Metropolitan Dade
County, Florida

DEPARTMENT OF ENVIRONMENTAL RESOURCES MANAGEMENT

1985 GROUND AND SURFACE WATER MONITORING PROGRAMS:
Ambient Groundwater
General Canal
Background Discharge
Snake Creek Canal

Technical Report 88-15

1985 GROUND AND SURFACE WATER MONITORING PROGRAMS

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Environmental Planning and Evaluation Section

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PREFACE

Dade County's Department of Environmental Resources Management (DERM) regulates potential pollution sources and utilizes land use controls in an effort to prevent degradation of the County's sole drinking water supply, the Biscayne aquifer. The effectiveness of these measures are monitored by four water quality programs:

1. Ambient Groundwater Network - biannual sampling to quantify a wide variety of parameters which are used to establish a data base as well as to characterize the water's quality. 1985 sampling took place in August and December.

2. General Canal Monitoring Program - monitors physical and chemical parameters on the majority of the canals throughout the County on a monthly basis.

3. Annual Pollutant Study - incorporates a more extensive range of parameters on a biannual basis and monitors the impact of urbanization along the canals. 1985 sampling occurred in February and August.

4. Intensive Canal Study - highlights one canal per year and extensively monitors it on a quarterly basis. 1985 sampling occurred in February, May, July and November.

The following report discusses the 1985 analytical results obtained from conducting these programs. The standards referenced throughout this report were obtained from Department of Environmental Regulation (DER) Water Quality Standards, Florida Administrative Code (F.A.C.) Chapters 17-3 and 17-22, Metropolitian Dade County Environmental Protection Ordinance Chapter 24-11, and Environmental Protection Agency (EPA) Water Quality Criteria (EPA 440/5-86-001).

PART I

1985 AMBIENT GROUNDWATER QUALITY MONITORING NETWORK

Groundwater wells representative of the major types of land use in Dade County are sampled biannually in the Department of Environmental Resources Management's groundwater quality monitoring program. The program is designed to characterize existing groundwater quality and to develop a data base to examine long term trends.

Sampling took place in July/August during the wet season and in December during the dry season. A total of 49 wells were sampled at 33 sites (see Figure 1 and Table 1 for location and land use), and analyzed for the following parameters:

Physical Properties
- Conductivity
- Color
- Turbidity
- Total Filtrable Residue

Major Inorganics
- Sulfate (wet season only)
- Chloride
- Fluoride
- Alkalinity

Nutrients
- Ammonia
- Total Nitrate/Nitrite
- Ortho phosphate
- Total phosphate

Trace Elements
- Arsenic
- Barium
- Cadmium
- Chromium
- Copper
- Iron
- Lead
- Manganese
- Mercury
- Nickel
- Selenium
- Silver
- Zinc

Organic Parameters
- Phenols

FIGURE 1: LOCATION OF SITES IN THE 1985 GROUNDWATER MONITORING PROGRAM

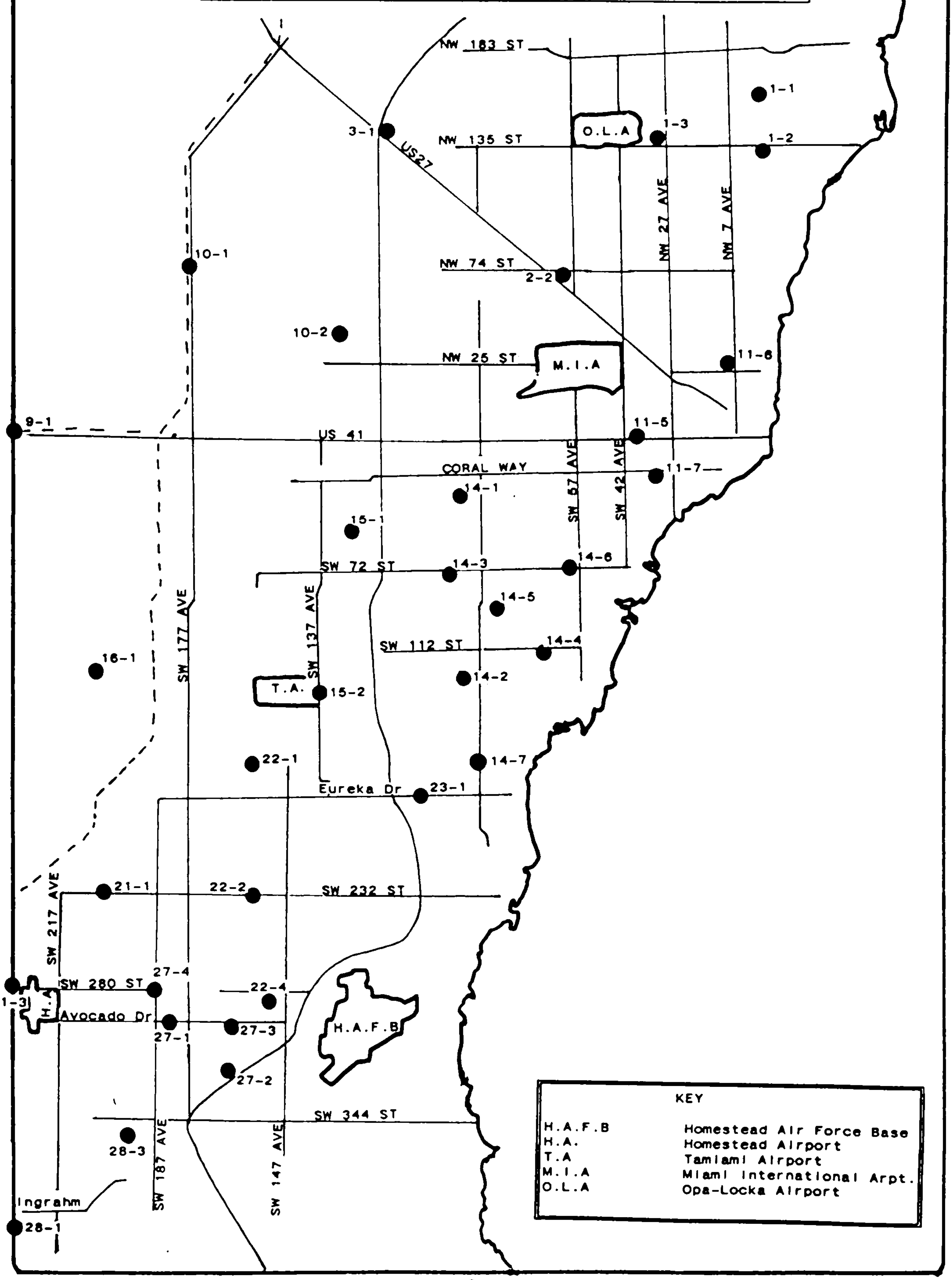


TABLE 1: LOCATION AND LAND USE OF SITES
IN THE 1985 GROUNDWATER NETWORK PROGRAM

NETWORK #	SITE	USGS # (1)	DEPTH (feet)	LAND USE	SEWERED	LOCATION
1	1-1A	G-1630		Residential	No	NE 2nd Ave & 163 St
	B	G-1631	20	Residential	No	NE 2nd Ave & 163 St
	C	G-1632	31	Residential	No	NE 2nd Ave & 163 St
	D	G-1633	45	Residential	No	NE 2nd Ave & 163 St
2	1-2	G-430	97	Residential	No	Meml. Hwy & NE 136-7 St
3	1-3	OPWTP(2)	100	Residential	No	Burlington & Codadad
4	2-2	GW-4	8	Resid./Bus.	No	W 8th Ave & 74 St
5	3-1	G-1637	26	R/S(3), Ind.	No	US 27, Opa-Locka W Airpt
6	9-1A	G-3202	10	Resid./Bus	No	SW 8th St at Coopertown
	B	G-3203	35	Resid./Bus	No	SW 8th St at Coopertown
7	10-1	G-1488	20	R/S	No	NW 177 Ave & 72 St
8	10-2	G-3103	21	R/S	No	NW 120 Ave & 42 St
	11-5	GW-6	10	Residential	Yes	SW 37 Ave & SW 2nd St
9	11-6		60	Industrial	Yes	NW 11 Ave & 22 St
10	11-7	F-179	77	Resid./Bus.		SW 32 Ave & 24 Terr
11	14-1A	G-1605		Residential	Yes	SW 90 Ave & 38 St
	B	G-1606	20	Residential	Yes	SW 90 Ave & 38 St
	C	G-1607		Residential	Yes	SW 90 Ave & 38 St
	D	G-1608	40	Residential	Yes	SW 90 Ave & 38 St
12	14-2	G-553	91	Resid./Ind	No	SW 89 Ave & 128 St
13	14-3	G-3073	20	Resid./Bus	Yes	SW 97 Ave & 72 St
14	14-4	G-580A	22	Residential	No	SW 67 Ave & 112 St
15	14-5	G-1604	62	Resid./Bus	No	SW 75 Ave & 105 Terr
16	14-6	F-319	20	Resid./Bus	Yes	US 1 & SW 72 St
	14-7		60	Residential	No	SW 87 Ave & 143 St
17	15-1	G-958A	27	Resid./Undev	No	SW 127 Ave & 51 St
18	15-2	G-858	20	Airport/R/U/I	No	SW 137 Ave & 128 St
19	16-1A	G-3188	11	R/S		SW 207 Ave & 120 St
	B	G-3189	21	R/S		SW 207 Ave & 120 St
	C	SFWMD	55	R/S		SW 207 Ave & 120 St
20	21-1	G-3108	15	Resid./Agri	No	SW 202 Ave & 232 St
21	21-3A	G-3177	22	Airport/Agri	No	SW 237 Ave & 280 St
	B			Airport/Agri	No	SW 237 Ave & 280 St
	C	SFWMD		Airport/Agri	No	SW 237 Ave & 280 St
22	22-1	G-1362	33	Resid./Agri	No	SW 157 Ave & 168 St
23	22-2	G-614	18	Resid./Agri	No	SW 157 Ave & 232 St
24	22-4	G-1486	20	Resid./Agri	Yes	SW 152 Ave & 284 St
25	23-1	S-182	51	Resid./Bus	Yes	SW 104 Ave & 185 Terr
26	27-1A	G-1615	12	Resid./Agri	No	SW 182 Ave & 296 St
	B	G-1616		Resid./Agri	No	SW 182 Ave & 296 St
	C	G-1617	36	Resid./Agri	No	SW 182 Ave & 296 St
	D	G-1618	45	Resid./Agri	No	SW 182 Ave & 296 St
27	27-2		27	Residential	Yes	SW 162 Ave & 320 St
28	27-3		20	Undev.,/Bus		US 1 & SW 296 St
	27-4	IFAS (4)	23	Resid./Agri.	No	SW 187 Ave & 280 St
	28-1A	SFWMD		R/S	No	SW 232 Ave & 392 St
	B	G-3180	21	R/S	No	SW 232 Ave & 392 St
	C	SFWMD		R/S	No	SW 232 Ave & 392 St
29	28-3	G-864	20	Resid./Agri.	No	SW 192 Ave & 352 St

(1) - United States Geological Survey
(2) - Opa-Locka Water Treatment Plant
(3) - Recharge/ Storage
(4) - Institute of Food and Agricultural Sciences

RESULTS

Water quality standards referenced in this report (Table 2) are derived from the Metropolitian Dade County Environmental Protection Ordinance, Chapter 24-11, DER Water Quality Standards, F.A.C. Chapters 17-3 and 17-22, and EPA Water Quality Criteria (E.P.A. 440/5-86-001).

Physical Properties

Conductivity

Conductivity reflects the ability of an aqueous solution to carry an electric current and therefore relates to the concentration of ions.

Conductivity levels for the 1985 network ranged between 220 and 11,000 umhos/cm (Figure 2). With the exception of 28-1B (which was omitted from the calculation of average because of a value of 6000 umhos/cm), the average conductivity level of the wells located in recharge/storage areas is considered as background for this study. Using this value of 511 umhos/cm, there were 7 exceedances of the standard: wells 1-1B, 1-1C, 11-6, 27-1A, 27-1C, 27-2 and 28-1B. With the exception of 27-2, all exceedances occurred during the dry season. Well 11-6 had high levels throughout the year, a result of salt water intrusion. Elevated conductivities at sites 28-1B (6000 umhos/cm), 27-1A (3900 umhos/cm) and 27-1C (11,000 umhos/cm), all of which are well inland of the zone of salt water intrusion, indicate pollution, possibly from nearby agricultural activities.

Site 27-2 had higher values in the wet season (1410 umhos/cm) than the dry season (650 umhos/cm).

Color

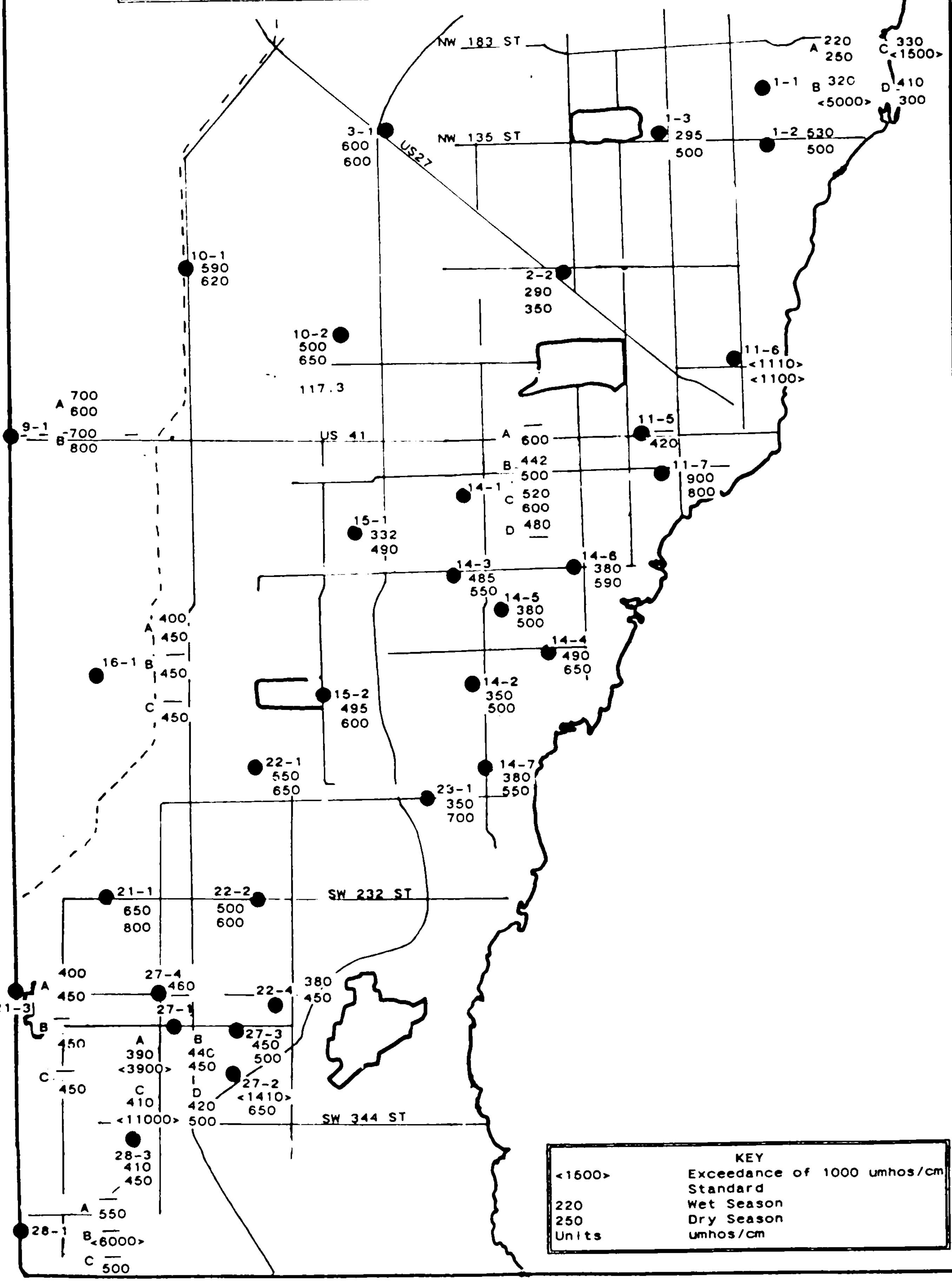
Color is an aesthetic property having no direct chemical significance. The highest color values measured in groundwater samples were from

TABLE 2 : STANDARDS*

PARAMETER	UNITS	MAXIMUM ALLOWABLE CONCENTRATION GROUNDWATER	SURFACE WATER
Alkalinity	mg/l	-	Not <20 (3)*
Ammonia	mg/l	0.5	0.5
Chlorides	mg/l	500	500
Conductivity	UMHOS/cm	100%>background	500
Dissolved Oxygen	mg/l	Not less than 4	-
Fluorides	mg/l	1.4	1.4
Nitrates	mg/l	10 (2)	10 (1)
Phenols	ug/l	1	1
Total Filtrable Residue	mg/l	1000/any time 500/monthly average	1000/any time or 500/monthly average
Turbidity	JCU	50	50
Methylene Blue Active Substances(MBAS)	mg/l	0.5	0.5
Oil & Grease	mg/l	15	15
Arsenic	ug/l	50	50
Barium	ug/l	1000 (2)	1000 (1)
Cadmium	ug/l	10 (2)	1.2 (3)
Chromium	ug/l	50	50
Copper	ug/l	400	400
Iron	ug/l	300	300
Lead	ug/l	50	950
Mercury	ug/l	N.D•	N.D
Nickel	ug/l	-	100 (3)
Selenium	ug/l	10 (2)	25 (3)
Silver	ug/l	50 (2)	0.07 (3)
Zinc	ug/l	1000	1000
Carbon Tetrachloride	ug/l	3.0 (2)	-
1,2-Dichloroethane	ug/l	3.0 (2)	-
Tetrachloroethylene	ug/l	3.0 (2)	-
1,1,1-Trichloroethane	ug/l	200 (2)	-
Trichloroethylene	ug/l	3.0 (2)	-
Vinyl Chloride	ug/l	1.0 (2)	-
Aldrin plus Dieldrin	ug/l	-	0.003 (3)
Chlordane	ug/l	-	0.01 (3)
Endosulfan	ug/l	-	0.003 (3)
Endrin	ug/l	0.2 (2)	0.004 (3)
Heptachlor	ug/l	-	0.001 (3)
Lindane	ug/l	4 (2)	0.01 (3)
Methoxychlor	ug/l	100 (2)	0.03 (3)
Myrex	ug/l	-	0.001 (3)
Toxaphene	ug/l	5 (2)	0.005 (3)
2,4-D	ug/l	100 (2)	-
2,4,5-TP (Silvex)	ug/l	10 (2)	-
Fecal Coliform	MF/100ml or MPN	-	800/any one day 200/monthly avg 400 in 10% of samples (3)
Total Coliform	MF/100ml or MPN	50	1000

* Unless otherwise noted the standards referred to were taken from Dade County Enviromental Code Chapter 24-11.
(1) Environmental Protection Agency Surface Water Criteria
(2) Florida Primary Drinking Water Standards
(3) Department of Environmental Regulation Water Quality Standards Chapter 17-3.121
• N.D = None Detected

Figure 2: Conductivity Levels in the 1985 Groundwater Monitoring Program



sites in highly developed residential/industrial areas and areas containing muck or other highly organic soils in the northern part of the county (Figure 3). The overall average value was around 15 platinum - cobalt units (PCU) with no significant variation between wet and dry seasons. The variation in color during this groundwater study closely parallels variation in the manganese or iron concentrations (see page 20), major contributors to water coloration.

Turbidity

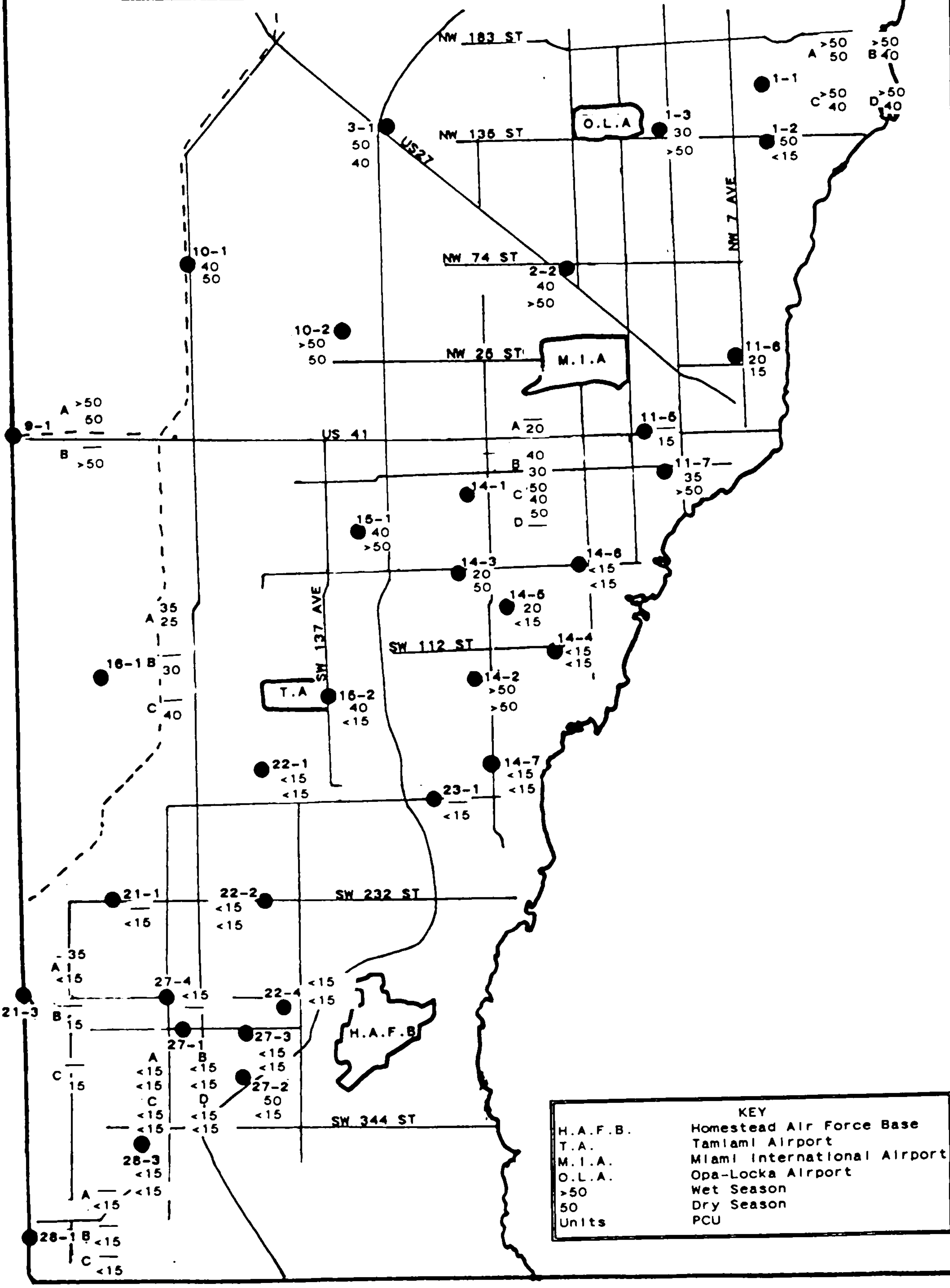
Turbidity is a measure of the clarity of water. The median turbidity value was 1.0 nephelometric turbidity units (NTU). Levels had high variability and ranged from 0-150 NTU (Figure 4). Sites 2-2, 11-7, 14-2, 15-1 and 1-1A exhibited higher than average (8 NTU) levels of turbidity. In previous years site 2-2 has shown elevated turbidity (increased stormwater runoff) in the wet season. 1985 data reflect the same trend: 27.0 NTU (wet season) and 8.4 NTU (dry season).

Site 14-2, which is associated with residential and industrial land uses, had high turbidity values throughout the year: 25.5 NTU (wet season) and 22 NTU (dry season).

Site 1-1A (a residential area) had 73 NTU for the wet season and 150 NTU during the dry season.

For the first time, elevated turbidity values were encountered at site 15-1 (95 NTU dry season). No determination as to the probable cause can be made at this time. Sites 11-6 and 11-7 are located in areas affected by salt water intrusion; however, the turbidity data exhibited a seasonal trend for site 11-7 only. Previous years' data indicated a similar tendency although the turbidity values were generally much lower. It is possible that constituents at site 11-7 are diluted during the wet season (turbidity value of 4.6 NTU) because of increased fresh water head in the area. In the dry season turbidity increases (37 NTU), possibly as the water table drops and sea

Figure 3: Variation of Color in the 1985 Groundwater Monitoring Program



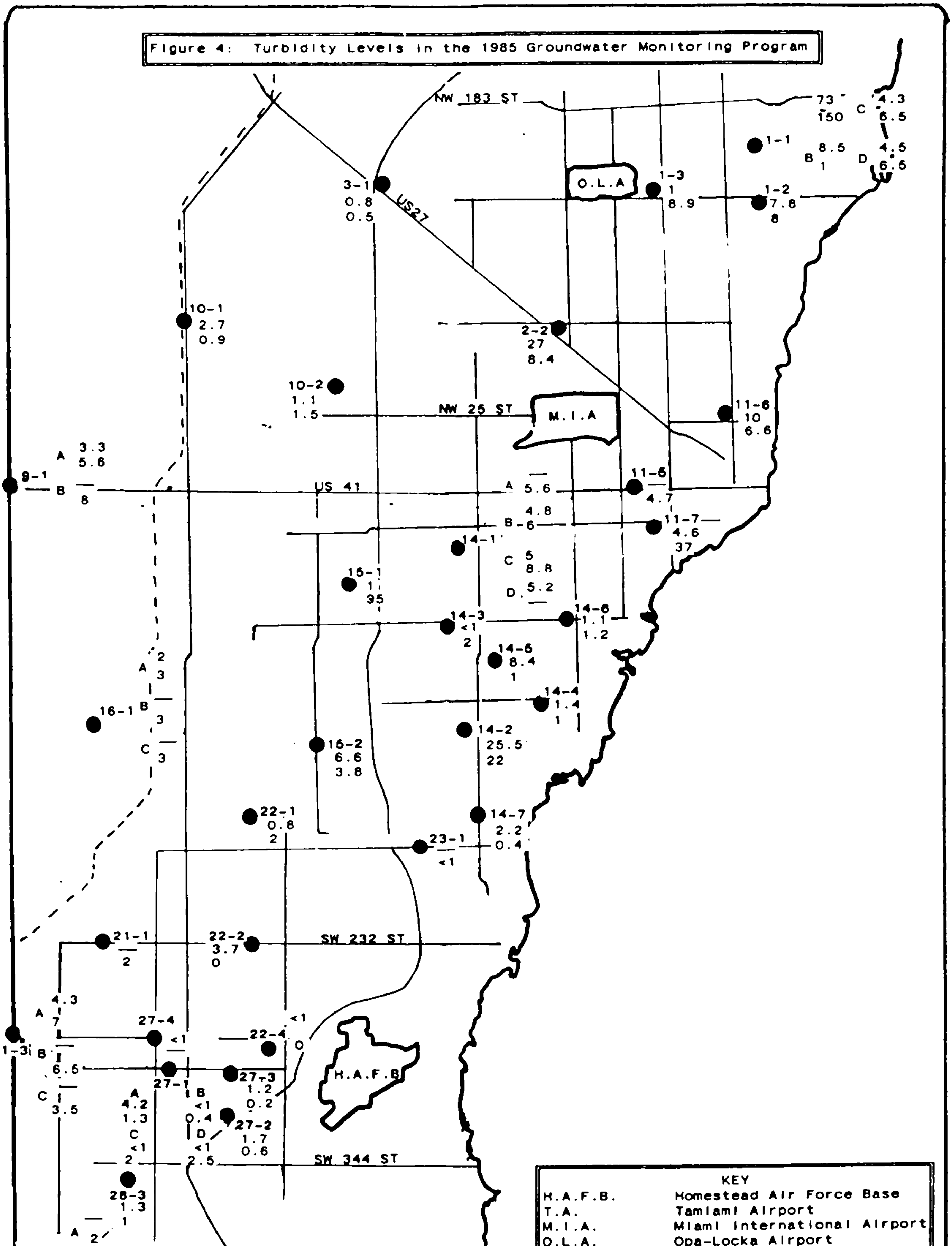


Figure 4: Turbidity Levels in the 1985 Groundwater Monitoring Program

water moves inland. The level of turbidity at this site was ten times higher than in 1984 and is an indication that the well casing may be deteriorating, allowing stormwater to enter at or near the top of the casing. The data from site 11-6 showed very little seasonal change, probably indicating year round salt water intrusion. Application of the water quality standard is not appropriate because it is based on outdated methodology which is measured in Jackson candle turbidity units (JCU).

Total Filtrable Residue (TFR)

TFR is the total concentration of dissolved material in water not retained by a special type of glass fiber filter. Waters with high residue are generally of inferior palatability. TFR values in this study ranged from 107 - 1559 mg/l (Figure 5). With the exceptions noted below, the average TFR value for this groundwater monitoring network was 325 mg/l. Sites 11-6 and 11-7 averaged 607 mg/l, reflecting salt water intrusion. Site 9-1A had a wet season TFR value of 706 mg/l that decreased to 413 mg/l during the dry season. Site 27-2 had 1559 mg/l during the wet and 463 mg/l during the dry season. This was the first exceedance of the 1000 mg/l TFR standard at this site and requires further testing for confirmation.
There was no seasonal trend evident for TFR.

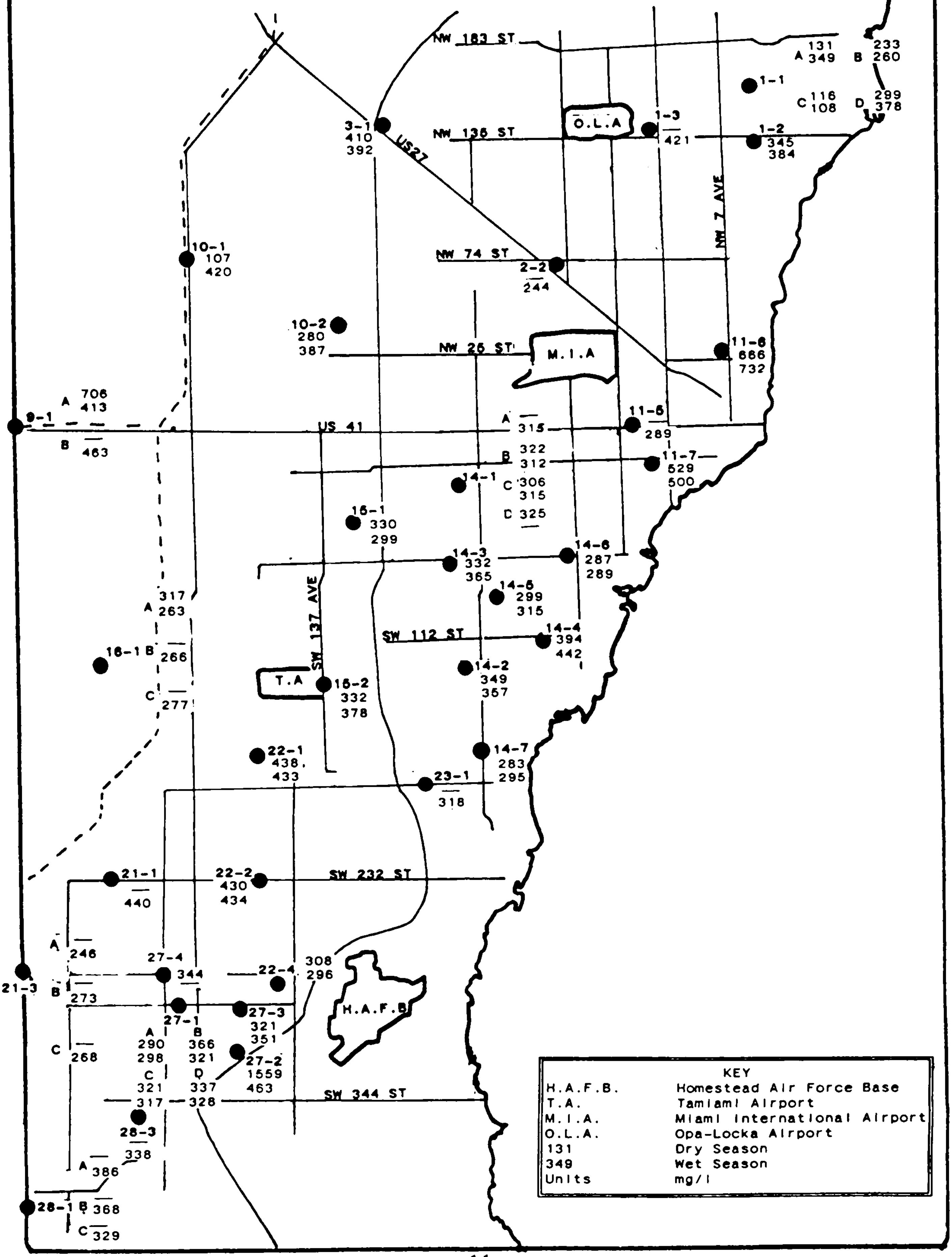
Major Inorganic Anions

The major anions present in groundwater are chlorides, bicarbonates (expressed as alkalinity), sulfates, and to a lesser extent, fluorides. The concentrations of these ions are controlled by the availability of elements in the soil and rock through which water passes, by geochemical constraints, e.g., solubility and adsorption; and finally, by the sequence in which water comes into contact with minerals.

