

QUALITY OF UNTREATED WATER FOR PUBLIC SUPPLIES IN FLORIDA WITH REFERENCE TO THE NATIONAL PRIMARY DRINKING WATER REGULATIONS

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The quality of public drinking water is of major concern to all. Safe drinking water is fundamental to the health and well-being of any society. Recorded knowledge of water treatment is found in Sanskrit medical lore and in Egyptian inscriptions dating back to the 15th century B.C. In his writings on public hygiene the Greek physician, Hippocrates, (460?-377? B.C.) prescribed that rainwater should be boiled and strained before domestic use (National Academy of Sciences, 1977). Soon after the discovery of the germ theory of disease by Louis Pasteur in the late nineteenth century, harmful (pathogenic) bacteria in water were recognized as the major cause of epidemics. Interestingly, water was isolated as a source of cholera by John Snow in 1855 before the germ theory of disease had been formulated. In the early 1900's, chlorination was found to be very effective in destroying harmful bacteria in drinking water and since about 1908 has been used for treating drinking water throughout the country. The practice of chlorination has assured that virtually all public drinking water supplies are bacteria-free.

Surveillance of public water supplies for bacteria as a safeguard against waterborne disease has been ongoing for half a century. However, scientific discoveries made during the last decade or so, show that harmful microbiological contaminants are not the only substances which may be a threat to public health. Such substances in drinking water as pesticides, toxic metals, fibrous inorganic material, organics, and radioactive materials may also have adverse effects on human health.

Because of national concern for the establishment of strict and enforceable regulations on drinking water quality, on December 16, 1974, the U.S. Congress adopted Public Law 93-523 (U.S. Congress, 1974), commonly referred to as the "Safe Drinking Water Act." As a result of the legislation, the U.S. Environmental Protection Agency on March 14, 1975, instituted the "National Interim Primary Drinking Water Regulations" which appeared in the Federal Register (U.S. Environmental Protection Agency, 1975a). On June 24, 1977, a revised version of these regulations went into effect (U.S. Environmental Protection Agency, 1975b). These standards supersede, but closely parallel, the drinking water standards as set forth in 1962 by the U.S. Public Health Service. The overall objective of the "Safe Drinking Water Act" is to encourage public water-supply agencies to provide water of high quality to users throughout the United States by establishing and maintaining national standards. This goal is to be achieved primarily by expanding the scope and level of water utility service; thus, improving the quality and dependability of the nation's drinking water.

STUDY BACKGROUND

In the State of Florida, the Department of Environmental Regulation is the agency charged with implementing the "Safe Drinking Water Act." As part of the implementation program the Department and the U.S. Geological Survey entered into a cooperative program to conduct a statewide reconnaissance sampling of about 130 major public water supplies. This sampling program was conducted in August and September of 1976. The primary objective of the reconnaissance was to sample the quality of both the treated and untreated (raw) public supplies to determine baseline concentrations of those chemical and physical parameters which have maximum contaminant levels established in the National Interim Primary Drinking Water Regulations (tables 1 and 2).

The purpose of this map-atlas report is to present selected results of the 1976 water-sampling reconnaissance. Specifically included in this report are the data from the untreated source water supplies. The results are presented in a series of small maps and supplemental information is given in the following text. A complete presentation of the 1976 results may be found in a report entitled "Chemical and Physical Quality of Selected Public Water Supplies in Florida, August-September 1976," by G. A. Irwin and H. G. Healy.

SAMPLING PROGRAM

During the 1976 reconnaissance at least one public water supply was sampled in each of the 67 counties in the State. At each site samples of both the untreated (raw) water and the treated water were collected. In counties where only one supply was sampled, for a common reference, the sample was collected at or near the county seat. In selected high-population counties, such as Hillsborough, Polk, Lee, Palm Beach, and Broward, several public supplies were sampled in addition to the one at or near the county seat. A table listing the public water-supplies that were sampled and several illustrations showing their location are given in Irwin and Healy (1978). The methods used in analyzing water for the constituents given in this map-atlas are described in Brown, Skougstad, and Fishman (1970), Goerlitz and Brown (1972), and Fishman and Brown (1976). For more specific information about methods refer to table 1 in Irwin and Healy (1978). Samples were processed and analyzed at either the U.S. Geological Survey Quality of Water Service Unit in Ocala, Florida, or the U.S. Geological Survey Central Water Quality Laboratory in Doraville, Georgia. Analyses are for total concentrations except fluoride which is a dissolved concentration.

