HYDROGEOLOGIC SUMMARY OF OKEECHOBEE COUNTY

This report presents an overview of the ground water resources of Okeechobee County, Florida. Ground water occurrence, use and related management problems are emphasized to provide the reader with a usable planning reference.

Okeechobee County encompasses parts of several different surface water drainage basins. To facilitate the management and control of these surface-waters, the state of Florida has placed those areas of the county where the surface-waters drain to the south under the jurisdiction to the South Florida Water Management District, and those areas of the county where the surface-waters drain to the north under the jurisdiction of the St. Johns Water Management District (Figure 1). The Resource Planning Department of the South Florida Water Management District has further divided south Florida into planning areas. This division has made regional studies of the hydrogeology, maintenance of a ground water monitoring network and the collection and storage of hydrologic data more manageable. Okeechobee County is part of the Kissimmee Planning Area.

Information on ground water in Okeechobee County is somewhat limited. Most early studies in the area were of a regional nature (Stringfield, 1936; Applin and Applin, 1944; Parker et al, 1955). More contemporary studies have focused primarily on the hydrogeologic conditions existing at the edge or just outside of the county boundaries (Brown and Reese, 1979; Miller, 1980; Mooney, 1980).

In 1984, the South Florida Water Management District performed a comprehensive hydrogeologic assessment of the Kissimmee Planning Area. The results of this assessment were published as Technical Publication 84-1, "Hydrogeology of the Kissimmee Planning Area, South Florida Water Management District" (Shaw and Trost, 1984). This report is currently the best source of

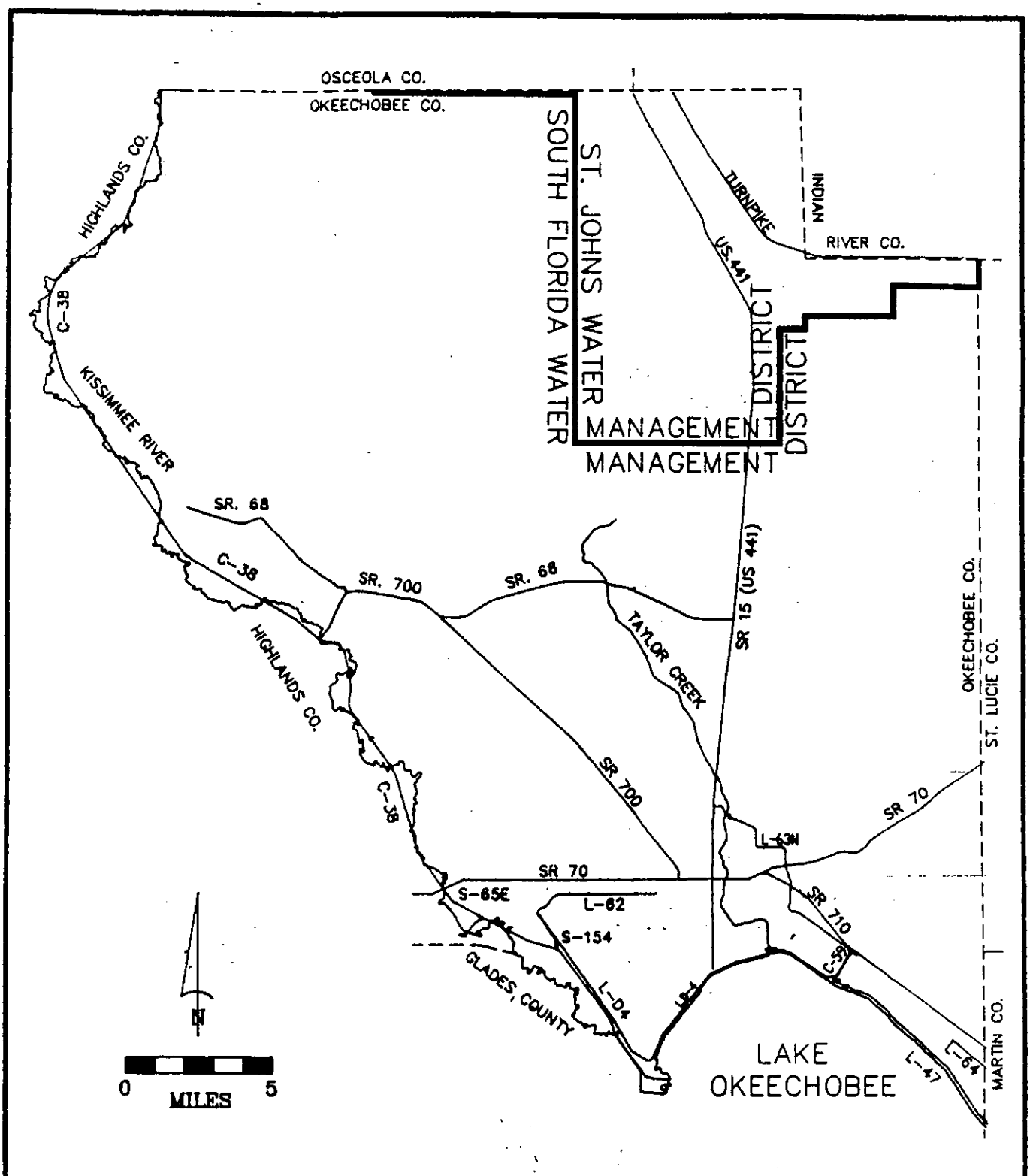

Figure 1 WATER MANAGEMENT DISTRICT BOUNDARIES IN OKEECHOBEE COUNTY

hydrogeologic data for most of Okeechobee County and is the reference for most of the material presented in this report.

