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HYDROGEOLOGIC DATA AND INFORMATION COLLECTED FROM THE SURFICIAL AND FLORIDAN AQUIFER SYSTEMS, UPPER EAST COAST PLANNING AREA

PART 1 - TEXT

by

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EXECUTIVE SUMMARY

The Upper East Coast Planning Area (UECPA) includes most of Martin and St. Lucie counties, and a small portion of eastern Okeechobee County. The boundaries of the UECPA generally reflect the drainage patterns of the C-23, C-24, C-25 and C-44 canals. Two major aquifer systems underlie the Upper East Coast Planning Area; the Surficial Aquifer System and the Floridan Aquifer System. Between 1989 and 1992, the South Florida Water Management District (SFWMD) drilled fifty-seven wells in the UECPA, fifty-one of which were completed in the Surficial Aquifer System and six into the Floridan Aquifer System. Some of these wells were used in aquifer performance tests to define aquifer characteristics, while most were used solely as water-level monitoring wells. These hydrogeologic data were used by Lukasiewicz (1992), Adams (1992), and Butler and Padgett (1995) to develop and calibrate ground water flow models simulating the aquifers underlying the UECPA. The purpose of this report is to present a compilation of previously unpublished hydrogeologic field data used in the development of these ground water models. This information includes: 1) lithologic and geophysical logs, 2) observed water-level elevations, 3) aquifer performance test data and analyses, and 4) other supportive documentation.

This is the second of a two-part study summarizing aquifer characteristics in the UECPA. The first phase involved describing water quality characteristics in both the Surficial and Floridan Aquifer Systems (Lukasiewicz and Switanek, 1995). In this first phase, laboratory analyses of water sampled from one hundred twenty-four Surficial and fifty-two Floridan Aquifer System wells were presented in tables and as regional contour maps of the major ions.

The Surficial Aquifer System provides the majority of potable water used in the study area. It is unconfined to semi-confined in the study area and comprised of three hydrogeologic units defined primarily by lithology. They are, in descending order, the shallow unconsolidated sand/soil unit, the more permeable sandy shell beds and sandstones which together comprise the production unit, and the less permeable granular limestone unit. These units exhibit fair to good hydraulic connection. Most large capacity wells in the study area are completed in the production unit (hence its name).

The Floridan Aquifer System is found well below the Surficial Aquifer System and is composed of an aerially extensive sequence of granular and crystalline limestones, dolomitic limestones, and dolomites. The Upper Floridan aquifer, which is the primary source of water to most agricultural wells in St. Lucie County, occurs between 300 feet and 1,000 feet below land surface in the study area and is approximately 500 feet thick (Lukasiewicz, 1992).

Lithologic and geophysical logs for most of the Surficial Aquifer System wells drilled by the SFWMD are provided in the appendices of this report. Most of the well cuttings were described by the Florida Geologic Survey and are incorporated into their state-wide geologic database. Geophysical logs were run using primarily SFWMD equipment; however, those of the Floridan Aquifer System pilot well (SLF-73) were run by a contracted borehole geophysical survey company (Schlumberger) using more advanced equipment. All the geophysical logs, which have been digitized and graphically plotted, are provided in the appendices of this report.

Monthly water-level elevations from all SFWMD Surficial Aquifer System wells were combined with data from the U.S. Geological Survey database and the SFWMD Regulation Department's SALT monitoring well database. Additional well data are also listed including state planar coordinates, completion depths, etc. Previously published maps showing regional water-level elevations in both the sand/soil and production units were compared and contrasted. Water-level elevations in the two units are similar, ranging between 0 to +35 feet national geodetic vertical datum (NGVD) in the study area. Those elevations are influenced by land surface and surface water stage elevations as well as ground water withdrawals.

Water-level elevations were measured by SFWMD staff in fifty-four Upper Floridan aquifer wells between May 1989 and March 1991. These measurements were used to calibrate a ground water flow model simulating the Floridan Aquifer System. Subsequent water-level measurements were collected on a semi-annual basis (May and September) from twenty-four of those wells. Upper Floridan aquifer water-level elevations are higher than land surface in the study area and range between 30 to 50 feet NGVD. The flow direction is to the north-northeast (Lukasiewicz, 1992). A hydrograph of well SLF-50, located in central St. Lucie County, was developed using data from a continuous recorder installed in 1983. Average recorded monthly values ranged between 38.7 feet and 44.0 feet NGVD over the eleven-year period of record. The trends in all years were similar, with minimum levels recorded in May and maximum levels in October and November. These months correspond to the end of dry and wet seasons, respectively.

The SFWMD conducted Surficial aquifer performance tests at twelve sites in the study area, the results of which were used to define aquifer characteristics for the ground water flow models previously discussed. Aquifer test analyses including drawdown and recovery plots, as well as supporting documentation, are presented here. Results from several unpublished USGS Surficial aquifer performance tests were also used in the models. Eight of those tests are summarized in this report using the field notes and data provided by the USGS. Results of all available tests conducted prior to 1991 in the UECPA are tabulated in this report.

The SFWMD constructed six wells into the upper one-thousand feet of the Floridan Aquifer System at a site in central St. Lucie County. These wells were tested to determine aquifer parameters and water quality in three distinct flow zones within the Upper and Lower Floridan aquifers. Type-curve analyses and leakance observations show that each of the three zones have high transmissivity and are at least partially connected hydraulically. The most transmissive interval tested at this site was in the Lower Floridan aquifer, with a transmissivity of 485,200 gallons per day per foot (gpd/ft). These aquifer tests are summarized along with pilot hole (SLF-73) information including lithologic descriptions, geophysical logs, and water quality with respect to depth.

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This document is a product of several years of efforts by many individuals involved with hydrogeologic work conducted in the Upper East Coast Planning Area. A significant amount of this work was conducted in St. Lucie County by Don Padgett, formerly with the Hydrogeology Division. Don designed the aquifer performance test sites and water-level networks in St. Lucie County and dedicated much of his time to conducting field work. Don did a fine job exploring the hydrogeology in this area, and his efforts are appreciated. Many of the wells installed and subsequently documented in this report were drilled by the late Paul Benton. Paul's drilling expertise and dedication to his work will be sorely missed at the District. The idea for this document and the subsequent support for its completion are credited to Keith Smith, Director of the Hydrogeology Division. Keith also provided several editorial reviews of this manuscript during the publication process.

Since this is a particularly large and technical document, it was difficult finding individuals who were willing to thoroughly review it. Many individuals on the peer review committee edited this entire document on their own time. Those editorial reviews and comments vastly improved the quality of this report and are greatly appreciated. The committee was composed of the following individuals:

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ABSTRACT

The South Florida Water Management District has drilled fifty-seven wells in the Upper East Coast Planning Area since 1989. Six wells were completed in the Floridan Aquifer System and the remainder in the Surficial Aquifer System. Some of the wells were constructed as part of thirteen aquifer performance test sites in the study area, while most were used primarily to obtain monthly ground water-level elevations. All hydrogeologic data obtained from these wells were combined with those from other available sources and used in the calibration of ground water flow models simulating the Surficial and Floridan Aquifer Systems underlying the Upper East Coast Planning Area. These data include lithologic descriptions, geophysical logs, aquifer performance test analyses and results, and tables of observed ground water-level elevations. Data from eight additional aquifer performance tests conducted by the U.S. Geological Survey were also used in the models, but have not been previously published. The purpose of this report is to present a compilation of this information to augment existing model documents and also to update the existing hydrogeologic database for the Upper East Coast Planning Area.

INTRODUCTION

PURPOSE AND SCOPE

A substantial amount of hydrogeologic field work was performed in the Upper East Coast Planning Area (UECPA) between 1989 to 1992. The work included drilling fifty-one Surficial Aquifer System (SAS) and six Floridan Aquifer System (FAS) wells, collecting monthly water-level elevations from eighty-eight SAS and fifty-four Upper Floridan aquifer (UFA) wells, and conducting aquifer performance tests (APTs) at twelve SAS sites and one FAS site. These data were combined with those from previous investigations and collectively used by South Florida Water Management District (SFWMD) staff to develop three independent ground water flow models. Two county models simulating the SAS were developed, one representing Martin and eastern Okeechobee counties (Adams, 1992) and the other representing St. Lucie and eastern Okeechobee counties (Butler and Padgett, 1995). The third flow model simulates the FAS underlying the entire UECPA (Lukasiewicz, 1992).

Although this new hydrogeologic information was incorporated into the development of the flow models, the raw data and analyses of APTs were not published in the model documentation. The purpose of this report is to provide that information and to document the methods used for data collection and analysis. In addition, unpublished APT and lithologic data and analyses, collected by the United Stated Geological Survey (USGS) in the late 1970's, are included in this report since that information was also used to develop the models. Finally, a brief overview of the subsurface geology and aquifers underlying the study area is provided for background information.

This report is the second of a two part ground water reconnaissance study of the aquifers underlying the UECPA. The first phase documented water quality characteristics of ground water sampled from wells completed into both the Surficial and Floridan Aquifer Systems (Lukasiewicz and Switanek, 1995). Water-level elevations from those wells were measured monthly and are presented in this report.

LOCATION OF STUDY AREA

The UECPA is one of four regional planning areas for which the District is preparing regional water supply plans. The planning areas are generally defined by the drainage divides of major surface water systems in South Florida. The UECPA incorporates the northern reaches of the SFWMD on the east coast. The area includes most of Martin and St. Lucie counties, and a small portion of eastern Okeechobee County, as shown in Figure 1. The boundaries of the UECPA generally reflect the drainage basins of the C-23, C-24, C-25, and C-44 canals. The northern boundary corresponds to the St. Lucie-Indian River County line and the southern boundary is the Martin-Palm Beach county line.

PREVIOUS INVESTIGATIONS

The hydrogeology of southeastern Florida was examined by Parker and others (1955). Miller (1979) provided data on the SAS and also evaluated the major lithologies of the aquifer (1980). MacVicar and others (1983) examined the ground water flow in the SAS. Brown and Reece (1979) examined the FAS. Brown (1980) provided aquifer test data and analyses of the FAS. Ground water flow in the FAS was modeled by Bower (1988) and Lukasiewicz (1992). Water quality characteristics in both the SAS and FAS were assessed by Lukasiewicz and Switanek (1995). Other comprehensive regional studies of the FAS include: Tibbals (1991), Stringfield (1966), Puri and Vernon (1964), Cooke (1945), and Applin and Applin (1944).

Stodgehill and Stewart (1984) measured the electrical properties of the SAS in Martin County. Ground water resources investigations of Martin County were performed by Lichtler (1960), Earle (1975), Miller (1978, 1980), and Nealon et al. (1987). Adams (1992) developed a ground water flow model of the SAS underlying Martin County. Hopkins (1991) modeled the SAS and analyzed the water resources underlying the Jensen Beach peninsula in Martin County. A water resource investigation of St. Lucie County was conducted by Bearden (1969). Butler and Padgett (1995) developed a groundwater flow model simulating the SAS underlying St. Lucie County. A number of other authors have also provided information on the aquifers in the UECPA on a site-specific basis.

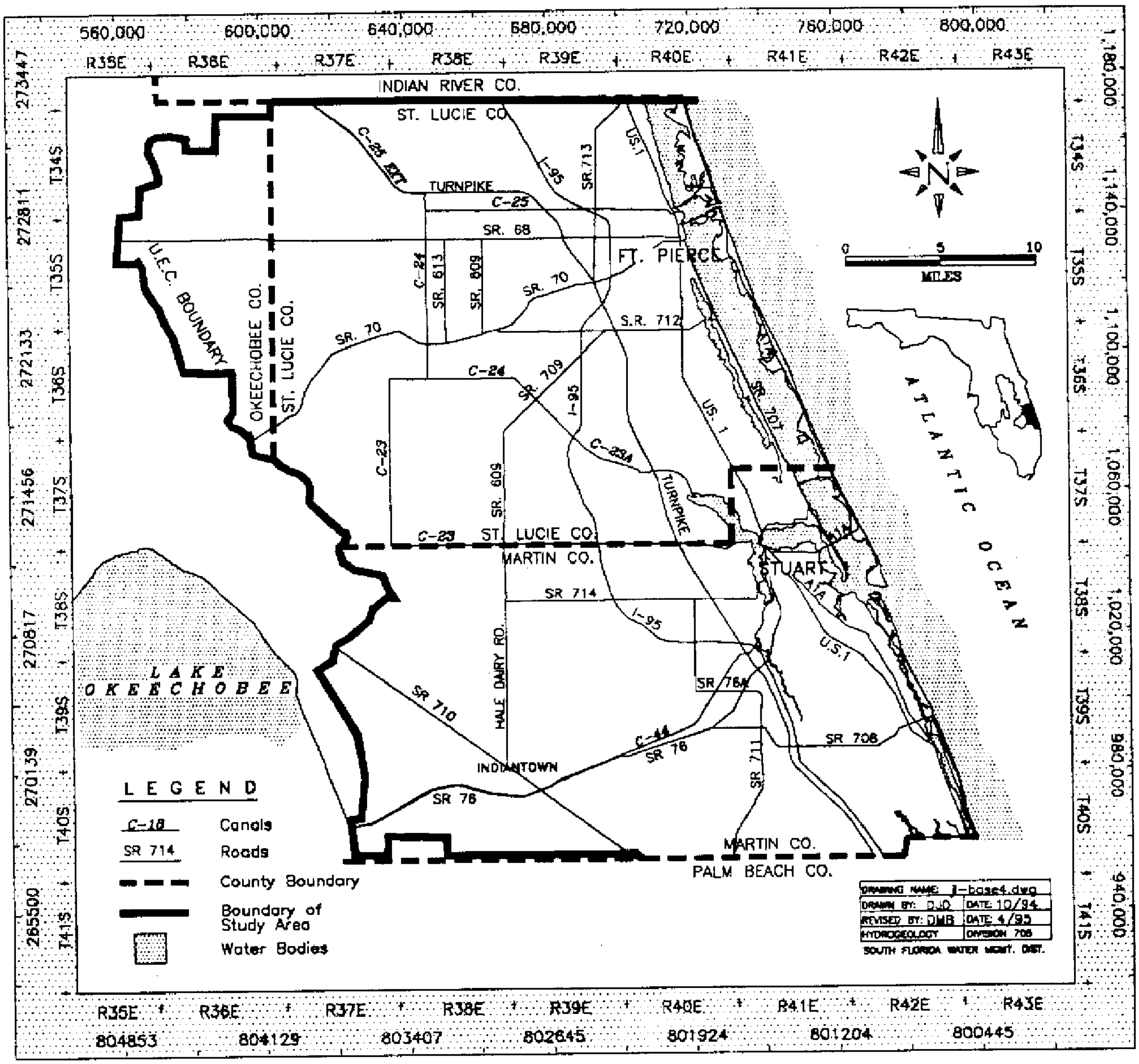


FIGURE 1. Location Map of the Upper East Coast Planning Area

TOPOGRAPHY

Land surface in most of the study area is relatively featureless with elevations ranging from 0 feet to 60 feet above the National Geodetic Vertical Datum (NGVD), averaging approximately 25 feet NGVD. The major topographic feature is the Orlando Ridge (Lichtler, 1960) which trends northwest-southeast and occurs in the western portion of the study area. The ridge extends southeastward starting from the northwestern portion of the UECPA and has a maximum elevation of approximately 60 feet above NGVD (Figure 2). In addition, there are coastal sandhills adjacent to the Intracoastal Waterway which are higher than most other parts of the study area and extend to approximately 50 feet NGVD (Bearden, 1969). These sandhill features are too small in aerial extent to appear on the regional topographic map seen in Figure 2.

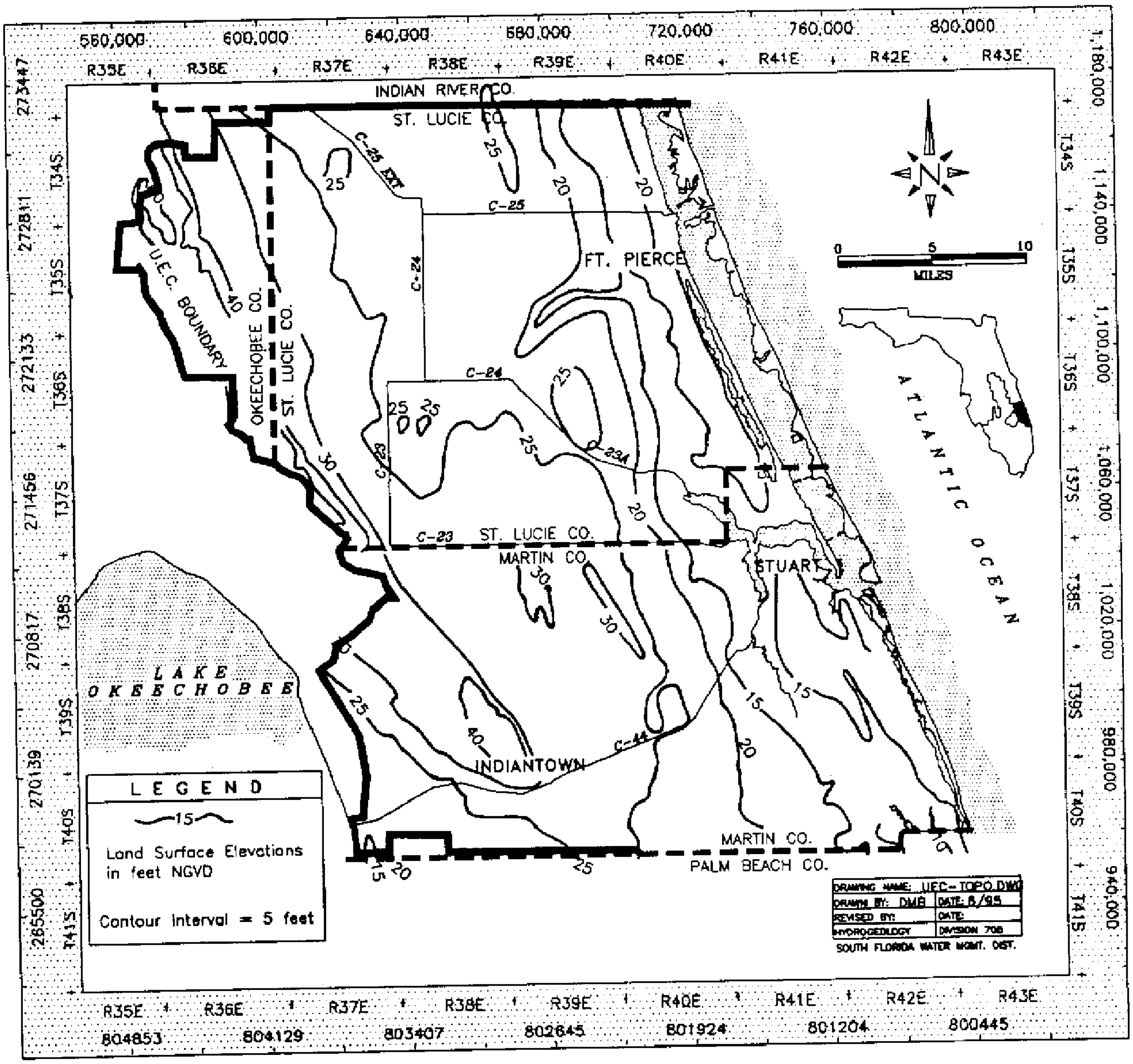


FIGURE 2. Land Surface Elevations of the Upper East Coast Planning Area

HYDROGEOLOGY OF THE STUDY AREA

Two major aquifer systems underlie the study area; the Surficial Aquifer System and the Floridan Aquifer System. They extend from land surface to a depth of over 2,500 feet below land surface (BLS) and are separated by a thick confining unit consisting of the Hawthorn Group. Figure 3 is a generalized hydrogeologic cross section taken from west to east through St. Lucie County. The uppermost water-bearing interval is the SAS which is also the primary source of potable water used in the study area. The FAS is found well below the SAS and is the primary source of ground water used for agricultural irrigation in St. Lucie County. Although ground water plays an important role in satisfying irrigation demands, far more surface water than ground water is used for this purpose in the study area.

SURFICIAL AQUIFER SYSTEM

The SAS is unconfined to semi-confined in the study area and is composed of three hydrogeologic units (Adams, 1992) based primarily on lithology. A hydrogeologic unit is defined by the USGS (1989) as "any soil or rock unit or zone which by virtue of its hydraulic properties has a distinct influence on the storage or movement of ground water." The three hydrogeologic units in the SAS in the study area are (in descending order): the shallow unconsolidated sand/soil unit, the more permeable sandy shell bed and sandstone beds which together comprise the production unit, and the less permeable granular limestone unit which interfingers with and underlies the production unit in much of the study area.

The lithology of the SAS changes laterally as well as vertically so that permeable zones are not always found at the same depth at different locations; in fact, in some areas they are missing entirely. The geologic units which comprise the SAS are (in descending order) the Pamlico sand (Pleistocene), the Anastasia formation (Pleistocene), the Fort Thompson formation, and possibly part of the Tamiami formation of Pliocene age.

The Pamlico sand unconformably overlies the Anastasia formation and is only a few feet thick in most of Martin County. It is not a source of appreciable amounts of ground water. The Anastasia Formation constitutes the bulk of the SAS and differs in composition from place to place, ranging from almost pure coquina to almost pure quartz sand. In Martin County, however, the Anastasia Formation is composed of sand, shell beds, and thin, discontinuous layers of sandy limestone or sandstone (Lichtler, 1960). The Fort Thompson formation consists, in its type area, of alternating beds of fresh-water deposits as well as marine shell marl and limestone of Pleistocene age (Sellards, 1919). Although some evidence of fresh water gastropods in well cuttings exists, the occurrence of the Fort Thompson formation in the study area is debatable (Lichtler, 1960). Parker (1951) defined the Tamiami formation as including all deposits of late Miocene age in southern Florida. Unfortunately, it is difficult to distinguish between the Tamiami formation of late Miocene age and the Hawthorn Group of early to middle Miocene age as there is no distinct lithologic change.

Six cross-sectional profiles of the SAS were developed to correlate the hydrogeologic units underlying Martin and St. Lucie counties. The orientations of the profiles are shown in Figures 4 and 5, respectively. Three of these sections traverse St. Lucie County (Figures 6, 7, and 8) and three traverse Martin County (Figures 9, 10 and 11). All were generated using the lithologic descriptions provided in Appendices A-1 and A-2. The cross sections are summarized below in terms of each units thickness and regional continuity. The actual thickness ranges are probably larger than those quantified here since the sections do not define the entire study area.

The shallow sands (as shown in the cross sections) range in thickness from 20 to 100 feet in the Martin County sections and from 10 to 80 feet in the St. Lucie County sections. Butler and Padgett (1995) named this unit the "sand/soil zone" in St. Lucie County. The sands range from very fine to coarse grained and have low to moderate permeability. Also included in this zone are "hardpan" beds (Adams, 1992) and/or interbedded lenses of shell, sandy clay and silt. In most of the UECPA, the sand/soil unit directly overlies sandy shell beds and sandstones. However, in southern Martin County and in west-central St. Lucie County, it is underlain by a laterally persistent granular limestone.

Most large-capacity wells in the study area are completed into the more permeable shell and/or sandstone beds which are referred to in this report as

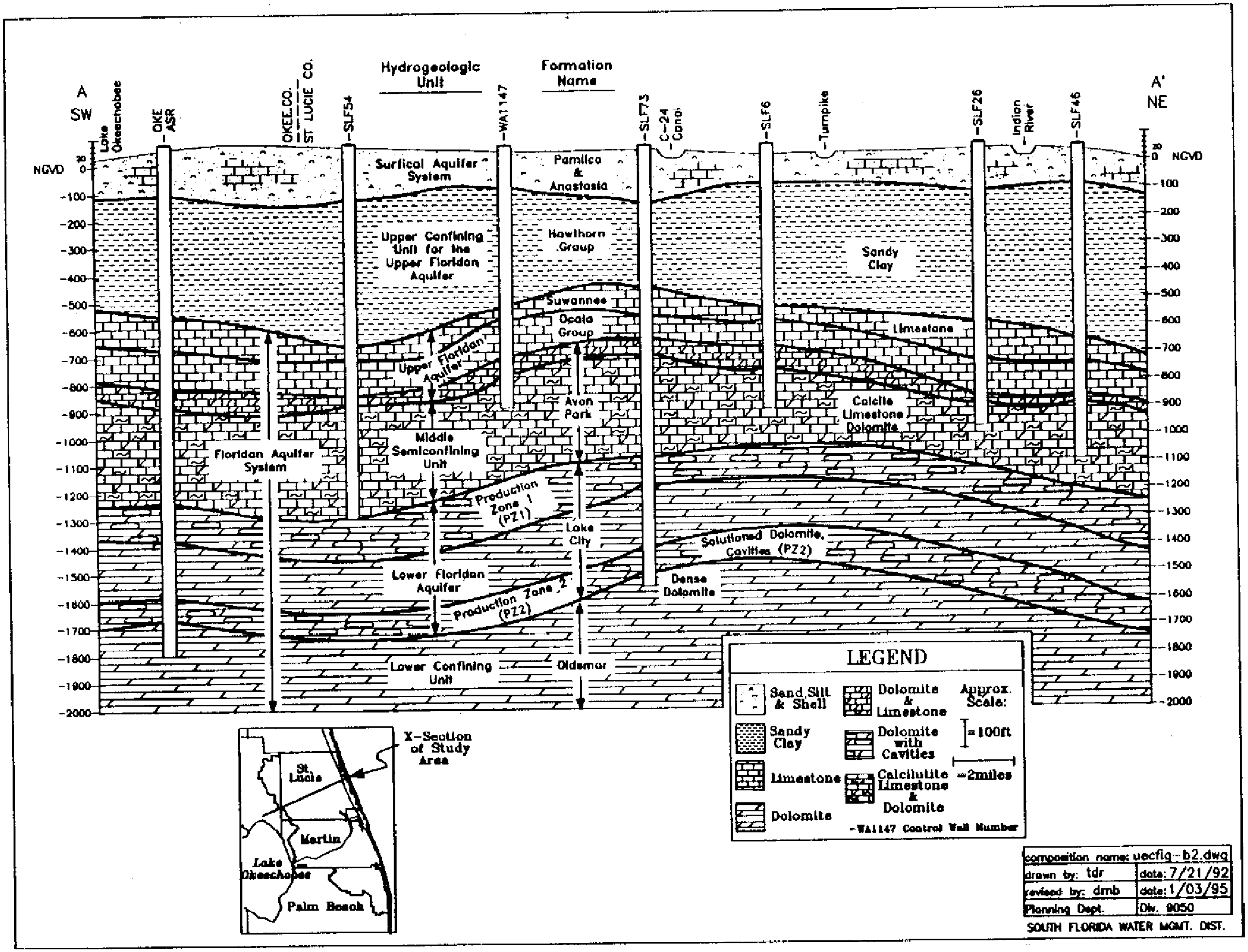


FIGURE 3. Generalized Hydrogeologic Cross-Section, St. Lucie County

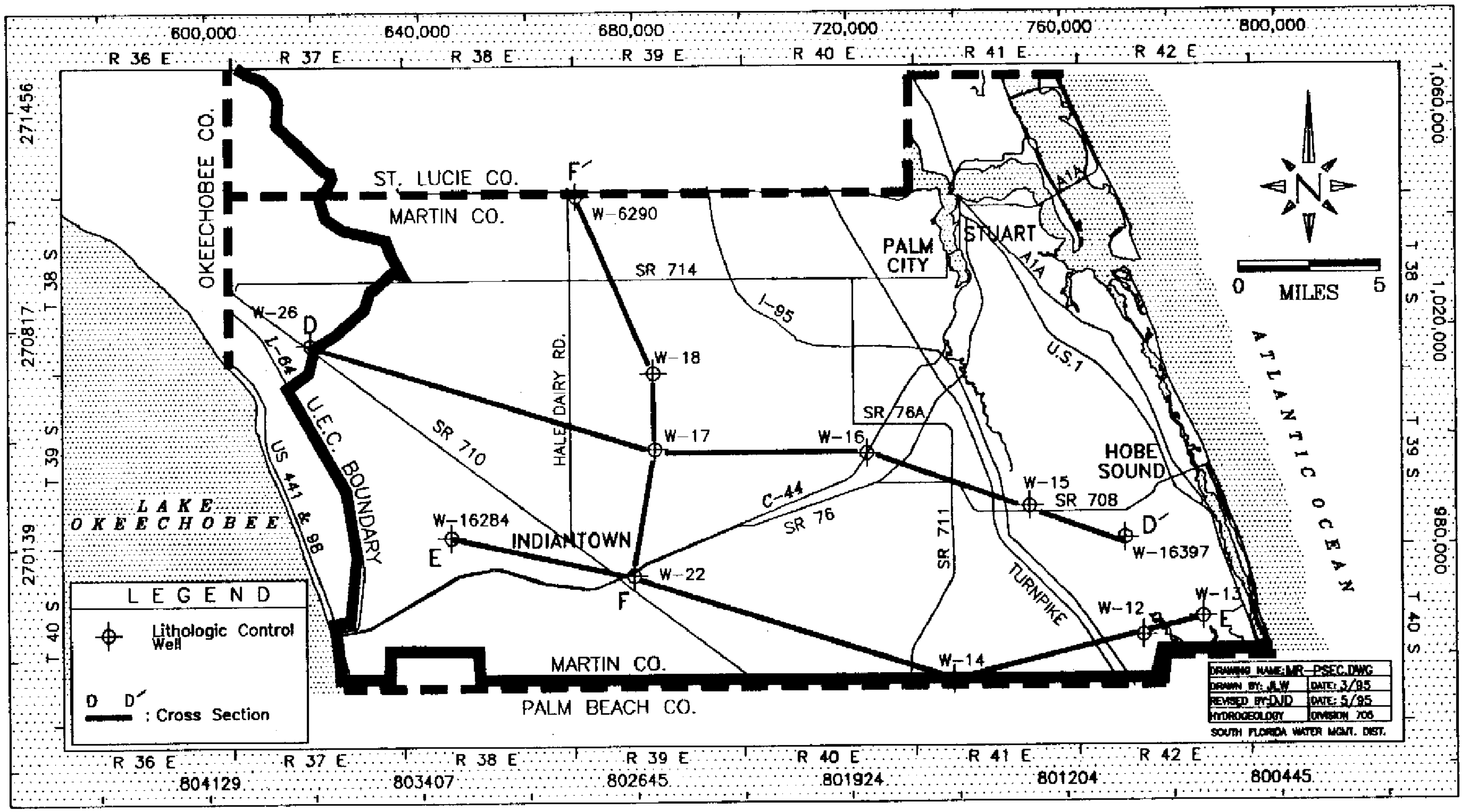


FIGURE 4. **Locations of Cross-Sections through the Surficial Aquifer System, Martin County**

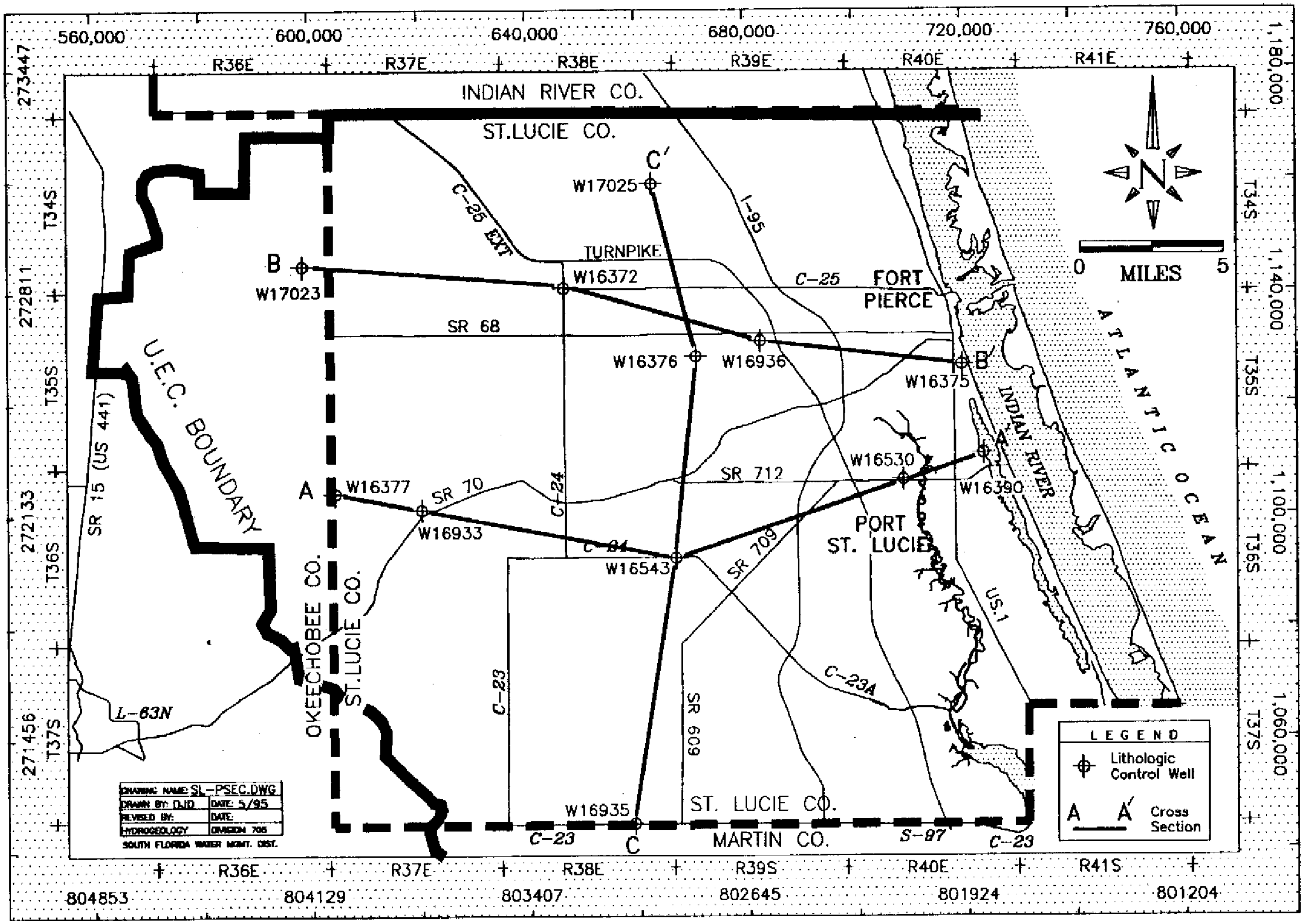


FIGURE 5. Locations of Cross-Sections through the Surficial Aquifer System, St. Lucie County

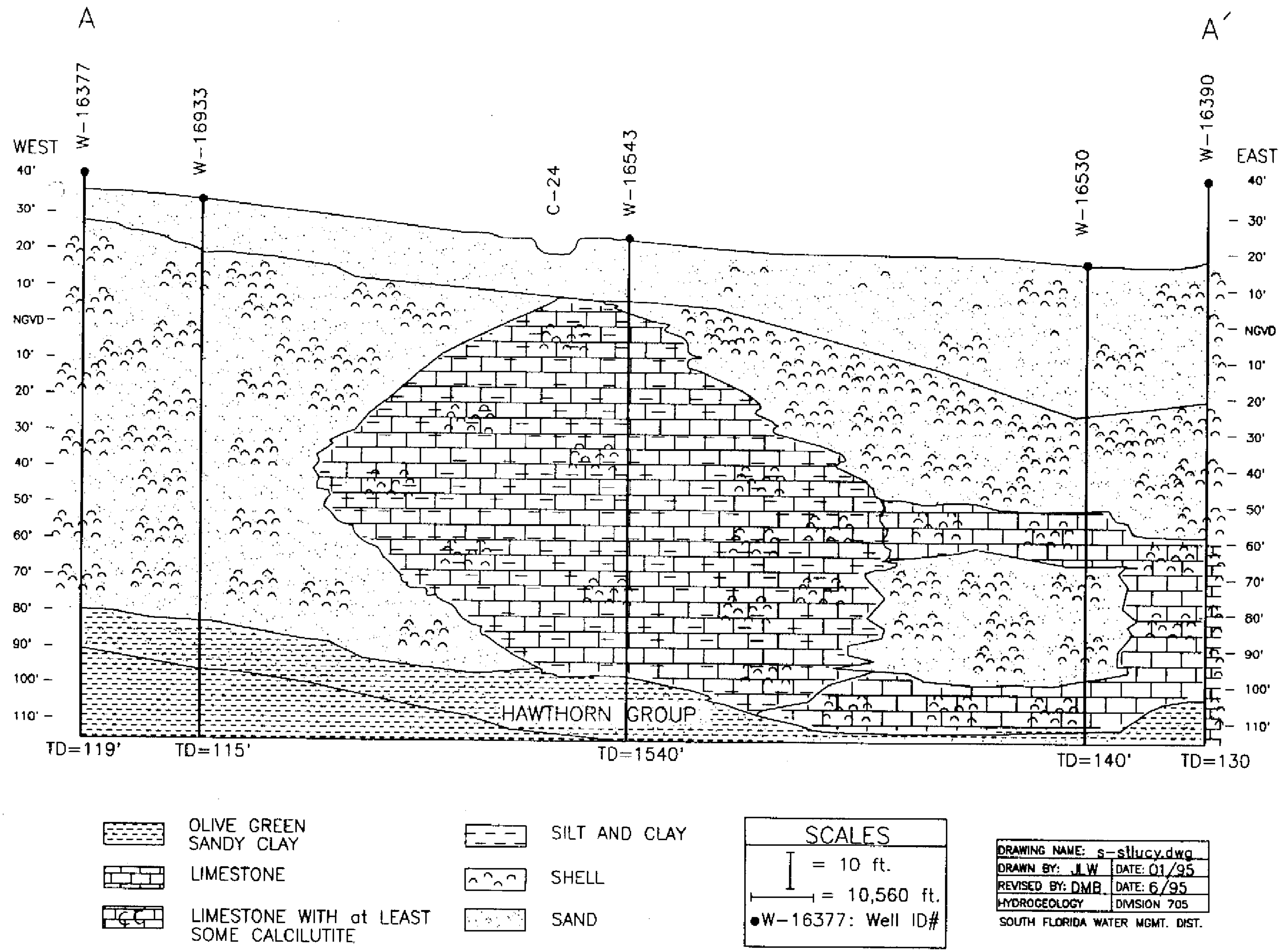


FIGURE 6. Cross-Section A-A', St. Lucie County

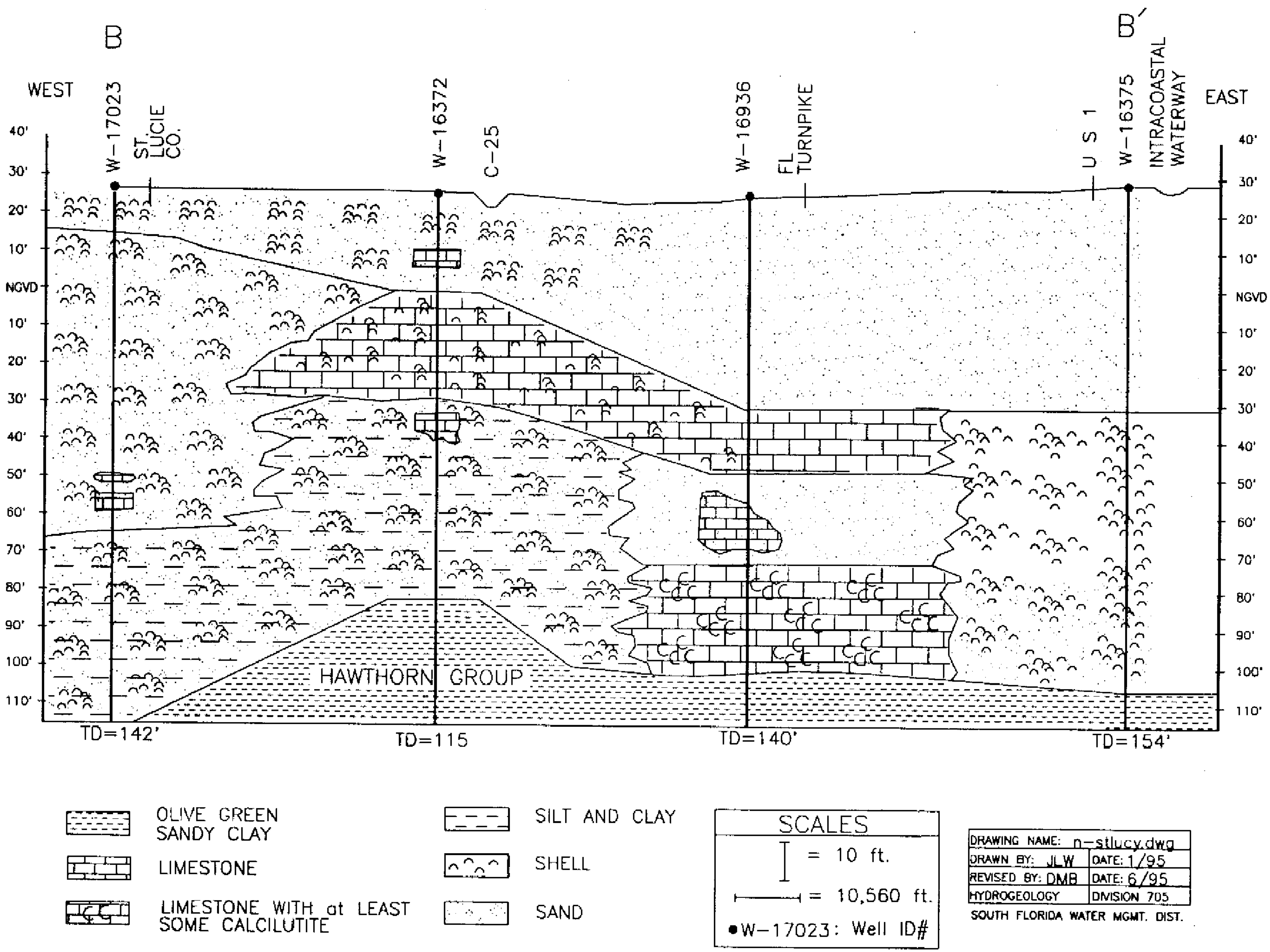


FIGURE 7. Cross-Section B-B', St. Lucie County

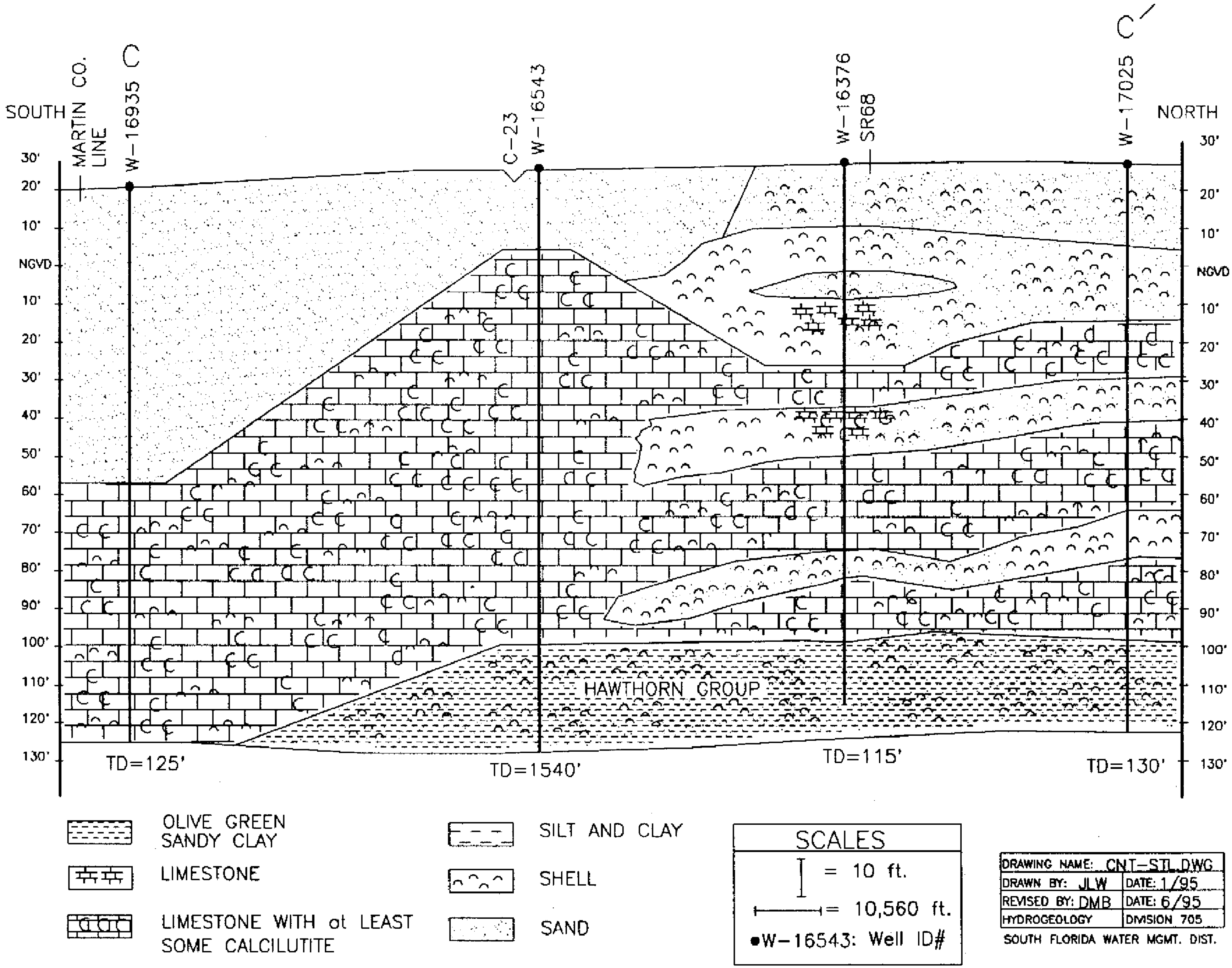


FIGURE 8. Cross-Section C-C', St. Lucie County

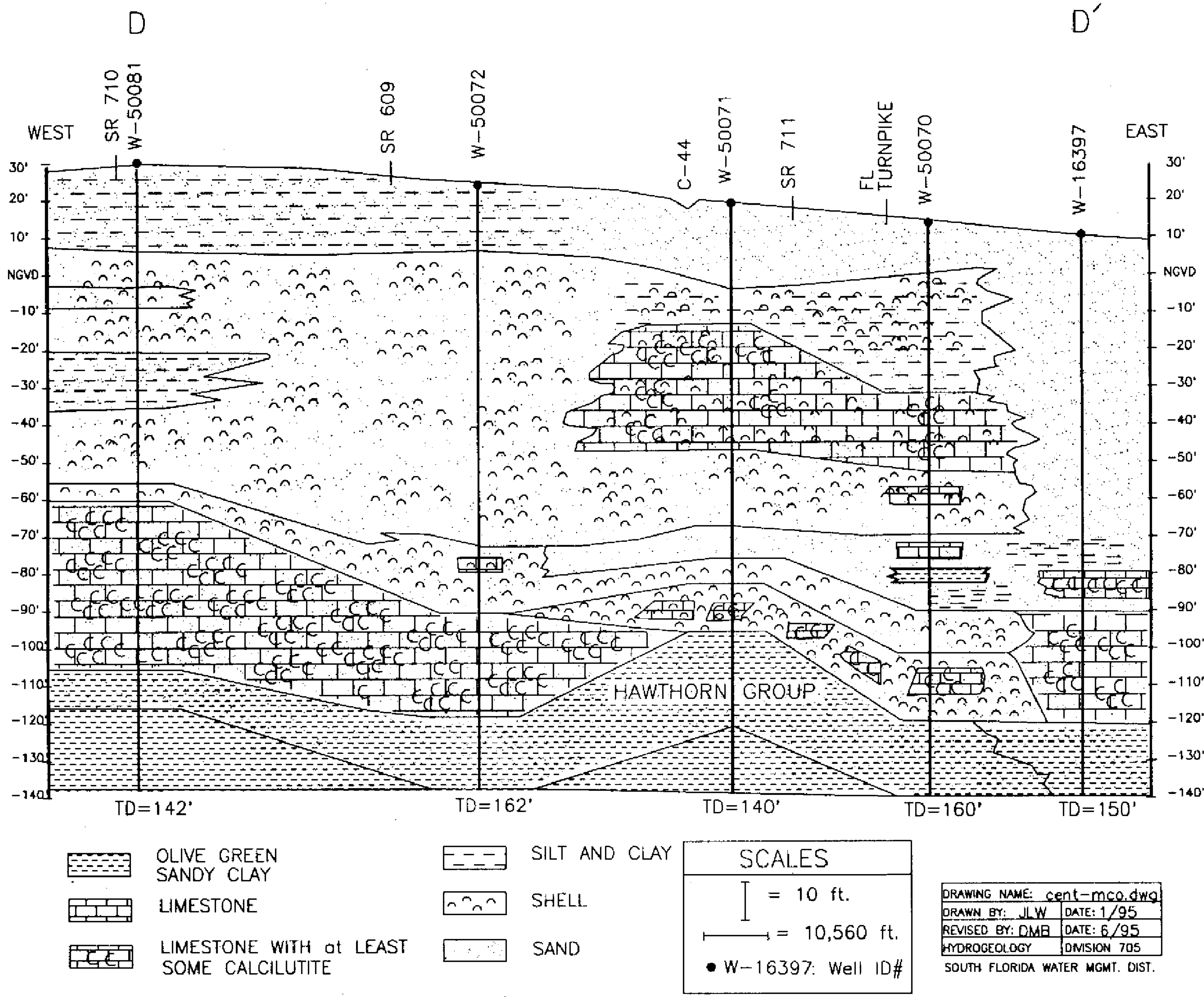


FIGURE 9. Cross-Section D-D', Martin County

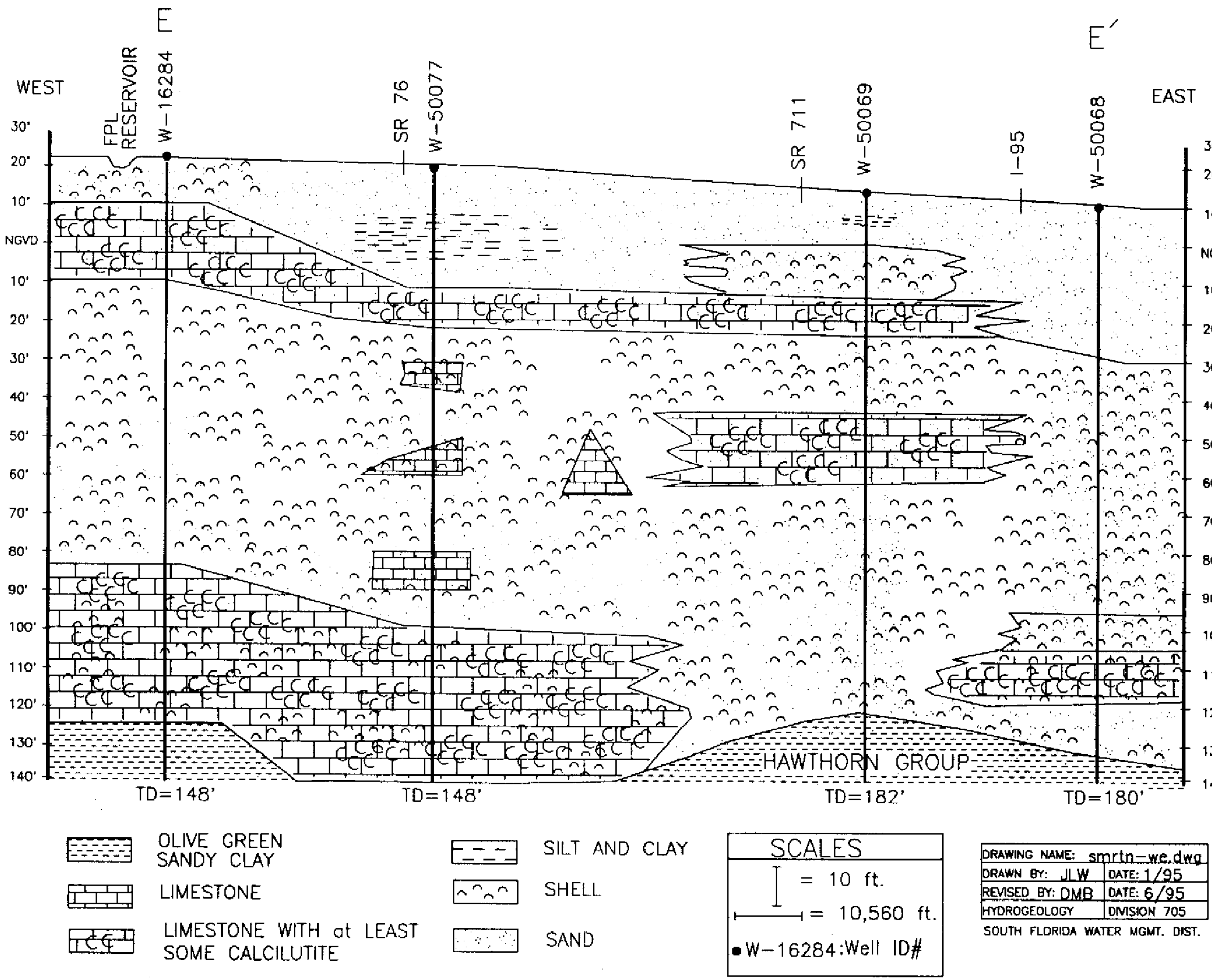


FIGURE 10. Cross-Section E-E', Martin County

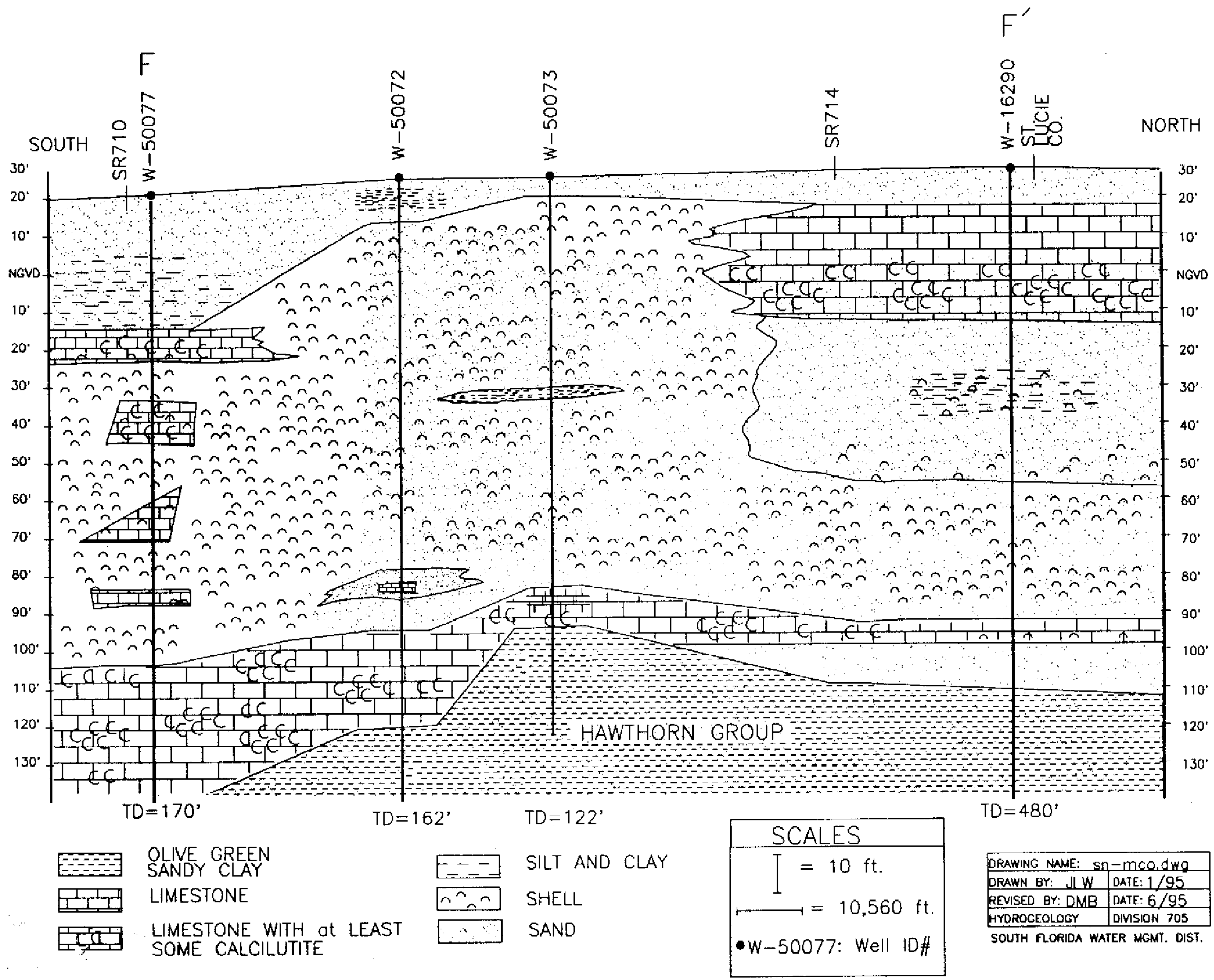


FIGURE 11. Cross-Section F-F', Martin County

the "production unit". Butler and Padgett (1995) used the term "production zone" to describe that portion of the Surficial Aquifer System below the sand/soil unit. This broad interpretation was adopted primarily because of the non-uniformity of the production unit underlying St. Lucie County. The production unit (as defined in this report) ranges in thickness from 0 to 110 feet in Martin and St. Lucie counties and, with few exceptions, is aerially persistent throughout the study area. It is capable of yielding large quantities of water to wells depending on the percentage of fine sand and/or silt present in the zone. Permeability generally increases to the south and east in Martin and St. Lucie counties (Adams, 1992 and Butler and Padgett, 1995). In many parts of the UECPA, the sandy shell zone is interbedded with granular limestone, typically in the form of calcilutite. In northwestern Martin County, the unit is interbedded with thin beds of silty sand. The production unit is not present in three of the St. Lucie County wells shown in Figures 6 and 7, two of which (W-16936 and W-16543) are in south-central St. Lucie County. It is also absent in well W-16397 (Figure 9), located in southeastern Martin County.

The production unit overlies and interfingers with a granular limestone unit in most of Martin County. The production unit forms the basal portion of the SAS in Martin County but occurs at the base only sporadically in St. Lucie County. Because it can be regionally correlated throughout most of the study area, it is referred to as a hydrogeologic "unit" in this report. The underlying granular limestone unit ranges in thickness from 0 to 50 feet in Martin County as seen in the cross sections. The granular limestone unit is significant from a water resources perspective in that it has the ability to store and release water to the production unit when needed (Adams, 1992). Wells completed into this unit in Martin County seldom yield useful quantities of water due to the presence of silts and fine grained carbonates which reduce the permeability. In St. Lucie County, the granular limestone unit is from 0 feet to 110 feet thick and interfingers with the sandy shell and sandstone beds of the production unit. In areas where it is crystalline rather than granular this limestone unit can yield significant amounts of water, however, these areas are not common.

In most of study area, the granular limestone unit overlies the silty sands and clays of the Hawthorn Group. Where the unit is absent at the base of the SAS, either the production unit or the sand/soil unit directly overlies the Hawthorn Group.

The Hawthorn Group is part of the Upper Tertiary System (including the Miocene and Pliocene Series) and is composed of dark green to white phosphatic sand containing silt and/or quartz (Lichtler, 1960). It is typically described as a light olive-gray silt and/or sand in lithologic descriptions. The Hawthorn Group has very low permeability and serves as the intermediate confining unit between the SAS and FAS. The thickness of the Hawthorn Group ranges between 250 feet to 750 feet in the study area (Lukasiewicz, 1992). It is thinnest in northwestern St. Lucie County and thickens to the south-east.

FLORIDAN AQUIFER SYSTEM

The FAS is composed of a sequence of limestones, dolomitic limestones, and dolomites ranging in age from Eocene to early Miocene. In the UECPA, it is aerially extensive and ranges from 2,700 to 3,400 feet in thickness (Miller, 1982). Tibbals (1991) divided the FAS into two aquifers based on the vertical occurrence of two highly permeable zones; the Upper Floridan aquifer (UFA) and the Lower Floridan aquifer (LFA) as seen in Figure 3. The UFA is approximately 500 feet thick in the study area and is composed of several flow zones. It is underlain by the middle semi-confining unit which is approximately 300 feet thick and composed primarily of calcilutite (Lukasiewicz, 1992). These sediments have low permeability and inhibit vertical flow between the UFA and LFA. Water in the LFA is significantly more saline than that in the UFA; therefore, the vast majority of existing FAS wells in the study area terminate in the UFA.

Hydrogeologic cross sections through the FAS in the UECPA were developed by previous investigators and, therefore, no new cross sections have been developed for this report. For additional information about the FAS in the study area, the reader is referred to the authors listed in the section of this report entitled "Previous Investigations".

LITHOLOGIC AND GEOPHYSICAL LOGS

INVENTORY OF RECENTLY COLLECTED INFORMATION

Table 1 lists eighty-five wells with lithologic and/or geophysical logs provided in Appendices A and B. The locations of these wells in Martin and St. Lucie counties are plotted by map number in Figures 12 and 13, respectively. SFWMD staff and contractors drilled all fifty-one of the SAS wells listed in Table 1, and seven FAS wells (SLF-73 through SLF-78, and SLF-50). Aside from the seven FAS wells mentioned, all other FAS wells were drilled for and are owned by private land owners and cuttings were never described. All logs in Table 1 and those from other published sources, were used by SFWMD staff to conceptualize the hydrogeology for ground water flow model discretization.

Table 1 also lists total depths and location data, ground-level elevations, types of geophysical logs available for each well with the corresponding SFWMD geophysics code number, and the Florida Geological Survey's (FGS) well name assigned to each well. The original well names assigned by the SFWMD are found under the column "SFWMD Well Name". Appendix A contains lithologic descriptions for most of the SFWMD wells and for wells used in (non-District sponsored) pumping tests conducted in the study area. Those wells, most of which were described by either the SFWMD, the U.S. Geological Survey, or private engineering consultants, are referenced in the Aquifer Performance Test (APT) section of this report. Their locations and depths are listed in Table 2. The geophysics code number seen in column four of Table 1 was assigned by the SFWMD's Hydrogeology Division and refers to a database of digitized geophysical logs. Those digitized logs were graphically plotted and are presented in Appendix B.

FIELD METHODS USED BY THE SFWMD

Methods Used to Drill Wells

Forty-five of the fifty-one SAS wells listed in Table 1 were constructed by the SFWMD using the conventional mud-rotary method. With this method, rock and soil cuttings are lifted to the surface suspended in the mud column where they are collected, washed and bagged by a site geologist at least every ten feet of bit penetration. Six SAS wells were drilled using a combination of split-spoon sampling and dual-tube coring at various intervals in order to recover more continuous lithologic samples. Table 3 lists the intervals sampled for each of the six wells.

Table 3. Split Spoon and Cored Intervals in SFWMD Wells in the UECPA.

SFWMD Well Name	FGS Well Name	Split Spooned Interval (Ft. BLS)	Cored Interval (Ft. BLS)
STLAPT4	W-16933	0-56	56-126
CH5	W-16935	0-80	80-125
STLAPT1-H2	W-16525	0-56	56-123
STLAPT2-CH2	W-16542	0-57	57-128
M-1281	W-16937	0-120	120-242
M-1283	W-16460	0-33	33-182

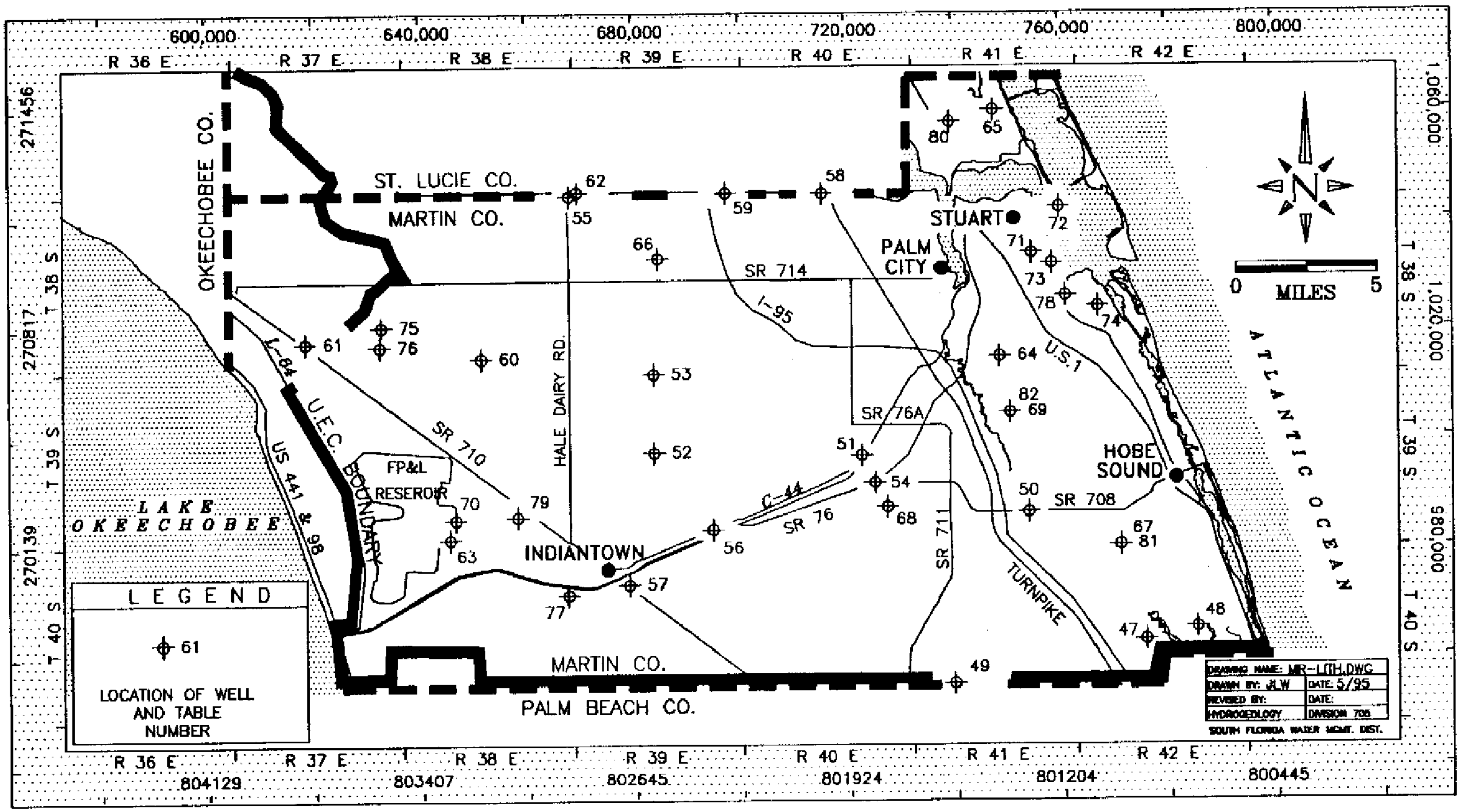


FIGURE 12. Locations of Control Wells in Martin County with Lithologic Descriptions and/or Geophysical Logs Provided in Appendices A and B

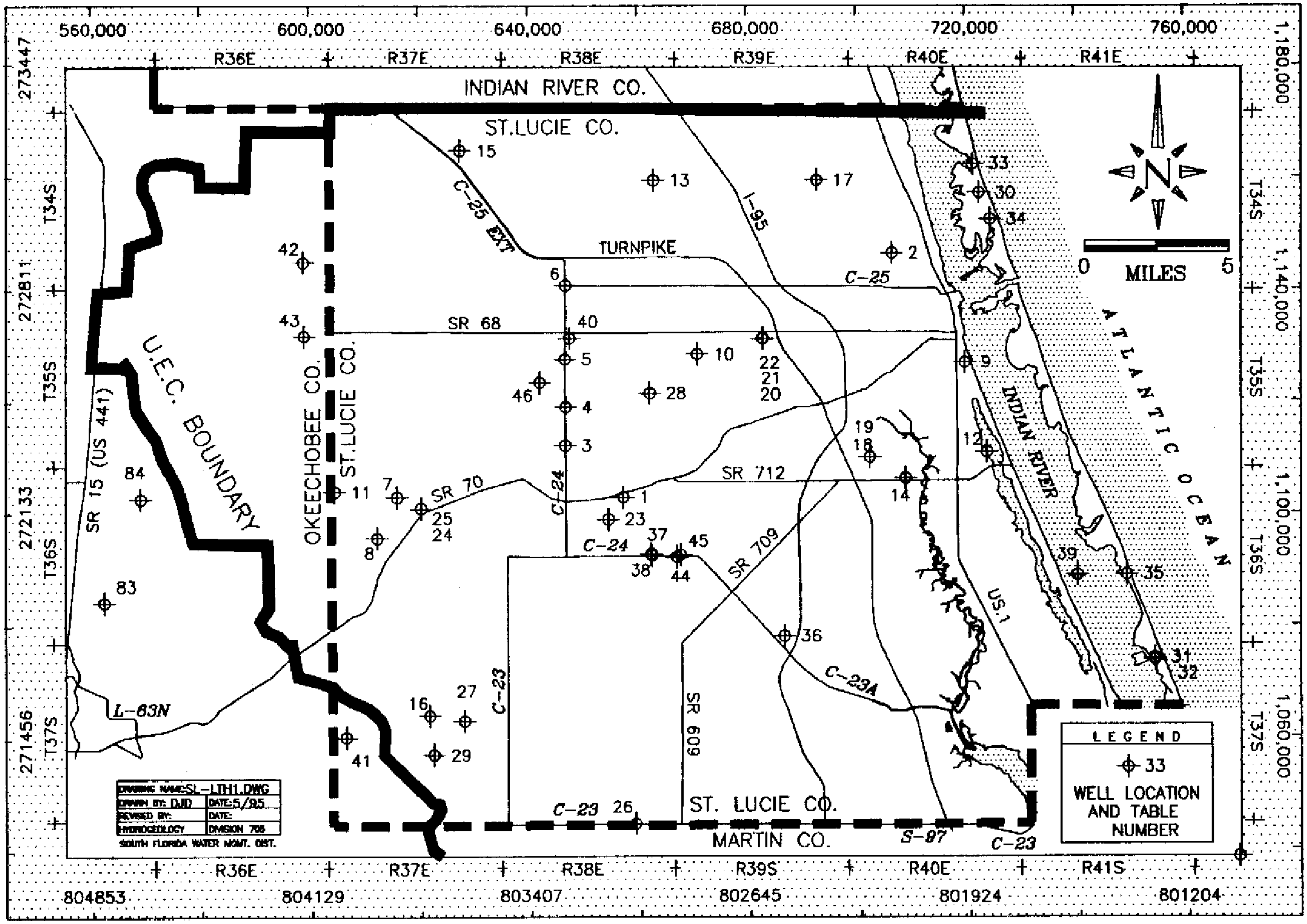


FIGURE 13. **Locations of Control Wells in St. Lucie County with Lithologic Descriptions and/or Geophysical Logs Provided in Appendices A and B**

TABLE 1. Inventory of Lithologic and Geophysical Data for SFWMD Wells in the Upper East Coast Planning Area

MAP #	SFWMD WELL NAME	SFWMD I.D.#	SFWMD GEOPHYS I.D.#	FGS WELL NAME	TOTAL DEPTH (BLS)	GROUND LEVEL (FEET NGVD)	STATE EAST (FEET)	PLANARS NORTH (FEET)	S/T/R	GEOPHYSICS AVAILABLE
St. Lucie County										
1	STLMW1	111-21	111000056	W-16289	134	22.60	657595	1102620	10/36/38	C,D,E,EL,G,N
2	SLMW4D	111-41	111000069	W-16386	118	22.00	706690	1146162	29/34/40	C,D,E,G,N, SP
3	SLMW5D	111-32	111000060	W-16384	122	26.00	647013	1111870	32/35/38	D,G,N
4	SLMW6D	111-33	111000061	W-16385	112	26.40	647078	1118737	29/35/38	C,D,G,N
5	SLMW7D	111-34	111000062	W-16371	110	26.00	646957	1127218	17/35/38	C,D,G,N
6	SLMW8D	111-35	111000063	W-16372	115	24.60	646998	1140447	05/35/38	C,D,G,N
7	SLMW9D	111-36	111000064	W-16373	122	30.00	616302	1102581	09/36/37	C,D,E,G,N,SP
8	SLMW10D	111-37	111000065	W-16374	120	30.50	612626	1095300	17/36/37	C,D,E,G,N,SP
9	SLMW11D	111-38	111000066	W-16375	154	27.00	720126	1126642	15/35/40	C,E,G,SP
10	SLMW12D	111-39	111000067	W-16376	115	24.40	671191	1128122	18/35/39	D,E,G,SP,N
11	SLMW13D	111-40	111000068	W-16377	119	33.30	604850	1103559	06/36/37	C,D,E,G,N, SP
12	SLMW14D	111-43	111000071	W-16390	130	16.70	724089	1110709	35/35/40	D,E,G,N,SP
13	SLMW20	111-47	111000072	W-17025	130	24.20	663136	1159191	13/34/38	C,D,E,EL,G,SP
14	SLMW21	111-44	111000073	W-16530	140	14.50	709240	1105984	05/36/40	C,D,E,EL,G,SP
15	SLMW22D	111-50		W-16932	116	25.00	627736	1164515	11/34/37	
16	SLMW23D	111-52	111000074	W-16931	320	32.00	622280	1063621	15/36/21	C,D,E,G,N,SP
17	SLMW24D	111-53	111000075	W-16964	142	22.00	692937	1159222	14/34/39	C,E,EL,G,SP
18	STLAPT1PW1	111-16	111000055	W-16288	142	17.00	702639	1109788	31/35/40	C,E,G,N,SP
19	STLAPT1-H2	111-51		W-16525	123	18.00	702643	1109788	31/35/40	
20	STLAPT2-CH2	111-54		W-16542	128	22.00	683162	1130901	09/35/39	

TABLE 1. Inventory of Lithologic and Geophysical Data for SFWMD Wells in the Upper East Coast Planning Area (Continued)

MAP #	SFWMD WELL NAME	SFWMD I.D.#	SFWMD GEOPHYS I.D.#	FGS WELL NAME	TOTAL DEPTH (BLS)	GROUND LEVEL (FEET NGVD)	STATE EAST (FEET)	PLANARS NORTH (FEET)	S/T/R	GEOPHYSICS AVAILABLE
21	STLAPT2-PW1	111-26	111000058	W-16936	137	23.00	683162	1130901	09/35/39	C,D,E,EL,G,N,SP
22	STLAPT2-TW	111-27	111000057		134	23.00	682982	1130900	09/35/39	C,D,EL,G,N,SP
23	STLAPT3-PW1	111-28	111000059	W-16383	142	25.00	654904	1098673	10/36/38	C,D,EL,G,N,SP
24	STLAPT4-PW1	111-42	111000070	W-16389	122	29.00	620726	1100574	10/36/37	EL,G,N,SP
25	STLAPT4-SS	111-46	111000070	W-16933	115	30.00	620738	1100574	10/36/37	EL,G,N,SP
26	CH-5	111-49		W-16935	125	25.00	659808	1044364	35/37/38	
27	EP	111-9		W-16957	120	27.00	628608	1062732	14/37/37	
28	SLF-40		111000040		786	20.00	662479	1121219	24/35/38	C,E,EL,N,F,G,FR,T,SP
29	SLF-41		111000041		1272		623023	1056656	22/37/37	C,E,EL,SP
30	SLF-42		111000042		1060	05.00	722662	1156952	14/34/40	C,E,F,N,G,T,SP
31	SLF-43		111000043		863	N/A	754880	1073931	02/37/41	C,E,EL,F,N,G,FR,T,SP
32	SLF-44		111000044		876	05.00	754882	1073628	02/37/41	C,E,F,G,T
33	SLF-45		111000045		1100	05.00	721463	1162095	11/34/40	C,E,G,FR,T,SP
34	SLF-46		111000046		1100	05.00	724669	1152217	23/34/40	C,EL,N,G,T,SP
35	SLF-47		111000047		1230	05.00	749646	1088844	22/36/41	C,E,EL,N,G,FR,T,SP
36	SLF-48		111000048		800	25.00	687102	1077803	34/36/39	G,T
37	SLF-49		111000049		893	---	662774	1092542	14/36/38	C,F,G,FR,T
38	SLF-50	111-01	111000050	W-17136	1000	25.00	662866	1092240	14/36/39	C,E,F,G,N,T
39	SLF-52		111000052		1262		740646	1088743	22/36/41	C,E,EL,F,FR,G,N,T
40	SLF-53		111000053		911		647754	1130958	09/35/38	C,E,EL,F,FR,G,N,T
41	SLF-54		111000054		1304		606948	1059741	19/37/38	C,E,EL,F,FR,G,N,T

TABLE 1. Inventory of Lithologic and Geophysical Data for SFWMD Wells in the Upper East Coast Planning Area (Continued)

MAP #	SFWMD WELL NAME	SFWMD I.D.#	SFWMD GEOPHYS I.D.#	FGS WELL NAME	TOTAL DEPTH (BLS)	GROUND LEVEL (FEET NGVD)	STATE EAST (FEET)	PLANARS NORTH (FEET)	S/T/R	GEOPHYSICS AVAILABLE
42	SLF-55	111-04		W-17023	1260	28.00	599083	1144542	36/34/37	
43	SLF-56	111-05		W-17024	1220	30.00	599293	1131314	12/35/37	
44	SLF-73	111-15	111000077	W-16543	1540	25.00	667466	1091955	24/36/38	C,D,DI,F,FRG,N,S,T
45	SLF-74		111000078		1450		668186	1092362	24/36/38	C,T
46	SCD-PW		111000076		402		642376	1123062	20/35/38	C,D,E,EL,F,G,NS,T
Martin County										
47	M-1229	085-12	085000061	W-50067	170	9.00	776688	962387	21/40/42	E,EL,G
48	M-1230	085-13		W-50068	180	9.00	786328	964574	14/40/42	
49	M-1231	085-14	085000062	W-50069	182	22.00	740620	954284	29/40/41	E,EL,G
50	M-1235	085-15	085000063	W-50070	160	17.00	754551	985772	27/39/41	E,EL,G
51	M-1236	085-16	085000064	W-50071	140	25.00	723287	995991	23/39/40	E,EL,G
52	M-1237	085-17	085000065	W-50072	162	27.00	684323	996504	16/39/39	E,EL,G
53	M-1238	085-18	085000066	W-50073	122	27.00	684269	1010942	04/39/39	E,EL,G
54	M-1239	085-19	085000067	W-50074	130	23.00	725760	990955	23/39/40	E,EL,G
55	M-1240	085-20	085000068	W-50075	130	30.00	668575	1043491	06/38/39	E,EL,G
56	M-1241	085-21	085000069	W-50076	162	34.00	695320	982418	36/39/39	E,EL,G
57	M-1242	085-22	085000070	W-50077	170	25.00	679628	972349	09/40/39	E,EL,G
58	M-1246	085-23	085000071	W-50078	155	22.00	715979	1043916	04/38/40	E,EL,G
59	M-1248	085-24	085000072	W-50079	162	32.00	697920	1044027	01/38/39	E,EL,G
60	M-1250	085-25	085000073	W-50080	158	45.00	651983	1013839	34/38/38	E,EL,G
61	M-1251	085-26	085000074	W-50081	142	31.00	619002	1016658	33/38/37	E,EL,G
62	SCD#2	085-27	085000075	W-16290	480	30.00	670019	1044203	06/38/39	C,D,E,EL,G N

TABLE 1. Inventory of Lithologic and Geophysical Data for SFWMD Wells in the Upper East Coast Planning Area (Continued)

MAP #	SFWMD WELL NAME	SFWMD I.D.#	SFWMD GEOPHYS I.D.#	FGS WELL NAME	TOTAL DEPTH (BLS)	GROUND LEVEL (FEET NGVD)	STATE EAST (FEET)	PLANARS NORTH (FEET)	S/T/R	GEOPHYSICS AVAILABLE
63	M-1252	085-28	085000076	W-16284	148	24.00	646058	980698	32/39/38	E,EL,G
64	M-1253	085-29	085000077	W-16287	157	17.00	749150	1014020	34/38/41	E,EL,G
65	M-1254	085-30	085000078	W-16283	182	16.00	748140	1059146	22/37/41	E,EL,G
66	M-1280	085-31	085000079	W-16400	155	30.00	685153	1032152	15/38/39	C,D,E,EL,G,N,SP
67	M-1281	085-32	085000080	W-16397	242	12.00	771772	979521	05/40/42	D,E,EL,G,N SP
68	M-1282	085-33	085000081	W-16398	130	22.00	728055	986525	25/39/40	C,E,EL,G,SP
69	M-1283	085-34	085000082	W-16460	182	13.00	751003	1003826	10/39/41	C,D,E,EL,G N,SP
70	MF-25		085000052		1220	28.00	647112	984337	33/39/38	C,E,T,SP
71	MF-27		085000045		991	15.00	755137	1033035	14/38/41	C,E,EL,F,G,FR,T,SP
72	MF-28		085000046		1088	27.00	760322	1041348	01/38/41	C,E,F,N,G,FR,T,SP
73	MF-30		085000053		1157	16.00	758942	1031140	13/38/41	C,E,G,T,SP
74	MF-31		085000054		1091	05.00	767575	1023218	19/38/41	C,E,EL,F,N,G,FR,T,SP
75	MF-32		085000057		1100	20.00	633253	1019631	25/38/37	C,E,EL,F,N,G,FR,T,SP
76	MF-33		085000056		1200	12.50	632994	1015995	36/39/37	C,E,EL,F,N,G,FR,T,SP
77	MF-35		085000058		1340	20.00	668237	970484	07/40/39	C,EL,F,G,FR,T
78	MF-36B		085000059		1021	20.00	761509	1025199	23/38/41	C,G,T,E,SP
79	MF-37		085000060		1243	20.00	658684	984784	26/39/38	C,EL,F,G,N,FR,T,SP
80	MARTINRO#1	085-35		W-16963	1290	17.00	739926	1056975	20/37/41	
Okeechobee County										
83	OKF-5		093000052		1181		562688	1083782	26/36/35	C,E,EL,G,F,FR,FS,T,SP

TABLE 1. Inventory of Lithologic and Geophysical Data for SFWMD Wells in the Upper East Coast Planning Area (Continued)

MAP #	SFWMD WELL NAME	SFWMD I.D.#	SFWMD GEOPHYS I.D.#	FGS WELL NAME	TOTAL DEPTH (BLS)	GROUND LEVEL (FEET NGVD)	STATE EAST (FEET)	PLANARS NORTH (FEET)	S/T/R	GEOPHYSICS AVAILABLE
84	OKF-7		093000042		962	50.68	569511	1102271	34/35/35	EL,N,G,T,SP
85	OKF-29		093000029		1039	66.70	551354	1129710	09/35/35	C,F,E,N,G,FR,T,SP

GEOPHYSICS ABBREVIATIONS:C=CALIPER/D=DENSITY/DI=DUAL INDUCTION/E=ELOG/EL=6'LAT/F=FLOWMETER/G=GAMMA
FR=FLUID RESISTIVITY/N=NEUTRON/S=SONIC/T=TEMPERATURE

TABLE 2. Inventory of Lithologic Descriptions for Wells used in APTs

SFWMD WELL NAME	TOTAL DEPTH (FEET NGVD)	STATE PLANAR COORDINATES EAST (Feet)	NORTH	SECTION/ TOWNSHIP/ RANGE	AVAILABLE GEOPHYS.
Martin County					
C-23 Well#1	180	641000	1043900	06/38/38	No
L-65 Well#2	180	614400	1008600	05/39/37	No
Caulkin's Grove	160	704550	996900	19/39/40	No
State Route 76 Well#3	240	745300	1028000	HG/38/41	No
PB-3	80	795900	960400	19/40/43	No
VS-PW2 (Vista Salerno)	110	761400	1015600	25/39/40	No
HSBC 32W (M-1120)	215	779850	996200	SGG/39/42	No
St.Lucie County					
STL-185	118	662913	1058109	23/37/38	No
STL-213	115	597159	1117373		No
STL-214 (PSL-125N)	134	689672	1068323	11/37/39	No
STL-264-75N	125	678000	1158042		No
PSLW	130	689672	1068323	11/37/39	No

Methods Used to Describe Cuttings

Cuttings from forty-eight wells were described by the Florida Geological Survey (FGS) and incorporated into their state-wide geologic database. SFWMD staff described cuttings from fifteen Martin County wells (W-50067 through W-50081), these wells have also been incorporated into the FGS database.

All lithologic descriptions provided in Appendices A-1 and A-2 were generated using a software database program called Well Log Data System. This PC software was developed by the FGS and Florida State University to store geologic data on a mainframe computer. Sediment types were identified using a binocular microscope and coded in the program format. The data input criteria are standardized, making correlations between different wells more uniform. The primary lithologies identified were limestone, micrite and calcilutite, sand, sandstone, shell, coquina, silt, clay, and phosphate. Color was determined using the Geological Society of America (GSA) Munsell chart. Data input to the program includes: porosity type and percent, relative permeability, grain size and type, degree of induration, cement or matrix components, color, accessory minerals, and fossils.

Methods Used to Geophysically Log Wells

Geophysical borehole surveys (logs) were conducted in most of the wells listed in Table 1 using a Mineral Logging Systems (MLS) truck owned and operated by the SFWMD. The logging truck uses analog downhole probes and surface equipment. In some cases, borehole logs were recorded on digital tape. The downhole probes used include the natural gamma ray, caliper, 16-inch and 64-inch normal resistivity, 6-foot lateral resistivity, single-point resistivity, spontaneous potential, neutron and density porosity, temperature, and flow meter. One Floridan well (SLF-73) was surveyed by a wireline geophysical logging company (Schlumberger), using more advanced equipment.

Geophysical Log Types, Theory, and Applications

Geophysical logs are continuous analog or digital records that can be interpreted to provide physical properties of the rock matrix, the contained fluids, and construction of the well. Logs are used for the identification and lateral correlation of rocks and sediments and to help identify water producing intervals for well completion. Brief descriptions of each log type are discussed below.

<u>Gamma Ray Log</u>

The natural gamma ray log is obtained using a geiger-counter type tool. The tool counts the number of natural gamma rays emitted by the layers of sediments and rock present in the wall of the borehole. Geologic formations normally exhibit similar gamma "signatures" within a given area. Gamma ray logs are the most widely used nuclear logs in ground water applications (Keys, 1989). The most common uses are for identification of lithology and stratigraphic correlations.

<u>Electrical and Spontaneous Potential Logs</u>

Electrical logs, such as the 16-inch and 64-inch normal resistivity, 6 foot lateral resistivity, dual induction/focused resistivity and spontaneous potential, detect changes in the conductivity of sediments and aquifer fluids. The logs record apparent resistivity which can be converted into true resistivity by correcting for borehole effects, including; bed thickness, resistivity of adjacent beds, borehole diameter, temperature, etc.. Once true resistivity is obtained it can be used in conjunction with other logs to determine water quality within an aquifer. In most District applications, quantifying water quality is not emphasized, instead the resistivity logs are primarily used to correlate aquifers across a region and/or to determine their thicknesses. The spontaneous potential (SP) log records potentials or voltages that develop at the contacts between clay beds and a permeable aquifer. The log reaction is a function of the chemical activities of fluids in the borehole and adjacent rocks and the type and quantity of clay present. Generally, SP deflections away from the shale/clay baseline indicate the presence of permeability in the rocks or sediments.

<u>Caliper Log</u>

The caliper log measures borehole diameter which in turn helps identify competent and incompetent beds, solution cavities and fractures. Borehole diameter is also used during well construction to calculate the volume of cement needed to fill the annular space between well casings and the borehole wall.

<u>Temperature and Flow Meter Logs</u>

The temperature and flow meter logs are run in flowing, artesian wells (primarily UFA wells) and are used to identify flow zones in the borehole. A flow zone is characterized by a slight temperature increase. This temperature increase is probably caused by friction generated by the turbulence associated with the water rushing into the borehole. Flow meter logs, also referred to as spinner logs, consist of a small propeller mounted on a shaft and enclosed in a basket. When run down hole at a constant rate, the propeller spin speed (in rotation per minute) is directly proportional to the velocity with which water passes by the propeller. Once corrected for borehole diameter, flow zones are identified by an increase in the rate of spin observed across each flow zone.

Neutron Porosity Log

The neutron porosity log measures the hydrogen content within the formation material and its pores. Water is typically the hydrogen-based fluid within pore spaces. Neutrons are emitted from a neutron source (Americium-Beryllium) in the probe, travel through the formation and back to the probe's scintillation detector some distance from the neutron source where they are counted (counts per second). The formation porosity is inversely related to the flux of neutrons counted by the detector.

Density and Sonic Velocity Porosity Logs

Density and sonic velocity logs both measure relative porosity. The density log is equipped with a gamma radiation source (Cesium 137) and gamma ray counter. The more gamma rays counted by the detector, the lower the formation density. The sonic log uses high frequency sound waves to determine formation density based on the speed sound travels through the sediment and rock formations. The faster sound waves travel, the denser the formation.

WATER-LEVELS

SURFICIAL AQUIFER SYSTEM

Background Information

The USGS has been measuring water-levels from SAS wells in the study area for over forty-five years. Wells STL41, STL42, and STL125 were first measured in 1950. The number of wells measured by the USGS has gradually increased since that time and, as of 1993, totaled fifty-six. Water-levels from several additional wells in Martin and St. Lucie counties were measured by the District between January 1989 and February 1991 to supplement the USGS database. All available water-level measurements were used to calibrate models which simulate ground water flow in the SAS underlying Martin and St. Lucie counties. These models compute spatial water-level distributions in three layers representing discrete depth-variant hydrogeologic units in the SAS. From land surface down, these units are the sand/soil unit (layer 1), the production unit (layer 2), and the granular limestone unit (layer 3). One objective of this report is to augment these model documents and to assist in future model updates.

The steady state, water level elevations computed in these calibrated models reflect not only measured ground water levels but also observed stages in surface water bodies. Therefore, they are the most comprehensive estimation of regional ground water levels that the District has. Contour maps illustrating these computed water levels were previously published (in the model documents referenced above) but are shown again here to compliment and illustrate the water level data tabulated in Appendix C. These maps are referenced by model layer so the reader can easily associate these layers with hydrogeologic units described in this report.

Concurrent with model development, the USGS developed SAS water-level maps based solely on field observations (Kane, 1992). These maps assume one interconnected SAS aquifer rather than three independent hydrogeologic units and represent the end of wet and dry seasons during 1989 and 1990. Both the modeled and observed water-level maps are discussed below by county (Martin-Palm Beach and St. Lucie) and hydrogeologic unit. Except for a few minor local variations, it was found that water-levels in each of the three units are similar. Their similarity indicates that the three units are, at least partially, connected hydraulically.

Martin and Northern Palm Beach Counties

Sand/Soil Unit. Monthly water-levels (in feet NGVD) measured in ninety-two monitoring wells completed in the sand/soil unit, in Martin and northern Palm Beach counties (Figure 14) are listed in Appendix C, Table C-1. The time interval represented is from January 1989 through February 1991. Data in the table were taken from the SFWMD, including a salt water intrusion (SALT) monitoring well network database and they were taken from the USGS. This table also includes annual values for the minimum, maximum, mean, and the difference between minimum and maximum water-levels for each year.

Additional monitoring well information, including state planar coordinates, well construction information, measuring point elevations, and data sources, are presented in Appendix C, Table C-2. A key to the abbreviations used in the source column is given in Appendix C, Table C-3. Water-level data from some of these wells are also documented in USGS Water Resources Data reports (USGS, Vol. 2B, 1991, 1992, 1993).

