Michigan Department of Natural Resources

Remedial Action Plan

for

RIVER RAISIN

Area of Concern

October 27, 1987

Michigan Department of Natural Resources
Surface Water Quality Division
Great Lakes and Environmental Assessment Section
P.O. Box 30028
Lansing, Michigan 48909

ACKNOWLEDGEMENT

The initial draft of the River Raisin Remedial Action Plan was completed through the technical assistance of Science Application International Corporation under EPA Contract No. 68-04-5041, Work Assignment GL86-11, SAIC Project No. 2-813-03-202-11. Assistance in reviewing, selecting, extracting, organizing available information and shaping it into a readable initial draft is acknowledged and appreciated.

Thanks is also given to those individuals that have provided technical assistance and information during the preparation of this remedial action plan. We are grateful for those who took the time to become involved in this project. We are also deeply indebted to the numerous people whose hard work produced the research papers cited in the Remedial Action Plan.

A special thanks goes to Ms. Julie Rann in appreciation of her patience, innumerable hours of hard work, and conscientious efforts in the editing and typing of this Remedial Action Plan.

TABLE OF CONTENTS

Page

LIST OF FIGURES

LIST OF TABLES

I. EXECUTIVE SUMMARY

The lower River Raisin was identified by the International Joint Commission as one of Michigan's fourteen Areas of Concern due to the polychlorinated biphenyl (PCB) contamination of fish from this area. The River Raisin Area of Concern (AOC) is located in the southeastern portion of Michigan's lower peninsula in Monroe County. The boundaries of the Area of Concern have been defined as the lower (2.6 miles) portion of the River Raisin, downstream from Dam No. 6 at Winchester Bridge in the City of Monroe, extending one-half mile out into Lake Erie following the Federal Navigation Channel and along the nearshore zone of Lake Erie, both north and south, for one mile.

Problems that exist today in the Area of Concern are heavy metals and polychlorinated biphenyl (PCB) contamination of the sediments and water column, sediment input from non-point sources outside of the Area of Concern and PCB contamination of fish. These problems have, in many cases, manifested themselves into current use impairments of the Area of Concern. As a result of PCB contamination, a fish consumption advisory has been issued by the Michigan Department of Public Health. The fish contamination and consumption advisory has been identified as the primary impaired use in the Area of Concern. The Remedial Action Plan (RAP) is designed to address this impaired use in the Area of Concern.

MDNR is continuing to investigate the landfills, lagoons and industrial sites in the Area of Concern along the banks of the River Raisin. The following sites are included on Michigan's Act 307 Proposed Priority List for Fiscal Year 1988: the Port of Monroe Landfill, Ford Motor Company Monroe Stamping Plant, Detroit Edison, Consolidated Packaging - South Plant, the City of Monroe Landfill, and the lower (2.6 miles) portion of the River Raisin itself. Preliminary site assessment indicates that all six sites possess two or more of the following: soils, groundwater or surface water contaminated with PCB's and/or heavy metals. Most of these sites also possess overland pathways for movement of toxic organics (PCBs) and heavy metals off site and into the surface water of the Area of Concern. Clean-up of all these sites is pending, with the exception of the Port of Monroe Landfill, which a remedial investigation was completed in January of 1987 and Ford's Monroe Stamping Plant which has completed the first phase of a feasibility study.

The purpose of the RAP is to compile and analyze existing data which will be used to develop a plan for the restoration of impaired uses in the Area of Concern. There are two main objectives of the Remedial Action Plan 1) to determine data deficiencies and recommend additional investigations that will help define the problems and sources, and 2) to recommend remedial actions that will lead to restoration of impaired uses in the AOC.

2. INTRODUCTION

2.1 BACKGROUND

The International Joint Commission (IJC) and the Michigan Department of Natural Resources (MDNR) have identified the River Raisin as an Area of Concern. The River Raisin Area of Concern (AOC) is located in the Southeastern portion of Michigan's lower peninsula in Monroe County (Figure 1). The Area of Concern has been defined as the lower (2.6 miles) portion of the River Raisin, downstream from the low head dam (No. 6) at Winchester Bridge in the City of Monroe, extending east one-half mile out into Lake Erie following the Federal Navigation Channel and along the nearshore zone of Lake Erie, both north and south for one mile. Figure 2 shows a map of the Area of Concern. The MDNR is developing this Remedial Action Plan (RAP) to address water quality and the impaired uses in the River Raisin Area of Concern.

Data collected from the AOC indicates that both the water and sediments are contaminated with organic chemicals (PCBs) and heavy metals and that fish collected from the river have elevated body burden levels of PCB. To fully understand how this area has progressed from a once productive, wetland ecosystem to an AOC, one must examine the historical pathway that lead up to the complex situation that exists today.

Prior to 1946, this area was renowned for the hunting and fishing opportunities it had to offer. This fact is substantiated by the existence of two notable hunting and fishing lodges. These lodges were situated at the present day sites of Ford Motor's Stamping Plant and Detroit Edison's Power Plant and were owned by the Ford family (Ford Motor Company) and Fisher family (Fisher Body) respectively.

The Port of Monroe Authority (PMA), was established (1932) to guide the industrial development of the area which at that time included over 800 acres of wetlands. Recognizing the potential for industrial development, the PMA in 1947, decided that filling the wetland with commercial fill (topsoil, sand and gravel) would be to expensive and opted instead to use industrial waste as fill material. The uncontrolled filling with industrial waste over the last 40 years has produced several contaminated waste sites on both sides of the river. During the landfill process the wetland was covered up and contaminated by the industrial waste fill. This process also created a very shallow watertable aquifer which is contaminated and has hydraulic connections to both the deep bedrock aquifer and surface water.

Preliminary site inspection and investigation in the AOC has shown that numerous industrial sites containing lagoons, sludge disposal areas, and landfills are inadequately contained and have direct inputs to the AOC via groundwater infiltration and/or surface water runoff.

The Great Lakes Water Quality Board (GLWQB) 1985 report has identified the major types of problems in the River Raisin AOC as:

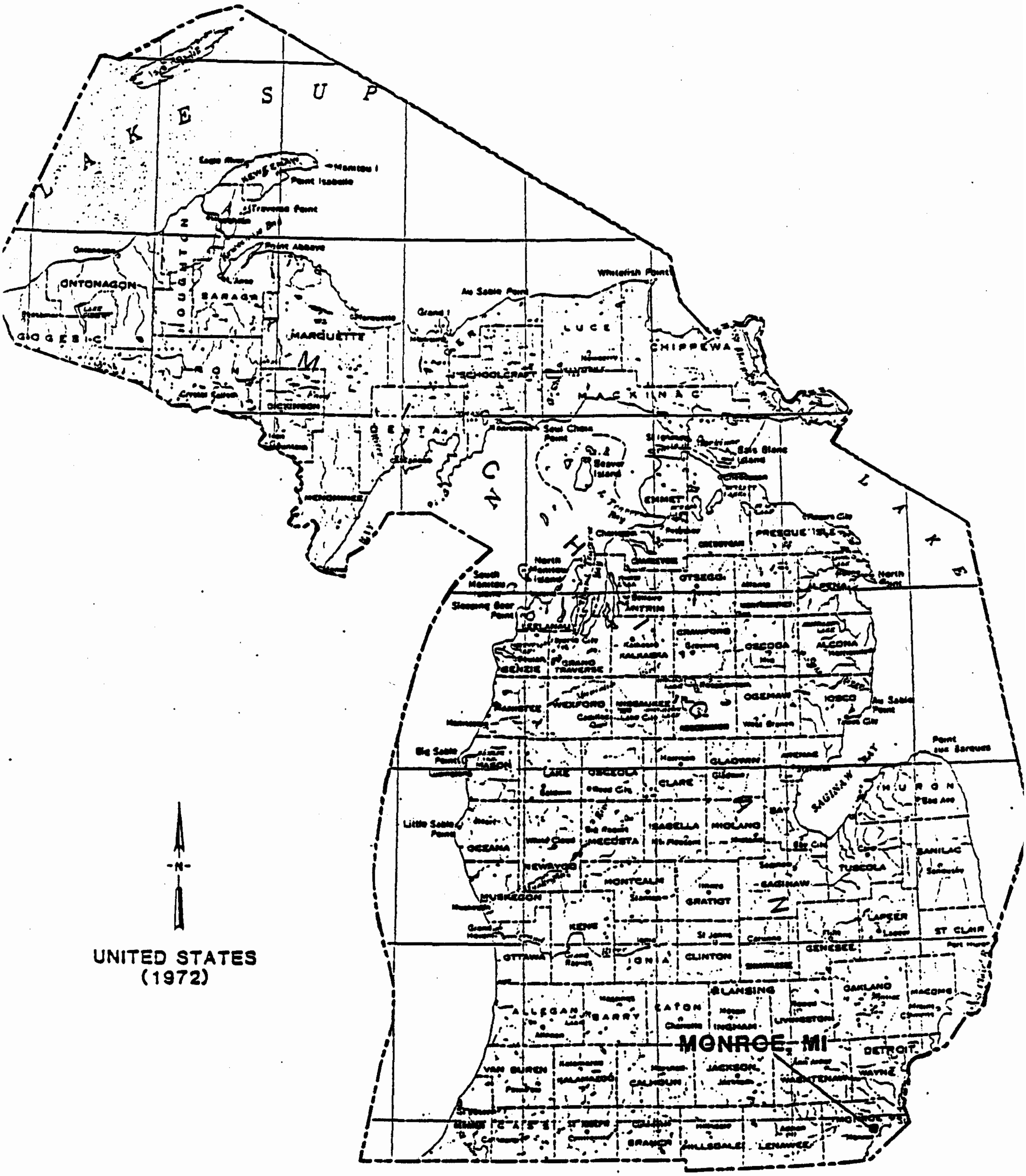
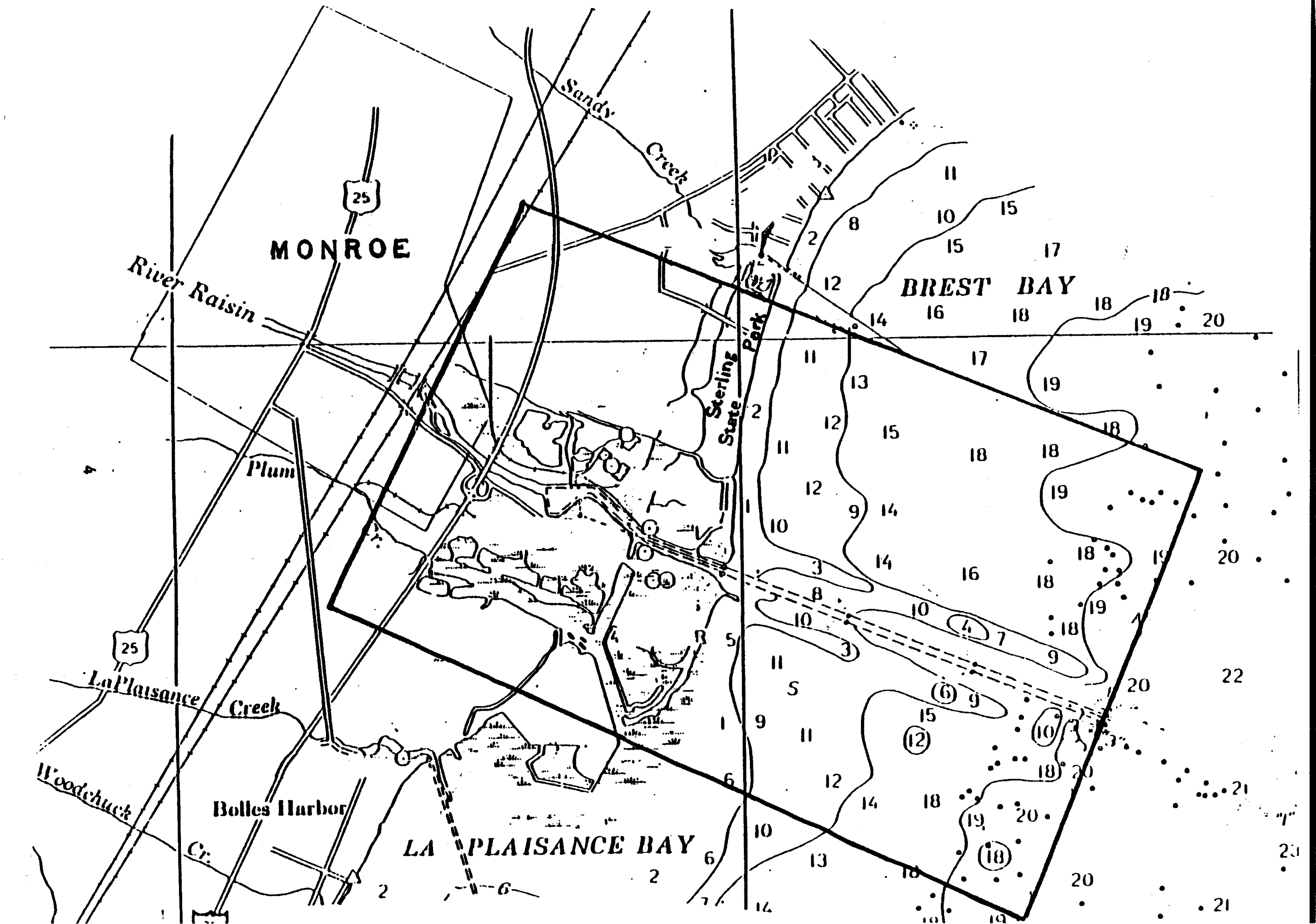


Figure 1. Area of Concern location. Scale 1:3,125,000.



MONROE
25
River Raisin
Sandy Creek
Plum
Sterling State Park
BREST BAY
LaPlaisance Creek
Woodchuck Cr.
Bolles Harbor
LA PLAISANCE BAY

* Conventional pollutants
* Heavy metals
* Toxic organics (PCBs)
* Contaminated sediments
* Fish consumption advisory
* Biota impacted
* Aethetics

The Report on Great Lakes Water Quality (GLWQB 1985) also identified the following potential pollutant sources for the AOC:

* Municipal point sources
* Industrial point sources
* Urban non-point sources
* Rural non-point sources
* Combined sewer overflows
* In-place pollutants (contaminated sediments)

2.1.1 Great Lakes Water Quality Management

The Great Lakes Water Quality Board (GLWQB) adopted a system to track the progress of remedial activities for pollution problems in the 42 Areas of Concern identified in the Great Lakes. The system is comprised of 6 categories that address the status of the information base, current programs to fill information needs, and the status of remedial efforts. Relative to these considerations, each of the 42 Areas of concern in the Great Lakes and connecting channels has been classified according to the six categories listed below.

Category 1: Causative factors are unknown and there is no investigative program underway to identify causes.

Category 2: Causative factors are unknown and an investigative program is underway to identify causes.

Category 3: Causative factors are known, but a Remedial Action Plan has not been developed and remedial measures have not been fully implemented.

Category 4: Causative factors are known and a Remedial Action Plan has been developed, but remedial measures have not been fully implemented.

Category 5: Causative factors are known, a Remedial Action Plan has been developed, and all remedial measures identified in the plan have been implemented.

Category 6: Confirmation that uses have been restored and deletion from list of Areas of Concern in the next Great Lakes Water Quality Based Report.

In 1985, Michigan classified the River Raisin AOC as a Category 2 AOC since the causative factors for major pollutant problems were not well understood.

2.2 PURPOSE AND OBJECTIVES

The purpose of the Remedial Action Plan (RAP) process is to provide a system-wide approach to environmental management that will ultimately lead to the successful rehabilitation of the Great Lakes. This approach requires an integration of available data on the environmental conditions, socioeconomic influences, and political/institutional frameworks. The purpose of this plan is to focus the data gathering and data synthesis to resolve the immediate problems which impair the AOC designated uses. Recommendations for restoring the impaired use and maintaining other designated uses are based on currently available data.

2.3 INTENDED USE OF THE PLAN

This RAP is intended as a technical management document providing a platform for future analyses and decision making. It is not a detailed review and synthesis of all data and/or information on the Area of Concern. Every attempt has been made to identify the major documents that relate to the critical environmental issues affecting the River Raisin AOC. Remedial action planning is an iterative process, and suggestion and additions are welcome.

3. ENVIRONMENTAL SETTING

This chapter of the Remedial Action Plan defines the Area of Concern and provides background information on:

* Natural features and hydrologic conditions
* Land uses
* Water uses
* Water quality criteria and use designations

Each Remedial Action Plan concentrates on a specific Area of Concern identified by the International Joint Commission. The physical boundaries are defined after consideration of sources, effects on the Great Lakes and extent of pollution from Great Lakes tributaries to the adjacent near shore zone. For clarity, the River Raisin watershed has been divided into the Area of Concern and the External Area. The External Area includes a much larger portion of the river upstream of the Area of Concern.

3.1 LOCATION

3.1.1 General

The River Raisin, located in the extreme southeastern portion of Michigan's lower peninsula, flows in a generally southeast direction and discharges into the western basin of Lake Erie at Monroe Harbor. The River Raisin basin includes portions of five Michigan counties and a small part of northern Ohio (Figure 3).

3.1.2 The Area of Concern

The River Raisin Area of Concern (AOC) comprises the lower 2.6 miles of the River Raisin, from Dam No. 6 downstream through Monroe Harbor. It includes the Federal navigation channel from the river mouth into Lake Erie for a distance comparable to the extent of the Detroit Edison-Monroe Power Plant cooling water discharge plume (Figure 2). The width of the AOC extends from the north end of the Sterling State Park to one-half mile south of Dunbar Road on the south bank of Plum Creek.

3.2 NATURAL FEATURES

The following sections describe the natural features of the River Raisin basin with special regard to the topography, hydrology, and soils of the River Raisin watershed.

8

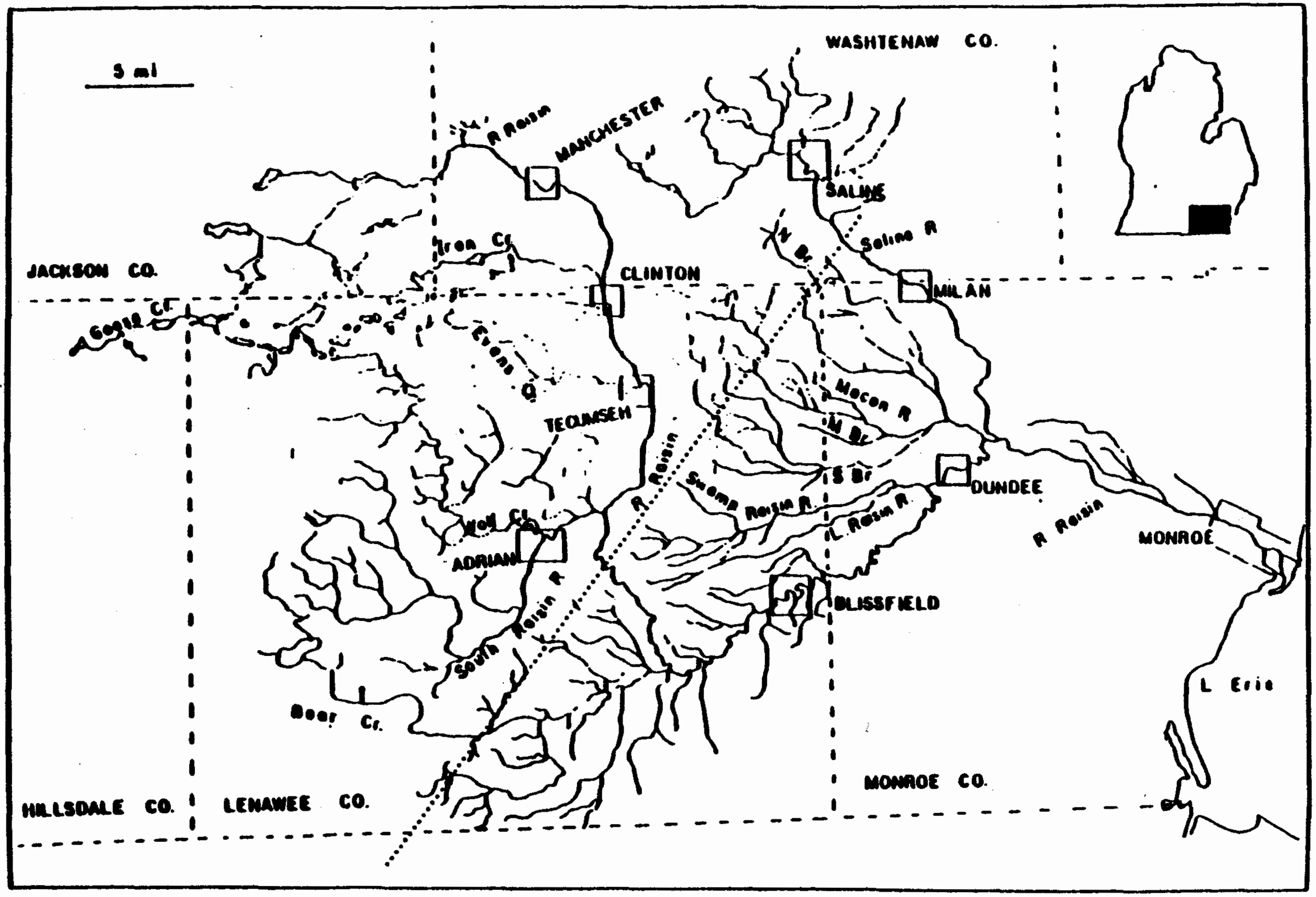


Figure 3. Raisin River Basin (Source: MWRC 1965).

3.2.1 Drainage Basin

The River Raisin basin is approximately 60 miles long (96 km), ranges in width from 2 to 45 miles (3.2-72 km) and has a drainage area of 1,072 square miles (2,776 square km) (Di Toro et al. 1985a). The major tributaries to the River Raisin includes; Wolf Creek, South Branch of River Raisin, Black Creek, Macon Creek, and the Saline River (Figure 3). Between Dundee and the river mouth at Lake Erie (approximately 15 miles) the basin narrows to a width of 2.5 miles (4 km).

3.2.2 Topography

The River Raisin headwaters originate in the extreme northeastern part of Hillsdale County near the headwaters of the Grand, Kalamazoo, St. Joseph and Maumee Rivers. As the river flows south and east it drops over 500 feet in elevation before it reaches Lake Erie. The northwestern portion of the basin is located within the highland area of the Irish Hills and Lake District.

The River Raisin basin within the Area of Concern is essentially flat terrain. A large portion of the eastern fringe of the City of Monroe was once wetland, but with the development of the area over the last thirty years approximately 80% of the wetlands were filled for industrial and recreational uses (Rathbun 1985). However, a large percentage of the AOC is still composed of wetlands. In Monroe County, there is a gentle slope southeastward from a maximum elevation of 730 feet (223 m) in the northwest corner to 572 feet (174 m) at Lake Erie approximately 26 miles (42 km) downstream (Rathbun 1985).

3.2.3 Hydrology

The River Raisin flows into the Western Basin of Lake Erie and has a mean annual discharge of 728 cfs (21 ms/s) (MDNR and USGS 1985). The river covers an area of 805,000 acres (326,000 hectares). The U.S. Geological Survey and Nation Weather Service collect and evaluate hydrologic data at three gaging stations in the River Raisin basin. One of the stream flow gages (station #04176500) is located near the Area of Concern in Monroe County, 1.3 km down stream from the bridge on the Ida Maybee Road, at latitude 41° 57' 38" and longitude 83° 31' 52". The drainage area above the gage point in the river is 1,042 square miles (2,699 square km). The only tributary which flows into the River Raisin within the Area of Concern is Mason Run.

Flow characteristics of the River Raisin are summarized in Figure 5 which includes: average annual flow (1938-1983), average monthly flow (1938-1983); 7 day minimum flow (1938-1983), and monthly 7Q10 flow (the lowest average seven day flow over a period of ten years). The average annual flow ranges from 178 cfs (1964) to 2374 cfs (1943). The monthly average flow distribution indicates that minimum river flows occur during late summer and early fall. The month with the minimum average flow is August (213 cfs) and the maximum average monthly flow occurs in March (1697 cfs) (Di Toro et al. 1985a). Extreme discharges recorded for the period 1973-1985 show a maximum discharge of 15,300 cfs (407.3 cubic m/sec) and a minimum discharge of about 2 cfs (0.06 cubic m/sec) (MDNR and USGS 1985).

The annual 7Q10 flow for the period of record (41.1 cfs) is indicated by the dashed line in each panel in Figure 4. The minimum 7 day flow of 22 cfs occurred in 1941 and the maximum 7Q10 of 1976 cfs occurred in 1981. The months with the lowest average 7QIO flows are August (49.7 cfs) and September (45.7 cfs) (Di Toro et al. 1985a).

Lake level variation in Lake Erie directly affects the water level of the River Raisin below Dam No. 6 causing the portion of the river included in the AOC to behave as an estuary. A lake level recorder, which records the stage on an hourly basis, is maintained in the turning basin by the National Oceanic and Atmospheric Administration (NOAA). The river/lake mixing dynamics are a function of the characteristics of the shoreline and nearshore currents. However, this mixing is strongly influenced by the operation of the Detroit Edison-Monroe electric generating plant. This plant, which is the largest coal-burning plant in the United States, intakes 2500 cfs of cooling water from the River Raisin via an intake canal (Di Toro et al. 1985a). Except during times of high flow such as spring runoff conditions, essentially the entire River Raisin flow is diverted through the facility into Plum Creek discharge canal (Rathbun 1985). The average annual river discharge is equivalent to 30% of the electric plant's cooling water demand; the remainder is drawn from Lake Erie (Cole 1978 as cited in Rathbun 1985).

The annual precipitation on the River Raisin basin averages 31.52 inches, of which 58 percent occurs during the six-month period April through September. Heaviest average precipitation occurs in June (3.49 inches) while February has the least average precipitation (1.79 inches) (MWRC 1965).

3.2.4 Soils, Runoff, and Erosion

Several major soil types are found in the River Raisin basin. In general, the soils in this region consist of clay till reworked by glacial lake water and veneered by lacustrine sands, silts, and clays. The parent material of the soils of the River Raisin basin is from the Wisconsin stage of Pleistocene glaciation and the lacustrine deposits of the ancestral Great Lakes associated with it (MWRC 1965). Figure 5 depicts the general distribution of soil association's in the basin and Table 1 lists the glacial origin, texture, and drainage of each association. In Monroe County, a glacial drift less than 50 feet (15 m) in thickness covers approximately two-thirds of the area. Underlying this material is bedrock which is mostly carbonate in composition.

The gray-brown soils of this region are leached soils developed under moist temperature conditions. Organic materials have accumulated in the upper horizons and clay in the lower horizons (MWRC 1965). Due to the predominance of clay till, runoff in the watershed is significant after rain or during snow-melt. The runoff during storm events causes both rapid stream fluctuations and very turbid waters. Erosion in the River Raisin basin is estimated to be as high as five tons per acre per year in some areas.

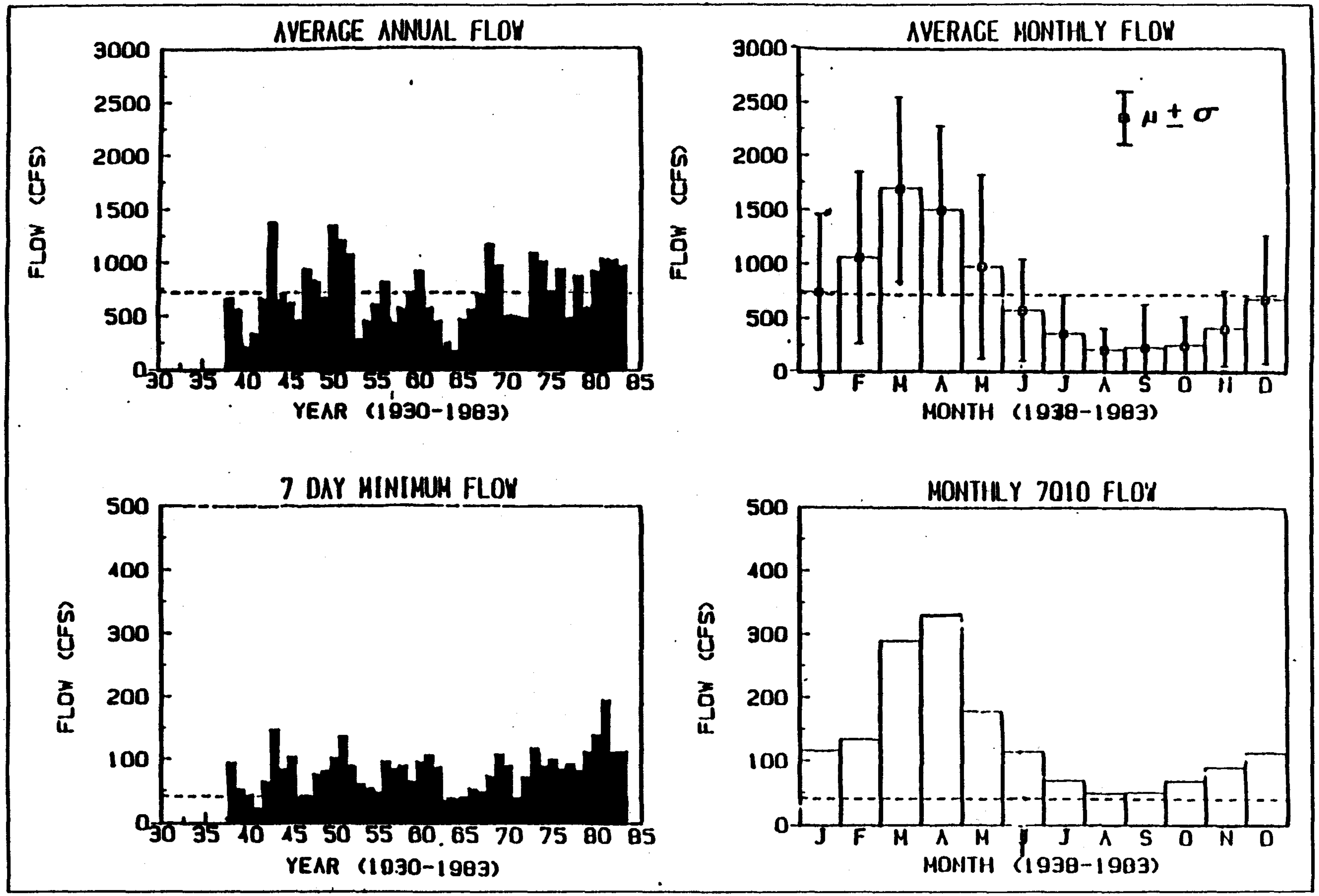


Figure 4. Raisin River Average Annual Flow, Average Monthly Flow 7 Day Minimum and Monthly 7Q10 Flow. (Source: Di Toro et al. 1985a)

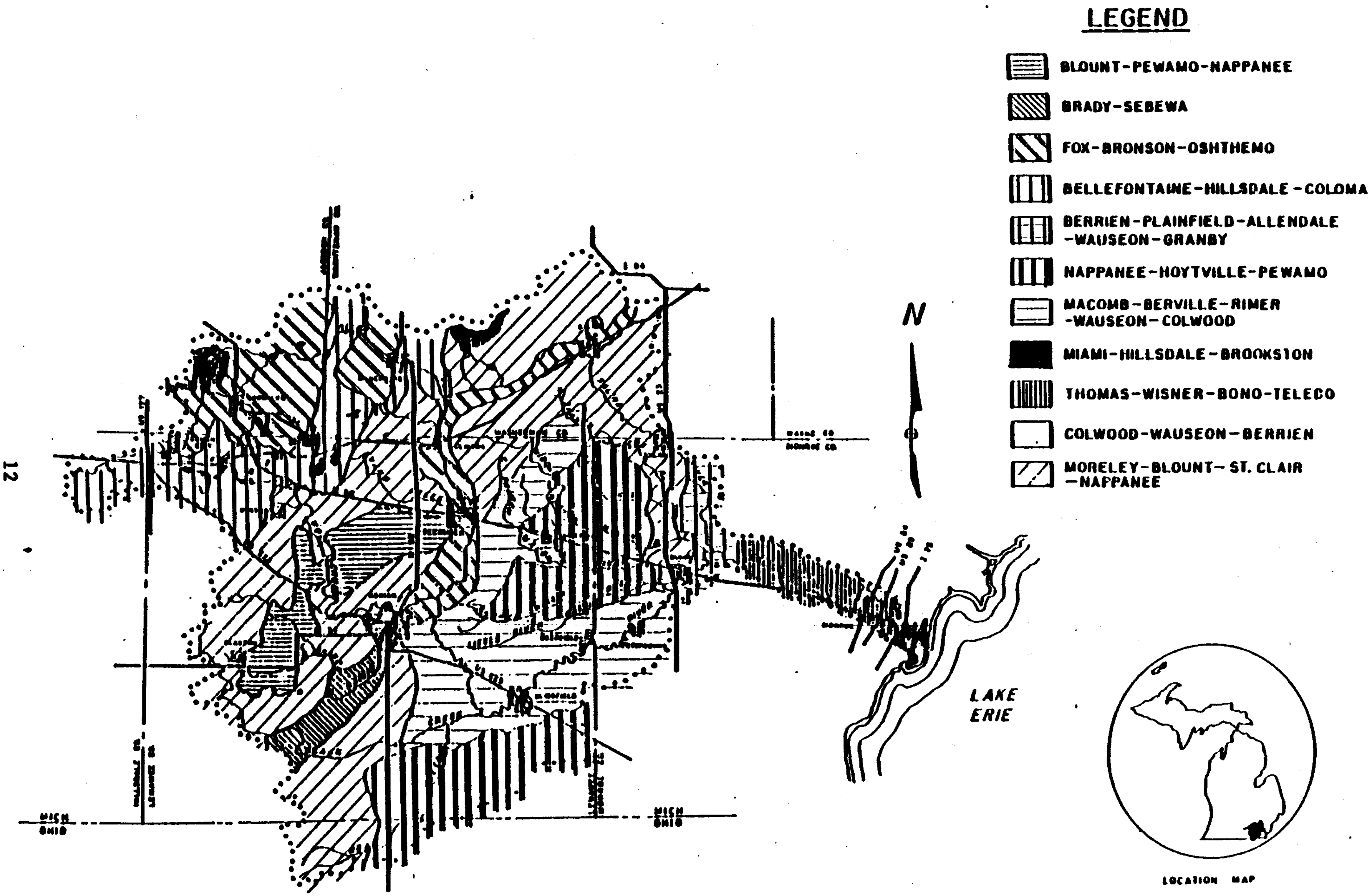


Figure 5. River Raisin Basin - Soil Associations
(Source: MWRC 1965)

Table 1. Soils of the River Raisin Basin

Soil Association	Glacial Origin	Texture	Natural Drainage
Thomas, Wisner, Bono, Toledo	lake bed plains & lacustrine deposits	loams	wet
Nappanee, Hoytville, Pewamo	lake bed plains & lacustirne depsoits	clay loams silty clays clays	wet
Macomb, Berville, Rimer, Wauseon, Colwood	lake bed plains & lacustrine deposits	clay loams silty clays clays	wet
Brady, Sebewa	lake bed plains & lacustrine deposits	loams sandy loams loamy sands	wet
Berrien, Plainfield Allendale, Wauseon, Colwood	lake bed plains & Lacustrine deposits	loamy fine sands fine sandy loams	wet
Blount, Pewamo, Napanee	till plain	clay loams silty clay loams clays	imperfect to poor
Miami, Hillsdale, Brookston	till plain	loams	well to imperfect
Bellefontaine, Hillsdale Coloma	moraines	sandy loams loamy sands	dry
Fox, Oshtemo, Bronson	outwash	sandy loams	dry

(Source: MWRC 1965)

Wind and water erosion are occuring on all occurring on all croplands in the Monroe, Lenawee and Washtenaw Counties. The input of sediments from these counties are degrading the aquatic habitat in the entire river and filling in the Federal Navigation Channel in the Area of Concern. Sedimentation is impairing the navigational use of the lower river and is cost the tax payers millions of dollars for the annual dredging of this channel.

The Soil Conservation Service has estimated that Monroe, Lenawee and Washtenaw Counties possess 83,000, 155,000 and 102,700 acres of cropland respectively, that are eroding faster than the land can tolerate and remain productive. Summary of the erosion and conservation needs for these three counties are shown in Table 2. According to the Soil Conservation Service, the average erosion rate on Michigan's cropland is 4.5 tons/acre/year. The River Raisin watershed contains a significant portion of cropland with an average erosion rate of over five tons/acre/year (Figure 6).

3.3 LAND USES

The River Raisin drainage basin and the nearshore area of Lake Erie have undergone profound changes in land use in the past century. Once forested with mature hardwoods or wetlands, this area is now mostly cleared or filled and used for a mixture of urban, suburban, and agricultural land uses. extent of urban development within the City of Monroe.

A summary of the land use survey conducted by the Soil Conservation Service is presented in Table 3 for Monroe, Lenawee and Washtenaw Counties. The majority of land in the River Raisin watershed is used for agriculture. Croplands dominate the agricultural land use and are very susceptible to wind and water erosion.

3.3.1 Industrial and Port Uses

A diversity of complex manufacturing and industrial activities are performed at plants located within the external area and the Area of Concern. These include primary metal industries; fabrication of metal products, machinery, and transportation equipment; manufacture of paper and allied products, chemicals, and furniture; food processing and dairy related industries. In addition to the presence of Monroe and Adrian as industrial centers, industrial development has occurred throughout the basin.

The City of Monroe has been served by Great Lakes commerce for approximately 150 years. By 1840, Monroe was an important produce and grain shipping port, and was the distribution point for the Central Division of the Western Union Telegraph Company. Presently, the Port of Monroe facilities are used primarily by coal ships. The Port of Monroe is served by a dredged shipping channel 15,800 feet (4.8 km) long, 300 feet (91.2 m) wide and 21 feet (6.4 m) deep from Lake Erie to the mouth of the River Raisin. From the mouth of the river to the turning basin, there is a dredged channel 8,000 feet (2.5 km) long, 200 feet (60.8 m)

TABLE 2. EROSION AND CONSERVATION NEEDS FOR MONROE, LENAWEE, AND WASHTENAW COUNTY

Land Capability Class*	Acres of Cropland	Erosion Rate (Tons/Acre/Year) Water	Wind	Total	Acres Needing Treatment
MONROE COUNTY					
II	126,900	1.6	1.2	2.8	28,200
III	95,200	1.3	5.4	6.7	59,700
IV	5,700	1.1	12.7	13.8	4,400
V	1,300	2.2	1.7	3.9	500
VI	0	0	0	0	0
TOTAL	229,100				92,800
LENAWEE COUNTY					
II	231,000	2.7	1.6	4.3	156,300
III	95,800	4.3	2.1	6.4	66,900
IV	6,700	11.4	0.3	11.7	4,800
V	600	2.3	2.0	4.3	600
VI	3,600	8.9	3.9	12.8	2,400
TOTAL	337,700				231,000
WASHTENAW COUNTY					
II	127,400	2.5	1.3	3.8	71,600
III	69,800	4.5	2.0	6.5	46,600
IV	12,600	9.5	4.0	13.5	10,400
V	500	1.8	0.2	2.0	0
VI	1,400	2.1	0	2.1	400
TOTAL	211,700				129,000

Source: United States Department of Agriculture Soil Conservation Service, 1982.

*Land Capability Classes are defined in Appendix.

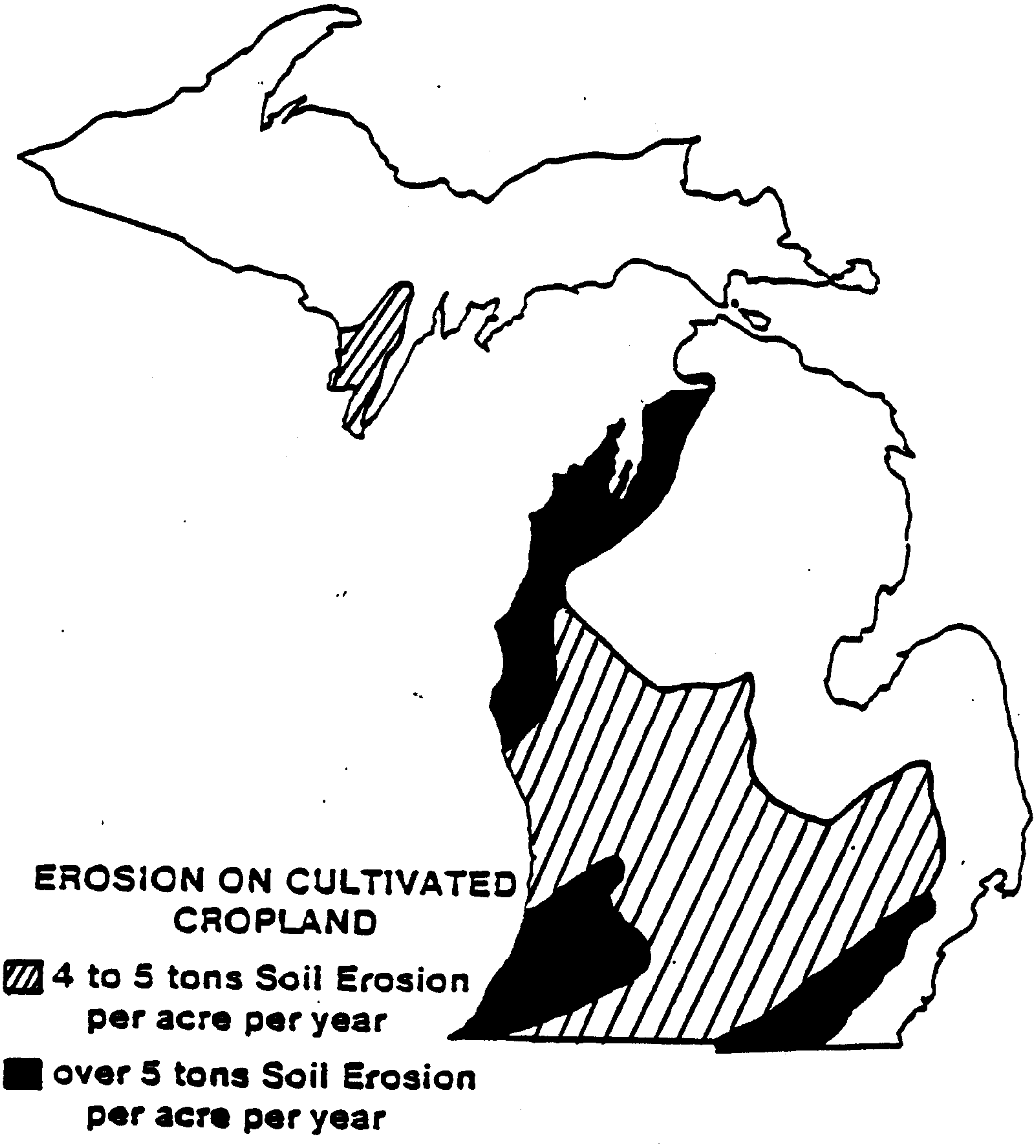


Figure 6. Erosion on Cultivated Cropland

Source: United States Department of Agriculture
Soil Conservation Service, 1982

TABLE 3. LAND USE IN ACRES FOR MONROE, LENAWEE, AND WASHTENAW COUNTY

County (Total Acreage)	Cropland	Pasture & Idle Grassland	Rural Trans-portation	Forest Land (non-federal)	Other Rural Land	Water Areas	Urban Land	Federal Land
Monroe County (360,700 Acres)	229,100	17,400	17,400	27,400	24,100	9,500	35,800	---
Lenawee County (487,300 Acres)	337,700	13,800	14,600	46,200	46,200	10,100	18,700	---
Washtenaw County (462,500 Acres)	211,700	83,900	16,100	46,600	41,200	14,000	48,700	300

(All measurements in Acres)

Source: United States Department of Agriculture, Soil Conservation Service, 1982.

wide and 21 feet (6.4 m) deep. The turning basin is approximately 18 feet (5.5 m) deep. A nine foot (2.7 m) channel extends up-river an additional 3,800 feet (1.2 km) to wharfs in Monroe (MWRC 1965). The channels in the Lower River Raisin and Lake Erie are maintained by the U.S. Army Corps of Engineers.

3.3.2 Regional Sewer Service and On-Site Disposal

Two basic types of wastewater treatment systems are available to Monroe County residents: 1) municipal collection and treatment systems, and 2) on-site sewage treatment systems (septic tank and leach fields).

Nearly all of the more urbanized or densely settled portions of the county are served by municipal wastewater treatment systems. The rural portions of the county are served by individual on-site systems. The characteristics of the existing municipal systems in Monroe County are described in Table 4 and shown in Figure 7.

3.4 WATER USES (RIVER/STREAM)

The following sections descibe consumptive water uses, fishing activities, noncontact and contact recreation, navigation, and waste disposal in the river portion of the Area of Concern.

3.4.1 Water Supply

Water supply to the Monroe County has been divided into four areas. These areas correspond to the source of the water supply.
Characteristics of existing municipal water supply systems are presented in Table 5 and areas serviced by these systems are depicted in Figure 8.

3.4.1.1 Water Supply in the Area of Concern

The City of Monroe provides public water to the entire city area, large portions of Monroe Township and Frenchtown Township, and a small section of eastern Raisinville Township. The estimated service area population is between 40,000 and 45,000 people (Monroe County Planning Department, 1985).

Monroe's water supply is drawn from Lake Erie by a pump located off Pointe Aux Peaux Road in Frenchtown outside of the Area of Concern. This facility has a raw water pumping capacity of 12 MGD. The city's water treatment facility, located on the River Raisin in the City of Monroe, has a rated capacity of 18 MGD. Treatment consists of sterilization, pretreatment, sedimentation, pH control, filtration and taste and odor control. Water usage (Table 5) in the Monroe urbanized area ranges from a low of 7.5 MGD in winter to 11.5 MGD in summer months. While there is a considerable amount of unused treatment capacity at the water filtration plant, the existing water intake at Brest Bay is operating near capacity.

The city currently maintains a storage capacity of 4 million gallons. A 3 million gallon underground storage reservoir is available at the site of the water treatment plant. The remaining storage capacity is

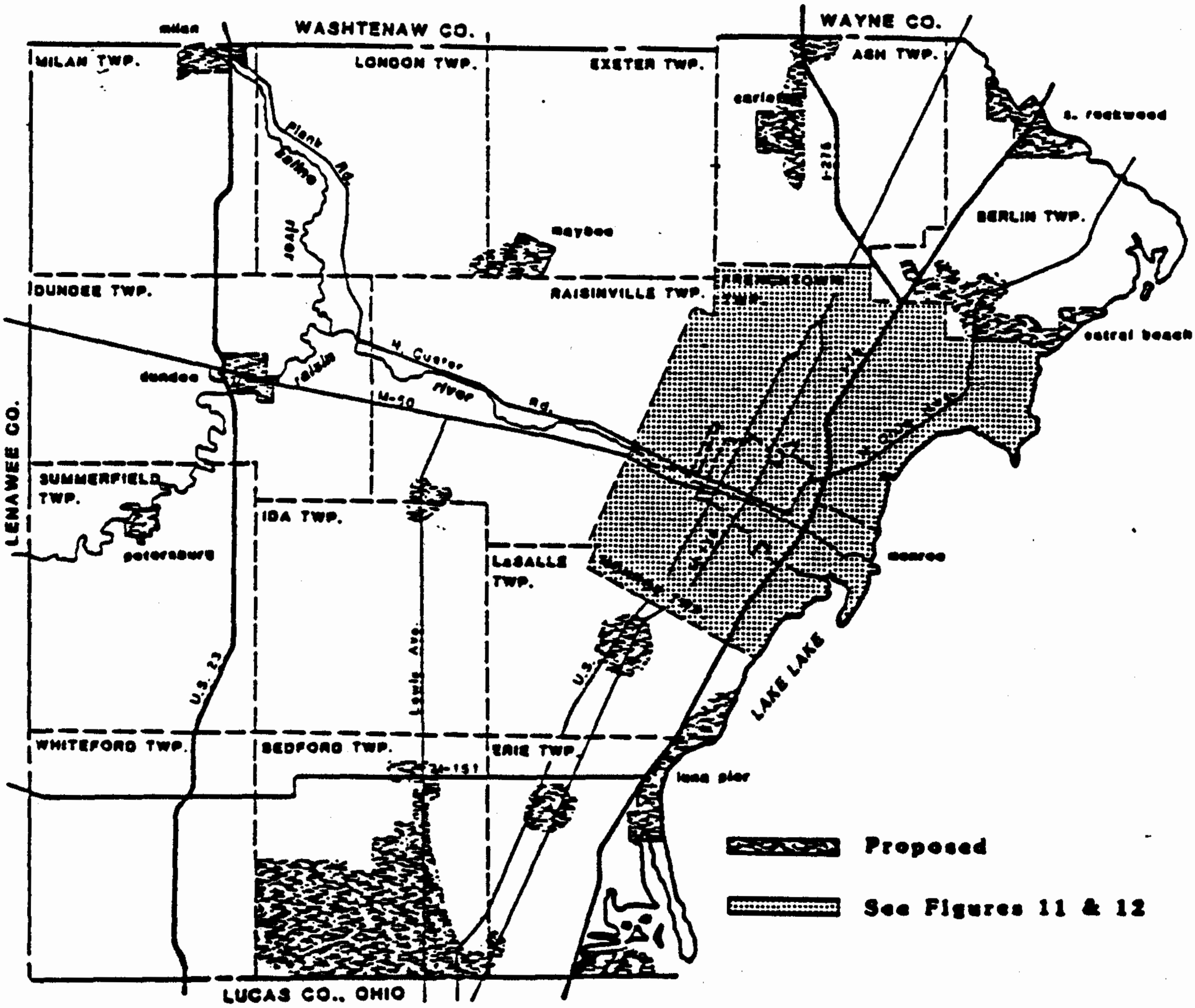
Table 4. Characteristics of Existing Municipal Wastewater Treatment Systems.

Service Area	Plant Capacity	Daily Flows	Level of Treatment
Monroe Urban Area	30 MGD(1)(2)	12-14 MGD	Secondary
Bedford Township	3.0 MGD	3.0 MGD	Teritiary
Berlin township	0.81 MGD	0.35 MGD	Secondary
South Rockwood Village(3)	1.2 MGD	0.5 MGD(4)	Secondary
Ash Township(5)			
Carleton Village	--	--	Lagoon System
Maybee Village	0.18 MGD	0.03 MGD	Lagoon System
Dundee Village	0.43 MGD	0.33 MGD	Primary
Milan city	1.8 MGD	0.83 MGD	Tertiary
Petersburg City	0.7 MGD	0.12 MGD	Secondary
Luna Pier City	0.3 MGD	0.15 MGD	Secondary

(1) MGD - Million Gallonds per Day.
(2) 24 MGD - Average Design Capacity
(3) Wastewater from South Rockwood is treated at a facility located in the City of Rockwood.
(4) Approximately 35 percent of the existing flows through this facility are from the Village of South Rockwood.
(5) The Village of Carleton operates a lagoon treatment system capable of serving a population of between 2,800 and 2,900 people. This system also serves a portion of ash Township. The system is currently undergoing an expansion which will increase its capacity to approximately 3,500 people.

(Source: Monroe County Planning Department, 1985).

Figure 7. Sanitary Sewer Service Areas



(Source: Monroe County Planning Department, 1985)

Table 5. Characteristics of Existing Municipal Water Supply Systems.

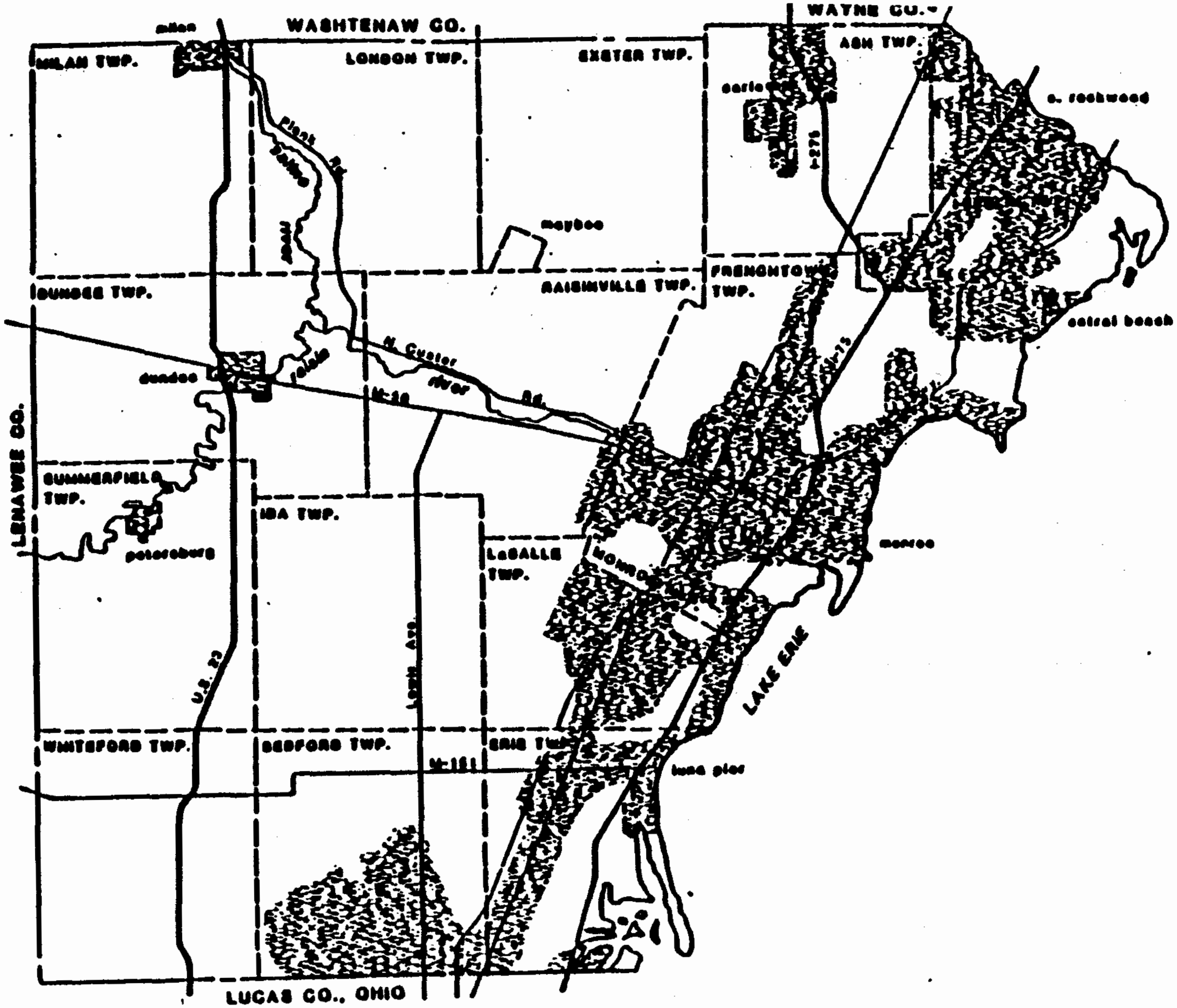
Service Area	System Capacity	Capacity	Daily Water Usage
Monroe Urban Area	12.5 MGD[1]	4 MGD	7.5-11.5 MGD
South Monroe County	10 MGD	3.5 MGD	1-1.5 MGD
Bedford Township	--	2.5 MGD	0.69 MGD
Erie Township	--	--	0.12 MGD
LaSalle Township	--	0.5 MGD	0.18 MGD
City of Luna Pier	--	0.5 MGD	0.09 MGD
Ash Twp./Carleton Vlg.	(3)	--	0.578 MGD
Berlin Twp./Estral Beach Vlg.	(3)	--	0.333 MGD
Village of South Rockwood	(3)	--	0.1 MGD
City of Milan	3 MGD	0.75 MGD	0.8-0.9 MGD
City of Petersburg	0.22 MGD	0.125 MGD	0.14-0.16 MGD
Village of Dundee	0.6 MGD	0.3 MGD	0.25-0.3 MGD

(1) 12.5 MGD is the capacity of the existing water intake in Lake Erie. The water plant has a capacity of 18 MGD.