Chlorides

Chlorides are found in practically all natural waters. They may be of (a) natural minerals associated with the aquifer, (b) salts spread on

FIGURE 5: TOTAL FILTRABLE RESIDUE DATA FOR THE 1985 GROUNDWATER MONITORING PROGRAM



fields for agricultural purposes (e.g., fertilizer components), (c) human or animal sewage, (d) industrial effluents (paper works, galvanizing plants, water softening plants, etc.) or (e) salt water intrusion. Chlorides are generally not harmful to man until substantially high concentrations are reached. Restrictions on chloride concentration are generally based on palatability requirements with a maximum allowable level of 500 mg/l.

Chloride concentrations ranged from 5.4 mg/l to 285 mg/l (Figure 6) with a median value of 66 mg/l. The highest levels were recorded at sites 11-6 and 11-7, both influenced by salt water intrusion. Site 21-1 had an average chloride value of 125 mg/l due to the influence of an artesian well located at Chekika Hammock State Park. Until the well was capped recently, it tapped the brackish Floridian aquifer. Previous studies (US Geological Survey 82-20) have shown that the artesian plume into the Biscayne terminates southeast of site 21-1.

Chloride levels were elevated in the dry season at sites in recharge/ storage areas 3-1 (106 mg/l), 10-1 (92 mg/l) and 28-1A and B (129 and 130 mg/l), probably due to recharge of more mineralized water conveyed via the Miami and L-31N Canals. Canal conveyances into Dade County are affected by runoff from Lake Okeechobee agricultural areas.

None of the sites exceeded the 500 mg/l standard.

Alkalinity

Alkalinity is mainly affected by the presence of carbonates, bicarbonates and hydroxides. Elevated alkalinity levels are generally associated with high pH values, hardness and excessive dissolved solids. The average alkalinity level in the groundwater network was 215 mg/l but values ranged widely from 114 mg/l to 366 mg/l (Figure 7). This pattern is consistent with historical data and is due to variation in organic matter and sulfate reduction:

$$CH_2O + \tfrac{1}{2}SO_4^{2-} = \tfrac{1}{2}HS^- + HCO_3^- + \tfrac{1}{2}H^+$$

FIGURE 6: CHLORIDE LEVELS IN THE 1985 GROUNDWATER MONITORING PROGRAM

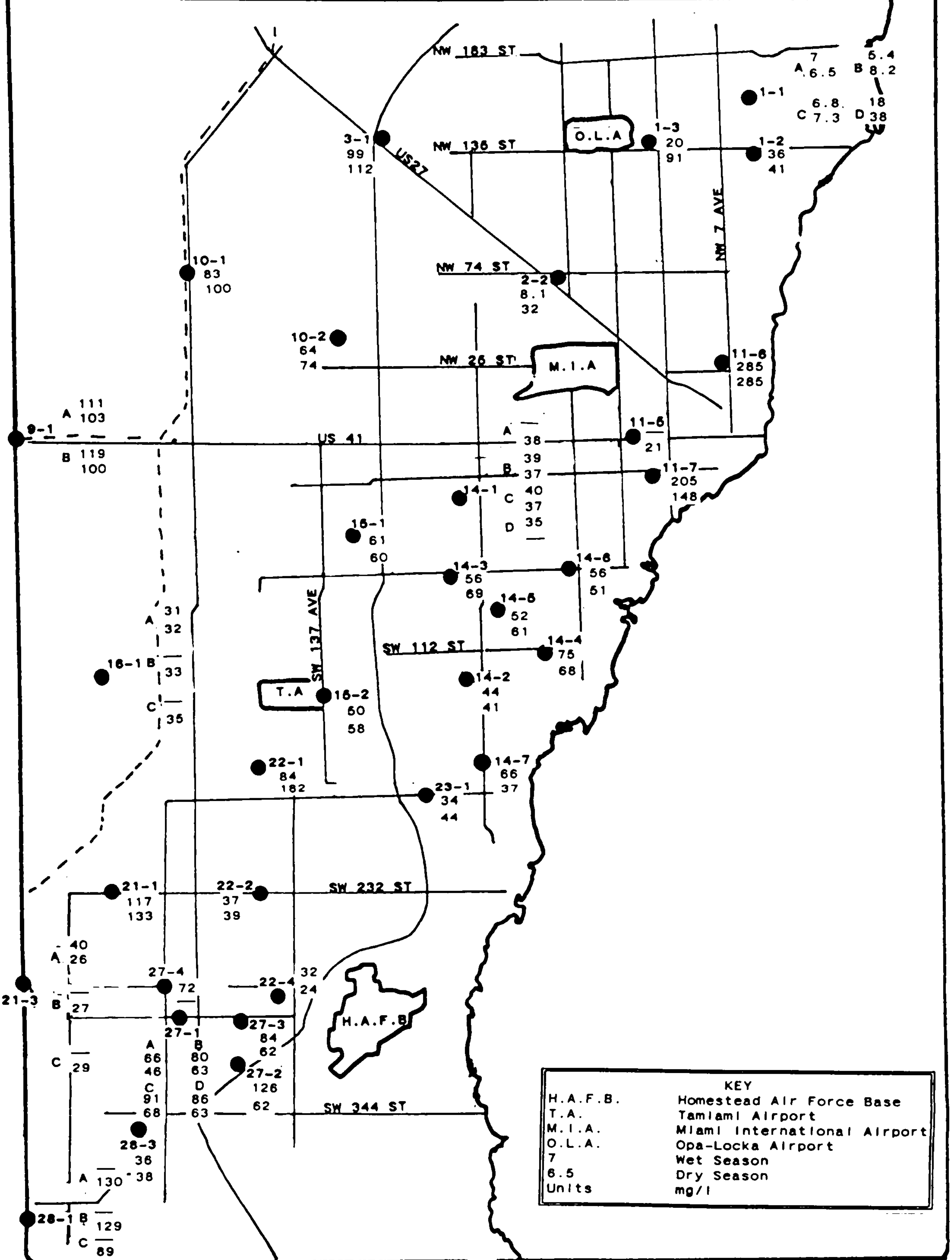
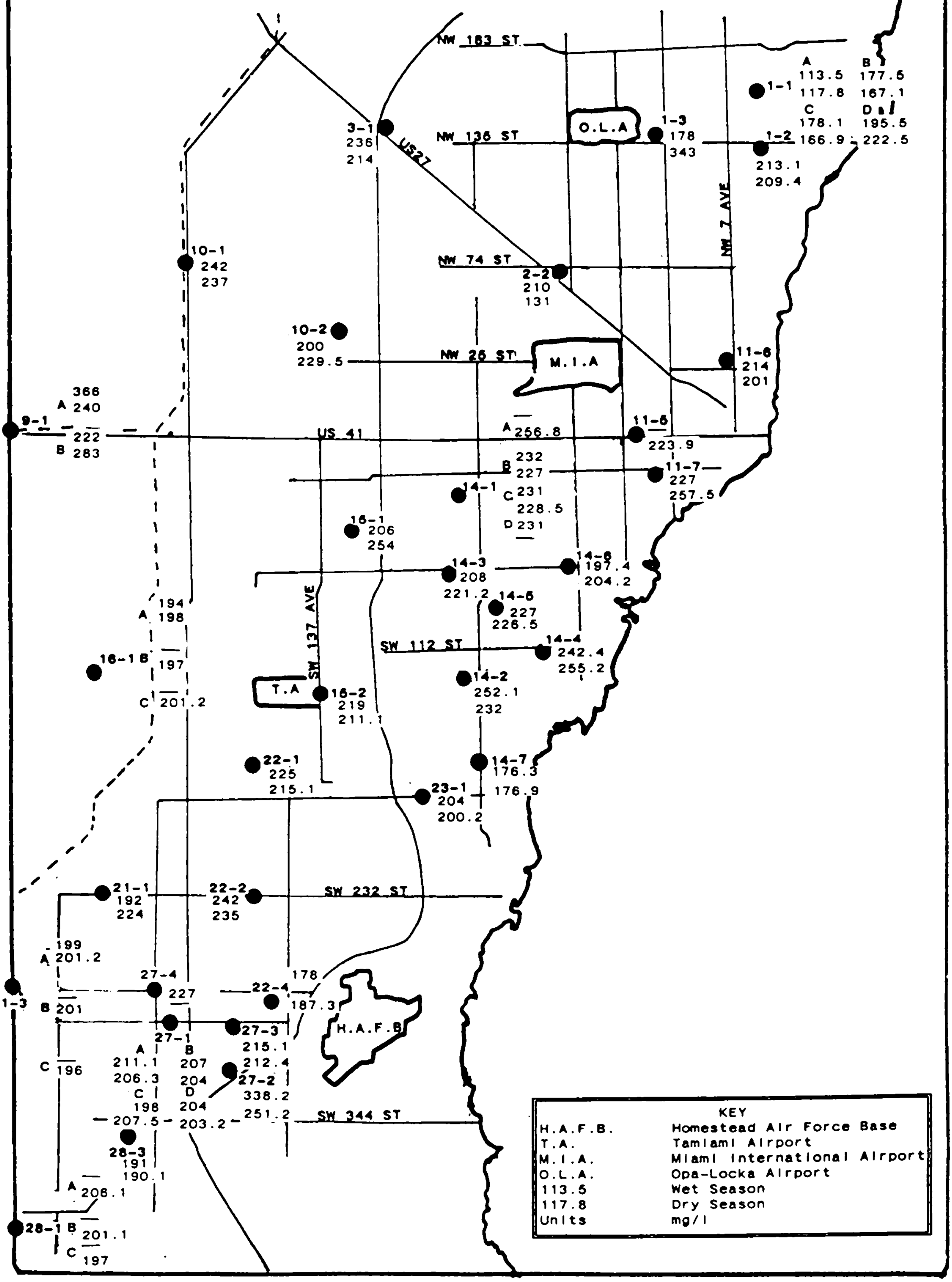


FIGURE 7: ALKALINITY LEVELS IN THE 1985 GROUNDWATER MONITORING PROGRAM



Significant variations from the mean (i.e. greater that 3 standard deviations), were found at 1-3 in the dry season; 9-1A and 27-2 in the wet season.

<u>Sulfate</u> (SO_4^{2-})

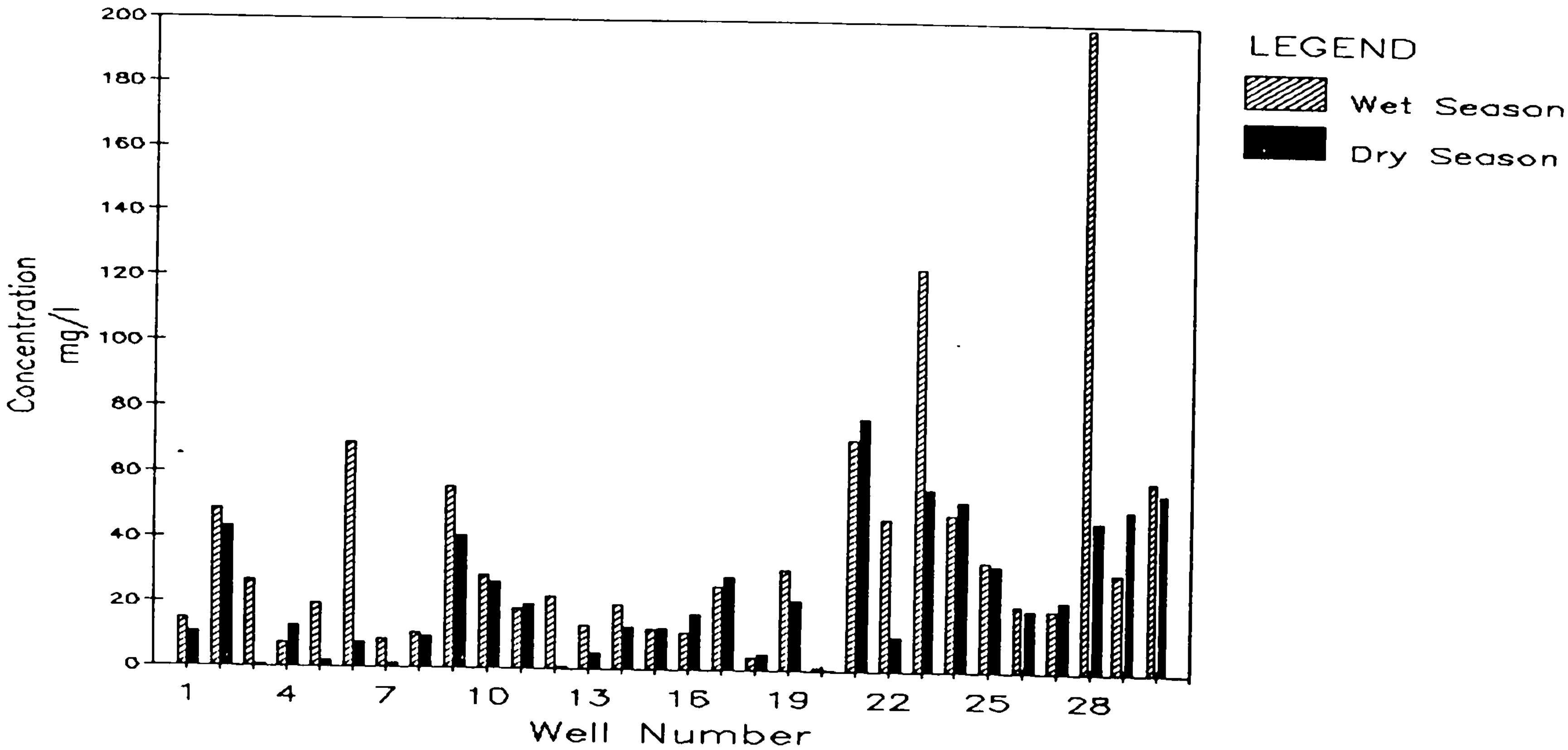
Sulfate concentrations vary widely. Excessive concentrations (about 250 mg/l) of sulfates (a) can have an initial laxative action in humans, (b) may cause precipitation of calcium, and (c) may be phytotoxic. In this groundwater study, the SO_4^{2-} concentration ranged from below detectable levels to 406.8 mg/l with a median level of 12 mg/l. The wet season values were generally higher than those of the dry season (Figure 8). Site 27-2 (406.8 mg/l) varied by more than three standard deviations from the arithmetic mean, continuing a trend noted in 1984. Site 21-1 had an average SO_4^{2-} level of 74.72 mg/l, exhibiting the impact of a plume of mineralized water originating from the the Floridan aquifer.

At site 11-6, elevated sulfate levels (48.74 mg/l) indicated salt water intrusion, consistent with previous findings. Sulfate levels at site 11-7, however, were three times lower (28.06 mg/l) than previous years. This may be a result of increased water table elevations in the area pushing back the salt water. Site 9-1 had higher levels during the wet season (69.49 mg/l) than the dry season (8.03 mg/l), which is probably the result of the site being recharged with mineralized water from the L-37A. Generally, southern sites had higher sulfate averages than northern sites.

<u>Fluoride</u> (F^-)

Fluoride minerals occur naturally in sedimentary rock but have a low solubility. The overall average recorded for the network was 0.15 mg/l; none of the sites had levels above the 1.4 mg/l standard.

Figure 8: Seasonal Variation of Sulfate Data in the 1985 Groundwater Monitoring Program



For well identification, see Table 1

Nutrients

Nitrogen

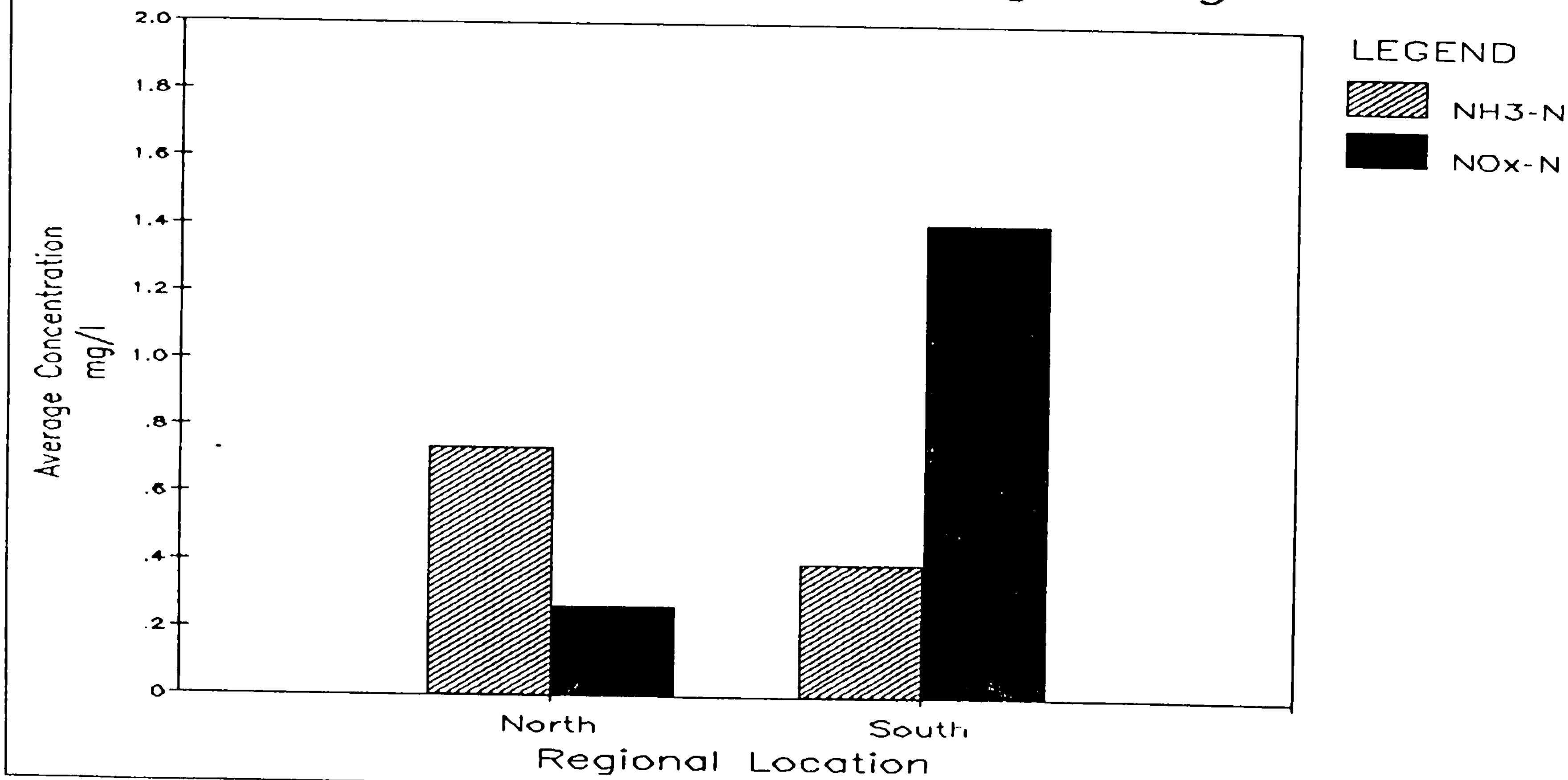
In water and wastewaters, the most common forms of nitrogen are nitrate (NO_3^-), nitrite (NO_2^-), ammonia (NH_3) and organic compounds which contain nitrogen. These compounds are inter-convertible components of the nitrogen cycle (Appendix I). The dominant species present depends largely upon the geology and soils of the area. As a result of the highly permeable limestone in southern Dade County, oxygen rich rainwater infiltrates the groundwater and promotes conversion (oxidation) of ammonia to nitrate. Due to the mucky soils in northern Dade County, reducing conditions prevail and ammonia remains the dominant species.

The southernmost sites had higher NOx-N levels than NH_3 values, averaging 0.31 mg/l (with site 27-2 omitted from the calculation due to an NOx-N level of 28 mg/l in the wet season) and 0.14 mg/l respectively. In the northern sites the reverse was true with averages of: 0.23 mg/l for NOx-N and 0.73 mg/l for NH_3 (Figure 9). Sites 22-1, 22-2 and 22-4 had elevated levels of NOx-N which may be attributable to agricultural fertilizers. Decreasing concentrations of NOx-N with depth at sites 28-1 A, B and C may also be a result of agricultural land usage. Site 27-2, a residential area, was almost three times above the 10 mg/l standard during the wet season, perhaps due to stormwater runoff from fertilized lawns.

Phosphorus (P)

Phosphorus occurs in natural waters almost solely as phosphates. Orthophosphates are readily assimilated by plants. The utilization of phosphorus by aquatic vegetation and the adsorption of phosphate ions by metal oxides and especially $Fe(OH)_3$ are major factors that prevent concentrations greater than a few tenths of a milligram per liter from being present (in solution) in most waters. Phosphate levels were consistently low throughout the network. The average

Figure 9: Nutrient Data for the Northern and Southern Sites in the 1985 Groundwater Monitoring Program



orthophosphate was 0.022 mg/l during the wet season and 0.035 mg/l during the dry season. The highest values found were at sites 14-6 (0.131 - 0.146 mg/l) and 15-1 (0.15 - 0.162 mg/l).

Total phosphate values were similarly low with averages of 0.069 mg/l (wet season) and 0.058 mg/l (dry season). Values that varied significantly (three standard deviations) from the arithmetic mean were at sites 1-1D (0.544 mg/l in the wet season), 14-1C (0.315 mg/l in the wet season), and 15-1 (0.29 mg/l in the dry season). The majority of these higher values for both ortho- and total phosphates occurred at sites having septic tanks in the area.

Trace Metals and Non-Metals

Although metals such as silver, cadmium, chromium, copper, mercury, lead, manganese, and zinc rarely occur in groundwater at concentrations large enough to comprise a significant percentage of the total dissolved solids, their concentrations can, depending on the source and hydrochemical environment, be above the limits specified by drinking water standards. These trace metals, with the exception of iron, typically occur at concentrations well below 1 mg/l. Concentrations are low because of constraints imposed by solubility of minerals or amorphous substances and adsorption on clay minerals or on hydrous oxides of Fe and Mn or organic matter. It is not surprising that there are relatively few instances of trace metal pollution of groundwater; however, when it does occur, the consequences can be serious.

Sites 15-1 (dry season) and 9-1A (wet season) had elevated levels for 7-9 different metals. Three sites exceeded the lead standard (50 ug/l).

Iron (Fe)

Fe values are expected to be higher than the other trace elements in water because relatively small shifts in pH can cause significant changes in Fe solubility. Typical values range from 1 - 10 mg/l. Twenty four of the 40 sites studied had levels that exceeded the Dade County standards of 0.3 mg/l with the highest value being 38.4 mg/l at site 1-1A (Figure 10). The highest values were found at sites in septic tank areas. The northern sites had higher iron levels than those in the south, which may be a result of both geology and the predominance of septic tanks in the north (Figure 11).

Manganese (Mn)

Mn imparts objectionable and tenacious stains to laundry and plumbing fixtures. Mn is an essential element in plant metabolism and its occurrence in natural water is influenced by organic cycling. The average Mn level encountered was 17.5 ug/l and ranged from 1.0 to 160.9 ug/l (Figure 10). Elevated levels were noted at sites 1-1A (139 ug/l) and 14-2 (107 ug/l), probably the result of pollution by septic tanks. Seasonal trends were not evident for Mn with the possible exception of site 9-1A which may be affected by dry season recharge via the Tamiami Canal with water containing high color levels. Like iron, the highest levels of Mn occur in the northern part of the County (Figure 11).

Lead (Pb)

Lead values were lower in southern than in northern Dade County (Figure 11) where industry may be the major contributing factor. Exceedances of the 50 ug/l standard occurred at three sites: 9-1A, 15-1 and 1-1A. Site 9-1A had a level of 172.1 ug/l during the wet season, and 4 ug/l during the dry season. Well 9-1 is located in the immediate vicinity of a residential/business franchise which operates a restaurant and an airboat ride/rental service. The occurrence of lead in the shallow well (9-1A) during the wet season is indicative of polluted stormwater runoff and needs to be confirmed. The highest exceedance of the Pb standard was at site 15-1 (251.8 ug/l) which decreased during the wet season to 5.4 ug/l (suggesting dilution of contaminants by rainfall infiltration). Site 15-1 had not previously

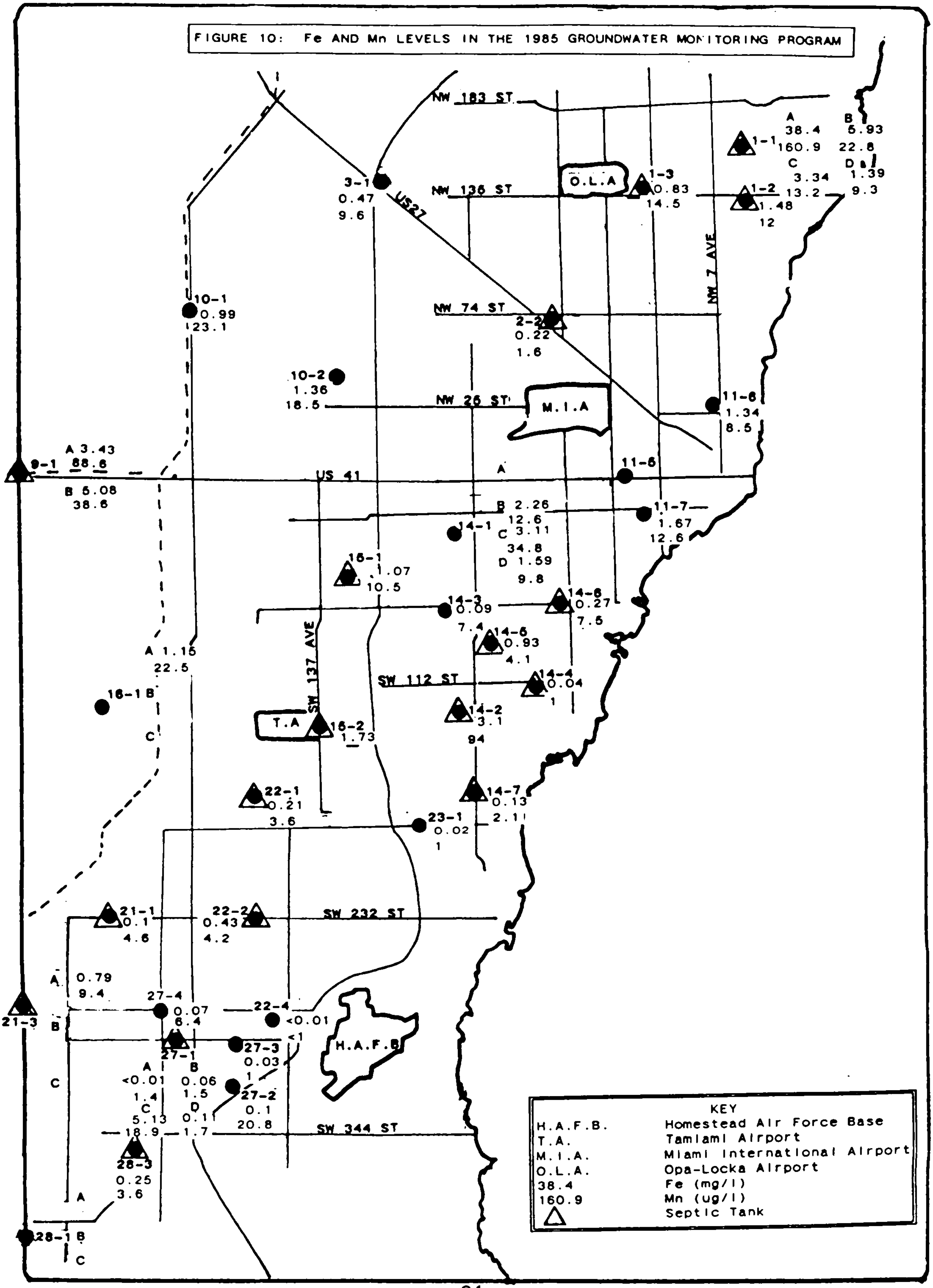


FIGURE 10: Fe AND Mn LEVELS IN THE 1985 GROUNDWATER MONITORING PROGRAM

Figure 11: Comparison of Metals Data for the Northern and Southern Sites in the 1985 Groundwater Monitoring Program

shown this level of lead and needs to be investigated to confirm possible sources of pollution. In contrast, lead levels at site 1-1A decreased from 197.7 ug/l during the wet season to 26.6 ug/l in the dry season. The data suggest the wet season infiltration of stormwater containing lead. There was no other exceedance of the lead standard.

Barium (Ba)

Ba is relatively abundant in nature but occurs only in trace amounts in water. Barium solubility in natural water is likely to be dependent on the solubility of barite ($BaSO_4$), which is a common mineral. The highest Ba value obtained was for site 9-1A (126.5 ug/l) during the wet season.

Zinc (Zn)

In most surface and groundwaters, zinc occurs in trace amounts. Elevated levels may be a result of industrial pollution since zinc is used in paint pigments, cosmetics, dyes, insecticides, etc. Zinc is an essential element in body growth and has no adverse physiological effect on man except at excessively high concentrations. However, zinc in domestic water at concentrations exceeding 5000 ug/l causes a bitter, astringent taste, gives water a milky appearance and leaves a greasy film when boiled. No exceedance of the 1000 ug/l standard was detected in this groundwater network. The highest detected value was 320 ug/l at site 1-1A.

Silver (Ag)

Silver can cause a discoloration of the skin and eyes referred to as argyria. Levels in the range of 400 - 1000 ug/l have caused pathologic changes in the urinary system of rats. Ag levels were very low throughout the groundwater network, with a median level of less than 0.1 ug/l. The highest value detected was 3 ug/l at site 28-3. No historical data is available for this site.

