Metropolitan Dade
County, Florida

DEPARTMENT OF ENVIRONMENTAL RESOURCES MANAGEMENT

1981 Ground and Surface Water Monitoring Programs

DERM

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Ground and Surface Water

Monitoring Programs

1981

Metropolitan Dade County, Florida
Department of Environmental Resources Management
Planning and Evaluation Division

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Preface

This report presents information and discusses results of programs the Dade County Department of Environmental Resources Management, Planning and Evaluation Division, is currently conducting to ascertain the quality of the county's ground and surface waters. These programs include the Groundwater Quality Monitoring Network, Monthly Canal Monitoring Program, Intensive Canal Program, and Annual Pollutant Study.

The Groundwater Quality Monitoring Network features biannual (rainy and dry season) sampling for a wide array of parameters to characterize existing groundwater quality in the county and provide a data base to establish long-term trends.

The Canal Monitoring Program provides an overview of water quality on all of the county's major canal systems via monthly sampling and analysis of general physical and chemical parameters. A companion program is the Intensive Canal Study which samples on a monthly basis a comprehensive set of parameters on one major canal per year. This program can determine if any specific problems exist for that canal, as well as establishing baseline water quality for future studies. A third surface water program, the Annual Pollutant Study, was initiated this year to provide a measure of the effects of increasing urbanization on the major canals of the county by comparing physical and chemical parameters at background and discharge stations along the canals.

Groundwater Quality Monitoring Network

A complete description of Dade County's groundwater quality monitoring program has been presented in an earlier report (DERM, 1980a). Briefly, the network is designed to monitor the quality of groundwater in the county via biannual (rainy and dry season) sampling and analysis of significant parameters (field analyses, nutrients, major ions, indicator bacteria where appropriate, etc.) and analysis of more specific parameters (metals, volatile organics, pesticides and herbicides) on an intermittent basis. The objective is to characterize existing groundwater quality in Dade County and build a data base from which long-term trends might be discerned.

Results

The initial sampling of this network was done from September 14th through September 25th, near the end of the 1981 rainy season. In all, twenty-nine (29) sites and thirty-five (35) wells were sampled. Figure 1 shows the locations of these sites and Table 1 provides information about each of the wells.

The following parameters were analyzed for each site (field analyses were done at each well):

General (field) analyses

- Specific conductance
- pH
- Alkalinity
- Temperature

Indicator bacteria (all shallow wells, less than 30 feet)

- Total coliform
- Fecal coliform
- Fecal streptococci

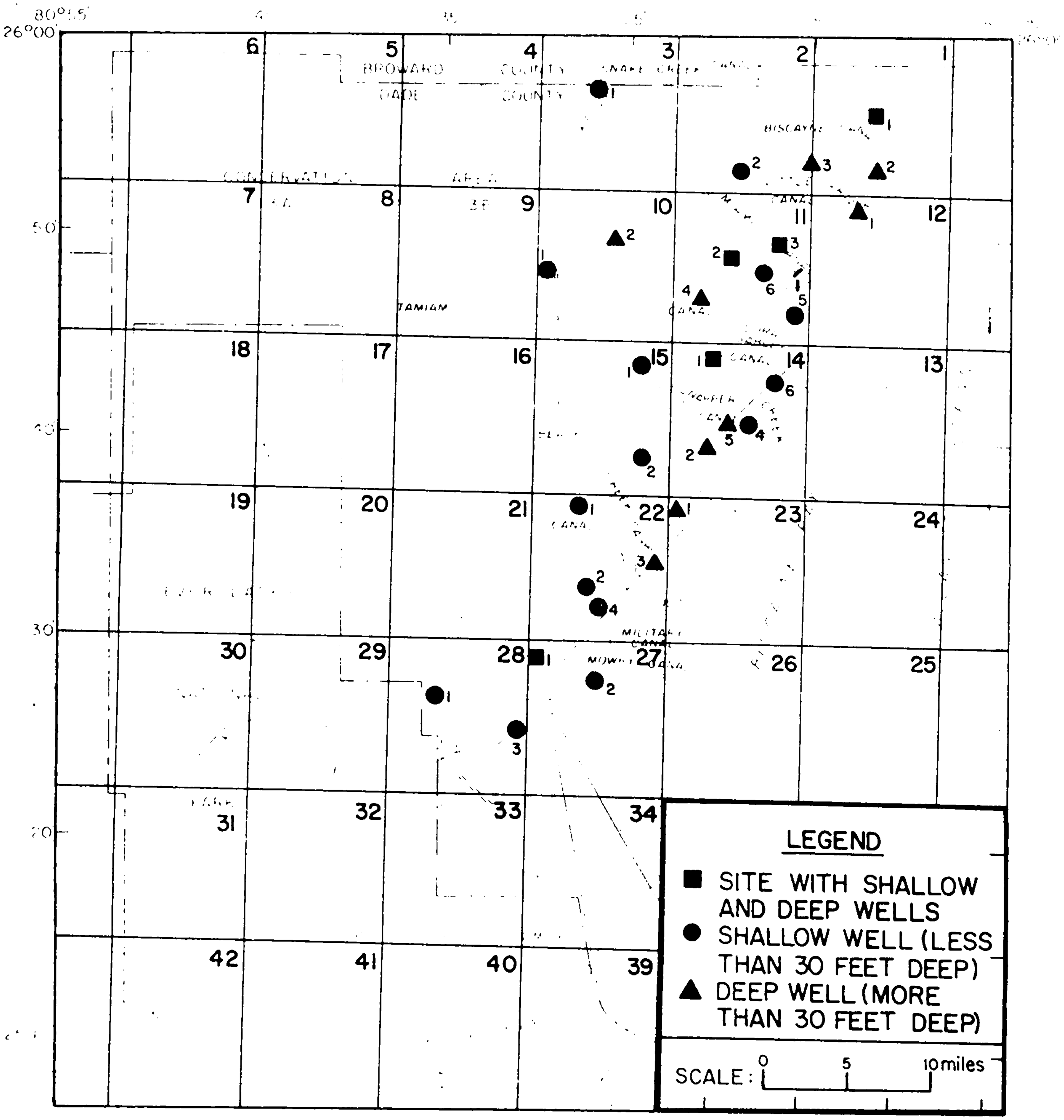


Figure 1

Locations of groundwater quality network sites and superimposed 7.5 identification grid