(2) No more than 5 MGD can be drawn from the City of Toledo without causing water pressure problems for the city.

(3) Public water to these communities is provided by the Detroit Metropolitan Water Board. No specific limits have been established regarding the amount of water that is available from this system. The Detroit system provides more than enough water to supply the needs of these communities.

Figure 8. Existing Public Water Service Areas.



(Source: Monroe County Planning Department, 1985) available in two 500,000 gallon elevated storage tanks located at Roessler Field and Pointe Aux Peaux, respectively. The Pointe Aux Peaux storage tank is currently not being used.

3.4.1.2 <u>Water Supply to the External Area</u>

Public water systems in western Monroe County are confined to the existing Cities of Milan and Petersburg and the Village of Dundee. The remaining portions of western Monroe County rely on private on-site wells as the source of their water.

The City of Milan's public water supply is provided by five municipal wells which have a capacity in excess of 3 MGD. Daily water usage volumes for the city are between 800,000 and 900,000 gallons. The city does not provide filtration of this water; however, the water is chlorinated before it is distributed.

The entire city is served by the existing water system. Water is also provided to the Milan Correctional Facility and to a limited amount of residential customers located outside of the city limits. The city maintains a water storage capacity of 75,000 gallons which is located in an overhead storage tank. An adequate supply of water at sufficient pressure is available in the city for fire fighting purposes.

The River Raisin is the source of Dundee's public water supply. The existing supply and distribution system has the capacity of providing 600,000 gallons of water per day. Daily water usage volumes for the village average between 250,000 and 300,000 gallons. Treatment consists of a process to remove turbidity, plus the addition of chloride, alum and floride. The entire village is served by this system plus a few homes along Lloyd Road in Dundee Township which are served by a private line.

Public water for the City of Petersburg is provided by two wells which have a capacity of supplying the city with approximately 220,000 gallons of water per day. Current daily water usage levels range between 140,000 and 160,000 gallons. Treatment of this water consists of aeration, filtration and the addition of chlorine and another chemical to reduce the sulfur content of the water. Storage is provided by a newly constructed 125,000 gallon elevated storage tank.

Public water to the four south county communities of Bedford Township, Erie Township, LaSalle Township and the City of Luna Pier is provided by the City of Toledo via the south county water distribution system. The main pumping station for this system is located near the intersection of Lewis Avenue and Smith Road less than one-half mile from the City of Toledo corporate boundary. The station has a rating of 10 MGD although the south county system cannot draw more than 5 MGD without causing pressure problems for the City of Toledo's distribution system.

Approximately 14,769 people are served by the south county system. Average daily water usage is between 1 and 1.5 million gallons per day. A summary of the water usage figures and the number of people served in each community is indicated below:

* Bedford Township - 690,975 gallons per day (9,213 people)

* Erie Township - 121,275 gallons per day (1,617 people)

* LaSalle Township - 182,025 gallons per day (2,427 people)

* City of Luna Pier - 90,720 gallons per day (1,512 people)

Four reservoirs are currently being utilized to store this water. A two million gallon storage reservoir is located at the pump station. Three 500,000 gallon elevated storage tanks are also available in the Lambertville area, LaSalle Township and the City of Luna Pier.

Before this water reaches Monroe County, it receives a high level of treatment from the City of Toledo including filtration, chemical treatment, chlorination and odor removal. The water is also rechlorinated in Bedford Towhship before being pumped out for public use.

The existing south county supply and distribution system has more than enough capacity to accommodate considerable growth in the future.

The Detroit Metropolitan Water Board provides public water to the five communities in northeast Monroe County including Ash Township, the Village of Carleton, Berlin Township and the Villages of Estral Beach and South Rockwood. A high grade of treated water is provided through this system.

Ash Township operates a water distribution system serving the north and central portions of the township including the Village of Carleton. Approximately 50 percent of the township is served by this system; 100 percent of the village is served. Collectively, these two units of governments use approximately 578,200 gallons of water per day. Industrial users in northern Ash Township, primarily Guardian Glass, account for a large portion of the total daily water consumption in this area.

Both Berlin Township and the Village of South Rockwood share a common main water line feed from the Detroit Metropolitan Water Board. The South Rockwood system serves the entire village area. The village uses approximately 100,000 gallons of water per day. Two major industries in the village account for a significant amount of daily water consumption within the village.

Berlin Township owns and operates its own public water distribution system which was constructed in 1970 and 1971. This system provides public water to large portions of the township plus the Village of Estral Beach. Approximately 75 percent of the township is currently served by this system. Total daily water consumption for these two communities average 333,333 gallons per day.

Industry uses water for both consumptive and non-consumptive purposes. There are three types of industrial water: cooling, potable and process.

Table 6 provides information on quantity and type of water use for industries in the River Raisin Basin. A survey conducted by MDNR revealed that industry uses over 40 million gallons of water per day, the greatest portion (approximately 85%) being from independent supplies (Table 6) (MWRC 1965).

3.4.1.3 Agricultural Land Use

The River Raisin is primarily located in areas of agricultural production (Figure 9). Farmland represents over 70% of the land use in Lenawee and Monroe Counties. These counties rank among the 10 leading counties in Michigan in the production of corn, winter wheat, soybeans, potatoes, and sugar beets. Lenawee County also ranks in the production of oats and cattle (MWRC 1965). The total acreage used for agriculture in the counties of Monroe, Lenewee and Washtenaw are shown in Table 3.

3.4.2 Navigation

Monroe Harbor in the Area of Concern, is served by a dredged Federal shipping channel maintained by the U.S. Army Corps of Engineers. Amounts of dredge material removed by the USCOE from 1981-1984 are presented in Table 7. Presently, Monroe port facilities are used primarily by ships delivering coal to the Detroit Edison Monroe Power Plant. This need for annual dredging is due to erosional inputs from the agricultural lands which are in the external areas.

3.4.3 Waste Disposal

The River Raisin and its tributaries receive wastewater discharges from publicly owned sewage treatment plants and industries. Within the Area of Concern, there are currently five point source wastewater discharges and six potential non-point sources. The City of Monroe Wastewater Treatment Plant (WWTP) discharges approximately 30 MGD of secondary treated wastewater into Plum Creek. In addition to treating domestic wastewater, the plant receives wastewater from a number of industries. Just downstream at RM 0.9, the Ford Motor Company discharges 7.5 MGD of treated wastewater to the River Raisin. The outfall is located across from the Detroit Edison cooling water intake canal. The Union Camp Corporation discharges 0.07 MGD of treated water to Mason Run, a tributary to the River Raisin (Di Toro 1985). The La-Z-Boy Chair Company discharges non-contact cooling water only. Point source discharges are described in detail in Sections 5 and 6. The River Raisin Area of Concern also contains six non-point source solid waste disposal areas. These six areas are the Port of Monroe Landfill, City of Monroe Landfill, Consolidated Packaging Corporations' lagoons, Detroit Edison's fly ash and dredge spoil disposal areas, the Ford Motor Company's metal sludge disposal areas, and the Confined Disposal Facility at Sterling State Park (Table 7).

3.4.4 Contact Recreation

There is one beach at the north end of the AOC, Sterling State Park. With the exception of this park, very little of Lake Erie's shoreline in the

TABLE 6. INDUSTRIAL WATER USE IN THE RIVER RAISIN BASIN (SOURCE: MWRC 1965)

City / Industry	% Source City	% Source Own	Days Week	Weeks Year	Use in 1,000 GPD (Working Days) Processing	Cooling	Sanitary	Other	Source of Supply City	Own*	Total
Adrian											
Ace Drill Corp.	100		5	52	0.7	6.1	3.4		10.2		10.2
Acme Preserve Co.	100		6	6	99.6		4.5		104.1		104.1
Adrian Steel Co.	100		5	52	12.0		2.3		14.3		14.3
Aget Mfg. Co.	100		5	52	0.8	3.1	0.9	2.4	7.2		7.2
American Chain & Cable Co., Inc.	100		5	52	55.6	55.6	17.8		129.0		129.0
Bohn Alum. & Brass Corp.	96.7	3.3	5	50	21.8	196.0	7.5		217.8	7.5 w	225.3
Brazeway, Inc.	100		5	50		5.3	2.4		7.7		7.7
Buckeye Products Corp.	100		5	52	24.4		0.7	2.4	27.5		27.5
Culligan Soft Water, Inc.	100		5	52	23.6		0.2		23.8		23.8
Drug Processors, Inc.	100		5	52	0.7	5.6	0.7		7.0		7.0
Ervin Foundry & Mfg. Co.	1.0	99.0	5	52		148.6	1.4		1.4	148.6 w	150.0
Harvey Alum. Co.	100		5	52	86.5	67.8	2.0	4.7	161.0		161.0
Hurd Lock & Mfg. Co.	100		5	52	151.9	119.7	3.8		275.4		275.4
Kewaunee Mfg. Co.	100		5	52	14.5	44.9	10.8	1.7	74.3		74.3
Merrilat Woodworking Co.		100	5	52			3.8			3.8 w	3.8
Mich. Prod. Dairy Co.	74.6	25.4	7	52	90.7	28.6	7.5		94.6	32.2 w	126.8
Plymouth Tube Div., Van Pelt Corp.	100		5	52	65.6	65.6	3.8		135.0		135.0
Simplex Paper Corp.	100		5.5	52	41.7	2.4	3.8	2.8	50.7		50.7
Stearns Mfg. Co., Inc.	100		5	52	10.2		3.4		13.6		13.6
Stubnitz Green Corp.	12.7	87.3	5	52		283.5	14.7	6.6	38.8	266.0 w	304.8
Blissfield											
Blissfield Canning Co., Inc.	100		7	10	229.6	26.4	8.0		264.0		264.0
Home Canning Co.	100		6	10	147.0		3.0		150.0		150.0
Brooklyn											
Ford Motor Co., Hdwe. and Acc. Div.		100	5	52	38.8	116.2	3.8	2.4		161.2 w	161.2
Clinton											
Clinton Eng. Corp. Plant #1	100		5	50	4.6	40.9	2.5		48.0		48.0
Clinton Eng. Corp. Plant #2	100		5	50	4.0	1.0	4.4		9.4		9.4

TABLE 6. INDUSTRIAL WATER USE IN THE RIVER RAISIN BASIN (SOURCE: MWRC 1965) (Continued)

City / Industry	% Source City	% Source Own	Days / Week	Weeks / Year	Use in 1,000 GPD (Working Day*) Processing	Cooling	Sanitary	Other	Source of Supply City	Own*	Total
Deerfield											
Revco, Inc.	100		5	49	65.0	28.2	8.8	2.4	104.4		104.4
Dundee											
Dundee Cement Co.		100	7	52	1,496		4.0			1,500.0 s	1,500.0
Dundee Products Co.	7	93	5	52		25.0	2.0		2.0	25.0 s	27.0
Wolverine Fabricating & Mfg. Co.		100	5	52		30.0				30.0 s	30.0
Manchester											
Double A Products Co.	100		5	52	0.9	1.4	7.0	0.4	9.7		9.7
Milan											
American Foundries Co, Div. Donovan Wire & Iron Co.	100		5	50	5.0	1.0	1.0		7.0		7.0
Arbor Container Co.	100		6	52		32.0	2.7		34.7		34.7
PK&A Foundry, Inc.		100	5	50		4.0				4.0 w	4.0
Squires Mfg. Co.	100		5	50		7.8	.2		8.0		8.0
Wolverine Plastics, Inc.	100		5	52			86.0	6.0	92.0		92.0
Monroe											
Consolidated Paper Co.	1.2	98.8	5	50	18,826.1		42	7.2	226	18,649.2 s	18,875.2
Detroit Stoker Co.	14	86	5	52			5.5	0.9	5.5	0.9 w	6.4
Ford Motor Co., Metal Stamping Div.	5	95	5	50	5,700	1,500	40	86	394	6,932.0 w	7,326.0
Gould National Batteries, Inc.	100		5	50	107	8.4	3.6		119.0		119.0
La-Z-Boy Chair Co.	100		5	51	1.4	1.4	3.1		5.9		5.9
Leake Stamping Co., Div. Monarch Pro. Co.	100		5	52	21.0	10.3	3.0		31.6		31.6
Midway Products Co.	100		5.5	52	3.0	6.0	1.3		10.3		10.3
Monroe Auto Equip. Co.,The	100		5	52	50.0	15.0	2.8	10.0	77.8		77.8
Monroe Paper Prod. Co.	1	99	5	50	2,000	170.2	4.5		14.7	2,160 s	2,174.7
Monroe Steel Casting Co.	100		5	50		5.1	4.2		9.3		9.3
Paragon Aluminum Corp.	100		5	52		35.0	3.3		38.3		38.3
River Raisin Paper Div. Union Bag-Camp Corp.	1.2	98.8	5	50	4,276.5	225.1	13.5	38.4	53.5	4,500.0 s	4,553.5
Woodall Industries, Inc.	100		5	52	9.5	4.5	5.0	5.0	24.0		

28

TABLE 6. INDUSTRIAL WATER USE IN THE RIVER RAISIN BASIN
(SOURCE: MWRC 1965) (Continued)

City Industry	% Source City	 Own	Days Week	Weeks Year	Use in 1,000 GPD (Working Days) Processing	 Cooling	 Sanitary	 Other	Source of Supply City	 Own*	 Total
Palmyra											
Driggs Dairy Farms, Inc.		100	7	52	2.0	22.8	.2			25.0 s	25.0
Simplex Paper Corp.		100	5	50	31.0		.8			31.8 s	31.8
Saline											
Alumaloy Fabricators, Inc.	100		5	50	5.0		1.0		6.0		6.0
Hoover Containers, Inc., Sub. Hoover Ball and Bearing Co.		100	6	51		30.0	3.0			33.0 w	33.0
Universal Die Casting & Mfg. Div. Hoover Ball and Bearing Co.		100	6	52	330.0		6.0			336.0 w	336.0
Tecumseh											
Bruce Foundry & Mfg. Co.	100		5	52	5.0	3.0	1.4		9.4		9.4
Faraday Co.	100		5	50	9.0	2.0	4.4		15.4		15.4
Tecumseh Products Co.	100		5	52					2,150.0		2,150.0
Tuttle, H.W. & Co.	100		5	52	8.3	1.0	1.5		10.8		10.8
Weston											
Anderson Chem. Div., Stauffer Chem. Co.		100	5	52	303.0		7.0			310.0 w	310.0
Totals									5,324.1	35,156.2	40,480.3

* s - surface
w - well

Table 7. Amount of Dredged Material Removed by the Detroit District U.S. Army Corps of Engineers from Monroe Harbor (Federal Projects): Fiscal Years 1981-1984*

Fiscal Year	Amount Dredged (cubic yards)	Area Dredged	Disposal Site
1981	157,539	1,000 ft west to 8,000 ft east of ** reference	Detroit Edison
1982	248,069	Entire channel, excluding turning basin	Detroit Edison
1983	117,237	1,000 ft west to 8,000 ft east of reference	Detroit Edison
1984	83,944	1,000 ft west to 8,000 ft east of reference	Detroit Edison
1984	14,218	----	Sterling CDF

* Information obtained from EPA record of communication date 6/10/85, S. Jacik.

**Reference = point where River Raisin widens from 200-300 ft.

Area of Concern is accessible to the public for recreational use.

3.4.5 Recreational Land Uses/Open Space and Wildlife Habitat

Several parks, fish and game areas, and golf courses are located in the River Raisin basin. These recreational facilities (Figure 9) include:

* Onsted State Game Area
* Petersburgh State Game Area
* Sharonville State Game Area
* Walter Hayes State Park
* Allens and Sand Lakes Public Fishing Sites
* State roadside park
* Two county and five municipal parks
* Nine golf courses.
* Sterling State Park

3.4.6 Fishing

The River Raisin supports no commercial fisheries. However, the External Area still supports some game fisheries. Most of the sportfishing on the main branch of the River Raisin occurs in three general areas: (1) near Brooklyn, (2) from Manchester to Tecumseh, and (3) from Dundee to Monroe (Figure 10) (Towns 1985). The impoundments influence sports fishing for bluegills and largemouth bass in the Brooklyn area and for smallmouth bass, northern pike, and rock bass near Manchester. The water between Dundee and Monroe is fished primarily for smallmouth bass, rock bass, northern pike, and walleye to a lesser extent.

The Michigan Department of Natural Resources surveyed the River Raisin fish populations in 1971 and 1984. Locations of the 1984 sampling stations are depicted in Figure 12. The numbers and weight of game and non-game fish collected by MDNR in 1984 are shown in Figure 11. Areas previously identified as having a fair game fish population include (MWRC 1974, MDNR 1979 a):

* Norvell Pond (bluegill, largemouth bass, northern pike)
* Clinton (smallmouth bass, rock bass)
* Beamer Road upstream of Blissfild (northern pike)
* Downstream of Petersburg (rock bass)
* Ida-Maybee to Raisinville Highway bridge (smallmouth bass, rock bass)

Although game fish are found in the Area of Concern, this area is generally dominated by non-game fish.

3.4.7 Canoeing

Throughout Michigan, canoe enthusiasts are becoming aware of the recreation opportunities provided by the rivers close to home. The River

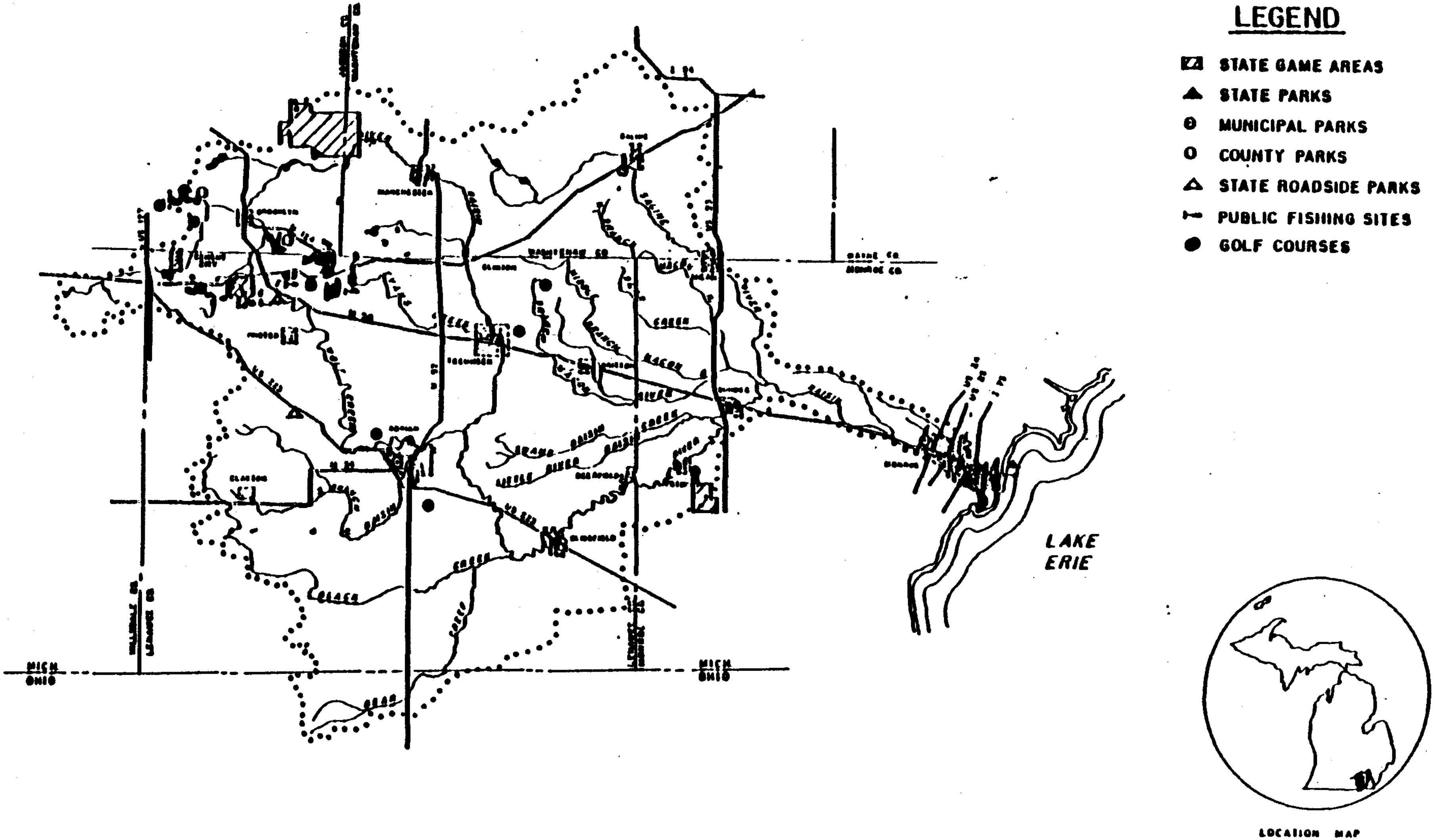


Figure 9. River Raisin Basin - Recreational Areas
(Source: MWRC 1965)

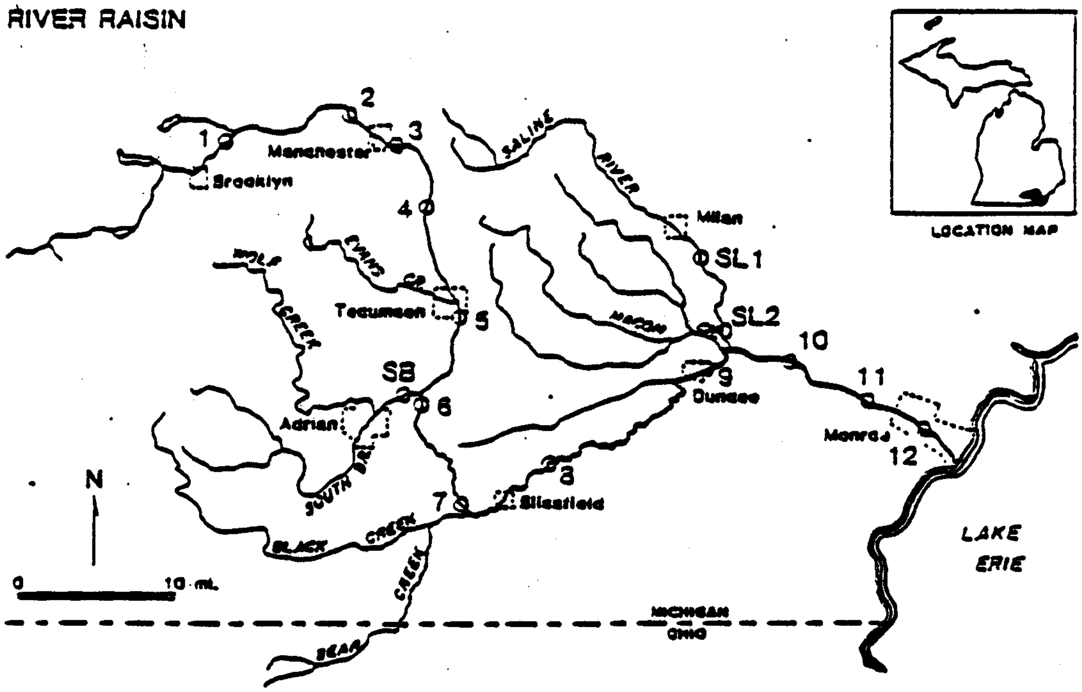


Figure 10. Locations of Sampling Stations During the 1984 River Raisin Fisnery Survey

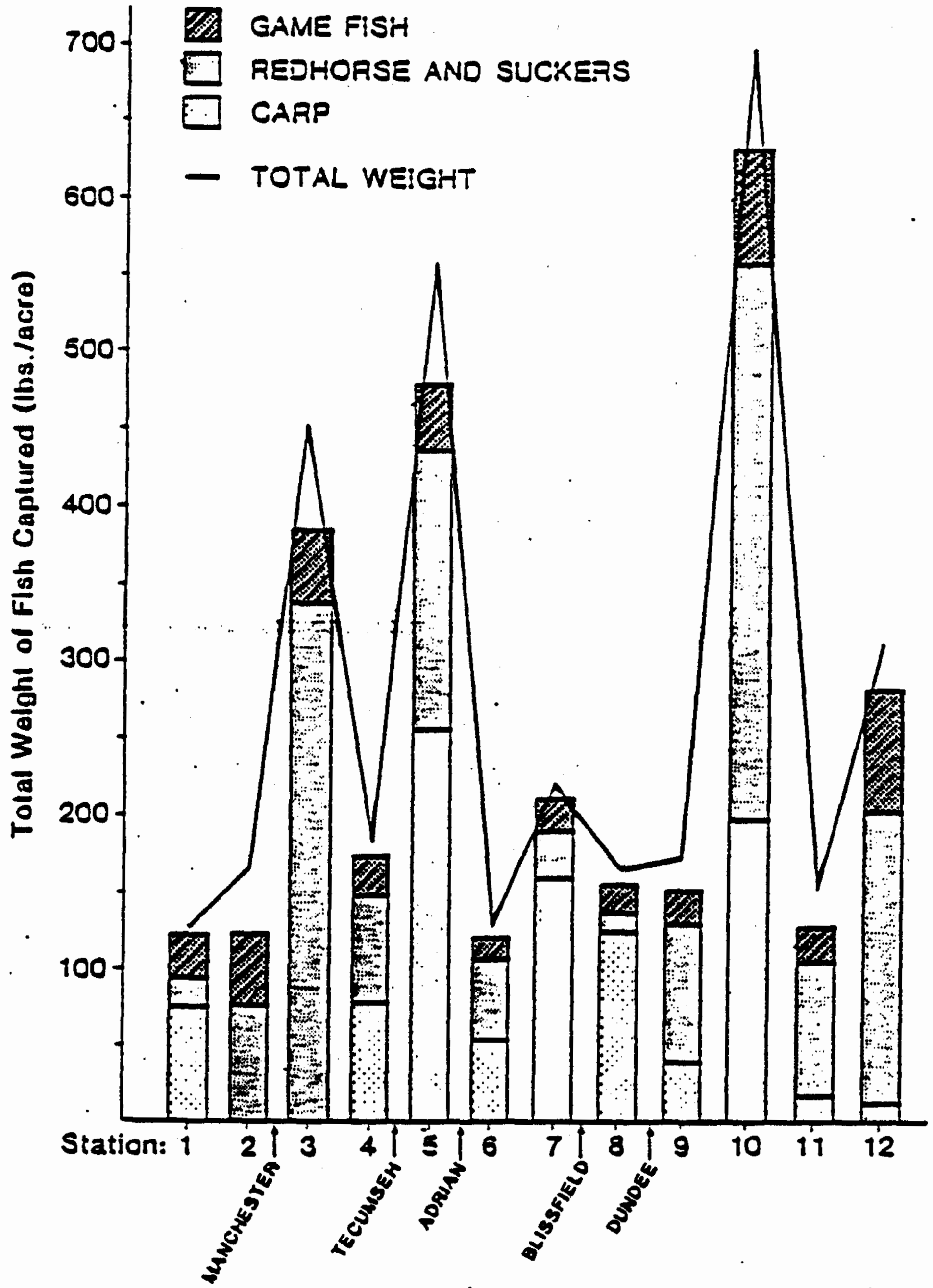


FIGURE 11. THE WEIGHT OF GAME FISH, REDHORSE AND SUCKERS (INCLUDES NORTHERN HOG SUCKER, WHITE SUCKER, AND ALL REDHORSE SP.), AND CARP CAPTURED AT EACH STATION DURING THE 1984 RIVER RAISIN FISHERY SURVEY. THE SOLID LINE REPRESENTS THE WEIGHT OF ALL FISH CAPTURED. (SOURCE: TOWNS 1985)

Raisin watershed is no exception to this growing interest. Canoeing is becoming a popular non-contact recreation sport on the River Raisin. But, like most rivers, this recreational use is hindered by log jams. Fortunately, the River Raisin Watershed Council (RRWC) formed in 1974, and representing a coalition of 60 local governments which are working together to improve the River Raisin, has taken an interest in this problem. The RRWC's has dedicated their time and money to planing, organizing and supervising the vast undertaking of log jam removal on the River Raisin. In the first year (1986) alone, they were able to clear over 5000 feet of the River Raisin in the following five areas:

1. North of Laberdee Road - primarily on the Benny Hyder property.

2. North and South of Academy Road bridge. North side owned by Charles Yessian and South side owned by Duane Roesch.

3. East and West from Crockett highway bridge on property owned by Sheldons and the Lenawee County Road Commission.

4. Deerfield area where some hand work was performed in the Village and a dragline used on property owned by George Kohl and the Gilson family.

5. Blissfield Township on property owned by Harry Brown - off Seager Road.

If not for this effort by the RRWC, recreational opportunities would be lost.

4. DEFINITION OF THE PROBLEM

4.1 IMPAIRED USES AND SPECIFIC CONCERNS

The objective of this Remedial Action is to restore the impaired use of the River Raisin Area of Concern. Therefore, it is critical to identify the impairment that is or has occurred. The International Joint Commission identified the River Raisin as an Area of Concern because of the presence of toxic organics and inorganics, contaminated sediments and a fish consumption advisory. Given that the major impaired use in the Area of Concern is the fish consumption advisory, and that this is a consequence of water and sediment PCB contamination, the primary objective of this Remedial Action Plan is to address the PCB contamination of water, sediments and biota. The Remedial Action Plan's secondary objective is to point out the need for erosion control in the external area.

4.1.1 Eutrophication/Impacts on Biota

Water quality of the River Raisin during the 1960s and 1970s was considered generally poor. River mouth data collected between August 1976 and February 1977 showed uniformly tolerable (0.5 to 4.2 mg/l) BOD levels; however, the turbidity and total phosphorus was consistently high These characteristics are indicative of highly eutrophic conditions (SEMCOG 1978).

A study conducted by the USCOE showed that the during wet weather events total phosphorus concentrations consistently exceeded 0.1 mg/l and sedimentation rates increased (SEMCOG 1978). The report indicated that the source of high phosphorus and sediment loadings appeared to be related to runoff from agriculture rather than municipal or industrial discharges. Sedimentation from this source has reportedly harmed both the benthos and fish in the River Raisin. Progress in the area of erosion control has been very slow in coming.

4.1.2 Fish Consumption and Consumption Advisory

In 1979, the Michigan Department of Natural Resources examined fish from the River Raisin and found Arochlor 1254 in concentrations up to 6.45 mg/kg in northern pike (wet weight) and up to 3.08 mg/kg in carp (wet weight). A preliminary data report on PCBs in Great Lakes fish in 1979 reported PCB concentrations in a carp (77.2 mg/kg), a 3-year-old northern pike (10.8 mg/kg), a 1-year-old northern pike (8.1 mg/kg), and a gizzard shad (4.6 mg/kg) taken from the River Raisin (Bowden 1981). Final analyses of the samples revealed a PCB concentration of 111.69 mg/kg in the carp, comprised of Arochlor 1242 (76.6 mg/kg), Arochlor 1248 (27.4 mg/kg), and Arochlor 1254 (7.74 mg/kg) (Table 8).

Table 8. Concentrations of PCBs in Fish Collected from the River Raisin from 1971 to 1984.

Species	PCB Range (mg/kg)	Year
Northern pike	6.45	1971
Carp	3.08	1971
Carp	111.69	1979
Northern pike	8.1 - 10.8	1979
Gizzard shad	0.0056 - 2.9	1983 - 1984
Carp (whole fish)	1.7 - 100.0	1983 - 1984
Carp (fillet)	0.21 - 15.0	1983 - 1984
Mirror carp	26.0	1983 - 1984
Rock bass	0.10	1983 - 1984
Smallmouth bass	0.22 - 3.4	1983 - 1984
Largemouth bass	0.19	1983 - 1984
Emerald shiner	0.48 - 3.7	1983 - 1984

During 1983 and 1984, the USEPA Large Lakes Research Station (LLRS) analyzed seven species of fish collected from the River Raisin in the vicinity of the Turning Basin for PCB body burdens (USEPA 1987). Carp exhibited the greatest total PCB concentrations, with values ranging from 0.21 to 100.0 mg/kg (Table 9). The FDA action level of 2 mg/kg were exceeded in twenty-five of 31 carp samples. Concentrations of PCBs in young-of-the-year emerald shiners were relatively high, ranging from 0.48 to 3.7 mg/kg. The FDA action level was exceeded in five of seven emerald shiners. In addition, the action level was exceeded in one of eight smallmouth bass (3.4 mg/kg), three of eleven larval gizzard shad (2.5, 2.7, and 2.9 mg/kg), and one mirror carp (26.0 mg/kg). Relatively low PCB concentrations were exhibited in single samples of rock bass and largemouth bass. The results of the analysis suggested that concentrations of PCBs in such bottom feeders as the common carp were probably the result of direct sediment exposure and a benthic-based food chain.

During 1978, four carp were collected from the River Raisin AOC as part of a U.S. EPA Region V study. The carp were analyzed as a four whole-fish composite sample and reported to contain 14.6 ppm total PCB (Table 10). Based upon these findings, the Michigan Department of Public Health (MDPH) established a fish consumption advisory for all species in 1982. This was a precautionary action until additional data could be obtained. In 1984, carp, smallmouth bass, largemouth bass and rock bass were collected and analyzed. PCB levels exceeded the FDA action level of 2 mg/kg (ppm) only in the carp, other fish sampled contained low levels of PCBs (Table 10). Based on this data, the 1985 consumption advisory was amended to apply only to carp.

The Public Health Fish Consumption Advisory for 1987 placed carp from the River Raisin below Dam No. 6 at Winchester bridge in the "No Consumption" category due to their body burden levels of PCBs. In general, nursing mothers, pregnant mothers, women who expect to bear children and children under the age 15 are also advised not to eat fish from any area that has known PCB contamination such as the Area of Concern. All of the advisories on the River Raisin are based on PCB contamination of fish. This will be the major focus of this Remedial Action Plan.

Two composite samples of boneless, skinless fillets from seven carp (18 to 24 inches in length) collected from the lagoons adjacent (Port of Monroe Landfill) to Plum Creek in October 1976 revealed Arochlor 1254 in concentrations of 0.73 and 2.5 mg/kg (Evans 1976). The FDA action level for human consumption in 1976 was 5.0 mg/kg which was not exceeded (1987 FDA action level is 2.0 mg/kg). However, there was concern over the thousands of aquatic birds (mostly terns) that frequent the Plum Creek area which might be contaminated.

4.1.3 Acute Toxicity Impacts on Aquatic Life

The Michigan Department of Natural Resources has conducted (July 12-16, 1983) an acute toxicity bioassay on the Monroe WWTP's final effluent using adult fathead minnows. The results of this test indicate that the chlorinated effluent had a 96 hour LC_{50} of 13 percent effluent and the

TABLE 9 PCBs in River Raisin Fish (1983-1984) (Source: IJC and USEPA 1985)

SPECIES	STATION	DATE	NO. IN SAMPLE	SEX	WEIGHT (g)	LENGTH (mm)	SAMPLE TYPE (FI or WH)	% LIPID	TOTAL PCB (mg/kg)
Larval Gizzard Shad	4	830714		N/A	N/A	N/A	WH (Composite)	.32	.056
	5	830714		N/A	N/A	N/A	WH (Composite)	1.05	.44
	7	830818		N/A	N/A	N/A	WH (Composite)	.47	.40
	4	830901		N/A	N/A	N/A	WH (Composite)	.11	.91
	4	830721		N/A	N/A	N/A	WH (Composite)	1.10	2.9
	5	830818		N/A	N/A	N/A	WH (Composite)	1.12	1.1
	4	840628		N/A	N/A	N/A	WH (Composite)	.60	.91
	4	840621		N/A	N/A	N/A	WH (Composite)	.68	.26
	4	840621		N/A	N/A	N/A	WH (Composite)	1.35	.44
	4	840712		N/A	N/A	N/A	WH (Composite)	1.87	2.7
	4	840718		N/A	N/A	N/A	WH (Composite)	1.82	2.5
Carp	4	830422	1	M	1233.76	446	WH	19.45	29.
	4	830422	1	M	916.25	401	WH	7.70	38.
	4	830422	1	M	997.90	421	WH	1.77	100.
	4	830422	1	M	861.82	398	WH	5.48	3.9
	4	830422	1	M	802.85	397	WH	7.07	5.8
	4	830422	1	M	707.60	357	WH	16.73	25.0
	4	840627	1	F	222.26	238	FI	.26	.21
	4	840627	1	M	1496.85	489	FI	3.82	4.7
	4	840627	1	M	503.48	330	FI	1.50	2.0
	4	840627	1	F	1424.27	456	FI	5.16	7.4
	4	840627	1	M	997.90	437	FI	6.13	15.0
	4	840627	1	F	1056.86	413	FI	7.02	14.0
	4	840627	1	M	290.30	272	FI	.74	.87
	4	840627	1	M	2376.81	542	FI	4.6	8.5
	4	840627	1	M	1914.16	505	FI	3.50	7.1
	4	840627	1	M	1442.42	466	WH	4.32	4.3
	4	840627	1	F	2050.23	536	WH	6.25	13.0
	4	840627	1	F	2594.53	500	WH	17.18	9.9
	4	840627	1	F	1165.73	440	WH	3.79	2.6
	4	840627	1	M	1265.52	455	WH	9.94	8.3
	3	830315	1	F	811.93	414	WH	1.65	5.8
	3	830315	1	F	979.75	419	WH	8.91	18.0

WH = whole body samples

TABLE 9 PCBs in River Raisin Fish (1983-1984) (Source: IJC and USEPA 1985)(Continued)

SPECIES	STATION	DATE	NO. IN SAMPLE	SEX	WEIGHT (g)	LENGTH (mm)	SAMPLE TYPE (FI or WH)	% LIPID	TOTAL PCB (mg/kg)
Carp (Cont'd)	3	830315	1	F	1065.94	450	WH	10.70	3.3
	3	830315	1	F	929.86	399	WH	20.05	26.0
	4	840627	1	F	830.07	380	WH	5.53	6.0
	4	840627	1	M	299.37	294	WH	.77	2.0
	4	840627	1	F	235.87	250	WH	5.72	4.6
	4	840627	1	F	226.79	266	WH	4.32	1.7
	4	840627	1	M	2154.55	534	FI	1.38	4.5
	4	840627	1	F	435.45	306	FI	1.49	1.2
	4	840627	10	M	884.50	370	WH (Composite)	10.49	20.0
				F	834.61	368			
				M	1524.06	490			
				F	1596.64	460			
				F	997.90	420			
				M	1115.83	425			
				F	870.89	385			
				M	734.82	374			
				M	693.99	345			
				M	802.85	405			
Mirror Carp	4	840627	1	M	1891.47	478	WH	21.22	26.0
Rock Bass	4	840627	1	M	113.40	174	FI	.04	.10
Small Mouth Bass	4	840627	1	F	108.86	210	FI	.25	.48
	4	840627	1	M	217.72	241	FI	.32	.57
	4	840627	1	F	108.86	200	FI	.20	.40
	4	840627	1	M	213.19	255	FI	.12	.34
	4	840627	1	F	145.15	230	FI	.21	3.4
	4	840627	1	F	199.58	242	FI	.46	.26
	4	840627	1	M	172.36	225	FI	.24	.22
	4	840627	1	M	154.22	222	FI	.26	.49
Large Mouth Bass	4	840627	1	F	99.79	183	FI	.20	.19

TABLE 9 PCBs in River Raisin Fish (1983-1984) (Source: IJC and USEPA 1985)(Continued)

SPECIES	STATION	DATE	NO. IN SAMPLE	SEX	WEIGHT (g)	LENGTH (mm)	SAMPLE TYPE (FI or WH)	% LIPID	TOTAL PCB (mg/kg)
Young-of-Year Emerald Shiner	4	840817	9	N/A	N/A	N/A	WH (Composite)	1.45	1.7
	1	840906	10	N/A	N/A	N/A	WH (Composite)	3.60	.71
	1	840906	10	N/A	N/A	N/A	WH (Composite)	3.02	.79
	4	840906	10	N/A	N/A	N/A	WH (Composite)	3.08	2.8
	4	840904	10	N/A	N/A	N/A	WH (Composite)	3.13	2.9
	45	840906	10	N/A	N/A	N/A	WH (Composite)	2.17	2.4
	45	840906	10	N/A	N/A	N/A	WH (Composite)	2.58	3.7
	45	840817	10	N/A	N/A	N/A	WH (Composite)	1.84	3.4
	1	840906	10	N/A	N/A	N/A	WH (Composite)	2.30	.48

Table 10. Raisin River Fish PCB Analysis, 1978.

Sample Number	Species	Sex	Length (mm)	Weight (g)	% Lipid	Total PCB (ppm)
13	Carp	M	542	2373	4.60	9.3
14	Carp	M	505	1911	3.51	6.6
15	Carp	M	534	2151	1.38	4.1
16	Carp	F	306	434	1.49	0.95
17	Carp	F	238	221	0.28	0.22
18	Carp	M	469	1494	3.82	6.1
19	Carp	M	330	502	1.50	1.6
20	Carp	F	455	1422	5.16	8.6
21	Carp	M	437	996	6.13	15.0
22	Carp	F	413	1055	7.02	16.0
23	Carp	M	272	289	0.47	1.1
24	Smallmouth Bass	M	241	217	0.32	0.64
25	Rock Bass	M	174	113	0.04	0.2
26	Smallmouth Bass*	-	-	-	-	-
27	Smallmouth Bass	M	255	212	0.12	0.53
28	Smallmouth Bass	F	230	144	0.21	6.3
29	Smallmouth Bass	F	242	199	0.46	0.4
30	Smallmouth Bass	M	225	172	0.24	0.39
31	Smallmouth Bass	M	222	154	0.26	0.69
32	Largemouth Bass	F	183	99	0.20	0.26
33	Smallmouth Bass	F	210	108	0.25	0.38
34	Smallmouth Bass	F	200	108	0.20	0.28

*Sample lost during extraction

Analysis conducted by U.S. EPA, Large Lakes Research Station and Cranbrook Institute of Science.

dechlorinated effluent caused no mortality. The report concluded that chlorine appeared to be responsible for the acute toxicity.

Acute Toxicity evaluation of the effluent discharged by the Ford Motor Company to the River Raisin through outfall 580288 (002) was conducted January 19-22, 1984 by the MDNR as part of the compliance monitoring activities of Surface Water Quality division. The effluent was determined to be acutely toxic to Daphnia magna in a 72-hour static test. Test results indicate that the 72-hour EC_{50} was 16.9 percent effluent. The report concluded that elevated levels of oil and grease appeared to be the primary cause for the observed immobilization.

4.1.4 Chronic Toxicity Impacts on Aquatic Life

The chronic toxic effects of the Area of Concern water quality on fathead minnow larvae were examined by Dolan et al. (1985). During a seven-day early life stage growth test for fathead minnows, the percent survival ranged between 100 percent in the Lake Erie control to 12.5 percent near the Monroe WWTP. Stations immediately downstream of the plant all showed low survival and no growth when compared to stations located opposite the plant along the north bank. Dolan et al. (1985) indicated that the effects on fathead minnows appeared to follow the gradient of the effluent plume.

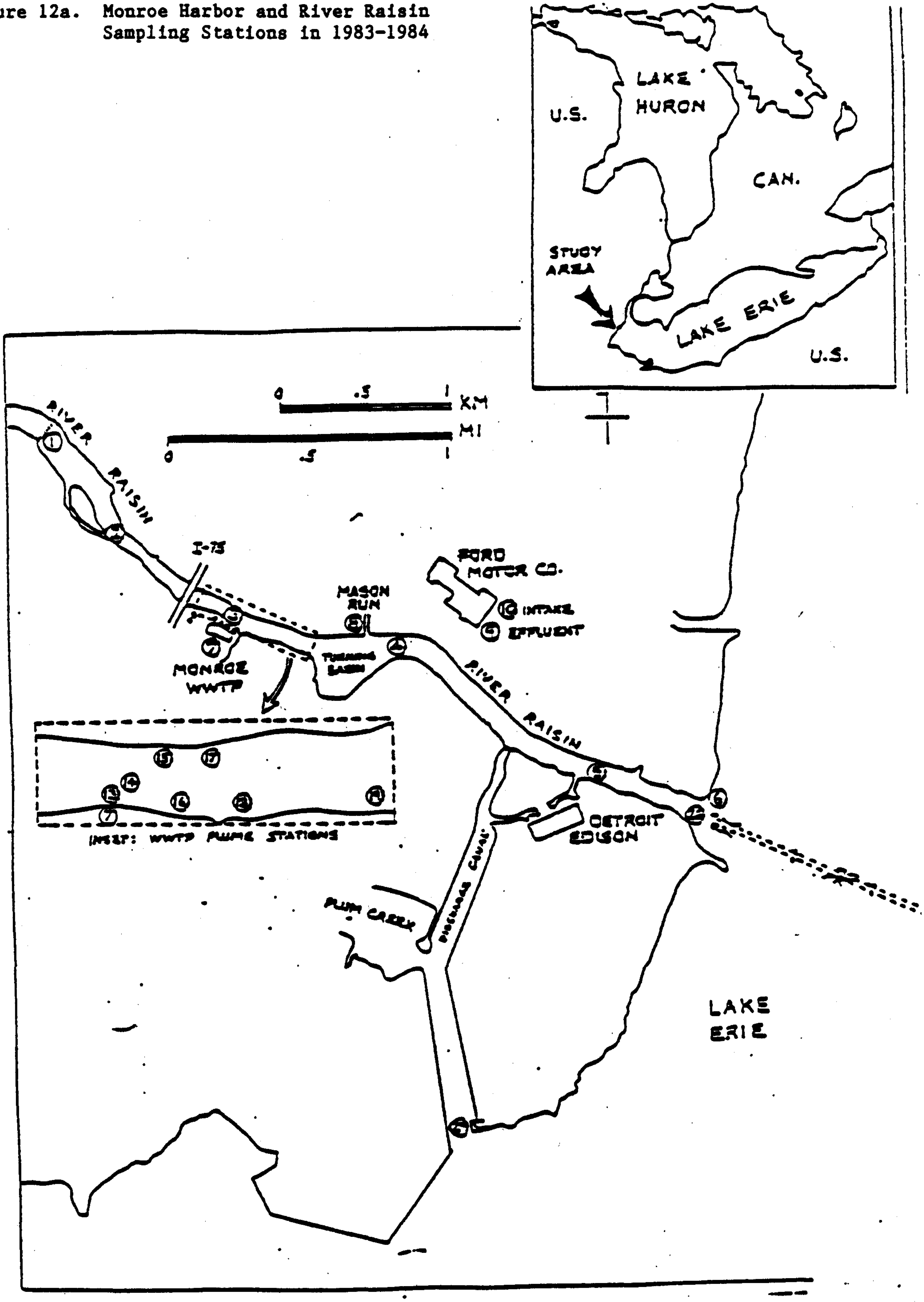
Chronic toxicity was also examined as part of the River Raisin-Monroe Harbor study performed during 1983 and 1984. The Large Lakes Research Station (LLRS) Monroe Harbor team conducted a series of phytoplankton and zooplankton functional impairment assays and surveys of larval fish size distribution were performed for various locations in the river and nearshore Lake Erie (DiToro et al. 1985a). The sampling station locations are illustrated in Figure 12a. The assays included a primary ecosystem function assay that measured the rate of phytoplankton photosynthesis, a secondary ecosystem function assay that measured the grazing rate of zooplankton, and a contaminant impaired reproduction bioassay that measured the reproductive fitness of zooplankton (Ceriodaphnia sp.).

The results of the primary system function assay indicated that no consistent spatial trend was evident in the river. With regard to the point source discharges, only the Monroe WWTP exhibited a consistent effect relative to the control. Photosynthesis was inhibited at that station at all times and at all dilutions.

In spite of indications that toxic constituents were present in the River Raisin plume entering Lake Erie, the secondary system function assay revealed no obvious dramatic spatial trend in the lake plume surveys conducted in 1984. However, with regard to the river plume survey, the lowest grazing rates were reported at stations just below the Monroe WWTP. Effluent from the plant tended to lower grazing for all but one sampling date, thus suggesting that the plant a source of the toxicity. Some inhibition of grazing was also evident at Mason Run, but the results with the Ford Company effluent were similar to the controls.

The contaminant impaired reproduction bioassays performed during September 1983 indicated depressed rates in Mason Run, whereas the rates

Figure 12a. Monroe Harbor and River Raisin Sampling Stations in 1983-1984



at the Monroe WWTP and Ford Company were similar to the control. During the October survey population growth and net reproduction rates were depressed relative to the control in all samples from the river.

The results of the fish larvae size distribution surveys suggested inhibition of growth stage 4 larvae lakeward. Although the data for larval fish density were widely scattered, no significant differences existed between stations, thus suggesting that species diversity was not being impacted by the point source discharges. Comparisons between gizzard shad and emerald shiner did not reveal any patterns that would suggest a toxic effect.

Comparison of the estimates of the EC_{50} from the various types of studies was facilitated by expressing the values as toxic units. After this conversion, the data were fit to a dose response function. This allowed the bioassay results to be examined with respect to the chemical data reported for the River Raisin and nearshore Lake Erie.

Analysis of the results from the July and September 1983 samples indicated that a significant concentration of primary production toxicity was entering the River Raisin upstream of Station 1 (Figure 13) and appeared to decrease slightly in the downstream direction. There did not appear to be any noticeable impact from loadings from the Monroe WWTP, Mason Run, or the Ford Company.

The zooplankton reproduction toxicity increased dramatically at the stations near the Monroe WWTP effluent, but was low at the at far shore stations. The distribution of grazing toxicity was essentially constant throughout the river, but the highest concentrations were found at the upstream boundary. During the plume survey performed in April 1984, the distribution of grazing and reproduction toxicities were surprisingly high and appeared to be flat as a function of distance along the plume axis. The grazing toxicity for the May 1984 survey was again constant with respect to position along the plume axis, but the reproduction toxicity appeared to increase from one side of the plume to the other. Comparison of the results with the point source discharges into the River Raisin revealed that the Monroe WWTP discharge had the greatest impact on the reproduction success of Ceriodaphnia sp. (in terms of mean brood/female and mean young/adult), whereas that the Ford Company effluent had the greatest mortality impact.

Regression analysis was employed to evaluate the relationship of toxicity to chemical concentrations in the samples. A definite correlation appeared to exist between copper and zinc concentrations (corrected for hardness) and zooplankton grazing EC_{50}. Although the data were somewhat scattered, there was an apparent trend between increasing copper reproduction toxicity and decreasing Ceriodaphnia fecundity. The trend was less clear, however, for zinc net reproduction toxicity.

Comparisons were made between the spatial distribution of larval emerald shiners and gizzard shad, Ceriodaphnia fecundity toxicity, and net reproduction copper and zinc toxicity. Copper and zinc toxicity were both found to increase from approximately one toxic unit at the upstream Station 1 to between two and three toxic units at the downstream stations of the River Raisin. The incremental increase in Ceriodaphnia fecundity toxicity, emerald shiner toxicity, and gizzard shad toxicity was approximately one toxic unit for each category, thereby corresponding reasonably well with the increase in heavy metal toxicity. The study concluded that zooplankton functions and larval fish growth are adversely affected by heavy metal toxicity in the River Raisin, and that the impact is intensified by the decreasing hardness encountered in the downstream reach of the river.

Although the study identified residual chlorine, un-ionized ammonia, pesticides, PCBs, and heavy metals (Cu, Zn, and Cr) as the major classes of potential toxicants for which simultaneous data were available, correlations were made only for copper and zinc.

4.1.5 Physical Impacts on Aquatic Life

Biotic impairment is not limited to the municipal and industrial loadings of toxic substances into the River Raisin Area of Concern. Significant impacts to the biotic community of the Area of Concern have been attributed to entrainment of planktonic organisms (including larval forms of such representative fish species as yellow perch, freshwater drum, white bass, white perch, and channel catfish) and impingement of fish larger than 3 inches in length against the intake screens of the Detroit Edison Company (DECO) Monroe Power Plant. A 316(b) demonstration indicated that approximately 21.4 million fish larvae (including about 5 million yellow perch) were entrained at the Monroe Plant during 1976. More extensive subsequent sampling (in 1978) showed an average annual range of 58 million (based on pump samples) to 352 million (based on net samples) entrained larvae at this intake. A study performed by the Great Lakes Research Division regarding the impact of the Detroit Edison's Monroe Electric Generating Facility on the fishery found that , 4.7 billion larval fish were entrained at the plant in a one-year period, from February 1982 to Feburary 1983 (Doyle 1984).

An independent review of the Monroe Plant 316(b) demonstration revealed that the total number of fish impinged was significantly underestimated. The corrected impingement value was reported to be 4.7 million total fish, including 626,000 yellow perch.

