AQUIFER TESTS IN WEST-CENTRAL FLORIDA, 1952-76

By R. M. Wolansky, and M. A. Corral, Jr.

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Factors for converting inch-pound units to International System of Units (SI) and abbreviation of units

Multiply	By	To obtain
	Length	
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Flow	
cubic foot per minute (ft^3/min)	0.02832	cubic meter per minute (m^3/min)
	Transmissivity	
foot squared per day (ft^2/d)	0.0929	meter squared per day (m^2/d)
gallon per day per foot [(gal/d)/ft]	0.0124	meter squared per day (m^2/d)
	Hydraulic conductivity	
foot per day (ft/d)	0.3048	meter per day (m/d)
	Leakance coefficient	
foot per day per foot [(ft/d)/ft]	1.0	meter per day per meter [(m/d)/m]
gallon per day per cubic foot [(gal/d)/ft^3]	0.1337	meter per day per meter [(m/d)/m]
	Specific capacity	
cubic foot per minute per foot [(ft^3/min)/ft]	0.0929	cubic meter per minute per meter [(m^3/min)/m]

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ABSTRACT

The ground-water system in west-central Florida is composed of, in descending order, the surficial aquifer (usually unconfined), intermediate aquifer and confining beds that extend south and east of central Hillsborough and Polk Counties, the Floridan aquifer, and the lower confining bed. Aquifer test data are compiled for 29 aquifer tests performed within the Southwest Florida Water Management District. Selected aquifer test data are analyzed to determine transmissivity, storage coefficient, leakance, and the vertical hydraulic conductivity of the aquifers and confining beds.

Transmissivities obtained from aquifer tests range from 1,900 to 920,000 feet squared per day for the Floridan aquifer, 740 to 7,800 feet squared per day for the intermediate aquifer, and 240 to 600 feet squared per day for the surficial aquifer. Storage coefficients obtained from aquifer tests range from $1.3x10^{-4}$ to $1.5x10^{-3}$ for the Floridan aquifer, $5x10^{-5}$ to $1.7x10^{-4}$ for the intermediate aquifer, and $4x10^{-3}$ to $2.0x10^{-1}$ for the surficial aquifer. The values of leakance obtained from aquifer tests range from $5x10^{-5}$ to $9x10^{-3}$ feet per day per foot for the Floridan aquifer and $2x10^{-4}$ to $7x10^{-4}$ feet per day per foot for the intermediate aquifer.

INTRODUCTION

Aquifer test data have been collected by the U.S. Geological Survey, local government agencies, and private industries within west-central Florida. The results of many tests are included in published reports; however, the data on which the results are based are not readily available. The purpose of this report is to present a compilation of selected data and to provide a probable range of hydraulic characteristics of aquifers in west-central Florida. The study area includes all of the Southwest Florida Water Management District, an area of about 10,000 mi^2 (fig. 1).

Where warranted by the data, analyses herein have been made to obtain a probable range of values of transmissivity, storage coefficient, and leakance for the three major aquifers (surficial, intermediate, and Floridan) in west-central Florida. Analyses of tests that provide ambiguous results are not included in this report.

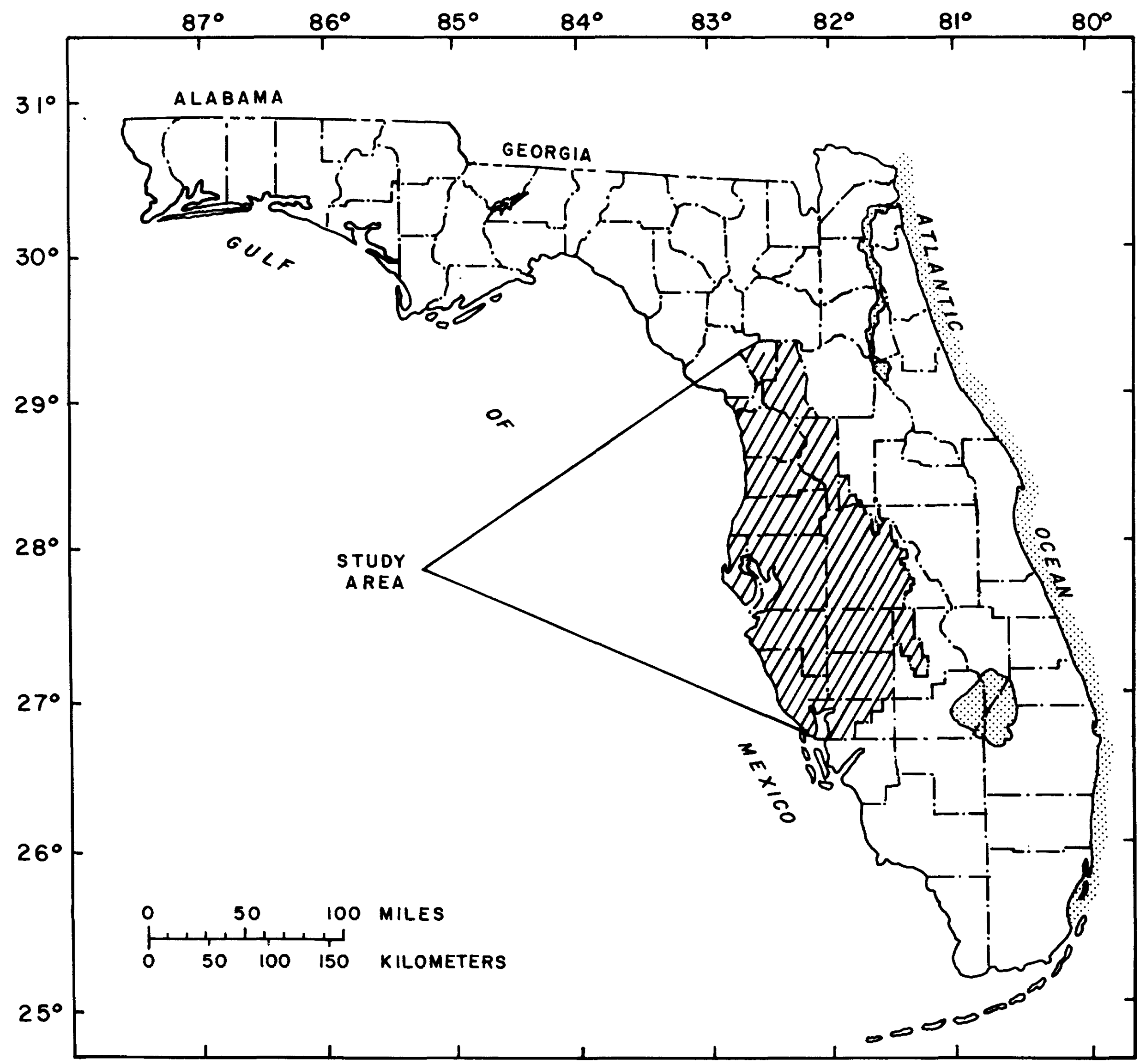

Figure 1.--Location of study area.

Much of the data in this report were collected by U.S. Geological Survey personnel; additional data were furnished by other government agencies whose efforts are gratefully acknowledged.

PREVIOUS INVESTIGATIONS

Numerous reports on the hydrology and geology in the area have been published. Stringfield (1936; 1966) described the stratigraphy and occurrence of ground water in Florida. Parker and others (1955) described the Floridan aquifer in a water-resources report for southeastern Florida. Wetterhall (1964) described zones of variable hydraulic conductivity in the Floridan aquifer for Pasco and Hernando Counties.

Geology and the results of aquifer tests have been described for Manatee and southwest Hillsborough Counties (Peek, 1958; 1959); Hillsborough County (Menke and others, 1961); Polk County (Stewart, 1966); northwest Hillsborough, northeast Pinellas, and southwest Pasco Counties (Stewart, 1968); and the Tampa area (Motz, 1975). Bredehoeft and others (1965) described an aquifer test of the Floridan aquifer in northwest Hillsborough County.

A detailed investigation of the geology and ground water of the Green Swamp area of Polk, Lake, and Sumter Counties (Pride and others, 1966) included results of aquifer and laboratory tests of the surficial and Floridan aquifers. A report by Cherry and others (1970) describes the geology and results of aquifer tests for the Floridan aquifer and laboratory tests for the surficial aquifer. Specially designed aquifer tests along the proposed Cross-Florida Barge Canal (Marion County) were conducted (Tibbals, 1975) to evaluate the exchange of water between the aquifer and the canal.

GEOHYDROLOGIC SETTING

The availability of good quality ground water in required quantities in the west-central Florida area is related in part to the area's geologic units. Marine sediments that range in thickness from about 4,000 to 16,000 feet underlie the area. Of these sediments, approximately the top 1,000 feet are utilized for water supply. Tables 1 and 2 and figure 2 describe the geologic and hydrologic units from the undifferentiated sediments (Holocene) to the Lake City Limestone (middle Eocene). The components of the ground-water system are the surficial (usually unconfined) aquifer, intermediate aquifer and confining beds, Floridan aquifer (Parker and others, 1955, p. 189), and lower confining bed (table 2).

The surficial aquifer occurs throughout west-central Florida with the exception of parts of the northeast section where it is very thin or absent. Normally, the aquifer is composed of undifferentiated sediments that consist of fine to medium sand and clayey sand, increasing in clay content with depth. In some areas, beds of shell, shelly marl, and limestone constitute the aquifer. The aquifer has an average thickness of about 30 feet.

Table 1.--Generalized stratigraphic section and description, west-central Florida

