U.S. GEOLOGICAL SURVEY

QUALITY OF THE WATER IN BORROW PONDS NEAR A MAJOR HIGHWAY INTERCHANGE, DADE COUNTY, FLORIDA, OCTOBER–NOVEMBER, 1977

Open-File Report 78-1029

Prepared in cooperation with
FEDERAL HIGHWAY ADMINISTRATION

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UNITED STATES
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Tallahassee, Florida

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UNITED STATES DEPARTMENT OF THE INTERIOR

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GEOLOGICAL SURVEY

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CONTENTS

ILLUSTRATIONS

TABLES

TABLES (Continued)

CONVERSION FACTORS

For readers who prefer metric units rather than inch-pound units, the conversion factors for terms used in this report are listed below:

Multiply inch-pound units	By	To obtain SI (metric) unit
foot (ft)	.3048	meter (m)
square foot (ft^2)	.0929	square meter (m^2)
cubic foot (ft^3)	.0283	cubic meter (m^3)

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ABSTRACT

Water, bottom sediment, and aquatic plants were sampled from ponds near a major south Florida highway interchange to document concentrations of selected constituents in an aquatic environment near heavy vehicular traffic. Generally, concentrations of constituents were within the range expected in an uncontaminated environment in south Florida. However, concentrations did exceed south Florida background levels or Environmental Protection Agency criteria in a few cases. Two trace elements--chromium (20 micrograms per liter) in ponded surface water and lead (500 micrograms per gram) in bottom sediment--exceeded background levels. Concentrations of dieldrin (22 micrograms per kilogram) and polychlorinated biphenyls (53 micrograms per kilogram) also exceed background levels in bottom sediment. The concentration of phenol (23 micrograms per liter) in ground water exceeded Environmental Protection Agency quality criteria by 22 micrograms per liter, but was within the background range for south Florida. Ten metals were detected in the cattail or algal samples, but only iron, manganese, and zinc were in higher concentrations than those in the bottom sediment.

INTRODUCTION

Each day nearly 200,000 automobiles pass through the major Miami interchange at the confluence of Interstate 95 and State Road 836 in Dade County (figs. 1 and 2). The interchange crosses over sections of three borrow ponds that receive dustfall from vehicular traffic, as well as background dustfall, and wet-weather drainage from the roadways (fig. 2). The ponds and ground water at the interchange offer an opportunity to sample an aquatic environment that has been exposed for over 10 years to contaminants from heavy vehicular traffic.

OBJECTIVES AND SCOPE

The objective of the investigation was to collect data on traffic-generated constituents and other selected parameters in the aquatic environment at the interchange and compare the concentrations with water-quality criteria. Ground water, surface water, bottom sediment, and biota were sampled.