SOURCES OF PUBLIC WATER-SUPPLIES

Five principal sources of ground water are used in addition to surface water for public water supply in Florida (Healy, 1977). Figure 1 shows the sources of ground water for public supply as follows: (1) the Floridan aquifer, (2) the Biscayne aquifer, (3) the sand-and-gravel aquifer, (4) aquifers in the Hawthorn and Tampa Formation, and (5) the shallow-sand aquifer. The Floridan aquifer is used in part for public supplies in Okaloosa, Brevard, and Monroe Counties, but another aquifer or surface water is the principal source of water (fig. 1). The average quantities of water obtained daily from these sources for public use in 1975 are given in Irwin and Healy (1978) which also compares the statewide total average daily water use with the total average daily water use of the 115 selected municipalities and 5 county water-supply systems that were sampled.

The Floridan aquifer is utilized by more than 50 percent of the State by area. In 1975, it supplied about 43 percent of all the ground water pumped for public use. The Biscayne aquifer is utilized over a much smaller area of the State than the Floridan aquifer, but yielded about 44 percent of the water used for public use in 1975. The other ground-water sources contributed the remaining 13 percent for public use. On the average, ground water supplied about 46 percent of all water used for public supply in 1975, with surface water supplying 14 percent. The combined surface-water supply included selected rivers, lakes, and reservoirs.

RESULTS

The results of the water-quality reconnaissance of raw water are summarized by individual parameter. In the series of maps the color of each symbol (triangle or circle) shows the concentration range in which the sample concentration (or average of several samples from each source by county falls. For most counties only one sample was collected by source. Counties where more than one sample was collected by source are: Floridan aquifer—Dade (2), Highlands (2), Hillsborough (2), Monroe (2), Orange (2), Pasco (2), Seminole (2), Okaloosa (3), Volusia (4), Pinellas (6), and Polk (9); Biscayne aquifer—Dade (5), and Broward (6); Hawthorn and Tampa aquifers—Sarasota (2), and Lee (4); and surface water—Palm Beach (3). The location of circles with respect to the darkened lines shows the aquifer source (fig. 1). The triangle symbol denotes surface-water sites. More detailed information concerning locations and sources can be found in Irwin and Healy, 1978.

Arsenic

Concentrations of arsenic in raw public water supplies throughout the State ranged from 0 ug/L in several supplies to 16 ug/L in water from a well in the shallow-sand aquifer at Fort Myers in Lee County. (Concentrations for four samples from that source in Lee County ranged from 0 to 16 ug/L with a mean value of 5 ug/L. The mean arsenic concentration in 123 samples from all sources was 1 ug/L. None of the samples had concentrations approximating the maximum contaminant level of 50 ug/L.)

Arsenic was detected in 46 percent of the samples. It was found in 11 of 15 surface-water samples, 29 of 69 Floridan aquifer samples, 6 of 12 Biscayne aquifer samples, 0 of 2 sand-and-gravel aquifer samples, 3 of 8 Hawthorn and Tampa aquifer samples, and 6 of 17 shallow-sand aquifer samples. Mean arsenic concentrations for each source by county were 5 ug/L or less except those supplies in Dixie (15 ug/L, Floridan aquifer), and Hendry (7 ug/L, shallow-sand aquifer).

Barium

Concentrations of barium in raw public water supplies throughout the State ranged from 0 mg/L in several supplies to 200 ug/L in water from a Floridan aquifer well in Gadsden County and in a surface water supply in Palm Beach County. (Concentrations for three samples from the surface-water supply from Palm Beach County ranged from 0 to 200 ug/L with a mean of 100 ug/L. The mean barium concentration in 125 samples from all sources was 0 ug/L. None of the samples had concentrations approximating the maximum contaminant level of 1000 ug/L.)

Barium was detected in 23 percent of the samples from all sources. It was found in 3 of 15 surface-water samples, 19 of 71 Floridan aquifer samples, 1 of 12 Biscayne aquifer samples, 0 of 2 sand-and-gravel aquifer samples, 3 of 8 Hawthorn and Tampa aquifer samples, and 3 of 17 shallow-sand aquifer samples. Mean barium concentrations for each source by county were 100 ug/L or less except for the Floridan aquifer (200 ug/L) in Gadsden County.