Hydrologic unit	Series	Stratigraphic unit	Areal and vertical extent: SWFWMD counties in which unit is present	Areal and vertical extent: Thickness (feet)	Lithology
Surficial aquifer	Holocene	Undifferentiated sediments	All SWFWMD counties.	0-100	Nonmarine; light gray to yellow, fine- to medium-grained quartz sand; underlain by marine terrace deposits of sand, marl, including clay, shell, and peat deposits.
Surficial aquifer	Pleistocene and Pliocene	Caloosahatchee Marl	Southeast Sarasota, southeast De Soto, and northern Charlotte Counties.	0-50	Shallow marine; gray, tan, or cream, unconsolidated sandy marl, marl and shell beds, hard sandy limestone; some phosphate.
Intermediate aquifer	Pliocene	Bone Valley Formation	Southeast Hillsborough, central and southwest Polk, eastern Manatee, Hardee, northeast Sarasota, and northwest De Soto Counties.	0-40	Mostly nonmarine; very light gray to gray, clayey sand and sandy clay, with lens-like beds of light gray, fine- to medium-grained quartz sand, with a considerable amount of land vertebrate fossil fragments, and phosphate nodules, and quartz pebbles.
Intermediate aquifer		Alachua Formation[1/]	Northeast Levy, southwest Marion, central Citrus, southwest Sumter, and northeast Hernando Counties.	0-100	Nonmarine; interbedded deposits of gray to greenish-blue, sandy clay and clayey sand; gray, medium to coarse, quartz sand, with a considerable amount of land vertebrate fossil fragments and phosphorite.
Intermediate aquifer	Lower Pliocene	Tamiami Formation	Southern De Soto and Charlotte Counties.	0-250	Marine; interbedded layers of buff, sandy, clayey, phosphatic limestone and dolomite; gray, fine to medium sand, gray to greenish-blue sandy clay, with abundant phosphate nodules.
Intermediate aquifer	Middle Miocene	Hawthorn Formation	Northeast Marion, southeast Citrus, southwest Sumter, Lake, northeast Pasco, Pinellas, southeast Hillsborough, Polk, Manatee, Hardee, Sarasota, De Soto, and Charlotte Counties.	0-400	Marine; interbedded layers of buff, sandy, clayey, phosphatic limestones and dolomites; gray, fine to medium sand, gray to greenish-blue sandy clay, with abundant phosphate nodules.
Floridan aquifer	Lower Miocene	Tampa Limestone	Southwest and northwest Pasco, Pinellas, Hillsborough, Polk, Manatee, Hardee, Sarasota, De Soto, and Charlotte Counties.	0-450	Marine; white to light gray, sandy, often phosphatic, silicified in part, clayey limestone, with many molds of pelecypods and gastropods; the limestone is often interbedded with beds of light gray clay and sandy clay, and with a residual mantle of green to greenish-blue calcareous clay.
Floridan aquifer	Oligocene	Suwannee Limestone	Southeast Citrus, southern Sumter, southwest Lake, Pasco, Pinellas, Hillsborough, Polk, Manatee, Hardee, Sarasota, De Soto, and Charlotte Counties.	0-450	Marine; cream to buff, often soft, granular limestone composed of loosely cemented foraminifers.
Floridan aquifer	Upper Eocene	Ocala Limestone	All SWFWMD counties.	100-300	Marine; white to cream, often soft and finely granular, very pure limestone, grading into less pure tan limestone near the bottom with beds of grayish brown dolomite.
Floridan aquifer	Middle Eocene	Avon Park Limestone	All SWFWMD counties.	200-1,000	Marine; cream to tan, soft to hard, granular to chalky, highly fossiliferous limestone interbedded with grayish brown to dark brown, highly fractured dolomite; carbonaceous and clayey zones are found along with some gypsum and anhydrite near the bottom.
Lower confining bed		Lake City Limestone	All SWFWMD counties.	300-500	Marine; cream to tan, slightly carbonaceous and cherty limestone, and grayish to dark brown dolomite; both with varying amounts of gypsum and anhydrite.

1/ Alachua Formation occurs only in the northern part of the study area and is not part of the intermediate aquifer.

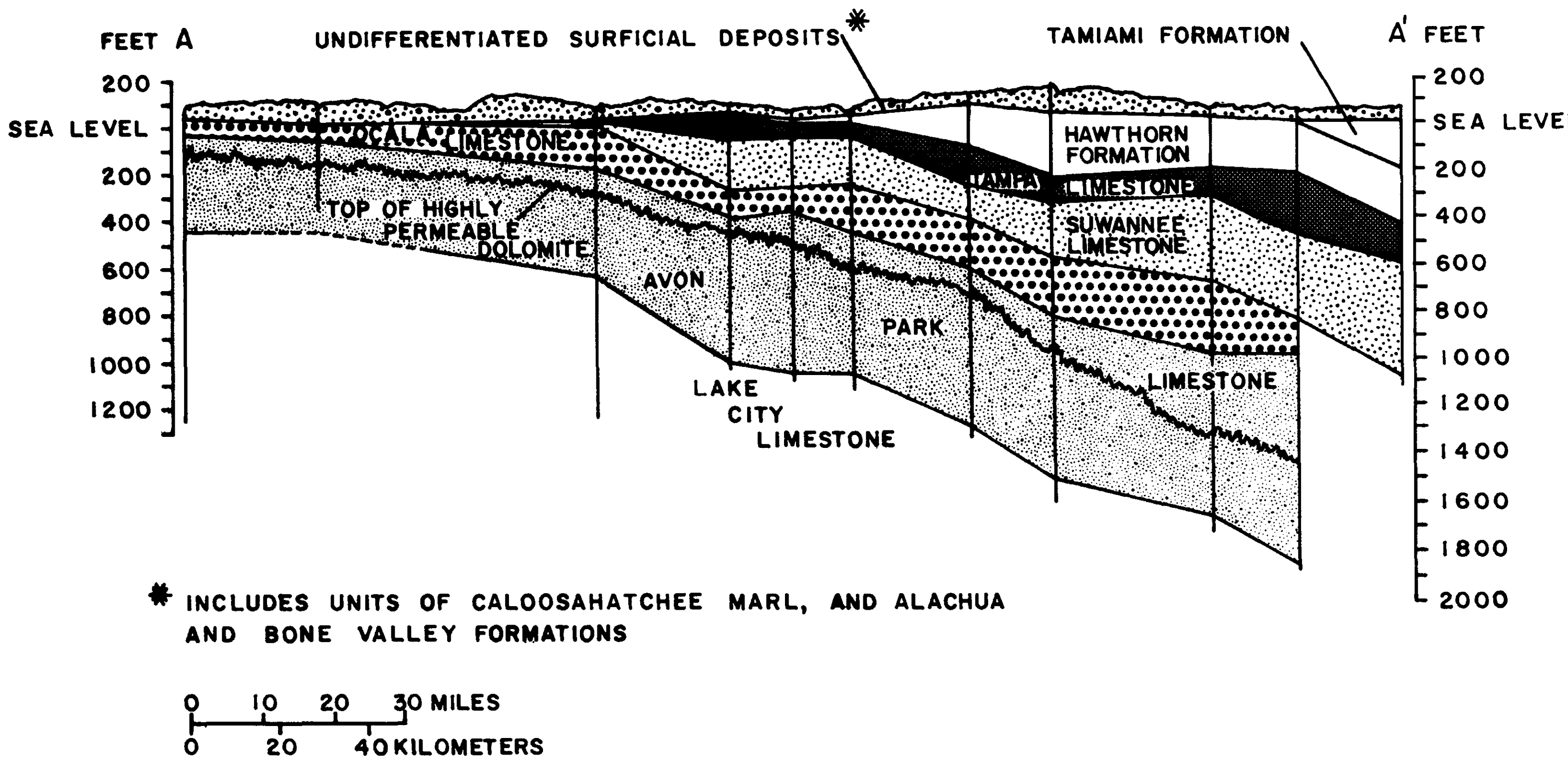

Figure 2.--Generalized geologic section showing formations and lithology penetrated by wells in west-central Florida. (Line of section is shown in figure 11.)

Table 2.--Probable range of well and aquifer characteristics for wells

Hydrologic unit	Equivalent stratigraphic unit	Approximate thickness (feet)	Yields of wells (gal/min)
Surficial aquifer	Undifferentiated sediments and units of Caloosahatchee Marl and Alachua and Bone Valley Formations.	0-100	5-750
Confining bed (northern section)	Units of undifferentiated sediments and Alachua and Hawthorn Formations.	0-50	--
Intermediate aquifers	Units of Caloosahatchee Marl, Tamiami and Hawthorn Formations, and Tampa Limestone.	0-400	10-300
Intermediate confining beds	Units of Caloosahatchee Marl; Bone Valley, Tamiami, and Hawthorn Formations; and Tampa Limestone.	0-200	--
Floridan aquifer	Units of Tampa Limestone, Suwannee Limestone, Ocala Limestone, Avon Park Limestone, and Lake City Limestone.	700-1,600	500->5,000
Relatively impermeable confining bed	Units of Lake City Limestone.	--	--

1/ Unit for specific storage is $feet^{-1}$.

From northern Hillsborough and Polk Counties southward to the southern boundary of the study area, the Floridan aquifer is separated from the surficial aquifer by the intermediate aquifer. The intermediate aquifer is comprised of one to three aquifer units, overlain and underlain by confining beds. The aquifer consists of interbedded sandy and phosphatic limestone, marls and clays, and lenses of sand of the Caloosahatchee Marl, the Tamiami and Hawthorn Formations, and the Tampa Limestone. The confining beds of the aquifer are composed of clay, sandy to marly clay, and clayey sand of these formations (Corral and Wolansky, 1984). The aquifer ranges from zero to 600 feet thick.

In the northern part of the study area where the intermediate aquifer is absent, the confining bed that separates the surficial aquifer from the Floridan aquifer is composed of sandy clay, clay, and marl that range from zero to 50 feet thick. In the northwestern section of the study area, the beds are very thin or absent, and in parts of the northeastern section, the beds are breached by lakes penetrating large sections of the aquifers in west-central Florida

Specific capacity [(gal/min)/ft]	Aquifer characteristics			
	Transmissivity (ft^2/d)	Storage coefficient	Vertical hydraulic conductivity (ft/d)	Leakance [(ft/d)/ft]
1-40	100-10,000	0.004-0.25		
--	--	Specific storage[1/] $1x10^{-5}$-$1x10^{-4}$	$1x10^{-4}$-$1x10^{-3}$	
1-25	100->5,000	$5x10^{-5}$-$3x10^{-4}$	$1x10^{-3}$-10	$1x10^{-4}$-$1x10^{-3}$
--	--	Specific storage[1/] $1x10^{-5}$-$1x10^{-4}$	$1x10^{-4}$-$1x10^{-3}$	
40->2,500	2,000->800,000	$5x10^{-4}$-$2x10^{-3}$	$1x10^{-2}$-100	$1x10^{-6}$->$1x10^{-3}$
--	--	--	$1x10^{-5}$-$1x10^{-3}$	

and sinkholes. In the northern section, the confining bed is composed of undifferentiated sediments, the Alachua and Hawthorn Formations, and the Tampa Limestone. Throughout the study area, the confining bed overlying the Floridan aquifer is generally composed of clay that increases in purity with depth until a relatively pure clay overlies a weathered limestone at the contact.

Beds of limestone and dolomite that average about 1,000 feet in thickness comprise the Floridan aquifer. The aquifer consists of vertically persistent limestone and dolomite that include part or all of the following formations in ascending order: Lake City Limestone, Avon Park Limestone, Ocala Limestone, Suwannee Limestone, and Tampa Limestone (table 1 and fig. 2). A highly permeable dolomite stratum is generally located near the top of the Avon Park Limestone and is areally persistent throughout most of west-central Florida (Wolansky and others, 1980). Less areally persistent permeable zones occur locally at formational contacts. The Floridan aquifer is confined except in northern portions of west-central Florida.

Relatively impermeable units of the Lake City Limestone generally form the base of the Floridan aquifer in the study area. The impermeability is due to the intergranular anhydrite and gypsum within the limestone-dolomite sequence.

HYDRAULIC PROPERTIES OF AQUIFERS

The quantity of water that an aquifer will yield to wells is dependent upon the hydraulic characteristics of the aquifer and its overlying and underlying confining beds. The principal characteristics are: transmissivity (the ability of the aquifer to transmit water), storage coefficient (the ability of the aquifer to store water), and leakance (the ability of the confining beds to transmit water vertically from an underlying or overlying source). Transmissivity (T), expressed in feet squared per day, is the rate at which water of the prevailing kinematic viscosity is transmitted through a unit width of an aquifer under a unit hydraulic gradient. Storage coefficient (S), dimensionless, is the volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head.