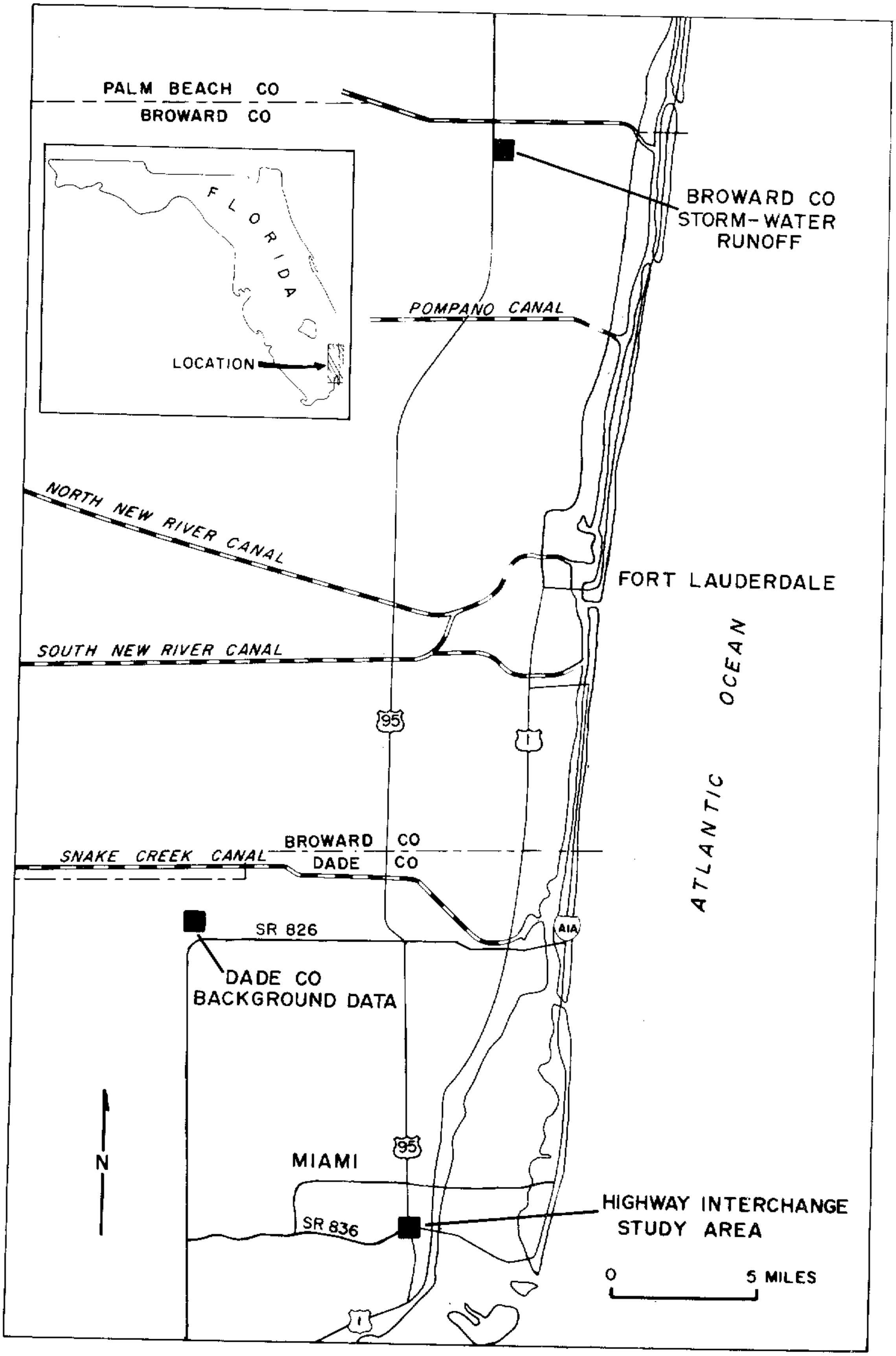

Figure 1.--Highway interchange study area, Dade County, and relative locations of comparative sampling sites in Dade and Broward Counties.

