the harbor. The data show that shallow groundwater flows to Lake Michigan, and that there is potential for future use impairment due to discharge of contaminated groundwater to Lake Michigan.

Examination of Water and Sediment Quality at the Intake of the Waukegan (Drinking) Water Treatment Plant

Responsible Parties: IEPA
Estimated Cost: $ 25,000
Completion Date: 1993
Funding Source: IEPA, USEPA

Raw and finished water samples were collected from the Waukegan Water Treatment Plant and analyzed. Samples of sediment collected near each of the inlets to the plant and samples of water treatment sludge also were analyzed.

Sample data collected during the sampling allowed evaluation of the potential for drinking water restrictions or taste and odor problems. Evaluation of sediment samples provided information on sediment quality and the potential for intake into the water treatment plant.

In 1992, water sampled from the Waukegan Water Treatment Plant showed no organics in either raw or finished water. Sludge filtrate at the water treatment plant also had organic concentrations below detectable levels. Other parameters were within expected ranges. In the harbor entrance channel, PCB levels in sediments were below 1.5 ppm. Highly elevated levels of arsenic in sediments were detected at 18.1 to 23.0 ppm in this vicinity while no additional parameters were rated as

highly elevated at all locations. Based on available information, harbor and open lake sediments do not pose a threat to the public water supply. Drinking water continues to meet standards set forth by the Safe Drinking Water Act after conventional treatment.

4.2. SPECIFIC REMEDIAL ACTIONS

Specific remedial actions are aimed at removing, destroying, and/or containing constituents which are associated with impairment of uses within the Waukegan ESA or are considered a health or environmental threat. In addition to alleviating listed use impairments, these specific remedial actions will promote the reestablishment of any impaired uses which are not currently identified and will reduce the potential for further use impairments.

Remove Contaminated Sediments from Waukegan Harbor

Responsible Parties: USACE, Harbor Area Industries, Local Sponsor
Estimated Cost: $12,000,000
Completion Date: 2002
Potential Funding Source: USACE, Harbor Area Industries, Local Sponsor

The area to be dredged should include maintenance dredging between slip 1 and the outer harbor, as currently proposed by the USACE, as well as the inner harbor extension area between the OMC Superfund site and slip 1.

These sediments must be removed from Waukegan Harbor and to prevent contamination of areas for which dredging has already occurred. Dredging of this portion of the harbor should allow passage of fully loaded commercial vessels into slip 1. As discussed earlier, removal of contaminated sediments from Waukegan Harbor will greatly reduce aquatic organism contact with hazardous substances. This will reduce the impacts of environmental degradation on these populations, such as degradation of plankton and benthos and contamination of fish flesh. Once contained, migration of contaminants from the harbor to Lake Michigan will be curtailed.

Select and Implement Remedial Actions at the Griess-Pfleger Tannery Site

Responsible Parties: Commonwealth Edison Company, IEPA
Estimated Cost: $ 230,000
Completion Date: 1999
Funding Source: Commonwealth Edison Company

The Commonwealth Edison Company (CEC) plans to use the site of the former Griess-Pfleger Tannery site for

construction of generators to supply electricity during peak periods of demand. Before construction can commence,

hazardous materials must be located, identified, and removed from the site. CEC has conducted an investigation of contamination at the tannery site. The work plan was approved by IEPA in 1993. When the site investigation is complete, alternative remedial activities, if necessary, will be evaluated and the most effective remedial actions identified.

As with other remediations throughout the Waukegan ESA, cleanup activities at the Griess-Pfleger Tannery site will reduce the potential for contaminant transport to the water resources of the ESA and also will reduce the potential for contact between contaminants and the environment.

Select and Implement Remedial Actions at Waukegan Manufactured Gas and Coke Plant

Responsible Parties: North Shore Gas Company, OMC, General Motors, USEPA, IEPA
Estimated Cost: $ 1,500,000
Completion Date: Continuing
Funding Source: North Shore Gas Company, OMC, General Motors

A Remedial Investigation/Feasibility Study (RI/FS) has been initiated at the Waukegan Manufactured Gas and Coke Plant Site. North Shore Gas has retained Barr Engineering to perform the Remedial Investigation/Feasibility Study.

The Feasibility Study will identify site-specific remedial goals and objectives and will evaluate alternatives for the remediation of contaminated soils and groundwater. Completion of the RI/FS will determine the areas of the site which require remediation and will allow selection of an effective remedial action. The specific remedial activities required at the site have not been determined. Once selected and implemented, the required remedial activities should provide significant reductions in the contaminant mass at the site. Consequently, the potential for transport of the contaminants to nearby water resources and the risks to humans and environment will be reduced. In addition, since some of the contaminants found at the coke plant site are associated with tainting of fish flavor, removal of these contaminants should reduce the risk of fish flesh tainting.

A phase I field inspection was conducted in 1992 to define the areal extent of contamination. Soil samples indicated the presence of PAHs at the site. A phase II field investigation to determine the vertical extent of contamination and groundwater flow pattern was finished in 1993. USEPA completed a risk assessment of the site in 1995. The Feasibility Study, has identified potential groundwater and soil remedies.USEPA is negotiating with the potentially responsible parties to determine when construction of the remedy will begin.

Implement Remedial Actions at Yeoman Creek Landfill

Responsible Parties: Browning-Ferris Industries, OMC, T.K. Disposal Inc., USEPA, City of Waukegan, Waukegan School District

Estimated Cost: $26 million

Completion Date: Indeterminate

Potential Funding Source: Browning-Ferris Industries, OMC, T.K. Disposal Inc., USEPA, City of Waukegan, Waukegan School District

A remedial investigation of the Yeoman Creek Landfill and Edwards Field Superfund site has been completed. Some remedial activities have already been completed: a two-foot cover was installed over Yeoman Creek Landfill in 1980, a fence was installed around the site in 1990, and erosion control measures have been initiated. Leachate movement from the landfill into the North Branch of the Waukegan River (Yeoman Creek) has been reduced as a result of these activities, but has not been completely controlled. Superfund remedial actions begun in 1997 will further reduce leachate movement from the landfilled areas to surface water and groundwater. As transport of contaminants to nearby water resources is reduced, contact risks in the North Branch of the Waukegan River will be reduced as will the possibility of eventual transport of contaminants to Lake Michigan.

A Record of Decision (ROD) was signed in 1996. The plan calls for containing contaminated soils and sediments with a landfill cap, collecting and treating landfill gases, and a long term monitoring system, including sampling of groundwater, surface water, creek sediments, and leachate.

Complete Preliminary Assessment of Alloy Casting and Engineering

Responsible Parties: IEPA

Estimated Cost: Indeterminate

Completion Date: Indeterminate

Funding Source: IEPA, USEPA

Preliminary assessment of property within the ESA referred to as Alloy Casting and Engineering is currently being conducted by the IEPA. Alloy Casting and Engineering has not operated on the segment of property where the preliminary assessment will be conducted. As of this publication, the current owner has not been identified. When completed, this assessment will indicate the most appropriate program through which remediation, if needed, may be accomplished.

Initiate Preliminary Assessment of Greenwood Avenue Dump

Responsible Parties: IEPA
Estimated Cost: Indeterminate
Completion Date: Indeterminate
Funding Source: IEPA, USEPA

In 1994, this inactive dump site was added to the list of sites that need a preliminary assessment. When completed, this assessment will indicate the most appropriate program through which remediation, if needed, may be accomplished.

Promote the Development of Fish Habitat

Responsible Parties: IDNR, USFWS
Estimated Cost: Indeterminate
Estimated Completion Date: Indeterminate
Potential Funding Source: IDNR, Illinois-Indiana Sea Grant Program, USFWS

A management plan for the development and enhancement of fish habitat in the water resources of the Waukegan ESA will be prepared according to the guidelines of the Great Lakes Fishery Commission (GLFC, 1987). The plan will allow for protection, rehabilitation, and enhancement of the physical, chemical, and biological features required for the development and maintenance of a stable fishery.

Waukegan River Rock Riffle Restoration Project

Responsible Parties: IL State Water Survey, Waukegan Park District
Estimated Cost: $ 80,000
Completion Date: 1996
Funding Source: IEPA, USEPA

A series of pools and riffles were created in the Waukegan River to create aeration and improve habitat for aquatic life. The proposed techniques for recreating riffles should prevent further streambank erosion and will act as protection for the sewer stream crossings. When combined with vegetative bank stabilization that has been done, this process will reverse the instability created by runoff and early channel modifications.

In addition, the creation of riffles will improve water aeration during normal stream flows when urban streams typically have very low oxygen levels. The stream habitat improvements resulting from the creation of deep pools, rock riffles, and increased water aeration has provided strong positive benefits for aquatic life.

Waukegan River Bank Stabilization and Management

Responsible Parties: City of Waukegan, IEPA, Illinois State Water Survey
Estimated Cost: $ 416,667
Completion Date: 1995
Funding Source: IEPA, USEPA, City of Waukegan

The banks of the Waukegan River within Powell and Washington Parks have been stabilized through the application of vegetative stream stabilization techniques. Concurrent with establishment of streambank vegetation, local government employees and private contractors received vegetative management training.

Stabilization of the streambanks in the study area has provided a reduction in erosion rates along the river and, consequently, a decrease in sediment loads delivered to Lake Michigan. Since erosion along the river is reduced, further exposure of sanitary sewer lines and the associated damage has diminished. Flow velocities in the river have been sufficiently decreased by the establishment of vegetation to allow sediment to be deposited within the channel.

Additional erosion controls utilizing vegetative stabilization, structural stabilization, and habitat structures with vegetation will be applied to the Waukegan River in Washington Park.

Complete OMC Superfund Remedial Activities

Responsible Parties: OMC, USEPA
Estimated Cost: $ 21,000,000
Completion Date: 1994
Funding Source: OMC

Remedial activities for the OMC property and the northernmost portions of Waukegan Harbor were initiated in 1990 and completed in 1993. All dredged sediment has been placed in containment cells. A detailed description of activities which have been completed at the OMC Superfund site can be found in the Stage I and II Remedial Action Plan.

All three containment cells have been capped. Extraction wells have been installed into each of the containment cells to ensure that groundwater flows into the cells. Extracted water is analyzed and treated prior to being discharged.

Five of the six original use impairments in the Waukegan ESA (restrictions on fish consumption, degradation of benthos, restrictions on dredging activities, degradation of phytoplankton and zooplankton populations, and loss of fish and wildlife habitat) were associated with contaminated sediments. Removal of contaminated sediments has already provided a positive first step toward reestablishment of some impaired uses. Removal of highly contaminated sediments will provide cleaner conditions for benthic organisms and bottom dwelling fish. Transport of contaminants from sediment into the water column through sediment suspension, desorption, and solution also should be reduced once contaminated sediments are removed. Lower constituent concentrations in the water column will promote reestablishment of phytoplankton and zooplankton populations and reduce assimilation of constituents by aquatic organisms.

The indirect benefits resulting from removal of highly contaminated sediments are many. Increased populations of plankton and benthic organisms will improve fish forage in the ESA and, thus will improve fish and wildlife habitat. Since the concentration of contaminants in the tissues of aquatic organisms is likely to be reduced, bioaccumulation of contaminants through the food web should decrease. Lower tissue contaminant concentrations in Waukegan Harbor and Lake Michigan fish will continue to reduce the need for fish consumption advisories. Lower tissue concentrations in high trophic level organisms will alleviate any possible wildlife deformity or reproductive problems and fish and wildlife population declines. Finally, removal of the most contaminated sediments will prevent further spread of constituents to less contaminated areas of the harbor and lake. Slowing transport of highly contaminated sediment will protect down-gradient sediment and water quality and will facilitate future needed dredging activities.

Shoreline Stabilization at Illinois Beach State Park

Responsible Parties: IDNR, ISWS, IEPA
Estimated Cost: $ 100,000
Completion Date: 1994
Funding Source: IEPA, USEPA

A beach restoration project for the Illinois Beach State Park in Zion was implemented by the Illinois Department of Natural Resources. Approximately 26,000 - 30,000 cubic yards of washed pea gravel was used to slow downstream shoreline erosion. Monitoring of transport rates will provide sound baseline data on how and where future beach nourishment activities will achieve the best results.

Lake Michigan Watershed Inventory/Identify and Control Sources of Nonpoint Source Pollution

Responsible Parties: IEPA, Lake County Stormwater Management Commission
Estimated Cost: $ 140,000
Completion Date: 1994
Funding Source: IEPA, USEPA, Lake County Stormwater Management Commission

The Lake County Stormwater Management Commission (LCSMC) has completed an investigation of the quality of stormwater generated in the portion of the Lake Michigan basin which is within Lake County. The investigation incorporated the evaluation of data collected during previous studies, an assessment of surface water uses and impairments, water quality monitoring in select homogeneous watersheds, and the development of urban nonpoint source pollution management programs specific to the studied basin. Resultant information has been incorporated into the LCSMC's Stormwater Management Technical Reference Manual.

Expansion of the North Shore Sanitary District's Waukegan Sewage Treatment Plant

Responsible Parties: North Shore Sanitary District
Estimated Cost: $ 21,135,000
Completion Date: 1993
Funding Source: IEPA (WPC Revolving Loan Fund)

The North Shore Sanitary District (NSSD) expanded the Waukegan Sewage Treatment Plant (STP) with construction of additional treatment facilities increasing the average daily plant capacity from 19.8 million gallons per day to 22 million gallons per day. Peak plant capacity was increased from 39.6 mgd to 44 mgd.

Expansion of the Waukegan STP resulted in increased treatment capacity and will reduce the frequency and magnitude of overflows to Lake Michigan. Reduced overflows will result in the reduction of nutrients, residual chlorine loadings, and releases of fecal coliform and other pathogens.

Complete an Extent of Contamination Study at the Waukegan Tar Pit Site

Responsible Parties: EJ&E Rail Road, North Shore Gas Company, North Shore Sanitary District, USEPA
Estimated Cost: Indeterminate
Completion Date: 1993
Funding Source: EJ&E Rail Road, North Shore Gas Company, North Shore Sanitary District, USEPA

All tar-like substances have been removed from the Waukegan Tar Pit. Investigations are currently underway to assess the nature and extent of tar in soils in areas adjacent to the excavated pit, and of associated chemical constituents in the groundwater. Location and identification of contamination at the Tar Pit site away from the actual pit will indicate the remedial actions necessary to complete cleanup at the site. Threats posed at the site associated with exposure to tar substances, particularly wildlife entrapment, have been substantially reduced through removal of free tar in the pit. Further treatment of contaminated soils and groundwater will virtually eliminate remaining contact hazards and will prevent future transport of contaminants from the site.

Removal of Contaminated Soils from the North Ditch

Responsible Parties: OMC, USEPA, IEPA
Estimated Cost: $ 3.6 million
Completion Date: 1993
Funding Source: OMC, USEPA

Soils from the North Ditch have been removed and placed in confined disposal facilities as part of the OMC Superfund remediation. Removal of the soils has reduced the risk of human exposure to PCBs and of PCBs impacting Lake Michigan.

Complete Removal Actions at the Waukegan Paint and Lacquer

Responsible Parties: USEPA, Waukegan Paint and Lacquer
Estimated Cost: $ 150,000
Completion Date: 1992
Funding Source: USEPA, Waukegan Paint and Lacquer

Remedial activities for the removal and destruction of hazardous materials at the Waukegan Paint and Lacquer site were completed in 1992. Removal of these substances from the site have decreased or eliminated the potential for transport of contaminants from the site to groundwater, Lake Michigan, or the harbor. Risks to human, wildlife, or environmental health also have been substantially reduced or eliminated.

Waukegan Harbor South Pier Resurfacing

Responsible Parties: USACE
Estimated Cost: $ 1,300,000
Completion Date: Completed
Funding Source: USACE

The entire concrete surface of the outermost 1600 feet of the existing south pier at Waukegan Harbor has been replaced. The old concrete was removed and replaced. When completed, this project will protect the harbor entrance channel for navigational purposes as well as provide for pedestrian use.

4.3. MAINTENANCE AND PROTECTIVE ACTIVITIES

Maintenance and protective activities recommended for the Waukegan ESA are geared towards protecting natural resources, limiting the spread of existing contamination, and preventing future contamination. These activities include regulatory functions, monitoring efforts, and public awareness and education.

Promote Participation in Pollution Prevention Programs

Responsible Parties: IEPA, Harbor Area Industries within the ESA
Estimated Cost: Indeterminate
Completion Date: Ongoing
Funding Source: Participating Industries

The IEPA administers the "Partners in Pollution Prevention", a program aimed at assisting industries to target methods for reducing waste production and encouraging waste recycling. The program focuses on identifying ways to modify processes or raw materials which result in an overall decrease in waste production. Abbott Laboratories is one of the leading industries involved in this program. In addition, the IEPA is involved in the Industrial Material Exchange Service through which industries may market their waste materials for reuse elsewhere.

Protect Wetlands and Other Natural Areas in the Waukegan ESA

Responsible Parties: IEPA, USACE, IDNR, USEPA, Waukegan Park District
Estimated Cost: Indeterminate
Completion Date: Ongoing
Funding Source: IEPA, USACE, IDNR

Wetlands provide several functions beneficial to the Waukegan ESA. First, wetlands provide flood storage for runoff waters generated in upland areas. Second, wetlands enhance water quality through detention, filtering, microbial degradation, and biological uptake. Finally, wetlands provide unique habitats suited to diverse vegetation and wildlife communities.

Wetland resources in the ESA are federally protected through Section 404 of the Clean Water Act. In addition, wetlands are included in the Lake County Watershed Development Ordinance. Any modifications to wetland through fill, excavation, and/or flooding require a permit, and modifications totalling more than one-third acre require mitigation.

Initiate Monitoring of Stormwater Runoff Discharges

Responsible Parties: IEPA, Lake County Stormwater Commission, Municipalities, Industry
Estimated Cost: Indeterminate
Completion Date: Ongoing
Funding Source: IEPA, Lake County Stormwater Commission, Municipalities, Industry
The NPDES permit program which is currently in place for municipal and industrial discharges will be expanded to include additional stormwater discharges. Some additional industrial discharges may be monitored for constituents expected to be present in significant concentrations. New stormwater discharges require NPDES permits.

Monitoring of these discharges should help to identify constituent loads which may be controlled through application of urban NPS pollution controls and may indicate which of these NPS controls would most likely be effective. Implementation of applicable NPS pollution controls, such as best management practices, may provide improvements in water and sediment quality in Waukegan Harbor and nearshore Lake Michigan.

Continue Public Participation

Responsible Parties: Waukegan CAG, IEPA, USEPA, USACE
Estimated Cost: Indeterminate
Completion Date: Ongoing
Funding Sources: Corporate Sponsors, Illinois-Indiana Sea Grant Program, USEPA

Public participation has played a key role in many of the remedial activities which have been conducted or are currently underway in the Waukegan ESA. Public involvement is an integral part of both the Superfund and the RAP programs. Superfund activities in the ESA have included placement of relevant documents in repositories and USEPA sponsored availability sessions during which concerned citizens may question USEPA representatives about current projects. Past public participation efforts associated with RAP development are discussed in detail in the Stage I and II remedial Action

Plan. Additional public efforts include participation in the Lake Michigan Beach Sweep and a cleanup of reaches of the Waukegan River sponsored by Friends of the Waukegan River.

Efforts to promote public participation and action must continue throughout the duration of remedial activities in the Waukegan ESA. Certainly, public involvement should continue through implementation and update of the RAP and ongoing Superfund remediations. Public comment also must be solicited before the selection of the location for the CDF which eventually will receive dredge spoils from Waukegan Harbor. Other public activities which may occur in the near future include an Amnesty Day for pick-up of hazardous household materials and participation in future Lake Michigan Beach Sweeps.

Protect Threatened and Endangered Species Which Use the Waukegan ESA

Responsible Parties: IDNR, USFWS
Estimated Cost: Indeterminate
Completion Date: Ongoing
Funding Source: IDNR, USFWS

The threatened and endangered species database managed by the IDNR should be maintained. If possible, information contained within the database and added to it in the future should be examined for indications of population trends. Information collected through current inventories and research studies conducted at the Illinois Beach State Park should be added to the IDNR's database.

Maintain Adequate Public Access to the Water Resources of the Waukegan ESA

Responsible Parties: City of Waukegan, Waukegan Port District
Estimated Cost: Indeterminate
Completion Date: Ongoing
Funding Source: Corporate Sponsors, City of Waukegan, Waukegan Port District

Currently, many opportunities exist for public access to the water resources of the Waukegan ESA. Access within the ESA include two beaches, marinas, boat launches, public parks, and the Government Pier. At least two city parks, Washington Park and Powell Park, are situated along the Waukegan River upstream of the ESA. Public access to the harbor area also is facilitated through special events held during the recreation season.

Public access to Waukegan Harbor and the nearshore areas of Lake Michigan promotes awareness of the amenities provided by the Waukegan area. In addition, as the environmental quality of the ESA improves through the implementation

of remedial actions, demand for access to Waukegan Harbor and Lake Michigan may increase thereby enhancing economic growth. Greater public access to the harbor and Lake Michigan may potentially be accomplished through development of some of the old industrial sites, especially those located in the southern portion of the ESA. Expansion of existing marina facilities may be possible to increase boat mooring and launching capacity.

Habitat Protection at Illinois Beach State Park

Responsible Parties: IDNR, IEPA
Estimated Cost: Indeterminate
Completion Date: Ongoing
Funding Source: IDNR, IEPA

Illinois Beach State Park provides unique and high quality habitats for vegetative communities and wildlife as well as a valuable public beach. Resource management activities currently conducted by park staff should be continued to control establishment of invasive plant species and to promote vegetative and habitat diversity and protection of all park lands.

Continue Monitoring of Industrial Discharges

Responsible Parties: IEPA, USEPA
Estimated Cost: Indeterminate
Completion Date: Ongoing
Funding Source: IEPA, USEPA

The IEPA has NPDES program authority within the State of Illinois. Consequently, the IEPA is responsible for issuance, modification, and enforcement of NPDES permits. The permit requires that discharges be monitored for chemical and biological parameters to assure compliance with permit limits. Results of monitoring efforts must be reported to the IEPA. This monitoring will identify excursions above permit limits for all discharges in and tributary to the Waukegan ESA. Necessary enforcement actions are taken by IEPA to correct violations of permit limits for these discharges. Continued control of new and existing point source discharges will help assure improved water and sediment quality in the ESA.

Continue Monitoring at Johns Manville Superfund Site

Responsible Parties: Johns Manville Corp., USEPA, IEPA
Estimated Cost: Indeterminate
Completion Date: Ongoing for 15 to 30 years
Funding Source: Johns Manville Corporation

Although Superfund construction at this site has been completed, monitoring of air quality, surface water and groundwater quality, and containment cell soil cover at the site will continue. Air quality will be monitored for a duration of 15 years. Surface water and groundwater quality will be monitored for 30 years. The soil cover of on-site containment cells will be observed for 30 years to ensure that erosive processes do not cause asbestos-containing materials to reach the soil surface. Contingency plans have been developed should monitoring results indicate that further remedial activities are necessary. Additional monitoring will be accomplished under the applicable NPDES permit with oversight by IEPA.

4.4. REFERENCES

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GLOSSARY

ABBREVIATIONS

ACM - Asbestos-Containing Materials

AET - Apparent Effects Threshold

AOC - Area Of Concern

AQCR - Air Quality Control Region

ATSDR - Agency for Toxic Substance and Disease Registrary

BDL - Below Detection Limit

BETX - Benzene, Ethylbenzene, Toluene, and Xylene

BHC - Benzene hexachloride

BOD - Biological Oxygen Demand

CAG - Citizen's Advisory Group

CBOD - Carbonaceous Biological Oxygen Demand

Cd - Cadmium

CDF - Confined Disposal Facility

CEC - Commonwealth Edison Company

CERCLA - Comprehensive Environmental Response Compensation and Liability Act (Superfund)

cfs - cubic feet per second; a measure of velocity

Cl - Chlorine

cm/sec - centimeters per second

COA - bioeffects/contaminant Co-Occurrence Analysis

COD - Chemical Oxygen Demand

Cr - Chromium

CSO - Combined Sewer Overflow

Cu - Copper

CWA - Clean Water Act/Public Law 92-500

DDE - Dichloro-diphenyl-dichloro-ethylene

DDT - Dichloro-diphenyl-trichloro-ethane; a colorless and odorless insecticide. This insecticide has been banned because of its' persistence in the environment.

DMR - Discharge Monitoring Report

DO - Dissolved Oxygen

EMC - Ethylmercury chloride

EP - Sediment-water equilibrium approach

ER-L - Effects Range-Low; effects observed one time out of ten

ER-M - Effects Range-Median; effects observed over half of the time

ESA - Expanded Study Area

FDA - Food and Drug Administration

FWPCA - Federal Water Pollution Control Administration

g - gram

GLFC - Great Lakes Fishery Commission

GLWQA - Great Lakes Water Quality Agreement

IDEM - Indiana Department of Environmental Management

IDNR – Illinois Department of Natural Resources (formerly Department of Conservation)

IDPH - Illinois Department of Public Health

IEPA - Illinois Environmental Protection Agency

IJC - International Joint Commission

INHS - Illinois Natural History Survey

ISWS - Illinois State Water Survey

MCL - Maximum Contaminant Levels

MDNR - Michigan Department of Natural Resources

mgd - million gallons per day; a term commonly used to express rate of flow of a liquid.

mg/kg - milligram per kilogram; the concentration at which one thousandth of a gram (one milligram) is contained in a mass of one kilogram. A gram contains 1000 milligrams.

mg/L - milligrams per liter; the concentration at which one milligram (10^{-3} g) is contained in a volume of one liter; generally equivalent to parts per million.

ml - milliliter; a volume equal to one thousandth of a liter.

Mn - Manganese

MWRDGC - Metropolitan Water Reclamation District of Greater Chicago

NAAQS - National Ambient Air Quality Standards

ng/L - nanogram/liter; the concentration at which one billionth of a gram (10^{-8} g) is contained in a volume of one liter; generally equivalent to parts per trillion.

NH_3 - ammonia

NH_4 - ammonium

NIPC - Northeastern Illinois Planning Commission

NO_2 - Nitrate; a form of nitrogen used by algae. Excessive concentrations result in eutrophication and algal blooms.

NO_3 - Nitrite; a form of nitrogen toxic to aquatic life which rapidly oxidizes to nitrates.

NPDES - National Pollutant Discharge Elimination System

NPL - National Priorities List

NPS - Non-Point Source

NSSD - North Shore Sanitary District

NTU - Nephelometric Turbidity Unit

NURP - National Urban Runoff Program

O_3 - Ozone

OMC - Outboard Marine Corporation

PAH - Polynuclear Aromatic Hydrocarbons

Pb - lead

PCB - Polychlorinated biphenyl

ppb - part per billion

ppm - part per million; a concentration at which one unit is contained in a total of a million units. Any units may be used (e.g. weight, volume) but in any given application identical units should be used (e.g. grams per million grams or liters per million liters).

RAP - Remedial Action Plan

RCRA - Resource Conservation and Recovery Act of 1976

RI/FS - Remedial Investigation/Feasibility Study

ROD - Record of Decision

SARA - Superfund Amendments and Reauthorization Act

SLC - Screening Level Concentration

SO_2 - Sulfur dioxide

SOD - Sediment Oxygen Demand

SRAPL - State Remedial Action Priorities List

SSB - Spiked Sediment Bioassay

STORET - The USEPA data management system for storage and retrieval of water quality information

STP - Sewage Treatment Plant

SRU - Site Review Update

TKN - Total Kjeldahl Nitrogen

TMDL - Total Maximum Daily Load; the maximum amount of a pollutant that can be discharged into a stream without causing a violation of water quality standards.

TOC - Total Organic Carbon

TRE - Toxicity Reduction Evaluation

TSCA - Toxic Substance Control Act

TSP - Total Suspended Particulates

TVS - Total Volatile Solids

ug/kg - microgram per kilogram; the concentration at which one thousandth of a gram (one microgram) is contained in a mass of one kilogram. A kilogram is 2.046 pounds.

ug/L - microgram per liter; a unit of measure for concentration generally equivalent to parts per billion (ppb).

USACE - United States Army Corps of Engineers

USEPA - United States Environmental Protection Agency

USFDA - United States Food and Drug Administration

VOC - Volatile Organic Compound

VSS - Volatile Suspended Solids

WDNR - Wisconsin Department of Natural Resources

Zn - Zinc; a bluish-white element used to form a wide variety of alloys including brass, bronze, solders, and nickel silver.

DEFINITIONS

A

action levels - a value that if exceeded requires action, such as an investigation or warning, to be taken.

activated carbon treatment - treatment where undesirable colors or odors are removed, gases absorbed, and solvents are recovered.

acutely toxic - causing death or severe damage to an organism by poisoning during a brief exposure, normally ninety-six hours or less, although there is no clear line of demarcation between acute and chronic toxicity.

additive - a substance added in small amounts to something else to improve, strengthen, or otherwise alter it.

adsorption - Adhesion of molecules of gas, liquid, or dissolved solids to a surface.

advection - The transportation of an atmospheric property solely by the mass motion of the atmosphere.

aerated - to supply or impregnate with air.

aesthetics - Science of the beautiful, philosophy of taste. Pertaining to the attraction of a subject.

airshed - The geographic area covered by an air supply.

alachlor - A herbicide, marketed under the trade name Lasso, used mainly to control weeds in corn and soybean fields.

aliphatic compounds - a large class of organic compounds characterized by an open chain structure.

ambient - An encompassing atmosphere: environment.

ammonia - NH_3; an unionized form of nitrogen found in human and animal wastes. Ammonia is toxic to aquatic life depending upon pH, temperature and ionic strength of the water. NH_4; an ionized ammonia found in human and animal waste.

angler - one that fishes with hook.

anthropogenic - induced or altered by the presence and activities of man.

aquifer - an underground formation composed of materials such as sand, soil, or gravel that can store and supply groundwater to wells and springs.

aquitard - Geologic beds within a stratigraphic sequence which are less permeable than those of an aquifer.

Area of Concern (AOC) - An area of the Great Lakes identified by the International Joint Commission (IJC) as having serious water pollution problems.

artesian wells - a well in which the water is capable of rising to the surface by internal hydrostatic pressure.

asbestos - either of two incombustible, chemical resistant, fibrous mineral forms of impure magnesium silicate, used for fire proofing, electrical insulation, building materials, and chemical filters.

atmospheric deposition - Materials deposited onto land and water from the atmosphere.

attainment area - an area that meets environmental regulations concerning air.

avian foraging - process of birds or fowl look for food or provisions.

B

bacteria - singe-cell, microscopic organisms. Some can cause disease, and some are important in the stabilization of organic wastes.

beneficial uses - uses that maintain the chemical, physical and biological integrity of an ecosystem.

below detection limits - at a level that is not detectable by a specific piece of equipment.

benthos degradation - decrease in the number and diversity of organisms at the bottom of a lake.

beneficial water resource - water resource which contributes to well-being or personal health.

benthic life (benthos) - organisms living on the bottom of the sea or lake.

berm - Man-made, above ground, earth wall

bioaccumulation - the uptake and retention of substance by an organism from its surrounding medium and from its food. Chemicals move through the food chain and tend to end up at higher concentration in organisms at the upper end of the food chain such as predator, fish, or in people or birds that eat fish.

bioassay - see biomonitoring

biodegradable - waste which can be broken down by bacteria into basic elements. Most organic wastes such as food remains and paper are biodegradable.

biological nitrification - Oxidation into nitric acid, nitrous acid, or any nitrite by the action of bacteria.

biological oxygen demand (BOD) - The amount of dissolved oxygen needed by biological processes breaking down organic matter.

biomass - the amount of living matter (as in a unit area or volume of habitat).

biomonitoring (bioassay) - A test for pollutant toxicity. Tanks of fish or other organisms are exposed to varying doses of wastewater effluents, lethal doses of pollutants are thus determined.

biota - the animal or plant life of a particular region considered as a total ecological entity.

biotic - having the qualities of an animal or plant life of a particular region considered as a total ecological entity.

bloaters - a small but common cisco (whitefish) of the Great Lakes region.

blowdown - Hydrocarbons purged during refinery shutdown and startup.

C

chemical oxygen demand (COD) - a measure of the amount of oxygen required to oxidize compounds in water.

chlordane - A colorless, odorless, viscous (highly resistant to flow) liquid. Chlordane is used as an insecticide.

chronically toxic - causing death or damage to an organism by poisoning during prolonged exposure, which depending on the organism testing and the test conditions and purposes, may range from several days, to weeks, months, or years.

Citizens Advisory Group (CAG) - group of concerned individuals that work with and advise the IEPA.

Clean Water Act/Public Law 92-500 - The federal law that set national policy for improving and protecting the quality of the nation's waters. The law set a timetable for the cleanup of the nation's waters and stated that they are to be fishable and swimmable. This also required all pollutant dischargers to obtain a permit and meet the conditions of the permit. To accomplish this pollution cleanup billions of dollars have been made available to help communities pay the cost of building sewage treatment facilities. Amendments to the Clean Water Act were made in 1977, 1981 and 1989.

coagulation - A clumping of particles.

