Water Quality of the Buffalo River: There is Hope for Remediation

An Independent Research Project
May 11, 1990

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Environmental Science 102
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FIGURE 1

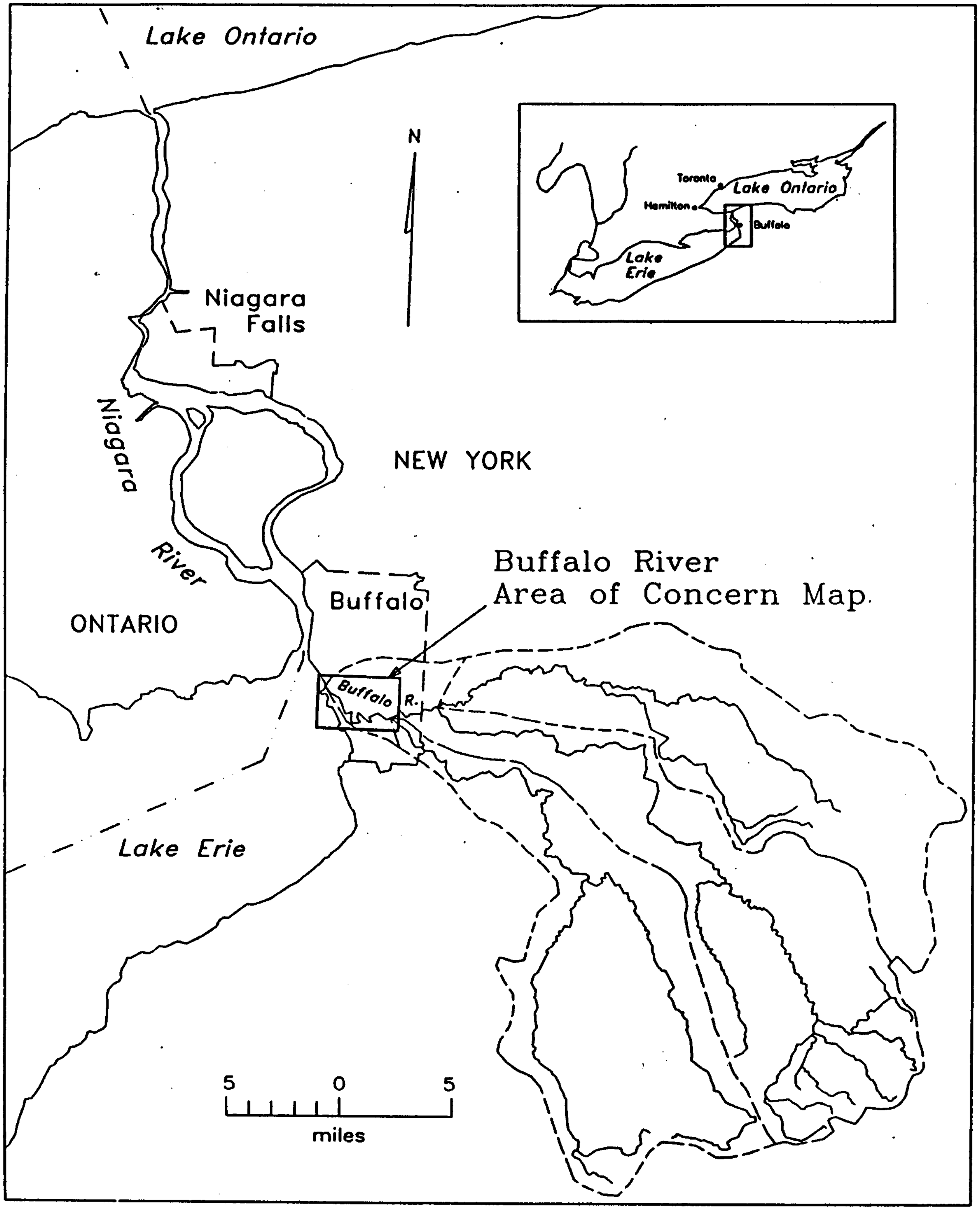


Figure 2.1 Buffalo River Area of Concern Location Map

DEC Buffalo River Rap Report, 1989

FIGURE 2
2-3

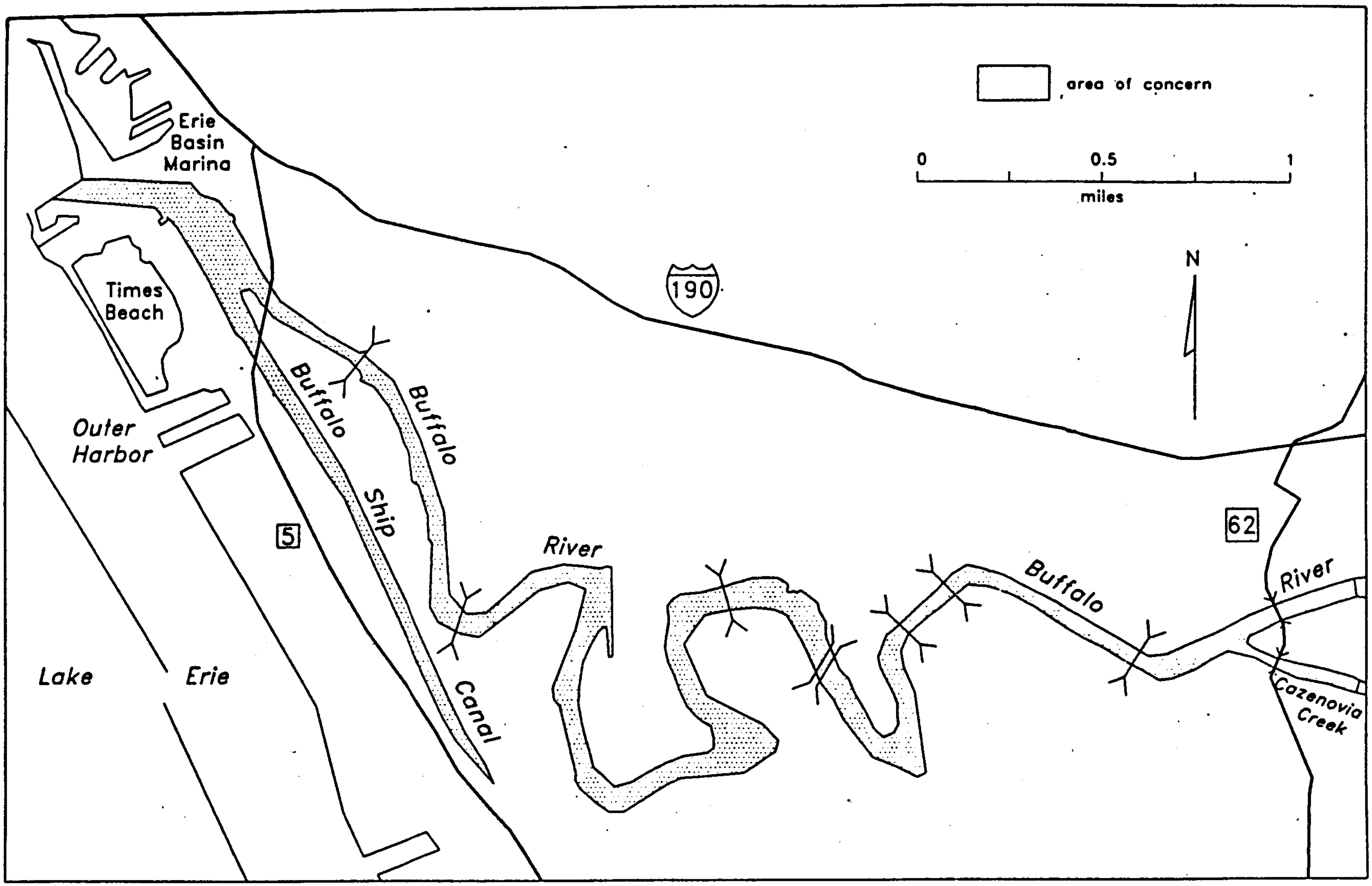


Figure 2.2 Buffalo River Area of Concern

RAP, 1989

FIGURE 3

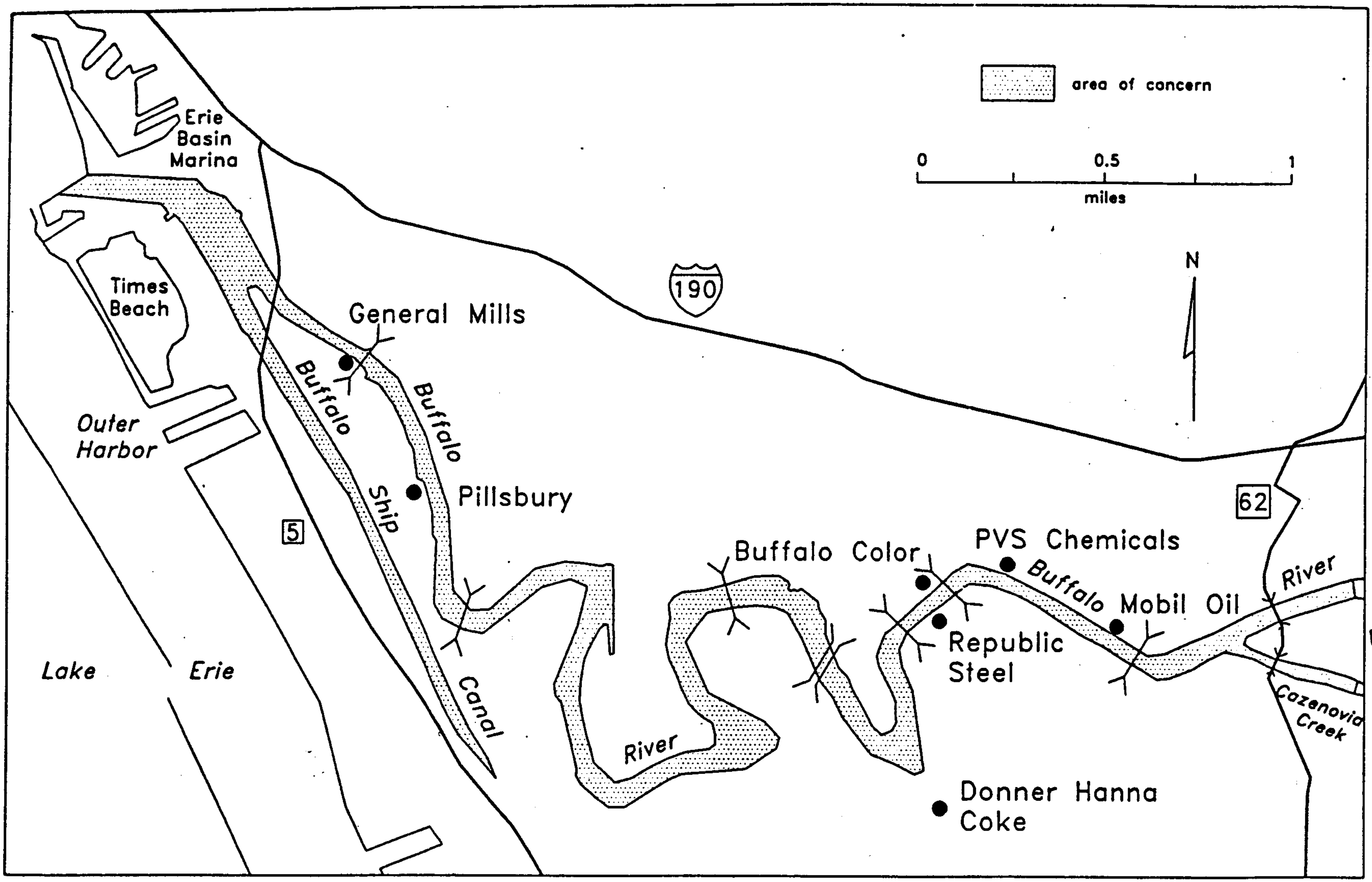


Figure 2.3 Location of Major Industries Along the Buffalo River

RAP, 1989

A. The Setting

The Buffalo River Area of Concern is located in the industrial heart of the city of Buffalo in Western New York State at the Northeastern tip of Lake Erie. (Figures 1, 2) The area of concern portion of the Buffalo River is heavily lined on both sides with industrial facilities that presently or formerly have served as major polluters of the river. These industries include General Mills, Pillsbury, Buffalo Color, PVS Chemical(formerly Allied Chemical), Mobli Oil, and various other facilities including coke and steel manufacturing operations. Many of these businesses are presently abandoned (Figure 3). why

The flow of the Bufalo River is characteristically very low and is augmented by the Buffalo River Improvement Corporation(BRIC) with an average of 18 million gallons per day(mgd). This is the result of a river rehabilitation plan executed in the late 1960's which involves pumping water from Lake Erie to increase the flow of the river in order to alleviate severe pollution build-up in the river due to low flow.

The Buffalo River is fed by three tributaries: Cazenovia Creek, Buffalo Creek, and Cayuga creek. The River itself drains into Lake Erie which has a backflow influence for 6.5 miles upstream.