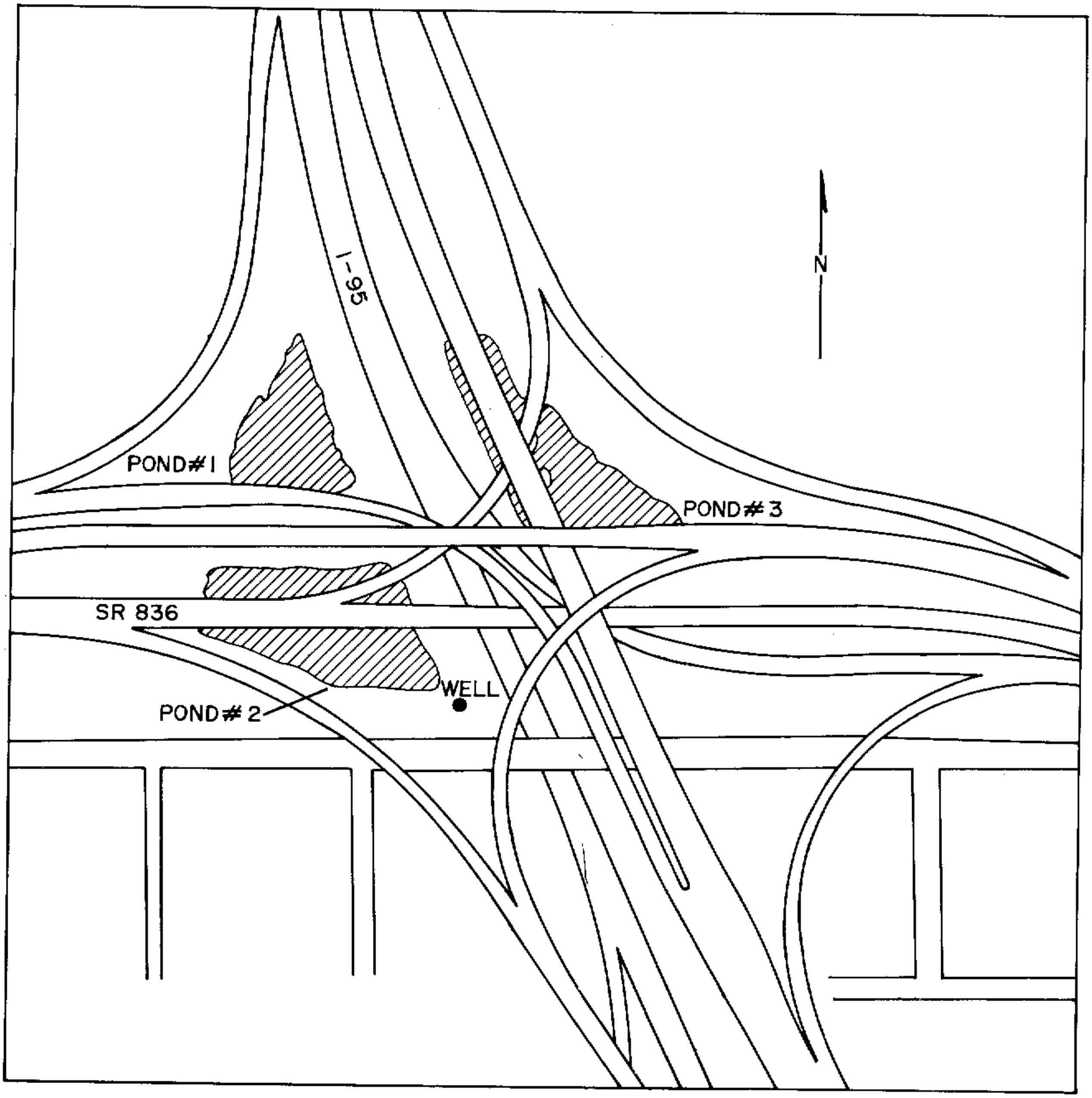

Figure 2.--Interchange at the confluence of Interstate 95 and State Road 836 Miami, Florida

DESCRIPTION OF THE AREA SAMPLED

The three ponds under the interchange, which were dug in the mid-1960's, have an area of about 194,000 square feet, a volume of about 2,522,000 cubic feet, and reach a depth of at least 13 feet. The ponds were dug in limestone, and have steep sides and only a fringe of emergent aquatic plants. Ponds 1 and 2 are connected by a narrow canal.

The ponds are enclosed by a chain-link fence. The fence, however, is broken in a few places and allows entrance. Within the fenced area and along the bank of the ponds, the land is not maintained and is overgrown by shrubs and brush. The grass-covered land outside the fenced area is maintained by the Florida Department of Transportation.

DESCRIPTION OF SAMPLING

Ponds 1 and 2 were sampled on October 4, 1977. Depth profiles for dissolved oxygen (DO) and temperature were made, and water samples in each pond were collected using a Kemmerer sampler at 1, 3, 6, 9, and 12 feet and composited by mixing with a churn spliter. Bottom sediment was collected using an Ekman grab near the center of pond 1, and the algal mat and cattail (*Typha* sp.) were sampled by hand along the edge of the pond.

Two wells were drilled about 50 feet southeast of pond 2 to a depth of 20 feet on September 28, 1977. For sampling, the two wells were considered as one (fig. 2). One well was cased with polyethylene; the other with metal. The wells were sampled on November 9, 1977, by pump. Each well was pumped for about 5 minutes before the samples were collected. The sample from the metal-cased well was analyzed for pesticides; the one from the polyethylene well, for trace elements.