NETWORK #:	USGS #:	DEPTH (Feet)	LAND USE	SEWERED	LOCATION
1-1B	G-1631	20	Residential	No	N.E. 2nd Ave. & 163rd Street
D	G-1633	40			
1-2	G-430	97	Residential	No	Memorial Hwy. & N.E. 136-7 St.
1-3	(Opa-Locka WTP)	100	Residential	No	Burlington & Codadad (Opa-Locka)
2-2	GW-4	8	Bus., Residential	No	W. 8th Ave. & 74h St. (Hialeah)
3-1	G-1637	26	Recharge/Storage, Ind.	No	U.S. 27 & Opa-Locka W. Airport
10-1	G-1488	20	Recharge/Storage	No	N.W. 177 Ave. & 72nd Street
10-2	G-3103	21	Recharge/Storage	No	N.W. 120th Ave. & 42nd Street
11-2B	G-3057	20	Bus., Industrial	No	N.W. 74th Ave. & 70th Street
D	G-3059	40			
11-3B	G-1611	20	Residential, Bus.	Yes	West 1st Ave. & 19th Street (Hialeah)
D	G-1613	40			
11-4		60	Mia. Int'l Airport	Yes	N.W. 66th Ave. & 18th Street
11-5	GW-6	10	Residential	Yes	S.W. 37th Ave. & Ponce de Leon Blvd.
11-6		60	Industrial	Yes	N.W. 11th Ave. & 22nd Street
12-1	F-46	90	Residential	Yes	N.W. 5th Ave. & 69th Street
14-1B	G-1606	20	Residential	Yes	S.W. 90th Ave. & 38th Street
D	G-1608	40			
14-2	G-553	91	Residential, Ind.	No	S.W. 89th Ave. & 128th Street
14-4	G-580A	22	Residential	No	S.W. 67th Ave. & 112th Street
14-5	G-1604	62	Residential, Bus.	No	S.W. 75th Ave. & 105th Terr.
14-6	F-319	20	Residential, Bus.	No	U.S. 1 & S.W. 72nd Street
15-1	G-958A	27	Residential, Undev.	No	S.W. 127th Ave. & 51st St.
15-2	G-858	20	Resid., Undev., Ind.	No	S.W. 137 Ave. & 128 Street
22-1	G-1362	33	Residential, Agric.	No	S.W. 157th Ave. & 180th Street
22-2	G-614	18	Residential, Agric.	No	S.W. 257th Ave. & 232nd Street
22-3	(Marcia Jane WTP)	27	Residential, Agric.	No	S.W. 117th Ave. & 224th Street
22-4	G-1486	20	Residential, Agric.	Yes	S.W. 152nd Ave. & 284th St.
23-1	S-182	51	Residential, Agric.	Yes	S.W. 104 Ave. & 185th Terrace
27-1A	G-1615	10	Residential, Agric.	No	S.W. 182nd Ave. & 296th Street
D	G-1618	40			
27-2		27	Residential	Yes	S.W. 162nd Avenue & 320th Street
28-1B	G-3180	21	Recharge/Storage	No	S.W. 232nd Ave. & 392 Street
28-3	G-864	20	Residential/Agric.	No	S.W. 192nd Ave. & 352nd Street

Table 1

Groundwater Sites Sampled

Major inorganics

- Calcium
- Sodium
- Potassium
- Magnesium
- Sulfate
- Chloride
- Fluoride

Nutrients

- Ammonia
- Total Organic Nitrogen
- Nitrate
- Nitrite
- Total Kjeldahl nitrogen
- Ortho-phosphorus
- Total phosphorus

Pesticides

- Aldrin
- γ Chlordane
- α Chlordane
- DDE op'
- DDE pp'
- DDD op'
- DDD pp'
- DDT op'
- Dieldrin
- Endrin
- Heptachlor epoxide
- Lindane
- Methoxychlor
- Mirex
- Toxaphene
- Heptachlor

Herbicides

- 2,4, -D
- 2,4,5, - TP (Silvex)

Other significant parameters

- Dissolved solids (total filterable residue)
- Phenols
- MBAS (detergents)
- Color

As mentioned above, analysis for metals, volatile organics, pesticides and herbicides are more specialized and time-consuming. These parameters will be done initially for all wells in the network (to establish baseline groundwater quality) and later on a more site-specific basis.

Conductivity is the ability of a substance to conduct an electric current, and is reported in micromhos per centimeter. The measurement provides an indication of ion concentration. Natural waters are not simple solutions, and contain a variety of both ionic and undissociated species. However, conductivity readings are very useful in a practical way as general indications of dissolved solids concentrations.

Conductivity readings were generally in the 350-700 micromho range, which is consistent with past groundwater information in Dade County (for example, see recent U.S. Geological Survey reports). The only reading which fell out of this range was that obtained at site 11-6 (1,150 micromhos), which also showed chloride levels an order of magnitude higher than any other site in the network. The well is a deep one (60 feet), and is located in an industrial area near the inland extent of seawater intrusion. High levels of both of these parameters can be indicative of either industrial pollution or saltwater intrusion. It is interesting to note that sodium concentration was not high at this site, as would have been expected in the case of seawater intrusion. If these high conductivity and chloride values are the result of pollution, they might be expected to fluctuate somewhat in future sampling events.

pH, or hydrogen-ion activity, is expressed in logarithmic units, the abbreviation "pH" representing the negative base -10 log of the hydrogen-ion activity in moles per liter.

Most groundwaters have a pH range from around 6.0 to 8.5, but there is much variation. In the network, values ranged from 6.70 to 7.14.

Alkalinity is defined as the capacity of a solution to neutralize acid at a specified pH value. In Dade groundwaters, alkalinity is practically all produced by dissolved bicarbonate ions (see discussion under Major Inorganic Ions), and is expressed as equivalent concentrations of calcium carbonate.

In the groundwater network, alkalinity ranged from 172 mg/l to 400 mg/l. Some variation can be expected in future analyses, as processes releasing carbon dioxide (such as sulphate reduction) can contribute to higher values of alkalinity.

Temperature ranged from 24.5 to 30.0° Centigrade for the wells sampled. It might be expected that the shallow wells would show the highest temperatures and the deeper ones lower temperatures; this holds true in some cases, but from the available data no trend is evident. At this time the above temperature range will be considered normal for the rainy season.

Indicator Bacteria (see also discussion under the Monthly Canal Program, p.16-17.) Total and fecal coliform and fecal streptococci were sampled for all shallow wells (less than 30 feet), since past experience has shown that bacteria in groundwater are generally short-lived and found close to the source of contamination.

Results from twenty-two (22) wells showed that no bacteria problems are evident in the network. The only high total (920 MPN/100 ml) and fecal (220 MPN/100 ml) coliform levels were observed at site 27-2. A check on previous monitoring data (Roger Gatlin, oral communication) revealed some past irregularities. A likely explanation for these high levels is the fact that, on more than one occasion, a black snake has been observed inhabiting the well casing.

Major Inorganic Ions. It is the character and proportions of the major inorganic ions and nutrients which constitute a certain "type" of groundwater, imparting some of the water's physical properties (hardness, dissolved solids, etc.). More complete background information with regard to major inorganic ions and nutrients in Dade's groundwater is presented in the report describing the groundwater network (DERM, 1980a, pp.4-5) and the references contained therein.

Groundwater in Dade County is dominated by calcium and bicarbonate, with chloride, sulfate, potassium, sodium, and magnesium being, for the most part, less significant. The inorganic ions are largely the dissolution products of the geologic materials comprising the aquifer. The principal component of the aquifer is limestone. Carbonic acid, formed by carbon dioxide dissolving in the groundwater, leaches the limestone, forming large quantities of calcium bicarbonate.

Sulfate concentrations were found to vary greatly over the county. This is largely due to the fact that the chemistry of sulfur in groundwater is controlled by many factors, particularly the presence of anaerobic bacteria and availability of oxygen, but also by pH, other dissolved ions in solution, and plant utilization. Although much sulfur might be available in the environment, the reduction of sulfate to sulfide by anaerobic bacteria can lower the sulfate concentration. This is particularly evident in the recharge-storage areas, as represented by Sites 3-1, 10-1, 10-2, and 11-2. Water obtained from these wells during sampling yielded the characteristic "rotten egg" smell of hydrogen sulfide.