why is there so little flow?

B. Introduction

History. "The Buffalo River is a repulsive holding basin for industrial and municipal wastes under the prevalent sluggish flow conditions. It is devoid of oxygen and almost sterile." Thus reads a 1968 Report issued by the Department of the Interior. It goes on to state that "oils, phenols, color, oxygen demanding materials, iron, acid, sewage, and exotic organic compounds are present in large amounts. . .Thick films of oil are present on the Buffalo River at all times except during flood conditions." Another report described the river as "a vast septic tank, with no dissolved oxygen and high biochemical oxygen demand."(Federal Water Pollution Control Administartion, 1965.) In 1928 it was recorded that the dissolved oxygen level at the mouth of the river was zero.(RAP, 1989)
No concrete data could be found illustrating the massive pollution of this period, but an idea of the nature of the contamination levels can be found in Table 1.(Also see Figure 4)

The Present. Although a distinct need for improvement was recognized in the 1960's, it has taken twenty years for a comprehensive remedial plan to be designed and executed. This has taken form in the Buffalo River Remedial Action Plan (RAP), which was finalized in November, 1989. Since the 1960's, water quality of the Buffalo River has improved dramatically for a number of reasons which include remedial measures(BRIC flow augmentation), the abandonment of many of the industries, and settling of the most priority pollutants into the sediment. To the naked eye, the river still looks vaguely like a "septic tank" and it was the purpose of my project to determine whether the river water truly has improved to a substantial degree. I was also skeptical of the RAP committe's goal to upgrade the water of the Buffalo River from a "D" classification to a "C".