RESULTS

Analyses of surface water, ground water, bottom sediment, and aquatic plants in the borrow ponds are given in summary data tables 1-7. Also included in the tables are background levels of selected constituents, concentrations of selected constituents in highway stormwater runoff, and Environmental Protection Agency (EPA) water-quality criteria.

Generally, concentrations of constituents were within the range expected in an uncontaminated environment in south Florida. However, a few concentrations did exceed south Florida background levels or EPA criteria.

The concentration of chromium in the pond surface water (20 ug/L) and lead in the bottom sediment (500 ug/g) exceeded south Florida background levels. The background for chromium averaged 4.0 ug/L with a standard deviation of 10 ug/L (Goolsby and others, 1976). The background for lead ranged from 10 to 38 ug/g (McPherson and others, 1976).

Table 1.--Temperature and dissolved oxygen (DO) profiles for the northwest and southwest borrow ponds, October 4, 1977

	Northwest Borrow pond (no. 1)			Southwest Borrow pond (no. 2)		
Depth (ft)	Time (a.m.)	Temp °C	DO (mg/L)	Time (a.m.)	Temp °C	DO (mg/L)
0.5	09:15	28.0	3.1	10:00	28.5	2.1
3.0	09:16	28.5	4.0	10:01	28.5	1.9
6.0	09:17	28.5	2.8	10:02	28.5	1.6
9.0	09:18	28.5	2.3	10:03	28.5	0.7
12.0	09:19	28.5	2.3	10:04	28.5	0.3

Table 2.-- Concentrations of selected constituents in borrow ponds and ground water near borrow ponds and the average concentrations for highway stormwater runoff and ground water from 10 wells upgradient of known sources of contamination in Dade County

[Values in mg/L except as indicated]

	Borrow ponds (Oct. 4, 1977 at 1030)	Broward County Highway-storm water runoff 1/	Ground Water	10 wells *2/
Temperature (°C)	28.0	--	28.0	--
Turbidity (JTU)	4	9.6	7	14
Transparency (Secchi Disk, In)	85.0	--	--	--
Color (Platinum cobalt unit)	0	29	5	103
Specific conductance (micromhos/cm at 25°C)	535	--	635	530
Dissolved oxygen	3.1	--	--	--
Percent saturation	39	--	--	--
5-day BOD	0.3	9.0	0.8	.5
COD	13	59	20	50
pH	7.8	--	7.4	7.4
CO_2	3.9	--	15	23
Alkalinity as $CaCO_3$	125	--	197	247
Bicarbonate as HCO_3	150	--	240	301
Carbonate as CO_3	0	--	0	0
Phenol in ug/L	--	--	23	20
Hardness (Ca, Mg)	150	--	260	256
Non-carbonate hardness	25	--	63	11
Dissolved calcium	52	--	98	92
Dissolved magnesium	4.4	--	4.1	5.8
Dissolved sodium	40	--	24	15
Sodium absorption ratio	1.4	--	0.6	--
Percent sodium	36	--	16	--
Dissolved potassium	3.7	--	4.2	.5
Dissolved chloride	73	12.0	35	25
Dissolved sulfate	24	--	26	1.8
Dissolved fluoride	0.1	--	.2	.3
Dissolved silica (SiO_2)	3.4	--	7.7	6.7
Dissolved Solids (residue at 180°C)	292	97		
(Sum)	276	--		
Coliform (colonies/100 ml)	160	8000		
Fecal coliform (colonies/100 ml)	72	2400		

* 10 wells represent probable background levels in Dade County.

1/ Data from Mattraw, 1978

2/ Data from Mattraw and others, 1978

Table 3.-- Concentrations of macronutrients in borrow ponds and ground water near a major Dade County highway interchange compared with average values for highway storm-water runoff and ground water at 10 wells upgradient of a known source of pollution in Dade County and the EPA criteria