Common Tern (Sterna hirunda) - a sea bird similar to a gull which frequents bodies of water.

compost substrate - The humus like product of the process of composting waste.

comprehensive narrative toxic controls - effluent concentrations based on the narrative water quality standard that are required of all discharges.

condensate - a liquid obtained by the condensation of a gas or vapor (e.g. steam).

confined disposal facility - a structure built for the containment and disposal of contaminated dredged material.

congeners - a chemical substance related to another. ie. a derivative.

Consent Decree - a formal agreement binding consenting parties to a specific course of action under the sanctions of the court.

contact recreation - referring to recreation which requires direct contact with water.

contaminant - an element or chemical compound which by its introduction, results in one or more components of the ecosystem being detrimentally affected.

creosote - coal tar used as a wood preservative.

cross connection - a physical connection (pipes or hose) that allows contaminated water to mix with clean water.

D

decant - to pour from one vessel to another without disturbing the sediment or lower liquid layers.

degradation - The process by which a chemical is reduced to a less complex form

deposits - mineral or sandy material settled out of water.

desorption - to be removed from. the opposite of absorption.

Dieldrin - a white crystalline insecticide consisting chiefly or entirely of the epoxide C(12) H(8) Cl(6) O(1) obtained by the oxidation of aldrin. (SAC 60-57-1)

disinfection - neutralizing or the cleansing of microorganisms in water by chemical oxidants or equivalent agents.

dispersion - A separation or suspension of particles in a liquid, solid, or gaseous medium. Smog is an example of a dispersion of particulate matter in the atmosphere.

dissolved oxygen - Oxygen dissolved in water. Low levels of dissolved oxygen threaten fish survival and are often due to inadequate wastewater treatment.

downspouts - a pipe to carry off rainwater

dredge - To deepen a waterway with a machine used for removing earth.

dressed weight - the weight of an animal after being prepared for market.

dry fall - Precipitation of particles from the air due to gravitational forces.

E

ecosystem - an ecological community together with its physical environment, considered as a unit.

effluent - solid, liquid or gas wastes (by-products) which are disposed on land, in water or in air. As used in the RAP generally means wastewater discharges.

electrofishing - the taking of fish by a system based on their tendency to respond positively to a source of direct electric current.

emergency water intake - an access pipe to lake that is not normally used because of its proximity to the shore.

Equality Formation - a sediment formation in Gallitan County which consists of laustrine silt, clay and sand underlying a lake plane or beach complex of the present under most of Lake Michigan.

eutrophic - designating a body of water in which the increase of mineral and organic nutrients has reduced the oxygen, producing an environment that favors plant over animal life.

eutrophication - the accumulation of nutrients in a water body. Eutrophication can be accelerated by human activity such as agriculture and improper waste disposal.

event mean concentration - the total constituent mass discharge divided by the total runoff volume (U.S. EPA, 1983).

event sampling - the collection of water samples in rivers and streams for biological, physical and chemical analyses, in response to the occurrence of snowmelt or storm events.

F

feasibility study - investigative and analytical studies usually performed at the same time in an interactive and iterative process, and together referred to as the "RI/FS". They are intended to:
- Gather the data necessary to determine the type and extent of contamination at a Superfund site;
- Establish criteria for cleaning up a site;
- Identify and screen cleanup alternatives for Remedial Action;
- Analyze in detail the technology and costs of the alternatives.

fecal coliform - a group of organisms (bacteria) common to the intestinal tracts of man and other warm-blooded animals.

fecal contamination - excrement or sewage contamination.

filter-backwash solids - material that has been trapped in a filter and is subsequently released by reversing the flow of liquid.

finished drinking water - see raw water

foraging - wandering in search of food.

fracture - a crack, joint, or fault in a rock due to mechanical failure by stress.

furan - 2,3,7,8-Tetra-chloro-dibenzofuran; a chlorinated organic compound which is highly toxic.

G

geometric mean - the nth root of the product of n numbers (ex. The geometric mean of 3, 8, and 9 n=3, 3*8*9 = 216, the cubed root of 216 is 6. The geometric mean of 3 and 27 n=2, 3*27 = 81, the square root of 81 is 9).

Glacial Lake Chicago - predecessor of Lake Michigan that existed during the past periods of glaciation.

glacial till - unsorted and unstratified drift consisting of a heterogeneous mixture of clay, sand, gravel, and boulders which is deposited by and underneath a glacier.

granular activated carbon - a highly adsorbent powdered or granular carbon or charcoal made usually by carbonization of materials such as wood or coconut shells and chemical activation (by oxidizing gases).

Great Lakes Water Quality Agreement - This regional agreement was originally signed by Canada and the United States in 1972 and was subsequently revised in 1978 and 1987. It provides guidance for the management of water quality, specifically phosphorus and toxics in the Great Lakes.

groundwater - Water beneath the Earth's surface in saturated soil and rock that supplies wells and springs.

groundwater levels - the depth or elevation above or below sea level at which the surface of the groundwater stands.

gypsum - a white mineral used in the manufacturing of plaster of Paris, gypsum plaster, and plasterboard, wallboards and fertilizers.

H

habitat - the place or type of site where a plant or animal naturally lives and grows.

harbor sediment - material settled in the harbor or suspended in the water of the harbor.

heavy metals - a group of metals which may be present in municipal and industrial wastes that pose long-term environmental hazards if not properly disposed. Heavy metals can contaminate ground and surface waters, fish and food. The metals of most concern are: arsenic, cadmium, chromium, copper, lead, mercury, selenium and zinc.

herbicide - a type of pesticide that is specifically designed to kill plants and can also be toxic to other organisms.

hydraulic conductivity - the rate of water flow in gallons per day through a cross-section of 1 square foot under a unit hydraulic gradient at the prevailing temperature or 60 F.

hydrocarbons - any of a large class of chemicals containing carbon and hydrogen in a virtually infinite number of combinations.

hydrologic budget - a systematic summary of the terms (inflow, outflow, storage) of the storage equation as applied to the computation of soil-moisture changes; an evaluation of the hydrologic balance of an area.

hydrologic cycle - The manner in which rain and snow circulates between the earth and the atmosphere.

hydrology - the scientific study of the properties distribution and effects of water on the earth's surface, in the soil, underlying rocks, and in the atmosphere.

I

International Joint Commission (IJC) - A binational commission formed by the United States and Canada to guide management of the Great Lakes and resolve border issues, particularly water quality issues.

imported fill - material used for fill that is brought in from outside of the immediate area.

indigenous - having originated in and being produced, growing, or living naturally in a particular region or environment.

infiltration and inflow analysis - Detailed description of the characteristics of a liquid, whether it be untreated water or sewage, before it is treated at a drinking water or sewage treatment facility.

influent - a tributary stream or other body of water flowing into another water body.

in-situ - in the original place.

in-situ hydraulic conductivity measurement - slug test

interceptor sewers - a sewer which prevents the entrance of solid matter, grease, or other material into the main sewer line.

isomers - a compound, ion or nuclide having the same number of atoms of the same element, but differing in structural arrangement and properties.

iterative - involving replication; relating to or being a computational procedure in which replication of a cycle of operation produces results which approximate the desired result more and more closely.

L

leachate - liquid that has come into contact with solid waste.

lead (Pb) - soft bluish-gray metal. Lead is used in batteries, ammunition, brass, solder, pipes, power and communication cable coverings.

limnology - The scientific study of the life and phenomenon of lakes, ponds, and streams.

liter (L) - the volume occupied by one kilogram of water at a pressure of 760 mm of mercury and a temperature of 4 C. A liter is 0.9463 quart.

litigation - a legal contest according to the judicial process.

load - the total amount of materials or pollutants reaching a given water body.

littoral drift - the materials moved by waves and currents of the littoral zone or area along the shore.

load - The total amount of materials or pollutants reaching a given body of water.

M

macroinvertebrates - Animals without a vertebral column and which are visible to the unaided eye.

macronutrients - an element such as carbon, hydrogen, oxygen, or nitrogen, required in large proportion for the growth and development of plants.

macrophylic vegetation - vegetation with highly specialized cell groups.

marsh - wetland community dominated by emergent vegetation which has water at or above the surface for most of the year. Soils may be organic or mineral.

mesotrophic - refers to a moderately fertile nutrient level of a lake between the oligotrophic and eutrophic levels.

metabolites - any of the various organic compounds produced by metabolism. This substance is essential to the metabolism of a particular organism or a particular metabolic process.

microbial degradation - degradation of compounds by microbes in the soil.

mitigation - the effort to lessen damages caused by modifying a project, providing alternatives, compensating for losses, or replacing lost values.

mitigation wetlands - Wetlands used to reduce adverse impacts to the environment.

monitoring well - A special well drilled at specific locations on or off a site where groundwater can be sampled at selected depths and studied to determine such things as direction in which groundwater flows and the types and amounts of contaminants present.

N

narrative water quality standards - (as defined in Title 35, Subtitle C, Chapter I, Subpart B of the State of Illinois Rules and Regulations) Waters of the State shall be free from any substances in concentrations toxic or harmful to human health, or to animal, plant or aquatic life. Complemented through use of Subpart F.

National Pollutant Discharge Elimination System (NPDES) - a federal permit system to monitor and control the point source dischargers of wastewater. Dischargers are required to have a discharge permit and meet the conditions it specifies.

neoplastic - of, relating to, or constituting a new growth of tissue serving no physiologic function (tumor).

New Harbor - the harbor south of Government Pier.

nonattainment area - an area that is not meeting specific environmental standards.

nonpoint source (NPS) - Pollution sources which are diffuse and do not have a single point of origin or are not introduced into a receiving stream from a specific outlet.

nonpoint source pollution - pollution whose sources cannot be traced to a single point such as municipal or industrial wastewater treatment plant discharge pipe. Nonpoint sources include eroding farmland and construction sites, urban streets and barnyards. Pollutants from these sources reach water bodies in runoff, which can best be controlled by proper land management.

O

oligotrophic - lacking in plant nutrients and having an abundance of dissolved oxygen throughout the water.

organic silt - accumulation of the organic and inorganic fragmental products of the weathering and erosion of land; very soft silt.

organochlorine pesticides - pesticides containing carbon and chlorine, such as DDT

outfall - the mouth of a sewer, drain or pipe where wastewater effluent is discharged.

ozone - a triatomic form of oxygen that is a bluish irritating gas of pungent odor, is formed naturally in the upper atmosphere by a photochemical reaction with solar ultraviolet radiation or generated commercially by a silent electric discharge in ordinary oxygen or air, is major agent in the formation of smogs.

P

parts per thousand - a concentration at which one unit is contained in a total of a thousand units. The rules for using this term are the same as those for parts per million. Normally, this term is used to specify the salinity of estuarine or sea waters.

parameters - characteristic elements of an area or the specified boundaries of the area.

pathogenic organisms - organisms capable of causing disease.

pH - a measure of the acidity or alkalinity of a solution.

phenols - caustic and poisonous crystalline in resins, plastics, disinfectants, and pharmaceuticals.

phosphorus - a nutrient that in excess amounts in lakes and streams can lead to overfertile (eutrophic) conditions and algae glooms.

photosynthesis - the process by which chlorophyll-containing cells in green plants convert incident light to chemical energy and synthesize organic compounds from inorganic compounds.

phreatophyte - a deep rooted plant that obtains its water from the water table or the layer of soil just above it.

phytoplankton - microscopic, photosynthetic floating aquatic plants.

piezometers - a basic device for measurement of hydraulic head consisting of a tube or pipe, open to water flow at the bottom and open to atmosphere at the top, through which the elevation of water level can be determined.

plankton - tiny plants (phytoplankton or algae) and animals (Zooplankton) that live in water.

plume - visible emissions in air; visible discharge in water.

point sources - sources of pollution that have discrete discharges, usually from a pipe or outfall.

pollutant - any material introduced into the environment that makes a resource unfit for a specific purpose.

pollution tolerant - the ability to survive in polluted areas.

polychlorinated biphenyls (PCB) - A group of 209 compounds. PCB's have been manufactured since 1929 for such common uses as electrical insulation and heating/cooling equipment because they resist wear and chemical breakdown. Although banned in 1979 because of their persistence in the environment, they have been detected in air, soil and water, and recent surveys have found PCB's in every section of the country, even those remote from PCB manufacturers.

post-aeration - Any activity occurring after water had been aerated.

potable water supply - drinkable water supply.

precipitation scavenging - The process by which particles are taken from the air and deposited on the surface by rainfall.

primary standard - Sewage treatment standard that every municipal and industrial sewage treatment facility in Illinois must meet.

priority pollutant - toxic chemicals identified by the federal government because of their potential impact on the environment and/or human health. Major discharges are required to monitor all or some of these chemical when their permits are reissued.

productivity - a measure of the amount of living matter which is supported by an environment over a specific period of time. Often described in terms of algae production for a lake.

protozoan - minute protoplasmic single-celled animals which have varied physiologies and are often complex life cycles and are represented in almost every kind of habitat. Some are parasites of man and domestic animals.

R

raw water - undiluted water.

remedial action - a long-term action that stops or substantially reduces a release or threat of a release of hazardous substances that is serious, but does not pose an immediate threat to public health or the environment.

Remedial Action Plan (RAP) - Document outlining a long-term action that stops or substantially reduces a release or threat of a release of hazardous substances that is serious, but does not pose an immediate threat to public health or the environment.

Remedial Investigation/Feasibility Study - an investigation of problems and assessment of management options conducted as part of a superfund project.

Resource Conservation and Recovery Act of 1976 (RCRA) - this federal law amends the Solid Waste disposal Act of 1965 and expands on the Resource Recovery Act of 1970 to provide a program which regulates hazardous wastes to eliminate open dumping and to promote solid waste management programs.

risk assessment - a measure of the possible danger for undertaking a specific course of action.

round weight - Adjusted weight to express a whole number.

runoff - water from rain, snow melt or irrigation that flows over the ground surface and return to streams. Runoff can collect pollutants from air or land and carry them to receiving waters.

S

sanitary sewers - a sewer that carries wastewater together with incidental land runoff.

sanitary district - a special-purpose unit of government providing sanitary service in its jurisdictional area.

scuds - the matter worked out of a hide or skin during scrapping.

sediment - soil particles suspended in and carried by water as a result of erosion. Particles are deposited in areas where the water flow is slow (e.g. harbors, wetlands, lakes).

sediment oxygen demand (SOD) - a measure of the amount of dissolved oxygen demand by sediment reactions. The SOD can have a significant influence on the amount of dissolved oxygen available in the water column.

sedimentation - act or process of depositing sediment.

seiche - An oscillation of the surface of a lake or landlocked sea that varies in period from a few minutes to several hours and is thought to be initiated chiefly by local variations in atmospheric pressure aided in some instances by winds and tidal currents and that continues for a time after the inequalities of atmospheric pressure have disappeared.

settling - an area or container used for holding liquids so that suspended matter may settle or matter that settles at the bottom of a liquid.

shallow bedrock - solid rock that underlies all soil, sand, clay, gravel, and loose material on the earth's surface.

silt curtain - A wall of earth used to reduce contaminated sediment from moving to uncontaminated areas.

Silurian age dolomite - a mineral which is presently used as a furnace refractory, construction or ceramic material, and fertilizers. A magnesium rich sedimentary rock resembling limestone that was deposited under water 400,000,000 years ago.

sludge - any solid, semi-solid, or liquid waste generated from a municipal or industrial wastewater treatment plant.

slug tests - a test used to determine the in-situ hydraulic conductivity by causing an instantaneous change in the water level in a piezometer through sudden introduction of an unknown water level.

solid waste - unwanted or discharge material with insufficient liquid to be free flowing.

storm sewers - sewer intended to only receive land runoff.

stormwater runoff - rainwater that drains over land from any part of the facility.

streambank - The margin of a stream; the rising ground bordering a stream.

Superfund - Comprehensive Environmental Response and Liability Act (CERCLA); a federal program administered by the EPA which provides for cleanup of major hazardous waste landfills and land disposal areas.

surface water - natural water which has not penetrated much below the surface of the ground.

surficial groundwater - groundwater very near the surface of the earth.

surges - A series of large waves or billows.

suspended solids - small particles of solid matter suspended in water. Cloudy or turbid water is due to the presence of suspended solids in the form of silt or clay particles. These particles may carry pollutants adsorbed to the particle surfaces.

synergism - the characteristic property of a mixture of toxic substance that exhibits a greater-than-additive cumulative toxic effect.

T

Taciuk process - Thermal treatment process used to separate PCBs from soil.

tannery - a place where the conversion of hide into leather takes place.

tar derivatives - Breakdown products resulting from the biological or chemical degradation of tar.

taxa - groups of classified organisms.

terrestrial - land dwelling inhabitants.

total coliform counts - number of colon bacteria present.

total organic carbon - one of several chemical parameters used to measure the enrichment of sediment with organic materials. TOC levels can effect the bioavailablity of organic contaminants.

toxicity - the degree of danger posed by at toxic substance to animal or plant life.

toxicity reduction evaluation - for a discharger, it is required that causes of toxicity in an effluent be determined and that measures be taken to eliminate the toxicity. The measures may be treatment, product substitution, chemical use reduction or other actions achieving the desired result.

Toxic Substance Control Act (TSCA) - act that regulates certain toxic wastes (PCB's, and some pesticides).

trophic status - the types of food or nutrients which can be found in the water.

turbidity - lack of water clarity due to sediment or foreign particles being stirred up or suspended.

U

urban - of, relating to, or constituting a city.

V

variance - government permission for a delay or exception in the application of a given law, ordinance or regulation.

volatile - any substance that evaporates at a low temperature.

volatile organic compound - an organic (carbon-containing) compound that evaporates (volatilizes) readily at room temperature.

volatilization - the act of evaporating readily at relatively low temperatures.

W

Wadsworth Till - a glacial formation made of an unconsolidated mixture of clay, sand, gavel, and boulders found in Lake County and present under most of Lake Michigan.

wastewater treatment facilities - a facility for purifying wastewater. Modern wastewater treatment facilities may be capable of removing 95% of organic pollutants.

wasteload allocation - division of the amount of waste a stream can assimilate among the various dischargers to the stream. This results in a limit on the amount (in pounds) of a chemical or biological constituent discharged from a wastewater treatment plant to a water body. A water quality model may be used to calculate allowable loadings, which vary seasonally due to flow.

wastewater: Water that has become contaminated as a byproduct of some human activity. Wastewater includes sewage, washwater and the waterborne wastes of industrial processes.

water filtration facilities - facility that treats water by filtration to remove impurities.

watershed - a ridge of high land dividing two areas that are drained by different river systems.

wetlands - a lowland area, such as a marsh or a swamp, that is saturated with moisture.

wet meadow - Wetland community dominated by emergent vegetation which has water at or above the surface for most of the year. Soils may be organic or mineral.

Z

zooplankton - minute, free-floating microscopic aquatic animals. They form an important food supply for larger aquatic animals.

APPENDIX 1

Illinois Environmental Protection Agency
News Release Announcing
Removal of Fish Consumption
Warning Signs In Waukegan Harbor

February 20, 1997

IEPA NEWS
Illinois Environmental Protection Agency
2200 Churchill Road, P.O. Box 19276, Springfield, Illinois 62794-9276 217/782-3397

FOR IMMEDIATE RELEASE
Feb. 19, 1997

Contact: Joan Muraro
217-785-7209
TDD 217-782-9143

SIGN REMOVAL MARKS MILESTONE IN WAUKEGAN HARBOR PCB CLEANUP

SPRINGFIELD, ILL.---Signs warning anglers not to eat fish caught in Waukegan North Harbor will be removed Feb. 20, 1997, putting fish taken from the harbor in the same consumption categories applied to all Lake Michigan fish. Removal of the signs will mark the end of nearly two decades of restrictions imposed after polychlorinated biphenyl (PCB) contamination of the harbor was identified in 1981.

Officials from Waukegan, the Lake County Health Department, the Illinois Environmental Protection Agency (EPA), and members of the Citizens' Advisory Group (CAG) for the harbor will take part in ceremonies celebrating removal of the warning signs. The event is scheduled for 3 p.m.

Illinois EPA Director Mary A. Gade hailed removal of the signs, saying "Several years ago we celebrated the removal of more than one million pounds of PCBs in harbor sediments. Today, we mark another milestone with the removal of the fish consumption warning signs. Our fish sampling program since the sediment cleanup has shown that the harbor is no longer a significant source of PCBs in Lake Michigan fish.

"The Illinois EPA remains committed to working with the local community to restore full beneficial uses of the harbor and the lakefront," she said.

Rescinding restrictions on Waukegan Harbor fish consumption coincides with the adoption of expanded, more precise guidelines for eating all Lake Michigan fish. The new

--more--

guidelines will add two categories to the existing three advisory levels, providing more specific health-based information for eating Lake Michigan fish species.

Previous advisories classified fish in one of three categories: unlimited consumption (no restriction), do-not-eat, or eat no more than once-a-week. Newly added classifications recommend one meal a month or one meal every two months for certain kinds and sizes of Lake Michigan fish.

The decision to remove the warning signs and withdraw warnings targetted specifically at fish taken from Waukegan North Harbor reflects continuing improvements in the harbor following removal of approximately one million pounds of PCB-contaminated soil from the harbor in 1992.

Subsequent monitoring of fish from both the harbor and Lake Michigan have shown no appreciable difference in PCB concentrations in fish from the harbor and those from the open lake.

Waukegan North Harbor has been designated an Area of Concern (AOC) by the International Joint Commission on the Great Lakes, U.S. EPA and the Illinois EPA, under a U.S.-Canadian agreement that requires this designation when conditions exist on the Great Lakes that have caused or are likely to cause impairment of beneficial uses.

In response, the advisory group was formed, and a plan developed that included removal of the PCB contaminated soil as well as other needed corrective actions at sites within the area. Work is now underway identifying other needed cleanups in the vinicity of the harbor and the near-shore area. Efforts in Waukegan illustrate one of the first AOCs to actually demonstrate environmental benefits resulting from a cleanup.

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#97-103

APPENDIX 2

Illinois Department of Public Health
News Release Announcing
New and Revised
Fish Consumption Advisories
For Lake Michigan and Waukegan Harbor

1997 - 1998

Illinois Department of Public Health

NEWS RELEASE

FOR IMMEDIATE RELEASE
January 23, 1997

CONTACT: 217-782-5750
TTY: 800-547-0466
FAX: 217-782-3987

NEW FISH CONSUMPTION ADVISORIES FOR LAKE MICHIGAN AND WAUKEGAN HARBOR

SPRINGFIELD, IL -- The Illinois Department of Public Health today issued new and revised fish consumption advisories for fish caught in Lake Michigan that include the lifting of a do not eat warning for fish taken from Waukegan Old North Harbor.

Illinois, along with five other Great Lakes states, have adopted a new method of assessing the effect fish flesh contaminants have on humans. The new method was developed specifically to address fish from the Great Lakes.

Consumption advisories for fish caught in other Illinois lakes, streams and rivers are unchanged and continue to utilize a rating system based on U.S. Food and Drug Administration (FDA) levels of concern.

Under the new Great Lakes ratings, eating categories have been expanded to five levels of advice compared to the previous three levels. Do not eat, unlimited consumption (no restriction) and one meal a week advice remain. Added have been categories for one meal a month and one meal every two months.

While both the Great Lakes and FDA rating systems use the same PCB (polychlorinated biphenyl) level to determine fish that should not be eaten at all, the new system uses additional lower PCB levels to decide when fish can be eaten once

-- more --

a week, once a month or once every two months.

As a result of the new advisory changes, rainbow trout, yellow perch and smelt, which were previously listed as unlimited consumption, have moved to the eat once a week category. Large brown trout, most lake trout and chinook salmon were moved from no consumption to either six or 12 times per year. Unchanged from the previous fish advisory are large lake trout, carp and channel catfish of all sizes, which remain in the do not eat category.

The change in the consumption warning for Waukegan Old North Harbor fish, announced in 1993, was made because PCB levels in fish species have declined significantly due to harbor cleanup activities.

Recent tests of fish taken from the harbor found the contamination equivalent to fish in the rest of Lake Michigan, so the new Great Lakes advisory also is now applicable to fish caught in the harbor.

Fish is a good source of high quality protein and is low in cholesterol and harmful fats. Anglers can get the health benefits of fish and reduce unwanted contaminants by following the meal advice and cooking and cleaning recommendations in this advisory.

In any freshwater fishery, anglers who vary the type and source of sport fish consumed -- opting for the younger; smaller fish; avoiding bottom-feeders; and preparing and cooking fish in ways that reduce the amount of contaminants -- can reduce their exposure to fish contaminants.

-- more --

There are several ways to reduce contaminants in edible portions of the fish:

- Before cooking, remove the skin from the fillet and cut away fatty tissue from the belly and dorsal areas.
- Broil, bake, barbecue or cook in a way that allows the fat to drip away.
- Discard fat drippings or broth from boiled or poached fish. Do not use in other dishes.

While there is no known immediate health threat from eating contaminated fish from Lake Michigan or any other Illinois body of water, there are public health concerns about the effects of long-term low-level exposure to the pesticides and chemicals found in the fish listed in the advisories. Laboratory tests have shown that high doses of some PCBs and related contaminants cause adverse health conditions in animals, including cancer, liver damage, and reproductive and developmental damage.

To ensure that fish are safe for consumers to eat, the Illinois Fish Contaminant Monitoring Program screens fish samples for contamination from 13 banned pesticides and industrial chemicals.

The fish are collected by the Illinois Department of Natural Resources (DNR) and tested by the Illinois Environmental Protection Agency (EPA). The Department of Public Health bases its consumption advisories on the EPA test results.

This year's advisories are included in the Illinois 1997 Fishing Information Guide, which is available from DNR or from businesses that sell state fishing

licenses. Information also may be found in the EPA's Guide to Eating Illinois Sport Fish 1997, which will be published in the spring.

The Illinois Fish Contaminant Monitoring Program is a joint effort of the departments of Agriculture, Natural Resources, Nuclear Safety, Public Health and Illinois EPA.

# # #

Meal Advice for Eating Sport Fish from Lake Michigan

Measure fish from the tip of the nose to the end of the tail. Find the species and size of fish caught in the table that follows. The table shows each kind of fish which has been tested for contaminants. If a species is not listed, it has not been tested.
At the top of the table, find the meal advice for the size of fish caught:.

- **No Restriction** means you can eat as many meals as you like.
- **One Meal a Week (52 meals per year), One Meal a Month (12 meals per year),** and **One Meal Every Two Months (6 meals per year)** is advice for how long to wait before eating your next meal of sport fish.
- **Do Not Eat** means no one should eat those fish because of very high contamination.

(Note that the amount of contaminants in a fish listed in the "One Meal a Month" group is four times higher than the amount of contaminants in a fish listed in the "One Meal a Week" group).

One Meal is assumed to be one-half pound of fish (weight before cooking) for a 150 pound person. The meal advice is equally protective for larger people who eat larger meals and smaller people who eat smaller meals. Follow cleaning and cooking directions to prepare fish.

The meal advice that follows is for eating trimmed and skinned fish (except smelt). This advice in this table has been developed to protect infants, children, and women of child bearing age. The advice may be over protective for women beyond child bearing age and adult men.

Special Risk Groups:

People who regularly eat sport fish, women of childbearing age, and children under six years of age are particularly susceptible to contaminants that build up over time. If you fall into one of these categories, you should be especially careful to space fish meals out according the advisory table that follows. Your body can get rid of some contaminants, such as mercury, over time. Spacing the meals out helps prevent the contaminants from building up to harmful levels in the body. For example, if you eat a fish from the "One Meal a Month" group, wait a month before eating another meal of fish from **any** restricted category.

Others:

Women beyond their childbearing years and men face fewer health risks from contaminants such as mercury and PCBs. For these groups, it is the total number of meals that you eat during the year that becomes important and many of those meals can be eaten during a few months of the year. If most of the fish you eat are from the "One Meal a Week" category, you should not exceed 52 meals per year. Likewise, if most of the fish you eat are in the "One Meal a Month" category, you should not exceed 12 meals per year. Remember, eating one meal of fish from the "One Meal a Month" group is comparable to eating four fish meals from the "One Meal a Week" group.

Cleaning and Cooking - It is important to following these cleaning and cooking directions!

Many contaminants are found at higher levels in the fat of fish. You can reduce the amount of these contaminants in a fish meal by properly trimming, skinning, and cooking your catch. Remove the skin and trim all the fat from the belly flap, the line along the sides of the fish, the fat along the back, and under the skin.
Cooking does not destroy contaminants in fish, but heat from cooking melts some of the fat in fish and allows some of the contaminated fat to drip away. Broil, grill, or bake the trimmed, skinned fish on a rack so the fat drips away. Do not use the drippings to prepare broth, sauce, chowder or soup.
These cleaning and cooking precautions will not reduce the amount of mercury or other metals. Mercury is distributed throughout a fish's muscle tissue (the part you eat) rather than in the fat and skin. Therefore, the only way to reduce mercury intake is to reduce the amount of contaminated fish you eat.

Fish Species	No Restriction	One Meal a Week (52 meals per year)	One Meal a Month (12 meals per year)	One Meal Every Two Months (6 meals per year	DO NOT EAT
Chinook Salmon			Less than 30"	Larger than 30"	
Coho Salmon			All sizes		
Lake Whitefish		Less than 19"	19" to 25"	Larger than 25"	
Rainbow Trout		Less than 17"	Larger than 17"		
Brown Trout			Less than 22"	Larger than 22"	
Lake Trout			Less than 23"	23" to 27"	Larger than 27"
Yellow Perch		All sizes			
Smelt		All sizes			
Channel Catfish					All sizes
Carp					All sizes

(Effective 1997 and 1998)

A Guide to Your Health

Fish are nutritious and good to eat. But some fish may take in contaminants from the water they live in and the food they eat. Some of these contaminants build up in the fish - and in you - over time. These contaminants could harm the people who eat them, so it is important to keep your exposure to these contaminants as low as possible. This advisory helps you plan what fish to keep as well as how often and how much sport fish to eat. This advisory is not intended to discourage you from eating fish, but should be used as a guide to eating fish low in contaminants.

Health Benefits

When properly prepared, fish provide a diet high in protein and low in saturated fats. Many doctors suggest that eating a half-pound of fish each week is helpful in preventing heart disease. Almost any kind of fish may have real health benefits when it replaces a high-fat source of protein in the diet. You can get the health benefits of fish and reduce unwanted contaminants by following this advisory.

Contaminants in Fish

Long-lasting contaminants such as PCBs, DDT, and mercury build up in fish in amounts which are a health concern. Health problems which **may** result from contaminants found in fish range from small changes in health that are hard to detect to birth defects and cancer. The meal advice in this advisory is intended to protect children from potential developmental problems. Adults are less likely to have health problems at the same low levels of exposure that affect children.

Although this advisory is primarily based on effects other than cancer, some contaminants cause cancer in animals. Your risk of cancer from eating contaminated fish cannot be predicted with certainty. Cancer currently affects about one in every three people by the age of 70, primarily due to smoking, diet and hereditary risk factors. Exposure to contaminants in the fish you eat may not increase your cancer risk at all. If you follow this advisory over your lifetime, you will minimize your exposure and reduce whatever cancer risk is associated with contaminants. At worst, using Environmental Protection Agency methods to calculate risk, it is estimated that approximately one additional cancer case may develop in 10,000 people who eat fish according to this advisory over their lifetime.

FISH CONSUMPTION ADVISORIES FOR ILLINOIS WATERS OTHER THAN LAKE MICHIGAN

GROUP 1 Unlimited Consumption – Fish pose little or no health risks.

GROUP 2 Limited Consumption – Moderate levels of contaminants. NURSING MOTHERS, PREGNANT WOMEN, WOMEN WHO ANTICIPATE BEARING CHILDREN, FEMALE CHILDREN OF ANY AGE, AND MALE CHILDREN AGE 15 OR UNDER SHOULD NOT EAT GROUP 2 FISH. All other individuals should limit their consumption of these fish to no more than one meal per week, and heed the preparation and cooking recommendations given above.

