THE SHEBOYGAN RIVER

REMEDIAL ACTION PLAN

Wisconsin Department of Natural Resources
Southeast District Headquarters

Wisconsin Department of Natural Resources Board

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July 31, 1989

IN REPLY REFER TO: 8250

To the Citizens of the Sheboygan Area:

I am pleased to approve the Sheboygan River Remedial Action Plan as part of Wisconsin's Water Quality Management Plan. The plan is an important contribution to Great Lakes cleanup. It is also an important step in the long-term effort of the communities, industries, and citizens of the area to restore and protect this valuable state resource.

The Wisconsin Department of Natural Resources in conjunction with the International Joint Commission and the United States Environmental Protection Agency have targeted the Lower Sheboygan River and Harbor and nearshore Lake Michigan as one of 42 Great Lakes Areas of Concern.

Within the Area of Concern, impairment of the beneficial uses of the water resources has occurred as a consequence of the introduction of pollutants. These pollutants include polychlorinated biphenyls (PCB's) and other

Harbor. All of these groups worked together to identify management goals for the harbor and river for the year 2000. The plan's goals call for: 1) Providing a fishery and ecosystem that is free from the effects of toxic contamination, 2) maintaining diverse communities of aquatic and terrestrial life, 3) controlling eutrophication, and 4) enhancing recreational uses of the harbor. The attainment of these goals is a worthwhile endeavor.

Judging by the response at the public hearing and the commitment of those that contributed to the preparation of the plan, there is great opportunity to achieve the water quality goals laid out in the plan. The plan incorporates the updating requirements of Public Law 92-500 as amended by Public Law 95-217 and as outlined in Federal Regulations 40 CFR, Part 35. This planning document is governed by the process for adoption of areawide water quality management plans as set forth in NR 121.08(1)(a) and (b).

Sincerely,

C. D. Besadny
Secretary

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ACKNOWLEDGEMENTS

Many people have contributed information and comments in the development of this Remedial Action Plan. Among those that have contributed to this effort are the Sheboygan Water Quality Task Force, the Sheboygan River and Harbor Interagency Technical Advisory Committee, and the WDNR Workgroup for the Sheboygan River Project. We appreciate their contribution on the plan and welcome further input from these and other groups during the implementation phase of the plan.

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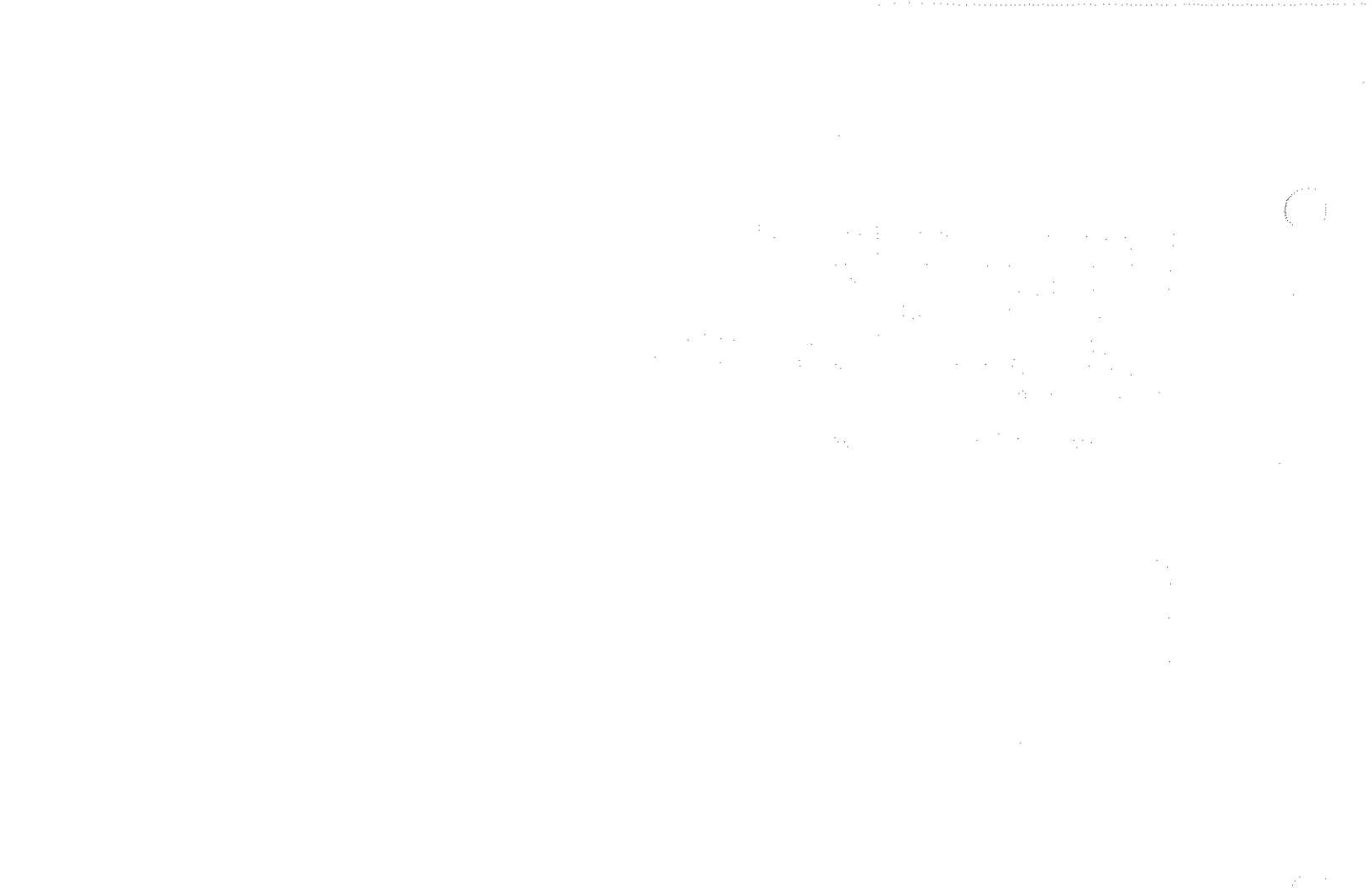


I. SUMMARY

Pollutants are often a major problem around municipal and industrial centers on the tributary rivers and harbors of the Great Lakes. The Lower Sheboygan River and harbor has been identified as an Area of Concern (AOC) where there is an impairment of the beneficial uses of the water resources as a consequence of the introduction of pollutants (Figure II.1). These pollutants include polychlorinated biphenyls (PCBs) and other chlorinated organic compounds, heavy metals, phosphorus, nitrogen, suspended solids, and fecal coliform. Examples of impaired uses that have resulted include waterfowl and fish consumption advisories, degradation and loss of habitat, dredging restrictions, reduced swimming opportunities, and accelerated eutrophication.

Primary sources of pollution are those which manufacture, use, or produce the materials which subsequently become pollutants. Sources of pollution include municipal treatment plants, industries, and agricultural and urban runoff.

Polychlorinated biphenyls contained in the sediment are the most widespread and environmentally significant contaminant in the AOC based on current data. Their presence is primarily attributable to industrial sources.

Heavy metal contamination is also of concern in the AOC. Potential sources of these parameters will be identified by the Sheboygan River and Harbor Superfund Project.

Conventional pollutants of concern in the Sheboygan area are phosphorus, nitrogen, suspended solids, and fecal coliform. They are routinely monitored in private and public wastewater discharges in the AOC and are also

of Sheboygan, Sheboygan County) agencies will need to be actively involved. Close cooperation from private industry is also critical to the successful attainment of these goals.

Many individual and site-specific remedial actions have been recommended. These actions will ultimately provide for the control of toxic sources, clean-up of in-place pollutants, protection of wetlands, reduction of bacteria levels, increased public understanding of the goals of this plan, and continued public participation and citizen involvement throughout the implementation of the remedial actions.

The Remedial Action Plan will be updated in order to monitor the status of ongoing work and refine remedial action steps. Ongoing investigations are scheduled to be completed by mid-1991. At that time, the Sheboygan Remedial Action Plan update will specify the selected method of remediation along with a final schedule of implementation.

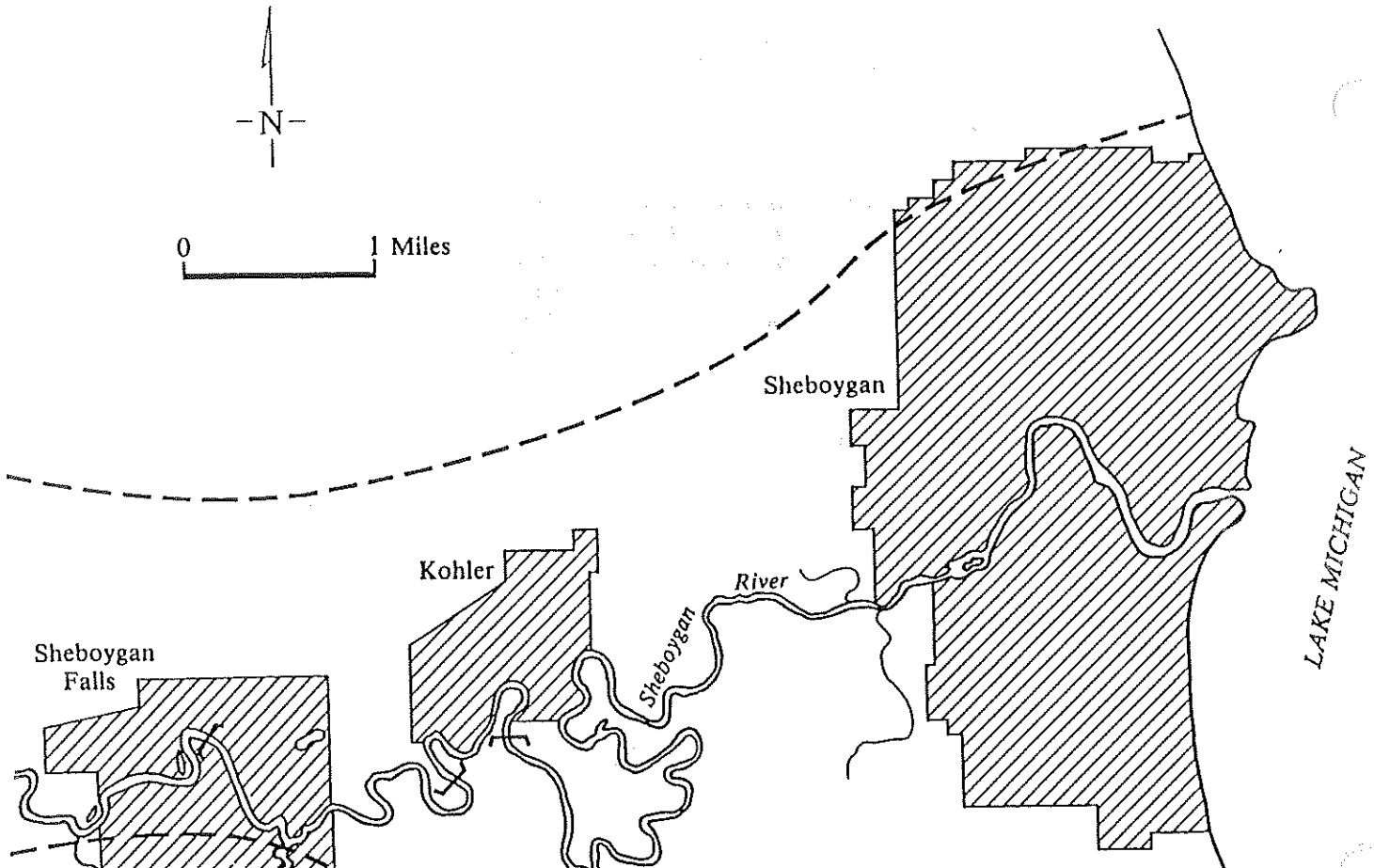
II. INTRODUCTION

BACKGROUND

The State of Wisconsin's Department of Natural Resources (WDNR) in conjunction with the International Joint Commission (IJC) and the United States Environmental Protection Agency (U.S. EPA) have targeted the Lower Sheboygan River and Harbor as an Area of Concern (AOC) for remedial action (Figure II.1). Through the IJC, Canada and the United States cooperatively resolve problems associated with the Great Lakes. Areas of Concern include major urban and industrial centers on Great Lakes rivers, harbors and connecting channels where beneficial uses are impaired. Toxic contamination is often a major problem in these areas. Sheboygan is one of the 42 Great Lakes AOCs and one of four AOCs in Wisconsin.

The Remedial Action Plan is one of several efforts underway which are working to correct water quality problems in the Sheboygan Basin. Other concurrent efforts include the Onion and Sheboygan River Priority Watershed Projects and the Water Quality Management Plan for the Sheboygan River Basin being developed by the WDNR (Meyer 1988), and Remedial Investigations and Feasibility Studies being conducted for the Kohler Co. landfill and the Sheboygan River and Harbor under guidance of U.S. EPA's Superfund Program.

The Sheboygan River Basin Water Quality Management Plan identifies water quality goals, problems, improvements, and management needs for the lakes and streams in the entire basin. This plan also examines existing and future wastewater treatment facility management needs. The Remedial Action Plan will


N
0
1 Miles
Sheboygan
Kohler
Sheboygan
River
Sheboygan
Falls
LAKE MICHIGAN

The Kohler Company landfill was proposed for inclusion in the Superfund National Priorities List in September 1983 and it was placed on the list in September 1984. Kohler Company is currently conducting a Remedial Investigation and Feasibility Study at this site.

The public is also aware of the Sheboygan River and harbor contamination. In 1984, the Sheboygan County Water Quality Task Force was created by citizens who were concerned about the effects of pollution on recreational and economic development in the AOC. The Task Force is composed of members from industry, government, fishing and conservation groups, and others. The WDNR selected the Task Force to be the citizens advisory committee for development of the Sheboygan River Remedial Action Plan (RAP).

The Task Force has facilitated informational exchange sessions between environmental agencies and the public. Results from a questionnaire which was distributed by the Sheboygan County Water Quality Task Force to the local community indicated that fishing, swimming, and canoeing would be more desirable if the Sheboygan AOC were cleaned up. A marina in the harbor is also desired whether the area is cleaned up or not. (See Appendix F for more information on public participation.)

PURPOSE

The IJC requested the WDNR to prepare a Remedial Action Plan (RAP) which will identify specific management strategies to control existing sources of pollution, abate environmental contamination already present, and restore beneficial uses in the AOC. As defined in the Water Quality Agreement between

I. *Protect the ecosystem (including humans, wildlife, fish and other organisms) from the adverse effects (reproduction, survival, and health of individuals and the integrity of interspecies relationships) of toxic substances.*

II. *Maintain diverse communities of aquatic and terrestrial life.*

III. *Control eutrophication (nutrient enrichment of water) for the protection of Lake Michigan.*

IV. *Enhance recreational uses of the harbor.*

Specific Objectives of this plan are:

1. Describe the existence and extent of contamination due to chlorinated organic compounds, heavy metals, and others in the AOC (the emphasis will be on in-place pollutants, specifically polychlorinated biphenyls);

2. Describe the problems the contaminants pose to ecosystem health, public health, recreational uses, and economic development in the AOC;

3. Discuss alternatives for remediation; and

4. Provide a timetable and identify programs and agencies for implementation and remediation.

III. ENVIRONMENTAL SETTING

LOCATION

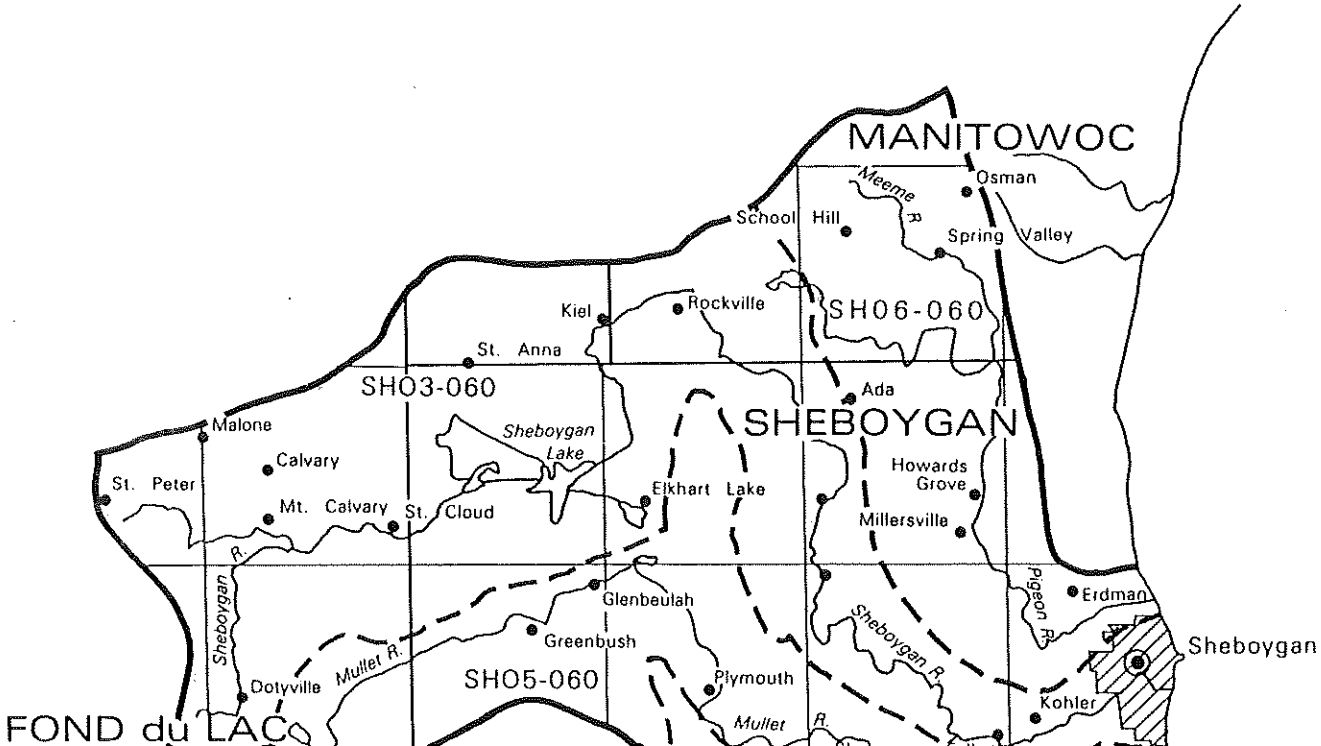
The Area of Concern (AOC) (and impacted area, as defined by IJC) encompasses the lower Sheboygan River downstream from the Sheboygan Falls Dam including the entire harbor and nearshore Lake Michigan (Figure II.1). The Sheboygan harbor consists of an outer harbor formed by two breakwalls and an inner harbor which extends from the Coast Guard station upstream to Jefferson Avenue. The source area, which is the area from which pollutants are generated, is the entire Sheboygan River Basin which includes three watersheds: the Sheboygan River mainstem, Mullet River, and Onion River (Figure III.1). The Onion and Mullet Rivers are direct tributaries to the Sheboygan River mainstem and contribute some point, but principally nonpoint sources of pollution to the AOC. Pollutants to the Sheboygan River mainstem watershed, above the Sheboygan Falls Dam, are also mainly from nonpoint sources.