TABLE A-8

PENNSYLVANIA AND NEW YORK AREAS MAJOR INDUSTRIAL WASTE PROBLEMS

TABLE I

Industry	Flow (mgd)	Waste Constituents (lbs./day)	Control Measures Needed	Abatement Schedule
PENNSYLVANIA AREA				
Small Tributaries				
Gunnison Bros.	0.002	BOD 6; Solids 100T; Solids 20S	Secondary	5/68
Brown Slaughter	x	BOD x; Grease x; Solids xS	Secondary	NS
Specialty Valve and Control	x	Oil x	Oil	NS
Direct to Lake Erie				
Hammermill	20	BOD 62,000; Solids 530,000T; Solids 84,000S; SO_4 51,000	BOD, Color, Odor (IE)	12/70
Erie Reduction	0.2	BOD 10; Solids x	BOD (E)	3/68
NEW YORK AREA				
Buffalo River Basin				
General Mills	x	BOD x; Solids xS	Connect to Metro or Secondary	NS
Pillsbury Mills	x	BOD x; Solids xS	Connect to Metro or Secondary	NS
Perot Malting	x	BOD x; Solids x	Connect to Metro or Secondary	NS
Allied Chemical Buffalo Dye	14.8	BOD 31,300; Solids 14,000S; pH 2.5–4.0; COD 80,000; Chlorides 96,000; Cyanide 12; Iron 7,400; Phenol 150	Color, Solids, BOD, Acid, Phenols (IE)	1/71
Republic Steel	26.5	Solids 16,000S; pH 3.7–9.5; COD 73,000; Oil 9,900; Iron 16,000	Oils, Solids, Color, Acid, Iron (IE)	7/71
Donner Hanna Coke	6.0	COD 2,500; Oil 780; Phenols 120	Oil, Phenols, BOD (IE)	12/69
Mobil Oil	22.5	BOD 3,700; Solids 25,000T, Solids 2,600S; pH 7.4–8.0; COD 4,700; Oil 1,500; Chlorides 2,500; Phenol 380	Oil, Phenols (IE)	12/69 Plans to discontinue refinery 6/68
Symington Wayne	x	BOD x; pH x; Oil x	Oil, BOD, Color	NS
Pennsylvania Railroad Shops	x	Oils x; pH x	Oil	1/68
Cattaraugus Creek Basin				
Silver Creek Preserving			Solids, Color, Oil & Connect to Silver Creek (E)	UN
Peter Cooper Eastern Tanners and Glue	3.6	BOD 26,000; Solids 131,000T, Solids 9,600S	Advanced Waste Treatment, Ammonia, Grease, Chrome (IE)	1/70
Moench Tannery	1.7	BOD 8,700; Solids 90,000T, Solids 7,600S	Advanced Waste Treatment, Ammonia, Grease, Chrome	1/71
Small Tributaries				
Welch Grape Juice (Westfield)	0.5	BOD x; Solids xS	Connect to city sewers (IE)	12/69
Growers Coop. Grape (Westfield)	x	BOD x; Solids xS	Connect to city sewers (IE)	12/69
Direct to Lake Erie				
Hanna Furnace	26	Solids xS; Oil x	Solids (IE)	4/72
Bethlehem Steel	350	BOD 5,200; Solids 350,000S; pH 4.0–7.0; COD 11,000; Oil 31,000; Phenols 680; Cyanide 950	Oil, Phenols, Solids, Color, Cyanides, Ammonia, Acid, Iron (IE)	1/70

Lake Erie Report. US Dept. Interior, 1968

FIGURE 4

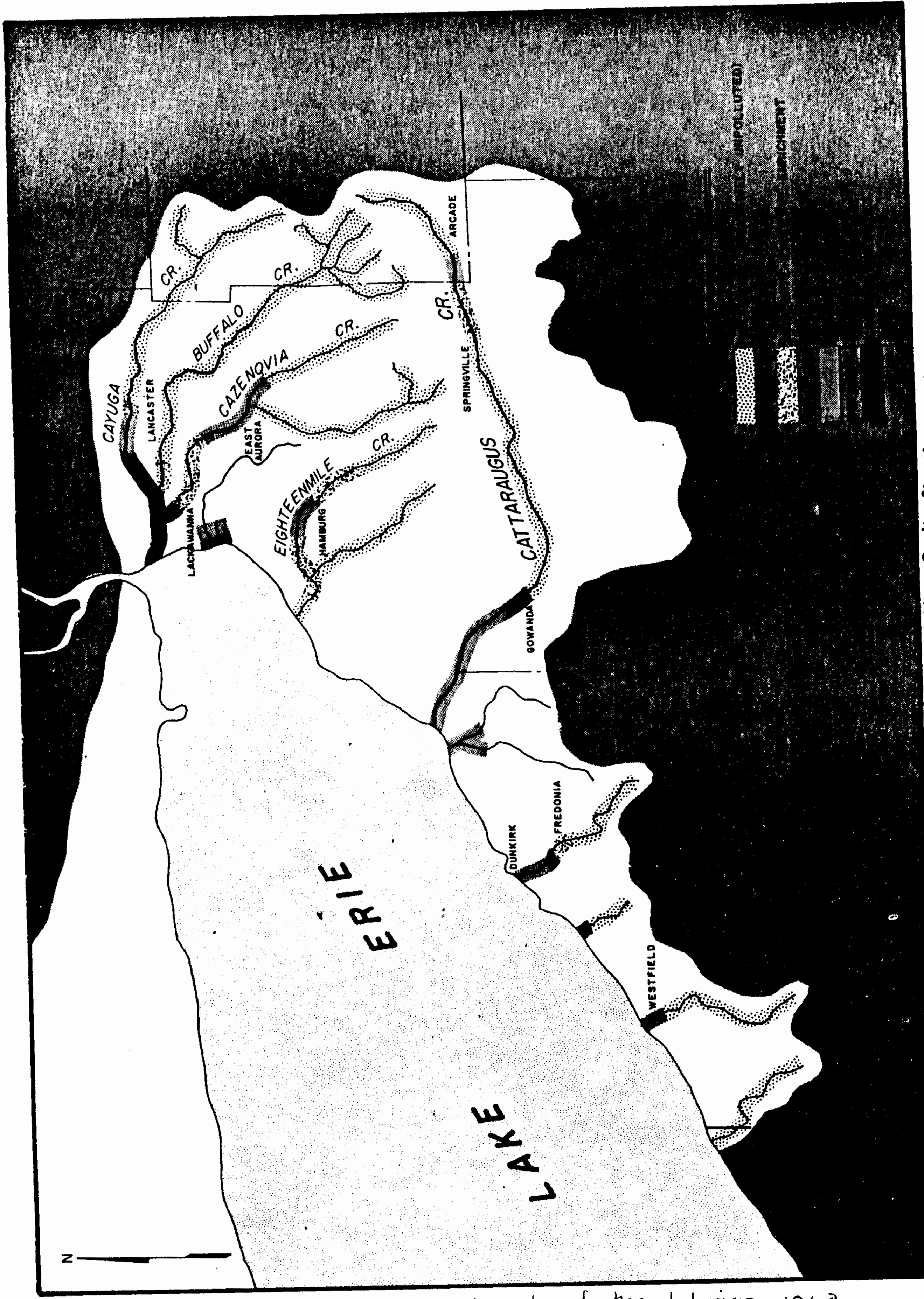


Figure 3-14 – New York Area Water Quality Situation – 1968

Lake Erie Report. US Department of the Interior, 1968.

At a loss for where to begin, I initiated my research efforts by accosting two staff members of the New York Department of Environmental Conerevation (DEC) who were sampling at the Michigan Bridge site where my father works. I asked what would be interesting things to look for in the water, expecting the opportunities to be boundless. I was quite disappointed when the man flatly replied that I would not find much of anything in the water. The woman with him was a bit more helpful and promised to think about my questions and give me a call. A few days later she called with an invitation to go with her on her next sampling run which I promptly accepted. We agreed that it would be best for me to test for common ions.

C. Procedure

I collected seven samples on March 29, 1990. The weather was overcast and cold with a temperature of about 7 degrees centigrade. Readings were taken with a Hydrolab II instrument. The Hydrolab can test for depth, pH, dissolved oxygen, conductivity, and temperature on the spot. Data was collected for all of these parameters at intervals of one meter except for the South Ogden and Cazenovia Creek sites where the water was not deep enough to allow for this. Hydrolab data was not collected at the Ohio street site for some reason not explained by Ms. Anderson.

My water samples were collected using a Van Dorn sampler at a depth of about 3 meters excepth for the S. Ogden and Cazenovia sites where the samples were taken at a depth of approxomately 0.5 meters. Samples were placed on ice immediately after they were collected. I brought my samples back to Williamstown in a cooler packed with ice and stored them in my friends refri~~d~~gerator for the next three weeks. At the end of this period, I discovered that three samples(S.Park -NW, S.Park-SE, S.Ogden-N) were completely frozen. - probably OK

The Ion Chromatograph. The ion chromatograph is a very good instrument for measuring low concentrations of negative ions. My first IC run only included four of my samples as three remained frozen. All samples were filtered before they were loaded into the IC. All four samples "pegged" on chloride and sulfate. The following week I diluted all seven samples by a factor of 10 and again ran them through the IC. (All data reflects total concentrations--not diluted ones.) However, this time the printer was not on while my first five samples were running. On Monday, May 7 I reloaded the samples neglected by the printer and finally had a successful run.

- this is our informal use

I decided not to test for metals using the AA because the DEC officials I talked to said I would not find anything and the reports I looked at attested to this.

what is a combined sewer overflow?

4. Site Locations

Site 1: This site is 1.1 miles from the mouth of the river. General Mills is located at the SW end of the bridge and Pillsbury is about one half mile upstream. There is also a combined sewer overflow at this site.