** Further restrict consumption to no more than one meal per month where noted by double asterisk.

GROUP 3 No Consumption – High levels of contaminants. **NO ONE SHOULD EAT GROUP 3 FISH.**

Cedar Lake
GROUP 1: Largemouth and Spotted Bass under 18":
GROUP 2: Largemouth and Spotted Bass 18" and larger **
GROUP 3:

Clinton Lake
GROUP 1: Carp, Crappie,Channel Catfish under 21", Largemouth Bass, Walleye
GROUP 2: Bigmouth Buffalo, Channel Catfish 21" and larger
GROUP 3:

Crab Orchard Lake (East of Wolf Creek Road)
GROUP 1: Bluegill, Bullheads, Carp under 15", Channel Catfish, Largemouth Bass, White Crappie
GROUP 2: Carp 15" and larger
GROUP 3:

Des Plaines River (Lockport to Kankakee River)
GROUP 1: Carp under 15", Largemouth Bass
GROUP 2: Freshwater Drum, Smallmouth Buffalo
GROUP 3: Carp 15" and larger, Channel Catfish

Dresden Lake (Not currently open to public. Contact DNR Silver Springs Office (630-553-8680) for any change in the status.)
GROUP 1: Smallmouth Bass
GROUP 2:
GROUP 3: Channel Catfish

Highland-Silver Lake
GROUP 1: Largemouth Bass
GROUP 2: Carp, Channel Catfish
GROUP 3:

Illinois River (Headwater to Peoria Lock & Dam)
GROUP 1: Carp under 15", Largemouth Bass, Smallmouth Bass
GROUP 2:
GROUP 3: Carp 15" and larger, Channel Catfish

Kinkaid Lake
GROUP 1:
GROUP 2: Largemouth and Spotted Bass **
GROUP 3:

Lake Bracken
GROUP 1: Bluegill, Crappie, Largemouth Bass
GROUP 2:
GROUP 3: Carp, Channel Catfish

Lake Decatur
GROUP 1: Carp, Carpsuckers, Channel Catfish, Crappie, Flathead Catfish, Freshwater Drum, Largemouth Bass
GROUP 2: Smallmouth Buffalo
GROUP 3: Bigmouth Buffalo

Lake Springfield
GROUP 1: Carp under 26", Catfish under 15", Crappie, Largemouth Bass
GROUP 2: Bigmouth Buffalo, Catfish 15" and larger
GROUP 3: Carp over 26"

Lake Taylorville
GROUP 1: Largemouth Bass
GROUP 2:
GROUP 3: Bigmouth Buffalo, Carp, Channel Catfish

Lake Vermilion
GROUP 1: Carp, Crappie, Largemouth Bass
GROUP 2:
GROUP 3: Channel Catfish

Lou Yeager Lake
GROUP 1: Carp, Largemouth Bass, Channel Catfish under 18", Crappie, Bluegill
GROUP 2:
GROUP 3: Channel Catfish 18" and larger

Mississippi River (Lock & Dam 22 to Cairo)
GROUP 1:
GROUP 2:
GROUP 3: Shovelnose Sturgeon, Sturgeon Eggs

Sangamon River (Lake Decatur Dam to Roby)
GROUP 1:
GROUP 2:
GROUP 3: Carp

The advisories are based upon fish flesh samples prepared in accordance with U.S. Food and Drug Administration guidelines and are analyzed with laboratory procedures approved by the Illinois Department of Public Health and Illinois Environmental Protection Agency

APPENDIX 3

Illinois Department of Natural Resources Memorandum Potential Natural Reproduction of Smallmouth Bass in Waukegan Old North Harbor

August 25, 1997

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

MEMORANDUM

to: Bob Schacht, IEPA

from: Frank Jakubicek, IDNR Lake Michigan Program

date: August 25, 1997

subject: Potential natural reproduction in Waukegan (North) Harbor

On August 13, 1997 during our monthly contaminant sampling regime in Waukegan's North Harbor we observed 5-10 young of the year (YOY) smallmouth bass along the eastern rip-rap shore-line of Larsons Marine directly north of their boat ramp. The area is difficult to enter with an electrofishing boat and only accessible because of the high water.

This was our first observation of YOY smallmouth bass (probably resident fish) in Waukegan's North Harbor. If in the future, more resident-type YOY fish are observed voucher specimens will be collected for the record.

Other fish observed on August 13, 1997 (See attached sheet) included: 1 northern pike (840 mm), 5-6 largemouth bass 8"-14", smallmouth bass yearlings 90 mm-100 mm, adult bluegill, pumpkinseed, 1 black crappie, 2 green-sunfish, and several white-suckers and carp. One black-bullhead was seen and missed.

Cc: Tom Trudeau

APPENDIX 4

IEPA Assessment of Waukegan Harbor Macroinvertebrates

October, 1996

Assessment of Waukegan Harbor Macroinvertebrates

October 1996

Prepared by Howard Essig

Northern Monitoring and Assessment Unit
Maywood, Illinois

State of Illinois
Environmental Protection Agency
Bureau of Water
Planning Section

May 1998

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I. Executive Summary

Waukegan Harbor was designated as an Area of Concern in 1981 by the International Joint Commission, the U.S. EPA and the Illinois EPA. This designation was prompted by the discovery of high levels of polychlorinated biphenyls (PCBs) in harbor sediments (IEPA 1994a). Fish consumption restrictions, macroinvertebrate degradation, restrictions on dredging, and loss of fish and wildlife habitat were identified as harbor use impairments attributable to contaminated sediments. Outboard Marine Corporation (OMC) was identified as the source of PCBs in the harbor sediments. Sediments were removed and treated from the federal superfund site beginning in 1992. Long term monitoring at the site is ongoing.

In order to document the effectiveness of the remedial dredging of the harbor, macroinvertebrate samples were collected at 10 Waukegan Harbor stations in October 1996. Tubificid oligochaeta (aquatic worms) dominated the collections (82%) and high Biotic Index values (>4.00) were found at all stations indicating very poor environmental conditions probably due in part to high organic enrichment/low dissolved oxygen. In addition, deformities of larval chironomidae (midges) head capsules were found in 16 percent of the specimens suggesting moderate to severe sediment contamination (U.S. EPA 1994). Comparison of 1996 with 1972 data shows little if any improvement in Waukegan Harbor macroinvertebrate communities.

II. Introduction

While ambient water quality criteria have been instrumental in assuring attainment of a healthy aquatic environment, they alone have not been sufficient to ensure appropriate levels of environmental protection. Sediment contamination, which can involve deposition of toxicants over long periods of time, is responsible for water quality impacts in some areas (USEPA 1991).

Many water-borne contaminants sorb to particulate suspended and settleable materials. Metals, nutrients and oxygen-demanding materials are naturally occurring in sediments and elevated levels can generally be attributed directly or indirectly to man. Organochlorine compounds, however, are not naturally occurring substances and their presence in sediments attest directly to man's influence in the watershed (Kelly and Hite 1984).

Use of macroinvertebrates to evaluate overall water quality is well established. Macroinvertebrate communities are relatively easy to sample and are indicative of the quality of their environment. Each species is dependent on specific ranges of environmental conditions, i.e. water quality, sediment quality, habitat and flow throughout its life span. The resulting community is an indication of these conditions over weeks and months prior to collection. This makes the macroinvertebrate community especially useful under conditions of intermittent or mild organic enrichment when altered water quality is not readily detectable by conventional chemical surveys. The underlying rationale is that good environmental conditions support a diverse community containing pollution intolerant forms and that poor environmental conditions tend to restrict the number of species and simultaneously increase the density of pollution tolerant species.

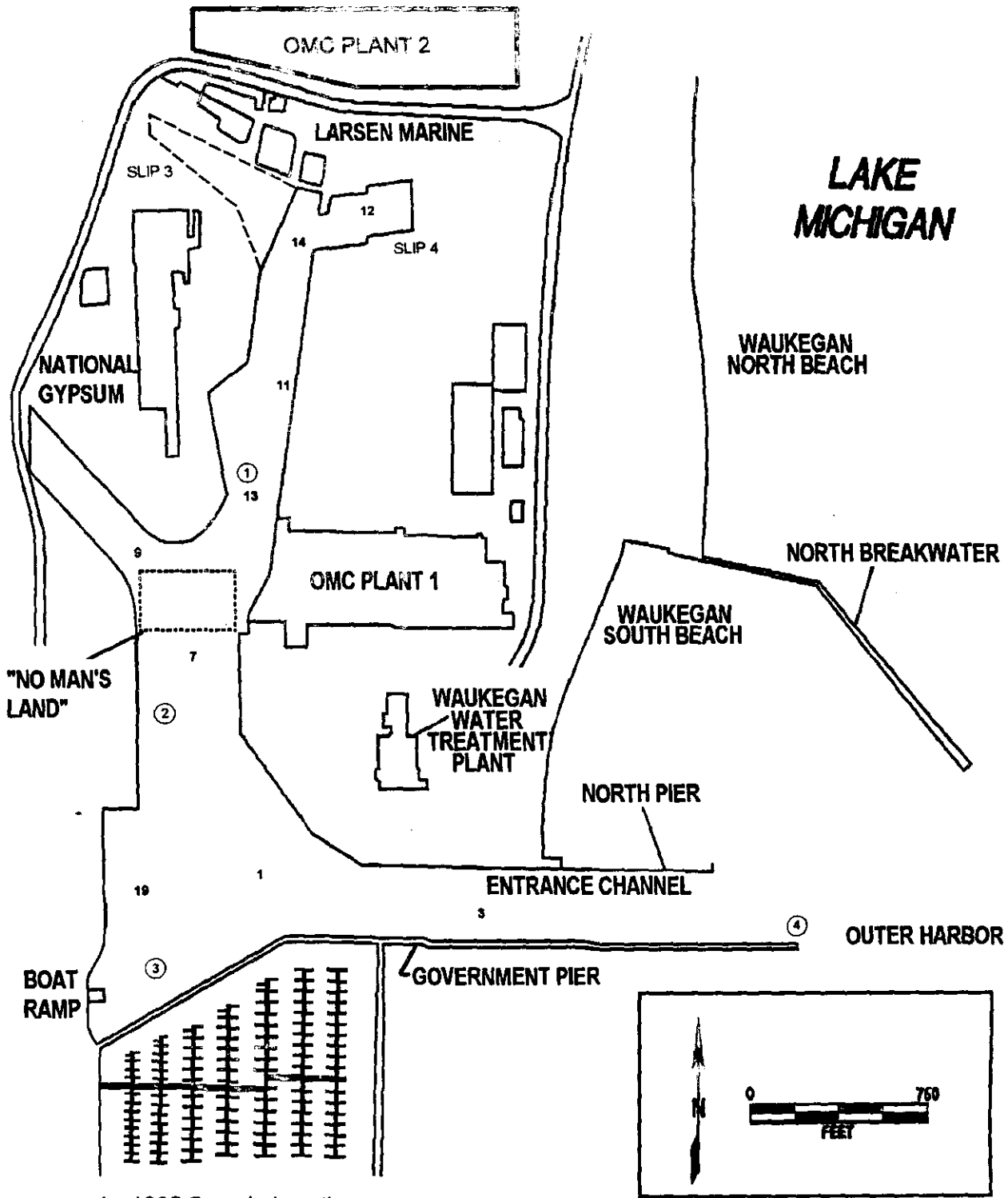
Waukegan Harbor was designated as an Area of Concern in 1981 by the International Joint Commission, the U.S. EPA and the Illinois EPA. This designation was prompted by the discovery of high levels of polychlorinated biphenyls (PCBs) in harbor sediments (IEPA 1994a).

Outboard Marine Corporation (OMC) was identified as the source of PCBs in the harbor sediments. Sediments were removed and treated from the federal superfund site beginning in 1992. Long term monitoring at the site is ongoing.

Site Setting

Waukegan Harbor is largely man-made, being constructed in the late 1800s and early 1900s. Wetlands adjacent to the harbor were filled with natural materials from the adjacent shoreline and demolition debris to form its present shape. Waukegan Harbor

Figure 1. Macroinvertebrate sampling locations in Waukegan Harbor, October 1996 and 1972.



1 - 1996 Sample Location

①- 1972 Sample Location

Note: 1996 Macroinvertebrate sites were also sampled for sediment chemistry in April 1996.

is about 37 acres in size with water depths ranging from 14 to 21 feet. Virtually the entire harbor is bordered by 20 to 25 foot long steel sheet pilings driven into the harbor floor. The Waukegan Harbor watershed consists of approximately 0.47 square miles of industrial, commercial, municipal and open/vacant lands (IEPA 1994a).

Harbor sediments consist of 1 to 10.5 feet of very soft organic silt (muck) overlaying 9 feet of medium dense, fine to coarse sand. A very stiff silt (glacial till) bed more than 100 feet thick underlies the sand. The sheet pilings mentioned above are anchored in this till unit. Under this layer and resting on bedrock is a sand and gravel deposit ranging from 3 to 20 feet thick. The uppermost bedrock under the harbor is Silurian age dolomite. This bedrock unit is fractured, facilitating groundwater movement within the area (IEPA 1994a).

Lake Michigan and Waukegan Harbor serve as discharge areas for shallow ground water. However, several factors could affect the groundwater levels and flow direction, including the presence of silt below the sandy near shore lake deposits, water levels in a ditch and canal tributary to Lake Michigan (both of which are located north of the harbor) and fluctuations in the level of the lake (IEPA 1994a).

Site History

The Waukegan Harbor watershed has seen commercial and heavy industrial use since the late 1800s. Several industries have operated on land directly adjacent to the harbor, discharging waste intentionally or unintentionally into the harbor.
OMC maintains two manufacturing facilities adjacent to the harbor. From approximately 1961 to 1972, OMC purchased a hydraulic fluid which contained PCBs and was used in the die-casting works in plant 2 located at the north end of the harbor. Some of this hydraulic fluid entered the floor drains and escaped from the oil interceptor, diversion and pump system and was released into the harbor. This oil was released into the western end of slip 3 (Figure 1). The discharge pipe to the harbor was sealed in 1976. It is estimated that there were approximately 300,000 pounds of PCBs in Waukegan Harbor (IEPA 1994a).

The Illinois EPA collected macroinvertebrate samples at four Waukegan Harbor stations in 1972. All samples were dominated by oligochaeta (aquatic worms) and were classified as polluted (IEPA 1972).

In 1976, the Illinois EPA notified the U.S. EPA that high concentrations of PCB compounds had been found in the discharge of a local industry which discharged to the harbor. This discharge had been going on for more than 20 years and involved more than 100,000 pounds of PCB compounds (U.S. EPA, 1976).

The U.S. EPA collected 15 sediment samples in 1976 and found levels of PCBs ranging from 0.1 mg/kg east of the entrance channel to 4200 mg/kg at the upper end of the harbor in slip 3 (U.S. EPA, 1976).

Harbor sediment sampling in 1985 and 1986 by the Illinois Department of Energy and Natural Resources found the highest levels of PCBs in slip 3 (17,251 ppm) with decreasing concentrations toward the harbor mouth (IEPA 1994a).

The toxicity of Waukegan Harbor sediments to macroinvertebrate organisms was evaluated by Marking et el. (1981). Organisms tested included scuds, mayfly nymphs, midge larvae, snails, and fingernail clams. All species except fingernail clams experienced increased mortality attributed to sediment exposure (IEPA 1994a).

A 1987 macroinvertebrate survey was conducted by the Illinois Natural History Survey (Ross et al., 1989) within Waukegan Harbor and in Lake Michigan immediately outside the harbor. Dominant species included aquatic worms and fingernail clams. Biomass was lower in areas of marked contamination (IEPA 1994a).

Sediment samples were collected for chemical analysis by the Illinois EPA in November 1990 at five stations in Waukegan Old North Harbor. The resulting laboratory analyses were compared to the U.S. EPA (1977) Great Lakes harbor sediments classifications for those constituents. The upper harbor (QZO-01) had the highest number of parameters rated as heavily polluted with 11, followed by central harbor (QZQ-01) with eight, slip 1 (QZP-01) with five, harbor channel (QZS-01) with one, and the boat ramp (QZR-01) with none. Heavily polluted levels of arsenic and lead were found at four stations; cadmium and copper at three stations; chromium, zinc, nickel, COD and volatile solids at two stations; iron, phosphorus and Kjeldahl nitrogen at one station. Moderately polluted levels of barium were found at five stations; and manganese and PCBs at three stations (IEPA, 1994).

The International Joint Commission identified fish consumption restrictions, macroinvertebrate degradation, restrictions on dredging, and loss of fish and wildlife habitat as harbor use impairments attributable to contaminated sediments.

In 1981, the U.S. EPA recommended that fish caught in Waukegan Harbor not be eaten (USEPA 1981). The Lake County Health Department posted signs indicating fish consumed from the "North" part of the harbor may be dangerous to human health. A sport fish advisory jointly issued by the Department of Public Health, Department of Natural Resources (formerly the Department of Conservation), Department of Agriculture and Environmental Protection Agency, recommended that no fish from Waukegan Old North Harbor be consumed (IEPA 1994b).

Waukegan Harbor and the harbor entrance channel are impacted by accumulation of sediment. Previously, clean accumulated material was dredged and transported out into the lake for disposal. Dredging of the inner portion of Waukegan Harbor was discontinued after 1972 because the sediments were classified as polluted. Since water depths in the harbor have been reduced by sedimentation, shipping vessels may not safely navigate the harbor when fully loaded. Consequently, ships may only be loaded to approximately 70 percent capacity requiring more frequent dockages. These additional shipping costs are estimated to be $500,000 per year for two building product manufacturers (IEPA 1994b).

The near-shore Lake Michigan area is impacted by sediment accumulation and contamination. Fish spawning and rearing habitat and avian foraging habitat have been adversely impacted. Sediment accumulation may bury spawning and shelter areas used by small or immature fish. PCBs have been associated with an increase in lake trout egg and fry mortality (IEPA 1994b).

Remedial Actions

In accordance with the 1984 Record of Decision (as amended in 1989), remedial operations began in October 1990. A steel curtain was erected across the mouth of slip 3 at the harbor and the slip was filled in. A comparably sized slip was cut on the north end of the harbor, immediately east of slip 3 and the commercial marina that was located on slip 3 was relocated to the newly cut slip 4.

Dredging to remove PCB contaminated sediments from the upper reaches of Waukegan Harbor took place from early January to mid-February 1992. Sediments were treated onsite using the Taciuk process, which removed over 97 percent of PCBs from the treated material (IEPA 1994a).

Remedial operations were completed in June 1993. Removal of PCBs in the harbor area is estimated to be 96 percent and all remaining sediments will not exceed 50 parts per million of PCBs (IEPA 1994a).

Macroinvertebrate samples were collected in October 1996 to document the effectiveness of the remedial dredging of Waukegan Harbor.

III. Methods

Quantitative macroinvertebrate samples were collected at 10 Waukegan Harbor stations on October 28 and 29, 1996 (Figure 1). One sample was collected at each station with a petite Ponar dredge. Samples were rinsed sequentially through a U.S.

Standard number 30 mesh sieve (600 um) and a number 60 mesh sieve (250 um) as recommended by USEPA (1994). Samples from these two sieve sizes were stored in separate bottles and preserved with 95 percent ethanol. Species level identifications and examination of chironomidae for head capsule deformities were performed under contract by Freshwater Benthic Services, Inc., located in Petoskey, Michigan.

Macroinvertebrate data were converted into a Biotic Index (BI) for evaluation purposes. Pollution tolerance ratings from zero (least tolerant) to five (most tolerant) from Klemm et al. (1990) were used to calculate the biotic index. This tolerance list was used because species level tolerances were given for Oligochaeta. The Biotic Index is an average of tolerance values weighted by abundance and is used as a measure of degradation. BI values less than 1.75 indicate excellent environmental conditions, 1.76 - 2.50 indicate good conditions, 2.51 - 3.75 indicate fair conditions, 3.76 - 4.00 indicate poor conditions and values greater than 4.00 indicate very poor environmental conditions. The BI is calculated from the formula:

$$BI=\sum(niti)/N$$

where ni is the number of individuals in each taxon, ti is the tolerance value assigned to each taxon and N is the total number of individuals in the sample.

Chironomidae larvae were examined for head capsule deformities. A relationship between increased sediment contamination and the presence of deformities in chironomid larvae has been documented by many investigators (USEPA, 1994). In unimpacted areas, the prevalence of deformities is generally less than one percent, while in areas of moderate to severe sediment contamination the prevalence of deformities may be 5 to 25 percent (USEPA, 1994).

IV. Results and Discussion

Macroinvertebrate samples were collected once at 10 stations in the Waukegan Harbor in October 1996. Ten major groups of organisms were collected. Oligochaeta was the predominant group making up 88 percent of the total collection, followed in relative abundance by Gastropoda (5%), chironomidae (4%) and Hirudinea (1%) (Tables 1 and 2). Oligochaeta made up at least 80 percent of the population at each station except at stations QZO-26 (54%) and QZO-02 (59%). Station QZO-02, located near slip 4, had the highest percentage of Gastropods (30%) probably due to the substantial amount of macrophytes found at this station. Station QZO-26, located in "no man's land," had the fewest total number of organisms (35). Hirudinea made up 28 percent of the population at this station compared to less than 4 percent at the other stations.

A total of 50 taxa were collected at 10 Waukegan Harbor stations. Oligochaeta had the greatest diversity with 19 taxa, followed by chironomidae with 10 taxa. Remaining groups had one to four taxa. Total taxa at each station ranged from nine at station QZO-26 to 27 at station QZO-02 and averaged 15.

Oligochaeta

Immature tubificids without hair chaeta made up 85 percent of all Oligochaeta collected. The tubificid *Limnodrilus hoffmeisteri* and the naid *Nais variabilis* were the next abundant making up five and three percent, respectively. Both of these species are considered tolerant of organic waste (Klemm et al, 1990) and *Limnodrilus hoffmeisteri* is also considered tolerant of metal contamination (USEPA, 1994). Overall, tubificids made up 82 percent of all organisms collected in the Waukegan Harbor (Tables 1 and 3). According to U.S. EPA (1994), invertebrate communities dominated by the tubificid oligochaetes, to the exclusion of other invertebrate groups, are often indicative of organic enrichment.

Biotic Index

Biotic Index (BI) values ranged from 4.07 at station QZO-02, near the entrance to slip 4, to 4.96 at station QZO-03, just north of the OMC Plant (Table 1). These values indicate very poor conditions in Waukegan Harbor (Klemm et al. 1990).

Chironomidae Head Capsule Deformities

A total of 217 chironomidae individuals were collected in the Waukegan Harbor. Thirty-five head capsule deformities were found (Tables 3, 4 and 5). Only one individual, *Chironomus ?staegeri*, had two deformities, all other individuals had one deformity. The most common deformity was abnormal mentum (68%), followed by missing antennal blade (23%), deformed mandible (6%) and abnormal antennal segments 2-5 (3%). Missing antennal blades were found only in *Procladius sp.*, all other deformities were limited to four species of *Chiromonus*. Five genera collected in the Waukegan Harbor had no deformities. However, few individuals of these genera were found (Tables 4 and 5). U.S. EPA (1994) reported that most deformities in three Areas of Concern (AOCs) were found in the genera *Procladius* and *Chironomus*.

Proportion of deformities found within each species in the Waukegan Harbor ranged from 6 percent of *Procladius sp* to 47 percent of *Chironomus plumosus*. Overall, the frequency of deformities was six times greater in *Chironomus* than in *Procladius*. Warwick (1989) found frequencies from 2 - 24 times greater in *Chironomus* and suggested that this indicated that *Chironomus* is more sensitive to contaminant stress than *Procladius*.

Deformities were not found at three of the 10 Waukegan Harbor stations (QZO-04, QZO-10 and QZO-03). *Chironomus* were not collected at any of these stations, but *Procladius* were found at all three stations. The other seven stations had deformities ranging from 4 to 27 percent. Six of these stations had deformities greater than 5 percent indicating moderate to severe sediment contamination (U.S. EPA, 1994).

Trends

The Illinois EPA collected macroinvertebrate samples at four Waukegan Harbor stations in 1972. Samples were collected with a Peterson or Ponar dredge and were rinsed through a US standard 30 mesh sieve (600 um). Results from 1972 were compared to the 30 mesh samples from 1996. Oligochaeta still dominated the collections comprising 86 percent of the population in both 1972 and 1996 (Table 5). Four additional major groups were found in 1996 that were not found in 1972, including Isopoda, Acariformes, Basommatophora and Turbellaria. However, these were found in very low numbers at a few locations.

According to the Illinois EPA (1972), a polluted condition is indicated by a population of 100 or more aquatic worms per square foot of bottom and a clean water situation is indicated by 150 scuds per square foot of bottom. Areas of high organic enrichment are indicated by aquatic worm populations in excess of 200 per square foot. These criteria are considered with the numbers of species of all organisms found in a sample to give the final classification. A well balanced population will include a variety of species. A degraded environment usually reduces the total number of species while it increases the number of individuals of the few remaining species which are more tolerant of polluted conditions (IEPA 1972).

Scuds were not found above seven per square foot in 1972 and 44 per square foot in 1996. Half of the stations in both 1972 and 1996 had no scuds. Aquatic worms were found in excess of 200 per square foot at all but one station in 1972 (station 2) and in 1996 (QZO-26). Station QZO-26, sampled in 1996, was the only sample to have less than 100 aquatic worms per square foot. However, this station had the lowest number of total organisms and the fewest number of total taxa. All of the stations in 1972 and 1996 would be classified as polluted following the above procedure.

Table 1. Macroinvertebrates collected in Waukegan Harbor, October 28 and 29, 1996. Samples were collected with a petite Ponar dredge and rinsed through U.S. Standard 30 (600 um) and 60 (250 um) sieves. Numbers indicate actual numbers of organisms collected.

		Stations											
Organism	Tolerance *	1 QZO-04	3 QZO-06	7 QZO-10	9 QZO-12	11 QZO-01	12 QZO-14	13 QZO-03	14 QZO-02	19 QZO-19	NML QZO-26	Total	Percent
Coelenterata													
Hydrozoa													
Hydra sp.	–	1							4			5	0.08
Platyhelminthes													
Turbellaria													
Dugesia tigrina	4								1			1	0.02
genus?	(3)	1							1			2	0.03
Annelida													
Oligochaeta													
Chaetogaster diaphanus	2			2	1		7	1	69		2	82	1.33
Chaetogaster limnaei	(2)								4			4	0.06
Daro digitata	2		3		1		2		10	28		44	0.71
Nais communis	4	1			4			5				10	0.16
Nais variabilis	5			1		1		9	162			173	2.80
Ophidonais serpentina	4		6									6	0.10
Slavina appendiculata	2									1		1	0.02
?Stavina appendiculata	2						1		2			3	0.05
Specaria josinae	2		2									2	0.03
Stylaria lacustris	3			1					4			5	0.08
Vejdovskyella intermedia	4	1	5	1	1			5			5	18	0.29
immature w/o hair chaetae	(5)	885	271	187	291	828	418	1318	181	438	11	4608	74.62
immature w/ hair chaetae	(3)	32	20		6		2	3	5	12		80	1.30
Aulodrilus americanus	3		9									9	0.15
Aulodrilus piqueti	3		1									1	0.02
Aulodrilus pluriseta	3		11									11	0.18
Ilyodrilus templetoni	3				2							2	0.03
Limnodrilus cervix variant	4		6	3			4					13	0.21
Limnodrilus hoffmeisteri	5	47	40	8	9	15	59	51	9	19	1	258	4.18
Limnodrilus udekemianus	5			1						44		45	0.73
Potamothrix vejdovski	3		3									3	0.05
Quistadrilus multisetosus	4	2	15				9	1	16			43	0.70
Hirudinea													
Mooreobdella ?fervida	(4)					1						1	0.02
Mooreobdella microstoma	4							2		2		4	0.06
unid. erobdellid	(4)		1		3	3		9		1	2	19	0.31
Glossiphonia complanata	4								1		3	4	0.06
Helobdella stagnalis	4	3	1	4	9	4		11	1	2	5	40	0.65
Arthropoda													
Arachnida													
Lebertia sp.	(1)					1						1	0.02
Limnesia sp.	(2)			1					4			5	0.08
?Najadicola sp.	(2)						1					1	0.02
Crustacea													
Caecidotea intermedius	3		2									2	0.03
Caecidotea sp.	(3)	4	2							1	1	8	0.13
Crangonyx sp.	(2)						1		1			2	0.03
Gammarus fasciatus	2	4	10			1			1	1		17	0.28
Hyalella azteca	2		1									1	0.02
Insecta													
Chironomus anthracinus-gr.	3		18				4					22	0.36
Chironomus fluviatilis-gr.	(4)		4									4	0.06
Chironomus plumosus	5		18				1					19	0.31
Chironomus ?staegeri	3		12				9		2			23	0.37
Chironomus spp.	3						1					1	0.02
Cladopelma sp.	(3)	2					3		3	2		10	0.16
Cricotopus sylvestris-gr.	2								1			1	0.02
Cryptochironomus sp. 2	(2)		1									1	0.02
Parachironomus sp.	(2)							1	5			6	0.10
Polypedilum scalaenum-gr.	2		1									1	0.02
Procladius sp.	(3)	26	25	1	11	12	3	6	15	26	4	129	2.09
Mollusca													
Gastropoda													
Physella spp.	(4)	6				9	3		209	5	1	233	3.77
Gyraulus circumstriatus	(3)						9		20	1		30	0.49
Valvata sincera	3	11			1	16	11		8	21		68	1.10
Pelecypoda													
Pisidium casertanum	4					1						1	0.02
Pisidium compressum	4	2							4	10		16	0.26
Pisidium walkeri f. mainensis	(3)						12					12	0.19
Pisidium spp.	(3)	6	1			1			3			11	0.18
Sphaerium corneum	3			1					1			2	0.03
Sphaerium (young specs.)	(3)								34			34	0.55
unid. sphaeriid	(3)	2	1				9		5			17	0.28
Total Number of Benthos		1036	490	191	339	693	589	1422	786	614	35	6175	
Total Number/Square Meter		44548	21070	8213	14577	29799	24487	61146	33798	26402	1505	265525	
Total OTUs		18	28	12	12	13	21	13	31	17	10	59	
Total Taxa		15	25	11	10	10	18	11	27	15	9	50	
Biotic Index		4.81	4.38	4.88	4.81	4.88	4.89	4.96	4.07	4.62	4.08	4.69	

* Tolerances from Klemm et. al., 1990. Ranking from 0 (least tolerant) to 5 (most tolerant).
Tolerances in parentheses are means of species tolerances within the family or genus, or in the case of Tubificidae, the tolerances for immature specimens are the weighted tolerances of species with and without hair chaetae found in this study.

Table 2. Percent contribution of major taxa to the total number of macroinvertebrate organisms collected in the Waukegan Harbor, October 28 and 29, 1996. Samples were collected with a petite Ponar dredge and rinsed through U.S. Standard 30 (600 um) and 60 (250 um) sieves.

	Stations										
	1	3	7	9	11	12	13	14	19	NML	
Organism	QZO-04	QZO-06	QZO-10	QZO-12	QZO-01	QZO-14	QZO-03	QZO-02	QZO-19	QZO-26	Total
Hydrozoa	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.00	0.00	0.08
Turbellaria	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.05
Oligochaeta	93.44	80.00	96.34	92.92	92.93	88.22	97.96	58.78	88.27	54.29	87.79
Hirudinea	0.29	0.41	2.09	3.54	1.15	0.00	1.55	0.25	0.81	28.57	1.10
Arachnida	0.00	0.00	0.52	0.00	0.14	0.18	0.00	0.51	0.00	0.00	0.11
Isopoda	0.39	0.82	0.00	0.00	0.00	0.00	0.00	0.00	0.16	2.86	0.16
Amphipoda	0.39	2.24	0.00	0.00	0.14	0.18	0.00	0.25	0.16	0.00	0.32
Chironomidae	2.70	16.12	0.52	3.24	1.73	3.69	0.49	3.31	4.56	11.43	3.51
Gastropoda	1.64	0.00	0.00	0.29	3.61	4.04	0.00	30.15	4.40	2.86	5.36
Pelecypoda	0.97	0.41	0.52	0.00	0.29	3.69	0.00	5.98	1.63	0.00	1.51
Total Number of Organisms	1036	490	191	339	693	569	1422	786	614	35	6175
Total Number/Square Meter	44548	21070	8213	14577	29799	24467	61146	33798	26402	1505	265525
Total Number of Taxa	15	25	11	10	10	18	11	27	15	9	50

Table 3. Summary of macroinvertebrate data collected in the Waukegan Harbor, October, 1996. Samples were collected with a petite Ponar dredge and rinsed through U. S. standard 30 (600 um) and 60 (250 um) sieves. Data are from 30 and 60 mesh sieve samples combined unless noted otherwise.

	Stations										
	1 QZO-04	3 QZO-06	7 QZO-10	9 QZO-12	11 QZO-01	12 QZO-14	13 QZO-03	14 QZO-02	19 QZO-19	NML QZO-26	Mean
Total Number of Organisms	1036	490	191	339	693	569	1422	786	614	35	618
Total Number of Taxa	15	25	11	10	10	18	11	27	15	9	15
Biotic Index (1)	4.81	4.38	4.88	4.81	4.88	4.69	4.96	4.07	4.62	4.08	4.62
Percent Oligochaeta	93.44	80.00	96.34	92.92	92.93	88.22	97.96	58.78	88.27	54.29	84.32
Percent Tubificidae (2)	93.24	76.73	93.72	90.86	92.78	86.47	96.55	26.84	83.55	34.28	77.50
Oligochaeta (N/sqr ft) 30 mesh sieve (3)	3472	1366	631	1011	2233	1798	3703	935	1398	12	1656
Amphipoda (N/sqr ft) 30 mesh sieve (4)	16	44	0	0	4	0	0	8	4	0	8
Total Number of Chironomidae	28	79	1	11	12	21	7	26	28	4	22
Number of Chironomus	0	52	0	0	0	15	0	2	0	0	7
Number of Procladius	26	25	1	11	12	3	6	15	26	4	13
Number of Chironomus Deformities	0	20	0	0	0	5	0	2	0	0	3
Number of Procladius Deformities	0	0	0	3	2	0	0	1	1	1	1
Percent Chiromomus Deformities (5)	—	38.46	—	—	—	33.33	—	100.00	—	—	57.26
Percent Procladius Deformities (5)	0.00	0.00	0.00	27.27	16.67	0.00	0.00	6.67	3.85	25.00	7.95
Percent Chironomidae Deformities (6)	0.00	25.32	0.00	27.27	16.67	23.81	0.00	11.54	3.57	25.00	13.32

1. Biotic Index Values based on Klemm et al, 1990.
   - <1.75 Excellent
   - 1.76 - 2.50 Good
   - 2.51 - 3.75 Fair
   - 3.76 - 4.00 Poor
   - >4.00 Very Poor

2. Invertebrate communities dominated by the tubificid oligochaetes, to the exclusion of other invertebrate groups, are often indicative of organic enrichment (USEPA, 1994).

