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Ground Water Quality in the Surficial and Floridan Aquifer Systems Underlying the Upper East Coast Planning Area

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GROUND WATER QUALITY IN THE SURFICIAL AND FLORIDAN AQUIFER SYSTEMS UNDERLYING THE UPPER EAST COAST PLANNING AREA

by

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EXECUTIVE SUMMARY

The Upper East Coast Planning Area, as defined by the South Florida Water Management District, currently encompasses most of St. Lucie and Martin counties as well as the eastern portion of Okeechobee County. A small portion of Palm Beach County was also included in the Planning Area during the initial stages of report development and was retained in the maps and databases presented in this study. Increasing demand for ground water supplies in the Upper East Coast Planning Area makes it necessary for water managers to compile data and integrate information for responsible development of the ground water resources. Therefore, ground water flow models simulating water levels in the Surficial and Floridan Aquifer Systems were developed and documented by the South Florida Water Management District (Lukasiewicz, 1992; Adams, 1992; Butler and Padgett, 1995) which estimate the quantity of ground water available. This report addresses the ground water quality in those aquifer systems and is intended for use in conjunction with the flow models to more thoroughly characterize the ground water resources of the region.

The Surficial and Floridan Aquifer Systems underlie the entire Upper East Coast Planning Area. Water quality characteristics in these two aquifers are significantly different. The Surficial Aquifer System is composed of low to moderately permeable clastic and carbonate sediments. Ground water in the aquifer exists under unconfined conditions in some areas and semi-confined conditions in others. Water levels are typically below land surface and the quality of water is good. Butler and Padgett (1995) conceptualized the system in St. Lucie County as two hydrogeologic zones: a shallow unconfined sand/soil zone which extends from the surface down to approximately 50 feet below land surface, and an underlying unconfined to semi-confined production zone extending from the base of the overlying sand/soil zone down to the base of the Surficial Aquifer System. Water quality characteristics in these two Surficial Aquifer System zones are examined independently in this report. The production zone is the highest yielding and most commonly used interval for water supply. Water from both zones meets drinking water standards with respect to chloride, total dissolved solids and sulfate concentrations.

The Upper Floridan aquifer occurs well below the base of the Surficial Aquifer System and is separated from it by a thick sequence of fine sands, silts and clays comprising the Hawthorn Group. The Hawthorn Group prevents significant communication between the two aquifer systems. Water levels in the Floridan Aquifer System rise above land surface in most of the study area. The water is moderately to highly mineralized and is usually blended with surface waters prior to use for irrigation.

In 1989, water from one hundred thirty-two (132) Surficial and fifty-two (52) Upper Floridan aquifer wells in and near the Upper East Coast Planning Area were sampled and analyzed by the South Florida Water Management District. These analyses quantified major ion concentrations, color, specific conductance, and selected trace metal content. These data were combined with those from several other sources and used in this report to examine the spatial distribution of water characteristics in the two aquifer systems.

In the sand/soil zone of the Surficial Aquifer System, concentrations of total dissolved solids, chlorides and sulfates are highest in the northwest study area and decrease to the southeast. Ground water in this zone gradually changes character from a calcium chloride ($CaCl_2$) type in the northwest to a calcium bicarbonate ($Ca(HCO_3)_2$) type in the east and southeast portions of the study area. Eight areas with unusually high chloride concentrations were identified in the sand/soil zone. Three of these are located near coastal inlets and the remaining five are located inland. It is postulated that salt water intrusion is the process for chloride transport into the sand/soil zone near the coast. Brackish Upper Floridan aquifer irrigation water is probably the primary source of chlorides inland, remnant (connate) seawater is a possible secondary source.

Calcium bicarbonate ($Ca(HCO_3)_2$) type water is found in the production zone of the Surficial Aquifer System throughout the study area. Relatively high chloride concentrations were identified in this zone at nine locations, three near the coast and six inland. As with the shallow sand/soil zone, high chloride concentrations near the coast are presumed to exist due to salt water intrusion. Inland, the sources of chloride are probably seepage of brackish irrigation water (from Upper Floridan aquifer wells) and/or residual connate water. Water quality characteristics of the two zones are often dissimilar with respect to major ion concentrations in central and western St. Lucie County. Here, the sand/soil zone is often more mineralized than the production zone. This is probably due to the seepage of brackish irrigation water into the shallower sand/soil zone. Seepage to the deeper production zone is reduced due to the low to moderately permeable sediments overlying it.

Knowledge of hardness, expressed as milligrams per liter $CaCO_3$, is often necessary for designing water treatment facilities. Water in the sand/soil zone ranges from soft to very hard. From U.S. 1 to the Florida Turnpike, water hardness gradually increases to moderately hard, and west of the turnpike is very hard. Water in the production zone is harder than that in the sand/soil zone and is classified as hard to very hard in the study area.

Concentrations of total iron in the sand/soil zone varied significantly between sampling events; therefore, they were not mapped regionally. In contrast, there was minimal total iron variability between sampling events in the production zone. The concentrations of iron in the production zone were lower than those in the sand/soil zone and ranged between 0.1 mg/l to 7.2 mg/l, but were typically below 1.0 mg/l in most of the study area.

The sand/soil zone is directly below land surface, and is therefore most vulnerable to contaminants introduced at land surface, such as brackish irrigation water, landfill leachates, and contaminant spills. The impact of Upper Floridan aquifer wells on water in the Surficial Aquifer System as well as the locations of landfills and major contaminated (Superfund) sites are discussed in this report.

Although water from the Upper Floridan aquifer does not meet drinking water standards in the Upper East Coast Planning Area, it is a major source of agricultural irrigation water in St. Lucie County when blended with surface waters. South of central Martin County, however, this water is generally too saline for irrigation, even when blended. Concentrations of total dissolved solids, chloride, and sulfate in the Upper Floridan aquifer increase from north to south in the study area. Local variations to the regional trend are common.

Upper Floridan aquifer water quality variations over a thirteen year time span were investigated using historic records between 1977 and 1990. Data from eighteen SFWMD and USGS agricultural monitor wells and five public water supply wells were used for this portion of the study. Four of the eighteen agricultural monitor wells, and two of the five public water supply well fields experienced moderate water quality deterioration over time. A strong correlation between increases in Upper Floridan aquifer water withdrawal rates and total dissolved solids concentration was observed at two public water supply utilities located in Vero Beach (Indian River County) and Sailfish Point (Martin County). As pumping increased over time, so did the concentration of total dissolved solids.

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ABSTRACT

The boundaries of the Upper East Coast Planning Area currently encompass most of St. Lucie and Martin counties as well as a small portion of eastern Okeechobee County. In the early stages of report development, the planning area also included a small portion of Palm Beach County. This portion was retained in the study area discussed in this report. Potable ground water in the Upper East Coast Planning Area is obtained from two zones within the Surficial Aquifer System: the sand/soil and production zones. The sand/soil zone is found in most of the region from approximately 0 feet to 50 feet below land surface, whereas the production zone typically occurs between 50 feet to 200 feet below land surface.

Water quality in the sand/soil zone meets potable standards in most of the study area. The sand/soil zone is not considered to be very productive and, consequently, is not frequently used for public water supply; however, it is used for domestic self-supply by individual home owners. Trilinear and Stiff diagrams show the dominant water type in this zone to be calcium chloride in the north-west and calcium bicarbonate in the east and southeast study area. Relatively high concentrations of chloride and total dissolved solids exist in the sand/soil zone underlying central and western St. Lucie County. These higher concentrations are probably related to the use of Floridan aquifer irrigation water, and/or the presence of relict (connate) seawater in these areas. Three areas with relatively high chloride and total dissolved solids concentrations were identified near the coastal inlets and are probably the result of salt water intrusion from the Atlantic Ocean.

Water for public supply in the Upper East Coast Planning Area is obtained primarily from the deeper production zone within the Surficial Aquifer System. Water in this zone also meets potable standards in most of the planning area. Nine areas were identified with relatively high concentrations of total dissolved solids and chlorides. Three of these areas are near the coast, while the remaining six occur inland. Unlike the sand/soil zone, Trilinear and Stiff diagrams illustrate that water in the production zone is consistently a calcium bicarbonate type. The production zone lacks the dominant chloride ion found in the sand/soil zone in central and western St. Lucie County. This is probably due to its hydraulic insulation from land surface provided by overlying low-moderately permeable silts and sands. These sediments probably inhibit downward percolation of brackish irrigation water used in the agricultural areas.

Ground water for irrigation is primarily obtained from the brackish Upper Floridan aquifer in the north-western study area (central and western St. Lucie and Okeechobee counties). Water from Upper Floridan aquifer wells is blended with fresh surface water prior to use as an irrigation source. However, even when blended, this water is too saline for irrigation use south of central Martin County. Trilinear and Stiff diagrams identify the water type as sodium chloride throughout the study area. Regional contour maps illustrate increasing concentrations of chloride, total dissolved solids, sulfates, and hardness as well as specific conductance from northwest to southeast.

Concentrations of total dissolved solids increased in four out of eighteen Upper Floridan aquifer monitor wells over a six to thirteen year period. They also increased for two out of five public water suppliers using this aquifer in and near the study area. Those two utilities pumped water at higher rates, over longer periods of time, than the other three.

INTRODUCTION

PURPOSE AND SCOPE

The purpose of this study was to document the results of a comprehensive water quality sampling program undertaken in 1989-1990 by the Hydrogeology Division of the South Florida Water Management District (SFWMD). These results may be useful to the public where knowledge of water quality characteristics is required and can also be used as background information for developing comprehensive water supply plans. These water supply plans, developed by the SFWMD's Planning Department, utilize quantitative assessments of both water supply and water quality. Evaluation of existing and potential water supply and water quality problem areas and development of management guidelines will be integral parts of each plan.

The scope of this study includes describing ground water characteristics in the Surficial Aquifer System (SAS) and the Upper Floridan aquifer (UFA) underlying the Upper East Coast Planning Area (UECPA). The ground water characteristics discussed include the major dissolved ions, specific conductance, hardness, and temperature. These parameters were measured in 132 SAS and 52 UFA wells in and near the study area between 1989-1990. These data were combined with those from other sources and used to describe regional water quality characteristics as well as changes in UFA water quality over time. Sources of anthropogenic contaminants to the SAS are also addressed.

This document represents the first of a two-phased ground water reconnaissance study of the UECPA. The second phase will document the results of hydrogeologic field work conducted by the SFWMD in the study area including: aquifer performance tests, measured water levels, lithologic and geophysical data, and stratigraphic correlations. The data summarized in the second phase were used to develop ground water flow models representing both the SAS and the Floridan Aquifer System (FAS) in the study area. Those models are documented in three separate publications: Adams, 1992; Butler and Padgett (1995); and Lukasiewicz, 1992.

BACKGROUND INFORMATION

The location of the study area, the underlying hydrogeology, and brief definitions of the water quality parameters discussed in this report are provided below to familiarize the reader with the subject material presented.

Location of Study Area

The UECPA is located in southeastern Florida. At the time this study commenced, it included most of St. Lucie (92%) and Martin (92%) counties and parts of Okeechobee (12%) and Palm Beach counties (Figure 1), which is herein defined as the "study area". It lies generally within Townships 34 through 43 South and Ranges 35 through 43 East, and encompasses approximately 1,500 square miles. Subsequent to compiling this report, the boundaries of the UECPA were re-defined to exclude Palm Beach County.

Hydrogeology of the Study Area

Two major aquifer systems underlie the study area: the Surficial Aquifer System and the Floridan Aquifer System. They extend from land surface to over 2,500 feet below land surface (BLS). Figure 2 is a generalized hydrogeologic cross section taken from west to east through St. Lucie County as shown in the inset map. The uppermost water-bearing interval is the SAS, the source of potable water used in the study area. It is comprised of unconsolidated fine to medium quartz sand with interbedded lenses of limestone, sandstone, shell and clay of late Pliocene and Pleistocene age that overlie the clays and silts of the confining Hawthorn group.

The FAS is composed of a sequence of limestones, dolomitic limestones, and dolomites ranging in age from Eocene to early Miocene. It is aerially continuous and ranges from 2,700 to 3,400 feet thick in the UECPA (Miller, 1982). Tibbals (1991) divided the FAS into two aquifers based on the vertical occurrence of two highly permeable zones; the Upper Floridan aquifer and the Lower Floridan aquifer (LFA). The UFA is approximately 500 feet thick in the study area and is composed of several flow zones. It is underlain by the middle semi-confining unit which is approximately 300 feet thick and composed primarily of granular limestone and calcilutite. These sediments have low permeability and inhibit communication between the UFA and LFA. Water in the LFA is significantly more saline than that in the UFA; therefore, the vast

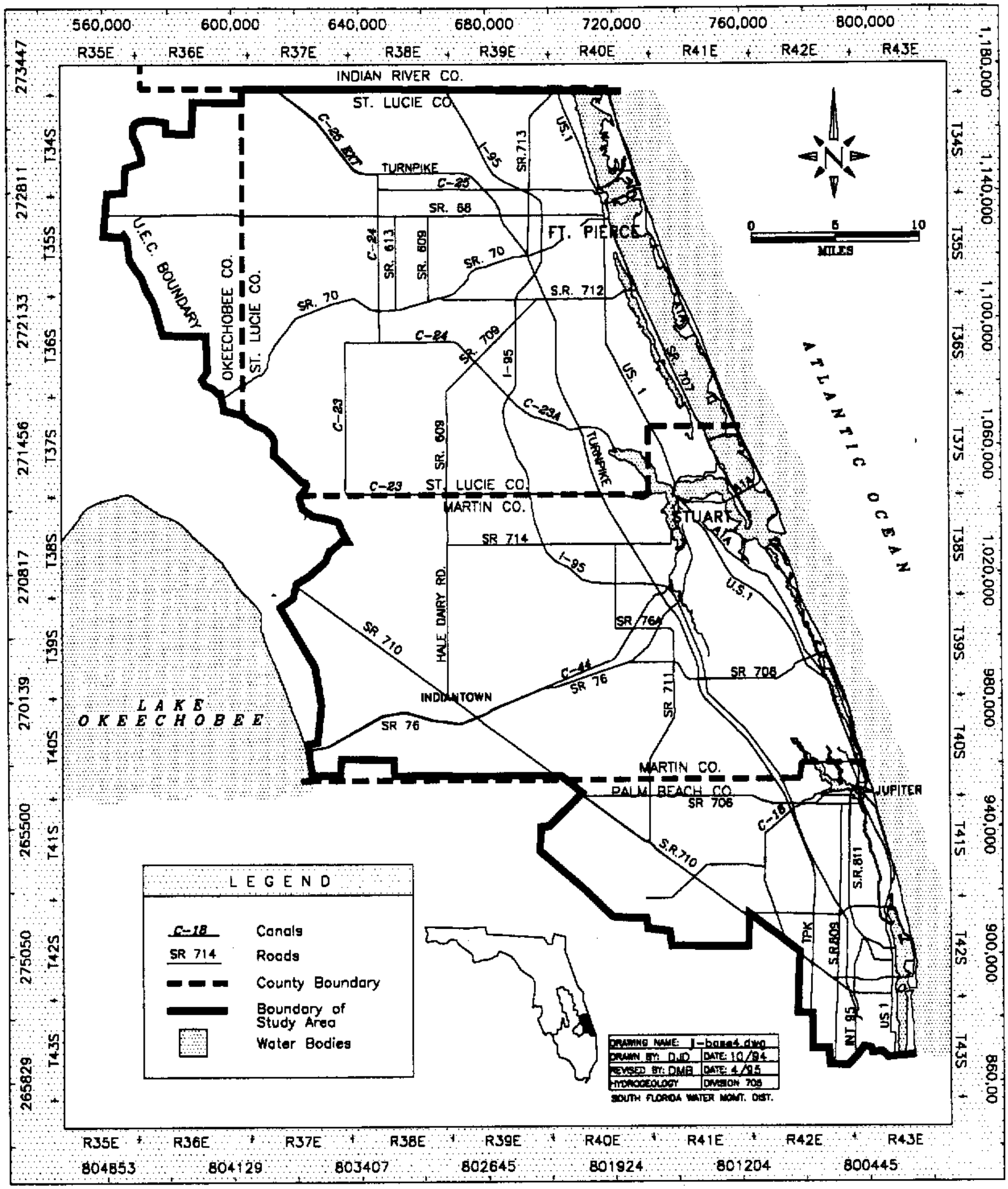

FIGURE 1. Location of Study Area.

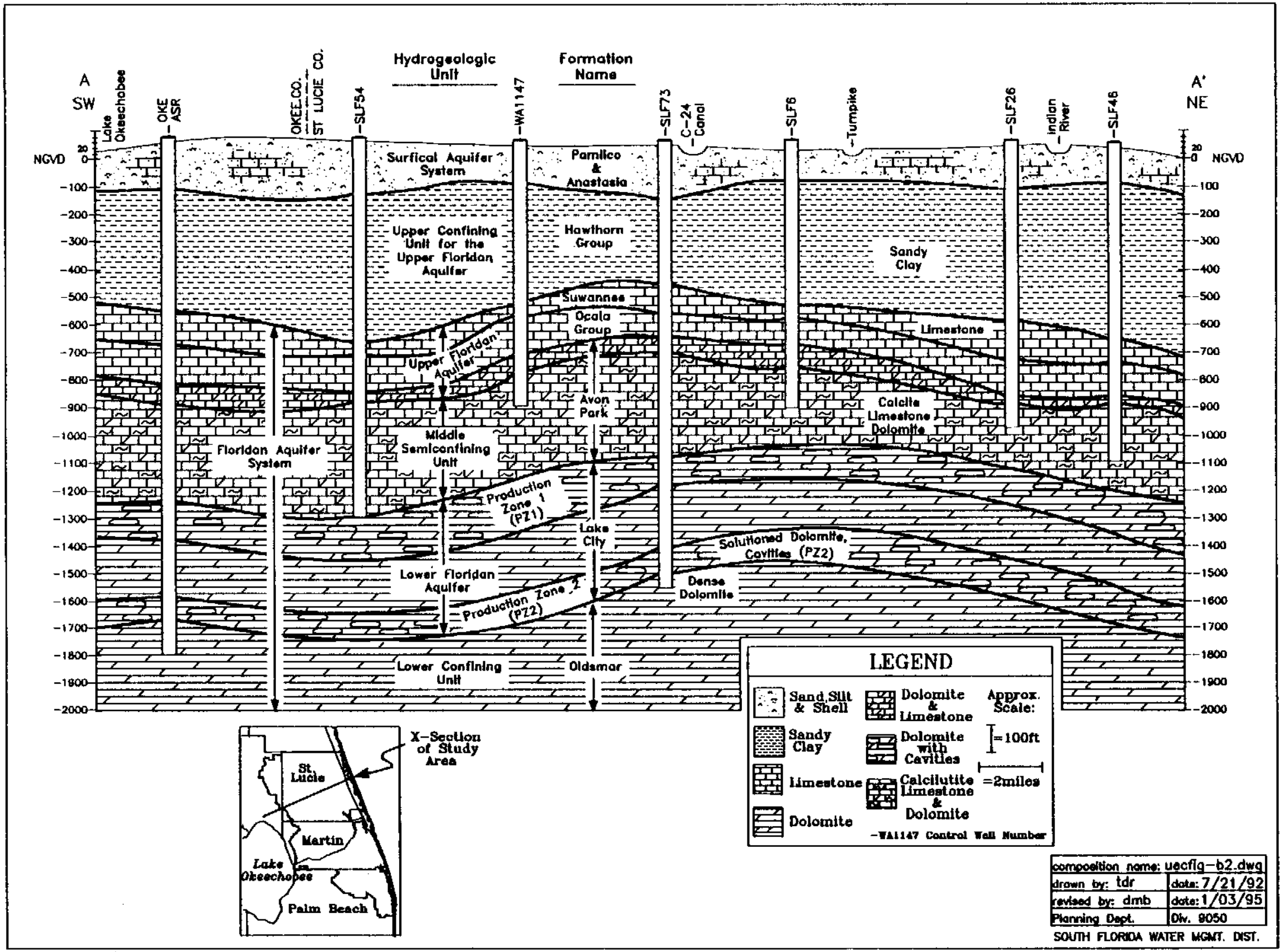

FIGURE 2. Hydrogeologic Cross Section, St. Lucie County, Florida (after Lukasiewicz, 1992).

majority of existing FAS wells in the study area terminate in the UFA.

The SAS is unconfined to semi-confined in the study area and is comprised of three hydrogeologic zones in Martin County (Figure 3): the surficial sands, the primary water-producing zone, and a less permeable zone overlying the Hawthorn Group. The surficial sands are shallow and may not be completely saturated throughout the year. The primary water-producing zone consists of sand, shell, and relatively thin beds or lenses of sandstone/ limestone. The less permeable zone is composed of sand, silt, shell, and soft micritic limestone and is part of the Tamiami Formation. Since few monitor wells are completed in it, water quality from this lower zone is not discussed in this report

Butler and Padgett (1995) conceptualized the Surficial Aquifer System in St. Lucie County as two hydrogeologic zones (Figure 4): a shallow unconfined sand/soil zone which extends from the surface down to a depth of approximately 50 feet BLS, and an underlying unconfined to semi-confined production zone which extends from the base of the sand/soil zone to the base of the SAS. Models which simulate the flow in the SAS underlying Martin and St. Lucie counties were developed by Adams (1992) and Butler and Padgett (1995). Water quality characteristics in each of these two zones are discussed individually in this report.

Water Quality Parameters Measured

The Florida Department of Environmental Protection (FDEP) has adopted ground water standards for a variety of chemical constituents. A current partial list of primary and secondary drinking water quality standards which pertain to parameters discussed in this study are shown in Table 1, (FDEP, 1993).

Ground water characteristics addressed include concentrations of total dissolved solids (TDS), chloride (Cl^-), sulfate (SO_4), specific conductance (Sp.Cond), hardness ($CaCO_3$), total iron (TotFe), and temperature. Regional distributions of these parameters are defined in this report to identify local areas where highly mineralized water occurs in the SAS and UFA. Brief parameter definitions and descriptions are provided below.

Table 1. Selected FDEP Water Quality Classifications and Standards for Ground Water (F.A.C., Chapter 17-550.310, Revised 1993)

Parameter	FDEP Standard
Calcium	1.0 mg/l
Chlorides	250 mg/l
Color	15 color units
Total Dissolved Solids	500 mg/l
Fluoride	2 mg/l
Iron	0.3 mg/l
pH	6.5-8.5
Sodium	160 mg/l
Sulfates	250 mg/l

Total Dissolved Solids (TDS)

One basic measure of the degree of mineralization in water is total dissolved solids (TDS). TDS is the total weight of dissolved ions per unit volume of sample that remain when a water sample is evaporated to dryness. It does not include suspended sediment, colloids, or dissolved gases. A classification scheme which gives the class of water based on TDS concentration is presented in Table 2. Water naturally contains various dissolved inorganic ions. The major cations are calcium, magnesium, sodium, and potassium; the major anions are chloride, sulfate, carbonate, and bicarbonate. These major constituents comprise the bulk of the mineral matter contributing to TDS. Additional minor constituents that may be present include: iron, fluoride, nitrate, strontium, and boron (Fetter, 1988).

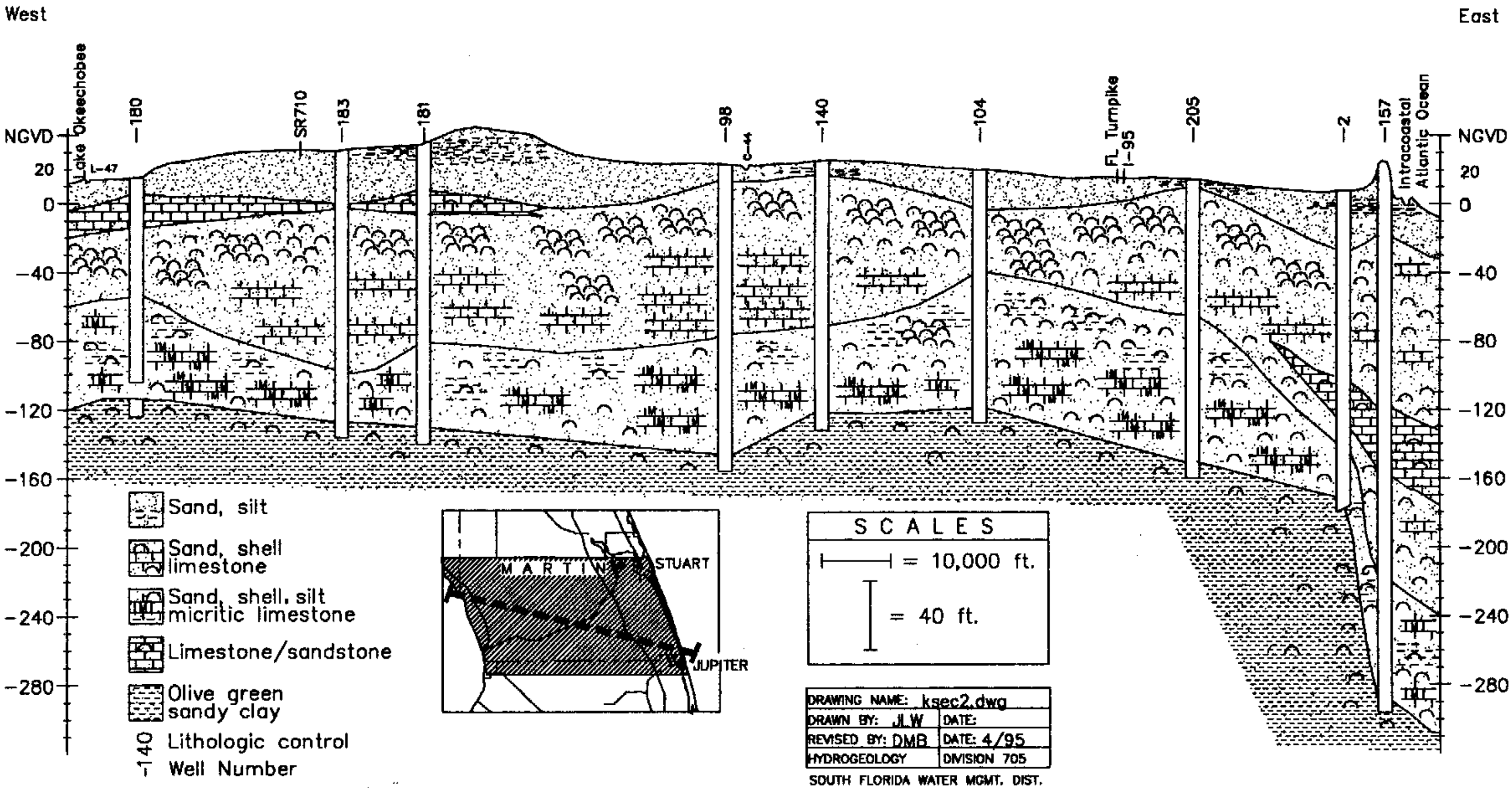

FIGURE 3. Hydrogeologic Cross Section through the Surficial Aquifer System, Martin County, Florida (after Adams, 1992).

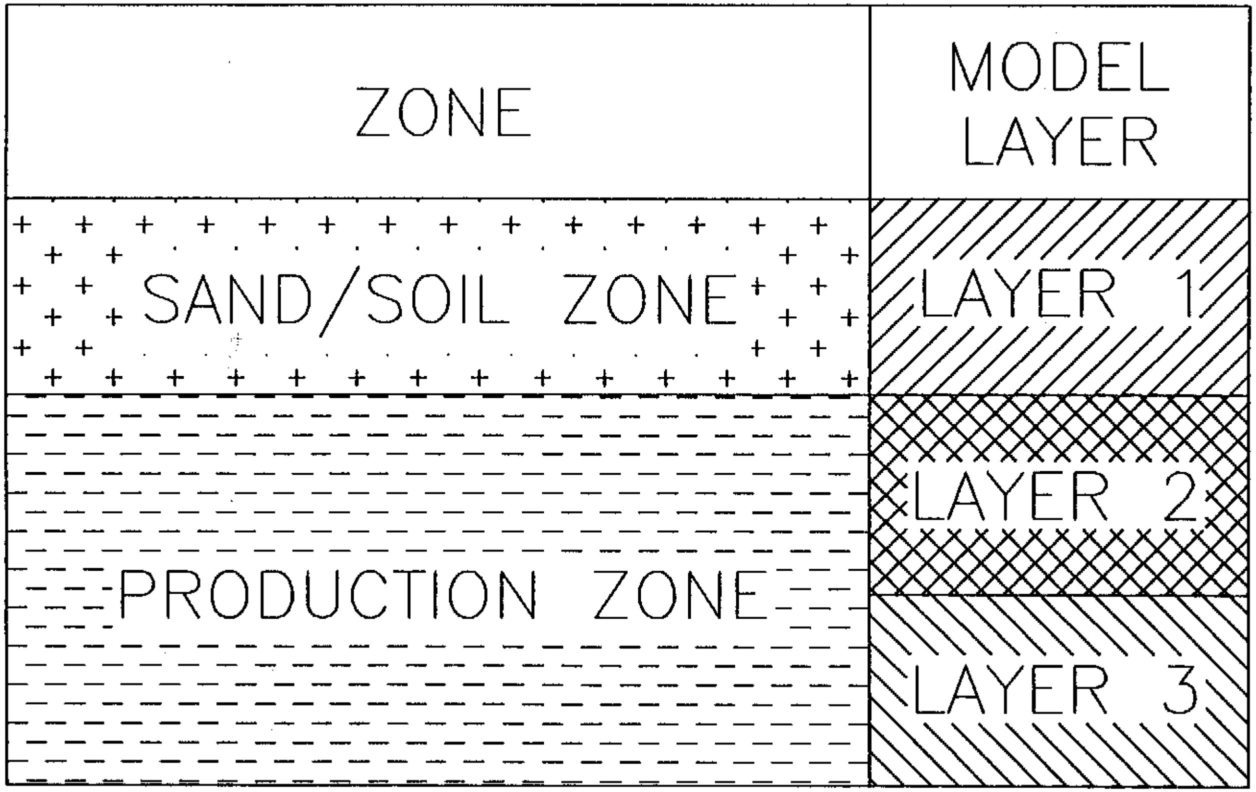

FIGURE 4. **Generalized Hydrogeologic Column of the Surficial Aquifer System and Corresponding Model Layers, (after Butler and Padgett, in review).**

Chloride (Cl^-)

Chloride is generally dissolved in water as the chloride ion, Cl^-. One source of chloride to ground water is the ocean. Chloride ions in connate water occur in aquifers when porous rocks are submerged by a rising sea, allowing seawater to intrude and permeate the rock unit with soluble salts. When the ocean recedes and the rocks again emerge, chloride is retained in the form of crystals or as a solution of remnant (connate) seawater. Other possible sources of chloride ions present in aquifers include coastal salt water intrusion and inter-aquifer mixing. A "salty" taste can usually be detected in water when chloride concentrations exceed 400 mg/l (Faust and Aly, 1981). Chloride, in sufficient concentration, can generally render the water harmful as an irrigation source because it can burn tree leaves and roots and/or create caliche soils.

Sulfate (SO_4)

Sulfate and other sulfur species are common constituents of all natural waters. Sulfur, when dissolved in water, usually occurs with oxygen as the anion sulfate (SO_4). Sulfate may originate from the chemical weathering of geologic formations or from the oxidation of sulfide. Odorous hydrogen sulfide usually evolves as the result of microbiological processes. Laxative effects may be experienced when sulfate concentrations in drinking water are high, approximately 1,000 mg/l (Faust and Aly, 1981).

Table 2. Classification of Water Based on Total Dissolved Solids (Fetter, 1988)

Class	TDS (mg/l)
Fresh	0-1,000
Brackish	1,000-10,000
Saline	10,000-100,000
Brine	>100,000

Specific Conductance

Electrical conductance of ground water is dependent on the concentration and type of dissolved ions in solution and the temperature at which the measurement is made. *Specific* conductance is the electrical conductance of a cubic centimeter of water at 25 degrees Celsius (C). Generally, as more solids are dissolved in water, its ability to conduct electricity increases. Therefore, conductivity is a good indicator of the degree of mineralization of ground water. In general, calcium bicarbonate and calcium sulfate waters have low conductivity, while sodium chloride waters have high conductivity. Rainwater ranges from 5 umhos/cm to 30 umhos/cm, and potable water ranges from 50 to 1,500 umhos/cm (Shaw and Trost, 1984).

Specific conductance is relatively easy to measure in the field. These measurements can be used to extrapolate concentrations of TDS and chlorides using linear regression models. These models were developed for each aquifer in the study area and are further discussed under the section entitled Regression Line Analysis.

Hardness

High levels of hardness are associated with the amount soap lathers or the degree of scaling. Hardness of water is determined by the concentration of calcium (Ca) and magnesium (Mg) in water and is calculated by multiplying the concentration (mg/l) of Ca and Mg by factors of 2.447 and 4.118, respectively, then summing the two values (Shaw and Trost, 1984). The resulting sum is then reported as hardness in mg/l $CaCO_3$. Table 3 gives ranges and descriptions for degrees of hardness.

Table 3. Water Descriptions Used for Various Hardness Ranges (USEPA, 1976)

Hardness Range (mg/l $CaCO_3$)	Description
0-75	Soft
75-150	Moderately Hard
150-300	Hard
>300	Very Hard

Quantification of ground water hardness is needed by public water suppliers to calculate chemical dosages where lime softening is used. Hardness of water does not cause health problems; therefore, a criterion for public supply water has not been established (USEPA, 1976).

Iron (Fe)

Iron is a common constituent of rocks and soils; therefore, almost all ground and surface waters contain significant quantities of dissolved or suspended iron (Fe). In natural waters it represents a nuisance type of constituent. Frequently, water initially contains dissolved ferrous iron, which is slowly oxidized to ferric hydroxide in the presence of dissolved oxygen. This precipitate increases turbidity in water and stains clothing, sinks, tubs, etc. (Faust and Aly, 1981).

Iron in drinking water imparts a metallic taste at concentrations over 1.8 mg/l; however, soluble iron at concentrations in excess of 0.3 mg/l can stain surfaces (Fetter, 1988). A water quality criterion for iron of 0.3 mg/l is the standard for public supply (F.A.C., Chapter 17-550, 310, 1993). The FDEP has not yet specified whether this value refers to total iron or total dissolved iron (Herr, 1994, verbal communication).

Both total recoverable iron and total dissolved iron concentrations were measured in laboratory analyses presented in this report. However, only total iron (Tot Fe, dissolved and in suspension) is discussed since it imparts taste and stains and would be present in untreated domestic self-supplied water.

GROUND WATER USE

Various types of ground water use occur in the study area including use for public and domestic water supply, agricultural irrigation and industry. Water from the SAS and UFA is used for different purposes in the study area. Each major use category is discussed below.

Public and Domestic Water Supply

Surficial Aquifer System (SAS)

The SAS is the primary source of ground water for potable public supply in the UECPA due to its relatively high quality. The production zone yields more water to wells than the sand/soil zone and is, therefore, more frequently used by public water supply utilities. The sand/soil zone, however, is used by many individual homeowners for domestic self-supply. Public water supply accounts for 24 percent of the total SAS ground water withdrawals in Martin County, while domestic self supply accounts for 45% (Adams, 1992). Domestic self supply includes all non-potable and potable water use not supplied to residential areas by a utility. In St. Lucie and eastern Okeechobee counties, public supply and domestic water-use accounts for approximately 42% and 51%, respectively, of SAS ground water withdrawals (Butler and Padgett, 1995).

Upper Floridan Aquifer (UFA)

Although the SAS is the primary source of drinking water in the UECPA, the UFA is used to augment public water supplies in some areas. Some small utilities and individual condominiums on the barrier islands of Martin and St. Lucie counties currently use desalinated UFA water as their primary drinking and irrigation water source. In 1989, Fort Pierce Utilities, located in St. Lucie County, began blending UFA and SAS water to augment public water supplies. Martin County Utilities has a reverse osmosis (R.O.) system which uses UFA wells at their north system in Jensen Beach. The town of Jupiter in Palm Beach County began using R.O. to desalinate UFA water for public supply in 1991. Also, the Village of Tequesta has recently applied to modify their water-use permit from the South Florida Water Management District incorporating plans to desalinate UFA water.

Agricultural Water Supply

Surficial Aquifer System (SAS)

Agricultural water use accounts for 27% of ground water withdrawals from the SAS in Martin County (Adams, 1992) and only 7% of the total in St. Lucie County (Butler and Padgett, 1995). This category includes all farming, golf, recreational, landscaping and nursery uses.

Upper Floridan Aquifer (UFA)

The primary ground water irrigation source in St. Lucie County is the UFA. Ninety-nine percent of permitted UFA water use in the UECPA is for agricultural irrigation (Lukasiewicz, 1992). In most cases, UFA water requires blending with surface waters prior to crop application. Water users in the agricultural sector use the UFA instead of the SAS as a ground water source because it yields greater quantities of water and does not require pumping (UFA wells flow at land surface throughout most of the UECPA). Chloride concentrations in UFA water increase to unacceptable levels for use in irrigation south of central Martin County and is seldom used there.

The tolerance range of citrus trees to chloride levels in irrigation water varies depending on the tree type (i.e. orange, grapefruit, tangerine, etc.) and the irrigation method. The leaves of the trees are more sensitive to saline water than their roots. Therefore, methods of irrigation such as overhead spraying require that the water contain lower chloride concentrations than that used in the drip or flood irrigation methods. The tolerance range for the three most commonly used irrigation methods in the UECPA are listed in Table 4.

UFA water is also used for frost protection, cleaning, watering livestock, and mixing chemical sprays. Table 5 shows the upper limits for TDS content in water that may safely be used for most livestock, (Shaw and Trost, 1984).

Table 4. Chloride Tolerance Levels for Common Citrus Irrigation Methods. (Calvert, 1982)

Irrigation Method	Chloride Concentration (mg/l) Tolerance Level
Overhead Sprinkler	800 to 1,000
Drip	1,500 to 2,000
Flood	<2,000

Industrial Water Supply

The quality of water utilized for industrial purposes varies greatly, depending on the type of industrial use for which the water is required. Cooling water may have a wide range of ion concentrations. Since ground water usually maintains a relatively constant temperature, many industries use it for this purpose.

Table 5. Upper Limit of Total Dissolved Solids Content for Live Stock Water. (Mckee and Wolf, 1963)

Stock	TDS Concentration (mg/l)
Poultry	2,860
Pigs	4,290
Horses	6,435
Cattle (dairy)	7,150
Cattle (beef)	10,100
Sheep (adult)	12,900

There are several permitted industrial users of ground water in the UECPA, such as: Florida Power and Light, Pratt and Whitney, Loxahatchee River Environmental Control District, and Caulkins fruit processing plant. Industrial water use accounts for only four percent of the total permitted use from the SAS in Martin County (Adams, 1992). Industrial water use from the SAS in St. Lucie and Okeechobee counties total only 284 million gallons per year, a small percentage of the total for these counties (Butler and Padgett, 1995). The SAS is the primary industrial source for this ground water use category, while the UFA is used primarily as a backup industrial water supply, particularly where large volumes of water are required.

THE SOUTH FLORIDA WATER MANAGEMENT DISTRICT'S MONITOR WELL NETWORK

The SFWMD collected and analyzed water samples from 132 SAS and 52 UFA wells in and near the UECPA as part of this study. These wells comprise the SFWMD's water level monitoring network established primarily to provide data for calibrating ground water flow models. The levels were measured monthly by the SFWMD during the time interval between 1989-1990. Water from these wells was sampled and analyzed for physical parameters, major ions, and specific trace metals. The results of these analyses are presented by aquifer and SAS zone in tables which will be discussed later (see Results section).

Analyses of water sampled from the monitor well network (SFWMD, 1989) were supplemented with like data from various sources, all of which are listed in Appendix A and include:

* The SFWMD's regulatory salt water intrusion monitor well database (SALT)
* The SFWMD's well abandonment (WA) program database
* The SFWMD's and FDEP's General Well Information System (GWIS) database (SFWMD, 1993)
* Various Consulting reports and U.S. Geological Survey documents.

SAMPLING METHODS

All water samples were collected and analyzed using applicable procedures as outlined in the SFWMD's Comprehensive Quality Assurance Plan (SFWMD, 1993B). Temperature, pH, and specific conductance were measured in the field using a Hydrolab.

SAMPLING SCHEDULE

All wells on the SFWMD's monitor well network were sampled on two occasions, once at the end of wet season and again at the end of dry season, between the years 1989 and 1990. These two seasons were selected in order to detect water quality variations between periods of high and low rainfall corresponding with the wet and dry seasons, respectively. The SAS monitor wells in Martin County were sampled in May and October of 1989, while the St. Lucie County SAS and all UFA monitor wells were sampled in October 1989 and May 1990. UFA water samples collected during the October 1989 sampling event are not presented in this report due to large mass balance errors detected during the QA/QC process.

METHODS OF REPRESENTING WATER QUALITY DATA

The character of water in the two SAS zones (sand/soil zone and production zone) is sometimes unique; therefore, separate contour maps and analyses were developed for each. Water quality data from all sources are displayed using regional contour maps, Trilinear diagrams, Stiff diagrams, and frequency distribution plots. Regression line analyses were also developed for each zone which relate specific conductance to both chloride and TDS concentrations in water.

REGIONAL CONTOUR MAPS

Contour maps showing the regional distribution of TDS, sulfates, chlorides, conductivity, and hardness in both zones of the SAS and in the UFA were developed using the various sources of data previously discussed (see SFWMD Monitor Well Network). Data from the most recent SFWMD sampling event were used to develop contour maps and are presented in Appendix A. The contours were developed using a kriging technique found in SURFER (a software program). Krigged contours were modified according to the authors' interpretations in areas lacking data, then were smoothed by hand to obtain the best possible interpolations of regional parameter distributions. Since many data sources were used, the maps do not reflect a unique period in time.

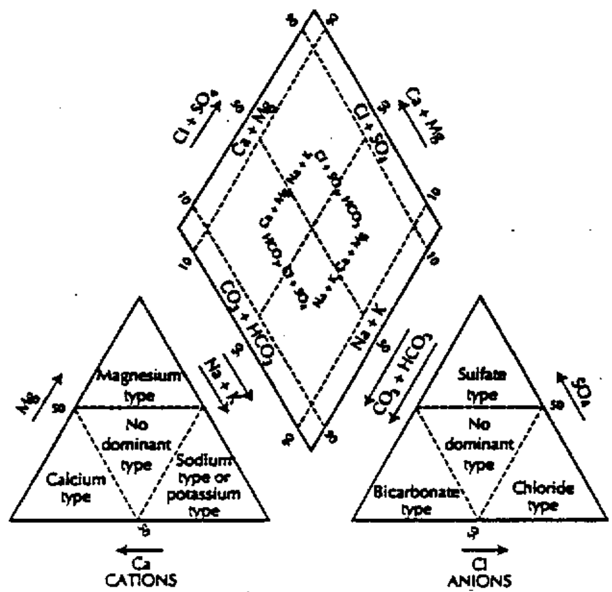

FIGURE 5. **Trilinear Diagram (from Fetter, 1988**

TRILINEAR DIAGRAMS

The chemical composition of ground water is influenced by the lithology, solution kinetics, and flow patterns within the aquifer. Hydrochemical facies can be classified on the basis of the dominant ions in ground water by means of the Trilinear diagram (Figure 5). A Trilinear diagram can show the percentage composition of three ions. By grouping Na^{++} and K^{++} together, the major cations can be displayed on one Trilinear diagram. Likewise, the major anions such as CO_3^- and HCO_3^- can be grouped and displayed in the same manner. Analyses are plotted on the basis of the percent of each cation or anion (Fetter, 1988).

Piper Trilinear diagrams (Piper, 1944) were developed with the ion concentration data from wells on the SFWMD's monitor well network and are presented in Appendix C. These diagrams were generated using a commercially available computer software program called Rockstat and are particularly useful for studying spatial differences in water quality. The program converts ion concentrations to milliequivalents per liter (meq/l) then computes cation and anion percentages along with a mass ion balance error. The ion percentages are then plotted as points on the Trilinear diagram. The program also shows the total ionic concentration of each sample as a circle centered on the plotted point.

Trilinear diagrams were developed for water sampled from each of the two SAS zones and the UFA. To avoid crowding of points on the diagrams and to provide a good regional representation of the data, the UFA and both SAS zones in each county (except Okeechobee County) of the study area were plotted separately on independent Trilinear diagrams. This resulted in a total of nine Trilinear plots (UFA and 2 SAS zones multiplied by 3 counties). Due to the large number of wells in the database, only four to seven representative wells were plotted per county. These wells were selected by dividing each county into four to six equal geographical areas and selecting one well to represent each area. Area specific wells were selected which had TDS concentrations close to the median of the sample population in each area.

STIFF DIAGRAMS

Stiff diagrams are similar to Trilinear diagrams in that they represent ion concentrations in water. To create a Stiff diagram, a polygon is created from four parallel horizontal axes extending on either side of a vertical zero axis (see Figure 6). Cations are plotted in milliequivalents per liter (meq/l) in three tiers left of the zero axis. Anions are plotted in a similar fashion on the right. The larger the area of the polygonal shape, the greater the concentration of the various ions. Stiff diagrams were created for four representative wells per county. Wells were selected using the same methodology described for the Trilinear diagrams. The Stiff diagrams were then superimposed on a basemap of the study area to provide a spatial comparison between water types.

FREQUENCY DISTRIBUTION PLOTS

Frequency distribution plots were developed to illustrate the variance in sample populations for each parameter analyzed. Statistical analyses of sample variance are summarized in Appendix B for concentrations of chloride, TDS, and sulfates as well as specific conductance for both zones in the SAS and for the UFA.

REGRESSION LINE ANALYSES

Regression models defining the linear relationship between specific conductance and TDS concentration, and between specific conductance and chloride concentrations, were developed for the UFA and both SAS zones. Specific conductance is a measure of water's ability to conduct electricity and is easily and inexpensively measured in the field. Conversely, concentrations of TDS and chloride must be determined in either a laboratory setting or with fairly cumbersome field titration methods. With knowledge of specific conductance, TDS and chloride concentrations can be predicted using a regression model.

The regression line is given by the function:

$$y = mx + b \qquad (1)$$

where:

x and y are the independent and dependent variables, respectively

m = slope of the line or x coefficient, and

b = the y intercept, referred to as a "constant".

These variables are defined for each regression plot. The plots were developed using data from the SFWMD's monitor well network and selected Palm Beach County wells (Appendix A). A computer software package (Lotus 1-2-3) was used to generate the regression analyses and plots. Additional information describing each line's "goodness of fit" (how well the two variables define a linear relationship) is given beneath the plots in the form of an R-squared value, degrees of freedom, and standard error of the Y estimate. The sample correlation coefficient, R, is the statistic that determines the strength of the linear relationship and is unit-less. As the absolute value of R approaches one (1), the correlation between the two variables gets stronger. The R-squared value indicates the proportion of variability in Y explained by the linear relationship and is provided in each regression plot.

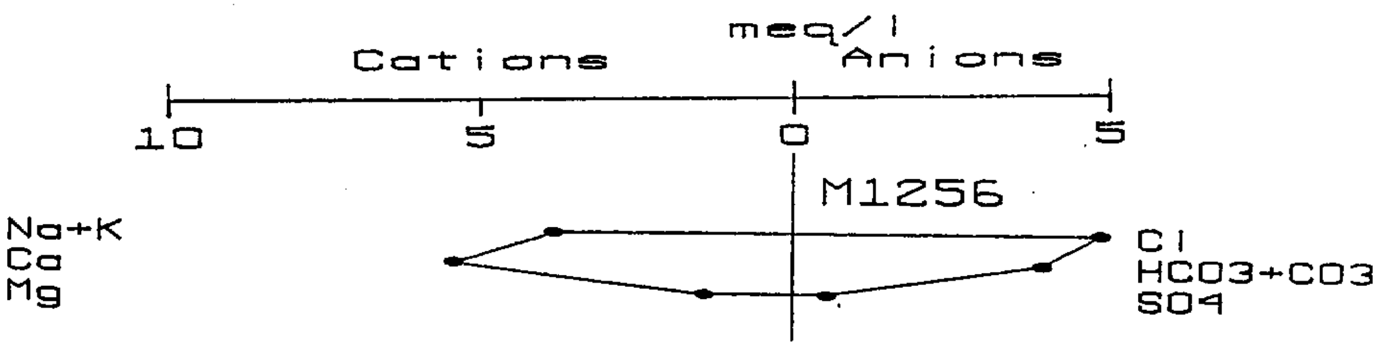

FIGURE 6. Stiff Diagram.

RESULTS OF SAMPLE ANALYSES

SURFICIAL AQUIFER SYSTEM SAND/SOIL ZONE (MODEL LAYER 1)

Contour maps showing the regional distribution of dissolved ions and specific conductance in the SAS sand/soil zone were developed with data from eighty-three wells using the sources listed in Appendix A, Table A-3. The chloride concentration maps developed also incorporated selected data from fifty-four wells in the SFWMD's SALT database (Appendix A, Table A-1). That data is presented in Appendix A, Table A-4 and includes well completion data, well locations in state planar coordinates, sampling dates, and the measured chloride concentrations for each well. The locations of all wells completed in the sand/soil zone and used in this report are plotted in Figure 7. SALT wells are represented by darkened circles, while network and other wells are shown as crosses through open circles on the map. The numbers next to each well correspond with the "Map #" shown in the Appendix A tables. The most recent sampling results in the databases were used in all illustrations and in the statistical summaries.

SALT wells are located at or near municipal well fields, close to the coast, where the movement of salt water from the ocean is monitored. They are sampled and analyzed monthly by individual utilities as a requirement of their water use permits. The SALT database is maintained by the SFWMD's Regulation Department.

Chloride Concentrations

Chloride (Cl^-) concentrations in the sand/soil zone ranged from 6.0 mg/l to 9,600 mg/l. The mean and median of the sample population was 82 mg/l and 43 mg/l, respectively. A statistical summary and frequency distribution curve describing that sample population are provided in Appendix B, Table B-1 and Figure B-1, respectively. Figure 8 depicts the spatial distribution of chloride concentrations for the most recent time period in the database. This map illustrates that relatively high chloride concentrations (200-500 mg/l) exist in central and western St. Lucie County, and lower concentrations exist in the eastern (except near coastal inlets) and southern portions of the study area. Eight localized areas with high chloride concentrations are evident, three near the coast and five inland. The three coastal areas are clustered near the Ft. Pierce, St. Lucie, and Jupiter inlets. High chloride concentrations here are probably the result of salt water intrusion from the ocean. A local study to assess the extent of salt-water intrusion in northern Martin County was done by Technos, Inc. for the Hobe Sound Water Company, which located the salt-water interface in a wellfield located along U.S. 1 south of Bridge Road (Horne, verbal communication, 1995).

The five inland areas with relatively high chloride concentrations are scattered throughout the study area. These occurrences are probably the result of blending with brackish UFA well water used for agricultural irrigation and/or incomplete flushing of residual connate seawater. Ground water containing residual seawater occurs in the western portion of Palm Beach County (Miller, 1988) and may extend into the UECPA.

Chloride concentrations are generally within potable water standards (less than 250 mg/l) throughout the remainder of the study area. However, it is presumed that a greater density of sampling sites may yield other areas with high chloride concentrations due to the observed variability of ground water mineralization in the western portions of the study area.

A comparison of wet and dry season chloride concentration data shows that some seasonal fluctuations in the sand/soil zone occurred. Concentrations were lower at the end of wet season and higher at the end of dry season in St. Lucie County wells. These fluctuations may have been due to seasonal flushing of UFA well water from the sand/soil zone in response to rainfall patterns and/or from the increased use of UFA wells for irrigation during the dry season. UFA wells are suspected to influence fluctuations because of their proximity to the monitor wells in St. Lucie County. Temporal chloride fluctuations are observed primarily in St. Lucie County and are negligible in Martin, Okeechobee and Palm Beach counties where few UFA wells exist.

Total Dissolved Solids Concentrations

Total dissolved solids (TDS) concentrations in the sand/soil zone ranged from 40 mg/l to 2,063 mg/l. The mean and median of the sample population was 392 mg/l and 311 mg/l, respectively. A statistical summary and frequency distribution

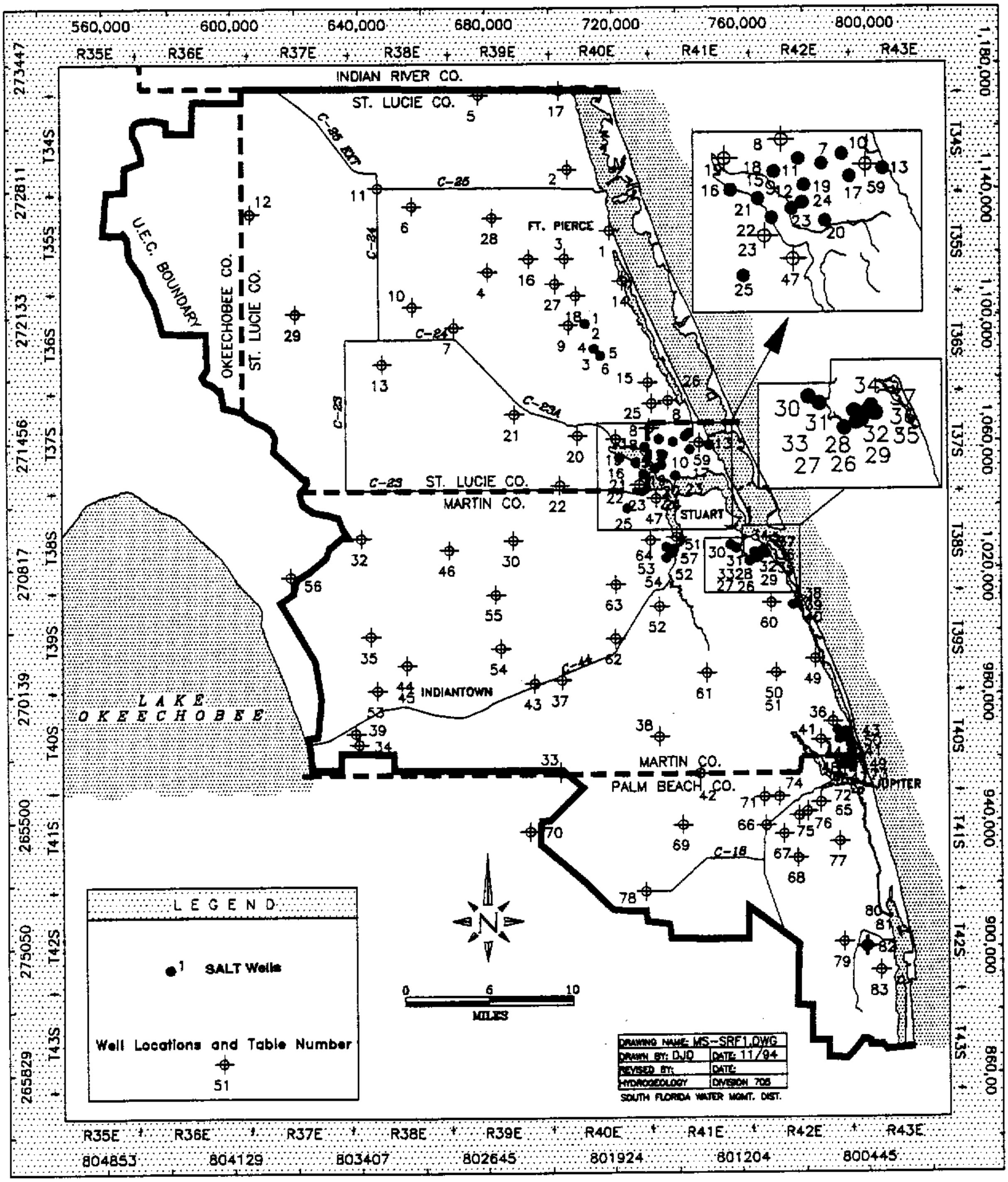

FIGURE 7. Location of Wells Completed in the Sand/Soil Zone (Layer 1).

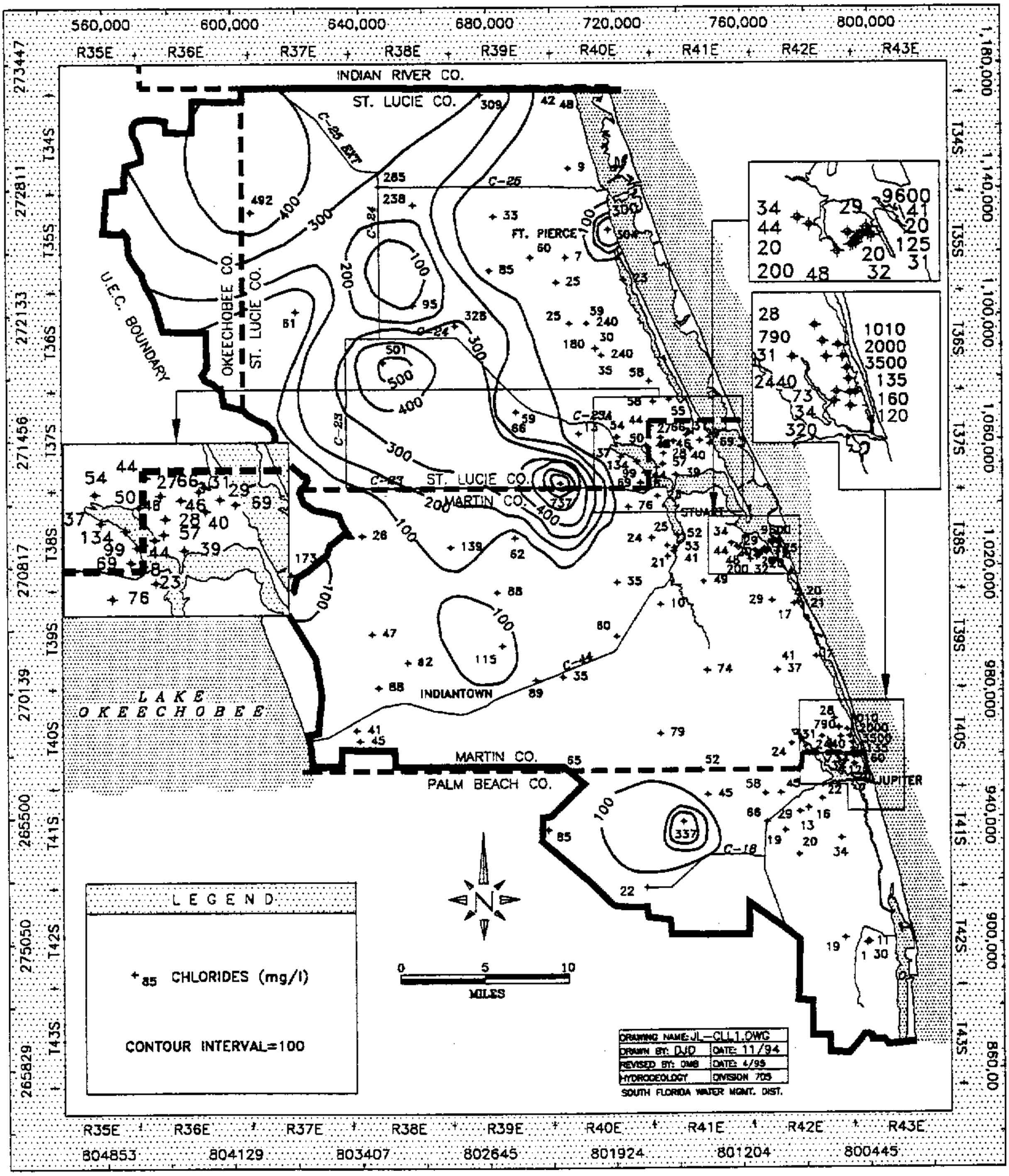

FIGURE 8. **Distribution of Chloride Concentrations in the Surficial Aquifer System Sand/Soil Zone.**

curve describing that sample population are provided in Appendix B, Table B-2, and Figure B-2, respectively. The spatial distribution of TDS concentrations in the sand/soil zone is shown in Figure 9. Regionally, TDS concentrations are highest in the western portion of St. Lucie County and decrease to the east and southeast where they are typically less than 500 mg/l. Localized areas with high TDS concentrations correlate with the areas of high chloride concentrations previously discussed. Figure 10 illustrates how relatively high TDS concentrations (darker shades of grey) in the sand/soil zone are found primarily in those areas with the most permitted UFA wells. Grey shades on this map are used to illustrate TDS concentrations in the sand/soil zone while black dots represent permitted UFA well locations.

Specific Conductance

Specific conductance in the sand/soil zone ranged from 75 umhos/cm to 3,090 umhos/cm in the study area. The mean and median of that sample population was 649 umhos/cm and 537 umhos/cm, respectively. A statistical summary and frequency distribution curve are provided in Appendix B, Table B-3 and Figure B-3, respectively.

A contour map showing the regional distribution of specific conductance in the sand/soil zone is presented in Figure 11. Locations found to have high specific conductance also have high chloride concentration. Excluding these eight areas, the specific conductance of water is typically less than 1,000 umhos/cm in the study area.

Dissolved Sulfate Concentrations

Concentrations of dissolved sulfate (SO_4) are contoured in Figure 12 and range from below detection limits (2 mg/l) to 478 mg/l. The mean and median of the sample population was 36 mg/l and 9 mg/l, respectively. A statistical summary and frequency distribution curve are provided in Appendix B, Table B-4 and Figure B-4, respectively.

Sulfate concentrations in the study area are generally less than 40 mg/l, but are relatively high in two localized areas near coastal inlets and along a strip running from north to south through west-central St. Lucie County. Here again, areas with high sulfate concentrations in the sand/soil zone correlate well with those areas previously identified as having high concentrations of chloride and TDS.

Hardness

Hardness ($CaCO_3$) values are contoured in Figure 13. This map illustrates that hardness generally increases from east to west in the study area. East of U.S. 1 in St. Lucie and northern Martin counties, hardness is generally below 50 mg/l, and is classified as soft. This same area in southern Martin County and in Palm Beach County typically contains water with less than 100 mg/l (moderately hard). Between I-95 and U.S. 1, hardness is generally less than 100 mg/l; whereas, between I-95 and the Florida Turnpike, hardness gradually increases to approximately 200 mg/l (hard). With few exceptions, water is moderately hard to very hard west of the Florida Turnpike throughout the study area. Hardness may also vary with depth since shell layers are present within ten feet of land surface in some areas.

Iron Concentrations

Iron (Fe) concentrations were not mapped for the sand/soil zone because they varied by more than an order of magnitude between sampling events. This may have been due to surface water interactions with the sand/soil zone. Surface waters can be turbid and contain high suspended iron concentrations.

Linear Regression Models

Relation Between Specific Conductance and Chloride Concentration

Linear regression models were developed to mathematically predict concentrations of chloride and TDS from known values of specific conductance. Linear regression curves defining the relationship between specific conductance and chloride concentration, and between specific conductance and TDS concentration for the sand/soil zone are shown in Figures 14 and 15, respectively.