Site 2: This site is located 1.8 miles upstream. There is a combined sewer overflow here as well. This site has been monitored by the DEC for the past eight years and is the basis for the findings in the RAP report.

Site 3: South Park Bridge-NW end: Located 4.9 miles upstream, this site is just downstream from one of the 42 inactive hazardous waste sites in the Buffalo River Basin. PVS Chemical and the abandoned mobil oil refinery are both less than a mile upstream. PVS has an outflow discharge pipe which has tested positive for priority pollutants. Buffalo Color is just how does this work?

downstream, but backflow interference from Lake Erie could affect this site as well.

Site 4: South Park Bridge-SE end: The same conditions apply as for the NW end , except that the sewer overflow and the hazardous waste site are located on the northern bank and thus might have a greater impact on the northwern end of the bridge.

Site 5. Cazenovia Creek: This is the only sample not taken in the river. The water here was extremely shallow. Although this location is not within the boundaries of the map, it is likely that there is a combined sewer overflow nearby as there are a great many along the creek.

Site 6. South Ogden Bridge-S. end: This site is about 8 or 9 miles upstream . This site lies outside the designated area of concern of the RAP plan. The water here was relatively shallow as well. What was unique about this site was that it was not in the industrial section of the river, but in a residential area.

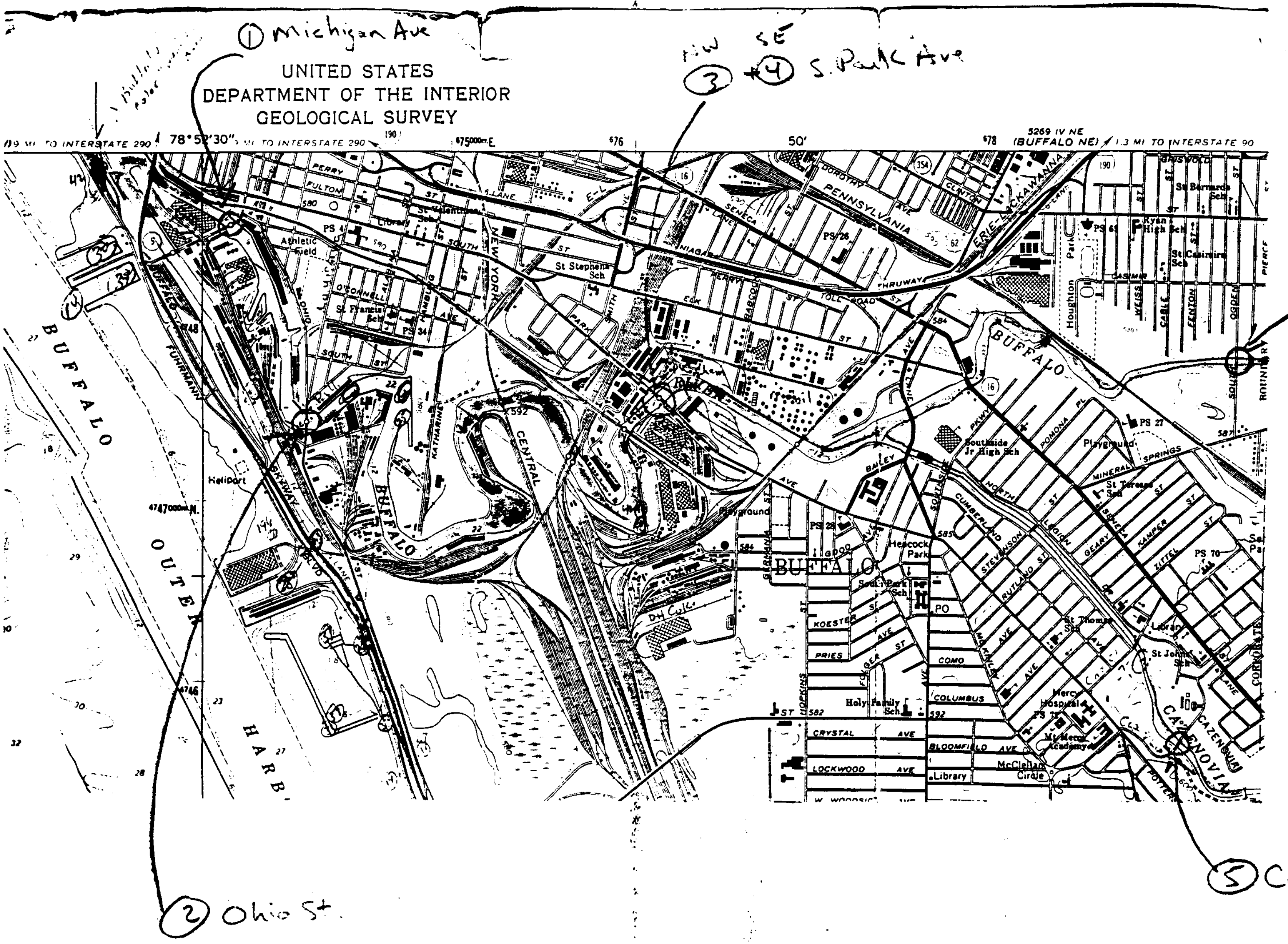
where does the L. Erie water come in?

Site 7. South Ogden Bridge-N. end: This site was sampled because there was a massive drainage pipe directly underneath the bridge at the North end. The conductivity hare was particularly high so we decided to take a water sample.

(See Figures 5-9)

5. Data and Discussion.

The results of my IC tests were for the most part rather unexciting and seemed to indicate that the water in the Buffalo River is indeed within range of a Class C designation. The only possible problem is DO concentrations in the summer. All of the parameters tested fell well within range of standards for reasonably clean water.



⑥ S. Ogden St.

