United States
Environmental Protection
Agency

Region V
230 South Dearborn Street
Chicago, Illinois 60604

905R81103

The PCB Contamination Problem in Waukegan, Illinois

THE PCB CONTAMINATION PROBLEM IN WAUKEGAN, ILLINOIS

January 21, 1981

Prepared By

U.S. Environmental Protection Agency
Region V
230 South Dearborn Street
Chicago, Illinois 60604

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT.)

LIST OF FIGURES

CHAPTER I

INTRODUCTION

The presence of high levels of polychlorinated biphenyls (PCBs) in soils and harbor sediments in the vicinity of the Johnson Outboard Division of Outboard Marine Corporation (OMC) in Waukegan, Illinois, was first discovered in 1975. Subsequent new areas of contamination have been uncovered as recently as last year. The site contains the highest known concentrations of uncontrolled PCBs in the country, and there are few precedents for dealing with the many problems that it presents. It is inevitable that new things will be learned as the work progresses, requiring changes in both planning and procedures.

The immediate threat to Lake Michigan water quality, where unacceptably high concentrations of PCBs have been found in fish tissue, and the ultimate threat posed by this comtamination to human health in the area, have prompted the U.S. Environmental Protection Agency (U.S. EPA) to pursue remedy through two paths:

- Seeking, through litigation, to require the OMC as discharger of the PCBs, and Monsanto Company as the PCB manufacturer, to pay the costs for removing the contaminated material from the environment.

- Proceeding to solve the contamination problem before the issue of responsibility is resolved by the courts, with reimbursement expected at a later date from the party judged responsible.

Investigations into the extent and nature of the environmental problem commenced in 1976, are still going on, and continue to provide us with new information. However, the solution of the problem depends not only upon our ability to develop adequate and cost-effective engineering plans, but also on the availability of funding with which they can be implemented. Although there are still some unanswered questions, it has been possible in the following pages to describe the environmental conditions that have been found at the site and to discuss plans and funding mechanisms the implementation of which will allow us to take some major cleanup steps.

The U.S. EPA has already initiated a preliminary action in response to the severity of the contamination problem in Slip #3 in Waukegan Harbor, which was announced and described in a November 24, 1980 report. That plan is compatible with, and can be incorporated into, the more extensive program proposed in the following pages.

This report presents an opportunity for thorough and thoughtful public review of and comment on the total approach that the agency is prepared to take to resolve the problem. The planning process, both now and as the project proceeds, will be flexible enough to permit us to take into consideration the concerns of the public, as well as the emergence of new data and new technologies.

CHAPTER II

THE PCB PROBLEM AND GOVERNMENT RESPONSE

THE PCB PROBLEM

PCBs, or polychlorinated biphenyls, are compounds which belong to a broad family of organic chemicals known as chlorinated hydrocarbons. Virtually all the PCBs in existence today have been synthetically manufactured. Although they were first discovered in the late 1800's, they were not produced until 1929 in the United States, where the Monsanto Company has been their principal manufacturer.

A number of different mixtures of PCBs have been distributed by Monsanto under the overall trademark of "AROCLOR", each characterized by the percentage of chlorine it contains and identified by a number which refers to that percentage (for example, Aroclor 1254 is 54% chlorine). Aroclor characteristics vary according to the mixture. As the chlorine content increases, for example, the physical characteristics change from colorless oils to sticky resins to white powders, and their persistence in the environment increases. The general properties of PCBs -- unusually good chemical and thermal stability, fire resistance, non-conductivity, and low solubility in water -- have resulted in widespread industrial use. Among the most popular uses of PCBs have been as fluids in transformers and capacitors and as dye carriers in carbonless paper.

It was not until the 1960's that indications of the toxicity of PCBs began to emerge clearly. In the early 60's mink ranchers noticed increases in sterility and mortality of the newborn among animals with substantial amounts of Lake Michigan coho salmon in their diet, but it was not until the end of the decade that PCBs began to surface as the cause. It was only after a severe human PCB contamination accident occurred in Yusho, Japan, in 1968, that world attention began to focus on the magnitude and scope of the potential toxic effect of PCBs on humans. The Yusho victims, who had consumed rice oil contaminated with PCBs, were afflicted by skin lesions, blindness, hearing loss, jaundice and abdominal pain. Much of our data on human health effects of PCBs stems from this incident, and the affected population is still being studied. Among the other observed symptoms of PCB toxicity in humans have been chloracne (skin rash), discoloration of the gums and nailbeds, swelling of joints, waxy secretions of glands in the eyelids, and the general symptoms of lethargy and joint pain. Many of the risks to human health resulting from PCB exposure are perceived as subtle physical and behavioral changes.

There are also well-documented tests on laboratory animals that show PCBs to cause reproductive failures, gastric disorders, skin lesions, and tumors. Although data on the possible cancer-producing effects of PCBs in humans is still sketchy, there are substantial indications from laboratory testing that the compounds are carcinogenic for animals.

The growing body of knowledge of the toxicity and carcinogenicity of PCBs has been particularly alarming in view of their remarkable persistence in the environment, a result of the high chemical stability that made them so desirable in industrial use. Once released into the environment, PCBs do not readily break apart into new chemical arrangements -- they bioaccumulate in the fatty tissue of the organisms that consume them. Even more serious for humans, PCBs "biomagnify" in the food chain. This means that at each step of the food chain - beginning with microorganisms and plants that take in traces of PCBs from the environment and moving through the smaller fish that eat them into the larger fish that are eventually eaten by humans - the PCB concentrations increase.

Since PCB accumulation occurs primarily in fat tissue, fatty fish, such as salmon and trout, are the most susceptible. Fish have been known to bioconcentrate PCBs to factors of a hundred thousand or more times the concentrations of PCBs in the waters where the fish live. High bioaccumulation of PCBs in human fatty tissue can also occur, and even if the exposure is to very low concentrations in the environment, chronic (long-term) toxic effects can result.

Documented occurrences of high levels of human exposure to PCBs have almost always resulted from the consumption of contaminated foods, contamination which occurs both as a result of accident (as in the Yusho case) and through the accumulation of PCBs in fatty tissues in the food chain. Detectable levels have been found in tissues of up to 91% of individuals in groups tested in the United States.

Inhalation and skin contact with PCBs are not considered to be significant sources of contamination for the general public, but are of concern in situations of occupational exposure. Although PCBs do not easily vaporize, recent studies suggest that new attention should be paid to the possibly significant losses of PCBs to the atmosphere through volatilization.

THE RESPONSE

As the evidence of the toxicity of PCBs accumulated in the late 60's and early 70's, both government and industry responded. Monsanto restricted its sales of PCBs to closed system uses (those uses which do not release fluids to the environment) in 1971 and, by 1977, had voluntarily terminated production in all their facilities. Because of their unusual persistence, however, most of the PCBs manufactured between 1929 and 1971 still existed, and much of it had been released into the environment. This release occurred primarily through spilling and dumping to surface waters and landfills and, to a lesser extent, through volatilization (release to the air).

The federal government, particularly the Food and Drug Administration (FDA) of the Department of Health and Human Services and the U.S. Environmental Protection Agency (U.S. EPA) took a series of steps during the 1970's to regulate and control human exposure to these toxic substances.

As early as 1973 the FDA established "temporary" tolerance limits for PCB concentrations for various categories of foods, setting a 5 ppm (parts per million) limit, at that time, on fish and shellfish. Thus, interstate transport of fish shipments containing more toxic levels was prohibited.

In November, 1975, the U.S. EPA convened a National Conference on PCBs in Chicago to present and discuss the growing body of data on the persistence and toxicity of PCBs. The U.S. Congress responded by including in the Toxic Substances Control Act of 1976 (TSCA) a provision to ban the manufacture of PCBs except for use in closed systems, and to prohibit their use in non-closed systems. TSCA required U.S. EPA to regulate the disposal and marking of PCBs and to ban, with certain exceptions, the manufacture, processing, distribution in commerce, and non-totally enclosed use of PCBs. U.S. EPA published the final rules on marking and disposal in the Federal Register on February 17, 1978. Final rules on the ban were published on May 31, 1979, taking effect on July 2, 1979.

The PCB disposal rules developed by the agency to implement TSCA set 50 ppm as the level above which materials must be disposed of in a Federally approved landfill or incinerator, and established criteria for U.S. EPA to follow in making such approvals.

On April 1, 1977, the FDA proposed new tolerance limits for PCBs. The proposal recommended that the level for fish and shellfish be reduced from 5 to 2 ppm in response to new data received since the earlier tolerances were set in 1973. This new information included: (1) new toxicity data; (2) indications that PCBs were carcinogenic; and (3) indications of the widespread occurrence of PCB residues in fish resulting from the presence of PCBs in the environment.

When the same limits were published in final form on June 29, 1979, FDA stated that although they were required to weigh public health protection against commercial losses and losses of food supplies to consumers, and although they had received considerable public comment protesting the commercial losses that would result from the 2 ppm tolerance level, the new toxicity and carcinogenicity data prompted the agency to promulgate the lower limit. An objection and request for a hearing lodged subsequently by the National Fisheries Institute, however, automatically stayed the promulgation of the new level for fish, and the 5 ppm limit remains in effect until this appeal process is completed.

In addition to the regulations promulgated by FDA and EPA, various guidelines for safe PCB limits in the environment have been recommended by government agencies. The National Institute for Occupational Safety and Health (NIOSH) has recommended to the Occupational Safety and Health Administration (OSHA) of the Department of Labor that no worker be exposed to greater than 1.0 microgram of total PCBs per cubic meter of air, for up to a 10-hour work day and 40-hour work week.

U.S. EPA has used a guideline for safe levels of PCBs in water of approximately one part per billion (ppb) for drinking water and one part per trillion (ppt) or less for ambient surface water. The increased restriction for ambient water is based upon the tendency of the substances to bioaccumulate in marine organisms. The two levels are roughly equivalent in the protection that they give an individual drinking water containing the 1 ppb level and a person eating 1/2 pound per week of fish which live in waters containing the PCBs at the 1 ppt level. A level of 14 ppt is now also being used by U.S. EPA as a guideline for protection of fish. Additionally, U.S. EPA imposes limits, through its National Pollution Discharge Elimination System (NPDES) permits, on PCB discharges into the national waterways by industrial and municipal facilities. A limit of 1 ppb or less is commonly advocated at this time. Finally, as recently as July 1980, the Carcinogen Assessment Group of the U.S. EPA included PCBs in their list of chemicals identified as "having substantial evidence of carcinogenicity".

Government regulations can be expected to continue to change, over time, in response to the influx of new and more definitive scientific data on the effects of PCBs on human health and aquatic life.

SUMMARY

PCBs have been manufactured in the United States for only half a century and awareness of their toxicity began to develop little more than a decade ago. We still know very little about their long-term toxic and carcinogenic effects on humans. We do know, however, of incidents where human exposure to PCBs has caused severe toxic reactions, and of laboratory experiments where PCBs have been accountable for a variety of toxic symptoms and cancers in animals.

We also know that PCBs are unusually persistent, and that, although their manufacture ceased in this country in 1977, most of the hundreds of thousands of tons that were manufactured between 1930 and 1977 are still with us and are uncontrolled in the environment. Because of the low solubility of PCBs in water and their high affinity for fatty tissue, it appears that the primary exposure by humans to existing PCBs is through accumulation in the food chain. Thus it appears that those deposits of PCBs in aquatic environments accessible to fish populations pose the greatest threat to human health.

Government response has been, on the one hand, to restrict or prohibit the manufacture and distribution of PCBs in order to eliminate new releases into the environment, and, on the other, to reduce the threat to human health from existing environmental reservoirs of PCBs by limiting commerce in fish and other foods containing certain levels of these compounds. As more data is generated and scientific understanding of PCBs is improved, it can be anticipated that government regulation and response will adjust accordingly.

CHAPTER III

THE LAKE MICHIGAN PCB PROBLEM

HISTORY

Pesticide monitoring programs were first established in the Great Lakes in the late 1960's in response to public concern over pesticide contamination following the publishing of Rachel Carson's Silent Spring. Due to the chemical stability of some of these compounds and their tendency to bioaccumulate in the food chain, high levels of pesticides such as DDT (dichlorodiphenyltrichloroethane) and dieldrin were found in Lake Michigan fish. Chemists began to discover other unidentified compounds that were being coanalyzed with DDT and dieldrin and that were interfering in the pesticides analyses. These other compounds were PCBs, which were subsequently added to the Great Lakes fish pesticide monitoring programs.

An EPA study of Lake Michigan fish in 1971 found mean concentrations in fish of PCBs (Aroclor 1254) ranging from 2.7 ppm in rainbow smelt to 15 ppm in lake trout. PCB concentrations in all trout and salmon more than 12 inches long were found to exceed 5 ppm (the FDA temporary tolerance level that was set in 1973). Larger fish such as brown, lake and rainbow trout and chinook and coho salmon contained PCBs at two to three times the FDA tolerance level. Concentrations increased with the percentage of fat and the size of the fish. PCB concentrations in Lake Michigan coho salmon were two to three times greater than in coho from Lake Huron, and approximately ten times greater than in coho from Lakes Erie and Superior.

Lake Michigan PCB fish monitoring programs were also begun in 1971 by the States of Indiana and Wisconsin and in 1972 by the State of Michigan and the U.S. Fish and Wildlife Service. Results from these monitoring programs painted the same picture of very high levels of PCBs in larger fish, well above the FDA tolerance level. The 1971 studies also showed that fish from the southern part of Lake Michigan had higher levels of contamination than fish from the northern portion of the lake.

Responding to this evidence of severe PCB contamination, the governors of Michigan and Wisconsin banned or restricted the sale of certain species of Lake Michigan fish (primarily salmon and lake trout) in their States in 1971.

Shortly thereafter, the sale of PCBs was restricted by Monsanto to manufacturers of closed systems (1971), and the U.S. Food and Drug Administration established the temporary 5 ppm tolerance level for fish (1973).

At about this time, researchers were reaching the conclusions associating PCB contamination of Great Lakes coho salmon with reproductive failures of minks (see Chapter II). Other Great Lakes Basin research implicated PCBs in the reproductive failure of stocked salmon populations as well as the reproductive failure and decline in populations of fish-eating birds, such as herring gulls, bald eagles, and the double-breasted cormorant, in the Lake Michigan Basin.

Because of the fish sale restrictions, the establishment of the FDA tolerance level, and Monsanto's voluntary restriction on the sale of PCBs, it was expected that the PCB levels would decline substantially, as the DDT levels had. By 1974, however, PCB levels in fish had not decreased.

LEVELS OF CONTAMINATION

High PCB contamination levels have been found both in the tissues of Lake Michigan fish, and in the bottom sediments of the lake, its harbors and its rivers.

Studies of lake trout and coho salmon conducted between 1972 and 1974 showed PCB concentrations ranging from 7 to 20 ppm. Subsequent testing indicates that contamination levels may be dropping, but these two species still tend to exceed the FDA guideline.

Sediment samples showing PCB levels in excess of 50 ppm have been taken from the Fox River at Green Bay, Wisconsin, and harbors located at Waukegan, Illinois; Sheboygan and Milwaukee, Wisconsin, and in the Grand Calumet River and Indiana Harbor Canal in Indiana.

SOURCES OF CONTAMINATION

The primary source of PCBs in Lake Michigan in the past was industrial discharges. In 1975, the Johnson Motors Division of Outboard Marine Corporation (OMC) in Waukegan, Illinois was found to be discharging PCBs to the Waukegan Harbor and to a tributary of Lake Michigan known as the "North Ditch." It now appears reasonably clear that this facility was one of the major sources if not the major source of PCB contamination in Lake Michigan during the early 1970's. According to a letter from its attorney dated March 24, 1976, OMC purchased approximately 8.4 million pounds of PCB in the form of hydraulic fluids from Monsanto between 1959 and 1972. OMC estimated (on a speculative basis) that 15-20% of this amount may have been discharged to water; that is, between 1.3 and 1.7 million pounds might have been discharged either to the ditch, harbor or lake. (More recently the company has been using lower figures for this discharge.) U.S. EPA's consultant has estimated that as much as 275,000 pounds of PCBs remain in the harbor sediments alone. As much or more PCBs have been estimated to be in the North Ditch and parking lot area.

Simulations done by a USEPA contractor indicate on a preliminary basis that discharges from the harbor and ditch to Lake Michigan were in the thousands of pounds per year during the peak years that PCB fluid was in primary use. Estimates are also being made of the contribution of this OMC discharge to the whole PCB problem in Lake Michigan. The OMC discharge, at its peak, itself appears to have represented a sizable fraction of the total load of PCBs into the lake.

This conclusion, together with its underlying assumptions, is supported by information from other sources. OMC was a large purchaser of PCBs, Monsanto's second largest customer for hydraulic fluids and one of the largest purchasers of PCBs in the Lake Michigan Basin. Moreover, a high proportion of OMCs purchases were of Aroclor 1248, the same PCB blend that is typically found to make up one-third or more of the contamination in open Lake Michigan sediments. Only Lake Michigan shows these significant levels of 1248. In 1970, for example, OMC purchased more than 90% of the 1248 sold in the Lake Michigan Basin for open system use.

OMC's heavy leakage of PCBs to the harbor and ditch resulted in heavy water and sediment concentrations of PCBs. Natural flow and flushing mechanisms in the harbor, ditch and groundwater, together with dredging operations in the harbor, resulted in much of this contamination being carried to the lake. In addition, the company had and still has a water intake in the most contaminated portion of the harbor which moves PCBs through the plant and thence to Lake Michigan through outfalls into the lake and ditch. PCB transfer into the atmosphere from OMC stacks or from uncovered contaminated soils may also have reached the lake. Although quantitative division of past sources cannot be done precisely after the fact, all these loads have certainly contributed substantially to the Lake Michigan PCB problem.