Leakance is defined by Hantush (1964, p. 334) as the rate of flow that crosses a unit area of the interface between the main aquifer and its semiconfining bed if the difference between the head in the main aquifer and the source supplying leakage is unity. Leakance equals K'/b' where K' and b' express, respectively, the vertical hydraulic conductivity and the thickness of the confining bed through which leakage occurs. Leakance units are in foot cubed per day per foot squared per foot $[(ft^3/d)/ft^2]/ft$ and are commonly simplified to foot per day per foot [(ft/d)/ft].

Table 2 presents the probable range of well and aquifer characteristics reported for aquifers in west-central Florida. Aquifer characteristics determined from aquifer tests that fall outside the reported range should be given careful consideration as to their validity.

METHODS OF ANALYZING AQUIFER TESTS

Analytical methods that were applicable to the analysis of aquifer tests in this report are briefly described in the following section. The methods are the Theis (1935) nonequilibrium, nonleaky aquifer; Cooper and Jacob (1946) modified nonequilibrium method; Hantush and Jacob (1955) nonsteady-state, leaky aquifer; Neuman and Witherspoon (1972) ratio method; Boulton (1963) method for analyzing delayed yield from storage under water-table conditions; Hantush (1966) anisotropic method; and Hantush (1964) partially penetrating, leaky method.

Early time-drawdown data from tests of aquifers that are not anisotropic or partially penetrated can generally be analyzed by the nonequilibrium or modified nonequilibrium nonleaky-aquifer methods, particularly if the leakance is not large and the observation wells are not too distant. The assumption is that leakage has not affected drawdown or has not affected it enough to make the nonleaky-aquifer methods inapplicable.

Late time-drawdown data can generally be analyzed by the nonsteady-state, leaky-aquifer method. This method does not take into account confiningbed storage; however, in much of west-central Florida, the confining bed is thin or discontinuous. It is therefore assumed that confining-bed storage has a minimal effect on most aquifer tests. Although not shown in the report, all tests analyzed by the nonsteady-state, leaky-aquifer method were also analyzed by the steady-state, leaky-aquifer method. The latter method assumes that steady state had been attained. However, the method can be used to verify the nonsteady-state analysis if only a quasi-steady-state had been reached.

Aquifer tests in areas where the confining bed is known to be thick were evaluated to determine whether the modified leaky method that accounts for water released from storage in the confining bed was applicable. These tests finally were analyzed by the nonequilibrium, nonleaky methods because the drawdown data fit the Theis curve. Unless data were available from several observation wells at different distances from the pumping well, it would be difficult to prove that the modified leaky method was applicable because the tests generally utilized observation wells that were less than 1,000 feet from the pumping well and were in areas of high transmissivity. Therefore, any departure of a single drawdown curve from the nonleaky (Theis) curve would be slight and could be attributed to inability to correct for regional water-level changes or effects of partial penetration.

The ratio method was utilized to determine the vertical hydraulic diffusivity of the confining bed in tests where a confining-bed well was measured. None of the tests were designed to make use of the ratio method. However, the vertical hydraulic diffusivities obtained from these tests are considered to be plausible. If the specific storage and thickness of the confining bed can be estimated with some confidence, the vertical hydraulic conductivity and leakance can be estimated from the calculated diffusivity. The vertical hydraulic conductivity obtained from the ratio method is a point value. If the confining bed varies in thickness or is absent in parts of the test area, leakance obtained from a point may not be representative.

The Boulton method was used to analyze surficial aquifer tests. Because the surficial aquifer is usually stratified and composed of fine sediments, the early time-drawdown data often match the nonleaky Theis curve. This indicates that water is released instantaneously from storage by compaction of the aquifer and expansion of the water. Late in the pumping test, specific yield attains an almost constant value, and drawdown data match the nonequilibrium curve at a point that gives a water-table storage coefficient.

It is assumed that only one answer exists for each parameter to be quantified; therefore, only a single value of transmissivity, storage coefficient, and leakance is reported for each test. The tables preceding each test show values for only those observation wells that contributed to the test answer. For the few tests that have a range of leakance values reported, the range is relatively small and is the best that can be obtained from the data.

Aquifer tests that exhibited an eliptically shaped equal drawdown curve were analyzed utilizing the anisotropic method. An eliptically shaped drawdown curve usually indicates that the aquifer is anisotropic in the horizontal plane. The method yields the transmissivity in the major and minor direction of anisotropy in addition to the storage coefficient and leakance of the aquifer.

Aquifer tests with wells that partially penetrate the aquifer were analyzed utilizing the partial-penetration method. Partial penetration causes vertical-flow gradients near the wells and makes analytic methods for fully penetrating wells nonapplicable.

Many of the tests are open to alternative interpretations because, in some tests, hydrologic conditions were less than ideal. Observation and pumping wells may not have been optimally spaced or wells may not have penetrated the same producing horizons. During a test, there may have been regional water-level changes, barometric changes, or interference from other pumping wells. Also, the well discharge may not have been constant or water-level measurements may have been inaccurate. Where the aquifer is stratified, the observation wells may not have been far enough from the pumping well that stratification did not affect the drawdown distributions. Nevertheless, the analyses provide a probable range for the hydraulic characteristics of the aquifers.

Theis Nonequilibrium Method

The nonequilibrium, nonleaky formula was derived by Theis (1935) from the analogy between the hydraulic conditions in an aquifer and the thermal conditions in an analogous thermal system. It is based upon the following assumptions: (1) the aquifer is homogeneous and isotropic, (2) the aquifer has infinite areal extent, (3) the aquifer is bounded above and below by impervious layers, (4) transmissivity and storage coefficient are constant at all times and all places, (5) the discharge well penetrates and receives water from the entire thickness of the aquifer and pumps water at a constant rate, (6) the well has a reasonably small diameter so that well-bore storage can be ignored, and (7) water removed from storage is discharged instantaneously with decline in head. The above assumptions appear to be very restrictive, and in fact, the first four are never fully met and seldom closely approached. Nevertheless, the Theis nonequilibrium formula has been applied successfully to many ground-water flow problems.

The nonequilibrium formula in consistent-unit form is

$$s = \frac{Q}{4\pi T} \int_{r^2S/4Tt}^{\infty} \frac{e^{-u}}{u} \, du \qquad (1)$$

where the integral expression is known as the well function of u, W(u), and where:

$u = r^2S/4Tt$ (dimensionless),

s = drawdown at a point in the vicinity of a discharge well (feet),

Q = discharge of well (cubic feet per day),

T = transmissivity (square feet per day),

r = distance from discharging well to observation point (feet),

S = coefficient of storage, expressed as a decimal fraction,

t = time since pumping started (days).

The nonequilibrium formula in its simplest form is

$$T = \frac{Q}{4\pi s} W(u) \qquad (2)$$

$$S = \frac{4Tut}{r^2} \qquad (3)$$

where W(u) represents the integral referred to in the mathematical literature as the "exponential integral." It can not be integrated directly, but its value is given by the series

$$W(u) = [-0.577216 - \ln u + u - \frac{u^2}{2.2!} + \frac{u^3}{3.3!} - \frac{u^4}{4.4!} + ...] \qquad (4)$$

Values of W(u) for values of u from 10^{-15} to 9.9 are tabulated in Lohman (1972, p. 16). Analysis by the nonequilibrium method usually employs a nonleaky artesian "type curve" (fig. 3) obtained by plotting values of u, or more commonly 1/u, against corresponding values of W(u) on logarithmic paper.

Values of drawdown (s) are plotted against t/r^2 for an observation well (at a known distance r) on logarithmic tracing paper that has the same scale as used to plot the nonleaky type curve. The shape of the plot of the observed data should be similar to that of the nonleaky type curve. The data curve may then be superimposed on the nonleaky type curve with the coordinate axis of the two curves held parallel and then translated to a position that represents the best fit of the field data to the nonleaky type curve. A match point is selected on the overlapping portion of the curves, preferably at a point where the "type curve" coordinates both equal 1, and the coordinates of this common point on the nonleaky type curve and data plot are recorded. These data are then used in equations 2 and 3 to solve for T and S. Figure 4 is an example of plotted field data with a match point indicated and gives sample calculations for solution by the nonequilibrium Theis method.

Cooper and Jacob Modified Nonequilibrium Method

Cooper and Jacob (1946) found that for values of u less than approximately 0.02 (generally small values of r, large values of t, or both), the sum of the terms beyond ln u in equation 4 are not significant. Therefore, equation 2 may be closely approximated by

$$s = \frac{Q}{4\pi T} (-0.577216 - \ln u). \qquad (5)$$

Equation 5 can be applied to measurements of drawdown (or recovery) changes in a particular observation well thusly by converting to common logarithms

$$T = \frac{2.30\ Q(\log_{10} t_2/t_1)}{4\pi(s_2 - s_1)} = \frac{2.30\ Q}{4\pi\ \Delta s} \qquad (6)$$

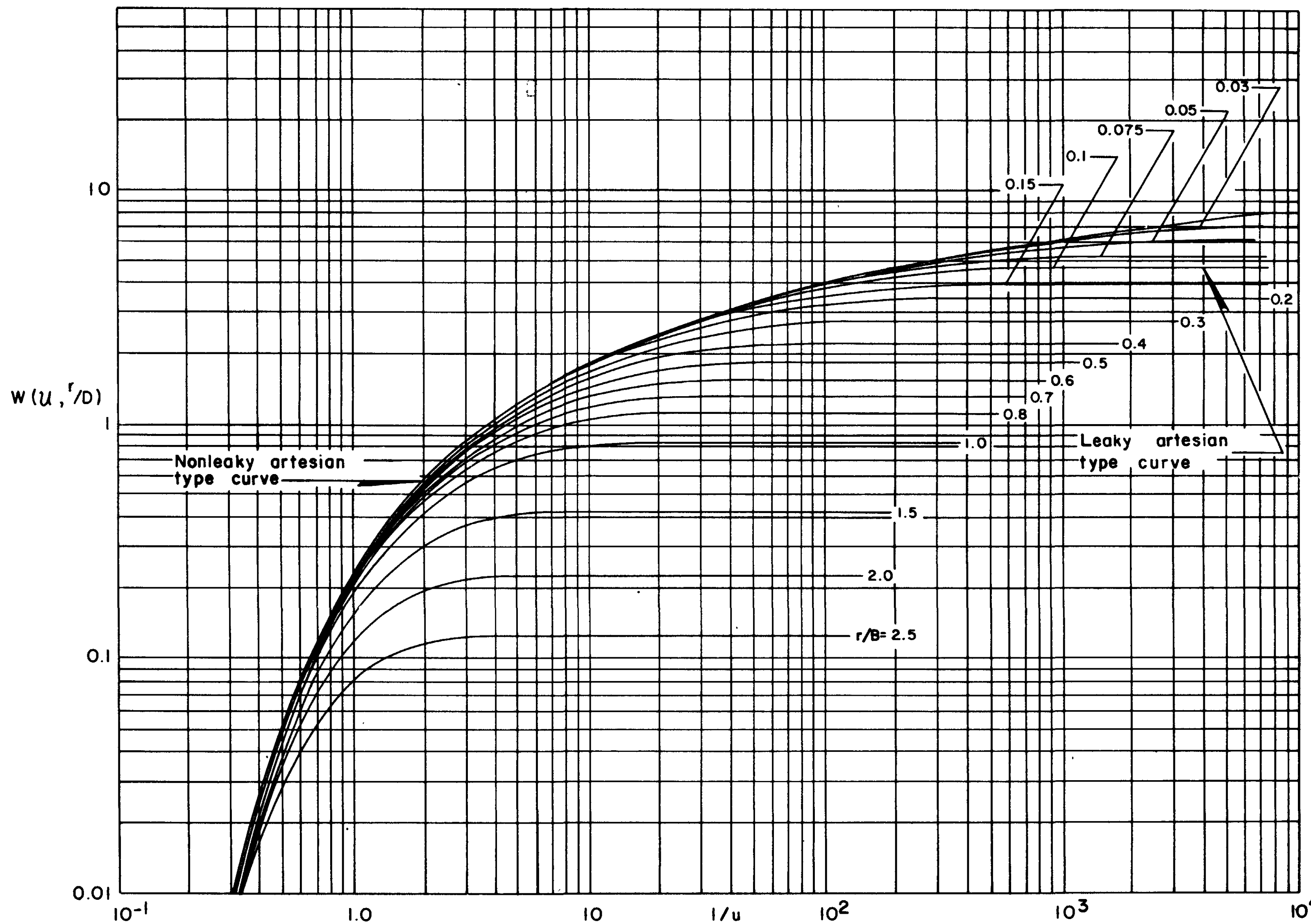

Figure 3.--Constant discharge type curves for nonleaky and leaky artesian aquifers without water being released from storage in confining beds.