The regression analysis for specific conductance and chloride concentration yielded the following equation for the best-fit line:

$$y = 0.202(x) - 48.2 \qquad (2)$$

where:

x = specific conductance value (umhos/cm), and
y = chloride concentration (mg/l)

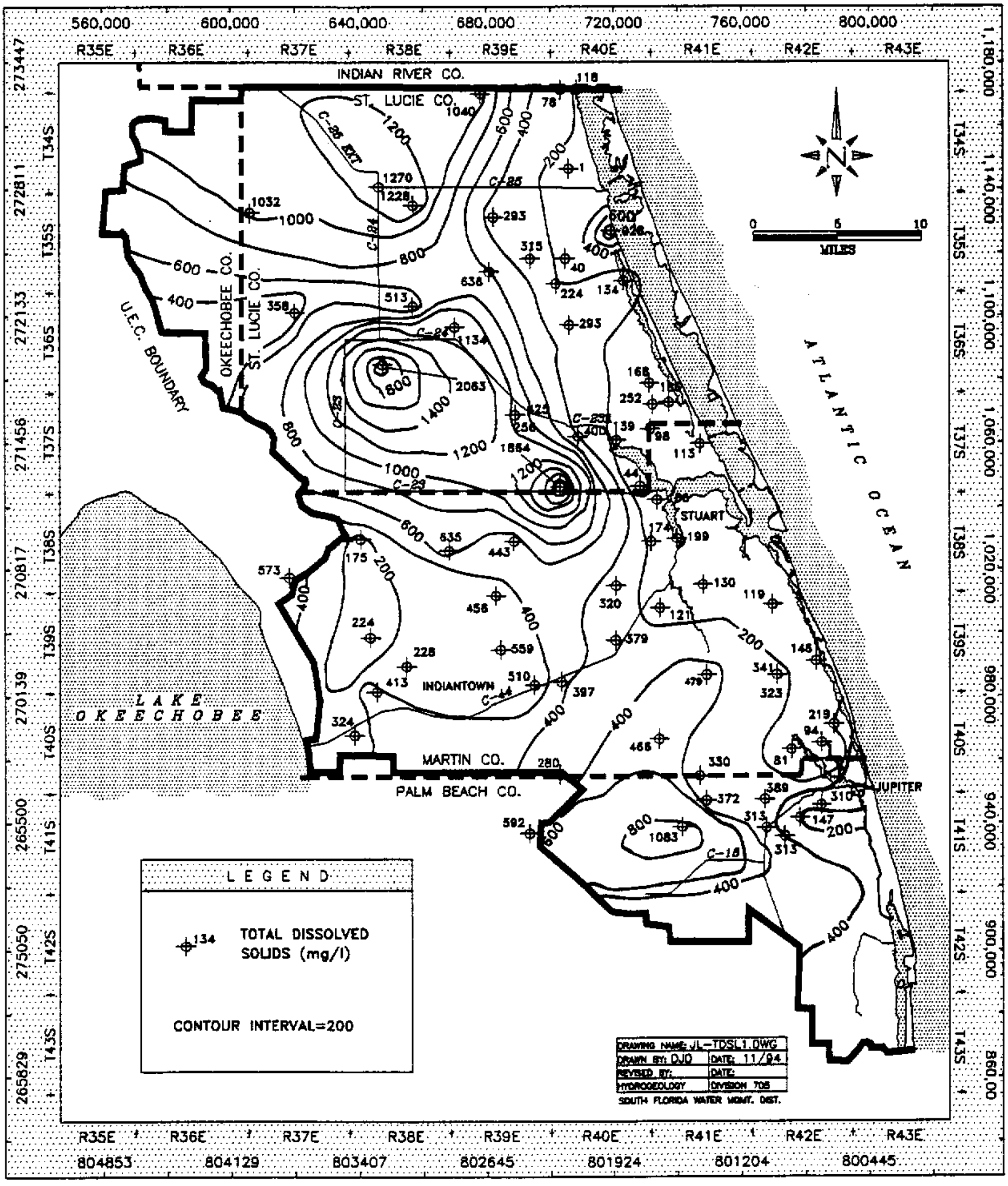

FIGURE 9. **Distribution of Total Dissolved Solids Concentrations in the Surficial Aquifer System Sand/Soil Zone.**

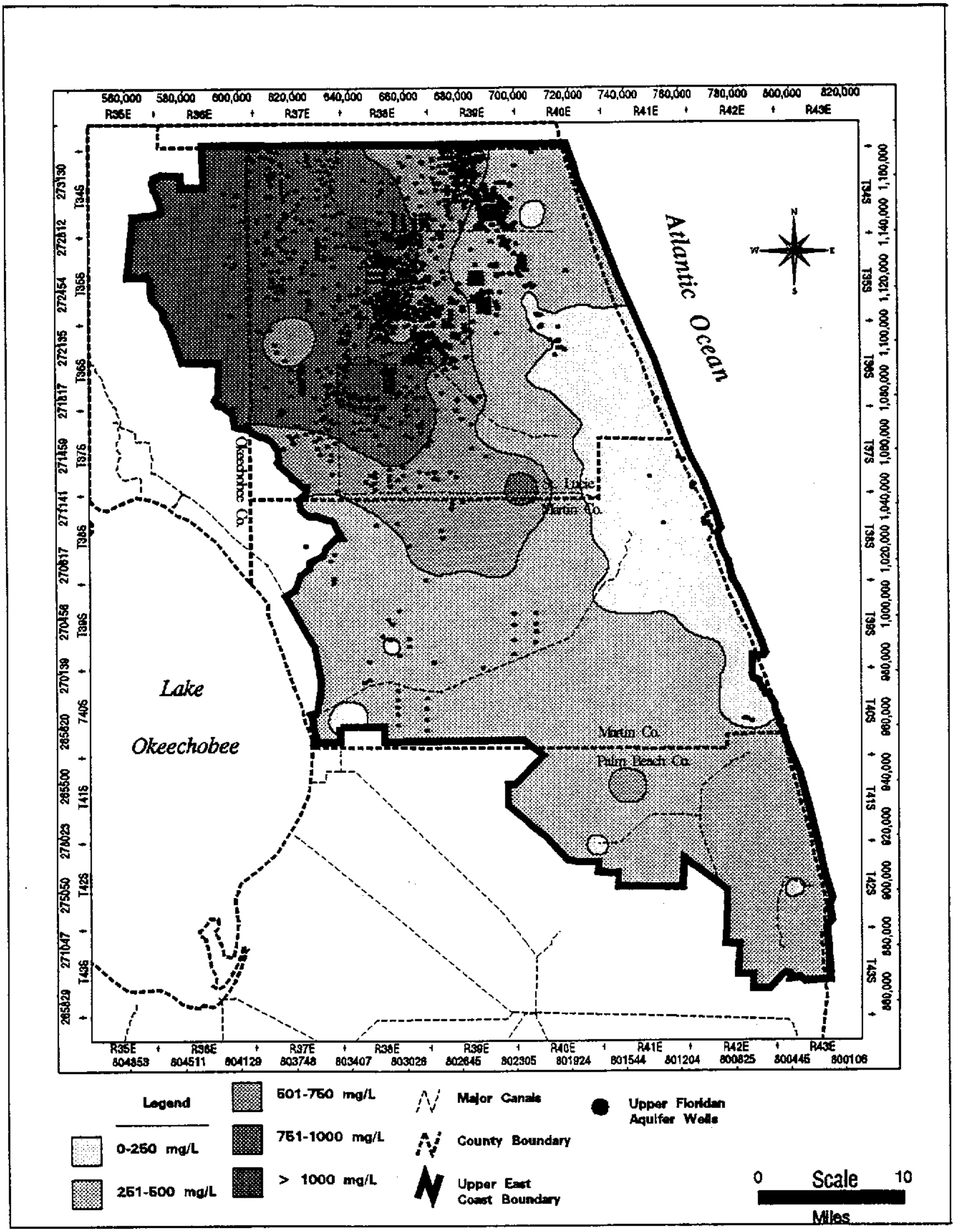

FIGURE 10. **Total Dissolved Solids Concentrations in the Surficial Aquifer System Sand/Soil Zone and Permitted Upper Floridan Aquifer Well Locations.**

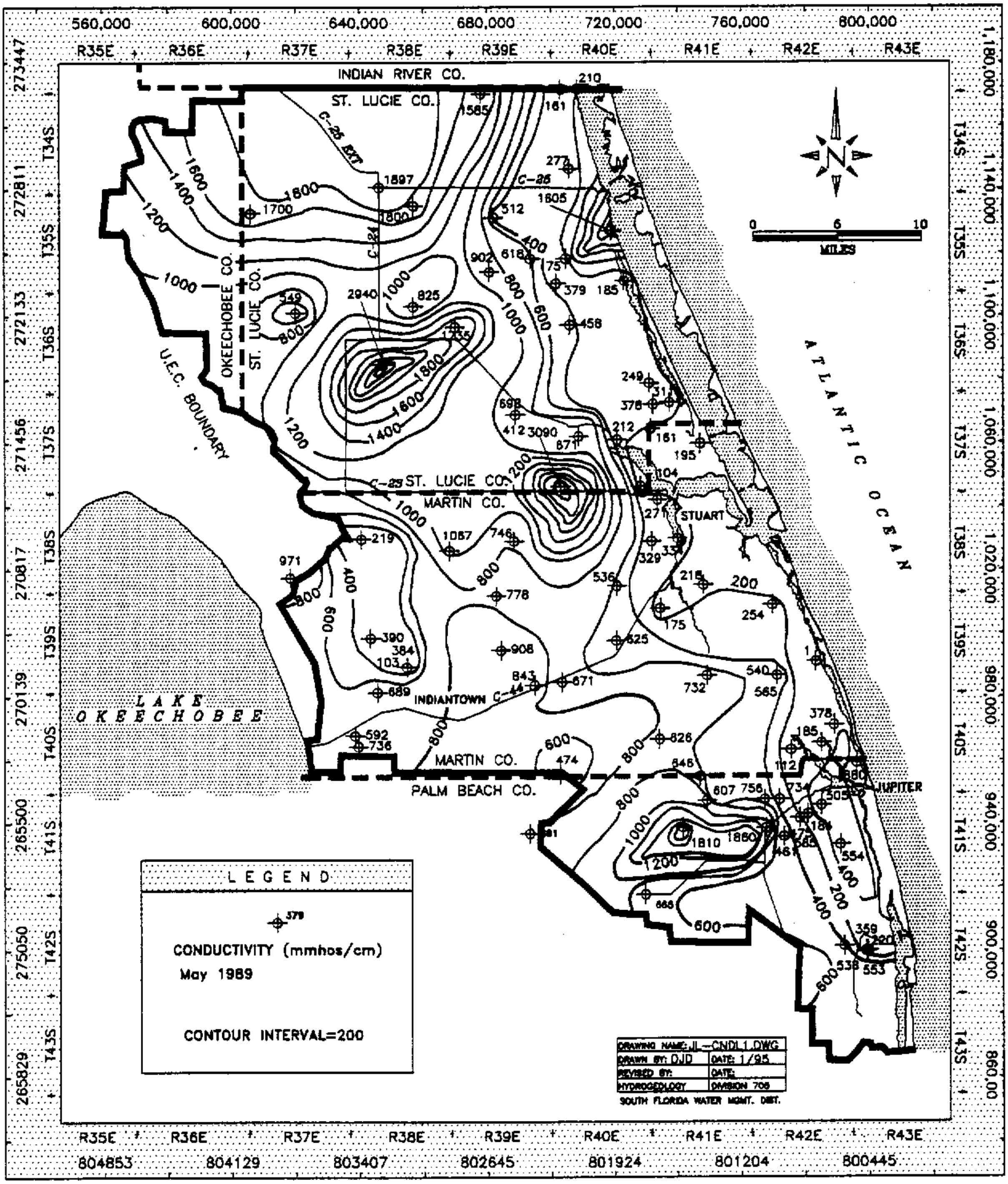

FIGURE 11. **Distribution of Specific Conductivity Values in the Surficial Aquifer System Sand/Soil Zone.**

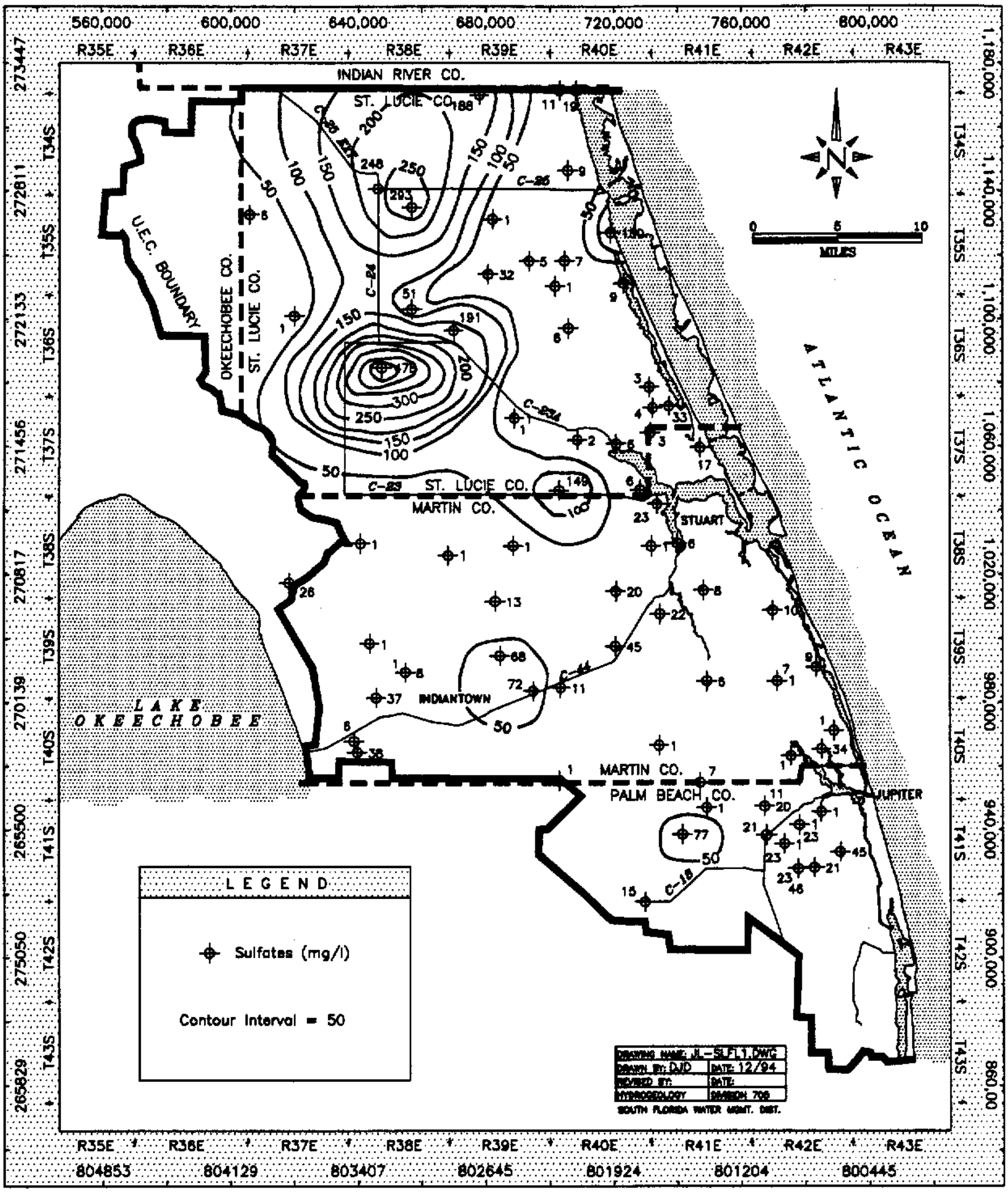

FIGURE 12. Distribution of Dissolved Sulfate Concentrations in the Surficial Aquifer System Sand/Soil Zone.

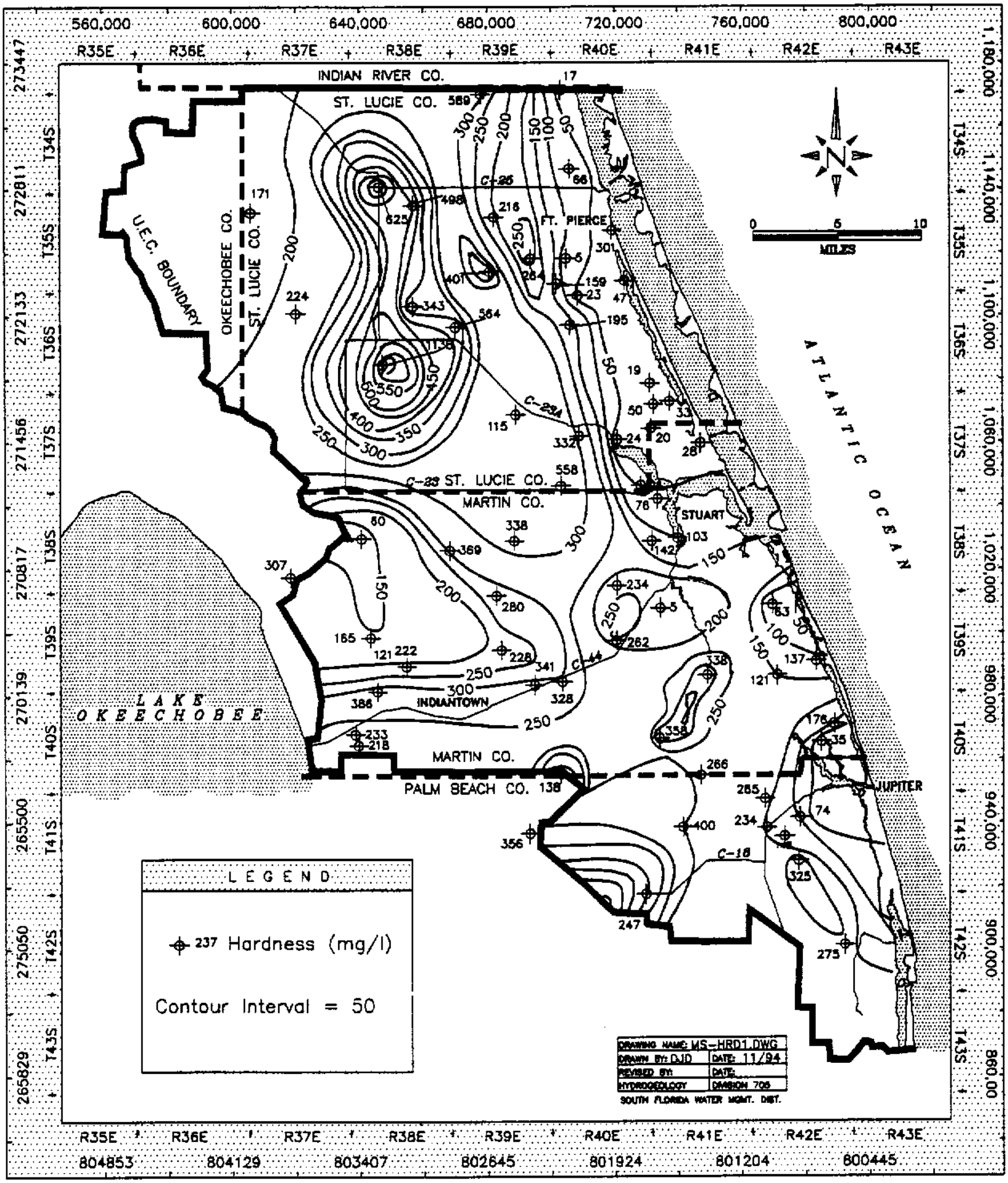

FIGURE 13. Distribution of Hardness ($CaCO_3$) in the Surficial Aquifer System Sand/Soil Zone.

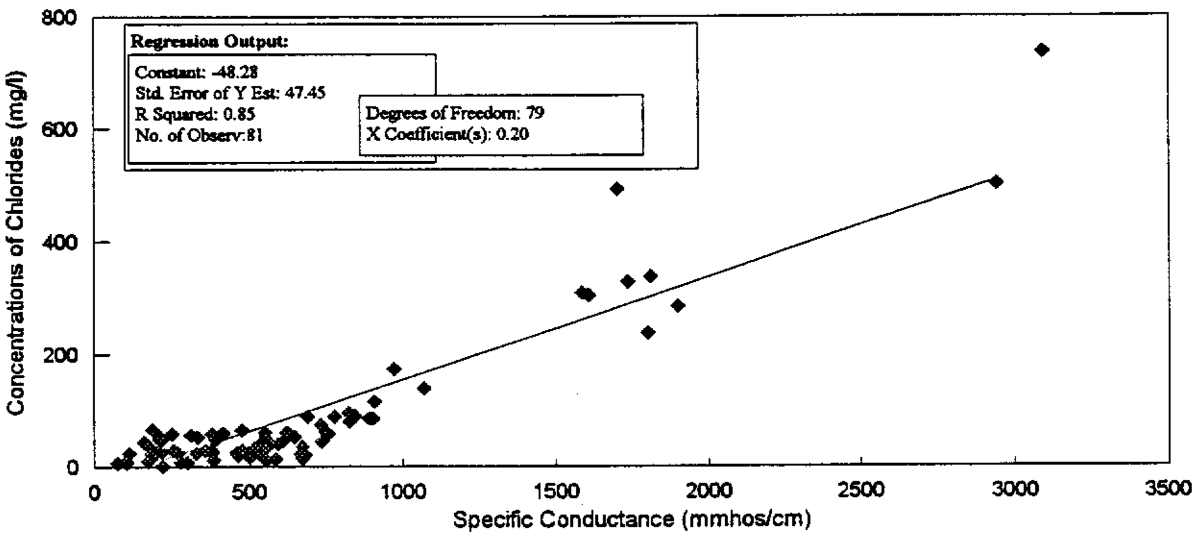

FIGURE 14. **Linear Regression of Specific Conductivity and Chloride Concentrations in the Surficial Aquifer System Sand/Soil Zone.**

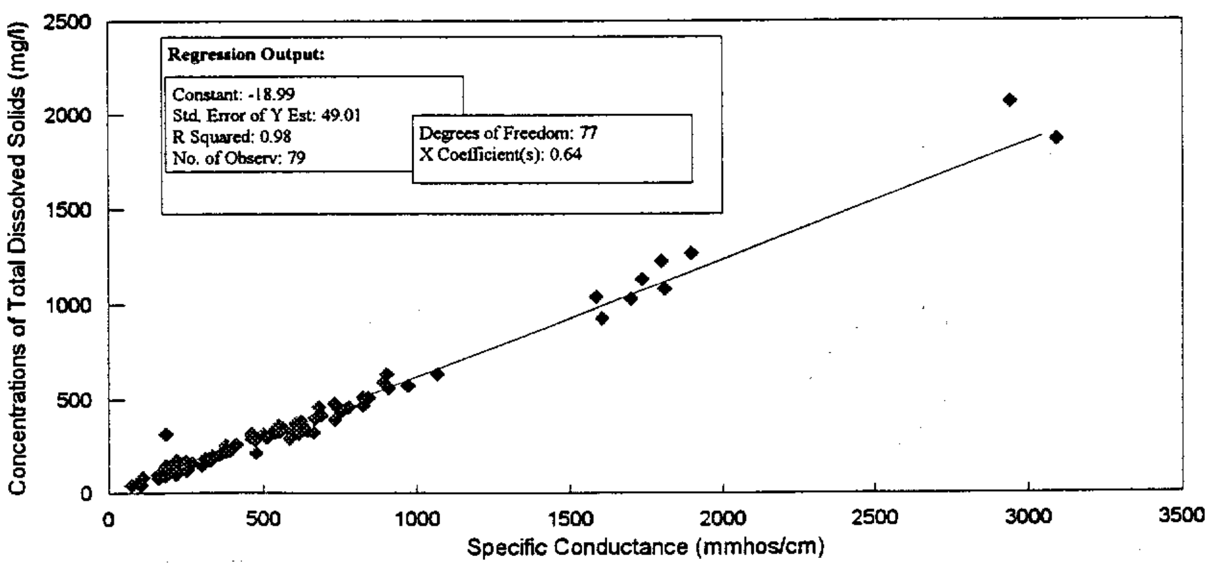

FIGURE 15. **Linear Regression of Specific Conductivity and Total Dissolved Solids Concentrations in the Surficial Aquifer System Sand/Soil Zone.**

This equation and/or the nomograph can be used to compute a chloride concentration (y) with a known specific conductance measurement (x), or vice versa. The R-squared coefficient is equal to 0.85; therefore, 85% of the variability between conductivity and chloride concentration values can be explained on the basis of the linear relationship.

Relation Between Specific Conductance and Total Dissolved Solids Concentration

The regression analysis for specific conductance and TDS concentration yielded the following equation for the best-fit line:

$$y = 0.6446(x) - 19.0 \qquad (3)$$

where:

x = specific conductance value (umhos/cm), and
y = TDS concentration (mg/l)

The R-squared coefficient is equal to 0.98, indicating that 98% of the variability between conductivity and TDS values can be explained on the basis of the linear relationship. The relationship between TDS and specific conductance is much better than that between chloride and conductivity as indicated by the larger R-squared value. This is because the specific conductance of ground water is related to the concentration of all dissolved ions in water, not just that of chloride.

Trilinear Diagrams

Trilinear diagrams were constructed for each county in the study area to provide a visual representation of the dominant ions present in the sand/soil zone and are presented in Appendix C. The method for selecting representative wells for each county diagram was based on the median TDS concentration per county area as previously explained (see Methods, Trilinear Diagrams).

A comparison of Trilinear diagrams between the three counties reveals a distinct trend in water types. From north (St. Lucie County) to south (Palm Beach County), the position of the data points in the central diamond shifts from the upper right to lower left portion of the diagram. This trend can be interpreted as a change in ground water from a calcium-chloride type in the north to a calcium-bicarbonate type in the south. One possible explanation for this north to south freshening trend could be that water in the sand/soil zone to the north has mixed with brackish UFA well water used for irrigation. UFA water has been used for irrigation in this area for over fifty years, primarily in St. Lucie County. Further south, in Martin and Palm Beach counties, the UFA is rarely used for irrigation. A second (although unlikely) explanation for the north to south freshening trend is that connate seawater may reside in the aquifer to the north, and not the south.

Stiff Diagrams

Stiff diagrams were developed representing water in the sand/soil zone for each county using the same well data used in the Trilinear diagrams and are presented in Appendix D, Figures D-1 through D-3. These diagrams were reduced in size and overlain on a basemap of the study area (Figure 16), to provide an easy spatial comparison between water types. Comparisons of the St. Lucie County Stiff diagrams reveal two types of ground water in the county: a calcium-chloride type in the west and a fresher calcium-bicarbonate type in the east. To the south, in Martin and Palm Beach counties, the dominant anion shifts from chloride (in St. Lucie County) to bicarbonate (in Martin County), with the exception of well M-1265 in western Martin County.

SURFICIAL AQUIFER SYSTEM PRODUCTION ZONE (MODEL LAYER 2)

SAS production zone water quality maps were developed using data gathered from sixty wells on the SFWMD's monitor well network (Appendix A, Table A-5), twenty-eight wells in the SFWMD's SALT database, and thirteen Palm Beach County wells from various sources as listed in Appendix A, Table A-6. Table A-6 also includes well completion and location data as well as the results of analyses. A map showing the locations of all these wells is presented in Figure 17. SALT wells are represented by darkened circles on this map, while the monitor well network and other wells are depicted as crosses through open circles. The numbers next to each well correspond with the Map # listed in the Table A-5. Results are summarized below.

Chloride Concentrations

Concentrations of dissolved chloride (Cl^-) measured from wells on the SFWMD's monitor well network and completed to the production zone ranged from 9 mg/l to 8,894 mg/l. The mean and median of the sample population was 292 mg/l and 64 mg/l, respectively. A statistical summary and frequency diagram describing the sample population are provided in Appendix B, Table B-5, and Figure B-5, respectively.

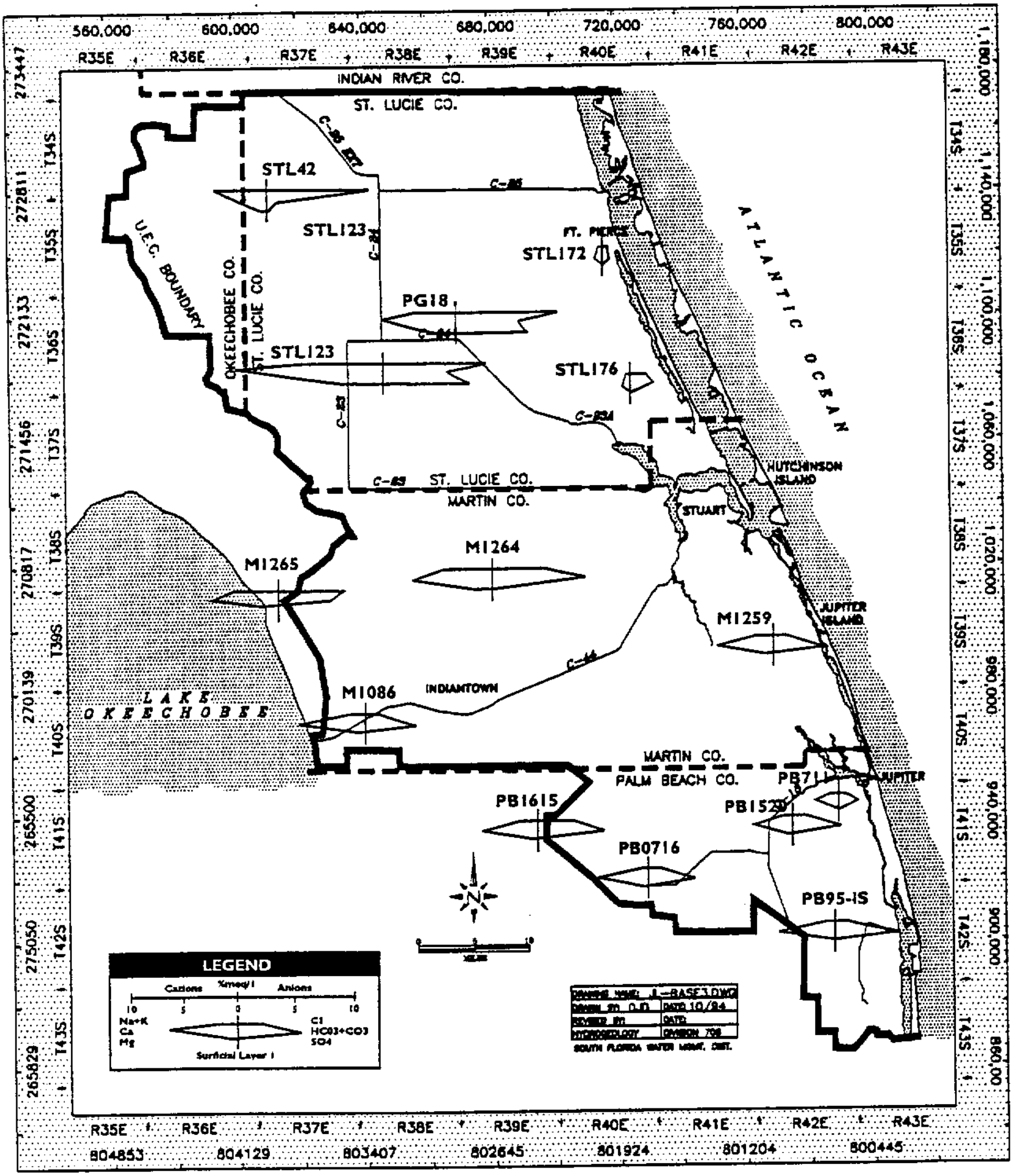

FIGURE 16. **Stiff Diagrams Showing Regional Characteristics of Water in the Surficial Aquifer System Sand/Soil Zone.**

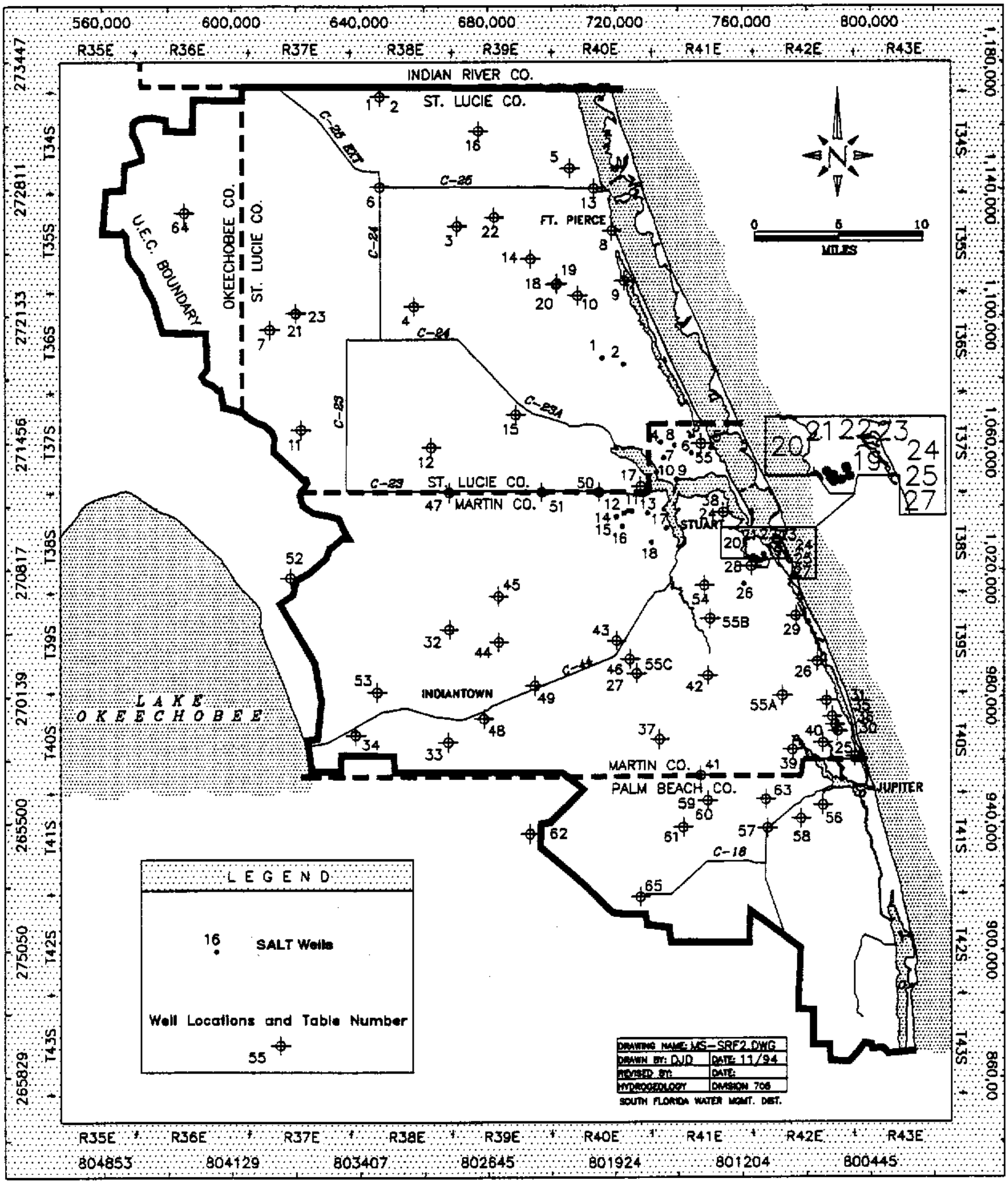

FIGURE 17. Location of Wells Completed in the Surficial Aquifer System Production Zone.

Regional chloride concentrations in the production zone are illustrated with the contour map presented in Figure 18. High chloride concentrations can be identified on this map in three coastal and six inland areas. As in the sand/soil zone, wells with high concentrations near the coast are located near the three major inlets. Water from monitor wells completed to both SAS layers in these areas had high concentrations of chloride, indicative of salt water intrusion. Inland, however, chloride concentrations in the two layers were often independent. Locations with high concentrations in layer one often had low concentrations in layer two, and vice versa. Two potential sources of chlorides to the production zone inland are UFA irrigation water and residual (connate) seawater.

Residual seawater, emplaced in the aquifer during the Pleistocene Epoch, was postulated as the chloride source in western Palm Beach County (Miller, 1988). Brackish water from the UFA is probably also a source of chlorides in the UECPA (especially St. Lucie County). The locations of those areas in the production zone with high chloride concentrations inland are predominantly near clusters of permitted UFA wells. It is possible that the well casings in some of these UFA wells have deteriorated and are allowing mixing between the UFA and production zone.

Total Dissolved Solids Concentrations

Concentrations of TDS in the production zone ranged from 65 mg/l to 13,292 mg/l. The mean and median of the sample population was 840 mg/l and 424 mg/l, respectively. A statistical summary, and a distribution curve describing the sample population are provided in Appendix B, Table B-6 and Figure B-6, respectively.

TDS concentrations in the production zone generally meet potable standards (less than 500 mg/l) throughout most of the study area. A contour map showing the regional distribution of TDS concentrations is presented in Figure 19. Several areas with higher than normal TDS concentrations are evident on this map, most of which correlate with areas having high chloride concentrations previously discussed.

Specific Conductance

Specific conductance of sampled water ranged from 106 umhos/cm to 7,340 umhos/cm. The mean and median of the sample population was 1,108 umhos/cm and 702 umhos/cm, respectively. A statistical summary, based on the distribution curve and the frequency diagram, are provided in Appendix B, Table B-7 and Figure B-7, respectively.

A contour map showing specific conductance regionally is shown in Figure 20. This map illustrates two coastal areas with high specific conductance. The first is located just southeast of the Ft. Pierce inlet and the second is found north of Jupiter. Five inland areas in this zone also have anomalously high specific conductance values. These areas correspond to those with high chloride concentrations previously discussed.

Dissolved Sulfate Concentrations

Concentrations of dissolved sulfate in the production zone ranged from 1.5 mg/l to 1,078 mg/l. The mean and median of the sample population was 81 mg/l and 5 mg/l, respectively. A statistical summary, based on the distribution curve and the frequency diagram, are provided in Appendix B, Table B-8, and Figure B-8, respectively.

The regional distribution of dissolved sulfates in the production zone is presented in Figure 21. High concentrations of dissolved sulfate are evident in the northeastern corner of Palm Beach County near the C-18 canal and the Loxahatchee Slough, and in the extreme southeastern portion of Martin County near the Loxahatchee River. High sulfate concentrations are also observed near the Fort Pierce inlet in northern St. Lucie County and inland in the groves of south-central and northwestern St. Lucie County. The probable sources of sulfates in these areas include seawater intrusion, UFA irrigation water, and connate water.

Hardness

Hardness of water from monitor wells were used to develop the contour map presented in Figure 22. This map indicates that hardness generally ranges between 200 mg/l to 600 mg/l in the study area. These values classify the water as hard to very hard (Table 3). Hardness levels in the production zone are generally higher than those found in the sand/soil zone; the reason for this is that water is coming from a calcium carbonate aquifer. Whereas hardness in the sand/soil zone exhibits a strong east to west trend, this trend is not evident in the production zone. Three distinct locations in the production zone exhibit higher than average hardness. They are located primarily in a band running down the western-central portion of the study area. In these three areas, hardness values range between 400 mg/l to 800 mg/l.

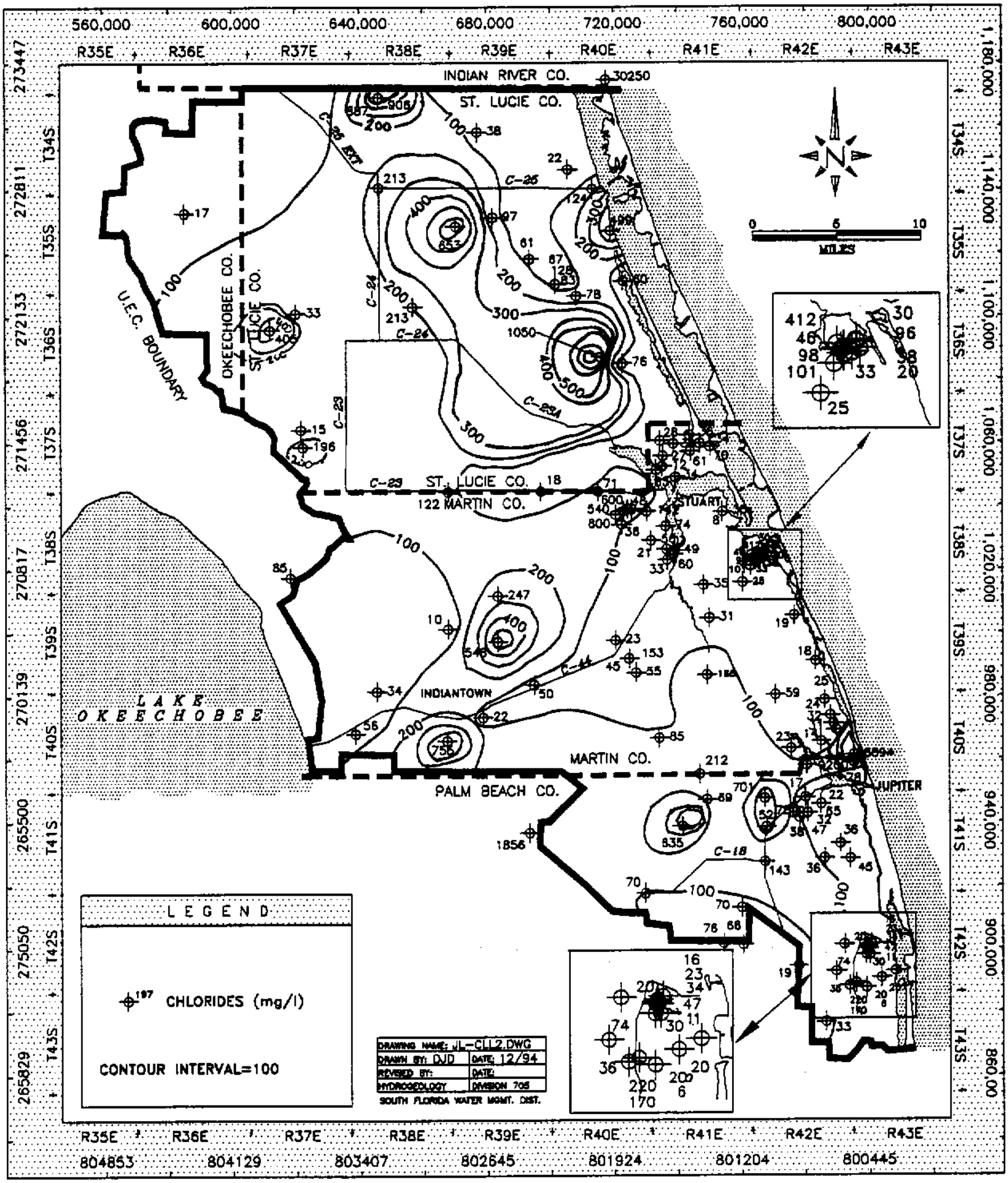

FIGURE 18. **Distribution of Chloride Concentrations in the Surficial Aquifer System Production Zone.**

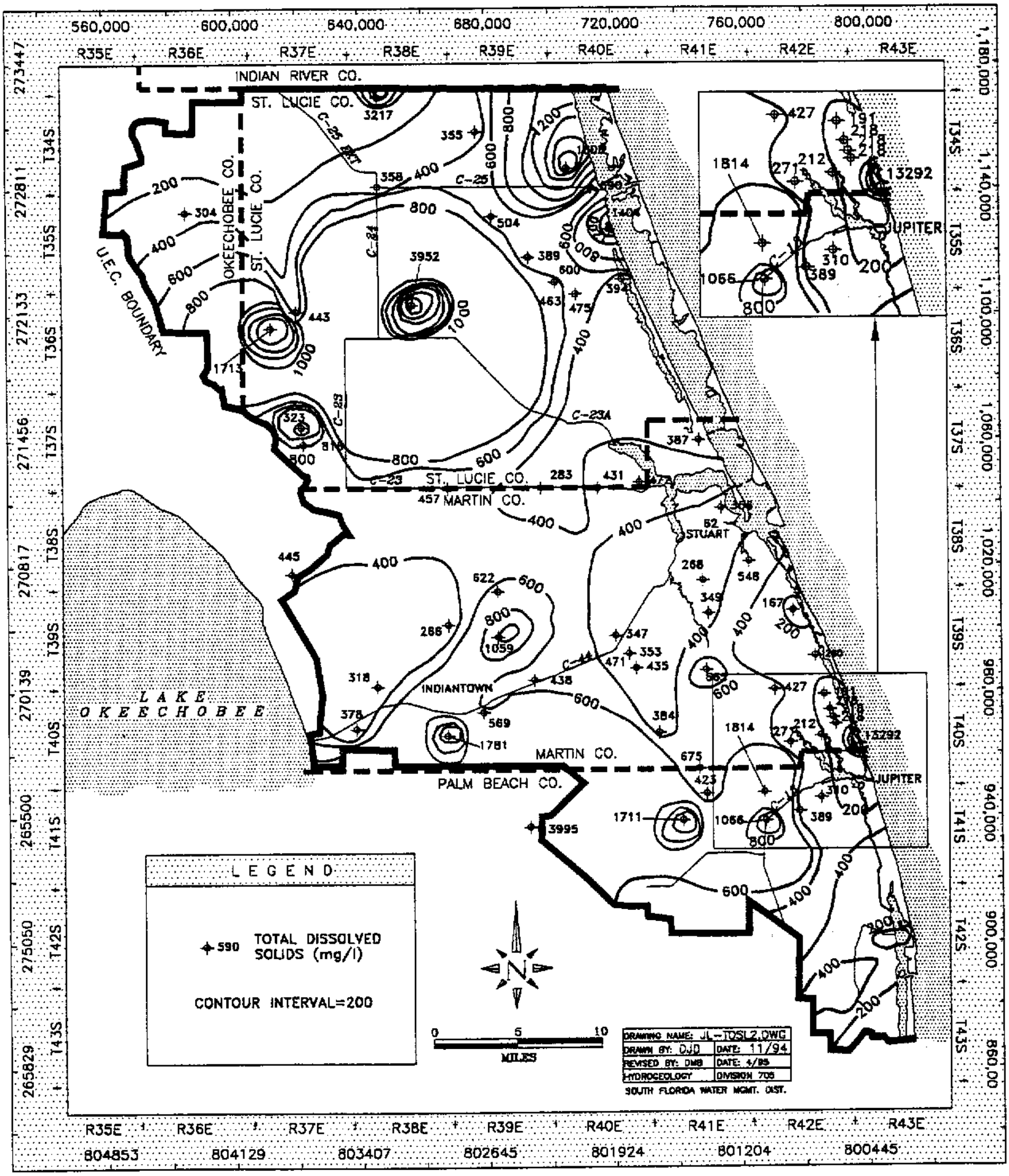

FIGURE 19. **Distribution of Total Dissolved Solids Concentrations in the Surficial Aquifer System Production Zone.**

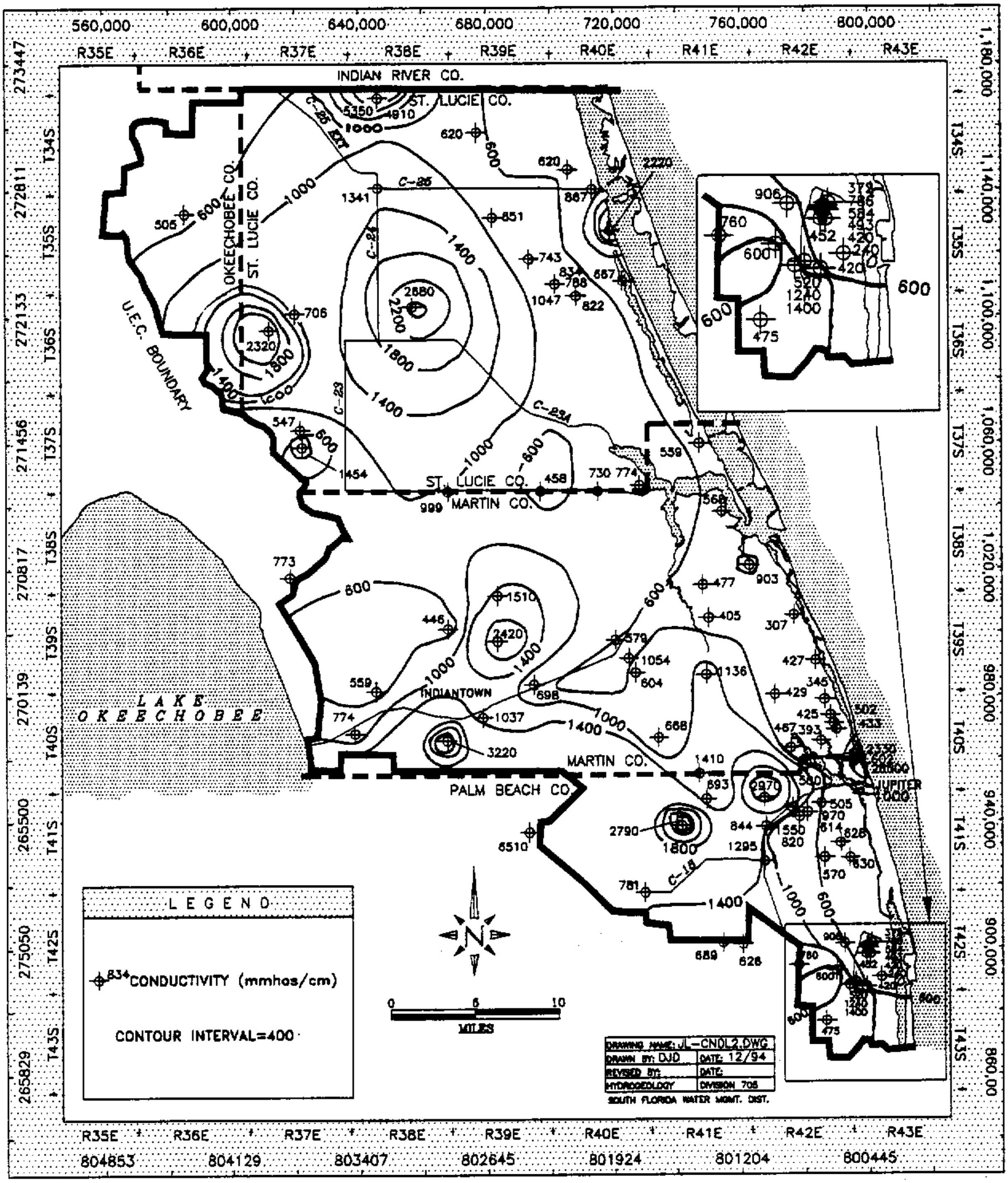

FIGURE 20. Distribution of Specific Conductivity Values in water in the Surficial Aquifer System Production Zone.

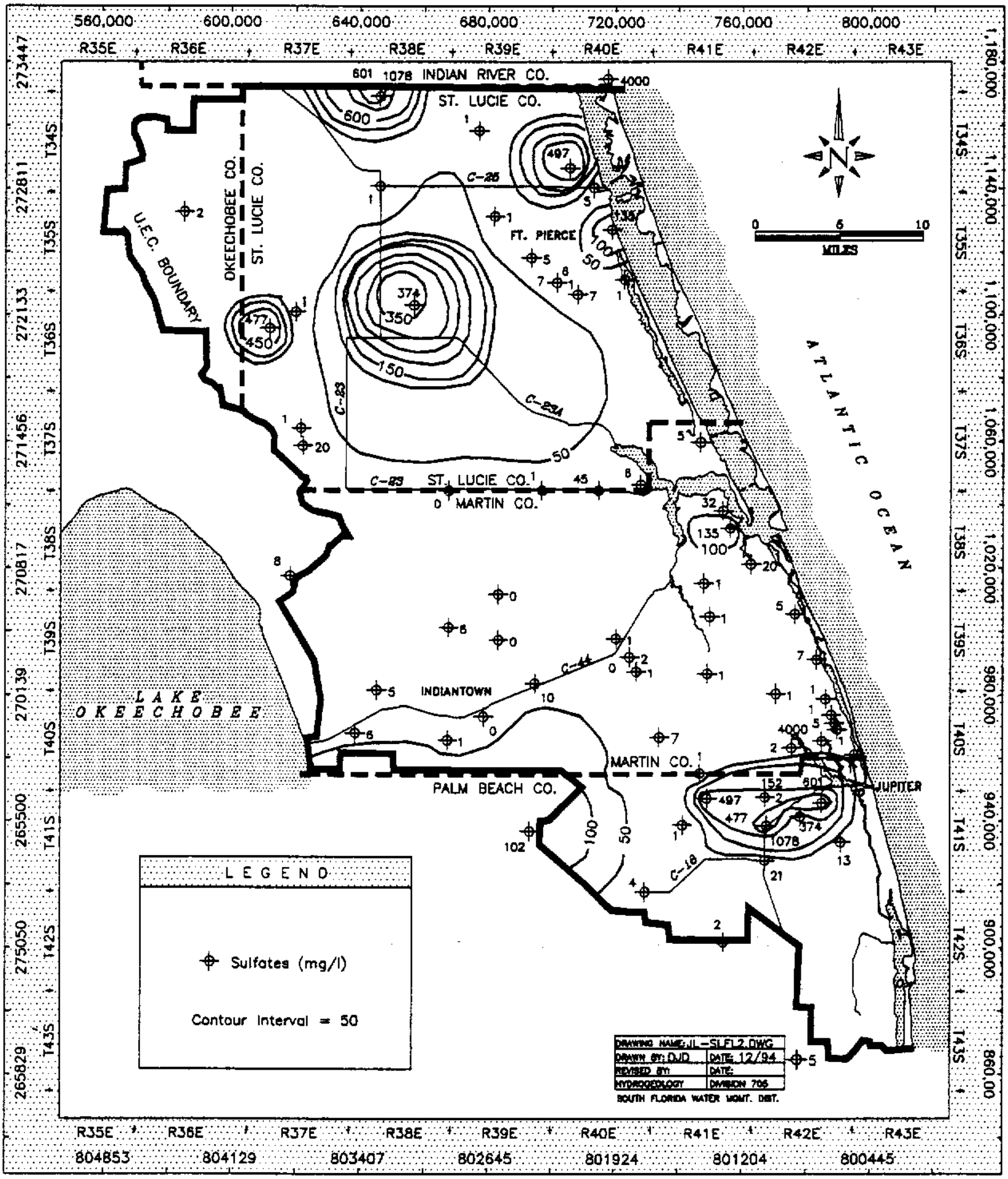

FIGURE 21. Distribution of Dissolved Sulfate Concentrations in the Surficial Aquifer System Production Zone.

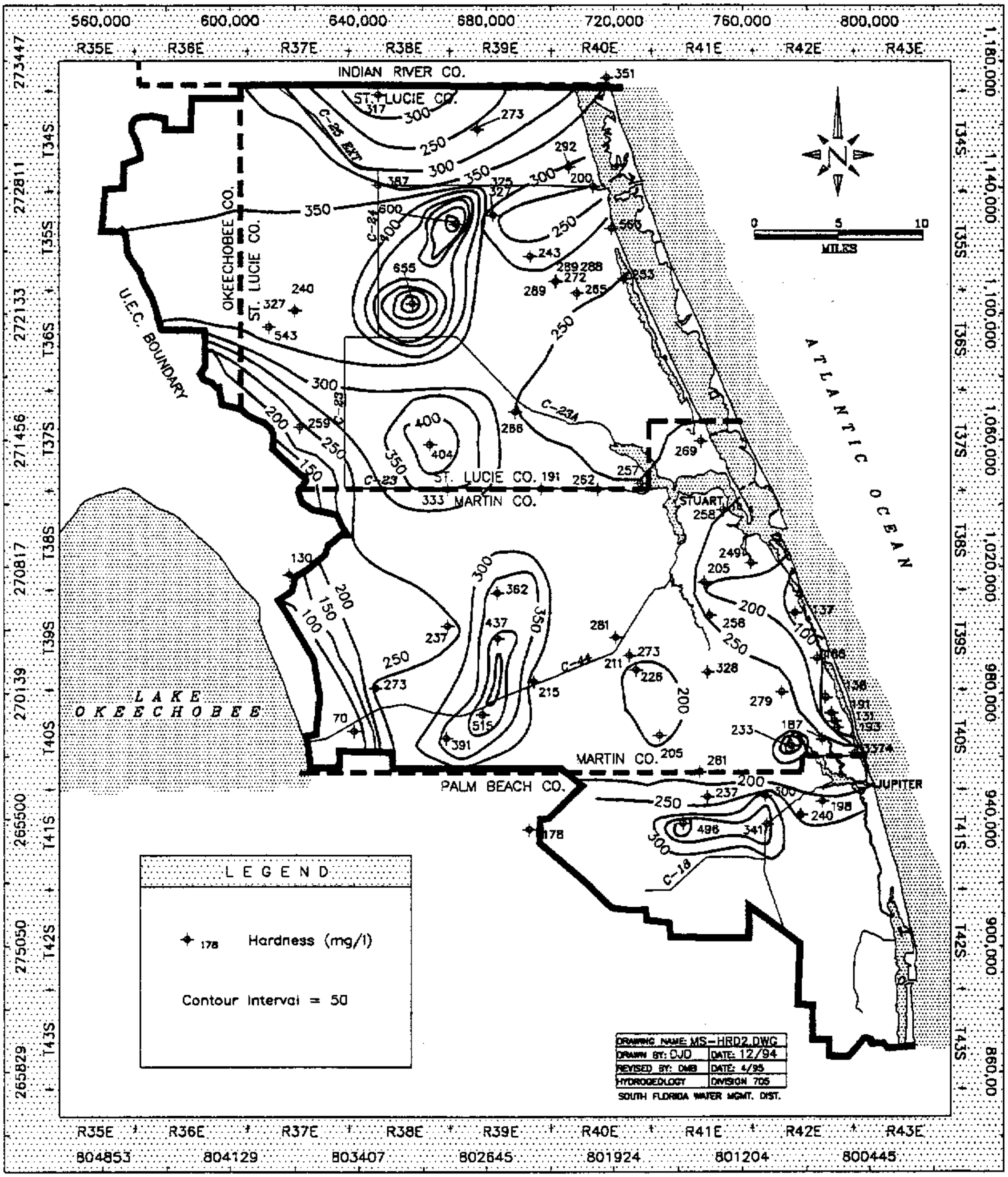

FIGURE 22. Distribution of Hardness ($CaCO_3$) in the Surficial Aquifer System Production Zone.

Iron Concentrations

The total iron (TotFe) content in the production zone is much lower than that in the sand/soil zone. This is probably due to filtering and/or a pH increase with depth. As ground water percolates downward into this zone from land surface, iron probably precipitates and bonds with the sediments overlying the production zone. Total iron content in the production zone did not significantly change between the two sampling events.

A contour map showing the regional distribution of total iron concentration is shown in Figure 23. Most concentrations were below 1.0 mg/l in the study area. In many areas, the total iron content was below the FDEP standard of 0.3 mg/l. Higher concentrations between 1.0 mg/l and 8.8 mg/l were found in isolated portions of the study area. In at least four of these areas, concentrations exceeded 7.0 mg/l. No regional trend is evident on the map.

Linear Regression Models

Relationship Between Specific Conductance and Chloride Concentration

Linear regression models were developed for the production zone to mathematically predict concentrations of chloride and TDS using specific conductance data. Regression lines defining the relationships between specific conductivity and chloride concentration, and between specific conductance and TDS concentration are shown in Figures 24 and 25, respectively. These plots were developed using well data from both the SFWMD's monitor well network and the Palm Beach County wells shown in Appendix A.

The regression line relating conductivity to chloride concentrations yielded the following equation for the best-fit line:

$$y = 0.231(x) - 95.9 \qquad (4)$$

where:

x = specific conductance value (umhos/cm), and
y = chloride concentration (mg/l).

This equation can be used to compute chloride concentration (y) with a known specific conductance measurement (x), or vice versa. The R-squared coefficient is equal to 0.95; therefore, 95% of the variability of conductivity and chloride values can be explained on the basis of the linear relationship.

Relation Between Specific Conductance and Total Dissolved Solids

The regression relating specific conductance and TDS for water in the production zone yielded the following equation for the best-fit line:

$$y = 0.518(x) + 85.3 \qquad (5)$$

where:

x = specific conductance value (umhos/cm), and
y = chloride concentration (mg/l).

The R-squared coefficient is equal to 0.64; therefore, 64% of the variability between specific conductance and TDS values can be explained on the basis of the linear relationship.

Trilinear Diagrams

Trilinear diagrams which illustrate the dominant ions present in the production zone were constructed and are presented in Appendix C. Individual diagrams were developed for each county in the study area to reduce crowding of data. The method for selecting representative wells plotted in these diagrams was based on the median TDS concentration for each quarter of each county as previously explained in the section "Methods, Trilinear Diagrams".

A comparison between the three Trilinear diagrams reveals no distinct differences in water types between counties. The dominant water type in the study area is calcium bicarbonate. Only two wells in St. Lucie County and one well in western Palm Beach County had distinctly different water types which were calcium-chloride (STLMW-1D) and sodium-chloride (SLMW-8D, PB-1552).

Stiff Diagrams

Stiff diagrams were developed for each county using the same well data used in the Trilinear diagrams and are presented in Appendix D, Figures D-4 through D-6. The Stiff diagrams were reduced in size and overlain on a basemap of the study area (Figure 26) to facilitate spatial comparisons between water types. With a few exceptions, the diagrams consistently illustrate that the water type is calcium-bicarbonate in the production zone underlying the study area.

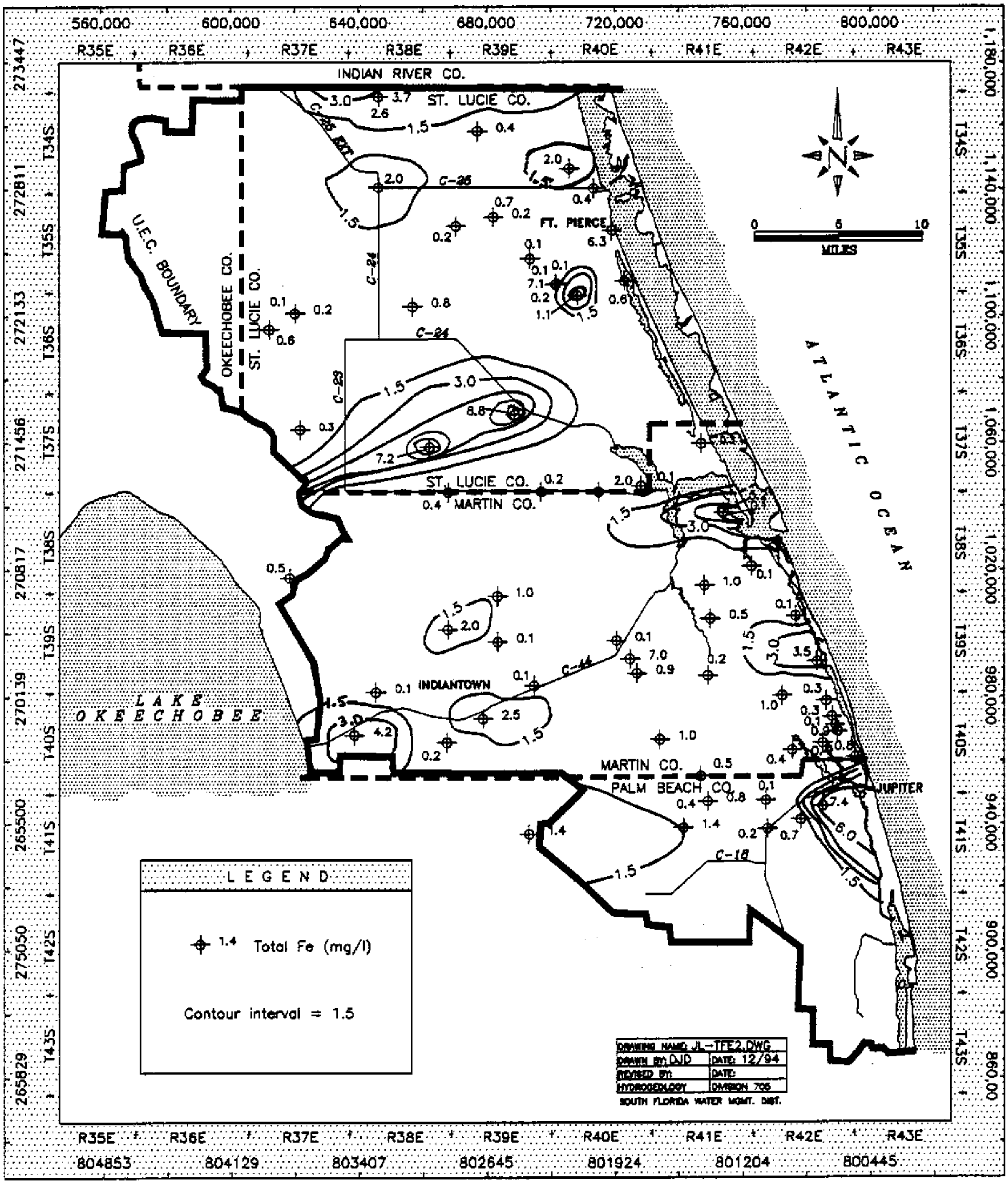

FIGURE 23. **Distribution of Total Iron Concentrations in the Surficial Aquifer System Production Zone.**

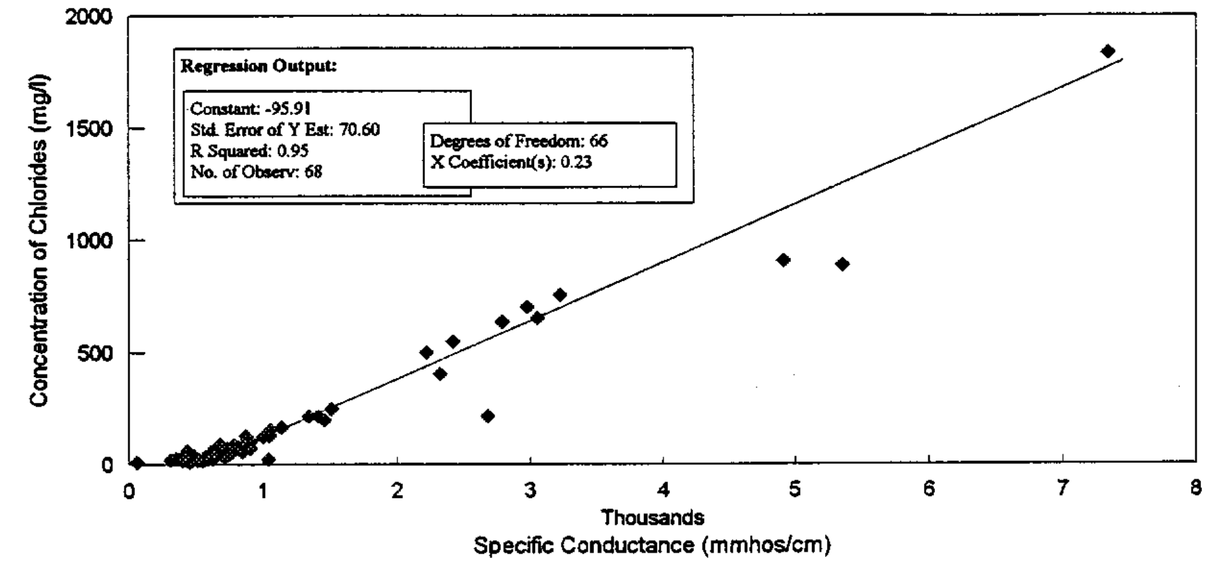

FIGURE 24. **Linear Regression of Specific Conductivity and Chloride Concentrations in the Surficial Aquifer System Production Zone.**

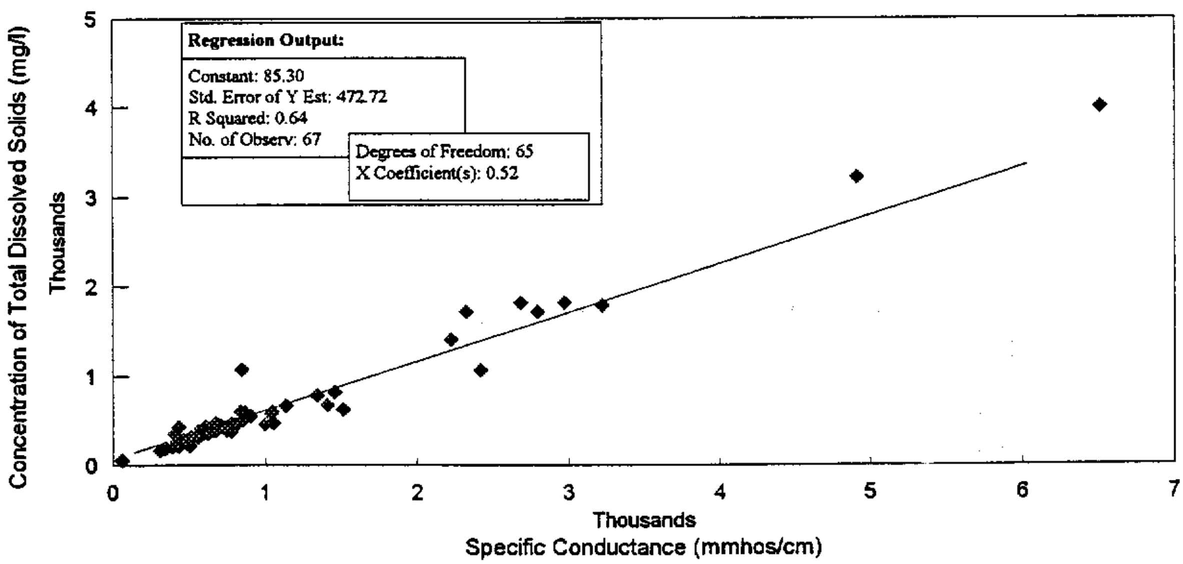

FIGURE 25. **Linear Regression of Specific Conductivity and Total Dissolved Solids in the Surficial Aquifer System Production Zone.**

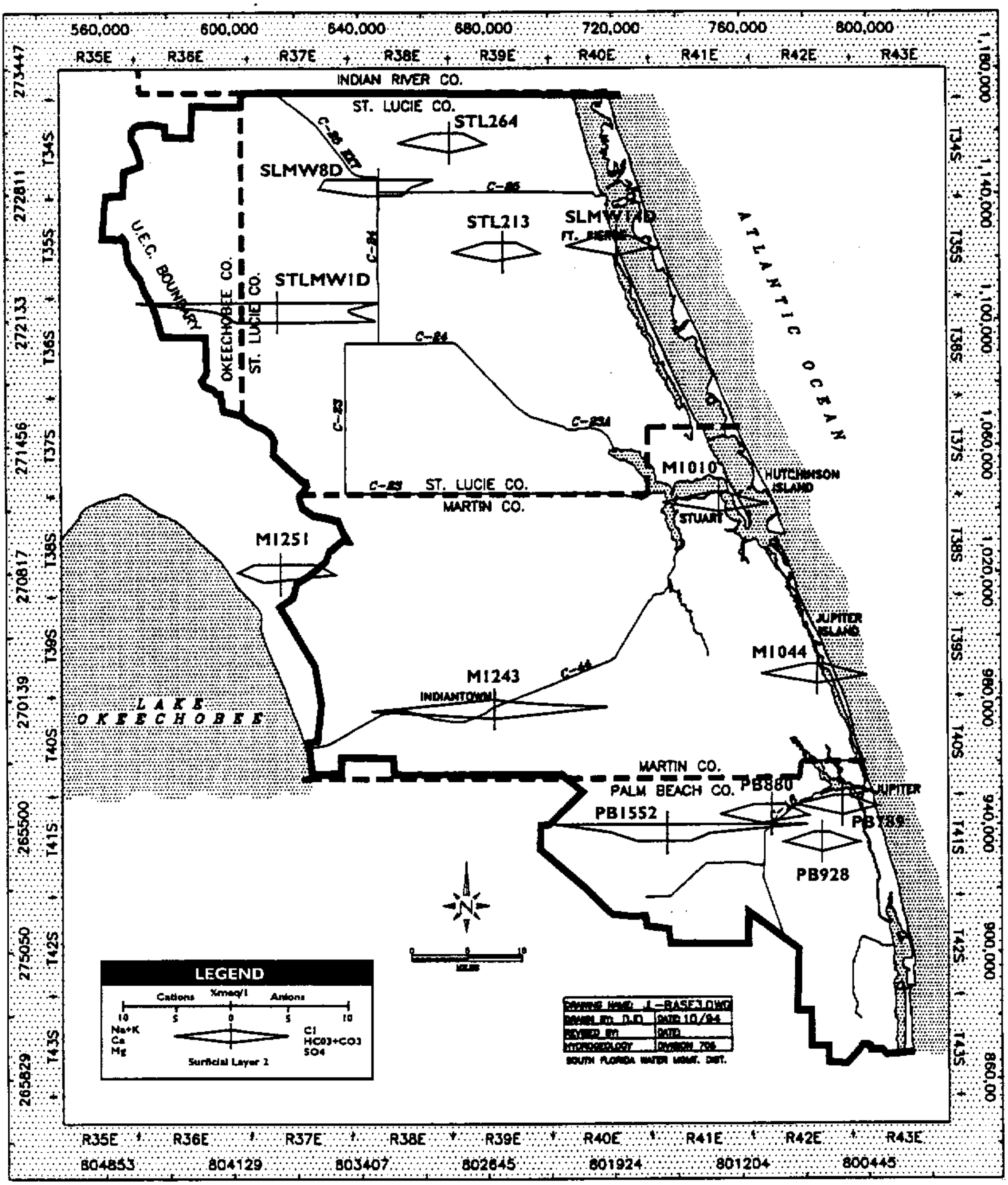

FIGURE 26. Stiff Diagrams Showing Regional Characteristics of Water in the Surficial Aquifer System Production Zone.