Cadmium

Concentrations of cadmium in raw public water supplies throughout the State ranged from 0 ug/L in several supplies to 7 ug/L in water from a well in the Biscayne aquifer at Florida City near Homestead in Dade County. (Concentrations for five samples from that source in Dade County ranged from 0 to 7 ug/L with a mean of 1 ug/L.) The mean concentration of 125 samples from all sources was 1 ug/L. None of the samples had concentrations approximating the maximum contaminant level of 10 ug/L (table 1).

Cadmium was detected in 46 percent of the samples. It was found in 3 of 15 surface-water samples, 38 of 71 Floridan aquifer samples, 8 of 12 Biscayne aquifer samples, 1 of 2 sand-and-gravel aquifer samples, and 1 of 8 Hawthorn and Tampa aquifer samples, and 7 of 17 shallow-sand aquifer samples. Mean cadmium concentrations for each source by county were 2 ug/L or less except for Sarasota (4 ug/L, sand-and-gravel aquifer), Jackson (3 ug/L, Floridan aquifer), Calhoun (3 ug/L, Floridan aquifer), Hamilton (4 ug/L, Floridan aquifer), and St. Lucie (3 ug/L, shallow-sand aquifer).

Chromium

Concentrations of chromium in raw public water supplies throughout the State ranged from less than 10 ug/L in several supplies to 50 ug/L in water from a well in the Floridan aquifer at Cocoa in Brevard County. The mean chromium concentration in 125 samples from all sources was 20 ug/L. The concentration in the sample from Cocoa in Brevard County equaled the maximum contaminant level of 50 ug/L (table 1).

Chromium was detected in 88 percent of the samples from all sources. It was found in 15 of 15 surface-water samples, 64 of 71 Floridan aquifer samples, 1 of 12 Biscayne aquifer samples, 1 of 2 sand-and-gravel aquifer samples, 8 of 8 Hawthorn and Tampa aquifer samples, and 15 of 17 shallow-sand aquifer samples. Mean chromium concentrations for each source by county show that only seven are greater than 30 ug/L. Those sources with averages exceeding 30 ug/L are in: Brevard (50 ug/L, Floridan aquifer), Marion (40 ug/L, Floridan aquifer), Osceola (40 ug/L, Floridan aquifer), Okeechobee (40 ug/L, surface-water), and Glades Counties (40 ug/L, shallow-sand aquifer).

Fifteen analyses reported chromium concentration in water of less than 10 ug/L.

Lead

Concentrations of lead in raw public water supplies throughout the State ranged from 0 ug/L in a few supplies to 45 ug/L in water from a well in the Biscayne aquifer at Florida City near Homestead in Dade County. (Concentrations for the five samples from that source in Dade County ranged from 0 to 45 ug/L with a mean value of 16 ug/L.) The mean lead concentration in 125 samples from all sources was 9 ug/L. Only two samples approximating the maximum contaminant level of 50 ug/L (Hendry County, 42 ug/L, and Dade County, 45 ug/L, table 1).

Lead was detected in 94 percent of the samples. It was found in 15 of 15 surface-water samples, 68 of 71 Floridan aquifer samples, 12 of 12 Biscayne aquifer samples, 2 of 2 sand-and-gravel aquifer samples, 5 of 8 Hawthorn and Tampa aquifer samples, and 17 of 17 shallow-sand aquifer samples. Mean lead concentrations for each source by county show that all but six are 20 ug/L or less. Those sources with averages exceeding 20 ug/L are in Jackson (21 ug/L, Floridan aquifer), Hamilton (27 ug/L, Floridan aquifer), Dixie (25 ug/L, Floridan aquifer), Bradford (22 ug/L, Floridan aquifer), Sunter (21 ug/L, Floridan aquifer), and Hendry Counties (2 ug/L, shallow-sand aquifer).

Mercury

Concentrations of mercury in raw public water supplies throughout the State ranged from 0.0 ug/L in several supplies to 0.9 ug/L in water from a well in the Floridan aquifer in Pinellas County. (Concentrations for six samples from that source in Pinellas County ranged from 0.0 to 0.9 ug/L with mean of 0.3 ug/L.) The mean mercury concentration in 117 samples from all sources was 0.1 ug/L. None of the samples had concentrations approximating the maximum contaminant of 2 ug/L (table 1).