The monthly water-level data listed in Table C-1, combined with surface water stage data, were used to calibrate the Martin County ground water flow model. Modeled steady-state water-level distributions in the sand/soil unit (layer 1) are shown in Figure 15, and represent an average 1989 condition. The USGS water-level map, based on May 1989 observations, is presented in Figure 16 and is similar to water levels predicted by the model. Equipotential lines on both maps tend to follow land surface elevations and surface water bodies. A regional map illustrating land surface elevations in Martin County is provided in Figure 17 for comparison. The highest water-levels in the sand/soil unit stand approximately 35 feet NGVD and occur in the north-central portion of the county,a few miles north west of Indiantown. This is also the location of the highest land surface elevation in the study area (approximately 40 feet NGVD). Regionally, ground water flows toward the east-northeast in Martin County from the western ridge area to the Atlantic Ocean and varies in gradient from approximately ten feet per mile in the ridge

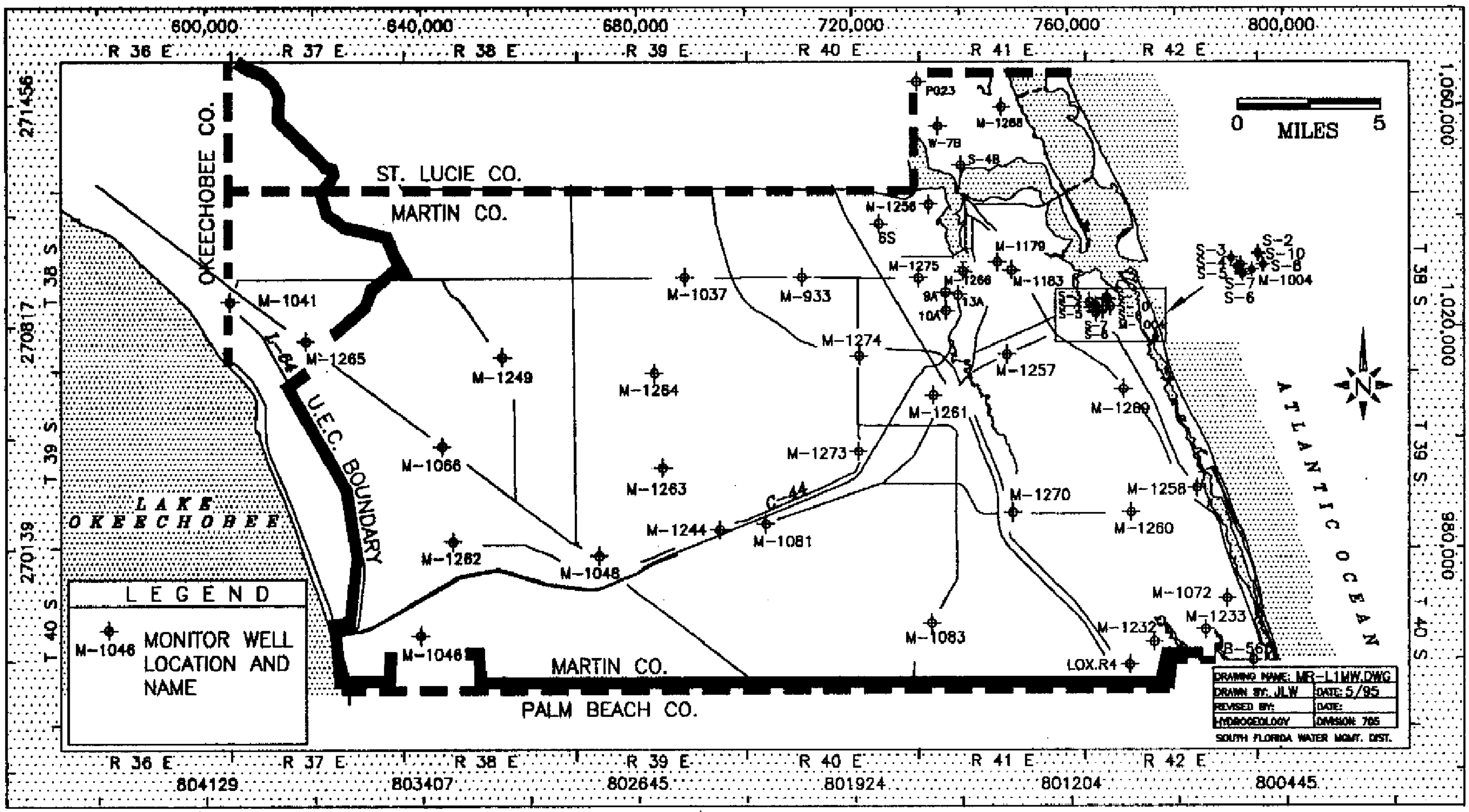


FIGURE 14. **Locations of Monitoring Wells Completed in the Sand/Soil Unit, Martin County (after Adams, 1992)**

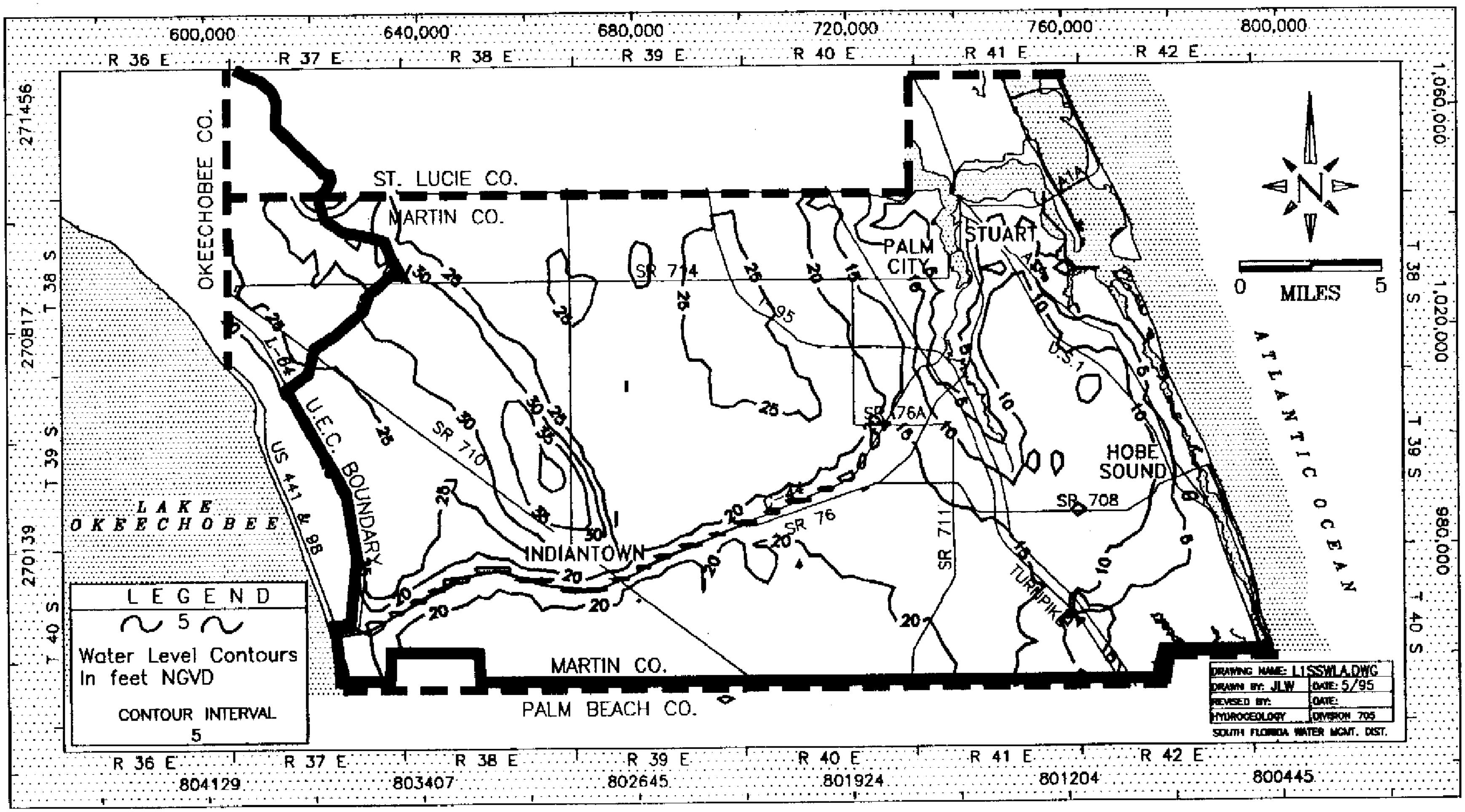


FIGURE 15. Modeled Water-Level Elevations in the Sand/Soil Unit (Layer 1), Martin County (after Adams, 1992) Representing Average 1989 Conditions

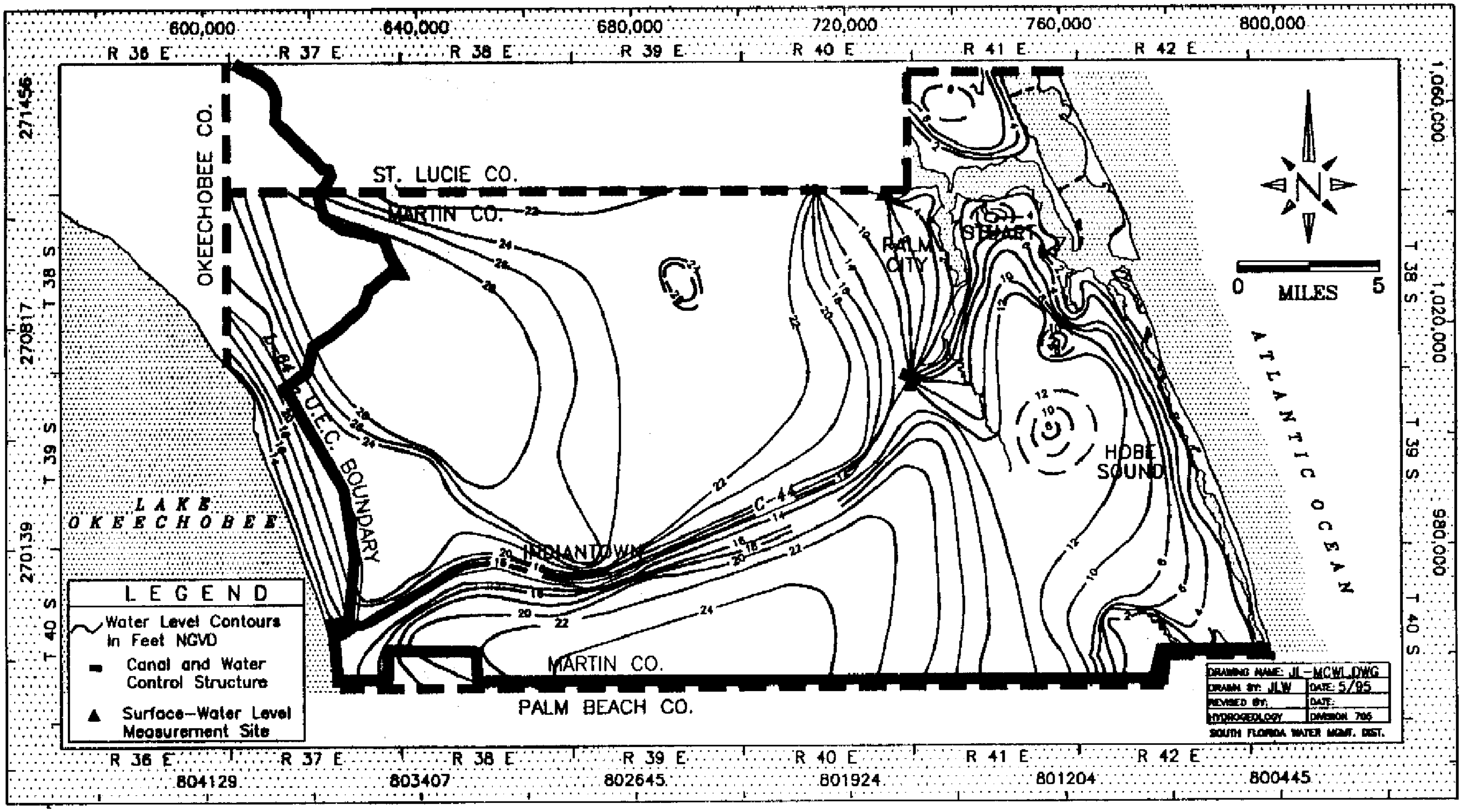


FIGURE 16. Observed Water-Level Elevations in the Sand/Soil Unit, Martin County, Representing May 1989 (after Kane,1992)

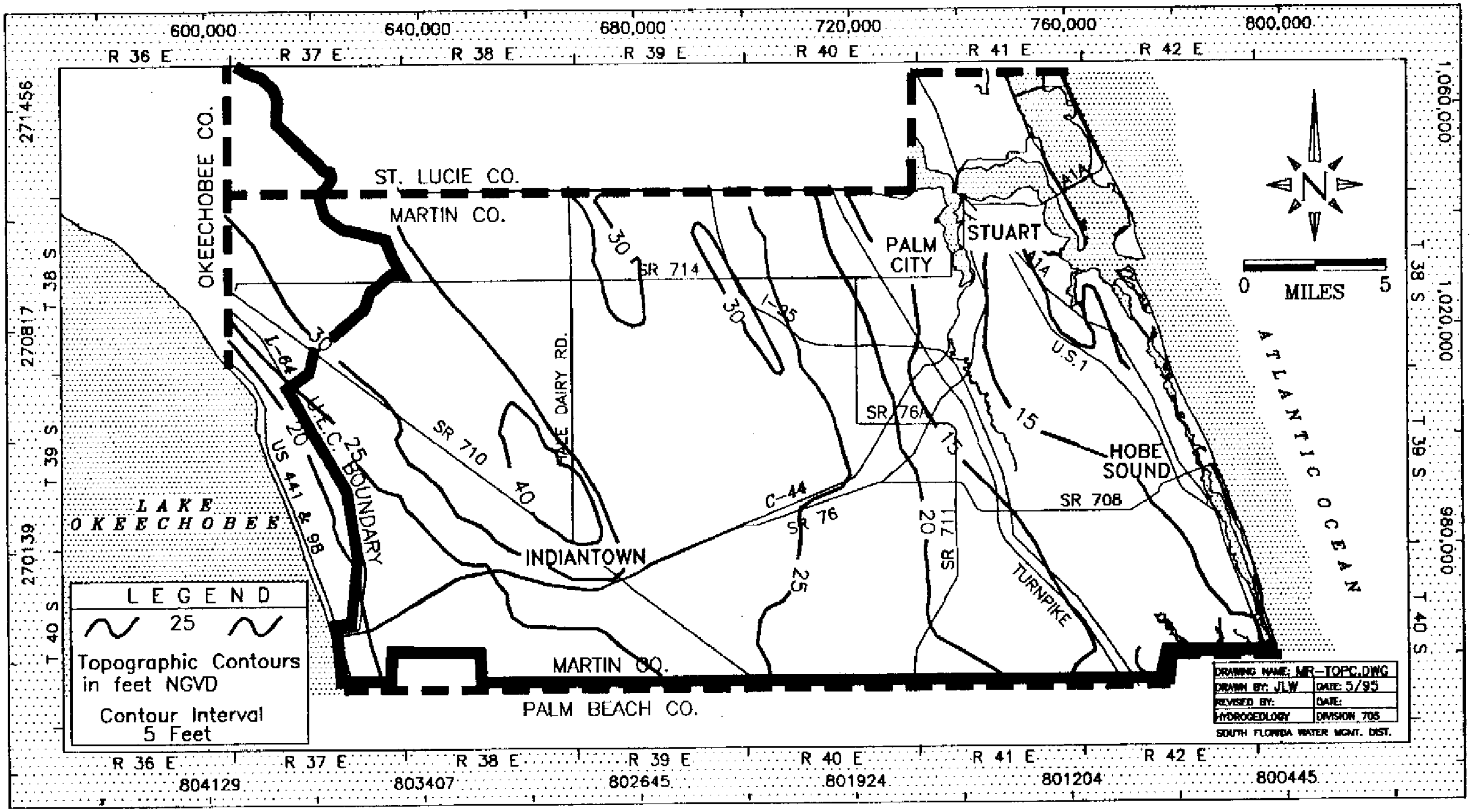


FIGURE 17. Land Surface Elevations, Martin County

area to near zero in the central flat areas of the county. Ground water gradients are primarily controlled by land surface elevation, aquifer lithology, permeability, and proximity to discharge and recharge areas.

Production Unit. Monthly water-levels (feet NGVD) from one hundred forty-four (144) monitoring wells in Martin and northern Palm Beach counties, completed into the production unit and granular limestone unit, are listed in Appendix C, Table C-4 for the time interval extending from January 1989 through February 1991. Additional monitoring well information is listed in Appendix C, Table C-5. The locations of wells completed to the production unit are plotted in Figure 18.

Computed steady-state water-level contours for model layer 2 are presented in Figure 19. These levels are similar to those measured in the sand/soil unit (Figure 15).

The values plotted on Figure 20 were computed by subtracting observed May 1990 water-levels in the production unit from those observed in the sand/soil unit in the same month. Water levels collected from locations with wells completed into both units were used in this map. Water level differences ranged from -0.32 feet to +2.02 feet but were typically less than one foot. Darker grey shades were used to illustrate larger (positive) differences between levels.

Granular Limestone Unit. The locations of those monitoring wells completed into the granular limestone unit in Martin and northern Palm Beach counties are shown in Figure 21. The computed steady-state water-level distributions in this unit (layer 3) are mapped in Figure 22. Water-levels in model layers 2 and 3 are similar. Figure 23 displays water-level differences between the production unit and the granular limestone unit. It was developed by subtracting (May, 1990) observed water-levels in the granular limestone unit from those observed in the production unit using only sites with monitoring wells completed into both units. Again, darker shades of grey represent larger differences in levels. The maximum difference in levels between these units was 0.15 feet, with the minimum having been -0.53 feet.

St. Lucie County

Sand/Soil Unit. Monthly water-level data from twenty-eight SFWMD and USGS monitoring wells, and twenty SALT wells, completed into the sand/soil unit in St. Lucie County, are listed in Appendix C, Table C-6. Water-levels listed here are in units of feet NGVD. State planar coordinates and completion data for these wells are listed in Appendix C, Table C-7. The locations of monitoring wells completed into the sand/soil unit in St. Lucie County are plotted in Figure 24. Water-levels in Table C-6, along with surface water stage data, were used by SFWMD staff to calibrate the St. Lucie County SAS ground water flow model. Steady-state water-levels computed for layer 1 by the model are contoured in Figure 25 and represent average 1990 water-levels in the sand/soil unit. A second water-level map, developed by the USGS (Kane, 1992), is shown in Figure 26. It is based solely on observed water-levels from wells and surface water bodies. As expected, these two maps are very similar; however, some local differences are evident, primarily near the western and northern county boundaries. In these areas, the model provides a higher level of detail.

As observed in Martin County, equipotential lines tend to follow land surface contours and surface water bodies. The highest observed average water-table elevations in St. Lucie County are approximately 33 feet NGVD and occur in the extreme west-central portion of the county, a few miles north west of SR-70 near the Okeechobee County border. These correspond to the highest land surface elevations in the county, as seen in the land-surface elevation map presented in Figure 27. Ground water flows eastward from the western ridge area of St. Lucie County toward the coast. The water-level elevation gradient in the sand/soil unit varies from approximately twelve feet per mile, near the Intracoastal Waterway to one foot per three miles in the central flat areas of the county.

Production Unit. Monthly water-levels (feet NGVD) from twenty- five SFWMD and USGS monitoring wells along with three SALT wells completed to the production unit in St. Lucie County are listed in Appendix C, Table C-8. These water levels were measured between July 1989 and September 1991. Additional well data, including state planar coordinates, screened intervals, and measuring point elevations are given in Appendix C, Table C-9. The locations of monitoring wells completed in the production unit are shown in Figure 28.

Observed water-levels from clustered wells, completed into both the sand/soil and production units (model layers 1 and 2, respectively) at four sites, were used to determine the water-level differences between these two hydrogeologic units. The values plotted on Figure 29 were computed by

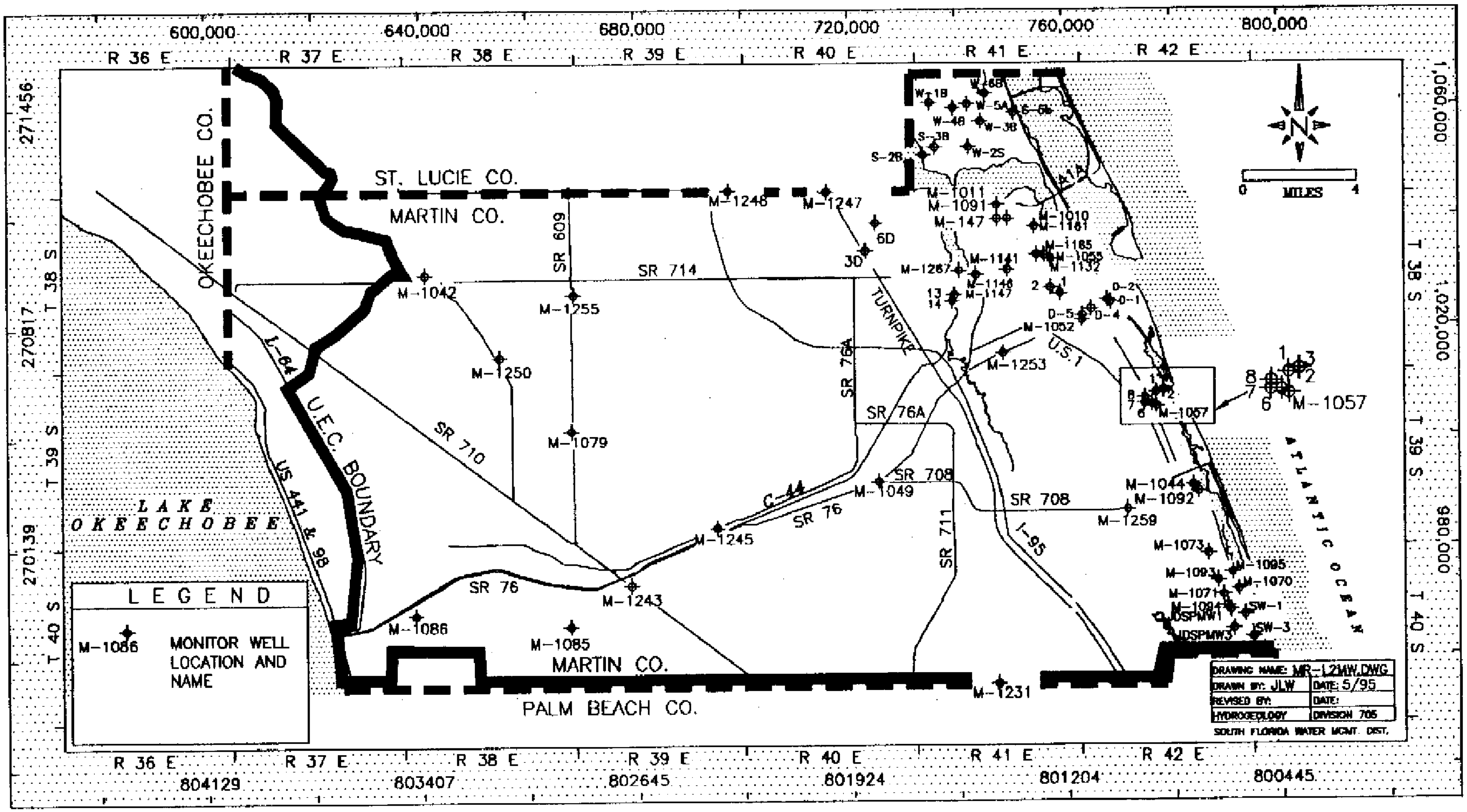


FIGURE 18. **Locations of Monitoring Wells Completed in the Production Unit, Martin County**

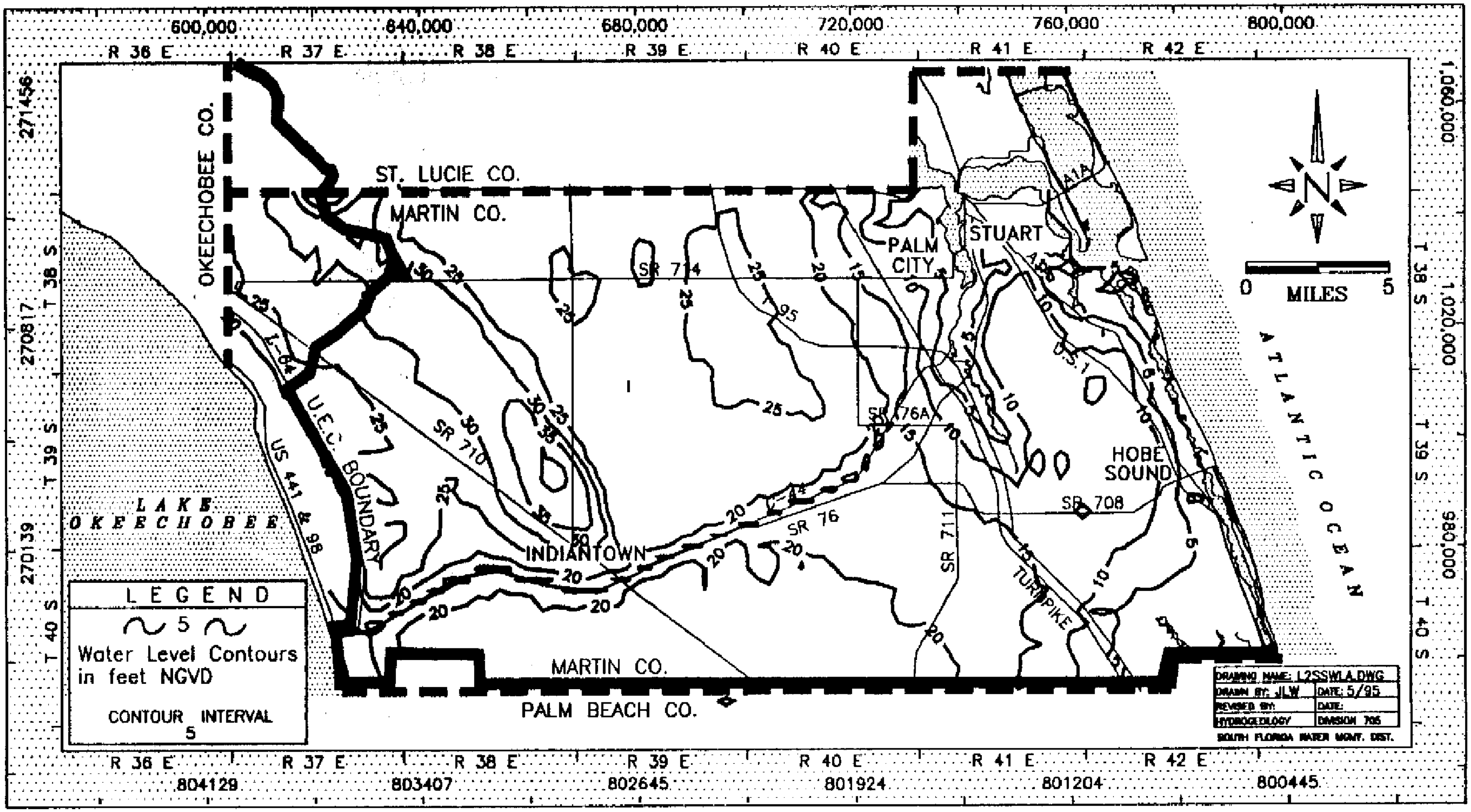


FIGURE 19. Modeled Water-Level Elevations in the Production Unit (Layer 2), Martin County (after Adams, 1992), Representing Average 1989 Conditions

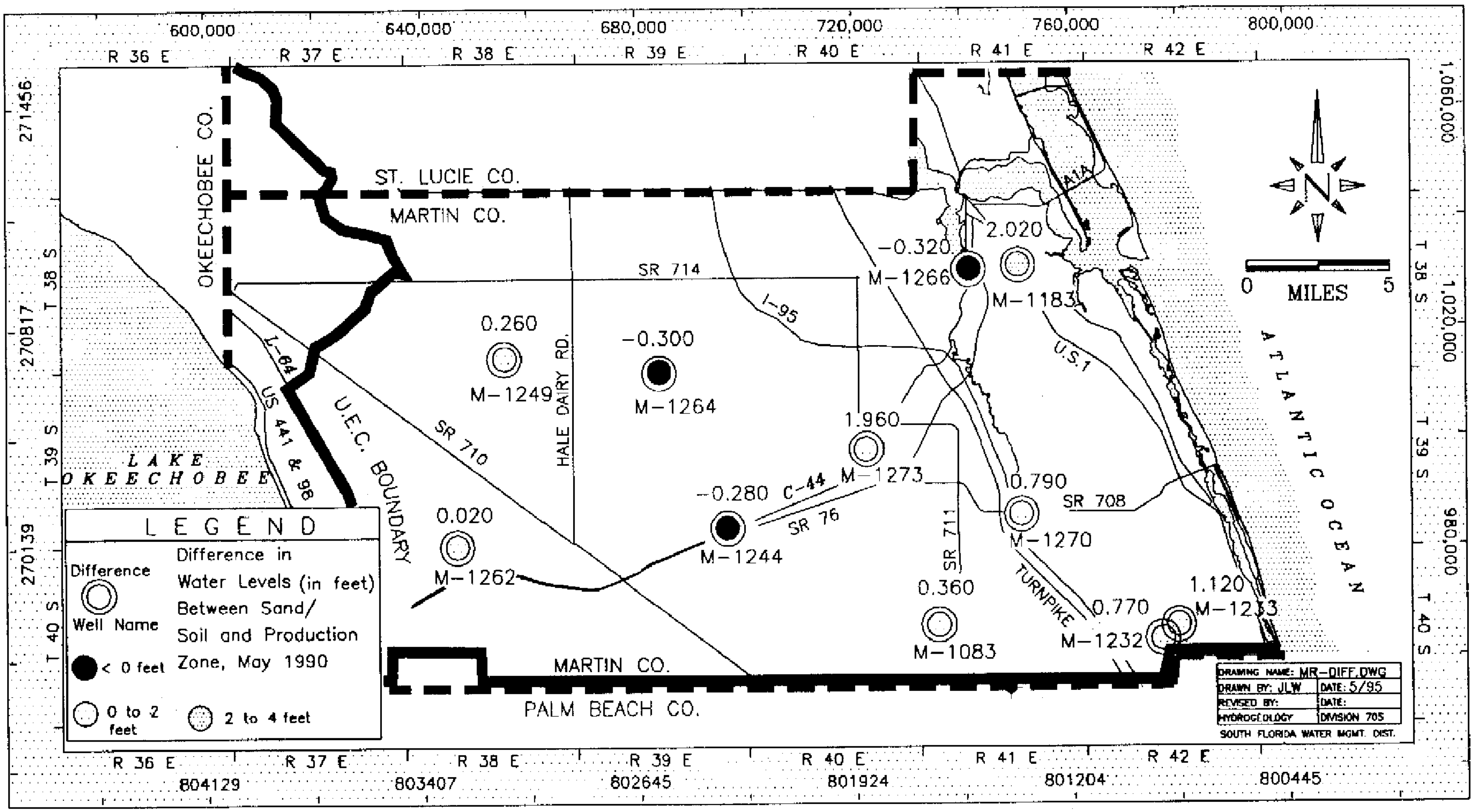


FIGURE 20. Water-Levels in the Sand/Soil Unit Minus those in the Production Unit in Martin County (May, 1990)

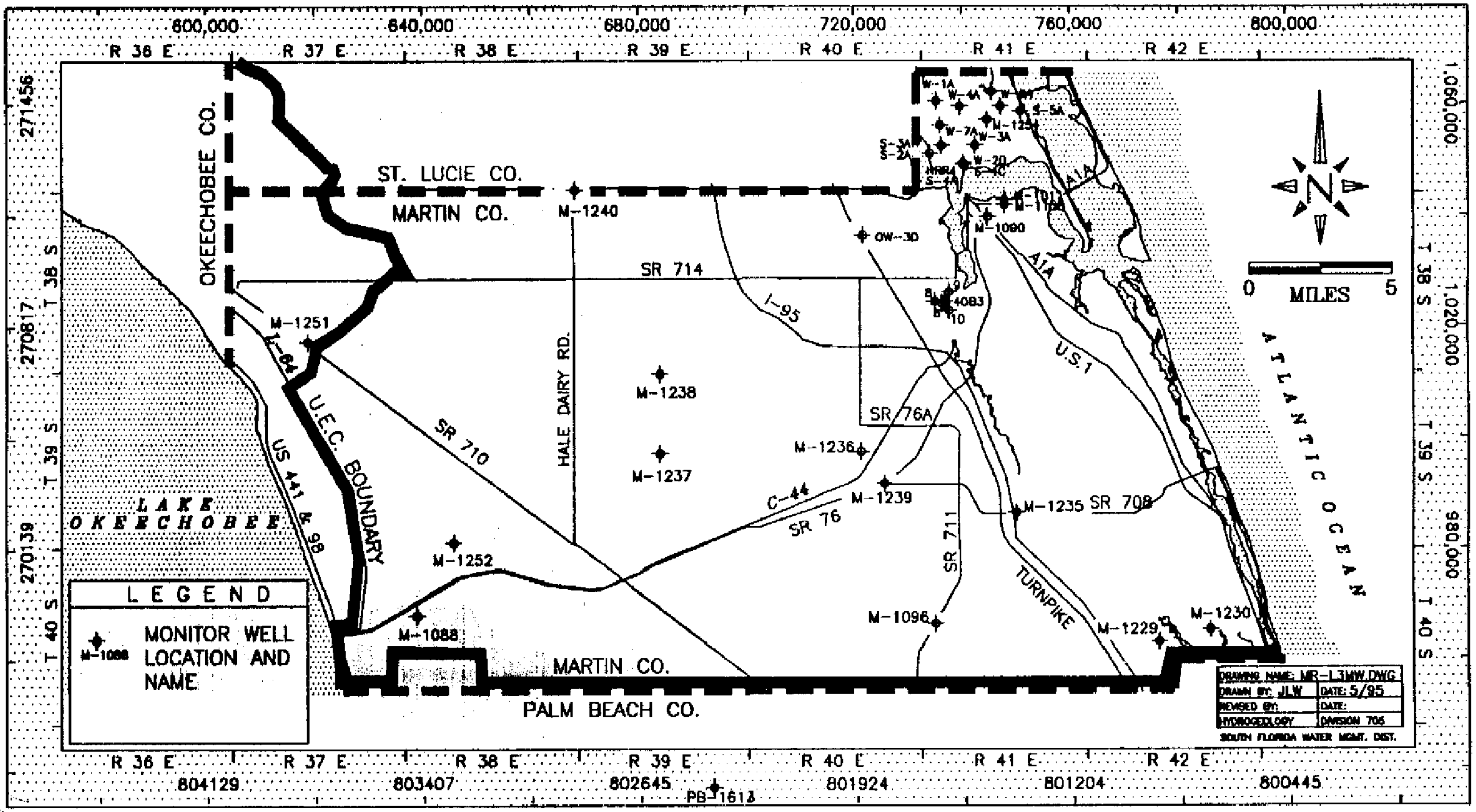


FIGURE 21. **Locations of Monitoring Wells Completed in the Granular Limestone Unit, Martin County**

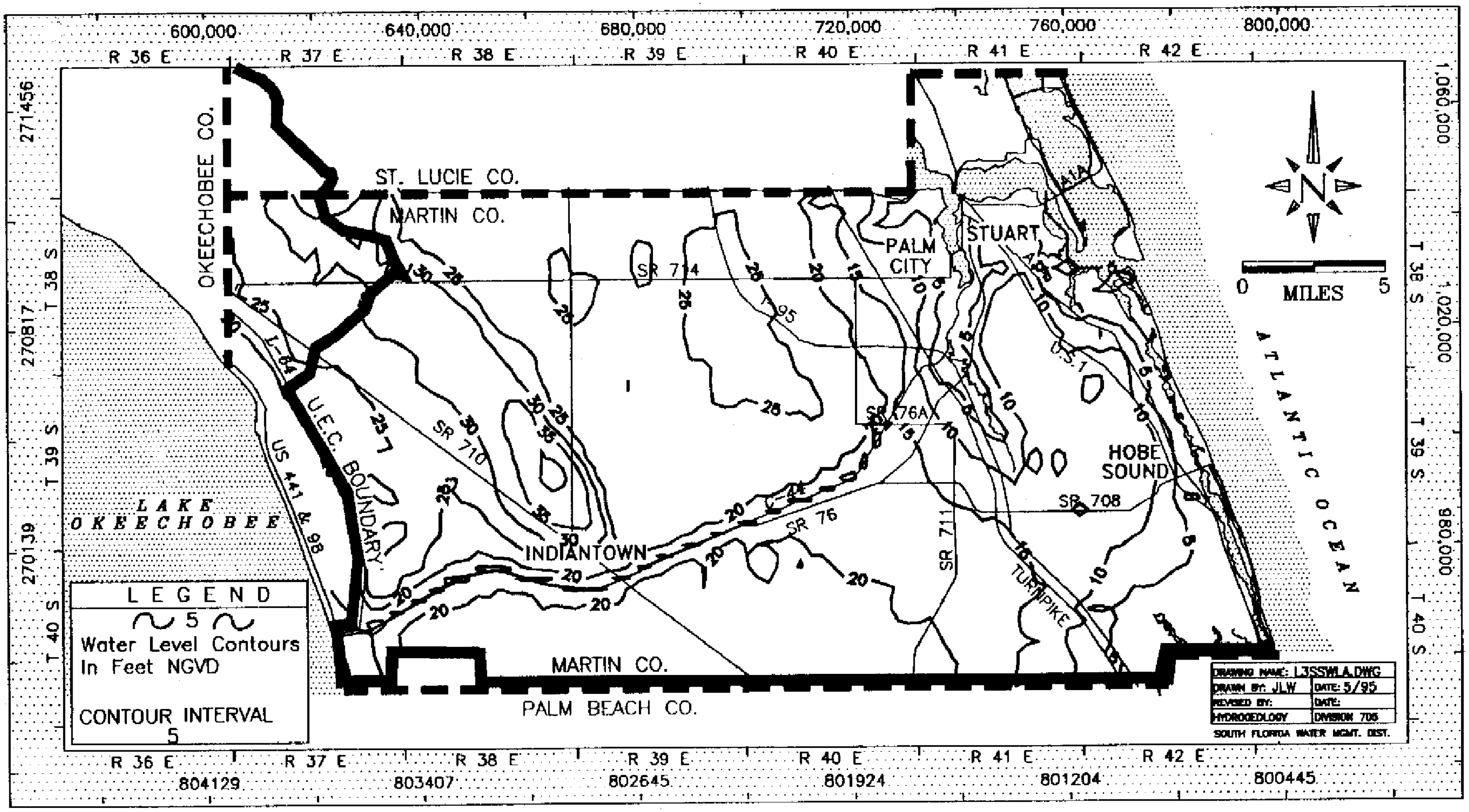


FIGURE 22. Modeled Water-Level Elevations in the Granular Limestone Unit (Layer 3), Martin County, (after Adams, 1992) Representing Average 1989 Conditions

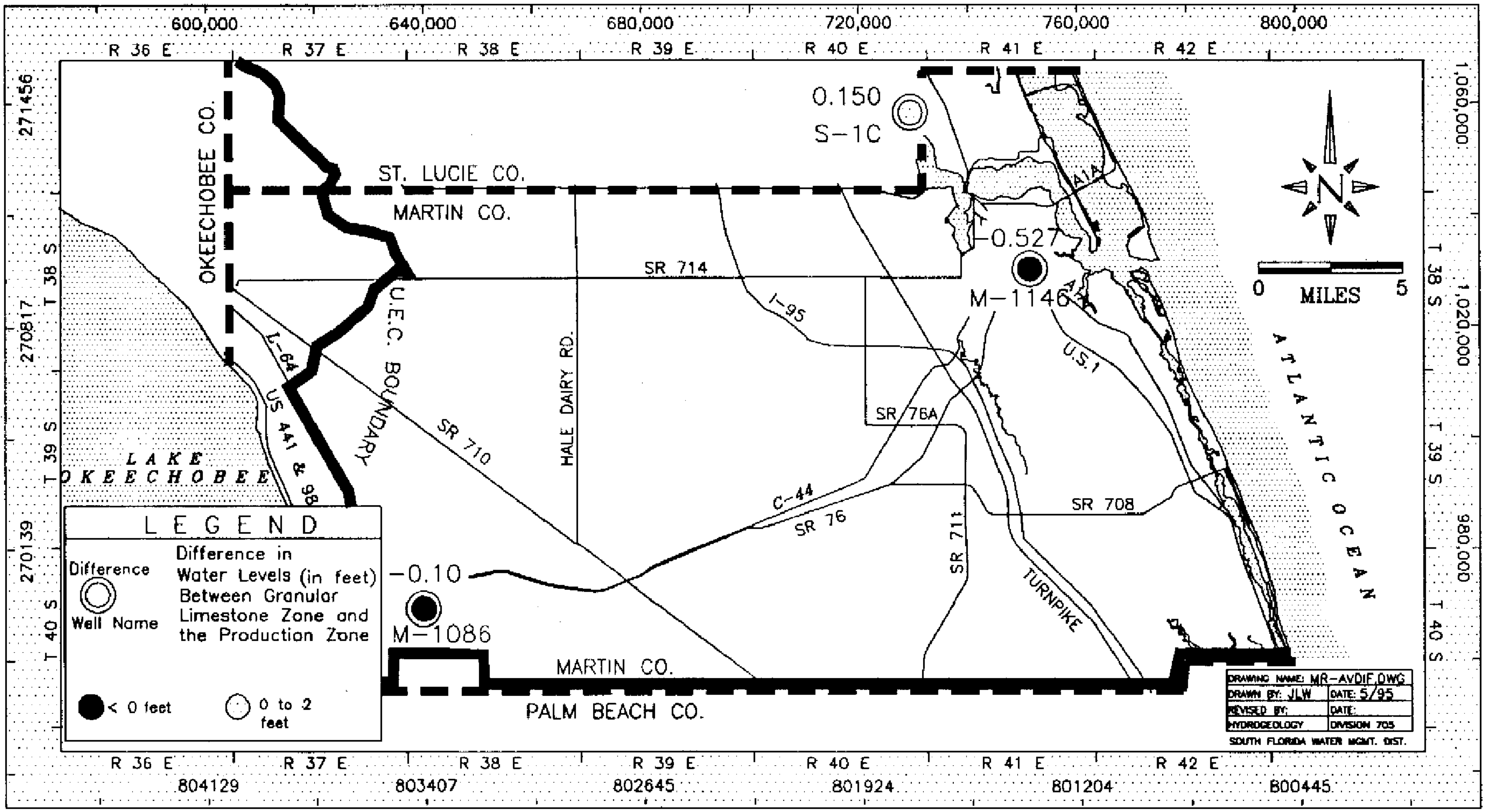


FIGURE 23. **Water-Levels in the Production Unit Minus those in the Granular Limestone Unit in Martin County (May, 1990)**

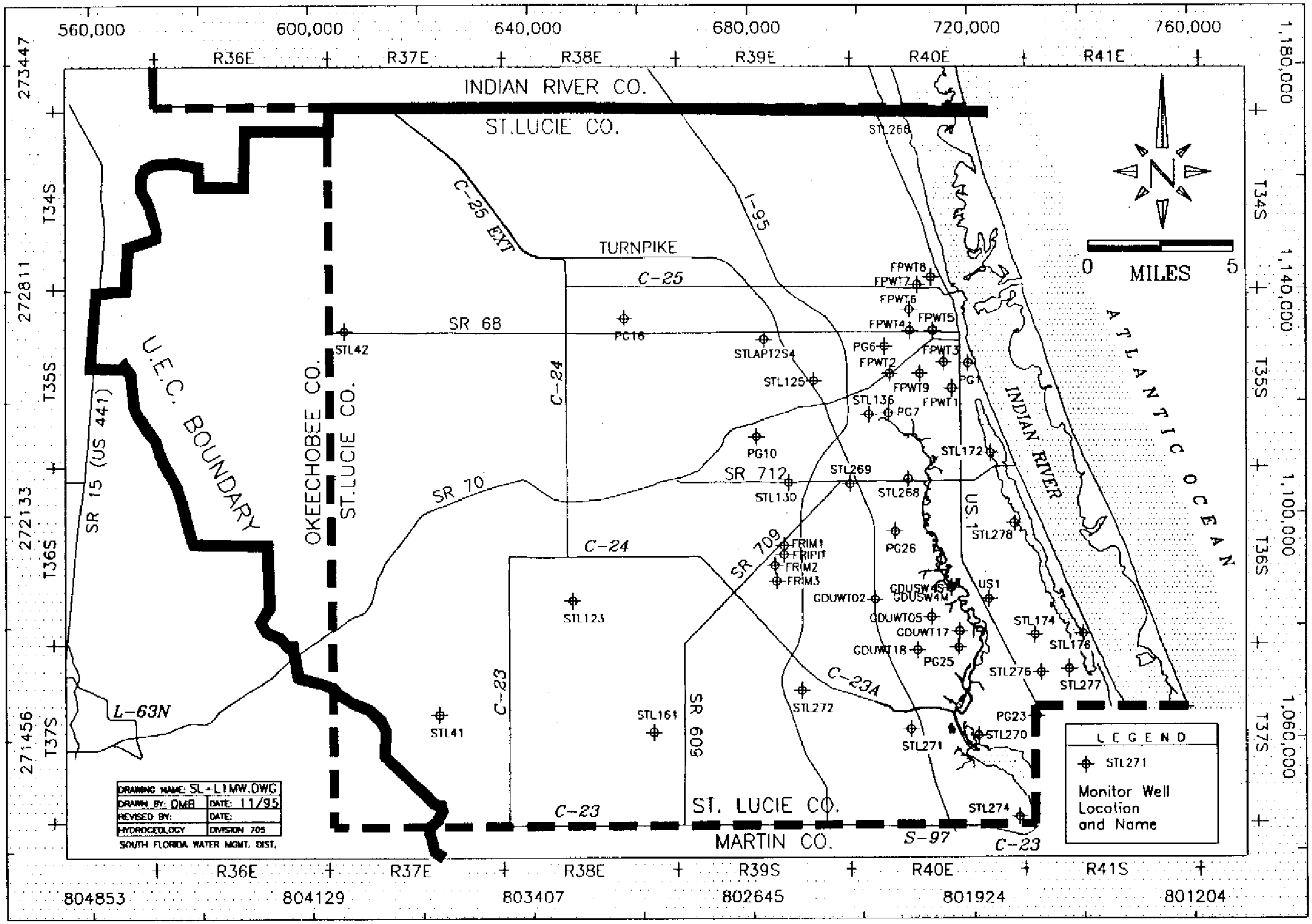


FIGURE 24. Locations of Monitoring Wells Completed in the Sand/Soil Unit, St. Lucie County

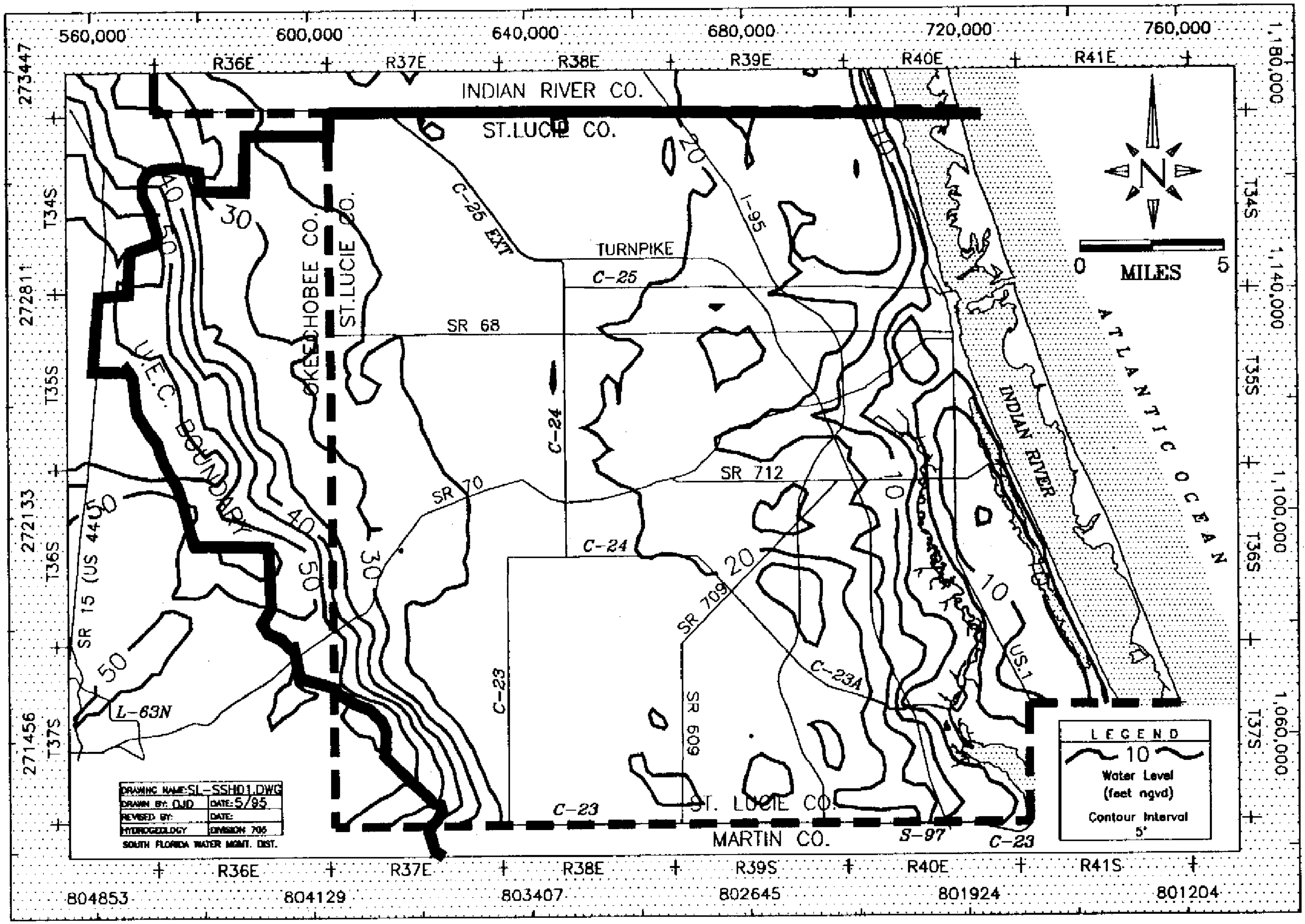


FIGURE 25. **Modeled Water-Level Elevations in the Sand/Soil Unit (Layer 1), St. Lucie County, Representing Average 1990 Conditions (after Butler and Padgett, 1995)**

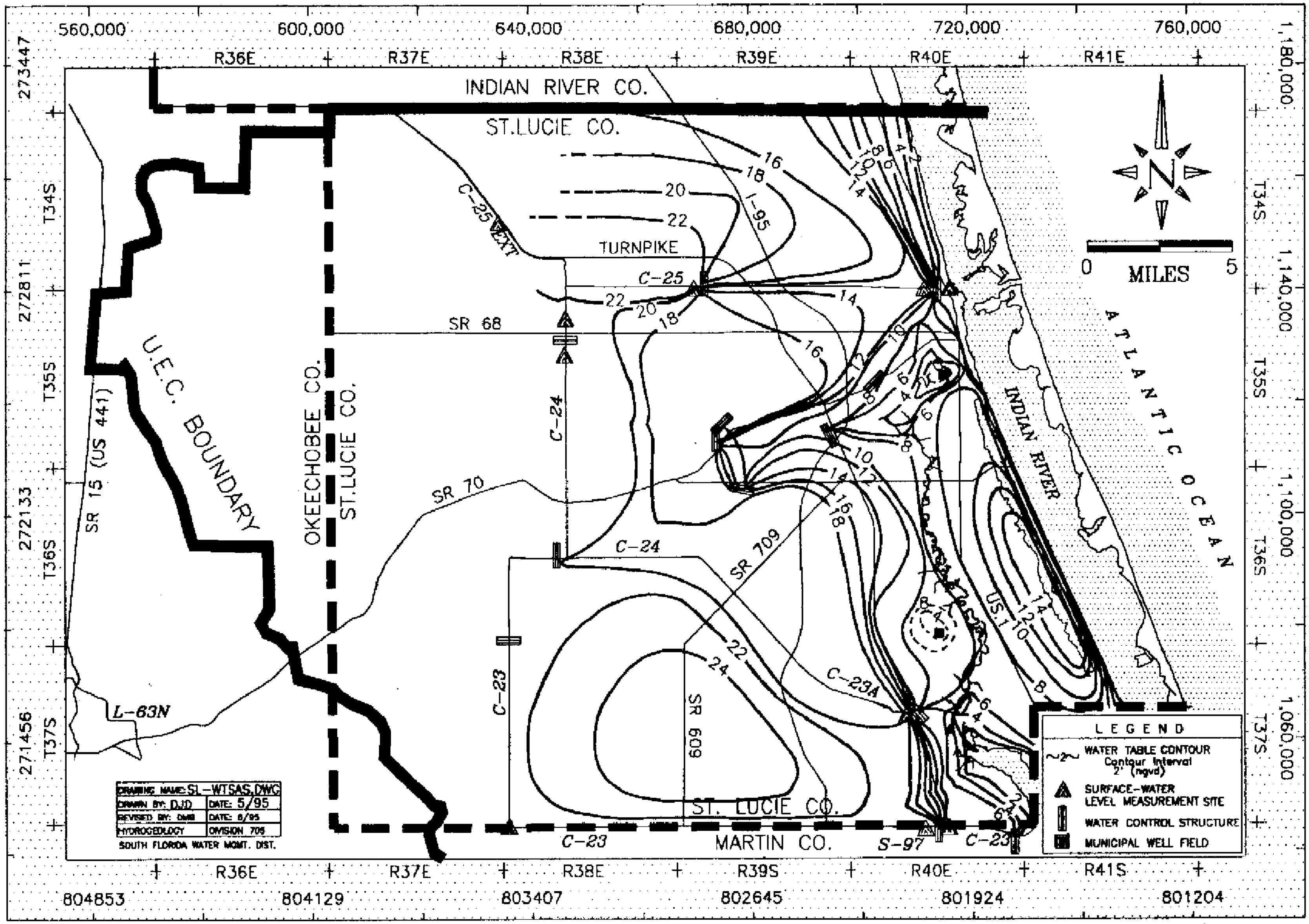


FIGURE 26. **Altitude of the Water Table in the Surficial Aquifer System, St. Lucie County, May 1988 (after Kane, 1992)**

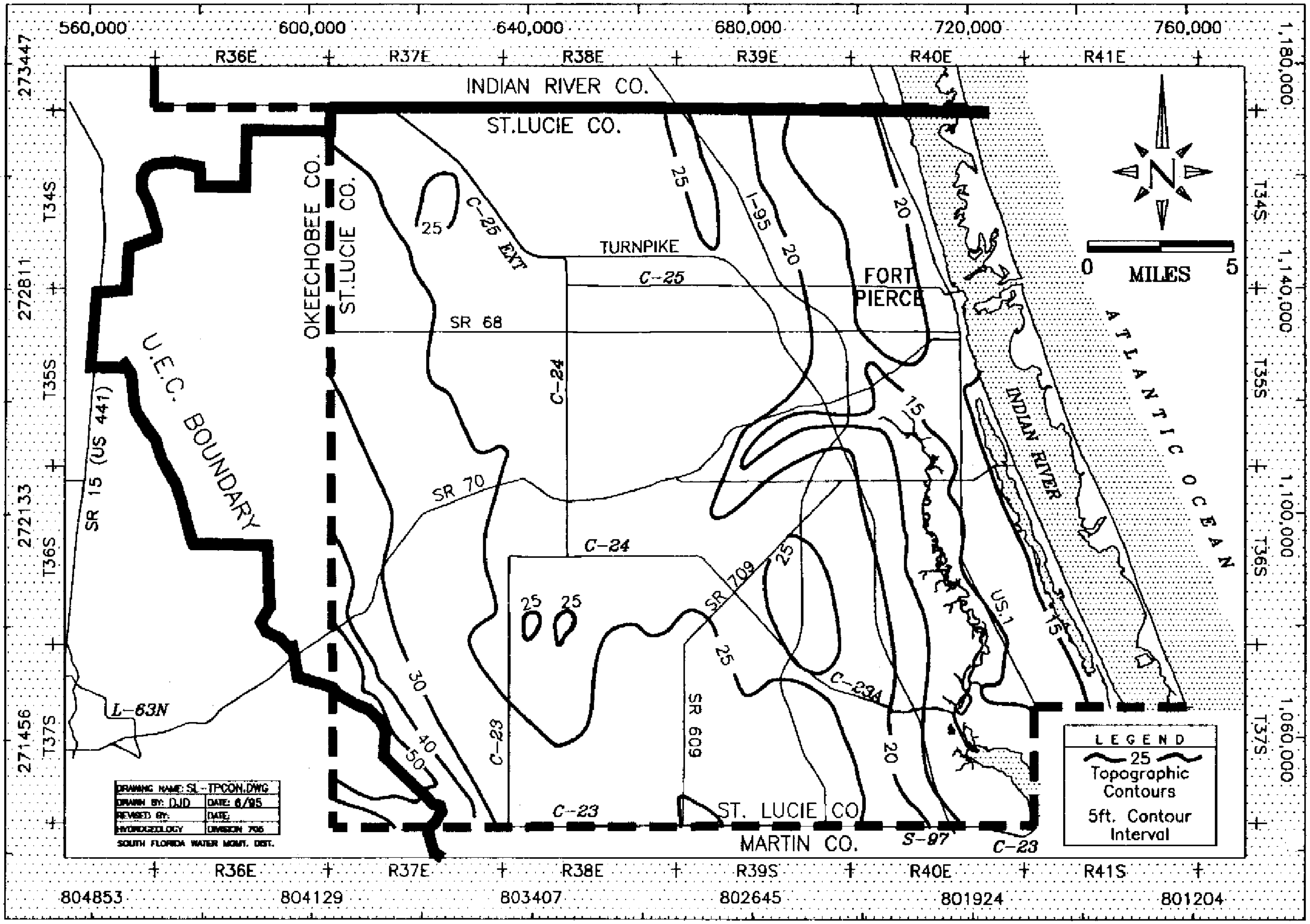


FIGURE 27. Land Surface Elevations, St. Lucie County

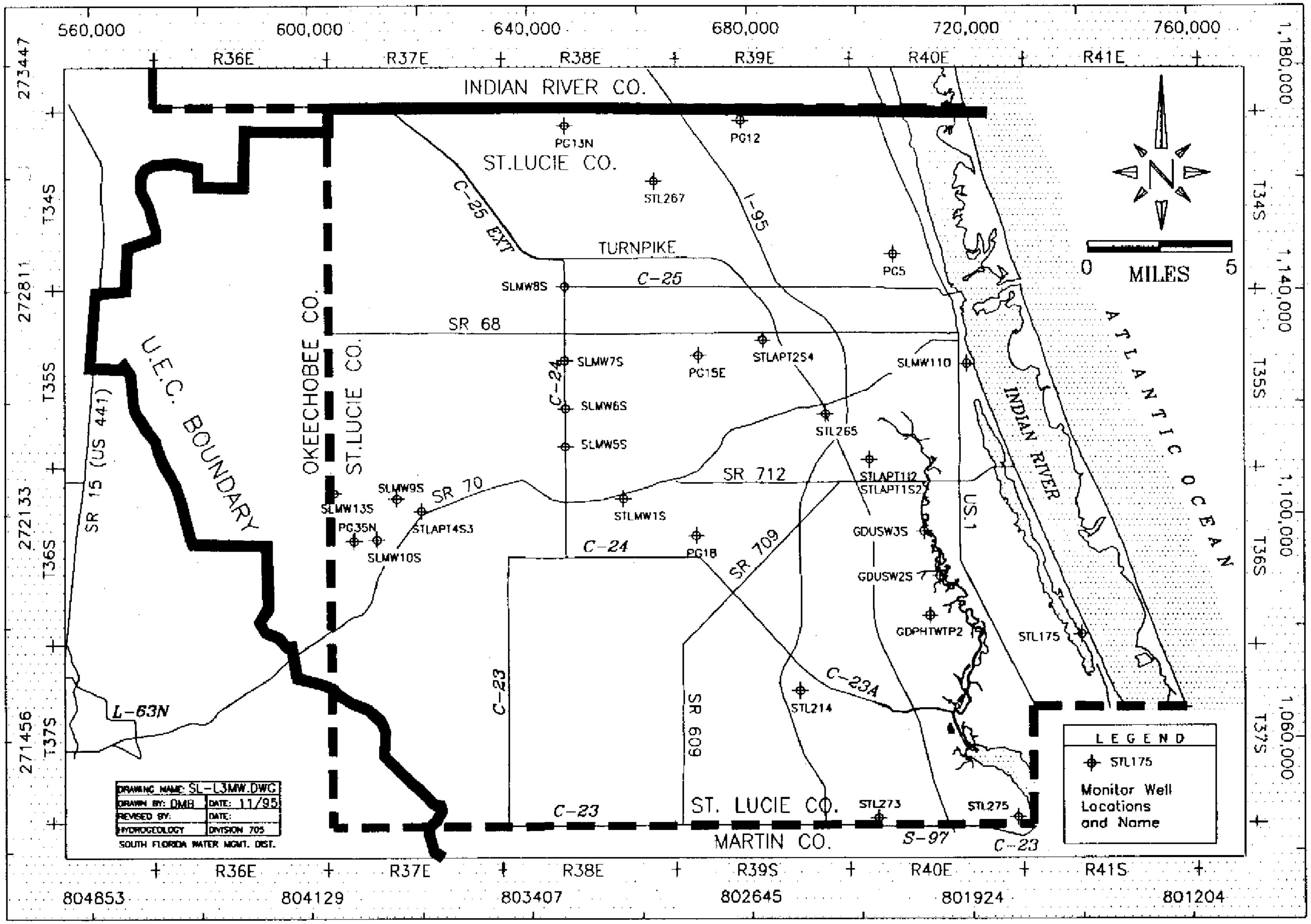


FIGURE 28. **Locations of Monitoring Wells Completed in the Production Unit, St. Lucie County**

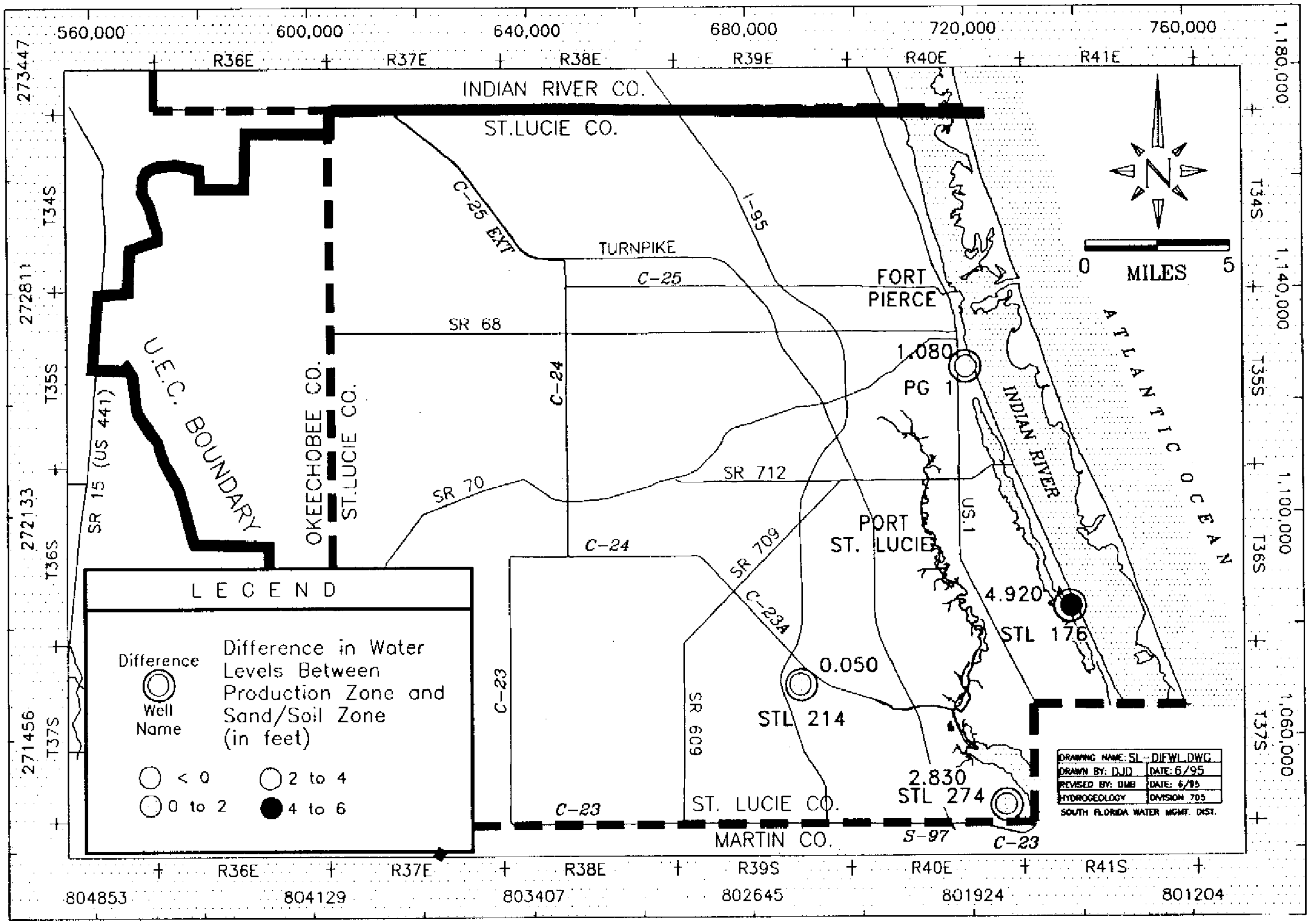


FIGURE 29. Water-Levels in the Sand/Soil Unit Minus those in the Production Unit in St. Lucie County (May, 1990)

subtracting observed May 1990 water-levels in the production unit from those observed in the sand/soil unit in the same month. The differences ranged from 0.05 feet to 4.92 feet. Larger positive differences are represented by darker grey shades on the map. The computed steady-state water-level distribution in model layer 2 is shown in Figure 30. These levels represent average 1990 conditions.

Granular Limestone Unit. Monthly water-levels (feet NGVD) from twenty-one SFWMD and USGS monitoring wells along with nineteen SALT wells completed to the production unit in St. Lucie County are listed in Appendix C, Table C-9. These were measured between July 1989 and September 1991. Additional well data, including state planar coordinates, screened intervals, and measuring point elevations are given in Appendix C, Table C-10. The locations of monitoring wells completed in the granular limestone unit are shown in Figure 31.

The computed steady-state water-level distributions in this unit (layer 3) are mapped in Figure 32. Water-levels in model layers 2 and 3 are similar. Figure 33 displays average observed water-level differences between the production unit and the granular limestone unit. The values plotted on Figure 33 were computed by subtracting average 1989 water-levels observed in the granular limestone unit from those observed in the production unit in the same time period. Darker grey shades on the map represent larger water-level differences. The minimum and maximum differences were -0.36 feet and +4.14 feet, respectively. For the most part, differences averaged less than 0.5 feet. Two exceptions are wells STLAPT1-I2 and STL-177 located in east-central and southeastern St. Lucie County. At these locations, layer 2 levels were 4.14 feet and 3.01 feet greater than those in layer 3, respectively.

UPPER FLORIDAN AQUIFER

Methods Used to Measure Water-Levels

The potentiometric surface of the UFA is above land surface in most of the study area and is measured by SFWMD staff using digital data loggers and pressure transducers. The sonde of the pressure transducer screws into a brass valve (petcock) installed on each well. These petcocks were surveyed at each well to determine elevation above zero feet NGVD. The cable end of the transducer connects to a digital meter (Level-head) which displays the height of the formation water (in feet) above the petcock. This height is then added to the surveyed petcock elevation (NGVD) to obtain water-levels referenced to NGVD. All transducers used in this study were calibrated by SFWMD staff in April of 1990 and were determined to be accurate to within 0.2 feet for the range of pressures encountered.

Upper Floridan Aquifer Monitoring Well Network

Monthly water-levels for the period from May 1989 through March 1991 were measured in fifty-four (54) monitoring wells completed into the upper Floridan aquifer in the UECPA. These levels were used to calibrate a three-dimensional ground water flow model simulating the FAS in the UECPA. The locations of these monitoring wells are shown in Figure 34. A potentiometric map illustrating average 1990 (steady-state) modeled UFA water-levels is presented in Figure 35. The regional flow direction is to the north-east. For a detailed discussion on modeled UFA water-levels, including tables of observed monthly levels and monitor well construction information, see the model documentation by Lukasiewicz (1992).

Collection of monthly water-level measurements from the fifty-four UFA monitoring wells was discontinued in March 1991. Subsequent measurements were collected on a semi-annual basis (May and September) from twenty-four (24) of these wells, the locations of which are shown in Figure 36. These semi-annual data were, and continue to be, incorporated into the USGS database published in their semi-annual UFA potentiometric maps of Florida.

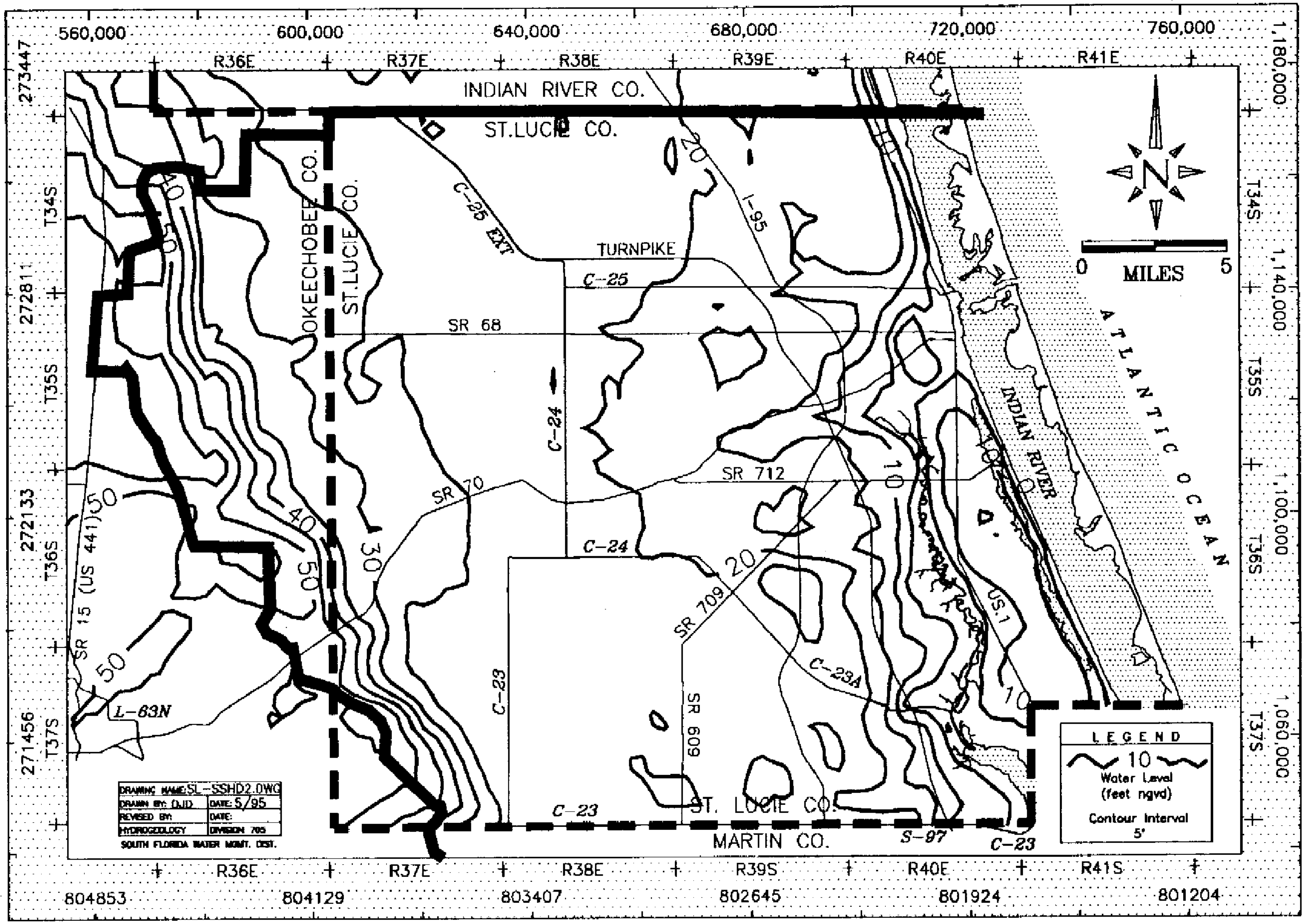


FIGURE 30. Modeled Water-Levels in the Production Unit (Layer 2), St. Lucie County, Representing Average 1990 Conditions (after Butler and Padgett, 1995)

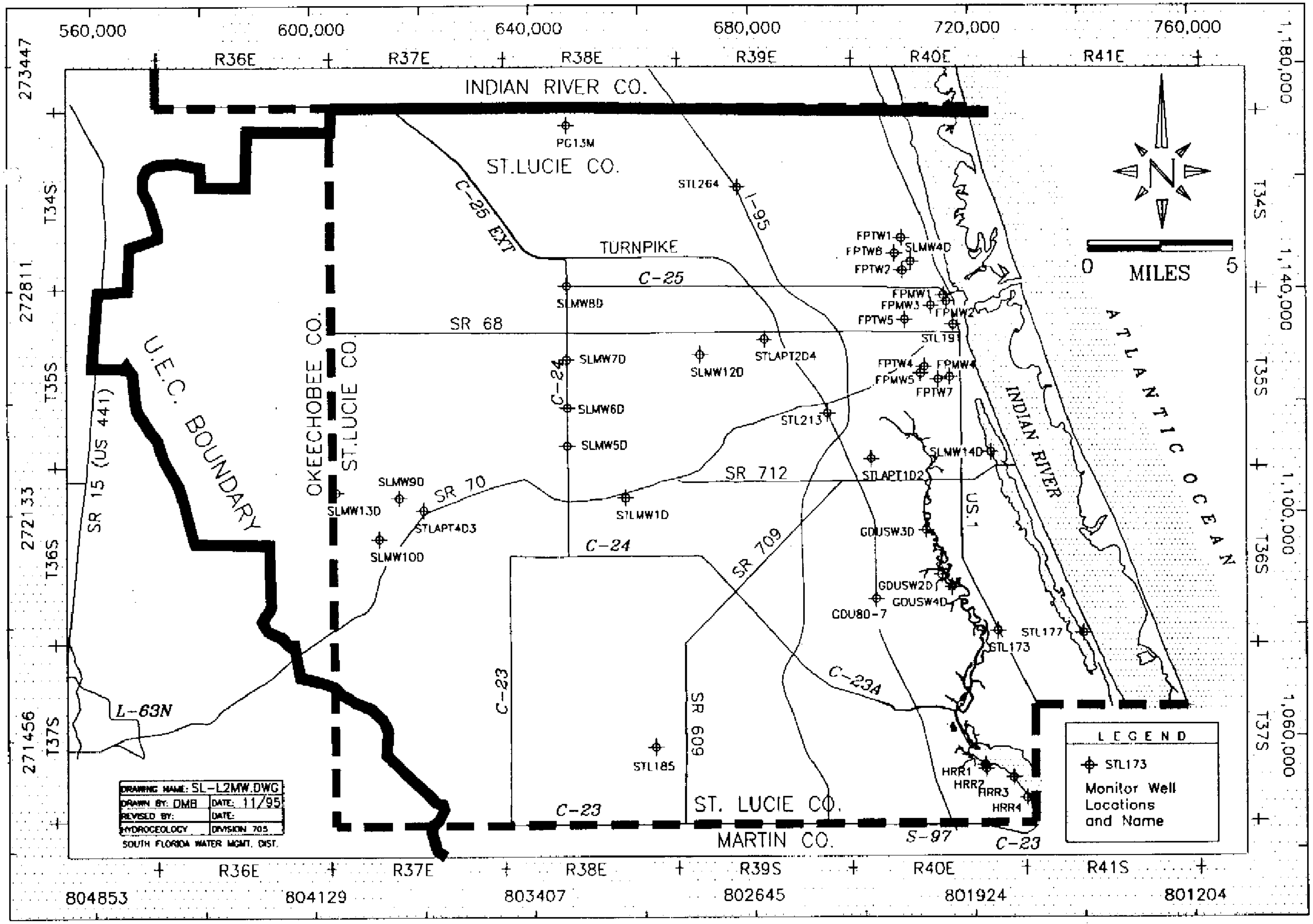


FIGURE 31. **Locations of Monitoring Wells Completed in the Granular Limestone Unit, St. Lucie County**

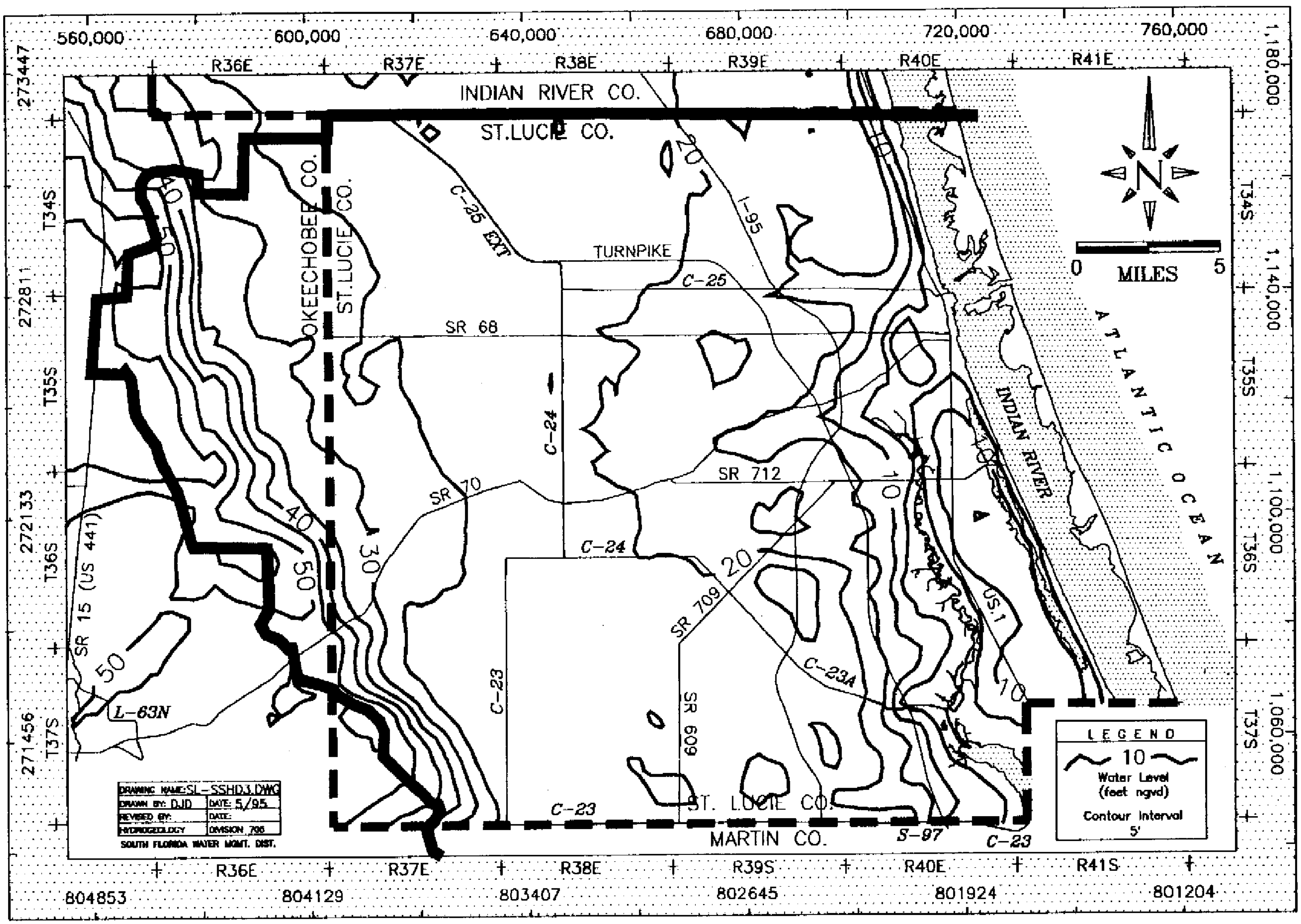


FIGURE 32. **Modeled Water-Levels in the Granular Limestone Unit (Layer 3), St. Lucie County, Representing Average 1989 Conditions (after Butler and Padgett, 1995)**

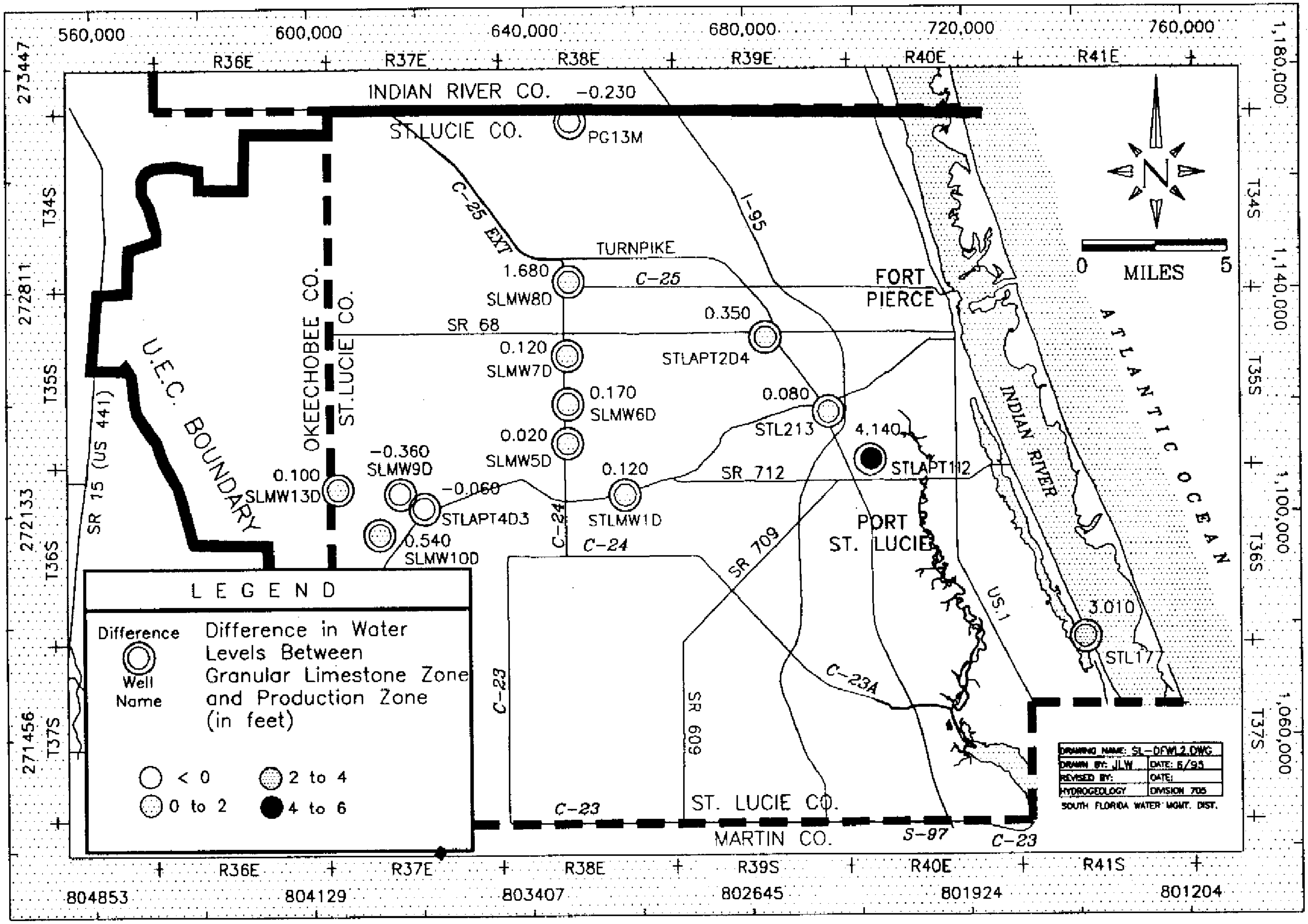


FIGURE 33. **Water-Levels in the Production Unit Minus those in the Granular Limestone Unit in St. Lucie County, Representing Average 1989 Conditions**

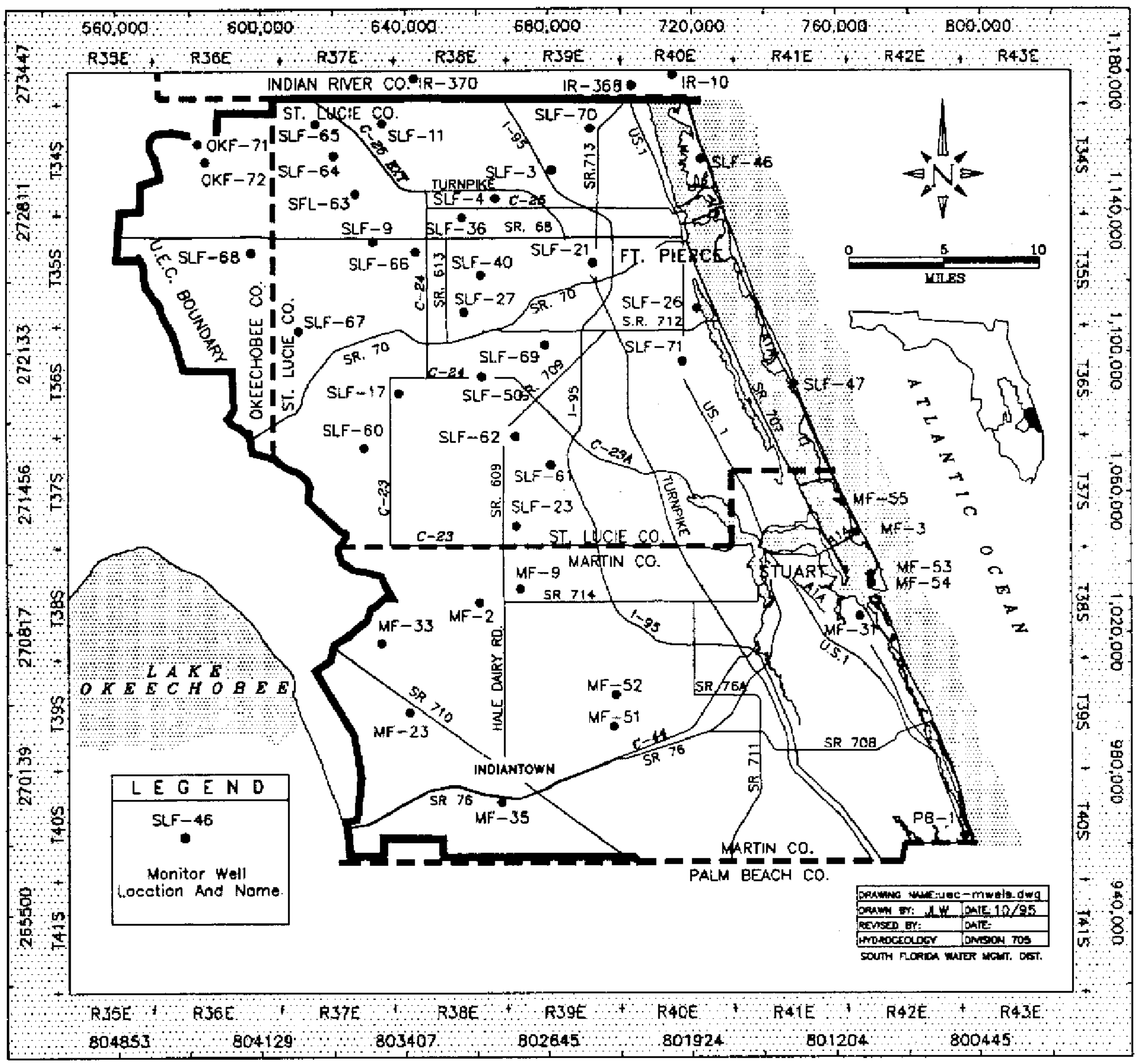


FIGURE 34. Locations of all SFWMD Monitoring Wells Completed in the Upper Floridan Aquifer, Upper East Coast Planning Area

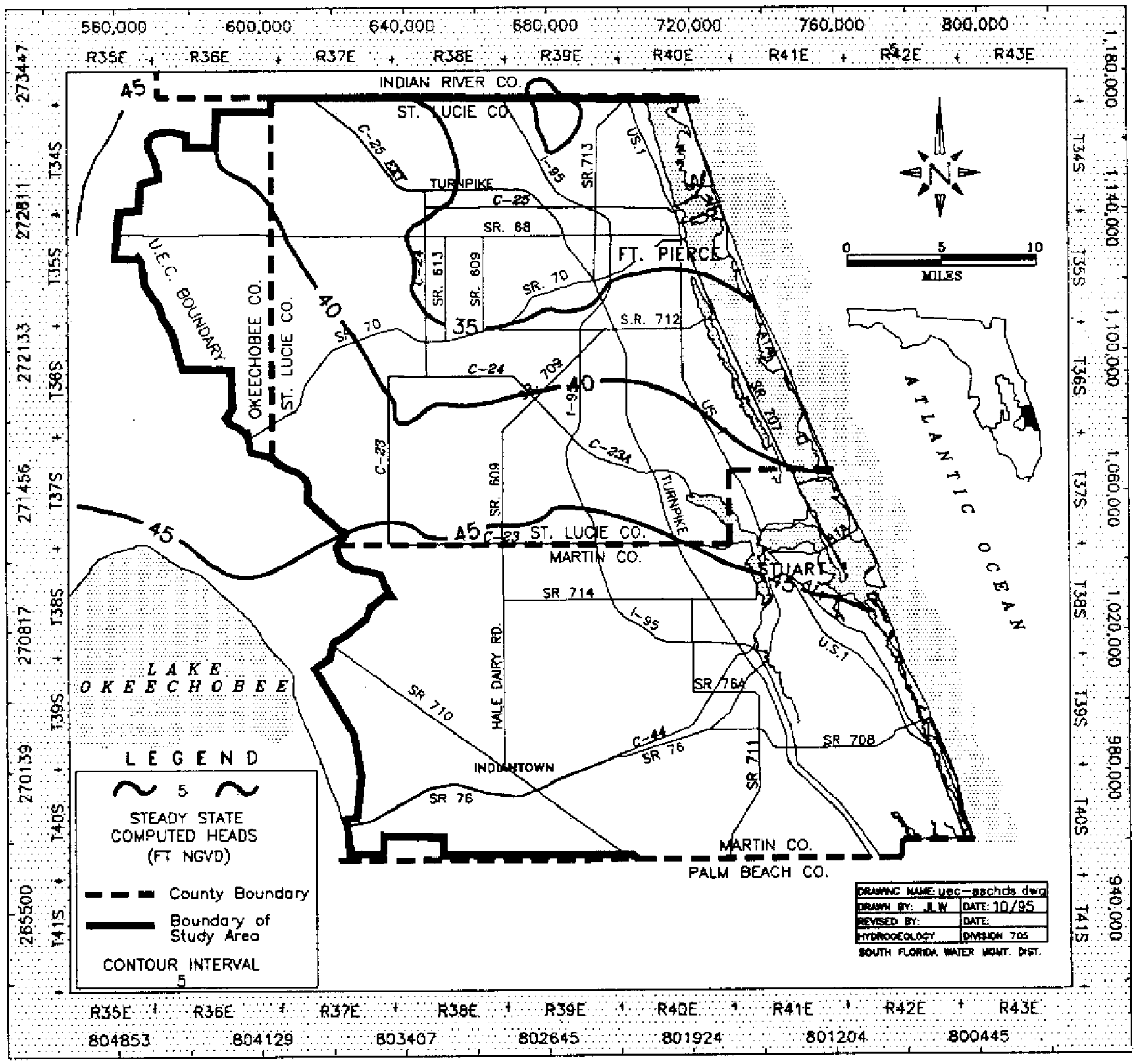


FIGURE 35. Modeled Steady-State Water-Levels in the Upper Floridan Aquifer, Upper East Coast Planning Area, Representing Average 1990 Conditions

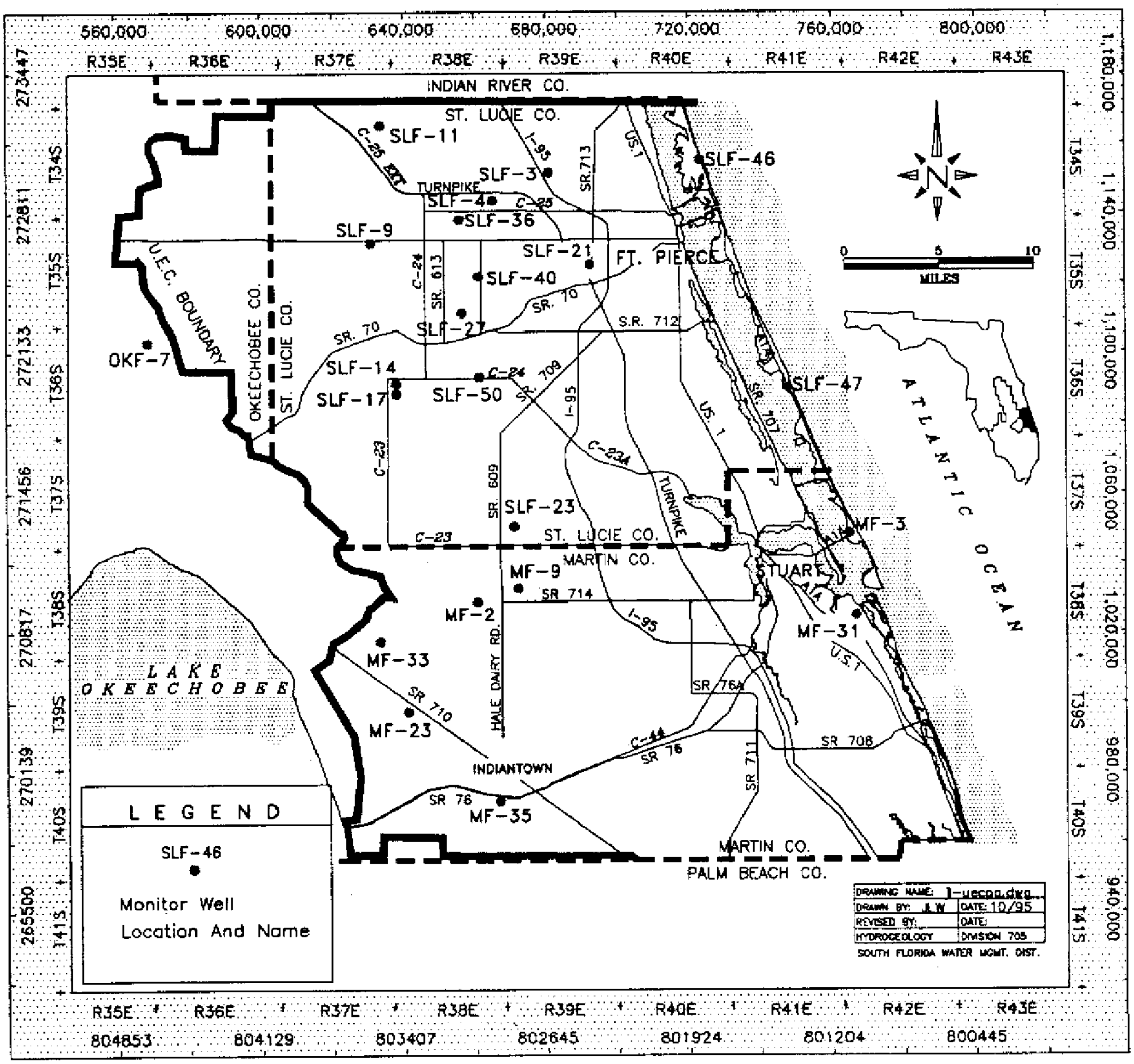


FIGURE 36. **Locations of Upper Floridan Aquifer Wells Currently Monitored by the SFWMD in the Upper East Coast Planning Area**

Hydrographs of Well SLF-50

Water-levels in well SLF-50, located in central St. Lucie County, were measured daily with a continuous recorder installed by the SFWMD in August 1983. This well was constructed in 1983 as part of a SFWMD study to determine the feasibility of aquifer storage and recovery (ASR) in the UFA (Wedderburn, 1983). It was subsequently converted into a monitoring well. This historical water-level record is stored in the SFWMD's hydrologic database (DBHydro) and was used to develop the annual hydrographs presented in Figures 37a and 37b, representing the time intervals between the years 1983-1988 and 1989-1994, respectively. The average monthly values plotted ranged between 38.7 feet (May, 1983) and 44.0 feet (February, 1993) NGVD over the eleven-year period of record. The trends in all years are similar, with the minimum levels recorded in May and maximum levels in October and November. These months correspond to the end of the dry and wet seasons, respectively. Water-level fluctuations in the UFA respond to agricultural water withdrawals in this area. UFA wells are primarily used (in St. Lucie County) as a water source for crop irrigation at the end of the dry season when rainfall and surface water sources are insufficient for citrus requirements. They are infrequently used at the end of the wet season when rainfall and surface water is plentiful.

The SFWMD plans to install continuous water-level recorders in three additional FAS wells (SLF-74, SLF-75, and SLF-76) located in central St. Lucie County in the near future. These wells are completed to various zones in the FAS, and are discussed further in the Aquifer Performance Test section of this report.

