GROUND-WATER RESOURCE AVAILABILITY INVENTORY:

CHARLOTTE COUNTY, FLORIDA

1961

SOUTHWEST FLORIDA WATER
MANAGEMENT DISTRICT
MARCH 1988

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PREPARED BY: RESOURCE MANAGEMENT AND PLANNING DEPARTMENTS OF THE SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

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EXECUTIVE SUMMARY

In response to increased local and national attention focusing on the availability and quality of our ground-water resources, the 1982 Florida Legislature directed each of Florida's five Water Management Districts to conduct a Ground-Water Basin Resource Availability Inventory "covering areas deemed appropriate by the Districts' Governing Boards". The completion of this Inventory in the Southwest Florida Water Management District (SWFWMD) is targeted for early 1988, and will culminate with the completion of county Inventory reports for 13 of the 16 counties within the SWFWMD's jurisdiction. The three remaining counties will be inventoried by other Water Management Districts. All 16 of these reports will be periodically updated to reflect additional data collection, analyses, and interpretations.

The county reports are divided into three sections. The first section includes an introduction, description of the purpose and scope, and a discussion of previous investigations. Section Two contains a discussion of the hydrology and related inventory issues of the ground-water basin(s) within which the county is located. Section Three contains a discussion of the hydrology and related inventory issues for the individual county.

This report contains a discussion of the hydrology and relevant Inventory issues for Charlotte County, Florida, which is entirely within the Southern West-Central Florida Ground-Water Basin (SWCFGWB). The significant findings relative to the Inventory are summarized below.

Basin Findings:

1) The SWCFGWB encompasses approximately 7,300 square miles and is bounded on the east by the axis of the Green Swamp/Central Florida Ridge potentiometric high of the Floridan aquifer system, on the north by the axis of the Pasco and Green Swamp potentiometric highs, on the south by a ground-water divide aligned in a northeast-southwest direction and bisects Glades and Lee Counties, and on the west by the Gulf of Mexico.

2) The SWCFGWB is underlain by a multi-layered aquifer system which includes the surficial, intermediate, and Floridan aquifer systems. The intermediate and Floridan systems can be

further subdivided into multi-unit aquifers. The surficial system varies from zero to greater than 200 feet in thickness. Thickness of the intermediate system varies from zero to 650 feet and the Floridan system varies from 800 to 2,200 feet. Both intermediate and Floridan systems thicken to the south-southwest.

3) The Upper Floridan aquifer system is by far the most productive aquifer in the SWCFGWB and supplies more than ten times the amount of water pumped from either the surficial or intermediate aquifer systems. However, the importance of the Floridan system as a source of potable water diminishes as the water quality deteriorates in the southern and western areas of the SWCFGWB. In these areas, concentrations of dissolved solids, chloride, and sulfate exceed maximum recommended drinking water standards.

4) Ground-water recharge to and discharge from the intermediate and Floridan aquifer systems in the basin is variable. In the northern and eastern areas of the basin the Floridan and intermediate aquifer systems are recharged at relatively high rates (>10 inches per year). In the southern and western areas of the basin the intermediate and Floridan aquifer systems discharge water to the surficial system.

5) The susceptibility to ground-water contamination of the basin aquifer system was mapped using the "DRASTIC" methodology, recently developed by the U.S. Environmental Protection Agency (EPA). The Floridan aquifer system is highly susceptible to ground-water contamination in the northern areas of the SWCFGWB and is less susceptible in the southern areas, primarily due to thickening of clay units overlying the Floridan in the southern area. Where the intermediate aquifer system is present in Highlands, Hillsborough, and Polk Counties, the aquifer is more susceptible to ground-water contamination than in the counties to the south. The surficial aquifer system is highly susceptible to contamination throughout the SWCFGWB.

6) During 1986, on an average daily basis, approximately 1,333 million gallons per day (Mgal/d) were withdrawn from within the SWFWMD jurisdictional areas of the SWCFGWB. Of this an estimated 600 Mgal/d was for agriculture, 360 Mgal/d was for public supply, 351 Mgal/d was for industrial pumpage, and 22 Mgal/d was withdrawn for domestic and other uses.

7) Although the SWCFGWB as a whole has not experienced an overdraft problem, there are areas where ground-water withdrawals are significant. Areas of the SWFWMD, within the SWCFGWB, that have significant ground-water withdrawals include central and southwestern Pasco County; northwest, central, and southwestern Hillsborough County; east-central, southwestern, and west-central Polk County; north-central Manatee County; north-central Hardee County; east-central Highlands County; southwestern DeSoto County; and, northwestern and coastal Charlotte County.

8) Under Chapter 373.042 Florida Statutes, the SWFWMD enacted Chapters 40D-8 and 40D-2 of its rules and regulations to specifically address criteria needed to establish minimum seasonal surface and ground-water levels. The intent of these

rules is to regulate water use so that the water resources are managed in such a way as to conserve those resources while allowing them to be put to their full beneficial use. Lake management levels have been established for 256 of the approximately 490 eligible lakes in the SWCFGWB under the SWFWMD's Lake Level Management Program. With the exception of ground-water regulatory levels for several of the major municipal wellfields in northwest Hillsborough County, regional minimum streamflow, and ground-water regulatory levels have not been implemented in the remainder of the basin. However, minimum streamflow and ground-water levels are addressed, on an individual basis, in the SWFWMD's Consumptive Use Permitting (CUP) Program.

9) In general, areas most suitable for potable ground-water resource development from the Floridan aquifer system are in the northern and eastern areas of the basin. However, the Floridan aquifer is capable of yielding large quantities of water in the southern and western areas of the basin. These waters can be utilized as source water for demineralized potable supply and other uses, such as for agricultural and industrial purposes. In general, areas most suitable for potable ground-water resource development from the intermediate aquifer system include eastern Manatee, north-eastern Sarasota, central and western Hardee, eastern DeSoto, and western Highlands Counties. As with the Floridan aquifer system, the intermediate system is capable of yielding significant quantities of water in coastal and southern counties of the basin. However, concentrations of certain water quality constituents exceed potable standards and demineralization is needed to utilize these waters for potable use. In general, areas most suitable for potable ground-water resource development from the surficial aquifer system include essentially all of the basin, except coastal areas. Yields are nearly always small, and with the exception of limited domestic wells, the surficial aquifer is a significant source of potable water in only the extreme southern counties of the basin where water quality of the Floridan and intermediate systems exceed potable standards.

10) Though trillions of gallons of potable water are stored in the surficial, intermediate, and Floridan aquifer systems in the SWCFGWB, only a small fraction of this resource is available for consumptive use. The amount of potable water available for consumptive use is generally a function of "safe yield", which can be defined as the amount of water that can be withdrawn without producing unacceptable effects such as significant lowering of lake levels and water table, significant reductions of spring and streamflow, saltwater intrusion, and significant environmental damage. The "safe yield" of the entire basin has not been determined at this time; however, the SWFWMD is refining a regional model of the entire basin from which detailed data on water resource availability can be derived in general terms. Additionally, the SWFWMD has initiated comprehensive water availability investigations in areas of the SWCFGWB where existing water use competition has resulted in significant impacts to the surface and ground-water resources, and associated natural systems. The first of these investigations include the areas of northwest Hillsborough

County, south Hillsborough - north Manatee Counties, and the ridge areas of Polk and Highlands Counties.

11) The SWFWMD and SFWMD conduct a number of continuing programs to study, assess, and manage the water resources of the SWCFGWB. The SWFWMD programs include: Hydrologic Data Collection and Monitoring Program, Regional Observation and Monitoring Program (ROMP), Quality of Water Improvement Program (QWIP), Surface Water Improvement and Management Program (SWIM), Save Our Rivers Program (SOR), Ambient Ground-Water Quality Monitoring Program (AGWQMP), Agricultural Irrigation Monitoring Program (AIM), Land Management Program, Aquatic Plant Management Program, Conservation Projects Program, Outreach Program, and Regulatory Programs. An overview of each of these programs is included in this report.

County Findings:

12) Charlotte County, which is located entirely within the SWCFGWB, is underlain by a multi-layered, freshwater aquifer system which includes the surficial, intermediate, and Floridan aquifer systems. The Floridan system, which can be divided into the Upper and Lower Floridan aquifers throughout the county, is approximately 1,800 feet thick. The intermediate system, which can be divided into the Tamiami-Upper Hawthorn and Lower Hawthorn-Upper Tampa aquifers, varies from less than 375 feet in the northern areas to greater than 500 feet in the south. The surficial system varies from less than 75 feet to greater than 100 feet, and is thickest in the northeastern and western areas of the county.

13) Charlotte County has limited potable surface and ground-water resources. Presently, approximately 2.7 Mgal/d of the 9.5 Mgal/d of municipal water supply in the county is derived from ground-water sources. About 1.1 Mgal/d of this 2.7 Mgal/d of ground water is imported from Englewood Wellfield in Sarasota County. Approximately 4.3 Mgal/d of surface water is imported from the Peace River in DeSoto County and about 2.4 Mgal/d is withdrawn from Shell Creek in Charlotte County.

14) Potable ground-water withdrawal from the Floridan aquifer system is restricted in Charlotte County because of the poor quality of water produced. Mineralization increases with depth, towards the south, and towards the coast where the surficial and intermediate aquifer systems are utilized. The intermediate aquifer is the principal potable ground-water source in Charlotte County. Surface water, however, is the principal potable water supply in the county.

15) Several studies indicate ground-water recharge rates to the intermediate and Floridan aquifer systems in Charlotte County are low. The highest recharge rates to the Floridan in the county are less than 2 inches per year and occur in the northeastern upland areas (Stewart, 1980). Generally, discharge occurs from the Floridan aquifer along the coast and in central Charlotte County. The highest recharge rates to the intermediate aquifer system in the county are estimated to be less than two inches per year, but occur in a very limited area of northeastern Charlotte County. However, ground-water is actually discharged from the intermediate system in most of

Charlotte County. Infiltration rates to the surficial system in the county vary depending on depth to the water table, soil type, soil moisture, topography, vadose zone material, evapotranspiration, and runoff characteristics. Infiltration rates to the surficial system probably range up to 20 inches per year. Ground-water recharge areas most suitable for protection in Charlotte County include the extreme northeastern area of the county.

16) Results utilizing EPA methodology indicate that the surficial aquifer is highly susceptible to ground-water contamination in Charlotte County. This is primarily due to the shallow depth to the water table. Upland areas in northeastern Charlotte County are slightly less susceptible to contamination, because of the greater depths to the water table. The intermediate and Floridan aquifers have a very low susceptibility to contamination due to thick overlying confining layers which impede contamination.

17) Although Charlotte County is not presently experiencing an overdraft problem, there are areas of significant ground-water withdrawals. These areas include Rotunda West, Charlotte Harbor, Punta Gorda Isles, and Gasparilla Island Wellfields. These areas should be closely monitored to protect aquifers from saltwater encroachment, increased mineralization, and impacts to the terrestrial environment.

18) Proper management of the ground-water resource requires consideration of the potential for reuse of water. Currently, over eighty-five percent of the domestic class wastewater effluent within Charlotte County is produced by three large treatment plants. Primary disposal methods are rapid infiltration basins and drainfields. As large central wastewater facilities are constructed to meet the needs of the growing population, wastewater reuse options such as turf and agricultural irrigation may provide cost-effective disposal alternatives. This strategy could also decrease existing demand for potable water supplies and reduce the need for the development of new facilities.

19) One of the requirements of local government comprehensive plans requires local governments to show water wells and "cones of influence" on existing and future land use maps. A map that shows the locations of public water supply facilities in Charlotte County is included in this report. The SWFWMD does not currently have adequate data to define cones of influence for all the wells in Charlotte County. The SWFWMD's position concerning cones of influence is summarized below:

    a) Comprehensive plans should include policies that reflect local government's commitment to protect water quality by developing an effective wellfield protection program. Defining a cone of influence is one part of a total wellfield protection program.

    b) Estimation of cones of influence may involve extensive on-site testing and a sophisticated modeling process. To serve as a basis for land use decisions, the cones must be legally and technically defensible.

c) Preliminary limits for cones of influence may be mapped, based on best available data, at an early stage of a wellfield protection program to provide guidelines for studies and to comply with rule 9J-5. However, such limits must be recognized as being subject to change as a wellfield protection program is developed.

d) The assistance of public agencies such as the DER, regional planning councils, and the water management districts, and the use of qualified private consultants where appropriate, should be sought in defining cones of influence and in the development of wellfield protection programs.

20) Projections of population levels indicate that Charlotte County's population will increase to approximately 160,000 by the year 2010. Consequently, ground-water withdrawal rates are expected to increase to meet these growth demands. Northeastern Charlotte County appears to be most suitable for future ground-water supply development to meet these demands. Continued growth along with poor water quality support increased conservation, water reuse, and demineralization as a basic water treatment process as well as a supplemental water source in Charlotte County.

GROUND-WATER BASIN RESOURCE AVAILABILITY INVENTORY

ILLUSTRATIONS

TABLES

I. INTRODUCTION

Ground water is clearly one of the nation's most valuable resources supplying approximately forty percent of the water used for all purposes exclusive of hydropower generation and electric powerplant cooling. Americans have long depended on ground water for many uses, but the primary use has been as a source for drinking water. Over ninety percent of the nation's public supply systems, which account for approximately sixty percent of the public supply, utilize ground water as their source water (Lappenbusch, 1984). Additionally, ninety-seven percent of the water needs for domestic use in rural areas is served by ground-water resources (Solley and others, 1983). In Florida, ground water may be considered an even more precious commodity supplying greater than ninety percent of all drinking water. However, rapid population growth, urban sprawl, and increased agricultural and industrial activities during the past several decades have significantly impacted both the availability and quality of the state's ground-water resources.

In response to these impacts and increased local and national attention focusing on the availability and quality of our ground-water resources, the Florida Legislature enacted a series of legislative acts designed to protect the quality and assure adequate quantities of this most valuable resource. Included in these acts was the 1982 amendment (Section 373.0395, Florida Statues) of the 1972 Florida Water Resource Act, (Chapter 373, Florida Statues) which directed each of the state's five Water Management Districts (WMDs) to conduct a Ground-Water Basin Resource Availability Inventory (GWBRAI) "covering areas deemed appropriate by the District's Governing Board." The inventory was to include, but not be limited to, the following:

1. A hydrologic study to define the ground-water basin and its associated recharge areas;

2. Delineation of site specific areas in the basin deemed prone to contamination or overdraft resulting from current or projected development;

3. Delineation of prime ground-water recharge areas;

4. Criteria needed to establish minimum seasonal surface and ground-water levels;

5. Areas suitable for future water resource development within the ground-water basin;

6. Existing sources of wastewater discharge suitable for reuse as well as the feasibility of integrating coastal wellfields; and,

7. Potential quantities of water available for consumptive use.

Upon completion, a copy of the GWBRAI was to be submitted to each affected municipality, county, and regional planning agency and reviewed for consistency with the local government's comprehensive plan and to be considered in future revisions of such plans. It was the intent of the legislature that future growth and development planning reflect the limitations of the available ground water or other available water supplies.

PURPOSE AND SCOPE

The GWBRAI has two primary goals: the short-term goal is to provide local governments with available ground-water information, while the long-term goal is to enhance each WMD's technical capability to quantify and predict ground-water availability. Accomplishment of these objectives should enhance the protection of ground-water quality and quantity through effective land use planning, including identifying water resource limitations in future growth and development patterns.

The Southwest Florida Water Management District (SWFWMD) will be completing the GWBRAI for 13 of the 16 counties within its jurisdiction between January 1987 and March, 1988. These counties are Charlotte, Citrus, DeSoto, Hardee, Hernando, Hillsborough, Manatee, Marion, Pasco, Pinellas, Polk, Sarasota, and Sumter. Primarily, existing hydrologic, geologic, physiographic, demographic, and water use data are being compiled and evaluated to complete the GWBRAI. These data are being utilized to define the ground-water basins and their associated recharge areas, delineate site specific areas deemed prone to contamination or overdraft, delineate areas suitable for future water resource development, define criteria needed to establish minimum seasonal surface and ground-water levels, and delineate existing sources of wastewater discharge suitable for reuse, as well as assess the feasibility of integrating coastal wellfields. Additionally, the United States Environmental Protection Agency's (EPA's) recently developed DRASTIC* methodology, which ranks areas relative to their susceptibility to ground-water contamination from strictly a hydrogeologic viewpoint, is being utilized to aid in delineating site specific areas within the basins prone to contamination and to aid in locating areas suitable for future water resource development. Lastly, comprehensive hydrologic investigations, have been initiated to determine potential quantities of water available for consumptive use, establish seasonal surface and ground-water levels, aid in identifying ground-water recharge areas, and to aid in identifying areas suitable for future water resource development. These investigations will be useful in further addressing GWBRAI issues upon their completion.

The most detailed investigations are being developed in areas where existing water use competition has resulted in significant impacts to the surface and ground-water resources, and associated natural systems. These investigations, which are critical in determining water resources availability, are envisioned to result in management alternatives consistent with the available resources. In other areas minimal surface and ground-water levels will continue

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*The acronym DRASTIC is derived from the seven primary hydrologic parameters evaluated to determine an area's susceptibility to ground-water contamination. These parameters are Depth to water, Recharge, Aquifer characteristics, Soil type, Topography, Impact of the vadose zone, and Hydraulic Conductivity.

to be established based on criteria of the SWFWMD's Lake Level and Consumptive Use Permit (CUP) programs.

The compilation and evaluation of existing data, and the construction of DRASTIC maps will be completed and included in the thirteen county GWBRAI reports scheduled for completion in early 1988. However, the comprehensive investigations are targeted for completion in the late 1980's and early 1990's. Existing data and the DRASTIC maps will be utilized to qualitatively assess potential quantities of water available for consumptive use, to identify areas of ground-water recharge, to identify areas suitable for future water resource development, and to establish seasonal surface and ground-water levels. Quantitative assessment of these issues will be addressed in the comprehensive investigations. Upon completion of these investigations the county GWBRAI reports will be updated to include a more accurate assessment of water resources in the counties throughout the SWFWMD.

This report is divided into three sections. Section one includes an introduction, purpose and scope, and inventory of previous investigations. Section two is a physical and hydrologic discussion of the Southern West-Central Florida Ground-Water Basin (SWCFGWB), including recharge and discharge areas, minimum flows and levels criteria, areas deemed prone to contamination or overdraft, locations of potential point and non-point sources of contamination, areas suitable for water resource development, and major water resource activities in the SWCFGWB. Section three is a physical, demographic, and hydrologic assessment of Charlotte County and includes recharge and discharge areas, areas susceptible to ground-water contamination, water supply sources and alternatives, and a generalized discussion of the implications for county planning efforts. Additionally, a glossary is included as Appendix A, a summary of related Florida legislation as Appendix B, data on lakes in the SWCFGWB at which the SWFWMD has established management levels as Appendix C, a listing and location of the SWFWMD's Hydrologic Data Base (HDB) sites in Charlotte County as Appendix D, a description and location map of the SWFWMD's Ambient Ground-Water Quality Monitoring Program (AGWQMP) sites in Charlotte County as Appendix E, a location map of the SWFWMD's Agricultural Irrigation Monitoring sites in the SWCFGWB as Appendix F, Charlotte County DRASTIC indices as Appendix G, and point source waste site information for Charlotte County as Appendix H.

PREVIOUS INVESTIGATIONS

Southern West-Central Florida Ground-Water Basin (SWCFGWB)

Water supply development has been studied in many reports for areas located within the SWCFGWB. The "Hydrobiologic Assessment of the Alafia and Little Manatee River Basins," by Dames and Moore (1975), and the "SWFWMD Water Management Plan," (1978) identifies water management concepts, requirements, projections, rules, and a physical description of the SWFWMD area which includes the SWCFGWB, "The Four River Basins Water Resources Management Study and Evaluation," by Hayes and others (1978), covered the entire SWFWMD and takes into account many regional considerations and alternatives for potential water supply development. "The MacArthur Tract Hydrologic and Water-Supply Investigation," by Geraghty and Miller

(1981), address water supply proposals on the local county level. "The Water Resources of Manatee County," by Brown (1983), and the "Regional Water Supply Needs and Sources 1985-2020 Update Study," by Camp, Dresser and McKee (1986), prepared water system master plans for Hillsborough, Pasco, and Pinellas Counties, and the "Peace River/Manasota Regional Water Supply Authority Emergency Interconnect Study - Phase One," by Boyle Engineering Corp (1986), is a study of the interconnections between public water systems in Manatee, Sarasota, DeSoto, and Charlotte Counties.

The hydrology and geology of the SWCFGWB have been referenced in many reports published by several authors from governmental agencies. Several ground-water flow computer models have been developed in the SWCFGWB area, the major studies are: "Model Evaluation of the Hydrogeology of the Morris Bridge Wellfield and Vicinity in West-Central Florida," by Ryder and others (1980), "The Simulated Effects of Ground-Water Development on Potentiometric Surface of the Floridan Aquifer, West-Central Florida," by Wilson and Gerhart (1980), "Hydrogeology, Estimated Impact, and Regional Well Monitoring of Subsurface Wastewater Injection, Tampa Bay Area, Florida," by Hickey (1981), "Hydrogeology of Well-Field Areas Near Tampa, Florida, Phase 2," by Hutchinson (1984), "The Hydrology of the Floridan Aquifer System in West-Central Florida," by Ryder (1985), and the "Development and Documentation of a Transient, Quasi-Three-Dimensional, Finite Difference Model of the Tri-County Well-Field Area," by Bengtsson (1987).

Descriptions of the hydrogeology are well presented in the following reports: "Physiographic Divisions of Florida Map Report," by Brooks (1981), "Hydrogeology of the Sarasota-Port Charlotte Area, Florida," by Wolansky (1983), "Assessment of the Interconnection Between Tampa Bay and the Floridan Aquifer, Florida," by Hutchinson (1983), "Water Resources Atlas of Florida," by Fernaldo and Patton (1984), "Hydrogeology of the SWFWMD," by Gilboy (1985), "Types, Features, and Occurrences of Sinkholes in the Karst of West-Central Florida," by Sinclair and others (1985), describe physiographic and geologic features of the SWCFGWB. "Hydrogeologic Framework of the Floridan Aquifer System in Florida and in Parts of Georgia, Alabama, and South Carolina," by Miller (1986), "Hydrogeology of Surficial and Intermediate Aquifers of Central Sarasota County, Florida," by Duerr and Wolansky (1986), and "Aquifer Characteristics within the SWFWMD," SWFWMD (1987).

As part of a statewide inventory, the "Springs in Florida," by Rosenau and others (1977), describe several of the large springs included in the SWCFGWB. The Reports: "Chloride Concentrations in the Coastal Margins of the Floridan Aquifer," by Causseaux and Fretwell (1983), and "Distribution of Selected Chemical Constituents in Water From the Floridan Aquifer, SWFWMD," by Corral (1983), map chloride, sulfate, and TDS concentrations along the coastal margins of the Floridan aquifer system. The "Design and Establishment of a Background Ground Water Quality Monitor Network in the SWFWMD," by Moore and others (1986), describes the Ambient Ground-Water Quality.

Surface water is important as a public supply source in the SWCFGWB. Notable studies on this subject are: "Instream Reservoir Yield Analysis: Lake Manatee Reservoir," by Nguyen and McLean (1982), "Shell Creek Reservoir Expansion Option Analysis," by Nguyen and

McLean (1982), "Offstream Reservoir Yield Analysis: Peace River/Ft. Ogden Reservoir," by Nguyen and McLean (1983), "Instream Reservoirs Along the Tributaries of the Peace River," by SWFWMD (1985), and "Tampa Reservoir System Water Supply Analysis," by Ingram (1986).

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SECTION TWO

HYDROLOGIC INVESTIGATION AND RELEVANT GROUND-WATER BASIN RESOURCE AVAILABILITY INVENTORY ISSUES OF THE SOUTHERN WEST-CENTRAL FLORIDA GROUND-WATER BASIN

II. GROUND-WATER BASIN OVERVIEW

INTRODUCTION

A ground-water basin is a three-dimensional closed hydrologic unit that contains the entire flow paths followed by all water recharging the basin (Freeze and Witherspoon, 1966). The bottom boundary is usually an impermeable basement rock and the top boundary is land surface. The lateral boundaries are imaginary vertical impermeable ground-water divides. These ground-water divides are generally delineated by high and low ridges in the potentiometric surface of the aquifer. Although not as well defined as the more pronounced ground-water basins of western United States, ground-water resources in Florida can be divided into several distinct ground-water basins. Figure 1 is a modified version of Fisk's (1983) delineation of the ground-water basins in Florida. Two ground-water basins occur in west-central Florida and include nearly the entirety of the SWFWMD. For the purpose of this report these two basins are termed the Northern West-Central Florida Ground-Water Basin (NWCFGWB) and the Southern West-Central Florida Ground-Water Basin (SWCFGWB).

The SWCFGWB is bounded on the east by the axis of the Green Swamp/ Central Florida Ridge potentiometric high of the Floridan aquifer system, the most pronounced ground-water divide in peninsular Florida (Figures 1 and 2). To the north, the SWCFGWB is bounded by the axis of the Pasco and Green Swamp potentiometric highs, and on the south, by a ground-water divide aligned in a northeast-southwest direction that bisects Glades and Lee counties. To the west the SWCFGWB is bounded by the Gulf of Mexico. The NWCFGWB is bounded on the north by the axis of the Keystone and Bronson potentiometric highs, on the south by the Pasco and Green Swamp highs, on the east by the Green Swamp and Keystone highs, and on the west by the Gulf of Mexico. Although ground-water basin boundaries may change due to climatic conditions or ground-water withdrawals, presently ground-water north of the Pasco-Green Swamp divide flows north and west to the Gulf of Mexico and water to the south flows south and west to either the Gulf of Mexico or the Tampa Bay-Ruskin potentiometric low.

HYDROLOGIC AND PHYSICAL DESCRIPTION OF THE BASIN

GEOGRAPHIC SETTING, TOPOGRAPHY, AND DRAINAGE

The SWCFGWB is approximately 7,300 square miles in extent and includes all of DeSoto, Hardee, Hillsborough, Manatee, Pinellas, and Sarasota counties, and major areas of Charlotte, Glades, Highlands, Lee, Pinellas, Pasco, and Polk, counties (Figure 3). The SWCFGWB is characterized by relatively flat, generally swampy lowlands in the coastal areas with elevations increasing gradually to the east where a series of north-northwesterly trending ridges disrupt the landscape in Polk County. Land surface elevations range from sea level at the coast to greater than 290 feet above the National Geodetic Vertical Datum (NGVD) at several places along the Lake Wales Ridge (Figure 4). The ridges produce an irregular topography of rolling hills and valleys, but are generally outlined by the 150-foot contour. East and south of the ridges, the elevation ranges from 50 to 150 feet above NGVD and the topography is relatively

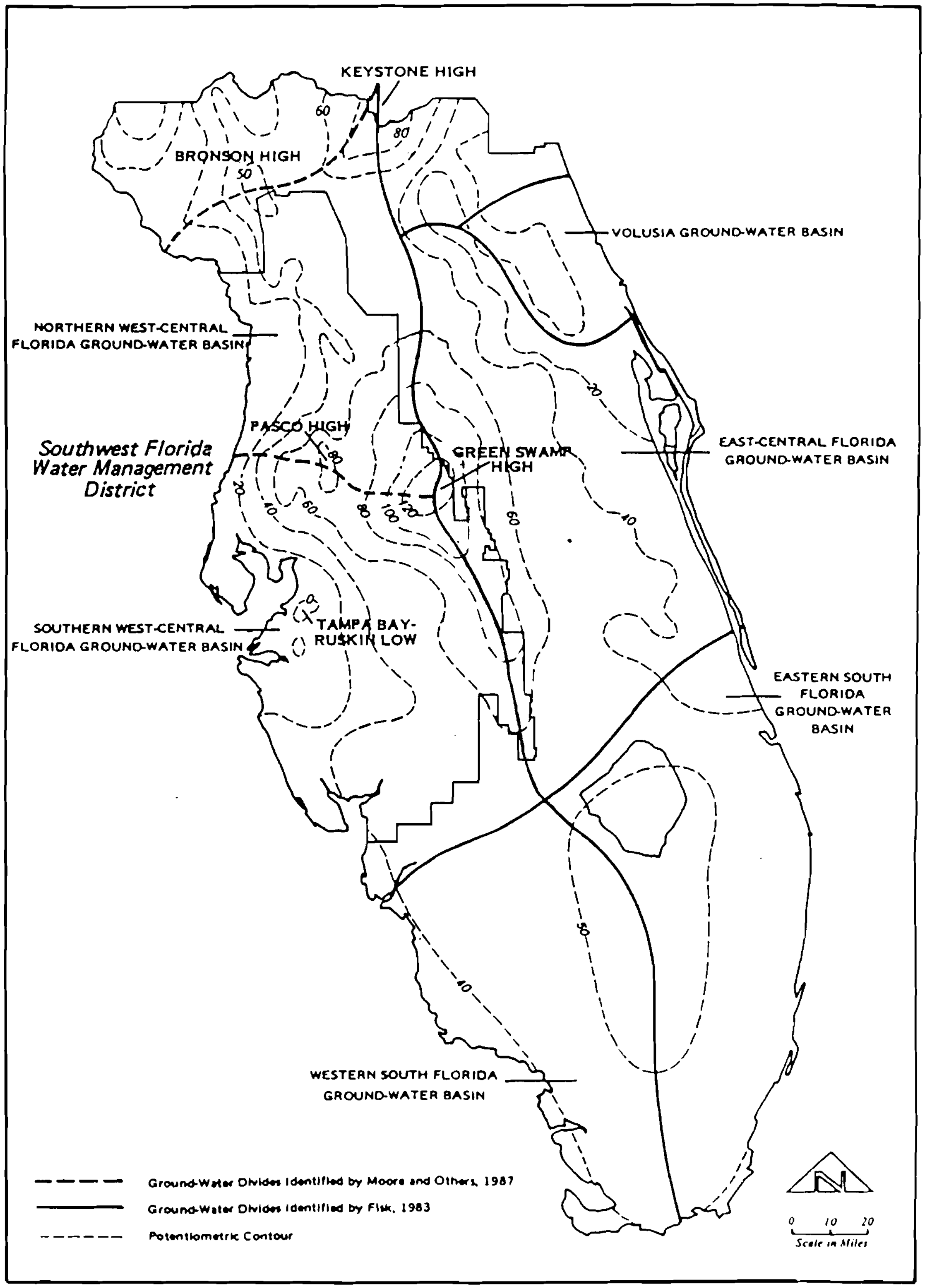


Figure 1. May 1980 potentiometric surface of the Floridan aquifer in peninsular Florida with the major ground-water basins delineated. Modified from Fisk (1983) and Johnston, Healy and Hayes (1981).

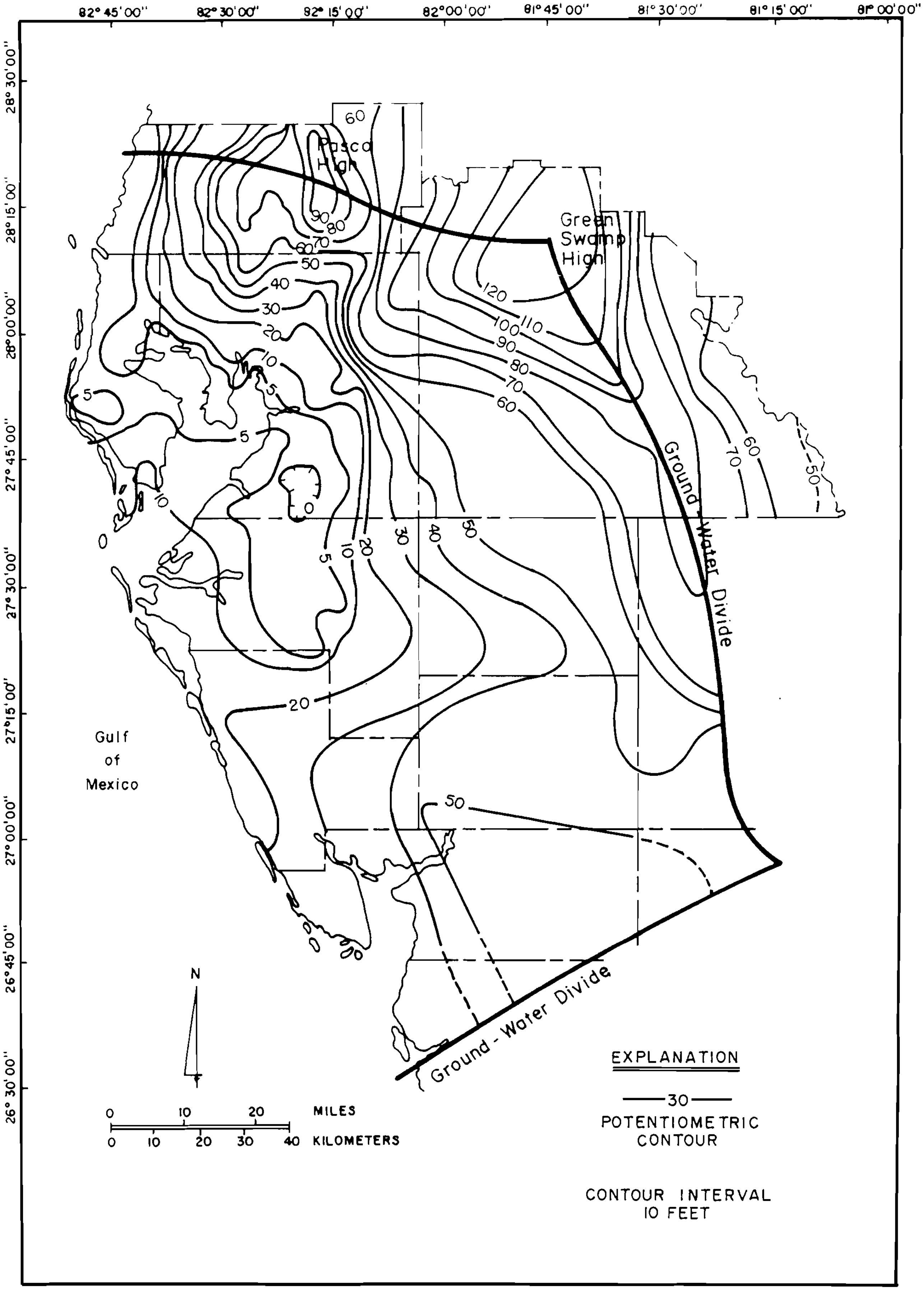


Figure 2. Delineation of the Southern West-Central Florida Ground-Water Basin with the May 1987 potentiometric surface of the Upper Floridan aquifer (modified from Lewelling, 1987).

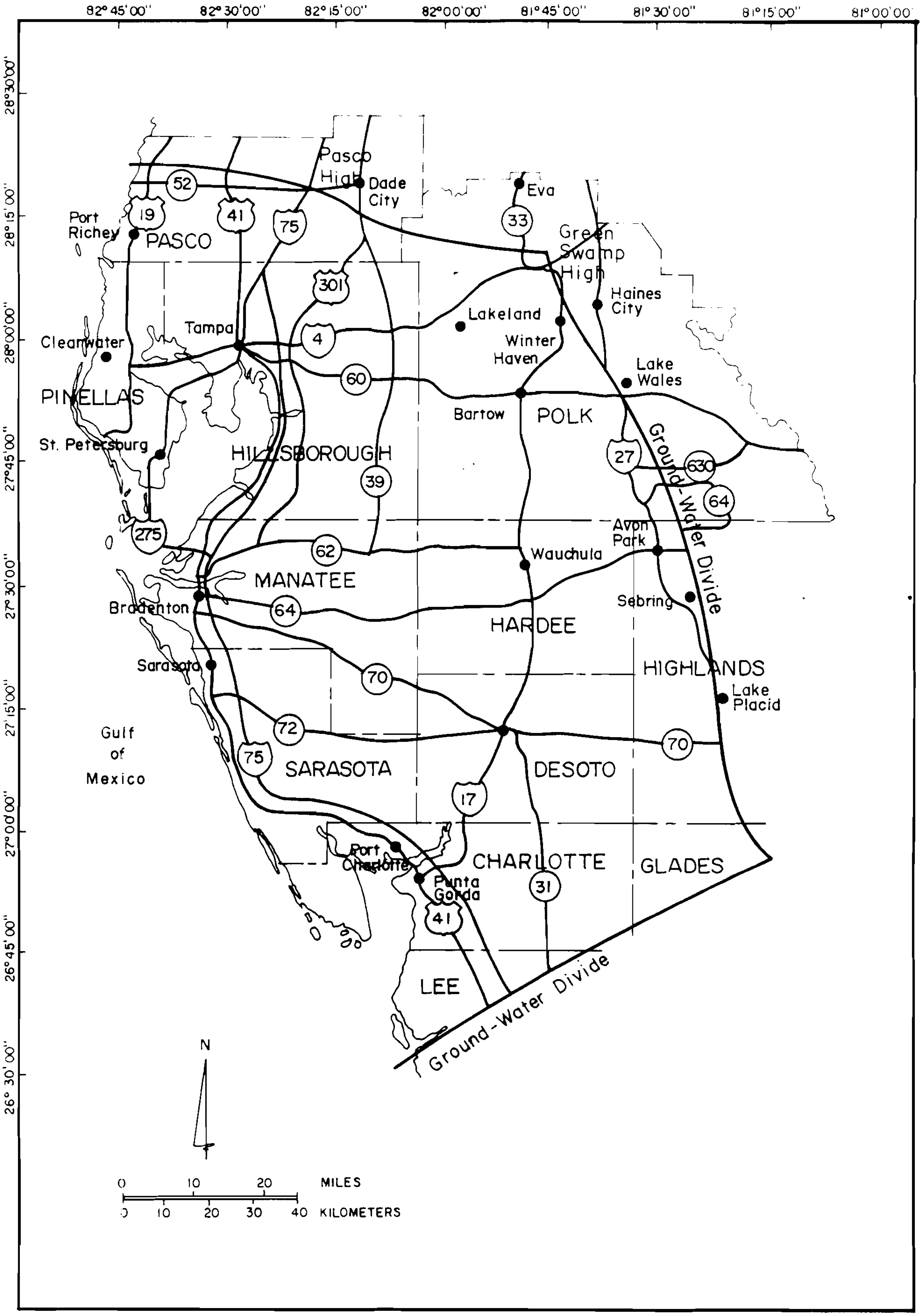


Figure 3. Location map of the Southern West-Central Florida Ground-Water Basin.

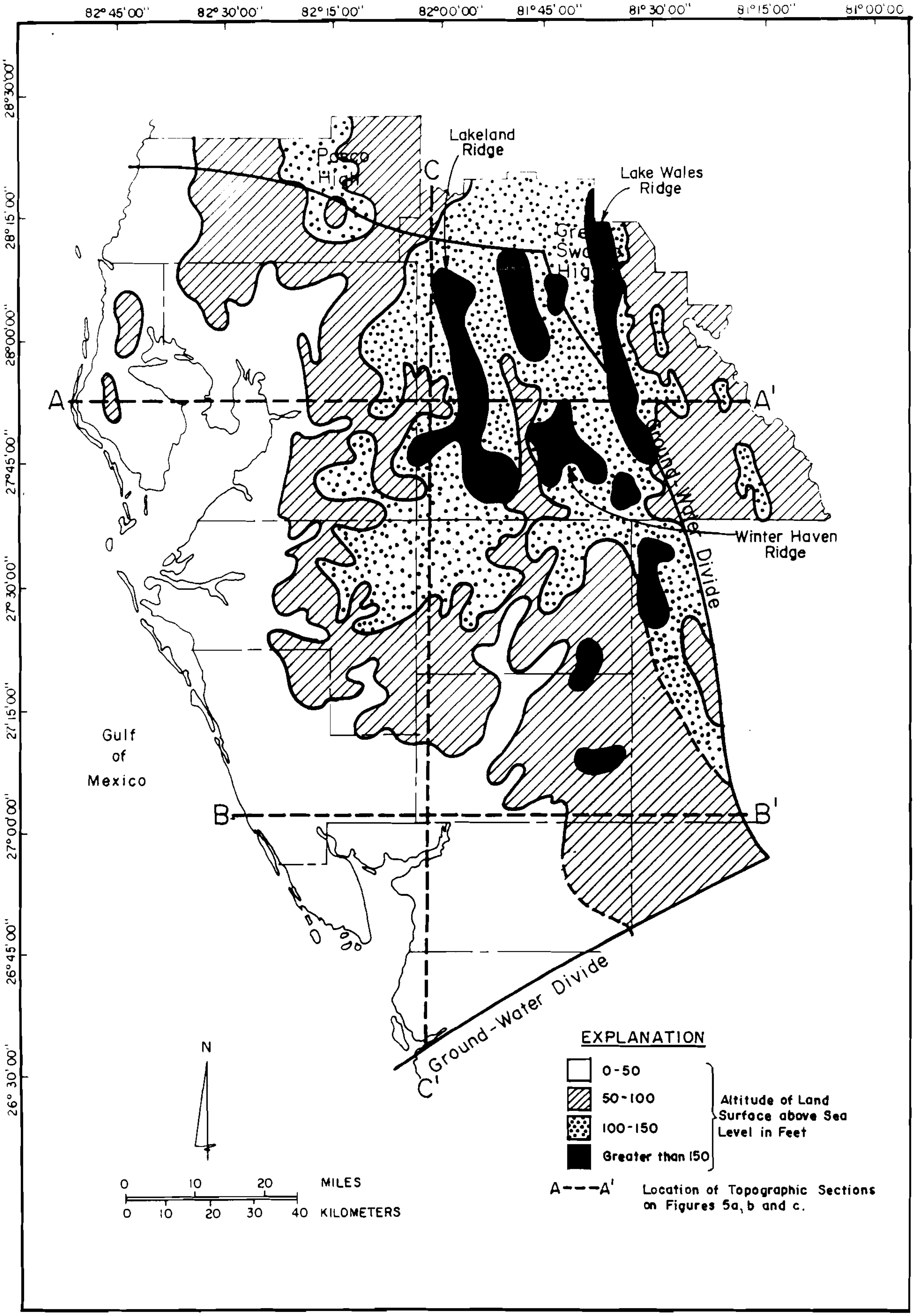


Figure 4. *Land surface* altitides in the Southern West-Central Florida Ground-Water Basin. Lines A-A', B-B', and C-C' are shown in Figure 5 (modified from Sinclair and others, 1985).

subdued. Figure 5 illustrates east-west and north-south trending cross-sections that depict the topography in the SWCFGWB. Figure 6 illustrates the physiographic regions of the SWCFGWB.

The dominant river basins, ranked in descending stream flow order are the Peace, Hillsborough, Alafia, Shell Creek, Myakka, Horse Creek, and Manatee Rivers. All of these rivers have an average flow greater than 100 cubic feet per second (cfs). The major rivers begin on the Polk Upland and flow west or southwest to the Gulf of Mexico. The major wetland is the Green Swamp but many of the river flood plains are low, wetland strands.

There are numerous second and third magnitude springs in the northern area of the SWFCGWB but south of central Hillsborough and Polk almost no springs exist today. The only three springs reported are Pinehurst, Little Salt, and Warm Mineral Springs, which are all located in Sarasota County. The latter two springs exceed potable standards for salts concentration. Virtually all springflow is derived from the Floridan aquifer system.

The geology, topography, and drainage are all interdependent with water erosion shaping the limestone chemically and mechanically. The karst nature of the limestone results in solution features redirecting runoff underground. The sand and soft limestone supporting the flat to hilly topography was first shaped by beach erosion terracing the sand and stone. Afterwards, weak limestone caverns collapsed and surface erosion reshaped the highland sands. The southern plains and lowlands lack the underground drainage and typical karst topography. Surficial erosion by rivers and transgressive/regressive seas dominate the land forms. Nutrients and fresh water entering the Gulf also supports a large estuary system along the coast.

The SWCFGWB is characterized by karst terrain, in the northern and eastern areas, developed through the dissolution of the underlying shallow sinkholes. Surface drainage is absent or poorly developed in most of these areas, but waters from Hillsborough, Anclote, and Pithlachascotee Rivers flow through well-defined stream channels. Thick clay layers of the Bone Valley, Caloosahatchee, and Hawthorn Formations subdue karst activity in the flat lands of the central and southern SWCFGWB.

CLIMATE

The climate of the SWCFGWB is characterized by long, warm, humid summers and short, mild winters. Average monthly temperatures range from 61^{o} F in January to 82^{o} F in July and August (National Oceanic and Atmospheric Administration (NOAA), 1986). Average annual temperature is 73^{o} F.

Some rainfall normally occurs during each month, but a SWCFGWB high rainfall season extends from June through September and a low rainfall season extends from October through May. The winter rainfall is relatively light because west-central Florida is south of the normal southern limit of winter frontal systems. About sixty percent of the annual rainfall occurs during the rainy season and is derived principally from convectional storms. The Weather Bureau Stations at St. Leo, Bartow, and Punta Gorda were chosen to

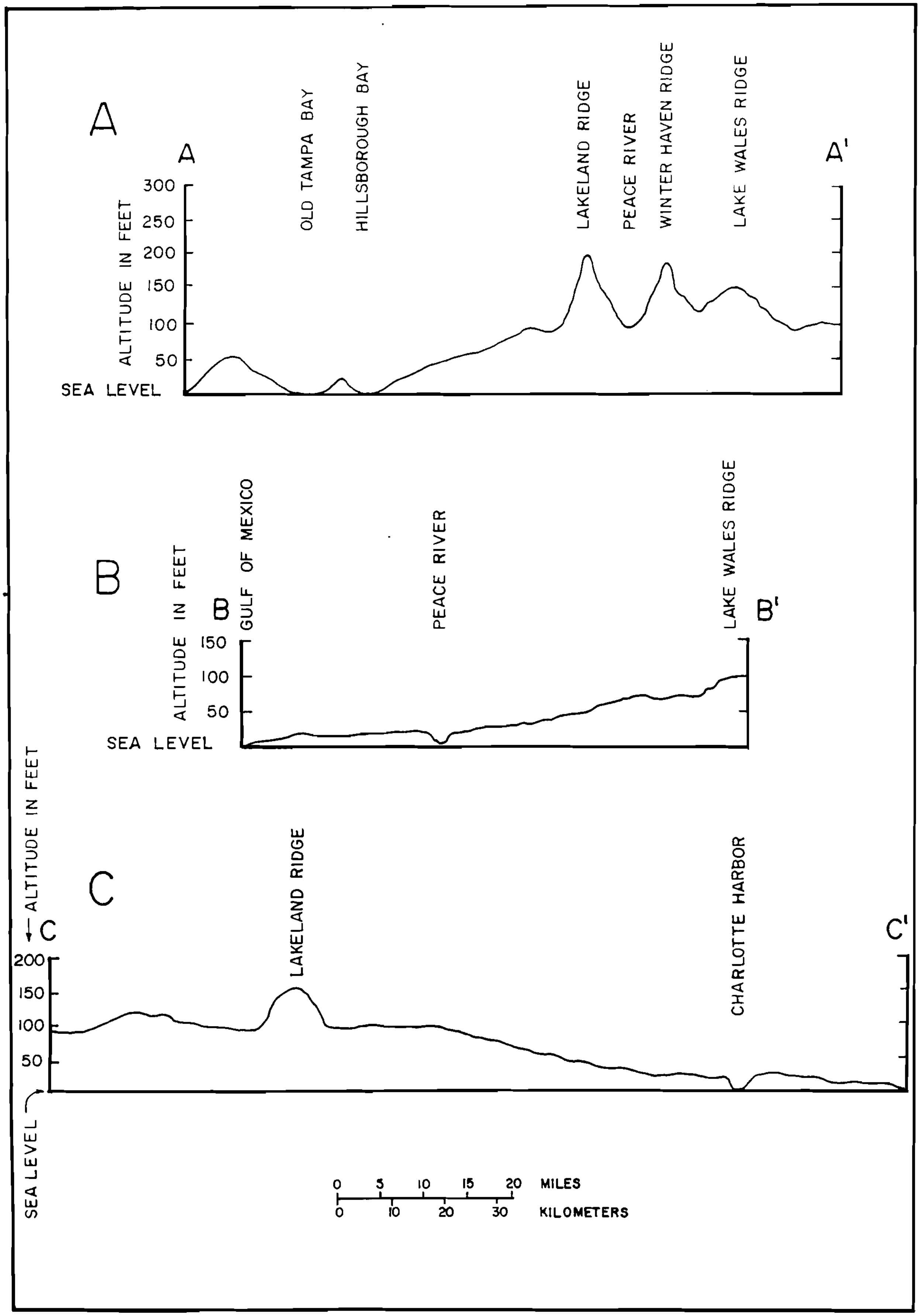


Figure 5. Topographic cross-sections of the Southern West-Central Florida Ground-Water Basin. Location of sections are shown in Figure 4.

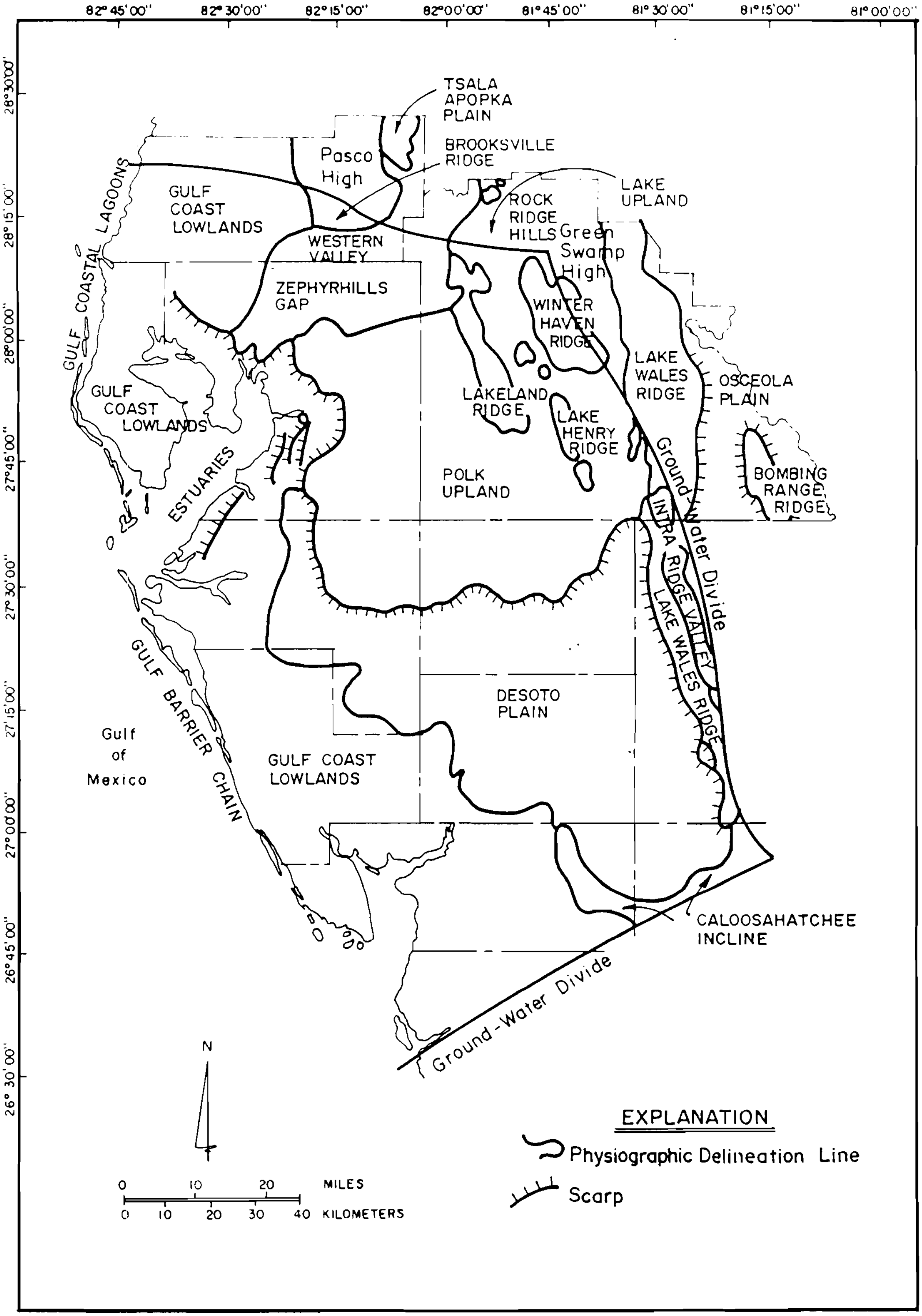


Figure 6. Physiographic map of the Southern West-Central Florida Ground-Water Basin (modified from White, 1970)

represent the SWCFGWB. Figure 7 shows the historic median and mean monthly rainfall. Figure 8 depicts the annual total rainfall record for these three weather stations in the SWCFGWB. Spatially, summer rainfall is highly variable; areas only a few miles apart often receive widely differing amounts of rain.

Estimates of evapotranspiration (ET) within the SWCFGWB vary; however, approximately 39 inches per year is generally accepted. Close to sixty percent of the total ET occurs in the six month period from May to October (SWFWMD, 1978). The highest ET rates occur in May and June.

GEOLOGY OF THE BASIN

Overview

The SWCFGWB is underlain by a thick sequence of Cretaceous and Tertiary carbonate rocks overlain by a wedge-shaped sequence of interbedded carbonate and clastic deposits. The principal hydrogeologic units are the surficial, intermediate, and Floridan aquifer systems, as described by the Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1984. The upper one to two thousand feet of the limestones and dolomites that comprise the Floridan aquifer system are considered the Upper Floridan aquifer (Miller, 1982). Table 1 contains the lithologic characteristics and water supply properties of the potable water bearing deposits in the SWCFGWB. Figures 9 and 10 is a hydrogeologic cross-section and a surficial geologic map of the SWCFGWB, respectively.

The Upper Floridan aquifer is a solution-riddled and faulted limestone comprised of chemically precipitated limestones and dolomites that contain shells and shell fragments of marine origin. The system was deposited throughout the Tertiary period. This aquifer system is the principal storage and water conveying component of the hydrologic system in the SWCFGWB. The carbonate units that are hydrologically significant, in ascending order include the Avon Park Formation, Ocala Limestone, Suwannee Limestone, Tampa Limestone, and portions of the Hawthorn Formation that are in hydrologic connection with underlying units. These units range in age from Eocene to Miocene. The Tampa Limestone of Miocene Age is generally thin to absent throughout the northern and eastern areas of the SWCFGWB. In the SWCFGWB the Upper Floridan aquifer may contain one or more inter-aquifer confining beds which, in turn, produce a multi-aquifer system. The system thickens from less than 800 feet in the north to greater than 2200 feet in the south (Figure 11).

Early in the Miocene Epoch, terrestrial deposits were carried by rivers from the north and intermixed with the upper Tertiary deposits. Clastic deposition continued through the Pliocene and Pleistocene Epochs with phosphatic enrichment of clastic sediments becoming more pronounced. The Hawthorn Formation of Miocene age and the Caloosahatchee, Tamiami, and Bone Valley Formations of Pliocene and Pleistocene age predominately comprise the intermediate aquifer system. In areas of Polk, Manatee, Hardee, DeSoto, Sarasota, and Charlotte Counties, sand and clay beds within the Tampa Limestone are hydraulically connected to the overlying units and are also included in the intermediate aquifer system (Corral and Wolansky, 1984). Units of the intermediate system consist of sand, gravel,

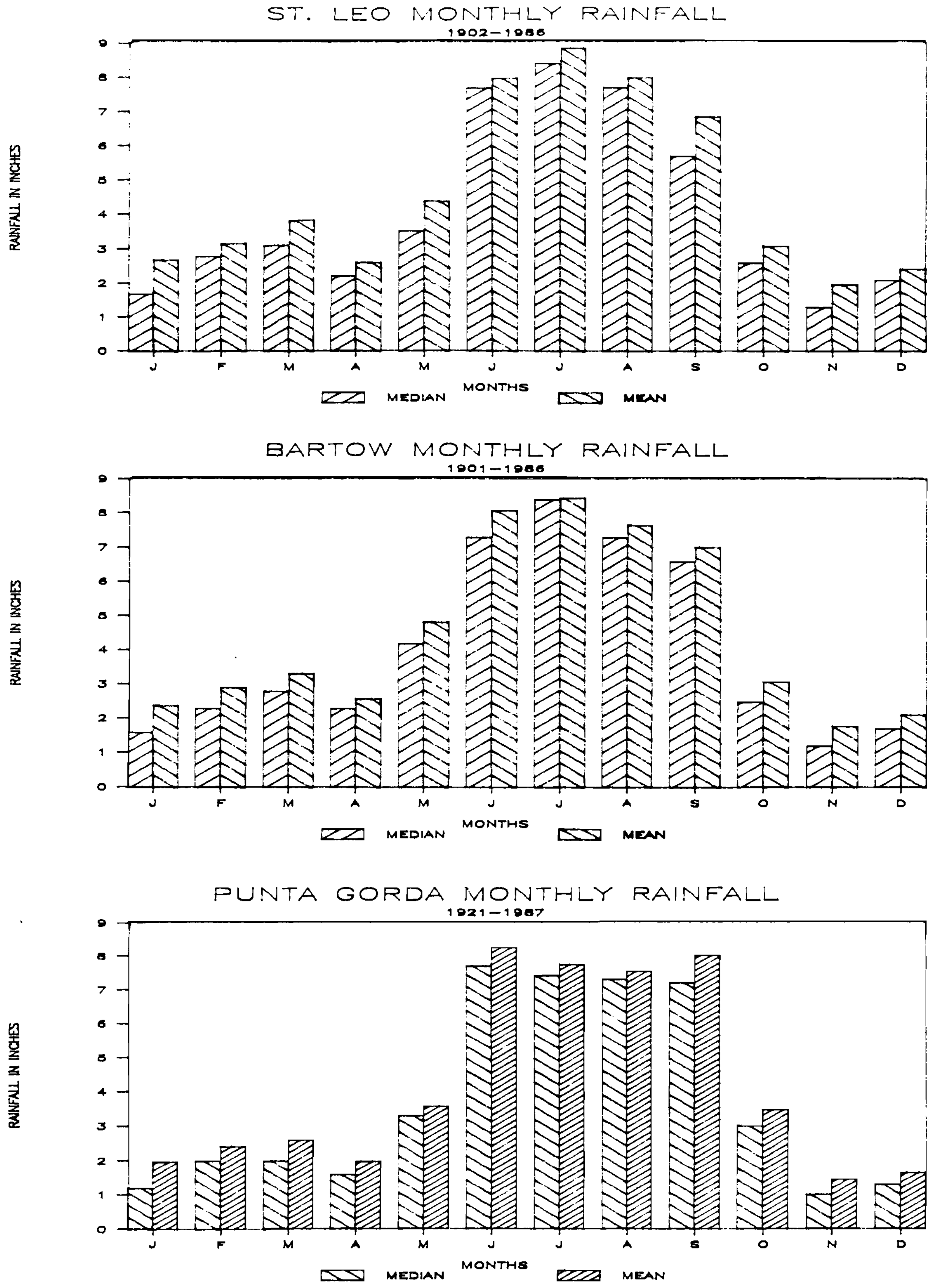


Figure 7. Hyetographs of median and mean monthly rainfall at 3 stations within the Southern West-Central Basin.

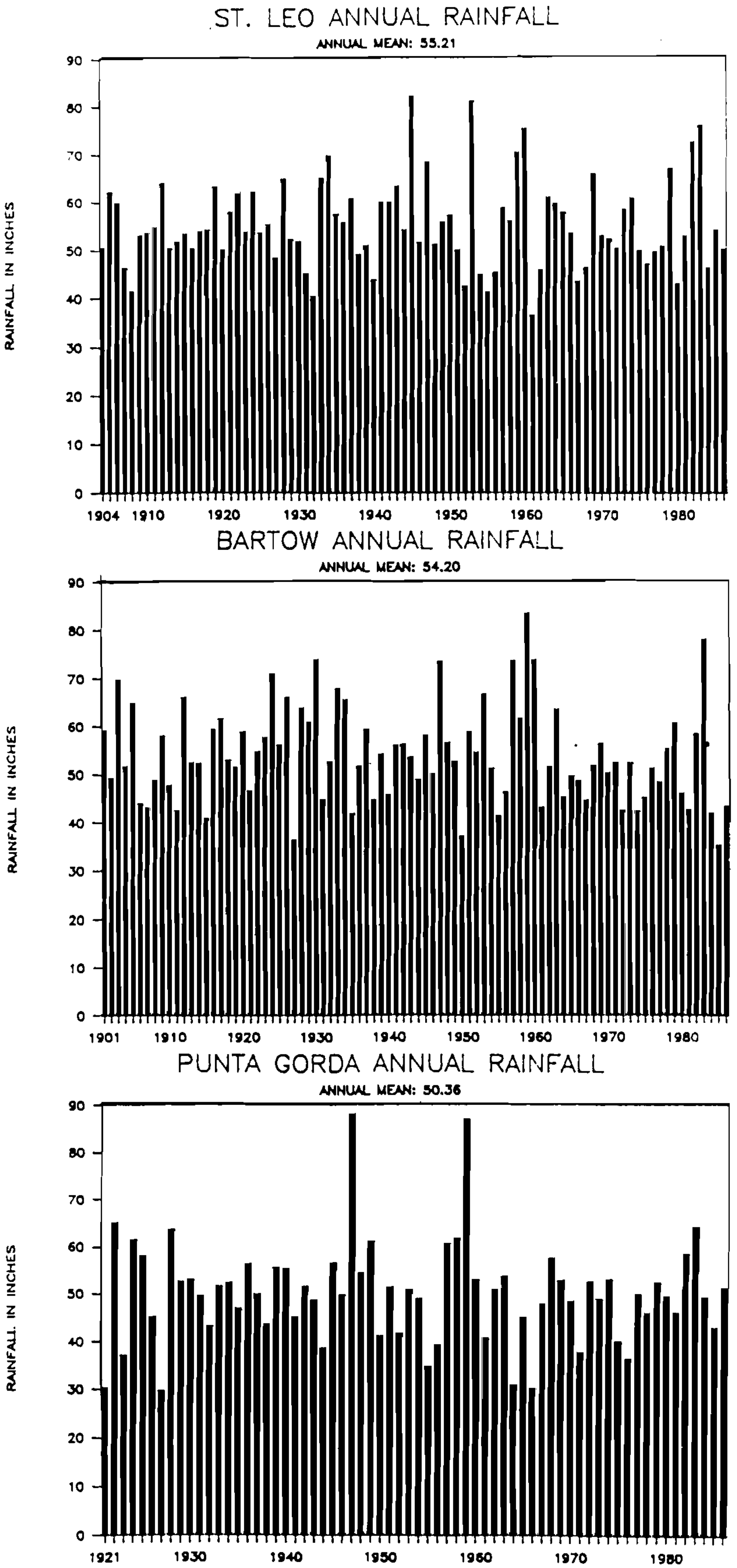


Figure 8. Hyetographs of annual rainfall records at 3 stations within the Southern West-Central Florida Ground-Water Basin.

System	Series	Stratigraphic unit	General lithology	Major lithologic unit	Hydrogeologic unit
Quaternary	Holocene and Pleistocene	Surficial sand, terrace sand, phosphorite	Predominantly fine sand; interbedded clay, marl, shell, limestone, phosphorite	Sand	Surficial aquifer
Tertiary	Pliocene	Undifferentiated deposits[1]	Clayey and pebbly sand; clay, marl, shell, phosphatic	Clastic	Confining bed INTERMEDIATE AQUIFER AND CONFINING BEDS
	Miocene	Hawthorn Formation	Dolomite, sand, clay, and limestone; silty, phosphatic	Carbonate and clastic	Aquifer
		Tampa Limestone	Limestone, sandy, phosphatic, fossiliferous; sand and clay in lower part in some areas		Confining bed
	Oligocene	Suwannee Limestone	Limestone, sandy limestone, fossiliferous	Carbonate	FLORIDAN AQUIFER SYSTEM
	Eocene	Ocala Limestone	Limestone, chalky, foraminiferal, dolomitic near bottom		
		Avon Park Limestone[2]	Limestone and hard brown dolomite; intergranular evaporite in lower part in some areas		Upper Floridan aquifer Middle confining unit
		Lake City Limestone and Oldsmar Limestone[2]	Dolomite and limestone, with intergranular gypsum in most areas	Carbonate with evaporites	Lower Floridan aquifer
	Paleocene	Cedar Keys Limestone[2]	Dolomite and limestone with beds of anhydrite		Lower confining unit

[1] Includes all or parts of Caloosahatchee Marl, Bone Valley Formation, Alachua Formation, and Tamiami Formation.

[2] Since this report was prepared, the Avon Park, Oldsmar, and Cedar Keys Limestones have been changed to the Avon Park, Oldsmar, and Cedar Keys Formations. The Lake City Limestone has been abandoned, and the rocks are included in the lower part of the Avon Park Formation (Miller, 1984).

Table 1. Hydrogeologic framework of the Southern West-Central Florida Ground-Water Basin (from Ryder, 1985; modified from Wilson and Gerhart, 1982).

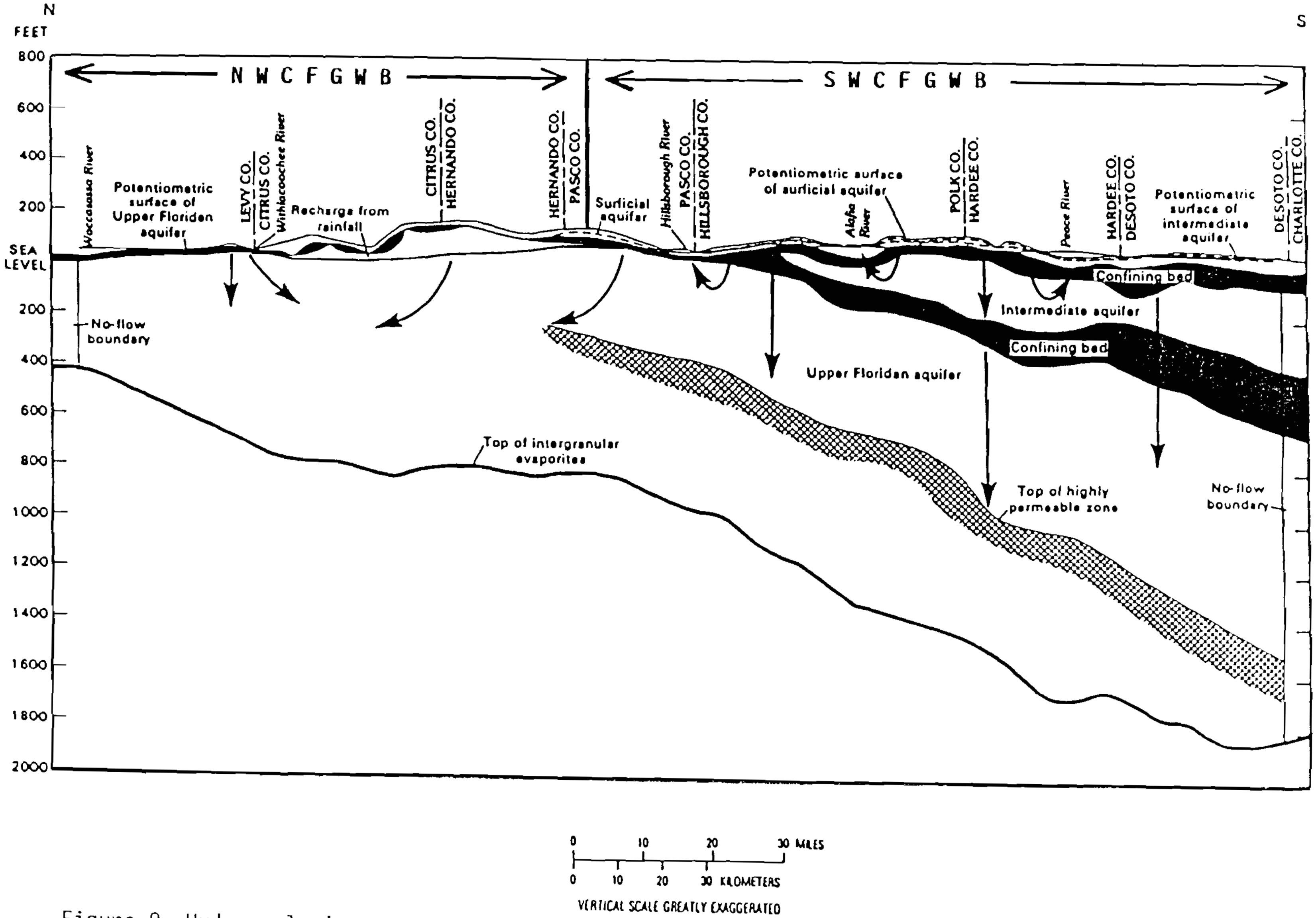


Figure 9. Hydrogeologic cross-section of the Southern and Northern West-Central Florida Ground-Water Basins (from Miller, 1986).

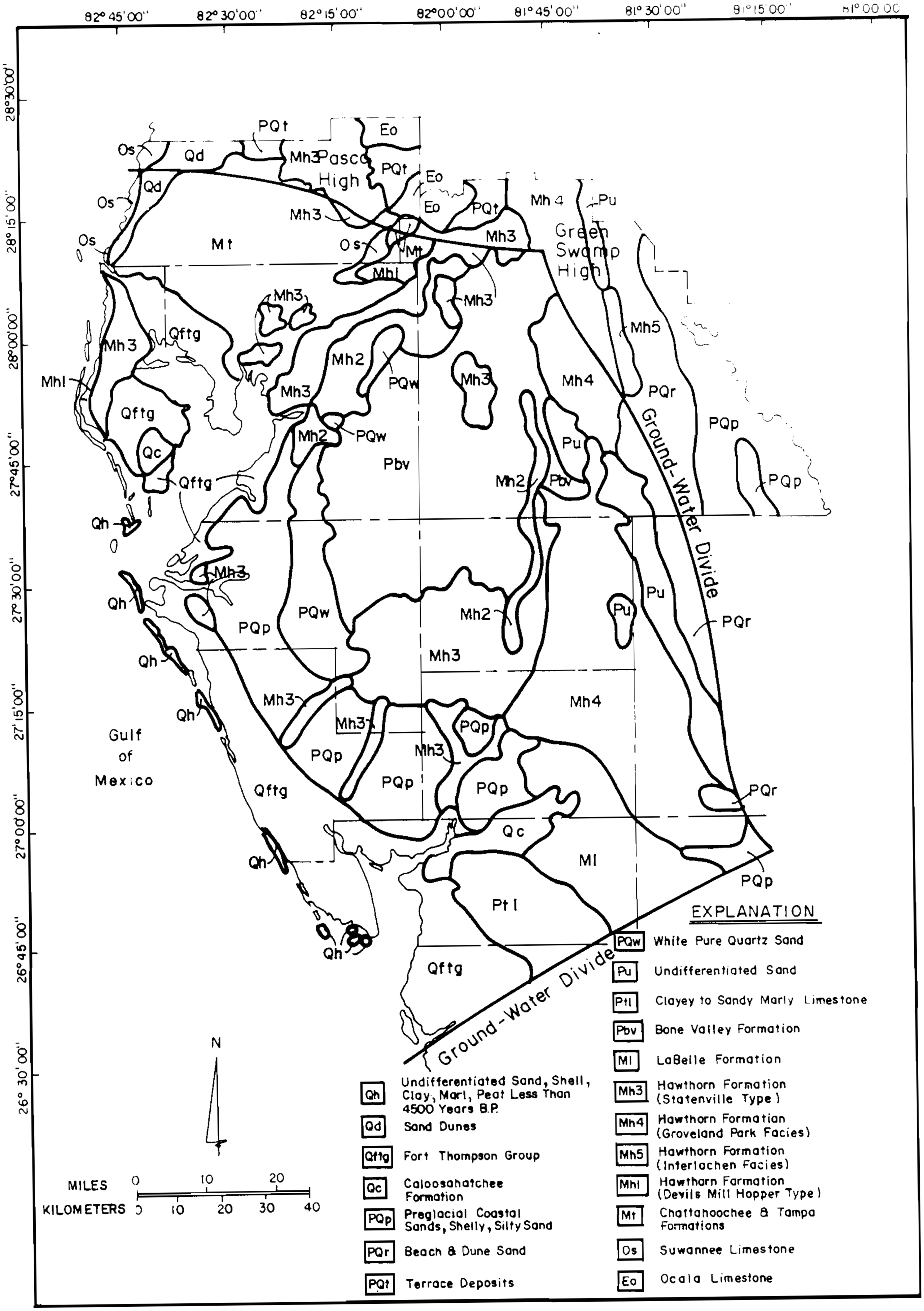


Figure 10. Surface geology of the Southern West-Central Florida Ground-Water Basin (from Brooks, 1981).

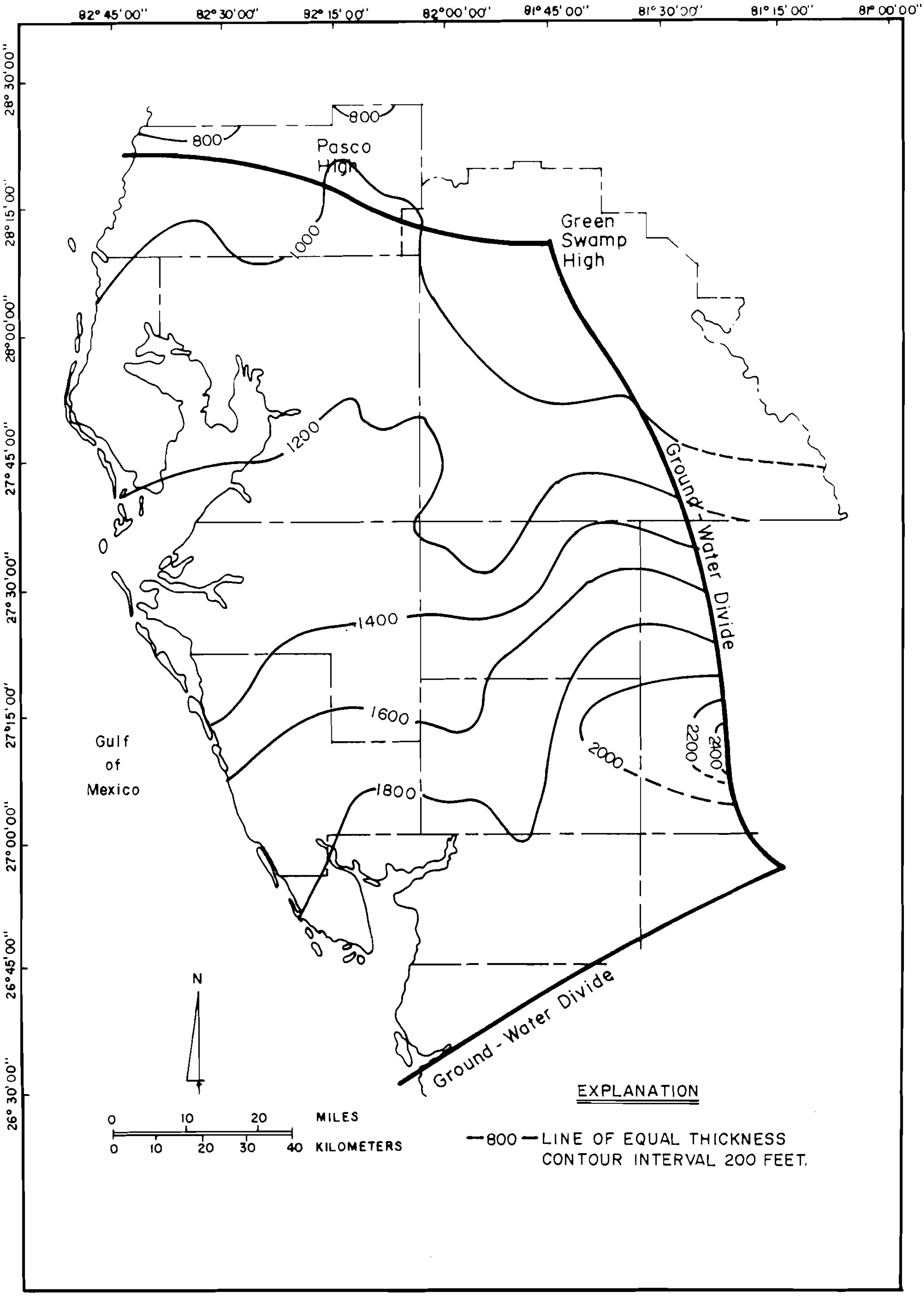


Figure 11. Generalized thickness of the Upper Floridan aquifer in the Southern West-Central Florida Ground-Water Basin (modified from Wolansky and Garbade, 1981).

shell beds, limestones, dolomites, marls, clays, chert, and calcareous sandstones. Many of these deposits are phosphatic in nature. This system ranges in thickness from zero in the north to greater than 600 feet in the southern areas (Figure 12).