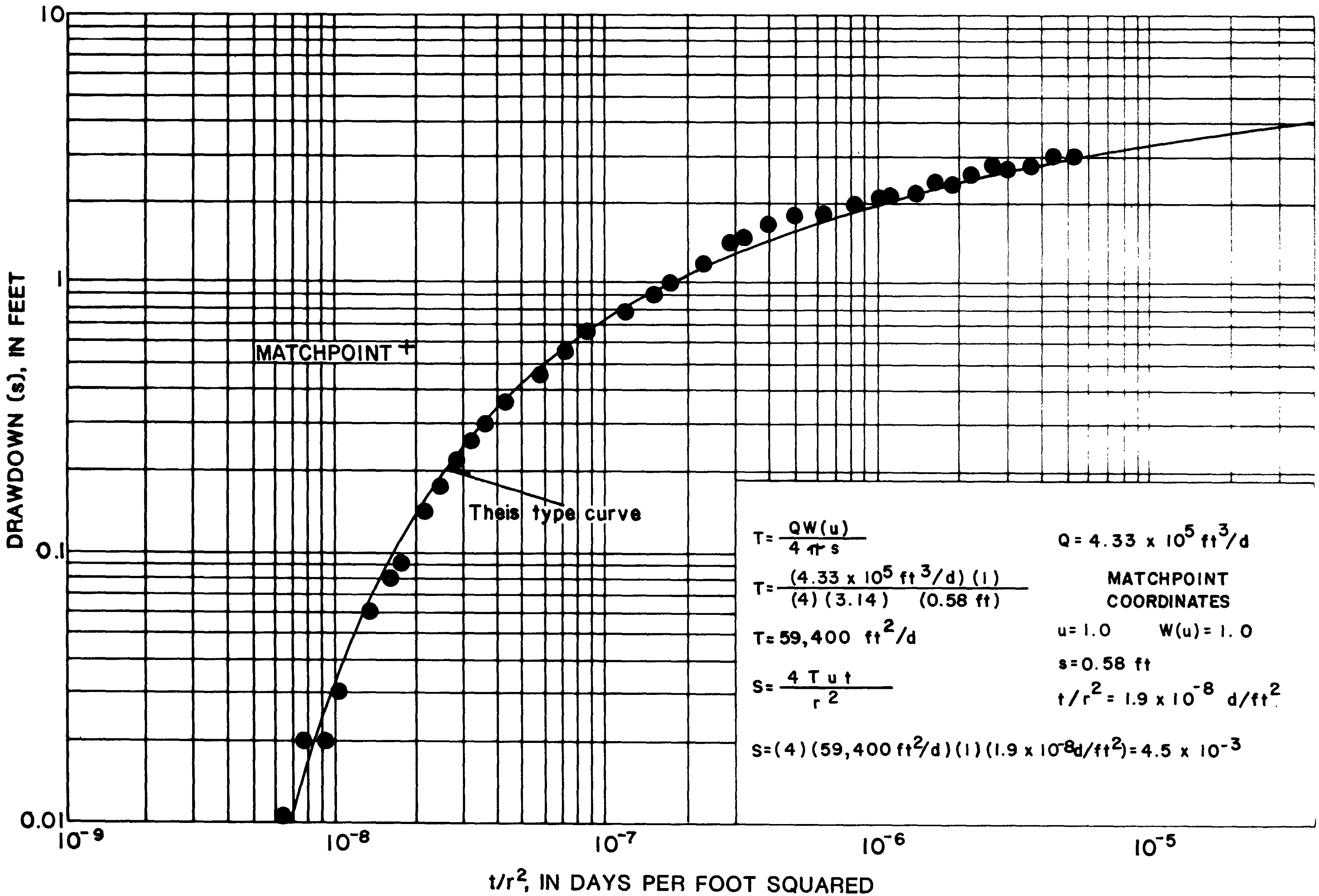

Figure 4.--Example of data plotted for analysis by the Theis nonequilibrium method.

where T and Q are as previously defined; drawdowns s_1 and s_2 are from the straight-line plot of s versus log t at times t_1 and t_2, respectively; and Δs is the drawdown or recovery in feet over one log cycle of time (t) in days.

The data from an observation well are plotted on semilogarithmic coordinate paper, plotting elapsed pumping time (t) on the logarithmic scale and drawdown (s) on the arithmetic scale. Values for u are determined by substituting actual values of S, T, t, and r in the equation $u = r^2S/4Tt$ to determine if straight-line plot is valid for actual time data used. After time becomes great and the values of u become small, the observed data should approximate a straight line for the time values used. From the straight line, the change in drawdown (Δs) over one log cycle is determined, and equation 6 can be solved for T.

When (s) = 0, equation 5 may be reduced to

$$S = \frac{2.25T\ t_o}{r^2} \qquad (7)$$

where S, T, and r are as previously defined and t_o is the time intercept of the fitted straight line on the zero drawdown axis, in days. Therefore, the coefficient of storage (S) can be determined from the same semilog plot of observed data that T was determined from by extrapolating the plotted straight line back to the zero drawdown intercept to obtain t_o and solving equation 7 for S (fig. 5).

Hantush and Jacob Nonsteady-State, Leaky Method

Hantush and Jacob (1955) found that, in addition to the transmissivity and coefficient of storage of a leaky artesian aquifer, the leakance can be determined by superimposing a plot of time versus drawdown on a family of type curves. The above method incorporates the assumptions of the Theis method except that assumption 3 is deleted and the following four assumptions are added: (8) flow in the aquifer is augmented by vertical leakage through the confining beds, (9) the flow lines are assumed to be refracted at a full right angle as they cross the confining bed and aquifer interface, (10) the confining beds are assumed to be incompressible so that water released from storage therein is negligible, and (11) the heads above an overlying confining bed and below an underlying confining bed are not influenced by the pumping.

The equation for nonsteady radial flow in an infinite leaky confined aquifer is

$$s = \frac{Q}{4\pi T} \int_u^\infty \frac{1}{y} \exp\left(-y - \frac{r^2}{4B^2y}\right) dy \qquad (8)$$

where s, T, S, Q, u, and r are as previously defined, y = the variable of integration, and $B = \sqrt{T/(K'/b')}$. If the integral in equation 8 is expressed symbolically as W(u,r/B), the equation may be rewritten as:

$$T = \frac{Q}{4\pi s}\ W(u,r/B). \qquad (9)$$

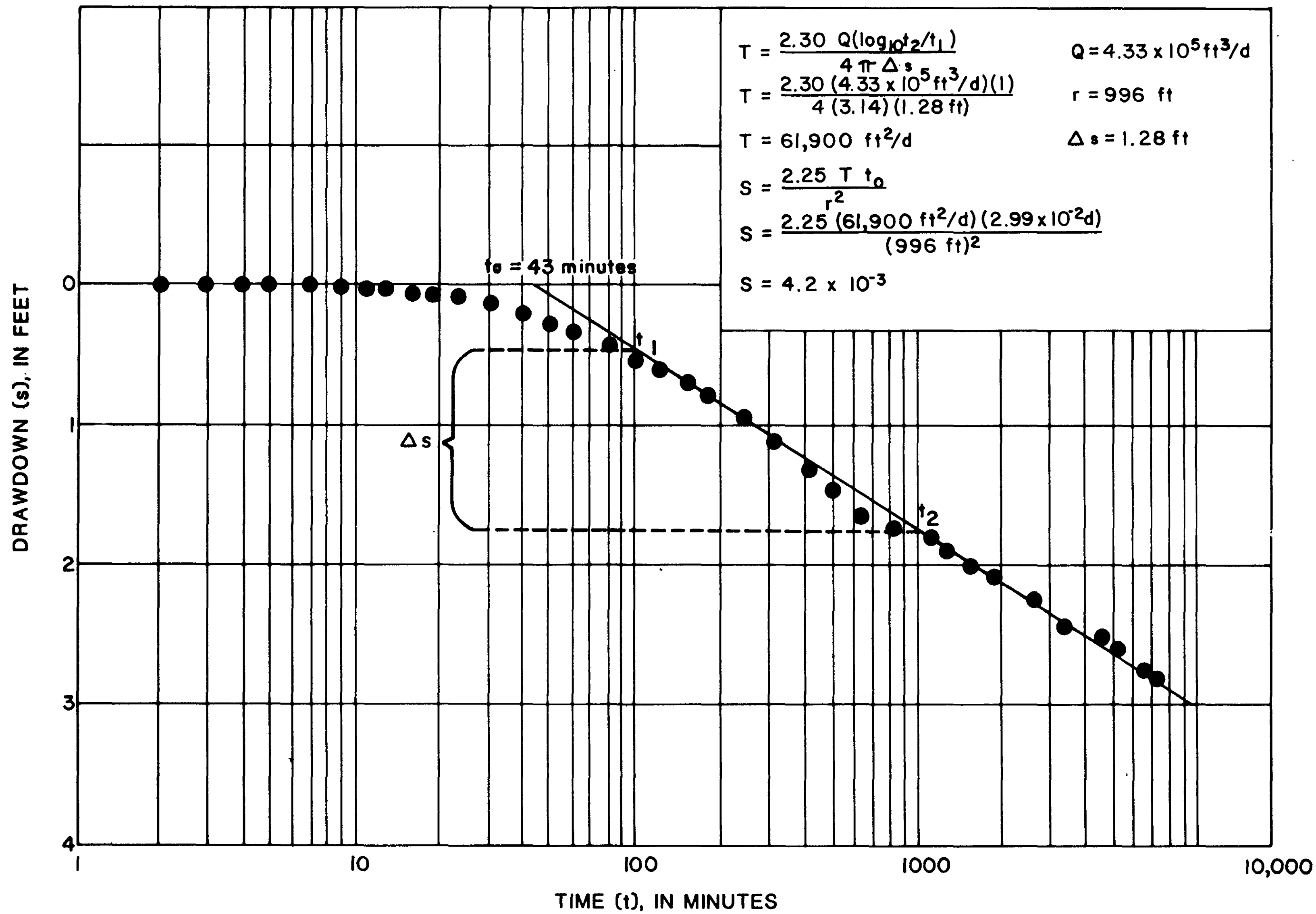

Figure 5.--Example of data plotted for analysis by the Cooper and Jacob modified nonequilibrium method.