	Borrow ponds	Highway [1/] Storm-water Runoff	Ground Water	10 wells [2/]	EPA Criteria
Total nitrogen as N	0.53	0.96	1.0	1.9	--
Total organic nitrogen, N	.48	.53	.14	1.0	--
Total ammonia as N	.03	.13	.02	.92	--
Total nitrite as N	.01	.02	.00	.00	--
Total nitrate as N	.01	.28	.90	.00	10.0
Total Kjeldahl N	.51	--	.16	--	--
Total nitrite plus nitrate	.02	--	.90	--	--
Total ortho-phosphorus	.00	--	.00	--	--
Total phosphorus as P	.03	.08	.01	.01	--
Total organic carbon	6.0	4.8	7.0	17	--
Total inorganic carbon	--	23	57	--	--
Total carbon	--	51	64	--	--

1/ Data from Mattraw (1978)

2/ Data from Mattraw and others (1978)

Table 4.-- Concentrations of trace metals (total unless otherwise indicated) in borrow ponds and in ground water near the borrow ponds and average values in south and central Florida, highway storm-water runoff, and at 10 wells upgradient of a known source of pollution in Dade County and the EPA criteria

[Values in ug/L]

	Borrow Ponds	South & Central Fla.	Standard Deviation 1/	Highway Storm-water Runoff	Standard Deviation 2/	Ground Water	10 wells 3/	EPA criteria
Aluminum	40	180	±369	--		60	156	--
Arsenic	1	9.6	±6.3	--		1	18	50
Boron	70	--		--		60	--	--
Cadmium	.00	.84	±2.9	0.7	±.1	1	3	--
Chromium	20	4.0	±10	17	±9.2	10	17	--
Cobalt	0	.50	1.1	--		3	4	--
Copper	12	5.4	±12	6.5	±6.1	3	11	1000
Iron	90	340	±483	207	±294	340	6060	1000
Lead	12	7.2	±12	282	±258	2	36	--
Lithium	0	--		--		0	1	--
Manganese	10	18	±21	--		10	79	50
Mercury	.6	.23	±.63	--		.5	0.2	2.0
Molybdenum	1	--		--		8	3	--
Nickel	3	6.9	±10	--		3	16	--
Strontium (dissolved)	650	--		--		200	769	--
Vanadium	.0	--		--		.0	--	--
Zinc	20	28	±44	90	±117	20	92	5000

1/ Data from Goolsby and others, 1976

2/ Mattraw, 1978

3/ Mattraw and others, 1978

Table 5.-- Concentrations of pesticides and other organics in borrow ponds and ground water near a major Dade County highway interchange and the EPA criteria

[Values in ug/L unless otherwise indicated]

	Borrow ponds October 4, 1977	Ground water November 9, 1977	EPA criteria
Aldrin	0.00	0.00	0.003
Lindane	.00	.00	.01
Chlordane	.0	.0	.01
DDD	.00	.00	--
DDE	.00	.00	--
DDT	.00	.00	.001
Dieldrin	.00	.00	.003
Endrosulfan	.00	.00	.003
Endrin	.00	.00	.2
Ethion	.00	.00	--
Toxaphene	0	0	5.0
Heptachlor	.00	.00	.001
Heptachlor epoxide	.00	.00	--
Malathion	.00	.00	.1
Parathion	.00	.00	.04
Diazinon	.00	.00	--
Methyl parathion	.00	.00	--
2, 4-D	.28	.00	100
2, 4, 5-T	.00	.00	--
Silvex	.00	.00	10
Trithion	.00	.00	--
Methyl Trithion	.00	.00	--
PCB	.0	.0	.001
PCN	.00	.00	--
Phenol	0	23	1
Oil and grease (mg/L)	0.0	1	--

Table 6.-- Concentrations of pesticides and other organics in bottom sediment from borrow ponds near a major Dade County interchange

[Values in ug/kg unless otherwise indicated]

	Bottom sediment October 4, 1977
Aldrin	0.0
Lindane	.0
Chlordane	0
DDD	.0
DDE	16
DDT	.6
Dieldrin	22
Endrin	.0
Ethion	.0
Toxaphene	0
Heptachlor	.0
Heptachlor epoxide	.0
Malathion	.0
Parathion	.0
Diazinon	.0
Methyl parathion	.0
2, 4-D	.0
2, 4, 5-T	.0
Silvex	.0
Trithion	.0
Methyl Trithion	.0
PCB	53
Oil and grease, (mg/kg)	0