3. Polluted conditions are indicated by oligochaeta populations of >= 100/sqr. ft., and areas of high organic enrichment are indicated by oligochaeta populations >200/sqr ft. (IEPA, 1972).

4. Clean water conditions are indicated by Amphipoda populations of >=150/sqr. ft. (IEPA, 1972).

5. Comparison of morphological responses between Chironomus and Procladius suggest that Procladius is the more tolerant of environmental contaminants (Warwick, 1989).

6. In unimpacted areas, the prevalence of chironomidae deformities is generally <1%, while in areas of moderate to severe sediment contamination the prevalence of deformities maybe 5% - 25% (USEPA, 1994).

Table 4. Head capsule deformities found in chironomidae collected in the Waukegan Harbor, October 28 and 29, 1996.

Station	Chironomidae Taxon	Number	Deformities				
			Mentum	Mandible	Ant. segs. 2-5 abn.	Blade Missing	Total
QZO-04	Cladopelma sp.	2	0	0	0	0	0
	Procladius sp.	26	0	0	0	0	0
	Total Number	28	0	0	0	0	0
	Percent Deformities	—	0.00	0.00	0.00	0.00	0.00
QZO-06	Chironomus anthracinus-gr.	18	6	0	0	0	6
	Chironomus fluviatilis-gr.	4	1	0	0	0	1
	Chironomus plumosus	18	8	0	0	0	8
	Chironomus ?staegeri	12	5	0	0	0	5
	Cryptochironomus sp. 2	1	0	0	0	0	0
	Polypedilum scalaenum-gr.	1	0	0	0	0	0
	Procladius sp.	25	0	0	0	0	0
	Total Number	79	20	0	0	0	20
	Percent Deformities	—	25.32	0.00	0.00	0.00	25.32
QZO-10	Procladius sp.	1	0	0	0	0	0
	Total Number	1	0	0	0	0	0
	Percent Deformities	—	0.00	0.00	0.00	0.00	0.00
QZO-12	Procladius sp.	11	0	0	0	3	3
	Total Number	11	0	0	0	3	3
	Percent Deformities	—	0.00	0.00	0.00	27.27	27.27
QZO-01	Procladius sp.	12	0	0	0	2	2
	Total Number	12	0	0	0	2	2
	Percent Deformities	—	0.00	0.00	0.00	16.67	16.67
QZO-14	Chironomus anthracinus-gr.	4	1	1	0	0	2
	Chironomus plumosus	1	1	0	0	0	1
	Chironomus ?staegeri	9	2	0	0	0	2
	Chironomus spp.	1	0	0	0	0	0
	Cladopelma sp.	3	0	0	0	0	0
	Procladius sp.	3	0	0	0	0	0
	Total Number	21	4	1	0	0	5
	Percent Deformities	—	19.05	4.76	0.00	0.00	23.81
QZO-03	Parachironomus sp.	1	0	0	0	0	0
	Procladius sp.	6	0	0	0	0	0
	Total Number	7	0	0	0	0	0
	Percent Deformities	—	0.00	0.00	0.00	0.00	0.00
QZO-02	Chironomus ?staegeri *	2	0	1	1	0	2
	Cladopelma sp.	3	0	0	0	0	0
	Cricotopus sylvestris-gr.	1	0	0	0	0	0
	Parachironomus sp.	5	0	0	0	0	0
	Procladius sp.	15	0	0	0	1	1
	Total Number	26	0	1	1	1	3
	Percent Deformities	—	0.00	3.85	3.85	3.85	11.54
QZO-19	Cladopelma sp.	2	0	0	0	0	0
	Procladius sp.	26	0	0	0	1	1
	Total Number	28	0	0	0	1	1
	Percent Deformities	—	0.00	0.00	0.00	3.57	3.57
QZO-26	Procladius sp.	4	0	0	0	1	1
	Total Number	4	0	0	0	1	1
	Percent Deformities	—	0.00	0.00	0.00	25.00	25.00

* Both deformities were found on same midge.

Table 5. Summary of chironomidae head capsule deformities in the Waukegan Harbor, October, 1996.

Taxon	Total	Total All Stations Deformities					
		Mentum	Mandible	Ant. segs. 2-5 abn.	Blade Missing	Total	Percent
Chironomus anthracinus-gr.	22	7	1	0	0	8	36.36
Chironomus fluviatilis-gr.	4	1	0	0	0	1	25.00
Chironomus plumosus	19	9	0	0	0	9	47.37
Chironomus ?staegeri	23	7	1	1	0	9	39.13
Chironomus spp.	1	0	0	0	0	0	0.00
Cladopelma sp.	10	0	0	0	0	0	0.00
Cricotopus sylvestris-gr.	1	0	0	0	0	0	0.00
Cryptochironomus sp. 2	1	0	0	0	0	0	0.00
Parachironomus sp.	6	0	0	0	0	0	0.00
Polypedilum scalaenum-gr.	1	0	0	0	0	0	0.00
Procladius sp.	129	0	0	0	8	8	6.20
Number of Chironomidae	217	24	2	1	8	35	---
Percent Deformities	---	11.06	0.92	0.46	3.69	16.13	---

Table 6. Comparison of macroinvertebrate samples collected in Waukegan Harbor, 1972 and 1996. Samples were collected with a Peterson or Ponar dredge in 1972 and with a petite Ponar dredge in 1996. Samples were rinsed through a US standard 30 mesh sieve (600 um) in 1972 and 1996.

Organism	1972 Mean N/sq.ft.	1996 Mean N/sq.ft.	1972 Percent	1996 Percent
Amphipoda (Scuds)	2	8	0.03	0.42
Isopoda (Sow Bugs)	0	4	0.00	0.21
Acariformes (Water Mites)	0	1	0.00	0.05
Spaeriidae (Fingernail Clams)	843	37	11.90	1.92
Mesogastropoda (Gilled Snails)	5	26	0.07	1.35
Basommatophora (Pulmonate Snails)	0	105	0.00	5.45
Chironomidae (Midges)	23	60	0.32	3.12
Turbellaria (Flat Worms)	0	1	0.00	0.05
Hirudinea (Leeches)	112	27	1.58	1.40
Oligochaeta (Aquatic Worms)	6101	1656	86.10	86.03
Total Number of Organisms	7086	1925		
Total Number of Major Taxa	6	10		
Total Number of Stations	4	10		

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12. Sponsoring Organization Name and Address **As above**			13. Type of Report & Period 14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

In accordance with a 1984 Record of Decision, PCB contaminated sediments were dredged from the Waukegan harbor and treated for removal of the contaminants. Remedial operations were completed in June 1993. Harbor macroinvertebrates were collected in October 1996 to document the effectiveness of the remedial dredging.

Macroinvertebrate samples were collected at 10 stations within Waukegan Old North Harbor using a petite Ponar dredge. Samples were rinsed sequentially through a U.S. standard number 30 mesh sieve (600 um) and a number 60 mesh sieve (259 um) . Samples from these two sieve sizes were stored in separate bottles and preserved with 95% ethanol. Species level identifications and examination of chironomidae head capsule deformities were performed by Freshwater Benthic Services, Inc., located in Petoskey, Michigan.

Tubificid oligochaeta (aquatic worms) dominated the collections (82%) and high Biotic Index values (>4.00) were found at all stations indicating very poor environmental conditions. In addition, deformities of larval chironomidae head capsules were found in 16 percent of the specimens suggesting moderate to severe sediment contamination.

17. Document Analysis
a. Descriptors
PCBs
Macroinvertebrate Quality
Great Lakes Harbor

b. Identifiers/Open-Ended Terms
Waukegan Harbor
Illinois

18. Availability Statement	19. Security Class (This Report) Unclassified	21. No. of Pages 14
	20. Security Class (This Page) Unclassified	22. Price

(See ANSI-Z39.18)
272 (4-77)

See Instructions on Reverse

OPTIONAL FORM
(FORMERLY NTIS-35)
Department of Commerce

APPENDIX 5

Summary Results
Corps of Engineers 1995 Sediment Core Sampling
Waukegan Inner Harbor
Sampling and Analysis

November 21, 1995

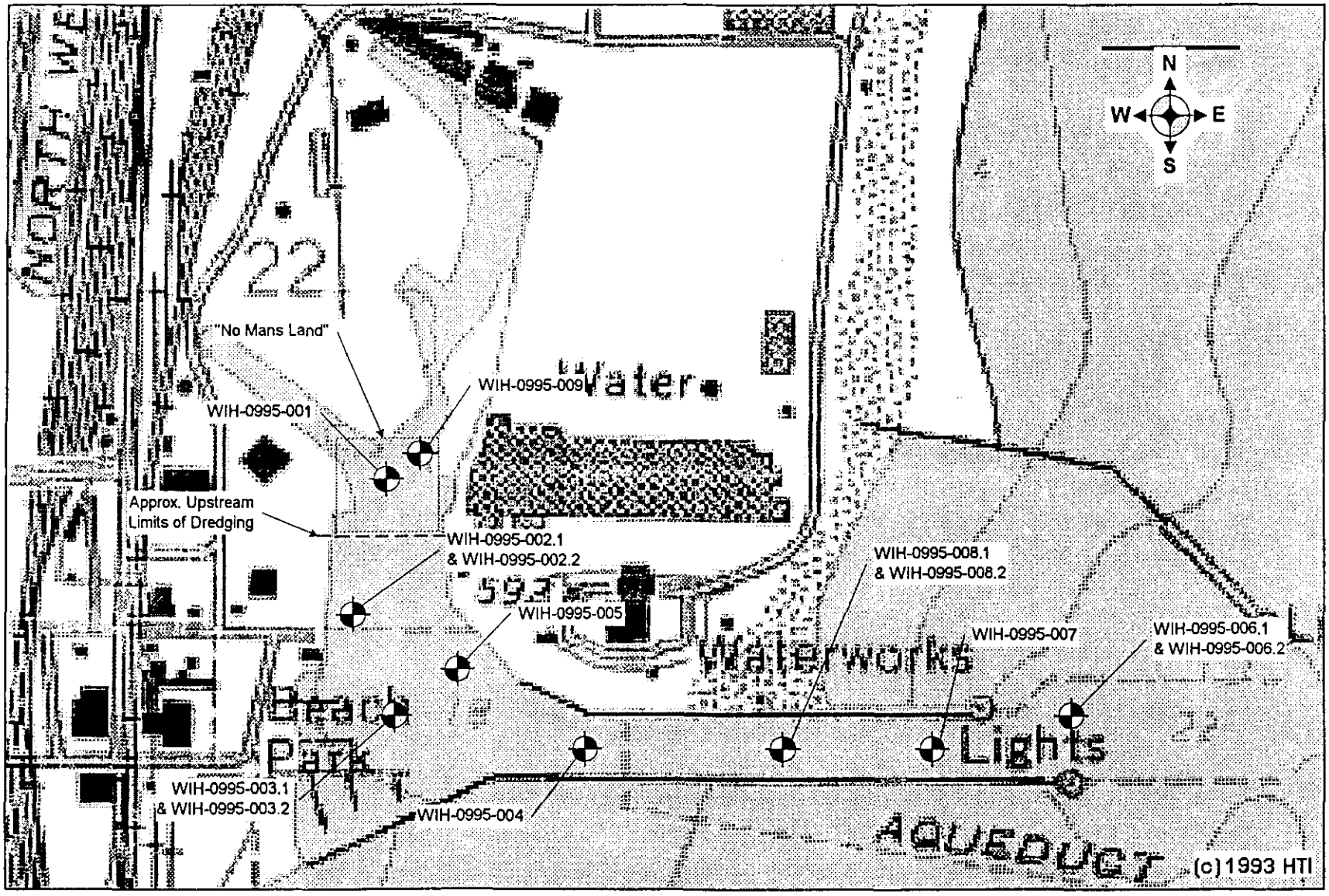

Figure 1. Sampling Locations

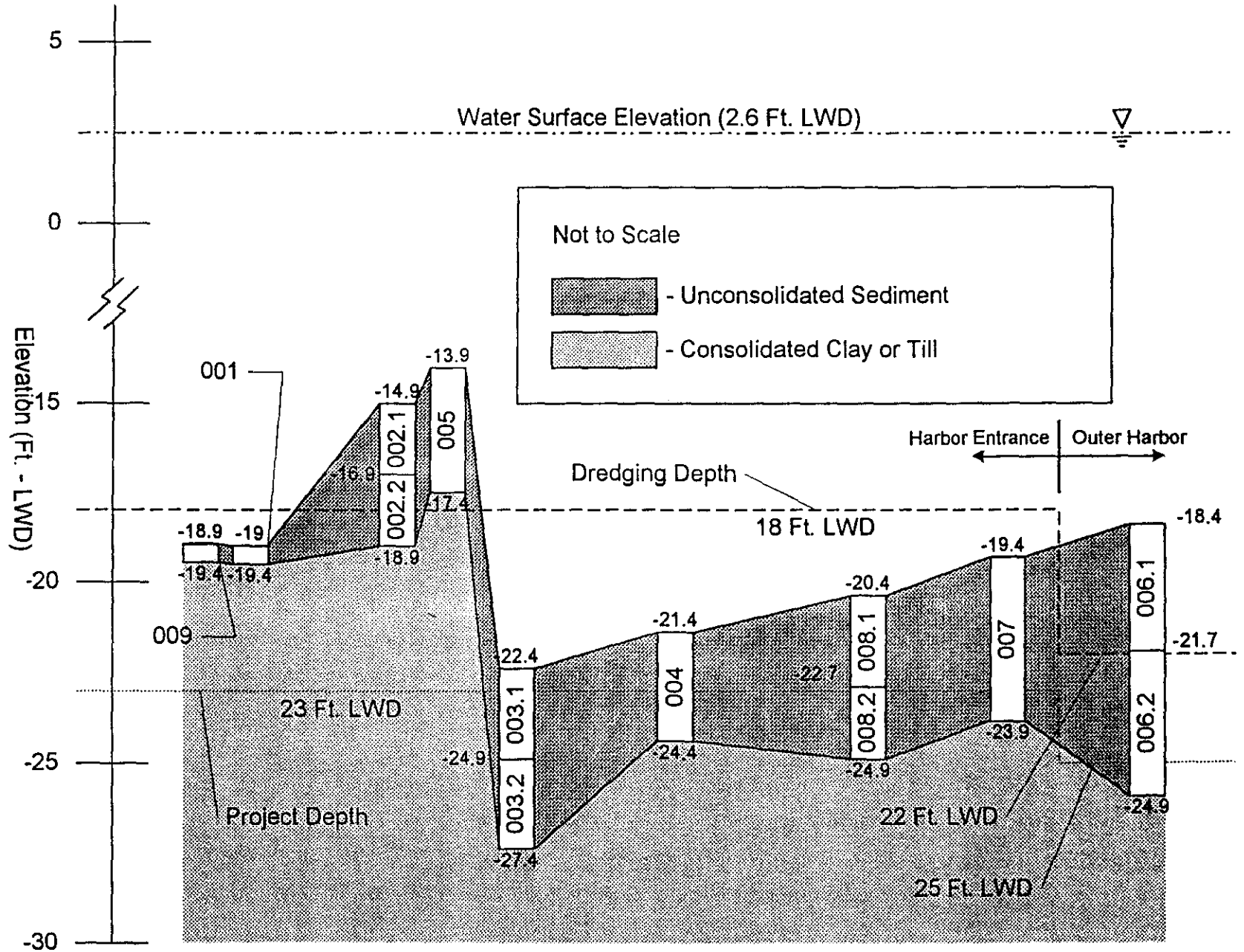

Figure 2. Sediment Sample Stratigraphy

Table 1. Sediment Stratigraphy

Sample	Sediment Surface (LWD)	Hammer Refusal (LWD)	Sample Length (ft)	Sample Description
WIH-0995-001	-19.0	-19.4	0.4	hard packed clay, little sand, light gray, no odor
WIH-0995-002.1	-14.9		2.0	loose silty sediment, gray in color, no sand, no odor
WIH-0995-002.2		-18.9	2.0	loose silty sediment, gray in color, no sand, no odor
WIH-0995-003.1	-22.4		2.5	loose silty sediment, gray in color, no sand, no odor
WIH-0995-003.2		-27.4	2.5	loose silty sediment, gray in color, no sand, no odor
WIH-0995-004	-21.4	-24.4	3.0	loose silty sediment, gray in color, some sand, no odor
WIH-0995-005	-13.9	-17.4	3.5	loose silty sediment, gray in color, no sand, no odor
WIH-0995-006.1	-18.4		3.3	lake sand, tan, brown, and black grains, no odor
WIH-0995-006.2		-24.9	3.3	lake sand, tan, brown, and black grains, no odor
WIH-0995-007	-19.4	-23.9	4.5	lake sand with some gray silt, no odor
WIH-0995-008.1	-20.4		2.3	sandy silt, gray in color, no odor
WIH-0995-008.2		-24.9	2.3	sandy silt, gray in color, no odor
WIH-0995-009	-18.9	-19.4	0.5	hard packed clay with some sand, light gray, no odor

Table 2. Sediment Analytical Parameters

SUMMARY OF SITE SPECIFIC ACCEPTANCE LIMITS

PROTOCOL B

PROTOCOL	ACCEPTANCE LIMITS
pH	2.5 < pH ≤ 12.5
Specific Gravity	
Total Solids	40 percent
Free Liquids	0% free liquids (paint filter test)
Flash Point	> 140° F (closed cup)
% Acidity (if pH ≤ 4)	no limit
% Alkalinity (of pH ≥ 10)	no limit
ACCEPTANCE LIMIT	
Arsenic	TCLP extraction procedure < 5.0 mg/l
Barium	TCLP extraction procedure < 100.0 mg/l
Cadmium	TCLP extraction procedure < 1.0 mg/l
Chromium	TCLP extraction procedure < 5.0 mg/l
Copper	TCLP extraction procedure < 100.0 mg/l
Lead	TCLP extraction procedure < 5.0 mg/l
Mercury	TCLP extraction procedure < 0.2 mg/l
Nickel	TCLP extraction procedure < 35.0 mg/l
Selenium	TCLP extraction procedure < 1.0 mg/l
Silver	TCLP extraction procedure < 5.0 mg/l
Zinc	TCLP extraction procedure < 200.0 mg/l
Chlorine	< 1.0%*
Reactive Sulfide	< 50 mg/l
PCB's	< detection limit
Phenol	TCLP extraction procedure < 2000 mg/l
Cyanide (as free CN)	< 50 mg/l
Benzene	TCLP extraction procedure < 0.5 mg/l
Carbon Tetrachloride	TCLP extraction procedure < 0.5 mg/l
Chlorobenzene	TCLP extraction procedure < 100.0 mg/l
Chloroform	TCLP extraction procedure < 6.0 mg/l
o-Cresol	TCLP extraction procedure < 200.0' mg/l
m-Cresol	TCLP extraction procedure < 200.0' mg/l
p-Cresol	TCLP extraction procedure < 200.0' mg/l
1,4-Dichlorobenzene	TCLP extraction procedure < 7.5 mg/l
1,2-Dichloroethane	TCLP extraction procedure < 0.5 mg/l
1,1-Dichloroethylene	TCLP extraction procedure < 0.7 mg/l
2,4-Dinitrotoluene	TCLP extraction procedure < 0.13' mg/l
Hexachlorobenzene	TCLP extraction procedure < 0.13' mg/l
Hexachloro-1.3-butadiene	TCLP extraction procedure < 0.5 mg/l
Hexachloroethane	TCLP extraction procedure < 3.0 mg/l
Methyl Ethyl Ketone	TCLP extraction procedure < 200.0 mg/l
Nitrobenzene	TCLP extraction procedure < 2.0 mg/l
Pentachlorophenol	TCLP extraction procedure < 100.0 mg/l
Pyridine	TCLP extraction procedure < 5.0' mg/l
Tetrachloroethylene	TCLP extraction procedure < 0.7 mg/l
Trichloroethylene	TCLP extraction procedure < 0.5 mg/l
2,4,5-Trichlorophenol	TCLP extraction procedure < 400.0 mg/l
2,4,6-Trichlorophenol	TCLP extraction procedure < 2.0 mg/l
Vinyl Chloride	TCLP extraction procedure < 0.2 mg/l

CONSTITUENTS	
* If chlorine is ≥ 1%, the following compounds must be analyzed.	
tetrachloroethylene	SUM MUST BE LESS THAN 1% OF TOTAL WEIGHT.
trichloroethylene	
methylene chloride	
1,1,1-trichloroethane	
carbon tetrachloride	
chloroform	
ortho-dichlorobenzene	
dichlorodifluoromethane	
1,1,2 trichloro - 1,2,2 trifluoroethane	
trichlorofluoromethane	
1,1 dichloroethylene	
1,2 dichloroethylene	

' Quantitation limit is greater than the calculated regulatory level. The quantitation limit, therefore becomes the regulatory level.

' If o,m-, and p-Cresol concentrations cannot be differentiated, the total Cresol (0026) concentration is used. The regulatory level for total Cresol is 200 mg/l.

For all constituents which are identified as TCLP extraction, it is permissible to do a totals analysis instead of the extraction. If the totals analysis is not over the acceptance limit, no extraction is required.

SUMMARY CF WAUKEGAN INNER HARBOR SEDIMENT DATA

	Parameters	Landfill Acceptance Limits	Reporting Limits	WIH-0995- 001	002.1	002.2	003.1	003.2	004	005	006.1	006.2	007	008.1	008.2	009
	pH	2.5<pH<12.5	0.1	8.9	7.6	7.6	7.6	7.5	7.8	8.1	8.4	8.3	8	7.8	8.5	8.8
	Specific Gravity	g/ml	0.01	1.72	1.74	1.28	2.54	1.29	1.71	1.43	1.68	1.72	1.45	1.46	1.74	1.37
	Free Liquids	0% free liquids	1%	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Total Solids	> 40%		84.5	41.8	48.4	48	53.1	63.1	71.6	79.6	71.8	69.4	66.1	86.2	85.8
	Flash Point	> 140 F (closed cup)	1F	>140	>140	>140	>140	>140	>140	>140	>140	>140	>140	>140	>140	>140
	Chlorine	<1.0%	%	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Cyanide (as free CN)	<50 mg/L	1.0 mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Reactive Sulfide	<50 mg/L	matrix specific	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	PCB's	<50 mg/kg Total														
	PCB-1016		0.033 mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	PCB-1221		0.033 mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	PCB-1232		0.033 mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	PCB-1242		0.033 mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	PCB-1248		0.033 mg/kg	ND	5.7	9.3	7.3	4.1	1	2.9	0.21	0.91	1.3	2.8	0.14	ND
	PCB-1254		0.033 mg/kg	ND	1.3	1.6	1.6	0.82	0.17	0.67	0.037	0.35	0.33	0.91	ND	ND
	PCB-1260		0.033 mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TCLP	Arsenic	<5.0 mg/L	0.08 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	0.12	0.093	0.17	ND	0.086
TCLP	Barium	<100.0 mg/L	0.005 mg/L	0.48	0.36	0.45	0.39	0.45	0.27	0.24	0.15	0.28	0.27	0.27	0.33	0.33
TCLP	Cadmium	<1.0 mg/L	0.005 mg/L	ND	0.24	0.42	0.47	0.53	0.018	0.14	ND	0.018	0.05	0.065	0.012	ND
TCLP	Chromium	<5.0 mg/L	0.04 mg/L	0.005	0.027	0.038	0.025	0.024	ND	0.005	0.008	0.009	0.005	0.006	ND	ND
TCLP	Copper	<100.0 mg/L	0.005 mg/L	ND	0.031	0.049	0.073	0.11	0.022	0.028	0.014	0.027	0.031	0.051	0.04	0.009
TCLP	Lead	<5.0 mg/L	0.04 mg/L	ND	0.41	0.43	0.55	0.31	0.12	0.22	0.055	0.074	0.078	0.14	0.055	ND
TCLP	Mercury	<0.2 mg/L	0.2 ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TCLP	Nickel	<35.0 mg/L	0.02 mg/L	ND	0.051	0.076	0.1	0.12	0.049	0.044	0.027	0.097	0.078	0.098	0.33	0.032
TCLP	Selenium	<1.0 mg/L	0.07 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TCLP	Silver	<5.0 mg/L	0.005 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TCLP	Zinc	<200.0 mg/L	0.020 mg/L	0.064	0.36	0.61	1.6	1.8	0.83	0.49	0.35	2.1	1.6	2.8	0.48	0.084
TCLP	Phenols	<2000 mg/L	200 mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TCLP	Benzene	<0.5 mg/L	27 ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TCLP	Carbon Tetrachloride	<0.5 mg/L	38 ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TCLP	Chlorobenzene	<100.0 mg/L	25 ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TCLP	Chloroform	<6.0 mg/L	45 ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TCLP	o-Cresol	<200.0 mg/L	50 ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TCLP	m-Cresol	<200.0 mg/L	200 ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TCLP	p-Cresol	<200.0 mg/L	200 ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TCLP	1,4-Dichlorobenzene	<7.5 mg/L	100 ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TCLP	1,2-Dichloroethane	<0.5 mg/L	39 ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TCLP	1,1-Dichloroethylene	<0.7 mg/L	65 ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TCLP	2,4-Dinitrotoluene	<0.13 mg/L	100 ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TCLP	Hexachlorobenzene	<0.13 mg/L	50 ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TCLP	Hexachloro-1,3-butadiene	<0.5 mg/L	150 ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TCLP	Hexachloroethane	<3.0 mg/L	100 ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TCLP	Methyl Ethyl Ketone	<200 mg/L	100 ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TCLP	Nitrobenzene	<2.0 mg/L	100 ug/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TCLP	Pentachlorophenol	<100.0 mg/L	100 ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TCLP	Pyridine	< 5.0 mg/L	100 ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TCLP	Tetrachloroethylene	<0.7 mg/L	71 ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TCLP	Trichloroethylene	<0.5 mg/L	35 ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TCLP	2,4,5-Trichlorophenol	<400.0 mg/L	50 ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TCLP	2,4,6-Trichlorophenol	<2.0 mg/L	50 ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TCLP	Vinyl Chloride	<0.2 mg/L	60 ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:

1 - "ND" denotes that the parameter was analyzed for, but not detected.

2 - Shaded cells denote that total PCB was not analyzed for directly, but can be calculated from the sums of the individual Aroclors.

Table 3. Sediment Data Summary

APPENDIX 6

IEPA Assessment of Waukegan Harbor Sediment Contamination

April 1996

Assessment of Waukegan Harbor Sediment Contamination

April 1996

Prepared by
John Lesnak

Northern Monitoring and Assessment Unit
Maywood, Illinois

State of Illinois
Environmental Protection Agency
Bureau of Water
Planning Section

December 1997

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INTRODUCTION

While ambient water quality criteria have been instrumental in assuring attainment of a healthy aquatic environment, they alone have not been sufficient to ensure appropriate levels of environmental protection. Sediment contamination, which can involve deposition of toxicants over long periods of time, is responsible for water quality impacts in some areas (USEPA 1991).

Many water-borne contaminants sorb to particulate suspended and settleable materials. Metals, nutrients and oxygen-demanding materials are naturally occurring in sediments and elevated levels can generally be attributed directly or indirectly to man. Organochlorine compounds, however, are not naturally occurring substances and their presence in sediments attest directly to man's influence in the watershed (Kelly and Hite 1984).

Waukegan Harbor was designated as an Area of Concern in 1981 by the international Joint Commission, the U.S. EPA and the Illinois EPA. This designation was prompted by the discovery of high levels of polychlorinated biphenyls (PCBs) in harbor sediments (IEPA 1994a).

Outboard Marine Corporation (OMC) was identified as the source of PCBs in the harbor sediments. Sediments were removed and treated from the federal Superfund site beginning in 1990. Long term monitoring at the site is ongoing.

Site Setting

Waukegan Harbor is largely man-made, being constructed in the late 1800s and early 1900s. Wetlands adjacent to the harbor were filled with natural materials from the adjacent shoreline and demolition debris to form its present shape. Waukegan Harbor is about 37 acres in size with water depths ranging from 14 to 21 feet. Virtually the entire harbor is bordered by 20 to 25 foot long steel sheet pilings driven into the harbor floor. The Waukegan Harbor watershed consists of approximately 0.47 square miles of industrial, commercial, municipal and open/vacant lands (IEPA 1994a).

Harbor sediments consist of 1 to 10.5 feet of very soft organic silt (muck) overlaying 9 feet of medium dense, fine to coarse sand. A very stiff silt (glacial till) bed ranging from 50 to more than 100 feet thick underlies the sand. The sheet pilings mentioned above are anchored in this till unit. Under this layer and resting on bedrock is a sand and gravel deposit ranging from 3 to 20 feet thick. The uppermost bedrock under the harbor is Silurian age dolomite. This bedrock unit is fractured facilitating groundwater movement within the area (IEPA 1994a).

Lake Michigan and Waukegan Harbor serve as discharge areas for shallow ground water. However, several factors could affect the groundwater levels and flow direction,

including the presence of silt below the sandy near-shore lake deposits, water levels in a ditch and canal tributary to Lake Michigan (both of which are located north of the harbor), and fluctuations in the level of the lake (IEPA 1994a).

Site History

The Waukegan Harbor watershed has seen commercial and heavy industrial use since the late 1800s. Several industries have operated on land directly adjacent to the harbor, discharging waste intentionally or unintentionally into the harbor.

OMC maintains two manufacturing facilities adjacent to the harbor. From approximately 1961 to 1972, OMC purchased a hydraulic fluid which contained PCBs and was used in the die-casting works in plant 2 located at the north end of the harbor. Some of this hydraulic fluid entered the floor drains and escaped from the oil interceptor, diversion and pump system and was released into the harbor. This oil was released into the western end of slip 3 (Figure 1). The discharge pipe to the harbor was sealed in 1976. It is estimated that there were approximately 300,000 pounds of PCBs in Waukegan Harbor (IEPA 1994a).

Harbor sediment sampling in 1985 and 1986 by the Illinois Department of Energy and Natural Resources found the highest levels of PCBs in slip 3 (17,251 ppm) with decreasing concentrations toward the harbor mouth (IEPA 1994a).

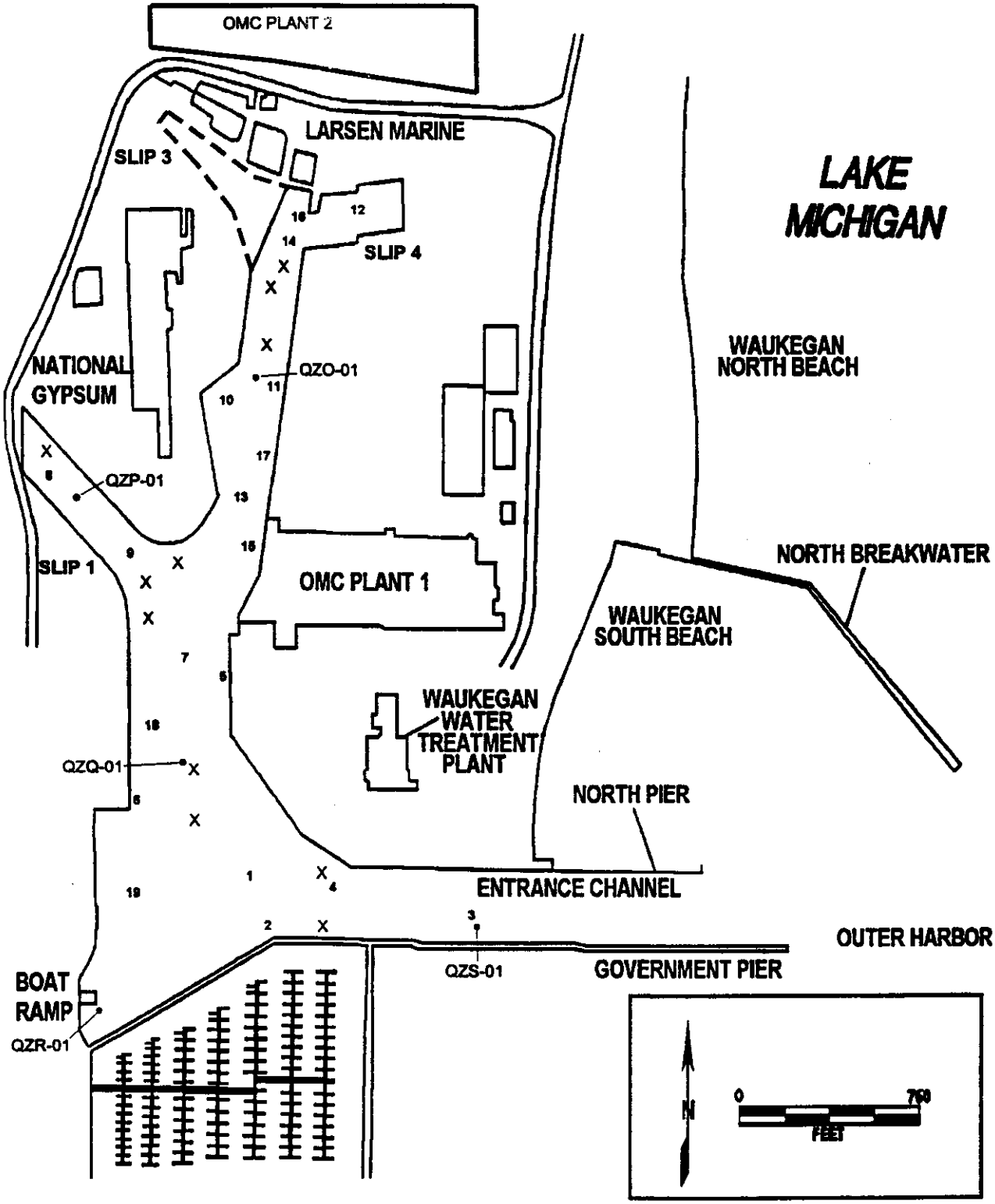
Sediment samples were collected for analysis in November 1990 in Waukegan Old North Harbor. The five sample sites were generally evenly placed from the entrance channel to the upper inner harbor (Figure 1). Unsieved surficial samples were collected using a petite Ponar device and delivered to the appropriate Illinois EPA laboratory for analysis for inorganic and organic constituents.