The coefficient of storage (S) may be determined from equation 3 in the same manner as the Theis method. Leakance (K'/b') is determined from the following equation:

$$K'/b' = \frac{T(r/B)^2}{r^2} \qquad (10)$$

where K' is the vertical hydraulic conductivity of the confining bed in feet per day and b' is the thickness of the confining bed in feet.

Figure 6 is an example of plotted field data, corrected for regional changes in water levels, with a match point indicated. A sample calculation for solution by the nonsteady-state, leaky method is also shown.

Type curves of W(u,r/B) versus 1/u for nonsteady radial flow in an infinite leaky artesian aquifer developed from equation 8 are shown in figure 3. The Hantush and Jacob method is frequently applied to drawdown curves that obviously depart substantially from the Theis nonleaky model. The results should be interpreted with caution because, under many natural circumstances, assumptions 10 and 11 are seriously unrealistic and cause the early and late drawdown data to depart from the Hantush and Jacob model.

Boulton Method--Delayed Yield from Storage Under Water-Table Conditions

Boulton (1963) introduced a method of analyzing aquifer test data from unconfined aquifers in which allowance is made for delayed yield from storage due to gravity drainage. The method assumes that drawdown is small relative to initial saturated thickness. The general solution of the flow equation may be written as:

$$T = \frac{QW\ (u_{AY},\ r/D)}{4\pi s} \qquad (11)$$

where $W\ (u_{AY},\ r/D)$ is the Boulton well function;

where $D = \sqrt{\frac{T}{\alpha S_y}}$;

where $\alpha = \frac{(r/D)^2 T}{r^2 S_y}$

the reciprocal of delay index.

Under early-time conditions, this equation describes the early-time segment of the time-drawdown curve and reduces to

$$T = \frac{QW\ (u_A,\ r/D)}{4\pi s} \qquad (12)$$

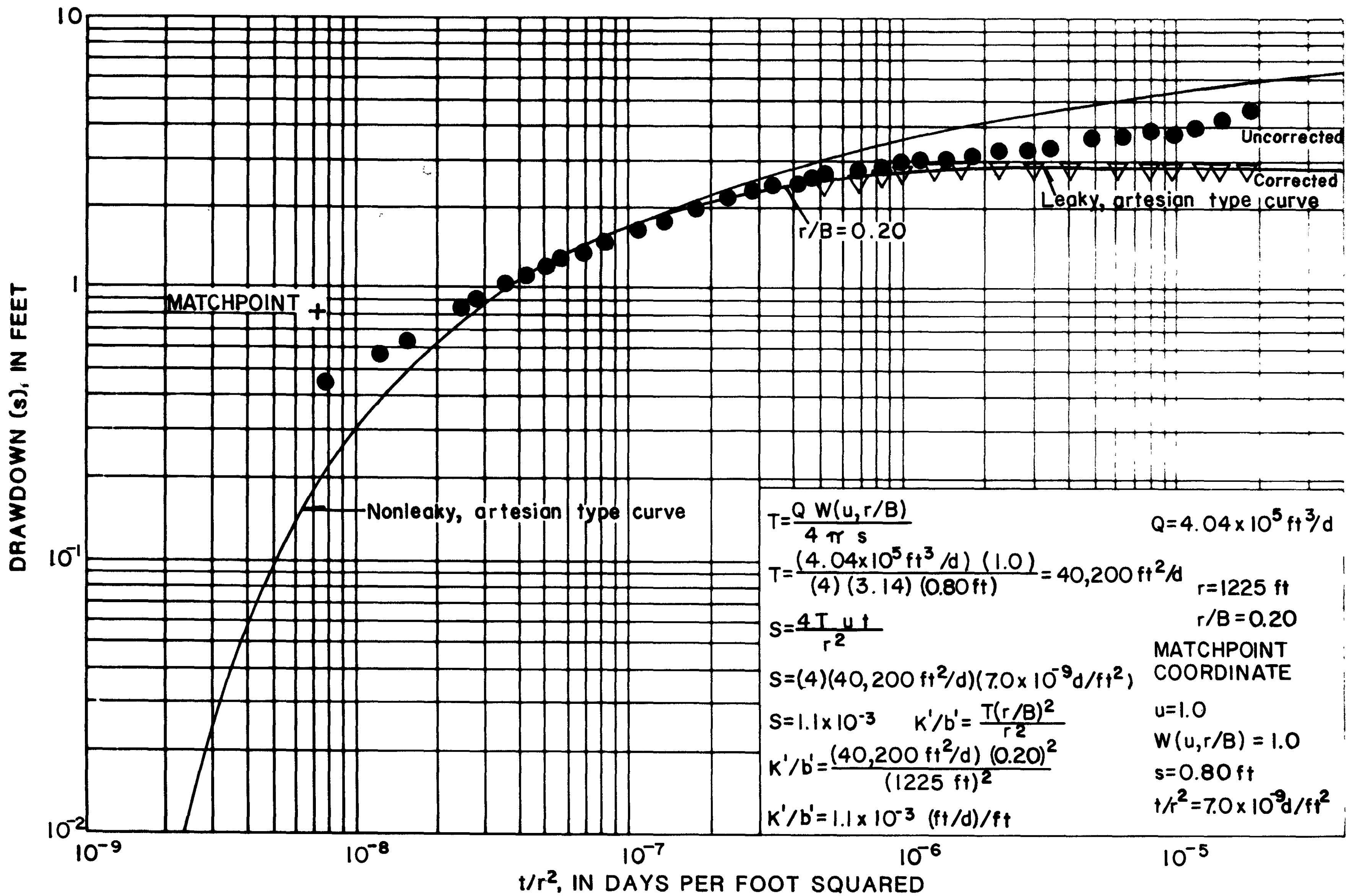

Figure 6.--Example of data plotted for analysis by the Hantush and Jacob nonsteady-state, leaky method.

where

$$S_A = \frac{4Tt\, u_A}{r^2} \qquad (13)$$

S_A is the effective early-time coefficient of storage (water instantaneously released from storage under water-table conditions).

Under later-time conditions, equation 11 describes the later-time segment of the time-drawdown curve and reduces to

$$T = \frac{QW\ (u_Y,\ r/D)}{4\pi s} \qquad (14)$$

where

$$S_Y = \frac{4Tt\, u_Y}{r^2} \qquad (15)$$

S_Y is the specific yield or coefficient of storage (delayed yield of water from storage) for the dewatered portion of the unconfined aquifer (fig. 7).

Figure 8 is an example of plotted field data with a match point indicated and gives sample calculations for solution by the Boulton method. For an unconfined aquifer, the storage coefficient (S) is virtually equal to the specific yield (S_Y).

There is disagreement in the literature as to the appropriate relationship between α and physical parameters. Boulton proposed that α is an aquifer constant, whereas Neuman (1975) suggests that α is an empirical term that is a function of vertical hydraulic conductivity, initial saturated thickness, specific yield, ratio of hydraulic conductivities in the vertical and horizontal directions, and that it decreases linearly with the logarithm of distance from the pumping well. On the other hand, Gambolati (1976) believes that α is "almost" linearly related to the inverse of the distance from the well and becomes constant at a distance of twice the aquifer thickness away from the pumping well. In a more recent paper, Neuman (1979) notes that, for analyzing time-drawdown data from fully penetrating wells in an unconfined aquifer, the approaches of Boulton and Neuman will yield practically identical values of transmissivity, early-time coefficient of storage, and the specific yield. Thus, it appears that for practical purposes, the uncertainty in the "true" meaning of the "delay index" term does not impact on the determination of the aquifer properties.

Neuman and Witherspoon Ratio Method

Neuman and Witherspoon (1972) developed a technique for determining hydraulic properties of confining beds in leaky systems. The ratio of drawdown in the confining bed to that measured in the aquifer at the same time and at the same radial distance from the pumping well can be used to evaluate hydraulic diffusivity of the confining bed. Drawdown in the confining bed must be measured at a known vertical distance, Z, from the aquifer-confining bed interface by means of an open-bottom well or piezometer tapping a small vertical section of the confining bed.

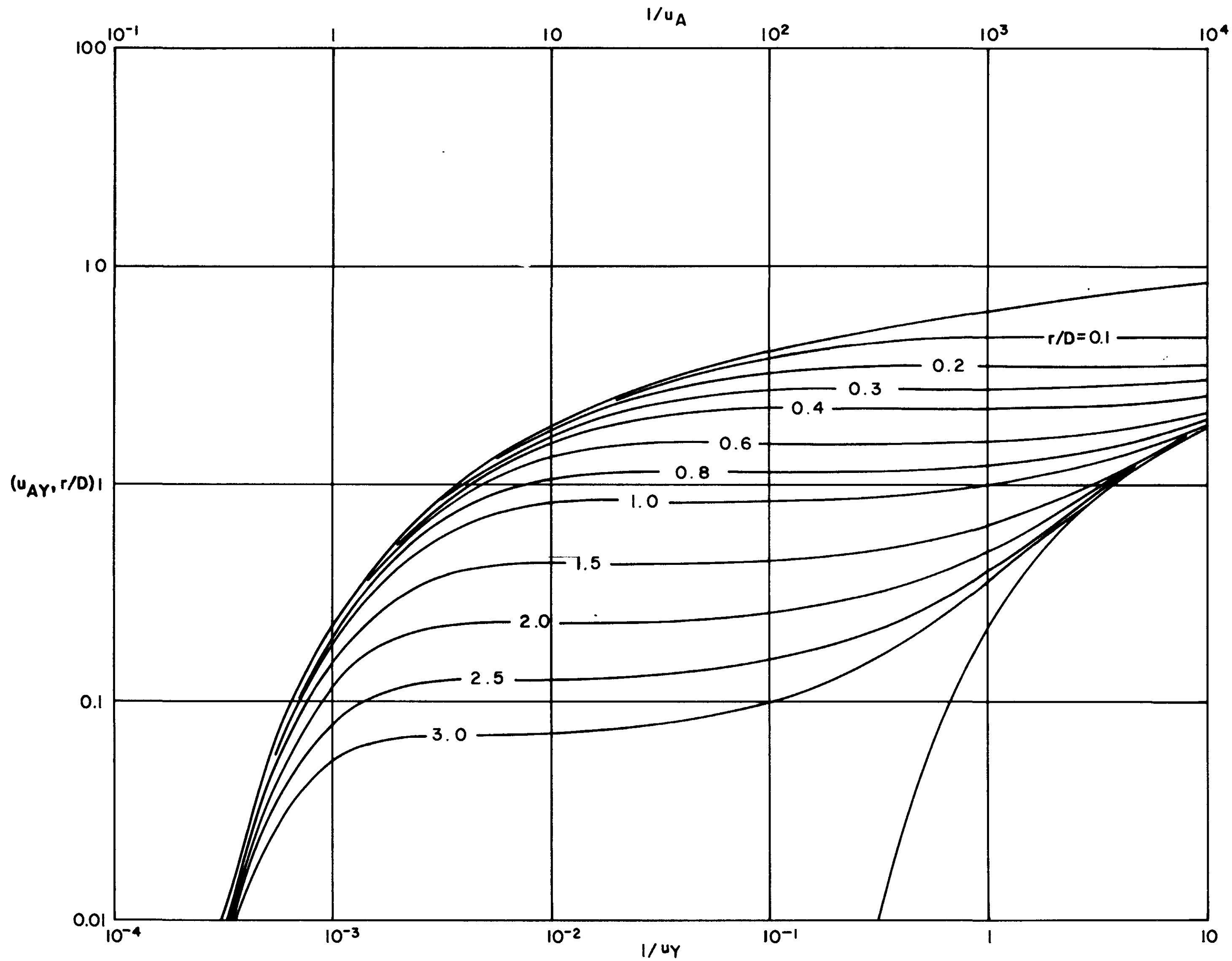

Figure 7.--Type curves for water-table aquifer with delayed yield from storage (Boulton, 1963).

