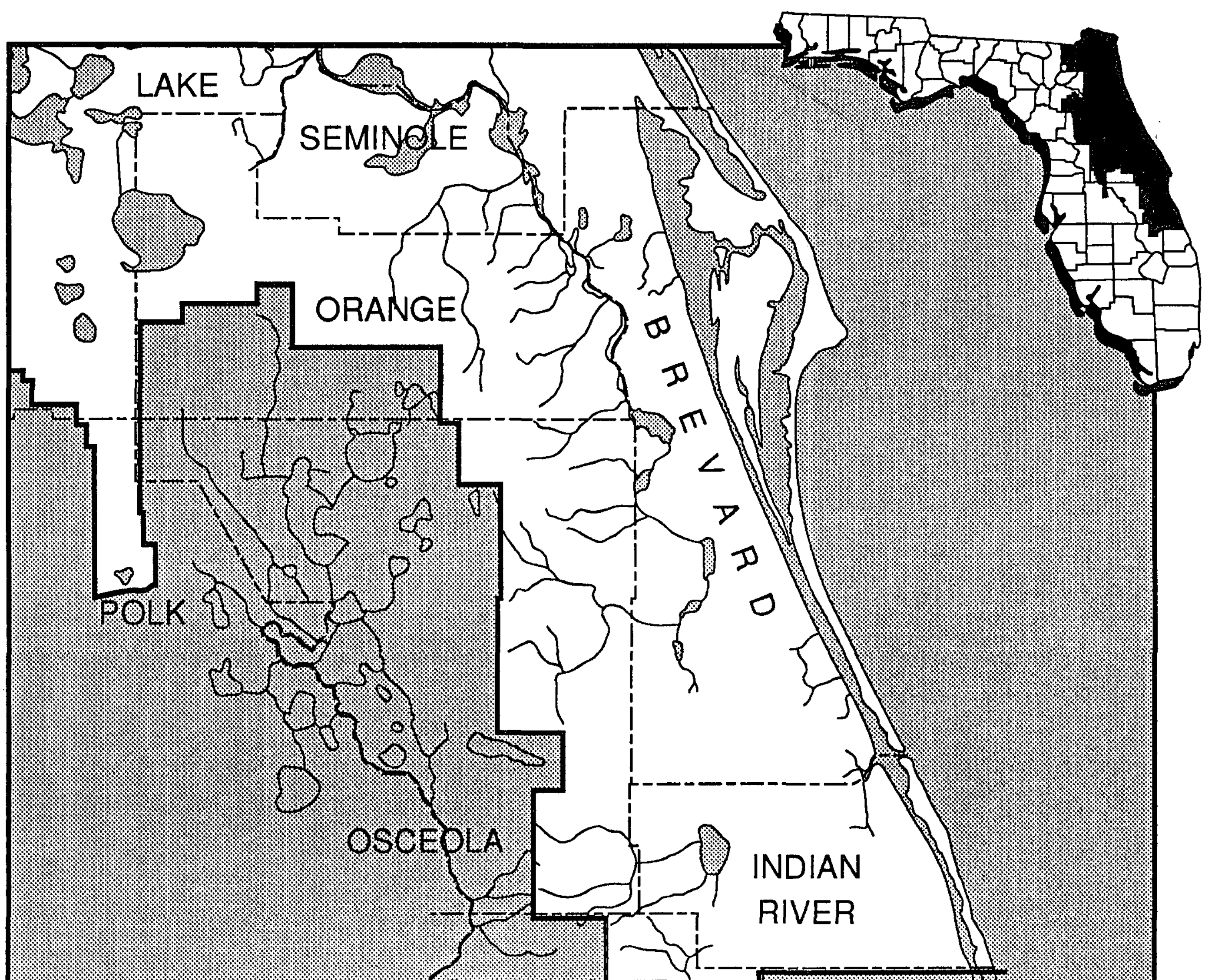
Technical Publication SJ 90-10

Upper St. Johns Ground Water Basin Resource Availability Inventory



St. Johns River Water Management District

Technical Publication SJ 90-10

UPPER ST. JOHNS GROUND WATER BASIN RESOURCE AVAILABILITY INVENTORY

by

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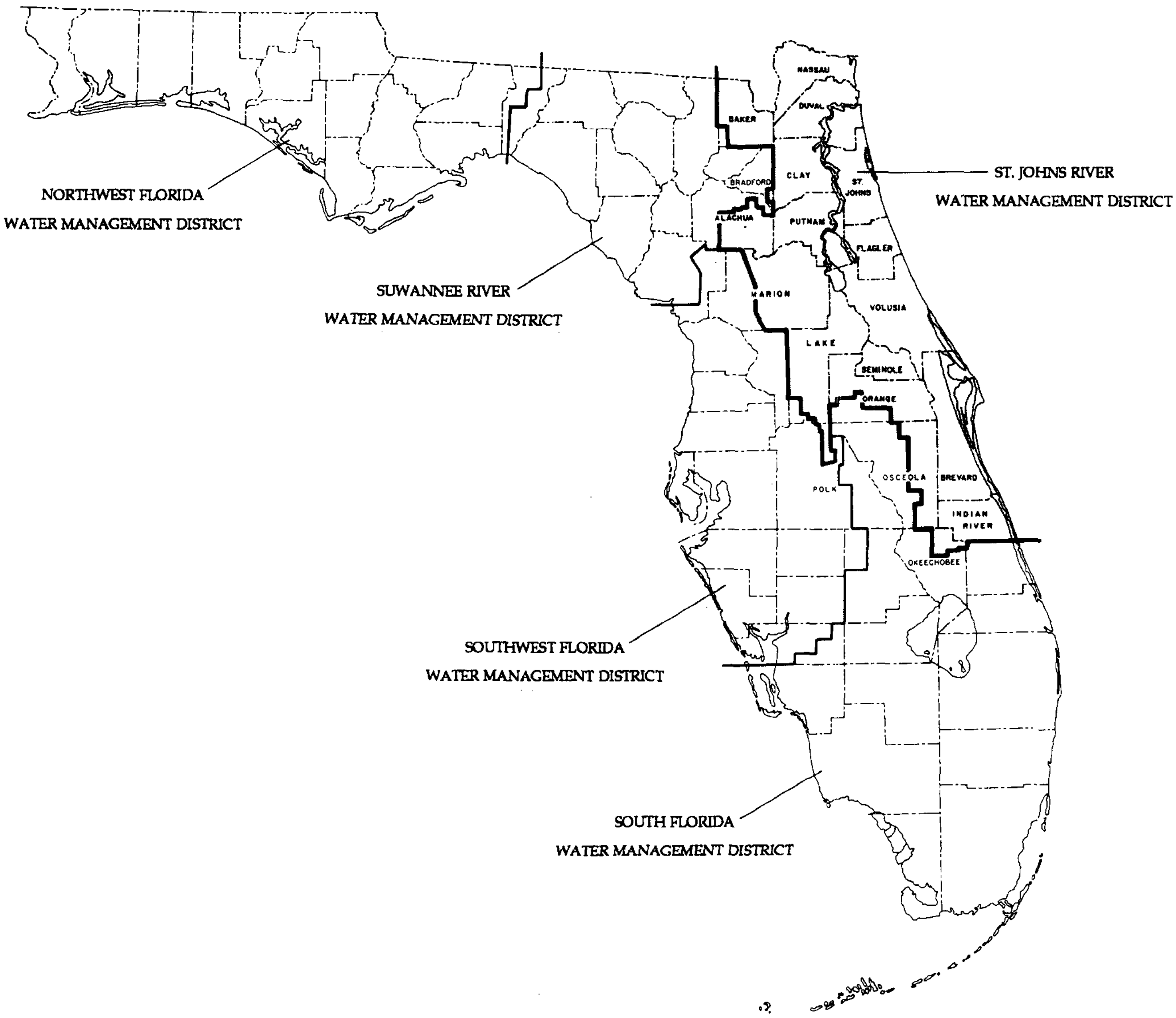
Palatka, Florida

1990



THE ST. JOHNS RIVER WATER MANAGEMENT DISTRICT

The St. Johns River Water Management District (SJRWMD) was created by the Florida Legislature in 1972 to be one of five water management districts in Florida. It includes all or parts of nineteen counties in northeast Florida. The mission of SJRWMD is to manage water resources to insure their continued availability while maximizing environmental and economic benefits. It accomplishes its mission through regulation; applied research; assistance to federal, state, and local governments; operation and maintenance of water control works; and land acquisition and management. Technical reports are published to disseminate information collected by SJRWMD in pursuit of its mission.

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INTRODUCTION

Rapid population growth, urban sprawl, and increased agricultural and industrial activities in recent years have resulted in significantly increased stress on the water resources throughout the state. In response to increased awareness of water resource issues, the Florida legislature has adopted legislation with the intent to improve water resource management and guide future growth through state, regional, and local planning programs.

This legislation has created a comprehensive planning process at the state, regional, and local levels of government. Local comprehensive plans address the elements set forth in the state comprehensive plan. One of these is conservation, addressing the conservation, use, and protection of natural resources, including water and water recharge areas (Section 163.3177, Florida Statutes). The legislature has directed the water management districts, pursuant to Section 373.0395, F. S. (Appendix A), to develop a ground water basin resource availability inventory and to disseminate the inventory to local governments and regional agencies for use in the comprehensive planning process.

This report provides a general inventory of the water resources of the Upper St. Johns (USJ) ground water basin, including hydrogeologic features, recharge and discharge areas, ground water quality characteristics, present and projected water use, direct water reuse, and areas suitable for future water resource development. The USJ ground water basin is one of five ground water basins in SJRWMD and is located largely in Brevard and Indian River counties and includes portions of Orange, Osceola, Volusia, Polk, Lake, Seminole, and Okeechobee counties (Figure 1).

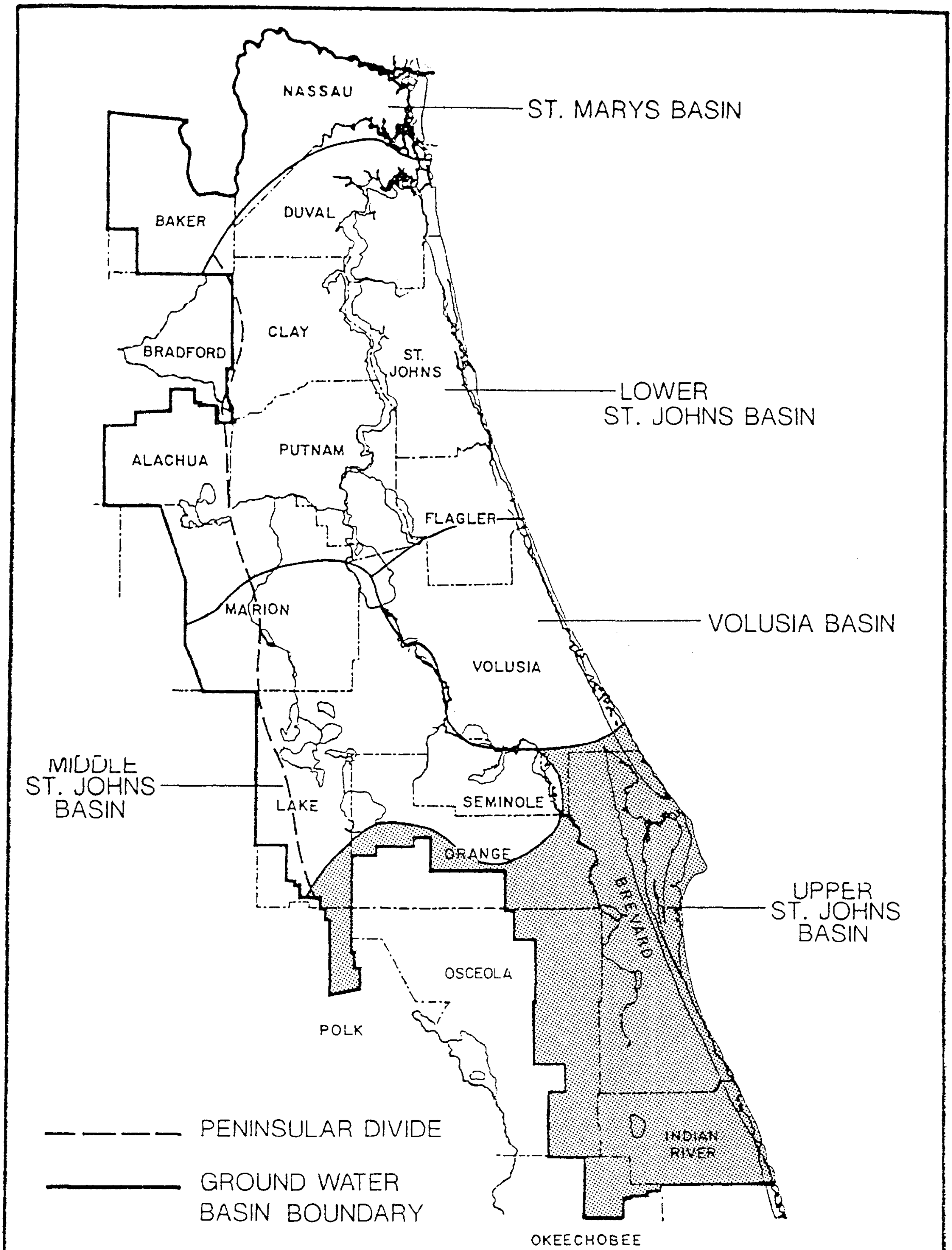


Figure 1. St. Johns River Water Management District and ground water basins

DESCRIPTION OF THE GROUND WATER BASIN

PHYSIOGRAPHY

The USJ ground water basin is predominantly in the Coastal Lowlands physiographic province (Cooke 1945). It is characterized by the St. Johns River Valley, the Atlantic Coastal Ridge, the barrier islands and coastal marine terraces (Figure 2).