Communities along the AOC in Sheboygan County include the City of Sheboygan, the Village of Kohler and the City of Sheboygan Falls with 1986 populations of approximately 48000, 2000, and 6000 respectively.

NATURAL FEATURES

Drainage Basin Size

Sheboygan River Basin (with watersheds)



Back water (seiche) effects of Lake Michigan can occur in the harbor and cause rapid rises in water levels and temporarily reverse river flow.

Soil types, runoff, erosion

Soils in the eastern third of the Sheboygan River Basin are primarily heavy clay soils intermixed with sands, silts, and gravels. Agricultural and urban runoff is fostered by these soil types. A more detailed discussion of erosion problems and erosion control techniques will be provided in the Sheboygan River Nonpoint Source Control plan which will be available in 1990. Erosion problems are also identified in all County Erosion Control Plans.

Navigational Channels and Structures

The harbor has an area of 96 acres contained by two breakwalls. Federal navigation channels within the harbor (Figure III.2) are:

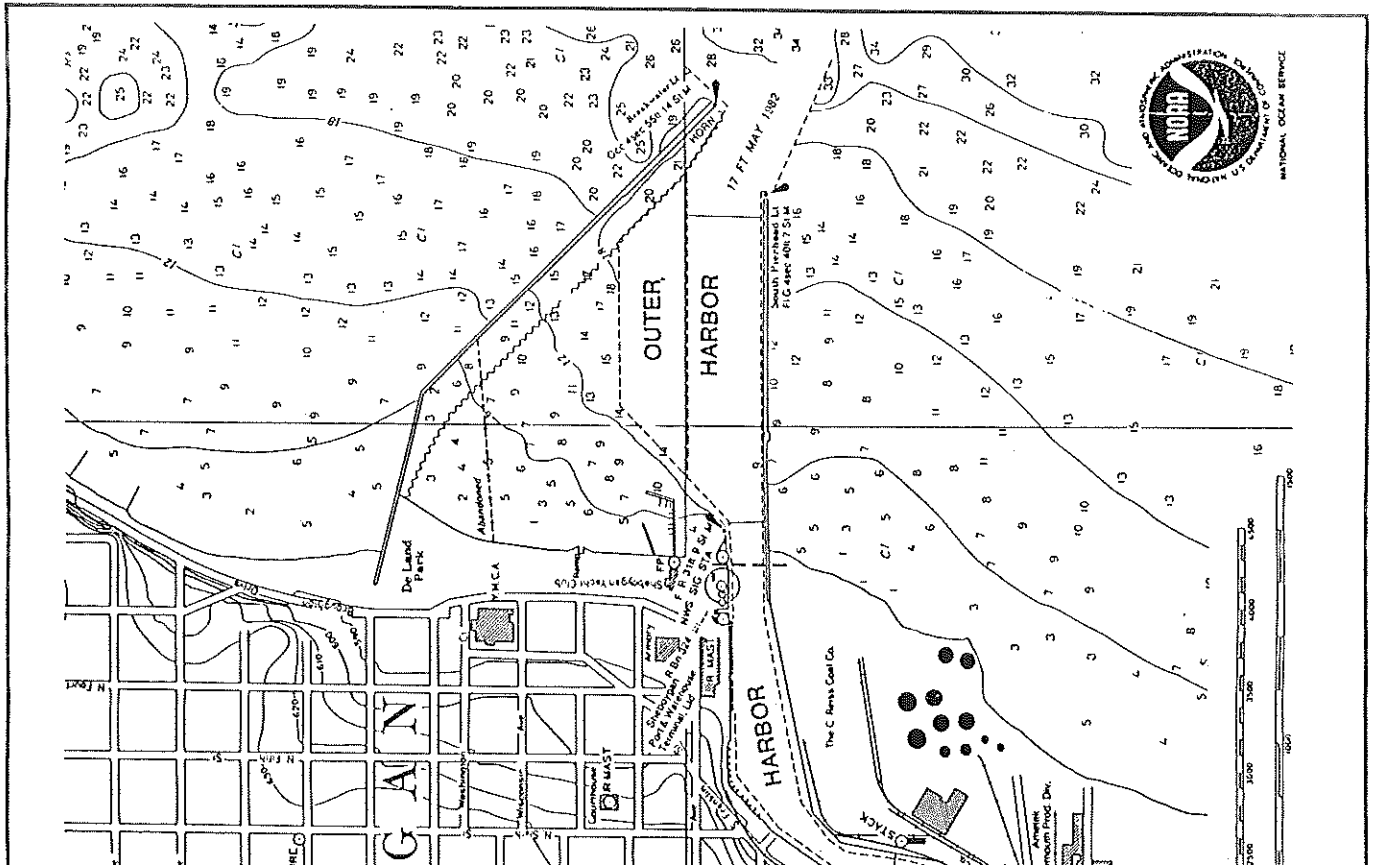
1. an entrance to the harbor 25 feet deep decreasing to 21 feet deep;

2. a turning basin 20 feet deep; and

3. a channel in the Sheboygan River 21 feet deep extending from the turning basin to Maryland Avenue and then 15 feet deep upstream to Jefferson Avenue.

Navigation channel bottom elevations are now several feet above the project design navigation depth due to sedimentation and a lack of dredging. The sediment input to the harbor is estimated to be 30,000 cubic yards per year.

Figure III.2 The Sheboygan Harbor



Funding has been requested by the Corps to review these 4 upland sites and to begin consultation with WDNR, the U.S. EPA, and U.S. Fish and Wildlife Service to obtain input on the potential use of these sites.

Other hydraulic restrictions, excluding the breakwaters, are two dams located in the Village of Kohler and one dam in the City of Sheboygan Falls, as shown in Figure II.1. The impounded water behind the dam in Kohler is used as an emergency source of cooling water for Kohler Co. and the Sheboygan Falls Dam is used for power generation.

Air Quality

Ambient air quality must meet the standards set in Wisconsin's Administrative Code NR 404, which are the same as the federal standards mandated by the Clean Air Act (Table III.1). Air quality monitoring is conducted at several sites near Sheboygan (Baggott et al. 1986). The Wisconsin Power and Light Co. (WP&L), located in the city of Sheboygan, is certified by the Wisconsin DNR to monitor sulfur dioxide, total suspended particulates, and ozone. Other WDNR monitoring sites in the Sheboygan area are located in the cities of Kewaunee and Manitowoc.

Ozone is the primary air quality problem in the Sheboygan area. Sheboygan County is a nonattainment area for ozone because it does not meet ambient air quality standards. Levels of sulfur dioxide and total suspended particulates do not exceed the primary ambient air quality standards in the Sheboygan area.

Monitoring of nitrogen dioxide, lead, and carbon monoxide elsewhere in the

Table III.1 Wisconsin Air Pollution Standards

WISCONSIN AMBIENT AIR QUALITY STANDARDS
NR 404.03, WISCONSIN ADMINISTRATIVE CODE
ADOPTED FROM NOVEMBER 25, 1971 NATIONAL AMBIENT AIR QUALITY STANDARDS,
LAST REVISED SEPTEMBER, 1981
40 CFR 50.4 TO 50.11

Pollutant	Time of Average	Primary Standard**	Secondary Standard**	Method of Determination
Particulate Matter	Annual (Geometric Mean) 24 hour	75 ug 260 ug*	60 ug@ 150 ug*	High Volume Sampler
Sulfur Oxides (SO_x) (Measured as SO_2)	Annual (Arithmetic Mean) 24 hour 3 hour	80 ug (0.03 ppm) 365 ug (0.14 ppm)* ----------	 1300 ug (0.5 ppm)*	Pulsed and Continuous Fluorescence
Carbon Monoxide (CO)	8 hour 1 hour	10 mg (9 ppm)* 40 mg (35 ppm)*	Same as primary Same as primary	Nondispersive Infrared
Nitrogen Dioxide (NO_2)	Annual (Arithmetic Mean)	100 ug (0.05 ppm)	Same as primary	Chemiluminescence
Ozone (O_3)	1 hour	0.12 ppm (235 ug)*	Same as primary	Ultraviolet absorption, and Chemiluminescence

Table III.2 Land Uses in Sheboygan Township (1980)

Type	% of Total Acreage	Acreage
Natural	14.6	1255
Residential	35.6	3059
Industrial	11.3	970
Commercial	5.73	493
Agricultural	11.3	968
Transportation	21.6	1854
Total	100	8599

Source: WDNR, 1980b

In Sheboygan, Kiwanis and Franklin Parks provide public boat access with

(Dale Katsma, WDNR Wildlife Manager, pers. comm. 1988). River banks provide habitat for belted kingfishers. Sandpipers and herons forage in shallow areas and mudflats. Raccoons and muskrats are common mammals associated with the river.

The nearshore area of the harbor and Lake Michigan provides foraging habitat for gulls, terns, shorebirds and ducks. Diving ducks have historically stopped in this area during their migration. In recent years, lesser scaup have used the area for 2 to 4 weeks during the fall (Dale Katsma, WDNR Wildlife Manager, pers. comm. 1988).

Appendix A (Tables 1-4) lists mammals and birds present in the AOC. Mink are rare in the AOC. The common tern, which is a seasonal resident only, is included on Wisconsin's Endangered Species List and has been reported in the harbor. The bald eagle and the piping plover are on the Federal Endangered Species List. While neither species have been reported to reside in the AOC, they have been reported in the AOC during migration.

Recreational Activities

Noncontact recreation such as walking, jogging and bicycling occurs in Sheboygan and Sheboygan Falls parks along the river. Much of the land near the river in Kohler is privately owned. Thus, public access is limited in the Village of Kohler, but not in Sheboygan and Sheboygan Falls.

The City of Sheboygan operates two public beaches for wading and swimming.

coho salmon, chinook salmon, and lake, brook, brown, and rainbow trout. Interestingly, smallmouth bass populations downstream of the Sheboygan Falls Dam have increased dramatically since 1980. They are now occasionally seen above the dam as well. The reason for this sudden increase is unknown. At any rate, it has enhanced the recreational fishery. Generally, there is a diversity of sport fish in the river between the dams. The impoundments are inhabited mainly by carp as habitat is limited for the more desirable sport and forage species.

Sport/Charter Fishing

Sheboygan harbor has periodic runs of Great Lake trout and salmon. Sport fishing begins in the spring for rainbow, brook, and brown trout. The summer months of June through August produce catches of brook and brown trout with coho and chinook salmon catches increasing during August. Catches of resident species such as yellow perch and whitefish are also prevalent. Rough fish such as carp and sucker are also fished. September marks the beginning of the fall salmon run when coho and chinook begin to ascend the Sheboygan River to spawn. Thus, the fall months are very productive for catches of coho and especially chinook salmon. Rainbow and brown trout catches also increase during the fall period. Late winter and spring produce runs of rainbow trout.

Stocking release sites are located within and outside of the Sheboygan harbor. Annual stocking of coho and chinook salmon and rainbow trout has been done in the fall and spring within Sheboygan harbor. Brook, brown, and lake trout are stocked at Lake Michigan sites in the spring and fall.

In 1969, the WDNR began annual creel surveys of Lake Michigan sport anglers at boat ramps and on piers, shores, and tributary streams all along the Wisconsin

Commercial perch fishing has seen a significant increase approximately one half mile from the harbor mouth. Perch do not spawn in the harbor, but principally near offshore reefs and similar structures in 20 to 30 feet of water. Whitefish and perch catches near Sheboygan harbor were productive in 1987. Chubs are also commercially fished, but well off shore and outside of the AOC.

Public Water Supply

The municipal water supply for the City of Sheboygan Falls, the Village of Kohler, and the City of Sheboygan is from Lake Michigan with an intake located north of the harbor approximately one mile out into the lake. The Sheboygan Water Commission provides 4.8 billion gallons per year to these communities. The amounts provided for industrial, residential, commercial and public uses are provided in Table III.3.

Table III.3 Public Water Supply - 1986 Uses and Amounts (gallons x 10^3)

Cities of Sheboygan, Sheboygan Falls, and the Village of Kohler

Use	Sheboygan	Sheboygan Falls	Kohler
Residential	1,016,830	96,221	27,004

Waste Disposal

The AOC also receives point (industrial and municipal effluent) and nonpoint (agricultural and urban runoff) sources of pollution. This information is presented in "Chapter V. Sources of Pollution".

WATER QUALITY OBJECTIVES

The Clean Water Act of 1986 mandates that the quality of state waters be sufficiently high to support aquatic life and recreational uses. The classification of this AOC is Full Fish and Aquatic Life capable of supporting a Warm Water Sport Fishery. This area also supports coldwater migrant fish from Lake Michigan. The AOC has suitable habitat to support a variety of warmwater and coldwater sport and forage fish species. Supporting water quality criteria are assigned according to this classification. Table III.4 summarizes the water quality criteria for the Full Fish and Aquatic Life and recreational use classification for the lower Sheboygan River.

Administrative Code NR 105 contains water quality standards for toxic substances. The standards are intended to protect the public interest including the protection of: 1) the public health and welfare, 2) the present and prospective uses of all waters of the state for public and private water supplies, 3) propagation of fish, other aquatic life, and wild and domestic animals, 4) domestic and recreational purposes, and 5) agricultural, commercial, industrial and other legitimate uses. The water quality standards for various organic and inorganic compounds that apply to Sheboygan are illustrated in Tables III.5 through III.7 and are based on NR 105.

S AND WATER QUALITY STANDARDS FOR LAKES
OUTHEASTERN WISCONSIN REGION: 1977

		Combinations of Water Use Objectives Adopted for Southeastern Wisconsin Inland Lakes and Stream					
ed w,x diate Life)	Marginal Aquatic Life[d,w]	Restricted Use and Minimum Standards[b]	Marginal Aquatic Life Recreational Use, and Minimum Standards[b]	Limited Fishery (Intermediate Aquatic Life), Recreational Use, and Minimum Standards[b]	Warmwater Fishery and Aquatic Life, Recreational Use, and Minimum Standards[b]	Trout Fishery and Aquatic Life, Recreational Use, and Minimum Standards[b]	Salmon Spawning Fishery and Aquatic Life, Recreational Use, and Minimum Standards[b]
[g]	89[e]	--[e]	--[e]	89[e]	89[e]	--[e,f]	--[e,f]
[g]	6.0-9.0[g]	6.0-9.0[g]	6.0-9.0[g]	6.0-9.0[g]	6.0-9.0[g]	6.0-9.0[g]	6.0-9.0[g]
	2.0	2.0	2.0	3.0	5.0[h]	6.0[i]	5.0[j]
	200-400[k]	1,000-2,000[l]	200-400[k]	200-400[k]	200-400[k]	200-400[k]	200-400[k]
	0.5	--	0.5	0.5	0.002[y]	0.002[y]	0.002[y]
	--	--	--	0.2[v]	0.02[u]	0.02[u]	0.02[u]
	--	--	--	--	--	--	--
	--	--	--	--	--	--	--
	--	--[q]	--	--[p]	--[p]	--[o,p]	--[p]

ural Resources plus those combinations of water use categories applicable to the Southeastern Wisconsin Region. It is recognized that, olate the established water quality standards for a reasonable length of time without damaging the overall health of the stream. It is —composed of "use designations" and "water quality criteria"—and the water use objectives and supporting standards of the Regional urces, being regulatory agencies, utilize water quality standards as a basis for enforcement actions and compliance monitoring. This t, must forecast regulations and technology far into the future, documenting the assumptions used to analyze conditions and problems some times more controversial—study findings must sometimes be applied. This results from the Commission's use of the water quality

will cause objectionable deposits on the shore or in the bed of a body of water shall not be present in such amounts as to interfere with n such amounts as to interfere with public rights in the waters of the State. Materials producing color, odor, taste, or unsightliness shall are acutely harmful to animal, plant, or aquatic life.

on.

vaters and includes selected continuous and noncontinuous streams as specified by the DNR on the basis of field surveys and identified

fluctuations shall be maintained. The maximum temperature rise at the edge of the mixing zone above the existing natural temperature

to be protected.

ted natural seasonal maximum and minimum.

d to the unstratified lakes; the dissolved oxygen standard does not apply to the hypolimnion of stratified inlake lakes. Trends in the nance of their natural water quality, however.

d below natural background during the period of habitation.

nonthly geometric mean of 400 per 100 ml in more than 10 percent of all samples during any month.

monthly geometric mean of 2,000 per 100 ml in more than 10 percent of all samples during any month.

hed Drinking Water Standards.

from natural background by effluents that influence the stream environment to such an extent that trout populations are adversely

esent are toxic to fish or other aquatic life. The determination of the toxicity of a substance shall be based upon the available scientific
ty Criteria for Water. EPA-440/9-76-003, U. S. Environmental Protection Agency, Washington, D. C., 1976, and Water Quality Criteria
ng Office, Washington, D. C., 1974. Questions concerning the permissible levels, or changes in the same, of a substance, or combination
ied in Water Quality Criteria 1972 and Standard Methods for the Examination of Water and Wastewater, 14th Edition, American Public

ded use, the specific chemical parameters may vary from one such reach of stream to another, since these criteria are established by the
er NR 104.

, endangered species habitat, and waters of high recreational potential all are subject to further pollution analysis and special standards
d by the Wisconsin Department of Natural Resources on a case-by-case basis. No waters in southeastern Wisconsin are designated under

cilities discharging heated water directly to Lake Michigan, excluding that from municipal waste and water treatment plants and vessels
ablished by the Wisconsin Department of Natural Resources by more than $3^{o}F$ and, except for the Milwaukee and Port Washington
ixing zones during the following months above the following limits:

July, August, September	$80^{o}F$
October	$65^{o}F$
November	$60^{o}F$
December	$50^{o}F$

million BTU per hour, mixing zones are established by the Department of Natural Resources. Any plant or facility, the construction of
ke Michigan comply with mixing zones established by the Department. In establishing a mixing zone, the Department will consider
requirements of the Federal Water Pollution Control Act Amendments of 1972, or regulations promulgated thereto.

ndard units, which are generally the critical conditions in the Region, and at ammonia-nitrogen concentrations of about 0.4 mg/l or
uatic life of the types found in the natural waters of the Region.

ndard units, which are generally the critical conditions in the Region, and at ammonia-nitrogen concentrations of about 3.5 mg/l or
insect life and forage minnows and other aquatic life of the types found in the Region.

entified as "surface waters not supporting a balanced aquatic community (intermediate aquatic life)."

ency, Washington, D.C., 1976.