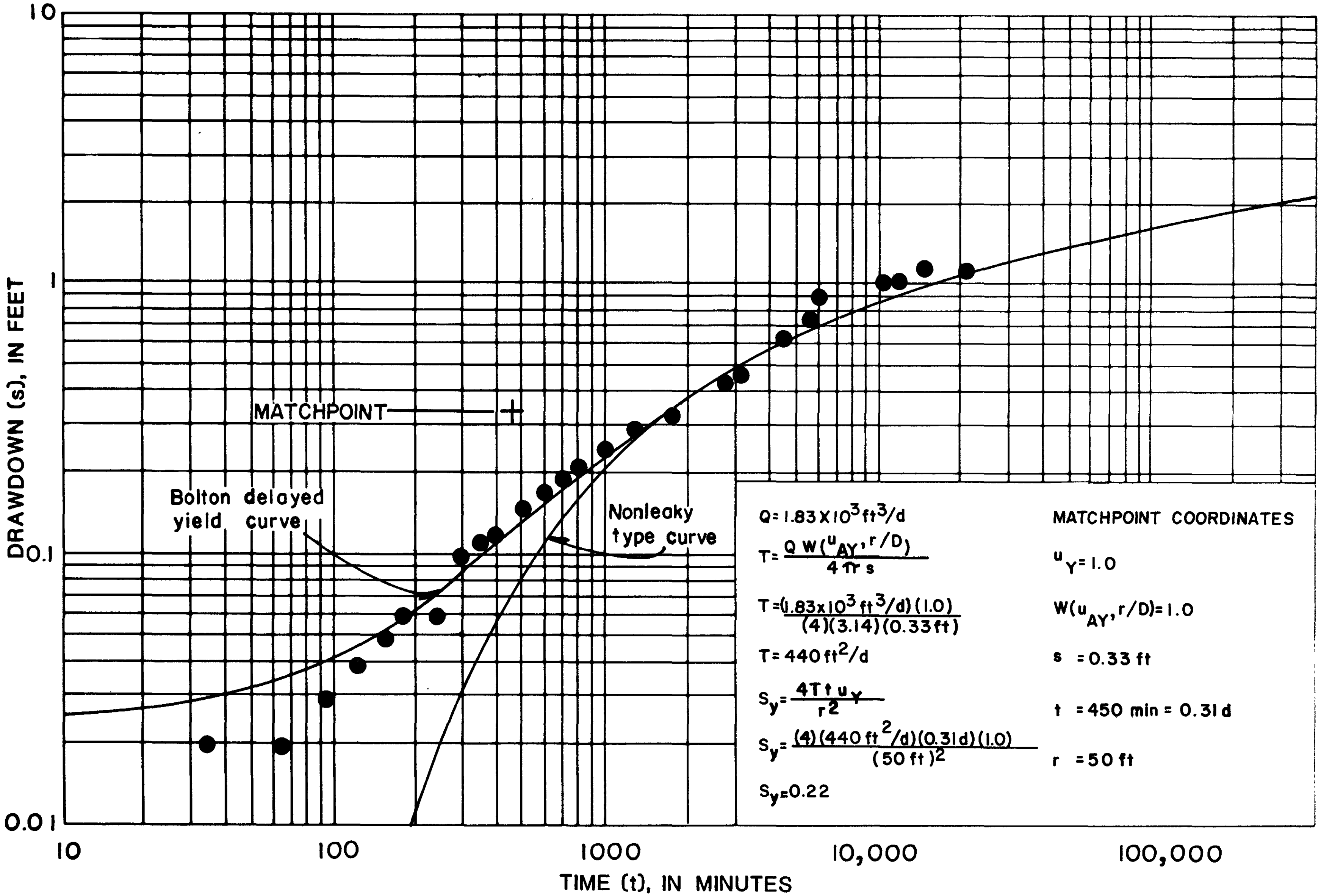

Figure 8.--Example of data plotted for analysis by the Boulton delayed yield from storage under water-table conditions method.

In applying the ratio method, T and S of the aquifer must first be determined. Once T and S have been determined, dimensionless time for the pumped aquifer (t_D) can be calculated at any given radial distance from the pumping well by

$$t_D = \frac{Tt}{Sr^2} \tag{16}$$

where T, S, t, and r are as previously defined and in any consistent set of units.

To evaluate the confining bed, the drawdown ratio (s'/s, drawdown in confining bed/drawdown in pumped aquifer) at early values of time, but after the confining bed responds to pumping, is determined. Equation 16 is used to determine t_D; then from the family of curves in figure 9, the value of t'_D that corresponds to the calculated coordinate values of s'/s and t_D is found.

By applying the Neuman and Witherspoon definition of t'_D, the hydraulic diffusivity can be evaluated as follows:

$$\alpha' = \frac{t'_D Z^2}{t} \tag{17}$$

where α' = hydraulic diffusivity of the confining bed, in square feet per day; and

Z = vertical distance between open part of confining-bed well and pumped aquifer, in feet.

If S_s' is known from laboratory tests or can be estimated from knowledge of the lithology of the confining bed, K' can be calculated from the definition for diffusivity of the confining layer:

$$\alpha = \frac{K'}{S_s'} \tag{18}$$

where K' = vertical hydraulic conductivity of the confining bed, in feet per day; and

S_s' = specific storage of the confining bed, in reciprocal feet.

There were insufficient field data to apply the Neuman and Witherspoon ratio method to any of the aquifer tests evaluated in this report. The method may be applicable to other tests in the study area.

Hantush Anisotropic Method

Hantush (1966) developed a method for determining the principal directions and hydraulic properties of homogeneous, anisotropic (the permeability varies in two directions) aquifers. This method incorporates the assumptions of the Theis

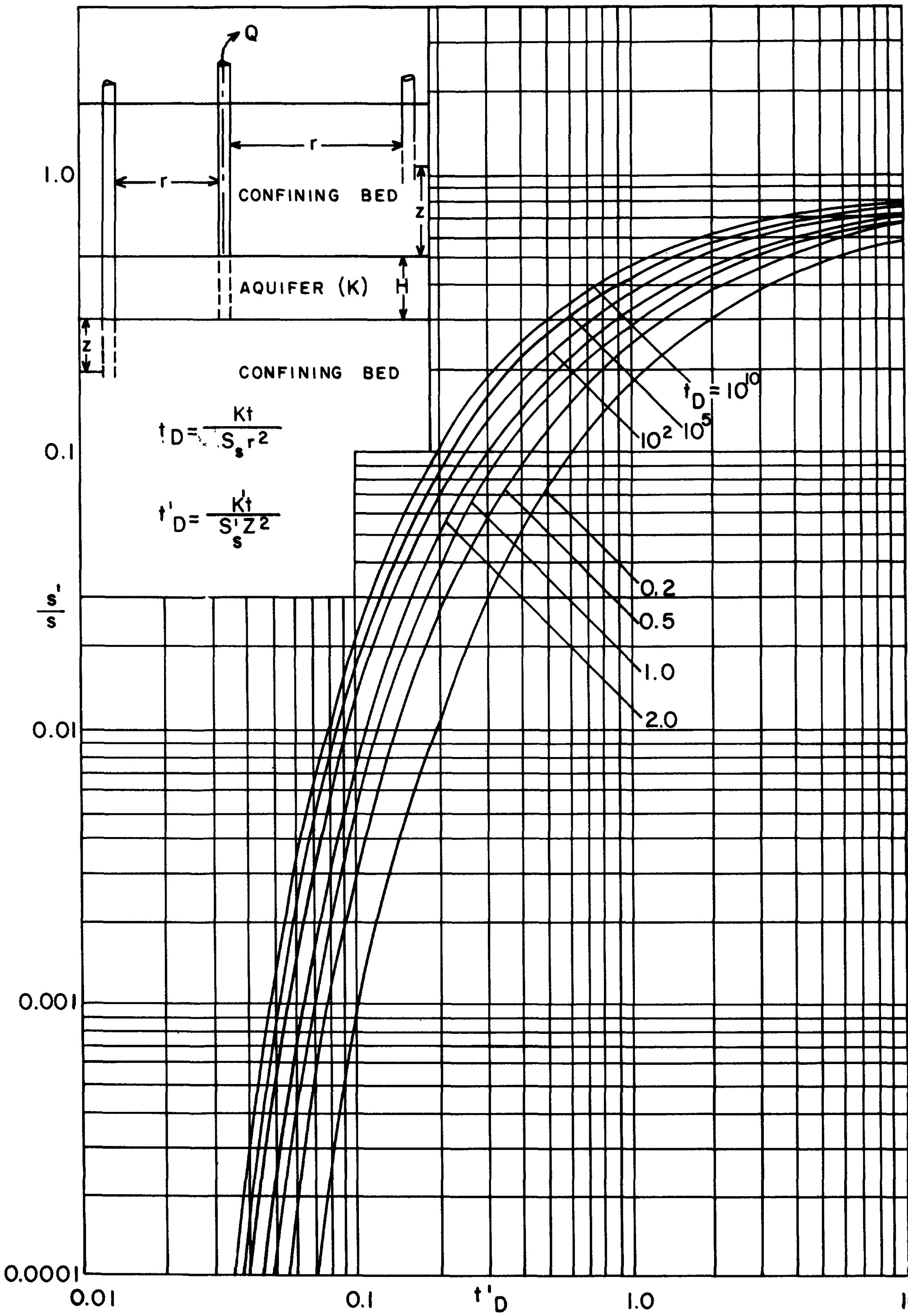

Figure 9.--Family of curves of s'/s versus dimensionless time (t'_D) for confining bed (Neuman-Witherspoon, 1972).

and the Hantush and Jacob methods except that assumption (1) of Theis is deleted and replaced by the following assumption: (12) the aquifer is homogeneous and anisotropic, the x-direction is parallel to the major axis of anisotropy, and the y-direction is along the minor axis.