Surficial deposits consisting of sand, clayey sand, silt, shell, shelly marl, and some phosphorite form a laterally discontinuous surficial aquifer system throughout the basin. These surficial deposits range in thickness from zero in the northern coastal areas to greater than 200 feet along the ridges in the eastern areas (Figure 13). During the Pleistocene Epoch (Ice Age), a series of marine terraces were formed along the coast by wave erosion and deposition (Figure 14). These terraces are former bottoms of shallow seas and are composed primarily of well-graded quartz sand (Fretwell, 1985).

STRUCTURE

The regional structure of the SWCFGWB incorporates sediments of the Florida Plateau which thicken to the south and southeast. The Florida Plateau is a structurally stable, partially submerged carbonate platform overlain by flat-lying Tertiary and Cretaceous deposits, primarily limestones (King, 1977). Deep wells in southern Florida have penetrated more than 10,000 feet of Tertiary and Cretaceous carbonates underlain by Jurassic basement.

Three structural elements played major roles in controlling the depositional environments of the SWCFGWB (Figure 15). The Peninsular Arch is the first feature which affects rocks through the Cretaceous period. The main axis is located east of the SWCFGWB and trends generally north-northwestward and is estimated to be 275 miles in length. The arch trends approximately S 35^{o} E and extends from South-Central Georgia to the vicinity of Lake Okeechobee (Applin and Applin, 1965). The arch is reported to be a buried anticlinal fold of late Paleozoic and early Mesozoic time which resulted in differential subsidence of the overlying coastal plain floor (Faulkner, 1970). A second structural feature, the Ocala Uplift, is southwest of and parallel to the Peninsular arch. It affects deposits of middle Eocene age and younger. This uplift raises Eocene limestones and dolostones to altitudes of 90 feet above NGVD. The crest covers an irregular elliptical area, about 45 miles long and 20 miles wide, trending approximately N 25^{o} W. The crest extends from the vicinity of Dunnellon to Otter Springs in Levy County north of the SWCFGWB. Mapping of this feature is documented extensively by Vernon (1951), who delineated it as a gentle southeast trending anticline estimated to be 230 miles long and 70 miles wide. A third structural feature, the South Florida Basin, includes much of the southern SWCFGWB. This broad and relatively flat synclinal feature trends approximately S 45^{o} W and extends nearly 200 miles across the Florida Peninsula. Maximum depositional thickening in the South Florida Basin occurred during Upper Jurassic and Lower Cretaceous sedimentation.

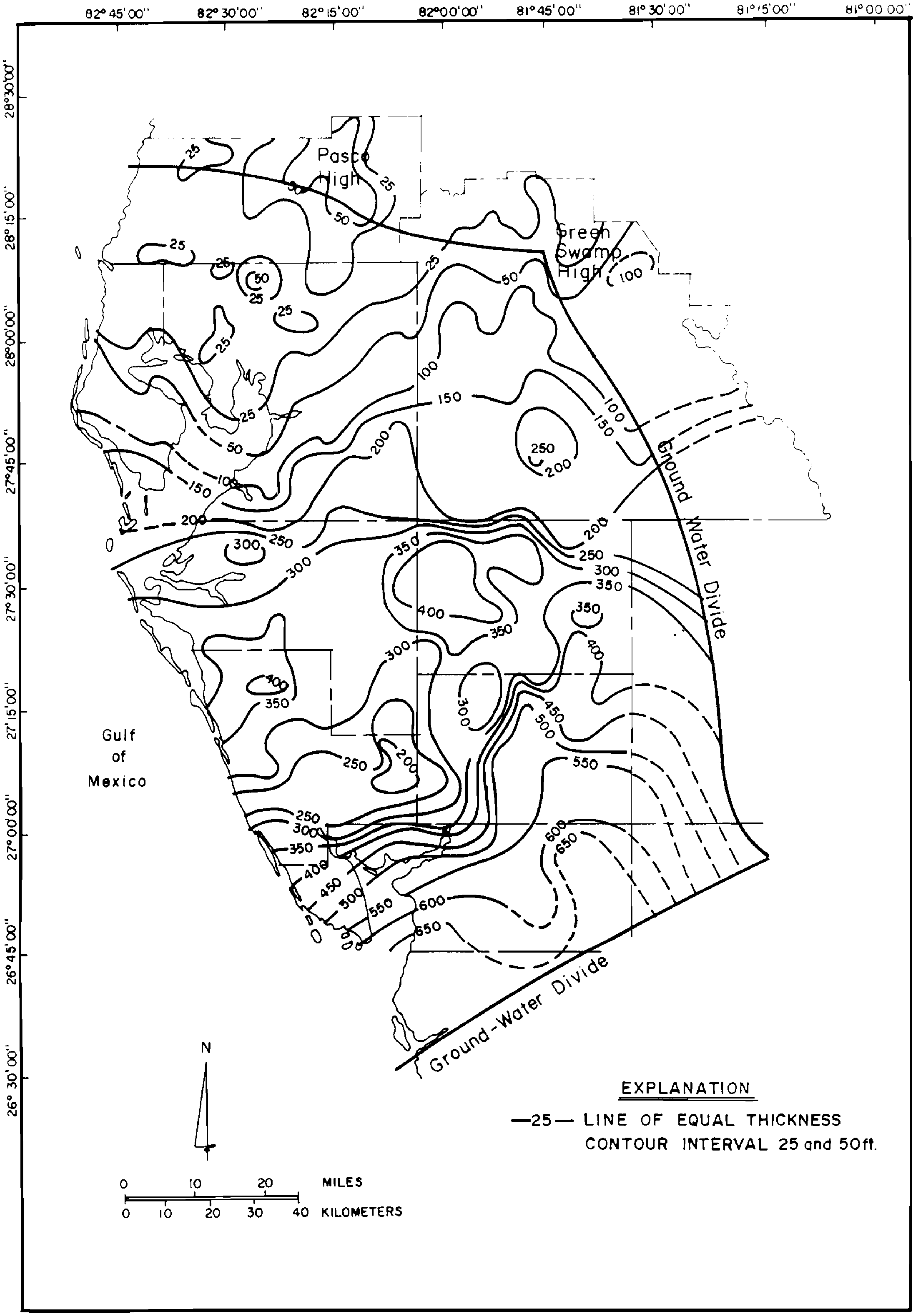


Figure 12. Thickness of the confining beds overlying the Floridan aquifer system in the Southern West-Central Florida Ground-Water Basin (from Buono and others, 1979).

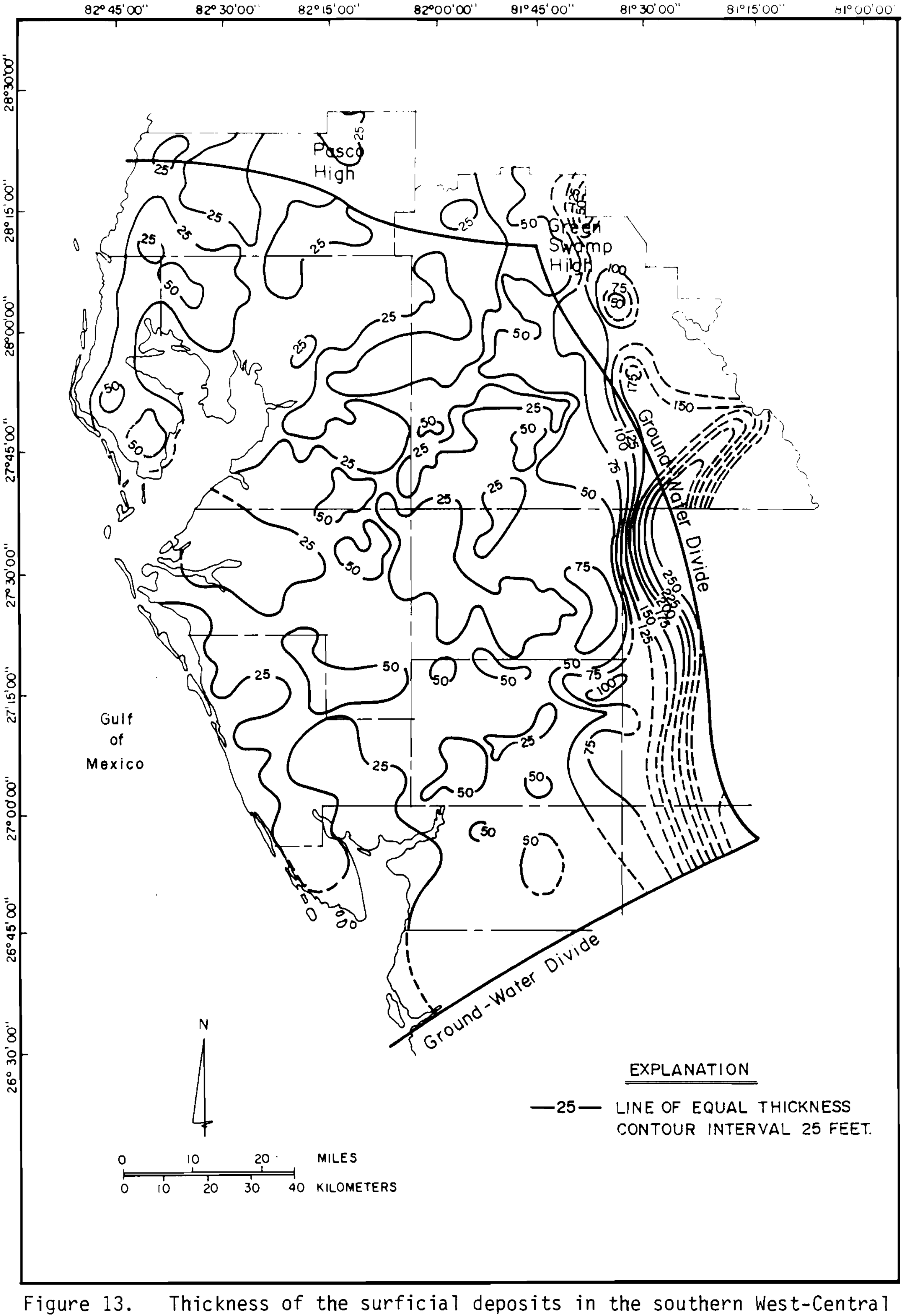


Figure 13. Thickness of the surficial deposits in the southern West-Central Florida Ground-Water Basin (from Wolansky and others, 1979).

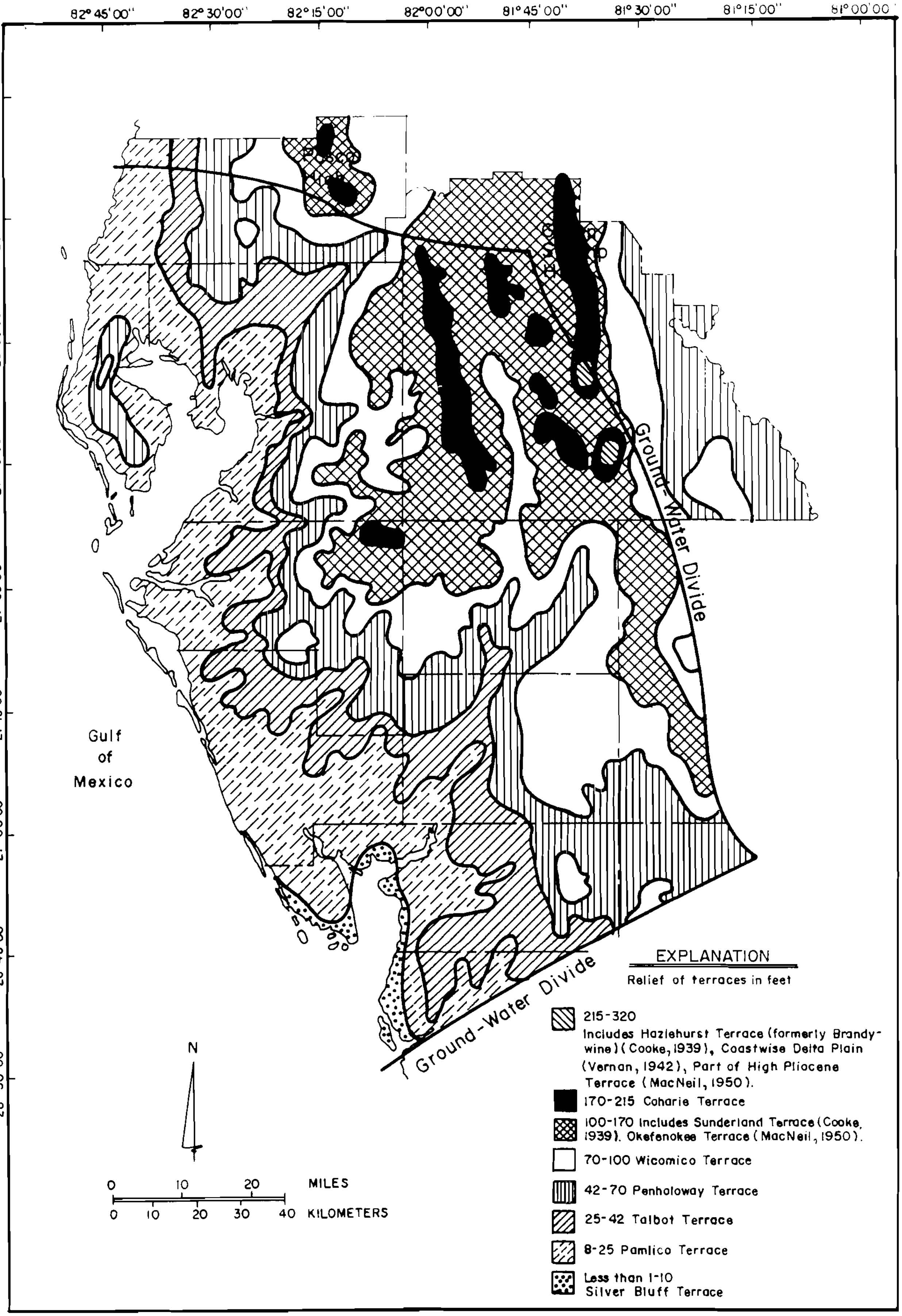


Figure 14. Location of terraces and shorelines in the Southern West-Central Florida Ground-Water Basin (from Healy, 1975).

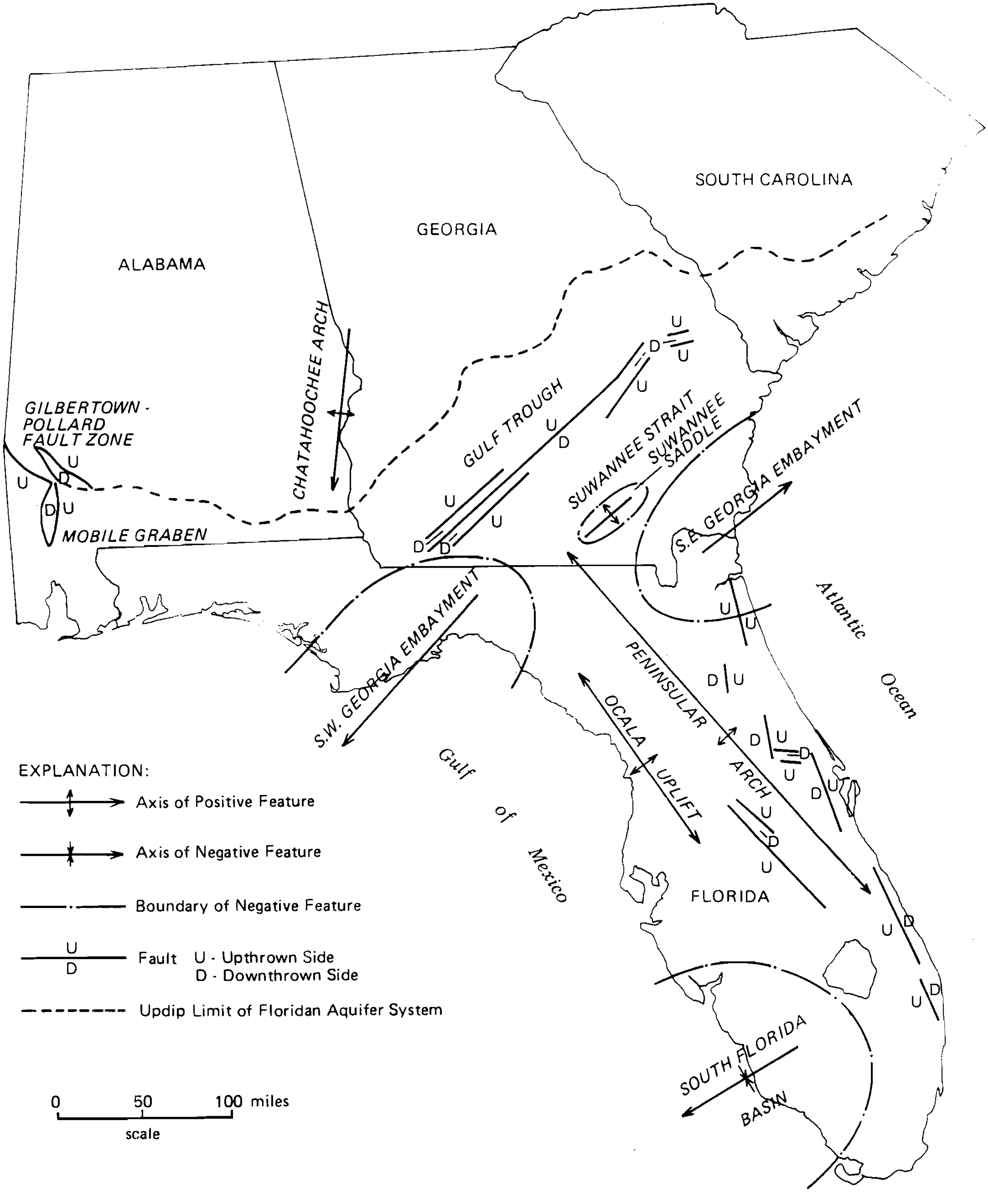


Figure 15. Structural features that affect the Floridan aquifer system (from Miller, 1986).

STRATIGRAPHY

The stratigraphy of the SWCFGWB are discussed in descending order beginning with the most recent geologic time period. The stratigraphic sequence of these deposits is given in Table 1.

Holocene and Pleistocene Epochs - Sediments deposited within these epochs are sometimes referred to as terrace deposits which consist generally of unconsolidated sand, clay, peat, and marl deposited during interglacial periods when water levels rose due to melting of the polar ice caps. During the high stands of the sea, deposits of well-graded quartz sand accumulated to form terraces. Figure 14 depicts the areal distribution of terraces.

Pliocene - The formations of this epoch consist of three stratigraphic units: the Caloosahatchee Marl, Tamiami Formation, and Bone Valley Formation, progressing from youngest to oldest.

The Bone Valley Formation consists of fine to coarse quartz sand, clay, thin chert sections, phosphate nodules, and vertebrate fossil fragments. It is well represented on structural highs in the Lakeland Ridge area. The Bone Valley Formation extends approximately from Polk and Hillsborough Counties southward into Manatee and Hardee Counties (Figure 16). Its thickness is generally less than 20 feet, but it is 60 feet or more thick in eastern Polk and Hardee Counties (Figure 16).

The Tamiami Formation is composed principally of white to cream-colored, sandy limestone that grades downward into clay, silt, and very fine sand beds of low permeability. The Tamiami contains abundant oyster shells and littoral deposits that attest to a shallow marine environment of deposition. The Tamiami Formation is laterally continuous south of northern Charlotte and Glades Counties, and discontinuous in DeSoto, Hardee, Manatee, and Sarasota Counties (Figure 16). The Caloosahatchee Marl overlies the Tamiami Formation and consists of a thin sequence of interbedded clay, calcareous clay, and sand that locally contain broken shelly material (Miller, 1986). The Marl is laterally continuous south of southern Sarasota and DeSoto Counties and reaches thicknesses of greater than 75 feet in Lee County (Figure 16). The upper part of the Caloosahatchee Marl is of Pleistocene age.

Miocene.--Miocene sediments are divided into two stratigraphic units, the Tampa Limestone and the overlying Hawthorn Formation. The Tampa consists of limestone and varying amounts of quartz sand and clay embedded in a carbonate matrix. It may be fossiliferous or can be devoid of fossils. The unit is absent in the northern SWCFGWB, but is as much as 300 feet thick in the south (Figure 9). The Tampa is differentiated from the overlying Hawthorn Formation based on a decrease in or absence of phosphorite and an increase in quartz sand within the rock matrix (King and Wright, 1979). The contact between the Hawthorn Formation and Tampa Limestone is a weathered, gray, dolomitic limestone. The unit is absent in central Polk County where it grades into a blue-green clay that is devoid of carbonates.

The Hawthorn Formation can generally be differentiated into three distinct units in the SWCFGWB. The basal Hawthorn section is

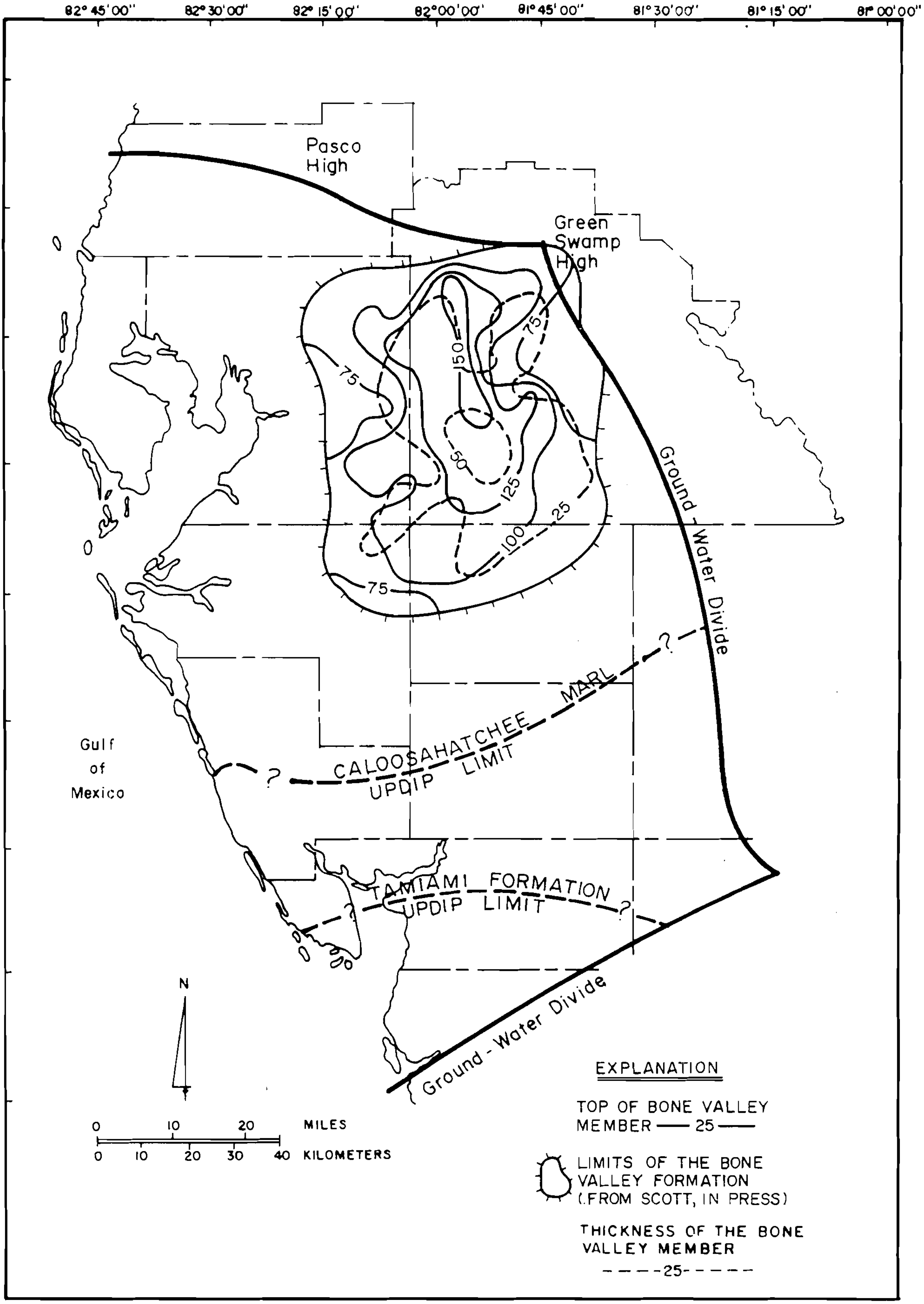


Figure 16. Structural and isopach maps of the Bone Valley Formation and depositional limits of the Caloosahatchee and Tamiami Marls in the Southern West-Central Florida Ground Water Basin (from Vernon, Puri 1964 Map Series 18, USGS; and, from Scott, in press).

composed of carbonate deposits (usually dolomitic) that contain varying amounts of interbedded quartz sand, clay, and phosphate. The middle section consists of interbedded sandy carbonate, clayey sand, and sandy clay. The upper Hawthorn section is predominantly composed of clastic deposits that consist of quartz, phosphate sand and pebbles, and light green to a moderately dark gray clay (Hall, 1983). The trifold subdivision of the Hawthorn Formation is most apparent in the south. Elsewhere, one or two of these units may be absent, or the upper unit may lie directly over the lowermost unit. In the north, the units become less distinctive and merge to a single unit where a sandy phosphatic clay predominates, or the Formation is absent. The thickness of the entire Hawthorn Formation varies from thin to absent in the northern areas of the SWCFGWB to greater than 600 feet in the southern areas.

Oligocene - The only formation of this epoch is the Suwannee Limestone. It is composed of hard, yellow or creamy fossiliferous limestone, which locally has an orange tinge. Interbeds may contain quartz sand, and dolomite is common toward the unit's base from the Tampa Bay area southward. The upper part may contain thin chert lenses and be highly macrofossiliferous. The Suwannee is exposed in parts of Pasco County, and in the northeast corner of Hillsborough County, and pinches out in Polk County. The Suwannee is as much as 300 feet thick in the southern areas of the SWCFGWB.

Eocene Epoch - The Eocene formations within the SWCFGWB consist of the Ocala Limestone, Avon Park Formation, and Oldsmar Formation, in descending order. The Ocala Limestone consists of three units. In descending order these units are the Crystal River, Williston, and Inglis. All three units generally consists of a coquinic foraminiferal limestone, usually cream to white in color. The Inglis Member frequently contains gray to brown dolomite, and chert layers that can be present throughout the entire Ocala Limestone. The Ocala Limestone outcrops in northern Polk and southern Sumter Counties within the Green Swamp area (Pride and others, 1966). The Ocala ranges in thickness from less than 300 feet in the northern areas of the SWCFGWB to greater than 600 feet in thickness in the southern areas.

The Ocala is unconformably underlain; by the middle Eocene Avon Park Formation. Lithologically, the Avon Park is composed of fossiliferous limestone and dolostone. The limestone is moderate brown, dark-yellow brown to rusty-yellow brown, porous and very fine to medium grained and may be crystalline or saccharoidal in texture. The top of the Avon Park may contain peat or carbonaceous layers and the bottom may contain small lenses of evaporite. The Avon Park Formation thickens to greater than 1,000 feet in the SWCFGWB. The Avon Park is the deepest potable water bearing formation in the SWCFGWB, therefore, older geologic formations will not be discussed.

KARST ACTIVITY

Florida's landscape, including the SWCFGWB, is dominated by features of karst topography. Karst topography develops where rainfall drains internally and rocks are susceptible to solution (Ritter, 1979). In these areas, the solution process can create and enlarge cavities within the rocks and allow underground circulation of water which, in turn, promotes further solution. This leads to progressive integration of voids beneath the surface and allows large amounts of water to be funneled into an underground drainage system, disrupting the pattern of surface flow. Chemical corrosion and internal drainage are the active processes rather than physical erosion from surface runoff (Sinclair, 1985). Dissolution is most active at the water-table or in the zone of water-table fluctuation where carbonic acid contained in atmospheric precipitation reacts with limestone and dolomite (Carroll, 1970). Because the altitude of the water table shifted in response to changes in sea level several times during the Pleistocene Epoch, many vertical and lateral paths have developed in the underlying carbonate strata in the SWCFGWB. Many of these features lie below the present water table and greatly facilitate ground-water flow.

Areas most susceptible to this process within the SWCFGWB are areas of Pasco, northern Hillsborough, and Polk Counties (Figure 17). In these areas the solution process can create and enlarge cavities within the rocks and allow underground circulation of water which in turn, promotes further solution. Karst activity is much slower in the southern and western areas of the SWCFGWB where the clays of the intermediate aquifer system retard water from moving down into the aquifer.

HYDROLOGY

SURFACE WATER

Although the Floridan aquifer system is the principle source of potable water in the SWCFGWB, generally, in localized areas where the ground-water quality is poor, much of the drinking water supply is provided by surface-water bodies. In the southern part of the basin, the water quality of the Floridan becomes less suitable for potable use and therefore many of the larger municipalities rely on surface water to obtain their drinking water. Listed below in Table 2, are the major municipalities in the SWCFGWB that rely, in part or whole, on surface water to supply their potable water needs:

TABLE 2. Major municipalities in the SWFWMD that rely, in part or whole, on surface water to supply their potable needs.

1/ MUNICIPALITY	SOURCE	PERCENT SUPPLIED
BRADENTON	BRADEN AND MANATEE RIVERS	100
NORTH PORT	PEACE AND MYAKKA-HATCHEE RIVERS AND FORDHAM WATERWAY	100
PALMETTO	MANATEE RIVER	100
PORT CHARLOTTE	PEACE AND MYAKKA-HATCHEE RIVERS AND FORDHAM WATERWAY	100
PUNTA GORDA	SHELL AND PRAIRIE CREEKS	100
TAMPA	HILLSBOROUGH RIVER	80

1/ Leve and Conover, 1986.

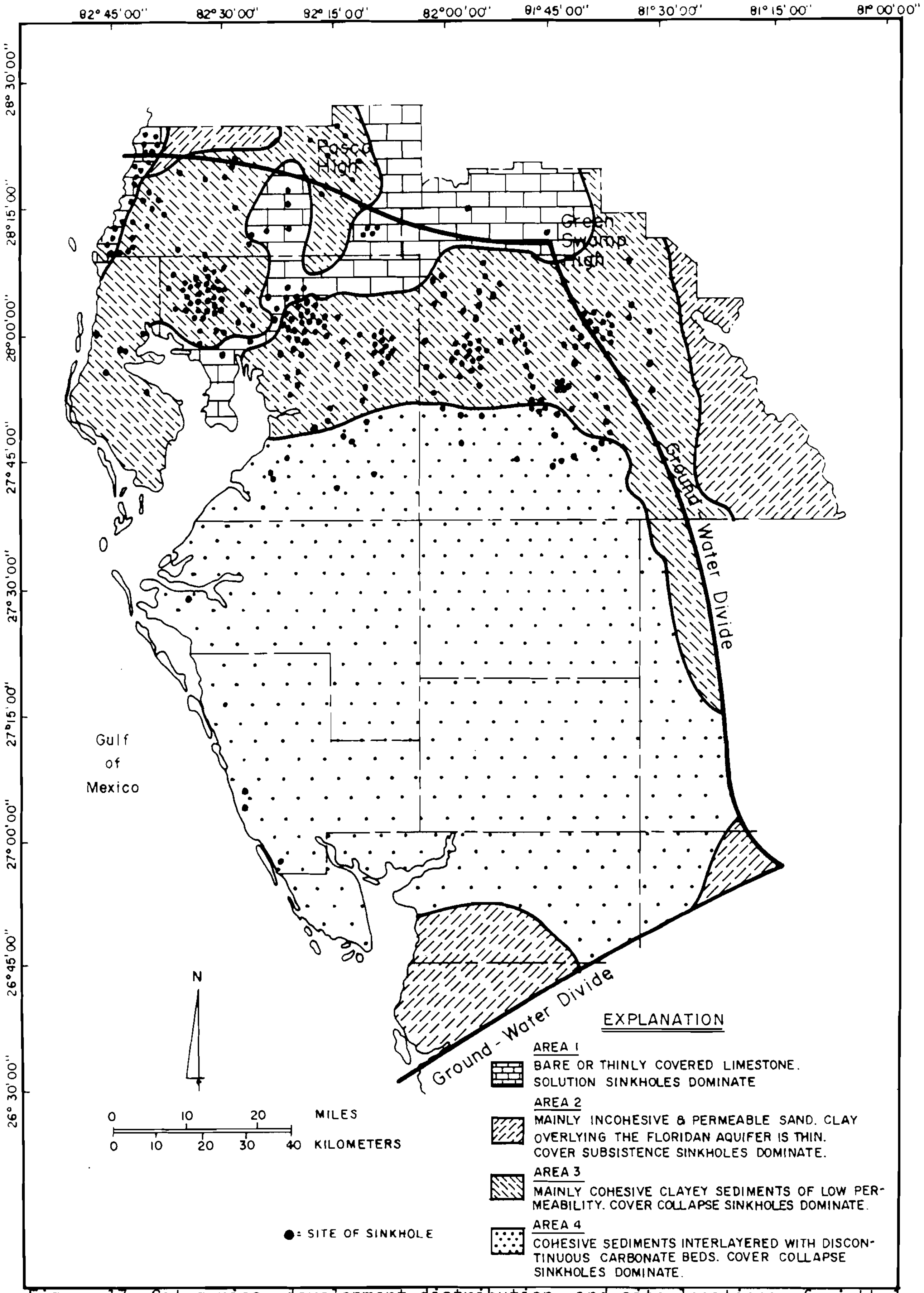


Figure 17. Categories, development distribution, and site locations of sinkholes in the Southern West-Central Florida Ground-Water Basin (modified from Sinclair and others, 1985).

The major surface-water drainage basins in the SWCFGWB include the Hillsborough River, Peace River, Alafia River, Manatee River, Little Manatee River, Myakka River and portions of Kissimmee River (Figure 18). In general, most of the river basins are considered to be poorly drained, have flat slopes, especially near the coast, and are characterized by shallow channels with broad flood plains and sluggish flow during low flow periods (Hammet, 1985). Lakes and swamps that exist in the river basins provide storage of floodwater thereby reducing flood crests and velocity which lower destructiveness of severe floods. Along the coastal reaches of these river basins, flows generally empty into estuaries and are tidally affected. In the more central areas some of the natural surface-drainage patterns have been altered due to mining operations for phosphate ore and agricultural purposes.

In the northern part of the SWCFGWB the Hillsborough River originates from the Green Swamp, meandering through defined channels and swamps for approximately 54 miles in a southwesterly direction to the coastal lowlands and Hillsborough Bay near Tampa. The drainage area of the river is about 690 square miles (SWFWMD, 1985). Major tributaries include Blackwater Creek and Flint Creek which drain the southern portions of the Hillsborough Basin and New River, Trout Creek, and Cypress Creek which drain the northern part of the Hillsborough Basin. As well, the river receives flow from the Withlacoochee River in periods of high flow near its headwaters near Richland and U.S. Highway 98, and ground-water flow from several springs within the river basin. In the river and its tributaries slopes range from 20 feet per mile in upper Cypress Creek to less than one foot per mile in the swampy areas. Flow in the Hillsborough River at the gauging station near Tampa (USGS number 02304500) has ranged from zero in 1945, to 14,600 cfs in 1960 (USGS, 1985). Average flow in the river for the period 1939 through 1978 was 593 cfs (adjusted for diversion).

In the mid 1960s the SWFWMD in cooperation with the U.S. Army Corps of Engineers began construction of the Tampa Bypass Canal (TBC) east of the city of Temple Terrace for the purpose of diverting flood waters from the Hillsborough River. The TBC extends approximately 14 miles from the Lower Hillsborough Flood Detention Area, near Cow House Creek, to its discharge point into McKay Bay southeast of Tampa. The canal was aligned with an existing drainage channel known as Six Mile Creek.

The riverine system of the Peace River arises from the Green Swamp to form the Peace River proper just northeast of Bartow and flows in a southerly direction to Charlotte Harbor, near the city of Punta Gorda. The Peace River Basin comprises approximately 1,800 square miles in area. Peace Creek drains approximately 93 square miles in the northeast part of the Peace Basin, serving as an outlet for several lakes near the towns of Lake Alfred and Haines City. Saddle Creek Canal drains about 231 square miles in the central and western portions of Polk County, where the dominant drainage feature is Lake Hancock situated near the towns of Lakeland, Winter Haven, and Bartow. In the area north of Bartow the landscape is heavily dotted with lakes ranging in size of a few acres to Lake Hancock which is 4,553 acres in size (Zellars and Williams, 1986). In this area surface drainage is often sluggish and ill defined through the lakes which sometimes control the flow of the river. Throughout the

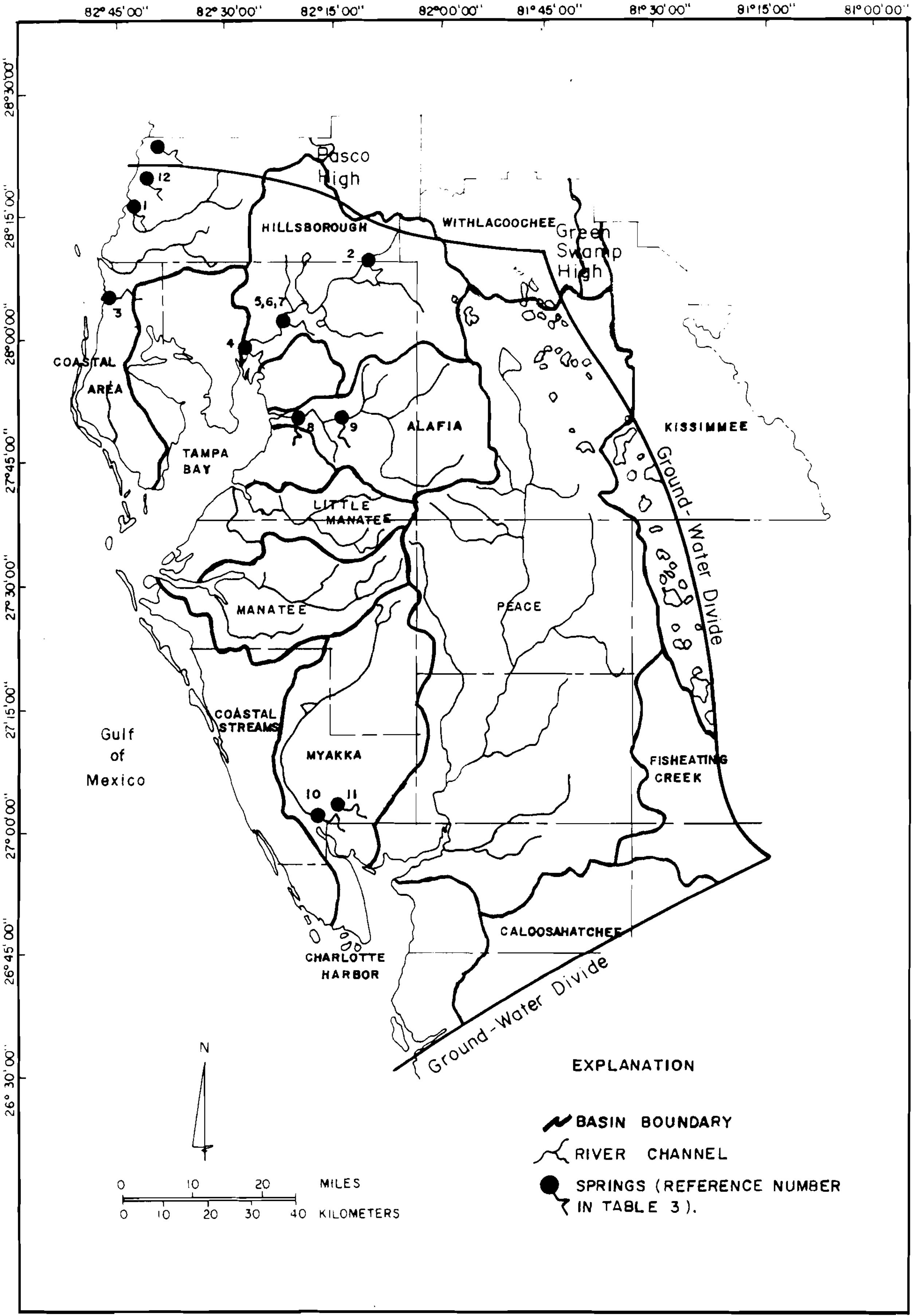


Figure 18. Major surface-water drainage basins and spring locations in the Southern West-Central Florida Ground-Water Basin.

course of the river tributaries are usually short and not well defined. Stewart (1966) noted that the Peace River has a well defined channel between Bartow and Fort Meade. Major tributaries along the southern portion of the river include Shell and Prairie Creeks. Average flow in the Peace River near Arcadia in DeSoto County was reported to be 1,126 cfs for the period 1931-1985 (USGS, 1985).

The Alafia River Basin is located primarily in southern Hillsborough County and western Polk County. Headwaters of the Alafia River are in the Phosphate District of Polk and Hillsborough Counties. The river is formed by the confluence of the North and South Prongs of the Alafia River and flows westward to where it empties into the Hillsborough Bay near Gibsonton. The drainage area of the river is about 410 square miles (Dames & Moore, 1975). Throughout its length the river flows through a shallow wooded valley and is considered to have a well-defined channel. Also throughout much of its length the stage in the Alafia River is below the potentiometric surface of the Floridan aquifer system and as a result many seeps and springs exist in the river channel and adjacent flood plains. Much of this flow re-enters the aquifer in downstream portions of the river and hence the central part of the river often exhibits the larger flows. Both the North and South Prongs of the Alafia River flow through wide marshy areas in poorly defined channels. Drainage areas are 75 and 120 square miles respectively. Within the Alafia River Basin few natural lakes exist (Giovannelli, 1981). Average flow in the Alafia River at Lithia for the period 1932 to 1972 was 380 cfs. Situated between the Alafia and Little Manatee Rivers is Bullfrog Creek which has a drainage area of about 40 square miles. The Bullfrog Creek Basin extends from near Wimauma to Hillsborough Bay and is comprised of several small lakes and sinkholes. It has a steep gradient near its headwaters and flattens out near the coast where it discharges to the bay. Flow in Bullfrog Creek averaged 28 cfs for the period 1956 to 1958 (Dames & Moore, 1975).

South of the Alafia River Basin is the Little Manatee River and Manatee River Basins. The Little Manatee River Basin is located primarily in southern Hillsborough County, is approximately 40 miles long and has a drainage area of 225 square miles (Dames & Moore, 1975). The Little Manatee River originates in southeastern Hillsborough County and flows generally westward about 32 miles towards its discharge point into Tampa Bay near Ruskin. Average flow at the mouth of the river is about 300 cfs.

The Manatee River Basin is located mostly in Manatee County and comprises an area of about 357 square miles (Brown, 1983). The Manatee River flows from its headwaters in northeastern Manatee County, west to the Gulf of Mexico about 53 miles away. In the upper reaches of the river the gradient is about 5 feet per mile; and in the lower reaches the gradient is small and flow in the river is tidally affected up to 20 miles from the mouth of the river. At its source the river is about 130 feet above NGVD. The major tributary to the river is the Braden River which drains about 86 square miles, is 23 miles long and is about 70 feet above NGVD at its origin. Average flow in the Manatee River near Bradenton for the period 1939 to 1965 was 109 cfs. Based on flow duration curves for the river (Brown, 1983), ninety percent of the time flow near Bradenton exceeded 9 cfs. Numerous small lakes can be found in the

Manatee River Basin, however they are mostly shallow and may go dry during moderate drought periods.

The Myakka River Basin is about 550 square miles in size (Brown 1982). Originating near Myakka Head in Manatee County, the Myakka River flows for approximately 50 miles through Manatee and Sarasota Counties to Charlotte Harbor in Charlotte County (Hammet and others, 1978). Major tributaries are Owen Creek and Deer Creek. Most of the streams in the Myakka River Basin have short channels lengths and do not yield high volumes of flow (Joyner and Sutcliffe, 1976). The natural channels are generally poorly developed and bordered by large swampy areas. The Myakka River is the only stream that has a well defined and naturally entrenched channel. In the agricultural areas of upper Big Slough, Phillipi Creek, and Cow Pen Slough extensive drainage changes have been made. Though several depressions exist throughout the Myakka River Basin most of these do not contain perennial ponds or lakes, however, unless they have been drained by canals they do hold water during wet periods. The Upper and Lower Myakka Lakes, through which the Myakka River flows, are the largest lakes in the Myakka River Basin and have a combined surface area of 1,380 acres at elevations of 13.6 and 9.9 feet, respectively. Average discharge in the river at a gaging station located between the two lakes was 266 cfs. As noted by Joyner and Sutcliffe many of the non tidal streams in the Myakka River Basin go virtually dry in late spring during most years.

Approximately 540 square miles of the Kissimmee River Basin is contained within the SWCFGWB, along the Lake Wales and Highlands Ridges (Geraghty & Miller, 1980). This area is dotted with lakes that appear to be sinkhole lakes originating in the collapse of solution features in the underlying Floridan aquifer. Several of these lake basins are considered to be internally drained, as some of the basins have demonstrated little surface-water outflow.

SPRINGS

Several springs exist within the SWCFGWB (Figure 18), however, unlike the NWCFGWB there are no first order magnitude springs. Total springflow from the SWCFGWB was estimated for predevelopment conditions to be 230.5 cfs (Ryder, 1985). Of the 12 springs identified by Ryder (Table 3), six are second order magnitude springs, defined as averaging between 10 and 100 cfs of discharge, and four are third order magnitude springs, average discharge between one and 10 cfs (Rosenau and others, 1977). The largest spring in the SWCFGWB is Crystal Spring, which is located in southeastern Pasco County and averages 60 cfs of discharge. Rosenau and others reported several springs that have ceased flowing in the SWCFGWB. Of these springs Kissengen Spring, located in Polk County, had the highest average discharge at 15 cfs, and a reported high flow of 46 cfs. Peek (1951) noted that the flow in Kissengen Spring ceased as a result of ground-water pumpage from the phosphate industry. Other springs reported by Roseneau and others to have ceased flowing include Phillipi Spring in Pinellas County and Palma Ceia Springs and Purity Spring in Hillsborough County. Based on information presented by Roseneau and others, no active springs currently exist in Charlotte, DeSoto, Highlands, Hardee, and Manatee Counties.

TABLE 3: Springflows greater than 1 cfs in the Southern West-Central Florida Ground-Water Basin (from Roseneau and others, 1977).

INDEX	SPRINGS	DISCHG(CFS)	INDEX	SPRINGS	DISCHG(CFS)
1	SALT	9.5	7	SIX MILE CREEK	1.5
2	CRYSTAL	60	8	BUCKHORN	15.5
3	HEALTH	6.5	9	LITHIA	51
4	SULPHUR	44	10	WARM MINERAL	9.5
5	LETTUCE LAKE	9.5	11	LITTLE SALT	1
6	EUREKA	1.5	12	UNNAMED	30

GROUND WATER

Surficial Aquifer System

A distinct surficial aquifer system exists throughout nearly all of the SWCFGWB and consists of marine and non-marine quartz sand, clayey sand, shell, shelly marl, and phosphorite, with occasional stringers of marl and limestone. The surficial system extends from land surface to the top of the upper confining bed of the Caloosahatchee Marl, Bone Valley Formation, Tamiami Formation, or Hawthorn Formation, whichever is first stratigraphically encountered. Water in the surficial aquifer system is generally unconfined; however, locally within the aquifer system are weak semi-confined layers that poorly confine the ground water. Average thickness of the aquifer is about 25 feet, but ranges from a foot or less, where limestone or clay outcrop or are near land surface, to several hundred feet beneath the Highland Ridge (Figure 13). Extreme thicknesses of 300 to 600 feet or more have been reported along the eastern side of the Lake Wales Ridge in Polk County (Stewart, 1966).

Surficial Aquifer Hydraulic Properties

Hydraulic properties of the surficial aquifer system in the SWCFGWB vary widely due to variation in types of material that comprise the aquifer; its physical characteristics, such as grain size and sorting; and thickness of the saturated zone. Hydraulic properties for the surficial aquifer system are listed in Table 4. The locations of the aquifer test sites at which these values were derived are given in Figure 19.

Transmissivity of the surficial aquifer system ranges from about 20 feet squared per day (ft^2/d) where fine clayey sand predominates, to greater than 5,000 ft^2/d in some clean shell beds in the southern areas of the SWCFGWB. Transmissivities are lowest to the north and along the coast where the aquifer is composed of mostly fine grained clastics, and saturated thickness is least. Transmissivities are greatest in southern Sarasota, Charlotte, and Lee Counties.

Specific yield of the surficial aquifer ranges from 0.05 to 0.3 (Wilson and Gerhart, 1980). Determinations of vertical hydraulic conductivity have been made from lab tests on undisturbed samples, range from 0.12 x 10^{-5} to 13 feet per day (ft/d) (Sinclair, 1974; Hutchinson and Stewart, 1978; Healy and Hunn, 1984). Determinations of horizontal hydraulic conductivity range from 0.0028 ft/d to greater than 1,000 ft/d (Healy and Hunn, 1984).

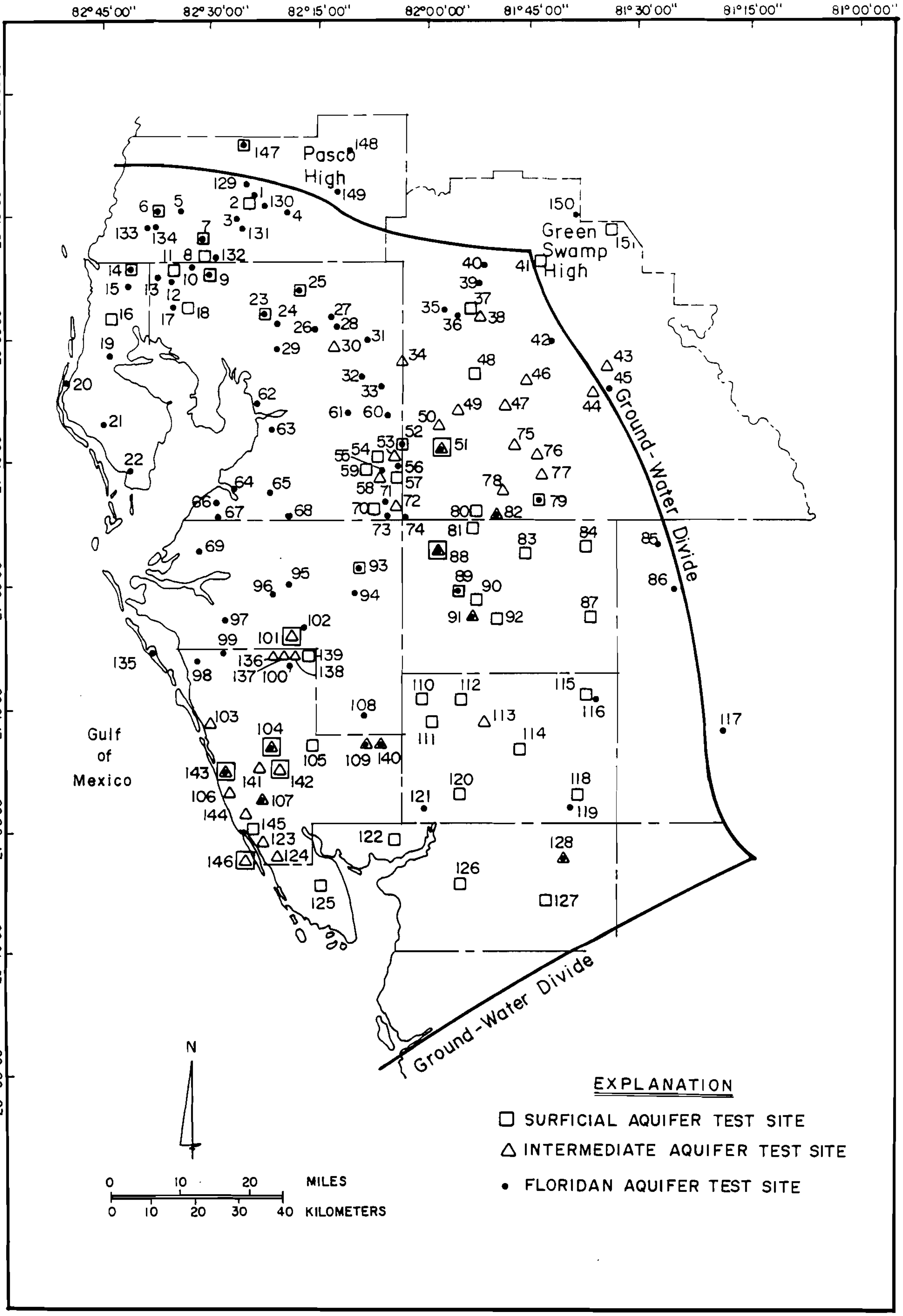


Figure 19. Aquifer test sites in the Southern West-Central Florida Ground-Water Basin (from SWFWMD, 1987; Wolansky 1983; and Fretwell, in press).

Table 4. Aquifer properties of the surficial, intermediate, and Floridan aquifer systems in the Southern West-Central Florida Ground-Water Basin, derived from aquifer tests and flow net analyses. Locations of the aquifer tests are depicted in Figure 19.

	SITE	AQUIFER TESTED	TRANSMISSIVITY (Ft^2/d)	STORAGE COEFFICIENT (Ft^3/Ft^3)	LEAKANCE (Ft^3/d) $/Ft^3)$
1.	Cypress Creek	Floridan	50,800.	0.001	0.0002
2.	Cypress Creek	Surficial	174.	0.2	----
3.	Lake Padgett	Floridan	28,342.	0.001	0.0027
4.	Murphey Well	Floridan	18,717.	0.0013	0.0001
5.	Starkey East	Floridan	60,695.	0.004	0.0003
6.	Starkey West	Surficial	334.	----	----
	" "	Floridan	40,107.	0.0002	0.0001
7.	South Pasco Wellfield	Surficial	201.	0.3	----
	" "	Floridan	46,791.	0.007	0.0001
8.	Dundee Ranch	Surficial	214.	0.004	----
9.	Section 21	Surficial	267.	0.2	----
	" "	Floridan	60,160.	0.0007	0.0001
10.	NW Hillsborough Wellfield	Floridan	50,134.	0.0001	0.0002
11.	NW Hillsborough Average	Surficial	214.	0.2	----
12.	Cosme-Odessa	Floridan	53,476.	0.0006	0.0001
13.	Sunset Lake	Floridan	28,476.	0.006	0.0001
14.	Eldridge-Wilde	Surficial	134.	0.16	----
	" "	Floridan	35,428.	0.0005	0.0003
15.	East Lake Road Wellfield	Floridan	40,107.	0.0009	0.0011
16.	Clearwater Landfill	Surficial	501.	0.2	----
17.	Sheldon Road Wellfield	Floridan	26,738.	0.001	0.0001
18.	NW Hillsborough Average	Surficial	214.	0.2	----
19.	Clearwater Wellfield	Floridan	33,422.	0.0004	0.0001
20.	McKay Creek	Floridan	895,722.	0.008	0.0013
21.	South Cross Bayou	Floridan	1,203,209.	0.0002	0.0001
22.	SW St. Pete Injection	Floridan	1,203,209.	0.0002	0.0001
23.	Temple Terrace	Surficial	455.	----	----
	" "	Floridan	129,947.	0.0003	0.0013
24.	Eureka Springs	Floridan	122,995.	0.0004	0.0013
25.	Morris Bridge	Surficial	267.	0.2	----
	" "	Floridan	51,003.	0.001	0.0001-0.0008
26.	RI 25 Test	Floridan	29,412.	0.002	0.003
27.	Swindle	Floridan	15,374.	0.001	----
28.	Roach	Floridan	15,642.	0.0004	----
29.	Six Mile Creek	Floridan	65,508.	0.0008	0.0013
30.	Unnamed	Intermediate	180.	----	----
31.	Plant City	Floridan	23,663.	0.002	----

Table 4. Continued

SITE	AQUIFER TESTED	TRANS-MISSIVITY (Ft^2/d)	STORAGE COEFFI-CIENT (Ft^3/Ft^3)	LEAKANCE (Ft^3/d) /Ft^3)
32. Medard	Floridan	31,039.	0.0008	0.0002
33. Hopewell	Floridan	60,160.	----	0.0001
34. Unnamed	Intermediate	740.	0.001	----
35. Lakeland	Floridan	98,797.	0.0015	----
36. Lakeland-USGS	Floridan	100,267.	0.0009	----
37. Lake Parker	Surficial	949.	0.3	----
38. Unnamed	Intermediate	670.	----	----
39. 807-154-4	Floridan	96,257.	0.0036	----
40. 808-153-2	Floridan	69,519.	0.005	0.0003
41. 810-144-2	Surficial	20.	0.22	----
42. Winter Haven	Floridan	106,952.	0.0015	----
43. Unnamed	Intermediate	2,600.	0.0001	----
44. Unnamed	Intermediate	5,000.	----	----
45. Lake Wales	Floridan	51,471.	0.047	----
46. Unnamed	Intermediate	640.	----	----
47. Unnamed	Intermediate	1,400.	----	----
48. Grace-Bonny Lk.	Surficial	769.	0.3	----
49. Unnamed	Intermediate	390.	----	----
50. Unnamed	Intermediate	270.	0.0001	----
51. Grace-Hookers	Surficial	2,393.	----	----
" "	Intermediate	3,837.	0.0003	0.0004
" "	Floridan	116,310.	0.0004	----
52. Borden Big 4-N	Surficial	762.	0.16	----
IMC-Ft.Lonesome	Floridan	125,668.	----	----
53. Unnamed	Intermediate	281.	$4X10^{-5}$	$8X10^{-7}$
54. Brewster Lonesome	Surficial	1,805.	0.12	----
55. Brewster Lonesome	Floridan	467,914.	0.001	----
56. Borden Big 4-N	Floridan	103,610.	0.0004	$3X10^{-5}$
57. Borden Big 4S	Surficial	254.	0.12	----
58. Unnamed	Intermediate	160.	----	----
59. Hutchinson #91	Surficial	1,604.	0.05	----
60. Aldermans Ford	Floridan	24,198.	0.0008	0.0002
61. Lithia	Floridan	36,096.	0.0009	0.0001
62. Gardinier Phosphate	Floridan	100,000.	----	----
63. Riverview	Floridan	46,791.	0.001	0.107
64. Ruskin	Floridan	80,214.	0.002	0.0005
65. Sun City	Floridan	65,508.	0.0007	0.0067
66. Peek Test Site	Floridan	15,321.	0.0006	----
67. TECO-MacInnes	Floridan	240,642.	$1X10^{-5}$	----
68. Florida Power & Light-Willow	Floridan	116,310.	0.001	----
69. Peek Test Site	Floridan	73,529.	0.001	0.0005
70. Grace 4 Corners	Surficial	535.	0.12	----
71. Grace 4 Corners (GD-7)	Floridan	548,128.	0.003	0.0008
72. Unnamed	Intermediate	267.	0.0001	0.0003
73. Grace 4 Corners (GD-10)	Floridan	735,294.	0.0002	0.0003

Table 4. Continued

SITE	AQUIFER TESTED	TRANS-MISSIVITY (Ft^2/d)	STORAGE COEFFI-CIENT (Ft^3/Ft^3)	LEAKANCE ((Ft^3/d) $/Ft^3$)
74. Grace 4 Corners (GD-11)	Floridan	280,749.	0.001	----
75. Unnamed	Intermediate	170.	----	----
76. Unnamed	Intermediate	13,300.	----	----
77. Unnamed	Intermediate	8,800.	0.0002	$3X10^{-5}$
78. Unnamed	Intermediate	160.	----	----
79. Mobil - S. Fort Meade	Surficial	8.	----	----
" "	Floridan	149,733.	0.0001	0.0001
80. Hutchinson #42	Surficial	2,206.	0.005	----
81. USSAC - S. Rockland	Surficial	668.	0.2	----
82. USSAC - S. Rockland	Intermediate	1,738.	0.0001	----
" "	Floridan	9,331,551.	0.0002	----
83. Hardee County Avg.	Surficial	2,206.	0.005	----
84. Hardee DeSoto County Avg.	Surficial	----	----	----
85. FPC Avon Park	Floridan	69,519.	0.0005	----
86. Sebring	Floridan	26,738.	0.0003	0.0003
87. Hardee County Avg.	Surficial	----	----	----
88. CF Industries	Surficial	401.	0.1	----
" "	Intermediate	535.	0.0001	----
" "	Floridan	267,380.	0.001	$1X10^{-5}$
89. Mississippi Chemical	Surficial	1,604.	----	----
" "	Floridan	133,690.	0.002	$1X10^{-5}$
90. Farmland N.	Surficial	1,711.	0.19	----
91. Farmland Industries	Intermediate	5,789.	0.0003	$1X10^{-9}$
" "	Floridan	89,572.	0.0025	0.0001
92. Farmland S.	Surficial	1,297.	0.1	----
93. Estech	Surficial	5,304.	----	----
" "	Floridan	102,941.	0.0005	0.0001
94. Beker	Floridan	61,497.	0.0004	0.0001
95. Rutland Ranch	Floridan	44,385.	0.002	0.0027
96. Lake Manatee Rechge/Recvry	Floridan	42,781.	0.0002	$4X10^{-5}$
97. Evers Reservoir	Floridan	37,433.	0.0006	0.0006
98. Sarasota	Floridan	35,428.	0.0007	0.0001
99. Sarasota-County Line Rd.	Floridan	4,906.	0.0002	0.0023
100. Verna	Floridan	2,005.	0.002	0.0005
101. Verna	Surficial	267.	0.1	----
" "	Intermediate	2,005.	0.002	0.0001
102. Elsberry Farms	Floridan	45,455.	0.001	- - - -
103. Unnamed	Intermediate	1,872.	0.0003	0.0001

Table 4. Continued

SITE	AQUIFER TESTED	TRANS-MISSIVITY (Ft^2/d)	STORAGE COEFFI-CIENT (Ft^3/Ft^3)	LEAKANCE (Ft^3/d) /Ft^3)
104. MacArthur Tract A	Surficial	1,110.	0.15	----
" "	Intermediate	2,674.	0.0001	0.0001
" "	Floridan	2,674.	0.0001	0.0001
105. MacArthur Tract E	Surficial	1,805.	0.19	----
106. Unnamed	Intermediate	1,875.	----	----
107. The Plantation	Intermediate	5,602.	0.0003	$3X10^{-5}$
" "	Floridan	5,602.	0.003	$3X10^{-5}$
108. Amax	Floridan	160,428.	0.0004	0.0001
109. ROMP 18	Intermediate	1,872.	0.0003	0.0001
" "	Floridan	16,043.	0.0001	$1X10^{-5}$
110. AMAX N (TCI)	Surficial	401.	0.01	----
111. AMAX S (TC2)	Surficial	602.	0.025	----
112. DeSoto Co. Avg.	Surficial	----	----	----
113. Unnamed	Intermediate	4,011.	0.0001	----
114. DeSoto Co. Avg.	Surficial	----	----	----
115. Connector Well	Surficial	1,750.	----	----
116. Tropical River Groves	Floridan	267,380.	$3X10^{-5}$	0.0001
117. Consolidated Tomoca	Floridan	56,150.	0.0002	0.0001
118. DeSoto Co. Avg.	Surficial	----	----	----
119. DeSoto Land and Cattle	Floridan	117,647.	0.02	----
120. DeSoto Co. Avg.	Surficial	----	----	----
121. Fort Ogden	Floridan	9,091.	0.0004	0.0003
122. Area B	Surficial	2,139.	----	----
123. Unnamed	Intermediate	2,674.	0.0003	0.0003
124. Unnamed	Intermediate	8,249.	$8X10^{-5}$	0.0003
125. Gasparilla Is.	Surficial	1,604.	0.22	----
126. Area C	Surficial	1,324.	----	----
127. Area D	Surficial	5,615.	----	----
128. Tropical River Groves, NE Charlotte Co.	Intermediate	3,075.	0.0001	0.0001
" "	Floridan	3,075.	0.0001	0.0001
129. Unnamed	Floridan	37,400.	----	----
130. Cypress Creek Wellfield	Floridan	31,500.	----	----
131. Unnamed	Floridan	28,100.	----	----
132. St. Pete-Pasco Wellfield	Floridan	53,000.	----	----
133. Starkey Wellfield	Floridan	40,000.	----	----
134. Starkey Wellfield	Floridan	33,400.	----	----
135. Unnamed	Floridan	35,400.	0.0007	0.0001
136. Unnamed	Intermediate	2,100.	0.0003	$1X10^{-5}$
137. Unnamed	Intermediate	1,500.	----	----
138. Unnamed	Intermediate	900.	0.0002	----

Table 4. Continued

SITE	AQUIFER TESTED	TRANS-MISSIVITY (Ft^2/d)	STORAGE COEFFI-CIENT (Ft^3/Ft^3)	LEAKANCE $(Ft^3/d)/Ft^3$
139. Unnamed	Surficial	600.	0.05	----
140. Unnamed	Intermediate	9,000.	0.0001	0.0001
" "	Floridan	16,000.	0.0001	----
141. Unnamed	Intermediate	2,400.	----	----
142. Unnamed	Surficial	1,070.	0.16	----
" "	Intermediate	2,740.	----	----
143. Unnamed	Surficial	1,000.	----	----
" "	Intermediate	800.- 2,500.	0.0001	0.0001- 0.0002
" "	Floridan	18,700.	----	----
144. Unnamed	Intermediate	500.	0.0002	0.0008
145. Unnamed	Surficial	3,800.	----	----
146. Unnamed	Surficial	6,000.	----	----
" "	Intermediate	8,000.	----	----
147. Cross Bar Ranch	Surficial	160.	0.2	----
" "	Floridan	70,855.	0.0004	0.0015
148. Dade City	Floridan	294,120.	----	----
149. IMC Murrell	Floridan	21,390.	0.0001	----
150. 814-139-5	Floridan	90,909.	0.0018	0.0056
151. 815-134-12	Surficial	16.	0.22	----

Surficial Aquifer Water Quality

Water quality of aquifer systems is primarily affected by the chemical nature of rainfall that infiltrates land surface, the composition and solubility of the surficial material coming in contact with the water, and the certain properties and characteristics that the soluble earth materials impart to the water. The water quality of aquifers is also influenced by surface water that directly recharges the aquifer via solution features and other direct hydraulic connections such as aquifer outcrop areas near rivers, streams, and swamps. Water quality along the coast is also effected by the position of the freshwater/saltwater interface.

Generally, with the exception of coastal areas, water quality of the surficial aquifer in the SWCFGWB is within the Florida Department of Environmental Regulations (DER) potable standards (Table 5). It is characteristically low in dissolved minerals, soft to moderate in calcium hardness, and frequently exceeds DER standards for iron and color. Chloride concentrations measured inland seldom exceed 250 milligrams per liter (mg/l).

Figure 20 illustrates regional trends of total dissolved solids (TDS), hardness, chloride, and sulfate in the surficial aquifer system of the SWCFGWB. These trends were depicted primarily utilizing data obtained during the initial sampling of the SWFWMD's Ambient Ground-Water Quality Monitoring Program Background Network, which was sampled between June, 1985 and December, 1985, and water-quality data obtained from public drinking water wells permitted under the Consumptive Use Permit (CUP) program of the SWFWMD. Other additional data sites were utilized to supplement the these data.

STATE OF FLORIDA DRINKING WATER STANDARDS

PRIMARY DRINKING WATER STANDARDS

Inorganics	MCL* (mg/L)
Arsenic	0.05
Barium	1.
Cadmium	0.010
Chromium	0.05
Lead	0.05
Mercury	0.002
Nitrate (as N)	10.
Selenium	0.01
Silver	0.05
Sodium	160
Flouride	1.4-2.4 (varies with temperature)
Turbidity	1 TU monthly ave. 5 TU two day ave.
Microbiological	
Coliform Bacteria	4/100 ml Total Coliform (see rules FAC 17-22)

Organics	MCL
Chlorinated Hydrocarbons	(mg/L)
Endrin	0.0002
Lindane	0.004
Methoxychlor	0.1
Toxaphene	0.005
Chlorophenoxys	
2,4,-D	0.1
2,4,5-TP, Silvex	0.01
Volatile Organics	(micrograms/l)
Trichloroethylene	3
Tetrachloroethylene	3
Carbon Tetrachloride	3
Vinyl Chloride	1
1,1,1-Trichloroethane	200
1,2-Dichloroethane	3
Benzene	1
Ethylene Dibromide	0.02

Radionuclides	MCL
Radium 226, 228	5 pCi/L
Gross Alpha Activity (Including ^{226}Ra, excluding Rn, V)	15 pCi/L
Beta Activity	4 mrem/yr
Tritium	20,000 pCi/L
Strontium-90	8 pCi/L

Trihalomethane	MCL
TTHM	10 mg/L

SECONDARY DRINKING WATER STANDARDS

Contaminant	Levels (mg/L)**
Chloride	250
Color	15 Color Units
Copper	1
Corrosivity	***Neither corrosive nor scale forming
Foaming Agents	0.5
Iron	0.3
Manganese	0.05
Odor	3 (threshold odor number)
pH (at Collection Point)	6.5 (min. allowable - no max.)
Sulfate	250
TDS	500 (may be greater if no other MCL is exceeded)
Zinc	5

* Maximum contaminant level

** Except color, odor, corrosivity, and pH

*** Assesament of degree of corrosion or scale forming tendencies must be based on historical water characteristics of the system. A Langelier Index range of -0.2 to +0.2 should be used as a guideline toward obtaining water stability if calcium carbonate is present. If stabilizers are used, the -0.2 to +0.2 range may not be applicable

Table 5. Department of Environmental Regulation (DER) primary and secondary drinking water standards, Florida Administrative Code, Chapter 17-22.

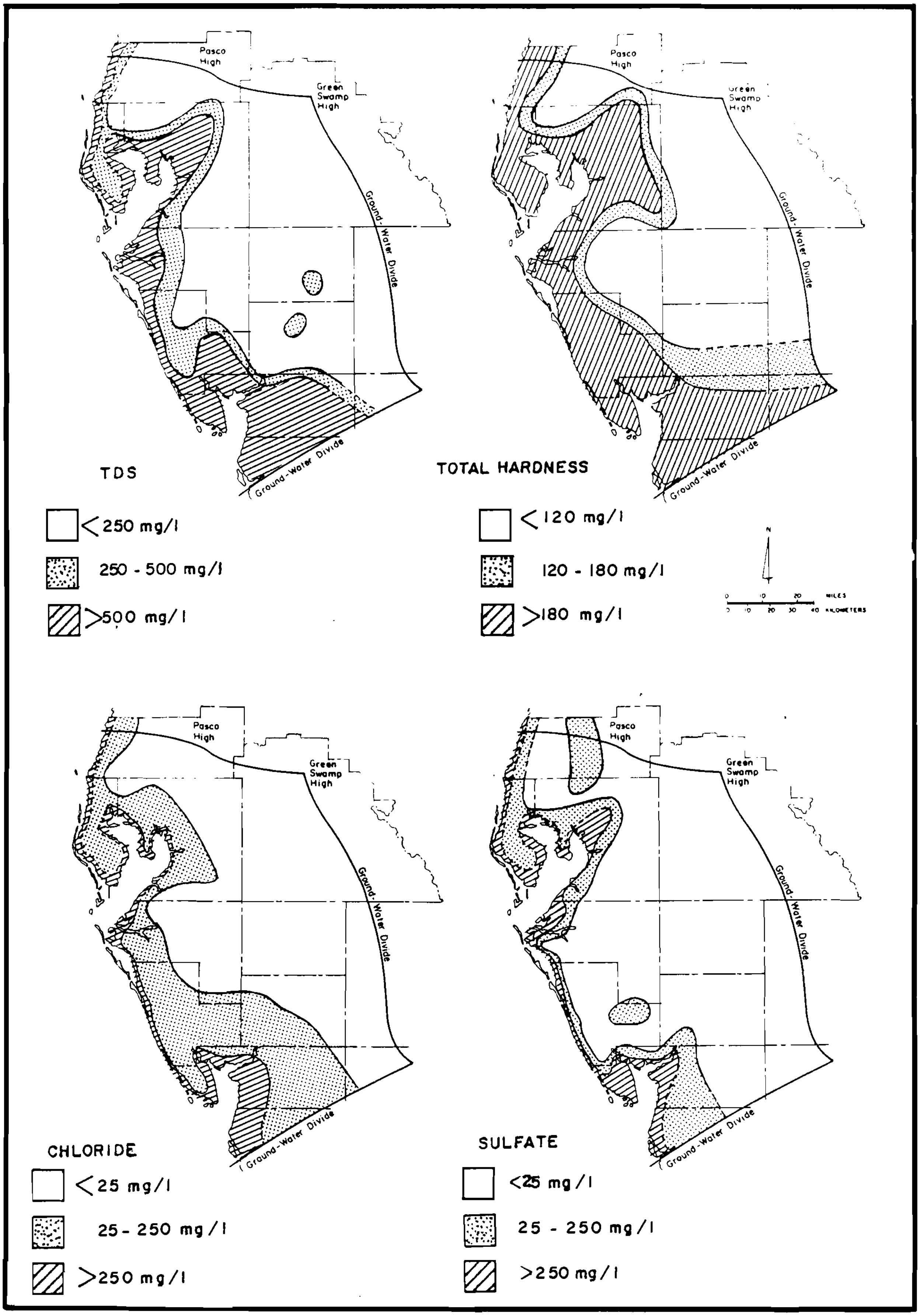


Figure 20. Naturally occurring major constituents within the surficial aquifer system in the Southern West-Central Florida Ground-Water Basin.

With the exception of the central and southern coastal areas, TDS in the surficial aquifer system is less than 500 mg/l. Total dissolved solids are least in the northern and central SWCFGWB areas and increase towards the coast. Hardness of the water is determined by the concentrations of the calcium and magnesium ions. The combined concentrations of both of these ions is generally below 180 mg/l for the surficial system and is considered to be moderately hard. Sulfate concentrations are less than the 250 mg/l DER potable standard in much of the SWCFGWB; however, sulfate concentrations are elevated in the coastal and southern areas and substantially increase the treatment cost of potable water use.

Chloride concentrations are low, except in the coastal areas, as are most ions. The exception is iron, which exceeds DER's 0.3 mg/l potable standard in much of the SWCFGWB. In addition to iron, the surficial system contains variable amounts of organic constituents that color the water and make it difficult to treat for potable supply. Water color increases near wetland areas where it leaches through organic matter and produces tannic acids. The combination of organics naturally found in the water with chlorine during treatment can produce high levels of trihalomethanes (THMs) which are considered a potential health concern. Special treatment is required to minimize the production of THMs.