COMPARISONS OF WATER IN THE SAND/SOIL AND PRODUCTION ZONES, SURFICIAL AQUIFER SYSTEM

Water in the sand/soil zone is very similar to that in the production zone throughout most of the study area, with the exception of St. Lucie County. Here, water in the production zone appears to be fresher than that in the sand/soil zone. Since UFA wells are used extensively for agricultural irrigation in St. Lucie County (and not in Martin or Palm Beach counties), it seems probable that the brackish water from these wells has mixed with water in the sand/soil zone increasing its chloride concentration (see Figure 10). The production zone (layer 2) is apparently shielded from percolating UFA irrigation water by overlying low permeability sediments. Naturally occurring connate seawater may also play a role as a source of brackish water in the sand/soil zone; its occurrence in western Palm Beach County was documented by Miller (1984).

UPPER FLORIDAN AQUIFER (UFA)

Fifty-two UFA wells from the SFWMD's monitor well network were sampled and analyzed in October 1989 and in May 1990, representative of the end of wet and dry seasons, respectively. Only data from the May 1990 sampling event are presented because of unacceptably high mass balance errors computed from the October 1989 laboratory results. Supplemental water quality data were added to the UFA database used in this report including data from five municipal injection wells and five USGS wells located in Palm Beach County. All data and sources are listed in Table A-7. Wells from the SFWMD's monitor well network are labeled with the prefixes MF (Martin Floridan), SLF (St. Lucie Floridan), IR (Indian River), and OKF (Okeechobee Floridan), while USGS wells are prefixed with PB and injection wells with the abbreviated name of the associated utility. The locations of all UFA wells used in this report were plotted on the map presented in Figure 27.

In addition to the sources listed above, unpublished data (Table A-9) collected from UFA wells during the SFWMD's Well Abandonment (WA) program were also used for mapping chloride concentrations, specific conductance, and temperature distributions. These wells are designated with the prefixes WA, M and SLF, the data from which include location information, well depth and diameter (where available), chloride concentrations, specific conductance, temperature, ground level elevation, and artesian flow rate (Q) measurements. Specific conductance and chloride concentration data in the WA database were obtained in the field using a Hydrolab and a Hach kit, respectively.

The Hach kit employs a titration method for measuring chloride concentration in water. A 100 milliliter (ml) sample of water is collected and mixed in a beaker with a diphenylcarbazone reagent. A solution of mercuric nitrate is then titrated into the beaker until a purple color is detected in the solution. At this point, the chloride concentration can be read directly from the counter window located on the titration device. Results using this method compared favorably with those obtained from lab analyses.

All wells used in this portion of the study were completed to various depths within the UFA and penetrate numerous flow zones within that aquifer. Therefore, all UFA water quality data presented represent the composite water from various flow zones penetrated by each well. Since water quality characteristics between flow zones in the UFA are usually fairly similar, the well depths and specific flow zones penetrated are inconsequential. Total dissolved solids generally increase with depth below the UFA (Lukasiewicz, 1992) and are noticeably higher in the Lower Floridan aquifer; only two known wells (M-150 and M-306) in the database penetrate this lower aquifer.

Water samples collected during reverse air drilling of research well SLF-73, located in central St. Lucie County, indicate no significant variation of TDS or chloride concentrations with depth until 1,100 feet (BLS) which corresponds to the top of the Lower Floridan Aquifer System (see "Florida Aquifer System Water Quality Variations with Depth" section). Wedderburn (1983) examined UFA water quality variations between producing zones in well SLF-50 located in central St. Lucie County and determined that relatively small differences in water quality occur with depth. Since thousands of wells completed to various UFA flow zones exist in the UECPA, it is likely that water in these zones have mixed over time and are now similar in character.

Chloride Concentrations

Concentrations of chloride in the UFA ranged from 209 mg/l to 4,200 mg/l in the study area. The mean and median of the sample population was 1,237 mg/l and 1,150 mg/l, respectively. A statistical summary, based on the distribution curve and the frequency diagram describing the sample population are provided in Appendix B, Table B-9 and Figure B-9, respectively.

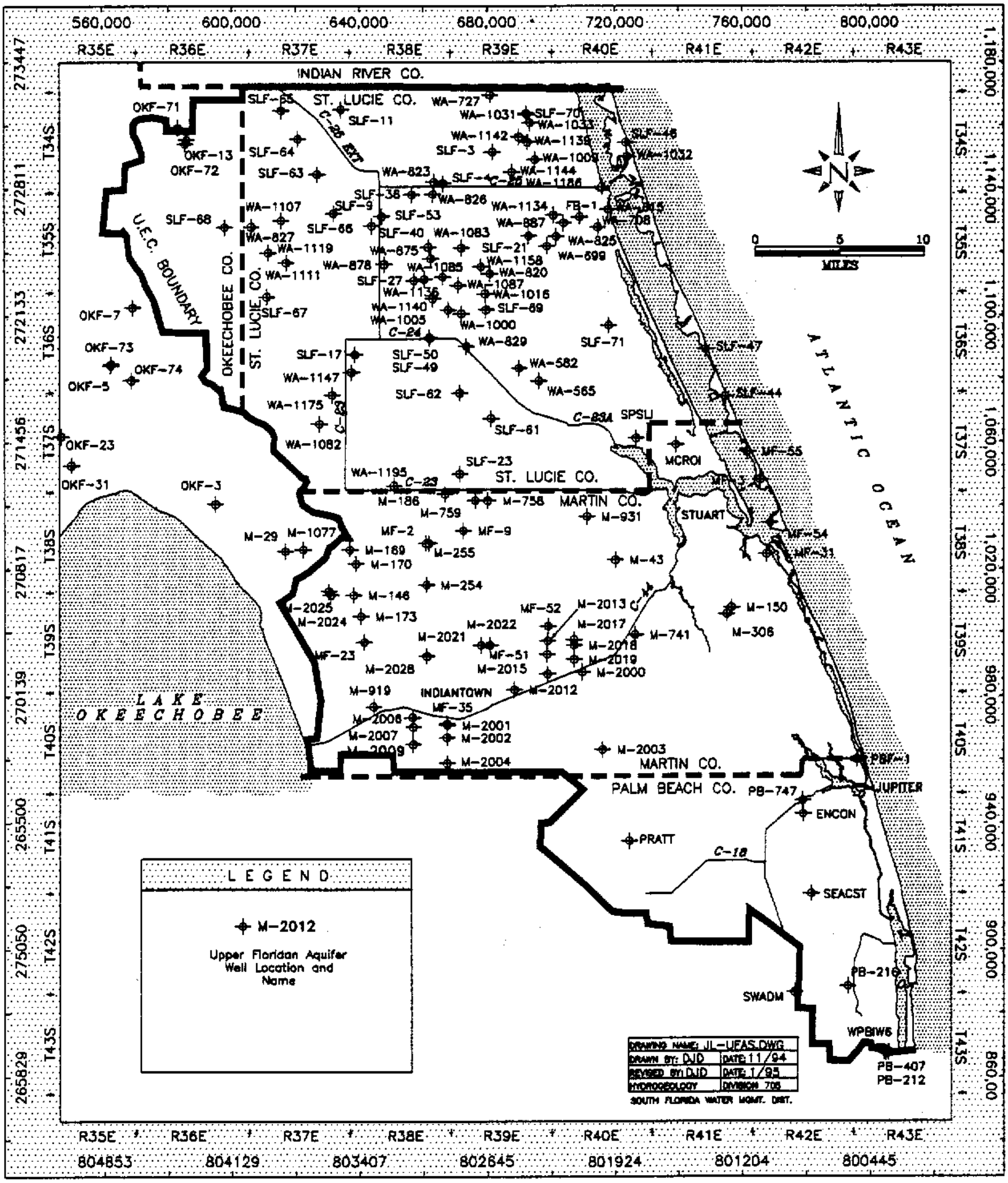

FIGURE 27. Locations of Sampled Upper Floridan Aquifer Wells.

Chloride concentrations and specific conduc-tance data are the most common water quality information available from UFA wells. More chloride concentration data (128 wells) were available for this study than any other single parameter (except specific conductance). Therefore, the chloride concentration contour map presented in Figure 28 provides one of the most comprehensive regional definitions of UFA water character. This map shows well locations and their respective chloride concentrations. The contour map is not representative of any one time period since wells used to develop it were sampled at different times ranging from the years 1940 to 1990. Because chloride concentrations in UFA water usually do not vary seasonally, temporal variability between sampling events should not detract from the validity of the map.

UFA chloride concentrations are just above FDEP potable standards (250 mg/l) in northeastern St. Lucie County and increase rapidly to the south. Relatively low concentrations (400 mg/l) occur in east-central St. Lucie County near the City of Fort Pierce. Fort Pierce Utilities currently blends this UFA water with water withdrawn from the SAS to augment the city's water supplies in periods of high demand. To the south and west of Fort Pierce, chloride concentrations increase to approximately 800 mg/l and are fairly consistent throughout the rest of St. Lucie County. In Martin County, the concentrations increase from approximately 800 mg/l in the west to 1,800 mg/l in the east, although this trend reverses east of the Intracoastal Waterway where they decrease to approximately 1,000 mg/l.

Extremely high concentrations (4,200 mg/l and 3,500 mg/l) were measured in wells M-150 and M-306, respectively, located in east-central Martin County as seen on the isochlor map (Figure 28). These anomalies may be related to their depths which are 1,315 feet and 1,170 feet below (NGVD), respectively. The top of the LFA is found approximately 1,300 feet below (NGVD) in this area (Lukasiewicz, 1992). LFA water is typically more saline than UFA water. Chloride concentrations in the UFA continue to increase to the southeast into Palm Beach County, where they range from approximately 1,200 mg/l to 2,800 mg/l.

The UFA isochlor map illustrates that exceptions to the regional chloride concentration trend are common. When the three counties are analyzed individually, it can be seen that chloride concentrations increase from east to west in St. Lucie to west in St. Lucie County, from west to east in Martin County, and from northwest to southeast in Palm Beach County.

Local variability of chloride concentrations in the UFA is also common. In central St. Lucie County, a cluster of wells completed to similar depths exhibit chloride concentrations ranging from 275 mg/l to 1,188 mg/l. The wells are found within a small area less than six miles in diameter. Local variability is also seen on the barrier island in southern St. Lucie County. Here, the chloride concentration in well SLF-47 is low (251 mg/l) relative to the regional trend. Chloride concentrations are also anomalously low in several wells just northwest of Indiantown in southwestern Martin County. Conversely, unusually high chlorides (4,200 mg/l) were observed in wells east of the South Fork St. Lucie River in east-central Martin County. Meyer (1989) proposed that salinity anomalies found in the UFA inland may be related to upwelling ground water from the Lower Floridan aquifer.

Total Dissolved Solids Concentration

Concentrations of TDS were measured in water sampled from fifty-two (52) UFA wells in and near the study area in May 1990. These data, along with additional Palm Beach County well data, were used to construct the regional TDS concentration map presented in Figure 29.

TDS concentrations in the UFA ranged from 449 mg/l to 5,929 mg/l in the study area. The mean and median of the sample population was 2,528 mg/l and 2,224 mg/l, respectively. A statistical summary, based on the distribution curve and the frequency diagram, are provided in Appendix B, Table B-10 and Figure B-10, respectively.

TDS concentrations are lowest in north-eastern and west-central St. Lucie County and highest in southern Palm Beach County. Concen-trations increase to the south, although local variations to this regional trend are common. TDS concentrations in most of St. Lucie County are less than 2,000 mg/l, although they become slightly higher (2,300 mg/l) in the southern portion of the county. Only a few wells were sampled for TDS in Martin County. Water from these wells had concentrations between approximately 2,000 mg/l to 3,000 mg/l. To the south, TDS concentrations increased dramatically to over 5,000 mg/l in Palm Beach County.

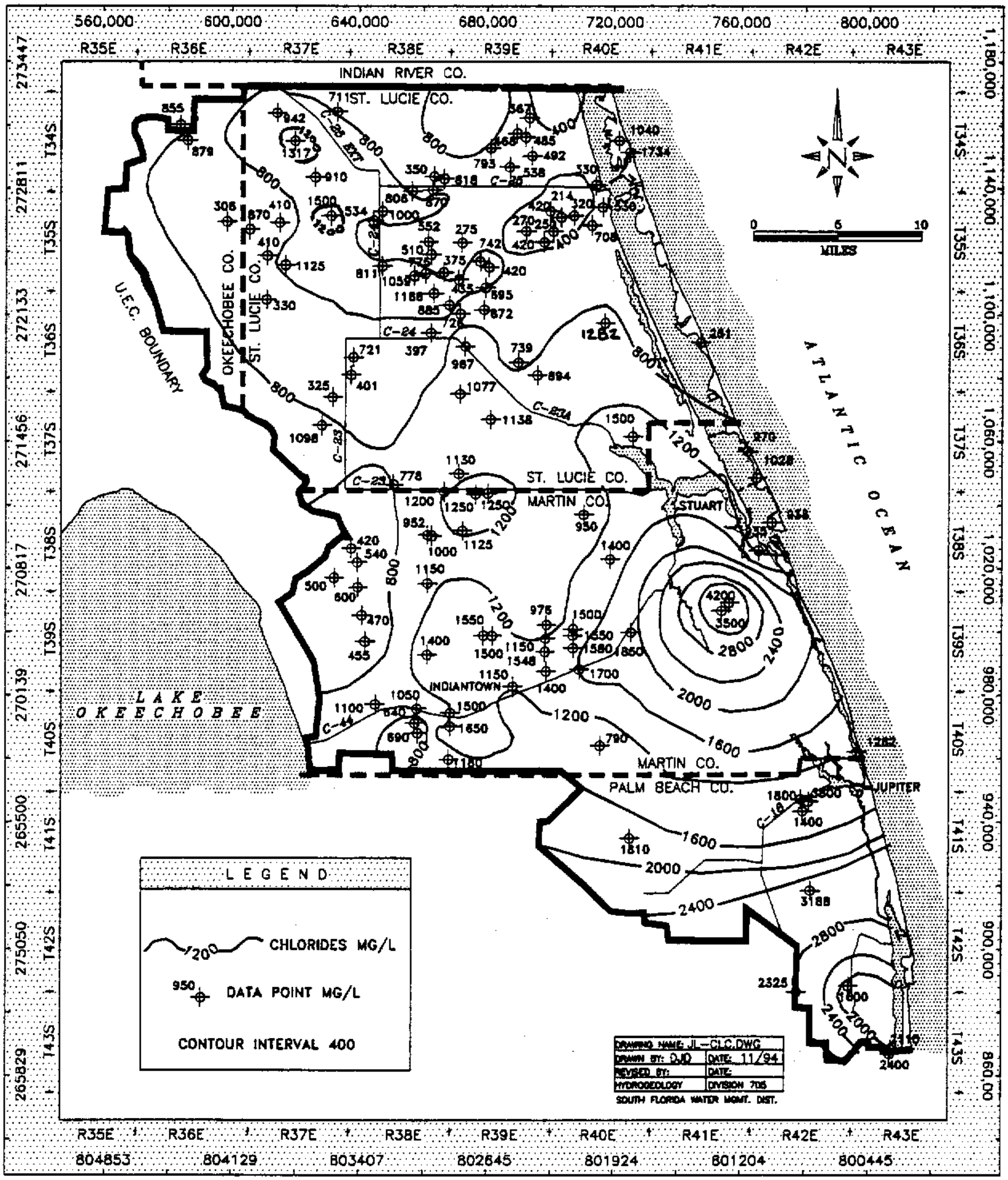

FIGURE 28. **Distribution of Chloride Concentrations in the Upper Floridan Aquifer.**

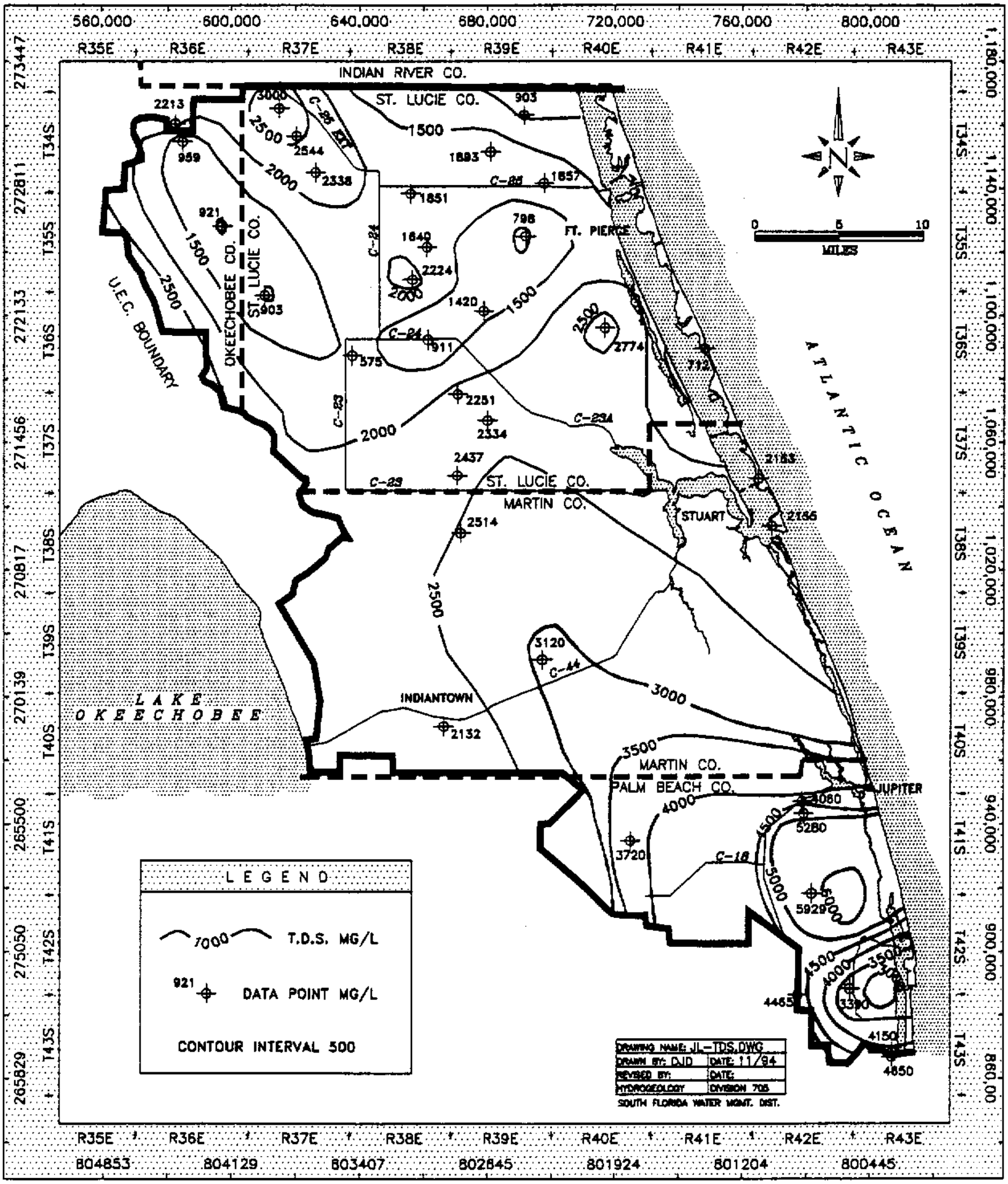

FIGURE 29. Distribution of Total Dissolved Solids Concentrations in the Upper Floridan Aquifer.

Specific Conductance

Specific conductance of water sampled from UFA wells in the study area ranged from 701 umhos/cm to 13,300 umhos/cm. The mean and median of the sample population was 4,103 umhos/cm and 4,062 umhos/cm, respectively. A statistical summary, based on the distribution curve and the frequency diagram, are provided in Appendix B, Table B-11 and Figure B-11, respectively.

The regional contour map of UFA specific conductance, presented in Figure 30, was developed using data from the SFWMD's monitor well network, the Well Abandonment program database, and other wells located in Palm Beach County. As expected, the trends in specific conductance are very similar to those of chloride concentration. This map can be used along with results of the regression analyses (see Linear Regression Models section) to predict TDS and chloride concentrations anywhere in the study area.

Sulfate Concentrations

Dissolved sulfate (SO_4) concentrations were measured in water collected from fifty-two (52) UFA wells in May 1990. These measurements, along with data from the Palm Beach County wells, were used to construct a regional contour map and to statistically describe the sample population.

Dissolved sulfate concentrations ranged from 85 mg/l in Indian River County to 481 mg/l in Palm Beach County. Concentrations of sulfate are generally less than 250 mg/l throughout most of the study area, which is below the FDEP standard for potable water (250 mg/l). The mean and median of the sample population was 222 mg/l and 198 mg/l, respectively. A statistical summary, based on the distribution curve and the frequency diagram are provided in Appendix B, Table B-12 and Figure B-12, respectively.

The dissolved sulfate contour map (Figure 31) illustrates how sulfate concentrations increase to the southeast in the study area. It also shows that many localized exceptions to the regional trend exist, such as well SLF-71 in southeastern St. Lucie County where a sulfate concentration of 412 mg/l, twice the level common for that area, were found. The reasons for these localized anomalies are not clear, although upwelling from lower depths has been suggested (Meyer, 1989).

Hardness

The regional distribution of hardness in UFA water is illustrated in Figure 32. Hardness values are generally between 150 mg/l to 800 mg/l in the study area with a few exceptions. Generally speaking, hardness increases from west to east. An exception to this trend occurs in northeastern St. Lucie County where hardness increases from west to east up to 500 mg/l in the central portion of the county and then decreases toward the coast to less than 200 mg/l near the Intracoastal Waterway. Water in coastal wells has relatively low hardness overall.

Temperature

The temperature of UFA water was measured from fifty-two (52) SFWMD monitor wells and from ninety-four (94) wells in the SFWMD's Well Abandonment program. A regional temperature map was developed with these data and is presented in Figure 33. The temperature of UFA water may be important information to some water users such as power plants (cooling water makeup) and fish farmers. Regional UFA variations in water temperature appear to be independent from those observed for other mapped parameters. Temperatures ranged from 67.1°F to 88.7°F in the study area, a difference of approximately 20° F. Temperatures increased from east to west and were generally coolest in wells on the barrier islands. Because the average annual ocean temperature is close to the temperature of UFA water observed in coastal wells (78°F), the cooling effect of the ocean seems to play a major role in regulating water temperatures. Meyer (1988) found that ground water temperatures in south Florida generally decrease with increasing depth and distance from the recharge areas located in central Florida. He also reported that temperature in UFA water was lowest along the southeastern coast of Florida because of heat transfer to the Atlantic Ocean (Straits of Florida) via the Lower Floridan aquifer.

Several exceptions to the regional temperature trend occur. For example, an area of relatively low water temperature, averaging 78° F, is evident in south-central St. Lucie County. Another area of cooler water is located near Indiantown in Martin County, while an area with relatively warm water (89° F) is located in north-central Martin County. Meyer (1988) proposed that elevated temperature anomalies found in inland areas of south Florida may be related to upwelling ground water from the Lower Floridan aquifer.

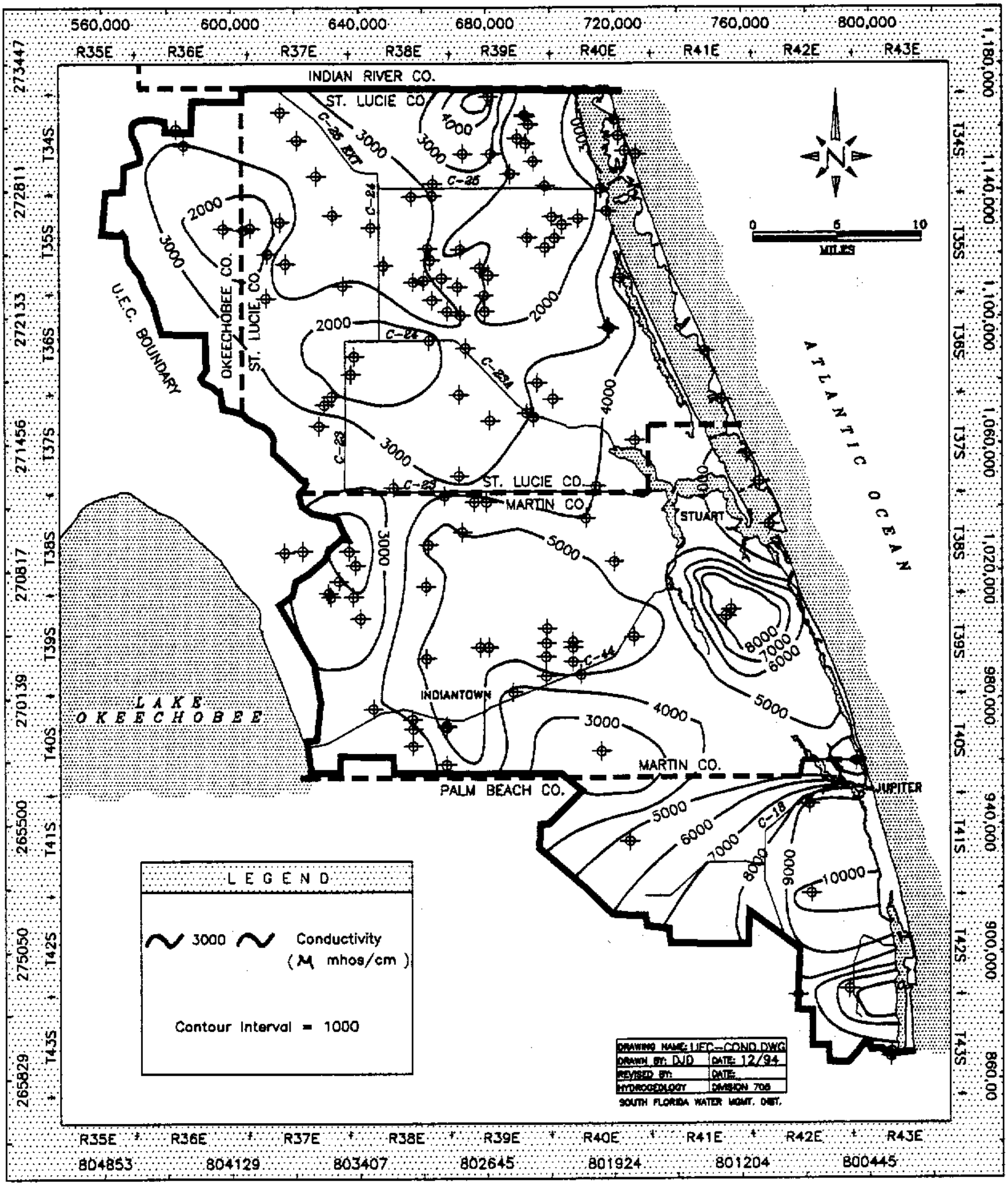

FIGURE 30. **Distribution of Specific Conductivity Values in the Upper Floridan Aquifer.**

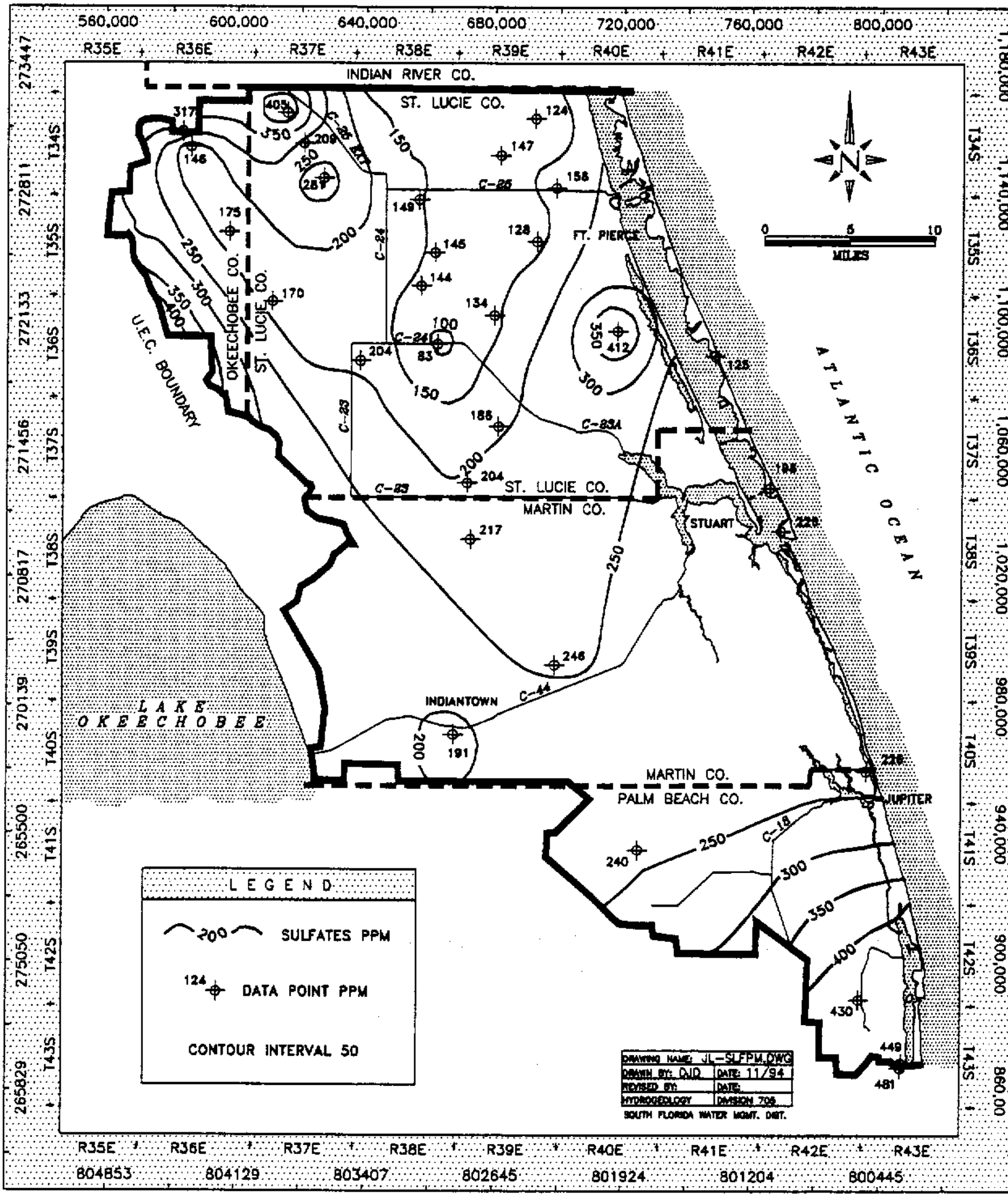

FIGURE 31. Distribution of Sulfate Concentrations in the Upper Floridan Aquifer.

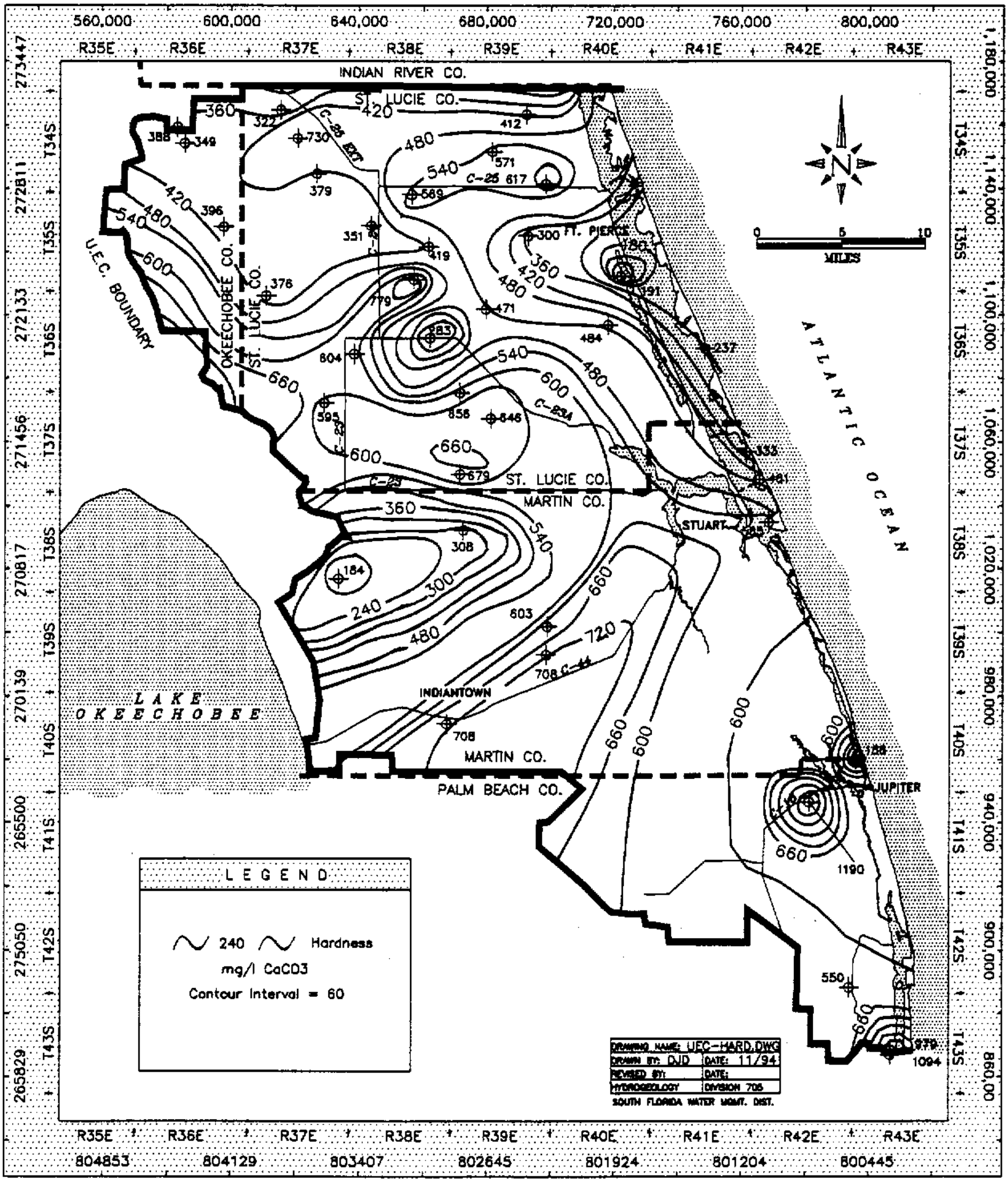

FIGURE 32. Distribution of Hardness ($CaCO_3$) in the Upper Floridan Aquifer.

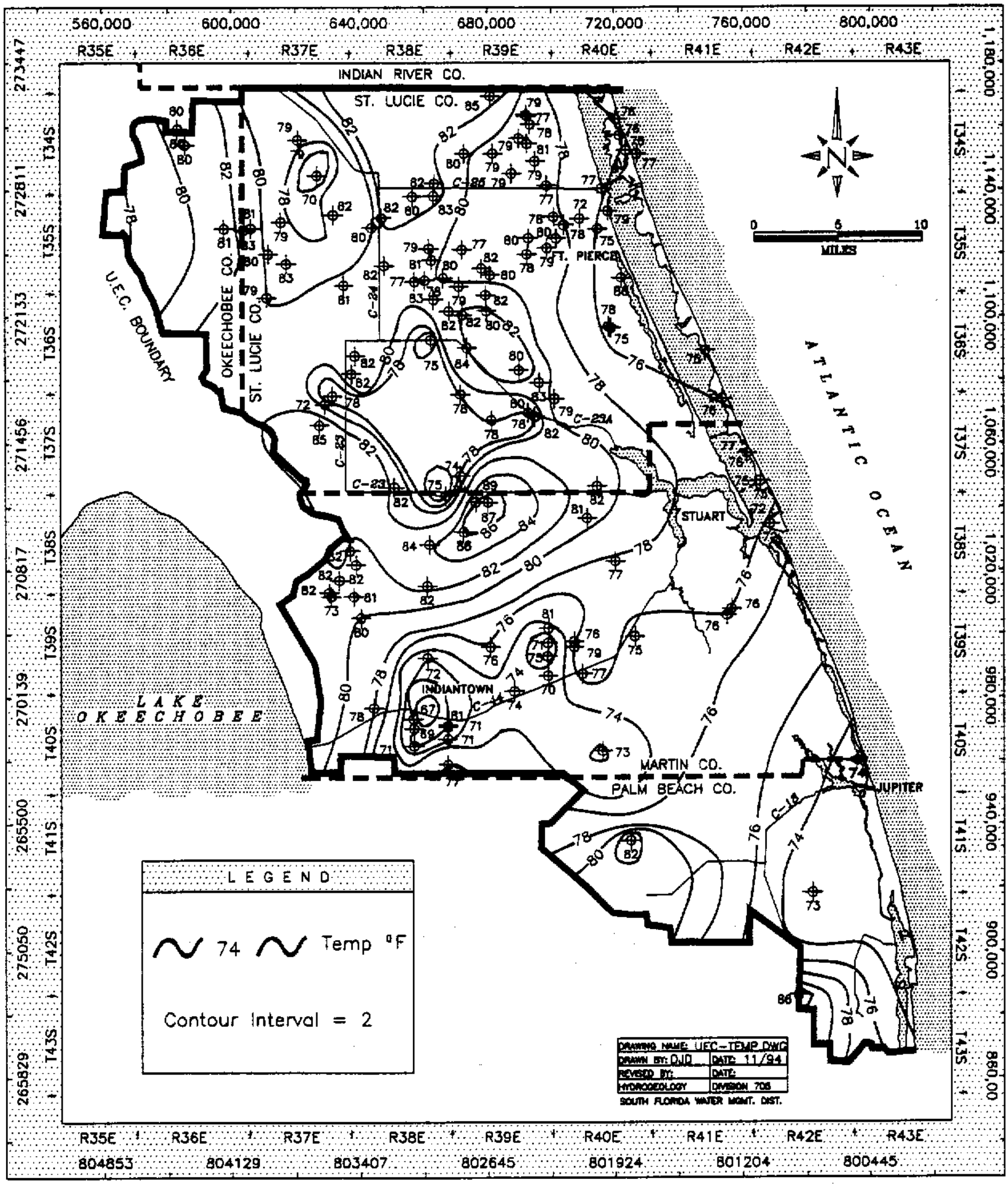

FIGURE 33. **Distribution of Water Temperatures (°F) in the Upper Floridan Aquifer.**

Linear Regression Models

Relation Between Specific Conductance and Chloride Concentration

Linear regression models were developed to predict concentrations of chloride and TDS using specific conductance measurements. Linear regression lines defining the relationships between specific conductance and chloride concentration, and between specific conductance and TDS concentration of UFA water are shown in Figures 34 and 35, respectively. These plots were developed using well data from the monitor well network and from the Well Abandonment program.

The regression between specific conductance and chloride concentration yielded the following equation for the best-fit line:

$$y = 0.2835(x) - 72.1 \qquad (6)$$

where:

x = specific conductance value (umhos/cm), and
y = chloride concentration (mg/l).

This equation can be used to compute a chloride concentration (y) with a known specific conductance measurement (x), or vice versa. The computed R-squared coefficient is equal to 0.82; therefore, 82% of the variability between conductivity and chloride values can be explained on the basis of the linear relationship.

Relation Between Specific Conductance and Total Dissolved Solids Concentration

The regression analysis for specific conductance and TDS concentrations yielded the following equation for the best-fit line:

$$y = 0.5942(x) - 36.2 \qquad (7)$$

where:

x = specific conductance value (umhos/cm), and
y = chloride concentration (mg/l).

The R-squared coefficient is equal to 0.94; so 94% of the variability between conductivity and TDS concentration values can be explained on the basis of the linear relationship. This relationship is better than that between chloride and conductivity, which is expected since the conductance of water is based on the total amount of solids dissolved, not just the amount of dissolved chloride ion.

Trilinear Diagrams

Trilinear diagrams were constructed to show the regional distribution of dominant ions present in the UFA. Two Trilinear diagrams were developed for St. Lucie County and one for Martin County. There was insufficient data to develop a Trilinear diagram for Palm Beach County. The method for selecting representative wells for Trilinear analyses was based on the median TDS concentration found in each portion of the county, as previously explained (see Methods, Trilinear Diagrams).

Five wells (OKF-71, SLF-4, SLF-11, SLF-65, and SLF-63) were plotted on the Trilinear diagram representing northern St. Lucie County, while four wells (SLF-27, SLF-71, SLF-23, and SLF-62) were plotted for southern St. Lucie County (Appendix C, Figures C-7 and C-8, respectively). All wells in both Trilinear diagrams cluster in the upper, far-right portion of the center diamond corresponding to sodium-chloride type water. Seven wells (MF-31, MF-3, MF-9, MF-54, MF-2, MF-35, PBF-1) were plotted on a single Martin County Trilinear diagram shown in Appendix C, Figure C-9. Here again, all wells are positioned in the portion corresponding to sodium-chloride type water.

Classification System

Frazee (1982) used Trilinear diagrams to group similar waters into patterns representing characteristic water types. These water types indicate the origin and degree of mineralization of various ground water environments common to northeastern Florida. Figure 36 illustrates Frazee's classification scheme for waters in the UFA. Five general classes of water are shown: fresh water, fresh recharge water, transitional water, connate water and laterally intruded water.

Fresh recharge water is characterized by low percentages of chloride, sulfate, sodium, and potassium, and higher percentages of calcium, magnesium, and bicarbonate (Frazee, 1982). Laterally intruded water is similar in composition to sea water and contains high concentrations of sodium and chloride. Transitional water has the characteristics of both fresh recharge water and either laterally intruded water or connate water, depending on the source of water being mixed.

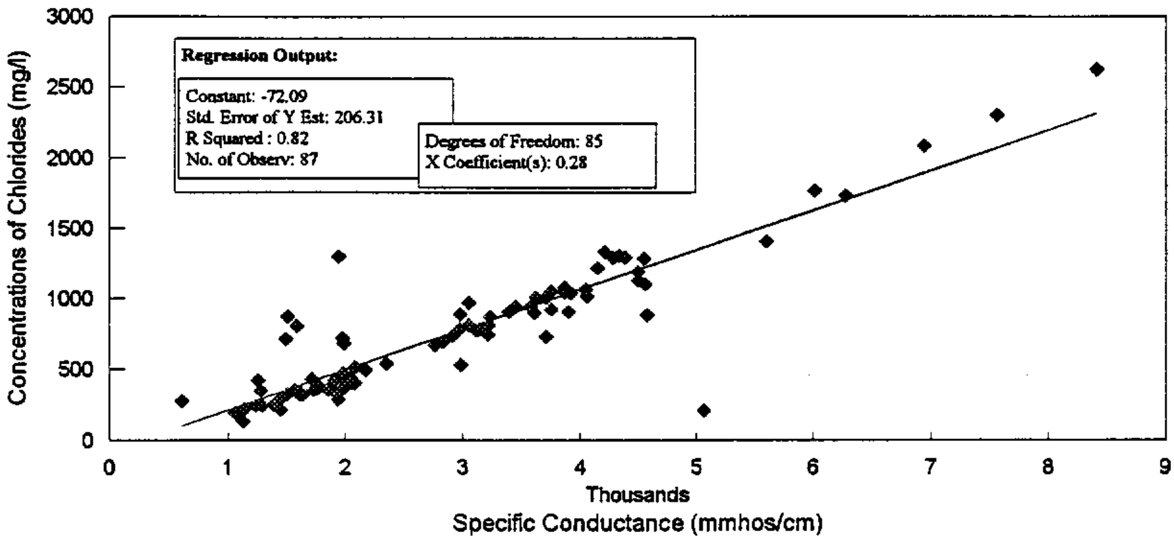

FIGURE 34. **Linear Regression of Specific Conductivity and Chloride Concentrations in the Upper Floridan Aquifer.**

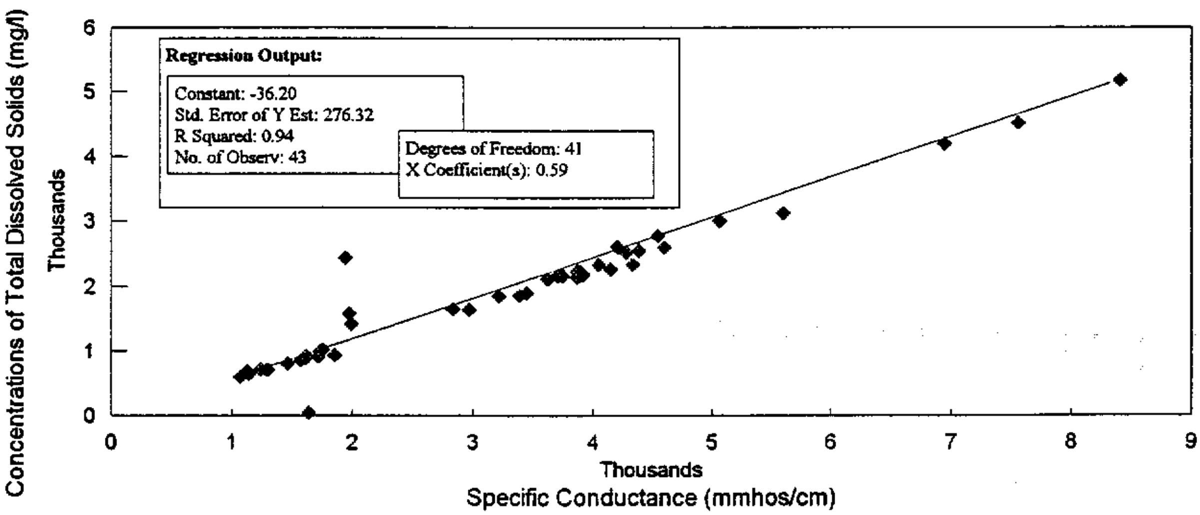

FIGURE 35. **Linear Regression of Specific Conductivity and Total Dissolved Solids Concentrations in the Upper Floridan Aquifer.**

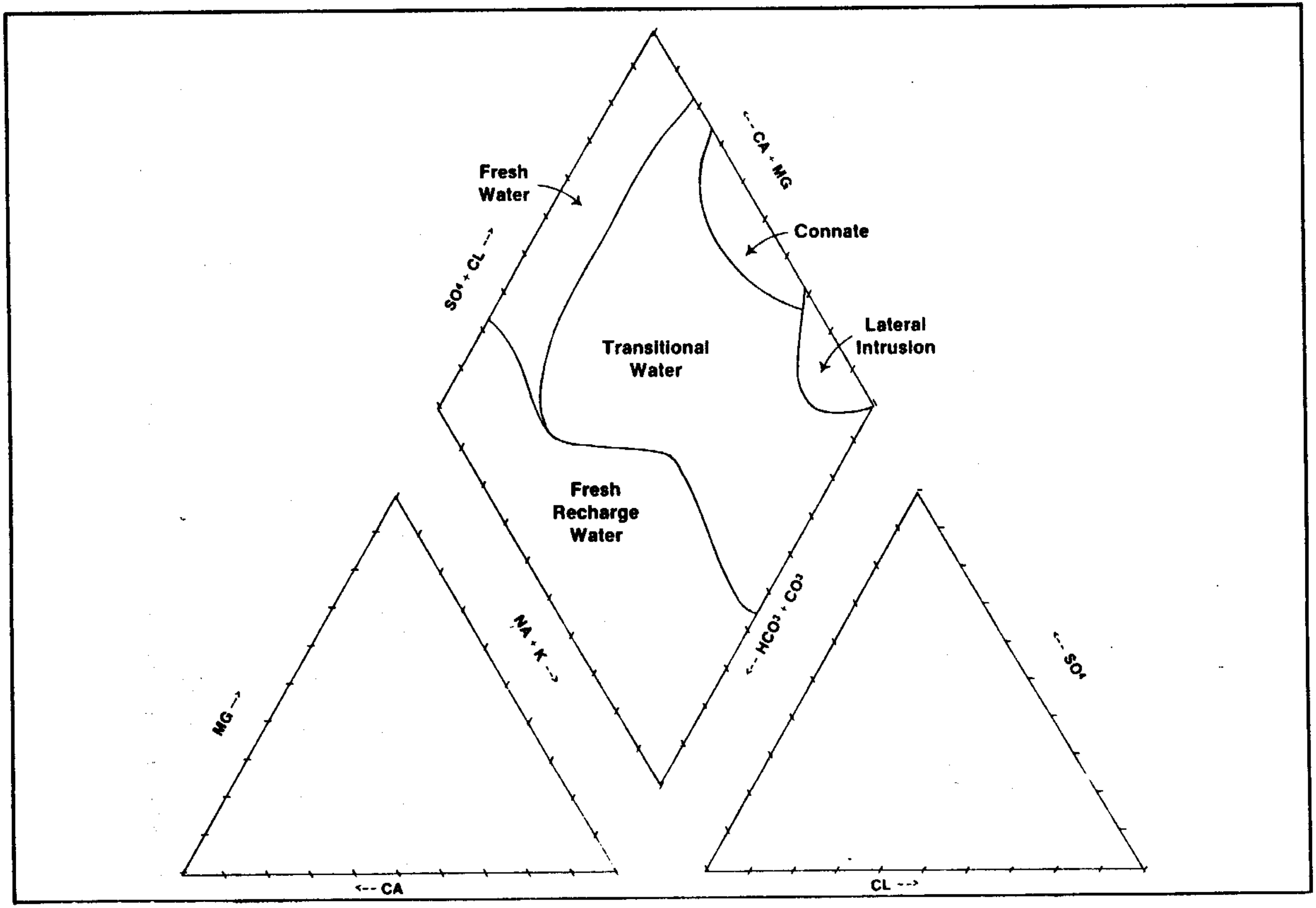

FIGURE 36. Classification of Waters Within the Floridan Aquifer System (After Frazee, 1982).

Although both counties have sodium-chloride type water in the UFA, a higher percentage of the sodium cation is present in Martin County wells than those in St. Lucie County. This is seen as a shift, from left to right, on the sodium + potassium axis (lower left portion of the diamond) from 55% (St. Lucie County) to 70% (Martin County). According to Frazee's classification scheme, UFA water in St. Lucie County is connate, whereas in Martin County it has both connate and lateral intrusive characteristics. This implies that the Atlantic Ocean may have been a recharge source to the UFA in Martin County at some point in geologic history.

Stiff Diagrams

Stiff diagrams, illustrating the proportions of each major ion dissolved in water, were developed for each of the counties in the study area with the same well data used in the Trilinear diagrams and are presented in Appendix D, Figures D-7 through D-9. Twelve of these plots were reduced in size and overlain onto a basemap of the study area (Figure 37) to compare water types regionally. The Stiff diagrams presented here are very similar to one another and display a consistent dominance of the sodium cation and chloride anion although percentages of these ions increase slightly to the south-southeast.

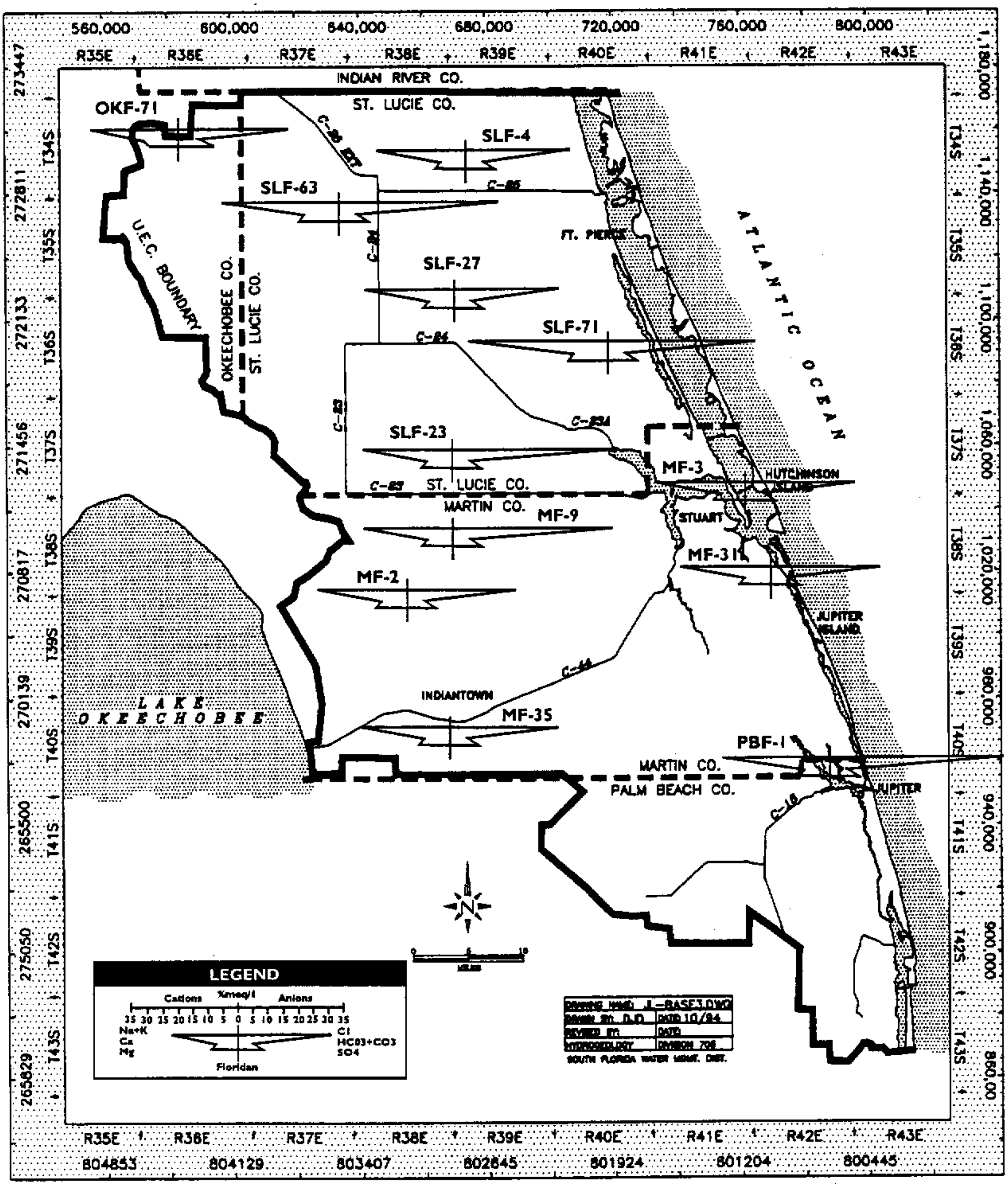

FIGURE 37. Stiff Diagrams Showing Regional Characteristics of Water in the Upper Floridan Aquifer.

TEMPORAL UPPER FLORIDAN AQUIFER WATER QUALITY CHANGES

Temporal water quality changes in UFA wells were examined where records were available. Available records included eighteen SFWMD and USGS monitor wells as well as data provided by five utilities in and near the study area. Total dissolved solids and chloride concentrations were graphed as a function of time and pumping rates for these wells. The results are summarized below.

SFWMD AND U. S. GEOLOGICAL SURVEY MONITOR WELLS

UFA water quality data from two SFWMD publications (Brown and Reece, 1979; Herr, 1989), the USGS, and the SFWMD's monitor well network were used to determine temporal shifts in ion concentrations between 1977 and 1990. The locations of those wells are plotted in Figure 38. Their water quality data are listed in Table 6 and were collected during three separate time intervals between 1977-1979, 1984-1987, and in 1990. Sampling events occurred during various months of the year; therefore, seasonal variations between months must be considered. For example, in at least two wells (SLF-3 and SLF-4), TDS values measured in September, 1977 (end of wet season) are 20% lower than those measured in March, 1977 (end of dry season). In most wells, however, seasonal variations are negligible.

TDS and chloride concentrations, as well as specific conductance of UFA water, did not change with time in fourteen of the eighteen monitor wells sampled. Water from four of the eighteen wells did exhibit increased TDS concentrations with time. Graphs of these are shown in Figure 39 and are based on water samples analyzed between two to five times over a maximum time span of thirteen years. Due to the lack of a continuous water sampling record, confidence in conclusions based on these observations is low. The four wells exhibiting increased TDS with time are located in all three of the counties within the study area (St. Lucie, Martin, and Okeechobee counties).

To best determine water quality trends in the UFA, several wells should be sampled on a regular basis (minimum of twice yearly), especially in areas with the heaviest UFA water use. In addition, at least three wells should be sampled in areas with light water use to provide control areas for comparisons. Three areas with intense UFA water use in the UECPA were identified by Lukasiewicz (1992) and are shown in Figure 40. Model results and field observations indicate that, between 1989 and 1991, seasonal water levels fluctuated as much as eight feet in these three areas. Based on surveys of well owners, chloride concentrations in these areas have increased over time (Lukasiewicz, 1992). These, therefore, would be ideal sites for implementing a long-term water quality monitoring program.

PUBLIC WATER SUPPLY WELLS

Four utilities in the study area, and one just north of the study area (Vero Beach), use UFA wells as a water source. Water from the UFA is either blended with fresh water from other sources, or is treated by reverse osmosis. The raw UFA well water was sampled and analyzed regularly by these utilities and, in most cases, records of monthly well withdrawals were recorded. These data were used to develop graphs illustrating TDS and chloride concentration changes as a function of withdrawal rates and time.

The five utilities are located at Sailfish Point, the town of Jupiter, Vero Beach, Fort Pierce, and Joe's Point, as shown in Figure 41. UFA well construction information for wells at these utilities is provided in Table 7. Parameters measured and time intervals sampled are shown in Table 8. Two of the five utilities (Vero Beach, Sailfish Point) experienced an increase in chloride and TDS concentrations over time in water from their UFA wells. These same two utilities have also been pumping at the highest rates from the UFA over the longest periods of time, relative to the other three.

Water quality data used in the graphs are compiled in Appendix E, Tables E-1 through E-11, and indexed by utility and water quality parameter for each well in the respective wellfield. Average yearly values were computed and used to develop the graphs. Water quality changes with time are discussed for each utility below.

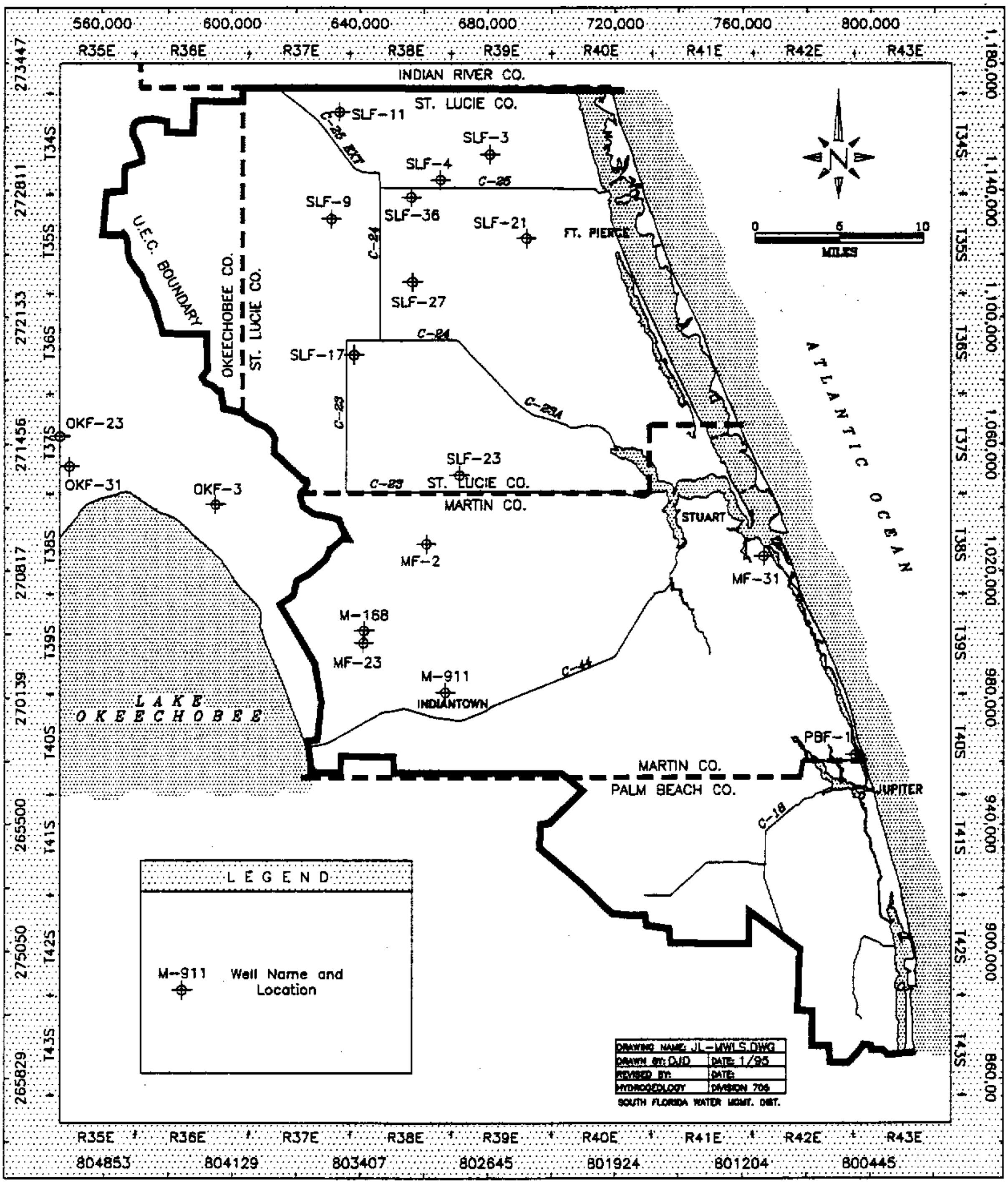

FIGURE 38. **Locations of Upper Floridan Aquifer Monitor Wells with Historic Water Quality Records.**

TABLE 6. **Historic Record of Upper Floridan Aquifer Water Quality, for Eighteen Monitor Wells in the Upper East Coast Planning Area.**

SFWMD WELL NAME	DATE M/D/YR	COND umhos	TEMP C°	PH	NA mg/l	K mg/l	CA mg/l	MG mg/l	CL mg/l	SO4 mg/l	ALK mg/l	SR mg/l	DISS. IRON mg/l	TDS mg/l		Reference See Legend
SLF-27	4/28/77		27.8	7.6	410	17	140	82	1040	170	135			2310		R
	9/27/77	2990	27.5		460	13	130	92	990	160		23		2420		R
	5/22/78	3410	26.1	7.5	520	13	140	110	1070	160	168	21				R
	9/20/78	2680	25.2	7	480	11	85	71	1040	120	75	19		2100		R
	5/7/79	3650	26.0	7	430	10	130	86	1070	150		8	0.17	2100		R
	5/23/90	3870			493	13	141	99	1074	144	127		0.05	2224		MWN
SLF-36	5/31/77		28.3	7.7	270	9	82	59	590		153			1430		R
	7/27/77		27.9	7.6	270	10	95	69	650	130	154	7	0.10	1470		R
	5/30/90	3220			438	14	121	82	811	149	136		0.20	1851		MWN
M-168	6/7/73								400							USGS
	9/6/74								400							
	5/14/75								380	LEGEND						
	7/27/76								550	SOURCES						
	5/27/77								430	References						
	6/29/79								420	B&R:	Brown and Reece, 1979					
	5/13/80								410	MWN:	SFWMD Monitor Well Network, 1989					
	7/16/80								400	H:	Herr and Shaw, 1989					
M-911	6/7/73								640	USGS:	Smith, Lidz, and Meyer, 1982					USGS
	9/6/74								670							
	5/14/75								650							
	7/27/76								700	Note: Locations of the USGS wells in this table are:						
	5/27/77								650	Well	Latitude	Longitude				
	5/17/78								700	M-168	270507	803348				
	6/29/79								650	M-911	270153	802906				
	7/16/80								640							

TABLE 6. Historic Record of Upper Floridan Aquifer Water Quality, for Eighteen Monitor Wells in the Upper East Coast Planning Area. (Continued)

SFWMD WELL NAME	DATE M/D/YR	COND umhos	TEMP C°	PH	NA mg/l	K mg/l	CA mg/l	MG mg/l	CL mg/l	SO4 mg/l	ALK mg/l	SR mg/l	DISS. IRON mg/l	TDS mg/l	Reference See Legend
SLF-4	3/28/77			7.5	350	22	120	70	900	180				2440	R
	9/26/77	2800	27.8		390	12	100	74	770	150		13		1670	R
	1/30/78	3270	27.6	7.2	380	12	100	74	800	150		12		1890	R
	5/7/79	3270	28.2	7.2	380	12	110	78	920	150		9	0.52	1970	R
	5/23/90	3390			440	15	119	86	902	156				1858	MWN
SLF-9	3/29/77		27.2	7.4	540	32	150	90	1230	240				2680	R
	9/26/77	3530	26.9		730	16	140	96	1110	230		26		2480	R
	1/30/78	4880	26.0	7.2	480	16	140	99	1210	220	154	18		2740	R
	5/8/79	4360	26.6	7.3	600	16	140	110	1200	230		27	0.18	2600	R
	11/28/84	5705	26.4	7.2	579	17	132	93	732	193	153	29	0.04	2872	H
	11/18/85	4650	27.1	6.9	577	17	156	101	1345	393			0.05		
	11/12/86				680	17	156	120	1660	226		31	0.05	2998	H
	8/31/87	4650	27.8	7	740	19	165	120	1660	226	125		0.05	2998	H
SLF-11	3/28/77		27.3	7.5	290	16	120	65	730	200				1650	R
	9/27/77	2070	27.4		270	9	88	59	490	150	149	14		1120	R
	1/30/78	2650	26.5	7.1	280	9	96	62	620	170		16		1500	R
	5/8/79	2130	27.5	7.6	280	8	84	76	550	140		9	0.60	1190	R
	5/24/90	2830			353	11	115	74	690	200				1648	MWN
SLF-17	3/29/77		26.9	7.5	320	18	110	67	760	230				1790	R
	9/27/77	2490	28.6		380	11	110	70	710	210		24		1630	R
	2/1/78	2830	28.5	7.8	350	11	100	70	720	210	151	23		1760	R
	9/20/78	2090	27.8	7.6	330	10	100	55	750	160	142	22		1820	R
	5/23/90	1977			365	13	99	72	713	205	132			1575	MWN
SLF-21	3/29/77		24.7	7.7	170	13	62	43	330	180				940	R
	9/27/77	1290	25.5		190	11	51	46	280	140		9		840	R
	1/31/78	1720	25.4	7.5		10	53	46	290	130	173	8		900	R
	9/19/78	1130	25.4	7.3	170	10	54	45	320	150	163	8		930	R
	5/7/79		25.1	7.4	180	10	54	43	290	150		4	0.13	920	R
	11/28/84	1398	24.3	7.3	240	9	49	43	285	92	170	9	0.17	840	R
	11/18/85	1520	25.3	7.3	178	10	53	44	302	127					
	11/12/86				175	9	52	42	294	138	164	9	0.11	890	H
	8/31/87	1603	26.3	7.3	203	10	51	46	351	148		9	0.69	916	H
	5/23/90	1458			174	10	52	46	295	128	161		0.27	798	MWN
SLF-23	3/30/77		32.0	7.4	590	33	150	91	1180	230				2510	R
	9/30/77	3830	32.0		580	18	130	93	1170	210		16		2460	R
	2/1/78	4660	32.0	7.7	610	19	120	95	1210	210	151	15		2690	R
	5/24/78	3720	32.0	7.4	650	20	130	100	1170	210	145	14		2640	R
	5/30/90				627	21	128	101	1295	204	143		54.00	2437	MWN

TABLE 6. Historic Record of Upper Floridan Aquifer Water Quality, for Eighteen Monitor Wells in the Upper East Coast Planning Area.(Continued)

SFWMD WELL NAME	DATE M/D/YR	COND umhos	TEMP C°	PH	NA mg/l	K mg/l	CA mg/l	MG mg/l	CL mg/l	SO4 mg/l	ALK mg/l	SR mg/l	DISS. IRON mg/l	TDS mg/l	Reference See Legend
MF-2	9/1/77	3480	29.4	7.3	550	18	110	90	1040	150	141	21	0.02	2550	R
	3/31/78	3900	28.0	7.4	490	17	120	89	980	230		22		2240	R
	9/21/78	3910	29.0	7.4	470	16	110	69	1100	230	157	18		2200	R
	5/10/79	3910	29.7	7.6	670		120	87	1050	240		15	0.37	2340	R
	5/18/90								1034	206			0.05	2177	MWM
MF-23	9/2/77	1780	27.4	7.6	220	11	63	60	420	180	131	13	0.02		R
	3/31/78	1600	27.3	7.8	210	9	65	57	390	200		12	0.00	1080	R
	9/21/78	1360	27.3	7.5	190	9	68	45	340	210	128	12	0.00	1110	R
	5/10/79	2050	27.1	7.6	280	2	73	69	440	230		7	0.19	1220	R
	5/18/90	1760			207		63	58							MWN
MF-31	11/29/84	3305	23.1	8	474	23	78	69	979	193		6	0.04	2045	H
	11/19/85	3510	24.0	7	521	13	82	76	930	182		7	0.05	2010	H
	11/13/86				540	22	80	70	896	194		6	0.05	2051	H
	9/1/87	3740	24.5	7	584	25	75	76	968	210		6	0.05	2090	H
	5/31/90	3620			586	27	80	80	1002	203	173		0.05	2106	MWN
OKF-3	9/19/84	3895	24.9	6.6	578	23	42	80	1130	162			0.07	2279	H
	8/26/86	3950	24.2	8.9	663	25	37	66	1100	202		10	0.05	2160	H
	7/14/87	1945	24.3	7.6		24	67	97	1074	274		12	0.12	2345	H
	5/17/90	4050			624	26	86	89	1063	271	113		0.32	2321	MWN
OKF-23	9/18/84	1745	26.5	7	181	8	63	42	339	134			0.01	1043	H
	8/26/86	1648	27.0	7.4	203	9	107	42	327	217		16	0.05	958	H
	7/15/87	1647	26.2	7.1	216	9	58	46	338	203		25	0.05	991	H
	5/17/90	1641			202	9	60	46	322	202	106		0.05		MWN
OKF-31	9/19/84	1841	26.4	7.2	259	9	89	55	416	156			0.03	1146	H
	8/26/86	2150	26.7	7.5	318	11	64	46	500	253		15	0.05	1231	H
	7/14/87	1780	29.1	6.8		27	194	131	2374	501		39	0.31	3691	H
	8/4/87				294	13	53	46	470	246		13	0.39	1255	H
	5/17/90				1196		223	171	2305	608			1.74	4520	MWN
PBF-1	10/5/77	4780	25.2		750		110	110	1360	300		7		2920	R
	9/22/78	3490	28.8	7.6	680	24	92	88	1410	270	139	7		2890	R
	5/31/90	4600			795	31	52	103	1489	226				2600	MWN
SLF-3	3/28/77		28.1	7.4	310	17	110	64	780	190				1800	R
	9/27/77	2510	28.2	--	340	11	98	79	700	140		11		1470	R
	2/1/78	2570	24.3	7.3	320	11	78	67	690	130	135	11		1520	R
	5/7/79		26.2	7.3	380	12	74	75	790	110		8	1.10	1700	R
	5/22/90	3450				15	113	89	940	148				1894	MWN
	SR: STRONTIUM														

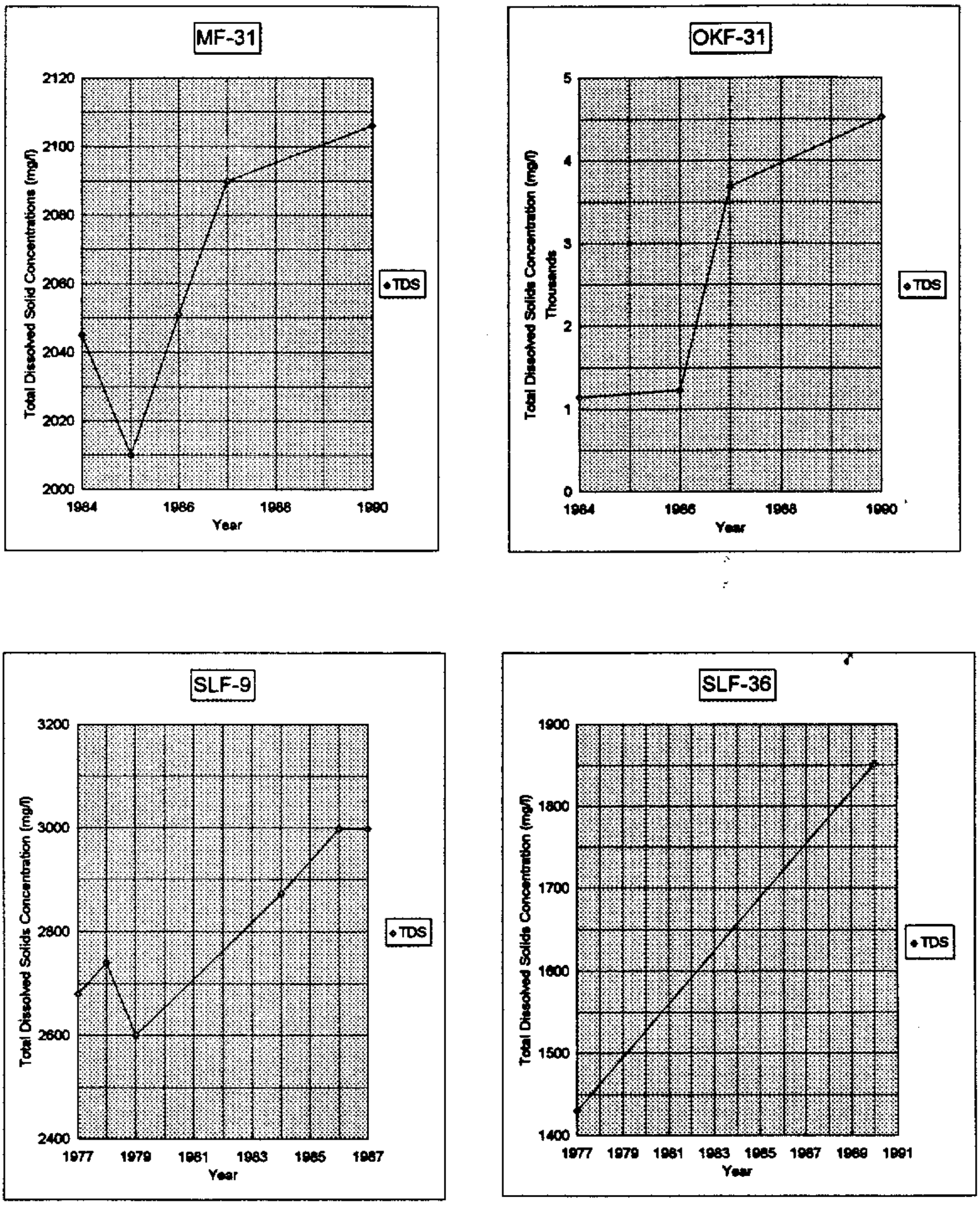

FIGURE 39. Total Dissolved Solids Concentration Variations over Time From Four Agricultural Monitor Wells Completed in the Upper Floridan Aquifer.