In a confined or unconfined anisotropic aquifer, equations 2 and 3 are replaced by

$$T_e = \frac{Q}{4\pi s} W(u') \tag{19}$$

$$S = \frac{4T_n u' t}{r^2} \tag{20}$$

where $T_e = \sqrt{T_x T_y}$ = the effective transmissivity (21)

T_n = transmissivity in a direction that makes an angle $(\Theta+\alpha_n)$ with the x axis where Θ is defined as the angle between the first ray of observation wells and the x axis and α_n as the angle between the n^{th} ray of observation wells and the first ray (fig. 10).

$$T_n = \frac{T_x}{[\cos^2(\Theta+\alpha_n)+M\sin^2(\Theta+\alpha_n)]} \tag{22}$$

where

$$M = \frac{T_x}{T_y} = \left(\frac{T_e}{T_y}\right)^2 \tag{23}$$

Because $\alpha_1 = 0$ for the first ray of observation wells, equation 22 reduces to

$$T_1 = \frac{T_x}{\cos^2\Theta+M\sin^2\Theta} \tag{24}$$

and therefore

$$a_n = \frac{T_1}{T_n} = \frac{\cos^2(\Theta+\alpha_n)+M\sin^2(\Theta+\alpha_n)}{\cos^2\Theta+M\sin^2\Theta} \tag{25}$$

and from equations 23 and 25

$$M = \frac{T_x}{T_y} = \frac{a_n\cos^2\Theta-\cos^2(\Theta+\alpha_n)}{\sin^2(\Theta+\alpha_n)-a_n\sin^2\Theta} \tag{26}$$

when three rays of observation wells, no two of which are on the same radial from the pumped well, are present, equation 25 can be solved for Θ by

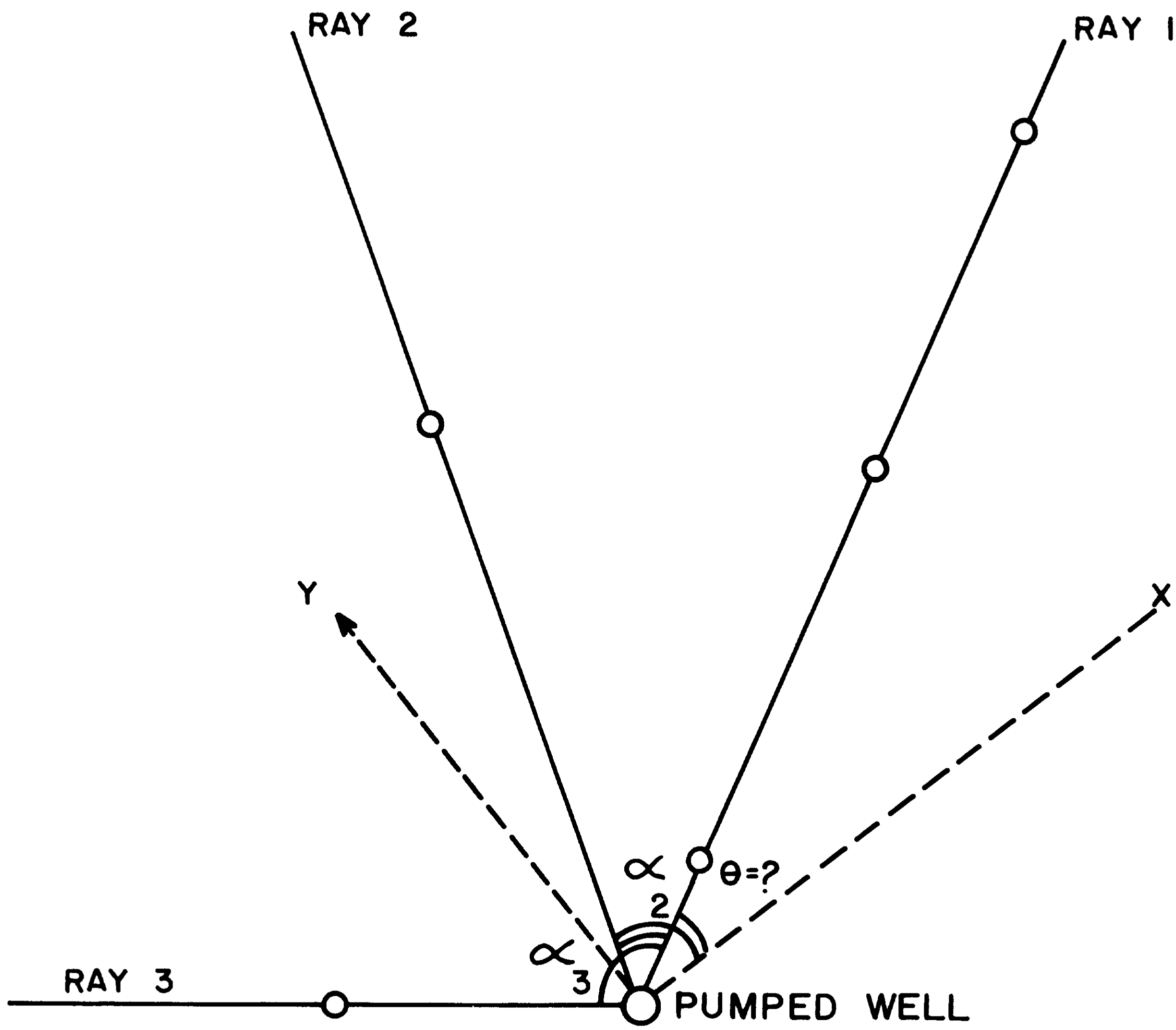

Figure 10.--Locations of three rays of observation wells and parameters in an anisotropic aquifer of unknown principal directions of anisotropy.

$$\tan(2\Theta) = -2\,\frac{(a_3-1)\sin^2\alpha_2-(a_2-1)\sin^2\alpha_3}{(a_3-1)\sin^2\alpha_2-(a_2-1)\sin^2\alpha_3} \qquad (27)$$

Equation 27 has two roots for the angle (2Θ) in the range 0 to 2π of the xy plane. One of the values yields $M < 1$ and the other $M > 1$. Because the x axis is assumed to be along the major axis of anisotropy, $M = \frac{Tx}{Ty} > 1$. Thus, the value of Θ that makes $M > 1$ locates the major axis and the other value locates the minor axis of anisotropy.

Values for a_2 and a_3 are determined from the application of the analytical methods for isotropic aquifers to the data from each ray of observation wells.

For example, for a nonleaky aquifer

$$a_1 = \frac{T_1/S}{T_1/S} = 1,\; a_2 = \frac{T_1/S}{T_2/S},\; a_3 = \frac{T_1/S}{T_3/S} \qquad (28)$$

and for a leaky aquifer,

$$a_1 = 0.5\left[\frac{T_1/S}{T_1/S} + \left(\frac{T_1/K'/b'}{T_1/k'/b'}\right)^2\right] = 1, \qquad (29)$$

$$a_2 = 0.5\left[\frac{T_1/S}{T_2/S} + \left(\frac{T_1/K'/b'}{T_2/K'/b'}\right)^2\right], \text{ and}$$

$$a_3 = 0.5\left[\frac{T_1/S}{T_3/S} + \left(\frac{T_1/K'/b'}{T_3/K'/b'}\right)^2\right]$$

Because α_2 and α_3 are known, Θ can be calculated from equation 27, M is calculated by substituting values of Θ, T_e, α_2 and a_2, or α_3 and a_3 into equation 26. From equation 23, T_x and T_y are calculated, and by substituting values of T_x, M, Θ, α_1, α_2, and α_3 into equation 22, T_1, T_2, and T_3 are calculated.

It follows that

$$S = 1/3\left[\frac{T_1}{T_1/S} + \frac{T_2}{T_2/S} + \frac{T_3}{T_3/S}\right] \qquad (30)$$

and that for a leaky aquifer

$$K'/b' = 1/3\left[\frac{T_1}{T_1/K'/b'} + \frac{T_2}{T_2/K'/b'} + \frac{T_3}{T_3/K'/b'}\right] \qquad (31)$$

If the principal directions of anisotropy are known, hydraulic properties of a anisotropic aquifer can be determined from two rays of observation wells. The procedure is the same as that for unknown principal directions, the only difference being that Θ is known from observation.

Hantush Partially Penetrating, Leaky Method

Hantush (1964) developed a method for determining the hydraulic properties of homogeneous, anisotropic, leaky aquifers utilizing partially penetrating wells. The method incorporates the assumptions of the Theis and the Hantush and Jacob methods except that assumptions (1) and (5) are deleted and replaced by the following assumptions: (13) the discharge well penetrates only part of the aquifer, and (14) the aquifer is homogeneous and has radial-vertical anisotropy. It is also assumed that the flux is distributed uniformly along the well bore open to flow.

In a leaky aquifer where discharge is from a partially penetrating well, equation 9 is replaced by

$$T = \frac{Q}{4\pi s}\left[W(u, r/B) + f'(u, \frac{ar}{b}, B, \frac{d}{b}, \frac{L}{b}, \frac{d'}{b}, \frac{L'}{b})\right] \qquad (32)$$

for the drawdown in an observation well, and by

$$T = \frac{Q}{4\pi s}\left[W(u, r/B) + f(u, \frac{ar}{b}, B, \frac{d}{b}, \frac{L}{b}, \frac{z}{b})\right] \qquad (33)$$

for the drawdown in a piezometer where

$$a = \sqrt{\frac{K_z}{K_r}}$$

K_r = hydraulic conductivity in the horizontal direction;

K_z = hydraulic conductivity in the vertical direction;

b = aquifer thickness;

d = depth from top of aquifer to top of pumped well screen or open hole;

L = depth from top of aquifer to bottom of pumped well screen or open hole;

z = depth from top of aquifer to bottom of a piezometer;

d' = depth from top of aquifer to top of observation-well screen or open hole;

L' = depth from top of aquifer to bottom of observation-well screen or open hole.

The method should be applied with caution at wells very near the pumped well. The effects of partial penetration are insignificant for $r > 1.5$ b/a and for practical purposes can be ignored for $r > 1.0$ b/a (Hantush, 1964). The solution is the same as the Hantush and Jacob nonsteady-state, leaky method.

Because of the large number of variables involved, it is impractical to develop a complete set of type curves for all possible configurations of partially penetrating wells. It is necessary to generate a family of type curves for each partial penetration situation encountered. Because the function values are tedious to compute by hand, Reed (1980) formulated a computer program to compute the functions for selected values of the above parameters.

RESULTS OF TESTING

Areal variations in the geology of aquifer systems result in a wide range in hydraulic properties from place to place. Varying degrees of aquifer stratification, localized solution channeling, interrupted confining beds, sinkholes and streams with varying connection to the aquifers, and vertical and horizontal anisotropy combine to make delineation of areal changes in hydraulic properties difficult.

Aquifer tests that imply a wide variation in hydraulic properties at any site, as determined by inconsistent responses in several observation wells, generally indicate that the basic assumptions of mathematical models used to analyze the test data were not entirely met. Heterogeneity, horizontal and vertical anisotropy, and impermeable barrier and stream recharge boundaries are frequent causes of the apparent variation in aquifer properties.

The available analytical models represent idealized aquifer systems in which aquifer properties are homogeneous and (in most cases) the areal extent of the aquifer is so great that it can be treated as extending infinitely in all horizontal directions. If the aquifer is overlain and/or underlain by a "leaky" confining zone, that zone's thickness and hydraulic properties are assumed to be uniform. In those very few cases where hydrogeologic boundaries are accounted for in analytical models, they are assumed to be either infinitely long straight-line boundaries or are made up of finitely long straight-line boundary sections that completely envelop the aquifer. Furthermore, those idealized boundaries are limited to be either perfectly impermeable barriers or surface-water bodies, such as a stream or lake, that are in perfect hydraulic connection with the aquifer. Field conditions in this area suggest some heterogeneity of aquifer system properties and, in some places, localized surface-water bodies that might function as partial boundaries.