CONTINUING SOURCES OF CONTAMINATION

The PCB-contaminated materials deposit at Waukegan is one of the largest potentially controllable current sources of PCBs in Lake Michigan, and is by far the largest uncontrolled reservoir of PCBs in the Great Lakes Basin. Other continuing sources of PCB contamination of Lake Michigan include: (1) additional industrial discharges; (2) atmospheric transport and deposition from incomplete incineration, and volatilization of PCBs from landfills containing PCB materials; (3) Effluents from municipal waste water treatment plants; (4) Leaking from chemical waste disposal sites; (5) Movement of water and sediments from contaminated tributary streams and harbors; and (6) Recycling of PCBs through the water column and food chain from sediments already in the lake.

CONTROL MEASURES

The Lake Michigan States have responded to the continuing problem by restricting or banning the sale of fish in which PCB contamination is at or above the limit set by the FDA, and by advising members of the public to restrict their consumption of the fish which they catch in Lake Michigan. The advisories caution against the consumption by pregnant and nursing women and small children of lake trout and other species from certain Great Lakes waters and recommend that all people limit consumption of certain fish to no more than one meal per week, or to less than one-half pound per week. These advisories warn against any consumption by anyone of certain fish species caught in specific waters.

In 1977, Region V EPA published guidelines, based on studies of PCB accumulation in fish affected by contaminated sediments, for evaluating Great Lakes harbor and river sediments. Those guidelines called for no open water disposal of dredged sediments that were contaminated by PCBs to a level in excess of 10 ppm. Application of this guideline in the Lake Michigan Basin has resulted in the restriction, curtailment, or cessation of dredging in the Fox River, Sheboygan Harbor, and Milwaukee Harbor, Wisconsin; Waukegan Harbor, Illinois and the Indiana Harbor Canal, Indiana, pending the application of environmentally sound dredging and disposal methods.

CONCLUSION

High PCB concentrations began to be identified in Lake Michigan fish during the early 1970's. Contamination levels in larger species were so much above the FDA temporary tolerence levels, in fact, that several adjacent states banned or restricted the sale of these fish.

These PCB contamination levels were attributed primarily to industrial dischargers into the Lake, the largest of which appears to have been the OMC facility in Waukegan, Illinois.

CHAPTER IV

THE SITE AND ITS CONTAMINATION

WAUKEGAN HARBOR

Description:

Waukegan Harbor is located on the west shore of Lake Michigan at Waukegan, 36 miles north of Chicago and 47 miles south of Milwaukee. (See Figure IV-1.) Waukegan, a city of 65,259 people (1970 census), encircles the irregularly-shaped harbor. (See Figure IV-2.) It is a busy fishing and charter boat area and prides itself on being a "Salmon Capital."

Figure IV-3 illustrates major points of interest in the harbor area:

- Larsen Marine Co., which uses Slip #3 and the north end of the harbor for boat docks and cranes to service its pleasure boat customers.

- OMC's Plant #2 which has a water intake in Slip #3. An OMC outfall, now closed, which was the source of PCBs to the harbor, is also located in the Slip.

- Vacant land owned by OMC that was the former site of a General Motors foundry.

- OMC's Plant #1 has a harbor intake across from Slip #1.

- Waukegan's water filtration plant which has an infrequently used auxiliary water intake in the harbor channel.

- Waukegan Port District which has heavily used public boat landing ramps.

- National Gypsum Company which receives gypsum in large boats at Slip #1.

The area of the harbor, exclusive of the mouth, is approximately 37 acres. Water depths vary from 14 to 25 feet with some shallower spots near boat launching locations and in the far upper reaches of Slip #3. The depth at any one location varies with time depending upon (1) degree of siltation and whether the area has been dredged, (2) mean lake level, and (3) local seiches due to storms, wind shifts or other causes.

In order to maintain the navigational uses of the harbor, the U.S. Army Corps of Engineers traditionally dredged an average of 30,000 cubic yards per year of sediments near the main entrance channel. With the exception of the

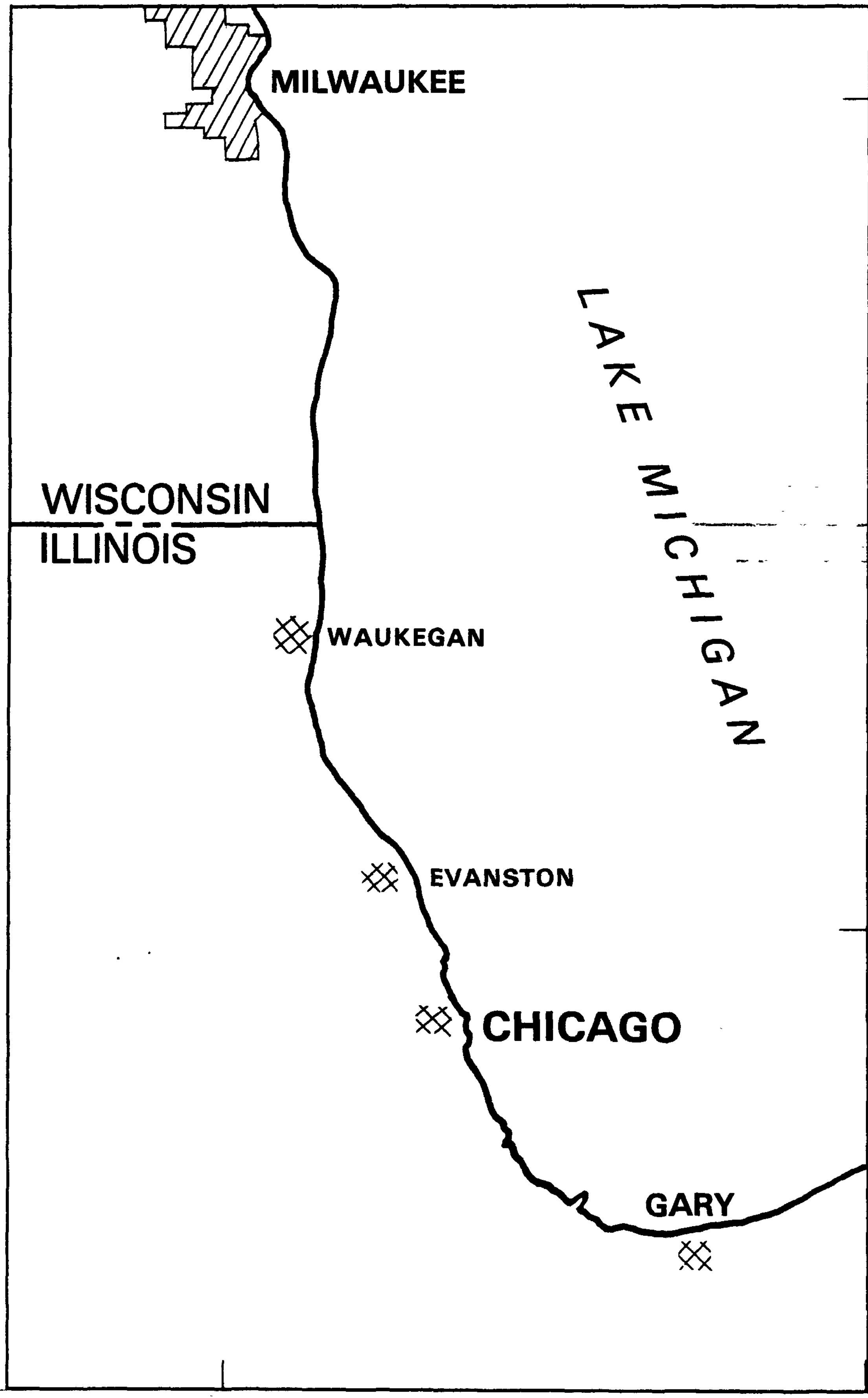


FIGURE IV-1: LOCATION OF WAUKEGAN HARBOR, ILLINOIS

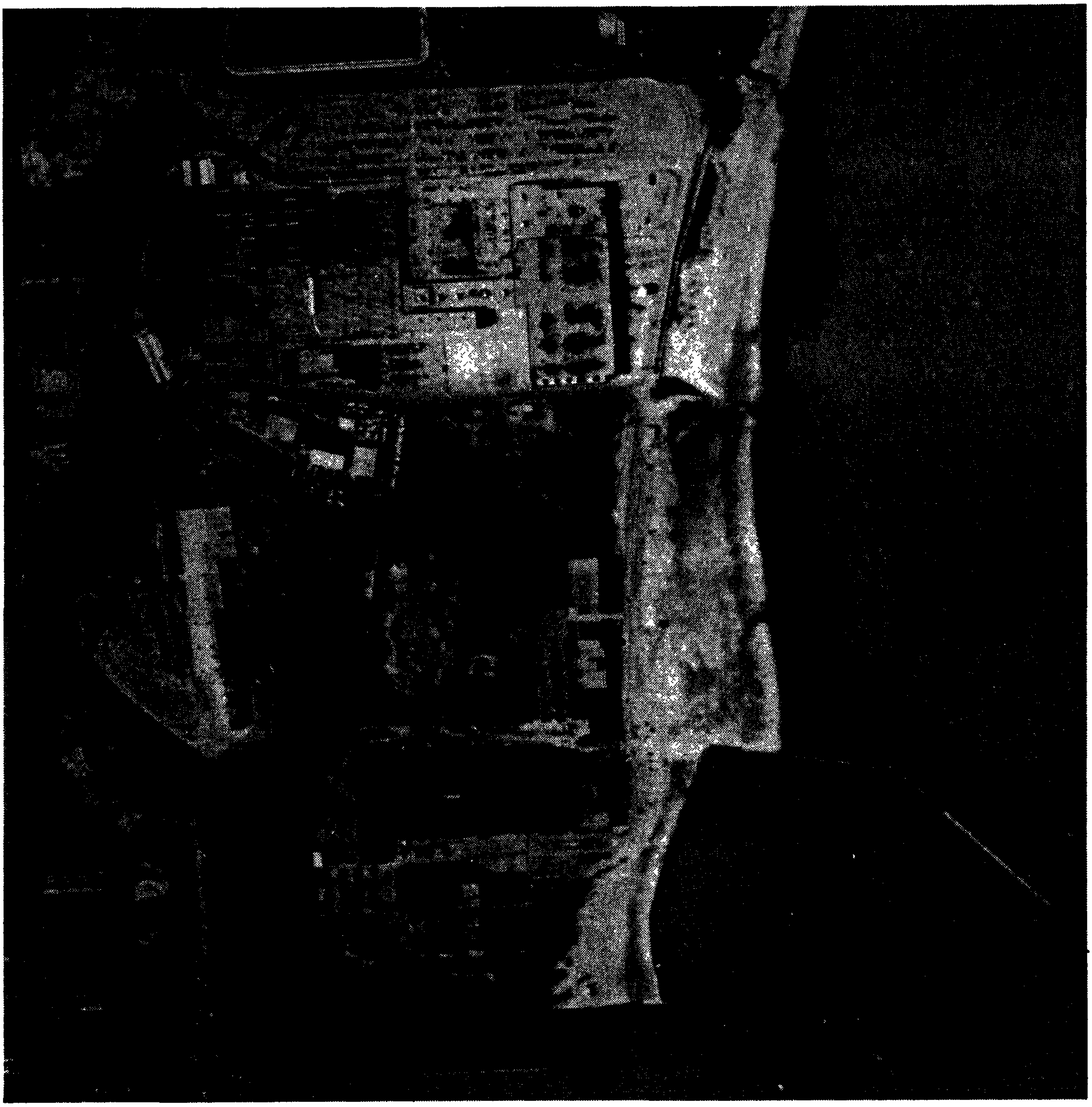


FIGURE IV-2: AERIAL PHOTO OF WAUKEGAN HARBOR, ILLINOIS

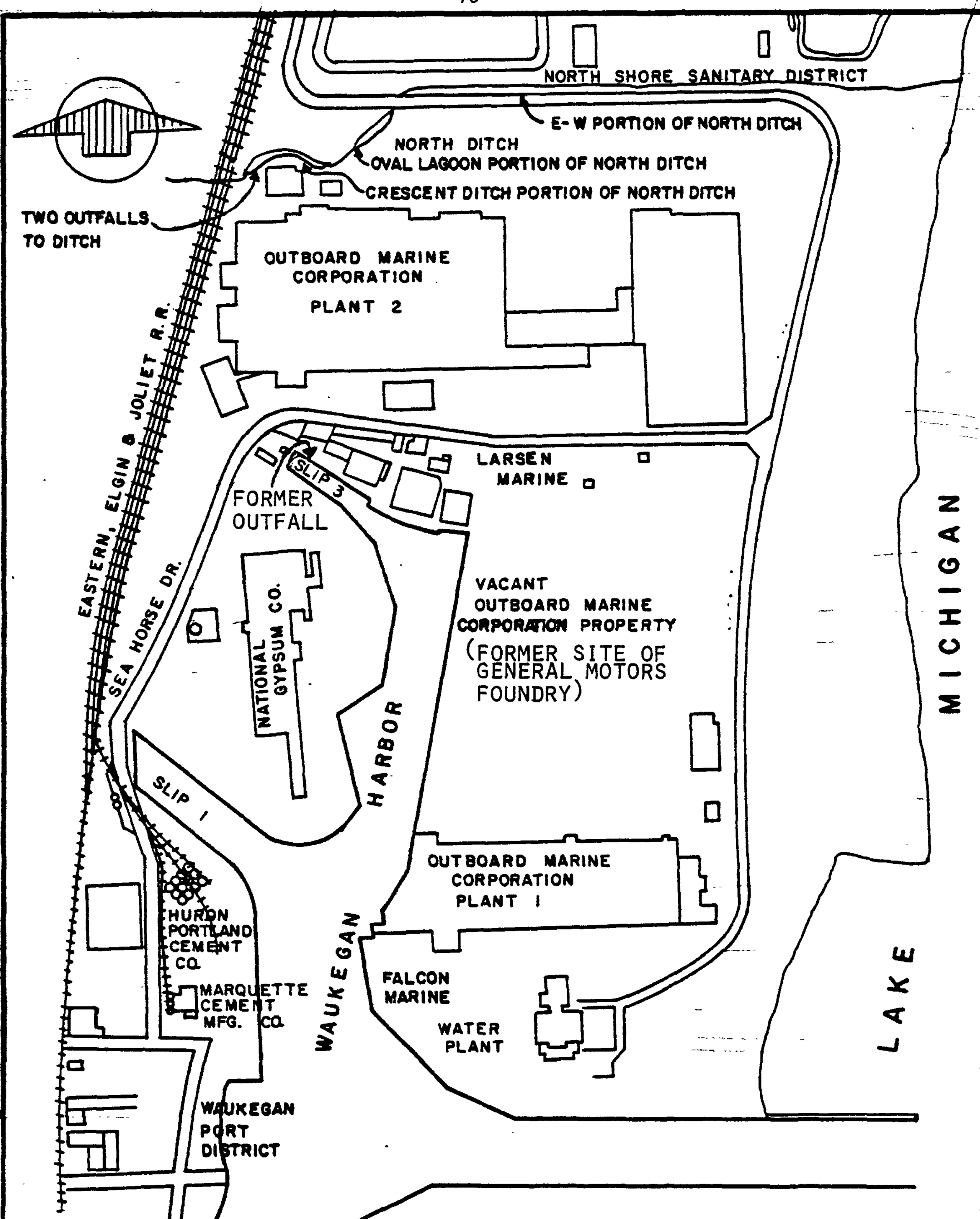


FIGURE IV-3: LOCATION OF OUTBOARD MARINE CORPORATION PLANT AND PCB OUTFALLS IN RELATION TO SLIP #3 AND THE NORTH DITCH removal of a small amount of uncontaminated material (contaminated to less than 1 ppm) from the southeast corner by the Waukegan Port Authority, no dredging has been performed in the harbor since PCB contamination was discovered in 1975. Spoils from the last dredging (1974) were placed in mounds up to 14 feet high located on vacant land owned by OMC and bordering the northeast portion of Waukegan Harbor. The mounds are composed of sand which for the most part contains 2 ppm or less of PCB. Earlier dredge spoils were usually dumped into Lake Michigan. Slip #3 reportedly has not been dredged since about 1950. The upper portion of the harbor was last dredged about 1957. Slip #1 was widened and dredged in 1968. Slip #2, formerly located at National Gypsum, was closed in 1957.

Contamination of Harbor Sediments

Waukegan Harbor appears currently to contain as much as 275,000 pounds of PCBs, which continue to contaminate the waters of Lake Michigan. This contamination occurs, to varying degrees, in bottom sediments throughout the entire harbor.

Harbor Sediments consist basically of 1) a top soft "muck" layer, 2) an underlying sand layer and, 3) a generally impervious silty clay layer. (See Figure IV-4.)

The muck layer varies from 0 to 10.5 feet in thickness. Available data have shown that this layer is contaminated at all depths and at any given location in the harbor. Contamination is highest in Slip #3 (as high as 500,000 ppm or 50% PCBs) and decreases towards the harbor mouth, where concentrations drop to the 5 to 10 ppm range.

The sand layer varies from 0 to 9 feet in thickness. The contamination level of this sand is less than 5 ppm, except below the old OMC outfall in Slip #3.

The underlying gray silty clay is generally impervious but may contain some gravel, sand, or thin organic seams that could allow PCB penetration. PCBs have been found to be less than 1 ppm in this layer, except immediately below the Slip #3 outfall.

The zones of harbor contamination exceeding, respectively, 500 ppm, 50 ppm and 10 ppm PCBs are shown in Figure IV-5. The high concentrations found in Slip #3 suggest that nearly pure PCB hydraulic fluid must have been deposited from the OMC outfall into harbor sediments during the years of maximum PCB fluid leakage. These PCBs have now spread out into the harbor through the muck layer.