Although DECO installed a fish pump at the Monroe Plant after the demonstration, the Company-sponsored study to evaluate the effectiveness of the system reported that only about 49 percent of the fish that enter the intake are saved by the fish pump. MDNR estimated that even with the fish pump in operation, the total number of fish impinged during 1976 ranged from 430,000 to 2.35 million, with yellow perch expected to range from 61,000 to 313,000.

The estimated number of fish impinged at the Monroe Plant during the one-year period from February 1982 to Feburary 1983 was 31 million, having a total weight of 1,364,000 pounds (Doyle 1983).

4.1.6 Toxic Impacts on Human Health (Drinking Water)

Ten residential wells that utilize the underlying bedrock water table aquifer for their drinking water are located near Dunbar Road on the south side of Plum Creek. This aquifer extends throughout the lower Area of Concern and provides an active hydrologic connection between the surface water and groundwater. It is possible that the source of both the inorganic and organic contaminants measured in the aquifer (including PCBs) is the result of the extensive (though now inactive) landfilling activities between the River Raisin and Plum Creek.

4.1.7 Impacts to Navigation

Navigation is impacted by the inputs from erosion of agricultural land in the external area. The current solution to this problem is sediment removal by dredging of the shipping channel by the Army Corps of Engineers. However, the Washtenaw County and Lenawee County Soil Conservation District have received grants from the Michigan Clean Water Incentives Program to investigate the feasibility of stopping agricultural soil loss at the source. The Wolf Creek study will 1) characterize the type and extent of pollutants that are being deposited from agricultural non-point sources and 2) assess the agronomic, economic and water quality impacts of Best Management Practices (BMP) such as tillage systems, vegetative buffers, crop rotations, fertilizer management systems, pesticide application, integrated pest management, contour farming, cover crop usage and land use conversion. Once determination and implementation of BMP are in-place, researchers expect a 53% reduction in sediment deposition and a 48% reduction in phosphorus deposition into Lake Adrian. The entire River Raisin basin will benefit from changes in agricultural practices, resulting in higher water quality. It is the hopes of these researchers that the establishment of data bases from this work will be applicable throughout the River Raisin watershed.

4.2 MAJOR POLLUTANTS OF CONCERN

Identified pollutants of concern in the Area of Concern is total residual chlorine, copper, zinc, chromium and PCBs. This section will discuss the contamination of water, sediments, and biota in the Area of Concern.

4.2.1 Water Quality Contamination

In the 1960s and 1970s, water quality of the River Raisin was considered generally poor due to nutrient enrichment and low dissolved oxygen (MDNR 1979a). Although water quality has improved, violations of water quality objectives still occur. Violations have occurred for pH, conductivity, iron, and nickel in the Area of Concern. Infrequent violations have also occurred in the part for dissolved oxygen, copper, zinc, and mercury (USEPA 1984a; GLWQB 1983b, 1984).

Chemical and Physical Parameters

Water quality data for the Area of Concern were collected from 1983 to 1984 by U.S. EPA Large Lakes Research Station. PCBs comprised the dominant group of organochlorine substances in Monroe Harbor, with average water column concentrations ranging from 0.0085 ug/l at the upstream boundary to 0.23 ug/l at the mouth of Mason Run in the Turning Basin (Table 11). The mean concentration at the Lake Erie sampling station was 0.029 ug/l, markedly higher than the River Raisin AOC upstream boundary. Average PCB concentrations in the vicinity of the Monroe WWTP were 0.18 ug/l. PCB concentrations were dominated by monochlorobiphenyls at the upstream boundary, but were relatively enriched in tri- and tetrachlorobiphenyls just downstream of the Monroe WWTP and Turning Basin (Figure 13).

As a fraction of the total metals concentrations, the dissolved metals portion averaged 38 percent for copper, 34 percent for zinc, and 34 percent for chromium (Table 12). USEPA (1987) reported that these metals appeared to be associated largely with suspended solids in the water column or in effluents. Mean concentrations of metals increased by approximately 50 percent from the upstream boundary (Station 1) of the AOC to within and below the Turning Basin (Stations 4, 5, and 26) (Table 9). Lake Erie stations (6, 11, and 25), on the other hand, exhibited concentrations similar to those of the upstream boundary. The study concluded that the metal contaminants appeared to exit the River Raisin mainly through the Monroe Power Plant discharge canal (Station 29).

The highest mean concentrations of copper (37.5 ug/l), zinc (61.3 ug/l), and chromium (24.8 ug/l) were measured in the Ford Company effluent (Station 12). The concentrations of heavy metals at this station were approximately one order of magnitude higher than at the upstream boundary. High concentrations of zinc (41.0 ug/l) were also seen in the Monroe WWTP effluent.

The spatial distributions of total, free, and combined residual chlorine were examined by the EPA/LLRS team from July to October 1983 (Di Toro et al. 1985a). During September and October, the total and free chlorine residual was consistently less than 0.05 mg/l. In the July survey the average total residual chlorine ranged from 0.2 to 1.5 mg/l in the River Raisin. These values all exceed the chronic toxicity criterion of 0.011 mg/l. The maximum total for chlorine residual occurred at the most upstream station indicating that the primary source is likely upstream of the study area. The USEPA total residual chlorine acute toxicity criteria is 0.019 mg/l. However, the measured levels of chlorine in the Area of Concern warrant further investigation as all values exceeded the acute and chronic toxicity criteria for aquatic life by at least one order of magnitude.

Analysis of water collected in the Monroe Harbor before and during the turning of a freighter in the Turning Basin revealed short-lived but substantial increases in total PCBs, total metals, and suspended sediments in the water column at the mouth of the Turning basin (Rathbun 1985). A summary of the results of the analysis is presented in Table 13. During the turning period of the freighter, total suspended solids increased 713 percent; total PCBs, 367 percent; total chromium, 2625 percent; total copper, 942 percent; and total zinc, 1027 percent (Table 13). Based on observations of total suspended solids, it was speculated that little of the resuspended particulate-bound metals were transported out of the basin. There was no observable increase in the concentrations

Table 11. Concentrations of Total PCBs (ug/l) in Monroe Harbor Water, July - September 1983

Station	Average Concentration	Range
1	0.0085	0.021 - 0.018
3	0.062	0.0042 - 0.240
4	0.180	0.0067 - 0.680
5	0.036	0.015 - 0.068
6	0.021	0.006 - 0.042
7	0.012	0.0042 - 0.027
8	0.230	0.0019 - 0.730
10	0.061	0.0022 - 0.160
11	0.029	0.003 - 0.210

Source: USEPA, 1987.

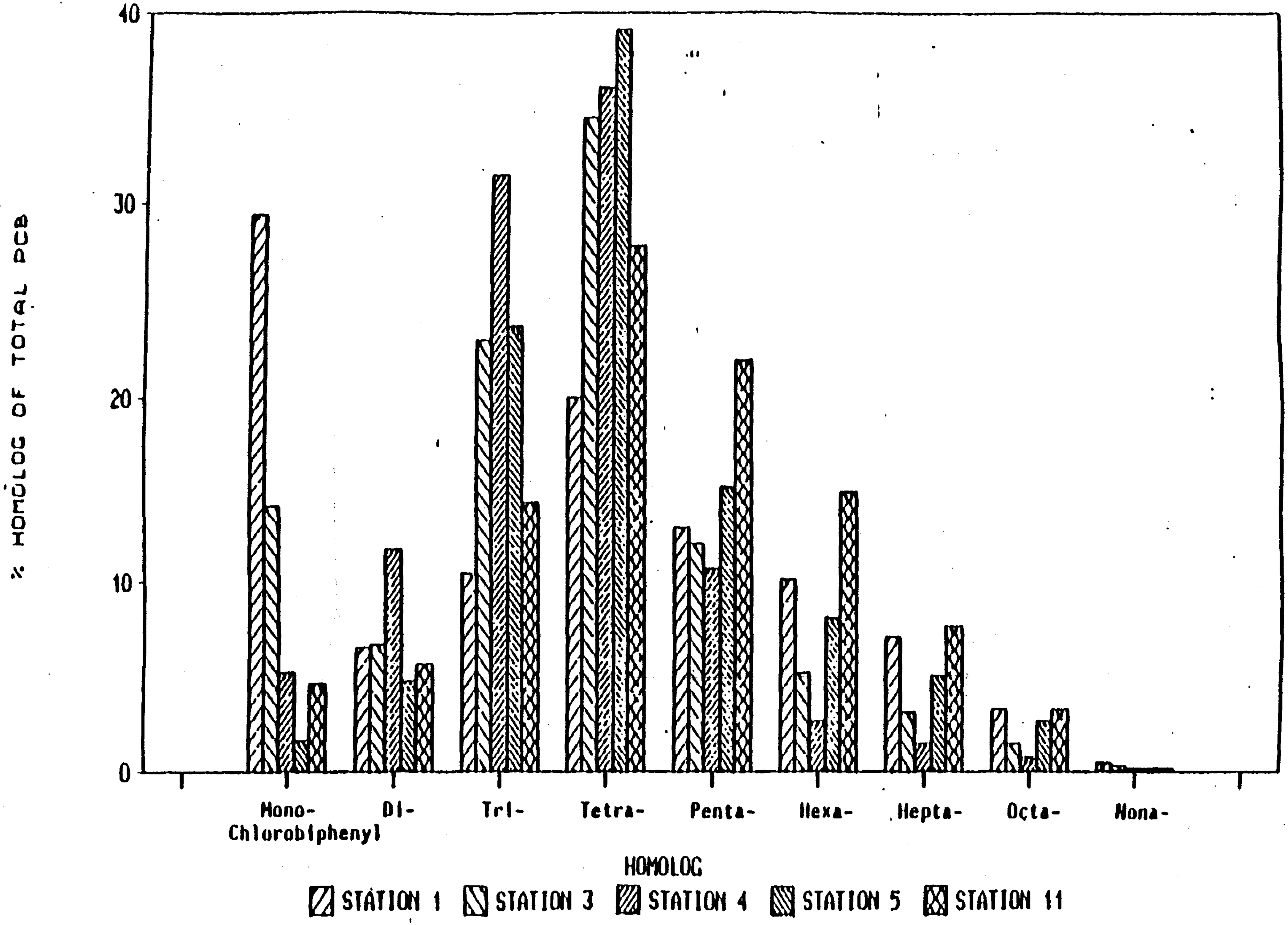


Figure 13. Monroe Harbor Water Chemistry: PCB Homolog Percent Composition at Selected Stations. (USEPA Second Draft April 1987, Summary Report An Integrated Approach)

TABLE 12 MONROE HARBOR WATER CHEMISTRY: METALLIC CONTAMINANTS

Station Number		Total Copper (ug/L)	Dissolved Copper (ug/L)	Total Zinc (ug/L)	Dissolved Zinc (ug/L)	Total Chromium (ug/L)	Dissolved Chromium (ug/L)
1	x̄ ± S.D. (Range) n	3.32 ± 1.65 (1.3 - 8.9) 26	2.25 ± 0.87 (1.4 - 5.6) 26	6.27 ± 4.64 (-2.0 - 21.0) 26	2.04 ± 1.78 (-2.0 - 5.0) 26	1.84 ± 1.27 (0.6 - 7.1) 26	0.27 ± 0.20 (0.0 - 0.8) 26
3	x̄ ± S.D. (Range) n	3.70 ± 0.78 (2.7 - 5.6) 15	1.93 ± 0.35 (1.2 - 2.4) 14	6.63 ± 6.10 (-12.0 - 15.0) 15	2.68 ± 2.83 (-3.0 - 7.0) 14	1.57 ± 0.51 (0.8 - 2.4) 15	0.20 ± 0.12 (0.1 - 0.5) 14
4	x̄ ± S.D. (Range) n	4.45 ± 1.65 (1.6 - 10.1) 77	1.96 ± 1.03 (0.9 - 5.6) 33	9.76 ± 5.38 (-5.0 - 26.0) 77	2.21 ± 2.37 (-2.0 - 7.0) 33	2.68 ± 1.49 (0.95 - 8.3) 77	(0.117 ± 0.148) (-0.1 - 0.6) 33
5	x̄ ± S.D. (Range) n	5.97 ± 2.72 (1.6 - 15.3) 35	2.29 ± 1.05 (1.0 - 5.1) 15	9.07 ± 4.83 (-2.5 - 20.0) 35	1.67 ± 2.02 (-3.0 - 4.0) 15	3.59 ± 1.97 (0.5 - 7.6) 35	0.90 ± 0.55 (0.2 - 2.2) 15
6	x̄ ± S.D. (Range) n	3.90 ± 2.02 (1.6 - 10.5) 16	1.45 ± 0.41 (0.8 - 2.3) 15	6.63 ± 5.68 (-9.0 - 14.0) 16	1.13 ± 2.10 (-3.0 - 4.0) 15	1.77 ± 1.09 (0.6 - 4.8) 16	0.17 ± 0.17 (-0.1 - 0.5) 15
7	x̄ ± S.D. (Range) n	6.04 ± 4.46 (2.0 - 21.2) 20	2.84 ± 1.77 (0.6 - 6.7) 19	41.0 ± 16.6 (22.0 - 86.0) 20	25.2 ± 7.4 (14.0 - 38.0) 19	1.47 ± 1.51 (0.2 - 6.8) 20	0.47 ± 0.33 (0.1 - 1.4) 19
8	x̄ ± S.D. (Range) n	7.57 ± 2.96 (1.4 - 14.5) 22	2.37 ± 1.17 (1.0 - 5.6) 21	11.30 ± 6.22 (-1.0 - 26.0) 27	2.07 ± 1.98 (-1.0 - 6.0) 21	3.77 ± 1.78 (1.8 - 8.3) 27	0.26 ± 0.15 (0.0 - 0.6) 21
9	x̄ ± S.D. (Range) n	37.50 ± 18.00 (18.3 - 72.2) 14	12.70 ± 4.70 (6.4 - 21.6) 15	61.30 ± 55.20 (31.0 - 251) 16	17.30 ± 5.00 (6.0 - 25.0) 15	24.80 ± 20.90 (0.00 - 60.2) 16	15.30 ± 8.90 (6.5 - 32.7) 15
10	x̄ ± S.D. (Range) n	6.42 ± 1.26 (4.3 - 8.8) 17	1.71 ± 0.58 (0.6 - 3.1) 16	11.10 ± 5.97 (5.0 - 28.0) 17	1.81 ± 2.17 (-1.0 - 6.0) 16	3.09 ± 1.47 (0.0 - 6.4) 17	0.19 ± 0.21 (0.0 - 0.8) 16
11	x̄ ± S.D. (Range) n	2.82 ± 1.45 (0.8 - 7.2) 22	2.08 ± 1.11 (0.6 - 4.3) 14	6.59 ± 5.10 (0.0 - 25.0) 22	1.36 ± 2.37 (-2.0 - 6.0) 14	1.88 ± 1.21 (0.4 - 4.7) 22	0.13 ± 0.06 (0.0 - 0.2) 14
25	x̄ ± S.D. (Range) n	3.65 ± 1.37 (2.1 - 5.4) 4	1.40 ± 0.14 (1.2 - 1.5) 4	8.25 ± 6.85 (2.0 - 16.0) 4	5.25 ± 1.26 (4.0 - 7.0) 4	2.50 ± 0.94 (1.5 - 3.6) 4	0.27 ± 0.17 (0.1 - 0.4) 4
26	x̄ ± S.D. (Range) n	4.58 ± 2.55 (1.9 - 8.2) 7	1.93 ± 0.54 (1.3 - 2.6) 7	11.00 ± 6.40 (2.0 - 22.0) 7	3.36 ± 3.57 (0.0 - 10.0) 7	2.79 ± 1.97 (0.5 - 5.7) 7	0.19 ± 0.21 (0.0 - 0.7) 7
29	x̄ ± S.D. (Range) n	11.00 ± 2.12 (8.4 - 14.1) 7	3.74 ± 0.37 (2.8 - 5.4) 7	14.90 ± 3.90 (4.0 - 33.0) 7	2.43 ± 4.31 (-1.0 - 11.0) 7	3.27 ± 1.78 (1.3 - 6.2) 7	0.30 ± 0.15 (0.1 - 0.5) 7

USEPA April 1987 Summary Report An Integrated Approach

Table 13. Summary of the Effects of Freighter Passage on Water Quality Parameters in the River Raisin

Parameter	Before Passage	After Passage	Percent Increased
TSS (mg/l)	29.4	239.0	713
Total Chromium (~~mg~~ ug/l)	1.6	43.6	2625
Total Copper (~~mg~~ ug/l)	4.0	41.7	942
Total Zinc (~~mg~~ ug/l)	11.0	124.0	1027
Total PCB (~~mg~~ ug/l)	450.0	2100.0	367

(Source: Rathbun, J.E. 1985b)

of dissolved, bioavailable forms of chromium, copper, and zinc. With regard to PCBs, dissolved forms were not quantified and, in addition, insufficient data from beyond the turning basin precluded any speculations about PCB transport from the basin.

Spatial profiles of the River Raisin AOC conventional water quality parameters were developed from an EPA July-October 1983 survey (DiToro et al. 1985a). Some of these profiles are presented in Figures 15 to 18.

Secchi depth and suspended solids profiles for the 1983 surveys are provided in Figure 16. Secchi depths in the River Raisin were consistently less than 1 meter and typically between 0.3 and 0.6 meters. In July, the Lake Erie secchi depth was considerably greater than that of the River Raisin. The suspended solids concentrations in Lake Erie were comparable to those observed in the River Raisin. Suspended solids concentrations in the River Raisin were fairly constant and typically ranged between 15 and 30 mg/l.

Specific conductance (Figure 17) was found to be significantly greater in the River Raisin than in Lake Erie. The River Raisin specific conductance levels ranged between 200 and 250 umhos. A specific conductance gradient is present between RM 2 and RM 0, resulting from the mixing of Lake Erie and River Raisin waters.

Both pH and alkalinity profiles are presented in Figure 18. The pH during the survey ranged generally between 8 and 9 Standard Units (SU). A gradient similar to that of specific conductance exists for the alkalinity profiles. Alkalinity in the upstream River Raisin (near RM 3) ranged between 200 and 250 mg/l, whereas Lake Erie alkalinity was approximately 80 mg/l for September to October and 100 mg/l in July.

4.2.2 Sediment Quality Contamination

Sediments in the Area of Concern are heavily contaminated with such pollutants as volatile solids, heavy metals, PCB, and oil and grease (GLWQB 1984). Based on USEPA guidelines for classification of Great Lakes sediments, sediments from certain portions of the AOC are "heavily polluted" with copper (Cu), chromium (Cr), zinc (Zn), and polychlorinated biphenyls (PCBs) (IJC 1985a). Sediment samples collected downstream of the Ford Motor Company plant in 1976 showed the highest levels of chromium, copper, and zinc in the AOC, and were above the limit for "heavily polluted" conditions (Evans 1977).

Sediment samples collected from the River Raisin in April 1981 for the Detroit District U.S. Army COE revealed PCB (Arochlors 1242, 1248, and 1254) contamination from the vicinity of the Monroe WWTP to Lake Erie (Environmental Research Group, Inc. 1981). Concentrations of total PCBs ranged from 0.76 to 18.8 mg/kg with the highest concentrations at the turning basin (11.1 mg/kg) and immediately downstream of it (18.8 mg/kg).

Sediment samples collected from the River Raisin Area of Concern during 1981 revealed that the levels of Cr, Cu, Zn, Arochlor-1248, Arochlor-1254, and Arochlor-1260, increased by up to two orders of magnitude downstream from Sterling Island to the outfall of the Ford

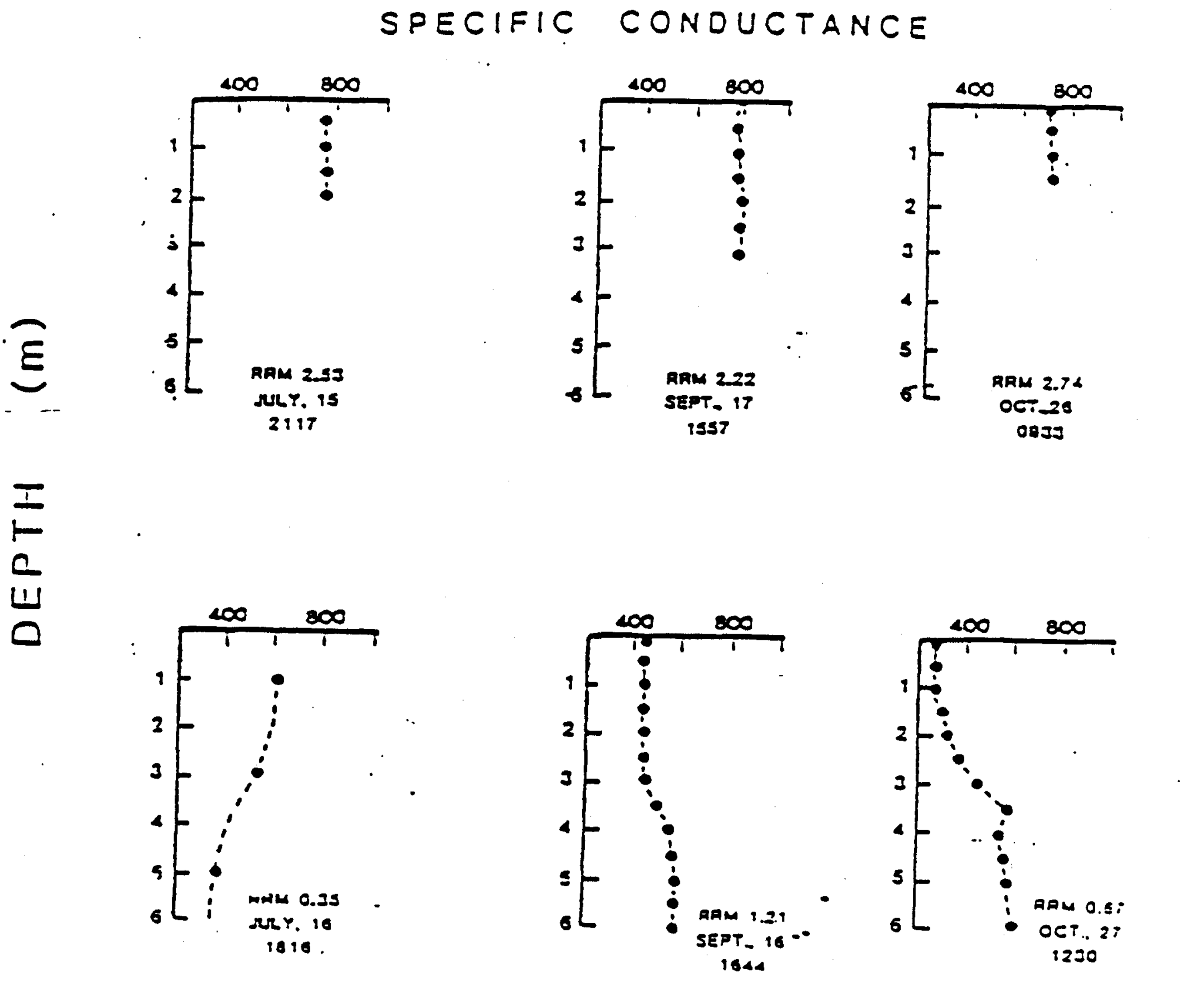


FIGURE 15 Representative Specific Conductance Profiles, Vertical Profiles of Upstream and Downstream River Raisin Stations - July, September, and October 1983 Surveys (Source: DiToro et al. 1985a)

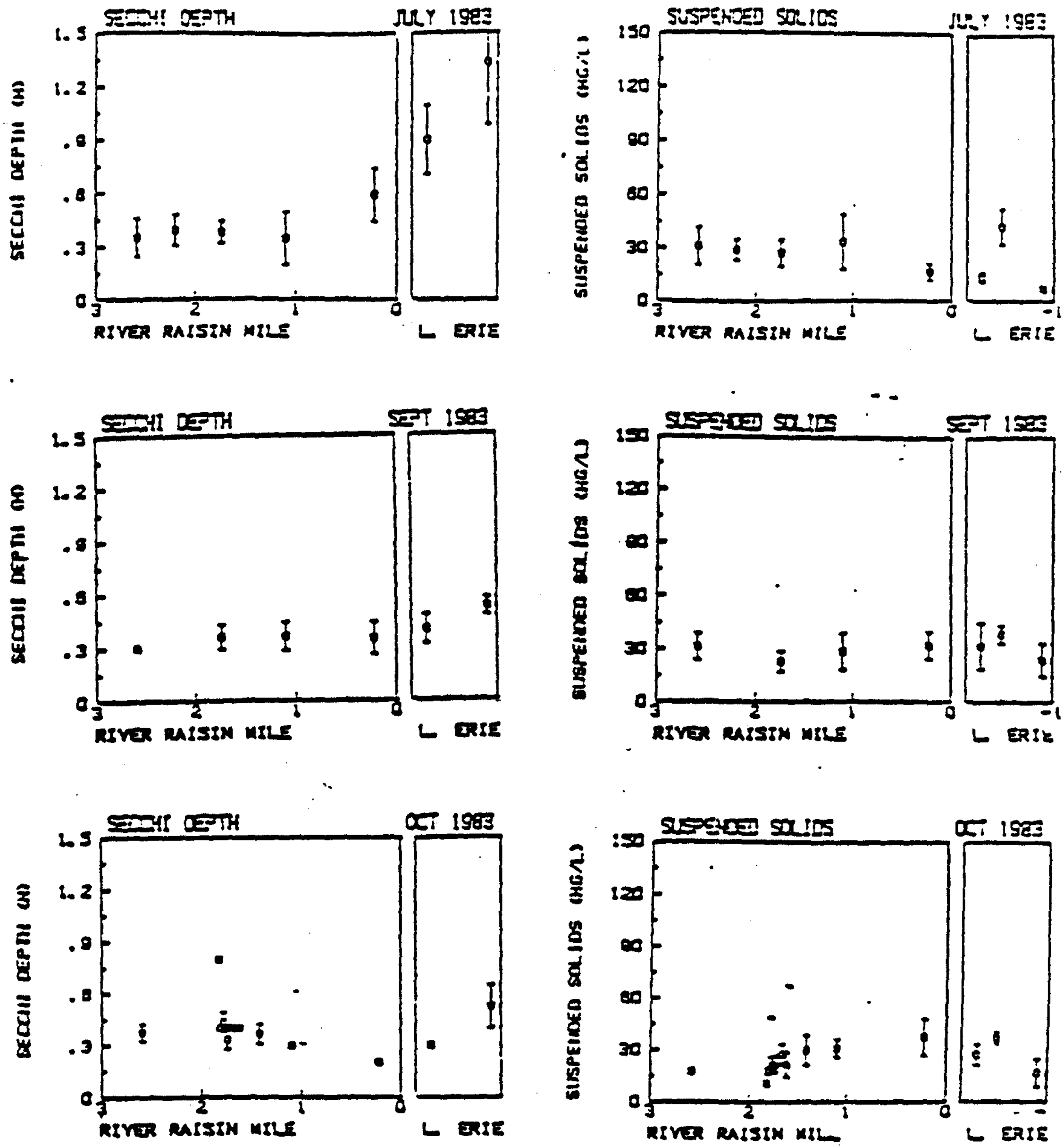


FIGURE 16 Spatial Secchi Depth and Suspended Solids Profiles for 1983 River Raisi
Surveys (Source: DiToro et al. 1985a)

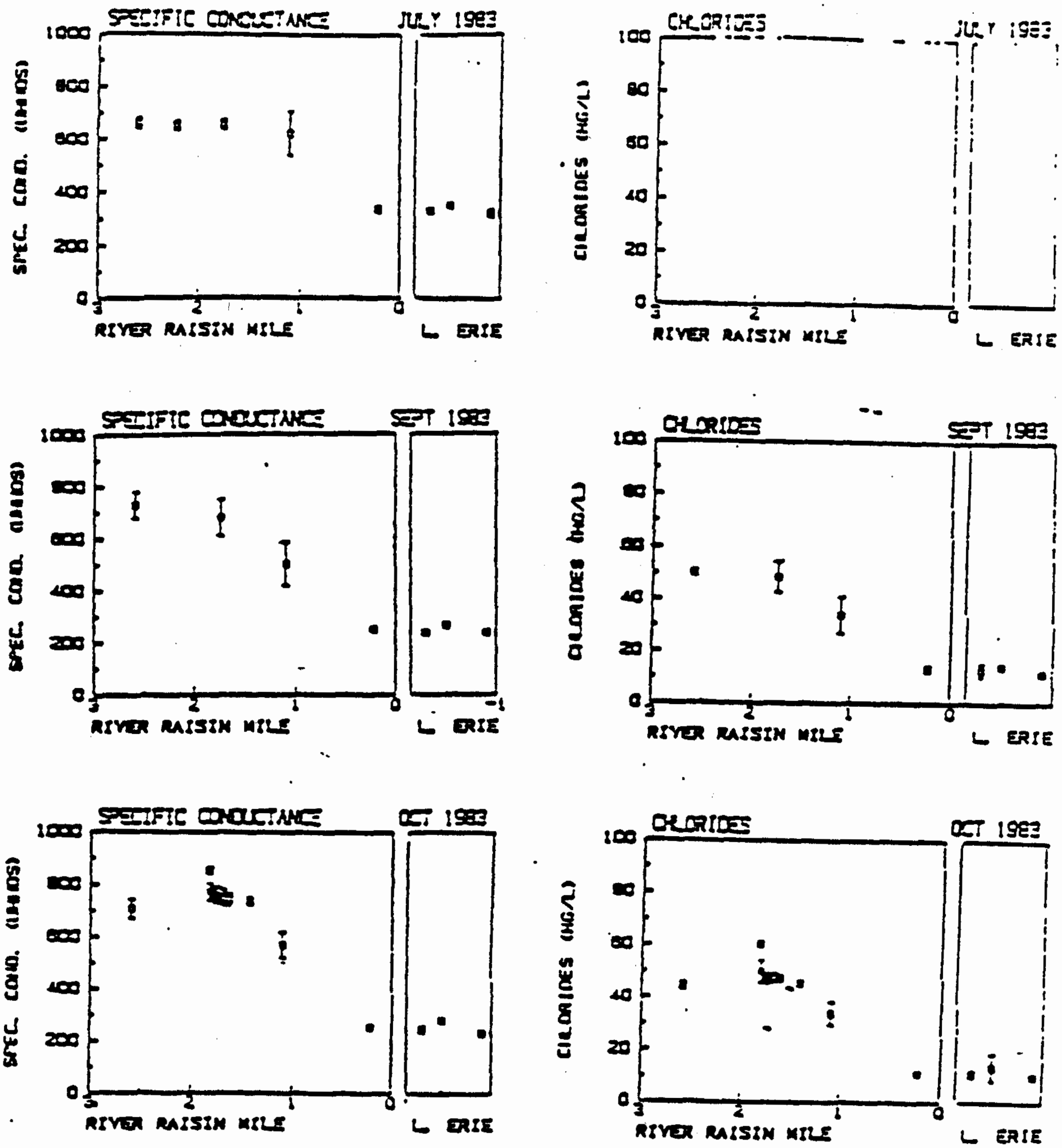


FIGURE 17 Spatial Specific Conductance and Chlorides Profiles for 1983 River Raisin Surveys (Source: DiToro et al. 1985)

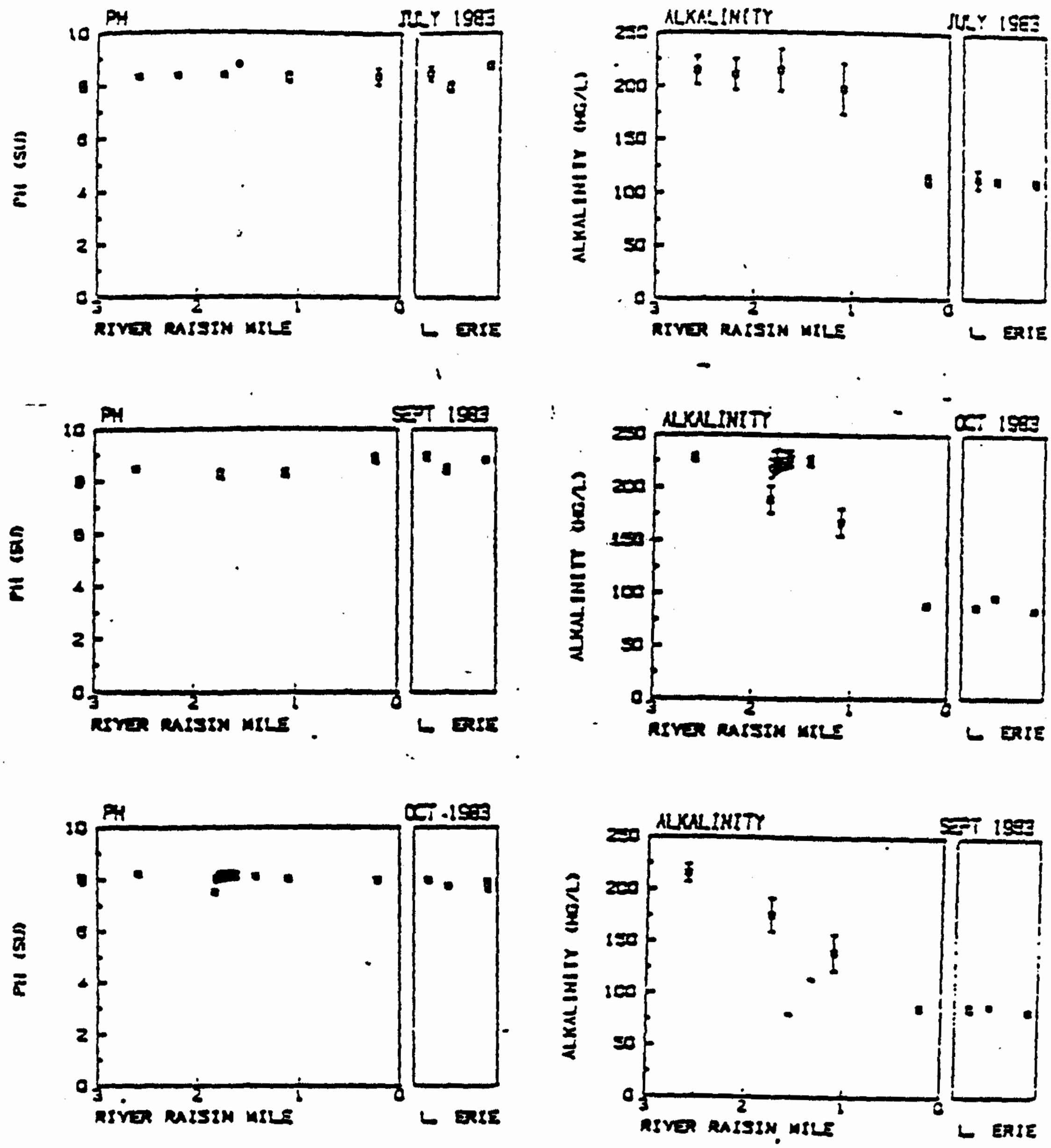


FIGURE 18. Spacial pH and Alkalinity Profiles for 1983 River Raisin Surveys (Source: DiToro et al. 1985a)

Company (Table 14). The order of magnitude differences for downstream distribution of these contaminants are similar to those realized in 1976 (Table 15) (Evans 1977).

A study of the sediments of the lower River Raisin during 1983 and 1984 (Filkins et al. 1985) reported that surficial concentrations of PCBs, the majority of which were tri- and tetrachlorinated biphenyl groups, increased in the area of the turning basin and downstream to the Detroit Edison Power Plant water intake. The maximum PCB concentration observed in 1983 was 5.1 mg/kg. Although the surficial PCB concentrations were higher in non-dredged areas of the turning basin in 1984 than the concentrations observed for the same area in 1983. It was speculated that the increase may have been the result of dredging and/or hydrologic events that have uncovered sediments exhibiting higher PCB concentrations than those removed.

4.2.3 Plum Creek

The wetlands north of Plum Creek, east and west of I-75, were licensed in 1967 to be utilized as an industrial landfill. Containment dikes, constructed in 1968 of porous material and located on pervious soils, did not provided adequate fill containment.

Four sediment samples collected from Plum Creek and two adjacent lagoons during August 1976 (Table 16) revealed that the stations contained "moderately" to "heavily polluted" concentrations of arsenic, copper, zinc, nickel, lead, and chromium (Evans 1976). The highest concentrations of heavy metals were detected in the sediments from the lagoons and Station 1 (Figure 19). Very high levels of PCBs were also detected in the lagoons and at Station 1. Later, the lagoons were found to contain Arochlor 1254. No PCBs were detected upstream at Station 4, and only Arochlor 1242 was found outside of the lagoons. Oils were also at "moderately" polluted levels in the lagoons. Contamination was attributed to wastes dumped behind the loosely constructed dikes.

4.2.4 Biota Contamination

Caged clams (*Lampsilis radiata* and *Anodonta grandis*) were suspended in the water column in the River Raisin-Monroe Harbor for 25 days during September-October 1983 (Rathbun et al. 1985). Analysis of the water quality revealed concentrations of total PCBs ranging from 0.009 mg/l upstream to 0.386 mg/l in the turning basin. Similar patterns of spatial increase were observed in *L. radiata* (0.03 mg/kg vs. 0.81 mg/kg) and *A. grandis* (0.02 mg/kg vs. 0.32 mg/kg). The total PCBs and PCB homologs accumulated by the clams after 25 days of exposure were in approximate proportion to the concentrations in the surrounding water. Downstream increases in trichloro- and tetrachloro biphenyls were observed in the water and both species of clams.

Adult fathead minnows (*Pimephales promelas*), yearling channel catfish (*Ictalurus punctatus*), and clams (*Lampsilis radiata*) were subjected to caged studies for 35 days during July and August 1984 (Rathbun *et. al.*, 1985). The study revealed that within two to four days, all of the organisms had accumulated the same PCB homolog pattern as found in the surrounding water and sediment. Although the sediments contained 10,000

Table 14. Sediment Quality for River Raisin Samples Collected April 19, 1981.

Location	Parameter					
				Arochlor		
	Cr mg/kg	Cu mg/kg	Zn mg/kg	1248 ug/kg	1254 ug/kg	1260 ug/kg
4000 Ft. Downstream of Site Sample (41°54'38"N 83°22'37"W)	18	18	52	48	39	23
S.E. of Sterling Is.	14	22	66	43	55	36
Downstream of Monroe STP at Entrance	72	66	430	249	411	169
Outfall of Ford Co. (RO Possible Ohio Power)	490	1500	1000	732	3197	1046

(Source: U.S. EPA STORET Data File)

Table 15. Sediment Quality (mg/~~l~~ Kg) for River Raisin Samples Collected August 12, 1976.

	Parameter					
				Arochlor		
Location	Cr	Cu	Zn	1242	1254	1260
Above Monroe WWTP	20	90	130	1.55	0.75	<0.5
Below Monroe WWTP (but above Ford Discharge)	15	30	58	5.22	1.86	<0.5
Below Ford Discharge	11,000	14,000	580	4.25	4.92	<0.5

(Source: Evans 1977)

Table 16 Sediment Contaminants in Plum Creek Near Monroe, Monroe County, Michigan, August 11, 1976.
All values on a dry weight basis

STATION AND LOCATION	PARAMETERS	TOTAL SOLIDS %	ARSENIC mg/kg	COPPER mg/kg	ZINC mg/kg	NICKEL mg/kg	LEAD mg/kg	MERCURY mg/kg	CADMIUM mg/kg	CHROMIUM mg/kg
STATION 1 - 200 yards east of Smith's Island		41	6.6[1]	140[2]	540[2]	94[2]	100[2]	0.39	2.2	47[1]
STATION 2 - Center of Lagoon east of Smith's Island		36	2.3	510[2]	640[2]	130[2]	100[2]	0.54	2.6	1802
STATION 3 - Center of Lagoon west of Smith's Island		34	3.8[1]	200[2]	660[2]	90[2]	230[2]	0.89	3.0	82[2]
STATION 4 - 200 yards west		46	5.0[1]	68[2]	700[2]	41[1]	100[2]	0.12	1.8	21

	PARAMETERS	ALDRIN µg/kg	DIELDRIN µg/kg	CHLORDANE µg/kg	D.D.D. µg/kg	D.D.E. µg/kg	o,p-DDT µg/kg	p,p-DDT µg/kg	H.C.B. µg/kg	H.C.B.D. µg/kg
STATION 1		<4	<4	<20	<10	<10	<10	<10	I	I
STATION 2		<4	<5	<20	<10	<10	<10	<10	I	I
STATION 3		<4	<5	<20	<10	<10	<10	<10	I	I
STATION 4		<4	<5	<20	325*	50*	27*	736*	I	I

	PARAMETERS	AROCHLOR 1242 µg/kg	AROCHLOR 1254 µg/kg	AROCHLOR 1260 µg/kg	DBP µg/kg	OIL as HEXANE EXTRACTABLES mg/kg	DEHP µg/kg
STATION 1		2100	<500	<500	<1000	800	<1000
STATION 2		5470	2520	<500	<1000	1700[1]	<1000
STATION 3		3510	2150	<500	<1000	2000[1]	<1000
STATION 4		<500	<500	<500	<1000	800	<1000

I = Interference

* Presence of o,p - DDT suggests polyethylene fragments and not DDT analogs.

[1] Moderately polluted

[2] Highly polluted. See Table 2 for EPA Interim Criteria.

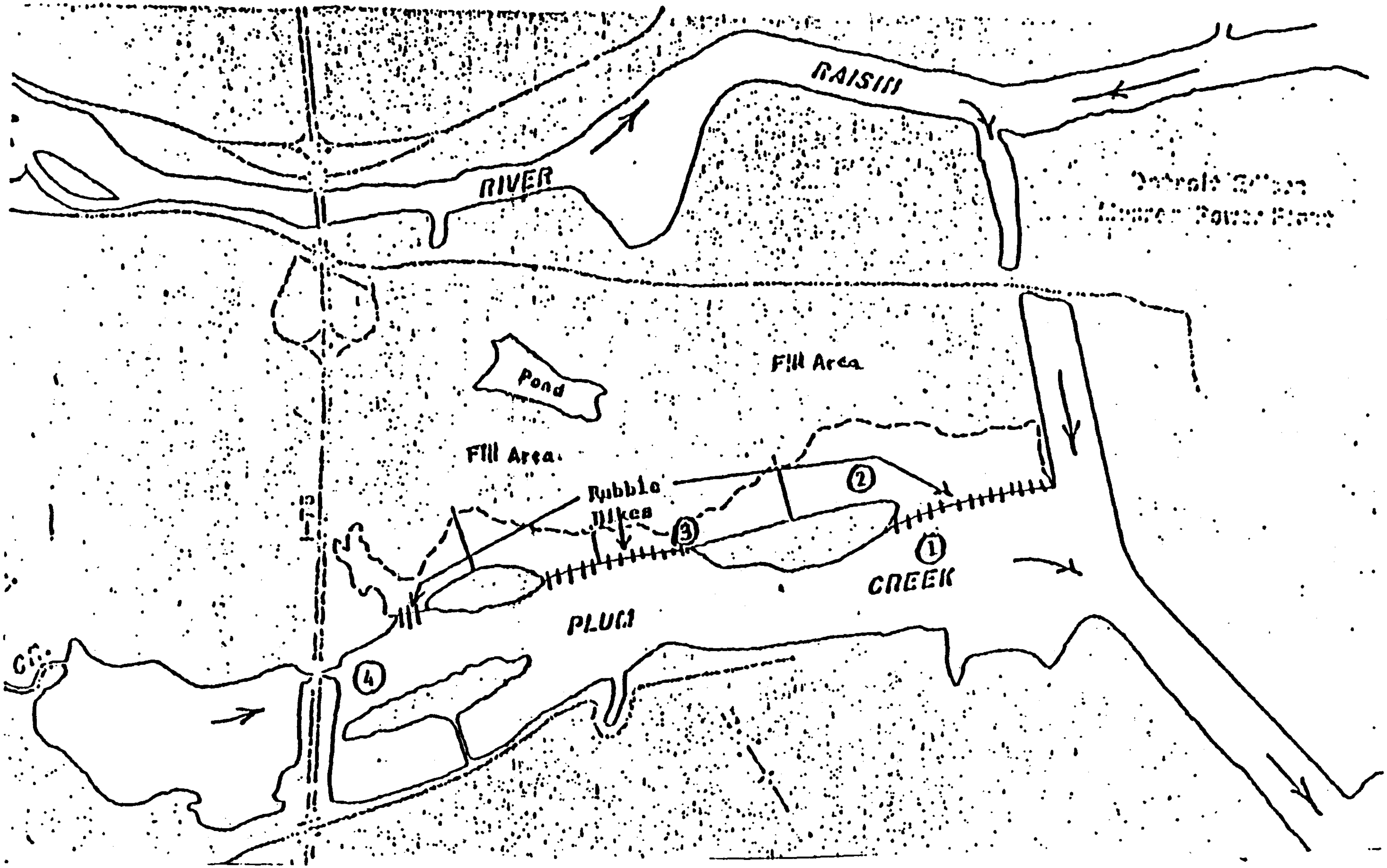


Figure 19 Sediment Sampling Locations on Plum Creek
Near the City of Monroe, Monroe County, Michigan,
August 11, 1976.

times more total PCBs than did the whole water (1.9 mg/kg vs an average of 0.00015 mg/l), there was no statistically significant difference in total PCB accumulation between animals caged in the water column and those on the sediments. The survey suggested that PCBs associated with the bedded sediments were much less bioavailable than those in the water column. The authors warned, however, that the experimental designs employed in the study did not permit an evaluation of the contributions of the dissolved and suspended particulate phases to PCB uptake.

During the study, the two fish species accumulated significantly more total PCBs (expressed on a wet weight basis) than the clams (by day 35). However, correcting for the lipid content of the samples (wet weight PCB concentration/lipid content) reduced the difference in PCB concentrations between fish and clams to statistical insignificance (USEPA 1987).

4.3 SUMMARY

Municipal, industrial, and non-point discharges have severely affected the lower River Raisin and Monroe Harbor. The lower river, including the shipping channel and the nearshore area of Lake Erie, has been identified as an Area of Concern (AOC) because of heavy metals contamination of the sediments and PCB contamination of the fish and sediments. The major impaired uses of the AOC are toxic and physical impacts on the biota, toxic impacts on human health due to PCB contamination of fish and sedimentation effects on navigation.

The Michigan Department of Public Health (MDPH) reissued the fish consumption advisories in 1987 for carp caught in the lower River Raisin. The contaminant listed in the advisory is PCBs in carp.

Water quality in the vicinity of the Monroe WWTP has been shown to be lethal to fathead minnows. A study suggested that the lethal effects followed the gradient of the treatment plant effluent plume. Although the 1983-84 USEPA Large Lakes Research Station (LLRS) study suggested that fish species diversity was not being impacted by point source discharges, data for size distribution of larval gizzard shad suggested that growth was inhibited lakeward (Rathbun et. al., 1985).

A series of phytoplankton and zooplankton functional impairment assays performed as part of the EPA/LLRS study determined the following:

* Photosynthesis was inhibited at the Monroe WWTP at all times and all dilutions.

* Zooplankton reproduction rates were depressed in Mason Run during September 1983 and in all samples from the river during the October 1983 survey.

When the assay values were converted to toxic units and fit to a dose response function the following correlations were realized:

* Although photosynthesis was depressed in the vicinity of the Monroe WWTP, there did not appear to be any noticeable impact of the loadings from the effluents of the plant, Mason Run, or the Ford Company. A significant concentration of primary production toxicity was entering the River Raisin upstream of Station 1 and appeared to decrease slightly in the downstream direction.

* Zooplankton reproduction toxicity increased dramatically at the stations near the Monroe WWTP and was lower at far shore stations. In addition, analysis revealed that although the Monroe WWTP had the greatest impact on the reproduction success of Ceriodaphnia, the Ford Company effluent had the greatest mortality impact.

* As with primary production toxicity, the highest zooplankton grazing toxicity concentrations were found at the upstream boundary.

Definite correlations existed between copper and zinc concentrations (corrected for hardness) at the sampling sites, and between zooplankton grazing EC_{50}, zooplankton fecundity, and larval fish growth.

Aquatic organisms are also physically impacted by the cooling water requirements of the Detroit Edison Company (DECO) Monroe Power Plant. Larval forms of such representative fish species as yellow perch, freshwater drum, white bass, white perch, and channel catfish, and other planktonic organisms that are integral parts of the food chain and sports fishery are entertained in the cooling water intake of the plant and exposed to sharp temperature increases. An independent study performed by the Great Lakes Research Division estimated that 4.7 billion larval fish were entrained at the Monroe Power Plant from February 1982 to February 1983.

Fish larger than three inches in length are too large to pass through the 0.25 inch mesh intake screen, but can be impinged against it. Consequently, DECO installed a fish pump at the plant, which decreased the number of fish killed by 49 percent. MDNR estimated that even with the fish pump in operation, the total number of fish impinged in 1976 ranged from 430,000 to 2.35 million. During the time period from February 1982 to February 1983, an estimated 31 million fish with a total weight of 1,364,000 pounds were impinged at the Monroe Power.

Ten residential drinking water wells on the south side of Plum Creek are connected to an aquifer that provides an active hydrologic connection between the surface water and groundwater. Since groundwater in the vicinity of the Port of Monroe landfill has been determined to be contaminated, the presence of the ten wells in the area poses a potential human health risk.

The average concentrations of water column contaminants measured in the River Raisin during the EPA/LLRS study were relatively lower at the upstream boundary of the river (Station 1). Concentrations generally increased downstream near the turning basin (Station 4), and then decreased to intermediate levels further downstream (Stations 6 and 26) near the river mouth of Lake Erie. PCB concentrations in the turning basin were dramatically higher and metal concentrations were slightly higher than either the upstream or lake boundary conditions. The PCB concentrations were found to be highest in the surface waters samples below the turning basin. In contrast, the metal levels were more elevated near the bottom. The contaminant concentrations in water were generally highest at the power plant discharge near Lake Erie (Station 29).

Sources of contaminants that may elevate concentrations at or below the turning basin include automotive and paper plant discharges (heavy metals and PCBs), the Monroe WWTP (zinc), and polluted turning basin sediments (metals and PCBs).

In addition to heavy metals and PCBs, the EPA/LLRS study measured total, free, and combined residual chlorine during the summer of 1983. The maximum, total for residual chlorine occurred at the upstream boundary. This indicates that the primary source is likely upstream of the study area. All chlorine values exceeded the acute and chronic toxicity criteria for aquatic life by at least one order of magnitude.

Sediments in the Area of Concern are heavily contaminated with such pollutants as copper, chromium, zinc, and PCBs. Sediment samples collected downstream of the Ford Company in 1976 and 1981 showed the highest levels (by up to two orders of magnitude) of chromium, copper, zinc, and Arochlor-1254 in the Area of Concern (Table 17a and 17b). Samples collected during 1983 and 1984 revealed that surficial concentrations of PCBs (primarily tri- and tetrachlorinated biphenyl groups) increased in the area of the turning basin and downstream of the Monroe Power Plant cooling water intake. This increase was probably due to the encovering of contaminated sediments.

Plum Creek sediments collected in 1976 were moderately to heavily polluted with concentrations of arsenic, copper, zinc, nickel, lead, and chromium. The highest concentrations of heavy metals and PCB (Arochlor-1242) were found in the sediments from the lagoons and Station 1 near the Port of Monroe landfill containment dikes. The dikes, constructed in 1968 of porous material and located on pervious soils, did not provided adequate fill containment. These dikes were replaced in 1983 with a new dike, see Section 7.1.3.

Fish collected from the River Raisin since 1971 were found to contain PCBs in their tissues. Fish species contaminated with PCB included northern pike, carp, gizzard shad, mirror carp, rock bass, smallmouth bass, largemouth bass, and emerald shiner. Carp generally exhibit the greatest total PCB concentrations.

Table 17a. Metal Concentrations (mg/kg) in Sediments of the River Raisin AOC

Location	As	Cu	Hg	Cd	Total Cr	Zn	Ni	Pb	Reference
River Raisin and Lake Erie									
Above Moroe WWTP	4.0	90	0.33	0.7	20	130	58	310	Evans 1977
Below Monroe WWTP (but above Ford discharge)	1.4	30	0.08	0.1	15	58	27	24	Evans 1977
Below Ford Discharge	12.0	14000	0.21	0.1	11000	580	5800	309	Evans 1977
Monroe WWTP									
Turning Basin									
Below Ford Discharge									
Below Detroit Edison Company									
Lake Erie (nearshore)									
4000 ft downstream of site sample (0415438N 0832237W)		18			18	52			STORET 1981
Southeast of Sterling Island		22			14	66			STORET 1981
Downstream of Monroe WWTP (at entrance)		66			72	436			STORET 1981
Outfall of Ford Company		1500			490	1000			Filkens et al 1985
Upstream end of Turning Basin									
Downstream end of Turning Basin									
Below Ford Discharge									
Below Detroit Edison Company									
Plum Creek									
Plum Creek (200 yards east of Smith's Island)	6.6	140	0.39	2.2	47	540	94	100	Evans 1976
Center of Lagoon (east of Smith's Island)	2.3	510	0.54	2.6	180	640	130	100	Evans 1976
Center of Lagoon (west of Smith's Island)	3.8	200	0.89	3.0	82	660	98	230	Evans 1976
Plum Creek (200 yards west of I-75 bridge)	5.0	68	0.12	1.8	21	780	41	100	Evans 1976

Table 17b. Organic Concentrations (mg/kg) in Sediments of the River Raisin.