Cadmium (Cd)

Cadmium is used in electroplating, ceramics, photography and in metallurgy to alloy with copper, lead, aluminum and nickel. It is highly toxic. Cd may enter water as a result of industrial discharges or the deterioration of galvanized pipe. There were no exceedances of the 10 ug/l standard.

Chromium (Cr)

The median level of Cr was 1 ug/l with the highest value obtained at site 15-1 (8.7 ug/l) which was well below the 50 ug/l standard. No clear seasonal difference in Cr concentration could be discerned.

Copper (Cu)

Cu is used in industrial operations and as an agricultural fungicide. It is essential to humans, but in excessive amounts over a prolonged period it can cause health problems. The groundwater standard for copper (400 ug/l) was not exceeded in samples from this network. The average Cu level was 1.1 ug/l; and the highest value was detected at site 15-1 (25.5 ug/l) during the dry season.

Mercury (Hg)

Mercuric salts are widely used commercially and industrially as medicinal products, disinfectants, photo-engraving, etc. Hg may be introduced into water through industrial waste disposal. It is very toxic, and the standard allows essentially no detectable amount. The minimum detectable concentration that can be measured by the analytical methodology used is 0.2 ug/l. This value was exceeded at these sites: 2-2, and 1-1B (0.6 ug/l); 11-5, 1-3, 28-1C, 28-3, 1-1A, and 1-1D (0.5 ug/l); and 14-7 (0.8 ug/l). The exceedances generally occurred during the dry season, site 2-2 being an exception. The median was less than 0.2 ug/l. This is the second year that this parameter was analyzed; additional monitoring will be necessary to assess the significance of the data.

Nickel (Ni)

As a pure metal, nickel generally does not pose a water pollution problem because it is not affected by, or soluble in, water. Many nickel salts are soluble in water; because they are commonly used in metal plating work, they may contaminate surface water or groundwater. While the toxicity of nickel to man is believed to be very low (except for nickel carbonyl), it is extremely toxic to some plants (e.g., citrus) and some fish. Nickel averaged less than 50 ug/l in the groundwater program.

Trace Non-metals

Arsenic and selenium are rarely present in natural or contaminated water above 1000 ug/l, but water should be monitored for them because they cause harmful health effects at low concentrations.

Arsenic (As)

As has been used in insecticides and herbicides, in metallurgy to increase hardening and heat resistance, in glassware and ceramics, in dye manufacturing, and as a wood preservative. It may be detected in water supplies affected by improper waste disposal. Although more modern synthetic organic pesticides have mostly replaced the use of arsenicals in agriculture, past usage has made As an element of interest in terms of environmental quality. In the pH range typical of groundwater, stable solid As forms are As_2O_5 and As_2O_3. The solubility of both are sufficient for these species to exist at concentrations that exceed groundwater standards (50 ug/l); however, the standard was not exceeded during their study. The As concentrations were very low with the highest detected at site 9-1A (13.9 ug/l).

Selenium (Se)

Above trace level, Se is toxic to animals and may be toxic to humans.

A sudden appearance of Se in water probably indicates industrial pollution resulting from its use in paints, dyes, glass products, electrical apparatus, insecticide sprays, etc. Wet season values for Se were all below the detection limit (5 ug/l), while dry season concentrations varied considerably (5 to 38.8 ug/l). The three highest levels: 11-6 (38.8 ug/l), 11-7 (26.1 ug/l) and 21-1 (32.3 ug/l) were due to the intrusion of salt water, which typically contains higher levels of trace elements. Other exceedances of the 10 ug/l standard occurred during the dry season at the following sites: 1-2 (11.7 ug/l), 3-1 (18.5 ug/l), 9-1A (11.5 ug/l), 9-1B (15.7 ug/l), 10-2 (12.5 ug/l), 14-4 (17.4 ug/l), 15-1 (14.9 ug/l), 15-2 (11.6 ug/l), 22-1 (19.9 ug/l), 22-2 (14.7 ug/l), 27-1B (11.7 ug/l), 27-1C (11.5 ug/l), 27-2 (15.3 ug/l), 27-3 (11.2 ug/l), 28-1A (21.3 ug/l), 28-1B (17.6 ug/l) and 28-1C (14.1 ug/l). Because these sites are located in residential areas, these Se levels should be reconfirmed.

Phenols

Very low concentrations impart such a disagreeable taste to water that it is highly improbable that harmful amounts could be consumed unknowingly. There were no exceedances in this study. The average phenol level was less than the detection limit of 2 ug/l and ranged from less than 2 ug/l to 8 ug/l.

Summary

This groundwater monitoring program was designed by Dade County's Department of Environmental Resources Management to monitor the County's only natural source of drinking water as well as to establish baseline data for long term trend analysis. The program is not only capable of generally characterizing the groundwater quality, but is also able to signal existing or impending non-point source pollution problems during formative periods.

The groundwater program has detected the effect of salt water intrusion, agricultural and industrial activities, septic tanks, recharge of canal waters, and a flowing artesian well. For the first time since the groundwater program was initiated, lead exceedances were detected at three of the groundwater monitoring sites. Other exceedances included mercury at nine sites, NOx-N at one site, TFR at one site and turbidity at two.

In general, trace elements were higher in the northern part of the county than in the south. Color values were consistent with the distribution of trace elements. Ammonia levels were higher in the north, whereas nitrate levels were more elevated in the south. Conductivity and sulfate levels were generally higher in the south.

APPENDIX I

1985 AMBIENT GROUNDWATER MONITORING PROGRAM

	1-1A		1-1B		1-1C		1-1D		1-2	
	AUG	DEC	AUG	DEC	AUG	DEC	AUG	DEC	AUG	DEC
ALKALINITY (mg/l)	113.5	117.8	177.5	167.1	178.1	166.9	195.5	222.5	213.1	209.4
CHLORIDES (mg/l)	7	6.5	5.4	8.2	6.8	7.3	18	38	36	41
COLOR (PCU)	>50	50	>50	40	>50	40	>50	40	50	<15
CONDUCTIVITY (umhos/cm)	220	250	320	5000	330	1500	410	300	530	500
FLUORIDES (mg/l)	0.1	0.07	0.23	0.17	0.15	0.1	0.13	0.09	0.13	0.13
NH3-N (mg/l)	0.9	0.27	0.34	0.1	0.13	0.12	0.1	0.09	0.38	0.2
NOx-N (mg/l)	0.2	0.02	0.02	0.02	0.01	0.02	<0.01	0.02	<0.01	<0.01
O-PO4-P (mg/l)	0.005	0.006	0.006	0.014	0.017	0.026	0.013	0.036	0.003	0.065
PHENOLS(ug/l)	2	2	2	2	2	2	<2	2	<2	<2
SULFATES (mg/l)	12.76	5.18	8.64	5.13	13.14	7.1	26.19	26.29	49.13	43.78
TFR (mg/l)	131	349	233	260	116	108	299	378	345	384
TURBIDITY (NTU)	73	150	8.5	1	4.3	6.5	4.5	6.5	7.8	8
T-PO4-P (mg/l)	0.006	0.071	0.221	0.073	0.05	0.103	0.544	0.1	0.075	0.094
Ag (ug/l)	<0.1	<0.1	<0.1	0.3	<0.1	0.2	<0.1	0.3	<0.1	<0.1
As (ug/l)	<1	<1	1.3	1.9	<1	<1	<1	4.6	1.6	<1
Ba(ug/l)	3.1	4.4	5.9	3.1	21.5	3.7	7.7	8.3	19.1	1
Cd (ug/l)	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cr (ug/l)	2.8	1.2	1	1.6	1.6	1.7	2.4	1.2	1.3	1
Cu (ug/l)	1	1.7	<1	<1	<1	1	<1	<1	<1	1
Fe (mg/l)	38.4		5.93		3.34		1.39		1.48	
Hg (ug/l)	<0.2	0.5	<0.2	0.6	<0.2	0.3	<0.2	0.5	0.2	0.4
Mn (ug/l)	160.9	117.3	22.8	23.4	13.2	21.7	9.3	11.6	12	11.1
Ni (ug/l)	<50		<50		<50		<50		<50	
Pb (ug/l)	197.7	26.6	7.5	10.6	4.6	39.8	4.5	2.4	1.2	10.7
Se (ug/l)	<5	<5	<5	<5	<5	<5	<5	9.3	<5	11.7
Zn (ug/l)	320		40		20		10		10	

1985 AMBIENT GROUNDWATER MONITORING PROGRAM

	1-3		2-2		3-1		9-1A		9-1B	
	AUG	DEC	AUG	DEC	AUG	DEC	AUG	DEC	AUG	DEC
ALKALINITY (mg/l)	178	343	210	131	236	214	366	240	222	283
CHLORIDES (mg/l)	20	91	8.1	32	99	112	111	103	119	100
COLOR (PCU)	30	>50	40	>50	50	40	>50	50		>50
CONDUCTIVITY (umhos/cm)	295	500	290	350	600	600	700	600	700	800
FLUORIDES (mg/l)	0.19	0.11	0.11	0.13	0.24	0.28	0.24	0.32	0.23	0.32
NH3-N (mg/l)	0.53	4.6	0.18	0.04	0.32	0.4	1.3	0.8	0.99	1.1
NOx-N (mg/l)	0.02	0.02	0.65	2.6	<0.01	0.02	0.01	0.02	<0.01	0.02
O-PO4-P (mg/l)	0.045	0.02	0.064	0.035	0.02	0.01	0.054	0.026	0.005	0.011
PHENOLS(ug/l)	<2	<2	2	2	<2	<2	<2	<2	<2	2
SULFATES (mg/l)	27.12	0.85	7.67	13.18	19.81	2.22	69.34	10.66	69.63	5.39
TFR (mg/l)		421		244	410	392	706	413		463
TURBIDITY (NTU)	1	8.9	27	8.4	0.8	0.5	3.3	5.6		8
T-PO4-P (mg/l)	0.077	0.067	0.085	0.089	0.049	0.017	0.059	0.058	0.062	0.018
Ag (ug/l)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
As (ug/l)	2.6	3	4.1	1.3	3.4	2.2	13.9	4.6	<1	2.2
Ba(ug/l)	10.1	47.4	12.8	6.3	38.6	17.6	126.5	38.9	55.4	19.2
Cd (ug/l)	0.1	3.7	0.2	0.1	<0.1	<0.1	0.8	<0.1	<0.1	<0.1
Cr (ug/l)	<1	1	1	1.3	4.8	1.2	6.4	1.1	6.2	1
Cu (ug/l)	<1	1	<1	1.2	<1	<1	11.6	1	<1	<1
Fe (mg/l)	0.83		0.22		0.47		3.43		5.08	
Hg (ug/l)	<0.2	0.5	0.6	0.4	<0.2	<0.2	<0.2	0.3	<0.2	<0.2
Mn (ug/l)	14.5	49.4	1.6	1.8	9.6	9.9	88.6	20.5	38.6	32.8
NI (ug/l)	<50		<50		<50		<50		<50	
Pb (ug/l)	<1	43.2	35.9	14.3	1	3.6	172.1	4.1	2.9	16.1
Se (ug/l)	<5	5.4	<5	5.1	<5	18.5	<5	11.5	<5	15.7
Zn (ug/l)	20		20		10		80		10	

1985 AMBIENT GROUNDWATER MONITORING PROGRAM

	10-1		10-2		11-5	11-6		11-7		14-1A
	AUG	DEC	AUG	DEC	DEC	AUG	DEC	AUG	DEC	DEC
ALKALINITY (mg/l)	242	237	200	229.5	223.9	214	201.1	227	257.5	256.8
CHLORIDES (mg/l)	83	100	64	74	21	285	285	205	148	38
COLOR (PCU)	40	50	>50	50	15	20	15	35	>50	20
CONDUCTIVITY (umhos/cm)	590	620	500	650	420	1110	1100	900	800	600
FLUORIDES (mg/l)	0.21	0.21	0.2	0.27	0.27	0.18	0.15	0.12	0.11	0.23
NH3-N (mg/l)	0.16	0.4	0.77	0.81	0.06	1.7	0.96	1.7	2.7	2
NOx-N (mg/l)	<0.01	0.01	<0.01	0.01	4.4	<0.01	0.01	<0.01	0.02	0.02
O-PO4-P (mg/l)	0.012	0.006	0.009	0.009	0.068	0.033	0.051	0.029	0.041	0.052
PHENOLS(ug/l)	<2		<2	<2	2	2	<2		2	2
SULFATES (mg/l)	8.98	1.65	11.1	10.08	24.35	56.17	41.31	29.16	26.96	20.62
TFR (mg/l)	107	420	280	387	289	666	732	529	500	315
TURBIDITY (NTU)	2.7	0.9	1.1	1.5	4.7	10	6.6	4.6	37	5.6
T-PO4-P (mg/l)	0.017	0.015	0.018	0.011	0.075	0.043	0.053	0.05	0.111	0.079
Ag (ug/l)	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	0.2	0.2
As (ug/l)	1.3	1.9	<1	1.7	3.3	2	6.6	<1	3.7	10.2
Ba(ug/l)	63.8	20	22.9	19.9	2.7	51.5	1.5	29.2	26	18.8
Cd (ug/l)	<0.1	<0.1	0.2	0.1	1.3	<0.1	<0.1	<0.1	0.1	<0.1
Cr (ug/l)	4.9	1	<1	1	1.9	<1	2.6	1.7	1	1
Cu (ug/l)	<1	<1	<1	1	2.4	<1	2.2	1	1.5	0.3
Fe (mg/l)	0.99		1.36			1.34		1.67		
Hg (ug/l)	<0.2	<0.2	<0.2	<0.2	0.5	<0.2	0.4	<0.2	<0.2	0.3
Mn (ug/l)	23.1	20.7	18.5	14.8	4.6	8.5	8.3	12.6	20.9	9.5
Ni (ug/l)	<50		<50			<50		<50		
Pb (ug/l)	1.4	<1	3	1	13	6.3	2.2	2.7	12.3	17.1
Se (ug/l)	<5	9.2	<5	12.5	6.5	<5	38.8	<5	26.1	10.4
Zn (ug/l)	10		50			20		20		

1985 AMBIENT GROUNDWATER MONITORING PROGRAM

	14-1B		14-1C		14-1D	14-2		14-3		14-4	
	AUG	DEC	AUG	DEC	AUG	AUG	DEC	AUG	DEC	AUG	DEC
ALKALINITY (mg/l)	232	227	231	228.5	231	252.1	232	208	221.2	242.4	255.2
CHLORIDES (mg/l)	39	37	40	37	35	44	41	56	69	75	68
COLOR (PCU)	40	30	50	40	50	>50	>50	20	50	<15	<15
CONDUCTIVITY (umhos/cm)	442	500	520	600	480	350	500	485	550	490	650
FLUORIDES (mg/l)	0.21	0.22	0.18	0.14	0.14	0.08	0.09	0.2	0.19	0.15	0.09
NH3-N (mg/l)	1.6	1.8	1.6	0.94	1.2	0.42	0.24	0.08	0.1	0.2	4.5
NOx-N (mg/l)	<0.01	0.03	<0.01	0.01	<0.01	0.01	0.02	0.14	<0.01	1.7	0.02
O-PO4-P (mg/l)	0.076	0.018	0.032	0.014	0.016	0.003	0.02	0.013	0.008	0.085	0.116
PHENOLS(ug/l)	2	2	6	2	<2	<2	<2	<2	<2	<2	<2
SULFATES (mg/l)	21.07	21.95	18.07	18.19	18.06	22.7	0.88	13.95	5.43	20.19	13.64
TFR (mg/l)	322	312	306	315	325	349	357	332	365	394	442
TURBIDITY (NTU)	4.8	6	5	8.8	5.2	25.5	22	<1	2	1.4	1
T-PO4-P (mg/l)	0.103	0.027	0.315	0.015	0.018	0.01	0.063	0.138	0.01	0.092	0.144
Ag (ug/l)	<0.1	<0.1	<0.1	2	<0.1	<0.1	0.3	<0.1	0.1	<0.1	0.3
As (ug/l)	6.4	8.4	6.2	2.1	2.7	<1	2.2	<1	1.5	<1	7.8
Ba(ug/l)	14.9	5.4	6.4	13.7	14.1	20.5	31.1	23.1	33.1	21.6	6.8
Cd (ug/l)	0.2	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cr (ug/l)	1.5	0.6	1	0.3	<1	<1	<1	4.8	1	1	<1
Cu (ug/l)	<1	0.2	<1	0.4	<1	<1	<1	2	13.6	<1	<1
Fe (mg/l)	2.26		3.11		1.59	3.1		0.09		0.04	
Hg (ug/l)	<0.2	0.4	0.2	0.4	<0.2	<0.2	<0.2	0.2	<0.2	<0.2	0.3
Mn (ug/l)	12.6	11	34.8	11.4	9.8	94	119.4	7.4	16.2	1	7
Ni (ug/l)	<50		<50		<50	<50		<50		<50	
Pb (ug/l)	3.8	14.7	14.2	2.9	<1	<1	11.2	1.8	26.5	1	10.7
Se (ug/l)	<5	8.3	<5	8	<5	<5	6.9	<5	9.8	<5	17.4
Zn (ug/l)	20		40		20	20		20		20	

1985 AMBIENT GROUNDWATER MONITORING PROGRAM

	14-5		14-6		14-7		15-1		15-2		16-1A	
	AUG	DEC	AUG	DEC	AUG	DEC	AUG	DEC	AUG	DEC	AUG	DEC
ALKALINITY (mg/l)	227	226.5	197.4	204.2	176.3	176.9	206	254	219	211.1	194	198
CHLORIDES (mg/l)	52	61	56	51	66	37	61	60	50	58	31	32
COLOR (PCU)	20	<15	<15	<15	<15	<15	40	>50	40	<15	35	25
CONDUCTIVITY (umhos/cm)	380	500	380	590	380	550	332	490	495	600	400	450
FLUORIDES (mg/l)	0.13	0.14	0.3	0.25	0.14	0.12	0.19	0.24	0.11	0.13	0.18	0.17
NH3-N (mg/l)	0.4	0.4	0.13	0.4	0.08	0.04	0.2	0.48	0.1	0.06	0.4	0.42
NOx-N (mg/l)	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	0.02	<0.01	0.02	<0.01	0.02
O-PO4-P (mg/l)	0.004	0.04	0.131	0.146	0.004	0.041	0.15	0.162	0.018	0.012	0.01	0.008
PHENOLS(ug/l)	<2	<2	4	<2	<2	<2	2	2	2	2	<2	
SULFATES (mg/l)	12.69	13.29	11.62	17.41	26.16	29.01	4.41	5.25	31.6	22.13	1.12	0.21
TFR (mg/l)	299	315	287	289	283	295	330	299	332	378	317	263
TURBIDITY (NTU)	8.4	1	1.1	1.2	2.2	0.4	1	95	6.6	3.8	2	3
T-PO4-P (mg/l)	0.008	0.068	0.146	0.158	0.118	0.056	0.026	0.29	0.019	0.017	0.015	0.009
Ag (ug/l)	<0.1	<0.1	<0.1	<0.1	<0.1	0.3	<0.1	<0.1		0.02	<0.1	<0.1
As (ug/l)	1.3	1.3	<1	<1	2.1	1.2	1.6	6.5		2.1	<1	<1
Ba(ug/l)	12.6	4.4	14.2	12.6	9.5	15	18.8	9.2		3.5	46.7	<1
Cd (ug/l)	<0.1	<0.1	<0.1	0.1	1	<0.1	<0.1	1.8	0.1	<0.1	<0.1	<0.1
Cr (ug/l)	<1	1	1	1	4.8	1.6	1	8.7	1	0.9	<1	<1
Cu (ug/l)	<1	<1	1	<1	<1	0.4	<1	25.5	<1	0.5	<1	0.1
Fe (mg/l)	0.93		0.27		0.13		1.07		1.73		1.15	
Hg (ug/l)	<0.2	<0.2	<0.2	<0.2	<0.2	0.8	0.4	<0.2	0.2	<0.2	<0.2	<0.2
Mn (ug/l)	4.1	6.1	7.5	6.3	2.1	0.8	10.5	62.4		6.4	22.5	18.4
Ni (ug/l)	<50		<50		<50		<50		<50		<50	
Pb (ug/l)	1	4	9	2.4	<1	1.8	5.4	251.8	1.7	1.9	1	11.2
Se (ug/l)	<5	5.1	<5	<5	<5	10	<5	14.9		11.6	<5	1.9
Zn (ug/l)	10		10		10		10		10		<10	

1985 AMBIENT GROUNDWATER MONITORING PROGRAM

	16-1B	16-1C	21-1		21-3A		21-3B	21-3C	22-1		22-2	
	DEC	DEC	AUG	DEC	AUG	DEC	DEC	DEC	AUG	DEC	AUG	DEC
ALKALINITY (mg/l)	197	201.2	192	224	199	201.2	201	196.2	225	215.1	242	235
CHLORIDES (mg/l)	33	35	117	133	40	26	27	29	84	182	37	39
COLOR (PCU)	30	40		<15	35	<15	15	15	<15	<15	<15	<15
CONDUCTIVITY (umhos/cm)	450	450	650	800	400	450	450	450	550	650	500	600
FLUORIDES (mg/l)	0.17	0.18	0.12	0.13	0.1	0.14	0.13	0.44	0.12	0.22	0.1	0.15
NH3-N (mg/l)	0.38	0.47	0.06	0.08	0.22	0.24	0.24	0.31	0.08	0.04	0.28	0.1
NOx-N (mg/l)	0.02	0.02	0.03	0.05	<0.01	0.17	0.03	0.02	4.4	3.1	4.9	5.9
O-PO4-P (mg/l)	0.005	0.006		0.008	0.014	0.011	0.011	0.01	0.006	0.013	0.02	0.016
PHENOLS(ug/l)			2	<2	<2	<2	<2	<2	2	<2	<2	
SULFATES (mg/l)	0	0.21	71.38	78.06	47.43	11.46	12.8	9.14	123.86	56.5	48.74	52.71
TFR (mg/l)	266	277		440		246	273	268	438	433	430	434
TURBIDITY (NTU)	3	3		2	4.3	7	6.5	3.5	0.8	2	3.7	0
T-PO4-P (mg/l)	0.009	0.008	0.022	0.01	0.02	0.015	0.013	0.014	0.01	0.015	0.022	0.021
Ag (ug/l)	0.3	<0.1	<0.1	<0.1	<0.1	0.4	<0.1	<0.1	<0.1	0.3	<0.1	0.1
As (ug/l)	<1	1	<1	3.5	2.3	<1	2	<1	<1	1	1.1	2.2
Ba(ug/l)	16.2	9.3	29.3	12.5	22.9	29.4	13.1	4.1	23.1	10.9	12.8	7.9
Cd (ug/l)	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.2	0.1	<0.1	<0.1	<0.1	<0.1
Cr (ug/l)	<1	1.5	1.3	1	<1	1	1.5	1.5	5.1	<1	4.8	<1
Cu (ug/l)	0.1	0.2	3.8	1.8	<1	1	<1	<1	1.2	1.4	1.1	1
Fe (mg/l)			0.1		0.79				0.21		0.43	
Hg (ug/l)	0.4	<0.2	<0.2	<0.2	<0.2	0.5	<0.2	<0.2	<0.2	<0.2	<0.2	0.3
Mn (ug/l)	19.5	21.2	4.6	6.3	9.4	7.2	7.4	8.4	3.6	5.8	4.2	5
NI (ug/l)			<50		<50				<50		<50	
Pb (ug/l)	2.9	2.3	2.2	3.6	<1	2.3	1	1	<1	2.2	1	15.6
Se (ug/l)	3.9	3.8	<5	32.2	<5	5.7	4.3	6.2	<5	19.9	<5	14.7
Zn (ug/l)			<10		<10				<10		10	

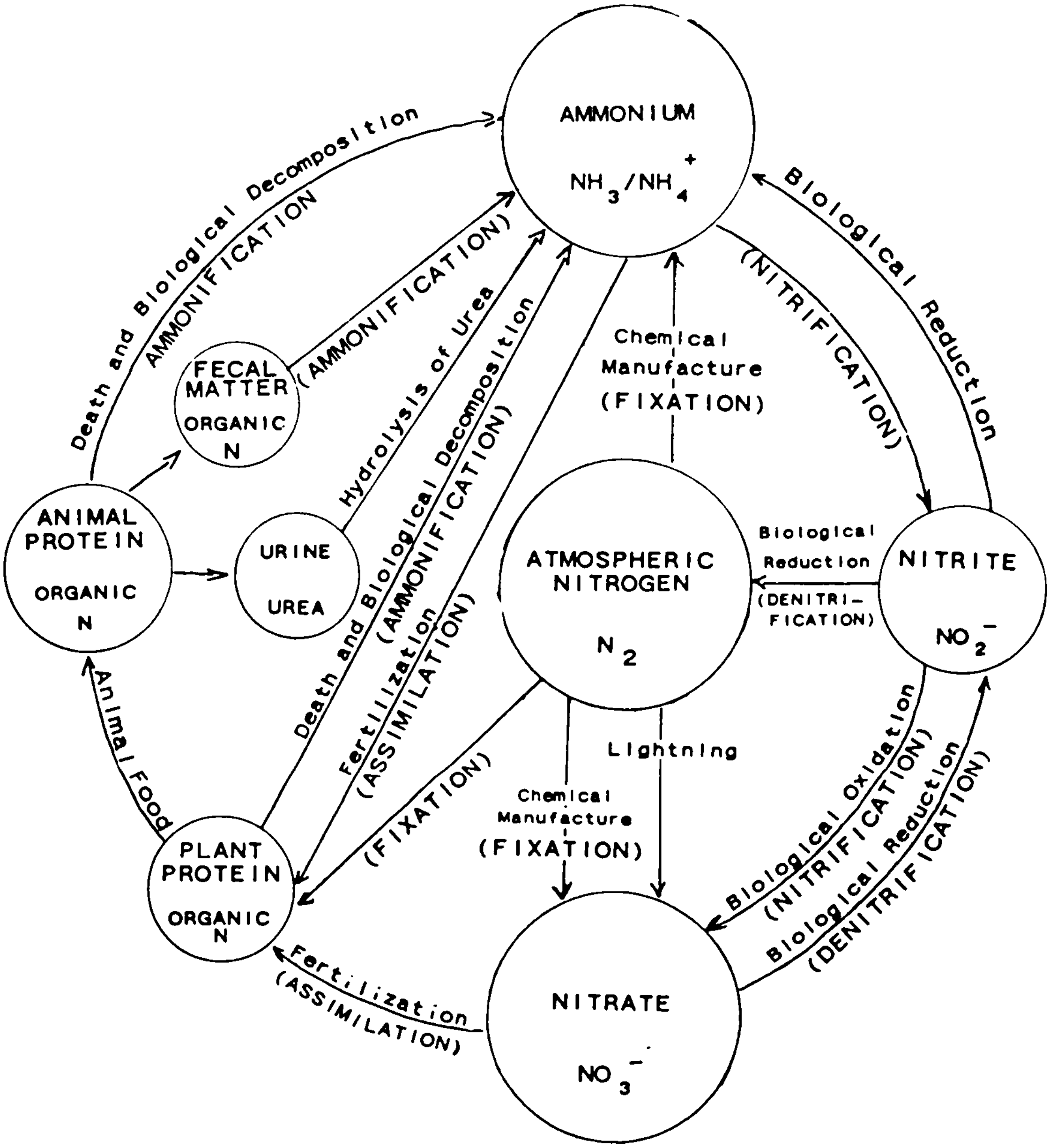
1985 AMBIENT GROUNDWATER MONITORING PROGRAM

	22-4		23-1		27-1A		27-1B		27-1C		27-1D	
	AUG	DEC	AUG	DEC	AUG	DEC	AUG	DEC	AUG	DEC	AUG	DEC
ALKALINITY (mg/l)	178	187.3	204	200.2	211.1	206.3	207	204	198	207.5	204	203.2
CHLORIDES (mg/l)	32	24	34	44	66	46	80	63	91	68	86	63
COLOR (PCU)	<15	<15		<15	<15	<15	<15	<15	<15	<15	<15	<15
CONDUCTIVITY (umhos/cm)	380	450	350	700	390	3900	440	450	410	11000	420	500
FLUORIDES (mg/l)	0.08	0.13	0.17	0.1	0.08	0.11	0.08	0.09	0.06	0.07	0.07	0.08
NH3-N (mg/l)	0.04	0.14	0.32	0.06	0.02	0.02	0.05	0.02	0.12	0.02	0.31	0.02
NOx-N (mg/l)	4.1	2.8	1.7	1.9	1.6	2	1	1.4	1.1	1.5	1.4	1.4
O-PO4-P (mg/l)	0.003	0.008		0.048	0.005	0.048	0.003	0.04	0.014	0.044	0.002	0.04
PHENOLS(ug/l)	2	2	<2	<2	<2	2	<2	2	<2	2	<2	2
SULFATES (mg/l)	34.13	33.29	21.05	19.66	18.11	20.53	20.13	22.51	18.44	22.57	21.52	23.87
TFR (mg/l)	308	296		318	290	298	366	321	321	317	337	328
TURBIDITY (NTU)	<1	0		<1	4.2	1.3	<1	0.4	<1	2	<1	2.5
T-PO4-P (mg/l)	0.009	0.01	0.13	0.05	0.012	0.068	0.004	0.058	0.017	0.059	0.008	0.053
Ag (ug/l)	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.1
As (ug/l)	<1	<1	1.2	4.5	<1	2.1	<1	2.4	1.2	<1	<1	3
Ba(ug/l)	11.5	10.7	8.6	7.4	19.5	4.9	22.7	4.4	9.3	15.7	10.1	9
Cd (ug/l)	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cr (ug/l)	<1	1.1	<1	1	<1	<1	<1	1.4	1	<1	1	<1
Cu (ug/l)	<1	<1	<1	1.5	<1	<1	<1	<1	1.2	1	<1	1
Fe (mg/l)	<0.01		0.02		<0.01		0.06		5.13		0.11	
Hg (ug/l)	<0.2	<0.2	<0.2	<0.2	<0.2	0.4	<0.2	0.4	<0.2	0.4	<0.2	0.4
Mn (ug/l)	<1	2.7	1	1	1.4	2.2	1.5	1.9	18.9	3	1.7	3.3
Ni (ug/l)	<50		<50		<50		<50		<50		<50	
Pb (ug/l)	<1	1.6	<1	1.8	<1	1.8	<1	8.9	13.5	11.8	<1	11
Se (ug/l)	<5	7	<5	6	<5	9.9	<5	11.7	<5	11.5	<5	10.8
Zn (ug/l)	10		10		<10		10		20		10	

1985 AMBIENT GROUNDWATER MONITORING PROGRAM

	AVERAGE VALUE	MAXIMUM VALUE	MINIMUM VALUE	VARIANCE	STANDARD DEVIATION
ALKALINITY (mg/l)	215	366	114	1414	38
CHLORIDES (mg/l)	66	285	5	2634	52
COLOR (PCU)	15	50	0	381	20
CONDUCTIVITY (umhos/cm)	809	11000	220	1930249	1397
FLUORIDES (mg/l)	0.15	0.44	0.06	0.00	0.07
NH3-N (mg/l)	0.52	4.60	0.01	0.66	0.82
NOx-N (mg/l)	1.01	28.00	0.00	10.19	3
O-PO4-P (mg/l)	0.030	0.162	0.002	0.001	0.03
PHENOLS(ug/l)	1	8	0	2	1
SULFATES (mg/l)	29.63	406.80	0.00	2105.79	46
TFR (mg/l)	361	1559	107	29167	172
TURBIDITY (NTU)	8.0	150.0	0.0	429.0	21
T-PO4-P (mg/l)	0.061	0.544	0.004	0.006	0.08
Ag (ug/l)	0.1	3.0	0.0	0.2	0.39
As (ug/l)	2.1	13.9	0.0	6.6	3
Ba(ug/l)	18.0	126.5	0.0	310.4	18
Cd (ug/l)	0.1	3.7	0.0	0.2	0.47
Cr (ug/l)	1.3	8.7	0.0	2.7	2
Cu (ug/l)	1.1	25.5	0.0	10.8	3
Fe (mg/l)	2.22	38.40	0.00	35.87	6
Hg (ug/l)	0.1	0.8	0.0	0.0	0.21
Mn (ug/l)	17.3	160.9	0.0	753.5	28
Ni (ug/l)	0	0	0	0	0.00
Pb (ug/l)	13.8	251.8	0.0	1450.8	38
Se (ug/l)	6.0	38.8	0.0	63.3	8
Zn (ug/l)	23.8	320.0	0.0	2463.4	50

THE NITROGEN CYCLE



PART II

1985 CANAL MONITORING PROGRAM

The Canal Monitoring Program was designed and implemented in 1980 by Dade County Department of Environmental Resources Management, to comprehensively monitor the quality of the County's major canal systems. The program for 1985 was reduced to bimonthly sampling. A total of 50 stations were sampled and analyzed for dissolved oxygen, conductivity, nitrate/nitrite and indicator bacteria. The site locations are listed on Table 3 and mapped in Figure 12. The locations represent background conditions (relatively unaffected by man-made pollution), mid-canal condition (shows the effect of land use) and discharge points (which characterize water quality entering Biscayne Bay and also demonstrates the extent of saltwater intrusion and the effectiveness of the salinity dams).