Mercury was present in 51 percent of the samples. It was found in 4 of 15 surface-water samples, 31 of 69 Floridan aquifer samples, 5 of 6 Biscayne aquifer samples, 1 of 2 sand-and-gravel aquifer samples, 7 of 8 Hawthorn and Tampa aquifer samples, and 12 of 17 shallow-sand aquifer samples. Mean mercury concentrations for each source by county were 0.2 ug/L or less except for Plaquemine (0.3 ug/L, shallow-sand aquifer), Pinellas (0.3 ug/L, Floridan aquifer), Highlands (0.3 ug/L, Floridan aquifer), and Lee (0.3 ug/L, surface water, and 0.3 ug/L, Hawthorn and Tampa aquifers).

Selenium

Concentrations of selenium in raw public water supplies throughout the State were found to be 0 ug/L in most supplies and 1 ug/L in six supplies. The mean selenium concentrations in 119 samples from all sources was 0 ug/L. None of the samples had concentrations approximating the maximum contaminant level of 10 ug/L (table 1).

Selenium was found in 5 percent of the samples from all sources. It was found in 4 of 67 Floridan aquifer samples and 2 of 16 shallow-sand aquifer samples, but in none of the other sources. Mean selenium concentrations for each source by county were 0 ug/L except for Lafayette (1 ug/L, Floridan aquifer), Columbia (1 ug/L, Floridan aquifer), St. Johns (1 ug/L, shallow-sand aquifer), Pasco (1 ug/L, Floridan aquifer), and Brevard (1 ug/L, shallow-sand aquifer). Pinellas County had one sample from the Floridan aquifer which had a concentration of 1 ug/L, but the average for the total of five samples was 0 ug/L.

Silver

Concentrations of silver in raw public water supplies throughout the State ranged from 0 ug/L in most supplies to 9 ug/L in water from a well in the shallow-sand aquifer in St. Lucie County. The mean silver concentration in 118 samples from all sources was 0 ug/L. None of the samples reached the maximum contaminant level of 50 ug/L (table 1).

Silver was detected in 3 percent of the samples. It was found in 1 of 70 Floridan aquifer samples, 1 of 12 Biscayne aquifer samples, and 1 of 14 shallow-sand aquifer samples and not found in the other sources. Mean silver concentrations for each source by county were 0 ug/L except for Dade (1 ug/L, Biscayne aquifer), and St. Lucie (9 ug/L, shallow-sand aquifer).

Fluoride

Concentrations of fluoride in raw public water supplies throughout the State ranged from 0.0 mg/L in a few supplies to 2.3 mg/L in water from a well in a Hawthorn or Tampa aquifer in De Soto County. The mean fluoride concentration in 124 samples from all sources was 0.4 mg/L. Four samples approximated the maximum contaminant level (Monroe County, 1.7 and 1.9 mg/L in the Floridan aquifer, De Soto County, 2.3 mg/L in the Hawthorn and Tampa aquifers, and Lee County, 2.1 mg/L in the Hawthorn and Tampa aquifers) (tables 1 and 2).

Fluoride was detected in 98 percent of the samples. It was found in all samples from all sources except the two from the sand-and-gravel aquifer. Mean fluoride concentrations for each source by county were 1.5 mg/L or less except for Monroe and De Soto as mentioned earlier.

Nitrate

Concentrations of nitrate-nitrogen (NO₃-N) in raw public water supplies throughout the State ranged from 0.00 mg/L in several supplies to 3.7 mg/L in water from a well in the Floridan aquifer in Hillsborough County. (The mean concentration for two samples from that source in Hillsborough County was 1.9 mg/L.) The mean nitrate concentration in 118 samples from all sources was 0.17 mg/L. None of the samples reached the maximum contaminant level of 10 mg/L (table 1).

Nitrate-nitrogen (NO₃-N) was present in 43 percent of the samples from all sources. It was found in 13 of 15 surface-water samples, 35 of 65 Floridan aquifer samples, 9 of 12 Biscayne aquifer samples, 2 of 2 sand-and-gravel aquifer samples, 7 of 8 Hawthorn and Tampa aquifer samples, and 6 of 16 shallow-sand aquifer samples. Mean nitrate concentrations for each source by county were 1 mg/L or less except for Escambia (3.6 mg/L, sand-and-gravel aquifer), and Hillsborough (1.9 mg/L, Floridan aquifer).