Chloride shows a more subdued chemical behavior in groundwater when compared to the other major ions. Chloride ions do not significantly enter into oxidation or reduction reactions, form no important solute complexes with other ions, do not form salts of low solubility, are not significantly adsorbed on mineral surfaces, and play few vital bio-chemical roles. The circulation of chloride ions in the hydrologic cycle is largely through physical processes. As such, this ion can be utilized as a measure of certain sources of pollution, such as septic tanks, dumps, and industrial contamination. The latter appears to be the case at Site 11-6 (as discussed under Conductivity, p. 5).

Fluoride concentration was also examined. This constituent is naturally occurring and sometimes larger amounts may be derived from deeply-buried residues left from former invasions of the sea. Though detected at all localities, no site in the network showed a higher fluoride concentration than 0.34 mg/l.

Nutrients are essential for the growth, maintenance, and regeneration of life. Certain nutrients (such as oxygen, hydrogen, and carbon) are abundant and generally available in sufficient amounts. Nitrogen and phosphorus compounds, however, are sometimes limited in their concentration and distribution. The nitrogen and phosphorus species examined in the groundwater sampling are listed on page 4. Although nitrogen and phosphorus are naturally occurring, they also may be added to the groundwater system via contamination from septic tanks, dumps, stormwater runoff, sewage effluent, and fertilizer application.

The dominant nitrogen species depends largely upon the geology and soils of the area. In the northern part of the county there is a greater proportion of sand to limestone, which lowers permeability and facilitates reducing conditions, leading to the formation of ammonia. Additionally, decaying organic matter in the muck soil of the (undeveloped) northwestern portion of the county produces ammonia and organic nitrogen. In south Dade, the highly permeable limestone substrata promotes oxidation, which favors the occurrence of nitrate. Agricultural practices in this part of the county also contribute nitrate.

A line can be drawn between grids 11 and 14 in the groundwater network (Fig. 1) approximating the area north of which ammonia predominates, and a second line can be drawn between grids 15 and 22, south of which nitrate predominates. Two sites in the northern section (2-2 and 11-5) show (relatively) high nitrate levels. The wells are both shallow (8 and 10 feet, respectively) and the areas are serviced by septic tanks, indicating contamination from this source. All other high nitrate levels are encountered in grids 22 and 27, which are agricultural areas; fertilizer application figures heavily in these readings.

The highest ammonia level (3.30 mg/l) was found at Site 11-3D, a 40 foot deep well in Hialeah. This reading is identical to levels obtained by the U.S. Geological Survey during a study of areas serviced by septic tanks (Pitt, Mattraw, and Klein, 1975). A second well (14-1B) in West Miami showing a relatively high ammonia level (1.60 mg/l) is also located in an area serviced by septic tanks.

Ortho- and total phosphorus concentrations are low throughout the network. Orthophosphorus, which is readily assimilated by plants, ranged from 0.001 to 0.112 mg/l and averaged 0.019 mg/l. Most of this nutrient is complexed with calcium ions, which chemically binds the phosphorus to limestone.

Total phosphorus, which includes phosphorus tied up in living cells and in detrital material, averaged 0.026 mg/l and ranged from 0.004 to 0.114 mg/l.

Ortho- and total phosphorus levels in the two wells discussed above (11-3D and 14-1B) showing high ammonia concentrations were above the averages (0.036 and 0.043 mg/l at Site 11-3, respectively, and 0.033 and 0.035 mg/l at Site 14-1). This again provides an indication of contamination by septic tank effluent. In the undeveloped (background) areas in northwest Dade (Sites 3-1. 10-1, and 10-2), which also show high ammonia levels (for reasons mentioned above), phosphorus concentrations are low. Of the nutrients, phosphorus is generally the limiting factor in these wetland areas.

Chlorinated Insecticides and Herbicides. Chlorinated insecticides were analyzed at all sites with the following results:

Site	Compound(s) present
1-1	0.001 ug/l p.p.'DDE
1-2	0.001 ug/l Dieldrin
1-3	0.0026 ug/l Dieldrin
11-3	0.002 ug/l Dieldrin
12-1	0.001 ug/l Dieldrin

No other detections were recorded at any other site (detection limits are given in Table 2 for the substances examined).

The herbicides 2,4-D and 2,4,5-TP (Silvex) were analyzed for all sites with no detections.

Other Significant Parameters. In addition to the parameters already mentioned, color, total filterable residue, methyl-blue activated substances (MBAS), and phenols were also examined.

Color is a physical property which has no chemical significance. Color (reported in platinum-cobalt units) tended to be highest (40-80 pcu) in the northern and north-western areas, and lowest (5-30 pcu) in the central and southern parts of the county.

The higher colors tend to be the result of leaching of organic debris. However, the color number is purely empirical and has no direct connection with the actual amount of organic material present.

Table 2

Detection Limits for

Chlorinated Insecticides and Herbicides

	DETECTION LIMITS (ug/l)
Chlorinated Insecticides:	
Lindane	0.0005
Aldrin	0.0005
Heptachlor Epoxide	0.0010
o,p-DDE	0.0010
p,p-DDE	0.0010
γ -chlordane	0.0010
α -chlordane	0.0010
0,p-DDD	0.0010
p,p-DDD	0.0025
o,p-DDT	0.0025
p,p-DDT	0.0025
Dieldrin	0.0010
Endrin	0.0025
Methoxychlor	0.0075
Mirex	0.0035
Toxaphene	0.010
Heptachlor	0.0005
Herbicides:	
2.4-D	0.001
2,4,5 TP (Silvex)	0.001

Total Filterable Residue (or dissolved solids) is the anhydrous residue of the dissolved substances in water. Several methods may be employed for this determination; DERM considers the residue-on-evaporation method to approach most closely this theoretical definition.

Water with several thousand mg/l of dissolved solids is generally not potable, and the U.S. Public Health Service recommends that the maximum concentration of dissolved solids not exceed 500 mg/l in drinking water (this is also Dade County's standard). Generally, most industrial users will not tolerate concentrations higher than 1000 mg/l. Water with less than 1000 mg/l of dissolved solids is considered non-saline, with concentrations of 1000 to 3000 mg/l being considered slightly saline.

Total filterable residue ranged from 48 to 1448 mg/l in the network, the latter occurring at Site 11-6, which has already been discussed in the sections on chloride and conductivity. The only other site with a concentration over 500 mg/l (538) was Site 14-1, which is probably contaminated by septic tank effluent (see discussion of ammonia levels, p. 9).

Although most of the wells sampled were shallow (less than 30 feet), deeper wells were also sampled and at this time no trend of concentration vs. depth can be discerned.

MBAS (sometimes referred to as detergents) can persist in waters which have been contaminated by sewage effluents. One mg/l is sufficient to cause a noticeable froth in water, and higher concentrations can be a serious problem. No excessive levels were observed in the network, as MBAS concentrations ranged from less than 0.010 mg/l to 0.109 mg/l.