Hydrostratigraphic nomenclature used in this report is consistent with the guidelines established by the Southeastern Commission on Hydrostratigraphic Nomenclature (FBG, 1986).

HYDROGEOLOGIC SYSTEMS

There are two exploitable sources of ground water (aquifers) underlying Okeechobee County. They are, in order of their occurrence going down a well: (1) the Surficial Aquifer System and (2) the Floridan Aquifer System (Figure 2).

These aquifer systems are separated from each other by low permeability rocks and sediments of the Intermediate Confining Unit. This confining unit effectively restricts the vertical movement of water from one aquifer system to another.

Surficial Aquifer System

The Surficial Aquifer System is the source of much of the potable ground water in Okeechobee County. In most of the county this aquifer system is bounded below by the impermeable sediments of the Intermediate Confining Unit and is unconfined above. Water within this type of aquifer exists under water table conditions. Rain, irrigation water and canal water percolate vertically and horizontally through the surface sediments to the water table and recharge the aquifer system. Rain is by far the most significant source of recharge water in the county.

Hydrogeology

The Surficial Aquifer System is composed of all saturated sediments and rocks from the water table down to the clays, silts and limestones of the Hawthorn Group (Intermediate Confining Unit, Figure 2). Aquifer thicknesses range from less than 40

GENERALIZED HYDROGEOLOGIC SECTION
OKEECHOBEE COUNTY

GEOLOGIC UNIT	GENERAL LITHOLOGY	APPROX. THICKNESS	AQUIFER CHARACTERISTICS
SURFICIAL SANDS	quartz sand w/some shell, localized organic soils at surface	10'-180'	SURFICIAL AQUIFER SYSTEM Wells commonly yield 100 gpm or less. Best production from shelly, semi-consolidated zones.
ANASTASIA FORMATION CALOOSA-HATCHEE MARL	sand, shell, limestone with some semi-consolidated intervals		
HAWTHORN GROUP	gray, calcareous, clayey, silty, sand grading downward into green phosphatic clay; may have producing limestone interval at base	200'-600'	INTERMEDIATE CONFINING UNIT
UNNAMED OLIGOCENE LIMESTONE	gray, silty limestone	0-30'	FLORIDAN AQUIFER SYSTEM Alternating producing and confining zones. Wells completed open hole. Production usually greater than 200 gpm. Aquifer productivity increases to the north.
OCALA GROUP	cream colored limestone, highly fossiliferous	110'-175'	
AVON PARK LIMESTONE	cream to dark brown limestone and dolomite, fossiliferous	≈400'	
LAKE CITY LIMESTONE	hard, brown dolomite with chalky limestone stringers	≈350'	
OLDSMAR LIMESTONE	hard, brown dolomite, abundant evaporite zones near the base	≈1200'	BOULDER ZONE?
CEDAR KEYS LIMESTONE	dolomite, limestone and evaporites	2000 + '	SUB-FLORIDAN CONFINING UNIT

FIGURE 2

feet in the northeast (Miller, 1980) to almost 200 feet in the southeastern corner of the county (Shaw and Trost, 1984).

The upper part of the aquifer system is made up of young, organic soils or of sands deposited by Pleistocene seas. These soils and sands act as "filters" through which waters percolate and recharge the aquifer. In most of the county, these surficial sands overlie shell, marls, and limestones of the Anastasia and Caloosahatchee formations. These marine sediments make up the lower part of the Surficial Aquifer System.

The most productive Surficial Aquifer System wells are usually completed in the lower part of the aquifer in zones of semiconsolidated shell and sandstone. Wells may be screened or completed open hole depending on the stability of the producing zone. Wells completed open hole usually have the best yields, although production rates are commonly less than 100 gallons per minute (gpm).

The ability of an aquifer to produce water is measured as transmissivity. Transmissivity measurements have units of gallons per day per foot of aquifer thickness (GPD/FT). Transmissivity values of the Surficial Aquifer System in Okeechobee County are low; often less than 5,000 GPD/FT.

Due to the low transmissivities of the Surficial Aquifer System, pumping large amounts of water from shallow wells for extended periods of time can severely stress the aquifer causing large declines in the local water table. Well locations must be chosen carefully to avoid impacting surface water bodies and local water users.

Water Quantity

The amount of water stored in the Surficial Aquifer System is directly related to the amount of rain that has fallen in the area. Rainwater percolates rapidly through the surface sands and soils down to the water table. In the Taylor Creek

watershed area, direct infiltration of rainfall raises the local water table within two hours (Knisel, Yates and others, 1985).

Once recharge water has reached the water table, it will begin to slowly flow down-gradient from areas of high water table elevation to areas of low water table elevation. In Okeechobee County the areas of high water table elevation correspond to areas of high ground elevation. Since the highest ground elevations occur in the northeast sections of the county, the regional flow direction in the Surficial aquifer is toward the south and west.

Exceptions to regional ground water flow trends occur in the extreme north and east portions of the county and in areas surrounding major surface water drainage routes such as the Kissimmee River and Taylor Creek. In the northern part of the county, shallow ground water flows to the northeast, while in the eastern part of the county shallow ground water tends to flow to the east. Where streams and rivers occur, the water in the Surficial Aquifer System flows toward these local surface drainage routes.

The rate at which the water in the Surficial Aquifer System moves is dependent on the change in the local water table elevation and the permeability of the surficial sediments. Rapid changes in stream or river stages will result in similar, but slower changes in the local water table. Lack of rainfall in high elevation areas can result in the lowering of the water table both locally and in down gradient areas of lower elevation.