Table III.5 Water Quality Criteria for Toxic Substances: Wild and Domestic Animal Criteria and Acute and Chronic Toxicity Criteria

Wild and Domestic Animal Criteria

Substance	Criteria (ng/L)
DDT and Metabolites	0.15
Mercury	2.0
Polychlorinated Biphenyls	
Aroclor 1248, 1254, 1260	3.0
Aroclor 1221, 1232, 1242	47.0
Aroclor 1016	233.0

Acute and Chronic Toxicity Criteria
(hardness of 140 ppm $CaCO_3$)

Substance	Criteria (ug/L)	
	Acute	Chronic
Arsenic (+3)	364	152

Table III.6 Water Quality Criteria for Toxic Substances: Human Cancer Criteria

Human Cancer Criteria

Substance	Criteria (ug/L unless specified otherwise)
Acrylonitrile	0.44
Aldrin (ng/L)	0.17
Arsenic[2]	50
alpha-BHC	0.034
beta-BHC	0.06
gamma-BHC (lindane)	0.068
BHC, technical grade	0.045
Benzene[3]	5
Benzidine (ng/L)	0.65
Benzo(a)pyrene	0.023
Beryllium	0.033
Bis(2-chloroethyl) ether	0.28
Bis(chloromethyl) ether (ng/L)	0.037
Carbon tetrachloride	2.1
Chlordane (ng/L)	1.3
Chloroethene (vinyl chloride)	0.15
Chloroform (trichloromethane)	1.8
4,4'-DDT (ng/L)	0.043
1,4-Dichlorobenzene	11

Table III.6 Water Quality Criteria for Toxic Substances: Human Cancer Criteria (con't)

Substance	Criteria (mg/L unless specified otherwise)
1,1,2-Trichloroethane	5.3
Trichloroethene[3]	5
2,4,6-Trichlorophenol	4.2

[1] A human cancer criterion expressed in micrograms per liter (ug/L), nanograms per liter (ng/L) or picograms per liter (pg/L) can be converted to milligrams per liter (mg/L) by dividing the criterion by 1000, 1,000,000 or 1,000,000,000, respectively.

[2] Human cancer criteria for arsenic equal the maximum contaminant level.

[3] For this substance the human cancer criteria for public water supply receiving water classifications equal the maximum contaminant level pursuant to s. NR 105.09(4)(b).

[4] Human cancer criteria for halomethanes are applicable to any combination of the following chemicals: bromomethane (methyl bromide), chloromethane

Table III.7 Water Quality Criteria for Toxic Substances: Human Threshold Criteria

Substance	Criteria (ug/L unless specified otherwise)
Acrolein	0.11
Antimony	0.12
Bis (2-chloroisopropyl) ether	0.026
Cadmium[2]	0.01
Chlorobenzene	0.95
Chromium (+3)	140
Chromium (+6)[2]	0.05
Cyanide, total	0.6
1,2-Dichlorobenzene	1.4
1,3-Dichlorobenzene	1.6
cis-1,2-Dichloroethene	0.27
trans-1,2-Dichloroethene	0.27
2,4-Dichlorophenol	1.4
Dichloropropenes[3]	0.066
Di-2-ethylhexyl phthalate	5.9
Diethyl phthalate	170
Dimethyl phthalate	190
Di-n-butyl phthalate	13
4,6-Dinitro-o-cresol	0.01
Dinitrophenols[3]	0.054
Endosulfan	0.023
Endrin (ug/L)	0.021
Ethylbenzene	1.4
Fluoranthene (ug/L)	0.3

IV. DEFINITION OF THE PROBLEM

IMPAIRED USES

As defined in the Great Lakes Water Quality Agreement between the United States and Canada, an impairment of beneficial use(s) means a change in the chemical, physical or biological integrity of the Great Lakes system sufficient to cause any of the following:

1) restrictions on fish and wildlife consumption;
2) tainting of fish and wildlife flavor;
3) degradation of fish and wildlife populations;
4) fish tumors or other deformities;
5) bird or animal deformities or reproduction problems;
6) degradation of benthos;
7) restrictions on dredging activities;
8) eutrophication or undesirable algae;
9) restrictions on drinking water consumption or taste and odor problems;
10) beach closings;
11) degradation of aesthetics;
12) added costs to agriculture or industry;
13) degradation of phytoplankton and zooplankton populations; or
14) loss of fish and wildlife habitat.

Waterfowl and fish consumption advisories and dredging restrictions are of

Table IV.1 A comparison between monitored data and water quality criteria for the Sheboygan AOC, 1985 and 1986 Calendar Years

Parameter	Observations	Minimum	Average	Maximum	Acceptable Level	% Parameter Exceedances
Dissolved Oxygen (mg/L)	23	7.20	11.96	18.50	5.00**	0
Temp. (°C)	23	0.10	10.78	25.10	30.0*	0
pH (low)	23	6.80	7.93	8.90	6.00**	0
pH (high)	23	6.80	7.93	8.90	9.00**	0
Phosphorus (mg/L)*	24	0.04	0.19	0.58	0.10*	67
Residue*	24	2.00	48.00	338.00	90.0*	13
Ammonia-NH_3 (mg/L)	22	0.000	0.001	0.007	0.040**	0
NO_2 + NO_3(mg/L)	24	0.02	1.10	2.30	1.00**	54
Fecal Coliform						

Mallards are the most common waterfowl species bagged by sportsmen in Wisconsin. Fortunately, less than 0.3 percent of the total annual waterfowl harvest comes from the areas covered by the advisory, which includes portions of the lower Fox River, Milwaukee harbor, and the Sheboygan harbor upstream to the Sheboygan Falls Dam.

Fish consumption advisories for sport fishermen developed by the WDNR and Department of Health and Social Services have been in effect since 1978 for the AOC. The advisories recommend that certain species and length of fish should not be consumed due to PCB concentrations in the tissue greater than the FDA tolerance limit of 2 ppm. See Appendix A (Tables 8-14) for fish contamination data. The 1989 advisory recommends that bluegill, crappie, rock bass, smallmouth bass, carp, walleye, northern pike, catfish, trout and salmon should not be eaten (Appendix A, Table 19).

Fish consumption advisories for the Sheboygan River are negatively perceived and may have influenced the desirability of the fish. The Wisconsin Department of Health and Social Services (DHSS) and WDNR conducted a study in 1985 in which 801 people from 10 counties in Wisconsin completed surveys and 198 anglers donated blood samples. Twenty eight anglers from Sheboygan County submitted to blood sampling. A conclusion of the study was that PCB concentrations in the blood increased as the amount of fish consumed from Lake Michigan increased. Lake Michigan sport fishing for salmon and trout has been a continuing recreational use over the years, even though these species are included on the consumption advisories. Although many anglers may be following the fish consumption advisories, the possibility remains that some people may not be aware of the advisories.

The native sport and commercial fish populations declined in Lake Michigan during the late 1950's primarily as a result of the introduction of exotic species (alewife and sea lamprey) and overfishing. Subsequent stocking of native and non-native salmonid species has contributed to increased native fish populations and a reduction in alewife populations. This revitalized fishery has also created a widely utilized recreational sport fishery.

Presently, the lower Sheboygan River supports a diverse population of fish and aquatic life. However, there is concern that sediment from upstream sources which has been deposited above the upper and lower Kohler Dams, along the river bank at bends in the river, and in the harbor may be negatively impacting the diversity and health of the local fishery. Excessive sedimentation can impact fish and aquatic life by:

1) acting directly on fish by either killing them or reducing their growth rate;
2) preventing the successful development of eggs and larvae;
3) modifying natural movement and migration;
4) reducing availability and abundance of food; and
5) degrading habitat.

The three dams in the AOC segregate the river and prevent natural migration of fish. Presently, cold water anadromous fish migrate from Lake Michigan to the lower Kohler Dam. If these dams were removed or modified to allow fish passage, a cold water anadromous fishery could be extended further up the river system, increasing recreational fishing opportunities.

Degradation of Wildlife Populations

The sediment deposition associated with heavy metals and PCBs has impacted dredging activities within the harbor. Since 1969, dredging of the harbor (excluding the mouth) has been restricted, partially because of the lack of a disposal site for contaminated sediment due to costs, liability, and siting and the potential for resuspension and exposure of more highly contaminated materials (see "Chapter VII. Historical Record").

The U.S. Army Corps of Engineers is responsible for maintaining federal navigation channels within the harbor. Lake Michigan water levels have been high between 1970 and 1987 (Appendix D) which has facilitated navigation even though sediment has continued to be deposited in the harbor. The amount of materials shipped in and out of the port per ship has remained fairly constant from 1970 to 1987 (reference Appendix D). Water levels decreased in 1987 and were at average levels in June of 1988 based on means calculated between 1900 and 1987. The Corps and C. Reiss Coal Co. are concerned that decreasing water levels and sediment deposition in the harbor will cause inefficient navigation in the future, necessitating more vessel trips to move the present amount of commerce, thereby, increasing transportation costs (U.S. COE 1979; Bob Beiver, C. Reiss Coal Co., pers. comm. 1988).

The Sheboygan River Water Quality Task Force (reference Appendix F) prepared and distributed a questionnaire in 1988 to obtain public input to the Remedial Action Plan. The responses suggest that citizens desire the development of a marina in the harbor (and more shops) whether the area is "cleaned-up" or not.

A Feasibility Study for a Sheboygan Marina was developed by Donohue and United Design Associates in 1985. The study recommended that the City of Sheboygan obtain the cooperation and assistance of other agencies in construction of a CDF.

Thus, CDF construction is considered by many members of the local community to be an important component of marina development, and hence, an enhancement of recreational uses. The City of Sheboygan, as sponsor of the CDF, would have long term liability and maintenance responsibility for the facility.

Eutrophication or Undesirable Algae

Eutrophication means an increase in algae and macrophyte production typically due to nutrient loadings, such as phosphorus and nitrogen, to the surface water. Phosphorus concentrations in the lower Sheboygan River routinely exceed the recommended U.S. EPA suggested water quality criteria of 0.1 mg/l (U.S. EPA 1976). Nitrogen concentrations are elevated and are typical of concentrations observed from other agricultural river basins located in southeast Wisconsin (WDNR 1980).

Eutrophication may negatively impact water supplies, recreational and aesthetic uses and water quality needed to sustain fish and other aquatic life communities. Table IV.2 describes potential water quality problems which may occur as a result of excessive primary producer growth (U.S. EPA 1983). Based on very limited data, none of these impacts have been identified as limiting water quality in the free-flowing reaches of the Sheboygan River. Occasional occurrences of undesirable algae have been observed in the harbor. With regard to potential impacts to Lake Michigan, the Sheboygan River is a source of nutrient loadings to the lake. Reducing nutrient loadings to the Great

Table IV.2 Water Quality and Related Problems Associated with Eutrophication in the Sheboygan AOC

Type of Use Use Impairment	Comment on Sheboygan AOC
Water Supply	
Taste and odor impairments	Do not exist
Filter clogging	
Turbidity	
Increased chlorine demand	
Algal growth in distribution system	
Blockage of intake screens	
Aesthetics	
Floating mats	Do not exist
Surface scums	
Turbidity	
Rooted aquatic plans	

1979 data. Thus, the water quality of the lower Sheboygan River is classified, however, as capable of supporting full body contact recreational use based on physical conditions, such as depth, width and current. Results from the 1988 citizen's questionnaire show that approximately 70% of the respondents agreed that unspecified contaminants in the Sheboygan River and harbor pose a threat to human health and well being. However, approximately 60% swim or wade and approximately 50% engage in some kind of fishing.

Degradation of Aesthetics

Degradation of aesthetics is not known to be a problem in the AOC.

Added Cost to Agriculture or Industry

Information on added costs to agriculture or industry is not available.

Degradation of Phytoplankton and Zooplankton Populations

There is no information on phytoplankton or zooplankton populations in the AOC.

Loss and Degradation of Fish and Wildlife Habitat

Based on limited data, the AOC supports a variety of wildlife for being within and adjacent to an urban area (Appendix A, Tables 1-4). However, agricultural and urban development, such as landfills, golf courses, and shopping malls, has resulted in a loss of wildlife habitat. Existing wetlands have been inventoried by the Wisconsin Wetlands Inventory (WDNR 1983). There is now a greater importance placed on the habitat that remains.

MAJOR POLLUTANTS OF CONCERN (CAUSING THE IMPAIRED USES)

The pollutants of potential concern include polychlorinated biphenyls (PCBs) and other chlorinated organic compounds, heavy metals, phosphorus, nitrogen, suspended solids and fecal coliform bacteria.

Toxic Substances

There are potentially toxic substances such as PCBs and heavy metals present in the AOC. A toxic substance can be defined as any substance causing an adverse effect on biological systems. To determine the toxicity of a specific compound, much information is needed, such as the dose, the bio-physical-chemical properties of the substance, the route, duration and frequency of exposure, the type of species exposed, and other factors.

Some of the possible toxic effects of heavy metals include the following: liver and kidney damage, tumors, birth defects from cadmium; hemorrhages of the gastrointestinal tract and lung and other respiratory cancers from chromium; brain, bone, and neurological damage, and learning disabilities from lead (U.S. EPA 1985).

Some of the possible toxic effects of PCBs include chloracne, dermal toxicity, thymic atrophy, immunotoxicity, reproductive toxicity, porphyria, organ/tissue-specific hypo- and hyperplastic responses, tumor promotion, body weight loss, and the induction of enzymes (Safe 1987a, Poland and Knutson

PCBs in fish, sediment, water, and other matrices have typically been analyzed using Aroclor pattern recognition. Over time, patterns of PCBs in environmental samples do not resemble a specific Aroclor mixture due to processes such as biodegradation, biotransformation, bioaccumulation, weathering, vapor phase transport and others. So, a total PCB concentration is often reported as a combination of Aroclors to approximate the observed PCB pattern.

Biota Contamination

The following discussion provides information on levels of toxic contaminants present in fish and wildlife from the Sheboygan River and harbor. High levels of PCBs in various species of fish and waterfowl have resulted in fish and waterfowl consumption advisories for the Sheboygan Area of Concern. Mercury was found at low levels, below the fish consumption advisory guidelines. Furan (2,3,7,8-TCDF) has been found at low levels (ppt) in fish. There is no information on toxic contaminant levels in shellfish nor information on tumors or other abnormalities in fish or wildlife.

Fish Data

Polychlorinated biphenyls (PCBs): The majority of PCB data for fish in the Sheboygan River Basin is derived from annual sampling by the WDNR. Sampling sites within the AOC are at the Sheboygan Falls Dam, upper Kohler Dam, lower Kohler Dam, Kiwanis Park and Sheboygan Harbor.

Because of the variations in the numbers of species collected, location of sampling stations, and the methods used for analyses, it is difficult to draw definitive trends for PCB concentrations between and within species. In

analyses conducted by a single laboratory under contract with the state. These data suggest that either transformation processes have occurred in the fish and/or the aquatic environment over the course of the monitoring years, or different reference standards were used depending on the judgement of the analyst (which is common within and between laboratories) and there are no real differences in Aroclors in the fish. A study on PCB congeners in Wisconsin fish (Maack and Sonzogni 1988) found that two trichlorinated congeners were prominent in coho salmon from the Sheboygan River. This pair is also present in Aroclor 1242 in the highest percentage relative to other Aroclor mixtures.

Three fish (smallmouth bass, rock bass, and bluegill) were collected from the Sheboygan River at Kiwanis Park by WDNR and analyzed in 1988 for PCB congeners by Dr. M. Mullin (U.S. EPA, Large Lakes Research Station, Grosse Ile, MI). Although the sample size was small and further sampling would be required to substantiate these results, they do provide useful information.

The length and weight, percent fat, and total PCB concentration varied among the three fish. The congener distribution was similar among all three species. Most levels of chlorination (di-nona) were observed in the fish with tetrachlorinated biphenyls comprising the greatest percentage of the total PCB concentration. Most of these congeners were also reported in fish from Wisconsin waters (Maack and Sonzogni 1988), except the trichlorinated pair were not the dominant congeners observed recently as they were in coho salmon, previously. Note that coho salmon are Lake Michigan migrants unlike bass and bluegill which are Sheboygan River residents.

Wildlife Data

Great blue herons, belted kingfishers, solitary sandpipers and spotted sandpipers were collected along the Sheboygan River in the AOC between 1976 and 1980 by the WDNR and U.S. Fish and Wildlife Service. PCB concentrations in these wild birds ranged from 23 to 218 ppm (wet weight) in the carcasses, 12 to 58 ppm in stomach contents, and 50 to 220 ppm in brains (Appendix A, Table 15). A DDT metabolite (p,p' DDE) ranged from 0.38 to 8.8 ppm in carcasses, 7.1-16 ppm in brains, and 0.10-0.55 ppm in stomach contents. Dieldrin ranged from nondetected to 0.92 ppm in carcasses, nondetectable to 2.8 ppm in brains, and nondetectable in stomach contents.

WDNR monitored wildlife contaminants again in 1985-1986. Five mallards, which were collected along the Sheboygan River between Sheboygan Falls Dam and Lake Michigan, contained a mean PCB concentration of 214 ppm on a fat basis and 10.3 on a wet weight basis (Appendix A, Table 16). Two lesser scaup samples (composites of 10 birds) from the Sheboygan Harbor contained a mean total PCB concentration of 25 ppm on a fat basis and 5.4 ppm on a wet weight basis (Appendix A, Table 17). These analyses resulted in consumption advisories for mallards and lesser scaup in the AOC (Appendix A, Table 18a). The WDNR and DHSS issued the advisory in 1987 to inform sportsmen of the potential health risks of consuming waterfowl where PCB concentrations exceeded the FDA tolerance level of 3 ppm (fat basis) in poultry.

An additional collection of ten mallards in the Kiwanis Park area in 1987 revealed a mean PCB concentration of 31.8 ppm on a fat basis and 2.6 ppm on a wet weight basis. Ten lesser scaup samples from the harbor area in 1987 yielded a mean PCB concentration of 25.1 ppm on a fat basis and 2.6 ppm on a wet weight basis. Two redheads, also collected in the harbor area in 1987

1987) ranged from zero to 75 mg/l approximately 90 percent of the time. Fecal coliform sampling has shown that the standard is routinely exceeded in the AOC (lower Sheboygan River at the U.S.G.S. gaging station at Interstate 43). As shown in Appendix B (Table 4), there were exceedances 38% of the time in 1985. Phosphorus and nitrogen concentrations routinely exceeded the U.S EPA suggested water quality criteria (Appendix B, Table 4).

Polychlorinated biphenyls (PCBs): WDNR sampled river water in the Sheboygan, Mullet, and Onion Rivers in April of 1978 and analyzed for PCBs. All samples contained less than 0.5 ppb PCBs, except for a Sheboygan River (at the junction of Hwy 28) flood stage sample which contained 3.0 ppb. The reported results are shown in Appendix B (Table 2). (Note in Table 2, the concentration unit of ug/L does not correspond to ppm; it should be ppb.)