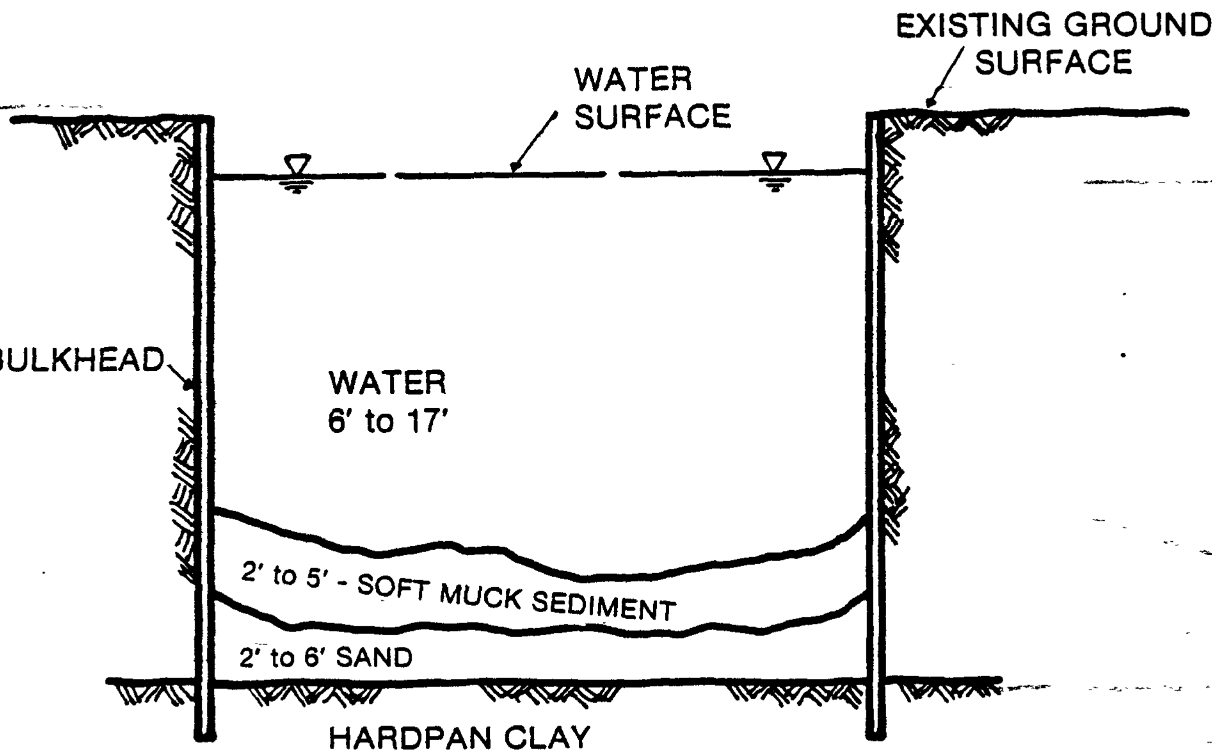


FIGURE IV-4: CROSS SECTION OF SLIP #3

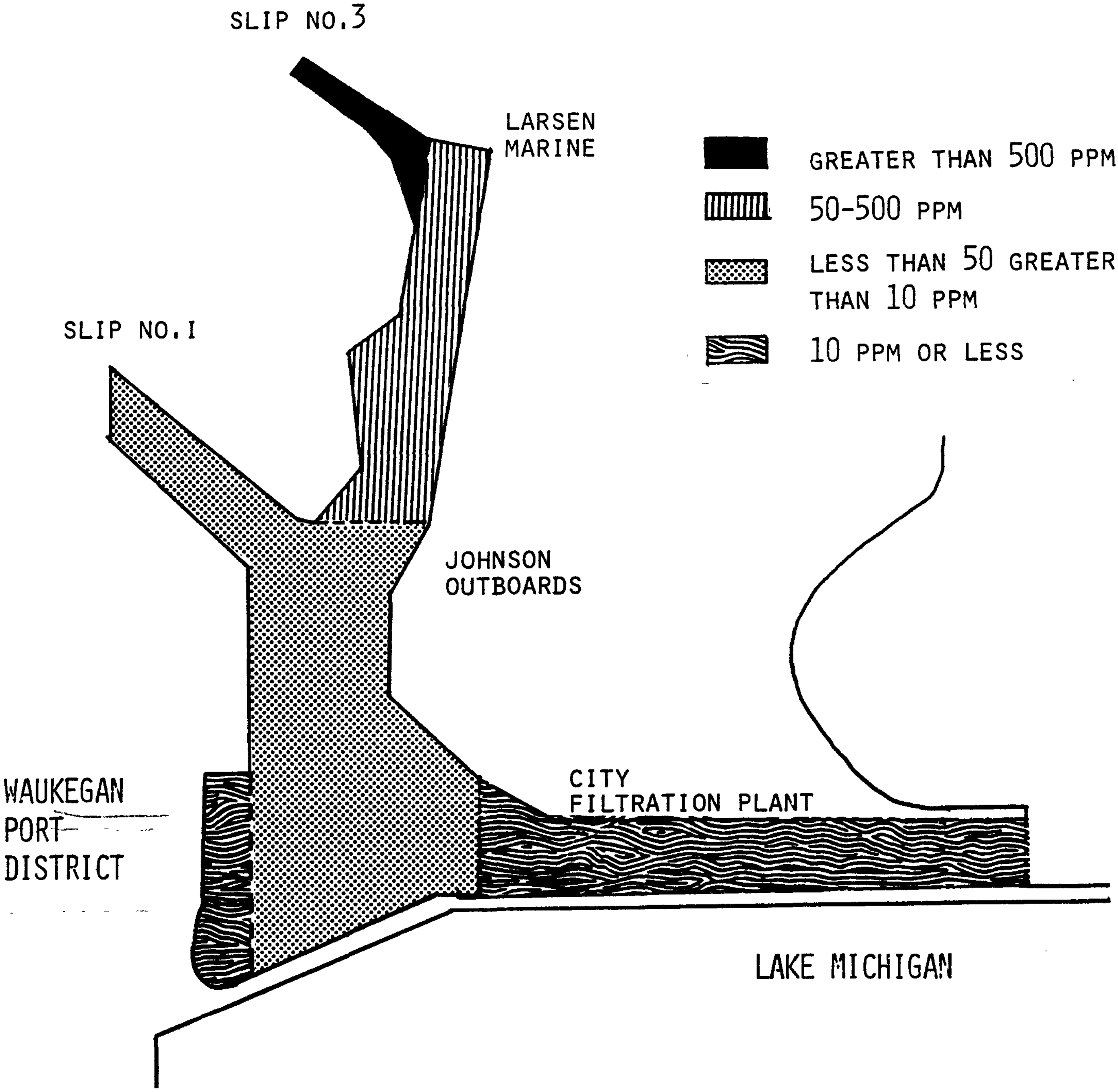


FIGURE IV-5: EXTENT OF PCB CONTAMINATION

The total volume of contaminated sediments in the harbors, as shown below, is estimated to be 168,000 cubic yards, containing up to approximately 275,000 pounds of PCBs. These calculations are based upon ongoing studies conducted by U.S. EPA and its consultants, the Illinois EPA, OMC consultants, and others, and are subject to futher refinement.

ESTIMATED PCB CONTAMINATION IN WAUKEGAN HARBOR

ZONE OF PCB CONTAMINATION *	MAXIMUM AMOUNT OF PCBs PRESENT	APPROXIMATE VOLUME OF CONTAMINATED SEDIMENT
More than 500 ppm (Slip #3)	270,000 pounds	7300 cubic yards, muck 1500 cubic yards, sand
50 ppm to 500 ppm (between Slip #1 and Slip #3)	4,000 pounds	39,000 cubic yards, muck
10 ppm to 50 ppm	2,000 pounds	120,000 cubic yards, muck
Total (more than 10 ppm)	276,000 pounds	168,000 cubic yards

* [See Figure IV-5.]

PCBs move from contaminated sediments into the waters of the harbor through two major interrelated pathways. In the first pathway, PCBs in sediments become soluble in overlying waters. Maximum solubility of Aroclor 1242 and 1248, the two primary Monsanto products used by OMC, is at the level of hundreds of parts per billion (ppb). Because of the mixing of contaminated waters with clear waters, and the adherence of dissolved PCBs to particles (and subsequent precipitation out of solution), actual environmental concentrations are far below the maximum level. The 2 to 10 ppb range observed in Slip #3 is unusually high for surface waters (see p. IV-19).

In the second major pathway, PCBs attached to sediment and soil particles become suspended in the water column as a result of turbulent water motion caused by winds, waves and boat movements. These suspended materials, along with the dissolved materials referred to above, are carried outward by circulation and flushing movements. Although much of the PCB is redeposited into downstream sediments during the process, some enters the lake. At each of these stages, the PCBs are accessible to living organisms and there is the ever-present danger that they will enter the food chain and bioconcentrate to high levels.

Measurements of the water concentrations of PCBs, water movement, suspended solids movement, and other chemistry, are allowing development of a mathematical model to estimate the current discharge of PCBs from Waukegan Harbor to the lake through the harbor channel. The U.S. EPA consultant's preliminary estimate is that approximately 20 pounds per year of PCBs are discharged from the harbor into the lake.

In the other significant route for transport of PCBs from the harbor to the lake, OMC currently withdraws approximately 1 million gallons per day (MGD) from Slip #3 of the harbor for use as cooling water. After circulation throughout the plant, the water is discharged to Lake Michigan and the North Ditch. Concentrations of PCBs in the outfalls result in approximately 2 pounds per year being discharged directly to the lake, according to company figures.

Waukegan Harbor Fish Contamination

Fish which have lived for long periods in Waukegan Harbor enter the lake, where they may stay for periods of from several days to several months. Some of the fish caught by fishermen in the Waukegan area have undoubtedly spent some time in the harbor, whether or not they are caught in the harbor.

By mid-1980, U.S. EPA had completed two types of studies to determine the extent of PCB contamination of fish in the harbor. In the first, 16 random samples of fish collected from the harbor averaged 18 ppm PCBs. All but three of these samples exceeded the 5 ppm FDA guideline and all but one exceeded 2 ppm, the proposed guideline. Those levels are higher than those found in the lake for the same species.

In the second study, uncontaminated fish were exposed for 30 days to water from Slip #3 in the harbor, and then placed in open lake water for an additional 84 days. The 30-day exposure to the harbor water resulted in 20 ppm PCB levels in the bluegills and 12 ppm levels in the yellow perch. Even after the 84-day exposure to cleaner open lake water, these levels did not drop below 8 ppm.

Although the determination of these concentrations was based upon analysis of the whole fish, and the FDA guidelines refer only to the edible portions of the fish, the tests strongly indicate that fish caught in Waukegan Harbor should never be eaten, and that fish spending even short periods of time in the harbor should not be eaten except on an infrequent basis.*

For comparison, Illinois EPA analyses of the edible portion of fish caught in Lake Michigan off Waukegan in 1978 indicate that PCB levels for bloater chubs are less than 1 ppm while levels in two groups of lake trout averaged 3.4 ppm and 5.4 ppm respectively, exceeding either existing or and proposed FDA levels. The Illinois Department of Public Health has issued warnings to limit consumption of salmon and trout from the lake.

Ambient Water Quality

The levels of PCBs in the waters of the harbor, the nearshore areas and even the lake itself are higher than the water quality criteria currently recommended by U.S. EPA. These elevated levels are of great concern because of their effect on fish contaminant levels and human health, due to the high bioaccumulation factors.

PCB levels in the open waters of Lake Michigan range from 5 to 10 ppt (parts per trillion) and typically up to 50 ppt in nearshore waters, substantially above the U.S. EPA recommended levels of one ppt or less, designed to reduce levels in fish to those acceptable for human consumption. Levels in Waukegan Harbor are much higher, ranging from less than 100 ppt in the harbor channel to several thousand ppt in Slip #3.

Water Supply

There is an auxiliary public water supply intake located in the harbor channel, which is used less than one or two days a year. Monitoring by the U.S. EPA and the State of Illinois indicates that it poses no threat to public health. The monitoring of nearby harbor water concentrations, as well as of the raw water actually taken in during periods of use, has always shown PCB levels to be well below the U.S. EPA current recommended maximum of 1 ppb for drinking water. Further, the water receives treatment before use and PCBs have not been detected during testing of the treated water. The situation requires, however, that such testing be continued as long as the harbor contamination exists.

* Concentrations in whole fish tend to be somewhat greater than in the edible portion, but on occasion the edible portion may contain even higher concentrations.

NORTH DITCH AND OMC PARKING LOT AREA SOILS

A second area of excessive PCB contamination by OMC, in addition to the harbor sediments, has been found in the nearby "North Ditch" and in the soils of the adjacent parking lot for OMC employees (see Figure IV-6).

The North Ditch is a small tributary approximately 1500 feet north of the harbor, which drains 0.11 square miles of property owned OMC and the North Shore Sanitary District. About 40 percent of this area has an impervious surface (roads, railroads, buildings, and parking lots). Upstream from OMC, North Ditch drains an area of landfill (which served as a disposal site for urban debris) composed of sandy material. It then crosses the Elgin, Joliet and Eastern Railway Company tracks, via a 36-inch culvert, before entering OMC property.

The ditch then enters a 600-foot-long-by-20-foot-wide channel, referred to in this report as the "Crescent Ditch". The Crescent Ditch formerly received OMC floor drain discharges containing PCBs and is still receiving once-through cooling water used in the plant. The Crescent Ditch conveys its waters to an "Oval Lagoon" approximately 240 feet long. A culvert at the end of the Oval Lagoon connects it to a straight East-West channel about 2,000 feet long which flows directly to Lake Michigan.

The North Ditch stream bed material is composed of sand with some gravel. The sand is overladen with organic debris, black-grit, and finer sediments, especially in the Crescent Ditch and Oval Lagoon. Cattails and other vegetation grow along the ditch, and the ditch itself contains considerable algae. Carp have been seen in it on occasion, and birds have nested along it.

The depth of water in North Ditch is influenced by Lake Michigan. During periods of on-shore winds, sand piles up at the mouth, even to the extent of closing it off. When lake levels are high with strong on-shore winds, the North Ditch level can reach the top of its banks. Then the excess sand at the mouth must be removed to prevent flooding of OMC property. During periods of off-shore winds, the North Ditch mouth tends to open up, the water level in the ditch drops, and there is a net flow of ground water up into the ditch. Lake water can likewise flow into North Ditch or North Ditch water can seep into the lake via the groundwater. During very dry weather, the flow may not even enter the lake, percolating through the bottom into groundwater.

A general picture of the geology underlying the OMC site is given in Figure IV-7. Across most of the OMC property, the ground surface has been raised by the dumping of artificial fill material up to an 8-foot depth. The fill lies over a sand layer which in turn overlays a clayey silt. Groundwater levels and movements are variable, depending on the stage of the ditch and rainfall. Groundwater levels can be within two feet of the ground surface in the vicinity of the ditch, while movement tends to be towards the lake.