Water Quality

Water from the Surficial Aquifer System in Okeechobee County is generally potable with minimal treatment. However, Parker and others (1955) collected water quality samples from domestic and stock supply wells in southeast Okeechobee county and found that chloride concentrations in several wells were

above 250 milligrams per liter. This suggests that in some areas, relict sea water has not yet been flushed from the lower portions of the Surficial Aquifer System.

FLORIDAN AQUIFER SYSTEM

The Floridan Aquifer System is a significant source of irrigation and stock water in Okeechobee County. Within the county, Floridan waters range from being poor quality with high dissolved solids concentrations in the south to being very good quality in the north. Aquifer productivity also increases from south to north within the county.

The Floridan Aquifer System is a confined aquifer containing water under pressure. Pressures in the aquifer are great enough to cause Floridan wells in the south and east of Okeechobee County to flow at the surface. Contamination of the aquifer system from sources within Okeechobee County is not a problem due to the presence of thick confining zones above and below.

Hydrogeology

The Floridan Aquifer System is composed of a thick sequence of limestones and dolomites. Early work by Parker (1955) describes the "Floridan Aquifer" as the hydrologic unit including parts or all of the Avon Park and Lake City limestones, Ocala Limestone, Suwannee Limestone, Tampa Limestone and permeable parts of the Hawthorn Formation (Group) that are in hydrologic contact with the rest of the aquifer. More recent investigations have resulted in the inclusion of the Oldsmar Limestone and parts of the Cedar Keys Limestone into the total hydrogeologic framework of the aquifer (Figure 2).

In 1986, the Florida Geologic Survey officially elected to replace the term "Floridan Aquifer" with "Floridan Aquifer System" in recognition of the many producing zones within this hydrogeologic unit.

The Floridan Aquifer System in Okeechobee County is confined above by the clays and silts of the Hawthorn Group (Intermediate Confining Unit) and below by the thick, anhydrite sequences of the Cedar Keys Limestone. The top of the aquifer system occurs at depths ranging from less than 250 feet below National Geodetic Vertical Datum (NGVD) in northwest Okeechobee County to greater than 600 feet below NGVD in the southeast portion of the county (Figure 3). Since no local water wells fully penetrate the Floridan Aquifer System, it's thickness throughout Okeechobee County is not known.

Transmissivities in the Floridan Aquifer System vary significantly throughout the county with a general trend of increasing transmissivity from south to north. Transmissivities in the southern part of the county are as low as 2,000 GPD/FT, while in the northern part they can exceed 500,000 GPD/FT (Shaw and Trost, 1984). High transmissivities in the Floridan are found in wells penetrating fractured limestone or solutioned dolomite zones. Producing zones occur where the limestone is dense or where dolomitization has occurred.

Several producing zones are continuous throughout a large part of the county. Shaw and Trost (1984) have correlated these zones through Okeechobee County, and they discuss the practicality of penetrating more than one producing zone to increase production efficiency.

Water in the Floridan Aquifer System exists under artesian conditions. When a well is drilled into a producing zone in the Floridan, water will rise in the well to a level above the top of the aquifer. How far the water will rise above sea level or some base elevation is called the hydraulic head.

Maps showing how head levels vary areally are called potentiometric surface maps. A potentiometric surface map of the Kississimee Planning area is generated twice a year by the U.S. Geological Survey from data collected by the South Florida Water Management District. Data is collected by the District from specific Floridan