FIGURE 5
SAMPLING SITES

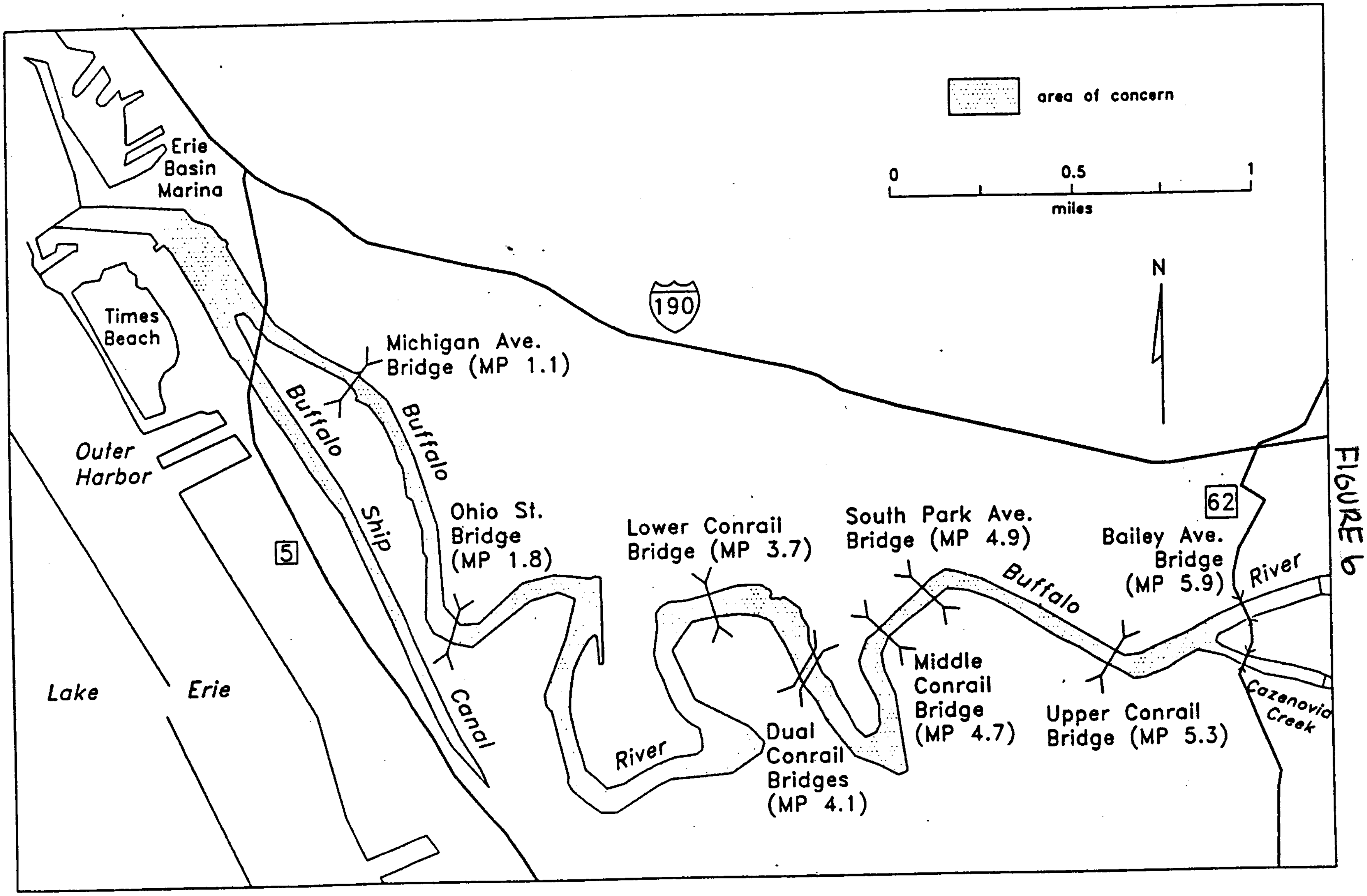


FIGURE 6

RAP, 1985

Figure 4.3 Location and Mile Point (MP) of Bridges Along the Buffalo River

FIGURE 7

5-23

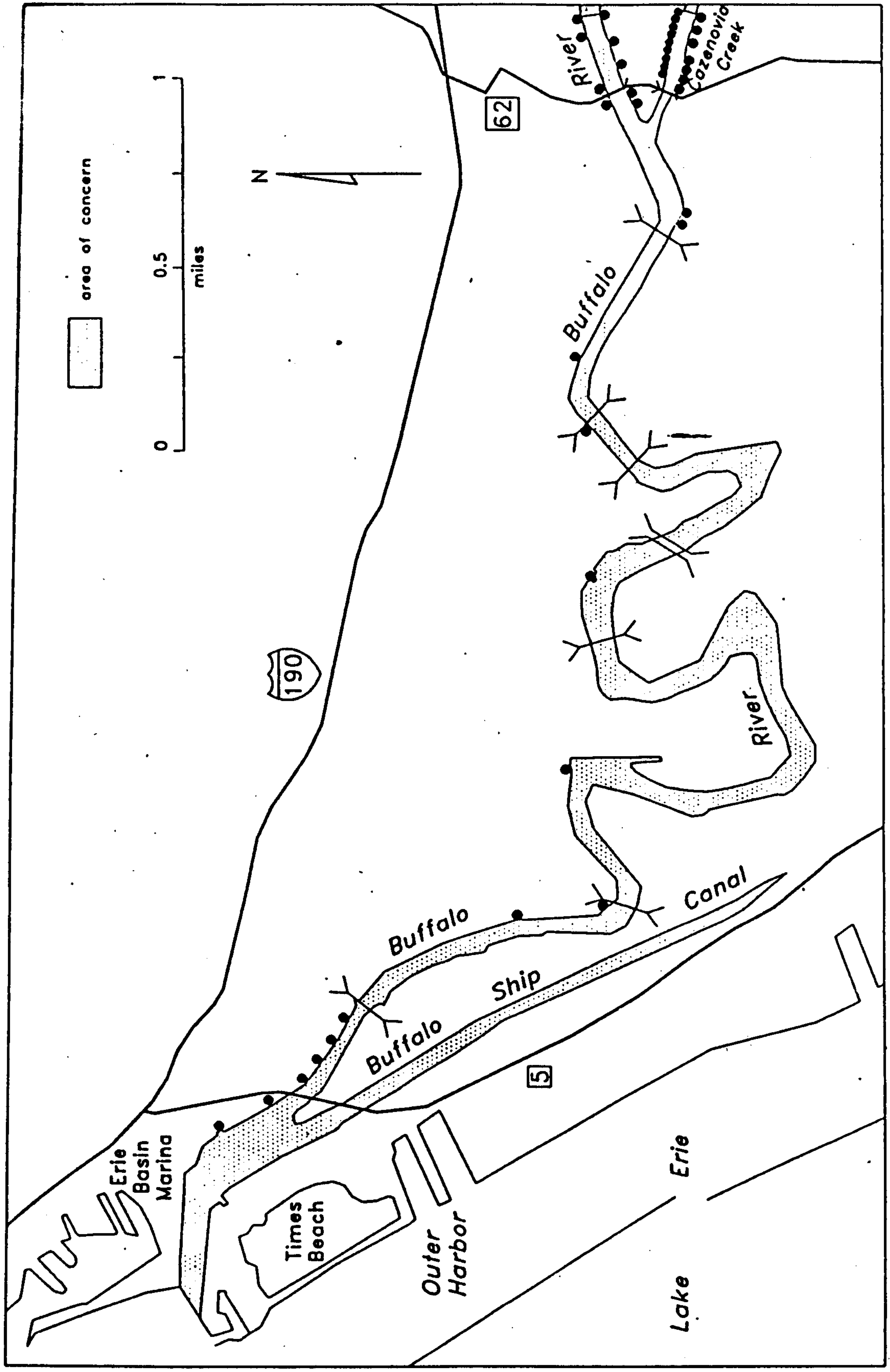


Figure 5.5 Location of Combined Sewer Overflows in the Buffalo River Area of Concern