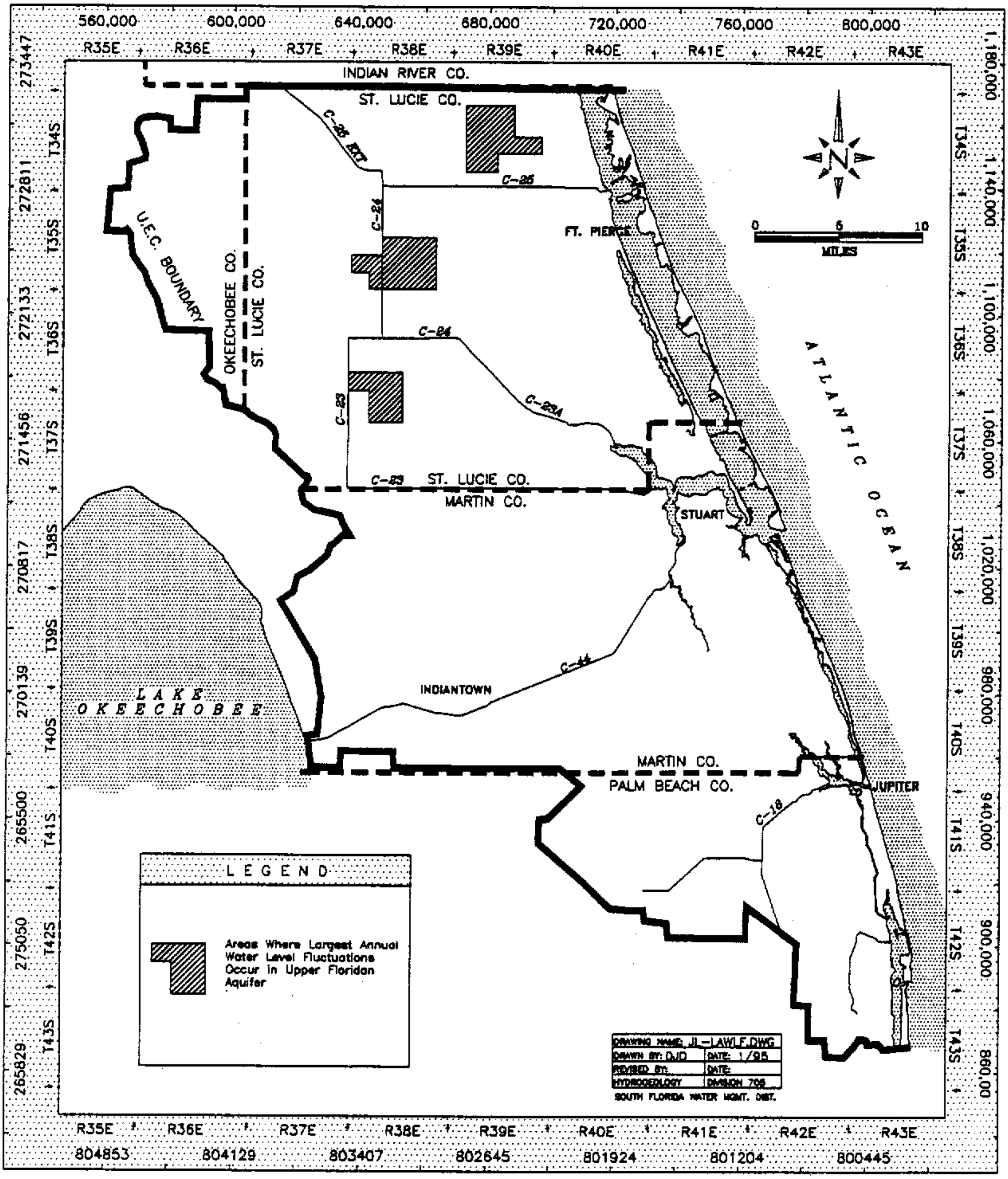

FIGURE 40. **Areas with the Largest Water Level Fluctuations and Water Withdrawals from the Upper Floridan Aquifer (after Lukasiewicz, 1992).**

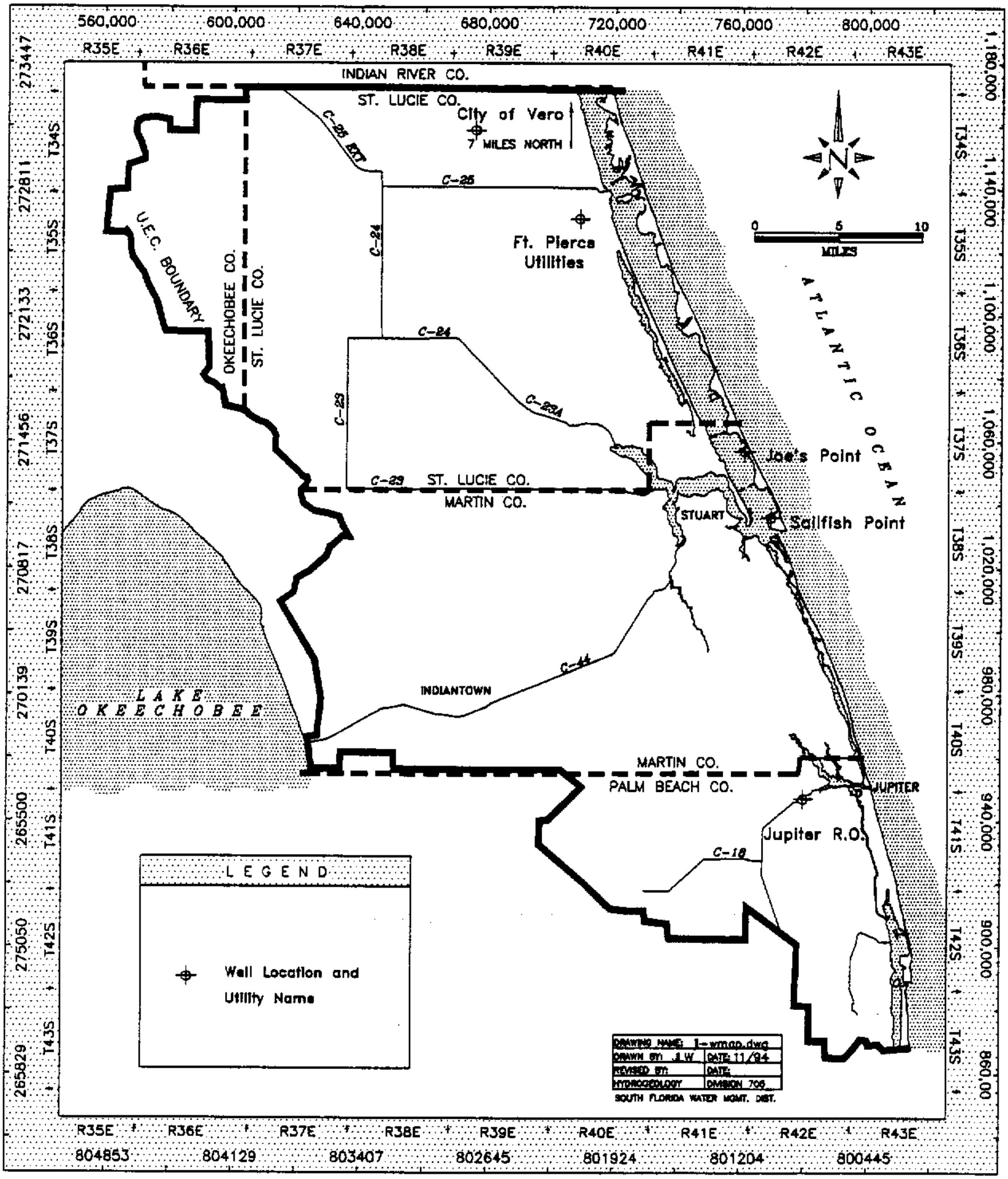

FIGURE 41. Locations of Utilities Using Upper Floridan Aquifer Water to Augment Public Water Supplies.

TABLE 7. **Coordinates and Well Construction Information for Upper Floridan Aquifer Wells used by Utilities for Public Supply and Landscaping in the Upper East Coast Planning Area.**

Utility	Well Name	Latitude	Longitude	State Planar X (Ft.)	State Planar Y (Ft.)	Total Depth (Ft.)	Casing Depth (Ft.)	Casing Diameter (IN)
City of Vero	# 5	271460	801757	727705	1060642	570	360	10
City of Vero	# 14	273919	802415	692892	1207794	688	313	10
City of Vero	# 21	273920	802545	684799	1207857	677	420	8
City of Vero	# 31	273957	802438	690824	1211622	570	380	8
City of Vero	# 101	273918	802530	686148	1207661	580	387	8
City of Vero	# 102	273933	802432	691363	1209201	571	380	8
City of Vero	# 103	273938	802455	689296	1209696	586	410	8
Ft. Pierce	FB-1	272627	802128	709040	1129928	904	508	12
Ft. Pierce	FB-2	272631	802127	708363	1130359	880	500	12
Joe's Point	# 1	271415	801134	762303	1056306	1600	700	8
Joe's Point	# 2	271415	801134	762303	1056306	1000	700	8
Jupiter R.O.	R.O.1	265603	800816	780933	946158	1500	1073	12
Jupiter R.O.	R.O.2	265542	800820	780612	944035	1350	1032	16
Jupiter R.O.	R.O.3	265547	800820	780613	944540	1455	1017	16
Jupiter R.O.	R.O.4	265555	800812	781337	945353	1348	1065	16
Sailfish Point	# 1	271102	800942	772527	1036871	1525	625	6
Sailfish Point	# 2	271042	800940	772766	1034866	1110	662	6
Sailfish Point	# 3	271028	801010	770042	1033436	912	300	6
Sailfish Point	# 4	271048	800959	770994	1035415	1140	315	6
Sailfish Point	# 5	271035	801010	770008	1034131	965	300	10
Sailfish Point	# 6	271032	800945	772314	1033853	1000	720	6

Table 8. Time Intervals with Historic Record of UFA Water Quality, Public Water Suppliers in the UECPA

Utility Name	Historic Record Available	Parameters Measured
Sailfish Point	1982-1992	Cl, TDS
Town of Jupiter	1987-1993	Cl, Sp. Cond.
Vero Beach	1979-1992	Cl, TDS, Sp. Cond.
Fort Pierce	1988-1993	Cl, TDS, Sp. Cond.
Joe's Point	1990-1992	TDS

Abbreviations:
Cl: Concentration of chlorides (mg/l)
TDS: Concentration of total dissolved solids (mg/l)
Sp. Cond.: Specific Conductance (umhos/cm)

Sailfish Point, Martin County

The utility on Sailfish Point provided temporal data for pumping rates, chloride and TDS concentrations from six UFA wells (Richard Marx, 1993), the locations of which are shown in Figure 42. Chloride and TDS concentration from two of the six wells (Wells 1 and 2), given in Tables E-1 and E-2, are graphed alongside the composite pumping rate for the time interval between 1983-1987 as shown in Figure 43. This graph illustrates that between 1982 and 1992, the concentration of TDS and the pumping rates have steadily increased by approximately 15% and 250%, respectively. The pumping rates represent the composite water use from all UFA wells on Sailfish Point and increased dramatically over the ten-year period from ten million gallons per month in 1982 to over thirty million gallons per month in 1991. Large seasonal fluctuations in water use is evident.

Town of Jupiter, Palm Beach County

The utility at the Town of Jupiter currently maintains four UFA wells. Operation of the first UFA well commenced in 1990. A record of chloride and total dissolved solids concentrations for the period between October 1987 to February 1993 is shown in Appendix E, Table E-3 and E-4. The TDS data in Table E-4 was used to construct the graph presented in Figure 44, which illustrates no significant change over time. The pumping rate from the aquifer here varies seasonally from approximately thirty million gallons per month in the wet season to approximately ninety million gallons per month in the dry season.

City of Vero Beach, Indian River County

Vero Beach is located near the coast approximately eight miles north of the study area in Indian River County. The City of Vero Beach has been using UFA water for public supply longer than any other utility in the study area. This utility provided temporal water quality data from four UFA wells which have been in use since 1979 (Tables E-5 through E-7). The locations of all UFA wells at the utility are shown in Figure 45. TDS and chloride concentrations, as well as specific conductance, were averaged for each year of record and graphed as a function of time in Figures 46, 47, and 48, respectively. All parameters increased in the four wells between 1981 to 1991, followed by a slight decrease from 1991 to 1992. In order to quantify the percentage change, the first and last years' data for the period of record were averaged and compared. The results of these comparisons are shown in Table 9.

Withdrawal rates over time were only available for a nine month period between January and September of 1992. The average monthly water use in 1992 was 20,600,000 gallons/month. Due to the lack of temporal water-use data, withdrawal rates as a function of time are not shown in the graphs.

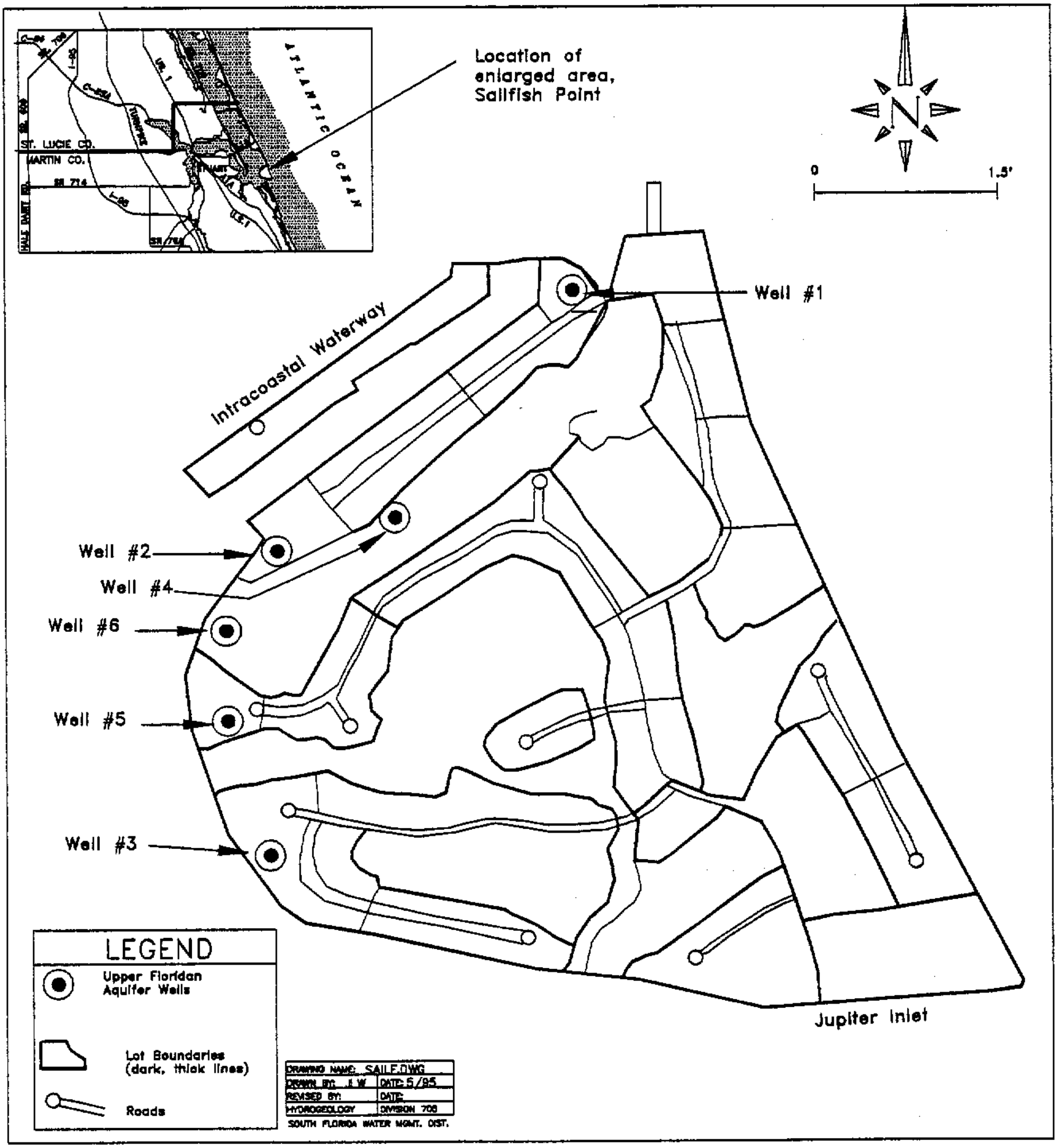

FIGURE 42. Upper Floridan Aquifer Well Locations on Sailfish Point.

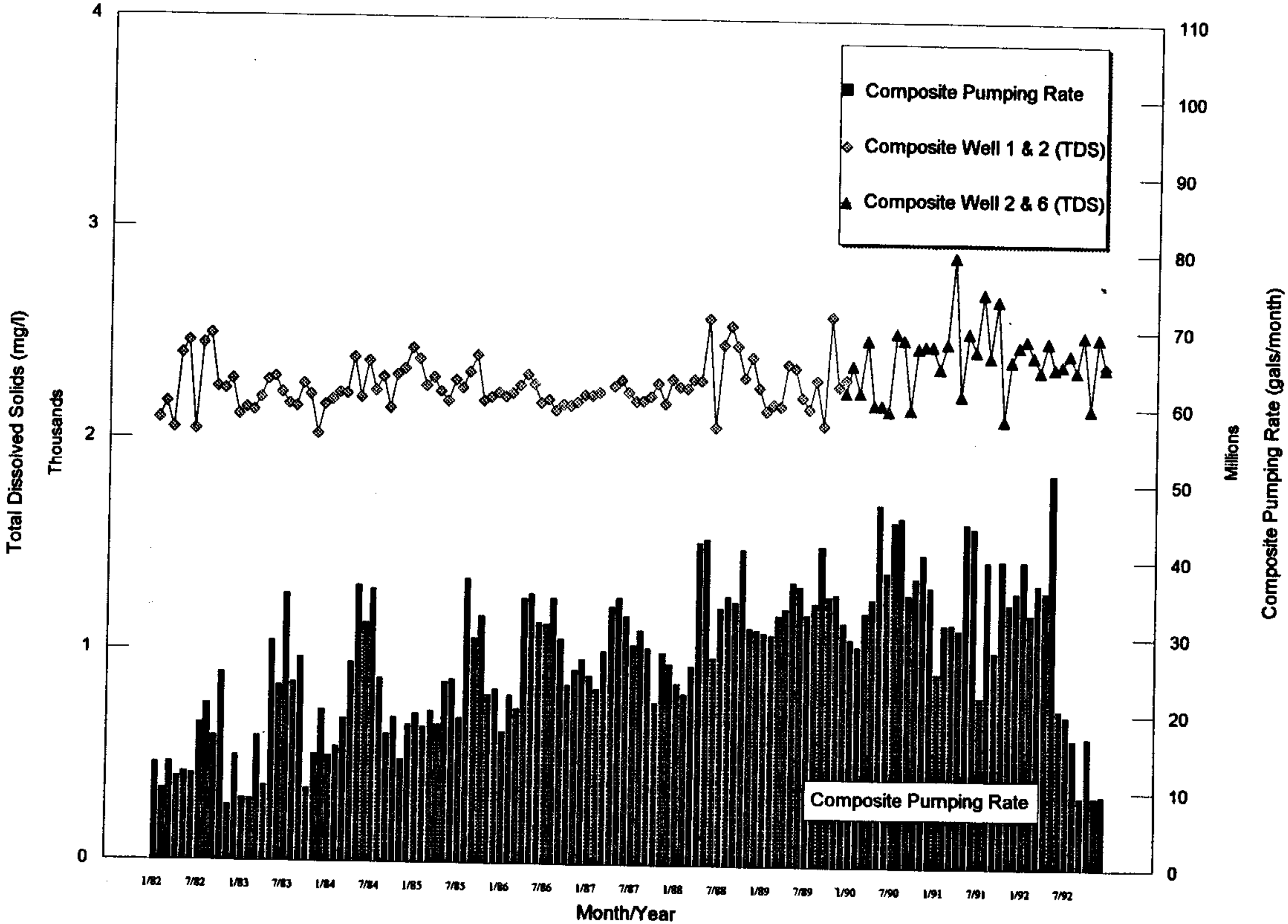

FIGURE 43. Variations in Total Dissolved Solids Concentrations in Two Upper Floridan Aquifer Wells as a Function of Time and Composite Pumping Rates at the Sailfish Point Utility.

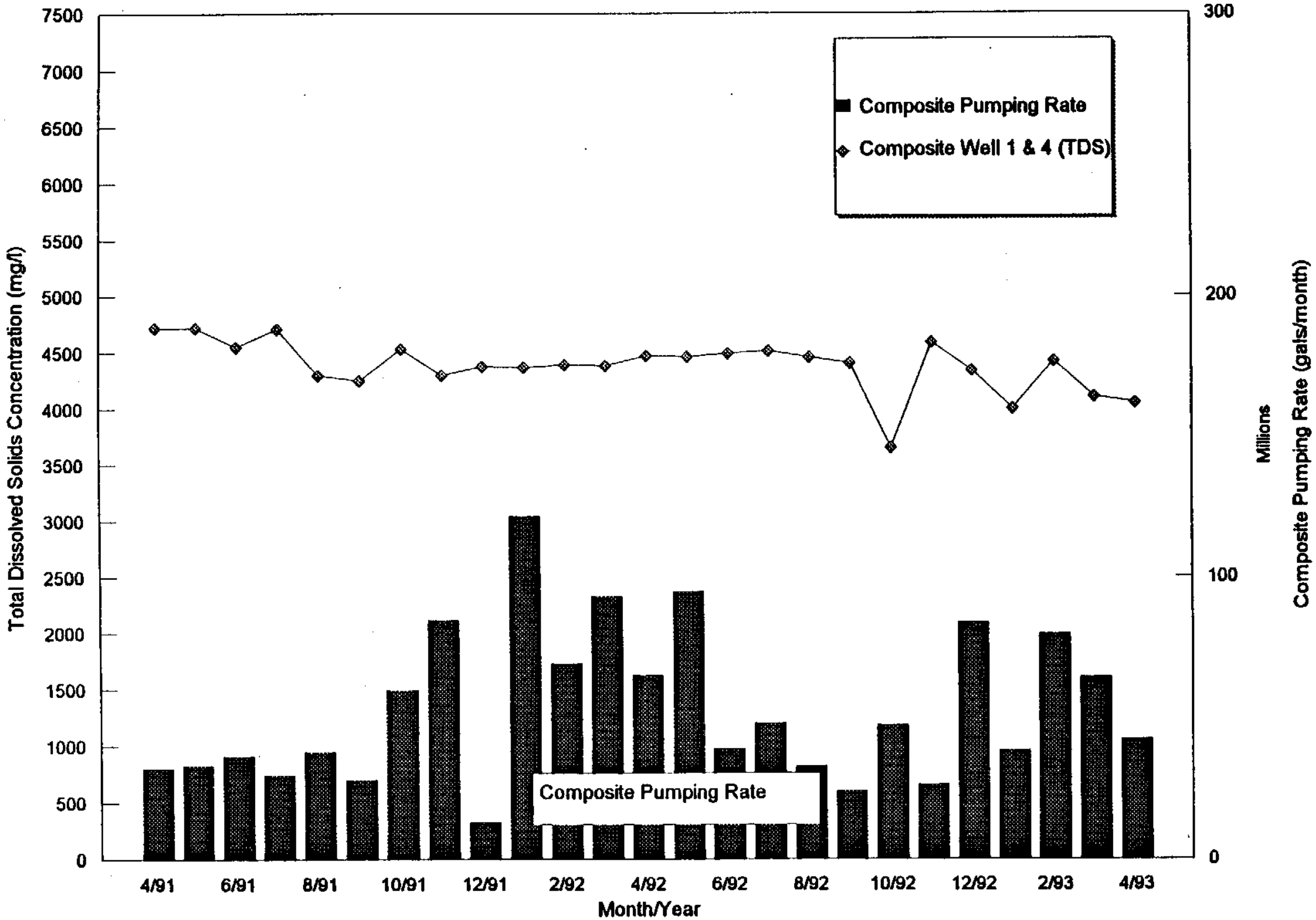

FIGURE 44. **Variations in Total Dissolved Solids Concentrations and Composite Pumping Rates Over Time From Upper Floridan Aquifer Wells at the Town of Jupiter Utility.**

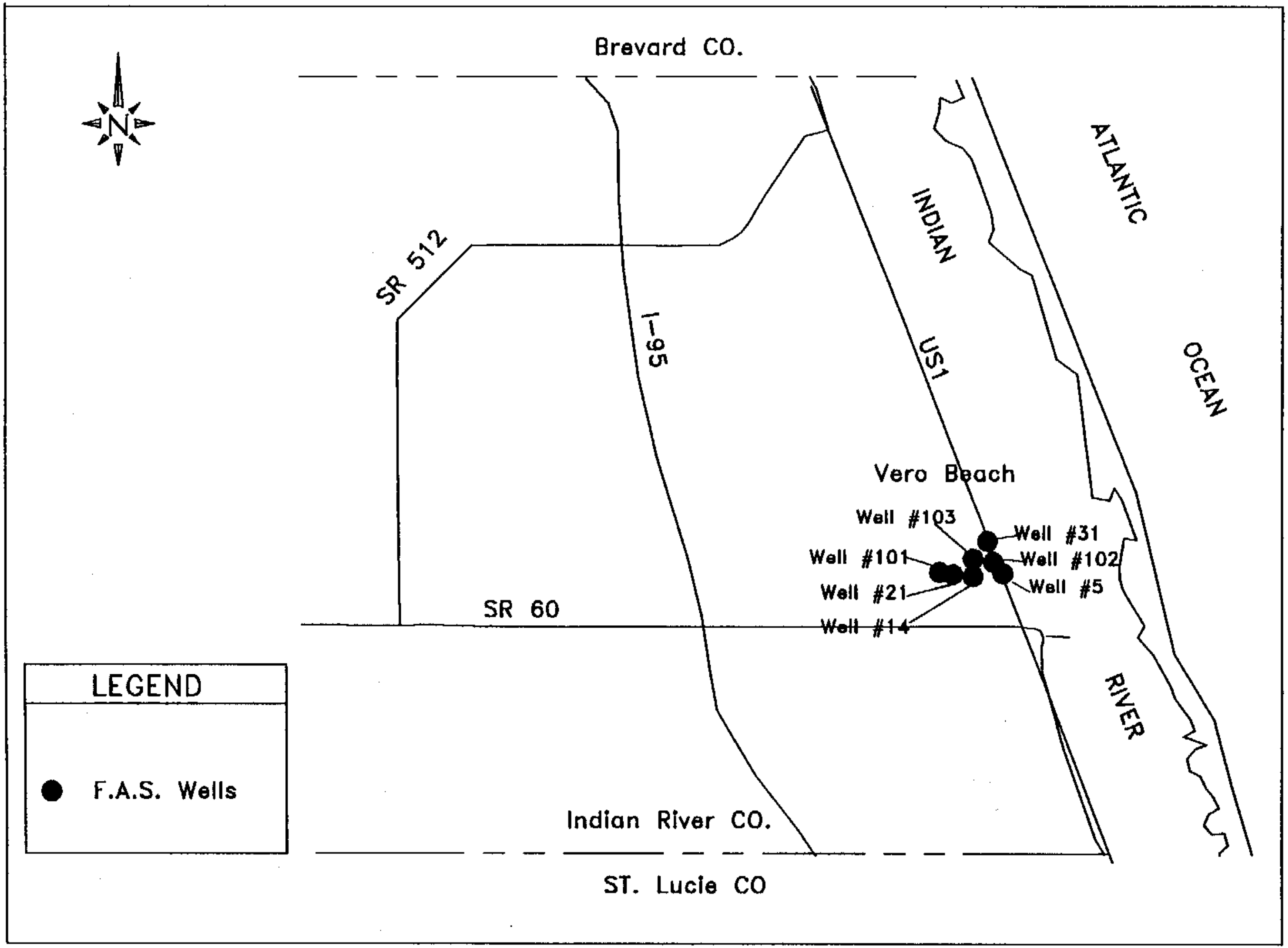

FIGURE 45. **Locations of Upper Floridan Aquifer Wells at the City of Vero Beach Utility in Indian River County, Florida.**

DRAWING NAME: UFAS.dwg	
DRAWN BY: JLW	DATE: 11/94
REVISED BY:	DATE:
HYDROGEOLOGY	DIVISION 706

SOUTH FLORIDA WATER MGMT. DIST.

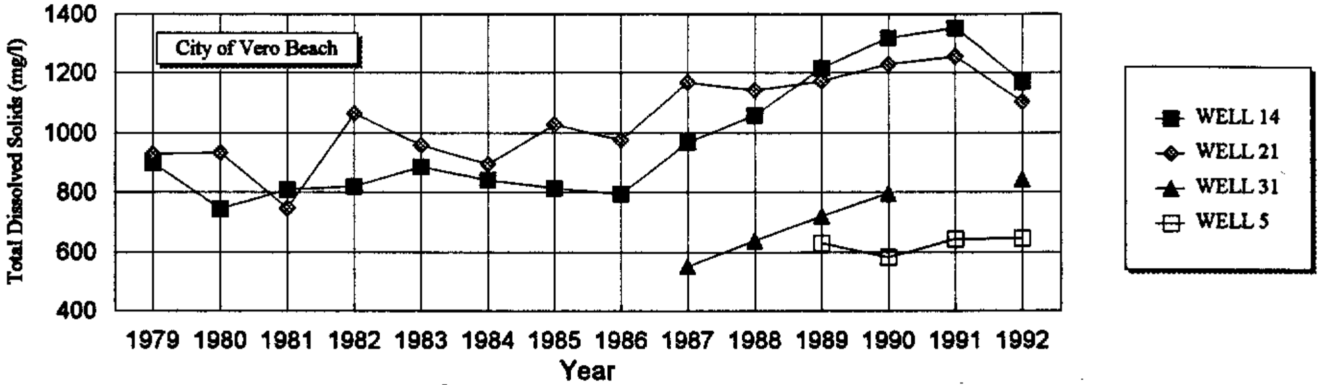

FIGURE 46. Variations in Total Dissolved Solids Concentrations over Time in Upper Floridan Aquifer Wells at the City of Vero Beach Utility, Indian River County, Florida.

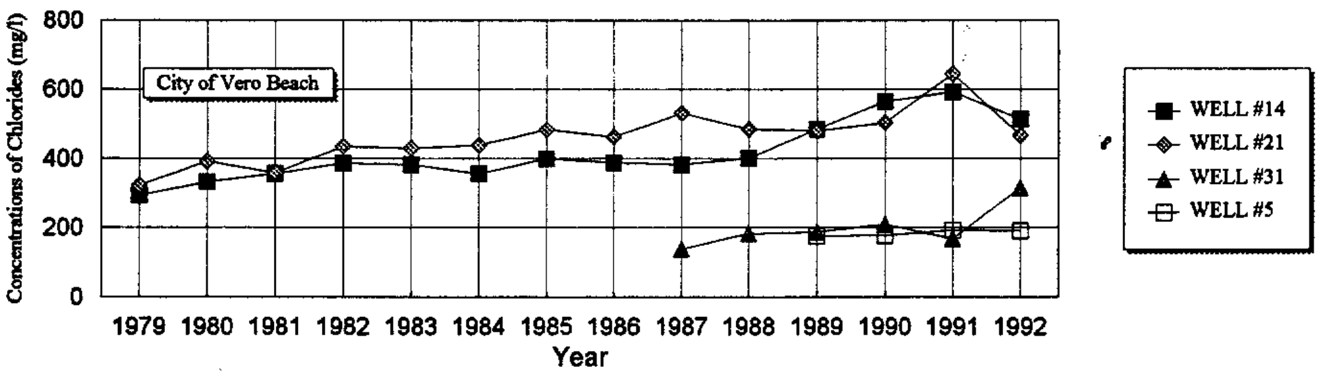

FIGURE 47. Variations in Chloride Concentrations over Time in Upper Floridan Aquifer Wells at the City of Vero Beach Utility, Indian River County, Florida.

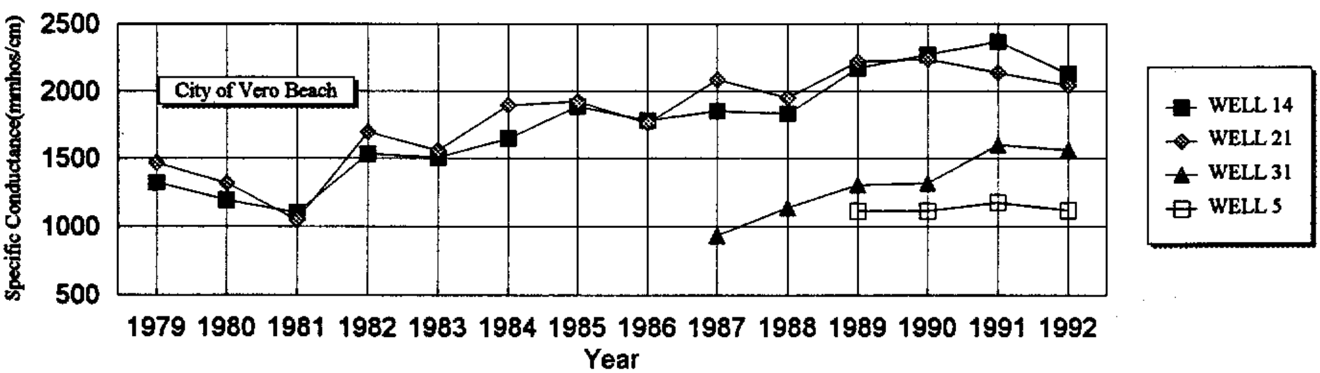

FIGURE 48. Variations in Specific Conductance over Time in Upper Floridan Aquifer Wells at the City of Vero Beach Utility, Indian River County, Florida.

Table 9. Percent Change in Water Quality Parameters from UFA Wells, Vero Beach Utility

Well #	Historic Record Years	Percent Change		
		Chloride	TDS	Conductance
14	1979-1992	+74	+30	+60
21	1979-1992	+45	+19	+39
31	1987-1992	+126	+53	+63
5	1987-1992	+8	+2	+1

Note: Percent change referenced to 1979 values.

Fort Pierce Utility, St. Lucie County

The utility in Fort Pierce has been blending water from one UFA well (FB-1) with water from its SAS wellfield during periods of high demand since 1988. A second UFA well (FB-2, Floridan blending well 2) was constructed more recently and is currently in use. The utility provided the SFWMD with results (Tables E-8 through E-10) of only one sampling analysis for each year of UFA well use for the time period between 1988 to 1992 (Rich Stenberg; verbal communication, 1993). Two additional UFA wells will be drilled in the near future.

Pumping rates between January 1988 and February 1993 for wells FB-1 and FB-2 were obtained from SFWMD records, totaled and superimposed on the graph of water quality shown in Figure 49. This figure indicates no significant TDS concentration changes over time. A slight increase in TDS concentration (9%) is apparent between the years 1989 to 1990; however, from 1990 to 1992 it remained constant at approximately 980 mg/l. Water withdrawals averaged less than twenty million gallons per month.

Joe's Point Utility, Martin County

Joe's Point is a small community on Hutchinson Island which maintains its own water plant for public supply. This plant processes water from two UFA wells through reverse osmosis membranes. Joe's Point utility provided TDS concentration data and records of water withdrawal rates for the time period between 1990-1992, as seen in Table E-11 and Figure 50. The graph illustrates that neither TDS concentration nor rate of pumping changed significantly through the period of record (1990-1992). Average withdrawals from the UFA here were less than one million gallons per month, a relatively low rate.

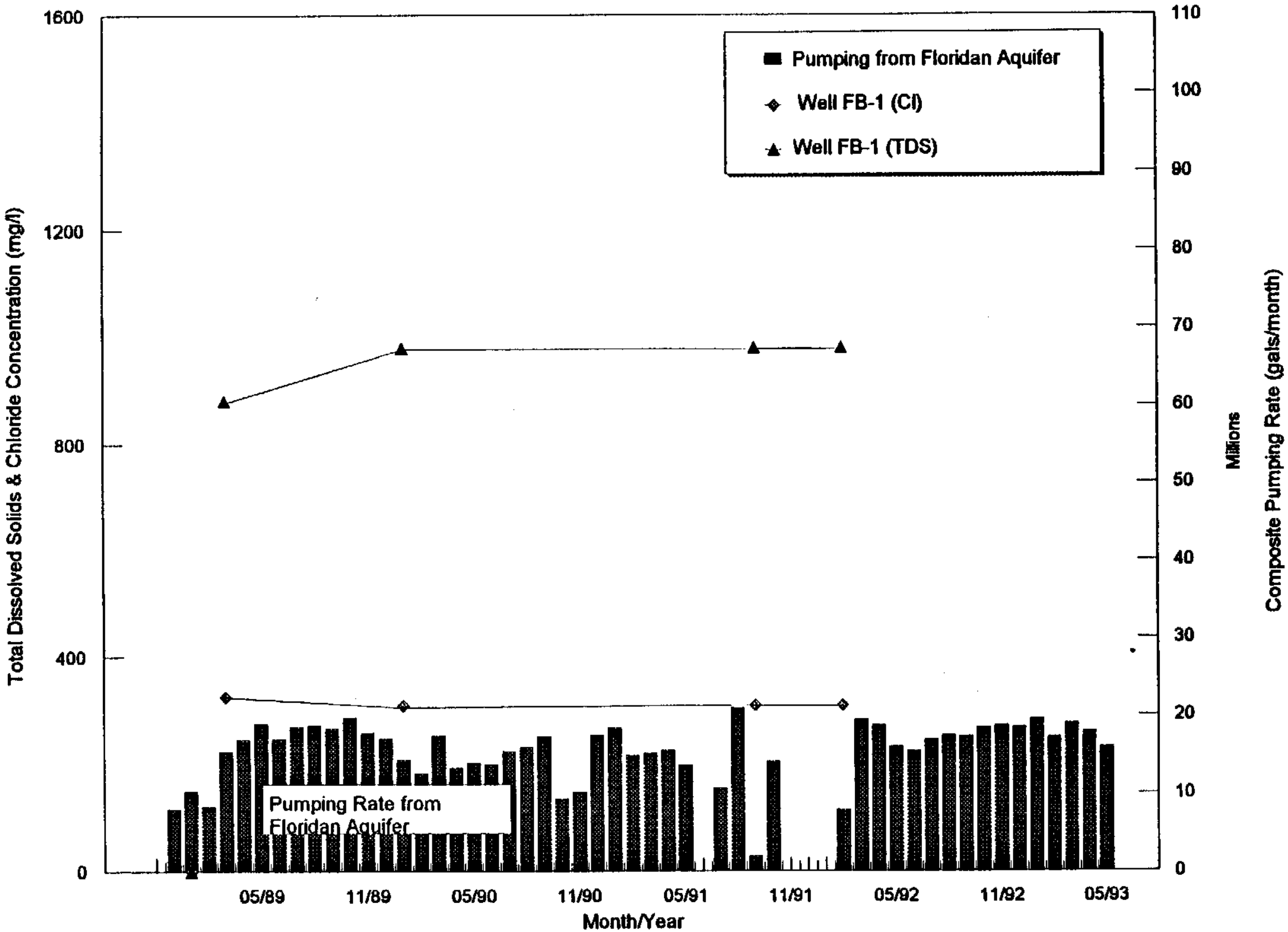

FIGURE 49. Variations in Total Dissolved Solids Concentrations, Chloride Concentrations and Composite Pumping Rates over Time in Upper Floridan Aquifer Wells at the Ft. Pierce Utility.

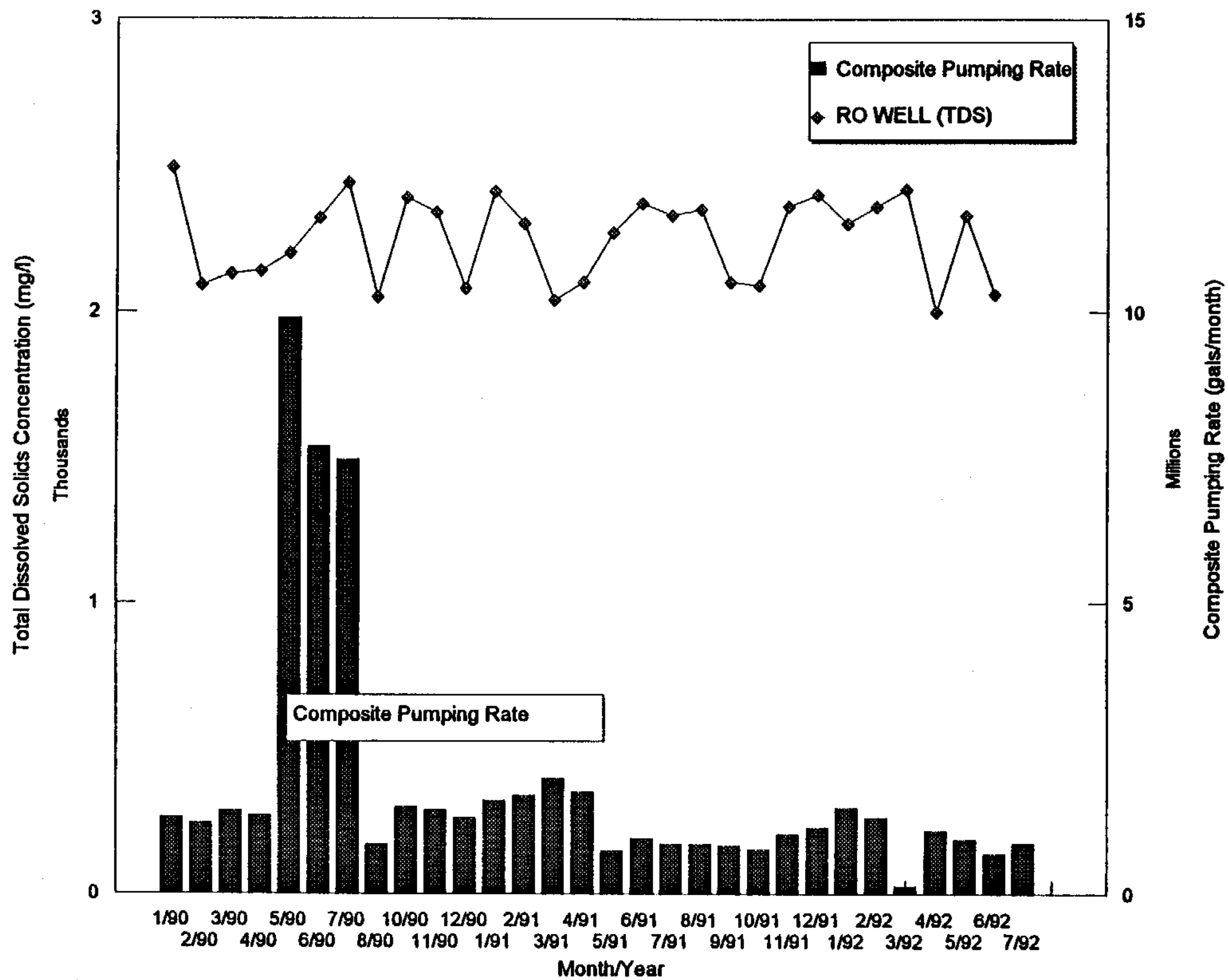

FIGURE 50. Variations in Total Dissolved Solids Concentrations and Pumping Rates over Time at Joe's Point Utility.

WATER QUALITY RESULTS FROM RECENT FLORIDAN AQUIFER SYSTEM RESEARCH DRILLING IN THE UECPA

The SFWMD constructed six FAS research wells at one site in central St. Lucie County in 1990 (Figure 51). One pair of wells was completed to each of three flow zones within the FAS; two in the UFA and one in the LFA. A pilot hole (SLF-73) was drilled to a total depth of 1,540 feet BLS. A stratigraphic cross section, running west to east through St. Lucie County, includes this well and is shown in Figure 2. The six FAS wells were used in three separate aquifer performance tests to determine each of the flow zones' characteristics including: transmissivity, storativity, leakance, static head and water quality. Once tested, three of the wells were selected for long term water level monitoring. The water quality results are discussed in this report, whereas, all other results will be summarized in the next phase of this project in a report which will be entitled *Hydrogeologic Data and Information Collected from the Surficial and Floridan Aquifer Systems, Upper East Coast Planning Area* (Lukasiewicz, in review).

UPPER FLORIDAN AQUIFER WATER QUALITY VARIATIONS WITH DEPTH

Samples from Reverse-Air Drilling, SLF-73

Samples were collected at regular depth intervals during reverse-air drilling of pilot well SLF-73 to best determine water quality changes with depth in the FAS. This pilot well was drilled using a reverse-air method in which cuttings and formation water were air-lifted to the surface through the drill pipe during bit penetration. Formation water samples were collected at 30-foot intervals between the depths of 560 feet (BLS, top of UFA) and total depth (1,540 feet BLS, LFA). These samples were analyzed in the SFWMD's laboratory for concentrations of chloride, sodium, sulfate, total iron, aluminum carbonate ($AlCO_3$), and TDS, as well as for hardness ($CaCO_3$), specific conductance, temperature, and pH. The results of the analyses, as well as results from several packer tests (discussed below), are shown in Tables 10 and 11, respectively.

Formation water collected during reverse-air drilling is not necessarily representative of the interval being drilled. Typically, water entering the borehole during bit penetration comes from those intervals (flow zones) providing the largest flow contribution. For example, a permeable flow zone which readily transmits water of one type may overlie a low permeable interval (minor flow zone) with a different water type. In this case, water from the permeable interval will be the dominant water air-lifted to the surface throughout the drilled section. To isolate specific zones and obtain zone-specific water samples, packer tests were run.

Samples from Packer Tests, SLF-73

Discrete water samples were collected and analyzed from well SLF-73 using a series of four packer tests (Table 11). A packer test is the preferred method of obtaining water quality information from a specific zone in an open borehole. A packer test tool consists of a length of slotted pipe with openings which can be remotely opened and closed from the surface. The slotted pipe is centered between two hydraulically-inflated rubber bladders and lowered down the borehole on the end of the drill string until it is positioned in the interval to be tested. Once in place, the bladders are inflated from the surface and the pipe slots opened. The bladders create a seal which permits only those fluids between the packed-off zone to enter the drill stem. Once inflated, the artesian head pressure in the tested zone lifts the formation water to the surface where it is collected and analyzed. Water in the drill stem was pumped in cases where artesian pressure was not sufficient to lift water to land surface.

The objective of the packer tests was to define the character of water in a proposed aquifer storage and recovery (ASR) injection horizon and in an overlying intra-aquifer confining bed. In this case, the targeted ASR horizon was between the depths of 1,100 feet BLS to 1,450 feet BLS within the dolomitic limestone section of the lower FAS (Lukasiewicz, 1992). Straddle packers were employed to isolate four zones for independent sampling. Static water levels were recorded and samples were collected at each zone. Samples were analyzed for concentrations of major ions by the SFWMD's laboratory. All results are listed in Table 11.

Analyses of packer test samples appear to contradict those from reverse air drilling. The intervals from 1,138 feet BLS to 1,176 feet BLS, and from 1,408 feet BLS to 1,446 feet BLS, were permeable flow zones, while the remaining two

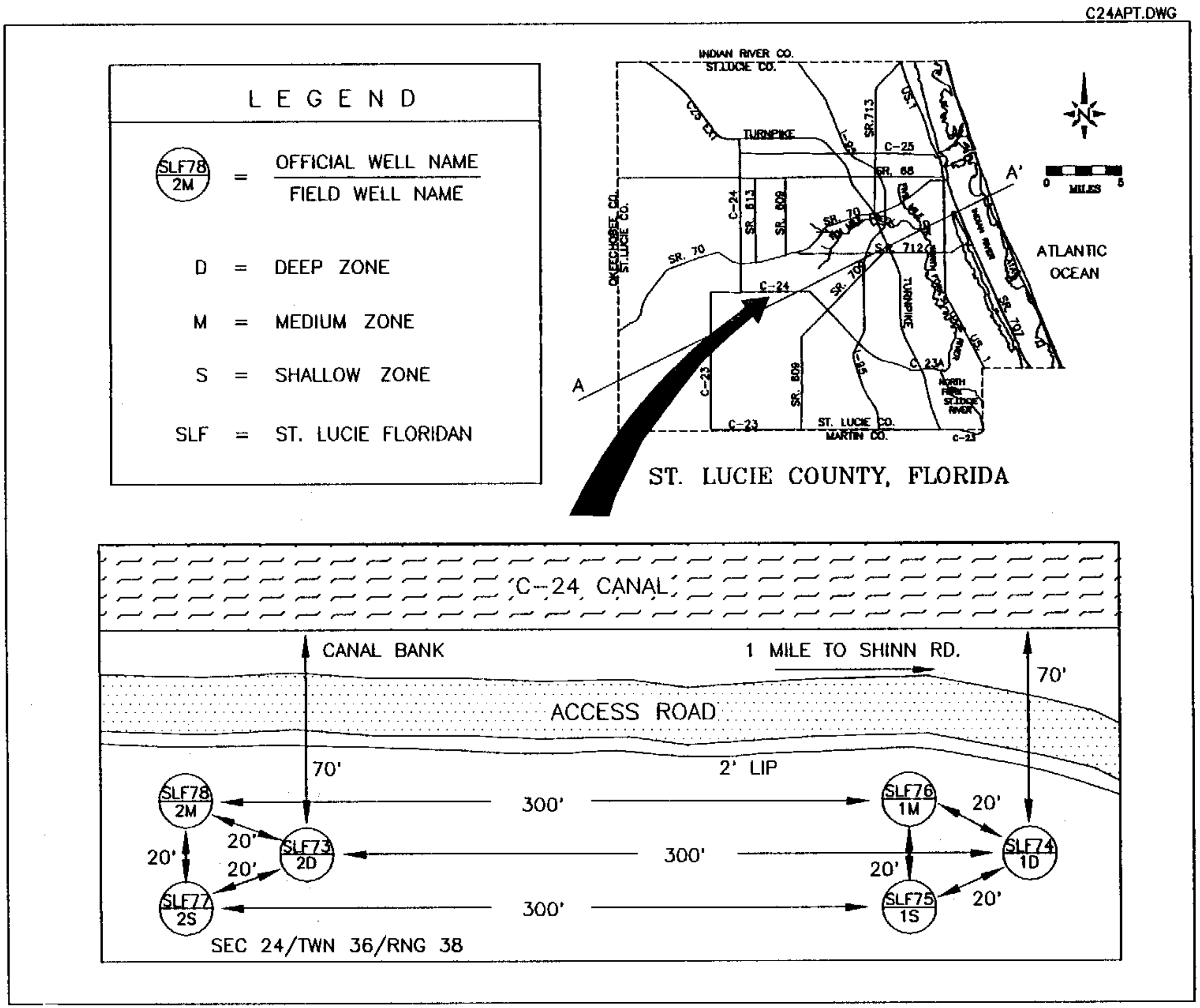

FIGURE 51. Locations of the South Florida Water Management District's Floridan Aquifer System Research Wells (Including SLF-73), St. Lucie County.

TABLE 10. Reverse-Air Water Sample Analyses From Well SLF-73, St. Lucie County.

FIELD MEASUREMENTS					LAB ANALYSIS								
Sample Depth BLS	Cl mg/l	Cond umhos	Temp Cent	pH	Na mg/l	Ca mg/l	Cl mg/l	SO4 mg/l	Alk mg/l	Hard mg/l	TotFe mg/l	AlCO3 mg/l	TDS mg/l
560	970	3580	29.3	7.9	480.3	118.2	123.7	177.6	3.1	642.1	0.4	153.9	1987.0
655	960	3570	27.7	8.0	427.1	123.7	969.9	175.2	2.7	659.4	0.9	133.5	1886.9
665	1020	3640	28.1	7.9	468.8	125.6	997.1	174.7	2.7	670.9	0.7	132.7	1962.0
685	970	3600	28.2	7.8	461.7	124.5	933.9	172.2	2.6	672.7	0.5	130.7	1967.0
700		3610	28.0	7.5	452.6	121.7	935.8	168.5	2.6	664.7	0.6	131.9	1957.1
750	945	3530	28.4	7.7	441.2	116.6	962.0	173.4	2.6	644.1	0.6	132.4	1929.0
805	955	3460	28.6	7.8	403.9	109.7	913.1	165.7	2.7	617.2	0.6	134.7	1900.0
865	1000	3620	28.5	7.8	424.3	129.6	1010.2	155.4	2.7	686.9	0.5	133.1	1922.9
990	965	3500	29.2	7.8	462.3	121.0	937.1	172.9	2.7	651.8	0.8	137.2	1902.9
1110	1300	4510	28.9	7.5	519.5	160.5	1369.6	180.8	2.5	858.1	1.1	127.0	2468.1
1205	1120	4100	29.6	7.4	491.7	145.9	1206.4	176.6	2.5	787.6	1.0	126.5	2188.1
1260	1130	4020	29.5	8.0	488.2	145.6	1044.8	172.8	2.6	782.8	0.7	128.0	2142.9
1325	1125	4050	30.1	7.5	532.5	147.5	1210.2	174.1	2.1	785.5	0.5	107.2	2195.9
1400	1105	3850	29.0	7.4	486.6	139.0	987.6	163.5	2.4	736.5	0.5	122.2	
1440	2460	7830	29.2	7.6	1085.0	279.5	2467.7	208.5	2.3	1497.4	1.0	113.9	4344.9
1540	3600	10087	29.5	7.5	1533.8	400.0	3560.2	190.3	2.0	2186.3	1.0	99.8	6078.9

TABLE 11. Packer Test Water Sample Analyses From Well SLF-73, St. Lucie County.

FIELD MEASUREMENTS					LAB ANALYSIS						
Sample Depth BLS	Cl mg/l	Cond umhos	TEMP. Cent	pH	Na mg/l	Ca mg/l	Cl mg/l	SO4 mg/l	Alk mg/l	TotFe mg/l	TDS mg/l
1138-1176	2194.0	7240.0	30.1	7.2	979.0	202.0	2194.0	203.0	119.0	1.3	3976.0
1313-1351	556.0	2280.0	30.3	7.4	251.0	85.0	556.0	185.0	137.0	0.6	1320.0
1351-1389	821.0	3080.0	30.6	7.4	384.0	104.0	821.0	161.0	138.0	0.5	1747.0
1408-1446	2361.0	7450.0	30.3	7.2	1027.0	252.0	2362.0	204.0	115.0	1.2	4440.0

intervals were confining zones. The chloride concentration in the upper flow zone (1,138 feet BLS to 1,176 feet BLS), sampled using packers was much higher (2,194 mg/l) than that determined from reverse air drilling (1,369 mg/l). Conversely, TDS concentrations measured in samples from the lower flow zone (1,408 feet BLS to 1,446 feet BLS) matched well, 2,362 mg/l and 2,468 mg/l, respectively. This is due to the fact that the upper flow zone contributed much less water to the borehole than the lower flow zone during borehole penetration. Also, chloride concentrations in the confining zone between 1,313 feet BLS and 1,389 feet BLS, sampled twice with packers, was much lower (556 mg/l and 821 mg/l, respectively) than concentrations measured during reverse air drilling (1,125 mg/l and 1,105 mg/l). Here again, results of reverse air sampling were misleading.

The salt-water interface occurs approximately 1,400 feet BLS in this well as evidenced by both the packer tests and by reverse-air samples. Water samples from a packer test conducted just above 1,400 feet BLS had a TDS concentration of 1,747 mg/l. Just below this depth samples from a packer test had a TDS concentration of 4,440 mg/l. Water sampled during reverse air drilling also changed abruptly from 2,196 mg/l TDS at 1,325 feet BLS to 4,345 mg/l TDS at 1,440 feet BLS.

SOURCES OF CONTAMINATION TO THE SURFICIAL AQUIFER SYSTEM

The SAS is susceptible to contamination from various anthropogenic sources since it is hydraulically connected to land surface, has high recharge rates and a high water table. The primary anthropogenic sources of SAS contaminants include surface contaminant spills, leaks from underground storage and septic tanks, landfills, and coastal salt-water intrusion caused by pumping wells. Brackish UFA water also degrades SAS water quality where it is used for irrigation.

BLENDING UPPER FLORIDAN AQUIFER AND SURFACE WATERS FOR IRRIGATION

Prior to crop application, brackish UFA water is typically mixed with fresh water. To dilute the brackish UFA water, grove owners and ranchers in the study area route the water from UFA wells to ditches where it is mixed with surface waters. Eventually the brackish water recharges the SAS. This practice is probably the reason elevated concentrations of dissolved ions are found in the sand/soil zone underlying the groves. This is best illustrated in Figure 10, which shows the regional distribution of sand/soil zone TDS concentrations (shades of grey) in relation to the locations of permitted UFA wells. Here, a correlation between high TDS concentrations in the SAS and UFA well locations is evident.

UFA wells have been used as a supplemental irrigation source since at least the 1940's and over time have probably elevated chloride concentrations of surface waters in the study area, particularly in St. Lucie and Okeechobee counties. For example, the C-25 canal in northern St. Lucie County contains water relatively high in chlorides and other dissolved ions. These ions probably originate from UFA well water used by citrus growers in the western part of that county (Adams, unpublished paper, 1991). It has been shown that there is interaction between water in the canals and aquifers via vertical leakage through canal bottoms (Butler and Padgett, 1995; Adams, 1992). Since flow is eastward in the C-25 canal, blended UFA water in this canal travels away from the groves and spreads eastward toward urban areas, where it percolates into the SAS.

FREE-FLOWING WELLS

Uncontrolled, free-flowing UFA wells exist in the study area (Hydro-Designs, 1988), primarily in St. Lucie County. These wells have either been unused and allowed to deteriorate to a condition where the valves no longer function, or are intentionally left flowing by the owner for a specific purpose (i.e. as a source of livestock water). In addition to elevating TDS concentrations in the sand/soil zone, free-flowing wells also reduce the potentiometric head in the UFA. This head loss induces upward movement of more saline water from the lower FAS, thus degrading UFA water quality as well.

INTER-AQUIFER MIXING

Few unused UFA wells are free flowing and most have functional valves; however, some of the older wells have corroded surface casings. Surface casing is pipe (usually steel) that extends from land surface to either the base of the SAS or through the less consolidated portions of the SAS. Most of the older wells were drilled using the cable-tool method; here, surface casings were jetted in through only the upper-most unconsolidated sand portion of the SAS. Drillers install surface casing to prevent the shallow, unconsolidated sediments of the SAS from caving into the borehole and to prevent UFA artesian water from entering the SAS. Many UFA wells were constructed in the 1940's and their surface casings have appreciably deteriorated. Because heads in the UFA are higher than those in the SAS, UFA water can travel up the borehole and enter the SAS through holes in the surface casing.

The SFWMD was required to plug abandoned UFA wells by the Water Quality Assurance Act. In 1987, the SFWMD sponsored a well abandonment program which provided the funding for well testing and plugging. Wells were tested for water quality and geophysically logged. Wells with surface casing integrity problems were plugged by filling them from bottom to top with cement grout. The purpose of the program was to eliminate old and unused UFA wells within the SFWMD, thereby decreasing a major source of contamination to the SAS. In the five years of operation, the program was credited with testing 626

UFA wells in the Upper East Coast Planning Area, (M. Krupa, 1994; verbal communication) approximately 338 of which were plugged. The program was discontinued in 1991 due to a reprioritizing of SFWMD programs. Many old UFA wells with highly corroded surface casings and some free-flowing wells still exist in the study area.

The federal government continues to offer a well abandonment cost-sharing program through the Farm Service Agency (FSA), formerly called the Agricultural Stabilization Conservation Service (ASCS) for wells on specific agricultural lands (Krupa, 1994, verbal communication).

CONTAMINATED SITES

The Florida Department of Environmental Protection (FDEP) serves as the regulating agency over all contaminant threats to the fresh water resources of Florida and has compiled a list of contaminated sites in the state which can be obtained through the Division of Waste Management in Tallahassee. At this time, there are hundreds of documented contaminated SAS sites within the study area, many of which are small in size, such as leaking underground storage tanks. Eleven of these contaminated sites are serious enough to have been ranked by the Environmental Protection Agency (EPA) as Superfund sites. The Comprehensive Environmental Response Compensation and Liability Act (CERCLA) of 1980, commonly referred to as "Superfund", legislates the cleanup of hazardous substances in the air, on land, or in the water. CERCLA requires the EPA to establish a National Priorities List of sites to be targeted for remedial action (Fetter, 1988).