Infiltration (Recharge)

The source of all freshwater in the SWCFGWB is rainfall. Part of the rainfall collects in topographic depressions such as lakes and swamps, or enters stream channels and flows into gulf and bay waters. Some rainfall infiltrates into the soil and surficial aquifer where it eventually returns to the surface as streamflow, is lost through evapotranspiration processes, or leaks into the deeper confined aquifers. Most rainfall is lost to evapotranspiration.

Infiltration rates to the surficial aquifer system vary depending on depth to the water table, soil type, soil moisture, topography, vadose zone material, evapotranspiration, and runoff characteristics. Infiltration rates to the surficial system in the SWCFGWB vary from zero when the water table is at land surface to greater than 20 inches per year in upland areas. Causseaux (1985) reported infiltration rates of 22 inches per year to the surficial aquifer in Pinellas County.

Water Use

The surficial aquifer system is used to a limited extent throughout the SWCFGWB for lawn irrigation and stock watering. However, in southern Sarasota and Charlotte Counties, where deeper aquifers are highly mineralized, the surficial system is used as a major source of water for domestic and public supplies. Municipal wellfields which withdraw water from the surficial aquifer system for public distribution include the Englewood, Rotunda, and Gasparilla Island Wellfields (Figure 21; Table 6). Except where permeable shell beds with high transmissivities are present, yields range from 5-50 gallons per minute (GPM), and multiple sand-point wells are used to keep drawdown effects to a minimum.

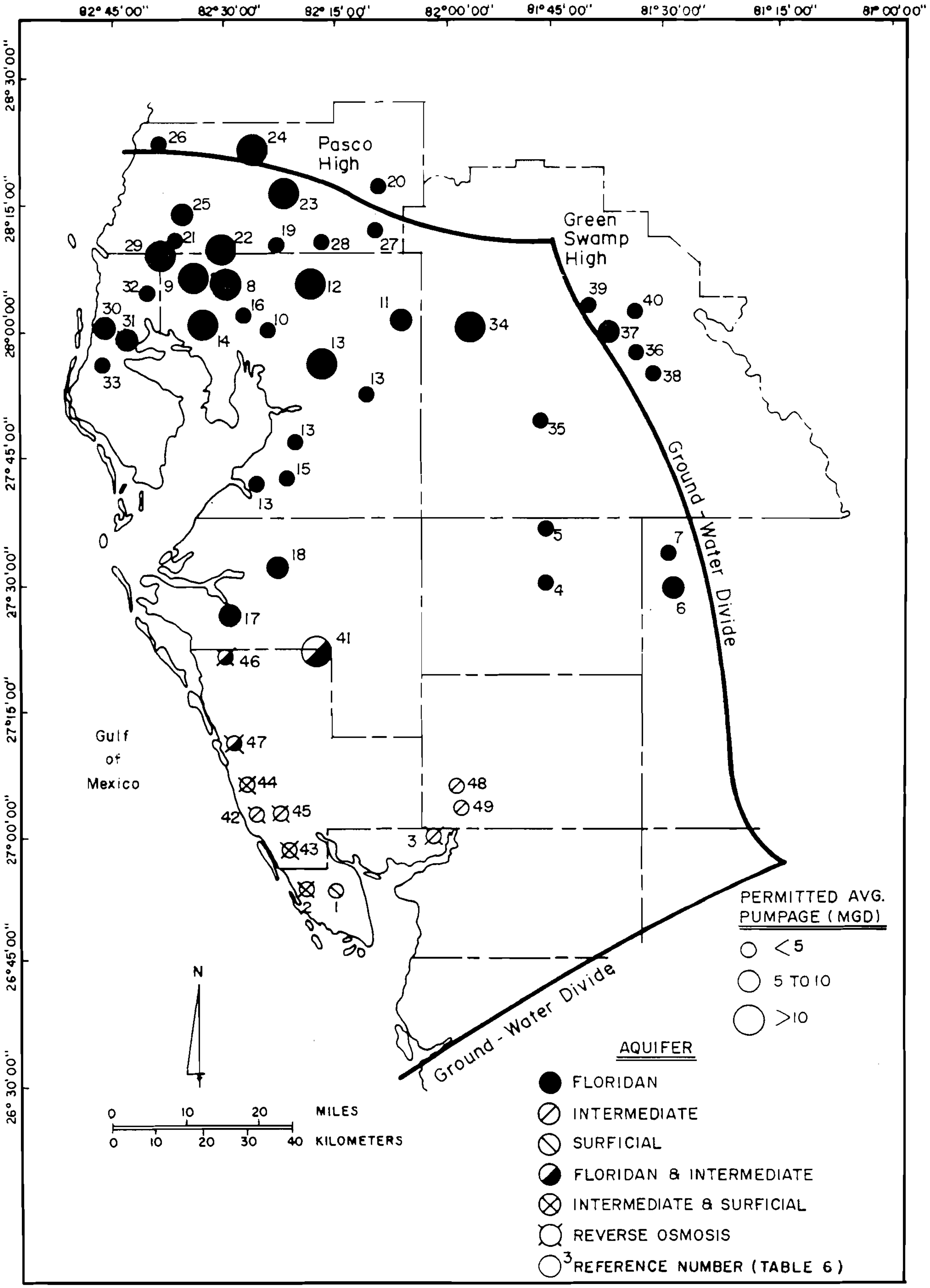


Figure 21. Location of the major municipal wellfields in the Southern West-Central Florida Ground-Water Basin.

Table 6. Public Supply Wellfields and Permitted Withdrawals.

Ref. No.	No. of Wells	CUP NO.	MGD P-AVG	MGD P-MAX	AVG TD(feet)	NAME
				- Charlotte -		
1	32	00718-01	0.5	1.9	30′	Gasparilla Island
2*	16	02839-02	0.9	1.6	30′/45′	Rotunda W.
3	4	01512-04	0.6	0.8	500′	Charlotte Harbor
				- Hardee -		
4	4	04461-01	1.7	3.5	900′	Wauchula
5	2	00030-02	0.5	0.7	1,100′	Bowling Green
				- Highlands -		
6	6	04492-01	5.0	11.5	1,400′	Sebring
7	6	06029-01	2.4	3.0	1,000′	Avon Park
				- Hillsborough -		
8	10	00003-01	13.0	22.0	500′	Section 21 WCRWSA
9	23	00004-01	13.0	22.0	330′	Cosme-Odessa WCRWSA
10	14	00450-04	4.5	10.3	300′	Temple Terrace
11	7	01776-01	6.3	9.7	700′	Plant City
12	20	04180-00	22.0	42.0	NA	Morris Bridge, Tampa
13	17	04352-01	24.1	44.6	900′	S. Central, WCRWSA (Brandon East)
14	7	06676-00	14.0	21.0	650′	NW Regional, WCRWSA
15	3	08440-00	0.06	0.12	380′	Sun City Util.
16	3	05886-01	1.2	2.5	500′	Florida Cities Wtr.Co.
				- Manatee -		
17	15	06392-00	8.0	12.8	650′	Bradenton, City of
18	1	05387-01	8.9	12.2	NA	Lk. Manatee Well
				- Pasco -		
19	48	00266-02	4.5	9.0	120′	Pasco County
20	6	01631-01	3.0	5.0	400′	Dade City, FL
21	6	03182-01	2.1	7.8	350′	Aloha Utilities, Inc.
22	8	03647-01	16.9	24.0	615′	(S.Pasco) St. Pete
23	13	03650-02	30.0	40.0	700′	Cypress Creek, WCRWSA
24	17	04290-01	30.0	45.0	700′	Cross Bar, WCRWSA
25	14	04446-02	8.0	15.0	750′	Starkey, WCRWSA
26	19	04669-02	1.1	2.4	100′	Hudson Water Works
27	7	06040-02	1.5	2.6	600′	Zephyrhills, FL
28	3	06539-00	1.0	2.1	600′	Int'l. Community
29	58	02673-01	35.2	55.0	98′	Eldridge-Wilde, Pinellas
30	25	02980-01	7.1	12.0	250′	Dunedin, FL
31	31	02981-01	9.1	16.3	250′	Clearwater, FL
32	8	04391-01	3.0	5.0	200′	Pinellas County
33	6	07692-00	1.1	2.2	300′	Belleair, FL
				- Polk -		
34	30	04912-02	28.3	54.5	700′	Lakeland
35	8	00341-01	3.8	6.2	500′	Bartow, FL
36	15	04279-03	3.6	7.2	600′	Garden Grove Water Co.
37	12	04607-03	7.5	13.0	650′	Winter Haven, FL
38	9	04658-03	4.0	12.5	1,000′	Lake Wales, FL
39	5	07119-02	3.4	6.3	600′	Auburndale, FL
40	6	08522-02	2.3	8.1	700′	Haines City, FL
				- Sarasota -		
41	51	04318-01	12.0	14.2	600′	Sarasota, FL (Verna)
42*	59	04836-02	3.2	4.3	120′	Venice Gardens Corp.
43*	63	04866-01	4.4	5.1	50′/425′	Englewood Water Dist.
44*	30	05393-02	4.6	7.3	130′/400′	Venice, FL
45*	12	06364-01	4.3	5.9	160′/380′	Plantation Util. Serv.
46*	7	07411-01	2.0	3.0	600′	Sarasota County
47*	3	07740-00	2.1	4.2	350′	Sorrento Util. Inc.
				- DeSoto -		
48	6	08107-01	4.9	4.9	600′	Gen. Dev. Corp.
49	1	06603-00	0.6	0.9	NA	Sandhill Prop. Inc.

*Reverse Osmosis

MGD : Million gallons per day
P-AVG : Consumptive use permitted average withdrawal
P-MAX : Consumptive use permitted maximum withdrawal
TD : Total depth, average
Ref.No: See Figure 21
CUP No: Consumptive use permit number (SWFWMD)
′ : Feet

Intermediate Aquifer System

Duerr and others (in press) have recently completed "Hydrogeology of the Intermediate Aquifer System, Southwest Florida". This report, which was prepared in cooperation with the SWFWMD, summarizes the most comprehensive investigation of the intermediate aquifer system in the SWCFGWB to date. For the sake of efficiently completing the intermediate aquifer system discussion of the SWCFGWB in this report, several section's of Duerr and other's report are included in nearly their entirety below. Sections included from Duerr and other's are delineated by an asterisk (*).

Overview of the Intermediate Aquifer System (*)

The intermediate aquifer system includes all water-bearing units and confining units between the overlying surficial aquifer system and the underlying Floridan aquifer system. The water-bearing units of the intermediate aquifer system consist of discontinuous sand, gravel, shell, and limestone and dolomite beds in the Caloosahatchee, Tamiami, and Bone Valley Formations of Pliocene and Pliestocene age, and the Hawthorn Formation of late and middle Miocene age. In parts of Polk, Manatee, Hardee, DeSoto, Sarasota, and Charlotte Counties, sand and clay beds within the Tampa Limestone are hydraulically connected to the Hawthorn Formation and are also included in the intermediate aquifer system (Corral and Wolansky, 1984). In these areas, a confining unit separates the Tampa Limestone from the underlying Floridan aquifer system.

The intermediate aquifer system also contains confining beds that consist of sandy clay, clay, and marl. These confining beds retard vertical movement of ground water between the overlying surficial aquifer and the underlying Upper Floridan aquifer.

Within the intermediate aquifer system are deposits of sufficient permeability to be used as important water supplies in coastal areas. The intermediate aquifer system thus consists of three hydrogeologic units (Table 1): (1) a confining unit in the lower part that lies directly on the Floridan aquifer system; (2) an aquifer unit that consists of one, two, or three water-bearing units made up primarily of sand and carbonate rocks; and (3) a confining unit in the upper part that separates the aquifers in the intermediate aquifer system from the overlying surficial aquifer (Ryder, 1985).

The water-bearing part of the intermediate aquifer system is equivalent to the secondary artesian aquifer as used by Stewart (1966) for Polk County; to zones 2 and 3 as used by Sutcliffe (1975) for Charlotte County; to the upper and lower Hawthorn aquifers as used by Sproul and others (1972) for part of Lee County; and to the upper unit of the Floridan aquifer as used by Wilson (1977) for DeSoto and Hardee Counties.

Six hydrogeologic cross-sections illustrating stratigraphic relationships of near surface deposits in the SWCFGWB are shown in Figure 22. Locations of the six cross-sections are depicted in Figure 23. The sections were constructed primarily from geologists' logs of test wells. Geophysical logs also were used for correlating aquifers. The sections show the thicknesses and relative positions

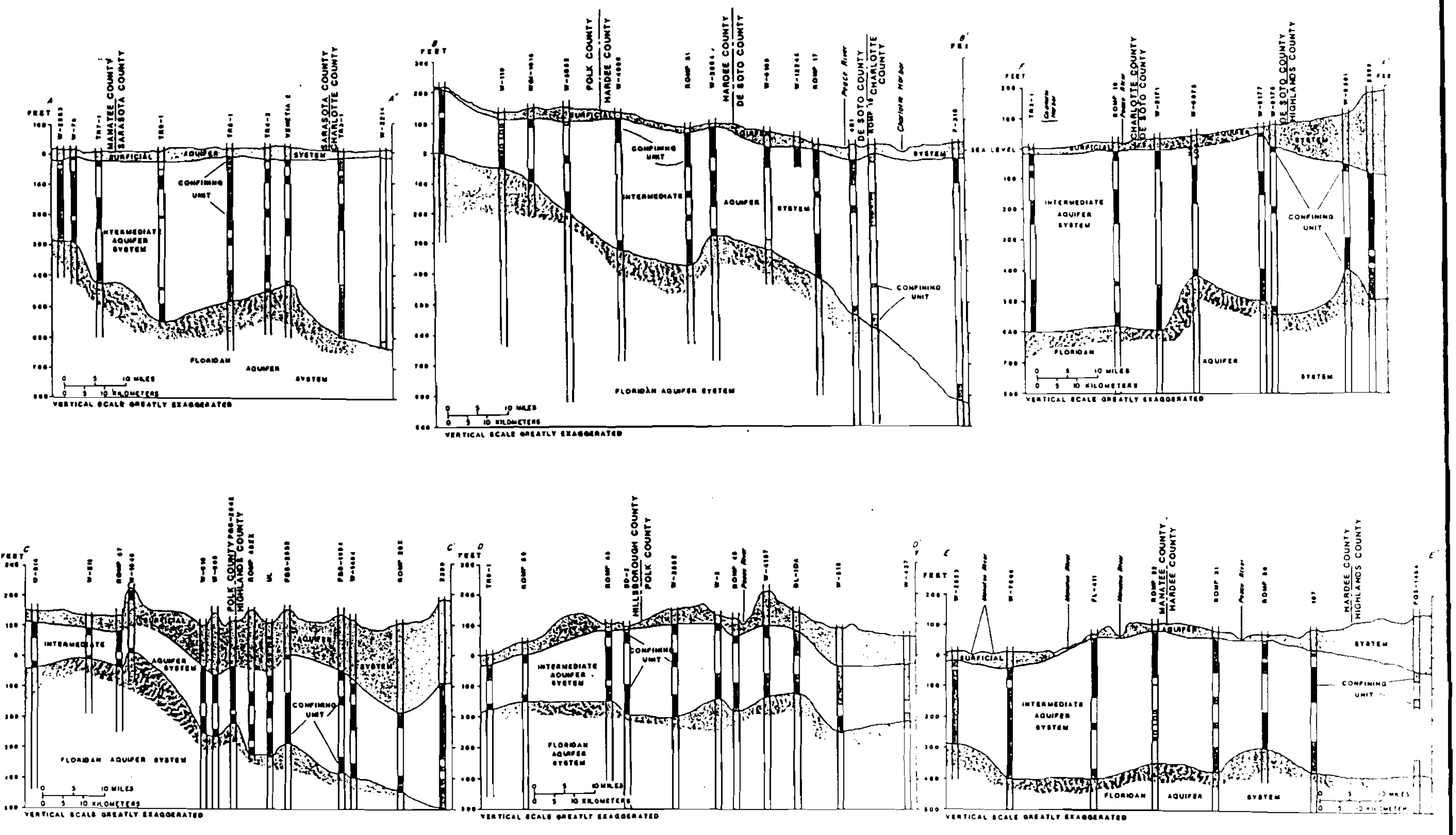


Figure 22. Six hydrogeologic cross-sections illustrating stratiographic relationships of near surface deposits, in the Southern West-Central Florida Ground-Water Basin (from Duerr, in press).

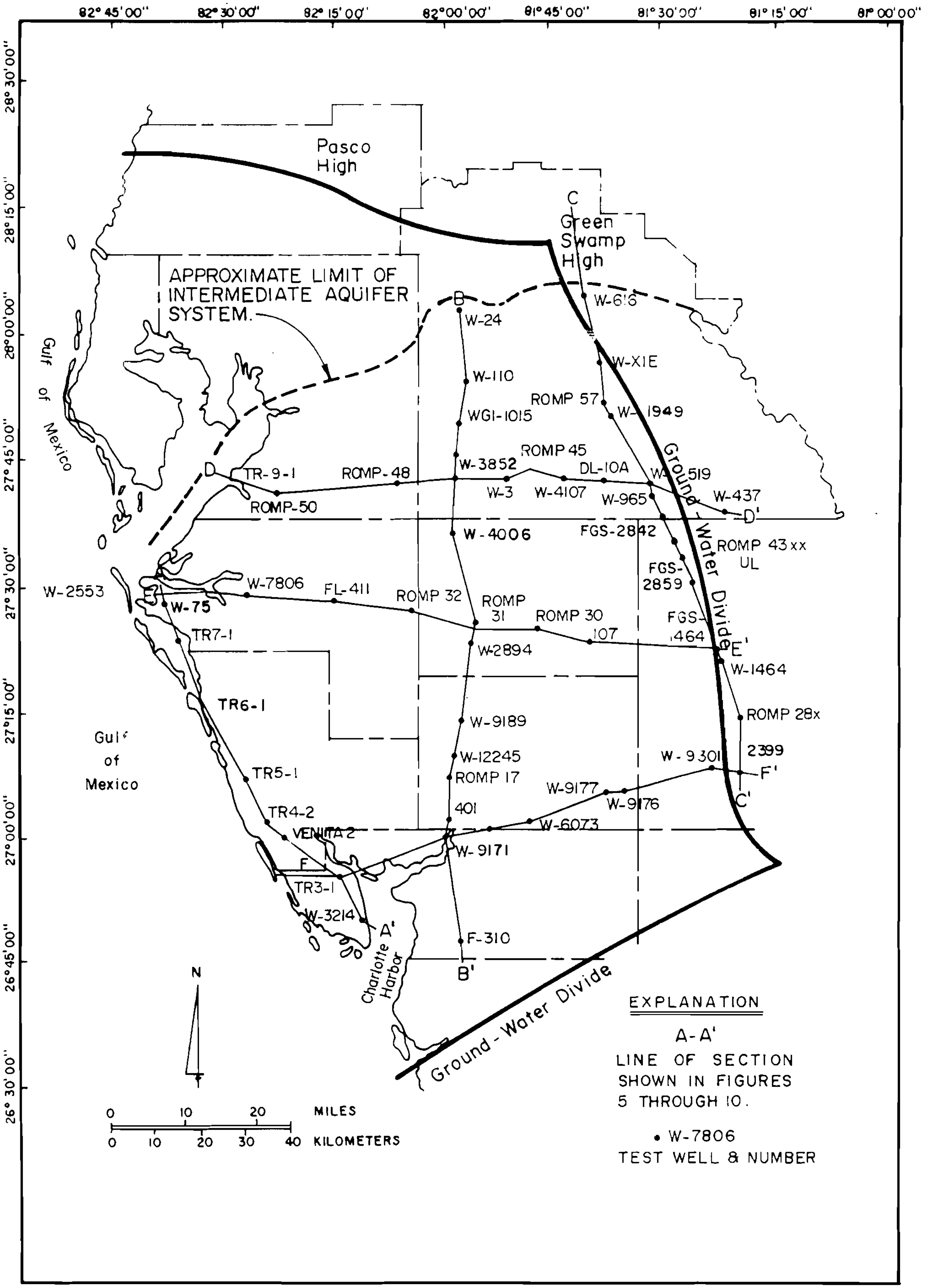


Figure 23. Locations of geologic sections shown in Figure 22.

of the surficial and intermediate aquifer systems. There are lateral inconsistencies between interpretations of rock stratigraphic units in the study area and they are not included in the sections.

In the SWCFGWB, the top of the intermediate aquifer system ranges from less than 100 feet below NGVD in Highlands County to more than 100 feet above NGVD in central Polk County (Figure 24). Throughout most of the southern and western parts of the study area, the top of the intermediate aquifer system is within 50 feet of NGVD. Along the Gulf Coast, it lies about 20 feet below NGVD. The thickness of the intermediate aquifer system ranges from less than 100 feet in central Hillsborough and northern Polk Counties to more than 800 feet in Southern Charlotte County (Figure 24). The bottom of the intermediate aquifer system (top of the Floridan aquifer system) ranges from about 50 feet above NGVD in northern Polk County to more than 800 feet below NGVD in southern Charlotte County.

Hydraulic Properties (*)

Transmissivities of the permeable deposits of the intermediate aquifer system, as determined by field tests, are given in Table 4. Transmissivity ranges from less than 200 to about 13,000 ft^2/d. Transmissivity is generally less than 1,000 ft^2/d in eastern Hillsborough and northern Polk Counties where the permeable deposits are thin. Near the Peace River, transmissivity is generally higher than 4,000 ft^2/d, indicating that perhaps a more active flow system exists in a carbonate section where ground-water discharges to the river and the carbonate rocks' secondary porosity has been enhanced by dissolution, thus providing greater permeability. Transmissivities of the permeable beds of the intermediate aquifer system in the SWCFGWB used by Ryder (1985) in a ground-water flow model ranged from 0.0001 ft^2/d in central Hillsborough and Polk Counties to greater than 10,000 ft^2/d in southern Sarasota County (Figure 25).

Clay beds of limited lateral extent and variable thickness may occur within the permeable deposits of the intermediate aquifer system, particularly near the coast. Where laterally persistent clay beds occur, the permeable zone has been separated into two or three local artesian zones by some investigators (Joyner and Sutcliffe, 1976; Sutcliffe and Thompson, 1983; Wolansky, 1983).

The permeable deposits of the intermediate aquifer system are confined above and below by less permeable material. Leakance of the uppermost confining bed used by Ryder (1985) in a ground-water flow model of west-central Florida range from 7×10^{-6} (ft/d)/ft in western Manatee County to 4×10^{-4} (ft/d)/ft near the Tampa Bay coast (Figure 26). Leakance of the lowermost confining layer of the intermediate aquifer system ranges from 1×10^{-7} (ft/d)/ft in southwest Sarasota and western Charlotte Counties to 7×10^{-5} (ft/d)/ft in the eastern part of the study area (Ryder, 1985).

Water Quality

Generally, with the exception of the central and southern coastal areas, water quality of the intermediate system is within DER potable standards. Figure 27 illustrates regional trends in TDS, hardness, chloride, and sulfate. These trends were also depicted primarily utilizing data obtained during the initial sampling of the

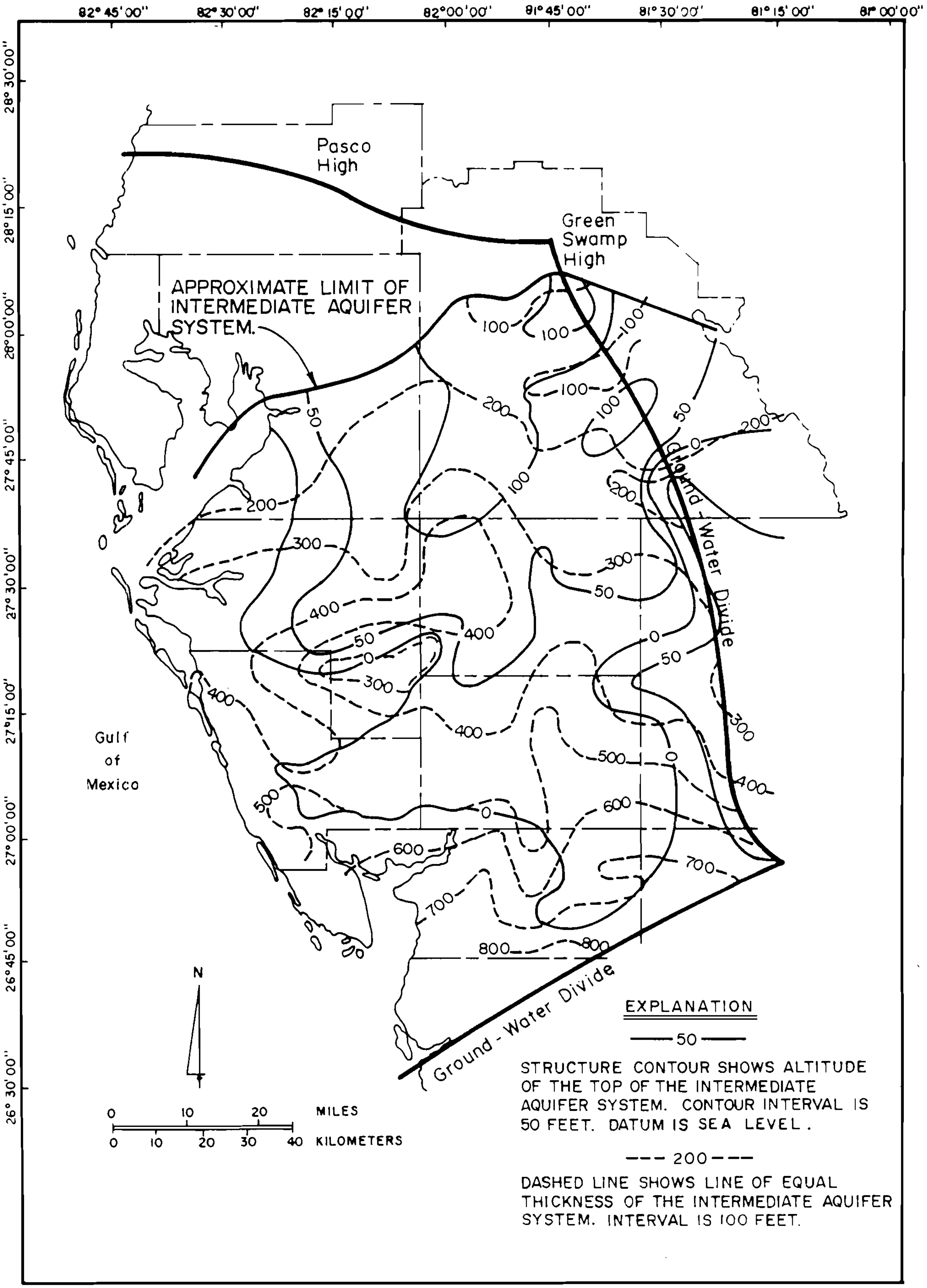


Figure 24. Altitide of the top of the intermediate aquifer system and lines of equal thickness of the intermediate aquifer system in the Southern West-Central Florida Ground-Water Basin (from Duerr, in press).

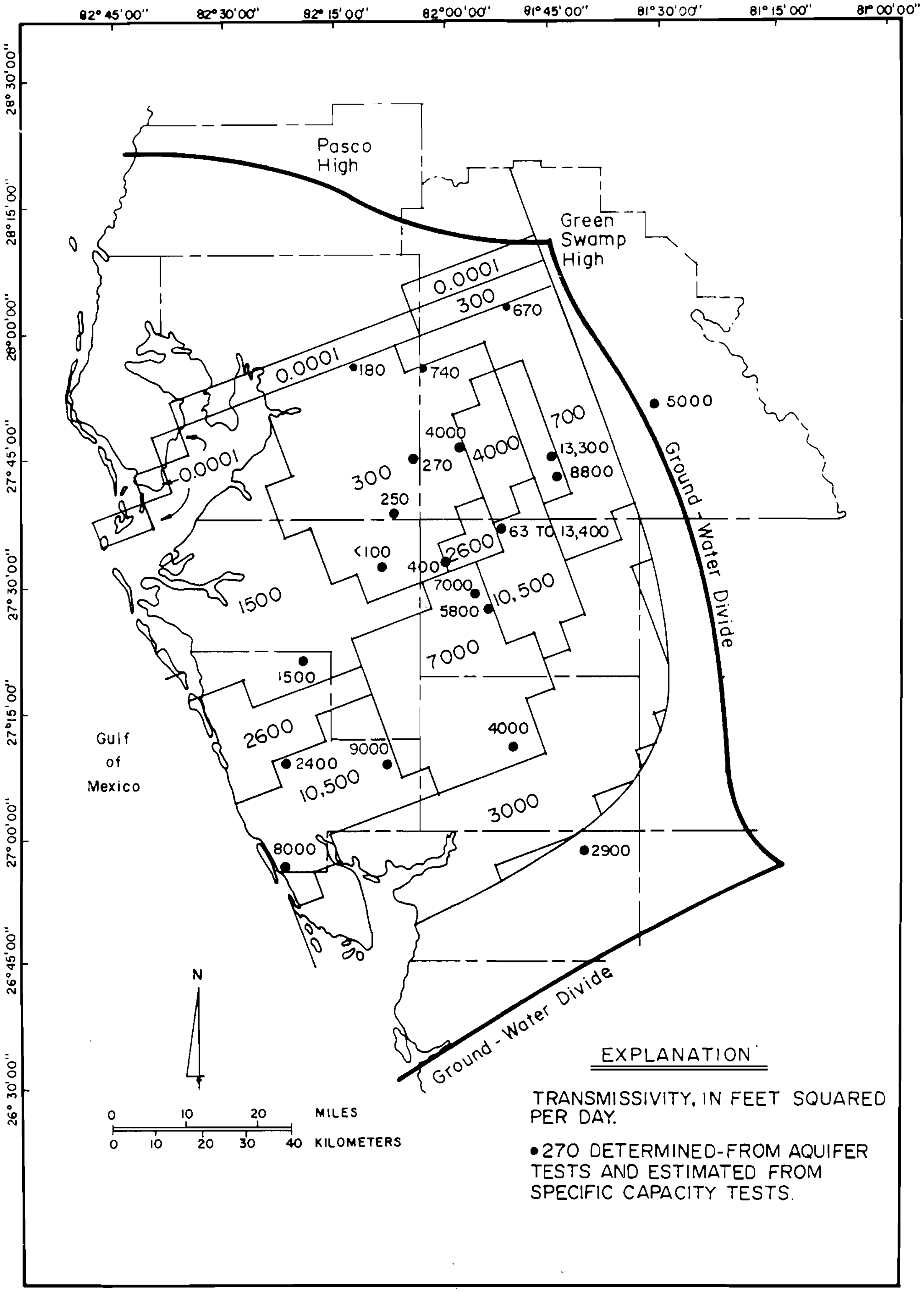


Figure 25. Field and model-derived transmissivity of the permeable deposits of the intermediate aquifer system in the Southern West-Central Florida Ground-Water Basin. Aquifer test references are given in in Table 4 (modified from Ryder, 1985).

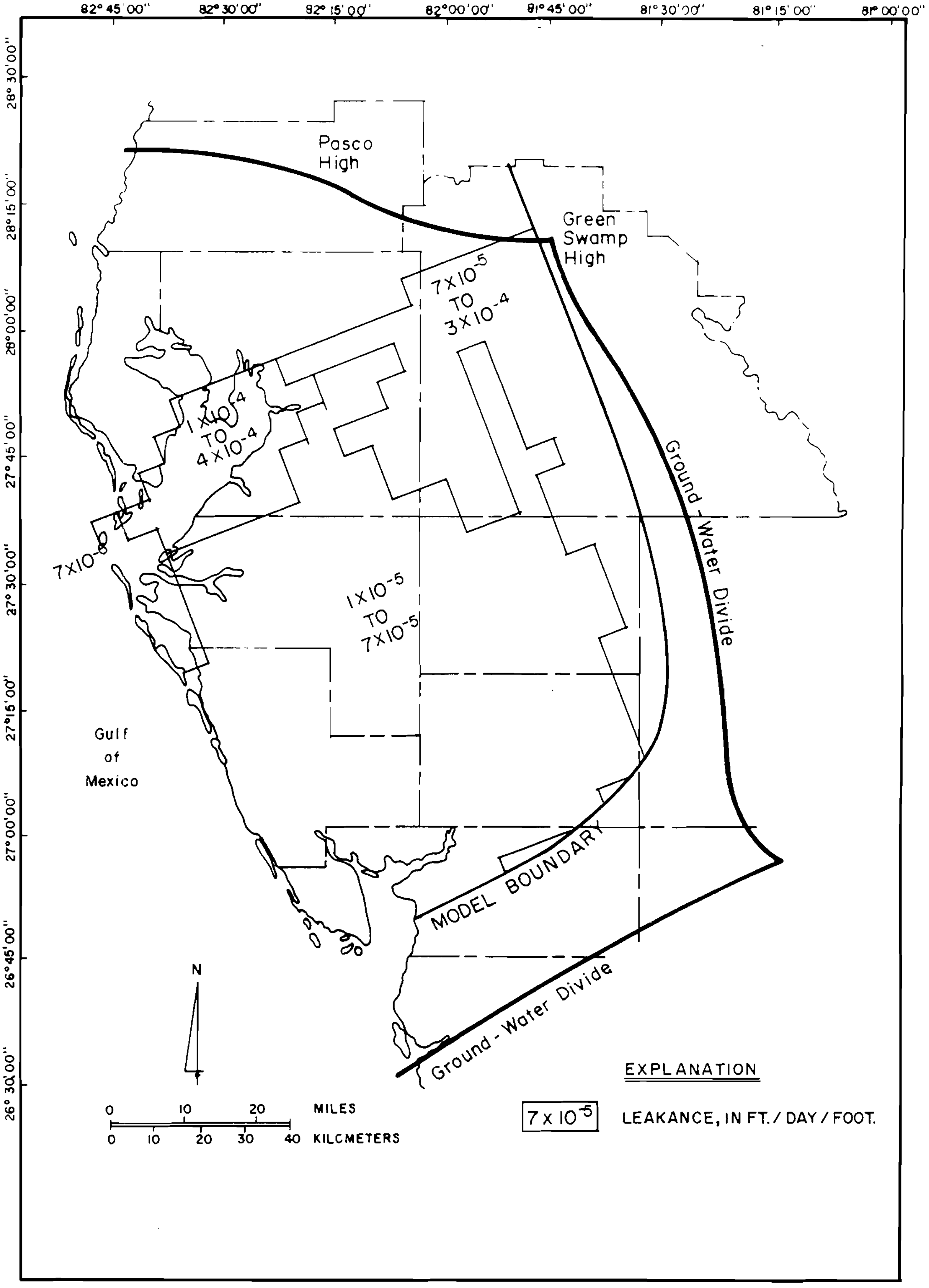


Figure 26. Thickness and model-derived leakance of the uppermost intermediate confining bed in the Southern West-Central Florida Ground-Water Basin, (modified from Ryder, 1985).

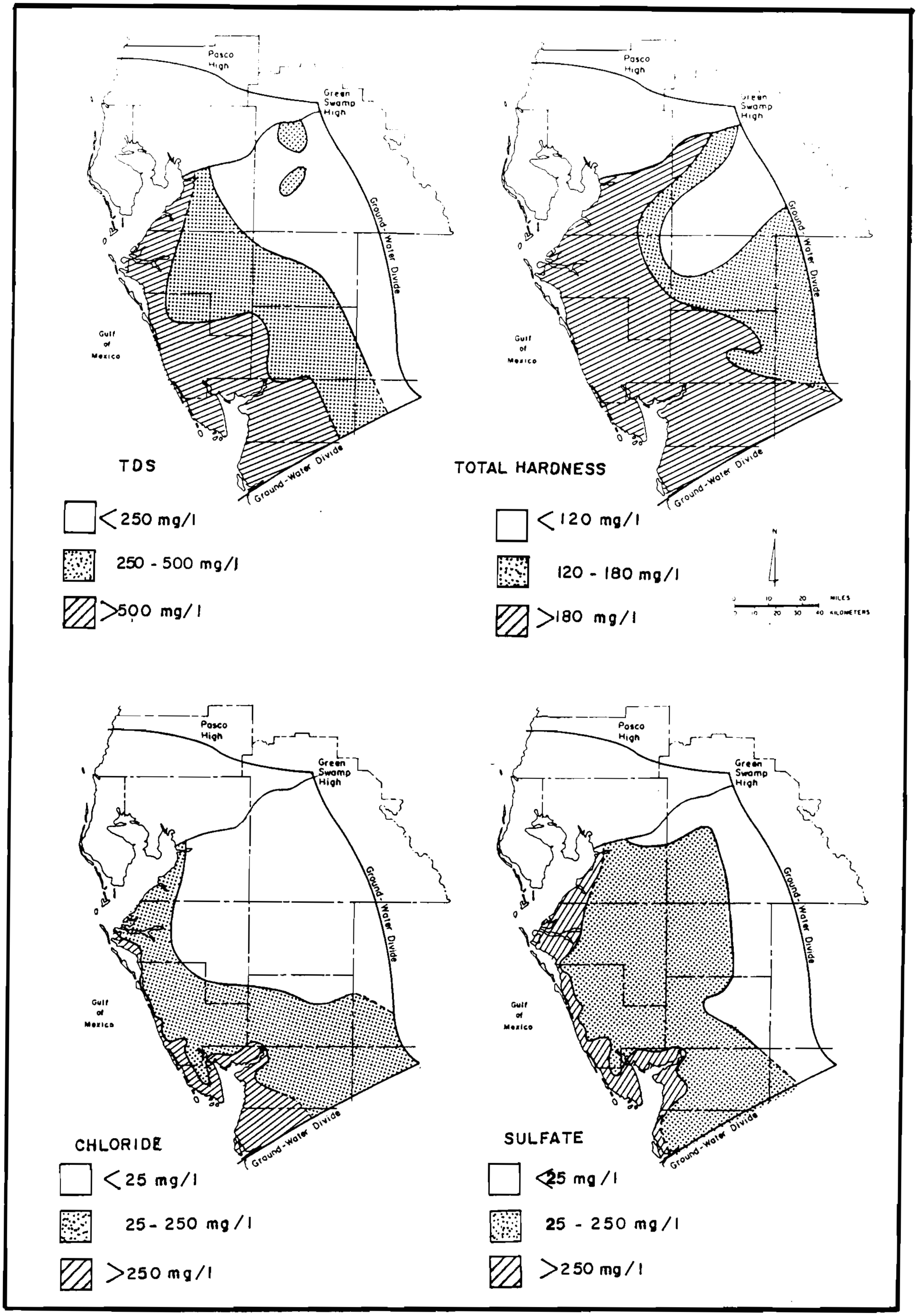


Figure 27. Naturally occuring major constituents in the intermediate aquifer system in the Southern West-Central Florida Ground-Water Basin.

SWFWMD's Ambient Ground-Water Quality Monitoring Program Background Network, which was sampled between June and December, 1985, and water-quality data obtained from public drinking water wells permitted under the CUP program of the SWFWMD. Again these data were supplemented with other additional data.

Total dissolved solids is less than 500 mg/l in the central, northern, and eastern areas of the SWCFGWB and increases in content to the south and towards the coast. Hardness of the intermediate systems is generally greater than 180 mg/l, which is very hard, with the exception of the most northeasterly area of the SWCFGWB. Sulfate concentrations are less than the 250 mg/l DER potable standard in nearly all the SWCFGWB. Chloride concentrations are low except in the southwest areas. As with the surficial aquifer system, iron exceeds DER's 0.3 mg/l potable standard throughout much of the SWCFGWB.

Potentiometric Surface (*)

The potentiometric surface, or hydraulic head, is an imaginary surface connecting points to which water would rise in tightly cased wells from a given point in an aquifer (Lohman, 1972). Potentiometric-surface maps of the intermediate aquifer system were constructed from water-level measurements made in 115 wells. Construction data and measurements for September, 1985 and May, 1986 will be given in Duerr and other's report, to be published. Wells were measured at the end of the wet season (September) and at the end of the normally dry season (May). In areas where multiple aquifers exist in the intermediate aquifer system, wells that were open to all aquifers in the system were selected for water-level measurements whenever possible. Thus, the potentiometric-surface maps of the intermediate aquifer system represent an average pressure surface of the multiple aquifers.

The potentiometric surface of the intermediate aquifer system in September 1985 is shown in Figure 28. The altitude of the potentiometric surface ranges from about 120 feet above NGVD in southwestern Polk County to less than 20 feet above NGVD near the coast. Lateral flow from areas of high potential to areas of low potential is generally south and west toward the coast.

Where aquifers are separated by confining beds, hydraulic heads may differ between aquifers. The confining beds have low hydraulic conductivity and consequently retard interaquifer ground-water flow and yield little water to wells. However, these confining beds do transmit, or leak, water from one aquifer to another, and the system is referred to as a leaky-aquifer system (Wilson, 1977a).

The potentiometric surface of the underlying Upper Floridan aquifer in September 1985 was mapped by Barr (1985) and is shown in Figure 29. Head differences between the intermediate aquifer system and the Upper Floridan aquifer in September 1985 are shown in Figure 30. In the northern part of the study area, heads in the intermediate aquifer system are higher than heads in the underlying Upper Floridan aquifer. Water is transmitted downward through the confining unit and these areas serve as recharge areas for the Upper Floridan aquifer. The gradient in head reverses in the southern part of the study area, and the underlying Upper Floridan aquifer

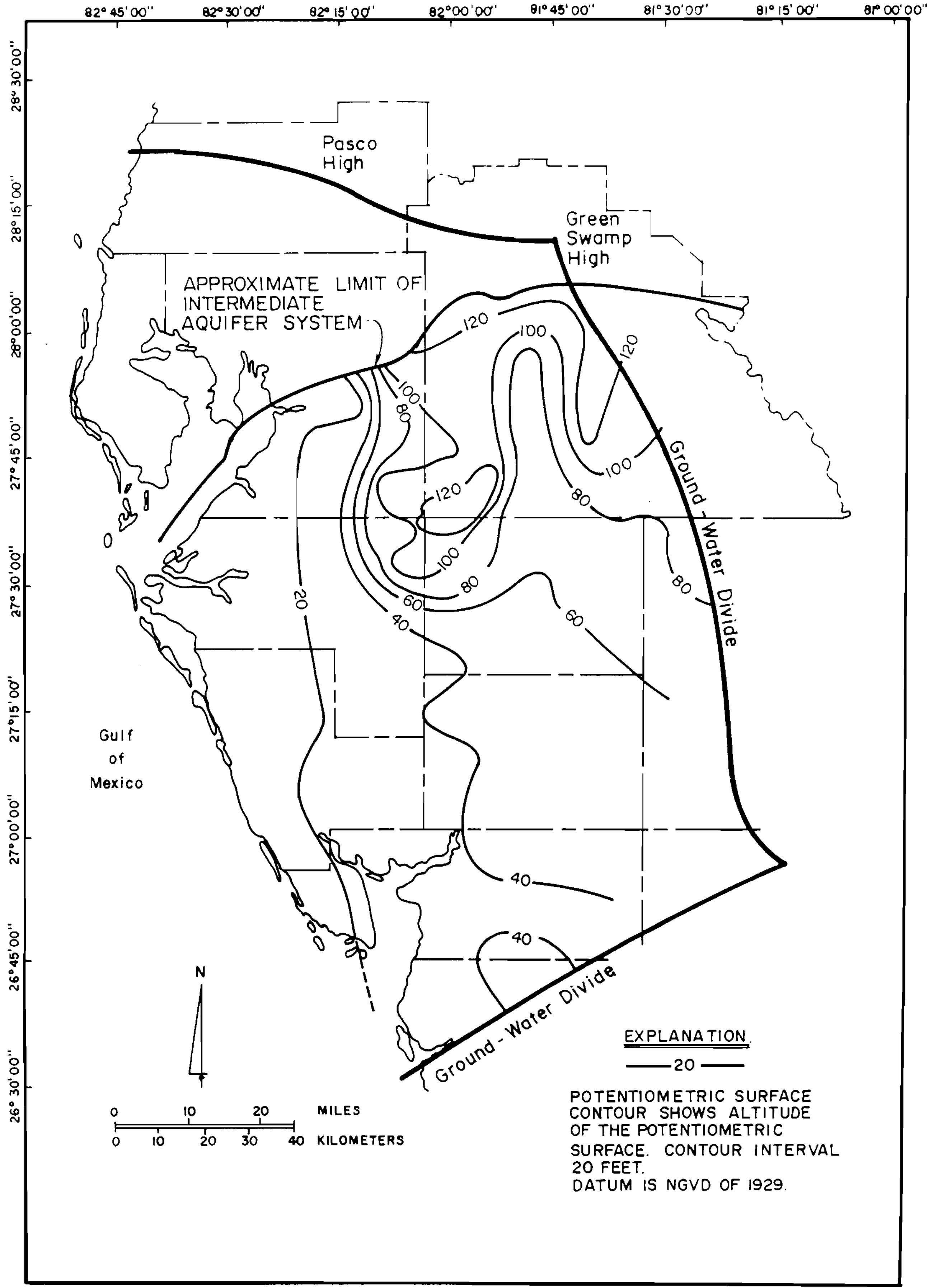


Figure 28. Potentiometric surface of the intermediate aquifer system, September 1985, in the Southern West-Central Florida Ground-Water Basin (from Duerr, in press).

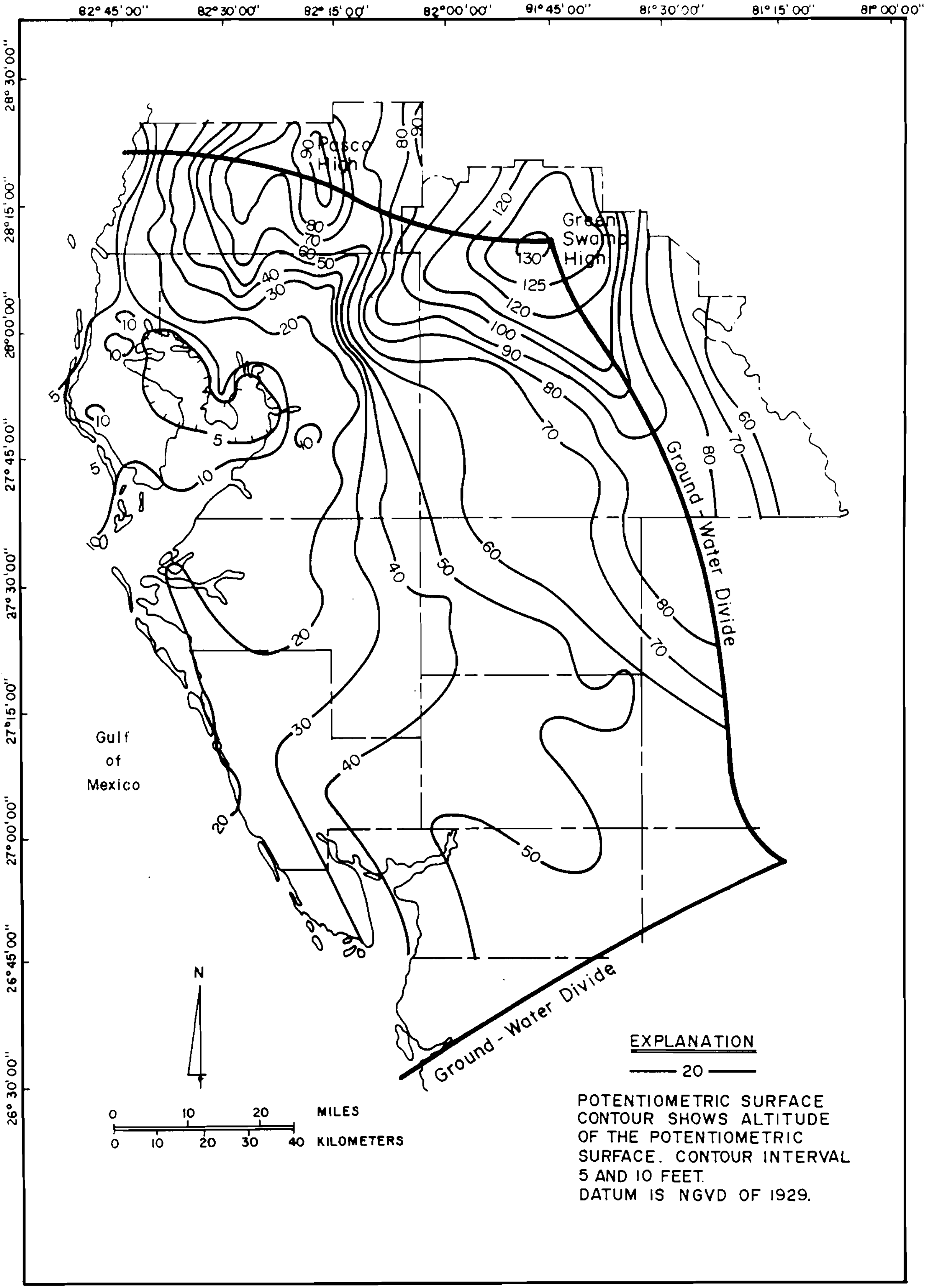


Figure 29. Potentiometric surface of the Upper Floridan aquifer, September 1985, in the Southern West-Central Florida Ground-Water Basin (from Barr, 1985).

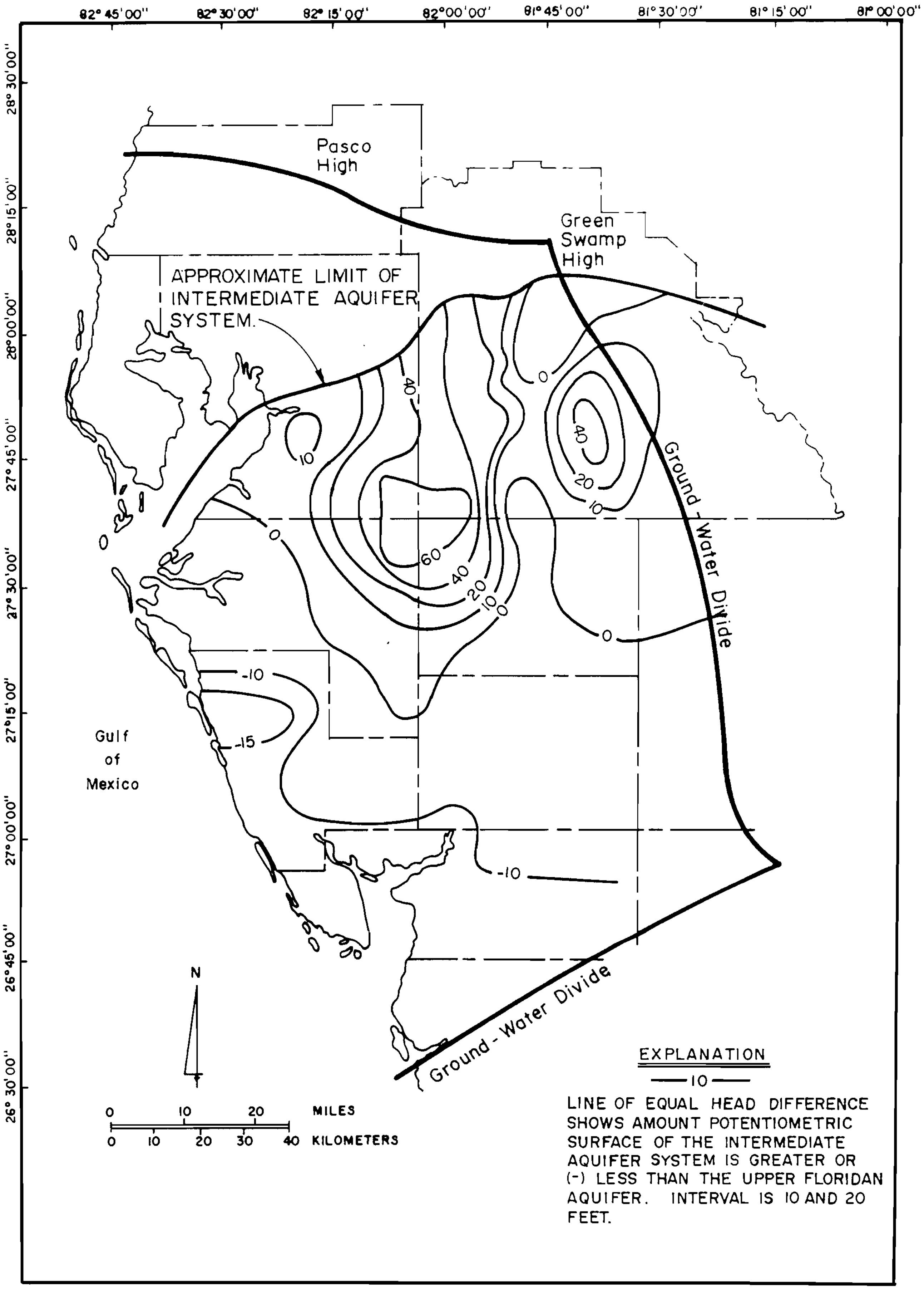


Figure 30. Head difference between the potentiometric surfaces of the intermediate aquifer system and the underlying Upper Floridan aquifer, September 1985, in the Southern West-Central Florida Ground-Water Basin (from Duerr, in press).

has a higher head than the head in the intermediate aquifer system. There, water is transmitted upward through the confining unit into the intermediate aquifer system. Head differences (intermediate-Upper Floridan) range from about +60 feet near the corner of Hillsborough, Manatee, Polk, and Hardee Counties to about -15 feet in western Sarasota County.

The potentiometric surface of the intermediate aquifer system is generally higher than the water level in the surficial aquifer system in the low-lying areas near the Peace River. As a result, in these areas, ground water moves upward from the intermediate aquifer system into the surficial aquifer system. The upward flow tends to depress the potentiometric surface of the intermediate aquifer system near the Peace River (Figure 28). Along reaches of the river where the Hawthorn Formation crops out, as in parts of Hardee and northern DeSoto Counties, ground water may discharge by springflow directly from the intermediate aquifer system to the river, thus further depressing the potentiometric surface of the intermediate aquifer system.

Figure 31 shows the potentiometric surface of the intermediate aquifer system in May 1986 near the end of the dry season when ground-water withdrawals are greatest and water levels are at their seasonal low. The altitude of the potentiometric surface ranges from about 120 feet above NGVD in Polk County to less than 10 feet above NGVD near the coast. The decline in the potentiometric surface from September 1985 to May 1986 ranged from about 1 to 20 feet. Largest declines were in south-central Polk, central Hardee, and north-central DeSoto Counties. Smallest declines were in Charlotte County.

The potentiometric surface of the Upper Floridan aquifer in May 1986 is shown in Figure 32. Head differences between the two aquifers are shown in Figure 33. As in September 1985, the potentiometric surface of the intermediate aquifer system in May 1986 was greater than the potentiometric surface of the underlying Upper Floridan aquifer throughout the northern part of the study area. Head differences were greater in May 1986 than in September 1985 and the area where the intermediate aquifer system heads were higher extended further south. Head differences ranged from +100 feet in southwestern Polk County to about -10 feet in Charlotte County.

Large head differences between the Upper Floridan aquifer and the intermediate aquifer system in May 1986 in the northern half of the study area were caused by large ground-water withdrawals from the Upper Floridan aquifer for irrigation during the dry spring season. The potentiometric surface of the intermediate aquifer system was only slightly lower in May than in September because of relatively small ground-water withdrawals from the intermediate aquifer system for irrigation during the dry spring season.

Water Use (*)

Ground-water and surface-water withdrawal data for the SWCFGWB are collected cooperatively by the SWFWMD and the U. S. Geological Survey (USGS). A combined total of about 1,512 Mgal/d of freshwater was withdrawn in 1986 for irrigation, public and rural supply, industrial, and other uses from the surficial, intermediate, and

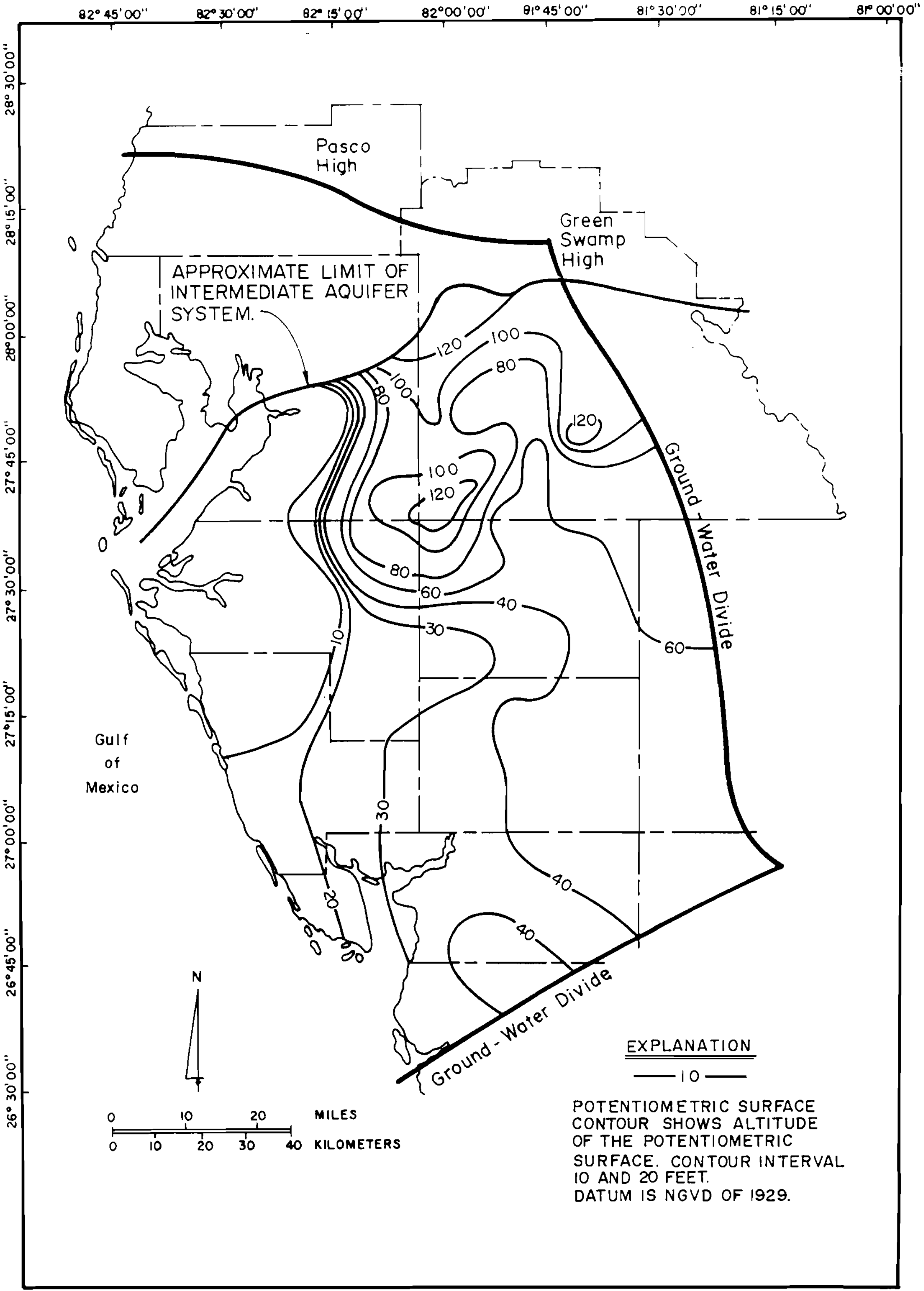


Figure 31. Potentiometric surface of the intermediate aquifer system May 1986, in the Southern West-Central Florida Ground-Water Basin (from Duerr, in press).

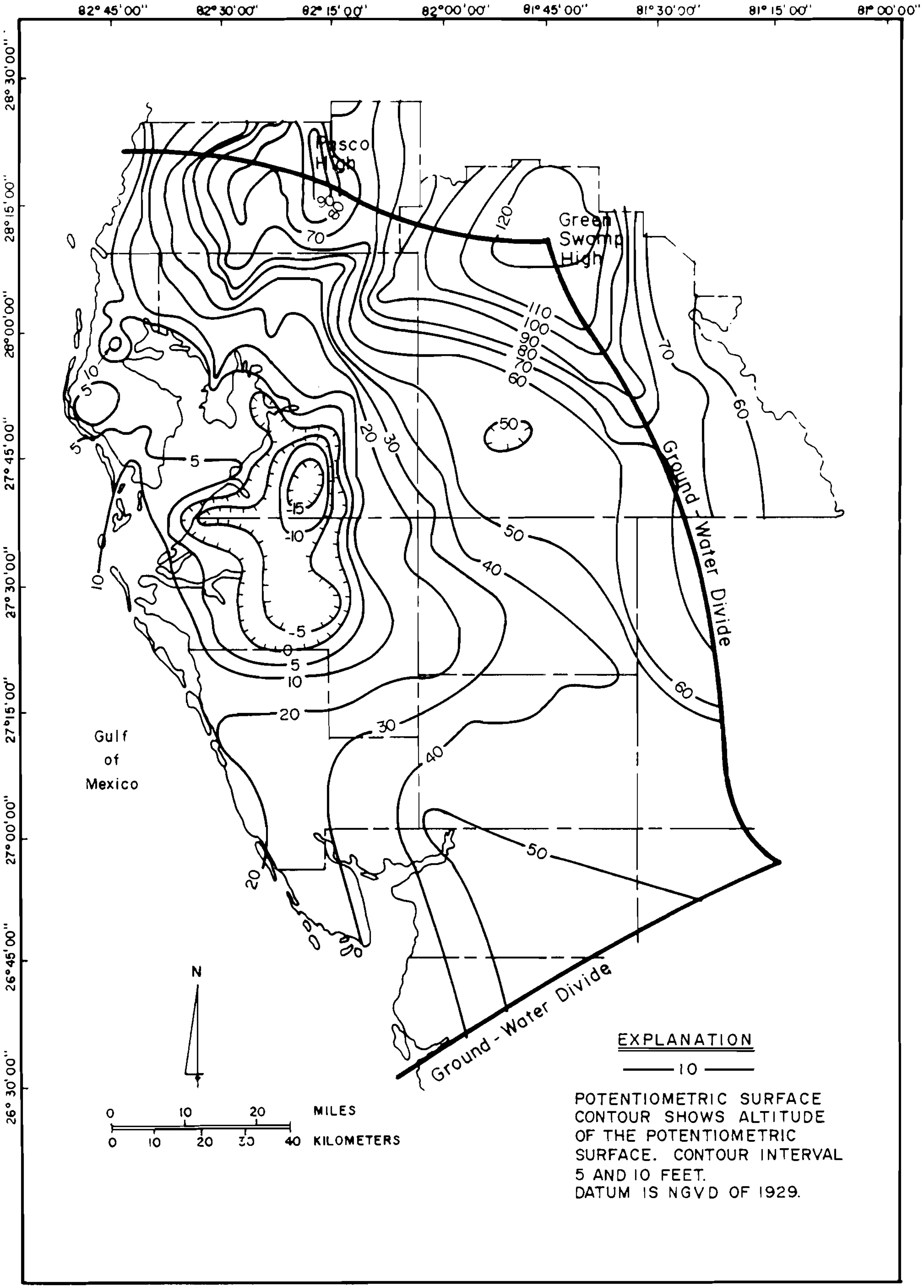


Figure 32. Potentiometric surface of the Upper Floridan aquifer May 1986, in the Southern West-Central Florida Ground-Water Basin (Barr and Lewelling, 1986).

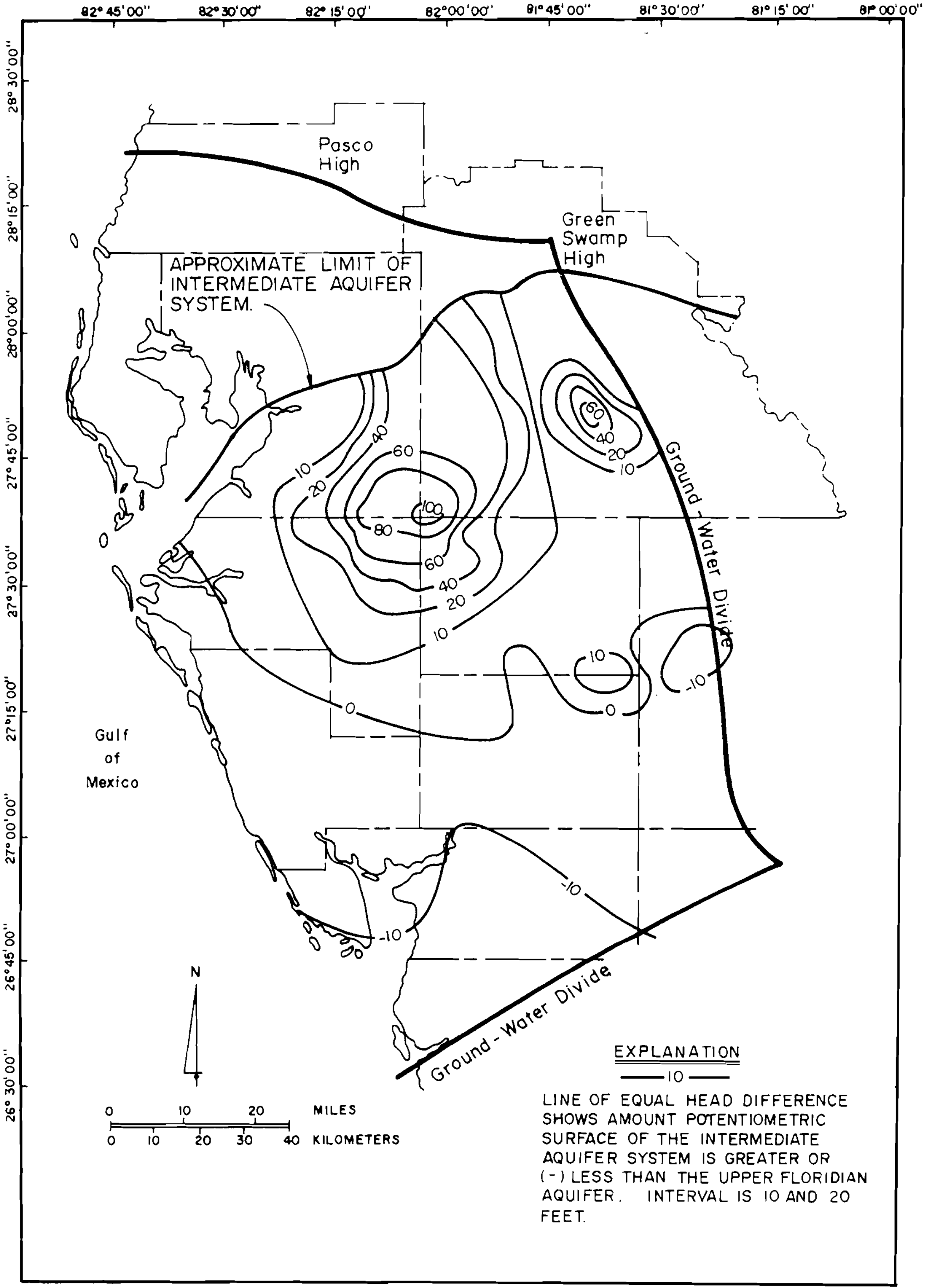


Figure 33. Head difference between the potentiometric surfaces of the intermediate aquifer system and the underlying Upper Floridan aquifer May 1986, in the Southern West-Central Florida Ground-Water Basin (from Duerr, in press).

Floridan aquifer systems in the SWFWMD (Stieglitz, 1986). Of this total, an estimated 1,310 Mgal/d was withdrawn in the SWCFGWB. Withdrawal data are not delineated by individual aquifers.

Following is an estimate of the amount of freshwater withdrawn from the intermediate aquifer system in 1985 in the study area and an explanation of the techniques used to make the estimate. Withdrawals outside of the SWFWMD boundary are not included in the estimate.

The Upper Floridan aquifer is by far the most productive aquifer and supplies more than 10 times the amount of water pumped from either the surficial aquifer or the intermediate aquifer system in most of the SWCFGWB. However, the importance of the Upper Floridan aquifer as a source of water diminishes as the water quality in the aquifer decreases in the southern and western areas where concentrations of dissolved solids, chloride, and sulfate exceed maximum drinking water standards (Wolansky, 1983). The saline water is the probable result of past marine inundations and subsequent mixing and water-rock reactions (Steinkampf, 1982). In these areas, the intermediate aquifer system is the most important source of ground water for public supply because it has better water quality.

Estimates of water withdrawn from the intermediate aquifer system were based upon: (1) SWFWMD well construction and consumptive-use permitting files; (2) USGS Ground-Water Site Inventory Files; (3) specific capacity and transmissivity data for various aquifers; (4) and data reported by previous investigators, such as Sutcliffe (1975), Wilson (1977), and Stieglitz (1986).

Well construction was the primary factor for estimating water withdrawn from the intermediate aquifer system. Depth and casing of withdrawal wells in each county were estimated from well-construction data. The depth and casing data indicated from which aquifer or aquifers the well was producing water. In areas where wells were constructed with producing zones in more than one aquifer, the ratio of the specific capacities or transmissivities of the two aquifers from the site or a nearby site was used to estimate the proportion of water withdrawn from each aquifer. Information on sources of withdrawals reported by previous investigators also was used to estimate withdrawals from the system.

An estimated 68.9 Mgal/d of water was withdrawn for all use categories in 1985 from the intermediate aquifer system in the SWCFGWB (Table 7). The largest of water was for irrigation, about 38.8 Mgal/d. Sarasota County used the most water from the system, about 18.3 Mgal/d (Stieglitz, 1986).

The public-supply water-use category includes all water distributed by public-supply water systems to households, industry, agriculture, and other uses (Duerr and Sohm, 1983). A total of about 11.1 Mgal/d was withdrawn from the intermediate aquifer system in the SWCFGWB within the SWFWMD. The largest withdrawals from the intermediate aquifer system for public-supply were in Sarasota County, about 10.0 Mgal/d.

Table 7. Water withdrawn from the intermediate aquifer system in the SWFWMD area of the SWCFGWB, 1985

County	Water withdrawn for indicated purpose, in million gallons per day				
	Public Supply	Rural	Industrial	Irrigation	Total
Charlotte[1/]	0.4	2.0	0.0	15.0	17.4
DeSoto	.7	1.1	.1	2.0	3.9
Hardee	0	1.2	.4	3.0	4.6
Highlands[1/]	0	1.0	0	3.6	4.6
Hillsborough	0	1.5	.1	.5	2.1
Manatee	0	.3	0	6.2	6.5
Polk[1/]	0	4.0	4.2	3.3	11.5
Sarasota	10.0	3.1	0	5.2	18.3
Total	11.1	14.2	4.8	38.8	68.9

[1/] Includes only data for parts of the county that are in the Southwest Florida Water Management District.

In coastal Charlotte and Sarasota Counties, the intermediate aquifer system contains some slightly saline water that is treated by reverse osmosis before it is used for public-supply (Sutcliffe and Thompson, 1983). In other parts of the study area, water from the intermediate aquifer system receives only minimal treatment before being distributed for use. Major municipal wellfields which utilize the intermediate system as a major supply are shown in Figure 21, and listed in Table 6. Major municipal wellfields in the SWCFGWB that utilize the intermediate aquifer system include the Englewood Water District, Venice Utilities, Sarasota County Utilities, and Verna Wellfield.

The rural water-use category includes all water used by households that are not supplied by large (withdrawing more than 100,000 gal/d) public-supply systems. This includes households that have their own water supply and households that are supplied by small public-supply systems. Well diameters generally range from 2 to 4 inches. About 14.2 Mgal/d was withdrawn from the intermediate aquifer system for rural use in the SWFWMD area of the SWCFGWB, in 1985 (Table 7). The largest rural water use from the intermediate aquifer system occurred in Polk County, about 4 Mgal/d.

The industrial water-use category includes water used by industries that supply their own water. Data do not include water sold to industries by public-supply systems. About 4.8 Mgal/d was withdrawn from the intermediate aquifer system in the SWFWMD area of the SWCFGWB, in 1985 (Table 7). Polk County had the largest use from the intermediate system in this category, about 4.2 Mgal/d, most of which was withdrawn for phosphate mining, chemical processing, and citrus processing.

The irrigation water-use category includes water withdrawn by irrigators from private wells and does not include water supplied by public-supply systems. Irrigation water use is generally not metered and estimates of water use for irrigation are the least accurate of all water use data. For a more complete discussion of irrigation water use see Duerr and Sohm (1983) and Stieglitz (1986). About 38.8 Mgal/d was withdrawn from the intermediate aquifer system in the SWFWMD area of the SWCFGWB, in 1985 (Table 7). Irrigation use was largest in Charlotte County, 15 Mgal/d, most of which was used for citrus and vegetable irrigation.

Upper Floridan Aquifer

The Upper Floridan aquifer is the principal source of water for consumptive use in the SWCFGWB. This aquifer is composed chiefly of limestone and dolomite beds that range in age from early Miocene to middle Eocene. The Upper Floridan thickens from less than 800 feet in the northern areas of the SWCFGWB to greater than 2,000 feet in the southern areas (Figure 11). The bottom of the Upper Floridan is defined as the beginning of vertically consistent intergranular evaporites (gypsum or anhydrite) occurring in either the Avon Park, Lake City, or Oldsmar Limestone of Eocene age, (Wolansky and Garbade, 1981).

Hydraulic Properties

Transmissivity of the Upper Floridan aquifer in the SWCFGWB is highly variable,a common occurrence in karst environments. Locations of known Upper Floridan aquifer tests in the SWCFGWB and aquifer test values are presented in Figure 19 and Table 4, respectively. Reported transmissivities range from less than 50,000 ft^2/d in the northern areas to greater than 9,000,000 ft^2/d in the central and eastern areas of the SWCFGWB. Values of leakance coefficients of the confining units overlying the Upper Floridan aquifer ranged from 1.0×10^{-4} to 2.0×10^{-2} cubic feet per day per cubic foot ($ft^3/day/ft^3$).

In addition to leakance and transmissivity values derived from aquifer tests, these values have been approximated by several digital models for the SWCFGWB during the past decade. One of the more recent models, Ryder (1985), derived transmissivity and leakance values from a two-layered, steady-state, finite-difference model with four-mile by four-mile nodes. This model included all of the SWCFGWB within the modeled area. Figure 34 and 35 respectively depict transmissivity values of the Upper Floridan aquifer and leakance values of the confining beds overlying the Upper Floridan aquifer derived from this model.