Phenols indicate a broad spectrum of substances. The source of phenolic compounds may be naturally occurring or from industrial waste, domestic sewage, or pesticides. An excess of phenols may cause odor in water supplies; hence, a stringent standard has been set (0.001 mg/l). Health limits are considerably higher (3 mg/l).

Previous groundwater investigations in Dade and Broward Counties have indicated that phenol concentrations, even in background areas, consistently exceed the above standard. This is verified by the results of the September sampling. Concentrations for the most part were 0.002 mg/l or less, but certain portions of the county showed higher levels (0.006 to 0.015 mg/l). These areas include sites 2-2 and 11-3 in Hialeah (see also the section on the Miami Canal Intensive Canal Study, p. 59) and some residential areas in central Dade (Sites 14-1 and 14-5). The latter is consistent with surface water data collected by DERM in 1980 (see Snapper Creek Intensive Canal Study in DERM, 1981b, p. 19).

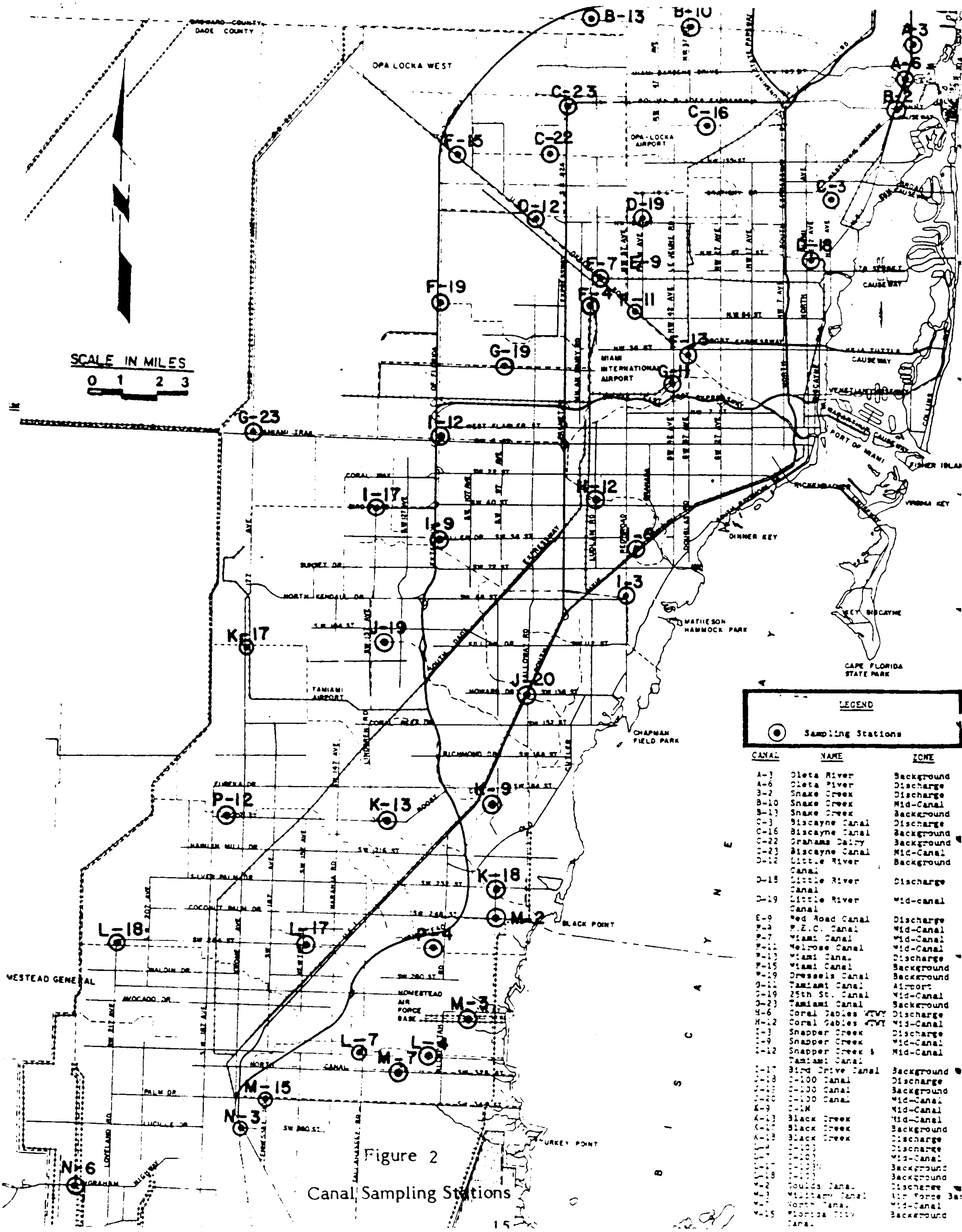
The results from Sites 3-1 and 10-1 (located adjacent to Water Conservation Area 3B) were expected to aid in determining whether these high levels are due to natural occurrences. These stations are located in the Area B floodplain (between Krome Avenue and the Palmetto Expressway), which is an area receiving the major overflow from the Everglades. Before development, this overflow went through the Miami River. The vegetation of the area consists largely of melaleuca trees, an exotic species which invades wetlands and serves as a source of phenolic compounds. Unfortunately, interference prevented determinations at these sites. This can be compensated for at the next analysis (April, 1982), and the data obtained should be particularly helpful.

Canal Monitoring Program

Dade County's Canal Monitoring Program (DERM, 1979) is designed to present an overview of water quality for the County's major surface water systems via monthly sampling and analysis of general physical and chemical parameters. The stations are located on each canal so as to obtain samples which are representative of background conditions (little affected by man), mid-canal conditions (which are representative of the predominant land use(s) along the canal and may or may not show the effects of contamination), and discharge points, which are representative of the quality of inland waters entering Biscayne Bay. The latter also serve to measure the inland extent of seawater intrusion and give indications whether or not salinity gates are functioning effectively.

The canals sampled in the network include the following (Figure 2):

1. Oleta River - A series
2. Snake Creek Canal - B series
3. Biscayne Canal - C series
4. Little River Canal - D series
5. Miami Canal - F series
6. Tamiami Canal - G series
7. Coral Gables Waterway - H series
8. Snapper Creek Canal - I series
9. C-100 Canal - J series
10. Black Creek Canal - K series
11. C-103 Canal - L series
12. Goulds Canal System - M series
13. C-102 Canal - P series



CANAL	NAME	ZONE
A-3	Oleta River	Background
A-6	Oleta River	Discharge
B-2	Snake Creek	Discharge
B-10	Snake Creek	Mid-Canal
B-13	Snake Creek	Background
C-3	Biscayne Canal	Discharge
C-16	Biscayne Canal	Background
C-22	Grahams Dairy	Background
C-23	Biscayne Canal	Mid-Canal
D-12	Little River Canal	Background
D-15	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	25th St. Canal	Mid-Canal
G-23	Tamiami Canal	Background
H-6	Coral Gables WTWY	Discharge
H-12	Coral Gables WTWY	Mid-Canal
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-102	Mid-Canal
L-17	C-103N	Background
L-18	C-102	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

Figure 2

Canal Sampling Stations

Three additional stations on the Miami Canal (F-5, F-6, and Station "X") are provided for this year's Intensive Canal Study (see Figure 3, p. 26 for locations).