Location	Oils	Arochlor 1242	Archlor 1248	Archlor 1254	Archlor 1260	Total PCBs	Reference
River Raisin and Lake Erie							
Above Moroe WWTP	2400	1.55		0.75	<0.5		Evans 1977
Below Monroe WWTP (but above Ford discharge)	700	5.22		1.86	<0.5		Evans 1977
Below Ford Discharge	24000	4.25		4.92	<0.5		Evans 1977
Monroe WWTP		4.5 (a)		1.7			EBG 1981
Turning Basin		3.9 (a)		3.2			EBG 1981
Below Ford Discharge		14.5 (a)		4.3			EBG 1981
Below Detroit Edison Company		9.46 (a)		0.3			EBG 1981
Lake Erie (nearshore)		1.1 (a)		1.0			EBG 1981
4000 ft downstream of site sample (0415438N 0832237W)			48	39	23		STORET 1981
Southeast of Sterling Island			43	55	36		STORET 1981
Downstream of Monroe WWTP (at entrance)		ug/kg	249	411	169		STORET 1981
Outfall of Ford Company			732	3197	1046		STORET 1981
Upstream end of Turning Basin						0.5 - 4.6	Filkens et al 1985
Downstream end of Turning Basin						1.3 -16.0	Filkens et al 1985
Below Ford Discharge						1.9 -17.0	Filkens et al 1985
Below Detroit Edison Company						0.23-0.42	Filkens et al 1985
Plum Creek							
Plum Creek (200 yards east of Smith's Island)	800	2.10		0.5	<0.5		Evans 1976
Center of Lagoon (east of Smith's Island)	1700	5.47		2.52	<0.5		Evans 1976
Center of Lagoon (west of Smith'. Island)	2000	3.51		2.15	<0.5		Evans 1976
Plum Creek (200 yards west of I-75 bridge)	800	0.5		0.5	<0.5		Evans 1976

5. SOURCES OF POLLUTION (PCBs)

The purpose of this chapter is to review and summarize available information on known or potential sources of PCB inputs to the lower River Raisin. The sources of PCBs to the Area of Concern will be defined as internal or external sources. External sources consist of direct and indirect sources upstream of the Area of Concern. Internal sources will consist of direct and indirect discharges within the Area of Concern. Throughout this RAP the term direct discharges will refer to all point sources such as NPDES permitted outfalls while the term indirect discharges is synonymous to with non-point source discharges in this RAP. Non-point source discharges include surface water runoff, atmospheric deposition, groundwater infiltration and in-place pollutants.

5.1.1 External Sources of Major Pollutants

There are no known direct discharges of PCBs to the River Raisin upstream of the Area of Concern. Indirect discharges of PCBs upstream of the Area of Concern may result from sediments. Presently, there is no evidence that the external area is a source of PCBs and therefore will not be considered further as a source to the Area of Concern.

5.1.2 Internal Sources of Major Pollutants

Internal sources of PCBs include atmospheric depostion, point source discharge, non-point source and in-place pollutants (sediment contamination). In the River Raisin Area of Concern, sediment PCB concentrations are generally elevated in depositional areas such as the turning basin. As water passes over these sediments, PCBs may enter the water column in the dissolved form or adsorbed onto suspended sediment. The presence of contaminated sediments is a major source of PCBs to the Area of Concern.

5.2 POINT SOURCES OF MAJOR POLLUTANTS

5.2.1 City of Monroe Waste Water Treatment Plant

The City of Monroe operates an activated sludge treatment plant with a design capacity of 30 MGD (37.1 cfs). The plant had an average annual flow of 13.98 MGD (21.6 cfs) in 1983 (Bednarz, Johnson, and Buda 1985). Wastewaters enter the plant through a bar screen and flows from there to a comminutor, grit chamber, primary clarifiers, aeration tank, secondary clarifiers, and a chlorine contact chamber. Until recently, treated effluent was discharged to the Raisin River via Outfall 580276 (Outfall 001). Effluent is now discharged to Plum Creek via Outfall 003. A flow diagram for the Monroe WWTP is provided in Figure 20.

The treatment plant currently receives city domestic wastewater along with septic tank deliveries, treated primary effluent from packing plants, and paper mill effluents (Thompson and Irvin 1980, and Boersen and McGarry 1984, both as cited in Bednarz, Johnson, and Buda 1985). In

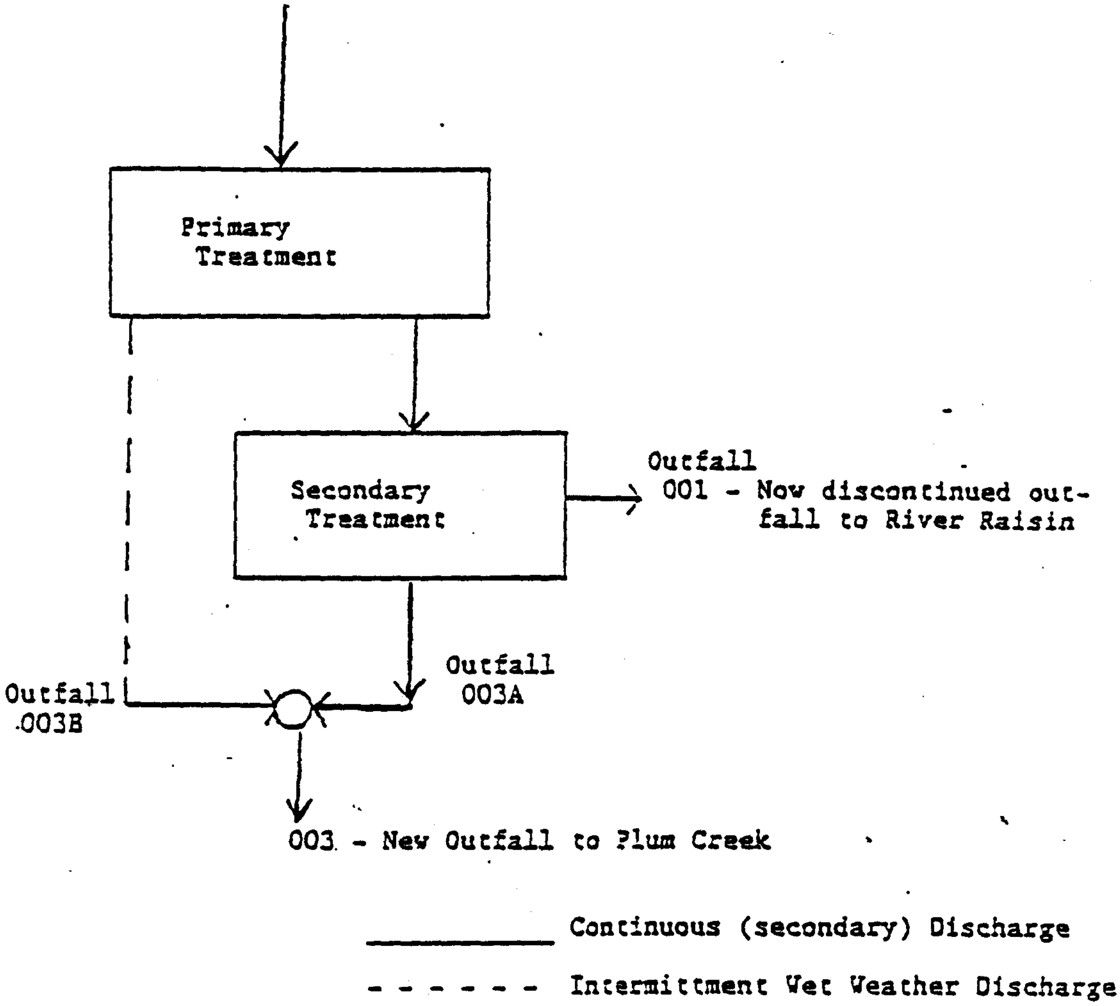


Figure 20 Monroe WWTP Outfall Locations

Source: MDNR 1984

1975, the WWTP received wastes from four paper mills: Time Container, Union Camp Corporation, and Consolidated Packaging Corporation's North and South plants (MDNR undated, Point Source Survey Summaries). However, Consolidated's South plant closed in 1975 and the North plant closed in 1978. An analysis of a sludge sample obtained from Consolidated Packaging Corporation on October 12, 1971, revealed the presence of "significant" amounts of PCBs (letter from F.B. Frost, Water Resource Commission to Mr. Csellak, Consolidated Packaging, October 26, 1971). However, no data were attached to this communication to clarify "significant amounts" of PCBs. A later sampling revealed PCB at up to 23.0 mg/kg (MDNR, 1984).

The Monroe WWTP NPDES permit (# MI0028401) was issued on December 20, 1984, and will expire October 31, 1989. An interim permit, which was issued on the same date (and expired on December 31, 1986) allowed a treated municipal wastewater to be discharged to the River Raisin from the WWTP through Outfall 001. The permit schedule of compliance requires the permitted to discontinue use of Outfall 001 with the construction of Outfall 003 (to be completed on December 31, 1986). The effluent from Outfall 003 (combined effluent of Outfalls 003A and 003B) will be discharged into Plum Creek. Effluent limitations and monitoring requirements for Outfall 003 are summarized in Table 18.

The 1986 Critical Materials Register did not list any PCB usage in plants discharging to Monroe WWTP. PCBs were below analytical detection limits of 1.0 ug/l in the WWTP discharges in 1980 and 1984. However, PCBs were found in sludge samples in 1984 (Arochlor 1254 was measured at 0.29 mg/kg (ppm)). All other arochlors were found to be below the analytical detection limit (.05 mg/kg).

Industrial sources of pollutants in the Area of Concern include not only the direct discharge of process waste and cooling water to the River Raisin or a tributary, but in addition, leachate from waste lagoons, stock piles, storage sites, and onsite landfills. The following discussion is confined to those sources of pollution discharging directly to the Area of Concern. Location of point and non-point sources in the AOC is presented in Figure 20b.

Four industries currently discharge to the River Raisin Area of Concern (MDNR 1983):

* Detroit Edison - Monroe Power Plant
* Ford Motor Company - Monroe Stamping Plant
* Union Camp Corporation
* La-Z-Boy Chair Co. - Telegraph Road Plant

5.2.2 Detroit Edison - Monroe Power Plant

The Monroe electric generating plant of the Detroit Edison Company is a coal-fueled facility with four sets of boilers, generators, and turbines. Normally, all four units are in operation. In 1973, the Monroe plant had a capacity of 2,160 megawatts per hour. This capacity was increased to 3,200 megawatts per hour by 1975 (MDNR undated).

Table 18 Final Effluent Limitations and Monitoring Requirements for Monroe WWTP Outfall 003 (Combined Effluent of 003A and 003B) to Plum Creek

Issue Date: January 1, 1987
Expiration Date: October 31, 1989

Effluent Characteristics	Dates in Effect	Load Limitations: 30-Day Average	Load Limitations: 7-Day Average	Concentration Limitations: 30-Day Average	Concentration Limitations: 7-Day Average	Monitoring Requirements
5-Day 20° BOD	All year	3,410 kg/day (7,500 lb/day)	5,120 kg/day (11,260 lb/day)	30 mg/l	45 mg/l	Daily
Suspended Solids	All year	3,410 kg/day (7,500 lb/day)	5,120 kg/day (11,260 lb/day)	30 mg/l	45 mg/l	Daily
Total Phosphorus (as P)	All year	----	----	1.0 mg/l	----	Daily
Fecal Coliform Bacteria	May 15 to Oct. 15	----	----	200/100 ml	400/100 ml	Daily
Ammonia Nitrogen (as NH_3-N)	May 1 to Sept. 30	630 kg/day (1,390 lb/day)	----	5.6 mg/l	----	Daily
	Oct. 1 to Nov. 30	1,360 kg/day (3,000 lb/day)	----	12 mg/l	----	Daily
	April 1 to April 30	1,590 kg/day (3,300 lb/day)	----	14 mg/l	----	Daily
pH	All year	----	----	Daily Min=6	Daily Max=9	Daily
Dissolved Oxygen	All year	----	----	4.0 mg/l	----	Daily

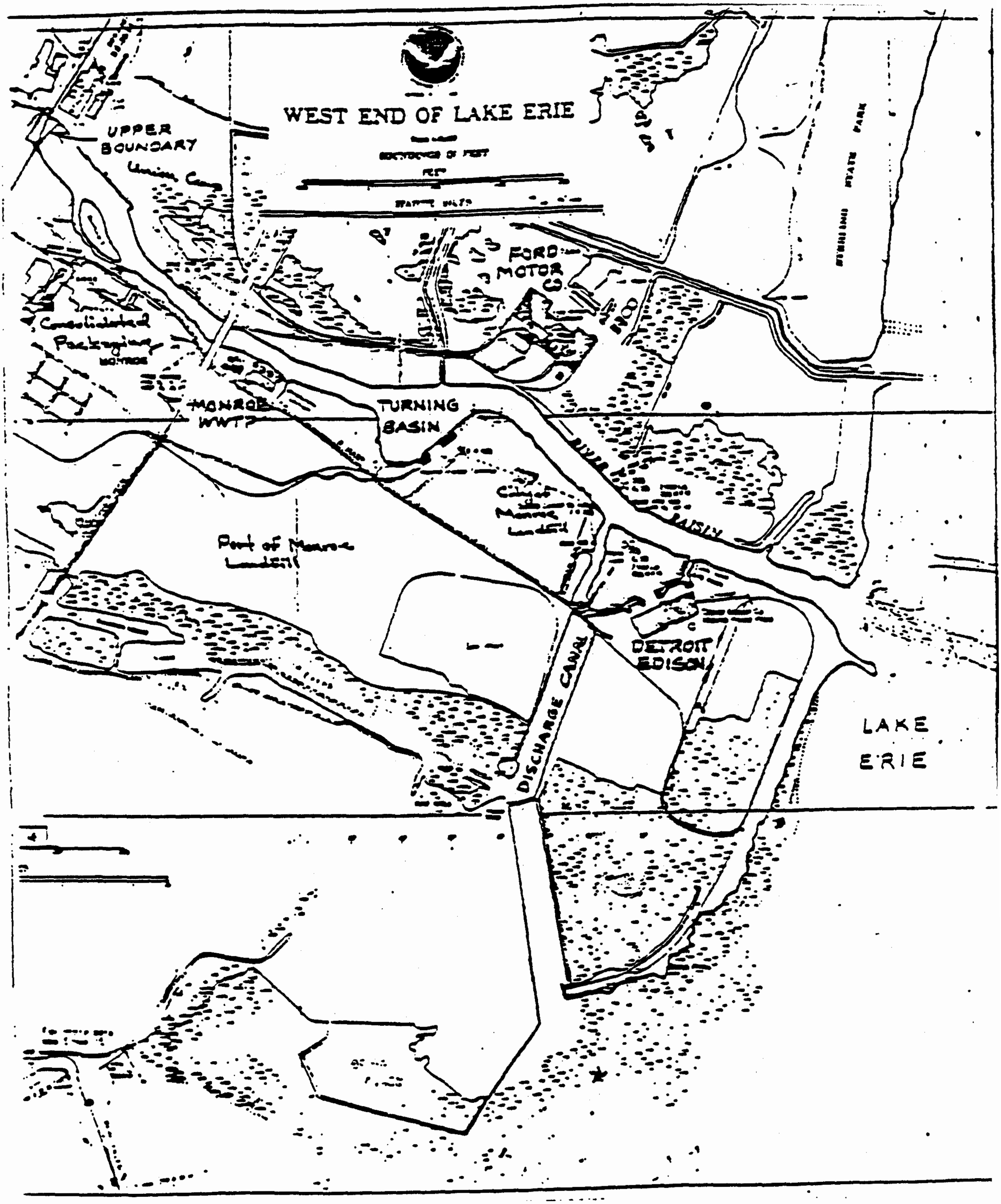


Figure 20b. Location of Point and Non-Point Sources

Water treatment at the plant has changed throughout the period of record. In 1973, ash water was discharged to a very large holding pond with baffles at discharge point. The remainder of the discharge was essentially cooling water and blowdown. In 1975, bottom ash, coal storage runoff, air heater wastewater, boiler cleaning water, demineralizer make-up water, and demineralizer polishing water were discharged to the ash pond. In addition, fly ash recovered by electrostatic precipitators was sluiced to a new settling pond that subsequently discharged to Plum Creek. Condenser cooling water, floor and roof drainage, and surface runoff were discharged to MacMillan Drain and/or Plum Creek. The floor drain water passes through an oil interceptor.

By 1979, boiler blowdown was routed to a 6.5 million gallon retention tank. The wastes were subsequently batch treated with lime, passed through a diatomaceous earth filter, and discharged. No apparent changes in water treatment have been made since the 1979 MDNR Point Source Survey (MDNR 1979).

The Monroe power plant uses large quantities of cooling water. Dis charges have ranged from 968 to 1,451 MGD. In 1973, PCBs were detected during the Point Source Survey (MDNR 1973). The only other measurement of PCBs (in 1982) resulted in no detection.

The final NPDES permit effluent limitations and monitoring requirements for Detroit Edison are provided in Table 19. A map identifying the permitted outfalls at the Monroe power plant is provided in Figure 21 (MDNR 1982 Point Source Survey). A diagram of the primary and alternative routing of wastes through the plant is illustrated in Figure 22.

The large flows used by the power plant have impacted the lower River Raisin and Lake Erie. The hydrology of the lower river is determined by the nearly complete withdrawal of river water at the power plant water intake. The majority of the cooling water moves upstream from Lake Erie. The alteration of water flow by Detroit Edison also results in significant entrainment and impingement of fish (see Chapter 4).

5.2.3 Ford Motor Company - Monroe Stamping Plant

The Ford Motor Company, Monroe Stamping Plant manufactures such automobile parts as wheels, stabilizers, coil springs, catalytic converters, and performs other miscellaneous stamping (MDNR 1984, Industrial Wastewater Survey). The plant operations can be divided into three parts: stamping, metal forming, and painting (MDNR undated, Industrial Survey Summary). Chrome plating was discontinued between 1982 and 1984.

Process and cooling water for the plant are obtained from Lake Erie. The plant's domestic water is obtained from the city of Monroe (MDNR 1984, Industrial Wastewater Survey). Lake water is screened at the water intake house, chlorinated, treated with lime and ferric sulfate,

Table 19 Final Effluent Limitations and Monitoring Requirements for Detroit Edison Company - Monroe Power Plant

Issue Date: August 22, 1985 Expiration Date: July 31, 1990
Receiving Water: Lake Erie

Outfall 001
Maximum Flow - 1,978,000,000 gallons/day of stormwater runoff; fly ash transport water; noncontact cooling water; coal pile runoff; bottom ash transport water; non-chemical metal cleaning wastes; chemical metal cleaning wastes; and low volume wastes consisting of boiler flowdown, demineralizer regenerant; oil wastewater, and air pre-heater wash water from Outfall 001 to Lake Erie

Effluent Characteristic	Discharge Limitations Kg/Day (lbs/Day) Monthly Ave.	Discharge Limitations Kg/Day (lbs/Day) Daily Max.	Other Limitations Monthly Ave.	Other Limitations Daily Max.	Monitoring Requirements Measurement Frequency	Monitoring Requirements Sample Type
Flow, M^3/Day (MGD)					Daily	
Temperature (°F)						
Intake					Daily	Reading
Discharge*					Daily	Reading
Total Residual Chlorine** (TRC)				.2 mg/l	5 x Weekly	3 Grab samples equally spaced
Heat Addition, BTU/Hr.				15.5×10^{9}		Calculation
Chlorine Discharge Time				160 min/day		Report Discharge Time
Outfall Observation						

*The discharge shall not increase the temperature of Lake Erie at the edge of the mixing zone more than 3°F above the existing natural temperature or above the following monthly temperatures:

Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
45	45	45	60	70	75	80	85	80	70	60	50

**No single sample may exceed 0.3 mg/l

pH 6.0 - 9.0 Weekly grab sample

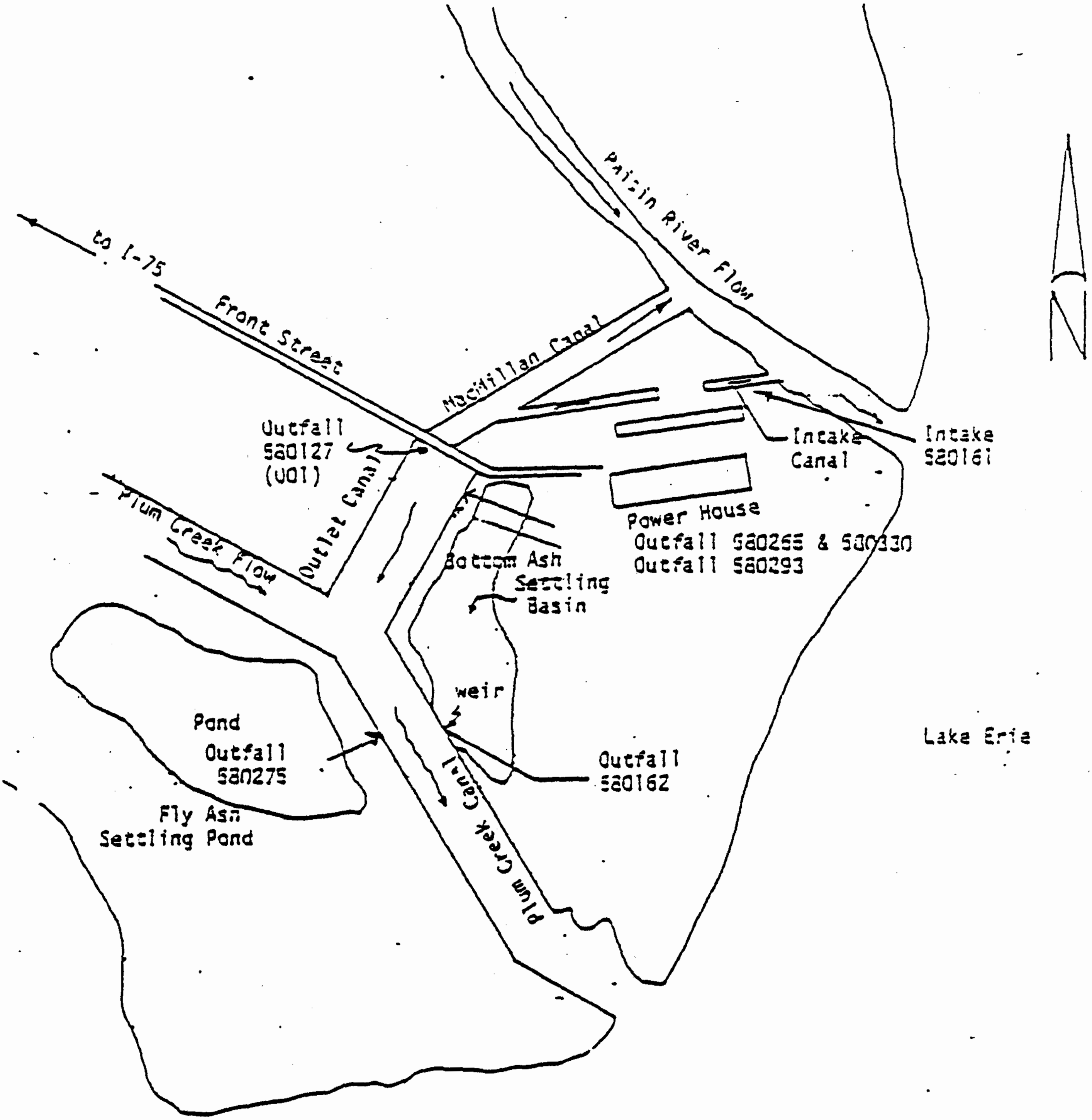


Figure 21 Detroit Edison Permitted Outfall Locations
(MDNR 1982)

NPDES PERMIT MI 0001848

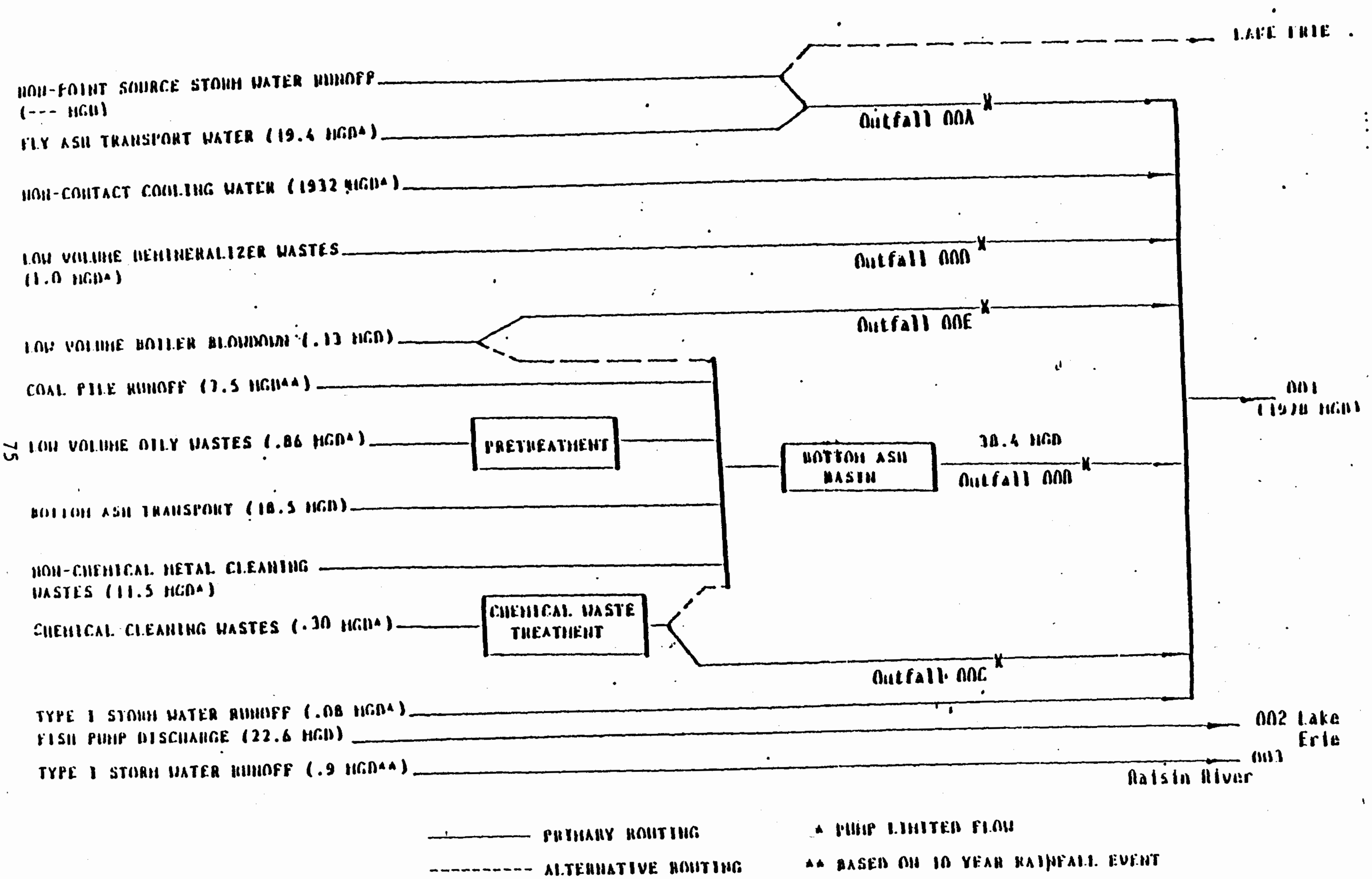


Figure 22 : Waste Treatment and Discharge Diagram
In Detroit Edison Power Plant

75

clarified, and passed through sand filters prior to plant usage. Sanitary wastewaters are treated at the plant, and undergo primary sedimentation before being discharged to the process channel. Oily wastes are also drained from the bottom of the treatment tanks to the process channel following batch treatment with acid, caustic, and polymer.

Cooling water is dispatched from welding machines, heat exchangers, air conditioners, and air compressors to the process channel. Boiler blowdown, yard drainage, and backwash from the sand filters also enter the process channel. The combined wastewaters are finally pumped from the end of the channel to the polishing lagoon. Overflow from the polishing lagoon is discharged to the River Raisin via Outfall 580288(002) depicted in Figure 23.

Polychlorinated biphenyls (PCBs) were measured in detectable amounts in composite samples taken from Ford Motor Company's Outfall 002 in 1980, and 1982. These data are summarized in Table 20. According to this limited set of data, all Arochlor mixtures have decreased in concentration between the years 1980 and 1984. The State concluded that contamination of the River Raisin sediments is a definite possibility.

5.2.4 Union Camp Corporation

Union Camp Corporation is a manufacturer of paperboard, solid fiber, and corrugated containers from recycleable waste materials (MDNR undated Briefing Memo). Union Camp produces its own steam for production processes at a rate of 128 MMKWH/day.

The expired NPDES permit (expiration date 6/30/81) authorized a discharge of 2,507,000 gallons/day of intake lake backwash, ash sluicing water, noncontact cooling water, and stormwater runoff to the River Raisin and Mason Run.

Seven active outfalls currently discharge to Mason Run and/or the River Raisin. One outfall discharges to the Monroe WWTP. The Mason Run discharges account for 63 percent (or approximately 0.945 MGD) of the 1.5 MGD discharge from the plant.

5.2.5 La-Z-Boy Chair Company

This facility is permitted to discharge non-contact cooling water.

5.3 NON-POINT SOURCES OF MAJOR POLLUTANTS

Non-point sources of pollutants (i.e., public and industrial landfills, dumpsites, and lagoons) pose a serious threat to the River Raisin Area of Concern. Examination of the Site Assessment System (SAS) screening scores for the AOC illustrates the magnitude of the overall environmental contamination from non-point sources. Explanation of Michigan's Public Act 307 is presented here, due to the number of potential contamination sources in the AOC that are Act 307 sites and their importance in the AOC.

Table 20 PCBs Detected in Ford Motor Company's Outfall 003 (Composite Samples)

Polychlorinated Biphenyls	Survey Dates 3/4/80	2/22/82	1/18/84
Arochlor 1242 (mg/l)	—	.0013 (.03)**	<.0001
Arochlor 1248 (mg/l)	.00061(.021)*	—	—
Arochlor 1254 (mg/l)	.0064 (.0054)*	<.0001	<.0001
Arochlor 1260 (mg/l)	<.0001(-)	<.0001	<.0001
Other Arochlors (mg/l)	—	Not Detected	<.0001

* Kg/day
Flow rate = 33,900 M^3/day (computed)
To obtain MGD multiply M^3/day by .0002642
To obtain lbs/day multiply Kg/day by 2.205

** Kg/day
Flow rate = 26,000 M^3/day (computed)

Source: MDNR 1980, 1982, 1984

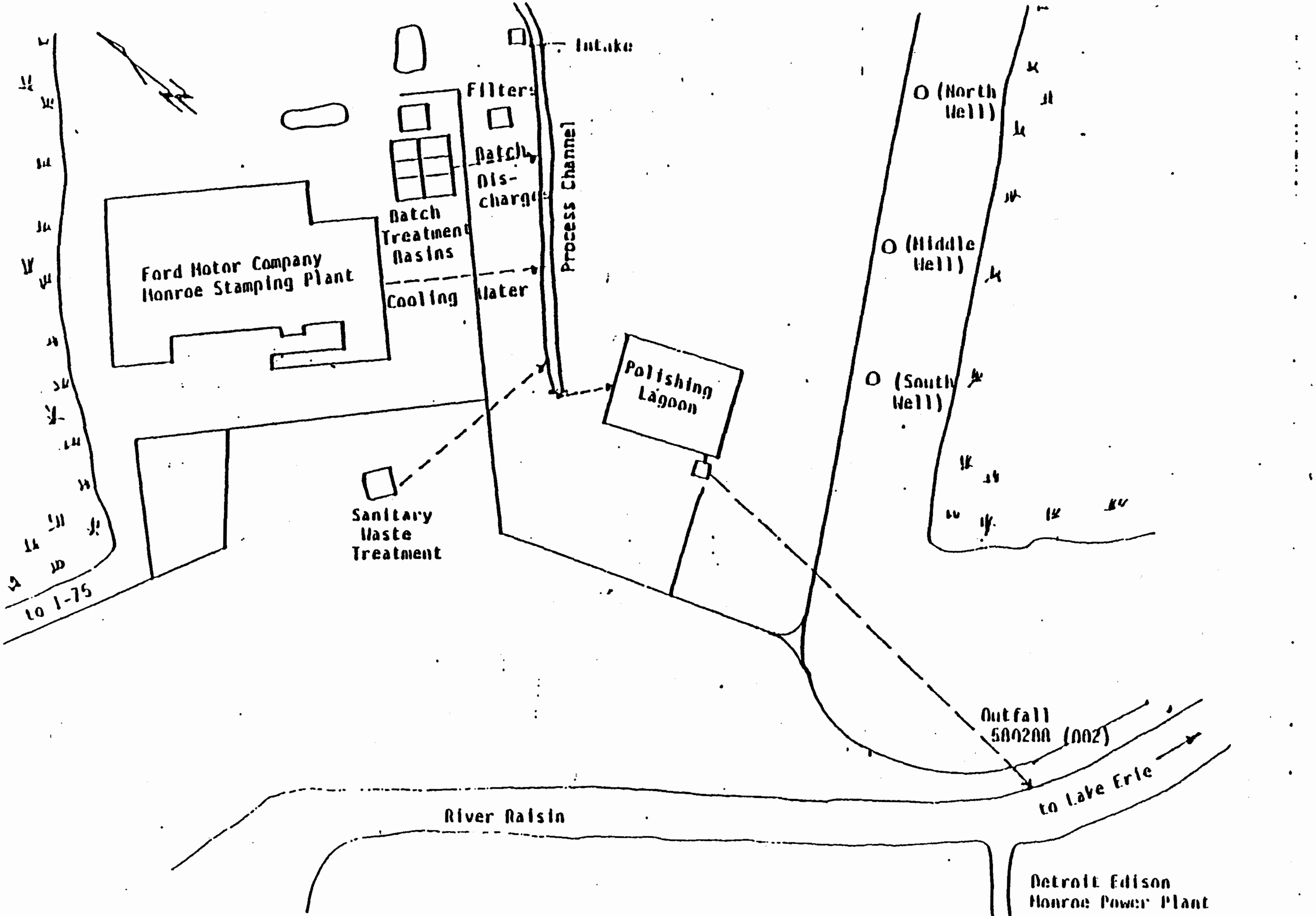


Figure 23 Ford Motor Company - Monroe Stamping Plant, Waste

Michigan's Public Act 307 (Michigan Environmental Response Act) provides for the identification, risk assessment and priority evaluation of environmental contamination at sites in the State. In part, Act 307 calls for the Governor or his designee to:

1. Develop a numerical risk assessment model for assessing the relative present and potential hazard posed to the public health, safety, or welfare, or to the environment by each identified site. The model shall provide a fair and objective site-specific numerical score, designating the relative risk posed by that site.

2. Submit the numerical risk assessment model for public hearings.

3. Annually identify and evaluate known sites of environmental contamination in the State for the purpose of assigning priority for evaluation and response actions.

4. Submit to the Legislature in November of each year two lists in order of relative risk. One list will identify all known sites requiring further "evaluation and interim response activity". The other list identifies sites where "response activities" are to be undertaken by the State. Evaluations will include actions such as hydrogeologic studies, drinking water sampling, air monitoring and engineering feasibility studies. Interim response will include actions such as control of leaking or exposed wastes, removal or fencing of hazardous materials, and provision of alternate waste supplies. Response actions will include the final remedies chosen which will permanently address the site.

5. Submit the lists for public hearings and to the Michigan Legislature.

6. Recommend to the Michigan Legislature a level of funding for response actions including detailed site evaluations and other remedial measures.

Development of the numerical risk assessment model was completed and public hearings held in July of 1983. The first annual proposed priority list was completed and submitted to the Legislature in November 1983. Public hearings were held in December and the final listing was completed in February 1984. Funding recommendations submitted to the Legislature resulted in a supplemental appropriation for fiscal year 1984 of $12.1 million and funding of $11.8 million for fiscal year 1985. Funding became available in September 1984.

This annual revision of the priority list is for evaluation and interim response actions at sites of environmental contamination. A "Response Activity List" is not being proposed at this time. As interim response activities and site evaluations lead to decisions about final site remedies, several sites will in subsequent years be placed on a "Response Activity List". Many cleanup and pollution control activities will, however, immediately proceed at sites on the present "Evaluation and Interim Response List".

Not all sites on the list will be recommended for funding. Recommendations will be based upon such factors as the availability of Federal Superfund money, voluntary action by responsible parties, the likelihood of successful legal action and the need to immediately address immediate human health concerns. In addition, remedies for some sites may be satisfactorily pursued through other specific pollution incident response programs such as the Brine Loss Contamination Fund provided by Section 32 of Act 61, P.A. 1939.

Michigan's Environmental Response Act (MERA) and the Federal Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, commonly known as Superfund) are similar in that they both provide a means for publicly financing remedial actions at sites where hazardous substances have polluted the environment. Both programs use prioritization systems to determine which sites are most in need of limited public funds. The State Act provides Michigan with the ability to take action at sites that are not eligible for remedies in the Superfund program (e.g. petroleum product losses) or at sites which do not rank high enough in the Federal system to receive funding.

Both the Federal and State programs employ a numerical rating system designed to determine the relative risk posed by sites. The Michigan Site Assessment System (MSAS) differs from the Federal Hazard Ranking System in several important ways. MSAS ranks sites according to their present conditions, where as the Hazard Ranking System evaluates the site at the point in time when site conditions were worst. The MSAS also places more emphasis on existing human exposure to pollutants (such as through contaminated water supplies) than the Federal system. In addition, direct human contact hazards are considered in MSAS ranking but not in Superfund remedial rankings. These factors can cause a given site's rating to be substantially different on the State and Federal priority lists.

The Priority List is divided into two groups of sites as follows:

Group 1 - Scored Sites (in rank order and by county)

Group 2 - Screened Sites (by county)

Group 1 is comprised of sites which have been scored on a scale of 0-2000 by the Michigan Site Assessment System. Sites included on the United State Environmental Protection Agency's National Priority List for Superfund, and sites which received Michigan Sites Assessment System screening scores of nine or more, are included. This list serves as a measure of the relative risk posed to the public health or environment by each site. There are approximately 305 sites which were evaluated (for the February 1985 list) under this most rigorous application of the MSAS.

Group 2 is comprised of sites which were screened by the Michigan Site Assessment System but were not scored by the detailed model. The screening process examines critical factors relevant to a site's relative risk and results in an number ranging from 1 to 15. Sites which screened at nine or above appear in Group 1.

Scoring data are presented in Table 21, and are summarized as follows:

* River Raisin - City of Monroe to Mouth, SAS = 848
* Port of Monroe Landfill, SAS = 829
* Consolidated Packaging Corp., SAS = 761
* Ford Motor Company, Monroe Plant, SAS = 487
* City of Monroe Landfill, Screen = 7
* Detroit Edison Dredge Spoils, Screen = 5

These sites of environmental contamination in the AOC are identified in Figure 24. Preliminary hydrogeologic investigations at these sites suggest that the area is highly interconnected as a result of fluctuating hydrologic conditions. The distribution and transport of contaminants in the surface water, ground water, and wetlands is directly related to the dynamic nature of the hydrologic regime.

All of the sites identified in Table 21 have detectable quantities of PCBs in the surface water, groundwater, and/or soils. The history and hydrogeologic setting of each site is discussed below, as well as the currently available information on PCB and metals contamination.

lagoons and the river sediments downstream of their outfall have been found to contain PCBs and heavy metals (MDNR 1985d).

5.3.1 Port of Monroe Landfill

The Port of Monroe Landfill is located approximately 3/4 miles southwest of the River Raisin at Interstate 75 (Figure 24). The total area covered by the landfill is approximately 480 acres of former wetland and floodplain, and contains a roughly even mixture of light and heavy manufacturing wastes (MDNR 1984). MDNR files attribute the following waste categories as comprising 90 to 95 percent of the fill (MDNR undated):

* Iron foundry sand and debris
* Steel mill furnace debris
* Blast furnace debris
* Coke oven debris
* Sinter plant debris
* Industrial wreckage debris
* Natural soil or dirt
* Limestone processing debris
* Construction debris
* Coal burning power plant debris
* Metals and wood products.

Table 21 River Raisin Sites of Environmental Contamination (Act 307)

SAS Score (Screen)	County & Date Scored	Common Site Name/Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Potentially Affected
0848	Monroe 08-08-86	River Raisin, City of Monroe to Mouth/ Monroe	Unknown	Unknown	PCB Heavy Metals	Soil	Surface Water Groundwater Residential Well
0829	Monroe 10-12-84	Port of Monroe Landfill/ Monroe	Landfill	Landfill	PCB Benzene Xylene Cumene Ethyl Benzene	Groundwater Soil Wetland	Surface Water Sediment Fauna Flora
0761	Monroe 10-14-85	Consolidated Packaging Corp./Monroe	Paper Products	Lagoon	PCB Chromium Lead	Sediment Surface Water Wetland Soil	Groundwater
0587	Monroe 10-04-84	Ford Motor Co. Monroe Plant/ Monroe	Plating Polishing	Waste Pile Lagoon	PCB Zinc Lead Chromium	Groundwater Soil	Surface Water
(07)	Monroe 10-12-84	City of Monroe Landfill/ Monroe	Landfill	Landfill	Domestic Comm. Heavy Mfg.	–	Surface Water Groundwater
(05)	Monroe 10-15-85	Detroit Edison Dredge Spoils/ Monroe	Coal-Fired Elec. Utility	Unknown	Nickel Lead Oils PCB Mercury Cadmium Chromium	Sediment	Surface Water Soil

Source: MDNR (1986)

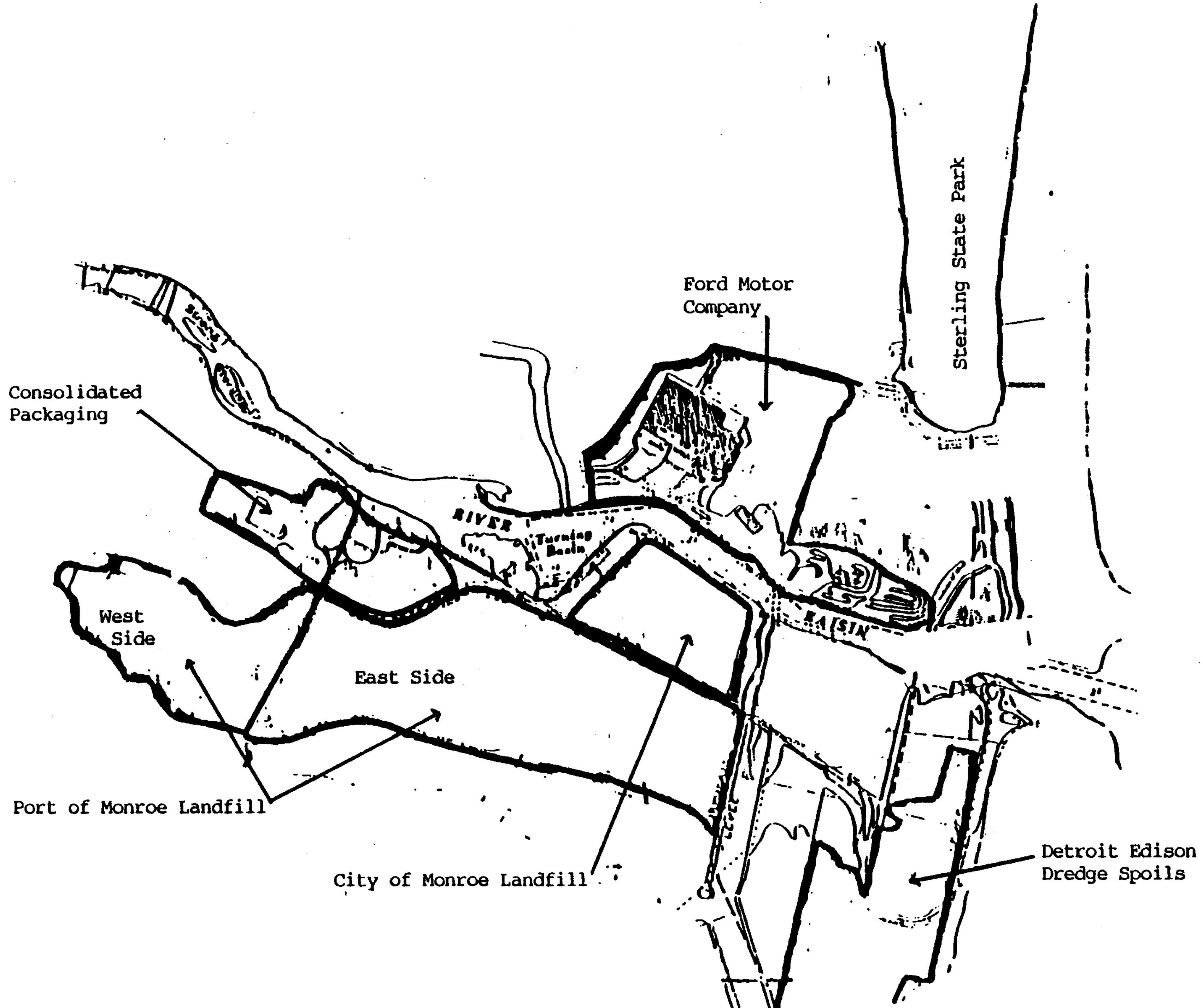


Figure 24. Location of Act 307 Sites of Environmental Contamination in the River Raisin Area of Concern

MDNR (undated file entry) summarized the documented disposal of wastes accepted at the Port of Monroe Landfill between the years 1947 to 1976. This summary is presented in Table 22. A Cease and Desist Order was issued by MDNR in 1975 to halt solid waste disposal encroachment into Plum Creek, occurring as a result of inadequate containment dikes along Plum Creek.

Johnson and Anderson, Inc., (1985) noted that the operational approach taken in landfilling from west to east would probably have resulted in an evolution of industrial chemical waste from the mid to late 1940s on the west side of I-75 to the early 1970s on the east side of I-75.

The Port of Monroe ultimately intended to use the landfill for industrial development. Consequently, all landfilling was approved and permitted (NUS 1986, Draft Work Plan). Although only solid wastes were generally accepted for disposal, the daylight monitoring schedule of landfilling operations precluded control of nighttime deliveries. Allegations of night dumping exist in MDNR files, suggesting possible disposal of unauthorized wastes. Unauthorized waste disposal may have included liquid wastes, including inorganic chemicals and PCBs. The landfill was burned periodically to reduce the volume of combustible materials.

The Port of Monroe Landfill is generally referenced in terms of two different areas. The West Side consists of 140 acres situated west of I-75. The East Side is located east of I-75 and south of Front Street, and consists of approximately 340 acres. The environmental contamination of each landfill area is discussed separately in Sections 5.

5.3.1.1 Port of Monroe - West Side

The Port of Monroe Landfill - West Side was originally sold to the city of Monroe in 1937 by Consolidated Paper Company. The general configuration of this site is shown in Figure 25. The area was operated as a landfill for industrial refuse by several firms, the first of which was Dixie Fuel and Supply. The landfill was subsequently leased to General Disposal and Heckett Engineering (MDNR 1984).

In 1982, the Port of Monroe began formal planning and permit acquisition for the development of an industrial park on the land west of I-75. However, MDNR and the Michigan Department of Public Health (MDPH) indicated that the issue of potential health threats posed by chemical disposal in the fill must be resolved before any construction would be allowed. This includes an assessment of the human health exposure to identified substances under present conditions as well as conditions during and after park development (i.e. determining the habitability of the site).

Landfilling activities at the West Side have been inactive for 10 to 15 years (NUS 1986). The fill surface is essentially level, with ground elevations ranging from 575 feet to 580 feet above Mean Sea Level (MSL). Approximately two-thirds of the site is tree-covered and the remaining third is typically vegetated with tall grass. The southern perimeter of the landfill, adjacent to Plum Creek, consists of steep slopes ending at

Table 22. Review of Wastes Accepted-Port of Monroe

May 26, 1947

Monroe Port Commission (MPC) granted Dixie Fuel & Supply Company the right to fill 300 acres (lying just east of, and adjacent to, the Detroit & Toledo Shore Line RR) with foundry sand and related industrial waste.

July 14, 1954

City of Monroe granted permission by MPC to use land lying west of the road running northward from near the eastern end of East Front Street to the channel.

Detroit Stoker Company granted permission by MPC to dump 2 to 3 truck loads/day in fill area (Ilgenfritz Pond, S. of Front Street). (Fill began in October, 1954, acc. to 10/17/62 minutes)

January 11, 1956

Survey of material by MPC entering Port fill over an 18 day survey period: 194 rail cards of foundry sand, 238 rail cars of combustible material. Location of fill not stated in minutes.

September 12, 1956

MPC gave permission to dump street sweepings, ashes, tin cans and other rubbish from down river Detroit communities. Approximately 5,000 yd^3/month. Location suspected to be western-most portion, but not stated.

Dixie Fuel & Supply stated that all of the property west of I-75 will be filled by Spring, 1957.

October 9, 1957

MPC entered into a 5 year contract with Pennsalt Chemicals Corp., Wyandotte, to receive 500 tons/week (total of 130,000 tons over entire period) of fly ash. Location of fill unknown.

April 9, 1958

MPC grants permission for Detroit Stoker to dump 75 yds^3/week of foundry sand, cores, coke and slag. Location of fill unknown.

Table 22 Continued

<u>August 13, 1958</u>

MPC grants permission for dredge spoil deposit in area bounded on the north by the south line of East Front St., on the east by the east property line of the Port, on the South by Smith's Island and on the west by a straight line extending from the western end of Smith's Island to the intersection of Port Ave. and E. Front St.

<u>October 2, 1959</u>

Due to holdups in extending a rail line east off of the Detroit-Toledo RR, much of the property b/w Clark St. extended and I-75 has been filled to a depth of as much as 5 or 6 feet above the desired grade.

<u>December 16, 1959</u>

Rail line to east still not completed. Expected to soon have 60 cars/day of refuse (no mention of type). Problem existed of where to put refuse.

<u>September 21, 1960</u>

Dixie Fuel & Supply given permission by MPC to fill east 60 acre parcel "beginning at the intersection of the east line of the second cut and the RR right-of-way lying south of, and adjacent to and parallel with East Front St. and continuing in a southerly direction along the east line of second cut to the point where the property line of the Port leaves second cut, in a S.E. direction parallel with E. Front St. a distance of 1600 feet, approximately 1300 feet to the railroad right-of-way, and approximately 2800 feet NW along the RR right-of-way.

Fill shall consist of used foundry sand and related industrial waste.

<u>December 19, 1960</u>

MPC stated that no fill will be accepted west of I-75 (except for extreme S.W. Portion, adjacent to Plum Creek).

<u>March 15, 1961</u>

MPC requests Dixie fuel Supply to immediately stop the inflow of combustibles (used lumber, heavy timbers, rubber). This fill suspected to have been placed east of I-75, south of Front St.

<u>June 6, 1961</u>

7 industries under contract with Dixie - three of the seven are Ford, Chrysler, and Chevrolet.

Table 22 Continued

August 16, 1961

MPC grants Dixie right to continue filling east of I-75 and along the S. side of East Front.

December, 1962

Dixie Fuel & Supply taken over by General Disposal.

October 31, 1966

MCHD found a railroad car parked next to Front Street on the NYC RR which had its contents of cutting oil distributed to the ground in the area.

November 18, 1966

Michigan Department of Public Health found 50 barrels of paint thinner and sludge on the refuse pile. Suspected location E. of I-75, S. of Front, although memo does not specify.

November 21, 1966

MCHD found two cars which were loaded with 55 gallon drums of paint sludge and thinner (from Chevrolet-Warren, Ford-Highland Park).

January 5, 1967

Memo from Wayne Denniston (2/2/62) states that there are two areas that are served by railroad sidings or spurs:

1) DT & I line on the above date in January, several barrels of heavy black sludge were noted along the siding of this line. Also, one railroad car load of white sludge from Ford was on track.

2) NY line on the above date in January, 24 barrels of heavy black oil or tar-like substance were in area. Material was spilled on ground and oozing from barrels.

July 17, 1968

Inspection of the City of Monroe SLF by MPC revealed excessive quantities of paper, wood and other objectionable material.

April 9, 1969

General Disposal accepting wood, soft plastic and garbage; noted after site inspection by unknown party. Location of inspection unknown.

Table 22 Continued

May 21, 1969

W.B. Salter from Penn Central RR told MPC that the material being used as fill "...is nothing but garbage."

April 11, 1969

Inspection by J & A revealed 50 wooden crates containing scrap paper, sanitary wastes and resin plastics. This material was located near the S. edge of the property west of I-75. Also noted were a pile of scrap rubber tires located immediately east of I-75 and adjacent to a north/south RR spur. Also noted was a car of rubber tire scrap on an unloading track on the extreme east end of the property and parallel to Front St.

January, 1973

General Disposal filling activities taken over by Heckett Engineering.

March 28, 1975

Site inspection (MDNR) revealed that wood was being landfilled in substantial quantities.

A liquid sludge was noted as being disposed of on-site (very liquid high Fe content, possibly contained oil) from Usher Oil Company. Location of disposal not stated.

July 14, 1976

43,000 gallons of tar removed from pit E. of I-75 and S. of Front.