The St. Johns River Valley is the location of the headwaters of the St. Johns River. The river flows through a series of lakes as it moves northward out of Brevard County. The land adjacent to the river is marshland bordered by a sandy prairie zone (Davis 1943).

The Atlantic Coastal Ridge, located east of the St. Johns River Valley, is prominent throughout the length of Brevard and Indian River counties and forms the drainage divide between the St. Johns River and Indian River drainage basins. The barrier islands, separated from the mainland by the Indian River, are composed of beach ridges that were formed by wind and wave action. This system of beach ridges generally parallels the coastline. The coastal marine terraces were formed when sea level stood at higher levels than at present. When the sea was higher it eroded the sea floor, and subsequent lowering of the sea exposed these erosional surfaces as marine terraces. In between each terrace is an abandoned shoreline represented by a sandy ridge. In the USJ ground water basin, six terraces are present. They are, in order of increasing age and elevation: the Silver Bluff, the Pamlico, the Talbot, the Penholoway, the Wilcomico, and the Sunderland terraces (Cooke 1945, Parker and Cooke 1944).

Land surface elevations range from 5 ft above mean sea level (msl) along the coast and the St. Johns River to approximately 85 ft above msl in eastern Orange County.

HYDROGEOLOGY

Three aquifer systems have been identified in the USJ ground water basin: the surficial aquifer system (unconfined), the intermediate aquifer system, and the Floridan aquifer (Figure 3). The intermediate aquifer system is found in the confining unit of the Floridan aquifer system.

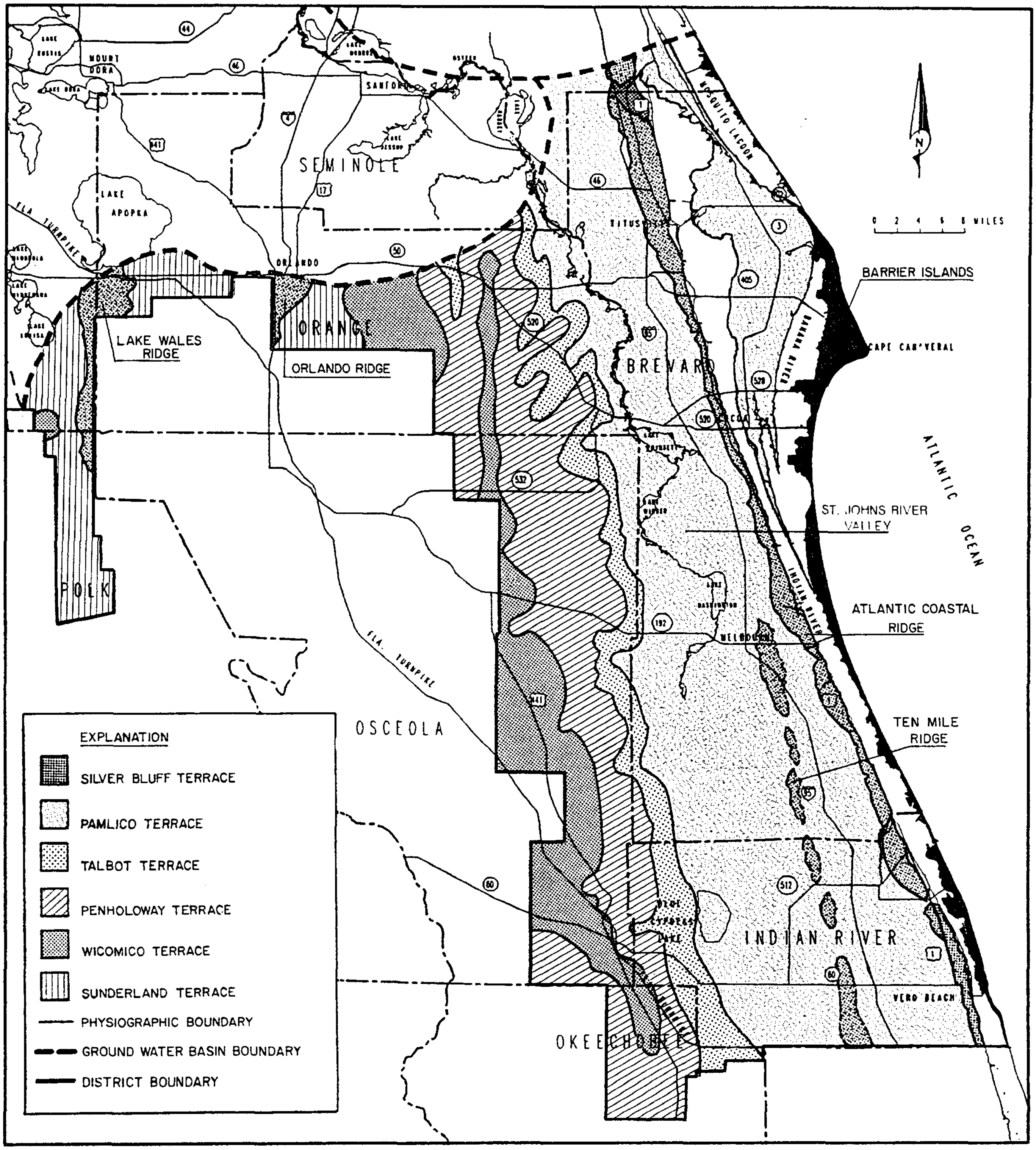
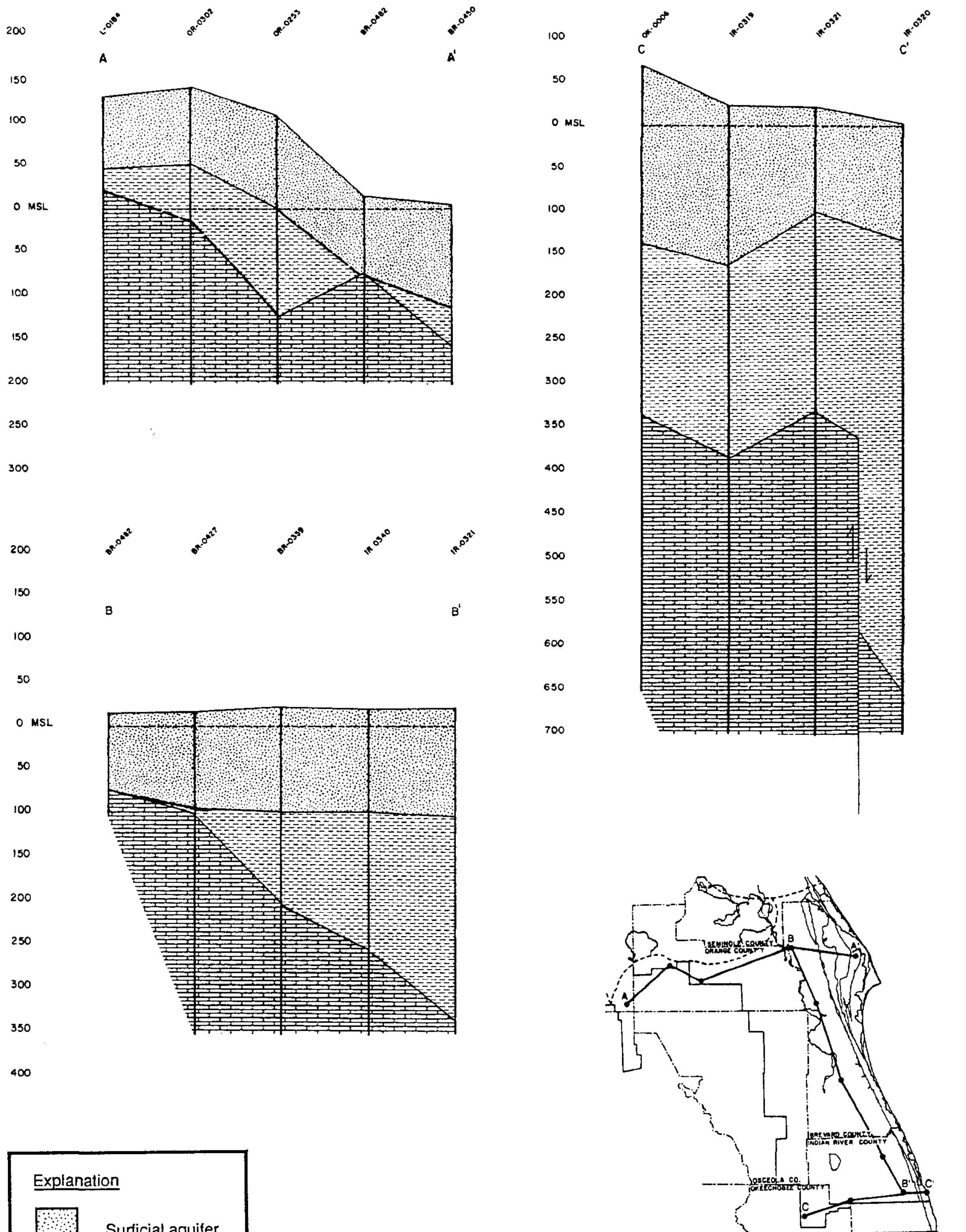


Figure 2. Physiographic features of the Upper St. Johns ground water basin, modified from Parker and Cooke (1944)



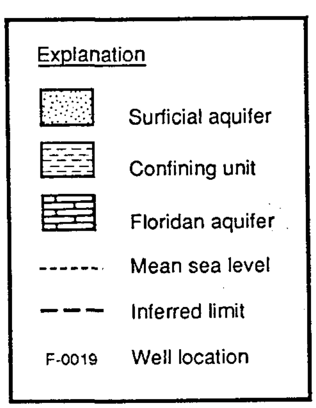


Figure 3. Hydrologic cross-sections of the Upper St. Johns ground water basin

The Surficial Aquifer System

The surficial aquifer system is composed of sand, shell, and some clay. The thickness of the surficial aquifer system is related to the topography, so it is thickest beneath the higher areas such as the Ten-Mile Ridge and the Atlantic Coastal Ridge. The surficial aquifer system ranges in thickness from less than 20 ft to as much as 200 ft in the basin (Planert and Aucott 1985, Schiner et al. 1988). Because there is no overlying confining unit, the aquifer is directly replenished by rainfall. The top of the aquifer is defined by the water table, which is free to rise and fall in response to atmospheric pressure. The water table marks the line below which all pore spaces are filled with water. Flow in the surficial aquifer system usually follows the topography of the land. In southeastern Brevard and Indian River counties the surficial aquifer system is a major source of water for public supply (Toth 1987).

The Intermediate Aquifer System

The intermediate aquifer, which also acts as a confining unit, is composed of clays, and thin, discontinuous water-bearing zones of sand, shell, and limestone. This aquifer occurs at depths ranging from 60 to 300 ft below land surface (Lichtler 1972). This low-yielding aquifer is not extensive enough throughout the basin to be considered a major source of water supply.

The Floridan Aquifer

The Floridan aquifer is an artesian aquifer composed of limestone and dolomite. In artesian aquifers the ground water is under pressure that is greater than atmospheric pressure. This pressure is demonstrated by the potentiometric surface, which is the level to which water will rise in tightly cased wells that penetrate the aquifer. When plotted on a map, this surface can be interpreted to show the direction of ground water flow (Figure 4). Ground water moves from areas of higher pressure to areas of lower pressure. Wells will flow when constructed in areas where the potentiometric surface of the aquifer is above land surface. Such flowing wells are common in Brevard and Indian River counties. This aquifer is an important source for public, industrial, irrigation, and rural domestic water supplies. Due to high salinity levels, water quality in this aquifer generally exceeds public drinking water standards in Brevard and Indian River counties.

In southern Brevard County, Lake Washington serves as a reservoir for public supply. It supplies water to Melbourne and adjacent areas of the county.