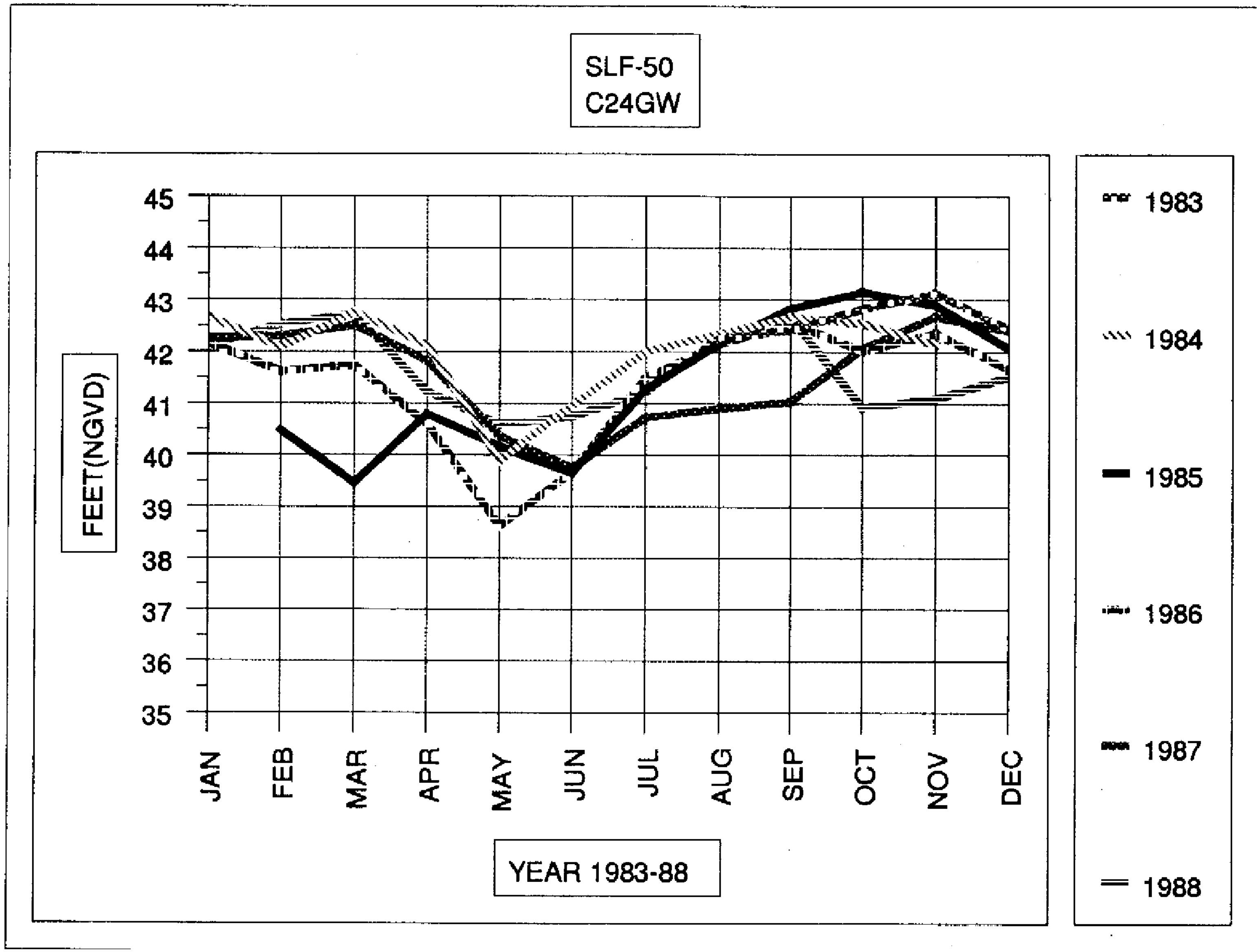


FIGURE 37a. Hydrograph of Well SLF-50, 1983-1988

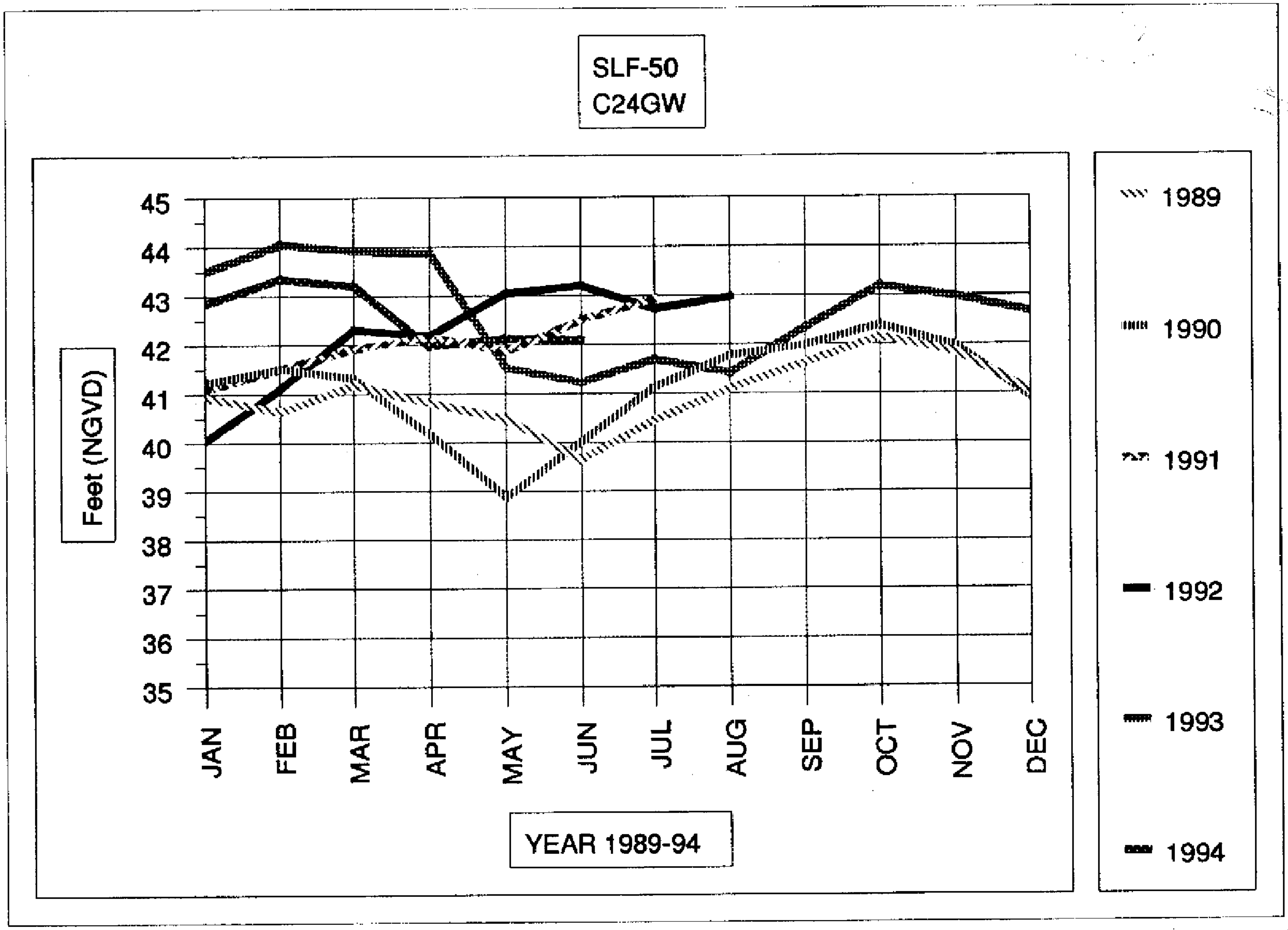


FIGURE 37b. Hydrograph of Well SLF-50, 1989-1994

AQUIFER PERFORMANCE TEST DATA AND ANALYSES

BACKGROUND ON AQUIFER PARAMETERS AND TESTS

An aquifer's potential to store and supply water is based on the hydraulic characteristics of the sediments which comprise the aquifer and adjacent confining and semi-confining strata. Aquifer parameters obtained from aquifer performance tests (APTs) include: transmissivity (T), hydraulic conductivity (k), storage coefficient or storativity (S), and the leakance coefficient (L). Transmissivity is the rate at which water of a prevailing density and viscosity is transmitted through a unit width of an aquifer or confining bed under a unit hydraulic gradient. Units of transmissivity are usually expressed in gallons per day per foot (gpd/ft) or in square feet per day (ft^2/day). Hydraulic conductivity (k) is a coefficient of proportionality describing the rate at which water can move through a permeable medium (Fetter, 1988). The density and viscosity of the water must be considered in determining hydraulic conductivity. It is expressed mathematically as an aquifer's transmissivity divided by its thickness (b) or T/b. Storativity is defined as the volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head (Fetter, 1988). Storativity is expressed as a dimensionless value. The coefficient of leakance is defined by Hantush (1964) as the rate of flow across a unit area of the semi-pervious layer, when the difference between the heads at the top and bottom of the semi-pervious layer is unity. The coefficient of leakance is often expressed in units of 1/t, where t is time (usually days).

These aquifer parameters are used in ground-water flow models which, in turn, are used to quantify the availability of ground water and to predict regional and local water-levels and water quality impacts due to the withdrawal of water from an aquifer. Models are also used to formulate water management strategies for the long-term development of aquifers. One way to determine aquifer parameters at a site is to conduct an aquifer performance test (APT). The APT involves analyzing the changes in water-levels in observation wells at known distances from a well from which water is being withdrawn at a constant rate. There are three phases to a pumping test: background, drawdown, and recovery. Background water-levels are measured to determine the natural patterns of ground-water-level changes with time in the area. The drawdown phase of an aquifer test is when one (production) well is pumped and the resulting water-level decline (drawdown) in observation wells and the pumping well are measured. Drawdown is the difference between the static water-level and the changing levels during pumping. Drawdown measurements recorded at the monitoring well(s) are the most important in the analyses. After pumping has stopped, the water-level within the cone of depression will rise (recover) and approach the static water-level observed before pumping began. This period is called the recovery period. Recovery data is analyzed and typically provides verification for the results of the drawdown analysis. Values of transmissivity, storage and leakance can be determined from the APT results.

SOURCES AND LIMITATIONS OF APTs CONDUCTED IN THE UECPA

APT results from thirteen SFWMD and eight previously unpublished USGS test sites are documented here. The SAS was tested at all but one of these sites. The FAS was tested by the SFWMD at one site located in St. Lucie County. Results of these tests are part of a larger inventory of APT results used by SFWMD staff for ground water flow model development. This inventory includes ninety-eight (98) SAS and sixty-four (64) FAS test sites and is presented in tabular format indexed by county and aquifer in this section (Tables 4, 10, 13, and 16).

Some APTs previously conducted and analyzed by engineering consultants were re-analyzed by SFWMD staff prior to incorporation into the model databases. In some cases, revisions to the original analyses were made. These revisions are also presented in this section. In many instances, confidence in APT results was low due to a variety of factors. Confidence was subjectively judged by the author based on the circumstances of each test.

Many of the APTs conducted and analyzed by the USGS (Hill, unpublished) were done in the late 1970's, but the results were never published because of various technical and mechanical problems encountered. Nevertheless, results from several of the more successful APTs are presented in this publication for two reasons. The first reason is that the aquifer parameters calculated from these tests were used in the SFWMD's ground water flow models. The second is that the information obtained (including lithologic descriptions, water-levels, aquifer drawdowns in response to pumping, etc.) is a valuable addition to the hydrogeologic data base describing the aquifers underlying the study area.

Many of the problems encountered with APT design and subsequent analyses were due to inaccurate preliminary interpretation of distinctions between permeable versus low permeable zones within the SAS during drilling. This sometimes resulted in production wells being screened through two or more permeable zones. When this occurred, multiple zones were subsequently pumped during the aquifer test and the interpretation of drawdown and recovery data were difficult to analyze. In some cases, aquifers were only partially penetrated by production wells or the percentage of penetration was unknown. Most design errors were due to incorrect interpretations of the subtle distinctions between sediments with moderate and low hydraulic conductivity, (i.e. fine sand and silt).

The SAS has low to moderate hydraulic conductivities (approximately 32 to 126 ft/day) in much of the study area (Adams, 1992). The difference between a confining unit and a water-bearing interval of low to moderate conductivity is often dependent on the sand/silt/clay ratio. This ratio is often impossible to ascertain in the field from cuttings and simple geophysical logs primarily because of the difficulty in obtaining a representative sample of the very fine-grained sands and silts in the cuttings. The fine-grained component of the cuttings can easily be overlooked since they are suspended in the drilling mud and pass through the sieve used by the field geologist to separate cuttings from mud.

PRESENTATION OF APT RESULTS

The original APT analyses conducted by SFWMD and USGS staff were finalized (not modified) for publication by this author. Analyses are presented in Graphs 1 through 78. Field data are plotted on the graphs as points, with bold type curves superimposed on the field data. Methods of analysis, match points, equations and computations are also shown in each plot. Lithologic descriptions from the pilot holes drilled at each APT site are provided (where available), in Appendix A. Geophysical logs of the pilot holes (where available) are given in Appendix B (see Table 1). Additional information presented includes: site maps, well construction details, water quality changes, and APT summary reports. These summary reports give a brief overview of each test, including confidence levels and influencing factors impacting each analysis. Confidence in analyses and test results were ranked by this author as very low, low, low-moderate, moderate, moderate-high and high on a subjective basis.

MARTIN COUNTY SURFICIAL AQUIFER SYSTEM APT RESULTS

APT results conducted at thirty-six (36) SAS well sites in Martin County and ten (10) in northern Palm Beach County were acquired from various sources and are summarized in Table 4. This table also lists well construction details and the methods of analysis used to calculate aquifer parameters. The map number appearing in column one matches those numbers used in the filing system established by the original author of the Martin County SAS model documentation (Adams, 1992). Those files are archived at the SFWMD's Hydrogeology Division.

Table 5 lists additional information about each test site, including: the landowner, source of information, location, date of test, the well name under which lithologic and geophysical logs are indexed, and whether the data was re-analyzed by SFWMD staff. The location of each aquifer test site in Martin County is plotted in Figure 38, identified by map number. A contour map illustrating the regional distribution of transmissivity is given in Figure 39. Here, the most transmissive zone encountered at each site was used to generate the contours.

SFWMD staff designed, conducted and analyzed eight of the Martin County aquifer tests listed in Tables 4 and 5 (Site# 1,2,5,6,30,42,43,and 45) between 1984 and 1989 (Adams, 1992). USGS staff (Hill, unpublished) conducted seven aquifer tests at separate sites in Martin County. There was only enough information in the SFWMD's files to summarize four (Site# 13,17,18, and 19) of these seven USGS tests. Aquifer tests conducted in northern Palm Beach County are outside the study area and, therefore, not included in the summaries. For additional information on these sites, the reader is encouraged to contact the SFWMD's Hydrogeology Division to access the archived APT files.

TABLE 4. Surficial Aquifer System Aquifer Performance Test Results, Martin and Northern Palm Beach Counties

MAP NO.	SITE ID	PUMPED WELL #	OBSERV. WELL #	PROD. CASED /TD(FT)	OBS. CASED /TD(FT)	WELL RADIUS r (FT)	PUMP RATE (GPM)	HOURS PUMPED	MAXIMUM DRAWDOWN (FT)	TRANSMISS (GPD/FT)	STORAGE (unitless)	LEAKANCE (GPD/FT3)	ANALYSIS METHOD
1	C-23 SITE	PW	D-OBS	30/110	40/180	28	405	16.0	10.7	18,565			Hantush
			S-OBS		20/40	20			0.4				
2	L-65 SITE	PW	D-OBS	30/100	40/180	75	339	23.0	5.2	25,064			Neuman
			S-OBS		20/40	28			2.9				
3	DUPUIS RANCH	PW	OBS	-/48	-/45	100	400			72,000	4.5E-04		Neuman
5	ALLAPATAH	PW	D-OBS	40/120	40/160	125	347	22.0	5.2	42,304	1.3E-02		Neuman
			S-OBS			18			4.6	19,888			Boulton
6	CAULKINS GR.	PW	D-OBS	30/110	40/160	70	378	19.0	4.3	28,879			Neuman
7	SOUTHEAST ST.	PW167	OB 168	-/105	-/103	585	200		4.3	8,400	2.5E-04		Prickett
8	MARTIN DOWNS	PW	OW-1D	100/140	80/140	97	850	72.0	6.3	89,367	8.8E-04		Boulton
			OW-2D		80/140	216			6.6	81,175	1.5E-02		Boulton
			OW-3D		80/140	51			5.9	90,194	3.0E-03		Boulton
9	LEIGHTON FARMS	PW 891	OB 892	-/75	-/40	190	725	27.0	9.8	30,000	2.3E-04	6.7E-03	Cooper
			OB 894		-/75	1300			0.4	83,000	6.5E-03	3.1E-02	Cooper
9	LEIGHTON FARMS	PW 894	OB 899	-/75	-/35	1,400	340	48.0	0.2	35,000	2.1E-03	1.8E-02	Cooper
			OB 900		135/155	1,400			0.4	55,000	1.2E-03	9.9E-03	Cooper
10	ST. LUCIE FALL	PW	OB 1			50	55	23.0	2.8	10,835	6.3E-03		TimeDrawdown
			OB 2			250			1.2				
11	HOBE GROVES	M1063	M1074	-/89	-/100	50	600		1.2	185,800	1.7E-01	2.9E+00	Hantush Jacob
			M1075		-/100	150			1.1	208,000	2.0E-02	3.7E-01	Hantush Jacob
12	MARTIN CO.NOR	PW	OB-1	148/150	130/150	25	300	4.0	13.2	11,100	4.0E-03		Boulton
			OB-3		130/150	75			13.7	10,400	1.8E-04		Boulton
			OB-4		130/150	150			11.1	18,600	1.0E-03		Boulton

TABLE 4. Surficial Aquifer System Aquifer Performance Test Results, Martin and Northern Palm Beach Counties (Continued)

MAP NO.	SITE ID	PUMPED WELL #	OBSERV. WELL #	PROD. CASED /TD(FT)	OBS. CASED /TD(FT)	WELL RADIUS r (FT)	PUMP RATE (GPM)	HOURS PUMPED	MAXIMUM DRAWDOWN (FT)	TRANSMISS (GPD/FT)	STORAGE (unitless)	LEAKANCE (GPD/FT3)	ANALYSIS METHOD
13	STUART SO.WEL	TPW-1	OW 1	110/140	80/117	149	160	27.0	3.9	31,522	1.4E-04		Semi-log
			OW 2		90/110	627			0.5	105,600	4.3E-04		Semi-log
13	INDIAN AVENUE	PW	TPW-1	-/140	110/140	43	312	36.0	13.1	54,342	7.3E-05		Hantush-Jacob
			OW-1		80/117	155			10.2	26,180	8.3E-05		Hantush-Jacob
			OW-2		90/110	629			1.7	134,640	9.5E-04		Hantush-Jacob
14	BANYAN BAY	PW-1	OW-1D	60/130	60/130	26	741	72.0	26.9	29,600	5.1E-04		Jacob I
			OW-2D		60/130	116			19.7	31,800	2.7E-04		Jacob I
			OW-3D		60/130	217			16.1	33,200	2.6E-04		Jacob I
15	MILES GRANT	PW-1	PW-2	110/127	110/127	500	150	7.0	0.9	39,976	6.6E-04		Boulton
			M1004		17/17	300			0.1	57,300	5.7E-03		Boulton
16	HYDRATECH	PW2A	OBS 1	102/130	105/120	20	300	72.0	4.6	54,620	2.8E-03		Curve
			OBS 2		105/120	100			2.9	56,571	1.7E-03		Curve
17	HOBE SOUND	PW	100W	103/138	103/148	100	132	7.0	4.3	15,109	1.6E-04		Hantush-Jacob
			79E		103/142	79			3.8				
			116S		103/143	116			3.7	15,109	1.2E-04		Hantush-Jacob
			32WD		105/135	32			6.2				
18	JDSP NORTH	PW	O1	70/90	70/90	25	312	16.6	2.7	92,000	1.1E-04	3.5E-02	Hantush-Jacob
			O2		70/90	100			1.5	67,500	1.1E-04	3.0E-01	Hantush-Jacob
19	TEQUESTA PARK	PW	O 1	40/60	40/60	2	150	6.0	2.4	60,000			Thiem
			O 2		40/60	10			1.3	60,000			Thiem
			O 3		40/60	50			0.5	60,000			Thiem
			0 4		40/60	140			0.2				
		PW	0 2	60/80	60/80	10	150	6.0	2.4	40,000			Thiem
			0 3		60/80	50			0.6	40,000			Thiem
			0 4		60/80	140			0.3	40,000			Thiem
20	WOODSIDE DEV.	PW	OBS	64/69		200	84.5	24.0		27,667	1.3E-04	1.7E-03	Cooper
21	PIPERS LANDING	TPW4	4OB1	115/141	105/115	400	200	72.0		41,673	2.3E-04	2.6E-03	Curve
			4OB2		105/115	100				40,928	1.2E-04	1.6E-03	Curve
			#6			650				47,750	3.6E-04	3.9E-03	Curve
			#10			1,250				67,412	2.2E-04	1.7E-03	Curve

TABLE 4. Surficial Aquifer System Aquifer Performance Test Results, Martin and Northern Palm Beach Counties (Continued)

MAP NO.	SITE ID	PUMPED WELL #	OBSERV. WELL #	PROD. CASED /TD(FT)	OBS. CASED /TD(FT)	WELL RADIUS r (FT)	PUMP RATE (GPM)	HOURS PUMPED	MAXIMUM DRAWDOWN (FT)	TRANSMISS (GPD/FT)	STORAGE (unitless)	LEAKANCE (GPD/FT3)	ANALYSIS METHOD
22	SOUTH RIVER CO	PW	1D		-/125	52	280	20.0	12.06	33,600	3.0E-05		Time-Drawdown
23	ROSCHMAN ENTER	PW	B1	62/70	66/69	600	300	72.0	0.79	181,000	3.3E-04		Prickett
			B3		66/69	1000			0.82	149,000	2.6E-04		Prickett
			B5		58/63	1000			0.57	164,000	1.2E-04		Prickett
			A1		68/73	198			2.12	146,298	4.7E-04		Neuman
			A4		66/71	399			2.69	125,018	2.6E-03		Neuman
24	GDC-MARTIN CO.	4	none	95/125			250	1.5	19.07	33,000			Recovery
28	SAVANNAH CLUB	TPW	OBS2	70/100	-/100	196	103	43.0	6.20	2,950	3.1E-04	2.8E-02	Cooper
			OBS3		-/100	405			3.60	10,264	2.3E-04	4.2E-03	Cooper
			OBS4		-/100	212			6.50	6,380	1.7E-04	5.6E-03	Cooper
			OBS5		-/100	412			3.60	9,836	3.5E-03	3.6E-03	Cooper
			OBS6		-/100	727			1.80	7,333	3.1E-04	7.8E-03	Cooper
29	INTRACOASTAL U	PW-2	OBS	106/115	105/107	610	450	72.0	0.96	161,000	2.7E-03	6.8E-02	Cooper
30	STATE ROAD 76	PW M31	OB M32	40/140	40/220	50	360	20.0	7.70	25,003	3.3E-04		Neuman
31	CITY OF STUART	657	656	115/125	144/145	11	135	11.0	5.75	18,000	2.5E-03	3.5E-02	Cooper
			658		115/125	100			3.39	23,000	1.5E-04	1.4E-02	Cooper
			659	115/125		300			1.29	27,000	3.5E-04	7.2E-03	Cooper
		724	659	115/125	115/125	300	140	5.0	1.76	17,000	3.5E-04	7.2E-03	Cooper
			658	115/125		500			0.67	23,000	5.1E-04	1.1E-02	Cooper
			657	115/125		600			0.41	24,000	5.6E-04	1.5E-02	Cooper
		723	658	115/125	115/125	500	112	5.0	0.63	26,000	3.8E-04	1.3E-02	Cooper
			724		115/125	750			0.10	22,000	6.4E-04	2.6E-02	Cooper
		657	658	115/125	115/125	100	105	9.0	3.58	16,000	1.0E-04	2.4E-02	Cooper
32	JUPITER	PW13	OB-1	130/201	124/145	408	555	24.0	1.86	98,100	7.1E-04		Boulton
			OB-2		129/145	400			3.85	33,300	1.5E-04		Boulton
			OB-3		124/145	402			2.46	39,800	3.6E-04		Boulton
			TW-1		124/155	807			1.26	125,000	1.6E-04		Boulton
			TW-3		126/160	810			1.66	85,600	1.5E-03		Boulton
33	PB CO. SITE 15	PB1547	PB1546	75/115	80/120	40	214	8.4	5.45	50,800			Jacob (USGS)

TABLE 4. Surficial Aquifer System Aquifer Performance Test Results, Martin and Northern Palm Beach Counties (Continued)

MAP NO.	SITE ID	PUMPED WELL #	OBSERV. WELL #	PROD. CASED /TD(FT)	OBS. CASED /TD(FT)	WELL RADIUS r (FT)	PUMP RATE (GPM)	HOURS PUMPED	MAXIMUM DRAWDOWN (FT)	TRANSMISS (GPD/FT)	STORAGE (unitless)	LEAKANCE (GPD/FT3)	ANALYSIS METHOD
34	PALM BCH PK OF	PW	OBS	74/94	74/94	200	225	24.0	2.2	30,426	3.6E-04		Neuman (Full)
35	TEQUESTA WELLF	7R	S1-2	50/90	15/60	48	457	72.0	1.6	308,072	1.4E-03		Boulton (Early)
			S2-2		15/80	103			1.1	402,863	1.4E-03		Boulton (Early)
			S3-2		15/80	194			0.8	374,087	1.4E-03		Boulton (Early)
36	TEQUESTA WELLF	8R	S1-3	50/70	15/60	100	950	74.0	1.3				
			S3-3		20/70	177			1.0	745,685	9.9E-04		Boulton (Early)
37	TEQUESTA WELLF	18	S1-5	38/60	23/63	51	218	36.0	0.6	227,116	9.8E-03		Boulton (Early)
			S2-5		22/62	100			0.5				
			S3-5		20/60	195			0.2				
38	FP&L BTW-1	BTW-1	1OBSA	41/165	62/165	81	365	23.5	19.0	11,619	2.7E-04		Neuman
39	FP&L BTW-2	BTW-2	2OBS	27/142	21/135	68.	206	22.0	9.7	17,883	1.8E-04	2.0E-04	Cooper
40	FP&L BTW-3	BTW-3	3OBS	47/165	46/165	63	388	38.7	14.6	21,376	6.4E-04	2.9E-04	Cooper
41	FP&L BTW-4	BTW-4	4OBS	55/165	52/165	120	248	24.0	11.1	15,615	2.4E-04	5.8E-05	Cooper
42	JDSP	PW	1D	30/120	30/120	75	160	71.5	3.2	26,965	5.2E-04		Neuman
			2D		30/120	157			2.4	21,075	4.7E-04		Neuman (Early)
43	MOBIL (TP&J Pr	PW	1I	60/85	60/85	76	136	42.9	4.2	12,671	1.5E-04		Neuman
			1D		100/105	75			3.3	16,852	3.4E-04		Neuman
			2I		60/85	153			2.8	14,431	1.8E-04		Neuman
			2D		100/105	151			2.8	16,493	2.0E-04		Neuman
44	No. MARTIN CO.	PW-7	PZ36D	71/120	105/110	36	349	72.0	15.8	9,500	3.0E-04	4.6E-07	Walton
			PZ87D		105/110	87			9.7	14,800	3.0E-04	1.9E-07	Walton
			PZ136D		105/110	136			7.3	1,900	4.0E-04	6.5E-08	Walton
45	MONREVE RANCH	PW	1D	30/70	30/70	49	136	72.0	5.4	8,425	4.0E-04		Neuman
			2D		30/70	100			3.8	11,132	3.8E-04		Walton
			3D		30/70	150			3.2	22,265	1.3E-03		Neuman

TABLE 4. Surficial Aquifer System Aquifer Performance Test Results, Martin and Northern Palm Beach Counties (Continued)

MAP NO.	SITE ID	PUMPED WELL #	OBSERV. WELL #	PROD. CASED /TD(FT)	OBS. CASED /TD(FT)	WELL RADIUS r (FT)	PUMP RATE (GPM)	HOURS PUMPED	MAXIMUM DRAWDOWN (FT)	TRANSMISS (GPD/FT)	STORAGE (unitless)	LEAKANCE (GPD/FT3)	ANALYSIS METHOD
46	VISTA SALERNO	PW-2	2-1	90/110	90/110	99	300	72.0	6.0	22,920	8.2E-03		Neuman
			2-3		90/110	650			1.3	89,298	1.5E-03		Neuman
			2-2		10/20	49			2.1				
47	PB CO SITE 14	PB1551	PB1550	70/130	75/135	30	212	5.0	6.7	33,473			Cooper-Jacob Straight
48	PB CO SITE 17	PB1607	PB1608	50/150	50/150	30	332	6.0	5.6	113,700			Cooper-Jacob Straight
49	JOHNATHAN'S LANDING	IW-1	TW-1	60/100	60/180	554	4						
			TW-2		50/180	30			16.7	67,540	5.4E-2		Boulton's Delayed Yield
			TW-3		40/180								
50	THREE SEASONS	TW	OBS1	130/170	130/150	75	510	24.0	7.2	40,000	3.4E-4	0.2	Avg. Jacob, Theis, Walton
			OBS2		130/150	125	3.8						

TABLE 5. Aquifer Performance Test Miscellaneous Information, Martin and Northern Palm Beach Counties

MAP NO.	LAND OWNER	SOURCE	REANALYZED	DATE OF TEST	S/T/R	STATE EAST (FT)	PLANARS NORTH (FT)	APPENDIX A-Z LITHOLOGIC WELL NAME
1	C-23 SITE	SFWMD (Hydro.Div.)	Y	11/13/84	06/38/38	641000	1043900	C-23 Well #1
2	L-65 SITE	SFWMD (Hydro.Div.)	Y		05/39/37	614400	1008600	L-65 Well #2
3	DUPUIS RANCH	USGS (Hill,unpub.)	N	06/01/76	18/40/38	639150	967000	
5	ALLAPATAH	SFWMD (Hydro.Div.)	Y	08/29/84	12/39/38	668120	1002250	W-31
6	CAULKINS GROVE	SFWMD (Hydro.Div.)	Y	09/25/84	19/39/40	704550	996900	Caulkins Grove Well 4
7	SOUTHEAST ST. LUCIE	USGS (Bearden,1972)	N	01/20/70	14/37/40	721550	1065400	
8	MARTIN DOWNS	Gee & Jenson (1980)	N	03/16/80	11/38/40	721850	1036350	
9	LEIGHTON FARMS	USGS (Lichtler,1960)	N	10/25/56	26/38/40	723300	1018750	
				07/10/57		724500	1019250	
10	ST. LUCIE FALLS	Lind.,Browning(1988)	N	07/25/80	12/39/40	729300	1004450	
11	HOBE GROVES	USGS (Hill,Unpub.)	N	12/02/75	33/39/41	745300	984400	
12	MARTIN CO. NORTH	LaMoreu & Assoc(1978)	N	12/20/77	20/37/41	742533	1056550	
13	STUART SO. WELLFLD.	CH2MHill (1979)	N	06/8/78	HG/38/41	749250	1029350	
	INDIAN AVENUE	USGS (Hill,Unpub.)	N	01/31/79	HG/38/41	749250	1029350	
14	BANYAN BAY	Gee and Jenson (1982)	N	02/20/82	HG/38/41	744400	1021850	
15	MILES GRANT	Gee and Jenson (1979)	N	10/03/79	30/38/42	766000	1022250	
16	HYDRATECH	G.Bobo & Assoc.(1980)	N	01/02/80	GG/39/42	775850	1005300	
17	HOBE SOUND	USGS (Hill,Unpub.)	N	09/11/79	GG/39/42	779850	996200	HSBC, 32W
18	JDSP NORTH	USGS (Hill,Unpub.)	N	05/29/79	11/40/42	789300	972900	M-1093, Lith Col. in text
19	TEQUESTA PARK	USGS (Hill,Unpub.)	N	03/25/74	19/40/43	795900	960400	PB-3
20	WOODSIDE DEV.	Geraghty & Miller	N	05/01/81	06/38/41	733850	1041450	
21	PIPERS LANDING	CH2MHill (1981)	N	02/11/81	HG/38/41	737350	1023500	
22	SOUTH RIVER CONDO	Unknown (1980)	N	09/09/80	HG/38/41	745550	1024650	
23	ROSCHMAN ENTERPR.	Geraghty & Miller(1978)	N	09/19/78	HG/38/41	749250	1022950	
24	GDC-MARTIN CO.	Geraghty & Miller(1978)	N		09/38/40	716300	1039300	
28	SAVANNAH CLUB	Geraghty & Miller(1981)	N	4/22/81	26/36/40	724600	1082500	
29	INTRACOASTAL UTIL.	Geraghty & Miller(1978)	N	02/08/78	HG/38/41	756900	1026250	
30	STATE ROAD 76 SITE	SFWMD (Hydro.)	Y	09/26/84	HG/38/41	745300	1028000	SR76, Well #3
31	CITY OF STUART	USGS (Hill,unpub.)	N	03/09/55	04/38/41	746450	1038750	
32	JUPITER WATER SYS	Geraghty & Miller	N	11/29/78	10/41/42	783600	943300	
33	PALM BCH CO SITE 15	USGS (Hill, unpub.)	N	07/16/86	03/41/41	750300	945150	

TABLE 5. Aquifer Performance Test Miscellaneous Information, Martin and Northern Palm Beach Counties (Continued)

MAP NO.	LAND OWNER	SOURCE	REANALYZED	DATE OF TEST	S/T/R	STATE EAST (FT)	PLANARS NORTH (FT)	APPENDIX A-Z LITHOLOGIC WELL NAME
34	PALM BCH PK OF COMM	Howard Searcy (1981)	N	1981	08/41/40	736400	935200	
35	TEQUESTA WELLFLD 2	Gee & Jenson (1981)	N	07/10/80	25/40/42	795400	955300	
36	TEQUESTA WELLFLD 3	Gee & Jenson (1981)	N	08/15/80	30/40/43	796200	955900	
37	TEQUESTA WELLFLD 5	Gee & Jenson (1981)	N	05/20/80	24/40/42	796500	959600	
38	FP&L BTW-1	Bechtel (1989)	N	04/13/89	28/39/38	652354	991086	
39	FP&L BTW-2	Bechtel (1989)	N	04/24/89	04/40/38	652258	977089	
40	FP&L BTW-3	Bechtel (1989)	N	04/18/89	20/39/38	643646	995507	
41	FP&L BTW-4	Bechtel (1989)	N	04/27/89	33/39/38	652283	984402	
42	JDSP	SFWMD (Hydro)	Y	09/26/89	05/40/42	771850	979525	W-32
43	MOBIL (TP&J Prop)	SFWMD (Hydro)	Y	10/09/89	10/39/41	750900	1003700	W-34, Lith Col.
44	NO. MARTIN CO.	JMMontgomery (1989)	N	10/05/89	20/37/41	742650	1058500	
45	MONREVE RANCH	SFWMD (Hydro)	N	12/04/89	25/39/40	728050	986500	W-33, Lith Col.
46	VISTA SALERNO	Hydrogeologic (1985)	Y	01/15/85	36/38/41	761400	1015600	VS-PW2
47	PB CO SITE 14	USGS (Hill, unpub.)	N	07/30/86	06/42/41	731213	918686	PB-1550
48	PB CO SITE 17	USGS (Hill, unpub.)	N	02/23/87	29/41/42	768207	926382	PB-1608
49	JOHNATHAN'S LANDING	Gee & Jenson (1980)	N	12/01/80	--/42/43	810000	878646	
50	THREE SEASONS, JUP.	Adair & Brady (1979)	N	10/29/74	11/41/42	787750	941500	

HG: Hanson Grant
GG:

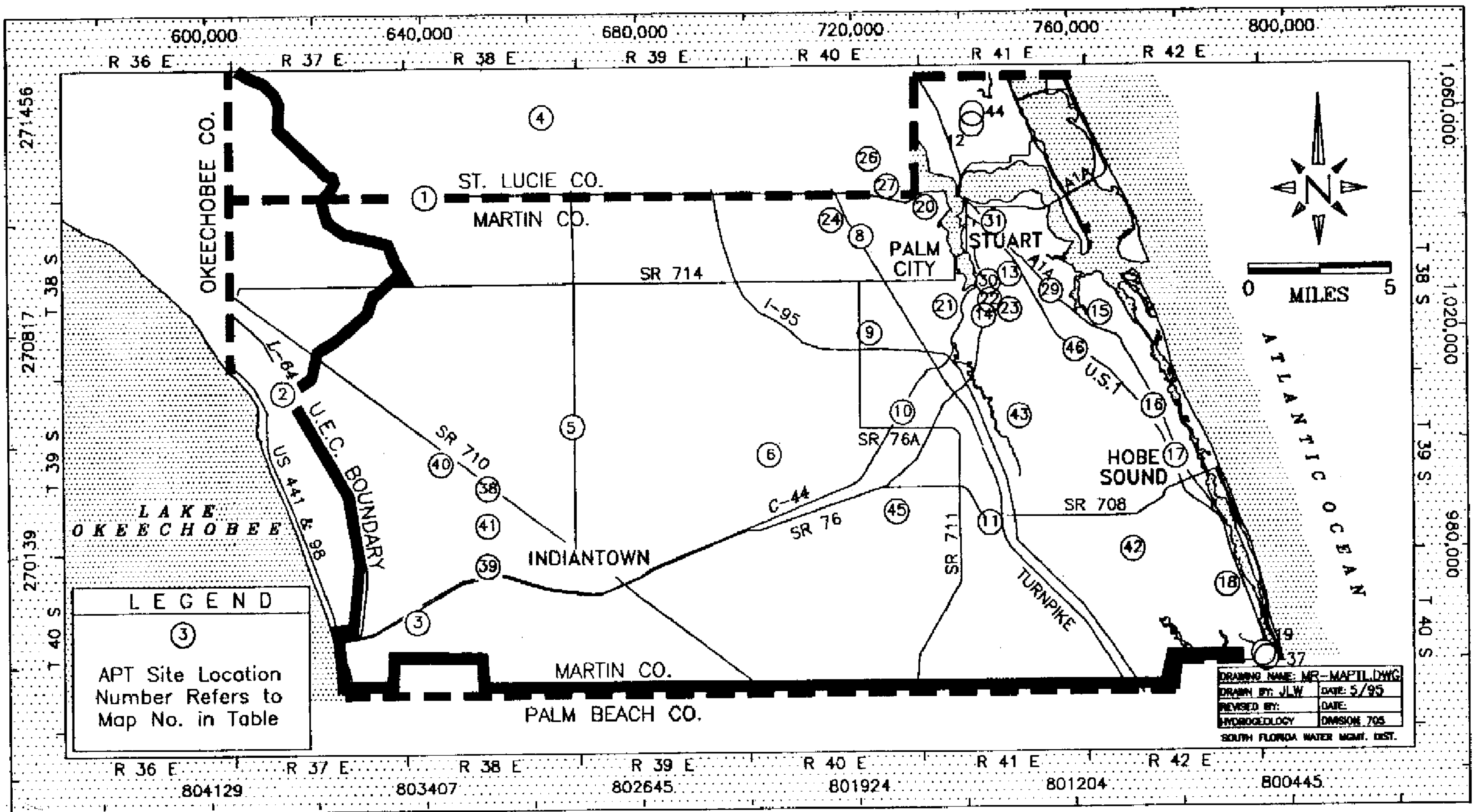


FIGURE 38. Locations of Surficial Aquifer System Aquifer Performance Test Sites in Martin County

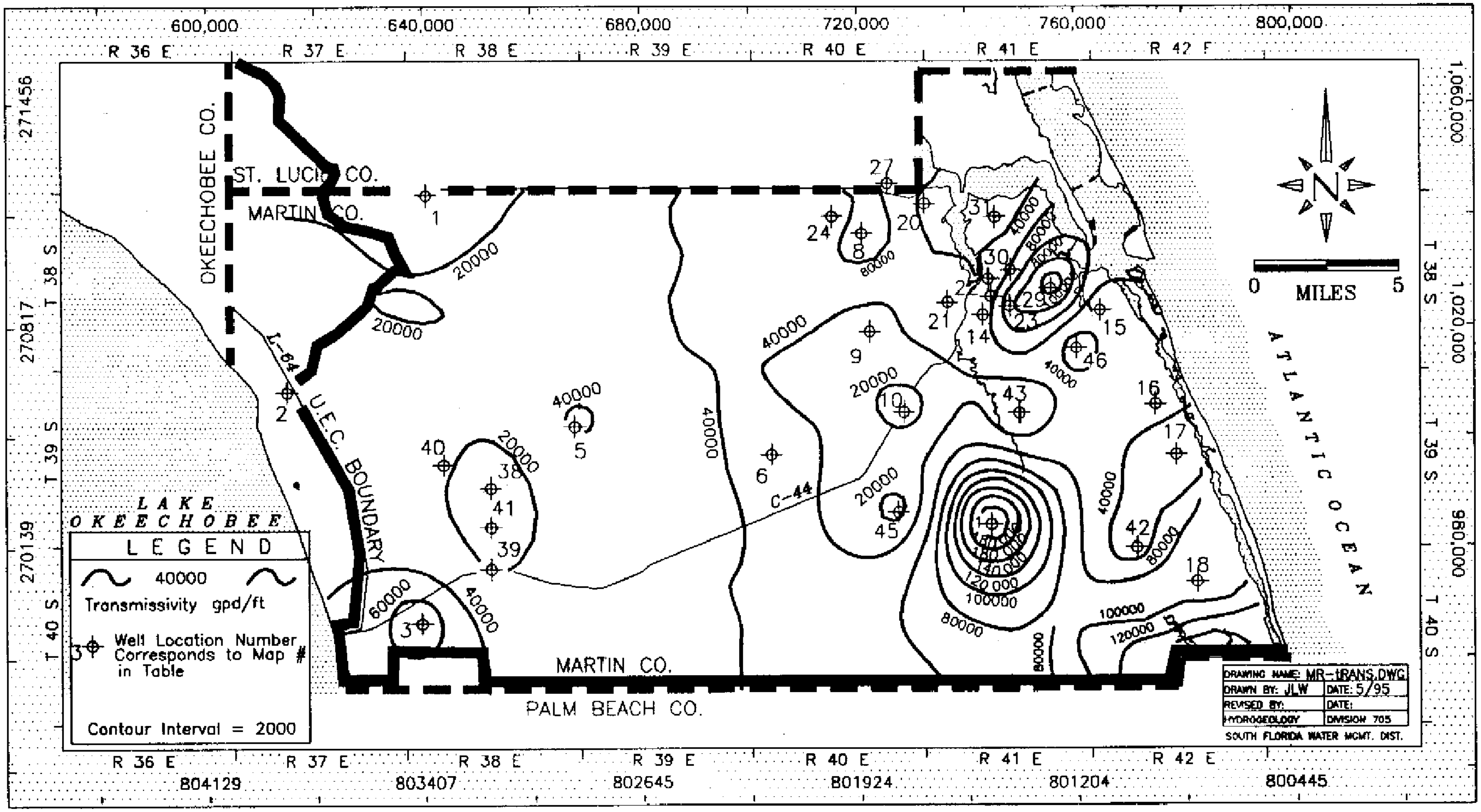


FIGURE 39. Regional Transmissivity of the Most Permeable Surficial Aquifer Units, Martin County

Summaries of APTs Conducted by the SFWMD

C-23 Canal Test Site

Map No. 1
Confidence in Analysis Low-Moderate
Status of Wells at Site Existing

Comments: This test site is located on the SFWMD's C-23 canal right-of-way as seen in Figure 40. The lithologic descriptions of the pilot hole (C-23, Well #1) are presented in Appendix A-3; geophysical logs were not run. Three wells were constructed at this location; one deep production, one deep monitor, and one shallow monitor.

The Hantush (1960) type-curve method was used to analyze the drawdown data shown in Graph 1. Fitting a type curve to early-time data (1 to 40 minutes) was difficult; therefore, a curve was selected weighted primarily on the late-time portion of the data. The early-time data was probably anomalous because the monitoring well was too close (28 feet) to the pumping well, causing non-laminar flow at the monitoring well.

The maximum drawdown in the deep monitoring well (located 28 feet from the pumping well) during pumping was 10.77 feet (see Table 4) after 16 hours of pumping at a rate of 406 gallons per minute (gpm). Drawdown in the shallow monitoring well was 0.39 feet. This relatively small drawdown in the shallow zone demonstrates that significant confinement exists between the shallow and deep zones at this site, although no evidence of this is found in the lithologic descriptions. A leakance value (not given in the type-curve plots) was computed using the following equation after Hantush-Jacob (1955):

$$\frac{k'}{b'} = 4T\frac{v^2}{r^2} \qquad (1)$$

$$\frac{k'}{b'} = \frac{4(2{,}001\ \text{ft}^2/\text{day})(.01)}{784\ \text{ft}} = 0.103\ \text{ft/day}$$

where:

T (transmissivity) = 2,001 ft^2/day
v (from type curve fit) = 0.1
r (radius) = 28 ft
k' = vertical hydraulic conductivity
b' = thickness of confining unit

Recovery was recorded for ten hours and plotted on semi-log paper (not presented here); however, the resulting semi-log plot was asymptotic and not linear. This is not surprising since the aquifer is leaky (v>0) and the Jacob recovery method is designed for a fully confined aquifer. Since no single slope could be distinguished from the plot, a Jacob (1952) straight-line analysis was not attempted.

L-65 Canal Test Site

Map No. 2
Confidence in Analysis Moderate-High
Status of Wells at Site Existing

Comments: Three wells were constructed along the L-65 canal levy in Martin County and used for this APT. They include; one deep production well, one deep monitoring well, and one shallow monitoring well. The locations of these wells are shown in Figure 41. Cuttings description from the pilot hole (L-65, Well #2) are presented in Appendix A-3, geophysical logs were not run.

Field notes taken during this test indicate that variations in the pumping rate occurred during the drawdown phase, although the magnitude was not given. Pumping rates ranged between 200 gpm and 400 gpm. An average rate of 339 gpm was computed by dividing the total gallons pumped by the total pumping time. The graphed log-log drawdown curve looks smooth and was easily matched with a Neuman (1975) type curve (Graph 2), indicating that variations in the discharge rates were probably not severe during the majority of the test. Computed transmissivity (25,064 gpd/ft) calculated from the drawdown data was lower than the 39,954 gpd/ft value calculated from the recovery data (Graph 3) using Cooper and Jacob's method (1946).

Total drawdown in the shallow monitoring well was 2.86 feet after 23 hours of pumping the deep aquifer zone at 339 gpm. The total drawdown observed in the deep monitoring well was 5.26 feet. Therefore, it can be concluded that the two zones(shallow and deep) communicate fairly well. The lithologic descriptions fail to identify confining sediments between the two zones. A fairly high value for vertical hydraulic conductivity was computed using the following equation from Neuman (1975):

$$K_v = \frac{BbT}{r^2} \qquad (2)$$

$$K_v = \frac{0.01\ (70\text{ft})(3{,}350\ \text{ft}^2/\text{d})}{4{,}900\ \text{ft}^2} = 0.478\ \text{ft/day.}$$

where:

B (type curve) = 0.01
b (aquifer thickness) = 70 feet

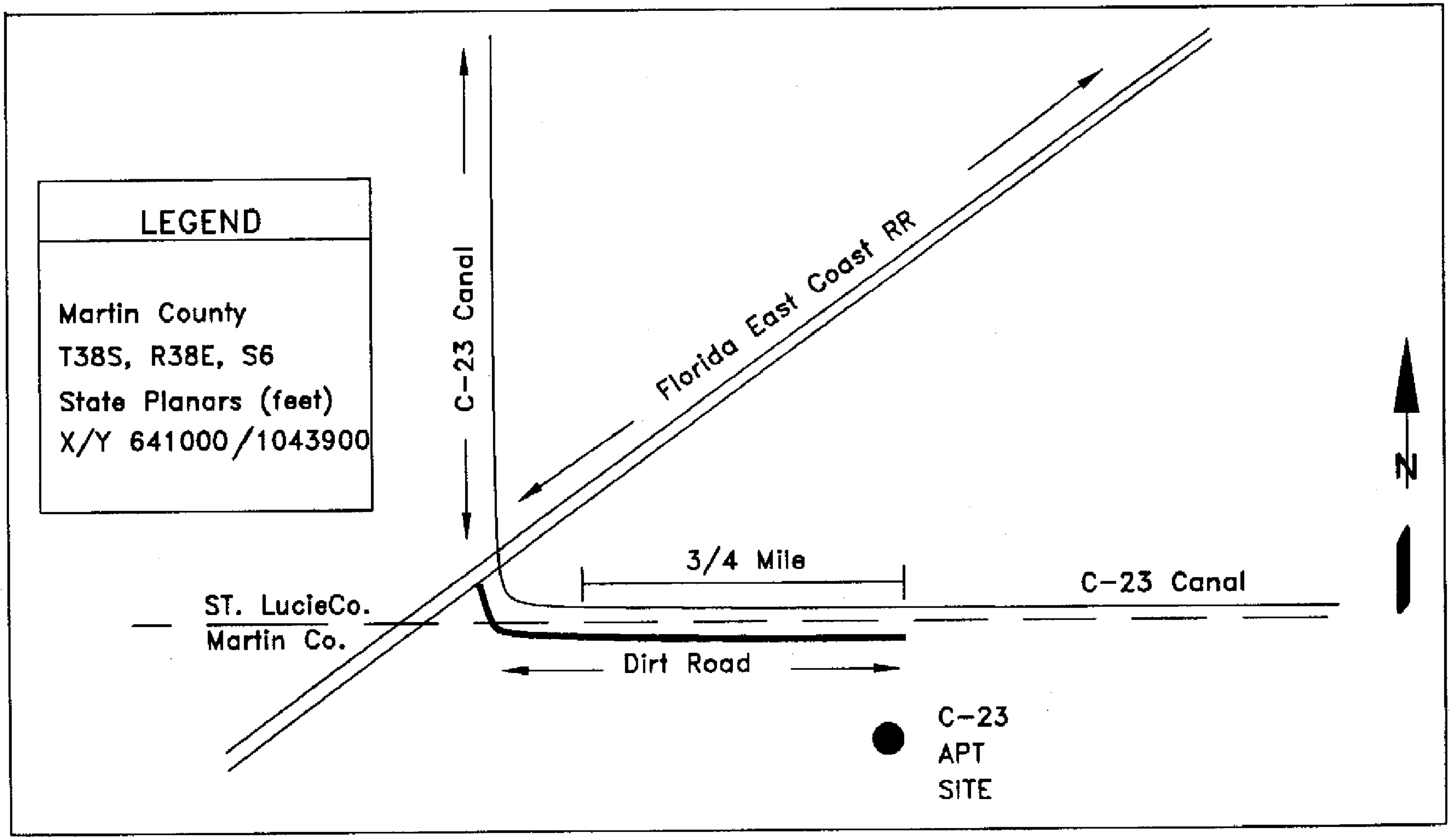
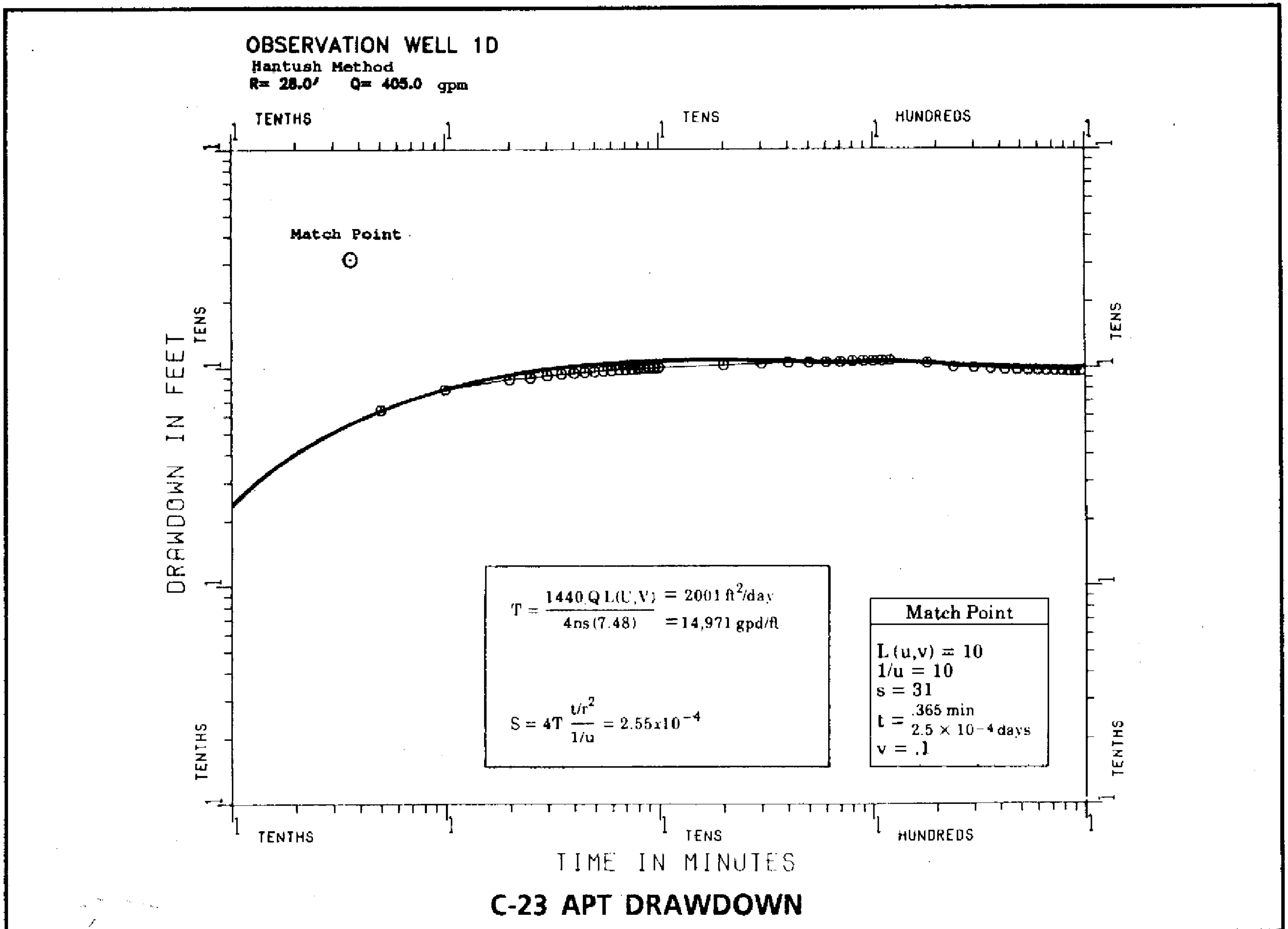


FIGURE 40. Location Map of the C-23 Canal APT Site



GRAPH 1. C-23 APT Drawdown: Observation Well 1D

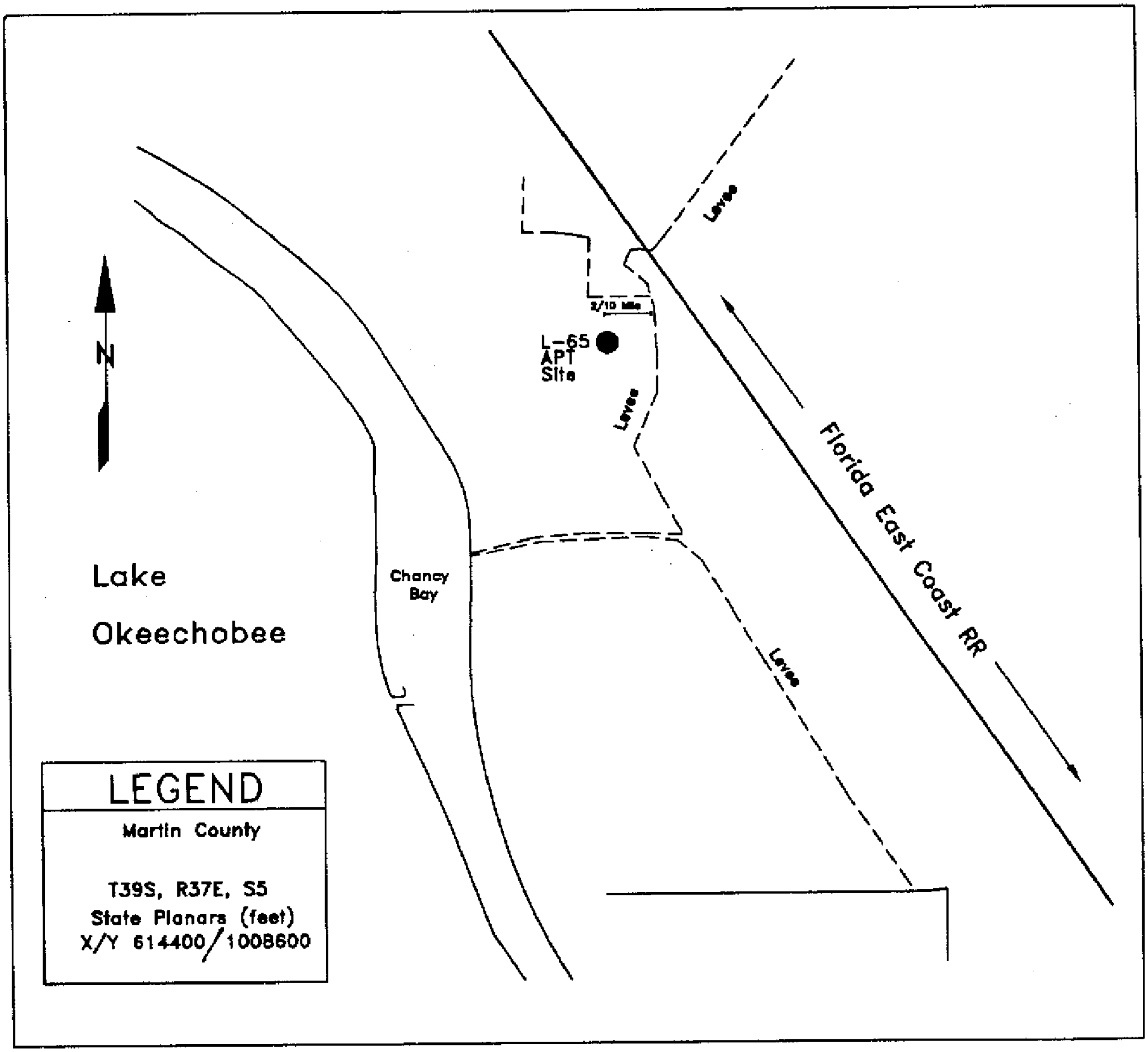
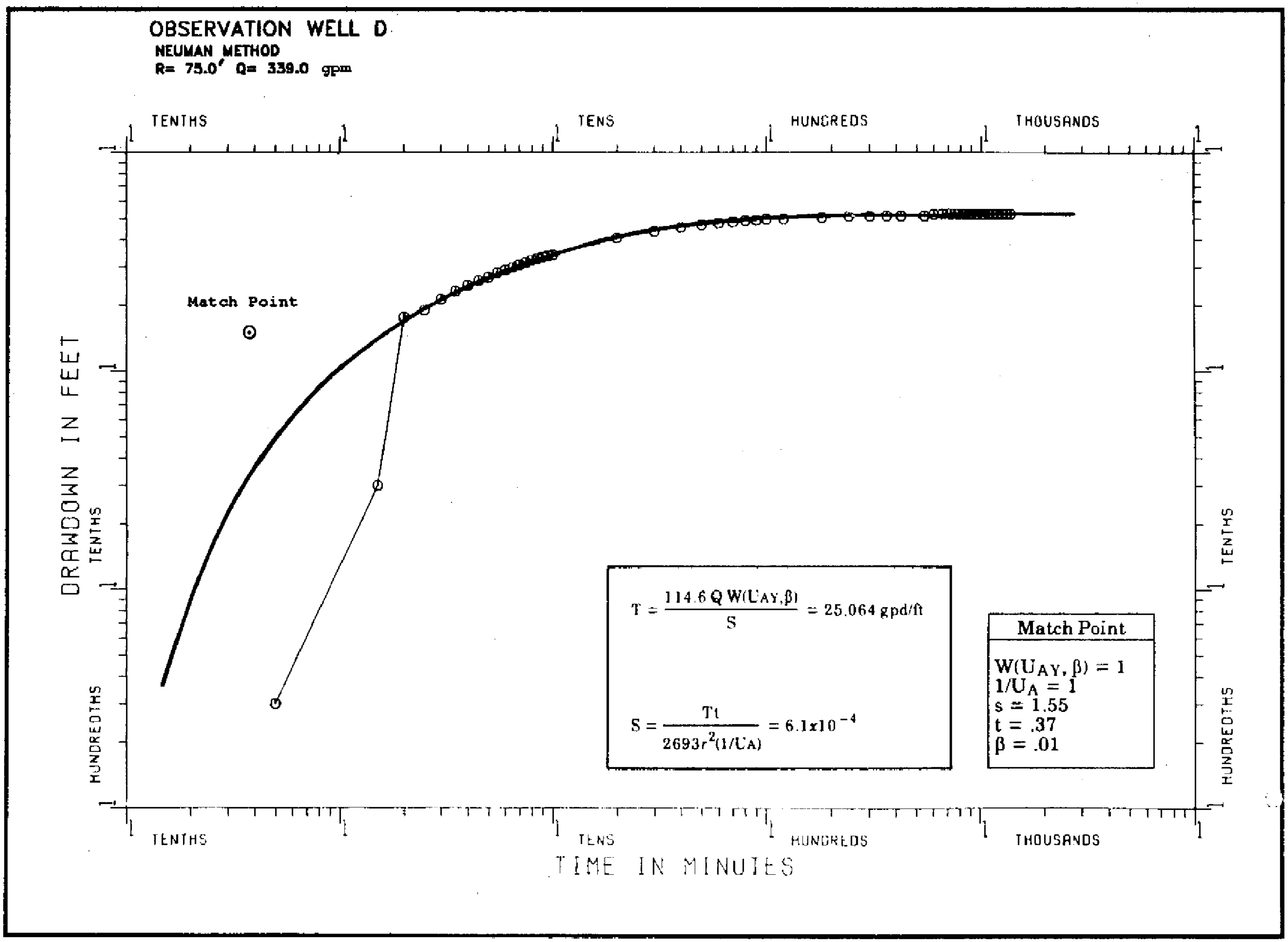
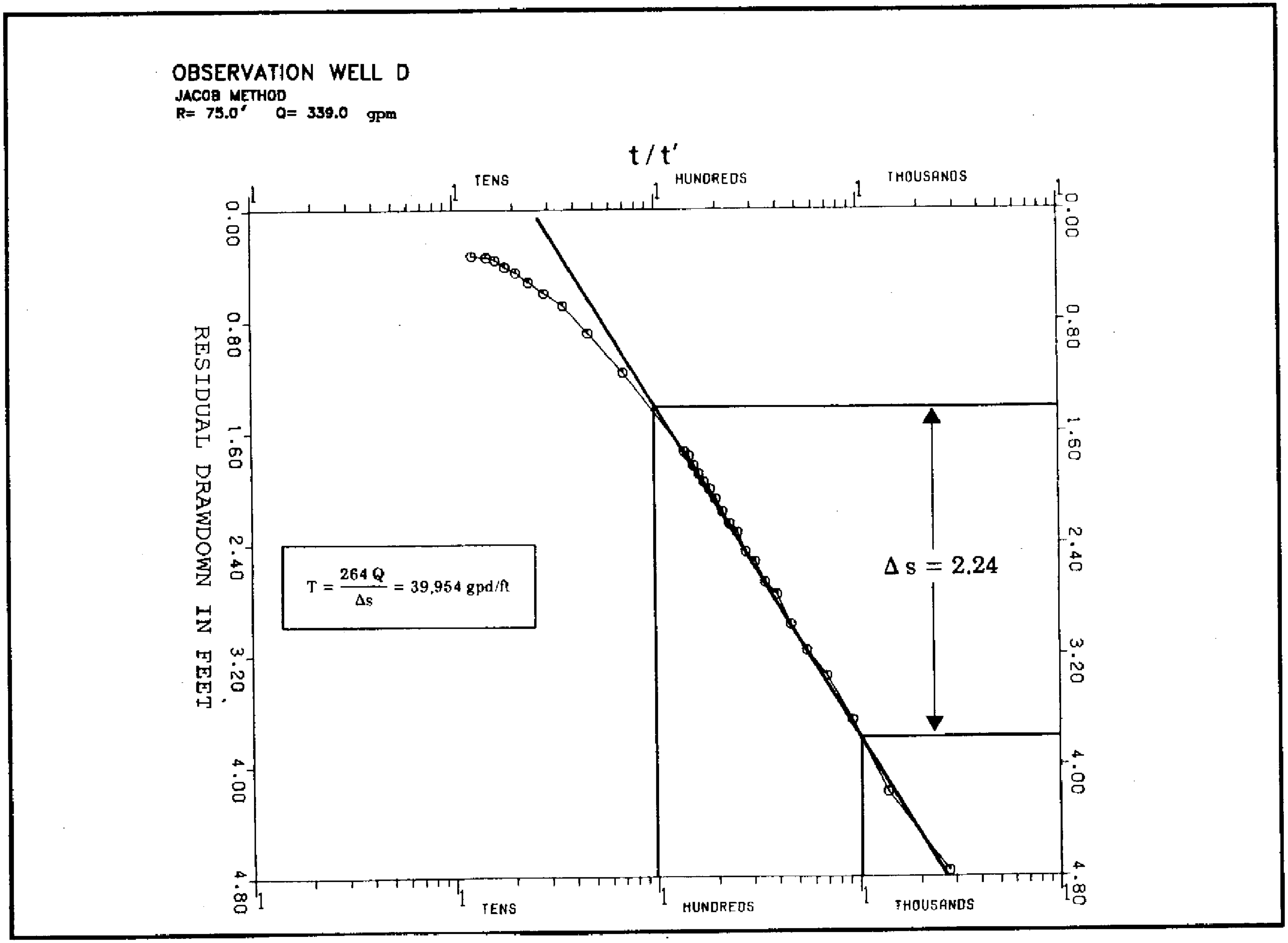


FIGURE 41. Location Map of the L-65 Canal APT Site



GRAPH 2. L-65 APT Drawdown: Observation Well D



GRAPH 3. L-65 APT Recovery: Observation Well D

K_v = vertical hydraulic conductivity
T (transmissivity) = 3,350 ft^2/d
r (radius) = 75 feet

Allapatah Ranch Test Site

Map No. 5
Confidence in Analysis High
Status of Wells at Site Existing

Comments: The Allapatah Ranch APT site is located in Martin County approximately two miles north of State Road (SR) 710 on SR 609, as shown in Figure 42. Lithologic descriptions and geophysical logs of the pilot hole are presented in Appendices A-1 (W-16400) and B (085000079), respectively. Three wells were constructed at this site: one deep production, one deep monitor, and one shallow monitor. The shallow and deep monitoring wells were constructed 125 feet and 18 feet away from the deep pumping well, respectively. The total depth of the shallow monitoring well was not documented. The production well is screened between 40 feet and 120 feet BLS.

The Neuman (1975) type-curve and Jacob (1952) straight-line methods were used to analyze drawdown and recovery data, respectively. The resulting graphs are presented in Graphs 4 and 5. Computed transmissivities (42,304 gpd/ft and 46,978 gpd/ft) agree very well between methods, and an excellent type-curve fit to the drawdown data was obtained. No mention of problems or irregularities during this test were documented.

The steady-state drawdown in the deep and shallow monitoring wells after 22 hours of pumping at 347 gpm was 5.17 feet and 4.65 feet, respectively, which indicates that these two zones are well connected. This is supported by the lithologic logs which describe the section between 0 feet and 40 feet BLS as being comprised of sand and shell. A relatively low value for vertical hydraulic conductivity was computed using Equation 2 from Neuman (1975). Because it is low, this value probably represents leakance from a source below the pumping zone, not from the shallow zone itself.

$$K_v = \frac{BbT}{r^2} = \frac{0.001\ (80\ ft)(5655\ ft^2/d)}{15{,}625\ ft^2} = 0.029\ ft/day$$

where:
B (type curve slope) = 0.001
b (thickness confining layer) = 80 feet
T (transmissivity) = 5,655 ft^2/d
r (radius) = 125 feet

Caulkin's Grove Test Site

Map No. 6
Confidence in Analysis Moderate
Status of Wells at Site Existing

Comments: This site is located approximately two miles north of SR-726 and six miles east of Indiantown, as shown in Figure 43. Lithologic descriptions collected from the pilot well (Caulkin's Grove Well #4) at this site are presented in Appendix A-3. Geophysical logs were not run. Three wells were constructed here: one shallow monitor, one deep monitor, and one deep production. The shallow and deep monitoring wells were constructed 45 feet and 70 feet away from the pumping well, respectively. The total depth of the shallow monitoring well was not recorded and is unknown. The deep production well is screened between 30 feet and 110 feet BLS.

Drawdown and recovery data were analyzed using the Neuman (1975) type-curve and Jacob (1952) straight-line methods, respectively, as shown in Graphs 6 and 7. Calculated transmissivities (46,084 gpd/ft and 63,969 gpd/ft) from the two methods agreed to some extent (within 40% of each other), and confidence in the analyses was ranked moderate to high. Available field notes indicate there were no problems during the course of this test.

The steady-state drawdown in the deep and shallow monitoring wells after 19 hours of pumping at 378 gpm was 4.35 feet and 1.10 feet, respectively, which indicates that a semi-confining layer exists between these two zones. However, no evidence of low-permeability materials between 0 and 30 feet BLS was apparent in the lithologic descriptions. A value for vertical hydraulic conductivity was computed using the Neuman (1975) equation:

$$K_v = \frac{BbT}{r^2} = \frac{0.004\ (80\ ft)(6{,}160\ ft^2/day)}{15{,}625\ ft^2} = 0.126\ ft/day$$

where:
B (type curve slope) = 0.004
b (thickness confining layer) = 80 feet
T (transmissivity) = 6,160 ft^2/d
r (radius) = 125 feet

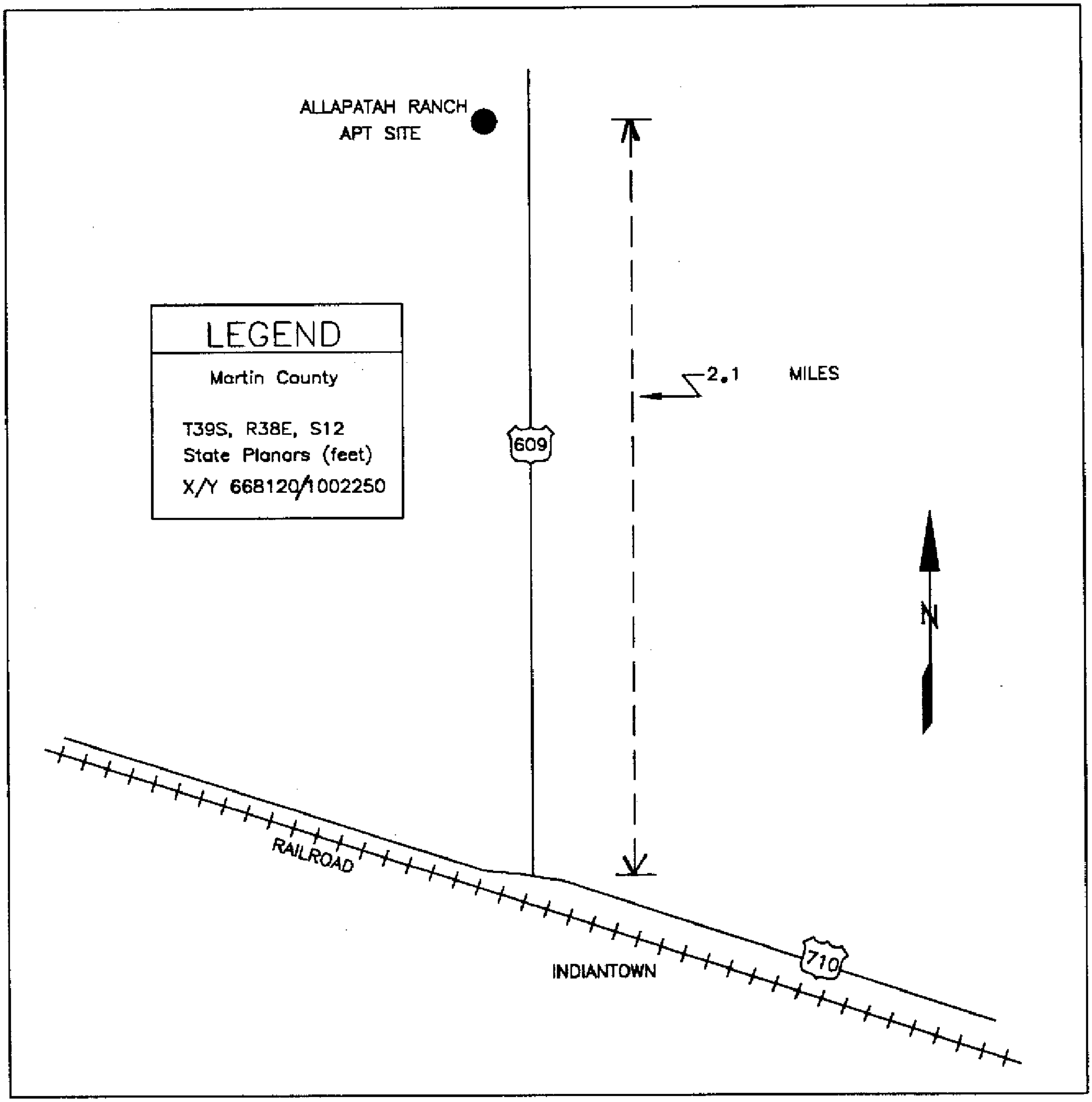
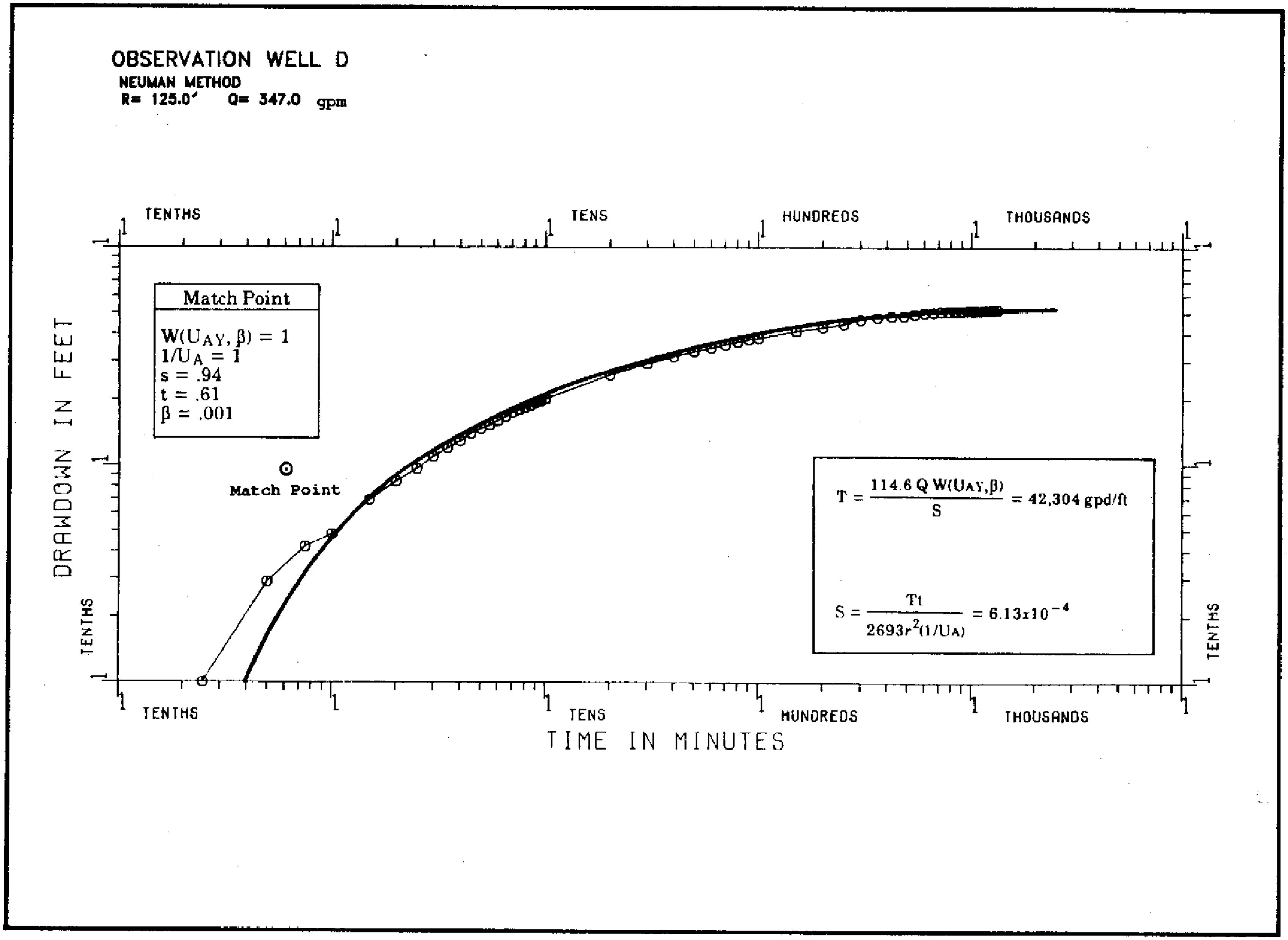
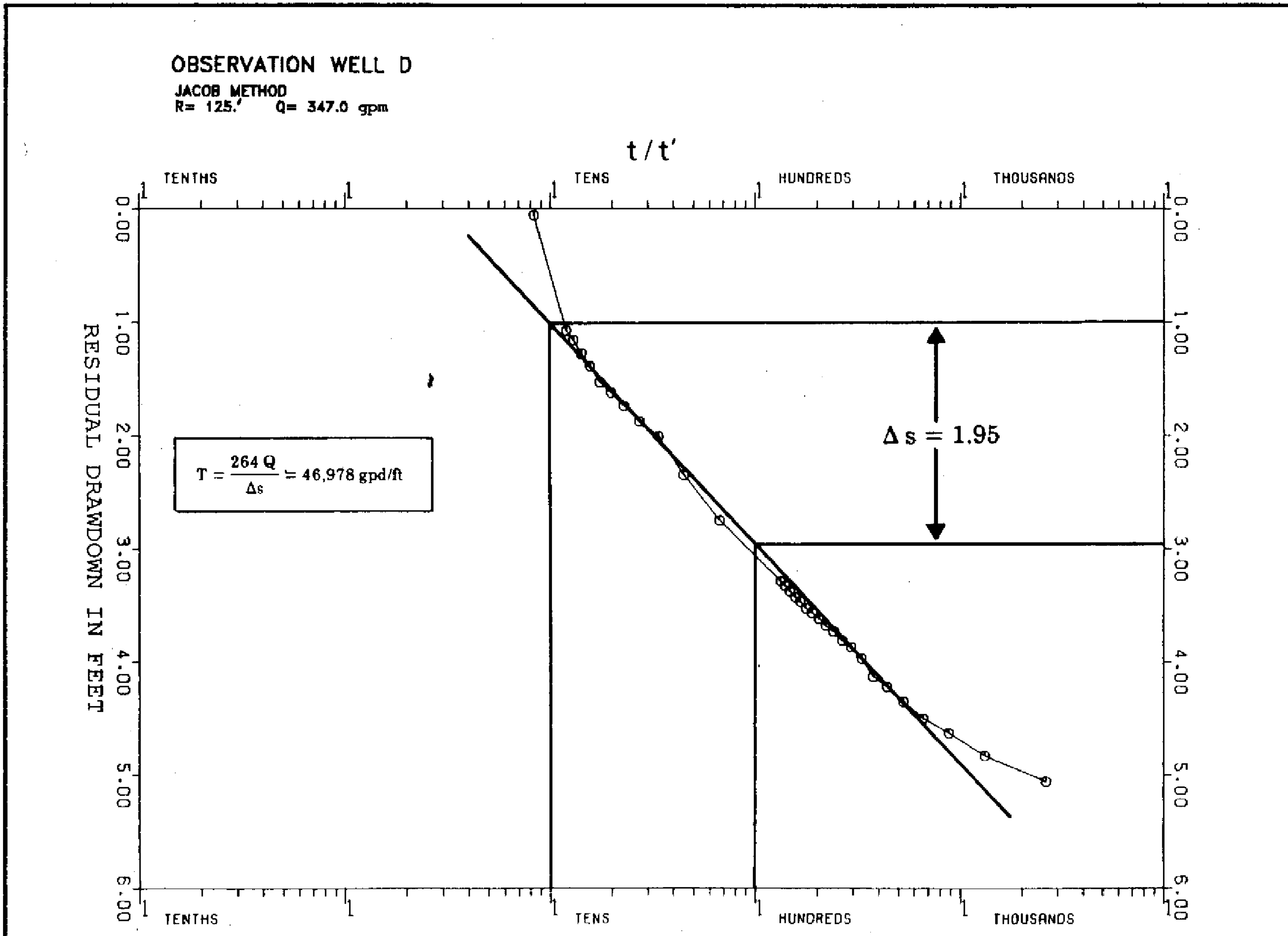


FIGURE 42. Location Map of the Allapatah Ranch APT Site



GRAPH 4. **Allapatah Ranch APT Drawdown: Observation Well D**



GRAPH 5. Allapatah Ranch APT Recovery: Observation Well D

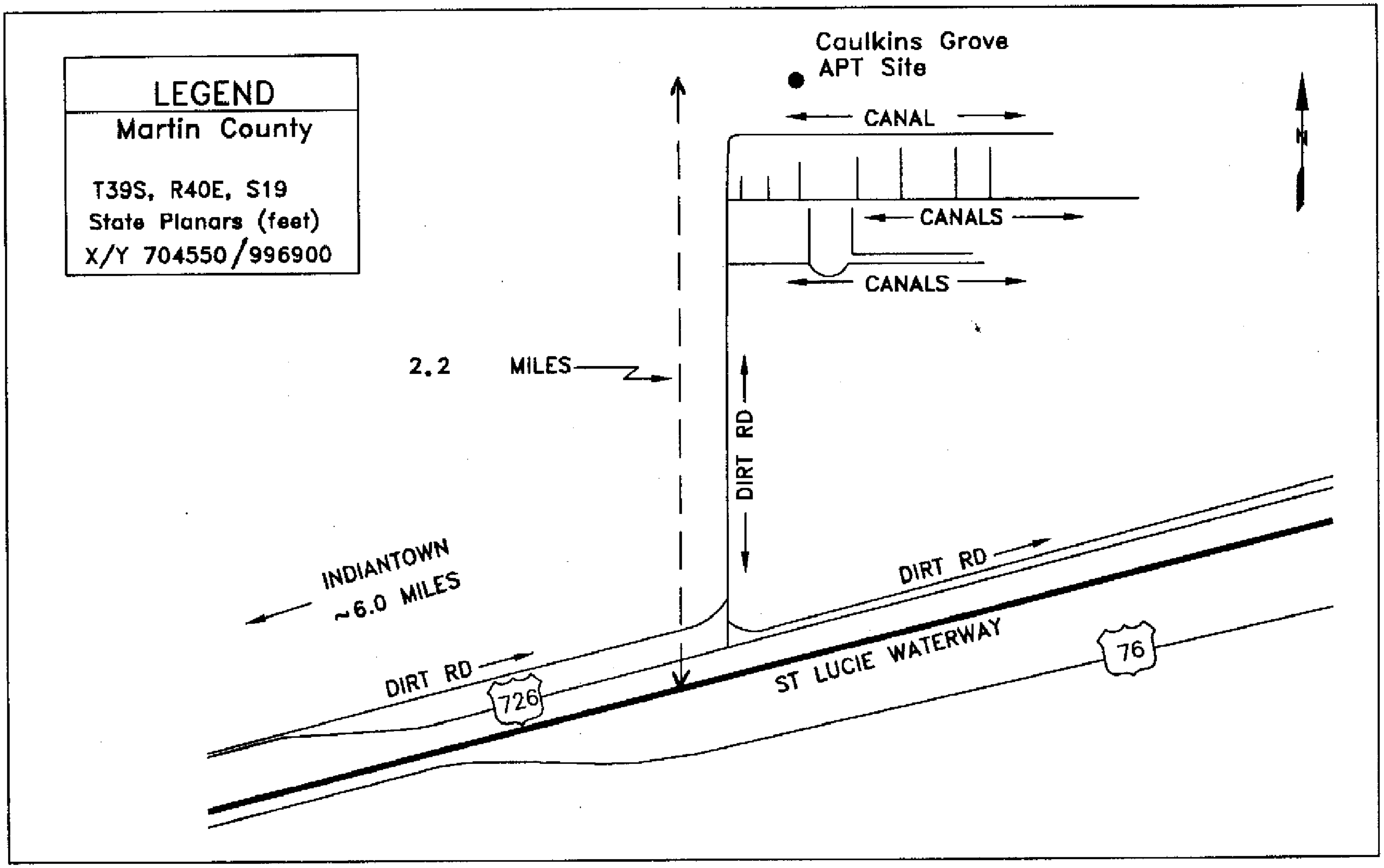
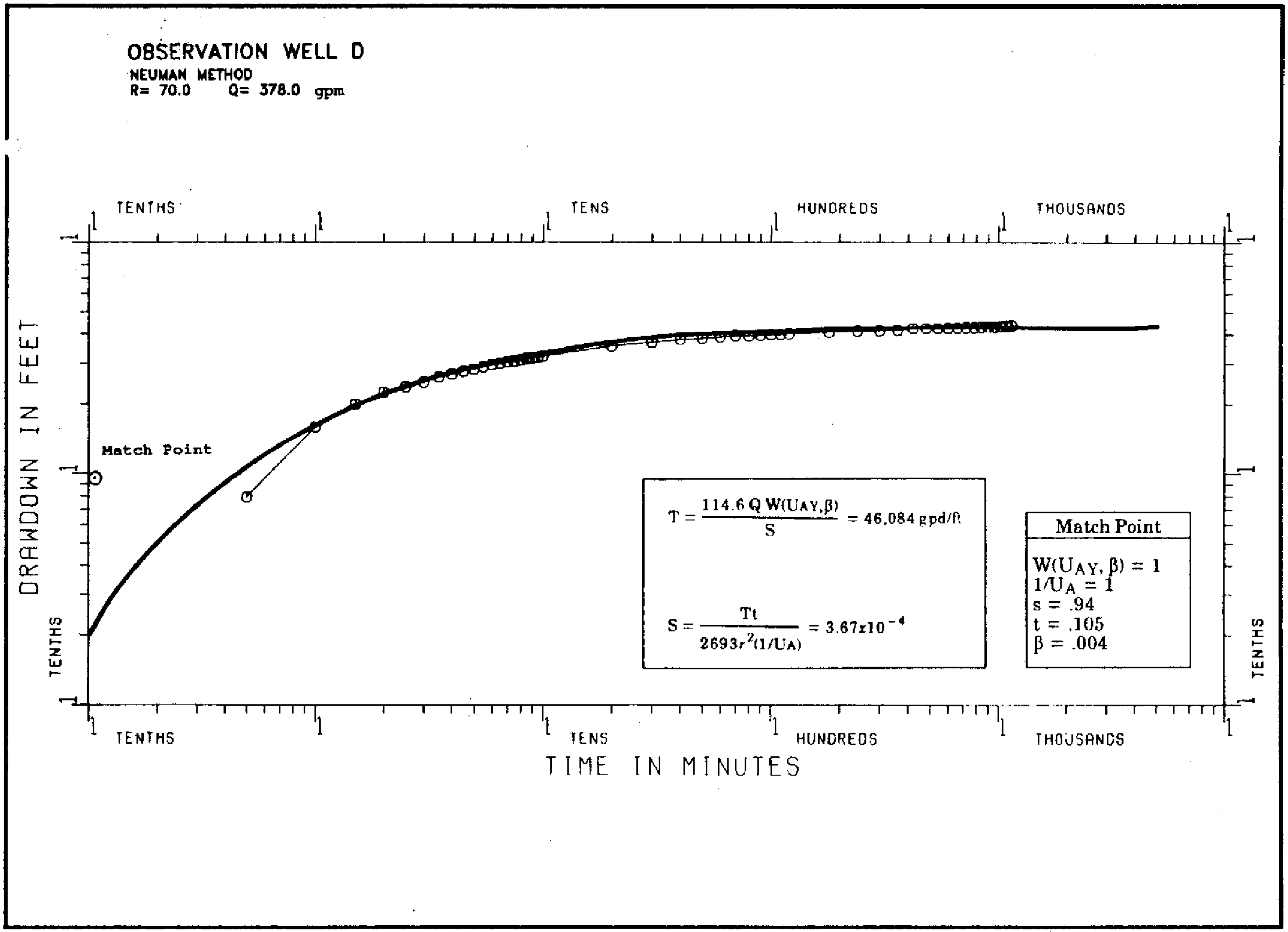
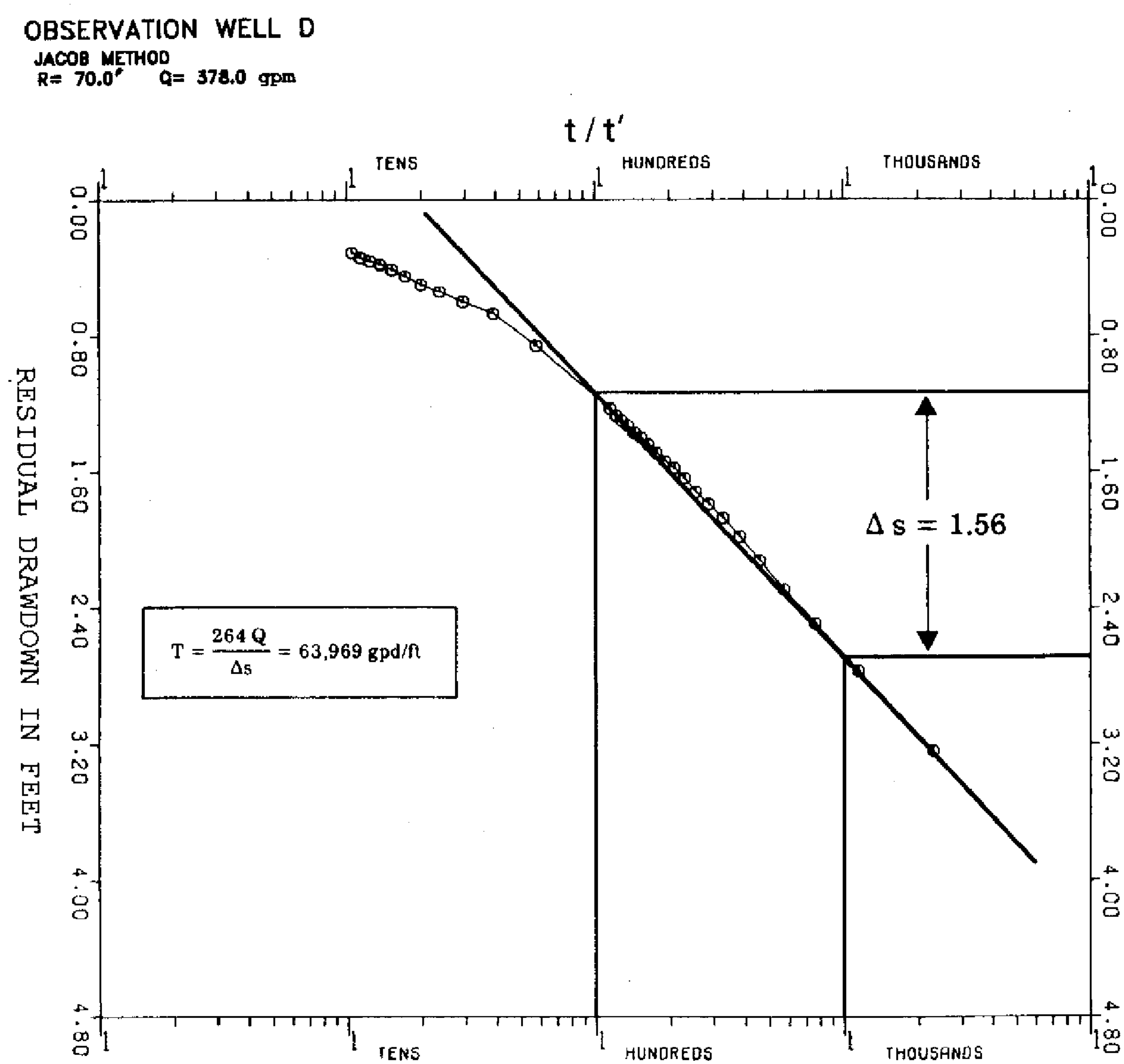


FIGURE 43. Location Map of the Caulkin's Grove APT Site



GRAPH 6. Caulkin's Grove APT Drawdown: Observation Well D



GRAPH 7. Caulkin's Grove APT Recovery: Observation Well D

State Road 76 Test Well

Map No. 30
Confidence in Analysis Moderate
Status of Wells at Site Existing

Comments: This APT site is located in northeastern Martin County near the intersection of SR-76 and Indian Street, just west of Witnam Airfield, as shown in Figure 44. Cuttings descriptions for the deep observation well (SR-76, Well #3) are presented in Appendix A-3, while geophysical logs are not available. Two wells, one deep production and one deep monitor, were constructed.

Drawdown data was analyzed using Neuman (1975) type curves and recovery data with the Jacob (1952) straight-line method. These analyses are presented in Graphs 8 and 9, respectively. The transmissivity values obtained from the two methods were 25,003 gpd/ft and 38,951 gpd/ft, respectively (a 56% difference).

Documentation of this test was generally poor. No problems or unusual circumstances were reported. The monitoring well, however, was located only 50 feet from the pumping well. Given that the thickness of the aquifer here is approximately 100 feet, it can be assumed that there may have been some non-laminar flow at the monitoring well during pumping.

No shallow monitoring well was constructed on this site; therefore, water-level changes in the shallow sand/soil unit (in response to pumping the deeper aquifer) are not known. A clay lens between 30 feet and 40 feet BLS was recorded in the lithologic descriptions, so at least some confinement may exist between these two zones. A value for vertical hydraulic conductivity was computed using Equation 2 (Neuman, 1975):

$$K_v = \frac{BbT}{r^2} = \frac{0.004\,(100\text{ ft})(3342\text{ ft}^2/\text{d})}{2{,}500\text{ ft}^2} = 0.535\text{ ft/day}$$

where:

B (type curve slope) = 0.004
b (thickness confining layer) = 100 feet
T (transmissivity) = 3,342 ft^2/d
r (radius) = 50 feet

Jonathan Dickinson State Park Test Well

Map No. 42
Confidence in Analysis Moderate
Status of Wells at Site Existing

Comments: This APT site is located near the Jonathan Dickinson State Park, east of Kitchen Creek Canal and south of the power lines, as shown in Figure 45. Figure 46 shows the locations of the deep production well, two deep monitoring wells and one shallow monitoring well. The pilot hole (M-1281) was drilled to a depth of 240 feet BLS, cuttings descriptions of which are presented in Appendix A-1, and indexed under the FGS number W-16397. The lithologic column, presented in Figure 47, was developed from these descriptions. Geophysical logs were run on the pilot hole and are indexed under the SFWMD I.D.# 085000080 found in Appendix B. Water samples were collected from the pumping well during the APT and analyzed for major ions, the results of which are given in Table 6.

Drawdown and recovery data from the two deep observation wells, located 75 feet and 157 feet from the pumping well, were used in the analysis presented in Graphs 10 through 13. Drawdown recorded in the near well (Well 1D) had an excellent type-curve fit (Neuman, 1975), resulting in a computed transmissivity of 26,965 gpd/ft. However, drawdown measurements taken from the far well (2D) did not fit to type curves very well. Separate early-time and late-time fits were established resulting in computed transmissivities of 21,075 gpd/ft and 37,420 gpd/ft, respectively.

Recovery data from both the close and distant deep monitoring wells were analyzed using the Jacob (1952) straight-line method resulting in computed transmissivities of 35,200 gpd/ft and 23,730 gpd/ft, respectively. Transmissivities for the deeper zone ranged between 21,075 gpd/ft and 37,420 gpd/ft, whereas storativity values ranged between 4.3 E-4 to 5.2 E-4.