The Snake Creek Canal was also extensively studied this year for the Intensive Canal Study.

Results

Conductivity

Conductivity levels in the canals ranged from 300 to 47,000 umhos/cm. The majority of the canals showed fairly consistent levels between background and discharge locations (Figure 13). Exceptions to this occurred at sites affected by sea water intrusion (Oleta River and Coral Gables Waterway) or pollution point sources (Miami Canal). At Miami Canal sites F-7 and F-15, high conductivitiy levels were detected during the month of November (5500 umhos/cm and 3500 umhos/cm respectively). This was anomalous with the rest of the data at these sites which both averaged 600 umhos/cm for the remaining months. Site F-7 is upstream of the salinity dam and representative of the canal water that normally recharges the old Hialeah-Preston wellfields.

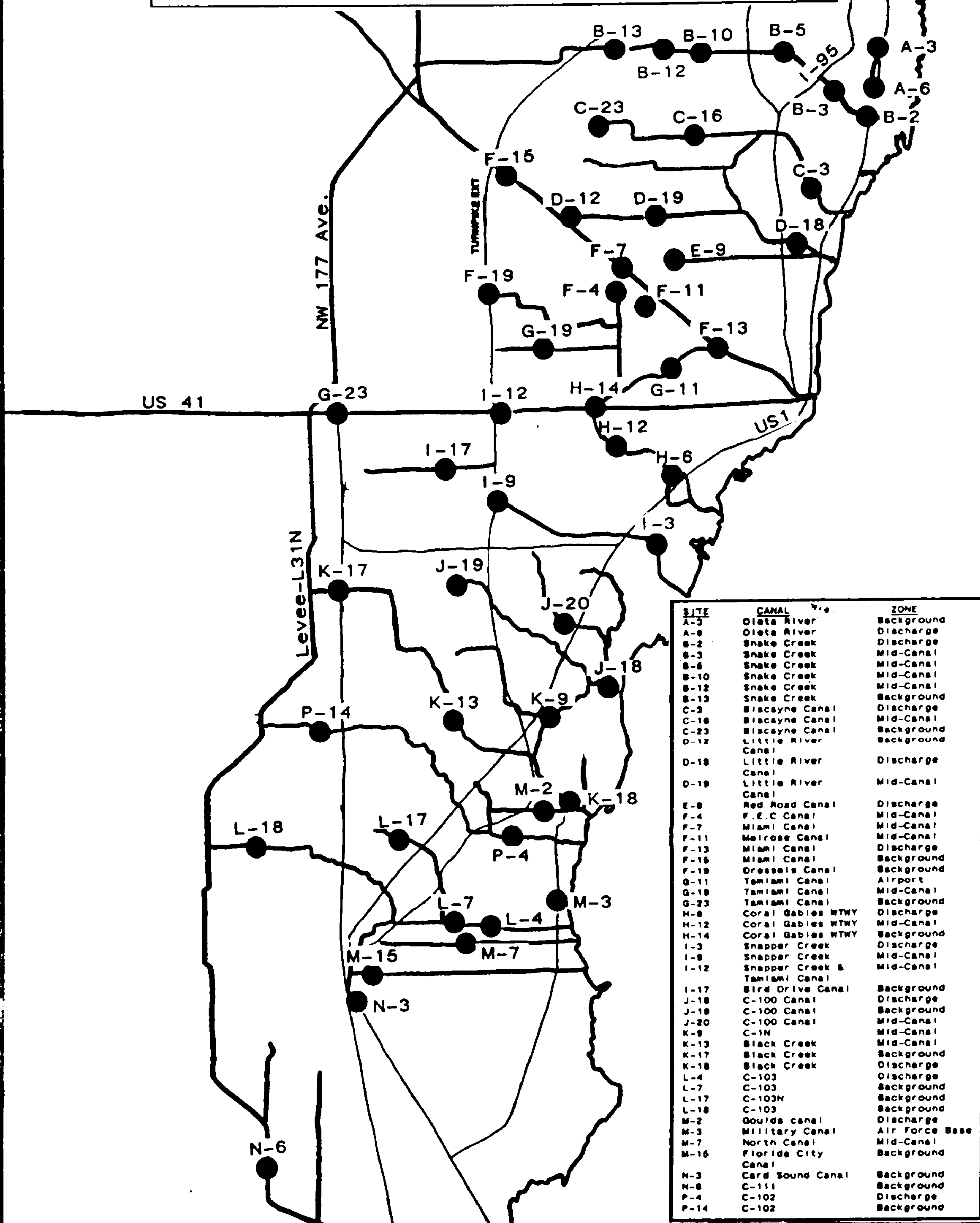
TABLE 3: LOCATION OF SITES IN THE 1985 CANAL MONITORING PROGRAM

Station	Canal River Name Major	Sub-System	Station Address
A-3	Oleta River		NE 26 Ave. & NE 203 St.
A-6	Oleta River		W.Dixie Hwy. & NE 176 St.
B-2	Snake Creek		US1 & NE 166 St.(Dam West)
B-3	Snake Creek		NE 15 Ave. & 170 St.
B-5	Snake Creek		NW 2 Ave. & 201 St.
B-10	Snake Creek		NW 37 Ave. & NW 204 St.
B-12	Snake Creek		NW 47 Ave. & 207 St.
B-13	Snake Creek		NW 67 Ave & 207 St.
C-3	Biscayne		NE 6 Ave. & NE 113 St.
C-16	Biscayne		NW 32 Ave. & NW 155 St.
C-23	Biscayne		NW 77 Ave. & NW 160 St.
D-12	Little River		NW 87 Ave. & NW 106 St.
D-18	Little River		NE 2nd Ave. & NE 85 St.
D-19	Little River		NW 107 St. & NW 52 Ave.
E-9	Little River	Red Road	NW 57 Ave & NW 70 St.
F-4	Miami River	FEC	NW 69 Ave & NW 69 St
F-7	Miami River		NW 65 Ave & US 27
F-11	Miami River	Melrose Canal	S.Esplanade & Morningside
F-13	Miami River		NW 39 Ave & NW 36 St. (Salinity dam west)
F-15	Miami River		NW 138 St & US-27
F-19	Miami River	Dressels	NW 117 Ave. & 58 St.
G-11	Tamiami Canal		NW 42 Ave. & NW 20 St.
G-19	Tamiami Canal	25 St.	NW 97 Ave & NW 25 St
G-23	Tamiami Canal		SW 177 Ave.& 8 St
H-6	Coral Gables Waterway	West Waterway	University of Miami at Student Union Bridge
H-12	Coral Gables Waterway		SW 67 Ave & SW 36 St.
H-14	Coral Gables Waterway		SW 77 Ave. & SW8 St.
I-3	Snapper Creek		SW 57 Ave & SW 88 St.
I-9	Snapper Creek	117 Ave.	SW 117 Ave & SW 55 St.
I-12	Snapper Creek	117 Ave.	SW 117 Ave & SW 8 St.
I-17	Snapper Creek	Bird Drive	SW 142 Ave & SW 42 St.

TABLE 3 (Cont): LOCATION OF SITES IN THE 1984 CANAL MONITORING PROGRAM

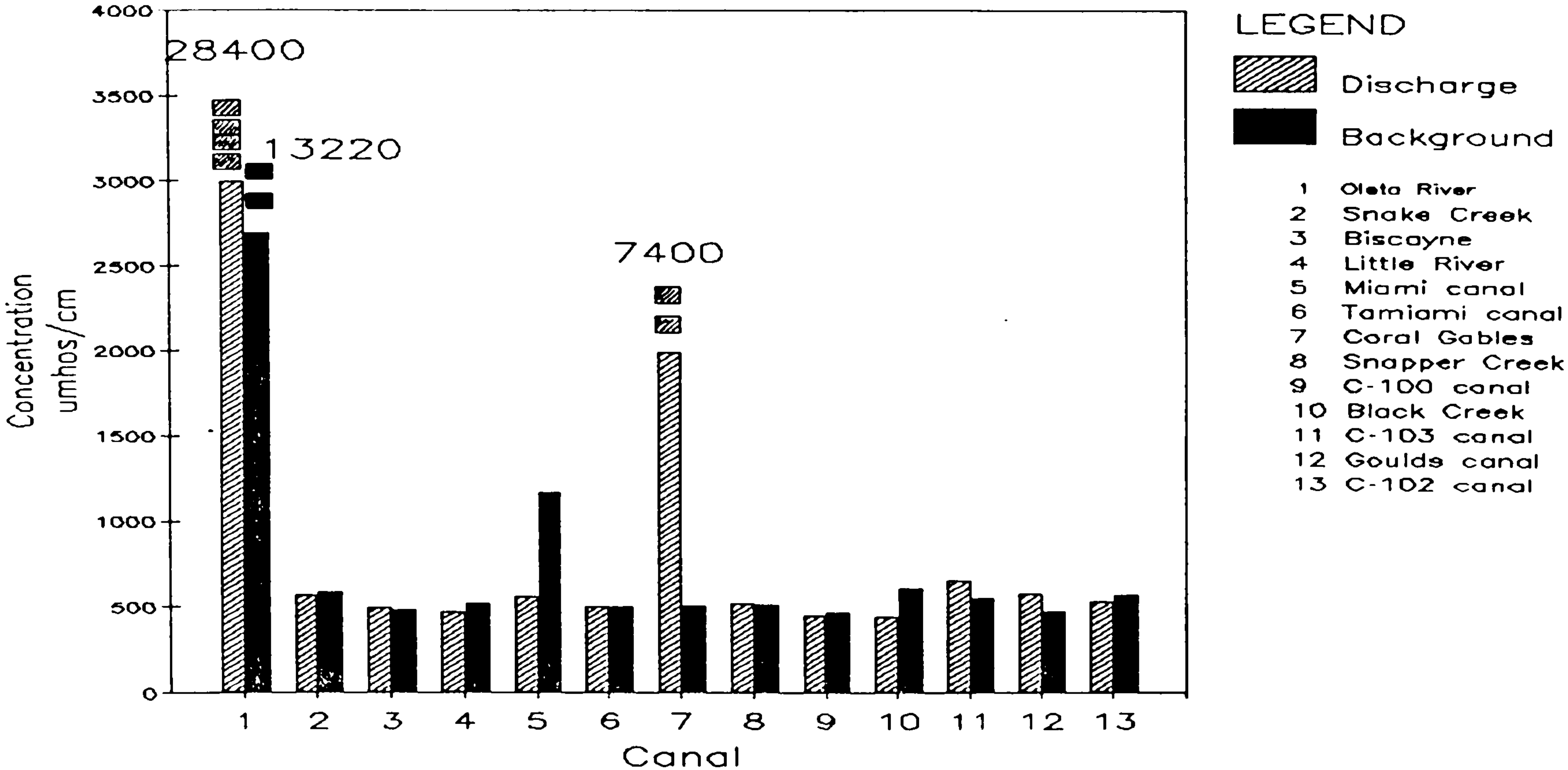
Station	Canal River Name Major	Sub-System	Station Address
J-18	C-100	Lindgren Road	SW 174 St & Old Cutler
J-19	C-100	"	SW 134 Ave & SW 110 St.
J-20	C-100	"	SW 92 Ave & SW 136 St.
K-9	Black Creek	C-1 North	SW 102 Ave & SW 192 St.
K-13	Black Creek		SW 130 Ave & SW 200 St.
K-17	Black Creek		SW 177 Ave & SW 112 St.
K-18	Black Creek		SW 97 Ave & 237 St.
L-4	C-103		SW 117 Ave & SW 320 St.
L-7	C-103		SW 137 Ave & SW 320 St.
L-17	C-103N		SW 157 Ave & 264 St.
L-18	C-103		SW 217 Ave & 266 St.
M-2	Goulds		SW 97 Ave & SW 248 St.
M-3	Military		SW 107 Ave & SW 300 St.
M-7	North		SW 137 Ave & SW 328 St.
M-15	Florida City		SW 167 Ave & 344 St.
N-3	Card Sound		Card Sound Rd. & US 1
N-6	C-111		SW 227 Ave & 396 St.
P-4	C-102		SW 112 Ave.
P-14	C-102		SW 187 Ave.

FIG. 12: LOCATION OF SITES IN THE 1985 GENERAL CANAL MONITORING PROGRAM



SITE	CANAL	ZONE
A-3	Oleta River	Background
A-6	Oleta River	Discharge
B-2	Snake Creek	Discharge
B-3	Snake Creek	Mid-Canal
B-5	Snake Creek	Mid-Canal
B-10	Snake Creek	Mid-Canal
B-12	Snake Creek	Mid-Canal
B-13	Snake Creek	Background
C-3	Biscayne Canal	Discharge
C-16	Biscayne Canal	Mid-Canal
C-23	Biscayne Canal	Background
D-12	Little River Canal	Background
D-18	Little River Canal	Discharge
D-19	Little River Canal	Mid-Canal
E-9	Red Road Canal	Discharge
F-4	F.E.C Canal	Mid-Canal
F-7	Miami Canal	Mid-Canal
F-11	Melrose Canal	Mid-Canal
F-13	Miami Canal	Discharge
F-15	Miami Canal	Background
F-19	Dressels Canal	Background
G-11	Tamiami Canal	Airport
G-19	Tamiami Canal	Mid-Canal
G-23	Tamiami Canal	Background
H-6	Coral Gables WTWY	Discharge
H-12	Coral Gables WTWY	Mid-Canal
H-14	Coral Gables WTWY	Background
I-3	Snapper Creek	Discharge
I-9	Snapper Creek	Mid-Canal
I-12	Snapper Creek & Tamiami Canal	Mid-Canal
I-17	Bird Drive Canal	Background
J-18	C-100 Canal	Discharge
J-19	C-100 Canal	Background
J-20	C-100 Canal	Mid-Canal
K-9	C-1N	Mid-Canal
K-13	Black Creek	Mid-Canal
K-17	Black Creek	Background
K-18	Black Creek	Discharge
L-4	C-103	Discharge
L-7	C-103	Background
L-17	C-103N	Background
L-18	C-103	Background
M-2	Goulds canal	Discharge
M-3	Military Canal	Air Force Base
M-7	North Canal	Mid-Canal
M-15	Florida City Canal	Background
N-3	Card Sound Canal	Background
N-6	C-111	Background
P-4	C-102	Discharge
P-14	C-102	Background

Figure 13: 1985 Canal Monitoring Program Comparison of Conductivity Data for the Discharge and Background Sites



Severe drought conditions in the Lake Okeechobee area during 1985 resulted in exceptionally low canal stages to be maintained in Dade County. Because groundwater in the developed area adjacent to the Miami Canal has been subjected to industrial contamination and historical salt water intrusion, high conductivities in the Miami Canal were a consequence of polluted groundwater in the area seeping into the canal. With the sites affected by salt water or point sources of pollution omitted, the average conductivity obtained for the canals was 531 umhos/cm, which may be considered background levels.

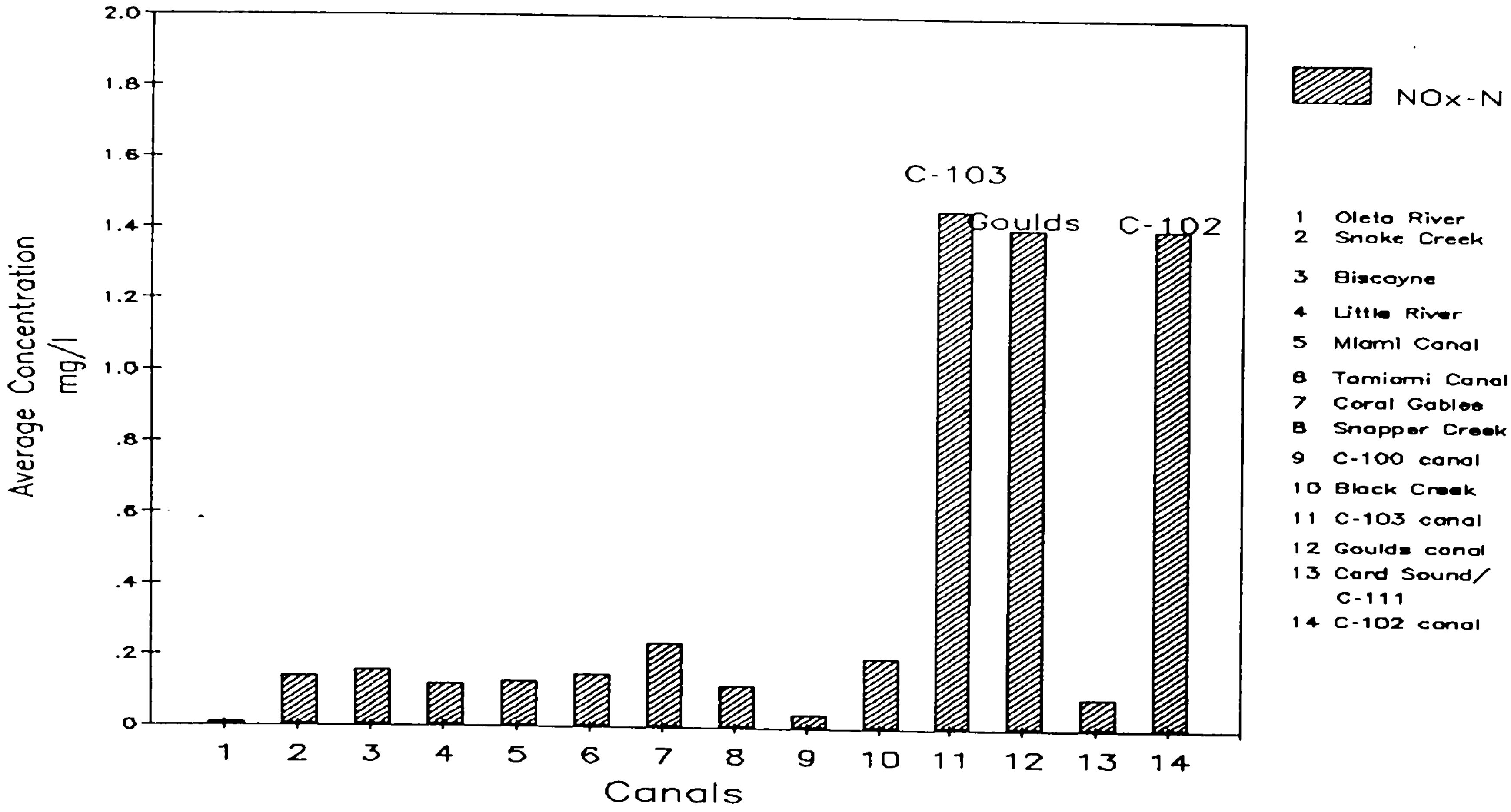
Dissolved Oxygen (DO)

Dissolved oxygen historically has been a major constituent of interest in water quality investigations. In general, DO is important in the protection of aesthetic qualities of water as well as for the support of fish and other aquatic life. Water should contain a sufficient level of dissolved oxygen (4 mg/l or greater) to maintain aerobic conditions. DO levels in the canals averaged 4 mg/l in the study and ranged from 1 to 12 mg/l. For the most part, the DO levels fluctuated from month to month and almost all the sites experienced low DO levels on at least one occasion during the year. Consistently low levels were found at two sites, N-3 (Card Sound Canal) and K-17 (Black Creek) which both averaged 2 mg/l. However, this does not necessarily imply a problem. In Dade County there is considerable interaction between surface water and groundwater. Groundwater typically has a low level of DO and when it seeps into a canal, it depresses the level of DO in the canal.

Nitrate/Nitrite (NOx-N)

The C-103, Goulds, and C-102 Canals have higher NOx-N values than the other canals (Figure 14). By omitting the data for these canals, which are probably influenced by agricultural practices, levels were fairly consistent for the southern and the northern canals. The discharge stations on C-102, C-103 and Goulds Canal were elevated above historical data by 2 to 3 times, probably a consequence of

Figure 14: Comparison of NOx-N Levels in the 1985 General Canal Monitoring Program



increased fertilizer application for agricultural and landscaping purposes. The overall average value was 0.42 mg/l. Values ranged from 0.01 mg/l to 4.2 mg/l; at no time was the 10 mg/l standard violated.

Indicator Bacteria

The coliforms are a group of gram-negative, rod-shaped bacteria which are found in the intestinal tract of warm blooded animals. Most species of total coliform can also exist as free-living saprophytes. Fecal coliform are differentiated from total coliforms by their ability to ferment lactose at the optimum temperature (35°C) as well as at elevated temperatures. Although coliforms are relatively harmless, their presence in surface water is an indicator of bacterial, viral, protozoan and fungal species which are either pathogens or possess the potential to infect man and other organisms. High densities of fecal coliform are indicative of relatively recent pollution since these organisms have much shorter survival rates than the rest of the coliform group.

Fecal streptococci are gram-positive bacteria that are present in the enteric tract of warm blooded animals or in their freshly excreted feces.

Levels of indicator bacteria are measured as a Most Probable Number (MPN) index. This is an index of the most likely number of bacteria that would give the results shown by the laboratory investigation.

Ratios of fecal coliform to fecal streptococci can provide valuable information about the source of fecal discharge. These ratios are summarized in Table 4. Ratios greater than 4.1 indicate pollution from domestic wastes composed of human excrement, while ratios of less than 0.7 are suggestive of non-human, animal pollution sources. Ratios between the two extremes are considered to be a result of pollution from mixed human and animal sources. The ratios may only be used when fecal streptococci levels are greater than 100 MPN.

TABLE 4: INDICATOR BACTERIA RATIOS FOR VARIOUS POLLUTION SOURCES

Pollution Source	FC/FS* Ratios
Human	4.4
Duck	0.6
Sheep/Chicken/Pig	0.4
Cow	0.2
Turkey	0.1

* Fecal Coliform/Fecal Streptococci

Bacteria data was available only for the latter part of the 1985 study for the period of August through December.

All the canals had exceedances of the 1000 MPN total coliform standard at least twice in the study. However, C-102 Canal was the only canal that did not exceed the 800 MPN fecal coliform standard. The canals with the highest percentages of exceedances of total coliform were: Biscayne Canal (87%), Coral Gables Waterway (67%), Little River Canal (65%), Oleta River (60%) and Miami Canal (60%).

Biscayne Canal had total coliform exceedances at all sites for most of the sampling events, but only once was the fecal coliform standard exceeded at the discharge site.

Coral Gables Waterway had exceedances of both total and fecal coliform at all sites. The most affected site along this canal was the discharge site which had high fecal coliforms for most sampling events.

Little River Canal had exceedances of total coliform at all sites and fecal coliform only at the discharge site.

Oleta River had exceedances of total coliform at both the discharge and background sites but the fecal coliform standard was exceeded only once at the background site.

Miami Canal had exceedances of total coliform at all sites and fecal coliform at background and discharge sites. The F.E.C. canal had the highest level of fecal coliform (35,000 MPN) indicating recent pollution.

Caculatable ratios indicate that pollution sources may have originated from human as well as animal wastes. There have been no permitted sewer outfalls to the canals since 1973. Consequently, one possible source of pollution from domestic wastes could result from unpermitted discharges to the stormwater outfalls. In general, the data reflects the need for continued, and in some cases increased, monitoring, especially along the heavily urbanized reaches of the canals.

Summary

The Canal Monitoring Program examines the water quality in Dade County's major canals in an effort to monitor long range effects of increasing urbanization in Dade County as well as the effectiveness of the salinity dams. Based on the limited parameters studied, no major water quality problem was observed in the canals during 1985. The low DO levels detected at some of the canals were attributable to the influx of groundwater which had lower DO levels than the surface water. Nitrate levels were elevated at the Goulds, C-102 and C-103 Canals which were affected by fertilizer application for agricultural and landscaping purposes. Indicator bacteria data indicates a need for continued monitoring especially along the more urbanized canals.

APPENDIX II

1985 GENERAL CANAL PROGRAM

SITES	CONDUCTIVITY (UHMOS/CM)					
	MARCH	MAY	JULY	SEPT	NOV	AVERAGE
A-3	20000	23000	15000	3200	4900	13220
A-6	47000	45000	19500	10000	20500	28400
B-2		500	600	600	600	575
B-3				600		600
B-5				600		600
B-10		520	600	600	500	555
B-13		520	600	650	600	593
C-3	500	600	450	500	450	500
C-16	550	500	500	550	450	510
C-23	300	550	500	600	500	490
D-12	300	600	550	650	550	530
D-18	300	500	500	600	500	480
D-19	550	550	500	600	590	558
E-9	600	600	500	600	450	550
F-4	500	650	500	520	500	534
F-7	550	600	600	650	5500	1580
F-11	350	600	500	490		485
F-13	550	600	500	650	550	570
F-14					12000	12000
F-15	450	650	600	700	3500	1180
F-19	700	550	500	550	450	550
G-11	550	500	500	550	450	510
G-19	550	600	500	650	500	560
G-23	550	500	500	550	450	510
H-6	12000	7500	7000	5000	5500	7400
H-12	550	650	500	550	500	550
H-14	550		500		500	517
I-3	600	500	450	600	490	528
I-9	550	500	500	550	500	520
I-12	550	550	500	550	450	520
I-17	500	500	500	600	500	520
J-18	500	400	400	500	500	460
J-19	500	400	450	520	500	474
J-20	300	300	400	350	350	340
K-9	400	400	400	400	490	418
K-13	500	550	500	600	520	534
K-17	600	700	600	650	550	620
K-18	400	400	400	500	550	450
L-4	400	850	700	800	550	660
L-7	400	500		550	700	538
L-17	450	500	500	600	550	520
L-18	490	750	500	550	500	558
M-2	400	320	600	1000	600	584
M-3	350	500	450	600	500	480
M-7	400	500	500	550	520	494
M-15	400	490	500	500	520	482
N-3	450	500	600	600	500	530
N-6	500	1300	600	550	500	690
P-4	450	520	550	600	600	544
P-14	470	750		600	500	580
YEARLY AVERAGE	1646					
MAXIMUM VALUE	47000					
MINIMUM VALUE	300					
VARIANCE	27185672					
STANDARD DEVIATION	5225.359					

1985 GENERAL CANAL PROGRAM

SITES	DISSOLVED OXYGEN (MG/L) MARCH	MAY	JULY	SEPT.	NOV.	AVERAGE
A-3	3	4	2	4	9	4
A-6	6	3	4	3	8	5
B-2		6	4	4	5	5
B-3				4		4
B-5				3		3
B-10		6	2	3	5	4
B-13		6	3	2	4	4
C-3	6	3	5	4	4	4
C-16	7	6	5	4	6	6
C-23	6	7	4	3	8	6
D-12	3	4	4	2	5	4
D-18	6	4	2	2	5	4
D-19	4	3	5	2	5	4
E-9	6	6	6	3	3	5
F-4	6	6	5	2	3	4
F-7	7	6	6	3	2	5
F-11	8	6	6	4		6
F-13	6	9	8	2	3	6
F-14						
F-15	4	1	2	1	2	2
F-19	6	4	5	4	2	4
G-11	4	6	6	4	5	5
G-19	4	5	2	5	2	4
G-23	4	1	9	3	3	4
H-6	6	4	8	3	6	5
H-12	4	5	2		2	3
H-14	4		3		4	4
I-3	5	6	5	3	3	4
I-9	4	2	1	3	1	2
I-12	4	2	4	4	3	3
I-17	2	2	2	6	2	3
J-18	8	8	6	4	6	6
J-19	4		5	3	3	4
J-20	10	10	6	4	6	7
K-9	6	8	7	2	5	6
K-13	6	8	7	6	2	6
K-17	3	1	1	2	2	2
K-18	8	8	6	3	3	6
L-4	10	12	2	5	3	6
L-7	6	8	5	3	5	5
L-17	7	6	4	4	3	5
L-18	7	5	2	2	1	3
M-2	6	9	6	6	6	7
M-3	7	5	2	8	3	5
M-7	7	4	4	4	4	5
M-15	5	3	3	2	2	3
N-3	3	2	1	1	2	2
N-6	6	7	2	1	1	3
P-4	8	9	2	2	6	5
P-14	10	5		5	1	5
YEARLY AVERAGE	4					
MAXIMUM VALUE	12					
MINIMUM VALUE	1					
VARIANCE	5					
STANDARD DEVIATION	2					

1985 GENERAL CANAL PROGRAM

SITES	TOTAL NOx-N (MG/L) MARCH	MAY	JULY	SEPT	NOV	AVERAGE
A-3	0.06	0.01	0.10	0.10	0.11	0.08
A-6	0.04	0.02	0.11	0.18	0.21	0.11
B-2		0.16	0.12	0.38	0.36	0.26
B-3				0.04		0.04
B-5				0.12		0.12
B-10		0.16	0.17	0.10	0.20	0.16
B-13		0.12	0.14	0.06	0.12	0.11
C-3	0.21	0.17	0.03	0.16	0.25	0.16
C-16	0.21	0.04	0.08	0.16	0.25	0.15
C-23	0.05	0.10	0.14	0.29	0.22	0.16
D-12	0.04	0.13	0.09	0.08	0.02	0.07
D-18	0.18	0.05	0.18	0.19	0.17	0.15
D-19	0.08	0.21	0.07	0.24	0.03	0.13
E-9	0.16	0.09	0.04	0.07	0.20	0.11
F-4	0.10	0.09	0.06	0.42	0.40	0.21
F-7	0.12	0.08	0.05	0.18	0.03	0.09
F-11	0.28	0.03	0.05	0.02		0.10
F-13	0.14	0.11	0.06	0.10	0.16	0.11
F-14					0.17	0.17
F-15	0.24	0.01	0.03	0.10	0.02	0.08
F-19	0.15	0.32	0.12	0.06	0.09	0.15
G-11	0.32	0.03	0.05	0.26	0.22	0.18
G-19	0.15	0.34	0.17	0.03	0.02	0.14
G-23	0.22	0.02	0.20	0.04	0.20	0.14
H-6	0.33	0.40	0.47	0.37	0.38	0.39
H-12	0.21	0.34	0.03	0.09	0.16	0.17
H-14	0.21		0.07		0.17	0.15
I-3	0.34	0.21	0.26	0.04	0.22	0.21
I-9	0.20	0.26	0.21	0.07	0.02	0.15
I-12	0.20	0.03	0.13	0.08	0.04	0.10
I-17	0.03	<0.01	0.02	0.02	0.01	0.02
J-18	0.02	<0.01	0.01	0.05	0.09	0.03
J-19	0.05	0.02	0.14	0.02	0.05	0.06
J-20	0.03	<0.01	0.03	0.06	0.01	0.03
K-9	0.13	0.03	0.20	0.39	0.28	0.21
K-13	0.14	0.34	0.16	0.43	0.40	0.29
K-17	0.15	0.29	0.04	0.02	0.40	0.18
K-18	0.03	<0.01	0.07	0.09	0.36	0.11
L-4	0.95	0.78	0.65	1.40	1.60	1.08
L-7	1.20	1.00	1.60	3.40	0.52	1.54
L-17	4.00	3.60	3.30	4.20	0.03	3.03
L-18	0.18	0.70	0.02	0.06	0.01	0.19
M-2	1.20	0.01	4.00	2.20	3.50	2.18
M-3	0.02	<0.01	0.45	0.70	0.45	0.32
M-7	1.60	1.60	1.80	1.60	2.10	1.74
M-15	1.50	1.80	1.10	0.92	1.60	1.38
N-3	0.07	0.01	0.04	0.11	<0.01	0.05
N-6	0.07	0.47	0.05	0.04	<0.01	0.13
P-4	2.10	2.40	2.30	2.70	2.80	2.46
P-14	0.15	1.00		0.23	<0.01	0.35
YEARLY AVERAGE	0.42					
MAXIMUM VALUE	4.20					
MINIMUM VALUE	0.00					
VARIANCE	0.61					
STANDARD DEVIATION	0.78					