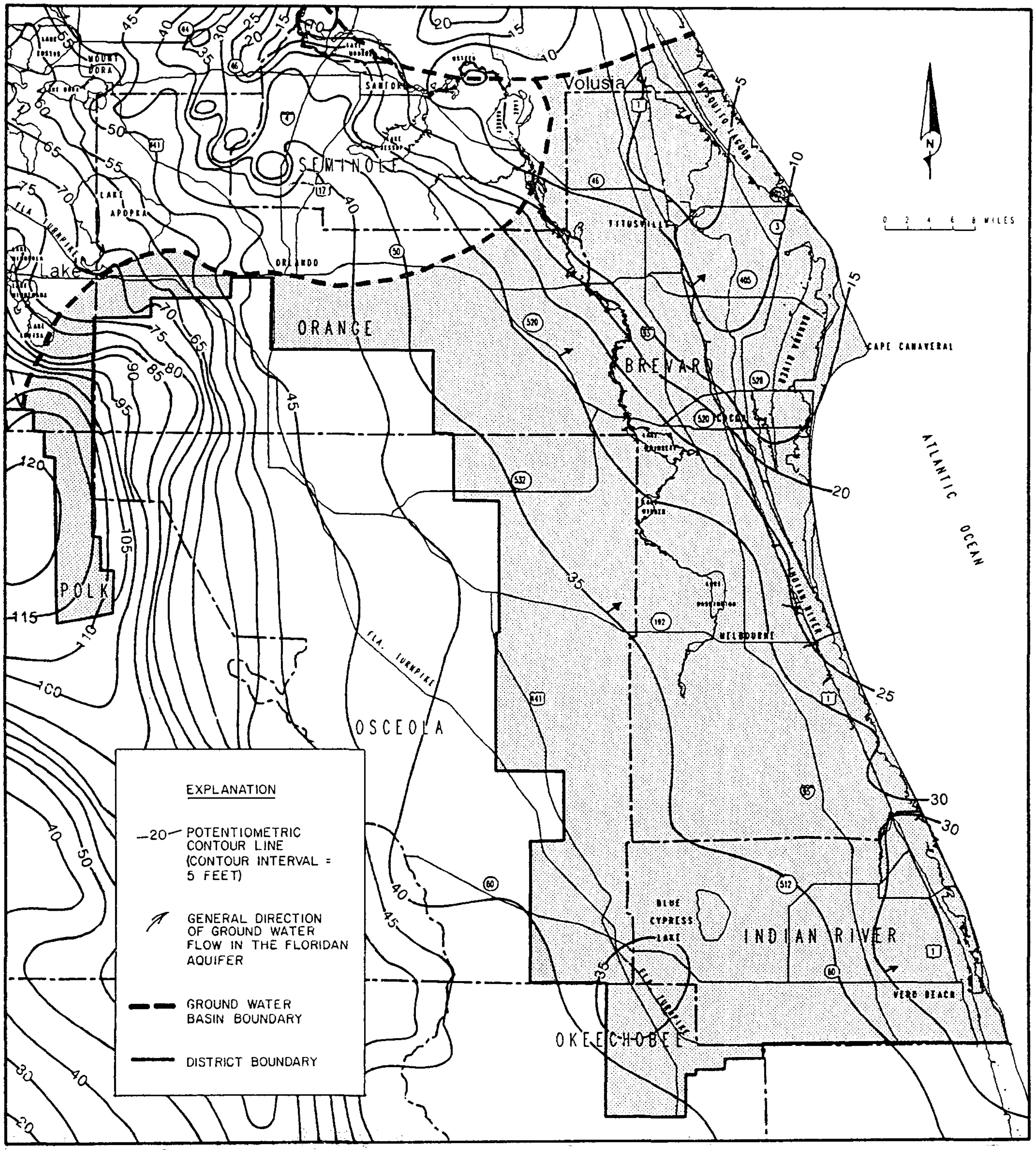


Figure 4. The Upper St. Johns ground water basin potentiometric surface of the Floridan aquifer for May 1987, modified from Schiner and Hayes (1981)

GROUND WATER RECHARGE

SURFICIAL AQUIFER SYSTEM

Recharge in any area is affected by local rainfall, vegetation, and topography. One way to assess recharge to the surficial aquifer system is to determine where the surficial soils are highly permeable. Figure 5 is a generalized soils map for the USJ ground water basin. Those areas that are identified by highly permeable sandy soils are potential recharge areas for the surficial aquifer system. These areas are very favorable for recharge if large quantities of water are to be withdrawn from the surficial aquifers. They are also highly sensitive to pollutant introduction. Areas characterized by impermeable soils are areas of little or no recharge to the surficial aquifer system.

FLORIDAN AQUIFER

The Floridan aquifer is recharged by the surficial aquifer system in areas where the water level in the surficial aquifer system is higher than the potentiometric surface of the Floridan aquifer. Areas within the USJ ground water basin have been classified according to potential recharge capability from the surficial aquifer system to the Floridan aquifer (Stewart 1980, Healy 1975) in four classes: areas of generally no recharge, areas of very low recharge (less than 2 inches per year), areas of very low to moderate recharge (less than 2 to as much as 10 inches per year), and areas of high recharge (10 to 20 inches per year) (Figure 6). The areas of high potential recharge in the USJ ground water basin are the Lake Wales and Orlando ridges.

Discharge from the Floridan aquifer in the USJ ground water basin occurs where the elevation of the potentiometric surface of the Floridan aquifer is greater than the elevation of the water table in the surficial aquifer system. In areas where the elevation of the potentiometric surface of the Floridan aquifer is above land surface elevation, Floridan aquifer wells will flow freely at land surface.

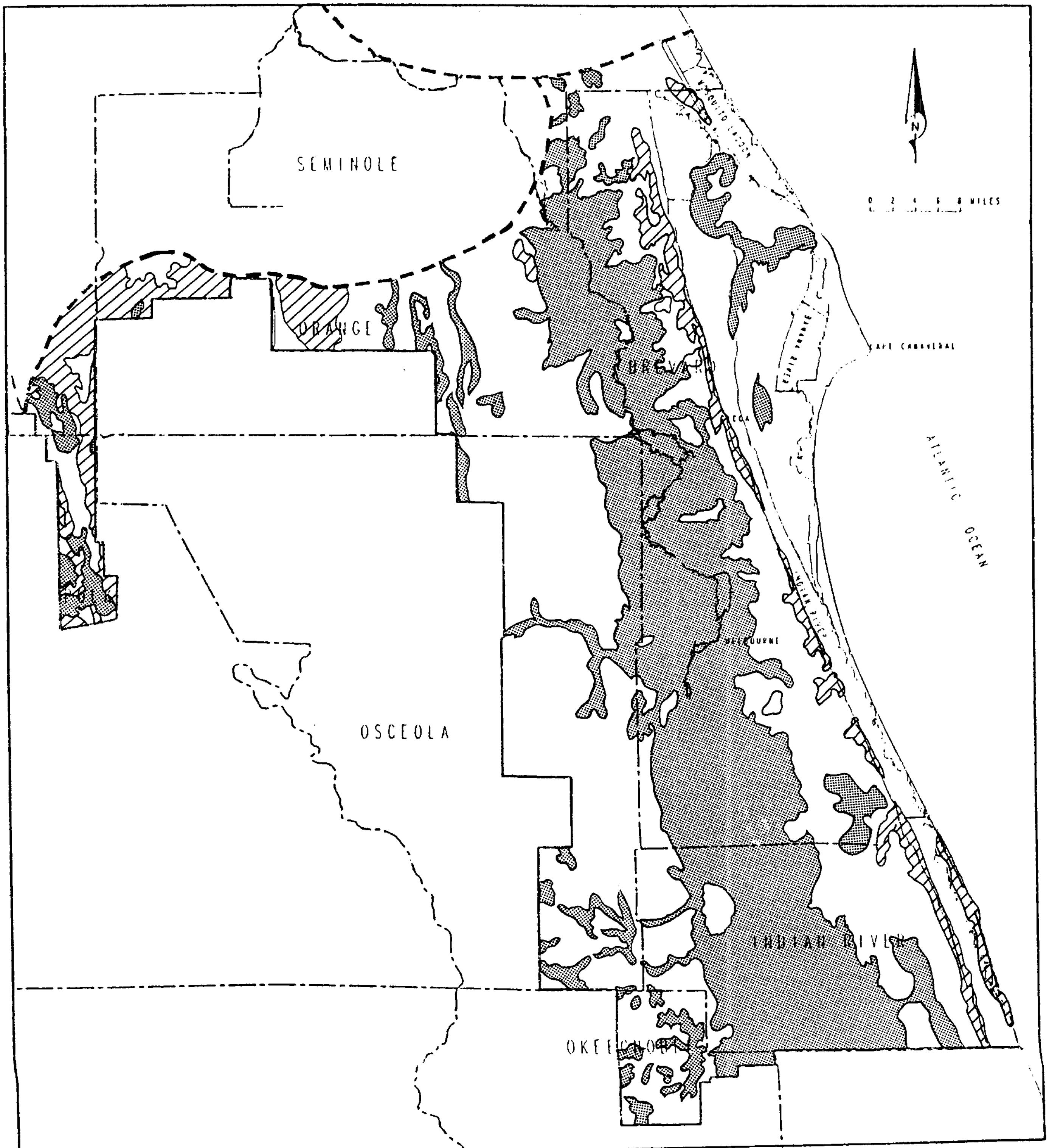


Figure 5.

Soils map for the upper St. Johns ground water basin. Very permeable soils indicate areas of potential recharge to the surficial aquifer.

Explanation

- Areas dominated by sandy soils: very permeable
- Areas dominated by poorly-drained soils: very impermeable
- Basin boundary line
- County line
- Peninsular divide
- District boundary line

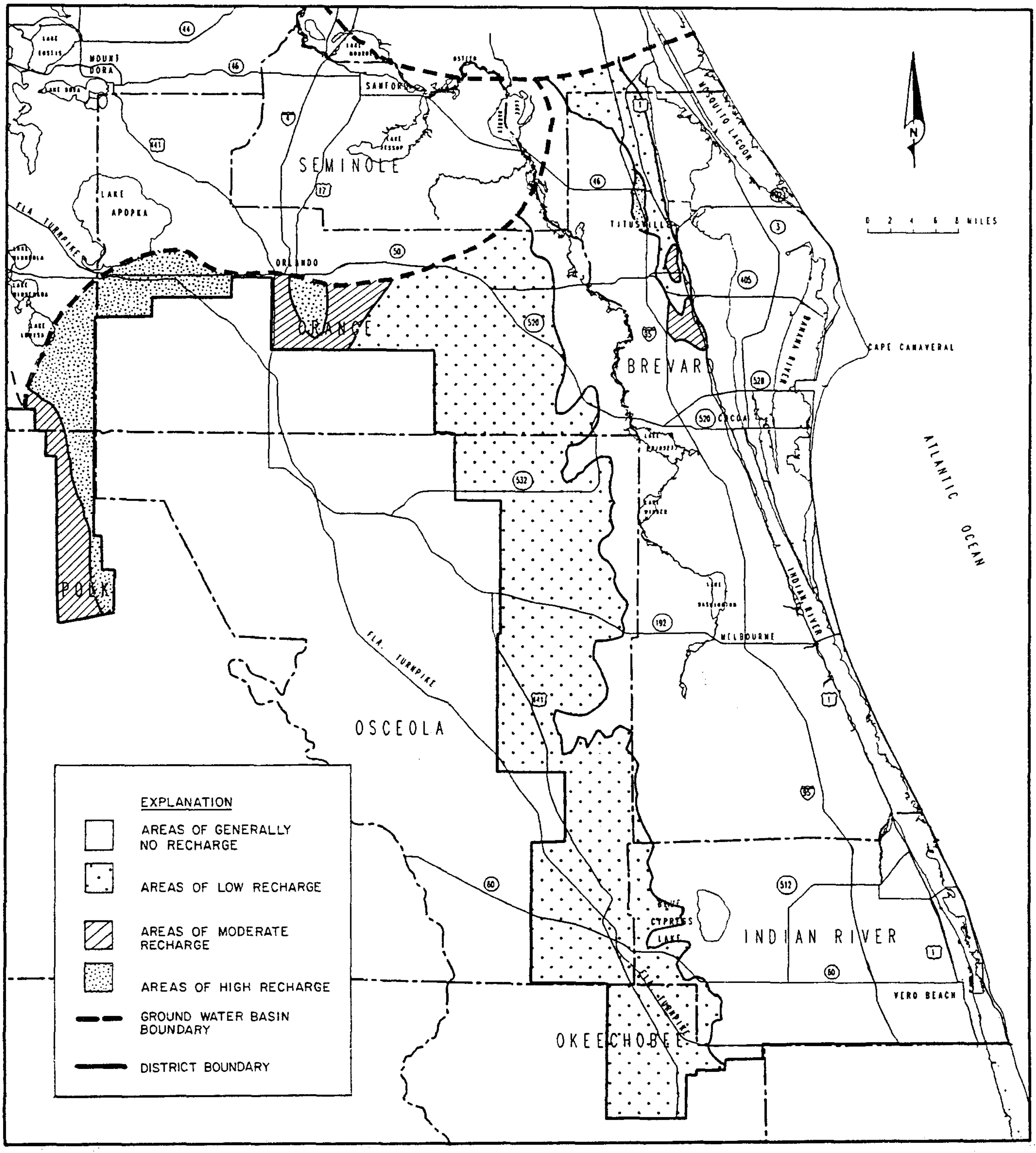


Figure 6. Approximate areas of natural recharge and discharge for the Floridan aquifer in the Upper St. Johns ground water basin (modified from Stewart 1980)

PRIME GROUND WATER RECHARGE AREAS

Section 373.0395, F. S., provides that the GWBRAI include the designation of prime ground water recharge areas. A pilot study to delineate areas of greatest recharge to the Floridan aquifer has been performed by the SJRWMD (Boniol 1990). The study area for the pilot study was the Crescent City Ridge area of southeast Putnam County. The methodology and knowledge gained from this pilot study will be used to delineate prime recharge areas in other parts of the district. Similar work in the northern part of the USJ ground water basin is scheduled to be completed by September 30, 1990.

GROUND WATER QUALITY

The natural quality of ground water in the USJ ground water basin varies greatly depending on the location and the depth from which water is obtained. A major concern in this basin is saltwater intrusion.

The quantity of potable water within the Floridan aquifer varies with fluctuations in the potentiometric surface. These fluctuations result from seasonal climatic changes and from changes in the magnitude of ground water withdrawal. The potable water within the aquifer is underlain by denser saline water. The potential exists for this saline water to move upward within the aquifer system in response to declines in the potentiometric surface (Figure 7).

Saline water--water with high salt content--can be characterized by a total dissolved solids (TDS) concentration in excess of 500 mg/l. The TDS concentration in public drinking water is required to be less than 500 mg/l. In drinking water systems the salts of greatest concern are chloride and sulfate. The Environmental Protection Agency (EPA) recommends that public drinking water contain less than 250 mg/l chloride and sulfate.

In the USJ ground water basin, chloride concentrations measured in water samples from wells that penetrate the Floridan aquifer generally increase from west to east and increase with depth within the aquifer. Chloride concentrations at depths of 300 ft below land surface vary from nearly zero in recharge areas to more than 1000 mg/l in discharge areas in the northern part of the basin. (Figure 8). The chloride concentrations in Figure 8 are based on all the Floridan aquifer wells in the SJRWMD data base, regardless of depth. Maps depicting the chloride concentration for part of the Floridan aquifer, i.e., the upper 500 ft, may be different, especially in Indian River County (see Schiner et al. 1988)

In addition to chloride concentrations, sulfate concentrations in the Floridan aquifer can be nearly zero in recharge areas at depths of 300 ft below land surface, but can increase to more than 1000 mg/l at equivalent depths in discharge areas in the northern part of the basin (Figure 9).