As part of the Remedial Investigation activities at the Sheboygan Harbor and River Superfund site, water samples were collected from five river and one harbor location over the period May 31-June 2, 1987. These samples were collected during moderate flow conditions. They were analyzed for PCBs and eight metals (Appendix B, Table 3). Three additional rounds of water samples (at high, moderate, and low flow conditions) were collected during the next phase of the Superfund project, during the spring and summer, 1988. They are currently being analyzed for PCBs and eight metals. The low flow samples will also be analyzed for volatile organic compounds. The results will be available in the Remedial Investigation/Enhanced Screening Report. Refer to the Quality Assurance Project Plan and Sampling Analysis Plan for the Sheboygan River and Harbor Remedial Investigation and Feasibility Study for

Sediment Contamination

The following information presents the historical sediment sampling results for the Sheboygan River and harbor since 1969 prior to presenting more recent Superfund sampling results. Currently, there are no criteria available for comparisons in order to present a sense of contaminant severity.

Historical Sediment Data

In 1969, Sheboygan harbor sediment sampling was conducted by the Federal Water Pollution Control Administration and the U.S. Army Corps of Engineers (FWPCA 1969). The conclusions of the study were that the bottom sediments within the federal navigation channel between Jefferson Avenue and station Sheb 69-5 and 69-6 were "heavily polluted" and the sediments in the outer harbor near the breakwater lights were "lightly polluted" due to heavy metals (Appendix C, Figure 1).

The sediment analysis included chemical and physical parameters (Appendix C, Tables 1,2). It was reported that three sampling locations contained high concentrations of nitrogen, chemical oxygen demand, oil and grease and heavy metals. Heavy metal concentrations were highest at site 16 (Eighth St.) and decreased to the river's confluence with Lake Michigan. Copper, lead, and chromium concentrations ranged between 45 to 175 ppm, 80 to 335 ppm, and 170 to 1400 ppm, respectively.

In 1974, U.S. EPA collected harbor sediment samples and analyzed them for chemical and physical parameters similar to the 1969 study (U.S. EPA 1974). The study reported that a comparison of the two studies indicated no change in pollution levels (Appendix C, Tables 3,4). Lead and chromium concentrations

that partial dredging would expose aquatic organisms to higher PCB concentrations. Thus, as reported in the WDNR report, if dredging were necessary, a total dredging of all contaminated bottom sediment may be environmentally warranted.

In 1979, U.S. Army Corps of Engineers conducted sampling at 11 sites within the Sheboygan harbor (Appendix C, Table 9). Analyses were performed on heavy metals (Pb, Zn, Cu, Cr) and PCBs. The May 1979 results, presented in Appendix C (Tables 12 and 13), indicated that sites between Jefferson Ave. and the outer harbor (a through f) were heavily contaminated with Pb, Cu, and PCBs and moderately to heavily contaminated with Cr and Zn. Samples from sites in the harbor mouth area (g through i) were nonpolluted for all parameters sampled. These assessments were based on U.S. EPA Great Lakes harbor sediment guidelines of 1977 in which sediment concentrations greater than 10 ppm for PCBs, 60 ppm for Pb, 200 ppm for Zn, 50 ppm for Cu, and 75 ppm for Cr were defined as heavily contaminated.

Based on the 1972 Clean Water Act and the early sediment sample results (1969-1974), it was concluded that Sheboygan harbor sediment should not be disposed in open water due to heavy metal contamination. 1978 PCB analyses of the sediment in the AOC stemmed from observations that PCB concentrations were at significant levels in fish from the Sheboygan River. Harbor maintenance dredging did not occur in 1979 because study results indicated that the proposed project depth would expose a sediment surface layer in which concentrations of heavy metals and PCBs would exceed those in the existing surface layer. Also, a suitable disposal site for dredged material was unavailable.

Data for other compounds are also presented in Appendix C (Table 14).

Sheboygan River and Harbor Superfund Data: Phase II

The second phase of the Superfund (river and harbor) investigation occurred in September 1987 and consisted of collecting river and harbor sediment and river bank soil samples. Ninety six river sediment cores (which translates to 104 samples), twenty harbor sediment cores, and twenty soil samples along the river bank and islands were collected. The U.S. Army Corps of Engineers extensively sampled the C. Reiss Coal area of the harbor in 1982 and 1984. Consequently, the Superfund Project did not sample that area to a significant degree. The Corps data is presented in Appendix C; maps will be provided when available. The following is a summary of preliminary results for chemical and physical analyses which were available at the time of preparing this report.

<u>Polychlorinated biphenyls (PCBs)/River Sediment:</u> The sediment depth in the river ranged from approximately 0.4 feet, about two thirds of a mile downstream of the Upper Kohler Dam to over 12 feet near the Pennsylvania Avenue bridge. At each river sample location, the core segments were composited by the laboratory prior to analysis for total PCBs, except for two cores near the island upstream of the Pennsylvania Avenue bridge. Both of these cores (R98 and R100) were analyzed by depth such as was done with the harbor sediment cores.

There were a wide range of total PCB concentrations in the sediments. The site above the Sheboygan Falls Dam contained 0.07 ppm, two sites downstream of Tecumseh contained 4500 and 4300 ppm. One site below the upper Kohler Dam contained 890 ppm. Approximately 70% of the samples contained less than 20 ppm, and some sites contained relatively low concentrations of

PCBs). The sediment cores were segmented in the following way: 0-0.5, 0.5-2, 2-4, 4-6, 6-8, 8-12, 12-16, and 16-20 feet. The cores ended when native lake sediments were encountered.

The study found that the entire harbor (sites H1-H20) contains less than 6 ppm of PCBs in the top one half foot of sediment. The highest total PCB concentrations are observed within the inner harbor (H11-20) and generally increased with depth. The maximum observed concentration is 220 ppm in the 8-12 ft segment at site H15 (above Eighth St.). The outer harbor (H1-9) contains less than 8 ppm at all depths.

All samples, except one, collected in the outer harbor (sites H1-H9, relative to the inner harbor sites H11-H20) contained less than 3 ppm total PCBs, with many segments containing less than the detection limit of 0.025 ppm. The one exception contained 8 ppm. Combinations of Aroclors 1242, 1248, and 1254 were reported in these samples. All of the samples in the northern portion of the outer harbor (sites H4-H9) contained less than 0.2 ppm.

The inner harbor (sites H11-H20, between Pennsylvania Avenue and the turning basin, n=10) contained less than 6.0 ppm (a mean concentration of 3.4 ppm, and a standard deviation of 1.2) for the segment at 0-0.5 ft, which is in direct contact with the water. The top two feet contained less than 12.5 ppm. Total PCB concentrations were higher at greater depths. For example, six samples from depths below 0.5 feet had total PCB concentrations greater than 50 ppm. Appendix C, Table 16 illustrates the mean concentration for each segment at sites H11-H20. The standard deviations are high and similar segments do not

site (S2) downstream of Rochester Park in Sheboygan Falls, contained 71 ppm. A river bank site (S3) downstream of the upper Kohler Dam, contained 30 ppm. The remaining samples contained less than 10 ppm.

Relationship of Particle Size to PCB Levels/River Sediment: Sediment particle sizing was conducted on 10 river samples to evaluate the relationship of particle size to contamination distribution (R56, R49, R76, R79, R73, R97, R83, R3, R11, R18). The samples were collected at various sites between the Pennsylvania Avenue bridge and the Sheboygan Falls Dam. Some of the samples support the general tendency of higher PCB concentrations to be associated with smaller particle sizes. Exceptions are samples R97 (upstream of the Pennsylvania Ave. bridge) and R76 (upstream of Kiwanis Park) which contain a large percentage of relatively small particles and low PCB concentrations and the R11 sample (downstream of Tecumseh Products) which contains a large percentage of relatively large particles with a high PCB concentration (Appendix C, Table 2).

Relationship of Particle Size to PCB Levels/Harbor Sediment: Sediment particle sizing was also conducted on the 20 harbor cores. Two different segments per core were analyzed (2-4 ft, and a deeper segment which varied with each core, Appendix C, Table 3).

For the outer harbor sites (H1-H9), total PCB concentrations were low (less than 1 ppm) regardless of particle size.

Sites between the inner and outer harbors (H10 and H11), for the 2-4 ft segment, contained a similar particle size distribution, yet a large difference in PCB concentration, 38 vs. 3.5 ppm, respectively. Sites in the inner harbor (H11, H12, H13, H15, and H17) are similar in that higher PCB

There does not appear to be an association between high PCB concentrations and black organic matter (or strong organic odor). Some samples from various river sites, such as R4 and R7 (downstream of Tecumseh Products Co.), were described as containing black organic matter and the R4 sample had a strong organic odor. These samples contained 4300 and 4500 ppm of PCBs, respectively. Other samples with a similar physical description with relatively high PCB concentrations were from sites R5, R12, R22, R23, R33, R36, and R10 with concentrations of 59, 156, 93, 890, 110, 230, and 280 ppm, respectively. However, there were 12 other sites with a similar physical description and PCB concentrations less than 11 ppm. There were three other sites, R17, R19, and R25, without that description containing relatively high PCB concentrations of 50, 250, and 140 ppm, respectively.

Dioxins and Furans: One harbor sediment sample, H12, was analyzed for tetrachlorinated dioxins and tetrachlorinated furans in the 6-8 ft segment. None of these compounds were detected at detection levels of 0.16 ppb for total tetrachlorinated dioxins and 0.25 ppb for total tetrachlorinated furans. Note, this segment contained 180 ppm of PCBs.

Heavy Metals: The sediment samples analyzed for metals (As, Cd, Cr, Cu, Pb, Ni, Zn, and Hg) showed relatively low concentrations upstream and increased concentrations downstream to the harbor. The inner harbor contains Cd, Cr, Cu, Pb, Ni, and Zn. Hg was detected at relatively low levels and As was not detected in most samples. If detected, arsenic levels were close to the detection limit. Levels of all metals in the outer harbor were low or

The outer harbor PCB results for 1987 are similar to those obtained from past sampling; i.e., PCB concentrations less than 8 ppm.

Inner harbor samples were quantitated as a combination of Aroclors 1242 and 1254 for all depths in 1979 (a ratio was not reported). 1987 samples were quantitated with Aroclor 1242 for those samples containing high concentrations of PCBs and Aroclors 1242 and 1254 were used for lower concentrated samples (i.e. those near the sediment water interface). It is not clear from these Aroclor analyses if there has been a change in PCB distributions in the inner harbor sediment.

PCB Congener Analyses

In 1988, Sheboygan River sediment from two different sites (Lower Kohler Dam and Kiwanis Park) were analyzed for PCB congeners by Dr. M. Mullin (U.S. EPA, Large Lakes Research Station, Grosse Ile, MI, unpublished data). Since there were only two samples, the results are not definitive.

The Lower Kohler Dam sample had a total PCB concentration of 110 ppm. Approximately 50% of the total concentration was comprised of di and tri chlorinated congeners. The Kiwanis Park sample had a total PCB concentration of 8 ppm. Approximately 60% of the total concentration was comprised of di and tri chlorinated congeners. Additional samples would be required to confirm the abundance of these lower chlorinated congeners; the toxicological findings could be of practical importance in development of remedial actions. The relationship between congeners present in fish and in sediment also merits further investigation.

V. SOURCES OF POLLUTION

PRIMARY SOURCES

Primary sources are those which manufacture, use, or produce the materials which subsequently become pollutants. Sources of pollution include municipal treatment plants, industries, and agricultural and urban runoff.

Heavy metal contamination is also present in the AOC and sources will be identified by the Sheboygan River and Harbor Superfund Project. Data is presented in "Chapter IV. Definition of the Problem".

Wisconsin is initiating a program to develop and enforce toxic effluent limits for dischargers to surface waters. Administrative codes NR 105 and 106 contain the procedures for determining water quality criteria for toxic substances and incorporating these criteria into effluent limits.

Conventional pollutants of concern in the Sheboygan area are suspended solids, phosphorus, nitrogen and fecal coliform. They are routinely monitored in private and public wastewater discharges in the AOC. They are also transported to the AOC via urban and rural sources.

The following narrative will list the pollution sources and their current characteristics.

Municipal Sources

City of Sheboygan Incinerator

The City of Sheboygan Incinerator's cooling water discharge has also been in compliance with its WPDES permit for flow, BOD, suspended solids, pH and temperature. PCBs were monitored in 1978 and reported to be at levels less than 1.0 ppb.

Industrial Sources

Potential industrial pollutants of concern originating from both upstream areas and within the AOC include cyanide, cadmium, chromium, copper, lead, mercury, nickel, zinc, silver, and phenols. The Sheboygan River Basin Water Quality Management Plan (Meyer 1988) contains specific point source information for the Sheboygan River mainstem and the entire Sheboygan River Basin. Individual industries are identified by name, permit type, receiving water, industrial activities and other pertinent information.

Polychlorinated biphenyls (PCBs) contained in the sediment are the most widespread and environmentally significant contaminant in the AOC. PCBs were present in the hydraulic fluids used in manufacturing processes by Tecumseh Products Company Diecast Division between 1966 and 1971. Tecumseh is located adjacent to the Sheboygan River in Sheboygan Falls. Prior to the issuance of regulations governing PCBs, PCB contaminated material was inadvertently used to construct a dike located along the river downstream of the Sheboygan Falls Dam. Following EPA's issuance of regulations governing PCB use, Tecumseh Products Co. voluntarily excavated and replaced 72,300 cubic feet of PCB

Sample #	Material Sampled	Sample Location	Approximate PCB Level (ppb)
1	cooling water	east outfall to storm sewer	<0.50
2	ponded material	base of east loading dock	150
*3	sediment	east loading dock catch basin	940
*3	liquid	east loading dock catch basin	30
4	oily tar-like substance	small hole in base of south wall	4600

*Sample #3 contained both liquid and sediment portions which were analyzed separately.

A March 1986 follow-up investigation by the U.S. EPA and DNR reported no violations of the federal PCB regulations by Thomas Industries.

Kohler Co., a bathroom fixture manufacturer, is the only industry with known WPDES permit violations (suspended solids, chromium, nickel, and pH) which

Runoff and erosion of the clay soils in the eastern third of the Sheboygan River Basin results in turbid water, sedimentation, and elevated nutrient levels. Runoff from feedlots and manure spreading sites carry bacteria and nutrients into the water. When cattle have unrestricted access to the river they increase land streambank and streambed erosion and sediment deposition downstream. The Mullet and Onion Rivers, direct tributaries to the Sheboygan River, carry pollution from nonpoint sources in addition to the Sheboygan River mainstem. These three river systems contribute significant nutrient and bacteria loads to the AOC and Lake Michigan (USGS and WDNR 1984). It should also be noted that between 1957 and 1967, 7620 pounds of sodium arsenite were applied directly to the Sheboygan River for purposes of aquatic plant control (Lueschow 1972).

The Nonpoint Source Water Pollution Abatement Program has designated the Sheboygan River as a Priority Watershed and is currently gathering information on nonpoint sources and critical areas that will be available in late 1989. The Onion River is also a Priority Watershed. This watershed project will complete implementation of nonpoint source control measures in late 1988. The Sheboygan River Basin Water Quality Management Plan (WDNR 1988) contains information on how nonpoint and point source pollution affect water quality.

Since 1986, C. Reiss Coal Company has been storing fertilizer in tanks located near Lake Michigan. The Department of Agriculture, Trade, and Consumer Protection (DATCP) is responsible for reviewing the C. Reiss Coal Company's

With respect to the closed landfills, the Town of Sheboygan and one of the WP&L sites are not located near the Sheboygan River. Due to the groundwater pollution from the Town of Sheboygan landfill, people living in the area switched from private water supplies to Sheboygan's municipal water supply. The WP&L landfill associated with the AOC is south of the harbor adjacent to Lake Michigan. This contains fly ash and bottom ash generated from the burning of coal. Groundwater is monitored on a quarterly basis for the parameters contained in Wisconsin's Administrative Code NR 140, and also for boron.

The City of Sheboygan and the Kohler Co. landfills are the only two active facilities in close proximity to the river.

The Kohler Co. landfill Superfund site occupies approximately 82 acres of land in the Village of Kohler. It is bounded on three sides by the Sheboygan River and to the north by State Highway 28. Kohler Co. landfill is approximately 300 feet north of the river (Appendix E, Figure 2). It has been in operation since the 1950's, primarily for the disposal of foundry and manufacturing wastes for Kohler Company. Certain waste streams disposed of in the landfill, such as chrome plating wastes and enamel powder, contained heavy metals such as chromium, cadmium, and lead. Eight metals, including chromium, cadmium, and lead, have been identified as contaminants of concern in the Sheboygan Harbor and River Superfund site's RI/FS. The Kohler Superfund site's RI/FS has also included the metals portion of the U.S. EPA's Hazardous Substance List as contaminants of concern. In 1978, a dredging project within the Sheboygan River produced approximately 75 to 85 cubic yards of PCB-contaminated sediments (1.3 to 37.5 ppm PCBs) which were subsequently disposed in the Kohler Co. landfill following approval by the WDNR.

Wet and dry deposition monitoring for toxins in air has, however, been initiated in Door County (Peninsula State Park) and is expected to be initiated in Milwaukee County in 1990. This monitoring should provide some information on deposition of these substances in Sheboygan harbor as well. A mass balance study as part of the Lower Green Bay Remedial Action Plan is currently underway in the city of Green Bay. It includes intensive monitoring of both wet and dry toxics deposition.

PCBs can enter the air through combustion processes. Either incomplete combustion of PCBs or the generation of PCBs from chloroalkanes** (and possibly chlorinated organics, in general) at an incinerator can result in PCBs entering the atmosphere. Atmospheric emissions of PCBs have not been monitored at the City of Sheboygan Incinerator.

Air toxics administrative code NR 445 was adopted by the Natural Resources Board in September, 1988. The "DNR Report of Recommendations--Hazardous Emissions Task Force, July 1985" and administrative code NR 445 contain additional information.

VI. POLLUTANT TRANSPORT MECHANISMS AND LOADINGS

TRANSPORT MECHANISMS

In general, the contaminants of concern, primarily PCBs, are transported to the Sheboygan River and harbor and Lake Michigan via sediment, biota, water, and air.

PCBs are adsorbed to the sediments because of their physicochemical properties, such as hydrophobicity. Levels of PCBs in the sediment are much higher than those in water or fish. "Chapter IV. Definition of the Problem" contains information on the levels of contamination in sediment, water, and biota.

The PCBs are available from the water, sediment, and particulate matter to benthic invertebrates which are consumed by forage fish and in turn piscivorous fish. PCBs are also available to fish via water, phytoplankton, suspended particulates, zooplankton and macroinvertebrates. This availability also extends to those birds and mammals that consume insects and fish. Species at the top of the food chain contain higher concentrations than species at lower trophic levels because PCBs bioaccumulate. It has been reported that food chain transfer accounts for more than 99% of the body burden of adult trout (Thomann and Connolly 1984).

A 1984/1985 study by the U.S. Army Corps of Engineers (McFarland et al. 1985) on Sheboygan harbor sediment reported that transport of PCBs from the sediment

Total Phosphorus: Total phosphorus loadings from the Sheboygan River to Lake Michigan for 1980, 1981, and 1982 were estimated at 74.9, 58.4, and 97.6 tons, respectively (Bannerman et al. 1984).

Suspended Solids: Bannerman and coworkers (1984) also estimated sediment suspended solids loadings of 21815, 16278, and 27280 tons to Lake Michigan from the Sheboygan River in 1980, 1981, and 1982, respectively.