Water Quality

Figure 36 illustrates regional trends in TDS, hardness, chloride, and sulfate for the upper producing zones of the Upper Floridan aquifer in the SWCFGWB. Figure 37 illustrates regional trends in TDS, hardness, chloride, and sulfate for the lower producing intervals of the Floridan aquifer system in the SWCFGWB. These trends were depicted primarily utilizing data obtained during the initial sampling of SWFWMD's Ambient Ground-Water Quality Monitoring Program Background Network, which was sampled between May and December, 1985, and water-quality data required from public supply wells under the CUP program of the SWFWMD. As with the surficial and intermediate aquifer systems, these data were supplemented utilizing other additional data. Within most of the SWCFGWB the quality of water in the Upper Floridan aquifer is within DER standards; however, the quality deteriorates at depth, towards the coast, and towards the south where the surficial and intermediate aquifer systems are extensively utilized for consumptive use due to

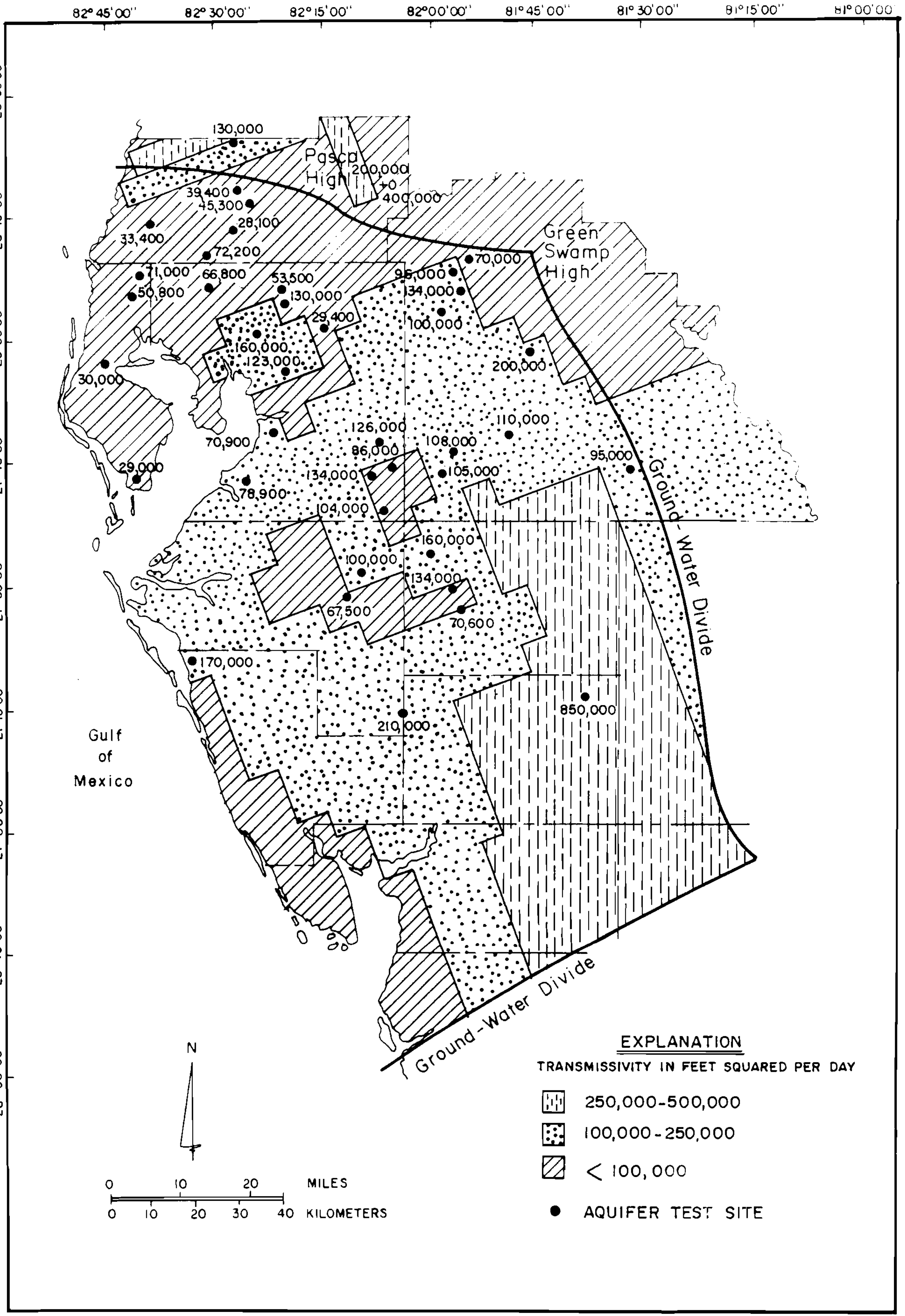


Figure 34. Generalized transmissivity values in the Southern West-Central Florida Ground-Water Basin from a two-layered, steady-state digital model (from Ryder, 1985; and Bush, 1982).

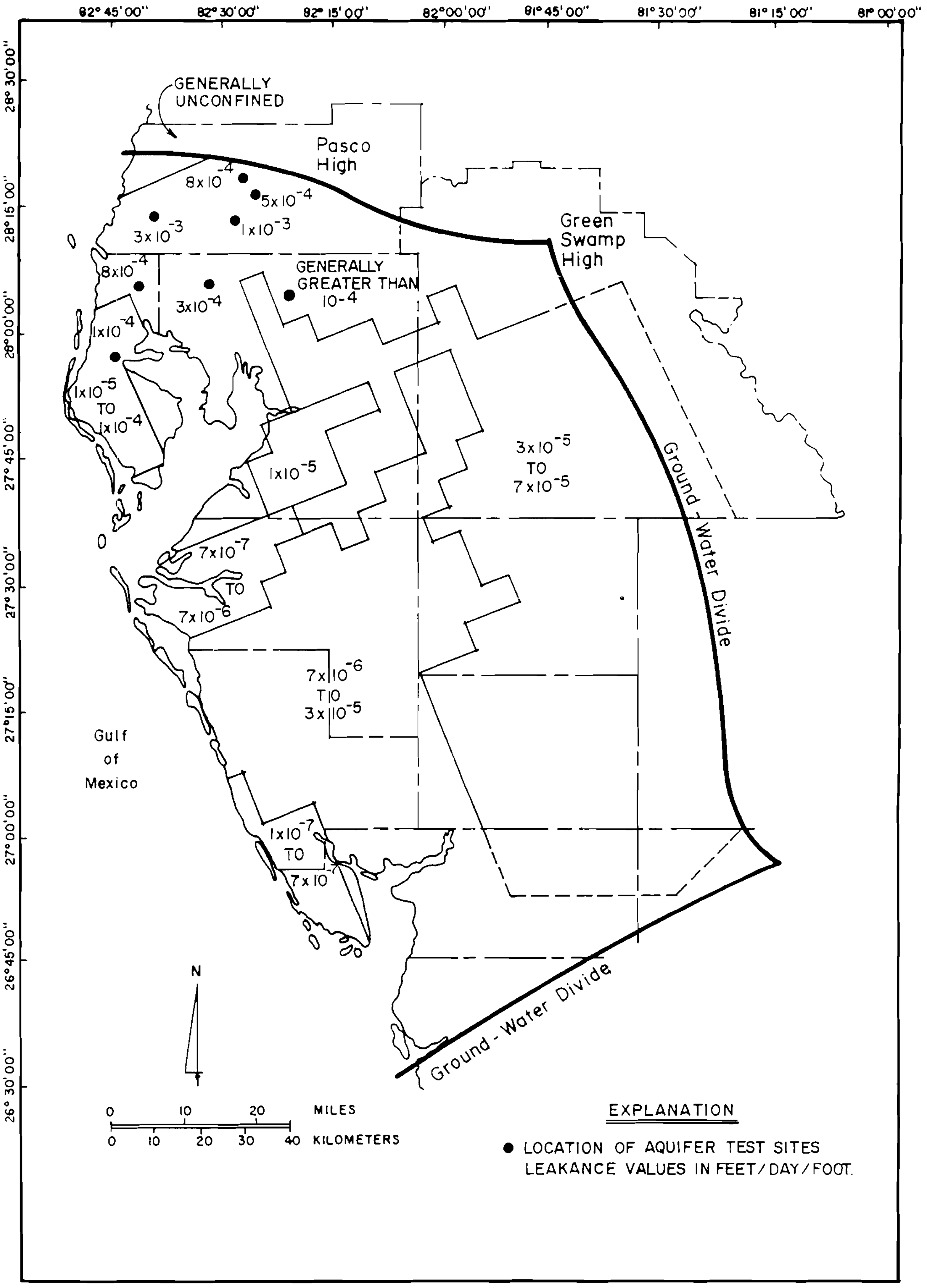


Figure 35. Generalized leakance values of the confining unit overlying the Upper Floridan aqufier in the Southern West-Central Florida Ground-Water Basin, derived from a two-layer, steady-state, digital model (modified from Ryder, 1985).

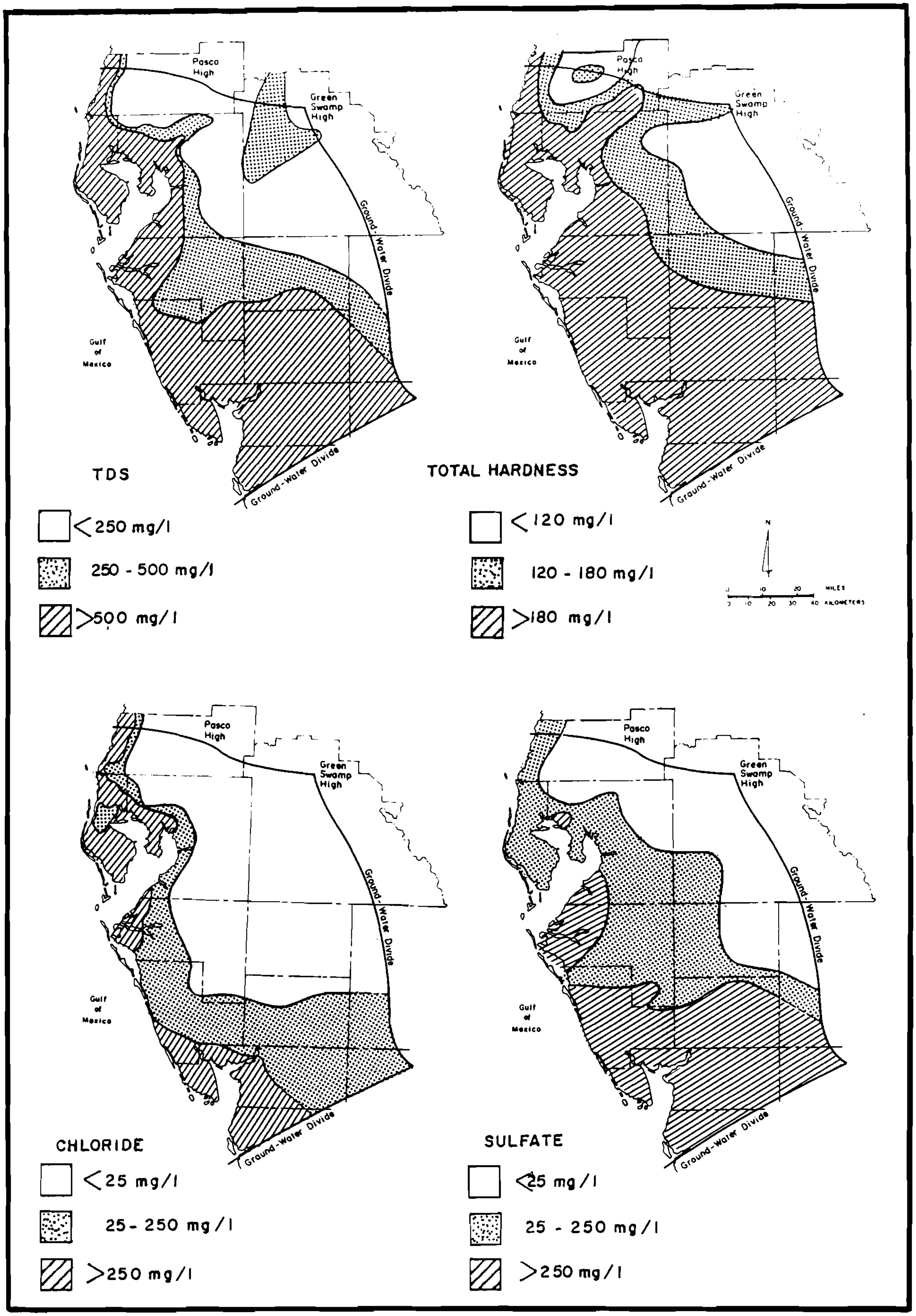


Figure 36. Naturally occurring major constituents in the upper producing intervals of the Upper Floridan aquifer within the Southern West-Central Florida Ground-Water Basin.

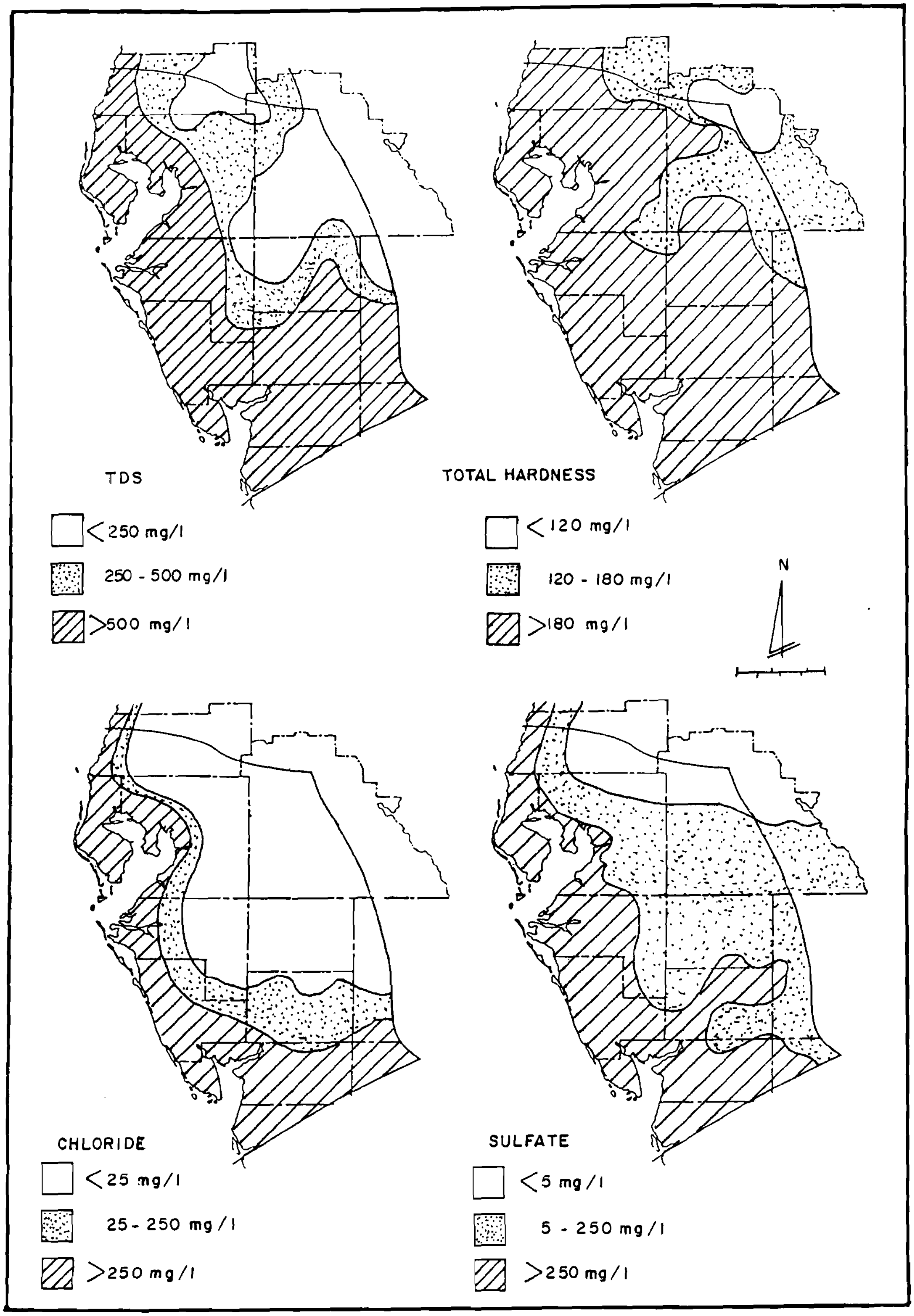


Figure 37. Naturally occuring major constituents in the lower producing intervals of the Floridan aquifer system within the Southern West-Central Florida Ground-Water Basin (from Corral, 1983).

the excessive mineralization of the Upper Floridan. The best water quality for the Upper Floridan in the SWCFGWB is in the northern and eastern areas where the aquifer is essentially the sole ground-water supply for consumptive use.

Figure 37 depicts the water quality of the highly permeable unit in the lower sections of the Upper Floridan aquifer, as reported by Corral (1983). Water quality of this lower zone is poorer than overlying units again indicating that water quality deteriorates with depth.

RECHARGE AND DISCHARGE AREAS

One of the WMD's primary requirements relative to the GWBRAI is the delineation of the ground-water basin's "associated recharge areas". There have been numerous investigations which include recharge/discharge discussions relative to the SWCFGWB. The more significant studies include Parker's (1955) "Water Resources of Southeastern Florida, with special references to the geology and ground-water of the Miami area"; Pride's and others' (1966) "Hydrology of the Green Swamp area in central Florida"; Stewart's (1966) "Ground-Water Resources of Polk County"; Tibbal's (1975) "Recharge Areas of the Floridan Aquifer in Seminole County and Vicinity, Florida"; Grubb's and Rutledge's (1979) "Long-Term Water Supply Potential, Green Swamp Area, Florida"; Stewart's (1980) "Areas of Natural Recharge to the Predevelopment Flow in the Tertiary Limestone (Floridan) Aquifer System in West-Central Florida"; Geraghty and Miller's (1980) "Highlands Ridge Hydrologic Investigation"; Ryder's (1982) "Digital Model of Predevelopment Flow in the Tertiary Limestone (Floridan) Aquifer System in West-Central Florida"; Brown's (1983) "Water Resources of Manatee County, Florida", and Wolansky's (1983) "Hydrogeology of the Sarasota-Port Charlotte Area, Florida". Recharge values for the SWCFGWB reported through 1980, estimated recharge by analyzing certain hydrogeologic factors which affect recharge such as soil type, confining bed thickness and continuity, water balance calculations, and difference between water table and the potentiometric levels. Ryder (1985) used a two-layer steady-state digital model to simulate hydraulic head and calibrate recharge and upward leakage from the Upper Floridan aquifer.

Stewart (1980) delineated four categories of natural recharge: areas of generally no recharge, areas of known very low recharge (less than 2 inches per year), areas of very low to moderate recharge (less than 2 inches to as much as 10 inches per year), and areas of high recharge (greater than 10 inches per year). Areas of generally no recharge are located where the potentiometric surface of the Upper Floridan aquifer is above land surface much of the time and coincide with areas of artesian flow shown by Healy (1975). The areas of known very low recharge are where the Upper Floridan aquifer is known to be overlain by relatively impermeable confining beds generally more than 25 feet thick. In these areas recharge rates are estimated to be less than 2 inches per year. The areas of very low to moderate recharge are where the confining beds are generally less than 25 feet thick and unbreached. Areas of very low to moderate recharge also include areas where the confining bed is absent, but where the water table and potentiometric surface of the Upper Floridan aquifer are both close to land surface so little recharge occurs. The areas of high recharge are generally a combination of an absence of a confining unit or presence of a very discontinuous confining unit, a significantly elevated water table above the potentiometric surface of the Upper Floridan, and the aquifer system is overlain with relatively permeable soils and vadose zone.

Figure 38 is an excerpt from Stewart's statewide map depicting generalized areas of natural recharge in the SWCFGWB. The SWCFGWB includes all four of Stewart's recharge categories, but only a small percentage of the area has high recharge rates. The high recharge rates are associated with the Highlands and Lake Wales Ridges in Polk County and southern portions of the Brooksville Ridge in central Pasco County. High land-surface elevations, large vadose zone thickness, and highly permeable soils create high infiltration rates into the subsurface in these areas. In the Highlands and Lake Wales Ridge areas the infiltration does recharge the Upper Floridan even if confining units of the intermediate aquifer system are present due to a significant downward ground-water flow component. Infiltration in the southern portion of the Brooksville Ridge recharges the Upper Floridan aquifer at a high rate because the intermediate aquifer system is absent and only a thin, discontinuous confining bed exist above the Upper Floridan.

Most of the SWCFGWB has little or no recharge to the Upper Floridan aquifer. Thick, confining units of the intermediate aquifer system and artesian conditions in the intermediate and Upper Floridan aquifers prevent infiltration at land surface from reaching the Upper Floridan. Upper and lower confining units of the intermediate aquifer system keeps the Upper Floridan aquifer tightly confined and builds significant artesian pressure towards the coast. No or very little infiltration occurs because a vertical hydraulic gradient opposes it. As a result, the Upper Floridan aquifer has a regional flow pattern with recharge occurring in the north, north-central, and eastern portions of the SWCFGWB and discharge occurring along coastal and riverine areas.

Ryder (1985) calibrated values of recharge and upward leakage from a simulation of the Upper Floridan aquifer using a two-layer, steady-state digital model (Figure 39). Along the coast, Tampa Bay, and inland from the Port Charlotte, areas of discharge (diffuse upward leakage, spring discharge areas excluded) were calibrated to 1976 average hydrologic conditions. Most of the SWCFGWB had less that 6 inches of recharge per year with the exceptions of central Pasco, northwestern Hillsborough, and northern and southern Polk Counties. These areas had a range of recharge between 6 to 16 inches per year and represented 20% of the area of the SWCFGWB. The model-derived recharge rates coincided reasonably well with recharge estimates made by Bush (1982) using water balance calculations for surface-water basins.

The information contained in Figures 38 and 39 represent recent, regionally accepted, recharge values for the SWCFGWB. Using more recent and additional information, SWFWMD staff recently prepared recharge rate maps of the intermediate aquifer system and Upper Floridan aquifer for September 1986, and May 1987. Water levels from potentiometric surface maps (Lewelling, 1986, Lewelling and Belles, 1986; and Lewelling, 1987a and b), surficial monitor wells,

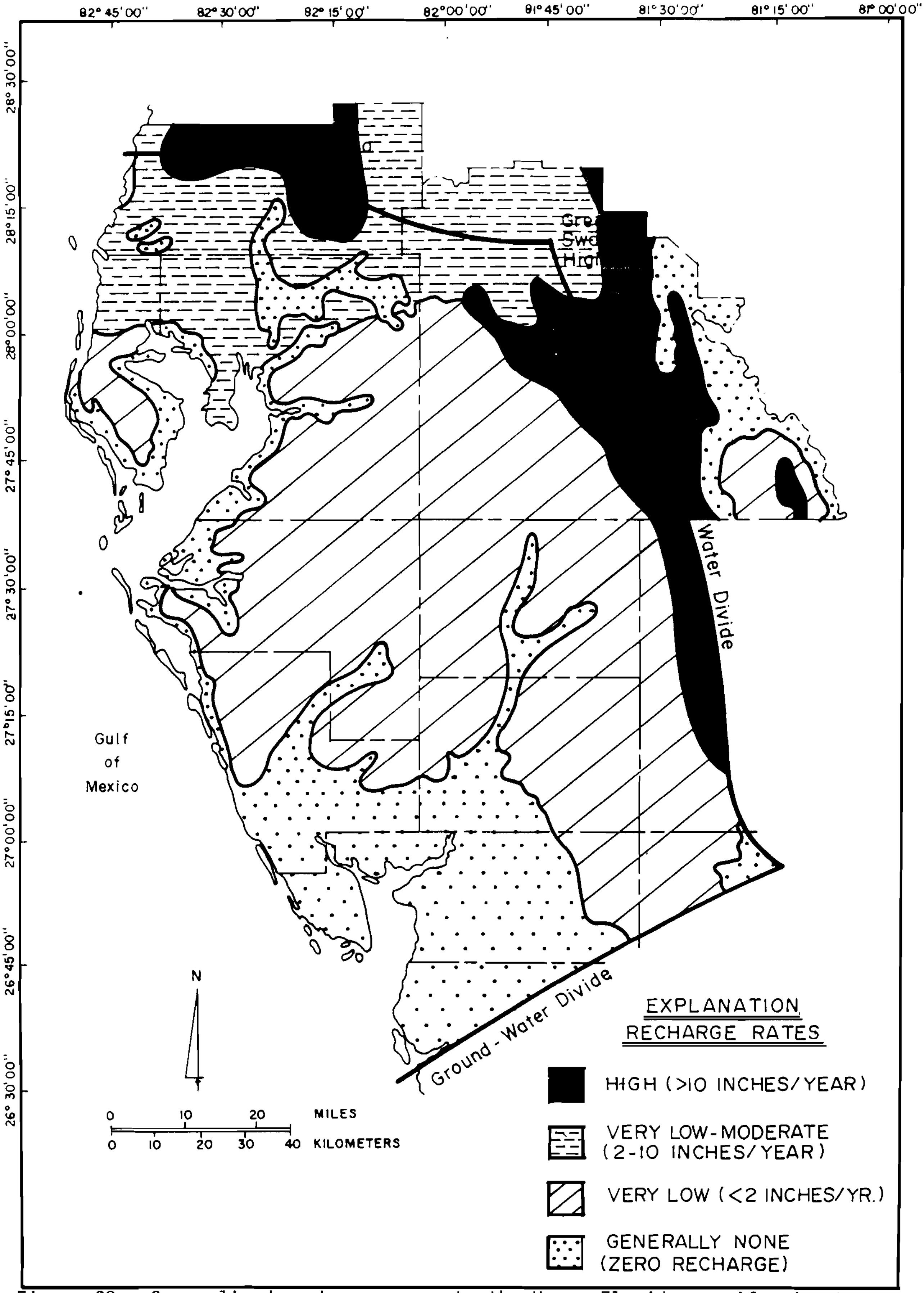


Figure 38. Generalized recharge areas to the Upper Floridan aquifer in the Southern West-Central Florida Ground-Water Basin (from Stewart, 1980).

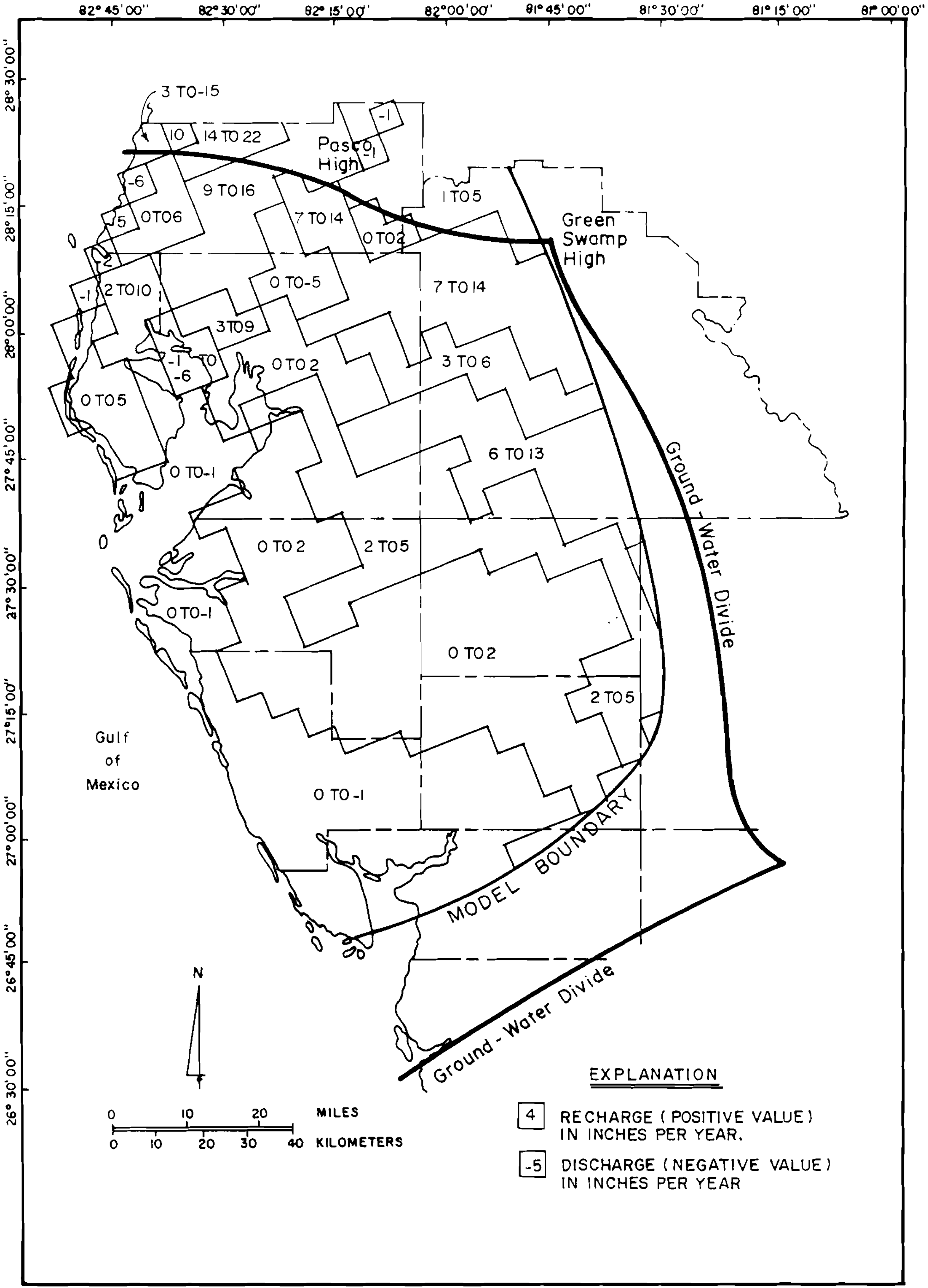


Figure 39. Generalized estimated, calibrated model-derived recharge and discharge values for the Upper Floridan aquifer, in the Southern West-Central Florida Ground-Water Basin (from Ryder, 1985).

lake levels, and stream gauges, and model-derived leakance coefficients (Ryder, 1982) were used to develop these maps.

Recharge maps of the intermediate aquifer system for September, 1986 and May, 1987 are shown in Figures 40 and 41, respectively. These recharge maps identify four prominent, high-recharge areas to the intermediate aquifer system: the Lakeland Ridge in southwestern Polk County, the Lake Henry Ridge in south-central Polk County, the Balm-Boyette Plateau of south-central Hillsborough County, and the Verna wellfield area of north-central Sarasota County. Recharge rates are based on actual or estimated head differences occurring in the wet and dry seasons. The persistence of these four high recharge areas is a good indication that the total recharge for the water year will be between 10 and 20 inches in those areas. Recharge rates are out-of-phase with rainfall rates, as more areas experience greater recharge during the dry season (April and May) than during the wet season (August and September).

The northern and eastern reaches of the intermediate aquifer system are not clearly defined. The aquifer system is interfingered with less transmissive units and aquifer units pinch-out. Because of inconsistencies in lithology and complexity of the hydrogeology, northern and eastern portions of the intermediate aquifer system as delineated by the USGS (Duerr, 1987) are considered too uncertain for determining recharge. With high water level elevations in the surficial aquifer system and suspected interconnection between the surficial and the Upper Floridan aquifers through karst features, recharge to the Upper Floridan aquifer is inferred in these areas.

Recharge maps for the Upper Floridan aquifer for September 1986, and May 1987, are given in Figures 42 and 43, respectively. Consistently high recharge is again found in the Lake Henry Ridge area and in the Lake Wales Ridge, Pasco High, and Clearwater High. The Upper Floridan aquifer has areas of no recharge associated with the Peace, Myakka, and Hillsborough Rivers as does the intermediate aquifer system. These riverine systems serve as major drainage systems for the SWCFGWB.

Similarities between Stewart's (1980), Ryder's (1982), and 1986 and 1987 recharge maps of the Upper Floridan aquifer verify certain areas as high recharge areas or areas of no recharge. Dissimilar features between the maps result from annual changes in hydrologic conditions, addition of new information, and changes in interpretations.

It can be summarized from the recharge maps that the deep aquifers in the SWCFGWB do not receive recharge in most of Charlotte, Sarasota, Pinellas, and DeSoto Counties. Higher recharge rates occur during the dry season as approximately 30% of the SWCFGWB receives moderate or high recharge to the intermediate aquifer system and Upper Floridan aquifer. During the wet season the aquifers are at their highest levels, recharge is reduced, and only approximately 15% of the SWCFGWB receives moderate or high recharge. High recharge areas are associated with regional topographic and potentiometric highs and presence of semiconfining units.

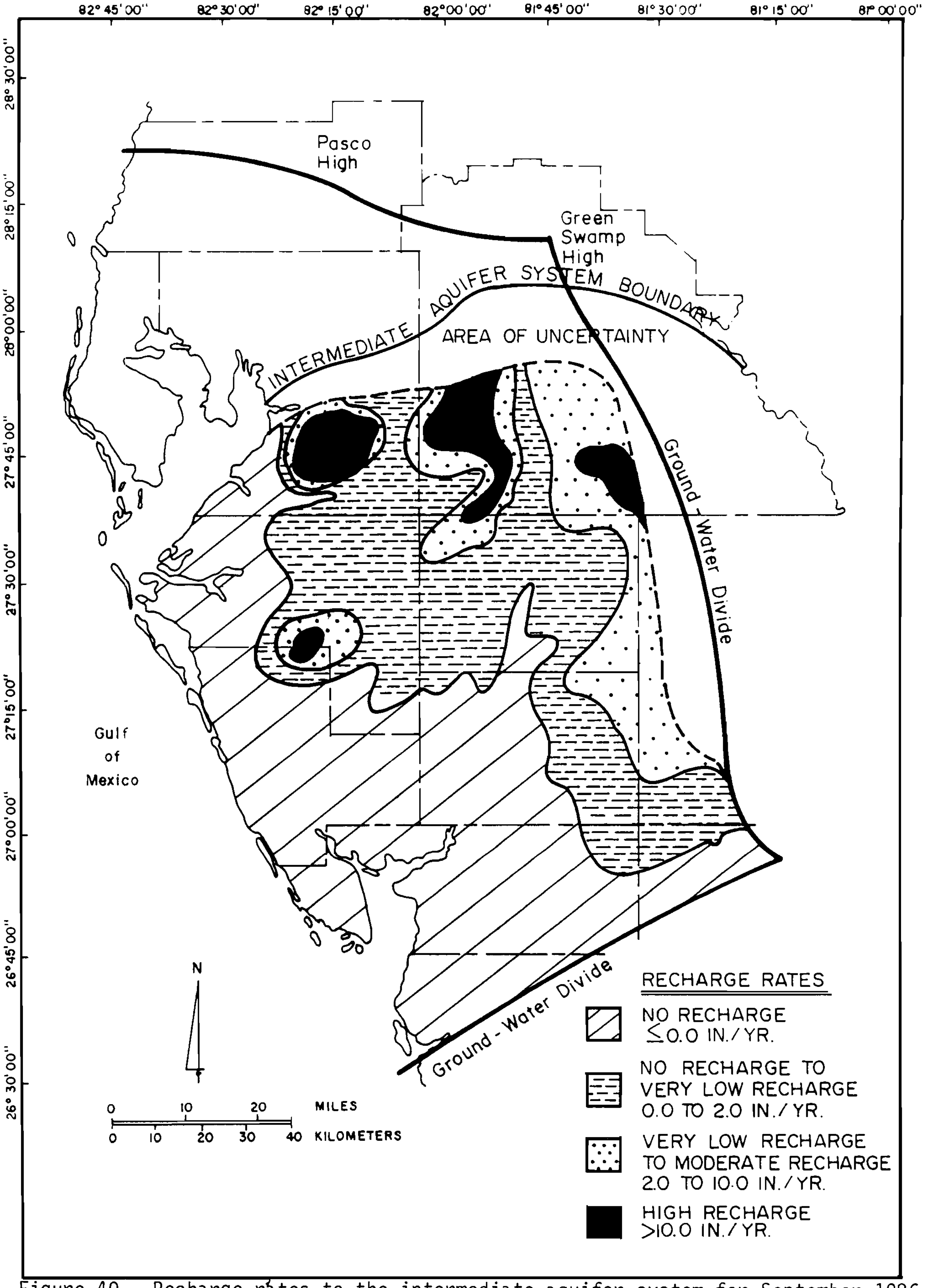


Figure 40. Recharge rates to the intermediate aquifer system for September 1986, in the Southern West-Central Florida Ground-Water Basin.

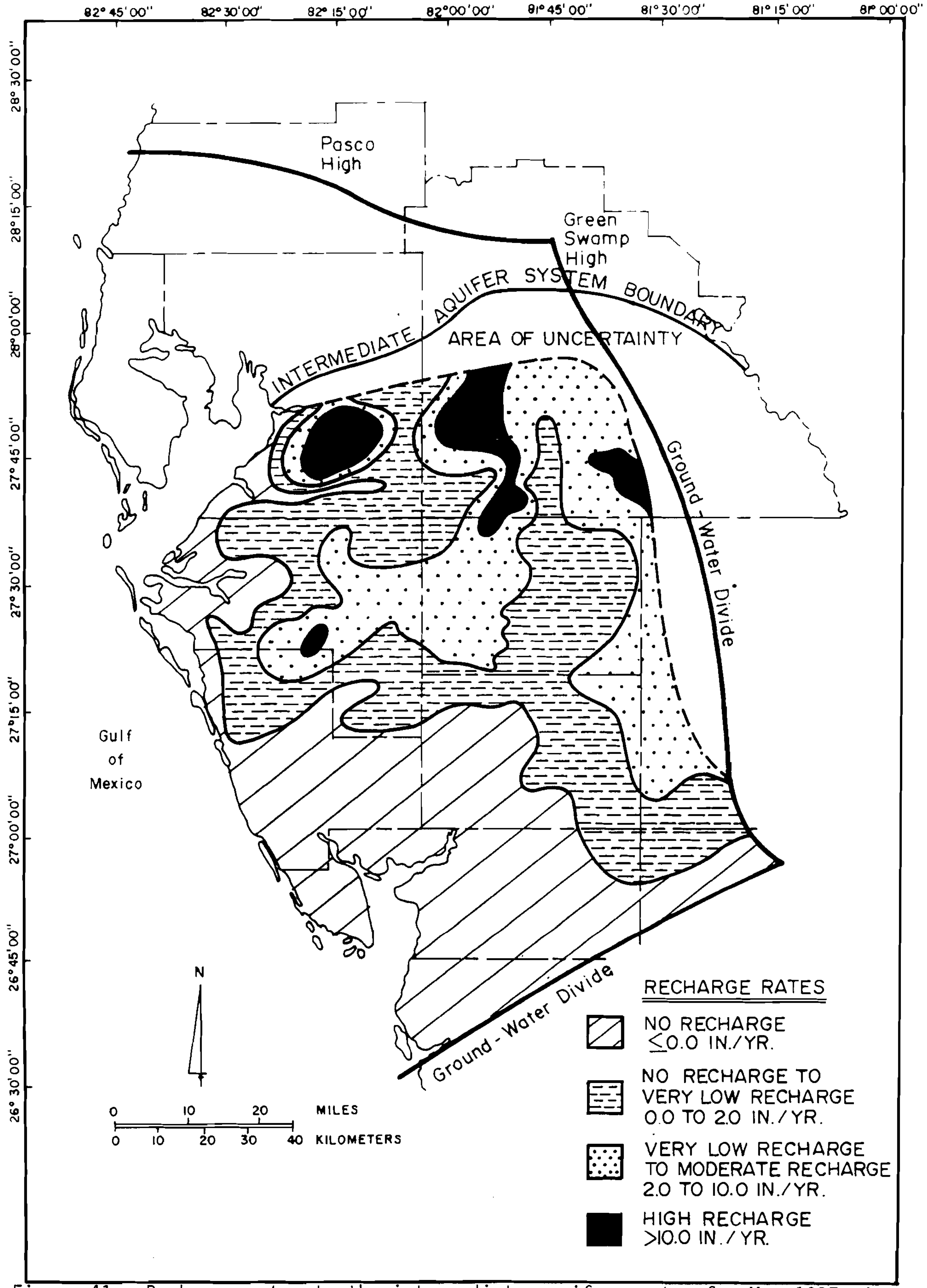


Figure 41. Recharge rates to the intermediate aquifer system for May 1987, in the Southern West-Central Florida Ground-Water Basin.

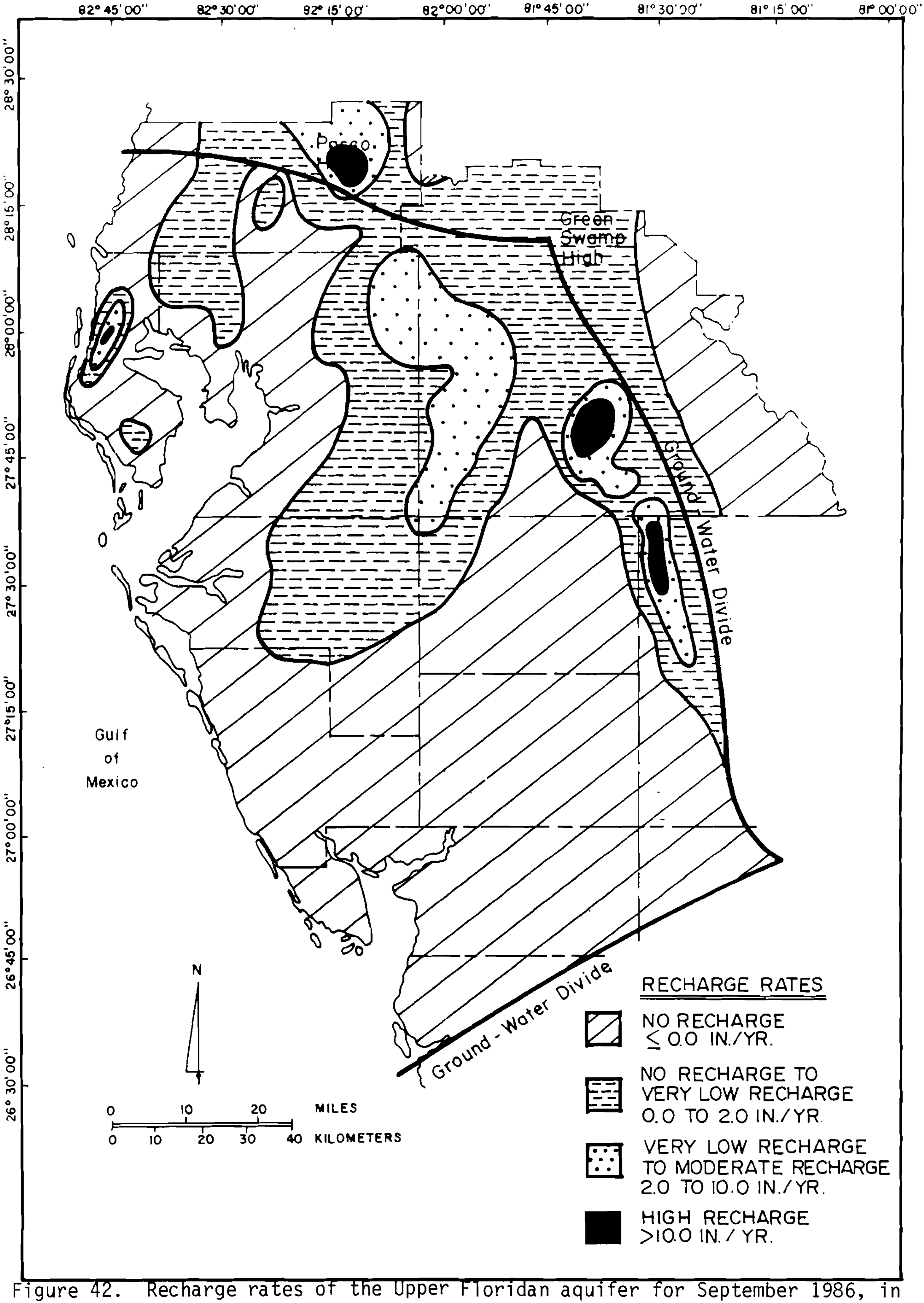


Figure 42. Recharge rates of the Upper Floridan aquifer for September 1986, in the Southern West-Central Florida Ground-Water Basin.

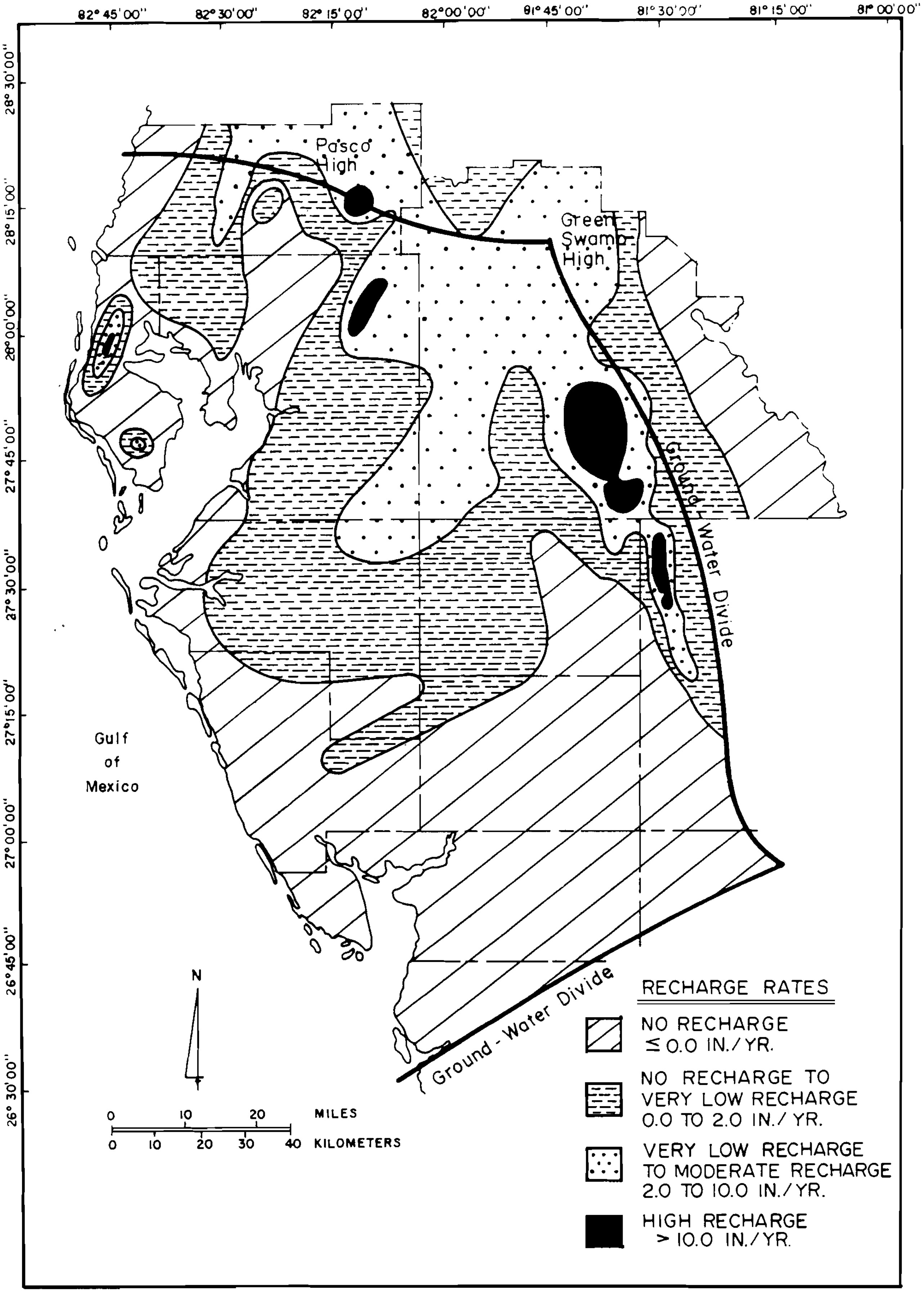


Figure 43. Recharge rates of the Upper Floridan aquifer for May 1987, in the Southern West-Central Florida Ground-Water Basin.

SUITABILITY OF AREAS FOR FUTURE GROUND-WATER SUPPLY DEVELOPMENT

Another of the WMD's requirements relative to the GWBRAI is to "delineate areas suitable for future water resource development within the ground-water basins". Generally, hydrogeologic criteria used to identify areas suitable for ground-water development in west-central Florida include:

- quantity criteria
  - . potable aquifer thickness
  - . transmissivity
  - . storativity
  - . leakance (recharge potential)
  - . potentiometric surface elevation
  - . seasonal fluctuation of the water table and potentiometric surfaces
- quality criteria
  - . ambient aquifer water quality
  - . anthropogenic effects on aquifer water quality
  - . location and nature of the saltwater/freshwater interface
- resource competition
  - . existing and projected water withdrawal
  - . existing and future land use projections

To fully evaluate these criteria, the SWFWMD conducts, or cooperatively sponsors, numerous data collection and analyses programs and projects. Examples of data collected include surface and ground-water levels, quality, and withdrawals; reservoir and aquifer characteristics; and, meterological data such as rainfall, evapotranspiration, and solar intensity. Examples of analyses conducted include descriptive analyses such as construction of potentiometric surface, recharge, and DRASTIC maps, and simulation of hydrologic conditions utilizing surface and ground-water models. The most detailed models are being constructed in areas where comprehensive investigations are being conducted primarily to determine water resource availability. These comprehensive investigations are necessitated due to competition for the water resources resulting in significant impacts to the surface and ground-water systems, and associated natural environments. Assessment of areas suitable for future water resource development will also be addressed in these comprehensive studies.

Presently, these investigations are being conducted in the Northwest Hillsborough and South Hillsborough/North Manatee areas (areas A and B in Figure 44; areas of significant withdrawals were identified utilizing Figure 48), and the Highlands Ridge and Hardee/DeSoto Counties areas (area C in Figure 44). When these projects are completed, and areas suitable for future water resource development are identified in detail, the affected GWBRAI's will be updated to include this information.

In the interim, general areas suitable for future ground-water resource development within the SWCFGWB are delineated for the Floridan, intermediate, and surficial aquifer systems in Figures 45, 46, and 47, respectively. These areas were delineated utilizing

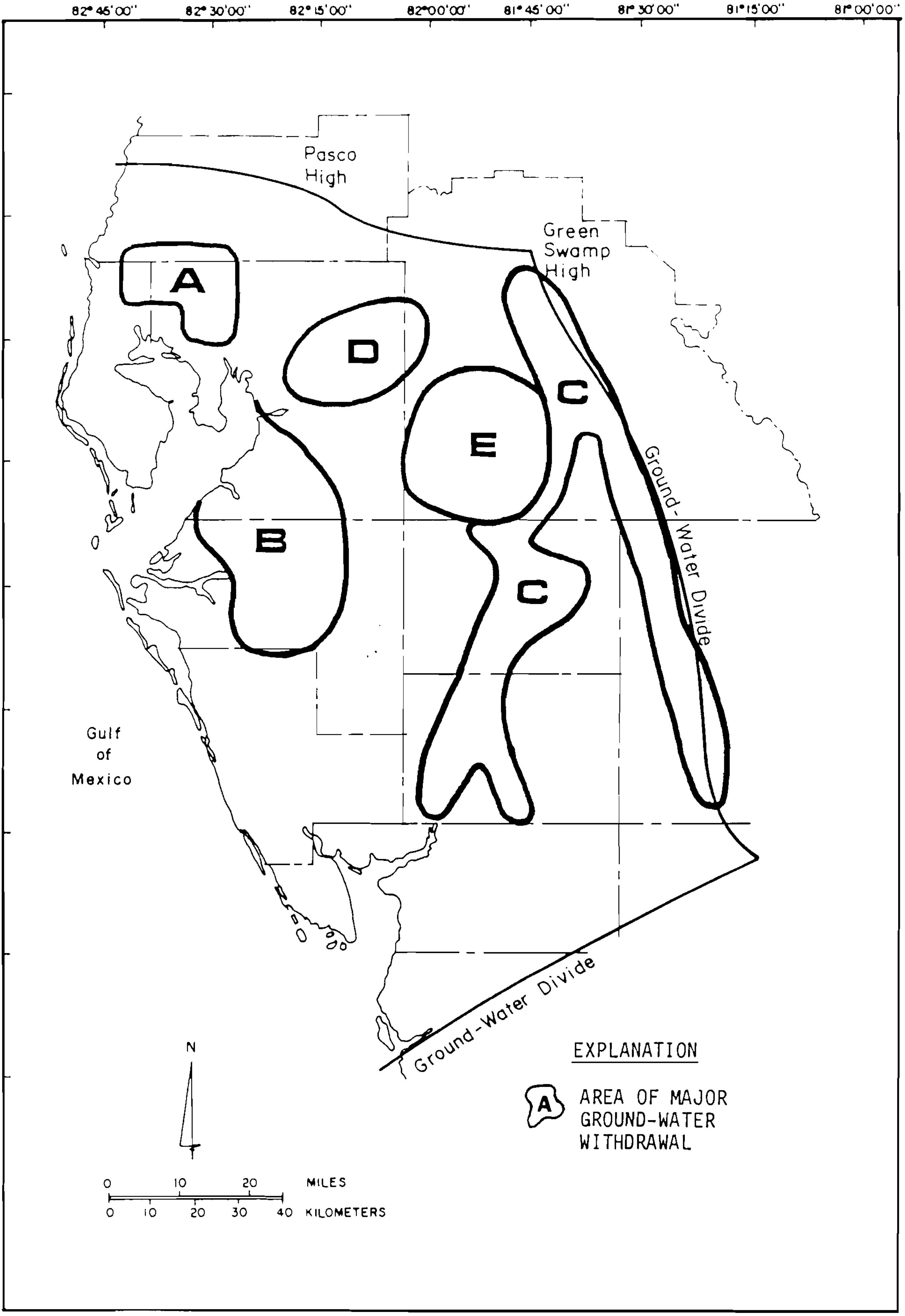


Figure 44. Areas of significant ground-water withdrawal within the Southern West-Central Florida Ground-Water Basin.

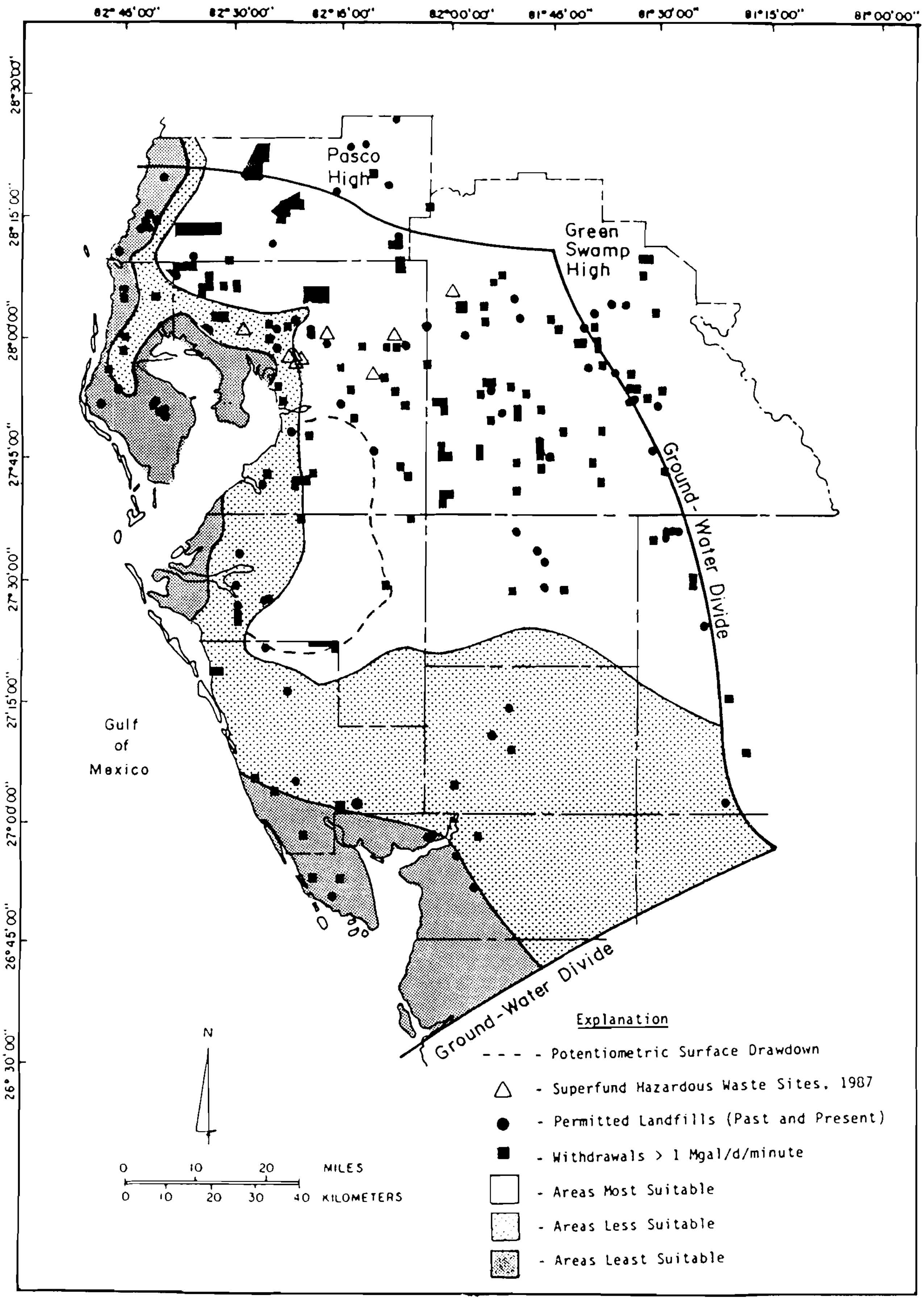


Figure 45. Suitability of areas for future ground-water supply development in the Upper Floridan aquifer, in the Southern West-Central Florida Ground-Water Basin.

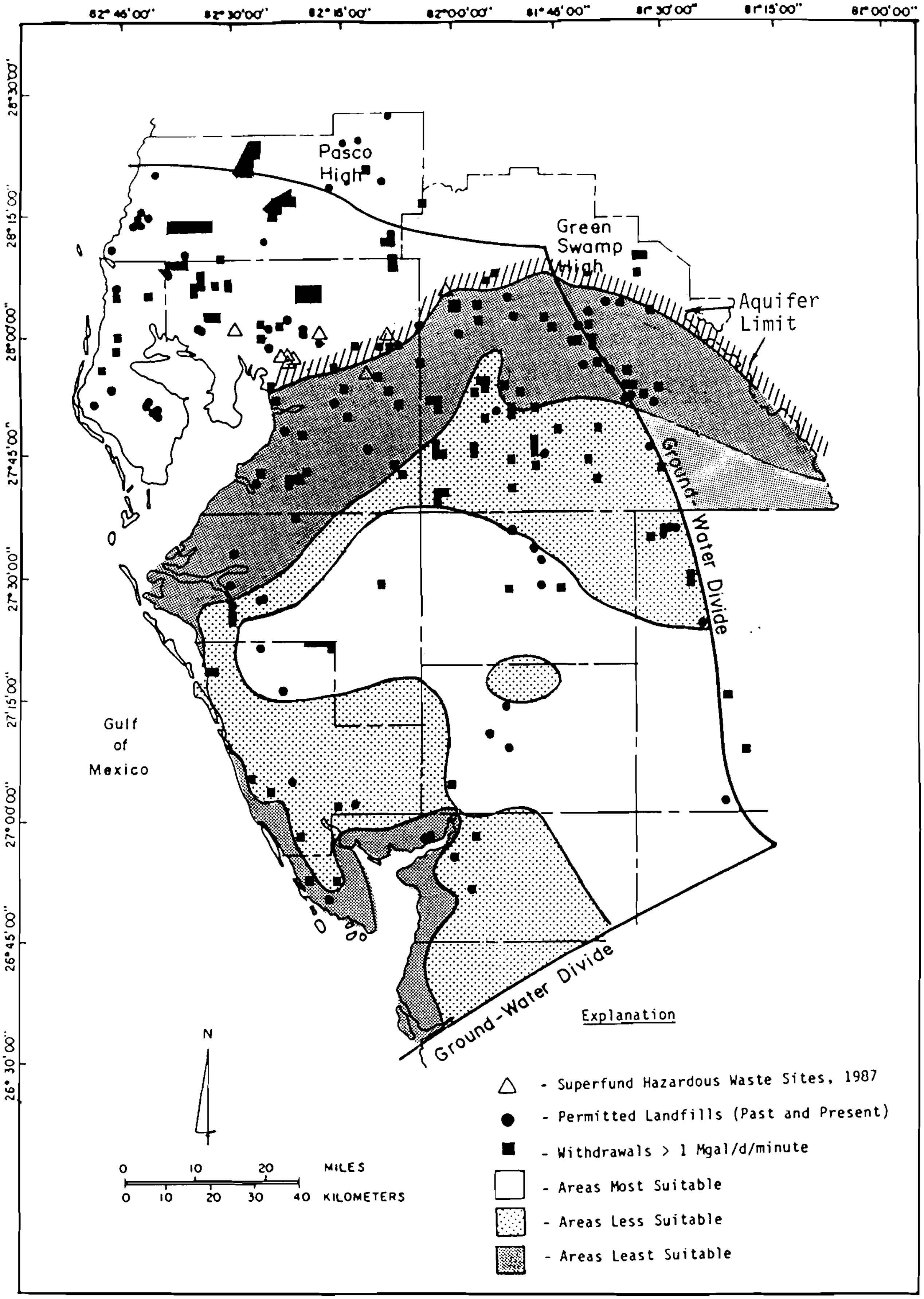


Figure 46. Suitability of areas for future ground-water supply development of the intermediate aquifer system in the Southern West-Central Florida Ground-Water Basin.

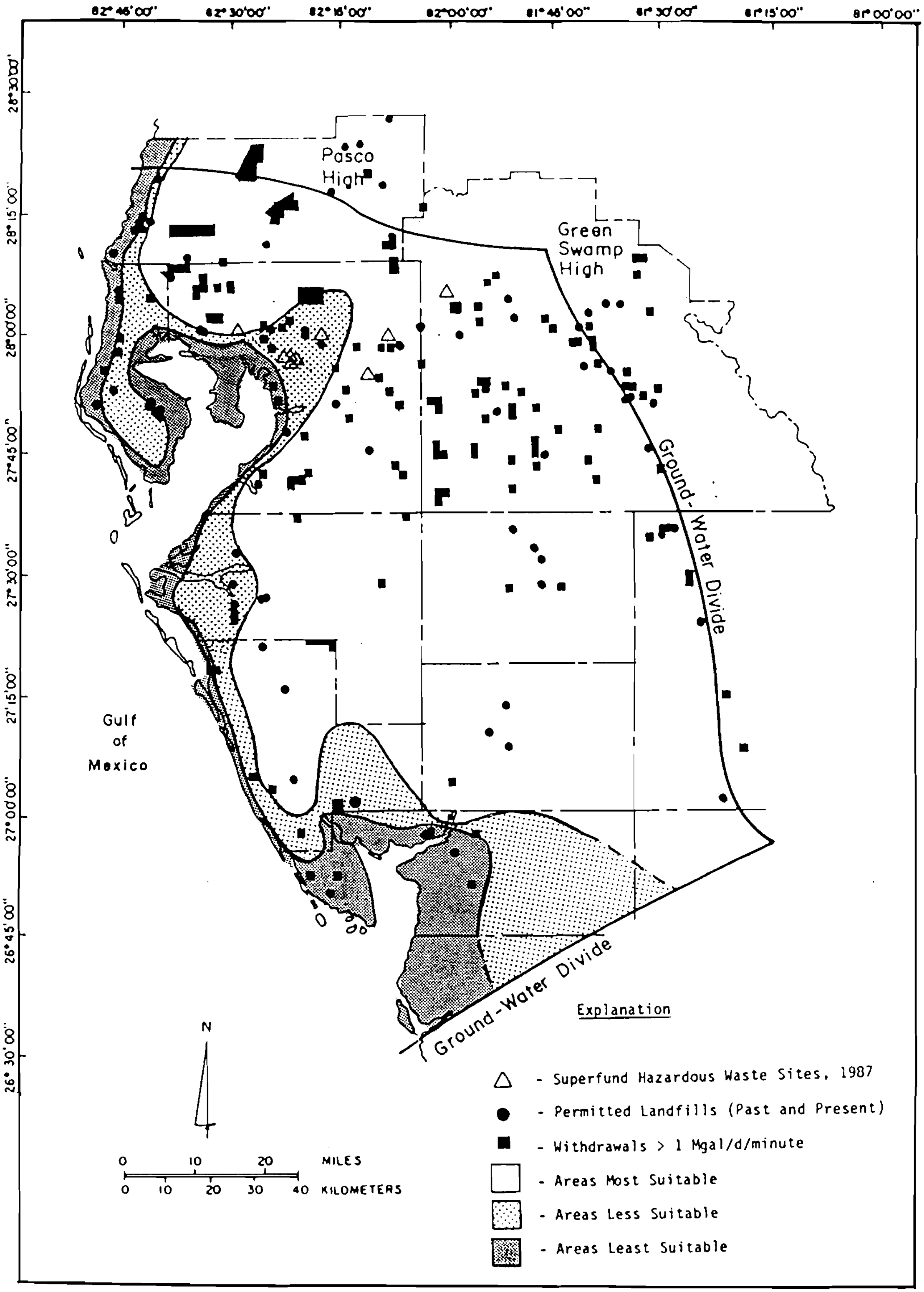


Figure 47. Suitability of areas for future ground-water supply development in the surficial aquifer system in the Southern West-Central Florida Ground-Water Basin.

existing or recently constructed maps. Areas least, less, and most suitable correspond to regions where two, one, or no criteria (quantity, quality, or resource competition) are unsuitable, respectively. Generally, the Upper Floridan aquifer is the most suitable and productive aquifer for consumptive use in the SWCFGWB. However, ground water from the intermediate and surficial aquifer systems may be necessary where the Floridan water quality is poor, such as in Charlotte and Sarasota Counties.

As previously mentioned, ground-water quality is an important limiting factor for future water supply development. Ground water must have sufficient quality to meet public health standards. Recently the SWFWMD created ground-water quality maps of selected major ions for each aquifer in the SWCFGWB. The naturally occurring major-ions mapped were: TDS, sulfate, and chloride. A composite of potable limit contours was used to delineate the suitability of areas for water supply development. Generally, the potable limit contours of major-ions follow the Gulf coastline, tidally affected streams, canals, and estuaries where seawater has intruded into the aquifers. Generally, quality deteriorates at depth and towards the coast. Major-ions exceed recommended potable standards furthest inland in the Upper Floridan, intermediate, and surficial aquifer systems, respectively. Potable limit contours for TDS, sulfate, and chlorides generally reach furthest inland respectively in each aquifer. The concentration of iron and amount of color in ground water from the surficial aquifer are usually high near marshes; however, both can be removed during water treatment.

Another limiting factor in delineating areas suitable for future ground-water supply development is an aquifer's ability to yield the quantities of water desired. Primary criteria which limit an aquifer's ability to yield water include aquifer thickness, transmissivity, storativity, and leakance.

The thickness of the potable water zone in each aquifer is primarily a composite of water quality and aquifer thickness maps. Causey and Leve, 1976, mapped the approximate thickness of the potable water zone in the Floridan aquifer. They concluded that the thickness of the potable water zone of the Upper Floridan aquifer increases towards the northeastern part of the SWCFGWB and is greatest in northern Polk County.

Ryder, 1985, mapped the generalized thickness of the permeable zone in the intermediate aquifer. Based on this map and Figure 27, water quality of the intermediate aquifer system, the thickness of the potable water zone for the intermediate system is greatest in central and east-central parts of the SWCFGWB.

Wolansky and others, 1979, mapped the generalized thickness of the surficial deposits above the confining bed overlying the Floridan aquifer. Based on this map and Figure 20 water quality of the surficial aquifer, the thickness of the potable water zone is greatest along the eastern boundary of the SWCFGWB.

Hydraulic properties of the aquifer systems in the SWCFGWB vary greatly due to the heterogeneity of lithologic units and various saturated thicknesses. However, in general, transmissivity values are greatest in the Floridan, intermediate, and surficial systems, respectively; storativity is greatest in the surficial (specific yield), intermediate, and Floridan systems, respectively; and, leakance is greatest in the northern and eastern areas of the SWCFGWB.

Another limiting factor for future ground-water development is competition for the surface and ground-water resources and associated natural systems. Competition includes existing and projected water withdrawal and land uses. Figure 48 depicts the distribution of ground-water withdrawals in the SWCFGWB in 1986. Areas of current major withdrawals are delineated in Figure 44 and discussed in detail in the following section. The area of major withdrawals shown on Figure 48 (>1 Mgal/d/minute) result in those areas being downgraded by at least one category (i.e. most to less, less to least) in degree of suitability for future water resource development. Existing and future land uses are being given more consideration in determining areas suitable for future water resource development primarily due to ever-rising incidents of anthropogenic constituents in ground-water systems. In particular, proximity of heavily developed areas, industrial sites, landfills, waste water disposal sites, and agricultural areas, are factors which should affect site selection of future wellfields. Figure 49 and 50 show the location of past and present permitted landfills and hazardous waste sites which are considered major potential contamination sources, and potential agricultural non-point source contamination in the SWCFGWB, respectively. Many of these activities are reflected in selecting the areas suitability for ground-water development in Figures 45, 46, and 47.

AREAS IN THE BASIN DEEMED PRONE TO CONTAMINATION AND OVERDRAFT

Another of the primary WMD's requirements relative to the GWBRAI is to delineate site specific areas in the basin deemed prone to contamination or overdraft resulting from current or projected development. This requirement can be further divided into two subrequirements: 1) delineation of areas deemed prone to contamination; and, 2) areas deemed prone to overdraft.

Areas Prone to Contamination

Two tasks were needed to complete the identification of areas in the SWCFGWB deemed prone to contamination. The first was an inventory of existing potential point and non-point sources of contamination and the second was completing an evaluation of the SWCFGWB's susceptibility to ground-water contamination utilizing the USEPA's DRASTIC methodology.

Figures 49 and 50 depict the locations of selected potential point and non-point sources in the SWCFGWB. Additional potential point sources in Manatee County are shown, and discussed, in Figures 78 and 79 in the county section of this report.

The second task needed was the evaluation of the SWCFGWB's susceptibility to ground-water contamination using EPA's DRASTIC methodology. As mentioned in the introduction, the DRASTIC evaluations are being conducted on a county by county basis. These evaluations are designed to assist planners, managers, and administrators in the task of directing resources, land disposal,

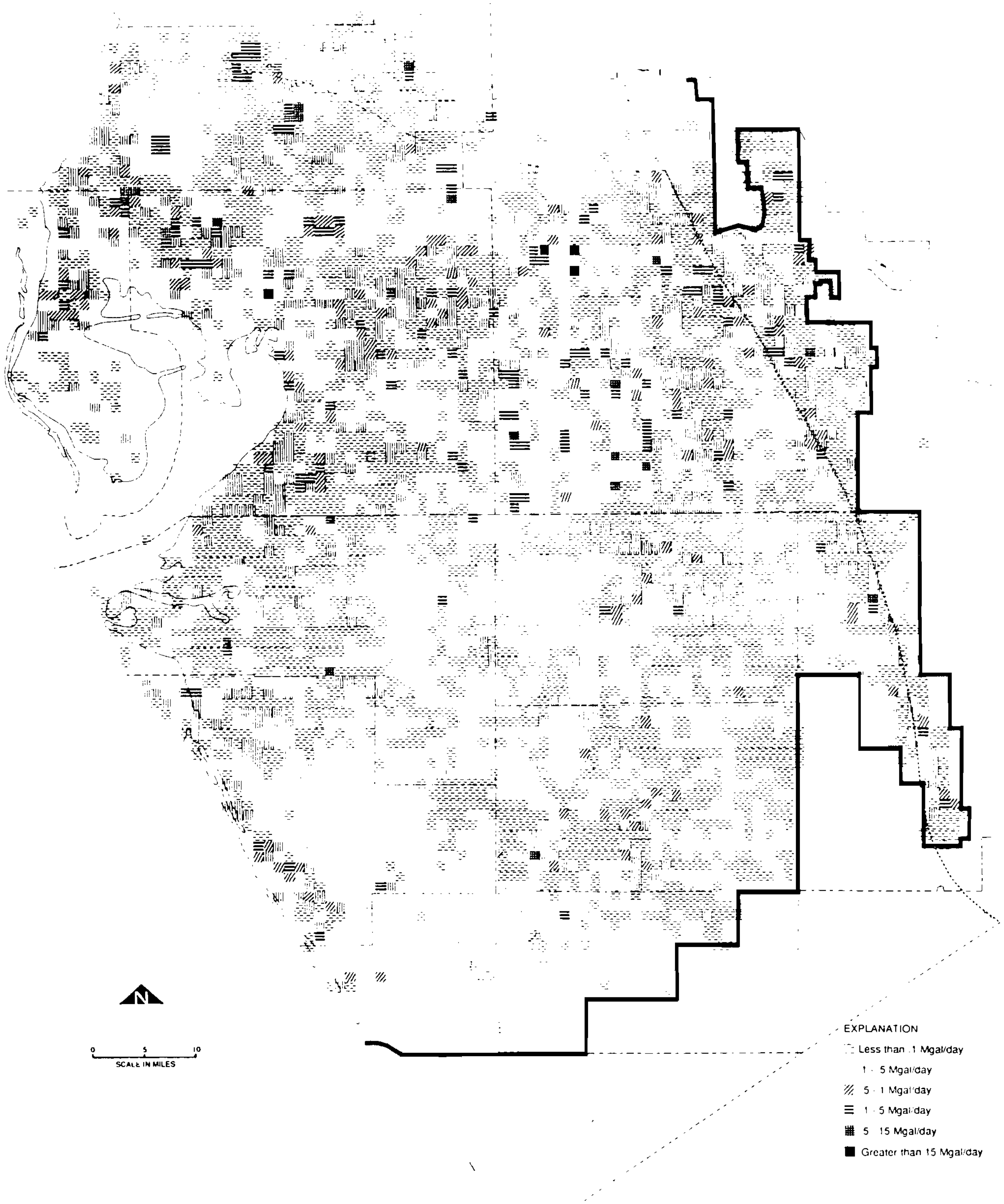


Figure 48. Estimated 1986 average annual daily withdrawals in the Southern West-Central Florida Ground-Water Basin. Withdrawals are determined for one minute square areas.

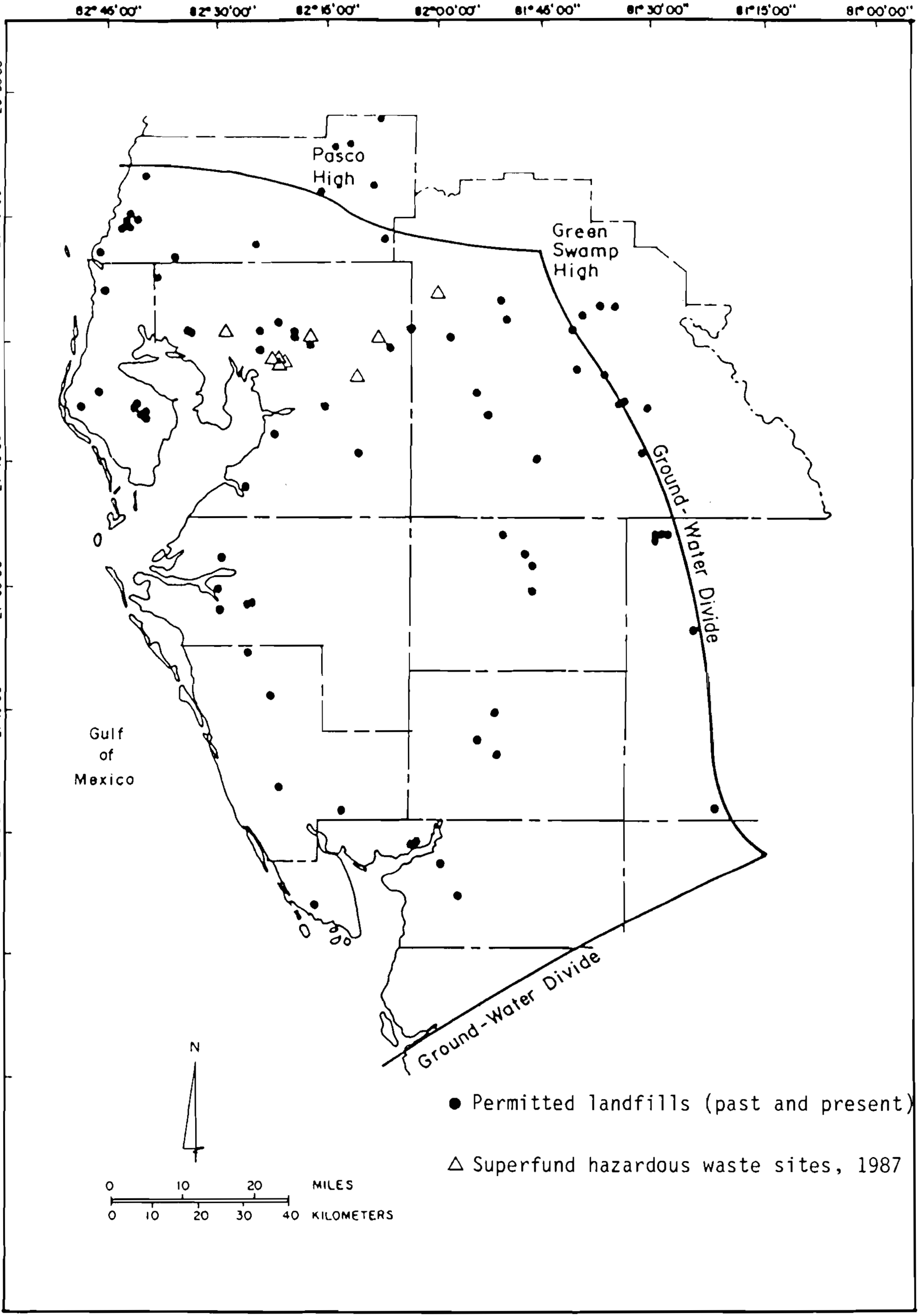


Figure 49. General location of major point-source contamination sites in the Southern West-Central Florida Ground-Water Basin (from FDER database, 1987).