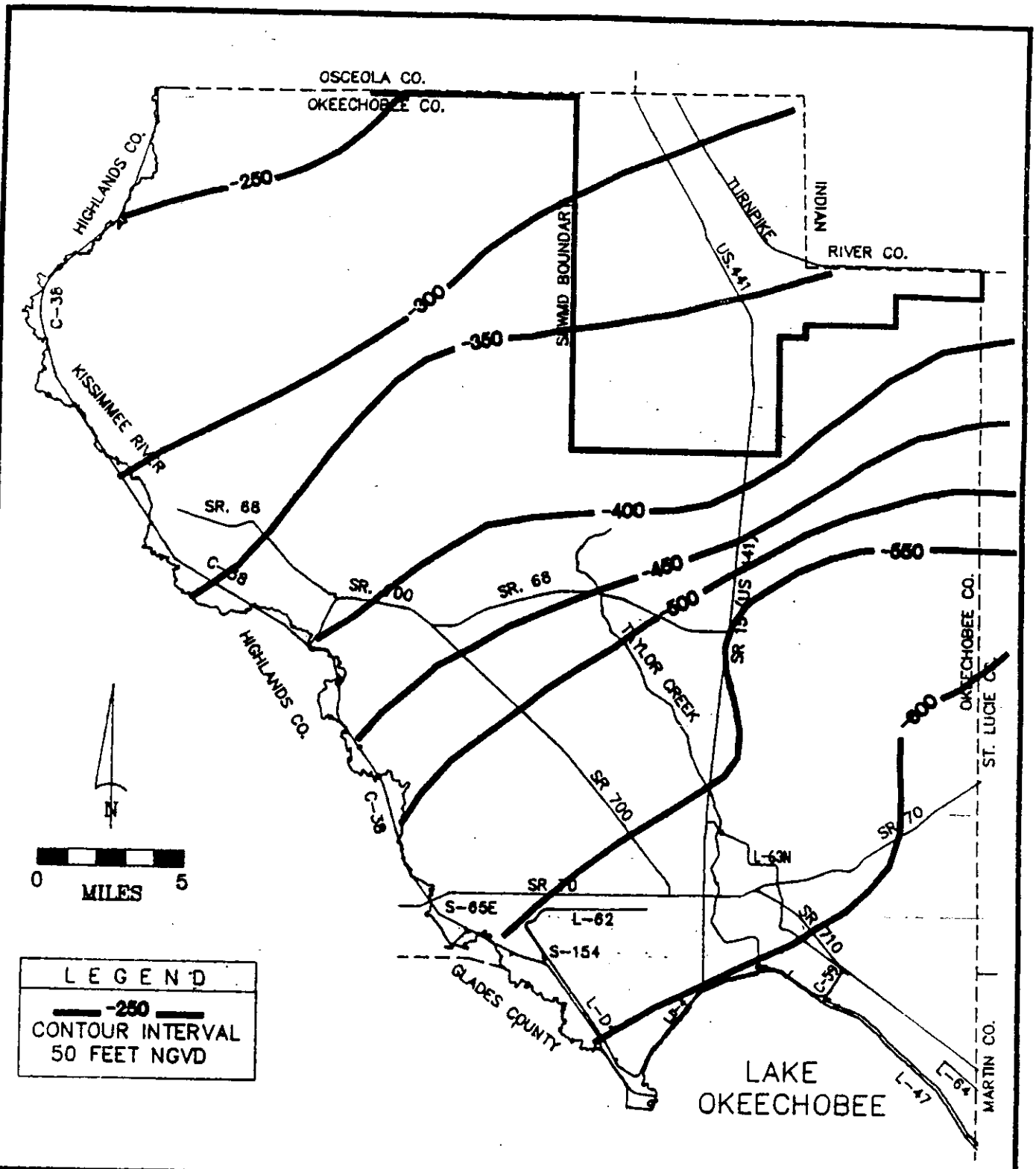

Figure 3 TOP OF THE FLORIDAN AQUIFER SYSTEM

(Shaw & Trost, 1984)

wells during late September, the end of the wet season, and late May, the end of the dry season. Figure 4 shows that head levels in the Floridan in Okeechobee County ranged from 39 feet to 49 feet above NGVD in September 1986. Figure 5 shows the Floridan head levels in Okeechobee County ranging from 37 feet to 47 feet in May 1986. A comparison of these two maps illustrates a typical increase in maximum and minimum Floridan head levels at the end of the wet season compared to head levels at the end of the dry season.

In much of south and eastern Okeechobee County head levels in Floridan wells exceed surface elevations. In the outlined areas shown in Figure 6, Floridan wells can be completed as flowing artesian wells. The amount of flow from this type of well will depend on the transmissivity and thickness of the producing zone(s), the well diameter, and the difference between the head level and the surface elevation at the well. Maps of transmissivity can be used in conjunction with topographic and potentiometric surface maps to determine the best location for well placement. Large diameter wells completed in highly transmissive zones where hydraulic head is much higher than the ground surface will produce the most water.

In coastal and southern Florida, highly fractured and solutioned dolomite zones exist within the lower portion of the Floridan Aquifer System. Although disagreement exists concerning what to call this hydrogeologic interval, drillers in Florida have named these collective zones the boulder zone (Figure 2).

The boulder zone is commonly separated from the upper part of the Floridan Aquifer System by a thick section of impermeable limestones. Sections of the boulder zone are often highly cavernous and, as a result, may have transmissivities in the range of millions of gallons per day per foot. Water in this zone is artesian and extremely saline. Concentrations of dissolved salts in boulder zone waters are greater than 10,000 milligrams per liter.