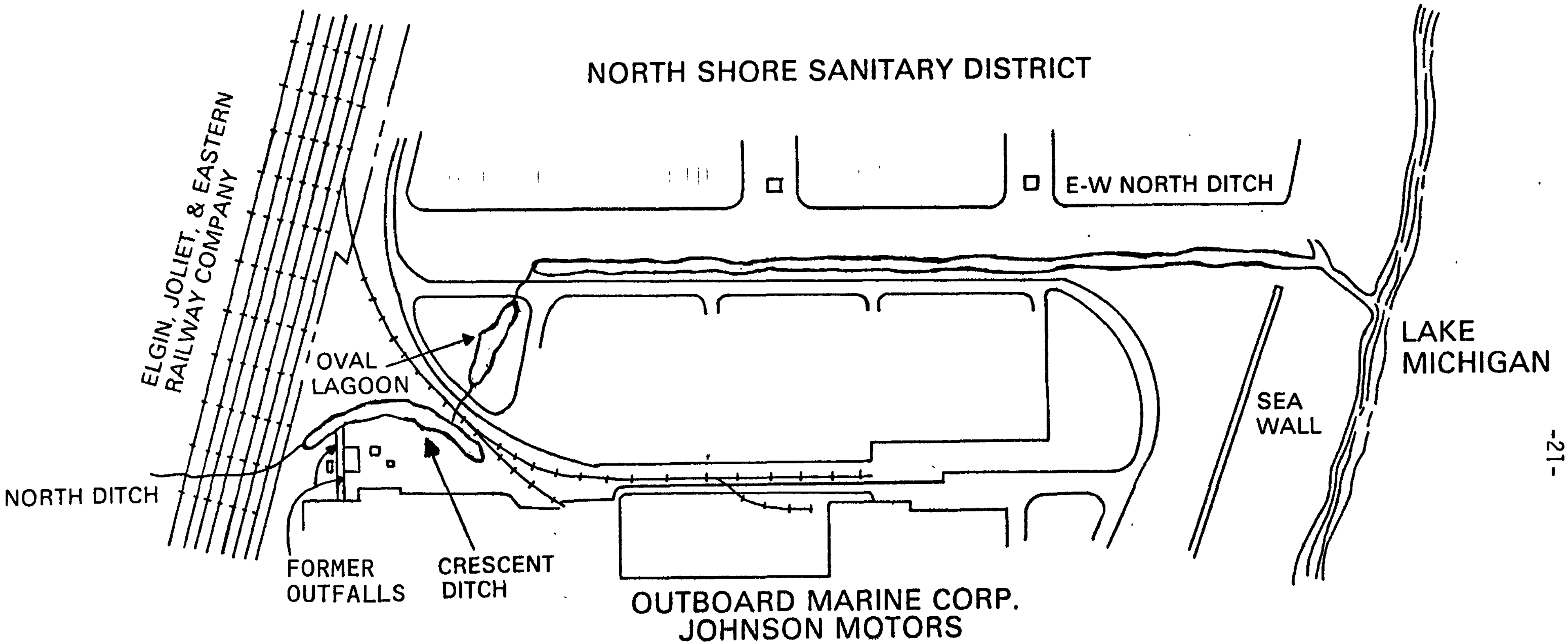


FIGURE IV-6: NORTH DITCH AND PARKING LOT AREA

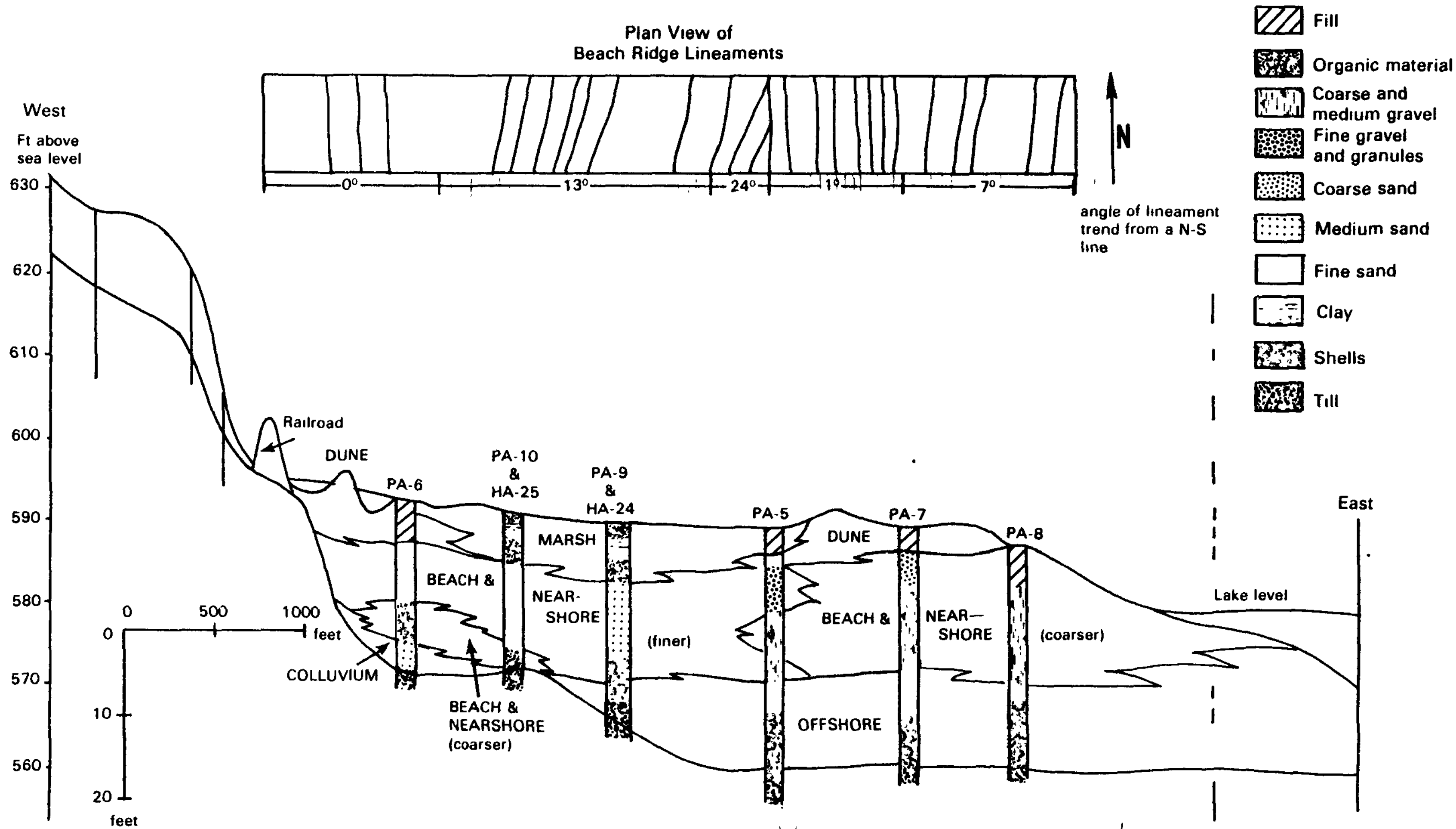


FIGURE IV-7: GEOLOGY UNDERLYING OMC SITE

The North Ditch apparently received the largest portion of all PCBs discharged from OMC between 1959 and 1972. These PCBs may be found in very high concentrations: as much as 25% PCBs (250,000 ppm) had been found in surface sediments near the OMC outfalls and 38% PCBs in underlying sediments as early as 1977. Concentrations as high as 24,000 ppm were found 7 feet below the ditch.* Figures IV-8 and IV-9 indicate the extent of the problem known then. As may be seen, the worst areas are immediately downstream of OMC's former outfalls which carried the heaviest PCB load from the old die cast building. Downstream surface concentrations stay above 50 ppm almost to the lake. Based on data gathered through 1977, it was estimated that approximately 4500 cubic yards are contaminated at a level higher than 50 ppm PCBs, and 6300 cubic yards at a level above 10 ppm. Continuing study of soils and groundwater on OMC property has shown high levels of PCB contamination in water and soil adjacent to the ditch and at depths below it. (See Figure IV-10). Thus the volumes noted above are substantial underestimates of the amount of sediment and soil which must be removed or otherwise dealt with.

As has been discussed above, combined discharges of PCBs to Lake Michigan from the ditch and harbor during OMC's greatest use of PCB hydraulic fluids were in the thousands of pounds.

The North Ditch discharges PCBs to the lake during its regular flow and during rainstorms. OMC's consultant estimated, in 1977, that roughly 7 to 8 pounds per year were entering the lake through this route. In U.S. EPA's view there is the possibility that the ditch could, under special conditions, produce large additional releases of PCBs.

Finally, the slow migration of PCBs through the contaminated soils results in gradual release of PCBs into shallow groundwater aquifers which are believed to be discharging into the lake. As PCBs are probably spreading through the groundwater and soils, this source is believed to be increasing.**

In late 1979, the U.S. EPA took steps to implement the construction of a bypass to divert flows around the most contaminated portion of the ditch. Preconstruction soil testing revealed new areas of previously undiscovered contaminated soils in the OMC parking lot located just south of the east-west section of the ditch. The diversion construction was delayed while further studies were undertaken which have shown substantial additional PCB contamination (See Figure IV-10) in both the soils of the parking lot and in the underlying groundwater.

* Data on PCB concentrations obtained by U.S. EPA since October of 1978 are subject to a protective order issued by the Federal District Court at the request of OMC. The order provides that such data cannot be discussed until "the data and tests are used in the prosecution of this matter." Since trial is not expected to occur until later this year, U.S. EPA is attempting to gain release of the most pertinent information for public disclosure.

** U.S. EPA data on the ditch and groundwater are subject to the protective order.

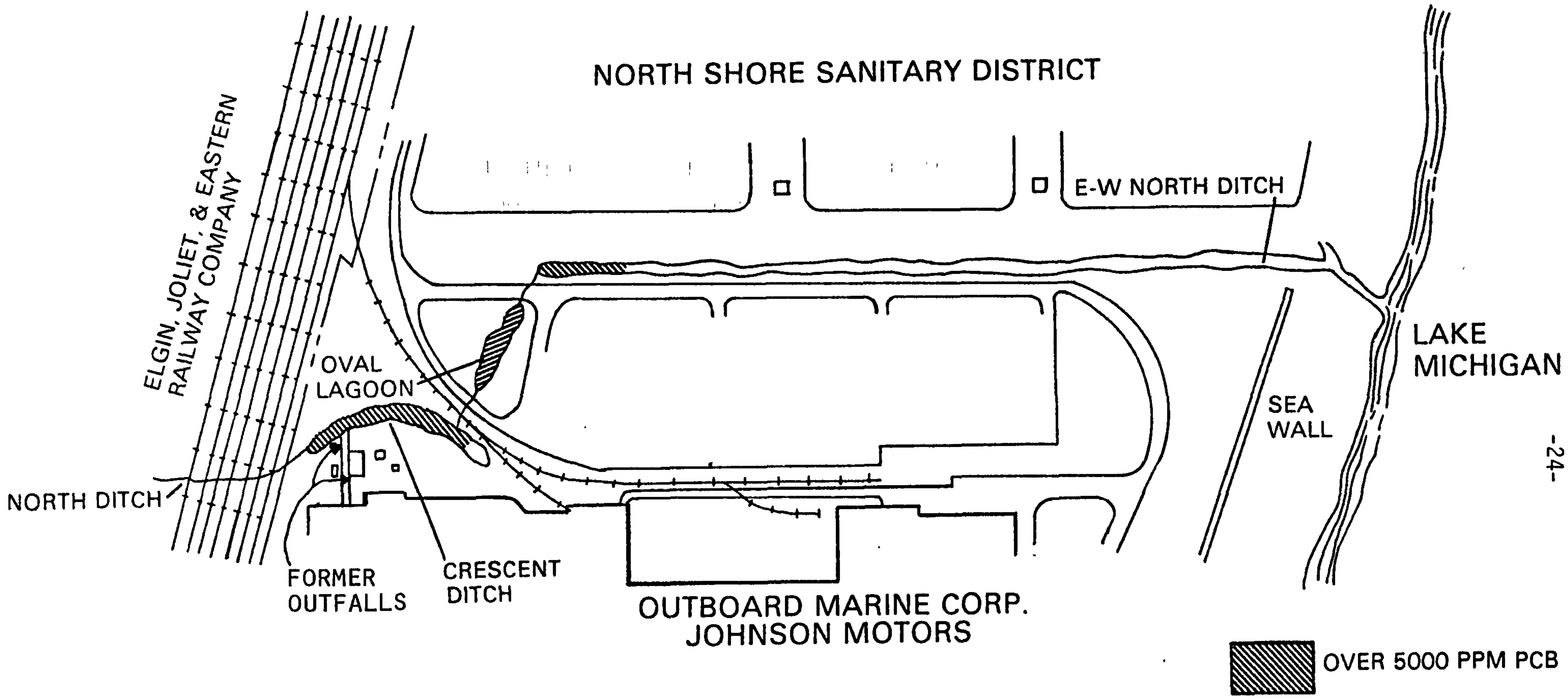


FIGURE IV-3: NORTH DITCH AREA APPROX. EXTENT OF PCB CONTAMINATION 5000 PPM--1977 DATA

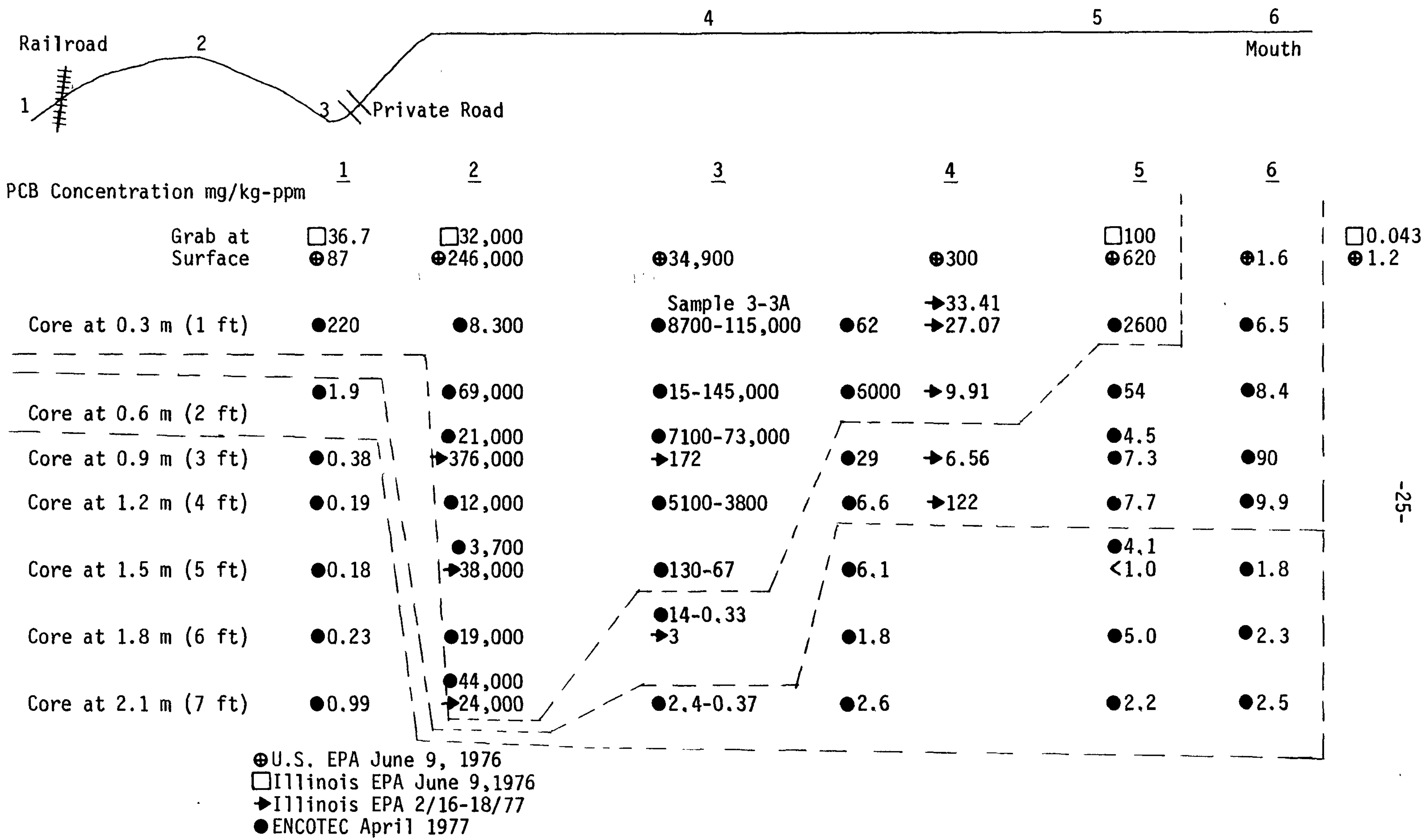
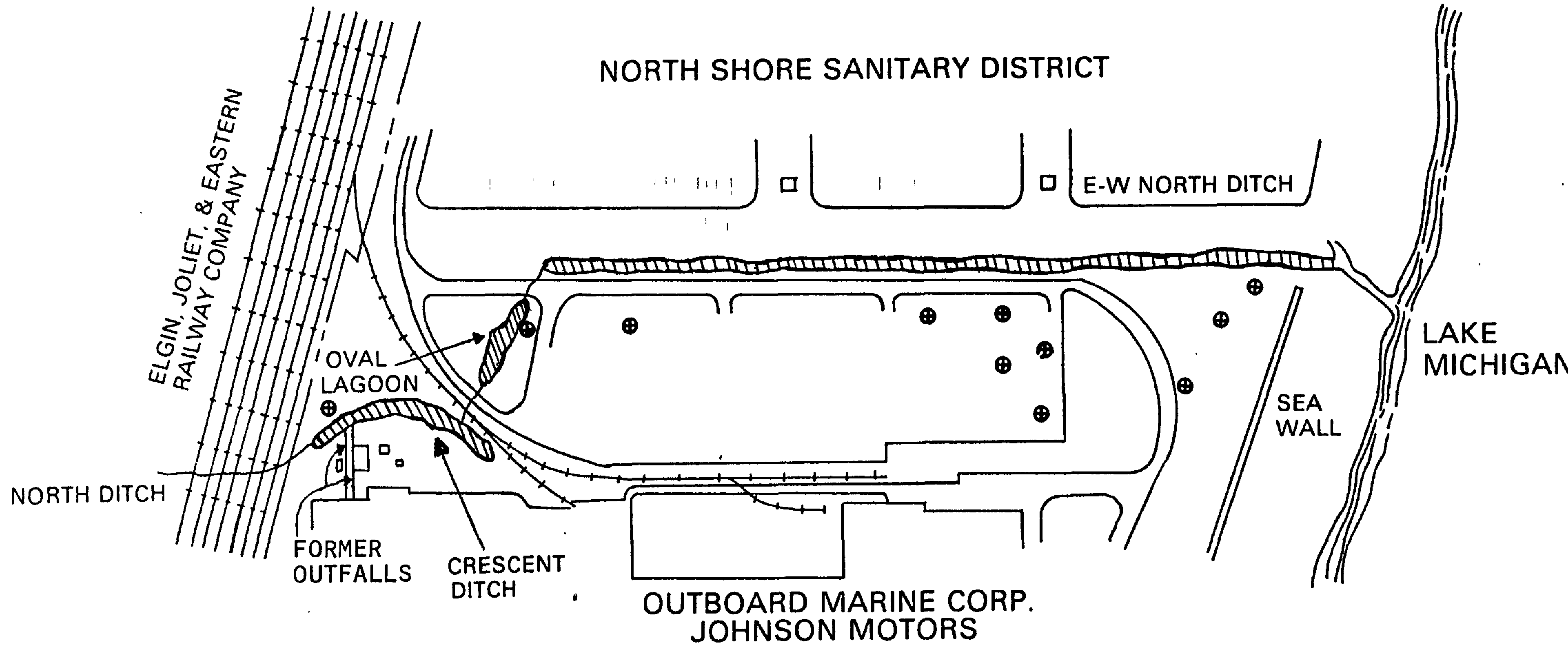


FIGURE IV-9: PCB CONCENTRATION PROFILE IN THE NORTH DITCH



▨ = OVER 50 PPM PCB (1977 DATA)

⊕ = APPROX. SAMPLE LOCATIONS OVER 50 PPM PCB (DATA COLLECTED DURING SECTION 311 BYPASS INVESTIGATIONS, 1979, 1980)

<u>FIGURE IV-10: NORTH DITCH AREA--EXTENT OF PCB CONTAMINATION OVER 50 PPM</u>

High soil concentrations of up to 14,000 ppm PCBs were found in 1979 just south of the North Ditch and only 500 feet from the lake, in OMC's parking lot area. Six other samples exceeded 1000 ppm. Contamination of groundwater, in levels ranging from 2 to 680 parts per billion, was found in sampling conducted by OMC's consultant on the OMC site in 1977. The concentrations of PCBs that have been found in soils on OMC property are higher than the level at which PCB contaminated materials are required by U.S. EPA regulations to be contained in a secure landfill, approved for PCB disposal. *

Although the full extent of this new area of contamintion is still being investigated, it is clear that the parking lot soils represent, in actuality, an unlicensed and unsecure PCB landfill.