Polychlorinated Biphenyls (PCBs): Marti (1984) reported a PCB loading to Lake Michigan from the Sheboygan River between 14.4 and 29.9 kg/yr (Appendix B, Table 4). This is a relatively low loading rate due primarily to the low flow rate. The Sheboygan River had the highest PCB concentration (~ 100 ng/L) among the tributaries listed in Appendix B (Table 4). It was further reported that the loading rate could vary by an order of magnitude.

VII. HISTORICAL RECORD OF MANAGEMENT ACTIONS

Table VII.1 lists the historical record of remedial actions directed at reducing and managing environmental pollution. This chapter briefly describes each of these actions between the years of 1969 and 1987 in the AOC.

Table VII.1 Management Actions in the Sheboygan AOC: 1969-1987

Date	Action	Impaired Use Affecting
1969	Dredging of Sheboygan harbor halted.	Navigation
1977	PCBs banned.	
1978	City of Sheboygan wastewater treatment plant upgraded, providing service for Kohler, Sheboygan Falls and Sheboygan.	Fish and Wildlife, Recreation Use
1978	Fish consumption advisories established for AOC.	Recreational Use
1979	Tecumseh dike evacuated and replaced.	Fish and Wildlife, Navigation
1980	Onion River watershed designated as a Priority Watershed by Wisconsin's Nonpoint Source Water Pollution Abatement Program.	Fish and Wildlife, Recreational Use
1984	Sheboygan River Task Force formed.	--

HARBOR SEDIMENT MANAGEMENT

The existing Federal navigation project at Sheboygan was authorized by the Rivers and Harbors Acts of 1866, 1907, 1927, 1954 and subsequent acts (U.S. ACOE 1979). The first harbor improvements, constructed in 1852, consisted of parallel piers at the mouth of the Sheboygan River. The first dredging occurred in 1867, providing a channel with a project depth of 12 feet and length of 320 feet. Minor construction and dredging continued through the 19th century. The south pier was completed in 1904. Construction of the north breakwater commenced in October 1913 and was completed in October 1931. Dredging of the existing turning basin was completed in 1931. Dredging of the entrance channel to current project depth was completed in July 1938. The authorized project which includes present navigation features (see "Chapter III. Environmental Setting"), was completed in December of 1956 (Figure III.1).

The Sheboygan harbor, from Lake Michigan to Eighth Street, was dredged to project navigation depths (25 and 21 ft) by the U.S. Army Corps of Engineers between 1956 and 1969. The sediments were removed annually and disposed of in the off shore waters of Lake Michigan. Dredging of the harbor (excluding the mouth) was halted in 1969 due to U.S. EPA and WDNR's decision prohibiting open water disposal of contaminated sediments. The Corps' sediment sampling revealed heavy metal contamination at that time.

In 1979, the Corps (Chicago District) produced a draft Environmental Impact Statement (EIS) relating to the operation and maintenance of Sheboygan harbor

PCB REGULATION

The U.S. Food and Drug Administration (FDA) became involved in the regulation of PCBs in 1969 when the chemical was first discovered in food items (Sonzongni and Swain 1984). In 1973, temporary tolerance limits were established to protect the consumer from food products indirectly contaminated with PCBs. A 5 ppm tolerance level in fish for human consumption was also established in 1973 (Federal Register 38 FR 18096). The manufacture of PCBs and the purchase for use in the U.S. was prohibited as of July 1, 1977 (Federal Register 42 FR 6531 and 44 FR 31514). As a result of increased concern over PCB toxicity, the federal FDA lowered the tolerance levels for several food categories in 1979. The 5 ppm tolerance level for fish was lowered to 2 ppm in 1984 (Federal Register 49 FR 21514). In 1985, a tolerance level of 3 ppm (fat basis) was established by the federal FDA for poultry consumption.

The ban of PCBs and the establishment of fish and poultry consumption tolerance levels by regulatory agencies constitutes wildlife and human health risk management.

DEVELOPMENT OF REGIONAL AND WASTEWATER TREATMENT FACILITIES IN SHEBOYGAN

The 1978 upgrading and expansion of the City of Sheboygan wastewater treatment plant to provide regional treatment services for Sheboygan Falls, Kohler and nearby areas was a major step for improved water quality in the Sheboygan AOC. The City of Sheboygan first constructed a wastewater treatment plant on the

of Sheboygan's two major wastewater pumping stations located at North Avenue and N. 3rd Street and at Kentucky Avenue and S. 7th Street.

Following the 1977 approval by the WDNR of the plans and specifications for the regional wastewater treatment facilities, the City of Sheboygan received federal funding for 75 percent of the project cost. The WDNR provided approximately five percent of the project cost, with the remainder being funded locally.

In January 1978, construction of the $23.9 million regional treatment facilities commenced. The liquid handling portion became operational in December 1979 and the solids handling portion in the fall of 1981. Construction of the $1.04 million west interceptor, $810,000 sanitary sewer rehabilitation, and $1.55 million upgrading of the North America and Kentucky Avenue pump stations was concurrent with construction of the treatment facilities (Unpublished data, WDNR Southeast District Wastewater files). The construction of these facilities was a positive action taken to improve the quality of the effluent discharged to the surface water.

CONSUMPTION ADVISORIES

On April 20, 1978, the WDNR and Department of Health and Social Services recommended that the public not eat the fish from the Sheboygan River between the Sheboygan Falls Dam and the Coast Guard Station in Sheboygan because the fish tissue contained PCBs in excess of the FDA tolerance limit of 5 ppm.

block house located near the Sheboygan Falls landfill. This was scheduled to be an eighteen month storage site until a permanent site was located. In July, 1982 Tecumseh arranged to have the material transported to a federally licensed disposal site near Cincinnati, Ohio. The disposal cost was $1.0 million. The temporary storage facility was cleaned and it presently used by the city as a garage.

ONION RIVER PRIORITY WATERSHED

In 1980 the Onion River watershed was designated as a Priority Watershed under Wisconsin Nonpoint Source Pollution Abatement Program. Implementation of nonpoint source control measures began in 1981 and will be completed in late 1989. See the "Sheboygan River Priority Watershed" discussion for information on priority watersheds and Wisconsin's Nonpoint Source Pollution Abatement Program.

SHEBOYGAN COUNTY WATER QUALITY TASK FORCE

The Sheboygan County Water Quality Task FOrce was self created in late 1984 to explore possible cleanup solutions and to coordinate restoration efforts for the Sheboygan River and harbor. Task Force members include representatives from industry, government, fishing and conservation groups, and the general public (Appendix F, Figure 1). Among the Task Force's accomplishments and/or projects underway are:

* Establishment of an administrative facility to manage the affairs for the

accomplishments and interest in the project. The role of the Task Force in development of the RAP is the following:

* Review and comment on draft chapters of the Remedial Action Plan;

* Assist the DNR in the preparation of a popular summary of the final plan;

* Maintain a mailing list of interested individuals; and

* Sponsor three informational meetings for the public.

DESIGNATION OF TWO SUPERFUND PROJECTS

The Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) responds to hazardous waste problems on a national level. The objectives of CERCLA are: 1) to develop a comprehensive program to set priorities for cleaning up hazardous waste sites; 2) to make responsible parties pay for these cleanups; 3) to set up a hazardous waste trust fund, popularly known as "Superfund" (for the twofold purpose of performing remedial cleanups in cases where responsible parties could not be found and responding to emergency situations involving hazardous substances); and 4) to advance scientific and technological capabilities in all aspects of hazardous waste management, treatment, and disposal. CERCLA's reauthorization in 1986, commonly referred to as Superfund Amendments and Reauthorization Act (SARA),

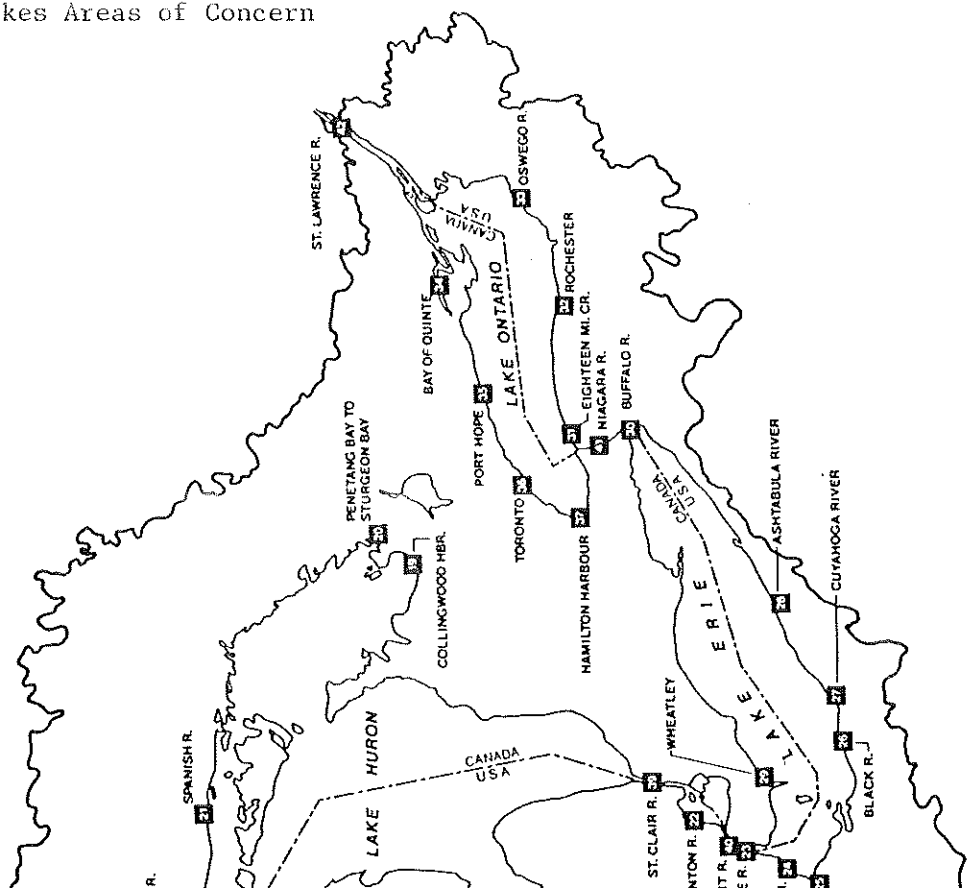
including water purification and treatment, to control the pollution. Such efforts eventually let to the elimination of waterborne disease epidemics in the Great Lakes Basin.

With the passage of time, other problems became evident, particularly eutrophication. Increasing concern for eutrophication of certain areas of the Great Lakes culminated in the signing of the 1972 Great Lakes Water Quality Agreement. The 1972 Agreement provided the focus for a coordinated effort to control phosphorus inputs and thus abate eutrophication problems. As scientific knowledge increased, the 1972 Agreement was expanded in 1978 to recognize the need to understand and effectively manage toxic substance loadings into the Great Lakes. An ecosystem approach, requiring a more integrated and holistic perspective to protect water quality and health of the entire Great lakes system, was also emphasized. That approach recognizes the complex interrelationships among water, land, air, plant and animal life, including humans.

Since 1973, in its annual assessments of Great Lakes water quality, the IJC's Water Quality Board has identified Problem Areas. There were designated as Areas of Concern in 1980. These are areas where Water Quality Agreement objectives or jurisdictional standards, criteria, or guidelines established to protect uses have been exceeded and remedial measures are necessary to restore all beneficial uses. Areas of Concern include the major municipal and industrial centers on Great Lakes rivers, harbors, and connecting channels.

The number of Areas of Concern has changed with time due to improvements in water quality, the emergence of new problems or, reinterpretation of the significance of previously reported problems based on more comprehensive data.

Figure VII.1 Great Lakes Areas of Concern



* Describe the causes of the problems and identify all known sources of pollutants.

* Provide a schedule for implementing and completing remedial measures.

* Identify jurisdictions and agencies responsible for implementing and regulating remedial measures.

* Describe the process for evaluating remedial program implementation and effectiveness.

* Describe surveillance and monitoring activities that will be used to tract effectiveness.

* Describe surveillance and monitoring activities that will be used to track effectiveness of the program and eventually confirm that uses have been restored.

The development of RAPs represent a challenging departure from most historical pollution control efforts. Previously , separate programs for regulation of municipal and industrial discharge., urban runoff, and agricultural runoff were implemented without considering overlapping responsibilities or whether the programs would be adequate to restore all beneficial uses. This new process will call upon a wide array of government agencies at all levels. All programs, agencies, and communities affecting an Area of Concern must work together on common goals and objectives in the RAP to assure its successful implementation (IJC 1987a.)

out the plan and installing the necessary nonpoint source control measures. The period of plan implementation will likely be eight years in length.

FIVE YEAR STUDY AND IN-PLACE POLLUTANT DEMONSTRATION PROJECT

The Federal Water Pollution Control Act of 1987 proposed the Sheboygan Harbor as a site for priority consideration for a five year study and demonstration project. The U.S. EPA Great Lakes National Program Office (GLNPO) will carry out the study and project relating to toxic pollutants in the Great Lakes. Chemical, biological, and physical data will be utilized for the development of a Sediment Action Index. This work will emphasize site specific toxicity and bioavailability of contaminants when assessing the problem and remedial options. The Sheboygan harbor investigation is expected to be initiated in the summer of 1989.

VIII. GOALS AND OBJECTIVES FOR THE SHEBOYGAN AOC ECOSYSTEM

The goals for the Sheboygan AOC were established with consideration for the goals and objectives of the Clean Water Act and Great Lakes Quality Agreement, state and federal water quality standards, and the concerns of the public and the Sheboygan County Water Quality Task Force. A public survey developed by the Task Force aided in the development of the goals and objectives. The following are Wisconsin's long term goals and objectives for achieving beneficial uses in the Sheboygan AOC by the year 2000.

ECOSYSTEM GOALS AND OBJECTIVES FOR RESTORATION OF IMPAIRED USES

I. PROTECT THE ECOSYSTEM (INCLUDING HUMANS, WILDLIFE, FISH, AND OTHER ORGANISMS) FROM THE ADVERSE EFFECTS (ON THE REPRODUCTION, SURVIVAL, AND HEALTH OF INDIVIDUALS, AND THE INTEGRITY OF INTERSPECIES RELATIONSHIPS) OF TOXIC SUBSTANCES;

II. MAINTAIN AND ENHANCE A DIVERSE COMMUNITY OF TERRESTRIAL AND AQUATIC LIFE AND THEIR NECESSARY HABITAT;

III. CONTROL EUTROPHICATION (NUTRIENT ENRICHMENT OF WATER) FOR THE PROTECTION OF LAKE MICHIGAN; AND

6. *Reduce bacteria levels in the Sheboygan, Onion, and Mullet Rivers to meet state recreational use standards (Goal IV)*

7. *Provide adequate public access and recreational facilities (Goal IV)*

8. *Enhance public understanding, education, and participation to support the ecosystem goals of this plan (Goals I, II, III, and IV)*

The Sheboygan AOC is a valued state resource. It is important from an economic and recreational standpoint. The Sheboygan area is utilized for sport and charter fishing, and commercial shipping and development. Sheboygan has taken a lead in charter fishing along Wisconsin's coast of Lake Michigan. The Sheboygan Harbor area experienced increases in catch and angler pressure between 1969 and 1984. Commercial shipping also occurs in the harbor for transport of coal and other materials. Shops have been developed around the old fish shanties and there are city plans for continued waterfront development, which includes a marina.

The plan's goals describe a desired ecosystem that is a compromise between the extremes of full restoration to presettlement conditions and continuing degradation. Environmental, economic and recreational concerns are reflected in these goals. Wisconsin expects these goals to be achieved by the year 2000.

WATER USE AND QUALITY OBJECTIVES

Water Quality Criteria

Water quality necessary to support the above biological and recreational uses are quantified by certain measurable criteria. These criteria are specified for critical water quality parameters which must be maintained to enable the waterway to continually meet its designated use. Water quality criteria for the lower Sheboygan River and the inner and outer harbor area are contained in Tables III.4 through III.7.

"HOW CLEAN IS CLEAN?" AND SEDIMENT QUALITY CRITERIA

The sediment in some areas of the Sheboygan River and harbor is contaminated with PCBs, heavy metals, and other compounds. (See Chapter IV. "Definition of the Problem" for data.) Potentially toxic substances, such as PCBs, have caused fish and waterfowl consumption advisories and dredging restrictions. In order to remediate these problems and protect the ecosystem from the adverse affects of toxic substances (as identified in Goal I), the determination of "How clean is clean?" is required.

Because the sediment is a major sink as well as a source of PCBs to aquatic organisms, a sediment PCB concentration which would produce a nontoxic PCB concentration in organisms is needed in order to make environmentally, socially, and economically sound management decisions regarding remediation. A nontoxic PCB concentration in organisms can be defined in various ways depending on who/what is being protected and the manner in which PCBs are defined.

Applicable LIC, Federal and State Guidelines

Contaminated Sediment Disposal Guidelines: PCBs are toxic substances under the federal Toxic Substance Control Act (TSCA). Dredge spoils containing greater than 50 ppm total PCBs are required to be disposed of at a federally approved chemical waste facility.

Sites and facilities for the disposal of PCBs in Wisconsin require review under administrative rules NR 157, 181, 500-522, and 347. There are currently no state rules that identify acceptable PCB concentrations in dredge spoils for disposal in confined disposal facilities (CDFs) in water. Management decisions are made on a case by case basis.

Chapter NR 157, the State's PCB regulations, require that the disposal of any waste containing PCBs be in a state approved incinerator or hazardous waste landfill for PCBs. NR 157 also allows other methods of disposal as approved by the WDNR on a case-by-case basis.

WDNR considers dredge spoils containing less than 10 ppm PCBs as solid waste (subject to NR 500-520) and the provisions of NR 157 for an incinerator or hazardous waste landfill are not required. Dredge spoils containing greater than 50 ppm PCBs must be disposed in a facility approved under hazardous waste disposal regulations NR 181. Dredge spoils containing more than 10 ppm PCBs but less than 50 ppm PCBs may also be disposed in a solid waste landfill if approved by the WDNR.

The proposed Wisconsin Rule NR 522 sets technical standards for the construction of dredge spoil disposal facilities. Under WDNR guidance issued in February 1987, dredge spoils containing less than 10 ppm PCBs could be

-- congener 77 (one of the more toxic congeners) is probably not present in Sheboygan sediments;

-- aquatic organism bioaccumulation is minimal at 4 C and greater at 20 C;

-- organisms' PCB concentration increased with increasing sediment PCB concentration, but at a decreasing rate (steady state concentrations were predicted for each organism at each PCB treatment level and temperature and for PCB homologs);

-- uptake occurred without direct sediment contact;

-- the degree of sediment contamination is much less a determinant of actual bioaccumulation than are physical, chemical, and biological processes affecting bioavailability;

-- bioavailability is enhanced by the suspension of contaminated sediment;

-- PCB transport from sediment to aquatic organisms is a function of organic carbon content; and

-- if dredging of the harbor is to occur, it should be done during the time of year when water temperature and biological activity are low and in such a way to minimize suspension of contaminated sediment.