1985 GENERAL CANAL PROGRAM

STATION #	DATE	TOTAL COLIFORM	FECAL COLIFORM	FECAL STREPTOCOCCI
A-3	Aug. 6, 1985	11000	2400	78
	Sept. 9, 1985	3300	490	1300
	Oct. 1, 1985	490	330	78
	Nov. 4, 1985	3300	310	220
	Dec. 2, 1985	2200	330	20
A-6	Aug. 6, 1985	790	330	
	Sep. 9, 1985	1100	490	490
	Oct. 1, 1985	3300	700	
	Nov. 4, 1985	170	45	
	Dec. 2, 1985	490	170	
B-2	Aug. 7, 1985	3300	1700	130
	Sep. 4, 1985	4900	790	78
	Oct. 2,1985	7900	220	220
	Nov. 26, 1985	3300	3300	<18
	Dec. 3,1985	790	130	18
B-3	Aug. 7, 1985	490	330	<18
	Sep. 4, 1985	1100	490	78
	Oct. 2, 1985	130	20	45
	Nov. 26, 1985	3300	3300	230
	Dec. 3, 1985	270	68	45
B-5	Aug. 7, 1985	2400	790	130
	Sep. 4, 1985	700	210	14
	Oct. 2, 1985	330	110	<18
	Nov. 26, 1985	260	220	490
	Dec. 3, 1985	270	68	45
B-10	Aug. 7, 1985	1100	490	230
	Sep. 4, 1985	790	170	<18
	Oct. 2, 1985	78	45	20
	Nov. 26, 1985	20	20	230
	Dec. 3, 1985	330	330	78
B-12	Aug. 7, 1985	3100	3100	790
	Sep. 4, 1985	790	78	20
	Oct. 2, 1985	1300	490	<18
	Nov. 26, 1985	20	<18	45
	Dec. 3, 1985	1300	490	45
B-13	Aug. 7, 1985	270	130	45
	Sep. 4, 1985	490	490	<18
	Oct. 2, 1985	490	110	<18
	Nov. 26, 1985	20	20	230
	Dec. 3, 1985	220	110	40
C-3	Aug. 6, 1985	11000	790	140
	Sep. 9, 1985	4600	700	68
	Oct. 1, 1985	2200	950	45
	Nov. 4, 1985	3300	490	78
	Dec. 2, 1985	490	230	140
C-16	Aug. 6, 1985	1100	68	68
	Sep. 9, 1985	1800	78	
	Oct. 1, 1985	1300	93	<18
	Nov. 4, 1985	4900	45	20
	Dec. 2, 1985	4300	61	45

1985 GENERAL CANAL PROGRAM

STATION #	DATE	TOTAL COLIFORM	FECAL COLIFORM	FECAL STREPTOCOCCI
C-23	Aug. 6, 1985	950	140	45
	Sep. 9, 1985	17000	130	45
	Oct. 1, 1985	4600	700	45
	Nov. 4, 1985	13000	110	<18
	Dec. 2, 1985	4900	20	<18
D-12	Aug. 6, 1985	490	330	
	Sep. 9, 1985	1300	4	<18
	Oct. 1, 1985	330	170	
	Nov. 4, 1985	790	170	
	Dec. 2, 1985	4900	790	
D-18	Aug. 6, 1985	1300	1300	45
	Sep. 9, 1985	7900	4900	68
	Oct. 1, 1985	7000	1300	23
	Nov. 4, 1985	4900	700	170
	Dec. 2, 1985	2400	330	130
D-19	Aug. 6, 1985	790	490	45
	Sep. 9, 1985	1300	790	
	Oct. 1, 1985	1300	790	78
	Nov. 4, 1985	230	45	78
	Dec. 2, 1985	1300	170	140
E-9	Aug. 6, 1985	330	330	<18
	Sep. 10, 1985	1700	170	110
	Oct. 7, 1985	11000	4600	110
	Nov. 6, 1985	2800	1700	330
	Dec. 4, 1985	490	78	140
F-4	Aug. 6, 1985	790		
	Sep. 10, 1985	3300	2300	
	Oct. 7, 1985	92000	35000	
	Nov. 6,1985	790	78	
	Dec. 4, 1985	330	130	
F-7	Aug. 6, 1985	1700	700	
	Sep. 10, 1985	1300	170	
	Oct. 7, 1985	2400	790	
	Nov. 6, 1985	490	170	
	Dec. 4, 1985	490	330	
F-11	Aug. 6, 1985	4900	790	
	Sep. 10, 1985	1700	490	
	Oct. 7, 1985	1700	330	
	Nov. 6, 1985	1100	490	
	Dec. 4, 1985	1300	170	
F-13	Aug. 6, 1985	3300	490	33
	Sep. 10, 1985	1700	460	230
	Oct. 7, 1985	7900	3500	68
	Nov. 6, 1985	700	110	110
	Dec. 4, 1985	5400	5400	>2400
F-15	Aug. 6, 1985	1300	110	78
	Sep. 10, 1985	700	110	490
	Oct. 7, 1985	11000	4600	27
	Nov. 6, 1985	790	45	490
	Dec. 4, 1985	330	230	130
F-19	Aug. 12, 1985	490	20	
	Sep. 11,1985	330	170	
	Oct. 8, 1985	230	20	
	Nov. 5, 1985	1700	330	
	Dec. 9, 1985	270	78	

1985 GENERAL CANAL PROGRAM

STATION #	DATE	TOTAL COLIFORM	FECAL COLIFORM	FECAL STREPTOCOCCI
G-11	Aug. 12, 1985			78
	Sep. 11, 1985	220	68	22
	Oct.8, 1985	1100	490	490
	Nov. 5, 1985	130	78	20
	Dec. 9, 1985	330	20	<18
G-19	Aug. 12, 1985	490	78	
	Sep. 11, 1985	78	<18	
	Oct. 8, 1985	170	170	
	Nov. 5, 1985	220	45	
	Dec. 9, 1985	45	<18	
G-23	Aug. 12, 1985	1300	40	170
	Sep. 11, 1985	2200	220	170
	Oct. 8, 1985	20	<18	230
	Nov. 5, 1985	120	20	20
	Dec. 9, 1985	110	<18	20
H-6	Aug. 12, 1985	2200	640	68
	Sep. 16, 1985	11000	4900	>2400
	Oct. 8, 1985	7900	2200	330
	Nov. 5, 1985	1700	1100	20
	Dec. 4, 1985	700	490	170
H-12	Aug. 12, 1985	7900	4900	130
	Sep. 16, 1985	1000	170	130
	Oct. 8, 1985	17000	790	230
	Nov. 5, 1985	1300	140	45
	Dec. 4, 1985	330	330	20
H-14	Aug. 12, 1985	490	490	<18
	Sep. 11, 1985	270	20	45
	Oct. 8, 1985	17000	1700	490
	Nov. 5, 1985	1300	790	45
	Dec. 9, 1985	1300	490	270
I-3	Aug. 12, 1985	1700	790	45
	Sep. 16, 1985	790	130	20
	Oct. 8, 1985	1100	490	130
	Nov. 5, 1985	700	110	45
	Dec. 4, 1985	490	68	45
I-9	Aug. 12, 1985	1700	790	
	Sep. 16, 1985	1300	790	
	Oct. 8, 1985	790	93	
	Nov. 5, 1985	330	330	
	Dec. 4, 1985	140	45	
I-12	Aug. 12, 1985	7900	4900	790
	Sep. 16, 1985	490	140	93
	Oct. 8, 1985	130	130	78
	Nov. 5, 1985	170	110	93
	Dec. 4, 1985	330	330	78
I-17	Aug.12, 1985	790	330	
	Sep. 16, 1985	1700	790	
	Oct. 8, 1985	790	45	
	Nov. 5, 1985	130	<18	
	Dec 4, 1985	1100	490	

1985 GENERAL CANAL PROGRAM

STATION #	DATE	TOTAL COLIFORM	FECAL COLIFORM	FECAL STREPTOCOCCI
J-18	Aug. 13, 1985	270	170	
	Sep. 13, 1985	490	330	
	Oct. 9, 1985	130	20	
	Nov. 25, 1985	490	170	
	Dec. 9, 1985	330	330	
J-19	Aug. 13, 1985	1700	170	
	Sep. 17, 1985	790	120	
	Oct. 9, 1985	790	110	
	Nov. 25, 1985	330	330	
	Dec. 9, 1985	790	40	
J-20	Aug. 13, 1985	490	230	
	Sep. 17, 1985	3300	790	
	Oct. 9, 1985	2400	490	
	Nov. 25, 1985	140	61	
	Dec. 9, 1985	270	40	
K-9	Aug. 13, 1985	490	330	20
	Sep. 17, 1985	3300	1300	45
	Oct. 19, 1985	2400	1300	45
	Nov. 25, 1985	130	790	20
	Dec. 9, 1985	7900	950	<18
K-13	Aug. 13, 1985	490	20	
	Sep. 17, 1985	170	170	
	Oct. 9, 1985	130	45	
	Nov. 25, 1985	<18	<18	
	Dec. 9, 1985	170	18	
K-17	Aug. 13, 1985	330	78	
	Sep. 17, 1985	1300	220	
	Oct. 9, 1985	110	110	
	Nov. 25, 1985	45	<18	
	Dec. 9, 1985	20	<18	
K-18	Aug. 13, 1985	330	<18	<18
	Sep. 17, 1985	460	78	45
	Oct. 9, 1985	110	45	<18
	Nov. 25, 1985	490	45	45
	Dec. 9, 1985	140	20	20
L-4	Jul. 15, 1985	4900	2400	
	Aug. 19, 1985	330	<18	
	Sep. 23, 1985	1300	68	
	Oct. 15, 1985	490	110	
	Nov. 26, 1985	490	330	
	Dec. 10, 1985	1700	20	490
L-7	Jul. 15, 1985	1100	130	
	Aug. 19, 1985	170	40	
	Sep. 23, 1985	130	78	
	Oct. 15, 1985	230	20	
	Nov. 26, 1985	45	45	
	Dec. 10, 1985	3300		170
L-17	Jul. 15, 1985	1300	40	
	Aug. 19, 1985	490	<18	
	Sep. 23, 1985	2400	45	
	Oct. 15, 1985	20	<18	
	Nov. 26, 1985	68	20	
	Dec. 10, 1985	220		45

1985 GENERAL CANAL PROGRAM

STATION #	DATE	TOTAL COLIFORM	FECAL COLIFORM	FECAL STREPTOCOCCI
L-18	Jul. 15, 1985	790	45	
	Aug. 19, 1985	790	230	
	Sep. 23, 1985	2400	61	
	Oct. 15, 1985	20	20	
	Nov. 26, 1985	40	40	
	Dec. 10, 1985	<18	<18	<18
M-2	Jul. 16, 1985	790	130	130
	Aug. 19, 1985	2200	1300	45
	Sep. 23, 1985	11000	170	93
	Oct. 15, 1985	260	45	68
	Nov. 26, 1985	790	230	
	Dec. 10, 1985	4900	330	
M-3	Jul. 16, 1985	330	45	<18
	Aug. 19, 1985	330	20	<18
	Sep. 23, 1985	3300	170	1300
	Oct. 15, 1985	78	20	20
	Nov. 26, 1985	490	490	
	Dec. 10, 1985	700	210	
M-7	Jul. 16, 1985	790	<18	170
	Aug. 19, 1985	1300	220	40
	Sep. 23, 1985	4900	220	20
	Oct. 15, 1985	490	78	40
	Nov. 26, 1985	790	220	
	Dec. 10, 1985	3500	140	
M-15	Jul. 16, 1985	230	20	<18
	Aug. 19, 1985	230	45	20
	Sep. 23, 1985	3300	20	<18
	Oct. 15, 1985	700	140	110
	Nov. 26, 1985	20	<18	
	Dec. 10, 1985	330	<18	
N-3	Jul. 16, 1985	790	78	230
	Aug. 19, 1985	7900	7900	130
	Sep. 23, 1985	2400	78	
	Oct. 15, 1985	140	<18	
	Nov. 26, 1985	<18	<18	
	Dec. 10, 1985	78	<18	
N-6	Jul. 16, 1985	1300	130	45
	Aug. 19, 1985	110	<18	20
	Sep. 23, 1985	790	20	
	Oct. 15, 1985	<18	<18	
	Nov. 26, 1985	<18	<18	
	Dec. 10, 1985	170	45	
P-4	Jul. 15, 1985	490	<18	
	Aug. 19, 1985	490	78	
	Sep. 23, 1985	330	<18	
	Oct. 15, 1985	170	20	
	Nov. 26, 1985	230	45	
	Dec. 10, 1985	1100		<18
P-14	Jul. 15, 1985	700	170	
	Aug. 19, 1985	130	<18	
	Sep. 23, 1985	2400	130	
	Oct. 15, 1985	220	45	
	Nov. 26, 1985	78	20	
	Dec. 10, 1985	68		<18

C-23

PART III

1985 ANNUAL POLLUTANT SURVEY

The Annual Pollutant Survey (or the Background Discharge Study) was designed to assess the impact of urbanization and agriculture on canal water quality prior to potential discharge into Biscayne Bay. The objective was to contrast physical and chemical parameters measured at upstream (i.e., background) and discharge stations from Dade County's major canals. There were two sampling episodes: six canals were sampled in the program during the dry season (Oleta, Little River, Tamiami, C-103, C-100 and Coral Gables Waterway Canals); and seven canals were sampled during the wet season (Black Creek, Biscayne, C-111, C-102, Snapper Creek, North and Miami Canal). The sites are shown in Figure 15.

Water samples were analyzed for the following parameters:

Physical Parameters

Conductivity
Color
Turbidity
Total Filtrable Residue

Chemical Parameters

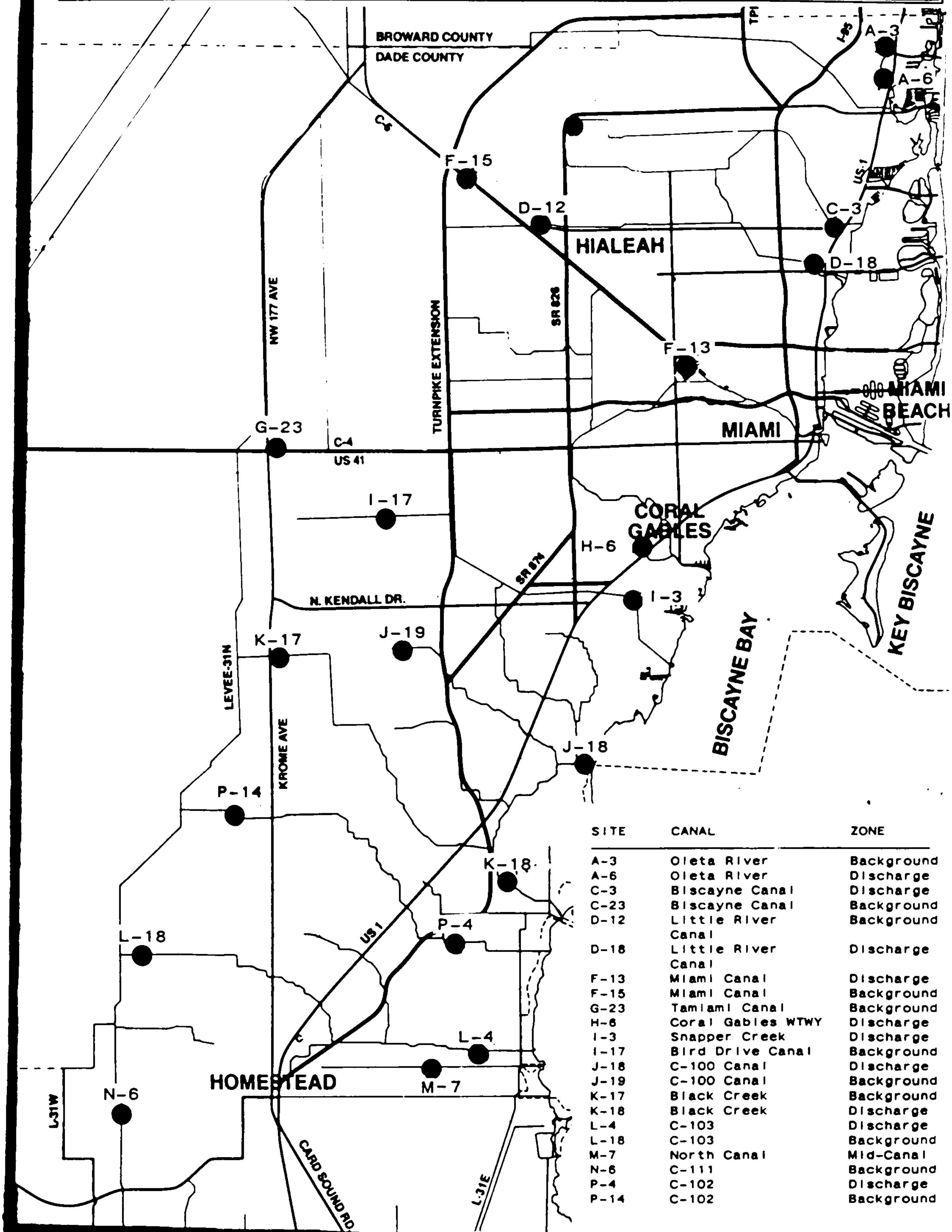
Inorganics

Alkalinity
Fluorides
Ortho Phosphate
Total Phosphate
Ammonia
Total Kjeldahl Nitrogen
Total Organic Nitrogen
Total Nitrates/Nitrites
Chloride
Metals

Organics

Phenols
Biochemical Oxygen Demand
Chemical Oxygen Demand
Chlorinated Insecticides and Herbicides

Figure 15: Location of Canal Sites in the 1985 Annual Pollutant Survey



SITE	CANAL	ZONE
A-3	Oleta River	Background
A-6	Oleta River	Discharge
C-3	Biscayne Canal	Discharge
C-23	Biscayne Canal	Background
D-12	Little River Canal	Background
D-18	Little River Canal	Discharge
F-13	Miami Canal	Discharge
F-15	Miami Canal	Background
G-23	Tamiami Canal	Background
H-6	Coral Gables WTWY	Discharge
I-3	Snapper Creek	Discharge
I-17	Bird Drive Canal	Background
J-18	C-100 Canal	Discharge
J-19	C-100 Canal	Background
K-17	Black Creek	Background
K-18	Black Creek	Discharge
L-4	C-103	Discharge
L-18	C-103	Background
M-7	North Canal	Mid-Canal
N-6	C-111	Background
P-4	C-102	Discharge
P-14	C-102	Background

RESULTS

Physical Parameters

Conductivity

Conductivity values ranged from 300 to 40,000 umhos/cm with the highest levels detected at the Oleta River and Coral Gables Canals. Omitting data from these two tributaries, the average conductivity for the study was 562 umhos/ cm. The Oleta River's high conductivity values (A-3: 15,500 umhos/cm and A-6: 40,000 umhos/cm) are a result of salt water intrusion in the general area as determined by a U.S.G.S. chloride monitoring program. Salt water intrusion is also responsible for high conductivity detected at H-6 (Gables Waterway - 8,500 umhos/cm). Conductivity values were consistent with historical data; with the exception of the salt-intruded canals, levels were higher at the background sites than the discharge sites, indicating no major effect of land use with respect to conductivity (Figure 16).

Color

Color was analyzed during the wet season; values ranged from below 0 platinum-cobalt units (PCU) to 50 PCU (Figure 17) with an average of 33 PCU. Because of an incomplete data base, no consistent trend could be observed for the discharge or mid-canal sites, but all the background sites sampled gave high color values. Miami and Biscayne Canals had high color at both the discharge and the background sites. Color levels were lower at the discharge sites than at the background sites on Black Creek, C-102 and Snapper Creek Canals. Sites in the northern and southwestern part of the county have higher color levels than those in the southeast. The distribution of color values in the canal network roughly reflects the distribution of color in the groundwater, probably the result of intermixing between canal water and groundwater. Groundwater in northern Dade and western water conservation areas and other wetlands is highly colored as a result of rainfall which leaches organics from soils and into the groundwater. Soils in northern Dade County are

Figure 16: 1985 Annual Pollutant Survey Conductivity Data

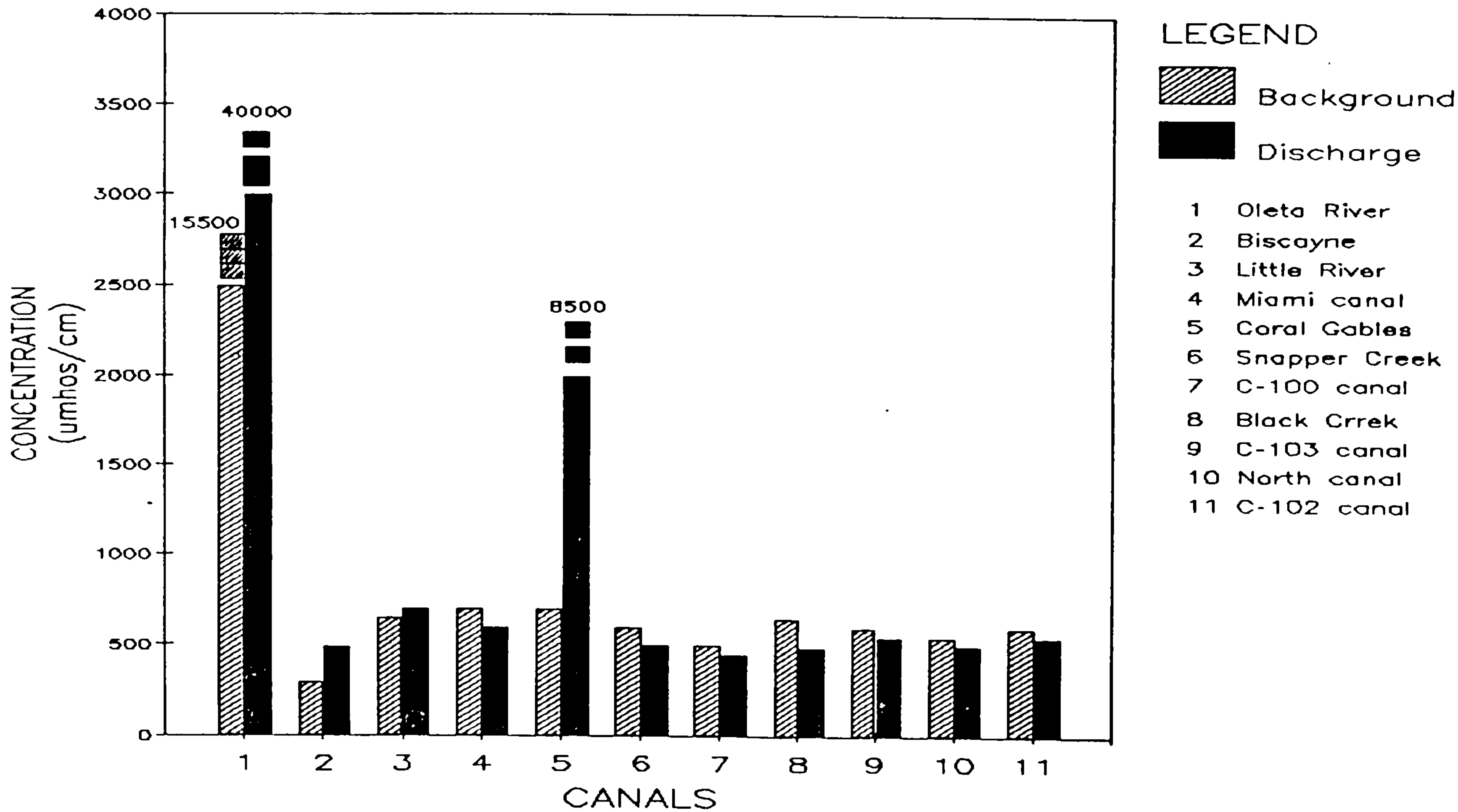
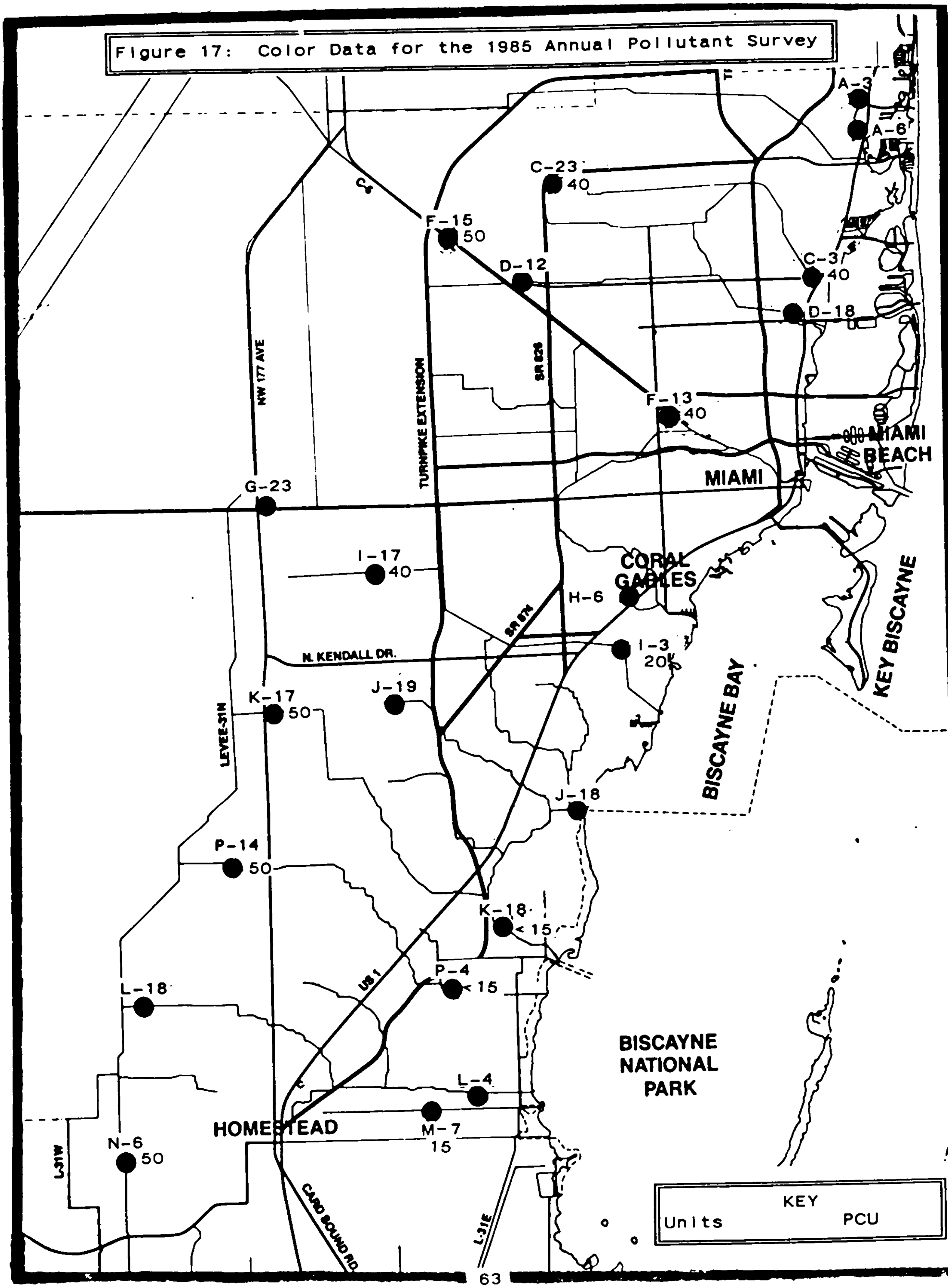


Figure 17: Color Data for the 1985 Annual Pollutant Survey



more organic than soils in southern Dade and therefore have higher levels of color. Color levels in southwestern canals are probably due to the L-31N canal conveying more highly colored water there from northwestern Dade County and the conservation areas.

Turbidity

The median turbidity obtained in this study was 3 nephelometric turbidity units (NTU) and ranged from 0.5 to 7.0 NTU. The highest levels were at N-6 (C-111) and H-6 (Coral Gables Waterway) with 7.0 NTU. Sources of turbidity include stormwater runoff from urban areas and runoff from peat and muck soils prevalent in the western water conservation areas and other wetlands. Most of the southern canals had levels of turbidity that were higher at background than discharge sites while the reverse was true for the northern canals (Figure 18). This is probably a result of heavier urbanization in the northern part of the county.