Parameters and Standards

The following standards are applicable to the parameters analyzed monthly:

Indicator Bacteria	
Total Coliform	1000 MPN/100m/
Fecal Coliform	200 MPN/100 m/
Fecal Streptococci	No Standard
Conductivity	500 micromhos/cm
Dissolved Oxygen	4 mg/l
Nitrate	No Standard
Nitrite	No Standard
Transparency	The depth of the compensation point for photosynthetic activity not reduced by 10% over background

Additionally, water depth and temperature, and general field observations (wind speed and direction, canal flow, cloud cover, air temperature and any other pertinent water conditions) are recorded for each station as an aid in the interpretative process.

Results and Discussion

Indicator bacteria Most natural aquatic systems contain bacteria, some of which are pathogenic. Pathogenic bacteria may enter water bodies through discharge of domestic sewage into the waterway or from stormwater or agricultural runoff. Certain non-pathogenic bacteria (coliforms and fecal streptococci) are used as indicators of pathogens. The number of these bacteria indicate the degree of contamination, and their ratios may indicate the source.

Coliform bacteria are the most commonly used indicators of domestic sewage and runoff entering a water body. This group of bacteria includes Escherichia coli, a variety of intermediary species from warm-blooded animals. Coliform bacteria also include a variety of species occurring naturally in soils.

Fecal streptococci are found in greater numbers within the intestines of warm-blooded animals than in human intestines. The ratios of fecal coliform to fecal streptococci give an indication of the source of fecal contamination (Goldreich and Kenner, 1969).

As reported last year (DERM, 1981b), high total and fecal coliform levels are the major surface water problem plaguing the county at the present time; Table 3 shows these levels and Table 4 provides the 1980 data for comparison. While high levels of indicator bacteria at background stations are infrequent and can be explained as due to wildlife, high coliform levels at mid-canal and discharge points may be due to contamination from surrounding land uses, sewage disposal, stormwater runoff and drainage systems, septic tank effluent, as well as the number of birds and animals on or in the canals. These levels fluctuate greatly; of course, it can be expected that canals receiving large quantities of stormwater would show very high coliform levels during the rainy season and much lower levels during the dry season. This pattern is seen at stations on the Little River, Miami, Red Road, and Melrose Canals and at the discharge station along Snapper Creek. Data from the canal program correlate well with a stormwater outfall inventory previously conducted by Dade County (DERM, 1981c).

Table 3

1981 Levels of Indicator

Bacteria in Major Canals

Canal System	No. of Stations	Total Coliform	Fecal Coliform	Fecal Strep
Oleta River	2	968	30	43
Snake Creek	3	551	133	32
Biscayne Canal	4	1,132	152	40
Little River Canal	3	984	295	77
Red Road Canal	1	2,034	636	87
Miami Canal	8	613	184	59
Tamiami Canal	4	579	126	61
Coral Gables Waterway	2	1,232	707	78
Snapper Creek Canal	3	635	289	66
C-100 Canal	3	248	53	26
Black Creek Canal	4	682	117	25
C-103 Canal	4	128	41	25
Goulds Canal	4	1,145	80	35
Card Sound	1	606	56	61
C-111 Canal	1	145	54	27
C-102 Canal	2	288	44	31
Overall Canal System Average	49	706	177	47

Table 4

1980 Levels of Indicator

Bacteria in Major Canals

	No. of Stations	Total Coliform	Fecal Coliform	Fecal Strep
Oleta River	2	5,661	1,404	145
Snake Creek Canal	3	635	109	44
Biscayne Canal	4	1,109	164	45
Little River Canal	3	1,130	293	79
Miami Canal	6	1,312	316	58
Tamiami Canal	5	569	114	37
Coral Gables Waterway	2	2,855	624	89
Snapper Creek Canal	3	712	275	55
C-100 Canal	3	338	51	25
Black Creek Canal	4	1,062	138	30
C-103 Canal	4	225	38	29
Goulds Canal System	4	934	100	40
C-102 Canal	2	344	58	33
Overall Canal System Average		1,079	226	50

Other canals, such as the Biscayne, Military, Snake Creek, North, Florida City, and the Coral Gables Waterway show no such trends, with high bacteria levels occurring at some times in the rainy season and at some times in the dry season. All canals showing high levels of indicator bacteria which could not be ascribed to stormwater runoff were field investigated for sources of contamination. The stations along the Coral Gables Waterway (H-6 and H-12) revealed a large number of ducks in the vicinity, and this is a likely explanation for the high levels obtained. The other canals appeared to be healthy water bodies, not stagnant, and with the expected amount of vegetation, fish, and wildlife. This is particularly true of many of the stations in the largely undeveloped southeastern portion of the county, where wildlife is most likely the major source of bacteria. Also, a certain amount of illegal dumping occurs in this area, and may constitute another source.

The stations investigated in the northern portion of the county did not reveal pollution problems either. North Dade has a thicker soil mantle than does south Dade, and probably the high bacteria counts obtained here result from an increased contribution by soil coliforms.

In summary, though high levels of indicator bacteria occur often in Dade canals, this does not always indicate a pollution problem. In many instances these high levels result from natural causes, such as wildlife or soil. The major contamination problems at this time are related to stormwater runoff, and occur mainly in the northern and (less frequently) in the central portions of the county. DERM is currently examining the feasibility of removing some existing positive drainage systems as part of Dade County's Areawide Water Quality Management Plan. It is also county policy to allow positive drainage in new developments only when other alternatives prove inadequate. It is hoped that these measures will serve to alleviate this problem in the future.

Dissolved Oxygen (Table 5) on some major canals did not meet the standard (at least 4 mg/l) at all times, but this does not necessarily indicate a problem. D.O. levels are lower in the South Florida surface water system than in other surface water systems due to the close hydraulic interraction between the canals and the groundwater, which contains little dissolved oxygen. This is borne out by the variation of D.O. levels through the county, with the lowest levels seen in north Dade and the highest levels observed in south Dade canals. This is consistent with geologic conditions in the county, the predominantly sandy substrata in the north allowing much less oxygen to mix with the groundwater than the highly porous limestone in the south.

Low D.O. levels can result in eutrophic conditions, but as water is continually released through control structures, this problem seldom occurs in Dade County.

Conductivity values for Dade canals generally range from 500 to 800 mmhos/cm, which exceeds the state standard (500 mmhos/cm). This is due in part to the calcium bicarbonate equilibrium system (discussed in the groundwater section, p. 5). Saturation with respect to calcium bicarbonate can contribute as much as 300 mmhos to the overall value. Conductivity values greater than 1000 mmhos/cm occur at discharge stations located near the inland extent of seawater intrusion, including stations A-3 and A-6 (Oleta River), H-6 (Coral Gables Waterway), K-18 (Black Creek), L-4 (C-103), M-2 (Goulds Canal) and M-3 (Military Canal). The fact that the salt front extends farthest inland in south Dade is reflected at these stations.

Nitrate and Nitrite occur as different oxidation states of nitrogen. In general, the oxidation of organic nitrogen in air can be expected to produce nitrite (N^{+3} oxidation state) and finally nitrate (N^{+5} form).