Thus, two major conclusions of the Corps study were that high PCB concentrations in sediment did not result in proportionately high concentrations in the organisms' tissue and that the degree of sediment contamination is much less a determinant of actual bioaccumulation than are

A study on Puget Sound, WA sediment was conducted by Chapman (1986) to derive sediment quality criteria for lead, polycyclic aromatic hydrocarbons (PAHs), and total PCBs. This was reported to be the first study in which sediment contaminant criteria were derived using sediment chemistry, in situ studies, and sediment bioassays in combination. Chapman dubbed the combination of these studies as the "Sediment Quality Triad". Thus, the study utilized toxicological data in addition to observed levels of contaminants in sediment and organisms in determining criteria.

The sediment concentration derived for total PCBs at which no or minimal biological effects were observed was 0.1 ppm. The derivation of this concentration ignored which of the contaminants may have caused the observed biological effects. However, synergistic or antagonistic interactions between the chemicals were possible, providing more of a real world system. Toxicological and biological effects were measured using three bioassays and fish histopathology. It was reported that biological effects increased with a corresponding increase in contaminant concentrations in the sediment.

Transfer or application of these criteria to the Sheboygan River is currently not possible. However, similar work is being done on areas of the Great Lakes by U.S. EPA. The U.S. EPA Great Lakes National Program Office in coordination with U.S. Army Corps of Engineers, U.S. EPA Large Lakes Research Lab, and others are developing a Sediment Action Index as part of a 5 year study and demonstration project as authorized by the Clean Water Act Amendment of 1987. In development of this index, chemical, physical, biological and bioassay data are being used to rank sediment quality for various Great Lakes areas. This

The most toxic congeners (of those for which toxicity data exists) have been reported to be the coplanar hexachlorinated (3,3',4,4',5,5'--no.169) and pentachlorinated (3,4,4',5,5'--no. 126) biphenyls (Safe et al. 1985, Leece et al. 1985, McKinney and Singh 1981, Goldstein et al. 1977, Silkworth and Grabstein 1982, Yoshihara 1979). These congeners are present in Aroclors in very minute quantities (Duinker 1988). Congeners 118, 105, 156, 123, and 157 are mono-orthochloro-substituted isomers of the coplanar PCBs which have displayed toxic and biologic responses, but are much less potent than 169 and 126 and their potency is 3 to 4 orders of magnitude smaller than 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) (Safe et al. 1985, Safe 1987b).

The toxic responses and enzyme induction produced by the most toxic PCB congeners are similar to those produced by tetrachlorodibenzo-p-dioxin (TCDD). These compounds are also structurally similar. Thus, the research emphasis has been to study structure activity relationships between PCB congeners and TCDD. Not all of the PCB congeners have been studied in terms of laboratory toxicity testing, but there are general conclusions with respect to toxicity based on the structure activity relationships and from the congeners that have been tested. Since the toxicity of halogenated organic compounds is often compared to the highly potent TCDD, one might expect the coplanar 3,3'4,4'-tetrachlorobiphenyl (77) to be highly toxic, since it is most structurally similar to TCDD of all the congeners. However, the in vivo toxicity of 77 is significantly lower than 169 and 126 (Leece et al. 1985, Safe et al. 1985). It appears that congener 77 along with other lesser chlorinated congeners, particularly those with two adjacent unsubstituted carbon atoms, are rapidly metabolized in vivo, and, therefore detoxified (Safe 1987b, Birnbaum 1985). Note that metabolism does not always imply detoxification of chemicals, but with PCBs, this appears to be the general rule.

IX. RECOMMENDED REMEDIAL ACTIONS

In this chapter, the four ecosystem goals of this planning process will be discussed individually. It is essential that the RAP, the Superfund Project and other projects that are investigating the contaminated sediment problems and associated toxicity, coordinate their efforts to have a positive effect in Sheboygan. Ongoing work should continue in order to refine the definition of the problem and insure proper decisions are made regarding remediation of the contaminated sediment. Since the RAP is being completed prior to the other Sheboygan efforts, this RAP identifies informational needs for determining "How Clean is Clean?" for the Sheboygan AOC. Remedial alternatives for the contaminated sediment are discussed based on information currently available. There may be more options available to control toxics in sediment if the informational needs outlined below proceed. Thus, the RAP should be updated when additional information is available from the ongoing toxics control projects (~1991).

Remedial actions for enhancing fish and wildlife habitat, controlling eutrophication, and enhancing recreation (goals II, III, and IV) are available and the appropriate management actions are listed and discussed.

ECOSYSTEM GOAL I: PROTECT THE ECOSYSTEM (INCLUDING HUMANS, WILDLIFE, FISH, AND OTHER ORGANISMS) FROM THE ADVERSE EFFECTS (ON THE REPRODUCTION, SURVIVAL, AND HEALTH OF INDIVIDUALS, AND THE INTEGRITY OF INTERSPECIES RELATIONSHIPS) OF TOXIC SUBSTANCES

Who's Responsible: University of Wisconsin, Wisconsin DNR
Estimated Cost: $200,000 (Wisconsin Coastal Management, Wisconsin Sea Grant), $1,000-$6,000 (WDNR)
Target Completion Date: Oct 1988-1990

The proposed Wisconsin Sea Grant / Coastal Management study (Appendix G) to be initiated in the fall of 1988 will assess the types and levels of PCB congeners in several sediment samples from the Sheboygan AOC and determine whether dechlorination and detoxification have occurred. Congener toxicity information available from the scientific literature will be utilized to determine the potential toxicity of the congeners present. The results of this study could have major environmental and economic implications if it were found that toxic congeners were not present in significant concentrations. If it were found that toxic congeners were present, there may be a greater incentive to "clean-up" this area. The estimated cost of this two year study is approximately $200,000.

WDNR will collect fish from the Sheboygan AOC and perform congener specific PCB analyses as specified in the 1988 fish collection schedule. The approximate cost of the laboratory analyses is $1000. The cost for the total Sheboygan AOC fish contaminant effort is approximately $6000.

#I. A.1.b. Perform 2,3,7,8-TCDF (furan) analyses in fish to determine if they are present in the ecosystem.

Who's Responsible: WDNR

consideration as a site for a Demonstration Project under the Clean Water Act Amendments of 1987 under GLNPO's guidance. The total estimated cost for analysis is estimated at $85,000.

Remedial Action #I. A. 2. Complete Remedial Investigation and Feasibility Study (RI/FS) for the Sheboygan River and Harbor.

Who's Responsible: Tecumseh Products Co., U. S. EPA
Estimated Cost: $1,000,000 +
Target Completion Date: 1989

The Remedial Investigation phase of the Superfund Project was completed by Tecumseh Products Co. (Blasland and Bouck Engineers, P.C.) in October 1988. This phase included sample collection, analysis, and interpretation, contaminant transport assessment, endangerment assessment, and screening of remedial alternatives. The Feasibility Study will proceed, which includes the selection of remedial actions. The cost associated with this investigation and study are being borne by Tecumseh Products, Inc. in cooperation with the U.S. EPA.

Remedial Action #I. A. 3. Implement Superfund Remediation.

Who's Responsible: USEPA-identified PRP's (Tecumseh Products Co., Kohler Co., Thomas Industries, Inc.)
Estimated Cost: To be identified in Sheboygan River and Harbor RI/FS
Target Completion Date: After completion of the RI/FS

Table IX.3 illustrates the processes for the management of contaminated sediment (LIC Sediment Subcommittee report 1987a). Assuming that the sediment

-- Cost and the associated economic impacts need to be considered.

-- Public perception & expectations need to be reconciled.

Current data for the Sheboygan Area of Concern indicates that PCBs will bioaccumulate in aquatic organisms when exposed to "high" or "low" sediment PCB concentrations (Tatem 1986). The Corps study concluded that high PCB concentrations in sediment did not result in proportionately high concentrations in the organisms' tissue and that the degree of sediment contamination (by itself) is much less a determinant of bioaccumulation than are the sum total of physical, chemical, and biological processes affecting bioavailability. There does not appear to be a simple sediment - organism relationship, i.e. a sediment concentration which would establish a "desired" (or predetermined) level of PCBs in organisms. Thus, when using bioaccumulation of PCBs for determining "How Clean is Clean?", a relatively low sediment concentration may produce levels in fish that could also be obtained from a relatively high sediment PCB concentration. So, while dredging of just the "hot spots" is a possible management alternative, it is stressed that the problems identified to date will likely remain, i.e. PCBs in organisms, fish and waterfowl consumption advisories, and harbor dredging restrictions.

Disposal and treatment options for dredged spoils include confined disposal facility, incineration, and other options:

Confined Disposal Facility (CDF): CDFs are the most frequently used disposal

	Island		Landfill	
nual	Total	Annual	Total	
	200,000[1]– 300,000[2]		200,000[1]– 300,000[2]	
	3,600[1]– 8,100[2]		3,600[1]– 8,100[2]	
800[2]	17,500[2]	800[2]	17,500[2]	
	26,847,000		8,480,000	
20,000	25,400,000	2,070,000	41,400,000	
	2,427,000		2,472,000	
76,950[2]	1,539,000[2]	76,950[2]	1,539,000[2]	
20,400	408,000	20,400	408,000	
90,400	55,285,600	2,090,400	52,918,600	
	13.82		13.23	
68,200	56,946,600	2,168,200	54,579,000	
	14.24		13.62	

es and Landfills

-- the sediment to be dredged was sufficiently contaminated to cause the Corps to determine it to be confined

-- CDF design similar to eastern Wisconsin CDFs

-- mechanical dredging

-- direct transfer of dredged material to a CDF

-- CDF a few miles away from dredging site

-- design fill volume of 4×10^6 yd^3

-- the future use of the CDF was not evaluated

Variations in site design, as well as changes due to regulatory reviews could change the individual cost components substantially and contractors could also have an effect through judicious selection of materials, construction techniques, experience, labor, and machinery (Grefe 1988). The report also noted that the IJC total cost estimates varied, but individual construction costs often equaled or exceeded WDNR construction cost estimates (IJC estimates range from \$1-5/m^3).

PCB concentrations greater than 50 ppm in dredge spoils must be disposed at a federally licensed chemical waste facility under the rules of the Toxic Substance Control Act. This could be an approved landfill or an incinerator.

Table IX.2 Unit Cost Estimates for Steps Involved in Treatment and Disposal of PCB-Contaminated Sediments

Operation	Cost, $/m^3
Dredging	20
Transport	13 to 126
Storage	10
Landfill and Disposal	260 to 490
Landfarming	33
Restricted Land Disposal	111
Incineration	1680

Source: Carpenter, 1987

Table IX.3 Screening of PCB Treatment Processes

Screening of PCB Treatment Processes			
Generic technology	*References*	*Process*	*Evaluation[a]*
Chemical	*Centofanti 1971; Chen 1982; Childs 1982; Craddock 1982; Edwards et al. 1982; Environment Canada 1983; Hornig 1984; Massey and Walsh 1985; Rogers and Kornel 1985; Rogers 1983; Rogers 1985.*		
Low-temperature oxidation			
Wet air oxidation	*Baillod et al. 1978; Miller and Sevientoniewski (n.d.); Miller and Fox 1982.*	*Uncatalyzed, general*	*2*
		Zimpro Process, Santa Maria, CA Waste Site	*4, 13*
		Catalyzed	
		Dow Chemical Co. Patent 3,984,311	*2*
		IT Environmental Science	*2*
Supercritical water oxidation	*Modell et al. 1982.*	*Modar*	*1*
Chemical oxidants	*FMC Corporation (n.d.); March 1968.*	*Potassium permanganate plus Chromic Acid and Nitric Acid*	*6*
		Chloroiodides	*4, 7*
		Ruthenium tetroxide	*3, 4, 8*
Ozonation	*Arisman et al. 1981; Lacy and Rice Deschlaeger 1976; Prengle and Mauk 1978.*	*GE UV/ozonation process*	*2*
Chlorine removal	*U.S.P. 346, 636*	*Molten aluminum/distillation*	*14*
Dehydrochlorination	*Chu and Vick 1985; Lapiere et al. 1977.*	*Catalytic:*	*2, 3*
		Nickel on kieselguhr	*2, 3*
		Pd on charcoal	*2, 3*
		Lithium aluminum hydride	*2, 3*
		Butyl lithium	*2, 3*
		Raney Nickel	*2, 3*
Reducing agents	*Chu and Vick 1985; Sworzen and Ackerman 1982.*	*Sodium in liquid ammonia*	*7, 9*
		Nickel-catalyzed zinc reduction	*7, 9*

Table IX.3 (cont.)

(Continued) Generic technology	References	Process	Evaluatio.
Physical			
Removing and concentrating	*Angiola and Soden 1982; Caron 1985; Gilmer and Freestone 1978; Githens 1984; Hancher et al. 1984; Hawthorne 1982; Lee et al. 1979; Saunders 1985; Schwinn et al. 1984; Versar, Inc. 1984.*		
Heated Air Stripping		*American Toxics Disposal, Inc.*	*14*
Extraction		*Critical Fluid Systems, CO_2*	*14*
		Furfural	*15*
		Acurex solvent wash	*1*
		O.H.M. extraction	*1*
		Soilex process	*1*
Adsorption		*Carbon adsorption, general*	*13*
		Neoprene rubber adsorption	*15*
Vitrification	*Timmerman 1985.*	*Battelle vitrification process*	*1*
Stabilizing	*Ghassemi and Haro 1985; Law Engineering Testing Company 1982; Stroud et al. 1978; Subramanian and Mahalingam 1977; Tittlebaum et al. 1985.*	*Asphalt with lime pretreatment*	*16*
		Z-Impremix	*15*
		Sulfur-asphalt blends (K-20)	*16*
		Ground freezing	*13*
Bottom recovery	*Carich and Tofflemire 1983; Hand and Ford 1978; Murakami and Takeishi 1978; U.S. Army Corps of Engineers Water Resources Support Center 1983; Zimmie and Tofflemire 1978.*	*Dredging*	*13*
Biological			

Table IX.4 Treatment Process Assessment

Treatment Process Assessment						
Process	*Status*[a]	*Estimated D/D/R efficiency, %*[b]	*Estimated residual PCB, ppm*	*Test and evaluation data needs*	*Estimated costs, $/m³*	*Rating*[c]
Chemical/physical						
Supercritical water oxidation, Modar	*Field test with PCB liquids*	*>99.9995*	*<0.1 ppb*	*1,2,3,4,5,6,7*	*250-733*	*4.58*
KPEG Terraclean-CL	*Pilot tests*	*>98*	*<1 ppm*	*1,6*	*208-375*	*5.42*
LARC	*Lab tests*	*>90*	*38-50*	*2,3,4,5,6,7*	*223-336*	*5.26*
Advanced electric reactor	*Pilot tests*	*>99.9999*	*<1 ppb*	*None*[d]	*830-943*	*4.58*
Physical						
O. H. Materials, methanol extraction	*Field tests under way*	*97*	*<25 ppm*	*2,3,6,7*	*401-514*	*4.16*
Soilex	*Pilot tests*	*95 (3 stages)*	*6-9 ppm*	*5,6,7*	*856-913*	*3.26*
Acurex solvent wash	*Pilot-scale (field tests planned)*	[e]	*<2 ppm*	*Identity of mixed solvent, 6,7*	*196-569*	*5.21*
In-situ vitrification Battelle Pacific NW for EPRI	*Pilot test of soil*	*99.9*	*None in vitrified block, 0.7 ppm in adjacent soil*	*6*	*255-548*	*4.53*
Biological						

Table IX.5 Treatment Process Cost Comparison/m^3

KPEG	$ 211-378
LARC	$ 223-336
Acurex Solvent Wash	$ 196-569
Bio-Clean	$ 191-370
Modar Supercritical Water	$ 250-733
Advanced Electric Reactor	$ 830-942
Vitrification	$ 255-548
OHM Methanol Extraction	$ 400-514
Soilex Solvent Extraction	$ 856-913
Composting	Unable to Estimate Cost
Sybron Bi-Chem 1006	Unable to Estimate Cost

< 1 ppm, respectively. It appears that removing and concentrating (vitrification) has the potential to achieve no residual PCBs in the vitrified block and 0.7 ppm in adjacent soil. Microbial processes vary in PCB concentrations that are treatable and the residual concentrations attained. All of the processes were reported to have achieved better than 90% destruction/detoxification/removal efficiency. These processes are emerging as potential alternatives to incineration and chemical waste landfills.

Remedial Action #I. A. 4. Establish State and Federal In-Place Pollutant Management Program.

Who's Responsible: Wisconsin DNR, U.S. EPA
Estimated Cost: $240,000 (start-up costs for state program)
Target Completion Date: 1990

Neither the state nor federal environmental protection authorities have established an in-place pollution program. Wisconsin will be developing guidance documents for establishing a program. The guidance should be completed within 2 years. It is estimated that $240,000 will be required to establish this program in Wisconsin. This cost is not specific to the Sheboygan AOC.

Remedial Action #I. A. 5. Apply state and federal programs if Superfund Implementation programs do not meet sediment quality criteria as established in Remedial Action A.1.

Follow-up chemical monitoring and/or bioassay studies will be conducted at the following facilities:

* Village of Belgium Wastewater Treatment Plant
* City of Plymouth WWTP
* City of Sheboygan WWTP
* Village of Waldo WWTP
* City of Keil WWTP
* Lakeland College
* Kohler Company (in progress; a permit will be issued)

Facilities identified as having toxic materials in their waste discharge will be regulated under the proposed administrative codes NR 105 and NR 106. Identification of toxic sources will cost approximately $25,000 and will be the responsibility of permit holders. Treatment for reduction of toxics from point sources is not estimated.

Remedial Action #I. B. 2. Identify and reduce nonpoint sources of toxicity.

Who's Responsible: WDNR, Sheboygan County, Cities of Sheboygan and Sheboygan Falls and Village of Kohler
Estimated Cost: (See cost estimates for Remedial Action #II.D.2)
Target Completion Date: 1998

The Nonpoint Source Water Pollution Abatement Program will help reduce sources of lead from urban runoff through implementation of the Sheboygan River Priority Watershed Plan. (See Remedial Action II.D.2 for more detailed information).

REMEDIAL ACTION #I. C: MONITOR TO EVALUATE RESTORATION OF BENEFICIAL USES AND ACHIEVEMENT OF GOAL I.

Remedial Action #I. C. 1. Monitor contaminant levels in wildlife.

Who's Responsible: WDNR Wildlife Management
Estimated Cost: $2700 (1988)
Target Date: Annually

WDNR (Southeast District Wildlife staff in conjunction with the Bureau of Wildlife Management) will continue to collect waterfowl and perform tissue analyses to determine toxic contaminant levels. This information will be used to refine waterfowl consumption advisories, if necessary, and track trends in contaminant levels. The approximate cost for the laboratory analyses is $2700 for 30 samples. Fifteen mallard ducks will be collected from the Sheboygan River and 15 lesser scaup from the harbor in 1988.

Remedial Action #I. C. 2. Monitor contaminant levels in fish.