Turbidity

Turbidity in raw public water supplies throughout the State ranged from 0 nephelometric turbidity units (NTU) in a few supplies to 5 NTU in water from two supplies in Broward and Lee Counties. (The mean for Broward County for the Biscayne aquifer was 3 NTU and ranged from 2 to 5 NTU; the mean for Lee County for the shallow-sand aquifer was 2 NTU and ranged from 1 to 5 NTU.) The mean turbidity in 108 samples from all sources was 1 NTU. Two samples reached the maximum contaminant level of 5 (table 1). These data only give a general idea of compliance to the Federal standard as the maximum contaminant level for turbidity in drinking water is based on monthly averages and not on a single observation as utilized in this study.

Seventy-four percent of the samples had measurable turbidity. It was found in all samples from all sources except for 29 of 57 Floridan aquifer samples. Mean turbidity values for each source by county were 2 NTU or less except for Gadsden (4 NTU, surface-water), Brevard (4 NTU, Floridan aquifer), Sarasota (3 NTU, surface-water), Broward (3 NTU, Biscayne aquifer), and Monroe (3 NTU, Floridan aquifer).

Pesticides

Concentrations of selected pesticide compounds in raw public water supplies throughout the State ranged from 0.00 ug/L in most supplies to 0.91 ug/L in water from a well in a Hawthorn or Tampa aquifer in Charlotte County. The mean pesticide concentration in 121 samples from all sources was 0.02 ug/L. None of the samples approximated the maximum contaminant levels (table 1). Except for silver and 2,4-D, virtually all samples of public waters in the State were devoid of all pesticide compounds for which maximum contaminant levels have been established by the Federal Government. However, silver and 2,4-D were detected in trace amounts at several sites throughout the State with 2,4-D occurring slightly more frequently.

Pesticide compounds were detected in 12 percent of the samples. It was found in 7 of 15 surface-water samples, 0 of 68 Floridan aquifer samples, 2 of 12 Biscayne aquifer samples, 0 of 2 sand-and-gravel aquifer samples, 1 of 8 Hawthorn and Tampa aquifer samples, and 3 of 16 shallow-sand aquifer samples. Mean pesticide concentrations for each source by county were 0.10 ug/L or less except for Plaquemine (0.24 ug/L, shallow-sand aquifer), Hillsborough (0.31 ug/L, surface water), Manatee (0.13 ug/L, surface water), Charlotte (0.18 ug/L, surface-water, and 0.91 ug/L, Hawthorn and Tampa aquifer), and Hendry (0.23 ug/L, shallow-sand aquifer).

DISCUSSION AND SUMMARY

The reconnaissance program which supplied these data (Irwin and Healy, 1978) provides an excellent beginning for what may result in an extensive and complex hydrologic endeavor for the State of Florida, but it is not without certain limitations which need brief comment. Perhaps the most obvious limitations is that, except for high population areas, only one set of samples was collected from each selected public supply. For many reconnaissance studies this would be sufficient for a general baseline approximation for many chemical constituents, particularly in ground-water environments. However, for the data in this map atlas, federally mandated maximum contaminant levels have been designated and although a single sample gives an approximation of the constituent levels, there is a certain probability of error. A further constraint is that many of the raw samples were composites of water from several wells and/or surface waters, and are not composites of sources. In view of these limitations, virtually all the public supply waters sampled during the August-September 1976 reconnaissance in Florida should be considered as set forth in the "National Interim Primary Drinking Water Regulations." However, several thousand public water supplies exist in the State, thus, the reconnaissance represents only a general overview of present water quality.

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Table 1.—Maximum contaminant levels as given in the "National Interim Primary Drinking Water Regulations."