The superfund sites within the study area (excluding Palm Beach County) are shown in Figure 52. The portion of Palm Beach County in the study area has no superfund sites.

LANDFILL SITES

There are approximately forty-nine (49) landfills, dumps, and domestic sludge-spreading sites within the boundaries of the UECPA. The locations of these facilities are shown in Figure 53 and listed in Appendix F, Table F-1. Sludge-spreading sites are not classified as landfills and are usually tracts of land, often open range or citrus, where the sludge from domestic waste water treatment plants is spread onto the soil.

Many of the older landfills and dumps were used for years with little or no control or regulation over the materials disposed in them. Although most have not been active for some time, they still pose a potential threat to the ground water resources, particularly in cases where public water supply wells are in the vicinity of the site.

Ground water beneath most unlined landfills and dumps is typically nutrient-rich, with elevated levels of nitrogen and ammonia compounds. Iron levels are typically high in leachate, as are sodium, sulfate, total organic carbon, and biological and chemical oxygen demand. Other, less common constituents found in leachate include metals such as lead and chromium, and volatile or synthetic organic compounds which are often associated with industrial solvents, such as trichloroethylene, tetrachloroethylene, and benzene.

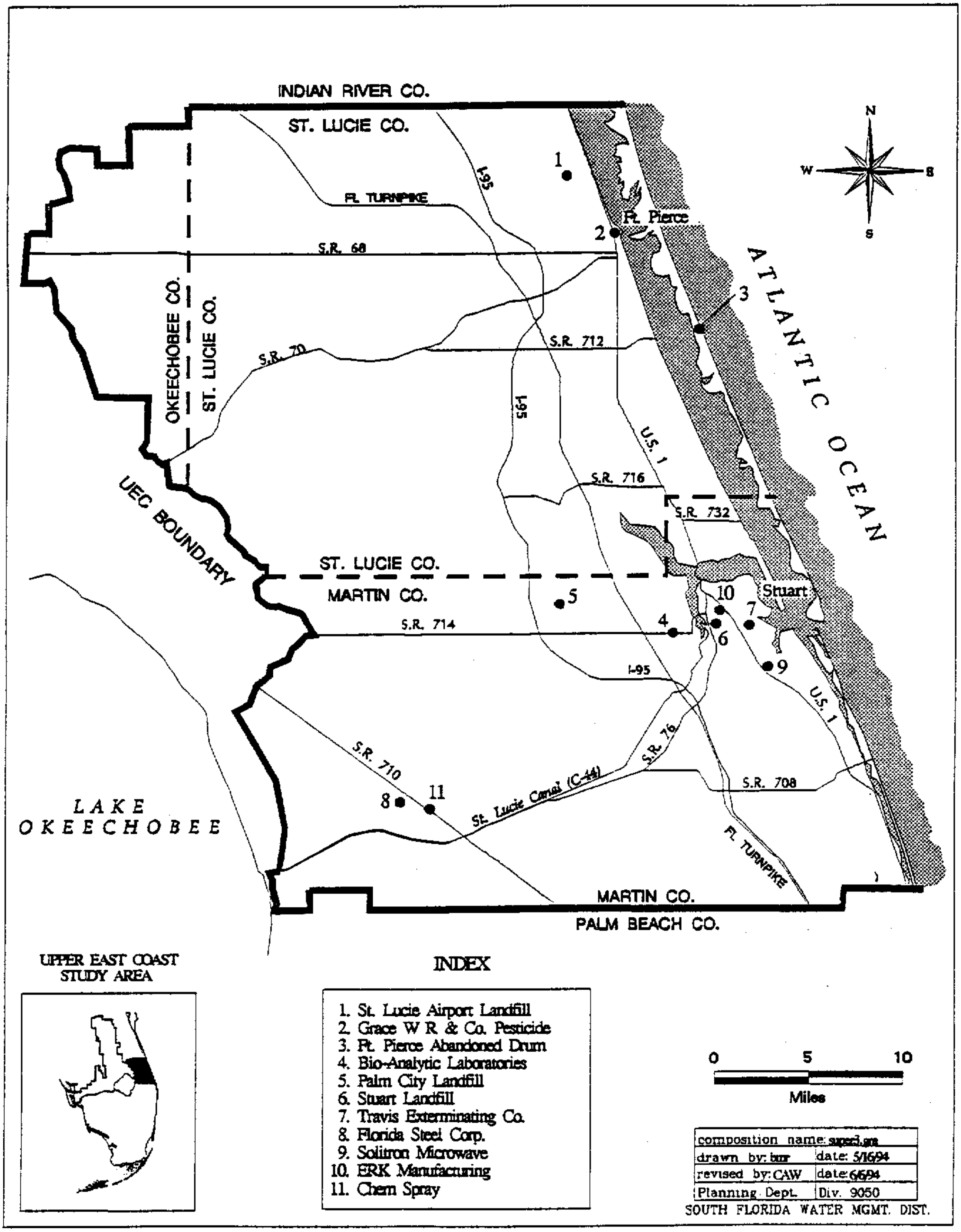

FIGURE 52. Superfund Sites in the Upper East Coast Planning Area.

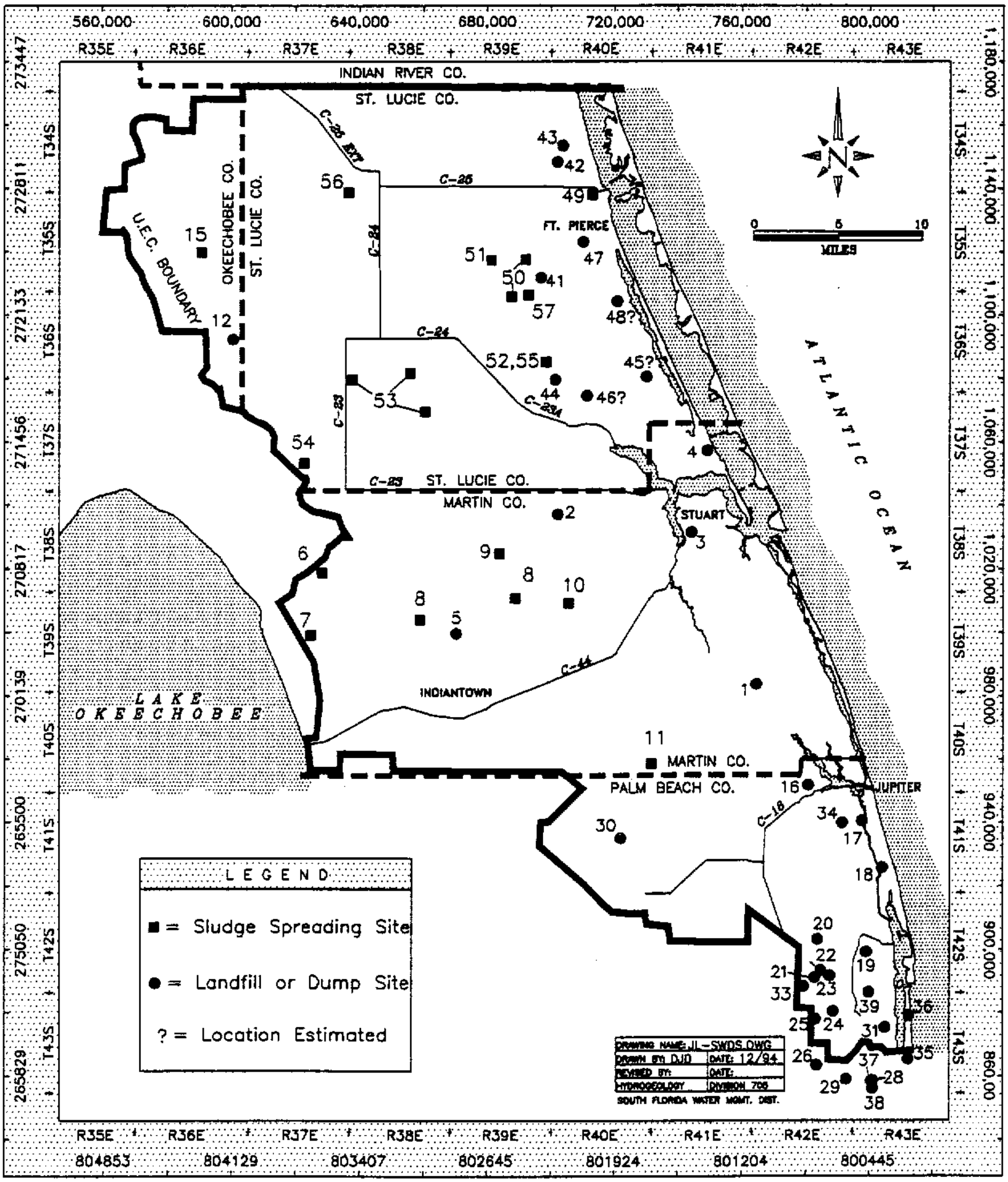

FIGURE 53. Solid Waste Disposal Sites in the Upper East Coast Planning Area.

CONCLUSIONS

The Surficial and Floridan Aquifer Systems underlie the entire Upper East Coast Planning Area. The Surficial Aquifer System here is typically composed of two zones: a sand/soil zone and a production zone. The depths to the sand/soil and production zones vary regionally but are generally found between land surface and 50 feet below land surface (BLS) and from 50 feet to 200 feet BLS, respectively. The Upper Floridan aquifer occurs well below the SAS and is separated from it by the intermediate confining unit consisting of a thick sequence of fine sands, silts and clays of the Hawthorn Group. The Hawthorn Group prevents significant interchange of water between the two aquifer systems.

One-hundred thirty-two (132) SAS and fifty-two (52) UFA wells were sampled and analyzed in and near the UECPA in October 1989 and again in May 1990 by the SFWMD. These wells made up the SFWMD's water level monitoring network developed in conjunction with ground water modeling activities. Other sources of data used in this report include those from the SFWMD's SALT network, the Ambient Ground Water Quality (GWIS) program, and the (now discontinued) UFA Well Abandonment program. Combined, these sources provide comprehensive definition of water quality characteristics in the UECPA. Conclusions drawn from analyzing these combined data are listed below.

SURFICIAL AQUIFER SYSTEM SAND/SOIL ZONE

In most of the UECPA, water in the SAS sand/soil zone meets drinking water quality standards with respect to chloride, total dissolved solids (TDS) and sulfate concentrations. Regionally, concentrations of these parameters are highest in the northwestern study area and decrease to the east and southeast. Eight localized areas with relatively high chloride concentrations were identified, three near the coast and five inland. TDS and sulfate concentrations, as well as specific conductance, were elevated in these same areas. The three coastal areas with high chloride concentrations in the sand/soil zone are located near the Ft. Pierce, St. Lucie, and Jupiter inlets. Here, the source of chloride is seawater which has intruded inland from the ocean. The five inland areas with high chloride concentrations are scattered throughout the study area.

Hardness of water increases to the west in the sand/soil zone from soft to very hard. East of U.S. 1 in St. Lucie County, and in northern Martin and Palm Beach counties, water is soft (below 50 mg/l $CaCO_3$). Between U.S. 1 and the Florida Turnpike, hardness gradually increases to moderately hard (approximately 200 mg/l $CaCO_3$). With few exceptions, water is moderately to very hard in the sand/soil zone underlying the study area west of the Florida Turnpike.

Trilinear and Stiff diagrams illustrate that ground water in the sand/soil zone changes gradually from a calcium chloride type in the northwestern portion of the study area to a calcium bicarbonate type in the southern portion. The presence of high dissolved solids in central and western St. Lucie County may be a result of blending UFA well water with surface waters in the citrus groves for irrigation water supply. UFA wells are extensively used in St. Lucie County for irrigation and much less so in Martin and Palm Beach counties. A second viable source of these chloride anions is residual seawater, emplaced in the aquifer system by ocean transgressions during the Pleistocene Epoch. Residual seawater was postulated by Miller (1988) as the source of chlorides in central and western Palm Beach County where low permeabilities in the geologic matrix have retarded its dilution.

SURFICIAL AQUIFER SYSTEM PRODUCTION ZONE

Water in the production zone also meets drinking water standards in most of the study area. Water quality characteristics in this and the sand/soil zones are similar in the study area with the exception of central and western St. Lucie County. Local areas with anomalously high TDS concentrations in the production zone occur in nine individual portions of the study area which include three areas near the coast and six areas inland. As in the sand/soil zone, high concentrations of chloride, TDS and sulfate occur near the three major inlets, indicative of salt water intrusion. Inland, water quality characteristics in the two zones are sometimes unique. Locations with high dissolved ion concentrations in the sand/soil zone often have low concentrations in the production zone, and vice versa.

Hardness is regionally consistent in the production zone and is generally between 200 mg/l ($CaCO_3$) and 600 mg/l ($CaCO_3$) which is classified as hard to very hard. Overall, hardness is higher in the production zone than in the sand/soil zone. There is no increase in hardness to the west as was the case in the sand/soil zone. Water is hardest (400 mg/l to 800 mg/l $CaCO_3$) in a line running north to south through the west-central portion of the study area.

The total iron content of water in the production zone is generally lower than that in the sand/soil zone. In at least four portions of the study area, however, concentrations exceeded 7.0 mg/l. In most areas, the total iron concentration is below the drinking water standards of 0.3 mg/l. No discernible regional trend in total iron concentration was identified.

Trilinear and Stiff diagrams illustrate that the dominant water type in the production zone is calcium bicarbonate. Unlike the sand/soil zone, no distinct differences in water types between counties were identified. Three anomalous areas were observed in western St. Lucie, Martin and Palm Beach counties which contained calcium chloride and sodium chloride water types in the production zone. The anomalies here were attributed to either mixing with UFA well water and/or the presence of connate seawater.

UPPER FLORIDAN AQUIFER

The Upper Floridan aquifer is approximately 500 feet thick in the study area (Lukasiewicz, 1992) and is composed of multiple flow zones. Concentrations of TDS, chloride and sulfate in the Upper Floridan aquifer do not meet drinking water standards in the study area. Their concentrations are lowest in the north-central portion of the study area and increase to the south and southeast. Exceptions to this regional pattern are common. Chloride concentrations increase from east to west in St. Lucie County, from west to east in Martin County, and from northwest to southeast in Palm Beach County. No directional trend was identified in Okeechobee County.

Isochlor and specific conductance maps developed for this study incorporate several sources of data and, relative to other parameters (except specific conductance), provide the best regional definition of UFA water character. The isochlor map illustrates that, in some areas, large local variations in chloride concentrations occur. For example, a cluster of wells completed to similar depths in central St. Lucie County exhibit chloride concentrations ranging from 275 mg/l to 1,188 mg/l. The wells are found within a small region less than six miles in diameter. Values of chloride and TDS concentrations can be extrapolated from known specific conductance of water using the linear regression nomographs and equations developed for this study.

Temperature of UFA water was mapped and found to increase from east to west in the study area. Regionally, UFA water temperature was coolest in wells on the barrier islands, confirming Meyer's (1989) findings that temperatures in UFA water are lowest along the southeastern coast of Florida because of heat transfer to the Atlantic Ocean. Several exceptions to this regional trend were observed where large temperature variations occurred in water from wells relatively close (four miles) to one another. Meyer also proposed that temperature and salinity anomalies observed in the inland areas of south Florida are related to upwelling ground water from the lower FAS.

Hardness values in UFA water are generally between 150 mg/l $CaCO_3$ and 800 mg/l $CaCO_3$ in the study area and are classified as hard to very hard. Hardness increases toward the east to approximately I-95 at which point, in the northeastern section of the study area, it decreases again toward the coast.

Trilinear and Stiff diagrams illustrate the dominance of the sodium cation and chloride anion in UFA waters throughout the study area. This dominance becomes stronger to the southeast. A higher percentage of sodium cations in UFA water is present in Martin County than in St. Lucie County. According to Frazee's classification system (1982), UFA water in St. Lucie County is considered to be connate in origin, while that in Martin County is between connate and lateral intrusive. This implies that the ocean may be, or may have been, a source of recharge to the UFA in Martin County. Potentiometric maps of the UFA indicate that flow is from the south-southwest to north-northeast regionally (Lukasiewicz, 1992). It does not seem probable that the Atlantic Ocean is currently recharging the aquifer.

UFA water quality changes with time were examined using data from eighteen (18) SFWMD and USGS monitor wells and five (5) public water supply utilities in and near the study area. Specific conductance, chloride, and TDS concentrations showed little change with time in fourteen of the eighteen monitor wells with a historic record. Water in four of the eighteen wells, however, experienced increased values for each of these three parameters with time. The historic record available from these four wells include only between two to five sampling events over a span of thirteen years; therefore, confidence in specific long-term trends is low.

Four utilities within, and one just north of the study area, process UFA water for either drinking or irrigation. Most of these utilities provided water quality as well as monthly pumpage data for this study. Graphs of those data illustrate that UFA water from two out of the five utilities experienced an increase in chloride and TDS concentrations over time. These two utilities have also been withdrawing water at relatively high rates over a long time period. A correlation between increased concentrations of TDS and increased withdrawal rates over time was observed at the Sailfish Point utility.

WATER QUALITY RESULTS FROM RECENT FLORIDAN AQUIFER SYSTEM DRILLING BY THE SFWMD IN THE UECPA

Recent FAS research drilling was conducted by the SFWMD in central St. Lucie County in 1990. Data from reverse air drilling and four packer tests indicate that water quality variations with depth are minimal in the UFA. TDS and chloride concentrations increased slightly (~15%) in the upper portion of the LFA and drastically (>200%)with increased depth near the salt-water interface at 1,440 feet BLS. Water quality samples collected during packer tests and reverse air drilling were compared and found to have inconsistencies due to the differences in the methods used to obtain the samples.

ANTHROPOGENIC SOURCES OF CONTAMINATION TO THE SURFICIAL AQUIFER SYSTEM

Brackish UFA irrigation water was identified as the probable cause for high TDS concentrations in the SAS sand/soil zone inland. Additional sources of human-induced contamination to the SAS are surface contaminant spills, leakage from underground storage and septic tanks, and landfills. There are forty-nine (49) landfills, old dumps, and domestic sludge-spreading sites in the study area. Eleven (11) contaminated sites are serious enough to have been ranked by the EPA as Superfund sites.

RECOMMENDATIONS

The SFWMD's Planning Department is currently developing a water supply plan for the UECPA. Water quality information presented in this document should be used by the Planning Department in conjunction with existing ground water flow models to identify optimum areas for future development of the ground water resources and to develop policies in the UECPA. Likewise, future ground water users, such as public water suppliers, industry and agricultural enterprises, can use the information provided here to assess the character of water in the study area prior to expansion.

Brackish UFA water used for irrigation in the UECPA (primarily St. Lucie County) percolates down and mixes with water in the sand/soil zone. The sand/soil zone is seldom used as a water source by public suppliers in St. Lucie County (Butler and Padgett, 1995) or Martin County (Adams, 1992) due primarily to its low yield in these areas. However, it is used by individual home owners for domestic self supply. The sand/soil zone's future value as a water resource should be carefully assessed to determine whether regulatory policy is needed to reduce or eliminate the ongoing mineralization of that zone by UFA irrigation practices. The use of UFA irrigation wells has been occurring for over fifty years. Even if discontinued, it would probably take many years of rainfall to significantly flush the zone of the brackish water currently in place.

Data provided in this report indicates that large UFA water withdrawals may result in increases in chloride and TDS concentrations over time. Utilities using UFA water for public supply should be required to submit to the SFWMD monthly water quality data from one or two of their deepest UFA wells as part of their water use permit. Monitoring of these wells will provide a good method for detecting early signs of upconing at the wellfield. Water quality data should include chloride and TDS concentrations and specific conductance. This data should then be used by the SFWMD to quantify changes in water quality as a function of withdrawal rates and time. With this information, the SFWMD can better manage the UFA water resource by allocating maximum withdrawals based on the potential for long term salt water upconing.

TDS concentrations have increased over time in four of eighteen UFA monitor wells located in Martin, St. Lucie and Okeechobee counties. These wells were sampled two to five times over approximately a ten-year period. Confidence in the conclusions about water quality trends is low due to the lack of continuity in sampling events. It is recommended that these wells be sampled at least twice each year (wet and dry seasons) to determine potential trends with confidence. Wells in three additional areas, identified by Lukasiewicz (1992), with extreme water level fluctuations and high agricultural water use (see Figure 40) should also be sampled and analyzed yearly for TDS and chloride concentration to determine whether the salt water interface is moving up in response to withdrawals. Additional wells, in areas with light water use should also be sampled regularly to provide control areas to facilitate comparisons.

Six inland areas were identified with unusually high chloride concentrations in the SAS production zone. It is probable that more areas exist and were not detected. One possible source of chlorides to the production zone is UFA water which has leaked through holes in the casings of wells completed to this aquifer. Thousands of UFA wells exist in the UECPA (Lukasiewicz, 1992), many of which were constructed several decades ago. The casing integrity of these wells should be tested on a regular basis to ensure that it is adequate to protect water in the SAS. The integrity test could consist of a caliper log which would be relatively easy and inexpensive to run. Caliper surveys should be required at least once every ten years as part of the water use permit renewal requirements. If it is determined that the casing integrity is compromised, the well should be repaired or plugged as soon as possible.

Many UFA wells exist in the study area which are currently unused or abandoned. In many cases, the wells are no longer needed because existing fresh water supplies are being used more efficiently than in the past. Unused UFA wells should be plugged to reduce the risk of inter-aquifer mixing. A cost-sharing program conducted by the SFWMD in the past resulted in three hundred thirty-eight (338) plugged UFA wells over a five-year period. Current SFWMD policy requires wells to be plugged when the permittee classifies the well(s) as unused in the permit renewal process.

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APPENDIX A

WATER QUALITY ANALYSES
SURFICIAL AND FLORIDAN AQUIFER SYSTEMS

LIST OF TABLES - APPENDIX A

TABLE A-1. Data from SALT Network Wells Completed in the Sand/Soil Zone (Surficial Aquifer System)

Map #	Well Name	State Planars X	Y	Water Use Permit Number	Total Depth	Cased Depth	Mar 1991 CL mg/l	May 1989 CL mg/l	Oct 1989 CL mg/l	Min CL Low mg/l	Date obs Mo/Yr	Max CL High mg/l	Date obs Mo/Yr
1	GDUSW3S	712300	1096800	56-00142W	43	38	59	52	37	37	06/90	59	09/90
2	GDUSW3D	712300	1096800	56-00142W	118	108	240	132	145	106	01/89	240	12/90
3	GDUSW2S	715100	1088800	56-00142W	25	20	30	62	30	27	01/89	62	09/89
4	GDUSW2D	715100	1088800	56-00142W	126	105	180	184	190	170	01/89	220	02/90
5	GDUSW4D	717000	1086600	56-00142W	107	104	240	265	200	100	11/90	440	8/89
6	GDUSW4M	717000	1086600	56-00142W	28	25	35	128	99	30	12/89	222	11/90
7	MCW4A	739900	1059050	43-00102W	140	120	46	42		31	02/89	52	08/89
8	MCW6A	744850	1061900	43-00102W	136	120	31	38	54	30	02/89	56	03/89
9	MCS1C	731102	1057600	43-00102W	140	120	48	52	41	10	10/90	58	06/90
10	MCW5A	743750	1060875	43-00102W	140	50	66	60		35	07/89	66	06/89
11	MCS1C	731102	1057600	43-00102W	140	120	48	52	41	10	10/90	58	06/90
12	MCW1A	735600	1060000	43-00102W	134	125	27	18	38	18	05/89	46	12/89
13	MCS5A	751325	1058150	43-00102W	104	95	69	46		30	07/89	69	11/89
14	HRR1	772863	1054859	43-00102W	149		39	89	93	37	07/90	101	12/89
15	MCS1A	731100	1057600	43-00102W	70	5	48	54	32	28	03/90	55	11/89
16	HRR2	723048	1054153	56-00450W	149		37	84	91	33	07/90	91	05/90
17	MCW3A	745150	1056650	43-00102W	137	120	40	38	50	29	07/89	54	12/89
18	MCS1B	731101	1057600	43-00102W	175	155	50	50	42	11	10/90	60	11/89
19	MCS3A	736300	1051800	43-00102W	128	108	57	48	44	29	03/89	77	11/89
20	MCW7A	740550	1048400	43-00102W	137	120	39	50	40	29	07/89	61	02/89
21	HRR3	728112	1052566	56-00450W	129		134	169	105	75	04/90	234	02/89
22	HRR4	730660	1048945	56-00450W	131		99	122	118	97	08/90	130	03/90
23	MCS2A	734400	1050702	43-00102W	108	98	44	64	71	50	03/90	86	01/89
24	MCW2D	736650	1055100	43-00102W	140	130	28	54	34	28	08/90	46	11/89
25	MD6D	725394	1038110	43-00169W	150	70	76	44	69	10	01/89	76	10/90
26	MGP6	767725	1023950	43-00086W	143	126	41	34	37	34	05/89	41	08/89
27	MGD-5	763974	1021276	43-00086W	135	125	200	75	107	20	12/90	210	08/90
28	MGD-4	765592	1024134	43-00086W	140	130	29	32	27	24	10/90	290	08/90
29	MGP3	766875	1022650	43-00086W	127	110	20	23	23	22	05/90	38	07/90
30	ICU-1	758000	1026500	43-00089W	106	96	34	46	54	0.71	03/90	54	10/89
31	ICU-2	759800	1025400	43-00089W	87		44	50	48	34	10/90	55	12/90
32	MGP4	767000	1023375	43-00086W	143	126	48	36	29	27	02/89	48	07/90
33	MGD-3	768400	1024950	43-00086W	150	5	9600	3000	2300	342	08/89	9600	12/90
34	MGD-2	768653	1024134	43-00086W	150	5	125	108	105	64	01/89	5000	10/90
35	MGD-1	769198	1023734	43-00086W	110	50	31	31	1400	31	02/89	1400	10/89
36	MGP2	766400	1022475	43-00086W	127	110	20	35	34	20	11/90	42	07/89
37	MGP1	766050	1022300	43-00086W	127	110	32		26	25	05/90	32	08/89
38	HY2R	779065	1007643	43-00066W	260	189	21			16	10/90	1750	11/90
39	HY3R	778974	1007642	43-00066W	200	149	20			15	06/90	1900	11/90
40	HY1R	777712	1007229	43-00066W	200	149	17			15	06/90	1600	11/90
41	JHSW2	795000	964725	43-00054W	157	40	2000	120	2000	120	06/89	2000	11/89
42	TQD35	796033	960704	50-00046W	125	100	135						
43	JHMW1	791500	967450	43-00054W	64	59	790			520	07/92	790	08/92
44	JHMW3	792100	964650	43-00054W	64	59	2440			790	08/92	2440	07/92

TABLE A-1. Data from SALT Network Wells Completed in the Sand/Soil Zone (Surficial Aquifer System) (Continued)

Map #	Well Name	State Planars X	Y	Water Use Permit Number	Total Depth	Cased Depth	Mar 1991 CL mg/l	May 1989 CL mg/l	Oct 1989 CL mg/l	Min CL Low mg/l	Date obs Mo/Yr	Max CL High mg/l	Date obs Mo/Yr
46	TQRD1	793528	956747	50-00046W	127	20	34						
47	TQD1-4	796232	958282	50-00046W	121	80	160						
48	TQT231	793900	958450	50-00046W	104	93	73						
49	TQD1-3	796339	955859	50-00046W	97	80	320						
50	JHSW1	794200	966800	43-00054W	157	40	1010	202	130	130	10/89	1680	11/90
51	WELL 13	740100	1025067	43-00172W	100		53		53				
52	WELL 14	739745	1023954	43-00172W	110	105	41		41				
53	WELL 9	737747	1025760	43-00172W	100		25		25				
54	WELL 10	737767	1022327	43-00172W	100		21		21				

TABLE A-2. Data from SALT Network Wells Completed in the Production Zone (Surficial Aquifer System)

Map #	Well Name	State Planars X	Y	Water Use Permit Number	Total Depth	Cased Depth	Mar 1991 CL mg/l	May 1989 CL mg/l	Oct 1989 CL mg/l	Min CL Low mg/l	Date obs Mo/Yr	Max CL High mg/l	Date obs Mo/Yr
1	GDUSW4S	717000	1086600	56-00142W	16	13	1050	1330	1150	0.12	12/89	1800	12/90
2	US1	723800	1084600	56-00097W	10		76	63		61	06/89	76	02/89
3	MCW6B	744860	1061900	43-00102W	71	5	36	36	43	16	11/90	54	03/89
4	MCW1B	735605	1060000	43-00102W	61	5	28	48	42	12	10/90	50	06/89
5	MCS5B	751325	1058145	43-00102W	63	5	70	48		33	07/89	70	11/89
6	MCW3B	745155	1056650	43-00102W	70	5	61	36	48	32	07/89	74	08/89
7	MCW2S	736560	1055100	43-00102W	70	5	27	56	47	34	05/90	56	04/89
8	MCW4B	739901	1059050	43-00102W	60	5	34	40	50	30	07/89	50	08/89
9	MCW7B	740500	1048405	43-00102W	71		34	48	39	25	10/90	60	02/89
10	MCS2B	734400	1050700	43-00102W	68	5	83	62	70	60	03/89	98	11/90
11	MDSW10	724000	1037650	43-00169W			540		540				
12	MDSW08	726575	1038300	43-00169W			48	106	93	48	10/90	385	01/89
13	MDSW06	731450	1037600	43-00169W			142		142				
14	MDSW11	721650	1036500	43-00169W			800		800				
15	MDSW09	725325	1038400	43-00169W			600		600				
16	MDSW12	723500	1033400	43-00169W			36	144	31	31	08/89	144	04/89
17	MDSW04	737400	1032850	43-00169W			74	1150	1870	74	10/90	6800	01/89
18	MDSW03	732750	1028350	43-00169W			56	272	510	56	10/90	510	08/89
19	MGS-08	768298	1023122	43-00086W	15		20	30	31	23	01/90	140	08/90
20	MGS-07	766947	1022507	43-00086W	20		38	30	29	20	10/90	120	08/90
21	MGS-10	767749	1024330	43-00086W	15		96	107	66	29	11/90	130	08/90
22	MGS-02	767656	1024632	43-00086W	20	5	30	44	38	25	11/90	150	08/90
23	MGS-06	765594	1022195	43-00086W	15		33	16	19	15	01/89	130	08/90
24	MGS-05	765048	1022899	43-00086W	20		98	120	11	11	10/89	598	10/90
25	MGS-04	765588	1023205	43-00086W	30		21	21	20	20	08/89	23	01/90
26	ICU2-1	761500	1015200	43-00089W	30		33		33				
27	MGS-03	764409	1023904	43-00086W	31	20	49		49				

TABLE A-3. Results of Water Quality Analyses from the SFWMD's Network of Monitor Wells Completed in the Sand/Soil Zone (Surficial Aquifer System)

Map #	Well Name	Date sampled	Na mg/l	K mg/l	Ca mg/l	Mg mg/l	Cl- mg/l	SO4 mg/l	HCO3 mg/l	Alk mg/l	Fl mg/l	SiO2 mg/l	Tot Fe mg/l	TDis Fe mg/l	TDS mg/l	Color units	Sp.Cond. umhos/cm	pH	Hardness CaCo3	% Error
	St. Lucie County Water Quality																			
1	PG1	MAY 10 90	186.3	20.4	70.4	30.4	303.5	149.5	13.0	10.7	0.2	2.7	6.0	<.05	927.9	29.0	1605.0	5.4	301.0	10.6
		OCT 26 89	127.9	13.7	53.3	20.0	269.7	142.1	17.1	14.0	4.2	2.3	0.1	<.05	871.0	30.0	1350.0	6.9	215.4	2.8
2	PG5	OCT 25 89	5.3	0.5	18.8	4.6	8.8	8.7	59.9	49.1	7.0	6.9	0.6	0.3		46.0	277.0	6.7	65.8	5.4
3	PG7	OCT 24 89	6.8	0.4	0.0	1.8	6.9	6.5	8.3	6.8	1.2	5.7	0.5	<.05	40.0	30.0	75.0	6.3	4.9	0.6
4	PG10	OCT 24 89	49.0	0.5	148.6	7.2	85.0	32.0	255.2	209.3	1.2	13.0	0.1	<.05	636.0	8.0	902.0	6.7	400.5	16.9
5	PG12	MAY 2 90	111.7	1.0	196.5	23.8	308.9	187.6	171.1	140.3	13.9	14.4	8.9	4.6	1040.0	402.0	1585.0	6.4	588.7	4
		OCT 25 89	95.1	0.7	177.5	23.2	241.9	145.4	155.2	127.3	1.4	11.5	1.7	<.05	1319.0	15.0	1480.0	6.8	538.7	9.5
6	PG16	OCT 25 89	130.1	2.9	147.0	31.9	237.5	292.5	418.2	343.0	2.4	29.7	0.9	<.05	1228.0	25.0	1800.0	7.0	498.3	10.7
7	PG18	MAY 8 90	141.9	3.6	185.0	24.8	327.8	191.2	274.8	225.4	0.7	12.6	2.5	1.5	1133.9	80.0	1735.0	7.0	563.8	0.3
8	PG23	MAY 16 90	17.4	1.0	2.1	3.7	44.0	2.5	13.9	11.4	0.3	11.5	3.2	1.9	98.0	21.0	161.0	4.8	20.3	12.4
		OCT 26 89	15.7	1.4	5.9	3.7	48.2	11.6	8.8	7.2	0.3	10.5	0.3	0.1	218.0	20.0	186.0	4.9	29.8	14.1
9	PG26	MAY 9 90	19.6	0.4	74.4	2.3	25.2	5.8	232.4	190.6	0.2	19.5	17.2	3.6	293.0	131.0	458.0	6.8	195.2	1.6
		OCT 24 89	24.4	0.4	71.7	2.8	16.6	5.5	100.2	82.2	0.7	10.5	4.2	1.0	332.0	63.0	497.0	6.8	190.4	37.5
10	SLMW1S	MAY 3 90	37.7	1.0	114.4	14.0	94.9	51.4	207.0	169.8	1.4	13.6	5.0	3.3	513.0	311.0	825.0	6.3	343.4	9.1
		NOV 1 89	43.3	1.1	111.1	13.5	92.4	45.6	177.3	145.4	1.1	9.9	0.4	<.05	544.9	19.0	757.0	7.3	333.0	14.2
11	SLMW8S	MAY 8 90	203.1	12.9	165.5	51.3	284.6	248.2	392.5	321.9	0.6	44.4	5.1	<.05	1270.0	16.0	1897.0	7.2	624.5	5.3
		OCT 31 89	114.3	5.2	115.8	21.2	128.7	90.4	157.6	129.3	0.8	12.5	0.2	0.1	813.9	14.0	1110.0	7.3	376.2	22.2
12	STL42	OCT 25 89	108.4	5.2	55.1	8.1	491.7	5.6	74.6	61.2	2.5	<1.0	4.7	<.05	1032.1	5.0	1700.0	7.0	171.0	29.8
13	STL123	MAY 15 90	214.1	2.5	374.0	49.7	500.9	478.2	470.3	385.7	1.4	23.9	24.8	10.2	2063.0	406.0	2940.0	6.6	1138.2	0.9
14	STL172	MAY 10 90	14.3	0.7	15.5	2.0	22.7	9.1	40.7	33.4	0.1	9.0	36.2	4.3	134.0	271.0	185.0	5.9	46.9	2.9
		OCT 24 89	36.8	0.8	97.1	3.8	58.6	<2.00	274.7	225.3	3.2	16.6	0.2	<.05	377.0	26.0	620.0	7.3	258.2	5
15	STL174	MAY 15 90	33.1	0.7	2.5	3.1	58.0	2.7	24.1	19.8	0.2	8.2	80.5	16.2	168.0	139.0	249.0	5.2	19.0	6.3
		OCT 24 90	17.5	0.3	8.7	1.4	54.0	7.2	0.0	0.0	1.1	8.7	8.7	2.2	151.1	167.0	237.0	5.7	27.3	12.2
16	STL265	OCT 24 89	36.9	2.5	92.7	8.0	60.2	5.0	311.5	255.5	0.5	26.2	1.4	<.05	315.1	22.0	618.0	7.1	264.4	0.6
17	STL266	MAY 2 90	20.7	0.7	2.9	2.4	41.8	10.7	0.0	0.0	0.7	4.0	4.9	0.3	78.0	17.0	161.0	4.3	17.2	5.2
18	STL268	OCT 24 89	24.8	1.0	2.8	3.9	48.4	18.7	0.0	0.0	1.4	12.2	2.8	<.05	118.1	12.0	210.0	4.6	23.1	5.6
19	STL270	MAY 16 90	19.5	2.4	2.0	4.7	53.8	5.5	6.9	5.7	0.1	10.7	5.8	4.9	139.0	57.0	212.0	4.9	24.4	11.1
		OCT 23 89	12.9	1.1	2.9	2.3	50.1	11.7	0.0	0.0	0.4	12.0	8.9	<.05	118.1	20.0	347.0	4.5	16.8	28.2
20	STL271	MAY 16 90	9.1	0.4	128.9	2.5	13.0	2.4	386.7	317.2	0.6	10.6	3.2	2.1	400.1	146.0	671.0	6.7	332.3	2.4
		OCT 23 89	10.7	0.4	135.1	2.4	10.2	4.6	279.2	229.0	0.7	8.1	2.2	<.05	385.0	31.0	620.0	6.8	347.1	20.1
21	STL272	MAY 11 90	29.5	0.5	42.6	2.2	59.3	<2.00	109.4	89.7	0.7	13.3	13.7	9.3	256.0	273.0	412.0	6.1	115.3	1.9
		OCT 23 89	28.9	0.5	47.6	2.1	28.4	<2.00	64.3	52.7	3.1	8.0	3.4	0.1	247.0	17.0	354.0	6.7	127.4	34.7
22	STL273	MAY 11 90	394.8	2.0	202.5	12.6	736.9	148.8	230.9	189.4	0.5	15.8	28.4	12.8	1864.0	144.0	3090.0	6.8	557.5	1.2
		OCT 23 89	431.5	1.6	215.7	13.9	339.9	58.8	126.1	103.4	6.8	6.4	3.2	<.05	1739.0	6.0	2930.0	6.8	596.0	40.9

TABLE A-3. Results of Water Quality Analyses from the SFWMD's Network of Monitor Wells Completed in the Sand/Soil Zone (Surficial Aquifer System) (Continued)

Map #	Well Name	Date sampled	Na mg/l	K mg/l	Ca mg/l	Mg mg/l	Cl- mg/l	SO4 mg/l	HCO3 mg/l	Alk mg/l	Fl mg/l	SiO2 mg/l	Tot Fe mg/l	TDis Fe mg/l	TDS mg/l	Color units	Sp.Cond. umhos/cm	pH	Hardness CaCo3	% Error
23	STL274	OCT 23 89	6.5	0.5	9.1	0.8	8.4	6.1	14.8	12.1	1.4	8.7	0.6	<.05	44.1	11.0	104.0	7.2	26.0	15
25	STL276	OCT 24 89	16.4	0.3	17.2	1.6	57.8	4.3	130.3	106.9	5.1	32.1	1.0	0.2	252.1	36.0	378.0	6.3	49.5	38.4
26	STL277	MAY 16 90	45.3	0.4	3.3	6.0	55.4	32.6	27.2	22.3	0.3	8.7	1.8	0.7	186.0	38.0	311.0	4.8	33.0	0.5
		OCT 24 89	34.1	0.2	2.0	3.4	55.2	28.1	22.8	18.7	0.6	8.4	0.8	0.5	179.0	58.0	287.0	5.4	18.9	14.4
27	STLAPT1S	MAY 9 90	13.7	0.6	60.6	1.8	25.1	<2.00	188.7	154.8	0.5	16.4	1.5	0.6	224.0	40.0	379.0	7.2	158.7	0
	STLAPT1S	NOV 2 89	51.9	0.6	59.2	2.2	22.6	4.2	121.3	99.5	0.3	9.7	0.4	<.05	215.9	23.0	375.0	7.6	156.8	33.4
28	STLAPT2S	MAY 3 90	20.6	0.4	82.4	2.6	33.3	<2.00	232.9	191.0	1.0	12.0	3.6	2.0	293.0	100.0	512.0	6.2	216.3	5
	STLAPT2S	NOV 1 89	20.5	0.3	76.9	2.5	31.8	<2.00	172.5	141.5	0.3	8.7	2.2	<.05	269.9	18.0	383.0	7.3	202.5	14.3
29	STLAPT4S	MAY 4 90	24.8	0.4	85.2	2.8	60.6	<2.00	217.4	178.3	1.2	15.9	14.1	9.2	358.0	106.0	549.0	5.8	224.3	2.9
	STLAPT4S	NOV 1 89	23.3	0.4	75.4	3.0	39.0	5.9	160.4	131.6	0.9	11.4	9.3	<.05	323.9	25.0	509.0	7.0	200.4	13.4
	Martin County Water Quality																			
30	M1037	MAY 2 89	33.2	0.4	104.6	5.4	61.8	<2.0	322.0	264.0	0.3	20.8	11.1	0.6	443.0	75.0	746.0	7.2	278.0	0.9
		OCT25 89	37.5	0.5	125.2	7.7	82.1	<2.0	381.6	312.9	0.4	19.6	3.9	<.05	467.1	7.0	828.0	6.8	337.9	0.1
31	M1041	MAY03 89	22.0	1.1	76.9	7.1	37.5	<2.0	294.0	241.1	0.4	16.5	8.5	0.2	324.9	47.0	530.0	7.2	217.3	3.9
		OCT25 89	26.5	1.2	83.0	8.2	40.6	<2.0	281.7	231.0	0.4	19.7	73.1	0.2	299.1	52.0	522.0	7.0	236.7	2.3
32	M1042	MAY 2 89	7.5	4.1	21.6	1.8	25.6	<2.0	93.4	76.6	0.3	6.5	41.2	2.8	175.0	260.0	219.0	7.5	60.4	15.1
		OCT25 89	11.7	9.5	36.4	2.8	22.4	4.3	126.6	103.8	0.2	2.3	5.6	<.05	542.0	21.0	417.0	7.2	100.4	0.2
33	M1045	MAY 1 89	31.4	1.1	47.8	4.8	65.0	<2.0	187.2	153.5	0.8	15.0	4.1	0.1	280.0	15.0	474.0	7.5	136.7	7.8
34	M1046	MAY 3 89	30.2	0.6	80.0	5.3	44.8	37.7	333.0	273.1	0.3	10.9	43.7	0.1		50.0	736.0	7.3	217.5	12.9
35	M1066	OCT25 89	24.0	1.1	58.4	5.5	47.2	<2.0	178.5	146.4	0.2	16.9	3.8	<.05	224.0	10.0	390.0	6.4	165.4	2.2
36	M1072	MAY 1 89	13.9	0.3	59.4	1.6	28.2	<2.0	206.6	169.4	0.1	4.4	1.3	<.05	219.0	8.0	378.0	7.6	152.0	5.7
		OCT24 89	26.6	0.9	67.4	2.7	56.2	22.5	200.4	164.3	0.1	4.5	0.3	<.05	252.1	8.0	958.0	7.0	176.1	5.4
37	M1081	MAY 1 89	16.7	1.1	120.2	8.7	34.8	11.4	342.0	280.4	0.3	14.3	1.6	0.1	397.0	31.0	671.0	7.3	330.1	4.8
		OCT24 89	17.2	1.0	119.0	8.9	33.8	11.0	377.8	309.8	0.4	13.1	0.9	<.05	245.1	28.0	684.0	7.2	327.7	0.8
38	M1083	MAY 2 89	48.1	0.8	119.1	9.5	78.9	<2.0	332.0	272.2	0.3	16.2	19.8	<.05	466.0	22.0	826.0	7.3	330.7	7.3
		OCT26 89	54.0	1.0	128.5	10.5	85.2	5.0	424.9	348.4	0.5	14.6	7.9	<.05	530.1	24.0	831.0	7.0	357.5	1.1
39	M1086	MAY 3 89	26.6	1.3	89.3	4.8	40.8	6.0	303.2	248.6	0.2	10.9	5.1	<.05	324.1	28.0	592.0	7.4	238.2	1.4
		OCT24 89	26.8	1.2	87.4	4.6	40.3	5.0	293.4	240.6	0.2	10.2	1.7	<.05	276.9	28.0	533.0	6.8	232.8	0.7
40	M1232	MAY 1 89	10.6	0.9	1.7	1.8	23.9	<2.0	6.1	<5.0	0.0	6.1	1.3	1.1	81.0	11.0	112.0	6.4	11.4	4.1
		OCT23 89	15.2	1.0	22.1	2.7	33.1	5.3	63.7	52.2	0.2	8.1	0.8	0.2	103.0	15.0	204.0	6.8	65.0	1.8
41	M1233	MAY 1 89	14.8	0.9	2.9	6.7	31.4	34.4	6.1	<5.0	0.0	5.5	2.0	1.4	94.0	11.0	185.0	4.6	34.9	10.3
		OCT24 89	12.3	0.9	2.2	3.8	18.6	19.0	6.1	<5.0	<.05	4.1	1.0	0.2	67.0	16.0	187.0	5.1	21.2	1.3
42	M1234	MAY 2 89	40.2	1.2	97.8	6.6	51.6	7.2	332.0	272.2	0.3	15.3	1.7	0.2	330.0	113.0	646.0	7.3	266.3	1.3
43	M1244	OCT24 89	50.7	5.3	126.1	7.8	89.1	72.0	299.3	245.4	0.4	10.4	5.0	<.05	509.9	11.0	843.0	7.1	340.7	2.3
44	M1249	MAY 2 89	9.9	0.6	5.5	0.8	8.3	8.3	18.9	15.5	0.1	5.6	1.6	0.6	71.1	58.0	103.0	7.0	16.6	4.8
		OCT25 89	11.0	1.0	47.1	1.3	18.2	5.7	149.4	122.5	0.1	11.3	3.2	<.05	157.9	29.0	551.0	6.5	120.5	1.7

TABLE A-3. Results of Water Quality Analyses from the SFWMD's Network of Monitor Wells Completed in the Sand/Soil Zone (Surficial Aquifer System) (Continued)

Map	Well	date	Na	K	Ca	Mg	Cl-	SO4	HCO3	Alk	Fl	SiO2	Tot Fe	TDis Fe	TDS	Color	Sp.Cond.	pH	Hardness	% Error
#	Name	sampled	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	units	umhos/cm		CaCo3	
45	M1250	MAY 2 89	7.8	1.4	80.5	0.9	11.5	<2.0	255.0	209.1	0.6	16.0	122.0	<.05	228.1	23.0	384.0	7.0	200.9	0.1
		OCT25 89	9.0	1.3	89.0	1.1	12.9	3.8	274.5	225.1	0.1	15.1	4.8	<.05	251.0	15.0	446.0	6.9	222.4	0.4
46	M1255	MAY 2 89	85.3	1.4	133.6	16.1	139.2	<2.0	389.8	319.6	0.4	27.4	19.1	<.05	635.1	39.0	1067.0	7.1	393.3	6.6
		OCT25 89	89.0	1.5	124.0	16.0	146.8	<2.0	414.9	340.2	0.3	27.2	3.9	<.05	620.9	35.0	1028.0	6.9	369.3	2.3
47	M1256	MAY 2 89	31.5	1.0	6.6	2.7	23.4	22.9	39.9	32.7	0.0	12.5	30.8	1.8	156.1	43.0	271.0	6.7	27.3	4.7
		OCT26 89	20.7	0.7	26.7	2.7	33.0	11.9	106.0	86.9	0.8	11.5	13.3	0.1	132.9	21.0	263.0	6.8	76.3	7.9
48	M1257	MAY 2 89	31.4	1.3	6.0	2.1	48.5	8.3	25.0	20.5	0.0	7.5	2.3	1.2	130.0	45.0	218.0	6.8	23.5	1.9
		OCT24 89	33.0	2.0	17.4	1.8	36.3	8.4	87.9	72.1	0.1	8.5	0.5	0.1	141.0	43.0	284.0	6.6	49.9	2.4
49	M1258	MAY 1 89	12.3	0.9	37.4	3.2	7.4	8.5	147.6	121.0	0.1	4.2	0.9	<.05	145.9	6.0	301.0	6.7	104.8	1.7
		OCT24 89	7.9	1.0	49.3	3.9	12.1	9.7	138.2	113.3	0.1	3.7	10.8	<.05	177.0	6.0	305.0	7.5	136.8	6.1
50	M1259	MAY 1 89	25.7	0.8	93.2	6.3	37.2	<2.0	309.4	253.7	0.3	11.6	7.4	0.8	323.0	96.0	540.0	6.8	253.8	1.8
		OCT24 89	3.9	13.9	46.9	1.6	4.7	8.0	155.7	127.7	0.3	5.9	0.3	0.1	169.1	60.0	289.0	6.9	121.4	2.8
52	M1260	MAY 1 89	19.8	0.9	115.2	3.8	41.1	6.6	350.9	287.7	0.1	9.8	4.2	0.3	341.0	59.0	565.0	6.4	297.4	0.5
		OCT24 89	19.6	1.4	117.0	3.8	38.1	4.9	347.0	284.5	0.4	9.7	2.4	0.4	382.1	57.0	591.0	6.9	301.8	1.5
52	M1261	MAY 2 89	36.2	1.3	3.4	0.6	9.9	21.7	73.9	60.6	0.1	17.0	3.9	0.2	121.0	59.0	175.0	7.2	10.8	2.4
		OCT24 89	17.9	1.0	1.3	0.4	11.0	10.3	74.4	61.0	0.4	4.6	21.0	0.1	94.0	46.0	153.0	7.6	5.0	31.1
53	M1262	MAY 3 89	50.6	1.1	103.3	3.6	88.4	36.9	254.9	209.0	0.3	12.4	1.4	<.05	412.9	36.0	689.0	6.7	267.4	1.8
		OCT25 89	36.7	1.2	148.9	5.3	71.6	130.2	301.6	247.3	0.3	13.2	1.5	<.05	463.0	23.0	840.0	7.0	386.2	0.5
54	M1263	MAY 3 89	54.0	7.9	126.4	14.8	115.3	68.4	275.9	226.2	0.5	14.8	1.4	<.05	559.1	30.0	908.0	6.7	370.3	4.8
		OCT25 89	36.9	9.0	76.4	9.9	58.7	39.2	198.4	162.7	0.8	12.3	1.2	0.2	358.0	174.0	618.0	7.0	227.7	6.4
55	M1264	OCT24 89	56.9	12.8	94.5	11.9	88.5	13.3	332.6	272.7	0.4	19.2	3.6	<.05	456.1	48.0	778.0	7.0	280.1	1.8
56	M1265	MAY 3 89	81.5	9.9	108.3	17.3	173.3	26.1	294.9	241.8	0.1	11.8	6.7	<.05	573.1	40.0	971.0	6.8	336.1	1.8
		OCT25 89	83.1	8.5	100.3	15.0	167.3	24.4	261.1	214.1	0.2	12.2	2.6	<.05	295.1	44.0	902.0	6.7	307.3	3
57	M1266	OCT25 89	23.3	1.0	36.9	3.0	51.7	6.0	94.0	77.1	4.1	11.0	63.3	2.6	199.0	171.0	334.0	6.7	102.8	0.2
58	M1267	OCT25 89	19.3	0.8	100.0	2.1	52.3	<2.0	281.0	230.4	0.2	12.9	14.5	<.05	331.9	18.0	547.0	6.9	253.3	0.3
59	M1268	OCT23 89	15.6	5.6	6.6	2.9	28.6	16.7	22.3	18.3	0.1	9.2	0.8	0.6	113.1	44.0	195.0	5.7	28.1	4.3
60	M1269	OCT25 89	16.6	1.2	23.0	1.6	29.1	10.1	68.3	56.0	0.1	8.8	0.3	0.1	118.9	12.0	254.0	6.5	62.9	2.6
61	M1270	OCT24 89	51.0	1.8	121.1	10.1	73.9	5.9	397.2	325.7	0.4	24.4	0.2	<.05	479.0	27.0	732.0	6.9	337.8	2.6
62	M1273	OCT24 89	33.5	2.8	79.2	16.7	60.4	45.1	248.2	203.5	0.7	4.1	8.6	<.05	379.0	40.0	625.0	7.0	262.4	1.5
63	M1274	OCT25 89	17.0	0.5	91.3	2.6	35.4	20.2	260.0	213.2	<.05	15.2	1.9	<.05	320.0	39.0	536.0	6.9	234.3	1.1
65	PB711	MAY 1 89	7.6	0.2	29.1	0.7	16.1	<2.0	97.9	80.3	0.2	5.7	7.7	4.0	146.9	203.0	184.0	6.5	74.0	5.3
66	PB875	OCT25 89	28.5	0.3	90.2	3.3	65.6	21.2	286.8	235.2	0.9	10.1	1.6	<.05	313.0	19.0	186.0	7.1	234.4	7.2
67	PB1520	MAY 1 89	11.6	0.5	57.6	1.6	19.0	<2.0	288.5	236.6	0.3	10.8	1.0	0.4	313.1	107.0	461.0	6.8	147.5	19.6
68	PB1521	MAY 1 89	13.4	0.3	128.4	2.5	19.8	46.3	407.6	334.2	0.3	10.5	1.9	<.05	456.1	29.0	681.0	6.8	324.6	6.1
69	PB1524	MAY 2 89	212.5	9.7	127.3	21.6	337.0	77.0	390.1	319.9	0.4	22.4	0.1	0.1	1082.9	46.0	1810.0	6.8	400.3	0.5

TABLE A-3. Results of Water Quality Analyses from the SFWMD's Network of Monitor Wells Completed in the Sand/Soil Zone (Surficial Aquifer System) (Continued)

Map #	Well Name	date sampled	Na mg/l	K mg/l	Ca mg/l	Mg mg/l	Cl- mg/l	SO4 mg/l	HCO3 mg/l	Alk mg/l	Fl mg/l	SiO2 mg/l	Tot Fe mg/l	TDis Fe mg/l	TDS mg/l	Color units	Sp.Cond. umhos/cm	pH	Hardness CaCo3	% Error
	Palm Beach County Water Quality																			
70	PB1615	MAY 1 89	43.4	0.8	135.3	6.1	85.0	<2.0	389.5	319.4	0.6	16.0	4.3	0.1	592.0	61.0	891.0	7.0	356.3	2.3
		OCT26 89	45.5	0.9	109.2	4.8	60.1	<2.0	354.1	290.4	0.8	14.8	2.3	0.4	424.0	75.0	668.0	7.0	287.1	2.5
		JAN 2 90	74.8	2.5	77.2	7.4	55.0	4.5	329.3	270.0	1.3	14.7	2.3	0.9	460.0	115.0	753.0	7.3	219.4	6.3
71	PB-1648	MAY 2 89	45.9	3.2	66.1	4.9	44.5	11.2	302.1	247.7	0.3	10.1	4.2	0.2	388.9	24.0	734.0	7.5	181.7	5.1
		OCT23 89	18.4	2.8	102.9	3.2	22.9	9.0	272.7	223.6	0.3	9.6	0.8	<.05	320.0	17.0	560.0	7.1	264.9	8.6
74	PB-591						58								440		756			
75	PB-792-26						13								288		585			
76	PB-792-10						29								212		475			
77	PBMT-01S	APR 6 89	16.64	0.24	103	1.87	34	<2.0		246	0.1		1.3		327		554	6.8		
78	PB-0716	Nov 18 88	12.98	0.87	88.9	18	22.3	<2.0		248	0.3		2.4	309	321.7		665		247.2	
79	PB95-1S	Aug 31 87	18.2	0.51	108	1.49	18.9	10.4		252	0.28		0.32		334		538	6.8	275.1	
80	LP-02S	Nov 9 84	3.3	0.79	34.4	4.5	1.1	9.4		104			1.61	0.03	101		220	7.2		
81	LP-02	Sept 12 84	20.8	15.3	55.4	21	10.8	35.6		225			0.32	0.17	329		553	6.3		
82	LP-01S	Nov 8 84	16.3	2.59	34.3	5	29.7	13		106			0.88	0.02	206		359	7.2		
83	PB-618						17								311		500			

TABLE A-4. Well Completion Data from the SFWMD's Network of Monitor Wells Completed in the Sand/Soil Zone (Surficial Aquifer System)

Map #	Well Name	Location S/T/R	Coordinates Latitude	Longitude	Total Depth (ft.)	Casing Depth (ft.)	Reference #
	St. Lucie County Water Quality						
1	PG1	15 35 40	272554	801917	37	29	1
2	PG5	29 34 40	272908	802145	30	17	1
3	PG7	29 35 40	272427	802158	30	16	1
4	PG10	28 35 39	272347	802625	30	18	1
5	PG12	05 34 39	273305	802652	22	18	1
6	PG16	11 35 38	272716	803050	26	18	1
7	PG18	18 36 39	272053	802826	30	16	1
8	PG23	18 37 41	271531	801704	30	19	1
9	PG26	17 36 40	272058	802146	30	19	1
10	SLMW1S	10 36 38	272159	803052	18	13	1
11	SLMW8S	05 35 38	272814	803248	35	25	1
12	STL42	07 35 37	272655	804016	18	13	1
13	STL123	28 36 38	271858	803238	13		1
14	STL172	35 35 40	272316	801834	30	26	1
15	STL174	36 36 40	271754	801707	30	26	1
16	STL265	26 35 39	272427	802402	28		1
17	STL266	06 34 40	273317	802213	42	39	1
18	STL268	05 36 40	272230	802119	22	19	1
19	STL270	14 37 40	271457	801902	24	20	1
20	STL271	17 37 40	271509	802117	24	20	1
21	STL272	11 37 39	271618	802457	23	20	1
22	STL273	31 37 40	271233	802221	21	18	1
23	STL274	36 37 40	271233	801740	25	21	1
25	STL276	06 37 41	271648	801655	23	20	1
26	STL277	05 37 41	271657	801558	22	19	1
27	STLAPT1S	31 35 40	272308	802232	45	34	1
28	STLAPT2S	09 35 39	272638	802609	45	35	1
29	STLAPT4S	10 36 37	272140	803741	40	20	1
	Martin County Water Quality						1
30	M1037	22 38 39	270942	802504	28	9	1
31	M1041	19 38 37	270931	804038	22	21	1
32	M1042	18 38 38	270951	803355	46	41	1
33	M1045	30 40 40	265731	802227	23	22	1
34	M1046	19 40 38	265903	803408	15	15	1
35	M1066	17 39 38	270441	803324	30	25	1
36	M1072	12 40 42	270002	800632	34	30	1
37	M1081	31 39 40	270220	802220	24	24	1
38	M1083	18 40 41	265920	801639	24	24	1
39	M1086	18 40 38	265937	803419	45	40	1
40	M1232	21 40 42	265725	801418	18	13	1
41	M1233	14 40 42	265906	800716	17	12	1
42	M1234	27 40 41	265724	801418	18	15	1
43	M1244	36 39 39	270210	802355	30	20	1

TABLE A-4. Well Completion Data from the SFWMD's Network of Monitor Wells Completed in the Sand/Soil Zone (Surficial Aquifer System) (Continued)

Map #	Well Name	Location S/T/R	Coordinates Latitude	Longitude	Total Depth (ft.)	Casing Depth (ft.)	Reference #
44	M1249	34 38 38	270270	803120	23	13	1
45	M1250	34 38 38	270270	803120	47	37	1
46	M1255	18 38 39	270913	802849	39	34	1
47	M1256	06 38 41	271150	801642	20	15	1
48	M1257	34 38 41	270721	801403	20	16	1
49	M1258	27 39 42	270320	800733	18	15	1
50	M1259	29 39 42	270237	800949	38	35	1
51	M1260	29 39 42	270237	800949	23	20	1
52	M1261	06 39 41	270609	801634	20	17	1
53	M1262	32 39 38	270151	803302	18	15	1
54	M1263	22 39 39	270401	802551	15	12	1
55	M1264	04 39 39	270651	802607	15	13	1
56	M1265	33 38 37	270750	803803	21	18	1
57	M1266	17 38 41	270948	801533	20	17	1
58	M1267	17 38 41	270948	800803		110	1
59	M1268	22 37 41	271444	801411	24	21	1
60	M1269		270618	801003	23	20	1
61	M1270	27 39 41	270238	801352	21	18	1
62	M1273	22 39 40	270429	801909	20	17	1
63	M1274	35 39 40	270720	801906	23	20	1
64	M1275	19 38 41	270939	801703	23	20	1
	Palm Beach County Water Quality						1
65	PB711	10 41 42	265510	800834	23	21	1
66	PB875	17 41 42	265439	801029	24	20	1
67	PB1520	16 41 42	265412	800927	22	20	1
68	PB1521	22 41 42	265255	800839	22	20	1
69	PB1524	16 41 41	265443	801520	19	17	1
70	PB1615	14 41 39	265426	802415	20	15	1
71	PB-1648	06 41 42	265609	801034	20	17	1
74	PB-591		265609	800942	43		2
75	PB-792-26		265522	800805	26		2
76	PB-792-10		265522	800805	10		2
77	PBMT-01S		265346	800613	45		2
78	PB-0716		265114	801731	15		2
79	PB95-1S		264829	800602	46		2
80	LP-02S		264815	800438	40		2
81	LP-02		264812	800445	30		2
82	LP-01S		264815	800444	30		2
83	PB-618		264659	800354	36		2

Legend

Reference #	Reference
1	SFWMD., 1989 Ground Water Monitoring Network
2	SFWMD., 1993 Data Base

TABLE A-5. Results of Water Quality Analyses from the SFWMD's Network of Monitor Wells Completed in the Production Zone (Surficial Aquifer System)

Map #	Well Name	date sampled	Na mg/l	K mg/l	Ca mg/l	Mg mg/l	Cl- mg/l	SO4 mg/l	HCO3 mg/l	Alk mg/l	Fl mg/l	SiO2 mg/l	Tot Fe mg/l	TDis Fe mg/l	TDS mg/l	Color units	Sp.Cond. umhos/cm	pH	Hardness CaCo3	% Error
	St. Lucie County Water Quality																			
1	PG13M	MAY 3 90	674.3	24.8	243.5	118.7	906.1	600.5	893.2	732.6	1.2	75.1	3.7	0.1	3216.9	179.0	4910.0	6.1	1096.4	0.4
		OCT 25 89	163.5	7.4	85.1	25.5	169.8	75.5	260.9	214.0	1.3	13.8	0.6	<.05	782.9	23.0	1266.0	7.0	317.5	12.7
2	PG13N	MAY 3 90	818.3	13.8	334.5	124.2	887.1	1077.5	738.5	605.7	11.6	61.4	2.6	0.1	96.0	160.0	5350.0	6.1	1346.3	3.2
		OCT 25 89	109.6	4.5	70.1	18.1	192.5	123.2	233.5	191.5	6.6	15.2	0.6	<.05	695.0	24.0	1131.0	7.0	249.7	8.6
3	PG15E	OCT 25 90	362.1	7.5	166.5	44.7	653.9	373.7	389.8	319.7	6.8	42.8	0.2	<.05	3952.0	10.0	3050.0	7.0	599.8	7.4
4	SLMW1D	MAY 3 90	367.4	15.6	166.5	58.1	213.7	496.9	431.4	353.8	31.2	69.3	0.8	0.1	1808.0	12.0	2680.0	6.3	654.7	12.1
5	SLMW4D	MAY 2 90	22.8	0.5	109.5	4.6	22.6	<2.00	346.3	284.0	14.5	15.6	2.0	0.4	358.0	31.0	620.0	6.3	292.3	4.4
		OCT 26 89	29.0	1.3	101.0	7.6	18.8	5.0	287.4	235.7	0.9	10.5	0.2	<.05	367.1	23.0	608.0	7.3	283.6	13.5
6	SLMW8D	MAY 8 90	113.6	5.2	119.6	21.5	213.1	101.9	242.0	198.5	0.5	15.6	2.0	0.1	784.0	40.0	1341.0	7.1	386.9	3.1
		OCT 31 89	185.3	11.5	162.5	47.7	145.6	163.4	242.9	199.2	0.7	12.5	7.3	<.05	1186.1	10.0	1600.0	7.3	602.1	28.4
7	STLMW10	NOV 1 89	333.3	12.9	138.7	47.8	405.5	476.5	407.1	333.9	0.2	65.8	0.6	<.05	1713.1	11.0	2320.0	7.3	542.9	3.9
8	SLMW11D	MAY 10 90	237.0	4.0	214.5	6.6	499.8	134.6	279.0	228.8	0.7	9.6	6.3	0.2	1404.0	18.0	2220.0	6.9	562.8	0.5
		OCT 26 89	43.2	0.7	58.0	1.6	369.4	66.7	274.9	225.5	1.2	9.8	0.5	<.05	1255.0	12.0	1660.0	7.2	151.3	53.7
9	SLMW14D	MAY 10 90	39.6	1.2	94.6	4.0	60.2	<2.00	290.4	238.2	0.5	14.7	0.6	0.3	394.0	40.0	667.0	7.0	252.6	2.8
10	SLMW21	MAY 16 90	70.4	4.6	87.0	11.7	78.7	7.0	332.6	272.8	0.9	18.1	1.1	0.1	475.0	45.0	822.0	7.1	265.3	4.3
11	SLMW23D	MAY 15 90	11.1	1.6	95.5	5.0	15.1	<2.00	318.5	261.2	1.2	23.5	0.3	<.05	323.0	22.0	547.0	6.9	259.1	0.8
12	STL185	MAY 8 90	143.0	5.7	127.2	21.0	196.5	20.4	461.1	378.2	0.8	26.3	7.2	1.9	816.0	131.0	1454.0	6.8	403.9	3.5
		OCT 26 89	32.4	0.5	71.3	8.4	93.0	<2.00	472.9	387.9	6.1	24.0	0.2	<.05	560.0	33.0	992.0	7.2	212.6	29.1
13	STL192	OCT 25 89	24.0	0.4	75.7	2.6	124.8	5.3	338.8	277.9	6.2	11.8	0.4	0.1	589.9	9.0	867.0	6.7	199.9	29
14	STL213	MAY 15 90	44.3	4.1	79.8	10.6	61.4	5.3	286.8	235.2	1.0	26.3	0.1	<.05	388.9	23.0	743.0	7.2	243.0	2.8
		OCT 24 89	40.8	3.9	65.8	9.4	54.7	7.7	253.0	207.5	0.7	25.6	0.1	<.05	284.0	17.0	546.0	7.6	202.9	1
15	STL214	MAY 11 90	38.0	0.6	100.7	3.6	65.6	<2.00	266.2	218.3	0.7	14.8	8.8	8.5	425.0	114.0	698.0	6.6	266.3	6
16	STL264	MAY 3 90	29.4	1.4	99.6	5.9	38.4	<2.00	302.9	248.4	11.7	20.7	0.4	0.3	355.1	32.0	620.0	6.4	272.8	5.9
		OCT 25 89	19.0	0.8	60.1	3.9	50.0	5.0	312.9	256.6	1.4	20.4	0.2	<.05	357.1	32.0	642.0	7.3	166.1	22.7
17	STL275	OCT 23 89	70.1	4.8	88.0	9.0	68.8	6.4	255.2	209.3	1.3	19.2	<.05	<.05	472.0	24.0	774.0	7.4	256.7	14.3
18	STLAPT1I	MAY 9 90	54.5	0.8	100.3	5.3	83.5	<2.00	295.4	242.3	0.6	17.5	7.1	4.9	463.0	317.0	788.0	7.0	272.4	4.4
19	STLAPT1D	MAY 9 90	109.0	6.6	94.7	12.4	128.9	5.7	411.2	337.3	0.8	27.7	0.2	0.1	600.0	34.0	1047.0	7.2	287.5	1
20	STLAPT1D	NOV 2 89	128.0	6.4	94.9	12.6	67.4	6.8	253.8	208.2	0.4	18.1	0.1	<.05	600.0	23.0	834.0	7.5	288.9	30.2
21	STLAPT4D	MAY 4 90	24.9	0.7	121.1	5.9	33.4	<2.00	377.3	309.5	7.7	24.7	0.2	0.1	443.0	44.0	706.0	6.2	326.8	3.7
22	STLAPT2D	MAY 3 90	49.5	1.6	117.9	7.5	97.8	<2.00	323.2	265.1	7.2	19.8	0.2	0.1	504.0	33.0	851.0	6.3	325.2	3.9
22	APT2D4	NOV 1 89	52.1	1.5	116.4	7.5	85.6	4.2	295.9	242.7	0.4	12.7	0.7	<.05	594.0	30.0	714.0	7.1	321.5	8.7
23	APT4D3	NOV 1 89	48.9	1.7	81.9	8.7	43.3	5.1	368.3	302.1	0.8	24.8	0.1	<.05	419.0	52.0	736.0	7.2	240.4	2.4