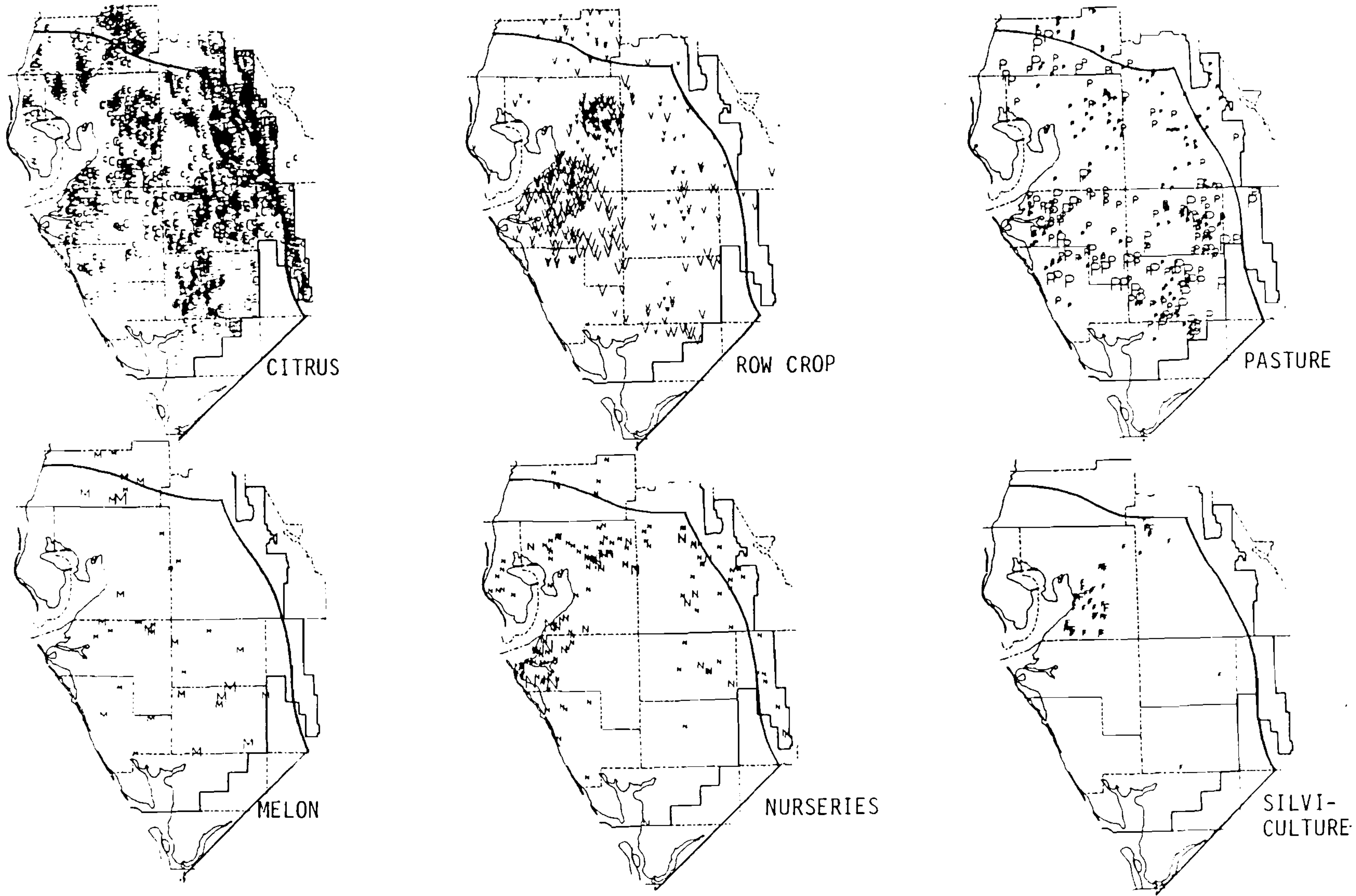


Figure 50. Potential non-point source contamination locations in the Southern West-Central Florida Ground-Water Basin (from Moore and others, 1986).

and other land use activities to the appropriate areas. The Manatee County maps are complete and included in the county section of this report (see Areas Prone to Contamination and Figure 77). However, a composite DRASTIC map for the entire SWCFGWB will not be available until a later date, at which time this report will be updated to include a more comprehensive discussion of the areas within the SWCFGWB deemed prone to contamination from current or projected development.

Areas Prone To Overdraft

In initial response to delineate areas prone to overdraft in the SWCFGWB, staff at the SWFWMD developed a map of the major ground-water users. Permitted wells were grouped together in one-square minute of latitude and longitude (approximately one-square mile) grids. Reported monthly pumpage from public supply and industrial users were used, while average daily permitted pumpage was used for agricultural water use, and where reported pumpage from public-supply and industrial use was unavailable. The monthly and daily data were converted to an average annual daily ground-water withdrawal rate in the SWCFGWB. Ground-water withdrawal quantities for the SWCFGWB (excluding areas outside the SWFWMD) are shown in Figure 48, and represent the 1986 average annual daily pumpage in Mgal/d. In the SWFWMD area of the SWCFGWB, the total 1986 average day withdrawal was approximately 1,333 Mgal/d. Of this, 600 Mgal/d was estimated agricultural withdrawal, 360 Mgal/d was for public supply, 351 Mgal/d was reported pumpage from industrial users, and 22 Mgal/d by other uses.

Although the SWCFGWB, as a whole, is not experiencing overdraft, there are areas of significant ground-water withdrawal (Figure 44). A description of these areas, including major SWFWMD investigations in these areas, are discussed below.

Area "A" is an area of significant public-supply withdrawal and includes the Cosme-Odessa, East Lake, Eldridge-Wilde, Northwest Hillsborough, Section 21, and South Pasco Wellfields. The total average daily permitted pumpage is approximately 108 Mgal/d, with maximum daily permitted pumpage of approximately 288 Mgal/d. Ground-water withdrawals during the past several decades has resulted in increases in chloride levels, reduction of lake levels and streamflow, and alteration of native environmental systems. The SWFWMD initiated a comprehensive four-year investigation of this area in October, 1987. The purpose of the investigation is to develop management alternatives consistent with available water resources in the area.

Area "B" is an area of primarily agricultural pumpage, with additional significant industrial and public-supply pumpage. Average daily permitted pumpage, which exceeds 300 Mgal/d, has resulted in the lowering of the Floridan aquifer potentiometric surface below sea level for extended intervals on an annual basis. Typically, reducing potentiometric levels below sea level in coastal areas result in a landward movement of the freshwater/saltwater interface. The concern for saltwater intrusion has prompted the SWFWMD to initiate a second comprehensive investigation in January, 1988. The purpose of this four-year investigation is again to develop management alternatives consistent with available water resources in the area.

Area "C" is another area of significant ground-water withdrawal. The primary withdrawals in this area are agricultural (predominantly citrus), and average daily permitted pumpage exceeds approximately 200 Mgal/d. The SWFWMD is currently conducting, or sponsoring, three investigations in area "C". The objective of one is to determine why lake levels in the upland areas are declining so rapidly. The objective of another is to determine the potential for cross-contamination of poor water quality between aquifers in Hardee and DeSoto Counties due to large open hole intervals of production wells. The objective of a third is to determine the origin and effects of elevated nitrate levels in the surficial aquifer system in the upland areas of Area "C".

Area "D" is also an area of primarily agricultural (strawberries and tomatoes) pumpage. Permitted average daily agricultural water use in this area is less than 50 Mgal/d; however, maximum permitted daily pumpage exceeds 275 Mgal/d. Maximum pumpage occurs in this area during times of freeze and frost protection, and can result in failure of well pumps and sinkhole development. The SWFWMD conducted a series of investigations in this area in the early 1980's, which resulted in well drilling stipulations for the area.

Area "E" is an area of major ground-water withdrawals due to phosphate mining. Average daily permitted withdrawals exceed 100 Mgal/d and are primarily the result of dewatering for mining and water needed for chemical manufacturing. A series of investigations conducted by the public and private sector resulted in new mining practices for this area in the early 1980's. These practices emphasize recycling water, thereby reducing impacts on the ground and surface-water resources and associated natural systems.

Other areas of significant water withdrawal in the SWCFGWB include, but are not limited to, the Cypress Creek, Cross Bar, and Starkey Wellfields in Pasco County; the Morris Bridge Wellfield and Hillsborough River Reservoir in Hillsborough County; the City of Lakeland Wellfields and Florida Power and Light Station in Polk County; Clearwater and Dunedin Wellfields in Pinellas County; the Lake Manatee Reservoir and Wellfield in Manatee County; and, the Verna and several coastal wellfields in Sarasota County.

DISTRICT ACTIVITIES IN THE SWCFGWB

The SWFWMD conducts a number of continuing programs to study, assess, and manage the water resources in the SWCFGWB. These programs include, but are not limited to:

- Regulatory Programs
- Hydrologic Data Collection and Monitoring Program
- Regional Observation and Monitoring Program (ROMP)
- Quality of Water Improvement Program (QWIP)
- Surface Water Improvement and Management Program (SWIM)
- Save Our Rivers Program (SOR)
- Ambient Ground-Water Quality Monitoring Program (AGWQMP)
- Agricultural Irrigation Monitoring Program (AIM)
- Land Management Program

- Aquatic Plant Management Program
- Outreach Program

A brief description of these programs follows.

REGULATION

The SWFWMD issues permits for the consumptive use of water, for the construction of wells, and the construction of facilities which impound or otherwise alter the flow of surface waters. The SWFWMD is also a source of technical information on the geology and hydrology of areas within its jurisdiction.

The SWFWMD was created by a special act of Florida legislature in 1961 after Hurricane Donna passed through the Tampa area and necessitated a regional study to alleviate flooding problems. The SWFWMD continues to address structural and non-structural flood control as well as other water management problems. The Florida Water Resources Act of 1972 (Chapter 373, Florida Statues) defines the responsibilities of WMD's and establishes funding, administration, and operational procedures. The jurisdictional rules of the SWFWMD are found in Chapter 40D of the Florida Administrative Codes (FAC).

A short summary of the regulatory programs of the SWFWMD follows:

Consumptive Use of Water

All consumptive uses of water within the state of Florida require a permit from the WMD's, except for domestic consumptive of water by individual users. The SWFWMD requires a permit for users that withdraw more than 100,000 gallons per day average, or for withdrawals from facilities which have the capacity to withdraw more than 1,000,000 gallons per day, or for withdrawals from wells which are 6 inches in inside diameter or greater. The owner of a well, or combination of wells, meeting the criteria above (Chapter 40D-2, FAC), must obtain a consumptive use permit (CUP) before a well construction permit will be issued, unless a well exemption or temporary CUP is issued. The intent of the CUP program is to conserve and effectively manage the water resource. In order to obtain a permit, the applicant must show there is reasonable and beneficial use of the water being withdrawn and that the withdrawal does not interfere with existing legal use of water.

Currently, the SWFWMD also requires applicants to meet the "5/3/1 drawdown criteria". The "5/3/1 drawdown criteria" balances ground-water users needs with minimal environmental damage. For example, lowering the water table may not adversely affect the hydrologic system, but vegetation could be sensitive to reduced moisture in the soils induced by pumping. The SWFWMD's "5/3/1 criteria" states that ground-water withdrawals must not cause the potentiometric surface of lands not owned, leased, or otherwise controlled by the applicant to be lowered more than 5 feet. The water table of areas outside of the applicants control must not be lowered more than 3 feet. Also, the level of the surface water in any lake or impoundment must not be lowered by more than 1 foot, unless the applicant wholly owns, leases, or otherwise controls those surface-water bodies.

Additionally, the potentiometric surface cannot be lowered below sea level, as this would induce saltwater intrusion.

Water Well Construction

All water wells regardless of size, must comply with Florida's well construction standards. Permits are required for the construction, alteration, repair or abandonment of water wells with an inside diameter of 2 inches or greater. Within the SWFWMD, water wells are required to be constructed under the supervision of a licensed water well driller. The SWFWMD issues water well construction permits and also licenses water well contractors and registered water well drillers within its jurisdictional boundaries.

Generally, wells to be used for public consumptive use purposes must be grout sealed to protect the well from possible contamination and must be located at least 100 feet from any potential source of contamination, such as: septic tanks or stormwater facilities. If the septic tank facility exceeds 2,000 gal/d, the minimum set back is 200 feet from the facility. Specific construction requirements may be found in Chapter 373 Florida Statues and Chapters 17-21 and 40D-3, FAC.

Surface-Water Management and Storage

This program requires permits for projects that require construction, alteration, or operation of surface-water management works not specifically exempted by law or administrative rule, or for which a general permit has not been issued. The intent of this program is to regulate projects that would impact water quantity, water quality, wetlands, and other associated environmental concerns.

The SWFWMD may issue a general permit for projects that do not affect lakes, streams, or other water courses, which have the approval of the appropriate unit of local government and involve a project land area of less than 40 acres. Public highway projects may also fall into the general permit category (see Chapter 40D-40.302, FAC). Individual permits are required for projects which exceed the general permit threshold. Exemptions from the SWFWMD surface-water permitting are found in Chapter 40D-4.051 FAC and generally apply to certain agricultural activities and small projects which do not impact wetlands.

Minimum Flows and Levels

Another primary requirement of the GWBRAI is to address the criteria for establishment of minimum flows and/or management levels for both surface and ground-water resources of the SWFWMD. Under Chapter 373,042 Florida Statutes, the SWFWMD enacted Chapters 40D-8 and 40D-2 of its rules and regulations to specifically address these issues. The intent of these rules is to regulate water use so that the water resources are managed in such away as to conserve those resources while allowing them to be put to their full beneficial use. When deemed appropriate, a schedule of rates of flow and levels may be established to reflect seasonal or cyclic variations. The Governing Board of the SWFWMD will also consider, and at its discretion may provide for, the protection of non-consumptive uses, including navigation, recreation, and the preservation of natural resources, fish and wildlife.

The SWFWMD may elect to establish a minimum aquifer levels, or minimum stream or river flows, or minimum lake levels. Two SWFWMD programs used to meet these objectives are the CUP process and the Lake Levels Project.

The CUP process (Chapter 40D-2) is required for all users of surface and ground-water within SWFWMD jurisdiction. Users of ground-water must comply with specific conditions; reflected by local geological and hydrological factors influencing the amount of water that can be withdrawn and the vulnerability of the resource to its withdrawal. Further explanation is provided in the Regulatory Section of this document.

The relationship between estuaries and the volume and timing of freshwater flows from rivers and springs is important. Up to 97% of the fishery products harvested on Florida's Gulf Coast depend upon estuaries during some phase of their cycle for food and shelter. Most streams and estuaries require range of flows for proper ecological functioning.

The current rules limiting individual withdrawals address this consideration to some extent. The current SWFWMD rules contain two passages specifying formulas which are to be used for the computation of regulatory levels regarding streamflow. These methods of computation are to be used throughout the SWFWMD unless the Board approves other regulatory levels for individual CUP's. The first of these pages (40D-2.301(3a)) states that an individual water user may not withdraw more that 5 percent of streamflow at a given point on a stream. The second passage, (40D-8.041(2)) specifies the calculated minimum flow rule is established for each month of the calendar year and represents an average of five of the lowest monthly mean discharges for the preceding twenty years.

The Rules of the SWFWMD which relate to streamflow regulation are currently undergoing revision. The intent of the SWFWMD is to better understand this relationship by collecting and analyzing biological, chemical and discharge with rivers which discharge into the Gulf of Mexico.

Although the SWFWMD has the authority to establish minimum levels of lakes in regard to monitoring withdrawals, the SWFWMD has instead created the Lake Levels Project. This on-going project created in 1976 was designed to set both management levels and management schedules for lakes within the SWFWMD.

The project objectives are fivefold:

1. Conserve the water storage and recharge capabilities of the lakes;
2. Provide levels for the operation of control structures;
3. Provide information for CUP permitting activities;
4. Provide guidelines for development bordering lakes; and

5. Provide the necessary fluctuations in water levels to keep a lake biologically healthy.

The selection criteria devised for lakes to be included in the Lake Levels Project is as follows: The lake must

1. Be twenty acres or greater in size;
2. Not be wholly owned by one owner;
3. Have existing flood control structures; or
4. Have existing or proposed CUPs; or
5. Be a special or problem lake.

If the lake meets the selection criteria, then the SWFWMD will develop, establish, and adopt the lake's levels based on the individual nature of the lake, and upon public comments and testimony.

Four management levels are determined for these selected lakes:

1. Ten-year Flood Warning Level;
2. Minimum Flood Level;
3. Low Management Level; and
4. Extreme Low Management Level.

The levels set accomplish the project objectives as follows:

Ten-Year Flood Warning Level -

This is an advisory level provided only as a discretionary guideline for the lake shore development.

Minimum Flood Level -

This is a level that conserves the water storage and recharge capability of a lake. Drainage works into and out of the lake require SWFWMD permits to ensure proper design and prevent excessive drainage, thereby maintaining and protecting the lake's ability to reach the minimum flood level and see that it is maintained, and protected.

For lakes with control structures, this is the maximum level which the lake would achieve by operation of the control structure. This is a peak elevation and not one which is held constant.

Low Management Level -

This is the normal yearly low level used as a guide to operate a lake control structure.

For CUP purposes this level may be used to:

1. Regulate the upper limit of lake augmentation to reduce evapotranspiration and water table losses, prevent possible flooding through loss of storage, reduce possible solution of limestone in the aquifer, and lessen the water-quality impacts to the lake.

2. Provide information to regulate withdrawals that substantially affect the level of a lake.

Extreme Low Management Level -

This is the drought year low level used to operate a lake control structure. It is not a drawdown level, but merely a normal cyclic low that the lake should reach periodically for the biological health of the lake.

For CUP purposes, this level is provided as information for consumptive use permitting.

As of January, 1988, 262 of the 490 qualified lakes in the SWCFGWB have adopted management levels. Appendix C lists the lakes, their sizes, and locations. Figure 51 is a location map of these 262 lakes.

Management levels will be adopted for the remaining qualified lakes in the future. All information requests concerning specific lake levels should be directed to the SWFWMD Environmental Section.

Hydrologic Data Collection and Monitoring Program

The hydrologic data collection network at the SWFWMD has evolved over the past 28 years. As the SWFWMD expanded in focus from flood management into water resource regulation, both the quality and the variety of the data has dramatically increased. The basic hydrologic data networks utilized by the SWFWMD include rainfall, ground-water levels, static surface-water levels, and streamflow records. This information is stored in the hydrologic data base at the SWFWMD. Appendix D of this report provides a listing of hydrologic data collected in Charlotte County by the SWFWMD.

Regional Observation and Monitoring Program (ROMP)

The Regional Observation and Monitoring Program (ROMP) was designed as a basic network of ground-water monitor wells to record water levels, water quality, to locate fresh/saltwater interface, and to determine aquifer properties. Presently the ROMP network is designed to contain a total of 159 sites with 271 wells installed when complete. As of March, 1987, ROMP has completed a total of 92 monitoring sites with 172 wells installed. ROMP wells in Charlotte County are included in Appendix D.

Quality of Water Improvement Program (QWIP)

The Quality of Water Improvement Program (QWIP) was designed to control interaquifer contamination and wasteful artesian flow.

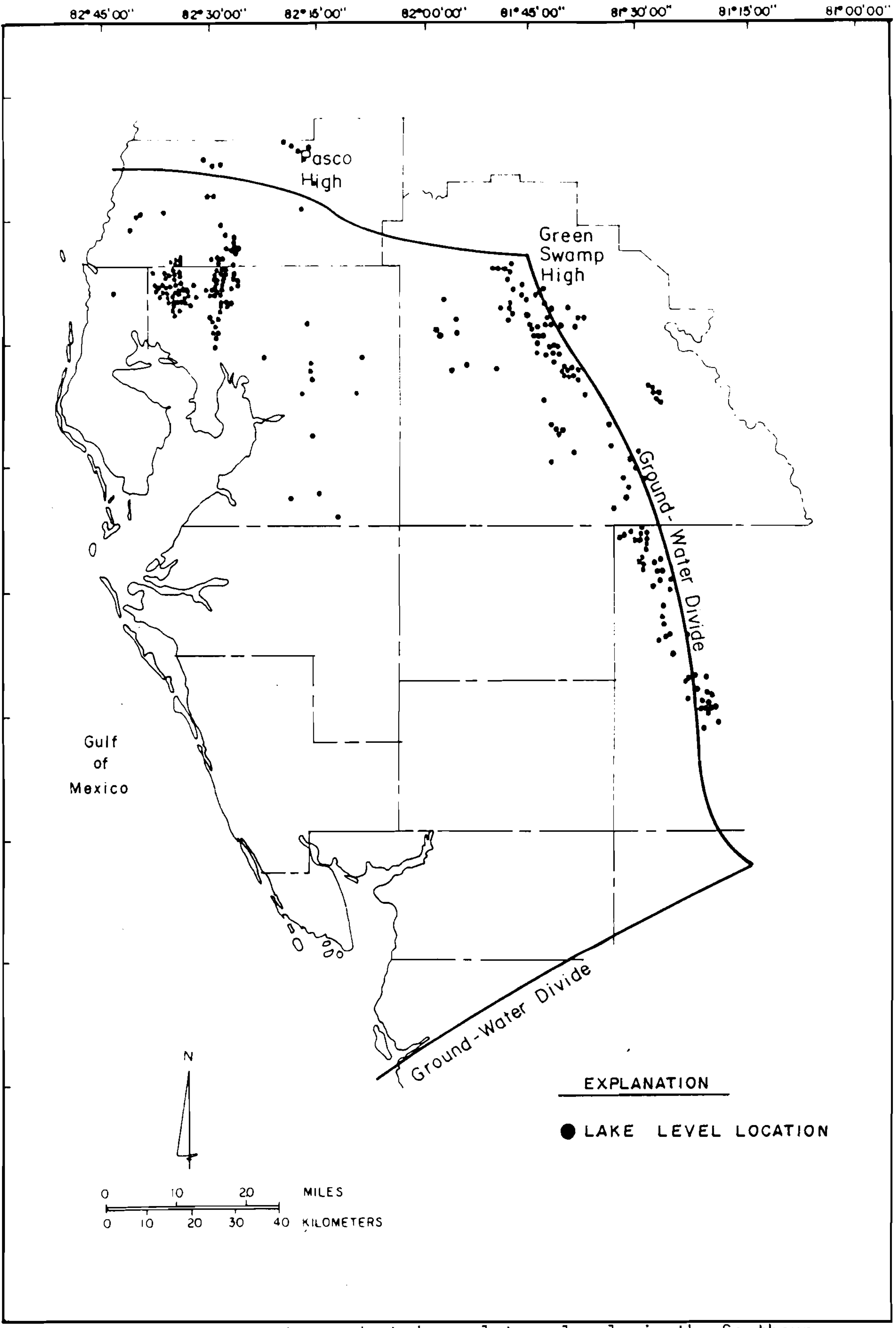


Figure 51. Lakes that have adopted regulatory levels in the Southern West-Central Florida Ground-Water Basin.

Interaquifer contamination due to differential hydrostatic pressures within uncased sections of wells that connect more than one aquifer and wasteful artesian flow at land surface from improperly controlled wells are responsible for deterioration of water quality in the artesian system. The areas of major interaquifer contamination and wasteful artesian flow are found in Hillsborough, Manatee, Sarasota, Charlotte, DeSoto, Pinellas, and Hardee Counties. Reestablishing the separation between aquifers by plugging the sections of well bores is necessary to maintain the integrity of high water quality zones. To restore hydrologic conditions altered by uncontrolled discharge by abandoned artesian wells, SWFWMD began QWIP. As of December, 1987, the SWFWMD has plugged or capped 490 wells and inspected 2,371 wells.

Surface Water Improvement and Management Program (SWIM)

The purpose of the Surface Water Improvement and Management Program (SWIM) is to oversee cleanup of surface-water bodies in the SWCFGWB. These surface-water bodies include Tampa Bay and a priority list of approximately 65 water bodies with regional or statewide significance, which warrant restoration or protection under the SWIM Program. Items the SWFWMD will examine in regard to the SWIM Program include; 1) water quality problems, 2) point sources of storm water and other discharges, 3) fisheries, 4) loss of sea grasses and other vegetation, and 5) retrofiting existing stormwater systems. Currently identified SWIM sites in the SWCFGWB are shown in Figure 52 and listed in Table 8.

Save Our Rivers Program (SOR)

The Water Management Trust Fund provides monies for the Save Our Rivers Project (SOR) for acquiring lands necessary for water management, water supply, and the conservation and protection of water resources. The water management benefits/criteria are outlined below and each play an important role in the protection of water and land-related resources.

- Natural flood control water detention and/or retention,
- Preservation and/or restoration of natural systems,
- Water conveyance,
- Water quality enhancement,
- Structural flood control,
- Recharge to aquifers,
- Potable water supply, and
- Recreation.

Utilizing these criteria, project proposals for purchasing land are evaluated via resource evaluation studies, to determine if they meet the objectives of the Save Our Rivers Program. The SWFWMD has acquired 33,041 acres of land as of December, 1987, under the SOR Program. SOR project in the SWCFGWB are shown in Figure 52 and listed in Table 8.

Ambient Ground Water Quality Monitoring Program (AGWQMP)

The Ambient Ground Water Quality Monitoring Program (AGWQMP) is a network established to monitor water quality of the freshwater bearing aquifers throughout Florida. The network emphasizes areas

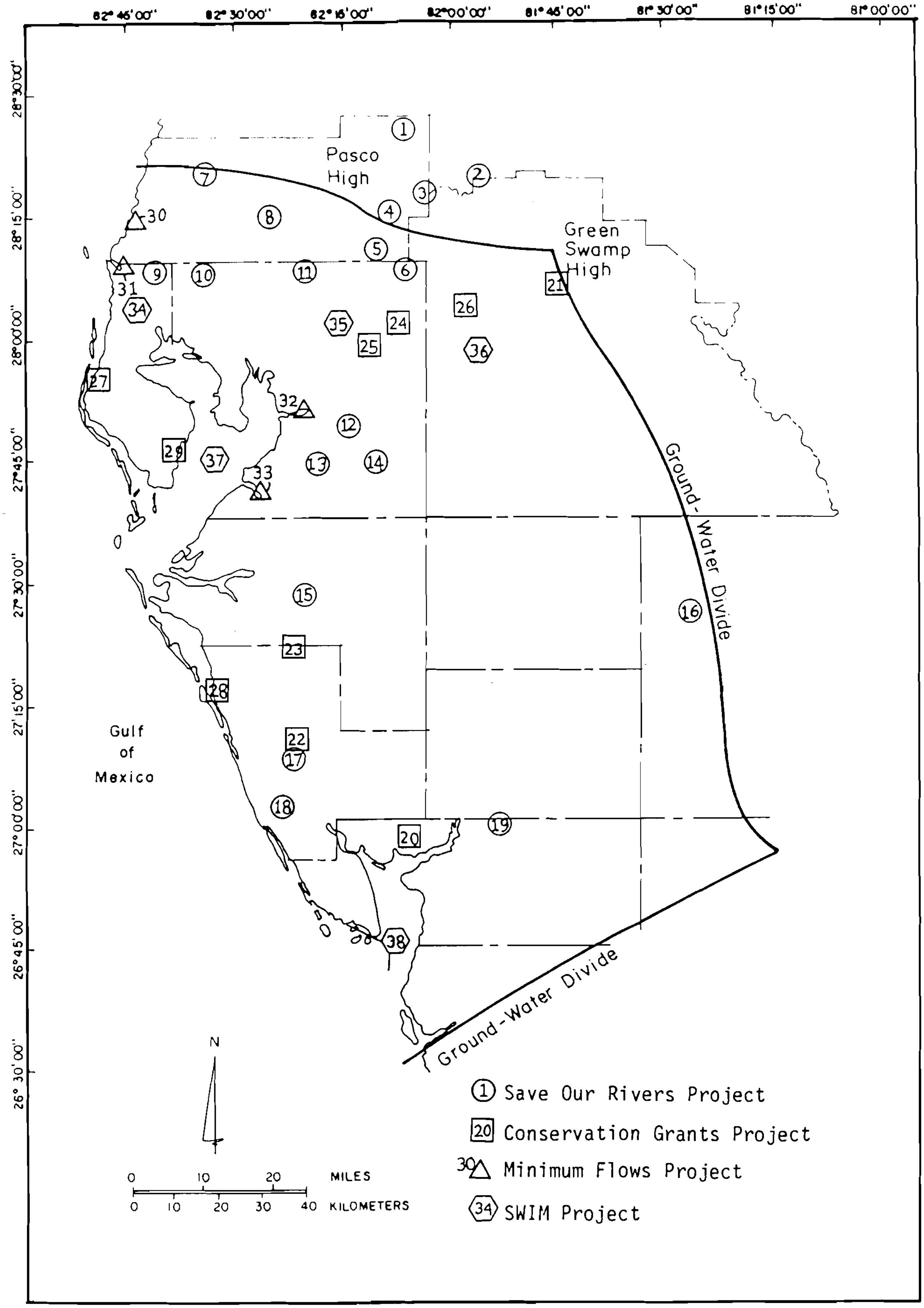


Figure 52. Locations of other major Southwest Florida Water Management District projects in the Southern West-Central Florida Ground-Water Basin (refer to Table 8).

which have been "relatively unaffected" by man's activities, and non-point sources of pollution. Nearly all the primary and secondary drinking water standards are monitored. The AGWQMP monitor wells for Charlotte County are included in Appendix E.

Agricultural Irrigation Monitoring Program (AIM)

The Agricultural Irrigation Monitoring Program (AIM) is a voluntary data collection program designed to gain information concerning variations of water use by different agricultural producers. Data from each site is categorized according to crop type, irrigation method, soil type, and climatological conditions. Approximately 450 selected volunteers will have water meters installed on their systems to monitor water usage. This information will be used to provide realistic water use ranges for similar sites. The ranges will be used in the consumptive use permit system and in the agricultural conservation effort. About one half of the targeted 450 volunteer sites have been established as of December, 1987. AIM sites in the county are listed in Appendix F.

Water Conservation Grants Program

The purpose of the water conservation grants program is to balance the regulatory efforts within the overall conservation program by providing funds as an incentive to implement water conservation measures. The more specific goals of the program are as follows:

- Implement proven or innovative water conservation measures.
- Ensure that the proposed water saving benefits are equitably distributed among user groups.
- Ensure that the program is responsive to water resource limitations.
- Ensure that funded projects result in data and information that will be useful to the other elements of the District Water Conservation Program.

The location of the Water Conservation projects in the SWCFGWB are shown in Figure 52 and listed in Table 8.

Land Management Program

Lands owned by the SWFWMD are managed and maintained in an environmentally acceptable manner, in such a way as to restore and protect their natural state and condition. Principal efforts of the Land Management Program is to plan and control the various uses of SWFWMD owned land, habitat protection and wildlife conservation, fencing and fence maintenance, monitoring of private and public uses, prescribed burning, reforestation, and road and bridge maintenance. SWFWMD property in the SWCFGWB is shown in Figure 52 and listed in Table 8.

Aquatic Plant Management Program

The Aquatic Plant Management Program within the SWFWMD performs aquatic vegetation control on designated water bodies for objectives which include navigation, flood control, and to provide unrestricted water flow. The SWFWMD performs navigational work under contracts with the Florida Department of Natural Resources and Hernando and Sumter Counties. Aquatic plant control is implemented to ensure the proper operation of our flood control systems as approved by applicable Basin Boards and the Governing Board. The Aquatic Section utilizes biological, mechanical, and herbicidal methods to control aquatic vegetation. Plants of major concern are hydrilla and water hyacinth. Aquatic plants can choke a body of water and destroy its recreational uses.

Outreach Program

In order to coordinate with the local governments within the 16 county jurisdiction of the Southwest Florida Water Management District, the current Governing Board approved the opening of four new District Service Offices. These offices are located in the cities of Inverness, Tampa, Bartow, and Venice, as well as the Brooksville Headquarters.

Each office is staffed with a District Service Representative whose responsibilities include personally contacting all the counties, cities, and towns within the service area. The District Service Representative is the outreach vehicle for the many services the District has to offer. They provide for communication and coordination between the local government officials and District's headquarters. The District Service Representatives are required to spend a minimum of 50% of their time in the field with the local governments attending meetings, performing speaking engagements, and providing training and technical assistance in the areas of water management.

TABLE 8. MAJOR SWFWMD PROJECTS IN THE SWCFGWB

Ref.No.	Project Name
	SAVE OUR RIVERS
1.	Withlacoochee Riverine Corridor "B"
2.	Green Swamp Riverine Corridor
3.	Withlacoochee Riverine Corridor "A"
4.	Withlacoochee/Hillsborough Riverine Corridor "D"
5.	Hillsborough Riverine Corridor "C"
6.	Cone Ranch
7.	Hidden Lake
8.	Cypress Creek
9.	Brooker Creek Riverine Corridor "B"
10.	Brooker Creek Riverine Corridor "A"
11.	Lower Hillsborough Flood Detention Area (Flint Creek)
12.	Medard Reservoir Floodway

TABLE 8. (continued)

Ref.No.	Project Name
	SAVE OUR RIVERS (continued)
13.	Buckhorn Creek
14.	Lithia Springs
15.	Lake Manatee Lower Watershed
16.	Jack Creek
17.	Myakka River
18.	Englewood Wellfield
19.	Prairie Creek
	WATER CONSERVATION GRANTS - 1987
20.	Port Charlotte - General Development Utilities - Residential Xeriscope
21.	Lake Alfred - J.P. Syvertsen - Saline Irrigation Research
22.	Sarasota County - Sarasota County Water Ad-Visor
23.	Manatee and Sarasota Counties - Manasota Water Suppliers Assoc. Education Program
24.	Plant City - Leak Detection/Water Audit
25.	Sydney - Three Star Farms - Drip Irrigation
26.	Lakeland - Leak Detection Survey
27.	Largo - Sparkling Water System - Reclaimed Waste Water
28.	Sarasota - Reverse Osmosis Membrane Testing
29.	St. Petersburg - Irrigation System Designed for Reclaimed Water
	MINIMUM FLOWS PROJECT
30.	Pithlachascotee River
31.	Anclote River
32.	Alafia River
33.	Little Manatee River
	NOMINATED SWIM WATER BODIES
34.	Lake Tarpon
35.	Lake Thonotosassa
36.	Banana Lake
37.	Tampa Bay
38.	Charlotte/Placida Harbors

WETLANDS

Wetlands can be defined as natural communities where lands transitional between terrestrial and aquatic systems are saturated or covered with shallow water for a significant part of the year (Anderson and others, 1976). Wetlands are of major importance to the hydrologic regime of the SWCFGWB. In the context of ground-water quantity and quality it is important to discuss management benefits that wetlands provide: water quality improvement, flood control, and recharge and discharge.

One of the most significant roles of wetlands is their ability to remove pollutants. They filter out and absorb many pollutants such as water borne chemicals and nutrients. Through biochemical processes in wetlands, some pollutants may be converted to more innocuous forms (U.S. Congress 1984). Wetlands also remove suspended solids and act as a siltation trap. The efficiency of wetlands to improve the quality of water varies with the vegetative life forms of wetlands, as well as chemical, hydrogeological, and soil influences. The improved water leaving the wetlands moves either into the ground or to another surface-water body.

Flood control benefits of wetlands have been well documented for those wetlands that are part of a stream or river system (Sather and Smith, 1984). Wetlands provide temporary storage of floodwater thereby reducing flood crests and velocity which lower the destructiveness of severe floods. The degree of attenuation is associated with both type and size of wetland, as a greater surface water area results in a greater detention storage and, consequently, lower flood peaks (USEPA, 1983). By providing storage and slowing the velocity of flood waters, wetlands reduce the erosive forces and promote settlement of suspended solids.

Some wetlands play a role in recharge, but most wetlands in Florida are situated in the low-lying areas that are discharge areas of the ground-water system. In the hydrologic budget of a wetland, surface storage fluctuates in response to infiltration capacity, which in part depends upon soil type, soil moisture content, evapotranspiration, and level of the water table. Recharge results from the vertical movement of water through the soil and seepage through the confining layers. The slow movement and resulting long detention time in a wetland facilitates infiltration and during high flow maintains a ready supply of water in excess of that evapotranspired or discharged. However, the abundant organic litter found in wetlands inhibits infiltration, and many wetlands are underlain by virtually impermeable clay layers that severely restrict ground-water recharge.

Ecologically wetlands are complex transitional systems between aquatic and terrestrial environments. Wetland environment range from coastal wetlands, freshwater marshes and forested swamps. Each type of wetland has a unique and essential habitat for a diversity of plant and animal life (Wharton and others, 1977).

Coastal mangrove swamps are shallow tidal areas that provide habitat for numerous wading birds and other wildlife species. Biologically, the waters are rich and productive. Mangrove estuaries serve as habitat and nursery grounds to sports and commercial fisheries. The flow of freshwater through coastal wetlands creates ground-water pressure that prevents saltwater intrusion coastal marshes provide storm protection to inland areas by absorbing wave and storm energy. Wetlands vegetation also serves as a buffer against shoreline erosion. The brackish and saltwater coastal marshes are dominated by cordgrass, needlerush, saltgrass, and glassworts. Coastal wetland forests are interspersed among the marshes and contain red cedar, cabbage palm, and salt-tolerant shrubs.

The freshwater forested wetlands generally occupy the floodplains and swamps of the major riverine systems. This vegetative community is also predominate with the area known as the Green Swamp, a portion of which occurs within the SWCFGWB. The dominant tree species of the forested wetlands include Cypress, Tupelo, Black Gum, Red Maple, and Sweetgum. The riverine swamps and floodplains have been described as providing free flood control and pollution assimilation benefits to downstream areas. The Green Swamp area is itself an indispensable element by providing enormous water storage capacity and forming SWFWMD's three major riverine systems (Withlacoochee, Hillsborough, and Peace rivers).

Wetlands offer unspoiled, open space for the aesthetic enjoyment of nature as well as well as activities such as hiking, fishing, hunting, photography, and environmental education.

The freshwater marshes and wet prairies are also associated with the riverine systems, but occur frequently as isolated communities within upland vegetative association. Freshwater marsh communities have a diverse variety of landscape signatures, but predominant plants include: Maidencanes, Sawgrass, Arrowhead, and Duck Potato. Wet prairies include the above mentioned plants plus Spikerushes and Beakrushes.

Hampson (1984) calculated the total number of surface acres that wetlands occupied in each county in Florida for the period of 1972-1974. A breakdown of this data within the counties encompassing the SWCFGWB is as follows:

TABLE 9. WETLAND ACREAGE IN THE SWCFGWB.

COUNTY	COUNTY AREA (IN ACRES)	ESTIMATED COUNTY AREA W/I SWCFGWB (IN ACRES)	ESTIMATED % OF ACRES W/I SWCFGWB	ESTIMATED AREA OF WETLANDS (IN ACRES)
CHARLOTTE	521,623	521,623	100.0	84,659
DESOTO	407,721	407,721	100.0	48,749
GLADES	632,632	173,644	27.4	41,759
HARDEE	408,850	408,850	100.0	65,473
HIGHLANDS	707,836	380,040	53.7	47,224
HILLS.	685.490	685,490	100.0	75,090
LEE	655,366	243,827	36.6	44,898
MANATEE	494,130	317,079	65.7	59,478
PINELLAS	200,465	200,465	100.0	16,141
POLK	1,283,740	843,203	65.7	143,164
SARASOTA	388,528	388,528	100.0	28,921
TOTALS	6,905,823	5,080,512	73.6	702,328

The total estimate of forested and non-forested wetlands within the SWCFGWB can be conservatively stated as 1,015,987 acres. This value reflects data determined using level I categories (the most generalized categories for use on a nationwide, interstate, or statewide basis and are further explained in Anderson and others, 1976). Note that the estimated area of wetlands for those counties that were only partly contained by the boundaries of the NWCFGWB were calculated as multiplying the estimated percentage the county within the SWCFGWB by the total wetland acreage value appearing in the Hampson (1984) report. For the techniques used to determine these initial values, please refer to Hampson, 1984.

This information was collected for the period 1972-74, and is presented for historical purposes only. It should not be construed for current condition as development and population growth since 1974 has resulted in a reduction of the state's wetland inventory.

Currently, efforts are underway to assist in mapping the wetlands as they exist today. Hernando County, for example, has recently obtained a comprehensive land cover map from LANDSAT imagery. Other data bases include the United States Fish and Wildlife Service's National Wetlands Inventory, (USFWS, 1986), which prepared large scale maps of the entire state. Most of the counties within the SWFWMD are now available. The SWFWMD is embarking on a detailed 3-year mapping project designed to locate every wetland area within its boundary and create small scale maps for use in planning and protection. All of the aforementioned data bases now, or will in the future, serve a role in identifying and protecting wetland ecosystems within the SWFWMD.

In summarizing, the relationship of wetlands and ground-water availability, it can be said that one of the primary functions of the wetland areas within the SWCFGWB is discharge of ground water, rather than recharge. The relative dependency of the wetlands on this discharge cannot be overstated. The associated hydrological, water quality, habitat, and socii-economic attributes of wetland environments strengthens their importance in the protection, development, and maintenance of any water resource, both surface and ground related.

SECTION THREE

DISCUSSION OF THE HYDROLOGY AND RELEVANT GROUND-WATER BASIN RESOURCE AVAILABILITY INVENTORY ISSUES OF CHARLOTTE COUNTY, FLORIDA

III. CHARLOTTE COUNTY OVERVIEW

GEOGRAPHIC SETTING, PHYSIOGRAPHY, TOPOGRAPHY, AND DRAINAGE

Charlotte County is located on the coast of southwest Florida. It is bounded on the west by the Gulf of Mexico, on the north by Sarasota and DeSoto Counties, on the east by Glades County, and on the south by Lee County (Figure 53). Charlotte County has a surface area of approximately 832 square miles which includes 129 square miles of inland surface-water area. Land surface altitudes range from sea level at the coast to a maximum of 74 feet above NGVD in the northeast corner of the county (Figure 54).

White (1970) delineated four major physiographic provinces in Charlotte County: the Gulf Barrier Chain, the Gulf Coastal Lowlands, the Caloosahatchee Incline, and the DeSoto Plain (Figure 54). The physiographic areas are primarily a function of topographic relief and underlying sediments.

The Gulf Barrier Chain is a system of barrier lagoons and islands that were formed by erosion of headlands and sediment transport along shore by waves. The barrier island chain is very dynamic and the inlets are prone to shifts in position. The barrier island chain consists of clean sand and shell deposits. The coastal pine flatwoods are sparse and generally elevations are less than 15 feet.

The Gulf Coastal Lowlands is a low-lying area which covers most of Charlotte County. As described by White, the Gulf Coastal Lowlands is a broad, gently sloping marine plain that is characterized by karst flatlands with many sloughs and swampy areas. Land-surface altitudes range from sea level near the coast to about 35 feet above NGVD at the toe of the Caloosahatchee Incline, in the northeast part of the county. Generally, the Gulf Coastal Lowlands are covered with unconsolidated sand which becomes increasingly clayey with depth. Organic soils generally overlay wetland areas.

The Caloosahatchee Incline is a transition zone between the Gulf Coastal Lowlands and the DeSoto Plain. It marks a steeper incline which elevations range from 35 feet above NGVD at the toe to 60 feet at the crest. Underlying sediments generally consist of sands deposited at the down-current end of a submarine shoal.

A portion of the DeSoto Plain lies in the northeastern and eastern part of Charlotte County. This province is characterized by wet prairie, cypress swamps, and flatwoods. A sloping plain from about 60 to 74 feet in elevation marks a change in nature of the topography left by the regression of the Gulf of Mexico. Soils are somewhat poorly drained with shallow sediments overlying organic hardpans.

Charlotte County is drained by a few major rivers and an extensive system of canals (Figure 55). Most of the streams and canals in Charlotte County drain into Charlotte Harbor or into the Caloosahatchee River, in Lee County. The Myakka River, Peace River, Prairie Creek, Shell Creek, Alligator Creek, Myrtle Slough, and Cypress Slough drain into Charlotte Harbor. Trout Creek, Big Island Canal, and Jacks Branch drain into the Caloosahatchee River. The majority of surface-water runoff in Charlotte County occurs as

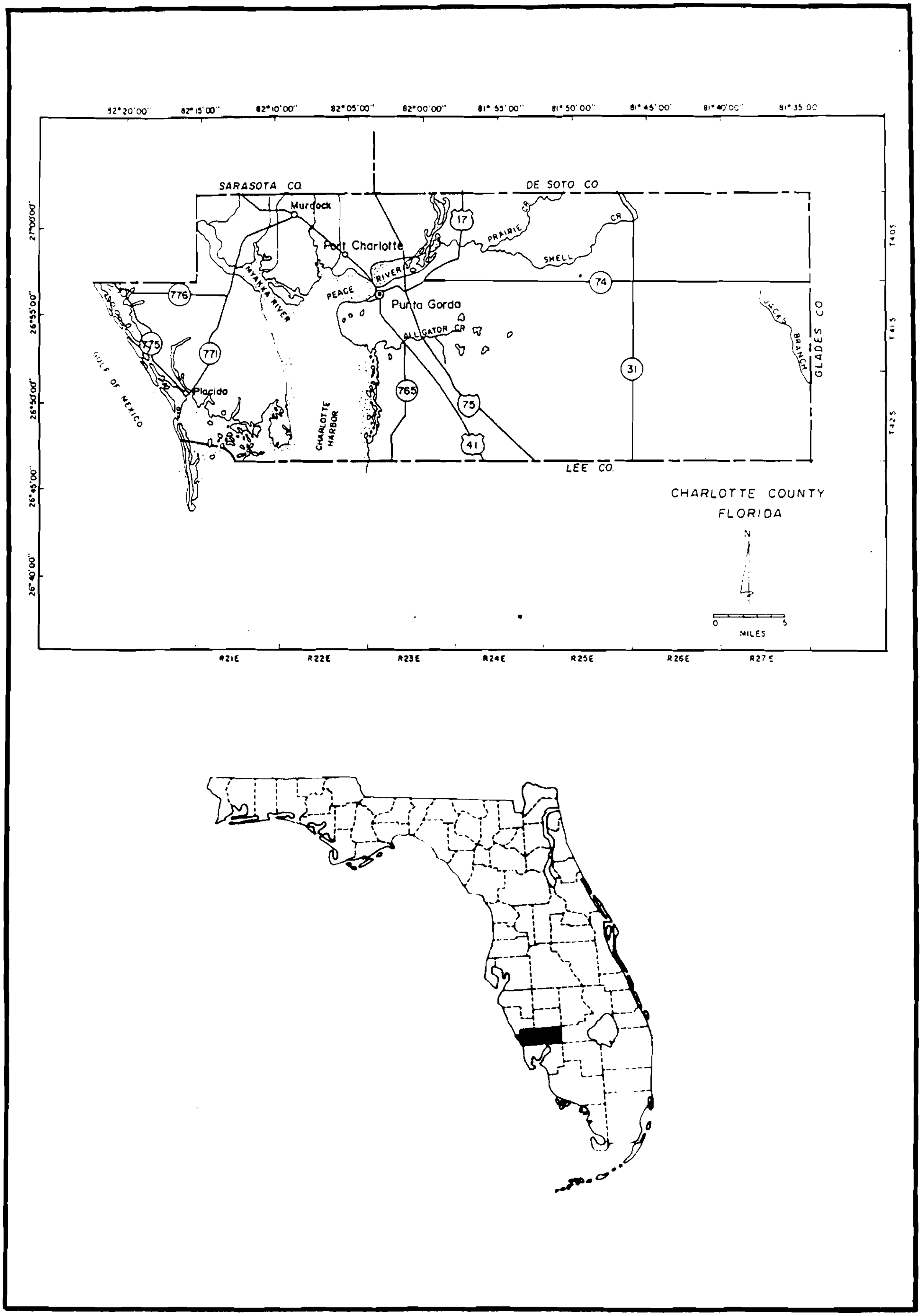


Figure 53. Charlotte County location map.

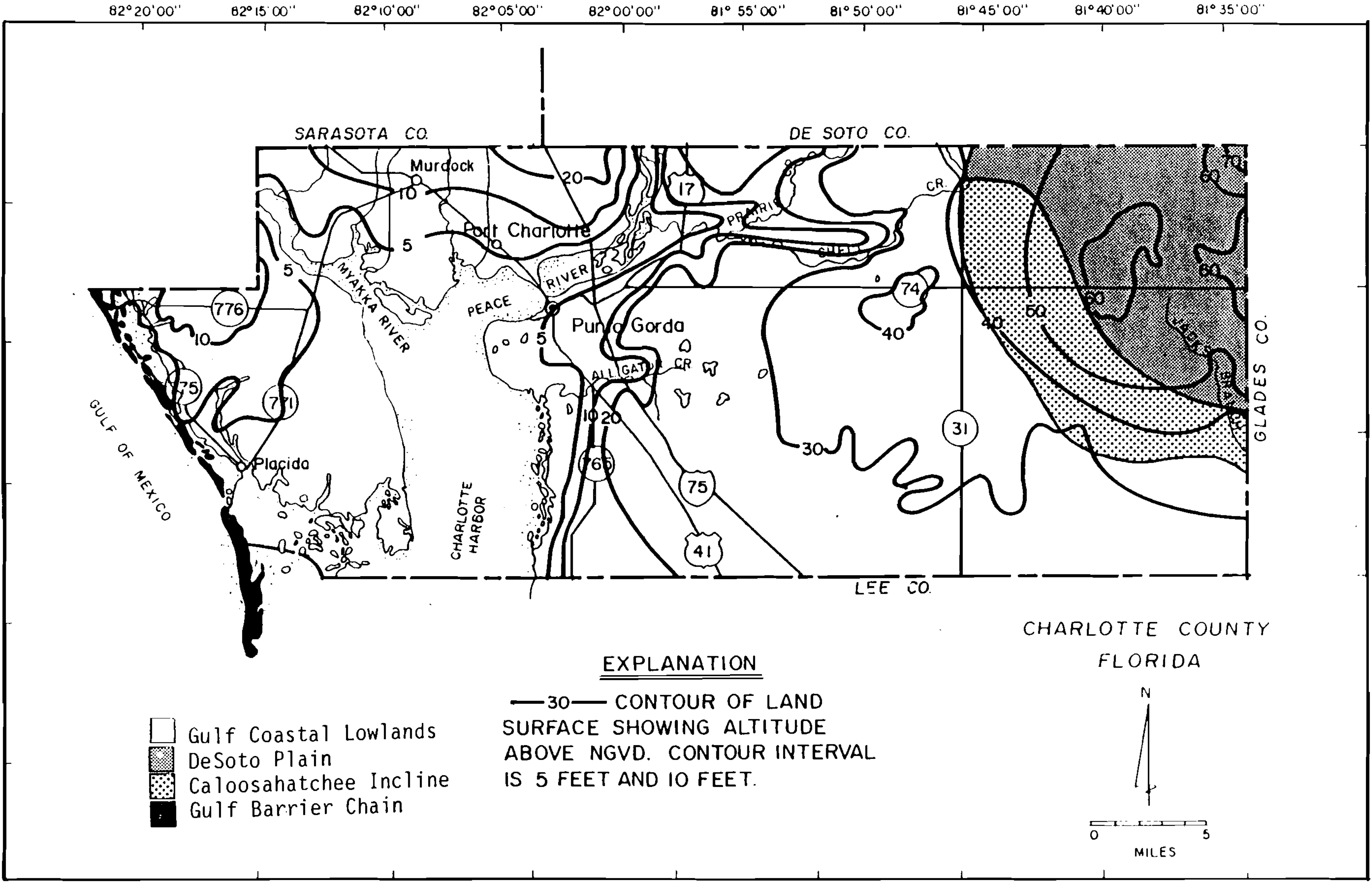


Figure 54. Physiographic sub-divisions (from White, 1970) and topography of Charlotte County.

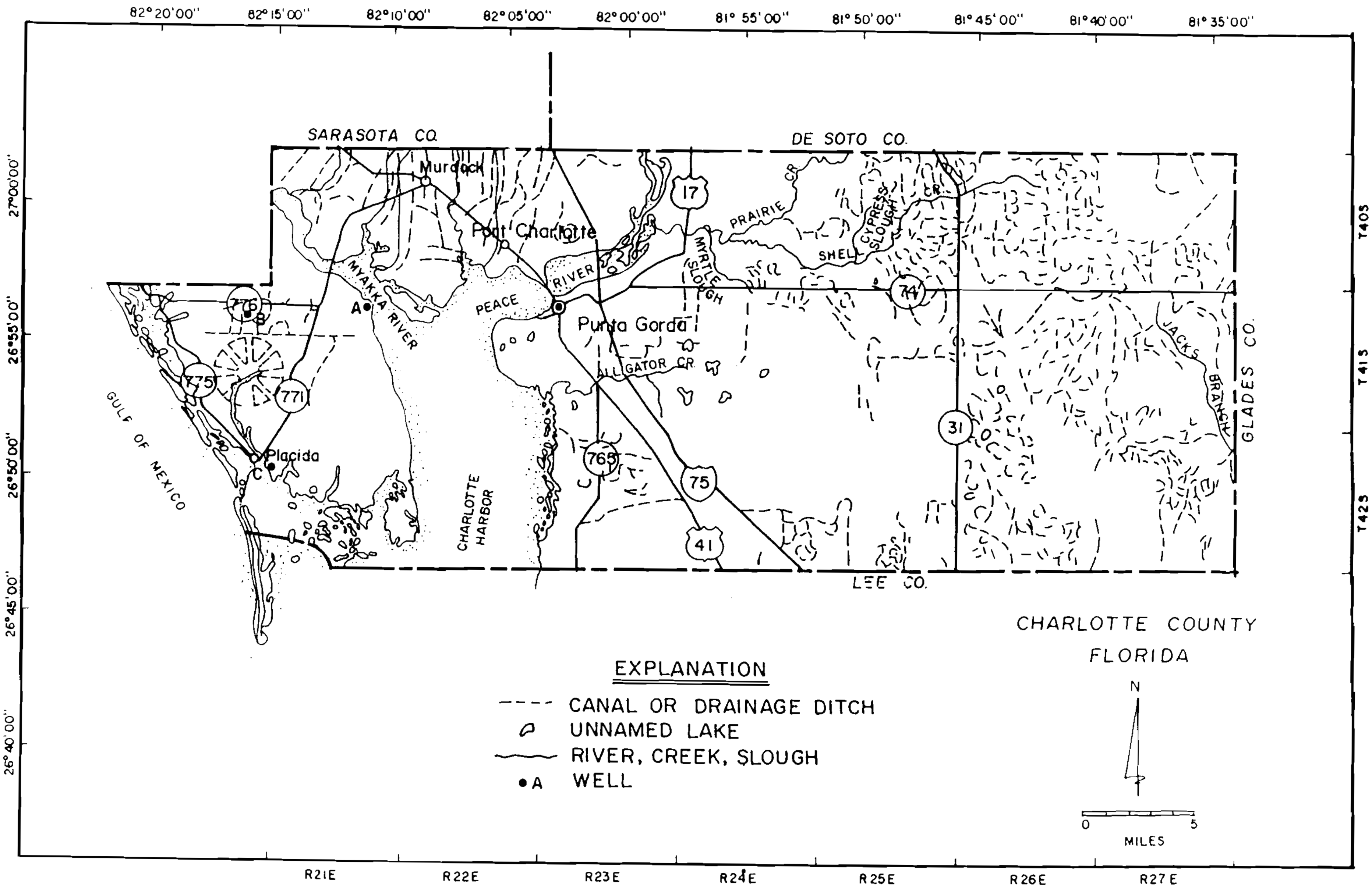


Figure 55. Major surface water features in Charlotte County.

overland flow due to flat topography and near-surface water table conditions. Rain fills the unsaturated zone between the water table and the ground surface and flows in "sheets" to drainage canals, ponds, sloughs, and swamps.

CLIMATE

The climate of Charlotte County is humid sub-tropical, characterized by high mean annual rainfall and temperature. Warm humid summers and mild winters are the result of the low latitude and the stabilizing affect of the Gulf of Mexico and the Atlantic Ocean.

Data collected by the National Weather Service indicate that the mean annual air temperature in the county is about 74°F. The annual means at the various temperature recording stations in the area are all within 1.2°F of the areal mean. Mean daily temperatures range from 82°F in August, to 64°F in January. Temperatures below 32°F may occur about two to four times each winter; the frequency depends upon the location within the area. Along the coast, temperatures are slightly higher in the winters and lower in the summers than they are in the interior, due to the moderating effect of the Gulf of Mexico.

Figure 56 shows the historic median, mean monthly, and annual rainfall at the Punta Gorda National Weather Station, located in Charlotte County. The average annual rainfall for 65 years is 50.4 inches. Average annual rainfall ranged between 30.0 inches in 1927, and 88.1 inches in 1947. Rainfall shows a marked seasonal distribution; about 60% of the annual rainfall occurs in June through September (Figure 56). Most of the summer rainfall is associated with convective thunderstorms that are usually localized, of short duration, and produce high-intensity rainfalls. Tropical depressions and hurricanes may produce heavy rainfall lasting several days during the summer and fall.

The dry season is from October to May. Often, in the late spring, no measurable rainfall will occur for 60 days or more. During the dry season, the irrigation of row crops and citrus and also the period of peak tourism occurs in this area. Therefore, October to May is the time of high water use and consumption.

GEOLOGY

Charlotte County is underlain by several thousand feet of limestone and dolomite with interbedded layers of evaporitic deposits. These deposits are overlain by marine and non-marine sand, silts, and clays. Regionally, these sediments form a wedge that thickens from central Florida southwest beneath Charlotte County.

The fresh-water bearing units underlying Charlotte County range in thickness from about 2,200 to 2,500 feet and thicken to the southwest. Below these depths, vertically persistent evaporites occur which fill pore spaces, restricting ground-water flow and reducing ground-water quality. The hydrogeologic discussion is limited to the lithologic units above this depth. Most of the hydrogeologic discussion is based on Wolansky's 1983 report entitled, "Hydrogeology of the Sarasota-Port Charlotte Area, Florida".

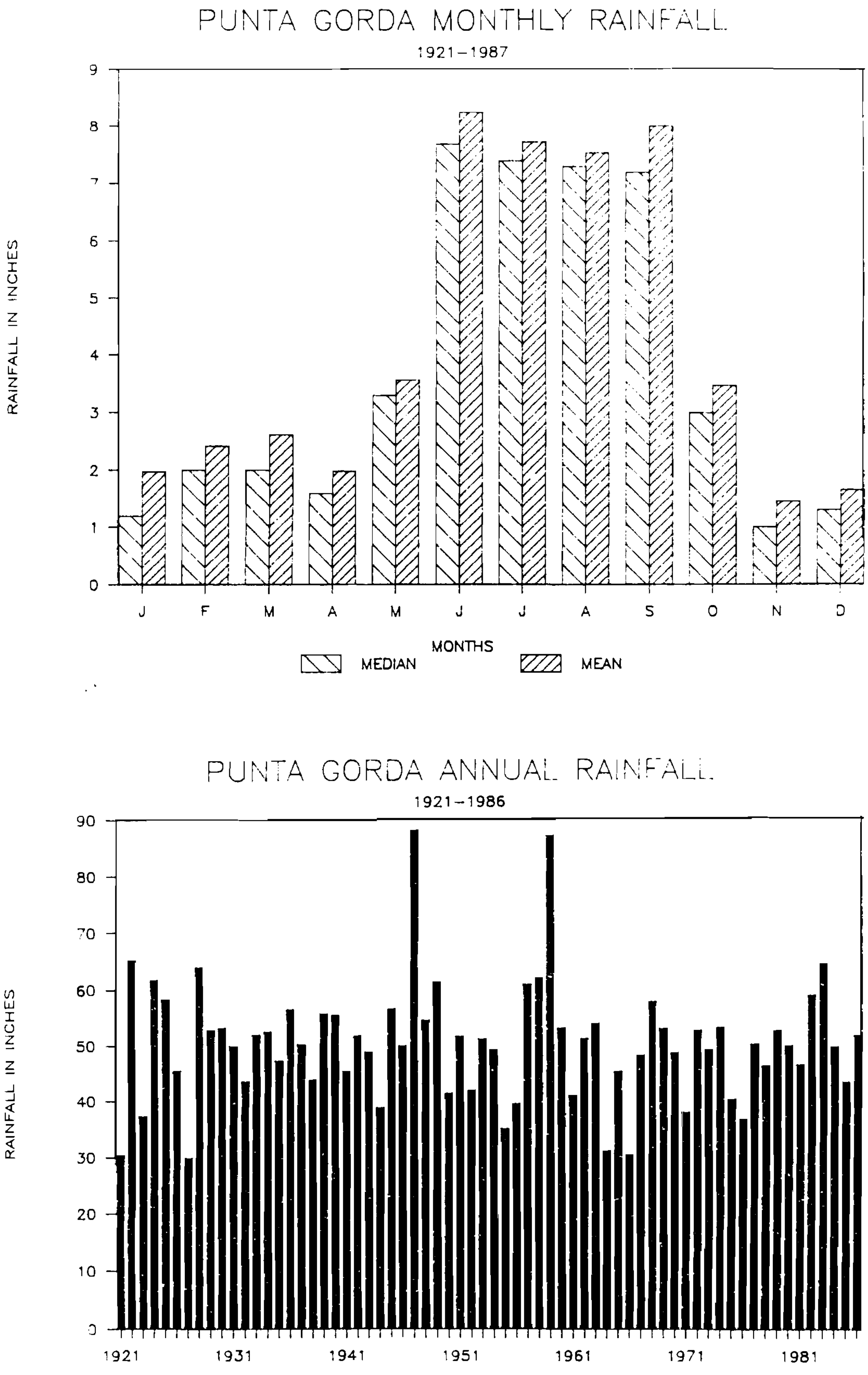


Figure 56. Mean and median monthly and total annual rainfall at Punta Gorda (from SWFWMD database, 1987)

The formations that comprise the fresh-water bearing hydrogeologic framework in Charlotte County in descending order are the undifferentiated surficial deposits, Caloosahatchee Marl, Tamiami Formation, Hawthorn Formation, Tampa Limestone, Suwannee Limestone, Ocala Limestone, and the Avon Park Formation. These formations were sequentially deposited in shallow transgressive and regressive seas during interglacial periods. Additional processes of physical and chemical weathering has formed the karst landscape of Charlotte County as it is today.

The lithologic descriptions, unit thicknesses, and stratigraphic relationships of these units are listed in Table 10. Geologic cross-sections, which illustrate the vertically and lateral variability of the units in Charlotte County, are shown as Figure 57. Additionally, the surficial geology of Charlotte County is depicted in Figure 10.

Unnamed Holocene deposits consist of surficial sand, shell, and alluvium. These deposits are present throughout most of the area and may be as much as 20 feet in thickness. Pleistocene terrace deposits unconformably underlie the Holocene sand and alluvium. The terrace deposits are predominantly fine to medium, well-sorted, pale yellow-orange sand with some clay and shell. Thickness and areal distribution of the terrace deposits are more variable than the Holocene deposits. They range from zero to 40 feet in thickness.

The Caloosahatchee Marl of Pliocene and Pleistocene age unconformably underlies the terrace deposits. Typically, the Caloosahatchee Marl sediments consist of unconsolidated shell beds; light gray, sandy, shelly marl; and thin beds of hard, sandy limestone. The Marl varies laterally from very shelly to very sandy and silty, and ranges from zero to 40 feet in thickness.

The Tamiami Formation of Pliocene age consists of clayey, sandy, phosphatic limestone. In general, the upper-most part of the Tamiami Formation is a calcareous, nearly impermeable clay throughout Charlotte County. This clay is a confining layer that forms the base of the surficial aquifer in the county. It ranges in thickness from 0 to 100 feet and averages about 50 feet thick.

The Hawthorn Formation of Middle Miocene age unconformably underlies the Tamiami Formation. Sutcliffe (1975) divides the Hawthorn formation into an upper and lower unit. The upper Hawthorn ranges in thickness from 70-260 feet. The upper Hawthorn consists principally of beds of sandy, phosphatic limestone, dolomite and chalky to granular phosphatic marl and clay. The lower Hawthorn ranges in thickness from 50-130 feet. The lower Hawthorn is usually a more dolomitized and crystalline limestone with less clayey sand and sandy clay than the upper part.

The Tampa Limestone of early Miocene age is a granular phosphatic limestone with varying amounts of interbedded sand and clay. Its thickness ranges from 90 to 450 feet. The Suwannee Limestone of Oligocene age is a granular limestone that ranges from 140 to 450 feet in thickness. The Ocala Limestone of late Eocene age is a relatively pure limestone that grades into a dolomite near the bottom. It is about 400 feet thick. The Avon Park of middle Eocene

Series	Stratigraphic unit	Hydrogeologic unit	Thickness (feet)	Lithology
Holocene Pleistocene	Undifferentiated sediments	Surficial aquifer	0-60	Nonmarine, light gray to yellow, fine- to medium-grained quartz sand; underlain by marine terrace deposits of sand and marl, including clay, shell, and peat deposits.
Pliocene	Caloosahatchee Marl		0-50	Shallow marine, gray, tan, or cream, unconsolidated, sandy marl, marl, and shell beds; hard, sandy limestone; some phosphate.
	Bone Valley Formation		0-20	Mostly nonmarine, very light gray to gray, clayey sand and sandy clay with lens-like beds of light gray, fine- to medium-grained quartz sand with a considerable amount of land vertebrate fossil fragments, some marine fossil fragments, phosphate nodules, and quartz pebbles.
	Tamiami Formation	Confining bed Tamiami-upper Hawthorn aquifer	0-150	Shallow marine, green to gray, sandy, calcareous clay, gray marl, gray sandstone, and slightly consolidated tan to light gray limestone; all units contain some phosphate.
Middle Miocene	Hawthorn Formation	Confining bed	200-400	Marine, interbedded layers of buff, sandy, clayey, phosphatic limestone and dolomite; gray, fine to medium sand; gray to greenish-blue sandy clay with abundant phosphate nodules.
Lower Miocene	Tampa Limestone	Lower Hawthorn-upper Tampa aquifer Confining bed	150-300	Marine, white to light gray, sandy, often phosphatic, clayey limestone, silicified in part, with many molds of pelecypods and gastropods; often interbedded with light gray clay and sandy clay. A residual mantle of green to greenish-blue, calcareous clay is often developed.
Oligocene	Suwannee Limestone		200-300	Marine, cream to buff, often soft, granular limestone composed of loosely cemented foraminifers.
Upper Eocene	Ocala Limestone	Upper Floridan aquifer	200-300	Marine, white to cream, often soft and finely granular limestone, grading near the bottom into tan limestone with beds of grayish-brown dolomite.
Middle Eocene	Avon Park Limestone		600-700	Marine, cream to tan, soft to hard, granular to chalky, highly fossiliferous limestone interbedded with grayish-brown to dark-brown, highly fractured dolomite; some carbonaceous and clayey zones; some intergranular gypsum and anhydrite near the bottom in places.
	Lake City Limestone	Lower confining bed	300-500	Marine, cream to tan, slightly carbonaceous and cherty limestone and grayish- to dark-brown dolomite; both with varying amounts of intergranular gypsum and anhydrite.

Table 10. Generalized stratigraphic section and hydrogeologic description (from Wolansky, 1983).

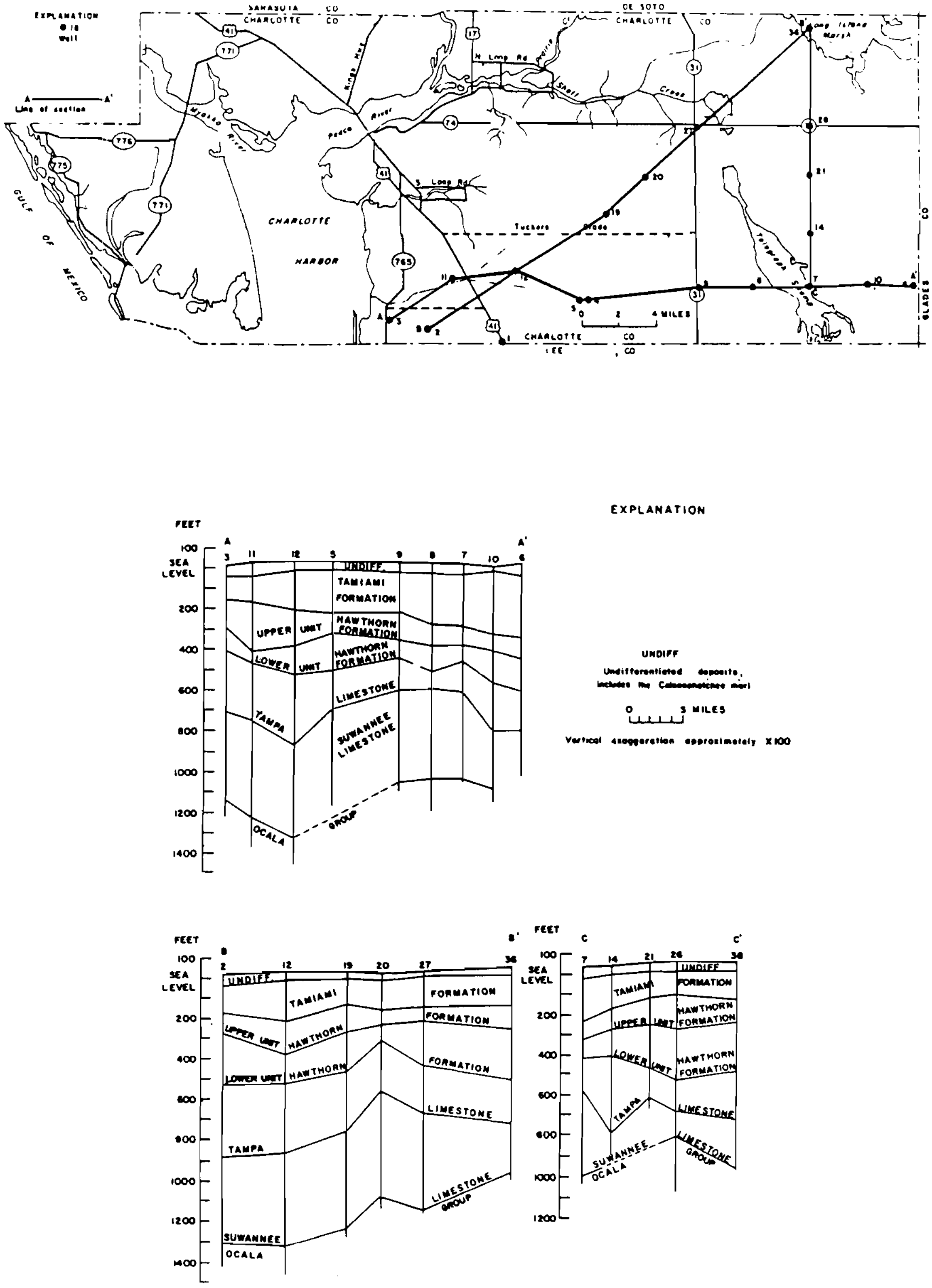


Figure 57. Generalized geologic cross section of Charlotte County (from Sutcliffe, 1975).

age consists primarily of limestone interbedded with dark brown, highly fractured dolomite that is about 500 feet thick.

SOILS

The general soils map for Charlotte County depicts five broad divisions as follows:

1. moderately well drained
2. somewhat poorly drained
3. poorly drained
4. poorly drained and very poorly drained
5. very poorly drained

Each area outlined in Figure 58 consists of more than one type of soil; therefore this figure is intended for general planning purposes (refer to USDA Soil Conservation Service publication "Soil Survey of Charlotte County, Florida" for a detailed description of soil types in the county).

Moderately well-drained soils occur in low ridge areas near Prairie Creek and Alligator Creek. The soil map unit in this division is Orsino-Daytona. Natural vegetation is oak, south Florida slash pine, and saw palmetto.

Somewhat poorly drained soils occur in various man-made (filled) areas around Charlotte Harbor. The soil map unit is Matlacha. Most of the natural vegetation has been removed. The existing vegetation consists of scattered South Florida slash pine and various native grasses.

The most extensive soils found in Charlotte County are poorly drained soils which occur in flatwoods and sloughs. Soil map units in this division include the following: Hallandale-Wabasso-Boca, Wabasso-Pineda-Boca, Immokalee-Myakka, Malabar-Oldsmar-Immokalee, Heights-Felda-Oldsmar, Oldsmar-Myakka, and Wabasso-Isles-Boca. Natural vegetation is South Florida slash pine, saw palmetto, pineland threeawn, and wax myrtle.

Poorly drained and very poorly drained soils occur in the Telegraph Swamp and Long Island Marsh areas. Soil map units in this division are the Pineda-Floridana-Gator and the Chobee-Felda-Pineda. A wide variety of natural plants occur in these swampy areas. On the sloughs, the vegetation is pineland threeawn, panicums, sedges, maidencane, wax myrtle, South Florida slash pine, and scattered clumps of saw palmetto. Natural vegetation on the depressions is cypress, pickerelweed, sedges, sawgrass, and other water-tolerant plants.

Very poorly drained soils occur in tidal areas of Charlotte Harbor and the Peace River, and on barrier islands along the Gulf of Mexico. The soil map units in these areas are Kesson-Wulfert-Canaveral and Peckish-Estero-Isles. Natural vegetation in the tidal areas is mangrove; on the ridges is cabbage palms, seagrapes, and various grasses and scrubs; and in the marshes is seashore saltgrass, batis, and sea-oxeye.