The resulting laboratory analysis for 11 metals were compared to the U.S. EPA 1977 Great Lakes harbor sediments classifications for those constituents. Based on this classification, 71 percent of the samples were considered moderately or heavily polluted. The upper harbor station (QZO-01) indicated the heaviest pollution loading, having the highest value for all but two parameters. The central harbor station (QZQ-01) indicated the next highest level of metals contaminated sediment, followed by slip 1 (QZP-01), harbor channel (QZS-01), and the boat ramp (QZR-01) stations.

Sample results for PCBs at the five harbor sample sites indicated that sediments were moderately polluted at three stations and nonpolluted at the remaining two. The highest contamination occurred at the upper harbor station (QZO-01) followed by slip 1 (QZP-01), central harbor (QZO-01), harbor channel (QZS-01) and the boat ramp (QZR-01) stations.

The International Joint Commission identified fish consumption, restrictions on

Figure 1. Sediment sampling locations in Waukegan Old North Harbor, April 1996.



• + code indicate 1990 stations

Numbers indicate 1996 stations

X indicates 1996 stations sampled and archived but not analyzed

dredging, and loss of fish and wildlife habitat as harbor use impairments attributable to contaminated sediments.

In 1981, the U.S. EPA recommended that fish caught in Waukegan Harbor not be eaten (USEPA 1981). The Lake County Health Department posted signs indicating fish consumed from the "North" part of the harbor may be dangerous to human health. A sport fish advisory jointly issued by the Department of Public Health, Department of Natural Resources (formerly Department of Conservation), Department of Agriculture and Environmental Protection Agency, recomended that no fish from Waukegan Old North Harbor be consumed (IEPA 1994b).

Waukegan Harbor and the harbor entrance channel are impacted by accumulation of sediment. Previously, clean accumulated material was dredged and transported out into the lake for disposal. Dredging of the inner portion of Waukegan Harbor was discontinued after 1972 because the sediments were classified as polluted. Since water depths in the harbor have been reduced by sedimentation, shipping vessels may not safely navigate the harbor when fully loaded. Consequently, ships may only be loaded to approximately 70 percent capacity requiring more frequent dockages. These additional shipping costs are estimated to be $500,000 dollars per year for two building product manufacturers (IEPA 1994b).

The nearshore Lake Michigan area is impacted by sediment accumulation and contamination. Fish spawning and rearing habitat and avian foraging habitat have been adversely impacted. Sediment accumulation may bury spawning and shelter areas used by small or immature fish. PCBs have been associated with an increase in lake trout egg and fry mortality (IEPA 1994b).

Remedial Actions

In accordance with the 1984 Record of Decision (as amended in 1989), remedial operations began in October 1990. A steel piling curtain was erected across the mouth of slip 3 at the harbor and the slip was filled in. A comparably sized slip was cut on the north end of the harbor, immediately east of slip 3 and the commercial marina that was located on slip 3 was relocated to the newly cut slip 4.

Dredging to remove PCB-contaminated sediments from upper reaches of the Waukegan harbor took place from early January to mid-February, 1992. Sediments were treated onsite using the Taciuk process, which removed over 97 percent of PCBs from the treated material (IEPA 1994a).

Remedial operations were completed in June 1993. Removal of PCBs in the harbor area is estimated to be 96 percent and all remaining sediments will not exceed 50 parts per million of PCBs (IEPA 1994a).

Harbor sediment samples were collected in April 1996 to document the effectiveness of the remedial dredging. Samples were collected and processed for shipment to the Illinois EPA laboratory for chemical analysis and the National Biological Service's Midwest Science Center for toxicity and bioaccumulation studies.

Methods

Sediment samples were collected at 29 stations (one station was replicated) in Waukegan Harbor on April 17-19, 1996. Samples were analyzed for constituents in the Illinois EPA Core sediment inorganics and metals group, Illinois EPA Core sediment organic group (which includes PCBs) and additional USEPA priority pollutants, including Polynuclear Aromatic Hydrocarbons (PAHs). A list of parameters is presented in Appendix Table 1.

Original project plans called for samples to be taken using a vibrating core sampler, capable of retrieving samples up to ten feet in length, from the USEPA shallow draft vessel the Mudpuppy by USEPA staff. After retrieval, each core sample was to be delivered to shore to Illinois EPA staff for preparation prior to being sent to the appropriate laboratory. Chronic technical problems with the core sampler resulted in only one very shallow core sample (approximately 23 inches) successfully retrieved. Due to the inability of the vibra-corer to successfully retrieve a sample, methods were changed to using a stainless steel petite Ponar sampling device onboard the Mudpuppy. The petite Ponar removes a surfacial sample approximately 6" x 6" to a depth of 3". After collection, the sample was deposited in a stainless steel pan and transported to shore, where it was homogenized and placed into the respective sample containers.

All sediment samples were prepared and shipped to the appropriate laboratory in accordance with the Illinois EPA Quality Assurance and Field Methods Manual (1987) and the Illinois EPA Field Guide for Environmental Sampling (1991). Prior to each sample collection, the stainless steel pans and spoons that came into contact with the sample were rinsed once with acetone and deionized water and multi-rinsed with ambient harbor water to reduce the risk of cross contamination. Samples delivered to the Midwest Science Center were kept on ice prior to shipment for toxicity tests. Those samples analyzed for chemical constituents were chilled on ice and then frozen prior to shipment to the appropriate laboratory. Analysis for inorganic and metal constituents and organic constituents were conducted at the Illinois EPA's Champaign and Springfield Laboratories, respectively.

Twenty-nine stations were sampled with one station (P-11) sampled as a replicate. Nineteen of the 30 samples taken were sent to laboratories for chemical or toxicity analysis. The remaining 11 samples are currently archived in a freezer at the Illinois EPA Northern Monitoring and Assessment Unit office in Maywood.

Station locations were determined by the crew of the Mudpuppy. The crew attempted to sample all representative areas of the harbor from mid-way in the entrance channel up to mid-slip 4 (Figure 1). After fixing at a station, location information was recorded by the crew. The Mudpuppy is equipped with a Global Positioning System that is capable of determining real-time Latitude and Longitude with sub-meter accuracy.

Results and Discussion

Sediment samples were collected once at 29 stations (one replicate) to evaluate the success of the dredging operation in Waukegan Harbor. Sediment results that indicate nutrient loading (Phosphorus, Kjeldahl-Nitrogen and Volatile Solids), metals and arsenic and organic constituents (including PCBs) are grouped together and are discussed below. Results of the laboratory sediment analysis for inorganic and metal constituents and organic constituents are presented in Tables 1 and 2, respectively.

There are no Illinois state standards for sediment constituents. However, in an attempt to quantify the analytical results of this sampling effort, sediment chemistry values were compared to guidelines for the evaluation of Great Lakes harbor sediments prepared by the USEPA (1977). These same criteria were used for the Waukegan Harbor Remedial Action Plan, Stage I & II, Final Report (IEPA 1994a). These guidelines, developed to facilitate decisions regarding the disposal of dredged material, classify the sediment as nonpolluted, moderately or heavily polluted. Guidelines for pollutional classification of Great Lakes harbor sediments are presented in Table 3. These data ranges are based on analysis of samples from 34 to over 100 Great Lakes harbors from 1967 to 1977. The data ranges are considered interim guidelines until more scientifically sound guidelines are developed (USEPA 1977).

Table 1. Nutrient and metal compounds in surficial sediment from Waukegan Old North Harbor collected in April 1996. Results shown as mg/kg (ppm) unless otherwise noted.

Station	QZO-04	QZO-05	QZO-06	QZO-07	QZO-08	QZO-09	QZO-10	QZO-11	QZO-12	QZO-13	QZO-01	QZO-01	QZO-14	QZO-03	QZO-02	QZO-15	QZO-16	QZO-17	QZO-18	QZO-19
Parameter	C-1	P-02	P-03	P-04	P-05	P-06	P-07	P-08	P-09	P-10	P-11	P-11R	P-12	P-13	P-14	P-15	P-16	P-17	P-18	P-19
Phosphorus-P	914	575	571	668	766	618	796	443	515	715	392	592	521	633	890	532	696	825	905	837
% Volatile Solids	6.1	5.2	4.6	6.1	7.1	7.2	8.3	5.1	5.4	5.6	3.5	5.2	9.2	7.5	13.2	5.9	7.4	7.9	7.7	7.4
Mercury	0.50	0.18	<.10	0.18	0.19	0.20	0.21	0.14	0.12	0.24	0.12	0.16	0.17	0.26	0.23	0.15	0.23	0.22	0.16	0.39
Barium	54	38	32	39	36	41	54	31	32	38	22	32	43	37	53	29	43	37	40	42
Chromium	145	56	28	57	59	72	96	51	40	70	32	49	50	63	71	107	59	67	74	82
Iron	22,000	17,000	14,000	16000	14000	16000	21000	17000	12000	16000	10000	13000	21000	16000	23000	12000	17000	16000	17000	19000
Manganese	465	480	505	456	414	497	550	372	309	384	261	320	447	426	492	341	353	402	490	540
Silver	< 1	< 1	< 1	< 1	< 1	< 1	< 1	<1	<1	< 1	<1	<1	<1	<1	<1	<1	<1	<1	<0.3	<0.3
Kjeldahl-Nitrogen	5,000	4,973	109	4946	2919	1685	3370	939	966	1452	1105	1792	3333	2529	3232	1158	1988	224	4601	2892
Arsenic	43	20	11	22	22	25	33	20	14	31	20	31	120	28	100	18	40	32	24	27
Potassium	1400	1,600	1300	1800	1300	1200	1700	<1000	<1000	1200	<1000	<1000	1200	1200	1600	<1000	1200	1100	1100	1100
Cadmium	30	8	2	7	8	12	16	8	6	12	5	7	6	9	9	9	8	10	11	13
Copper	133	74	46	72	64	85	92	66	51	93	46	68	228	82	170	57	148	96	87	98
Lead	188	80	45	93	64	112	119	93	64	117	49	77	82	96	105	89	106	105	120	130
Nickel	27	18	14	19	16	20	26	15	12	18	10	16	19	19	21	14	18	20	21	23
Zinc	298	169	106	170	151	189	198	147	119	213	98	148	202	178	255	143	262	185	200	220

Table 2. Organochlorine compounds in surficial sediment from Waukegan Old North Harbor collected in April 1996.
Results for PCBs shown as mg/kg (ppm), all others shown as ug/g (ppm) or ug/kg (ppb) dry weight.

Station / Parameter	QZO-04 C-1	QZO-05 P-03	QZO-07 P-04 (A)	QZO-08 P-05	QZO-09 P-06	QZO-10 P-07	QZO-11 P-08	QZO-12 P-09	QZO-13 P-10	QZO-01 P-11	QZO-01 P-11R	QZO-14 P-12	QZO-03 P-13	QZO-02 P-14	QZO-15 P-15	QZO-16 P-16	QZO-17 P-17	QZO-18 P-18	QZO-19 P-19
Total PCBs mg/kg	5.1	0.3	0.87	3.6	5.2	4.7	4.7	5.0	3.0	4.3	5.6	6.8	7.4	7.7	4.9	7.3	7.3	4.4	5.2
Aldrin ug/kg	<1.0	<1.0	<1.0	<240	<400	<360	<340	<330	<210	<330	<480	<660	<520	<600	<370	<520	<520	<320	<330
Dieldrin ug/kg	<19	<22	<8.0	<19	<27	<20	<21	<19	<11	<26	<30	<62	<76	<63	<25	<45	<47	<26	<26
Total DDT ug/kg	<100	<95	<35	<76	<82	<87	<81	<101	<70	<66	<116	<170	<170	<140	<100	<130	<130	<100	<120
P,P'-DDE ug/kg	<75	<72	<20	<56	<60	<63	<61	<70	<40	<34	<86	<96	<96	<130	<97	<74	<84	<110	<70	<84
P,P'-DDD ug/kg	<16	<23	<11	<13	<20	<17	<20	<18	<19	<16	<15	<11	<22	<13	<16	<12	<20	<11	<14
P,P'-DDT ug/kg	<19	<1.8	<5.0	<7.0	<12	<10	<1.0	<13	<19	<16	<24	<63	<14	<26	<14	<37	<17	<10	<23
Total Chlordane ug/kg	<14	<20	<5.0	<12	<16	<14	<16	<15	<9.0	<16	<20	<32	<31	<29	<20	<27	<20	<17	<20
Chlordane, Cis Isomer ug/kg	< 2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Chlordane, Trans Isomer ug/kg	< 14	<20	<3.0	<12	<16	<14	<16	<15	<9.0	<16	<20	<32	<31	<29	<20	<27	<20	<17	<20
Endrin ug/kg	<1.0	<1.8	<1.0	<1	<1.0	<1.0	<1.0	<1.8	<1.0	<1.8	<1.0	<1.0	<1.8	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Methoxychlor ug/kg	<62	<38	<25	<45	<50	<46	<44	<57	<34	< 36	< 48	<80	<84	< 100	<54	<60	<57	<55	<48
Alpha-BHC ug/kg	<1.0	<1.0	<1.0	<1.0	<1.3	<2.0	<3.0	<2.0	<1.0	<1.8	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Gamma-BHC (Lindane) ug/kg	<1.0	<1.8	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.8	<1.0	<1.0	<1.8	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Hexachlorobenzene ug/kg	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.2	<1.8	<1.0	<1.0	<1.8	<1.0	<1.0	<1.0	<1.0	<1.0	14
Heptachlor ug/kg	<1.0	<1.8	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.8	<1.0	<1.0	<1.8	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Heptachlor Epoxide ug/kg	<1.0	<1.8	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.8	<1.0	<1.0	<1.8	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Phenol ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bis (2-Chloroethyl) Ether ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2-Chlorophenol ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,3-Dichlorobenzene ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,4-Dichlorobenzene ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzyl Alcohol ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2-Dichlorobenzene ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2-Methylphenol ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bis (2-Chloroisopropyl) Ether ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
4-Methylphenol ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
N-Nitroso-Di-N-Propylamine ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Hexachloroethane ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Nitrobenzene ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Isophorone ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2-Nitrophenol ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2,4-Dimethylphenol ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzoic Acid ug/g	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Bis (2-Chloroethoxy) Methane ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2,4-Dichlorophenol ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2,4-Trichlorobenzene ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Napthalene ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.66	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
4-Chloroaniline ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Hexachlorobutadiene ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
4-Chloro-3-Methylphenol ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2-Methylnapthalene ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Hexachlorocyclopentadiene ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2,4,6-Trichlorophenol ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2,4,5-Trichlorophenol ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2-Chloronapthalene ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2-Nitroaniline ug/g	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dimethylphthalate ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Acenaphthylene ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2,6-Dinitrotoluene ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
3-Nitroaniline ug/g	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.69	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2,4-Dinitrophenol ug/g	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
4-Nitrophenol ug/g	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dibenzofuran ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2,4-Dinitrotoluene ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Diethylphthalate ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
4-Chlorophenyl Phenyl Ether ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluorene ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.84	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
4-Nitroaniline ug/g	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
4,6-Dinitro-2-Methylphenol ug/g	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
4-Bromophenyl Phenyl Ether ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Hexachlorobenzene ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Pentachlorophenol ug/g	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.2	<0.5	<0.5	2.8	0.56	<0.5	1.6	<0.5	<0.5	0.53	<0.5
Anthracene ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.75	<0.5	<0.5	0.83	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Di-N-Butylphthalate ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluoranthene ug/g	<0.5	0.60	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.3	<0.5	<0.5	3.1	0.97	<0.5	2.1	0.70	0.56	0.64	<0.5
Pyrene ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.71	<0.5	<0.5	1.8	0.56	<0.5	1.3	<0.5	<0.5	<0.5	<0.5
Butyl Benzyl Phthalate ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
3,3'-Dichlorobenzidine ug/g	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo (A) Anthracene ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.98	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chrysene ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.66	<0.5	<0.5	1.7	<0.5	<0.5	0.86	<0.5	<0.5	<0.5	<0.5
Bis (2-Ethylhexyl) Phthalate ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.89	<0.5	0.56	<0.5	2.8	<0.5	<0.5	<0.5
Di-N-Octylphthalate ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo (B) Fluoranthene ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.53	<0.5	<0.5	1.7	0.60	<0.5	1.0	<0.5	<0.5	<0.5	<0.5
Benzo (K) Fluoranthene ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo (A) Pyrene ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.64	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Indeno (1,2,3-CD) Pyrene ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dibenzo (AH) Anthracene ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo (GHI) Perylene ug/g	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

(A) The sample bottle for station QZO-07 (P-07) was found broken at the lab, these results may be suspect.
The sample bottle for station PZO-05 (P-03) was broken in transit to the lab, therefore no organic analysis is available.

Table 3. Guidelines for pollutional classification of Great Lakes harbor sediments, (from USEPA 1977). Values in mg/kg dry weight unless otherwise noted.

Parameter	Non Polluted	Moderately Polluted	Heavily Polluted
PCBs	<1	1-10	>10
Volatile Solids (%)	<5	5-8	>8
COD	<40,000	40,000-80,000	>80,000
TKN	<1,000	1,000-2,000	>2,000
Oil & Grease (Hexane solubles)	<1,000	1,000-2,000	>2,000
Lead	<40	40-60	>60
Zinc	<90	90-200	>200
Mercury	<1.0	N.A.	>1.0
Ammonia	<75	75-200	>200
Cyanide	<0.10	0.10-0.25	>0.25
Phosphorus	<420	420-650	>650
Iron	<17,000	17.000-25,000	>25,000
Nickel	<20	20-50	>50
Manganese	<300	300-500	>500
Arsenic	<3	3-8	>8
Cadmium	*	*	>8
Chromium	<25	25-75	>75
Barium	<20	20-60	>60
Copper	<25	25-50	>50

* Lower limits not established.

Nutrients

Kjeldahl-Nitrogen, phosphorus and volatile solids were reported to be moderately or heavily polluted for 23 (38%) and 30 (50%) analyses, respectively. Only 7 (12%) of the 60 analyses indicated nonpolluted conditions for one of these parameters. All stations had at least one elevated parameter (Table 1). There is no apparent spatial trend within the harbor for these parameters.

Metals

Analyses for 13 metals were conducted on the sediment samples collected from the harbor. Of the total 260 analyses (20 samples x 13 parameters), 89 (34%) were considered nonpolluted, 66 (25%) were moderately polluted and 105 (40%) were heavily polluted. All samples were considered nonpolluted for mercury, silver and potassium. All samples were heavily polluted with barium and arsenic, while 18 of the

20 samples showed heavy pollution by copper and lead. Ratings for the remainder of the metal parameters for each sample ranged from non-polluted to heavily polluted. There is no apparent spatial trend within the harbor for metal-contaminated sediment.

Organics (PCBs)

A total of 81 organic parameters consisting of PCBs, pesticides and USEPA priority pollutants, including PAHs, were analyzed from 19 samples as part of the Waukegan Harbor sediment collection of April 1996. Samples from a total of 19 stations plus one replicate were collected (total of 20 samples). However, the sample bottle from station QZO-05 (P-02) was broken in transit to the laboratory and therefore analysis was not performed. Also, the sample bottle for sample QZO-07 (P-04) was found cracked upon arrival at the lab. Analysis was performed on this sample and the results are presented in Table 3. However the results from station QZO-07 (P-04) are not included in this discussion due to the questionable PCBs value.

Generally, the vast majority of the analyses for the organic constituents resulted in less than the applicable reporting value. Of the 1,458 analysis (18 stations x 81 parameters), less than 4 percent resulted in values greater than quantifiable reporting limits.

Polychlorinated biphenyls (PCBs) is the only organic constituent included in the Great Lakes harbor sediment guidelines. Because of the known bioaccumulation characteristic of PCBs, a rigid limit is used rather than the multi-step ranges used to classify the other constituents. If the guideline value of > 10 mg/kg (ppm) is exceeded, the sediment is classified as heavily polluted. Pollutional classification of sediments with total PCBs concentrations between 1.0 and 10.0 mg/kg are considered moderately polluted (USEPA 1977). The significance of PCBs concentrations between 1.0 and 10.0 mg/kg are determined on a case-by-case basis.

All of the 18 harbor samples analyzed resulted in values less than 10 mg/kg of total PCBs. Concentrations ranged from 3.0 - 8.9 mg/kg with an average harbor-wide concentration of 5.6 mg/kg. The highest concentration (8.9 mg/kg) was found at station QZO-14 (P-12), which is located in the newly constructed slip 4, (Figure 1). Six of the nine samples collected in the harbor near or above the OMC plant 1 resulted in values that exceeded the average harbor value. Only one of the samples from the lower harbor and entrance channel exceeded the average value for the harbor. Station three, which is sited in the harbor entrance channel, reported a value of 6.3 mg/kg.

Laboratory analysis resulted in values greater than detection limits for only 35 (2.4 %) of the remaining 1,440 analyses included in the Illinois EPA Core organic and priority pollutants lists. Hexachlorobenzene, which is included on the Illinois EPA organics list, was reported as 1.2 and 14 ug/kg at stations QZO-13 (P-10) and QZO-19 (P-19), respectively. Station P-19 is adjacent to a marine fueling station at the Waukegan Old

North Harbor docks. Twelve parameters on the priority pollutants list had values greater than the minimum reporting value at one or more stations in Waukegan Harbor. Listed below are the parameters and number of stations where the minimum reporting value was exceeded for the survey.

Napthalene	1	Acenaphthene	1
Fluorene	1	Phenanthrene	5
Anthracene	2	Fluoranthene	8
Pyrene	4	Benzo (A) Anthracene	1
Chrysene	3	Bis (2-Ethylhexyl) Phthalate	3
Benzo (B) Fluoranthene	3	Benzo (A) Pyrene	1

Nine of the 17 stations (one replicate sample was collected) reported the elevated levels described above. Six of the nine stations had elevated results for four or fewer parameters. Two stations had five elevated parameters and station QZO-14 (P-12) had 12 priority pollutants over the minimum reporting value. Station QZO-14 (P-12) is located in slip 4 at the northern end of the harbor. This station also had the highest concentration of PCBs for this survey. Spatially, seven of the nine stations with elevated priority pollutants are located in the upper harbor, being near or above OMC plant 1.

Appendix Table 1. Compounds sampled for the Waukegan Harbor Remedial Action Plan, 1995. Included are parameters in the Illinois EPA Core sediment Inorganics and metals group, Illinois EPA Core sediment organics group and additional priority pollutants, including Polynuclear Aromatic Hydrocarbons (PAHs). USEPA STORET parameter codes are listed in parentheses.

Illinois EPA Core Sediment Inorganics and Metals

(70322) % Volatile Solids
(00668) Phosphorus
(01003) Arsenic
(01043) Copper
(01052) Lead
(71921) Mercury
(01078) Silver
(01028) Cadmium
(00627) Kjeldahl Nitrogen
(00938) Potassium
(01008) Barium
(01170) Iron
(01053) Manganese
(01068) Nickel
(01093) Zinc
(01029) Chromium

Illinois EPA CORE Sediment Organics

(39519) Total PCBs
(39383) Dieldrin
(39321) p,p' DDE
(39301) p,p' DDT
(39064) Chlordane cis isomer
(39393) Endrin
(39343) Gamma BHC - Lindane
(39413) Heptachlor
(39076) Hexachlorocyclohexane-alpha BHC
(39333) Aldrin
(39359) Total DDT
(39311) p,p' DDD
(39351) Total Chlordane
(39067) Chlordane trans isomer
(39481) Methoxychlor
(39701) Hexachlorobenzene
(39423) Heptachlor epoxide

PAHs and additional priority pollutants

(34694) Phenol
(34586) 2-Chlorophenol
(34571) 1,4-Dichlorobenzene
(34536) 1,2-Dichlorobenzene
(34283) Bis (2-Chloroisopropyl) Ether
(34428) N-Nitroso-Di-N-Propylamine
(34447) Nitrobenzene
(34591) 2-Nitrophenol
(77247) Benzoic Acid
(34601) 2,4-Dichlorophenol
(34273) Bis (2-Chloroethyl) Ether
(34566) 1,3-Dichlorobenzene
(77147) Benzyl Alcohol
(00000) 2-Methylphenol
(00000) 4-Methylphenol
(34396) Hexachloroethane
(34408) Isophorone
(34606) 2,4-Dimethylphenol
(34278) Bis (2-Chloroethoxy) Methane
(34551) 1,2,4-Trichlorobenzene

Appendix Table 1. (continued) Compounds sampled for the Waukegan Harbor Remedial Action Plan, 1995. Included are parameters in the Illinois EPA Core sediment inorganics and metals group, Illinois EPA Core sediment organics group and additional priority pollutants, including Polynuclear Aromatic Hydrocarbons (PAHs). USEPA STORET parameter codes are listed in parentheses.

(34696) Naphthalene
(34591) Hexachlorobutadiene
(77416) 2-Methylnapthalene
(34621) 2,4,6-Trichlorophenol
(34581) 2-Chloronaphthalene
(34341) Dimethylphthalate
(34626) 2,6-Dinitrotoluene
(34205) Acenaphthene
(34646) 4-Nitrophenol
(34611) 2,4-Dinitrotoluene
(34641) 4-Chlorophenyl Phenyl Ether
(00000) 4- Nitroaniline
(34636) 4-Bromophenyl Phenyl Ether
(39032) Pentachlorophenol
(34220) Anthracene
(34376) Fluoranthene
(34292) Butyl Benzyl Phthalate
(34526) Benzo (A) Anthracene
(39100) Bis (2-Ethylhexyl) Phthalate
(34230) Benzo (B) Fluoranthene
(34247) Benzo (A) Pyrene
(34556) Dibenzo (AH) Anthracene
(00000) 4-Chloroaniline
(34452) 4-Chloro-3-Methylphenol
(34386) Hexachlorocyclopentadiene
(77687) 2,4,5-Trichlorophenol
(00000) 2-Nitroaniline
(34200) Acenaphthylene
(78300) 3-Nitroaniline
(34616) 2,4-Dinitrophenol
(81302) Dibenzofuran
(34366) Diethylphthalate
(34381) Fluorene
(00000) 4,6-Dinitro-2-Methylphenol
(39700) Hexachlorobenzene
(34461) Phenanthrene
(39110) Di-N-Butylphthalate
(34469) Pyrene
(34631) 3,3-Dichlorobenzidine
(34320) Chrysene
(34596) Di-N-Octylphthalate
(34242) Benzo (K) Fluoranthene
(34403) Indeno (1,2,3-CD) Pyrene
(34521) Benzo (GHI) Perylene

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15. Supplementary Notes

16. Abstract (Limit: 200 words)

In accordance with a 1984 Record of Decision, PCBs contaminated sediments were dredged from the Waukegan Harbor and treated for removal of the contaminants. Remedial operations were completed in June 1993. Harbor sediments were collected in April 1996 to document the effectiveness of the remedial dredging.

Surficial sediment samples were collected at 29 stations (one replicate) within Waukegan Old North Harbor using a petite ponar dredge. Samples were analyzed at IEPA laboratories for parameters in the IEPA inorganic and metals group, parameters in the IEPA organic group and for parameters in the USEPA priority pollutant group.

While no state standards exist for sediment constituents, results were compared to USEPA Guidelines for Pollutional Classification of Great Lakes Harbor Sediments. Parameters in the inorganic and metals groups were determined to be moderately or heavily polluted in 88 percent and 65 percent of the analyses, respectively. Less than four percent of the organic analyses resulted in values greater than reporting limits. Results for all of the 18 samples analyzed for PCBs indicated moderate pollution.

17. Document Analysis
a. Descriptors
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Sediment Quality
Great Lakes Harbor

b. Identifiers/Open-Ended Terms
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18. Availability Statement	19. Security Class (This Report) Unclassified	21. No. of Pages 14
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See Instructions on Reverse

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Department of Commerce

APPENDIX 7

Concentrations of Organochlorine Compounds In Fish Samples For Lake Michigan and Waukegan Harbor, 1991-1998

(Tables A7.1. – A7.17.)

Table A7.1 Concentrations of organochlorine compounds in fish composite samples from the Illinois area of Lake Michigan, 1991.

Date Collected	Station Code	Location	Species	No. Fish in Sample	Mean Length (in)	Mean Weight (lbs)	Percent Lipid	Total Chlordane (mg/kg)	Dieldrin (mg/kg)	Heptachlor Epoxide (mg/kg)	Total DDT (mg/kg)	Total PCBs (mg/kg)
07/19/91	QZO01	Waukegan N Hbr	Alewife	5 (W)	6.6	0.1K	3.7	0.07	0.02	0.01 K	0.40	10.00 *
04/16/91	QZB14	Off North Ave.	Alewife	25 (W)	7.9	0.1	13.0	0.16	0.38 *	0.01 K	0.30	1.00
04/16/91	QZB14	Off North Ave.	Rainbow Smelt	25 (W)	5.9	0.1K	4.5	0.08	0.07	0.01 K	0.21	0.22
04/24/91	QZB14	Off North Ave.	Bloater	10 (F)	8.7	0.2	4.6	0.22	0.04	0.01 K	0.28	0.16
07/19/91	QZO01	Waukegan N Hbr	Carp	2 (F)	27.4	11.9	14.0	0.18	0.10	0.01 K	2.10	19.00 *
06/04/91	QZB14	Off North Ave.	Yellow Perch	10 (F)	9.0	0.3	0.2	0.02 K	0.01 K	0.01 K	0.03	0.12
09/25/91	Q02	Mult. Hbrs.	Brown Trout	5 (F)	14.4	1.4	3.6	0.12	0.03	0.01 K	0.31	0.46
10/01/91	Q02	Mult. Hbrs.	Brown Trout	5 (F)	18.5	3.6	8.5	0.21	0.05	0.01 K	0.50	0.74
10/01/91	Q02	Mult. Hbrs.	Brown Trout	5 (F)	24.1	7.0	8.8	0.22	0.09	0.02	0.50	0.90
10/01/91	Q02	Mult. Hbrs.	Brown Trout	2 (F)	25.7	8.3	11.8	0.19	0.08	0.02	0.47	0.74
08/07/91	QZB02	Off Waukegan	Lake Trout	5 (F)	17.8	2.1	6.0	0.16	0.08	0.01 K	0.41	0.89
08/09/91	QZB02	Off Waukegan	Lake Trout	4 (F)	23.5	4.4	12.0	0.32 *	0.10	0.01 K	1.00	2.00
08/07/91	QZB02	Off Waukegan	Lake Trout	5 (F)	28.7	8.0	17.0	0.99 *	0.24	0.01 K	1.10	4.10 *
10/10/91	Q02	Mult. Hbrs.	Rainbow Trout	3 (F)	15.1	1.5	5.6	0.02	0.02	0.01	0.05	0.20 K
11/19/91	Q02	Mult. Hbrs.	Rainbow Trout	2 (F)	18.0	1.8	10.3	0.03	0.02	0.01 K	0.09	0.20 K
10/24/91	Q02	Mult. Hbrs.	Rainbow Trout	5 (F)	24.4	6.9	6.4	0.08	0.04	0.01	0.14	0.28
10/03/91	Q02	Mult. Hbrs.	Rainbow Trout	5 (F)	28.1	8.2	6.5	0.13	0.02	0.01 K	0.41	0.56
Fall/91	Q02	Mult. Hbrs.	Chinook Salmon	5 (F)	23.0	--	3.7	0.13	0.03	0.01 K	0.40	0.80
Fall/91	Q02	Mult. Hbrs.	Chinook Salmon	5 (F)	27.9	--	2.3	0.16	0.03	0.01 K	0.42	0.83
Fall/91	Q02	Mult. Hbrs.	Chinook Salmon	5 (F)	32.2	--	2.7	0.15	0.04	0.01 K	0.43	0.88
Fall/91	Q02	Mult. Hbrs.	Chinook Salmon	5 (F)	38.2	--	1.1	0.15	0.02	0.01 K	0.43	0.89
09/26/91	Q02	Mult. Hbrs.	Coho Salmon	5 (F)	19.6	2.7	4.7	0.05	0.01 K	0.01 K	0.19	0.29
09/26/91	Q02	Mult. Hbrs.	Coho Salmon	5 (F)	22.8	4.6	5.4	0.14	0.03	0.01 K	0.28	0.40
10/01/91	Q02	Mult. Hbrs.	Coho Salmon	5 (F)	26.3	7.0	4.9	0.12	0.02	0.01 K	0.26	0.40
10/09/91	Q02	Mult. Hbrs.	Coho Salmon	1 (F)	27.8	7.9	5.2	0.17	0.03	0.01 K	0.37	0.59
					USFDA Action Level (mg/kg)			0.30	0.30	0.30	5.00	2.00
					Number Above Action Level			2	1	0	0	3

(F) = Fillets (W) = Whole
K = Actual Value Known to be Less Than Value Reported
* Value Exceeds USFDA Action Level

Table A7.2 Concentrations of organochlorine compounds in fish composite samples from the Illinois area of Lake Michigan, 1992.