Total Filtrable Residue

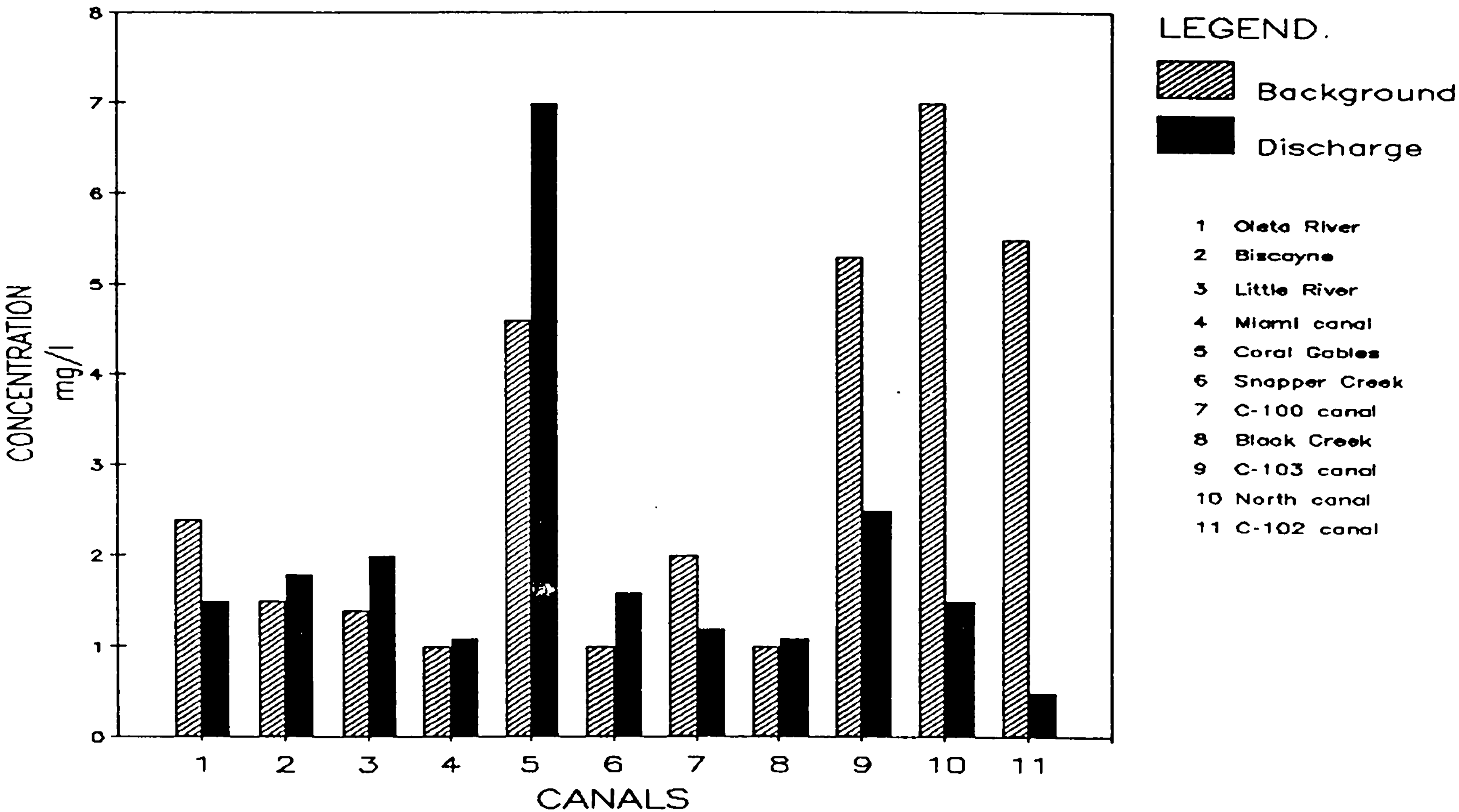
The median value for total filtrable residue (TFR) was 394 mg/l when the data for the salt water intruded areas (Oleta River and Coral Gables Waterway) were excluded. The excluded canals had averages of 19,844 mg/l (Oleta River) and 5,772 mg/l (Coral Gables Waterway) and there is no applicable standard for dissolved solids in salt water. Oleta River had a TFR value at the discharge site almost threefold greater than at the background location. The other canals did not show consistent trends between the background and discharge sites.

Chemical Parameters

Alkalinity

In general the alkalinity levels remained high throughout the canal sampling network and averaged 221 mg/l. All of the canals (with the

Figure 18: 1985 Annual Pollutant Survey Turbidity Data



exceptions of C-103 and Coral Gables Canals), exhibited a decrease in alkalinity from background to discharge stations (Figure 19).

Fluorides

There was no consistent difference in fluoride levels between discharge and background stations. The median value was 0.11 mg/l (range, 0.08 to 0.64 mg/l); levels at no time approached the 1.4 mg/l standard. The highest fluoride levels were found in areas of saltwater intrusion (Oleta River and Coral Gables Waterway).

Phosphates

Levels of orthophosphates and total phosphates showed no pronounced trends between background and discharge stations. Elevated levels of ortho and total phosphates were detected at the discharge station of C-103 Canal (1.59 mg/l and 1.64 mg/l, respectively) and at the background station of C-100 Canal (1.78 mg/l and 1.86 mg/l, respectively). Both sites are located in agricultural areas, so the increased levels may be attributable to fertilizer application. Excluding these sites, the average orthophosphate level was 0.028 mg/l and the average total phosphate level was 0.063 mg/l.

Ammonia (NH_3-N)

Ammonia levels in surface waters are generally higher than in groundwater because the NH_3-N adsorbs to soil particles and is not readily leached.

The median ammonia value was 0.40 mg/l. Four sites exceeded the standard of 0.5 mg/l. These were (Figure 20): Oleta River (0.8 mg/l); Little River Canal (3.10 mg/l); Snapper Creek/Bird Drive Canal (0.65 mg/l) and C-102 Canal (0.57 mg/l). Levels are historically higher during the dry season along Little River and Oleta Canals where ammonia originates from the mucky soil in the north and is diluted during the rainy season. Factors along the Bird Drive and C-102 Canals were more

Figure 19: 1985 Annual Pollutant Survey Alkalinity Data

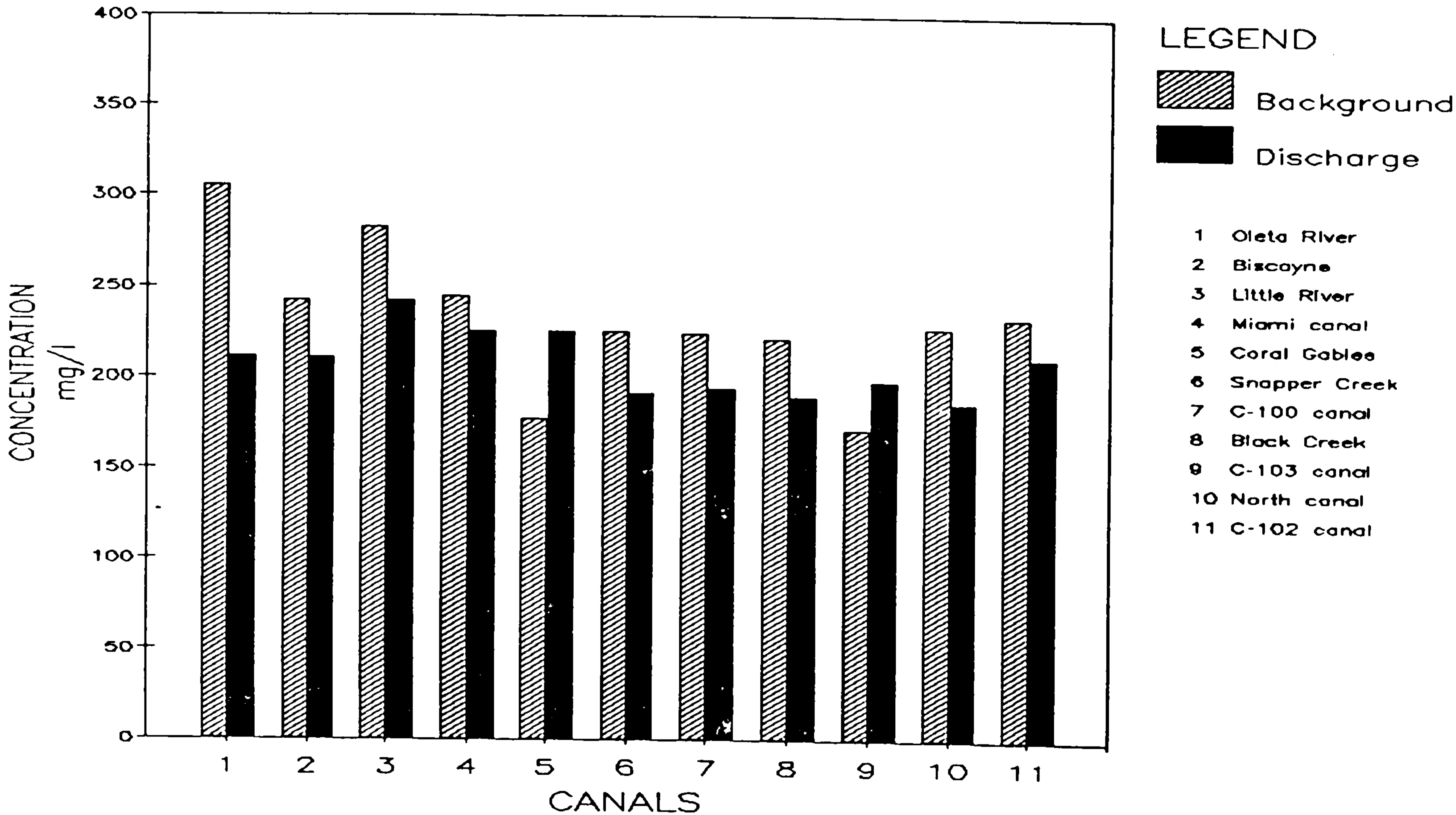
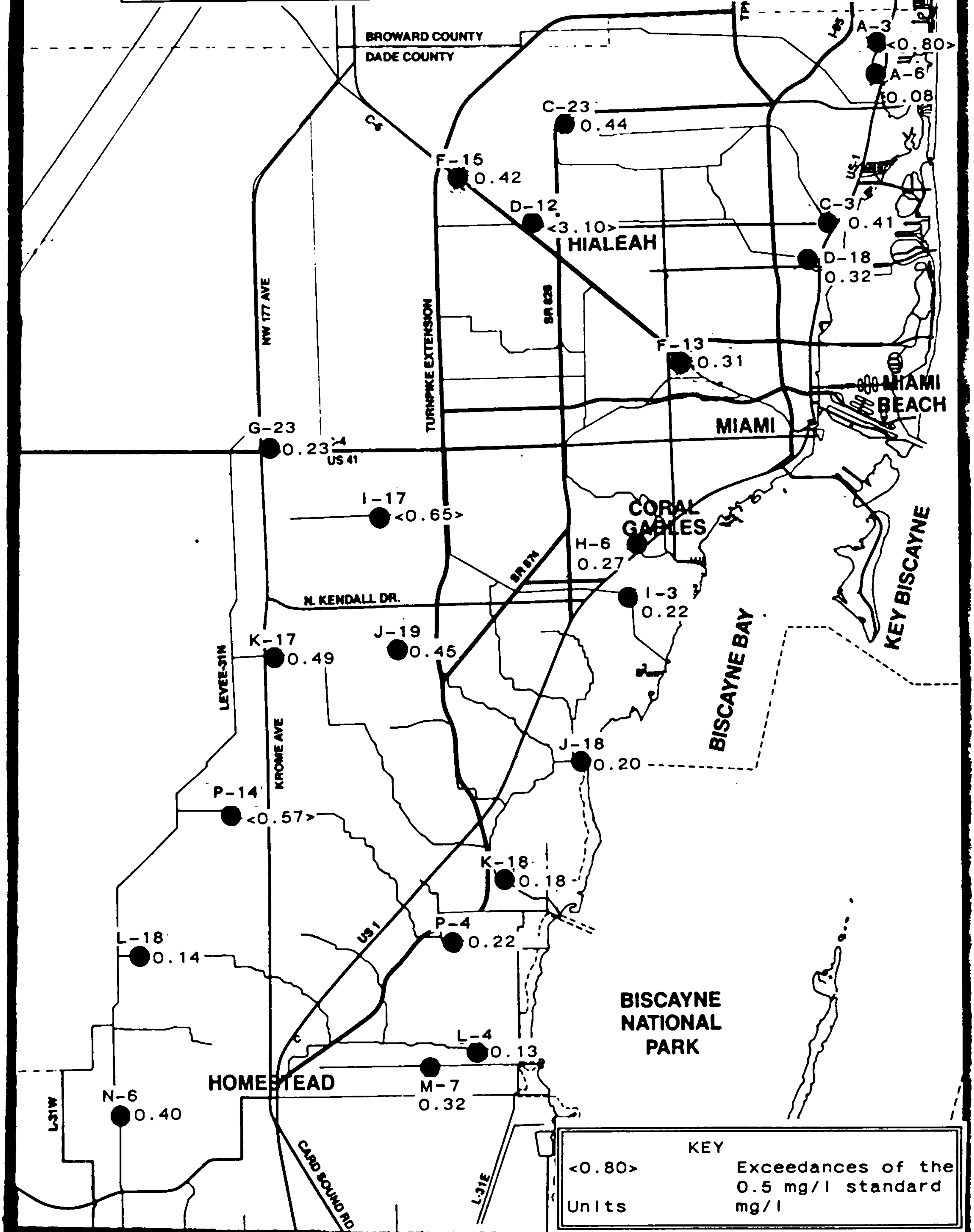


Figure 20: Ammonia Data in the 1985 Annual Pollutant Survey



evenly balanced, with little seasonal variation. These exceedances are new for these canals. In general, there was no significant (± 3 standard deviations) difference between the northern and southern canals, averaging 0.29 mg/l and 0.28 mg/l, respectively.

Total Kjeldahl Nitrogen (TKN) and Total Organic Nitrogen (TON)

Total organic nitrogen is defined functionally as organically bound nitrogen in the tri-negative oxidation state. TON includes such natural materials as proteins, nucleic acids, urea, and numerous synthetic organic materials. Total Kjeldahl Nitrogen is the total of ammonia and organic nitrogen concentrations.

The median TKN value was 1 mg/l with a median TON value of 0.6 mg/l. The highest values occurred at the background station of Little River Canal. TKN concentrations are generally lower at the discharge stations because of inorganic ion uptake, sedimentation phenomena and/or dilution sequences (Figure 21).

Nitrates/Nitrites (NOx-N)

The median NOx-N value was 1.72 mg/l. The highest level detected was 3.4 mg/l at the discharge station of the C-102 Canal, well below the 10 mg/l standard. This area is predominately agricultural; the high nitrate/nitrite level probably results from agricultural activity. Sixty-four percent of discharge sites had higher NOx-N levels than the background sites (Figure 22), but for the majority of canals the differences were very small. Where the canals traverse residential areas, increases were probably due to the impact of fertilizer application for landscaping purposes.

Chlorides

Chlorides were only analyzed during the wet season, and the canals affected by salt water intrusion were not analyzed. The average chlo-

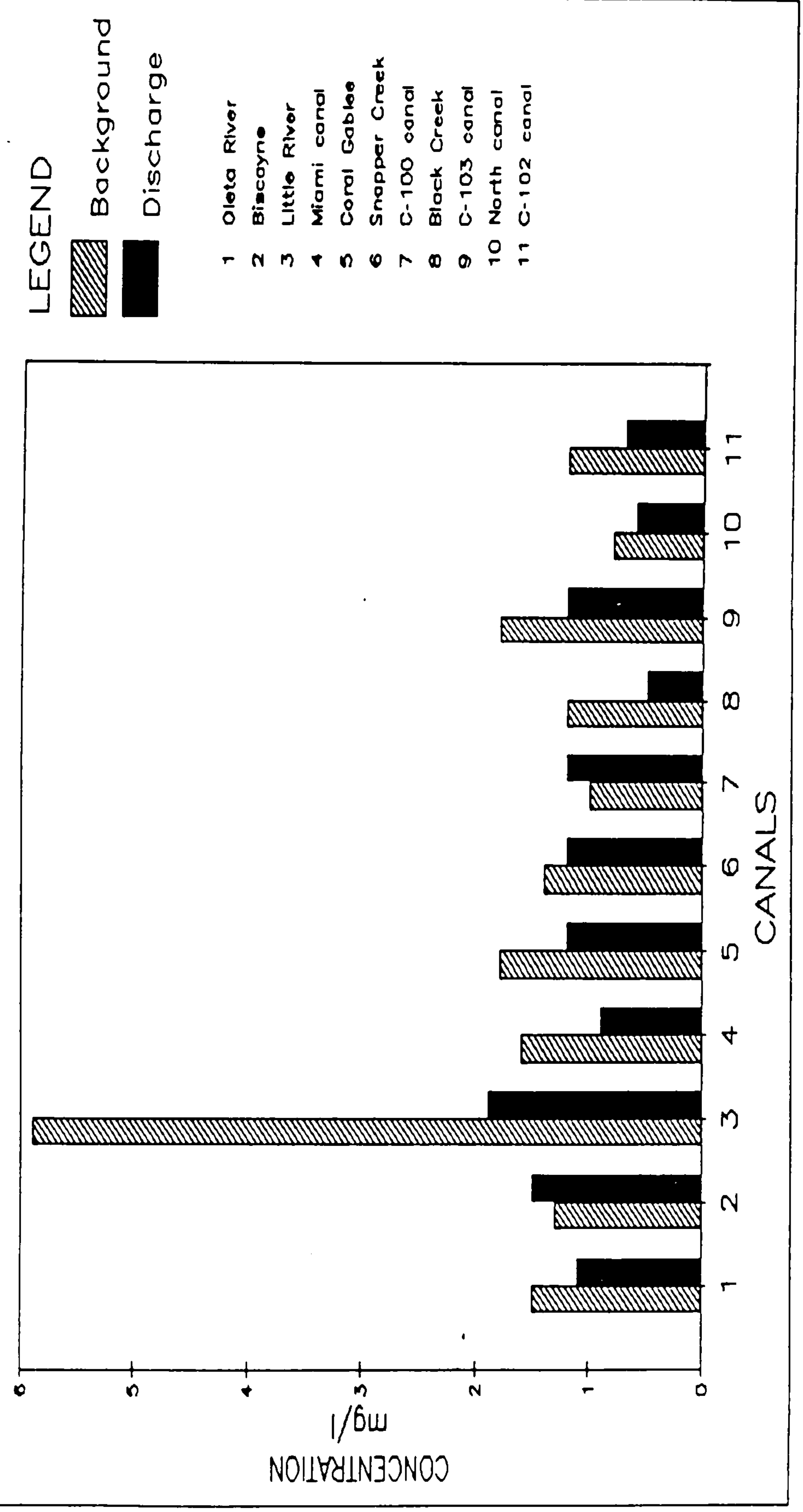
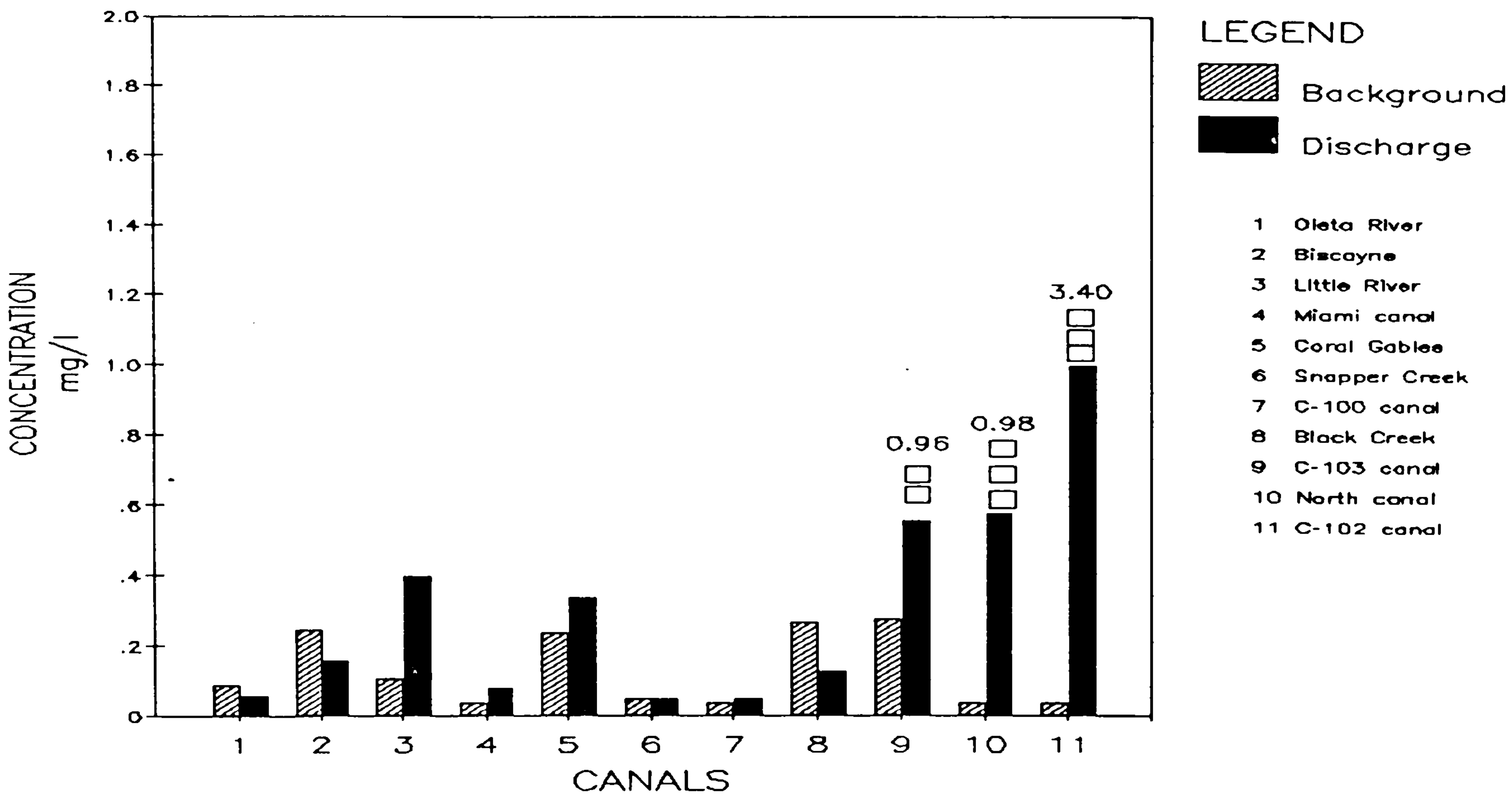


Figure 21: 1985 Annual Pollutant Survey Comparison of T.K.N. Data Background and Discharge Locations

Figure 22: 1985 Annual Pollutant Survey Comparison of NOx-N Data Background and Discharge Locations



ride level was 72 mg/l. The highest value, 130 mg/l, was detected at the background site of Black Creek. All the background stations of the canals studied had higher chloride levels than those of the discharge sites (Figure 23). This may be the result of conveyance of water into Dade County which contains higher chloride levels than those typically detected locally. Levels were, however, still below standards.

Trace Elements

In general, the highest trace element concentration of chromium, copper and nickel were detected in samples from the Oleta River . The levels were similar to previous data. Levels never exceeded standards and remained very low.

Arsenic (As)

Arsenic was near or below detection levels (1.0 ug/l) in all canal samples. The Little River Canal had the highest level detected (2.7 ug/l), well below the 50 ug/l standard, and comparable to previous data.

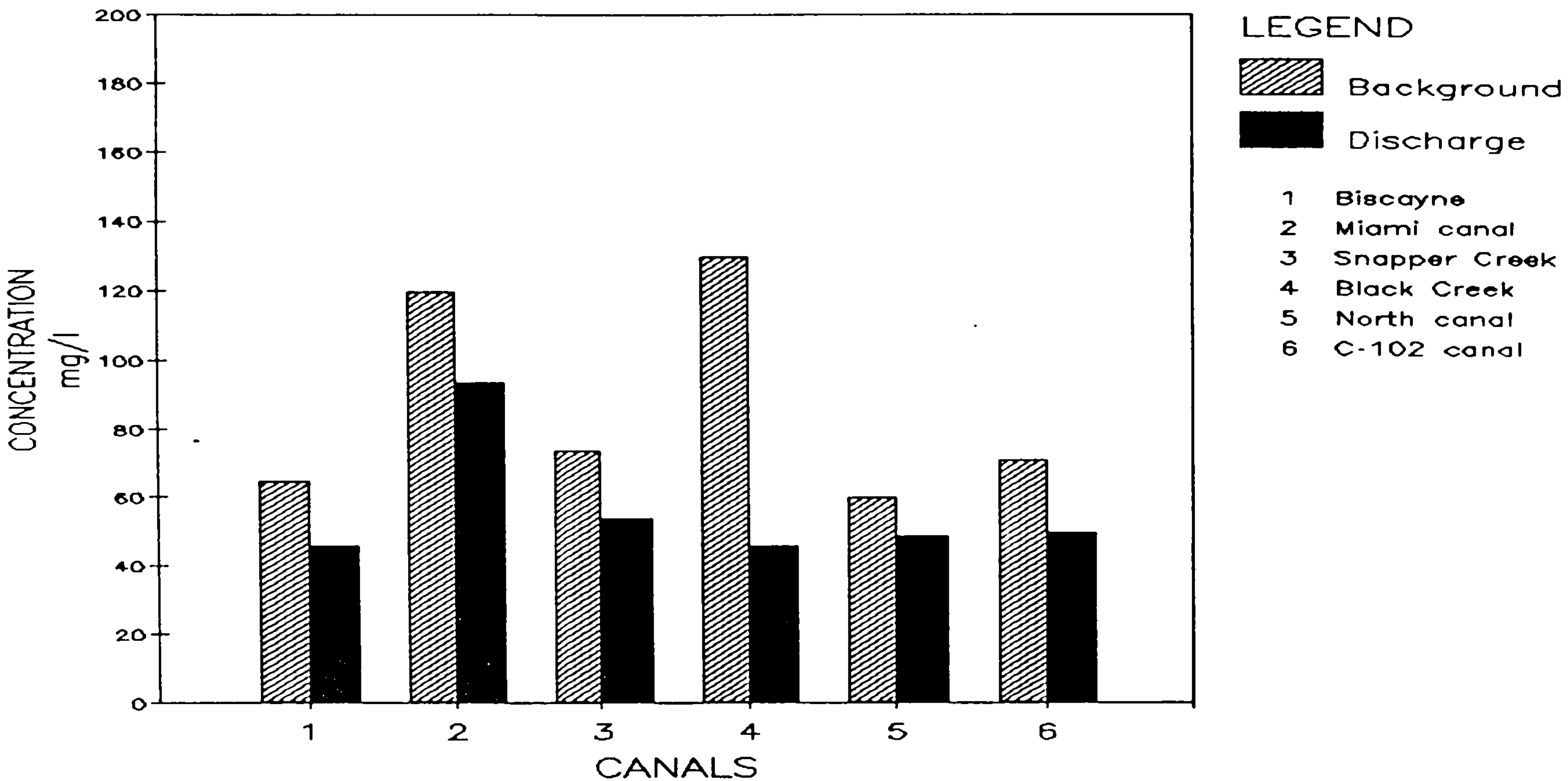
Cadmium (Cd)

Levels were consistently low in all canal samples with a median value of less than the minimum dectectable limit of 0.1 ug/l. The range was from less than 0.1 ug/l to 0.60 ug/l (Little River Canal). All levels were below the 1.2 ug/l standard.

Total Chromium (Cr)

Cr levels averaged below the detection limit of 1 ug/l. Oleta River Canal had the highest level, 5.2 ug/l at the discharge site. This was a five-fold increase from previous data but remains 10 times below the 50 ug/l standard. Future testing will determine whether or not the increase was due to urban activities.

Figure 23: 1985 Annual Pollutant Survey Comparison of Chloride Data for Background and Discharge Locations



Copper (Cu)

Copper had a median value of 1 ug/l in the canal samples and ranged from less than 1 ug/l to 16.8 ug/l. Copper levels were elevated at Oleta River from 8.2 ug/l at the background to 16.8 ug/l at the discharge site. The elevated copper and chromium levels indicate possible pollution from an urban source, although levels were well below the 400 ug/l standard.

Lead (Pb)

Lead values in all of the samples were below the standard (50 ug/l) and averaged 2.1 ug/l. The highest level was 8.7 ug/l in Coral Gables Waterway. Lead concentrations in the canals appear to be on the increase from previous years. The Coral Gables Waterway was the subject of the 1984 Intensive Canal Study (DERM 1984). No unusual lead concentrations were evident at that time.

Mercury (Hg)

The only detections of mercury (detection limit 0.2 ug/l) were at C-103 (1.3 ug/l at the discharge site) and C-100 (2 ug/l at background station). The standard (none detected) was exceeded at these sites, so future monitoring will be required to confirm water quality degradation.

Nickel (Ni)

Nickel concentrations in the canal samples ranged from below detection limits (5 ug/l) to 208 ug/l, with a median value of less than 5 ug/l. The highest level was in Oleta River Canal. The only other data available on this canal was obtained during the 1984 wet season; at that time nickel levels were very low. However, typical levels of Ni for surface water (below 10 ug/l), indicates that levels in Oleta River are elevated. It is possible that the data reflects seasonal variation rather than pollution sequences. There is currently no standard for nickel.

Selenium (Se)

Selenium was not detected in any of the canal samples at the current detection level of 5 ug/l.

Zinc (Zn)

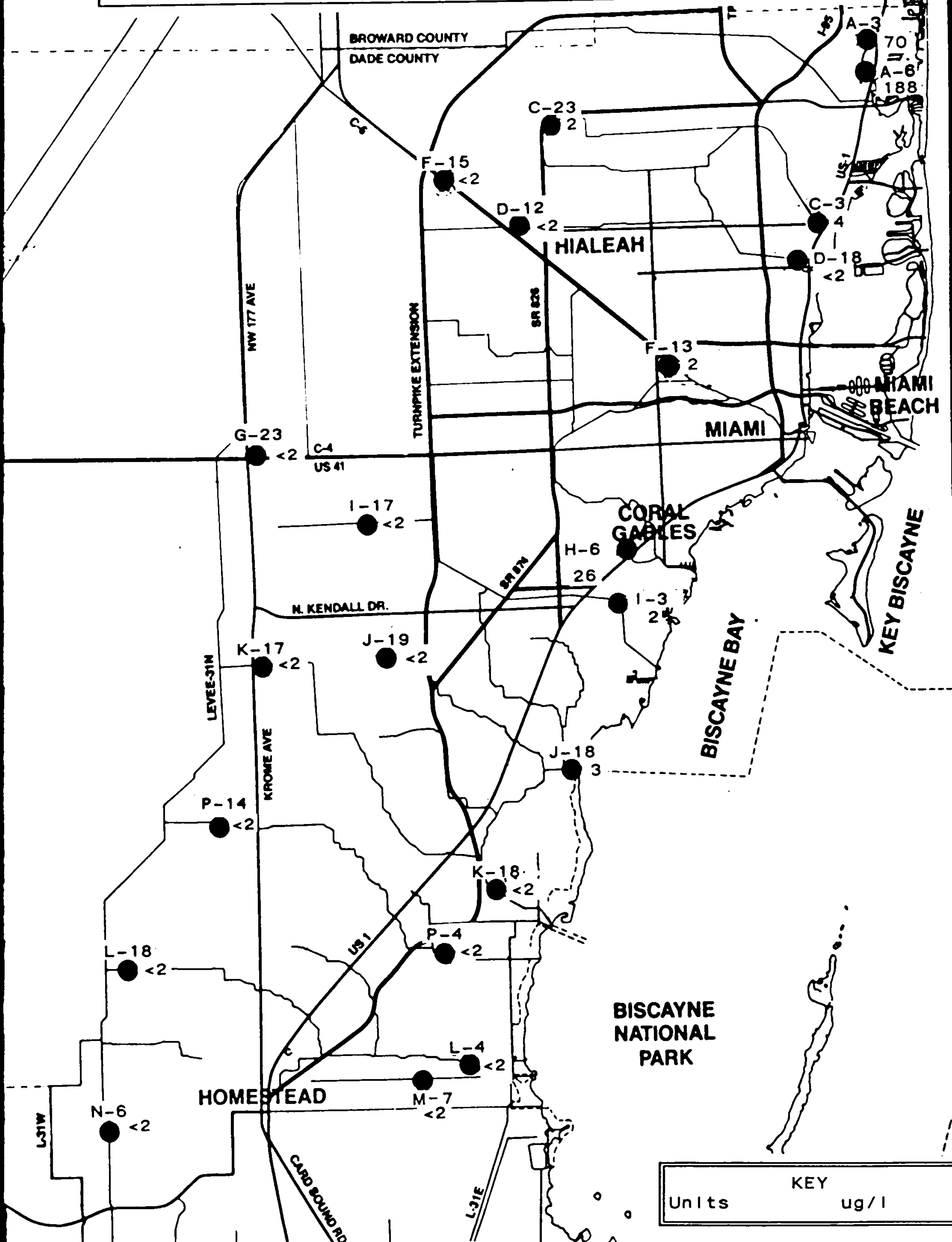
Zinc levels in the canal samples averaged 133 ug/l, well below the county standard of 1000 ug/l. The highest level (600 ug/l) was detected at the C-102 background station. Previous data from this location has shown that background levels of Zn are consistently higher than those found at discharge sites. The levels may result from farming practices as Zn is a component of heavily used agricultural fungicides.