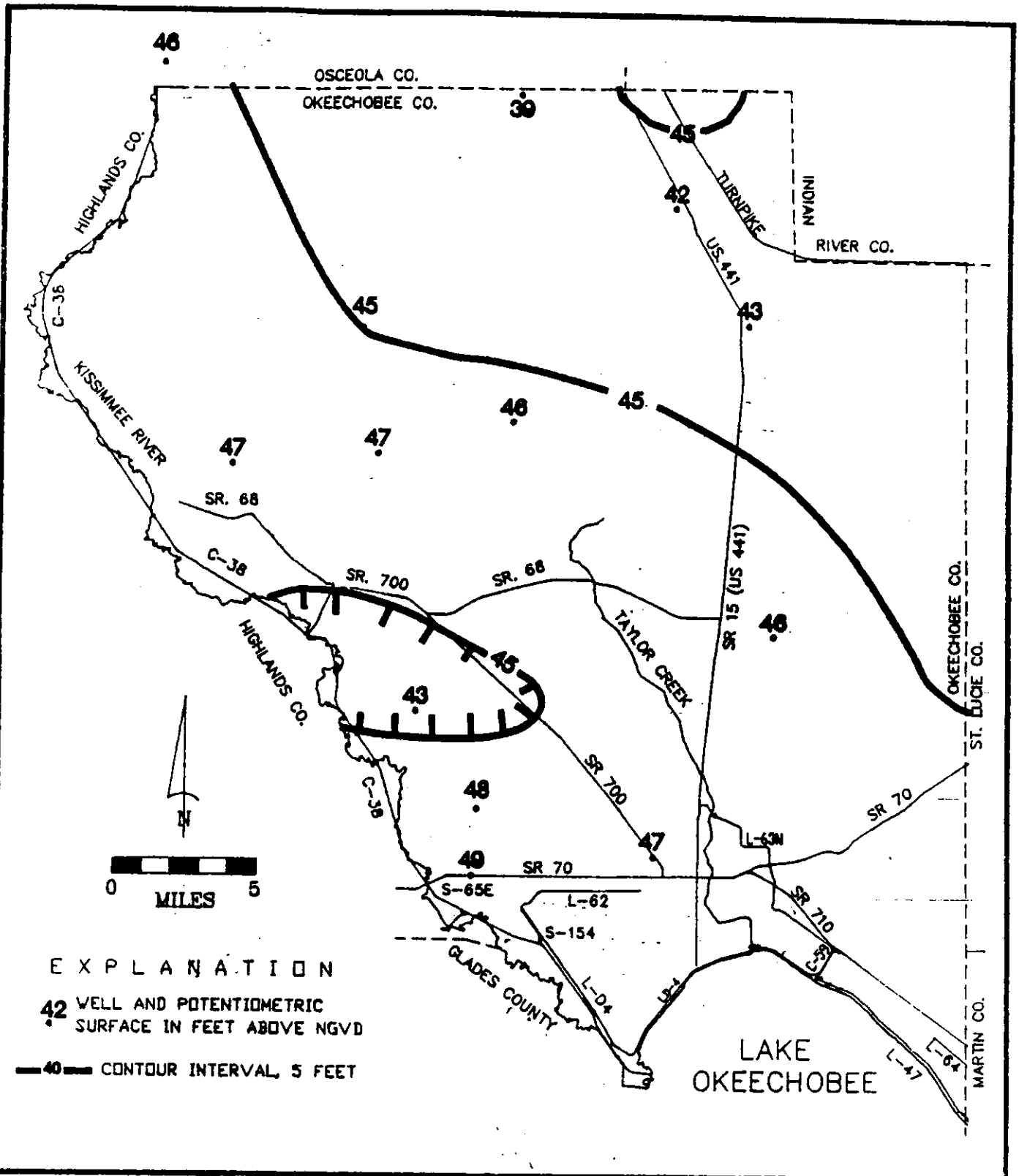

Figure 4 POTENTIOMETRIC SURFACE OF THE UPPER FLORIDAN AQUIFER, SEPTEMBER, 1986 (SPECHLER, 1987)

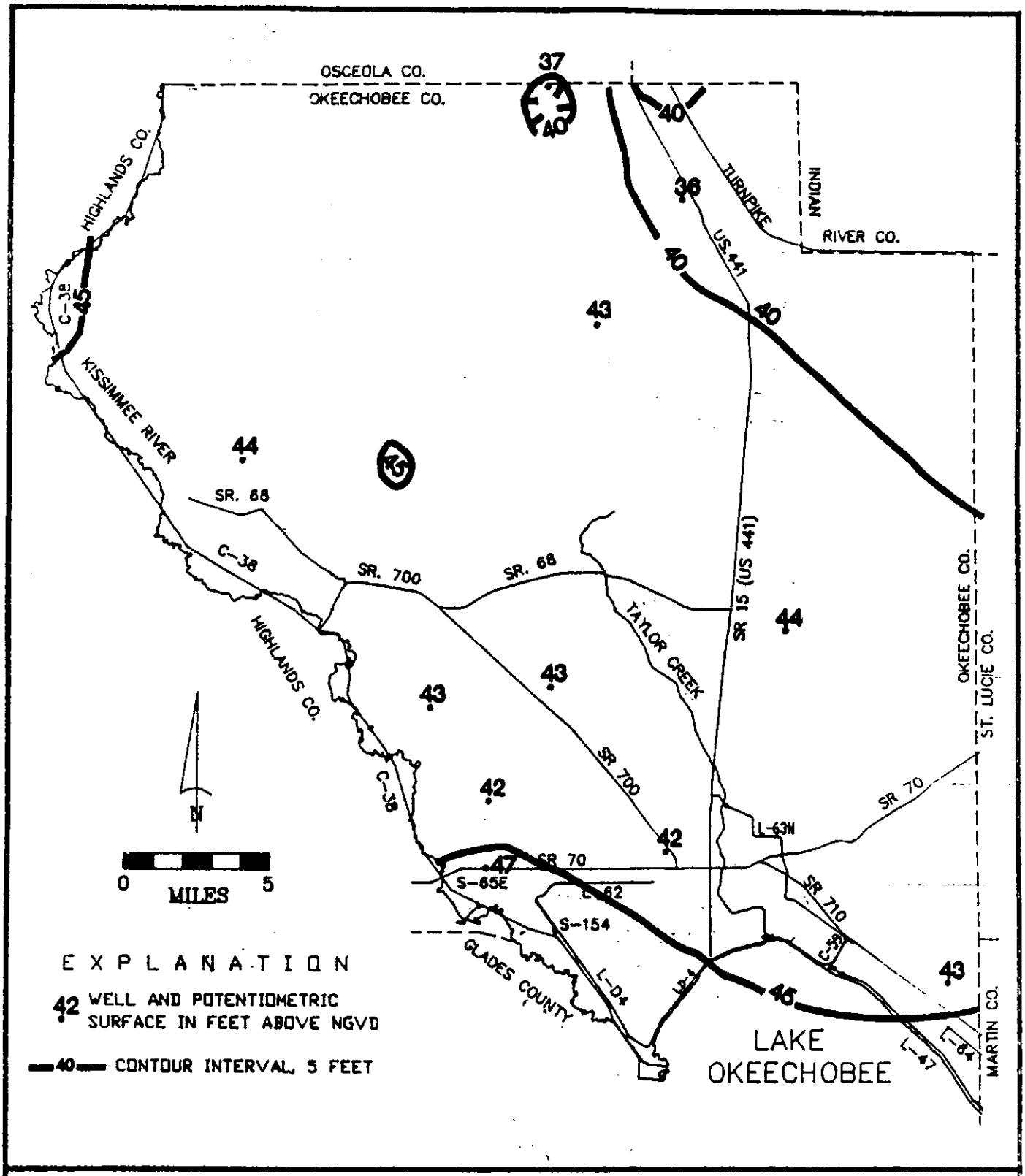

Figure 5 POTENTIOMETRIC SURFACE OF THE UPPER FLORIDAN AQUIFER MAY, 1987 (SCHINER 1987)