Date Collected	Station Code	Location	Species	No. Fish in Sample	Mean Length (in)	Mean Weight (lbs)	Percent Lipid	Total Chlordane (mg/kg)	Dieldrin (mg/kg)	Heptachlor Epoxide (mg/kg)	Total DDT (mg/kg)	Total PCBs (mg/kg)
04/14/92	QZB02	Off Waukegan	Alewife	25 (W)	7.0	0.1	10.7	0.05	0.06	0.01	0.17	0.17
04/16/92	QZB02	Off Waukegan	Rainbow Smelt	25 (W)	5.8	0.0	2.8	0.02	0.02	0.01 K	0.11	0.06 K
04/23/92	QZB02	Off Waukegan	Bloater	10 (F)	9.3	0.3	8.3	0.13	0.08	0.02	0.38	0.13
04/24/92	QZB02	Off Waukegan	Bloater	10 (F)	9.0	0.2	9.3	0.13	0.07	0.02	0.40	0.13
06/03/92	QZB06	Off Foster Ave.	Yellow Perch	10 (F)	9.5	0.3	0.1	0.01 K	0.01 K	0.01 K	0.00 K	0.10 K
06/05/92	QZB15	Off Lake Bluff	Yellow Perch	10 (F)	9.1	0.3	0.3	0.01 K	0.01 K	0.01 K	0.01 K	0.10 K
09/15/92	Q02	Mult. Hbrs.	Brown Trout	2 (F)	26.4	9.4	10.2	0.12	0.09	0.02	0.40	0.62
09/22/92	Q02	Mult. Hbrs	Brown Trout	5 (F)	23.3	6.4	8.2	0.08	0.05	0.01	0.34	0.67
07/29/92	QZB02	Off Waukegan	Lake Trout	5 (F)	18.4	2.0	6.2	0.07	0.03	0.01 K	0.23	0.17
07/29/92	QZB02	Off Waukegan	Lake Trout	5 (F)	23.1	4.1	11.4	0.19	0.11	0.02	0.41	0.47
07/29/92	QZB02	Off Waukegan	Lake Trout	5 (F)	29.2	9.3	17.8	0.34 *	0.15	0.03	0.47	0.56
10/23/92	Q02	Mult. Hbrs.	Rainbow Trout	3 (F)	14.3	1.1	7.0	0.00 K	0.01	0.01 K	0.03	0.04 K
11/24/92	Q02	Mult. Hbrs.	Rainbow Trout	1 (F)	16.2	1.9	5.6	0.05	0.02	0.00 K	0.42	0.17
11/24/92	Q02	Mult. Hbrs.	Rainbow Trout	1 (F)	24.8	7.1	5.9	0.13	0.05	0.01 K	0.40	0.38
11/24/92	Q02	Mult. Hbrs.	Rainbow Trout	4 (F)	30.7	10.0	6.9	0.11	0.04	0.01 K	0.32	0.24
09/22/92	Q02	Mult. Hbrs.	Chinook Salmon	5 (F)	22.2	4.4	3.6	0.09	0.03	0.01 K	0.33	0.28
09/22/92	Q02	Mult. Hbrs.	Chinook Salmon	5 (F)	28.8	8.6	2.3	0.12	0.03	0.00 K	0.45	0.47
09/22/92	Q02	Mult. Hbrs.	Chinook Salmon	5 (F)	32.2	12.5	2.4	0.09	0.02	0.00 K	0.39	0.38
09/22/92	Q02	Mult. Hbrs.	Chinook Salmon	5 (F)	36.6	19.4	3.1	0.13	0.04	0.01 K	0.51	0.55
Fall/92	Q02	Mult. Hbrs.	Coho Salmon	5 (F)	19.3	2.4	3.0	0.06	0.02	0.01 K	0.31	0.63
Fall/92	Q02	Mult. Hbrs.	Coho Salmon	5 (F)	22.0	3.9	2.3	0.08	0.02	0.01 K	0.37	0.68
Fall/92	Q02	Mult. Hbrs.	Coho Salmon	5 (F)	25.2	5.8	2.7	0.11	0.03	0.01 K	0.42	0.89
					USFDA Action Level (mg/kg)			0.30	0.30	0.30	5.00	2.00
					Number Above Action Level			1	0	0	0	0

(F) = Fillets
(W) = Whole
K = Actual Value Known to be Less Than Value Reported
* = Value Exceeds USFDA Action Level

Table A7.3 Concentrations of organochlorine compounds in fish samples from the Illinois waters of Lake Michigan in 1993.

Date Collected	Station Code	Location	Species	No. Fish in Sample	Mean Length (in)	Mean Weight (lbs)	Percent Lipid	Total Chlordane (mg/kg)	Dieldrin (mg/kg)	Heptachlor Epoxide (mg/kg)	Total DDT (mg/kg)	Total PCBs (mg/kg)
04/28/93	QZB-14	Off North Ave	Alewife	25 (W)	6.7	0.1	10.8	0.02	0.08	0.01 K	0.08	0.10 K
04/22/93	QZB-14	Off North Ave	Rainbow Smelt	25 (W)#	5.5	0.1K	1.6	0.02 K	0.01	0.01 K	0.05	0.10 K
04/23/93	QZB-14	Off North Ave	Bloater	10 (F)	10.4	0.3	8.5	0.10	0.07	0.01	0.22	0.13
06/03/93	QZB-15	Off Lake Bluff	Yellow Perch	10 (F)	9.8	0.4	0.2	0.01 K	0.01 K	0.01 K	0.01 K	0.10 K
09/24/93	Q-02	Mult. Hbrs.	Brown Trout	5 (F)	13.9	1.7	4.7	0.04	0.02	0.01 K	0.21	0.20
09/24/93	Q-02	Mult. Hbrs.	Brown Trout	5 (F)	18.0	3.3	6.8	0.06	0.06	0.01 K	0.28	0.23
09/24/93	Q-02	Mult. Hbrs.	Brown Trout	5 (F)	22.1	6.7	10.6	0.08	0.07	0.01 K	0.38	0.30
10/19/93	Q-02	Mult. Hbrs.	Brown Trout	5 (F)	26.8	10.6	7.6	0.22	0.05 K	0.01 K	0.58	0.51
08/03/93	QZB-02	Off Waukegan	Lake Trout	5 (F)	18.5	2.4	8.0	0.13	0.06	0.01 K	0.37	0.23
08/03/93	QZB-02	Off Waukegan	Lake Trout	5 (F)	22.7	4.0	9.4	0.15	0.07	0.01	0.46	0.33
08/03/93	QZB-02	Off Waukegan	Lake Trout	5 (F)	28.4	8.4	13.4	0.56 *	0.13	0.06	1.75	1.92
10/27/93	Q-02	Mult. Hbrs.	Rainbow Trout	1 (F)	12.6	1.1	4.7	0.07	0.03	0.01 K	0.23	0.17
11/04/93	Q-02	Mult. Hbrs.	Rainbow Trout	3 (F)	19.0	3.7	7.9	0.10	0.02	0.01 K	0.20	0.99
11/03/93	Q-02	Mult. Hbrs.	Rainbow Trout	2 (F)	23.0	5.4	9.3	0.15	0.08	0.01 K	0.40	0.76
09/30/93	Q-02	Mult. Hbrs.	Rainbow Trout	5 (F)	28.9	9.6	7.3	0.14	0.05	0.02	0.43	0.58
Fall/93	Q-02	Mult. Hbrs.	Chinook Salmon	5 (F)	21.6	5.1	3.6	0.15	0.04	0.01 K	0.34	0.90 K
Fall/93	Q-02	Mult. Hbrs.	Chinook Salmon	5 (F)	27.3	9.3	2.8	0.17	0.04	0.01 K	0.33	1.09
Fall/93	Q-02	Mult. Hbrs.	Chinook Salmon	5 (F)	32.3	14.9	3.2	0.19	0.04	0.01 K	0.41	1.05 K
Fall/93	Q-02	Mult. Hbrs.	Chinook Salmon	5 (F)	36.6	21.2	2.6	0.18	0.04	0.01 K	0.41	1.10
09/23/93	Q-02	Mult. Hbrs.	Coho Salmon	5 (F)	18.3	3.1	3.3	0.04	0.01	0.01	0.12	0.18
09/23/93	Q-02	Mult. Hbrs.	Coho Salmon	5 (F)	23.1	6.0	6.2	0.32 *	0.06	0.01	0.32	0.41
09/24/93	Q-02	Mult. Hbrs.	Coho Salmon	5 (F)	25.4	7.4	4.9	0.06	0.03	0.01 K	0.27	0.36
10/06/93	Q-02	Mult. Hbrs.	Coho Salmon	5 (F)	28.1	9.5	5.4	0.06	0.04	0.01 K	0.32	0.39
						USFDA Action Level (mg/kg)		0.30	0.30	0.30	5.00	2.00
						Number Above Action Level		2	0	0	0	0

(F) = Fillet Sample
(W) = Whole Fish Sample
# = Whole Sample with Heads Removed and Gutted
K = Actual Value Known to be Less Than Value Reported
* = Value Exceeds USFDA Action Level.

Table A7.4 Concentrations of organochlorine compounds in fish composite samples from Illinois waters of Lake Michigan in 1994.

Date Collected	Station Code	Location	Species	No. Fish in Sample	Mean Length (in)	Mean Weight (lbs)	Percent Lipid	Total Chlordane (mg/kg)	Dieldrin (mg/kg)	Heptachlor Epoxide (mg/kg)	Total DDT (mg/kg)	Total PCBs (mg/kg)
April/94	QZB02	Off Waukegan	Alewife	25 (W)	6.9	0.1	8.0	0.04	0.05	0.01	0.14	0.34
April/94	QZB02	Off Waukegan	Rainbow Smelt	25 (W)	5.9	0.1K	3.0	0.03	0.03	0.01	0.11	0.18
April/94	QZB02	Off Waukegan	Bloater	11 (F)	11.3	0.3	10.6	0.16	0.10	0.03	0.33	0.33
June/94	QZB15	Off Lake Bluff	Yellow Perch	10 (F)	9.2	0.3	0.3	0.01 K	0.01 K	0.01 K	0.01	0.10 K
June/94	QZB06	Off Chicago	Yellow Perch	10 (F)	9.1	0.3	0.2	0.01 K	0.01 K	0.01 K	0.02	0.10 K
Fall/94	QO2	Waukegan S	Brown Trout	5 (F)	13.3	1.0	5.3	0.03	0.01 K	0.01	0.22	0.97
Fall/94	QO2	Waukegan S	Brown Trout	5 (F)	18.2	2.6	5.5	0.01 K	0.01 K	0.01	0.04	1.01
Fall/94	QO2	Waukegan S	Brown Trout	5 (F)	22.6	6.1	8.0	0.23	0.10	0.03	0.48	0.66
Fall/94	QO2	Mult. Hbrs.	Brown Trout	3 (F)	26.4	10.0	8.8	0.26	0.10	0.03	0.58	0.68
July/94	QZB02	Off Waukegan	Lake Trout	5 (F)	16.8	1.6	5.5	0.08	0.03	0.01	0.12	0.41
July/94	QZB02	Off Waukegan	Lake Trout	5 (F)	23.1	4.4	12.3	0.15	0.07	0.02	0.43	0.60
July/94	QZB02	Off Waukegan	Lake Trout	5 (F)	28.2	8.5	16.4	0.41 *	0.14	0.05	1.40	2.35 *
Fall/94	QO2	Mult. Hbrs.	Rainbow Trout	3 (F)	14.1	1.4	6.2	0.02	0.01	0.01 K	0.04	0.15
Fall/94	QO2	Mult. Hbrs.	Rainbow Trout	4 (F)	18.4	3.3	8.9	0.06	0.02	0.01	0.16	0.66
Fall/94	QO2	Mult. Hbrs.	Rainbow Trout	5 (F)	24.1	6.1	8.4	0.12	0.04	0.01	0.36	1.06
Fall/94	QO2	Mult. Hbrs.	Rainbow Trout	5 (F)	26.5	6.9	5.6	0.12	0.01	0.01	0.35	0.76
Fall/94	QO2	Waukegan S	Chinook Salmon	5 (F)	21.2	4.0	3.3	0.10	0.03	0.01 K	0.33	0.29
Fall/94	QO2	Waukegan S	Chinook Salmon	5 (F)	28.4	8.6	2.7	0.19	0.05	0.01	0.47	0.52
Fall/94	QO2	Mult. Hbrs.	Chinook Salmon	5 (F)	31.1	11.8	2.9	0.19	0.04	0.01	0.43	0.50 K
Fall/94	QO2	Mult. Hbrs.	Chinook Salmon	5 (F)	36.3	21.2	1.4	0.14	0.02	0.01	0.36	0.97
Fall/94	Q02	Waukegan S	Coho Salmon	5 (F)	18.1	2.3	4.3	0.10	0.03	0.01 K	0.22	0.81
Fall/94	Q02	Mult. Hbrs.	Coho Salmon	5 (F)	21.7	3.6	2.4	0.04	0.01	0.01 K	0.11	0.29
Fall/94	Q02	Mult. Hbrs.	Coho Salmon	2 (F)	25.0	6.3	2.6	0.11	0.03	0.01 K	0.29	1.01
					USFDA Action Level (mg/kg)			0.30	0.30	0.30	5.00	2.00
					Number Above Action Level			1	0	0	0	1

(F) = Fillets
(W) = Whole
K = Actual Value Known to be Less Than Value Reported
* = Value exceeds USFDA Action Level.

Table A7.5 Concentrations of organochlorine compounds in fish composite samples from the Illinois area of Lake Michigan, 1995.

Date Collected	Station Code	Location	Species	No. Fish in Sample	Mean Length (inch)	Mean Weight (lbs)	Percent Lipid	Total Chlordane (mg/kg)	Dieldrin (mg/kg)	Heptachlor Epoxide (mg/kg)	Total DDT (mg/kg)	Total PCBs (mg/kg)
Fall/95	Q02	Mult. Hbrs.	Coho Salmon	5 (F)	19.5	2.7	2.5	0.02 K	0.02	0.01 K	0.13	0.37
Fall/95	QZB-13	Diversey Hbr.	Coho Salmon	5 (F)	22.8	4.5	5.0	0.02 K	0.01	0.01 K	0.31	0.99
Fall/95	Q02	Mult. Hbrs.	Coho Salmon	5 (F)	25.4	6.2	3.5	0.02 K	0.04	0.01 K	0.35	0.78
Fall/95	Q02	Mult. Hbrs.	Coho Salmon	5 (F)	27.7	7.7	4.5	0.02 K	0.01	0.01 K	0.13	0.37
Fall/95	QO2	Mult. Hbrs.	Chinook Salmon	5 (F)	22.8	5.0	4.9	0.12	0.03	0.01	0.39	1.07
Fall/95	QO2	Mult. Hbrs.	Chinook Salmon	5 (F)	27.6	8.1	1.9	0.11	0.02	0.01 K	0.38	1.00
Fall/95	QO2	Mult. Hbrs.	Chinook Salmon	5 (F)	31.8	12.2	2.4	0.13	0.03	0.01	0.40	1.09
Fall/95	QO2	Waukegan S Hbr.	Chinook Salmon	5 (F)	37.8	21.2	1.5	0.14	0.03	0.01	0.48	1.24
Fall/95	QO2	Mult. Hbrs.	Rainbow Trout	5 (F)	13.1	0.9	5.5	0.02 K	0.02	0.01 K	0.10	0.24
Fall/95	QO2	Mult. Hbrs.	Rainbow Trout	2 (F)	19.1	3.2	9.0	0.02 K	0.06	0.01 K	0.42	1.10
Fall/95	QO2	Mult. Hbrs.	Rainbow Trout	5 (F)	24.1	5.5	7.2	0.02 K	0.03	0.01 K	0.27	1.70
Fall/95	QO2	Mult. Hbrs.	Rainbow Trout	5 (F)	29.4	8.4	5.5	0.02 K	0.04	0.01 K	0.35	0.77
Fall/95	QO2	Mult. Hbrs.	Brown Trout	5 (F)	14.6	1.2	4.3	0.02 K	0.01	0.01 K	0.10	0.33
Fall/95	QO2	Mult. Hbrs.	Brown Trout	5 (F)	18.1	2.8	6.4	0.02 K	0.03	0.01 K	0.27	0.99
Fall/95	QO2	N. Pt. Marina	Brown Trout	5 (F)	22.8	6.1	6.2	0.02 K	0.05	0.01 K	0.31	0.85
Fall/95	QO2	Waukegan S Hbr.	Brown Trout	5 (F)	26.6	10.0	10.2	0.02 K	0.11	0.01	0.48	1.20
Fall/95	QZB02	Off Waukegan	Lake Trout	5 (F)	18.9	2.4	8.2	0.02 K	0.08	0.02	0.40	0.81
Fall/95	QZB02	Off Waukegan	Lake Trout	5 (F)	22.4	4.1	13.4	0.02 K	0.06	0.01	0.28	0.64
Fall/95	QZB02	Off Waukegan	Lake Trout	5 (F)	29.5	10.3	20.2	0.13	0.16	0.03	1.10	2.60 *
Fall/95	QZB14	Off Chicago	Yellow Perch	10 (F)	9.1	0.3	0.6	0.02 K	0.01 K	0.01 K	0.02	0.11
Fall/95	QZB03	Off Lake Bluff	Yellow Perch	10 (F)	9.5	0.4	0.6	0.02 K	0.01 K	0.01 K	0.02	0.12
Fall/95	QZB14	Off Chicago	Alewife	25 (W)	6.8	0.1K	9.3	0.02 K	0.05	0.01 K	0.14	0.44
Fall/95	QZB14	Off Chicago	Rainbow Smelt	25 (W)	6.0	0.1K	2.1	0.02 K	0.01	0.01 K	0.07	0.18
Fall/95	QZB14	Off Chicago	Bloater	10 (F)	9.8	0.2	7.3	0.02	0.04	0.01 K	0.29	0.67
Fall/95	QZB14	Off Chicago	Bloater	8 (F)	11.7	0.5	6.3	0.02	0.04	0.01 K	0.23	0.59
					USFDA Action Level (mg/kg)			0.30	0.30	0.30	5.00	2.00
					Number Above Action Level			0	0	0	0	1

(F) = Fillets
(W) = Whole
K = Actual Value Known to be Less Than Value Reported.
* = Value Exceeds USFDA Action Level.

Table A7.6 Concentrations of organochlorine compounds in fish composite samples from the Illinois area of Lake Michigan, 1996.

Date Collected	Station Code	Location	Species	No. Fish in Sample	Mean Length (inch)	Mean Weight (lbs)	Percent Lipid	Total Chlordane (mg/kg)	Dieldrin (mg/kg)	Heptachlor Epoxide (mg/kg)	Total DDT (mg/kg)	Total PCBs (mg/kg)
09/25/96	QO2	Mult. Hbrs.	Coho Salmon	5 (F)	20.1	3.1	2.4	0.06	0.01	0.01 K	0.22	0.51
09/20/96	QO2	Mult. Hbrs.	Coho Salmon	5 (F)	22.0	4.3	3.8	0.09	0.02	0.01 K	0.32	0.83
09/25/96	QO2	Mult. Hbrs.	Coho Salmon	5 (F)	25.6	7.1	3.6	0.10	0.02	0.01 K	0.32	0.75
10/07/96	QO2	Mult. Hbrs.	Coho Salmon	5 (F)	27.8	8.2	2.3	0.12	0.02	0.01 K	0.40	0.92
09/22/96	QO2	Mult. Hbrs.	Chinook Salmon	5 (F)	22.8	4.7	2.4	0.08	0.01	0.01 K	0.19	0.43
09/22/96	QO2	Mult. Hbrs.	Chinook Salmon	5 (F)	27.1	8.0	2.9	0.12	0.02	0.01 K	0.32	0.65
09/25/96	QO2	Mult. Hbrs.	Chinook Salmon	5 (F)	32.1	12.6	2.0	0.11	0.02	0.01 K	0.30	0.52
09/25/96	QO2	Mult. Hbrs.	Chinook Salmon	5 (F)	36.5	18.8	2.0	0.14	0.02	0.01 K	0.52	0.80
09/25/96	QO2	N. Pt. Marina	Rainbow Trout	1 (F)	18.3	3.0	9.4	0.07	0.03	0.01 K	0.25	0.43
10/11/96	QO2	Mult. Hbrs.	Rainbow Trout	4 (F)	23.2	6.2	11.0	0.14	0.04	0.01 K	0.35	0.69
09/26/96	QO2	Mult. Hbrs.	Rainbow Trout	5 (F)	30.9	11.7	8.9	0.14	0.05	0.01 K	0.38	0.72
09/23/96	QO2	Mult. Hbrs.	Brown Trout	5 (F)	13.5	1.0	3.6	0.04	0.01	0.01 K	0.19	0.38
09/23/96	QO2	Mult. Hbrs.	Brown Trout	5 (F)	17.9	2.7	5.2	0.07	0.03	0.01 K	0.22	0.45
09/19/96	QO2	N. Pt. Marina	Brown Trout	5 (F)	22.6	5.2	5.8	0.10	0.04	0.01 K	0.30	0.65
09/25/96	QO2	Mult. Hbrs.	Brown Trout	5 (F)	26.8	10.6	12.0	0.18	0.07	0.01	0.63	1.50
08/02/96	QZB02	Off Waukegan	Lake Trout	5 (F)	18.5	2.2	5.4	0.09	0.04	0.01 K	0.18	0.39
08/02/96	QZB02	Off Waukegan	Lake Trout	5 (F)	23.2	4.6	12.0	0.14 K	0.04 K	0.01 K	0.44 K	0.75
08/02/96	QZB02	Off Waukegan	Lake Trout	5 (F)	28.9	10.6	18.0	0.39 *	0.13	0.02	0.95	1.70
06/04/96	QZB06	Off Chicago	Yellow Perch	10 (F)	9.3	0.3	0.4	0.02 K	0.01 K	0.01 K	0.01 K	0.10 K
06/06/96	QZB15	Off Lake Bluff	Yellow Perch	10 (F)	9.2	0.3	0.4	0.02 K	0.01 K	0.01 K	0.01	0.10 K
04/17/96	QZB02	Off Waukegan	Alewife	25 (W)	6.9	0.1	2.8	0.03	0.02	0.01 K	0.13	0.24
04/24/96	QZB02	Off Waukegan	Rainbow Smelt	25 (W)	6.1	0.1K	2.0	0.02 K	0.01 K	0.01 K	0.06	0.10 K
04/24/96	QZB02	Off Waukegan	Bloater	10 (F)	9.1	0.2	5.9	0.10	0.04	0.01 K	0.29	0.35
04/25/96	QZB02	Off Waukegan	Bloater	7 (F)	10.7	0.3	7.7	0.13	0.07	0.02	0.30	0.42
					USFDA Action Level (mg/kg)			0.30	0.30	0.30	5.00	2.00
					Number Above Action Level			1	0	0	0	0

(F) = Fillets
(W) = Whole
K = Actual Value Known to be Less Than Value Reported.
* = Value Exceeds USFDA Action Level.

Table A7.7 Concentrations of organochlorine compounds in fish composite samples from the Illinois area of Lake Michigan, 1997.

Date Collected	Station Code	Location	Species	No. Fish in Sample	Mean Length (inch)	Mean Weight (lbs)	Percent Lipid	Total Chlordane (mg/kg)	Dieldrin (mg/kg)	Heptachlor Epoxide (mg/kg)	Total DDT (mg/kg)	Total PCBs (mg/kg)
09/16/97	QO2	Mult. Hbrs.	Coho Salmon	5 (F)	18.5	2.3	3.6	0.06	0.01	0.01K	0.20	0.38
09/25/97	QO2	Mult. Hbrs.	Coho Salmon	5 (F)	22.2	3.5	3.7	0.12	0.01	0.01K	0.36	0.65
10/07/97	QO2	Mult. Hbrs.	Coho Salmon	4 (F)	25.4	5.8	2.7	0.08	0.01K	0.01K	0.27	0.57
09/24/97	QO2	Mult. Hbrs.	Chinook Salmon	5 (F)	20.4	3.2	2.0	0.07	0.01	0.01K	0.33	0.76
09/24/97	QO2	Mult. Hbrs.	Chinook Salmon	5 (F)	29.2	8.7	2.6	0.10	0.02	0.01K	0.42	1.03
09/24/97	QO2	Mult. Hbrs.	Chinook Salmon	5 (F)	32.9	13.0	2.5	0.10	0.02	0.01K	0.46	1.19
09/24/97	QO2	Mult. Hbrs.	Chinook Salmon	5 (F)	36.5	16.6	1.9	0.11	0.02	0.01K	0.50	1.17
10/07/97	QO2	N. Pt. Marina	Rainbow Trout	1 (F)	11.0	0.7	1.9	0.02	0.01K	0.01K	0.08	0.23
10/14/97	QO2	Mult. Hbrs.	Rainbow Trout	2 (F)	20.1	4.0	12.0	0.15	0.03	0.01K	0.43	1.30
10/28/97	QO2	Mult. Hbrs.	Rainbow Trout	5 (F)	21.8	5.0	9.8	0.15	0.03	0.01K	0.41	0.90
09/17/97	QO2	Mult. Hbrs.	Rainbow Trout	5 (F)	28.2	7.1	6.6	0.13	0.03	0.01K	0.34	0.52
09/30/97	QO2	Mult. Hbrs.	Brown Trout	5 (F)	14.2	1.0	4.6	0.08	0.01	0.01K	0.25	0.61
09/24/97	QO2	Mult. Hbrs.	Brown Trout	5 (F)	19.9	3.0	5.7	0.11	0.03	0.01K	0.36	0.70
09/24/97	QO2	N. Pt. Marina	Brown Trout	5 (F)	23.6	5.1	8.0	0.16	0.04	0.01K	0.51	0.96
09/26/97	QO2	Mult. Hbrs.	Brown Trout	5 (F)	26.3	7.8	6.8	0.20	0.04	0.01K	0.70	1.30
08/05/97	QZB02	Off Waukegan	Lake Trout	5 (F)	17.9	2.0	4.9	0.09	0.03	0.01K	0.19	0.58
08/05/97	QZB02	Off Waukegan	Lake Trout	5 (F)	22.0	3.9	9.2	0.19	0.05	0.01	0.39	0.32
08/05/97	QZB02	Off Waukegan	Lake Trout	5 (F)	28.0	8.3	16.0	0.40*	0.09	0.02	1.00	1.80
09/25/97	Q02	Mult. Hbrs.	SMBass	2(F)	15.2	2.0	3.0	0.02K	0.01K	0.01K	0.05	0.20
05/07/97	Q02	Mult. Hbrs.	SM Bass	5(F)	17.4	3.1	3.4	0.05	0.01	0.01K	0.17	0.41
09/16/97	Q02	N. Pt. Marina	LM Bass	4(F)	14.9	1.5	3.3	0.06	0.01	0.01K	0.17	0.38
06/03/97	QZB06	Off Chicago	Yellow Perch	10 (F)	9.7	0.4	0.7	0.02K	0.01K	0.01K	0.02	0.14
06/06/97	QZB15	Off Lake Bluff	Yellow Perch	10 (F)	9.5	0.3	0.7	0.02K	0.01K	0.01K	0.02	0.10K
08/13/97	Q02	N. Pt. Marina	Carp	3(F)	21.5	4.3	6.0	0.12	0.01	0.01K	0.38	0.69
08/13/97	Q02	N. Pt. Marina	Carp	2(F)	25.9	8.2	5.5	0.13	0.01	0.01K	0.24	1.60
05/07/97	Q02	Jackson Hbr.	Carp	3(F)	22.6	6.9	16.0	0.16	0.03	0.01K	0.32	2.30*
05/08/97	Q02	Jackson Hbr.	Carp	2(F)	27.6	11.3	12.0	0.15	0.03	0.01K	0.55	1.30
04/22/97	QZB14	Off Chicago	Alewife	25 (W)	6.9	0.1	6.2	0.07	0.03	0.01K	0.12	0.47
04/15/97	QZB14	Off Chicago	Rainbow Smelt	25 (W)	5.9	0.1K	2.4	0.02	0.01K	0.01K	0.06	0.14
04/24/97	QZB14	Off Chicago	Bloater	10 (F)	10.9	0.4	12.0	0.14	0.06	0.02	0.35	0.72
					USFDA Action Level (mg/kg)			0.30	0.30	0.30	5.00	2.00
					Number Above Action Level			1	0	0	0	1

(F) = Fillets
(W) = Whole
K = Actual Value Known to be Less Than Value Reported.
* = Value Exceeds USFDA Action Level.

Table A7.8 Concentrations of organochlorine compounds in Coho and Chinook Salmon samples from the Waukegan Old North Harbor collected in Fall, 1993.

Date Collected	Station Code	Location	Species	No. Fish in Sample	Mean Length (in)	Mean Weight (lbs)	Percent Lipid	Total Chlordane (mg/kg)	Dieldrin (mg/kg)	Heptachlor Epoxide (mg/kg)	Total DDT (mg/kg)	Total PCBs (mg/kg)
10/19/93	QZO01	Waukegan N Hbr	Coho Salmon	1 (F)	17.7	2.0	1.7	0.03	0.01 K	0.01 K	0.10	0.14
11/02/93	QZO01	Waukegan N Hbr	Coho Salmon	1 (F)	19.4	2.8	1.8	0.04	0.01	0.01 K	0.14	0.23
10/19/93	QZO01	Waukegan N Hbr	Coho Salmon	1 (F)	19.4	3.1	1.9	0.03	0.01	0.01 K	0.09	0.14
11/19/93	QZO01	Waukegan N Hbr	Coho Salmon	1 (F)	22.2	4.4	4.8	0.06	0.03	0.01 K	0.19	0.42
11/09/93	QZO01	Waukegan N Hbr	Coho Salmon	1 (F)	25.6	6.5	4.1	0.08	0.03	0.01 K	0.19	0.29
10/05/93	QZO01	Waukegan N Hbr	Coho Salmon	1 (F)	25.6	6.4	2.3	0.06	0.02	0.01 K	0.24	0.36
11/02/93	QZO01	Waukegan N Hbr	Chinook Salmon	1 (F)	18.9	2.9	2.4	0.02	0.01	0.01 K	0.07	0.20
10/05/93	QZO01	Waukegan N Hbr	Chinook Salmon	1 (F)	24.9	6.2	4.5	0.12	0.05	0.01 K	0.28	0.35
10/05/93	QZO01	Waukegan N Hbr	Chinook Salmon	1 (F)	31.3	10.6	1.1	0.15	0.03	0.01 K	0.49	0.71
10/05/93	QZO01	Waukegan N Hbr	Chinook Salmon	1 (F)	32.7	13.0	1.3	0.01	0.01 K	0.01 K	0.24	0.31
10/05/93	QZO01	Waukegan N Hbr	Chinook Salmon	1 (F)	35.2	17.2	3.0	0.10	0.03	0.01 K	0.43	0.64
10/26/93	QZO01	Waukegan N Hbr	Chinook Salmon	1 (F)	36.0	18.8	0.7	0.12	0.03	0.01 K	0.36	0.27
10/05/93	QZO01	Waukegan N Hbr	Chinook Salmon	1 (F)	36.2	20.0	0.6	0.09	0.01 K	0.01 K	0.28	0.48
10/05/93	QZO01	Waukegan N Hbr	Chinook Salmon	1 (F)	39.8	27.0	1.9	0.14	0.04	0.01 K	0.51	0.47
					USFDA Action Level (mg/kg)			0.30	0.30	0.30	5.00	2.00
					Number Above Action Level			0	0	0	0	0

(F) = Fillets
(W) = Whole
K = Actual Value Known to be Less Than Value Reported.
* = Value Exceeds USFDA Action Level.

Table A7.9 Concentrations of organochlorine compounds in fish samples from the Waukegan Old North Harbor area, 1993.