Organics Parameters

Phenols

Phenols concentrations varied from below detection limits (2 ug/l) to 188 ug/l. Although phenols averaged 13 ug/l in the canal samples, only a few of the canals had levels of phenols above the 1 ug/l standard. One was the Oleta River in which samples ranged from 70 ug/l at the background station to 188 ug/l at the discharge station, an increase above the typically high phenol concentrations detected in previous years. Decay of vegetation (especially in the wetlands) is a natural source of phenols. High phenols were detected at the Coral Gables Waterway discharge site (26 ug/l) which was consistent with similar levels found there during an intensive survey conducted in 1984. Because the waterway traverses a residential area, urban sources may contribute to the phenol levels. About half of the canals had phenol levels that were higher at discharge sites, which indicate significant impact from urban sources (Figure 24). These canals were: Biscayne Canal, Miami Canal, Snapper Creek Canal, Oleta River Canal, Coral Gables Waterway and the C-100 Canal.

FIGURE 24: PHENOL LEVELS IN THE 1985 ANNUAL POLLUTANT SURVEY



Biochemical Oxygen Demand (BOD)

BOD measures the oxygen required for the biochemical degradation of material and the oxygen used to oxidize inorganic material such as sulfides and ferrous iron. Elevated BOD can be an indication of sewage pollution. BOD is important because it can produce septic conditions and leads to decreased dissolved oxygen. Resulting growth of saprophytic bacteria can increase the turbidity of the water and produce other undesirable characteristics.

BOD values averaged 1 mg/l in the canal samples and ranged from below detection limits to 5 mg/l at the Tamiami Canal's background location. Levels did not vary significantly (±3 standard deviations) between background and discharge sites.

Chemical Oxygen Demand

COD is a measure of the oxygen equivalent of the organic matter content of a sample that is susceptible to oxidation by a strong chemical oxidant. COD values averaged 55.0 mg/l in the canal samples and ranged from below the detection limit to 213 mg/l at the Oleta River discharge site. There was no discernible trend; about half of the canals (Black Creek, Miami, Snapper Creek and C-102 Canal) had COD levels higher at the background sites than at the discharge sites. The Oleta, Little River and C-103 Canals had higher COD levels at the discharge sites.

Chlorinated Insecticides and Herbicides

Large scale application of synthetic organic pesticides (especially the chlorinated hydrocarbons) in agricultural areas contribute to the presence of these toxic compounds in surface and groundwaters. Contamination can occur through drainage from surrounding terrain, precipitation from the atmosphere, and accidental spills. Although most of these organic substances have low solubility in water, their toxicities have necessitated the establishment of permissible concentrations that are generally much lower than their solubilities. Low water solubility does not prevent compound migration at significant levels. Table 5 lists the chlorinated insecticides and herbicides that were analyzed in the annual pollutant study. The table incorporates the structures, detection limits, some health effects, uses and applicable standards.

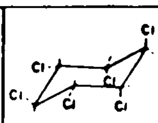
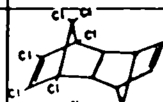
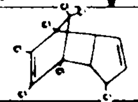
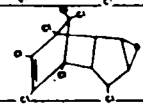
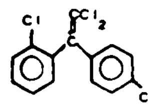
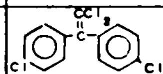
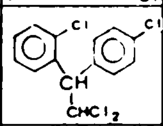
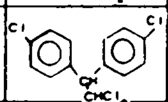
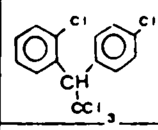
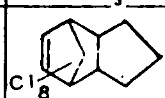
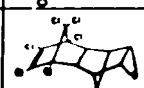
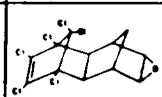
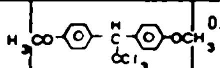
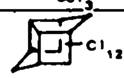
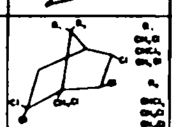
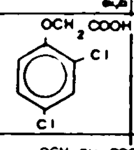
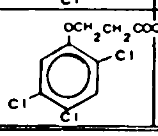
In Dade County most chlorinated hydrocarbons are no longer used on a large scale for agricultural purposes. Levels are expected to be low.

Analysis for chlorinated insecticides was made only during the dry season (October). Heptachlor was detected in C-111 at 0.007 ug/l which is above the 0.0001 ug/l standard. Heptachlor was historically used as an insecticide, but it is currently limited to use as a termiticide and for special use on a small number of crops. It is biotransformed to heptachlor epoxide which is more chemically and biologically persistent. Both compounds have a strong affinity for soils, but it can also migrate slowly to groundwater. No chlorinated insecticide was detected in samples from other sites. Herbicides were not detected during the wet season in any of the canal samples. In the 1985 dry season however, 2,4-D was detected in samples from two canals at discharge sites: Snake Creek Canal - 0.07 ug/l; and Little River Canal - 0.06 ug/l. 2,4-D is a broadleaf weed herbicide used on pasture, lawns, utility easements, canal banks and some crops. 2,4-D is degraded in the environment and is not persistent. The differences between the data obtained during the wet and dry seasons may be attributed to dilution of the existing low levels of residues.

Summary

The Annual Pollutant Survey was designed to determine the effect of urbanization upon surface water quality. Whereas historical data did not indicate impact from urbanization, the 1985 data indicated some signs of contamination along the Oleta, C-103 and C-100 Canals. A major area of concern is the C-103 and C-100 Canals in which mercury was detected above the standard. Ortho and total phosphate were also elevated at these canals; the most probable source(s) of these should be determined. Most of the parameters analyzed on the Oleta Canal samples were eleva-

TABLE 5: CHLORINATED INSECTICIDES AND HERBICIDES

COMPOUNDS	STRUCTURE	DET. LIMITS ug/l	HEALTH EFFECTS	USES	DRINKING WATER STANDARD ug/l
CHLORINATED INSECTICIDES: Lindane		0.0005	Mutagen, Skin irritant and potential carcinogen	Termite control, tree spraying	0.01
Aldrin		0.0005	Bioaccumulative, carcinogenic	Used on Carrots, peas, cabbage, etc.	0.003 (with Dieldrin)
Heptachlor		0.0005	Toxic to aquatic life	Used in conjunction with chlordane	0.001
Heptachlor Epoxide		0.0010		Oxidation product of Heptachlor	
o,p-DDE (dichlorodiphenyldichlor-ethylene)		0.0010	Bioaccumulative	Degradation product of DDT	
p,p-DDE		0.0010	Bioaccumulative		
o,p-DDD (dichlorodiphenyldichloro-ethane)		0.0010	Toxic to fish at conc. above 0.03mg/l. Less toxic than DDT	Control of gnats, mosquito larvae	
p,p-DDD		0.0025	Toxic to fish at conc. above 0.03mg/l. Less toxic than DDT	Control of gnats, mosquito larvae	
o,p-DDT (dichlorodiphenyltrichloro-ethane)		0.0025	More harmful to aquatic organisms than terrestrial	Used in paints, wall washes, as an insecticide to control mosquito breeding.	0.001
Chlordane		0.0010	Potential human carcinogen High chronic toxicity	As an insecticide	0.01
Dieldrin		0.0010	Fatal to a variety of animals and fish	Effective larvicide	0.003 (with Aldrin)
Endrin		0.0025	Suspected animal carcinogen. Damage to Central Nervous System	Control of insects on fiels crops. NOTE: BANNED IN DADE	0.004
Methoxychlor		0.0075	CNS effects in large dosages. One of the safest insecticide	Applied to fruits,vegs and domestic use	
Mirex		0.0035	Toxic to some crayfish. Bioaccumulative	Control of fire ants	0.001
Toxaphene		0.010	Affects CNS and respiratory system	Control of bugs and insects-grasshoppers, lice NOTE: BANNED IN DADE	0.005
HERBICIDES: 2,4-D (2,4-Dichlorophenoxyacetic acid)		0.001	Possible carcinogen, CNS disturbance	Control of broad leaf weeds and water hyacinths	
2,4,5-TP(SILVEX) (2-(2,4,5-Trichlorophenoxy propionic acid))		0.001	Liver and Kidney toxin	Control of Turf Weeds, Sugarcane and aquatic weeds. NOTE: BANNED IN DADE	

ted over previous years (DERM 1983 and 1984). More monitoring will be necessary to determine whether or not this is an anomaly. Heptachlor was detected in the C-111 Canal at a level above the Dade County standard. Also, 2,4-D was detected in two of the canals studied.

APPENDIX III

1985 ANNUAL POLLUTANT SURVEY

PARAMETER	DRY SEASON									
	B	D	B	D	B	D	D	B	D	B
	A-3	A-6	D-12	D-18	G-23	H-6	J-18	J-19	L-4	L-18
ALKALINITY(mg/l	306	212	283	243	178	226	195	225	199	172
AMMONIA (mg/l)	0.80	0.08	3.10	0.32	0.23	0.27	0.20	0.45	0.13	0.14
B.O.D(mg/l)	3	3	2	2	5	2	4	1	2	3
CHLORIDE(mg/l)										
COLOR(PCU)										
CONDUCT.(UHMOS)	15500	40000	650	700	700	8500	450	500	550	600
C.O.D(mg/l)	172.0	213.0	50.0	51.0	46.0	116.0	17.0	12.0	12.0	<1
FLUORIDE(mg/l)	0.43	0.64	0.23	0.26	0.26	0.30	0.11	0.09	0.10	0.22
NOX-N(mg/l)	0.09	0.06	0.11	0.40	0.24	0.34	0.05	0.04	0.96	0.28
O-PO4(mg/l)	0.090	0.007	0.006	0.004	0.033	0.033	0.015	1.780	1.590	0.232
PHENOLS(ug/l)	70	188	<2	<2	<2	26	3	<2	<2	<2
TURBIDITY (NTU)	2.4	1.5	2.0	1.4	4.6	7.0	1.2	2.0	2.5	5.3
T-ORG-N (mg/l)	0.70	1.00	2.80	1.60	1.60	0.90	1.00	0.60	1.10	1.70
T-PO4(mg/l)	0.117	0.026	0.042	0.032	0.036	0.067	0.028	1.860	1.640	0.248
T.F.R (mg/l)	10501	29187	412	463	423	5772	314	351	390	426
T.K.N (mg/l)	1.50	1.10	5.90	1.90	1.80	1.20	1.20	1.00	1.20	1.80
ARSENIC(ug/l)	<1	<1	1.4	2.7	<1	1.0	1.5	1.9	<1	1.6
CADMIUM(ug/l)	<0.1	0.30	0.20	0.60	0.10	0.10	0.10	0.10	0.30	0.10
CHROMIUM(ug/l)	2.0	5.2	1.3	1.1	<1	2.7	<1	<1	<1	<1
COPPER(ug/l)	8.2	16.8	2.0	5.8	2.3	9.7	4.4	1.1	8.2	2.1
LEAD(ug/l)	<1	2.6	2.7	2.0	6.8	8.7	5.4	<1	6.5	<1
MERCURY(ug/l)	<0.2	<0.2	<0.2	0.2	<0.2	<0.2	<0.2	2.0	1.3	<0.2
NICKEL(ug/l)	92	208	56	57	80	83	40	66	71	57
SELENIUM(ug/l)	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
ZINC(ug/l)	140	260	160	180	100	110	100	70	110	100

1985 ANNUAL POLLUTANT SURVEY

PARAMETER						WET SEASON						
	D C-3	MC C-23	D F-13	B F-15	D I-3	B I-17	B K-17	D K-18	MC M-7	B N-6	D P-4	B P-14
ALKALINITY(mg/l	211	243	226	245	192	226	222	190	187	228	212	234
AMMONIA (mg/l)	0.41	0.44	0.31	0.42	0.22	0.65	0.49	0.18	0.32	0.40	0.22	0.57
B.O.D(mg/l)	1	1	1	1	<1	<1	1	<1	1	<1	<1	<1
CHLORIDE(mg/l)	46	65	94	120	54	74	130	46	49	60	50	71
COLOR(PCU)	40	40	40	50	20	40	50	<15	15	50	<15	50
CONDUCT.(UHMOS)	490	300	600	700	500	600	650	490	500	550	550	600
C.O.D(mg/l)	44.4	43.1	50.9	60.5	26.1	48.4	53.3	47.2	20.5	44.4	3.8	77.5
FLUORIDE(mg/l)	0.12	0.12	0.16	0.15	0.16	0.11	0.17	0.08	0.10	0.17	0.09	0.13
NOX-N(mg/l)	0.16	0.25	0.08	0.04	0.05	0.05	0.27	0.13	0.98	0.04	3.40	0.04
O-PO4(mg/l)	0.013	0.011	0.011	0.010	0.010	0.010	0.019	0.010	0.013	0.010	0.009	0.010
PHENOLS(ug/l)	4	2	2	<2	2	<2	<2	<2	<2	<2	<2	<2
TURBIDITY (NTU)	1.8	1.5	1.1	1.0	1.6	1.0	1.0	1.1	1.5	7.0	0.5	5.5
T-ORG-N (mg/l)	1.10	0.90	0.60	1.20	1.00	0.80	0.70	0.30	0.30	0.40	0.50	0.60
T-PO4(mg/l)	0.058	0.060	0.061	0.051	0.050	0.051	0.060	0.050	0.059	0.057	0.047	0.056
T.F.R (mg/l)	331	379	396	410	321	369	445	296	369	377	405	383
T.K.N (mg/l)	1.50	1.30	0.90	1.60	1.20	1.40	1.20	0.50	0.60	0.80	0.70	1.20
ARSENIC(ug/l)	1.5	1.3	1.8	<1	<1	<1	1.3	1.0	1.7	<1	<1	<1
CADMIUM(ug/l)	0.10	0.10	0.10	0.10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
CHROMIUM(ug/l)	<1	<1	<1	<1	1.0	<1	<1	<1	<1	<1	<1	<1
COPPER(ug/l)	1.6	1.1	1.8	1.6	1.0	2.8	1.7	0.3	0.9	0.6	0.7	1.3
LEAD(ug/l)	<1	1.0	1.1	1.0	<1	1.3	1.4	2.3	<1	1.1	<1	1.9
MERCURY(ug/l)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.2
NICKEL(ug/l)	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
SELENIUM(ug/l)	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
ZINC(ug/l)	60	110	100	220	70	100	60	30	80	70	90	600

1985 ANNUAL POLLUTANT SURVEY

PARAMETER	AVERAGE	MAXIMUM	MINIMUM	VARIANCE	STANDARD DEVIATION
ALKALINITY(mg/l)	221	306	172	980	32
AMMONIA (mg/l)	0.47	3.10	0.08	0.36	0.61
B.O.D(mg/l)	1	5	0	2	1.418
CHLORIDE(mg/l)	72	130	46	753	29
COLOR(PCU)	33	50	0	335	19
CONDUCT.(UHMOS/CM	3395	40000	300	75690025	8905
C.O.D(mg/l)	55	213	0	2561	52
FLUORIDE(mg/l)	0.19	0.64	0.08	0.02	0.13
NOX-N(mg/l)	0	3	0	1	1
O-PO4(mg/l)	0.178	1.780	0.004	0.230	0.491
PHENOLS(ug/l)	13	188	0	1680	42
TURBIDITY (NTU)	2.5	7.0	0.5	3.8	2.0
T-ORG-N (mg/l)	0.97	2.80	0.30	0.31	0.57
T-PO4(mg/l)	0.216	1.860	0.026	0.238	0.500
T.F.R (mg/l)	2396	29187	296	39633729	6444
T.K.N (mg/l)	1.43	5.90	0.50	1.09	1.07
ARSENIC(ug/l)	0.9	2.7	0.0	0.7	0.9
CADMIUM(ug/l)	0.10	0.60	0.00	0.02	0.14
CHROMIUM(ug/l)	0.6	5.2	0.0	1.6	1.3
COPPER(ug/l)	3.5	16.8	0.3	15.5	4.0
LEAD(ug/l)	2.1	8.7	0.0	6.0	2.5
MERCURY(ug/l)	0.2	2.0	0.0	0.2	0.5
NICKEL(ug/l)	37	208	0	2536	52
SELENIUM(ug/l)	0.0	0.0	0.0	0.0	0.0
ZINC(ug/l)	133	600	30	13165	117

1985 ANNUAL POLLUTANT SURVEY

DRY SEASON

PARAMETER	C-3	C-23	F-13	F-15	I-3	I-17	K-17	K-18	M-7	N-6	P-4	P-14
HERBICIDES												
2,4-D(ug/l)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,5-TP(ug/l)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CHLORINATED INSECTICIDES												
ALDRIN(ug/l)	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	-	ND
CHLORDANE(ug/l)	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	-	ND
(o,p)-DDD(ug/l)	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	-	ND
(p,p)-DDD(ug/l)	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	-	ND
(o,p)-DDE(ug/l)	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	-	ND
(p,p)-DDE(ug/l)	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	-	ND
(o,p)-DDT(ug/l)	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	-	ND
DIELDRIN(ug/l)	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	-	ND
ENDRIN(ug/l)	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	-	ND
HEPTACHLOR(ug/l	ND	-	ND	ND	ND	ND	ND	ND	ND	0.007	-	ND
HEP. EPOX(ug/l)	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	-	ND
LINDANE(ug/l)	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	-	ND
METHOX.(ug/l)	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	-	ND
MIREX(ug/l)	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	-	ND
TOXAPHENE(ug/l)	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	-	ND

1985 ANNUAL POLLUTANT SURVEY

WET SEASON

PARAMETER	A-3	A-6	B-2	B-13	D-12	D-18	G-23	H-6	J-18	J-19	L-4	L-18
HERBICIDES												
2,4-D(ug/l)	ND	ND	0.07	ND	ND	0.06	ND	ND	ND	ND	ND	ND
2,4,5-TP(ug/l)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CHLORINATED INSECTICIDES												
ALDRIN(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
CHLORDANE(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
(o,p)-DDD(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
(p,p)-DDD(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
(o,p)-DDE(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
(p,p)-DDE(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
(o,p)-DDT(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
DIELDRIN(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
ENDRIN(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
HEPTACHLOR(ug/l	-	-	-	-	-	-	-	-	-	-	-	-
HEP. EPOX(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
LINDANE(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
METHOX.(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
MIREX(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
TOXAPHENE(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-

PART IV

1985 INTENSIVE CANAL STUDY

The Intensive Canal Study was established in 1980 by the Dade County Department of Environmental Resources Management to comprehensively examine the water quality of a different major canal system each year. Previous studies include the Snapper Creek Canal (1980), Miami Canal (1981), Tamiami/Dressels Canal (1982), Black Creek Canal (1983) and Coral Gables Waterway (1984).

For the 1985 study, six sites along the Snake Creek Canal were selected for monitoring (Figure 25). This canal is one of the major contributors of freshwater to Biscayne Bay, discharging an average of 202,700 acre-ft/year. Water in the canal generally moves from land toward the bay; however spring tides occasionally top a salinity structure (Figure 25) and reverse flow occur. Six monitoring sites were sampled quarterly in February, May, July and November and analyzed for the following parameters:

Physical Properties

Conductivity
Turbidity
Total Filtrable Residue

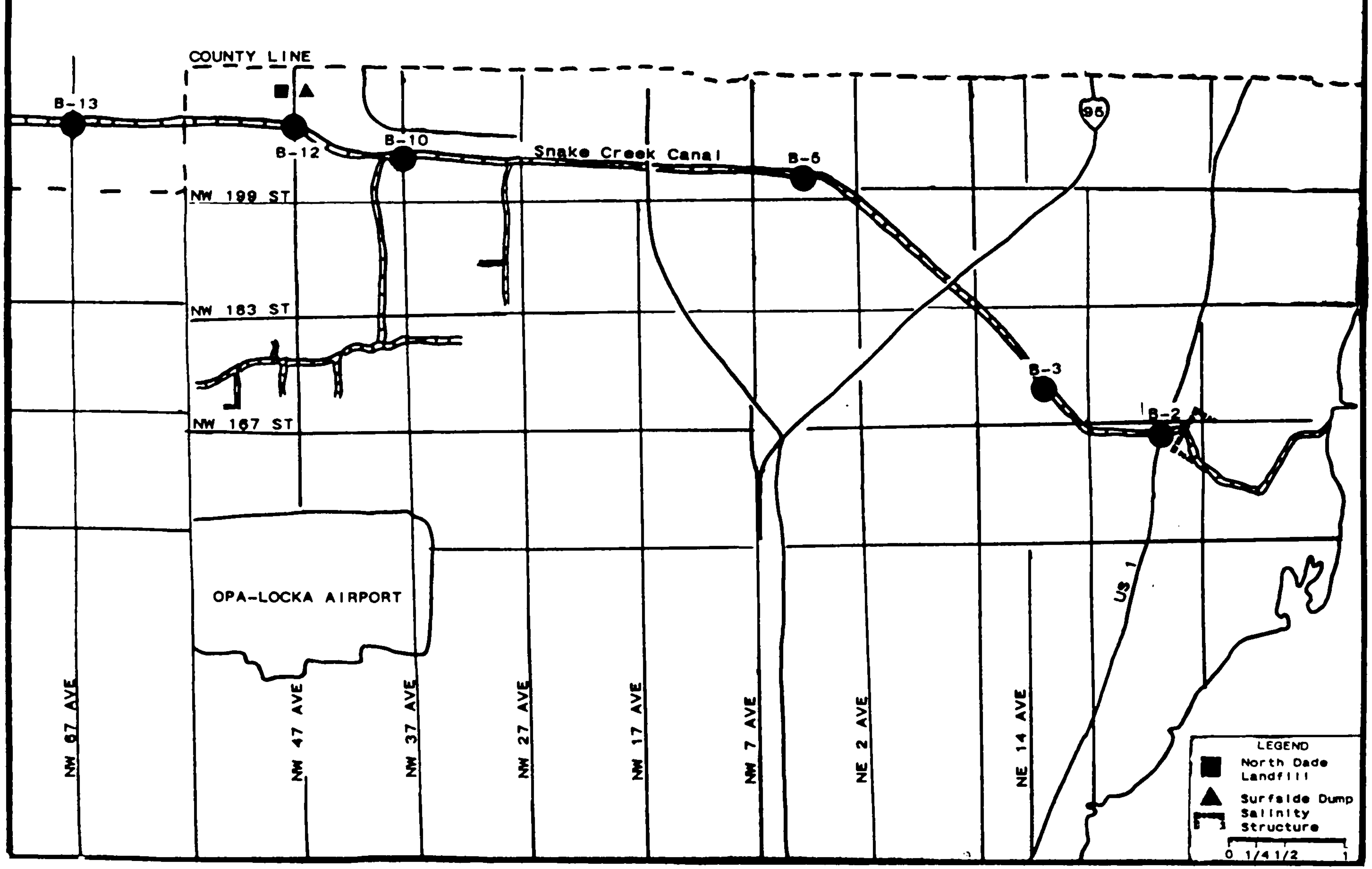
Nutrients

Ammonia
Total Nitrate/Nitrites
Total Kjeldahl Nitrogen
Ortho and Total Phosphates

Major Inorganics

Alkalinity
Fluorides
Sulfates (biannually)
Chlorides

FIGURE 25 : 1985 INTENSIVE CANAL SURVEY
LOCATION OF MONITORING SITES IN THE SNAKE CREEK CANAL



Trace Elements

Arsenic	Nickel
Cadmium	Lead
Chromium	Selenium
Copper	Zinc
Mercury	

Organic Constituents

Biochemical Oxygen Demand
Chemical Oxygen Demand
Phenols
Pesticides and Herbicides

Site B-2 is approximately one-fifth of a mile upstream of salinity structure S-29. When the gates are closed, it may act like a settling pond. It is predominantly in a residential area; possible pollution sources include runoff from activities associated with residential development (e.g., lawn maintenance) and the major highway (US1) which crosses the canal at NW 166 Street. B-3 is also located in a residential area and may be affected by runoff from heavily used Golden Glades Interchange. B-5 is near a residential area which has some commercial development including small businesses, nurseries and retail operations. B-10 is surrounded by a residential area and is located downstream of two closed landfills, Dade County's North Dade Landfill and the Surfside Dump, both of which may adversely affect the site. Site B-12 is located between the North Dade Landfill and the Surfside Dump, about one quarter of a mile north of the Suniland Training Center. While it is possible that the North Dade Landfill may affect B-12, the Surfside Dump would not be expected to affect the site because it is upstream of the dump. B-13 runs through low density residential development with a few cattle pastures and horse-rearing operations. This canal serves as a background location inasmuch as it is affected by only a few pollution sources.

RESULTS

Physical Properties

Conductivity

Conductivity in the Snake Creek Canal averaged 579 umhos/cm and ranged between 400 - 750 umhos/cm. The highest levels of conductivity were generally recorded during the dry season (Figure 26). With the exception of site B-2 in July, all levels of conductivity were at or exceeded the 500 umhos/cm standard, which is typical of the canals in Dade County. The highest recorded value was 750 umhos/cm at B-12. This indicates a need to monitor for further impacts from these two landfills.

Turbidity

Turbidity values were low at all sites throughout the year with an average of 3.0 nephelometric turbidity units (NTU). The highest measurement was 4.4 NTU from site B-3 during the 3rd quarter. Since this site had low turbidity values at other times the elevated value may be due to illegal dumping into the canal rather than natural causes. No clear seasonal differences in turbidity were noted.

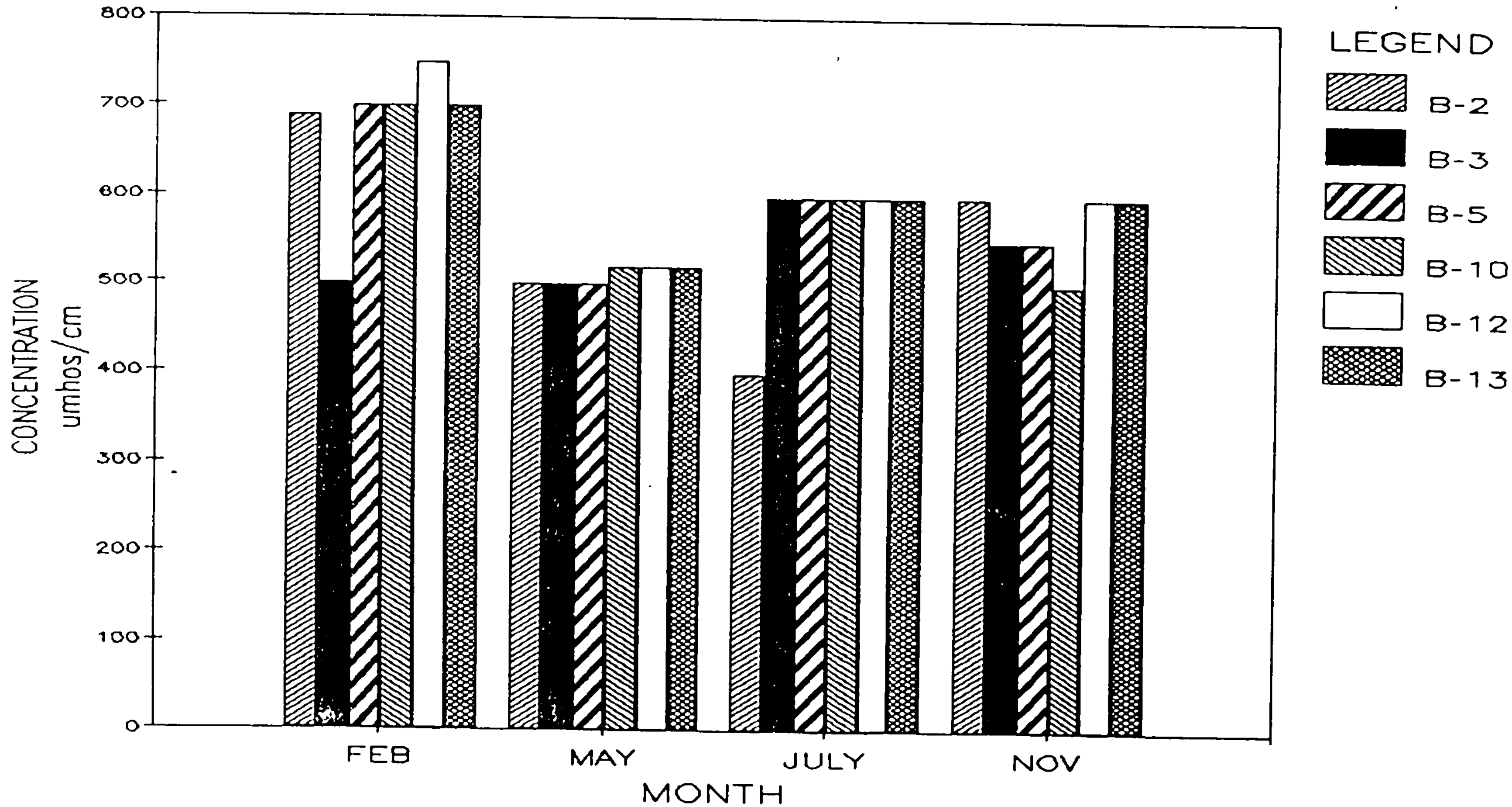
Total Filtrable Residue (TFR)

TFR averaged 459 mg/l and ranged from 379 to 1,389 mg/l. Peak TFR levels exceeding the 1000 mg/l standard were recorded at site B-10 during the wet season. Leachate production from the two nearby dumps, enhanced by heavy rains, may be responsible for elevated residues in this area. There were no other exceedances of the standard.

Nutrients

Human activities are usually the cause of elevated nutrient levels in urban surface waters. Pollution sources of nitrogen and phosphorus in the Snake Creek drainage basin include septic tanks, sewage treatment

Figure 26: 1985 Intensive Canal Study Variation in Conductivity



plants, lawn fertilizers, nurseries and landfills. Levels of all nutrients were highest during the fourth quarter sampling (Figure 27).

Ammonia (NH_3)

The NH_3 levels in this canal resembled those from other canals. The 0.5 mg/l standard was exceeded at one site, B-5 (0.60 mg/1), during the early dry season sampling. The fluctuation in ammonia encountered at this site suggests that sewage entered the canal periodically. Levels of ammonia do not indicate any major impact from the landfills at this time, but close monitoring for this possibility should continue.

Total Kjeldahl Nitrogen (TKN)

TKN averaged 1.5 mg/l in the canal samples. A high value of 2.4 mg/1 detected for B-5 may have been due to the introduction of sewage into the canal.