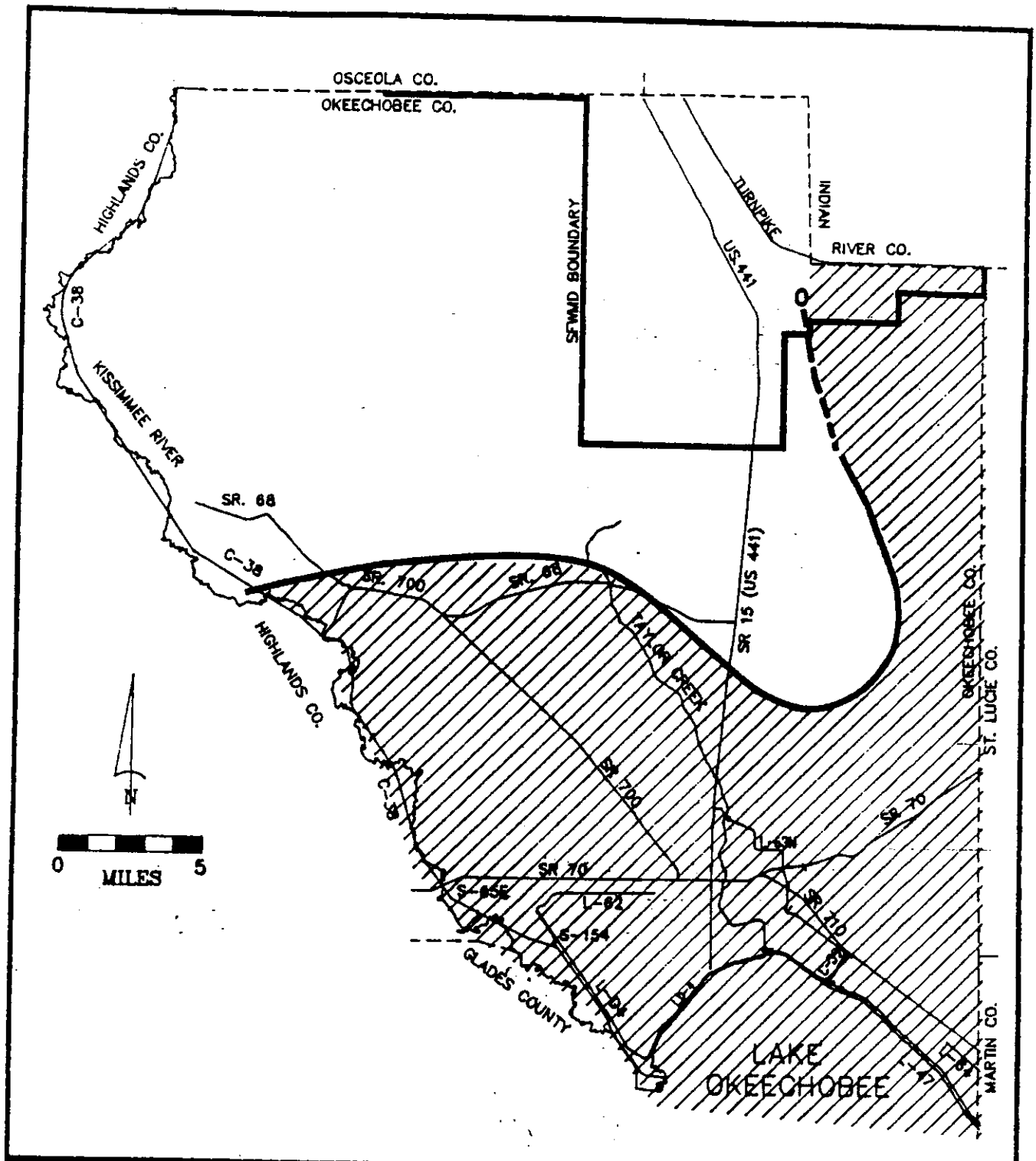

Figure 6 AREA OF FLOWING ARTESIAN CONDITIONS, SEPTEMBER 1982, FLORIDAN AQUIFER SYSTEM. (After Shaw & Trost, 1984)

Because the boulder zone is well confined, highly transmissive, and contains water of very poor quality, it is used by some counties as a disposal zone for both chemical and sewage treatment plant wastes. These wastes are pumped into the boulder zone through carefully constructed and monitored injection well systems.

There are currently no injection well systems operating in Okeechobee County.

Water Quantity

Water in the Floridan Aquifer System originates from two sources, relict sea water and rainwater from recharge areas. Remnant sea water deposited along with the marine limestones of the Floridan is characterized by very high concentrations of dissolved salts.

Rainwater is the recharge water for the Floridan Aquifer System. Recharge of the Floridan occurs in the northern part of Polk County where Hawthorn confining beds are thin or absent (Stringfield, 1936). Rainwater in Polk County percolates down into the Floridan. From there it flows down-gradient towards the southern and central counties of Florida. As this water moves, it mixes with the relict seawater. This mixed water continues to move down-gradient until it is discharged through wells or aquifer outcrops in the ocean floor.