TABLE A-5. Results of Water Quality Analyses from the SFWMD's Network of Monitor Wells Completed in the Production Zone (Surficial Aquifer System) (Continued)

Map #	Well Name	date sampled	Na mg/l	K mg/l	Ca mg/l	Mg mg/l	Cl- mg/l	SO4 mg/l	HCO3 mg/l	Alk mg/l	Fl mg/l	SiO2 mg/l	Tot Fe mg/l	TDis Fe mg/l	TDS mg/l	Color units	Sp.Cond. umhos/cm	pH	Hardness CaCo3	% Error
	Martin County Water Quality																			
24	M1010	MAY 2 89	34.7	1.5	90.5	4.5	35.2	4.7	300.5	246.4	0.1	18.4	0.7	<.05	356.0	2.0	568.0	7.5	239.9	3.6
		OCT24 89	18.1	0.6	99.2	3.6	28.5	<2.0	312.2	256.0	0.1	8.9	0.1	0.1	284.0	4.0	522.0	7.6	257.6	1.3
25	M1039	OCT23 89	5138.0	150.5	247.0	672.5	8894.0	1038.9	69.1	56.7	0.9	1.9	0.8	<.05	13292.0	10.0	2330.0	6.3	3373.8	3.7
26	M1044	MAY 1 89	12.2	0.6	67.8	3.1	18.7	<2.0	262.8	215.5	0.3	23.1	0.6	0.1	260.0	19.0	427.0	7.4	178.5	6.9
		OCT24 89	14.5	0.9	69.4	3.8	18.8	<2.0	231.1	189.5	0.5	4.5	3.5	<.05	211.0	9.0	370.0	7.6	185.5	1.6
27	M1049	OCT24 89	23.4	0.8	79.5	4.0	45.7	<2.0	312.7	256.4	0.3	12.5	0.7	<.05	353.1	40.0	593.0	7.4	210.8	9
		MAY 1 89	13.8	2.9	28.8	3.3	24.6	4.5	106.0	86.9	0.2	2.1	7.0	<.05	132.0	8.0	315.0	7.5	83.9	2.8
28	M1052	MAY 2 89	47.2	1.9	89.3	7.4	101.2	<2.0	371.3	304.5	0.4	26.6	0.8	0.1	547.9	39.0	903.0	7.3	249.0	10.8
		OCT24 89	65.1	2.6	113.5	10.9	104.1	<2.0	382.8	313.9	0.3	10.7	0.1	<.05	484.9	14.0	819.0	7.3	322.4	1.5
29	M1057	MAY 2 89	7.3	0.6	27.1	0.7	19.5	4.6	158.0	129.6	0.1	6.2	<.20	<.05	167.1	5.0	307.0	7.6	69.2	29.8
		OCT24 89	14.2	0.5	53.0	1.7	23.2	<2.0	162.1	132.9	0.1	4.2	0.1	<.05	167.1	2.0	360.0	7.6	136.6	1.7
30	M1071	OCT24 89	12.1	0.9	50.0	2.2	27.2	<2.0	217.0	177.9	0.2	11.5	<.31	<.05	225.1	6.0	392.0	7.6	131.3	14.3
		MAY 1 89	22.9	1.0	66.9	3.3	32.8	4.0	213.9	175.4	0.3	10.8	0.1	<.05	217.9	5.0	502.0	7.1	177.2	1.5
31	M1073	OCT24 89	14.0	0.5	52.2	2.4	25.8	6.1	155.1	127.2	0.4	5.2	0.3	<.05	191.0	15.0	345.0	7.3	137.5	0.6
32	M1079	MAY 3 89	6.6	1.5	72.8	1.7	9.6	<2.0	292.3	239.7	0.2	19.4	0.5	<.05	266.0	7.0	446.0	7.4	184.9	10.3
		OCT25 89	6.9	1.4	91.8	2.4	12.3	<2.0	290.4	238.1	0.4	17.5	2.0	<.05	250.1	8.0	446.0	7.1	234.6	0.4
33	M1085	MAY 3 89	519.6	18.3	131.2	61.5	755.8	239.5	384.4	315.2	0.5	22.2	1.7	0.1	1781.0	49.0	3220.0	7.3	574.1	3.3
		OCT24 89	483.9	17.4	68.1	54.4	637.5	204.2	281.2	230.6	0.4	8.4	0.2	<.05	1565.0	12.0	2680.0	7.3	390.5	4.7
34	M1088	OCT24 89	120.3	6.8	24.4	2.4	56.0	26.6	30.5	25.0	0.4	<1.0	4.2	<.05	378.1	4.0	774.0	9.3	69.7	44.5
35	M1093	MAY 1 89	12.6	1.3	74.8	1.9	24.1	<2.0	249.4	204.5	0.1	6.5	0.3	0.1	217.9	33.0	425.0	7.5	191.0	2.9
36	M1094	MAY 1 89	15.4	0.8	74.6	2.6	31.0	<2.0	249.9	204.9	0.0	11.2	0.4	<.05	217.9	5.0	433.0	7.7	193.2	3.4
37	M1096	OCT26 89	72.4	1.3	73.8	6.0	85.0	14.1	278.9	228.7	0.8	7.9	1.0	<.05	384.1	12.0	668.0	7.1	205.3	0.9
38	M1161	MAY 2 89	5.4	0.9	1.9	1.3	8.4	<2.0	9.3	7.6	0.2	10.1	2.7	1.5	62.0	75.0	61.0	5.6	10.1	8.6
		OCT24 89	5.7	0.8	4.2	2.0	8.7	4.3	13.2	10.8	0.3	9.2	5.2	1.3	65.0	124.0	106.1	5.7	18.4	7.8
39	M1229	MAY 1 89	17.8	1.0	89.1	3.2	23.7	<2.0	293.8	240.9	0.2	18.3	0.5	0.1	271.0	29.0	467.0	6.9	231.4	0.5
		OCT23 89	16.7	1.0	90.2	3.0	22.6	<2.0	283.2	232.2	0.2	18.1	0.4	<.05	295.0	27.0	422.0	7.2	233.2	2.3
40	M1230	MAY 1 89	8.6	0.5	74.7	1.6	14.5	<2.0	243.3	199.5	0.1	11.6	0.9	<.05	212.1	11.0	393.0	7.0	189.4	1.5
		OCT24 89	9.3	0.5	73.3	1.8	13.3	<2.0	198.0	162.4	0.2	10.4	0.9	<.05	222.9	11.0	380.0	7.4	186.7	7.9
41	M1231	MAY 2 89	187.0	9.2	99.4	21.7	212.6	99.1	367.3	301.2	0.5	22.2	1.1	0.1	675.0	51.0	1410.0	7.0	332.5	3.9
		OCT26 89	112.3	8.6	85.3	17.5	116.5	57.8	248.0	203.4	0.4	19.8	0.5	0.3	589.9	56.0	910.0	7.2	280.8	11.9
42	M1235	MAY 1 89	89.7	4.0	73.1	12.2	165.4	26.5	361.6	296.5	0.4	29.9	0.9	<.05	665.0	26.0	1136.0	7.3	229.0	12.4
		OCT24 89	100.5	4.6	105.4	16.9	127.8	20.2	302.7	248.2	0.5	33.4	0.2	<.05	565.9	26.0	979.0	7.1	327.6	10.9
43	M1236	MAY 3 89	18.1	1.2	103.8	5.0	23.7	7.4	330.9	271.3	0.2	22.3	0.8	<.05	347.0	25.0	579.0	7.4	274.5	1.6
		OCT24 89	17.7	1.1	107.0	4.7	22.3	5.1	340.0	278.8	0.3	20.2	0.1	<.05	326.1	20.0	566.0	7.0	281.3	2
44	M1237	MAY 3 89	356.4	15.3	123.9	35.2	548.2	124.3	415.0	340.3	0.5	28.5	1.5	<.05	1059.0	18.0	2420.0	7.2	448.1	0.4
		OCT25 89	320.9	15.6	122.3	33.5	504.6	125.7	289.0	237.0	0.5	27.1	0.1	<.05	1252.9	17.0	2150.0	7.0	437.1	3.8
45	M1238	MAY 3 89	177.9	6.2	115.3	19.4	247.5	15.7	412.8	338.5	0.4	23.4	1.0	<.05	621.9	25.0	1510.0	7.3	362.2	4.1

TABLE A-5. **Results of Water Quality Analyses from the SFWMD's Network of Monitor Wells Completed in the Production Zone (Surficial Aquifer System) (Continued)**

Map #	Well Name	date sampled	Na mg/l	K mg/l	Ca mg/l	Mg mg/l	Cl- mg/l	SO4 mg/l	HCO3 mg/l	Alk mg/l	Fl mg/l	SiO2 mg/l	Tot Fe mg/l	TDis Fe mg/l	TDS mg/l	Color units	Sp.Cond. umhos/cm	pH	Hardness CaCo3	% Error
46	M1239	MAY 1 89	118.3	10.9	74.2	21.3	153.2	7.5	335.2	274.9	0.2	22.8	1.0	0.2	471.0	45.0	1054.0	7.3	269.2	4.6
		OCT24 89	101.1	9.9	78.2	19.9	135.5	10.1	364.8	299.1	0.3	22.1	0.1	<.05	529.9	35.0	916.0	7.2	273.1	1.1
47	M1240	MAY 2 89	78.6	3.2	115.3	12.3	122.4	<2.0	376.8	309.0	0.3	28.3	1.0	<.05	457.0	41.0	999.0	7.2	332.8	3.4
		OCT26 89	79.6	3.2	119.0	12.6	131.9	4.3	368.8	302.4	0.7	29.2	0.4	<.05	554.0	36.0	923.0	7.1	343.0	3.4
48	M1243	MAY 1 89	23.4	2.3	195.0	22.2	22.4	9.9	610.9	500.9	0.2	24.3	1.6	0.2	569.0	66.0	1037.0	6.7	568.5	8
		OCT24 89	24.7	2.1	176.5	20.3	19.6	8.0	671.8	550.9	0.3	23.3	2.5	0.1	611.9	54.0	989.0	6.6	515.3	0.1
49	M1245	OCT24 89	85.2	6.1	65.2	13.5	50.1	44.7	352.4	289.0	0.7	16.9	0.1	<.05	437.9	21.0	698.0	7.2	215.1	1.1
50	M1247	MAY 2 89	43.3	1.1	101.0	4.1	71.0	<2.0	325.2	266.7	0.4	20.3	0.8	0.2	430.9	35.0	730.0	7.1	263.9	0.1
		OCT25 89	45.8	1.1	100.2	4.1	72.6	<2.0	354.6	290.8	0.2	20.3	2.0	<.05	388.0	35.0	680.0	7.0	261.9	3.1
51	M1248	MAY 2 89	11.7	0.9	85.9	3.1	18.3	7.6	276.3	226.6	0.3	13.8	0.6	0.7	282.9	65.0	458.0	7.2	222.9	1
		OCT25 89	11.8	0.6	74.8	1.9	20.3	<2.0	232.7	190.8	0.2	20.6	0.2	<.05	244.0	32.0	437.0	7.1	190.7	0.5
52	M1251	MAY 3 89	61.4	4.3	75.9	16.8	85.3	5.1	308.3	252.8	0.4	20.3	0.6	0.1	444.9	64.0	773.0	7.1	254.7	2.7
		OCT25 89	32.1	3.5	45.8	4.2	72.1	9.5	98.2	80.5	0.7	10.8	0.5	0.1	267.9	73.0	457.0	7.1	129.5	3.5
53	M1252	MAY 3 89	29.6	4.3	76.5	11.9	34.3	<2.0	282.0	231.2	0.3	20.5	0.6	0.1	318.0	32.0	559.0	7.2	236.2	5.5
		OCT25 89	26.6	3.0	98.7	7.6	50.1	53.4	284.3	233.1	0.2	17.8	0.1	<.05	383.0	25.0	545.0	6.9	272.6	2.5
54	M1253	MAY 3 89	31.6	1.4	71.1	4.8	35.8	4.7	258.7	212.1	0.2	12.9	0.6	<.05	267.9	30.0	477.0	7.3	193.8	0.4
		OCT24 89	19.0	0.9	76.3	4.4	35.0	<2.0	242.0	198.4	0.1	13.0	1.0	<.05	254.1	27.0	452.0	7.5	205.0	0.9
55	M1254	MAY 2 89	19.2	0.7	106.4	2.0	34.2	<2.0	315.6	258.8	0.1	9.7	0.7	<.05	387.0	16.0	559.0	7.1	268.6	1.7
		OCT23 89	17.2	0.6	106.4	2.2	34.9	<2.0	333.0	273.1	<.05	10.2	0.3	<.05	344.0	15.0	575.0	7.1	269.4	1.3
55A	M1281	SEP26 89	35.1	0.7	0.4	0.2	59.6	<2.0	315.9	259.0	0.4	15.7	1.0	1.9	427.1	75.0	429.0	6.7		62.4
		SEP29 89	33.5	0.5	107.0	4.2	59.6	<2.0	352.4	289.0	0.4	15.8	0.9	1.9	429.1	64.0	478.0	7.1	279.2	1.9
55B	M1282	OCT 9 89	19.2	0.5	100.8	2.9	31.2	<2.0	296.0	242.7	0.3	14.6	0.5	0.4	349.0	26.0	405.0	6.5	258.6	3.5
		OCT11 89	18.1	0.4	100.8	2.8	33.3	<2.0	309.0	253.4	0.3	14.8	0.5	0.4	334.0	31.0	456.0	6.6	258.1	0.7
55C	M1283	DEC 4 89	19.9	0.8	86.0	3.8	55.8	<2.0	342.4	280.8	0.2	16.1	0.9	2.1	435.0	34.0	604.0	6.9	226.1	13.2
		DEC 7 89	16.0	0.4	58.5	2.4	56.2	<2.0	334.3	274.1	0.6	16.4	0.7	3.1	431.0	36.0	665.0	7.3	152.8	29.6
	Palm Beach County Water Quality																			
56	PB789	MAY 1 89	19.1	0.4	90.7	2.3	22.2	<2.0	241.3	197.9	0.2	12.6	0.6	0.1	310.1	29.0	505.0	6.4	231.2	9.8
		OCT23 89	15.9	1.1	77.2	2.1	20.3	<2.0	252.7	207.2	2.0	10.9	7.4	<.05	238.0	23.0	432.0	7.1	197.5	0.6
57	PB880	OCT26 89	70.7	2.8	110.5	17.2	52.8	22.6	431.0	353.4	0.6	29.0	0.2	0.1	1066.0	52.0	844.0	7.0	341.3	5.9
58	PB928	NOV 2 89	16.8	0.8	92.6	3.2	38.4	<2.0	328.4	269.3	0.2	19.7	0.7	<.05	388.9	33.0	614.0	6.6	239.8	6.6
59	PB1547	MAY 2 89	43.9	1.9	84.8	7.2	69.6	7.2	295.9	242.6	0.4	20.3	0.8	0.9	423.0	32.0	693.0	7.0	236.9	1.1
60	PB1548	MAY 2 89	23.6	0.5	92.1	2.8	44.9	<2.0	309.6	253.9	0.3	18.3	0.4	1.7	372.0	27.0	607.0	7.0	236.7	3.7
61	PB1552	MAY 2 89	379.6	16.8	147.2	33.0	635.6	161.5	437.9	359.1	0.4	22.7	1.4	3.4	1711.0	35.0	2790.0	7.0	495.9	2.5
62	PB1613	MAY 1 89	783.5	33.5	103.4	65.7	1856.4	303.8	456.1	374.0	0.6	23.8	1.4	1.6	3995.1	41.0	6510.0	7.4	523.4	18.5
		OCT26 89	28.4	0.7	67.5	3.1	22.5	11.6	255.0	209.1	0.9	9.9		1.4	16422.0	44.0	450.0	7.0	177.8	1.5
		JAN 2 90	877.8	36.2	110.0	76.7	1831.0	310.1	535.2	438.9	1.4	24.4		1.2	3788.0	37.0	7340.0	7.2	584.8	13.5

TABLE A-5. Results of Water Quality Analyses from the SFWMD's Network of Monitor Wells Completed in the Production Zone (Surficial Aquifer System) (Continued)

Map	Well	date	Na	K	Ca	Mg	Cl-	SO4	HCO3	Alk	Fl	SiO2	Tot Fe	TDis Fe	TDS	Color	Sp.Cond.	pH	Hardness	% Error
#	Name	sampled	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	units	umhos/cm		CaCo3	
63	PB1649	MAY 2 89	435.3	22.0	138.3	38.4	701.6	174.4	368.5	302.2	0.5	21.8	1.7	0.3	1814.0	41.0	2970.0	7.3	496.5	0.3
		OCT23 89	299.2	18.7	85.8	21.9	662.4	152.3	349.5	286.6	0.6	19.9	0.1	<.05		45.0	798.0	7.1	300.2	16.9
65	PB-0715	APR 6 89	56.73	3.1	118	14.1	70	4			0.26						902	6.8	350.6	
	Okeechobee County Water Qaulity																			
64	OKS55		9.1	0.7	95.0	1.6	17.0	1.5						470	304		505			
66	OKS30		32	2.6	93	8.8	31	8.2						90	378		607		240.5	

TABLE A-6. Well Completion Data from the SFWMD's Network of Monitor Wells Completed in the Production Zone (Surficial Aquifer System)

Map	Well	Location	Coordinates		Total	Casing	Reference
#	Name	S/T/R	Latitude	Longitude	Depth (ft.)	Depth (ft.)	#
	St. Lucie County Water Quality						
1	PG13M	05 34 38	273257	803247	91	83	1
2	PG13N	05 34 38	273257	803247	58	50	1
3	PG15E	18 35 39	272611	802820	58	50	1
4	SLMW1D	10 36 38	272159	803052	134	72	1
5	SLMW4D	29 34 40	272908	802145	120	60	1
6	SLMW8D	05 35 38	272814	803248	115	60	1
7	STLMW10	17 36 37	272048	803911	120	70	1
8	SLMW11D	15 35 40	272554	801917	153	80	1
9	SLMW14D	35 35 40	272316	801834	130	80	1
10	SLMW21	05 36 40	272230	802119	140	70	1
11	SLMW23D	15 36 37	271534	803725	322		1
12	STL185	23 37 38	271438	802955	113	103	1
13	STL192	04 35 40	272806	802020			1
14	STL213	26 35 39	272427	802402	115	75	1
15	STL214	11 37 39	271618	802457	63	33	1
16	STL264	17 34 39	273107	802703	90	60	1
17	STL275	27 12 33	271233	801740	136		1
18	STLAPT1I	31 35 40	272308	802232	75	64	1
19	STLAPT1D	31 35 40	272308	802232	103	93	1
20	STLAPT1D	31 35 40	272306	802235	103	91	1
21	STLAPT4D	10 36 37	272140	803741	80	60	1
22	STLAPT2D	09 35 39	272638	802609	143	80	1
22	APT2D4	09 35 39	272638	802609	143	80	1
23	APT4D3	10 36 37	272138	803741	80	60	1
	Martin County Water Quality						1
24	M1010	11 38 41	271109	801255	N/A	126	1
25	M1039		265822	800524	180	123	1
26	M1044	27 39 42	270320	800733	163	158	1
27	M1049	23 39 40	270331	801822	68	63	1
28	M1052	30 38 42	270820	801119	123	118	1
29	M1057	- 39 42	270543	800847	75	69	1
30	M1071	12 40 42	270002	800632	118	114	1
31	M1073	02 40 42	270117	800703	54	50	1
32	M1079	18 39 39	270507	802855	51	51	1
33	M1085	13 40 38	265915	802900	83	78	1
34	M1088	18 40 38	265938	803420	105	100	1
35	M1093	11 40 42	270028	800643	90	70	1
36	M1094	13 40 42	265942	800624	109	89	1
37	M1096	18 40 41	265920	801639	105	100	1
38	M1161	11 38 41	271109	801255	N/A	120	1
39	M1229	21 40 42	265845	800901	150	140	1
40	M1230	14 40 42	265906	800716	135	125	1
41	M1231	28 40 41	265726	801420	115	105	1
42	M1235	27 39 41	270238	801352	115	105	1
43	M1236	22 39 40	270429	801909	115	105	1
44	M1237	16 39 39	270427	802601	115	105	1
45	M1238	04 39 39	270650	802601	90	80	1

TABLE A-6. Well Completion Data from the SFWMD's Network of Monitor Wells Completed in the Production Zone (Surficial Aquifer System) (Continued)

Map	Well	Location	Coordinates		Total	Casing	Source
#	Name	S/T/R	Latitude	Longitude	Depth (ft.)	Depth (ft.)	#
46	M1239	23 39 40	270331	801822	107	97	1
47	M1240	06 38 39	271217	802853	100	90	1
48	M1243	09 40 39	270028	802654	58	48	1
49	M1245	36 39 39	270210	802355	96	86	1
50	M1247	04 38 40	271215	802008	110	100	1
51	M1248	01 38 39	271217	802328	60	50	1
52	M1251	33 38 37	270750	803803	85	75	1
53	M1252	32 39 38	270152	803305	88	78	1
54	M1253	34 38 41	270720	801402	111	102	1
55	M1254	22 37 41	271444	801411	105	95	1
55A	M1281	5 40 42	270134	800955	64	59	1
55B	M1282	10 39 41	270536	801343	85	60	1
55C	M1283	25 39 40	270246	801758	70	30	1
	Palm Beach County Water Quality						
56	PB789	02 41 42	265550	800718	113	112	2
57	PB880	17 41 42	265439	801029	90	118	2
58	PB928	10 41 42	265508	800833	115	110	2
59	PB1547	03 41 41	265606	801355	115	75	2
60	PB1548	03 41 41	265606	801355	60	20	2
61	PB1552	16 41 41	265443	801520	100	90	2
62	PB1613	14 41 39	265426	802415	120	110	2
63	PB1649	06 41 42	265609	801034		165	2
65	PB-0715		265114	801731	81		2
	Okeechobee County Water Qaulity						
64	OKS55		272656	804407	120		3
66	OKS30		271830	804935	230		3

Legend

Reference #	Reference
1	SFWMD., 1989 Ground Water Monitoring Network
2	SFWMD., 1993 Data Base
3	Bradner, L.A., 1993

TABLE A-7. Results of Water Quality Analyses from the SFWMD's Network of Monitor Wells Completed in the Upper Floridan Aquifer

Well name	date sampled	Na mg/l	K mg/l	Ca mg/l	Mg mg/l	Cl- mg/l	SO4 mg/l	HCO3 mg/l	Alk mg/l	Fl mg/l	SiO2 mg/l	Tot Fe mg/l	TDis Fe mg/l	TDS mg/l	Color units	Sp.Cond. umhos/cm	Temp degrees F	Hardness CaCo3	% Error
	Indian River County Water Quality																		
IR40	MAY 29 90	176.0	8.1	66.5	40.0	351.3	112.7	175.4	143.8	1.0	16.5	<.05	<.05	851.0	2.0	1572.0	76.5	330.8	1.1
IR312	MAY 29 90	149.3	13.8	37.3	49.0	243.0	110.8	201.1	164.8	1.3	25.3	<.05	<.05	703.0	2.0	1292.0	74.5	294.9	0.8
IR313	MAY 29 90	113.0	10.0	39.1	40.9	188.4	85.4	194.1	159.1	1.3	25.2	<.05	<.05	598.0	2.0	1066.0	75.9	266.1	0.8
IR368	MAY 29 90	174.7	11.5	27.9	27.9	131.3	163.8	253.0	207.4	1.4	23.3	0.53	<.05	687.0	5.0	1127.0	81.9	184.5	1.1
IR370	MAY 22 90	187.9	7.1	70.5	49.4	359.3	109.3	202.0	165.6	4.3	17.4	<.05	<.05	932.0	4.0	1854.0		379.5	0.5
IR373	MAY 22 90	108.0	5.4	59.0	41.2	217.2	101.5	194.5	159.4	4.4	18.7	1.10	0.14	645.0	8.0	1142.0	72.3	317.0	0.5
	Martin County Water Quality																		
MF2	MAY 18 90	561.0		113.3	88.0	1034.4	205.7	158.2	129.7	1.1	15.8	<.05	<.05	2177.0	2.0	3920.0	82.0	645.3	
MF3	MAY 31 90	611.0	25.4	58.9	93.4	1048.1	198.1	126.4	103.6	1.0	12.2	2.29	0.16	2153.0	5.0	3750.0	75.4	531.7	1.6
MF9	MAY 30 90	642.0	20.5	126.1	99.8	1287.9	217.7	153.6	125.9	0.7	16.1	<.05	<.05	2514.0	5.0	4280.0	85.6	725.9	0.3
MF23	MAY 17 90	207.4		62.8	57.7	363.1	185.8	144.4	118.4	1.2	15.4	0.08	<.05	1025.0	3.0	1760.0		394.4	
MF31	MAY 31 90	586.0	26.8	80.4	80.1	1002.4	203.3	210.6	172.6	1.1	16.8	<.05	<.05	2106.0	1.0	3620.0		530.6	0.7
MF35	MAY 17 90	556.8		100.1	88.7	1044.8	190.8	162.0	132.8	0.7	15.5	0.07	<.05	2132.0		3870.0		615.2	
MF51	MAY 17 90	864.7		129.5	126.1	1404.4	133.9	163.4	133.9	1.2	15.2	1.02	0.53	3120.9	18.0	5600.0		842.6	
MF54	MAY 31 90	573.0	23.4	88.2	91.6	1005.3	228.6	190.6	156.2	1.0	15.5	0.06	<.05	2156.0	1.0	3710.0	72.0	597.4	1.0
	Okeechobee Water Quality																		
OKF3	MAY 17 90	623.5	25.5	85.9	89.2	1063.2	271.8	138.3	113.4	1.3	16.5	0.32	0.19	2321.0	9.0	4050.0			1.1
OKF5	JUN 27 88	92.4		41.7	34.3	107.8	186.2		111.5	1.0		<.03		574.0		913.0		245.0	
OKF7	JUL 15 87	28.2		69.5	9.5	20.0	<5.0		251.1	0.6		0.6				532.0		212.5	
OKF13	JUN 27 88	276.8		103.9	64.3	588.3	205.7		119.6	0.8		<.05		1364.0		2330.0		524.1	
OKF23	MAY 17 90	202.4	8.8	60.2	45.7	321.9	202.5	129.3	106.0	3.0	16.1	<.05	<.05	40.0	2.0	1641.0		338.5	0.9
OKF31	MAY 17 90	1196.3		223.5	171.2	2305.9	607.9	73.7	60.4	1.0	13.2	1.74	0.42	4520.0	18.0	7560.0		1263.1	
OKF71	MAY 22 90	483.9	13.3	165.0	93.5	905.3	317.3	130.1	106.6	5.3	17.1	<.05	<.05	2213.0	4.0	3900.0		797.0	2.5
OKF72	MAY 22 90	198.3	9.5	67.4	55.9	357.6	146.3	188.1	154.2	6.3	19.3	<.05	<.05	989.0	5.0	1732.0		398.5	1.2
OKF73	MAY 18 90	1336.5		219.0	188.5	2626.0	652.9	104.6	85.7	1.1	13.5	0.55	0.42	5170.0	36.0	8410.0		1323.0	
OKF74	MAY 18 90	1039.8		218.2	160.5	2088.6	648.5	109.4	89.7	1.2	14.5	0.18	0.13	4186.0	10.0	6940.0		1205.8	
	Palm Beach County Water Quality																		
PBF-1	MAY 31 90	795.3	31.3	51.8	103.0	1489.1	226.6	64.7	53.0	0.9	1.9	0.57	<.05	2600.0	1.0	4600.0	73.9	553.4	0.7
PB212	OCT 1 40			140.0	181.0	2400.0	481.0		153.0					4650.0	5.0	810.0		1094.0	
PB216	JUL 1 74			65.0	94.0	1600.0	430.0		187.0					3390.0	7.0	5100.0		550.0	
PB407	OCT 9 41			127.0	161.0	2110.0	449.0		159.0					4150.0	5.0	7260.0		979.0	
PB747	JUN 6 74					1800.0								4060.0					
SWA DM	JAN 8 93					2325.0								4465.0		7700.0			
SEACST	DEC 1 91					3188.0								5926.0		10190.0			
PRATT	MAR 1 93					1810.0	240.0							3720.0		5550.0			
ENCON						1400.0								3280.0					
WPB IW6						3874.0								7388.0					
	St. Lucie County Water Quality																		
SLF3	MAY 23 90	455.3	14.8	113.1	88.8	940.6	147.9	163.7	134.2	4.5	15.5	0.06	0.06	1893.0	5.0	3450.0	79	648.1	0.7
SLF4	MAY 23 90	440.0	14.8	119.1	86.5	902.1	156.3	164.5	134.8	1.1	15.5	0.15	0.10	1858.0	6.0	3390.0	77	653.5	1.1
SLF9	AUG 15 88			149.0	113.2				128.1	0.8		0.06		3247.1		4860.0		837.8	
SLF11	MAY 24 90	352.7	11.1	114.5	73.8	690.4	200.4	166.7	136.6	5.5	16.3	<.05	<.05	1648.0	3.0	2830.0	78.4	589.8	1.2

TABLE A-7. Results of Water Quality Analyses from the SFWMD's Network of Monitor Wells Completed in the Upper Floridan Aquifer (Continued)

Well	date	Na	K	Ca	Mg	Cl-	SO4	HCO3	Alk	Fl	SiO2	Tot Fe	TDis Fe	TDS	Color	Sp.Cond.	Temp	Hardness	% Error
name	sampled	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	units	umhos/cm	degree F	CaCo3	
SLF17	MAY 23 90	365.0	12.7	99.3	71.7	712.7	204.8	161.5	132.4	1.2	16.6	<.05	<.05	1575.0	2.0	1977.0	80.2	543.0	0.1
SLF21	MAY 23 90	174.6	9.9	52.3	46.2	295.1	128.6	196.3	160.9	1.1	19.2	0.27	0.22	798.0	7.0	1458.0	74.1	320.8	0.3
SLF23	MAY 30 90	627.0	20.9	127.8	101.4	1294.9	204.5	174.2	142.8	0.9	16.3	0.54	<.05	2437.0	3.0	1940.0	86.4	736.6	0.7
SLF27	MAY 23 90	493.2	13.1	141.4	99.2	1074.6	144.2	155.4	127.4	3.7	16.3	0.05	<.05	2224.0	5.0	3870.0	80.4	761.2	0.9
SLF36	MAY 30 90	438.6	13.7	121.5	82.0	811.1	149.3	166.0	136.1	0.9	17.2	0.20	<.05	1851.0	5.0	3220.0	78.8	641.1	3.3
SLF40	MAY 23 90	372.0	11.9	111.8	75.3	782.3	145.4	167.9	137.6	5.4	16.2	<.05	<.05	1640.0	3.0	2970.0	75.2	589.3	0.4
SLF47	MAY 31 90	169.5	14.4	34.7	37.0	242.7	125.1	190.4	156.1	1.4	21.1	<.05	<.05	713.0	1.0	1239.0	74.7	239.0	0.1
SLF49	AUG 31 87			132.0	86.6				133.4	0.8								686.2	
SLF50	MAY 23 90	237.3	10.1	34.3	46.6	430.5	83.4	116.1	95.2	4.9	4.5	0.26	<.05	911.0	4.0	1719.0	71.6	277.4	0.6
SLF61	MAY 25 90	599.5	21.0	132.5	99.6	1307.8	186.1	159.6	130.8	1.2	16.4	0.09	<.05	2334.0	3.0	4340.0	78.1	741.0	1.3
SLF62	MAY 25 90	589.5	21.1	120.0	98.8	1214.7	186.3	167.0	136.9	2.6	16.0	0.09	<.05	2251.0	3.0	4150.0	69.8	706.5	0.4
SLF63	MAY 30 90	657.8	17.4	152.5	107.2	1290.4	209.6	157.9	129.4	0.9	18.1	0.05	<.05	2544.0	2.0	4390.0	78.8	822.2	1.3
SLF64	MAY 30 90	742.7	21.2	206.5	122.3	1317.0	405.7	139.6	114.4	0.9	15.8	0.32	0.21	3000.0	11.0	5060.0	79.9	1019.3	31.0
SLF65	MAY 30 90	598.5	16.8	181.0	101.0	1332.7	336.6	128.2	105.1	0.9	16.3	0.20	0.12	2602.0	9.0	4210.0	81.1	867.8	1.7
SLF67	MAY 24 90	176.1	7.7	75.1	50.6	337.4	170.5	154.5	126.6	4.7	16.7	<.05	<.05	903.0	1.0	1622.0	81.0	395.8	0.5
SLF68	MAY 24 90	163.3	7.4	75.3	50.9	318.0	175.4	159.2	130.5	1.2	18.2	<.05	<.05	922.0	4.0	1618.0	80.4	397.4	0.2
SLF69	MAY 23 90	344.9	12.2	90.0	70.7	678.7	134.0	175.8	144.1	5.0	16.2	<.05	<.05	1420.0	1.0	1990.0	77.4	515.8	0.9
SLF70	MAY 23 90	189.9	9.6	57.9	50.8	335.7	124.5	189.0	154.9	6.0	20.6	<.05	<.05	903.0	3.0	1611.0	78.1	353.7	0.9
SLF71	MAY 31 90	801.3	31.5	68.4	93.9	1282.3	412.3	214.5	175.8	1.4	16.6	<.05	<.05	2774.0	1.0	4550.0	73.4	557.5	0.7

TABLE A-8. Well Completion Data from the SFWMD's Network of Monitor Wells Completed in the Upper Floridan Aquifer

Well Name	Location S/T/R	Coordinates Latitude	Longitude	Total Depth (ft.)	Casing Depth (ft.)	Reference #
Indian River County Water Quality						
IR40		273536	802402	704		1
IR312	27 33 39	273435	802551	568	120	1
IR313	34 32 39	273846	802547			1
IR368	31 33 40	273354	802208			1
IR370	29 33 38	273427	803324		300	1
IR373	03 33 37	273812	803747			1
Martin County Water Quality						
MF2	23 38 38	270935	803009		300	1
MF3	31 38 42	271249	801044	980	543	1
MF9	17 38 39	271014	802800	680	342	1
MF23	18 39 38	270425	803347	1119	456	1
MF31	19 38 42	270856	801025	1091	844	2
MF33		270742	803528			2
MF35	07 40 39	270010	802900	1250	400	1
MF51	24 39 39	270344	802312	1250	400	1
MF54	17 38 42	271034	801012	1111	300	1
Okeechobee Water Quality						
OKF3	02 38 36	271140	804222	1300	700	2
OKF5		271855	804825	1181	440	2
OKF7		272158	804709	963	412	2
OKF13		273043	804400	1200	600	2
OKF15		271934	805913			2
OKF17		272010	805508			2
OKF23	17 37 35	271514	805116	925	496	2
OKF31	28 37 35	271343	805040	1079		2
OKF71	16 34 36	273120	804430	800	500	1
OKF72	21 34 36	273030	804405	800	500	1
OKF73	23 36 35	271900	804824	1000	500	1
OKF74	25 36 35	271804	804714	1000	500	1
Palm Beach County Water Quality						
PBF-1	30 40 43	265811	800516	1038	250	1
PB212	27 43 43	264244	800323	1080	997	3
PB216	30 42 43	264618	800545	1000		3
PB407	27 43 43	264259	800320	1035		3
PB747		265604	800826	1265		3
SWA DMW1	27 42 43	264600	800845	1871		4
SEACST	11 41 43	265118	800755	1103	995	5
PRATT		265405	801823	1237		6
ENCON				955		7
WPB IW6	21 43 43	264254	800349	973		7
St. Lucie County Water Quality						
SLF3	21 34 39	273000	802613	1106	310	1
SLF4	36 34 39	272822	802904	993	482	1
SLF9		272650	803528	1058	256	2
SLF11	12 34 37	273216	803500	946	224	1
SLF17	19 36 38	271927	803415	1286	320	1
SLF21	14 35 39	272536	802409	800	300	2
SLF23	13 37 39	271311	802811	894	350	1
SLF27	35 35 38	272319	803048	900		1
SLF36	03 35 38	272747	803054			1
SLF40	24 35 38	272503	802957			1
SLF47	22 36 41	271938	801352	1000	200	2
SLF49		272019	802955	893		2
SLF50	22 36 41	272016	802953	775	600	1

TABLE A-8. Well Completion Data from the SFWMD's Network of Monitor Wells Completed in the Upper Floridan Aquifer (Continued)

Well	Location	Coordinates		Total	Casing	Reference
Name	S/T/R	Latitude	Longitude	Depth	Depth	#
SLF61	09 37 39	271604	802622	695	350	1
SLF62	06 37 39	271725	802810	935	480	1
SLF63	35 34 37	272853	803624	1040	250	1
SLF64	22 34 37	273044	803731	1080	246	1
SLF65	09 34 37	273213	803829	1020	240	1
SLF67	05 36 37	272230	803921			1
SLF68	11 35 36	272608	804149			1
SLF69	09 36 39	272146	802637	866	420	1
SLF70	11 34 39	273157	802413	638		1
SLF71	15 36 40	272055	801930	820		1

Legend

Number	References
1	SFWMD., 1989 Ground Water Monitoring Network
2	SFWMD., 1993 Data Base
3	Smith, Lidz, and Meyer, 1982 (USGS)
4	Palm Beach Solid Waste Authority, Injection Well, 1993
5	Seacoast Utilities, Injection Well, 1992
6	United Technologies, Injection Well , 1993
7	West Palm Beach Water Plant, Injection Well, 1993

TABLE A-9. Well and Water Quality Data from the SFWMD's Floridan Aquifer Well Abandonment Program

	FLORIDA STATE PLANAR COORDINATES								
								Casing	Approx.
	X	Y	Total Depth	Cond.	Cl-	Temp	Flow	Dia.	G.L.
NAME	ft.	ft.	ft.	m.s.	mg/l	deg.F	GPM	in.	NGVD
WA-547	635843	1109508	820	2870		80.6	20	6	25
WA-565	697021	1078759	763	3610	894	83.0	170	6	25
WA-582	690777	1082768	930	2913	739	80.0	130	6	25
WA-612	693638	1069251	870	1590	799	79.6	75	5	20
WA-611	701918	1073633	750	3582	940	79.2	25	6	20
WA-615	695629	1068048	970	4580	880	78.2	100	6	20
WA-625	715418	1046034	1012	4060	1010	81.6	50	4	20
WA-699	699517	1121486	900	1910	420	79.0	600	6	25
WA-708	715616	1127527	920	1496	708	75.0	125	4	10
WA-727	681817	1169470	1000	6010	1770	84.6	2430	10	20
WA-815	718920	1133099	995	2982	530	79.0	600	8	5
WA-820	681712	1112819	922	1260	420	79.6	254	8	20
WA-823	664197	1141826	640	1280	350	82.0	135	4	20
WA-825	702475	1124530	670	1390	250	80.0	360	3	16
WA-826	663853	1137987	814	3230	870	82.9	249	5	20
WA-827	606769	1127698	830	1510	870	81.0	153	4	25
WA-829	674420	1089763	741	3050	967	84.0	360	5	20
WA-875	663214	1117587	704	2080	510	81.0	95	4	20
WA-878	648530	1115814	766	3050	811	82.0	1000	10	20
WA-887	704887	1128784	894	1450	214	78.0	243	5	17
WA-100	672933	1100158	888	3710	726	82.0	258	5	15
WA-100	668690	1101352	830	2975	885	82.0	217	4	20
WA-100	695779	1148834	904	2168	492	79.2	221	5	20
WA-101	680298	1106451	876	2838	695	82.0	425	8	20
WA-103	693006	1163564	686	1935	283	79.0	135	4	20
WA-103	728097	1151125	1020	6270	1734	76.5	250	5.5	20
WA-103	694281	1160541	740	1990	367	78.1	219	4	20
WA-108	628231	1065255	1324	4558	1098	85.0	571	7	25
WA-108	672844	1120959	646	612	275	76.8	156	4	20
WA-108	666933	1111846	784	1780	375	79.8	124	4	20
WA-108	671903	1109141	624	2046	435	79.4	202	4	20
WA-110	616134	1129642	636	2012	410	78.8	164	5	26
WA-111	719842	1096043	820	3752	920	74.6	246	5	13
WA-113	701631	1131292	923	2000	420	78.0	320	5.5	20
WA-113	661167	1111116	674	3110	775	78.0	100	4	20
WA-113	693411	1154377	987	2764	665	81.0	478	8	20
WA-111	617795	1116419	1108	4500	1125	83.0	110	6	25
WA-111	612108	1119533	673	2052	410	80.4	50	5	25
WA-114	663896	1104967	792	4500	1188	83.0	126	4	20
WA-114	690791	1156081	823	1984	468	79.0	209	4	20
WA-114	688502	1144962	891	2347	538	79.0	245	5	20
WA-114	638282	1081546	891	2080	403	82.0	184	5	25
WA-115	678998	1115028	840	3218	742	81.8	161	4	20
WA-117	632262	1074457	750	1512	325	77.7	150	4	5
WA-118	716989	1140258	824	1928	330	76.6	500	6	10
WA-119	651586	1045645	950	3138	778	82.1	1000	8	30
SLF-5	673614	1151257	1227	3680		79.5		12	25
SLF-6	693308	1119537	596	1518		77.5		3	20
SLF-9	632615	1131915	1058	3880	1500	81.5			25
SLF-20	604518	1127187	896	1465		83.3			29
SLF-31	695810	1067948	1008	2579		82.0			25
SLF-42	722662	1156952	1060	3900		76.2		6	5
SLF-44	754882	1073628	876	2712		76.0	500	6	5
SLF-45	721463	1162095	1100	4310		75.8		6	5
SLF-46	724669	1152217	1100	3754		75.8	100	6	5
SLF-53	647734	1130958	906		1000	82.0	500	10	25
FB-1	709923	1130728	904	630	320			12	20
SPSLI	727706	1060642	3500	4500	1500				15?

TABLE A-9. **Well and Water Quality Data from the SFWMD's Floridan Aquifer Well Abandonment Program (Continued)**

WELL NAME	X ft.	Y ft.	Total Depth ft.	Cond. m.s.	Cl- mg/l	Temp deg.F	Flow GPM	Casing Dia. in.	Approx. G.L. NGVD
M-29	617428	1025035	1100	3325	750	77.9			
M-43	721235	1022234	800	4800	1400	77.0		4	
M-148	638974	1011067	1155	2660	600	80.6		5	
M-150	757829	1007099	1315	13300	4200	76.1		6	
M-169	637750	1025502	1080	2000	420	81.5		5	
M-170	639663	1021066	1080	2400	540	81.5		5	
M-173	641166	1004309	1080	2180	470	79.7		5	
M-186	667668	1042982	843	4240	1200	75.2		5	
M-254	661822	1014382	840	4540	1150	82.4		5	
M-255	662583	1027512	800	5200	1000	84.2		6	
M-306	756306	1005070	1170	12000	3500	76.1		6	
M-741	727420	998437	890	6550	1850	75.2		6	
M-758	681041	1040919	835	4700	1250	86.9		6	
M-759	677158	1041003	853	4710	1250	88.7		6	
M-919	645153	975848	950	4025	1100	77.9		8	
M-931	712220	1035919	900	4100	950	80.6		6	
M-1077	623117	1025556	1200	2340	690	83.3			
M-2000	710668	986634		6000	1700	77.0		8	
M-2001	668330	969979		5300	1500	70.7		8	
M-2002	668255	966142		5900	1650	70.7		8	
M-2003	717126	962332		2825	780	72.5		10	
M-2004	668288	958064		4550	1180	77.0		10	
M-2006	657466	972461		3875	1050	67.1		10	
M-2007	657658	969432		2575	640	68.9		10	
M-2009	657679	963980		2800	690	70.7		10	
M-2012	689264	981178		4250	1150	74.3		10	
M-2013	699769	996475		4300	1150	70.7		10	
M-2015	699730	986074		5000	1400	68.9		10	
M-2017	708084	996920		5650	1500	76.1		10	
M-2018	708093	995103		5700	1550	78.8		10	
M-2019	708116	990660		5650	1550			10	
M-2021	678984	995167		5600	1550			10	
M-2022	681696	995179		4950	1350	76.1			
M-2024	631835	1011043		2175	490	73.4		12	
M-2025	631199	1012253		2875	690	82.4			
M-2028	661912	991663		5200	1400	71.6		10	

References

WA:	Well Abandonment Program Database, SFWMD, 1989.
SLF:	SFWMD Research Well, 1990.
FB-1:	Ft. Pierce FAS Blending Well
SPSLI:	South Port St. Lucie Injection Well, 1990
M-29 to M-931:	Lichler, 1960
M-1077 to M-2025:	USGS Stuart Office, Unpublished 1990

APPENDIX B

STATISTICAL SUMMARIES OF SAMPLE VARIANCE

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STATISTICAL VARIANCE OF GROUND WATER SAMPLE POPULATIONS

METHODS USED TO DESCRIBE SAMPLE POPULATIONS

The SFWMD's monitor well network and selected Palm Beach County wells were used in the statistical analyses since these wells are spatially distributed equally among the four counties in the study area. These two data sources comprise what is herein referred to as the "sample population".

SALT wells were excluded from the sample population because their locations are clustered in three coastal areas and their existence is primarily for the purpose of detecting intruding salt water from the ocean. Following the same logic, UFA wells from the Well Abandonment (WA) program were also left out of the statistical summaries because all WA wells are located in St. Lucie County citrus groves. Their inclusion in the statistical summary would bias the outcome toward a reflection of central St. Lucie County ground water characteristics rather than the entire study area.

A statistics software package (Statgraphics) was used to generate frequency histograms, box and whisker plots, and summary statistics which, in turn, were used to describe the distribution (among the sample population) of TDS, chloride and sulfate concentrations as well as specific conductance of sampled ground water. Ground water samples were collected from wells completed to the two SAS zones (sand/soil and production) and the UFA throughout the study area.

For any given parameter (i.e. chloride concentration), frequency histograms illustrate the percent of sample population which falls within a specific range of values. The frequency, in percent of sample population (y axis), is plotted against individual parameter values (i.e. conductance, TDS, etc.) along the x-axis, as seen in Figure B-1. The vertical bars in the graph illustrate the percent sample population with values between the ranges defined on the x axis (i.e., 54 % of the ground water samples from the SAS sand/soil zone had concentrations of chlorides between 0-50 mg/l). The dashed curve plotted over the frequency distribution represents how well the frequency fits a normal distribution for each sample set. In all cases, the distribution is skewed to the right which is typical for most ground water data (Helsel, 1992). Statistical summaries include skewness, kurtosis, standard deviation, mean, median, etc.

Standard box plots were also constructed and are inset within each frequency histogram. Boxplots were developed to further illustrate the sample distribution for each parameter. The box plots consist of a center line (the median) splitting a rectangle defined by left and right hinges which represent the 25th and 75th population percentile, respectively. The whiskers are lines drawn one step beyond the ends of the box. A step equals 1.5 times the width of the box (1.5 times the interquartile range). Sample values between one to two steps from the box in either direction, if present, are plotted individually with square dots ("outside values"). Observations farther than two steps beyond the box, if present, are distinguished by pluses (+) and represent "far-out values". The occurrence of outside or far-out values more frequently than expected gives a quick visual indication that the data may not originate from a normal distribution (Helsel, 1992). The median is represented by a plus (+) if it occurs within the box, and as a vertical slash along the whisker (I) if it occurs outside the box.

RESULTS OF STATISTICAL ANALYSES

The results of the statistical analyses of sample variance is presented below for each aquifer/zone by parameter. Results are given as statistical summaries of sample variance along with frequency histograms and box plots.

Sand/Soil Zone

Chloride (Cl^-) Concentrations. Chloride (Cl^-) concentrations sampled in the sand/soil zone ranged from 1.1 mg/l to 736.9 mg/l. The mean and median were 82 mg/l and 43 mg/l, respectively. The large difference between the mean and median implies that the distribution is skewed to the right of a normal distribution. A statistical summary,based on the distribution curve, and the frequency diagram are provided in Table B-1 and Figure B-1, respectively. The frequency histogram and box and whisker plot show that 54% of the sample population had chloride concentrations between 0 and 50 mg/l, and 32% between 50 mg/l and 100 mg/l. Approximately 10% of the population, defined as outliers on the box and whisker plot, had concentrations between 150 mg/l and 760 mg/l.

Total Dissolved Solids (TDS) Concentrations. TDS concentrations sampled from the sand/soil zone ranged between 10 mg/l to 2,063 mg/l. The mean and median of the sample population was 392 mg/l and 311 mg/l, respectively (Table B-2). The frequency histogram and box and whisker plot (Figure B-2) show that approximately 70% of the sample population had TDS concentrations between 0 and 400 mg/l, and approximately 20% were between 400 mg/l and 800 mg/l. Approximately 10% of the population, defined as outliers on the box and whisker plot, had concentrations between 810 mg/l and 2,100 mg/l.

Specific Conductance. Specific conductance of water sampled from the sand/soil zone ranged from 75 umhos/cm to 3,090 umhos/cm in the study area. The mean and median of that sample population were 649 umhos/cm and 537 umhos/cm, respectively (Table B-3). The frequency histogram and box and whisker plot (Figure B-3) illustrate that approximately 40% of the sample population had specific conductance values between 0 and 400 umhos/cm, and approximately 48% were between 400 umhos/cm and 1,000 umhos/cm. Approximately 12% of the population had concentrations between 1,000 umhos/cm and 3,100 umhos/cm.

Dissolved Sulfate (SO_4^-) Concentrations. The minimum and maximum sulfate concentrations in the sample population were 2.0 mg/l and 478 mg/l, respectively. The mean and median were 36 mg/l and 9 mg/l, respectively (Table B-4). The frequency histogram and box and whisker plot (Figure B-4) show that approximately 76% of the sample population had dissolved sulfate concentrations between 0-25 mg/l, and approximately 15% between 25-60 mg/l. Approximately 10% of the sample population had concentrations between 60-480 mg/l.

Production Zone

Chloride (Cl^-) Concentrations. Concentrations of dissolved chlorides in the production zone ranged from 9 mg/l to 8,894 mg/l. The mean and median of the sample population were 292 mg/l and 64 mg/l, respectively (Table B-5). The frequency histogram and box and whisker plot (Figure B-5) show that 87% of the sample population had chloride concentrations between 0 and 50 mg/l, and 10% had values between 50 mg/l and 100 mg/l. Approximately 2% of the sample population had chloride concentrations between 150 mg/l and 200 mg/l, and 2% between 8,500 mg/l and 9,000 mg/l.

Total Dissolved Solids (TDS) Concentrations. Concentrations of TDS in the production zone ranged from 65 mg/l to 13,292 mg/l. The mean and median of the sample population were 840 mg/l and 424 mg/l, respectively (Table B-6). The frequency histogram and box and whisker plot (Figure B-6) show that approximately 80% of the samples had concentrations between 0 and 800 mg/l, and approximately 13% between 800 mg/l and 2,000 mg/l. Four outlier wells had concentrations between 3,000 mg/l and 13,000 mg/l.

Specific Conductance. Specific conductance of the sample population ranged between 106 umhos/cm to 7,340 umhos/cm. The mean and median were 1,108 umhos/cm and 702 umhos/cm, respectively (Table B-7). The frequency histogram and box and whisker plot (Figure B-7) show that approximately 79% of the sample population had specific conductance values between 0 and 1,000 umhos/cm, and 6% between 1,000-1,500 umhos/cm. Approximately 12% had measurements between 2,000-3,000 umhos/cm. Three outlier wells had specific conductance values of 5,000 umhos/cm, 5,500 umhos/cm, and 7,500 umhos/cm.

Dissolved Sulfate (SO_4^-) Concentrations. Concentrations of dissolved sulfates in the sample population ranged from 1.5 mg/l to 1,077 mg/l. The mean and median of the sample population were 81 mg/l and 5 mg/l, respectively (Table B-8). The frequency histogram and box and whisker plot (Figure B-8) show that 80% of the samples had concentrations between 0 and 80 mg/l, and approximately 8% had between 100 mg/l and 200 mg/l. Several outlier wells had concentrations ranging between 200 mg/l and 11,000 mg/l.

Upper Floridan Aquifer (UFA)

Chlorides (Cl^-) Concentrations. Chloride concentrations in the UFA ranged from 209 mg/l to 4,200 mg/l in the study area. The mean and median of the sample population were 1,237 mg/l and 1,150 mg/l, respectively (Table B-9). The frequency histogram and box and whisker plot (Figure B-9) show that approximately 1% of the sample population had chloride concentrations between 0 and 200 mg/l, 73% between 200 mg/l and 1,400 mg/l, and 15% between 1,400 mg/l and 1,800 mg/l. Another 8% of the population, defined by two outlier wells, had chloride concentrations between 1,800 mg/l and 4,200 mg/l.

Total Dissolved Solids (TDS) Concentrations. TDS concentrations in the UFA ranged from 449 mg/l to 7,388 mg/l in the study area. The mean and median were 2,528 mg/l and 2,224 mg/l, respectively (Table B-10). The frequency histogram and box and whisker plot (Figure B-10) show that approximately 2% of the sample population had concentrations below 500 mg/l, while 76% had concentrations between 500 mg/l and 3,000 mg/l. Another 17% of the sample population had between 3,000 mg/l to 4,500 mg/l while two (outlier) wells had concentrations of 6,000 mg/l and 7,000 mg/l.

Specific Conductance. Specific conductance of water ranged from 701 umhos/cm to 13,300 umhos/cm. The mean and median of the sample population were 4,103 umhos/cm and 4,062 umhos/cm, respectively (Table B-11). The frequency histogram and box and whisker plot (Figure B-11) show that approximately 6% of the samples had specific conductance values under 2,000 umhos/cm and approximately 85% between 2,000 umhos/cm and 6,000 umhos/cm. Another 4% of the population had between 9,200 umhos/cm and 13,000 umhos/cm.

Sulfate (SO_4^-) Concentrations. Sulfate concentrations ranged from 11 mg/l to 481 mg/l. The mean and median of the sample population were 222 mg/l and 198 mg/l, respectively (Table B-12). The frequency histogram and box and whisker plot (Figure B-12) show that approximately 75% of the samples had concentrations between 100 mg/l and 250 mg/l. One well was below 100 mg/l. Another 20% of the sample population, represented by five wells, had concentrations between 250 mg/l and 500 mg/l dissolved sulfates.

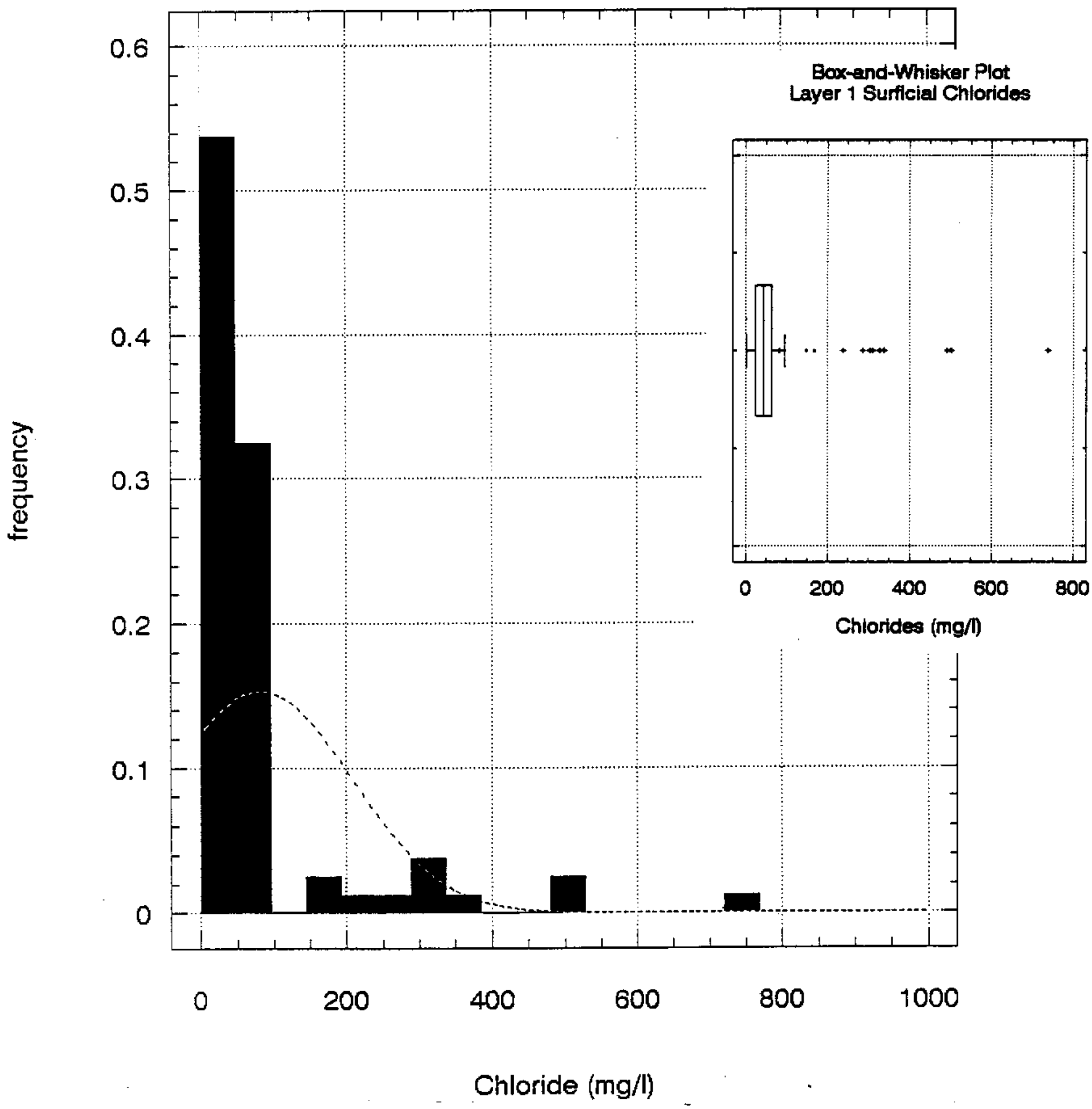

FIGURE B-1. Frequency Histogram and Box and Whisker Plot Showing Chloride Concentration Sample Variance from the SFWMD's Network of Wells Completed to the Sand/Soil Zone (Surficial Aquifer System)

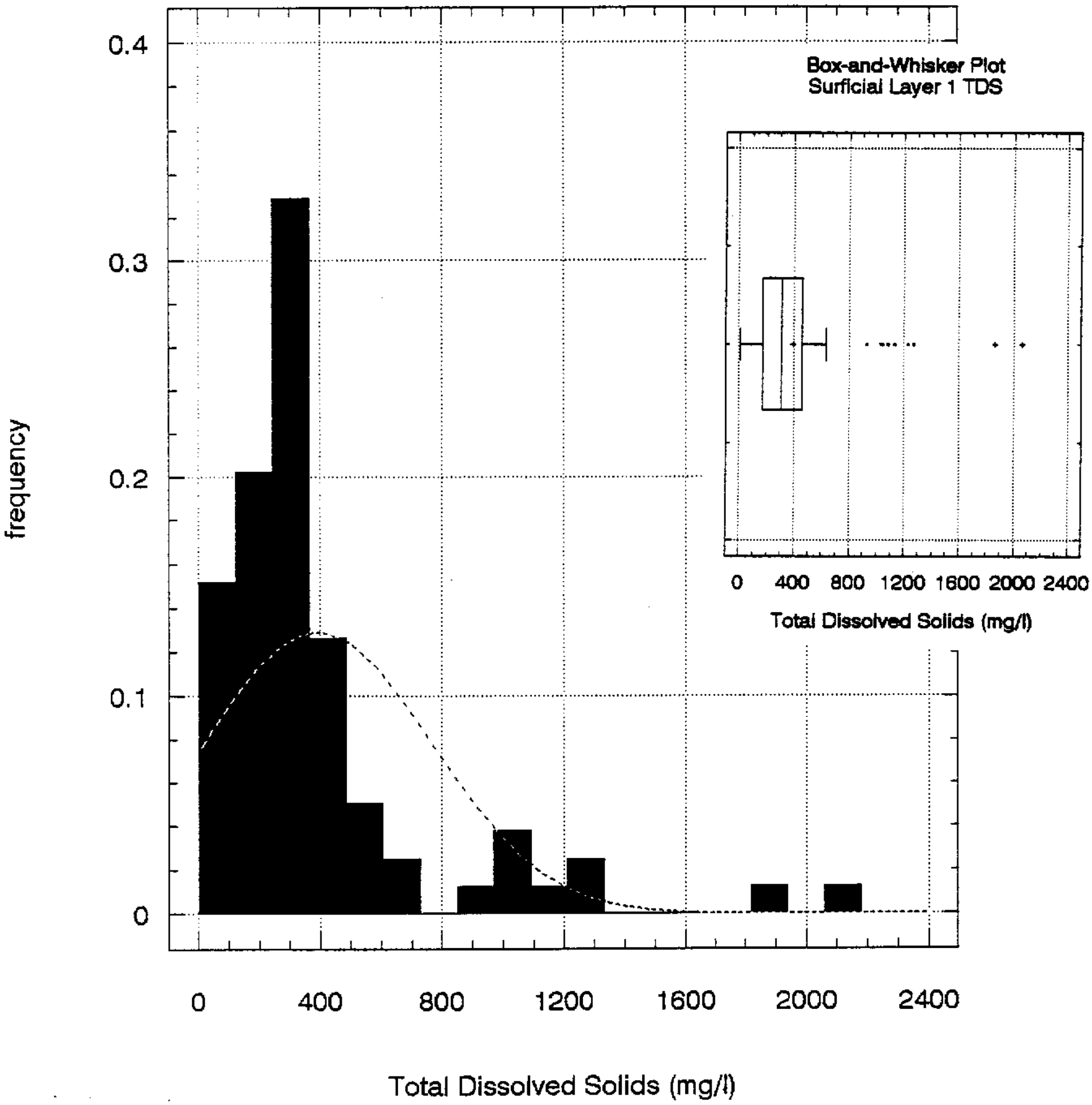

FIGURE B-2. Frequency Histogram and Box and Whisker Plot Showing Total Dissolved Solids Concentration Sample Variance from the SFWMD's Network of Wells Completed to the Sand/Soil Zone (Surficial Aquifer System)

TABLE B-1. Statistical Summary of Chloride Concentration Sample Variance from the SFWMD's Network of Wells Completed to the Sand/Soil Zone (Surficial Aquifer System)

Sample size	80.
Average	82.0375
Median	42.9
Mode	13.
Geometric mean	42.881652
Variance	15654.043386
Standard deviation	125.11612
Standard error	13.988407
Minimum	1.1
Maximum	736.9
Range	735.8
Lower quartile	22.55
Upper quartile	63.4
Interquartile range	40.85
Skewness	3.184116
Standardized skewness	11.626748
Kurtosis	11.302184
Standardized kurtosis	20.63487
Coeff. of variation	152.510888
Sum	6563.

TABLE B-2. Statistical Summary of Total Dissolved Solids Concentration Sample Variance from the SFWMD's Network of Wells Completed to the Sand/Soil Zone (Surficial Aquifer System)

Sample size	79.
Average	392.329114
Median	311.
Mode	320.
Geometric mean	277.808151
Variance	140515.81568
Standard deviation	374.854393
Standard error	42.174414
Minimum	10.
Maximum	2063.
Range	2053.
Lower quartile	169.1
Upper quartile	456.1
Interquartile range	287.
Skewness	2.49703
Standardized skewness	9.0607
Kurtosis	7.181195
Standardized kurtosis	13.028806
Coeff. of variation	95.545902
Sum	30994.