RAP, 1989

FIGURE 8

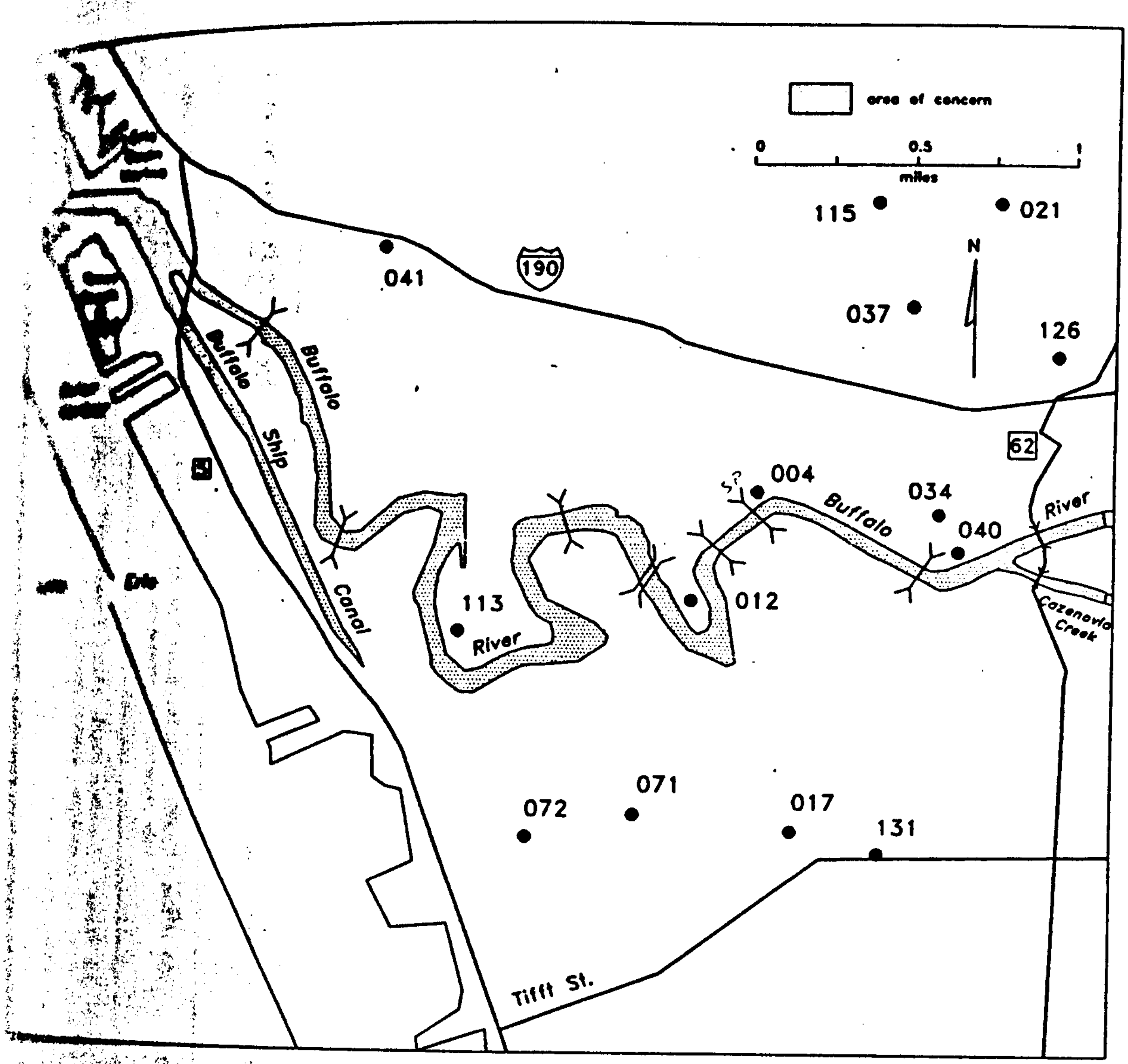


Figure 5.4 Location of Inactive Hazardous Waste Sites in the Buffalo River Area of Concern

(See Table 5.4 for site identification - last three digits of site number)

RAP, 1989

FIGURE 9

RAP, 1985

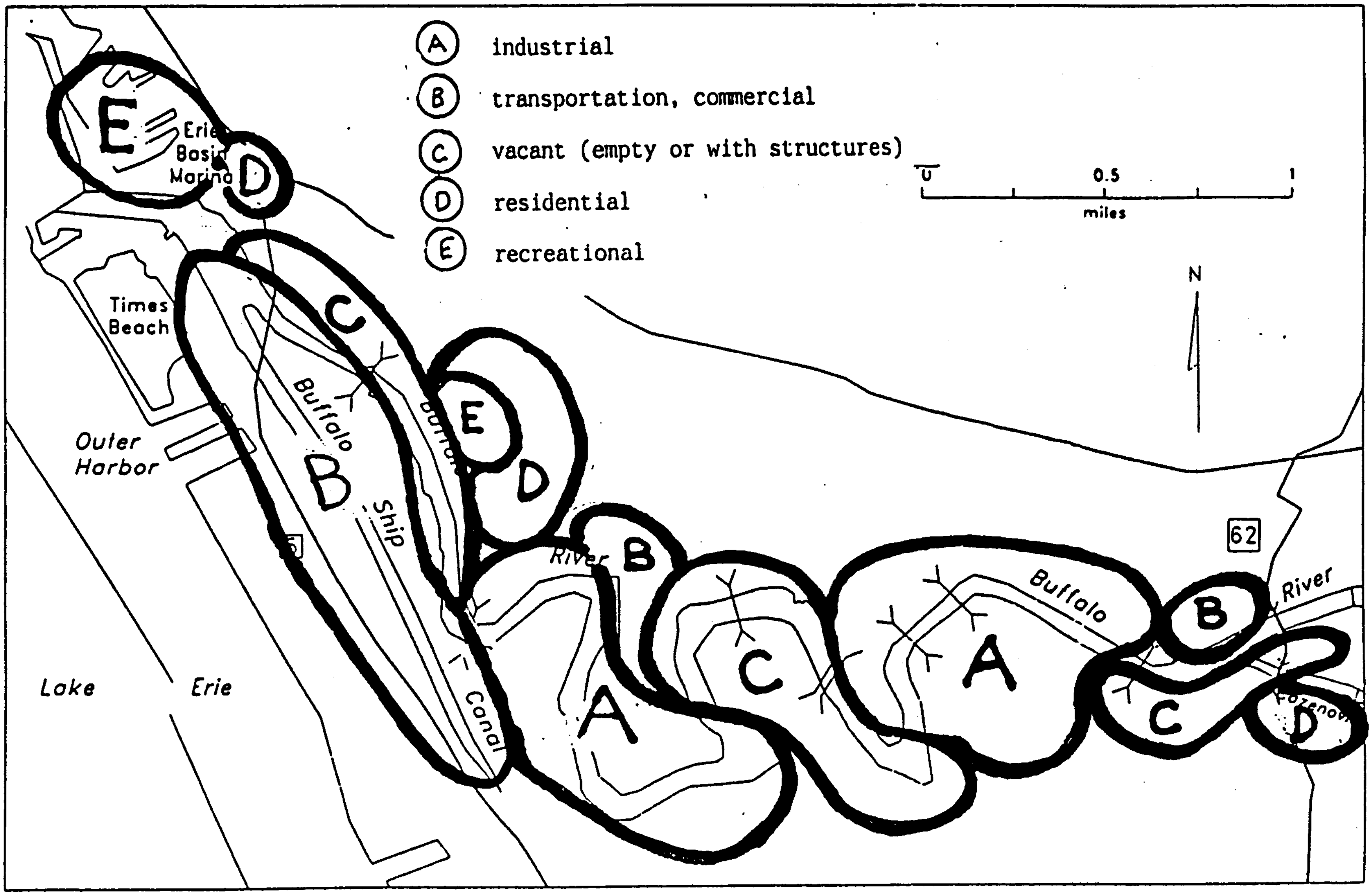


Figure 11.1 - General distribution of current land use along the Buffalo River (compiled with information from the Draft Buffalo Waterfront Masterplan, 1987)

Summary of Data*

Table 2

ocation	Avg.Temp.	Avg.pH	Avg.DO	Avg.Cond.	chloride	sulfate	nitrate
ichigan	3.9	7.08	12.5	411.2	18.0	19.4	2.90
nio	---	---	---	---	21.1	23.4	2.86
.Park-NW	3.1	6.7	14.0	457	7.0	9.9	0.00
.Park-SE	4.4	5.0	13.1	451.5	5.7	6.0	0.00
az.Cr.	4.3	8.3	14.9	378	21.8	23.4	2.90
.Ogden-S	3.9	7.8	14.5	460	16.7	18.7	4.21
.Ogden-N.	4.0	7.7	14.0	498	11.2	12.3	0.00

units, please?

* See Appendix 1 for full data report.

Pollution Standards

Table 3

parameter	normal	contaminated
chloride	5-30 mg/L	30-100 mg/L
nitrate	5-10mg/L	50-150mg/L
sulfate	10-30mg/L	100-200 mg/L

Information found in Koll's Water, 1972.

these designations, as you know, are relative if Birch Brook ever had $5 mg L^{-1}$ of Cl, we'd know it was contaminated!

When the Buffalo River samples are compared to these criteria, it is obvious that river anion concentrations do not come close to levels which would indicate highly polluted waters. The RAP report states that levels of Cl used to be as high as 125 mg/L, but now are usually less than 30 due to the reduction of domestic pollutants. This is the case with my data samples as well. The highest concentration of Cl found was 21.8 mg/L and this was not even in the river, but in Cazenovia Creek where the water is not considered to be very polluted at all. When Buffalo River chloride levels were compared to the levels observed in the Hoosic River by Suasn Kegley in her study of the Hoosic River, the concentrations were quite high in comparison. However, I tend to attribute the discrepancy to the fact that the Buffalo River has a great many more combined sewer overflows and wastewater treatment discahrges. Overall I think most of the chloride and sulfate enters the river from these two sources. High sulfate levels indicate the presence of urine or liquid manure, and the normal levels of sulfate indicate that there is no raw sewage in the water. A lot of the sulfate (no) and chloride probably enters the river in the form of road salt (NaCl, no SO_4). I found it interesting that the sulfate and chloride were present in relatively congruent concentrations. The graph below illustrates this.