Water-levels in the shallow monitoring well, screened from 20 feet to 40 feet BLS, and located 75 feet from the pumping well, drewdown only 0.24 feet in response to pumping the deeper zone at 160 gpm for 71.5 hours. This indicates that the confinement between these two zones is good. Confinement is further evidenced by the presence of a clay bed recorded in the lithologic log between 0 feet and 20 feet BLS. A value for vertical hydraulic conductivity is computed below. Late-time data from the deep monitoring well, located 157 feet from the production well, was used along with Equation 2 (Neuman,

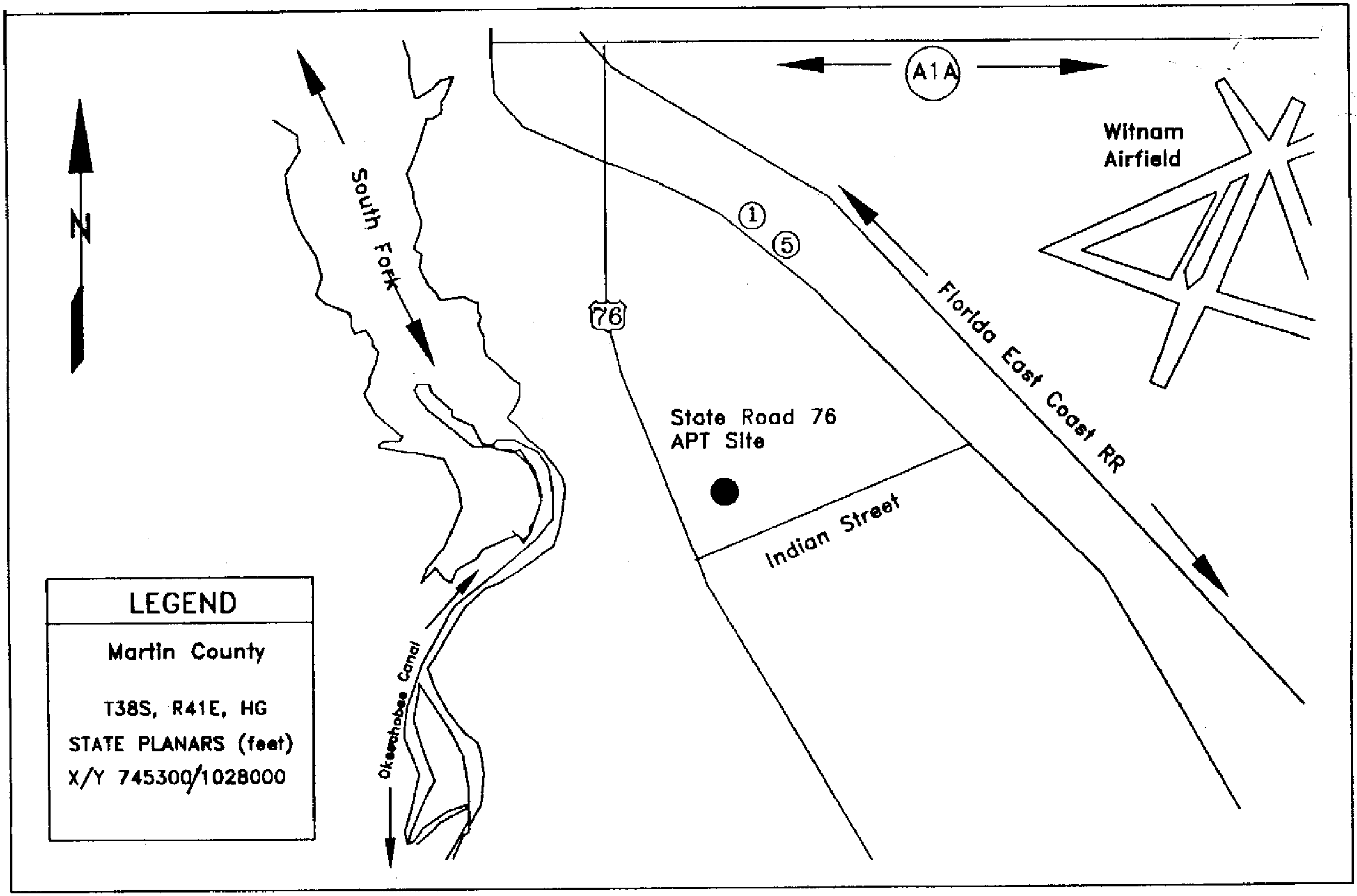
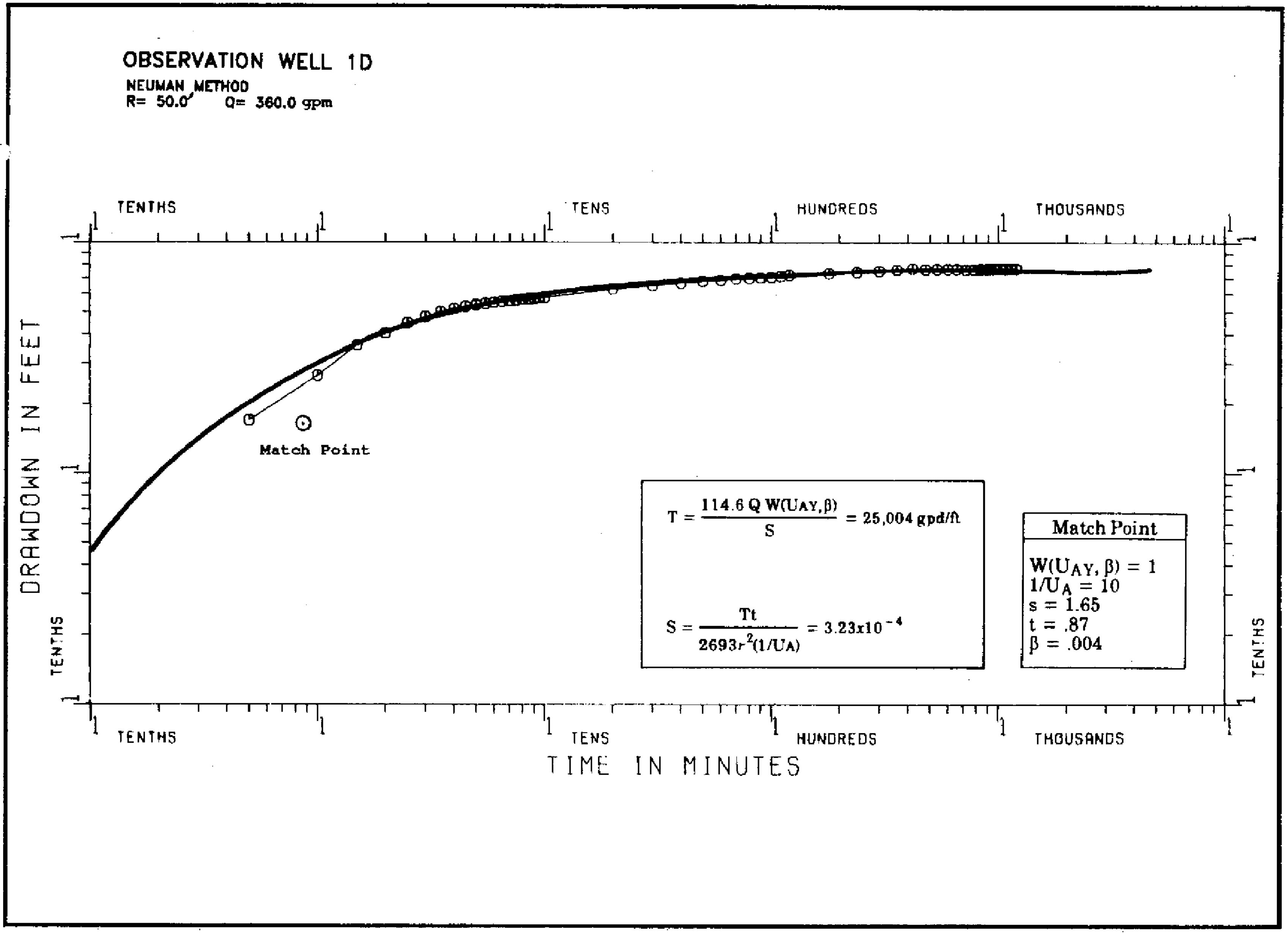
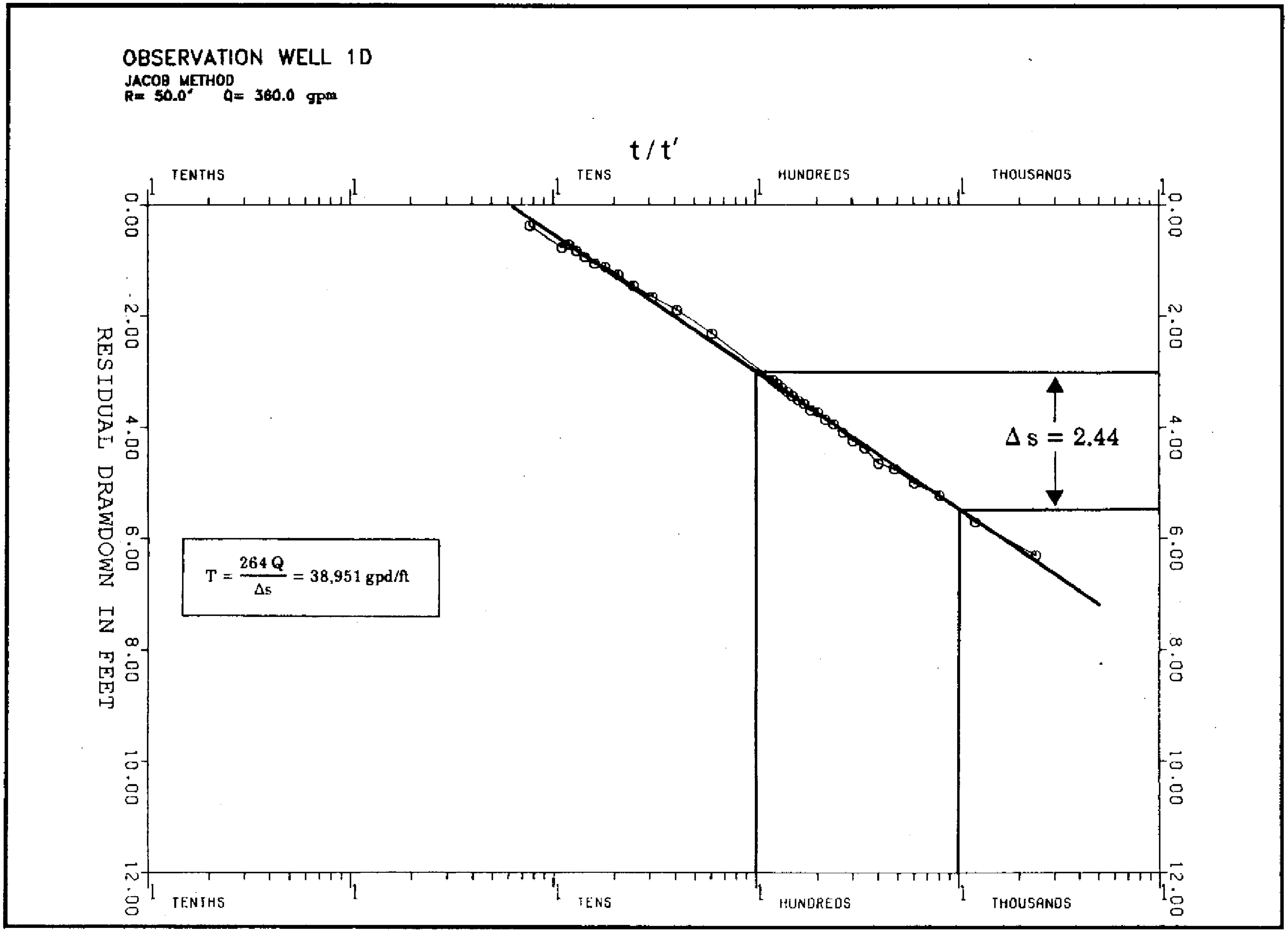


FIGURE 44. Location Map of State Road 76 APT Site



GRAPH 8. **State Road 76 APT Drawdown: Observation Well 1D**



GRAPH 9. State Road 76 APT Recovery: Observation Well 1D

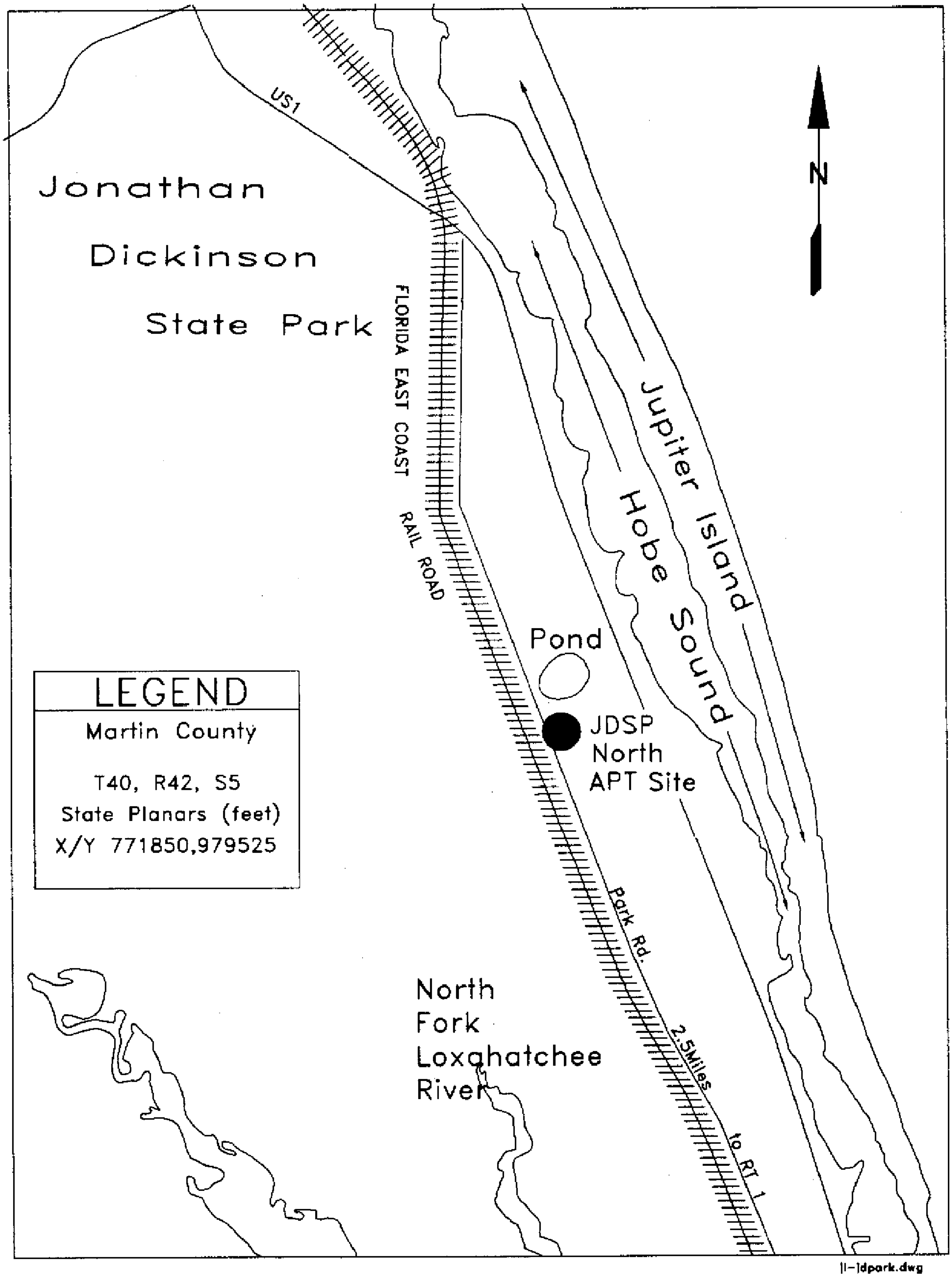


FIGURE 45. Location Map of the Jonathan Dickinson State Park APT Site

JONATHAN DICKINSON STATE PARK APT SITE

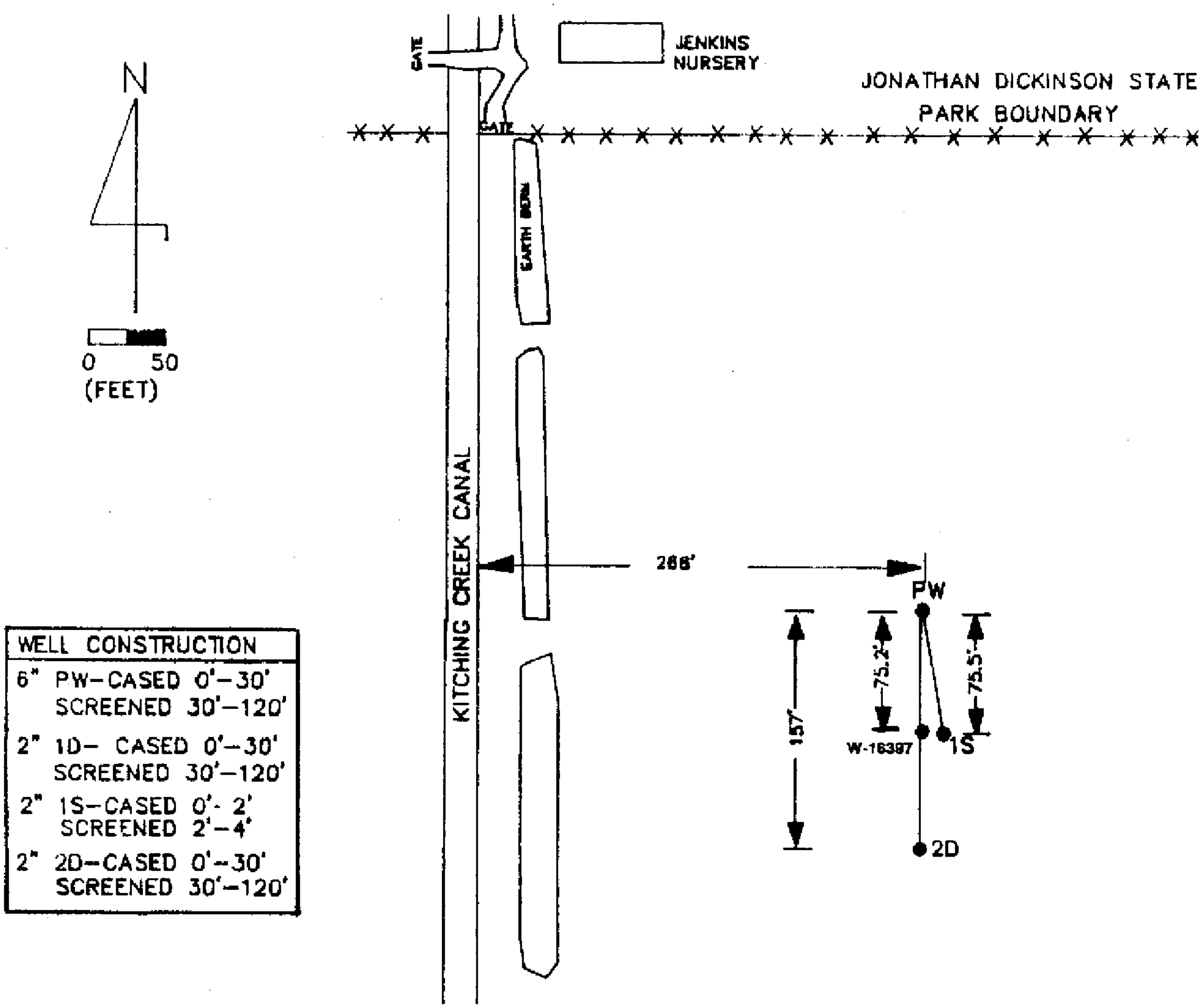


FIGURE 46. Site Layout and Well Construction Details- Jonathan Dickinson State Park APT Site

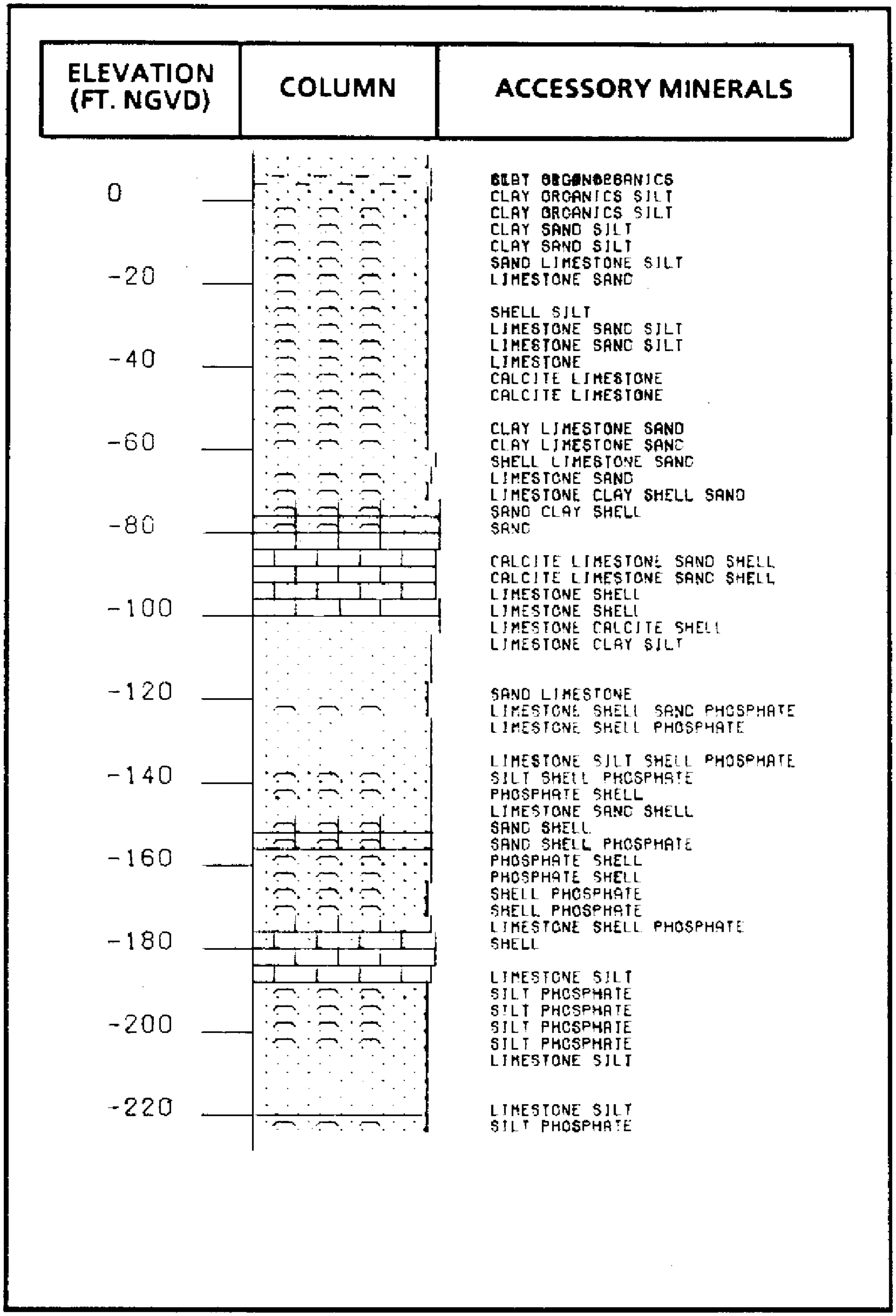
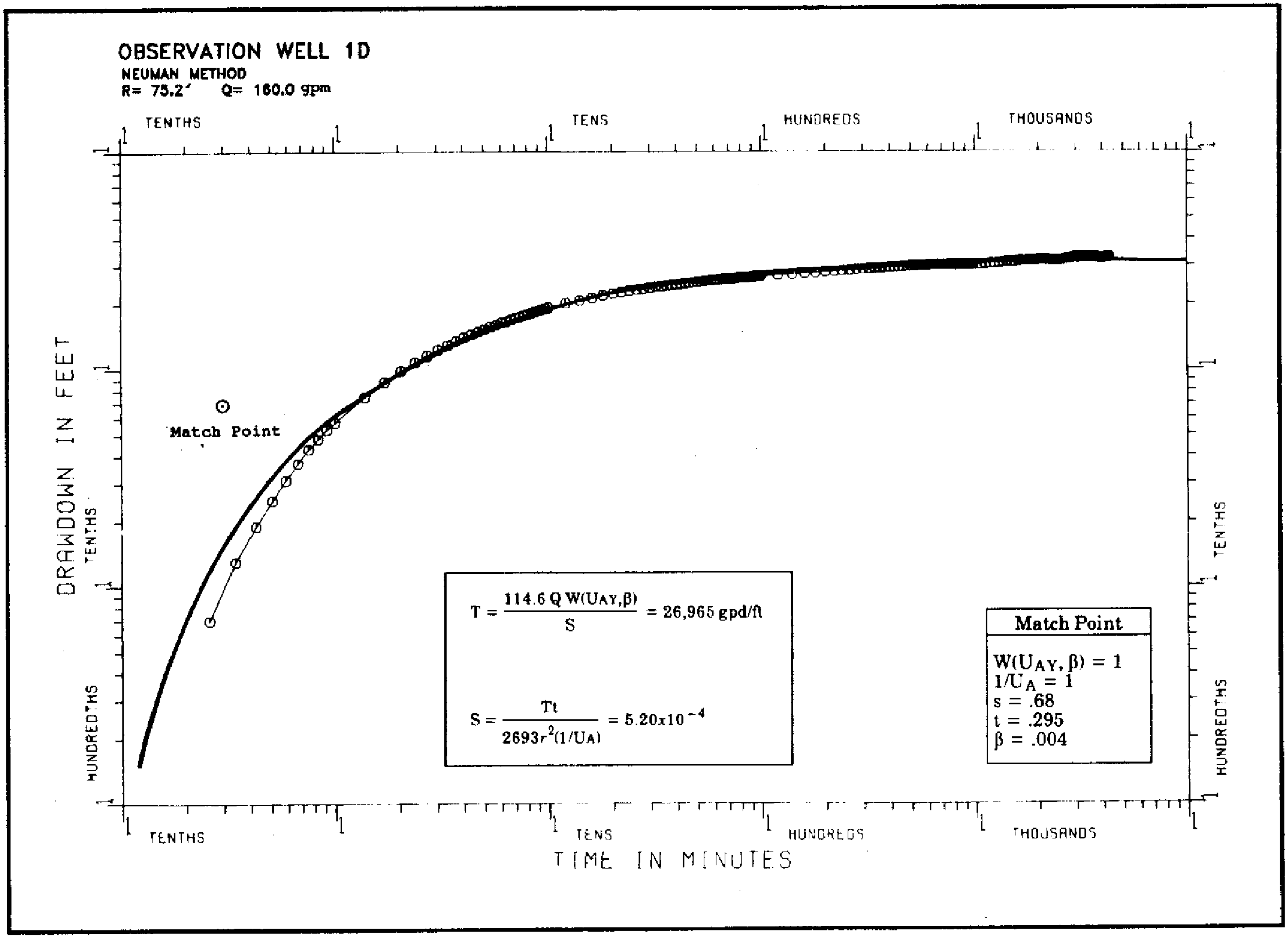


FIGURE 47. Lithologic Column - Jonathan Dickinson State Park APT Site

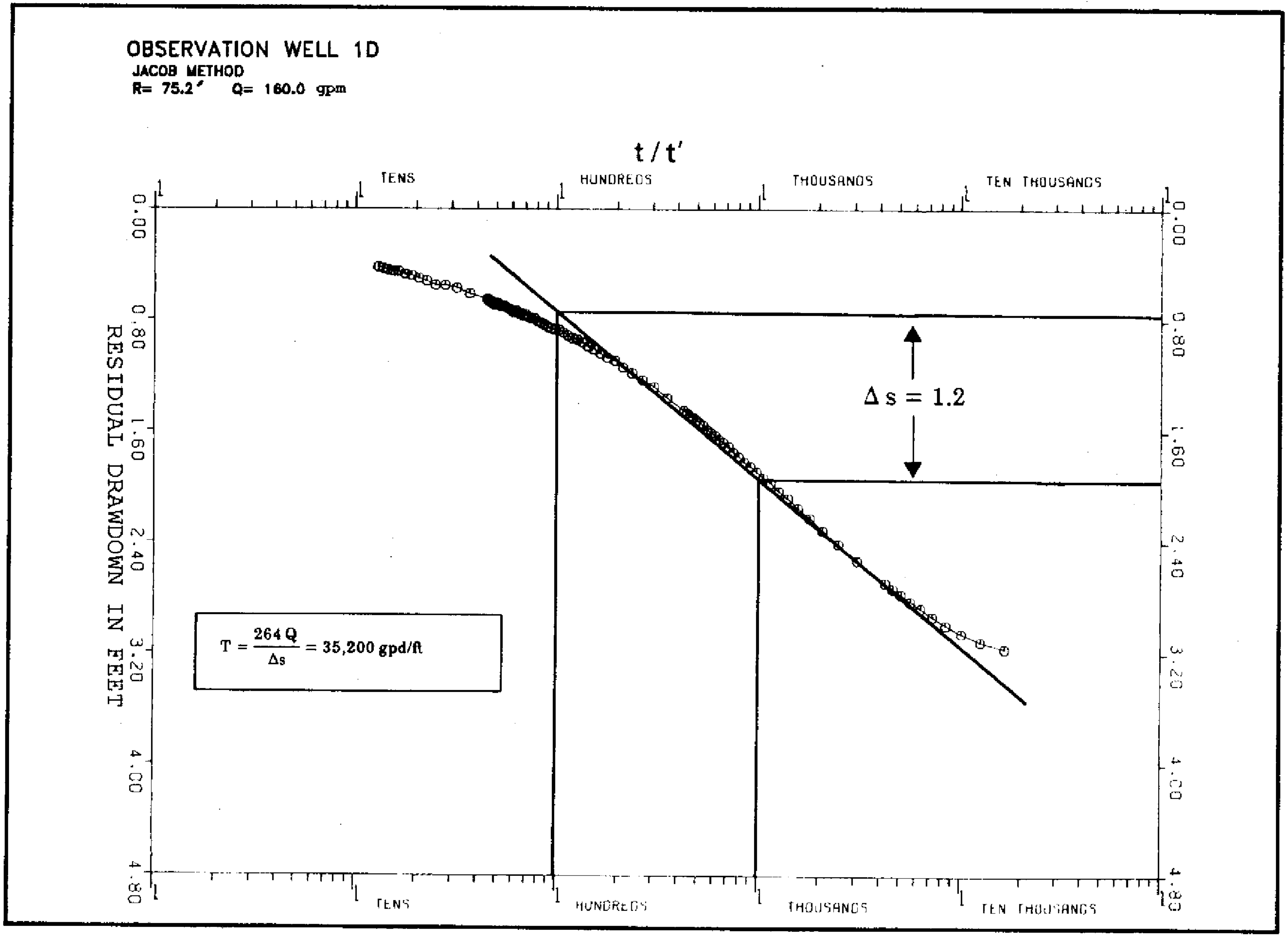
TABLE 6. **Water Quality Laboratory Results - Jonathan Dickinson APT Site**

Parameter Tested	Start of Test 9/26/89	End of Test 9/29/89
Sodium	35.10	33.51
Potassium	.67	.48
Calcium	.40	107.0
Magnesium	.16	4.21
Chloride	59.6	59.6
Sulfate	<2.0	<2.0
Total Alkalinity	259	289
Fluoride	.378	.433
Silicon Dioxide	15.74	15.81
Total Dissolved Strontium	1.00	.90
Total Iron	1.90	1.87
Total Dissolved Iron	.43	.64
Total Dissolved Solids	427.1	429.1
Color (Units)	75	64
Lab Conduct. (umhos/cm)	429	478
Lab pH (Units)	6.69	7.09

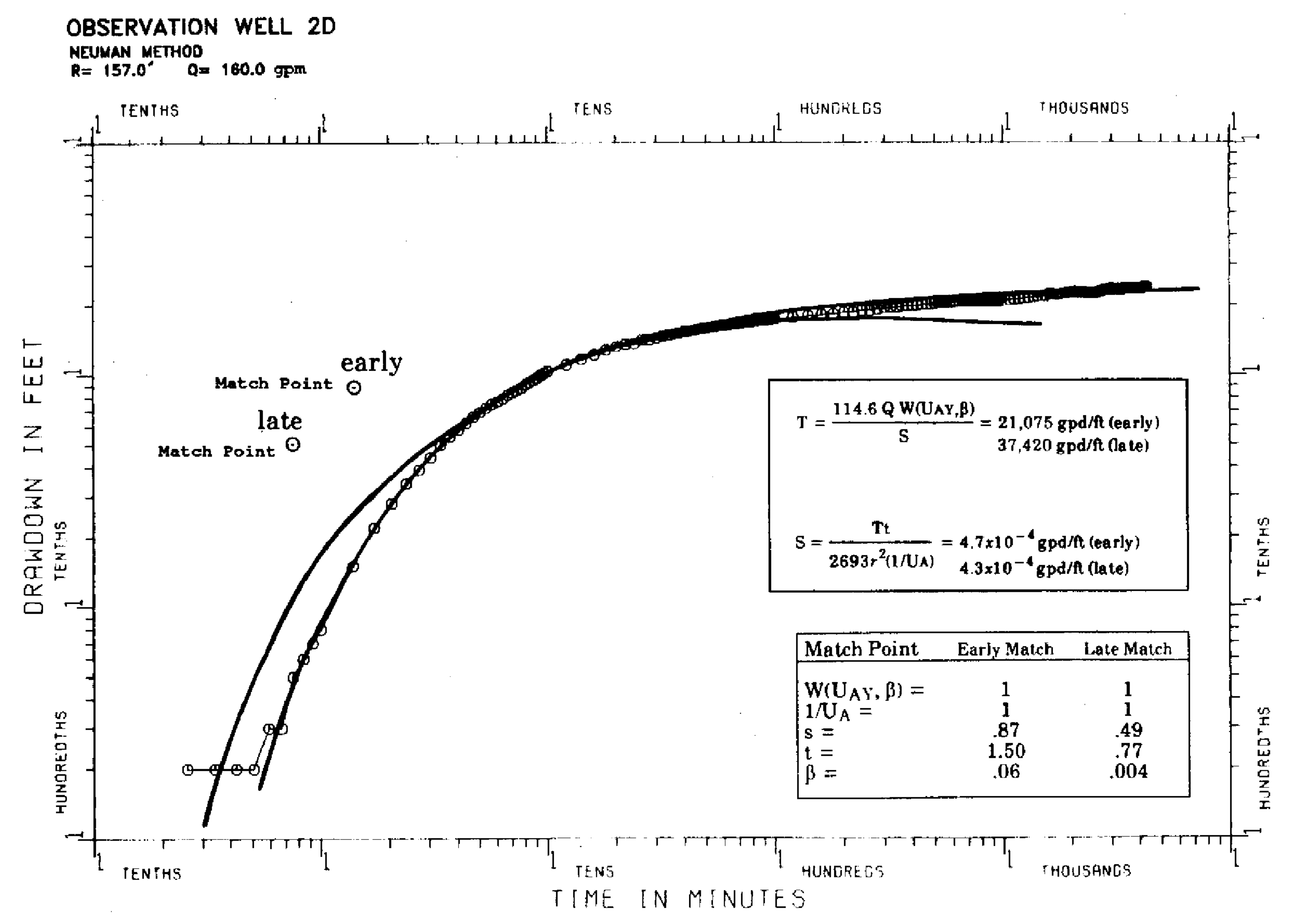
Note: All results are given in mg/l unless otherwise specified.



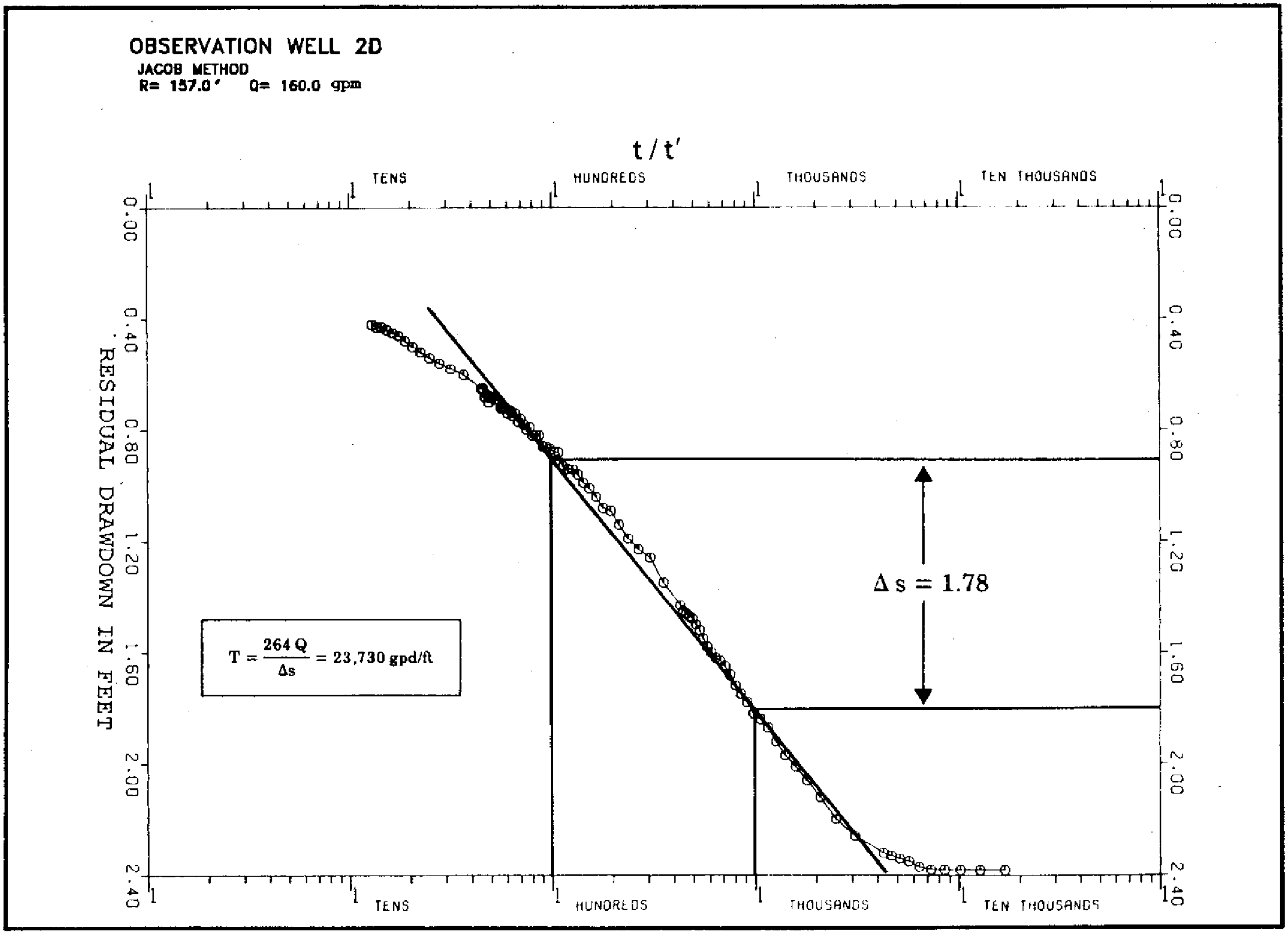
GRAPH 10. Jonathan Dickinson State Park APT Drawdown: Observation Well 1D



GRAPH 11. Jonathan Dickinson State Park APT Recovery: Observation Well 1D



GRAPH 12. Jonathan Dickinson State Park APT Drawdown: Observation Well 2D



GRAPH 13. Jonathan Dickinson State Park APT Recovery: Observation Well 2D

1975) to compute the leakance value of 0.073 ft/day as shown below.

$$K_v = \frac{BbT}{r^2} = \frac{0.004\ (90\ ft)(5{,}002\ ft^2/d)}{24{,}649\ ft^2} = 0.073\ ft/day$$

where:

B (type-curve slope) = 0.004
b (thickness confining layer) = 90 feet
T (transmissivity) = 5,002 ft^2/d
r (radius) = 157 feet

Mobil (TP&J) Test Site

Map No. 43	
Confidence in Analysis	High
Status of Wells at Site:	Existing

Comments: This site is located in east-central Martin County (Figure 48), east of the intersection of Interstate-95 (I-95) and SR 76. Figure 49 illustrates the locations of the seven wells drilled at this site, along with well construction details. The pilot hole was drilled to a depth of 182 feet BLS. Cuttings description for this well (W-16460) are presented in Appendix A-1 and were used to develop the lithologic column shown in Figure 50. Geophysical logs were also run on this pilot hole and are indexed under the SFWMD I.D.# 085000082 in Appendix B. The pumping well was screened across an intermediate aquifer between 60 feet and 85 feet BLS. A water sample was collected from this well during the APT and analyzed for major ions, the results of which are listed in Table 7.

Water-level changes from the two intermediate observation wells, located 76 feet and 153 feet from the pumping well, were used in the analyses presented in Graphs 14 through 17. Drawdown recorded from both intermediate monitoring wells (wells 1I and 2I) had excellent Neuman (1975) type-curve fits which resulted in transmissivity computations of 12,671 gpd/ft and 14,431 gpd/ft, respectively. Recovery data from both these wells were analyzed using the Jacob (1952) straight-line method resulting in transmissivities of 19,513 gpd/ft and 27,200 gpd/ft, respectively. The Jacob (1952) semi-log plots are curved rather than straight. Each curve has two apparent slopes, one for early-time data and one for late-time data. The early-time slope was used to obtain the transmissivities reported above. It was reasoned that two slopes were formed due to lagged recharge to the aquifer from rainfall. One and a half days after pumping commenced, 0.34 inches of cumulative rainfall was measured at the site. The shallow wells fully recovered to pre-test levels in two hours after pumping terminated and continued to rise. Twenty-four hours after pumping terminated, water-levels rose above initial levels by 0.34 feet in the shallow sand/soil unit, 0.39 feet in the intermediate zone, and 0.38 feet in the deeper zone.

Drawdown of water-levels in the shallow monitoring wells was 0.79 feet in response to pumping the intermediate aquifer at 136 gpm for 42.9 hours, suggesting that these two aquifers have fair confinement between them. However, little evidence of confinement is found in the lithologic descriptions. Water-levels in the two deep monitoring wells (completed below the pumped zone) decreased approximately 2.8 feet during pumping. This relatively large difference in drawdowns in the two zones indicates there is at least some confinement between them. Some silt and clay were found between these two zones, but not enough to indicate significant confinement. Vertical hydraulic conductivity is computed using Equation 2 (Neuman,1975) and the drawdown data from the far monitoring well, as shown below.

$$K_v = \frac{BbT}{r^2} = \frac{0.03\ (25\ ft)(1{,}929\ ft^2/d)}{23{,}409\ ft^2} = 0.062\ ft/day.$$

where:

B (type-curve slope) = 0.03
b (thickness confining layer) = 25 feet
T (transmissivity) = 1,929 ft^2/d
r = 153 feet

Monreve Ranch Test Site

Map No. 45	
Confidence in Analysis	Moderate-High
Status of Wells at Site	Existing

Comments: The Monreve Ranch APT site is located in east-central Martin County, approximately one mile south of the intersection between SR 76 and SR 708, as shown in Figure 51. A total of five wells were drilled at this site. One shallow and three deep monitoring wells were spaced 100 feet, 49 feet, 100 feet, and 150 feet from the deep pumping well, respectively (Figure 52). The deep production well was screened between 30 feet and 70 feet BLS. Cuttings descriptions of the pilot hole (W-16398), drilled to a depth of 132 feet BLS, are presented in Appendix A-1. These descriptions were used to develop a lithologic column for the site displayed in Figure 53. Geophysical logs were run on this well and are included in Appendix B, referenced by the geophysics I.D.# 085000081. A water sample was taken from the pumping well during the course of

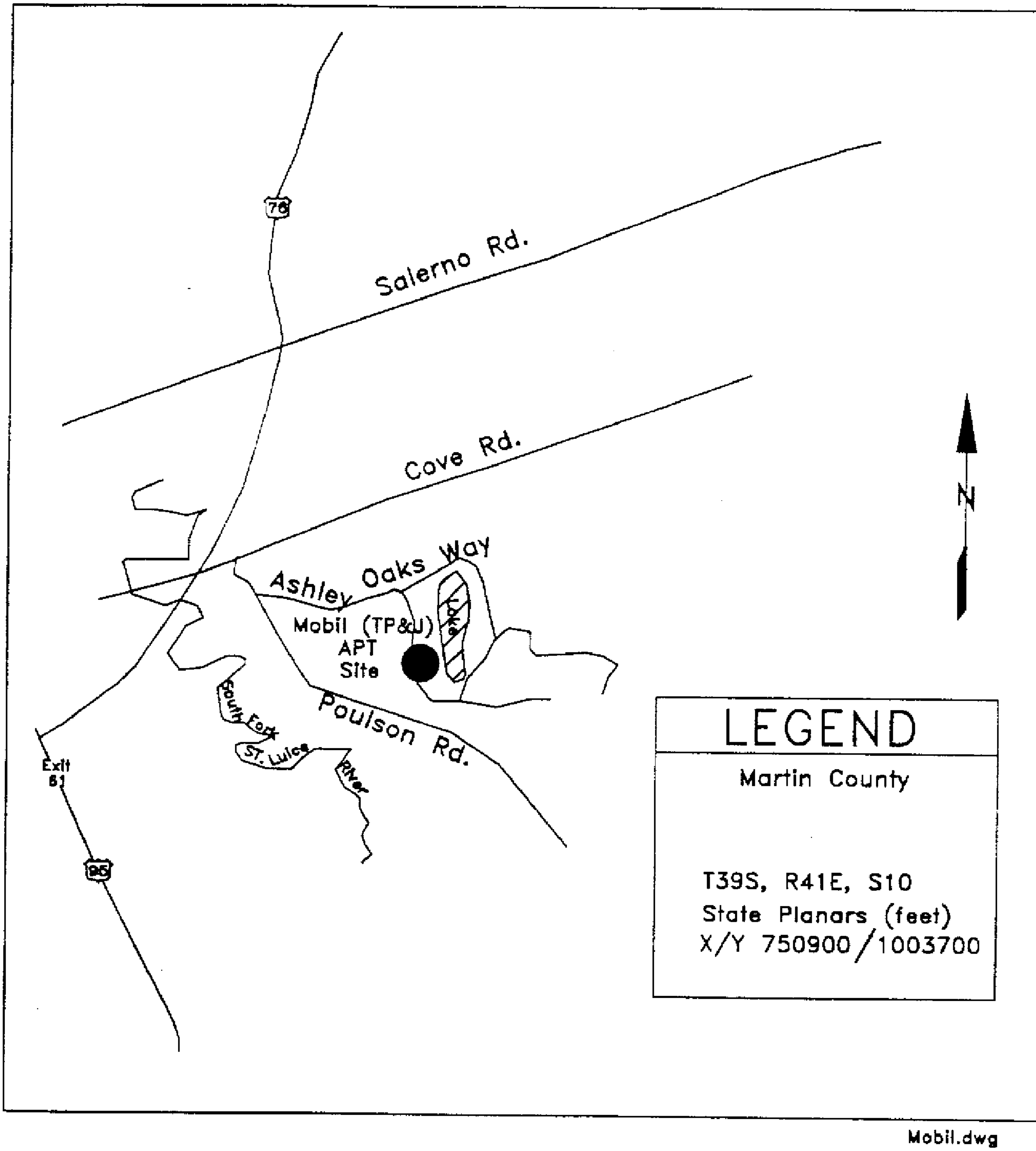


FIGURE 48. Location Map of the Mobil (TP&J) APT Site

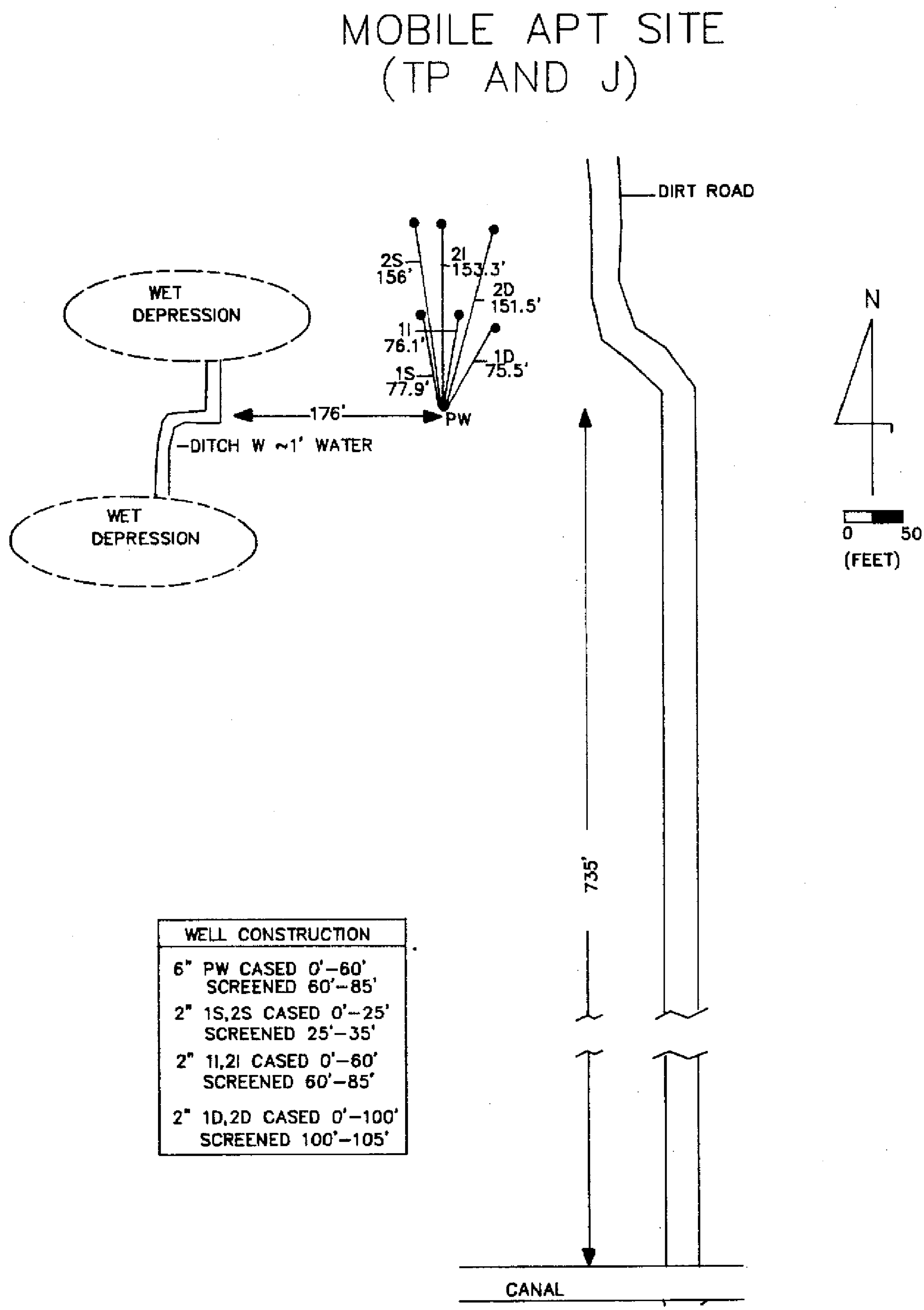


FIGURE 49. **Site Layout and Well Construction Details-Mobil (TP&J) APT Site**

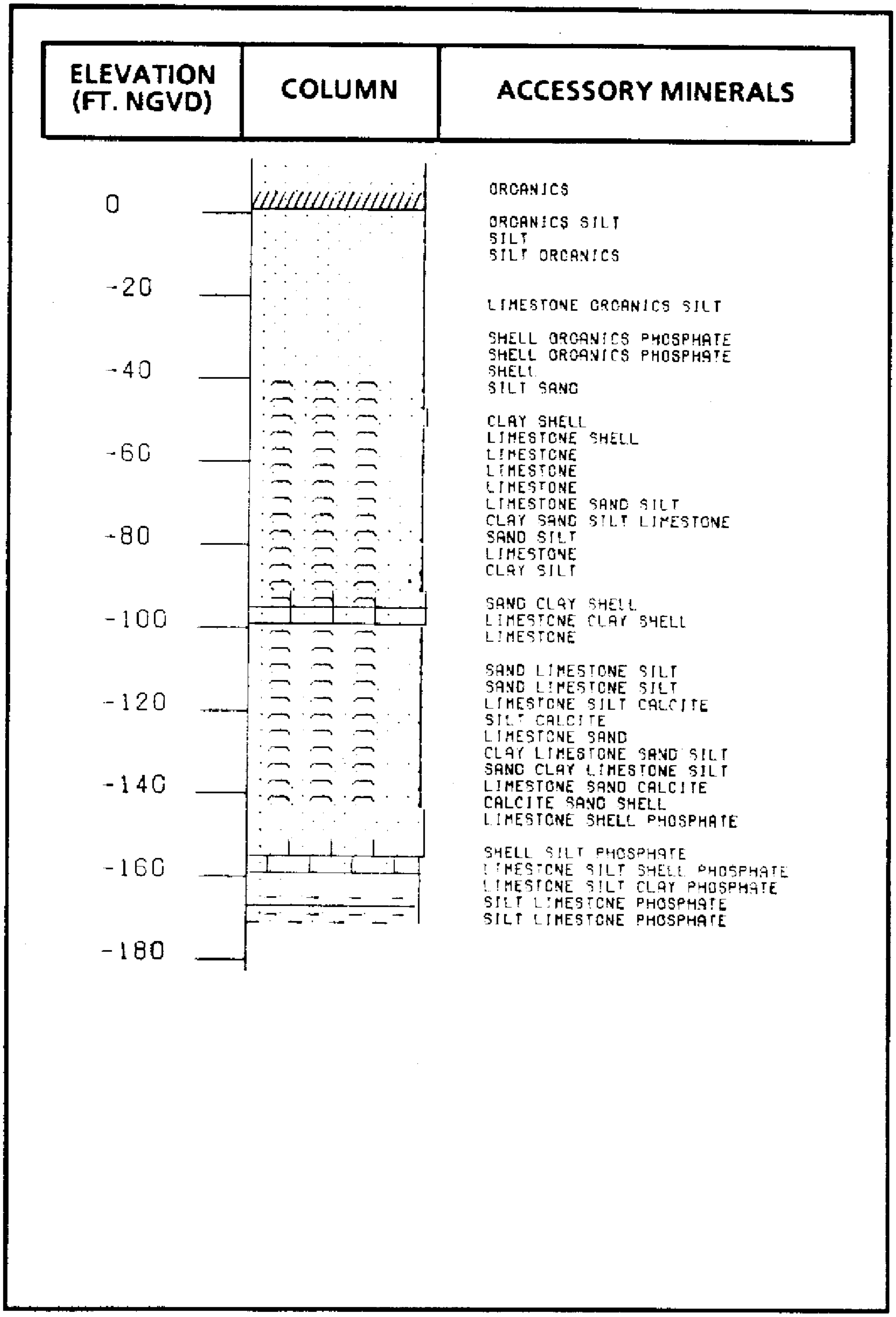
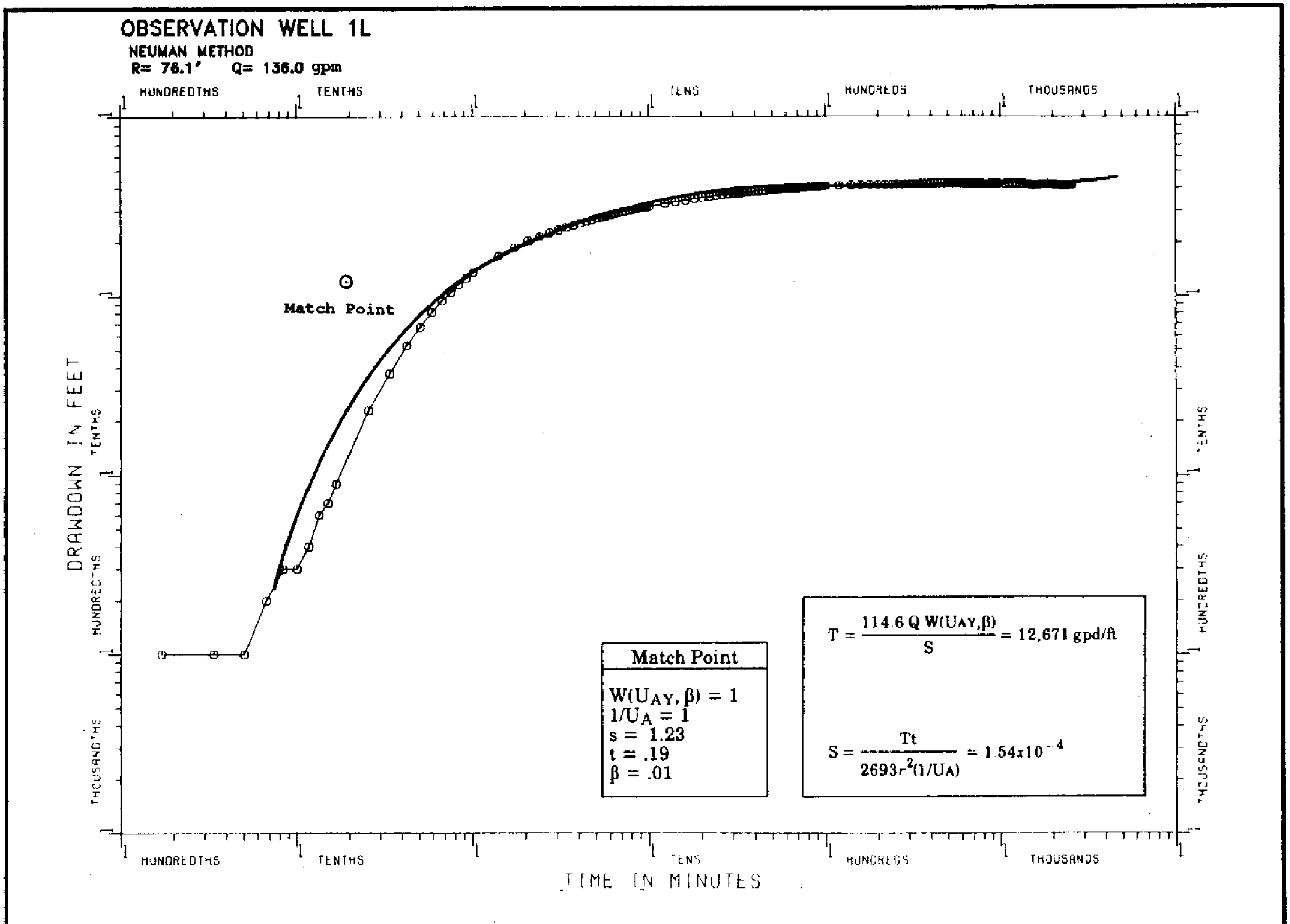


FIGURE 50. Lithologic Column for Well W-16460, Mobil (TP&J) APT Site

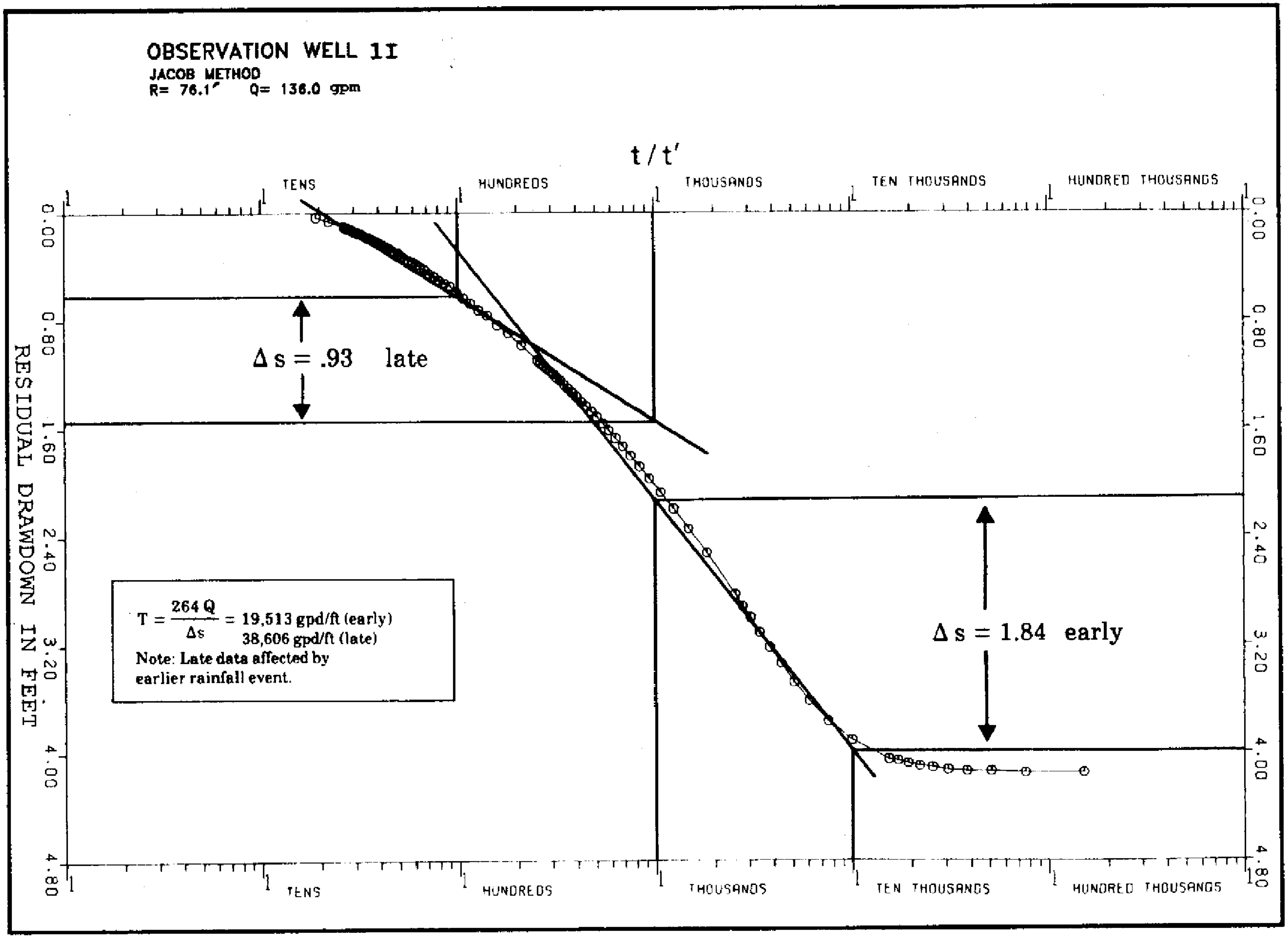
TABLE 7. Water Quality Laboratory Results - Mobil (TP&J) APT Site

Parameter Tested	Start of Test 10/9/89	End of Test 10/11/89
Sodium	19.21	18.10
Potassium	.49	.43
Calcium	100.8	100.8
Magnesium	2.91	2.77
Chloride	31.2	33.3
Sulfate	<2.0	<2.0
Total Alkalinity	242.7	253.4
Fluoride	.284	.268
Silicon Dioxide	14.6	14.8
Total Dissolved Strontium	.50	.50
Total Iron	.42	.37
Total Dissolved Iron	.07	.05
Total Dissolved Solids	349	334
Color (Units)	26	31
Lab Conduct. (umhos/cm)	405	456
Lab pH (Units)	6.45	6.62

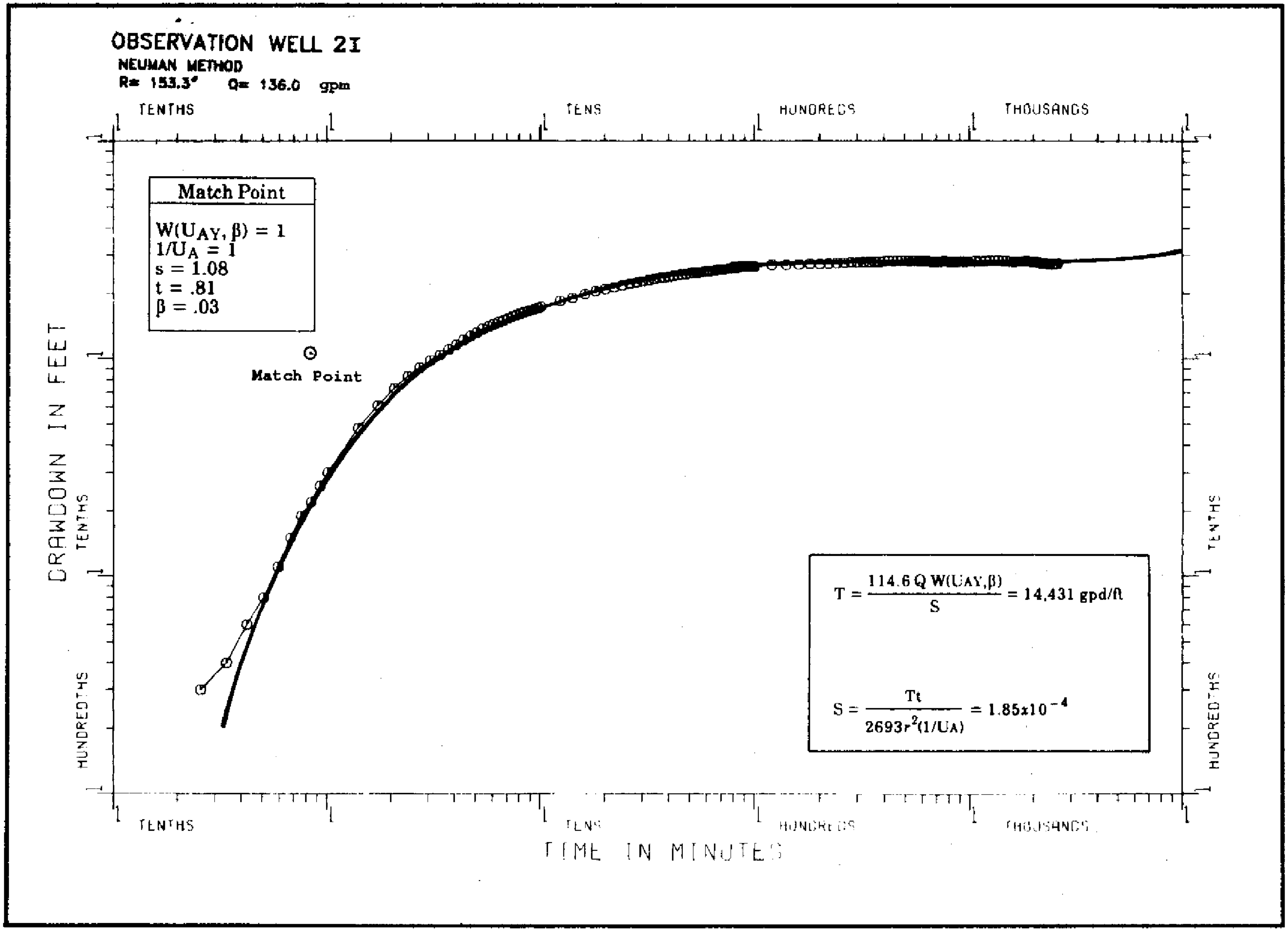
Note: All results are given in mg/l unless otherwise specified.



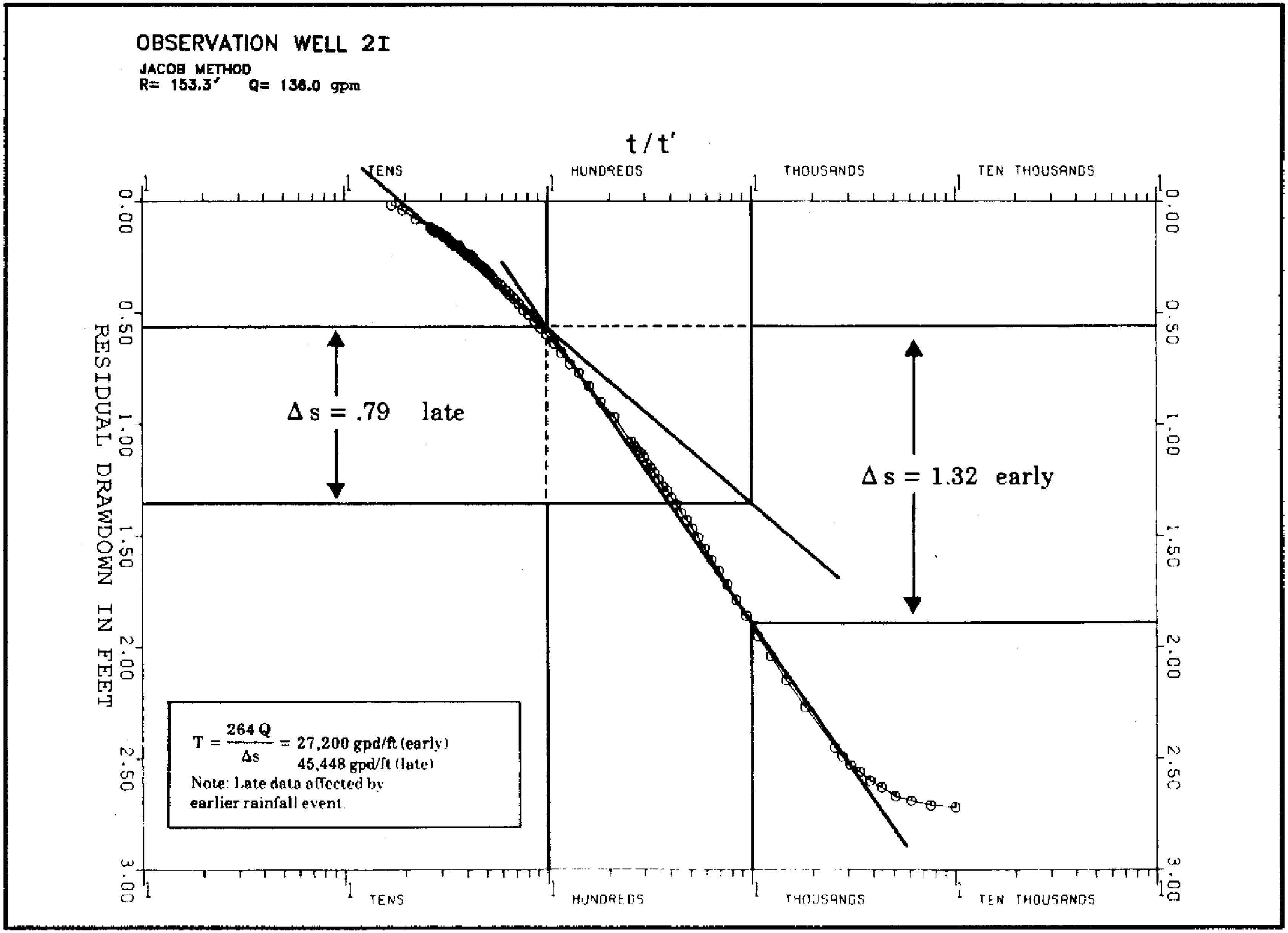
GRAPH 14. Mobil (TP&J) APT Drawdown: Observation Well 1L



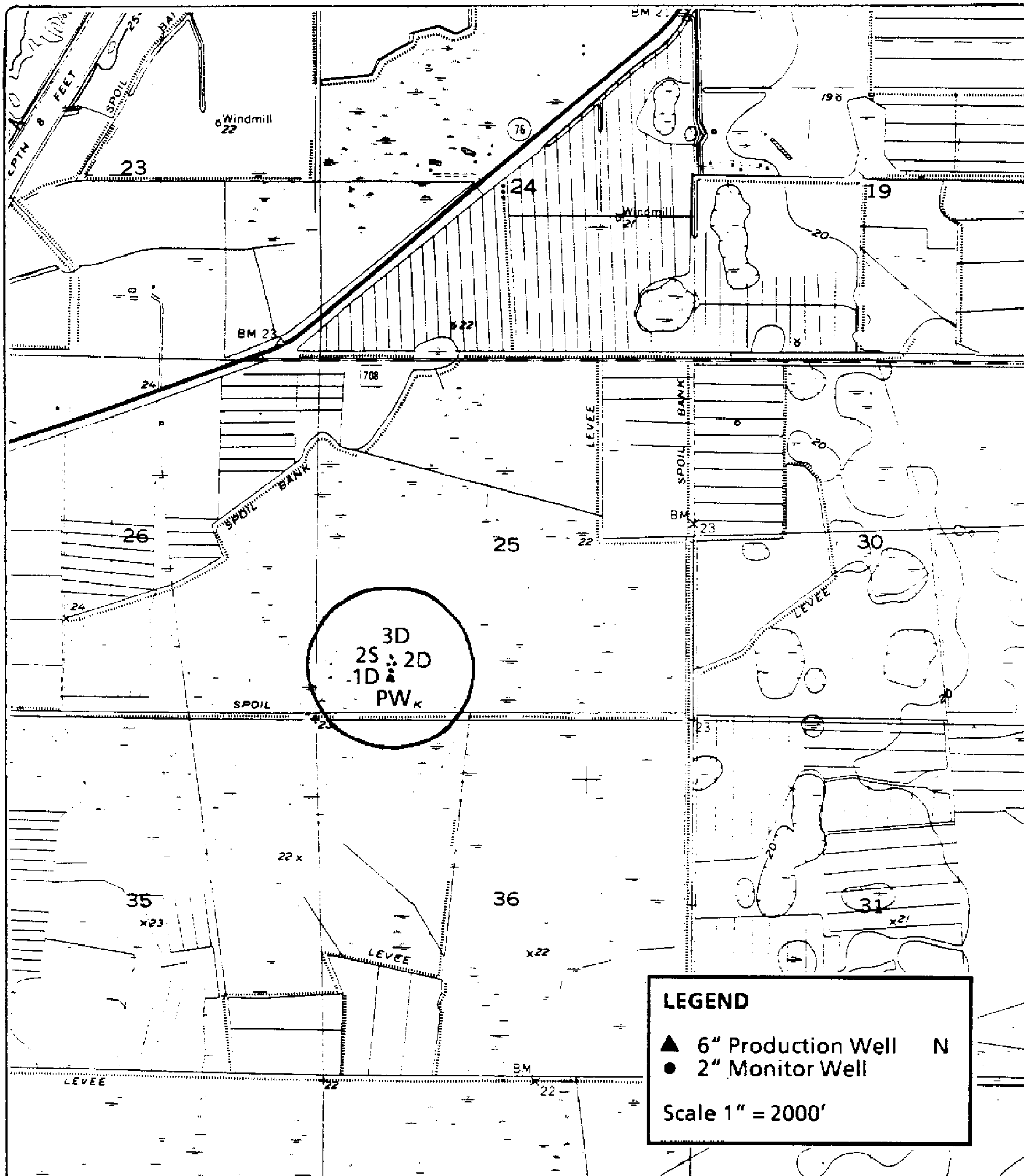
GRAPH 15. Mobil (TP&J) APT Recovery: Observation Well 1L



GRAPH 16. Mobil (TP&J) APT Drawdown: Observation Well 2L



GRAPH 17. Mobil (TP&J) APT Recovery: Observation Well 2L



Test Location Coordinates	Lat 27° 02' 46"	X 727050 feet
	Long 80° 17' 58"	Y 986500 feet
	SE¼ SW¼ SW¼	Sec 25 Twp 39S Rng 40E

FIGURE 51. Location Map of the Monreve Ranch APT Site

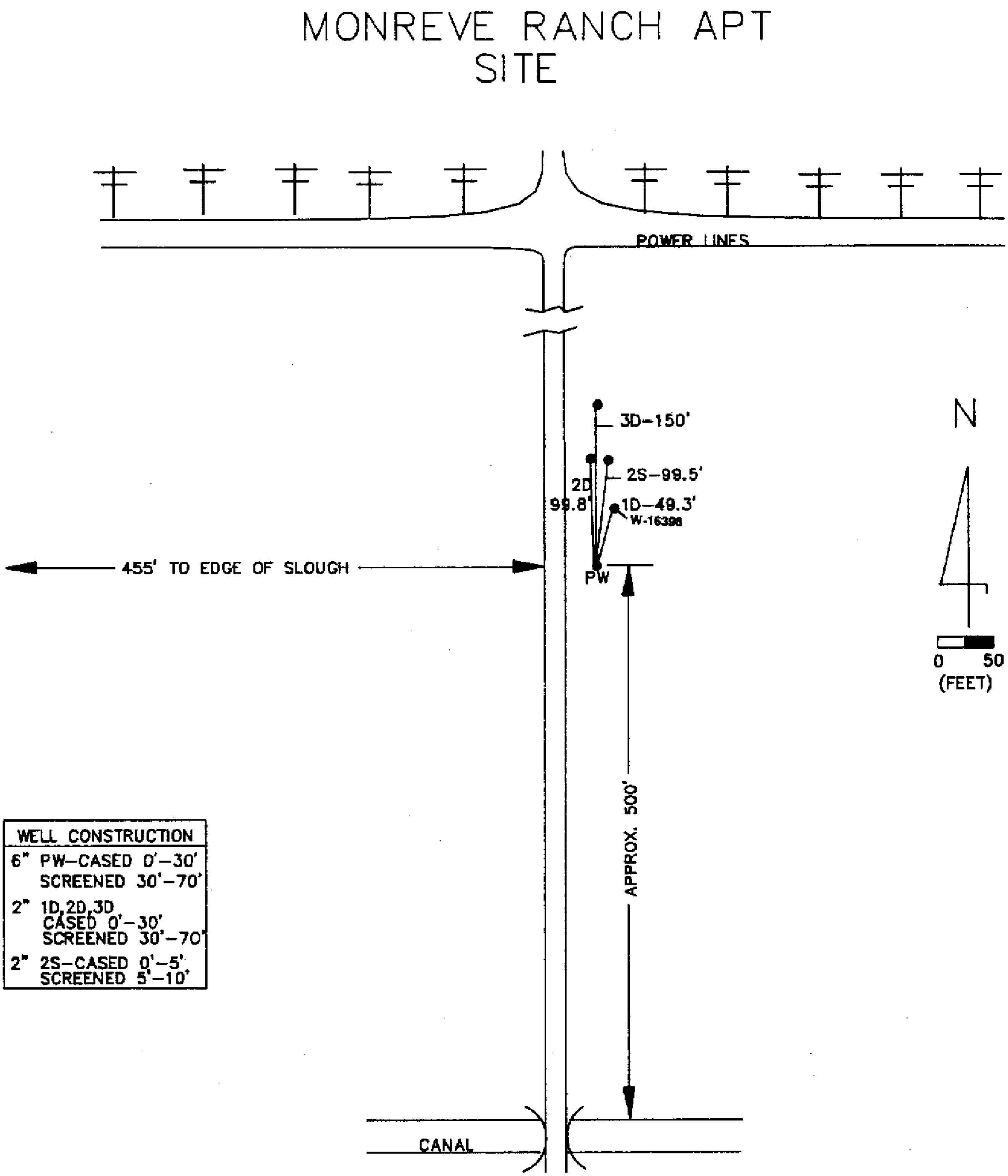


FIGURE 52. **Site Layout and Well Construction Details - Monreve Ranch APT Site**

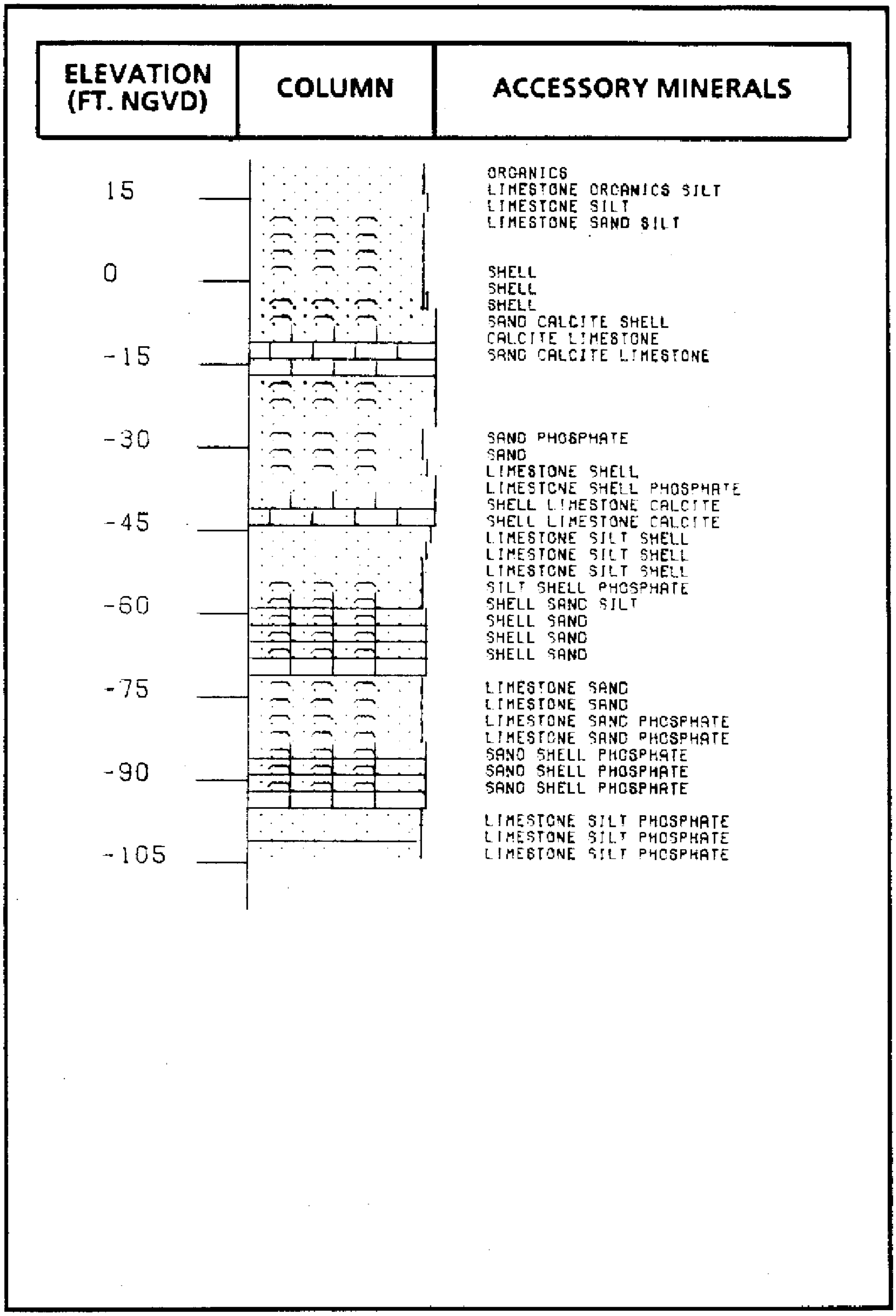


FIGURE 53. Lithologic Column for Well W-16398, Monreve Ranch APT Site

the APT and analyzed by the SFWMD lab for major ions. Those results are provided in Table 8.

Neuman (1975) type curves were used to analyze drawdown in the three deep monitoring wells (Graphs 18,19 and 20) resulting in computed transmissivity values of 8,425 gpd/ft, 11,132 gpd/ft and 22,265 gpd/ft, respectively, in order of increasing distance from the pumping well. Recovery data from these same wells (Graphs 21, 22 and 23) were analyzed using the Jacob (1952) straight-line method resulting in computed transmissivities of 28,723 gpd/ft, 24,259 gpd/ft, and 30,687 gpd/ft, respectively. The results are inconsistent but show a higher degree of consistency with increased distance from the pumping well. It is possible that the wells spaced 49 feet and 100 feet from the pumping well may have been within the radius of turbulent (non-laminar) flow. Therefore, the analyses of the most distant monitoring well (150 feet) are assumed to be most accurate.

Water-levels in the shallow and deep monitoring wells, located 100 feet from the pumping well, declined 2.68 feet and 3.78 feet, respectively, in response to pumping the deep aquifer at a rate of 136 gpm for 72 hours. This relatively large decline in water-level in the shallow aquifer indicates that the two zones communicate near the well. This conclusion is supported by lithologic descriptions of the interval between the two zones. A value for vertical hydraulic conductivity is computed below using Equation 2 (Neuman, 1975):

$$K_v = \frac{BbT}{r^2} = \frac{0.004\ (40\ \text{ft})\ (2{,}977\ \text{ft}^2/\text{d})}{22{,}500\ \text{ft}^2} = 0.021\ \text{ft/day}$$

where:

B (type-curve slope) = 0.03
b (thickness confining layer) = 25 feet
T (transmissivity) = 1,929 ft^2/d
r (radius) = 153 feet

Summaries of APTs Conducted by the USGS in Martin County

Hobe Sound Test Site

Map No. 17
Confidence in Analysis Moderate
Status of Wells at Site Existing

Comments: This site is located in Hobe Sound near the intersection of Route A-1A and Church Street (Figure 54). Seven wells were constructed here, five of which were screened across a deeper SAS zone occurring between approximately 100 feet and 150 feet BLS. Two wells were completed in a shallower zone and screened between 70 feet and 89 feet BLS. The distances between these wells and the pumping well are presented in Table 4. Cuttings descriptions are presented in Appendix A-3, referenced as HSBC 32W. Geophysical logs were run on the pilot hole and assigned the local USGS number M-1120. They were not available for this publication, but can probably be obtained from the USGS office in Miami.

According to the field notes recorded during this test, erratic downward spikes in water-levels occurred in both background and drawdown recordings. Those spikes were attributed to trains passing nearby and were filtered out of the time-drawdown graphs of monitoring wells 100W and 116S. No significant surface-water bodies exist near the site and no rain fell during the test. Discharge from the pumping well was routed to a drainage gutter located 400 feet from wells and was constant at 132 gpm during the seven hours of the drawdown test. The Hantush-Jacob (1955) type-curve method was used to analyze drawdown data; recovery data was not analyzed. The analyses of monitoring wells 100W and 116S yielded identical transmissivity values of 15,109 gpd/ft as seen in Graph 24.

Leakance calculations, based on Equation 1, are shown below using the type curve v = 0.0045, as reported in the documentation. Negligible drawdown (0.05 feet) was observed in the shallower monitoring wells; therefore, it can be assumed that the two zones are separated by low permeability sediments. This is verified by the computed leakance as well as the lithologic descriptions which identify clay beds between the two zones.

$$K'/b' = 4T\,v^2/r^2 = \frac{4(2{,}020)(0.0045)^2}{r^2} = 1.64\ E^{-5}/\text{day}$$

Jonathan Dickinson State Park North Test Site

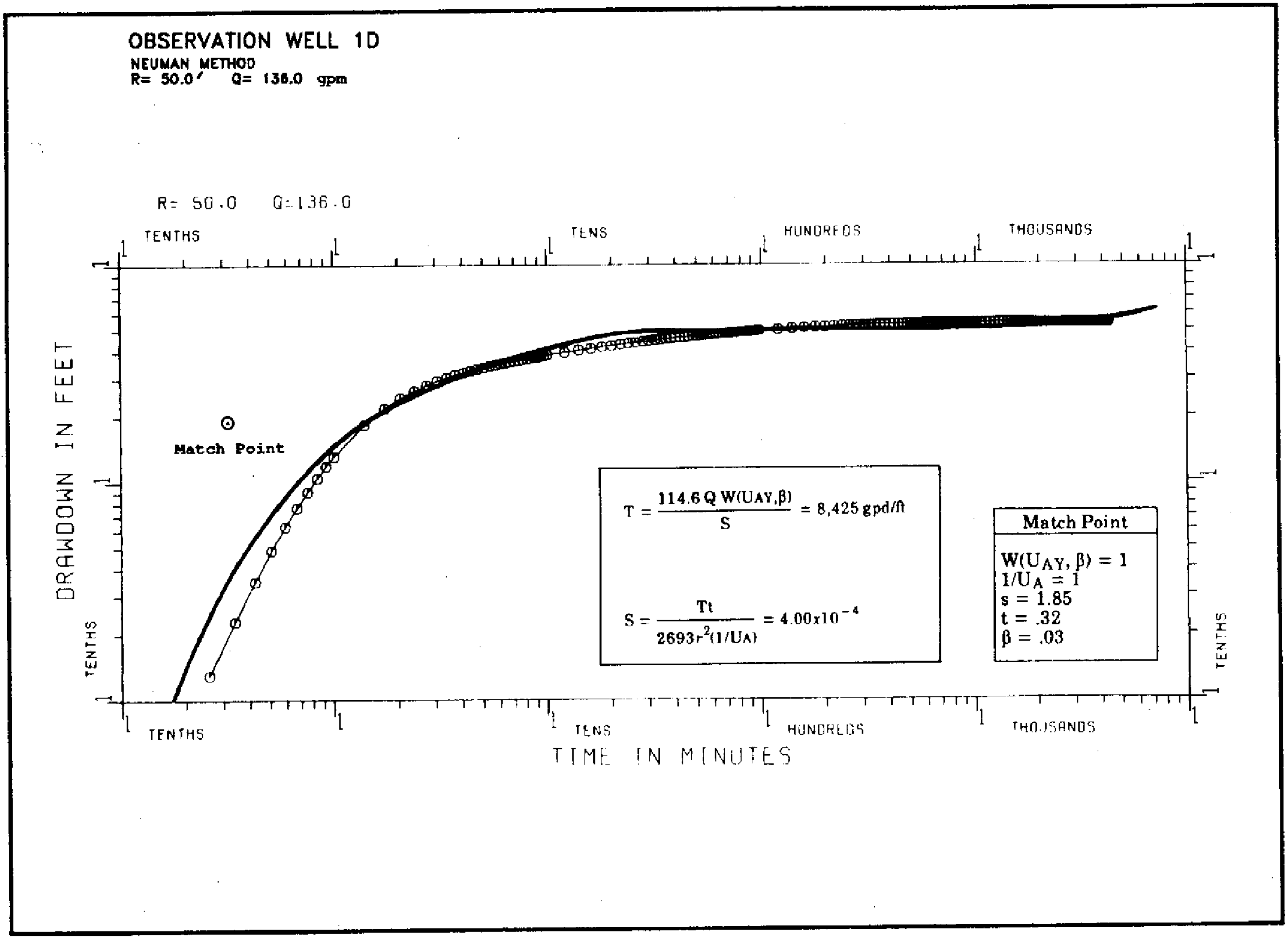
Map No. 18
Confidence in Analysis Moderate
Status of Wells at Site Existing

Comments: This site is located in the southeastern corner of the park near Tequesta, east of the Florida Coast rail road tracks, as shown in Figure 55. Three wells were constructed at this site, all of which were screened between 70 feet and 90 feet BLS. A pilot hole was drilled here to a depth of 92 feet BLS and has a local USGS well designation of M-1093. Lithologic descriptions and geophysical logs were not available for this report; however, a cross-section was constructed by the original (USGS) site geologist in Figure 56.

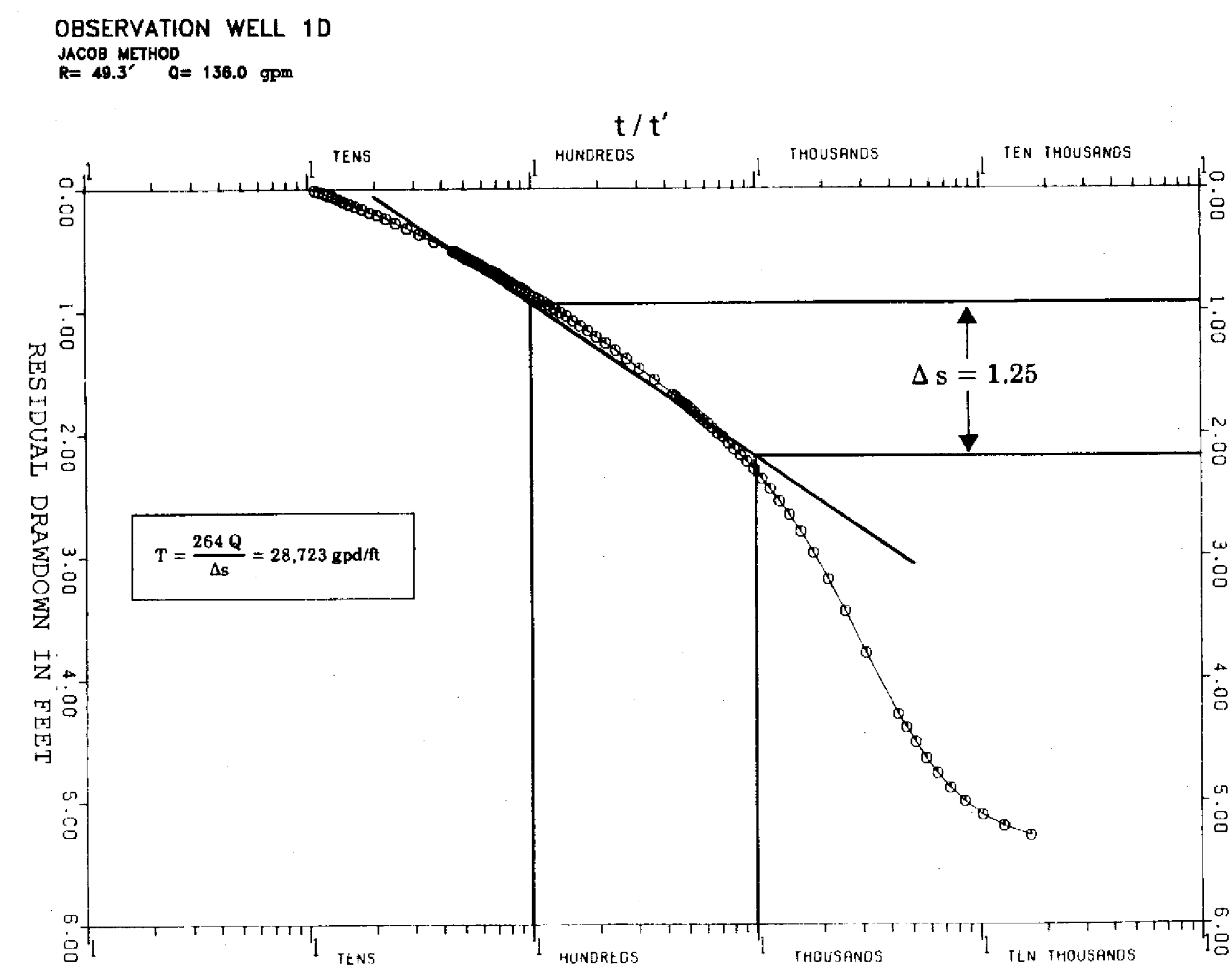
TABLE 8. Water Quality Laboratory Results - Monreve Ranch APT Site

Parameter Tested	Start of Test 12/4/89	End of Test 12/7/89
Sodium	19.9	15.96
Potassium	.79	.44
Calcium	86	58.5
Magnesium	3.8	2.35
Chloride	55.8	56.2
Sulfate	<2.0	<2.0
Total Alkalinity	280.8	274.1
Fluoride	.175	.642
Silicon Dioxide	16.14	16.4
Total Dissolved Strontium	.89	.72
Total Iron	2.14	3.12
Total Dissolved Iron	<.05	.021
Total Dissolved Solids	435	431
Color (Units)	34	36
Lab Conduct. (umhos/cm)	604	665
Lab pH (Units)	6.86	7.29

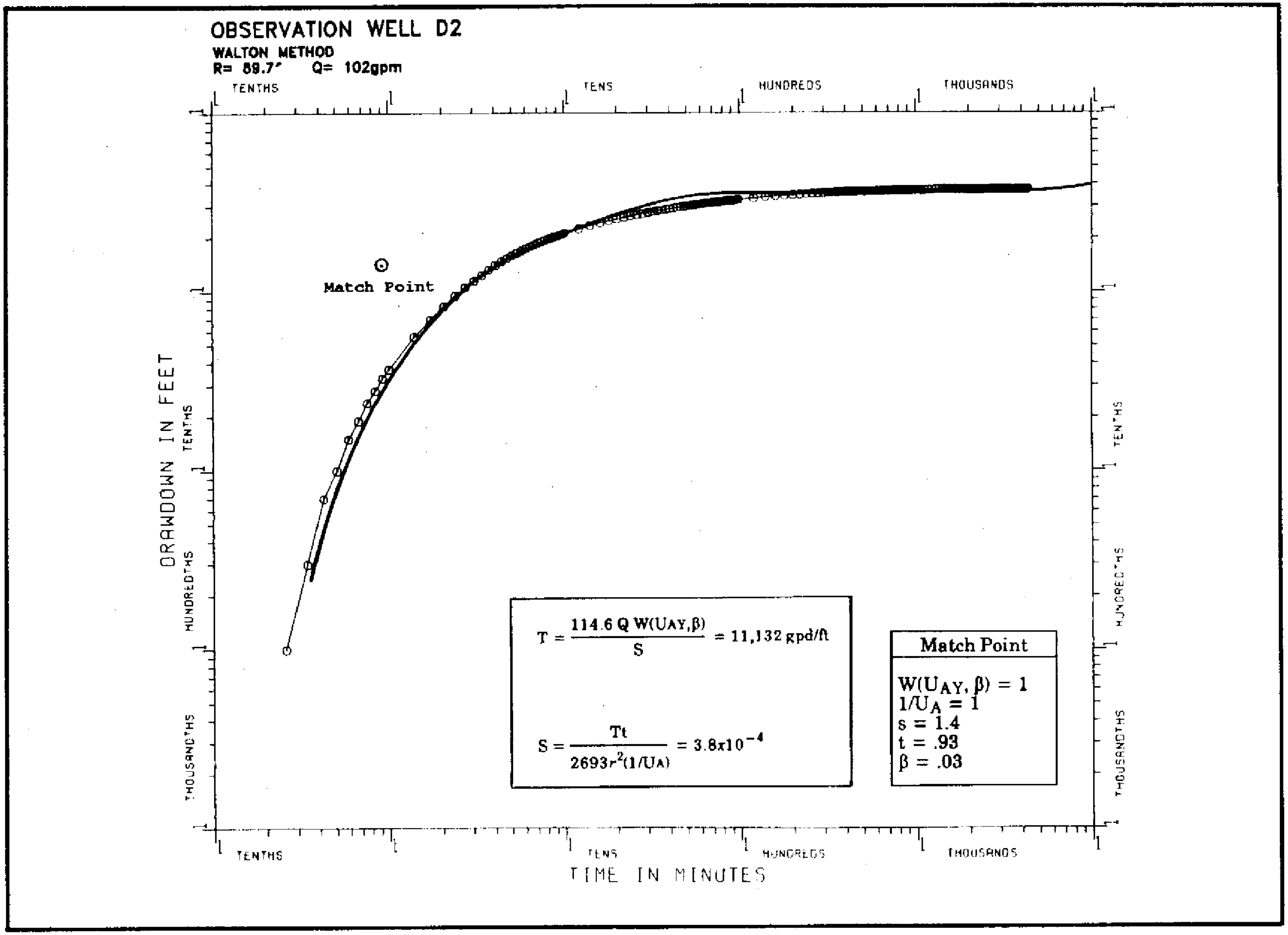
Note: All results are given in mg/l unless otherwise specified.