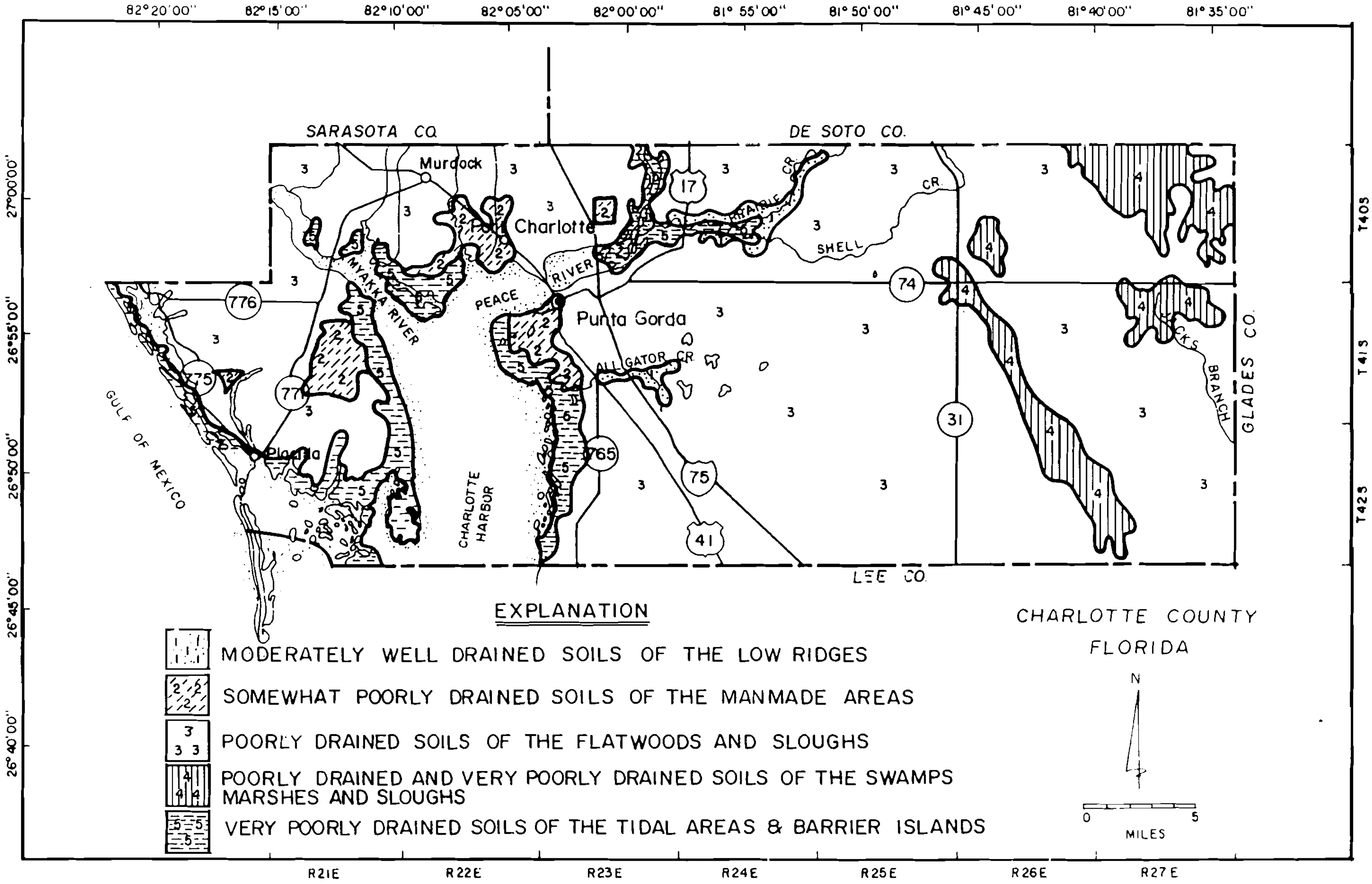


Figure 58. Generalized soils map of Charlotte County.

POPULATION, DISTRIBUTION AND PROJECTIONS

Charlotte County has been experiencing one of the fastest rates of population growth in the state. Between 1970 and 1980, Charlotte County's population grew from an estimated 27,559 to 58,460, an increase of 112 percent (U.S. Bureau of the Census). This rate of population growth ranked eighth in the state. In comparison, the population for the State of Florida grew from 6,791,418 to 9,747,197 during the same time period, an increase of 43.5 percent. The Bureau of Economic and Business Research estimates the 1985 Charlotte County population at 78,475 (Smith and Sincich, 1986). This represents an increase of 34.24 percent over the 1980 total.

The estimated distribution of the 1980 and 1985 Charlotte County population is represented by Figure 59. This figure shows that Charlotte County's population is concentrated in the coastal areas in and around the cities of Port Charlotte and Punta Gorda. During the past five years, the majority of the population growth for the county has taken place in these areas.

Population projections for Charlotte County are taken from the 1985 Florida Statistical Abstract (Bureau of Economic and Business Research, 1986). These projections are displayed in graph form in Figure 60 and generally show that the population of Charlotte County is expected to increase substantially in the future.

HYDROLOGY OF THE COUNTY

Several hydrologic investigations have included Charlotte County within their study area. These studies include the following: Sutcliffe's (1975) appraisal of the water resources of Charlotte County; Wolansky's (1978) study of water-supply development from the unconfined aquifer in Charlotte County; Geraghty and Miller's (1982) appraisal of potential for water supply development in the Port Charlotte Region; Wolansky's (1983) description of the hydrogeology of the Sarasota-Port Charlotte area; and Miller's (1986) description of the hydrogeologic framework of the Floridan aquifer system in Florida and parts of Georgia, South Carolina, and Alabama.

Surface Water

Major surface-water drainage features in Charlotte County are the Peace River, Myakka River, and Shell Creek which all drain into Charlotte Harbor. Each of these flows is tidally influenced, therefore, streamflow is measured in their upper reaches. The Peace River, near Arcadia, has an average flow of 1,126 cfs during the period from 1931-1985. The Myakka River, near Sarasota, has an average flow of 248 cfs for the period 1936-1985. Shell Creek, near Punta Gorda, has an average flow of 338 cfs for the period 1965-1985.

Most surface-water runoff in Charlotte County occurs as overland flow due to the flat topography and near-surface water table conditions. Heavy rainfall fills the unsaturated zone between the water table and ground surface and flows in "sheets" to drainage canals, ponds, sloughs and swamps. The Telegraph Swamp and Long Island Marsh drain south to the Caloosahatchee River in Lee County. Hundreds of miles of canals have been excavated in the interior part

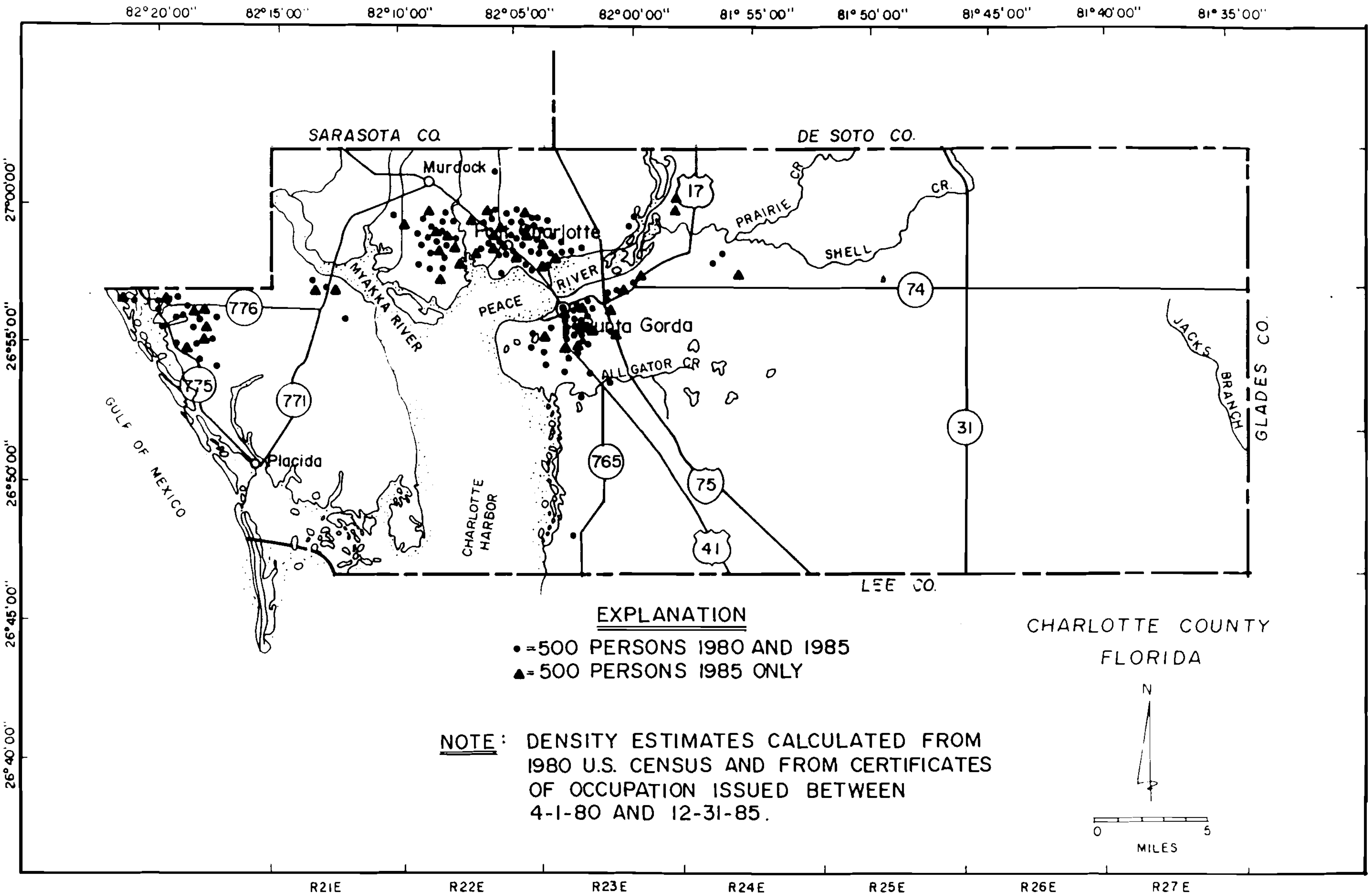


Figure 59. Estimated 1980 and 1985 population density of Charlotte County.

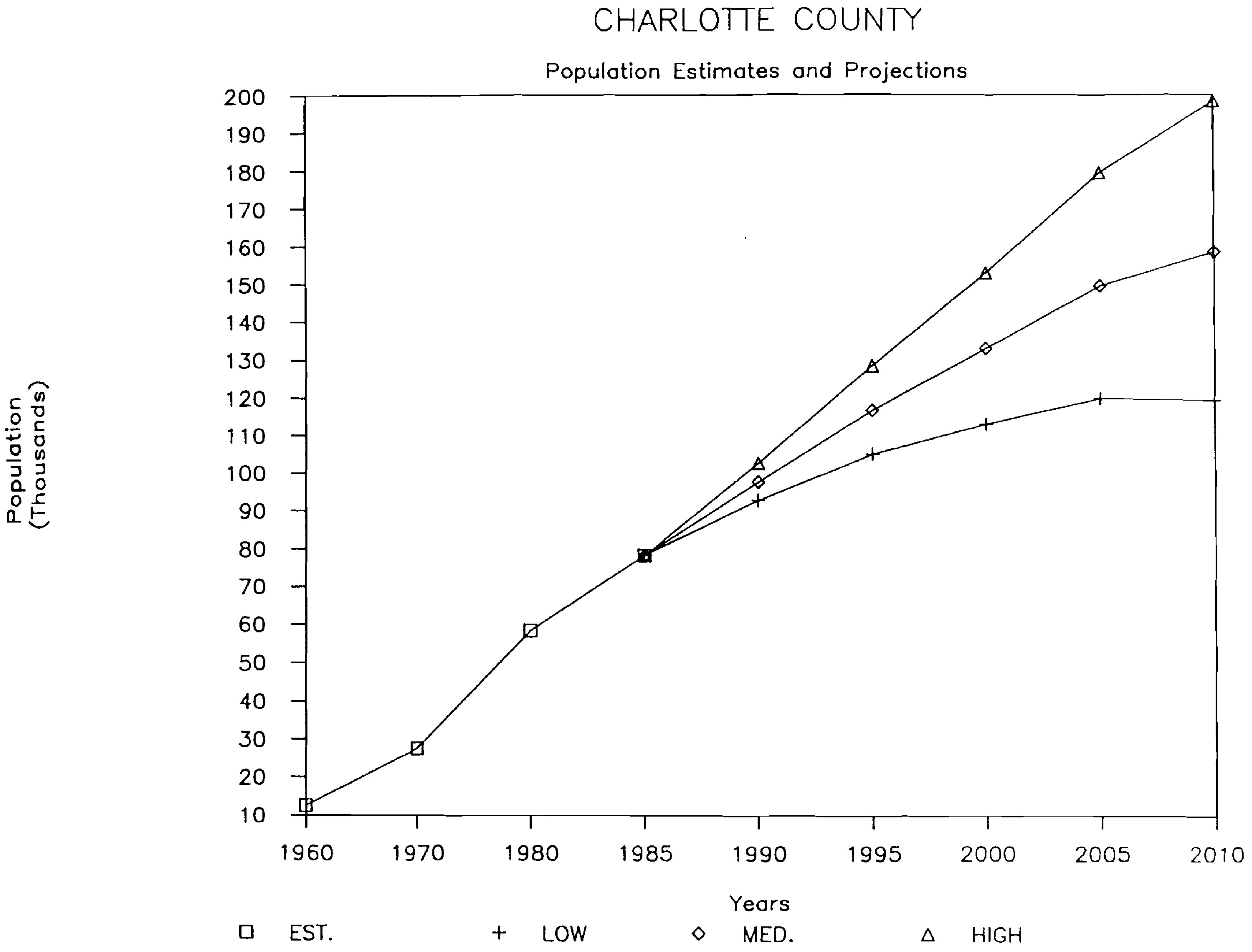


Figure 60. Population estimates through year 2010 for Charlotte County.

of the county to drain agricultural land and urbanized areas, such as Rotunda West and Punta Gorda have planned drainage canal systems. Charlotte County has a multitude of intermittent ponds, but only a few perennial lakes. Surface-water features are shown in Figure 55.

Surface-Water Quality

In the coastal areas, the chloride concentration of all tidal affected streams generally exceeds potable use limits. Water quality data for upper Shell Creek is listed in Table 11. During the spring dry season, most of the streamflow is maintained by ground water which may increase dissolved solids, sulfate, chloride, and hardness concentrations of stream water.

Surface-Water Use

The 1987 Water Use Estimates of the SWFWMD (Stieglitz, 1987) show that Charlotte County uses surface-water sources for 24 percent of all water used in the county. Most of this water is imported from adjacent counties and is primarily used for public supply purposes. This includes an average of 6.78 Mgal/d, imported by General Development Utilities, which is distributed to other various county utilities.

SPRINGS

There are no true springs in Charlotte County according to Rosenau and others (1977). An artesian well has been identified by the public as the "Hot Springs." This deep artesian well was discharging water at a rate of 2,750 gal/min and a temperature of 96°F in November of 1965.

GROUND WATER

Wolansky, (1983) described four fresh-water bearing aquifers in Charlotte County: the surficial aquifer, two intermediate aquifers (Tamiami-upper Hawthorn and lower Hawthorn-upper Tampa aquifers), and the Floridan aquifer. The aquifers are consistent with the surficial, intermediate, and Floridan aquifer system as defined by the Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition (1984), and are described below.

Surficial Aquifer

The surficial aquifer system, as defined by the Ad Hoc Committee (1984) is the "permeable hydrogeologic unit contiguous with land surface that is comprised principally of unconsolidated to poorly indurated clastic deposits". In Charlotte County, the aquifer consists primarily of permeable units in the undifferentiated surficial deposits, and the Caloosahatchee Marl (Table 10). Permeable units near the top of the Tamiami Formation, where present, may be hydraulically connected to the surficial aquifer system. The surficial system is generally unconfined; however, lenses of sand, marl, and limestone contain water under semi-confined conditions in some areas. The thickness of the surficial system is about 100 feet throughout Charlotte County (Figure 61a). The base of the surficial aquifer system consists of clayey sand and

02298202 SHELL CREEK NEAR PUNTA GORDA, FL--

WATER-QUALITY RECORDS

PERIOD OF RECORD.--Water years 1966 to current year.

WATER QUALITY DATA, WATER YEAR OCTOBER 1985 TO SEPTEMBER 1986

DATE	TIME	GAGE HEIGHT (FEET ABOVE DATUM)	STREAM-FLOW, INSTAN-TANEOUS (CFS)	SPE-CIFIC CON-DUCT-ANCE (US/CM)	PH (STAND-ARD UNITS)	TEMPER-ATURE (DEG C)	OXYGEN, DIS-SOLVED (MG/L)
OCT 04...	1345	5.38	245	468	7.10	30.5	2.4
DEC 03...	1058	5.29	96	610	6.80	22.0	5.3
FEB 04...	1327	5.18	38	917	7.10	19.0	8.6
APR 10...	1118	5.09	41	728	7.50	22.0	5.5
JUN 13...	1340	5.21	50	915	7.30	28.5	1.0
AUG 08...	1020	5.29	186	588	7.20	29.0	2.6

DATE	NITRO-GEN, NITRITE TOTAL (MG/L AS N)	NITRO-GEN, NO2+NO3 TOTAL (MG/L AS N)	NITRO-GEN, AMMONIA TOTAL (MG/L AS N)	NITRO-GEN,AM-MONIA + ORGANIC TOTAL (MG/L AS N)	PHOS-PHORUS, TOTAL (MG/L AS P)	PHOS-PHORUS, ORTHO, TOTAL (MG/L AS P)
OCT 04...	0.00	0.05	0.04	0.0	0.19	0.15

WATER QUALITY DATA, WATER YEAR OCTOBER 1984 TO SEPTEMBER 1985

DATE	TIME	STREAM STAGE (FT ABOVE DATUM)	STREAM-FLOW, INSTAN-TANEOUS (CFS)	SPE-CIFIC CON-DUC-TANCE (US/CM)	SPE-CIFIC CON-DUC-TANCE LAB (US/CM)	PH (STAND-ARD UNITS)	TEMPER-ATURE (DEG C)	OXYGEN, DIS-SOLVED (MG/L)
OCT 10...	1320	5.14	61	463	461	6.9	25.0	7.2
DEC 06...	1030	5.22	81	780	794	6.6	22.0	5.4
FEB 07...	1350	5.11	33	967	907	7.6	22.0	6.4
APR 04...	1005	5.66	23	1060	1060	6.9	19.5	5.3
AUG 12...	1630	5.43	416	550	565	7.0	27.0	4.6

DATE	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	NITRO-GEN, NITRITE TOTAL (MG/L AS N)	NITRO-GEN, NO2+NO3 TOTAL (MG/L AS N)	NITRO-GEN, AMMONIA TOTAL (MG/L AS N)	NITRO-GEN,AM-MONIA + ORGANIC TOTAL (MG/L AS N)	PHOS-PHORUS, TOTAL (MG/L AS P)	PHOS-PHORUS, ORTHO, TOTAL (MG/L AS P)
OCT 10...	67	<.010	.01	.030	1.2	.130	.070
DEC 06...	100	.010	.10	.080	.68	.100	.070
FEB 07...	150	.010	.05	.050	.67	.080	.050
APR 04...	190	<.010	<.01	.030	.71	.080	.080
AUG 12...	85	.020	.09	.090	.65	.220	.180

Table 11. Shell Creek water quality data for water years 1985 and 1986 (from USGS, 1985, 1986).

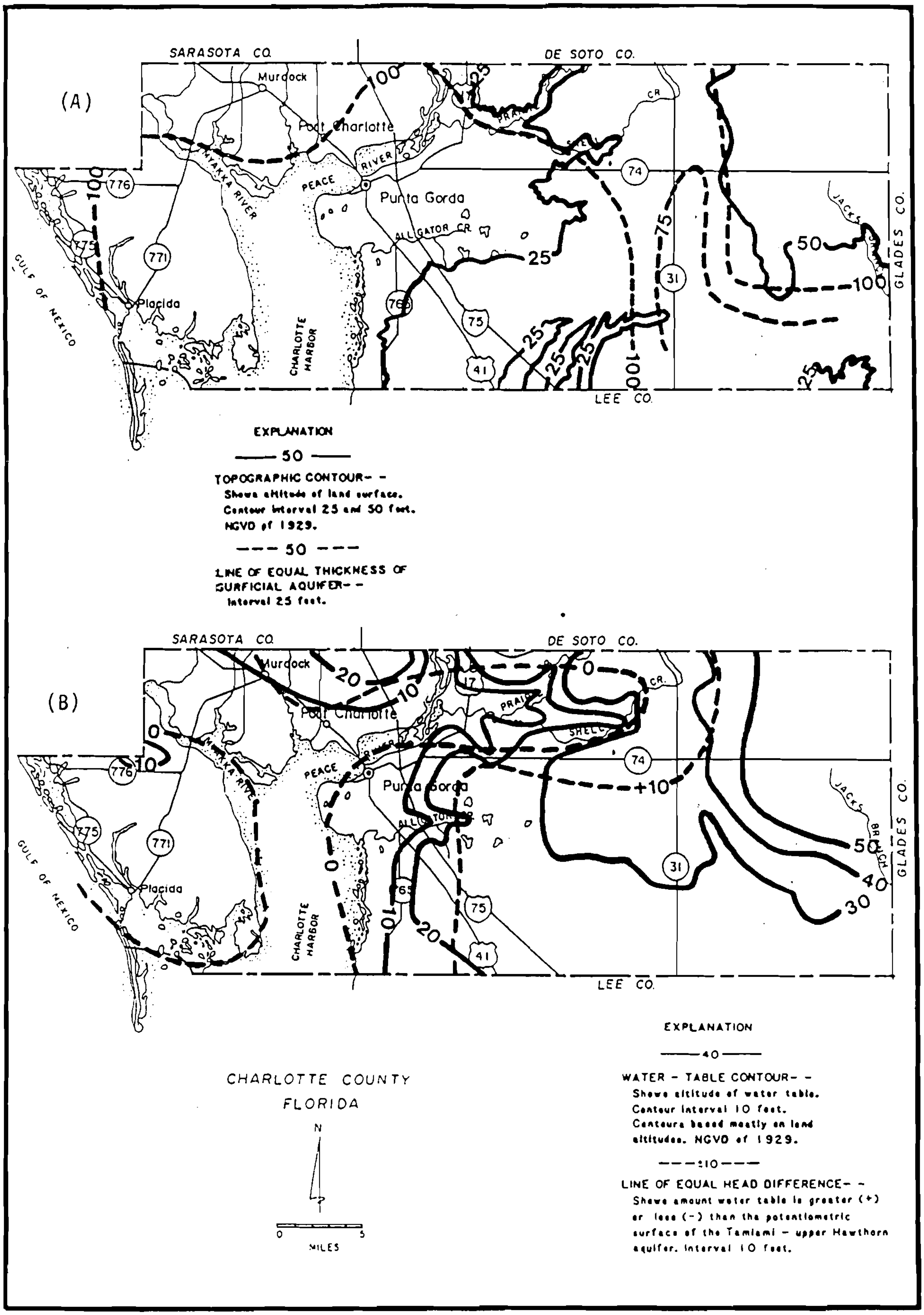


Figure 61. A,B. (A) Altitude of the top and thickness of the surficial aquifer, and (B) Altitude of the water table and adjacent head difference from the Tamiami-Upper Hawthorn aquifer (from Wolansky, 1983).

sandy clay in the lower part of the Caloosahatchee Marl or upper part of the Tamiami Formation (Wolansky, 1983).

The depth to the water table of the surficial aquifer in Charlotte County is generally less then five feet below land surface. In areas of low topographic relief and near the coast, the water table may be virtually at land surface. Fluctuations of the water table are generally seasonal and vary within about a five foot range. The lowest water table usually occurs during May or June at the end of the dry season. Water levels recover during the wet summer months to the annual high in September or October. Figure 62 illustrates the seasonal water level trend of three ROMP-10 cluster wells whose screened intervals are located in the surficial, intermediate, and Floridan aquifers separately.

The altitude of the water table ranges from sea level to greater than 50 feet above NGVD in the northeast part of Charlotte County (Figure 61b). The direction of flow of the water is downgradient and normal to the contour lines. The water generally flows west; however, this pattern is interrupted locally where the aquifer discharges into streams, lakes, or low swampy areas.

Surficial Aquifer Properties

The hydraulic properties of the surficial aquifer vary from place to place because of the large range of hydraulic conductivity of individual lithologic units (Wolansky, 1983). For four tests, in Charlotte County, transmissivity ranged from 1,325 to 5,640 ft^2/d, and specific yield determined from one test was 0.22 (Table 4 and Figure 19).

Surficial Aquifer Water Quality

Water from the surficial aquifer is generally of acceptable quality for potable use except near the coast, along tidally affected streams and canals, where seawater has intruded into the aquifer or poorer quality water from abandoned flowing wells has contaminated the aquifer. Figure 63 shows that the concentrations of constituents generally increase to the west. The concentrations of chloride range from 32 mg/L in the northeast to more than 500 mg/L near the coast. The concentrations of sulfate are about 54 mg/L in the eastern part of the county and more than 250 mg/L in the western coastal area. The concentration of dissolved solids is less than 500 mg/L in the northeast and is more than 1,000 mg/L near the coast. The U.S. Environmental Protection Agency (EPA) recommended limit for dissolved solids is 500 mg/L (may be greater if no other MCL is exceeded); however, water with concentrations of less than 1,000 mg/L in dissolved solids is commonly used for public supply in this area. Concentrations of fluoride vary considerably, but are usually less than the 1.4 mg/L EPA recommended limit (U.S. EPA, 1975). Iron and color often affect the potability of water from the surficial aquifer; however, both can be easily removed during water treatment by aeration and filtration. The concentration of iron and amount of color in water from the surficial aquifer are usually highest near marshes where decaying plants release iron and organic compounds that can be taken into solution by water infiltrating into the aquifer (Figure 64).

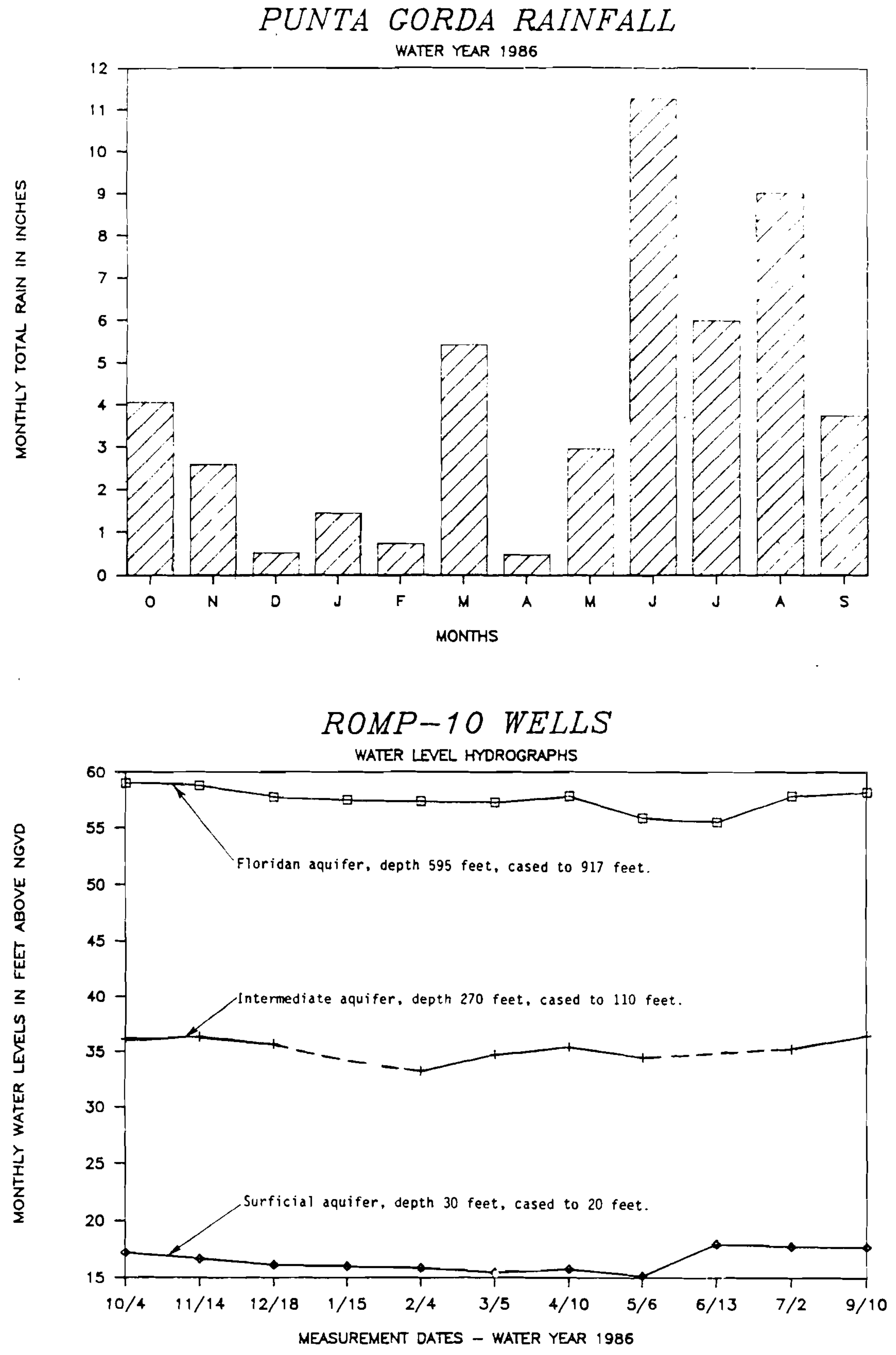
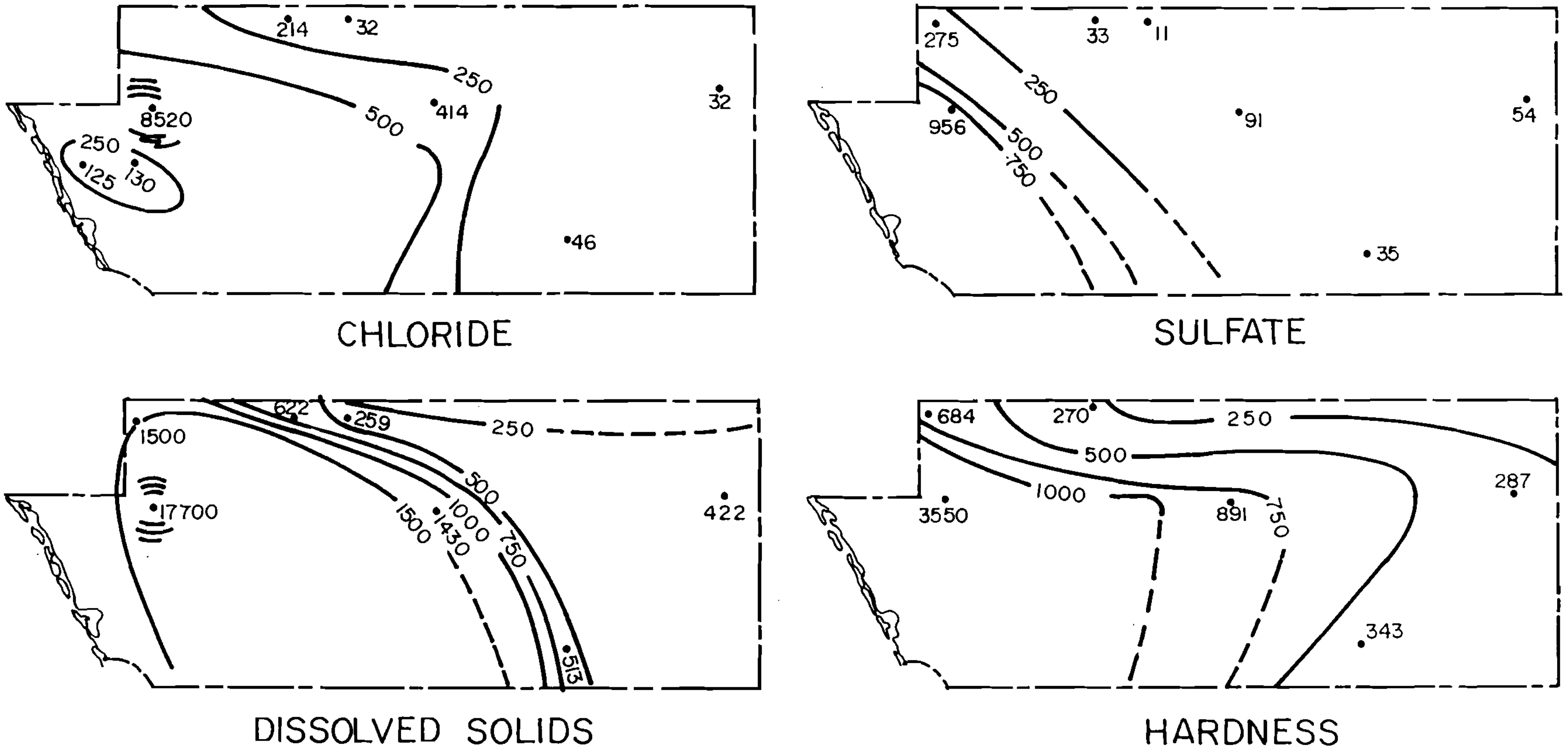


Figure 62. Hydrographs showing interrelationship of rainfall to ground-water levels in the surficial, intermediate, and Floridan aquifers at ROMP-10 wells in Charlotte County (from SWFWMD database, 1987).



EXPLANATION

——250——

LINE OF EQUAL CHLORIDE, SULFATE, HARDNESS, AND DISSOLVED SOLIDS CONCENTRATIONS IN MILLIGRAMS PER LITER. INTERVALS VARY. DATA FROM 1984-1987. SURFICIAL AQUIFER.

Figure 63. Concentrations of major-ions in water from the surficial aquifer system (SWFWMD, 1988).

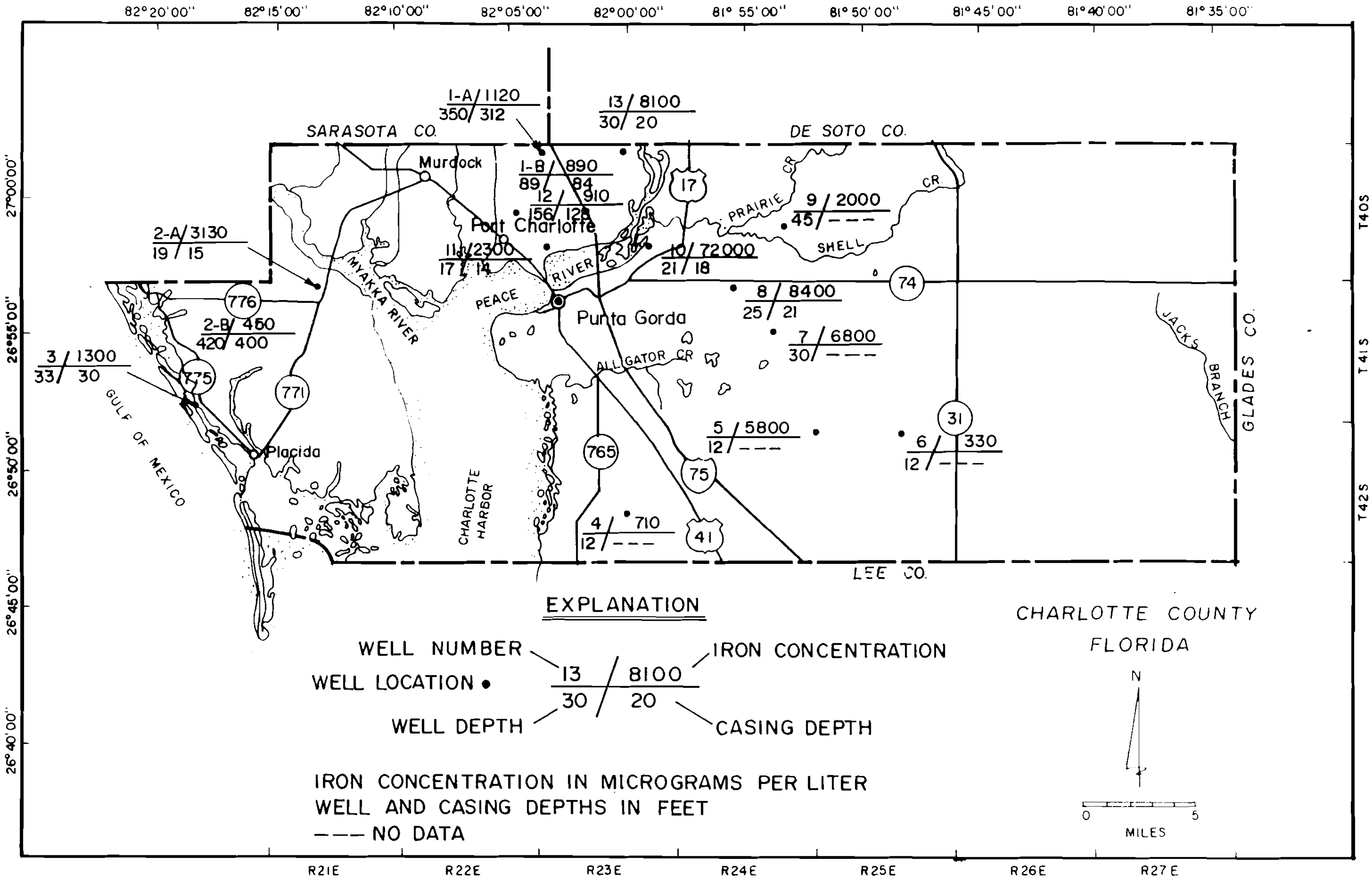


Figure 64. Concentrations of iron in ground-water in Charlotte County (SWFWMD, 1987)

Surficial Aquifer Water Use

The surficial aquifer system is the principal source of ground water for domestic and public supply along the coast. Most wells are two-inch diameter, drive-points that yield as much as 30 gallons per minute (gpm) and are used to obtain water for domestic supply, lawn irrigation, or for watering livestock. Some three to six-inch diameter irrigation wells, finished as open hole through limestone stringers or cemented sand and shell, yield about 100 gpm. Wells tapping shell beds in Caloosahatchee Marl yield as much as 600 gpm in eastern parts of the county (Sutcliffe, 1975).

The surficial aquifer system has potential as a dependable water supply because it is readily recharged by precipitation. Wolansky (1978) estimated that 150 billion cubic feet of relatively good quality water is stored in the surficial aquifer in Charlotte County. The system can be developed by means of conventional wells, collector wells, and tile drains. Water supply criteria appear to be most suitable for future development, of the surficial aquifer system, in the northeast part of the county. However, the surficial aquifer has the greatest potential for contamination from surface sources and large withdrawals may cause severe impacts to the terrestrial environment.

Intermediate Aquifer System

The intermediate aquifer system as defined by the Ad Hoc Committee (1984) "includes all material that lies between and collectively retard the exchange of water between the overlying surficial aquifer system and underlying Floridan aquifer system". In Charlotte County these units consist of a series of mixed permeable and poorly permeable material that function regionally as a water-yielding hydraulic unit and hydraulically separate the surficial and Floridan aquifer systems. Within the study area, a discontinuous confining bed separates the intermediate aquifer system into two distinct water bearing units. The upper unit consists of the Tamiami Formation and the upper Hawthorn Formation, herein called the Tamiami-upper Hawthorn aquifer, following the usage by Wolansky (1983). The lower unit consists of the lower Hawthorn Formation and permeable parts of the upper Tampa Limestone that are not in hydraulic connection with the Floridan aquifer system and is called the lower Hawthorn-Upper Tampa aquifer. The total combined thickness of these two aquifers ranges from about 400 feet in the northern areas of the county to 600 feet in the southern areas.

The altitude of the top of the Tamiami-Upper Hawthorn aquifer ranges from about 100 feet below NGVD in the north to about 125 feet below NGVD in the southwest (Figure 65a). Its thickness averages about 150 feet. Clayey materials above and below the aquifer confine it; however, many breaches within the confining units result in local hydraulic connection between overlying or underlying aquifers. The Tamiami-Upper Hawthorn aquifer, or parts of it, has also been referred to as "artesian zones 1 and 2" (Joyner and Sutcliffe, 1976) and "first artesian aquifer" (Clark, 1964).

The lower Hawthorn-Upper Tampa aquifer consists of permeable limestone and dolomite beds in the lower part of the Hawthorn Formation and upper parts of the Tampa Limestone. The top of the

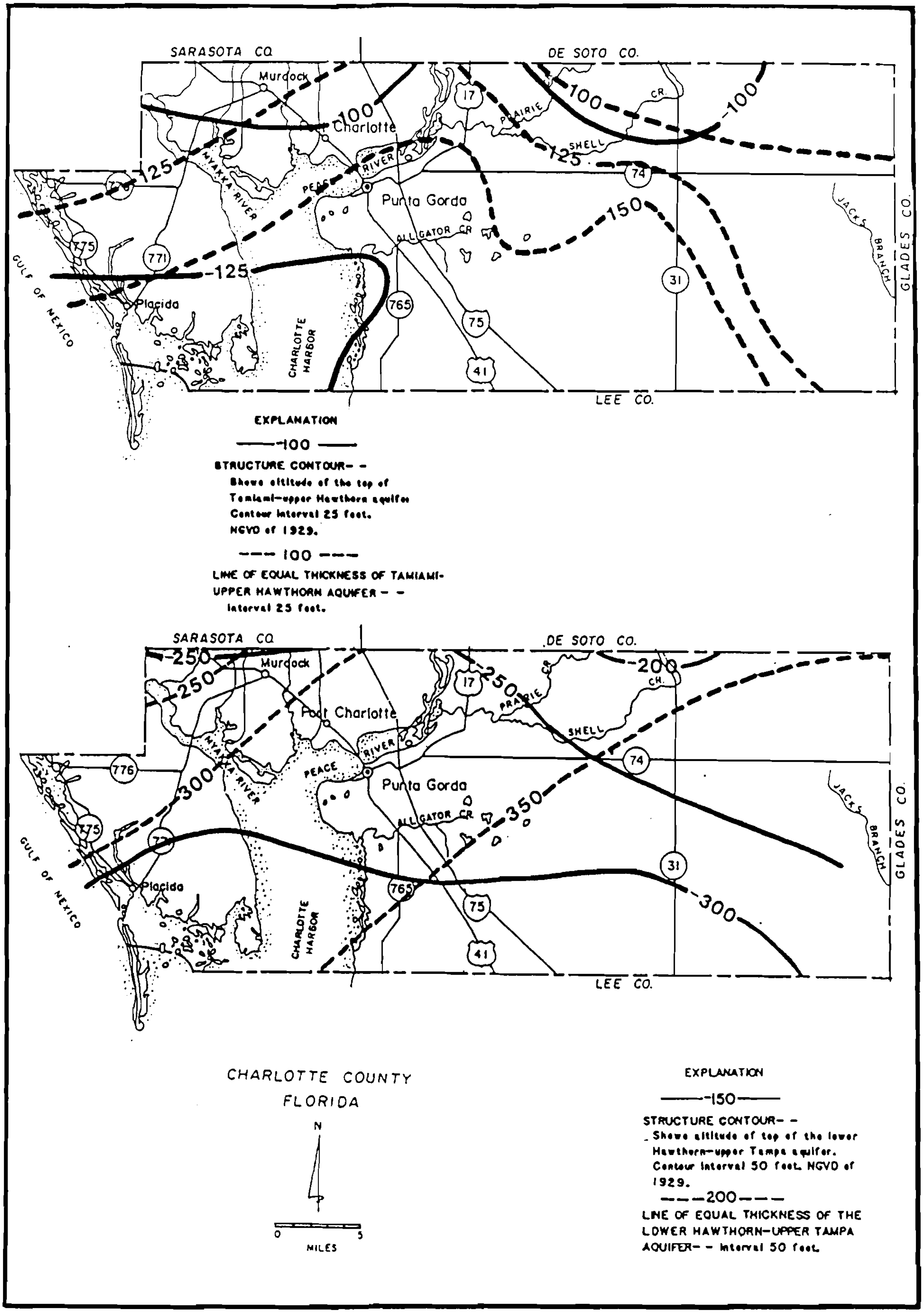


Figure 65 A,B. Altitude of the top and thickness of (A) Tamiami-Upper Hawthorn aquifer, and (B) lower Hawthorn-Upper Tampa aquifer (from Wolansky, 1983).

aquifer is about 250 to 300 feet below NGVD, which is below the beds of clayey limestone and dolomite that occur near the middle of the Hawthorn Formation (Figure 65b). Beneath the aquifer is a unit that is comprised of clayey sand and sandy clay that occurs 50 to 100 feet below the top of the Tampa Formation. Its thickness ranges from about 250 feet in the north to 350 feet in the south. The lower Hawthorn-Upper Tampa aquifer has also been called "lower Hawthorn aquifer" (Sproul and others, 1972) and "artesian zone 3" (Sutcliffe, 1975).

Intermediate Aquifer Potentiometric Surface

Figures 28 and 31 represent the potentiometric surfaces of the intermediate aquifer system, which includes a network of wells open to the entire system between the surficial and Floridan aquifers, in September 1985, and May 1986, respectively. The altitude of the potentiometric surface generally ranges from 20 feet above NGVD near the coast to 50 feet above NGVD in the eastern part of the county. Water generally flows from east to west. Wolansky (1983) developed individual potentiometric surface maps for both the Tamiami-Upper Hawthorn and the lower Hawthorn-Upper Tampa. Figure 66a,b illustrate the potentiometric surfaces of these aquifers.

Intermediate Aquifer Hydraulic Properties

The hydraulic properties of the intermediate aquifer vary according to its lithology and to solution development within limestone and dolomite units more so than to variation in thickness. For two aquifer tests, transmissivity was 8,249 and 2,674 ft^2/d, storativity was $3.0x10^{-4}$ and $8.0x10^{-5}$, and leakance was $2.7x10^{-4}$ ft/d/ft for both tests (Table 4 and Figure 19).

Intermediate Aquifer Water Quality

In general, water quality of the intermediate aquifer system in Charlotte County, exceeds potable limits for major-ions throughout the county. Figures 27 and 67 illustrate that water quality in the intermediate system is best in the eastern part of the county and degrades towards the west. Generally, ground-water is of a higher quality in the Tamiami-upper Hawthorn aquifer and it decreases with depth. Water in the aquifer is saline west of Charlotte Harbor.

Intermediate Aquifer Water Use

The Tamiami-upper Hawthorn aquifer is used extensively in the populous coastal area. It supplies most of the water for domestic and irrigation use. The Rotunda Wellfield has wells that tap the aquifer. Wells two to four inches in diameter, open to the upper part of the aquifer, usually yield about 25 gal/min. Larger wells (six to eight inches in diameter) open to the full thickness of the aquifer, yield as much as 200 gal/min.

The lower Hawthorn-upper Tampa aquifer is used as a source of water for irrigation only. The aquifer contributes water to wells for public supply at the Rotunda Wellfield and water from the aquifer is treated by reverse-osmosis. Wells open to the aquifer yield as much as 500 gal/min. Water supply criteria appear to be most suitable

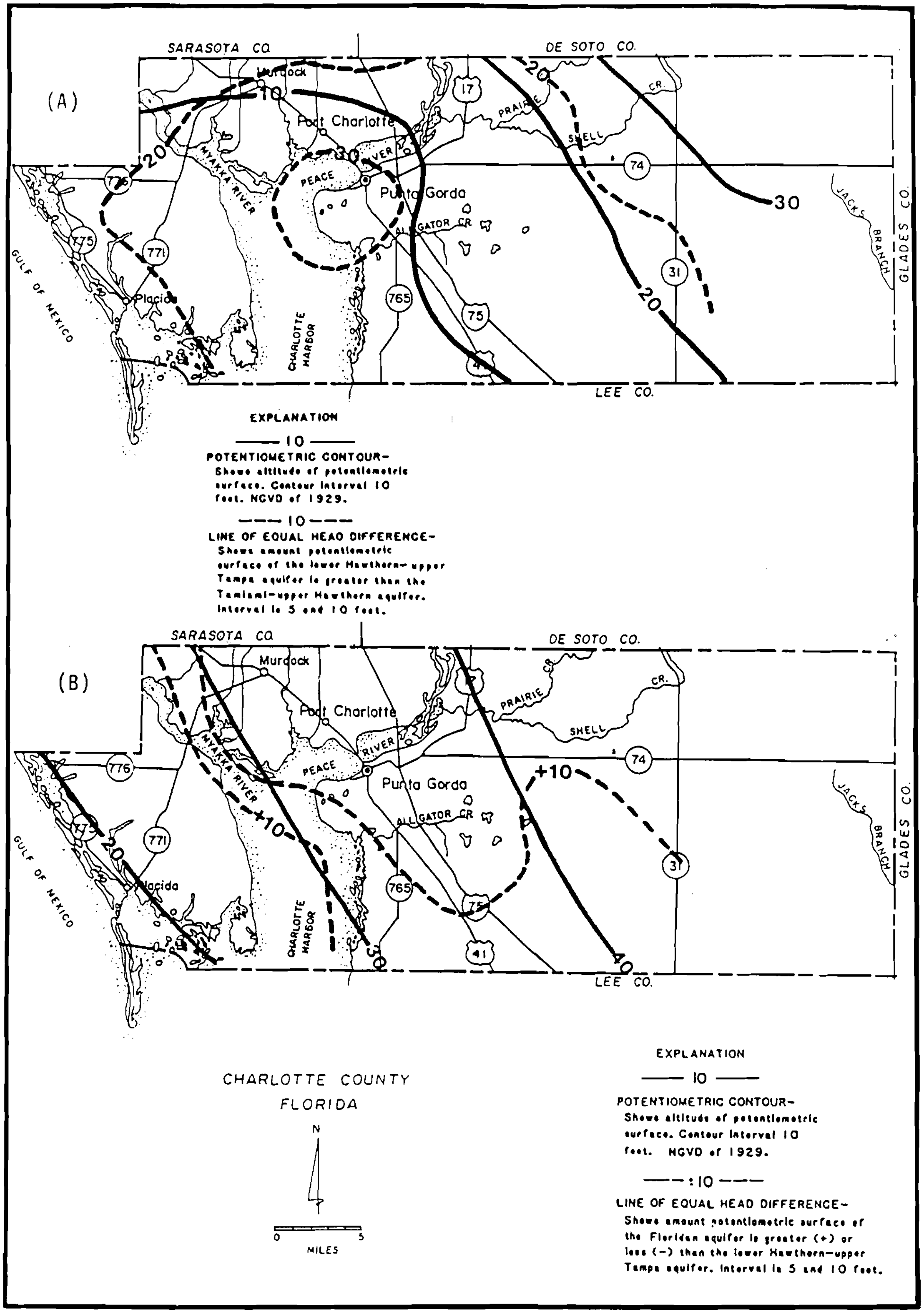


Figure 66 A,B. Altitude of the potentiometric surfaces and the head differences of (A) Tamiami-Upper Hawthorn, and (B) lower Hawthorn-Upper Tampa aquifers in Charlotte County (from Wolansky, 1983).

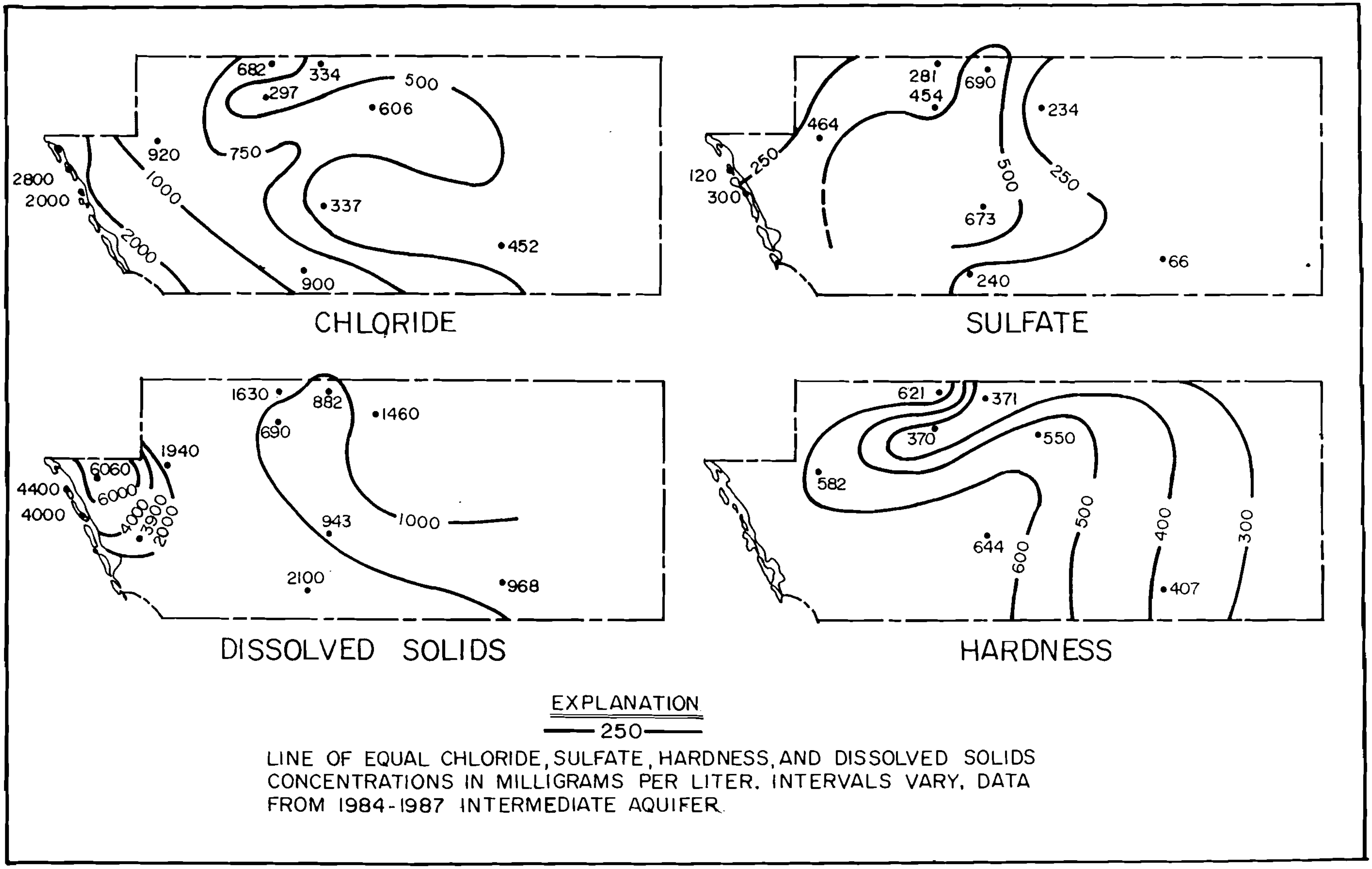


Figure 67. Concentrations of majors-ions in water from the intermediate aquifer system (SWFWMD; 1988).

for future development in upper parts of the intermediate aquifer and in the northeastern parts of the county.

Floridan Aquifer System

In Charlotte County, water use from the Upper Floridan aquifer is generally restricted because of the poor quality of the water produced. The aquifer is composed of a thick stratified sequence of limestone and dolomite. The top of the Upper Floridan aquifer is a limestone defined as the first persistent rock of early Miocene age, or older, below which clay confining beds do not occur. This surface generally coincides with the lower part of the Tampa Limestone or the top of the Suwannee Limestone. The altitude of the top of the Upper Floridan ranges from about 500 feet below NGVD in the northwest to about 650 feet below NGVD in the southeast, and its average thickness is about 1,800 feet in Charlotte County (Figure 68a).

The Upper Floridan generally functions regionally as a single hydrogeologic unit; however, two distinct water-bearing zones are known to exist in Charlotte County. They are the upper zone (parts of the Tampa Limestone and the Suwannee and Ocala Limestones) and the lower zone (the Avon Park Limestone). In the southern and southwest area, water in the lower zone is distinctly more mineralized than that in the upper zone. These zones were designated as artesian zones 4 and 5, respectively, by Joyner and Sutcliffe (1976). In Charlotte County, the most permeable part of the Floridan aquifer occurs near the contact between the Tampa and Suwannee Limestones and near the contact between the Suwannee and Ocala Group (Sutcliffe, 1975).

Floridan Aquifer Potentiometric Surface

Figures 29 and 32 illustrate the September 1985 and May 1986 potentiometric surface of the Upper Floridan aquifer in Charlotte County. It ranges from about 50 feet above NGVD in eastern Charlotte County to about 30 feet above sea level in the west. The potentiometric surface of the Floridan aquifer usually shifts slightly westward between May and September as the aquifer is recharged by summer rains and pumping is reduced. In Charlotte County this shift is slight except for the 40-foot contour interval in Charlotte Harbor. Figure 68b shows the generalized potentiometric surface of the Floridan aquifer from Wolansky, 1983. The regional gradient and direction of flow is west and southwest.

Floridan Aquifer Properties

Areal variation of transmissivity of the Floridan aquifer is primarily controlled by the occurrence of solution features and fractures. The aquifer storage coefficient is controlled by thickness, and confining bed lithology and thickness control leakage. For four aquifer tests, transmissivity ranged from 3,074 to 117,647 ft^2/d; storage coefficient $1x10^{-4}$ to 2x10. and leakage coefficient $3.5x10^{-5}$ to $2.7x10^{-4}$ ft/d/ft (Table 4 and Figure 19).

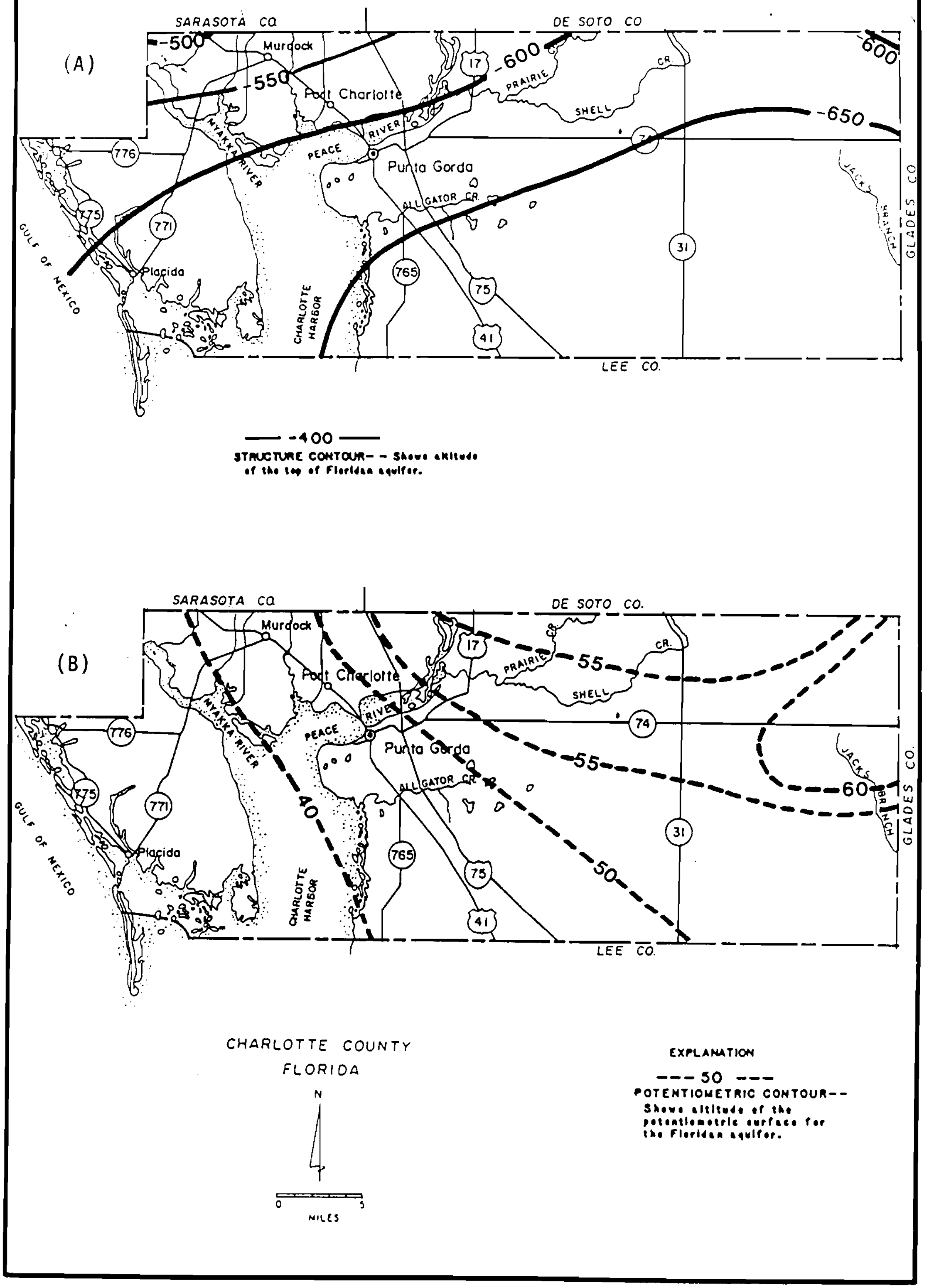


Figure 68 A,B. (A) Top of the Floridan aquifer, and (B) generalized potentiometric surface of the Floridan aquifer (from Wolansky, 1983).

Floridan Aquifer Water Quality

In general, water quality is naturally poor from the Floridan aquifer in Charlotte County. All major ions except sulfate exceed potable limits throughout the county. Concentrations of major ions in the Floridan aquifer generally increase towards the west and with depth (Figure 69). A possible explanation is that most of the county is very close to sea level and has relatively thick confining units separating the aquifers. There has been very little flushing of the salty aquifers with rainwater.

Floridan Aquifer Water Use

Generally, the upper-part of the Upper Floridan aquifer yields as much as 1,000 gpm and the lower-part more than 1,000 gpm (Sutcliffe, 1975). Water from the Upper Floridan is used as a source for irrigation wells only. Water is very highly mineralized in the Floridan aquifer and is generally unsuitable for potable supply development in Charlotte County.

GROUND-WATER RECHARGE AND DISCHARGE

In most of Charlotte County the potentiometric surfaces of the confined aquifers are higher than the water levels in the surficial aquifer and water generally leaks upward to the surficial (Figure 62). Also, the surficial aquifer is recharged by rainfall that has not been intercepted by evapotranspiration, runoff, foliage, or depression storage; upward leakage from the intermediate and Floridan aquifers; and ground-water flow from outside the county. Discharge from the surficial aquifer can occur as evapotranspiration, horizontal discharge to surface-water bodies, vertical discharge to underlying aquifers, and pumpage. The majority of recharge is by infiltration of rainfall. Upward leakage and ground-water flow from outside the county contribute minor amounts and flowing artesian wells contribute appreciable amounts. Wolansky (1978) estimates that recharge to the surficial aquifer in Charlotte County ranges from less than 1 inch per year to 16 inches per year depending on permeability and thickness of aquifer material and the topography. In the Shell Creek area, hydrographs for the period 1969-1973 indicate that the surficial aquifer usually receives 9 to 12 inches of rain per year as natural recharge, using an average effective porosity of 0.25 for the aquifer (Wolansky, 1978).

Wolansky (1983) produced a map showing head differences between the surficial aquifer and Tamiami-Upper Hawthorn (upper intermediate). In the northeastern corner of the county, the water table of the surficial aquifer is about 10 feet above the potentiometric surface of the intermediate aquifer; therefore, surficial aquifer water is recharging the intermediate aquifer. Figure 70a delineates the zone where this head difference is greater than 10 feet.

SWFWMD staff, for this report, examined head differences and leakance values between the surficial and intermediate aquifer systems to determine recharge/discharge rates for the intermediate system in the SWCFGWB. Figure 70b,c illustrate the recharge rates to the intermediate system in the SWCFGWB for September 1986, and May 1987, respectively. The highest rates of recharge (0-2 inches)

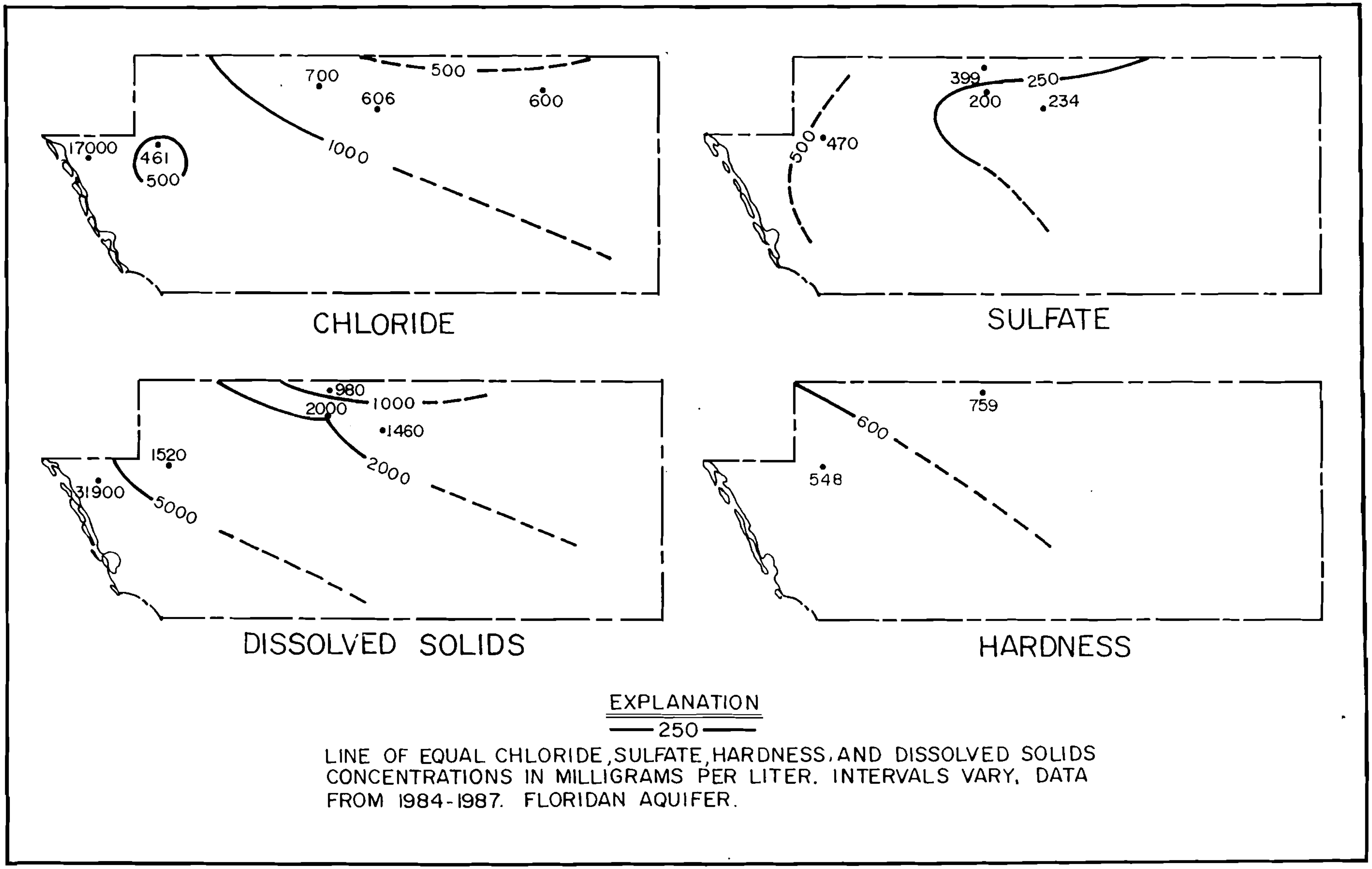
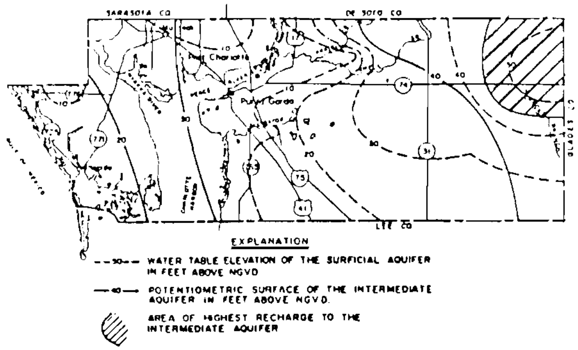


Figure 69. Concentrations of major-ions in water from the Floridan aquifer system (SWFWMD, 1988).

(A)

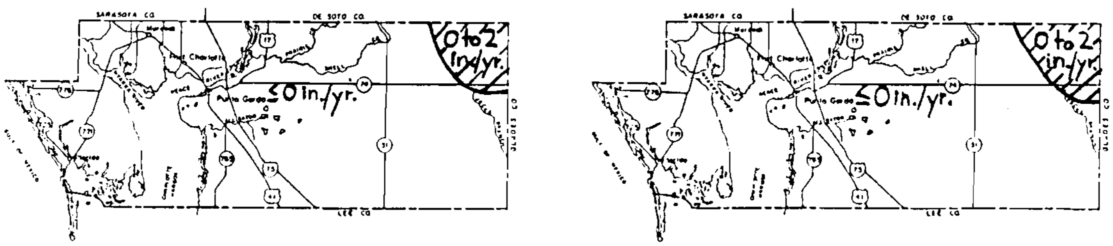
INTERMEDIATE AQUIFER



(Wolansky, 1983)

(B)

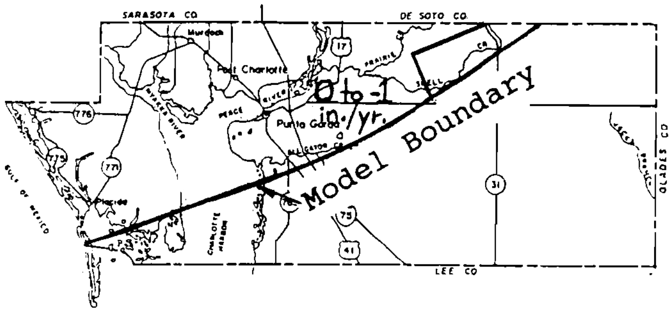
INTERMEDIATE AQUIFER



September, 1986 (SWFWMD, 1988) May, 1987

(C)

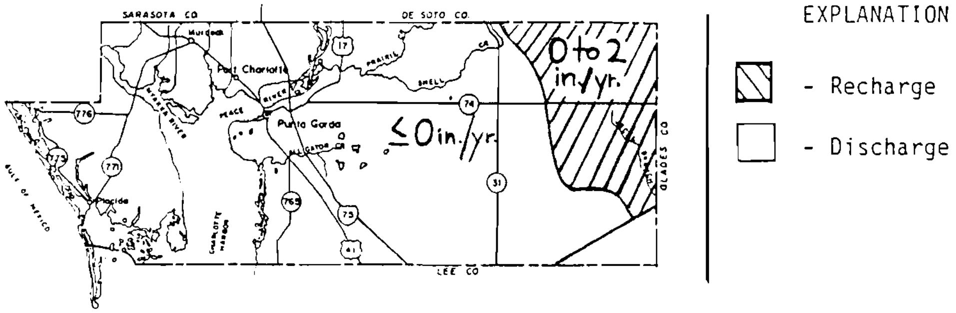
FLORIDAN



(Ryder, 1985)

(D)

FLORIDAN



(Stewart, 1980)

Figure 70 A,B,C,D. Recharge and discharge to the intermediate and Floridan aquifers in Charlotte County.

to the intermediate system is in the northeastern part of the county.

Several studies conclude that discharge occurs from the Floridan aquifer in Charlotte County. Ryder (1985) reported discharge values from zero to one inch per year occur from the upper Floridan aquifer in the northwest half of the county. These values were derived from a two-layered, steady-state digital model which included part of Charlotte County in the modeled area. Stewart (1980) primarily utilized the vertical hydraulic conductivity and thickness of the overlying confining units to calculate recharge rates to the Upper Floridan aquifer. Stewart reported that less than two inches of recharge occur in northeastern Charlotte County, and no recharge occurs in the remainder of the county.

SWFWMD staff also examined head differences and leakance values between the intermediate and Floridan aquifer systems to determine recharge/discharge rates for the Floridan aquifer system in the SWCFGWB. These results indicate that discharge occurs throughout Charlotte County from the Floridan aquifer.

AREAS PRONE TO CONTAMINATION (DRASTIC)

The GWBRAI legislation specifically states that the state's WMD's are to "delineate site specific areas in the basin deemed prone to contamination or overdraft resulting from current or projected development". As discussed previously in "Areas Deemed Prone to Contamination and Overdraft" section, the SWFWMD is using several methodologies to address this task. One method is the mapping of areas susceptible to ground-water contamination utilizing USEPA's recently developed DRASTIC methodology to produce a product that would permit ground-water pollution potential of any hydrogeologic setting, greater than 100 acres in size, to be systematically evaluated with existing information. This information can help planners, managers, and administrators direct resources, waste disposal, and other land-use activities to the appropriate areas.

DRASTIC maps are constructed by individually mapping variations of the seven DRASTIC parameters (example: mapping areas in Charlotte County where depth from land surface to the water table is 0-5 feet, 5-15 feet,..., or greater than 100 feet). The variations in the seven mappable parameters are then assigned ratings. In the case of depth to water in Charlotte County, 0-5 feet is assigned a rating of 10, 5-15 feet a rating of 9,..., and a depth of water greater than 100 feet a rating of 1. In addition to ratings, each of the seven parameters are assigned a weight relative to their importance of restricting the potential for the ground-water system to become contaminated. The weights of the seven mappable parameters are:

Parameter	Weighing Factor
Depth to water	5
net Recharge	4
Aquifer media	3
Soil media	2
Topography	1
Impact of the vadose zone	5
hydraulic Conductivity	3

Once the seven parameters are individually mapped and assigned ratings, the seven maps are superimposed, and composite DRASTIC areas are formed. These composite areas are assigned DRASTIC indices. These indices are the sum of the products of the ratings and weights of the seven parameters for the individual composite areas. Lastly, DRASTIC indices of the composite areas are grouped in categories for ease of map discernibility. These categories are listed below:

Category	Color
200+	Red
180-199	Orange
160-179	Yellow
140-159	Light Green
120-139	Dark Green
100-119	Light Blue
80-99	Indigo
79 and below	Violet

Interpreting DRASTIC maps is quite simple, the higher the DRASTIC index, the greater the ground-water pollution potential. DRASTIC methodology is designed to yield a relative numerical value which can readily be compared to a value obtained for another setting either in the same region or in a different region. A numerical value of 160, for example, has no intrinsic meaning. That number is of value only with respect to other numbers generated by the same DRASTIC index (Aller and others, 1985). Note that the number in each DRASTIC Polygon on Figure 71 is a reference number to Appendix G, where the DRASTIC indices are listed. For a thorough discussion of the construction and interpretation of DRASTIC maps, refer to USEPA/600/2-85/018, May 1985.

NOTE: The reader should be very cautious with utilization of DRASTIC methodology. The methodology was developed to be applied universally. Due to the unique hydrogeology of west-central Florida, the DRASTIC methodology can provide misleading results. Particularly, the competency of the clays overlying the intermediate and Upper Floridan aquifers is, in most cases, less than found in "typical" clay units, primarily due to breaching. However, if interpreted by a qualified professional the DRASTIC maps can be an effective reconnaissance tool to assess contamination potential to the ground-water system.

The staff at the SWFWMD prepared DRASTIC maps of the surficial aquifer for Charlotte County. No DRASTIC map was prepared for the intermediate or Floridan aquifer systems. It was determined that the intermediate and Floridan aquifers have a very low susceptibility to contamination and that DRASTIC color code is violet for the entire county due to the following reasons. A thick confining layer overlying these aquifers impede migration of contamination. Also, in Charlotte County, there is a great depth of material through which a contaminant must travel before reaching these aquifers. There is a greater chance for attenuation to occur as the depth to water increases because deeper water levels infer longer travel times. In most of Charlotte County, the aquifers discharge upward to the surficial aquifer. This direction of flow would carry pollution away from the intermediate and Floridan aquifers in most areas of the county.