Many of the Floridan wells in northeast Okeechobee County are completed as flowing artesian wells. Installing too many new wells or overpumping existing wells can lower head levels in the Floridan Aquifer System to the point where adjacent user wells no longer flow at the surface. To prevent user impact problems in this area (Figure 7), the South Florida Water Management District has adopted the following permitting restriction for Floridan wells: "...within the Eastern Okeechobee - Western St. Lucie basin the withdrawals from the Floridan Aquifer (System) are limited to 1.5" (acre inches) for the maximum month..." (SFWMD,

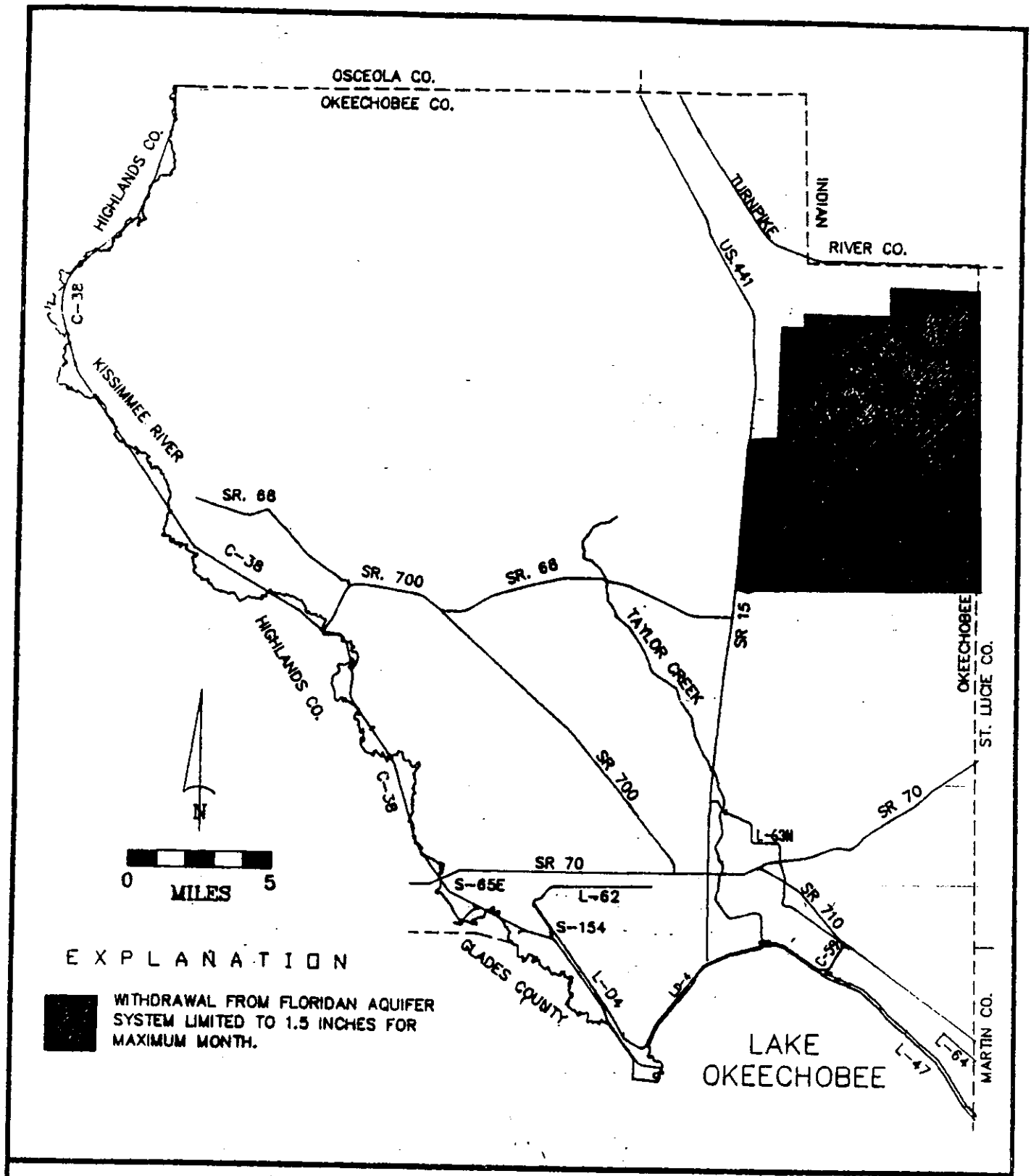

Figure 7 RESTRICTED ALLOCATION AREA FLORIDAN WELLS
EASTERN OKEECHOBEE BASIN

1985). These withdrawal limits are currently being reviewed based on recently aquired aquifer data and better impact modeling techniques.

Water Quality

The quality of water in the upper portion of the Floridan Aquifer Systen in Okeechobee County is poor to good. Waters in the southern and eastern part of the county may contain as much as 1000 milligrams per liter (mg/l) chloride ions and are, therefore, classified as non-potable. Waters in the central, northern and western part of the county often are of good quality and require minimal or no treament before use. Floridan water quality in Okeechobee County tends to decline with depth of occurrence within the aquifer system. Water from the upper producing zones generally has fewer dissolved salts than does water from deeper in the aquifer system.

Although Floridan waters may be non-potable in some areas of the county, the concentrations of dissolved salts may be low enough for these waters to be tolerated by several different agricultural plant species. These waters are used extensively for irrigation.

Contamination of Floridan Aquifer System water from sources located in Okeechobee County is not probable due to the well confined nature of the system. Of more significance is the contamination of the Surficial Aquifer System in southern Okeechobee County by poor quality Floridan water coming from abandoned, damaged or improperly constructed artesian wells.

Well construction requirements currently dictate that Floridan wells must be cased to the bottom of the Hawthorn confining beds. Exemptions to this requirement have been granted where it can be shown that alternate casing procedures will adequately protect the Surficial Aquifer System. Well casing requirements are presently being reviewed, and a revised minimum acceptable casing program will be adopted by early 1988.