Who's Responsible: WDNR Fishery Management
Estimated Cost: $7,000 (Annually)
Target Date: Annually

WDNR (Southeast District Fishery Staff in conjunction with the Bureau of Fisheries Management) will continue to collect various species of resident and migrant fish from the Sheboygan River and Harbor to determine contaminant

In order to determine the effectiveness of the above toxic substances management remedial actions, evaluation monitoring will be required. The WDNR will conduct in-situ assessment of biota to determine if the effects of toxic substances has been reduced to an acceptable level for restoration of beneficial use.

ECOSYSTEM GOAL II. MAINTAIN AND ENHANCE A DIVERSE COMMUNITY OF AQUATIC AND TERRESTRIAL LIFE

Objectives:

- **Protect natural areas (greenspaces) along the waterway and enhance habitat for aquatic and terrestrial communities**

- **Maintain diverse resident fishery and with the attainment of the toxic substance reduction, establish seasonal runs of coho and chinook salmon and steelhead**

- **Continue to control nutrient inputs to the Sheboygan River and nearshore areas of Lake Michigan to meet the goals of the Great Lakes Water Quality Agreement and to reduce abnormal occurrence of undesirable algae in the marina area of the harbor**

Presently, the Lower Sheboygan River supports a diverse population of fish and wildlife species. However, this diversity is being threatened due to:

commitment from the U.S. Army Corps of Engineers to conduct an Advanced Identification and Special Area Management Plan for the Sheboygan AOC to assure critical areas are protected.

Under Wisconsin administrative codes NR 115 and NR 117, local communities and counties are required to protect wetlands located in the shoreland area of navigable streams. Sheboygan County and the City of Sheboygan presently have wetland zoning ordinances. Due to the lack of wetlands and limited development pressure, the City of Sheboygan Falls and Village of Kohler have not been required to adopt wetland zoning ordinances to date. In the future, these communities will be required to have wetland zoning ordinances. All communities may wish to consider going beyond minimum requirements of NR 115 and 117. Rezonings, allowing the filling and draining of wetlands protected under these ordinances, will not be granted for parcels that provide water quality protection or important fish and wildlife habitat.

REMEDIAL ACTION #II. B: PROTECT GREEN SPACES THROUGH ADOPTION AND IMPLEMENTATION OF A SEWER SERVICE AREA PLAN.

Who's Responsible: Bay Lakes Regional Planning Commission, Village of Kohler, City of Sheboygan Falls, City of Sheboygan
Estimated Cost: $30,000 (WDNR)
Target Completion Date: 1990

Under the Federal 208 Water Quality Planning Program, administered by the State of Wisconsin (Wisconsin Administrative Code NR 121), sewer service areas

REMEDIAL ACTION #II. D: REDUCE SEDIMENTATION SO THAT SUSPENDED SOLID CONCENTRATIONS IN THE LOWER SHEBOYGAN RIVER ARE REDUCED TO A MEAN CONCENTRATION OF LESS THAN 25 MG/L FOR 90% OF THE TIME AND BEDLOAD (SOLIDS TRANSPORTED AND DEPOSITED ALONG RIVER BOTTOM) IS REDUCED BY 50 TO 75 PERCENT.

Suspended solid concentrations in the lower Sheboygan River from 1977 through 1987 have ranged from zero to 75 mg/l approximately 90 percent of the time. Sediment can impact the local fish and aquatic life in the following ways:

* By acting directly on fish by either killing them or reducing their growth rate, resistance to disease, etc.,
* By preventing the successful development of eggs and larvae,
* By modifying natural movement and migration,
* By reducing availability and abundance of food, and
* By degrading habitat

Research by the European Inland Fishery Commission (EIFAC) has shown that suspended solid concentrations below 25 mg/l have no impact on fish health. However, concentrations ranging from 25 to 80 mg/l produce populations with reduced yield, and concentrations greater than 80 mg/l are likely to produce an unbalanced fishery.

In addition to impacts on the local fishery, excess sediment deposited in the Sheboygan harbor is inhibiting commercial navigation. The U.S Army Corps of Engineers presently maintains navigation channels in the Sheboygan harbor. It is estimated that the Sheboygan River transported 21815, 16278 and 27280 tons of sediment in 1980, 1981 and 1982, respectively to the lower Sheboygan River and harbor (Bannerman et al. 1984). The City of Sheboygan is interested in maintaining a commercial harbor to sustain a diverse industrial and commercial

1987, 1214 acres of land have been set aside under this program in Sheboygan County. There are 24,000 eligible acres in Sheboygan County.

Under the Conservation Compliance provision of the 1985 Farm bill, agricultural producers receiving assistance from USDA programs (price supports, crop insurance, low interest loans, etc.) and farming highly erodible land, will be required to implement soil conservation practices. Landowners must have a conservation plan approved by the Soil Conservation Service (SCS) by January 1, 1990 and implemented by January 1, 1995 to remain eligible for USDA programs. This program will impact 60% of the cropland in the Sheboygan River Watershed, or approximately 26,000 acres.

The Wisconsin Farmland Preservation Program gives tax incentives for maintaining land in agricultural land use as well as for reducing soil erosion rates to tolerable levels. Presently, about 850 landowners have entered approximately 170,000 acres into this program in Sheboygan County. Erosion Control Plans completed by each county also identify problem areas and potential funding assistance.

Remedial Action #II. D.2: Implement intensive nonpoint source control programs in the Sheboygan River Basin's three watersheds:

* Initiate and complete implementation of the Sheboygan River Priority Watershed Project:

* Complete implementation of and maintain practices installed by the Onion River Priority Watershed Project; and

supporting, what the potential uses could be for each resource, and how much reduction of specific pollutants (including lead, copper, zinc, fecal coliform, and nutrients) must be attained to reach these potential uses. WDNR will combine these inventories to develop a management plan to attain the objectives for each water resource in the watershed through the control of nonpoint sources of pollution.

The planning process for the Sheboygan River began in 1987 and will be completed in late 1989. Upon completion of the planning, funding will be provided by the state to support local units of governments in carrying out the plan and installing necessary nonpoint source control measures. The project cost for the Sheboygan River is estimated at $2 to $3 million. The period of plan implementation will likely be eight years in length.

The Onion River Priority Watershed Project, selected in 1980, nears completion. 1989 is the last year cost sharing will be provided for implementation of nonpoint source controls. The management plan for the watershed was completed in 1981. The plan identifies $3.1 million of nonpoint source controls (best management practices) needed in the watershed to address the critical cropland, animal waste, and stream bank sources. $1.7 million of that amount was eligible for state funding under the project. During the sign-up period, 81 cost-share agreements were signed with landowners.

As of May, 1989, $311,650 in cost-sharing had been expended to install management practices. Thus a major focus of the remainder of this project (and future projects) must be encouraging landowners to install needed practices that are eligible for cost-sharing.

Studies of the Mullet River indicate that it is also a major source of

Remedial Action #II. D.3: Seek compliance with Wisconsin Act 297.

Who's Responsible: WDNR, Landowners
Estimated Cost: Ongoing program
Target Date: As necessary

The State of Wisconsin will issue orders for corrective action of any water pollution and habitat problems caused by nonpoint sources, including erosion problems where voluntary compliance cannot be obtained. The new law, passed in 1988, impacts on both urban and rural lands.

REMEDIAL ACTION #II. E: MANAGE DAMS TO MINIMIZE ANY ADVERSE ENVIRONMENTAL IMPACTS.

Who's Responsible: Owners of dams, with assistance from WDNR
Estimated Cost: $2,500/dam
Target Date: Upon request

There are three dams located in the AOC of which two are in the Village of Kohler and one in the City of Sheboygan Falls. These dams segregate the river, prevent natural migration of fish and contribute to degraded habitat for fish and aquatic life.

The WDNR has recommended terms and conditions to the Federal Energy Regulation Commission regarding the operation of the Sheboygan Falls dam. Under the proposed conditions, the operators of the dam would have to maintain run-of-

REMEDIAL ACTION #II. G: CONSIDER ESTABLISHMENT OF AN EGG COLLECTION FACILITY IN THE SHEBOYGAN AOC.

Who's Responsible: WDNR
Estimated Cost: $250,000
Target Date: Upon resolution of the PCB contamination problem in the AOC

The Sheboygan River is an excellent location for a coho salmon egg collection facility. Once the PCB issues are resolved, a Sheboygan River facility could be established as a back-up to the Kewaunee facility. WDNR Fisheries management will evaluate the need for a back-up facility to locate in the Sheboygan area. Cost for establishing this facility will be the responsibility of WDNR and are estimated at $250,000.

ECOSYSTEM GOAL III. CONTROL EUTROPHICATION (NUTRIENT ENRICHMENT OF WATER) FOR THE PROTECTION OF LAKE MICHIGAN

Objective: Continue to control nutrient inputs to the Sheboygan River and nearshore areas of Lake Michigan to meet the goals of the Water Quality Agreement and to reduce abnormal occurrence of undesirable algae in the marina area of the harbor.

Eutrophication in the AOC has not been a major problem due to the fast flushing rate of the Sheboygan River and harbor. Water movement is too rapid for excess nutrients to be utilized to form severe algal blooms. However, nutrients discharged from the Sheboygan River do cause some undesirable algal growth in the harbor and are contributing to the potential eutrophication of

REMEDIAL ACTION #III. A: REDUCE PHOSPHORUS IN DETERGENTS AND FROM MUNICIPAL WASTEWATER TREATMENT PLANTS TO MEET THE OBJECTIVES OF THE GREAT LAKES WATER QUALITY AGREEMENT.

Who's Responsible: State of Wisconsin and the Cities of Keil, Plymouth, and Sheboygan Wastewater Treatment Plants,
Estimated Cost: No new cost
Target Date: Ongoing

In 1978, the State of Wisconsin enacted a phosphorus detergent ban. This ban, reauthorized in 1983, limits phosphorus in domestic detergents to 0.5%, machine dishwashing and medical and surgical equipment cleaning agents to 8.7%, and water conditioners to 20% (by weight). This law provides an effective way of reducing phosphorus treatment costs at wastewater treatment plants and reducing phosphorus discharges to Great Lakes tributaries.

All municipal treatment plants treating the waste of communities greater than 2500 in population are required to limit phosphorus discharges to 1 mg/l in their effluent. Communities required to meet this limit include the City of Keil, City of Plymouth, and City of Sheboygan. These municipalities and WDNR will assure compliance with WPDES permit requirements.

REMEDIAL ACTION #III. B: IMPLEMENT INTENSIVE NONPOINT SOURCE CONTROL PROGRAMS IN THE SHEBOYGAN RIVER BASIN'S THREE WATERSHEDS.

* Initiate and complete implementation of the Sheboygan River Priority

coliform bacteria experienced violations of state standards. These high levels still exist today based on monthly monitoring at the U.S. Geological Survey station located 4.2 miles upstream of the harbor. The sources of these bacteria are a combination of point source discharges, malfunctioning septic systems, and runoff from animal feedlots.

The City of Sheboygan operates two public beaches, located north and south of the Sheboygan harbor. Bacterial monitoring of these beaches have not shown bacteria to be a problem outside the river and harbor. Records of the past three years show no beach closings due to bacterial contamination.

REMEDIAL ACTION #IV. A: REDUCE BACTERIA INPUTS.
REMEDIAL ACTION #IV. A.1: Conduct Bacteria Survey

Who's Responsible: WDNR
Estimated Cost: $3,000
Target Date: 1989

The specific sources and contributions of bacterial contamination to the lower Sheboygan River are unknown. A review of monthly discharge reports submitted by municipal wastewater treatment plants in the Sheboygan River Basin show that several are discharging bacteria at concentrations that exceed criteria for full body contact. Several of these plants discharge to stream reaches that are not designated for full recreational use and therefore technically do not need to meet the strict levels necessary in the lower Sheboygan River. These sources include the Lakeland College, Hingham, Plymouth, Waldo, and Belgium wastewater treatment plants. The bacterial contribution from these point sources to the lower river is not known. The WDNR, as part of the Basin Assessment Monitoring Program, will conduct a bacterial survey to identify the

Runoff from animal feedlots and areas spread with manure have been significant sources of bacteria to the Onion, Mullet and Sheboygan Rivers. Several federal and state programs are presently being implemented to control these sources.

Wisconsin continues to rely on federal programs administered by the Agricultural Stabilization and Conservation Service (ASCS) to help control animal waste runoff. These include the Agricultural Conservation Program (ACP) for cost-sharing installation of barn yard runoff control systems, and the Dairy Termination Program which retired 44 herds in Sheboygan County in 1987.

If deemed necessary by the results of the bacteria survey, the State can implement the following animal waste control programs to achieve water recreational use standards:

The Wisconsin Farmers Fund Program: administered by the Wisconsin Department of Agriculture, provides cost-share grants to land owners for the installation of barn yard runoff systems.

The Wisconsin Nonpoint Source Pollution Abatement Program: administered by the Wisconsin Department of Natural Resources, provides cost-share grants to land owners for the installation of animal waste control systems. Grants are provided to land owners in watersheds designated as "priority" areas by the state. The Onion and Sheboygan Rivers are designated as Priority Watersheds for nonpoint source pollution abatement.

REMEDIAL ACTION #IV. B: ENSURE ADEQUATE PUBLIC ACCESS AND RECREATIONAL FACILITIES

Who's Responsible: Local municipalities, U.S. Army Corps of Engineers, and WDNR
Estimated Cost: $17,000,000
Target Date: 2000

Although there is public access to the river and harbor primarily through several boat launches, fishing piers, parks, and walkways along the harbor which are associated with the commercial development, additional access may be desired as water quality improves. Past studies have looked at recreational needs in the area (U.W. Extension, 1987).

The City of Sheboygan is interested in developing a marina within the Sheboygan harbor. The marina would increase public access to Lake Michigan and provide an important economic and recreational resource to the City of Sheboygan. Proposed plans for a 580 slip marina have been developed. The marina would be built in three phases and cost approximately $17 million.

Development of the Sheboygan Marina has been on hold since 1979. WDNR determined that sediment from sampling conducted by the Superfund Project in 1987-88 in the area of the proposed marina was not contaminated (Frank Trcka, WDNR, to Mayor Schneider, in letter June 24, 1988). The City initiated dredging of this area on May 8, 1989. Phase 3, which is development of a park area on top of a confined disposal site for contaminated river sediment, will remain on hold until long range plans for management of these sediments are developed.

-- the preparation and implementation of a Community Relations Plan for each site

-- the preparation and distribution of at least 3 Fact Sheets

-- the preparation and submittal of site update reports as needed

-- providing a public comment period and public meeting once a remedial action is proposed

-- a written response to public comments

-- maintaining public information repositories

-- and holding public meetings.

Remedial Action A.2: Sheboygan River Priority Watershed Project

Who's Responsible: Sheboygan County, WDNR, DATCP
Estimated Cost: Existing program
Target Date: Ongoing

This nonpoint source pollution abatement program is being coordinated by the Wisconsin DNR and Sheboygan and Fond Du Lac Counties. The project is being overseen by a citizen advisory committee composed of sportsman groups, landowners, and county and municipal officials.

The WDNR has requested that the Sheboygan County Water Quality Task Force act as the citizen advisory committee for the RAP. The Task Force is a self formed group of concerned groups and citizens in the Sheboygan area. They represent several interests including charter captains, local yacht club, sportsman, commercial fisherman, industry and local government. The role of the Task Force is outlined in "Chapter VII. Historical Record".

REMEDIAL ACTION B: INCLUDE PUBLIC PARTICIPATION/CITIZEN INVOLVEMENT THROUGHOUT REMEDIAL ACTION PLAN IMPLEMENTATION

Who's Responsible: Sheboygan County Water Quality Task Force and WDNR
Estimated Cost: $2,000 annually
Target Date: Ongoing

Public participation efforts should include an annual review meeting, newsletters, informational releases, and involvement in local events.

REMEDIAL ACTION C: EVALUATE THE NEED FOR INCREASING AWARENESS OF FISH AND WATERFOWL CONSUMPTION ADVISORIES

Who's Responsible: WDNR and UW-Sea Grant
Estimated Cost: $1,000
Target Date: 1990

Fish and waterfowl consumption advisories were developed by the WDNR and the Department of Health and Social Services to inform anglers of the risk of consuming contaminated fish. The WDNR will evaluate the need for a Vietnamese translation of fish consumption advisories in the Sheboygan area and other means to increase awareness of these advisories if necessary. (The University

X. PROGRAMS, PARTICIPANTS, AND IMPLEMENTABILITY

APPLICABLE PROGRAMS (INCLUDING RESPONSIBLE IMPLEMENTATION ENTITIES)

Wisconsin Department of Natural Resources

Water Resource Management

-- Sheboygan River Priority Watershed Plan

Control of eutrophication, sedimentation, and bacteria levels will be addressed in this plan which is scheduled for implementation beginning in late 1989.

-- Onion River Priority Watershed Plan

This project is scheduled for completion in late 1988.

-- Water Quality Management Plan for the Sheboygan River Basin

This plan identifies water quality goals, problems, improvements, and management needs for the lakes and streams in the Sheboygan River Basin (which includes the AOC) and will also examine existing and future wastewater treatment facility and management needs. This updated plan is scheduled for implementation beginning in October 1988.

-- Wisconsin State Statute 30

This statue regulates dredging, filling, and placement of structures in navigable waters of the state.

Fisheries Management

-- Fish Collection and Stocking

Fishery managers are responsible for collection of fish for contaminant monitoring. 1988 analyses will include PCB congener analyses. Also, once the PCB problem is resolved, fishery managers will continue salmonid stocking within the Sheboygan harbor and evaluate the need for coho salmon egg collection facility.

Wildlife Management

-- Waterfowl Collection and Permit Review

Wildlife managers are responsible for collection of waterfowl for contaminant monitoring, review of Water Regulation and Zoning permits for potential impacts on wildlife habitat, and banding mallards to determine migration pattern.

Solid Waste Management

-- Administrative Code NR 445

This code is intended to protect the environment from toxic emissions. Over 400 chemicals are listed for regulation in this code, including PCBs.

Wisconsin Department of Agriculture, Trade, and Consumer Protection

-- Administrative Code Ag 166

This code covers implementation of the Soil and Water Resource Management Program.

-- Administrative Code Ag 162

This code contains procedures for storing fertilizer.

-- Farmland Preservation Program

This program gives tax incentives for maintaining land in agricultural land use as for reducing soil erosion rates.

Wisconsin Department of Industry, Labor, and Human Relations

-- Regulation of on-site waste disposal systems

-- Regulation of underground storage tanks

Wisconsin Department of Administration

Sheboygan County

-- Implement Sheboygan County Erosion Control Plan and Farmland Preservation Program

-- Regulate on-site wastewater disposal systems

-- Protect wetlands under Wisconsin Administrative Code NR 115

-- Carry out Sheboygan and Onion, and seek designation for the Mullet River Priority Watershed plans. Work with WDNR in inventory development, planning, and assisting landowners in design and installation of practices.