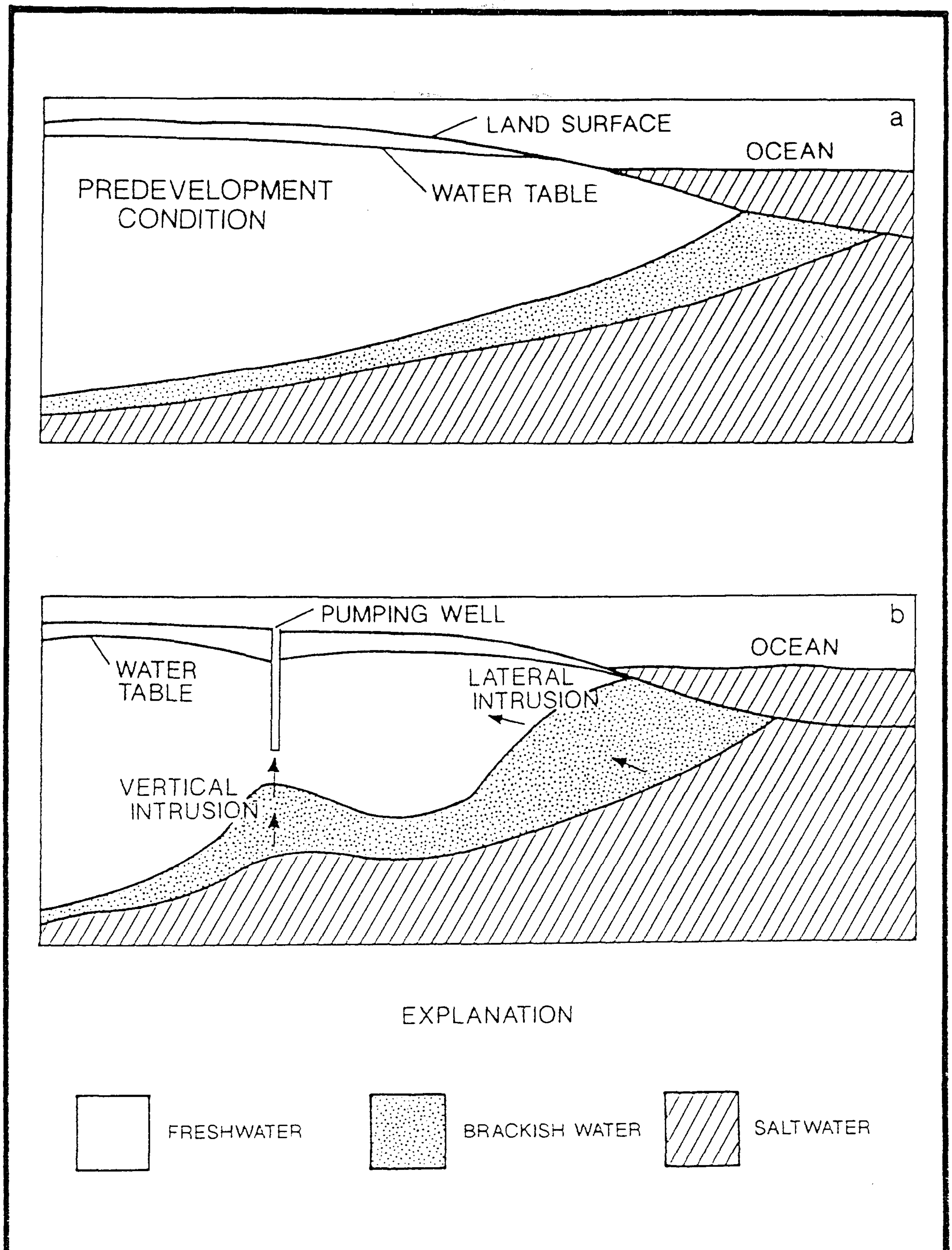


Figure 7. The movement of saline water caused by pumping

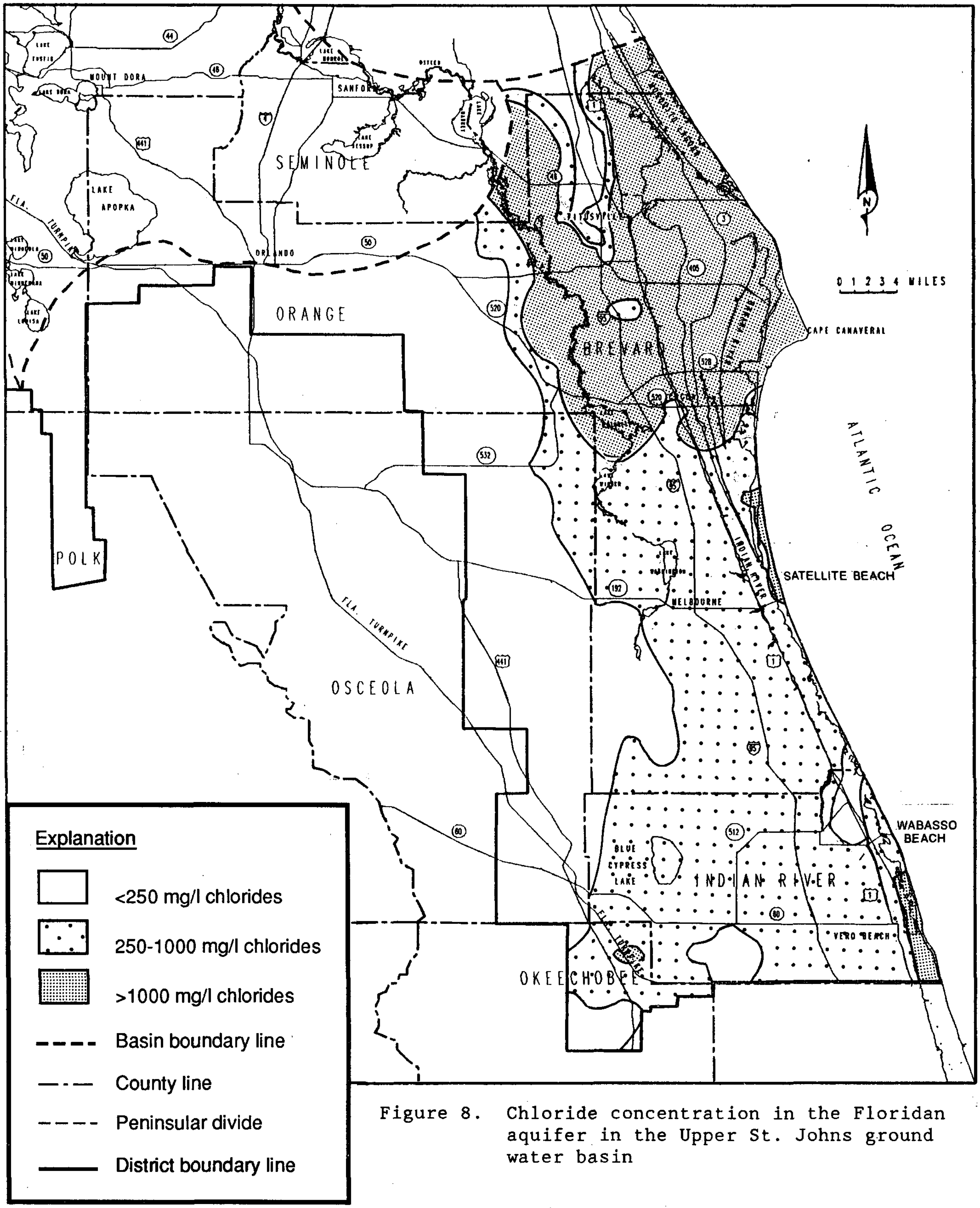


Figure 8. Chloride concentration in the Floridan aquifer in the Upper St. Johns ground water basin

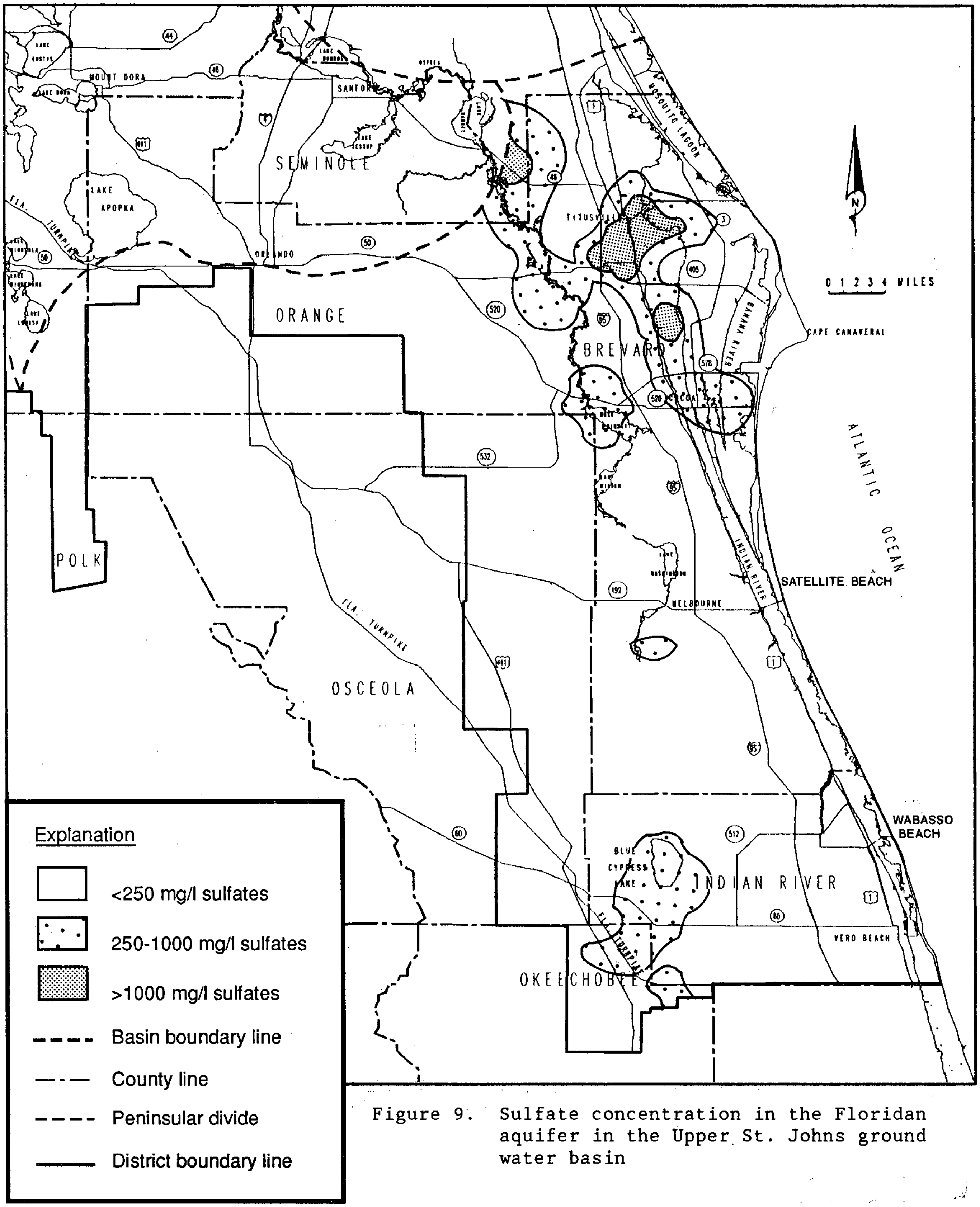


Figure 9. Sulfate concentration in the Floridan aquifer in the Upper St. Johns ground water basin

THICKNESS OF POTABLE WATER

Both the thickness of potable water in the Floridan aquifer and the depth to the base of potable water increase from east to west in the USJ ground water basin (Figure 10). The Floridan aquifer in most of Brevard and Indian River counties contains non-potable water. The thickness of potable water in the Floridan aquifer in Lake and Polk counties is more than 2000 ft. The depth to the base of potable water is also more than 2000 ft below mean sea level (msl) in both Polk and Lake counties. Water is considered potable if its chloride or sulfate concentration does not exceed 250 mg/l and its total dissolved solids (TDS) content is less than 500 mg/l.

In western Indian River County, the map of chloride concentration in the Floridan aquifer in the USJ ground water basin (Figure 8) shows a smaller area of potable water than the map of the thickness of potable water in the basin (Figure 10). The difference stems from the fact that the chloride concentration map is based on all wells that tap the Floridan aquifer, regardless of depth, whereas the map of the thickness of potable water is based on shallower wells. In western Indian River County, potable water only occurs in wells that are less than approximately 500 ft deep and tap only the upper 250 ft of the Floridan aquifer.

The reports and data used to compile Figure 10 span a period from about 1950 to 1969, and no consideration was given to seasonal or long-term changes in thickness or local variations due to pumpage. Therefore, Figure 10 cannot be used to determine the exact thickness of potable water in the Floridan aquifer at any specific location or at any specific time. In areas where the potentiometric surface has declined since 1950, both the thickness and depth to the base of potable water will be less.

AREAS PRONE TO SALTWATER INTRUSION

The potential for saltwater intrusion exists in the USJ ground water basin. The sources for this potential intrusion are lateral and vertical saltwater migration.

The freshwater/saltwater interface, as used in this study, denotes areas of the aquifer where chloride concentrations are above the public drinking water limit of 250 mg/l and the relative chemical composition of the water is similar to that of seawater. It does not represent the interface between fresh water and seawater, which occurs at a much higher chloride concentration of 19,000 mg/l.