Special Considerations

Surface water runoff is a problem in some areas of the county. Near surface water tables, low permeability surface soils and frequent, heavy thundershowers during the wet season are some of the conditions which help create surface water runoff. In agricultural areas, uncontrolled surface water runoff waters are usually very poor quality with respect to nitrogen, phosphorous and other nutrients. These waters accumulate in local streams and canals and are eventually channeled into Lake Okeechobee. The resulting high level of nutrients in the lake has resulted in large scale impacts on lake biology.

To help decrease the unwanted discharge of nutrients into Lake Okeechobee, nutrient rich inflowing water must be either treated, diverted, reused or disposed of. Each of these options is being evaluated and reviewed by both governmental agencies as well as private and commercial organizations.

The idea of reusing the nutrient laden waters would be the most desirable from a water conservation standpoint. While these waters may be harmful to lake ecology, they are an excellent source of irrigation water for citrus and most other crops in an area where Floridan waters are too brackish to use.

The South Florida Water Management District is currently pursuing this goal of water reuse by constructing an aquifer storage and recovery (ASR) demonstration facility for the Taylor Creek discharge waters. This facility is part of a test program to determine the practicality of storing nutrient laden waters in a zone of brackish water in the Floridan Aquifer System. This process of aquifer storage and recovery is being used successfully in several areas of southwest Florida (Pyne, 1987).

The ASR demonstration facility will be located near State Road 710 and next to Taylor Creek (Figure 8). The facility will be composed of a treatment/pumping structure and an injection/recovery well. The injection/recovery well will be drilled into a moderately permeable zone of the Floridan Aquifer System where ambient

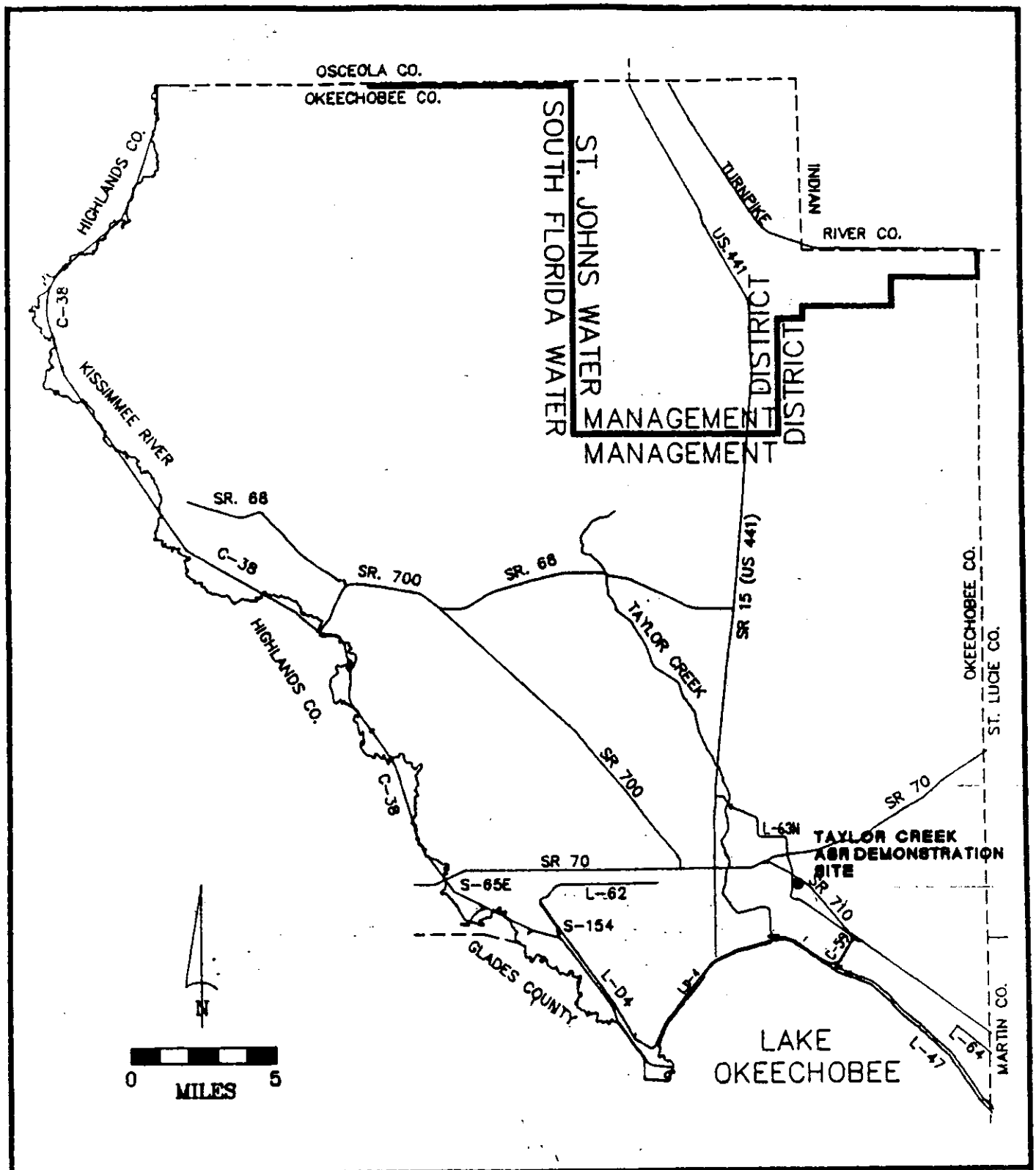

Figure 8 ASR DEMONSTRATION SITE

waters have chloride concentrations of less than 3000 milligrams per liter. Test programs conducted at this facility will help determine if water from Taylor Creek can be injected into the permeable zone during the wet season and then recovered for use as irrigation water for the Taylor Creek area during the dry season.

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