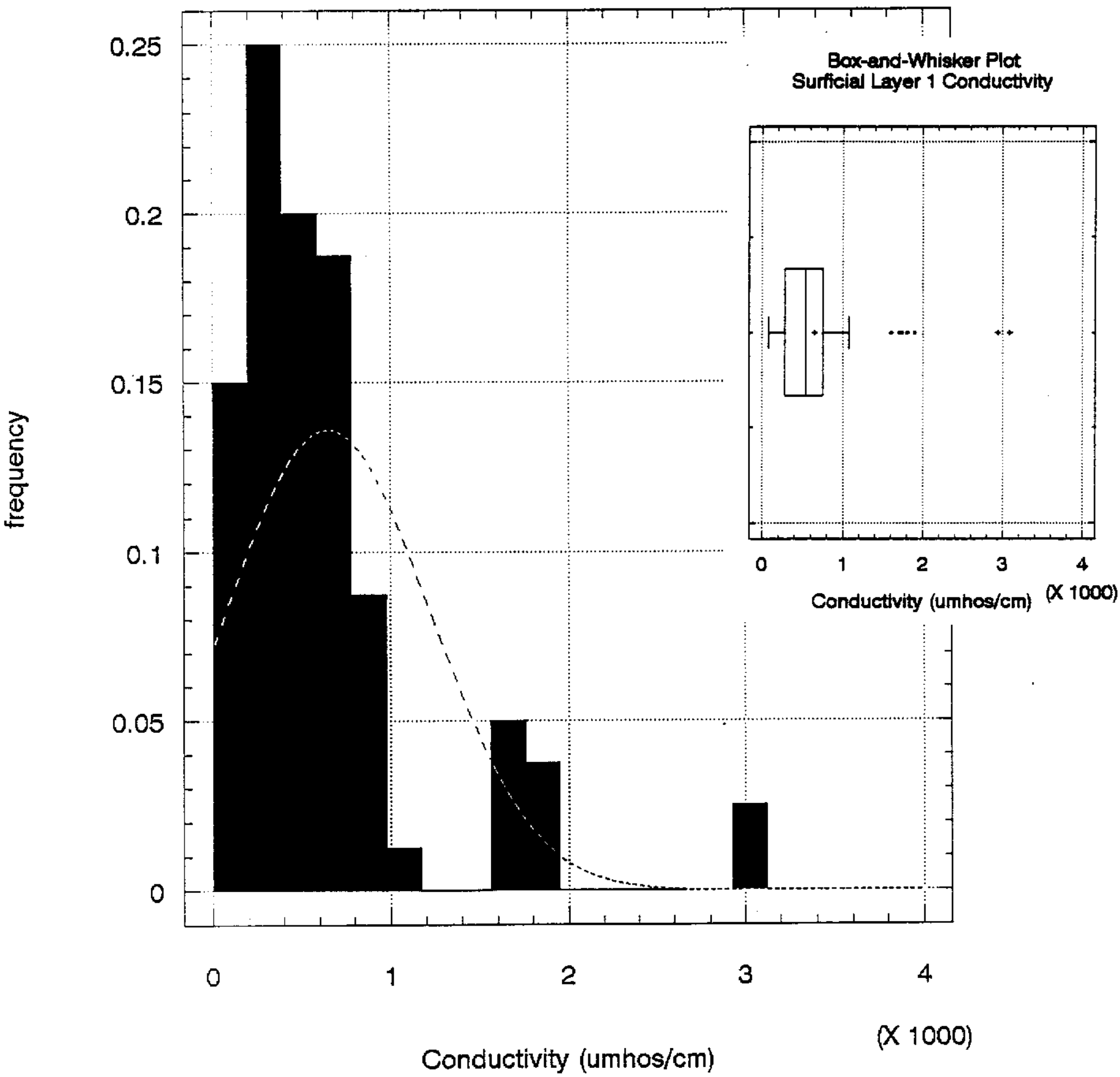

FIGURE B-3. **Frequency Histogram and Box and Whisker Plot Showing Specific Conductivity Sample Variance from the SFWMD's Network of Wells Completed to the Sand/Soil Zone (Surficial Aquifer System)**

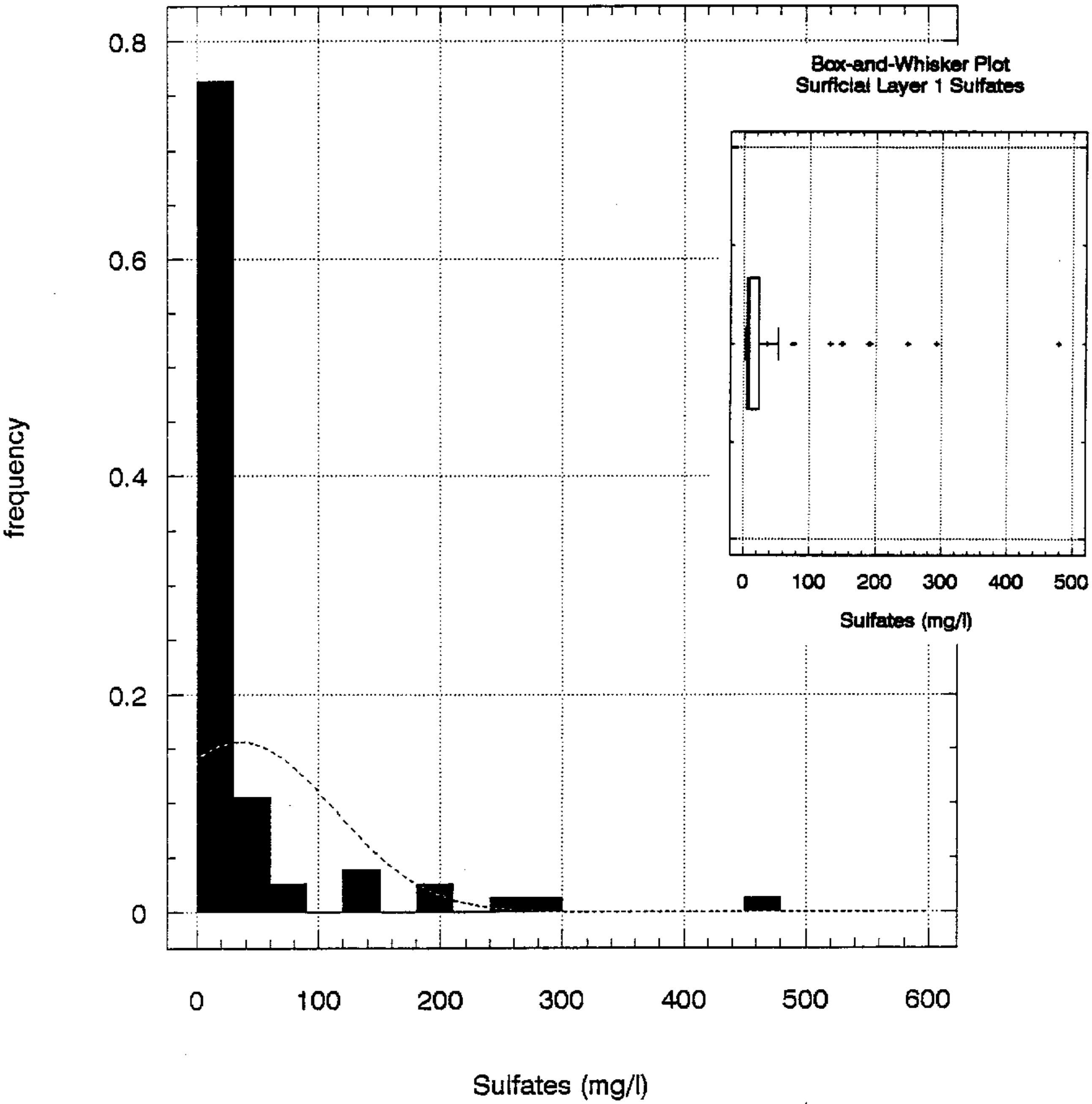

FIGURE B-4. Frequency Histogram and Box and Whisker Plot Showing Dissolved Sulfate Concentration Sample Variance from the SFWMD's Network of Wells Completed to the Sand/Soil Zone (Surficial Aquifer System)

TABLE B-3. Statistical Summary of Specific Conductivity Sample Variance from the SFWMD's Network of Wells Completed to the Sand/Soil Zone (Surficial Aquifer System)

Sample size	80.
Average	648.725
Median	537.
Mode	185.
Geometric mean	481.26189
Variance	328131.012025
Standard deviation	572.82721
Standard error	64.044029
Minimum	75.
Maximum	3090.
Range	3015.
Lower quartile	274.
Upper quartile	741.
Interquartile range	467.
Skewness	2.311577
Standardized skewness	8.440685
Kurtosis	6.329728
Standardized kurtosis	11.556449
Coeff. of variation	88.300468
Sum	51898.

TABLE B-4. Statistical Summary of Dissolved Sulfate Concentration Sample Variance from the SFWMD's Network of Wells Completed to the Sand/Soil Zone (Surficial Aquifer System)

Sample size	76.
Average	35.852632
Median	8.55
Mode	2.
Geometric mean	10.63201
Variance	5876.472926
Standard deviation	76.658156
Standard error	8.793294
Minimum	2.
Maximum	478.2
Range	476.2
Lower quartile	4.05
Upper quartile	23.45
Interquartile range	19.4
Skewness	3.728643
Standardized skewness	13.270339
Kurtosis	16.213224
Standardized kurtosis	28.851643
Coeff. of variation	213.814587
Sum	2724.8

TABLE B-5. Statistical Summary of Chloride Concentration Sample Variance from the SFWMD's Network of Wells Completed to the Production Zone (Surficial Aquifer System)

Sample size	70.
Average	291.522857
Median	63.5
Mode	22.6
Geometric mean	77.190636
Variance	1172236.851354
Standard deviation	1082.698874
Standard error	129.407267
Minimum	8.7
Maximum	8894.
Range	8885.3
Lower quartile	28.5
Upper quartile	128.9
Interquartile range	100.4
Skewness	7.524535
Standardized skewness	25.70118
Kurtosis	59.942475
Standardized kurtosis	102.371265
Coeff. of variation	371.394163
Sum	20406.6

TABLE B-6. Statistical Summary of Total Dissolved Solids Concentration Sample Variance from the SFWMD's Network of Wells Completed to the Production Zone (Surficial Aquifer System)

Sample size	68.
Average	840.005882
Median	424.
Mode	388.9
Geometric mean	481.144983
Variance	2917228.857577
Standard deviation	1707.989712
Standard error	207.124176
Minimum	65.
Maximum	13292.
Range	13227.
Lower quartile	299.5
Upper quartile	597.
Interquartile range	297.5
Skewness	6.159636
Standardized skewness	20.736426
Kurtosis	43.373976
Standardized kurtosis	73.00928
Coeff. of variation	203.330685
Sum	57120.4

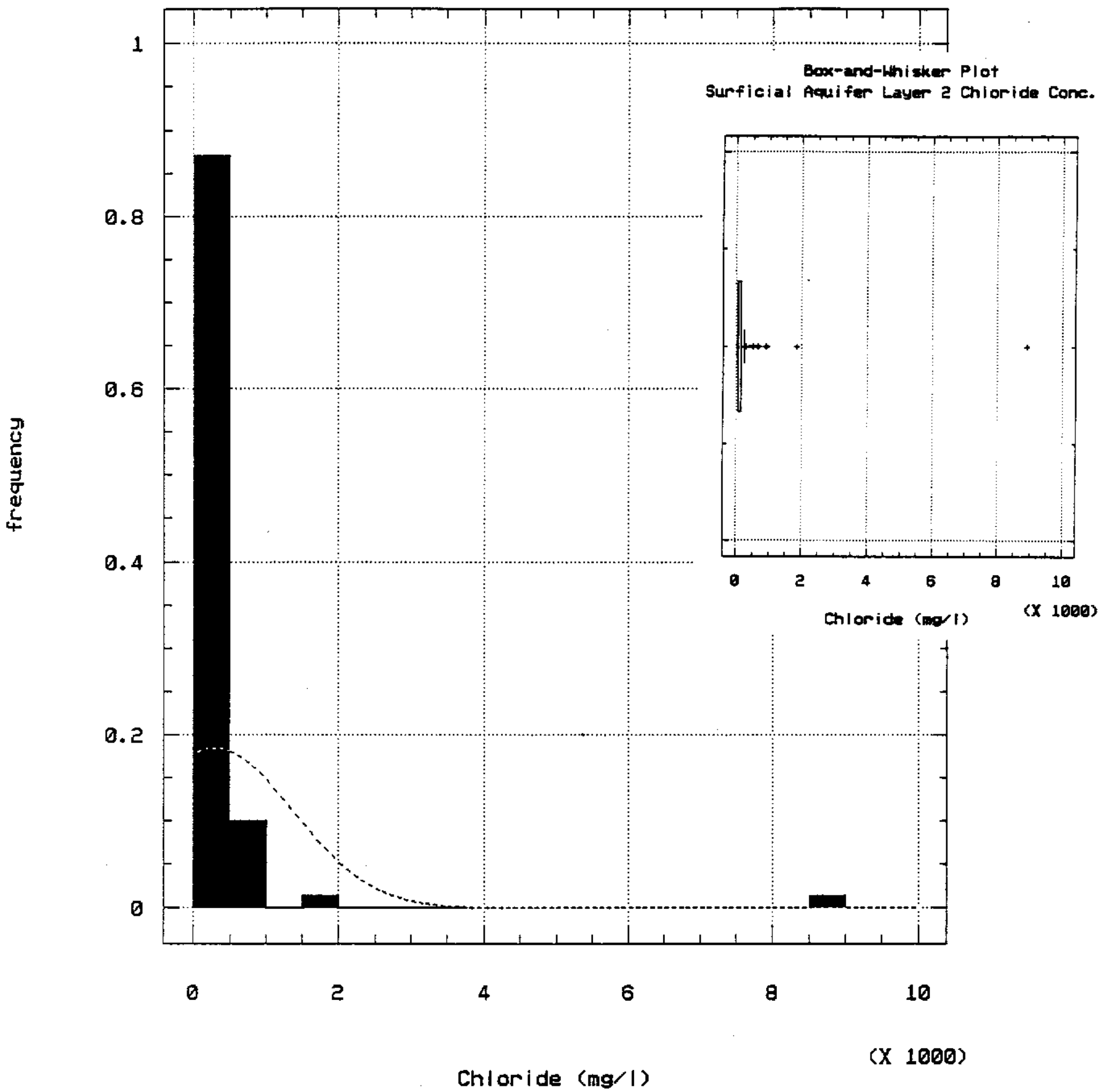

FIGURE B-5. Frequency Histogram and Box and Whisker Plot Showing Chloride Concentration Sample Variance from the SFWMD's Network of Wells Completed to the Production Zone (Surficial Aquifer System)

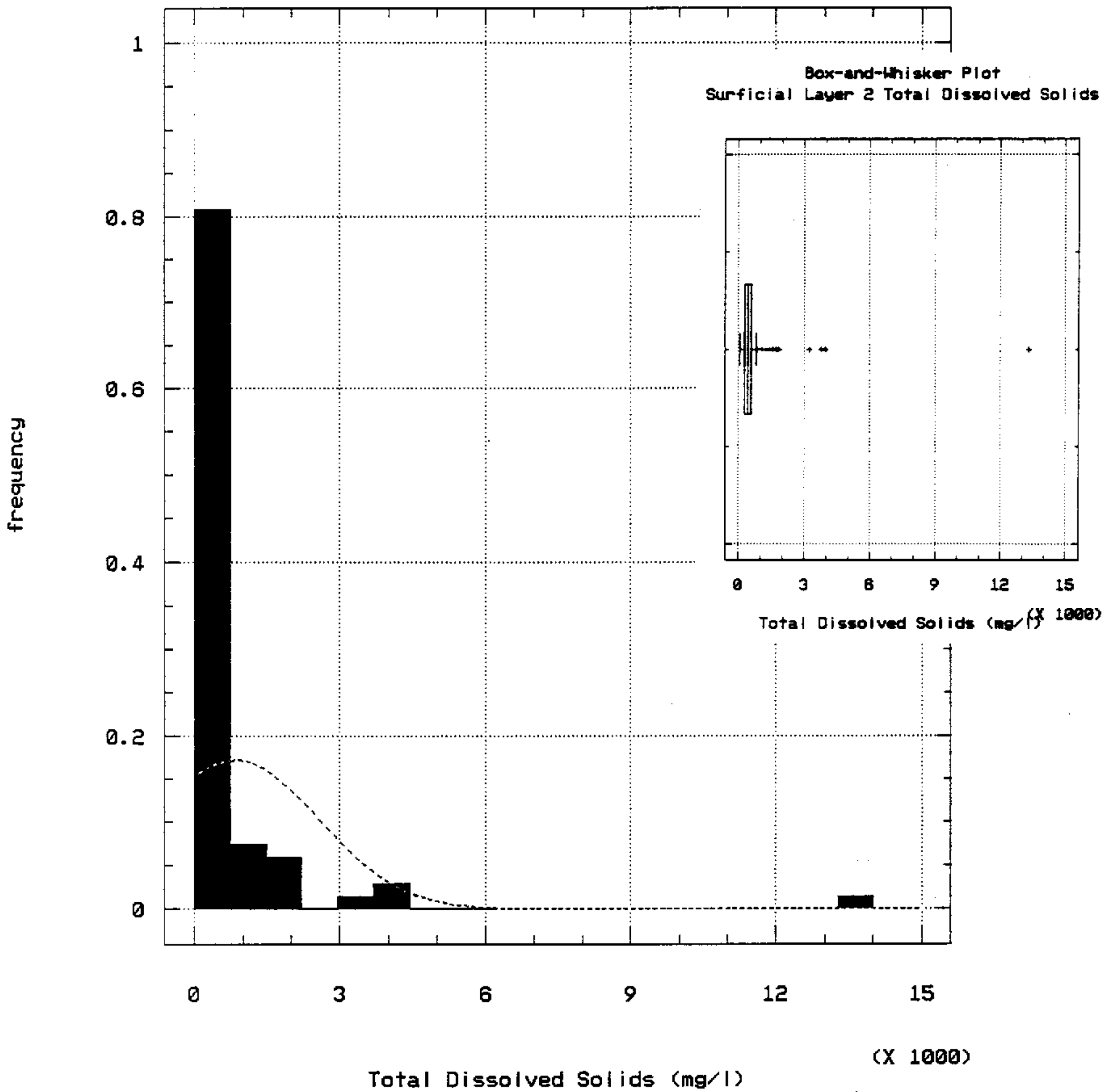

FIGURE B-6. Frequency Histogram and Box and Whisker Plot Showing Total Dissolved Solids Concentration Sample Variance from the SFWMD's Network of Wells Completed to the Production Zone (Surficial Aquifer System)

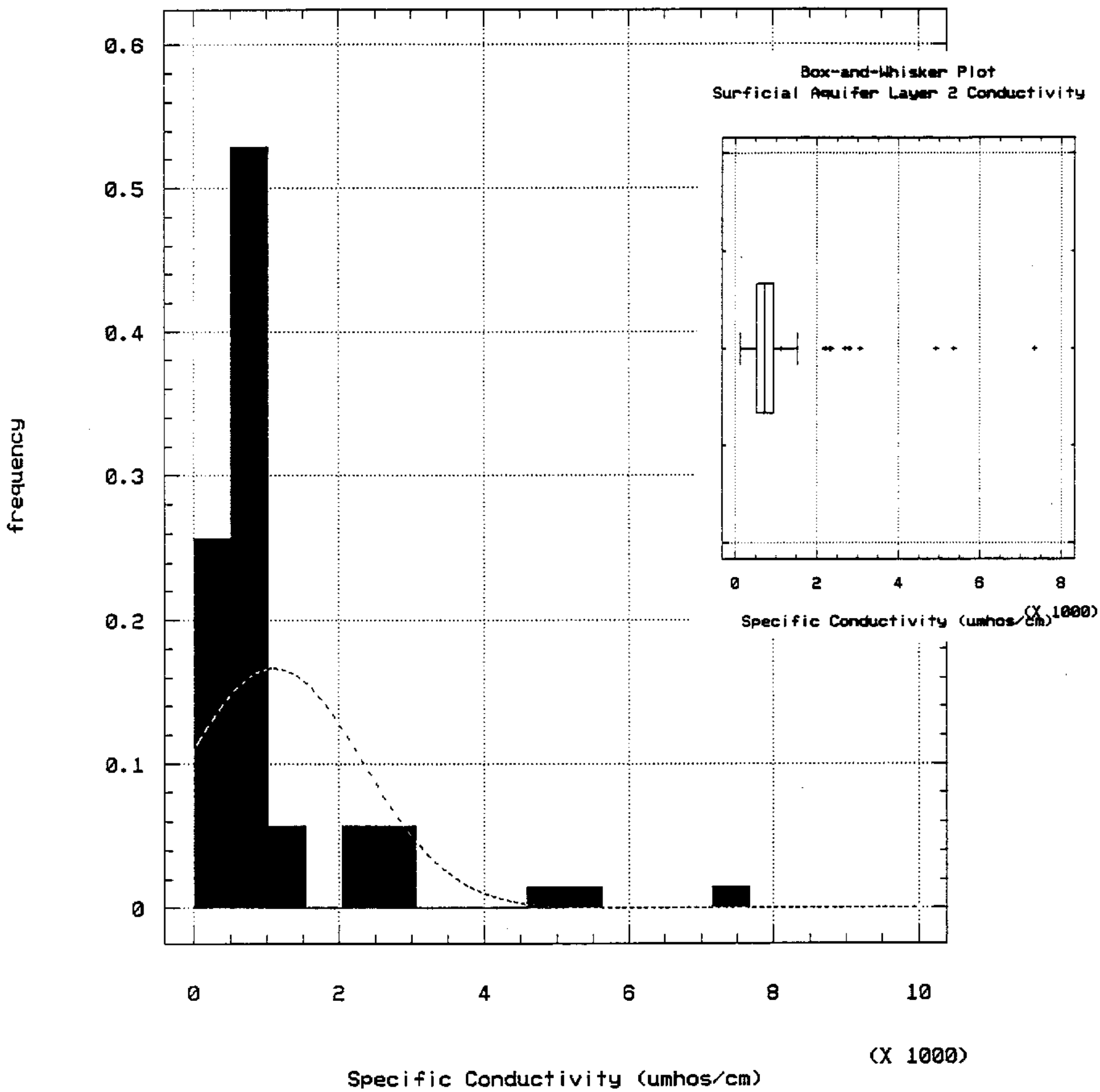

FIGURE B-7. Frequency Histogram and Box and Whisker Plot Showing Specific Conductivity Sample Variance from the SFWMD's Network of Wells Completed to the Production Zone (Surficial Aquifer System)

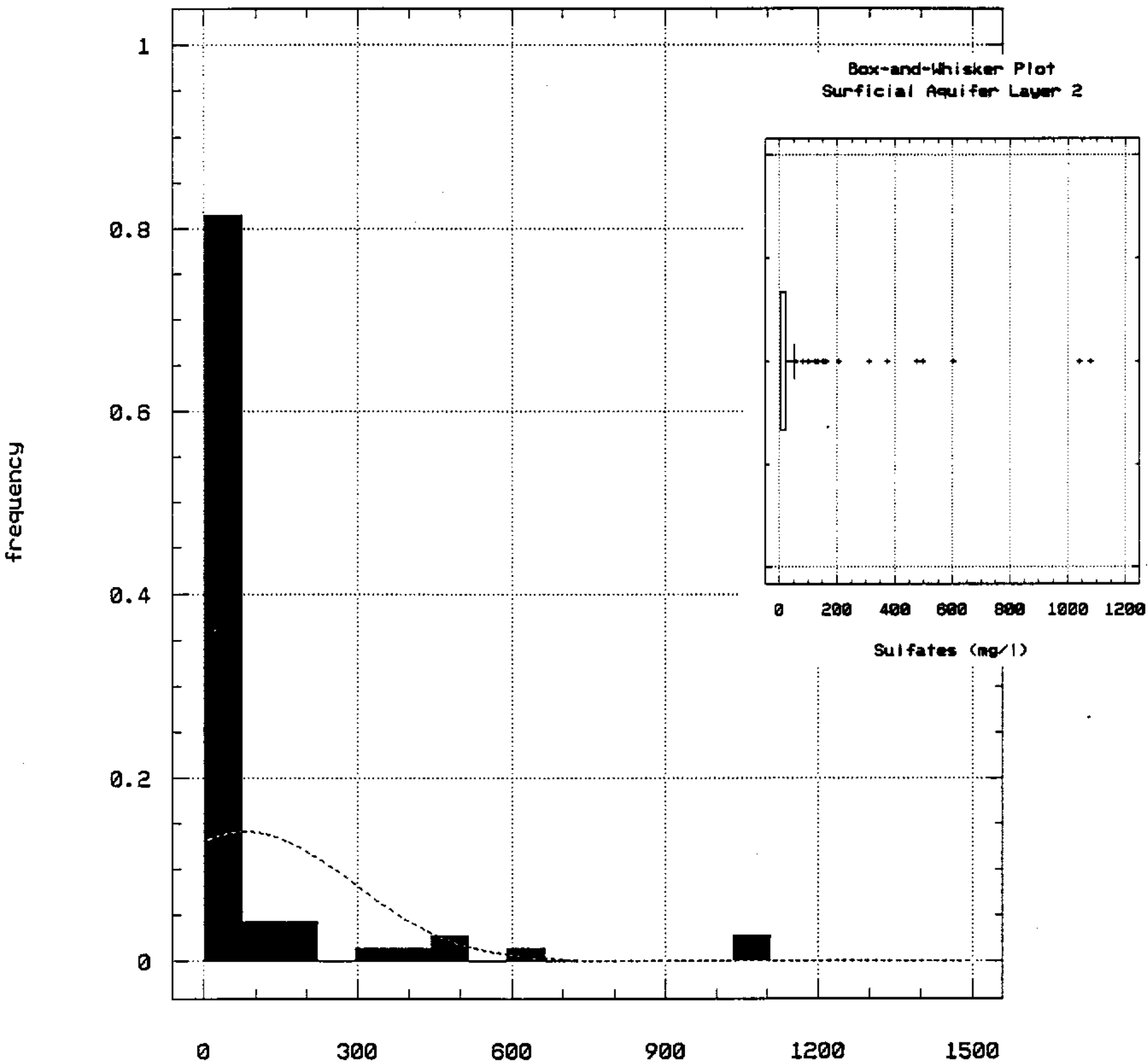

FIGURE B-8. **Frequency Histogram and Box and Whisker Plot Showing Dissolved Sulfate Concentration Sample Variance from the SFWMD's Network of Wells Completed to the Production Zone (Surficial Aquifer System)**

TABLE B-7. Statistical Summary of Specific Conductivity Sample Variance from the SFWMD's Network of Wells Completed to the Production Zone (Surficial Aquifer System)

Sample size	70.
Average	1108.172857
Median	702.
Mode	698.
Geometric mean	801.516144
Variance	1498543.384325
Standard deviation	1224.150066
Standard error	146.313918
Minimum	106.1
Maximum	7340.
Range	7233.9
Lower quartile	505.
Upper quartile	923.
Interquartile range	418.
Skewness	3.171927
Standardized skewness	10.834193
Kurtosis	11.570074
Standardized kurtosis	19.759664
Coeff. of variation	110.465624
Sum	77572.1

TABLE B-8. Statistical Summary of Dissolved Sulfate Concentration Sample Variance from the SFWMD's Network of Wells Completed to the Production Zone (Surficial Aquifer System)

Sample size	70.
Average	81.444286
Median	5.
Mode	2.
Geometric mean	9.410828
Variance	43379.410619
Standard deviation	208.277245
Standard error	24.893892
Minimum	1.5
Maximum	1077.5
Range	1076.
Lower quartile	2.
Upper quartile	22.6
Interquartile range	20.6
Skewness	3.558125
Standardized skewness	12.153311
Kurtosis	13.362425
Standardized kurtosis	22.820686
Coeff. of variation	255.729721
Sum	5701.1

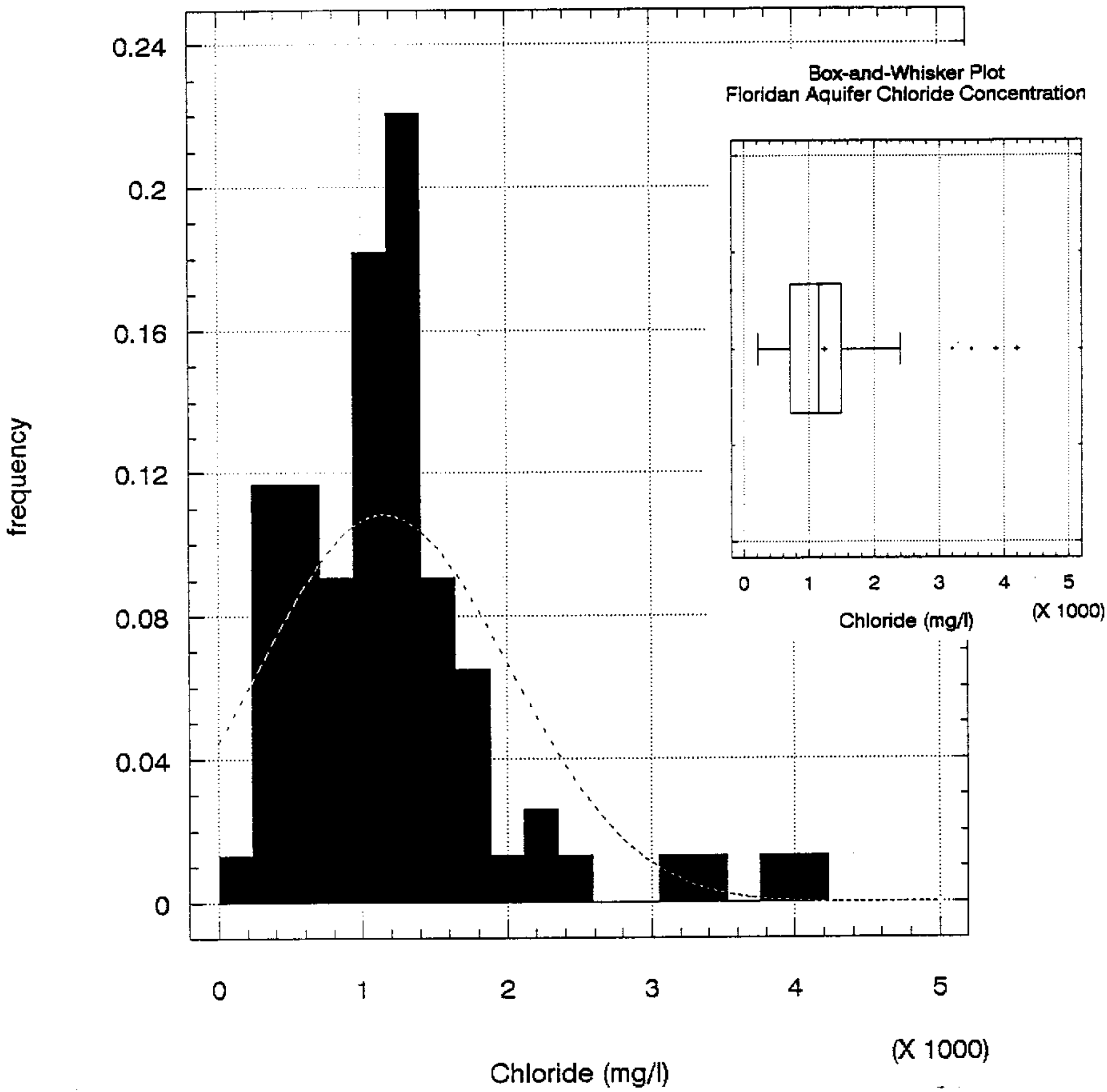

FIGURE B-9. **Frequency Histogram and Box and Whisker Plot Showing Chloride Concentration Sample Variance from the SFWMD's Network of Wells Completed to the Upper Floridan Aquifer**

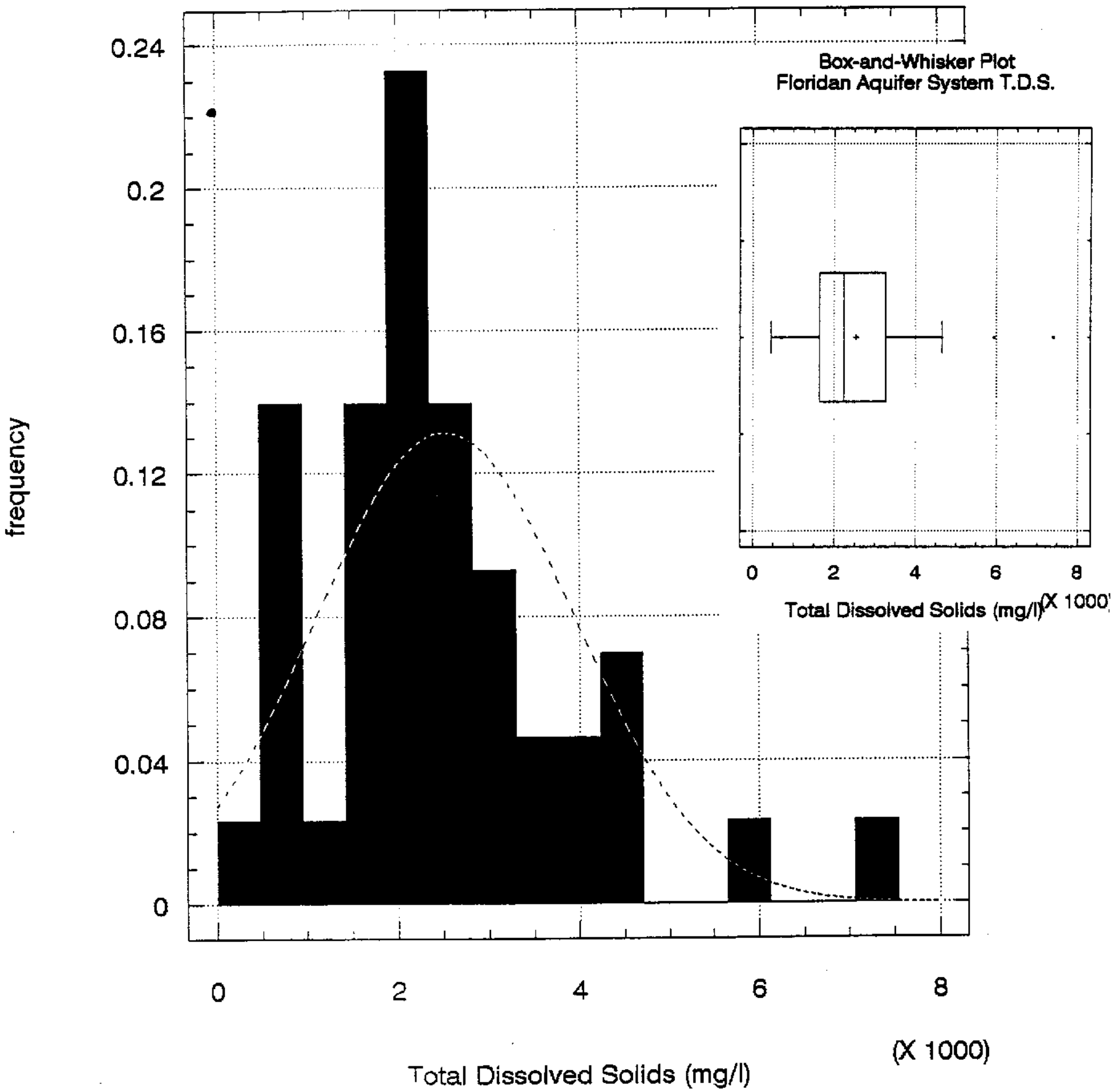

FIGURE B-10. Frequency Histogram and Box and Whisker Plot Showing Total Dissolved Solids Concentration Sample Variance from the SFWMD's Network of Wells Completed to the Upper Floridan Aquifer

TABLE B-9. Statistical Summary of Chloride Concentration Sample Variance from the SFWMD's Network of Wells Completed to the Upper Floridan Aquifer

Sample size	77.
Average	1236.57013
Median	1150.
Mode	1400.
Geometric mean	1037.722483
Variance	587813.443701
Standard deviation	766.689927
Standard error	87.372426
Minimum	209.4
Maximum	4200.
Range	3990.6
Lower quartile	712.7
Upper quartile	1489.1
Interquartile range	776.4
Skewness	1.774584
Standardized skewness	6.357206
Kurtosis	4.311622
Standardized kurtosis	7.7229
Coeff. of variation	62.00133
Sum	95215.9

TABLE B-10. Statistical Summary of Total Dissolved Solids Concentration Sample Variance from the SFWMD's Network of Wells Completed to the Upper Floridan Aquifer

Sample size	43.
Average	2527.513953
Median	2224.
Mode	903.
Geometric mean	2153.806381
Variance	2043429.530277
Standard deviation	1429.485757
Standard error	217.994534
Minimum	449.1
Maximum	7388.
Range	6938.9
Lower quartile	1640.
Upper quartile	3247.1
Interquartile range	1607.1
Skewness	1.242546
Standardized skewness	3.326374
Kurtosis	2.259041
Standardized kurtosis	3.023798
Coeff. of variation	56.556988
Sum	108683.1

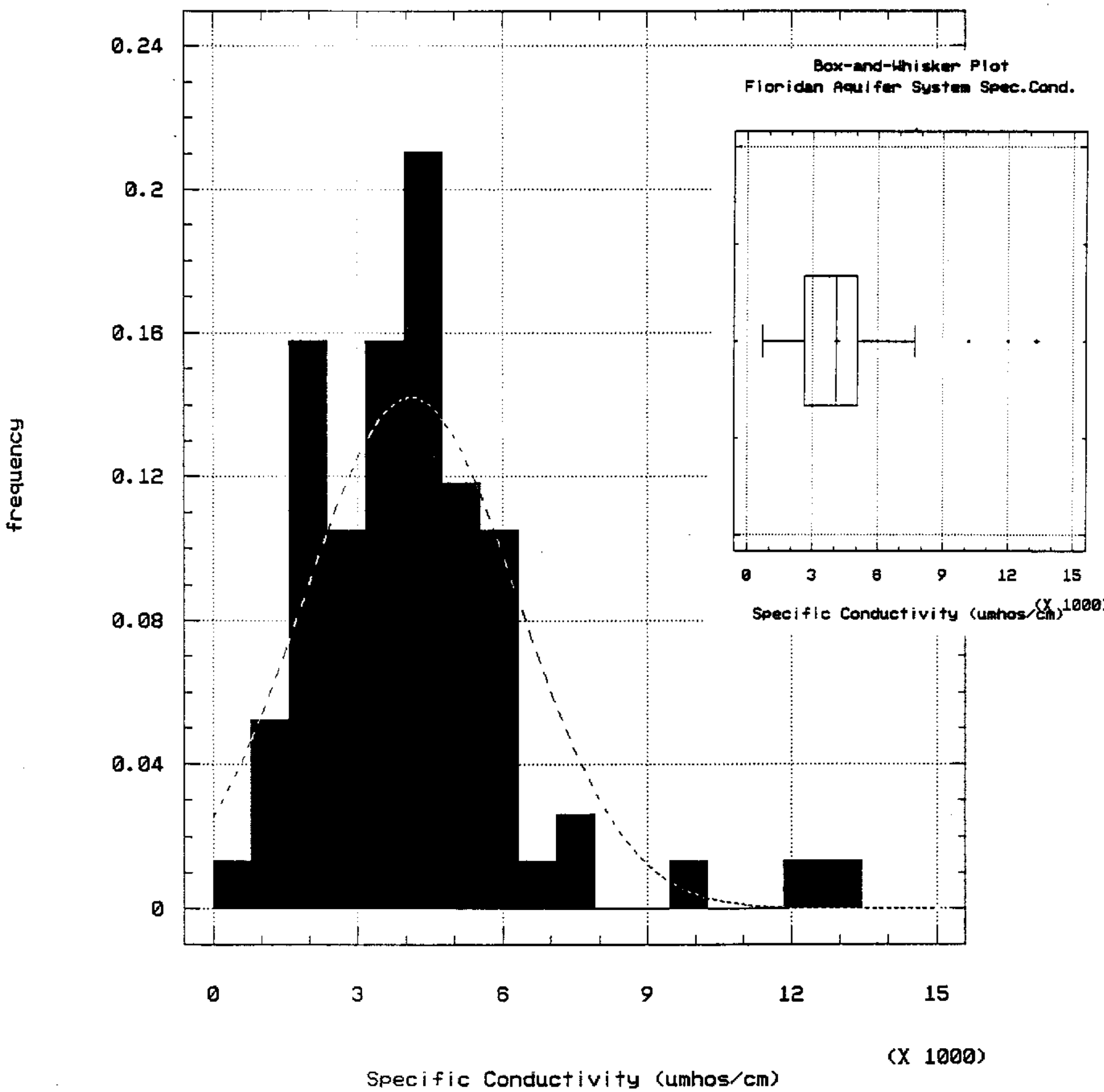

FIGURE B-11. Frequency Histogram and Box and Whisker Plot Showing Specific Conductivity Sample Variance from the SFWMD's Network of Wells Completed to the Upper Floridan Aquifer

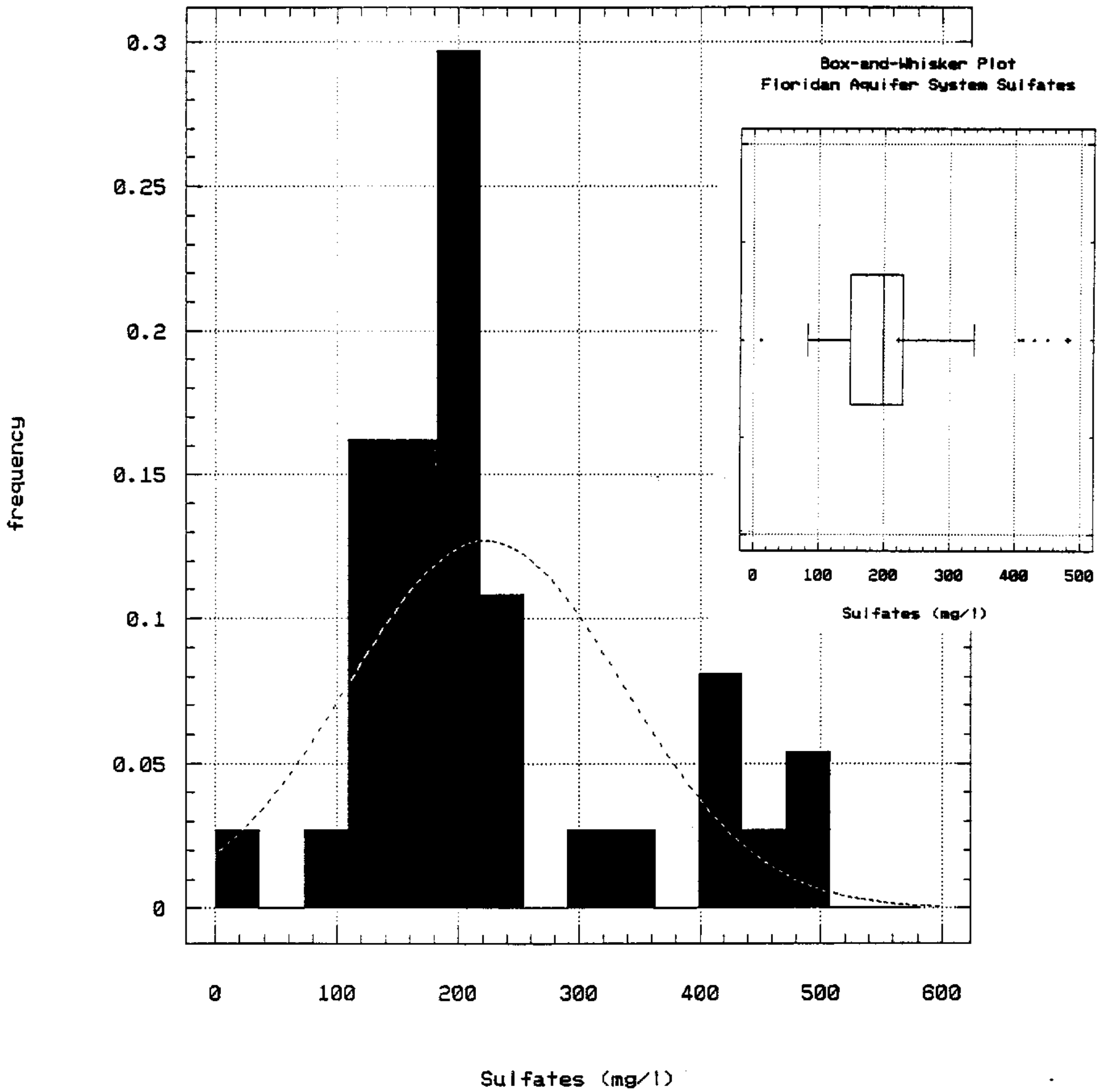

FIGURE B-12. Frequency Histogram and Box and Whisker Plot Showing Dissolved Sulfate Concentration Sample Variance from the SFWMD's Network of Wells Completed to theUpper Floridan Aquifer

TABLE B-11. Statistical Summary of Specific Conductivity Sample Variance from the SFWMD's Network of Wells Completed to the Upper Floridan Aquifer

Sample size	76.
Average	4103.052632
Median	4062.5
Mode	5200.
Geometric mean	3557.975736
Variance	4916763.677193
Standard deviation	2217.377658
Standard error	254.350661
Minimum	701.
Maximum	13300.
Range	12599.
Lower quartile	2617.5
Upper quartile	5030.
Interquartile range	2412.5
Skewness	1.663695
Standardized skewness	5.921132
Kurtosis	5.000715
Standardized kurtosis	8.898838
Coeff. of variation	54.042145
Sum	311832.

TABLE B-12. Statistical Summary of Dissolved Sulfate Concentration Sample Variance from the SFWMD's Network of Wells Completed to the Upper Floridan Aquifer

Sample size	37.
Average	222.389189
Median	198.1
Mode	198.1
Geometric mean	191.343755
Variance	12960.42488
Standard deviation	113.843862
Standard error	18.715816
Minimum	10.7
Maximum	481.
Range	470.3
Lower quartile	147.9
Upper quartile	228.6
Interquartile range	80.7
Skewness	1.023064
Standardized skewness	2.540553
Kurtosis	0.429101
Standardized kurtosis	0.532788
Coeff. of variation	51.191275
Sum	8228.4

APPENDIX C

TRILINEAR DIAGRAMS

LIST OF FIGURES - APPENDIX C

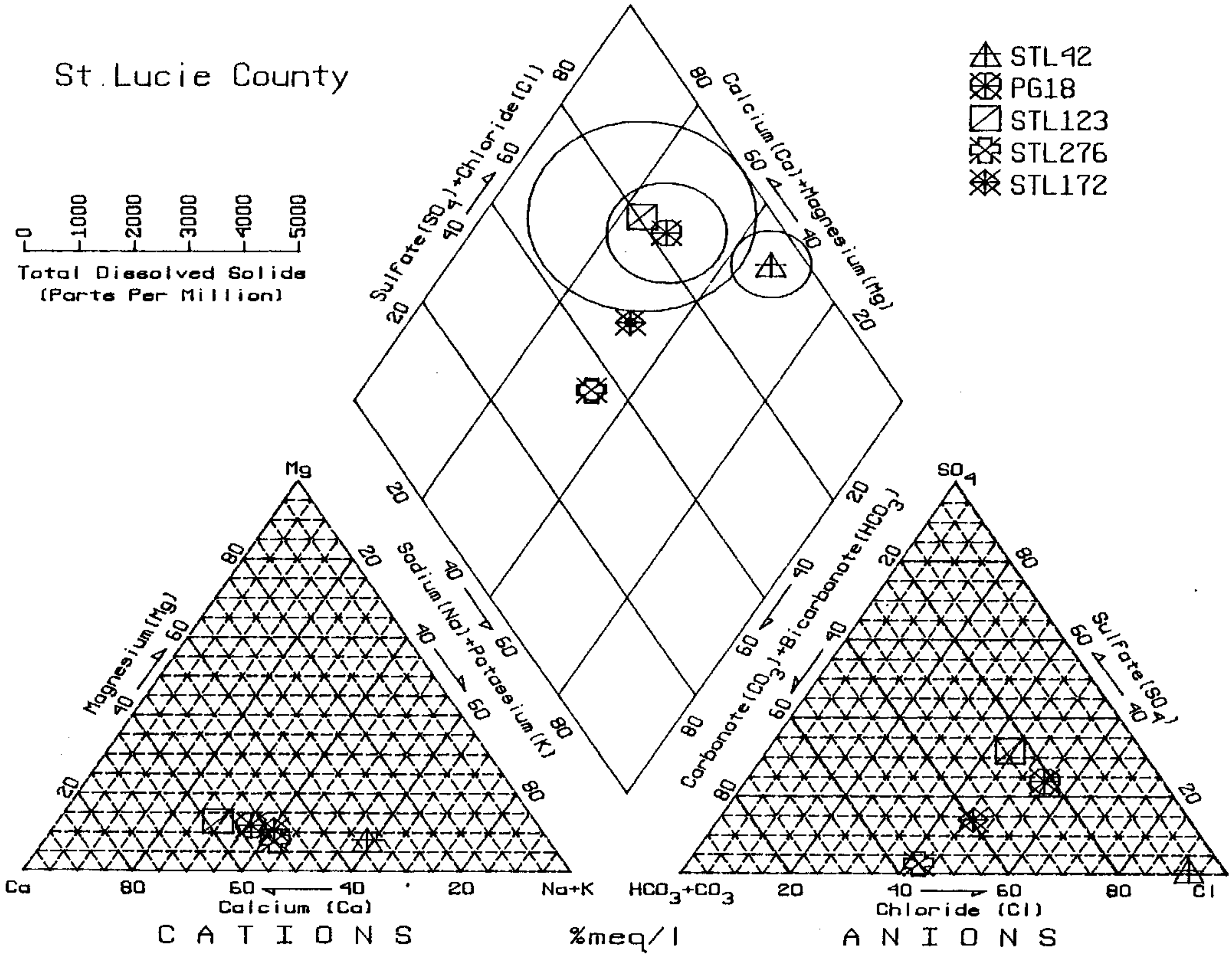

FIGURE C-1. Trilinear Diagram of Five Representative Water Samples from Wells Completed in the Sand/Soil Zone (Surficial Aquifer System) in St. Lucie County

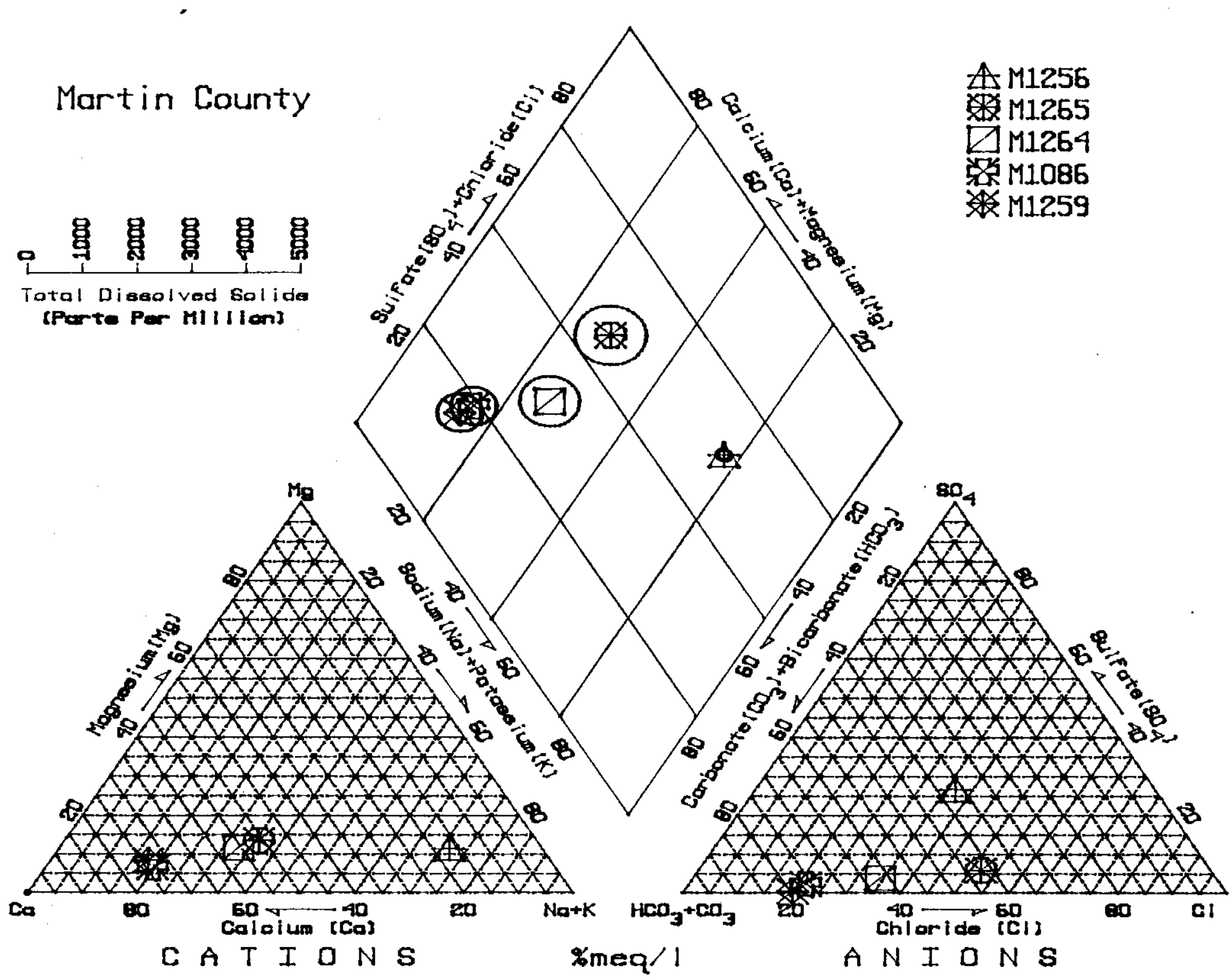

FIGURE C-2. Trilinear Diagram of Five Representative Water Samples from Wells Completed in the Sand/Soil Zone (Surficial Aquifer System) in Martin County

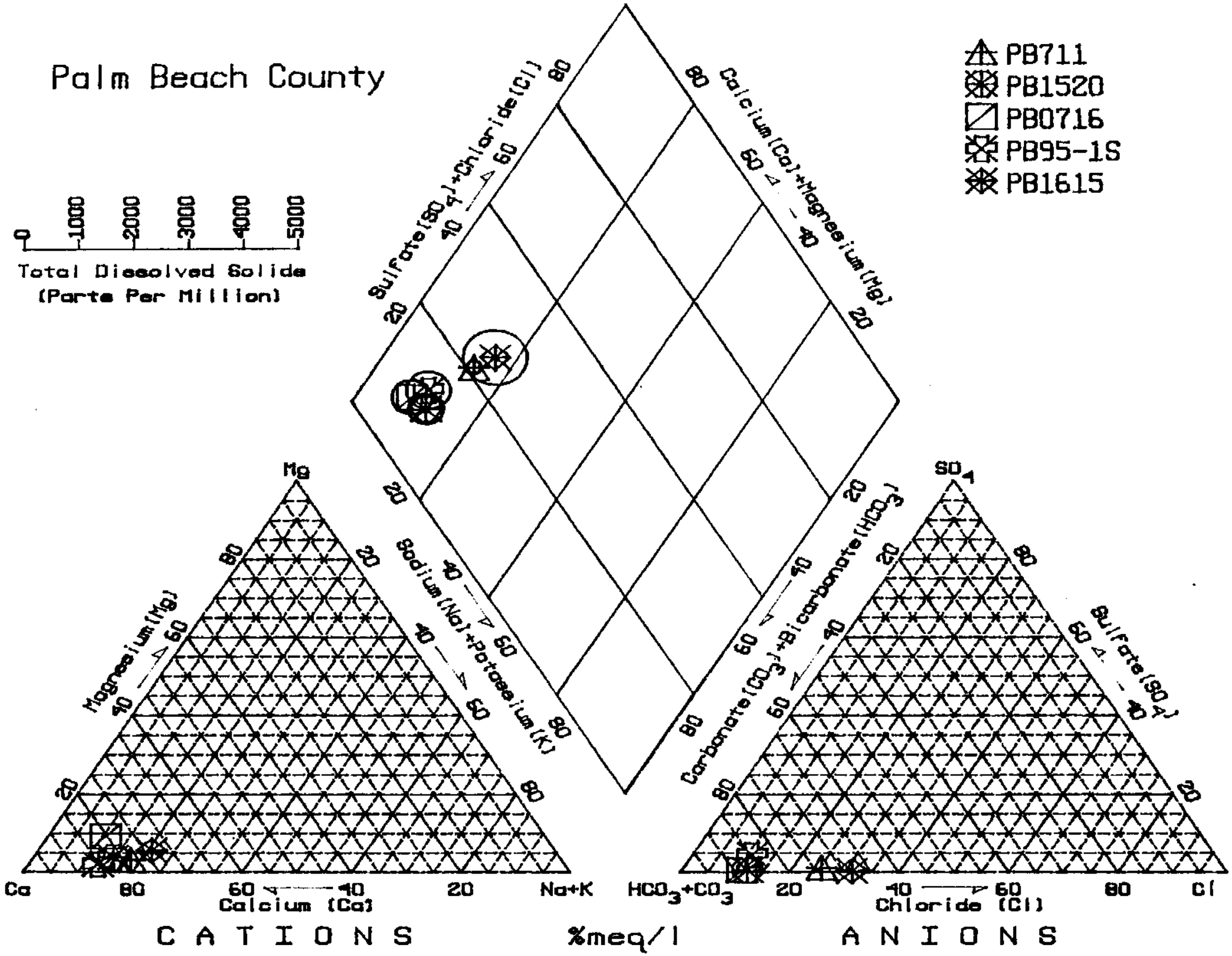

FIGURE C-3. Trilinear Diagram of Five Representative Water Samples from Wells Completed in the Sand/Soil Zone (Surficial Aquifer System) in Palm Beach County

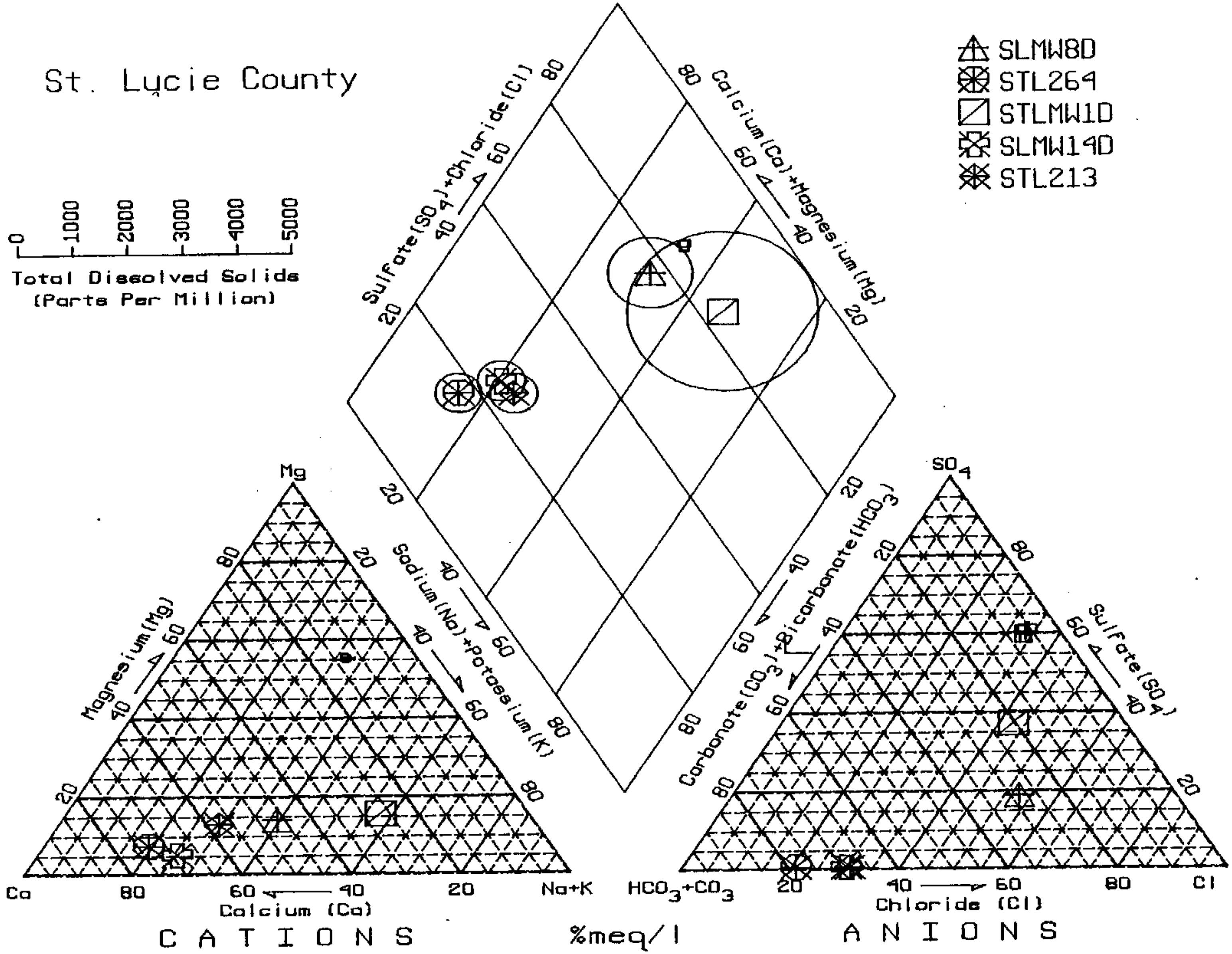

FIGURE C-4. Trilinear Diagram of Five Representative Water Samples from Wells Completed in the Production Zone (Surficial Aquifer System) in St. Lucie County

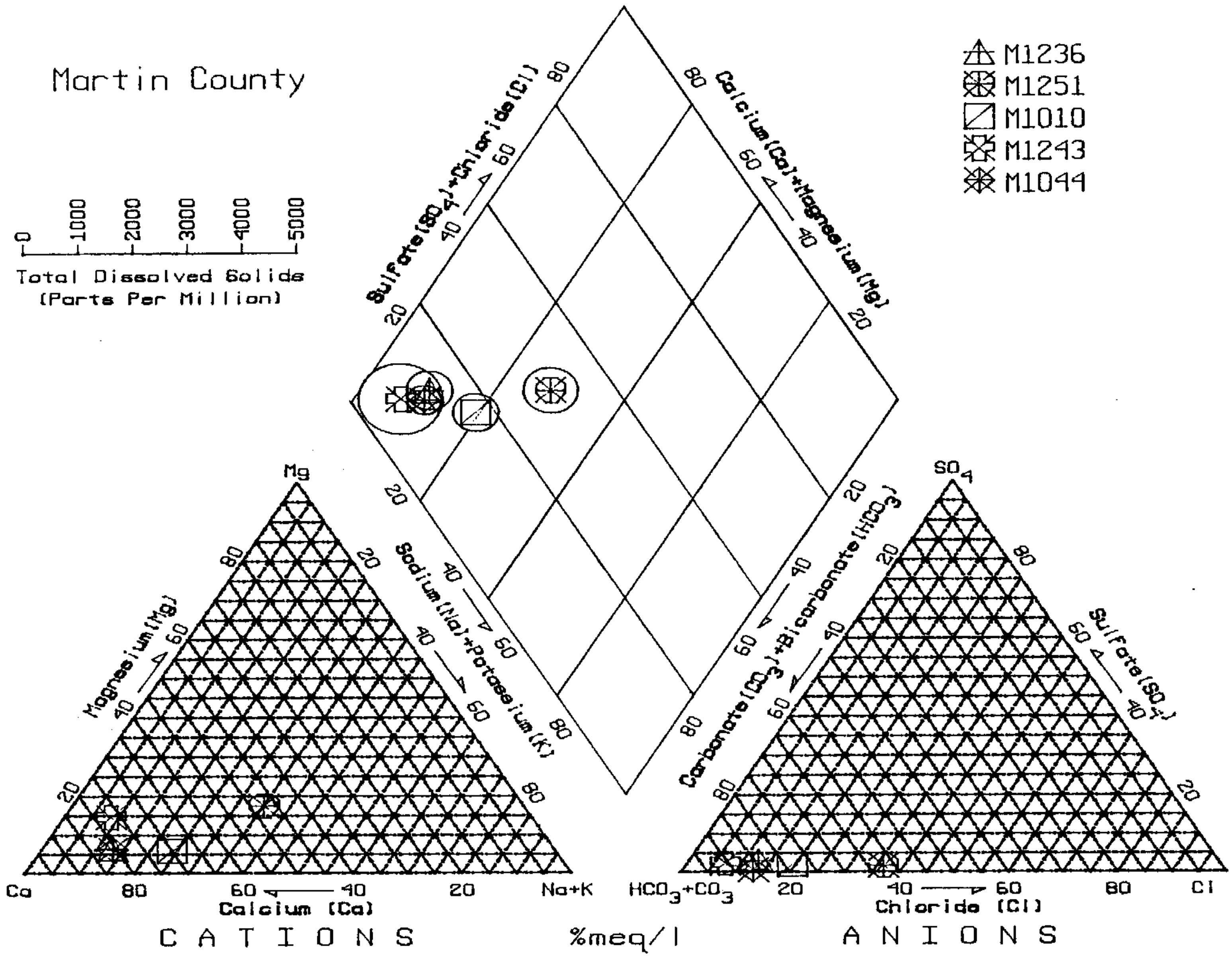

FIGURE C-5. Trilinear Diagram of Five Representative Water Samples from Wells Completed in the Production Zone (Surficial Aquifer System) in Martin County

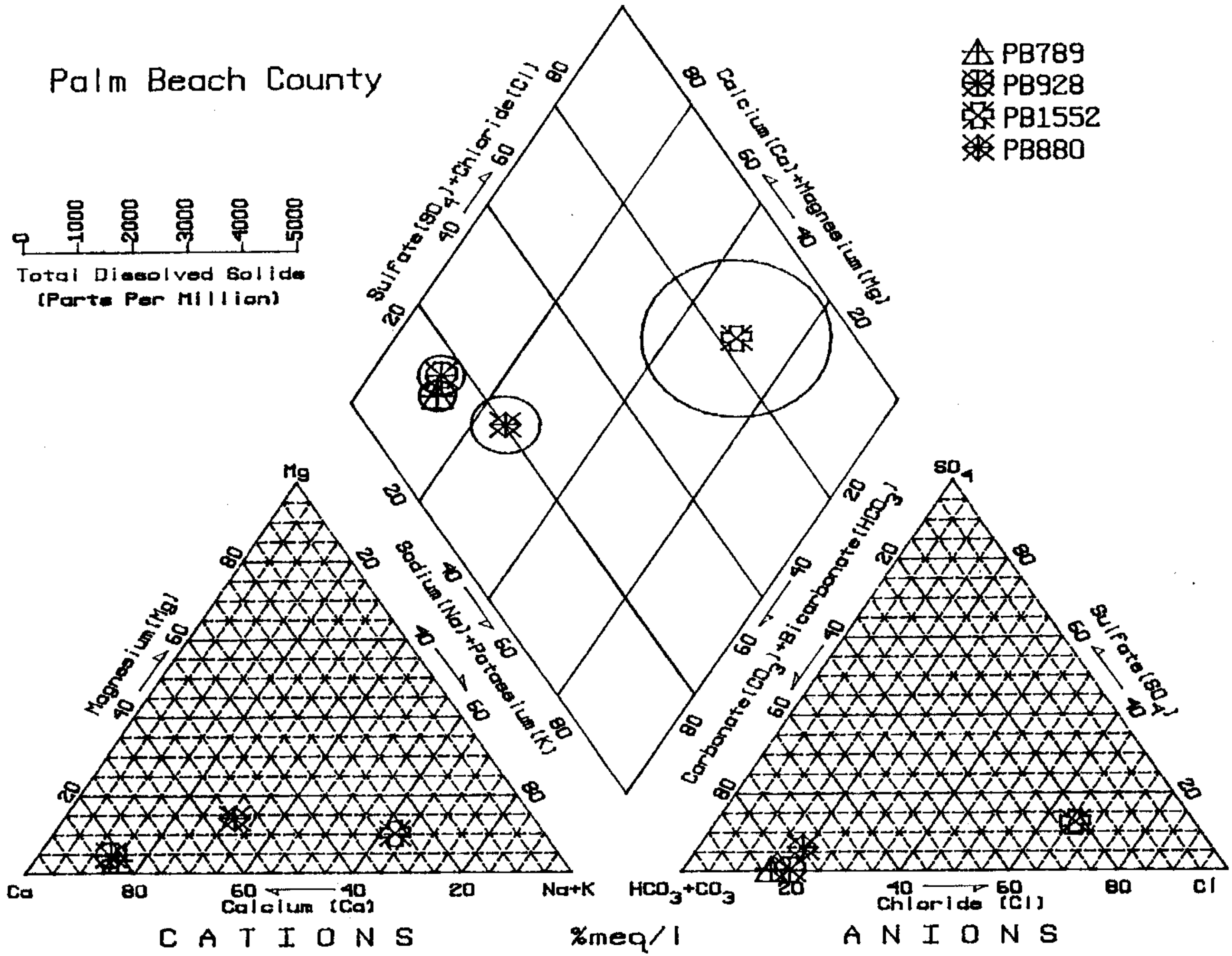

FIGURE C-6. Trilinear Diagram of Four Representative Water Samples from Wells Completed in the Production Zone (Surficial Aquifer System) in Palm Beach County