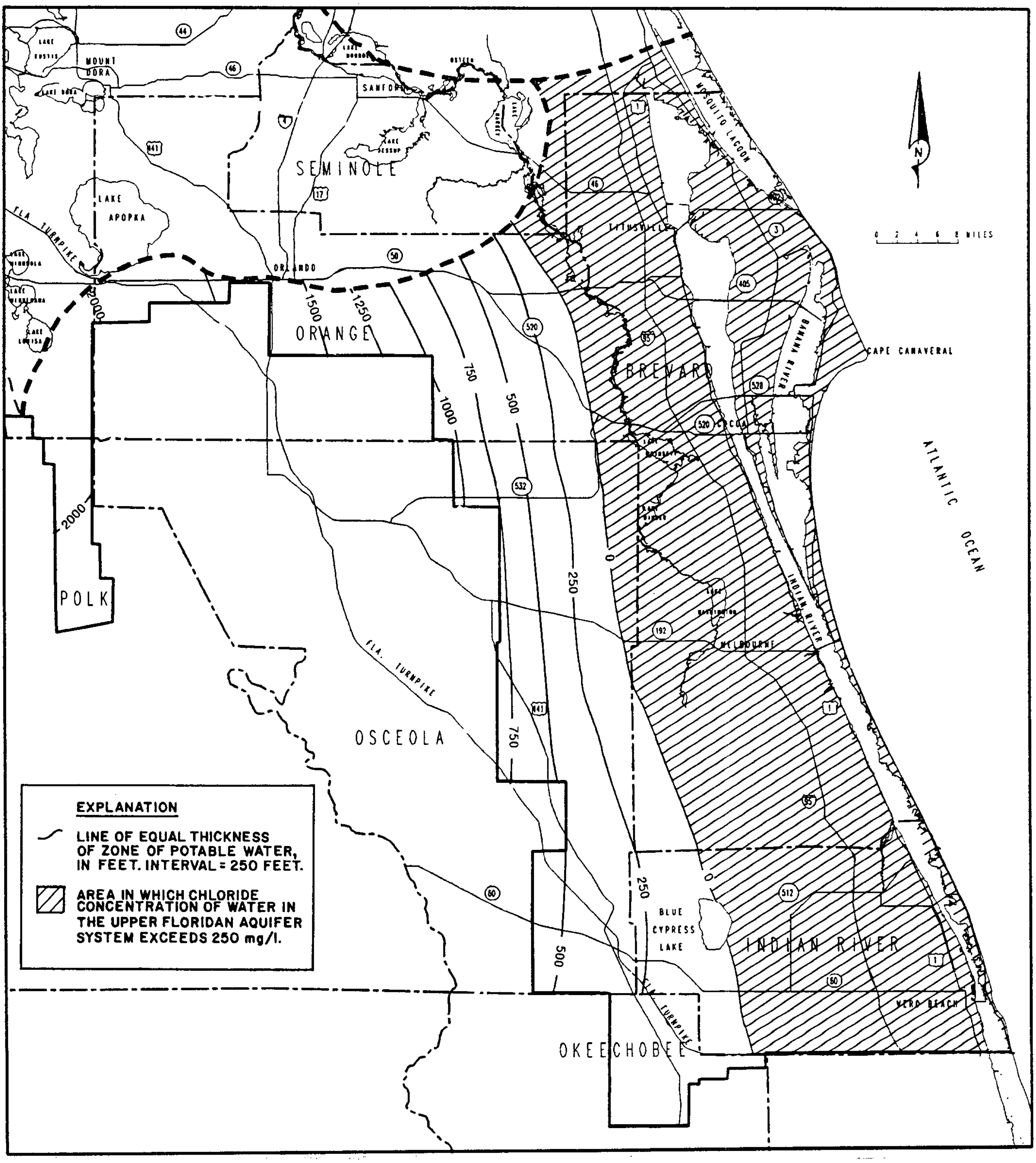


Figure 10. Thickness of the potable water zone in the Floridan Aquifer in the Upper St. Johns ground water basin

Surficial Aquifer

The surficial aquifer system is most prone to saltwater intrusion along the coast. The surficial aquifer system in the coastal areas depends upon rainfall to maintain its fresh water supply. Withdrawals from this aquifer in coastal areas are used primarily for lawn irrigation (Toth 1988).

In Brevard and Indian River counties, the shallow aquifer system contains laterally intruded seawater. Saltwater intrusion extends further inland in areas of large withdrawals. For example, at Vero Beach the freshwater/saltwater interface extends 1-3/4 miles west of the Indian River at the northern boundary of the city and 3/4 miles west of the Indian River at the southern boundary of the city. The majority of production in the Vero Beach well field is from wells in the northeast part of the city (Toth 1988).

The surficial aquifer system is also prone to high salinity in agricultural areas because of land surface application of saline irrigation water or contamination of the shallow ground water by deeper, more saline water, through deteriorated or leaking Floridan aquifer well casings.

Floridan Aquifer

Vertical and lateral saltwater intrusion in the Floridan aquifer occurs with change in the depth to the freshwater/saltwater interface. This depth changes in response to changes in the potentiometric surface; i.e., generally as the potentiometric surface declines, the depth to the freshwater/saltwater interface decreases (Figure 9). Changes in the potentiometric surface result from changes in the magnitude of ground water withdrawals and climatic changes.

The Floridan aquifer is prone to vertical saltwater intrusion in the coastal and northern portions of the basin, where the Floridan aquifer contains salt water. This salt water is classified as relict seawater--seawater that was trapped in the rocks when they were deposited. Sufficient time has not elapsed to flush all this seawater from the aquifer. The chloride concentration is above 1000 mg/l in these areas, which occur throughout most of northern Brevard, eastern Orange, eastern Seminole, northeastern Osceola, and southeastern Volusia counties, and from Wabasso Beach to the southern border of Indian River County (Figure 8).

The Floridan aquifer system is also prone to lateral saltwater intrusion in the north coastal portions of the basin. At Satellite Beach in eastern Brevard County, where the chloride concentration is above 1000 mg/l, withdrawals from numerous small diameter wells for cooling and irrigation on the barrier island has caused lateral movement of the freshwater/saltwater interface. Lateral intrusion also occurs at depth in the Floridan aquifer near

Wabasso Beach. The intrusion is the result of an estimated 20 ft decline in the potentiometric surface of the Floridan aquifer between 1936 and 1981. This decline was the result of large withdrawals for citrus irrigation to the west of the interface (Toth 1988).

AREAS SUITABLE FOR FUTURE WATER RESOURCE DEVELOPMENT

Water resource development is affected by such factors as the cost of developing and transporting potable water and/or the cost of treating water to an acceptable level. In addition, other factors influencing suitability for water resource development are:

1. presence of desirable water quality conditions,
2. thickness of potable water within a given aquifer,
3. presence of confining units above aquifer zones of supply to provide protection against contamination,
4. presence of unique geologic conditions which may cause sinkholes or land subsidence, and
5. magnitude of withdrawals associated with existing consumptive use permits.

Each of these factors must be considered specifically for any given site in the ground water basin.

Pursuant to the requirements of Section 373.0391(2)(e), F.S., by July 1, 1991, the district is required to prepare an assessment of the regional water resource needs and sources for the next 20 years. This assessment should provide more information concerning the suitability of water resource development in the USJ ground water basin.

MINIMUM GROUND WATER LEVELS

The state legislature has mandated the water management districts to establish minimum flows and levels for surface and ground water (Section 373.042, F. S.). SJRWMD is developing a technique for establishing these levels. These levels, when proposed, must be adopted through the public hearing process, which will provide the public, local governments, and regional agencies an opportunity for input. Information relating to minimum ground water levels is scheduled to be provided to local governments by July 1, 1991.

WATER USE

In 1985, three counties (Brevard, Indian River, and Orange counties) within the USJ ground water basin withdrew over 100 million gallons of water a day (mgd) and accounted for 42 percent of the total water use in SJRWMD (Marella 1986). The projected population growth and the resulting increase in water supply demands in the basin is anticipated to occur within these three counties. Because the portions of Lake, Okeechobee, Osceola, Seminole, and Polk counties included in the basin are primarily undeveloped and relatively small, their current and projected withdrawals are not delineated further in this report. Orange County is divided by two water management districts and two ground water basins. Because these boundaries do not coincide and data are collected and tabulated on a county basis, water withdrawal projections and population projections were calculated for the entire county.

BREVARD COUNTY

Since 1975, Brevard County has experienced increased population growth and water supply demands (Figure 11a). Combined water use from public supply and domestic self-supply systems has increased from 29.8 mgd in 1975 (Leach 1978) to 51.0 mgd in 1985 (Marella 1986). Surface water withdrawals from Lake Washington for public supply have also increased from 8.9 mgd in 1975 to 14.1 mgd in 1985. The population in this county increased 35 percent from 1975 to 1985 (251,986 to 339,473) (University of Florida 1976, 1986) and is expected to surpass 491,800 (almost double the 1975 population levels) by the year 2000 (Smith and Sincich 1987).

Agricultural water withdrawals in Brevard County have decreased from a high in 1980 (Figure 11b) of 155.9 mgd to 102.7 mgd in 1987. This change is the result of changes in rainfall, acres irrigated, and the manner in which withdrawals were calculated (see Marella 1990).

Water-to-air heat pumps, which take advantage of the hydrologic conditions within the county, are also popular in Brevard County. In 1977, a survey was conducted to estimate the number of these units (Post, Buckley, Schuh, and Jernigan 1979). An estimated 4,165 heat pump units were accounted for and estimated water use from these units equalled 22.8 mgd (Skipp 1988, appendix) from the Floridan aquifer. Additionally, an estimated 4.6 mgd of water was used from