Source: MDNR undated. Port of Monroe Landfill files, Groundwater Quality Division, MDNR

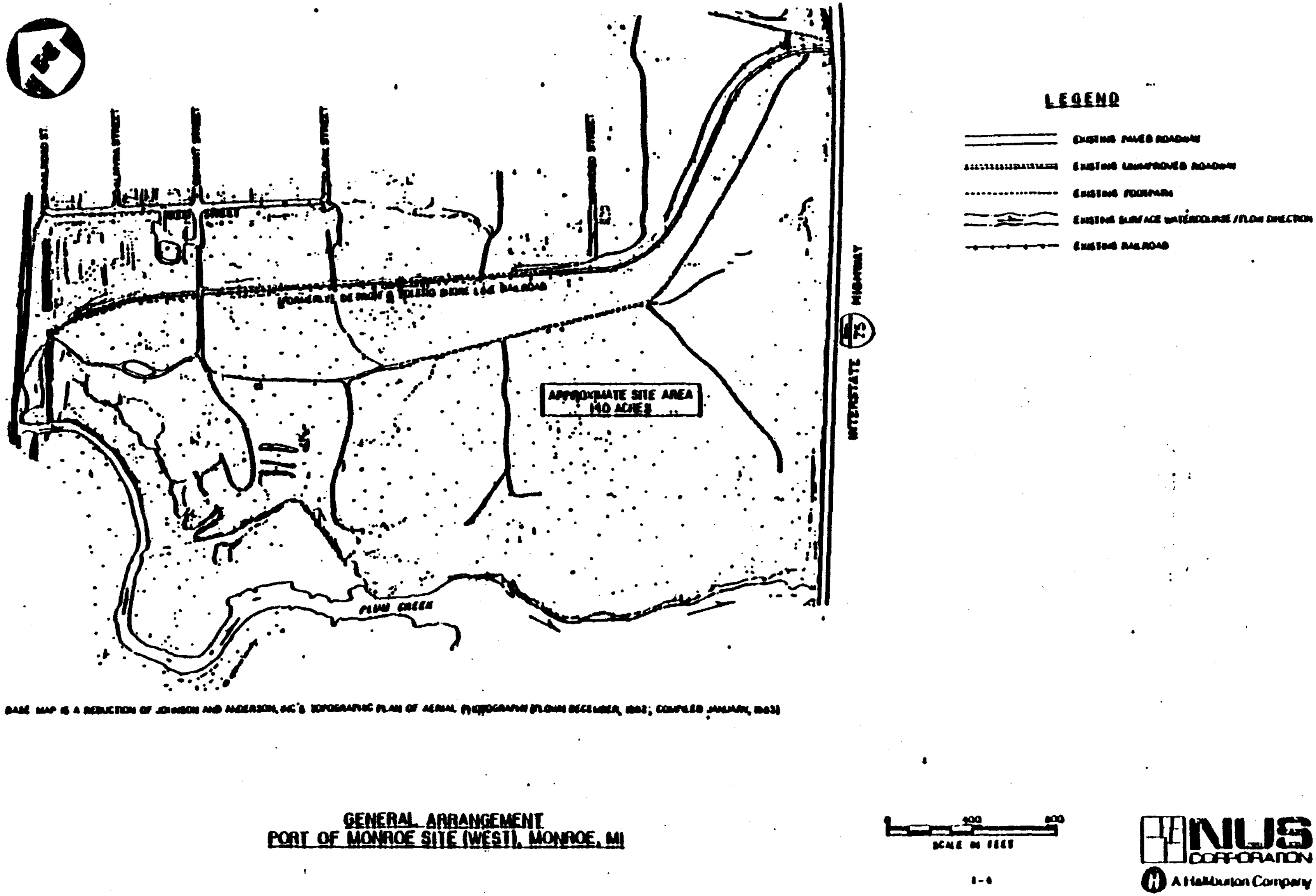


Figure 25 General Arrangement Port of Monroe Site (West), Monroe Michigan

the present stream channel. This area of the landfill covers former riparian wetlands (NUS 1986).

Hydrogeologic Setting. The Port of Monroe Landfill - West Side consists of three basic geologic layers. The uppermost layer is composed of 20 to 25 feet of fill material consisting of dark organic, sandy soil with wood debris and metal shards. Underlying the fill material is 10 to 15 feet of clay-till deposit. Below the clay-till layer is bedrock of dolomitic limestone. This material is usually highly fractured and contains numerous solution channels (NUS 1986).

Two groundwater zones are believed to exist under the West Side (Johnson and Anderson 1983). An upper water table aquifer is a local perched zone contained within the upper landfill strata. The primary flow of groundwater is northward towards the River Raisin, and southward towards Plum Creek as depicted in Figure 26. A smaller groundwater flow, believed to exist on the eastern end of the site, apparently flows eastward toward I-75.

The lower aquifer is contained in the limestone bedrock, below the clay-till deposit. Groundwater flow is dependent on the amount and degree of interconnection of the limestone fractures and solution channels (NUS 1986). Although local areas within the aquifer may be under artesian pressure as a result of confinement by the overlying clay-till (Johnson and Anderson, Inc. 1983), there is speculation that local areas of downward flow into the bedrock are possible (NUS 1986). NUS (1986) suggested that vertical movement through the clay layer is possible (as indicated by a monitoring well head difference of 6 feet), and that a potential exists for contamination of the bedrock aquifer.

PCB Contamination. The results of an initial hydrogeologic evaluation of the West Side (Johnson and Anderson 1983) indicate that both the soil and the groundwater are contaminated with PCBs. A composite sample of groundwater taken from the upper aquifer (water table aquifer) indicated the presence of 0.33 mg/l (ppm) of PCBs. PCBs were also detected in all soil boring samples (10 composite samples) ranging from 0.15 mg/kg to 1.8 mg/kg. It is suggested that PCB-contaminated soils may be extensive in the West Side. Given their relative insolubility (PCBs are hydrophobic compounds), the detection of PCBs in groundwater suggests that in some areas of the site PCB concentrations in the soil could be quite high. Although not measured in the bedrock aquifer, the limited sampling (i.e., one bedrock aquifer sample) does not preclude the possible occurrence of PCBs in that layer. The limited sampling did indicate that volatile organic compounds were present in the bedrock aquifer, and that their occurrence may be the result of the contaminants disposed in the overlying landfill.

5.3.1.2 Port of Monroe Landfill - East Side

The East Side of the Port of Monroe Landfill is approximately 340 acres of fill material overlying former riparian wetlands. The site is bounded on the north by Front Street, on the west by I-75, and on the east by the Detroit Edison cooling water channel. General site configuration is shown in Figure 27. The substantial filling of the wetlands on the north

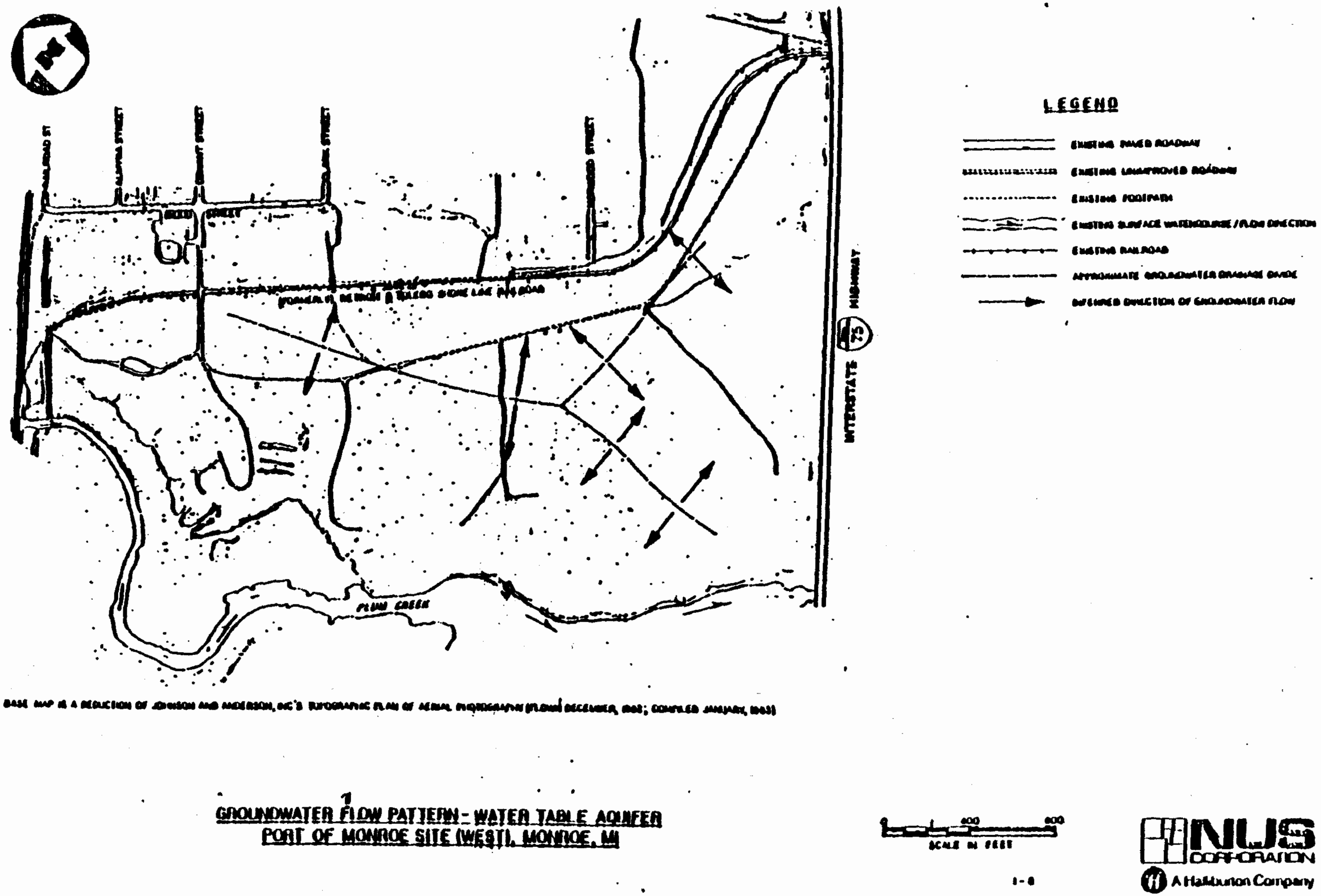


Figure 26 Groundwater Flow Pattern-Water Table Aquifer
Port of Monroe Site (West), Monroe, Michigan

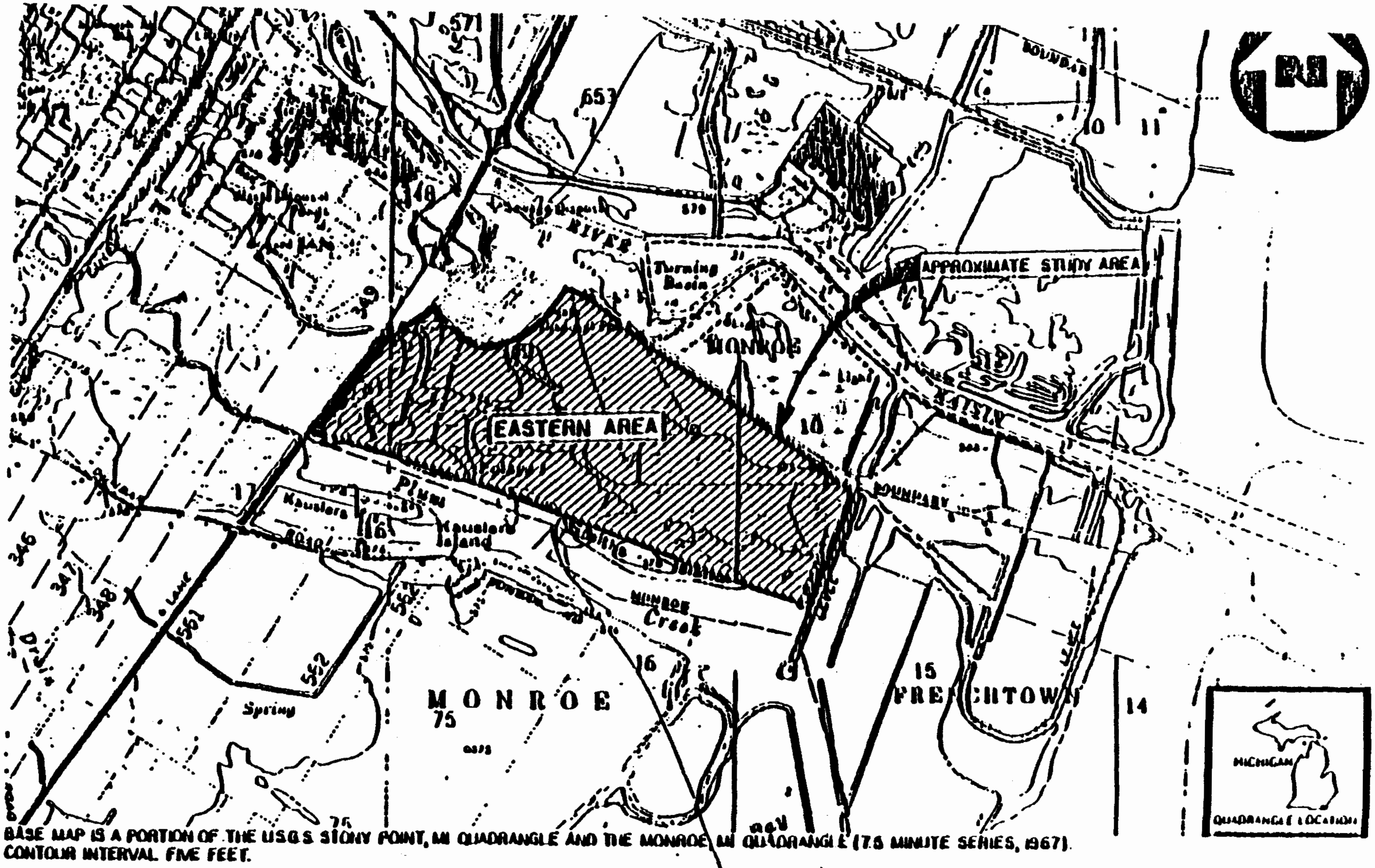


Figure 27 Location Map

Port of Monroe Site (East), Monroe, Michigan

NUS CORPORATION
A Halliburton Company

side of Plum Creek began in 1959, when the U.S. Army Corps of Engineers dredged the River Raisin navigation channel and turning basin (MDNR 1978, Interoffice Comm.). The polluted dredge spoils were pumped to the Plum Creek east marsh, and were deposited in an uncontained manner.

As in the Port of Monroe - West Side, fill material consists primarily of spent foundry sand with large amounts of automotive wastes, spent treated wood products, and packaging materials. The eastern portions of the landfill site also received dredge materials from the River Raisin (as mentioned above), in addition to pulp and paper waste. North Star Steel Company purchased 163 acres of the site and began construction of a mini-steel mill in 1978, as depicted in Figure 28.

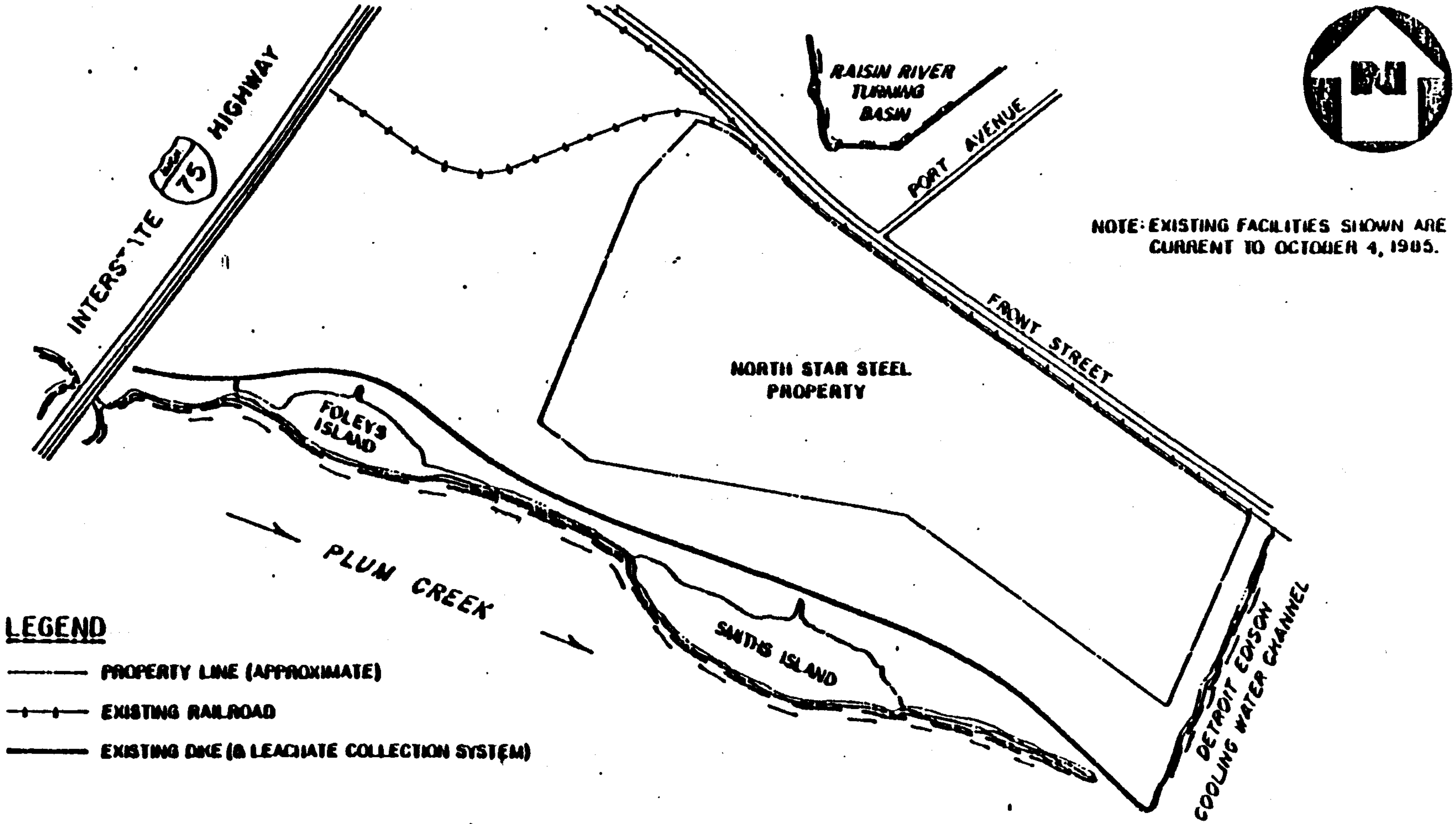
Because of citizen complaints regarding the encroachment of the landfill into Plum Creek, a retaining dike was constructed in 1968, which connected Foleys and Smith Islands, as shown in Figure 29. These dikes, constructed of porous materials and located on pervious soils, did not provide adequate containment of polluted leachate. High levels of PCBs were found in both fish and the sediments within the lagoons located behind the dike. Erosion and over-topping of the embankment was also occurring (MDNR 1976 Interoffice Comm.).

Plum Creek Dike. A new design for an impermeable earth dike was proposed by the Port of Monroe which would protect Plum Creek and Lake Erie from pollutants originating from the landfill. The resulting dike, completed in 1983, is approximately 7,300 feet long and extends from I-75 to the Detroit Edison Corporate levee (cooling water channel). The new dike is depicted in Figure 30. A 2.5-foot wide slurry wall runs along the entire length of the dike, extending from the dike surface to a depth of approximately 20 feet. The slurry wall is constructed of a crushed limestone/ bentonite mixture and is keyed into a clay-rich till layer (NUS 1986).

The leachate collection system within the newly constructed dike is composed of an 8-inch perforated pipe surrounded by a permeable bottom ash envelope. Leachate is collected, through gravity draining, into sumps and can be pumped north of the site to the Monroe WWTP. Analysis of the leachate is conducted quarterly by the Monroe WWTP. Results of the analysis are contained in Table 23.

The effectiveness of the Plum Creek Dike as a hydraulic and contaminant barrier has not been investigated to date. No data are available to assess the effectiveness of the removal of the contaminated Plum Creek sediments and their subsequent placement behind the new dike.

Hydrogeologic Characterization. Surface water drainage from the East Side flows to the Detroit Edison cooling water channel on the eastern side of the site, and to a detention basin on the west side of the site.



BASE MAP TAKEN FROM JOHNSON AND ANDERSON, INC.'S OVERALL SITE PLAN & INDEX SHEET, JOB NO 11209-07, SHEET 1 OF 15.

Figure 28 General Arrangement
Port of Monroe Site (East), Monroe, Michigan
SCALE: 1" = 1000'

NUS CORPORATION

Figure 29 . Sediment sampling locations on Plum Creek Near the City of Monroe, Monroe County, Michigan, August 11, 1976. MDNR, 1976

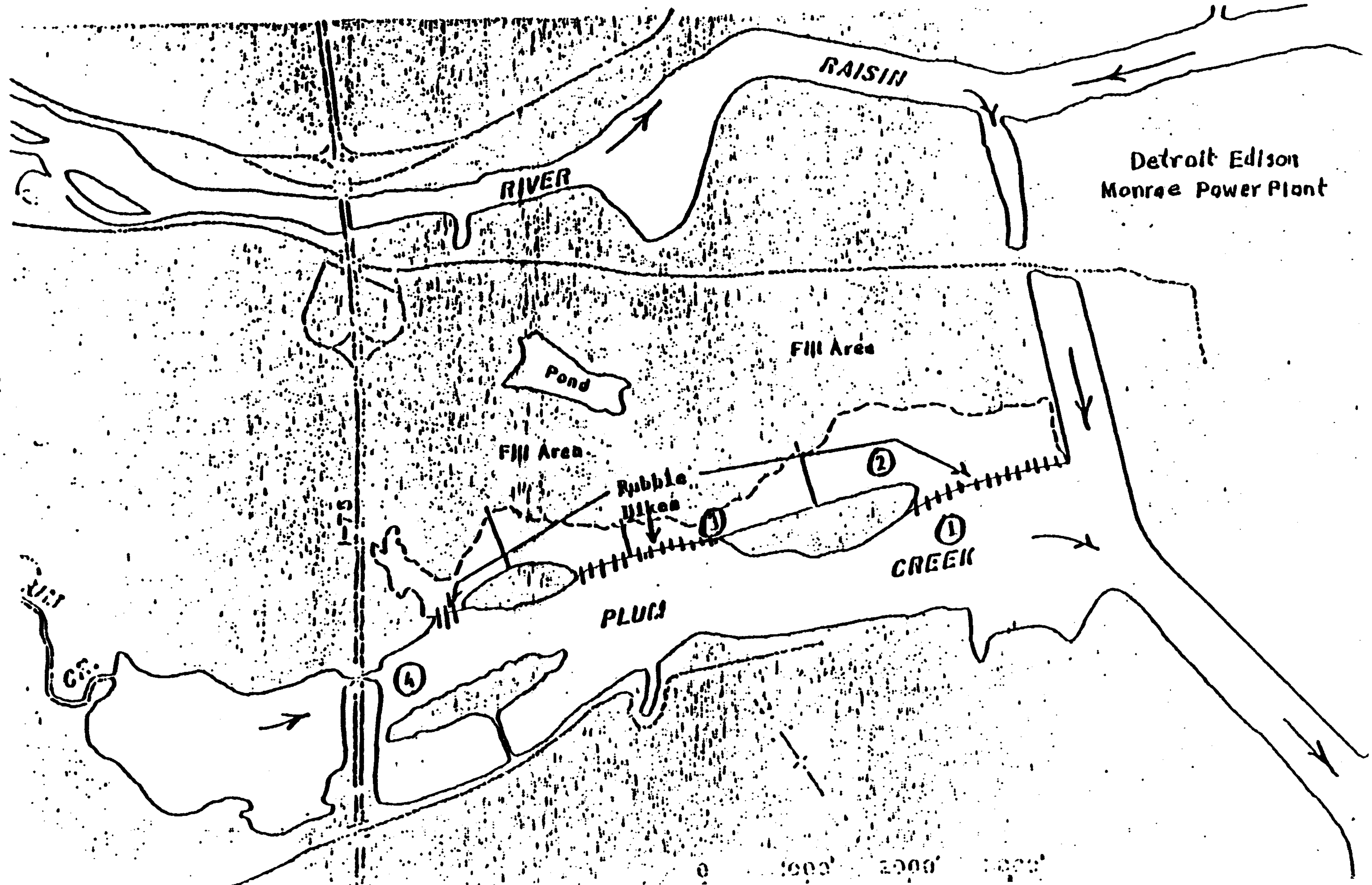


FIGURE 30 Location of New Containment Dike on South Side, Port of Monroe Landfill

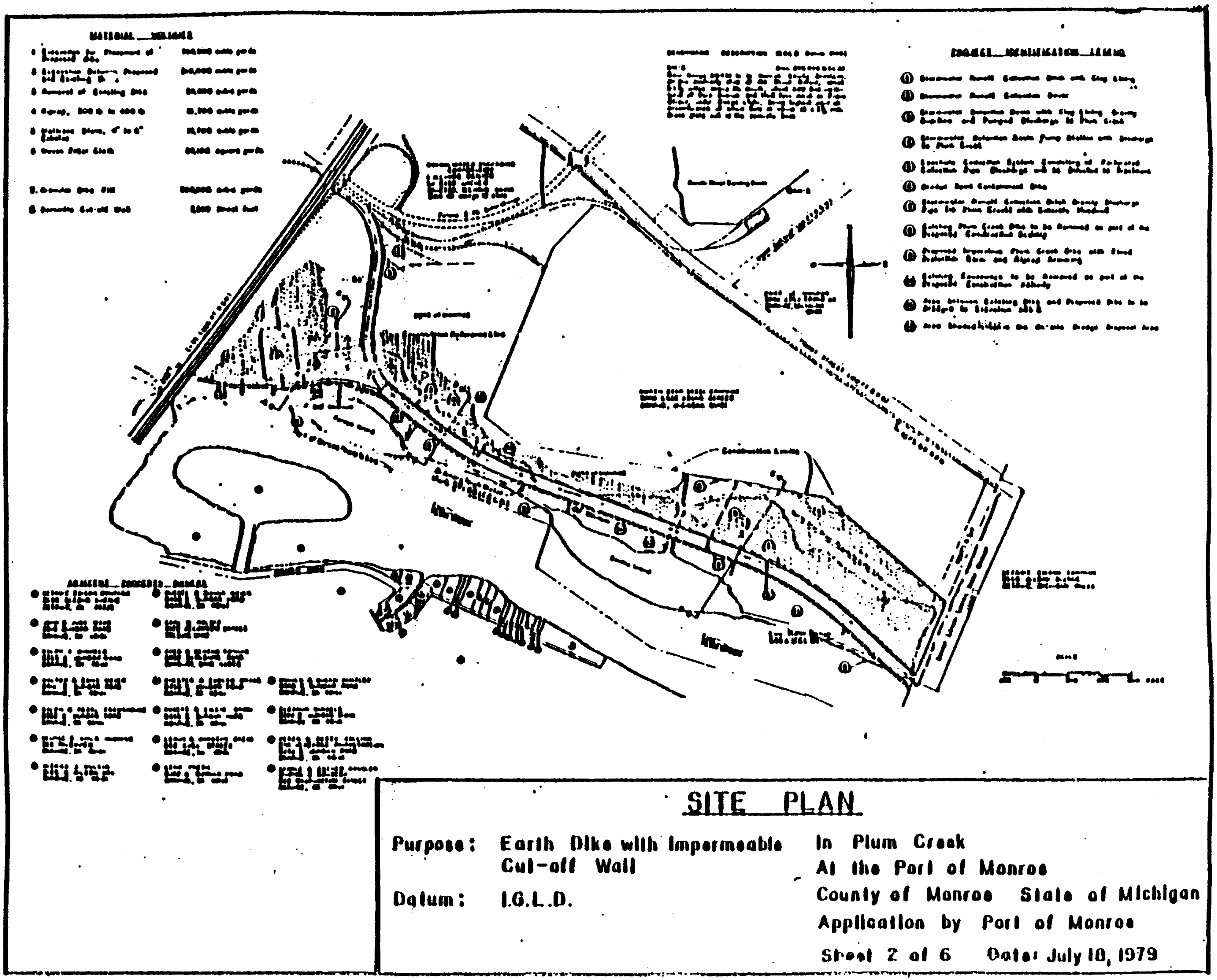


TABLE 23. ANALYSIS OF PORT OF MONROE LANDFILL LEACHATE RECEIVED BY THE MONROE WWTP.

Parameter	Units	Results 10/2/85	Results 11/21/86	Results 4/8/87
INORGANIC PRIORITY POLLUTANTS				
Antimony	mg/l	LT 0.002	LT 0.002	--
Arsenic	mg/l	LT 0.01	0.003	--
Beryllium	mg/l	LT 0.005	LT 0.002	--
Cadmium	mg/l	LT 0.002	LT 0.002	--
Chromium	mg/l	LT 0.006	0.003	--
Copper	mg/l	LT 0.002	LT 0.005	--
Lead	mg/l	0.010	LT 0.002	--
Mercury	mg/l	LT 0.0002	LT 0.0002	--
Nickel	mg/l	0.007	0.006	--
Selenium	mg/l	LT 0.03	LT 0.008	--
Silver	mg/l	LT 0.005	0.005	--
Thallium	mg/l	LT 0.05	LT 0.002	--
Zinc	mg/l	0.336	0.030	--
ORGANIC PRIORITY POLLUTANTS				
Acrolein	ug/l	LT 40	LT 5	LT 9
Acrylonitrile	ug/l	LT 20	LT 1	LT 2
Benzene	ug/l	LT 5	LT 0.2	LT 0.6
Bromodichloromethane	ug/l	LT 10	LT 0.3	LT 1
Bromoform	ug/l	LT 10	LT 2	LT 10
Bromomethane	ug/l	LT 10	--	--
Carbon Tetrachloride	ug/l	LT 10	LT 0.5	LT 0.8
Chlorobenzene	ug/l	LT 5	LT 0.6	LT 4
Chloroethane	ug/l	LT 10	LT 0.5	LT 0.9
2-Chloroethylvinyl Ether	ug/l	LT 70	LT 7	LT 10
Chloroform	ug/l	LT 5	LT 0.3	LT 0.5
Chloromethane	ug/l	LT 5	--	--
Dibromochloromethane	ug/l	LT 5	LT 0.5	LT 2
1,1 Dichloroethane	ug/l	LT 10	LT 0.8	LT 1
1,2 Dichloroethane	ug/l	LT 5	LT 0.4	LT 0.8

Table 23 Continued

Parameter	Units	Results 10/2/85	Results 11/21/86	Results 4/8/87
1,1 Dichloroethene	ug/l	LT 10	LT 0.7	LT 1
trans-1,2-Dichloroethene	ug/l	LT 5	--	--
1,2 Dichloropropane	ug/l	LT 5	LT 0.5	LT 2
cis-1,3-Dichloropropene	ug/l	LT 5	LT 0.4	LT 1
trans-1,3-Dichloropropene	ug/l	LT 5	LT 0.5	LT 2
Ethyl Benzene	ug/l	LT 5	LT 1	LT 7
Methyl Bromide	ug/l	--	LT 0.4	LT 0.9
Methyl Chloride	ug/l	--	LT 0.5	LT 0.9
Methylene Chloride	ug/l	LT 5	120	LT 1
1,1,2,2-Tetrachloroethane	ug/l	LT 5	LT 0.9	LT 8
Tetrachloroethene	ug/l	LT 5	LT 1	LT 10
Toluene	ug/l	LT 5	LT 0.7	LT 4
1,2-t-Dichloroethene	ug/l	--	LT 0.6	LT 0.9
1,1,1-Trichloroethane	ug/l	LT 5	LT 0.4	LT 0.7
1,1,2-Trichloroethane	ug/l	LT 5	LT 0.7	LT 3
Trichloroethene	ug/l	LT 5	LT 0.6	LT 2
Trichlorofluoromethane	ug/l	LT 10	LT 0.5	LT 0.8
Vinyl Chloride	ug/l	LT 5	LT 0.5	LT 0.9
4-Chloro-3-Methyl Phenol	ug/l	LT 5	--	--
2-Chlorophenol	ug/l	LT 5	LT 1	LT 1
2,4-Dichlorophenol	ug/l	LT 5	LT 1	LT 1
2,4 Dimethylphenol	ug/l	LT 5	LT 1	LT 1
4,6 Dinitro-O-Cresol	ug/l	--	LT 3	LT 2
2,4 Dinitrophenol	ug/l	LT 30	LT 5	LT 4
2-Methyl-4,6-Dinitrophenol	ug/l	LT 10	--	--
2-Nitrophenol	ug/l	LT 10	LT 2	LT 3
4-Nitrophenol	ug/l	LT 5	LT 3	LT 2
P-Chloro-M-Cresol	ug/l	LT 1	LT 1	--
Pentachlorophenol	ug/l	LT 10	LT 3	LT 3
Phenol	ug/l	13	LT 1	LT 0.7
2,4,6-Trichlorophenol	ug/l	LT 10	LT 1	LT 2
Acenaphthene	ug/l	LT 5	LT 1	LT 0.4
Acenaphthylene	ug/l	LT 1	LT 1	LT 0.3

Table 23 Continued

Parameter	Units	Results 10/2/85	Results 11/21/86	Results 4/8/87
Anthracene	ug/l	LT 1	LT 1	LT 0.3
Benzidine	ug/l	LT 10	LT 20	LT 9
Benzo (a) Anthracene	ug/l	LT 5	LT 1	LT 0.4
Benzo (b) Fluoranthene	ug/l	LT 5	LT 2	LT 0.3
Benzo (k) Fluoranthene	ug/l	LT 5	LT 2	LT 0.4
Benzo (ghi) Perylene	ug/l	LT 5	LT 3	LT 0.5
Benzo (a) Pyrene	ug/l	LT 10	LT 2	LT 0.4
4-Bromophenyl Phenyl Ether	ug/l	LT 10	LT 1	LT 1
Butyl Benzyl Phthalate	ug/l	LT 10	LT 3	LT 2
bis (2-Chloroethoxy) Methane	ug/l	LT 5	LT 1	LT 0.7
bis (2-Chloroethyl) Ether	ug/l	LT 5	LT 1	LT 0.8
bis (2-Chloroisopropyl) Ether	ug/l	LT 10	LT 1	LT 3
bis (2-Ethylhexyl) Phthalate	ug/l	LT 10	32	33
2-Chloronaphthalene	ug/l	LT 5	LT 1	LT 0.5
4-Chlorophenyl-Phenyl Ether	ug/l	LT 5	LT 1	LT 0.8
Chrysene	ug/l	LT 5	LT 1	LT 0.3
Dibenzo (ah) Anthracene	ug/l	LT 5	LT 3	LT 0.6
Di-n-Butyl Phthalate	ug/l	5	2.0	LT 0.4
1,2-Dichlorobenzene	ug/l	LT 5	LT 1	LT 0.8
1,3-Dichlorobenzene	ug/l	LT 5	LT 1	LT 0.8
1,4-Dichlorobenzene	ug/l	LT 5	LT 1	LT 0.8
3,3'-Dichlorobenzidine	ug/l	LT 20	LT 3	LT 0.7
Diethyl Phthalate	ug/l	LT 10	LT 1	LT 2
Dimethyl Phthalate	ug/l	LT 5	LT 1	LT 0.8
2,4-Dinitrotoluene	ug/l	LT 20	LT 5	LT 3
2,6-Dinitrotoluene	ug/l	LT 10	LT 5	LT 3
Di-n-Octyl Phthalate	ug/l	LT 5	8.4	LT 1.0
1,2-Diphenylhydrazine	ug/l	LT 1	LT 1	LT 0.4
Fluoranthene	ug/l	3	LT 1	LT 0.3
Flourene	ug/l	LT 2	LT 1	LT 0.4
Hexachlorobenzene	ug/l	LT 5	LT 1	LT 1.0
Hexachlorobutadiene	ug/l	LT 10	LT 1	LT 2
Hexachlorocyclopentadiene	ug/l	LT 10	LT 1	LT 4

Table 23 Continued

Parameter	Units	Results 10/2/85	Results 11/21/86	Results 4/8/87
Hexachloroethane	ug/l	LT 10	LT 1	LT 2
Indeno (1,2,3-cd) Pyrene	ug/l	LT 5	LT 3	LT 0.6
Isophorone	ug/l	LT 5	LT 2	LT 3
Naphthalene	ug/l	1	LT 1	LT 0.2
Nitrobenzene	ug/l	LT 5	LT 1	LT 0.8
N-Nitroso-Dimethylamine	ug/l	LT 5	LT 1	LT 2
N-Nitroso-Di-n-Propylamine	ug/l	LT 10	LT 2	LT 9
N-Nitroso-Diphenylamine	ug/l	LT 5	LT 1.0 (trace)	LT 1
Phenanthrene	ug/l	4	LT 1	LT 0.3
Pyrene	ug/l	4	LT 1	LT 0.3
1,2,4-Trichlorobenzene	ug/l	LT 5	LT 1	LT 1
Aldrin	ug/l	LT 20	LT 6	LT 3
Alpha-BHC	ug/l	LT 10	LT 2	LT 2
Beta-BHC	ug/l	LT 10	LT 3	LT 0.5
Gamma-BHC	ug/l	LT 20	LT 4	LT 4
Delta-BHC	ug/l	LT 10	LT 4	LT 3
Chlordane	ug/l	LT 30	LT 10	LT 6
4,4'-DDD	ug/l	LT 5	LT 2	LT 0.8
4,4'-DDE	ug/l	LT 10	LT 3	LT 1
4,4'-DDT	ug/l	LT 5	LT 4	LT 2
Dieldrin	ug/l	LT 5	LT 3	LT 2
Endosulfan I	ug/l	LT 50	LT 10	LT 5
Endosulfan II	ug/l	LT 40	LT 20	LT 8
Endosulfan Sulfate	ug/l	LT 20	LT 9	LT 4
Endrin	ug/l	LT 60	LT 50	LT 20
Endrin Aldehyde	ug/l	LT 30	LT 10	LT 7
Heptachlor	ug/l	LT 20	LT 6	LT 4
Heptachlor Epoxide	ug/l	LT 20	LT 8	LT 4
PCB-1016	ug/l	LT 6	LT 3	LT 1.0
PCB-1221	ug/l	LT 20	LT 3	LT 0.7
PCB-1232	ug/l	LT 10	LT 3	LT 1
PCB-1242	ug/l	LT 8	LT 3	LT 1
PCB-1248	ug/l	LT 9	LT 4	LT 1.0

Table 23 Continued

Parameter	Units	Results 10/2/85	Results 11/21/86	Results 4/8/87
PCB-1254	ug/l	LT 10	LT 4	LT 2
PCB-1260	ug/l	LT 10	LT 4	LT 1
Total PCB by Electron Capture	ug/l	LT 0.2	LT 0.1	--
Tetrachlorodibenzo-P-Dioxin	ug/l	LT 10	LT 4	LT 2
Toxaphene	ug/l	LT200	LT 10	LT 7
GENERAL CHEMISTRY				
Chemical Oxygen Demand	mg/l	134	47	48

LT = Less Than

(Source: Monroe Wastewater Treatment Plant, 1987).

The composition of the landfill and underlying material is nearly identical to the composition described for the West Side of the Port of Monroe landfill. Ten to fifteen feet of unconsolidated fill material are underlaid by a clay-rich till layer, also ranging between ten and fifteen feet in thickness. Highly fractured dolomitic limestone bedrock is present below the clay-till.

As in the West Side, two distinct groundwater regimes characterize the site: the upper water table aquifer within the fill material and the lower bedrock aquifer occupying fractures, solution channels, or other areas of secondary permeability in the dolomitic limestone (NUS 1986). Prior to dike construction, groundwater in the upper aquifer generally discharged to the River Raisin or to Plum Creek (H.C. Hall, 1981) as depicted in Figure 31.

NUS (1986) suggested that the Detroit Edison cooling water channel provides recharge for the water table (upper) aquifer at the East Side. The channel is a losing stream, according to water level elevations. However, the transmissivity of the corporate level adjacent to the cooling water channel is unknown.

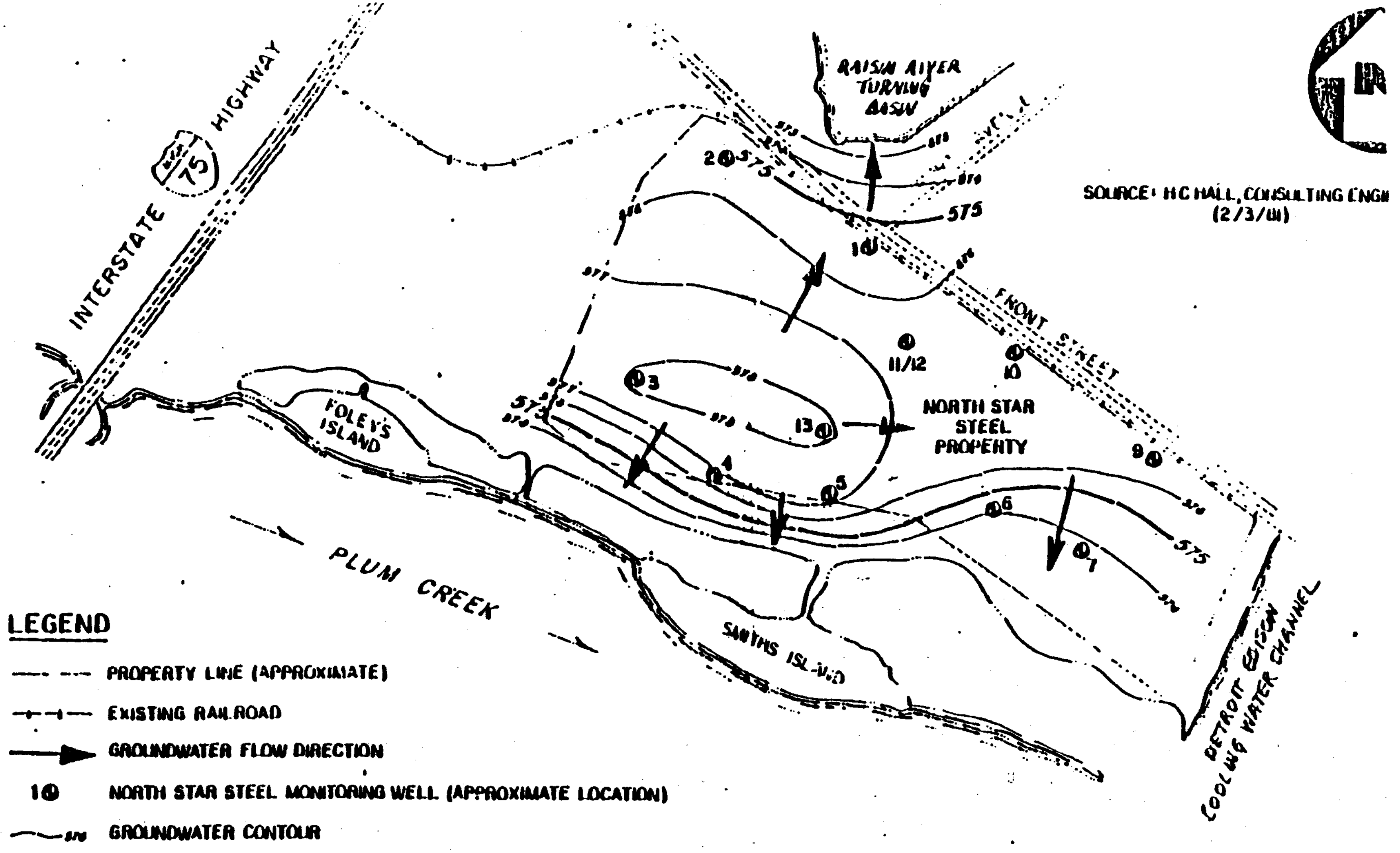
An upward gradient of water from the bedrock aquifer to the water table aquifer was suggested by an observed head differential of seven feet at a well cluster near Smith Island. This observation was made prior to the construction of the bentonite slurry wall (NUS 1986).

PCB Contamination. MDNR sampling in 1976 indicated that PCBs and numerous inorganic substances were contained in the lagoon sediments located behind the older ineffective dike. PCBs were also detected in fish tissue samples. No PCBs were detected in the limited groundwater sampling collected by Johnson and Anderson, Inc. (1983).

Groundwater flow direction prior to construction of the bentonite slurry wall suggested that pollutants (including PCBs) could have been leaching into the River Raisin. The river was identified as a major groundwater discharge point before implacement of the dike. It is believed that River Raisin may still be a groundwater discharge point and possibly a major receptor of site-related contamination (NUS 1986). No effort has been made to date to assess site-related impact or potential impact on the River Raisin. Unlike Plum Creek, no effort has been made to mitigate possible contaminant release from the East Side to the River Raisin.

NUS (1986) stated that no data are available to define the relationship between the water table and bedrock aquifers following placement of the Plum Creek Dike. The report suggested that a reversal of the upward gradient between the aquifers could occur with expanded use of the bedrock aquifer, coupled with water level increases in the water table aquifer. The current high water levels of Lake Erie (as in all of the Great Lakes) may also contribute to a gradient reversal between the aquifers.

Evidence of further groundwater contamination may suggest an increasing human health risk to the residents south of Plum Creek along Dunbar Road. This small residential area apparently uses groundwater as a potable



BASE MAP TAKEN FROM JOHNSON AND ANDERSON, INC'S OVERALL SITE PLAN & ...

Figure 31 Groundwater Contours - Pre-Dike Construction

Port of Monroe Site (East), Monroe, Michigan

SCALE: 1" = 1000'

NUS CORPORATION

A Halliburton Company

water source. These residents may be at risk because of site-related contamination.

5.3.2 Consolidated Packaging Corporation

Consolidated Packaging consisted of two plants, the North and South side divisions, located at approximately river miles 2.5 and 2.2, respectively. The North division closed in 1975, and the South division closed in 1978. Consolidated Packaging Corporation produced paper products, including paper board, corrugated papers, and liner board. The plant discharged most of its primary wastes to the Monroe WWTP, after applying primary treatment at the mill. Effluent from the South plant was discharged to the River Raisin and consisted of supernatant from sludge lagoons, along with screen washings from the plant's Lake Erie water intake (MWRC 1974).

The Consolidated Packaging Corporation (CPC) area includes the parcels of land east of Interstate 75 (I-75) (inside of the on/off ramps for the Front Street interchange), and acreage west of I-75. This area is depicted in (Figure 32). Also included in this area of potential environmental contamination are River Raisin sediments immediately below the outfall of the second cut (a tributary just downstream of I-75) (MDNR 1985, Site Description).

Consolidated Packaging manufactured paperboard and drums between the years 1889 and 1978. Approximately 27 acres of lagoons (7 lagoons in total) were utilized for the disposal of sludge from the Company's primary clarifiers. Locations of the sludge disposal beds are approximated in Figure 33. MDNR (1985) stated that, under abnormal circumstances, sludge would overflow to a ditch (presently running through the interchange of I-75, as seen in Figure 32), and drain into the second cut. In addition, supernatant from the sludge holding lagoons would also spill into the second cut.

Polychlorinated biphenyls have been measured in both the abandoned sludge lagoons and in the river sediments downstream of the plant's outfall. The sludge lagoon east of I-75 contain relatively high levels of PCBs (Arochlor 1242 = 23 mg/kg and Arochlor 1254 = 5.9 mg/kg). The river sediments down stream contained 5.2 mg/kg of Arochlor 1242 and 1.8 mg/kg of Arochlor 1254.

No groundwater monitoring has been undertaken in this area. The effect of the abandoned sludge lagoons on the groundwater and the potential for migration into the River Raisin is currently unknown. MDNR (1985) suggested that a high potential exists for the migration of contaminants from the lagoon because of the lack of protective barriers employed at the site.

The lagoons may also pose a threat to human health in terms of exposure through direct contact with soil or inhalation of contaminated material. The area is not restricted and only partially fenced. Foot paths were noted by MDNR on the west acreage. A school is situated approximately 300 feet from the western lagoons. Hunters have been known to roam through the area. The Michigan Department of Transportation was

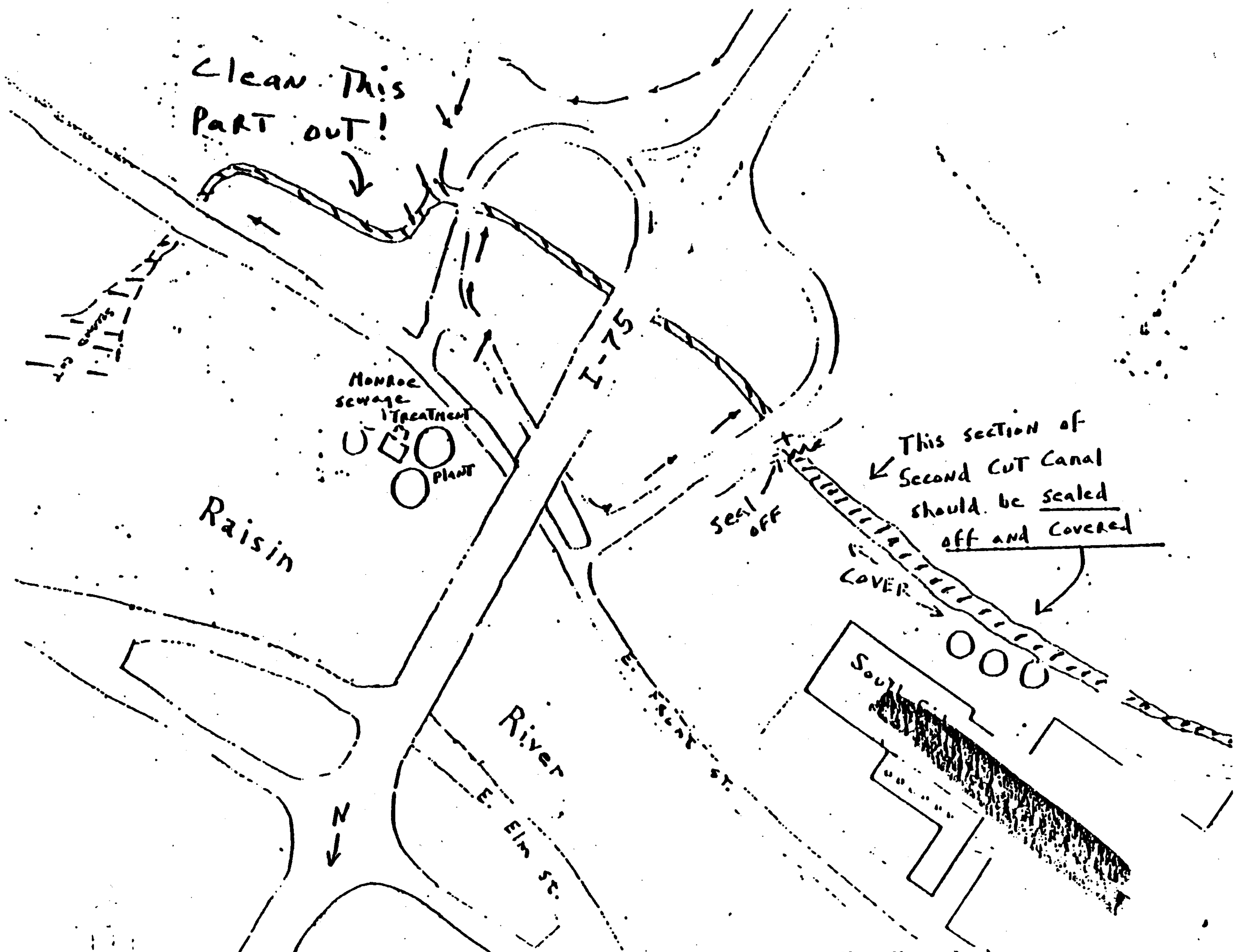


Figure ... Consolidated Packaging Corporation, Lagoons, and Second Cut Overflow Channel

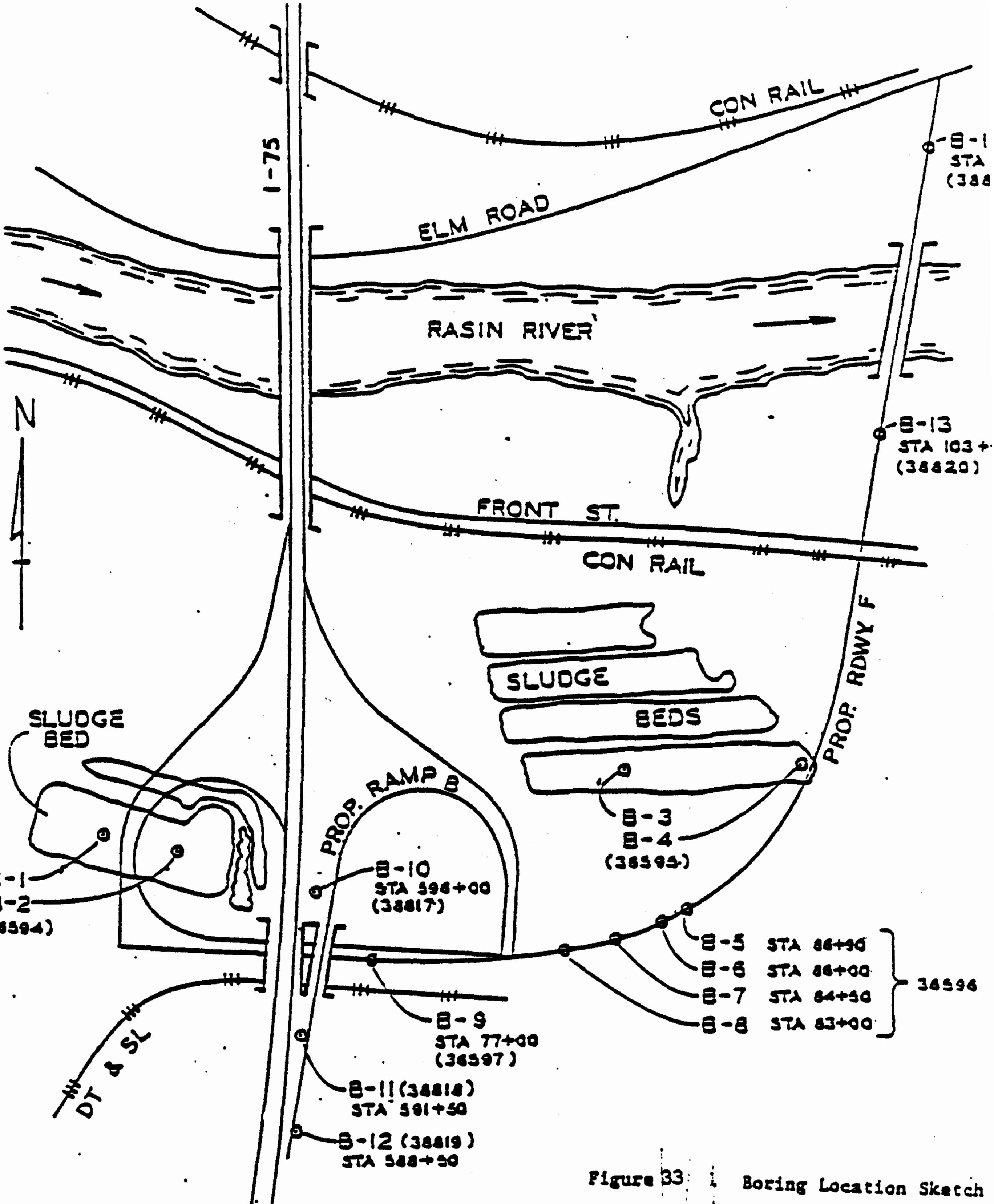


Figure 33 Boring Location Sketch

considering altering the exit ramps for Front Street from I-75. Although the current status of this project is unknown, the associated construction activities, including disturbance of the wastes in the area of the lagoons, would pose a threat to worker safety (MDNR 1985).