Nitrogen in the form of dissolved nitrate is a major nutrient for vegetation, and the element is essential to all life. Certain species of bacteria in soil and blue-green

Table 5

Dissolved Oxygen Levels on Major

Dade County Canals for 1980 and 1981

Canal System	1981	1980
Oleta River	3.85	3.45
Snake Creek Canal	3.57	4.13
Biscayne Canal	3.58	3.78
Little River Canal	2.67	2.73
Red Road Canal	3.20	----
Miami Canal	2.84	3.20
Tamiami Canal	2.78	3.18
Coral Gables Waterway	4.45	3.65
Snapper Creek Canal	2.07	4.00
C-100 Canal	4.83	5.00
Black Creek Canal	4.58	4.70
C-103 Canal	5.95	5.38
Goulds Canal System	6.53	4.98
C-102 Canal	5.15	4.35
Card Sound Canal	1.90	----
C-102 Canal	6.60	----
Overall Canal System Average	3.97 (weighted) mean	4.0 (not weighted)

algae and other micro-biota occurring in water can extract nitrogen from air and convert it to nitrate. Some nitrate also occurs in rainfall. Also, as explained in the Groundwater Section of this report (see p. 8), the oxidizing or reducing capability of the strata will determine whether nitrate or ammonia is the dominant nitrogen species in groundwater. This refers only to background water quality, and not contributions by man.

As shown in Table 6, nitrate levels in south Dade canals greatly exceed those in north Dade, due mainly to the agricultural activity in this area. However, at no time did levels reach as high as 6 mg/l, so despite contributions from this source, nitrate levels are not considered excessive.

Nitrite tends to be very short-lived and oxidizes immediately to nitrate. Nitrite concentrations in Dade canals in 1981 averaged 0.02 mg/l and at no time exceeded 0.18 mg/l.

Transparency. Secchi Disk readings have been taken at all canal stations for the past two years (1980 and 1981) on an experimental basis. What the data has shown thus far is that south Dade canals show a greater degree of transparency than those in north Dade. This is a result of higher color contributed from the better-developed soil cover in the north. Lowest secchi disk readings are seen in canals flowing through the Water Conservation Areas, including the Miami, Tamiami, and Snake Creek canals. The peat and muck soil of the Conservation Areas contribute organic matter which adds color to canal waters, reducing transparency.

Transparency is also low at discharge stations (including those in south Dade), probably as a result of increased turbulence and/or contributions from seawater.

Table 6

Nitrate-Nitrogen Levels on Major

Dade County Canals for 1981

Oleta River	0.26
Snake Creek Canal	0.16
Biscayne Canal	0.18
Little River Canal	0.16
Red Road Canal	0.13
Miami Canal	0.13
Tamiami Canal	0.09
Coral Gables Waterway	0.25
Snapper Creek Canal	0.08
C-100 Canal	0.06
Black Creek Canal	0.33
C-103 Canal	1.83
Goulds Canal System	0.88
C-102 Canal	1.11
Card Sound Canal	0.05
C-102 Canal	0.05
Overall Canal System Average	0.39 (weighted)

Intensive Canal Study

The Dade County Department of Environmental Resources Management annually samples one major canal and analyzes an extensive set of physical and chemical parameters. This program can detect water quality problems of a specific nature extending beyond the general canal monitoring program, and establishes baseline water quality for the county's surface water systems.

In 1980 Snapper Creek was selected as the first canal to be monitored in this program, largely due to its location near a major wellfield. The Miami Canal was sampled in 1981 for much the same reason. The Hialeah and Miami Springs wellfields are located adjacent to the Miami Canal and derive much dry-season recharge from the canal due to the close hydraulic connection between the canal and the aquifer in this area. As mentioned in the preceding section of this report, the Miami Canal receives a considerable amount of stormwater runoff, leaving the potential for contamination.

Site Location (Figure 8)

Three stations on the Miami Canal are included in the monthly canal program. Stations F-15, F-7, and F-13 provide background, mid-canal, and discharge points, respectively. Stations F-5 and F-6 were added to provide additional mid-canal sites upgradient to the wellfield area (Station F-7 in the monthly network is deemed representative of the canal water recharging the wellfields). An additional background site, Station X, located near the junction of Krome Avenue and U.S. 27, provides a characterization of water in the Miami Canal entering Dade County from Water Conservation Area 3B.

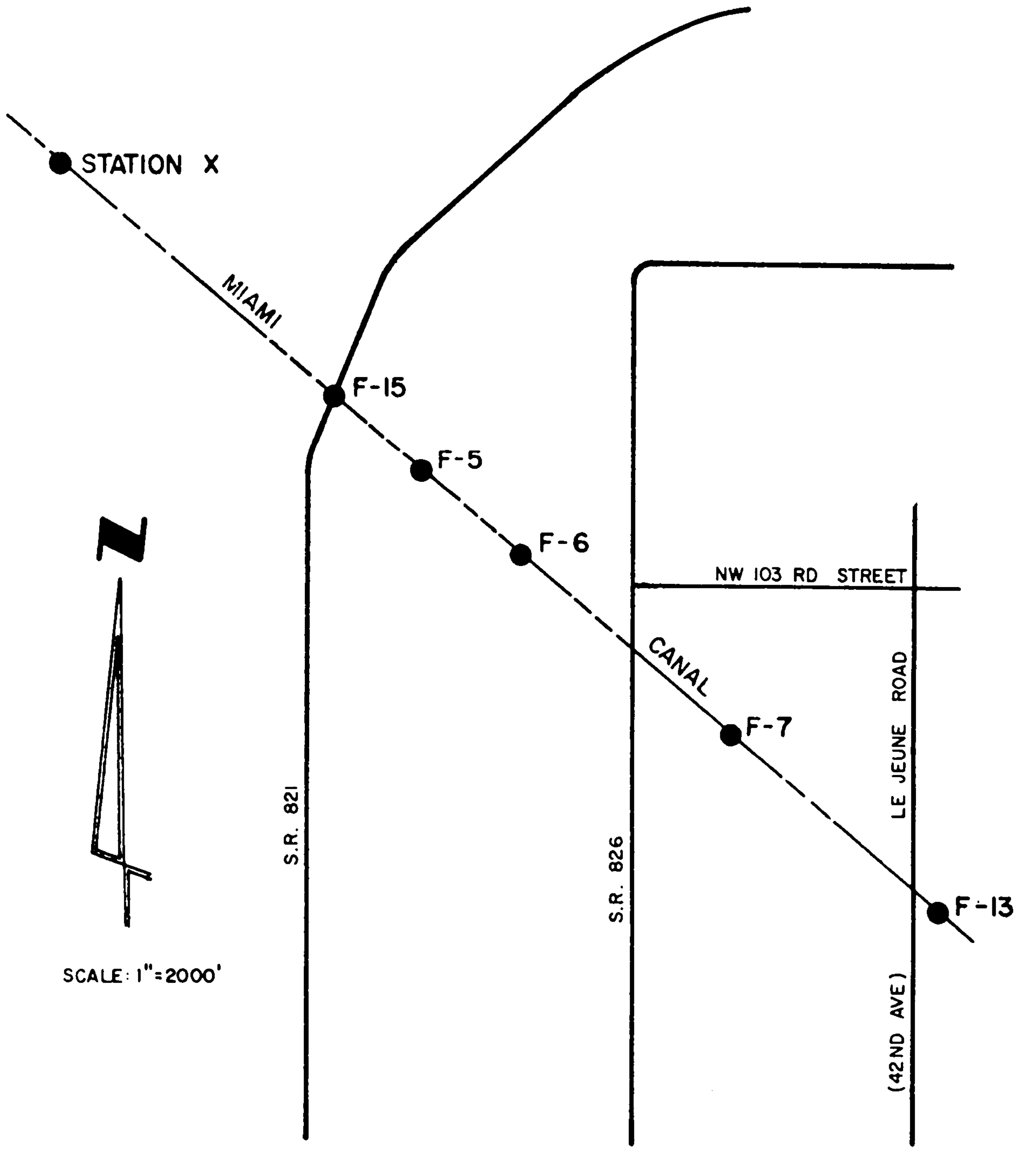


Figure 3
1981 Sampling Stations on the Miami Canal

Parameters

The following parameters were analyzed for the Miami Canal:

Alkalinity	Total Filterable Residue
Biochemical Oxygen Demand	Phenols
Chemical Oxygen Demand	Silver
Ammonia	Arsenic
Total Organic Nitrogen	Cadmium
Total Kjeldahl Nitrogen	Chromium
Nitrate	Copper
Nitrite	Mercury
Ortho-phosphorus	Lead
Total Phosphorus	Zinc
Flourides	Chlorinated Insecticides
MBAS	Herbicides
Turbidity	

All parameters were analyzed monthly (except where noted).

Results and Discussion

Alkalinity -- The state standard dictates that alkalinity exceed 20 mg/l. Values for the Miami Canal stations ranged from 108 to 281 mg/l and averaged 216 mg/l.

Biochemical Oxygen Demand -- BOD in surface water in South Florida is directly related to dissolved oxygen levels. As Dade's artificial waterways allow considerable interaction between ground and surface waters, BOD levels are difficult to assess (as explained earlier, dissolved oxygen is generally low in groundwater). If BOD does not exceed 4 mg/l, organic loading is usually not deemed a problem. BOD in the Miami Canal averaged 2 mg/l, with a maximum of 5 mg/l seen at Station F-7 in May (no samples in September or October).

Chemical Oxygen Demand -- COD is utilized as a general measure of pollutants and indicates everything in a sample which can be oxidized (including inert materials when made soluble). Values ranged from 30 to 96 mg/l, and averaged 53 mg/l for all stations. As this parameter has not been analyzed extensively in the past for Dade canals, the results obtained will at this time be considered as background (no samples in April).

Ammonia

Ammonia levels increased during and immediately following the rainy season, the average for all stations increasing from a 0.14 mg/l mid-year value to a final mark of 0.23 mg/l. This can be attributed to an increased contribution of groundwater to the canal when the flood gates are opened, as the groundwater in the northern part of the county is under reducing conditions (see p. 8), with ammonia the dominant nitrogen species. A similar pattern was not observed during the 1980 Snapper Creek study, since groundwater in central and south Dade shows oxidizing rather than reducing conditions.

Total Organic Nitrogen -- past data indicates that TON levels for Dade's surface waters are rarely below 0.7 mg/l, and the data for the Miami Canal are consistent with this. No seasonal fluctuations like those for ammonia were observed, and the overall average of 1.3 mg/l is not considered excessive.

Total Kjeldahl Nitrogen -- TKN is a combination of total organic nitrogen and ammonia. As such, levels increased slightly the second half of the year, as noted above. The mean value of 1.5 mg/l is consistent with background levels for north Dade canals.

Nitrate and Nitrite levels were low, as can be expected for north Dade canals. Nitrate averaged 0.123 mg/l for all stations, while nitrite showed a final mark of 0.014 mg/l.

Ortho- and Total Phosphorus — (See also the discussion in the groundwater section of this report, p. 9). Ortho- and total phosphorus levels were nowhere along the Miami Canal excessive, and can at this time be considered as background. Ortho-phosporus ranged from 0.001 to 0.011 mg/l (average at 0.003 mg/l), while total phosphorus ranged from 0.005 to 0.050 mg/l (average of 0.017 mg/l). No seasonal or station-to-station trend appeared evident.

Flourides — occur naturally in water and in some cases are added in treatment processes. Concentrations for the Miami Canal remained consistently low, averaging 0.26 mg/l and at no time rising above 0.43 mg/l or below 0.19 mg/l.

MBAS (detergents) — MBAS concentrations for the Miami Canal ranged from 0.01 to 0.17 mg/l and averaged 0.05 mg/l. The standard for Dade County surface water is 0.5 mg/l.

Turbidity — the turbidity standard for Dade County is 50 Jackson Turbidity Units. However, analysis by the DERM laboratory is now reported in Formazin Turbidity Units. A conversion (provided by the Florida Department of Environmental Regulation) shows the standard to equal 22 FTU's Turbidity for the Miami Canal averaged

4.0 FTU's and showed only one high value (32.0 FTU's, Station F-7 in January). This level did not persist, and was not approached at any other time of the year.

Total Filterable Residue -- a measure of dissolved solids, TFR levels on the Miami Canal are high with regard to Dade's standard of 500 mg/l. The overall average for all stations was 490 mg/l, but levels exceeded 700 mg/l only twice, 835 mg/l at Station F-7 in January (which also showed high turbidity, see above) and a maximum of 1399 mg/l at Station F-13 in December. In general, TFR appeared highest during the dry season and lowest during the rainy season (probably due to dilution).

Phenols -- as reported elsewhere (DERM 1981b, 1981d) and in this report (p. 13), baseline phenol levels tend to be high in Dade County due to the natural occurrence of these substances in wetland areas (the suspected culprit at this time is the melaleuca tree, an exotic species which has displaced native ones in these areas). The two background stations in this study (Station X and F-15) show average phenol levels approaching 0.003 mg/l. However, higher concentrations are noted down-gradient, particularly at Station F-13 (discharge), which showed readings of 0.018 mg/l in June and 0.020 mg/l in March. These occurrences are suggestive of pollution, although this cannot be verified until specific phenolic compounds are examined. Communication with the Dade County Pollution Control Division indicated that the most likely source of contamination would be the Miami International Airport, via connection with the 36th Street drainage canal. It should be noted that the station representing the recharge area for the wellfields (F-7) showed an average of 0.003 mg/l (which is also the overall canal average) and maximums (0.009 and 0.008 mg/l for January and June, respectively) that are consistent with background conditions.

Metals -- several of the trace metals were analyzed at various times during this study (noted below); at least one analysis was conducted for the rainy season, and at least one for the dry season, for each station.

Silver (March, May, September, December) was not detected at any time.

Arsenic (March, May, June, July) was everywhere below the detection limit of 0.010 mg/l.

Cadmium (March, May, June, September, December) was at all times below the aquatic standard of 0.012 mg/l (maximum of 0.001 mg/l at Station X in May).

Chromium (March, May, September, December) was below the detection limit of 0.001 mg/l at all sites.

Copper (March, September, December) at all times remained below the most stringent standard for canal waters (0.030 mg/l); the highest level seen was 0.0059 mg/l at Site F-5 in December.