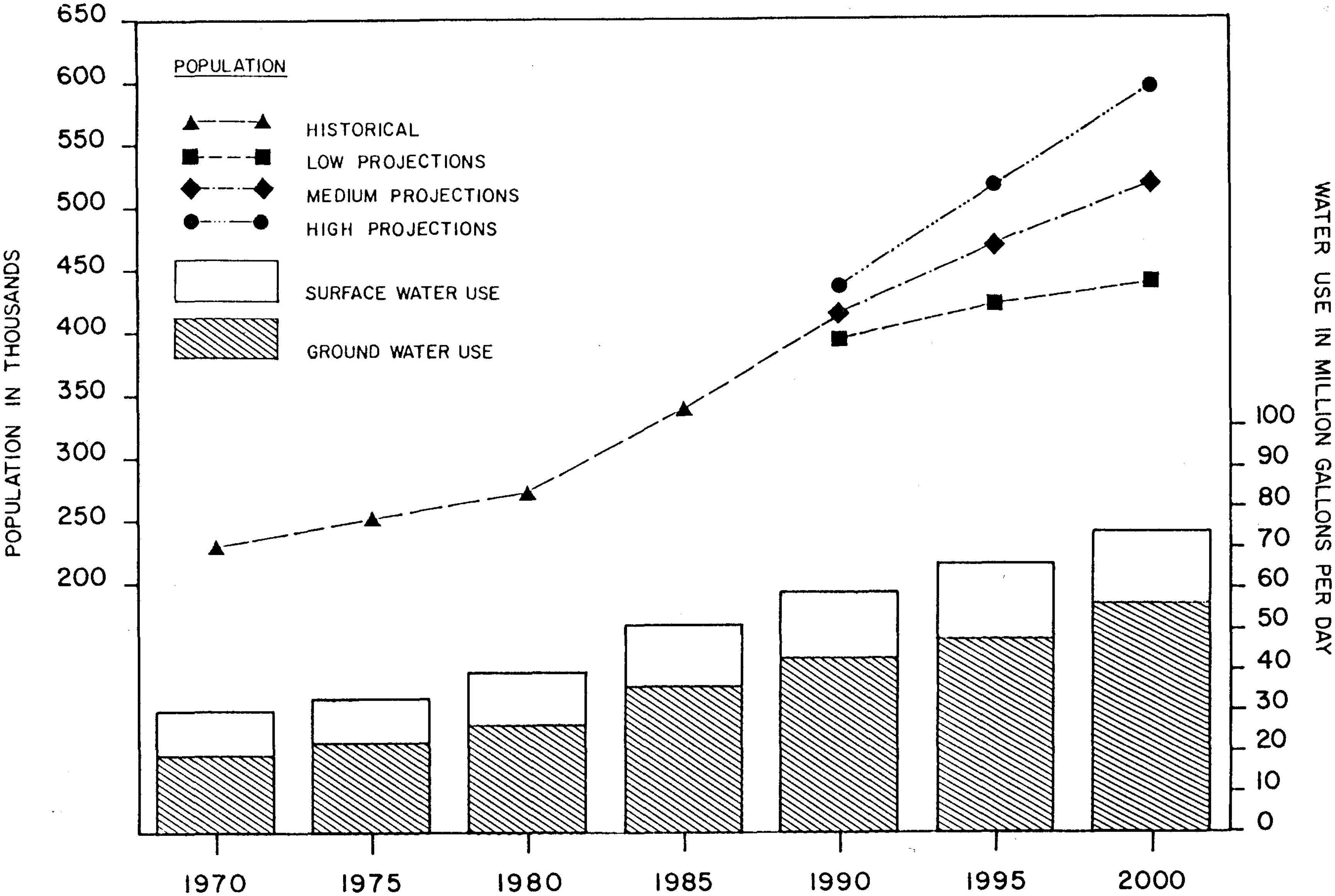


Figure 11a. Past and projected population and ground water use in Brevard County

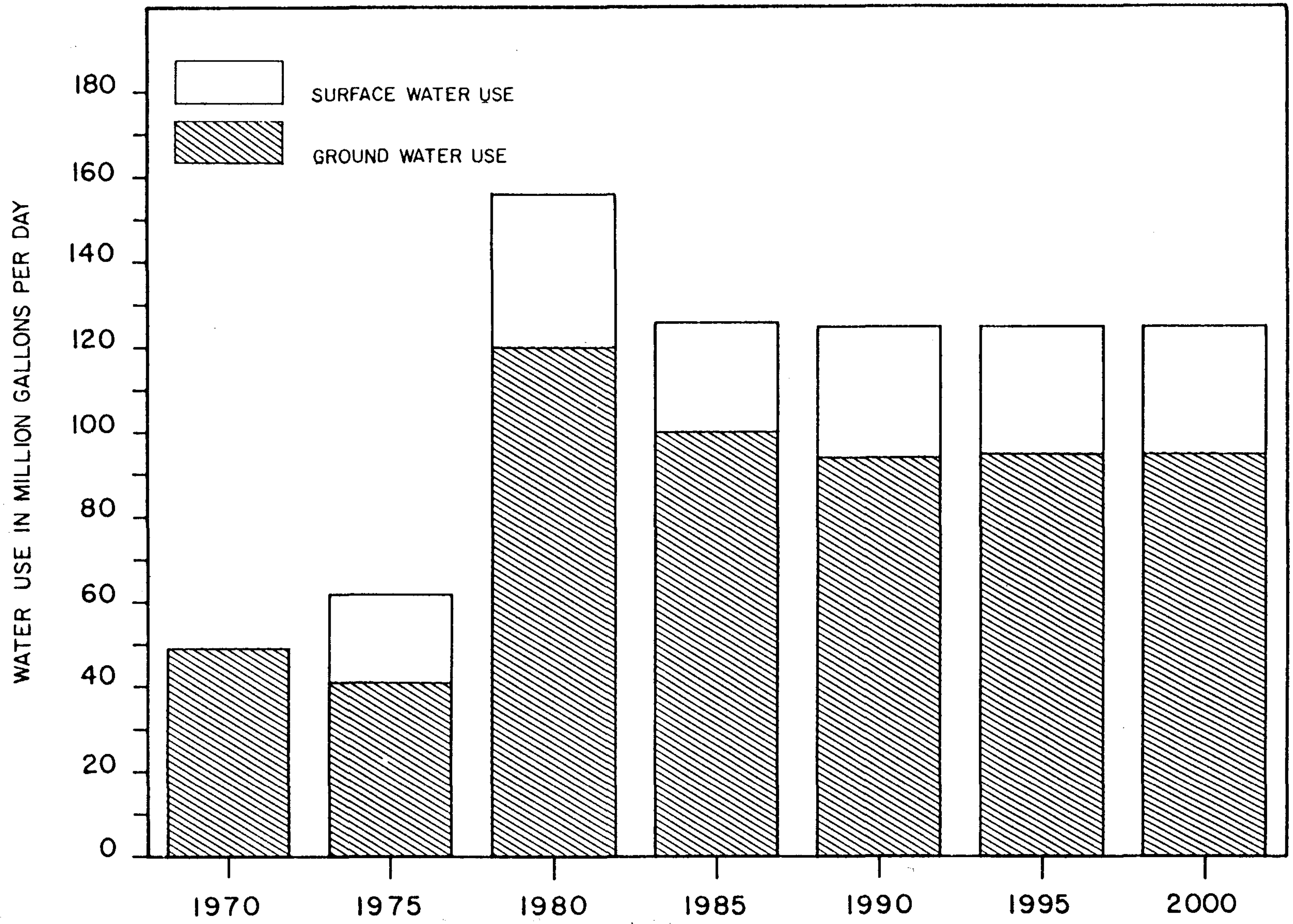


Figure 11b. Past and projected agricultural withdrawals in Brevard County

private shallow wells to irrigate residential lawns (Skipp 1988 appendix).

Total water use needed to supply Brevard County is estimated to range between 175 to 200 mgd by the year 2000 (Marella pers. comm. 1989). If ground water withdrawals continue in the same proportion as in 1985, between 75 and 85 percent of this estimated demand will be ground water. Estimates of water use through the year 2000 were made by assuming per capita water use will remain at approximately 150 gallons per day (gal/d), and no major self-supplied commercial or industrial facility will move into Brevard County in the next 15 years. The population served by public supply is assumed to remain at approximately 90 percent of the total population of the county. Further assumptions included: thermoelectric water use and self supplied commercial-industrial use will remain at approximately 1 mgd combined, and additional water for the City of Cocoa's public supply system will continue to be provided from ground water sources in Orange County. Agricultural irrigation will continue to range between 100-125 mgd through the year 2000. Additionally, the reliance on reclaimed water for irrigation of golf courses and turf grass will increase.

INDIAN RIVER COUNTY

In Indian River County water use from public supply and domestic self-supply systems has increased from 7.3 mgd in 1975 (Leach 1978) to 16.1 mgd in 1985 (Marella 1986), all from ground water sources (Figure 11c). The intermediate and surficial aquifers are the primary source of potable water in this county.

The population in this county increased 65 percent from 1975 to 1985 (46,254 to 76,442) (University of Florida 1976, 1986) and is expected to surpass 122,500 by the year 2000 (Smith and Sincich 1987). An estimated 40 percent of Indian River County's population received drinking water from public supplied systems in 1975. This usage increased to 55 percent in 1985.

Total agricultural withdrawals were 298.2 mgd in 1975, 137.1 mgd in 1980, 135.6 mgd in 1985, and 129.8 mgd in 1987 (Figure 11d). These changes result from changes in rainfall, acres irrigated, and the manner in which withdrawals were calculated. The majority of irrigation withdrawals in this county are from surface water sources. During the early and mid 1980s, surface water supplied between 70 and 80 percent of the irrigation withdrawals.

Total water use needed to supply Indian River County is projected to range between 150 and 180 mgd by the year 2000 (Marella pers. comm. 1989). If ground water withdrawals continue at the same proportion as in 1985, between 30 and 40 percent of this projected demand will be ground water. Predictions for ground water withdrawals

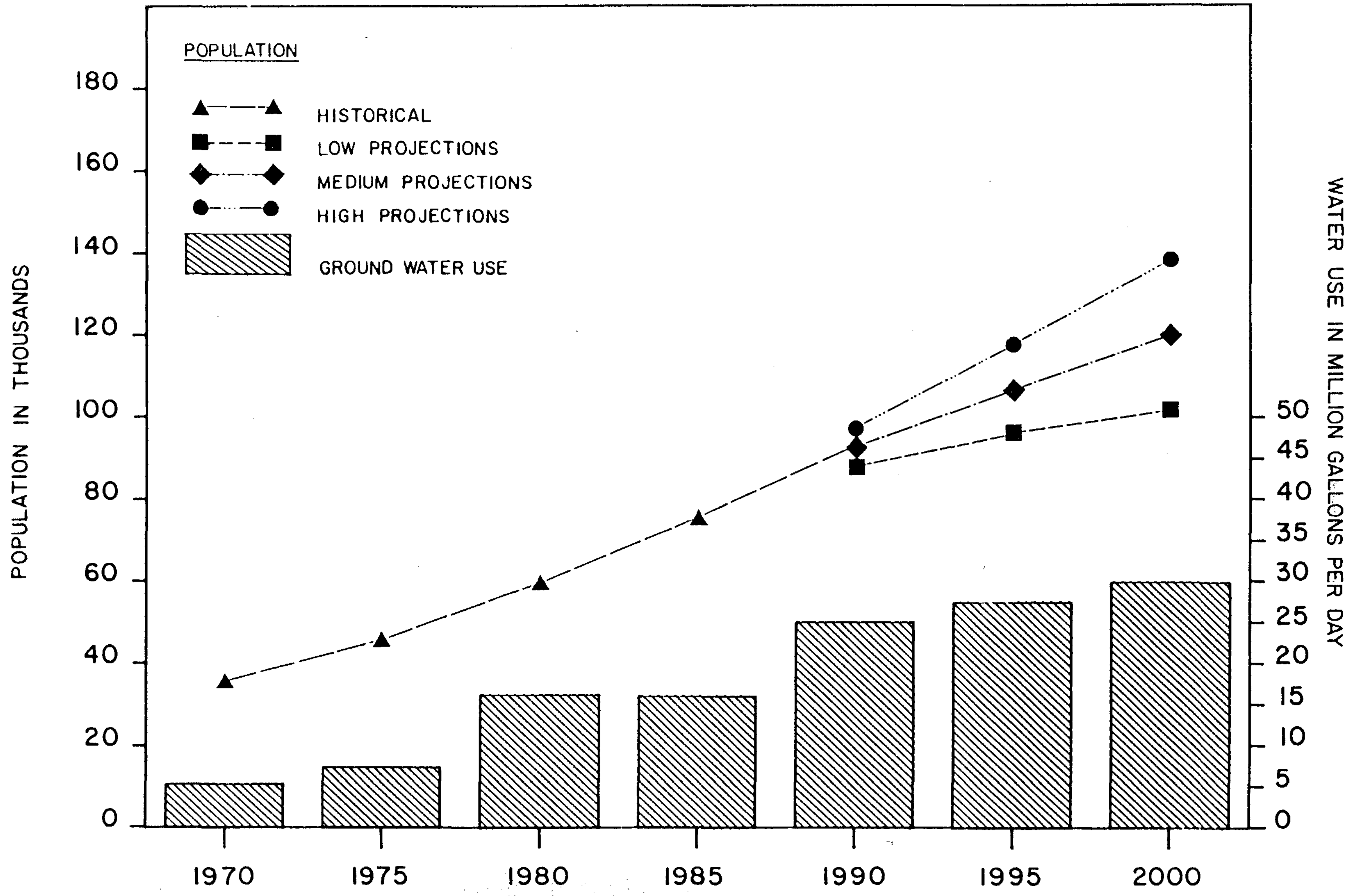


Figure 11c. Past and projected population and ground water use in Indian River County

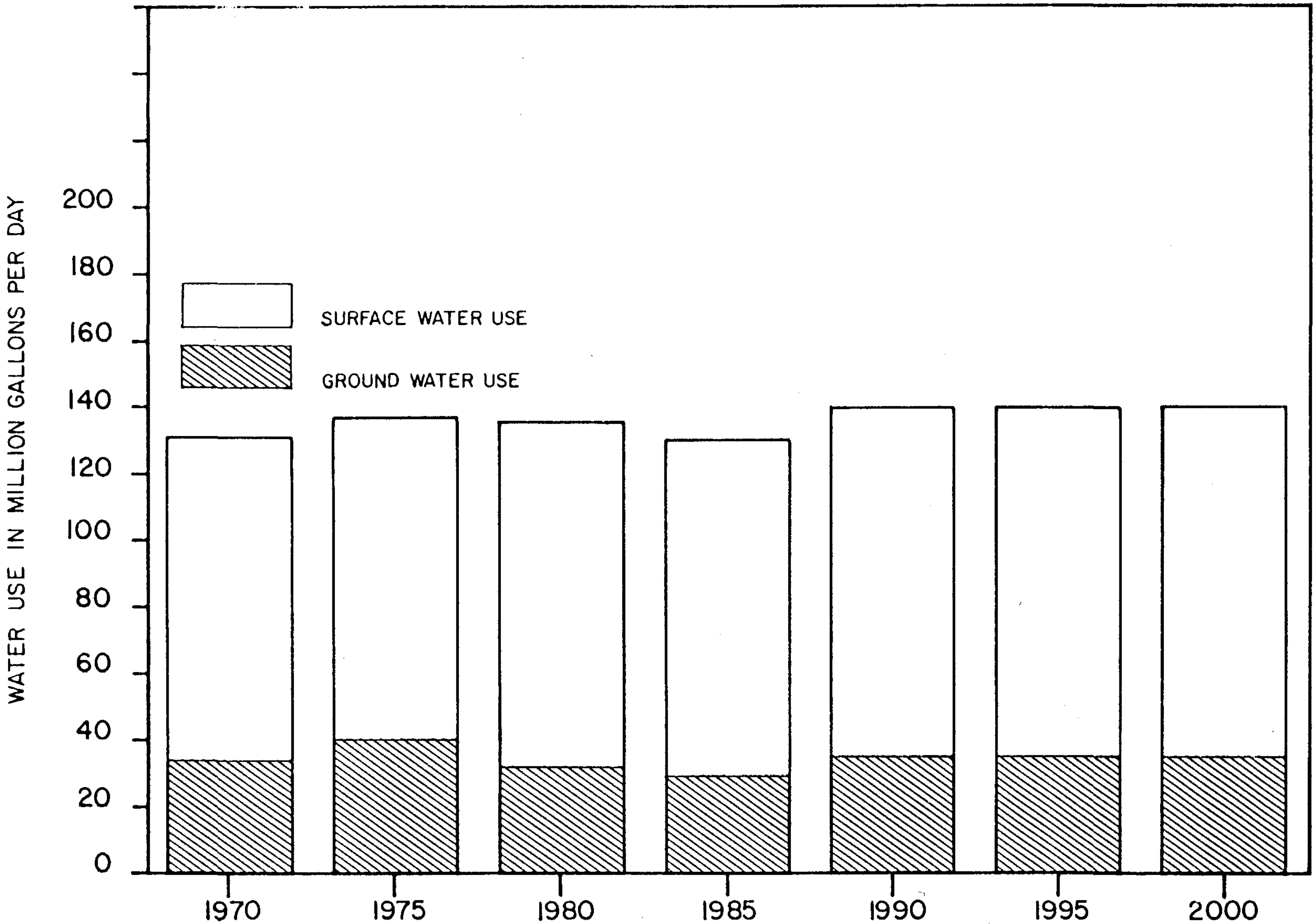


Figure 11d. Past and projected agricultural withdrawals in Indian River County

through the year 2000 were made by assuming that the population being served by public supply will remain at approximately 55 to 60 percent of the total population of the county, per capita water use will remain at approximately 223 gal/d and no major self-supplied commercial or industrial facility will move into Indian River County in the next 15 years. Further assumptions included: thermoelectric self-supplied fresh water use and self-supplied commercial-industrial use will remain at less than 1 mgd combined. Agricultural irrigation withdrawals will continue to range between 125 and 150 mgd through the year 2000 and between 70 and 80 percent of this will be surface water. Additionally, the reliance on reclaimed water for irrigation of golf courses and turf grass will continue to increase.