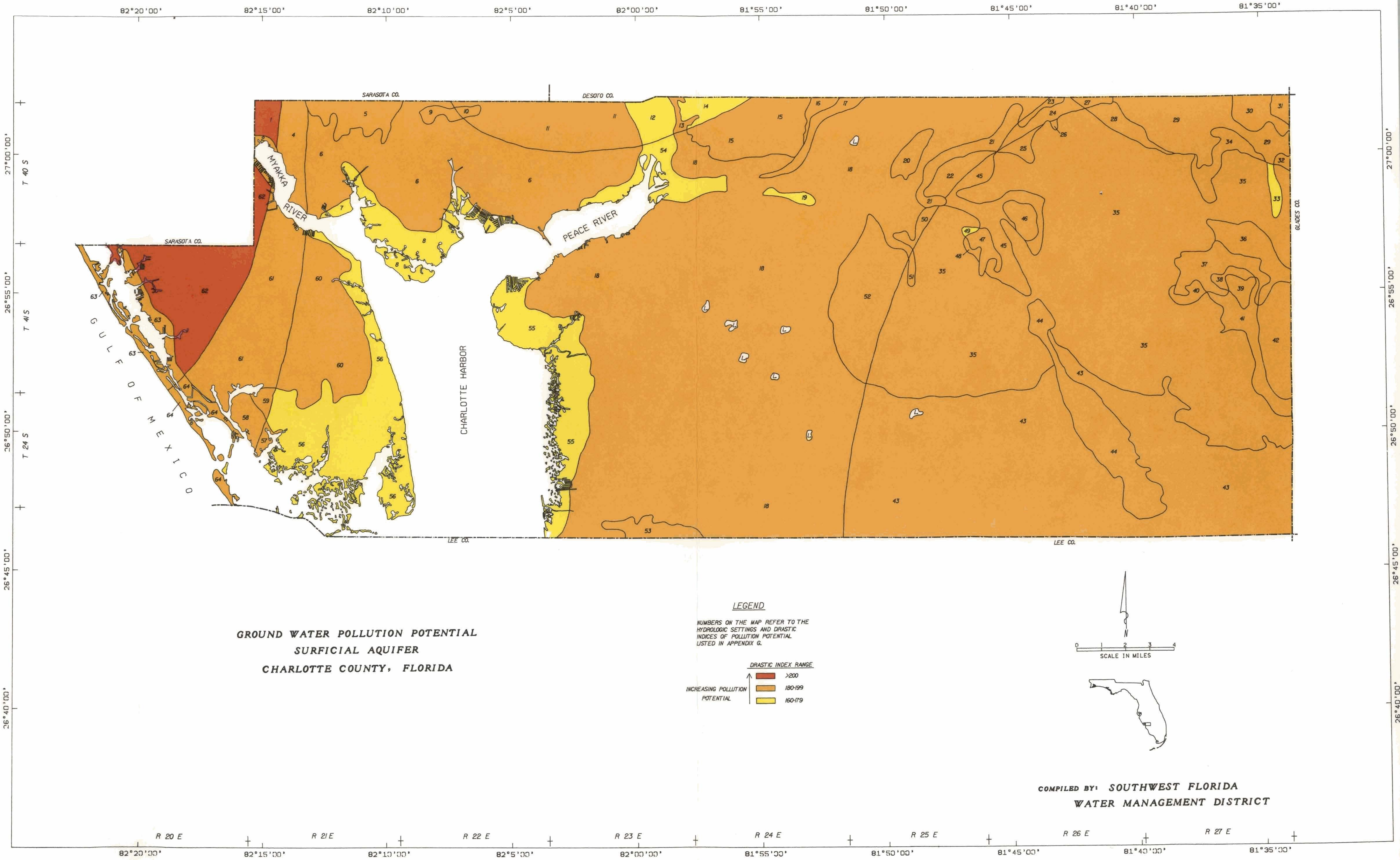


Figure 71: Susceptibility of Ground-Water Contamination in Charlotte County

Generally, the surficial aquifer in Charlotte County has a high susceptibility to contamination (Figure 71). This is primarily due to the shallow depth to the water table. Localized upland areas in northeastern Charlotte County are less susceptible to contamination because of the greater depths to the water table. The surficial aquifer system in northwestern Sarasota County has a greater hydraulic conductivity, and therefore higher susceptibility to contamination.

POINT AND NON-POINT SOURCE LOCATIONS

Man-made pollution from a variety of sources has the potential to deteriorate water quality in streams and aquifers throughout Charlotte County. The density and areal spread of contaminants from a potential source are divided into two categories by the FDER and are called point-source and non-point source. A "point-source" is defined as any discernible, confined and discrete facility that discharges pollutants. These are easily identifiable sources such as end-of-pipe discharge from a factory or from a municipal sewage treatment plant into a stream. They are controlled by State and Federal regulations. Violations can often be corrected by treating the water before it is discharged. Some of the more prominent examples of point-sources of ground-water contamination include percolation ponds associated with sewage treatment plants, landfills, and industrial waste sites. Figure 72 shows locations of FDER permitted point-source contamination sites in Charlotte County. Appendix H describes these referenced sites.

A "non-point source" of pollution is defined as any discernible source of pollution not associated with point-sources. These are more pervasive and less controllable sources of pollution. They affect ground water as well as surface water. Since they cannot be collected and treated, they can only be avoided by extreme care in our management of water and land resources. Some examples of non-point pollution include certain natural geochemical conditions, storm run-off from urban areas, agricultural areas, phosphate mining, and urban land use areas. Figure 50 shows agricultural land use areas which may apply pesticides and fertilizers.

Water from the intermediate and Floridan aquifers often does not meet drinking water regulations in Charlotte County, due to the degree of mineralization. The composition of soil and rocks and the nature of aquifer interconnections affect the degree of mineralization of ground water. Figures 63, 67, and 69 identify contamination areas where ground-water mineralization is high in Charlotte County.

Florida's surface and ground-water resources are not infinite and careful water management plans are necessary to insure adequate supplies. Any site where contaminants could be introduced into aquifers should be monitored. The potential exists for saltwater intrusion into freshwater aquifers in coastal areas as ground-water withdrawals increase. The construction of saltwater canals inland has caused some localized saltwater intrusion. The intermixing of water of different quality between aquifers occurs in wells with casing driven only to the first hard-rock stratum.

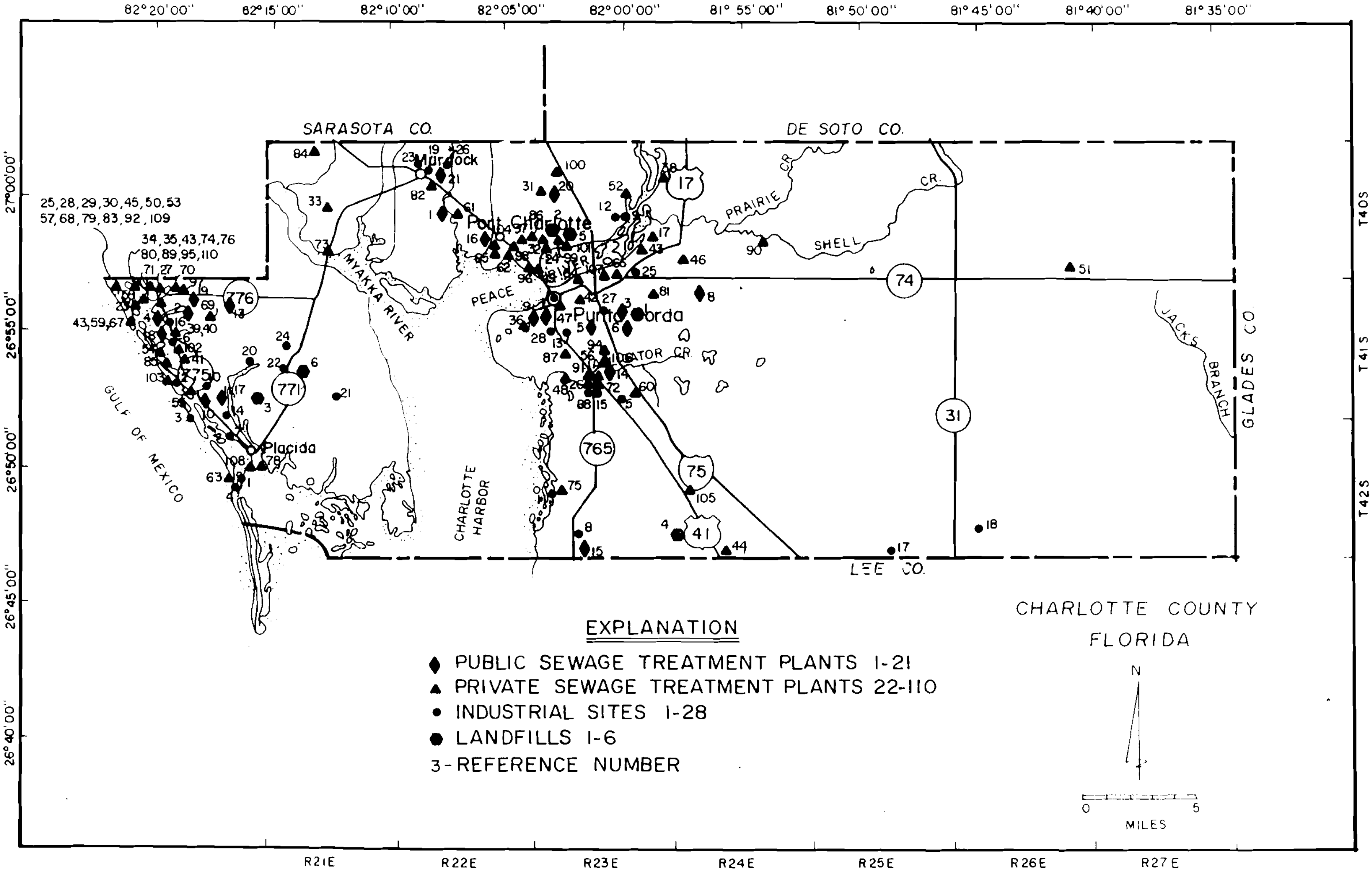


Figure 72. Point-source contamination sites in Charlotte County (from FDER database, 1987).

Artesian Well Plugging

The loss of potable and agricultural water due to the degrading effects of improperly constructed or deteriorated artesian wells has been recognized as a problem in Charlotte County for many years. Interaquifer contamination due to differential hydrostatic pressures within uncased sections of wells that connect more than one aquifer, and wasteful artesian flow at land surface from improperly controlled wells are responsible for deterioration of water quality in the artesian system.

The hydrogeologic system is complex in Charlotte County, where four artesian zones have been observed (Wolansky, 1983). Each hydrologic zone has distinct characteristics. In addition to their general location in the geologic column, the zones are identified by two major parameters - water quality and hydrostatic pressure. Generally, ground water becomes more highly mineralized with depth and increases in hydrostatic pressure with depth. The result of connecting an aquifer having low quality water and high hydrostatic pressure with an aquifer of high quality water and low hydrostatic pressure is that the high pressure water is forced into the low pressure zones, thus replacing the high quality water with low quality water. Therefore, re-establishment of the separation between aquifers by plugging the sections of well bores that allow hydrologic connection is essential to maintain the integrity of the high water quality zones.

Although interaquifer contamination is a major problem, uncontrolled discharge by artesian wells is also a serious problem. Uncontrolled discharge accelerates aquifer contamination by lowering the hydrostatic pressure in the artesian aquifer, consequently, accelerating intrusion of mineralized water from the sea and deep aquifers. Furthermore, while lowering the hydrostatic pressure, uncontrolled wells are discharging highly mineralized water at land surface, resulting in artificial recharge of the surficial aquifer with poor quality water.

The two sources of aquifer contamination mentioned above have been a major concern with abandoned wells for many years; however, a third major concern has now become important. The introduction of chemical contaminants through abandoned, improperly cased or improperly capped wells is now recognized as a major threat to ground-water resources.

To restore hydrologic conditions altered by well drilling activity, SWFWMD began the Quality of Water Improvement Program (QWIP) in 1974. The original emphasis of QWIP was on Charlotte County where the problems were most complex and severe. Free flowing wells and plugged wells in Charlotte County are shown in Figure 73. QWIP continues to inventory and plug artesian wells in order to restore the aquifer. The results are becoming evident, but the full benefit of restoration will not be realized for many years.

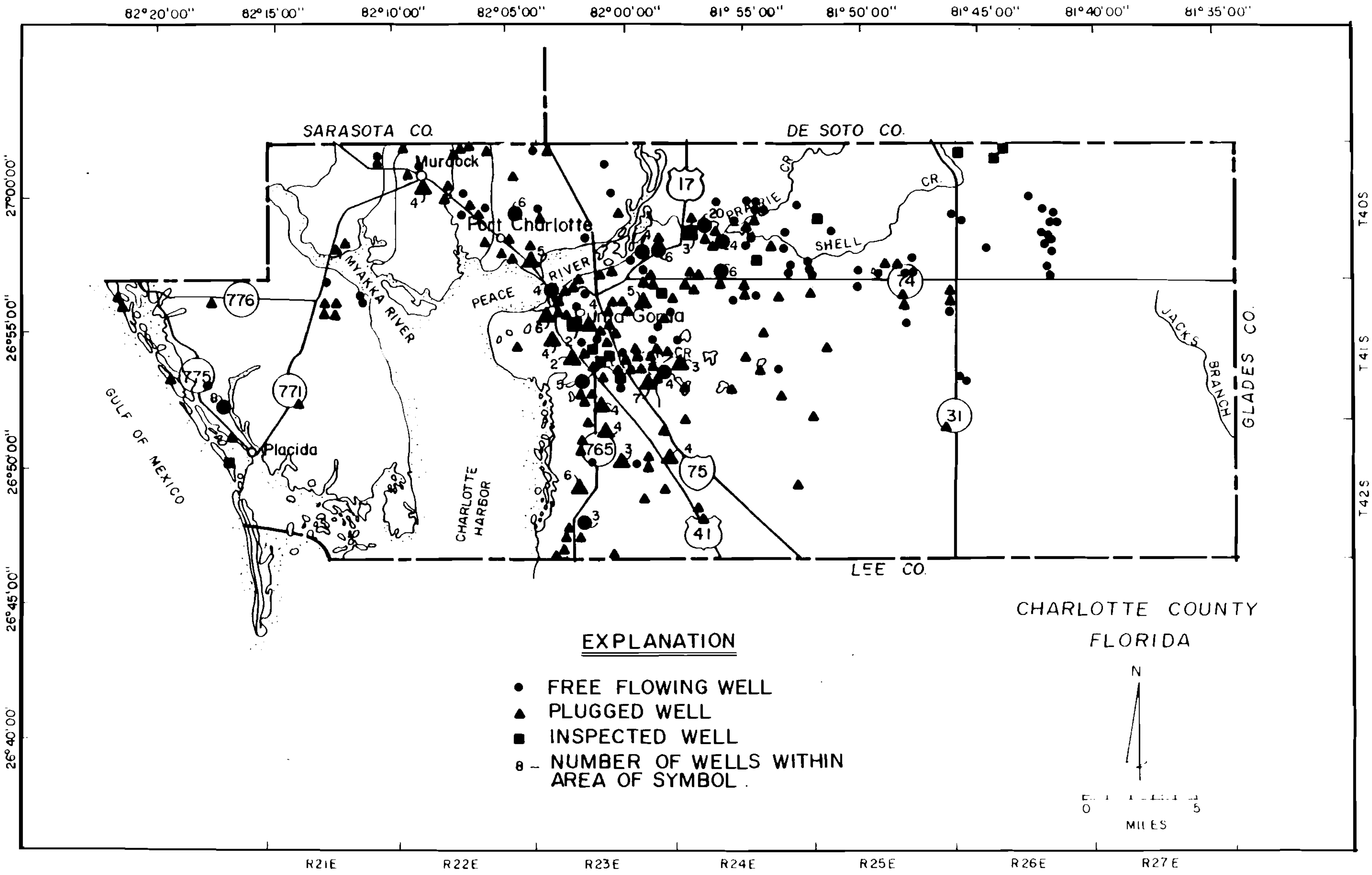


Figure 73. Plugged and capped artesian wells in Charlotte County (from SWFWMD, 1988)

WATER SUPPLY SOURCES AND ALTERNATIVES

Current Water Supply Sources, Use, and Protection

Beginning with 1977, which is the first year that water use information is available on an annual basis, to 1986, water use data which is the most current information available from the SWFWMD have been collected by two separate agencies. During this ten year period, the USGS collected information for the first five years and the SWFWMD for the last five years. Some differences exist between the methodologies used by the USGS and the SWFWMD in collecting and interpreting water use data, but generally the methodologies are comparable.

Figure 74a shows total water use and water use by categories for Charlotte County. As can be seen from this graph, agriculture has used a substantial amount of the total water used in the county for the ten year period. The largest percentage of this category is used for row crop farming. Public supply was the second largest user of water in the county and is expected to increase as the population grows. Historical water use information is presented in numerical form in Table 13.

The water use patterns within Charlotte County differ somewhat from the water use within the entire SWFWMD. In 1986, agriculture used approximately 43 percent of the total water used in the SWFWMD. The next largest user were the public supply category with 25 percent and the industrial category with 16 percent. Rural categories used 3 percent and power generation used 13 percent of the total water in the SWFWMD (Stieglitz, 1987). The comparable water use percentage figures for Charlotte County in 1986 are 72 percent for agriculture, 23 percent for public supply, 5 percent for rural, and 0 for both power and industrial. The agricultural category was much higher than the entire SWFWMD trend in 1986 and the industrial and power categories were considerably lower.

Figure 74b shows per capita water use for the residents of Charlotte County. This graph was developed by combining the water use of the public and rural categories and dividing by the population. This figure shows an overall increase of per capita water use, with a drop in 1978 and increasing to a high in 1984 that drops off in 1986. In the future, per capita water use can be estimated to remain at a minimum of 100 to 110 gallons per capita per day with fluctuations up to 165 to 175 gallons per capita per day depending on hydrologic conditions and water conservation measures.

Detailed water use projections will be developed for all counties within the SWFWMD at a later date. For the purposes of this report, however, general water use trends and projections will be discussed for Charlotte County.

Water use in the agricultural category has historically been in the 20 to 45 Mgal/d range, and is expected to remain within the same range. The public and rural use of water is expected to increase substantially as the population for Charlotte County increases. Figure 75 shows the locations and Table 12 describes information for public supply wells in Charlotte County which require permits from

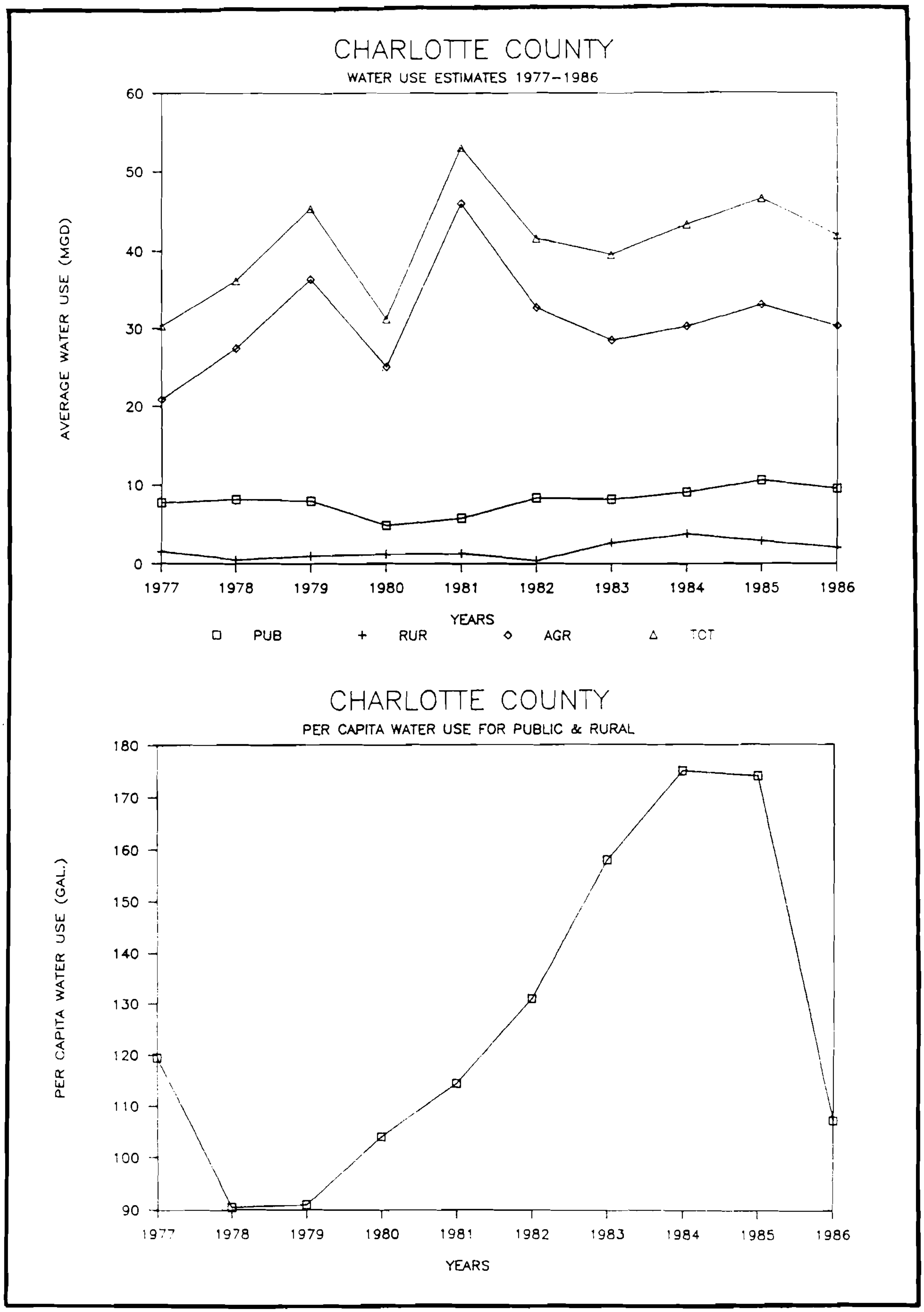


Figure 74 A,B. (A) Water use categories and, (B) per capita water use for public and rural supply systems in Charlotte County (from SWFWMD, 1985)

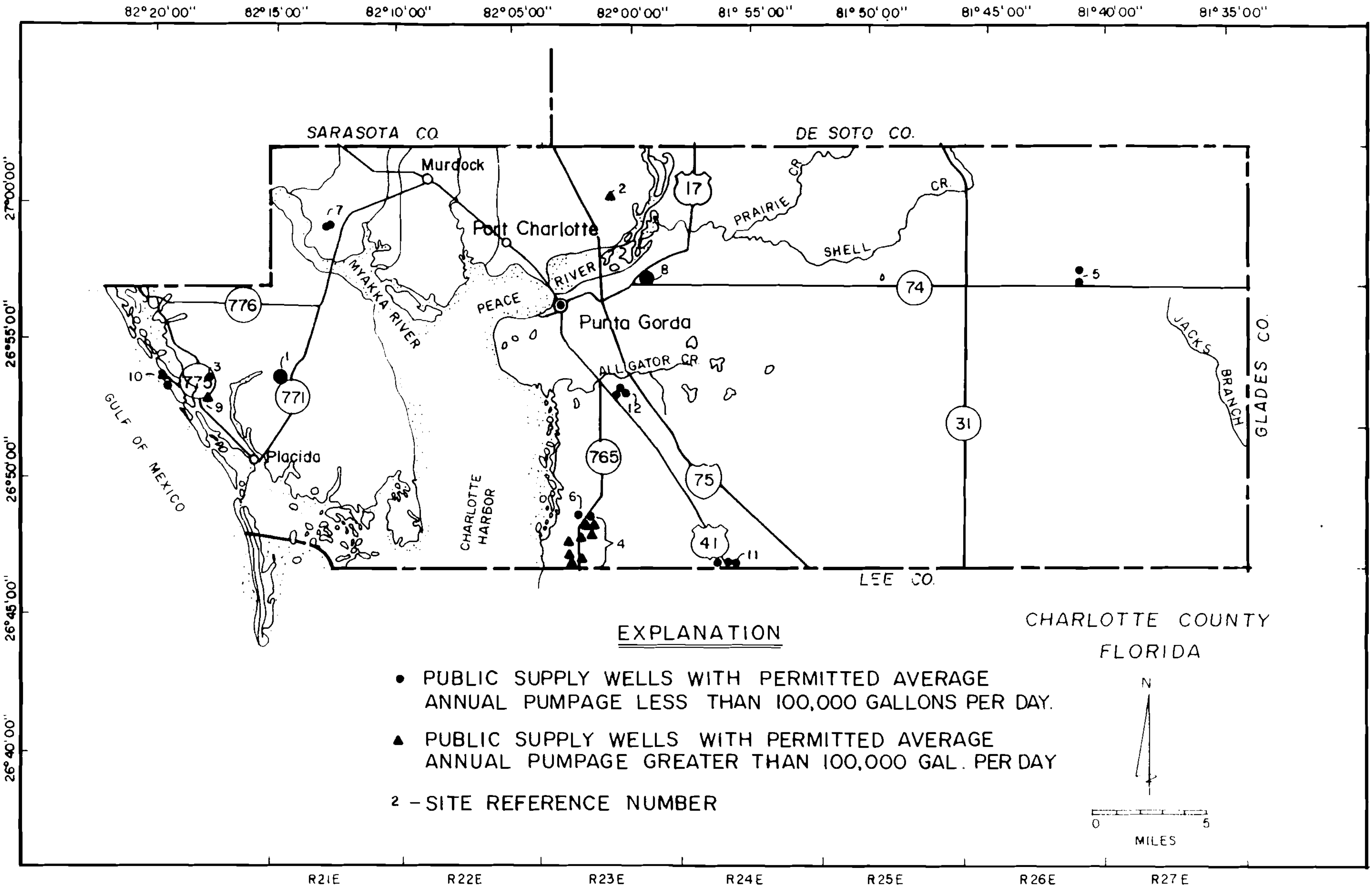


Figure 75. Location of public supply wells, which require permits from the SWFWMD, in Charlotte County (from SWFWMD database, 1987).

TABLE 13. PUBLIC SUPPLY WELLS

Ref. No.	Permit No.	Name	Address	Permitted Avg. (GPD)	Permitted Max. (GPD)	Expiration Date	No. PS Wells
1	0071801	Gasparilla Island Water Assn. Inc.	P.O. Box 326 Boca Grande 33921	510,000	1,020,000	88/05/05	32
2	0151204	Charlotte Harbor Water Assn. Inc.	27147 Del Prado Pkwy. Harbour Heights 33950	580,000	790,000	89/04/06	4
3	0283902	Rotonda West Utility Corp.	P.O. Box 3509 Rotonda West 33947	870,000	1,700,000	88/05/05	16
4	0352201	Punta Gorda Isles Inc.	1625 W. Marion Ave. Punta Gorda 33950	934,000	1,402,000	90/01/11	8
5	0504901	Paradise Park Ltd.	3049 Cleveland Ave. #255 Ft. Myers 33901	63,000	72,000	91/07/10	2
6	0635701	Gartridge Corp. N.V.	P.O. Box 2164 Port Charlotte 33952	87,500	95,000	87/06/03	2
7	0692201	Harbor Lakes Water System Inc.	10002 S. Tamiami Trail Venice 33595	80,000	150,000	88/12/04	2
8	0699900	1774 Water Cooperative Inc.	566 N.W. Olean Blvd. Port Charlotte 33951	394,000	590,000	89/04/06	8
9	0749400	Fiveland Investments Inc.	1100 S. Tamiami Trail Suite 2 Sarasota 33577	400,000	432,000	91/02/06	4
10	0776800	Charlotte Harbor Land Company	7092 Placida Rd. Cape Haze 33946	150,000	200,000	90/12/05	2
11	0794100	John C. Walker	Rt. 6 Box 882 Punta Gorda 33950	60,000	120,000	91/04/03	3
12	0862600	Carolyn and Ralph Bearden Jr.	1018 Emerald Pointe Punta Gorda 33950	53,400	104,000	92/12/02	3

the SWFWMD. Using the per capita water use figures as described above (100 and 175 gallons per capita per day) and the population figures described in Population Section of this report (between 115,000 and 320,000 persons in the year 2000), the combined public and rural water use for the year 2000 can be expected to be between 12 million gallons per day and 56 million gallons per day, depending on population growth, adoption of water conservation practices and hydrologic conditions. Based on the above assumptions, total water use can be expected to be between 32 million gallons per day and 100 million gallons per day for Charlotte County in the year 2000.

Table 13. Water Use Estimates for Charlotte County 1977-1985 (shown in Millions of gallons of water used per day).

	PUBLIC		RURAL		INDUSTR.		AGRIC.		MISC.	TOTAL		GRAND
YEAR	G.W.	S.W.	G.W.	S.W.	G.W.	S.W.	G.W.	S.W.	TOT.	G.W.	S.W.	TOTAL
1977	3.9	3.9	1.6	0.0	0.1	0.0	20.9	0.0	0.0	26.5	3.9	30.4
1978	4.1	4.1	0.5	0.0	0.0	0.0	26.6	0.8	0.0	31.2	4.9	36.1
1979	4.0	4.0	1.0	0.0	0.0	0.0	35.2	1.1	0.0	40.2	5.1	45.3
1980	0.0	4.9	1.2	0.0	0.0	0.0	22.5	2.5	0.0	23.7	7.4	31.1
1981	0.0	5.8	1.3	0.0	0.0	0.4	41.3	4.6	0.0	42.6	10.8	53.4
1982	2.3	6.1	0.4	0.0	0.0	0.0	29.3	3.3	0.0	32.0	9.4	41.4
1983	2.3	5.9	2.7	0.0	0.0	0.0	25.6	2.8	0.0	30.6	8.7	39.3
1984	2.7	6.4	3.8	0.0	0.0	0.0	27.2	3.0	0.0	33.7	9.4	43.1
1985	2.7	7.9	2.9	0.0	0.0	0.0	29.6	3.3	0.0	37.9	11.2	46.4
1986	2.7	6.8	2.0	0.0	0.0	0.0	27.2	3.0	0.0	31.9	9.8	41.7

The 1986 Water Use Estimates of the SWFWMD (Stieglitz, 1987) show that Charlotte County uses ground water for 76 percent of all water used. Surface-water sources comprise 24 percent of all water used in the county. These surface-water sources are primarily used for public supply purposes. Approximately 21 percent of all water used in the District comes from surface-water sources, while 79 percent comes from ground-water sources.

Desalination

Desalination of saline water is basically a process of separation. The main types of desalting are by electrodialysis, on exchange, and reverse osmosis. Of the types of desalination, reverse osmosis is clearly the choice as the most cost-effective and dependable method. Reverse osmosis is a mechanical technique which in effect separates the impurities out of the water by forcing the water through a semipermeable membrane at high pressure. The superior ability of reverse osmosis to remove pollutants and the enhanced taste, smell, and drinkability of water treatment by reverse osmosis should lend further to its increasing acceptance.

The continued growth in Florida's coastal areas along with unpredictable amounts of adequate rainfall and danger of saltwater intrusion in these areas has led to the increased use of desalination as a basic water treatment process as well as a supplemental water source. Reverse osmosis plants will probably continue to be concentrated along coastal areas.

In 1982, there were 70 desalination plants operating in Florida using reverse osmosis technology. The largest reverse osmosis plant in Charlotte County is Rotunda West's 0.5 Mgal/d facility built in 1972. Figure 72 and Table 14 describe the reverse osmosis plants operating in Charlotte County in 1982. Additional reverse osmosis plants listed by the FDER in 1987 include the following: Seaside Service System on Little Gasparilla Island, Knights Island Utilities, Don Pedro Island, Charlotte Harbor Water Association, and Burnt Store Colony.

Table 14. Reverse Osmosis Plants in Charlotte County in 1982.

PLANT NAME	ENGINEER	TYPE	MG/D
Alligator Utilities	D. Ambrose	Polymetrics	.030
Burnt Store Utilities	J. Elliot	Basic Tech	.160
Eagle Point MHP	C. Kimball		.036
Gasparilla Pines	A. Conyers	Permutit	.010
Rotunda West	F. Bell	Permutit	.500

Reverse osmosis was found to be generally competitive on a cost basis with more conventional systems of water supply in areas where it is used. However, the cost of demineralized water is considerably higher than the cost of conventional systems in areas where sufficient potable quality water is available. The cost effectiveness of reverse osmosis increases with the size of the plant and the process is superior to conventional treatment systems in removing pollutants. Counties which are considering relocating water from other counties to meet potable water demand should compare the cost-effectiveness of reverse osmosis treatment as one alternative.

Ninety-nine percent of reverse osmosis water in Florida is utilized for domestic potable water with the remainder going to industrial needs. Reverse osmosis does have its limitations, but its ability to remove numerous pollutants makes it superior to coagulation, chlorination or active carbon in this consideration. More importantly, reverse osmosis has the following additional advantages when compared with conventional water treatment methods:

(1) Ability to meet more stringent drinking water quality standards without incurring additional treatment to water;

(2) Ability to expand plant capacities by additional wells into the ground water and desalting these ground waters, as opposed to expanding infrastructure development of the conventional water plant; and,

(3) Minimal susceptibility to changing climatic conditions and salt water intrusion.

One problem presented by reverse osmosis is the disposal of the waste brine, especially in inland areas. However, adequate mitigation techniques appear to be available through deep well injection in inland areas and its return to sea water in coastal areas.

Existing and Potential Wastewater Reuse Source

Proper management of the ground-water resource requires consideration of the potential for reuse of wastewater. Reuse can supplement demands for potable water, solve limitations on the disposal of wastewater effluent, and mitigate the effects of excessive ground-water withdrawal. In the context of this discussion, wastewater is defined as potable quality water which has been changed through human activity to non-potable quality. Wastewater originates in industrial applications, agricultural activities, and from municipal sewage treatment. All of these types of activities produce water that, provided environmental and health considerations are met, can be reused for non-potable uses.

The focus of this discussion is to evaluate the incentives and disincentives of the direct and indirect reuse of domestic class wastewater. Direct reuse is defined as the direct transmission of treated wastewater to the user. Examples of direct reuse include irrigation of landscapes, agricultural areas, and golf courses of its use in industrial processes such as rinsing and cooling. Indirect reuse of domestic wastewater includes the most often used method, that is, disposal via rapid infiltration basins or percolation/evaporation ponds.

Other techniques of managing wastewater disposal requirements include:

> Separation of graywater from the wastestream at the source. Advantages of this option are the fewer limitations on application due to environmental and health constraints, as well as reduction in treatment and distribution costs.
>
> Deep well injection of wastewater. This option has been accepted in some coastal areas, where technically feasible and environmentally acceptable.
>
> Recycling, or the treatment of wastewater to potable water quality standards.

The opportunities to implement innovative strategies of this sort are dependent on the comparative perceived and real cost-effectiveness of these options, combined with any applicable financial incentives and/or regulatory disincentives provided by federal, state, and local government.

The primary constraints of direct and indirect reuse of reclaimed water include: (1) the initial costs, depending on land price and availability, method of treatment and distribution; (2) the subsequent monitoring requirements; and (3) the stigma attached to wastewater from the public viewpoint. Siting of wastewater treatment plants adjacent to potential users of the product water or restricting land uses surrounding treatment plants through regulation can aid in minimizing some of these constraints.

Other factors in the evaluation of the reuse option include the location and treatment/disposal method of the major domestic wastewater treatment plants, water supply and demand, land use, environmental factors such as soil types, and the existence of potential health hazards (Thabaraj and Rhodes, 1985).

Two recently completed studies on the applicability of direct reuse with municipal wastewater using the above criteria concluded that it is difficult to standardize cost-effectiveness due to the variability in distribution of suppliers and potential users, regardless of the size or capacity of the treatment plant (Stewart, 1985; Adam et al., 1984). Both studies also limited their respective analyses to major treatment facilities (greater than 1 Mgal/d capacity).

As shown in Table 15, the total design capacity of all of the private and public wastewater treatment plants in Charlotte County is approximately 11.4 Mgal/d. Of the 113 plants, only three facilities have a treatment capacity of greater than 1 Mgal/d (FDER, 1987). These three plant generate approximately 66% of the treatment volume and dispose of it primarily by RIB although direct reuse in the form of spray irrigation is utilized. Plants with a treatment capacity of between .05 and 1.0 Mgal/d generated 19.2% of the treatment volume. Eighty-two percent of the plants within Charlotte County have a treatment capacity of less than .05 Mgal/d. Most of these small facilities dispose of their effluent by drainfield and RIBs.

Table 15. Summary of Capacity, Number, Volume Generated and Percent of Total for Charlotte County's Domestic-Class Wastewater Treatment Facilities.

Plant Cap (Mgal/day)	No. of Plants	Volume (Mgal/day)	% total volume	No. of plants & primary means of disposal				
				RIB	SWD	SPR	INJ	DF
> 1.0	4	7.50	65.90	2	1	3	0	1
.50 - 1.0	0	0.00	00.00	0	0	0	0	0
.25 - .50	1	0.33	02.90	1	0	1	0	0
.10 - .25	5	8.90	08.90	4	0	2	0	1
.05 - .10	10	0.84	07.40	3	0	3	0	4
.00 - .05	93	1.69	14.80	37	0	3	0	59

NOTES:
Codes for each of the primary disposal options are as follows:

RIB = Rapid Infiltration Basin
SWD = Surface Water Discharge
SPR = Sprayfield Irrigation
INJ = Injection Well
DF = Drainfield

SOURCE: Florida Department of Environmental Regulation (FDER). 1987. Ground Water Management System, April 1987.

Because all of these treatment facilities discharge all or a portion of their effluent by means other than direct reuse, it would appear that the application of the methods developed by the above mentioned reports have a potential to be implemented. However, in order to determine direct reuse cost-effectiveness for the large facilities and the many smaller wastewater treatment plant sites, a more detailed analysis would be required.

As growth within the county continues and the provision of central wastewater treatment facilities is pursued, the economics of direct reuse will become more favorable. This approach, coupled with additional regulatory, fiscal, and other governmental incentives, will promote direct reuse as viable component within a water resource management strategy.

Feasibility of Integrating Coastal Wellfields

In the GWBRAI, each water management district is to address the feasibility of integrating coastal wellfields. Connecting individual wells with transmission mains in a network system and operating the system in a manner which prevents over-pumpage of a single well creates an integrated wellfield. In coastal areas this type of operation ensures an adequate supply of potable water while preventing degradation of an aquifer system from saltwater intrusion.

Presently Charlotte County does not have an integrated coastal wellfield. The county has at least 82 public supply wells that are within 10 miles of the coastline or Charlotte Harbor (Figure 75). To prevent saltwater intrusion and provide an adequate supply of potable water, Charlotte County should consider the options of coastal wellfield integration and/or inland development of new wellfields.

Conservation

Water conservation can play an important role in an area's efforts to plan for future water supplies, wastewater disposal and environmental protection. Typically, as areas experience growth, inexpensive sources of water are developed first. As growth continues, remaining sources become more expensive to bring to specific locations. Also, with increasing water use, more wastewater treatment and disposal is required.

Water conservation methods are available within all categories of water use. It is estimated that water use within the residential water use category can be reduced by 15% to 70%, depending on various factors such as the efficiency of existing distribution and use systems and the proportion of water used outdoors (Environmental Policy Institute, 1982). Elements in a program to implement residential water conservation may include plumbing code changes, retrofit of existing structures, leak repair, metering, rate structure revision, public education, outdoor water codes, water shortage contingency plans and reuse.

Water conservation in the agricultural category offers the potential for significant water savings while maintaining economic yields. The two principal elements to effective water management in agriculture are 1) an irrigation system that can deliver water uniformly to the crop in the right quantity and at the right time, and 2) an irrigator who knows and follows water conservation practices. Water conservation practices available to agriculturalists within the county include reducing losses to seepage and tailwater, scheduling and hardware modifications to deliver optimal quantities of water, use of mulching and other soil covers, and use of the lowest water quality necessary including wastewater reuse.

The potential exists to significantly increase the efficiency of water use and to reduce the per capita potable water demands within the county. The State Water Use Plan sets an objective for the state to reduce potable water use 15% by 1995 (Department of Environmental Regulation, 1986). This is considered to be a conservative objective of the level of water conservation towards which efforts should be focused.

In Current Water Supply Sources, Use and Projections Section of this document, low water use projections were developed based on the assumption that the county will be successful in achieving water conservation. The SWFWMD has an active Water Conservation Planning project which is dedicated to assuring that conservation is realized.

IMPLICATIONS FOR COUNTY PLANNING EFFORTS

Charlotte County has limited water resources whose quality is within drinking water standards ground-water supply. The technical information assembled in this report should assist the county in protecting these resources, developing facilities in an economically and environmentally sound manner, and providing alternatives to naturally occurring potable sources of water supply.

One of the primary purposes of the Ground-Water Basin Resource Availability Inventory (GWBRAI) is to provide water resources information to local governments for use in their comprehensive planning efforts. The Local Government Comprehensive Planning and Land Development Regulation Act (Chapter 163, F.S.) requires all local governments within the State of Florida to develop and adopt comprehensive plans. The Department of Community Affairs (DCA) has developed an administrative rule which sets the minimum requirements for the contents of local plans.

DCA's minimum criteria rule (Rule 9J-5, F.A.C.) contains many specific requirements for water resources information which can be at least partially met by the information presented in this GWBRAI. A detailed analysis of the specific requirements which may be satisfied within this document has been developed and is presented in a separate document, the Local Government Information Guide.

This GWBRAI has been developed in part in response to the requirements of Section 373.0395, F.S. This statute directs that the GWBRAI include several specific analyses. This report has presented those data and analyses which have been completed to date.

The SWFWMD is currently working on several ground and surface-water projects which will enhance the existing information. One particularly important linkage between local governments and these projects is the completion of existing and future land use maps within the revised Local Government Comprehensive Plans. It is anticipated that these maps will serve as valuable data sources to input surface parameters which will affect the recharge and runoff features of models used in these projects. This will serve to create an iterative process whereby local government plans are driven in part by SWFWMD data reporting efforts, and SWFWMD projects are driven by those local plans.

APPENDICES

APPENDIX A - GLOSSARY

ANTICLINE - A fold that is convex upward, the beds on opposite limbs dip in opposite directions.

AQUIFER - A water-bearing layer of rock or soil that will yield water in usable quantity to a well or spring.

ARCH - see ANTICLINE.

BASE FLOW - The ground water contribution to runoff that comes from springs or seepage into a stream channel.

BASIN - The drainage or catchment area of a stream, lake, or ground-water system; watershed.

BEDROCK - A general term for the consolidated (solid) rock that underlies soils or other unconsolidated surficial material.

BRACKISH - Waters whose saline content is intermediate between that of streams and sea water.

CAPILLARY FRINGE - The saturated zone above the water table in which water is held by surface tension. Water in the capillary fringe is under a pressure head is less than atmospheric.

CARBONATE - A compound containing the radical CO_3^{-2} limestone, $CaCo_3$. Is found naturally occurring in ground water in contact with limestone or dolomite in the form of $CaCo_3$ or $MgCo_3$.

CHERT - A compact siliceous rock of varying color occurring as nodules, lenses, or layers in limestone or shales.

CLASTIC - Sediment made up of fragmental material derived from pre-existing rocks.

CONE OF DEPRESSION - A depression in the potentiometric surface (drawdowns) around a pumping well caused by the withdrawal of water.

CONFINING BED - A layer of earth material, usually clay, that does not readily transmit water, generally restricting the vertical movement of water into and out of an aquifer.

CONTROL STRUCTURE - A structure placed on a lake, reservoir, river or stream etc. that regulates either the flow or water level.

CONVECTIONAL RAINS - Atmosphere motions that are predominantly vertical, resulting in vertical cloud formation with associated thunderstorms.

COQUINA - Limestone composed of broken shells, corals, and other organic debris.

CYCLONIC STORMS - Storms caused by rotating winds which move inward toward a center of minimum pressure; hurricane.

DATUM PLANE - An arbitrary surface (or plane) used as a reference plane in the measurement of hydraulic heads. The datum most commonly used is the National Geodetic Vertical Datum (NGVD) of 1929, which closely approximates sea level.

DELTAIC - A deposit of sediment formed at the mouth of a river either in an ocean or lake which results in progradation of the shoreline.

DEMOGRAPHY - Statistical study of births, deaths, movement, etc. of populations.

DIP - The angle at which a stratum or any planar feature is inclined from the horizonal.

DIRECT REUSE - The transmission of reclaimed water directly for some specific nonpotable use, such as irrigation of a golf course or public landscape, is called direct reuse. Under direct reuse, reclaimed water is used to satisfy demands that do not need the high quality potable water and thus is a substitute for potable water. For example, reclaimed water can be used for irrigation, industrial cooling, augmentation or maintenance of minimum flows in streams to protect ecological functions, and reclamation of drained wetlands.

DISPERSION - The extent to which a solute liquid introduced into a ground-water system spreads as it moves through the system.

DISSOLUTION - The process of dissolving.

DOLOMITE - A mineral, $CaMg(CO_3)_2$ occurring in many crystalline and noncrystalline forms the same as pure limestone.

DOMAL CREST - A roughly symmetrical upfold, the beds dipping in two directions, more or less equally.

DRAWDOWN - The reduction in hydraulic head at a point caused by the withdrawal of water from an aquifer.

EFFLUENT - The outflow of water, as from a lake, ditch, or pipe.

EPOCH - A division of geologic time corresponding to a series of rock and a subdivision of a period.

EQUIPOTENTIAL LINE - A line on a map or cross section along which hydraulic heads are equal.

ESCARPMENT - A slope, steep decent, terminating high lands abruptly.

ESTUARY - A funnel shaped mouth of a coastal river valley formed as a result of a rise in sea level or land subsidence.

EVAPORITE - Sediments deposited from seas or lakes as a result of extensive or total evaporation.

FAULT - Fractures or breaks in rocks along which there has been significant displacement of the sides relative to one another parallel to the fracture; NORMAL FAULT - Hanging wall depressed relative to footwall; VERTICAL FAULT - Wall displacement near vertical.

FLOW LINE - The idealized path followed by a particle of water in a flow system that intersects an equipotential line at right angles for a homogeneous and isotropic medium.

FLOW NET - a set of intersecting equipotential lines and flow lines.

FORAMINIFERA - Unicellular animals mostly of microscopic size that secrete shells, composed of calcium carbonate or build them of cemented sedimentary grains.

FORMATION - The primary unit of mapping or description possessing certain distinctive lithic features.

FRONTAL RAINS - Atmospheric flow of air masses from high to low pressure where cool air contacts warm air causing clouds and rain.

GRAYWATER - All residential wastewater except those carried off by toilet and kitchen drains and sewers.

GROUND WATER - Water in the saturated zone that is under pressure equal to or greater than atmospheric pressure.

GROUND-WATER HEAD - See TOTAL HEAD.

GROUND-WATER MODEL - Mathematical simulation of the flow of water through porous material by digital computer.

GROUP - Lithostratigraphic unit consisting of two or more formations; succession of strata too thick or inclusive to be considered a formation.

HYDRAULIC CONDUCTIVITY - The capacity of a rock or earth material to transmit water. It is expressed as the volume of water at the existing kinematic viscosity that will move in unit time under a unit hydraulic gradient through a unit area measured at right angles to the direction of flow.

HYDRO-PERIOD - An interval of time characterized by a hydrologic or climatic event.

INDIRECT REUSE - Indirect reuse involves returning reclaimed water to a natural storage area to provide a temporal and spatial separation of the reclaimed water from the point of actual reuse. For example, use of reclaimed water to recharge the ground water through rapid infiltration basins or to replenish and augment surface water supplies that serve as a source of water supply would be an indirect reuse. Also, disposal of secondary effluents by slow-rate land application (for crop irrigation) would be a form of indirect reuse. Even though this latter operation is designed exclusively for disposal of the wastewater, it would help to further renovate the wastewater and recharge the aquifers for potential future use.

INFILTRATION BASIN - The flow of water into a rock or soil through pores or small openings within a basin.

INFRASTRUCTURE - The basic facilities, equipment, and installations needed for the functioning of a system.

INTERBEDDED - Occurring between beds, or lying in a bed parallel to other beds of a different material; interstratified.

ISOCHLOR - Contour line indicating equal concentrations of chlorides.

KARST - Hummocky landscapes formed over limestone, dolomite or gypsum characterized by the features caused by the solution of rocks by ground water, such as closed depressions, sinkholes, and caves.

LANDSAT IMAGERY - Optical reproduction by camera of land forms, vegetation, structures, water, etc. from orbiting satellite.

LEAKANCE COEFFICIENT - The volume of water that flows through a unit area of a semi-confining layer separating two aquifers per unit of head difference per unit of time. In this report, the leakance coefficient is expressed in cubic feet per day per cubic foot ($ft^3/d/ft^3$). These units can be multiplied by 7.48 to obtain units of gallons per day per cubic foot (GPD/ft^3). Many of the test sites have no value for leakance, due to the substantial time of pumpage needed to show deviation from the theoretical log-log, time-drawdown curve or the Theis curve.

LIMESTONE - A bedded sedimentary deposit consisting chiefly of calcium carbonate ($CaCO_3$), equivalent of limy mud, calcareous sand, or shell fragments.

LITHOLOGIC - The physical character of a rock, description, and classification.

MEAN - The sum of items of a sample divided by the number of items in the sample.

MEDIAN - The value of a variable in a sample that has equal number of items on either side of it.

METABOLISM - Complex of chemical and physical processes involved in the maintenance of life.

MINERALIZATION - The conversion of an element from an organic form to an inorganic state as a result of microbial decomposition.

OUTCROP - Exposure of bedrock or strata projecting through the overlying cover of detritus and soil.

OVERDRAFT - Ground-water withdrawal in excess of the amount of water that can be withdrawn from the ground-water basin annually without producing an undesired result; specifically the rules of the SWFWMD state pumping from a well at such a flow rate that the resulting water level is below sea level, greater than 5 feet below original at property line, or causes environmental damage on the land surface.

PERCHED WATER - Water which is retarded from downward movement by impermeable material beneath, that in turn, over lies porous, unsaturated rock above the normal water table.

PERMEABILITY - Capacity for transmitting a fluid, measured by the rate at which a fluid of standard viscosity can move a given distance through a given interval of time.

PHYSIOGRAPHIC - Genesis and evolution of land forms with a unified geomorphic history.

POROSITY - The voids or openings in a rock. Porosity may be expressed quantitatively as the ratio of the volume of voids in a rock to the total volume of the rock.

POTABLE - Water that is fit for human consumption.

POTENTIOMETRIC SURFACE - A surface that represents the total head in an aquifer. It is determined by the height above a datum plane to which water will rise in tightly cased wells that penetrate the aquifer.

RECHARGE - Depth of water that enters an aquifer per unit area of the aquifer.

RECLAIMED WATER - Domestic wastewater that has been upgraded in quality for various forms of reuse in accordance with the criteria established by the FDER (Chapter 17-6, FAC).

RECYCLE - Recycle is the direct transmission and reuse of reclaimed water for the same original use. For example, use of highly treated (reclaimed) water directly for potable use would be a recycle.

REEFAL - A range or ridge of rocks lying at or near the surface of water, esp. coral; atoll, barrier.

REENTRANT - Recess; directed inward; indentation in a landform, more or less angular.

RETROFIT - To furnish or provide with new equipment or parts unavailable at the time of original construction.

RIDGE - A relatively narrow elevation which is prominent on account of the steep angle at which it rises.

ROCK - Any naturally formed, consolidated coherent, or relatively hard material (but not soil) consisting of two or more minerals; stone.

SACCHAROIDAL - Having a granular texture resembling that of sugar; some sandstones and marbles.

SATURATED ZONE - The subsurface zone in which all voids are filled with water.

SEDIMENTARY - Descriptive term for rock formed of sediment; clastic rocks, conglomerate, sand stone, shales, rocks formed by precipitation from solution as salt, gypsum, or from secretions of organisms as most limestones.

SOIL - The layer of material at the land surface that supports plant growth.

SPECIFIC CAPACITY - The yield of a well per unit of drawdown.

SPECIFIC RETENTION - The ratio of the volume of water retained in a rock after gravity drainage to the volume of the rock.

SPECIFIC YIELD - The ratio of the volume of water that will drain from an unconfined aquifer in a confined aquifer under the influence of gravity to the volume of saturated rock.

STORAGE COEFFICIENT - The volume of water released from storage in a unit area of a aquifer when the head is lowered a unit distance.

STRATIFICATION - The layered structure of sedimentary rocks.

SYNCLINE - A fold in rocks in which the strata dip inward from both sides toward the axis.

TAILWATER-applied irrigation - A water mass leaving an irrigated area as surface water.

TECTONICS - Designating the rock structure and external forms resulting from the deformation of the earths crust.

TERRACE - Benches; relatively flat, horizontal, or gently inclined surfaces, sometimes long and narrow which are bounded by steeper, ascending, and steeper descending slopes.

TOTAL HEAD - The summation of the elevation head, the pressure head, and the velocity head.

TRANSMISSIVITY - The rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient. It equals the hydraulic conductivity multiplied by the aquifer thickness.

UNCONFORMABLE - Relationship between strata where the contact is an erosion surface.

UNIT - An individual, group, or structure regarded as an elementary structural or functional constituent of a whole.

UNSATURATED ZONE - The subsurface zone, usually starting at the land surface, that contains both water and air; vadose; zone of aeration.

UPLIFT - Elevation of any extensive part of the earths surface relative to some other parts.

WATER TABLE - The level in the saturated zone at which the pressure is equal to the atmospheric pressure.

APPENDIX B -RELEVANT FLORIDA LEGISLATION

Florida's water resources have attracted significant attention from the government and the public, particularly during the past twenty years. Rapid population growth and urban sprawl, combined with a fragile natural environment, have created major problems throughout the state. Historically, government programs have responded primarily to immediate issues. With the multitude of government agencies in Florida, it has become apparent that consistency among policies and programs is essential to effective growth management. Statewide planning has emerged as a means of integrating local, regional, and state functions for such consonance.

The original Florida Comprehensive Planning Act (formerly Chapter 23, Florida Statutes, currently Chapter 186, Florida Statutes) was enacted in 1972, along with two other land management acts. The Florida Environmental Land and Water Management Act (Chapter 380, Florida Statutes) provided regulations for Developments of Regional Impact (DRI's) and Areas of Critical State Concern. The Florida Water Resources Act (Chapter 373, Florida Statutes) established state policies as well as implementation measures, including the creation of the regional water management districts (WMD's). This act also mandated the formulation of a State Water Use Plan (Section 373.036, Florida Statutes) as a functional development of the State Comprehensive Plan, the Local Government Comprehensive Planning Act (Chapter 163, Florida Statutes) was enacted in 1975. The purposes of these four legislative acts was to improve resource management and guide future growth through state and local planning programs.

In 1978, the legislature amended the Comprehensive Planning Act, reducing it to an advisory level. With the absence of enforcement power, the statewide planning effort was temporarily ended.

A new approach was taken in 1980 with the enactment of the Florida Regional Planning Council Act (Chapter 186, Florida Statutes). This act required each of the eleven regional planning councils (RPC's) to develop comprehensive plans. Lack of state funds largely inhibited this effort, and no link was provided between local and regional plans.

While the state comprehensive planning effort was halted, other water-resource related regulation/policy emerged. The State Water Policy (Chapter 17-40, FAC) was adopted in 1981, to guide the development of rules, plans, and programs of the FDER and the WMD's. WMD rules are required by Chapter 373 to be consistent with the State Water Policy.

The Ground-Water Basin Resource Availability Inventory (Section 373.0395, Florida Statutes), also mandated/authorized in 1982, was incorporated into the Florida Water Resources Act. The legislature mandated the WMD's to inventory ground-water resources within each District and disseminate the information to local and regional agencies.

The state comprehensive plan was readdressed in 1984 with the enactment of the Florida State and Regional Planning Act (formerly Chapter 23, Florida Statutes, currently in Chapter 186, Florida Statutes). This act not only required the preparation of a state comprehensive plan, but included consistency requirements for agency functional plans and regional policy plans. Conformity obligations were not included for local comprehensive plans.

In 1985, Chapter 85-87, Laws of Florida, adopted the state comprehensive plan which was comprised of 25 state goals and policies, one of which addressed water resources. This law also assigned a State Comprehensive Plan Committee to evaluate the funding needs of local and state agencies for implementation. The Local Government Comprehensive Planning and Development Regulation Act (Chapter 85-55, Laws of Florida) amended several development planning and regulatory laws, specifically addressing coastal protection, DRI's, and local comprehensive plans. This bill expanded the requirements of local comprehensive plans and provided a system of review to ensure consistency with the state comprehensive plan. Additionally, requirements were made for each local comprehensive plan to identify the need for and the process to ensure coordination of all development activities and services with the pertinent WMD.

Chapter 85-42, Laws of Florida, was also enacted in 1985, amending the Ground-Water Basin Resource Availability Inventory. The WMD's are now required to designate by rule, prime ground-water recharge areas upon completion of the Inventory. This information will be vital to local governments in preparation of the conservation element of their comprehensive plans which must address the preservation, use, and protection of ground-water recharge areas as well as other environmental issues.

VII. APPENDIX C. Lakes that have adopted levels within the Southern West-Central Florida Ground-Water Basin.

REF. NO.	NAME	LOCATION SECT-TWNSHP-RANGE	COUNTY	BASIN
1.	Adelaide	5-33-28	HIGHLANDS	20
2.	Angelo	25-33-28	HIGHLANDS	20
3.	Anoka	27-33-28	HIGHLANDS	20
4.	Apthorpe	18-36-30	HIGHLANDS	20
5.	Blue	30-36-30	HIGHLANDS	20
6.	Bonnet	8-34-29	HIGHLANDS	20
7.	Brentwood	10-33-28	HIGHLANDS	20
8.	Byrd	9-33-28	HIGHLANDS	20
9.	Charlotte	17-35-29	HIGHLANDS	20
10.	Chilton	7-38-28	HIGHLANDS	20
11.	Clay	29-36-30	HIGHLANDS	20
12.	Damon	3-33-28	HIGHLANDS	20
13.	Denton	2-34-38	HIGHLANDS	20
14.	Dinner	17-34-29	HIGHLANDS	20
15.	Francis	22-36-29	HIGHLANDS	20
16.	Glenada	34-33-28	HIGHLANDS	20
17.	Grassy	17-37-30	HIGHLANDS	20
18.	Henry	25-36-29	HIGHLANDS	20
19.	Huckleberry	7-35-29	HIGHLANDS	20
20.	Huntley	5-37-30	HIGHLANDS	20
21.	Jackson	30-34-29	HIGHLANDS	20
22.	Josephine	32-35-29	HIGHLANDS	20
23.	June-in-Winter	34-36-29	HIGHLANDS	20
24.	Lachard	36-36-29	HIGHLANDS	20
25.	Lelia	34-33-28	HIGHLANDS	20
26.	Letta	31-33-29	HIGHLANDS	20
27.	Little Bonnet	36-33-28	HIGHLANDS	20
28.	Little Jackson	6-35-29	HIGHLANDS	20
29.	Little Red Water	14-36-29	HIGHLANDS	20
30.	Little Red Water	12-34-28	HIGHLANDS	20
31.	Lotela	26-33-28	HIGHLANDS	20
32.	McCoy	6-37-30	HIGHLANDS	20
33.	Mirror	7-37-30	HIGHLANDS	20
34.	Olivia	6-33-28	HIGHLANDS	20
35.	Pearl	6-37-30	HIGHLANDS	20
36.	Pioneer	11-33-28	HIGHLANDS	20
37.	Placid	30-37-30	HIGHLANDS	20
38.	Pythias	2-33-28	HIGHLANDS	20
39.	Red Beach	15-35-29	HIGHLANDS	20
40.*	Red Water	14-36-29	HIGHLANDS	20
41.	Ruth	18-35-29	HIGHLANDS	20
42.	Saddlebags	6-37-30	HIGHLANDS	20
43.	Sebring	14-34-28	HIGHLANDS	20
44.	Sirena	1-37-29	HIGHLANDS	20
45.	Tulane	27-33-28	HIGHLANDS	20
46.	Verona	23-33-28	HIGHLANDS	20
47.	Viola	14-33-28	HIGHLANDS	20
48.	Wolf(Orange)	24-35-28	HIGHLANDS	20
49.	Alice	16-27-17	HILLSBOROUGH	14
50.	Allen	10-27-18	HILLSBOROUGH	14
51.	Armistead	25-27-17	HILLSBOROUGH	14
52.	Artillery	3-27-17	HILLSBOROUGH	14

APPENDIX C. (continued)

REF. NO.	NAME	LOCATION SECT-TWNSHP-RANGE	COUNTY	BASIN
53.	Avis	15-28-18	HILLSBOROUGH	14
54.	Bay	4-28-18	HILLSBOROUGH	14
55.	Bellows (East)	2-29-19	HILLSBOROUGH	13
56.	Bird	26-27-18	HILLSBOROUGH	14
57.	Boat	14-28-18	HILLSBOROUGH	14
58.	Brant	23-27-18	HILLSBOROUGH	14
59.	Brooker	2-27-18	HILLSBOROUGH	14
60.	Browns	2-27-18	HILLSBOROUGH	14
61.	Buck	29-27-17	HILLSBOROUGH	14
62.	Burrell	31-27-19	HILLSBOROUGH	13
63.	Calm	14-27-17	HILLSBOROUGH	14
64.	Carlton	7-32-21	HILLSBOROUGH	11
65.	Carroll	15-28-18	HILLSBOROUGH	14
66.	Chapman	25-27-18	HILLSBOROUGH	14
67.	Charles	23-27-18	HILLSBOROUGH	14
68.	Church	28-27-17	HILLSBOROUGH	14
69.	Commiston	12-17-18	HILLSBOROUGH	13
70.	Cooper	11-27-18	HILLSBOROUGH	14
71.	Crenshaw	22-27-18	HILLSBOROUGH	14
72.	Crescent	10-27-17	HILLSBOROUGH	14
73.	Crystal	14-27-28	HILLSBOROUGH	14
74.	Dan	6-27-17	HILLSBOROUGH	14
75.	Deer	1-27-18	HILLSBOROUGH	14
76.	Echo	28-27-17	HILLSBOROUGH	14
77.	Eckles	11-28-18	HILLSBOROUGH	13
78.	Egypt	27-28-18	HILLSBOROUGH	13
79.	Elizabeth	11-27-17	HILLSBOROUGH	14
80.	Elaine	15-28-18	HILLSBOROUGH	14
81.	Ellen	10-28-18	HILLSBOROUGH	14
82.	Fairy (Maurine)	34-27-17	HILLSBOROUGH	14
83.	Fern	11-27-17	HILLSBOROUGH	14
84.	Frances	11-27-18	HILLSBOROUGH	14
85.	Garden (Thomas)	17-27-17	HILLSBOROUGH	14
86.	Gass	36-27-18	HILLSBOROUGH	14
87.	George	10-28-18	HILLSBOROUGH	14
88.	Geraci	15-27-18	HILLSBOROUGH	14
89.	Gornto	21-29-20	HILLSBOROUGH	13
90.	Grady	26-30-20	HILLSBOROUGH	11
91.	Halfmoon	31-27-18	HILLSBOROUGH	14
92.	Halls	3-28-18	HILLSBOROUGH	14
93.	Hanna	18-27-19	HILLSBOROUGH	13
94.	Hart	6-27-19	HILLSBOROUGH	13
95.	Harvey (Ruth)	3-27-18	HILLSBOROUGH	14
96.	Hiawatha	2-27-17	HILLSBOROUGH	14
97.	Hickory Hammock	34-29-20	HILLSBOROUGH	11
98.	Hixon	3-28-17	HILLSBOROUGH	14
99.	Hobbs	1-27-18	HILLSBOROUGH	14
100.	Hog Island	6-27-19	HILLSBOROUGH	13
101.	Hooker	12-29-20	HILLSBOROUGH	14
102.	Horse	26-27-17	HILLSBOROUGH	14
103.	Island Ford	10-27-17	HILLSBOROUGH	14
104.	Jackson	17-27-17	HILLSBOROUGH	14
105.	James	23-27-17	HILLSBOROUGH	14

APPENDIX C. (continued)

REF. NO.	NAME	LOCATION SECT-TWNSHP-RANGE	COUNTY	BASIN
106.	Josephine	25-27-17	HILLSBOROUGH	14
107.	Juanita	22-27-17	HILLSBOROUGH	14
108.	Kathy	20-29-20	HILLSBOROUGH	13
109.	Keene	7-27-19	HILLSBOROUGH	13
110.	Kell	1-27-18	HILLSBOROUGH	13
111.	Keystone	15-27-17	HILLSBOROUGH	14
112.	LeClare	30-27-18	HILLSBOROUGH	14
113.	Lipsey	10-28-18	HILLSBOROUGH	14
114.	Little	23-27-17	HILLSBOROUGH	14
115.	Long	36-27-18	HILLSBOROUGH	13
116.	Long (Hunter)	13-29-20	HILLSBOROUGH	13
117.	Magdalene	2-28-18	HILLSBOROUGH	14
118.	Medard Reservior	36-29-21	HILLSBOROUGH	11
119.	Merrywater	22-27-18	HILLSBOROUGH	14
120.	Mound	11-27-17	HILLSBOROUGH	14
121.	Mud (Walden)	6-29-22	HILLSBOROUGH	13
122.	Osceola	3-27-17	HILLSBOROUGH	14
123.	Platt	35-27-18	HILLSBOROUGH	14
124.	Pretty	26-27-17	HILLSBOROUGH	14
125.	Rainbow	22-27-17	HILLSBOROUGH	14
126.	Raleigh	27-27-17	HILLSBOROUGH	14
127.	Reinheimer	15-27-18	HILLSBOROUGH	14
128.	Rock	25-27-17	HILLSBOROUGH	14
129.	Rogers	27-27-17	HILLSBOROUGH	14
130.	Saddleback	22-27-18	HILLSBOROUGH	14
131.	Starvation	21-27-18	HILLSBOROUGH	14
132.	Stemper	13-27-18	HILLSBOROUGH	13
133.	Strawberry(Crystal)	14-27-18	HILLSBOROUGH	14
134.	Sunset	17-27-18	HILLSBOROUGH	14
135.	Taylor	16-27-17	HILLSBOROUGH	14
136.	Thomas	10-27-18	HILLSBOROUGH	14
137.	Thonotosassa	11-28-20	HILLSBOROUGH	13
138.	Turkey Ford	18-27-18	HILLSBOROUGH	14
139.	Twin	22-28-18	HILLSBOROUGH	14
140.	Unnamed	18-27-19	HILLSBOROUGH	13
141.	Unnamed	22-32-21	HILLSBOROUGH	11
142.	Unnamed	8-27-19	HILLSBOROUGH	13
143.	Unnamed	2-28-17	HILLSBOROUGH	14
144.	Valrico	13-29-20	HILLSBOROUGH	13
145.	Velburton	21-27-17	HILLSBOROUGH	14
146.	Virginia	3-27-18	HILLSBOROUGH	14
147.	Weeks	1-29-20	HILLSBOROUGH	13
148.	White Trout	22-28-18	HILLSBOROUGH	14
149.	Wimauma	9-32-20	HILLSBOROUGH	11
150.	Bass (Holiday)	34-26-17	PASCO	16
151.	Bell	13-26-18	PASCO	13
152.	Big (Vienna)	23-26-18	PASCO	16
153.	Bird	36-26-18	PASCO	13
154.	Camp	34-26-18	PASCO	16
155.	Clear	1-25-20	PASCO	19
156.	Cow (East)	19-26-19	PASCO	13
157.	Fishing	34-26-17	PASCO	16
158.	Garden	25-25-16	PASCO	15

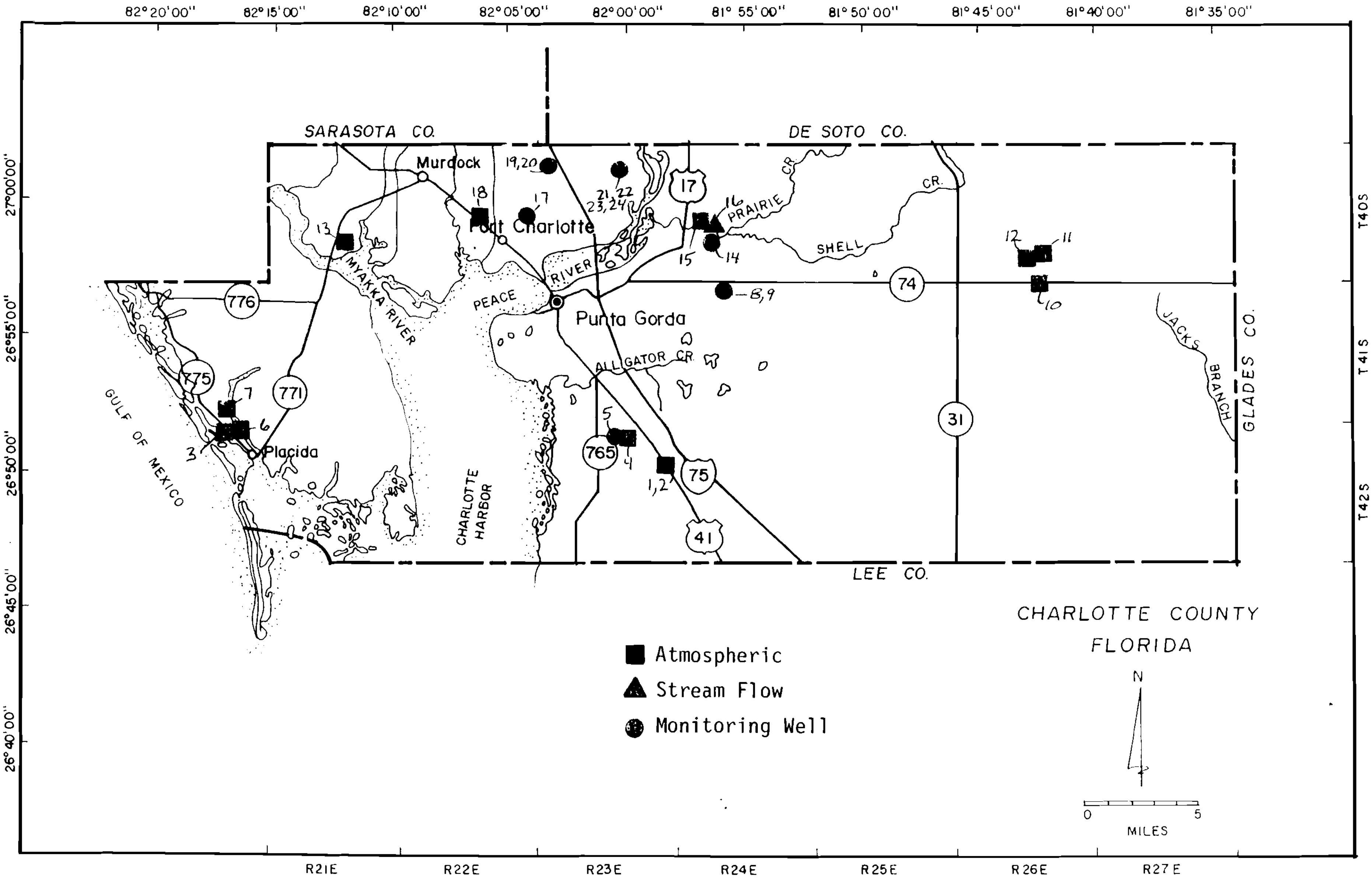
APPENDIX C. (continued)

REF. NO.	NAME	LOCATION SECT-TWNSHP-RANGE	COUNTY	BASIN
159.	Geneva (Mud)	26-26-17	PASCO	16
160.	Hog (Joyce)	19-26-19	PASCO	13
161.	King	7-26-19	PASCO	13
162.	King (East)	22-25-20	PASCO	13
163	Linda	26-26-18	PASCO	16
164.	Little Moss	35-26-18	PASCO	16
165.	Minniola	35-26-17	PASCO	16
166.	Moon	28-25-17	PASCO	15
167.	Moss	35-26-18	PASCO	16
168.	Padgett	24-26-18	PASCO	13
169.	Parker (Ann)	35-26-17	PASCO	16
170.	Pierce	9-25-18	PASCO	15
171.	Richey	3-26-16	PASCO	15
172.	Saxon	30-26-19	PASCO	13
173.	Seminole	35-26-17	PASCO	16
174.	Thomas	11-26-18	PASCO	16
175.	Wistaria	2-26-18	PASCO	16
176.	Worrell	26-25-16	PASCO	15
177.	Tarpon	20-27-16	PINELLAS	16
178.	Agnes	4-27-25	POLK	10
179.	Ariana	3-28-25	POLK	20
180.	Arietta	27-27-25	POLK	10
181.	Banana	10-29-24	POLK	20
182.	Bess	18-29-27	POLK	20
183.	Big Gum	26-29-28	POLK	20
184.	Blue	24-30-27	POLK	20
185.	Bonnet	14-28-23	POLK	20
186.	Bonny	20-28-24	POLK	20
187.	Buffum	12-31-26	POLK	20
188.	Camp	20-27-26	POLK	10
189.	Cannon	19-28-26	POLK	20
190.	Clearwater	5-27-25	POLK	10
191.	Clinch	31-31-28	POLK	20
192.	Conine	9-28-26	POLK	20
193.	Crooked	1-31-27	POLK	20
194.	Crystal	23-29-26	POLK	20
195.	Cypress	36-29-28	POLK	20
196.	Eloise	3-29-26	POLK	20
197.	Fannie	11-28-26	POLK	20
198.	Garfield	5-30-26	POLK	20
199.	Gator	26-30-26	POLK	20
200.	Gibson	25-27-23	POLK	20
201.	Grassy	19-27-26	POLK	10
202.	Gum	17-27-26	POLK	10
203.	Haines	33-27-26	POLK	10
204.	Hamilton	18-28-27	POLK	20
205.	Hancock	8-29-25	POLK	20
206.	Hart	24-29-26	POLK	20
207.	Hartridge	8-28-26	POLK	20
208.	Helene	34-26-25	POLK	10
209.	Henry	16-31-26	POLK	20
210.	Henry (Drane)	36-27-26	POLK	10
211.	Hickory	17-32-28	POLK	20

APPENDIX C. (continued)

REF. NO.	NAME	LOCATION SECT-TWNSHP-RANGE	COUNTY	BASIN
212.	Howard	30-26-28	POLK	20
213.	Hunter	24-28-23	POLK	20
214.	Ida	28-31-28	POLK	20
215.	Idylwild	18-28-26	POLK	20
216.	Jessie	12-28-25	POLK	20
217.	Juliana	15-27-25	POLK	10
218.	Lena	9-28-25	POLK	20
219.	Lenore	10-31-28	POLK	20
220.	Link	27-28-28	POLK	20
221.	Little Gum	35-29-28	POLK	20
222.	Little Agnes	4-27-25	POLK	10
223.	Little Hamilton	5-28-27	POLK	20
224.	Little Van	26-27-25	POLK	10
225.	Lulu	4-29-26	POLK	20
226.	Mariam	27-28-26	POLK	20
227.	Mattie	14-27-25	POLK	10
228.	May	29-28-26	POLK	20
229.	Middle Hamilton	7-28-27	POLK	20
230.	Mirror	20-28-26	POLK	20
231.	Moody	17-31-28	POLK	20
232.	Mud (Margaret)	6-27-35	POLK	10
233.	Myrtle	19-29-27	POLK	20
234.	Myrtle	32-27-25	POLK	10
235.	Otis	28-28-26	POLK	20
236.	Parker	8-28-24	POLK	20
237.	Parker	32-29-27	POLK	20
238.	Parks	36-29-27	POLK	20
239.	Polecat	27-30-26	POLK	20
240.	Reedy	35-31-28	POLK	20
241.	Reeves	13-29-26	POLK	20
242.	Rochelle	4-28-26	POLK	20
243.	Round	13-29-26	POLK	20
244.	Roy	34-28-26	POLK	20
245.	Ruby	12-29-26	POLK	20
246.	Saddlebag	25-32-27	POLK	20
247.	Scott	18-29-24	POLK	20
248.	Shipp	32-28-26	POLK	20
249.	Silver	20-28-27	POLK	20
250.	Smart	9-28-26	POLK	20
251.	Spring	20-28-26	POLK	20
252.	Streety	24-32-27	POLK	20
253.	Summit	34-28-26	POLK	20
254.	Surveyors	26-30-26	POLK	20
255.	Swoope	29-27-26	POLK	10
256.	Tennessee	9-27-25	POLK	10
257.	Thomas	1-30-28	POLK	20
258.	Trout	34-32-28	POLK	20
259.	Van	25-27-25	POLK	10
260.	Walker	21-30-26	POLK	20
261.	Whistler	33-27-25	POLK	10
262.	Winterset	11-29-26	POLK	20

All were adopted 8/4/87 except *.