SUMMARY

Since discovery of the Waukegan PCB problem, U.S. EPA, with the help of consultants and the cooperation of other agencies, has performed a number of studies regarding the nature and extent of the PCB problem and its effects, both locally and in Lake Michigan as a whole. The results of these efforts may be summarized briefly as follows:

- The PCB contamination site at Waukegan, Illinois, as a result of practices by the Outboard Marine Corporation, is the largest known reservoir of PCBs existing in the free environment.

- Waukegan Harbor is believed to contain up to 275,000 pounds of PCBs, distributed within approximately 168,000 cubic yards of sediments with average PCB levels above 10 ppm.

- The North Ditch tributary to Lake Michigan contains PCB concentrations as high as 380,000 ppm.

- A new area of soils and groundwater contamination was found in the OMC parking lot last year when U.S. EPA attempted to construct a bypass around the ditch area. Tests showed that contamination levels exceeded 14,000 ppm in soils and extended to 680 ppb in groundwater, although volumes are still under investigation and some of the existing data is protected by the court order.

- During the period of OMC's greatest use and discharge of PCBs to the Harbor, discharge of PCBs to Lake Michigan were in the thousands of pounds per year. Much of the Lake Michigan PCB problem was created as a result.

- Current PCB releases from the harbor to the lake are approximately 20 pounds per year, with additional discharges entering the lake from the ditch, through the groundwater, and from OMC discharges.

* Additional sampling has revealed further extent of contamination of soils and groundwater in this area but further description cannot be provided at this time due to the limitations of the protective order.

- Contamination of fish caught in the harbor averages 18 ppm PCBs, and two groups of lake trout collected in the lake near Waukegan had 3.4 ppm and 5.4 ppm average concentrations respectively. When these levels are compared with the FDA temporary tolerance limits of 5 ppm and proposed limits of 2 ppm, it suggests that all fish caught in Waukegan Harbor and some caught in the nearby area of the lake are unfit for regular consumption.

- Studies demonstrate that after exposure to the harbor waters, even fish that return to the lake may retain levels of PCBs exceeding FDA limits for several months.

CHAPTER V

THE OPTIONS FOR DEALING WITH THE PROBLEM AND THE PROPOSED SOLUTIONS

WAUKEGAN HARBOR

The foregoing section of this report has discussed the extensive contamination of Waukegan Harbor, including the presence of as much as 275,000 pounds of PCBs, the continued discharge of PCBs from the harbor to Lake Michigan and the resulting contamination of fish. As the information available to U.S. EPA describing the problem has increased, it has been possible to develop engineering evaluations of the options available to reduce or eliminate these problems. A discussion of these options follows, together with preliminary cost estimates, where available.

The Options

There are three general approaches to dealing with this problem:

- First, the no-action alternative, which could include taking measures which would mitigate the harmful effects of the contaminated harbor sediments but would do nothing to reduce the contamination itself or to prevent it from continuing to migrate into the waters of the lake and the food chain.

- Second, a set of options which would reduce the migration of PCBs from the sediments into the lake and the food chain, but which would require reduction or elimination of present uses of the harbor. This set of options includes closing or draining the harbor, securing the sediments and attempting to destroy the PCBs in place.

- Third, the removal of the contaminated sediments, which would permanently and dramatically reduce their adverse impacts on the environment while restoring the harbor to its original uses.

No Action. Efforts to mitigate the effects of the contamination might include bans on fishing in Waukegan Harbor and some nearby Lake Michigan waters, bans on dredging in the harbor, and restrictions on boat traffic. These efforts would reduce the exposure of fishermen and their families to PCBs, but would restrict recreational and industrial uses of Waukegan area waters. Normal sedimentation would cause water depths to decrease, restricting industrial and pleasure boat traffic. Although it should be possible to dredge small areas in the navigation channel safely as long as safe methods for toxicant dredging and disposal were employed, this would simply replace an immediate large dredging project with a piecemeal project to be accomplished over many years, thus increasing the overall costs and reducing the ultimate benefits. Discharges of PCBs into the lake would continue, as would the spread of PCBs into downstream harbor sections. In addition, PCBs from the very high contamination zones in Slip #3 could spread into the adjacent soils and groundwater.

Closing the Harbor. Installing a dam across the entire harbor or part of the harbor would both prevent PCBs from moving into the lake and keep fish from coming into the harbor. It would eliminate all boat traffic. Waters in the harbor would stagnate. PCB concentrations would increase in the water, increasing the possibility of movement of the toxicant into the air (volatilization). Highly contaminated sediments in the upper harbor could spread into the adjacent soils and groundwater.

Draining the Harbor. The permanent loss of part of the harbor suggests one further variation of the harbor closure option. In this concept, a dam would be build across the harbor and the water behind the dam pumped through a water treatment system back into the lake. Excavation of sediments would then occur with the material taken to a secure landfill or incinerated. The dam would then be opened and the harbor returned to use.

When water is drained from the harbor, however, sheet piling and the adjacent shore can be expected to cave in. To prevent this, a slurry wall must be constructed around the perimeter of the harbor. Well points would have to be installed to prevent groundwater from entering the harbor. This would be a very expensive alternative and would necessitate closing the harbor for more than a year. Volatilization of PCBs from exposed sediments could also be a problem.

This approach might be more plausible for the small area in slip #3 immediately around the old OMC outfall, the only spot where sand and clay have been found to be contaminated and where contamination behind the sheet pile wall is suspected.

In-place Secure Storage. In this concept, the upper (northern) portions of Waukegan Harbor, including but not necessarily limited to slip #3, would be sealed off by a dam. PCB-contaminated sediments from the lower portions of the harbor would then be removed, using a hydraulic dredge, and transferred to the sealed upper portion. The water in the upper portion would be treated for PCBs. A slurry wall made of clay and extending down into natural clays underlying the harbor would be constructed around the sealed portion to restrict horizontal movement of contaminated waters. Finally, the sediments in the sealed portion would be hardened by an in-place fixation method and covered with clay and soil. The upper portion of the harbor would then no longer exist. In its place would be a PCB disposal facility.

Approximate costs (excluding property aquisition) for this approach are as follows:

Contamination Level Sealed Off	Location of dam	Approximate cost
Over 500 ppm (Slip #3)	1/2 way up Slip #3	$2 million
Over 50 ppm (Above Slip #1)	just below Slip #3	$5.5 million
Over 10 ppm	just above Slip #1	$13 million

These alternatives do not conform to conventional PCB landfill practices and would require a special waiver from U.S. EPA. The upper end of the harbor would cease to exist, restricting or eliminating Larsen Marine's business, if contamination were secured to the 500 ppm and 50 ppm levels. If the dam were located to secure sediments at the 10 ppm level, it would probably affect National Gypsum as well. The PCBs would remain in proximity to the lake. Given the nature of the underlying sediments and the contamination already found in clay layers, U.S. EPA could not predict that the PCBs would be immobilized. Any penetration of underlying layers, if it were to occur, would be more difficult to detect and to deal with than in a conventional PCB landfill.

In-place Destruction.

Biological agents. It has been suggested that biological agents (microbes, worms) that have been tested in laboratory situations could be released to Waukegan Harbor or used after sediments had been confined by a method similar to that described above. No tests have shown, however, that these organisms will degrade PCBs of the type that are found in Waukegan Harbor in a natural environment. U.S. EPA scientists advise that any expected degradation would be on the order of only a few per cent. If the organisms did work, to any extent, there is no assurance that PCBs below the surface would be affected unless the sediment were stirred. Further, there has been no examination of additional risks that might result from application of the organisms and stirring of the sediments.

Chemical agents. Several chemical methods for destruction of PCB materials are under development. At the present time none will work for sediments in aqueous environments, nor even for water-containing sediments after removal from the harbor.

In-place Fixation. A Japanese firm has developed a method for turning contaminated sediments into a concrete-like material. Costs have been quoted at $20 to $40 per cubic yard or roughly $300,000 if fixation were limited to the materials above 500 ppm. Long-term stability has not been demonstrated for the technique, however, and as the concrete begins to deteriorate, it can be expected to release PCBs back into the environment. The resulting concrete-like harbor bottom would also create great difficulties in dredging the harbor bottom, thus severly restricting harbor use.

Removal of the Sediments Through Dredging. Dredging is a proven alternative which would remove the PCB-contaminated sediments from Waukegan Harbor. It would, however, require selection of a dredging technique that would restrict the dispersal of additional PCBs during the dredging operation. There are three main types of dredges applicable to this project: mechanical, hydraulic and pneumatic. Mechanical dredges, which include clamshell, dipper and bucket-and-chain dredges, scoop up sediment and bring it to the surface, where it is placed in trucks for disposal. A clamshell dredge would be the method of choice if there were no concern for either dispersal of PCBs or incomplete removal of sediments. There is, however, considerable disturbance and suspension of sediment with the clamshell dredge. An estimated 15 to 30% of the muck sediment is spilled when a clamshell lifts it out of the water, creating significant turbidity, and further spillage may occur when the material is placed in waiting trucks.

The hydraulic dredge uses a suction line, a pump and a discharge line to convey the sediment to a basin where it can be dewatered and treated. Turbidity is far less than from a mechanical dredge, and this technique is ideally suited to the harbor muck. Sand dredging of the type needed in a small zone of slip #3 would, however, require use of a cutter head to loosen the material.

Use of a hydraulic dredge requires a dewatering basin. If the basin were at a remote location or in a barge there would be considerable chance of spillage. The only open land for location of a dewatering basin available close enough to assure a clean operation is the OMC property formerly owned by General Motors. (See Figure IV-3).

Pneumatic dredges use compressed air to force the sediments through a pipe at the bottom. Less water is conveyed with the sediments than with a hydraulic dredge. A pneumatic dredge could be expected to be effective in the muck layer but less effective than a hydraulic dredge for sand. The use of compressed air might generate increased risks of volatilization.

Roiling of bottom sediments can be kept to a low level with both the hydraulic and pneumatic dredges. Silt curtains could be situated outside the area of dredging to restrict movements of sediment. The main drawback to these methods is the need to first dewater and then to dispose of or incinerate the sediments offsite. Dewatering would require temporary use of the OMC vacant land.

Dredging can be done safely and results in genuine cleanup, but it is more costly than some of the methods outlined above. Harbor usage would be restricted only during a period of a few months when dredging occurs. Following dredging, water depth would be greater than before and full harbor use could be achieved. The effects of contamination would be permanently reduced or eliminated, depending on the size of the dredging project. The cost of dredging the harbor sediments which are contaminated above 10 ppm, currently estimated to be 168,000 cubic yards, would be in the vicinity of ten million dollars, including the costs of dewatering, water treatment, loading into trucks and site restoration. Disposal costs would add $6 to $33 million, as discussed in Chapter VI.

The Preferred Option

Dredging and removal of the contaminated sediments from the harbor is clearly the only available option that will accomplish all the following objectives:

- Restoration of the harbor to its full recreational and commerical functions

- Removal of the severe PCB contamination risks to consumers of fish caught in the harbor and lake environs

- Reduction of a major source of PCB contamination of Lake Michigan fish

- Complete and permanent removal of the contamination problem from the area

These clear benefits to the citizenry of Waukegan and the Lake Michigan Basin more fully justify the costs of remedial work than do the other options currently available. In addition, this option would remove to a secure location up to 275,000 pounds of a contaminant whose toxic effects are serious, and whose persistence in the environment makes it a potential threat to human health forever.

If the harbor is dredged, the project should remove all of those sediments contaminated above 10 ppm. Recent studies strongly indicate that risk of human exposure cannot be completely eliminated without removal of all sediments above the 10 ppm PCB level.

U.S. EPA's consultant has done simulations of the effect of various removal strategies on average PCB concentrations in fish, which now routinely exceed health guidelines, in Waukegan Harbor. Preliminary figures indicate that removal of all soils contaminated at or above the 100 ppm level would result in concentrations in fish exceeding the FDA guideline of 5 ppm in the most contaminated portion of the harbor. This would drop to over 3 ppm near the mouth. Similar effects could be expected if removal took place at levels exceeding 50 ppm. Simulations for PCB removal to 10 ppm level indicate average concentrations in fish would generally be about 3 ppm throughout the harbor, below the current FDA guideline but above the recommended guideline of 2 ppm. Simulations for 1 ppm indicate little further decrease in fish contamination. Only if dredging is conducted to the 10 ppm level, therefore, can we expect contamination in fish to stay within the existing FDA limits.

Information to support the 10 ppm dredging objective comes from several other sources. U.S. EPA's 1977 Great Lakes criteria for sediments established 10 ppm as the level beyond which harbor sediments are classified as heavily polluted. The criteria are, in turn, based on tests of exposure of fish to PCB-laden sediments, and waters in contact with PCB-laden sediments, as well as on consideration of contaminant levels in other harbors. Taken together, this information supports the view that dredging to 10 ppm should reduce fish levels to within the 5 ppm FDA guideline.

The Plan for Cleanup

The U.S. EPA, with the assistance of its engineering contractor, Mason & Hanger, has proposed a program for dealing with PCB contamination in Waukegan Harbor based on hydraulic or pneumatic dredging of all sediments contaminated above the 10 ppm level (See Figure V-1). The proposal is compatible with the plan for dredging slip #3 of Waukegan Harbor made public by the U.S. EPA on November 24, 1980. This approach is presented schematically in Figure V-1, and described below.

a. The sediments will be dredged with a hydraulic or pneumatic dredge and conveyed to lagoons through a pipeline.

b. Lagoons will be constructed for the dewatering and temporary storage of the dredged sediments.

c. The sediments in the lagoon will be dewatered and the excess water treated at an on-site treatment plant before it is discharged back to the harbor.

d. Special handling of the most highly contaminated sediments in slip #3 will be provided by a combination of protective barriers, removal methods and storage.

e. The dewatered sediments will be removed to a permanent storage facility as soon as the necessary arrangement has been made.

U.S. EPA's November 24, 1980 proposal for slip #3 dredging covered the dredging, treatment and storage of up to 15,000 cubic yards of muck, including harbor materials exceeding 500 parts per million PCBs. The newest information has refined that estimate to 8800 cubic yards of muck and sand. The full proposal extends that plan to a total of 168,000 cubic yards of material exceeding 10 ppm. The area to be dredged can be seen in Figure IV-5. This proposal is contingent upon the use of the vacant OMC property adjacent to the harbor for the temporary storage and treatment facilities.

The Dredging Operation. The dredging operation involves three phases. Phase I consists of dredging slip #3. Phase II involves dredging between slip #3 and a point north of the mouth of slip #1. Phase III includes dredging from that point to the boundary of the 10 ppm level. The full project can take place in one field season.

During the dredging operation, the roiled sediments in slip #3 must be prevented from further contaminating other areas of the harbor. Also, there must be little interchange of the waters between the slip and the harbor. To perform both of these functions, a containment device (silt curtain) will be

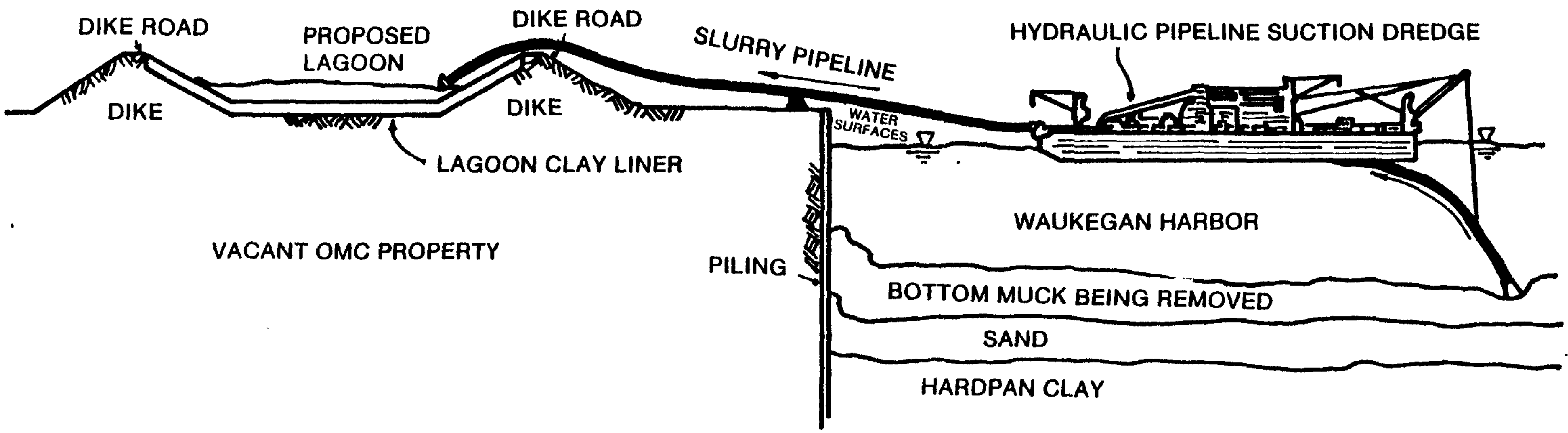


FIGURE V-1: DREDGING OPERATION--WAUKEGAN HARBOR put into place across the mouth of slip #3. Design of the curtain will allow for stress generated by water level fluctuations. At present, a double silt curtain (Figure V-2) is being considered. Additional containment will be provided during removal of the contaminated sand and clay at the tip of slip #3. A coffer dam is also being considered for use in this location.