Cities of Sheboygan and Sheboygan Falls, and Village of Kohler and Upstream Communities

-- Protect wetlands under Wisconsin Administrative Code NR 117 and adopt sewer service area plans and wetland zoning ordinances

-- Develop plans for a marina (City of Sheboygan)

-- Operate and maintain wastewater treatment plant

WPDES Permit Holders

project relating to toxic pollutants in the Great Lakes areas. Chemical, biological, and physical data will be utilized for the development of a Sediment Action Index. This work will emphasize site specific toxicity and bioavailability of contaminants when assessing the problem and remedial options. The Sheboygan harbor investigation is expected to be initiated in the summer of 1989.

U.S. Army Corps of Engineers

-- Wetland Regulation

Section 404 of the Clean Water Act requires that the U.S. Army Corps of Engineers regulate wetland filling.

-- Limited Dredge Project

The limited dredge project is designed to provide an access channel to the C. Reiss Coal Co. docks in the Sheboygan Harbor. Approximately 46,000 cubic yards of sediment would need to be dredged initially. A report on the evaluation of 19 sites for the disposal of the dredge spoils was completed in April, 1989.

U.S. Fish and Wildlife Service

-- Review U.S. Army Corps of Engineers permits for wetland filling operations (404 permits)

-- Review Federal dredging projects for effects on fish and wildlife

PUBLIC INVOLVEMENT

Participation by the public in this planning process is viewed as a critical element to its success. Therefore, extensive efforts were and continue to be made to involve the citizens in all planning phases. The Sheboygan County Water Quality Task Force has been the information and education liaison between the public and the environmental agencies since 1985. They have continued to play this role by acting as the Citizen Advisory Committee for the RAP and as a local citizen participation group for Superfund. Environmental advocacy groups, especially Lake Michigan Federation, have also provided significant input.

An interagency technical advisory committee was utilized for review purposes. The members are from Coastal Zone Management, Department of Health and Social Services, U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, and U.S. EPA. This group will oversee the coordination and promote exchange among the various investigations and ongoing work in the AOC.

Other specific efforts to involve the public have included:

1. The preparation and distribution of a questionnaire by the Task Force. The questionnaire was distributed to Sheboygan area citizens between February and April 1988 and gathered information on peoples' perceptions and uses of the river. Approximately 100 responses were received (Appendix F).

2. Three public informational meetings were held during February and March

action steps (Table X.1). WDNR staff will communicate with those involved in ongoing work. The Interagency Technical Advisory Group established for the Sheboygan RAP will convene meetings with those individuals or agencies to promote and obtain coordination of the various ongoing investigations.

The investigations outlined in this plan are scheduled to be completed by mid-1991 (Table X.1). At that time, the Sheboygan RAP update will specify the selected method of remediation along with a schedule of implementation. The update will also identify surveillance and monitoring needs for tracking the effectiveness of the remedial efforts.

Sheboygan has the opportunity for setting a precedent for the Great Lakes. We are encouraged by the public commitment to protecting and remediating the Sheboygan Area of Concern ecosystem and feel confident that the public will remain interested and active in the process.

tation Responsibilities, Costs, and Schedule

ble Entity*	Cost (Thousand $)	Funding Source (Potential)	Target Date
DNR	200	WI Coastal Mgt. & WI Sea Grant	Oct. 88-91
	10	WDNR	1989-91
& WDNR	85	WQA Great Lakes Demo	1990-91
Prod & USEPA	1000+	Tecumseh Prod.	1988-91
nsible Parties	Undetermined	All responsible parties	1991-?
& USEPA	240	Undetermined	1990
USEPA, Local Mun.	Undetermined	Undetermined	1991
permittees & WDNR	25	WPDES	1993
n Co., Mun. & WDNR	6000	WDNR-Cost Share	1997
o. & USEPA	Unknown	Kohler Co. & USEPA	1990
& C. Reiss Co.	Will vary per spill	Responsible Parties	ongoing
	3 annually	WDNR	ongoing
	7 annually	WDNR	ongoing
permittees & WDNR	1.5/test	Permit Holder	ongoing
	20	WDNR	After implementation is complete
lities, USACOE, WDNR	None	--	ongoing
s RPC, Municipalities	30	Federal	1990
ponsors, WDNR	None	--	ongoing

t)

onsible Entity*	Cost (Thousand $)	Funding Source (Potential)	Target Date
Co., USDA	None	--	ongoing
Co., WDNR	6000	WI Fund	2000
R, DATCP	Will vary	Responsible parties, state	as necessary
ers, WDNR	2.5/DAM	Owners, WDNR	Upon request
R	40 annually	WDNR	upon clean-up
R	250	WDNR	upon clean-up
WPDES permittees	Will vary	WPDES permittee	ongoing
Co., WDNR	6000	WI Fund	2000
R	3	WDNR	1991
R, Mun. permittees	None	--	1995
R, ASCS, Sheb. Co., DATCP	Unknown	Federal and State	ongoing
HR, Sheb. Co.	Unknown	Private landowner	ongoing
cipals, USACOE, WDNR	17,000	Private/county funds	2000
A, WDNR	Unknown	Responsible parties	2000
Co., UWEX, WDNR	2000	WI Fund	1997
R	Existing Program	--	ongoing
akes RPC	No new costs	--	ongoing
Co. W.Q.T.F., WDNR	2 annually	Various grants	ongoing
Co. W.Q.T.F., WDNR	2 annually	Various grants	ongoing
R, UW	1	Sea Grant	1990

chargers)

RPC = Regional Planning Commission
USACOE = U.S. Army Corps of Engineers
USDA = U.S. Dept. of Agriculture
NPS = Nonpoint Source
PCB = Polychlorinated Biphenyls

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XII. GLOSSARY FOR TERMS AND ABBREVIATIONS FOUND IN THIS PLAN

Abbreviations

208 plans: See Areawide Water Quality Management Plans.

ACP: See Agricultural Conservation Program.

AOC: See Area of Concern.

ASCS: Agricultural Stabilization Conservation Service of the U.S. Department of Agriculture.

BACT: Best Available Control Technology.

BCT: Best Conventional Technology.

BMP: See Best Management Practice.

BOD: See Biochemical Oxygen Demand.

BPT: Best Practicable Technology.

mg/L: Milligrams Per Liter; a unit of measure of concentration generally equivalent to parts per million.

ng/L Nanogram Per Liter; a unit of measures of concentration generally equivalent to parts per trillion (ppt).

NO_2: Nitrogen Dioxide.

NOAA: National Oceanic and Atmospheric Administration.

NPDES: National Pollution Discharge Elimination System.

O&M: Operation and Maintenance.

PAHs: See Polyaromatic Hydrocarbons.

PCBs: See Polychlorinated Biphenyls.

POTW: See publicly owned treatment works.

PPM: Parts Per Million; a unit of measure of concentration.

RAP: See Remedial Action Plan.

RI/FS: See Remedial Investigation/Feasibility Study

UWEX:	See University of Wisconsin Extension.
VOC:	Volatile Organic Compounds.
WDATCP:	Wisconsin Department of Agriculture, Trade and Consumer Protection.
WDHSS:	Wisconsin Department of Health and Social Services.
WDILHR:	Wisconsin Department of Industry, Labor and Human Relations.
WDNR:	Wisconsin Department of Natural Resources.
WDOA:	Wisconsin Department of Administration.
WDOD:	Wisconsin Department of Development.
WDOT:	Wisconsin Department of Transportation.
WGNHS:	Wisconsin Geologic and Natural History Survey.
WLA:	See Wasteload Allocation.
WPDES:	See Wisconsin Pollution Discharge Elimination System.
WSLH:	Wisconsin State Laboratory of Hygiene.
WWTP:	Wastewater Treatment Plant.

Glossary

ACUTE TOXICITY:
Any poisonous effect produced by a single short-term exposure to a chemical that results in a rapid onset of severe symptoms.

ADDITIVITY:
The characteristic property of a mixture of toxicants that exhibit a cumulative toxic effect equal to the arithmetic sum of the individual toxicants.

ADVANCED WASTEWATER TREATMENT:
The highest level of wastewater treatment for municipal treatment systems. It requires removal of all but 10 parts per million of suspended solids and biological oxygen and/or 50% of the total nitrogen. Advanced wastewater treatment is also known as "tertiary treatment."

AGRICULTURAL CONSERVATION PROGRAM (ACP):
A federal cost-sharing program to help landowners install measures to conserve soil and water resources. ACP is administered by the USDA ASCS through county ACP committees.

AIR POLLUTION:
Contamination of the atmosphere by human activities.

ANTIDEGRADATION:
A policy which states that water quality will not be lowered below background levels unless justified by economic and social development considerations. Wisconsin's antidegradation policy is currently being revised to make it more specific and meet EPA guidelines.

ASSIMILATIVE CAPACITY:
The ability of a water body to carry a load of pollutants before its water quality decreases to a minimum set level.

AVAILABILITY:
The degree to which toxic substances or other pollutants that are present in sediments or elsewhere in the ecosystem are available to affect or be taken up by organisms. Some pollutants may be "bound up" or unavailable because they are attached to clay particles or are buried by sediment. The amount of oxygen, pH, temperature and other conditions in the water may affect availability.

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

BASIN PLAN:
See "Areawide Water Quality Management Plan".

BENTHIC ORGANISMS (BENTHOS):
The organisms living in or on the bottom of a lake or stream.

BEST MANAGEMENT PRACTICE (BMP):

BIOTA:
All living organisms that exist in an area.

BUFFER STRIPS:
Strips of grass or other erosion-resisting vegetation between disturbed areas and a stream or lake.

BULKHEAD LINES:
Legally established lines which indicate how far into a stream or lake an adjacent property owner has the right to fill. Many of these lines were established many years ago and allow substantial filling of the bed of the River and Bay. Other environmental laws may limit filling to some degree.

CARCINOGENIC:
A chemical capable of causing cancer.

CATEGORICAL LIMITS:
All point source discharges are required to provide a basic level of treatment. For municipal wastewater treatment plants this is secondary treatment (30 mg/l effluent limits for SS and BOD). For industry the level is dependent on the type of industry and the level of production. More stringent effluent limits are required, if necessary to meet water quality standards.

CHLORINATION:

CONFINED DISPOSAL FACILITY (CDF):
A structure built for the containment of disposed dredged material.

CONGENERS:
A class or family of chemical compounds that have the same "core" molecular structure, but whose individual members differ from each other in the number and position of substituent atoms. For example, the congeners of PCBs differ by having different numbers of chlorine atoms on the biphenyl molecule as well as by the chlorine atoms located in different positions on the biphenyl molecule.

CONSERVATION TILLAGE:
Planting row crops while disturbing the soil only slightly. In this way a protective layer of plant residue stays in the surface; erosion is decreased.

CONSUMPTION ADVISORY:
A health warning issued by WDNR and WDHSS that recommends that people limit the fish they eat from specified rivers and lakes based on the levels of toxic contaminants found in the fish.

CONTAMINANT:
Some substance that has been added to water that is not normally present. This is different from a pollutant, as a pollutant suggests that there is too much of the substance present.

CONVENTIONAL POLLUTANTS:
Refers to suspended solids, fecal coliforms, biochemical oxygen demand, and pH, as opposed to toxic pollutants.

DREDGING:
Removal of sediment from the bottom of water bodies.

ECOSYSTEM:
The interacting system of a biological community and its environment which functions as a unit.

EFFLUENT:
Solid, liquid or gas wastes (byproducts) which are disposed on land, in water or in air. As used in the RAP generally means wastewater discharges.

EFFLUENT LIMITS:
The Department of Natural Resources issues WPDES permits that establish the maximum amount of pollutant that can be discharged to a receiving stream. Limits depend on the pollutant involved and the water quality standards that apply for the receiving waters.

EMISSION:
A direct (smokestack particles) or indirect (busy shopping center parking lot) release of any contaminant into the air.

ENVIRONMENTAL PROTECTION AGENCY (USEPA):
The primary federal agency responsible for enforcing federal environmental regulations. The Environmental Protection Agency delegates some of its responsibilities for water, air and solid waste pollution control to state

FECAL COLIFORM:
A group of bacteria used to indicate the presence of other bacteria that cause disease. The number of coliform is particularly important when water is used for drinking and swimming.

FISHABLE AND SWIMMABLE:
Refers to the water quality goal set for the nation's surface waters by Congress in the Clean Water Act. All waters were to meet this goal by 1984.

FLUORANTHENE:
A specific polyaromatic hydrocarbon (PAH) with toxic properties.

FLY ASH:
Particulates emitted from coal burning and other combustion, such as wood burning, and exited into the air from stacks, or more likely, collected by electrostatic precipitators.

FOOD CHAIN:
A sequence of organisms in which each uses the next as a food source.

FURANS (2,3,7,8-tetra-chloro-dibenzofurans):
A chlorinated organic compound which is highly toxic and produced as a by-product of PCB manufacture.

GREEN STRIPS:
See buffer strip.

GROUNDWATER:

INCINERATOR:
A furnace designed to burn wastes.

INFLUENT:
Influent for an industry would be the river water that the plant intakes for use in its processing. Influent to a municipal treatment plant is untreated wastewater.

IN-PLACE POLLUTION:
As used in the RAP refers to pollution from contaminated sediments. These sediments are polluted from past discharges from municipal and industrial sources.

INTERNATIONAL JOINT COMMISSION (IJC):
An agency formed by the United States and Canada to guide management of the Great Lakes and resolve border issues.

ISOROPYLBIPHENYL:
A chemical compound used as a substitute for PCB.

LANDFILL:
A conventional sanitary landfill is "a land disposal site employing an engineered method of disposing of solid wastes on land in a manner that minimizes environmental hazards by spreading solid wastes in thin layers, compacting the wastes to the smallest practical volume, and applying cover

MASS BALANCE:
A study that examines all parts of an ecosystem to determine the amount of toxic or other pollutant present, its sources, and the processes by which the chemical moves through the ecosystem.

MESOTROPHIC:
Refers to a moderately fertile nutrient level of a lake between the oligotrophic and eutrophic levels. (See also "Eutrophic" and "Oligotrophic.")

MILLIGRAMS PER LITER (mg/l):
A measure of the concentration of substance in water. For most pollution measurement this is the equivalent to "parts per million".

MILLIGRAMS PER KILOGRAM (mg/kg):
Concentration of a substance in solids such as sediment. Equivalent to "parts per million".

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

MIXING ZONE:
The portion of a stream or lake in which effluent is allowed to mix with the receiving water. The size of the area depends on the volume and flow of the discharge and receiving water.

PESTICIDE:

Any chemical agent used for control of specific organisms, such as insecticides, herbicides, fungicides, etc.

pH:

A measure of acidity or alkalinity, measured on a scale of 0 to 14 with 7 being neutral and 0 being most acid, and 14 most alkaline.

PHENOLS:

Organic compounds that are the byproducts of petroleum refining, textile, dye, and resin manufacture. Low concentrations can cause taste and odor problems in fish. Higher concentration can be toxic to fish and aquatic life.

PHOSPHORUS:

A nutrient that, in excess amounts, can lead to over fertile conditions and algae blooms in water bodies.

PLANKTON:

Tiny aquatic plants and animals.

POINT SOURCES:

Sources of pollution that have discrete discharges, usually from a pipe or outfall.

POLLUTION:

Because money is limited, only watersheds where problems are critical, control is practical, and cooperation is likely are selected for funding.

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.

PUBLIC LAW 92-500 (CLEAN WATER ACT):
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 discharges of pollutants 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 in the Clean Water Act were made in 1977 by passage of Public Law 95-217, and in 1987.

PUBLIC PARTICIPATION:
The active involvement of interested and affected citizens in governmental decision-making.

PUBLICLY OWNED TREATMENT WORKS (POTW):
A wastewater treatment plan owned by a city, village or other unit of government.

RAP:
See Remedial Action Plan.

RUNOFF:

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

SECONDARY IMPACTS:

The indirect effects that an action can have on the health of the ecosystem or the economy.

SECONDARY TREATMENT:

Two-stage wastewater treatment that allows the coarse particles to settle out, as in primary treatment, followed by biological breakdowns of the remaining impurities. Secondary treatment commonly removes 90% of the impurities. Sometimes "secondary treatment" refers simply to the biological part of the treatment process.

SEDIMENT:

Soil particles suspended in and carried by water as a result of erosion. Sediment ultimately settles in the bottom of lakes, streams, and rivers.

SEICHES:

Changes in water levels due to the tipping of water in an elongated lake basin whereby water is raised in one end of the basin and lowered in the other as a result of being pushed by strong winds. Also known as "wind tide".

clay particles. These particles may carry pollutants adsorbed to the particle surfaces.

SYNERGISM:
The characteristic property of a mixture of toxicants that exhibits a greater-than-additive cumulative toxic effect.

TACS:
Technical advisory committees that assisted in the development of the Remedial Action Plan.

TERTIARY TREATMENT:
See advanced wastewater treatment.

TOP-DOWN MANAGEMENT:
A management theory that uses biomanipulation, specifically the stocking of predator species of fish to improve water quality.

TOTAL MAXIMUM DAILY LOADS:
The maximum amount of a pollutant that can be discharged into a stream without causing a violation of water quality standards.

TOXIC:
An adjective that describes a substance which is poisonous, or can kill or injure a person or plants and animals upon direct contact or long-term exposure. (Also, see toxic substance.)

TOXIC SUBSTANCE:
A chemical or mixture of chemicals which through sufficient exposure, or

TURBIDITY:
Lack of water clarity. Turbidity is usually closely related to the amount of suspended solids in water.

UNIVERSITY OF WISCONSIN-EXTENSION (UWEX):
A special outreach, education branch of the state university system.

VARIANCE:
Government permission for a delay or exception in the application of a given law, ordinance or regulation. Also, see water quality standard variance.

VOLATILE:
Any substance that evaporates at a low temperature.

WASTELOAD ALLOCATION:
Division of the amount of waste a stream can assimilate among the various dischargers to a stream. Results in the limit on the amount (in pounds) of a chemical or biological constituent discharged from a wastewater treatment plant to a water body.

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

WATER QUALITY STANDARD VARIANCE:
When natural conditions of a water body preclude meeting all conditions necessary to maintain full fish and aquatic life and swimming a variance may be granted.

WATERSHED:
The land area that drains into a lake or river.

WETLANDS:
Those areas that are inundates or saturated by surface or groundwater at a frequency and duration sufficient to support a variety of vegetative or aquatic life. Wetland vegetation requires saturated or seasonally saturated soil conditions for growth and reproduction. Wetlands generally include swamps, marshes, bogs and similar areas.

WISCONSIN ADMINISTRATIVE CODE:
The set of rules written and used by state agencies to implement state statutes. Administrative codes are subject to public hearing and have the force of law.

WISCONSIN FUND:
A state program that helps pay the cost of reducing water pollution. Funding for the program comes from general revenues and bonds and is based on a percentage of the state's taxable property value. The Wisconsin Fund includes these programs:

Point Source Water Pollution Abatement Grant Program - Provides loans for the cost of constructing wastewater treatment facilities. Most of this program's money goes for treatment plant construction, but 3% of this fund