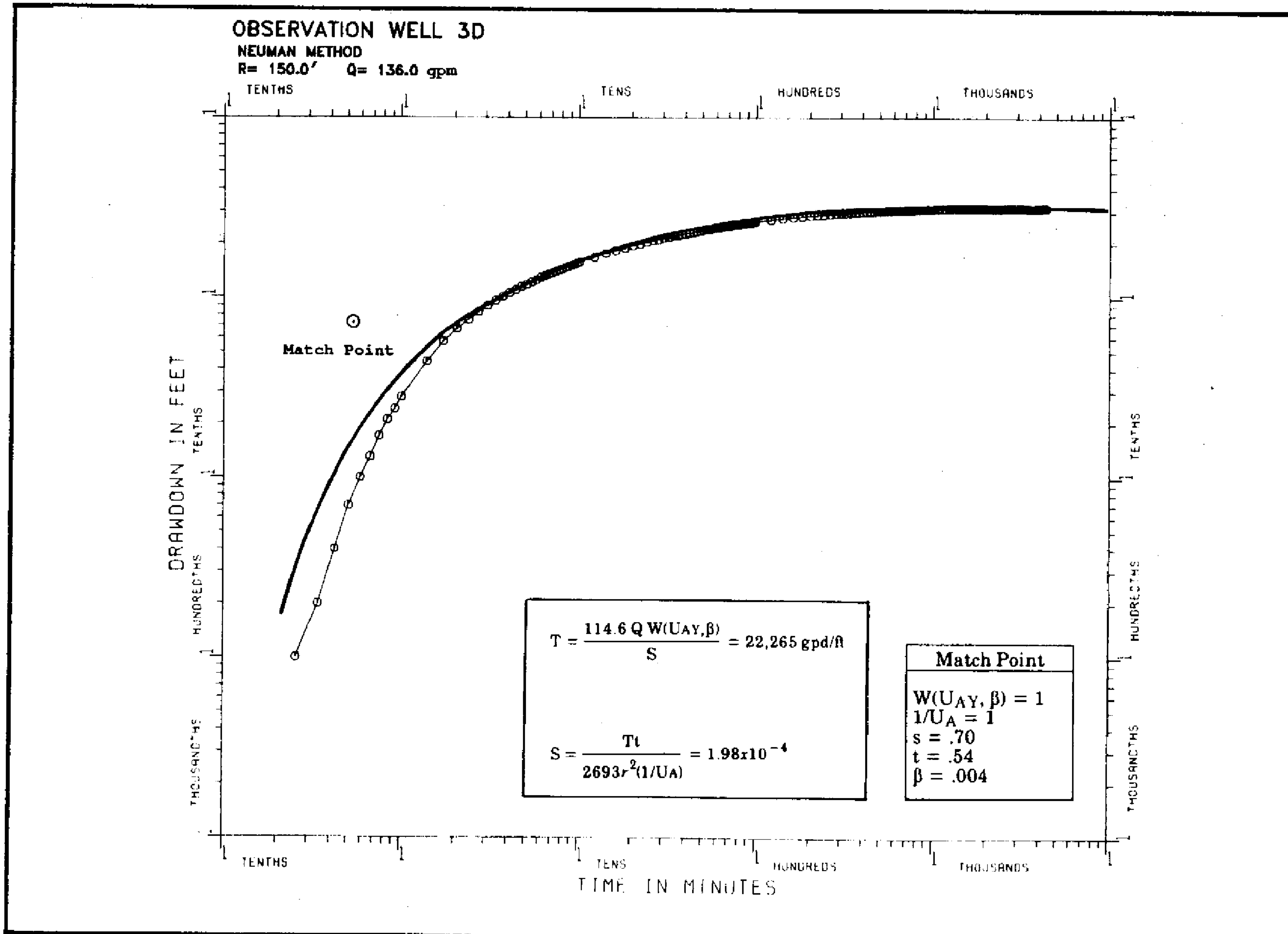
GRAPH 18. Monreve Ranch APT Drawdown: Observation Well 1D



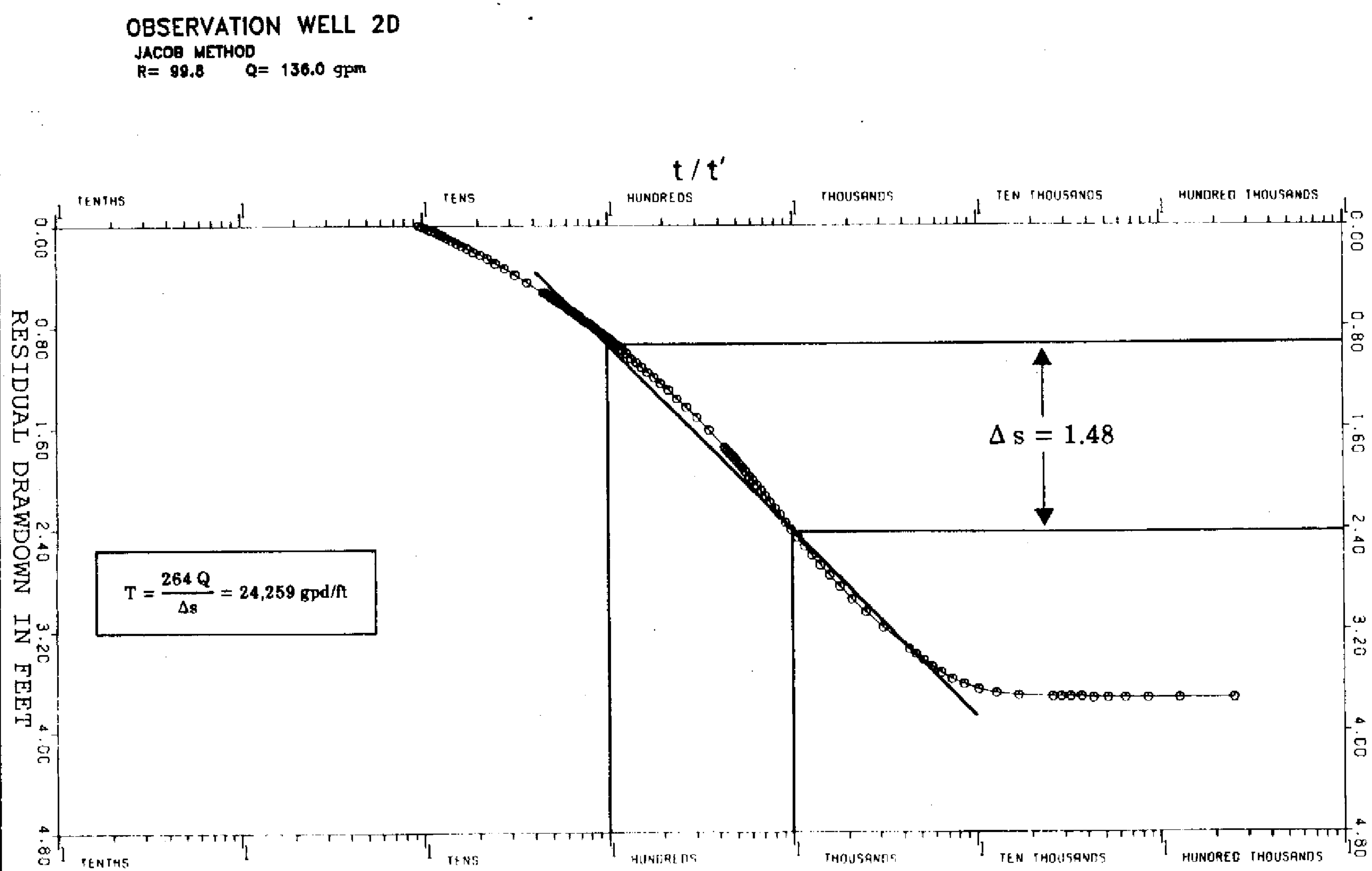
GRAPH 19. Monreve Ranch APT Recovery: Observation Well 1D



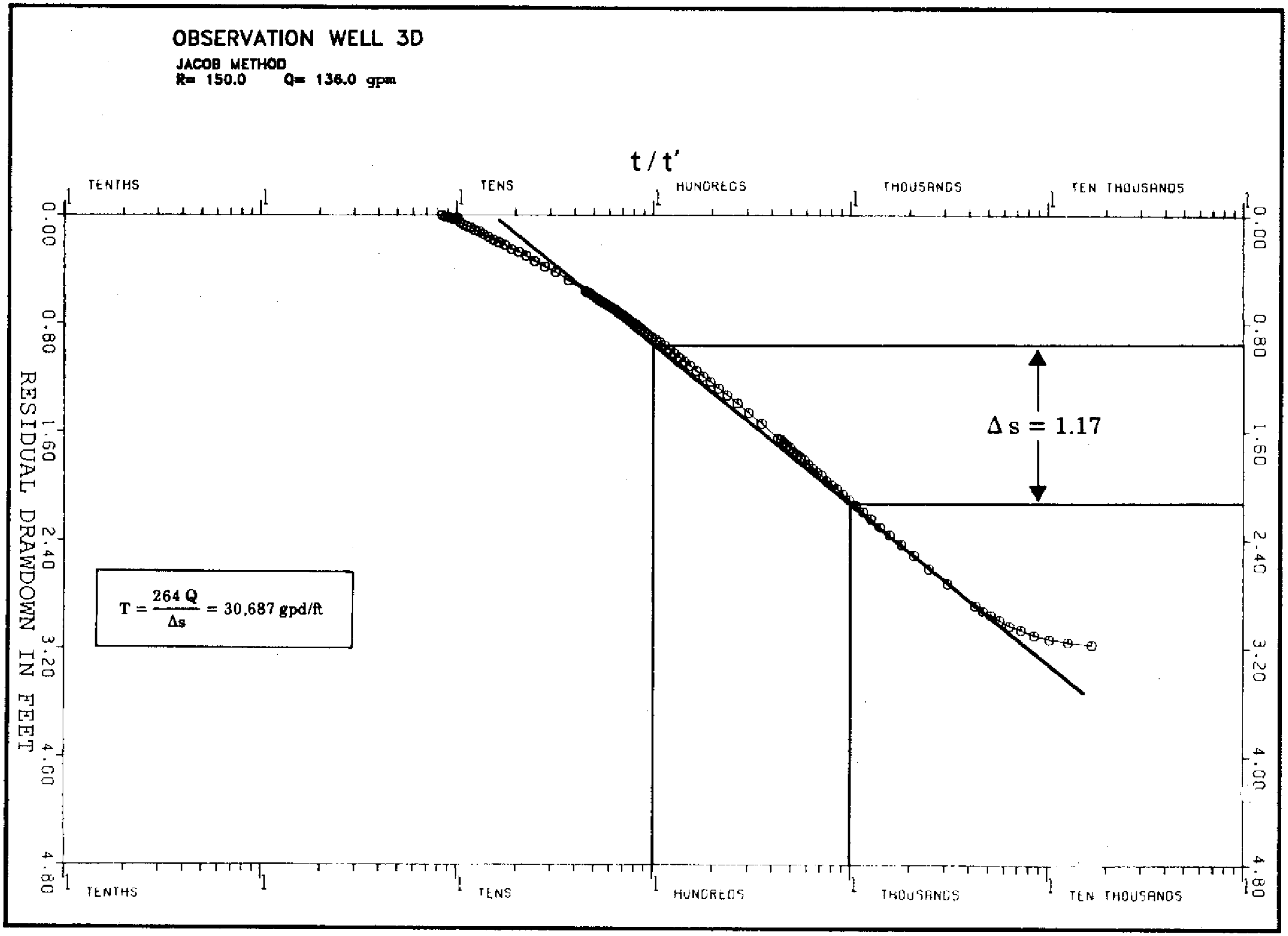
GRAPH 20. Monreve Ranch APT Drawdown: Observation Well 2D



GRAPH 21. Monreve Ranch APT Drawdown: Observation Well 3D



GRAPH 22. Monreve Ranch APT Recovery: Observation Well 2D



GRAPH 23. Monreve Ranch APT Recovery: Observation Well 3D

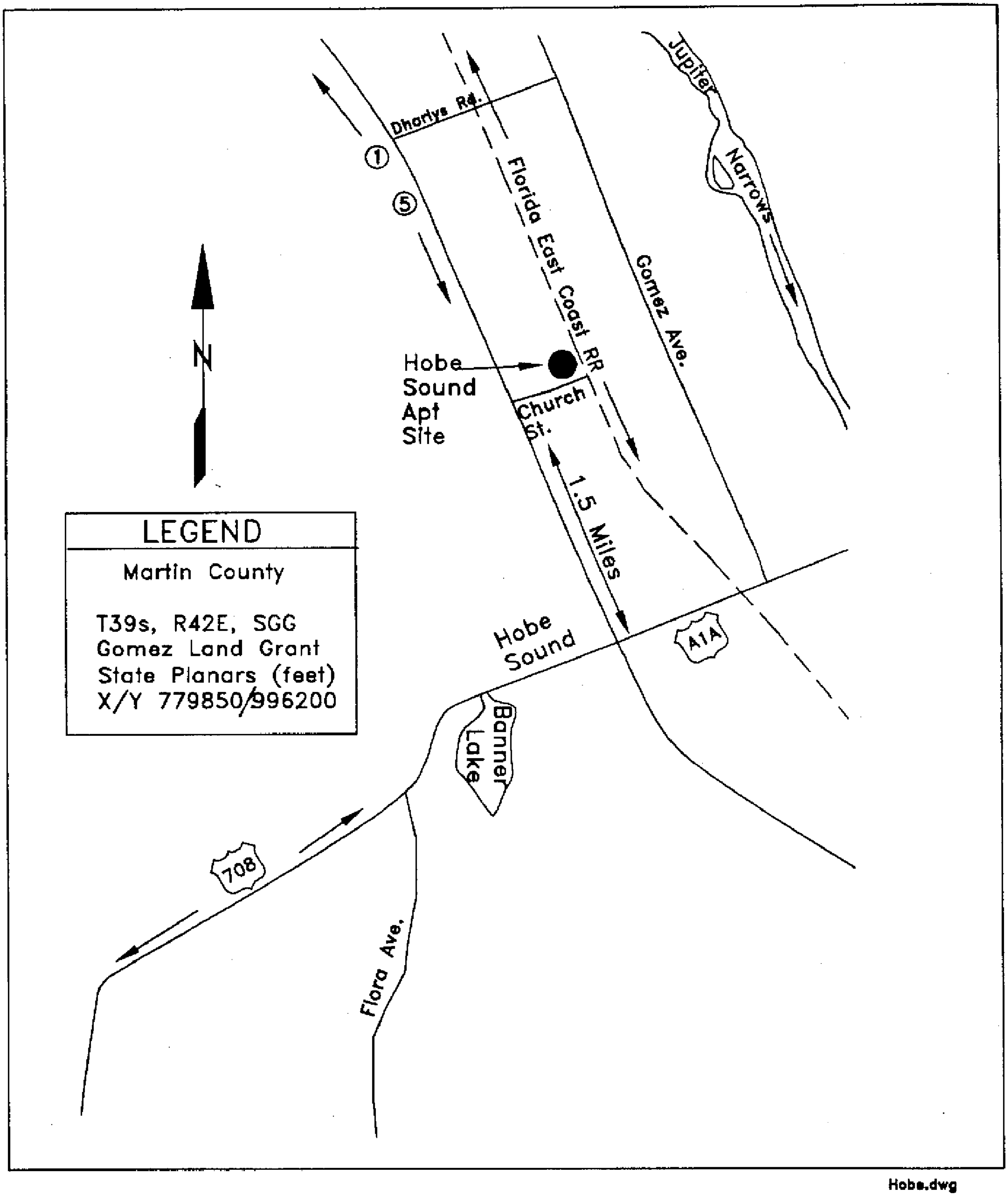
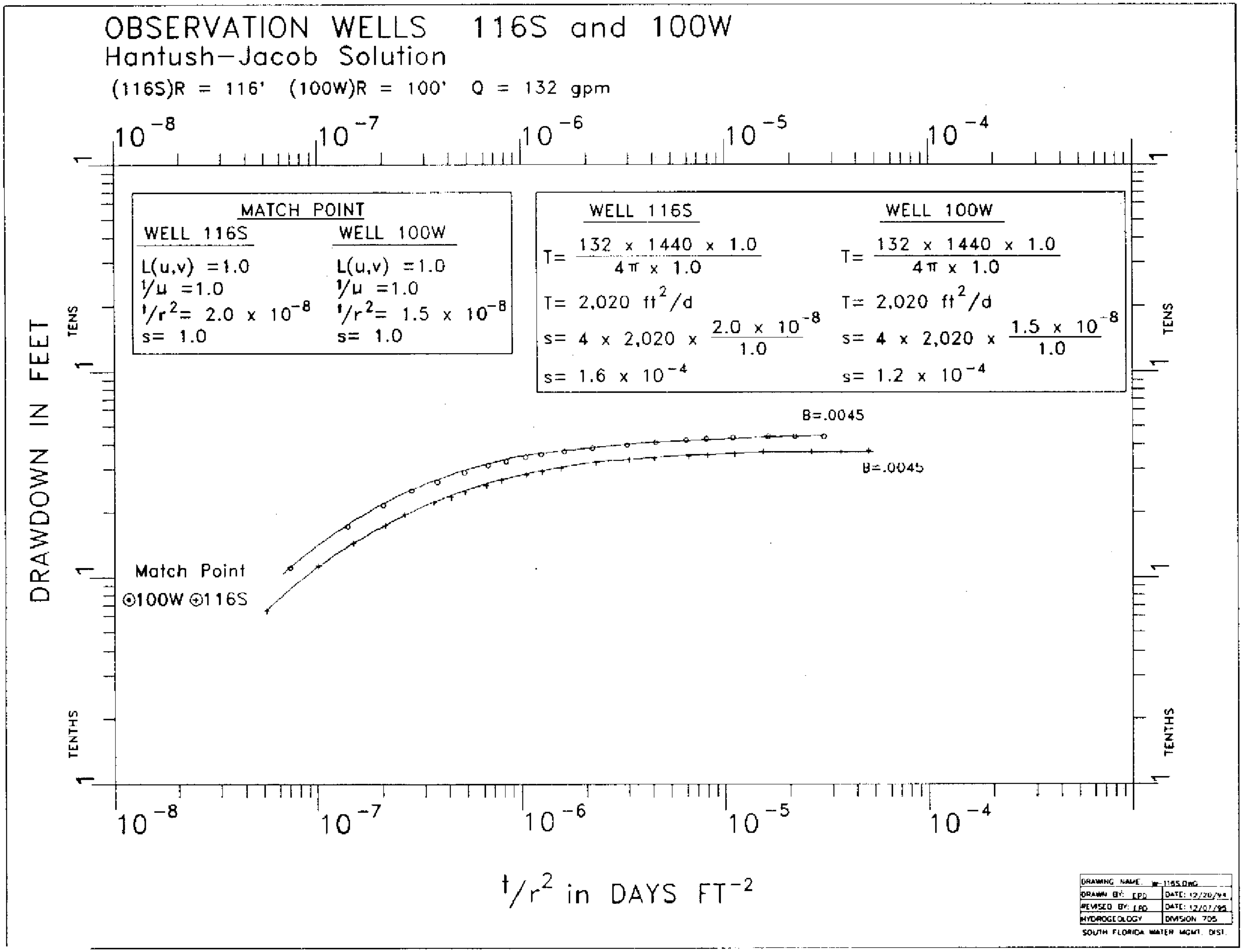


FIGURE 54. Location Map of the Hobe Sound APT Site



GRAPH 24. Hobe Sound APT Drawdown: Observation Wells 116S and 100W

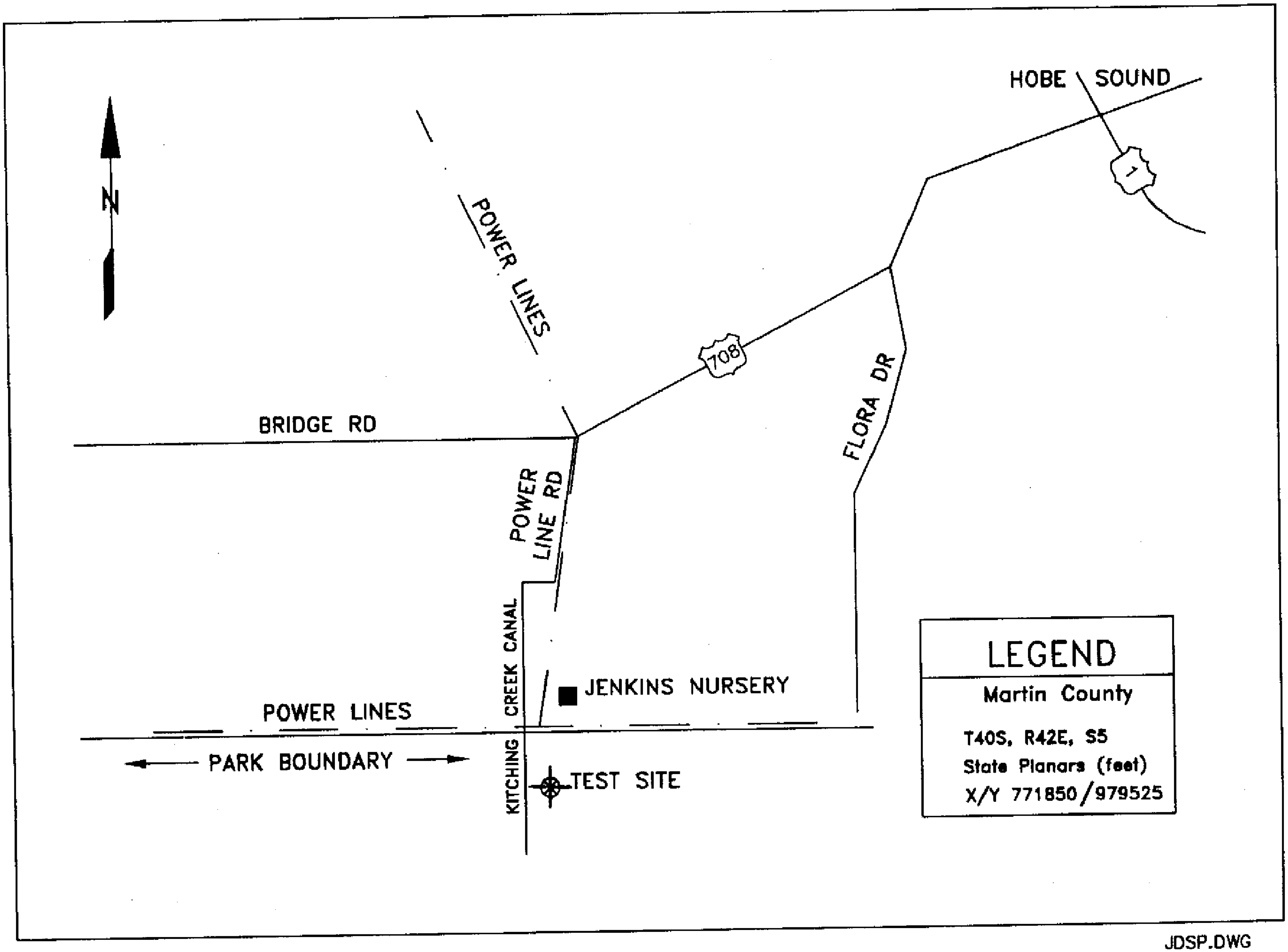


FIGURE 55. **Location Map of the Jonathan Dickinson State Park North APT Site**

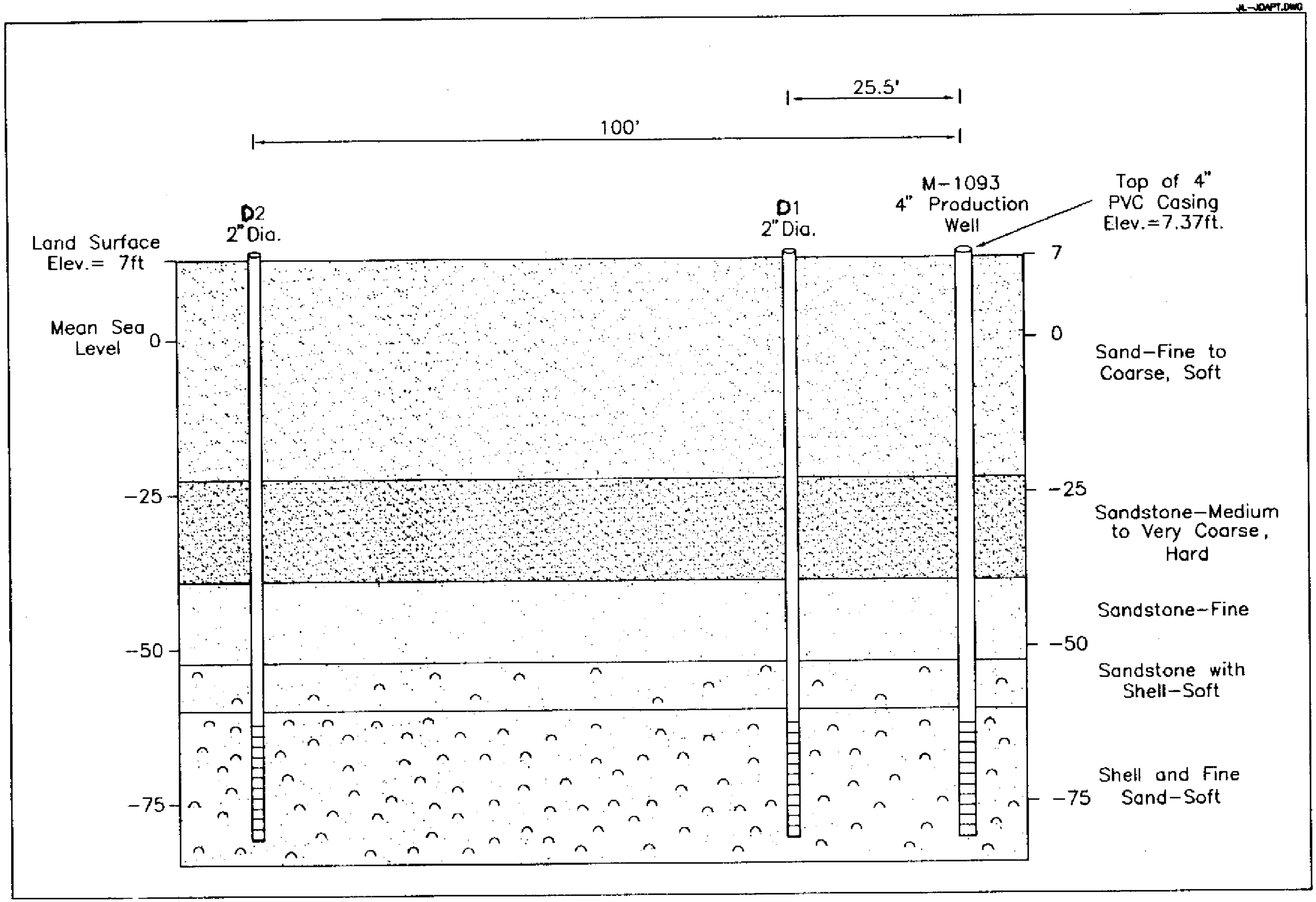


FIGURE 56. **Cross-Section of Jonathan Dickinson State Park North APT Site**

The following documentation was extracted from the USGS field report summarizing this APT (Hill, unpublished summary paper).

> Aquifer Description: The shallow aquifer is mainly composed of sand, clay, silt and shell of Pleistocene age. Sediments forming the aquifer system are components of the Fort Thompson and Anastasia Formations, overlain by Pamlico Sand (Miller, 1979). Shell and sand lenses in the Caloosahatchee Marl, and many facies changes are present. Wells set in the deeper, producing zone were screened in shell and fine sand overlain by slightly indurated sandstone with shell fragments.
>
> Problems: The results of the test and analyses were not considered acceptable by the regional USGS office, presumably "because of the very low pumping rate and possibly other factors". When the test was first started, a sizeable leak in the discharge pipe occurred and the test was temporarily halted and then restarted after approximately 30 minutes. After 998 minutes of discharge, the pump ran out of gas. The drawdown data was complete for the period of pumping, but both charts indicate poor response of the Keck surface follower, especially that for Well O2. A railroad track is located near the test site and passing freight trains resulted in numerous "loading" marks on each chart. Maximum deviation of pen alignment on Well O2 before and after each train was about 0.04 feet. This could be responsible for the upward trend on the log-log plot of Well O2 in the final hours of pumping. No corrections were made to the drawdown data for water-level fluctuations or trends during the test. Likewise, no corrections were made for mechanical problems or changes in barometric pressure (negligible).

The Hantush-Jacob (1955) type-curve matching method for leaky confined aquifers with vertical movement and non-steady flow was used by the USGS to evaluate the drawdown data. According to G. W. Hill of the USGS:

> "The loading effect on the drawdown data caused by passing trains suggest a leaky artesian system. Therefore, the results of the Hantush-Jacob Method for a leaky confined aquifer with vertical movement is the most reasonable solution".

The drawdown data and type-curve are both shown on Graph 25, along with parameter computations. Leakance was computed as 0.035 day-1.

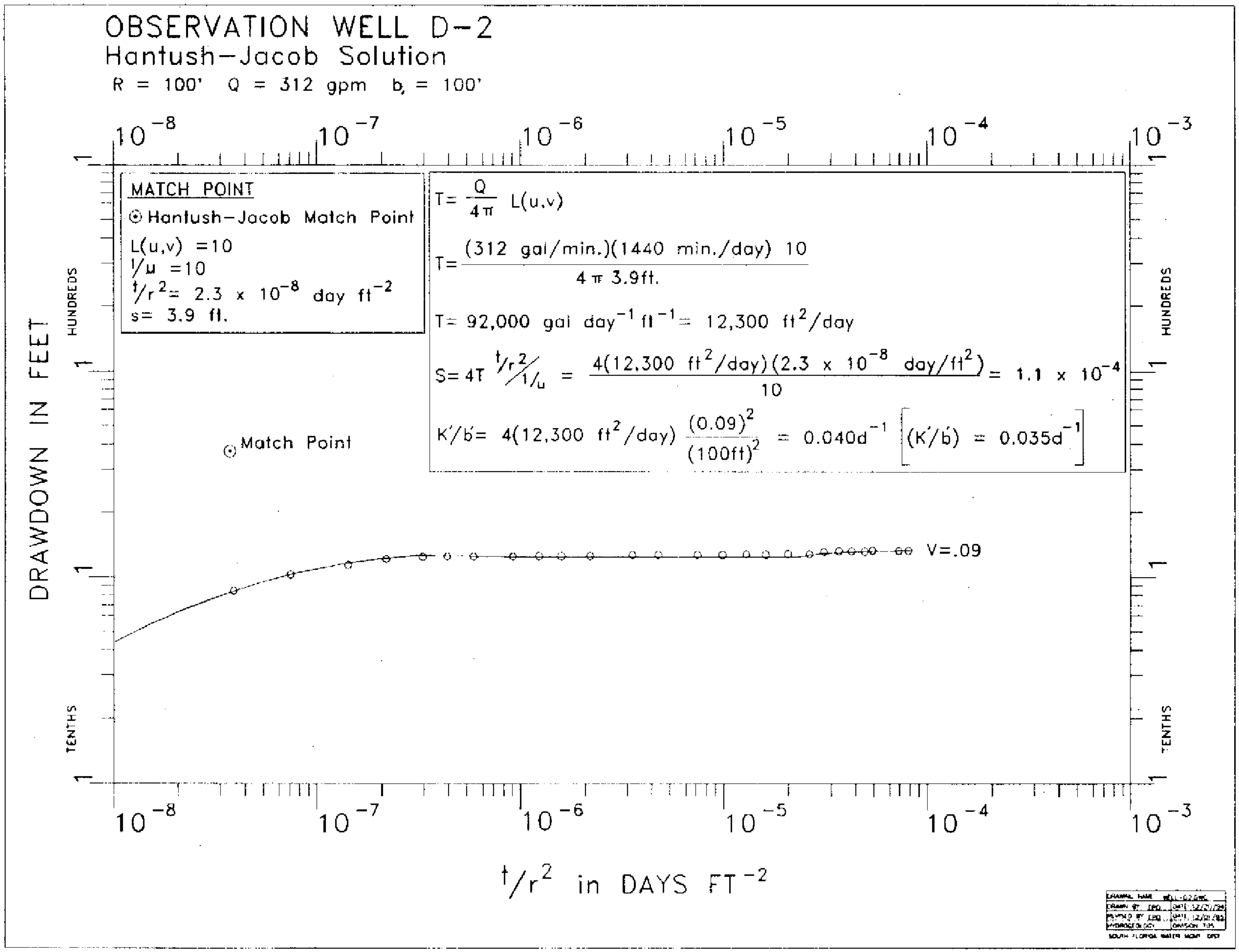
Tequesta Park Test Site

Map No. 19
Confidence in Analysis Moderate
Status of Wells at Site Existing

Comments: The Tequesta Park APT site is located in extreme southeastern Martin County, close to the Palm Beach County border and the Florida East Coast railroad tracks, as shown in Figure 57. A pilot hole (PB-3) was drilled 80 feet BLS, lithologic descriptions of which are given in Appendix A-3. No geophysical logs were found in the documentation for this site. This APT was conducted to determine the feasibility of developing a wellfield at Tequesta Park.

Excerpts from a letter dated May 15, 1974 from Larry Land (USGS), addressed to Dr. Robert Vernon (Florida Bureau of Geology), provides the only documentation available for this test:

> "The aquifer analysis included constructing four observation wells to depths of 60 feet (BLS) and constructing and pumping a test well with screen openings between 40 feet and 60 feet (BLS) and between 60 feet and 80 feet (BLS) in the northeastern corner of Tequesta Park. Unfortunately, these curves do not reasonably match any transient flow type curves. However, reasonable results can be obtained by using a steady-state solution. The difficulty in analysis is primarily caused by a very layered aquifer that has high leakage and delayed yields. A further complication is caused by the standard well construction practice in the area of using partially penetrating wells. In conclusion, it appears that the transmissivity is approximately 60,000 gpd/ft. The effective storage coefficient, after a long duration of pumpage is estimated to be between 0.1 and 0.2. Also, the 40-foot to 60-foot zone appears to be about 50% more permeable than the 60-foot to 80-foot zone. Forcing a match with the transient type curves showed that the transmissivity ranged from between 100,000 and 400,000 gpd/ft which ranges from possibly being reasonable to just too high."



GRAPH 25. Jonathan Dickinson State Park North APT Drawdown Observation Well D-2

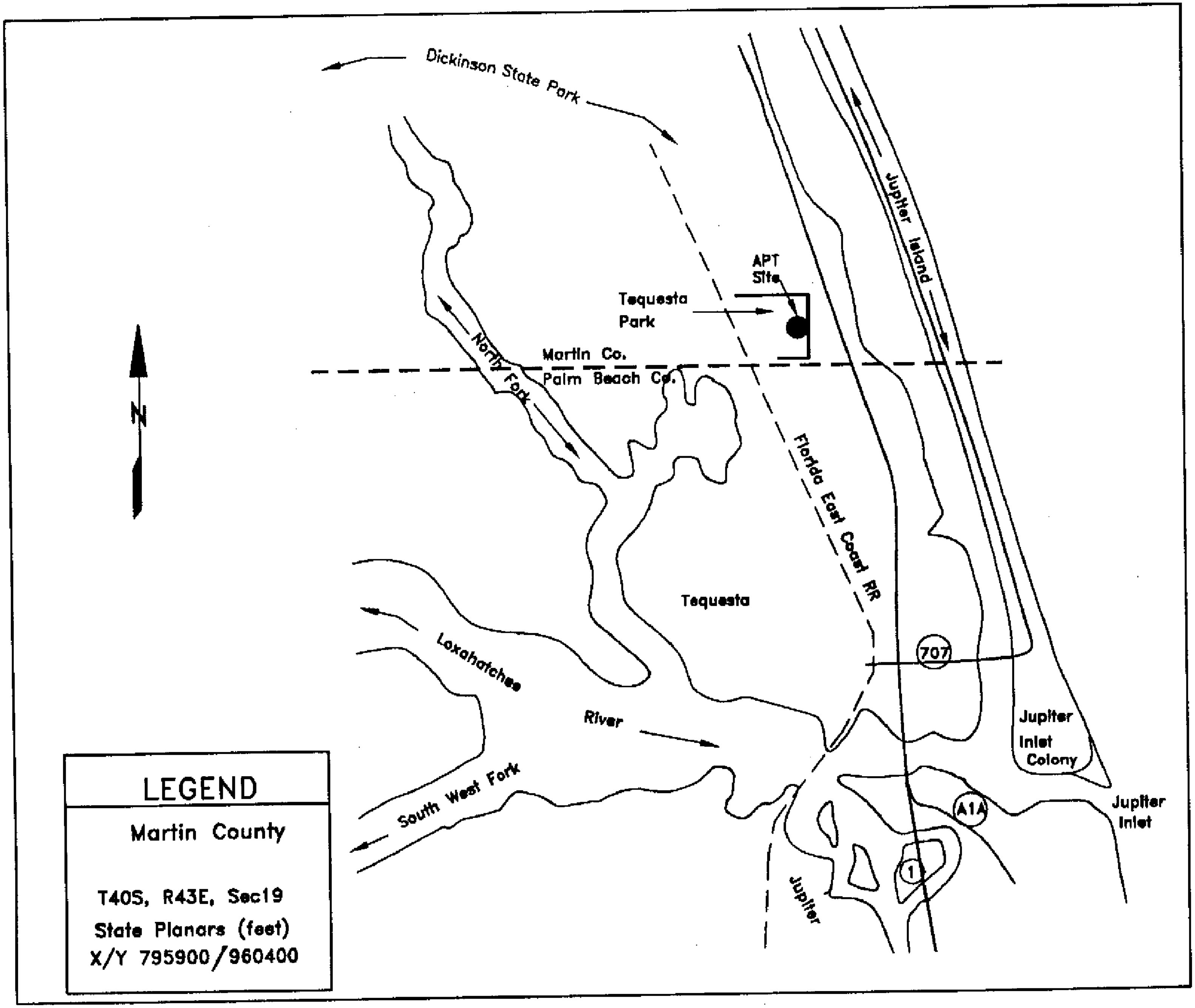


FIGURE 57. Location Map of the Tequesta Park APT Site

The time drawdown log-log plots and Theis steady-state computations are given for pumping well 1 (shallow zone) and pumping well 2 (deeper zone) in Graphs 26 and 27, respectively. As stated in Long's letter, the transmissivity of the shallower zone is 50% higher than that of the deeper zone. Leakance between these two layers was not computed and cannot be determined with available data.

Summaries of Previously Documented APTs Re-Analyzed by the SFWMD

<u>Vista Salerno Test Site</u>

<u>Map No.</u>	46
<u>Confidence in Analysis</u>	Moderate
<u>Status of Wells at Site</u>	Unknown

Comments: Intracoastal Utilities conducted an APT at Vista Salerno in 1984. Drawdown data from deep (90 to 110 feet BLS) monitoring wells 2-1 and 2-3, located 99 feet and 650 feet from the production well, were analyzed by SFWMD staff using the Neuman (1975) type curve method as shown in Graphs 28 and 29, respectively. This site is located near the intersection of S.E. Parkwood Drive (formerly S.E. Sidney Court) and U.S. Highway No. 1 at the Vista Salerno water treatment plant. Four wells were used for the pumping and recovery tests. A lithologic description of the Production well (VS-PW2) is given in Appendix A-3; no geophysical logs are available. A 4-inch Precision turbine meter and a 4-inch gate valve on the discharge of the pumped well were used to adjust the pumping rate to 300 gpm throughout the pumping test. The pumped water was discharged through a 6-inch pipe and a 6-inch hose into a ditch approximately 300 feet from the pumped well. The water in this ditch flows in a direction away from the pumped well across U.S. Highway No.1. Computed transmissivities from drawdown in monitoring wells 2-1 and 2-3 were 22,920 gpd/ft and 89,298 gpd/ft, respectively.

Water-levels in the shallow and deep monitoring wells (wells 2-2 and 2-1) located 49 feet and 99 feet from the pumping well declined 2.1 feet and 6.03 feet, respectively, in response to pumping the deep aquifer at a rate of 300 gpm for 72 hours. This relatively large decrease in water-level in the shallow aquifer indicates that the two aquifers at this site communicate well. This conclusion is supported by the lithologic descriptions which identify sand within the interval between the two zones. A value for vertical hydraulic conductivity is computed below using the analysis from MW 2-1 and Equation 2 (Neuman, 1975):

$$K_v = \frac{BbT}{r^2} = \frac{0.01\ (20\ \text{ft})\ (3{,}064\ \text{ft}^2/\text{d})}{9{,}801\ \text{ft}^2} = 0.0625\ \text{ft/day}$$

where:

B (type-curve slope) = 0.01
b (thickness confining layer) = 20 feet
T (transmissivity) = 3,064 ft^2/d
r (radius) = 99 feet

ST. LUCIE COUNTY SURFICIAL AQUIFER SYSTEM APT RESULTS

The results of forty-eight (48) St. Lucie County Surficial Aquifer performance tests, obtained from various sources, are given in Tables 9 and 10. The aquifer parameters listed in Table 9 were used to define the regional character of the SAS for the St. Lucie County ground-water flow model. The locations of these aquifer test sites are shown in Figure 58 by table numbers. A contour map illustrating the regional distribution of transmissivity for the most permeable aquifer within the SAS at each site in St. Lucie County is given in Figure 59.

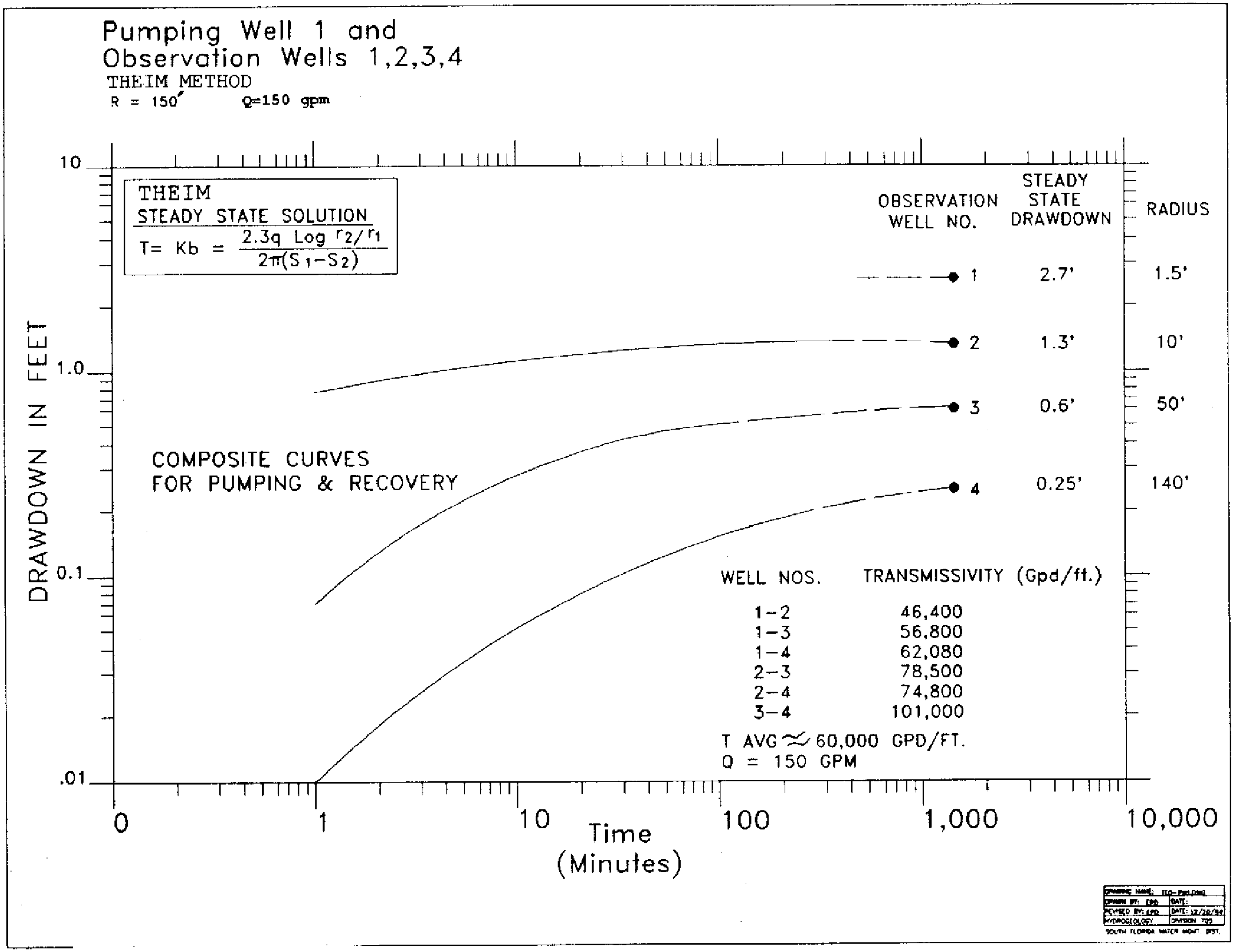
Four of the St. Lucie County aquifer test sites listed in Tables 9 and 10 (Sites# 7,8,10 and 11) were designed, drilled, and analyzed by SFWMD staff. The locations of these sites are shown in Figure 60. The USGS conducted five aquifer tests in St. Lucie County in 1979 (Sites# 9, 12,13,14,and 48), results of which are included in Tables 9 and 10. These SFWMD and USGS tests were not previously published and are summarized below. In addition, five APTs conducted by private consultants (Sites# 2,4,5,6, and 16) were re-analyzed by District staff and are discussed below. The plots and analyses of these re-analyzed tests were developed by previous SFWMD and USGS investigators and finalized (not modified) for this report. They are presented below with a brief discussion describing each APT and site.

Summaries of APTS Conducted by the SFWMD

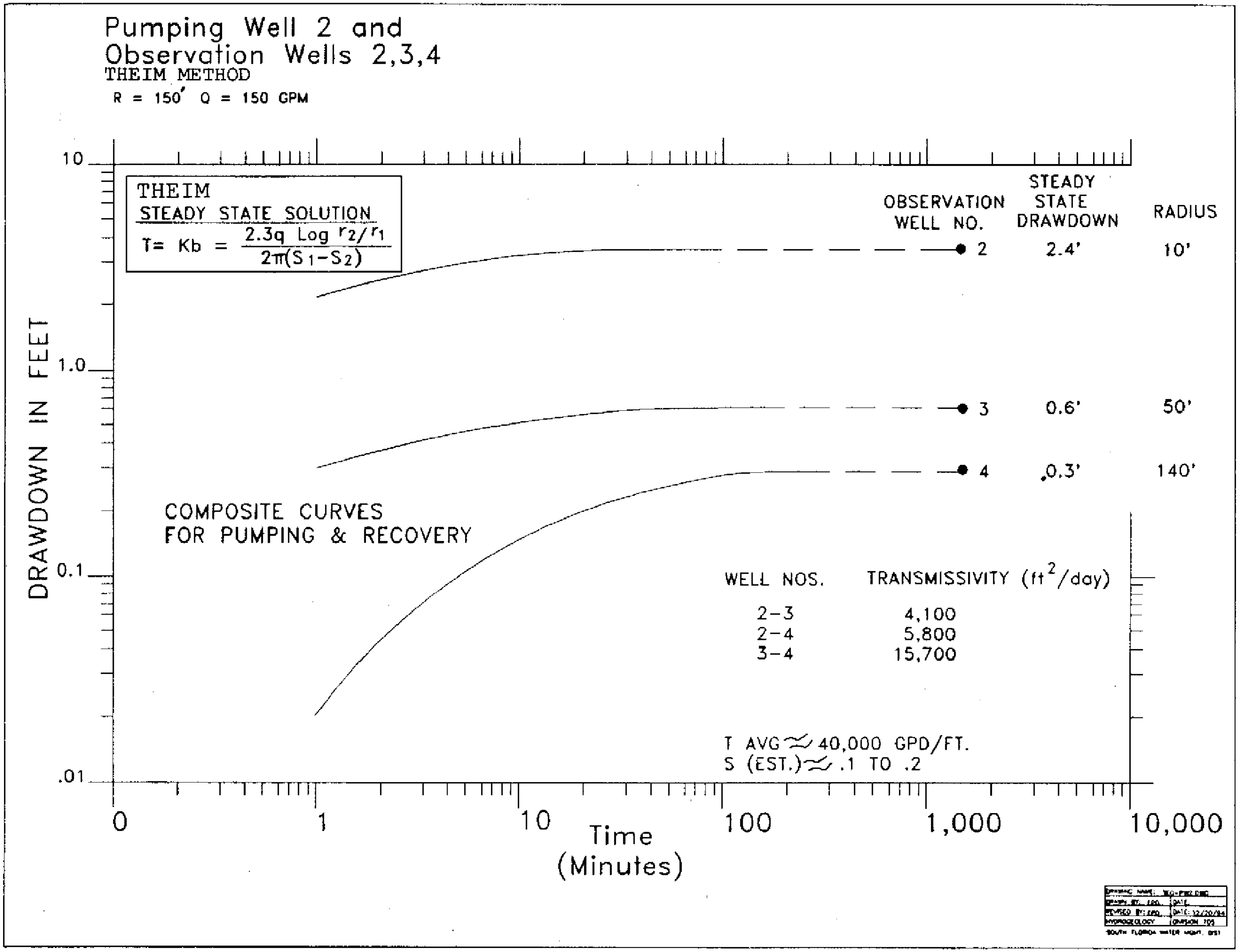
<u>STL-APT 1 Test Site</u>

<u>Map No.</u>	10
<u>Confidence in Analysis</u>	Moderate
<u>Status of Wells at Site</u>	Existing

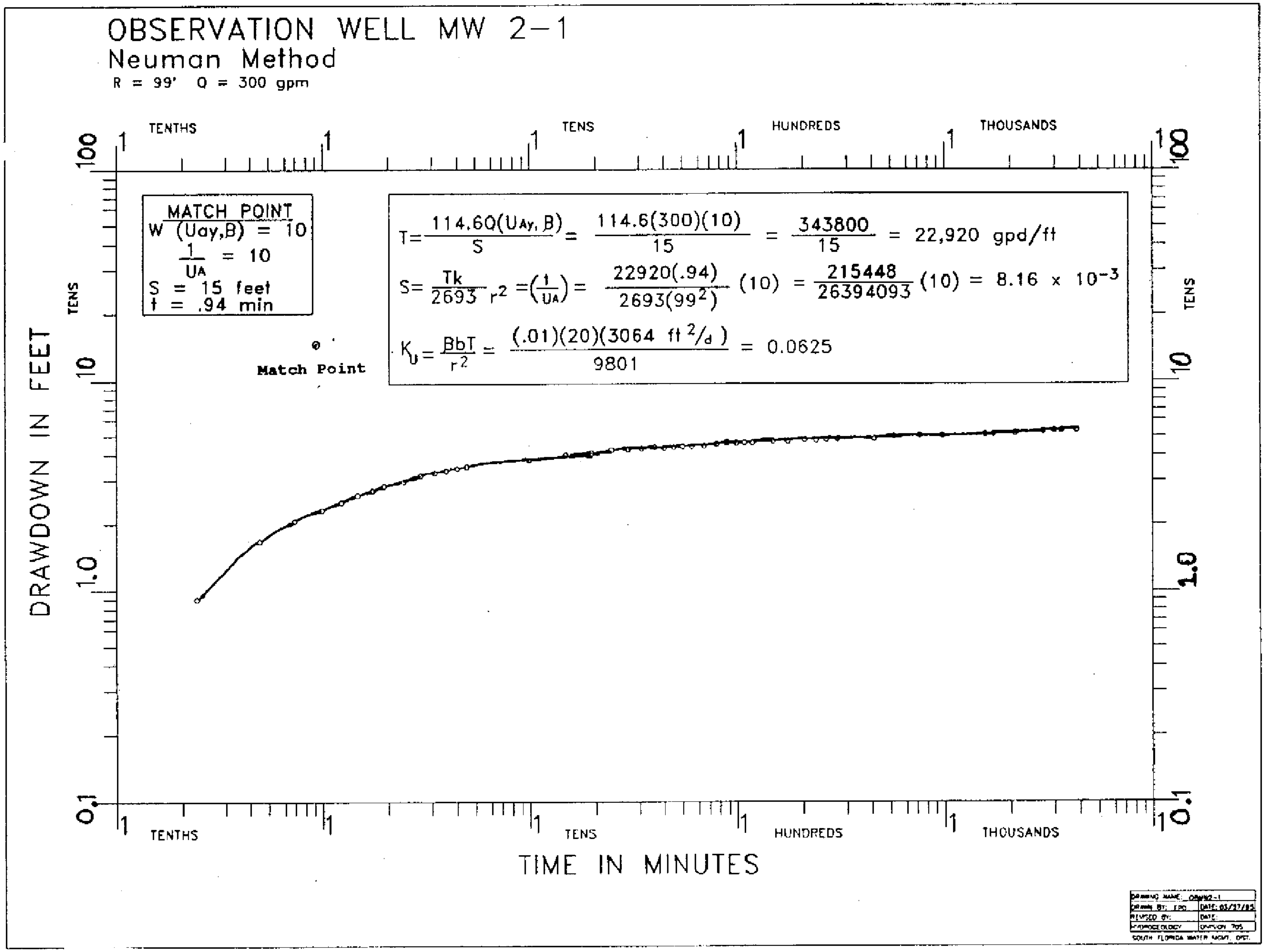
Comments: This test site is located in east-central St. Lucie County, north of Midway Road and east of the Florida Turnpike. The layout of the eleven wells at this site is shown in Figure 61. Two six-inch diameter production wells and nine two-inch diameter monitoring wells were constructed, completion details of these wells are listed in Table



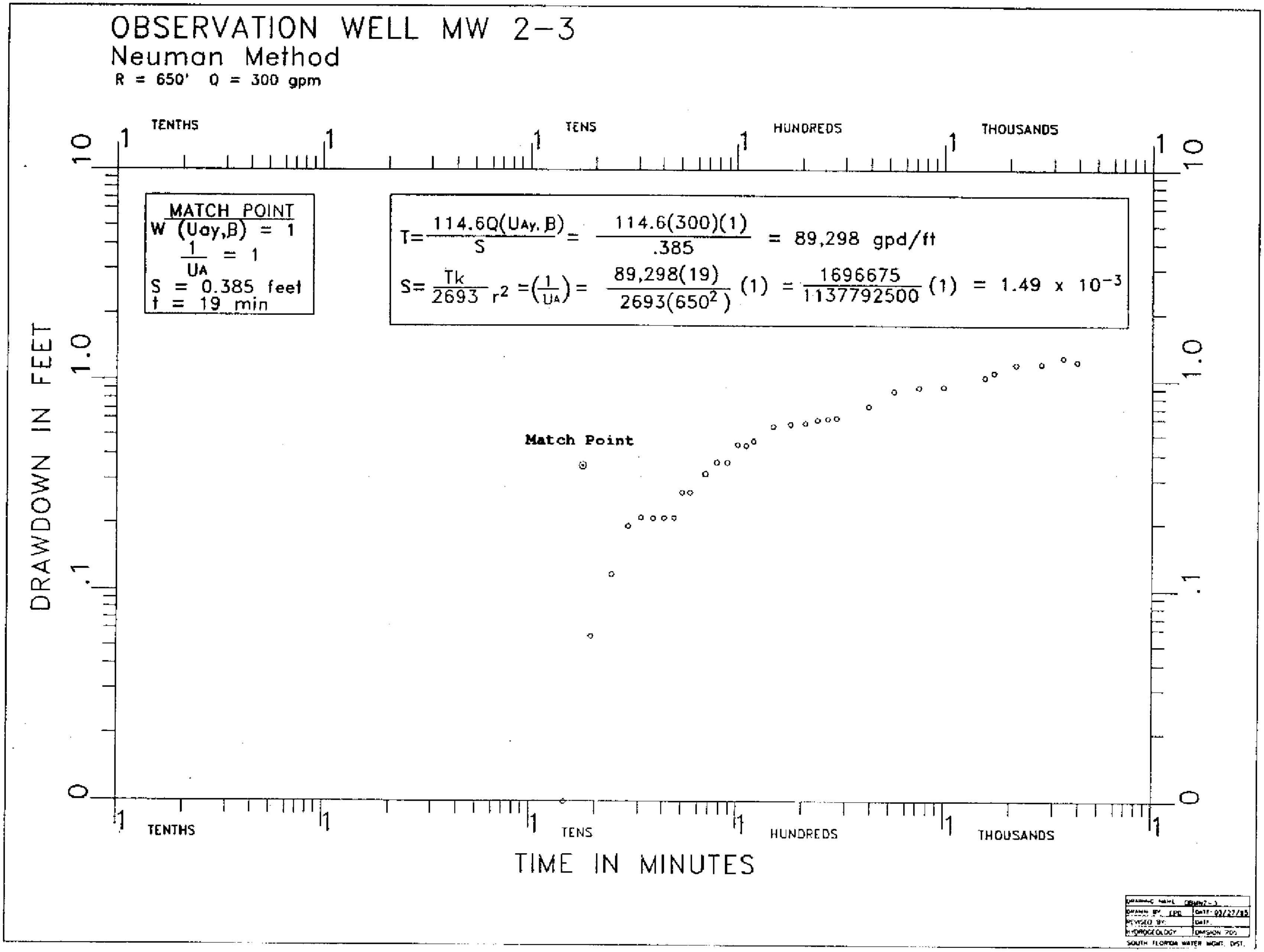
GRAPH 26. **Tequesta Park APT Drawdown: Pumping Well 1 and Observation Wells 1, 2, 3, and 4**



GRAPH 27. **Tequesta Park APT Drawdown: Pumping Well 2 and Observation Wells 2, 3, and 4**



GRAPH 28. Vista Salerno APT Drawdown: Observation Well 2-1



GRAPH 29. Vista Salerno APT Drawdown: Observation Well 2-3

TABLE 9. Surficial Aquifer System Aquifer Performance Test Results, St. Lucie County

MAP NO.	SITE ID	PUMPED WELL #	OBSERV. WELL #	PROD CASED /TD(FT)	OBS. CASED /TD(FT)	WELL RADIUS r (FT)	PUMP RATE (GPM)	HOURS PUMPED	MAXIMUM DRAWDOWN (FT)	TRANSMISS (GPD/FT)	STORAGE (unitless)	LEAKANCE (Day-1)	ANALYSIS METHOD
1	HARBOR RIDGE #1	TPW1	M-1	80/110	80/110	100	400	72.0	4.3	99,800	2.0E-4	1.3E-4	Hantush I
			M-2		80/110	200		3.1		69,500	3.0E-4	2.7E-4	Hantush I
			M-3		80/110	333		2.5		99,700	2.0E-4	5.3E-4	Hantush I
2	HARBOR RIDGE #2	PWZ	TW83-2	95/120	95/130	8.5	370	8.0	11.2	46,500	n/a Too short		Cooper-Jacob
3	SAVANNAH CLUB	TPW	OBS-2	70/100	70/100	196	103	43.0		2,950	3.1E-4	2.8E-2	Cooper (1965)
			OBS-3		70/100		405			10,264	2.3E-4	4.2E-3	Cooper (1965)
			OBS-4		70/100		212			6,380	1.7E-4	5.6E-3	Cooper (1965)
			OBS-5		70/100		412			9,836	3.6E-3	3.6E-3	Cooper (1965)
			OBS-6		70/100		727			7,333	3.1E-4	7.8E-3	Cooper (1965)
4	SP LAKES C CLUB	PW1	OBS-1	80/100	unknown	50	175	91.0	3.25	49,677	2.0E-5		Jacob
			OBS-2		unknown	200			1.42	43,597	7.7E-4	4.4E-2	Walton
5	NPT ST LUCIE PW11	PW-11	PW-12	71/106	850	250	250		4.2	13,902	2.3E-4	4.0E-4	Hantush
			PW-8		75/106	1,200			2.2				
6	NPT ST LUCIE PW12	PW-12	PW-11	71/106	71/106	850	220	24.0	3.8	11,085	1.8E-4	1.0E-4	Hantush
7	STL APT2-D	PW-1	D-2	67/117	91/101	90	102	61.0	12.1	5,845	1.1E-4	1.4E-3	Walton
			D-3		80/90	111			11.0	6,494	8.7E-5	7.8E-4	Walton
			D-4		81/91	171			9.0	7,792	8.9E-5	3.5E-4	Walton
			D-1		90/100	30			7.0				
			S-2		34/44	90			0.4				
			S-3		27/37	112			0.4				
			S-4		32/42	171			0.3				
7	STL APT2-S	PW-2	S-1	31/51	35/45	30	79	0.5	2.1	14,270			Jacob
8	STL APT3	PW-1		70/125		0							
		PW-2		30/46		0							
			S-1		30/50	30							
			I-1		70/80	30							
			D-1		100/128	30							
			S-2		30/50	90							
			I-2		70/80	90							
			D-2		100/125	90							
			S-3		30/50	110							
			I-3		70/80	110							
			D-3		100/125	110							

TABLE 9. Surficial Aquifer System Aquifer Performance Test Results, St. Lucie County (Continued)

MAP NO.	SITE ID	PUMPED WELL #	OBSERV. WELL #	PROD CASED /TD(FT)	OBS. CASED /TD(FT)	WELL RADIUS r (FT)	PUMP RATE (GPM)	HOURS PUMPED	MAXIMUM DRAWDOWN (FT)	TRANSMISS (GPD/FT)	STORAGE (unitless)	LEAKANCE (Day-1)	ANALYSIS METHOD
9	McCARTY RANCH	PW	OWD-1	103/113	88/98	72	131	24.5	9.3	9,383	1.1E-4	3.5E-3	Hantush-Jacob
			OWD-2		99/109	107			7.7	10,879	1.15E-4	2.5E-3	Hantush-Jacob
			S-1		11/23				0.7				
			S-2		11/23				0.7				
10	STL APT1	PW-1	D-1	56/109	92/102	90	192	38.8	2.0	77,962			Cooper-Jacob
			D-2		91/101	251			1.6	79,200	8.9E-4		Cooper-Jacob
			D		92/102	30			5.5	50,186	3.5E-5		Cooper-Jacob
			I		65/70	30			2.0	79,200	2.0E-2		Cooper-Jacob
			I-1		64/74	90			2.0				
			S		34/44	30			0.0				
			S-1		34/44	90							
			PW-2		34/44	0							
11	STLAPT4	PW	S-1	30/40	20/40	30	100	43.5	7.0	13,200	1.7E-4		Cooper-Jacob
			S-2		20/40	90			4.5	12,304	3.8E-4	8.1E-3	Walton
			S-3		20/40	190			2.3	22,372	7.2E-5		Cooper-Jacob
			S-4		20/40	91			4.0	12,988	5.8E-4	1.2E-2	Walton
			D-1		60/80	30			1.3				
			D-2		60/80	90			1.2				
			D-3		60/80	190			0.8				
12	FT PIERCE INT	PW	60N	70/110	70/110	60	158	22.7	8.0	13,456		VERYLOW	Jacob Recovery
			200W		70/110	200			7.0	13,904			Jacob Recovery
			30S		72/112	30							Jacob Recovery
			100S		72/112	100			7.0	15,004			
			300S		72/112	300							
13	INDRIO ROAD	PW	10N	60/90	59/89	10	203	26.5					
			75N		59/89	75							
			300N		59/89	300			4.0	19,779	7.0E-5	1.2E-3	Walton
			25S		60/90	25							
			150S		60/80	150			4.0	22,040	5.7E-5	1.3E-3	Walton

TABLE 9. Surficial Aquifer System Aquifer Performance Test Results, St. Lucie County (Continued)

MAP NO.	SITE ID	PUMPED WELL #	OBSERV. WELL #	PROD CASED /TD(FT)	OBS. CASED /TD(FT)	WELL RADIUS r (FT)	PUMP RATE (GPM)	HOURS PUMPED	MAXIMUM DRAWDOWN (FT)	TRANSMISS (GPD/FT)	STORAGE (unitless)	LEAKANCE (Day-1)	ANALYSIS METHOD
14	SAVAGE ROAD	PW	12S	33/63	33/63	12	70	19.0					
			74S		33/63	74			6.0	5,348	2.9E-4	2.9E-3	Walton
			35N		33/63	35				4,221	9.2E-3		Boulton
			125N		33/63	125			3.6	6,916	1.9E-3	5.3E-3	Walton
			300N		33/63	300							
			PG-29		28/30	300							
15	PORT ST LUCIE WEST	C-3	OW-1	30/60	30/60	50	156	24.5	7.8	15,151	1.8E-4	2.0E-3	Walton
			OW-2		30/60	200			4.0	17,700	1.9E-4	1.3E-3	Walton
16	MONTE CARLO CC	PW-1	OBS-1	65/95	110/120	100	180	12.0					
			OBS-2		70/80	150			10.0	12,893	7.7E-5	1.9E-4	Walton
			OBS-3		65/75	250			9.0	11,460	5.5E-06	2.4E-4	Walton
			WT		40/50	47							
17	FT.PIERCE,BCE#5	PW-5	PW-6	78/168	58/162	500	350	31.0	2.5	41,800	3.3E-4		Theis-Cooper
18	FT.PIERCE,BCE#10	PW-10	TW-10	71/131	75/85	100	400	2.0	3.1	32,300	1.4E-3		Cooper (1965)
19	FT.PIERCE,BCE#11	PW-11	TW-11	60/120	64/74	100	345			22,600	2.2E-4		Cooper (1965)
20	FT.PIERCEPW7	PW-7	TW7	60/100	62/86	205	500	23.5	2.1	95,564	2.4E-4		Boulton/Delayed
21	FT.PIERCEPW4	FPPW4	FPTW478	60/100	85/105	204	500	3.1	23.7	15,000	6.8E-3		Walton/Stallman
22	GEN DEV PW4	PW4		60/100	60/100	200				17,300	2.0E-4		Jacob
23	SAVANNAH DUNES			180/195						45,000	2.2E-4	6.7E-4	
24	BEARDEN 157									40,000	5.0E-5		
25	BEARDEN 162			58/						8,600	1.0E-4		
26	BEARDEN 160			21/						53,000	7.8E-5		
27	BEARDEN 167			105/						5,000	2.5E-4		
28	BEARDEN 165			100/						51,000	8.3E-4		
29	RESERVE TW1									4,200			

TABLE 9. Surficial Aquifer System Aquifer Performance Test Results, St. Lucie County (Continued)

MAP NO.	SITE ID	PUMPED WELL #	OBSERV. WELL #	PROD CASED /TD(FT)	OBS. CASED /TD(FT)	WELL RADIUS r (FT)	PUMP RATE (GPM)	HOURS PUMPED	MAXIMUM DRAWDOWN (FT)	TRANSMISS (GPD/FT)	STORAGE (unitless)	LEAKANCE (Day-1)	ANALYSIS METHOD
30	RESERVE TW2									4,300			
31	RESERVE TW3			100/135						3,650			
32	SP LKS FAIRWYS 1			68/9						40,000			
33	SP LKS FAIRWYS 2			75/83						15,000			
34	SP LKS FAIRWYS 3			65/80						6,500			
35	GEN DEV #13			71/95						23,000			
36	GEN DEV #14			54/100						29,500			
37	GEN DEV #15			60/100						54,700			
38	GEN DEV #16			64/90						71,400			
39	GEN DEV #17			55/110						35,900			
40	GEN DEV #18			50/95						11,200			
41	ST LUCIE W 1			30/70						26,000			
42	ST LUCIE W 2			30/70						4,714			
43	ST LUCIE W 3			30/70						24,000			
44	ST LUCIE W 4			30/70						21,000			
45	ST LUCIE W 5			30/70						26,000			
46	ST LUCIE W 6			30/70						18,000			
47	S.E. ST.LUCIE	PW167	OB 168	105/103		585	200		4.3	8,400	2.5E-04		Prickett

TABLE 10. Aquifer Performance Test Information, St. Lucie County

MAP NO.	LAND OWNER	SOURCE	REANALYZED	ANALYSIS IN APPNDX	DATE OF TEST	S/T/R	STATE PLANARS EAST (FT)	STATE PLANARS NORTH (FT)	LITHO WELL
1	HARBOR RIDGE #1	Geraghty & Miller (1982)	N	N	12/2/81	26/37/40	723702	1050219	
2	HARBOR RIDGE #2	Geraghty & Miller (1984)	Y	Y	10/14/83	36/37/40	726875	1047712	
3	SAVANNAH CLUB	Geraghty & Miller (1981)	N	N	04/22/81	26/36/40	725328	1082542	
4	SP LAKES C CLUB	SFWMD Permit File	N	Y	05/22/81	1/34/39	697753	1168535	SLMW24D*
5	NPT ST LUCIE PW12	Geraghty & Miller (1976)	Y	Y	05/26/75	20/36/40	710777	1087816	
6	NPT ST LUCIE PW11	Geraghty & Miller (1976)	Y	Y	05/15/75	29/36/40	710793	1087008	
7	STL APT2	SFWMD (Hydro.)	Y	Y	06/13/89	09/35/39	682980	1130900	W-16936
8	STL APT3	SFWMD (Hydro.)	Y	N	N/A	10/36/38	654904	1098673	W-16383
9	McCARTY RANCH	USGS (Hill,unpub., 1979)	Y	Y	03/28/79	23/37/38	662913	1058109	STL185
10	STL APT1	SFWMD (Hydro)	Y	Y	04/24/89	31/35/40	702639	1109785	W-16288
11	STLAPT4	SFWMD (Hydro)	Y	Y	08/14/89	10/36/37	620706	1100574	W-16933
12	FT PIERCE INTERCHANGE	USGS (Hill,unpub. 1979)	Y	Y	08/23/79	26/35/39	694488	1117725	STL213
13	INDRIO ROAD	USGS (Hill,unpub. 1979)	Y	Y	8/21/79	17/34/39	677997	1158042	STL264
14	SAVAGE ROAD	USGS (Hill,unpub. 1979)	Y	Y	11/13/79	11/37/39	689672	1068323	SLT214
15	ST LUCIE WEST	PBS&J (1985)	Y	Y	2/7/85	25/36/39	697638	1081690	
16	MONTE CARLO CC	LBF&H, Inc (SFWMD Permit File)		Y		28/34/39	686869	1147478	MCCC
17	FT.PIERCE,BCE#5	4 BC&E (1962)	N	N	4/12/62	23/35/40	721778	1123622	
18	FT.PIERCE,BCE#10	4 BC&E (1962)	N	N	7/12/62	5/35/40	710512	1138709	
19	FT.PIERCE,BCE#11	4 BC&E (1962)	N	N			705370	1138784	
20	FT.PIERCE PW7	BC&E (1978)	N	N	4/11/78	16/35/40	715452	1124256	
21	FT.PIERCE PW4	BC&E (1978)	N	N		16/35/40	710667	1126118	
22	GEN DEV PW4	Layne Atlantic Co. (1970)	N	N			710737	1083830	
23	SAVANNAH DUNES	Bearden, (1969)	N	N			747020	1066400	
24	BEARDEN 157	Bearden (1969	N	N			640276	1131032	
25	BEARDEN 162	Bearden (1969)	N	N			621827	1153894	
26	BEARDEN 160	Bearden (1969)	N	N			662811	1060936	STL185
27	BEARDEN 167	Bearden (1969)	N	N			721813	1065356	
28	BEARDEN 165	Bearden (1969)	N	N			712688	1084595	
29	RESERVE TW1	Geraghty & Miller (1969)	N	N			680542	1092315	
30	RESERVE TW2	Geraghty & Miller (1969)	N	N			684329	1092332	

TABLE 10. Aquifer Performance Test Information, St. Lucie County (Continued)

MAP NO.	LAND OWNER	SOURCE	REANALYZED	ANALYSIS IN APPNDX	DATE OF TEST	S/T/R	STATE PLANARS EAST (FT)	STATE PLANARS NORTH (FT)	LITHO WELL
31	RESERVE TW3	Bearden (1969)	N	N			686312	1092664	
32	SP LKS FAIRWYS 1	Bearden (1969)	N	N			673188	1166402	
33	SP LKS FAIRWYS 2	Bearden (1969)	N	N			670656	1169320	
34	SP LKS FAIRWYS 3	Bearden (1969)	N	N			672997	1169027	
35	GEN DEV #13	Bearden (1969)	N	N			708805	1085280	
36	GEN DEV #14	Bearden (1969)	N	N			710093	1080440	
37	GEN DEV #15	Bearden (1969)	N	N			709196	1079426	
38	GEN DEV #16	Bearden (1969)	N	N			709744	1078116	
39	GEN DEV #17	Bearden (1969)	N	N			714606	1080060	
40	GEN DEV #18	Bearden (1969)	N	N			713890	1078945	
41	ST LUCIE W 1	Bearden (1969)	N	N			697902	1083004	
42	ST LUCIE W 2	Bearden (1969)	N	N			685533	1083180	
43	ST LUCIE W 3	Bearden (1969)	N	N			698893	1083211	
44	ST LUCIE W 4	Bearden (1969)	N	N			699434	4083416	
45	ST LUCIE W 5	Bearden (1969)	N	N			698536	1083603	
46	ST LUCIE W 6	Bearden (1969)	N	N			698805	1082804	
47	SOUTHEAST St.LUCIE	USGS (Bearden,1972)	N	N	1/20/70	14/37/40	721550	1065400	
48	PT. ST. LUCIE WEST	USGS (Hill, Unpub., 1979)	N	Y	9/13/79	11/37/39	689672	1068323	

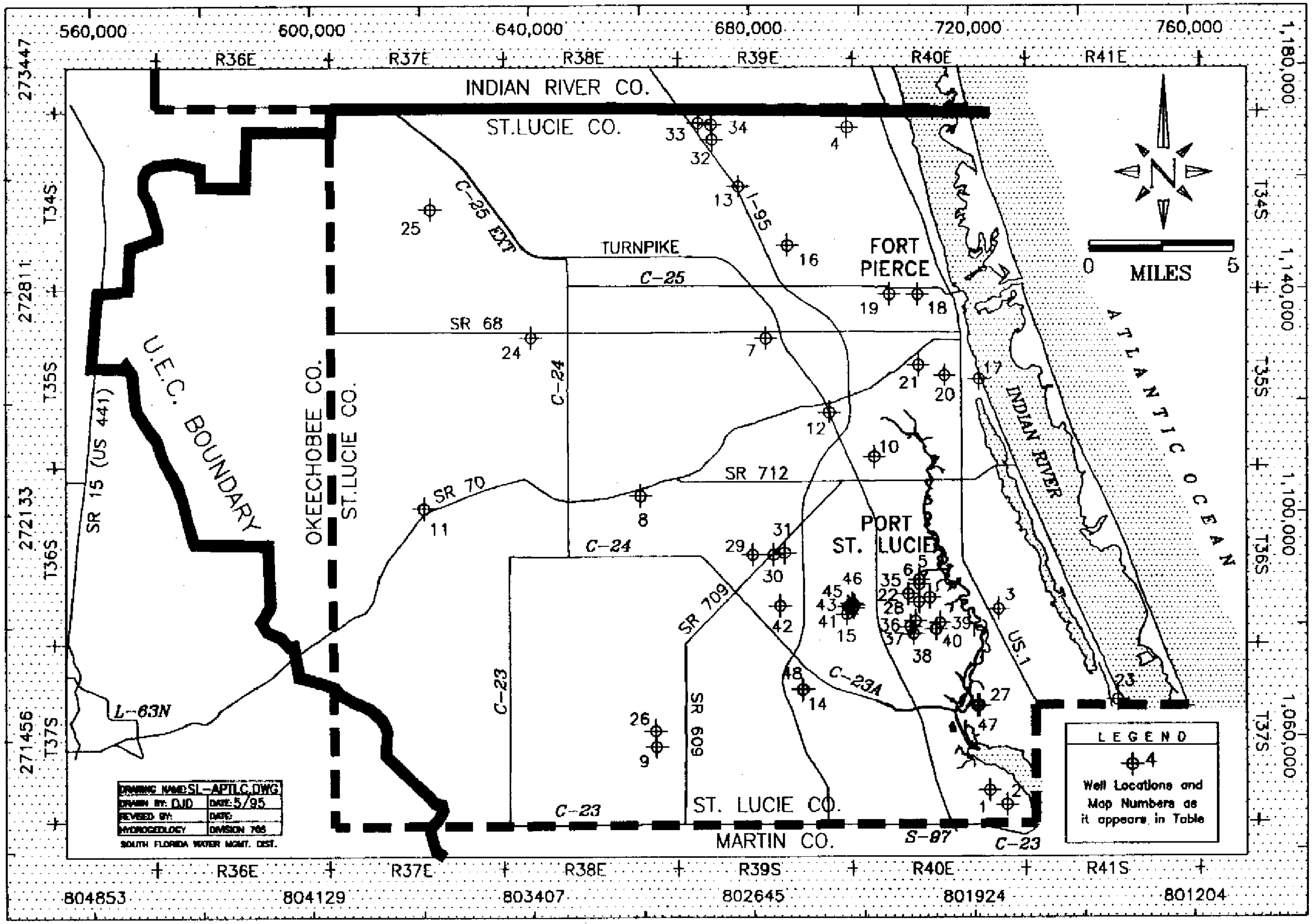


FIGURE 58. **Location Map of the Surficial Aquifer System APT Sites, St. Lucie County**

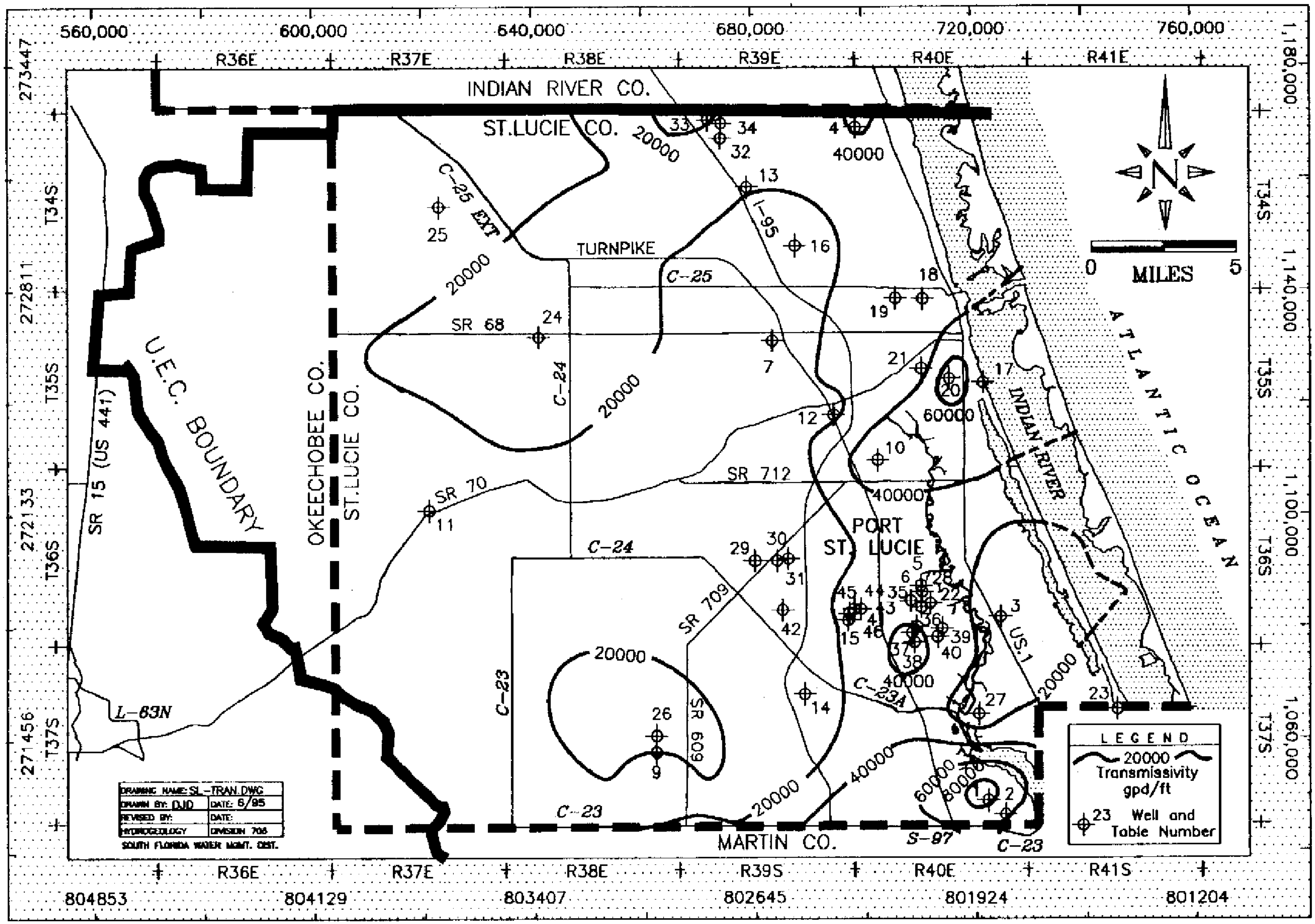


FIGURE 59. **Regional Transmissivity of the Most Permeable Surficial Aquifer Units, St. Lucie County**

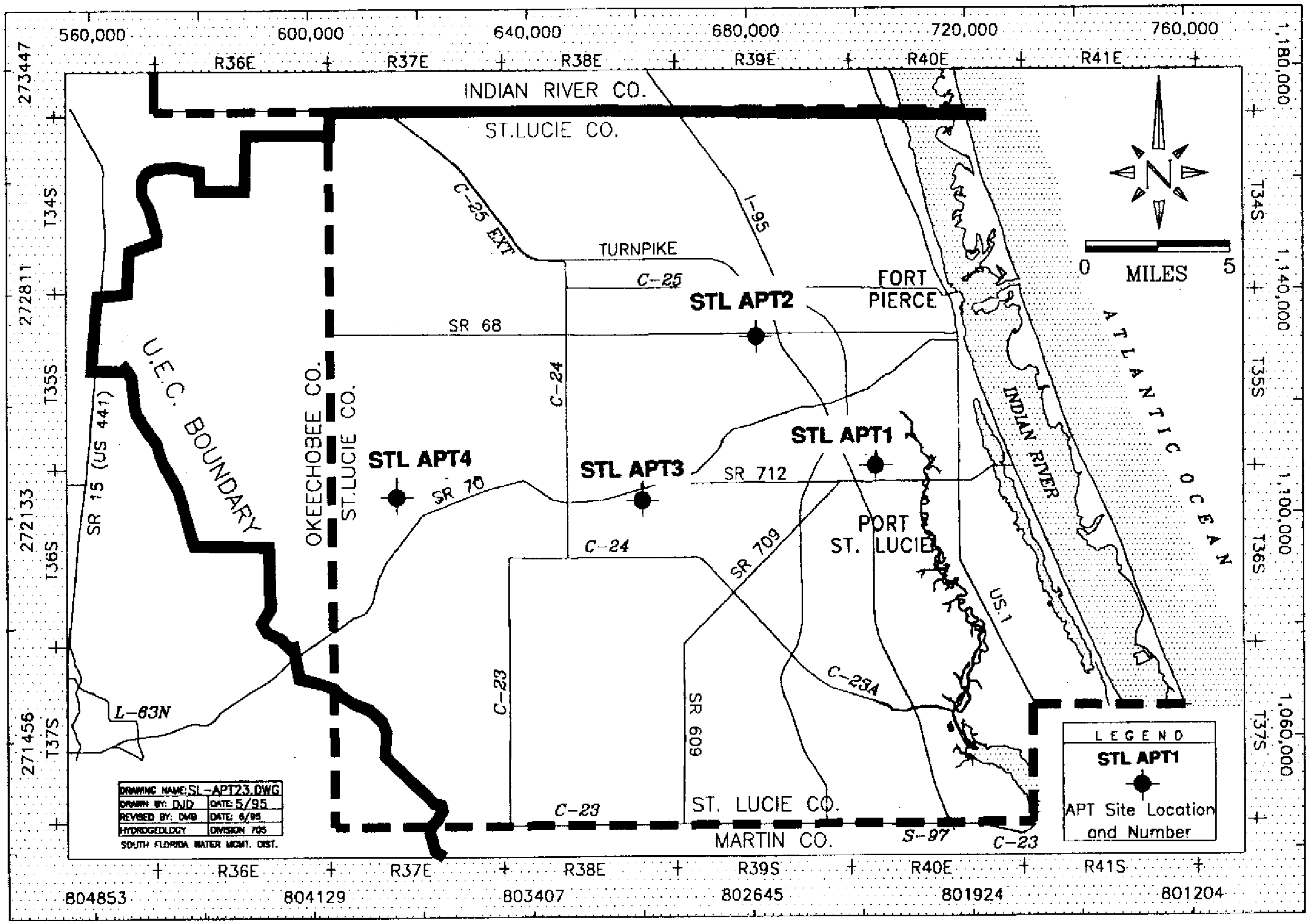


FIGURE 60. **Map Showing Locations of the four SFWMD Surficial Aquifer System APT Sites in St. Lucie County**

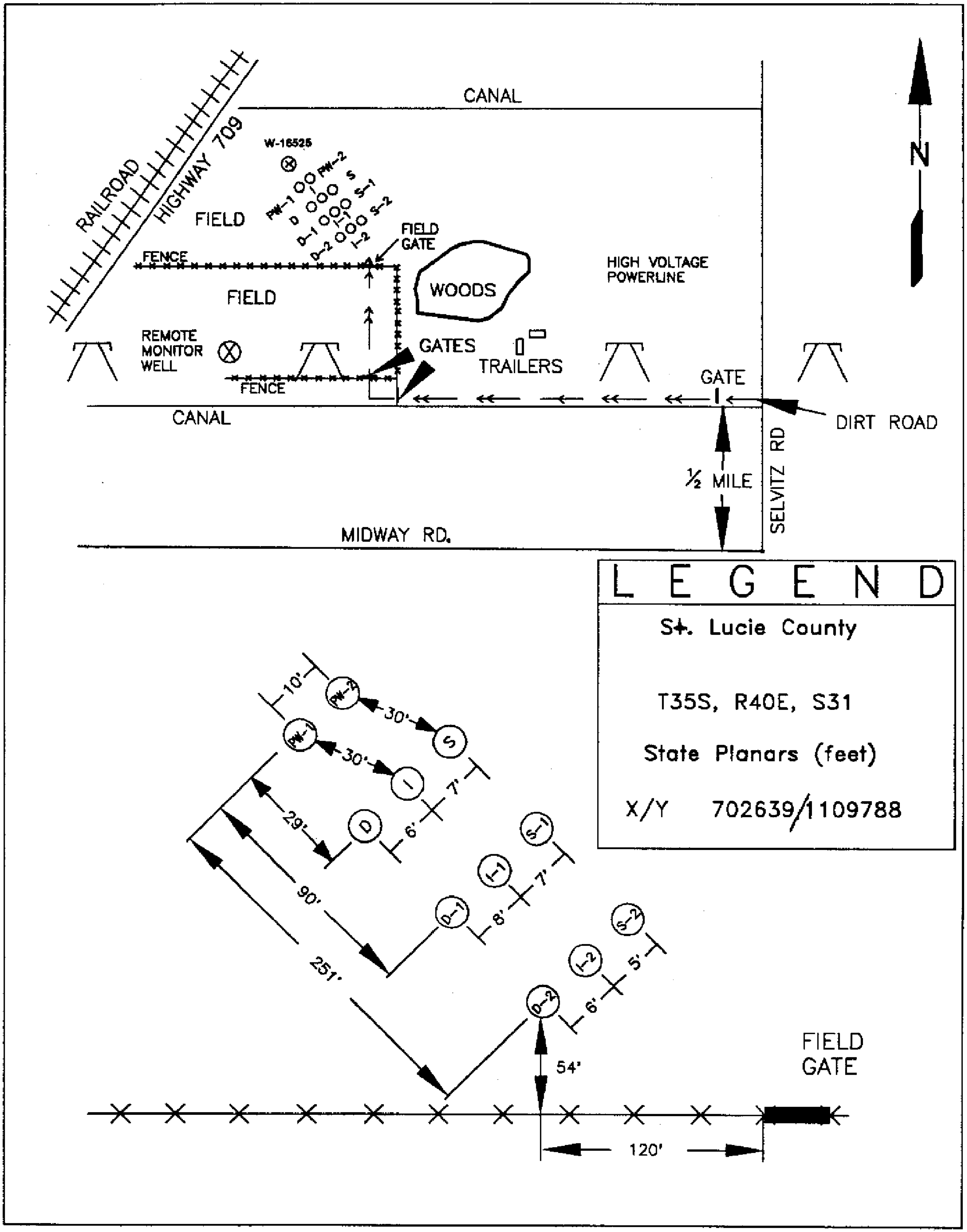


FIGURE 61. Location Map and Site Layout - STL-APT 1 Site

9. The pilot hole (PW-1) was drilled with mud to a depth of 142 feet BLS whereas well STLAPT1-H2 was split-spoon sampled and cored to a depth of 123 feet BLS to obtain more representative lithologic information. Cuttings were described for both wells and are provided in Appendix A-2 under the FGS well names W-16288 and W-16525, respectively. Geophysical logs were run on the pilot hole and are presented in Appendix B, under the SFWMD I.D.# 111000055.

Three major problems were encountered which compromised test results. The first problem was with well design. The deeper production well (PW-1) was screened through two separate aquifers. This site was designed to obtain aquifer parameters from three distinct units in the SAS: shallow, intermediate and deep. Although three monitoring wells were constructed into each of the three units, only two production wells were constructed. One production well was screened through the shallow zone, while the other through both the intermediate and deep zones.

The deeper production well (screened between 56 and 109 feet BLS) was pumped at a rate of 192 gpm for 38.8 hours. Drawdown was recorded and analyzed using the Cooper-Jacob (1946) method. The resulting aquifer parameters represent transmissivity and storage of the two aquifers combined. Those plots, analyses, and computations are provided in Graphs 30 through 32.

The second problem with this test was that no recovery data was recorded due to premature termination of pumping caused by a pump failure. The third problem was that the shallow zone was never tested due to extremely low yields and to the fact that a smaller capacity submersible pump was not available at the time.

Transmissivity and storage parameters were computed from drawdown data recorded in monitoring wells D, D2 and I using the Cooper-Jacob (1946) method. The computed transmissivity values range from 50,186 gpd/ft to 79,200 gpd/ft. Storage values have a much higher range between 2.0 E-2 to 8.97 E-4. Drawdown from D2, the furthest monitoring well from the pumping well (251 feet), is probably the most reliable since it was outside the radius of non-laminar flow. Type-curve matches were not obtained because the production well was completed and screened across multiple aquifers. During pumping of PW-1, water-levels in all intermediate monitoring wells declined significantly while those in the shallow monitoring wells were unaffected. This indicates poor communication between the intermediate and shallow aquifers at this site. However, lithologic descriptions indicate a high permeability limestone in the interval between the two zones (70 to 90 feet BLS).

Since the wells still exist, this site can be revisited to test the shallow aquifer, providing permission of the land owner is obtained.