For the second phase of the operation, a silt curtain similar to the one used in Phase I will be placed across the harbor near the mouth of slip #1. The dredge will start at the north end of this portion of the harbor and work south.

A silt curtain will be deployed around the dredge in Phase III. The curtain, in this case, will not be anchored to the harbor bottom but will move along with the dredge as it works its way through the harbor. A low turbidity dredge will be used, thus reducing sediment disturbance and placing less reliance on the silt curtain for its containment.

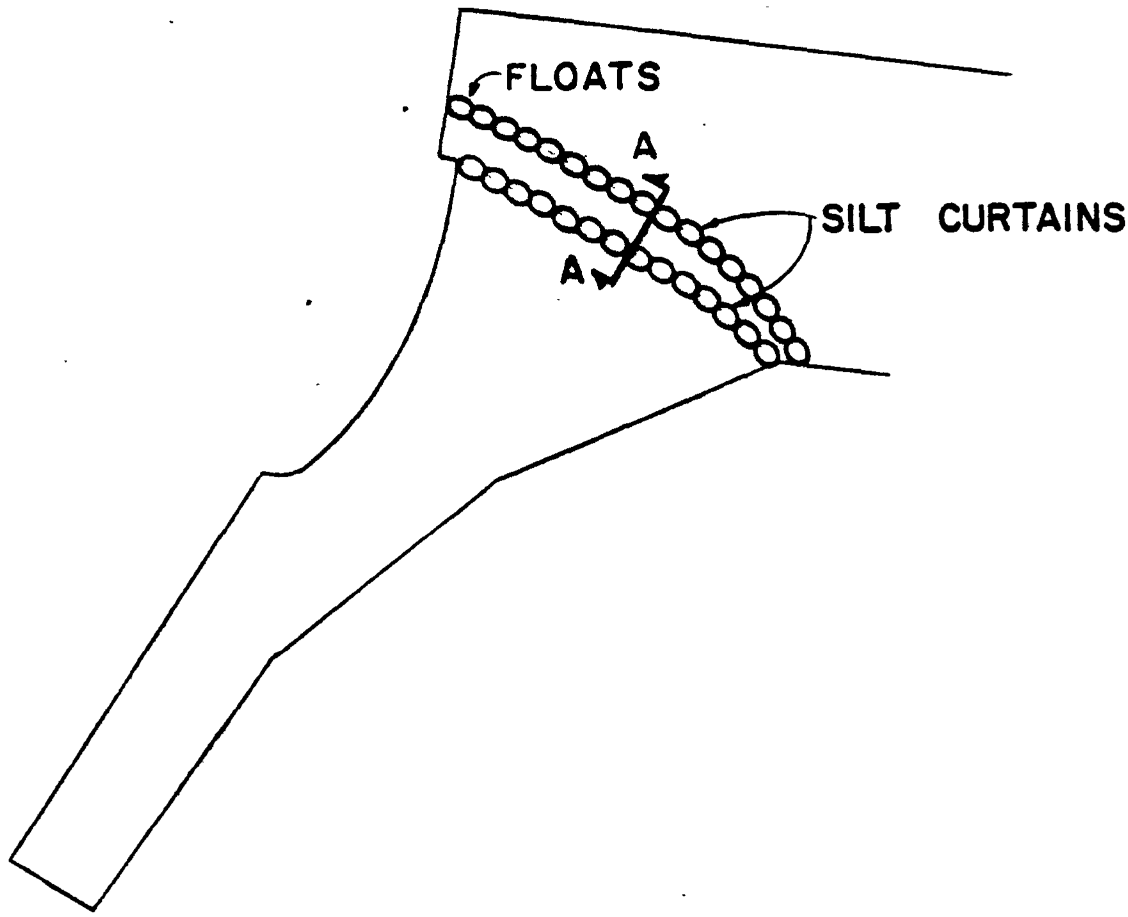
Continuous water quality monitoring will be conducted during all phases of the dredging operation to prevent dispersal of additional PCBs.

The most heavily contaminated sediments (slip #3) will be removed first, so that: (1) any of the slip #3 material that is roiled up will have a greater chance of being removed during the subsequent dredging and (2) the most heavily contaminated material will be placed in a confined area of the lagoon and covered by less-contaminated sediments to minimize the volatilization of PCBs from the lagoon site.

The Lagoons. The Waukegan Harbor bottom muck sediments will be slurried with water and transferred to storage lagoons on OMC property (Figure V-1) for settling. The excess water will then be withdrawn, treated to remove residual PCBs, and returned to the harbor containing PCB concentrations of less than 1 ppb.

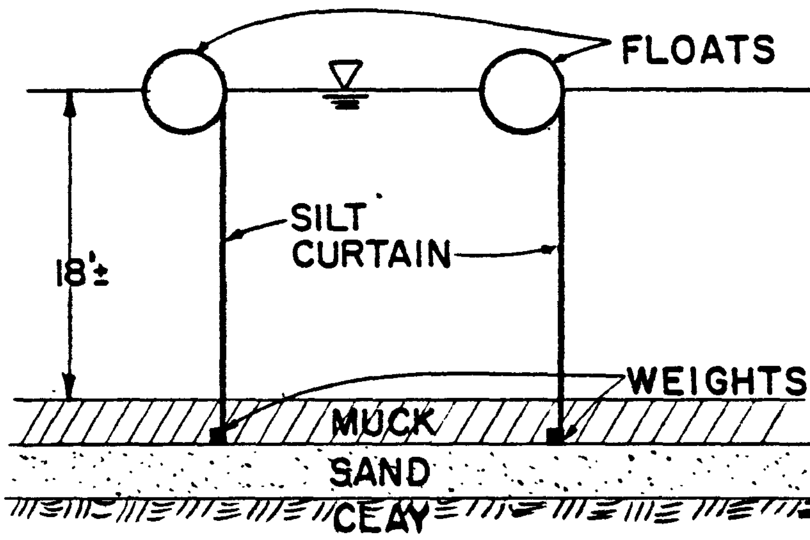
Lagoon construction will be similar to that of a secure landfill, with impermeable clay liners and leachate collection systems. One possible design is shown in Figure V-3, section A-A, which shows a cross-section through the bottom of the lagoon. Above the existing ground will be a one-foot clay liner, with a leachate collection system above it. The leachate collection system will have perforated pipes located in an average one-foot-thick gravel layer. Above this will be three feet of impermeable clay which will be compacted during construction to achieve a permeability coefficient of at least 10-7 cm/sec.

A six-inch thick layer of sand is being considered for placement above the clay liner. Its purpose would be to facilitate the dewatering of the sediments in the lagoon. The slightly contaminated (generally less than 5 ppm PCB) sand piles on OMC vacant land might be used for this purpose. The muck sediments, under natural sedimentation, would achieve approximately the same moisture content as they possess in the harbor after a few weeks. Drainage systems will be used to further reduce water content.



PLAN OF SILT CURTAINS-SLIP 3 DREDGING

NO SCALE



SECTION A-A

ELEVATION OF DUAL CURTAIN

FIGURE V-2: SILT CURTAIN PLAN & ELEVATION

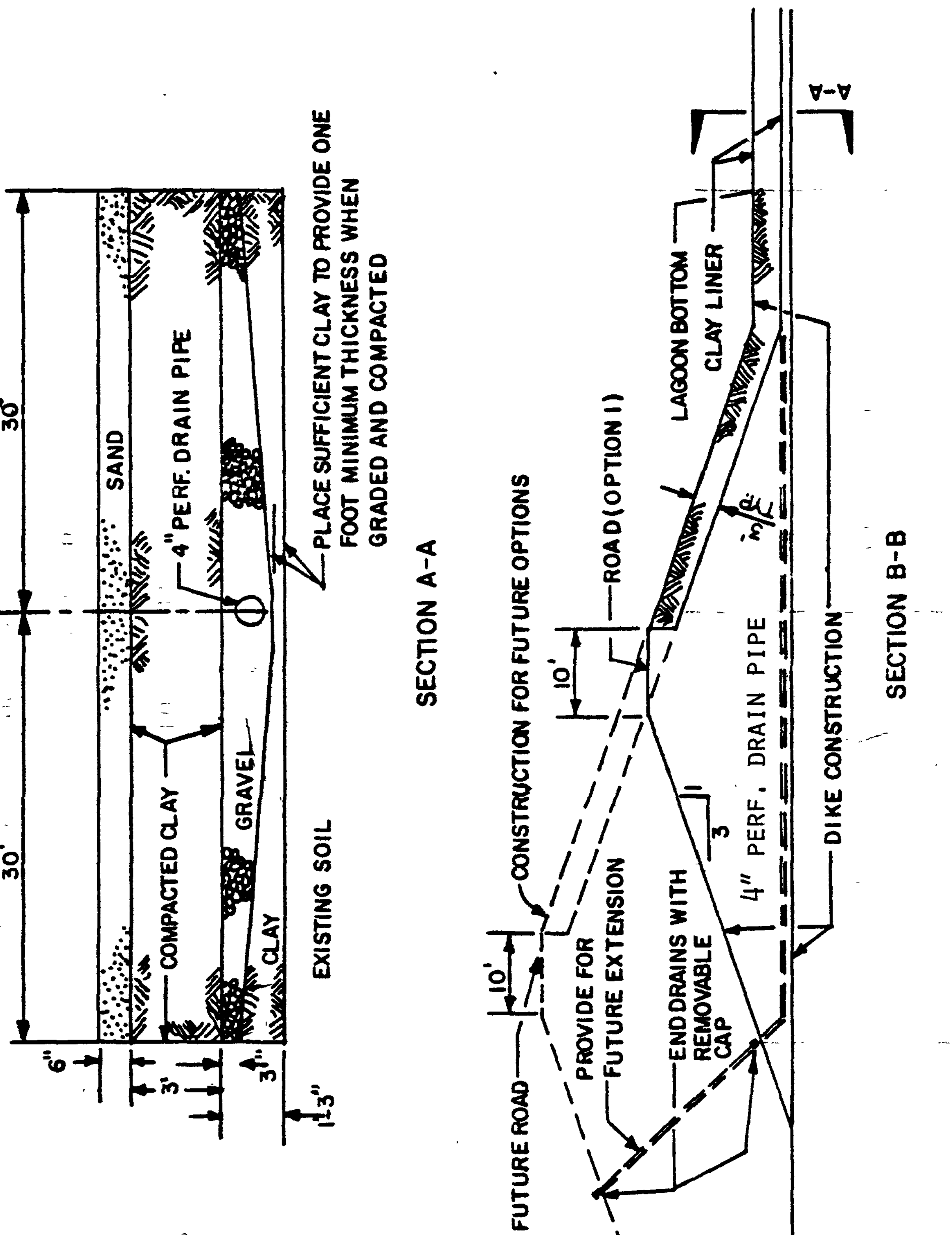


FIGURE V-3: CROSS-SECTIONS OF LAGOONS

The sides of the lagoon will be diked. A possible design is shown in Figure V-3, section B-B. The three-foot clay liner will extend up the slope of the lagoon from its bottom and will be in contact with the contaminated sediments. The dike sides will have 3:1 slope for stability, and the dike will be constructed of soil material brought in from off site and, perhaps, material from the sand piles. The leachate collection system will extend through the dike walls, as shown, to facilitate the collection of samples and the removal of any leachate collected.

Procedures will also be employed to minimize volatilization during the initial placement and temporary storage of the sediments in the lagoon.

The temporary storage lagoon will be large enough to contain all of the sediments to be dredged, plus slurry water. A lagoon with a capacity of 55,000 cubic yards should be large enough to contain 7,300 cubic yards of slip #3 muck sediments, up to 2,000 cubic yards of excavated Slip #3 sand and clay and up to 45,000 cubic yards of slurry water, including water used to clean out residual sediments and flush out slurry lines. Two lagoons will be needed to contain everything contaminated at a level above 10 ppm.

Although the storage lagoon is sufficiently well designed to provide security for these materials for a long period of time, U.S. EPA intends its use only for temporary storage, preferably less than 2 years and in any case not more than 5 years. Dewatered contaminated soil and the contaminated lagoon liner will then be removed for final disposal, and the land will be restored to a condition suitable for industrial use.

Treatment of Excess Water. Excess water used to slurry harbor sediments into the lagoon, plus water used in vacuuming up remaining contaminated harbor sediments and flushing out slurry lines, will be treated for PCB removal before being returned to the harbor. Treatment will consist of (1) settling of the sediments in the lagoon, (2) allowing excess water to overflow a weir placed at one end of the lagoon into a smaller sedimentation basin where a polymer will be added to coagulate and settle fines, (3) pumping the sedimentation basin water through pressure filters, and (4) conveying filter effluent through carbon filters to a clear well. The water in the clear well will be monitored for PCB content before it is returned to the harbor. A 1 ppb limitation of PCB concentration for water returned to the harbor will be maintained. Figure V-4 illustrates the proposed treatment system. Rainwater and leachate water will be treated in essentially the same manner, except that the operation will be intermittant and the system smaller.

NORTH DITCH AND OMC PARKING LOT AREA SOILS

Chapter IV of this report has discussed the extensive contamination of the North Ditch and nearby soils, including recently-discovered contamination of a section of OMC's parking lot. A court order prohibits full public disclosure of the data collected in this area, and the extent of parking lot contamination

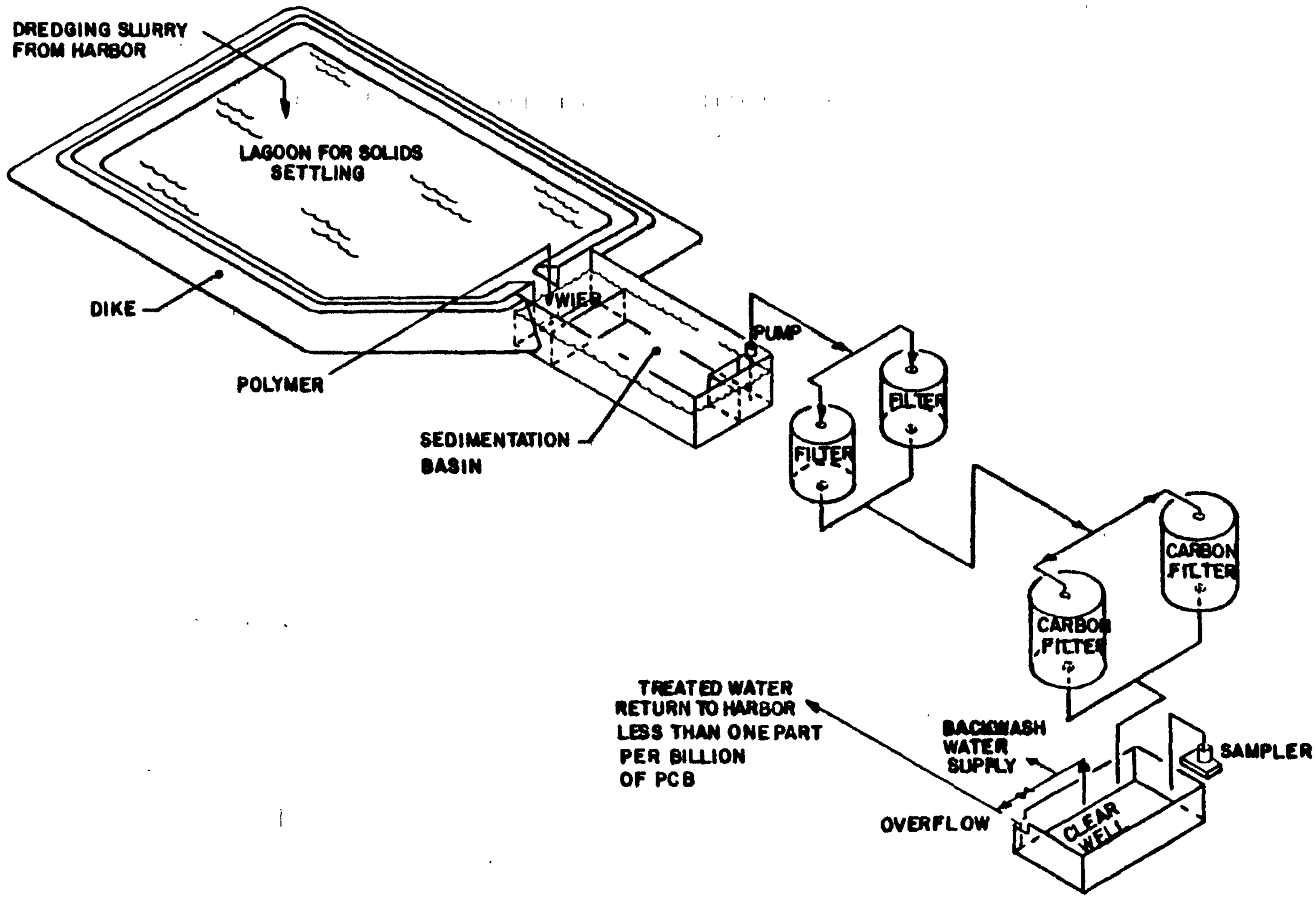


FIGURE V-4: PROPOSED TREATMENT SYSTEM FOR EXCESS WATER is still under investigation, but it is expected that the total amounts of PCBs may exceed the amounts estimated for the harbor, and the volumes of contaminated material are expected to be comparable to the amounts in the harbor. The contaminated materials include the ditch sediments and waters, the soils under the ditch and parking lot, and the surrounding groundwater. The following discussion summarizes the various options that have been evaluated, with preliminary cost estimates where available. The discussion is limited, to some extent, by the restrictions of the court's protective order.