Date Collected	Station Code	Location	Species	No. Fish in Sample	Mean Length (in)	Mean Weight (lbs)	Percent Lipid	Total Chlordane (mg/kg)	Dieldrin (mg/kg)	Heptachlor Epoxide (mg/kg)	Total DDT (mg/kg)	Total PCBs (mg/kg)
8/16/93	QZO01	Waukegan N Hbr	Carp	1 (F)	27.0	8.7	5.1	0.12	0.06	0.01K	0.27	2.40 *
8/16/93	QZO01	Waukegan N Hbr	Carp	1 (F)	26.4	10.6	5.5	0.05	0.04	0.02	0.24	6.39 *
8/16/93	QZO01	Waukegan N Hbr	Carp	1 (F)	31.3	23.2	40.1	0.81 *	0.25	0.06	0.66	2.66 *
8/16/93	QZO01	Waukegan N Hbr	Carp	1 (F)	27.6	12.6	20.3	0.10	0.01K	0.02	0.49	1.84
8/16/93	QZO01	Waukegan N Hbr	Carp	1 (F)	25.8	10.1	16.2	0.26	0.06	0.01K	0.62	1.66
8/16/93	QZO01	Waukegan N Hbr	Carp	1 (F)	24.6	8.6	5.3	0.12	0.02	0.01K	0.47	0.60
8/16/93	QZO01	Waukegan N Hbr	Gizzard Shad	1 (W)	16.3	1.8	3.6	0.01	0.01K	0.01K	0.06	0.41
8/16/93	QZO01	Waukegan N Hbr	Alewife	8 (W)	5.8	--	3.8	0.06	0.01K	0.01K	0.08	0.17
8/16/93	QZO01	Waukegan N Hbr	Lepomis sp.	6 (W)	5.0	--	2.6	0.02	0.03	0.01K	0.09	1.07
8/16/93	QZO01	Waukegan N Hbr	Golden Shiner	5 (W)	5.1	--	2.0	0.02	0.01K	0.01K	0.06	0.46
8/16/93	QZO01	Waukegan N Hbr	Golden Shiner	15 (W)	3.0	--	3.0	0.03	0.01K	0.01K	0.03	0.52
8/16/93	QZO01	Waukegan N Hbr	W.Sucker	1 (W)	14.4	1.3	4.1	0.04	0.01	0.01K	0.13	1.06
8/16/93	QZO01	Waukegan N Hbr	W.Sucker	1 (W)	10.8	0.7	3.0	0.04	0.01	0.01K	0.05	0.62
10/5/93	QZO01	Waukegan N Hbr	W.Sucker	1 (W)	11.5	0.4	0.9	0.00	0.01	0.01	0.01	0.10
10/5/93	QZO01	Waukegan N Hbr	W.Sucker	1 (W)	10.0	0.2	0.1	0.01	0.01	0.01	0.01	0.01
					USFDA Action Level (mg/kg)			0.30	0.30	0.30	5.00	2.00
					Number Above Action Level			1	0	0	0	3

(F) = Fillets
(W) = Whole
K = Actual Value Known to be Less Than Value Reported.
* = Value Exceeds USFDA Action Level.

Table A7.10 Concentrations of organochlorine compounds in fish samples from the Waukegan Old North Harbor, 1994 .

Date Collected	Station Code	Location	Species	No. Fish in Sample	Mean Length (in)	Mean Weight (lbs)	Percent Lipid	Total Chlordane (mg/kg)	Dieldrin (mg/kg)	Heptachlor Epoxide (mg/kg)	Total DDT (mg/kg)	Total PCBs (mg/kg)
08/16/94	QZO01	Waukegan N Hbr	Rainbow Trout	1 (F)	28.7	9.5	5.4	0.05	0.01 K	0.01 K	0.30	0.36
09/14/94	QZO01	Waukegan N Hbr	Coho Salmon	1 (F)	16.1	1.2	9.7	0.13	0.01 K	0.01	0.35	0.53
11/02/94	QZO01	Waukegan N Hbr	Coho Salmon	1 (F)	11.6	0.6	2.6	0.01 K	0.01 K	0.01 K	0.01 K	0.01 K
10/04/94	QZO01	Waukegan N Hbr	Brown Trout	1 (F)	13.8	1.2	3.6	0.01	0.01 K	0.01 K	0.11	0.06 K
10/04/94	QZO01	Waukegan N Hbr	Brown Trout	1 (F)	15.6	1.6	6.3	0.05	0.02	0.01 K	0.22	0.08 K
10/04/94	QZO01	Waukegan N Hbr	Brown Trout	1 (F)	15.9	1.8	4.2	0.04	0.02	0.01 K	0.21	0.27
10/04/94	QZO01	Waukegan N Hbr	Brown Trout	1 (F)	20.1	3.7	6.0	0.08	0.04	0.03	0.23	0.12
10/04/94	QZO01	Waukegan N Hbr	Chinook Salmon	1 (F)	20.3	3.7	3.3	0.04	0.01	0.01	0.17	0.07
10/04/94	QZO01	Waukegan N Hbr	Chinook Salmon	1 (F)	21.4	0.2	2.5	0.01	0.01 K	0.01	0.05	0.04 K
10/04/94	QZO01	Waukegan N Hbr	Chinook Salmon	1 (F)	21.6	4.2	1.2	0.04	0.01 K	0.01	0.23	0.13
10/04/94	QZO01	Waukegan N Hbr	Chinook Salmon	1 (F)	22.8	5.7	4.7	0.05	0.02	0.02	0.27	0.35
10/04/94	QZO01	Waukegan N Hbr	Chinook Salmon	1 (F)	25.0	5.7	2.3	0.04	0.01 K	0.01	0.22	0.18
10/04/94	QZO01	Waukegan N Hbr	Chinook Salmon	1 (F)	29.1	9.6	3.4	0.05	0.02	0.01	0.33	0.08 K
10/04/94	QZO01	Waukegan N Hbr	Chinook Salmon	1 (F)	29.9	11.0	1.1	0.08	0.01	0.01	0.37	0.11
10/11/94	QZO01	Waukegan N Hbr	Chinook Salmon	1 (F)	31.5	15.2	3.6	0.15	0.04	0.01	0.42	0.46
10/04/94	QZO01	Waukegan N Hbr	Chinook Salmon	1 (F)	32.3	12.2	2.4	0.13	0.03	0.01 K	0.36	0.40
10/04/94	QZO01	Waukegan N Hbr	Chinook Salmon	1 (F)	36.0	18.5	1.3	0.10	0.03	0.01	0.32	0.39
					USFDA Action Level (mg/kg)			0.30	0.30	0.30	5.00	2.00
					Number Above Action Level			0	0	0	0	0

(F) = Fillets
(W) = Whole
K = Actual Value Known to be Less Than Value Reported

Table A7.11 Concentrations of organochlorine compounds in fish samples from the Waukegan Old North Harbor, 1994.

Date Collected	Station Code	Location	Species	No. Fish	Mean Length (in)	Mean Weight (lbs)	Percent Lipid	Total Chlordane (mg/kg)	Dieldrin (mg/kg)	Heptachlor Epoxide (mg/kg)	Total DDT (mg/kg)	Total PCBs (mg/kg)
9/14/94	QZO01	Waukegan N Hbr	Carp	1 (F)	30.7	17.6	27.6	0.20	0.04	0.01 K	0.88	3.45 *
9/14/94	QZO01	Waukegan N Hbr	Gizzard Shad	1 (W)	12.0	0.6	13.5	0.05	0.01 K	0.01	0.16	0.72
9/14/94	QZO01	Waukegan N Hbr	Gizzard Shad	1 (W)	12.0	0.6	16.7	0.02	0.01 K	0.01	0.10	2.98 *
9/14/94	QZO01	Waukegan N Hbr	Gizzard Shad	1 (W)	12.6	0.7	12.2	0.02	0.01	0.01	0.07	0.20
9/14/94	QZO01	Waukegan N Hbr	Gizzard Shad	1 (W)	13.0	1.0	16.2	0.01	0.02	0.01 K	0.11	0.29
9/14/94	QZO01	Waukegan N Hbr	Gizzard Shad	1 (W)	12.4	0.7	12.5	0.01 K	0.01	0.01 K	0.10	0.44
9/14/94	QZO01	Waukegan N Hbr	Gizzard Shad	1 (W)	15.4	1.3	26.4	0.01 K	0.03	0.01 K	0.33	7.30 *
8/16/94	QZO01	Waukegan N Hbr	Black Bullhead	4 (F)	7.3	--	2.0	0.01	0.01 K	0.01	0.13	3.43 *
9/14/94	QZO01	Waukegan N Hbr	C. Catfish	1 (F)	12.8	0.7	3.8	0.04	0.01 K	0.01 K	0.19	0.38
8/16/94	QZO01	Waukegan N Hbr	Golden Shiner	5 (W)	4.8	--	4.2	0.02 K	0.01 K	0.01 K	0.06	0.83
9/14/94	QZO01	Waukegan N Hbr	W. Sucker	1 (W)	7.5	--	2.4	0.01 K	0.01 K	0.01 K	0.05	1.17
9/14/94	QZO01	Waukegan N Hbr	Northern Pike	1 (F)	17.7	1.3	0.8	0.01 K	0.01 K	0.01 K	0.02	0.24
8/16/94	QZO01	Waukegan N Hbr	Northern Pike	1 (F)	24.0	2.9	0.6	0.00 K	0.01 K	0.01 K	0.02	0.25
9/14/94	QZO01	Waukegan N Hbr	Yellow Perch	5 (F)	5.9	--	0.5	0.01 K	0.01 K	0.01 K	0.01 K	0.10 K
9/14/94	QZO01	Waukegan N Hbr	Yellow Perch	5 (F)	6.5	--	0.4	0.01 K	0.01 K	0.01 K	0.01 K	0.10 K
9/14/94	QZO01	Waukegan N Hbr	Yellow Perch	5 (F)	7.7	--	0.4	0.01 K	0.01 K	0.01 K	0.01 K	0.13
8/16/94	QZO01	Waukegan N Hbr	Yellow Perch	2 (F)	7.8	--	0.3	0.01 K	0.01 K	0.01 K	0.01 K	0.12
					USFDA Action Level (mg/kg)			0.30	0.30	0.30	5.00	2.00
					Number Above Action Level			0	0	0	0	4

(W)=Whole
(F)=Fillets
K = Actual Value Known to be Less Than Value Reported
* = Value Exceeds USFDA Action Level

Table A7.12 Concentrations of organochlorine compounds in fish samples from the Waukegan Old North Harbor, 1995.

Date Collected	Station Code	Location	Species	No. Fish in Sample	Mean Length (in)	Mean Weight (lb)	Percent Lipid	Total Chlordane (mg/kg)	Dieldrin (mg/kg)	Heptachlor Epoxide (mg/kg)	Total DDT (mg/kg)	Total PCBs (mg/kg)
10/16/95a	QZO01	Waukegan N Hbr	Brown Trout	2 (F)	19.8	4.0	10.1	0.15	0.08	0.02	0.35	0.82
09/19/95	QZO01	Waukegan N Hbr	Rainbow Trout	1 (F)	29.7	10.1	11.1	0.16	0.07	0.02	0.39	0.59
10/26/95	QZO01	Waukegan N Hbr	Chinook Salmon	3 (F)	21.2	3.5	2.2	0.10	0.02	0.01 K	0.29	0.43
10/26/95	QZO01	Waukegan N Hbr	Chinook Salmon	1 (F)	30.3	11.0	5.3	0.07	0.01 K	0.01 K	0.21	0.26
10/26/95	QZO01	Waukegan N Hbr	Chinook Salmon	1 (F)	37.4	19.8	1.1	0.07	0.02	0.01 K	0.28	0.36
10/26/95	QZO01	Waukegan N Hbr	Coho Salmon	3 (F)	16.2	1.5	3.3	0.01 K	0.01 K	0.01 K	0.02	0.05 K
10/16/95a	QZO01	Waukegan N Hbr	Coho Salmon	3 (F)	22.0	3.7	2.9	0.03	0.01	0.01 K	0.13	0.15
a = Median Collection Date					USFDA Action Level (mg/kg)			0.30	0.30	0.30	5.00	2.00
(F) = Fillets					Number Above Action Level			0	0	0	0	0

K = Actual Value Known to be Less Than Value Reported.

Table A7.13 Concentrations of organochlorine compounds in fish samples from the Waukegan Old North Harbor, 1995.

Date Collected	Station Code	Location	Species	No. Fish	Mean Length (in)	Mean Weight (lb)	Percent Lipid	Total Chlordane (mg/kg)	Dieldrin (mg/kg)	Heptachlor Epoxide (mg/kg)	Total DDT (mg/kg)	Total PCBs (mg/kg)
10/3/95	QZO01	Waukegan N Hbr.	Carp	1 (W)	6.7	0.2	3.3	0.02	0.02	0.01 K	0.07	1.30
8/07/95a	QZO01	Waukegan N Hbr.	Carp	4 (F)	25.6	9.1	12.1	0.26	0.08	0.01	0.59	1.71
9/06/95	QZO01	Waukegan N Hbr.	Carp	3 (F)	27.2	11.8	13.9	0.17	0.07	0.01	0.38	1.29
7/31/95	QZO01	Waukegan N Hbr.	Carp	3 (F)	30.3	14.5	13.8	0.22	0.08	0.01 K	0.38	0.99
9/20/95a	QZO01	Waukegan N Hbr.	Goldfish	2 (F)	10.7	1.1	2.3	0.08	0.02	0.01 K	0.13	1.43
7/31/95	QZO01	Waukegan N Hbr.	B. Bullhead	1 (F)	9.0	0.5	1.6	0.07	0.04	0.01 K	0.09	2.02 *
7/31/95	QZO01	Waukegan N Hbr.	Alewife	22 (W)	3.6	0.2	3.9	0.03	0.01	0.01 K	0.07	0.10 K
9/06/95	QZO01	Waukegan N Hbr.	Gizzard Shad	1 (W)	10.0	0.4	13.9	0.06	0.04	0.01 K	0.08	0.91
9/19/95	QZO01	Waukegan N Hbr.	W. Sucker	2 (W)	11.8	0.6	3.5	0.01 K	0.02	0.01 K	0.02	0.26
9/06/95	QZO01	Waukegan N Hbr.	W. Sucker	3 (W)	9.0	0.3	3.2	0.03	0.02	0.01 K	0.03	0.37
7/31/95	QZO01	Waukegan N Hbr.	W. Sucker	5 (W)	8.6	0.3	4.8	0.01 K	0.03	0.01 K	0.02	0.52
9/13/95a	QZO01	Waukegan N Hbr.	LM Bass	4 (F)	9.4	0.5	1.3	0.01 K	0.01 K	0.01 K	0.02	0.13
10/3/95	QZO01	Waukegan N Hbr.	Rock Bass	1 (F)	9.4	0.6	0.3	0.01 K	0.01 K	0.01 K	0.01 K	0.10 K
10/3/95	QZO01	Waukegan N Hbr.	N. Pike	1 (F)	23.4	3.1	1.4	0.02	0.02	0.01 K	0.06	0.42
7/31/95	QZO01	Waukegan N Hbr.	Yellow Perch	4 (F)	4.6	0.1K	5.8	0.03	0.03	0.01 K	0.05	0.59
7/31/95	QZO01	Waukegan N Hbr.	Yellow Perch	10 (F)	8.0	0.2	0.6	0.01 K	0.01 K	0.01 K	0.01	0.18
					USFDA Action Level (mg/kg)			0.30	0.30	0.30	5.00	2.00
					Number Above Action Level			0	0	0	0	1

a = Median Collection Date
(F) = Fillets
K = Actual Value Known to be Less Than Value Reported
(W) = Whole
* = Value Exceeds USFDA Action Level

Table A7.14 Concentrations of organochlorine compounds in samples of trout and salmon from the Waukegan Old North Harbor, 1996.

Date Collected	Station Code	Location	Species	No. Fish in Sample	Mean Length (in)	Mean Weight (lbs)	Percent Lipid	Total Chlordane (mg/kg)	Dieldrin (mg/kg)	Heptachlor Epoxide (mg/kg)	Total DDT (mg/kg)	Total PCBs (mg/kg)
10/14/96	QZO01	Waukegan N Hbr	Coho Salmon	4 (F)	12.7	0.9	3.1	0.05	0.01K	0.01K	0.19	0.33
10/01/96	QZO01	Waukegan N Hbr	Coho Salmon	5 (F)	23.4	5.4	1.9	0.05	0.01K	0.01K	0.21	0.62
10/01/96	QZO01	Waukegan N Hbr	Coho Salmon	2 (F)	25.1	6.5	1.5	0.05	0.01K	0.01K	0.20	0.70
10/11/96	QZO01	Waukegan N Hbr	Chinook Salmon	3 (F)	23.0	5.0	1.6	0.05	0.01K	0.01K	0.16	0.60
10/06/96	QZO01	Waukegan N Hbr	Chinook Salmon	2 (F)	27.5	8.8	1.2	0.06	0.01	0.01K	0.21	0.77
10/01/96	QZO01	Waukegan N Hbr	Chinook Salmon	5 (F)	33.4	13.7	1.2	0.07	0.01	0.01K	0.26	0.65
10/01/96	QZO01	Waukegan N Hbr	Chinook Salmon	5 (F)	38.9	21.8	1.9	0.11	0.02	0.01K	0.46	1.30
10/01/96	QZO01	Waukegan N Hbr	Brown Trout	2 (F)	16.9	2.9	3.3	0.05	0.02	0.01K	0.20	0.43
10/01/96	QZO01	Waukegan N Hbr	Brown Trout	2 (F)	22.5	5.4	6.4	0.09	0.04	0.01K	0.25	1.00
(F) = Fillets					USFDA Action Level (mg/kg)			0.30	0.30	0.30	5.00	2.00
K = Actual Value is Known to be Less Than Value Reported					Number Above Action Level			0	0	0	0	0

Table A7.15 Concentrations of organochlorine compounds in fish samples from the Waukegan Old North Harbor, 1996.

Date Collected	Station Code	Location	Species	No. Fish in Sample	Mean Length (in)	Mean Weight (lbs)	Percent Lipid	Total Chlordane (mg/kg)	Dieldrin (mg/kg)	Heptachlor Epoxide (mg/kg)	Total DDT (mg/kg)	Total PCBs (mg/kg)
07/16/96	QZO01	Waukegan N Hbr	Carp	1 (F)	33.7	19.6	12.0	0.18	0.03	0.01K	0.82	8.00*
08/14/96	QZO01	Waukegan N Hbr	Carp	1 (F)	15.2	1.7	0.3	0.02K	0.01K	0.01K	0.02	0.10K
07/30/96	QZO01	Waukegan N Hbr	Carp	4 (F)	26.8	10.4	12.0	0.14	0.03	0.01K	0.70	4.40*
07/16/96	QZO01	Waukegan N Hbr	CarpXGoldfish	1 (W)	6.5	0.2	3.8	0.04	0.01K	0.01K	0.14	0.38
05/15/96	QZO01	Waukegan N Hbr	B. Bullhead	1 (F)	7.7	0.3	0.6	0.02K	0.01K	0.01K	0.11	1.40
07/16/96	QZO01	Waukegan N Hbr	Alewife	8 (W)	6.5	0.1K	2.9	0.08	0.02	0.01K	0.17	0.40
06/19/96	QZO01	Waukegan N Hbr	Alewife	11 (W)	7.8	0.1	4.3	0.05	0.04	0.01K	0.20	0.39
06/19/96	QZO01	Waukegan N Hbr	Gizzard Shad	1 (W)	11.2	0.5	3.1	0.05	0.02	0.01K	0.16	0.31
06/19/96	QZO01	Waukegan N Hbr	Gizzard Shad	8 (W)	6.1	0.1	3.2	0.02K	0.01	0.01K	0.07	1.60
10/17/96	QZO01	Waukegan N Hbr	White Sucker	3 (F)	10.4	0.4	1.2	0.02K	0.01K	0.01K	0.02	0.17
10/08/96	QZO01	Waukegan N Hbr	White Sucker	3 (F)	15.6	1.6	1.7	0.02K	0.01K	0.01K	0.04	0.36
07/16/96	QZO01	Waukegan N Hbr	White Sucker	1(W)	10.6	0.5	4.5	0.04	0.02	0.01K	0.12	0.86
06/19/96	QZO01	Waukegan N Hbr	White Sucker	1(W)	13.0	0.9	4.8	0.02	0.01	0.01K	0.10	0.77
05/15/96	QZO01	Waukegan N Hbr	White Sucker	5 (W)	5.6	----	1.9	0.02K	0.01K	0.01K	0.06	0.90
10/08/96	QZO01	Waukegan N Hbr	White Sucker	7(W)	8.9	0.3	1.8	0.02K	0.01K	0.01K	0.05	0.30
07/16/96	QZO01	Waukegan N Hbr	LM Bass	3(F)	10.1	0.6	1.5	0.02K	0.01K	0.01K	0.05	0.30
07/16/96	QZO01	Waukegan N Hbr	SM Bass	1(F)	17.5	3.0	0.9	0.02K	0.01K	0.01K	0.10	0.39
10/01/96	QZO01	Waukegan N Hbr	B. Crappie	1(F)	8.1	0.3	0.7	0.02K	0.01K	0.01K	0.03	0.17
06/19/96	QZO01	Waukegan N Hbr	B. Crappie	4(W)	6.1	0.1	1.7	0.02K	0.01K	0.01K	0.09	0.36
10/17/96	QZO01	Waukegan N Hbr	Bluegill	1(W)	4.3	----	2.7	0,02K	0.01K	0.01K	0.08	0.95
10/17/96	QZO01	Waukegan N Hbr	N. Pike	1(F)	35.4	12.1	2.4	0.04	0.01	0.01K	0.13	1.30
05/15/96	QZO01	Waukegan N Hbr	N. Pike	1(F)	23.6	2.7	0.4	0.02K	0.01K	0.01K	0.03	0.17
08/14/96	QZO01	Waukegan N Hbr	Yellow Perch	5(F)	6.3	0.1	0.4	0.02K	0.01K	0.01K	0.01K	0.10K
10/17/96	QZO01	Waukegan N Hbr	Yellow Perch	5(F)	6.4	0.1	0.7	0.02K	0.01K	0.01K	0.02	0.24
07/16/96	QZO01	Waukegan N Hbr	Yellow Perch	5(F)	6.6	0.1	0.3	0.02K	0.01K	0.01K	0.01K	0.10K
10/17/96	QZO01	Waukegan N Hbr	Yellow Perch	5(F)	7.3	0.2	0.4	0.02K	0.01K	0.01K	0.01K	0.14
08/14/96	QZO01	Waukegan N Hbr	Yellow Perch	5(F)	8.2	0.2	0.4	0.02K	0.01K	0.01K	0.01K	0.10K
07/16/96	QZO01	Waukegan N Hbr	Yellow Perch	5(F)	7.9	0.2	0.5	0.02K	0.01K	0.01K	0.01K	0.16
10/17/96	QZO01	Waukegan N Hbr	Yellow Perch	5(F)	8.9	0.3	0.5	0.02K	0.01K	0.01K	0.01K	0.18
07/16/96	QZO01	Waukegan N Hbr	Golden Shiner	3(W)	4.3	0.1K	2.5	0.03	0.01	0.01K	0.12	0.59
10/17/96	QZO01	Waukegan N Hbr	Golden Shiner	4(W)	4.2	----	5.0	0.02K	0.01K	0.01K	0.06	1.20
10/17/96	QZO01	Waukegan N Hbr	Fathead Minnow	3(W)	2.8	----	2.1.	0.03	0.01K	0.01K	0.13	1.20
					USFDA Action Level (mg/kg)			0.30	0.30	0.30	5.00	2.00
					Number Above Action Level			0	0	0	0	2

(F) = Fillets
(W) = Whole
* = Value Exceeds USFDA Action Level
K = Actual Value Known to be Less Than Value Reported

Table A7.16 Concentrations of organochlorine compounds in fish samples from the Waukegan Old North Harbor, 1997.

Date Collected	Station Code	Location	Species	No. Fish in Sample	Mean Length (in)	Mean Weight (lbs)	Percent Lipid	Total Chlordane (mg/kg)	Dieldrin (mg/kg)	Heptachlor Epoxide (mg/kg)	Total DDT (mg/kg)	Total PCBs (mg/kg)
07/16/97	QZO01	Waukegan N Hbr	Carp	5 (F)	18.3	3.6	15.0	0.33*	0.03	0.01K	0.99	3.70*
09/19/97	QZO01	Waukegan N Hbr	Carp	1 (F)	19.3	3.8	9.3	0.11	0.02	0.01K	0.22	1.70
07/01/97	QZO01	Waukegan N Hbr	Carp	3 (F)	28.3	12.6	14.0	0.44*	0.11	0.01	0.68	9.20*
07/16/97	QZO01	Waukegan N Hbr	Carp	4 (F)	30.6	14.6	13.0	0.20	0.04	0.01	0.53	2.80*
07/01/97	QZO01	Waukegan N Hbr	Carp	2 (F)	32.8	20.8	24.0	0.60*	0.10	0.02	1.40	7.80*
07/16/97	QZO01	Waukegan N Hbr	Gizzard Shad	5 (W)	8.5	—	6.0	0.06	0.01	0.01K	0.16	0.53
07/16/97	QZO01	Waukegan N Hbr	Gizzard Shad	5 (W)	9.1	—	8.1	0.07	0.02	0.01K	0.17	0.71
07/16/97	QZO01	Waukegan N Hbr	Gizzard Shad	6 (W)	9.8	—	10.0	0.06	0.02	0.01K	0.11	0.80
09/19/97	QZO01	Waukegan N Hbr	Gizzard Shad	1 (W)	17.1	2.1	5.8	0.21	0.03	0.01K	0.04	6.30*
09/19/97	QZO01	Waukegan N Hbr	White Sucker	3 (F)	13.9	1.0	3.0	0.03	0.01K	0.01K	0.06	0.51
					USFDA Action Level (mg/kg)			0.30	0.30	0.30	5.00	2.00
					Number Above Action Level			3	0	0	0	5

(F) = Fillets
(W) = Whole
U = Not Detected
K = Actual Value Known to be Less Than Value Reported
* = Value Exceeds USFDA Action Level

Table A7.17 Concentrations of organochlorine compounds in fish samples from the Waukegan Old North Harbor, 1998.

Date Collected	Station Code	Location	Species	No. Fish in Sample	Mean Length (in)	Mean Weight (lbs)	Percent Lipid	Total Chlordane (mg/kg)	Dieldrin (mg/kg)	Heptachlor Epoxide (mg/kg)	Total DDT (mg/kg)	Total PCBs (mg/kg)
06/01/98	QZO01	Waukegan N Hbr	Carp	5 (F)	28.4	13.0	22.0	0.74*	0.09	0.02	1.70	8.10*
07/08/98	QZO01	Waukegan N Hbr	Carp	5 (F)	18.0	3.2	8.0	0.20	0.02	0.01K	0.26	4.90*
06/01/98	QZO01	Waukegan N Hbr	Carp	5 (F)	20.7	5.0	13.0	0.40*	0.02	0.01K	0.50	7.30*
07/08/98	QZO01	Waukegan N Hbr	LM Bass	5 (F)	13.0	1.3	2.0	0.07	0.01K	0.01K	0.11	1.20
07/28/98	QZO01	Waukegan N Hbr	Bluegill	5 (W)	5.0	--	2.4	0.08	0.01K	0.01K	0.09	1.50
07/28/98	QZO01	Waukegan N Hbr	Green Sunfish	4 (W)	5.8	--	2.0	0.13	0.01K	0.01K	0.11	3.50*
07/28/98	QZO01	Waukegan N Hbr	Spottail Shiner	20 (W)	4.5K	--	2.3	0.05	0.01K	0.01K	0.17	1.00
					USFDA Action Level (mg/kg)			0.30	0.30	0.30	5.00	2.00
					Number Above Action Level			2	0	0	0	4

(F) = Fillets
(W) = Whole
U = Not Detected
K = Actual Value Known to be Less Than Value Reported
* = Value Exceeds USFDA Action Level

APPENDIX 8

Lake Michigan
Water Quality Standards

December 18, 1997

Table A8.1 Lake Michigan Water Quality Standards for Surface Water (Subtitle C, title 35 Ill Admin Code 302.504 and others as noted). (1)

Parameter(2)	units(3)	Basin Wide Aquatic Life Acute	Basin Wide Aquatic Life Chronic	Basin Wide Human Health	Non-Designated Standard	Open Waters
Ammonia-N						
302.535 (tot)	mg/L	15	-	-	-	0.02
(un-ionized)	mg/L	0.33	0.057 Apr-Oct			
		0.14	0.025 Nov-Mar			
Arsenic						
(diss tri)	ug/L	340	148	-	-	-
(tot)	ug/L	-	-	-	-	50(c)
Barium (tot)	mg/L	-	-	-	5.0	1.0(c)
Boron (tot)	mg/L	-	-	-	1.0	-
Cadmium(diss)	ug/L	6.4(a)	3.1(a)	-	-	-
Chloride (tot)	mg/L	-	-	-	500	12
TRC	ug/L	19	11	-	-	-
Chromium						
hexavalent(tot)	ug/L	16	11	-	-	-
trivalent (diss)	ug/L	2300(a)	110(a)	-	-	-
Copper (diss)	ug/L	19(a)	12(a)	-	-	-
Cyanide (weak acid dissociable)	ug/L	22	5.2	-	-	-
Fluoride	mg/L	-	-	-	1.4	-
Iron (diss)	mg/L	-	-	-	1.0	0.30(c)
Lead (diss)	ug/L	120(a)	9.5(a)	-	-	-
(tot)	ug/L	-	-	-	-	50(c)
Manganese(tot)	mg/L	-	-	-	1.0	0.15(c)
Mercury (tot)	ng/L	1700(e)	910(e)	3.1(e)	-	-
		-	-	1.3(e)*	-	-
Nickel (diss)	ug/L	610(a)	68(a)	-	-	-
Nitrate-N	mg/L	-	-	-	-	10(c)
Phosphorus	ug/L	-	-	-	-	7.0

Table A8.1 (Continued) Lake Michigan Water Quality Standards for Surface Water (Subtitle C, title 35 Ill Admin Code 302.504 and others as noted). (1)

Parameter(2)	units(3)	Basin Wide Aquatic Life Acute	Basin Wide Aquatic Life Chronic	Basin Wide Human Health	Non-Designated Standard	Open Waters
Selenium						
(diss)	ug/L	-	5.0	-	-	-
(tot)	ug/L	-	-	-	-	10.0(c)
Sulfate	mg/L	500(b)	-	-	-	24.0
Zinc (diss)	ug/L	160(a)	160(a)	-	-	-
Benzene	ug/L	-	-	310(a)	-	12(d)
Chlordane	pg/L	-	-	250(e)	-	-
Chlorobenzene	mg/L	-	-	3.2(a)	-	470(d)
DDT	pg/L	-	-	150(e)	-	-
		-	-	11(e)*	-	-
Dieldrin	ng/L	240(e)	56(e)	0.0065(e)	-	-
2,4-Dimethylphenol	mg/L	-	-	8.7(a)	-	450(d)
2,4-Dinitrophenol	mg/L	-	-	2.8(a)	-	55(d)
Endrin	ng/L	86	36	-	-	-
Hexachlorobenzene	ng/L	-	-	0.45(e)	-	-
Hexachloroethane	ug/L	-	-	6.7(a)	-	5.3(d)
Lindane	ug/L	0.95(e)	-	0.5(e)	-	0.47(d)
Methylene Chloride	mg/L	-	-	2.6(a)	-	47(d)
Parathion	ng/L	65	13	-	-	-
PCBs	pg/L	-	-	26(e)	-	-
		-	-	120(e)*	-	-
Pentachlorophenol						
pH7	ug/L	8.5(a)	6.5(a)	-	-	-
pH8	ug/L	23	18	-	-	-

Table A8.1 (Continued) Lake Michigan Water Quality Standards for Surface Water (Subtitle C, title 35 Ill Admin Code 302.504 and others as noted). (1)

Parameter(2)	units(3)	Basin Wide Aquatic Life Acute	Chronic	Human Health	Non-Designated Standard	Open Waters
Phenols	ug/L	-	-	-	100	1.0(c)
TCDD	fg/L	-	-	8.6(e)	-	-
				3.1(e)*	-	-
Toluene	mg/L	-	-	51(a)	-	5.6(d)
Trichloroethylene	ug/L	-	-	370(a)	-	29(d)
TDS	mg/L	-	-	-	1000	180
Oil	mg/L	-	-	-	-	0.10(c)
pH 302.503		6.5-9	-	-	-	7-9
Dissolved oxygen 302.502	mg/L	>5	-	-	-	>90%sat
Fecal Coliform 302.505	N/100ml	-	-	200	-	20

Footnotes:

(1) Standards intended to protect waters of the open lake as a drinking water source and to preserve unique background conditions supercede other standards. Nondesignate standards may protect uses of Lake Michigan basin waters beyond human health and aquatic life toxicity in some instances.
(2) (diss) = dissolved ; (tot) = total ; Concentrations without specific notation are total concentrations.
(3) units: mg/L milligrams per liter = parts per million ; ug/L micrograms per liter = part per billion ; ng/L nanograms per liter = parts per trillion ; pg/L picograms per liter = parts per quadrillion ; fg/L femtograms per liter = parts per quintillion.
(a) Standards for cadmium, trivalent chromium, copper, lead, nickel and zinc are expressed as an equation with the value dependent on hardness. The values shown are for hardness of 136 mg/L. The standard for pentachlorophenol is expressed as an equation with the value dependent on pH.
(b) Standards for human health are based on protection from fish consumption and miscellaneous water consumption.
(c) Standards in this category are the drinking water standards of section 302.304 based on protection of human health.
(d) Standards in this category are based on protection of human health from both drinking water and fish consumption exposure taken from the Great Lakes Initiative (GLI).
(e) The substances in this category are "BCCs" (bioaccumulative chemicals of concern).
(e)* Values in this category are based on protection of wildlife.