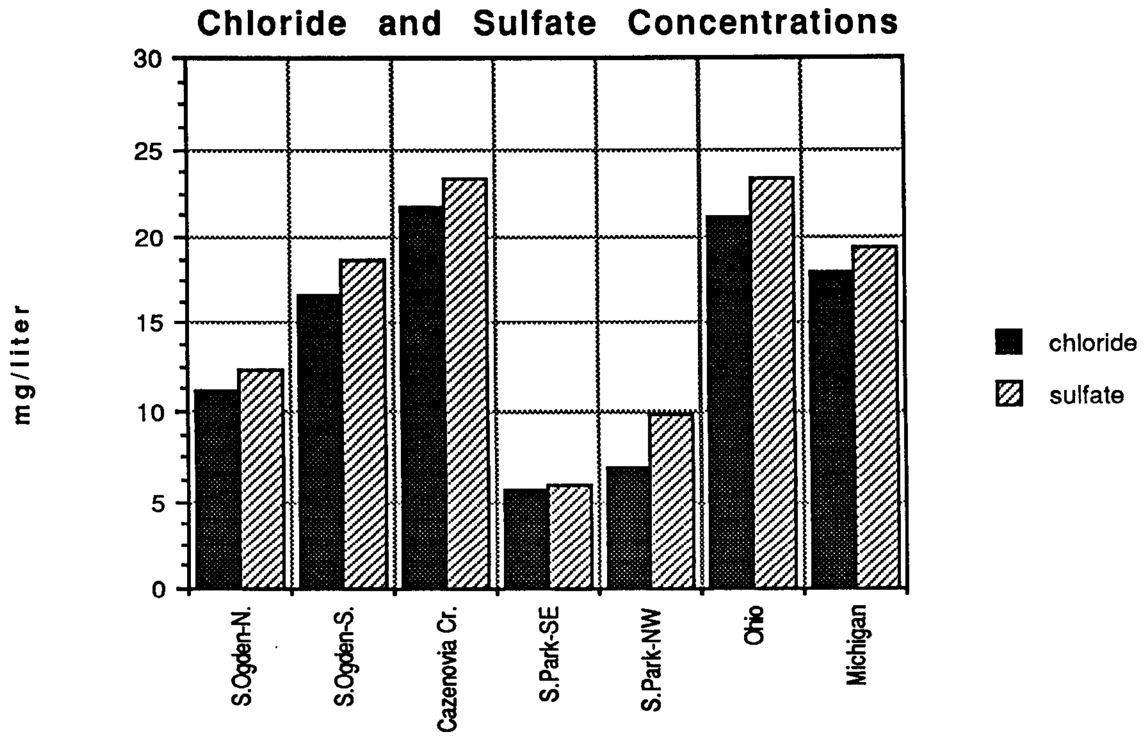
what are the levels of Cl so variable?

would road salt be getting in when you sampled?

Can you suggest another explanation?

is their ratio constant, or is it that $SO_4 > Cl$

Table 4



To upgrade the water quality of the Buffalo River to a class C designation, certain standards that are dictated by the DEC would have to be met. As stated before, the water of the Buffalo River is presently class D which means that it is designated for fishing and industrial use. However, most of the fish in the river are contaminated with PCBs, polyaromatic hydrocarbons and pesticides. Class C water is designated for fishing, fish propagation, and secondary contact.

- but not for fish consumption !

Standards for Class C Designation

Table 5

parameter	standard
Dissolved Oxygen	min. 5.0 mg/l in warm water min. 6.0 mg/l in cold water
pH	6.5-9.0

All of the samples I tested would easily fall within the class C range for pH with the exception of the S.Park-SE sample. However, it was surmised by Ms. Anderson that the Hydrolab was subject to electromagnetic interference at this site and that the readings could be erroneous. This makes sense as the pH readings taken at the other end of the bridge are all well within range. It is possible that there is some hidden inflow at this point that could be the cause of low pH readings, yet the additional data on this site does not support this theory.

why - the Cl and SO4 are substantially different!

Dissolved oxygen is a basic requirement to sustain aerobic biological life in water. Oxygen can be extracted from the water as a result of biological respiration and chemical reactions. As seen in Tables 1 and 6,

TABLE 4.6
BUFFALO RIVER DISSOLVED OXYGEN LEVELS
OHIO STREET BRIDGE
1982-1986

TABLE 8

Yr/Month	Flow (mgd)	Dissolved Oxygen (mg/l)	Temperature °C	Dissolved Oxygen Saturation Value (mg/l)	Percent Saturation
1982					
July	141	3.2	24	8.4	38
August	58	3.9	24	8.4	46
1983					
July	34	6.4	22	8.7	74
August	34	3.4	24	8.4	40
1984					
July	63	6.0	25	8.3	72
August	68	6.8	23	8.6	79
1985					
July	108	4.8	20	9.1	53
August	42	5.0	23	8.6	58
1986					
July	290	3.4	24	8.4	40
August	125	NA	24	8.4	NA

NA - Not Analyzed

TABLE 6

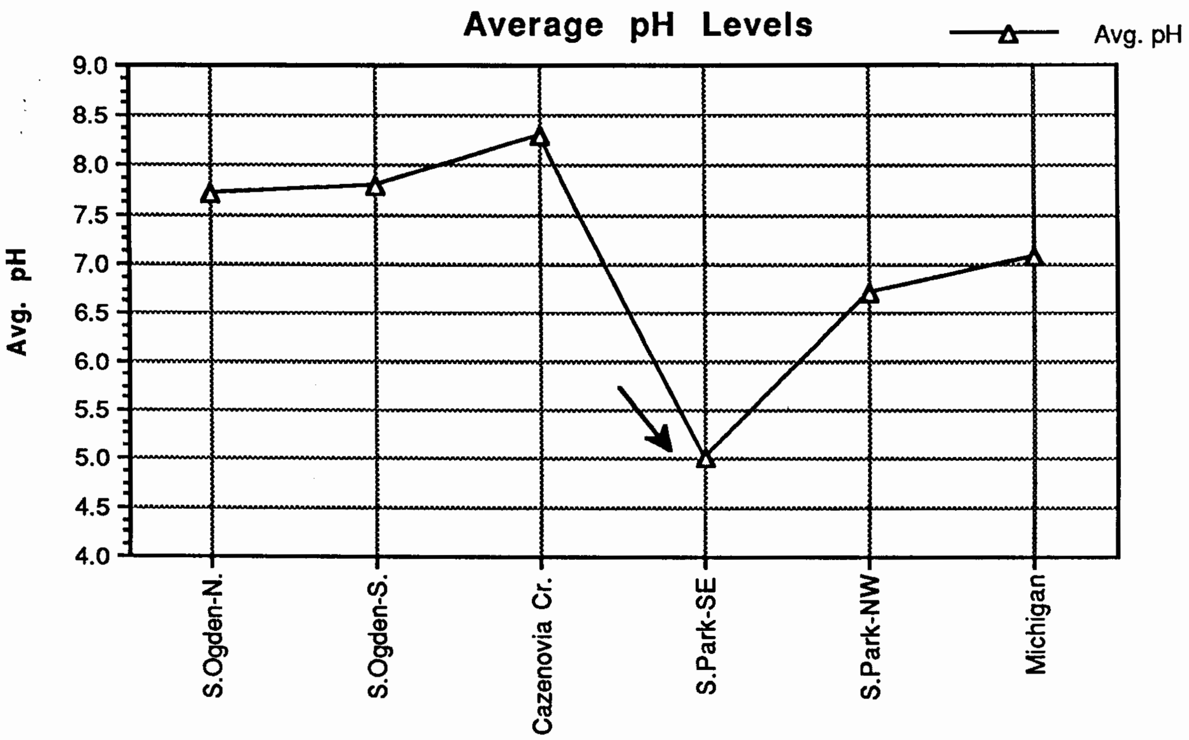
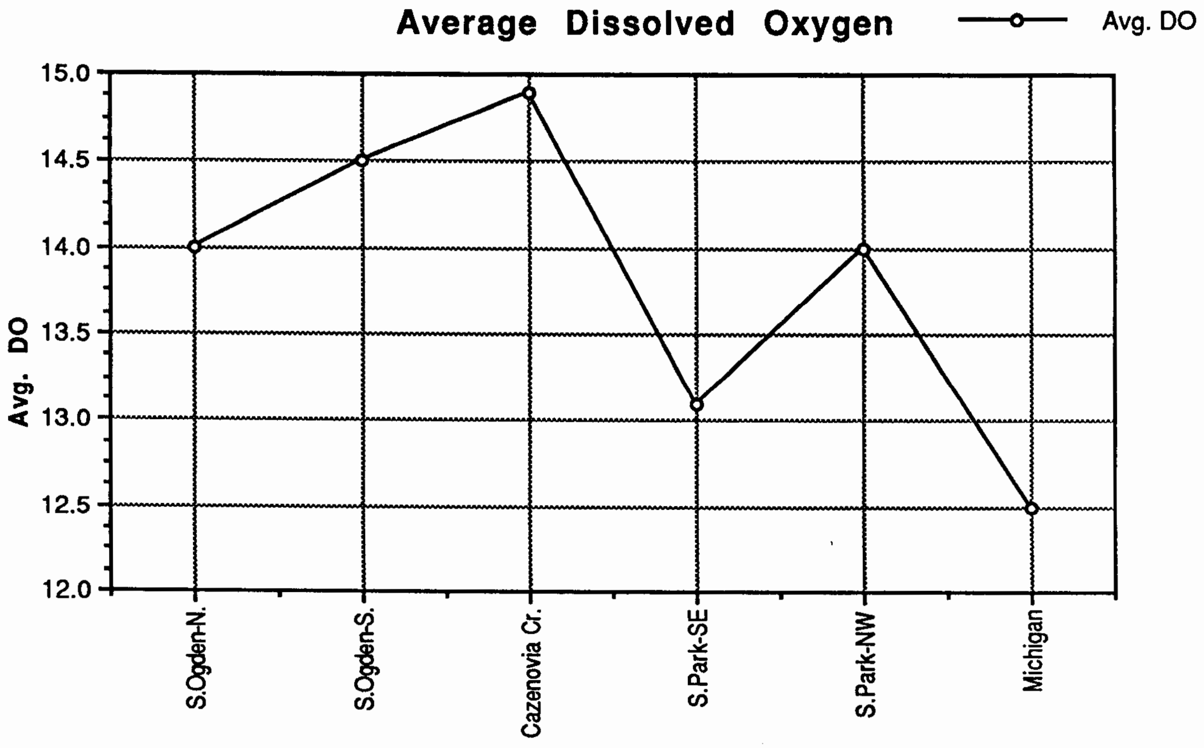