Table 7.-- Concentrations of nutrients, trace metals and other parameters in bottom sediment and aquatic plants from borrow ponds near a major Dade County interchange, October 4, 1977

[Values in mg/kg except trace metals which are in ug/g]

	Bottom Sediment	Cattail Typha	Algal Mat
Total nitrogen as N	3,700	19,000	30,000
Total ammonia as N	64	--	--
Total nitrite as N	.00	--	--
Total nitrate as N	.5	--	--
Total Kjeldahl as N	3,700	--	--
Total phosphorus as P	170	1,100	370
COD	55,000	--	--
Loss on ignition	27,600	821,000	279,000
Arsenic	0	1.9	2.0
Cadmium	10	0	0
Chromium	10	1.5	7.5
Cobalt	30	.3	.6
Copper	20	.1	2.0
Iron	470	580	2,400
Lead	500	.1	.0
Manganese	20	75	100
Mercury	.2	.1	.1
Molybdenum	10	.2	1.9
Nickel	10	.1	.2
Zinc	140	44	220

Chromium and lead are two potential pollutants from highway runoff. Average concentrations of both constituents in stormwater runoff at a Broward County highway site (Mattraw, 1978), were significantly higher than average background values for south and central Florida (table 4).

Concentrations of chromium and lead in ground water downgradient of the ponds were lower than background levels (table 4). This could indicate removal of these metals from water that moves underground. The relatively high concentration of lead in bottom sediment may indicate its uptake and removal from water.

The concentration of phenol in ground water was 23 ug/L which exceeded the EPA criterion of 1 ug/L (table 5). The background concentration of phenol in ground water in Dade County, however, exceeds 5 ug/L at some places. Concentrations of phenol in 10 Dade County wells upgradient of potential sources of pollution ranged from 7 to 37 ug/L and averaged 20 ug/L (Mattraw and others, 1978).

Dieldrin and PCB (polychlorinated biphenyls) in the bottom sediment sample were 22 and 53 ug/kg. Background levels of dieldrin are low as indicated by its detection in only 27 percent of 113 bottom sediment samples from areas in the Everglades National Park. Concentrations ranged from 0 to 9.3 ug/kg and averaged 0.2 ug/kg (Waller, written commun., 1978). Throughout south Florida, dieldrin has been detected in about half the bottom sediment samples (Mattraw, 1975). Background levels of PCB are low as indicated by detection in only 16 percent of 95 bottom sediment samples in Everglades National Park (Waller, written commun., 1978).

Concentrations of iron and manganese were higher in the aquatic plant samples than in the bottom sediment, and zinc concentration was higher in one of the samples--the periphyton--than in the bottom sediment (fig. 3). Chromium, cobalt, copper, molybdenum, mercury, and nickel were also detected in both cattail and periphyton samples, but concentrations were below those in the bottom sediment or below the accurate detection limit for bottom sediment. Cadmium was not detected in the plant samples, while lead was detected in the cattail but not in the periphyton (table 7).

NEED FOR ADDITIONAL STUDY

Additional study is needed to determine loads, sources, fluxes, and buildup of potential pollutants in the aquatic environment near the heavily-traveled Dade County highway interchange. The additional study should include the establishment of a control site in an area of the county remote from highway traffic, and an expanded sampling program for at least one year. The specific objectives of the expanded study would be:

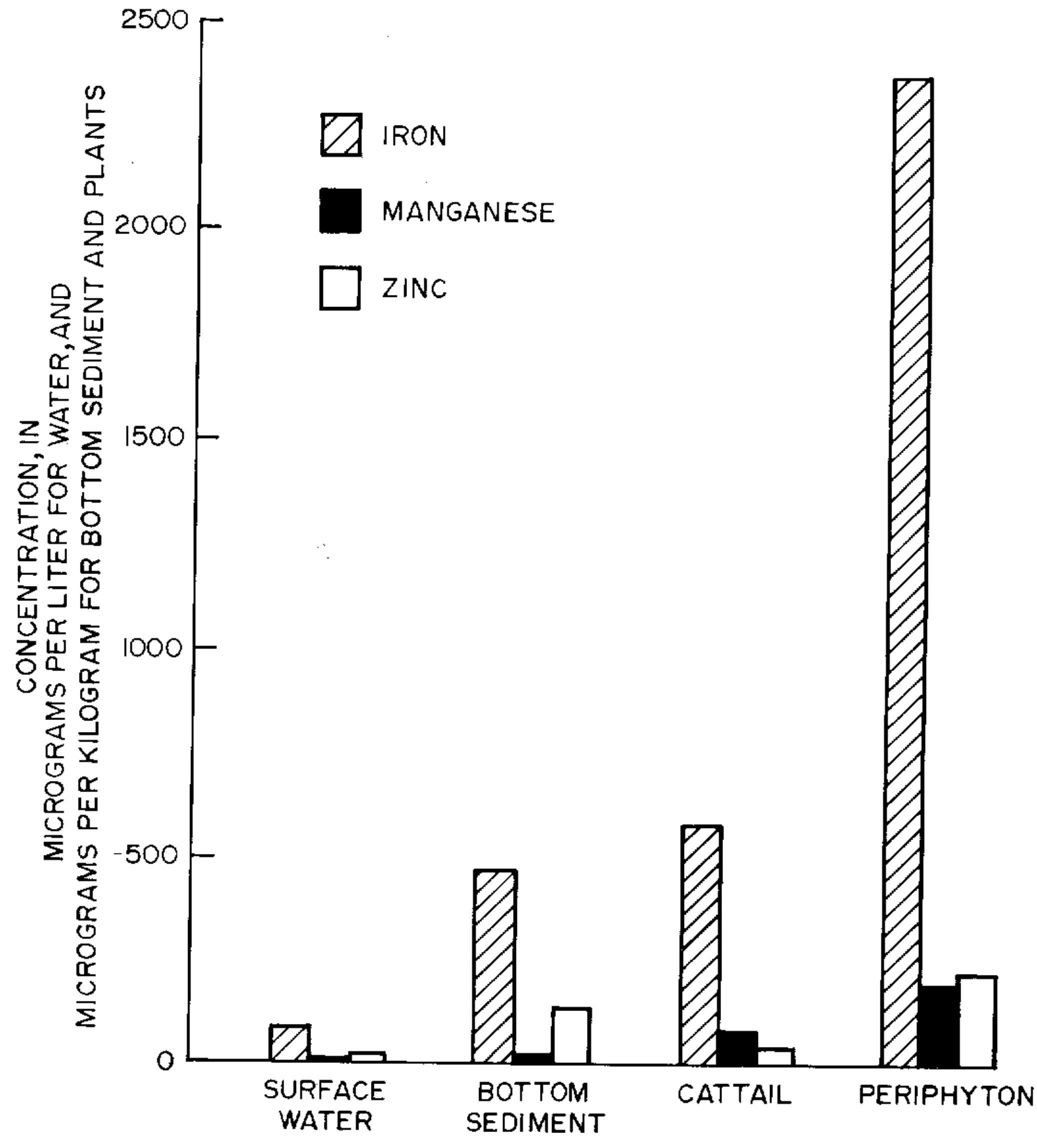

Figure 3.--Concentrations of iron, manganese and zinc in surface water, bottom sediment and aquatic plants.

1. Determine atmospheric input (loads) of selected constituents in dustfall and rainfall.

2. Determine surface water and highway runoff (loads) for selected constituents.

3. Determine seasonal water quality in ponds and ground water.

4. Determine concentrations of lead, chromium, iron, manganese, zinc, organic carbon, PCB, and selected pesticides at a series of depths (0-2 inches; 2-4 inches; 4-6 inches; etc.) within bottom sediment and underlying materials. Samples would be collected from cores.

SUMMARY

Water, bottom sediment, and aquatic plants were sampled at a major south Florida highway interchange to document concentrations of selected constituents in an environment near heavy traffic. Lead, PCB, and dieldrin exceeded background levels in bottom sediment. In ground water, the phenol concentration of 23 ug/L exceeded the EPA criteria, and chromium concentration was slightly higher than the background level. Ten metals were detected in the cattail and the periphyton mat but only iron, manganese, and zinc were found in concentrations higher than those of bottom sediment.

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