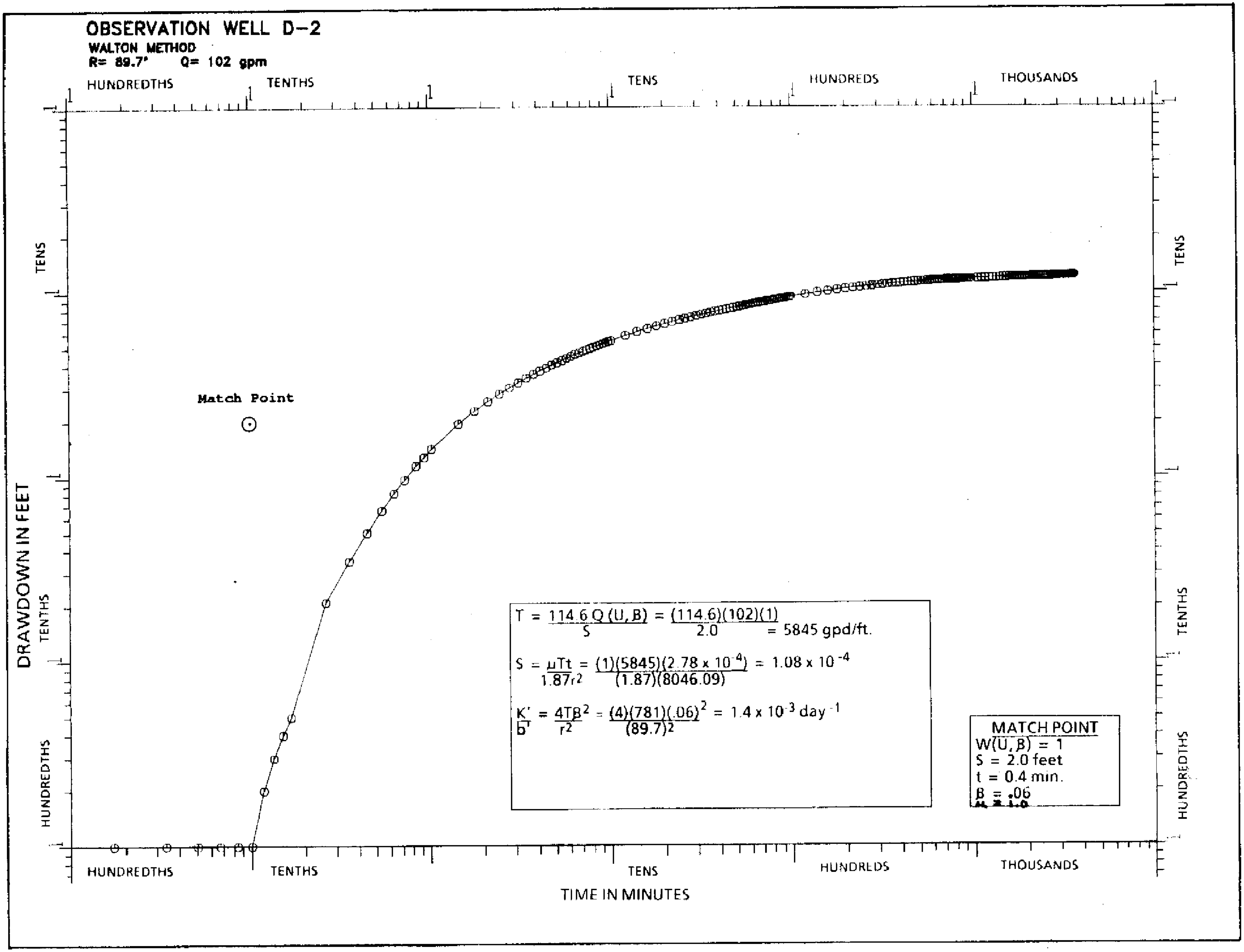
<u>STL-APT 2 Test Site</u>

<u>Map No.</u>	7
<u>Confidence in Analysis</u>	Moderate-High
<u>Status of Wells at Site</u>	Existing

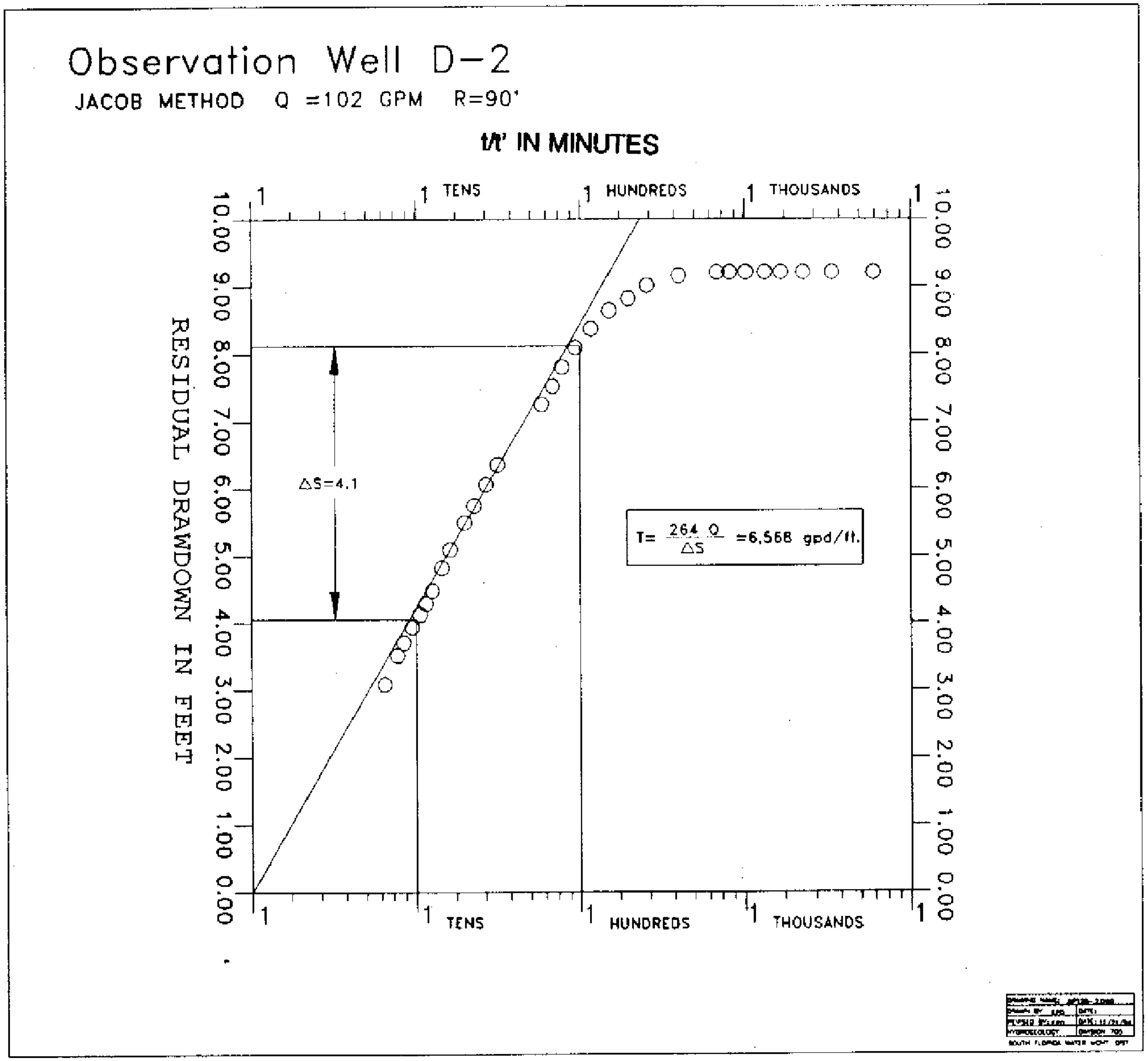
Comments: The STL-APT 2 site is located on the Spiterri Ranch in northeastern St. Lucie County near the Florida Turnpike and SR 68. A site location map, along with a map showing the relative positioning of the eleven wells, are shown in Figure 62. One core-hole, two six-inch diameter production wells and eight two-inch diameter monitoring wells were constructed. The pilot hole (W-16542) was split-spoon sampled from land surface to 57 feet BLS and dual tube cored between 57 feet and 128 feet BLS, the samples are described in Appendix A-2. Geophysical logs for production wells 1 and 2 are included in Appendix B, indexed under the SFWMD geophysical I.D.#'s 111000057 and 111000058, respectively.

Both the shallow and deep SAS zones were pumped in two separate tests. However, only the results from the latter are documented here. Apparently mechanical problems with the pump developed while pumping the shallow zone. Drawdown and recovery data from the deep wells were analyzed using the Walton (1962) and Jacob (1952) methods, respectively, as shown in Graphs 33 through 38. The transmissivities computed in these analyses are fairly consistent, ranging from 5,845 gpd/ft to 7,792 gpd/ft. Storativity ranged from 1.08 E-4 to 8.9 E-5 and leakance from 1.4 E-3/day to 7.08 E-4/day.

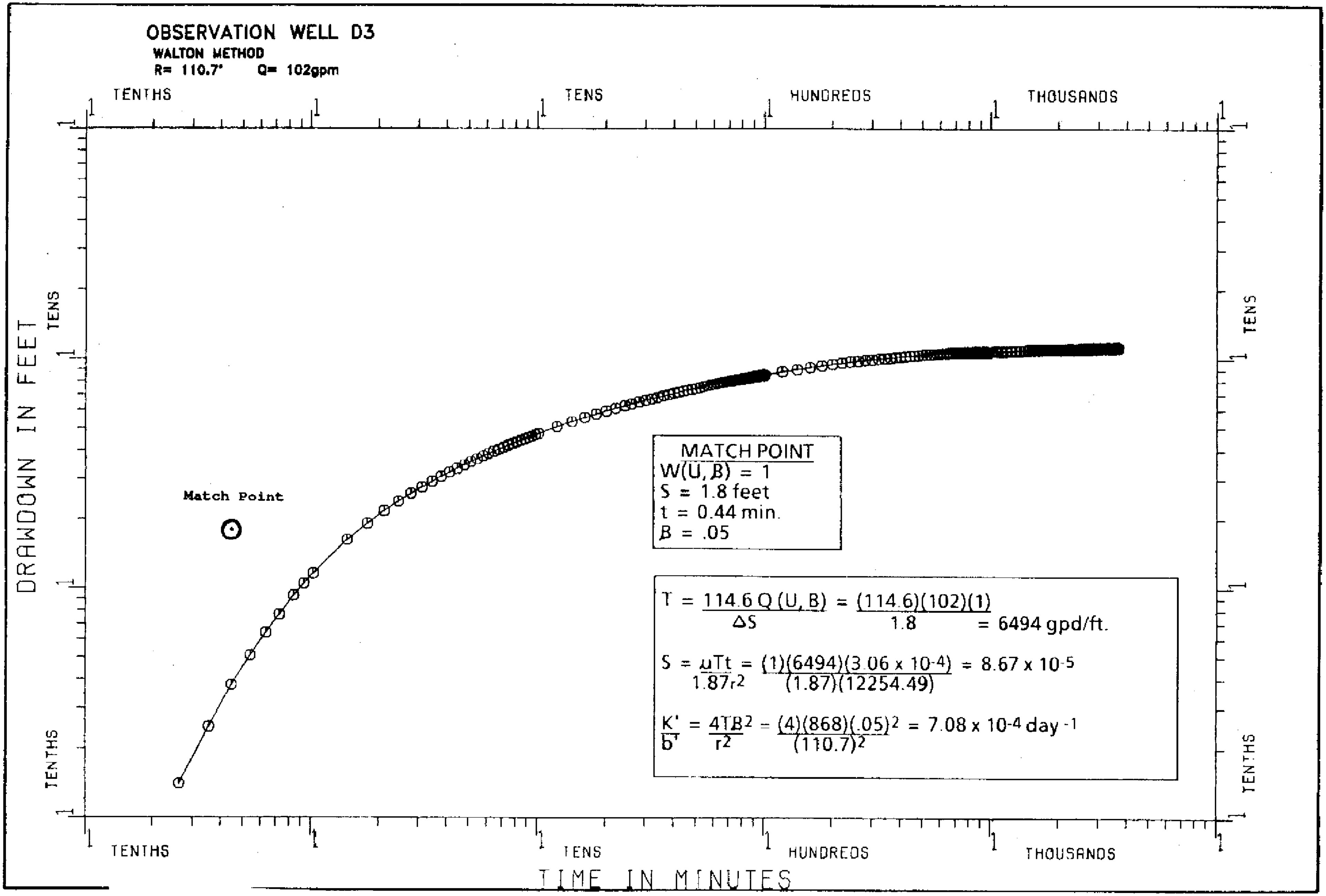
The leakance values are relatively small, indicating good confinement between the two zones. This is verified by the small amount of drawdown (0.4 feet) observed in the shallow well during pumping of the deep well. The production well, completed between 67 and 117 feet BLS, had very low yields which caused numerous false starts during testing. In several of the early test attempts, with pumping rates higher than 100 gpm, the pump cavitated due to excessive drawdowns. This low yield corresponds to the low values of calculated transmissivity.



GRAPH 30. STL APT 1 APT Drawdown: Observation Well D



GRAPH 31. STL APT 1 APT Drawdown: Observation Well D-2



GRAPH 32. STL APT 1 APT Drawdown: Observation Well I

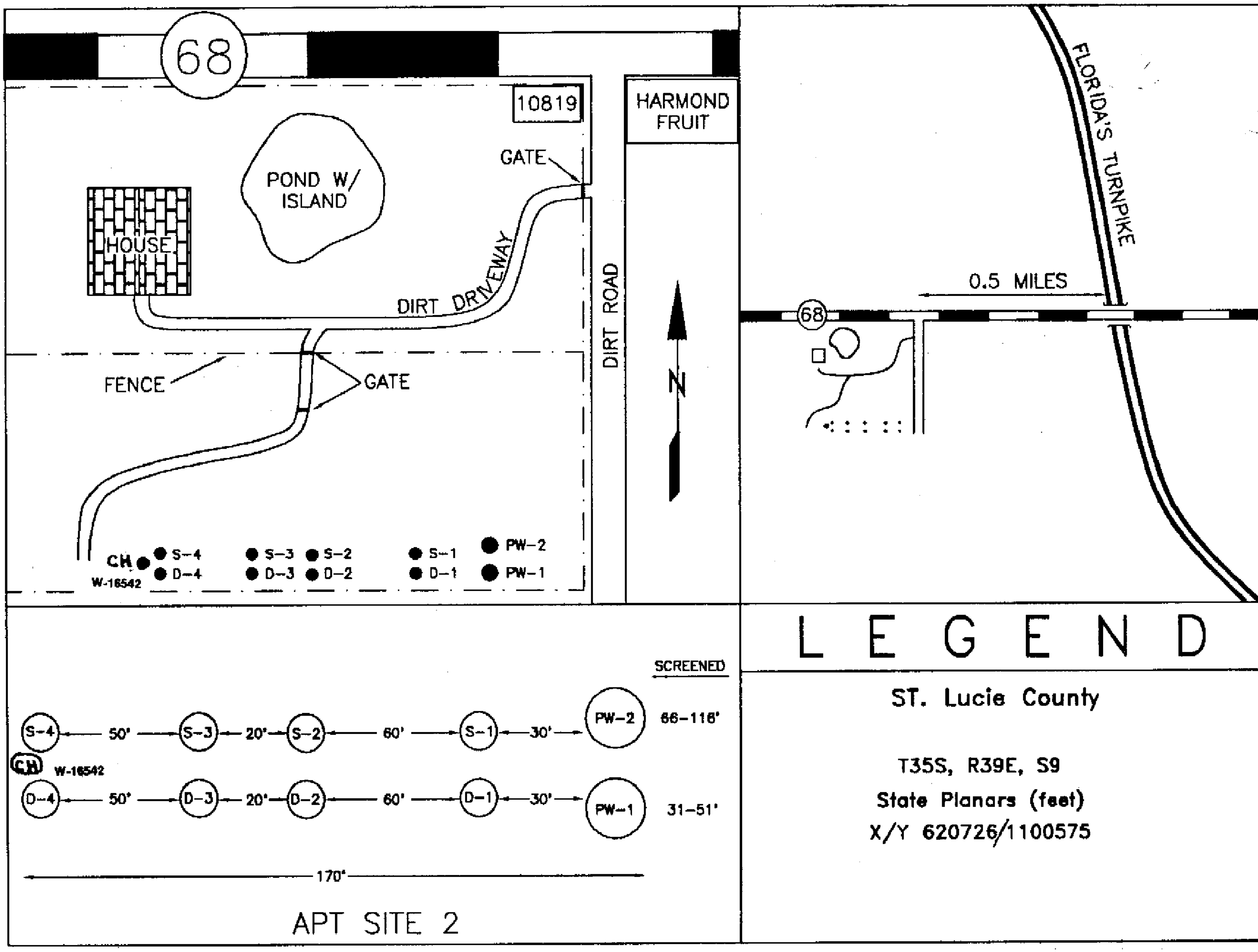
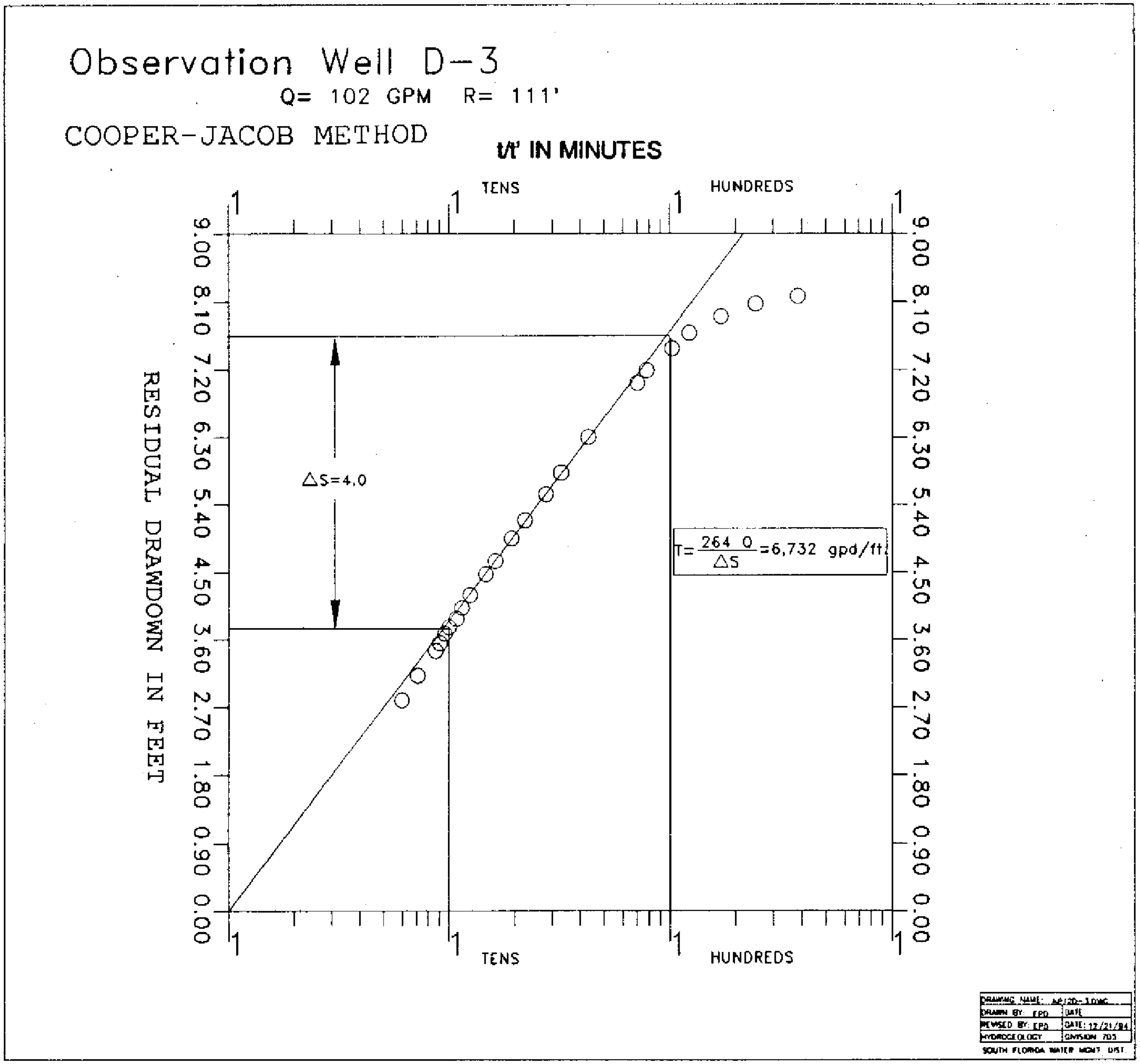
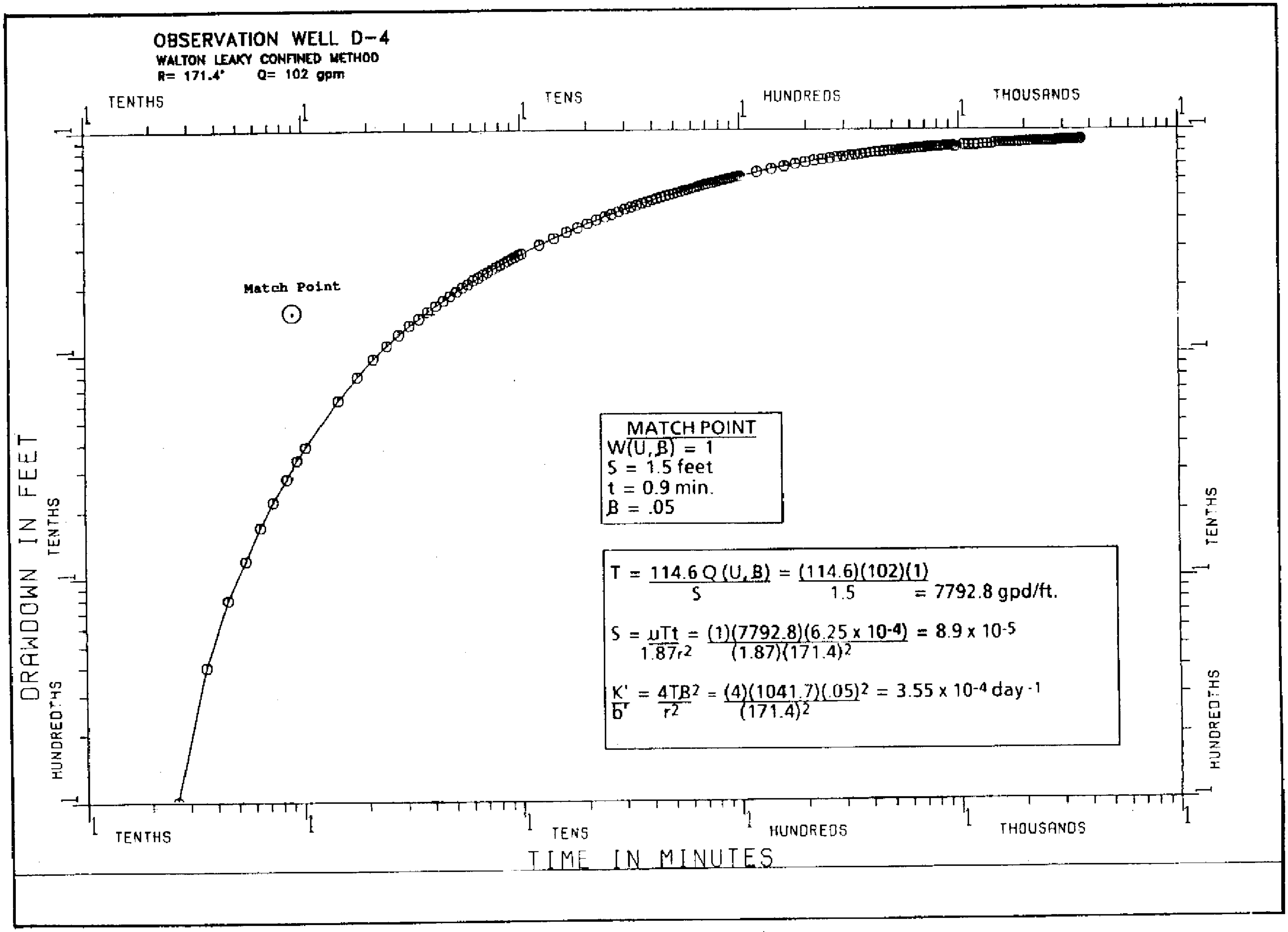


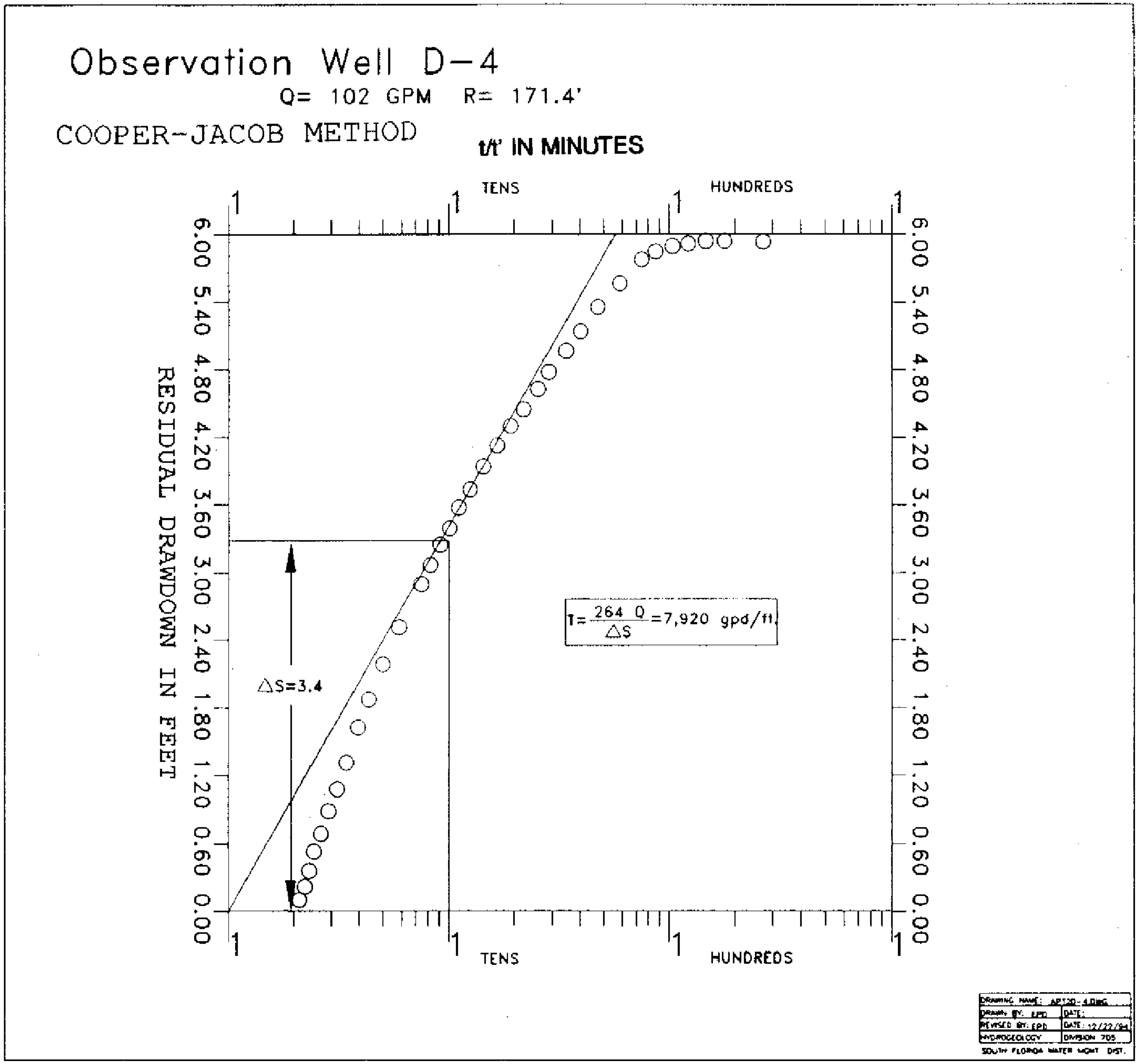
FIGURE 62. Location Map and Site Layout - STL-APT 2 Site



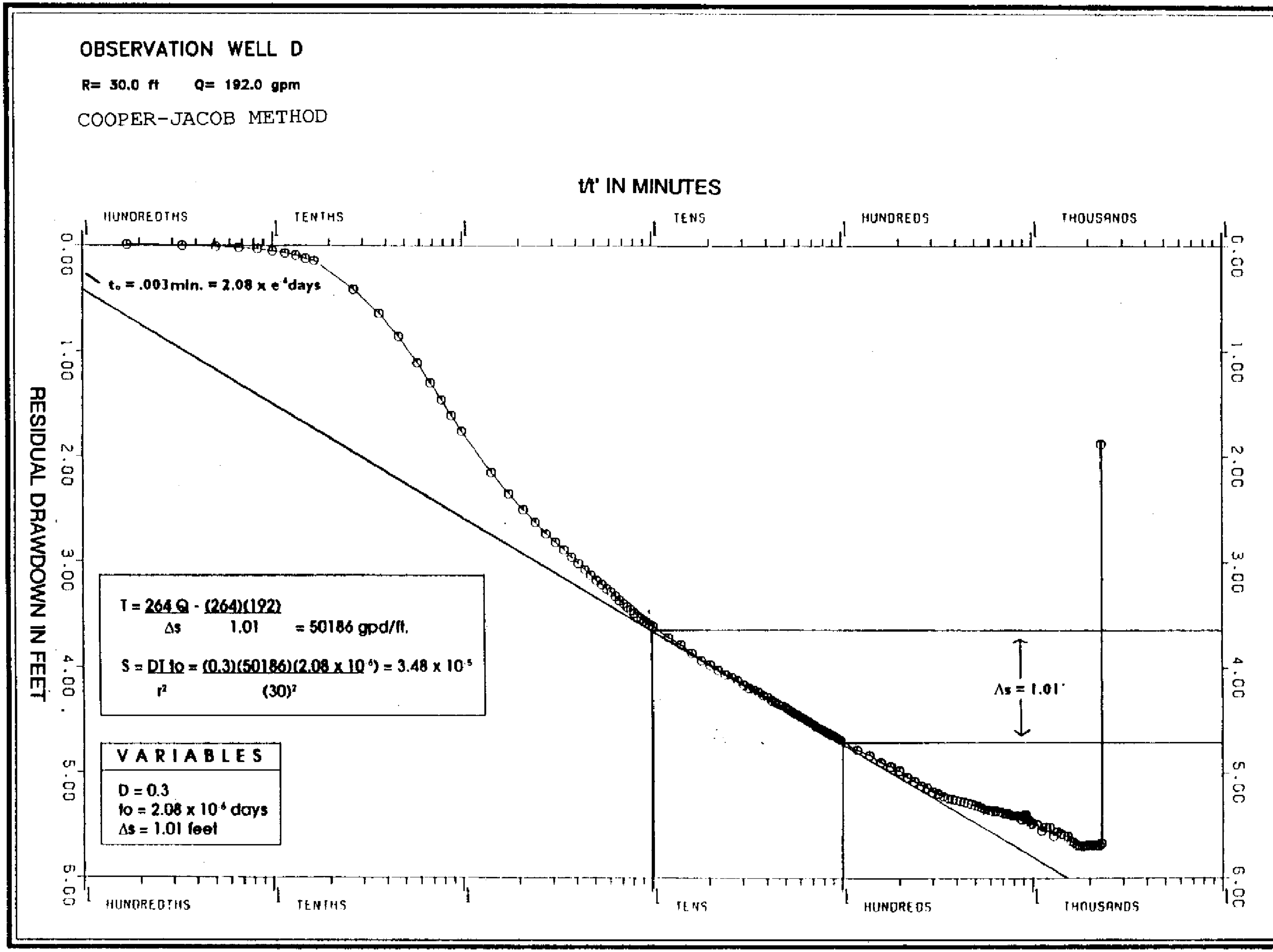
GRAPH 33. STL APT 2 APT Recovery: Observation Well D-3



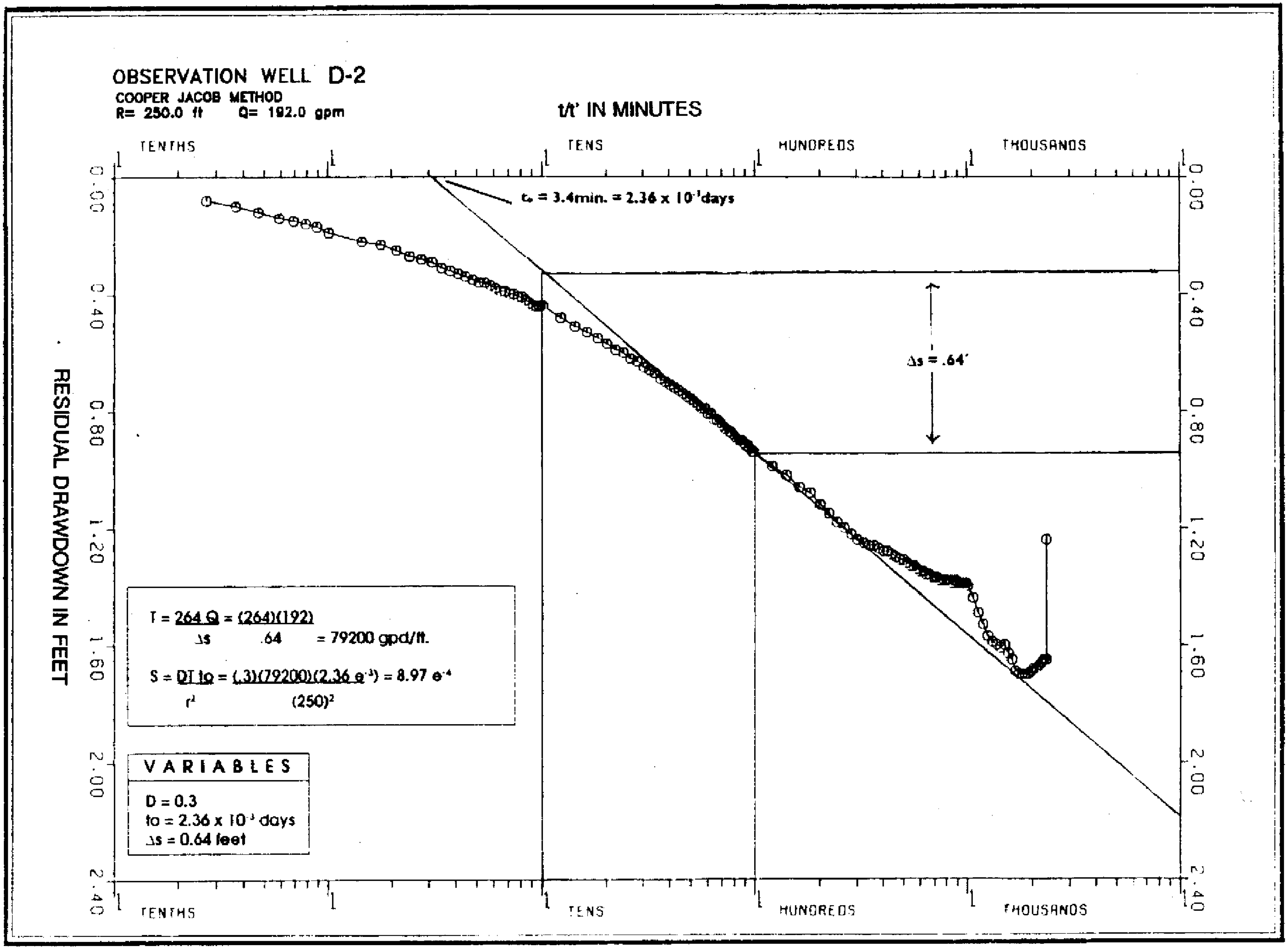
GRAPH 34. STL APT 2 APT Drawdown: Observation Well D-4



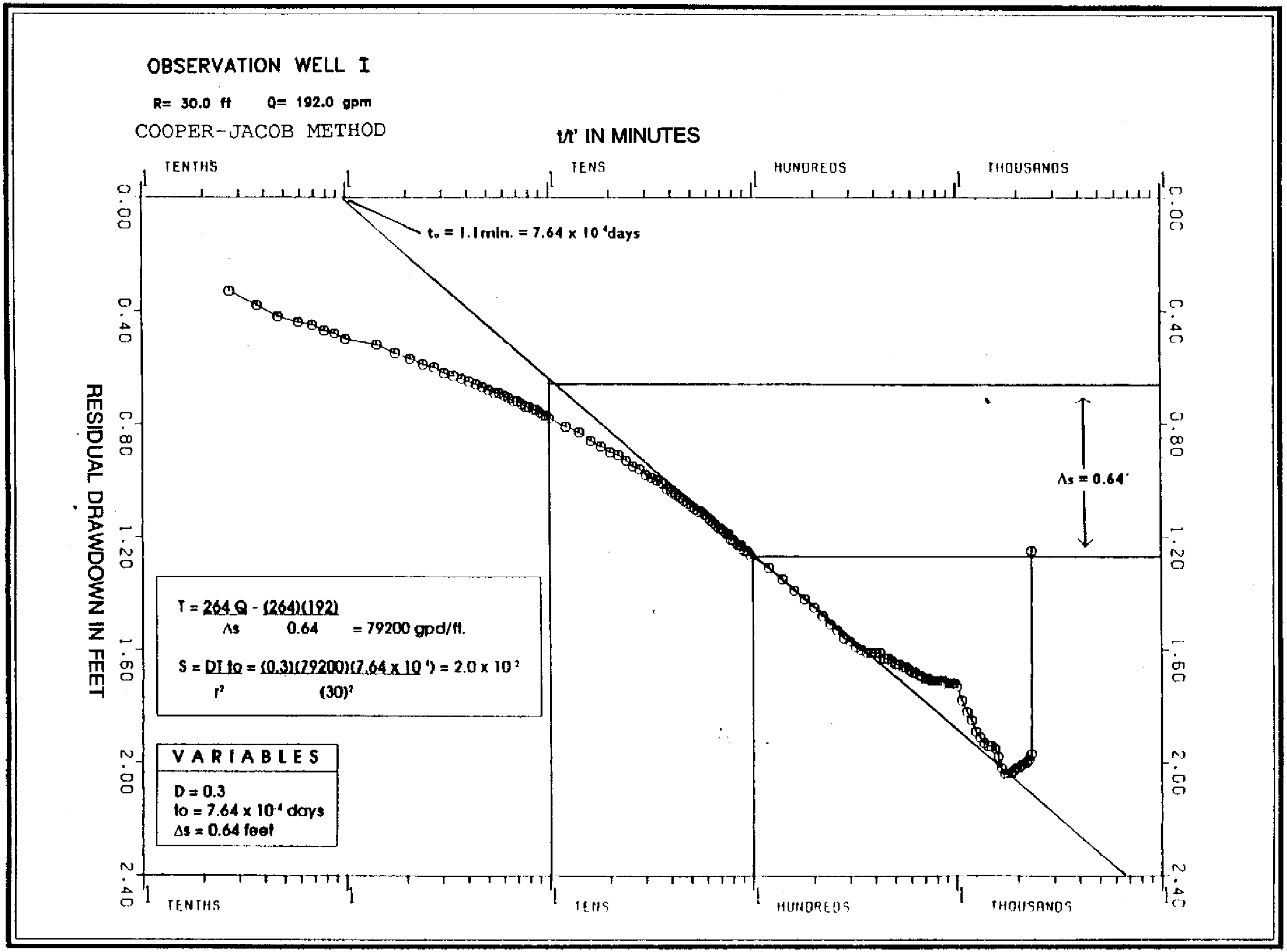
GRAPH 35. STL APT 2 APT Recovery: Observation Well D-4



GRAPH 36. STL APT 2 APT Drawdown: Observation Well D-2



GRAPH 37. STL APT 2 APT Recovery: Observation Well D-2



GRAPH 38. STL APT 2 APT Drawdown: Observation Well D-3

Because there were problems encountered with pumping the shallow zone, the testing at this site was never completed. All of the wells still exist and, with the permission of the property owner, can be re-tested again in the future.

STL-APT 3 Test Site

Map No. 8
Confidence in Analysis No Analysis
Status of Wells at Site Existing

Comments: Eleven wells were constructed at this site located on the Carlton Ranch in west-central St.Lucie County. The location of the wells are shown in Figure 63. Wells were screened across three separate zones within the SAS (shallow, intermediate, and deep). Well completion details are given in the table of results (Table 9). All wells, with the exception of D-3, are six inches in diameter. The production well (PW1) was drilled using the split-spoon method to obtain optimum recovery of lithologic samples, descriptions of which are presented in Appendix A-2 under the FGS well name W-16383. Geophysical logs are given in Appendix B under the SFWMD I.D.# 111000059.

APTs were not conducted at this site because the well yield was too low for the SFWMD's discharge pumps. A specialty 2-inch submersible pump was ordered for use at this site but did not arrive in time to meet the project deadline. Although a constant discharge APT was not conducted at this site, a small 2-inch centrifugal pump was used to determine well yields. Continuous drawdown data was not recorded during this testing, only maximum drawdown at the pumped wells. Each well was pumped between five and ten minutes. The following table (Table 11) summarizes the field measurements and notes collected during those well-yield tests.

No other data is available for this site; however, it is obvious from this information that each of the three zones present at this site has very low transmissivity and hydraulic conductivity.

Table 11. Summary of Well Yields from STL-APT 3 Site.

Pumped Well	Pumping Rate (gpm)	Drawdown Feet	Comments
PW-1	10.6	11.0	Water-level dropping very slowly, water clear. Conductivity = 2274 mmhos/cm.
PW-2	11.2	6.4	Water slightly cloudy. Conductivity = 1024 mmhos/cm.
S-1	10.0	8.0	Wa ter-level is static, discharge clear. Con ductivity = 1156 mmhos/cm.
I-1	<2.0	>13.0	Water-level fluctuating above and below base of suction. Water is clear. Conductivity = 2900 mmhos/cm.
D-1	2.0	12.0	Water-level fluctuating, water muddy. Conductivity = 2796 mmhos/cm.

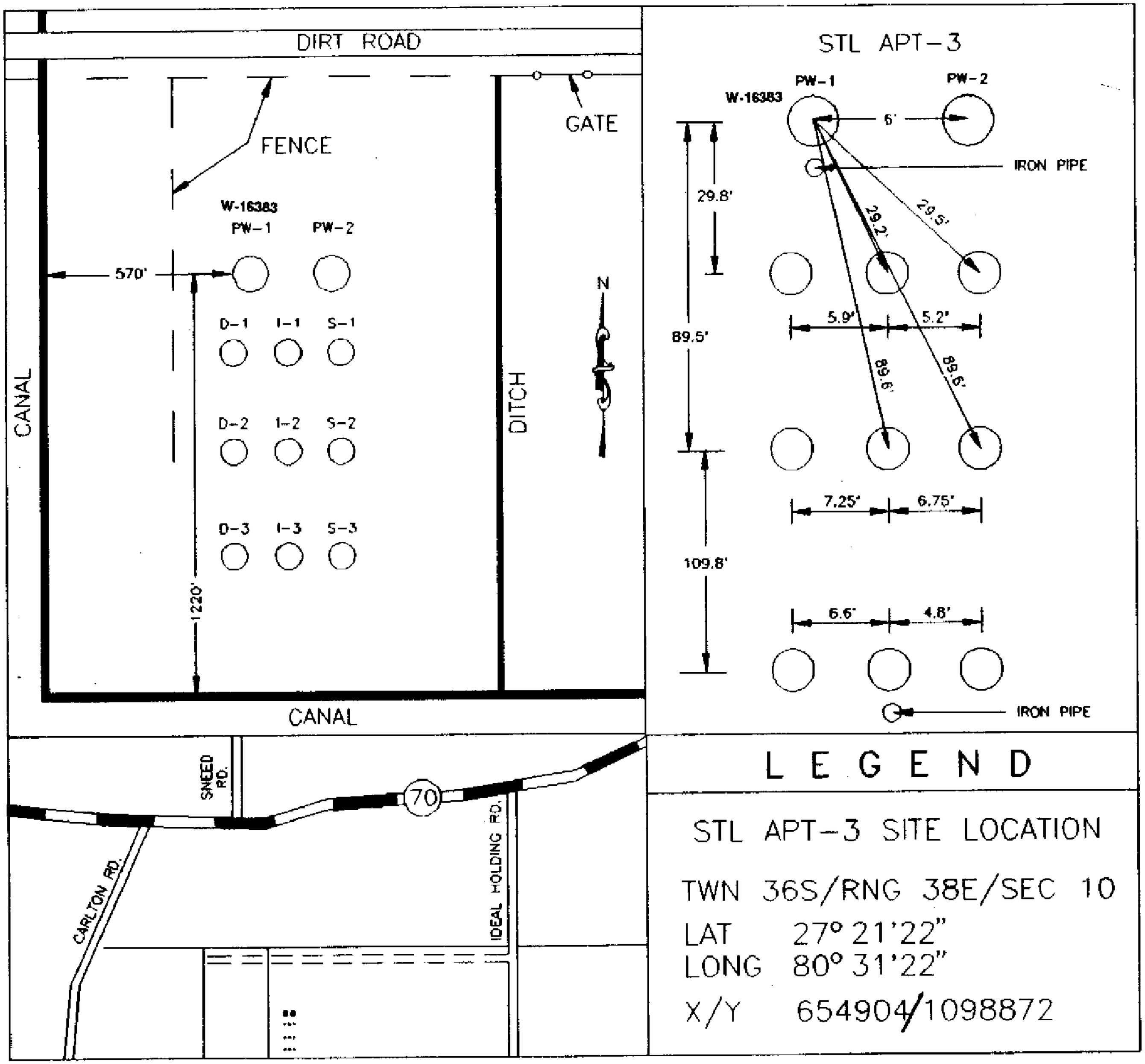


FIGURE 63. **Location Map and Site Layout - STL-APT 3 Site**

STL-APT 4 Test Site

Map No. 11
Confidence in Analysis High
Status of Wells at Site: Existing

Comments: This site is located in central St. Lucie County on the V-2 Bar Ranch, west of the intersection of Midway Road and SR 70. Eight wells completed to two aquifers were constructed here, as shown in Figure 64. A pilot hole (PW-1) was drilled to a depth of 126 feet BLS using a split-spoon method. The descriptions of these samples are provided in Appendix A-2 under the FGS well name W-16933. Geophysical logs for this well are presented in Appendix B under the SFWMD I.D.# 111000070.

One shallow, six-inch diameter production well, four shallow, two-inch diameter monitoring wells, and three deep, two-inch diameter monitoring wells were constructed at this site. Only the shallow aquifer was tested. It is not known why a second, deep production well was not constructed. The shallow aquifer was pumped at 103 gpm for 43.5 hours. Both drawdown and recovery were recorded in all monitoring wells. Drawdown data from monitoring wells S-2 and S-4 were analyzed using the Walton (1962) type-curve fitting method while drawdown data from wells S-1, S-3 and S-4 were analyzed using the Jacob Method (1952). These analyses are shown in Graphs 39 through 43. The transmissivity values computed were fairly consistent. Recovery data was recorded but not analyzed for this site.

Two values of leakance were computed from the type-curve analyses, 1.21E-2 /day (well S-4) and 8.12E-3 /day (well S-2). The two zones are separated by sand. Water-levels in the deep monitoring wells decreased over one foot while pumping the shallow aquifer. These observations indicate that there is significant leakance between the two zones.

Field notes mentioned only a few, relatively minor problems associated with this test. One was that it rained during the test, causing water-levels to rise in the upper sand/soil unit. Also, possible electronic noise in the data recorder, beginning approximately twenty minutes into the drawdown phase of testing,was observed in wells S-3 and D-3. Finally, it was noted that the data-logger recorded slightly higher water-level rises (maximum of 0.2 feet) approximately 1 to 2.5 minutes after pumping started in wells D-3, S-3, and D-2.

Summaries of APTs Conducted by the USGS

McCarty Ranch Test Site

Map No. 9
Confidence in Analysis Moderate-High
Status of Wells at Site Unknown

Comments: This site is located in southwestern St. Lucie County, west of SR 609 and 2.7 miles north of the Martin-St. Lucie county line. A site map showing the layout of the wells is given in Figure 65. Cuttings descriptions for the pilot hole, drilled to a depth of 118 feet BLS, is provided in Appendix A-3 indexed under the well name STL-185. Although probably run, geophysical logs could not be located for these boreholes.

Six wells were drilled at this site, three of which were completed as monitoring wells to a deep SAS zone from approximately 88 feet to 120 feet BLS. Another two were completed as monitoring wells to a shallow zone between 11 feet and 23 feet BLS. One 4-inch production well (Well PW), completed in the deep aquifer from 103 feet to 113 feet BLS, was pumped at a rate of 131 gpm during the early portion of the test and then at a reduced rate of 123 gpm for five hours after pumping began.

Drawdown data from wells OWD-1 and OWD-2 were analyzed using both the Hantush-Jacob 1 (1955) type-curve method and the Hantush (1964) straight-line method. Plots of these analyses, along with parameter computations, are presented in Graphs 44 through 47. The results of all analyses are fairly consistent, showing transmissivities ranging from 9,383 gpd/ft to 10,879 gpd/ft.

The following are selected field notes recorded by the original investigator describing important aspects of the test:

> "Wells set in the producing zone were screened in a zone consisting of unconsolidated shells and shell fragments with a minor component of sand, overlain by fine, gray sand with some minor shells and clay. Well OWD-3 was found by accident after the test was started and, therefore, limited drawdown data could be obtained from it. Shallow drainage ditches are located a short distance (within 130 feet) to the south, west, and northeast. Underlying the ditches is a layer of clay and, therefore, water in the ditches shouldn't recharge the pumped aquifer. Since the drawdown in the shallow

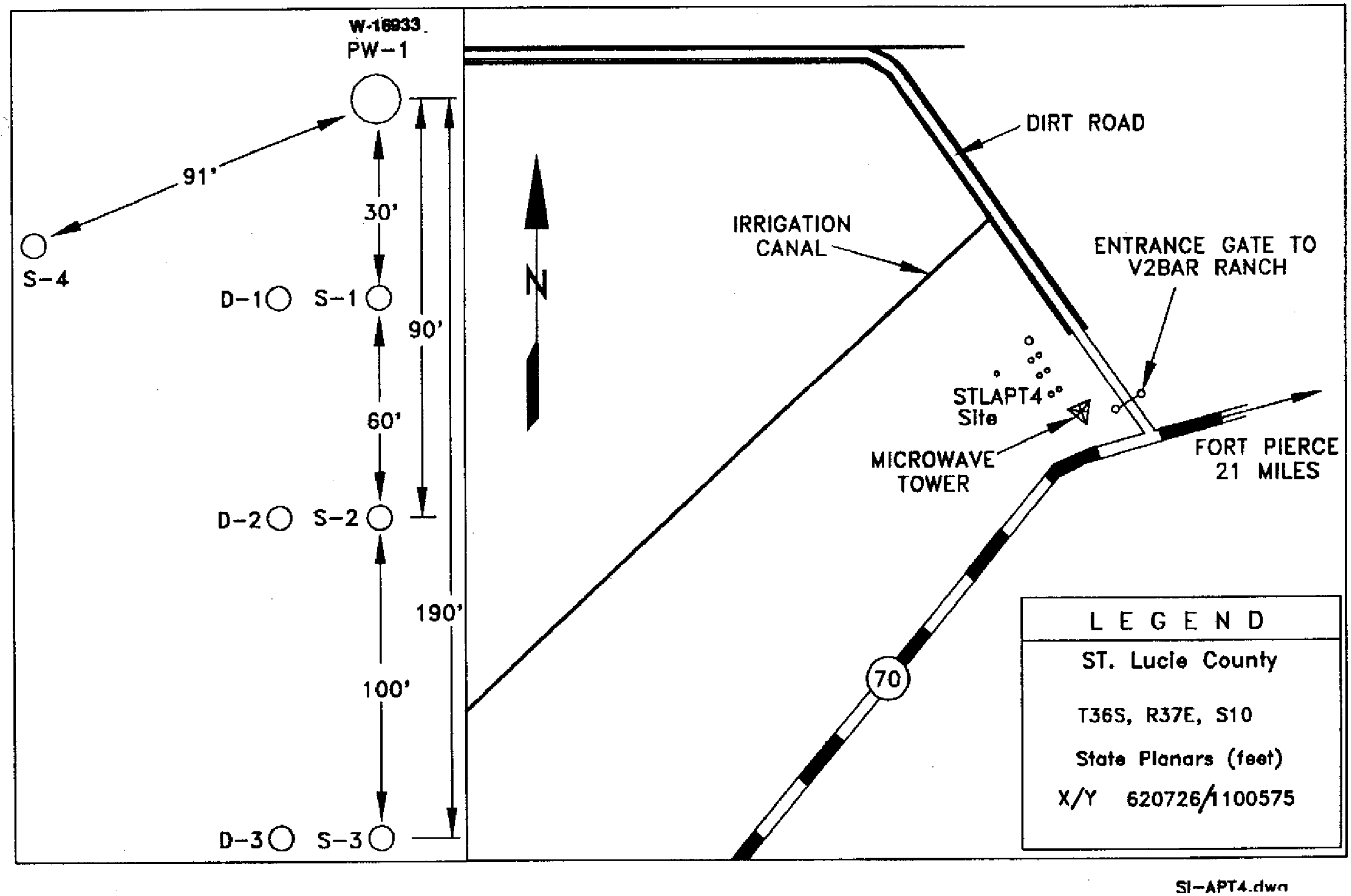
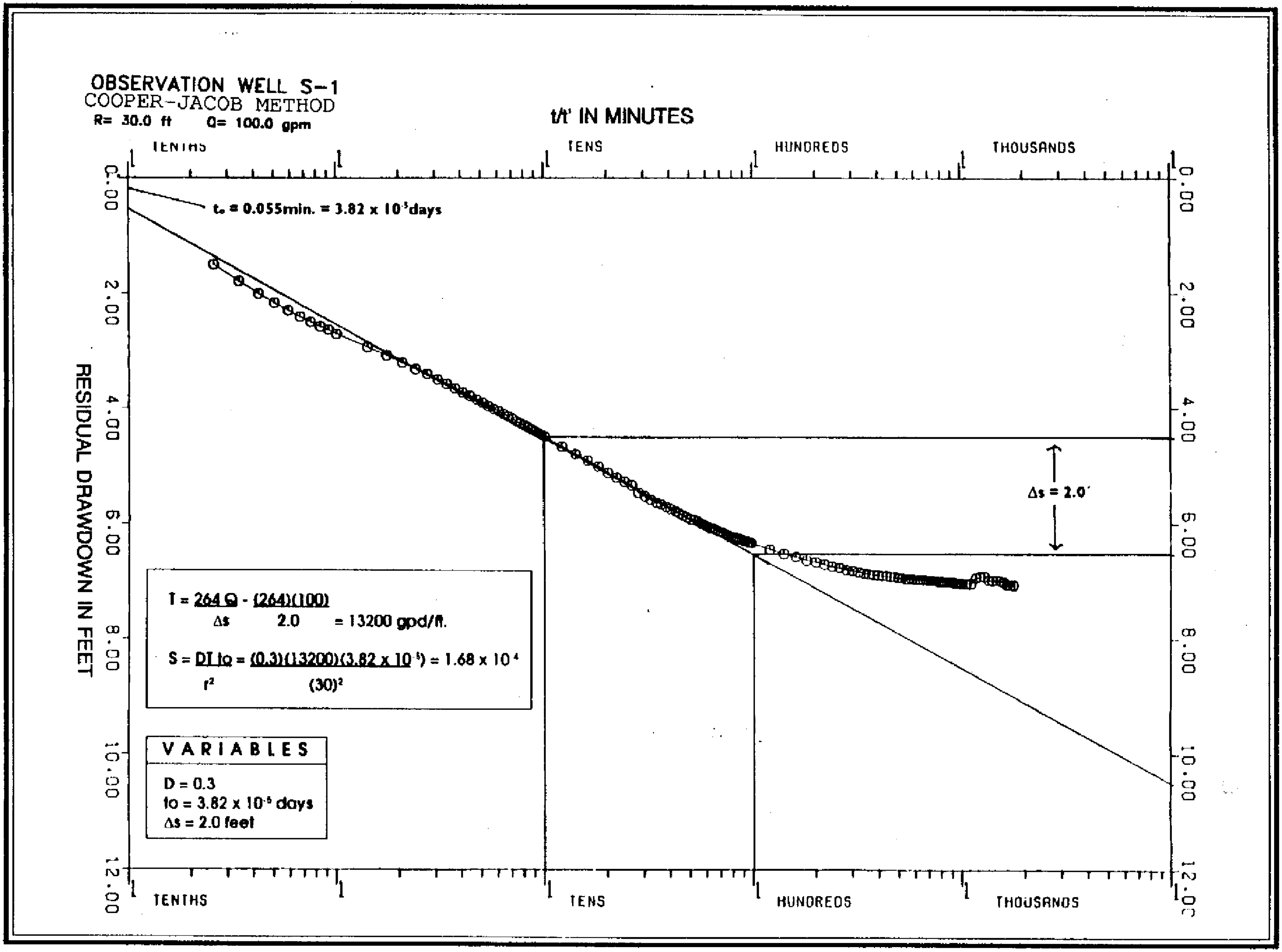
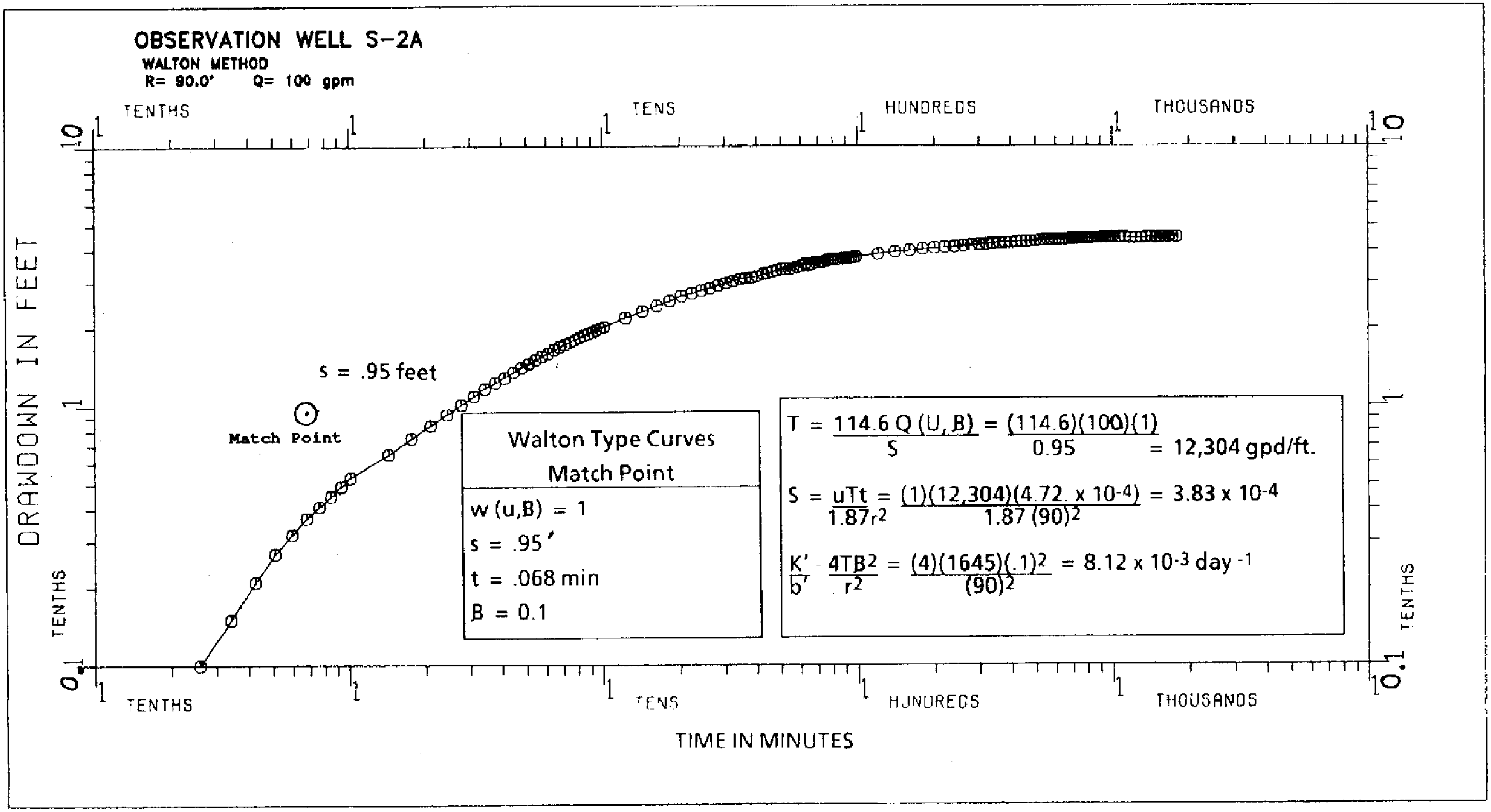


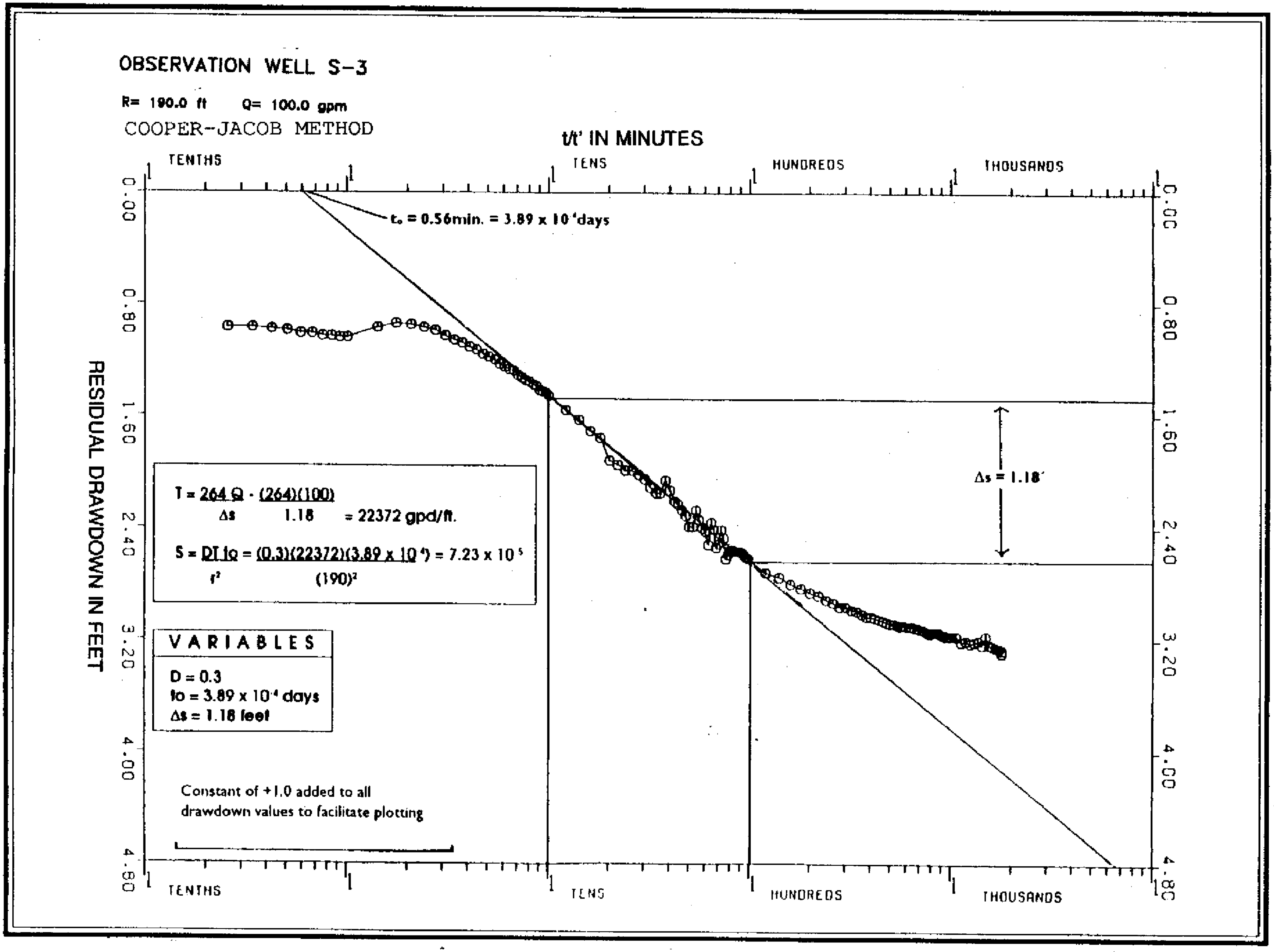
FIGURE 64. Location Map and Site Layout - STL-APT 4 Site



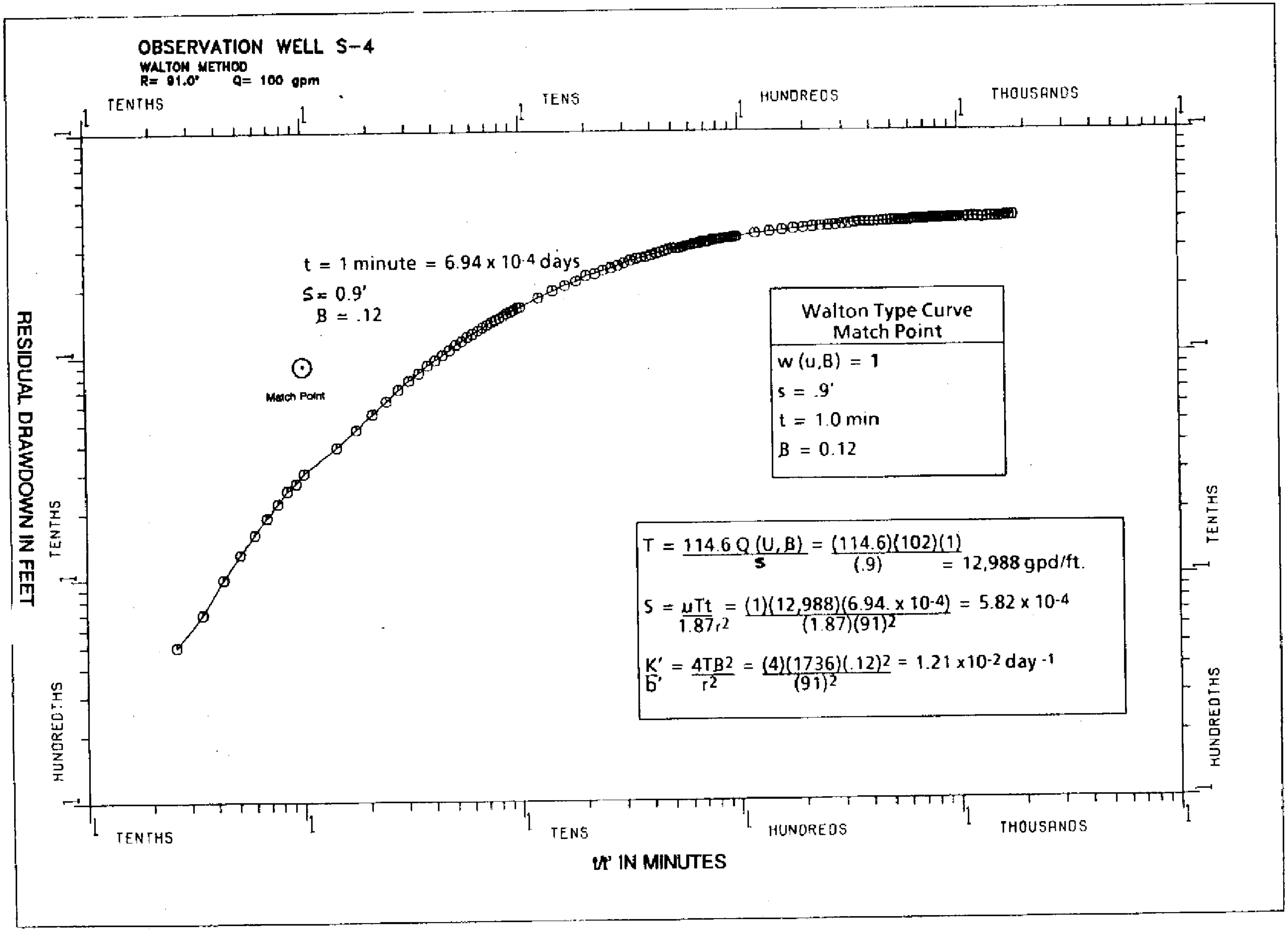
GRAPH 39. STL APT 4 APT Drawdown: Observation Well S-1



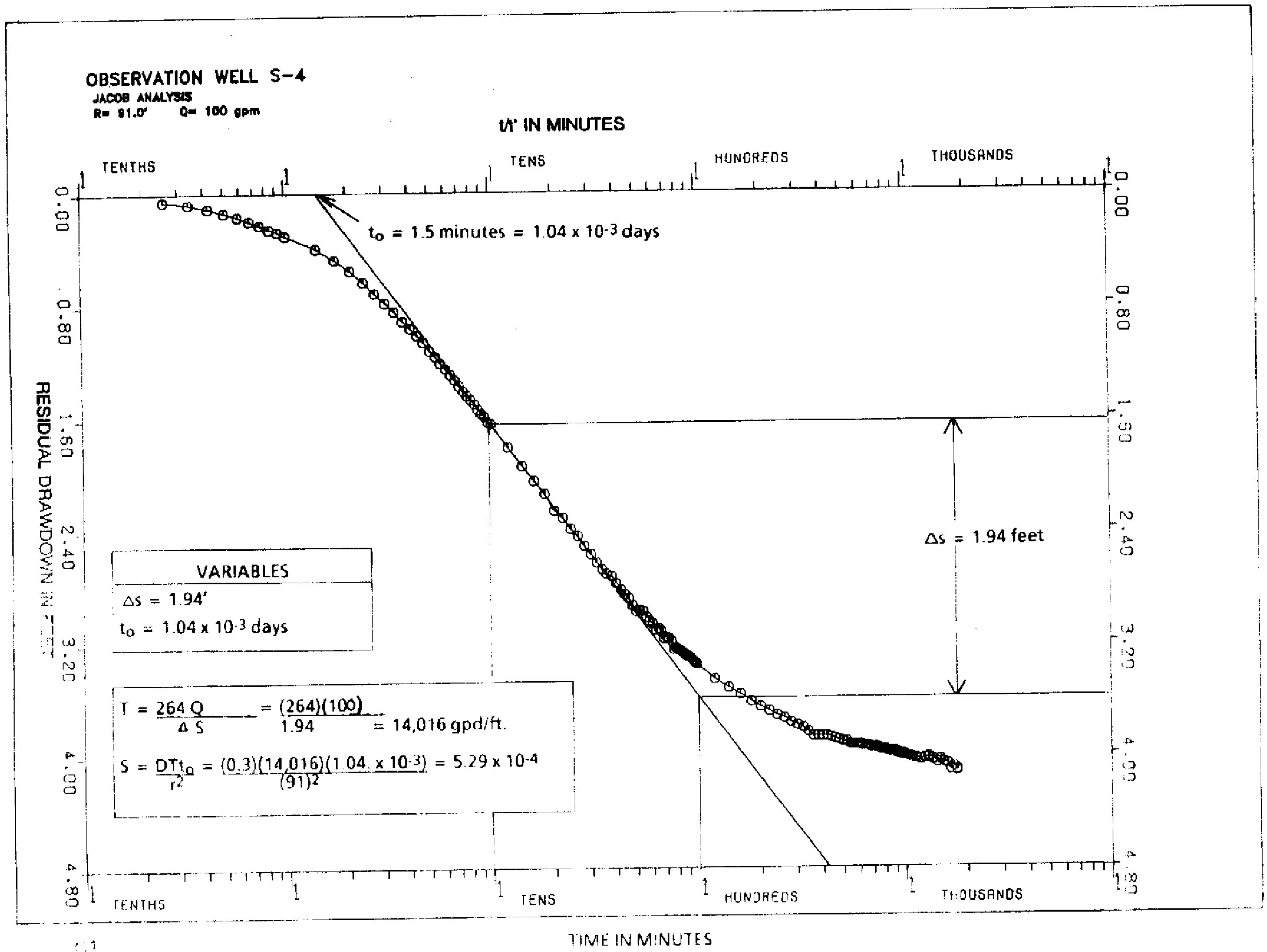
GRAPH 40. STL APT 4 APT Drawdown: Observation Well S-2



GRAPH 41. STL APT 4 APT Drawdown: Observation Well S-3



GRAPH 42. **STL APT 4 APT Drawdown: Observation Well S-4 (Walton Method)**



GRAPH 43. STL APT 4 APT Drawdown: Observation Well S-4 (Jacob Method)

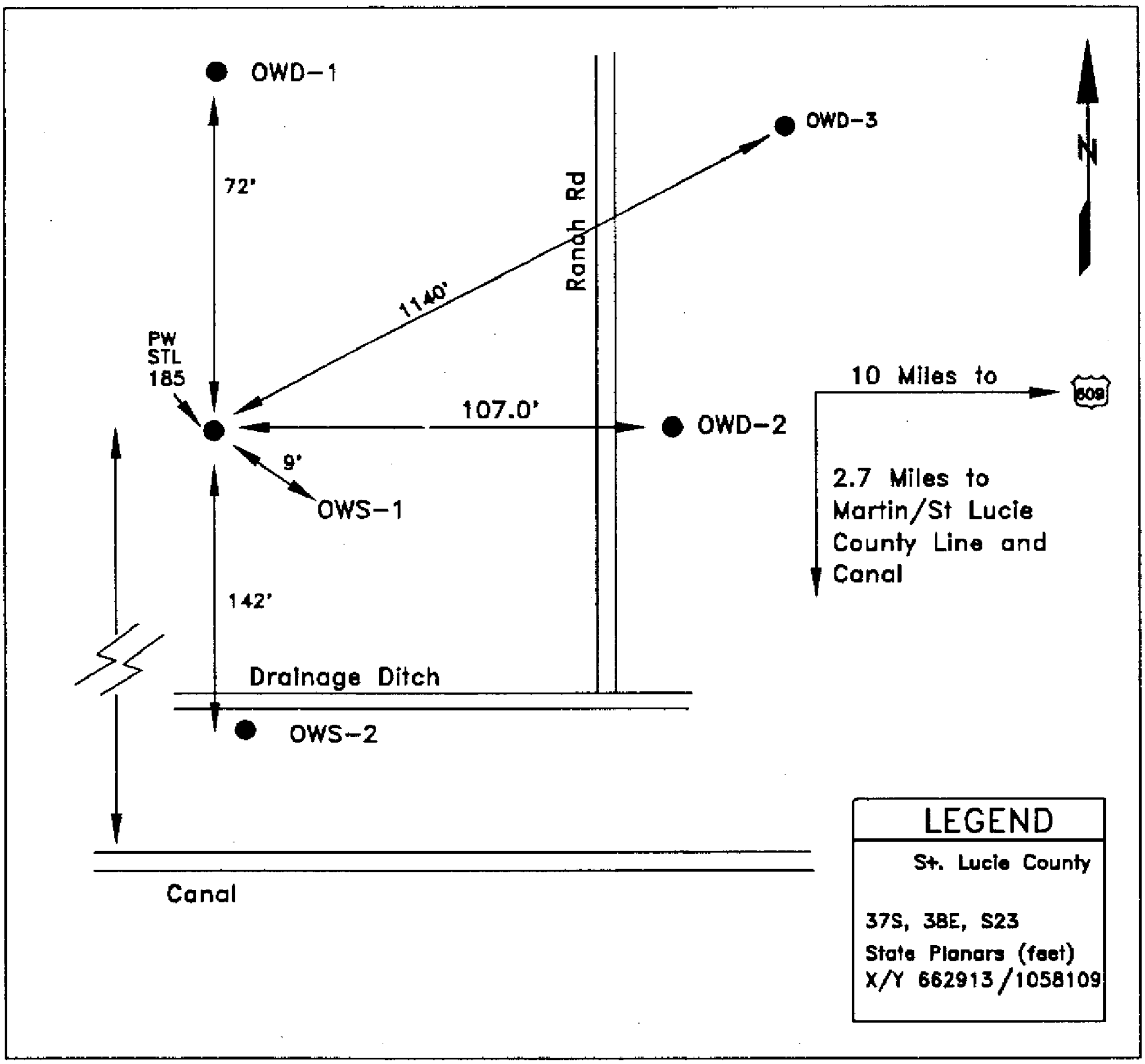
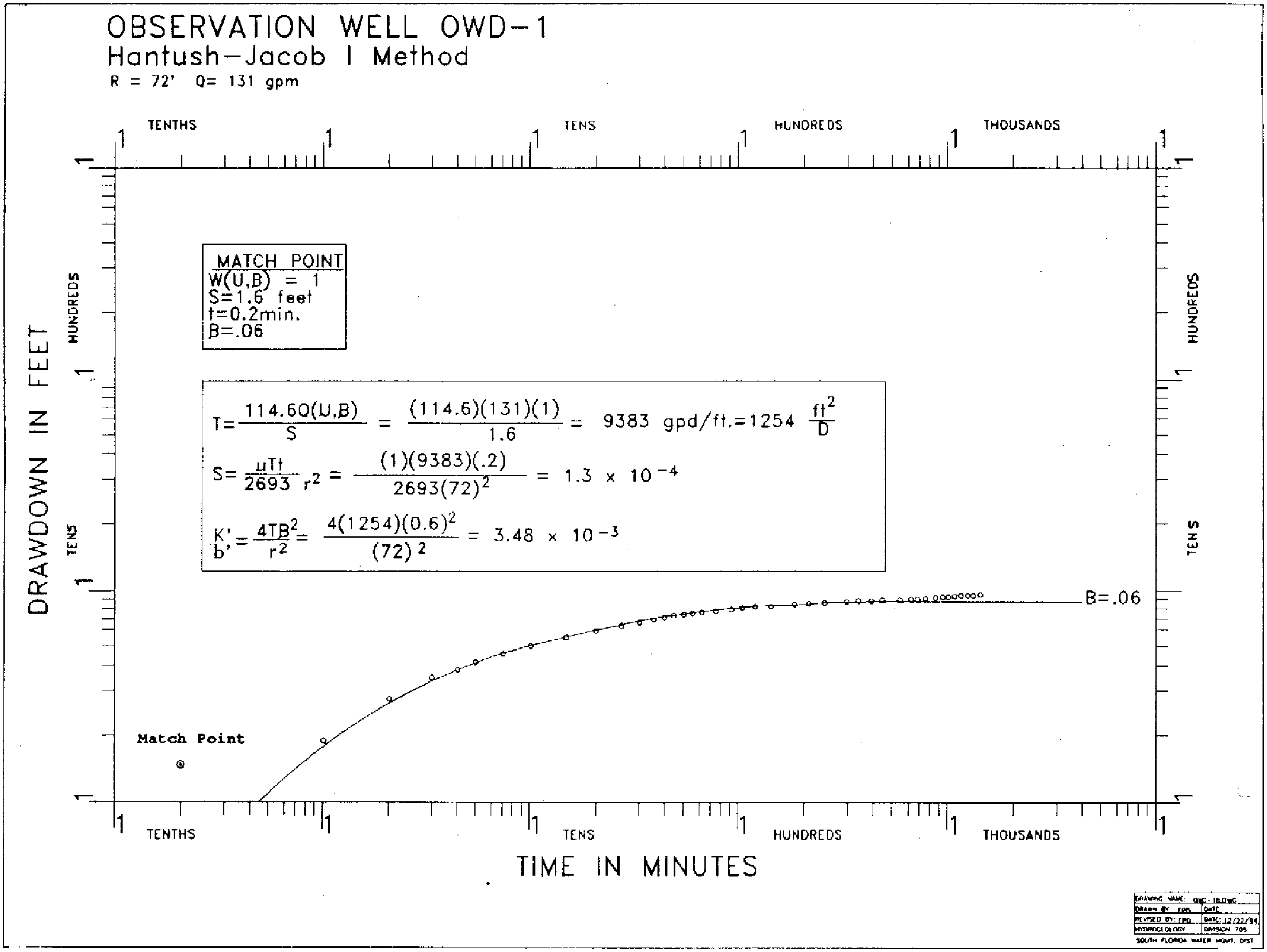
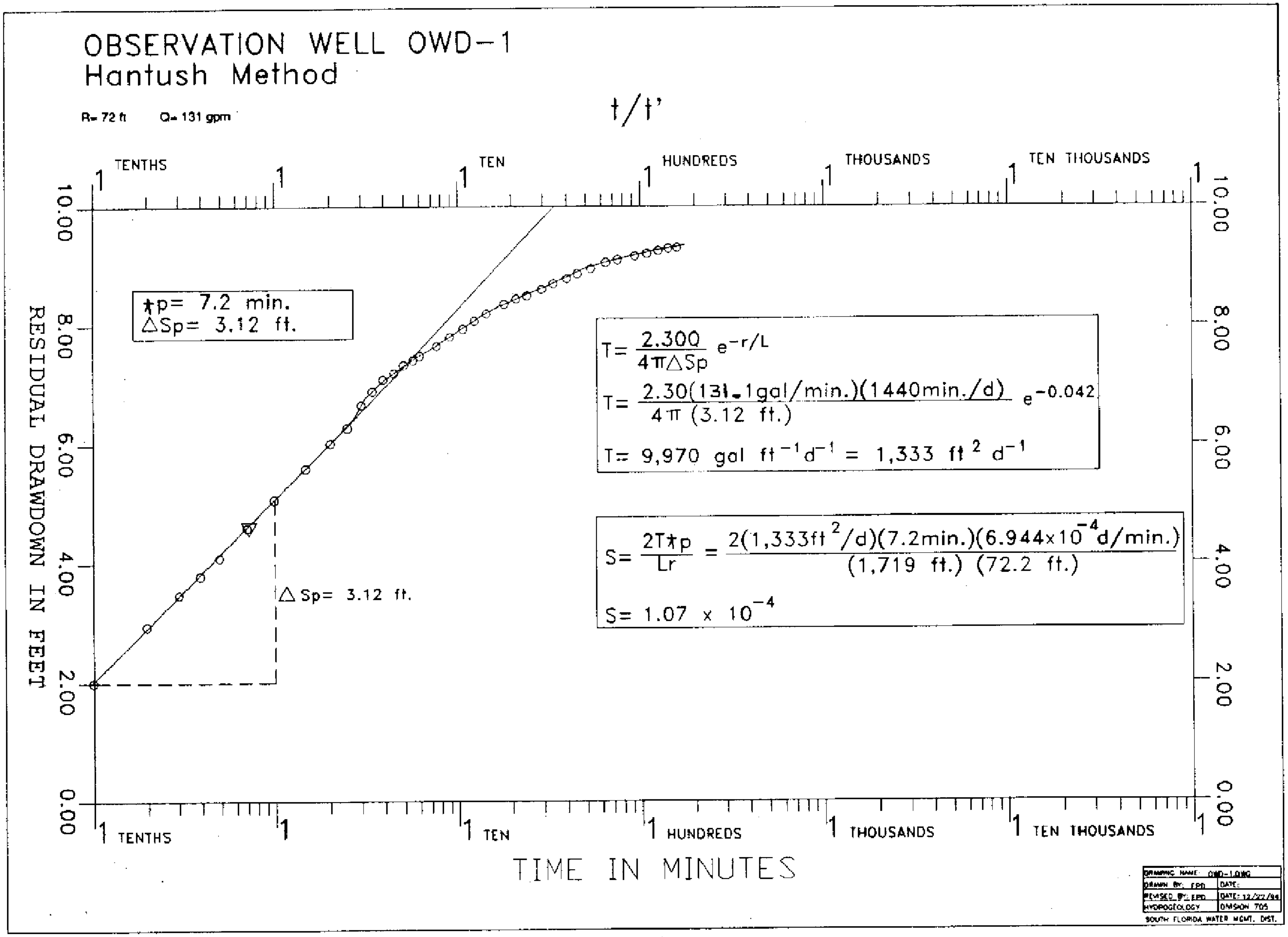


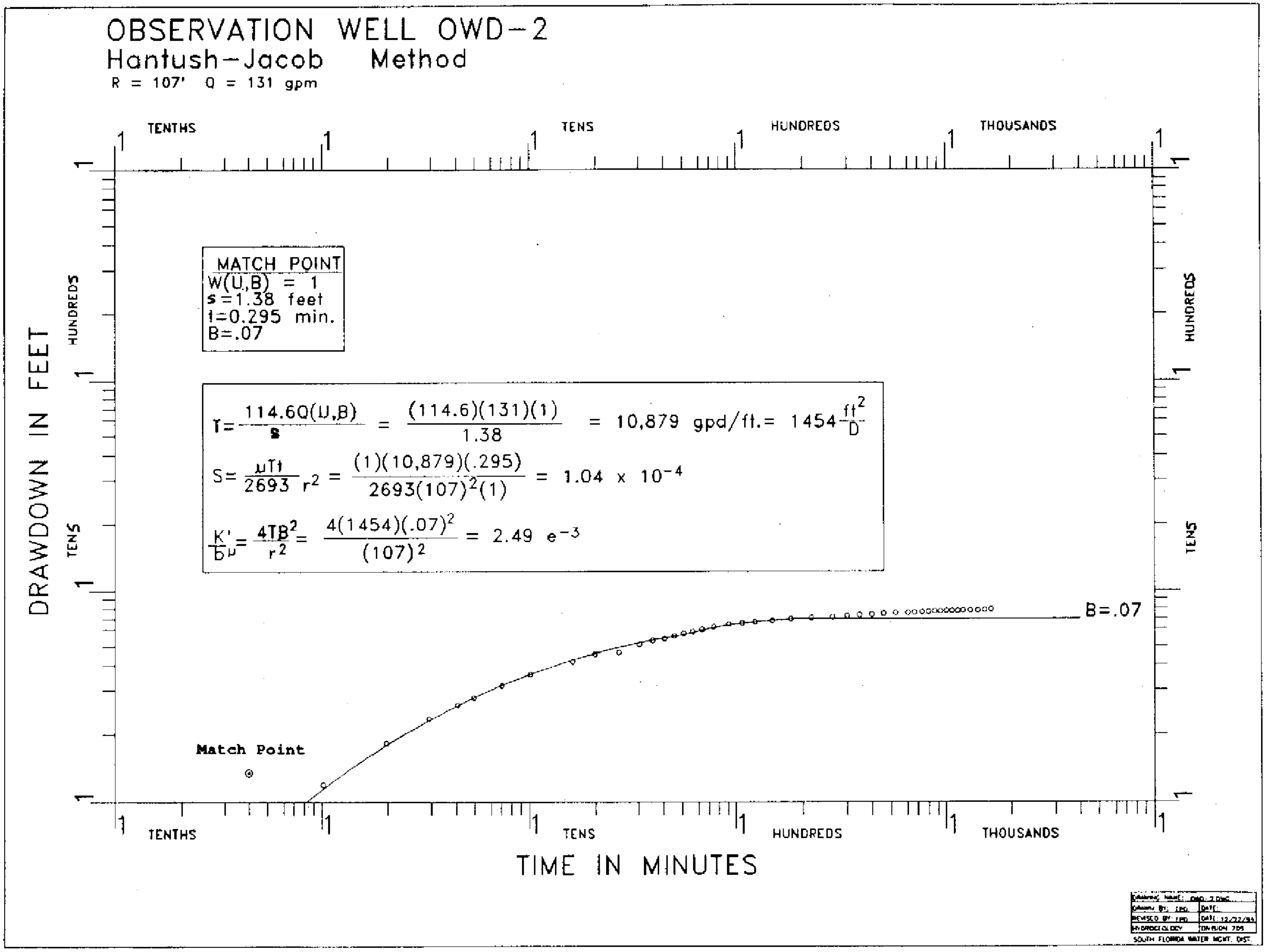
FIGURE 65. Location Map and Site Layout - McCarty Ranch APT Site



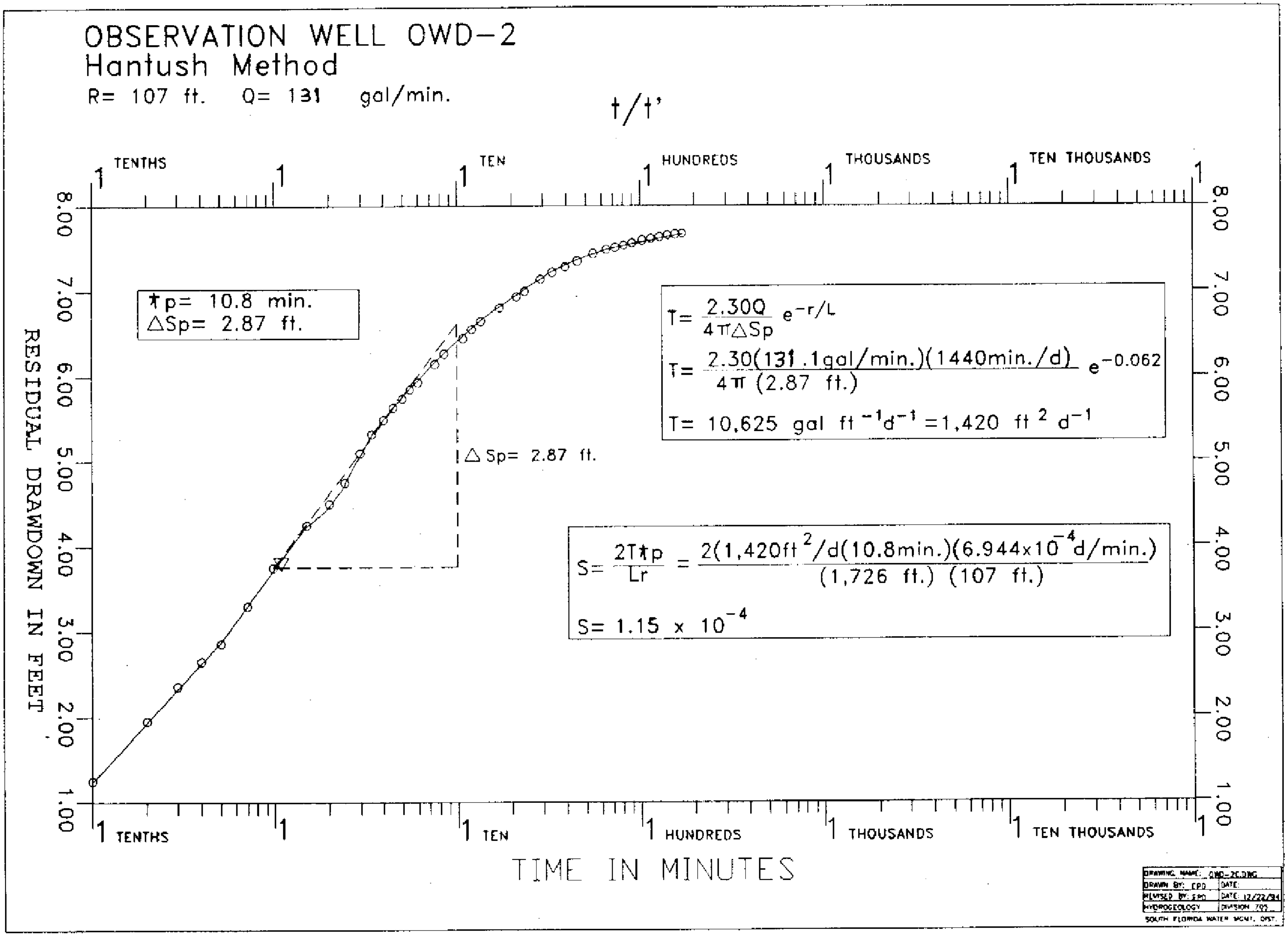
GRAPH 44. McCarty Ranch APT Drawdown: Observation Well OWD-1 (Hantush-Jacob Method)



GRAPH 45. **McCarty Ranch APT Drawdown: Observation Well OWD-1 (Hantush-Jacob Method)**



GRAPH 46. **McCarty Ranch APT Drawdown: Observation Well OWD-2 (Hantush-Jacob Method)**



GRAPH 47. McCarty Ranch APT Drawdown: Observation Well OWD-2 (Hantush Method)

observation wells was very little (0.7 feet) compared to the pumped zone (9.3 feet), the pumped aquifer is considered semi-confined. The Hantush-Jacob (1955) model is the most appropriate solution for determining aquifer parameters here".

Ft. Pierce Interchange Test Site

Map No. 12	
Confidence in Analysis	Unknown
Status of Wells at Site	Moderate

Comments: This APT was conducted near the Ft. Pierce Interchange at the intersection of Florida's Turnpike and SR 70. The general location of the APT site is shown on Figure 58. A pilot hole was drilled at this site to a depth of 115 feet BLS, the lithologic description of which are presented in Appendix A-3 indexed under STL-213. A resistivity and gamma ray log were run but were not available for this report. Seven wells were constructed: six deep wells (70 feet to 112 feet BLS) and one shallow well (0 feet to 30 feet BLS).

Recovery data from wells 60N, 200W, and 100S were analyzed using the Jacob (1952) method. The resulting plots and calculations are shown in Graphs 48 through 50. Very little documentation was available; however, some notes summarizing this test were compiled by SFWMD staff and are summarized below:

* Producing zone intervals are from 25 feet to 54 feet BLS and from 85 feet to 112 feet BLS.
* Large declines in discharge rates occurred during the course of the test.
* Surface-water bodies probably had little influence on water-levels in the shallow producing zone.
* Test approached steady-state.
* System is definitely semi-confined.
* Discharge was fairly constant (157 gpm to 160 gpm) during the last two-thirds of drawdown time.

Since the original documentation of this APT site was not available for this publication, the relative confidence in these analyses is assigned a moderate rank.

Indrio Road Test Site

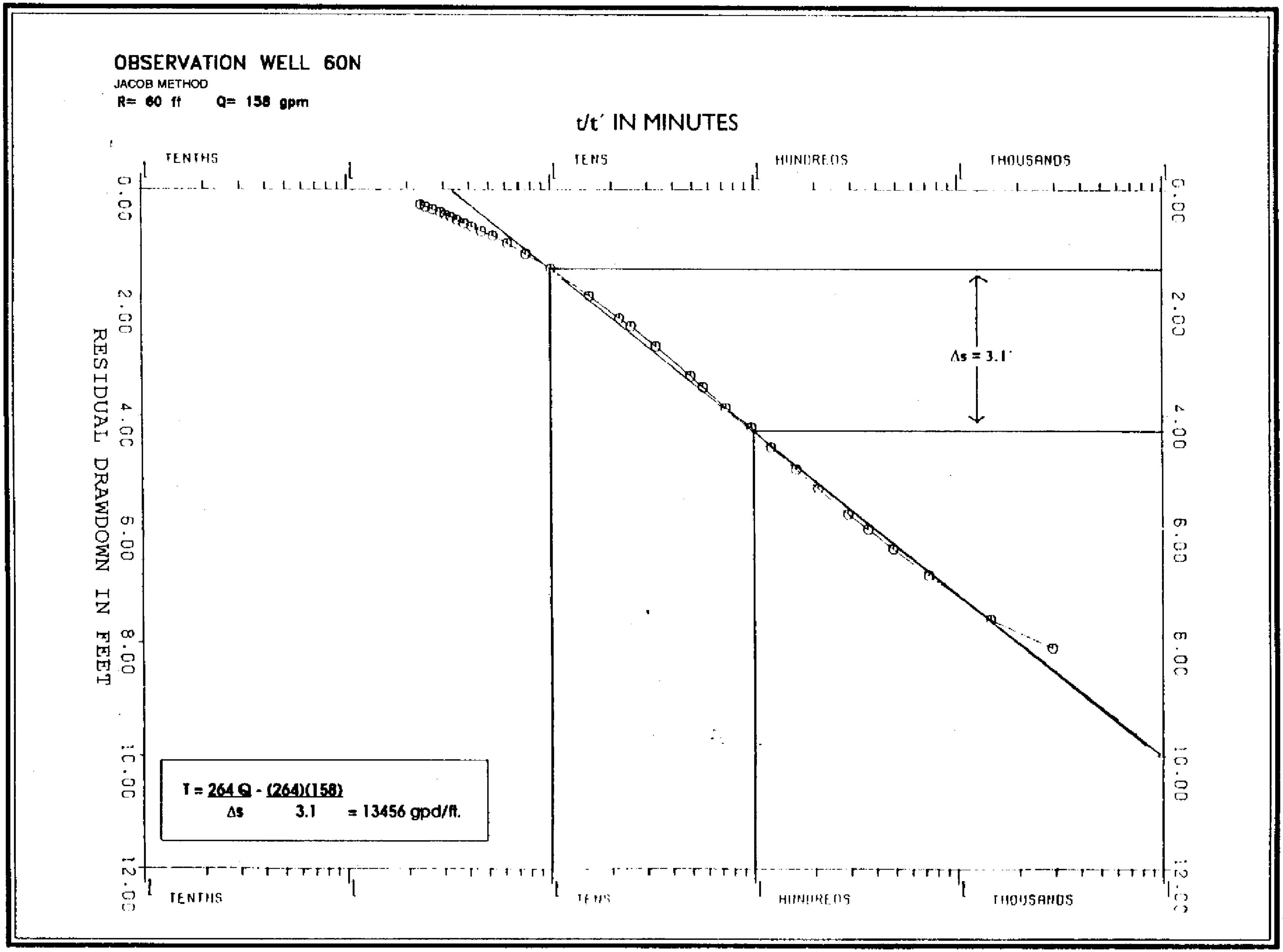
Map No. 13	
Confidence in Analysis	Moderate
Status of Wells at Site	Unknown

Comments: This APT site is located in northeastern St. Lucie County near I-95 and Indrio Road. A site-specific map was not available for this report; however, the general location of the site can be found on the APT site location map (Figure 58). A pilot hole was drilled to a depth of 125 feet BLS, the cuttings descriptions of which are presented in Appendix A-3, indexed under STL-264. Geophysical logs were run on the pilot hole but not available for this report. Six wells were constructed at the Indrio Road site, all of which were completed to the deep SAS zone occurring between 59 feet and 90 feet BLS.