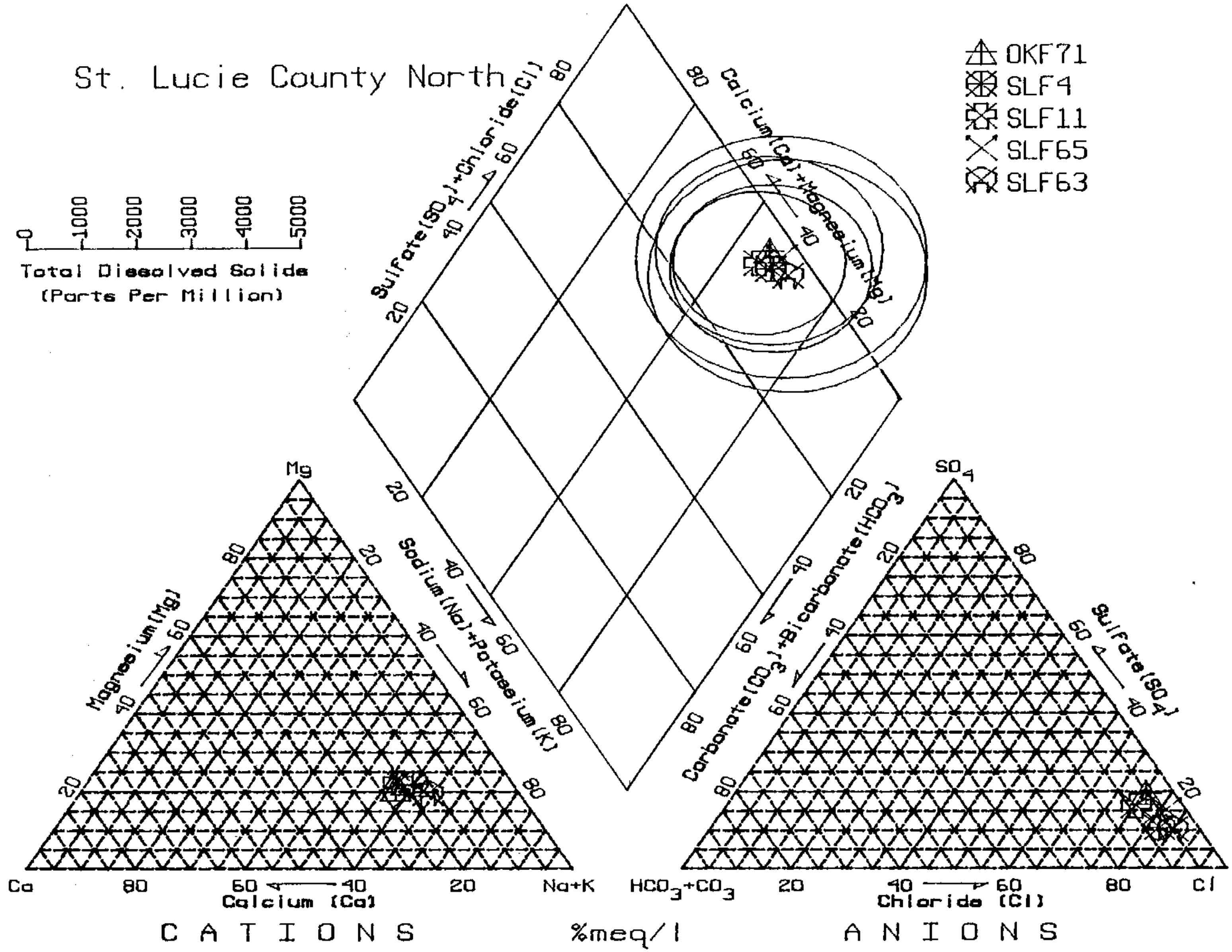

FIGURE C-7. Trilinear Diagram of Five Representative Water Samples from Wells Completed in the Upper Floridan Aquifer in Northern St. Lucie County

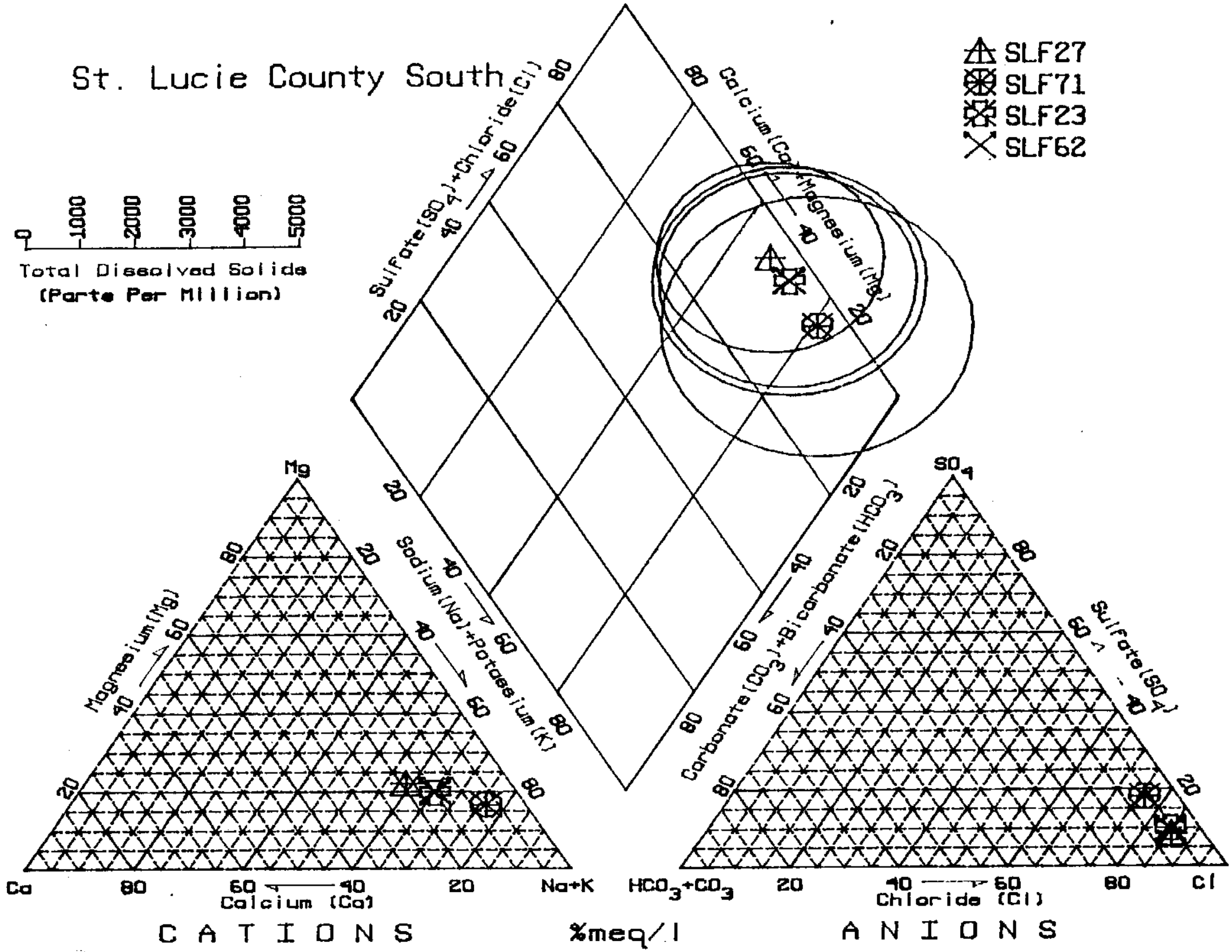

FIGURE C-8. Trilinear Diagram of Four Representative Water Samples from Wells Completed in the Upper Floridan Aquifer in Southern St. Lucie County

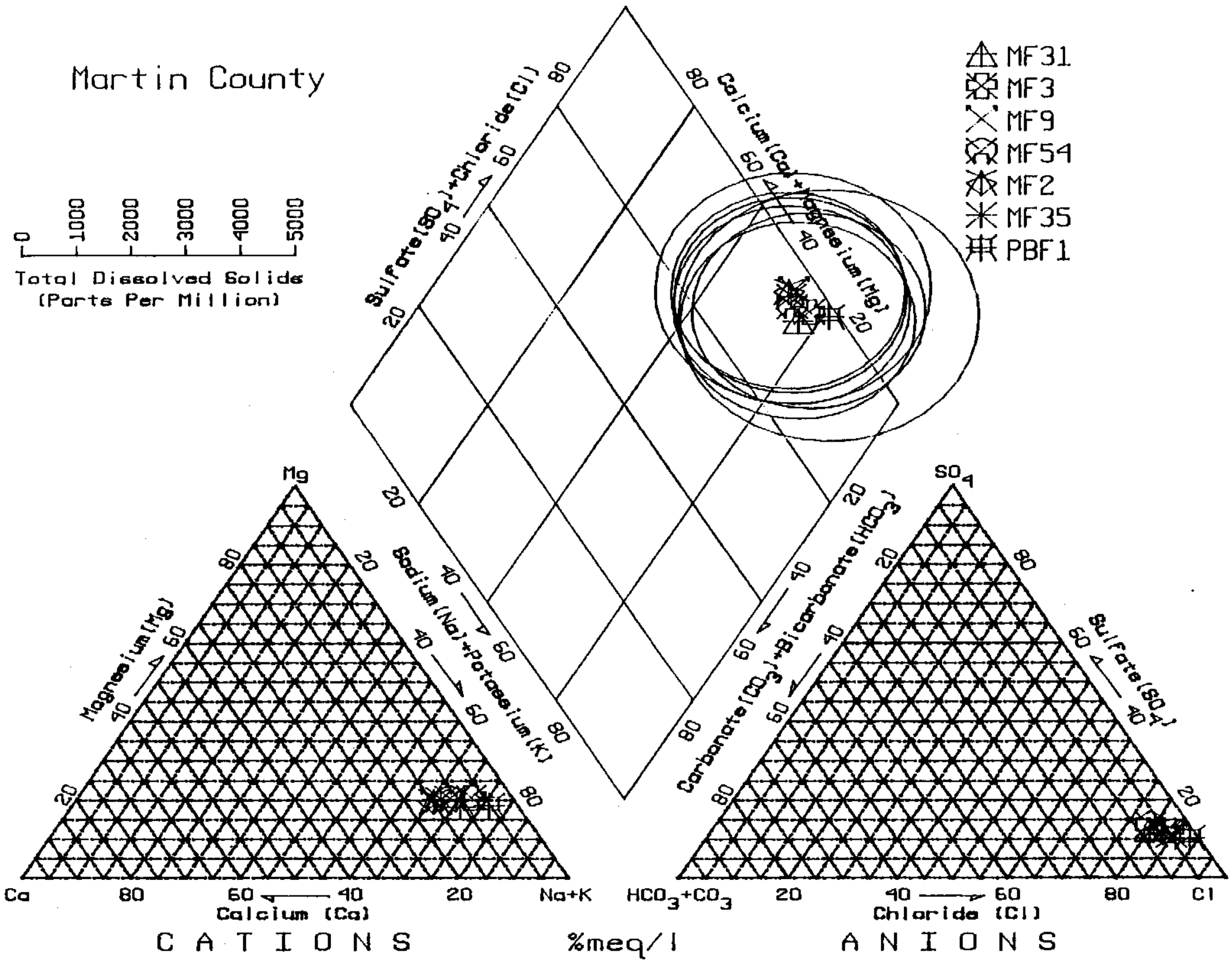

FIGURE C-9. Trilinear Diagram of Seven Representative Water Samples from Wells Completed in the Upper Floridan Aquifer in Martin and Northern Palm Beach Counties

APPENDIX D

STIFF DIAGRAMS

LIST OF FIGURES - APPENDIX D

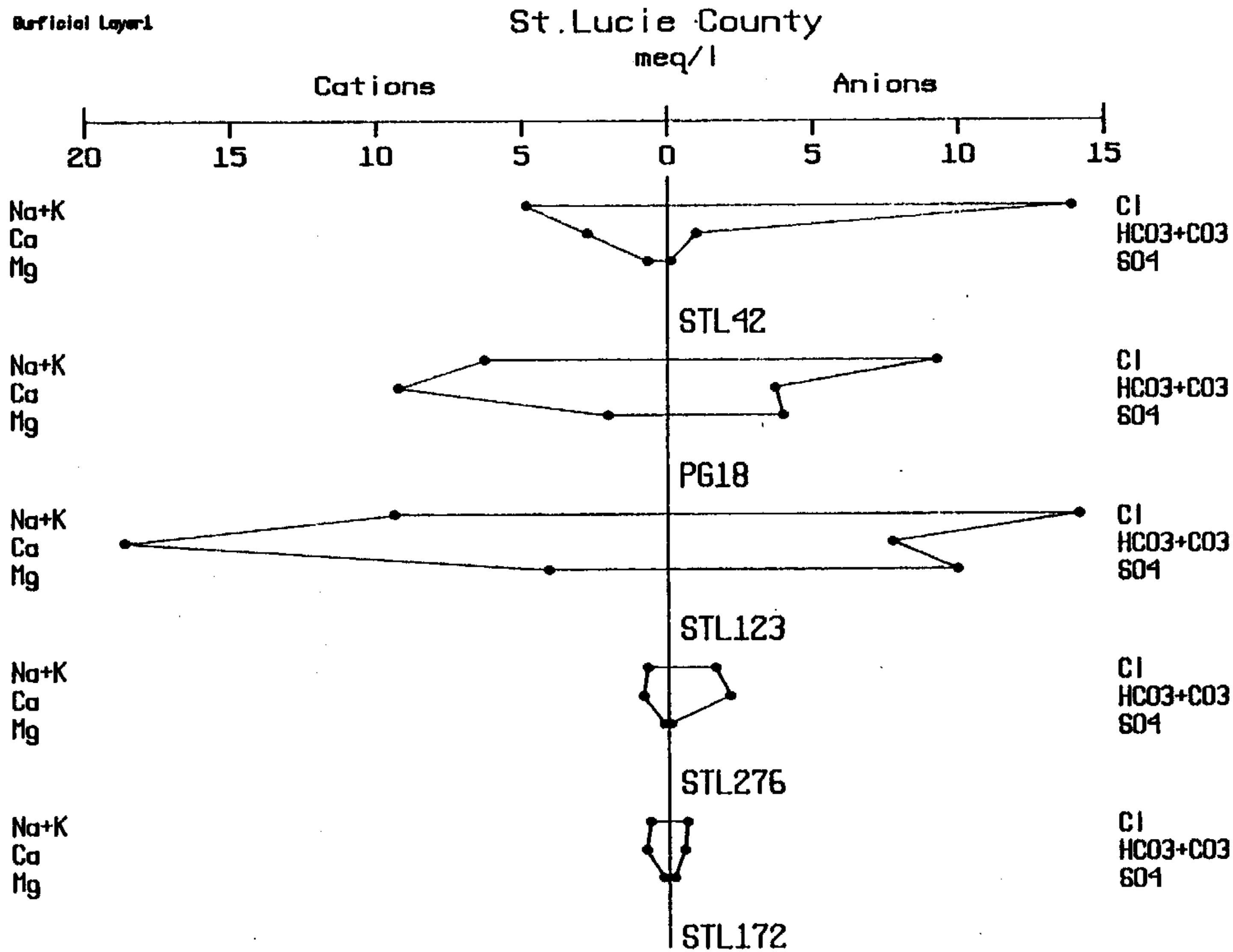

FIGURE D-1. Stiff Diagrams of Five Representative Water Samples from Wells Completed in the Sand/Soil Zone (Surficial Aquifer System) in St. Lucie County

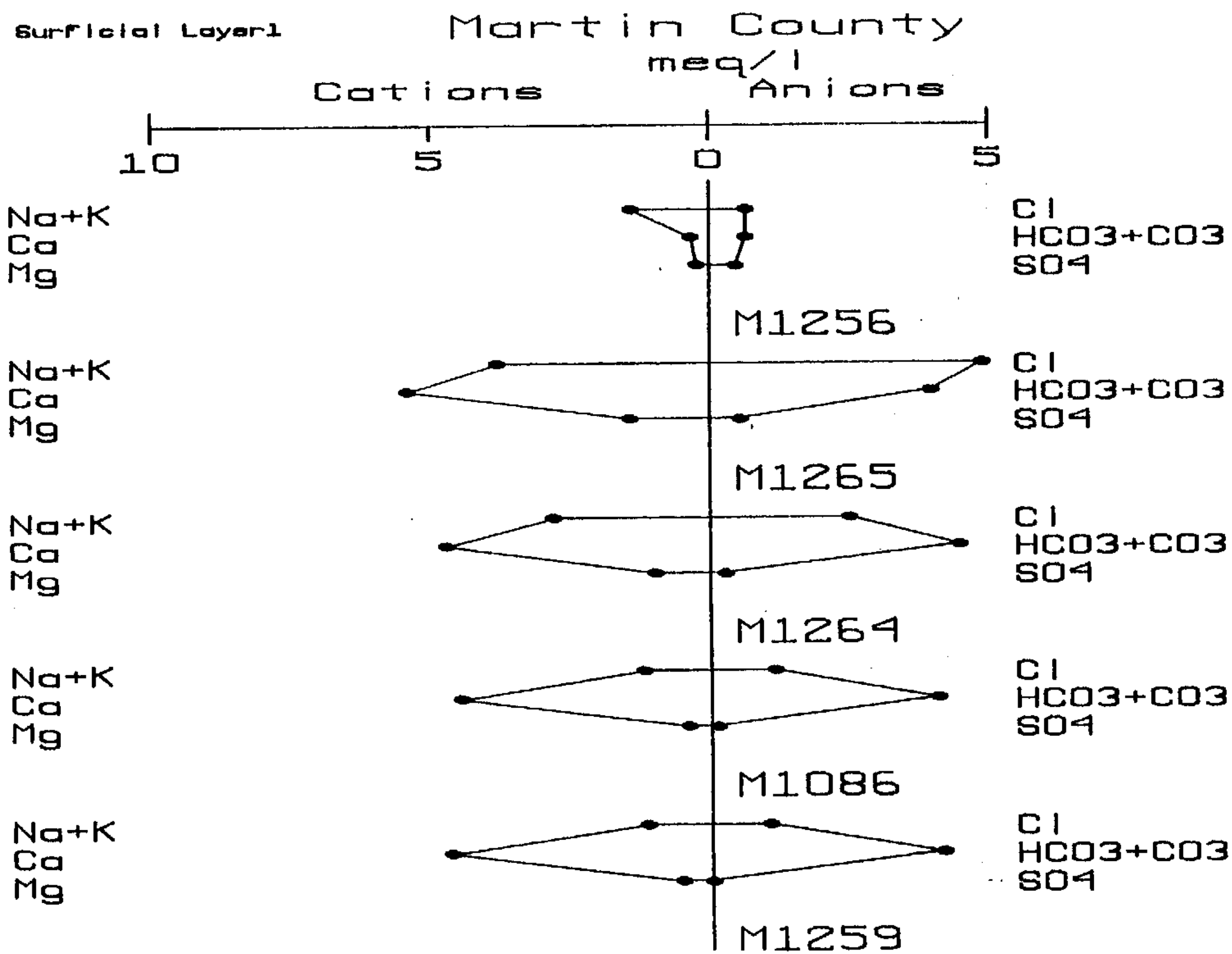

FIGURE D-2. Stiff Diagrams of Five Representative Water Samples from Wells Completed in the Sand/Soil Zone (Surficial Aquifer System) in Martin County

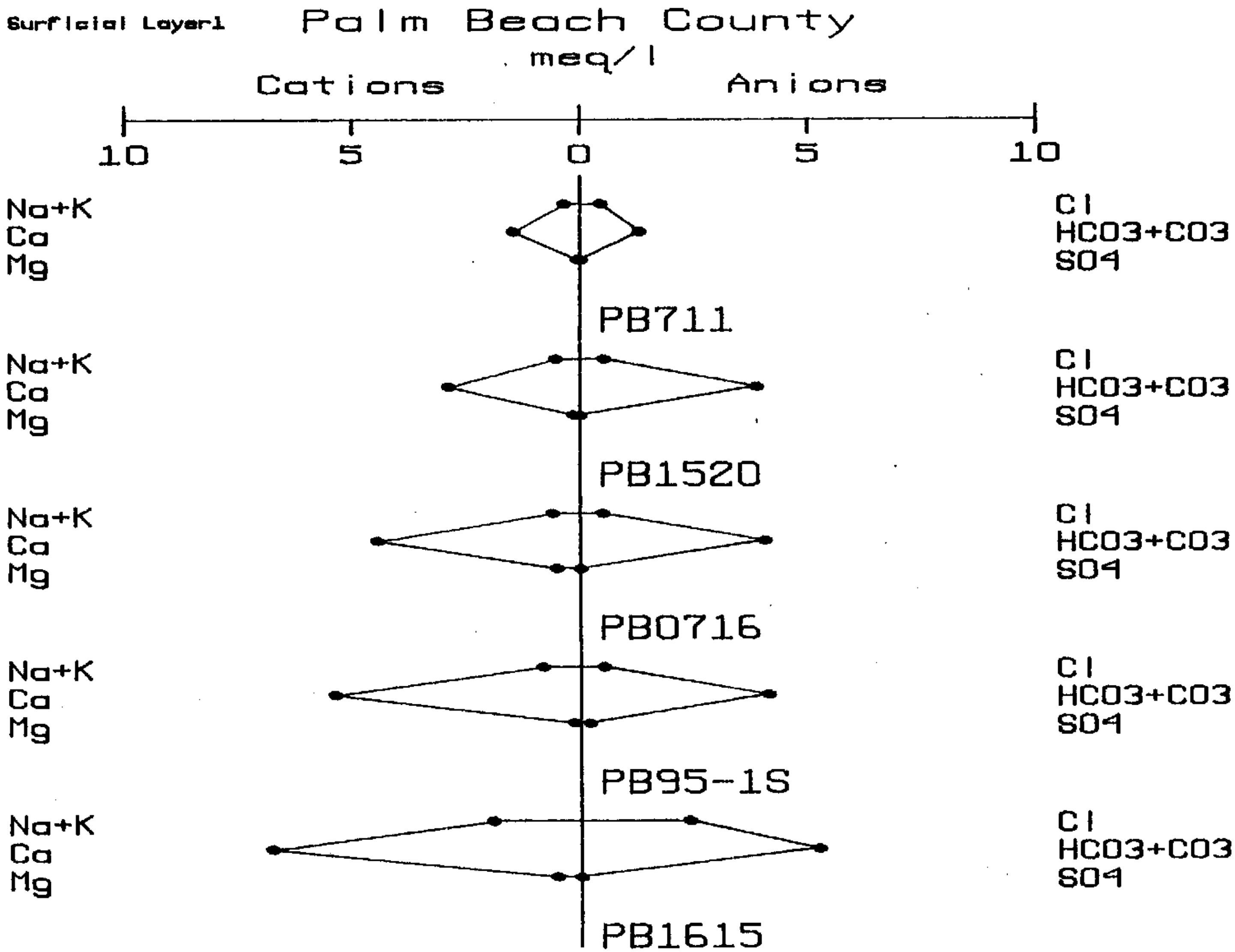

FIGURE D-3. Stiff Diagrams of Five Representative Water Samples from Wells Completed in the Sand/Soil Zone (Surficial Aquifer System) in Palm Beach County

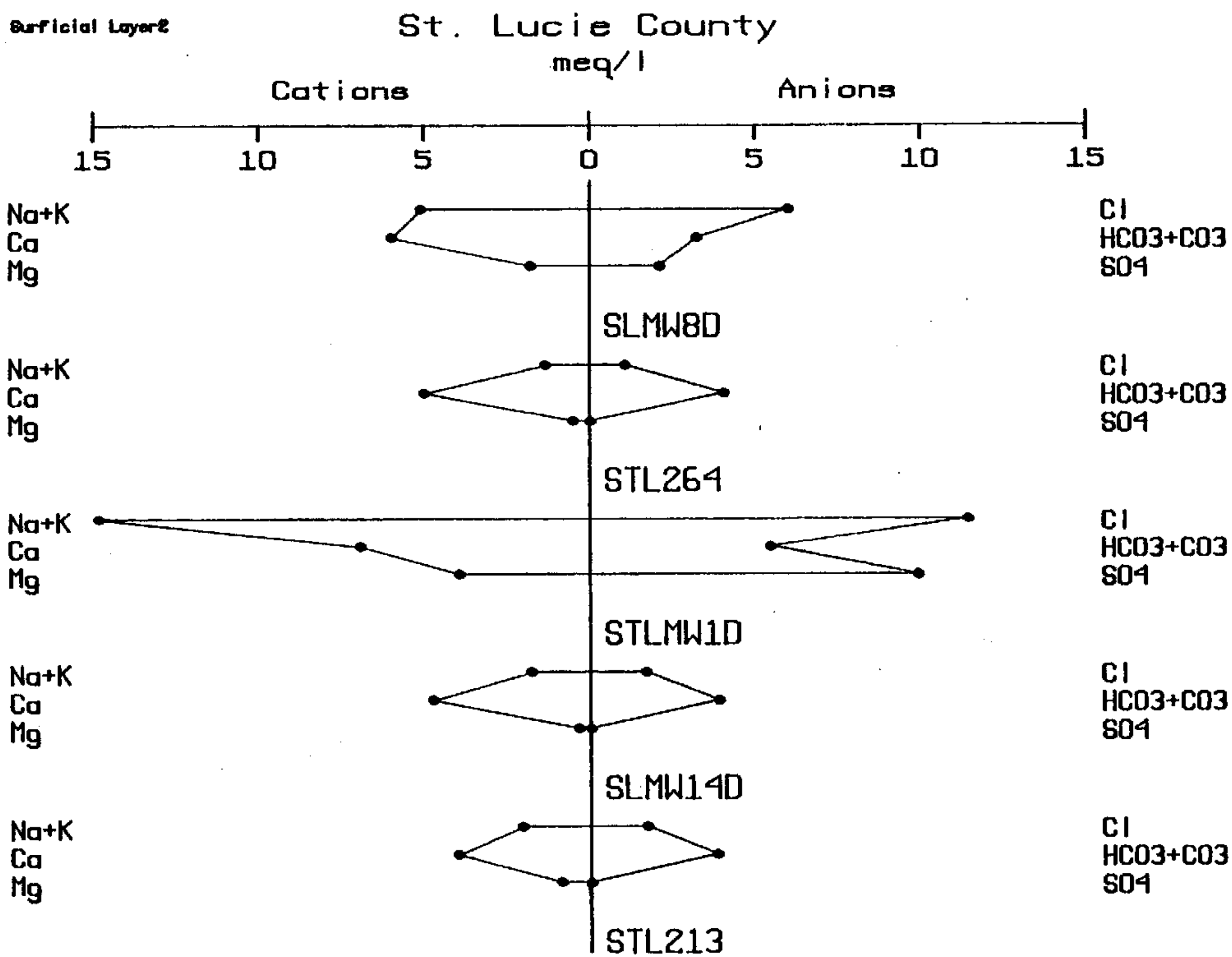

FIGURE D-4. Stiff Diagrams of Five Representative Water Samples from Wells Completed in the Production Zone (Surficial Aquifer System) in St. Lucie County

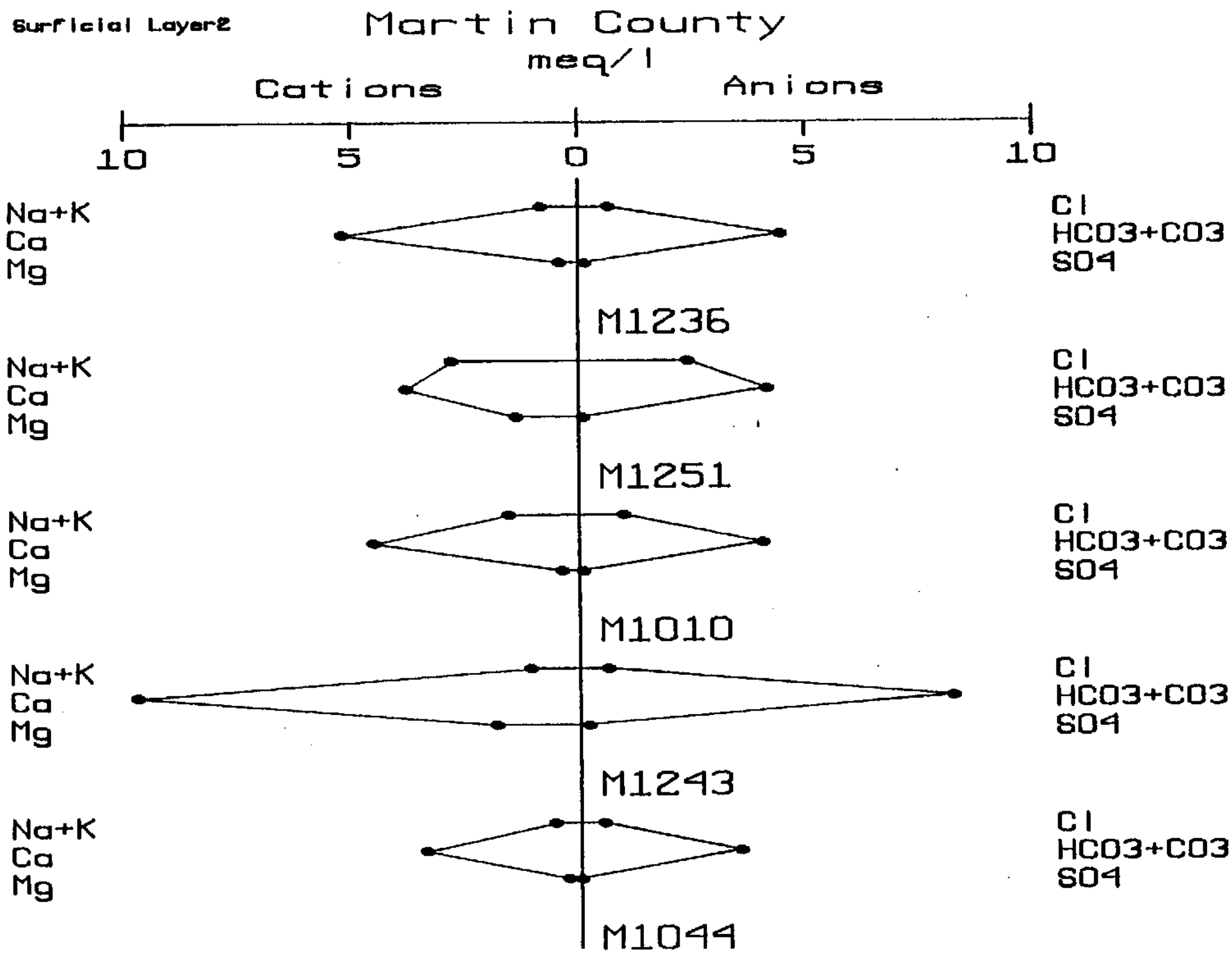

FIGURE D-5. Stiff Diagrams of Five Representative Water Samples from Wells Completed in the Production Zone (Surficial Aquifer System) in Martin County

Surficial Layer2

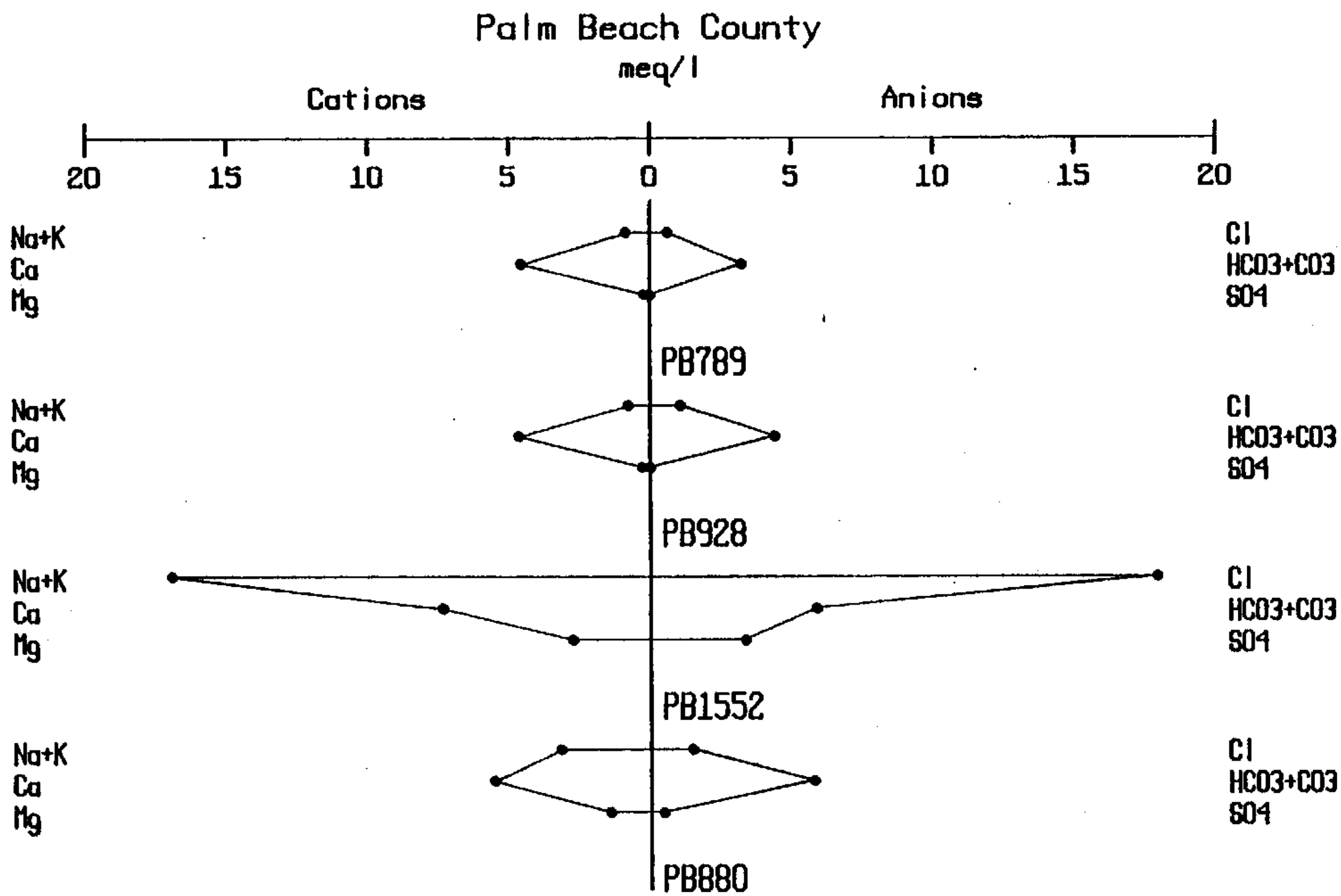

FIGURE D-6. Stiff Diagrams of Four Representative Water Samples from Wells Completed in the Production Zone (Surficial Aquifer System) in Palm Beach County

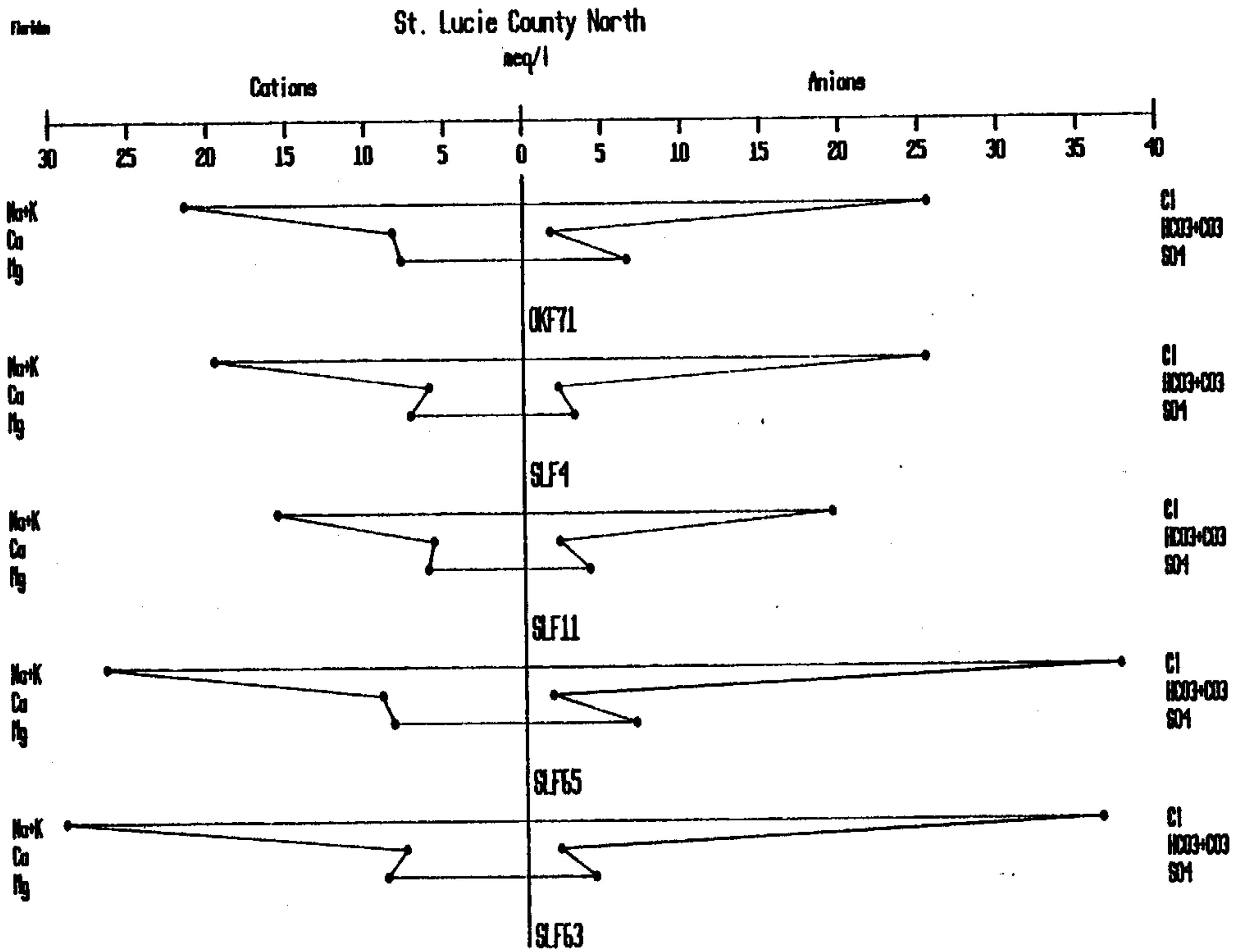

FIGURE D-7. Stiff Diagrams of Five Representative Water Samples from Wells Completed in the Upper Floridan Aquifer in Northern St. Lucie County

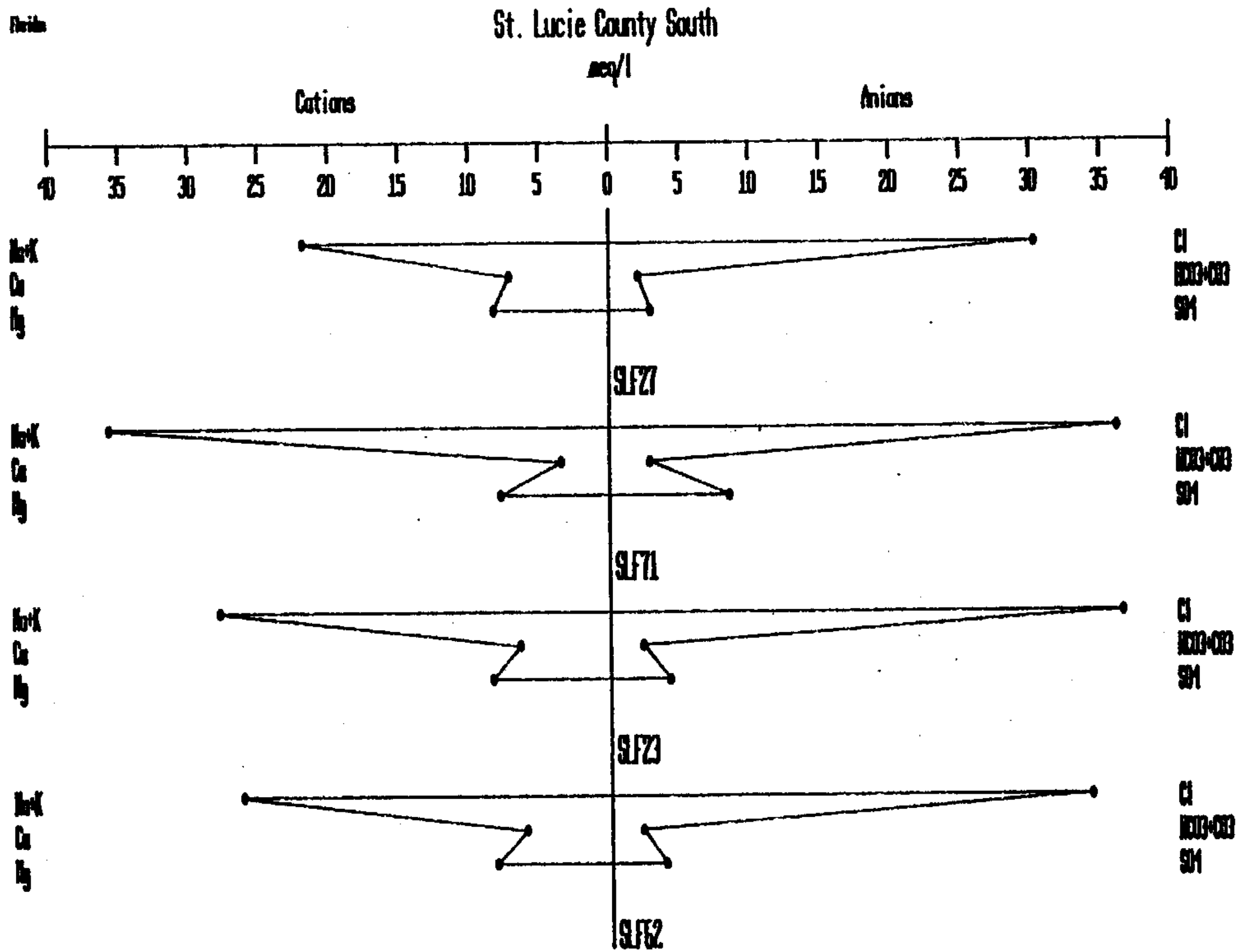

FIGURE D-8. Stiff Diagrams of Four Representative Water Samples from Wells Completed in the Upper Floridan Aquifer in Southern St. Lucie County

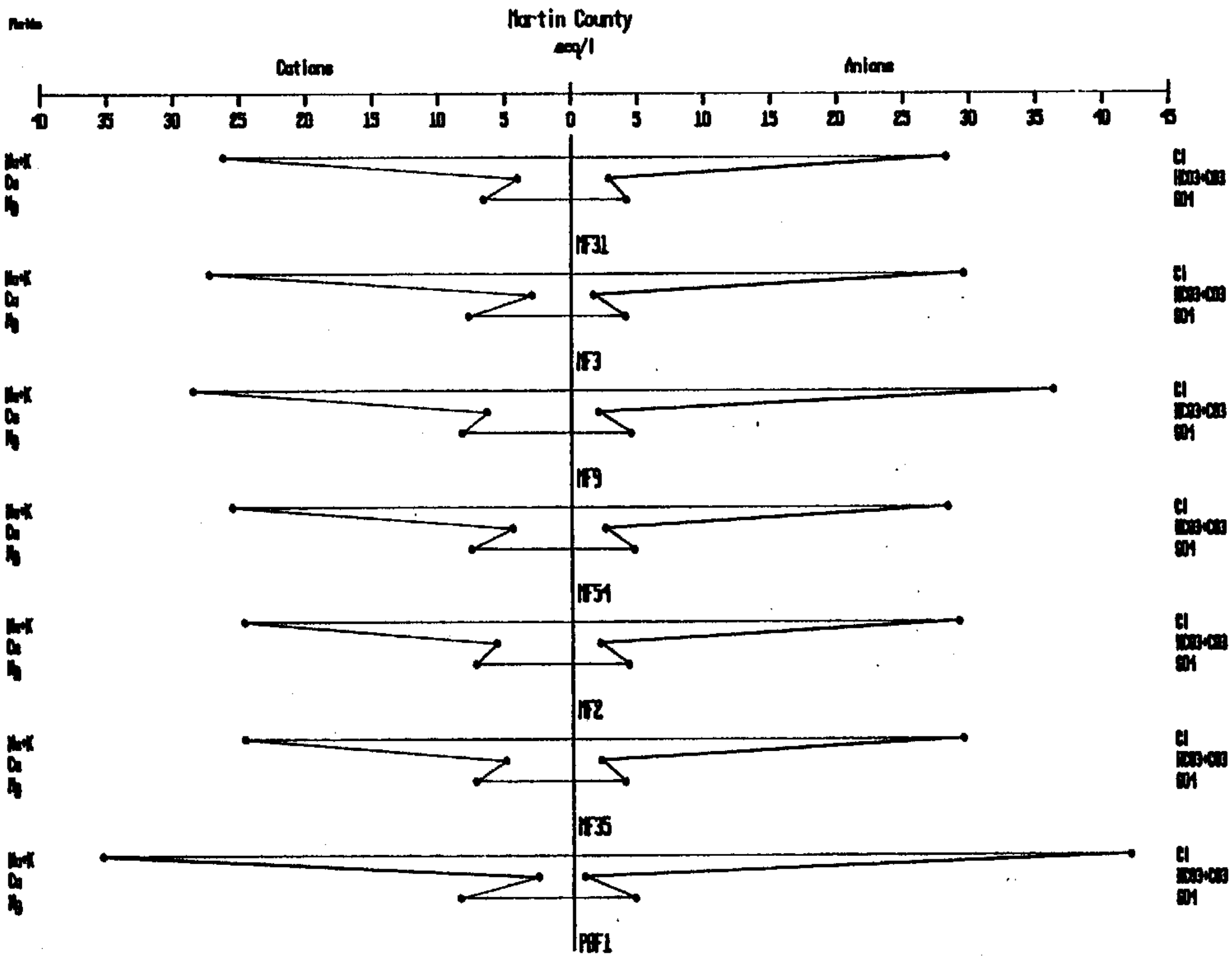

FIGURE D-9. Stiff Diagrams of Seven Representative Water Samples from Wells Completed in the Upper Floridan Aquifer in Martin

APPENDIX E

UPPER FLORIDAN AQUIFER PUBLIC WATER SUPPLY WATER QUALITY CHANGES WITH TIME

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TABLE E-1. Upper Floridan Aquifer Chloride Concentration Changes Over Time at the Sailfish Point Utility, Martin County

MO/YR	WELL #1 CL (mg/l)	WELL#2 CL (mg/l)	WELL #3 CL (mg/l)	WELL #4 CL (mg/l)	WELL #5 CL (mg/l)	WELL #6 CL (mg/l)
1/83	555	1080	705	1050	1000	
2/83	540	1110	700	1050	1000	
3/83	560	1130	710	1010	1000	
4/83	520	980	695	1102	971	
5/83	605	1035	720	1225	975	
6/83	545	1090	743	1090	990	
7/83	575	1045	731	1155	980	
9/83	545	1071	735	1150		
12/83	515		980	1225	980	
2/84	605	1105	725	1190	980	
6/84	685	1145	825	1165	1110	
12/84	675	1140	835	1165	1105	
1/85	650					
3/85	775	1125	775	1103	998	
6/85	675	1100	805	1110	995	
9/85	750	1290	960	1265	1185	
6/86	700	1150	925	1200	1015	
6/87	650	1100	875	1150	1000	980

TABLE E-2. Upper Floridan Aquifer Total Dissolved Solids Concentration Changes Over Time at the Sailfish Point Utility, Martin County

MO/YR	COMPOSITE WELL #1 & #2 TDS (mg/l)	WELL #3 TDS (mg/l)	WELL #4 TDS (mg/l)	WELL #5 TDS (mg/l)
1/82	2095			
2/82	2170			
3/82	1345			
4/82	1411			
5/82	2400			
6/82	2043			
7/82	2449			
8/82	2497			
9/82	2243			
10/82	2236			
11/82	2282			
12/82	2201			
1/83	2146	1575	2201	1988
2/83	2134	1545	2186	2018
3/83	2194	1585	2156	2100
4/83	2280	1740	2148	1980
5/83	2295	1772	2131	1996
6/83	2220	1655	2317	2063
7/83	2165	1630	2286	1994
8/83	2156			
9/83	2261			
10/83	2210			
11/83	2026			
12/83	2164			

TABLE E-2. Upper Floridan Aquifer Total Dissolved Solids Concentration Changes Over Time at the Sailfish Point Utility, Martin County (Continued)

MO/YR	COMPOSITE WELL #1 & #2 TDS (mg/l)	MO/YR	COMPOSITE WELL #1 & #2 TDS (mg/l)	MO/YR	COMPOSITE WELL #1 & #2 TDS (mg/l)
1/84	2188	1/86	2207	1/88	2265
2/84	2221	2/86	2225	2/88	2257
3/84	2216	3/86	2265	3/88	2302
4/84	2387	4/86	2315	4/88	2294
5/84	2199	5/86	2270	5/88	2589
6/84	2371	6/86	2181	6/88	2075
7/84	2232	7/86	2197	7/88	2464
8/84	2297	8/86	2145	8/88	2556
9/84	2150	9/86	2175	9/88	2460
10/84	2306	10/86	2172	10/88	2310
11/84	2336	11/86	2187	11/88	2407
12/84	2434	12/86	2220	12/88	2262
1/85	2382	1/87	2215	1/89	2154
2/85	2256	2/87	2232	2/89	2185
3/85	2298	3/87		3/89	2177
4/85	2229	4/87	2262	4/89	2377
5/85	2187	5/87	2292	5/89	2360
6/85	2285	6/87	2235	6/89	2219
7/85	2248	7/87	2192		
8/85	2322	8/87	2195		
9/85	2402	9/87	2217		
10/85	2189	10/87	2280		
11/85	2205	11/87	2182		
12/85	2227	12/87	2299		

TABLE E-2. Upper Floridan Aquifer Total Dissolved Solids Concentration Changes Over Time at the Sailfish Point Utility, Martin County (Continued)

MO/YR	COMPOSITE WELL #2 & #6 TDS (mg/l)	MO/YR	COMPOSITE WELL #2 & #6 TDS (mg/l)
7/89	2165	7/91	2721
8/89	2301	8/91	2422
9/89	2087	9/91	2688
10/89	2601	10/91	2123
11/89	2271	11/91	2403
12/89	2403	12/91	2340
1/90	2374	1/92	2501
2/90	2249	2/92	2426
3/90	2497	3/92	2356
4/90	2189	4/92	2491
6/90	2161	5/92	2369
7/90	2530	6/92	2382
8/90	2500	7/92	2436
9/90	2169	8/92	2356
10/90	2461	9/92	2523
11/90	2282	10/92	2177
12/90	2376	11/92	2514
1/91	2365	12/92	2374
2/91	2484		
3/91	2891		
4/91	2237		
5/91	2534		
6/91	2451		

TABLE E-3. Upper Floridan Aquifer Chloride Concentration Changes Over Time at the Town of Jupiter Utility, Palm Beach County

MO/YR	RO 1 CL (mg/l)	RO 2 CL (mg/l)	RO 3 CL (mg/l)	RO 4 CL (mg/l)
10/87	2298			
3/89		1850		
5/89			1775	
3/90	3460	1960	1866	2600
8/92	3800	2575	2950	2900
10/92	3800	2738	2975	2900
2/93		1900		2900

TABLE E-4. Upper Floridan Aquifer Total Dissolved Solids Concentration Changes Over Time at the Town of Jupiter Utility, Palm Beach County

MO/YR	R.O. COMPOSITE TDS (mg/l)
4/91	4720
5/91	4721
6/91	4554
7/91	4714
8/91	4300
9/91	4250
10/91	4534
11/91	4297
12/91	4379
1/92	4371
2/92	4390
3/92	4383
4/92	4468
5/92	4461
6/92	4491
7/92	4513
8/92	4459
9/92	4405
10/92	3648
11/92	4588
12/92	4338
1/93	3997
2/93	4422
3/93	4103
4/93	4049

TABLE E-5. Upper Floridan Aquifer Chloride Concentration Changes Over Time at the City of Vero Beach Utility, Indian River County

MO/YR	WELL #14 CL (mg/l)	WELL #21 CL (mg/l)	MO/YR	WELL #14 CL (mg/l)	WELL #21 CL (mg/l)	WELL #31 CL (mg/l)
1/79	278		12/82	410	440	
2/79	282		3/83	375	440	
3/79	298	304	5/83	375	455	
4/79	294	304	8/83	380	400	
5/79	295		11/83	405	420	
6/79	277		2/84	294	432	
7/79	293	331	5/84	372	452	
8/79	302	346	9/84	356	468	
12/79	325	325	12/84	400	400	
3/80	335	360	3/85	408	484	
5/80	321		6/85	380	468	
6/80		410	9/85	408	484	
9/80	330	395	12/85	404	496	
12/80	345	405	3/86	396	456	
3/81	315	410	6/86	354	461	
5/81	355	405	9/86	405	440	
8/81	350		12/86	395	490	
9/81		325	3/87	390	518	
11/81		295	6/87	375	490	
12/81	405		9/87	385	520	130
2/82	370	420	12/87		590	148
5/82	380	425	3/88	440	545	161
8/82	385	455	6/88	400	580	175

TABLE E-5. Upper Floridan Aquifer Chloride Concentration Changes Over Time at the City of Vero Beach Utility, Indian River County (Continued)

MO/YR	WELL #14 CL (mg/l)	WELL #21 CL (mg/l)	WELL #31 CL (mg/l)	WELL #5 CL (mg/l)
9/88	272	355	188	
12/88	493	454	210	
1,2,3/89	438	523	211	
4,5,6/89	438	515	202	
7,8,9/89	490	356	120	184
10,11,12/89	573	522	217	170
1,2,3/90	528	479	218	176
4,5,6/90	575	532	202	180
7,8,9/90		490	207	177
10,11,12/90	592	512		179
1,2,3/91	596	540		195
4,5,6/91	608	550		201
7,8,9/91	600	485		190
10,11,12/91	558	489	168	188
1,2,3/92	301	500	294	190
4,5,6/92	640	510	316	191
7,8,9/92	535	442	306	192
10,11,12/92	573	410	345	192

TABLE E-6. Upper Floridan Aquifer Total Dissolved Solids Concentration Changes Over Time at the City of Vero Beach Utility, Indian River County

MO/YR	WELL #14 TDS (mg/l)	WELL #21 TDS (mg/l)	MO/YR	WELL #14 TDS (mg/l)	WELL #21 TDS (mg/l)	WELL #31 TDS (mg/l)
1/79			12/82	654	1084	
2/79	902		3/83	718	906	
3/79	894	876	5/83	928	1060	
4/79	900	847	8/83	924	890	
5/79	904		11/83	972	982	
6/79	724		2/84	606	416	
7/79	964	916	5/84	942	1092	
8/79	1066	1120	9/84	876	1120	
12/79	836	892	12/84	934	950	
3/80	616	940	3/85	898	1198	
5/80	820		6/85	774	996	
6/80		934	9/85	796	876	
9/80	776	968	12/85	782	1040	
12/80	764	886	3/86	860	594	
3/81	866	928	6/86	484	1192	
5/81	774	636	9/86	922	1046	
8/81	676		12/86	904	1070	
9/81		678	3/87	914	1098	
11/81		742	6/87	952	1138	
12/81	915		9/87	978	1204	542
2/82	878	1034	12/87	1026	1228	562
5/82	906	1094	3/88	1080	1240	586
8/82	840	1046	6/88	1040	1290	622

TABLE E-6. Upper Floridan Aquifer Total Dissolved Solids Concentration Changes Over Time at the City of Vero Beach Utility, Indian River County (Continued)

MO/YR	WELL#14	WELL#21	WELL#31	WELL#5		
9/88	830	876	640			
12/88	1280	1160	704			
1,2,3/89	1100	1220	688			
4,5,6/89	1164	1280	684			
7,8,9/89	1194	960	774	636		
10,11,12/89	1400	1230	732	624		
1,2,3/90	1242	1160	742	450		
4,5,6/90	1350	1316	826	636		
7,8,9/90		1200	820	656		
10,11,12/90	1360	1240				
1,2,3/91	1340	1206		634		
4,5,6/91	1360	1350		646		
7,8,9/91	1384	1264		648		
10,11,12/91	1322	1194	912	646		
1,2,3/92	870	1190	800	630		
4,5,6/92	1340	1120	826	632		
7,8,9/92	1180	1080	840	664		
10,11,12/92	1290	1020	902	648		

TABLE E-7. Upper Floridan Aquifer Specific Conductance Changes Over Time at the City of Vero Beach Utility, Indian River County

MO/YR	WELL #14 Spec. Cond. (umhos/cm)	WELL #21 Spec. Cond. (umhos/cm)	MO/YR	WELL #14 Spec. Cond. (umhos/cm)	WELL #21 Spec. Cond. (umhos/cm)	WELL #31 Spec. Cond. (umhos/cm)	WELL #5 Spec. Cond. (umhos/cm)
2/79	1280		8/83	1500	1440		
3/79			11/83	1460	1420		
4/79	1280		2/84	2000	2050		
5/79	1290		5/84	1700	2000		
6/79	1300		9/84	1345	1725		
7/79	1390	1500	12/84	1555	1800		
8/79	1380	1550	3/85	1750	2000		
12/79	1340	1360	6/85		2025		
3/80	1260	1300	9/85	2050	1625		
5/80	1040	1190	12/85	1850	2050		
9/80	1325	1500	3/86	1700	1025		
12/80	1150	1280	6/86	1790	2000		
3/81	870	1020	9/86	1740	2010		
5/81	780	750	12/86	1890	2010		
8/81	1170		3/87	1650	2200		
9/81		1240	6/87	2200	2000		
12/81	1580	1170	9/87	1810	2250	1010	
2/82	1510	1720	12/87	1750	1880	860	
5/82	1500	1760	3/88	1900	2200	1025	
8/82	1540	1750	6/88	2000	2045	1100	
12/82	1590	1560	9/88	1450	1625	1180	
3/83	1500	1650	12/88	1990	1930	1250	
5/83	1570	1720	1,2,3/89	2000	2250	1320	1100

TABLE E-7. **Upper Floridan Aquifer Specific Conductance Changes Over Time at the City of Vero Beach Utility, Indian River County (Continued)**

MO/YR	WELL #14 Spec. Cond. (umhos/cm)	WELL #21 Spec. Cond. (umhos/cm)	WELL #31 Spec. Cond. (umhos/cm)	WELL #5 Spec. Cond. (umhos/cm)
4,5,6/89	1925	2400	1320	1000
7,8,9/89	2250	1925	1275	1200
10,11,12/89	2500	2300	1300	1150
1,2,3/90	2300	2050	1300	1100
4,5,6/90	2000	2500	1450	1000
7,8,9/90		2100	1200	1200
10,11,12/90	2500	2300		1150
1,2,3/91	2280	2180		1150
4,5,6/91	2420	2220		1200
7,8,9/91	2450	2120		1190
10,11,12/91	2320	2020	1600	1190
1,2,3/92	1500	2180	1500	1150
4,5,6/92	2450	2100	1550	1150
7,8,9/92	2200	2000	1550	1000
10,11,12/92	2360	1880	1650	1180

TABLE E-8. Upper Floridan Aquifer Specific Conductance Changes Over Time at the Ft. Pierce Utility, St. Lucie County

MO/YR	FB-1 Spec. Cond. (umhos/cm)	FB-2 Spec. Cond. (umhos/cm)
1/88	633	
1/91	1500	
8/91		1538
9/91		1529
1/92	1500	
1/93	1500	

TABLE E-9. Upper Floridan Aquifer Total Dissolved Solids Concentration Changes Over Time at the Ft. Pierce Utility, St. Lucie County

MO/YR	FB-1 TDS (mg/l)	FB-2 TDS (mg/l)
1/88	900	
1/89	882	
1/91	980	
9/91		894
1/92	980	
1/93	980	

TABLE E-10. Upper Floridan Aquifer Chloride Concentration Changes Over Time at the Ft. Pierce Utility, St. Lucie County

MO/YR	FB-1 CL (mg/l)	FB-2 CL (mg/l)
1/88	322	
1/89	326	
1/91	310	
8/91		270
9/91		256
1/92	310	
1/93	310	

TABLE E-11. Upper Floridan Aquifer Total Dissolved Solids Concentration Changes Over Time at Joe's Point Utility, Martin County

MO/YR	WELL #2 TDS (mg/l)	MO/YR	WELL #2 TDS (mg/l)
1/90	2493	1/92	2400
2/90	2092	2/92	2300
3/90	2130	3/92	2360
4/90	2140	4/92	2420
5/90	2200	5/92	2000
6/90	2320	6/92	2330
7/90	2440	7/92	2060
8/90	2050		
10/90	2390		
12/90	2340		
1/91	2080		
2/91	2410		
3/91	2300		
4/91	2040		
5/91	2100		
6/91	2270		
7/91	2370		
8/91	2330		
9/91	2350		
10/91	2100		
11/91	2090		
12/91	2360		

APPENDIX F

LOCATION OF LANDFILL SITES

LIST OF TABLES - APPENDIX F

TABLE F-1. Solid Waste Disposal Sites in the UECPA

MAP No.	SITE NAME	TYPE	STATUS Active /Inact	LINER	LOCATION T-R-S	ACRES	INFO. SOURCE CODE	COMMENTS
	MARTIN COUNTY LANDFILLS & DUMPS							
1	Hobe Sound	100	I	None	39S-42E-31		abd	Closed ~ 1977.
2	Martin Co. I (Palm City I)	100	I	None	38S-40E-7	40	ad	Closed 1985. Total Property 388 acres.
2	Martin Co. II (Palm City II)	100	I	20 mil PVC	38S-40E-7	10	a	
2	Martin Co. II (Palm City II)	100	A	Clay/PVC/Clay	38S-40E-7	5	abd	
2	Martin Co. II (Palm City II)	300	A	None	38S-40E-7	10	ad	
3	City of Stuart	100	I	None	38S-41E-16	62	ab	Closed 1980. Proposed golf course. There are 30 public wells within one mile. City was to perform remediation.
4	Town of Ocean Breeze	200	I	None	37S-41E-22		ab	
5	Indiantown Dump	520	I	None			ab	
	MARTIN COUNTY WWTP SLUDGE SPREADING SITES							USED BY:
6	Underhill	400	A	n/a		12,000	f	Envir. Sciences for South Central Regional WWTP
7	Brady	400	A	n/a		1,800	f	Envir. Sciences for South Central Regional WWTP
8	Allapattah Properties	400	A	n/a		14,000	f	H&H Sludge
9	Allapattah Properties	400	A	n/a		675	f	J&J Baker
10	Bessemer Properties	400	A	n/a		823	f	Martin County Solid Waste
11	Berg: Box Ranch	400	A	n/a		6,000	f	Hutchinson Utilities WWTP
	EASTERN OKEECHOBEE COUNTY LANDFILLS & DUMPS							
12	Okeechobee Co. Yard & Trash	320	A	None	36S-36E-13		b	Owner: Chambers Waste Systems of America
12	Okeechobee San. Landfill Phase I (Berman Road Landfill)	100	A		36S-36E-13		b	
	EASTERN OKEECHOBEE COUNTY WWTP SLUDGE SPREADING SITES WITHIN SFWMD							
15	Adam's Ranch	400		n/a				

TABLE F-1. Solid Waste Disposal Sites in the UECPA (Continued)

MAP No.	SITE NAME	TYPE	STATUS Active /Inact	LINER	LOCATION T-R-S	ACRES	INFO. SOURCE CODE	COMMENTS
	NORTH EASTERN PALM BEACH COUNTY LANDFILLS, DUMPS & SLUDGE DISPOSAL							
16	Jupiter Garbage Dump	100	I	None	40S-42E-34	10	e	Closed 1970. Ford Sanitation.
17	Salhaven Private Dump	520	I	None	41S-43E-7		e	Closed 1968. Alcoa Prop.
18	Juno Beach Dump	520	I	None	41S-43E-28, 29		e	Closed 1965.
19	Lake Park Trash Dump	310	I	None	42S-43E-20	4	e	Closed 1972.
20	W. Lake Park Rd. City Dump (N. County Dump)	520	I	None	42S-42E-14	60	e	Closed 1968. Palm Bch. County.
21	PBC Old Dyer Landfill	100	I	20 mil Top Cap	42S-42E-26	390	e	Closed 1983. Solid Waste Auth.
22	PBC Dyer Landfill	100 300	I I	30 mil reinf. 30 mil	42S-42E-35, 26	390	e	Closed 1990. Solid Waste Auth.
23	City of Riviera Bch Trash Dump	520	I	None	42S-42E-36	7	e	Closed 1972.
24	City of WPB Yard Trash	320	A I	None	43S-42E-01	80	e	Closed 1991.
25	City of WPB compost site	320	A	None	43S-42E-11	300	e	
26	Town of Palm Bch Yard Trash #2	310	A	None	43S-42E-26	5	e	
27	City of WPB Dreher Park Landfill	520	I	None	44S-43E-4	10-15	e	Closed 1965.
28	City of WPB Incinerator Landfill	200	I	None	43S-43E-32		e	Closed 1952.
29	Airport Trash Dump	310	A	None	43S-43E-31	1	e	Palm Bch County.
30	Pratt Whitney Landfill	100	I	None	41S-40E-14		e	Closed 1992. United Tech.
31	Tamerind Ave. Dump	500	I	None	43S-43E-09	11	e	Closed 1957. City of WPB.
32	Dixie Landfill	100	I	None	43S-42E-32	7.5	e	Closed 1979. Palm Bch County.
33	N. County. Resource Recovery Facility & Landfills	100 300	A A	60 mil HDPEx2 60 mil HDPE	42S-42E-34 43S-42E-03	150 235	e	Solid Waste Authority.
34	N. 161 St. Dump	520	I	None	41S-42E-12	2	e	
35	Town of Palm Bch Landfill #1	520		None	43S-43E-22	3	e	
36	Town of Palm Bch. Landfill #2	520		None	43S-43E-10		e	

TABLE F-1. Solid Waste Disposal Sites in the UECPA (Continued)

MAP No.	SITE NAME	TYPE	STATUS Active /Inact.	LINER	LOCATION T-R-S	ACRES	INFO. SOURCE CODE	COMMENTS
37	Airport #1	520	I	None	43S-43E-32	10	e	Closed 1967.
38	Airport #2	520	I	None	43S-43E-32	3/4	e	Closed 1966.
39	8th St. Landfill	520	I	None	42S-43E-31	15	e	
40	Consolidated Util. Sludge Disposal	400	I	n/a				
	ST. LUCIE COUNTY LANDFILLS & DUMPS							
41	St. Lucie Co. II (Glades Rd)	100	A	60 mil HDPE	35S-39E-36	60	abc	Total site 600 acres.
	St. Lucie Co. II (Glades Rd)	300	A	40 mil HDPE	35S-39E-36	10	abc	
	St. Lucie Co. I	100	A	Marl	35S-39E-36	25	b	
42	Hammond Road (Old City of Ft. Pierce I)	100	I	None	34S-40E-30	40	abc	Closed 1977. Sold to private owner in 1991.
	Center Road (Old City of Ft. Pierce II)	100	I	None	34S-40E-30	40	abc	Closed 1977. Located 1 mile south of Hammond Rd. Landfill. Sold to private owner in 1991.
42	St. Lucie Co. (Airport West)	100	I	None	34S-40E-19, 20	58	abc	Closed 1963. Across road from Ft. Pierce Landfills 1 and 2.
43	St. Lucie Co. (Airport N.E.)	100	I	None	34S-40E-19, 20	146	abc	Closed 1978 with remediation. Site is now a golf course.
44	White City Landfill	100		None	36S-40E-31	15	cb	
45	Stump Dump		I	None	Port St. Lucie		a	Construction/demo. debris.
46	City of Port St. Lucie	100	I	None	see comments	10	cb	Western Port St. Lucie. Closed 1971.
47	Old County Dump	520	I	None	see comments	20	cb	Closed approx. 1955. Current site of Indian River Comm. Coll.
48	Old Appliance Dump	520	I	None	see comments	10	c	Closed in early 1960s. South of Ft. Pierce City Limit.

TABLE F-1. Solid Waste Disposal Sites in the UECPA (Continued)

MAP No.	SITE NAME	TYPE	STATUS Active /Inact.	LINER	LOCATION T-R-S	ACRES	INFO. SOURCE CODE	COMMENTS
	ST. LUCIE COUNTY WWTP SLUDGE SPREADING SITES							
49	Biele	400	A	n/a			a	
50	Branscomb	400	I	n/a			a	
51	Dersam	400	I	n/a			a	
52	O'Connel	400	I	n/a			a	
53	Modine	400	A	n/a			a	
54	Stokes	400	A	n/a			a	
55	Frenz Enterprises Sludge Disp. 2	400	A	n/a	T36-R39-10		bc	Lime stabilized septage and WWTP sludge.
56	HES Corp; Roundtree Citrus Ranch	400	A	n/a	T35-R37-01		bc	
57	HES Trnsp. Sludge Disposal	400	I	None	T35-R39-21		bc	

KEY:

CLASS CODES (Type)

100 Class I Landfill
200 Class II Landfill
300 Class III Landfill
310 Trash/Yard Trash
320 Trash Composting
400 SludgeDisposal Facility
520 Old Dump

INFORMATION SOURCE CODES:

a FDER, West Palm Beach (Geetha Silvendra)
b SFWMD, Regulation Dept. (Eduardo Lopez)
c St. Lucie Co. Dept. of Public Works (Ron Sigmon)
d Martin Co. Solid Waste Dept. (Ray Cross)
e Solid Waste Authority of P.B. County (Ken Berg/Al Vasquez)
f Martin County Public Health Unit (Charles Hassler/Joe Grusauskas)