5.3.3 Ford Motor Company - Monroe Stamping Plant

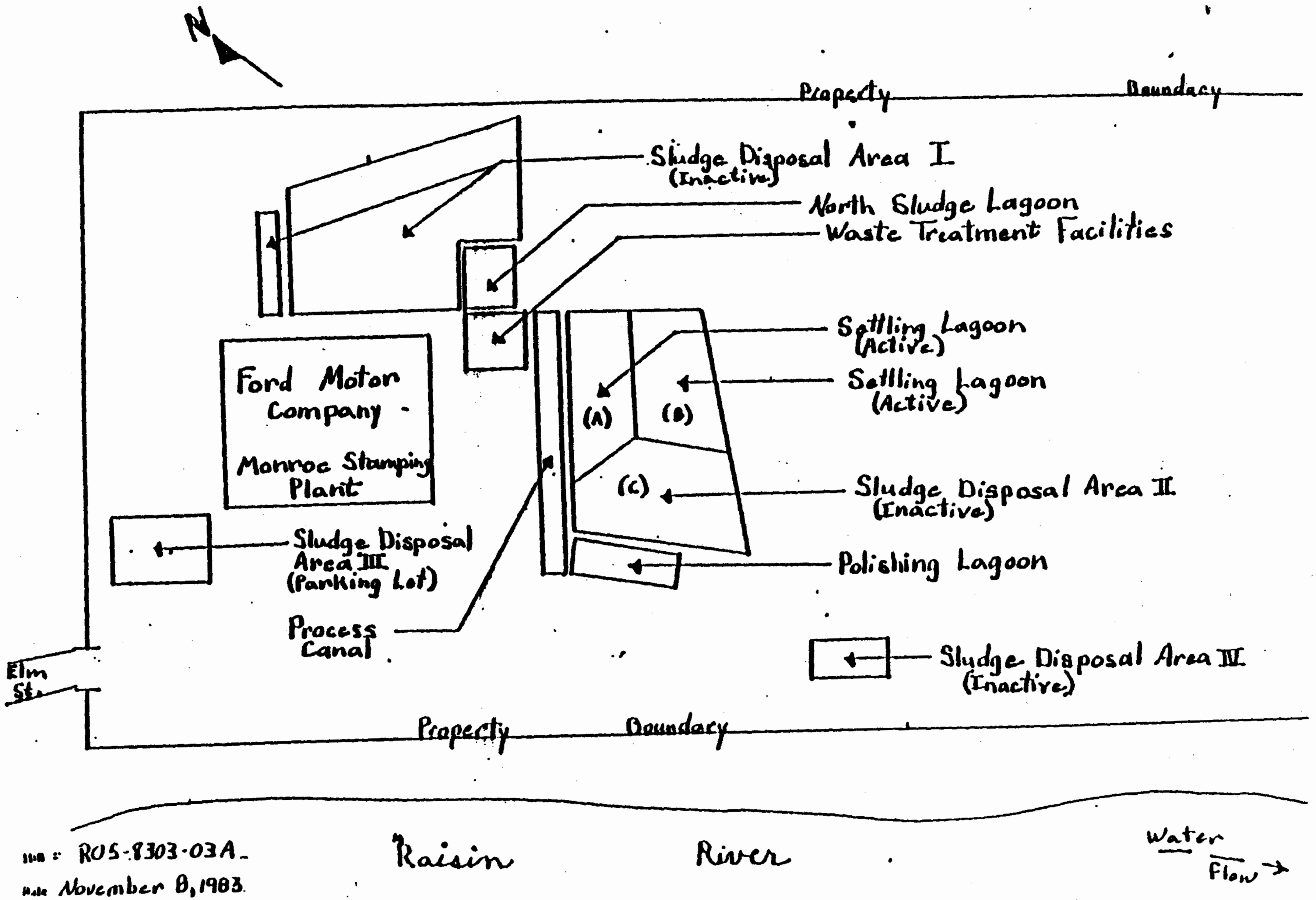
Ford Motor Company wastes largely include plating sludges which, prior to 1979, were collected in holding tanks, treated, and subsequently disposed of in settling lagoons (Ecology and Environment, Inc. 1983). The liquid portion was then released to a process water canal and a final polishing lagoon before being discharged, under an NPDES permit, to the River Raisin. Periodically the sludge was scooped out and removed to Sludge Disposal Areas I and II, as depicted in Figure 34. A small amount of the sludge (approximately 500 cubic yards) was allegedly mixed with fly ash and used for a parking lot base (Sludge Disposal Area III). Sludge was inadvertently disposed of in Area IV by a contractor. This material was believed to have been removed and the area filled with clay.

A wastewater treatment facility was completed after 1979, including the installation of sludge separation and dewatering systems. Treated wastewater is discharged to the River Raisin.

The Ford Motor Plant is situated on a slightly elevated site surrounded by a marshy area. The entire site is located on the flood plain. At high water, the lake elevation rises to within a foot of the top of the diking. There is a potential for dike erosion to occur at these times (MDNR 1986 - Site Visit Report). Because of the high clay content of the soils, precipitation generally runs off to one of the marshy areas on site, or to Lake Erie via the River Raisin and Mason Run Drain. Surface runoff collects in Disposal Area I, forming a well vegetated pond. Ford Motor Company officials state that the pond attracts wild birds. Disposal Area II, on the other hand, is mostly dry with only a small, low weedy area to retain water.

The high percentage of clay in the soil results in a low vertical hydraulic conductance (Ecology and Environment, Inc. 1983). The authors noted that pockets of sandy fill material could increase the horizontal hydraulic conductance. It was postulated that greater horizontal conductance could make the lagoons leak. The potential for an adverse affect from the lagoon wastes on the adjacent wetlands would then exist.

No groundwater contamination of PCBs has been documented to date at the Monroe Stamping Plant. Ford Motor Company is required to submit a semi-annual survey of groundwater contamination from 10 wells. Although concentrations of lead, fluoride, and coliform bacteria exceeded the USEPA Interim Drinking Water Standards in the 1983 first quarterly sampling, no measured constituents exceeded Drinking Water Standards in the 1985 sampling program. An illustration of the direction of groundwater flow, based on static elevations measured in 1985, are provided in Figure 35 (Ford Motor Company 1985).



ROS-8303-03A
Date November 8,1983
Prepared By A. Sause
ECOLOGY AND ENVIRONMENT, INC.

FIGURE 34 Ford Motor Company - Monroe Stamping Plant, Sludge Disposal Locations

Source: Ecology and Environment 3

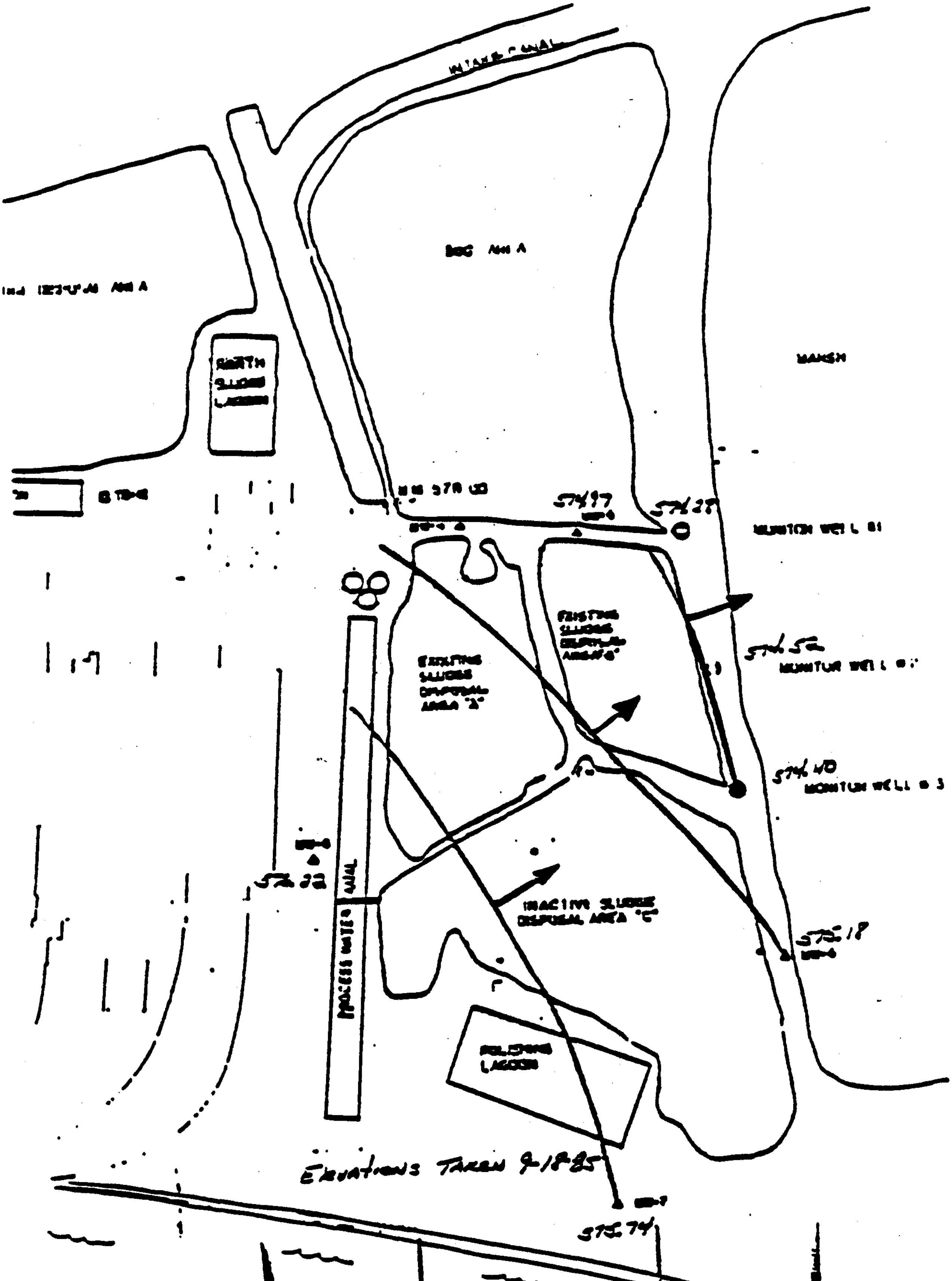


FIGURE 35 - Ford Motor Company - Monroe Stamping Plant, Location of Groundwater Monitoring Wells and Likely Direction of Groundwater Flow

Source: Ford Motor Company 1985. Ford Monroe Stamping Plant Semiannual Groundwater Monitoring Report.

5.3.4 City of Monroe Landfill

The City of Monroe Sanitary Landfill is located on 40 acres in the City of Monroe north of Front street between Port & McMillan streets. The City of Monroe owned the property at the time that the landfill was in operation. The Port of Monroe Authority was responsible for the landfill's operation. Industrial waste and general refuse were received at this site. According to Port of Monroe commission meeting minutes, filling of this property began in 1954. A list of industries using the site for disposal purposes at the time of its closure in 1969 included: Time Container Co., Union Camp Corp., Wood All Inc., Ace Paper Products, Consolidated Packaging Co., Detroit Stoker Co., La-Z-Boy Chair Co., and Monroe Steel Castings. Disposal methods were poor, utilizing inadequate daily and final cover, random dumping and filling into water. The last three years of the landfill's operation were licensed under Act 87.

The property is presently owned by the Detroit Edison Company. It is not known what types of releases may be occurring at the site. Because the landfill is located adjacent to the Raisin River and was essentially created out of a wetland, impacts to the surface waters in the area are of major concern.

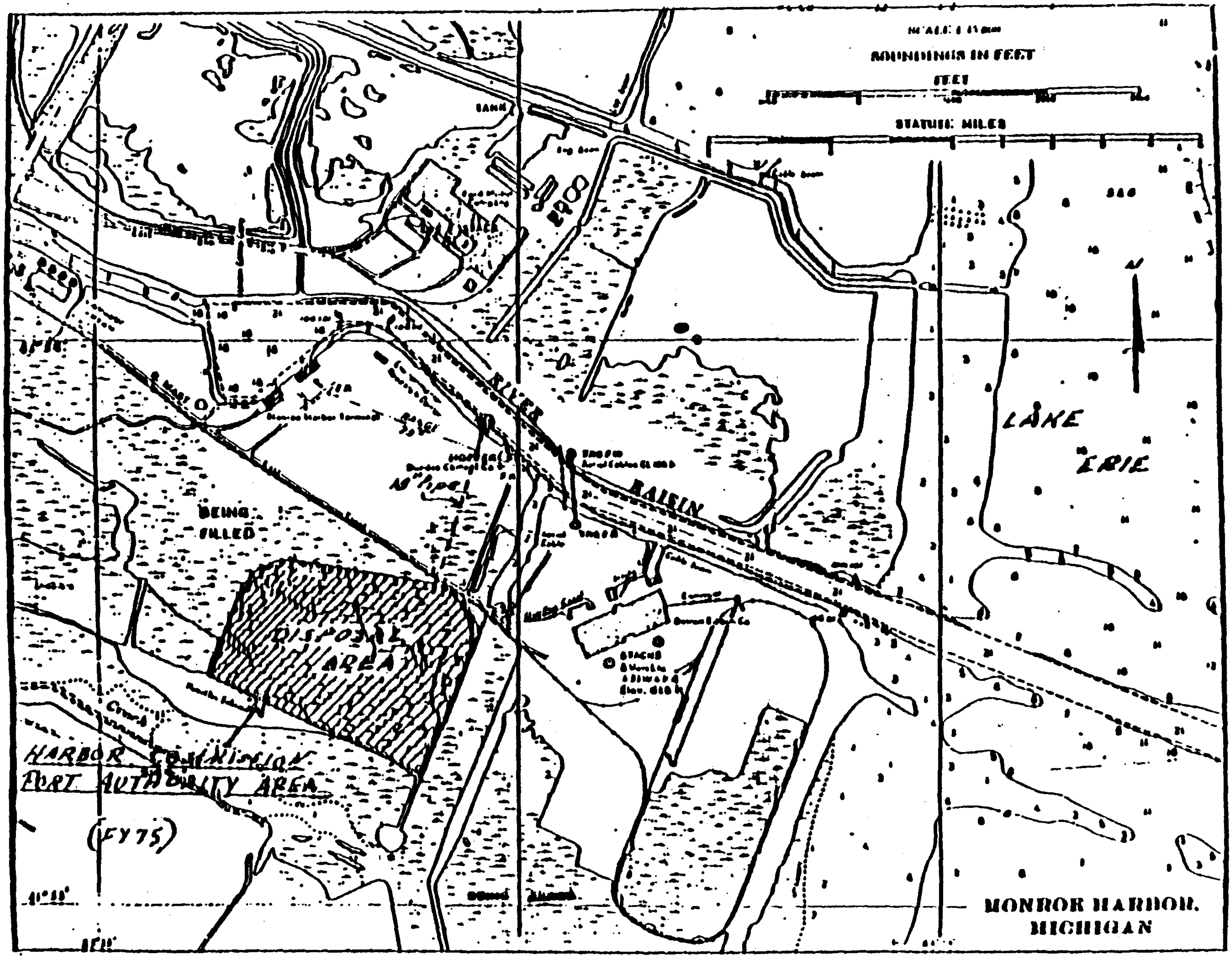
5.3.5 Detroit Edison - Dredge Spoil Site

Dredge spoil from the U.S. Corps of Engineers Channel maintenance operations has been deposited in four separate areas. These are the Harbor Commission Port Authority Area (Port of Monroe Landfill-Eastside) (Figure 36); Detroit Edison Disposal Area (within the railroad loop) (Figure 37); Detroit Edison Fly-Ash Area (Figure 38); and the Sterling State Park Confined Disposal Facility (Figure 39). A summary of the dredged material source, disposal area, and volume of fill is provided in Table 24. This table is further summarized according to the volume of material taken from the source area in Table 25, and then according to the volume of dredge spoil placed into each disposal area also in Table 25.

From Table 24, it is apparent that the highly PCB contaminated material dredged from the Turning Basin in 1981 and 1982 was placed in Detroit Edison's Fly-Ash disposal area (Figure 38). According to MDNR 1985 (Site Description), this disposal area is classified as a wetland with hydraulic connection to both ground and surface waters. The sediments in the River Raisin and the lake-channel contain lower concentrations of PCB than those measured in the Turning Basin (See Chapter 4, Section 4.2.2). These dredged sediments were placed in the Detroit Edison Railroad Loop and the Sterling Park CDF (Figures 37 and 39).

5.4 SUMMARY

The only municipal discharger in the Area of Concern is the City of Monroe activated sludge treatment plant. The plant currently receives domestic wastewater along with septic tank deliveries, treated primary effluent from packing plants, and paper mill effluent. PCBs were below analytical detection limits in the plant discharge in 1980 and 1984, although a sludge sample was found to have 0.29 mg/kg of Arochlor 1254, in 1984. As of January, 1987, Monroe WWTP has discontinued discharging



Source: USCOE 1985

... Harbor Commission Port Authority Area for Disposal of River

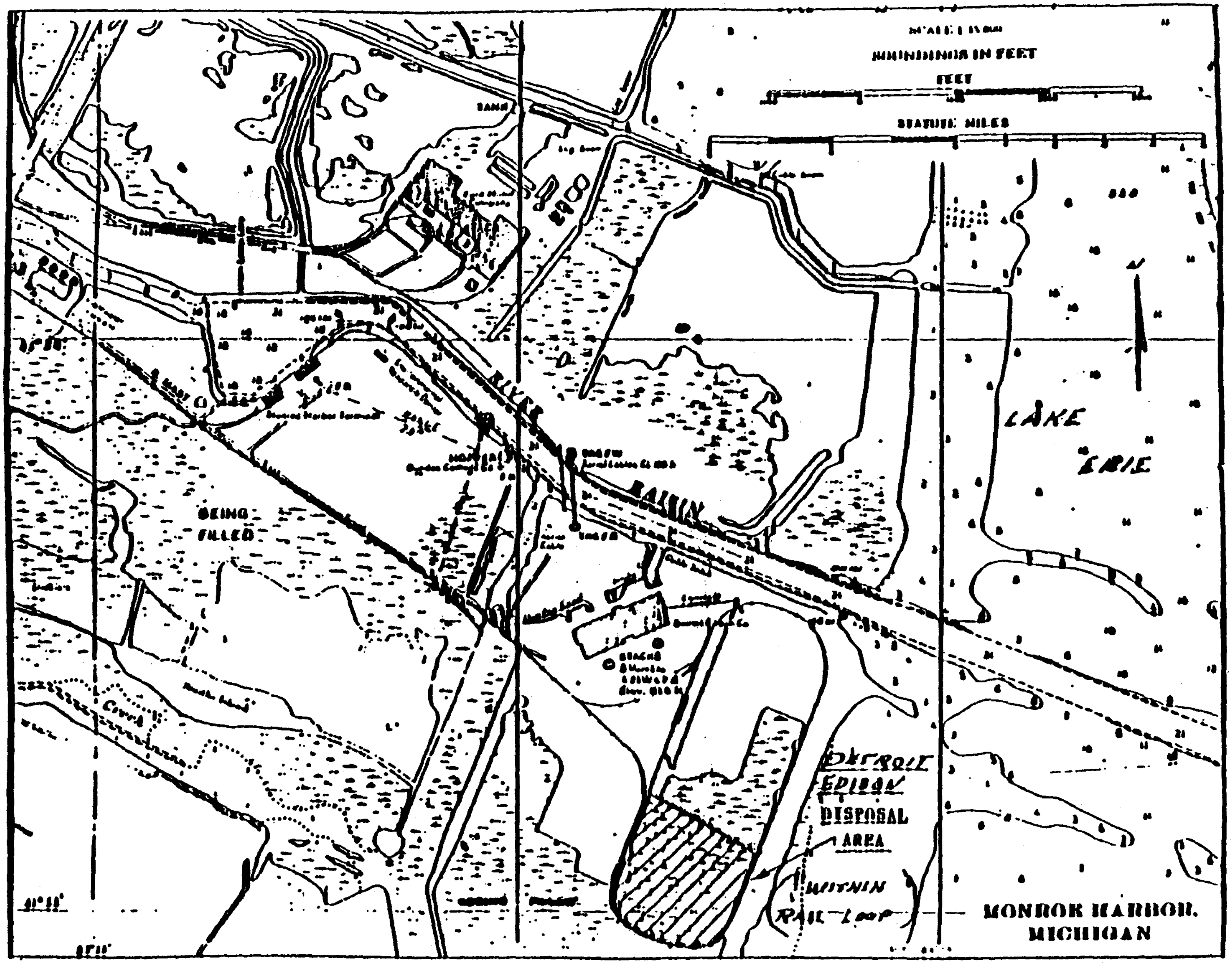


FIGURE 37 ' Detroit Edison Disposal Area for River Raisin Sediments

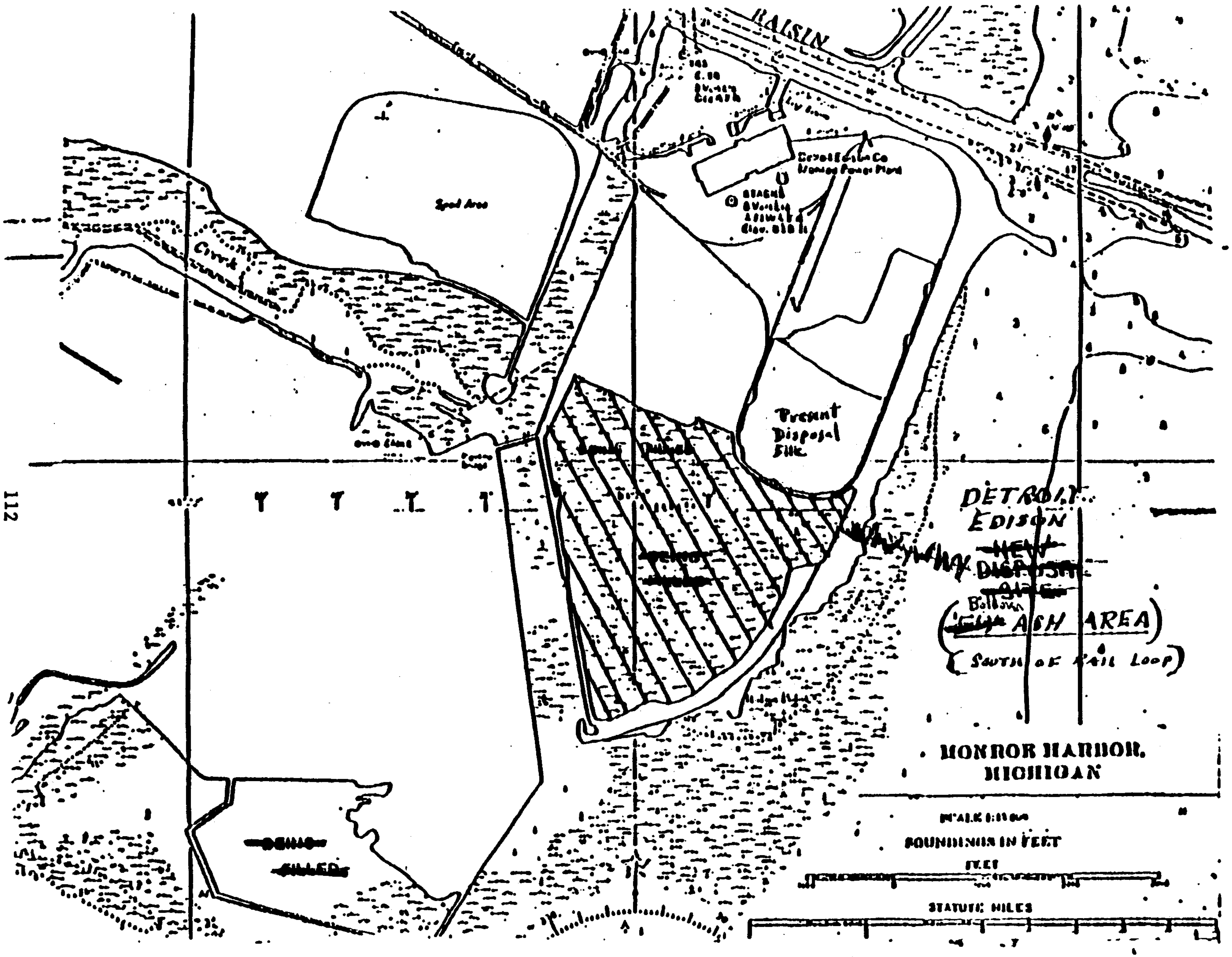


FIGURE 38 Detroit Edison Fly-Ash Area (South of Rail Loops) for Disposal of River Raisin Sediments

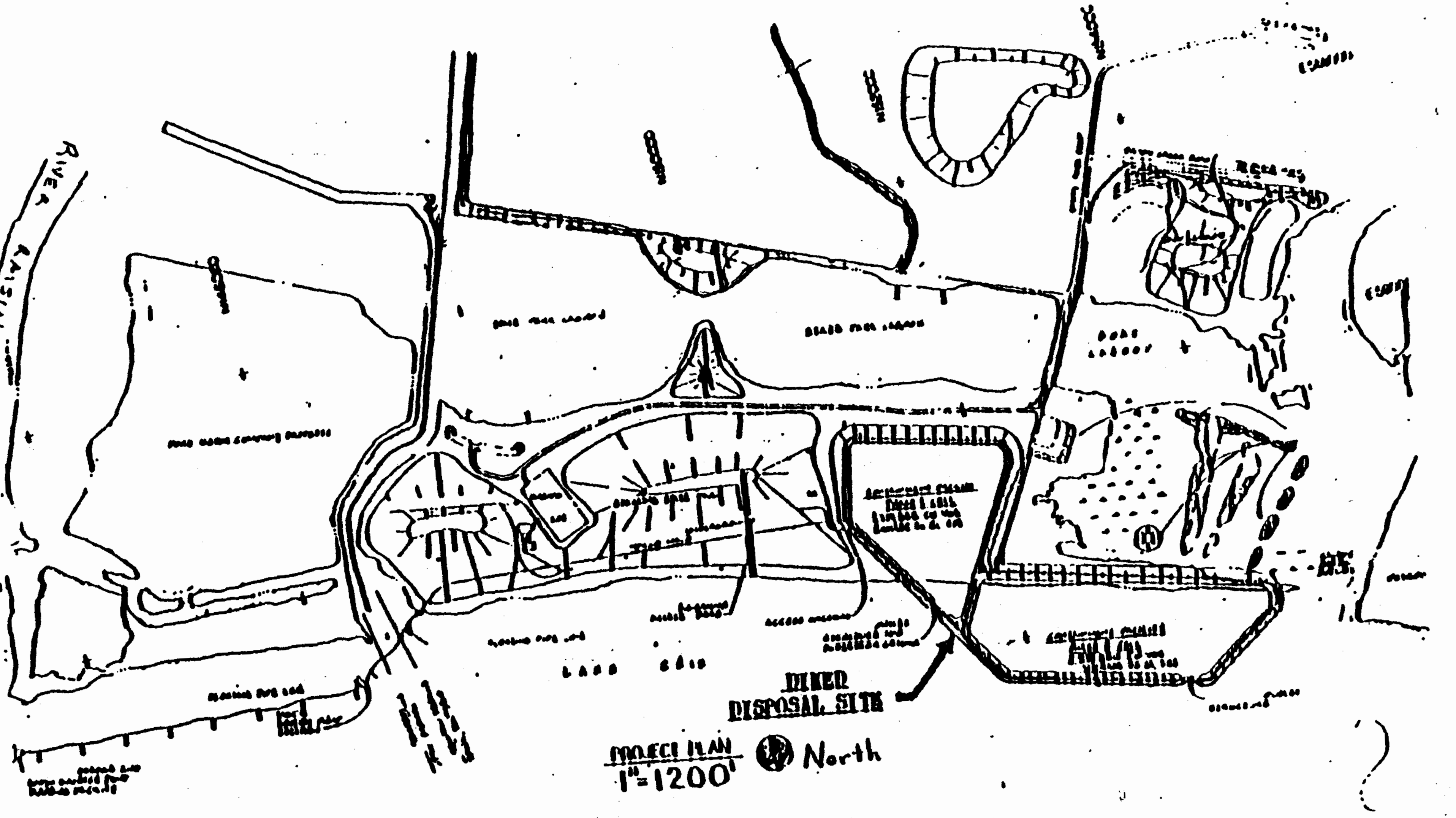


FIGURE 39 Sterling State Park Confined Disposal Area for River Raisin Sediments

Source: USCOE 1985

TABLE 24
U.S. A. . CORPS
DREDGINGREPORT FOR MONROE HARBOR
(FORTHE LAST 10 YEARS)
1975-1985

FY-YEAR	MATERIAL TAKEN FROM	MATERIAL PLACED	AMOUNT (C.Y.)	TYPE OF EQUIPMENT USED
1975	RIVER	HBR. COMM. AREA	106967	HOPPER DREDGE (HAINS)
	TURNING BASIN	HBR. COMM. AREA	51301	HOPPER DREDGE (HAINS)
			(158268)	
1977	RIVER	DETROIT EDISON R. R. LOOP	12988	HOPPER DREDGE (HAINS)
	RIVER	DETROIT EDISON R. R. LOOP	185230	HOPPER DREDGE (HOFFMAN)
			(198218)	
1978	RIVER	DETROIT EDISON R. R. LOOP	106496	HOPPER DREDGE (HOFFMAN)
1979	RIVER	DETROIT EDISON FLY ASH AREA	444656	HOPPER DREDGE (HOFFMAN)
	RIVER	DETROIT EDISON FLY ASH AREA	240029	HOPPER DREDGE (LYMAN)
			(684685)	
1980	RIVER	DETROIT EDISON FLY ASH AREA	119433	HOPPER DREDGE (HOFFMAN)
1981	TURNING BASIN	DETROIT EDISON FLY ASH AREA	42268	HOPPER DREDGE (HAINS)
	RIVER	DETROIT EDISON FLY ASH AREA	115271	HOPPER DREDGE (HAINS)
			(157539)	
1982	RIVER	DETROIT EDISON FLY ASH AREA	217620	HOPPER DREDGE (HAINS)
	TURNING BASIN	DETROIT EDISON FLY ASH AREA	30449	HOPPER DREDGE (HAINS)
			(248069)	
1983	RIVER	DETROIT EDISON FLY ASH AREA	117237	HOPPER DREDGE (HAINS)
1984	LAKE-CHANNEL	STERLING (CDF)	31125	HYDRAULIC DREDGE (CONTACTOR)
	LAKE-CHANNEL	STERLING (CDF)	83944	HOPPER DREDGE (HAINS)
			(115069)	
AS OF OCT. 22 1985	LAKE-CHANNEL	STERLING (CDF)	333686	HYDRAULIC DREDGE (CONTRACTOR)

NOTE: THE HAINS AND THE HOFFMAN ARE CORPS DREDGES

Table 25. U.S. Corp of Engineers Dredging Summary 1975-1985

Cubic Yards of Dredge Material Taken From:

Year	River Raisin	Turning Basin	Lake-Channel
1975	106,967	51,301	-
1977	198,210	-	-
1978	106,496	-	-
1979	684,685	-	-
1980	119,433	-	-
1981	115,271	42,268	-
1982	217,620	30,449	-
1983	117,237	-	-
1984	-	-	115,069
1985	-	-	333,696
Total	1,665,919	72,717	448,755

Cubic Yards of Dredge Material Placed In:

Year	HBR Comm. Area	Detroit Edison R.R. Loop	Detroit Edison Fly-Ash Area	Sterling CDF
1975	158,268	-	-	-
1977	-	198,210	-	-
1978	-	106,496	-	-
1979	-	-	684,685	-
1980	-	-	119,433	-
1981	-	-	157,539	-
1982	-	-	248,069	-
1983	-	-	117,237	-
1984	-	-	-	115,069
1985	-	-	-	333,686
Total	158,268	304,706	1,326,963	448,755

Source:

into the River Raisin and add a new outfall that discharges into Plum Creek which is still inside the Area of Concern.

Five industries discharge within the River Raisin AOC: Ford Motor Company-Monroe Stamping Plant, Detroit Edison-Monroe Power Plant, Union Camp Corporation, and La-Z-Boy Chair Company. Consolidated Packaging, a paper products plant which closed in 1978, discharged primary wastes and effluent from sludge lagoons to the WWTP. PCBs in the Consolidated Packaging sludge lagoon have been measured as high as 23.0 mg/kg (Arochlor 1242).

Detroit Edison-Monroe Power Plant, is a coal-fueled facility with a capacity of 3200 Megawatts per hour. The hydrology of the lower River Raisin is determined during low flow conditions by the complete withdrawal of river water at the power plant water intake. Discharges of cooling water have ranged from 968 to 1,451 MGD. In 1973, PCBs were detected in trace quantities during a Point Source Summary. The only other measurement of PCBs (1982) resulted in no detection. No definitive conclusion can be made from the current data relative to possible PCB contributions from the plant.

Ford Motor Company operates a stamping, metal/forming, and painting plant. Combined wastewaters (cooling water from welding machines, heat exchangers, air conditioners, and compressors; and backwash from sand filters) are pumped from the end of the process channel to the polishing lagoon. Overflow from the polishing lagoon is discharged to the River Raisin. PCBs were measured in both detectable and trace amounts in the Ford discharge during 1980 and 1982. However, in 1984, PCBs were below the analytical detection limit of 0.0001 mg/l.

Union Camp Corporation, a manufacturer of corrugated containers, discharges into Mason Run and/or the River Raisin through seven active outfalls. No PCB measurements have been conducted for the discharge or Mason Run, the receiving stream.

Wastewater discharged from La-Z-Boy Chair Company contains only non-contact cooling water.

Non-point sources of pollution to the AOC include the Port of Monroe Landfill (both east and west sides), Consolidated Packaging Corporation (former lagoons and lagoon overflows), Ford Motor Company lagoons, City of Monroe Landfill, Detroit Edison dredge spoils and the contaminated sediments of the River Raisin itself. PCBs have been identified at all of these locations, in either the surface water (i.e., standing water in adjacent waterbodies), the soils, the sediments (saturated), and/or the groundwater. Residential wells may also be contaminated with pollutants originating from inadequate disposal activities in the AOC.

Table 26 summarizes the detection of PCBs in the major landfills and sites of environmental contamination in the AOC. The measurement of PCBs at each site is provided according to the appropriate environmental medium (i.e., surface water, soil, sediments/sludge, groundwater). The spaucity of data across all environmental media is clearly evident.

Table 26 Summary of PCBs Detected in or Adjacent to the Major Landfills in the River Raisin AOC.

		Range of Concentration		
	Surface Water (mg/l)	Soil (mg/kg)	Sediment/Sludge (mg/kg)	Groundwater (mg/l)
I. LANDFILLS				
A. East Side-Port of Monroe	ND (J&A, 1983)	0.3-2.0 N. Star Steel (Clayton (1985))	ND (J&A, 1983)	ND (J&A, 1983) .0012 (N.Star Steel manhole-seepage, 1982)
B. West Side-Port of Monroe	(No Data)	Total .1-1.8 1242 <.02-.46 1248 .17-.55 1260 <.02-1.3	(Not Applicable)	Total <.0002-.00033 1242 <.0004-.00033 1248 <.0002-.0005 1260 <.0002
C. Consolidated Packaging	(No Data)	ND (MDNR 1984)	1242 .77-23.0 1254 .54-5.9 Sludge beds (MDNR 1984) Total .66-1.3 lagoons (east)(URS 1985) 1242 5.5 1254 1.5 (lagoons)	(No Data)
D. City of Monroe	(No Data)	(No Data)	(Not Applicable)	(No Data)
E. Detroit-Edison				
1. Port of Monroe Disposal Area	(No Data)	(No Data)	(Not Applicable)	(No Data)
2. Detroit Edison Disposal Area	(No Data)	(No Data)	(Not Applicable)	(No Data)
3. Fly-Ash Area				
4. Sterling State Park confined Disposal Area	(No Data)	(No Data)	(No Data)	(No Data)

Final summary Tables 27 and 28 of the environmental contaminants of the East Side and the West Side of the Port of Monroe Landfill are provided to clarify the nature and extent of contamination of these sites, the potential sources of contaminations, the potential discharge areas, public health concerns, and the currently proposed remedial investigations for each.

Table 27 Summary of the Environmental Contamination of the East Site of the Port of Monroe landfill

Port of Monroe - East Site

Nature and Extent of Contamination	Potential Sources	Potential Discharge Areas for Water Table Aquifer	Public Health Concerns	Current Proposed Remedial Investigation (NUS 1986)
• PCBs in sediments and fish sampled from the lagoons behind the old Plum Creek Dike (1976-1977 data)	• PCBs in sediment and fish probably derived from bulldozer activity and/or erosion of contaminated fill; however, PCBs were not measured in the groundwater.	• Plum Creek • River Raisin (Turning Basin) • Detroit Edison (cooling water channel)	• There are approximately 12 homes on Dunbar Rd. (southern shore of Plum Creek) which may still be using groundwater as their potable water supply.	Remedial Investigation: • Better define the hydro-geologic conditions in both water table and bedrock aquifers • Establish the nature of chemical contamination • Sample the existing leachate system • Surface water (Plum Creek) (Detroit Edison cooling channel)
• Inorganic substances detected at high concentration in groundwater: Pb = 1 mg/l Hg = 7 mg/l Cr = 1.75 mg/l	• Erosion and slumping of landfill into Plum Creek; but also groundwater source of contamination.			Feasibility Study: • Determine the potential value of the Plume Creek Dike Slurry wall and leachate collection system • Is remedial action needed?
• Low levels of organic chemicals detected in groundwater samples	• Loading via groundwater thought to be extremely likely prior to construction of dike; data is questionable, however, and values may be higher.			

Table 27 : Summary of the Environmental Contamination of the East Site of the Port of Monroe Landfill

Continued

Port of Monroe - East Side

Nature and Extent of Contamination	Potential Sources	Potential Discharge Areas for Water Table Aquifer	Public Health Concerns	Current Proposed Remedial Investigation (NUS 1986)
• Acid and Base Neutral compounds detected at high concentrations - Benzene, Napthalene, Toluene, Creosote, Ethylbenzene, Phenol, Phthalate esters, Cresol, Xylene, Cumene	• Organic chemical contamination may constitute a threat to local waterbodies			

Table 28 Summary of the Environmental Contamination of the West Site of the Port of Monroe Landfill

Port of Monroe - West Site

Nature and Extent of Contamination	Potential Sources	Potential Discharge Areas for Water Table Aquifer	Public Health Concerns	Current Proposed Remedial Investigation (NUS 1986)
• High concentrations of heavy metals in water table aquifer. All exceeded statutory and recommended drinking water standards in at least 3 of the 10 wells sampled. (Cr, Cu, Ni, Zn) • Elevated COD in 3 of 10 samples (65-8200 mg/l) • Elevated specific conductance in all samples (1100 µmhos/cm - 2,600 µmhos/cm) • Elevated levels of TOC in 5 of 10 samples from water table aquifer. • Groundwater sampling for priority pollutants limited to 1 bedrock aquifer sample. Low conc. (µg/l) of acrolein (46), benzene (20), tetrachloroethene (7), and toluene (33) were measured. • A composite sample from the water table aquifer (µg/l) indicted the presence of toluene (2), dimethylphthalate (120), and PCBs (330). • Soil samples (10) indicated PCBs at all locations (150-1,800 µg/kg).	• PCB contamination in soils may be extensive, and could be quite high. • Volatile organic compounds in the bedrock aquifer indicates that this aquifer may be affected by contaminants in the landfill. • Contaminant transport via groundwaer advection (water table aquifer) • Erosion of contaminated sediment/groundwater discharge to Plum Creek.	• River Raisin • Plum Creek (this site is adj. to the creek) • To a lesser extent, towads I-75 (eastward direction).	• Site habitability	<u>Remedial Investigation:</u> • Site characterization - Comprehensive sampling grid - Magnetometry - define sources of volatile organic contamination of fill • Soil gas testing • PCBs will be used as indicator of non-volatile organic contamination, as well as indicator of dioxins (from previous burning) • Surface water, sediment sampling in wetland areas to the southwest of the landfill, and in Plum Creek (River Raisin?) Determine: • Transmission of contaminants into bedrock aquifer • Habitability Assessment <u>Feasibility Study:</u> Evaluate Remedial Alternatives

6. POLLUTANT LOADINGS AND TRANSPORT MECHANISMS

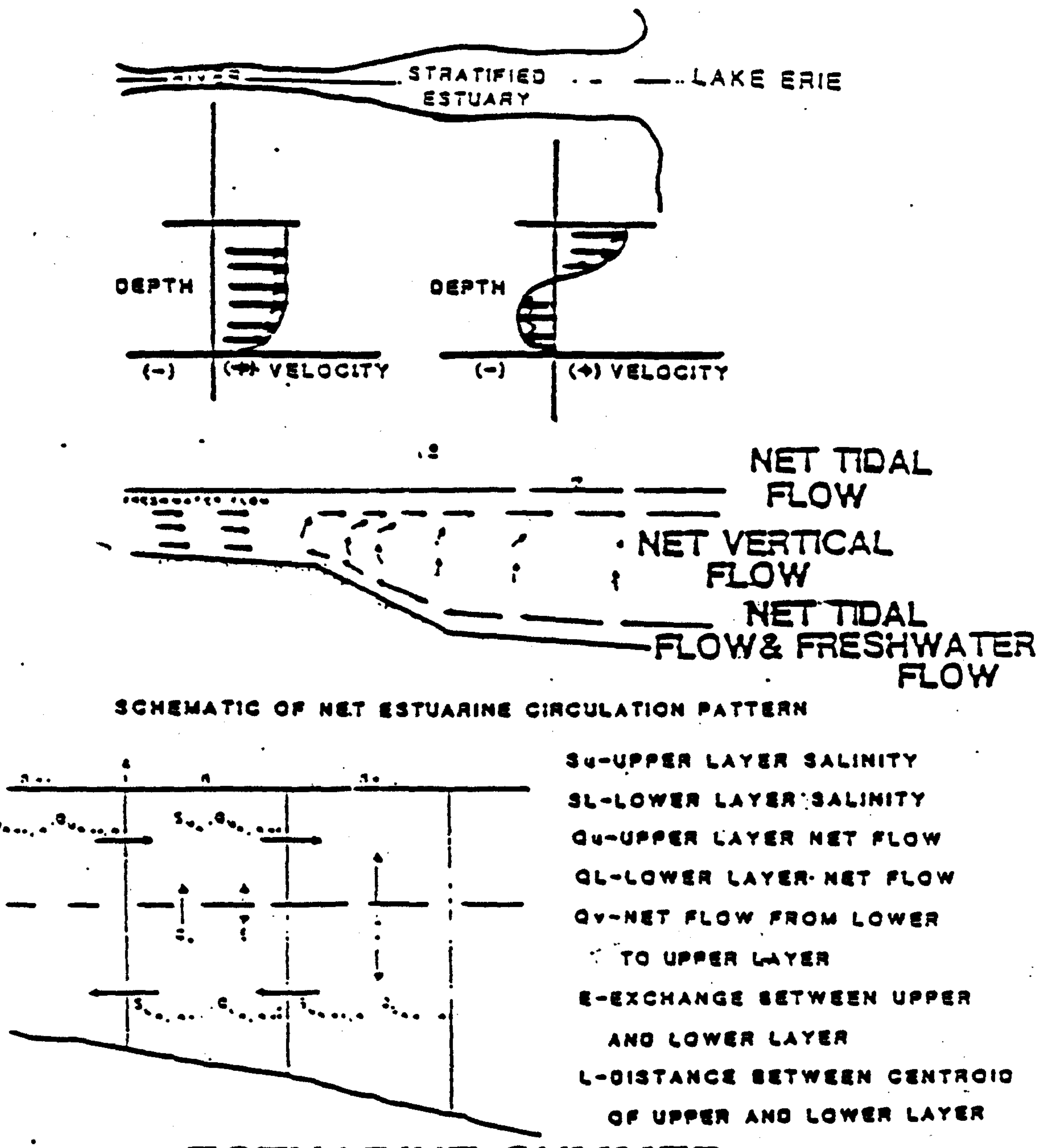
The distribution of pollutants in the River Raisin Area of Concern is a function of their transport through the aquatic ecosystem as well as their chemical transformation. Transport processes tend to distribute pollutants within and among phases, while transformation processes chemically alter the pollutants (USEPA 1987). The following chapter illustrates the current under standing of the fate of pollutants discharged into the AOC. Pollutant distribution is directly related to the riverine/lake hydrologic regime; therefore, this process is outlined prior to any specific discussion concerning PCBs and heavy metals. The hydrologic effects section is followed by a summary of the fate and transport of copper, chromium, and zinc in the AOC. Lastly, a mass balance model of PCB movement within the aquatic system (including total and individual homologs), is presented.

6.1 HYDROLOGIC REGIME

The River Raisin is characterized in the lower reaches (from approximately RM 1.4, below the turning basin, to the lake) as a stratified estuary. The typical estuarine density layers formed by the underflow of high salinity water is replicated through temperature differences between the river and lake water. Schematics of net estuarine circulation patterns under summer and fall conditions for the lower River Raisin are presented in Figures 40 and 41, respectively. During the summer, (July, in this example), the lake water is colder than the river water. The lake water travels upstream in the lower layer with river water flowing downstream along the top layer. The vertical flow of water is from the lower layer of cool lake water to the upper riverine layer (see Figure 41). The expected net transport out of the system is consequently at the surface (Di Toro et. al., 1985).

The fall circulation pattern is a result of the warmer lake water flowing over the cooler river water. The lake water moves upstream along the surface, creating a downward vertical flow towards the lakeward-flowing river water along the bottom. The expected net flow out of the system and into the lake therefore occurs as a bottom flow. With this complicated hydrology, it is conceivable that pollutants could travel upstream under fall circulation conditions.

A model was developed for the lower 2.6 river miles to estimate pollutant fate and transport (DiToro et. al., 1985). The transport regime used in this model followed a method of analysis for partially mixed estuaries (Pritchard 1979). The method assumes that in the vertical dimension, the estuary can be represented by a top and bottom layer. The segments utilized for the model boundary conditions are illustrated in Figure 42. Table 29 is a summary of the model segmentation geometry. The upstream boundary was established at Dam No. 6 (RM 2.6), upstream of the Monroe WWTP. The lower boundary (downstream) was established at a point just downstream of the Ford Motor Company discharge. The three point source discharges in the River Raisin model are the Monroe WWTP, Mason Run, and

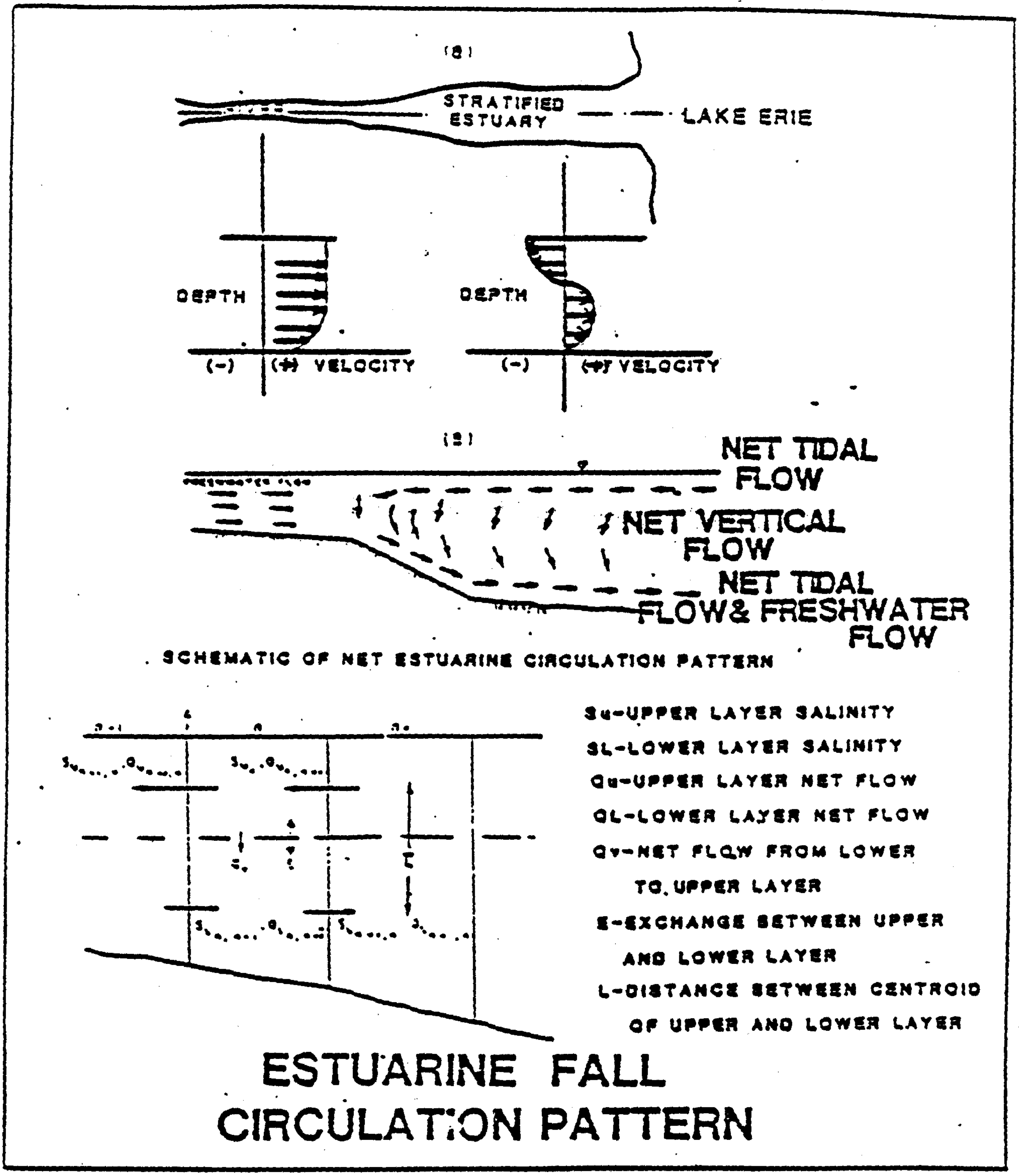


ESTUARINE SUMMER CIRCULATION PATTERN

(MODIFIED FROM HYDROSCIENCE.1978)

Source: DiToro et al 1985

Figure 40 Schematic of Net Estuarine Circulation Pattern for Summer

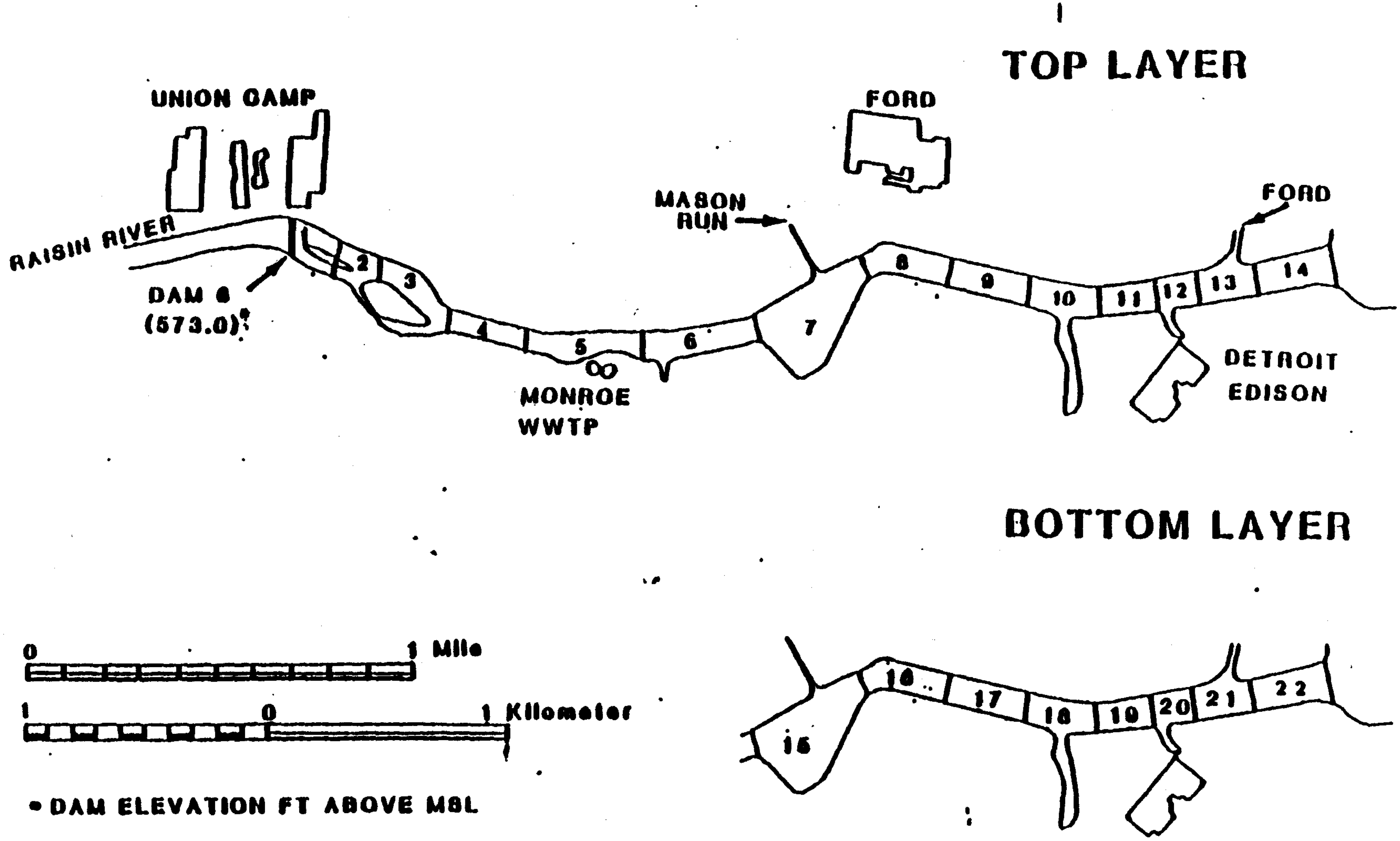


(MODIFIED FROM HYDROSCIENCE,1978)

Source: DiToro et al. 1985

Figure 41 Schematic of Net Estuarine Circulation Pattern for Fall

Figure 42. Schematic of River Raisin Mode Segmentation



RAISIN RIVER MODEL SEGMENTATION

Source: DiToro et al. 1985

Table 29 SUMMARY OF MODEL SEGMENTATION GEOMETRY

SEG. #	FROM RIVER MILE	TO RIVER MILE	AVG. DEPTH (ft)	AVG. CROSS SECTIONAL AREA (ft^2)	VOLUME (Million ft^3)
Upper Layer Segments					
1	2.63	2.5	5.4	2480	1.702
2	2.5	2.4	6.2	3760	1.985
3	2.4	2.2	6.3	3158	3.335
4	2.2	2.0	7.9	1981	2.092
5	2.0	1.7	9.1	2416	3.827
6	1.7	1.4	9.4	3258	5.161
7	1.4	1.1	4.9	4306	6.821
8	1.1	0.9	4.9	2107	2.225
9	0.9	0.7	4.9	2065	2.181
10	0.7	0.5	4.9	2038	2.152
11	0.5	0.35	4.9	1995	1.580
12	0.35	0.25	4.9	2118	1.118
13	0.25	0.1	4.9	2397	1.898
14	0.1	-0.1	4.9	2291	2.419
Bottom Layer Segments					
15	1.4	1.1	14.4	12655	20.045
16	1.1	0.9	14.4	6444	6.805
17	0.9	0.7	15.2	6648	7.020
18	0.7	0.5	15.2	6621	6.992
19	0.5	0.35	15.6	6583	5.214
20	0.35	0.25	15.4	6859	3.622
21	0.25	0.1	13.7	7057	5.589
22	0.1	-0.1	11.9	6045	6.384

Source: DiToro et al. 1985

Ford Motor Company. Detroit Edison-Monroe Power Plant represented the major withdrawal of water. At the time of the surveys (July, September, and October), all flow from the River Raisin was diverted through Detroit Edison. River flow met only 12.5%, 8.6%, and 9.1% of Detroit Edison's needs water intake for the mentioned sampling period. The remainder of the cooling water intake flow came from Lake Erie waters drawn up the River Raisin.