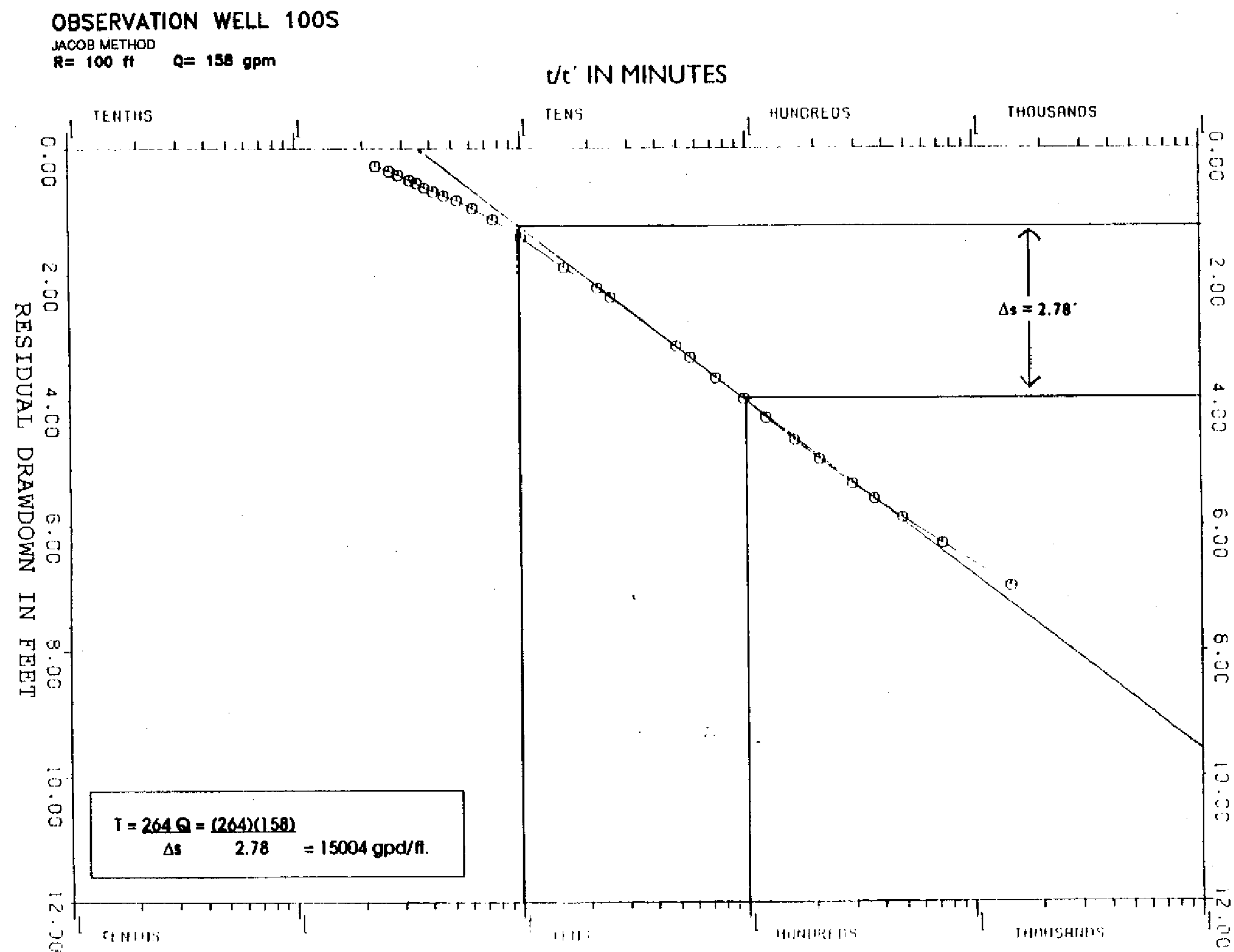
Drawdown and recovery data were analyzed for wells 150S and 300N using the Walton (1962) type-curve and Jacob (1952) straight-line methods, respectively. The plots and computations comprising these analyses are given in Graphs 51 through 54. A Walton type curve matched well with the field data and linear slopes were apparent on the semi-log recovery plots. Aquifer parameters computed from both monitoring wells were consistent, with transmissivity values ranging between 19,779 gpd/ft and 24,811 gpd/ft. Leakance values ranged between 1.18 E-3/day and 1.3 E-3/day, indicating a semi-confined condition.

A shallow aquifer monitoring well was not present at the site during testing; therefore, water-level changes in that zone during pumping are not known. The original USGS documentation for this test site was not available; however, notes later compiled by SFWMD staff addressing this APT are summarized as follows.

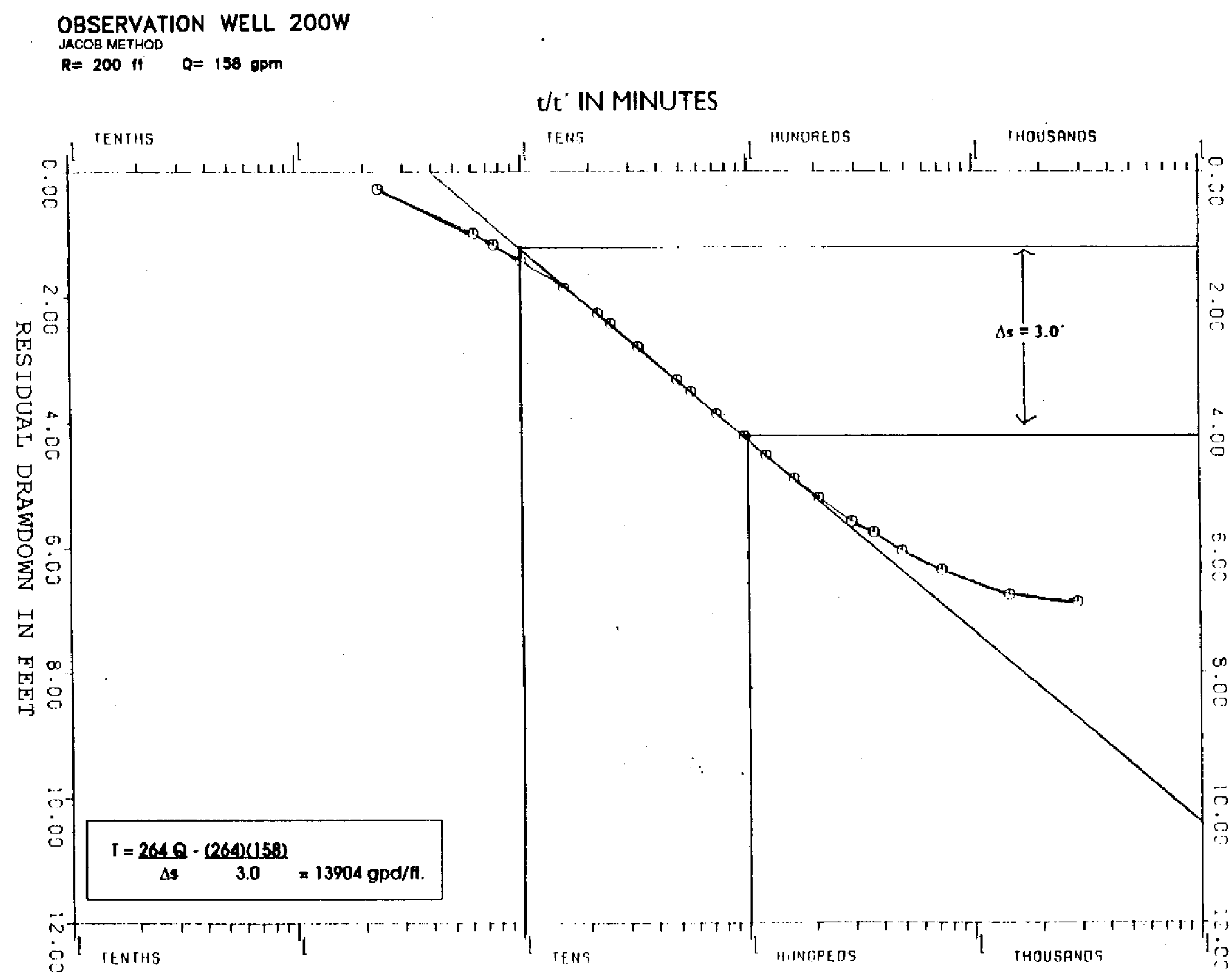
* Drawdown rate increased during the last four hours of pumping. It did not correlate to diurnal patterns from pre-test monitoring. No cause determined.
* Discharge rate varied slightly at the beginning of the test, but varied less than 5% after the first three minutes.
* Possible surface-water influences nearby (canals). No canal stage measurements were taken during course of APT.
* Test appeared to reach steady-state.



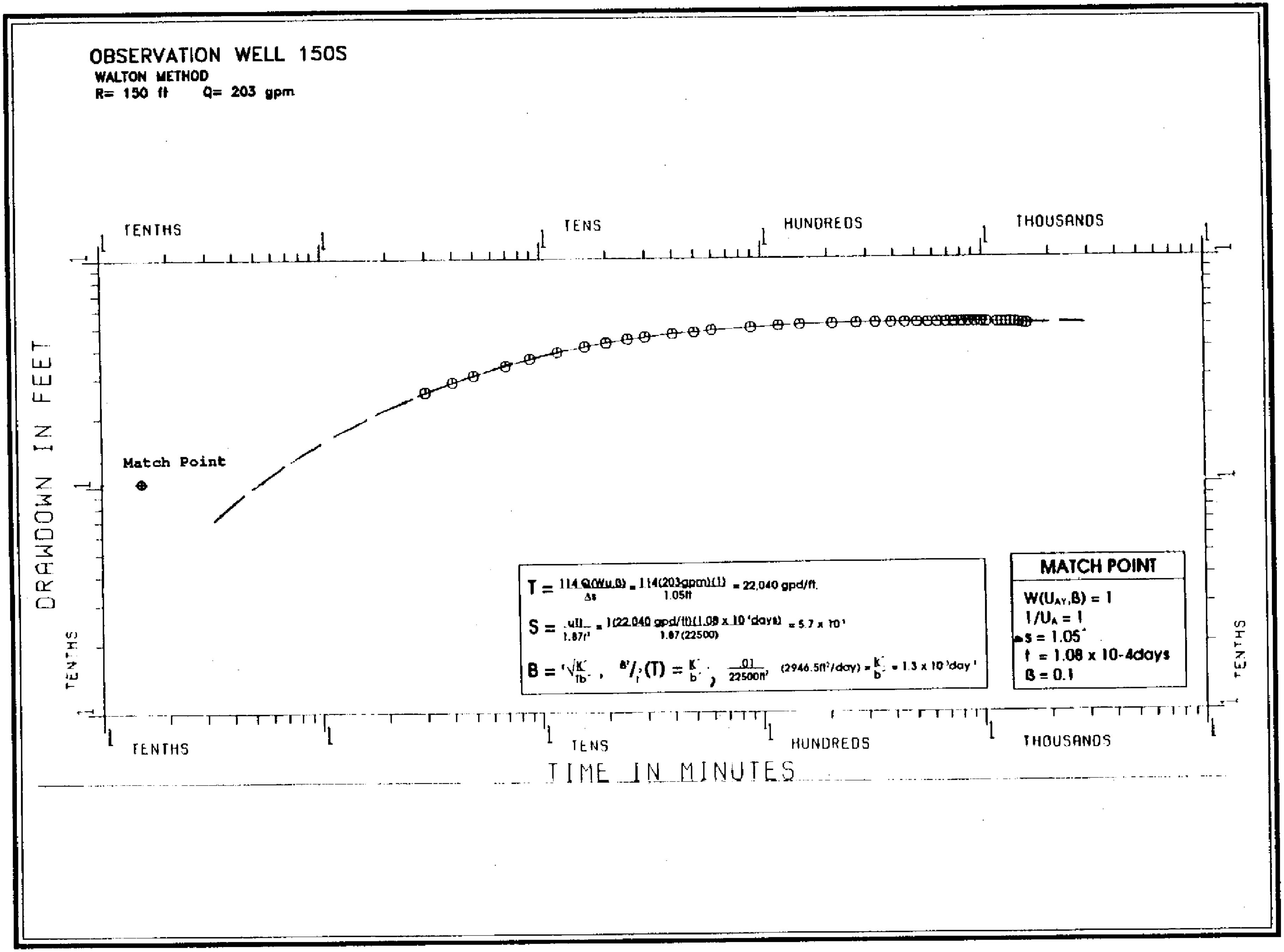
GRAPH 48. Ft. Pierce Interchange APT Recovery: Observation Well 60N



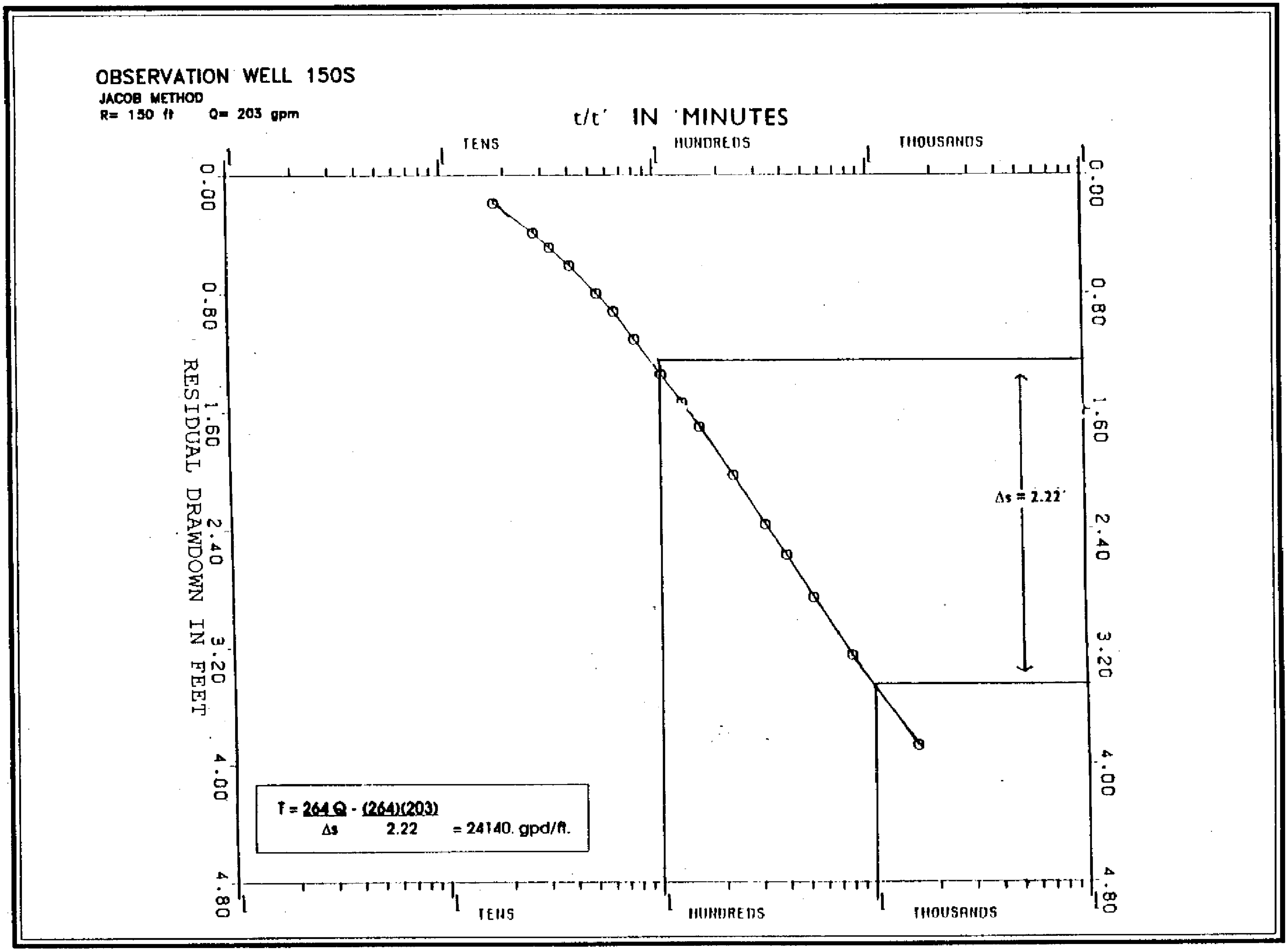
GRAPH 49. Ft. Pierce Interchange APT Recovery: Observation Well 100S



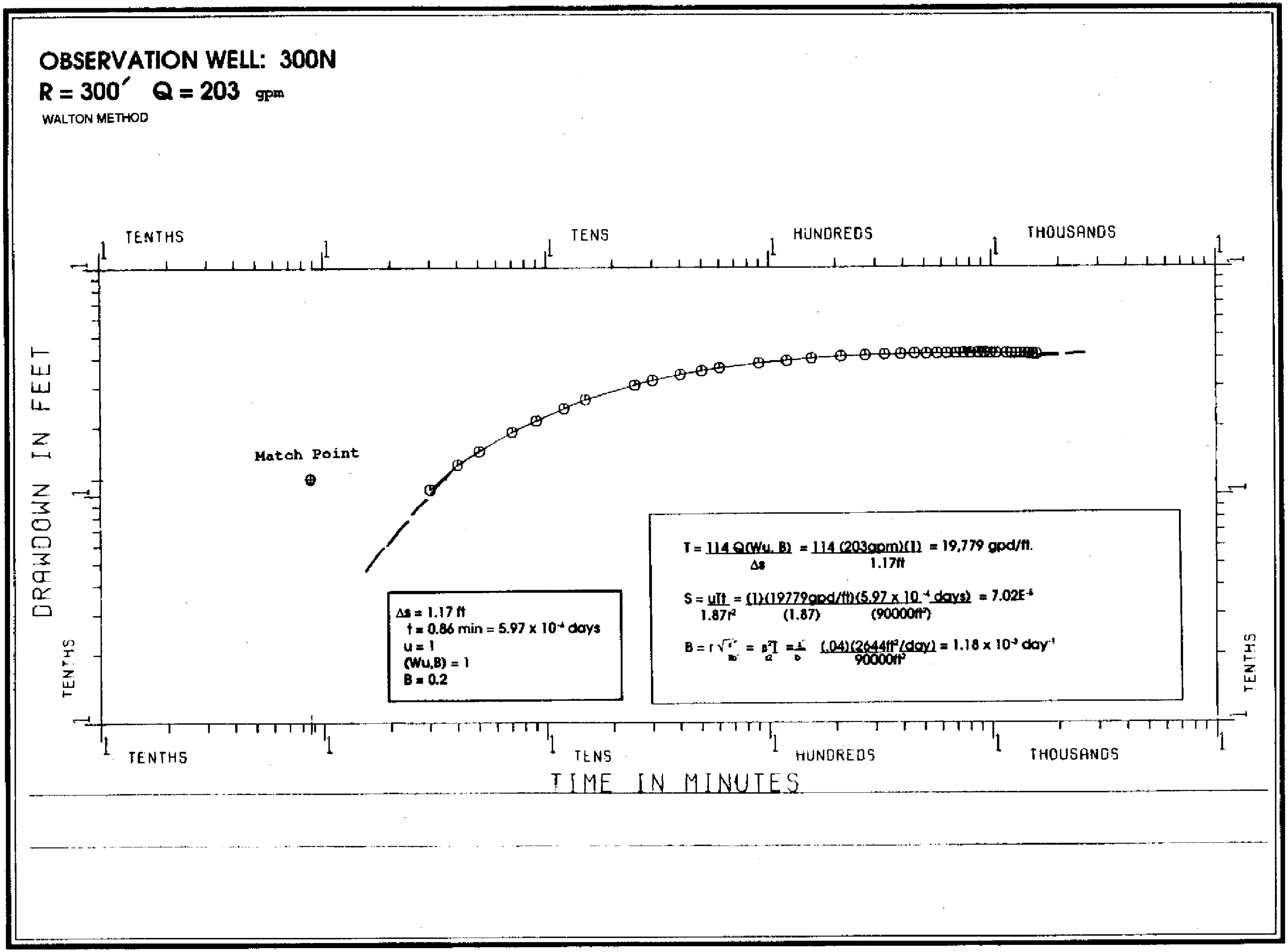
GRAPH 50. Ft. Pierce Interchange APT Recovery: Observation Well 200W



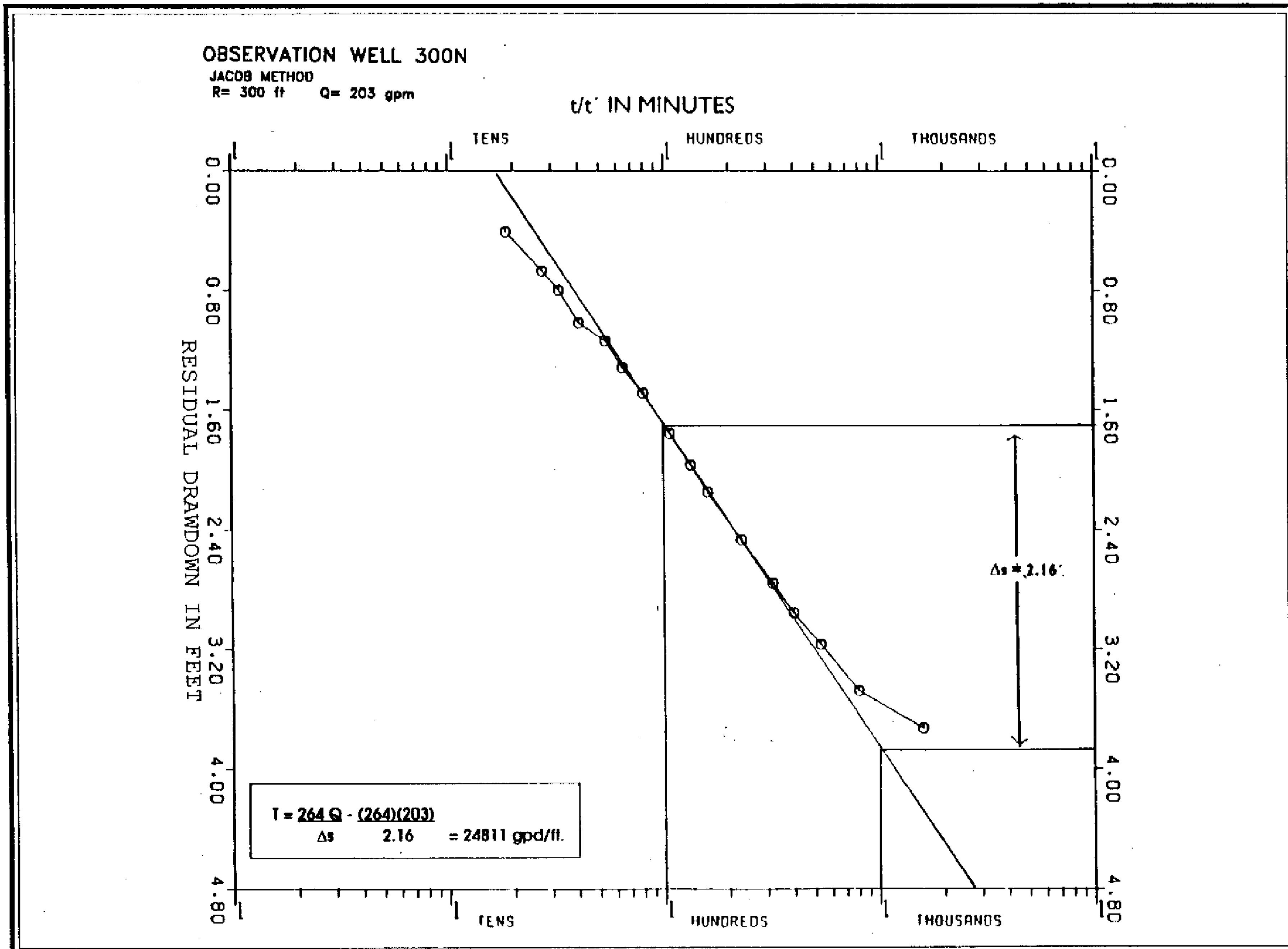
GRAPH 51. Indrio Road APT Drawdown: Observation Well 150S



GRAPH 52. Indrio Road APT Recovery: Observation Well 150S



GRAPH 53. Indrio Road APT Drawdown: Observation Well 300N



GRAPH 54. Indrio Road APT Recovery: Observation Well 300N

Savage Road Test Site

Map No. 14	
Confidence in Analysis	Moderate
Status of Wells at Site	Unknown

Comments: The Savage Road APT site is located in Port St. Lucie in south-central St. Lucie County. The pilot hole was drilled to a depth of 134 feet BLS, the lithologic descriptions of which are provided in Appendix A-3, indexed under STL-214 (PSL 125N). Geophysical logs were run but were not available for this report. Seven wells were constructed at this site, as displayed in Figure 66. Six wells (including the production well) were screened across the deeper zone between 33 feet and 63 feet BLS; one well (PG-29) was screened across a shallower interval between 28 feet and 30 feet BLS.

Drawdown and recovery data from well 74S were analyzed by SFWMD staff using the Walton (1962) method for drawdown and the Jacob (1952) method for recovery. The USGS analyzed drawdown in well 74S using the Boulton (1954) method. Drawdown data from well 125N was analyzed using the Walton (1962) and Boulton (1954) methods, while recovery data was analyzed using the Jacob (1952) straight-line method. These analyses, along with parameter computations, are shown in Graphs 55 through 59. The original analyses and calculations conducted by the USGS (Hill) at this site are shown in Graph 60, and the computations are listed in Table 12. The calculated transmissivity values from these analyses range from 5,348 gpd/ft to 9,625 gpd/ft. Leakance was calculated as 5.33 E-3 /day and 2.9 E-3 /day.

A summary of the conditions which existed at the site during the test, as well as comments provided by SFWMD staff while re-analyzing the test results, are summarized below:

* Discharge from pumping was routed 350 feet south of the site to the canal.
* Early-time data (0-3 minutes) is suspect due to varying pumping rates.
* Semi-confined conditions were indicated by lithologic data and by the relatively high drawdown experienced in the shallow well (PG-29) during pumping of the deep zone.
* Shape of drawdown curve suggests semi-unconfined conditions.
* Possible delayed yield effect was apparent in late-time drawdown data.
* System appears to be anisotropic from north to south.

Port St. Lucie West Test Site

Map No. 15	
Confidence in Analysis	Moderate
Status of Wells at Site	Unknown

Comments: This test site is located in the City of Port St. Lucie in south-central St. Lucie County, northeast of the intersection of I-95 and Gatlin Boulevard, as illustrated in Figure 67. Three wells were drilled at this location, all of which were screened between 30 feet and 60 feet BLS. Lithologic descriptions from the pilot hole, drilled to a depth of 134 feet BLS, are presented in Appendix A-3, referenced under well name PSLW. Geophysical logs were probably run for this well but were not available for this report.

The USGS conducted the test and analyzed the data; the test was not re-analyzed by SFWMD staff. Field data with type-curve fits and computations are presented in Graphs 61 and 62. Drawdown data from wells OW-1 and OW-2 were analyzed using the Walton (1962) type-curve method. Calculations of aquifer parameters were fairly consistent between wells OW-1 and OW-2, with computed transmissivities of 15,151 gpd/ft and 17,700 gpd/ft, respectively. Computed storage coefficients were 1.8 E-4 and 1.97 E-4, respectively. Leakance was computed as 2 E-3/day and 1.33 E-3/day for wells OW-1 and OW-2, respectively. It is assumed that the source of water from vertical leakance is the sand and clay layer above the monitoring wells, although this cannot be determined with available data.

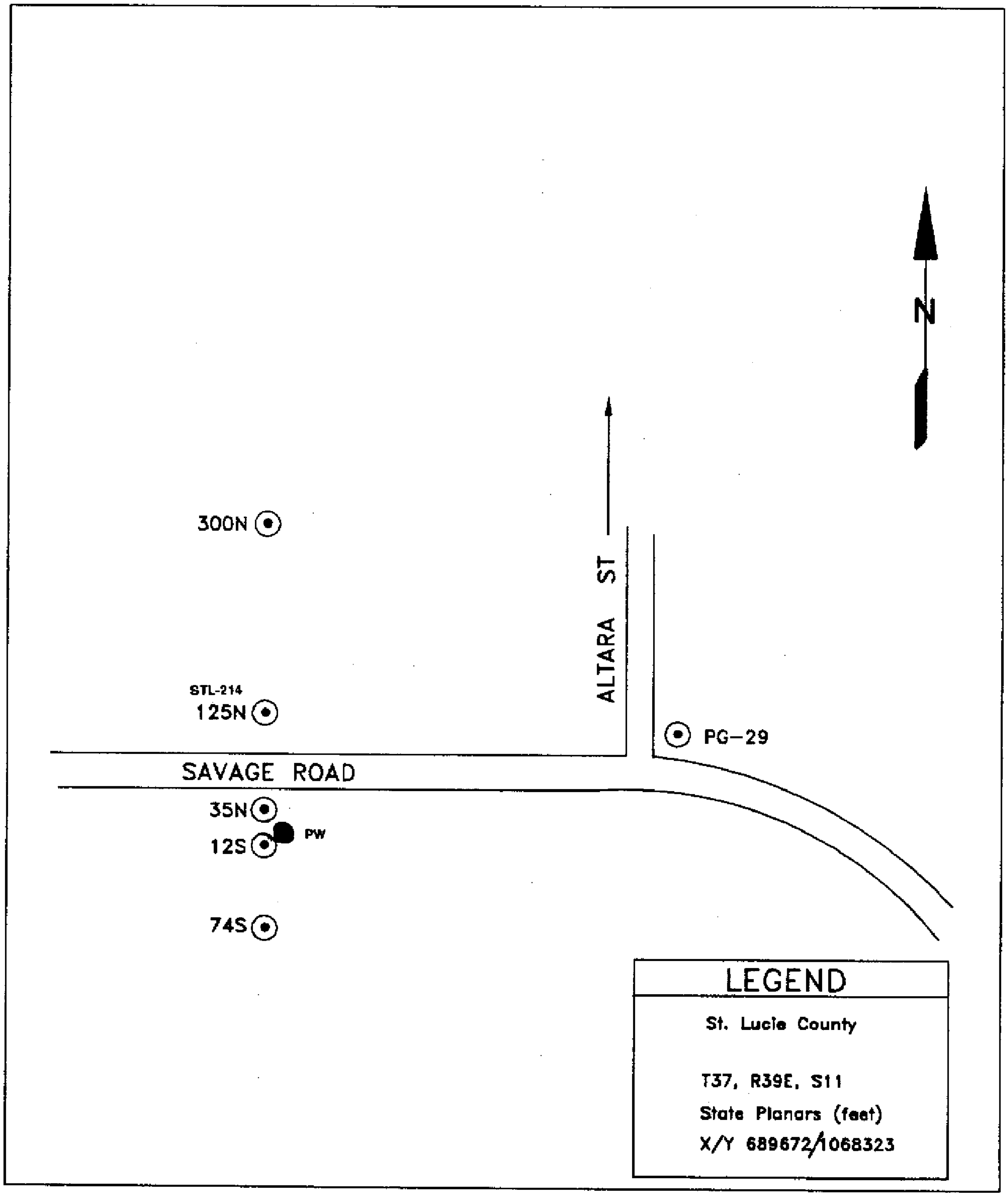
Summaries of Previously Documented APTs Re-Analyzed by the SFWMD

Harbor Ridge #2 Test Site

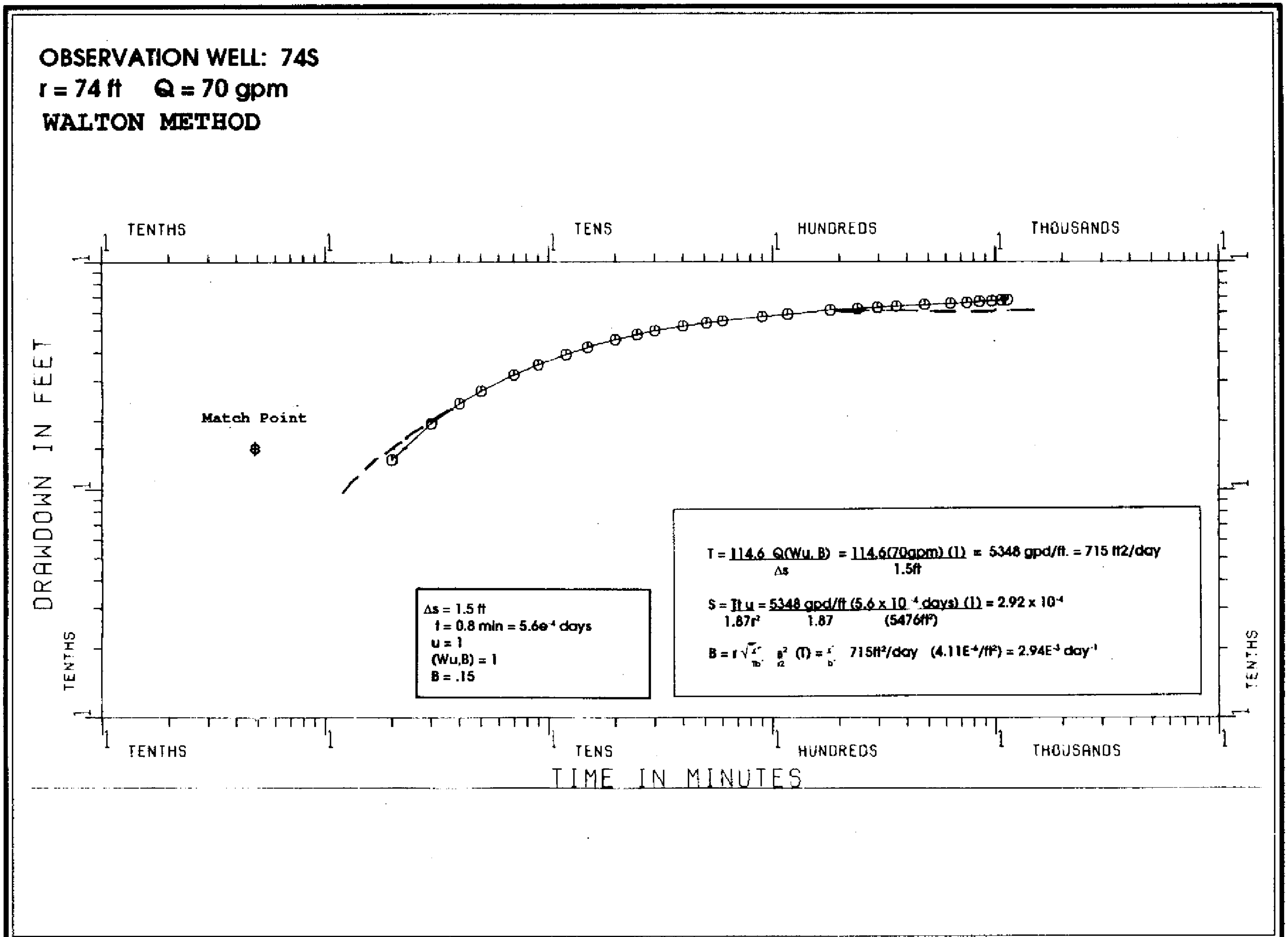
Map No. 2	
Confidence in Analysis	Very low
Status of Wells at Site	Unknown

Comments: Two wells, screened between 95 feet and 128 feet BLS, were constructed at the Harbor Ridge site in St. Lucie County. Two APTs were conducted and documented by Geraghty and Miller (1984). Cuttings descriptions from the pilot hole (PW-2) are provided in the Geraghty and Miller documentation.

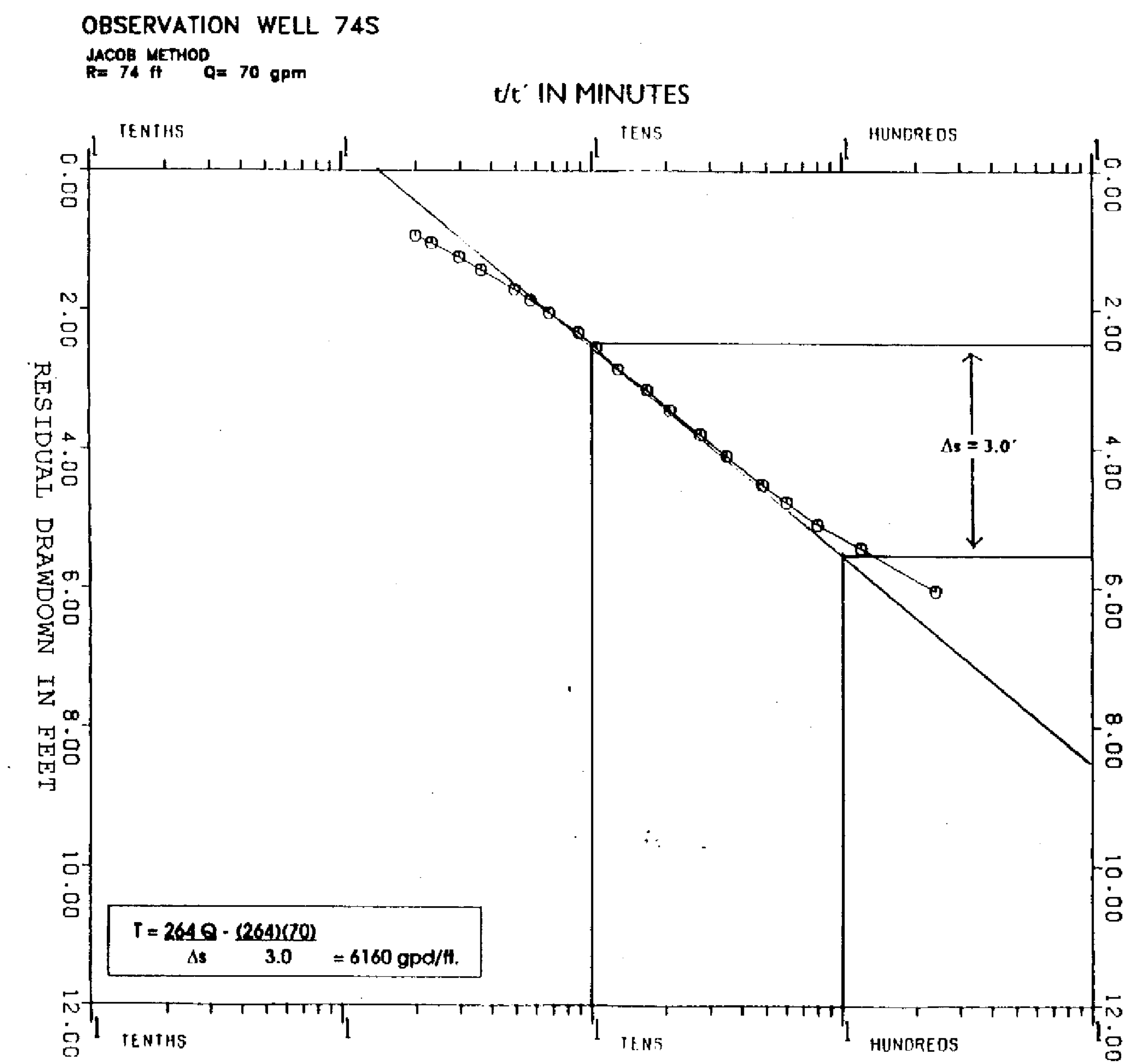
Drawdown data from the second APT were re-analyzed by SFWMD staff using the Cooper and Jacob (1946) straight-line method. Analyses were conducted on drawdown data from both the production and monitoring wells located only 8.5 feet



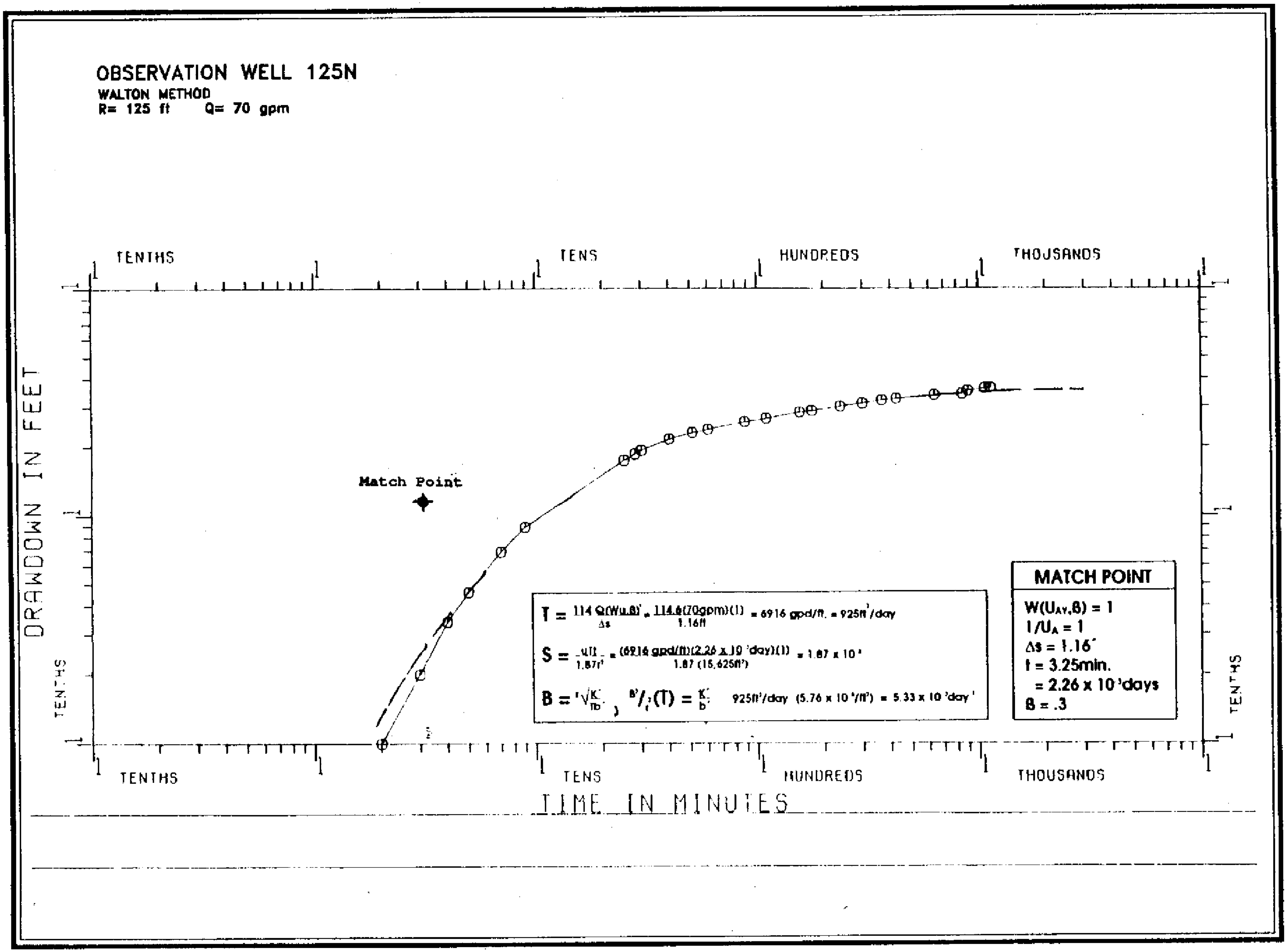
FIGURF 66. Location Map and Site Layout - Savage Road APT Site



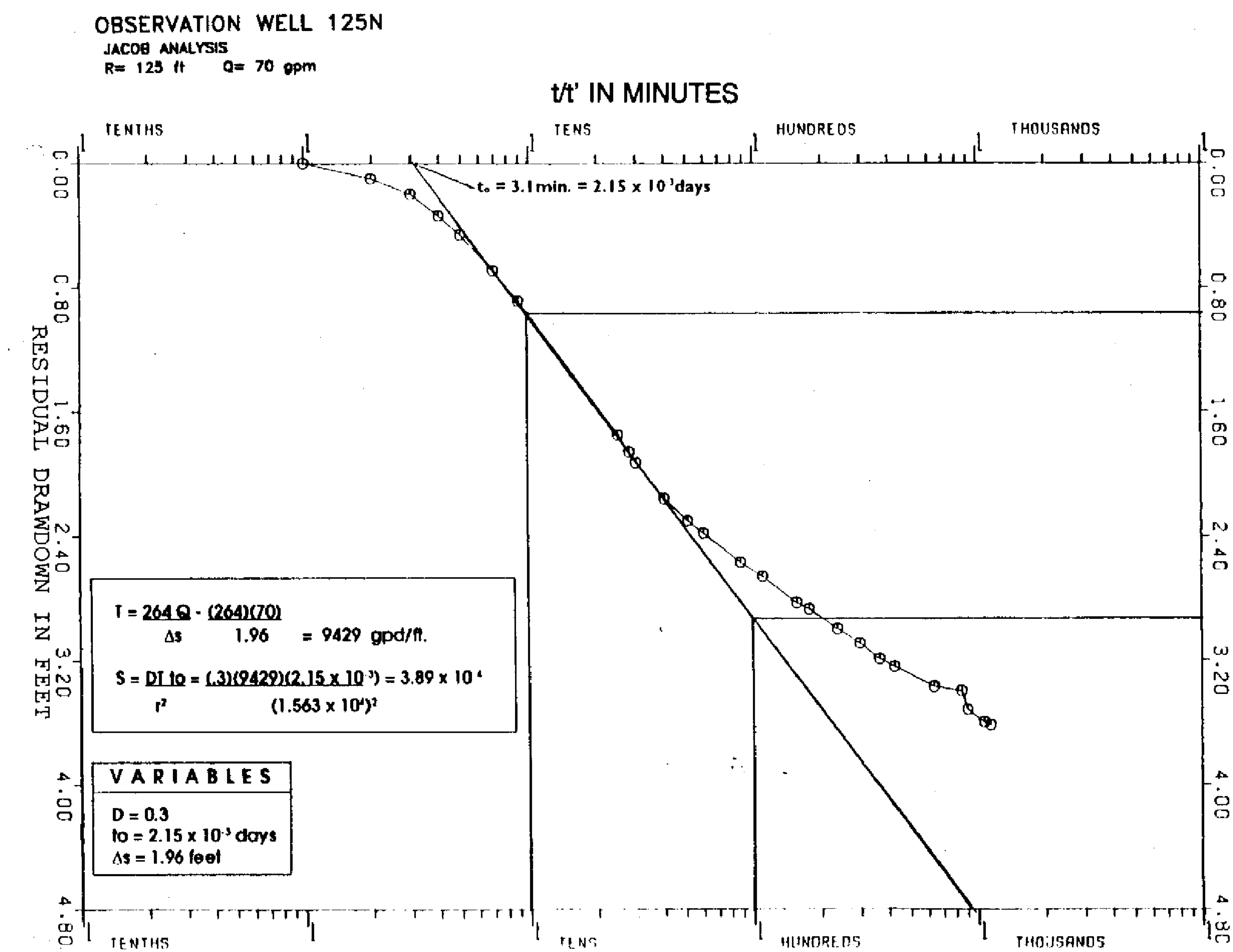
GRAPH 55. Savage Road APT Drawdown: Observation Well 74S



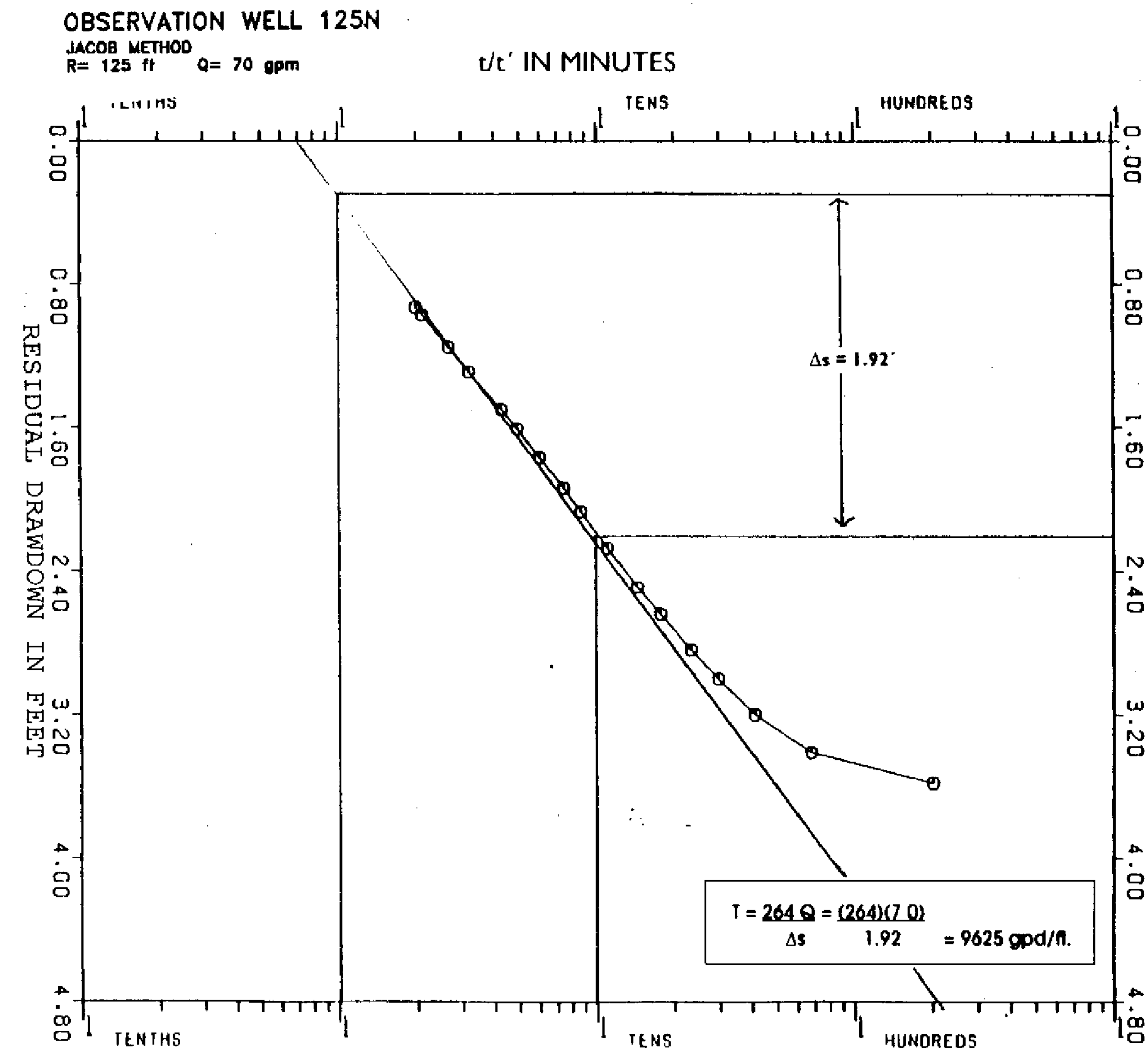
GRAPH 56. Savage Road APT Recovery: Observation Well 74S



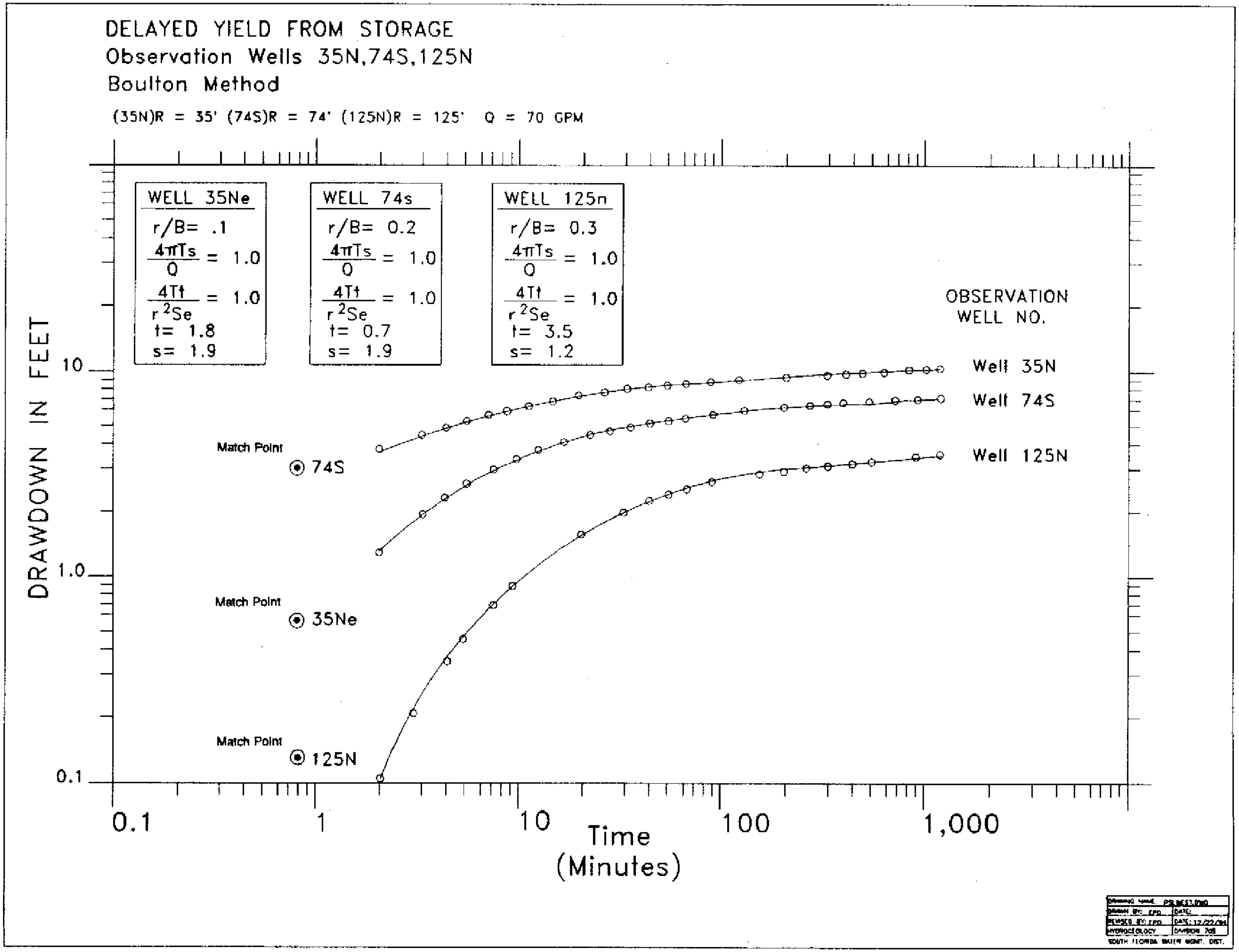
GRAPH 57. Savage Road APT Drawdown: Observation Well 125N (Walton Method)



GRAPH 58. **Savage Road APT Drawdown: Observation Well 125N (Jacob Method)**



GRAPH 59. Savage Road APT Recovery: Observation Well 125N



GRAPH 60. **Savage Road APT Drawdown: Observation Wells 35N, 74S, and 125N**

TABLE 12. Savage Road Site - APT Analysis Computations (Accompanies Graph 60)

COMPUTED BY GEORGE HILL

DELAYED YIELD METHOD, BOULTON, PLATE 8; PP 708

$$T = \frac{Q\ W(u,B)}{4\pi s}$$

WELL 74 SOUTH

$$T = \frac{70 \times 1440 \times 1.0}{4\pi \times 1.9}$$

T= 4,221 gpd/ft.

T= 564 ft^2/d

$$Se = \frac{4 \times 564 \times 0.7}{(74)^2 \times 1440}$$

$$= 2 \times 10^{-4}$$

WELL 35 NORTH

$$T = \frac{70 \times 1440 \times 1.0}{4\pi \times 1.9}$$

T= 4,221 gpd/ft.

T= 564 ft^2/d

$$Se = \frac{4 \times 564 \times 1.8}{(35)^2 \times 1440}$$

$$= 9.2 \times 10^{-3}$$

WELL 125 NORTH

$$T = \frac{70 \times 1440 \times 1.0}{4\pi \times 1.2}$$

T= 6,685 gpd/ft.

T= 894 ft^2/d

$$Se = \frac{4 \times 894 \times 3.5}{(125)^2 \times 1440}$$

$$= 6 \times 10^{-4}$$

HANTUSH-JACOB METHOD, PLATE 3; PP 708

WELL 74 SOUTH

$$T = \frac{(70)(1440)(1.0)}{4\pi \times 1.9}$$

T= 596 ft^2/d

S= 2.2×10^{-4}

WELL 125 NORTH

$$T = \frac{(70)(1440)(1.0)}{4\pi \times 1.1}$$

T= 975 ft^2/d

S= 5.5×10^{-4}

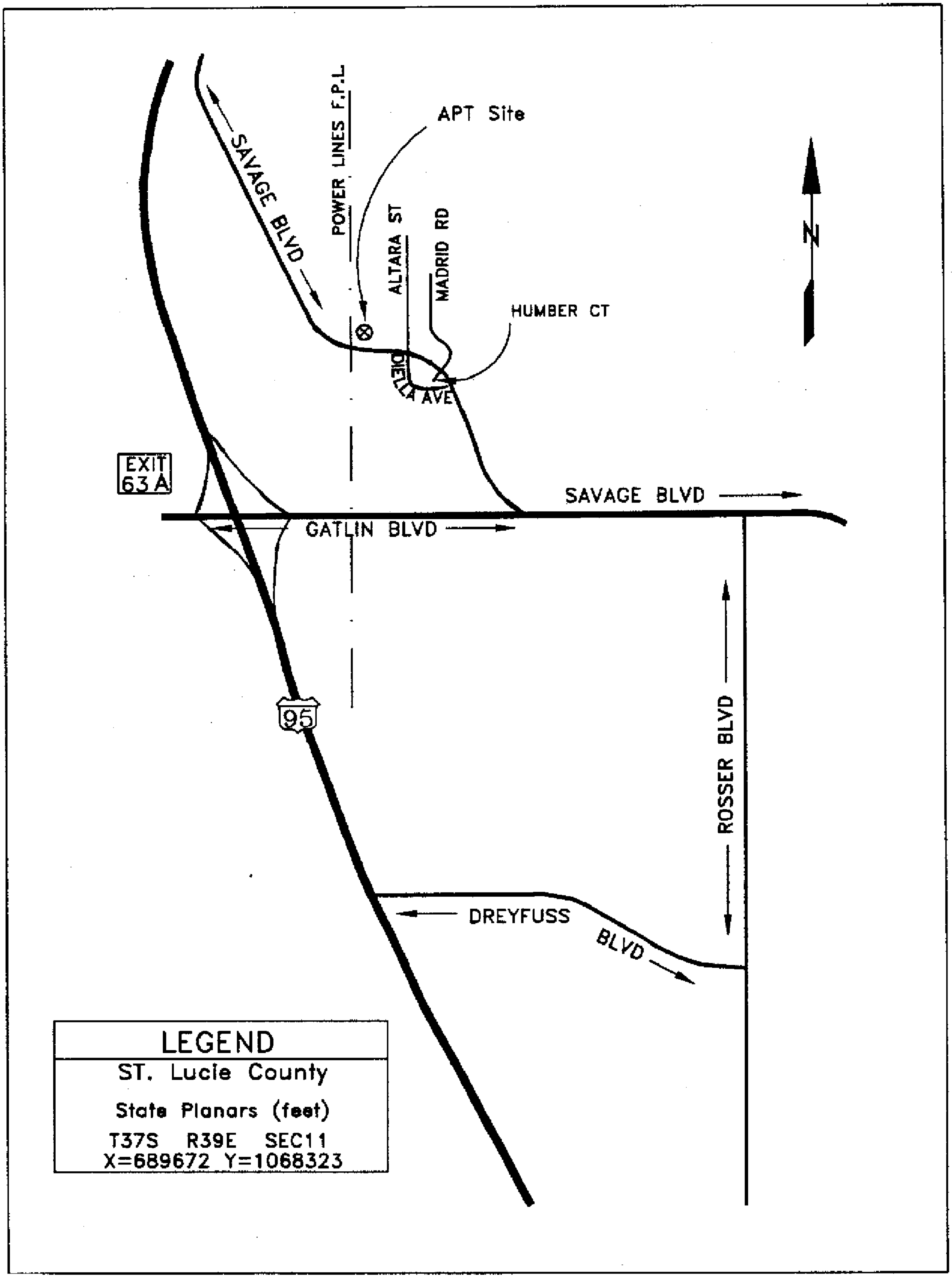
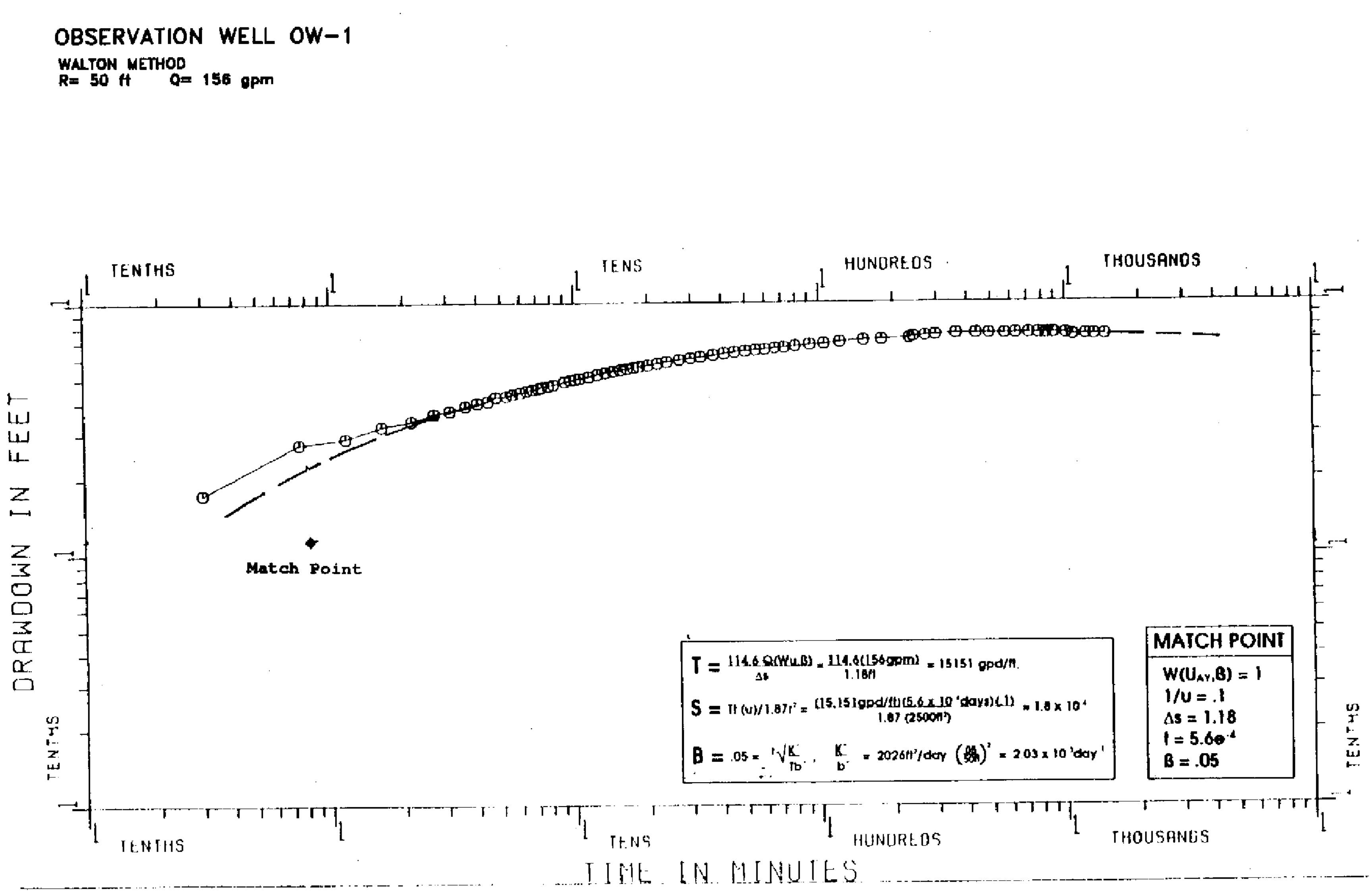
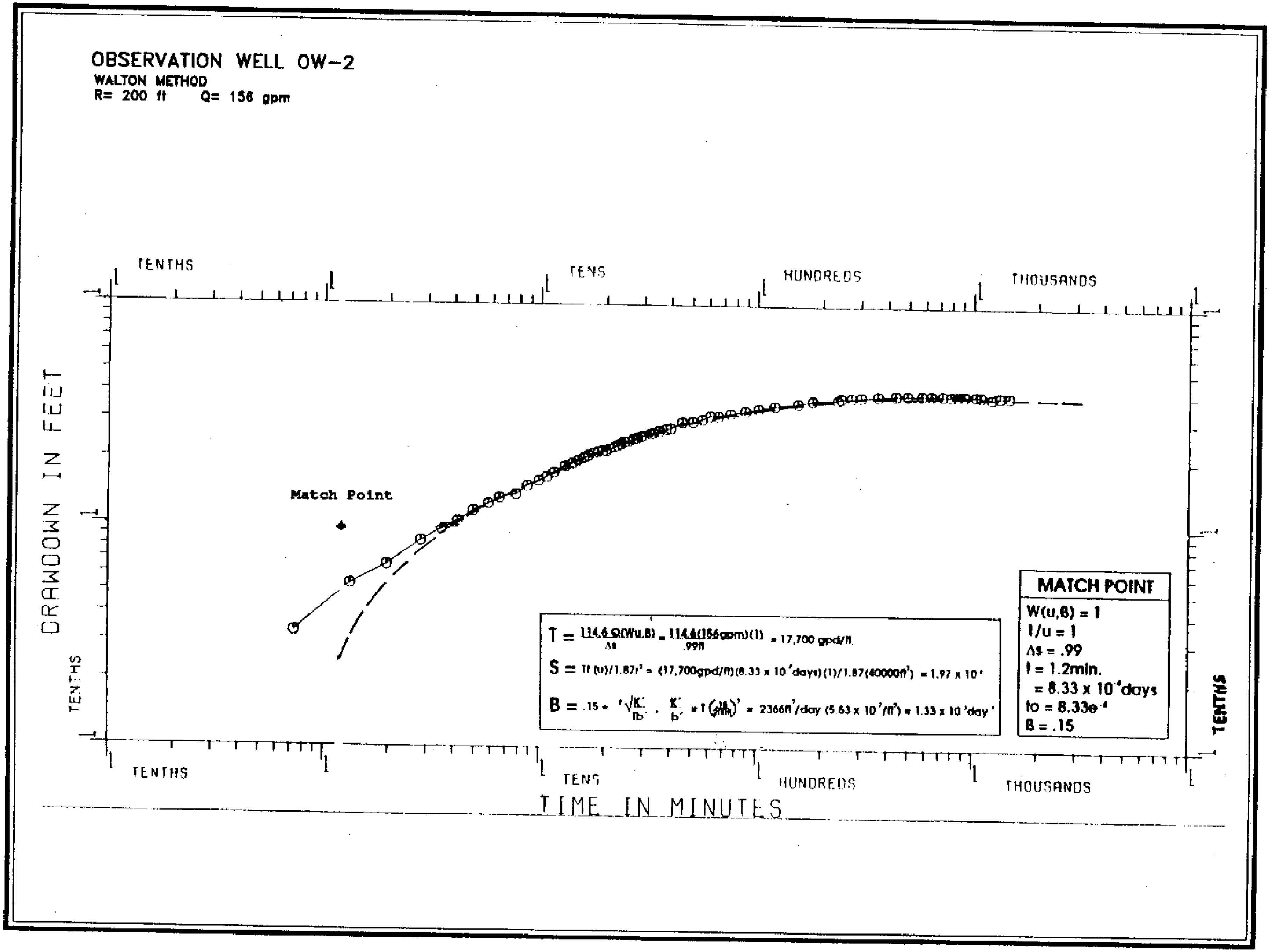


FIGURE 67. Locations Map - Port St. Lucie West APT Site



GRAPH 61. Port St. Lucie West APT Drawdown: Observation Well OW-1



GRAPH 62. Port St. Lucie West APT Drawdown: Observation Well OW-2

away from one another. Confidence in the results was very low due to the close proximity of the monitoring well to the pumping well. Darcey's limiting condition of laminar flow was probably violated. The analyses and corresponding calculations are presented in Graphs 63 and 64. Two additional problems with this test were that the pumping duration was too short (8 hours) to determine leakance and the wells only partially penetrated the aquifer.

Spanish Lakes Country Club Test Site

Map No. 4	
Confidence in Analysis	Moderate-High
Status of Wells at Site	Unknown

Comments: Documentation of this aquifer test was obtained from the SFWMD water-use permit file submitted by Spanish Lakes Country Club in 1981. Three wells were constructed at this site: one 8-inch production well screened from 80 feet to 100 feet BLS and two monitoring wells, the depths of which were not given. It is assumed the monitoring wells are screened across the same zone as the production well. Lithologic descriptions are presented in Appendix A-2, referenced under the FGS well name W-16964. Geophysical logs are given in Appendix B under the i.d. code 111000075.

The permit applicant performed the APT and analyzed the test results presented in Graphs 65 and 66. The Walton (1962) type-curve and Jacob (1952) straight-line methods were used to analyze drawdowns from wells. Computed aquifer parameters using the two methods matched well, as seen in the table of results (Table 9). Computed leakance was 4.4E-2/day, indicating fairly good communication with the overlying sand and shell layers.

North Port St. Lucie Test Site

Map No. 5,6	
Confidence in Analysis	Moderate-High
Status of Wells at Site	Unknown

Comments: An APT was conducted at this North Port St. Lucie site, results of which were documented by Geraghty and Miller, Inc. (1976). Three 8-inch diameter wells (PW-8, PW-11, PW-12), screened from 71 feet to 106 feet BLS, were constructed here. The pilot hole (PW-12) was drilled to a depth of 111 feet BLS, lithologic descriptions of which are provided in the above referenced report.

Two constant-rate pumping tests were conducted at this site, pumping first from well PW-11 then from well PW-12. Drawdown recorded from monitoring wells 11 and 12 were analyzed by SFWMD staff using the Hantush (1955) type-curve method. Results are shown in Graphs 67 and 68. Transmissivity calculations yielded similar results between wells: 13,643 gpd/ft and 13,902 gpd/ft, respectively. Storativity and leakance values were also similar and are given on the respective type-curve plots. Recovery data was not documented in the consultant's report. For further information about this site please refer to the original G&M documentation.

Monte Carlo Country Club Test Site

Map No. 16	
Confidence in Analysis	Moderate-High
Status of Wells at Site	Unknown

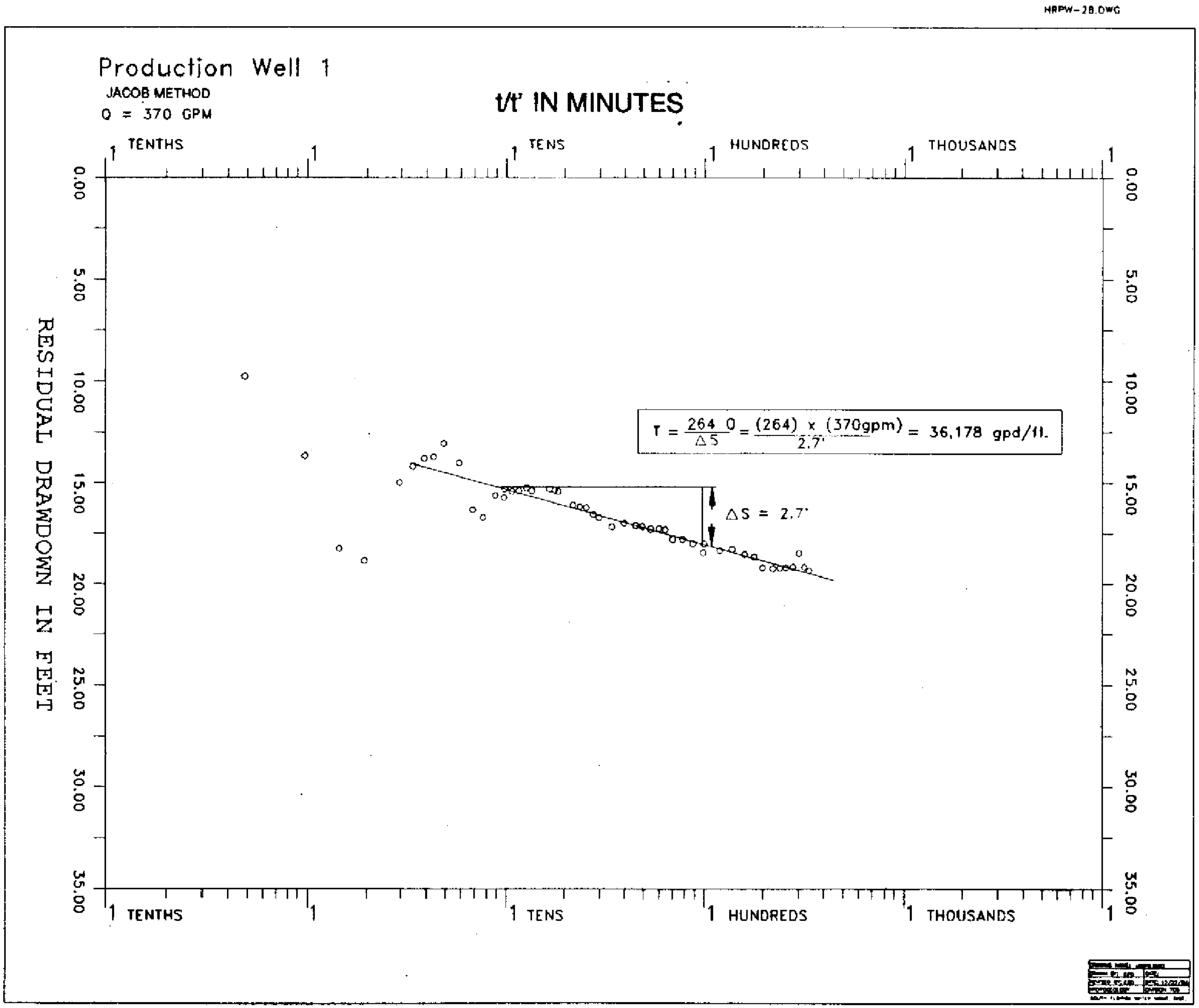
Comments: Lindahl, Browning, Ferrari and Hellstrom, Inc. (1988) constructed an APT site consisting of five wells, screened to three unique intervals in the SAS, at the Monte Carlo Country Club. Documentation includes lithologic logs, drillers logs, and well drawdown data. This data was submitted to the SFWMD as part of a water-use permit application.

Drawdown data was not analyzed in the consulting report. SFWMD staff used the Walton (1962) type-curve and Jacob (1952) straight-line methods to analyze drawdown data from wells OBS2 and OBS3 These plots and fitted type curves, along with match points and parameter calculations, are presented in Graphs 69 through 72. Computed transmissivities and storativities for the production interval, screened between 65 feet and 95 feet BLS, ranged from 11,460 gpd/ft to 13,577 gpd/ft and 5.4 E-6 to 7.7 E-5, respectively.

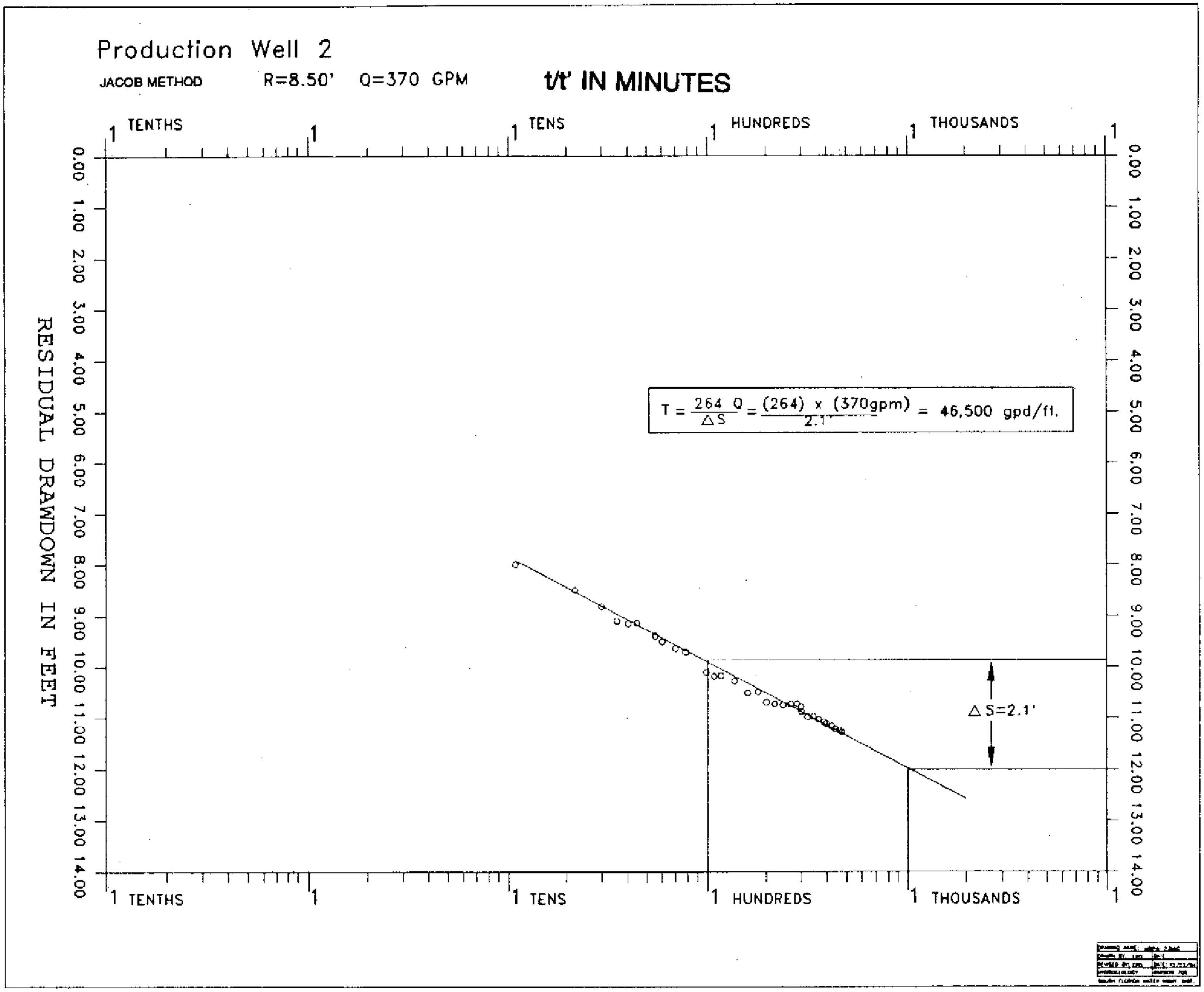
Leakance was computed for wells OBS2 and OBS3 using the Walton (1962) type-curve method as 1.9 E-4/day and 2.45 E-4/day, respectively. This low value indicates very little leakance across the confining layer.

Notes recorded by SFWMD staff performing the analysis include:

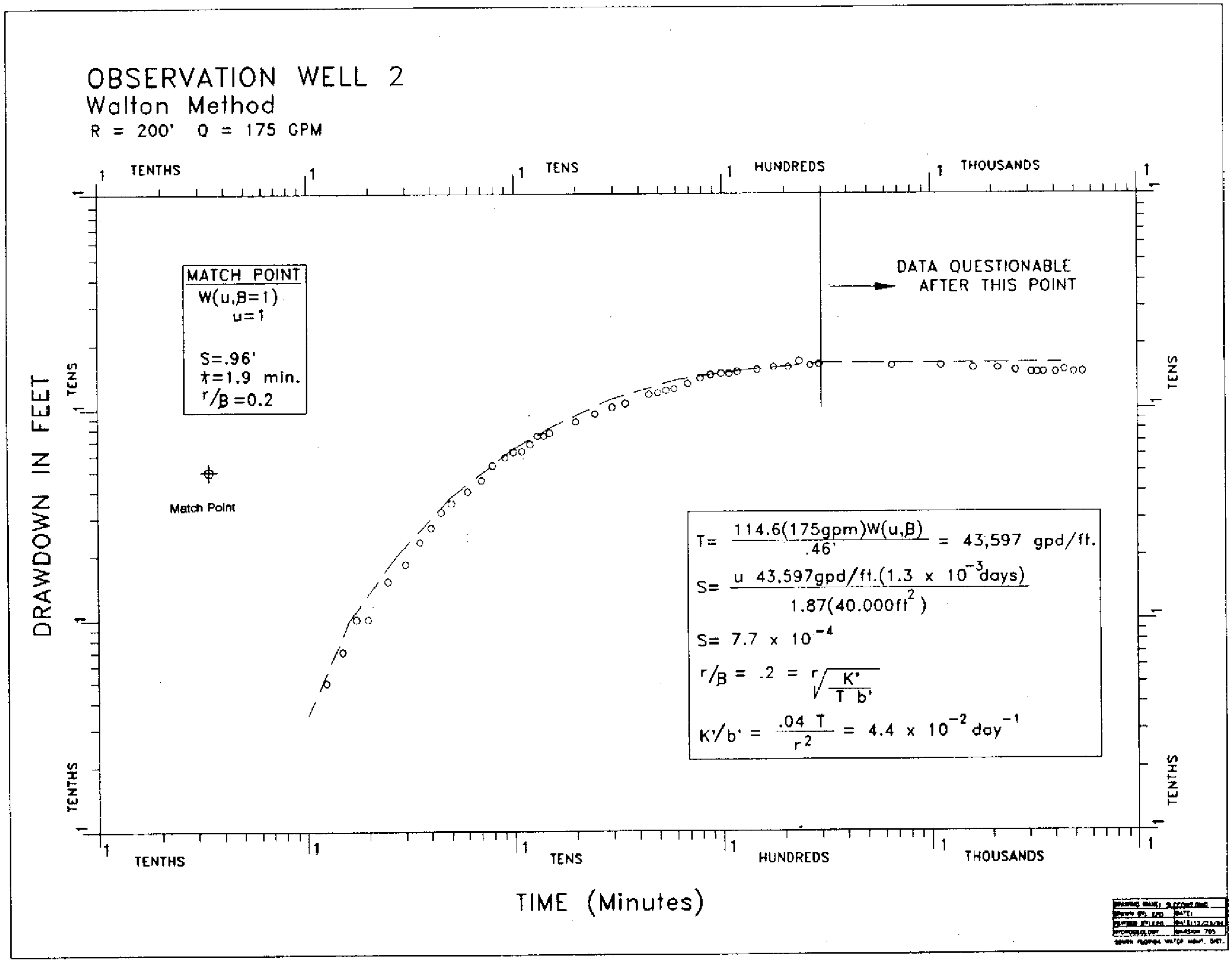
* OBS1 was not screened in a producing interval, water-levels in the well rose during the first 10 minutes of the pumping test.
* Friction loss in well PW-1 was excessive.
* Late-time drawdown indicates subtle changes in discharge rate possibly due to delayed yield or a boundary condition.



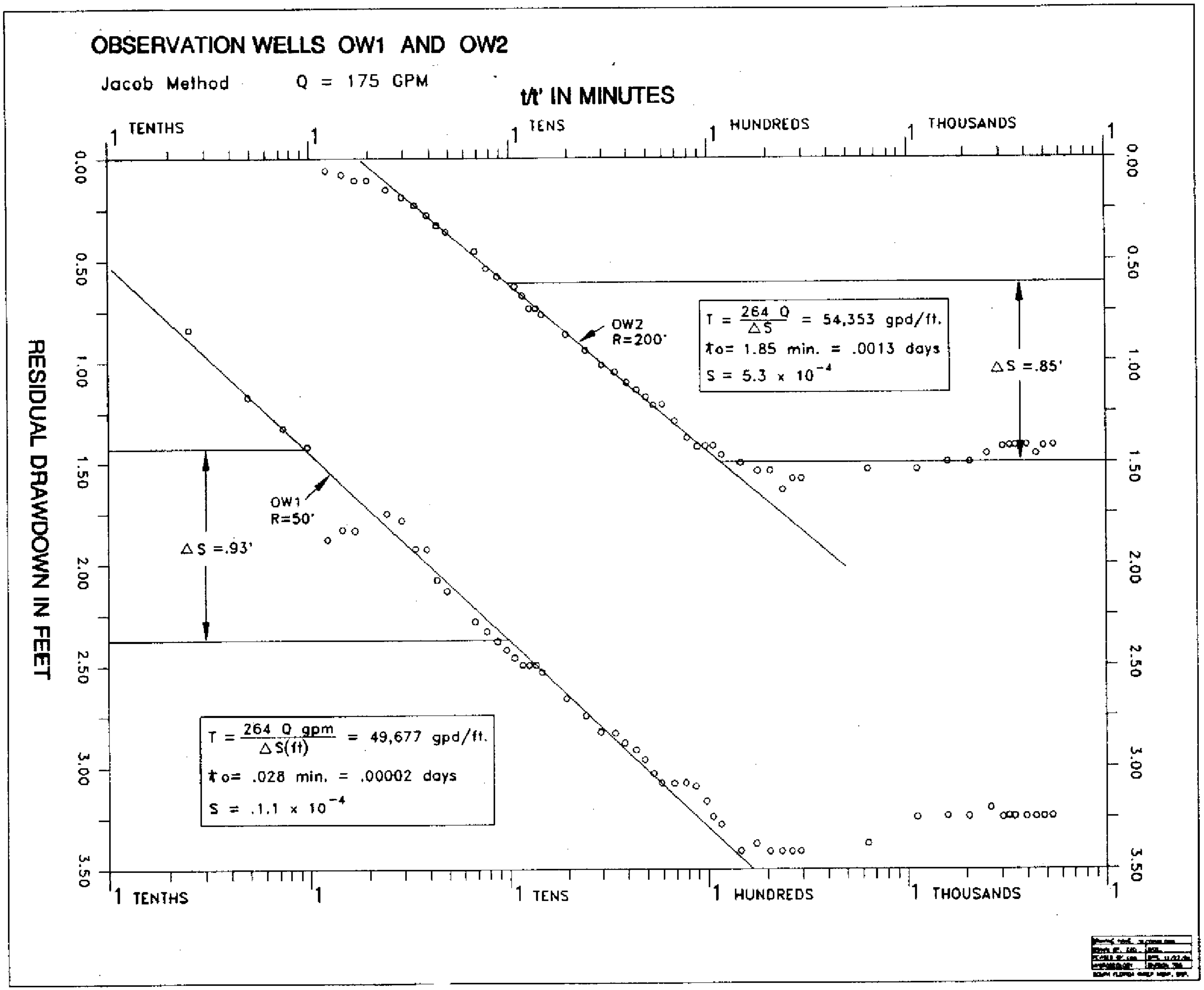
GRAPH 63. Harbor Ridge APT Drawdown: Production Well 1



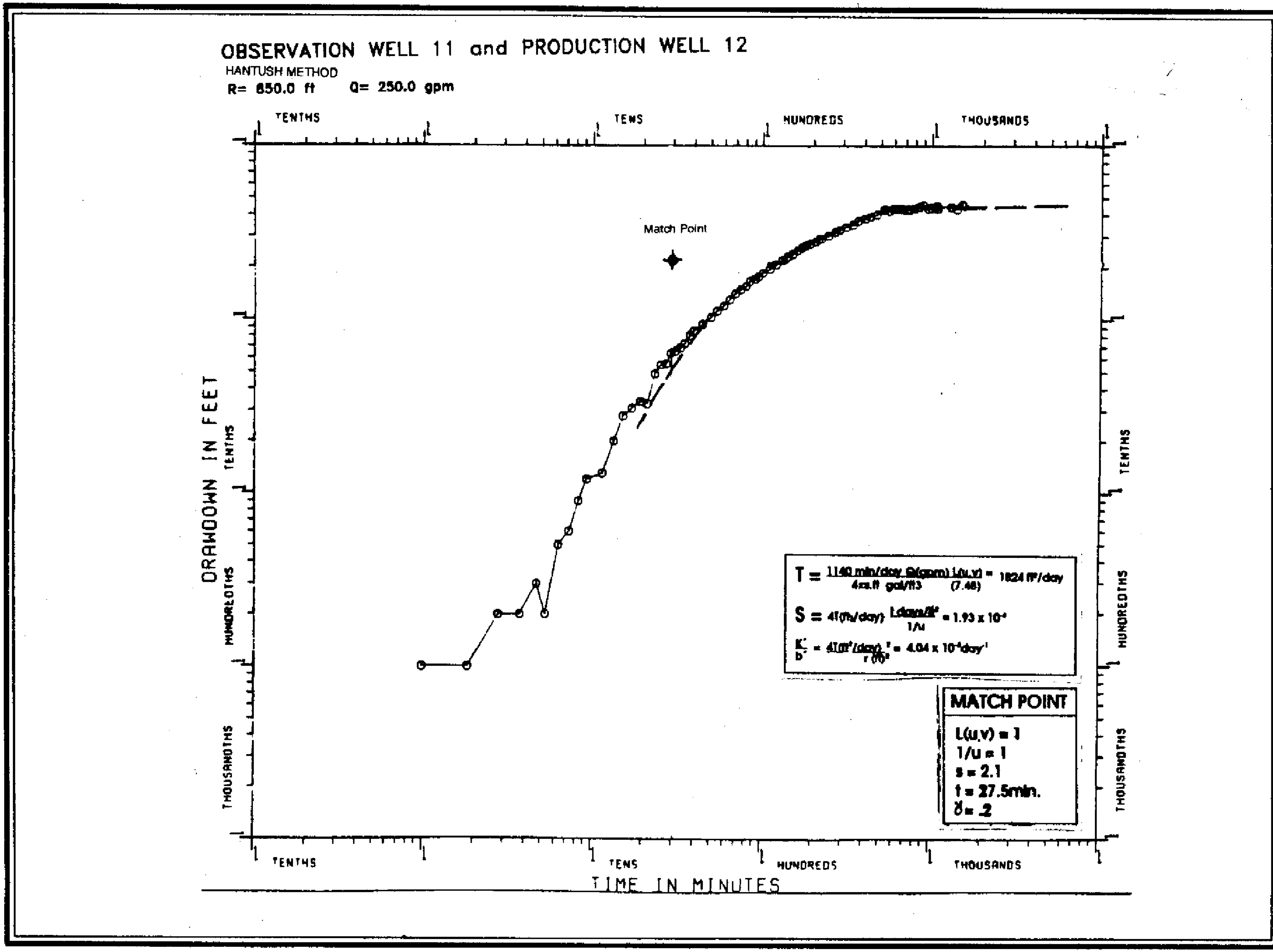
GRAPH 64. Harbor Ridge APT Drawdown: Monitor Well TW83-2



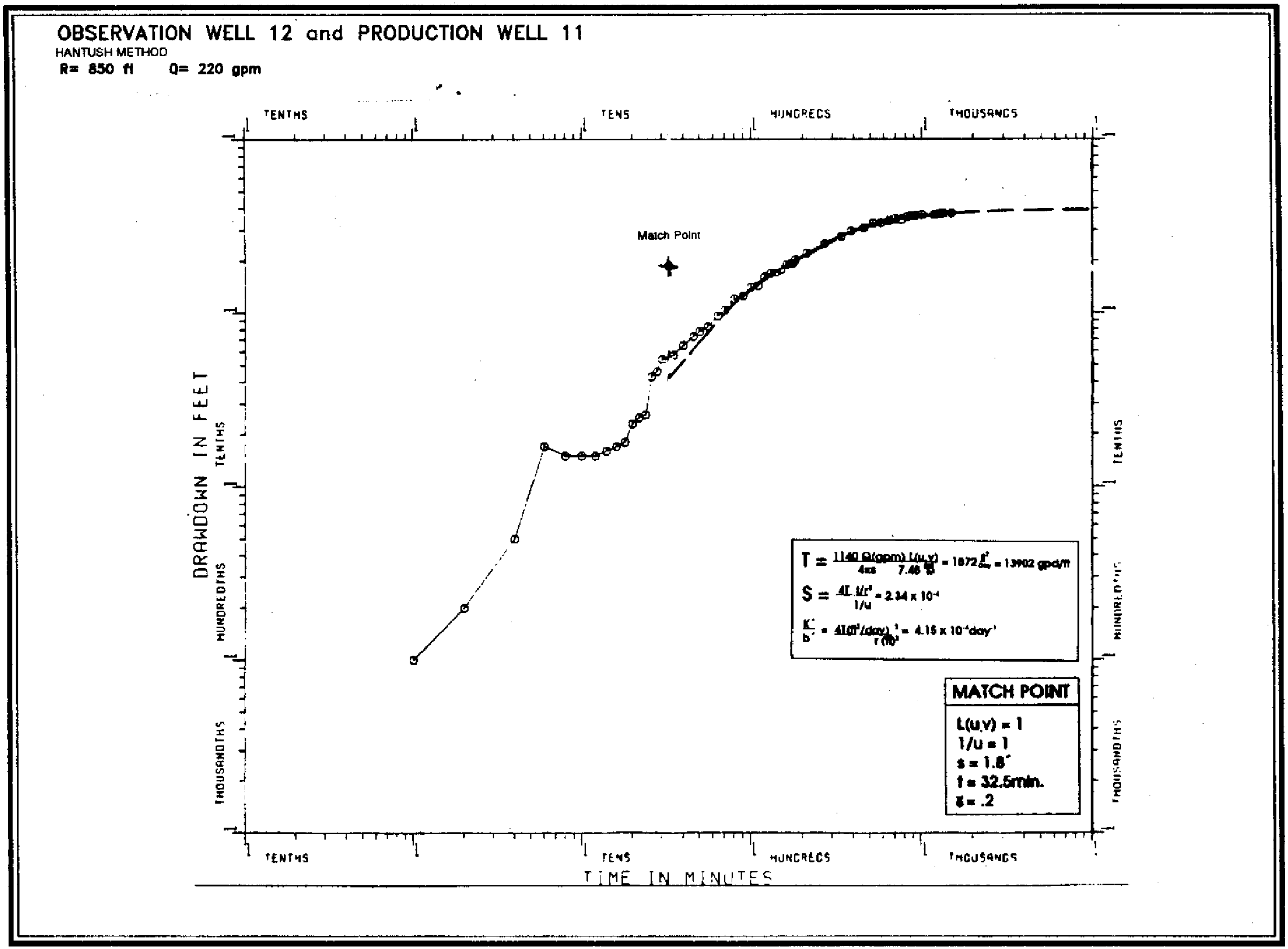
GRAPH 65. **Spanish Lakes Country Club APT Drawdown: Observation Well 2**



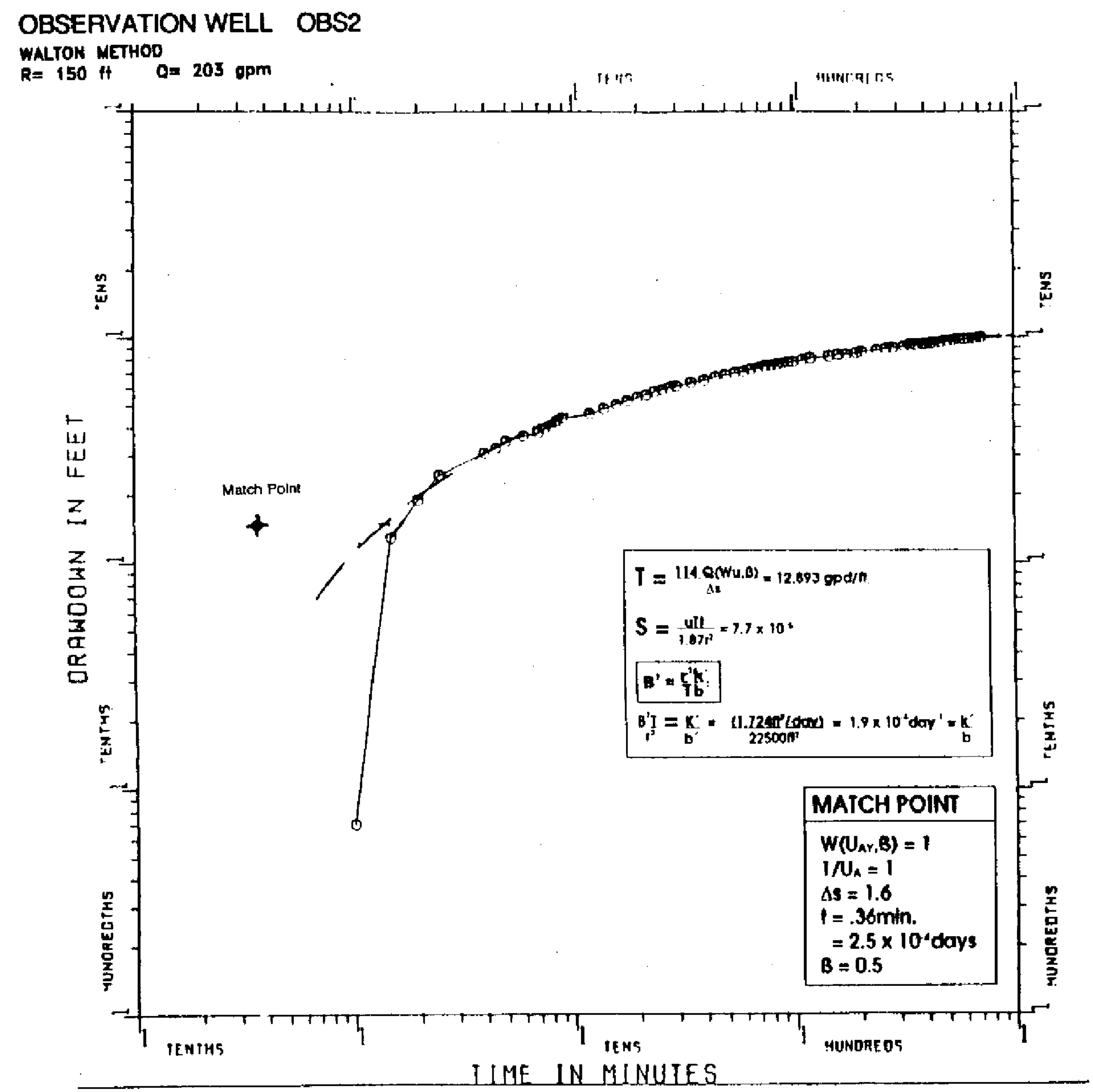
GRAPH 66. Spanish Lakes Country Club APT Drawdown: Observation Wells 1 and 2



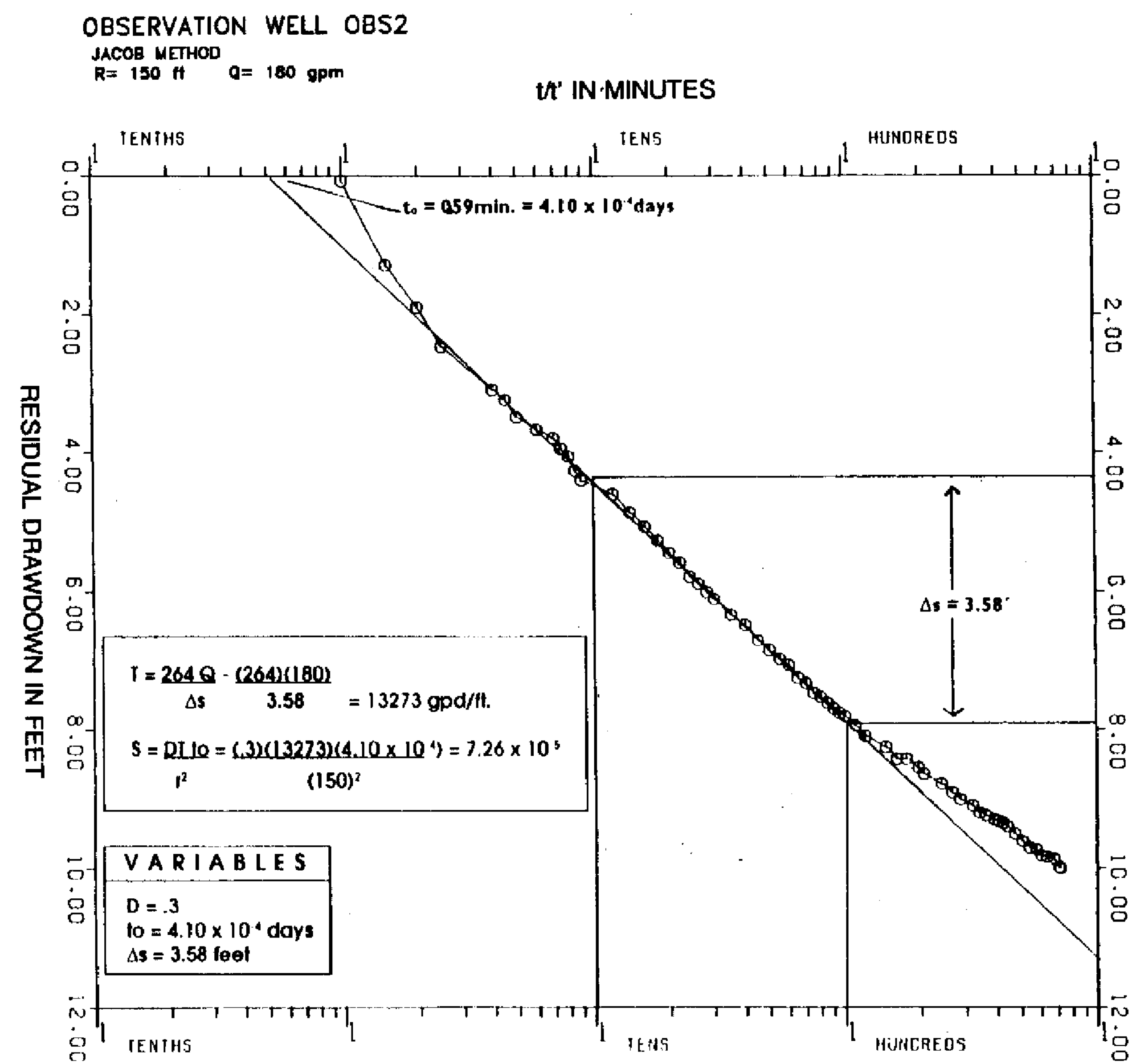
GRAPH 67. North Port St. Lucie APT Drawdown: Observation Well 11 and Production Well 12



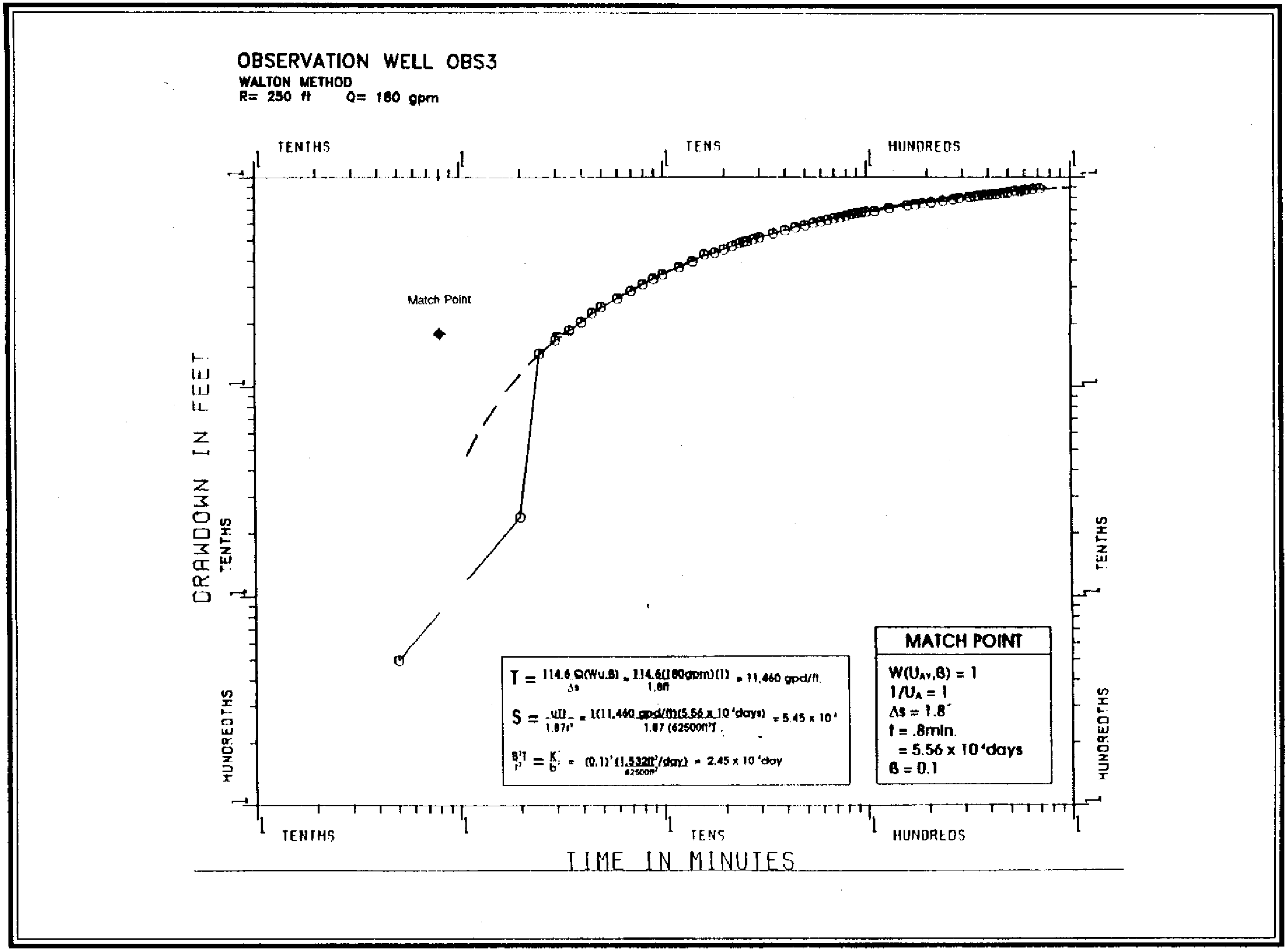
GRAPH 68. North Port St. Lucie APT Drawdown: Observation Well 12, Production Well 11



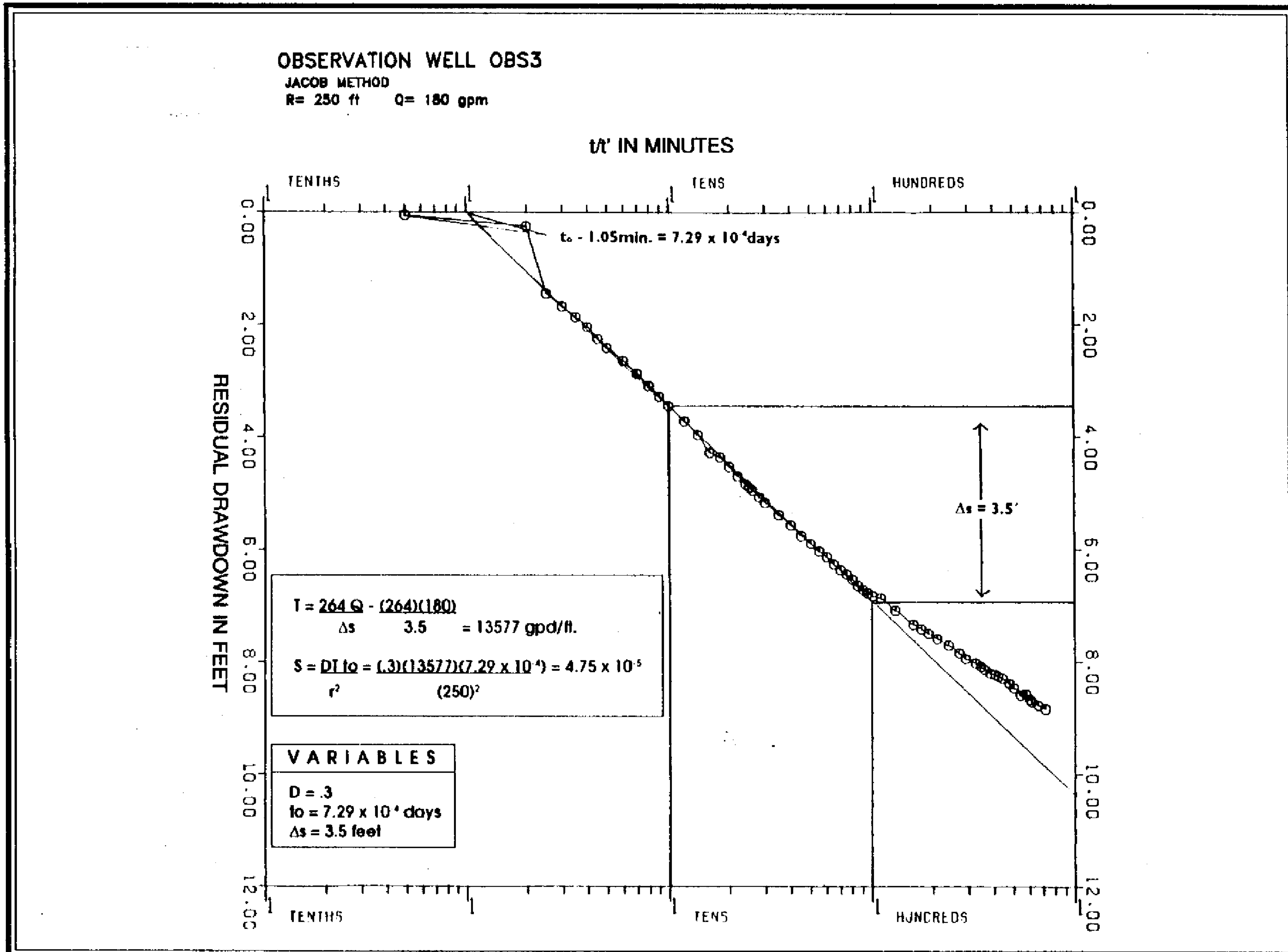
GRAPH 69. Monte Carlo Country Club APT Drawdown: Observation Well OBS2 (Walton Method)



GRAPH 70. Monte Carlo Country Club Drawdown: Observation Well OBS2 (Jacob Method)



GRAPH 71. Monte Carlo Country Club APT Drawdown: Observation Well OBS3 (Walton Method)



GRAPH 72. **Monte Carlo Country Club APT Drawdown: Observation Well OBS3 (Jacob Method)**

* No mention was made of where discharged water was routed.
* Monitoring well layout was not illustrated in the report.
* Driller's logs suggest that the water table well (WT) was shallower than the consultant's report claimed.