Appendix D. Hydrologic Monitoring Stations (Southwest Florida Water Management District).

APPENDIX D. HYDROLOGIC DATA BASE MONITORING STATION INFO EXPLANATION TABLE.

COUNTY CODE: County code in which the site is located.

015 - Charlotte
027 - DeSoto
049 - Hardee
055 - Highlands
057 - Hillsborough
081 - Manatee
101 - Pasco
103 - Pinellas
105 - Polk
115 - Sarasota

REF NUM	:	Number referenced to station location map
SITE ID	:	Numerical code based on USGS, SWFWMD, or other coding system
SITE NAME	:	Unique name assigned by the SWFWMD
DATA TYPE	:	Type of data collected
DATA SRC CODE	:	Agency which collected data
TOTAL DEPTH	:	Depth to base of well
CASE DEPTH	:	Depth to base of well casing
CASE DIAM	:	Diameter of well casing
GS AW CODE	:	USGS aquifer code
EVAPORATION	:	Evaporation station
RAINFALL	:	Rainfall station
STREAMFLOW	:	Streamflow station
TDS	:	Total dissolved solids
MAJOR IONS	:	$(HCO_3^-, CO_3^-, SO^{43-}, Cl^-, Ca^{2+}, Na^+, Mg^{2+}, K^+,)$
HARDNESS	:	Total hardness
BACTLOGICAL	:	Bacteriological: (Total and Fecal Coliform)
PHOSPHOROUS	:	Total
NITROGEN	:	Total
DETERGENTS	:	Cleansing agents
O MINORING CN	:	Other minor inorganic constituents $(S^{-2}, As, Se, Mn, F^-, Hg, Pb, Zn, Cd, Fe, Cu, Cr.Ba, Ag)$.
RADACTIVITY	:	Gross measurement of radioactivity (Alpha, Beta, Gamma) without regard to the radiochemical species that produces the radiation
RAD CHEM SP	:	Radiochemical species - refers to the individual radionuclide such as: Radium 226, Cobalt 60, Strontium 90, and Tritium
ORG GROUP	:	This component refers to the reporting of the presence of organic groups, such as the phenols or the methols, rather than of specific organic molecules, such as chloroform or DDT
PESTICIDES	:	This component includes insecticides, herbicides, fungicides, rodendricides, etc. (e.g.- chlordate, DDT, 2,4,5-TP, and silvex)
O ORGANICS	:	This component refers to the reporting of the presence of specific organic species, other than pesticides, such as chloroform, PCB's and formaldehyde
BOD	:	Biological oxygen demand
COD	:	Chemical oxygen demand
DO	:	Dissolved oxygen
O DISS GAS	:	Other dissolved gases (e.g. - nitrogen, hydrogen sulfide, methane)
pH	:	Hydrogen ion activity
SP COND	:	Specific conductance
TEMP	:	Temperature
TURBIDITY	:	
COLOR	:	
ODOR	:	
ALKALINITY	:	
WATER LEVEL	:	Water level measurement in well
COMPLETE		
#SAMP DATES	:	Number of dates on which sampling has been performed and are entered in the Hydrologic Data Base

PARAMETER SAMPLING FREQUENCY CODE:

A = 0
B = 1 - 100
C = 101 - 500
D = 501 - 1,000
E = 1,001 - 2,000
F = 2,001 - 5,000
G = 5,001 - 10,000
H > 10,000

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                                    HDB STATION INFO IN COUNTY TABLES FOR PARAMETERS SAMPLED

                                                            D
                                                            A
 C                                                          T    T                   E     BP  ORR               W      #
 O                                                          A    O    C          G   V S M AH D AA  PO   D      AA      S
 U                                    S                 D        T    A    C     S   A T A CO EMDD OE        T  LT      A
 N                                    I                 A   S    A    S    A         PRR JHTSNTIA  RSO   D   U  KE      M
 T    R       S                       T                 T   R    L    E    S     A   OAE OALPIENCC GTR   I S R  AR      P
 Y    E       I                       E                 A   C              E     O   PIA RROHTROTH  IG   S P B  L
      F       T                                                  D    D              ANM  DGORGRIE GCA   S   IC IL      D
 C            E                       N                 T   C    E    E    D     C   TFF INIROEGVM RIN     CTDOONE      A
 O    N                               A                 Y   O    P    P    I     O   TALTOECOGN I TODIBC G OEILDIV      T
 D    U       I                       M                 P   D    T    T    A     D   OLODNSAUETCTSOUECOODAPNMTOOTE      E
 E    M       D                       E                 E   E    H    H    M     E   NLWSSSLSNSNYPCPSSDDOSHDPYRRYL      S

015   1 26500908156220 PUNTA GORDA                     ATM N/A  N/A  N/A  N/A   N/A  AHAAAAAAAAAAAAAAAAAAAAAAAAAAA  26877
015   2 26500908156220 PUNTA GORDA TOWER               ATM SWFM N/A  N/A  N/A   N/A  AFAAAAAAAAAAAAAAAAAAAAAAAAAAA   4262
015   3 26511008217220 ROTUNDA                         ATM SWFM N/A  N/A  N/A   N/A  AFAAAAAAAAAAAAAAAAAAAAAAAAAAA   4200
015   4 26513808200220 CHARLOTTE SOUTH                 ATM SWFM N/A  N/A  N/A   N/A  ADAAAAAAAAAAAAAAAAAAAAAAAAAAA    822
015   5 26513808200220 PUNTA GORDA HEIGHTS             WEL USGS 125   84    6   N/A  AAAAAAAAAAAAAAAAAAAAAAAAAAAAF   4975
015   6 26514208217220 CAPE HAZE & ROTONDA             ATM SWFM N/A  N/A  N/A   N/A  AFAAAAAAAAAAAAAAAAAAAAAAAAAAA   4200
015   7 26520808217220 CAPE HAZE                       ATM SWFM N/A  N/A  N/A   N/A  AFAAAAAAAAAAAAAAAAAAAAAAAAAAA   4200
015   8 26564608155450 S.R. 74 SHALLOW                 WEL USGS  25   21    2   N/A  AAAAAAAAAAAAAAAAAAAAAAAAAAAAB     81
015   9 26564608155450 SR 74 DEEP                      WEL USGS 280  194    4   N/A  AAABAAAAAAAAAAAAAAAAAABAAAAAB     93
015  10 26570008142000 BERMONT 34                      ATM SWFM N/A  N/A  N/A   N/A  AFAAAAAAAAAAAAAAAAAAAAAAAAAAA   4261
015  11 26580008142000 BERMONT 22                      ATM SWFM N/A  N/A  N/A   N/A  AFAAAAAAAAAAAAAAAAAAAAAAAAAAA   4352
015  12 26580208142160 BERMONT                         ATM N/A  N/A  N/A  N/A   N/A  AAAAAAAAAAAAAAAAAAAAAAAAAAAAA      0
015  13 26581808212080 FRIZZELL TOWER                  ATM SWFM N/A  N/A  N/A   N/A  AFAAAAAAAAAAAAAAAAAAAAAAAAAAA   4262
015  14 26583708156110 ROMP 11                         WEL USGS 335  220    4   N/A  AAAAAAAAAAAAAAAAAAAAAAAAAAAAC    102
015  15 26590208156060 SHELL CREEK                     ATM SWFM N/A  N/A  N/A   N/A  ADAAAAAAAAAAAAAAAAAAAAAAAAAAA    578
015  16 26590408156090 SHELL CREEK NR PUNTA GORDA      FLO USGS N/A  N/A  N/A   N/A  AAGAAAAAAAAAAAAAAAAAAAAAAAAAG  13279
015  17 26592008204560 PT. CHARLOTTE UTIL DEEP         WEL USGS 156  128    4   N/A  AAAAAAAAAAAAAAAAAAAAAAAAAAAAB     82
015  18 26592708206280 LINTON LANE                     ATM SWFM N/A  N/A  N/A   N/A  ADAAAAAAAAAAAAAAAAAAAAAAAAAAA    730
015  19 27013308203460 PT. CHARLOTTE DEEP              WEL USGS 350  312    4   N/A  AAABAAAAAAAAAAAAAAAAAABAAAAAB     97
015  20 27013308203460 PT. CHARLOTTE SHALLOW           WEL USGS  89   84    4   N/A  AAABAAAAAAAAAAAAAAAAAABAAAAAB     86
015  21 27015208200280 ROMP 10 (917)                   WEL USGS 917  595    4   N/A  AAABAAAAAAAAAAAAAAAAAABAAAAAC    196
015  22 27015208200280 ROMP 10 (575)                   WEL USGS 575  303    4   N/A  AAABAAAAAAAAAAAAAAAAAABAAAAAC    187
015  23 27015208200280 ROMP 10 WT WELL                 WEL USGS  30   20    4   N/A  AAABAAAAAAAAAAAAAAAAAABAAAAAB    112
015  24 27015208200280 ROMP 10 (270)                   WEL USGS 270  110    4   N/A  AAABAAAAAAAAAAAAAAAAAABAAAAAC    189
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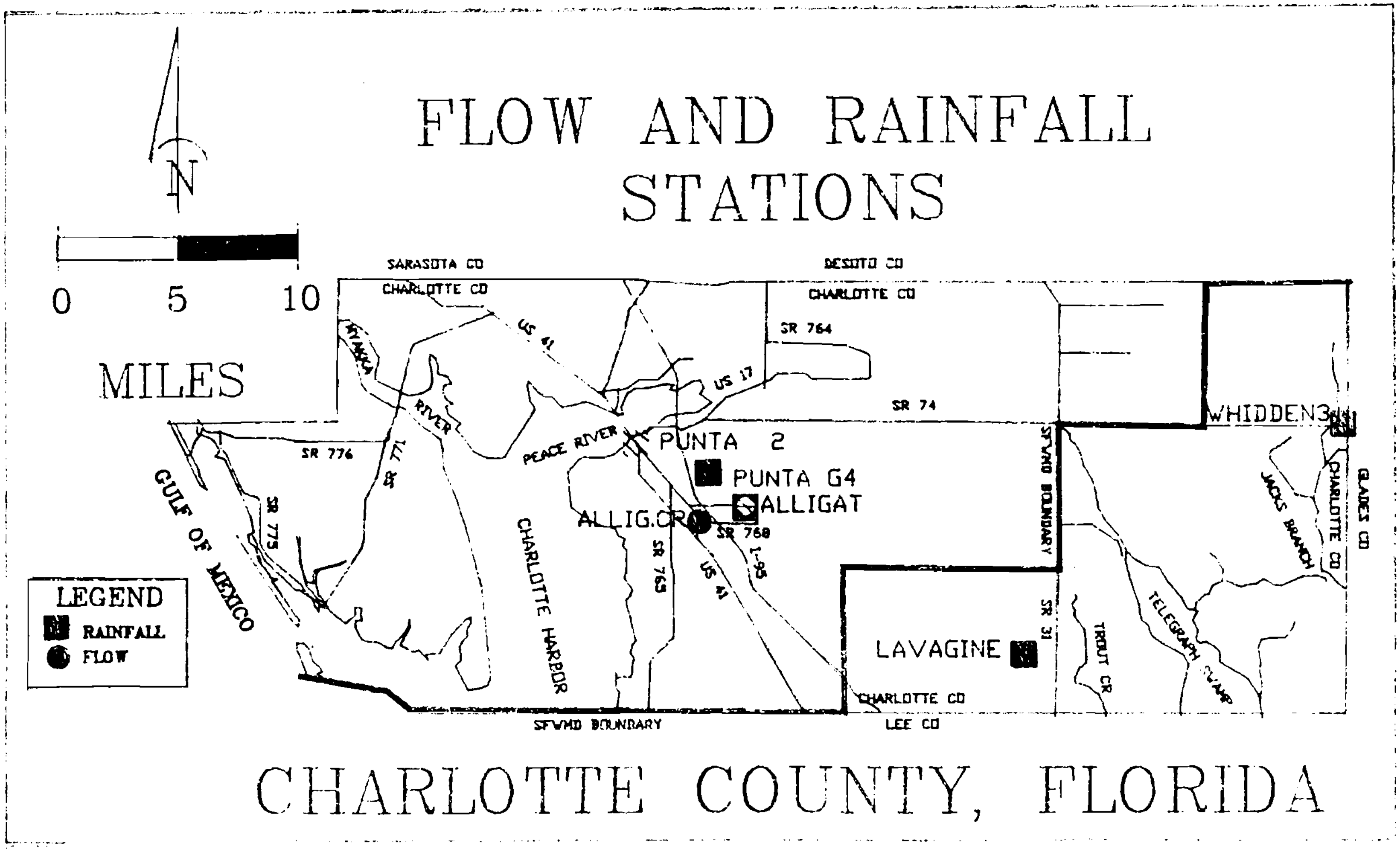
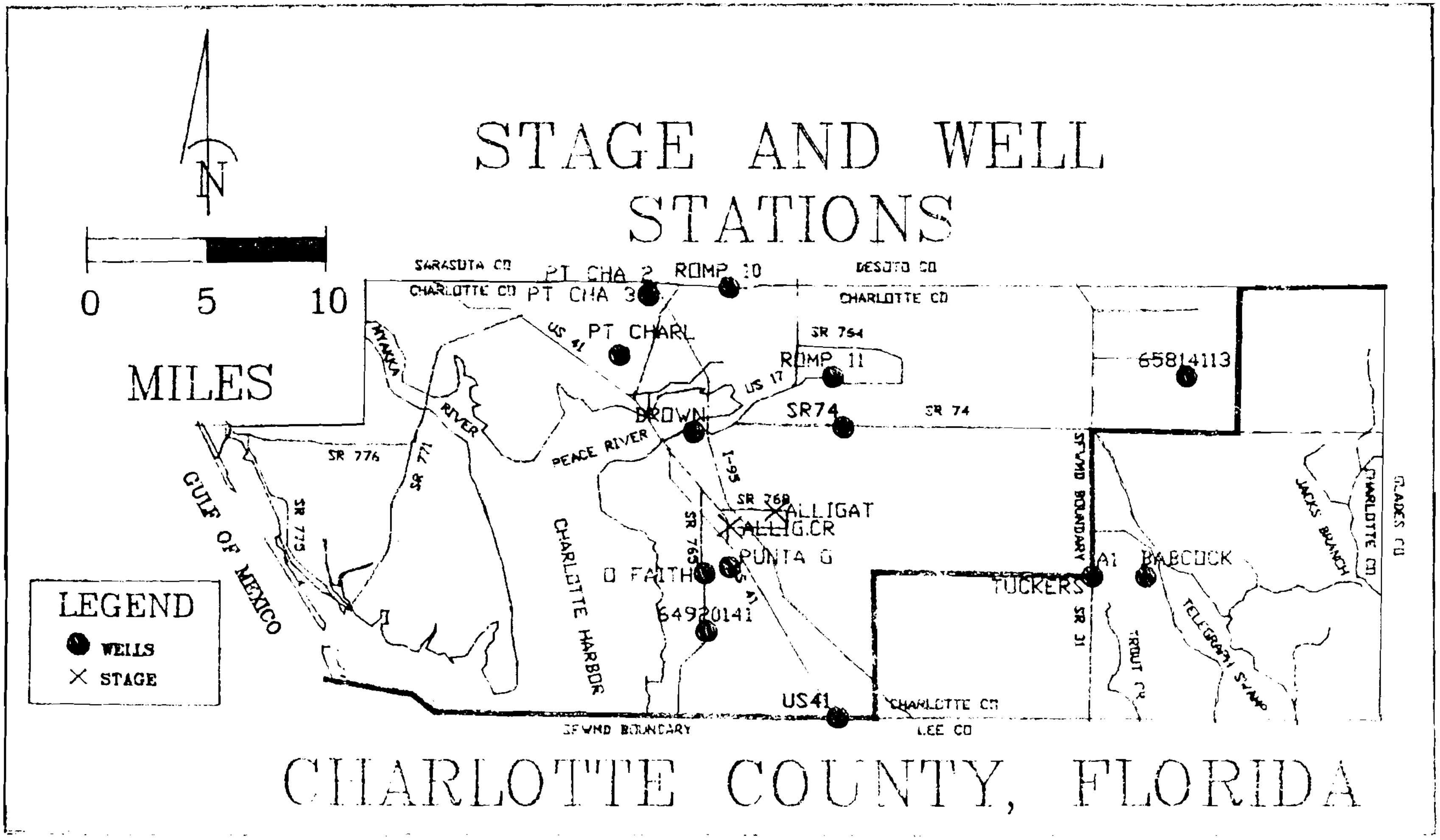
Appendix D. From Southwest Florida Water Management District.



Appendix D. Hydrologic Monitoring Stations (South Florida Water Management District).

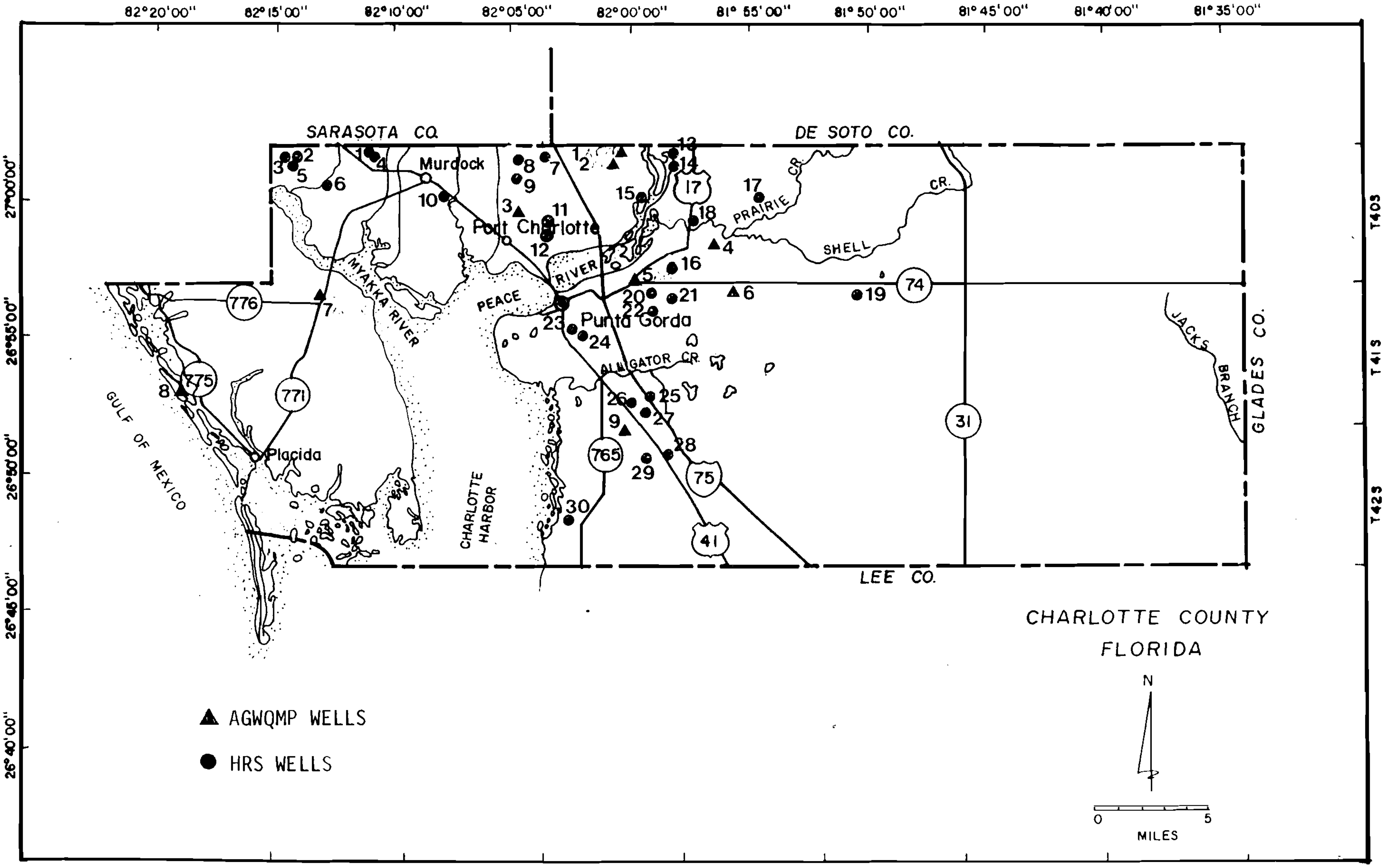


Appendix D. Hydrologic Monitoring Stations (South Florida Water Management District).

Climatological and Hydrologic Data Monitoring Stations in Charlotte County

STATION	ALT ID	CNTY	TYPE	METH	FQ	STRA	RCDR	STRT	END	FULL STATION NAME	SETNRG	LAT	LONG
ALLIGAT	2293390	CHARL	STG	MEAN	DA	000		1979-	1979	NORTH PRONG ALLIGATOR CREEK NR PUNTA GORDA, FLA.	234123	265341	815831
ALLIGAT	2293390	CHARL	RAIN	SUM	DA	000		1974-	1981	NORTH PRONG ALLIGATOR CREEK NR PUNTA GORDA, FLA.	234123	265341	815831
ALLIGAT	2293390	CHARL	FLOW	MEAN	DA	XX		1975-	1975	NORTH PRONG ALLIGATOR CREEK NR PUNTA GORDA, FLA.	234123	265341	815831
ALLIG.CR	2293400	CHARL	FLOW	MEAN	DA	XX		1982-	1983	ALLIGATOR CREEK NR PUNTA GORDA, FL	0 0 0	265307	820023
ALLIG.CR	2293400	CHARL	STG	MEAN	DA	000		1982-	1983	ALLIGATOR CREEK NR PUNTA GORDA, FL	0 0 0	265307	820023
ALLIG.CR	2293400	CHARL	STG	FWM	DA	000		1982-	1983	ALLIGATOR CREEK NR PUNTA GORDA, FL	0 0 0	265307	820023
A1	265124081453702	CHARL	WELL	MEAN	DA	000		1969-	1974	USGS A1	64226	265124	814537
BABCOCK	265124081432601	CHARL	WELL	MEAN	DA	-080		1969-	1975	BABCDCK RANCH WELL	34226	265124	814326
BABCOCK	265124081432601	CHARL	WELL	RAND	RI	-080		0-	0	BABCOCK RANCH WELL	34226	265124	814326
BROWN	265633082015201	CHARL	WELL	RAND	RI	-190		0-	0	BROWNS DEEP WELL PUNTA GORDA	34223	265633	820152
LAVAGINE	MRF404	CHARL	RAIN	SUM	DA	000	BELF	1985-	1986	LAVAGINE PROP. (BELFORT)	234225	263500	815300
L.B.MINO	MRF336	CHARL	RAIN	SUM	DA	000		1982-	1986	L.B.MINOR	104327	264435	813558
O FAITH	265124082012401	CHARL	WELL	RAND	RI	-214		0-	0	OLD FAITHFULL DEEP WELL NR PU	34223	265124	820124
PT CHARL	265920082045601	CHARL	WELL	RAND	RI	000		0-	0	PORT CHARLOTTE UTIL DEEP WELL	144022	265920	820456
PT CHA 2	270133082034601	CHARL	WELL	RAND	RI	-135		0-	0	PORT CHARLOTTE DEEP WELL	114022	270133	820346
PT CHA 2	270133082034602	CHARL	WELL	MEAN	DA	-135		1966-	1975	PORT CHARLOTTE DEEP WELL	114022	270133	820346
PT CHA 3	270133082034601	CHARL	WELL	RAND	RI	-135		0-	0	PORT CHARLOTTE DEEP WELL	114022	270133	820346
PT CHA 3	270133082034602	CHARL	WELL	MEAN	DA	-135		0-	0	PORT CHARLOTTE DEEP WELL	114022	270133	820346
PUNTA G4	MRF6017	CHARL	RAIN	SUM	DA	000	CAN	1965-	1986	PUNTA GORDA 4	154123	265456	820000
PUNTA G	265138082002201	CHARL	WELL	MIN	DA	-113		1976-	1978	PUNTA GORDA HTS WELL NR PUNTA GORDA, FLA	34223	265138	820022
PUNTA G	265138082002201	CHARL	WELL	MAX	DA	-112		1967-	1984	PUNTA GORDA HTS WELL NR PUNTA GORDA, FLA	34223	265138	820022
PUNTA G	265138082002201	CHARL	WELL	MEAN	DA	-112		1976-	1978	PUNTA GORDA HTS WELL NR PUNTA GORDA, FLA	34223	265138	820022
PUNTA G	265138082002201	CHARL	WELL	RAND	RI	-112		0-	0	PUNTA GORDA HTS WELL NR PUNTA GORDA, FLA	34223	265138	820022
PUNTA 2	MRF6016	CHARL	RAIN	SUM	DA	000	CAN	1914-	1965	PUNTA GORDA	64122	265600	820300
ROMP 10	270152082002801	CHARL	WELL	RAND	RI	-191		0-	0	OLIGOCENE WELL NEAR PORT CHAR	154023	270152	820028
ROMP 11	265837081561101	CHARL	WELL	RAND	RI	-122		0-	0	DEEP WELL NEAR PUNTA GORDA, F	294024	265837	815611
SR74	265646081554501	CHARL	WELL	RAND	RI	-128		0-	0	SR74 DEEP WELL NR PUNTA GORDA	94124	265646	815545
SR74	265646081554502	CHARL	WELL	MEAN	DA	-128		1969-	1975	SR74 DEEP WELL NR PUNTA GORDA	94124	265646	815545
TUCKERS	265124081453701	CHARL	WELL	MEAN	DA	-123		1968-	1975	TUCKERS CORNER DEEP WELL	64226	265124	814537
TUCKERS	265124081453701	CHARL	WELL	RAND	RI	-123		0-	0	TUCKERS CORNER DEEP WELL	64226	265124	814537
US41	264611081555401	CHARL	WELL	MEAN	DA	000		1968-	1969	US41 DEEP WELL @ COUNTY LINE	324224	264611	815554
US41	264611081555401	CHARL	WELL	RAND	RI	000		0-	0	US41 DEEP WELL @ COUNTY LINE	324224	264611	815554
US41	264611081555402	CHARL	WELL	MAX	DA	000		1968-	1969	US41 DEEP WELL @ COUNTY LINE	324224	264611	815554
WHIDDEN3	MRF344	CHARL	RAIN	SUM	DA	000	BELF	1982-	1986	WHIDDEN PROPERTY SITE #3	364027	265648	813037
64920141	264918082011801	CHARL	WELL	MEAN	DA	000		1957-	1971	649201414	324223	264918	820118
65814113	265842081414801	CHARL	WELL	RAND	RI	-213		0-	0	65814113 424	224026	265842	814148

Appendix D. From South Florida Water Management District.



Appendix E. Ambient Ground-Water Quality Monitoring Program (AGWQMP) and Health and Rehabilitative Services (HRS) Well Networks.

Appendix E.

EXPLANATION OF TITLES

REF NUMBER: well number within each county (corresponds to map plot).
SITE ID - latitude and longitude of well with USGS suffix (i.e. - 01,02,03, etc. for multiple well sites).
TOT DEPTH - total depth of well, in feet.
CASE DEPTH - depth of well casing, in feet.
CASING DIAM - diameter of well casing, in inches.
DATE DRILL - date on which drilling of the well was completed or water-quality sampling first performed.
#SAMP DATES - number of dates on which water-quality sampling of any kind has been performed and are entered in the WATSTORE historical water-quality files. Number of sampling dates from other sources has not yet been incorporated in the system.

EXPLANATION OF CODES

The following pages explain the codes used in this report.

COUNTY CODE: County code in which the site is located.

015 - Charlotte
017 - Citrus
027 - DeSoto
049 - Hardee
053 - Hernando
055 - Highlands
057 - Hillsborough
069 - Lake
075 - Levy
081 - Manatee
083 - Marion
101 - Pasco
103 - Pinellas
105 - Polk
115 - Sarasota
119 - Sumter

CASING MATERIAL: The material from which the casing is made. The codes and their meanings are:

B - brick
C - concrete
G - galvanized iron
I - wrought iron
M - other metal
P - pvc, fiberglass, other plastic
R - rock or stone
S - steel
T - tile
U - unknown
W - wood
Z - other material

USGS SUB-AQUIFER CODES: These codes are divided into two parts: a three digit code and a four or five letter code. The numeric code refers to the age of the formation(s) comprising the aquifer, while the letter code is an abbreviation of the aquifer's designated name. These codes and names are identical to those used by the USGS in its GWSI, NAWDEX, and WATSTORE data-bases. These codes are listed below.

AGE	CODE	ABBREVIATIONS	NAMES
Unknown Age	000	NRSD	Nonartesian Sand Aquifer
Cenozoic	100	HCPC	Holocene-Pleistocene Series
Quaternary	110	CLSC	Caloosahatchee Aquifer
Holocene	111	LMSN	Limestone Aquifer
Pleistocene	112	PLSC	Pleistocene Series
Tertiary	120	SDGV	Sand and Gravel Aquifer
Pliocene	121	SNDS	Sandstone Aquifer
Miocene	122	FLRD	Floridan Aquifer
Oligocene	123	PCPC	Pleistocene-Pliocene Series
Eocene	124	HTRN	Hawthorn Formation
Paleocene	125	SLML	Shell-Marl Aquifer
		TMIM	Tamiami Formation
		SWNN	Suwannee Limestone
		AVPK	Avon Park Limestone

WELL TYPE: The type of well located at the site. The codes and their meanings are:

MW	Monitoring Well
BW	Public Drinking Water Well
VW	Private Drinking Water Well
IW	Irrigation Well
DW	Drainage Well
IS	Industrial Supply Well
RW	Recharge Well
XW	Other

WELL FINISH: The method of finish or the nature of the openings that allow water to enter the well. The codes and their meanings are:

F	Gravel With Perforations
G	Gravel Screen
P	Perforated or Slotted
S	Screen
T	Sandpoint
W	Walled
X	Open Hole
Z	Other
U	Unknown

WELL STATUS: Hydraulic status of well. The codes and their meanings are:

D - Flowing - Abandoned - Operable Valve
E - Flowing - Abandoned - Inoperable Valve (Free Flowing)
F - Flowing - Active - Operable Valve
G - Flowing - Active - Inoperable Valve (Free Flowing)
H - Non-Flowing - Active - Pumped
P - Plugged
U - Unknown

SOURCE CODE: Indicates where well information was obtained. The codes and their meanings are:

GWSI - USGS's Ground Water Site Inventory.

WRD - 1982 and 1983 USGS Water Resources Data Book-Florida, 38. Southwest Florida Ground Water.

ROMP - SWFWMD's Regional Observation and Monitoring Program

GSDR - USGS Report to Florida Department of Environmental Regulation

"Chemical Analyses of Selected Inorganic and Organic Priority Pollutants and Other Variables in Ground Water Used for Public Supply in Florida: October - December, 1983", March, 1984.

MTWL - Unpublished manuscript and well listing by Martha E. Thaggard, USGS, Tallahassee, Fl. 1982.

STAR - "Establishment of Statewide Permanent Monitoring Network for Ground-Water Quality Florida", by P. Spangler and M. A. Silverman. Prepared for the Florida Department of Environmental Regulation - Ground Water Section with assistance from the USGS. Department of Geology, University of Florida, Gainesville.

CUP - SWFWMD's, Consumptive Use Permit Monitor Wells

STOR - Florida Department of Environmental Regulation GMS or EPA's (Storage and Retrieval) Data-Base.

REF NUM	COUNTY CODE	SITE ID	TOT DEPTH	CASE DEPTH	CASE DIAM	CASE MAT	GSAQ CODE	WELL TYPE	FINISH	WELL STATUS	DATE DRILL	SOURCE CODE	TDS	MAJOR IONS	HARDNESS	BACTLOGICAL	FHOSPHOROUS	NITROGEN	DETERGENTS	MINORG CN	RADACTIVITY	RAD CHEM SF	TOC	ORG GROUP	PESTICIDES	O ORGANICS	BOD	COD	DO	O DISS GAS	PH	SP COND	TEMP	TURBIDITY	COLOR	ODOR	ALKALINITY	# SAMP DATES
1A	15	270152082002801	917	595	4	P	123 LMSN	MW	X	F		WRD	X	X	X		X	X		X			X		X	X					X	X	X					39
1B	15	270152082002802	575	303	4	P	122 LMSN	MW	X	F		WRD	X	X	X		X	X		X			X		X	X					X	X	X					39
1C	15	270152082002803	270	110	4	P	122 HTRN	MW	X	F		WRD	X	X	X		X	X		X			X		X	X					X	X	X					40
1D	15	270152082002804	30	20	4	P	112 NRSD	MW	X	H		WRD	X	X	X		X	X		X			X		X	X					X	X	X					8
2A	15	270133082034601	350	312	4	U	122 HTRN	MW	X	F	1965	WRD	X	X	X		X	X		X			X		X	X					X	X	X					1
2B	15	270133082034602	89	84	4	U	112 NRSD	MW	S	H	1965	WRD	X	X	X	X	X	X		X			X		X	X					X	X	X					1
3	15	265920082045601	156	128	4	I	122 HTRN	MW	X	H		WRD	X	X	X	X	X	X		X			X		X	X					X	X	X					1
4	15	265837081561101	335	220	4	P	120 FLRD	MW	X	F	09/27/84	WRD	X	X	X		X	X		X			X		X	X					X	X	X					1
5A	15	265657081593201	160	U	6	U	122 HTRN	BW	X	H		CUP	X	X																								
5B	15	265653081593201	160	U	6	U	122 HTRN	BW	X	H		CUP	X	X																								
6	15	265646081554502	25	21	2	U	111 NRSD	MW	S	H	1969	WRD	X	X	X		X	X		X			X		X	X					X	X	X					1
7A	15	265638082130700	270	250	1	P	122 HTRN	MW	S	H	02/17/84	ROMP	X	X	X		X	X		X			X		X	X					X	X	X					1
7B	15	265638082130701	630	600	3	P	123 SWNN	MW	S	H	02/17/84	ROMP	X	X	X		X	X		X			X		X	X					X	X	X					1
7C	15	265638082130703	420	400	3	P	122 HTRN	MW	S	H	02/17/84	ROMP	X	X	X		X	X		X			X		X	X					X	X	X					1
7D	15	265638082130704	19	15	6	P	112 CLSC	MW	S	H	02/06/85	ROMP	X	X	X		X	X		X			X		X	X					X	X	X					1
8	15	265251082194201	168	U	4	U	122 HTRN	BW	X	H		CUP	X	X																								
9	15	265138082002201	125	84	4	U	122 TMIM	MW	X	H	1967	WRD	X	X	X		X	X		X			X		X	X					X	X	X					1

Appendix E. Ambient Ground-Water Quality Monitoring Program sites.

REF NUM	COUNTY CODE	SITE ID	TOT DEPTH	CASE DEPTH	CASE DIAM	CASE MAT	GS AQ CODE	WELL TYPE	FINISH	WELL STATUS	DATE DRILL	SOURCE CODE	TDS	MAJOR IONS	HARDNESS	BACTLOGICAL	PHOSPHOROUS	NITROGEN	DETERGENTS	MINDRG CN	RAOACTIVITY	RAD CHEM SP	TOC	ORG GROUP	PESTICIDES	O ORGANICS	BOD	COD	DO	O DISS GAS	PH	SP COND	TEMP	TURBIDITY	COLOR	ODOR	ALKALINITY	# SAMP DATES
1	15	270155082110101	65	55	3	P	122 HTRN	VW	X	H	1985	AGWP	X	X	X			X		X				X	X	X				X	X			X	X	X	X	0
2	15	270148092140801	74	42	2	S	122 HTRN	VW	X	H	1965	AGWP	X	X	X			X		X				X	X	X				X	X			X	X	X	X	0
3	15	270147082143801	72	42	4	S	122 HTRN	VW	X	H	1985	AGWP	X	X	X			X		X				X	X	X				X	X			X	X	X	X	0
4	15	270140082105801	65	47	4	P	122 HTRN	VW	X	H	1983	AGWP	X	X	X			X		X				X	X	X				X	X			X	X	X	X	0
5	15	270128082142801	60	35	3	P	122 HTRN	VW	X	H	1986	AGWP	X	X	X			X		X				X	X	X				X	X			X	X	X	X	0
6	15	270037082130201	51	44	2	P	122 HTRN	VW	X	H	1986	AGWP	X	X	X			X		X				X	X	X				X	X			X	X	X	X	0
7	15	270145082034501	180	106	3	P	122 HTRN	VW	X	H	1986	AGWP	X	X	X			X		X				X	X	X				X	X			X	X	X	X	0
8	15	270138082044701	190	105	2	P	122 HTRN	VW	X	H	1986	AGWP	X	X	X			X		X				X	X	X				X	X			X	X	X	X	0
9	15	270057082045701	80	70	2	P	122 HTRN	VW	X	H	1986	AGWP	X	X	X			X		X				X	X	X				X	X			X	X	X	X	0
10	15	270004082075501	115	75	4	P	122 HTRN	VW	X	H	1985	AGWP	X	X	X			X		X				X	X	X				X	X			X	X	X	X	0
11	15	265907082033201	165	136	2	S	122 HTRN	VW	X	H	1983	AGWP	X	X	X			X		X				X	X	X				X	X			X	X	X	X	0
12	15	265856082034001	190	130	3	P	122 HTRN	VW	X	H	1982	AGWP	X	X	X			X		X				X	X	X				X	X			X	X	X	X	0
13	15	270150081582701	140	105	3	P	122 HTRN	VW	X	H	1985	AGWP	X	X	X			X		X				X	X	X				X	X			X	X	X	X	0
14	15	270123081580701	130	124	2	G	122 HTRN	VW	X	H	1979	AGWP	X	X	X			X		X				X	X	X				X	X			X	X	X	X	0
15	15	27000081594801	95	75	2	P	122 HTRN	VW	X	H	1985	AGWP	X	X	X			X		X				X	X	X				X	X			X	X	X	X	0
16	15	265733081582301	210	170	2	P	122 HTRN	VW	X	H	1980	AGWP	X	X	X			X		X				X	X	X				X	X			X	X	X	X	0
17	15	27000081544701	240	147	4	S	122 HTRN	VW	X	H	1981	AGWP	X	X	X			X		X				X	X	X				X	X			X	X	X	X	0
18	15	265913081572101	165	125	4	P	122 HTRN	VW	X	H	1981	AGWP	X	X	X			X		X				X	X	X				X	X			X	X	X	X	0
19	15	275648081503201	210	140	4	P	122 HTRN	VW	X	H	1981	AGWP	X	X	X			X		X				X	X	X				X	X			X	X	X	X	0
20	15	265645081590801	265	265	4	P	122 HTRN	VW	X	H	1985	AGWP	X	X	X			X		X				X	X	X				X	X			X	X	X	X	0
21	15	265629081581701	260	163	3	P	122 HTRN	VW	X	H	1985	AGWP	X	X	X			X		X				X	X	X				X	X			X	X	X	X	0
22	15	265602081590801	267	207	4	P	122 HTRN	VW	X	H	1984	AGWP	X	X	X			X		X				X	X	X				X	X			X	X	X	X	0
23	15	265515082023801	60	50	2	P	122 HTRN	VW	X	H	1986	AGWP	X	X	X			X		X				X	X	X				X	X			X	X	X	X	0
24	15	265500082020301	220	U	4	S	122 HTRN	VW	X	H	1977	AGWP	X	X	X			X		X				X	X	X				X	X			X	X	X	X	0
25	15	265253081592801	147	100	3	P	122 HTRN	VW	X	H	1985	AGWP	X	X	X			X		X				X	X	X				X	X			X	X	X	X	0
26	15	265234082000001	110	87	4	P	122 HTRN	VW	X	H	1983	AGWP	X	X	X			X		X				X	X	X				X	X			X	X	X	X	0
27	15	265213081593301	118	98	4	P	122 HTRN	VW	X	H	1984	AGWP	X	X	X			X		X				X	X	X				X	X			X	X	X	X	0
28	15	265045081583801	220	180	2	G	122 HTRN	VW	X	H	1980	AGWP	X	X	X			X		X				X	X	X				X	X			X	X	X	X	0
29	15	265033081592201	245	200	4	P	122 HTRN	VW	X	H	1984	AGWP	X	X	X			X		X				X	X	X				X	X			X	X	X	X	0
30	15	264818082025201	140	110	2	P	122 HTRN	VW	X	H	1980	AGWP	X	X	X			X		X				X	X	X				X	X			X	X	X	X	0

Appendix E. Health and Rehabilitative Services Monitoring Well sites.

South Florida Water Management District--CHARLOTTE COUNTY AMBIENT NETWORK SAMPLING RESULTS

SURFICIAL AQUIFER SYSTEM

Site ID	Sample Date	Temp °Cent	pH Units	Sp Cond UMHOS/ CM	Al CaCO3 MG/L	NH$_4$ MG/L	OPO$_4$ MG/L	Na MG/L	K MG/L	Ca MG/L	Mg MG/L	Cl MG/L	SO$_4$ MG/L	SiO$_2$ MG/L	TDS MG/L	Sr MG/L	Fe MG/L	Tot Fe MG/L	NO$_3$ MG/L	NO$_2$ MG N/L	F MG/L	Tot As UG/L	Tot Cr UG/L	Tot Cu UG/L	Tot Mn UG/L	Tot Pb UG/L	Tot Zn UG/L
CHWQ-01	05/16/85	27 2		787	321.5	0.24	.004	73.1	0.99	113	14.80	43.9	34.5	51.9	550	.89	0.05	0.07	.004	.004	0.40	1.50	0.40	0.10	3.92	0.60	30
CHWQ-01	04/22/86	24 4	7.8	759	262.5	0.29	.004					46.3	33.2	66.6	513	.74	0.07	0.12	.004	.004	0.68	0.90	1.12	0.50	2.84	0.53	30
CHWQ-02	05/16/85	29		646	237	0.36	.004	36.4	0.81	87	6.14	38.5	24.5	5.2	360	.72	0.05	0.67	.004	.004	0.10	2.77	2.60	0.80	32.92	2.92	30
CHWQ-02	01/07/86	24	6 3	697	244.3	0 41	.004	28.1	0.63	105.4	5.80	31.6	54	5.8	422	.71	2.51			.016	0.19	2 00	6 31	0.69	35 15	1 87	18
	MIN	24	0	646	237	0.24	.004	0	0.00	0	0.00	31.6	24.5	5.2	360	71	0.05	0.00	0	004	0.10	0.90	0.40	0.10	2.84	0 53	18
	MAX	29	7.8	787	321.5	0.41	.004	73.1	0.99	113	14.80	46.3	54	66.6	550	.89	2.51	0.67	.004	.016	0.68	2.77	6.31	0.80	35.15	2 92	30
	AVE	26.15	7 05	722	266.32	0.32	.004	45.87	0.81	101.8	8.91	40.08	36.55	32.38	461	.765	0.67	0.29	.004	.007	0 34	1 79	2.61	0 52	18 71	1 48	27

INTERMEDIATE AQUIFER SYSTEM

Site ID	Sample Date	Temp °Cent.	pH Units	Sp Cond UMHOS/ CM	Al CaCO$_3$ MG/L	NH$_4$ MG/L	OPO$_4$ MG/L	Na MG/L	K MG/L	Ca MG/L	Mg MG/L	Cl MG/L	SO$_4$ MG/L	SiO$_2$ MG/L	TDS MG/L	Sr MG/L	Fe MG/L	Tot Fe MG/L	NO$_3$ MG/L	NO$_2$ MG N/L	F MG/L	Tot As UG/L	Tot Cr UG/L	Tot Cu UG/L	Tot Mn UG/L	Tot Pb UG/L	Tot Zn UG/L
CHWQ-03	01/07/86	24.8	6.6	1773	168.1	0.44	004	169.5	9.64	75.8	53 15	452	65.7	35.2	968	5.60	0.05	0.05	.004	.006	1 01	1.55	6.40	0.82	12 06	1 70	19
	MIN	24.8	6 6	1773	168.1	.44	.004	169.5	9.64	75.8	53 15	452	65.7	35.2	968	5.6	0.05	0.05	.004	006	1 01	1.55	6.40	0.82	12.06	1.70	19
	MAX	24 8	6 6	1773	168.1	.44	004	169.5	9 64	75 8	53.15	452	65.7	35 2	968	5.6	0.05	0.05	.004	.006	1.01	1.55	6.40	0.82	12.06	1.70	19
	AVE	24 8	6 6	1773	168 1	44	004	169 5	9.64	75.8	53.15	452	65.7	35.2	968	5.6	0.05	0.05	.004	.006	1.01	1.55	6.40	0.82	12 06	1 70	19

CHARLOTTE COUNTY AMBIENT MONITOR WELL CONSTRUCTION DATA

SITE ID	LAT	LONG	SEC-TWP-RGE-	TOT DEPTH (FT.)	CASE DEPTH (FT.)	WELL FINISH	SCREEN FROM (FT.)	OPEN TO (FT.)	CASE DIAM (IN.)	CASE MATER	AQUIFER	CONST METH	LSE (NGVD)	MPE (NGVD)	LIFT TYPE	WELL STATUS	G-LOG	D-LOG	H-DATA	SAMPLES COLLECT
CHWQ-01	265641	813633	19-42S-25E	60	50	P	50	60	2.00	P	SF	H	57.00	57 00	N	K	N	U	N	Y
CHWQ-02	264754	814602	34-40S-27E	33	18	S	18	28	2 00	X	SF	H	27 00	29.50	N	N	N	N	N	Y
CHWQ-03	264754	814602	34-40S-27E	240	175	X	175	240	6.00	P	IA	H	27.00	29.00	N	N	Y	Y	N	Y

CASING MATERIAL-- (P) PVC (X) THREADED PVC (NO PVC CEMENT)

WELL FINISH-- (P) PERFORATED OR SLOTTED (S) SCREEN (T) SANDPOINT (X) OPEN HOLE

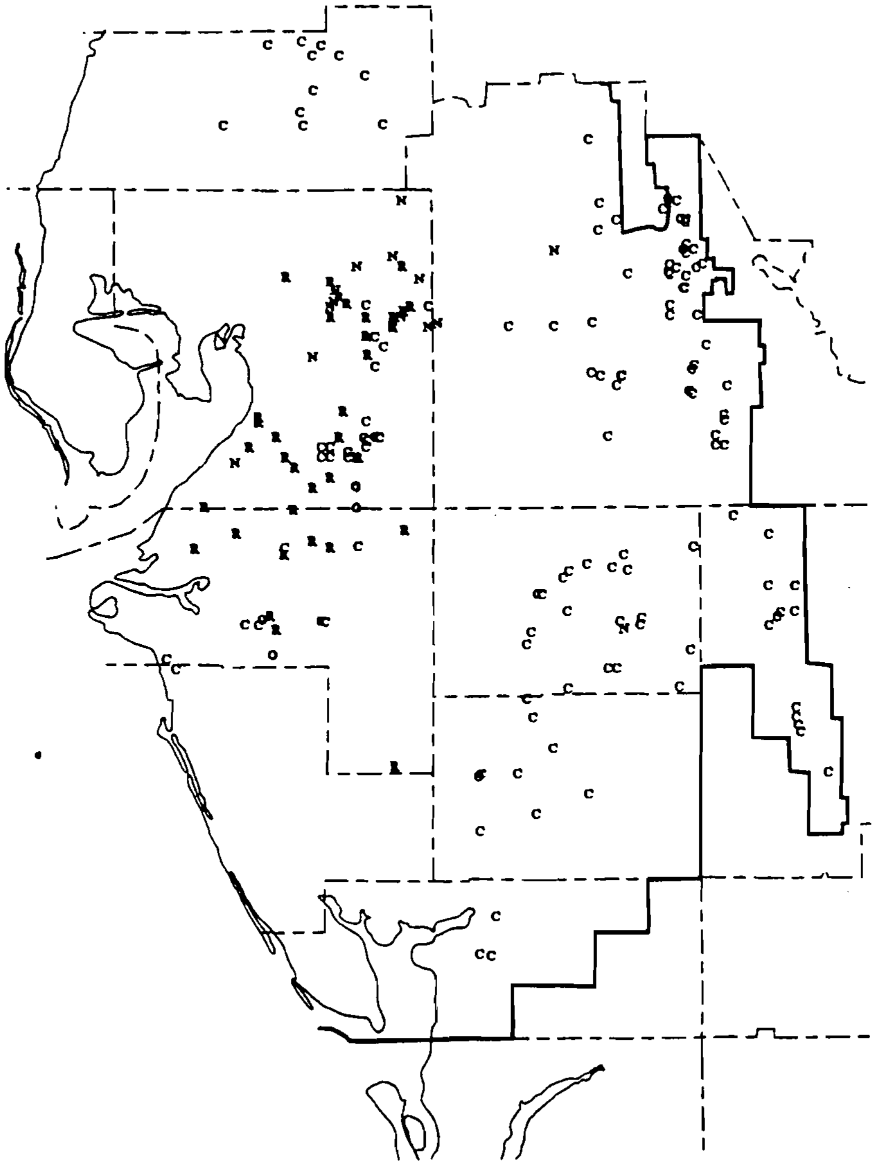
TYPE OF LIFT-- (N) NO LIFT

CONSTRUCTION METHOD-- ((H) HYDRAULIC ROTARY

WELL STATUS-- (K) NON FLOWING-ACTIVE-PUMPED (N) NON FLOWING-ACTIVE-NO PUMP

Appendix E. Refer to Appendix D figure for Locations.

JANUARY, 1988
A.I.M SITE
INSTALLATIONS



Appendix F

Appendix G

CHARLOTTE COUNTY, SURFICIAL AQUIFER (UNCONFINED)

	DRASTIC PARAMETERS, SETTINGS AND INDICES								
POLYGON	D	R	A	S	T	I	C	SETTING	INDEX
1	50	36	18	18	10	45	24	11A	201
2	50	36	18	4	10	45	24	11C	187
3	50	36	18	4	10	45	24	11C	187
4	50	36	18	18	10	45	18	11A	195
5	50	36	18	16	10	45	12	11A	187
6	50	36	18	18	10	45	12	11A	189
7	50	36	18	4	10	45	12	11C	175
8	50	36	18	4	10	45	12	11C	175
9	50	36	18	16	10	45	12	11A	187
10	50	36	18	16	10	45	6	11A	181
11	50	36	18	18	10	45	6	11A	183
12	50	36	18	4	10	45	6	11C	169
13	50	36	18	18	10	45	6	11A	183
14	45	36	18	18	10	45	6	11A	178
15	45	36	18	18	10	45	12	11A	184
16	50	36	18	18	10	45	12	11A	189
17	50	36	18	16	10	45	12	11A	187
18	50	36	18	18	10	45	12	11A	189
19	50	36	18	4	10	45	12	11C	175
20	45	36	18	18	10	45	12	11A	184
21	50	36	18	16	10	45	12	11A	187
22	50	36	18	18	10	45	12	11A	189
23	45	36	18	18	10	45	12	11A	184
24	45	36	18	16	10	45	12	11A	182
25	45	36	18	16	10	45	18	11A	188
26	45	36	18	16	10	45	18	11A	188
27	50	36	18	16	10	45	12	11A	187
28	50	36	18	18	10	45	18	11A	195
29	50	36	18	4	10	45	18	11C	181
30	50	36	18	18	10	45	18	11A	195
31	45	36	18	18	10	45	18	11A	190
32	50	36	18	18	10	45	18	11A	195
33	45	36	18	4	10	45	18	11C	176
34	50	36	18	18	10	45	18	11A	195
35	45	36	18	18	10	45	18	11A	190
36	50	36	18	18	10	45	18	11A	195
37	50	36	18	16	10	45	18	11A	193
38	50	36	18	18	10	45	18	11A	195
39	45	36	18	18	10	45	18	11A	190
40	50	36	18	18	10	45	18	11A	195
41	45	36	18	16	10	45	18	11A	188
42	45	36	18	18	10	45	18	11A	190
43	50	36	18	18	10	45	18	11A	195
44	50	36	18	4	10	45	18	11C	181

CHARLOTTE COUNTY, SURFICIAL AQUIFER (UNCONFINED)

DRASTIC PARAMETERS, SETTINGS AND INDICES

POLYGON	D	R	A	S	T	I	C	SETTING	INDEX
45	50	36	18	18	10	45	18	11A	195
46	50	36	18	4	10	45	18	11C	181
47	50	36	18	4	10	45	18	11C	181
48	50	36	18	18	10	45	18	11A	195
49	45	36	18	4	10	45	18	11C	176
50	45	36	18	18	10	45	12	11A	184
51	50	36	18	18	10	45	18	11A	195
52	45	36	18	18	10	45	12	11A	184
53	50	36	18	16	10	45	12	11A	187
54	50	36	18	4	10	45	12	11C	175
55	50	36	18	4	10	45	12	11C	175
56	50	36	18	4	10	45	12	11C	175
57	50	36	18	18	10	45	12	11A	189
58	50	36	18	18	10	45	18	11A	195
59	50	36	18	4	10	45	18	11C	181
60	50	36	18	18	10	45	12	11A	189
61	50	36	18	18	10	45	18	11A	195
62	50	36	18	18	10	45	24	11A	201
63	50	36	18	4	10	45	24	11C	187
64	50	36	18	4	10	45	18	11C	181

Appendix H

CODE EXPLANATION

Facility Status

A	Active
I	Inactive
K	Closed, but still monitored

Disposal Methods

BU	Burial
DR	Drainfield
IM	Impoundment
IN	Injection
LA	Land Application
LS	Land Spreading
SD	Surface Water Discharge
VR	Volume Reduction/Resource Recovery
OT	Other

CLASS CODES FOR TYPE 3 FACILITIES

Solid Waste Facilities:

100	Class I Landfill
200	Class II Landfill
300	Class III Landfill
	310 Trash/Yard Trash
	750 Transfer Station

CLASS CODES FOR FACILITIES OTHER THAN TYPE 3

Level	Type Plant		Plant Site MGD		
		A	B	C	D
1	AWT	3+	.5 to 3	.002 to .5	None
2	Activated Sludge/ Contact Stab.	5+	1 to 5	.002 to 1	None
3	Extended Air	8+	2 to 8	.025 to 2	.002 to .025
4	Trickling Filter	10+	3 to 10	.025 to 3	.002 to .025

LANDFILL SITE INFORMATION

Ref. No.	**Permit No.**	**Name**	**Owner Address**	**Population Served**	**Tons/Day**	**Expiration Date**	**Disposal Method**
*1	5208C02001	Charlotte Co. LF#1 Mosquito Control	P.O. Box 1054 Punta Gorda 33950	——	——	Closed 7/73	burial
*2	5208C02002	Charlotte Co. LF#2 Mosquito Control	P.O. Box 1054 Punta Gorda 33950	30,000	——	Closed 6/75	burial
*3	5208C02002	Charlotte Co. LF#3 Mosquito Control	P.O. Box 1054 Punta Gorda 33950	2,000	——	Closed 7/75	burial
4	5208C06145	Charlotte County SLF Mosquito	P.O. Box 1054 Punta Gorda 33950	80,669	270TPD	10/02/90	burial impoundment
5	5208P07115	Dan Raulerson	189 Rowland Drive Punta Gorda 33950	——	20CYD	10/19/89	burial
6	5208P07116	Gunter Schwabach	3275 Casa Grande Englewood 33533	1,000	180TPD	1/24/91	volume reduction

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* Closed

INDUSTRIAL SITE INFORMATION

Ref. No.	Permit No.	Name	Address	Facility Type	Permitted Quantity	Expiration Date	Disposal Method
1	5208P00095	Seaside Service System - Little Gasparilla Island	P.O. Box 5 Placida 33946	Reject Water from R.O. Plant	18TGD	6/25/88	IN
2	5208P00123	Knights Island Utilities, Inc.	7092 Placida Rd. Cape Haze 33946	R.O. reject stream	30TGD	12/02/88	IN
3	5208P00125	Don Pedro Island	7050 Placid Rd. Englewood 33533	R.O.	30TGD	9/12/87	IN
4	5208P00126	Seaside Service Little Gasparilla Island	P.O. Box 5 Placida 33946	R.O. brine reject	18TGD	9/19/87	IN
5	5208P00624	Alligator Utilities Inc.	c/o Alligator Park Punta Gorda 33950	brine from R.O. plant	13.3TGD	10/08/89	SD
6	5208P01659	MAR-JON Laundry	3000 Placida Rd. Grove City 33533	Laundromat	15TGD	12/02/86	IM, DR, LA, BU
7	5208P02001	Cape Haze Water Plant Rotonda	P.O. Box 7 Rotonda West 33497	water plant	——	——	IM
8	5208P02012	Burnt Store Utilities	1625 W. Marion Ave. Punta Gorda 33950	brine reject water from R.O. plant	64TGD	1/16/91	SD
9	5208P02017	Charlotte Harbor Water Assn.	555 Main St. Charlotte Harbor 33950	R.O. discharge	80TGD	2/05/85	SD
10	5208P02018	Gasparilla Pines	1100 S. Tamiami Trail - Suite 2 Sarasota 33577	R.O. water treatment plant	200TGD	5/18/89	SD
11	5208P02019	Burnt Store Colony	15550 Burnt Store Rd. Punta Gorda 33955	R.O. brine	27TGD	8/28/89	DR
12	5208P02027	Charlotte Harbor Water Assn.	555 Main St. Charlotte Harbor 33950	R.O. reject water	120 TGD	INACTIVE	IM, SD, BU
13	5208P02031	Florida Mining and Material	P.O. Box 23965 Tampa 33622	ready mix concrete batch plant	——	INACTIVE	——
14	5208P10511	Rotonda West Utilities	P.O. Box 450369 Miami 33145	R.O. water treatment plant	0.5MGD	2/17/92	SD
15	5208P10655	Eagle Point Mobile Home Park	Rt. 2 Box 460 Punta Gorda 33950	R.O. plant discharge	14.4TGD	9/27/89	SD
16	5208P10656	Gulf Shore Seafood Inc.	P.O. Box 1 Punta Gorda 33950	fish and crab waste	——	INACTIVE	SD, BU
17	5208P10657	Rabbit Factory U.S.A.	2231 Fowler St. Ft. Myers 33901	rabbits	——	10/03/89	DR
18	5208P10658	Babcock Aggregates Limerock Mine	P.O. Box 6 Brooksville 33512	limerock mining settling pond	——	5/09/90	IM
19	5208P98035	Cement Products Corporation	7810 38th Ave. N. St. Petersburg 33710	cement	——		IM
20	5208P98036	Deltona Corp.	P.O. Box 1859 Brooksville 33512	——	——		IM
21	5208P98037	General Development Co.	1111 S. Bayshore Dr. Miami 33131	——	——		IM

Ref. No.	Permit No.	Name	Address	Facility Type	Permitted Quantity	Expiration Date	Disposal Method
22	5208P98038	Martin Concrete	1022 Central Ave. Sarasota 33578	cement	——		IM
23	5208P98039	Port Charlotte Ready Mix	2285 Union St. P.O. Box 44 Ft. Myers 33902	cement	——		IM
24	5208P98040	Rock Block Inc.	P.O. Box 605 Placida 33946	cement	——		IM
25	5208P98041	Stans Septic Service and Concrete Pro	5210 Duncan Rd. Punta Gorda 33950	——	——		IM
26	5208P98042	Warren Brothers Asphalt	P.O. Box 2579 Sarasota 33578	asphalt	——		IM
27	5208P98043	West Coast Industries	P.O. Box 44 Ft. Myers 33902	——	——		IM
28	5208P98044	WR Willis Construction Co.	P.O. Box 1301 Punta Gorda 33950	——	——		IM

IM = impoundment
DR = drainfield
LA = land application
SD = surface water discharge
BU = burial
IN = injection

SEWAGE TREATMENT PLANT INFORMATION

Ref. No.	DER No.	Name	Address Owner	Population	Capacity	Expiration Date	Disposal Method
1	5208C00294	Meadow Park Elem. School	Chairman Co.School Bd. 1016 Education Ave. Punta Gorda 33950	750	10TGD	12/27/88	IM
2	5208C00298	Lemon Bay Jr/Sr. High School Plant B	1016 Education Ave. Punta Gorda 33950	150	15TGD	5/18/89	DR
3	5268C00375	East Elementary School	1016 Education Ave. Punta Gorda 33950	——	9TGD	5/18/89	IM
4	5208C00410	Lemon Bay Junior High School Plant A	1016 Education Ave. Punta Gorda 33950	90	9TGD	5/18/89	DR
5	5208C00496	Charlotte Co. Public Safety	2400 Airport Rd Punta Gorda 33950	125	10TGD	10/17/88	IM
6	5208C03184	Charlotte Co. Develop. Authority	4830 Airport Rd. Punta Gorda 33950	——	7.5TGD	12/30/88	IM
7	5208M00170	City of Punta Gorda	326 W. Marion Ave. Punta Gorda 33590	——	95TGD	8/17/87	LA
8	5208M00419	Punta Gorda Waste Management System	326 W. Marion Ave. Punta Gorda 33590	17,738	2MGD	4/29/90	LA
9	5208M05890	City of Punta Gorda	326 W. Marion Ave. Punta Gorda 33590	9,764	1MGD	INACTIVE	SD
10	5208P00097	Sandal Haven Utillity STP	800 Placida Rd. Englewood 33533	1,500	150TGD	4/11/87	LA
11	5208P00115	Rotonda West New Plant	P.O. Box 3509 Rotonda west 33947	960	96TGD	1/16/91	LA
12	5208P00117	East Port WWTD GDU	1111 S. Bayshore Dr. Miami, 33131	12,000	3MGD	3/31/87	LA,IM
13	5208P00303	GDU Gulf Cove #2	1111 S. Bayshore Dr. Miami 33131	3,300	330TGD	11/19/89	LA,IM
14	5208P00380	Punta Gorda Isles #15	City Hall 326 Marion Ave. Punta Gorda 33950	——	95TGD	8/17/87	LA,IM
15	5208P00462	Burnt Store Utilities	1625 W. Marion Ave. Punta Gorda 33950	2,500	250TGD	9/28/89	IM
16	5208P00981	GDU Port Charlotte	1111 S. Bayshore Dr. Miami 33950	13,213	1.5MGD	7/1/88	LA,IM
17	5208P01760	Rotonda West WWTP Kendall Road	P.O. Box 450369 Miami 33145	2,500	250TGD	11/12/87	IM
18	5208P01941	EBCO Wastewater Inc.	2000 Bay View Rd. Suite B Englewood 33533	500	30TGD	1/05/89	IM
19	5208P02579	West Charlotte Utilities	2430 S. McCall Rd. Englewood 33533	——	100TGD	6/12/89	IM
20	5208P05305	Rampart Utilities Inc.	2100 Kings Highway Port Charlotte 33952	2,170	200TGD	6/09/88	LA,IM
21	5208P0	GDU Quesada	1111 S.Bayshore Dr. Miami 33131	——	50TGD	INACTIVE	IM

Ref. No.	DER No.	Name	Address Owner	Population	Capacity	Expiration Date	Disposal Method
22	5208P0096	West Bay Congegate Living Facility	1861 Placida Rd. Englewood 33533	240	30TGD	8/28/87	DR
23	5208P0098	The Inn	2275 N. Beach Rd. Englewood 33533	200	25TGD	INACTIVE	DR
24	5208P0099	Harbor View Apts.	24450 Harbour View Rd. Charlotte Harbor 33950	115	10TGD	2/26/92	DR
25	5208P00100	Liberty Gardens Condo	P.O. Box 486 Englewood 33533	52	15TGD	INACTIVE	DR
26	5208P00102	Gulfview Resort	3049 Gulf-to-Bay Blvd. Clearwater 33519	546	20TGD	3/02/89	IM
27	5208P00103	Patches South Restaurant	611 N.E. Harbor Blvd. Port Charlotte 33952	150	8TGD	INACTIVE	DR
28	5208P00104	Bayview East Condo	53 Bay Heights Ave. Englewood 33533	60	8TGD	9/13/89	DR
29	5208P00105	Englewood Beach Place Condo	202 N. Center St. Bloomington, IL. 61701	———	6.6TGD	2/13/89	DR
30	5208P00106	Pelican Landing	P.O. Box 207/745 Hinsdale, IL. 60521	———	20TGD	3/29/89	DR
31	5208P00108	Sandhills Pines Condominiums	P.O. Box 2120 Port Charlotte 33952	526	50TGD	9/15/87	DR
32	5208P00111	Westchester Park	P.O. Box 4090 Port Charlotte 33592	———	15TGD	INACTIVE	DR
33	5208P00112	Vizcaya Lakes	29 Orange Ave. N. Sarasota 33577	980	98TGD	9/10/87	IM
34	5208P00113	Anthony's Lounge	1600 S. McCall Rd. Englewood 33533	———	3.6TGD	12/03/89	DR
35	5208P00114	Lemon Bay Pointe, Inc.	3916 Country View Dr. Sarasota 33583	90	16.8TGD	INACTIVE	DR
36	5208P00118	Coldeway Condominiums	574-C Tamiami Port Charlotte	———	7.5TGD	INACTIVE	DR
37	5208P00118	Westchester Woods Condominiums	760 N.E. Tamiami Trail Port Charlotte 33958	———	25TGD	1/10/90	DR
38	5208P00120	Hunters Creek Village	4433 S. Tamiami Trail Sarasota 33581	600	15TGD	4/12/89	IM
39	5208P00124	Landings of Lemon Bay	5710 Clark Rd. Sarasota 33581	116	35TGD	8/18/91	DR
40	5208P00127	Grove City Motel & Diner	2555 Placida Rd. Englewood 33533	———	9.3TGD	9/23/87	DR
41	5208P00129	Cricket's Wicket Condo	1587 E. Manaskota Englewood 33533	72	5TGD	1/29/88	DR, LA
42	5208P00293	Bay Palms Mobile Home Park	110 Lk. Emerald Dr. #406 Ft. Lauderdale 33309	100	10TGD	2/14/90	IM
43	5208P00295	Sandpiper Key	P.O. Box 1845 Venice 33595	750	55TGD	5/23/88	DR
44	5208P00296	Evergreen Mobile Community	Rt. 2 Box 882 Punta Gorda 33950	774	50TGD	11/28/88	IM
45	5208P00297	Castaways Condo	2240 N. Beach Rd. Englewood 33533	50	10TGD	12/05/88	DR
46	5208P00299	Lazy Lagoon Mobile Pk.	8320 Riverside Dr. Punta Gorda 33950	150	15TGD	6/30/88	IM

Ref. No.	DER No.	Name	Address Owner	Population	Capacity	Expiration Date	Disposal Method
47	5208P00300	Pine Terrace Motel & Trailer Park	2310 S. Tamiami Trail Punta Gorda 33950	235	15TGD	3/15/88	IM DR
48	5208P00301	Punta Gorda Kampground	102 Rio Villa Dr. Punta Groda 33950	150	12.5TGD	12/21/88	IM
49	5208P00302	Port Charlotte Resort Club	180 Seaview Ct. Marco Island 33937	66	10TGD	INACTIVE	DR
50	5208P00304	La Coquina Condo	825 S. Tamiami Trail Venice 33595	48	15TGD	9/17/87	DR
51	5208P00305	Paradise Park Condo	46900 S.R. 74 Punta Gorda 33950	630	35TGD	8/16/89	IM
52	5208P00306	Charlotte Bay Resort and Club	23090 Bayshore Rd. Charlotte Harbor 33952	——	15TGD	8/08/90	DR
53	5208P00309	Tamarind Gulf & Bay Condo	2955 N. Beach Rd. Englewood 33533	——	20TGD	10/07/88	DR
54	5208P00310	Oyster Creek Mobile Home Park	4637 Ashton Rd. Sarasota 33583	198	15TGD	5/19/88	DR
55	5208P00311	Fiddler's Green Condo	P.O. Box 432 Boca Grande 33921	250	25TGD	INACTIVE	IM
56	5208P00312	Emerald Pointe	1200 Retta Esplanado Punta Gorda 33950	——	30TGD	2/11/88	DR
57	5208P00313	Manasota Cove	4651 Higel Avenue Sarasota 33581	——	3.8TGD	INACTIVE	DR
58	5208P00315	Lemon Bay Medical Professional Center	P.O. Box 3979 Venice 34282	135	18TGD	3/11/88	DR
59	5208900377	El Galeon Motel	356 S.Indiana Ave. Englewood 33533	——	25TGD	12/22/88	DR
60	5208P00378	The Pines at Punta Gorda	P.O. Box 661 Punta Gorda 33951	1,000	95TGD	3/22/90	IM
61	5208P00379	Elks Lodge 2153	629 Tamiami Trail Port Charlotte 33952	——	5TGD	INACTIVE	DR
62	5208P00383	Edgewater Village Condo Assoc. Inc.	143 McCullough St. Port Charlotte 33952	——	25TGD	INACTIVE	DR
63	5208P00384	Bocilla Development Corp.	P.O. Box 910 Sarasota 33578	——	21TGD	7/24/91	DR
64	5208P00385	Sea Cove Inc.	900 E. Marion Ave. Punta Gorda 33950	——	3.3TGD	8/16/88	DR
65	5208P00386	Southern Oaks Condominium	208A Bayshore Dr. Charlotte Harbor 33950	——	7.5TGD	INACTIVE	DR
66	5208P00411	Punta Gorda Co. Club	3701 Duncan Rd. Punta Gorda 33950	200	5TGD	5/16/89	IM
67	5208P00412	Gulf to Bay Trailer Park	Rt. 1 Box 400 Englewood 33533	30	3TGD	11/28/88	DR
68	5208P00414	Fantasy Island II	318 Oakwood Cir. Englewood 33533	——	5TGD	11/13/91	DR
69	5208P00416	Waters Edge Condo	1860 San Casa Dr. Englewood 33533	——	25TGD	9/14/88	IM
70	5208P00417	Englewood Health Care Center	1111 Drury Lake Engelwood 33533	170	13TGD	10/08/89	IM
71	5208P00418	Super X Shopping Center	P.O. Box 1371 Cape Coral 33904	——	20TGD	1/22/90	DR
72	5208P00461	River Haven Inc.	Burnt Store Rd. Punta Gorda 33950	150	15TGD	9/11/90	IM

Ref. No.	DER No.	Name	Address Owner	Population	Capacity	Expiration Date	Disposal Method
73	5208P00463	Myakka River Condo	981 Hemenway Port Charlotte 33952	——	15TGD	12/22/88	DR
74	5208P00464	Lemon Bay Breezes Devel. Corp	3500 Dufferin St. Downsville Ontario Canada M3KINZ	384	31.5TGD	INACTIVE	DR
75	5208P00465	Burnt Store Colony	15550 Burnt Store Rd. Punta Gorda 33950	100	30.0TGD	10/31/88	DR
76	5208P00585	Bay Vista Restaurant	543 Buffalo Ave. N. Pt. Charlotte 33952	50	5TGD	5/07/89	DR
77	5208P00586	Palm & Pines M.H.P	5400 Riverside Dr. Punta Gorda 33950	150	15TGD	4/05/89	DR
78	5208P00587	Gasparilla Mobile Estates	P.O. Box 559 Placida 33946	150	15TGD	5/11/89	IM
79	5208P00590	Admiralty Villas, Inc.	2985 N. Beach Rd. Englewood 33533	50	5TGD	12/28/88	LA DR
80	5208P00590	Park Pointe MOB Villas	55 Park Pointe Englewood 33533	80	8TGD	8/12/88	IM DR
81	5208P00592	Villages of 1774	566 N.W. Olean Blvd. Office E-3 Port Charlotte 33952	——	28.5TGD	11/12/89	IM
82	5208P00608	Mundock STP GDU	1111 S. Bayshore Dr. Miami 33131	——	30TGD	INACTIVE	IM
83	5208P00609	Gulf Cove Suburboner STP	1111 S. Bayshore Dr. Miami 33131	220	11.5TGD	INACTIVE	IM
84	5208P00610	Westport	5224 Ave. Navarra Sarasota 33581	——	45TGD	INACTIVE	IM
85	5208P00982	Island Harbor Utilities	7092 Placida Rd. Cape Haze 33946	554	55TGD	5/24/90	DR
86	5208P01187	Palmetto MHP	110 S.E. Beeney Rd. Port Charlotte 33952	——	13.3TGD	1/25/88	IM
87	5208P01307	Windmill Village of Punta Gorda	215 Rio Villa Dr. Punta Gorda 33950	908	50TGD	12/10/87	IM DR
88	5208P01308	Parkhill Manor MHP #1	10101 Burnt Store #85 Punta Gorda 33950	——	30TGD	3/06/89	DR
89	52008P01759	Sea Horse Apts. (Sea Oats)	13955 Morse St. Cedar Lake, IN. 46303	——	7.2TGD	4/30/90	DR
90	5208P02096	Shell Creek Park	P.O. Box 755 Punta Gorda 33950	250	20TGD	7/1987	IM
91	5208P02468	Eagle Point MHP	Rt. 2, Box 460 Punta Gorda 33950	250	25TGD	4/27/88	IM
92	5208P02483	Tiki Apartments	P.O. Box 936 Englewood 33533	——	5TGD	6/12/89	LA
93	5208P02486	Pelican Harbor MHP	6720 Riverside Dr. Punta Gorda 33950	200	20TGD	12/26/88	IM
94	5208P02968	Parkhill Mobile Manor #2	2001 Wilshire Blvd. Suite 216 Santa Monica, CA 90403	368	15TGD	INACTIVE	DR
95	5208P02969	Palm Plaza Shopping Center	P.O. Box 271082 Tampa 33688	100	10TGD	7/21/87	DR

Ref. No.	DER No.	Name	Address Owner	Population	Capacity	Expiration Date	Disposal Method
96	5208P03196	Harbor Inn Motel	5000 Tamiami Trail Charlotte Harbor 33950	80	8.3TGD	12/06/88	DR
97	5208P03848	Holiday Travel	1475 Flamingo Dr. Englewood 33533	300	30TGD	11/23/88	IM
98	5208P04408	Tropicana Gardens Apartments	11400 Research Blvd. Austin, TX 78759	65	6.5TGD	12/28/88	DR
99	5208P05286	Mary-Lu Mobile Home Park	2424 Manatee Ave. W. Bradenton 33505	180	5.5TGD	9/16/88	DR
100	5208P05320	Port Charlotte Village	1000 Kings Highway Port Charlotte 33952	600	60TGD	2/25/88	IM
101	5208P05372	Harbor View Trailer Park	1635 E. Harbor View Rd. Charlotte Harbor 33950	456	25TGD	10/17/88	IM
102	5208P05688	Forest Park Condo	323 Shore Rd. Venice 33595	———	37.5TG	2/17/89	IM
103	5208P05689	Indigo Isles	323 Shore Rd. Venice 33595	144	15TGD	8/24/89	IM
104	5208P05895	Edgewater Manor Condo	685 S.E. Edgewater Dr. Apt. 58 Charlotte Harbor 33950	———	10TGD	10/12/88	DR
105	5208P05976	Sun-N-Shade Family Campground	P.O. Box 1718 Punta Gorda 33951	365	20TGD	8/25/88	IM
106	5208P06111	Alligator Utilities	Punta Gorda 33950	500	49TGD	10/14/88	DR, IM
107	5208P06189	River Forest MHP	10611 66 St. N. Pinellas Park 33565	406	35TGD	8/04/87	IM
108	5208P10373	Mercury Marine	State Rd. 775 Placida 33946	83	8.3TGD	11/09/88	DR
109	5208P10508	Oakwater Cove Condo	6005 N. Beach Rd. Apt. 5 Englewood 33533	60	6TGD	5/21/89	DR
110	5208P10847	Palm Manor	2430 S. McCall Rd Englewood 33533	112	15TGD	5/25/89	DR

IM = impoundment
DR = drainfield
LA = land application
SD = surface water discharge
BU = burial
IN = injection

XIV. REFERENCES

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