ORANGE COUNTY

Since 1975, Orange County has experienced large increases in population growth and tourism and consequently water supply demands (Figure 11e). Combined water use from public supply and domestic self-supply systems has increased 48 percent from 71.9 mgd in 1975 (Leach 1978) to 106.6 mgd in 1985 (Marella 1985). This figure does not include pumpage from the City of Cocoa's wellfield in eastern Orange County, which supplies water for use in Brevard County. All public supply and domestic self-supplied withdrawals in Orange County are from ground water sources. In 1987, 100 percent of the public supply withdrawals and approximately 35 percent of the domestic self-supplied withdrawals were from the Floridan aquifer (Marella 1989).

The population in this county increased 31 percent from 1975 to 1985 (424,556 to 554,659) (University of Florida 1976, 1986) and is expected to surpass 732,000 by the year 2000 (Smith and Sincich 1987). An estimated 80 percent of Orange County's population received drinking water from public supplied systems in 1975. This increased to 94 percent in 1985.

Tourism and related services together are the largest economic income for Orange County and account for approximately one third of the county's total income (Perspective on Regional Growth 1986-1990). The area near Disney World attracted 6.4 million visitors in 1980 and 8.8 million in 1986 (Florida Visitor Study 1980, 1986). Commercial-industrial self-supplied withdrawals in Orange County totaled 14.8 mgd in 1975 and 16.3 mgd in 1985.

Total agricultural withdrawals were 33.0 mgd in 1975, 94.3 mgd in 1980, 100.8 mgd in 1985, and 94.4 mgd in 1987 (Figure 11f). These changes result from changes in rainfall, acres irrigated, and the manner in which withdrawals were calculated. Approximately 50 percent of the total irrigation withdrawals in Orange County are from ground water sources.

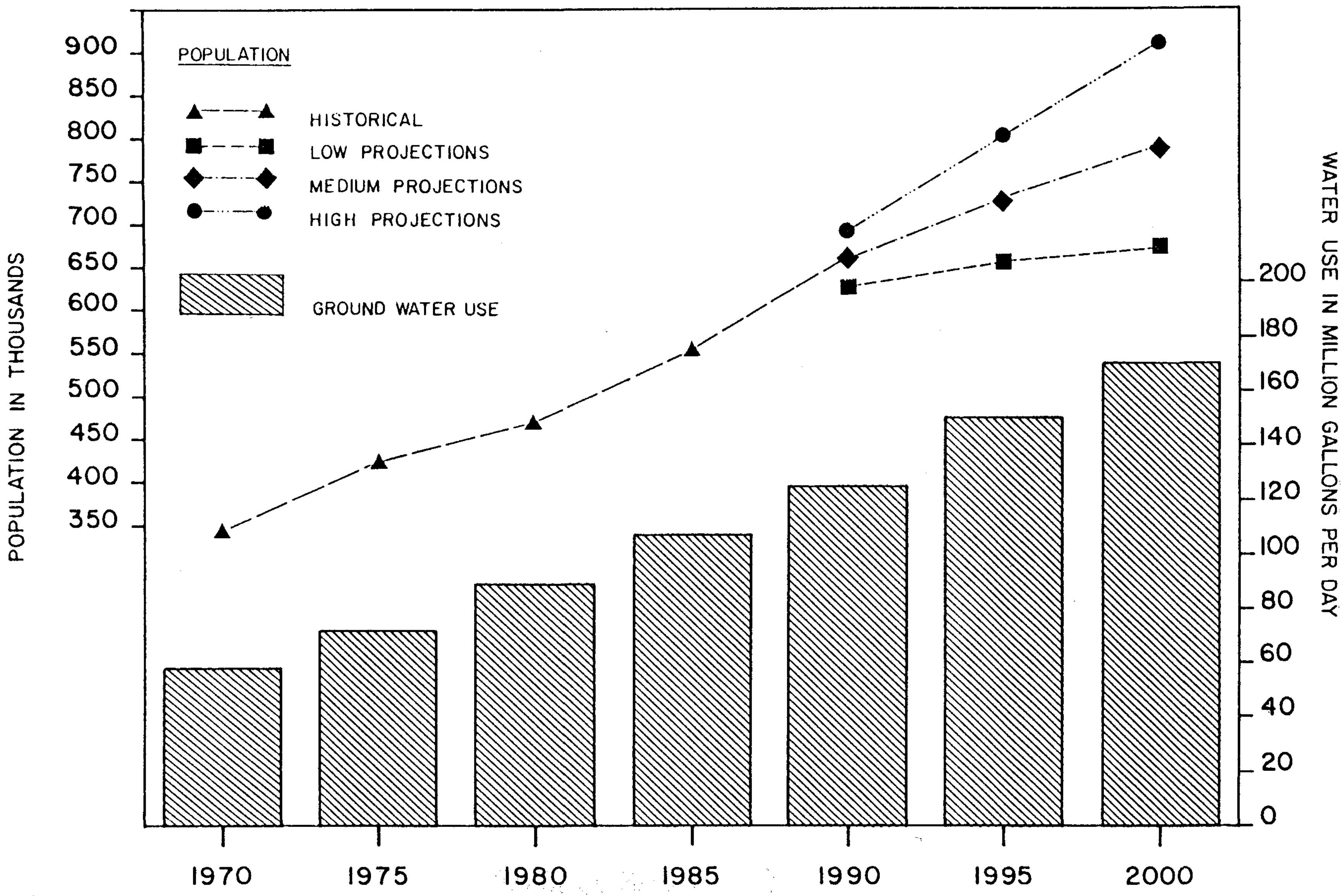


Figure 11e. Past and projected population and ground water use in Orange County

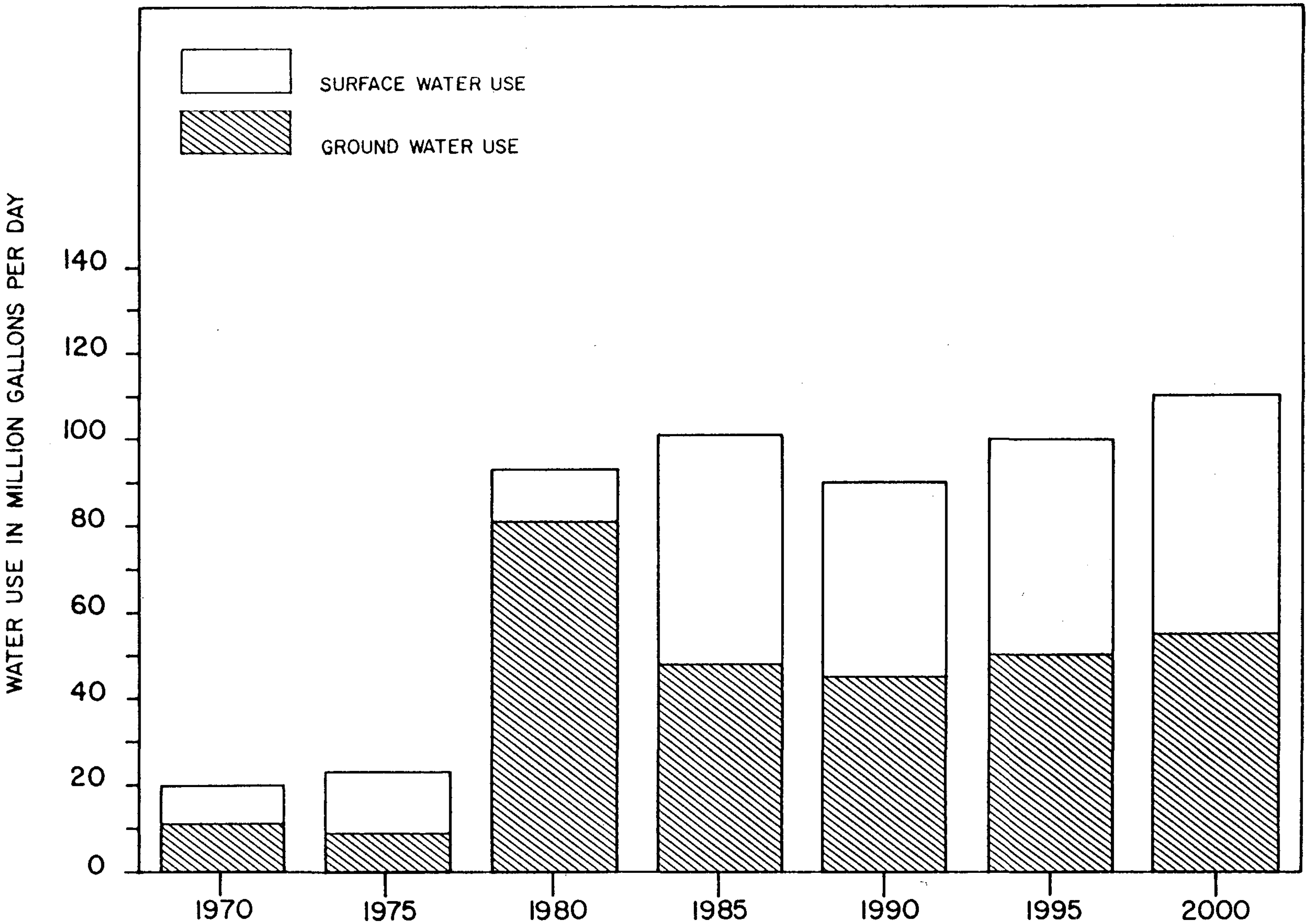


Figure 11f. Past and projected agricultural withdrawals in Orange County

Predictions for ground water withdrawals by the year 2000 were made by assuming that the population being served by public supply will remain at approximately 90 percent of the total population of the county, per capita water use will remain at approximately 200 gal/d and no major self-supplied commercial or industrial facility will move into the county or expand significantly in the next 15 years. Further assumptions included: thermoelectric self-supplied water use will remain at less than 1 mgd and Orange County will continue to be the source of water to the City of Cocoa for public supply use. Agricultural irrigation will continue to range between 90-110 mgd through the year 2000. Significant reliance on reclaimed water for agricultural irrigation will increase, the majority of this reuse will be for irrigation of citrus, golf courses, and commercial turf grass.

Total water needed to supply Orange County will range between 215 to 280 mgd by the year 2000 (Marella pers. comm. 1989). If ground water withdrawals continue at the same proportion as in 1985, between 70 and 80 percent of this projected demand will be ground water. Additionally, the Floridan aquifer will continue to supply approximately 95 percent of the ground water.

FREE-FLOWING WELLS

When the elevation of the potentiometric surface is higher than land surface elevation, wells penetrating the Floridan aquifer will flow at land surface. Wells will flow above land surface in most of Brevard and Indian River counties, and in some areas of Orange County. According to Healy (1978), 155 "flowing wells," or abandoned artesian wells, existed in Brevard County in 1975. SJRWMD recorded over 300 of these wells (Davis 1988). Of these, 105 have been plugged and 195 remain flowing. The ground water flowing from these 195 wells totaled 10.2 mgd in 1987 (Marella 1989).

Indian River County in 1975 had 45 flowing wells (Healy 1978). SJRWMD has recorded 46 of these wells (Davis 1988). Of these, 14 have been plugged and 32 remain flowing. The ground water flowing from these 32 wells totalled approximately 2.5 mgd in 1987 (Marella 1989). There are 18 flowing wells in Orange County (Healy 1978), none of which have been plugged by SJRWMD.

GROUND WATER CONSERVATION

DIRECT WATER REUSE

Effluent from a wastewater treatment plant (WWTP) can be treated to a specified level and then reapplied to land (i.e., lawns, golf courses, landscapes, and agricultural areas). In areas of increasing water demand or areas of limited water resources such as coastal Brevard and Indian River counties and in the metropolitan area of Orlando, reuse could provide an important conservation measure. Agricultural irrigation, sewage treatment, and industrial processes often generate water that could be used again if treated to an environmentally acceptable level. This approach to supplementing water supply could conserve significant quantities of fresh ground water for higher priority uses.

In this basin, only Brevard, Indian River, and Orange counties have the potential, based on guidelines developed by Steward (1985), to implement direct wastewater reuse programs in addition to existing programs (Figure 12). Lake, Osceola, Okeechobee, and Polk counties do not have wastewater treatment plants within district boundaries that meet the design capacity (1 million gallons per day or greater waste water) recommended by Steward (1985), and Volusia and Seminole counties do not have wastewater treatment plants within the USJ ground water basin. In 1985, these counties generated 60.5 mgd of waste water (Marella 1988) that was available for reuse. In 1985, these three counties used 1.4 mgd of reclaimed water, but in 1987 this figure was up to 7.1 mgd as a result of the Conserv II project and the Stanton Energy Plant, located in Orange County. Reuse in these counties could reduce potable water demands, help conserve water, solve problems with waste water disposal, and help lessen the impact of ground water withdrawals. However, reuse can increase the cost of wastewater disposal by requiring improvements to existing wastewater treatment plants to meet higher standards of treatment.

Some citrus is being replanted in the western portion of the county in conjunction with the Conserv II project. This project involves the City of Orlando providing up to 44.0 mgd (design capacity) of treated waste water for citrus growers to use for irrigation.