The Broad Options

Five broad options appear available for dealing with this problem:

- First, the no-action alternative.
- Second, construction of a bypass to convey storm waters and OMC effluents around the zones of contamination. (The bypass is viewed as a necessary preliminary to any of the next three cleanup actions).
- Third, destruction of the PCBs in place.
- Fourth, in-place secure storage to limit further movement of the contamination into other parts of the environment. Both in-place fixation and in-place slurry wall confinement are considered.
- Fifth, excavation of the contaminated materials and disposal of them in a manner which prevents further adverse impact on the environment.

No Action. In this approach, one would take only those steps necessary to reduce public exposure to PCBs. These might include further fencing around contaminated portions of the ditch and soil areas to prevent access by the public or OMC employees, and restrictions on fishing in nearby areas of Lake Michigan. Such an approach would be equivalent to locating an uncontrolled PCB landfill on the shores of the lake. PCB discharges to the lake and the spread of contamination through soil, sediments and groundwater would continue and the migration of PCBs to the lake from those soils would probably increase.

North Ditch Bypass. A bypass would intercept the flow of surface water that presently passes through the highly contaminated Crescent Ditch and Oval Lagoon sections of the ditch and direct these flows into a new storm sewer. The straight, east-west ditch section would then be cleaned out and replaced with a new storm sewer or ditch system leading to Lake Michigan. This effort would result in substantial reduction of PCB discharge to the lake, reduction of contaminated groundwater movement, and reduction of recharge into contamination soil zones by ditch waters. The spread of contamination from sediments, soil and groundwater would continue, but at a reduced rate. Construction of the bypass would thus allow some time to deal with contaminated soil, sediment, and groundwater issues. Construction of the bypass is estimated to cost approximately $2.4 million plus disposal costs, for approximately 6000 cubic yards of material. This material could be taken directly to a disposal site or it could be stored in the temporary disposal facility proposed for the harbor on vacant OMC land.

In-Place Destruction. As has already been discussed in the harbor section, biological and chemical approaches to in-place destruction of the PCBs cannot be relied upon at this time. At best, further research and development of these methods may possibly lead to their use to reduce the amounts of PCBs in secure storage after other options are applied.

In-Place Secure Disposal. The contaminated sediments and soils in the North Ditch and parking lot area are in one sense already in "storage" although they are certainly not secure. Securing them in their present place of storage requires adoption of solutions that would prevent their movement through the soils, into the groundwater, and into the air. In order to insure this kind of long-term security in the landfills they license for storage of toxic materials, U.S. EPA (which regulates such sites under TSCA) and the State of Illinois employ stringent requirements. The U.S. EPA normally requires at least 3 feet of low permeability clay as a liner and a leachate collection system to act as a backup in case any PCBs get through the clay. Proximity to bodies of surface water and groundwater is also restricted. On the OMC site, with groundwater sometimes only 2 feet below the surface and the lake only a short distance away, it is difficult to imagine how equivalent levels of security could be accomplished, especially under conditions of long-term erosion of the shoreline and very high lake levels. The State of Illinois is even more restrictive, requiring at least 10 feet of clay, and stricter permeability limits for the clay.

These landfill requirements reflect the high priority given to reducing the threat of any leaching of PCBs from landfills, of which the North Ditch and the parking lot area is an unauthorized example. The amounts of PCBs and volumes of contaminated material at Waukegan are very large, yet the PCBs are in contact with systems that connect them directly with the environment, they lie in permeable sand instead of being enclosed in impermeable clay, and their "leachate collection system" leads directly to Lake Michigan.

In-place Fixation. This method of turning the existing sediments and soils into a concrete-like substance was discussed in the harbor section. This method has the advantage of being less costly than excavation. Quoted costs are $20 to $40 per cubic yard plus equipment costs, compared to costs of $50 to $150 per cubic yard for disposal costs alone, if the materials were excavated. The PCBs would, of course, still be in place and the concrete would deteriorate, perhaps 20 to 100 years in the future, releasing the PCBs and leaving a situation similar to the present one. The method may have very useful application in limited situations, as in cases where contamination is found under buildings and cannot be dealt with in other ways.

In-place Slurry Wall Confinement. (See Figure V-5) This concept would involve construction of vertical walls of Bentonite clay 2.5 feet wide extending 25 to 30 feet into the natural silty and clay layer underlying the PCB contamination to effectively cut off horizontal groundwater motion. Such walls could be installed on OMC property around the perimeters of the Crescent Ditch, the Oval Lagoon and the parking lot contamination zone once the bypass has been constructed. Well points could also be installed inside the slurry walls at depths sufficiently below the groundwater table to assure that any groundwater movement is inward and to allow treatment of those groundwaters that may enter through the slurry walls or the underlying silt. This approach, together with the bypass, could reduce and perhaps prevent PCB migration.

This option has several disadvantages. The first is the lack of long-term reliability of the slurry cutoff walls. Failure of these walls could result in excessive leaching from the area and perhaps further groundwater contamination. There are similar concerns over the permeability and uniformity of the underlying silty clay layer.*

In-place secure disposal approaches raise other serious questions related to the long-term use and character of the site: Will the Lake Michigan shoreline erode and threaten the secure storage areas thus constructed? Will the area flood or be overtopped by very high lake levels? Will the use of this property be maintained indefinitely for secure storage? These questions raise doubts about the long-term usefulness of the approach. The relatively low cost of slurry wall confinement, however, encourages serious consideration of its implementation on a short-term basis if funds for the more expensive excavation approaches are not readily available. Construction of a slurry wall and leachate collection system around the entire North Ditch and parking lot area contamination zone should cost less than $3 million.

Excavation of Contaminated Sediments and Soils. This option would include removal of the most contaminated soils and sediments in the Crescent Ditch, Oval Lagoon, and parking lot areas by excavation and/or dredging after the bypass is accomplished. A dredging approach could be used for the shallow areas of contamination in the Crescent Ditch and Oval Lagoon but it would require dewatering similar to that proposed for the harbor. As excavation is needed for deeper sediments in all cases, it would be more cost-effective to do the entire job by excavation alone. Following excavation, the contaminated material could be taken directly to a final disposal facility.

The difficulties inherent in excavation can be satisfactorily overcome. Removal of contaminated materials below the water table would require lowering the water table through well points to permit excavation under dewatered

* Information on U.S. EPA measurements regarding this issue is subject to the protective order.

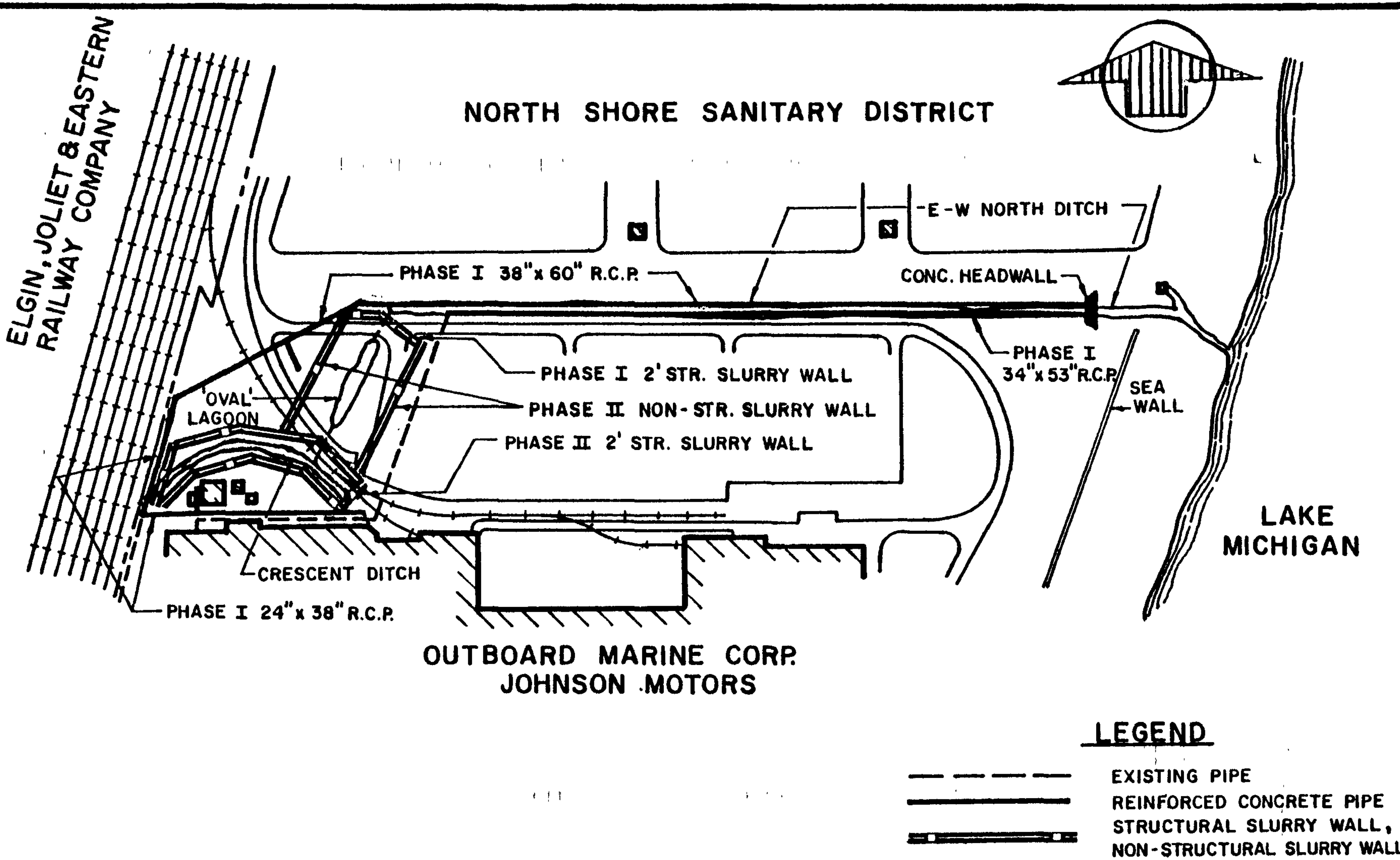


FIGURE V-5: NORTH DITCH BYPASS (PHASE I) AND SLURRY WALL (PHASE II) PLAN conditions. Where deep excavation is required, slurry walls to the depth of the silty clay would be constructed. Ground waters removed could be treated with sand filtration and carbon absorbtion to a contamination level of 1 ppb PCBs or less. Construction of the bypass would allow excavation from the Crescent Ditch and Oval Lagoon to occur in a dewatered condition without roiling the sediments. Where contamination is very deep near OMC buildings, a structural slurry wall could be employed with bracing to prevent damage to the structures. Contaminated soils would be exposed only briefly and then covered, to minimize volatilization. Given these precautions and techiques, excavation could remove contaminated sediments to the desired degree, with excavated areas backfilled with clean materials and the contaminated materials taken to a final disposal facility. Additional measures could be taken at the site to restrict movements of lower level contaminated materials that might remain.

The cost of the excavation approach would be in the area of $9 million exclusive of disposal costs, which will add $30 to $100 or more per cubic yard, as discussed in Chapter VI. It is the only approach that provides the permanent reduction and virtual elimination of the discharge of PCBs to the lake and the spread of PCBs through the soils and groundwater. It would make the site available for future industrial uses.

The Preferred Option

Construction of a bypass around the North Ditch is an essential first step to implementation of other options and itself accomplishes the following objectives:

- Greatly reducing discharges of PCBs from the ditch to the lake due to surface runoff

- Greatly reducing recharge to and interchange with the contaminated groundwater system

Once the contaminated flows from the ditch have been dealt with it will be necessary to select and proceed with a solution to the problems caused by the presence of the large volumes of PCB-contaminated sediments whose uncontrolled migrations through the environment are more subtle, yet, in the long term, equally threatening to human health. While the ongoing studies can be expected to further clarify the issues, investigations to date indicate that only the excavation of the contaminated soils and sediments in the North Ditch and parking lot area will allow the following objectives to be accomplished on a permanent basis:

- Virtual elimination of the spread of PCBs through soils, sediments and groundwater

- Virtual elimination of PCB discharges to the lake from the groundwater system.

- Removal of the potential of PCB movement through the underlying silty clay layer.

Although the slurry wall confinement approach could offer short-term security, only the excavation option eliminates the risk of PCB releases to the environment posed by slurry wall containment, and the possible penetration of the silty clay layer.

While bypass construction progresses, the precise delineation of the areas and volumes to be excavated can be accomplished. U.S. EPA already has a relatively good picture of the distribution of PCBs in the soil and groundwater and has made estimates of the amounts of material needed for removal. Their consulting engineer and hydrogeological contractor are completing reports based on the data which should allow more precise estimates to be made. Public release would be subject to the protective order.

The Plan for Cleanup

U.S. EPA, with the assistance of its engineering contractor, Mason & Hanger, has prepared a proposed program for dealing with PCB contamination in the North Ditch and the OMC parking lot area based on the immediate construction of a North Ditch bypass and subsequent excavation of the most contaminated materials from the bypassed portion of the ditch, nearby soil areas and the parking lot area.

Bypass Construction. The bypass work is similar to that proposed by U.S. EPA in 1979 except that the new storm sewer system will run in the east-west portion of the Ditch instead of through the contaminated parking lot. The approach, which will include some excavation, is to direct the flow now entering the ditch around its most contaminated portions (the Crescent Ditch and Oval Lagoon) and to tie it into a new storm sewer system which will replace the east-west portion of the ditch (Figure V-5).

The first step will be to intercept surface water now directed to the North Ditch from areas west of OMC's property, and from OMC property itself, with a new storm sewer collection system. The new sewer will be constructed to a point just west of the east-west part of the contaminated North Ditch. During construction, it will be necessary to block this new storm sewer and to temporarily bypass any water that it collects until construction in the section is completed.

An estimated 6000 cubic yards of contaminated sediments in the east-west ditch will then be cleaned out, dewatered and either disposed of offsite or stored temporarily in the lagoons on OMC property. A wastewater treatment system will also be available if it should be discovered that the dewatering of the storm sewer installation yields contaminated groundwater.

As the new storm sewer is installed in the east-west portion of the North Ditch, it will be necessary to install a second storm sewer to pick up any flows from the existing parking lot and the remainder of OMC's buildings. The two storm sewers will be built simultaneously along the centerline of the east-west section of the North Ditch until the entire bypass is completed.

By the time the bypass is completed, the area surrounding the two new storm sewers located in the east-west portion of the North Ditch will be "clean" and can be paved over as an extension of the existing parking lot. This work should provide removal of the contamination in this portion of the North Ditch and divert all flows proceeding to Lake Michigan from passing through contaminated portions of the ditch.

Excavation of Contaminated Sediments and Soils. When the bypass is completed, the spread of PCB contamination from surface water runoff will virtually be eliminated. Because of the characteristics of the soil, any migration of PCBs laterally from the ditch will be limited, provided the migration is not allowed to continue over many years. Elimination of the surface water entering the ditch will allow a complete cleanup program to proceed with reduced risks, as follows:

a. The Crescent Ditch and Oval Lagoon will be excavated using slurry wall and/or coffer dam techniques to reach the deepest contaminated material.

b. The parking lot and any other contaminated soil areas will be excavated, using well point techniques (and also slurry wall techniques if needed) for deep excavation.

c. Waters encountered in excavation will be treated prior to discharge.

d. The excavated material will be removed to a permanent disposal facility.

Excavation of the deeper areas of contamination will require special measures to protect buildings on the OMC sites. U.S. EPA's contractor has performed a feasibility study for the practical limits of excavation on the south side of the Crescent Ditch which has resulted in the formulation of two alternative plans. The first plan is to build a cellular coffer dam type structure completely encircling the Crescent Ditch. The second plan is to build a slurry wall that can be braced from side to side for lateral stability. Either the coffer dam or the slurry wall would be as close to the existing structures as is practical, on the south side of the ditch, to prevent disturbance of the OMC buildings.

Either a coffer dam or a slurry wall enclosure is necessary to allow excavation under dewatered conditions, so that the levels of contamination can be measured during excavation and so that the nearby structures will not be damaged. In order to accomplish this the coffer dam or slurry wall must be deep enough into the clay layer to prevent any significant leakage under its lower edge.

A similar plan could be used for the Oval Lagoon. There are no structures close enough to the sides of the lagoon, however, to limit the width of the area to be excavated. Therefore, a non-structural slurry wall method may be more economical, especially if there are not high concentrations of contamination in deep soils outside the confines of the lagoon itself.

Finally, it is proposed to remove a substantial amount of material * from the northeast part of OMC's parking lot. A well point system will be installed around individual zones to draw the water level down below the level of contamination so that conventional earthmoving equipment can be used. Each zone will be kept small enough so that nearby structures are unaffected. The project will benefit from the presence of the bypass, which removes one major source of recharge water. Waters will be treated before being returned to the bypass system. A slurry wall system may be necessary for the deepest contamination thus far encountered.

Excavated materials from the several areas of excavation will be taken directly to the final disposal facility. The excavated areas will be backfilled with clean material.

* It is not possible to further describe the extent of cleanup, the number of cubic yards proposed to be remopved or the number of pounds of PCBs present, given the restrictions of the protective order.

CHAPTER VI

FINAL DISPOSAL OF PCB-CONTAMINATED MATERIALS

Previous sections of this report have discussed the extent of contamination and the specific plans proposed by the U.S. EPA to remove the most contaminated materials from Waukegan Harbor, the North Ditch and the OMC parking lot areas. The preferred alternatives proposed--dredging of the harbor and construction of a bypass followed by excavation of the North Ditch and OMC parking lot areas--require that final disposal arrangements be made for a large quantity of contaminated material. The plan for harbor cleanup involves a two-step operation. In the first step, the sediments would be dredged and placed in a lagoon, where they are held in temporary storage. In the second step, they are removed from the site to a final disposal area. Excavation of the sediments and soils in the North Ditch and parking lot area, however, would require only a single step, since the materials would be moved directly to a final disposal area as they were evacuated.