APPENDIX 9

Waukegan Public Library News Release on Internet Access Computer and Waukegan CAG Fact Sheet

September 5, 1997

Waukegan Public Library

Illinois Environmental Protection Agency to Provide Internet Computer to Waukegan Public Library for Public Access

For Release:
September 5, 1997

Media Contact:
Elizabeth Stearns
Public Relations Coordinator
847-623-2041, ext. 233

Waukegan Public Library
128 N. County St.
Waukegan IL 60085
847-623-2041

Photo Opportunity:
Sept. 5 at 2:30 p.m. at the Waukegan Library

Waukegan, IL—The Waukegan Public Library has received an Internet Public Access Computer as the result of an intergovernmental cooperative agreement with the Illinois Environmental Protection Agency (IPEA) and the Waukegan Harbor Citizens Advisory Group (CAG).

As a result of the grant from the IEPA, library patrons will be able to log-on to the World Wide Web and link to a wealth of environmental information. The library will also provide a web page for CAG, allowing its successful work on the Waukegan Harbor cleanup to be published on the Internet. CAG's Internet address is: http://nsn.nslsilusorg/wkkhome/iepa.

The CAG, comprised of 26 members representing industry, fishing and environmental interests and residents, has been working successfully since 1990 to help solve environmental problems in the Waukegan Harbor area. CAG's web site will also allow them to link to other environmental agencies and citizens groups to exchange valuable information.

"The Waukegan Public Library is honored to be the host-site of this project. The library is also a repository of documents relating to other problem sites. The library also holds the Nuclear Regulatory Commission documents pertaining to the Zion Nuclear plant " states library director, Andrew Stimson.

Chuck Isley III, Chairman of CAG, adds that "Access to the Internet is important for the activities of CAG. The partnership with the Illinois Environmental Protection Agency has been a very positive experience for us. We are working together to make environmental progress on our lakefront. Our challenge now is to maintain the momentum and look for local funding to sustain our efforts".

The library is located at 128 N. County Street, just north of the County Courthouse. For further information call 847-623-2041.

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Waukegan Public Library

Fact Sheet:
Waukegan Harbor Citizens Advisory Group (CAG)

Established in August, 1990 at the request of the Illinois Environmental Protection Agency. This volunteer citizens group is comprised of 26 voting members from local industry, fishing and environmental interests, and residents. CAG holds monthly meetings that are open to the public. Issues identified by CAG as problems are either resolved by the IPEA, if under its jurisdiction or it has found help to enable the committee to deal with the issues head-on. CAG volunteers have tackled many of the issues on their own including:

- Assisted in obtaining access to private property and federal grant funds to install eight groundwater monitoring wells in the area.
- Cosponsored a proposal with the Illinois EPA for a $100,000 federal grant for follow-up monitoring (Stage III) of the harbor. Monitoring of harbor sediments, water , fish and other aquatic life was accomplished in 1996.
- Is participating in marsh bird and amphibian surveys concurrently with other RAPs and the Long Point Bird Observatory in Ontario, Canada.
- Sponsored a used tire collection with the City of Waukegan in which over 3,000 tires were collected.
- Coordinated annual beach cleanups each fall since 1991. In five beach sweeps conducted to date., 14,866 pounds of debris were collected.
- Sponsored household hazardous waste pickup days with Illinois EPA. In a May 20, 1995 event, approximately 1,413 households participated, and 336 55-gallon drums of hazardous material were collected.
- Promoted emergency remedial action at the abandoned Waukegan Paint and Lacquer facility to secure and remove leaking containers of paint, solvent and other materials.
- Encouraged an emergency remedial action at an area near the harbor known as the "Waukegan Tar Pit". Actions were taken to remove and secure free tar, protecting wildlife from becoming entrapped.
- Provided outreach and educational activities through tours of the area and presentations to schools and other groups. Videos of the Waukegan Harbor RAP prepared by Illinois EPA have been made available to groups and are available for loan at the Waukegan Public Library.
- Contacted local, state, and federal legislators to gain political support for local issues, including additional maintenance dredging of the harbor by the U.S. Army Corps of Engineers.
- Established a home page on the Internet to provide information on local environmental issues: http://nsn.nslsilus.org/wkkhome/iepa
- Together with the Illinois EPA provided an Internet computer to the Waukegan Public Library for public access.

TO LEARN MORE ABOUT OUR ACTIVITIES TO PROTECT AND RESTORE OUR LAKE MICHIGAN ENVIRONMENT

VISIT US ONLINE

AT

http://www.nsn.org/wkkhome/iepa

Waukegan Harbor Citizens Advisory Group (CAG)
P.O. Box 91
Waukegan, Illinois 60079

APPENDIX 10

IEPA
Waukegan Brownfield
Assessment Update

November, 1998

State of Illinois
ENVIRONMENTAL PROTECTION AGENCY

Mary A. Gade, Director

2200 Churchill Road, Springfield, IL 62794-9276

WAUKEGAN CAG
BROWNFIELD ASSESSMENT UPDATE
November 1997

The Illinois Environmental Protection Agency (Illinois EPA) will perform a Phase II Site Assessment on three different properties recommended by the Waukegan CAG for Brownfields Redevelopment. In a limited Phase II Assessment, the Illinois EPA conducts environmental sampling, collecting any or all of soil sediments, groundwater or surface water samples. The Illinois EPA then determines if contaminants exceed acceptable levels established by the Environmental Protection Act. These assessments are limited because they do not define vertical or horizontal extent of contamination.

The assessments are a part of the Brownfields Initiative for the Waukegan Expanded Study Area. Illinois EPA started negotiations with property owners to obtain access agreements on the initial group of candidate sites, (Alloy Engineering, Burt Diamond Scrap Yard Offices, and Manny-Winston), but a variety of problems prevented initial assessments. The Illinois EPA is currently investigating the possibility of two sites for brownfields redevelopment. Following is a brief description of each site studied and potential candidate sites for the Brownfields Redevelopment Grant:

WAUKEGAN GAS STATION (Clayton & Sheridan)
A limited Phase II site assessment will be conducted on this property the week of November 17 - 21 by the Illinois EPA. Results of the soil and groundwater samples will be available in the Spring. This parcel of property is envisioned to be part of a theater complex in the City of Waukegan redevelopment plan.

GENESSEE (DRYCLEANERS) (21 - 27 South Genessee)
The Illinois EPA has conducted "walk-through" site inspections on two occasions. As soon as the building on site is demolished and demolition debris is removed from the property, Illinois EPA will return and conduct a limited Phase II Assessment. As of November 13, it appeared that a site assessment will be conducted in early Spring 1998.

MANNY-WINSTON (Pershing Road)
Illinois EPA began discussions with the City of Waukegan and the property owner last Spring. Initially, the property owner expressed a desire to cooperate with the Illinois EPA. However, the property owner and attorney changed their minds and for two months, the Illinois EPA negotiated with the property owner and attorney. The Illinois EPA is not pursuing an assessment at this site.

BURT DIAMOND SCRAP YARD OFFICES (Old Feed Mill) (Water Street)
Dexter Corporation became interested in redeveloping this property and submitted an offer to the property owner in the fall of 1997. However, the property owner rejected Dexter's offer and the counter offer was reportedly much higher than the assessed value. Consequently, negotiations have stalled and CAG is seeking another brownfield site to replace this site.

ALLOY ENGINEERING (North Shore Gas South Plant)
North Shore Gas has entered into the Illinois EPA Site Remediation Program (voluntary program) Consequently, the Illinois EPA is not pursuing a redevelopment assessment at this time.

A status report providing results of investigations for these sites will be provided to the CAG next Spring.

APPENDIX 11

Marsh Bird and Amphibian Communities in the Waukegan Harbor AOC

1995 - 1996

Marsh Bird and Amphibian Communities in the Waukegan Harbor AOC, 1995 - 1996

Purpose of the MMP

The Marsh Monitoring Program (MMP) was established to provide a baseline survey of marsh bird and amphibian populations and their habitats in marshes within the Areas of Concern (AOCs) in the Great Lakes basin, at sites where rehabilitation and restoration efforts have taken place or are planned in the AOCs, and in many other sites across the Great Lakes basin. Marsh bird surveys were first undertaken in the Canadian and binational AOCs in 1994. In 1995, the program expanded to include surveys of calling amphibians. Over 300 volunteers have surveyed marsh bird and amphibian populations and their habitats under the MMP to date. Information on the abundance and diversity of these species provides useful, and fairly easily obtainable, indicators of habitat quality, structure and areal extent.

Purpose of this Report

This report summarizes the results of the MMP surveys in the Waukegan Harbor AOC in 1995 and 1996. It also explains the set of indicators used by the MMP to assess marsh quality and describes the significance of the MMP's results for the Waukegan Harbor AOC within the context of this set of indicators.

Indicator Species

The presence of the following suite of marsh bird and amphibian species indicates high quality marsh habitat.

A ✓ indicates those found in the Waukegan Harbor AOC marshes.

Birds

- Pied-billed Grebe
- ✓ American Bittern
- Least Bittern
- ✓ Blue-winged Teal
- Black Tern
- American Coot
- Common Moorhen
- C. Moorhen/A. Coot
- Virginia Rail
- ✓ Sora
- Common Snipe
- Marsh Wren

Amphibians

- Bullfrog
- ✓ Leopard Frog
- ✓ Chorus Frog
- Mink Frog
- ✓ Spring Peeper

Highlights of the MMP's Waukegan Harbor Results

- In 1995, one route was monitored for marsh birds in the Waukegan Harbor AOC. In 1996, 5 routes were monitored for amphibians; no marsh bird surveys were conducted. A total of 5 amphibian routes and one marsh bird route have been established in the Waukegan Harbor AOC.
- The number of species of calling amphibians ranged from 2 to 4 per route. Overall, 5 species were recorded — a moderate level of diversity.
- Three of the 5 amphibian indicator species were present in the AOC. Chorus frog scored above average in abundance, northern leopard frog abundance scored as average and spring peeper abundance scored below average.
- Thirteen species of marsh nesters, 4 water foragers and 5 air foragers were recorded in the Waukegan Harbor AOC — again a moderate level of diversity. Densities of 10 marsh nesting species were greater than the Great Lakes basin non-AOC averages.
- In total, 3 marsh bird indicator species were present in the Waukegan Harbor AOC. Blue-winged Teal abundance scored above average; the abundances of American Bittern and Sora scored as average.
- The marsh nesting bird diversity scored above average and marsh bird indicator species abundance scored as average in the AOC. Both the amphibian diversity and amphibian indicator species diversity scored below average. It would appear that, overall, the Waukegan Harbor AOC is not impaired in terms of its ability to support healthy marsh bird and amphibian communities.

MMP Methods

Table 1. Marsh Monitoring Program Survey Methods.

Survey	Time commitment	Skills Required	Survey Duration	Weather Conditions
Birds	2 evenings, 10 days apart, between May 20 and July 5	ability to identify about 50 common birds	10 minutes at each station	warm, dry weather with little or no wind
Amphibians	3 nights, 15 days apart, between April 1 and July 15	ability to learn about 10 frog calls	3 minutes at each station	warm, wet weather with little or no wind

A route, consisting of up to 8 semi-circular stations (100 m radius for marsh birds and unlimited distance for amphibians), is established in each marsh being surveyed. Stations are usually accessed on foot, but can be surveyed by canoe or boat. Marshes must be a minimum of 2 hectares and if very large, may support more than one route. The stations must be 500 m apart for amphibian surveys and 250 m apart for bird surveys. The number of marsh birds heard calling or seen in the station are recorded. At amphibian stations, one of three Call Level Codes is used to record calling intensity of each species; abundance estimates are also made. Each MMP volunteer is provided with a training kit which fully explains the survey methods. The kit also includes a copy of the MMP Training Tape which aids volunteers in learning the songs and calls of the common marsh birds and amphibians. For further information on the methods, please refer to the 1997 edition of the *MMP Training Kit and Instructions for Surveying Marsh Birds, Amphibians And Their Habitats*, which is available from the Long Point Bird Observatory.

MMP in Waukegan Harbor

In 1995, one route was monitored for marsh birds in the Waukegan Harbor AOC; no amphibian surveys were conducted. In 1996, 5 routes were monitored for amphibians; no marsh bird surveys were conducted. A total of 5 amphibian routes and one marsh bird route have been established in the Waukegan Harbor AOC.

Habitat rehabilitation projects have been initiated in the Waukegan Harbor AOC which address loss of marsh habitat. This site was not monitored under the MMP in 1995 or 1996. There are no additional marshes in the Waukegan Harbor AOC where survey routes could be established. However, on existing routes a complementary marsh bird or amphibian survey would permit a more definitive analysis of the AOC's wetland-dependent wildlife. Volunteer recruitment to fill these needs is ongoing.

Table 2. Marsh Monitoring Program Routes in the Waukegan Harbor AOC.

Year	Route Type	# Routes	# Volunteers
1995	Amphibian	0	0
	Bird	1	1
	Both	0	0
1996	Amphibian	5	3
	Bird	0	0
	Both	0	0
Total	Amphibian	5	3
	Bird	1	1
	Both	0	0

To become involved, please contact the MMP Coordinator, Long Point Bird Observatory at (519) 586-3531 (phone), (519) 586-3532 (fax) or by email at aqsurvey@bsc-eoc.org

Results

The marshes in the Waukegan Harbor AOC were mainly co-dominated by grass/sedge and cattail. Rush/bulrush, common reed and purple loosestrife occurred as co-dominate species in several sample areas. Horsetail, pickerel weed, arrowhead, water plantain and water willow were present in a few sample areas.

The number of species of calling amphibians ranged from 2 to 4 per route (Table 3). Overall, 5 species were present — a moderate level of diversity. Three of the 5 amphibian indicator species were present in the AOC (Table 3). Chorus frog was recorded in high levels (Call Level Code 3). American toad and northern leopard frog were present in moderate levels (Call Level Code 2). Pickerel frog and spring peeper were present in low levels (Call Level Code 1). American toad and chorus frog were present in all 5 marshes sampled. Northern leopard frog was present in 3 of the marshes; pickerel frog and spring peeper were only present in one of the marshes.

Thirteen species of marsh nesters were recorded in the Waukegan Harbor AOC (Table 4) — again a moderate level of diversity. In total, 3 marsh bird indicator species were recorded in the Waukegan Harbor AOC: American Bittern, Blue-winged Teal and Sora (Table 4). Densities of 10 marsh nesting species were greater than the Great Lakes basin non-AOC averages. Red-winged Blackbird was the most abundant species present. Other common species included Common Grackle, Mallard, Song Sparrow and Blue-winged Teal.

Four species of water foragers and 5 air foragers were recorded in the AOC (Table 4). Great Blue Heron was the most common water forager and Barn Swallow was the most common air forager. The densities of the foragers present in the sample areas were greater than the Great Lakes basin non-AOC averages.

Conclusions

Blue-winged Teal abundance scored above average; the abundances of American Bittern and Sora scored as average (Table 5). Chorus frog scored above average in abundance, northern leopard frog abundance scored as average and spring peeper abundance scored below average (Table 5).

The marsh nesting bird diversity scored above average in the Lakeview Ridge Marsh and marsh bird indicator species abundance scored as average (Table 6). Amphibian diversity scored below average in all of the marshes sampled (Table 6). The amphibian indicator species diversity scored as average in the Dahringer Marsh and the NSSD, Adid Wetland #191m (Table 6); the other marshes had lower than average amphibian indicator species diversity. Overall, both the amphibian diversity and amphibian indicator species diversity scored below average (Table 6).

The Waukegan Harbor AOC did not contain the full complement of expected marsh bird or amphibian species in the expected numbers. Nonetheless, it would appear that, overall, the Waukegan Harbor AOC is not impaired in terms of its ability to support healthy marsh bird and amphibian communities (Table 6).

Recommendations

Efforts should be made to continue to rehabilitate marsh habitat and to monitor marsh bird and amphibian populations to properly address loss of habitat in the Waukegan Harbor AOC. MMP routes should be established in all marshes and any marsh rehabilitation projects. Complementary amphibian and marsh bird surveys should be conducted on all routes.

Table 3. Amphibian species composition and abundance (maximum Call Level Code [1]) in the Waukegan Harbor AOC in 1995 and 1996. Shading denotes indicator species.

Amphibian Species	Dahringer Marsh	Hosah Prairie Main Trail Marsh	IBSP - NU Railroad Tracks Marsh	NSSD, Adid Wetland #191m Marsh	Waukegan, Com Ed Marsh
American Toad	2	1	2	1	2
Chorus Frog	3	3	3	3	3
Northern Leopard Frog	1	—	2	1	—
Pickerel Frog	—	—	1	—	—
Spring Peeper	—	—	—	—	1

[1] Call Level Code 1: Individuals can be counted; calls not simultaneous. Call Level Code 2: Calls distinguishable, some simultaneous calling. Call Level Code 3: Full chorus; calls continuous and overlapping.

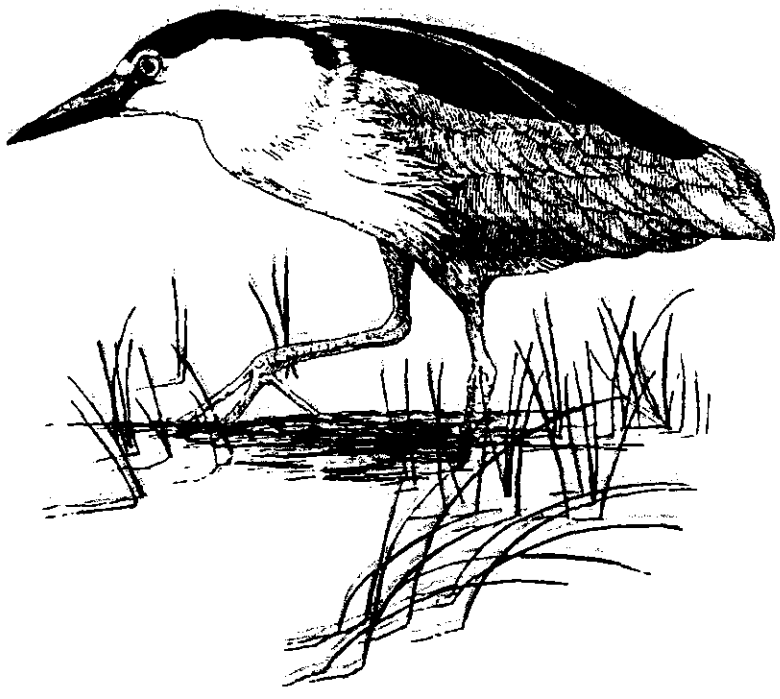


Table 4. **Marsh bird species composition and abundance (mean number per 10 stations) in the Waukegan Harbor AOC in 1995 and 1996. Shading denotes indicator species and "p" indicates that a species was present only outside of the sample stations.**

Marsh Bird Species	Lakeview Ridge Marsh	Waukegan Harbor AOC Mean	Great Lakes Basin Mean
Marsh Nesters			
American Bittern	1.7	1.7	0.8
Blue-winged Teal	13.3	13.3	1.0
Canada Goose	3.3	3.3	4.2
Common Grackle	30.0	30.0	6.8
Common Yellowthroat	11.7	11.7	6.3
Eastern Kingbird	3.3	3.3	1.5
Mallard	30.0	30.0	5.7
Red-winged Blackbird	60.0	60.0	49.2
Song Sparrow	15.0	15.0	5.1
Sora	1.7	1.7	1.1
Swamp Sparrow	1.7	1.7	11.1
Willow Flycatcher	1.7	1.7	0.5
Yellow Warbler	p	p	6.7
Water Foragers			
Black-crowned Night-Heron	p	p	0.4
Belted Kingfisher	3.3	3.3	0.5
Green Heron	p	p	0.4
Great Blue Heron	5.0	5.0	1.5
Air Foragers			
Barn Swallow	60.0	60.0	10.3
Chimney Swift	8.3	8.3	1.0
Common Nighthawk	15.0	15.0	0.3
N. Rough-winged Swallow	41.7	41.7	1.7
Purple Martin	15.0	15.0	2.2

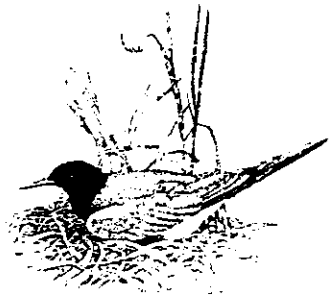


Table 5. Assessment of the status of individual species abundance in the Waukegan Harbor AOC in 1995 and 1996. "-" denotes values below the non-AOC average. "0" denotes values within the non-AOC average. "+" denotes values above the non-AOC average. Blank indicates that the species was not present and "p" indicates that a species was present only outside of the sample stations.

	Marsh Bird Indicator Species												Amphibian Indicator Species				
Marsh Name	AMBI	AMGO	BLTE	BWTE	COMO	COSN	LEBI	MAWR	MODT	RBGR	SORA	VIRA	BULL	CHFR	NLFR	MIFR	SPPE
Dabringer Marsh														0	0		
Hosah Prairie Main Trail Marsh														+			
Lakeview Ridge Marsh	00			+							00						
IBSP - NU Railroad Tracks Marsh														+	0		
NSSD, Acid Wetland #191m Marsh														0	0		
Waukegan, Com Ed Marsh														0			0
Waukegan Harbor Overall Assessment	0			+							0			+	0		—

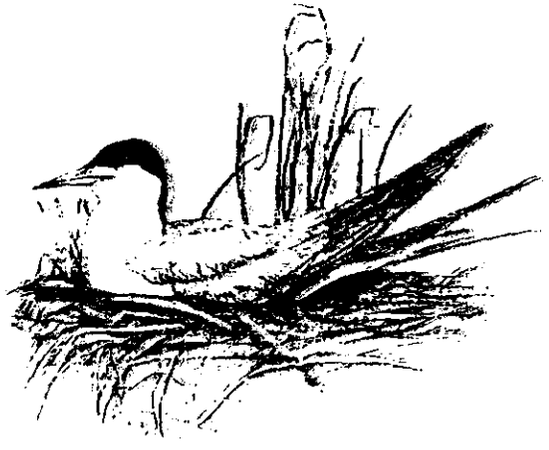


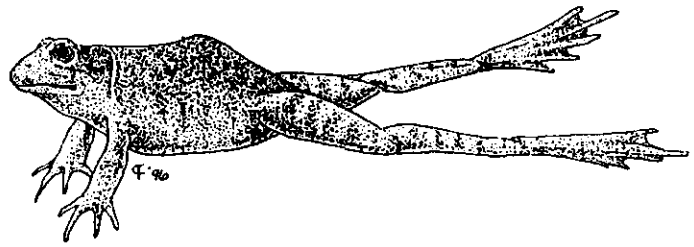
Table 6. Status of Waukegan Harbor AOC Marshes in 1995 and 1996 [1]. "-" denotes values below the non-AOC average. "0" denotes values within the non-AOC average. "+" denotes values above the non-AOC average.

					Assessment of Marsh Bird and Amphibian Species Diversity				
Marsh Name[2]	**Latitude/ Longitude**	**Survey Type**	**Year**	**Number of Stations**	**Marsh Nesting Bird Diversity**	**Marsh Bird Indicator Species Diversity**	**Amphibian Species Diversity**	**Amphibian Indicator Species Diversity**	**Overall Assessment[3]**
Dahringer Marsh N, Small	42°25'00" 87°50'00"	Amph	96	2			—	0	1
Hosah Prairie Main Trail Marsh C, Medium	42°30'00" 88°00'00"	Amph	96	5			—	—	0
IBSP - NU Railroad Tracks Marsh C, Medium	42°30'00" 87°50'00"	Amph	96	5			—	—	0
Lakeview Ridge Marsh C, Medium	42°23'24" 87°49'19"	Bird	95	6	+	0			3
NSSD, Adid Wetland #191m C, Small	42°25'00" 87°50'00"	Amph	96	2			—	0	1
Waukegan Com Ed Marsh N, Tiny	42°25'00" 87°50'00"	Amph	96	1			—	—	0
Waukegan Harbor Overall Assessment					+	0	—	—	3

[1] See the Marsh Monitoring Program's 1997 Final Technical Report for a detailed description of the scoring system.

[2] R = rehabilitation site, C = coastal, N = nearshore, I = inland. Tiny (2 - 2.5 ha), Small (2.5 - 5 ha), Medium (5 - 25 ha), Large (25 - 50 ha), Huge (>50 ha).

[3] A score of 0, 1 or 2 indicates impairment, a score of 3, 4 or 5 indicates no apparent impairment and a score of 6, 7 or 8 indicates an above average marsh.



Volunteer Efforts

Four participants contributed over 72 person hours in 1995 and 1996 to the program. In addition, many volunteer hours on non-AOC routes were required to produce results which were used for comparison purposes. Our thanks go to the dedicated participants who conducted the Waukegan Harbor surveys: Russ Hendricks, Kathy Jones, Sandy Kubillus and Pat Slusser.

The MMP is a joint program of Environment Canada (Canadian Wildlife Service and Great Lakes 2000 Cleanup Fund) and Long Point Bird Observatory, with considerable financial support from the Great Lakes Protection Fund. Additional funding for the development of these reports was provided by the Laidlaw Foundation.

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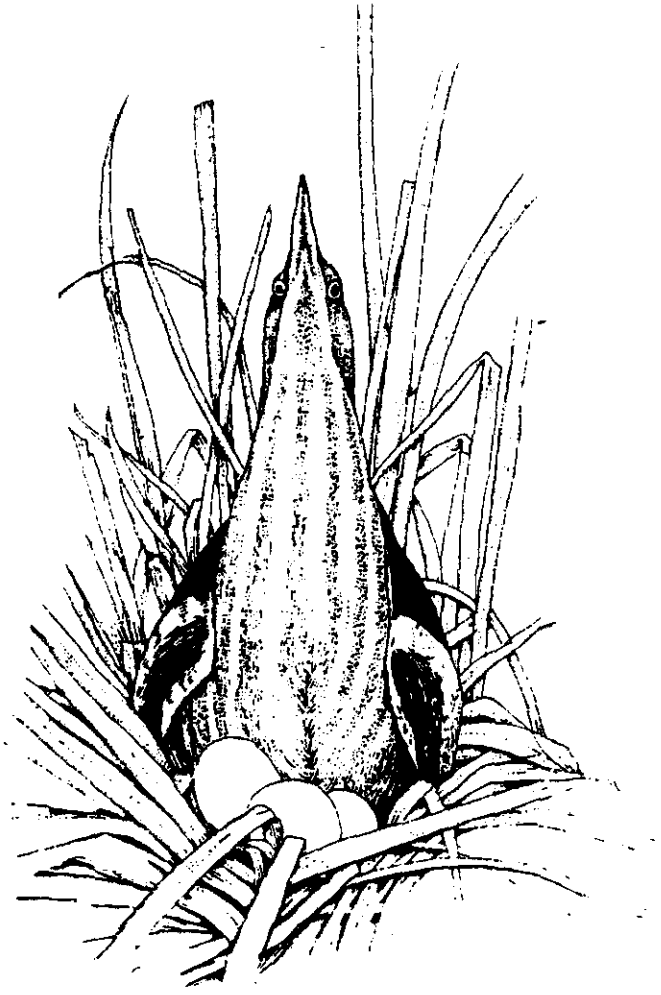

CONTEXT FOR MARSH MONITORING PROGRAM AREA OF CONCERN SUMMARY REPORTS

The information gained through the Marsh Monitoring Program (MMP) will fill the need for baseline data on the habitat associations and population trends of Great Lakes marsh bird and amphibian species. In Areas of Concern (AOCs), such information can help develop effective strategies, implement restoration projects and measure the success of these efforts. The information from the program can also contribute to the process of considering specific AOCs for delisting, specifically in terms of marsh bird and amphibian presence and abundance. However, although the MMP is intended to provide information toward evaluating the status of marshes within AOCs, the MMP should serve as a complementary source of information along with other assessment schemes and other perspectives on the function and integrity of AOC wetlands. The MMP does not provide an overall health judgement for all habitat types, or even for all marshes in surveyed AOCs; the scores presented should be viewed as preliminary indications of marsh bird and amphibian habitat function, particularly in AOCs with few survey routes.

Method of analysis

Based on input from several experts in marsh bird and amphibian ecology (i.e. Bird Studies Canada staff, Environment Canada staff and others), a set of amphibian and marsh bird species were selected to serve as indicators (i.e., surrogate measures) of marsh function and habitat provision. Because many of these relationships are only poorly understood, identification of these species must be considered preliminary. Along with other research programs, data collected under the MMP protocol will help clarify these relationships. Species selected as indicators were identified based on the following criteria:

- each species was sufficiently common to make detection likely
- each species was dependent on marshes for breeding, particularly marshes with a mix of open water and herbaceous vegetation and with a fairly diverse set of plant species
- each species required relatively undisturbed habitat conditions (e.g., habitats with few invasive species and low toxin levels)
- species that were known or suspected to be suffering from population declines were selected preferentially
- for amphibians: the set of species contained both early- and late-season callers

Because consideration of entire species communities can be extremely complex, other means are often necessary to describe species assemblages. Species diversity, defined in these reports in terms of the number of species present, scaled to sampling effort, was used in these reports as a descriptor of amphibian and marsh bird communities. Four measures of species diversity were calculated:

- all marsh nesting birds
- marsh bird indicators only
- all amphibian species
- amphibian indicators only

Calculations of each diversity measure were based on the total number of species detected on each station within each year. Each measure was expressed as the average species richness per station per year.

Scoring of AOCs

As part of the MMP contribution to assessing AOC marshes, a ranking system was developed that considered the amphibian and marsh bird occurrence in surveyed marshes within each AOC relative to that recorded in other marshes in the same lake basin (referred to as non-AOC marshes). Because the MMP-based evaluations are

currently based on only two years of data, the scoring system summarized below should be considered preliminary, particularly for those AOCs that received only minimal survey coverage (see individual AOC reports).

Surveyed marshes in each AOC were scored relative to the average for non-AOC marshes in the same lake basin. Scoring was done with respect to each of a series of dependent variables: the frequency of occurrence of each indicator species, and the four community descriptors described above. Expected values for each dependent variable were generated based on data from non-AOC marshes in each lake basin. Surveyed marshes in each AOC were then rated in terms of the difference between the expected values and the values observed in the AOC marshes. Surveyed marshes within each AOC were scored as below (impaired), above (healthy), or similar to (not impaired) the average in non-AOC marshes in the same lake basin. Use of the terms "impaired", "not impaired" and "healthy" in this context does not refer to the status of fish and wildlife beneficial uses as determined by the RAP process. The impairment refers only to the apparent ability of the surveyed marshes in an AOC to support diverse marsh bird and amphibian populations. Again, the scores presented should be viewed as the best approximations currently possible, particularly in AOCs with few survey routes.

Marshes throughout the Great Lakes basin, including 36 of the 43 AOCs, were surveyed. When scored relative to the average species richness of non-AOC marshes in the same lake basin, 22 received a provisional classification as impaired, 12 as not impaired (i.e. having no apparent impairment) and two were rated healthy. Among the Canadian AOCs, only Wheatley Harbour was not surveyed; among U.S. AOCs, Ashtabula River, Buffalo River, Grant Calumet River (Indian Harbor Canal), Menominee River, Milwaukee Estuary, and Sheboygan River were not surveyed under the MMP.

Surveyed marshes in the AOCs listed below are scored as healthy with respect to species diversity. This means that, overall, the surveyed marshes in the AOC scored above the average of surveyed non-AOC marshes in the lake basin in terms of the number of species present. The scoring cannot be used to evaluate all habitat types or even all marshes in the AOC, but does provide an overview or snapshot of the status of marsh habitat in the AOC relative to the lake basin.

- Oswego River, Severn Sound

Surveyed marshes in the AOCs listed below are scored as not impaired. This means that, overall, the surveyed marshes in the AOC scored similar to the average of surveyed non-AOC marshes in the lake basin in terms of the number of species present. As above, the scoring is intended as an overview of marsh habitat in the AOC relative to that of the lake basin.

- Black River; Fox River/Lower Green Bay; Maumee River; Muskegon Lake; Peninsula Harbour; Rochester Embayment; Saginaw River; St. Lawrence River; St. Marys River; Thunder Bay; Torch Lake; Waukegan Harbour

Surveyed marshes in the AOCs listed below are scored as impaired. This means that, overall, the surveyed marshes in the AOC scored below the average of surveyed non-AOC marshes in the lake basin in terms of the number of species present. As above, the scoring is intended as an overview of marsh habitat in the AOC relative to that of the lake basin.

- Bay of Quinte; Clinton River; Collingwood Harbour; Cuyahoga River; Deer Lake/Carp Creek; Detroit River; Eighteen Mile Creek; Hamilton Harbour; Jackfish Bay; Kalamazoo River; Manistique River; Metro Toronto; Niagara River; Nipigon Bay; Port Hope; Presque Isle Bay; River Raisin; Rouge River; Spanish River; St. Clair River; St. Louis Bay/River; White Lake