Proximity to golf courses, landscaped areas, agricultural areas, and industry is an important consideration when assessing the potential for implementing a reuse program. WWTPs must have a design capacity of 1.0 mgd for land application of waste water to be

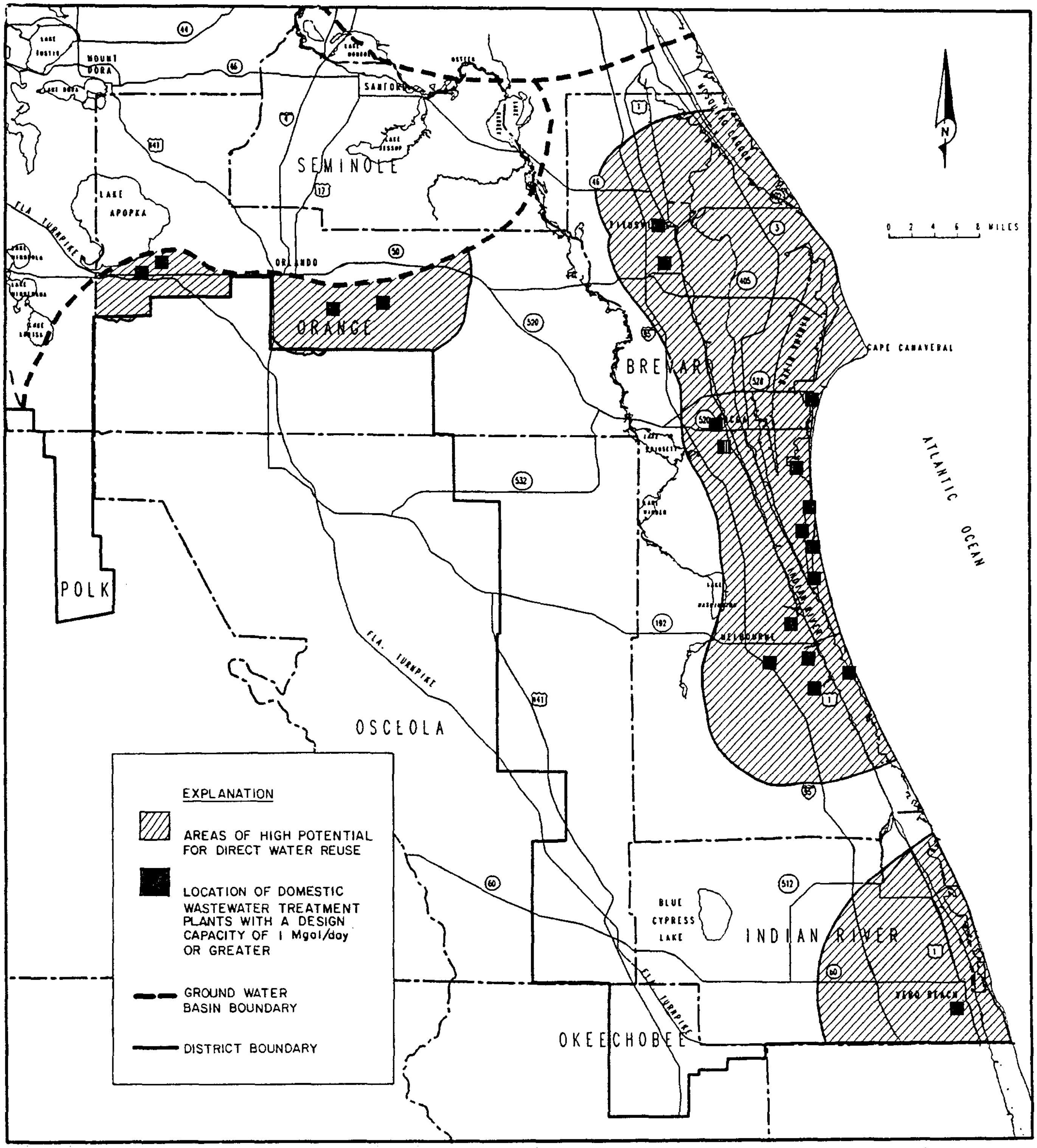


Figure 12. Areas of high potential for direct water reuse in the Upper St. Johns ground water basin

considered cost effective (Steward 1985). Environmental factors such as soil characteristics, depth to the water table, and proximity of application site to surface waters also need to be considered.

INTEGRATION OF COASTAL WELLFIELDS

One means of meeting increasing water demands for public supply is to integrate wellfields. Wellfields could be interconnected through inter-local agreements or the creation of regional water supply authority to distribute withdrawals among wellfields to provide for more flexible water management.

Decisions concerning integration of wellfields should be made based on hydrologic and economic considerations. Inadequate information is currently available to propose specific integration strategies.

ADDITIONAL INFORMATION

Additional information on the subjects contained in this report can be obtained by contacting the St. Johns River Water Management District. All of these references are available for review in major libraries, and the SJRWMD library.

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Appendix A

LEGISLATION

LEGISLATION

Section 373.0395, F. S. ground water basin resource availability inventory.

Each water management district shall develop a ground water basin resource availability inventory covering those areas deemed appropriate by the governing board. This inventory shall include, but not be limited to, the following:

(1) A hydrogeologic study to define the ground water basin and its associated recharge areas.

(2) Site specific areas in the basin deemed prone to contamination or overdraft resulting from current or projected development.

(3) Prime ground water recharge areas.

(4) Criteria to establish minimum seasonal surface and groundwater levels.

(5) Areas suitable for future water resource development within the ground water basin.

(6) Existing sources of waste water discharge suitable for reuse as well as the feasibility of integrating coastal wellfields.

(7) Potential quantities of water available for consumptive uses.

Upon completion, a copy of the ground water basin availability inventory shall be submitted to each affected municipality, county, and regional planning agency. This inventory shall be reviewed by the affected municipalities, counties, and regional planning agencies for consistency with the local government comprehensive plan and shall be considered in future revisions of such plans. It is the intent of the legislature that future growth and development planning reflect the limitations of the available ground water or other available water supplies.

Appendix B

PUBLIC SUPPLY VERIFIED LOCATIONS IN THE
UPPER ST. JOHNS GROUND WATER BASIN

Table B. Public supply withdrawals by utility in the Upper St. Johns ground water basin for 1987

(b)	Utility/Owner	County	Water Source Primary	Water Source Secondary	1987 Data (a) mgd	1987 Data (a) Population	Comments
	Aquarina Utilities	Brevard	Floridan		0.022	170	Reverse Osmosis
1	Avatar (Barefoot Bay) Util.	Brevard	Surficial		0.571	5,477	
2	Cocoa Water Utilities	Brevard	Floridan		23.486	123,673	
3	Melbourne - City of	Brevard	Lake Washington			126,890	
4	N. Brevard Utilities (Mims)	Brevard	Surficial		0.566	5,500	
	S. Brevard Util. (Sunnyland)	Brevard	Floridan		0.037	430	Reverse Osmosis
5	GDU - Palm Bay	Brevard	Surficial & Floridan		3.755	27,165	
6	Titusville - City of	Brevard	Floridan		5.119	41,213	
	Bent Pines Utilities	Indian River	Surficial		0.029	400	
	GDU-Vero Highlands/Shores	Indian River	Indian River Co. Util.			2,328	
7	GDU-Sebastian Highlands	Indian River	Floridan		0.244	2,156	
	Heritage Village	Indian River	Floridan		0.065	654	Reverse Osmosis
8	Indian River County Util.	Indian River	Floridan		1.613	15,500	Reverse Osmosis
	Lakewood Village	Indian River	Surficial		0.106	1,095	
	Marsh Island Utilities	Indian River	Floridan		0.012	88	Reverse Osmosis
9	North Beach Utilities	Indian River	Floridan		0.27	984	Reverse Osmosis
	Pelican Pointe Utilities	Indian River	Floridan		0.032	370	
10	Vero Beach - City of	Indian River	Surficial & Floridan		9.392	23,500	
	Village Green MHP	Indian River	Floridan		0.172	1,432	Reverse Osmosis
	Whispering Palms MHP	Indian River	Floridan		0.042	700	Reverse Osmosis
11	Apopka - City of	Orange	Floridan		4.45	20,100	
12	Eatonville - Town of	Orange	Floridan		0.65	2,700	
	Econ Utilities - Wedgefield	Orange	Floridan		0.12	854	
13	Maitland - City of	Orange	Floridan		3.19	9,945	
	Oakland - Town of	Orange	Floridan		0.09	702	
14	Ocoee - City of	Orange	Floridan		2.27	11,552	
15	Orange County Pub. Util.(c,d)	Orange	Floridan		11.91	69,175	SJRWMD Portion Only
16	Orlando Utilities (c,d)	Orange	Floridan		48.80	260,252	SJRWMD Portion Only
17	Rock Springs MHP	Orange	Floridan		0.22	1,240	

(a) Withdrawal and population data taken from Marella 1990.
(b) Number refers to location of utility/facility on following map.
Only utilities that withdrew more than 0.20 mgd in 1987 are plotted on the map.
(c) Numbers on map do not represent withdrawal site, only general location
(d) Water withdrawals located in both the South Florida and St. Johns River water management districts

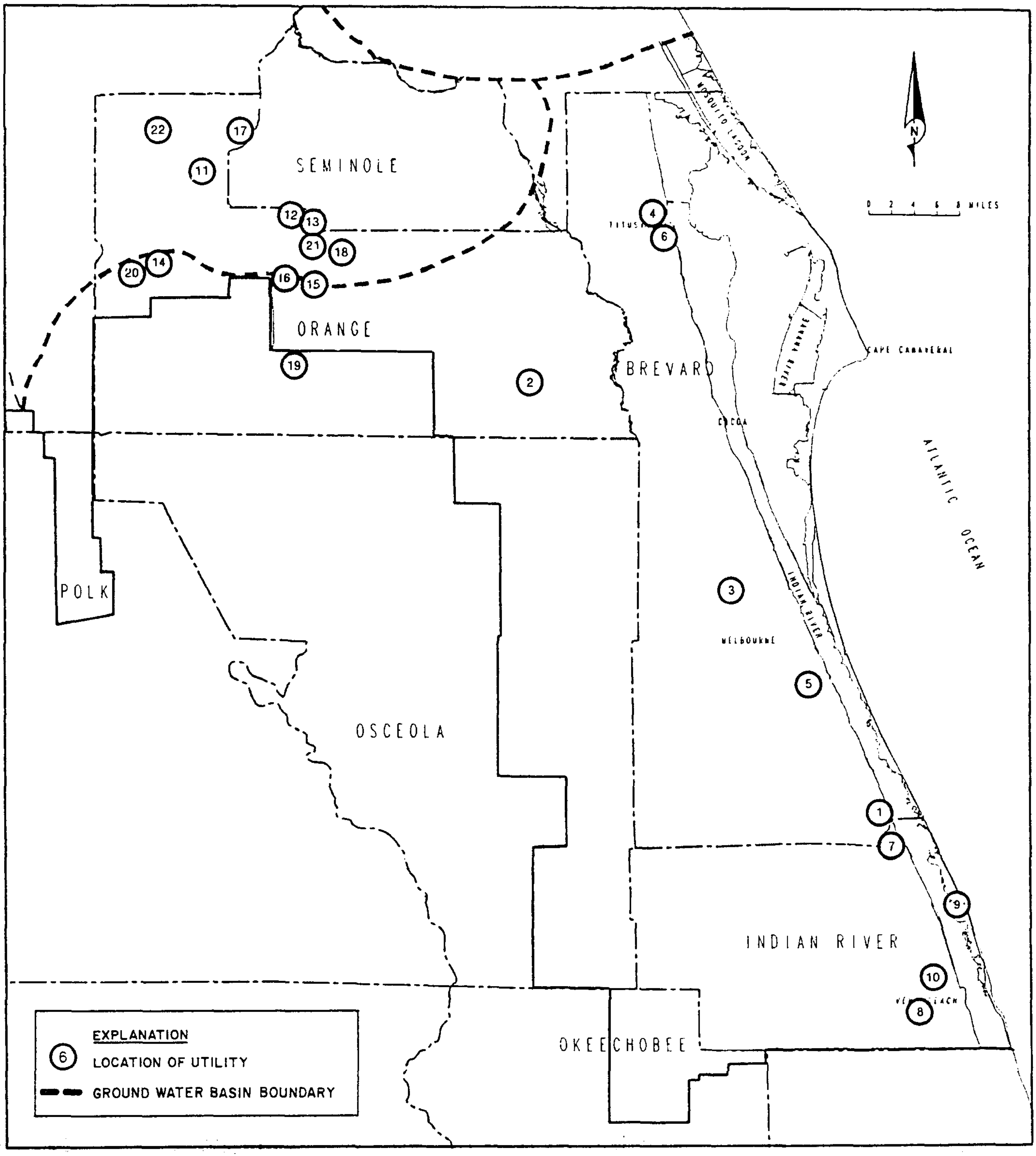
mgd = million gallons per day.

Table B. Public supply withdrawals by utility in the Upper St. Johns ground water basin for 1987

(b)	Utility/Owner	County	Water Source Primary	Water Source Secondary	1987 Data (a) mgd	1987 Data (a) Population	Comments
	Shadow Hills MHP	Orange	Floridan		0.17	1,280	
18	Southern States Utilities	Orange	Floridan		0.68	5,959	
	Starlight Range MHP	Orange	Floridan		0.19	1,560	
19	Tangerine - Town of	Orange	Floridan		0.13	408	
	Utilities Inc. of Florida	Orange	Floridan		0.11	955	
20	Winter Garden - City of	Orange	Floridan		1.38	11,250	
21	Winter Park - City of	Orange	Floridan		12.34	73,500	
22	Zellwood Station Utilities	Orange	Floridan		0.53	1,560	
	Zellwood Water Association	Orange	Floridan		0.19	900	
	Totals	Brevard			33.56	330,518	
		Indian River			11.98	49,207	
		Orange (e)			87.42	473,892	
					132.96	853,617	

(a) Withdrawal and population data taken from Marella 1990.
(b) Number refers to location of utility/facility on following map.
Only utilities that withdrew more than 0.20 mgd in 1987 are plotted on the map.
(c) Numbers on map do not represent withdrawal site, only general location
(d) Water withdrawals located in both the South Florida and St. Johns River water management districts
(e) Total represents only those utilities located in the St. Johns River Water Management District

mgd = million gallons per day.



Appendix B. Public supply verified locations in the Upper St. Johns ground water basin

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