A schematic of the calculated River Raisin steady state transport (flow) for July, September, and October 1983, is provided in Figure 43. The diagram is divided into the same segments shown previously in Figure 42. The flows (cfs) from each major discharge are illustrated, as well as the major outflow from the system (i.e., Detroit Edison). This diagram shows the extent of upstream transport, reaching Mason Run.

The complete diversion of mixed river and lake water may result in the transport of pollutants from the River Raisin to lower Plum Creek (via the cooling water channel). The effluent plume from Plum Creek movement northward could result in the possible re-entry of pollutants into the lower River Raisin.

6.1.1 Sediment Resuspension, Transport, and Deposition

The distribution of contaminants adsorbed onto sediment particles is partially a function of sediment resuspension, transport, and deposition. Adsorption/desorption may also occur during resuspension, thereby further contributing to contaminant fate and distribution. Quantification of sediment resuspension and transport, and its impact on contaminant loadings, was undertaken during the USEPA 1985 investigation (USEPA 1987). The analysis included improved acoustic and analytical methods for parameterizing resuspension (Bedford et al. 1986); a two-dimensional, vertically integrated, numerical model of sediment resuspension, transport, and deposition (Ziegler and Lich 1986); and a sediment mass balance for the system (Di Toro et al. 1985).

These investigations suggested that resuspension was not a major source of suspended solids for the measured river flow (July, September, and October). Although the system had enough energy to keep particles suspended, this energy was insufficient to result in appreciable resuspension (USEPA 1987). The majority of the variability in the suspended solids data was contributed to suspended solids acting as a conservative material. The remaining, nonconservative variability may not have been the result of the mean current, but rather of high-intensity intermittent events such as ship traffic.

6.2 FATE AND TRANSPORT OF COPPER, CHROMIUM, AND ZINC

The prediction of metals exposure concentrations in the River Raisin was determined using a mass balance approach (Di Toro et al. 1985). Using the twenty-two segments identified in Figure 42, transport coefficients and flows were estimated using a conservative substance (i.e., specific conductance). Steady state flows and exchange rates were determined based on a mass balance of other conservative substances such as

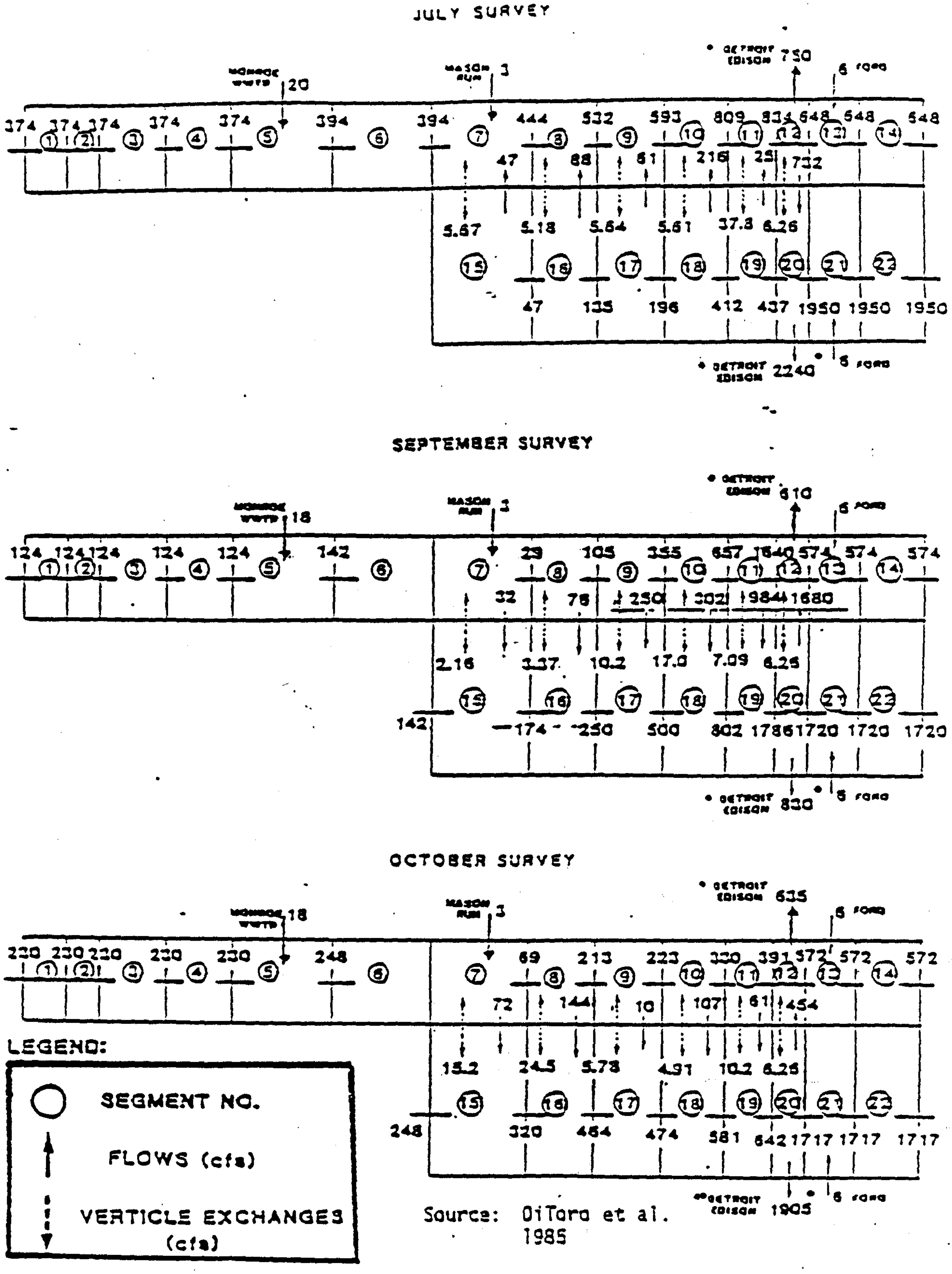


Figure 43 Schematic of Calculated River Raisin Steady State Transport for the July, September, ad October 1983 Surveys

alkalinity and hardness, and comparing the observations. This comparison between observed and predicted alkalinity and hardness is illustrated for the July survey in Figure 44.

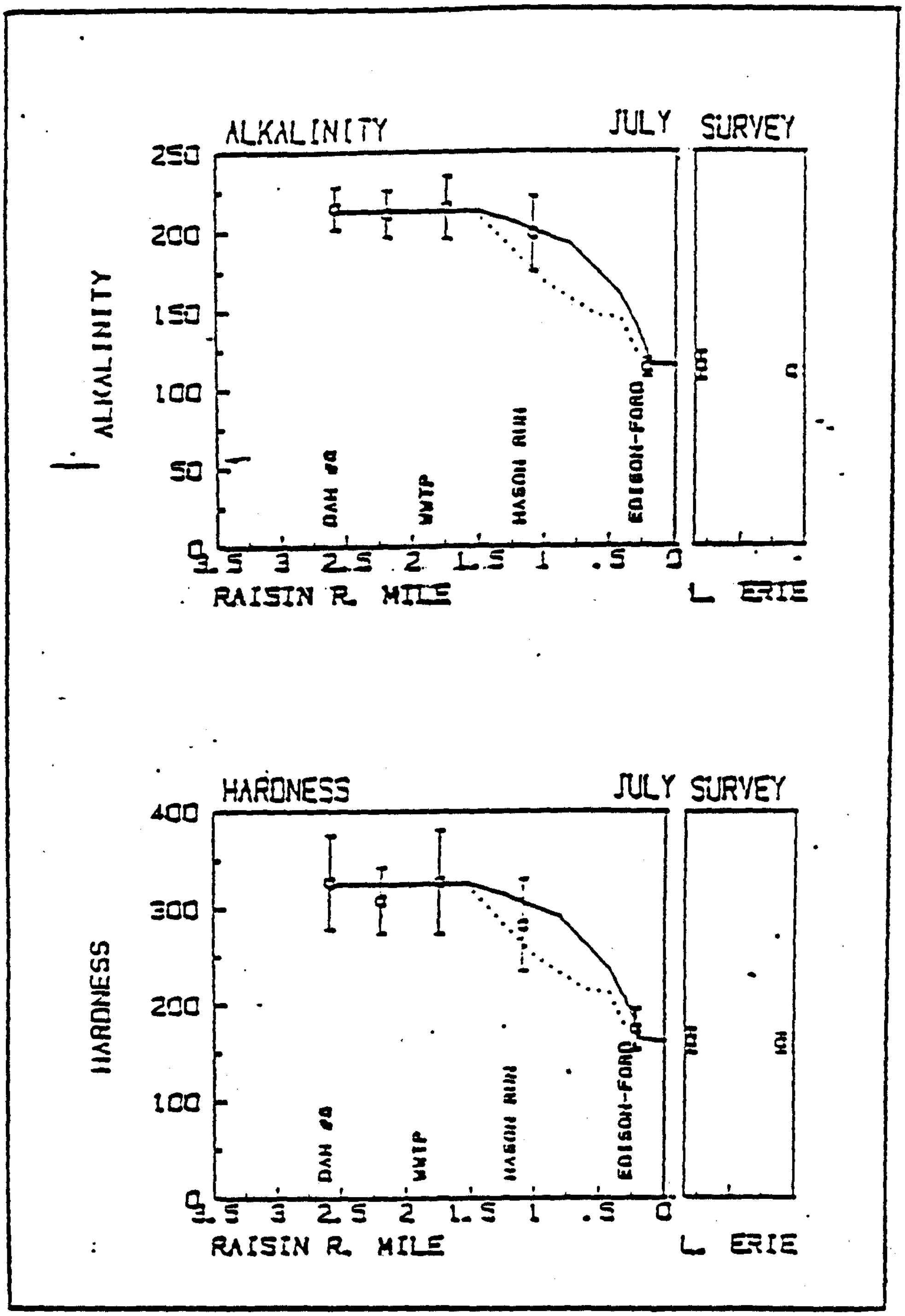
Pollutant loadings entering the study area from upstream, from the Monroe WWTP, from Mason Run, from Ford Motor Company, and from the downstream boundary, are summarized in Table 30. These loadings (in kg/day) were estimated from water quality concentrations and flow data provided in the USEPA summary report (USEPA 1987). These data are also provided in Appendix 6-1. The Ford discharge and flow from the upstream portion of the River Raisin provided the largest loads of copper and chromium to the study area. Zinc loadings were shared almost equally between the upstream boundary, Ford Motor Company, and the Monroe WWTP. The contribution of total residual chlorine and water hardness were highest from upstream loading, and second highest from the WWTP. In July, the upstream river basin and the WWTP contributed high loads of suspended solids. The contribution of suspended solids from the Monroe WWTP was reduced in both the September and October surveys. The upstream boundary remained the major source of suspended solids in the lower River Raisin.

The transport field from the twenty-two segment model that described the distribution of conservative water quality parameters provided the basis for computing transport in the metals model (USEPA 1987). Any systematic deviation from the conservative parameters would signal the presence of other transport phenomena, sources, and/or sinks. The spatial profiles of the total and dissolved concentrations of copper, chromium, and zinc are provided in Figures 45, 46 and 47 respectively. The authors note that the station at RM 0.2 was located directly over the Ford WWTP outfall plume, and is not judged to be representative of laterally average conditions. Also, the data collected during the October survey between RM 2 and RM 1.5 are not judged to be representative, as these sampling points were selected, by design, to characterize the Monroe WWTP. Overall, however, the mode-computed spatial profiles were considered in good agreement with actual observed conditions.

In conclusion, no systematic deviation was observed between the calculated and the observed spatial profiles, thus indicating that no other significant transport phenomena, sources and/or sinks were evident in the system.

6.2.1 Partition Coefficient

The effect of the sorption of heavy metals onto suspended solids or sediment, and their occurrence in either the particulate or dissolved phases, was investigated by Di Toro et al. (1985). The model employed in this investigation assumed that a local equilibrium existed between the dissolved and particulate phases. Partition coefficients were then calculated to determine the fraction of the metal that is in either phase. The partition coefficients for copper ranged from 104 to 105.3 l/kg. The zinc partition coefficients ranged from 104 to 106 l/kg. No strong relationship was apparent between partition coefficients and suspended solids.



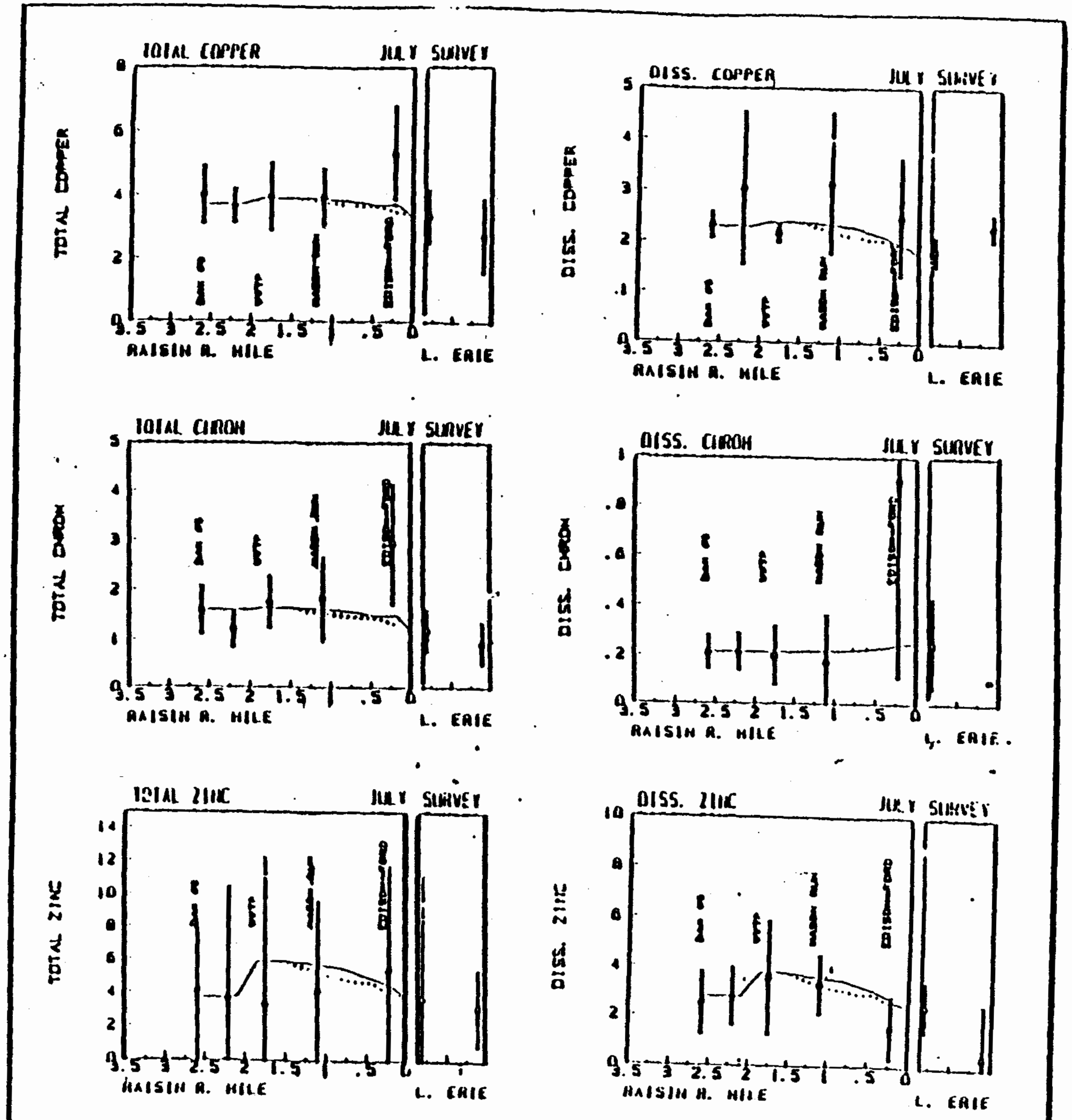
Source: USEPA 1987

Figure 44 Comparison of Observed and Model Computed Alkalinity and Hardness for Survey 1 (July 1983)

Table: 30 Pollutant Loadings from Major Point Sources for July, September, and October 1983

	Parameters (kg/day loadings)								
	Suspended Solids	Hardness	Total Residual Chlorine	Dissolved Chromium	Total Chromium	Dissolved Copper	Total Copper	Dissolved Zinc	Total Zinc
July									
Upstream	2,562.00	29,738.00	54.9	0.02	0.15	0.21	0.33	0.26	0.34
Monroe WWTP	357.24	1,707.90	16.76	0.001	0.01	0.02	0.04	0.11	0.23
Mason Run	25.69	221.68	0.33	0.0001	0.002	0.003	0.005	0.0009	0.006
Ford	32.30	552.01	0.53	0.0004	0.09	0.04	0.12	0.05	0.24
Downstream	8,242.00	10,271.00	65.3	2.17*	0.76*	1.14	2.09	1.59	2.35
September									
Upstream	940.57	9,951.80	Not Measured	0.003	0.05	0.07	0.13	0.02	0.19
Monroe WWTP	33.03	1,444.60		0.004	0.002	0.01	0.02	0.09	0.12
Mason Run	22.02	933.72		0.0002	0.002	0.001	0.006	0.001	0.007
Ford	46.98	466.86		0.005	0.04	0.03	0.10	0.03	0.12
Downstream	17,970.00	58,401.00		0.11	1.16	0.67	2.46	0.14	4.98
October									
Upstream	984.87	19,922.00	Not Measured	0.02	0.10	0.15	0.17	0.09	0.29
Monroe WWTP	66.94	1,101.11		0.0006	0.006	0.006	0.02	0.15	0.16
Mason Run	30.68	195.99		0.0001	0.004	0.001	0.07	0.01	0.01
Ford	22.02	393.45		0.06	0.11	0.05	0.12	0.07	0.14
Dountream	15,234.00	58,808.00		0.06	1.62	0.45	1.74	1.12	6.72

Loadings calculated from USEPA, 1987 (see Appendix 6-1 for original data).
Issolved component greater than total.



Source: DiToro et al 1985

Figure 45. Comparison of Observed and Model Computed Total

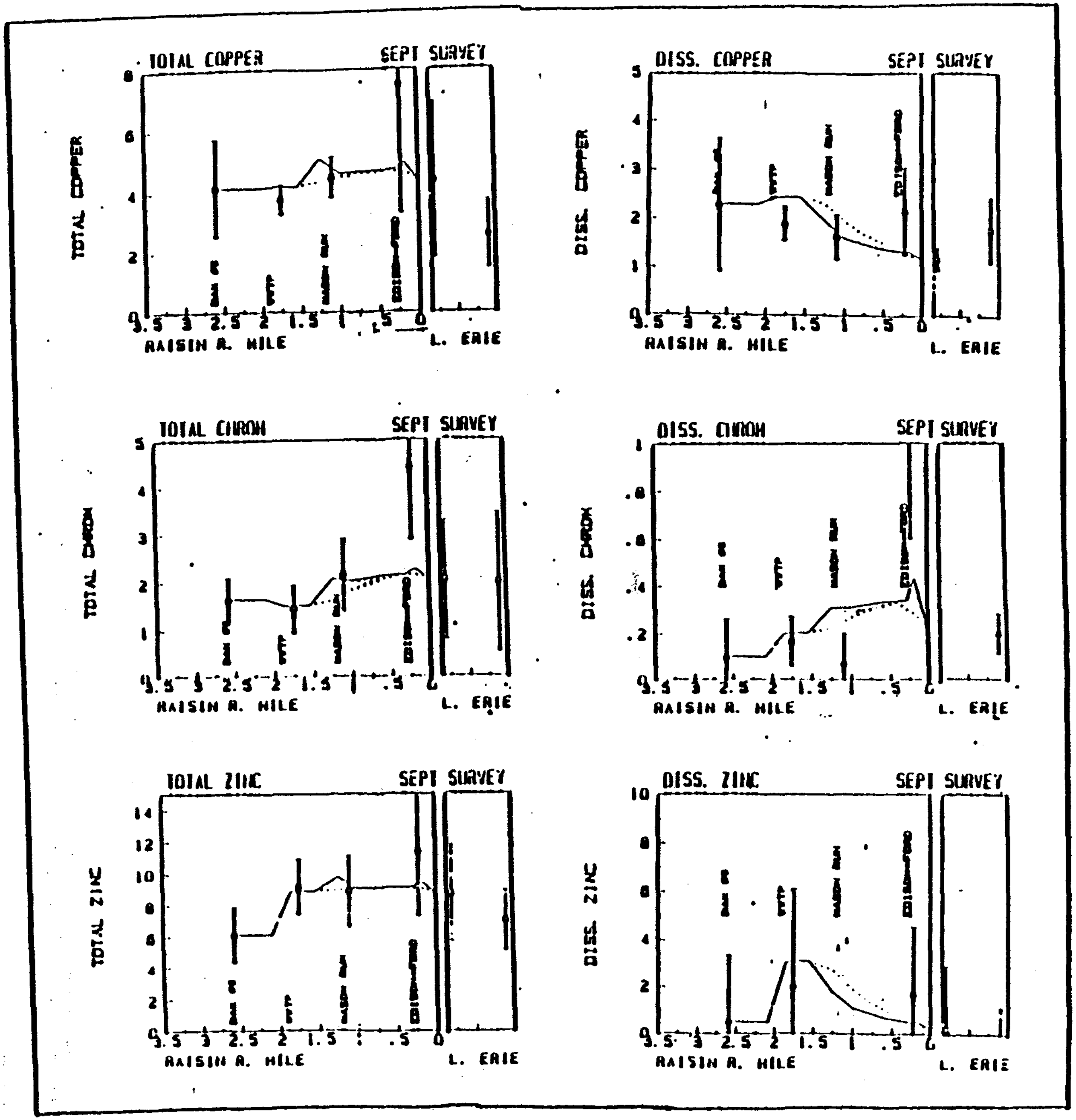
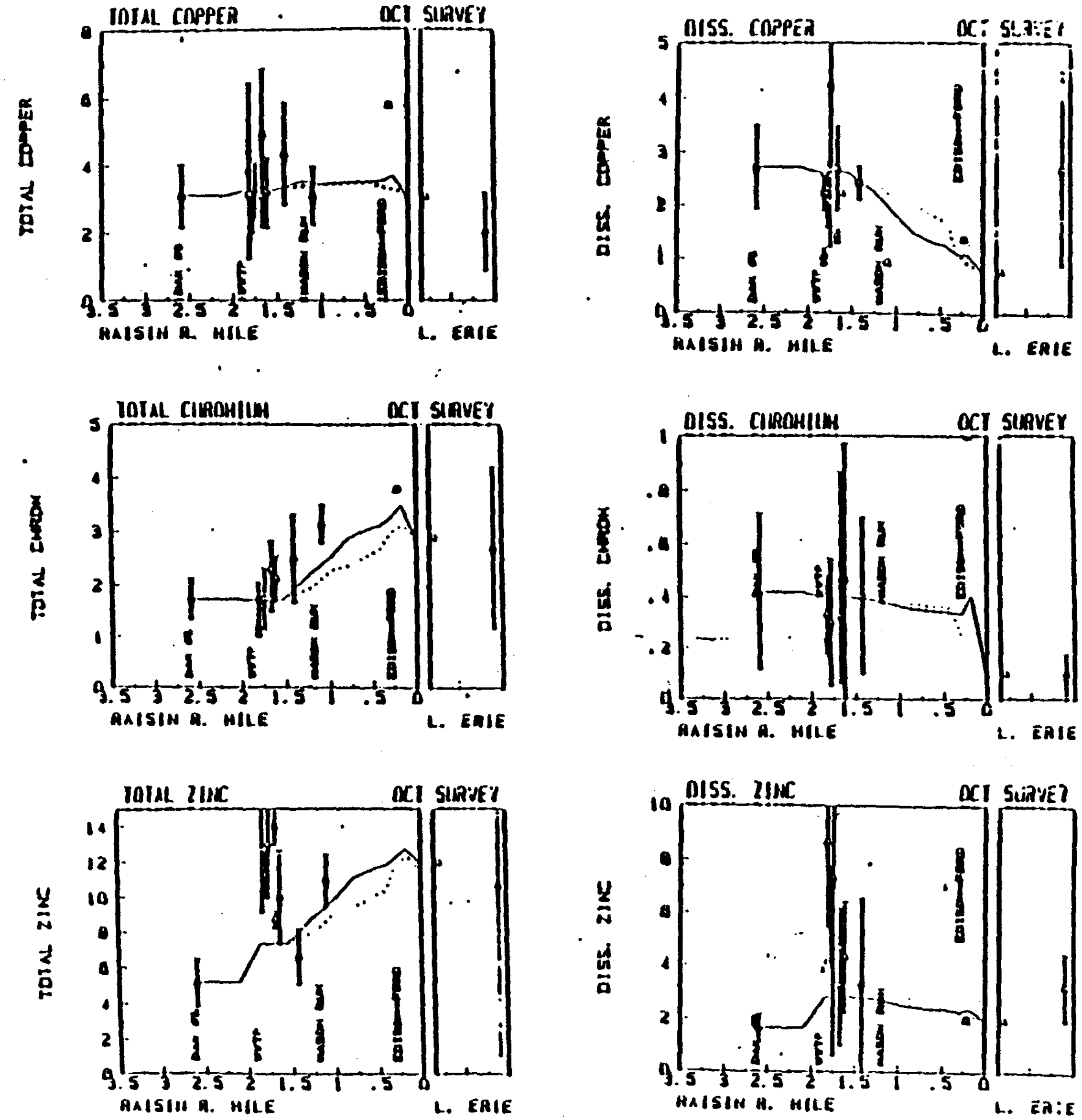


Figure 46 Comparison of Observed and Model Computed Total and Dissolved Copper, Chromium and Zinc for the September 1983 River Raisin Survey



Source: DiToro et al. 1985

The spatial distribution of dissolved copper and zinc was also computed using a range of partition coefficients. No singular partition coefficient could adequately describe the distribution of dissolved copper or zinc for each survey.

6.3 PCB MASS BALANCE

An analysis of PCB mass loadings in the Area of Concern was undertaken to identify significant pollutant sources and sinks (USEPA 1987). Several mass balance models were developed using Pritchard's simple algebraic input-output model. The following general questions were assessed:

* What is the status of PCBs in the water?
* Are local point sources contributing significant contaminant loads to Monroe Harbor?
* Does the River Raisin/Monroe Harbor act as a sink or a source for PCBs?
* If the point sources are important, what is their rank according to loading?
* Are non-point source loads a concern?

As in the metals model, the PCB model used two segment layers to represent the estuarine circulation sometimes found in the lower river. The upstream boundary was Station 1; the downstream boundary was Station 4 (downstream edge of the turning basin). Input loadings were the Monroe WWTP, upstream (Station 1), and Lake Erie (Station 4). Although the two segment PCB model does not provide spatial resolution, it was considered sufficient to address the question of whether the Area of Concern is a source or sink of PCBs (USEPA 1987).

6.3.1 Model Results

Two sources of pollutants identified in the metals model were not considered for the PCB input-output calculations. Mason Run flow was not high enough to cause a significant loading of PCBs to the system. For example, calculations of PCB loadings from Mason Run based on high flow (3 cfs) (measured in spring), and the September and July survey, PCB concentrations yielded 0.003 kg/day and 0.0009 kg/day, respectively. These loadings represent only 1.8 and 2.5%, respectively, of the loadings categorized as "unaccounted for" sources of PCBs in the river. In addition, no significant differences in water quality between Mason Run and the turning basin could be established. Thus, Mason Run is probably influenced more by the water in the River Raisin than the river water quality is affected by Mason Run discharges.

To demonstrate that the conservative input and output loadings for this model are balanced, models of chloride and hardness were developed based on transport coefficients using specific conductivity, as depicted in Figure 48. The unaccounted for term (inputs-outputs) is negligible when compared to the input loads.

Resuspension of contaminated sediments was ruled out as a significant source of PCBs to the system. Calculation of the unaccounted for total suspended sediment load and the PCB concentration in the sediments suggested that PCBs associated with particles could only account for 16% and 4% of the July and September "unaccounted for" PCB loading, respectively.

The PCB mass balance models results for July, September, and October are provided in Figure 49. Note the high proportion of the unaccounted for category as compared to the conservative parameters, chloride and hardness (Figure 48). The mass balance analysis of the PCB homologs suggest that the unaccounted for loading was enriched in tri- and tetrachlorobiphenyl compounds. This trend was most obvious in the September and October surveys, as depicted in Figure 50.

The PCB mass balance models for both total PCBs and the ten homologs suggest that the River Raisin Area of Concern is a source of PCBs which cannot be accounted for from upstream loadings, lake loadings, or loadings from one direct discharger (Monroe WWTP). Total PCBs in the AOC exceed the sum of these three source inputs, revealing the presence of an unaccounted for PCB source in the AOC. The turning basin acts as a natural sink for suspended solids and other conservative parameters, as well as PCBs. The unaccounted for PCB loadings from within the AOC essentially match the quantity of PCBs deposited in the turning basin. Other sources of PCBs not quantified in this model may include the following:

* Ford Motor Company (although the current data is insufficient to quantify PCB loadings)
* Port of Monroe Landfill (groundwater and surface water runoff)
* Consolidated Packaging Lagoons/Former Overflow Channel
* City of Monroe Landfill (groundwater and surface water runoff).

6.4 SUMMARY

The River Raisin AOC is characterized from the turning basin to Lake Erie as a stratified estuary. Density layers are formed from the temperature differences between the lake and river waters.. Although the expected net flow of water is outward towards the lake (either as a surface or bottom flow), the complete withdrawal of river water by Detroit Edison for cooling water results in a significant diversion of water through Plum Creek. This cooling water discharge flows eastward into Lake Erie as well as northward back towards the entrance channel of the River Raisin.

The prediction of metals exposure concentrations in the River Raisin was determined using a mass balance approach. Pollutant loadings were calculated for the upstream contribution, Monroe WWTP, Mason Run, Ford Motor Company, and the downstream boundary. The Ford discharge and the

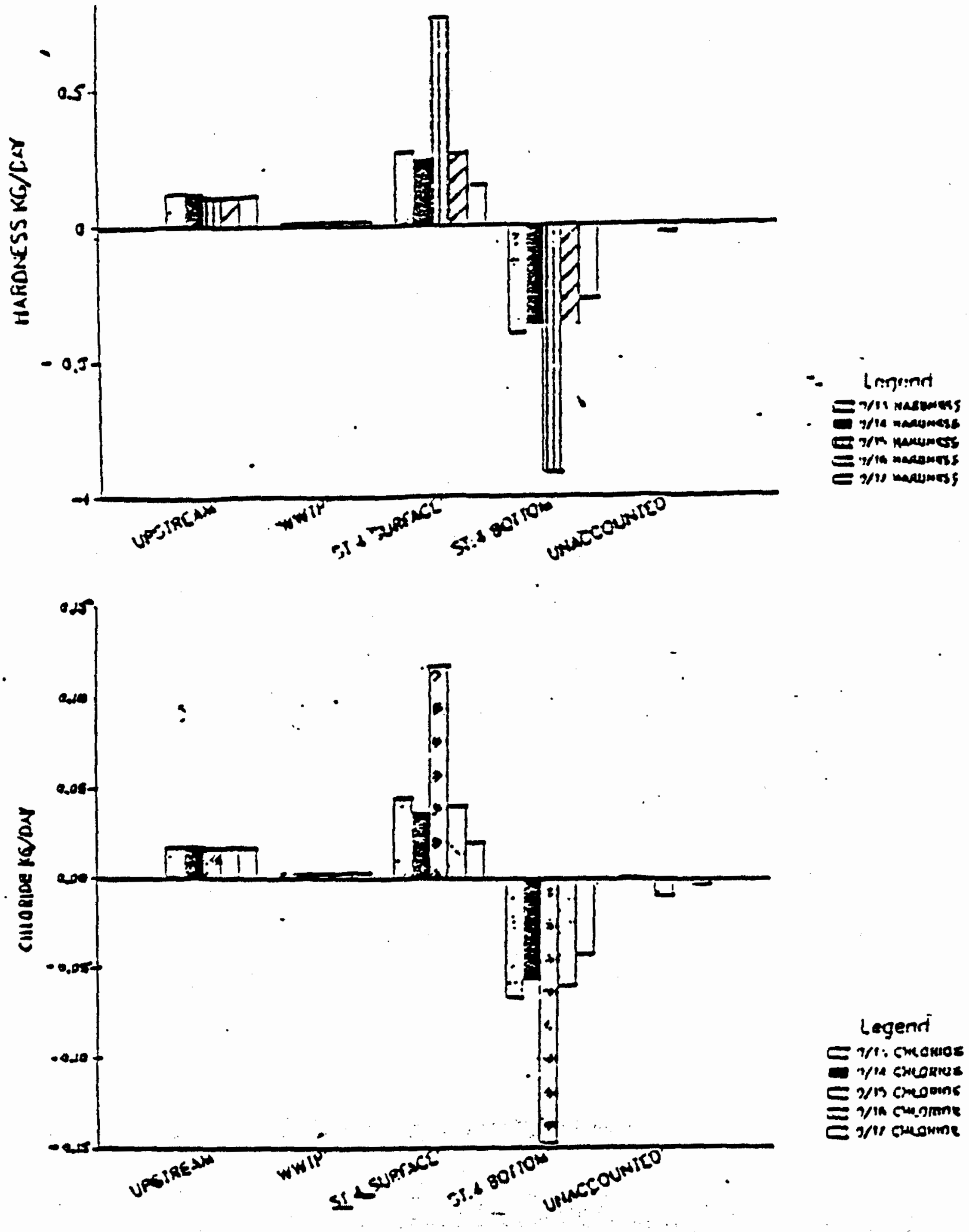


Figure 48 Monroe Harbor Hardness and Chlorides Mass Balance for September, 1985 (Survey 2).

Source: USEPA 1987

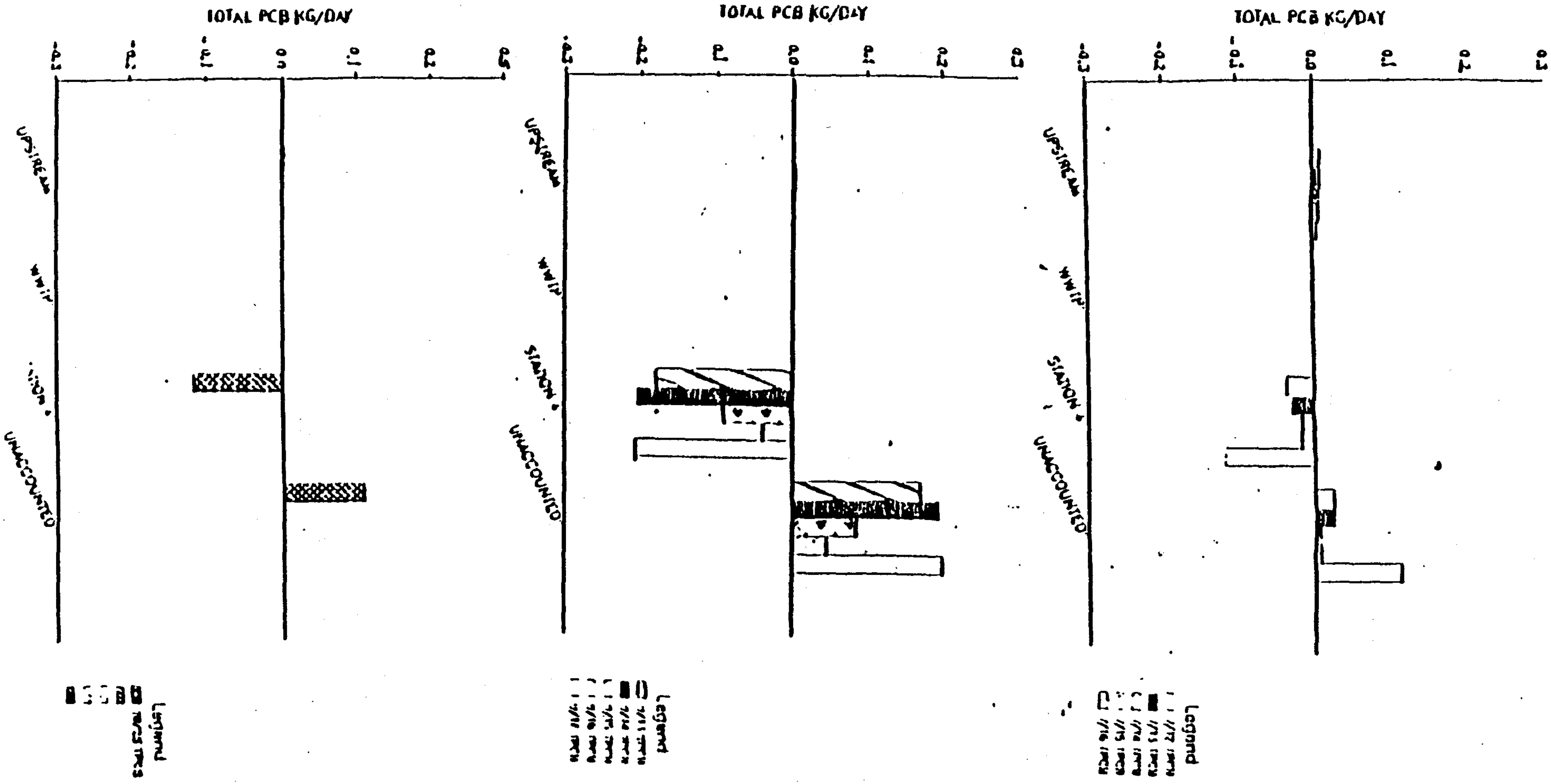
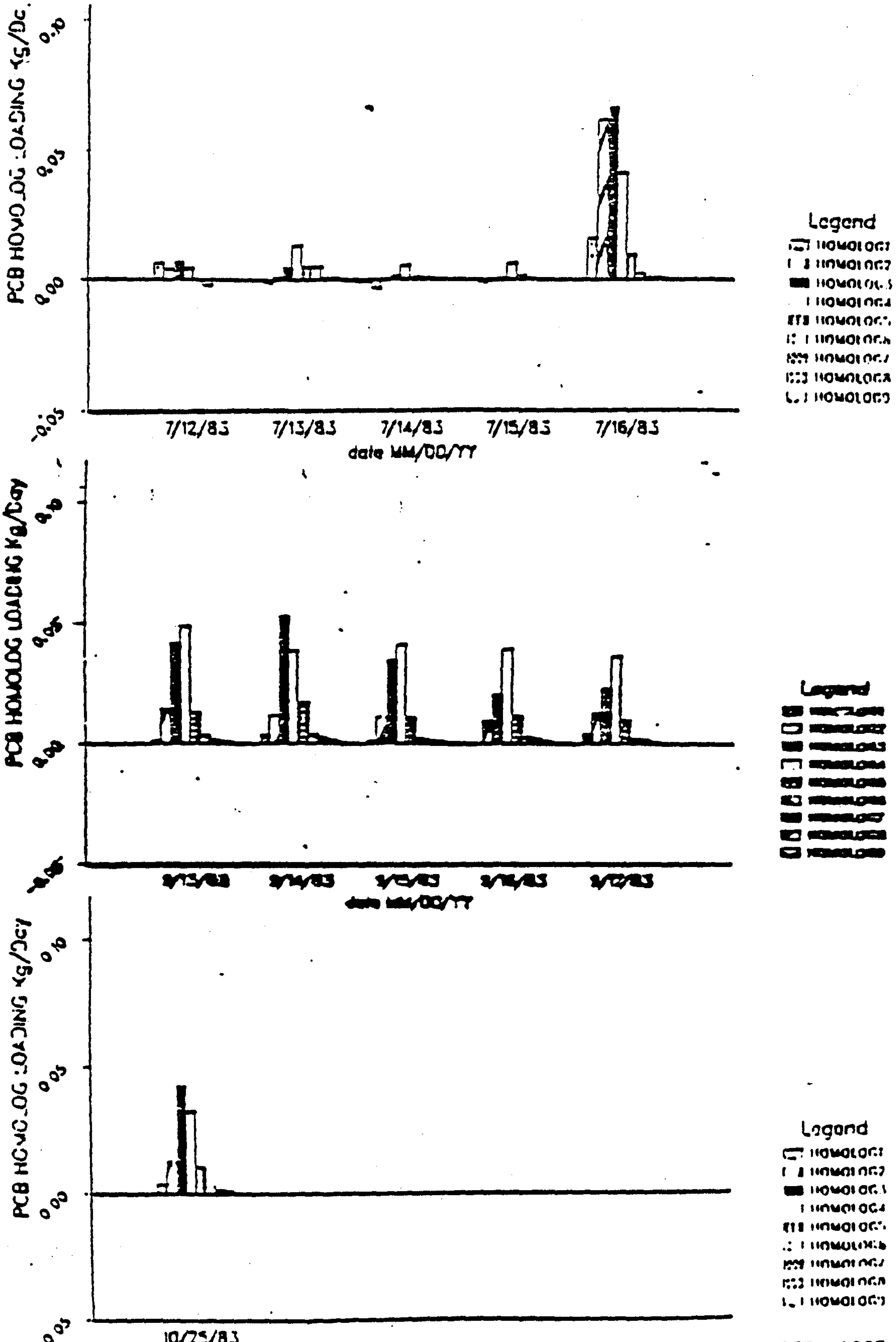


Figure 49 Monroe Harbor Total PCB Mass Balance for the Upper Reach of the Study Area for July, September, and October 1983.



Source: USEPA 1987

Figure 50. Unaccounted Loading of PCB Homologs in the Upper Reach of the Study Area in July, September, and October, 1983.

upstream portion of the River Raisin provided the largest loads of copper and chromium to the AOC. Zinc loadings were shared almost equally between the upstream boundary, Ford Motor Company, and the Monroe WWTP. Total residual chlorine and water hardness were highest from upstream loading, and second highest from the WWTP. Suspended solids loadings were generally highest from the upstream areas.

Overall, the model-computed spatial profiles were considered in good agreement with the actual observed conditions. No systematic deviation was observed between the calculated and the observed spatial profiles, indicating that no other significant transport phenomena, sources, or sinks were evident in the system.

A simple mass balance model of PCB loadings was developed for the lower River Raisin to determine whether the AOC is a source or a sink of this contaminant. The model results suggest that the River Raisin AOC is a source of PCBs which cannot be accounted for from upstream loadings, lake loadings, or discharges from Monroe WWTP. The turning basin acts as a natural sink for suspended solids and other conservative parameters, as well as PCBs. The unaccounted for quantity of PCBs originating in the Area of Concern equals the quantity of PCBs deposited in the turning basin. Other sources of PCBs to the AOC may be Ford Motor Company, Port of Monroe Landfill (groundwater and surface water runoff), Consolidated Packaging sludge lagoons/former overflow channel, and the City of Monroe Landfill (groundwater and surface water runoff).

7.0 REMEDIAL ACTIONS

The focus of remedial actions in the 1960s and 70s was the control of conventional pollutants. These problems were successfully dealt with in the River Raisin through the construction of new wastewater treatment plants and the National Pollutant Discharge Elimination System (NPDES) permit process. However, in the early 1970s, the focus of remedial action in the AOC shifted to the control of toxic organics (PCBs) and inorganics (copper, zinc and chromium) from point and non-point sources.

7.1 Completed Remedial Actions

Since PCBs were identified as a problem in Michigan in 1971, several actions have been taken to improve conditions. The direct discharge of PCB's has been substantially reduced due to the PCB ban, originally under Michigan law and now nation wide under the Toxic Substances Control Act. Consequently, the direct discharge of PCBs is not authorized in any of the NPDES permits for the River Raisin.

7.1.1 NPDES Permits

NPDES permits limit wastewater pollutants based on their sources and their impacts on the receiving stream. Permits have a life of five years. There are two point source dischargers to the AOC with current NPDES permits--Detroit Edison and the City of Monroe WWTP.

Regulated pollutants for Detroit Edison include conventional pollutants, residual chlorine, copper, and iron. For the City of Monroe WWTP, current regulated pollutants are limited to phosphorus and conventional pollutants. The existing permit includes a scheduled addition of limits for ammonia, dissolved oxygen, and residual chlorines. This change will be enforced prior to the December 31, 1986 expiration date (MDNR 1984g). The City of Monroe WWTP permit also contains a number of special requirements that will reduce the level of pollutants discharge to the AOC. These requirements include plant expansion, outfall relocation, infiltration/inflow control, and industrial pretreatment. Since these are actions that are to be completed during the life of the permit (expires 1989), the individual requirements are listed in Section 7.2, Actions Currently in Progress.

The remaining point source discharges currently active in the AOC are Ford Motor Company and Union Camp Corporation both are operating under the terms of expired NPDES permits. Regulated pollutants for Ford include conventionals, residual chloride, cyanide, and several metals. Union Camp Corporation permit limits their discharge of total suspended solids.

7.1.2 Waste Disposal

The most recent (January 1987) point source remedial action to be completed is the construction of the new wastewater treatment works at

Monroe WWTP. The new treatment works will expand secondary treatment capacity to 30 mgd, provide at least primary treatment for all flows above 30 mgd, and will help meet newly established limitations for dissolved oxygen, ammonia, and residual chlorine. The plant will also eliminate untreated wastewater bypass to River Raisin by 1988. The WWTP plants outfall has been relocated to Plum Creek from River Raisin and the implementation of the infiltration/inflow reduction plan was completed June 1987.

7.1.3 Waste Containment

Construction of the Plum Creek Dike by the Port of Monroe Authority is the largest non-point source remedial action to be completed (1983). The Port of Monroe Landfill is a demonstrated source of pollutants to groundwater (Johnson and Anderson 1978). Toxic metals and PCBs dumped at the landfill were reaching the aquatic environment of Plum Creek (Evans 1976). In 1983, the Army Corps of Engineers completed construction of an earth dike with an impermeable cut-off wall between the Port of Monroe Landfill and Plum Creek. The lagoons located between Plum Creek and the landfill were also filled in. Presently, the groundwater is collected and pumped to the City of Monroe WWTP for treatment. This action is expected to reduce the contamination of Plum Creek via groundwater and surface runoff.

Plum Creek Dike has created three concerns that must be addressed. First, does the dike effectively stop the movement of contaminants into the Plum Creek environment from the Port of Monroe Landfill. The dike's effectiveness still needs to be evaluated. Secondly, does the dike redirect the contaminated groundwater back towards the River Raisin. This possibility was suggested by NUS and also still needs to be evaluated. Finally, the possible pollutants passing through the Monroe WWTP due to its treating of the leachate from the Port of Monroe Landfill. The Monroe WWTP has implemented a monitoring program and to date has not found the leachate to certain high levels of contaminants (Table 23).

7.1.4 Biota Protection

In 1982 a remedial action aimed at the protection of biota (fish) was completed by Detroit Edison. They installed pumps in an effort to reduce the numbers of fish killed by the electrical generating plant. Tests of the effectiveness of this measure showed a reduction of fish killed by 49%.

7.2 REMEDIAL ACTIONS IN PROGRESS

Nine remedial actions are currently in progress. Eight of these deal with non-point sources and the first seven sites have been placed on the Act 307 State Priority List. There are generally four steps in the Act 307 remedial action process and these are listed below.

Steps

1. Site Assessment - based on existing data and on-site investigation determine if the site is a source of contamination to the AOC. If the site is determined to be a source continue to step 2.

2. Remedial Investigation - conduct study to define the problem.

3. Feasibility Study - determine cost-effective, technically feasible, and environmentally sound alternatives to stop the further release of contaminants to the environment.

4. Remedial Clean-Up

The following is a listing of all eight sites and the remedial action steps which have been completed to date.

* 1986 Site Assessment and Phase 1 of Remedial Investigation of the Port of Monroe Landfill - East Side completed and placed on the Act 307 State Priority List.

* 1986 Site Assessment, Remedial Investigation and Feasibility Study of the Port of Monroe Landfill - West Side completed and placed on the Act 307 State Priority List.

* 1987 Site Assessment, Remedial Investigation and Phase 1 of Feasibility Study of the Ford Motor Company, Monroe Stamping Plant completed and placed on the Act 307 State Priority List. The Ford Motor Company's metal sludge disposal site is a major fill site. As part of its previous permit, the company was required to install ten groundwater monitoring wells. These wells have allowed MDNR to determine the effect of the waste sludges on the groundwater. The data show exceedances of drinking water standards for several parameters.

* 1985 Site Assessment of the City of Monroe Landfill completed and placed on the Act 307 State Priority List.

* 1985 Site Assessment of the Detroit Edison property completed and placed on the Act 307 State Priority List.

* 1985 Site Assessment of the Consolidated Packaging Corp., South Plant completed and placed on the Act 307 State Priority List.

* 1986 Site Assessment of the River Raisin completed and placed on the Act 307 State Priority List.

The following is a listing of on-going remedial activities.

* 1985 Site Assessment of Consolidated Packaging - North Plant still being conducted.

* 1975 to present Sediment removal by the U.S. Army Corp of Engineers. In-place pollutants (contaminated sediments) are an important source of PCBs to the water column. The removal of sediments for the purpose of navigation can also be consider a remedial action. Since 1975 the U.S. Army Corps of Engineers has dredged portions of the River, from upstream of the turning basin to several thousand feet into Lake Erie. The largest amount dredged occurred in fiscal year 1982 when 248,000 cubic yards were removed from the channel. Prior to 1984, spillings were disposed of at the Detroit Edison power plant site and the Port of Monroe Landfill. Currently, wastes are disposed of in Sterling State Park Confined Disposal Facility (GLNPO 1985). Sediment removal should result in a decrease in polluted sediments. However, sediment analysis from the EPA/LLRS survey show continued heavy loads of pollutants in the river sediments (see Chapter 6, Figures 6.1 to 6.4). These results suggest that sediment removal alone will not cure this problem and that a continuous source exists.

* 1986 to present Investigation into Best Management Practices to stop agricultural soil losses and sedimentation in the river. Study is being conducted by Lenawee County Soil Conservation District on a grant from the Michigan Clean Water Incentives Program

* 1985 to present Saline Valley Rural Clan Water Project objective is to reduce the phosphorus input. This will be accomplished by reducing surface water runoff, improved application of phosphorus fertilizers, improved animal waste handling and disposal, and reduced soil erosion and sediment delivery.

* 1986 to present MDNR Fish Contaminant Monitoring Program. Collection and analysis of fish from the external area and within the AOC. Results of 1986 and 1987 sampling not yet available.

* 1987 to present Act 307 funding for the portion of the River Raisin in the AOC is available to conduct the following environmental sampling and analysis to help identify the extent and sources and determine the present state of contamination. Water samples will be collected at about 20 representative sites in the lower River Raisin area. One sample every month for five months will be collected and analyzed for the EPA Priority Pollutants with particular attention being given to PCB. Sediment

samples will also be collected at about 40 (20 grab and 20 core) sites for a one time analysis of the EPA Priority Pollutants.

This sampling scheme also includes a 28 day cage fish study to be conducted to determine the extent of bioaccumulation of PCB and mercury in fish flesh in this area. Two cages will be placed in the river mouth area and two cages should be placed above the Monroe Dam No. 6 to serve as a control site. This data would complement the resident fish data collected last year for the Fish Contaminant Monitoring Program. The projected cost is $87,000 to conduct the above environmental sampling and analysis.

8.0 REMEDIAL ACTION PLANS GOAL AND OBJECTIVES

8.1 USES TO BE RESTORED AND MAINTAINED

The Remedial Action Plan has been prepared to restore water quality and designated uses (warm water fishery) to the River Raisin Area of Concern. The ultimate long-term goal is the elimination of all sources of organic (PCBs) and inorganic (metals) toxics to the Area of Concern. Source identification and elimination is the only feasible solution to restoration of water quality and the warm water fishery.

8.2 GOALS REGARDING BIOTA

The objective of this Remedial Action Plan is to determine cost-effective, technically feasible, and environmentally sound alternatives to minimize and ultimately stop the further release of PCBs to the environment and thereby reduce human exposure to PCB's, and at a minimum to reduce the PCB concentrations in fish from the AOC to less than 2.0 mg/kg (ppm). The Remedial Action Plan will accomplish this objective in a two step process: 1) determine data deficiencies and recommend additional investigation that will define the problems and sources of contaminants and 2) recommend remedial actions that will eventually lead to restoration of the impaired use (fishery) of the AOC.

9.0 PUBLIC PARTICIPATION

9.1 PUBLIC INVOLVEMENT

The Surface Water Quality Division and the Office of the Great Lakes of the Michigan Department of Natural Resources has conducted two public meetings to provide status reports on the progress of individual remedial action plans and to ask interested individuals for their concerns and ideas on each RAP. The meetings were aimed at establishing an ongoing dialogue with affected local citizens and government which will help steer the RAP process from initial data gathering through the implementation and monitoring of remedial actions.