Mercury (January, May, June, July, September, December) remained below the detection limits for all stations, with the exception of Station X (0.0003 mg/l), F-5 (0.0004 mg/l), and F-13 (0.0003 mg/l), all in December. These occurrences are not of concern when it is remembered that mercury is naturally occurring and one of the highest levels was observed at a background station (Station X).

Lead (January, February, May, September, December) levels were low with regard to the standard of 0.03 mg/l, averaging 0.0026 mg/l with a high of 0.0133 mg/l at Site F-15 (background) in May.

Zinc (January, May, September, December) at no time approached the standard (0.03 mg/l). The highest level (0.0043 mg/l) was observed at Station F-5 in December.

Chlorinated Insecticides and Herbicides (See Table 2 on p. 11) were examined during the wet season (July) and the dry season (January) and were not detected.

Annual Pollutant Study

In 1981 DERM initiated a study to compare chemical and physical parameters measured at upstream (background) and discharge stations on the county's major canal systems. The results yield an indication of the influence of urbanization upon surface water quality.

Sampling for this year was conducted on six canal systems during the dry season (February) and five canal systems during the rainy season (August). The sampling will alternate in the coming years with no canal being sampled in the same season for two consecutive years.

Canal systems sampled during the dry season were the Oleta River, Snake Creek, Little River, Tamiami, C-100, and C-103 Canals. Those sampled during the rainy season included the Biscayne, Snapper Creek, Black Creek, C-111, and C-102 Canals (See Figure 2, on p. 15).

The following parameters were analyzed:

- Alkalinity
- Biochemical Oxygen Demand
- Chemical Oxygen Demand
- Total Filterable Residue
- MBAS
- Turbidity
- Phenols
- Flourides
- Ammonia

Total Organic Nitrogen

Total Kjeldahl Nitrogen

Nitrate

Nitrite

Ortho-Phosphorus

Total Phosphorus

Metals

Chlorinated Insecticides

Herbicides

Results

Alkalinity generally decreased slightly from background to discharge stations, but at all times remained at a high level.

Biochemical Oxygen Demand also decreased slightly from background to discharge stations, except on the Biscayne Canal (rainy season), where it increased. BOD at no time was at a high or significant level.

Chemical Oxygen Demand showed no discernible trend, but did decrease from background to discharge on the Black Creek and C-102 Canals (62 to 15 mg/l and 69 to 40 mg/lg respectively). All other stations showed comparable levels, and results from all stations were consistent with baseline levels obtained thus far.

Total Filterable Residue increased greatly at the discharge stations for the Oleta River and the Tamiami Canal (Coral Gables Waterway, Station H-6) and increased slightly at some south Dade discharge stations. These readings are doubtlessly due to the effects of seawater intrusion.

MBAS were not analyzed during the dry season, but showed comparable, low levels during the rainy season.

Turbidity would be expected to increase from background to discharge stations, but in fact this was not conclusively shown except at Black Creek (4.6 to 45.0 NTU's). The only other high value was seen at the background station of the Oleta River (16.5 NTU's; the discharge station showed a value of 0.6 NTU's).

Phenols — Phenols, when detected, were generally higher at background stations (exception: C-103, 0.004 mg/l at discharge, not detected at background). This general trend is consistent with the hypothesis that naturally-occurring phenolic compounds are contributed to the hydrologic system in wetland areas. This has already been referred to (see the discussion in the Groundwater and Intensive Canal Sections of this report, pages 13 and 30, respectively).

Flouride concentrations show no significant increase over the length of the canals studied and nowhere approached the Dade County standard of 1.4 mg/l.

Organic Nitrogen and Ammonia show highest concentrations at background stations. Especially in north Dade, ammonia is high due to the proximity of decaying organic matter in the muck soils of Water Conservation Area 3B. Concentrations are lower at discharge stations due to some inorganic uptake, sedimentation, and/or dilution.

Nitrate and Nitrite — In north and central Dade, nitrate and nitrite levels tend to increase slightly from background to discharge stations, largely due to fertilizer application on residential lawns. In south Dade, the background stations are located in the predominantly agricultural areas, and receive contributions of these nutrients from this source. The discharge stations are in coastal areas, and show lower nitrate and nitrite levels due to dilution.

Ortho- and Total Phosphorus would be expected to show tendencies similar to those of nitrate and nitrite, especially in south Dade. However, concentrations are generally so low that at this time it is difficult to say if a trend is real or imagined. In this area, phosphorus is the limiting nutrient.

Trace Metals -- (silver, arsenic, cadmium, chromium, copper, mercury, lead, and zinc were examined). Some of the metals were higher at some discharge stations. Most of these elements show background values which are so low to begin with that contributions from industrial activity does not raise them to significantly high levels. The only notable exception is the discharge station of the Coral Gables Waterway (Station H-6), which showed significant increases in nearly all of the metals. The results are such that a point source of pollution must be nearby.

Chlorinated Insecticides (See Table 2) were not detected at any site during the dry season. The rainy season sampling, conducted after heavy rains, revealed a few occurrences. They are as follows:

Snapper Creek

background -- 0.002 ug/l Dieldrin

discharge -- 0.001 ug/l Dieldrin

Biscayne Canal

background -- 0.003 ug/l op'-DDD

discharge -- 0.003 ug/l pp'-DDD

C-102

discharge -- 0.001 ug/l Dieldrin

Herbicides -- the herbicides 2,4-D and 2,4,5-TP (Silvex) were analyzed with no detections.

Summary

The current ground and surface water monitoring programs conducted by the County have been emplaced during the past two years and have the dual purpose of detecting problems which currently exist and establishing baseline water quality for these systems.

The biannual Groundwater Monitoring Program is designed to characterize existing groundwater quality throughout the county and serve as a basis for delineating long-term trends. The program provides background information for special studies and gives indications of the effect of septic tanks and various land uses on groundwater quality.

Dade's Canal Monitoring Program includes monthly sampling and analysis of general physical and chemical parameters for the county's major surface water systems. Results from the past two years show that the most serious water quality problems are high levels of indicator bacteria, which in turn is related to the amount of stormwater discharged into the canals. As the canals are primarily designed as a vehicle for drainage, there are limits to the corrective measures that can be taken. DERM is currently studying the possibility of removing some existing positive drainage systems as part of the county's Areawide Water Quality Management Plan, as well as encouraging alternatives to positive drainage in new developments.

A less serious problem involves low dissolved oxygen levels on some of the county's major canals. This is largely due to the close hydraulic connection between the canals and groundwater, which is low in D.O. As water is constantly released through control structures, eutrophic conditions seldom result from these low D.O. levels.

To supplement the Monthly Canal Program, DERM annually samples one major canal and analyzes a wide array of parameters. The subject of this year's Intensive Canal Study was the Miami Canal, selected largely due to its location with regard to the Hialeah wellfields. Results have shown that other than high bacteria levels mentioned above, the major water quality problem affecting the canal is high dissolved solids concentrations. Phenol levels, though high throughout the county, can in some instances along the Miami Canal be ascribed to pollution (including contributions from the Miami International Airport).

In 1981 DERM initiated an Annual Pollutant Study, designed to measure the impact of urbanization upon surface water quality. Results thus far have indicated that in most cases this impact has not been serious; however, it is necessary to accumulate several years of data before any trends can be documented.

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