The harbor plan calls for dredging approximately 168,000 cubic yards of sediment in which contamination exceeds 10 ppm PCBs. (Approximately 47,000 yards of this contamination exceeds 50 ppm PCBs.) When this material is removed from the dewatering basins for disposal, approximately 30,000 additional cubic yards of clay used for the liner, and sand from the OMC site that is being proposed for use in construction, will also require a permanent disposal facility. Therefore, in round numbers, we will have some 60,000 cubic yards exceeding 50 ppm and some 140,000 cubic yards between 10 and 50 ppm. A small amount of additional yardage could be included from the excavation of the east-west portion of the North Ditch during bypass construction. Equivalent amounts may well be excavated during the final North Ditch and parking lot area cleanup, which will require final disposal as well.

The yardage in the harbor above the 50 ppm level has been calculated separately because TSCA regulations (See Chapter II) require a specially-approved disposal facility for materials contaminated at or above that level.

THE DISPOSAL OPTIONS

Some final disposal alternatives have already been discussed. Biological destruction methods are unproven. Chemical destruction methods appear to be unsuitable for sediments and soils containing water. Slurry wall confinement in-place of contamination in the Crescent Ditch and Oval Lagoon parts of the North Ditch (after bypass), and of the OMC parking lot area contamination, have been described as effective in the short-term and less expensive than excavation approaches, but as not providing the permanent protection given by excavation.

Two broad final disposal options remain: incineration and secure landfills (which include existing licensed PCB landfills, nearby landfills which could be adapted for this use, and parts of the OMC site which could be adapted for secure disposal).

Incineration

No PCB incinerator has yet been licensed for commercial use, although one in Arkansas (ENSCO) and one in Texas (Rollins) are nearing U.S. EPA approval.

Costs for incineration would be most favorable if the incinerator could be brought to the OMC site and the residues after incineration could be judged clean and disposed of on the site. U.S. EPA's consulting engineer has investigated several incineration technologies and reports that costs could be well in excess of $100 per cubic yard. Further, it does not appear that available technology would meet U.S. EPA requirements without extensive testing and development. Although incineration could destroy PCBs, it appears to involve much more delay and considerably more cost than does the use of secure landfills. Removal to a secure landfill appears to be the only reasonable final disposal method presently available.

Secure Landfills

The closest commercial landfill now licensed by the U.S. EPA for the disposal of PCB contaminated materials is the Clermont Environmental Reclamation Site (CECOS) at Williamsburg, Ohio near Cincinnati. U.S. EPA's engineering contractor has advised that the landfill's user charge would be $90 per cubic yard and that transport costs would be approximately $1300 per 20 cubic yard truckload. Disposal of 200,000 cubic yards of contaminated harbor sediments above 10 ppm would thus cost approximately $33 million. If one assumes that only the 60,000 cubic yards above 50 ppm need be taken to CECOS, costs would be approximately 10 million dollars. If a cost of $50 to $100 per cubic yard for local disposal of the remaining 140,000 cubic yards which are in the 10 to 50 ppm contamination range is added, total harbor disposal costs would be in the $17 to $24 million range.

Given the high cost of disposal at the Ohio facility, U.S. EPA's contractor has recommended that closer landfills and the OMC site itself be considered for final disposal. Preliminary investigation has indicated that one or more nearby sites can be found which, with appropriate preparation, can be made suitable for secure disposal of this material and thus could be licensed. Cost estimates for nearby landfill disposal (including transportation) are in the range of $50 to $100 per cubic yard or $10 to $20 million for 200,000 cubic yards.

U.S. EPA's contractor has also examined several approaches to on-site disposal of materials dredged from the harbor and materials present in OMC's North

Ditch and parking lot area. These approaches are, in general, less expensive than off-site landfill disposal and require little trucking of materials. They are, however, subject to concerns regarding the proximity of Lake Michigan, the high water table, possible future use of the site, erosion of the Lake Michigan shoreline, potential flooding, etc. They also commit portions of the OMC site to permanent use for a PCB waste disposal facility. For these reasons the site is more risky than the type of site the regulatory agencies would normally consider approving.

On-Site Secure Storage. Ultimate disposal on the OMC site itself would cost on the order of $30 per cubic yard. This would be a substantial improvement over the existing situation. It replaces the uncontrolled PCB landfill that the OMC site has become with a controlled PCB landfill site that uses good protective practices and can be expected to be secure in the short term. The Lake Michigan shoreline is not, however, a very good long-term location for a PCB disposal facility. The two major OMC site options are as follows:

1. On-site secure storage facility under OMC's parking lot. The facility would extend approximately 30 feet below ground elevation and would be lined with 5 to 10 feet of recompacted clay imported to the site. A leachate collection system embedded in gravel would be sandwiched in the clay liner. The leachate system would lead to manholes for pumpout and treatment. The disposal facility would be capped with at least 3 feet of clay and surfaced with bituminous pavement or concrete so that its present use as a parking lot could be continued. The facility would be surrounded by a 2 1/2-foot slurry wall (that would be needed in any case for excavation of the area) tied to the natural silty clay layer. The cost of implementing this concept for the harbor materials alone would be in the neighborhood of $6 million. A larger facility would be needed if excavation of North Ditch and parking lot area materials were included.

The use of an underlying clay liner leachate system promises more secure disposal than use of the in-place slurry wall confinement system, as has been previously discussed. In particular, less reliance would be placed on the integrity of the underlying natural silty clay layer, because of the construction of a 5-to-10 foot clay liner, and less reliance would be placed on the slurry cut-off walls, since sidewalls of compacted clay at a 3-to-1 grade would be constructed.

A number of drawbacks remain. The approach demands much on-site handling of materials, requires extensive dewatering during construction, and involves disruption of OMC's parking lot for a long period.

2. On-site secure storage facility on OMC vacant land. In this variation of the above on-site option, the two lagoons for dewatering and temporary disposal of harbor materials would be constructed to the standards normally suitable for long-term disposal. The lagoons would be built with a ten-foot clay liner, a leachate system sandwiched in the liner, and a

cap of clay and topsoil. The lagoons would be constructed above ground and to a height of about 35 feet. The cost for harbor materials disposal alone would be approximately $6 million.

Advantages of this approach over the other on-site option are that only one disposal facility would be constructed for the entire project; there would be less leaching, over time, than in the below-ground alternatives; little material handling and site disruption would be required, and no slurry walls would need to be constructed.

Disadvantages of this approach compared to the other are its relative unsightliness; the need for permanent dedication of the property to this use; and the long-term maintenance requirement.

SUMMARY OF COSTS OF FINAL DISPOSAL OPTIONS (HARBOR ONLY*)

(PRELIMINARY ESTIMATES)

Disposal Option	Dredged material over 10 ppm plus liner, cap, & dike material (200,000 cubic yards)
Disposal at CECOS (Williamsburg) Ohio	$33 million
Disposal of 60,000 cubic yards at CECOS and 140,000 cubic yards at a local landfill	$17 to 24 million
Disposal of all material at a local landfill	$10 to $20 million
Disposal at a disposal facility under the OMC Parking Lot	$6 million
Disposal on OMC vacant land in lagoons	$6 million

* The addition of disposal costs for materials excavated from the North Ditch parking lot area would increase these costs significantly. Those costs and yardage estimates are now being refined, the refinement being based on new sampling data. Preliminary estimates are subject to the protective order.

THE RECOMMENDED APPROACH

The conclusion reached by the U.S. EPA is that both short-term and long-term interests would be best served by removal of these materials to a well-designed PCB disposal facility in a better location than the OMC site. The CECOS facility is certainly suitable in this regard. The high cost of transporting the materials to CECOS for final disposal, however, has prompted U.S. EPA to look for a more cost-effective use of the public funds involved.

Closer potential sites have been investigated, and the agency believes that one or more suitable sites are available for the purpose. The use of OMC sites for disposal, as has been discussed, is less expensive than any off-site disposal and this can be an effective containment strategy in the short run. During the time provided by the bypass, all such options will be given more intensive examination.

Finally, proper incineration technology is not now easily available, and is expected to continue to be costly even when available. It is intended, however, that those materials with the highest concentration of PCBs be segregated so that they can be readily retrieved from the disposal facility for later incineration, if this becomes desirable.

CHAPTER VII

FUNDING SOURCES

Preceeding chapters have assessed the Waukegan area PCB contamination problem and the options for cleanup. The next step is to analyze the potential sources of funds available to undertake the cleanup effort. The U.S. EPA, through the U.S. Department of Justice, has filed suit against OMC and Monsanto, asserting their liability for the PCB contamination in Waukegan, and has asked the court to hold them responsible for the necessary cleanup.

There are several funding mechanisms, i.e., special appropriation, Section 311 of the Clean Water Act, and Superfund, which will allow the commencement of various aspects of cleanup before liability is determined in the pending litigation. Any money expended under these laws would be ultimately recoverable from the responsible parties, after responsibility has been determined by the court. This chapter discusses the scope and limitations of the various funding mechanisms potentially available for cleanup of the Waukegan area PCB contamination.

THE LITIGATION

Following the breakdown of negotiations between the State of Illinois and OMC late in 1977, the United States Attorney for the Northern District of Illinois filed suit on behalf of U.S. EPA against OMC in Federal court on March 17, 1978. The complaint alleges that OMC used hydraulic fluids composed of PCBs in its Waukegan diecasting facility of Johnson Outboards for many years, and that the leaks and spills of the fluid, discharged without treatment into Lake Michigan and Waukegan Harbor, were a violation of the Refuse Act, the Clean Water Act, and the common law of nuisance. The United States further alleges that, as a result of this contamination , Lake Michigan waters and aquatic life have been harmed and pose a threat to health and to the environment. The complaint asks that OMC dredge and dispose of North Ditch sediments in a safe manner, similarly clean up contaminated harbor sediments, and pay a money penalty for violation of the Clean Water Act.

OMC subsequently filed a third-party complaint against its supplier of the PCB-bearing hydraulic fluid, alleging negligence and a breach of products liability law by the Monsanto Company as the manufacturer and supplier of the PCBs. In addition, after a review of documents produced in discovery, the United States also sued Monsanto in July 1980, alleging violations of the Refuse Act and products liability standards and negligence in Monsanto's conduct as supplier of the PCBs.

In answer to OMC's claim, Monsanto recently filed a crossclaim for reimbursement against OMC. Finally, pursuant to a ruling by the Seventh Circuit Court of Appeals, the State of Illinois has been allowed to file its own suit in Federal court against OMC. While the State is currently participating in discovery, OMC has filed a petition for certiorari with the Supreme Court asking for review of the Circuit decision. The Supreme Court has not yet ruled whether it will consider the case. A settlement of this case against OMC and Monsanto, or a judicial decision, will determine responsibility for cleanup of the Waukegan area.

The Special Congressional Appropriation

Since the PCB contamination in the Waukegan area was first identified in 1976, members of Illinois' congressional delegation have had great interest in its cleanup. As a result of their continuing concern about the contamination problem, the Illinois delegation were instrumental in obtaining, in the fall of 1980, a congressional appropriation of $1.5 million to enable the U.S. EPA "to begin the cleanup of Waukegan Harbor". This appropriation is currently available for the stipulated purpose.

SECTION 311 OF THE CLEAN WATER ACT

In the event of an oil or hazardous waste spill, or an actual or threatened discharge of oil or hazardous substances into or upon the waters of the United States, Section 311 of the Clean Water Act sets up a mechanism through which the Federal government is authorized to respond to the pollution emergency. Section 311 and the implementing regulations establish a "contingency plan" including a "National Response Team" (NRT), a "Regional Response Team" (RRT), and an "On-Scene Coordinator" (OSC) as the parties authorized to ensure proper cleanup in an emergency. While U.S. EPA and the U.S. Coast Guard have the main responsibility for implementing the regulations, other agencies (including state and local representatives) can, in their areas of expertise, offer advice to the RRT.

Once a hazardous waste site is identified as threatening, or an oil spill has entered the waters of the United States, it can be classified as "311 actionable". Usually an OSC is assigned to a large spill or cleanup activity. The discharger is then given an opportunity to clean up the area on its own, while the OSC monitors the activities. If the responsible party refuses to take action or is not performing effectively for other reasons, the OSC can initiate Federal activity to ensure public safety and the protection of the waters of the U.S. The OSC directs Federal efforts at the scene of a discharge or potential discharge and also consults regularly with the RRT in carrying out a cleanup activity. The RRT serves as an advisory team to the OSC.

If a discharger refuses to clean up the spill himself, the OSC and the RRT, with the approval of the Coast Guard, can initiate containment and cleanup activities using funds for that purpose authorized under Section 311. Actions under Section 311 focus on containment and prevention of further degradation of the waterways. At least part of the proposed Waukegan area cleanup efforts would be eligible for funding under Section 311.

Superfund

In December 1980, after months of debate and discussion, Congress passed the Comprehensive Environmental Response, Compensation and Liability Act of 1980, popularly known as "Superfund". This act establishes a $1.6 billion fund for five years that will enable the Federal government to pay for cleanup costs resulting from releases of hazardous substances into the environment.

The fund will pay for cleanup of sites or spills and will compensate Federal and State governments for damage to natural resources. The fund will not pay for medical expenses or loss of property or income. This new Act establishes strict liability for those who release hazardous substances into the environment, but deletes reference to joint and several liability, relying on common law principles to determine when parties should be severally liable. The government can sue the liable parties to recover the costs incurred in remedying releases of hazardous materials into the government, but the Act places limits on the amounts of liability and does not provide for third-party compensation.

U.S. EPA is preparing a "National Hazardous Substance Response Plan" which will establish response procedures, including methods to discover, investigate and remedy releases from facilities which pose substantial dangers. Each year a priority list of sites will be published. According to the Act, the first 100 listed sites requiring remedial action will include, to the extent practicable, at least one site from each state. The entire Waukegan area cleanup effort would appear eligible for funding under the Superfund legislation.

U.S. EPA's Budget Appropriation

The operating funds allocated to U.S. EPA's midwestern regional office and research laboratories out of congressional appropriations each year provide a limited source of funding for scientific and engineering investigations, such as those required to deal with the Waukegan problem. Without special legislation, however, (see above) the agency is not authorized to expend funds to initiate cleanup.

CHAPTER VIII

THE STATUS OF THE CLEANUP

To solve the PCB contamination problem in the Waukegan area, it is necessary to take the following steps:

1. Conduct the scientific investigations necessary to determine both the extent and effects of the contamination.

2. Identify and evaluate the engineering options available to clean up or mitigate the contamination.

3. Develop the detailed engineering designs for the selected cleanup option.

4. Secure funding authorization for the project.

5. Implement the cleanup project.

Scientific investigations to determine the extent of the PCB contamination problem in Waukegan began shortly after the contamination was first discovered in 1975. These efforts were escalated in 1978 when several new studies were undertaken. In 1980, USEPA's consultant, Mason & Hanger, began to examine the engineering options for solution to the PCB contamination problems using the results of previous investigations and conducting additional ones as the need arose. These scientific and engineering studies were funded out of the U.S. EPA annual operating budget.

This report has described, within the limits of the court's protective order, the extent of our current knowledge of PCB contamination in the sites under investigation. It also discusses the various engineering options which have been examined for cleaning up or mitigating the contamination. Finally, it identifies a set of "preferred" options which clearly provide the greatest environmental protection to Waukegan and the Lake Michigan Basin. For two of these, the dredging of harbor sediments and the construction of a bypass around the North Ditch, the extent of contamination and the costs and benefits of the cleanup are well understood. For the third, excavation of the sediments and soils of the North Ditch and Parking Lot Area, further investigations are necessary. These investigations are underway.

This report provides the public with the results of the scientific investigations, and presents them with the opportunity to review and comment on the analysis of engineering options that has been conducted. These comments, as well as those received from Federal, State and local agencies, will be incorporated into the on-going decision making process.

At this stage the availability of a funding mechanism becomes critical, and its own purviews and requirements will determine the actual implementation of and timetable for the cleanup. The status of the project in relation to each of the existing funding mechanisms (See Chapter VII) is as follows:

Section 311 of the Clean Water Act

Some action has already been taken to apply Section 311 to appropriate portions of the Waukegan contamination problem. U.S. EPA's On-Scene Coordinator (OSC) proposed, and the Regional Response Team (RRT) endorsed, the plan for dredging slip #3 of the harbor when it was determined that it posed a substantial threat of discharge of PCB. The OSC has authorized and the U.S. Coast Guard has approved the development of plans and specifications for dredging the harbor as well as constructing the North Ditch bypass. Additional funding for at least part of the project may be made available through this mechanism, upon the recommendation of the OSC and the approval of the RRT. These designs should be ready beginning in the Spring of 1981, making it possible to proceed immediately with implementation.

The Congressional Appropriation

This $1.5 million is available to fund immediately implementation of portions of the project, as the designs are completed.

Superfund

The Waukegan PCB contamination problem has been selected as one of the earliest sites eligible to receive Superfund money. Those funds are expected to become available within the next six to eight months.

The Litigation

The exchange of documents is substantially complete, and depositions have begun. Although the trial was scheduled by the former presiding judge to begin on April 6, 1981, that date is subject to change by a judge recently assigned to the case. Whether the case is resolved through settlement negotiations, the judge's decision, or a jury's verdict, it will assign the responsibility for payment for the clean up and disposal of the contaminated materials.

Summary

The litigation which is underway will determine who is ultimately responsible for paying the costs of cleanup. Execution of cleanup need not wait until that determination has been made, however, but can proceed with the understanding that reimbursement by the party found responsible will ultimately be made.

The timetable for the cleanup depends upon the understanding of the problem, the selection of cleanup options, the execution of engineering designs and, above all, the availability of funding mechanisms. It will be the constraints of these funding mechanisms, ultimately, that shape the final execution of the project.