Constituent	Maximum contaminant level in micrograms per liter, except as noted
Arsenic (As)	50
Barium (Ba)	1000
Cadmium (Cd)	50
Chromium (Cr)	50
Lead (Pb)	50
Mercury (Hg)	20
Selenium (Se)	10
Silver (Ag)	50
Erdra	2
Lindane	4
Medetoxin	100
Toxaphene	5
2,4-D	10
2,4,5-TP (Silvex)	10
Fluoride (F)	(See table 2)
Nitrate (NO ₃ -N)	(See table 2)
Turbidity (NTU)	(A monthly average of one nephelometric turbidity unit. Two samples reached the maximum contaminant level of 5 (table 1). These data only give a general idea of compliance to the Federal standard as the maximum contaminant level for turbidity in drinking water is based on monthly averages and not on a single observation as utilized in this study.)

Table 2.—Maximum contaminant levels for fluoride when the annual average of the maximum daily air temperature for the location in which the water supply source is located are within these ranges.

Temperature, in degrees Fahrenheit	Temperature, in degrees Celsius	MCL, in milligrams per liter
51.7 and below	12.0 and below	2.4
53.6 to 58.3	12.1 to 14.6	2.2
58.4 to 61.7	14.7 to 16.5	2.0
61.8 to 70.6	17.1 to 21.4	1.8
70.7 to 79.2	21.5 to 26.2	1.6
79.3 to 90.5	26.3 to 32.5	1.4

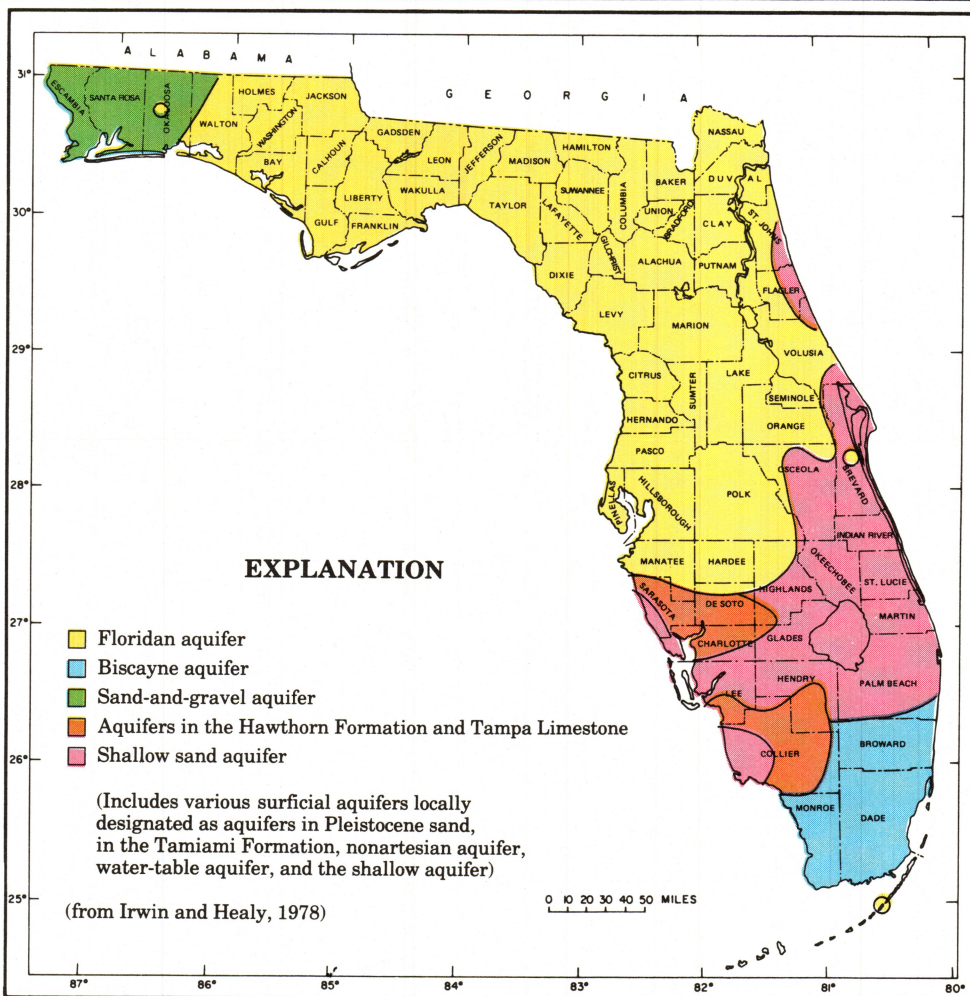


FIGURE 1.—Sources of ground water.