Nitrates/Nitrites

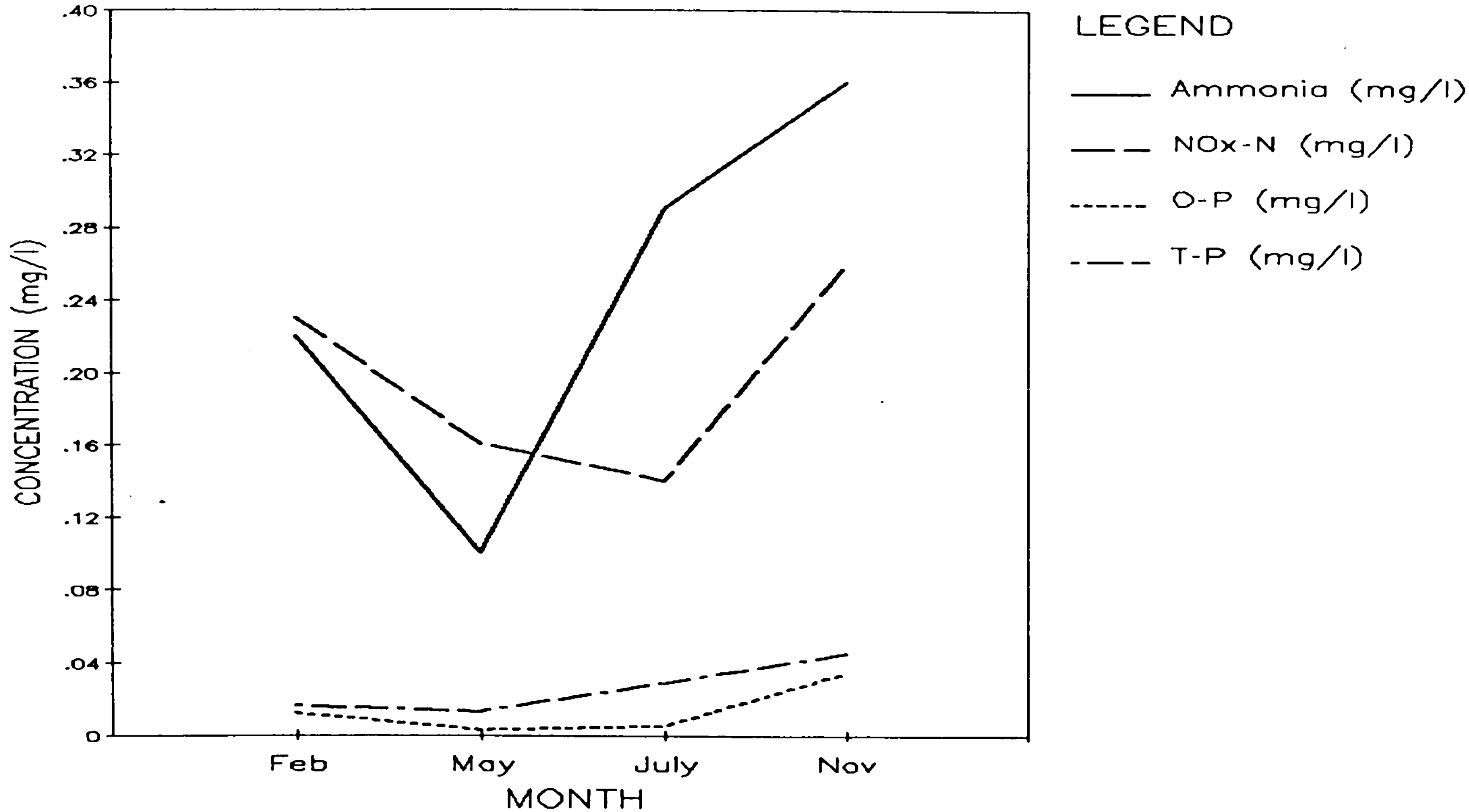
NOx-N in the sampling network averaged 0.20 mg/l, far below the 10 mg/l standard. The highest level (0.51 mg/1) was recorded at B-2 (dry season), just upstream of a salinity dam. When the gates of this structure are closed, restricted water flow converts this portion of the canal into a settling pond and leads to elevated NOx-N levels.

Ortho and Total Phosphates

Phosphates are generally not found in significant amounts in Dade County's surface water. The median orthophosphate level in the canal samples was 0.02 mg/l; for total phosphate, the average was 0.026 mg/l.

Generally, the concentrations of ortho and total phosphates detected in the canal were lower than levels in nearby groundwater samples. Groundwater may be directly affected by leaching fertilizers and from septic tanks. Phosphates in surface water may be attenuated by plant uptake.

Figure 27: 1985 Intensive Canal Study Variation of Nutrients' Data



Major Inorganics

Alkalinity

Alkalinity averaged 239 mg/l in the canal samples with a range of 207 - 315 mg/l. These levels indicate good water quality for the support of aquatic life. Alkalinity levels were highest during the dry season (Figure 28).

Fluorides

Fluoride averaged 0.23 mg/l in the canal samples. The highest value, 0.26 mg/l during the mid-dry season, did not exceed the 1.4 mg/l standard.

Sulfates

Sulfate concentrations ranged from 4.07 - 16.8 mg/l and averaged 8.86 mg/l. The highest value was detected at site B-5 early in the dry season. These values are consistent with expected ambient concentrations.

Chlorides

The average chloride value detected in the canal was 90 mg/l (range 61 - 107 mg/l). The highest values were detected in samples from sites B-5 (107 mg/l) and B-10 (103 mg/l) and never exceeded the 500 mg/l standard. Elevated chlorides at these sites may have been associated with urban sources in the case of B-5 and the landfills in the case of B-10.

Trace Elements

Consistently low levels of trace elements were found in the canal samples and the only violation of standards was for mercury. The highest trace element levels were detected during the dry season (Figure 29).

FIGURE 28: 1985 INTENSIVE CANAL STUDY ALKALINITY DATA

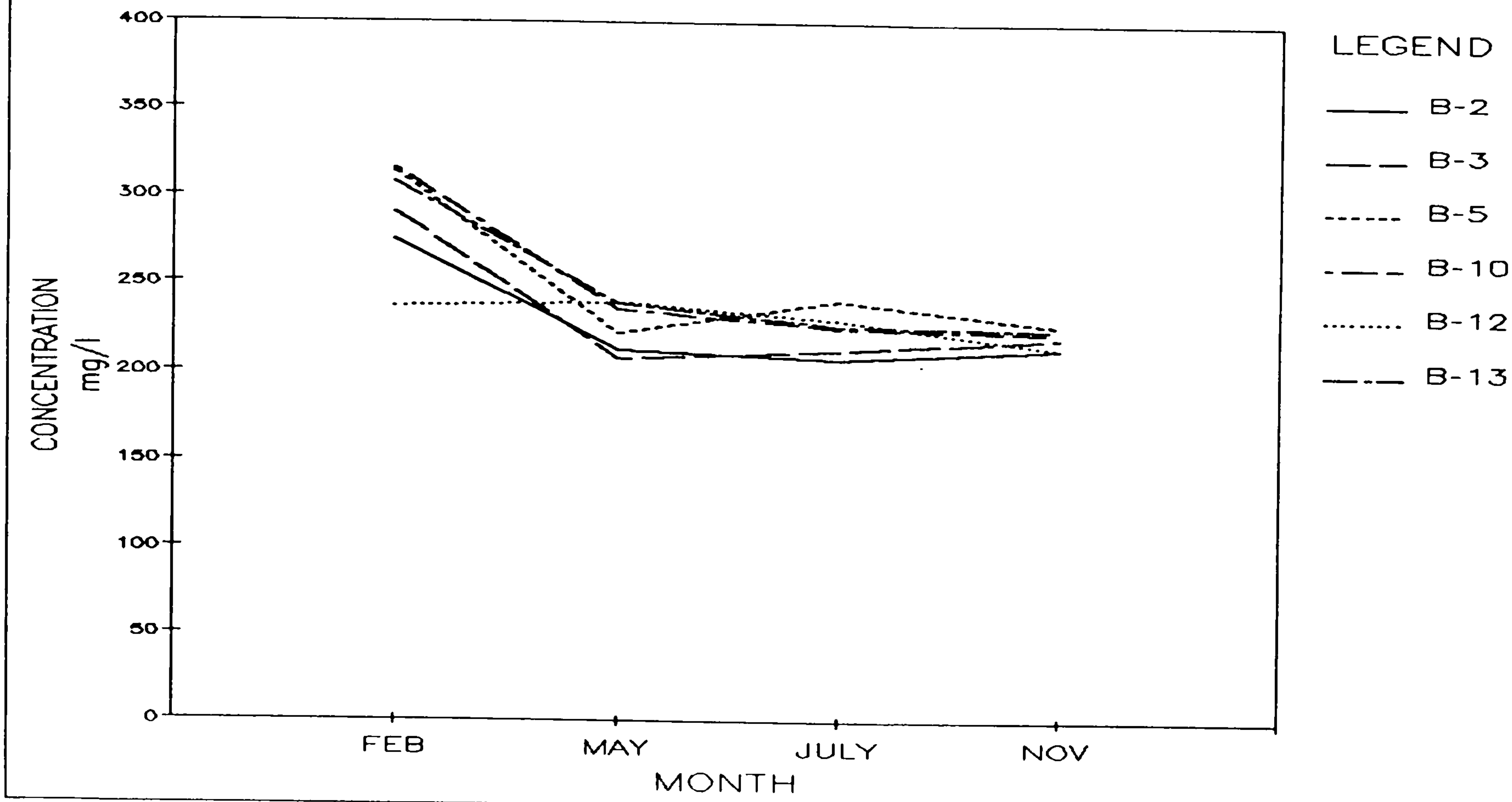
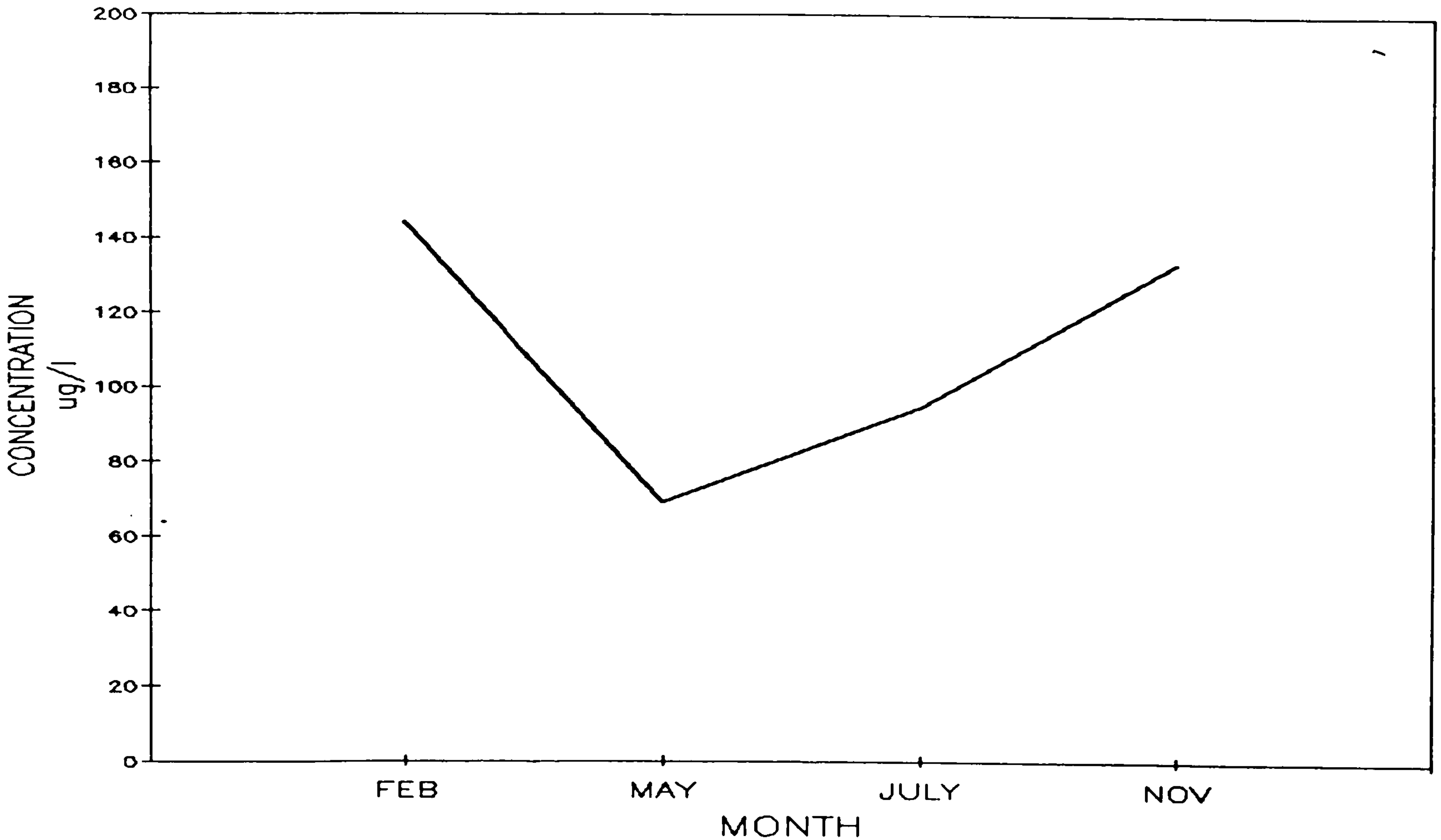


Figure 29: 1985 Intensive Canal Study
Variation of Total Metal Concentration



Arsenic

The arsenic concentration in the Snake Creek canal averaged 1.9 ug/l. The majority of the higher levels occurred during the mid-dry season with the highest at B-5 (4.6 ug/l).

Cadmium

Cadmium levels ranged from below the detection limits (BDL) to 0.4 ug/l and the median value was 0.14 ug/l. The highest level was detected at site B-2 (0.35 ug/l), below the 1.2 ug/l standard. The mid-dry season samples from all sites had consistently higher levels of cadmium.

Chromium

With an average of 0.7 ug/l, the chromium values obtained were well below the standard of 50 ug/l. The highest value was 2.5 ug/l at B-13.

Copper

Copper averaged 2.7 ug/l with the highest level detected at site B-2 (6.6 ug/l) during the wet season.

Mercury

The canal was sampled for mercury during the 1st and 2nd quarters. Mercury was detected in three of the samples, the highest level (0.4 ug/l) at B-2 during the 2nd quarter. Although the levels of mercury were above the standard, the levels (0.2 - 0.4 ug/l) approach the detection limit of the analytical procedure (0.2 ug/l) and therefore need to be confirmed.

Nickel

Nickel averaged 32 ug/l with the highest concentration detected at site B-5 (70 ug/l). The highest levels at all the sites were detected during the 2nd quarter sampling.

Lead

The average lead concentration was 2 ug/l with a peak concentration detected at site B-10 during the mid-dry season (4.5 ug/l).

Selenium

Selenium was detected only early in the dry season (detection limit: 5 ug/l), with levels ranging from 12.3 ug/l to 16.7 ug/l. At no time was the 25 ug/l standard exceeded. The background site, B-13, also had elevated values, suggesting the possibility of some type of interference. Additional monitoring will be necessary to confirm the levels of selenium.

Zinc

The average zinc concentration was 65 ug/l with the highest level detected (160 ug/l) at sites B-2 (early dry season) and B-13 (mid-dry season). All zinc values were below the standard of 1000 ug/l.

Organic Constituents

Biochemical Oxygen Demand (BOD)

BOD values averaged 2 mg/l in the Snake Creek canal samples, ranging from 1 mg/l to 4 mg/l. These data are comparable to the BOD levels detected in other canals (DERM 1981 and 1982).

Chemical Oxygen Demand (COD)

The average COD value was 52 mg/l (range: 39 - 64 mg/l). COD peaked during the early dry season for eighty-three percent of the sites. COD levels at site B-13 were higher than at other sites, ranging from 56 to 62 mg/l. The high COD and low BOD levels at this site is an indication of the presence of non-biodegradable organics that are not normally associated with domestic sewage, but may be from organics in top soil or residential organic matter such as peat and muck.

Phenols

The average level obtained was 2 ug/l and ranged from below the detection limit of the analytical procedure (2 ug/l) to 6 ug/l at B-12. The impact of the Surfside and North Dade Landfills is evident at sites B-10 and B-12 respectively. B-12, south of the landfills, had high phenols levels during the mid-dry to early wet season with levels decreasing in the mid-wet season. At B-10, which is downstream from both landfills, levels peaked in the mid-wet season (Figure 30).

Thirty-five percent of the samples exceeded background levels (B-13) and all elevated levels occurred downstream of the landfills. All sites exceeded the 1 ug/l standard at least twice during the study; levels of phenols are typically high in north Dade county as a result of exotic vegetation. This standard has been exceeded in other canal studies (DERM 1982, 1983).

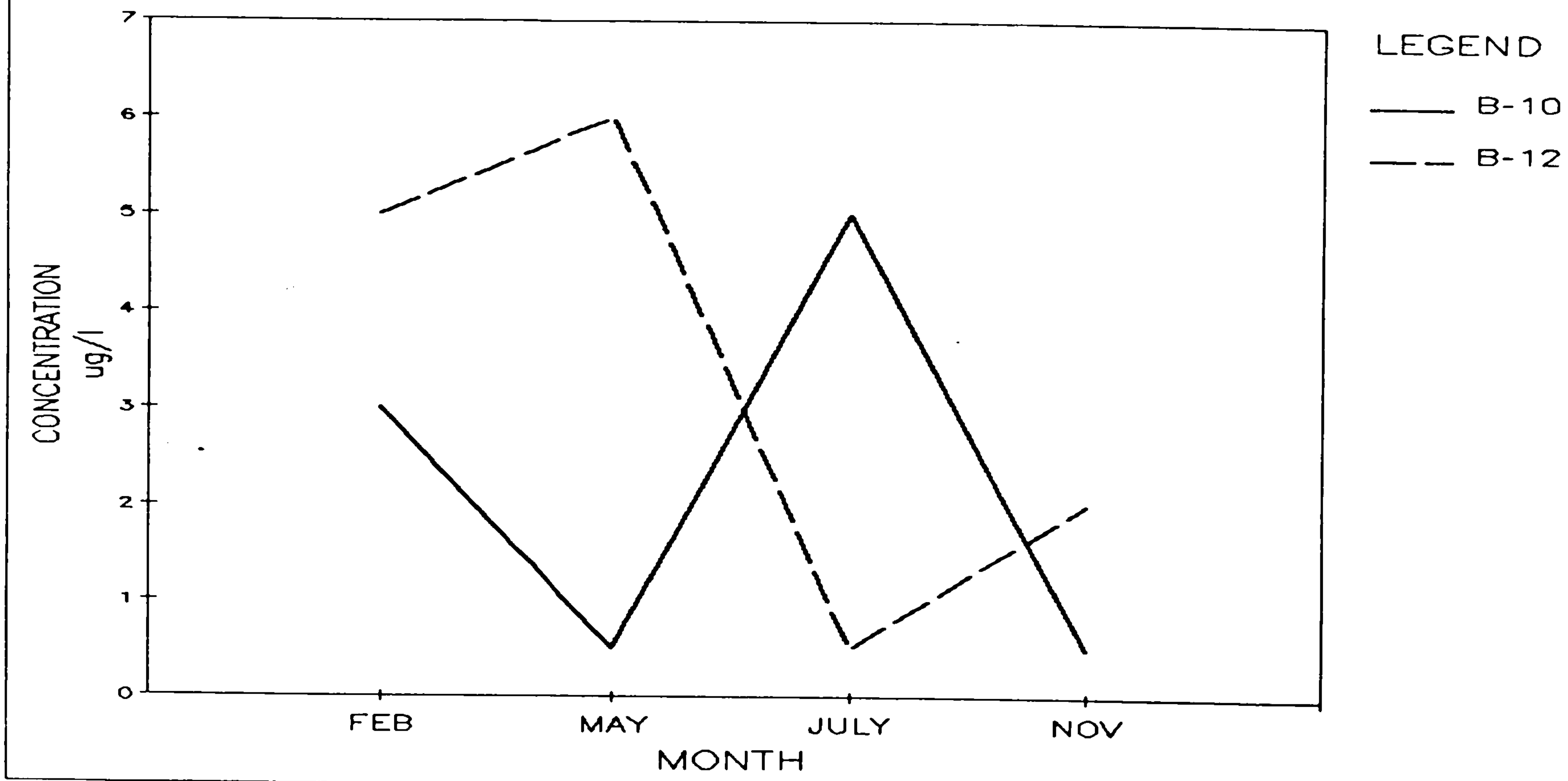
Chlorinated Insecticides and Herbicides

Samples from Snake Creek Canal were analyzed twice for herbicides (February and October) and once for chlorinated insecticides (October). With the exception of 1 herbicide (2,4-D), none of the pesticides or herbicides was detected. 2,4-D was detected at 3 sites during the dry season: B-2 (0.07 ug/l), B-3 (0.04 ug/l) and B-5 (0.10 ug/l). Site B-5 was at the maximum concentration permissible in drinking waters, probably the result of 2,4-D use for canal bank maintenance. The Canal Pollutant Study (DERM 1984) also detected high levels of 2,4-D at the background site (B-13) during 1984.

Summary

The Snake Creek Canal monitoring sites were chosen to assess the impact of the dominant features of the surrounding area: background conditions (B-13), a nearby county landfill (B-12), the closed Surfside landfill (B-10), and a salinity dam (B-2).

Figure 30: 1985 Intensive Canal Study Variation of Phenol Levels at Sites in Vicinity of Landfills



With few exceptions 1985 Snake Creek canal data exhibited normal ambient conditions and was consistent with findings for other canals of Dade county. Exceedances of standards included : total filtrable residue (1389 mg/l) and phenols (all sites). The highest levels of trace elements were at site B-2, which had higher than background levels of cadmium, chromium, copper and zinc. All levels were, however, far below standard values.

Although the canal data did not demonstrate major impact from the landfills, the highest levels of indicator parameters (ammonia, residues, chlorides, phenols and conductivity) were obtained at sites downstream from the landfills. This indicates a need for continued close monitoring of these potential pollution sources.

A P P E N D I X IV

1985 INTENSIVE CANAL SURVEY

PARAMETER	B-2				B-3				B-5			
	FEB	MAY	JULY	NOV.	FEB	MAY	JULY	NOV.	FEB	MAY	JULY	NOV.
ALKALINITY mg/l	274	212	207	213	290	207	212	219	313	222	240	226
AMMONIA mg/l	0.15	0.11	0.21	0.23	0.15	0.16	0.19	0.21	0.13	0.06	0.34	0.60
B.O.D mg/l	3	1	1	2	2	2	2	3	2	3	2	3
CHLORIDE mg/l			94	95			91	94			107	76
CONDUCT. umhos/cm	690	500	400	600	500	500	600	550	700	500	600	550
C.O.D mg/l	46	41		64	46	41		41	54	54		62
FLUORIDE mg/l	0.26	0.24	0.23	0.18	0.23	0.24	0.23	0.16	0.24	0.24	0.22	0.23
NOX-Nmg/l	0.51	0.16	0.12	0.36	0.32	0.20	0.08	0.42	0.16	0.19	0.21	0.31
O-PO4 mg/l	0.030	<0.001	0.005	0.036	0.013	<0.001	0.005	0.040	0.004	<0.001	0.005	0.032
PHENOLS ug/l	<2	3	2	<2	3	2	5		<2	3	2	<2
SULFATE mg/l		8.41		8.73		10.28		8.32		8.10		16.80
TURB. NTU	3.5	1.2	4.2	3.9	1.3	1.3	4.4	3.4	1.5	2.0	4.1	3.0
T-PO4 mg/l	0.040	0.013	0.027	0.048	0.016	0.009	0.033	0.050	0.007	0.009	0.026	0.042
T.F.R mg/l	435	408	379	421	397	398	384	405	423	410	423	393
T.K.N mg/l	1.60	1.30	1.90	1.30	1.60	1.40	1.40	1.40	1.60	1.60	2.40	1.80
ARSENIC ug/l	2.5	1.7	1.0	2.0	3.1	2.1	<1	1.9	4.6	1.4	<1	2.8
CADMIUM ug/l	0.35	0.10	0.20	0.20	0.11	0.10	0.10	0.20	0.12	0.10	0.10	0.10
CHROMIUM ug/l	1.0	1.0	1.0	2.2	<1	1.4	<1	2.3	<1	<1	<1	2.1
COPPER ug/l	3.9	2.2	6.6	2.2	2.0	1.8	4.4	3.2	1.8	2.2	4.0	3.7
LEAD ug/l	1.4	2.2	1.8	1.3	2.1	2.5	1.4	1.5	3.2	2.2	3.4	1.5
MERCURY ug/l	<0.2	0.4			<0.2	<0.2			<0.2	<0.2		
NICKEL ug/l	30.5	40.0	30.0	35.0	13.0	30.0	20.0		6.7	70.0	30.0	32.0
SELENIUM ug/l	<5	<5		13.0	<5	<5	<5	12.9	<5	<5	<5	12.3
ZINC ug/l	80	29	70	160	90	<10	40	100	100	27	70	70

1985 INTENSIVE CANAL SURVEY

PARAMETER	B-10				B-12				B-13			
	FEB	MAY	JULY	NOV.	FEB	MAY	JULY	NOV.	FEB	MAY	JULY	NOV.
ALKALINITY mg/l	315	235	225	222	236	239	229	214	307	238	226	224
AMMONIA mg/l	0.27	0.09	0.32	0.40	0.33	0.10	0.36	0.34	0.26	0.09	0.30	0.37
B.O.D mg/l	2	4	1	2	2	3	2	2	1	3	1	2
CHLORIDE mg/l			89	103			86	97			87	61
CONDUCT. umhos/cm	700	520	600	500	750	520	600	600	700	520	600	600
C.O.D mg/l	39	44		58	54	51		62	60	56		62
FLUORIDE mg/l	0.24	0.24	0.22	0.24	0.24	0.24	0.22	0.22	0.23	0.23	0.20	0.21
NOX-Nmg/l	0.14	0.16	0.17	0.20	0.13	0.15	0.10	0.16	0.13	0.12	0.14	0.12
O-PO4 mg/l	0.008	0.005	0.005	0.032	0.008	0.003	0.003	0.035	0.008	0.006	0.005	0.032
PHENOLS ug/l	3	<2	5	<2	5	6	<2	2	<2	2	2	2
SULFATE mg/l		5.25		9.10		4.68		15.87		4.07		6.66
TURB. NTU	1.9	3.9	3.2	2.9	3.5	3.1	3.3	3.9	3.0	3.3	3.6	3.0
T-PO4 mg/l	0.010	0.018	0.026	0.042	0.013	0.014	0.034	0.045	0.012	0.014	0.028	0.044
T.F.R mg/l	435	425	1389	405	534	437	394	412	447	435	405	413
T.K.N mg/l	1.60	1.10	1.40	1.60	1.70	1.00	1.70	1.20	1.60	1.30	1.50	1.20
ARSENIC ug/l	3.3	<1	<1	1.0	3.7	1.8	1.0	3.8	1.7	1.7	2.9	2.3
CADMIUM ug/l	0.18	0.10	0.10	0.20	0.14	<0.1	0.10	0.20	0.25	<0.1	0.10	0.10
CHROMIUM ug/l	1.0	<1	<1	<1	1.0	<1	<1	<1	<1	2.1	<1	2.5
COPPER ug/l	3.1	1.6	2.7	1.6	2.6	1.4	2.8	2.0	1.8	1.9	2.9	3.1
LEAD ug/l	4.5	1.8	0.8	1.1	3.8	1.8	0.6	0.7	3.7	2.2	0.7	0.9
MERCURY ug/l	<0.2	0.2			<0.2	<0.2			0.2	<0.2		
NICKEL ug/l	19.0	40.0	30.0	29.0	26.0	40.0	30.0	18.0	35.3	60.0	40.0	36.0
SELENIUM ug/l	<5	<5	<5	14.6	<5	<5	<5	13.0	<5	<5	<5	16.7
ZINC ug/l	110	<10	50	60	120	12	30	50	160	<10	70	50

1985 INTENSIVE CANAL DATA SUMMARY

PARAMETER	AVERAGE mg/l	MAXIMUM VALUE	MINIMUM VALUE	STANDARD DEVIATION
ALKALINITY mg/l	239	315	207	34
AMMONIA mg/l	0.24	0.60	0.1	0.1
ARSENIC ug/l	2.0	4.6	0.5	1.1
B.O.D mg/l	2	4	1.0	0.8
CADMIUM ug/l	0.1	0.4	0.1	0.1
CHLORIDE mg/l	90.0	107.0	61.0	12.2
CHROMIUM ug/l	1.0	2.5	0.5	0.7
CONDUCT. umhos/cm	579	750	400	85
COPPER ug/l	2.7	6.6	1.4	1.2
C.O.D mg/l	52	64	39	9
FLUORIDE mg/l	0.23	0.26	0.16	0.02
LEAD ug/l	2.0	4.5	0.6	1.1
MERCURY ug/l	0.1	0.4	0.1	0.1
NICKEL ug/l	32	70	7	14
NOX-Nmg/l	0.20	0.51	0.08	0.11
O-PO4 mg/l	0.01	0.04	0.00	0.01
PHENOLS ug/l	2.3	6.0	1.0	1.5
SELENIUM ug/l	5.4	16.7	2.5	5.1
SULFATE mg/l	8.86	16.80	4.1	4.0
TURB. NTU	3.0	4.4	1.2	1.0
T-PO4 mg/l	0.03	0.05	0.01	0.01
T.F.R mg/l	459	1389	379	200
T.K.N mg/l	1.51	2.40	1.0	0.3
ZINC ug/l	65	160	5	44

1985 INTENSIVE CANAL STUDY

DRY SEASON

PARAMETER	SITES				
	B-2	B-3	B-5	B-10	B-13
HERBICIDES :					
2,4-D(ug/l)	0.07	0.04	0.10	ND	ND
2,4,5-TP(ug/l)	ND	ND	ND	ND	ND
CHLORINATED INSECTICIDES:					
ALDRIN(ug/l)	-	-	-	-	-
CHLORDANE(ug/l)	-	-	-	-	-
(o,p)-DDD(ug/l)	-	-	-	-	-
(p,p)-DDD(ug/l)	-	-	-	-	-
(o,p)-DDE(ug/l)	-	-	-	-	-
(p,p)-DDE(ug/l)	-	-	-	-	-
(o,p)-DDT(ug/l)	-	-	-	-	-
DIELDRIN(ug/l)	-	-	-	-	-
ENDRIN(ug/l)	-	-	-	-	-
HEPTACHLOR(ug/l	-	-	-	-	-
HEP. EPOX(ug/l)	-	-	-	-	-
LINDANE(ug/l)	-	-	-	-	-
METHOX.(ug/l)	-	-	-	-	-
MIREX(ug/l)	-	-	-	-	-
TOXAPHENE(ug/l)	-	-	-	-	-

1985 INTENSIVE CANAL STUDY

WET SEASON

PARAMETER	SITES				
	B-2	B-3	B-5	B-10	B-13
HERBICIDES :					
2,4-D(ug/l)	ND	ND	ND	ND	ND
2,4,5-TP(ug/l)	ND	ND	. ND	ND	ND
CHLORINATED INSECTICIDES:					
ALDRIN(ug/l)	ND	ND	ND	ND	ND
CHLORDANE(ug/l)	ND	ND	ND	ND	ND
(o,p)-DDD(ug/l)	ND	ND	ND	ND	ND
(p,p)-DDD(ug/l)	ND	ND	ND	ND	ND
(o,p)-DDE(ug/l)	ND	ND	ND	ND	ND
(p,p)-DDE(ug/l)	ND	ND	ND	ND	ND
(o,p)-DDT(ug/l)	ND	ND	ND	ND	ND
DIELDRIN(ug/l)	ND	ND	ND	ND	ND
ENDRIN(ug/l)	ND	ND	ND	ND	ND
HEPTACHLOR(ug/l	ND	ND	ND	ND	ND
HEP. EPOX(ug/l)	ND	ND	ND	ND	ND
LINDANE(ug/l)	ND	ND	ND	ND	ND
METHOX.(ug/l)	ND	ND	ND	ND	ND
MIREX(ug/l)	ND	ND	ND	ND	ND
TOXAPHENE(ug/l)	ND	ND	ND	ND	ND

APPENDIX V

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