Table 7



high levels are maintained in the Buffalo River in the winter months. This is because cold water has the capacity to hold more dissolved oxygen than warm water and heavy oxygen demand from the biota is not present in the winter. All of my samples contained DO levels that were near the saturation level or super saturated. Thus, the winter DO levels would not present a problem as far as obtaining a class C designation. However DO tests taken in the summer low flow periods have have ranged from 3.2-6.8 mg/l. (Table 8) The potential sources of these unacceptable low DO concentrations include summer dredging to maintain a navigable depth , combined sewer overflows and depositin of organic sediments associated with runoff.(RAP report, 1989) (See Tables 6-7)

and biologic activity is low!

(plus seds are probably full of 'BOD')

There were no striking trends in the data save for the fact that the samples that froze (S. Ogden-N, S.Park NW, S.Park SE) had unuasually low anion concentrations. I do not know why being frozen would have such an effect on the samples because they thawed completely before they were diluted and run thruogh the IC and they were contained in bottles so theions had no place to go(i.e. they could not leach away).

you're right— this is puzzling

6. Conclusion

The general quality of the water bodes well for a cleaner river in the future and is a sign if significant progress in pollution abatement measures. However, when the Buffalo River is considered on a larger plane as an entire system, a lot of work remains to be done. Although the water might be relatively free of contaminants, the bottom sediments are rife with metals, PCBs, cyanides and other harmful chemicals. (Table 9)Yet there is hope. State interest has been encouraging. The DEC is committed to developing reqirements for sediment model improvements and the EPA and the the EPa

~~TABLE 7.3 (ATTACHMENT)~~

TABLE 9

	OBSERVATIONS IN BOTTOM SEDIMENT		OBSERVATIONS IN WATER		
CONTAMINANT	COE	EPA	Detection Limit (ug/l)	Propagation Standards & Criteria (ug/l)	Criteria Exceedance
Toxaphene	NA	0/17	NA	0.005	NA
PCB-1248	3/12	14/17	NA	0.001	NA
PCB-1254	12/12	11/17	NA	0.001	NA
PCB-1260	0/12	5/17	NA	0.001	NA
Mirex	5/12	6/17	NA	0.001	NA
Zinc	12/12	15/17	20[15]	30	5/30
Lead	12/12	15/17	10	5	2/30+
Beryllium	NA	1/17	2[16]	1100	0/30
Copper	12/12	15/17	10[17]	16	0/30
Nickel	12/12	15/17	1[18]	126	0/30
Silver	NA	1/17	1[19]	0.1	0/30+
Mercury	12/12	16/17	0.2[20]	0.2*	1/30
Arsenic	12/12	0/17	10	190	0/30
Cadimum	12/12	15/17	1[21]	2	0/30
Thallium	NA	0/17	10[23]	8	0/30+
Chromium	12/12	15/17	10	12	2/30
Selenium	NA	0/17	5[24]	1	0/30
Phenols (4AAP)	NA	4/17	1	5	0/24
Ammonia				1800	0/18
Nitrogen (NO_2)				100	0/18
pH				6.5-8.5	1/24
Temperature				32°C	0/24

can you help the reader
interpret, please!
are observations in seds.
values or ??

---

* Value is a criteria level

\+ Detection limit exceeds standard or criteria

[15] Detection limit was 50 ug/l in 1982-85

[16] Detection limit was 20 ug/l in 1982-84

[17] Detection limit was 50 ug/l in 1982-84

[18] Detection limit was 50 ug/l in 1982-84

[19] Detection limit was 20 ug/l in 1982-84

[20] Detection limit was 0.4 ug/l in 1982-83

[21] Detection limit was 2 ug/l in 1982-84

[22] Detection limit was 1000 ug/l in 1982-84

[23] Detection limit was 1000 ug/l in 1982-84

[24] Detection limit was 10 ug/l in 1982-83

is committed to developing methods for determining sediment criteria in 1990. In addition plans for dealing with the inactive hazardous waste sites are supposed to have been developed within the last few months. Although there are still many problems to be dealt with concerning the health of the Buffalo River, they have at least been addressed and remediation plans are in progress. It looks as if the Buffalo River is well on the road to recovery.

K – This is a good integration of your data and past work! I think that you could have been a bit more ambitious in discussing how and why this poor river ended in this condition. Does the composition of water resemble that pumped in from L. Erie? Why is there so little water in the river if all those industries are broke. I look forward to your poster.

APPENDIX 1.1

Comprehensive Data Collected
March 29, 1990

Samples	Depth	pH	DO	Cond.	Temp.	chloride	sulfate	nitrate
Michigan	0.5	6.9	12.2	410	4.5			
	1.5	6.9	12.7	410	4.0			
	2.5	7.0	12.7	413	3.9			
	3.5	7.2	12.6	413	3.8	18.0	19.4	2.90
	4.5	7.2	12.6	412	3.7			
	5.5	7.2	12.6	413	3.8			
	6.5	7.2	12.6	408	3.8			
Ohio						21.1	23.4	2.86
S.Park-NW	0.5	7.0	14.2	445	3.3			
	1.5	6.7	14.1	448	3.2			
	2.5	6.7	14.1	455	3.1			
	3.5	6.6	14.1	458	3.1	7.0	9.9	0.00
	4.5	6.7	14.0	469	3.0			
	5.5	6.9	14.0	468	3.0			
S.Park-SE	0.5	4.9	13.0	450	4.7			
	1.5	4.8	12.8	456	4.8	5.7	6.0	0.00
	2.5	5.0	13.3	450	4.2			
	3.5	5.4	13.4	450	3.9			
Caz.Creek	0.5	8.3	14.9	378	9.0	21.8	23.4	2.90
S.Ogden-S	1.0	7.8	14.5	460	3.9	16.7	18.7	4.21
S.Ogden-N	1.0	7.7	14.0	498	4.0	11.2	12.3	0.00

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