ST. LUCIE COUNTY FLORIDAN AQUIFER SYSTEM APT RESULTS

The SFWMD's C-24 Canal Test Site

Map No. Figure 68
Confidence in Analysis High
Status of Wells at Site Existing

The SFWMD constructed six Floridan Aquifer System (FAS) wells on the south bank of the C-24 canal located in central St. Lucie County, as shown in Figure 68. These wells were completed into three distinct flow zones, with two wells per zone. The drilling and testing programs, which commenced in the spring of 1990, were designed to gain information about the various flow zones within the FAS and their hydraulic interaction with one another. Results of APT analyses from this site and other relevant information are listed in Table 13.

Four major flow zones were identified using lithologic and geophysical logs from the pilot hole (Well 2D or SLF-73). These logs are presented in Appendices A-2 and Appendix B, respectively. The FGS well name for lithologic descriptions is W-16543, while the SFWMD geophysics I.D.# is 111000077. A profile showing construction of the wells relative to identified formations, aquifers and confining intervals is presented in Figure 69. Wells SLF-73 and SLF-74 (Well 1D) were open-hole completed through two flow zones in the Lower Floridan aquifer. These two flow zones are named PZ1 and PZ2 in Figure 3.

Background water-levels were recorded for two days prior to running each APT to determine the magnitude of tidal effects, as well as the impacts from surrounding wells, on each zone. A time-series plot of water levels is shown in Figure 70.

Three individual APTs, one per zone, were conducted at this site in 1991. The flow zones tested were; the top of the Ocala Group between 480 feet and 700 feet BLS; the Avon Park Formation between 790 feet and 860 feet BLS; and the top of the Lower Floridan aquifer encountered between 1,070 feet and 1,450 feet BLS. Two wells (an 8-inch diameter production and a 4-inch diameter monitor) were open-hole completed to each of the three zones. The paired wells were spaced approximately 300 feet apart (Figure 32). Both drawdown and recovery data were collected from all wells during each APT. A constant discharge rate during each pump test was maintained for 24 hours. Water samples were collected at the end of each pumping period and analyzed by the SFWMD laboratory for major ions. These results are listed in Table 14. Drawdown data were analyzed using the Hantush (1964) type-curve method while recovery data was analyzed using the Theis straight-line method. These plots and calculations are presented in Graphs 73 through 78 for each APT.

TABLE 14. Field Parameters of Floridan Aquifer System Ground Water Quality Measured at the C-24 Canal Site, St. Lucie County

SLF-74			
Pumping Time	Conductivity	Chlorides	Temperature
(hours)	(mmhos/sec)	mg/l	(C)
0.1	5880	2558	30.2
1.0	5910	1980	30.1
6.0	6040		20.2
14.0	5560		29.1
18.0	5730	1754	29.2
24.0	5630	1777	29.7
SLF-75			
Pumping Time	Conductivity	Chlorides	Temperature
(hours)	(mmhos/sec)	mg/l	(C)
0.1	3200	1001	25.1
6.0	3140	934	25.7
12.0	3180	1010	24.7
24.0	3310	925	26.0

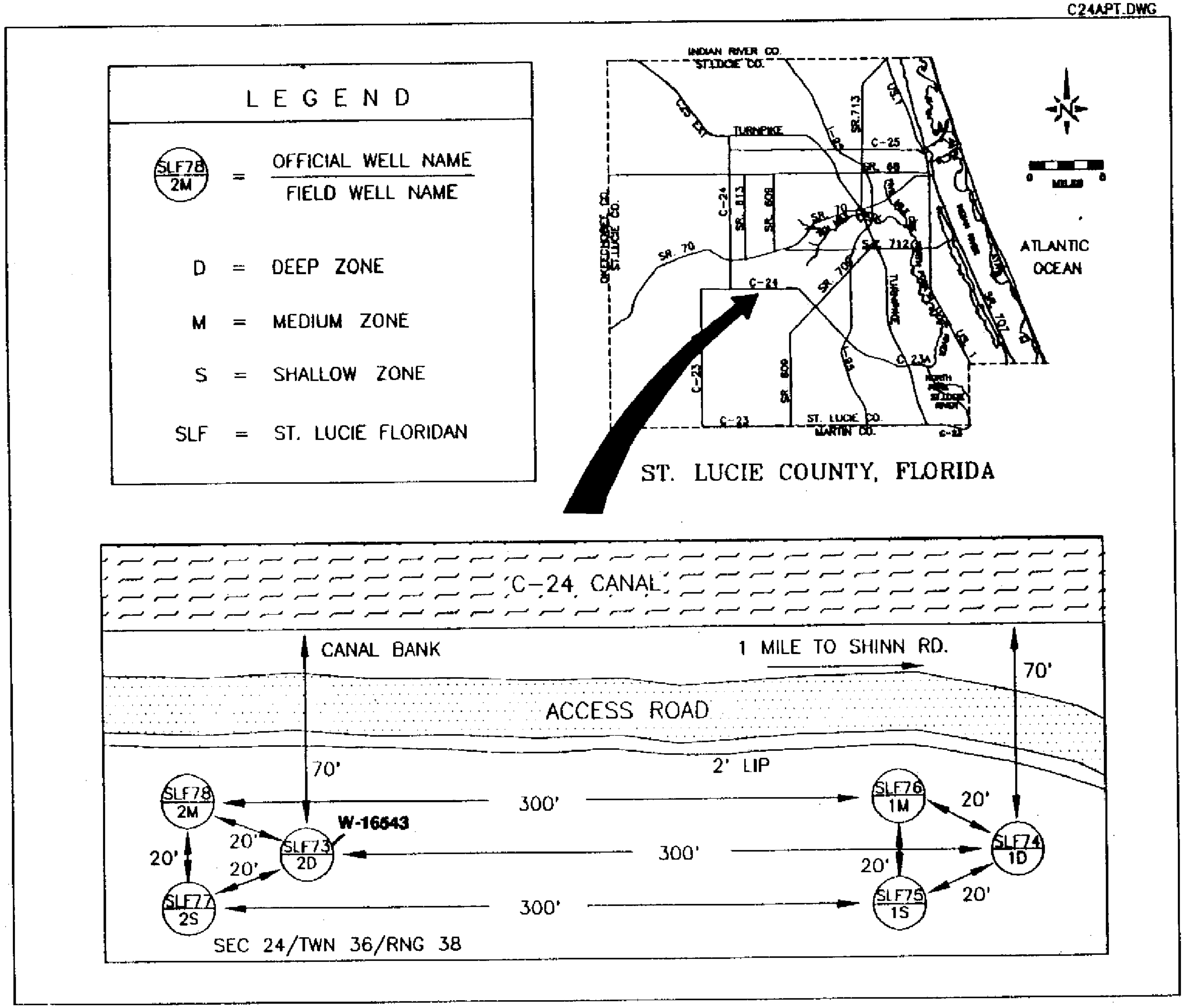


FIGURE 68. Locations Map and Site Layout of Floridan Aquifer System Wells - C-24 Canal APT Site

TABLE 13. Floridan Aquifer System APT Results - C-24 Canal Site, St. Lucie County

Pumped Well Name	Obs. Well Name	Prod Well Cased/TD (Feet)	Obs. Well Cased/TD (Feet)	Radius (Feet)	Q (gpm)	Hours Pumped	Max. Drawdwn (Feet)	Trans. (gpd/ft)	Storage Unitless	Leakance (gpd/ft3)	Analysis Method
SLF-74	SLF-73	1070-1450	1070-1450	300	622	33.6	1.3	485200	0.00018	0.01	Hantush I
D 1	D 2										
SLF-75	SLF-77	480-700	480-700	300	640	27.0	0.7	175260	0.00089	0.228	Hantush I
S 1	S 2										
SLF-76	SLF-78	790-860	790-860	300	373	28.6	3.3	221054	0.00016	0.048	Hantush I
M 1	M 2										

General Information

	Site Name	C-24 Site
	Date	Feb. 1992
	S/T/R	24/36/38
Litho.	Well Name	W-16543
	State Planars	
	East (ft)	659259
	North (ft)	1092023

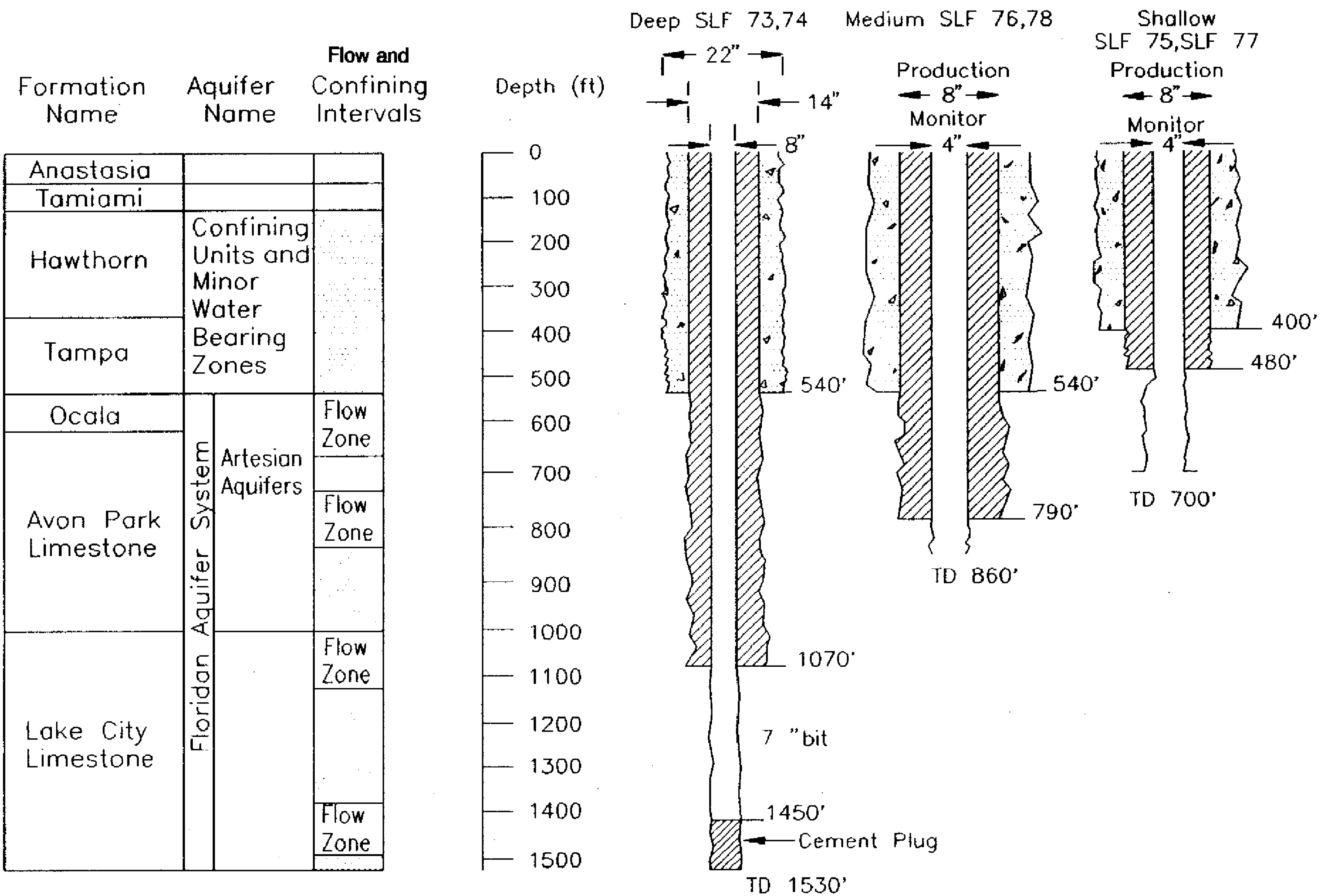


FIGURE 69. Hydrogeologic Column and Well Construction Details - C-24 Canal APT Site

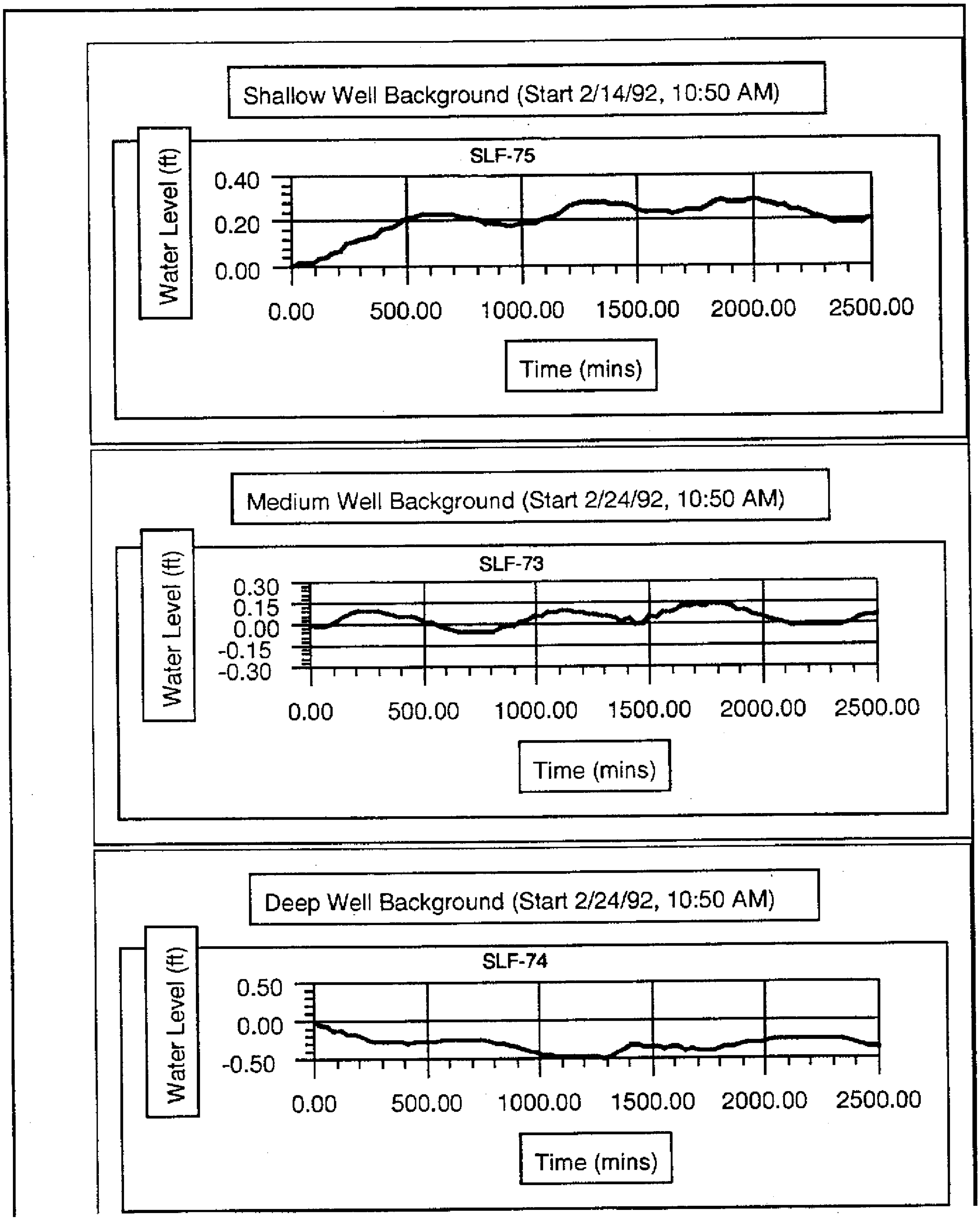
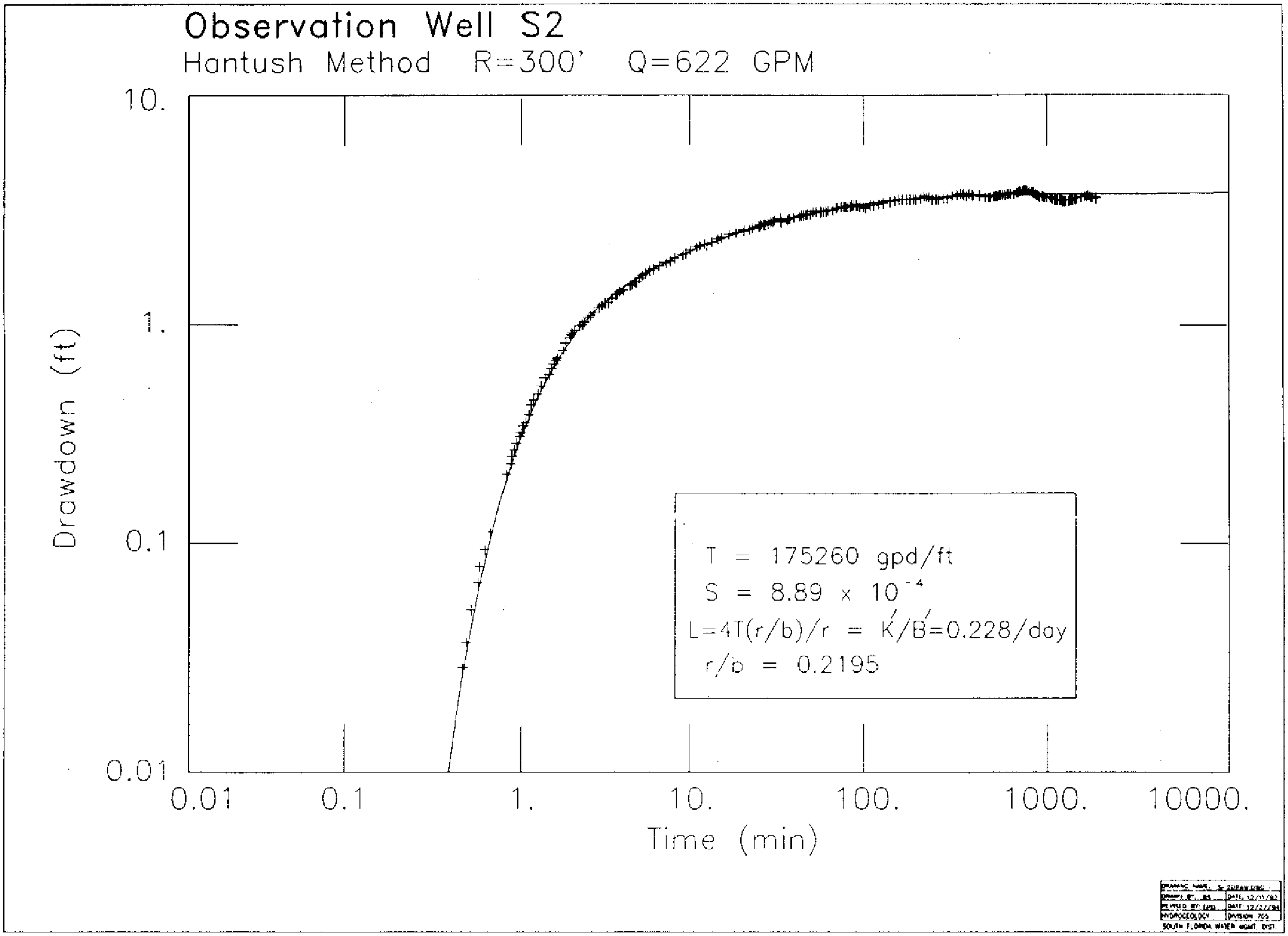
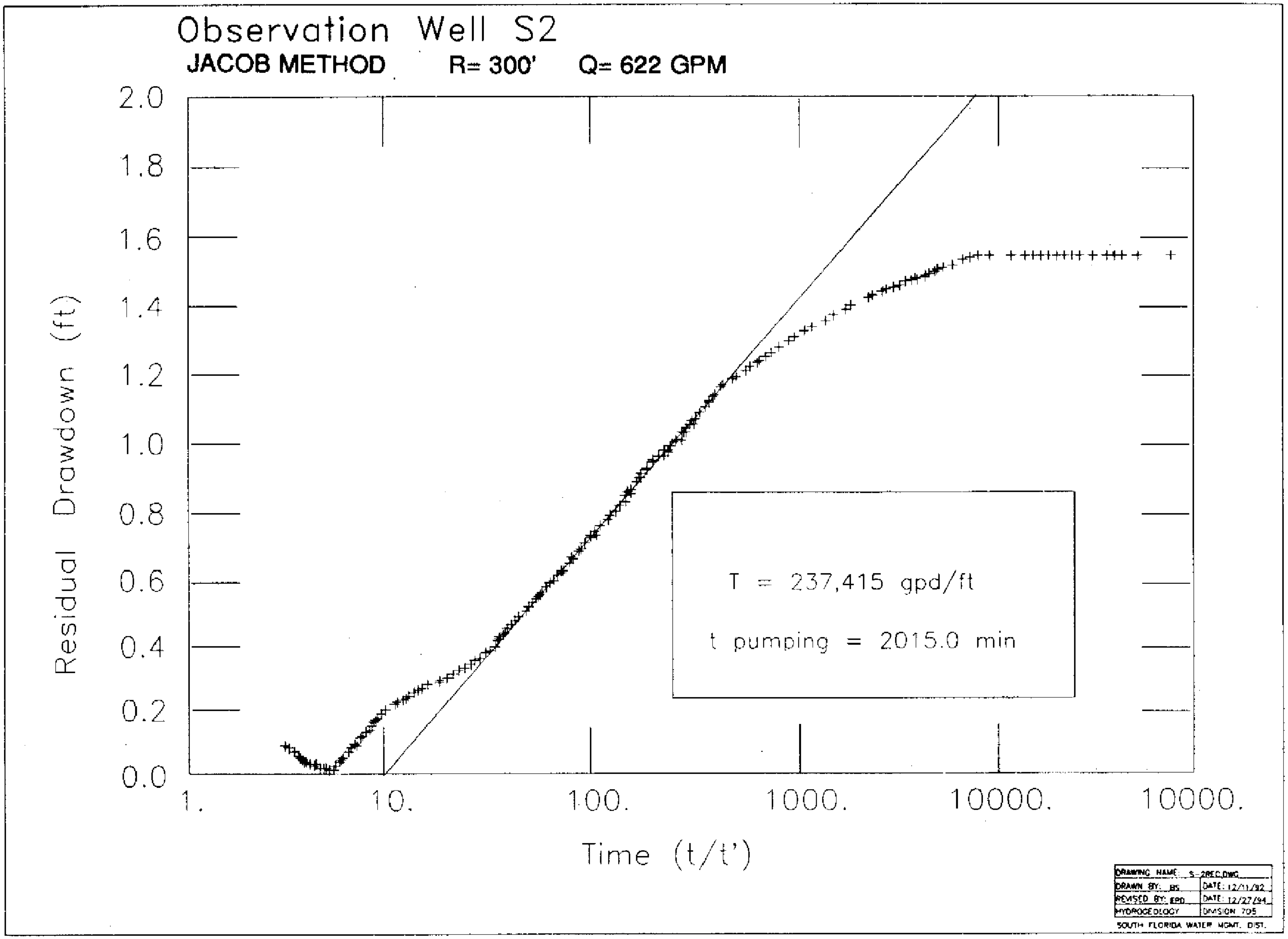


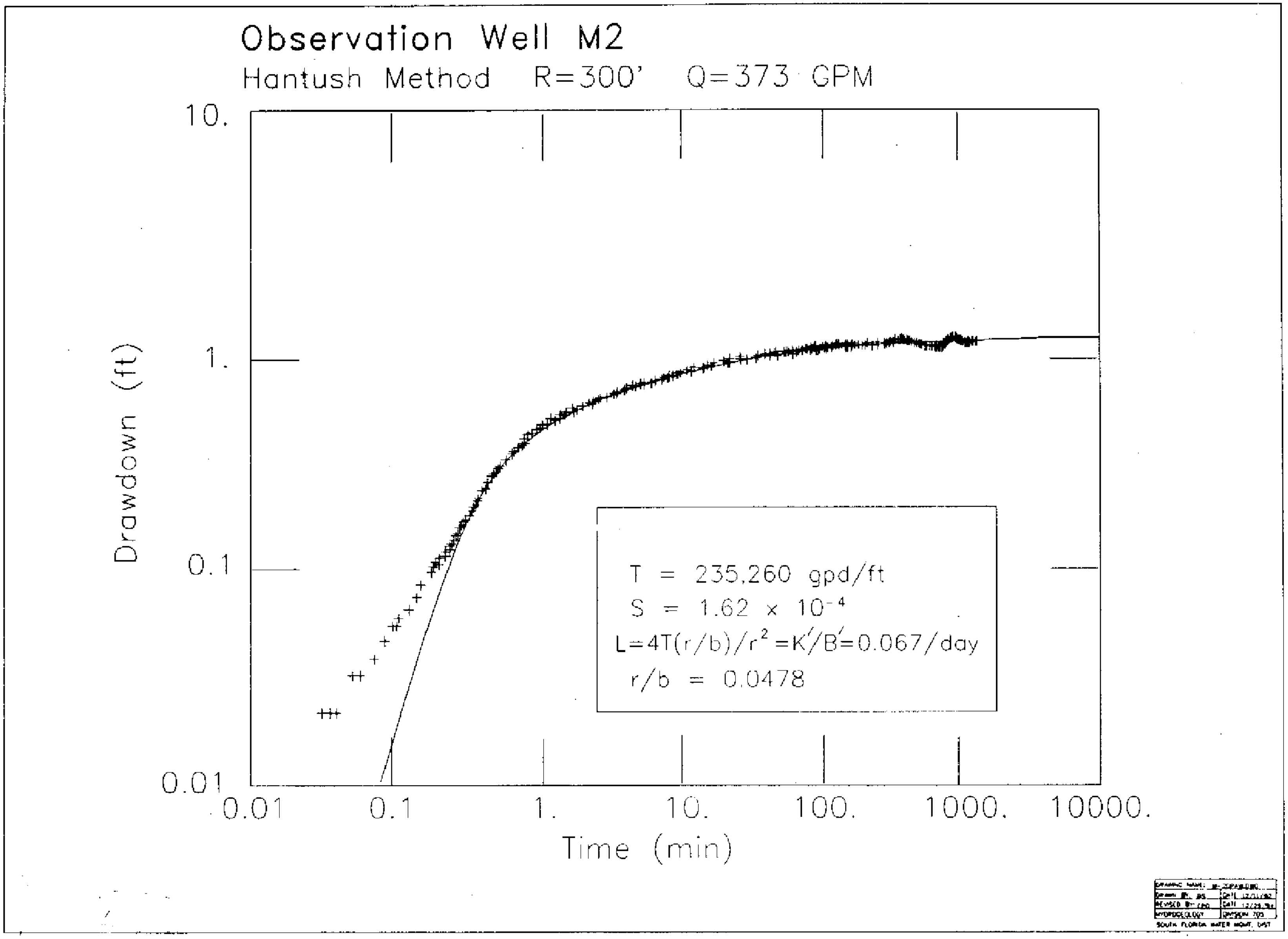
FIGURE 70. Background Water-Levels in three Floridan Aquifer System Zones from Wells SLF-75, SLF-73 and SLF-74, at the C-24 Canal APT Site, St. Lucie County



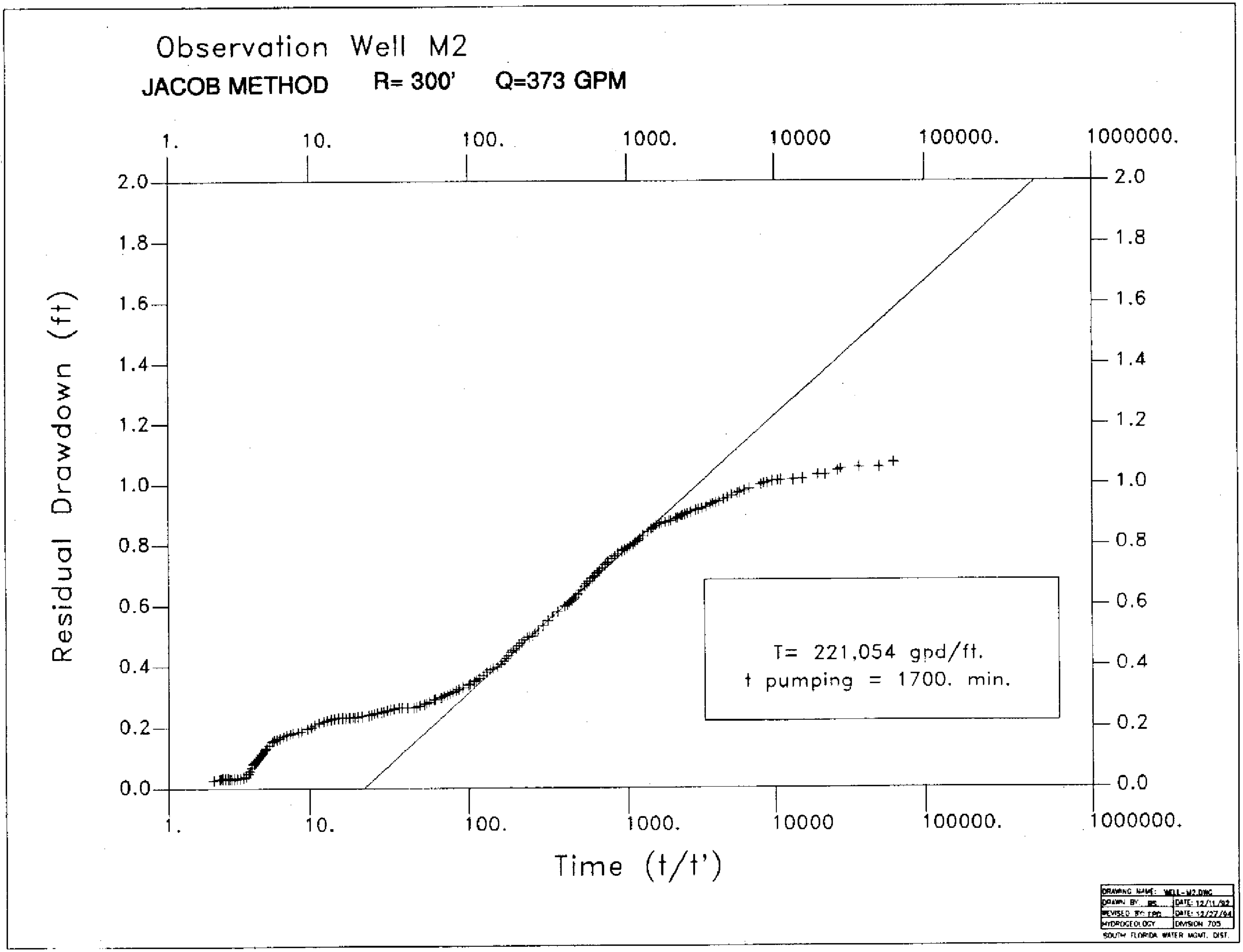
GRAPH 73. C-24 Canal Site APT Drawdown: Observation Well S2



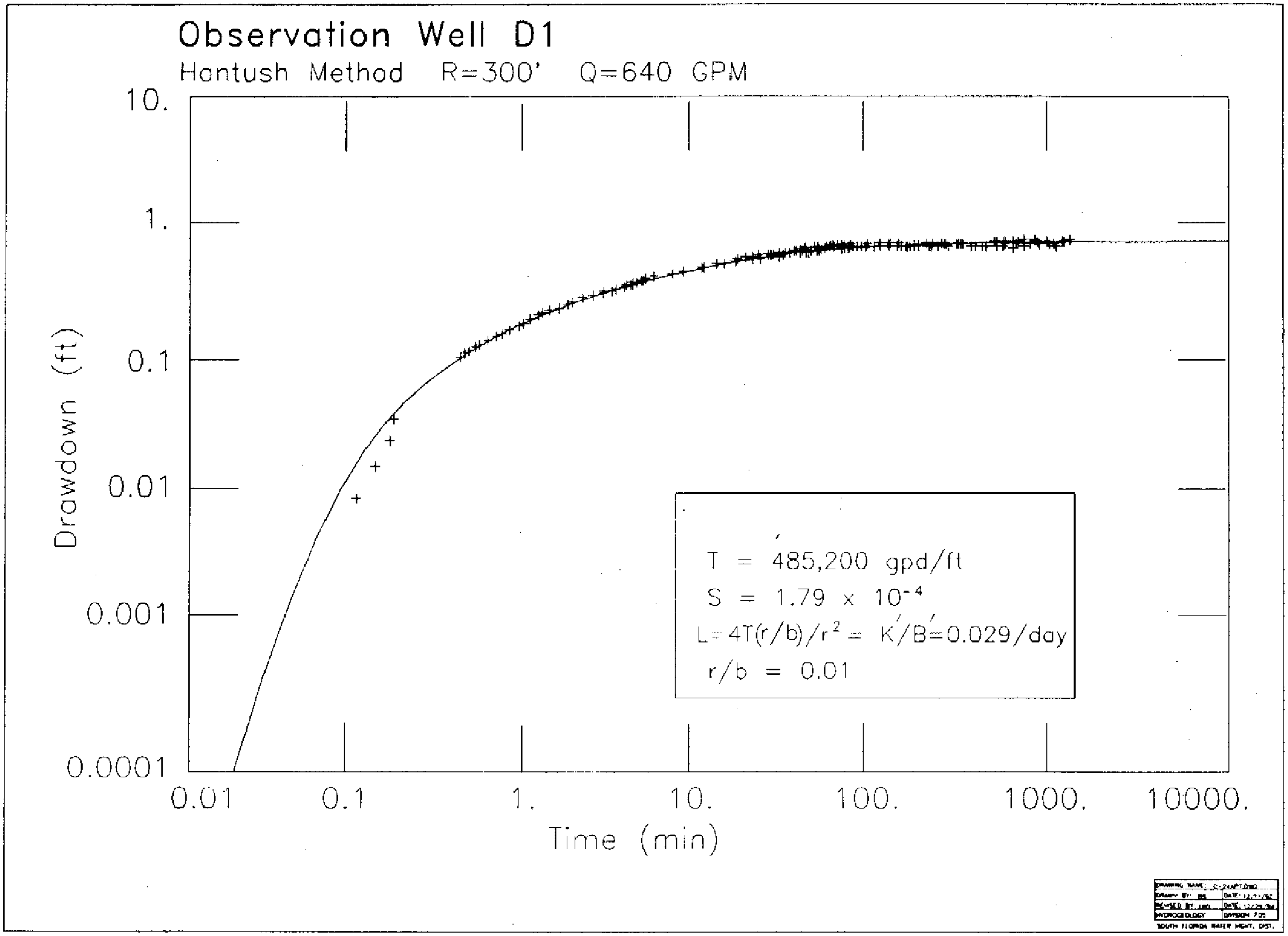
GRAPH 74. C-24 Canal Site APT Recovery: Observation Well S2



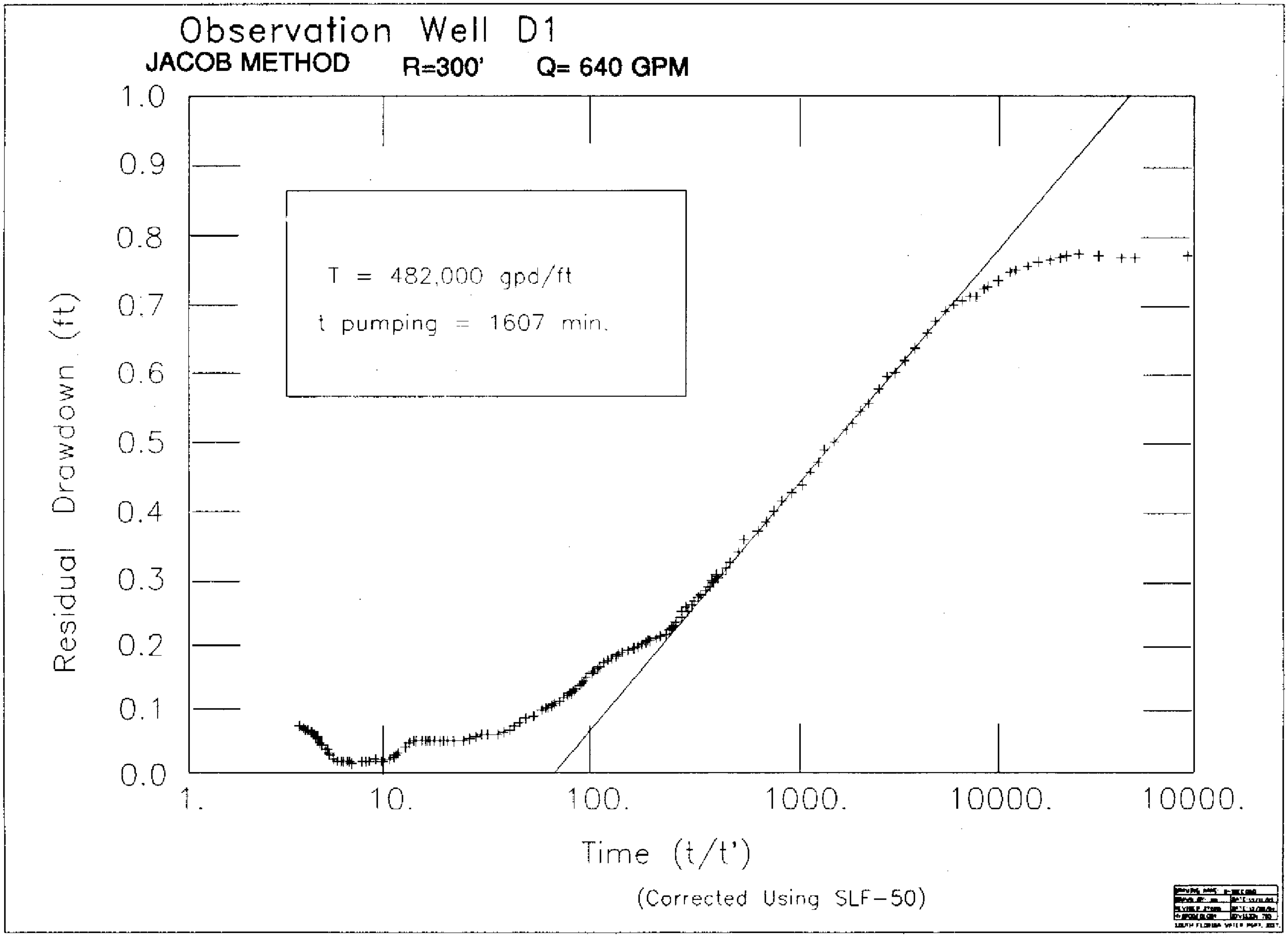
GRAPH 75. C-24 Canal Site APT Drawdown: Observation Well M2



GRAPH 76. C-24 Canal Site APT Recovery: Observation Well M2



GRAPH 77. C-24 Canal Site APT Drawdown: Observation Well D1



GRAPH 78. C-24 Canal Site APT Recovery: Observation Well D1

The APT results demonstrated that the most transmissive interval in the FAS at this site constituted the two flow zones within the Lower Floridan aquifer, designated Production Zone 1 (PZ-1) and Production Zone 2 (PZ-2) by Lukasiewicz (1992). Transmissivity, storativity and leakance values in this interval were determined to be 485,200 gpd/ft, 1.8 E-4 and 0.01/day, respectively.

Leakance Between Floridan Aquifers

During an APT, water can leak into the pumped aquifer through either the confining bed above or below, or both. Although leakance values for each layer were computed using the Hantush (1964) type-curve analysis, these values represent the composite rate of vertical leakance to the pumped aquifer and give no indication of the source water or direction of vertical leakance. To ascertain this, and to get a qualitative feel for the relative hydraulic communication between zones, water quality changes and water-level declines (drawdowns) recorded from wells in each of the three FAS zones during each APT were plotted as a function of time and are discussed below.

Four water samples were obtained from the pumping well during the course of each APT on the following schedule: 10 minutes, 1 hour, 6 hours, 14 hours, 18 hours and 24 hours. The purpose of obtaining this information was to provide supportive evidence of leakage across aquifers. Water quality trends identified while pumping one aquifer can be construed as mixing of water types between aquifers via vertical leakance. Temporal changes in water quality should cease when steady-state is reached. The samples were measured in the field for specific conductivity, chloride concentration, and temperature. Results are listed in Table 15. Figure 71 illustrates chloride and TDS concentration changes with depth sampled during reverse-air drilling.

When the shallow zone was pumped at 640 gallons per minute (gpm), water-levels in the middle zone began to decrease immediately (Figure 72) by 0.3 feet. Approximately 500 minutes into the test, they increased and approached initial conditions. During this same time, water-levels in the deep zone (Lower FAS) at first appeared to be influenced only by tidal effects and barometric pressure changes, then approximately 500 minutes into the test they declined approximately 0.15 feet. These observations suggest that there is significant leakance between the shallow and middle zones, and less between the shallow and deep. Leakance, calculated from the shallow aquifer pump test (APT-2), was 0.228/day, a relatively large value. When water is discharged from the shallow zone, the medium zone (top of Avon Park) immediately provides some replacement water via vertical leakance (top of Ocala) whereas replacement water from the deeper zone occurs much later. Water quality remained essentially the same throughout the course of the test.

When the medium zone (top of Avon Park) was pumped at 373 gpm, water-levels in the shallow zone gradually decreased approximately 0.3 feet (Figure 73) and appeared to level off toward the end of the test, suggesting a steady-state condition. At the same time, water-levels in the deep zone (lower FAS)

TABLE 15. Laboratory Analyses of Floridan Aquifer System Ground Water Quality Collected during APTs at the C-24 Canal Site, St. Lucie County

Well Name	Depth (Ft. BLS)	Cond (mmhos/sec)	Temp (C)	Na mg/l	Ca mg/l	Mg mg/l	K mg/l	Cl mg/l	SO4 mg/l	TotFe mg/l
SLF-74	1070-1450	5630	29.7	894	241	160	22	1929	198	0.06
D 1										
SLF-75	480-700	3310	24.7	520	118	90	16	948	186	<.05
S 1										
SLF-76	790-860	2037	33.2	602	129	101	17	1098	174	<.05
M 1										

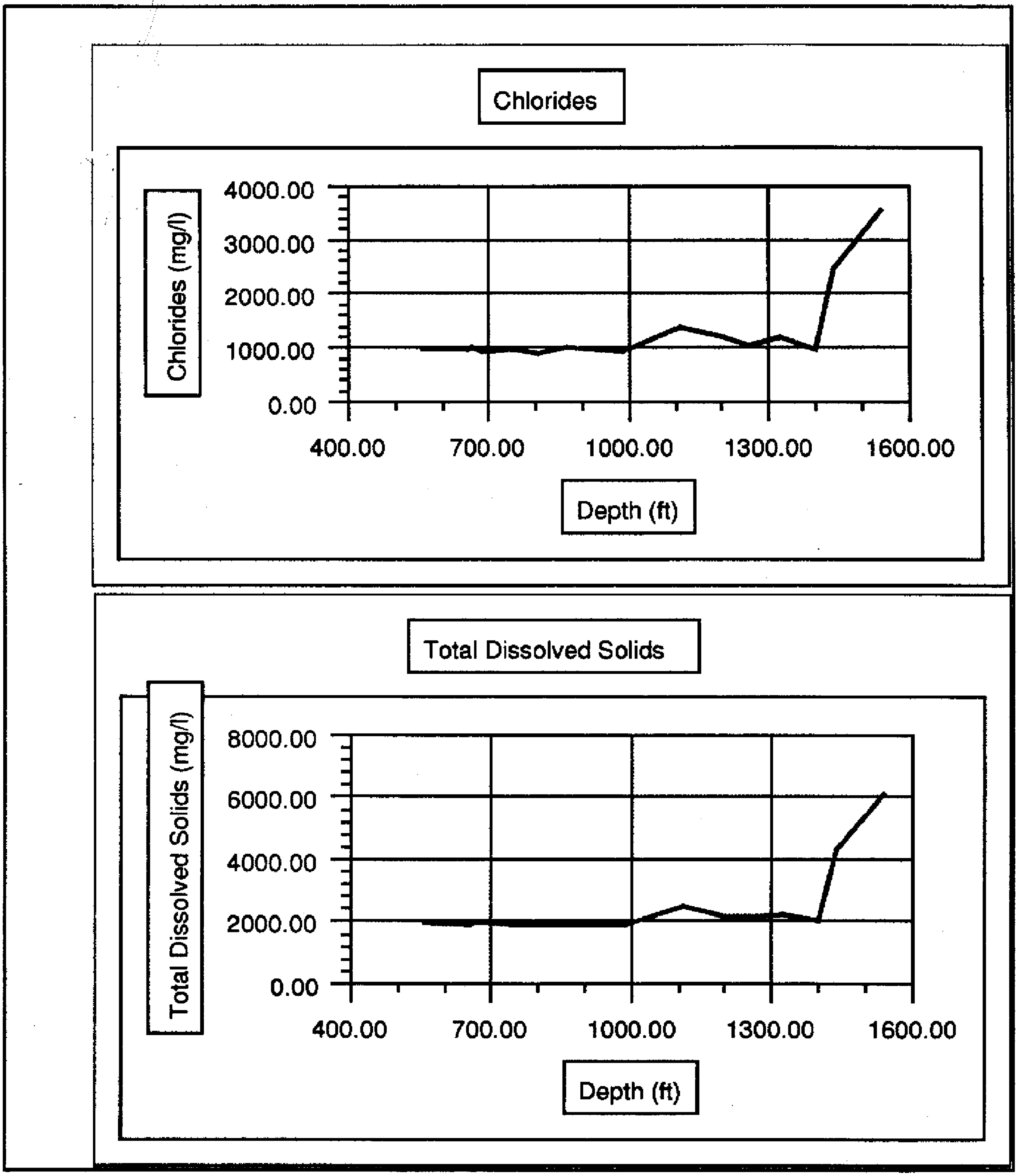


FIGURE 71. **Chloride and Total Dissolved Solids Concentrations with Respect to Depth taken during Reverse-Air Drilling at the C-24 Canal APT Site**

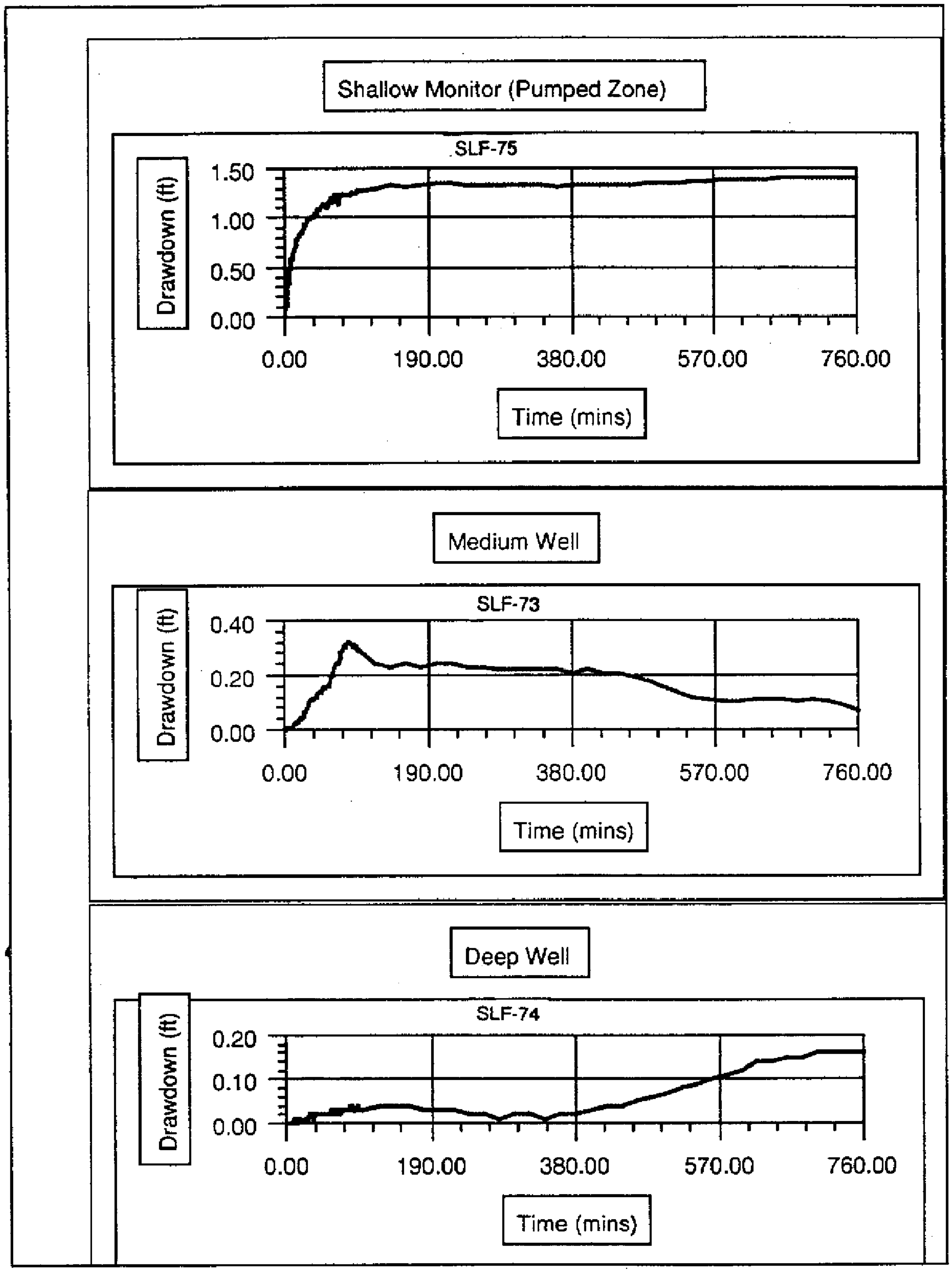


FIGURE 72. **Water-Level Drawdowns in three Floridan Aquifer System Zones (Wells SLF-73, SLF-74 and SLF-75) while Pumping the Shallow Zone (SLF-75)**

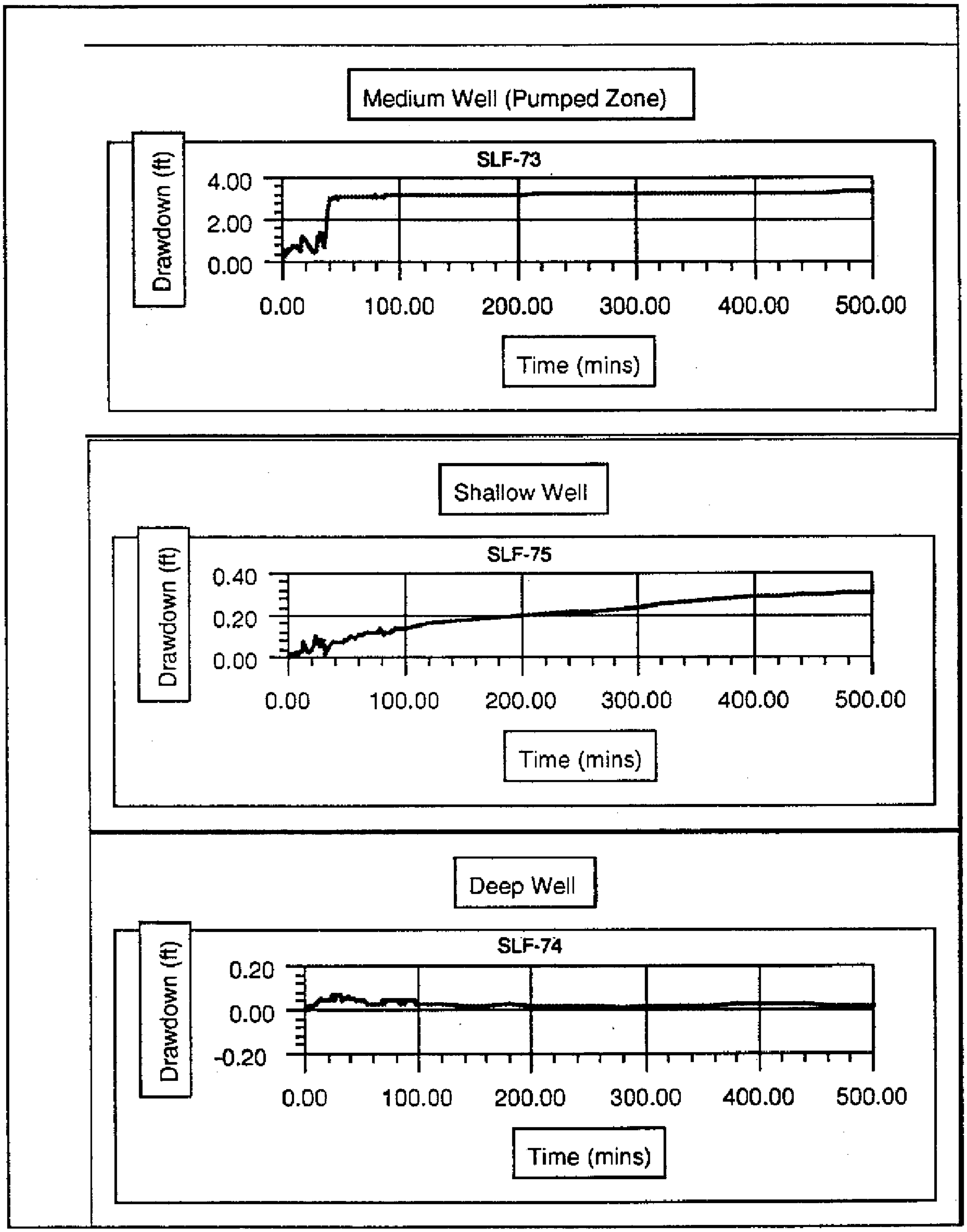


FIGURE 73. **Water-Level Drawdowns in three Floridan Aquifer System Zones (Wells SLF-73, SLF-74 and SLF-75) while Pumping the Middle Zone (SLF-76)**

decreased 0.05 feet almost immediately. After 100 minutes of pumping, it increased back to initial levels. No water samples were taken during this test. It can be concluded that, while pumping the medium zone, the primary source of water supplied via vertical leakance was from the shallow zone, with a minor contribution provided by the deep zone. The leakance value computed from this APT was 0.048/day.

While pumping the deep zone (lower FAS) at a rate of 622 gpm, water-levels in the medium zone decreased almost immediately by 0.13 feet (Figure 74). Then, approximately 100 minutes after pumping began, this water-level gradually increased to initial conditions. At the same time, water-levels in the shallow zone gradually decreased 0.07 feet (after 200 minutes) and stabilized at that level through the remainder of the test. Conductivity and chloride concentrations in water sampled from the deep pumping well appeared to decrease slightly during the course of the test. Twenty-four hours after pumping began, the water character stopped changing with time and equilibrium was attained at 1,777 mg/l Cl^- and 5,630 mmhos/sec specific conductivity. The leakance value calculated was 0.048/day, almost identical to that calculated for the medium zone.

It can be concluded that once steady-state is attained, water-levels in all FAS zones penetrated by these wells respond to the stress of pumping to some degree. The shallow and medium zones within the UFA are better connected hydraulically than the deeper zone (lower LFA) is with the medium zone (UFA).

Regional Distribution of Transmissivity in the Upper Floridan Aquifer

The FAS APTs discussed above were incorporated into an inventory of APT results listed in Table 16. A map showing the locations of the wells in this table is provided in Figure 75. This information was used to generate a regional transmissivity map of the Upper Floridan aquifer (Figure 76).

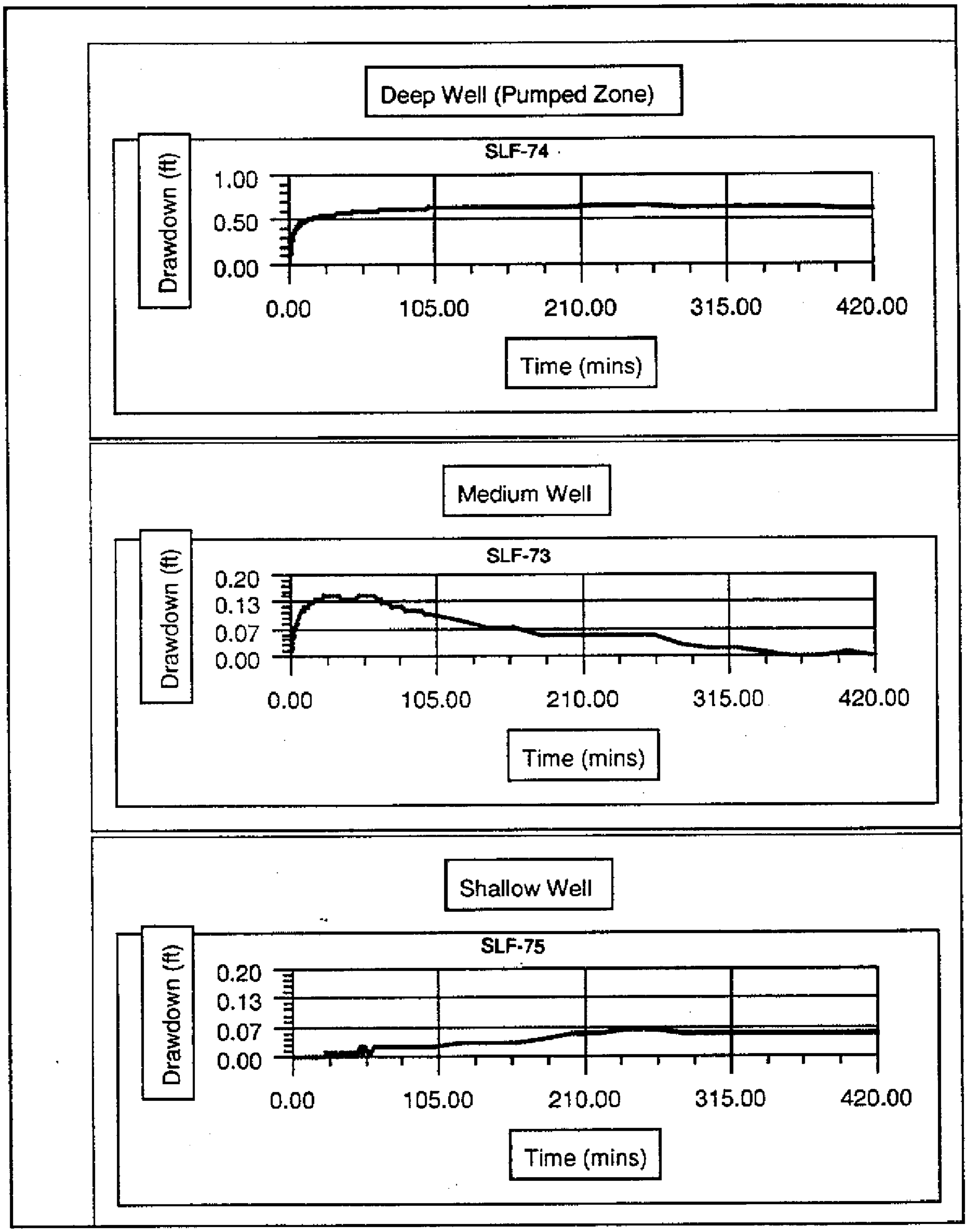


FIGURE 74. **Water-Level Drawdowns in three Floridan Aquifer System Zones (Wells SLF-73, SLF-74 and SLF-75) while Pumping the Deep Zone (SLF-74)**

TABLE 16. Other Aquifer Performance Test Results, Upper Floridan Aquifer, Upper East Coast Planning Area

MAP #	WELL NAME	STATE PLANE COORDINATES (FT)		TOTAL DEPTH (Feet)	CASING DEPTH (Feet)	TRANS-MISSI-VITY (gpd/ft)	ANALYSIS METHOD	STORA-TIVITY (E-4/D)	SOURCE
		X	Y						
1	MF-6*	635487	1027110	1052	400	104900	SR		BROWN, 80-1
2	MF-9*	673410	1030384	880	342	104300	SR		BROWN, 80-1
3	MF-23*	642188	996134	1119	456	73500	SR		BROWN, 80-1
4	OKF-2*	593433	1166945	666	218	153400	SR		BROWN, 80-1
5	OKF-5*	562688	1083782	1181	440	341600	SR		BROWN, 80-1
6	OKF-7*	569511	1102271	963	412	27200	SR		BROWN, 80-1
7	OKF-13*	584276	1155313	1200	600	556000	SR		BROWN, 80-1
8	SLF-4*	667351	1141435	993	482	461700	SR		BROWN, 80-1
9	SLF-9*	632615	1131915	1058	256	531526	SR		BROWN, 80-1
10	SLF-15*	639063	1090535			629200	MR	9.5	BROWN, 80-1
11	SLF-20*	604518	1127187	896	311	81495	SR		BROWN, 80-1
12	SLF-21*	693823	1124791	707	156	49000	SR		BROWN, 80-1
13	SLF-23*	672337	1049363	894	350	106700	SR		BROWN, 80-1
14	SLF-24*	686340	1125563			208500	MR	1.9	BROWN, 80-1
15	SLF-28*	734915	1093704	883	200	24600	SR		BROWN, 80-1

<u>LEGEND FOR METHODS OF ANALYSIS</u>:

WAL: WALTON TYPE CURVE MATCHING, MONITOR WELL AVAILABLE
SR: SINGLE WELL RECOVERY TEST/JACOB STRAIGHT LINE
USGS: USGS WATER INVESTIGATIONS REPORT 88-4073
SC: SPECIFIC CAPACITY FIT TO REGRESSION CURVE
MR: MONITOR WELL RECOVERY TEST/JACOB STRAIGHT LINE
USGS: USGS PROVISIONAL DATA TYPE UNKNOWN; TROST UNPUB.
WALT: WALTON TYPE CURVE MATCHING
*: DENOTES WELLS USED IN REGRESSION ANALYSIS
**: NEWEST DATA USED IN REGRESSION ANALYSIS

TABLE 16. Other Aquifer Performance Test Results, Upper Floridan Aquifer, Upper East Coast Planning Area (Continued)

MAP #	WELL NAME	STATE PLANE COORDINATES (FT)		TOTAL DEPTH (Feet)	CASING DEPTH (Feet)	TRANS-MISSI-VITY (gpd/ft)	ANALYSIS METHOD	STORA-TIVITY (E-4/D)	SOURCE
		X	Y						
16	SLF-51*	662505	1092238	1000	600	107077	WALT	2.7	Wedderburn, 83-7
17	FBW-1**	709923	1130728	904	508	309000	SR		CH2M HILL, 1988
18	GM.IR37F	693717	1184269	745	N/A	50000	USGS	4	Schiner, 1988
19	SJ.IR40F	694252	1185282	704	N/A	56800	USGS	3.9	Schiner, 1988
20	SLF75	659259	1092023	700	480	210000	WALT	2.3	SFWMD, Unpublished
21	SLF76	659259	1092023	860	790	110000	WALT	6.4	SFWMD, Unpublished
22	JUP-R.O.	781929	945861	1500	1073	36890	MR	8	Geraghty & Miller, 1989
23	LFM1-S**	642688	996090	1202	800	94000	WALT	7.0	Ebasco Environ., 1990
24	BRYN MAWR	722002	1162199	1730	640	253	SR		Geraghty & Miller, 1990
25	OKF-26	556377	1081248	825	625	54945	SC		Trost, Unpublished
26	OKF-27	556377	1081248	725	477	51695	SC		Trost, Unpublished
27	FGS-IR202	573587	1190634	700	209	126082	SC		Trost, Unpublished
28	FGS-IR243	695094	1197000	900	220	81666	SC		Trost, Unpublished
29	FGS-IR245	697706	1178129	850	220	100083	SC		Trost, Unpublished
30	FGS-IR251	683885	1189474	700	220	123915	SC		Trost, Unpublished
31	FGS-IR253	675286	1180751	800	220	119582	SC		Trost, Unpublished
32	FGS-M-29	617612	1023723	1100	450	82750	SC		Trost, Unpublished
33	FGS-M-34	664652	984707	1100	450	372713	SC		Trost, Unpublished
34	FGS-M-88	759605	1040536	1180	700	75167	SC		Trost, Unpublished
35	FGS-M-143	711689	1033897	958	272	139804	SC		Trost, Unpublished
36	FGS-M-146	640332	1010264	1155	432	217440	SC		Trost, Unpublished

TABLE 16. Other Aquifer Performance Test Results, Upper Floridan Aquifer, Upper East Coast Planning Area (Continued)

MAP #	WELL NAME	STATE PLANE COORDINATES (FT)		TOTAL DEPTH (Feet)	CASING DEPTH (Feet)	TRANS-MISSI-VITY (gpd/ft)	ANALYSIS METHOD	STORA-TIVITY (E-4/D)	SOURCE
		X	Y						
37	FGS-M-168	641808	1001484	1080	500	183136	SC		Trost, Unpublished
38	FGS-M-443	737038	1039085	951	275	70472	SC		Trost, Unpublished
39	FGS-M-740	733492	995745	990	474	278827	SC		Trost, Unpublished
40	FGS-M-741	727512	998235	890	460	71917	SC		Trost, Unpublished
41	FGS-M-742	729510	996530	1003	460	67945	SC		Trost, Unpublished
42	FGS-M-746	669159	1031881	510	360	103332	SC		Trost, Unpublished
43	FGS-M-748	726237	1032561	773	397	76611	SC		Trost, Unpublished
44	FGS-M-759	676080	1039584	853	650	164719	SC		Trost, Unpublished
45	FGS-M-901	655486	993658	1110	490	91777	SC		Trost, Unpublished
46	FGS-M-909	620247	1018480	1095	470	99360	SC		Trost, Unpublished
47	FGS-M-913	663174	992779	1100	500	93944	SC		Trost, Unpublished
48	FGS-M-919	646966	974744	950	636	176636	SC		Trost, Unpublished
49	FGS-M-920	640226	988554	1033	488	74444	SC		Trost, Unpublished
50	FGS-M-921	638228	991072	1032	455	87444	SC		Trost, Unpublished
51	FGS-M-923	664539	990361	1000	500	155692	SC		Trost, Unpublished
52	FGS-M-927	658408	1032645	792	450	109110	SC		Trost, Unpublished
53	FGS-STL44	680828	1169163	691	125	150637	SC		Trost, Unpublished
54	USGS-M-1	632877	1024072	NA	NA	104700	SC		Trost, Unpublished
55	USGS-M-2	696936	1002924	NA	NA	112200	SC		Trost, Unpublished
56	USGS-STL2	631458	1099699	NA	NA	464000	SC		Trost, Unpublished
57	USGS-STL3	631684	1085563	NA	NA	168000	SC		Trost, Unpublished

TABLE 16. Other Aquifer Performance Test Results, Upper Floridan Aquifer, Upper East Coast Planning Area (Continued)

MAP #	WELL NAME	STATE PLANE COORDINATES (FT)		TOTAL DEPTH (Feet)	CASING DEPTH (Feet)	TRANS-MISSI-VITY (gpd/ft)	ANALYSIS METHOD	STORA-TIVITY (E-4/D)	SOURCE
		X	Y						
58	IR7F	671990	1172961	940	NA	258319	SC		Schiner, 1988
59	IR12F	673781	1175190	900	NA	279472	SC		Schiner, 1988
60	IR20F	643803	1177697		NA	323745	SC		Schiner, 1988
61	IR21F	716332	1178730	943	NA	40508	SC		Schiner, 1988
62	IR26F	606897	1181217	900	NA	284558	SC		Schiner, 1988
63	IR28F	660076	1181596	880	NA	734668	SC		Schiner, 1988
64	IR42F	660240	1185434	836	NA	366662	SC		Schiner, 1988
65	IR47F	669582	1189108	860	NA	149033	SC		Schiner, 1988
66	IR53F	625673	1190764		NA	507890	SC		Schiner, 1988
67	IR54F	682166	1191587	900	NA	344646	SC		Schiner, 1988
68	IR57F	699153	1194798	660	NA	94309	SC		Schiner, 1988
69	IR61F	622778	1196107	960	NA	539193	SC		Schiner, 1988
70	IR64F	616298	1197602	570	NA	238340	SC		Schiner, 1988
71	IR72F	689587	1201215	671	NA	55619	SC		Schiner, 1988
72	IR76F	683379	1201691	750	NA	61336	SC		Schiner, 1988
73	IR77F	674565	1201853	746	NA	86492	SC		Schiner, 1988
74	IR80F	649290	1202367		NA	165091	SC		Schiner, 1988
75	IR84F	573834	1202752		NA	111344	SC		Schiner, 1988
76	IR95F	570407	1208199	960	NA	237501	SC		Schiner, 1988
77	SLF27	657833	1111002	900	300	229062	SC		Trost, Unpublished
78	SLF40	662479	1121219	NA	376	111367	SC		Trost, Unpublished

TABLE 16. Other Aquifer Performance Test Results, Upper Floridan Aquifer, Upper East Coast Planning Area (Continued)

MAP #	WELL NAME	STATE PLANAR COORDINATES (FT)		TOTAL DEPTH (Feet)	CASING DEPTH (Feet)	TRANS-MISSI-VITY (gpd/ft)	ANALYSIS METHOD	STORA-TIVITY (E-4/D)	SOURCE
		X	Y						
79	SLF61	682099	1066875	695	350	61119	SC		Trost, Unpublished
80	SLF62	672318	1075011	935	480	83132	SC		Trost, Unpublished
81	SLF67	611696	1105597	NA	300	107007	SC		Trost, Unpublished
82	SLF69	680591	1101403	NA	300	218429	SC		Trost, Unpublished
83	MF2	661770	1027509	NA	300	94933	SC		Trost, Unpublished
84	IR370	643803	1177697	NA	300	260087	SC		Trost, Unpublished

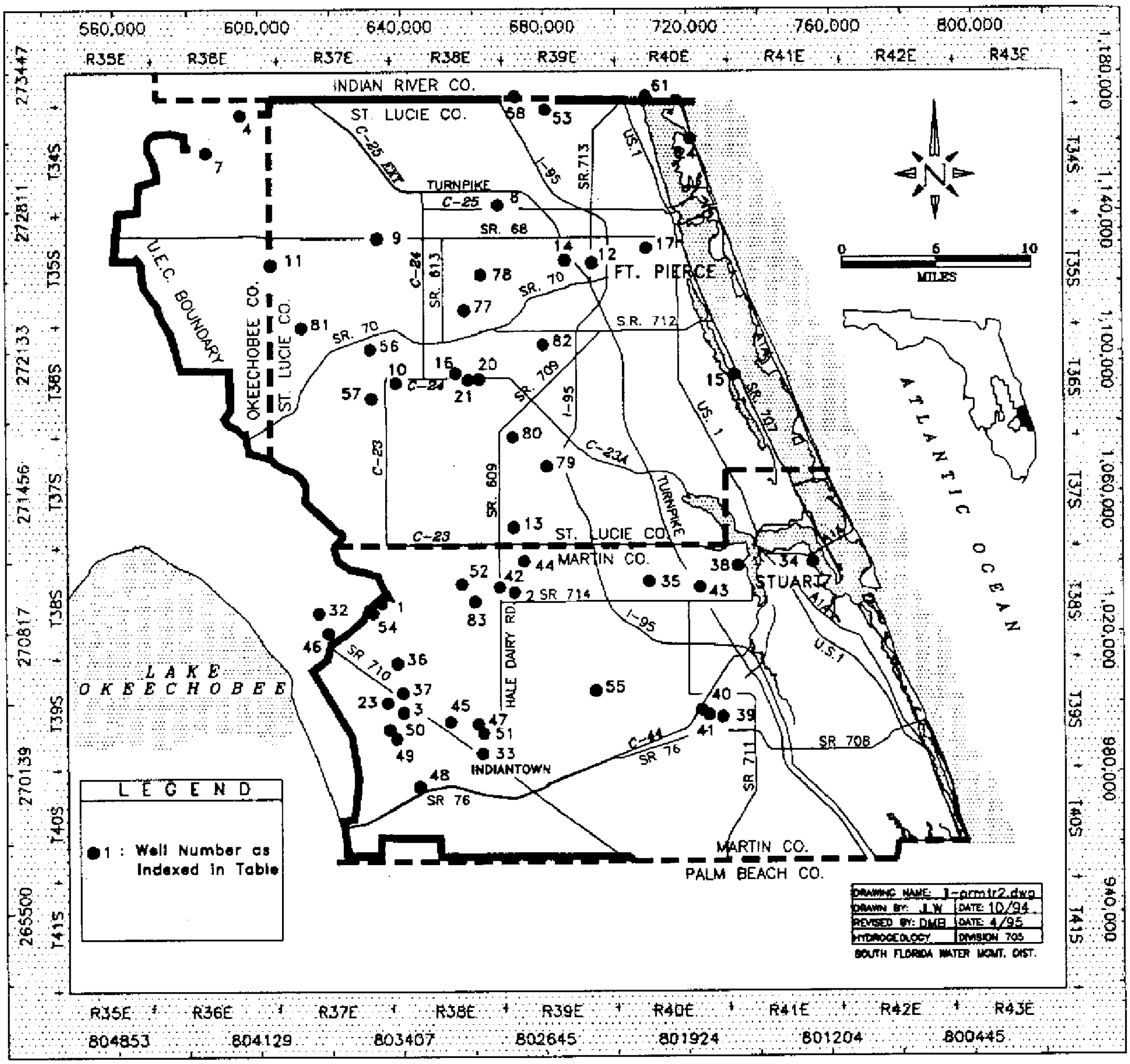


FIGURE 75. **Location Map of Floridan Aquifer System Wells with Transmissivity and Specific Capacity Data**

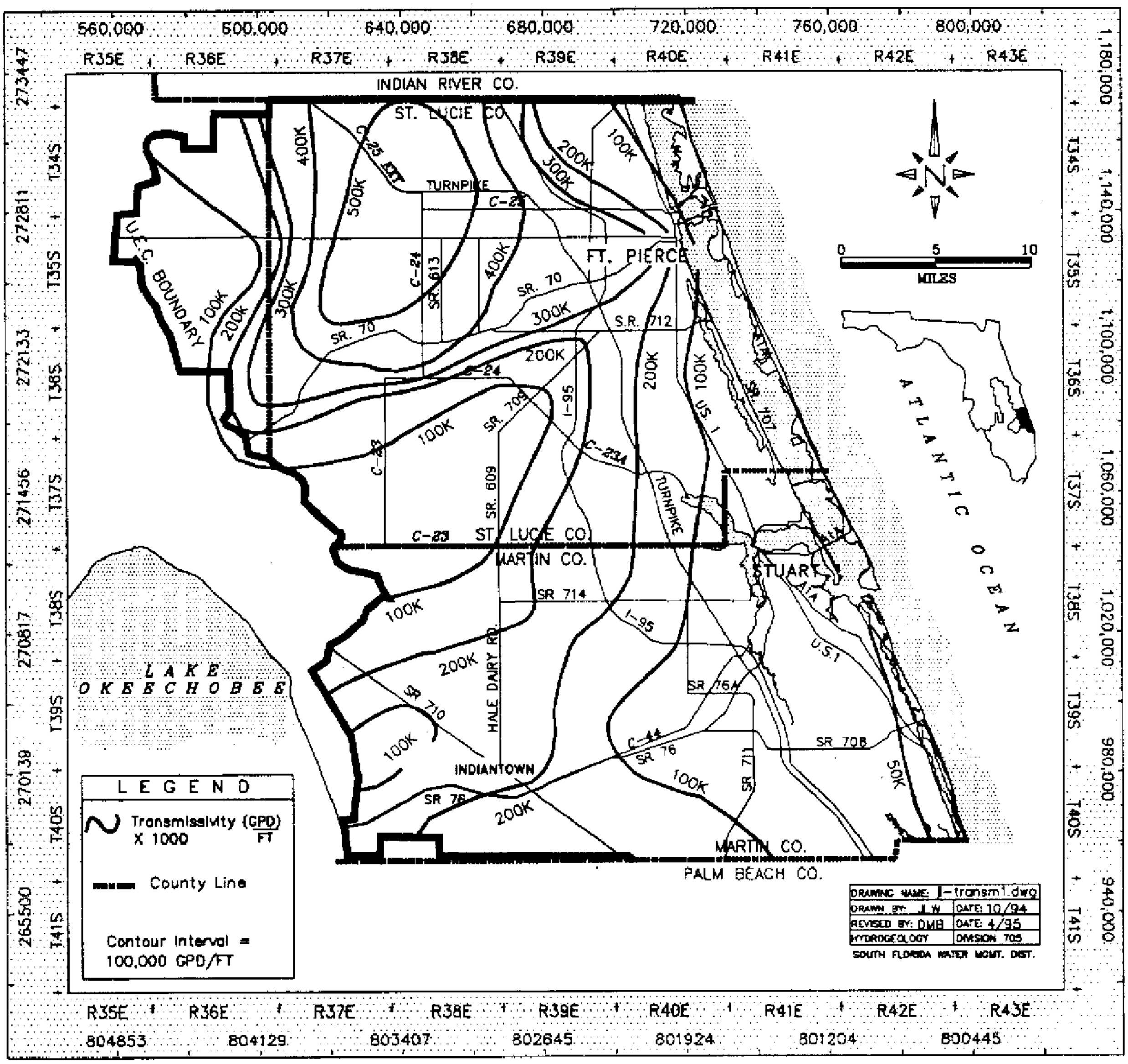


FIGURE 76. Transmissivity of the Upper Floridan Aquifer, Upper East Coast Planning Area

CONCLUSIONS

1. The Surficial Aquifer System is unconfined to semi-confined in the study area and comprised of three hydrogeologic units based primarily on lithology. They are, in descending order, the sand/soil unit, the more permeable production unit, and the less permeable granular limestone unit. Most large capacity wells in the study area are completed in the production zone.

2. Steady-state computed water levels from two SFWMD ground water flow models were used to compare water levels in the three hydrogeologic units, regionally. Those levels were found to be very similar indicating the units are, at least regionally, interconnected. Observed water levels at existing SFWMD APT sites (where wells are completed to each unit) indicate that differences in levels between units exist in some areas on a local scale. These local differences demonstrate that the degree of confinement between them varies aerially.

3. SFWMD staff designed, conducted and analyzed Surficial aquifer performance tests at eight sites in Martin County and four sites in St. Lucie County. In addition, three flow zones in the Floridan aquifer were tested at one site in central St. Lucie County. All tests were conducted to gain additional hydrogeologic data for ground water flow model development. The U.S. Geological Society also conducted aquifer performance tests (in the 1970's) at seven sites in Martin County and five sites in St. Lucie County, the results of which were not previously published. All tests are summarized in this report and include: site locations, well construction details, lithology, geophysical and lithologic logs, and aquifer performance test results and analyses.

4. Although wells were completed to both the sand/soil unit and the production unit at SFWMD APT sites in St.Lucie County, in two cases only the production unit was tested. If the need arises, the sand/soil unit can be tested in the future using existing wells at test sites described in this report.

5. The SFWMD constructed six wells into the upper one-thousand feet of the Floridan Aquifer System at a site in central St. Lucie County. These wells were tested to determine aquifer parameters and water quality from three distinct flow zones: the top of the Ocala Group, top of the Avon Park Formation, and top of the Lower Floridan aquifer. Results of that testing along with lithologic and geophysical logs are presented in this report. Aquifer performance tests demonstrated that the zones had relatively high transmissivities (175,260 gpd/ft to 485,200 gpd/ft). Water levels in all zones were monitored during each of the three aquifer performance tests and were found to decrease (0.1 to 0.3 feet) in response to pumping. These observations indicate that the three zones are hydraulically connected to some degree. For example, while pumping water out of the upper zone at a rate of 640 gpm, steady state water levels decreased 0.3 feet in the middle zone and 0.15 feet in the lower zone.

6. In 1983, the SFWMD installed a continuous water level recorder on an Upper Floridan aquifer well (SLF-50) located in central St. Lucie County. Hydrographs of that well (between 1983-1994) illustrate that water levels stood at their lowest and highest in May 1983 and February 1993, respectively, for the period of record. Further examination of the hydrographs revealed a recurring annual pattern in which water levels were typically highest in October and November and lowest in May. These months correspond to the end of the wet and dry seasons, respectively, and occur in response to agricultural water withdrawals in the area (Lukasiewicz, 1992).

7. Much of the hydrogeologic data used by the SFWMD to develop regional ground water flow models were not published in the model documentations but are now available in this document. This report is provided to augment those model documents and to assist in future model updates. The information presented in this report can also be used to assist future investigators to characterize local hydrogeology within the Upper East Coast Planning Area.

RECOMMENDATIONS

1. Data loggers need to be installed in three Floridan Aquifer System wells (SLF-74, SLF-75, and SLF-76) in St. Lucie County. These wells were designed and constructed by the District in 1990 to obtain hydrogeologic information from three distinct flow zones in the Floridan Aquifer System. Installation of data loggers will provide a temporal record of water levels for each of the three primary flow zones. This data will better enable future modelers to understand the hydrodynamic interactions between these zones of the Floridan Aquifer System. This understanding will help improve and defend assumptions about leakance between model layers made in the current UECPA model of the FAS. In addition, the data must be kept in a central database.

2. The SFWMD currently collects water levels semi-annually from twenty-four Upper Floridan aquifer wells in the UECPA. These levels should be collected monthly since this data will be needed to re-calibrated and/or verify the existing UECPA Floridan Aquifer System flow model over a future time interval. A semi-annual frequency is inadequate since time intervals simulated in the flow model are in months and therefore re-calibration of the flow model over some future time interval would not be impossible.

3. Several existing aquifer performance test sites in St. Lucie County can and should be more thoroughly tested prior to future flow model revisions. Nine wells at two sites (STL-APT2 and STL-APT3) were constructed in the sand/soil unit but that zone was never tested. At one site (STL-APT1), two production wells are required to properly test the intermediate and deep zones, here three monitoring wells are completed in each of these two zones. At a fourth site (STL-APT4), the sand/soil unit was tested and three deeper monitoring wells were constructed. One additional deep production well is needed to complete the original site design and resume testing of the deep zone.

4. Hydrogeologic data such as those presented in this report are the fundamental building blocks of any and all ground water flow models; however, they do not always accompany SFWMD numerical model documents. This occurs primarily because of time constraints placed on model development and the documentation process. Inclusion of these data should be required protocol at the SFWMD for all ground water models developed in the future unless it has been previously published independently. Since the models are used as tools in the planning process at the SFWMD and because (in some cases) rules are implemented based on their results, each model will ultimately be scrutinized by parties adversely impacted by those plans and rules. The fundamental hydrogeologic building blocks of the model need to be clearly communicated and made available to those parties and to the public at large in order for the models to stand up to the test of time. Furthermore, because all models will ultimately be updated, revised, and improved, future investigators need to be able to duplicate and defend the original data-sets and assumptions built into them.

5. The hydrogeology of the Surficial Aquifer System has not been adequately defined in western St. Lucie County (Butler and Padgett, 1995), additional wells and aquifer performance tests are needed in this area to improve assumptions made in the current version of the SAS ground water flow model. This western area is important since a significant amount of ground water recharge to the Surficial Aquifer System originates from the western portion of the county as well as from Okeechobee County. The District is currently compiling a ground water reconnaissance of Okeechobee County. Data from this study should be included in future versions of the St. Lucie County SAS flow model.

6. The SFWMD currently measures water levels monthly in over fifty Surficial Aquifer System wells located in the UECPA. It is vital to continue this monitoring program because it provides the data necessary to verify and improve current ground water flow models.

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