Public participation in both the development and implementation of the River Raisin Remedial Action Plan (RAP) is imperative. During the developmental process, the public provided a valuable historical perspective of a growing and changing area. The first public meeting, held June 26, 1986, gathered this information and provided a chance to develop communication pathways between the MDNR and the public. During this meeting, 53 individuals who lived in the area, attended and talked about their concerns for the river and the problems they would like to see resolved. These concerns will be presented and addressed in the RAP. A second public meeting was held September 3, 1987 after the RAP had been released to the public. The purpose was to receive their comments and recommendations on the draft RAP. During this meeting the public had a chance to discuss how they perceive their role in the RAP process and their expectations of the RAP. Because the "Waters of the State" are part of the public domain, it will take the public generated "political will" to implement this RAP.

10. REMEDIAL ACTION STEPS

Remedial Action Steps are described from a potential source perspective. As stated previously, the purpose of this RAP is to address the existing contamination problems and restore the impaired uses of the Area of Concern. Diagnostic studies, and completed, currently on-going or proposed remedial actions are discussed, as are specific recommended future remedial actions to restore the River Raisin AOC.

A listing of use impairments, causative pollutants, and pollutant sources is presented in Figure 27. The figure also shows the interrelationship between impairments, causes and sources. These relationships illustrate the complexity of the problems and develop the connections between use impairments and pollutant sources.

This River Raisin Area of Concern, Remedial Action Plan is not a static final plan, but a dynamic, changing document aimed at restoring the impaired uses of the AOC. The RAP should be viewed as a guidance framework for the remedial actions. As information becomes available from site assessments, remedial investigations or feasibility studies (i.e. Act 307, Federal Super Fund or studies recommended here in) the approach and emphasis of the remedial actions will be modified to fit the existing situation. Currently, most of the non-point source sites are in the early stages of the Act 307 assessment and remedial action investigation. The data gathered to date is sufficient only to provide a preliminary indication of the presence of potentially toxic heavy metals, volatile organics and PCBs in the water table aquifer, the underlying bedrock aquifer, soil, river sediments and surface water of the AOC.

10.1 REQUIRED PLANS AND STUDIES

The following studies are recommended in order to provide essential information that will allow implementation of appropriate and effective remedial actions.

10.1.1 River Raisin

The site assessment conducted by the MDNR has determined that the River Raisin sediments contain PCB and heavy metals and is itself a source of contaminants for further releases to the environment. MDNR has designated the river an Act 307 site and assigned it an SAS screening score of 848. Despite annual dredging by the Army Corp of Engineers, the sediment concentrations of PCB and heavy metals are not decreasing significantly. It may therefore be assumed that inadequately identified or quantified contaminant sources may potentially exist. The following investigative studies are suggested to explore this possibility:

Table 31. Summary of Impairments, Causes and Sources

Impairments	Causes	Sources
--Fish Consumption Advisory	PCBs	Contaminated Sediments Waste Disposal Sites Industrial Point Sources
--Fish Population Degraded	Residual Chlorine	Municipal Point Sources
	Oil & Grease	Industrial Point Sources Urban Non-Point Sources Combined Sewer Overflows
	Sedimentation	Agricultural Erosion
	PCBs	Contaminated Sediments Waste Disposal Sites Industrial Point Sources
	Heavy Metals	Urban Non-Point Sources Waste Disposal Sites Industrial Point Sources
--Navigation	Sedimentation	Agricultural Erosion
--Degraded Benthos	PCBs	Contaminated Sediments Waste Disposal Sites Industrial Point Sources
	Heavy Metals	Urban Non-Point Sources Waste Disposal Sites Industrial Point Sources
	Suspended Solids	Combined Sewer Overflows
	Oil and Grease	Industrial Point Sources Urban Non-Point Sources Combined Sewer Overflows
--Groundwater Contamination	PCBs	Contaminated Sediments Waste Disposal Sites Industrial Point Sources
	Heavy Metals	Urban Non-Point Sources Waste Disposal Sites Industrial Point Sources
	Other Toxic Organics*	Waste Disposal Sites

*Napthalene, Phthalates, Cresol, Creoscte, Benzene, Toluene, Ethyl Benzene, Xylenes, Cumene.

1. Monitor Union Camp Corporation's effluent and sample sludge for PCB's and heavy metals. Conduct a site assessment inspection and investigate possible groundwater contamination.

2. Conduct a site assessment inspection of the Consolidating Packaging - North Plant for possible sources of PCB discharged to surface water and groundwater.

3. Monitor Detroit Edison's fly ash lagoon effluent and sludge for PCB, heavy metals and selenium from dredge spoils and fly ash. Investigate possible groundwater contamination at the site.

4. Monitor groundwater quality for PCBs, heavy metals and toxic organics and determine flow rates and flow patterns for the following waste disposal sites:

   a. Port of Monroe Landfill northside along the River Raisin, southside to assess the Plum Creek dike and east side along the Detroit Edison Channel.

   b. City of Monroe Landfill northside along River Raisin, eastside along the Detroit Edison Channel.

   c. Consolidated Packaging - South Plant along all four sides of the lagoons and solid waste disposal sites.

The River Raisin's in-place sediments are heavily polluted with metals, PCBs, and oil and grease. Pollutants are transferred to the water column through adsorption and chemical reactions, and are then accumulated by aquatic organisms.

A portion of the river channel has been regularly dredged. However, the level of contamination remains high. It is apparent that restoration of the in-place sediments requires both elimination of pollutants entering the AOC and the physical removal of polluted sediments. The following actions are suggested:

1. Stop the input of PCBs and heavy metals to the River Raisin from point source and non-point sources.

   a. Continue to solve the problem of contaminant migration into the river through the Act 307 and Federal Superfund were possible. Sites currently in this process are the River Raisin, Port of Monroe Landfill, Consolidated Packaging Corporation - South Plant, City of Monroe Landfill and Detroit Edison. The Ford Motor Company, Monroe Stamping Plant is also in this system, however they are proposing their own clean-up and work on this should also be encouraged.

   b. Continue the Army Corp of Engineers' dredging project. Due to the PCBs associated with the sediments, it is imperative that the dredging continue to be of the closed system hydraulic type and that dredge spoils are disposed of at the Sterling State Park Contained Disposal (CDF) provided that the CDF operates as a containment system.

c. A sediment contamination mapping study should be conducted. This study would aid in the targeting of hot spots such as the areas downstream from the Consolidated Packaging Corporation - South Plant's former outfall, Union Camps outfall in Mason Run, the Mason Run's intersection with the River Raisin, the turning basin and the intersection of the Detroit Edison cooling channel with Plum Creek.

d. During the spring, the River is subject to heavy sediment and phosphorus loads. These sediments have reportedly harmed the benthos and fish life and impacted navigation to some degree. To reduce sediment loads, it is necessary to control soil erosion. Appropriate remedial actions include the use of Best Management Practices (BMP) for agriculture such as tillage systems (no-till farming), vegetative buffers, crop rotations, contour farming, cover crop usage and land use conversions. Other recommended measures are runoff control at construction sites, sediment basins, and slope and cover control in the watershed.

10.2 POINT SOURCE REMEDIAL ACTIONS

10.2.1. City of Monroe WWTP

The current condition for the plant is one of direct discharge of secondary treated effluents to the AOC. This discharge contains residual chlorine and metals which may be toxic to the biota. During wet weather conditions, bypasses of less than secondary treated effluent are discharged to the River Raisin. The current permit provides an implementation schedule that will relocate the outfall to Plum Creek, expand the hydraulic capacity of the plant, reduce infiltration/inflow, establish limits for residual chlorine, dissolved oxygen and ammonia, and require implementation of an approved, industrial pretreatment program. The following actions are suggested to control pollutants entering the AOC from this source:

* Enforce strict compliance with all requirements of the current NPDES permit.

* MDNR should conduct wasteload allocations for residual chlorine to provide a basis for establishing limits.

* Implement immediately a residual chlorine limit, a level of 0.036 mg/l.

* Require regular effluent monitoring for zinc and chlorine.

10.2.2 Ford Motor Company - Monroe Stamping Plant

The Ford Motor Company is a potential source of toxic pollutant to the AOC by way of direct discharge from its manufacturing operations. The plant's direct discharge has been shown to be toxic due to excessive levels of oil and grease (MDNR 1984d), and its current NPDES permit has expired. The following remedial actions are suggested:

- Enforce oil and grease limit
- Promulgate a new NPDES permit to replace the currently expired permit.
- Monitor toxic organics and metals in Ford discharge.
- Establish limits based on categorical standards or water quality criteria, whichever is more stringent.

10.2.3 Detroit Edison Monroe Power Plant

The effluent from the plant's fly ash lagoon should be regularly monitored for PCB, selenium and metal contamination as described in Section 10.1.1. If any contamination is found, further remedial actions should then be planned.

10.2.4 Union Camp Corporation

Union Camp Corporation is considered a potential source of PCBs because the receiving stream (Mason Run) exhibits very high PCB levels, and because paper product manufacturing can be a source of PCBs. Consequently, as described in part 10.1.1, the effluent from Union Camp should be monitored for PCBs. If any contamination is found, further remedial actions should then be planned.

The current NPDES permit for Union Camp is expired. A new NPDES permit should be promulgated as soon as possible.

10.2.5 Consolidated Packaging Corporation

The southside plant site contains seven sludge lagoons that hold sludges with high levels of PCBs and metals. PCBs and metals have also been found in sediments near the plant's former outfall. These toxic pollutants may be currently reaching the AOC, via groundwater or surface runoff which are contaminated by leakage from the lagoons. The State is contemplating an interim response action at this site due to the direct contact hazard associated with the lagoons. The goal of remedial actions at this site should be to remove all toxic pollutants to a proper disposal facility. Completion of this type of action would eliminate any current and future PCB and metals contamination from the site and significantly help to restore the AOC's impaired uses.

10.3 NON-POINT SOURCE REMEDIAL ACTIONS

10.3.1 Port of Monroe Landfill

The site assessment conducted by MDNR has identified the Port of Monroe Landfill (both east and west sides of I-75) as a source of toxic organics (PCB), Benzene, Xylene, Cumene and Ethyl Benzene) and heavy metals (Lead, Mercury, and Chromium) to the waters of the AOC. This landfill is the largest repository of industrial waste in the AOC and has been designated an Act 307 site. With an SAS screening score of 829 it ranks 36th on the State's Priority List. The following is a brief summary of the proposed Remedial Investigation (RI) and Feasibility Study (FS) for the Port of Monroe landfill - West Side and the Remedial Investigation for the Port of Monroe Landfill - East Side.

10.3.1.1 Port of Monroe Landfill - West Side

Presented here is the scope of work (20 tasks) to be conducted in the performance of the Port of Monroe Landfill - West Side RI/FS. Of these, Tasks 1 (Work Plan Preparation) and 2 (Project Management) are administrative tasks common to the entire RI/FS.

The following tasks comprise the Remedial Investigation (RI):

Task No.	Task Description
3	Collection and Evaluation of Existing Data
4	Detailed Site Reconnaissance
5	Development of Project Plans
6	Ground Survey
7	Field Equipment Mobilization
8	Magnetometry Investigation
9	Soil Gas Testing
10	Hydrogeologic Investigation
11	Environmental Sampling and Analysis
12	Test pit Excavation (optional)
13	Data Review, Reduction, and Evaluation
14	Preliminary Identification of Remedial Alternatives
15	Draft RI Report
16	Final RI Report

The Feasibility Study (FS) is composed of the following:

Task No.	Task Description
17	Draft FS Report
18	Revised Draft FS Report
19	Final FS Report
20	Conceptual Design

With regard to the above, it should be noted that Task 12 (Test Pit Excavation) is an optional task to provide additional definition of contaminant sources. The value of this task will be defined following review of the results of magnetometry and soil gas investigations (Tasks 8 and 9) and the analysis of environmental samples. In addition, Task 20 (Conceptual Design) has been identified in this Work Plan to complete the FS. The actual scope and extent of Task 20 will be defined during the conduct of the FS and be based on the recommended alternative.

10.3.1.2 Port of Monroe Landfill - East Side

Presented here is an overview of the technical approach for a complete RI/FS at the East Side. Because of the decision to proceed with the RI in a phased manner, only the initial phase (i.e. Phase I RI) has been fully scoped and costed in this Work Plan.

PHASED REMEDIAL INVESTIGATION

The approach taken in the East Side RI will be to build on the studies done previously by Johnson and Anderson, Inc., Clayton Environmental Consultants, and H.C. Hall to define the hydrogeologic conditions in both the water-table and bedrock aquifers, establish the nature of chemical contamination, and identify impact or potential impact to offsite receptors.

Because of the volume of material within the landfill and the lack of records regarding selective placement and segregation of wastes, little basis exists to design a study to evaluate the spatial distribution of wastes within the fill.

Phase I Remedial Investigation

In recognition of the present data limitations, the RI has been designed as a phased investigation. The Phase I RI, subject of the Work Plan, will discuss the site as a source, with the point of interest with respect to potential receptors being the landfill boundary. Data will be obtained to enable definition of the hydrogeologic system as a contaminant transport pathway and literature will be reviewed regarding the history of landfilling operations. Coupled with analysis of subsurface soils collected during monitoring well installation and analyses of samples from wells installed within the fill, this information will provide the basis for determining the need for subsequent investigation of specific sources of contamination within the landfill. If contaminant movement is suggested beyond the landfill periphery, or if potential offsite, upgradient contaminant sources are identified, additional investigation beyond the landfill limits may be required.

The central component of the Phase I RI will be the subsurface investigation. The present Work Plan specifies installation of 12 wells screened in the water-table aquifer, with companion bedrock wells at four of these points left as open boreholes in bedrock. The boring and well installation will permit NUS to map groundwater flow and to evaluate hydraulic conditions (i.e. presence of vertical gradients) between the two aquifers. Groundwater sampling will be undertaken to provide empirical evidence of the nature and extent of contamination in both the water-table and bedrock aquifers. Subsurface soils will be sampled and those samples exhibiting visual or field-measured evidence of contamination will be submitted for laboratory chemical analysis.

The existing leachate collection system will be sampled at various access points (manholes) along its length to assess contaminated groundwater movement from the water-table aquifer into the porous bottom-ash envelope. In the event that logistics can be worked out to permit purging of the collection system and routing of lechate to the POTW for treatment, the sampling will be done in advance of the monitoring well installation. Such an approach will provide an initial indication of the nature of contamination within the water-table aquifer as well as a basis for siting the shallow (water table) wells. If these logistics cannot be worked out, the leachate sampling will be conducted without pumping during a second sampling round.

Surface-water and sediment sampling will be undertaken at a number of background locations on site and in the immediate surrounding area. Samples will be obtained from Plum Creek upstream of the East Site, adjacent to the toe of the Plum Creek Dike, and within the Detroit Edison cooling water channel. Analyses of these samples will provide some insight into the degree to which site contaminants have migrated to the surrounding environment. Sample collection along the toe of the dike will also provide an indication of the effectiveness of the attempt to dredge contaminated sediments from Plum Creek in conjunction with the dike construction in 1985.

Surface-water and sediment sampling is purposefully scheduled to be conducted during the second tour of site sampling to obtain maximum benefit from definition of groundwater flow patterns and identification of suspected discharge areas in advance of the sampling.

Phase II Remedial Investigation

A subsequent phase or phases of remedial investigation will be developed based on the results of the Phase I Study. The objectives of additional RI study will be to refine characterization of the landfill as a source of contaminants to receptors in the site vicinity, to further define the relationship between the landfill and other potential sources, if any, and to evaluate specific sources of contamination within the landfill.

FEASIBILITY STUDY

Phase I Plum Creek Dike Assessment

Once the nature of contamination and the groundwater migration pathways have been defined, the potential value of the Plum Creek Dike slurry wall and leachate collection trench to the development of remedial action alternatives at the East Side will be more apparent. At this point, information from the RI will be used to refine a scope of work for evaluation of its effectiveness.

Phase II - Feasibility Study of Remedial Alternatives

Since the overall value and effectiveness of the Plum Creek Dike will have a significant bearing on the development of remedial alternatives, the configuration of the Phase II Feasibility Study will be dependent on the results of the dike investigation.

Site characterization in the RI provides the basis for a determination of how prominently the Plum Creek Dike, specifically, will figure in site remediation. Groundwater and subsurface soil sampling during the RI will aid in characterizing the source. The RI risk assessment will assist in establishing the need for remedial action, coupled with institutional requirements for groundwater renovation.

The Phase 1 FS will determine the effectiveness of the Plum Creek Dike in meeting some or all of the remedial action objectives established at the close of the RI. In addition, evaluation of the dike will provide site-specific evidence of the utility of this technology in source control. In the event that the dike proves highly effective, development of remedial alternatives in the FS will include a heavy reliance on the existing controls. If the dike performs well but is limited in effectiveness because of groundwater flow around the dike to the east, conduct of the FS may lead to a consideration of the relative cost effectiveness of incorporation modifications to the existing dike into specific remedial alternatives. If, however, the dike is ineffective in controlling groundwater discharge to Plum Creek from the water-table aquifer, or if interconnection between the water table and bedrock aquifers is found to exist, reliance on the Plum Creek Dike and the slurry wall technology in general will be much reduced, and the FS development of alternatives will focus on other remedial technologies.

Provided here is the technical scope of work (12 tasks) to be conducted in the performance of the Port of Monroe East Side Phase 1 RI. Of these, Tasks 1 (Work Plan Preparation) and 2 (Project Management) are common to the entire RI/FS.

The following tasks comprise the Remedial Investigation (RI):

Task No.	Task Description
3	Collection and Evaluation of Existing Data
4	Detailed Site Reconnaissance
5	Development of Project Plans
6	Hydrogeologic Investigation
7	Environmental Sampling and Analysis
8	Ground Survey
9	Data Review, Reduction, and Evaluation
10	Preliminary Identification of Remedial Alternatives
11	Draft Phase I RI Report
12	Final Phase I RI Report

More detailed information concerning the RI/FS for the West Side or RI for the East Side is contained in the appendices.

10.3.2 Ford Motor Company - Monroe Stamping Plant

The site assessment conducted by MDNR has identified the Ford Motor Company, Monroe Stamping Plant as an Act 307 site and assigned an SAS screening score of 487. The sludge lagoons contain listed hazardous wastes, and as such, are regulated under RCRA and Act 64. MDNR has determined that the sludge lagoons contain heavy metals (cadmium, nickel, cyanide, complex,copper, zinc, and chromium), oil and grease, and several organics produced by the company's electroplating process. The company is looking at options to adequately close the facility under the hazardous waste regulations. The Ford Motor Company has hired the consulting firm of Neyer, Tiseo and Hindo LTD. (NTH) to address this waste disposal problem.

NTH evaluated the feasibility of combining the sludge from all five existing disposal areas into a single permanent disposal area on-site. The factors used to evaluate the feasibility of this alternative included the general subsurface conditions, impact on surrounding areas, waste compatibility, Act 64 location standards and capacity. Using these factors, NTH concluded that on-site closure is feasible and that additional investigation and design should be pursued further.

10.3.3 Detroit Edison

The site assessment conducted by the MDNR identified the River Raisin dredge spoils deposited by the Army Corp of Engineers on Detroit Edison's property as an Act 307 site with a SAS screening score of 5. Currently, the river dredge spoils are classified as heavily polluted waste due to their concentration levels of PCBs and heavy metals. These dredge wastes must be disposed of in a category 1 contained waste disposal facility. However, in this case, they were deposited as fill material into wetlands and have direct connections to the surface waters of the AOC. The following are recommended actions that should be carried out as part of the RAP.

I. Conduct a remedial investigation to define the specific problems and develop a work plan which includes the following:

A. Characterize the type of waste to determine what contaminants are present and their concentrations. Preliminary sampling and analysis of the dredge spoils indicate that they contain PCBs, oil and heavy metals (nickel, lead, mercury, cadmium and chromium). This same area is also Detroit Edison's flyash disposal area. Due to the disposal of flyash, this area should also be analyzed for selenium.

B. Conduct a sampling and analysis program to determine the extent of the contamination, both vertically and horizontally. Aerial photographs indicate that a large portion of the coal storage area was once wetlands that have been filled with dredge spoils.

C. Conduct studies to identify the contaminant migration pathways to the environment. MDNR has identified several direct connections to the surface water due to the lack of proper containment, resulting from the disposal practices of the past. However, transport of the contaminants to the surface waters of the AOC via groundwater still needs to be investigated. The following actions would help identify if any groundwater infiltration is occurring.

1. Conduct a study to determine the groundwater direction of flow under the site for both aquifers.

2. Conduct a study to determine what discharges and recharges occur between the surface waters of the AOC and the groundwater under the site.

D. Utilizing the data gathered by the remedial investigation, conduct a feasibility study to determine the best suited remedial actions for the existing situation.

10.3.4 Consolidated Packaging Corporation - South Plant

The site assessment conducted by the MDNR has identified the Consolidated Packaging Corporation's - South Plant as a source of PCBs and heavy metals (Chromium and Lead) to the River Raisin and a threat to human health via direct contact with the soil or inhalation of contaminated material. This site is also designated as an Act 307 site with a SAS screening score of 804. The following are recommended actions for the consolidated Packaging Corporation - South Plant.

I. Conduct a remedial investigation (RI) for the purpose of defining the specific problems so a site specific work plan can be developed. Generally, the work plan should contain and address the following parameters.

A. Waste characterization sampling/analysis program should be implemented to determine what are the contaminants that are present and at what concentrations do they exist in the seven lagoons, the solid waste disposal area and the extensively stained areas. Chromium, lead, and PCB are the contaminants that have been identified by preliminary sampling. However, a complete inventory of contaminants needs to be compiled.

B. Determine the extent of the contamination of the site, both vertically and horizontally. According to the preliminary data heavy metals (chromium and lead) and PCB contamination exist in the seven (7) lagoons. Extensive staining is also noted southeast of the building and northeast of the lagoons that should be sampled. Also, over 200 barrels of various waste materials are stored in the buildings and should be removed.

C. Identify the contaminant migration pathways to the environment. According to the MDNR's site assessment, during wet weather the lagoons have overflowed and contamination has entered the river via the channel known as the second cut. However, migration pathways still need further identification.

   1. Determination of contaminant migration pathways in groundwater. The following studies should be conducted.

      A. Determine the groundwater flow direction under the site.

      B. Determine what discharges and recharges are occurring between the groundwater and the waters of the AOC.

Upon completion of the remedial investigation and data analysis, a feasibility study should be conducted to determine the best suited remedial actions for the existing situation.

Two remedial actions that should be completed as soon as possible are: 1) Removal of the 200 barrels of waste being stored in the building. 2) This area should be entirely fenced off and posted to prevent any possible threat to human health from exposure through direct contact with soil or inhalation of contaminated material.

10.3.5 City of Monroe Landfill

The site assessment conducted by the MDNR identified the City of Monroe Landfill as an Act 307 site and assigned an SAS screening score of seven. The currently available data are insufficient to adequately characterize any possible contamination at the site. However, it is known that this landfill has accepted industrial waste. The following are recommended actions that should be carried out to assess this site.

I. Conduct further site assessment to determine if this landfill is a potential source of contamination to the environment of the AOC.

II. Conduct a remedial investigation to define the specific problems and develop a work plan, which includes the following:

   A. Characterize the type of waste to determine what contaminants are present and their concentrations.

   B. Conduct a sampling and analysis program to determine the extent of the contamination, both vertically and horizontally.

   C. Conduct studies to identify the contaminant migration pathways to the environment.

      1. Conduct a study to determine if there are direct routes to surface water.

      2. Conduct a study to determine groundwater direction of flow under the site for both aquifers.

      3. Conduct a study to determine what discharges and rechargers occur between the surface waters of the AOC and groundwater under the site.

Utilizing the data gathered by the remedial investigation conduct a feasibility study to determine the best suited remedial action for the existing situation.

10.3.6 Consolidated Packaging Corporation - North Plant

Preliminary site inspection by the MDNR revealed no soil staining or solid waste disposal on site. However, further site assessment is necessary to determine if the site is a potential source of contamination to the waters of the AOC. The following are recommended actions that should be carried out as part of the remedial action.

I. Conduct a further in depth site assessment to determine if this site is a potential source of contamination to the environment.

II. Conduct a remedial investigation to define the specific problems and develop a work plan, which includes the following:

   A. Characterize the type of waste to determine what contaminants are present and their concentrations.

   B. Conduct a sampling and analysis program to determine the extent of the contamination, both vertically and horizontally.

   C. Conduct studies to identify the contaminant migration pathways to the environment.

1. Conduct a study to determine if there are direct routes to surface water.

2. Conduct a study to determine groundwater direction and flow under the site for both aquifers.

3. Conduct a study to determine what discharges and recharges occur between the surface waters of the AOC and groundwater under the site.

Utilizing the data gathered by the remedial investigation conduct a feasibility study to determine the best suited remedial action for the existing situation.

10.3.7 Union Camp Corporation

The recommended action for Union Camp is to conduct a site assessment to determine if this site is a potential source of contaminants to the waters of the AOC. The following are recommended actions that should be carried out as part of the remedial action.

I. Conduct further site assessment to determine if this site is a potential source of contamination to the environment.

II. Conduct a remedial investigation to define any specific problems which may be found and develop a work plan, which includes the following:

A. Characterize the types of waste present and determine the concentrations of these contaminants.

B. Conduct a sampling and analysis program to determine the extent of any contamination, both vertically and horizontally.

C. If contaminants are found, studies should be conducted to identify the contaminant migration pathways to the environment.

1. Conduct a study to determine if there are direct routes to surface water.

2. Conduct a study to determine groundwater direction of flow under the site for both aquifers.

3. Conduct a study to determine what discharges and recharges occur between the surface waters of the AOC and groundwater under the site.

RIVER RAISIN RAP
Bibliography

Allen County Soil and Water Conservation District. Undated. Environmental Impact of Land Use on Water Quality: Black Creek Project - Executive Summary.

Batchelor D. 1978. Briefing Memo.

Burby, B. G., Barnes, M. D., and Herdendorf, C. E. 1983. Organochlorine contaminant concentrations and uptake rates in fishes in Lake Erie tributary mouths. CLEAR Tech. Rep. No. 241. The Ohio State University, Center for Lake Erie Area Research, Columbus, OH.

Creal, W. 1986. Water, Sediment and Macroinvertebrate Survey of the South Branch Raisin River and Eastside Drain, 1982-1985. MDNR Surface Water Quality Division.

DePinto, J. V., Young, T. C., Autenrieth, R. L., and Kipp, T. W., 1985. Interactions of Heavy Metals and Organics with Particulate Matter From the Lower Raisin River, Michigan. (Draft). USEPA.

Di Toro, D. M., Winfield, R. P., Connolly, J. P., Karker, S. M., Wolf, W. A., Peterson, C. J., Glasland, J. R., and Econom, J. A. 1985(a). Development of Toxic Substances Models of Fate and Ecosystem Effects for Monroe Harbor - River Raisin, Michigan. (Draft). USEPA

Di Toro, D. M., Connolly, J. P., Winfield, R. P., Karkar, S. M., Wolf, W. A., Pederson, C. J., Blasland, J., and Econom, J. A. 1985(b). Field Validation of Toxic Substance Model of Fate and Ecosystem Effects for Monroe Harbor. (Draft). USEPA.

Dolan, D. M., Gessner, M. L., Hendricks, S., Griesmer, D. A., and Rygwelski, K. R. 1985. Correlations of Bioassay Results and Toxicant Concentrations at Monroe Harbor, Michigan, 1983-1984. (Draft). USEPA.

Evans, E. 1976. Raisin River Sediment Contaminants, Lenawee and Monroe Counties, Michigan. Michigan DNR Staff Report.

Fay, L. A., Gessner, M. L., Stromberg, P. C., and Hageman, J. 1985. Effects of Toxic Substances on Growth, Mortality, and Pathology of Larval Fishes in the River Raisin, Michigan. CLEAR Technical Report No. 295. (Draft). USEPA.

Filkins, J. C., Mullin, M. D., and Smith, V. E. 1985. The Surficial and Vertical Distribution of Polychlorinated Biphenyls in the Sediments of the lower River Raisin. (Draft). USEPA.

Fulcher, G. W., Miller, S. A., Van Til, R. 1986. Effects of Consumptive Water Uses on Drought Flows in the River Raisin. MDNR Engineering Water Management Division.

Gessner, M. and Richardson W. 1985. A Framework for Modeling Fate and Effects of Toxic Substances in Monroe Harbor, Michigan. (Draft). USEPA.

Great Lakes Water Quality Board. 1981. Report to the International Joint Commission. 1981 Report on Great Lakes Water Quality.

Great Lakes Water Quality Board. 1983(a). An Inventory of Chemical Substances Identified in the Great Lakes Ecosystem: Volume 3 - Lake Erie and Lake St. Clair.

Great Lakes Water Quality Board. 1983(b). Report to the International Joint Commission. 1983 Report on Great Lakes Water Quality.

Great Lakes Water Quality Board. 1984. Areas of Concern in the Great Lakes Basin. 1983 Update of Class "A" Areas (Appendix A - 1983 Report on Great Lakes Water Quality).

Great Lakes Water Quality Board. 1985. Report to the International Joint Commission. 1985 Report on Great Lakes Water Quality.

Great Lakes National Program Office. 1985. Memo from Stan Jacik to Pranas Pranckevicius concerning COE dredging of Monroe Harbor.

Hartig, J. H. 1981. Highlights of Water Quality and Pollution Control in Michigan - Water Year 1980. Publication No. 4833-9804. MDNR Environmental Services Division.

International Joint Commission. 1985. Great Lakes Water Quality Agreement of 1978 and Phosphorus Load Reduction Supplement Signed October 7, 1983.

Johnson and Anderson, Inc. 1978. Plumb Creek Dike: Groundwater Quality Analysis at the Port of Monroe.

Johnson and Anderson, Inc. 1985. Scope of Study for Remedial Action Plan for Port of Monroe/Lake Erie Industrial Park.

Lake Michigan Federation. 1985. Great Lakes Toxic Hotspots.

MacIntyre, S., Lick, W., and Tsai, Cheng-Han. 1985. Entrainment of Cohesive Riverine Sediments. (Draft). USEPA.

McNamee, Porter and Seeley Consulting Engineers. 1982. Tecumseh, Michigan POTW Evaluation Report.

Michigan Department of Natural Resources. 1973. Michigan Water Quality Standards.

Michigan Department of Natural Resources. 1974. Letter from J. Bohunsky to L. Leibold.

Michigan Department of Natural Resources. 1979(a). River Quality in the Raisin River Basin, 1971-1978.

Michigan Department of Natural Resources. 1979(b). Report of an Industrial Wastewater Survey of Detroit-Edison-Monroe Station conducted February 12-13, 1979.

Michigan Department of Natural Resources and U.S. Geological Survey. 1982. Michigan Water Resources Data - Water Year 1981. USGS Report MI-81-1.

Michigan Department of Natural Resources. 1983. Memo to Frank Horvath from Brenda Sayles concerning Point Source Discharges on the River Raisin and Monroe Harbor.

Michigan Department of Natural Resources. 1984(a). Designated Trout Streams for the State of Michigan.

Michigan Department of Natural Resources, et. al. 1984(b). State of Michigan Phosphorus Reduction Strategy for the Michigan Portion of Lake Erie and Saginaw Bay. (Draft).

Michigan Department of Natural Resources. 1984(c). Support Document for the Proposed Rule 57 Package.

Michigan Department of Natural Resources - Surface Water Quality Division. 1984(d). Toxicity evaluation of Effluent Discharged by Ford Motor Company of Monroe, Michigan. Staff Report.

Michigan Department of Natural Resources. 1984(e). Site Description of City of Monroe Landfill by Site Assessment Unit.

Michigan Department of Natural Resources. 1984(f). Site Description of Port of Monroe Landfill by Site Assessment Unit.

Michigan Department of Natural Resources. 1984(g). Draft NPDES permit for City of Monroe WWTP.

Michigan Department of Natural Resources - Groundwater Quality Division. 1985(a). Michigan Sites of Environmental Contamination - Priority List.

Michigan Department of Natural Resources. 1985(b). Michigan Water Quality Standards.

Michigan Department of Natural Resources and U.S. Geological Survey. 1985. Michigan Water Resources Data - Water Year 1984. USGS Report MI-84-1.

Michigan Department of Natural Resources. 1985(d). Site Description of Consolidated Packaging by Site Assessment Unit.

Michigan Department of Natural Resources. 1985(e). Site Description of Detroit Edison Dredge Spoils by Site Assessment Unit.

Michigan Department of Natural Resources. 1985(f). Report on Monroe Harbor by Frank Horvath.

Michigan Department of Natural Resources. 1985(g). Guidelines for Rule 57(2).

Michigan Department of Natural Resources. 1985(h). Unpublished Report - Monroe Harbor, Michigan.

Michigan Department of Natural Resources. 1985(i). Site Description of Salco Industrial Services by Site Assessment Unit.

Michigan Department of Natural Resources. 1986. Site Description of Ford Motor Company by Site Assessment Unit.

Michigan Water Resources Commission. 1965. Water Resource Conditions and Uses in the River Raisin Basin.

Michigan Water Resources Commission. 1971. Letter from F. B. Frost to W. R. Csellak of Consolidated Packaging Corporation.

Michigan Water Resources Commission. 1974. Raisin River Study - South Branch to Mouth, August 23-29, 1973.

Monroe County Planning Department. 1985. Monroe County Comprehensive Plan update Public Utilities Component.

Monroe County Soil and Water Conservation District. 1984. Otter Creek Conservation Tillage Project. Annual Report.

Neyer, Tiseo, and Hindo, LTD. 1985. Report on Phase I Engineering Study - Closure of Disposal Areas A and 3 (at Ford Motor Comapny - Monroe Stamping Plant). Project Number: 850040W.

Neyer, Tiseo, and Hindo, LTD. 1987. Phase I - Feasibility Study Closure of Disposal Areas Monroe Stamping Plant (Ford Motor Company). Project Number: 850040W.

NUS 1987. Phase I Remedial Investigation, Port of Monroe Landfill - East Side, Monroe County, Michigan. NUS Project # 8785.

NUS 1987. Remedial Investigation and Feasibility Study, Port of Monore Landfill - West Side, Monroe County, Michigan. NUS Project # 8785.

Rathbun, J. E., Gessner, M. L., Smith, T. E., Lemon, D. M., Brokaw, D. L., Hoeft, M. A., Richardson, W. L., and Rygwelski, K. R. 1985. Bioaccumulation of Total PCB and PCB Homologs in Caged Clams, Channel Catfish, and Fathead Minnows in the Monroe Harbor - River Raisin, Michigan. (Draft). USEPA.

Rathbun, J.E. 1985b. Impact of Freighter Passage and Resulting Sediment Resuspension on the Concentrations of Contaminants in the River Raisin-Monroe Harbor System (Draft). USEPA.

Shepard, Raymond. 1974. Inventory of Fish and Evaluation of Water Quality During Minimum Flow Period in the River Raisin, August 1971. MDNR Fisheries Division Technical Report 73-75.

Smith, G. R., Taylor, J. N., and Grimshaw, T. W. 1981. Ecological Survey of Fishes in the Raisin River Drainage, Michigan. Michigan Acadamician 8:275-305.

Smith, V. E., Rathbun, J. E., Rood, S. G., Rywelski, K. R., Richardson, W. L., and Dolan, D. M. 1985. Distribution of Contaminants in Waters of Monroe Harbor (River Raisin), Michigan and Adjacent Lake Erie. (Draft). USEPA.

Snyder, F. L. 1978. Icthyoplankton studies in the Maumee and Sandusky River Esturaies of Lake Erie. The Ohio State University, Center for Lake Erie Area Research, Columbus, CLEAR Tech. Rep. No. 92.

Southeast Michigan Council of Governments. 1978. Water Quality in Southeast Michigan: The Black, Belle, Pine, Raisin, and Shiawassee River Basins.

Suppnick, J. D. and Buda, S. G. 1980. River Raisin Study Below Tecumseh, August 7 and September 11, 1978. MDNR Report No. 4833-9012.

Towns, G. L. 1985. A Fisheries Survey of the River Raisin, August 1984. MDNR Fisheries Division, Technical Report No. 85-3.

Trautman, M. B. 1975. The Fishes of Ohio. Ohio St. Univ. Press, Columbus.

U.S. Army Corps of Engineers, Detroit District. 1976. Maintenance Dredging of the Federal Navigation Channel at Monroe Harbor Michigan.

U.S. Army Corps of Engineers, Buffalo District. 1977. Water Quality Data for Lake Erie Basin - Tributary Mouth Sampling Stations.

U.S. Army Corps of Engineers, Detroit District. 1979. Public Notice of Proposed Barrier and Fill in Plum Creek at Monroe, Michigan.

United States Department of Agriculture, Soil Conservation Service, 1982. Inventory of Soil, Water and Related Resources.

U.S. Department of the Interior Federal Water Pollution Control Administration, Great lakes Region. 1967. Report on Water Pollution in the Lake Erie Basin - Southeastern Michigan Area Raisin River.

U.S. Department of Interior Federal Water Pollution Control Administration, Great Lakes Region. 1969. Sediment Characteristics of Raisin River Navigation Channel in untitled report.

U.S. EPA. 1975. Report on the Degree of Pollution of Bottom Sediments, Monroe, Michigan.

U.S. EPA. 1976. Report on the Degree of Pollution of Bottom Sediments, Monroe, Michigan.

U.S. EPA. 1981. Watershed Handbook: A Management Technique for Choosing Among Point and Non-point Control Strategies. EPA-905/9-84-002.

U.S. EPA. 1984(a). Lake Erie Water Quality 1970-1982: A Management Assessment. EPA-905/4-84-007.

U.S. EPA. 1984(b). National Priorities List - 786 Current and Proposed Sites in Order of Ranking and by State. HW-7.2.

U.S. EPA. 1985. Record of Communication: Disposal of Monroe Sediments in Detroit Edison Fly Ash Pits. (6/10/85). J. Hooper.

U.S. EPA. 1986(a). Part B Call-In List (Region V).

U.S. EPA. 1986(b). PCS Facility Report. Facility Report on Selected Facilities.

Woods, R. and Wygant, J. 1980. River Raisin Study at Manchester, August 8 and September 11, 1979. MDNR Environmental Services Division Report No. 3730-0040.

Appendix 3-1
Land Capability Classes

Land Capability Classes - Land Suited to Cultivation and Other Uses

Class I - Soils in Class I have few limitations that restrict their use.

Soils in this class are suited to a wide range of plants and may be used safely for cultivated crops, pasture, range, woodland and wildlife. The soils are nearly level and erosion hazard (wind or water) is low. They are deep, generally well drained, and easily worked. They hold water well and are either fairly well supplied with plant nutrients or highly responsive to inputs of fertilizer.

The soils in Class I are not subject to damaging overflow. They are productive and suited to intensive cropping. The local climate must be favorable for growing many of the common field crops.

In irrigated areas, soils may be placed in Class I if the limitation of the arid climate has been removed by relatively permanent irrigation works. Such irrigated soils (or soils potentially useful under irrigation) are nearly level, have deep rooting zones, have favorable permeability and water-holding capacity, and are easily maintained in good tilth. Some of the soils may require initial conditioning including leveling to the desired grade, leaching of a slight accumulation of soluble salts, or lowering of the seasonal water table. Where limitations due to salts, water table, overflow, or erosion are likely to recur, the soils are regarded as subject to permanent natural limitations and are not included in Class I.

Soils that are wet and have slowly permeable subsoils are not placed in Class I. Some kinds of soil in Class I may be drained as an improvement measure for increased production and ease of operation.

Soils in Class I that are used for crops need ordinary management practices to maintain productivity - both soil fertility and soil structure. Such practices may include the use of one or more of the following: Fertilizers and lime, cover and green-manure crops, conservation of crop residues and animal manures, and sequences of adapted crops.

Class II - Soils in Class II have some limitations that reduce the choice of plants or require moderate conservation practices.

Soils in Class II require careful soil management, including conservation practices, to prevent deterioration or to improve air and water relations when the soils are cultivated. The limitations are few and the practices are easy to apply. The soils may be used for cultivated crops, pasture, range, woodland, or wildlife food and cover.

Limitations of soils in Class II may include singly or in combination the effects of (1) gentle slopes, (2) moderate susceptibility to wind or water erosion or moderate adverse effects of past erosion, (3) less than ideal soil depth, (4) somewhat unfavorable soil structure and workability, (5) slight to moderate salinity or sodium easily corrected but likely to recur, (6) occasional damaging overflow, (7) wetness correctable by drainage but existing permanently as a moderate limitation, and (8) slight climatic limitations on soil use and management.

The soils in this class provide the farm operator less latitude in the choice of either crops or management practices than soils in Class I. They may also require special soil-conserving cropping systems, soil conservation practices, water-control devices, or tillage methods when used for cultivated crops. For example, deep soils of this class with gentle slopes subject to moderate erosion when cultivated may need one of the following practices or some combination of two or more: Terracing, stripcropping, contour tillage, crop rotations that include grasses and legumes, vegetated water-disposal areas, cover or green-manure crops, stubble mulching, fertilizers, manure, and lime. The exact combinations or practices vary from place to place, depending on the characteristics of the soil, the local climate, and the farming system.

Class III - Soils in Class III have severe limitations that reduce the choice of plants or require special conservation practices, or both.

Soils in Class III have more restrictions than those in Class II and when used for cultivated crops, the conservation practices are usually more difficult to apply and to maintain. They may be used for cultivated crops, pasture, woodland, range, or wildlife food and cover.

Limitations of soils in Class III restrict the amount of clean cultivation; timing of planting, tillage, and harvesting; choice of crops; or some combination of these limitations. The limitations may result from the effects of one or more of the following: (1) Moderately steep slopes; (2) high susceptibility to water or wind erosion or severe adverse effects of past erosion; (3) frequent overflow accompanied by some crop damage; (4) very slow permeability of the subsoil; (5) wetness of some continuing waterlogging after drainage; (6) shallow depths to bedrock, hardpan, fragipan, or claypan that limit the rooting zone and the water storage; (7) low moisutre-holding capacity; (8) low fertility not easily corrected; (9) moderate salinity or sodium; or (10) moderate climatic limitations.

When cultivated, many of the wet, slowly permeable but nearly level soils in Class III require drainage and a cropping system that maintains or improves the structure and tilth of the soil. To prevent puddling and to improve permeability it is commonly necessary to supply organic material to such soils and to avoid working them when they are wet. In some irrigated areas, part of the soils in Class III have limited use because of high water table, slow permeability, and the hazard of salt or sodium accumulation. Each distinctive kind of soil in Class III has one or more alternative combinations of use and practices required for safe use, but the number of practical alternatives for average farmers is less than that for soils in Class II.

Class IV - Soils in Class IV have very severe limitations that restrict the choice of plants, require very careful management, or both.

The restrictions in use for soils in Class IV are greater than those in Class III and the choice of plants is more limited. When these soils are cultivated, more careful management is required and conservation practices are more difficult to apply and maintain. Soils in Class IV may be used for crops, pasture, woodland, range, or wildlife food and cover.

Soils in Class IV may be well suited to only two or three of the common crops or the harvest produced may be low in relations to inputs over a long period of time. Use for cultivated crops is limited as a result of the effects of one or more permanent features such as (1) steep slopes, (2) severe susceptibility to water or wind erosion, (3) severe effects of past erosion, (4) shallow soils, (5) low moisture-holding capacity, (6) frequent overflows accompanied by severe crop damage, (7) excessive wetness with continuing hazard of waterlogging after drainage, (8) severe salinity of sodium, or (9) moderately adverse climate.

Many sloping soils in Class IV in humid areas are suited to occasional but not regular cultivation. Some of the poorly drained, nearly level soils placed in Class IV are not subject to erosion but are poorly suited to inter-tilled crops because of the time required for the soil to dry out in the spring and because of low productivity for cultivated crops. Some soils in Class IV are well suited to one or more of the special crops, such as fruits and ornamental trees and shrubs, but this suitability itself is not sufficient to place a soil in Class IV.

In subhumid and semiarid areas, soils in Class IV may produce good yields of adapted cultivated crops during years of above average rainfall; low yields during years of average rainfall; and failures during years of below average rainfall. During the low rainfall years the soil must be protected even though there can be little or no expectancy of a marketable crop. Special treatments and practices to prevent soil blowing, conserve moisture, and maintain soil productivity are required. Sometimes crops must be planted or emergency tillage used for the primary purpose of maintaining the soil during years of low rainfall. These treatment must be applied more frequently or more intensively than on soils in Class III.

<u>Land Limited in Use - Generally Not Suited to Cultivation</u>

<u>Class V</u> - Soils in Class V have little or no erosion hazard but have other limitations impractical to remove that limit their use largely to pasture, range, woodland, or wildlife food and cover.

Soils in Class V have limitations that restrict the kind of plants that can be grown and that prevent normal tillage or cultivated crops. They are nearly level but some are wet, are frequently overflowed by streams, are stony, have climatic limitations, or have some combination of these limitations. Examples of Class V are (1) soils of the bottom lands subject to frequent overflow that prevents the normal production of cultivated crops, (2) nearly level soils with a growing season that prevents the normal production of cultivated crops, (3) level or nearly level stony or rocky soils, and (4) ponded areas where drainage for cultivated crops is not feasible but where soils are suitable for grasses or trees. Because of these limitations, cultivation of the common crops is not feasible but pastures can be improved and benefits from proper management can be expected.

Class VI - Soils in Class VI have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife food and cover.

Physical conditions of soils placed in Class VI are such that it is practical to apply range or pasture improvements, if needed, such as seeding, liming, fertilizing, and water control with contour furrows, drainage ditches, diversions, or water spreaders. Soils in Class VI have continuing limitations that cannot be corrected, such as (1) steep slope, (2) severe erosion hazard, (3) effects of past erosion, (4) stoniness, (5) shallow rooting zone, (6) excessive wetness or overflow, (7) low moisture capacity, (8) salinity or sodium, or (9) severe climate. Because of one or more of these limitations, these soils are not generally suited to cultivated crops. But they may be used for pasture, range, woodland, or wildlife cover or for some combination of these.

Some soils in Class VI can be safely used for the common crops provided unusually intensive management is used. Some of the soils in this class are also adapted to special crops such as sodded orchards, blueberries, or the like, requiring soil conditions unlike those demanded by the common crops. Depending upon soil features and local climate, the soils may be well or poorly suited to woodlands.

Class VII - Soils in Class VII have very sever limitations that make them unsuited to cultivation and that restrict their use largely to grazing, woodland, or wildlife.

Physical conditions of soils in Class VII are such that it is impractical to apply such pasture or range improvements as seeding, liming, fertilizing, and water control with contour furrows, ditches, diversions, or water spreaders. Soil restrictions are more severe than those in Class VI because of one or more continuing limitations that cannot be corrected, such as (1) very steep slopes, (2) erosion, (3) shallow soil, (4) stones, (5) wet soil, (6) salts or sodium, (7) unfavorable climate, or (8) other limitations that make them unsuited to common cultivated crops. They can be used safely for grazing or woodland or wildlife food and cover or for some combination of these under proper management.

Depending upon the soil characteristics and local climate, soils in this class may be well or poorly suited to woodland. They are not suited to any of the common cultivated crops; in unusual instances, some soils in this class may be used for special crops under unusual management practices. Some areas of Class VII may need seeding or planting to protect the soil and to prevent damage to adjoining areas.

Class VIII - Soils and landforms in Class VIII have limitations that preculde their use for commercial plant production and restrict their use to recreation, wildlife, or water supply or to esthetic purposes.

Soils and landforms in Class VIII cannot be expected to return significant on-site benefits from management for crops, grasses, or trees, although benefits from wildlife use, watershed protection, or recreation may be possible.

Limitations that cannot be corrected may result from the effects of one or more for the following: (1) Erosion or erosion hazard, (2) sever climate, (3) wet soil, (4) stones, (5) low moisture capacity, and (6) salinity or sodium.

Badlands, rock outcrop, sandy beaches, river wash, mine tailings, and other nearly barren lands are included in Class VIII. It may be necessary to give protection and management for plant growth to soils and landforms in Class VIII in order to protect other more valuable soils, to control water, or for wildlife or esthetic reasons.

APPENDIX 6-1. River Raisin Model Boundary, Tributary and Point Source Water Quality

Appendix 6-1. River Raisin Model Boundary, Tributary and Point Source Water Quality - July Survey

Input File	Parameter	Units	Upstream Boundary	Downstream Boundary	WWTP	Mason Run	Ford
July 001 Inp	Continuity[a]		100	100	100	100	100
002	Conduct. (Transect)	(μMHOS)	700	360	940	588	421
002B	Conduct. (Station)	(μMHOS)	650	330	940	588	421
003	S.S	(MG/L)	28	13	73	35	11
004	Alkalinity	(MG/L)	212	114	220	189	118
005	Hardness	(MG/L)	325	162	349	302	188
006	Temperature	(°C)	26.5	24.5	22.7	26.1	27.2
007	pH	--	8.3	8.5	7.8	8.3	7.8
008	Nitrite	(MG/L)	0.015	0.097	0.024	0.049	0.058
009	Free Res. Chlorine	(MG/L)	0.27	0.087	3.166	0.286	0.045
010	Combined Res. Cl	(MG/L)	0.30	0.016	0.244	0.164	0.136
011	Total Res. Chlorine	(MG/L)	0.6	0.103	3.425	0.45	0.181
012	Diss. Chrom.	(μg/L)	0.215	3.425	0.244	0.164	0.136
013	Total Chrom.	(μg/L)	1.6	1.2	2.3	3.4	32.0
014	Diss. Copper	(μg/L)	2.3	1.8	4.1	3.6	14.6
015	Total Copper	(μg/L)	3.7	3.3	7.7	6.5	42.0
016	Diss. Zinc	(μg/L)	2.8	2.5	22.5	1.25	16.0
017	Total Zinc	(μg/L)	3.7	3.7	47	8.6	80.2

Flows associated with above boundary conditions and loads <1 day

Upstream Boundary	374 cfs = 9.15×10^8 L/Day
Downstream Boundary	2593 cfs = 6.34×10^9 L/Day
Monroe WWTP	20 cfs = 48,936,960 L/Day
Mason Run	3 cfs = 7,340,544 L/Day
Ford	12 cfs = 29,362,176 L/Day

[a]These values are used to insure that the flow field satisfies continuity.

Source: USEPA 1987

Appendix 6-1. River Raisin Model Boundary, Tributary and Point Source Water Quality - September Survey

Input File	Parameter	Units	Upstream Boundary	Downstream Boundary	WWTP	Mason Run	Ford
Sept 300 Inp	Continuity[a]		100	100	100	100	100
301	Conduct. (Transect)	(μMHOS)	750	375	900	488	379
302	Conduct. (Station)	(μMHOS)	730	235	900	488	379
303	S.S.	(MG/L)	31	32	7.5	30	16
304	Alkalinity	(MG/L)	215	86	157	136	99
305	Hardness	(MG/L)	328	104	328	212	159
306	Temperature	(°C)	19.9	21.6	21.9	20.32	3.6
307	pH	--	8.46	8.93	7.38	8.33	7.74
308	Nitrite	(MG/L)	0.008	0.001	0.26	0.015	0.023
309	Diss. NH_3	(MG/L)	0.02	0.009	3.572	0.148	0.062
310	Diss. Chrom.	(μg/L)	0.10	0.2	0.89	0.34	15.43
311	Total Chrom.	(μg/L)	1.64	2.06	0.55	2.67	13.38
312	Diss. Copper	(μg/L)	2.29	1.19	3.46	2.07	10.16
313	Total Copper	(μg/L)	4.12	4.39	4.5	7.8	35.1
314	Diss. Zinc	(μg/L)	0.5	0.25	20.5	1.86	17.0
315	Total Zinc	(μg/L)	6.12	8.78	27.75	10.00	41.26

Flows associated with above boundary conditions

Upstream Boundary	124 cs = 3.041×10^8 L/Day
Downstream Boundary	2295 cfs = 5.6155×10^9 L/Day
Monroe WWTP	18 cfs = 44,043,264 L/Day
Mason Run	3 cfs = 7,340,544 L/Day
Ford	12 cfs = 29,362,176 L/Day

[a] These values are used to insure that the flow field satisfies continuity.
Source: USEPA 1987

Appendix 6-1. River Raisin Model Boundary, Tributary and Point Source Water Quality - October Survey

Input File	Parameter	Units	Upstream Boundary	Downstream Boundary	WWTP	Mason Run	Ford
Oct. 300	Continuity[a]		100	100	100	100	100
301	Conduct. (Transect)	(μMHOS)	725	240	615	579	344
302	Conduct. (Station)	(μMHOS)	705	245	615	579	344
303	S.S.	(MG/L)	17.5	27.2	15.2	41.8	7.5
304	Alkalinity	(MG/L)	228	87	142	177	114
305	Hardness	(MG/L)	354	105	250	267	134
306	Temperature	(°C)	9.6	11.1	15.9	10.3	15.6
30	pH	--	8.23	7.98	7.66	8.07	8.12
308	Nitrite	(MG/L)	0.011	0.02	0.10	0.022	0.029
309	Diss. NH_3	(MG/L)	0.024	0.124	1.572	0.225	0.24
310	Diss. Chrom.	(μg/L)	0.417	0.1	0.138	0.16	20.00
311	Total Chrom.	(μg/L)	1.73	2.9	1.45	5.42	38.9
312	Diss. Copper	(μg/L)	2.72	0.80	1.28	1.94	18.5
313	Total Copper	(μg/L)	3.10	3.10	5.14	9.18	39.6
314	Diss. Zinc	(μg/L)	1.67	2.0	17.23	3.0	25.0
315	Total Zinc	(μg/L)	5.17	12.0	35.31	17.2	48.0

Flows associated with above boundary conditions

Upstream Boundary	230 cfs = 5.6278 x 10^8 L/Day
Downstream Boundary	2289 cfs = 5.6008 x 10^9 L/Day
Monroe WWTP	18 cfs = 44,043,264 L/Day
Mason Run	3 cffs = 7,340,594 L/Day
Ford	12 cfs = 29,362,176 L/Day

[a]These values are used to insure that the flow field satisfies continuity.
Source: USEPA 1987