All tests were analyzed with analytical models that assume a homogeneous isotropic or anisotropic aquifer of uniform thickness and infinite areal extent. To the degree that the analytical model assumptions reflect the real aquifer system, the aquifer test results give some type of "equivalent" aquifer parameter estimates that are believed to be useful for many purposes. However, because a type curve from one of the idealized models can be fit to aquifer test data is no guarantee that the aquifer system satisfies the assumption on which the type curve was developed. Independent hydrogeologic information is needed to judge which, if any, of the available analytical models should give the most meaningful equivalent parameter estimates.

Many of the aquifer tests utilized pumping wells that only partially penetrated a stratified aquifer. However, differences in the drawdowns produced by partially penetrating wells, in contrast to fully penetrating wells, diminished with increasing distance from the pumping wells.

Those tests where the observation wells were of great enough distance from the pumping well that the effects of partial penetration could be ignored were analyzed with the appropriate analytical method. Tests where partial penetration could not be ignored were analyzed with the partial penetration method of Hantush (1964).

Observation-well response was corrected for barometric and water-level changes when data were available, and corrections appeared to improve the analyses. Barograph data were utilized to correct for the influence of barometric pressure changes upon well response. Water-level measurements at control wells that were not influenced by pumping were used to correct for regional water-level changes.

Hydraulic properties determined from aquifer test analyses given in the Summary Data section are summarized in table 3. The locations of aquifer tests listed in table 3 are shown in figure 11.

Transmissivity

Areal variation of transmissivity in the Floridan aquifer is primarily controlled by the occurrence of cavern systems, solution channels, and fractures (fracture porosity). The wide range of transmissivity calculated from Floridan aquifer tests is because: (1) some test wells do not penetrate the highly permeable dolomite stratum usually located near the top of the Avon Park Limestone, or (2) the wells may or may not penetrate a permeable stratum that only occurs locally. Transmissivities obtained from aquifer tests using wells that penetrated various sections of the Floridan aquifer range from 1,900 to 920,000 ft^2/d. Faulkner (1973) reported an average transmissivity of 2,090,000 ft^2/d from a flow-net analysis of Silver Springs (located in central Marion County) and a transmissivity range of 10,700 to 25,500,000 ft^2/d for flow cells of the flow net. Higher transmissivity values around springs are due to greater development of interconnected tubes and cavities in the carbonate rock that are caused by ground water that flows toward the spring.

Transmissivity of the intermediate aquifer is highly variable due to silt and clay interbedded with the limestone. Transmissivities obtained from tests of the aquifer range from 740 to 7,800 ft^2/d.

In the surficial aquifer, transmissivity is largely a function of grain size and shape, degree of sorting, and thickness. Transmissivities obtained from aquifer tests range from 240 to 600 ft^2/d.

Storage Coefficient

The wide range of storage coefficients from tests of the Floridan and intermediate aquifers is probably due to physical variations in the aquifers and partial penetration of the aquifers by test wells. Partial penetration of an aquifer, particularly a stratified aquifer, can affect the early-time drawdown curve from which the artesian storage coefficient is determined. The

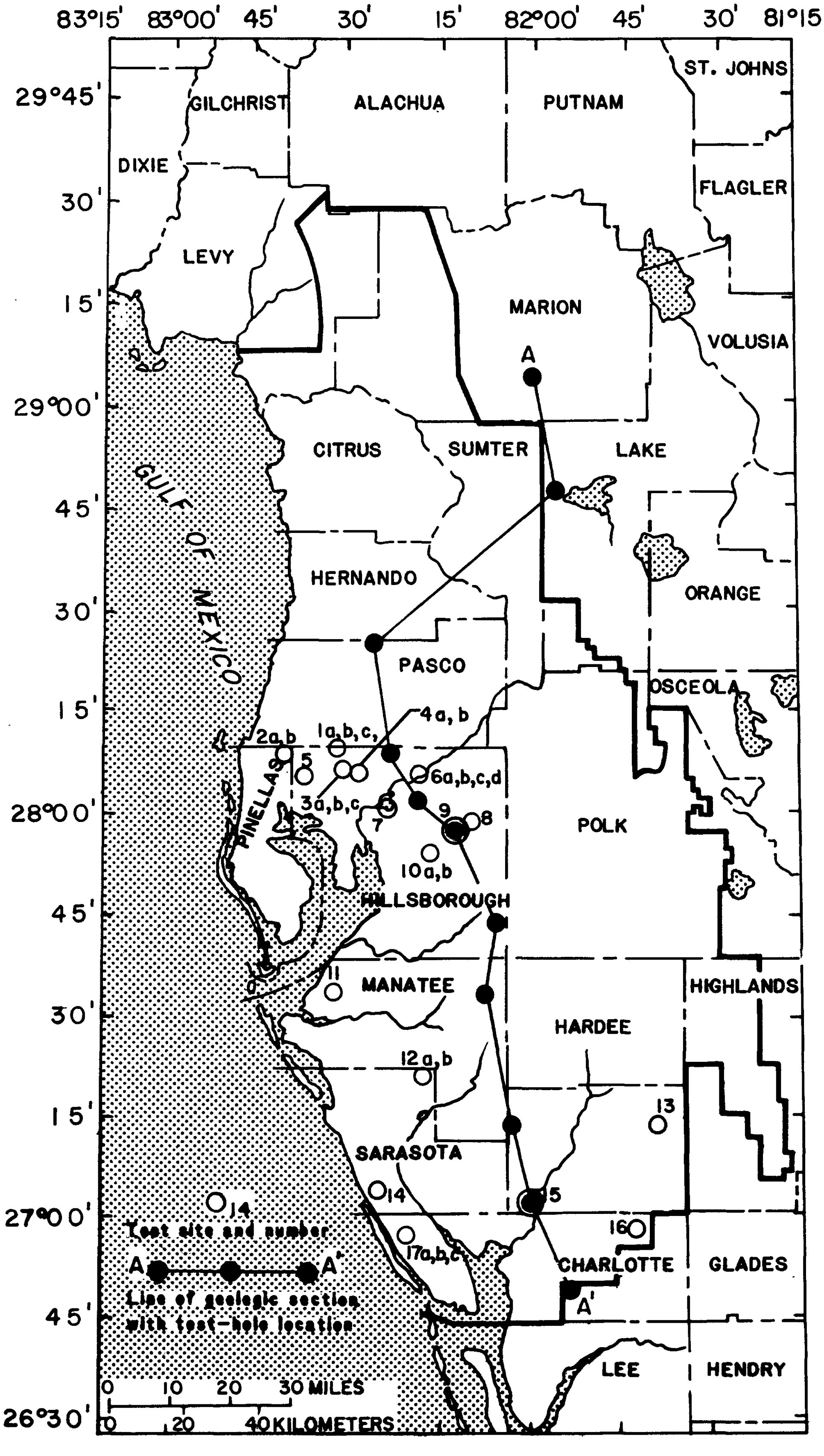

Figure 11.--Location of aquifer test sites and geologic section.

Table 3.--Aquifer

Location	Number of observation wells	Formations penetrated (aquifer)
Pasco well field, southwest Pasco County	8	Tampa, Suwannee, Ocala, Avon Park (Floridan)
Pasco well field, southwest Pasco County	9	Tampa, Suwannee, Ocala, Avon Park (Floridan)
Pasco well field, southwest Pasco County	8	Tampa, Suwannee, Ocala, Avon Park (Floridan)
Eldridge-Wilde well field, northeast Pinellas County	1	Tampa, Suwannee[2/] (upper Floridan)
Eldridge-Wilde well field, northeast Pinellas County	1	Tampa, Suwannee[2/] (upper Floridan)
Dundee Ranch test site, northwest Hillsborough County	1	Surficial deposits (surficial)
Dundee Ranch test site, northwest Hillsborough County	1	Surficial deposits (surficial)
Dundee Ranch test site, northwest Hillsborough County	3	Surficial deposits (surficial)
Section 21 well field, northwest Hillsborough County	3	Tampa, Suwannee, Ocala, Avon Park (Floridan)
Section 21 well field, northwest Hillsborough County	4	Surficial deposits (surficial)
Sunset Lake test site, northwest Hillsborough County	2	Tampa, Suwannee[2/] (upper Floridan)
Morris Bridge well field, northeast Hillsborough County	5	Tampa, Suwannee, Ocala, Avon Park (Floridan)
Morris Bridge well field, northeast Hillsborough County	3	Tampa, Suwannee, Ocala, Avon Park (Floridan)
Morris Bridge well field, northeast Hillsborough County	6	Tampa, Suwannee, Ocala, Avon Park (Floridan)

1/ Effective transmissivity.
2/ Highly permeable dolomite stratum in the Avon Park Limestone not penetrated by pumping well.

test results

Thickness of aquifer penetrated by pumping well (feet)	Aquifer characteristics			Test number	Test date
	Transmissivity (T) (ft^2/d)	Storage coefficient (S)	Leakance (K'/b') [(ft/d)/ft]		
662	71,000[1/]	$1x10^{-3}$		1a	6-19-71
626	68,000[1/]	$8x10^{-4}$		1b	6-28-71
610	51,000[1/]	$6x10^{-4}$	$5x10^{-5}$	1c	3-05-73
207	34,400	$1.5x10^{-3}$	$6.4x10^{-4}$	2a	1-08-52
220	58,800	$1.4x10^{-3}$	$<1.0x10^{-3}$	2b	8-25-54
12	600	$7x10^{-2}$		3a	4-21-72
3	240	$4x10^{-3}$		3b	3-15-73
10	380	$2.0x10^{-1}$		3c	4-22-74
400	71,000	$1.3x10^{-3}$	$3x10^{-4}$	4a	3-15-65
2	235	$2.4x10^{-1}$		4b	5-24-70
225	33,000	$9x10^{-4}$		5	4-12-74
480	38,000	$1.0x10^{-3}$	$3x10^{-3}$	6a	9-21-70
400	35,000	$1.0x10^{-3}$	5.3 to $8.0x10^{-4}$	6b	12-14-70
784	40,000	$1.5x10^{-3}$	$2.1x10^{-3}$	6c	3-02-71

Table 3.--Aquifer test

Location	Number of observation wells	Formations penetrated (aquifer)
Morris Bridge well field, northeast Hillsborough County	10	Tampa, Suwannee, Ocala, Avon Park (Floridan)
Temple Terrace well field, northwest Hillsborough County	3	Tampa, Suwannee[2/], Ocala (upper Floridan)
Plant City well field, northeast Hillsborough County	1	Suwannee, Ocala, Avon Park (Floridan)
Sixmile Creek test site, northeast Hillsborough County	4	Tampa[2/] (upper Floridan)
Eureka Springs test site, northeast Hillsborough County	4	Tampa[2/] (upper Floridan)
Peaks test site, northwest Manatee County	1	Hawthorn, Tampa[2/], Swuannee, Ocala (intermediate and upper Floridan)
Verna well field, northeast Sarasota County	1	Hawthorn, Tampa (intermediate and upper Floridan)
Verna well field, northeast Sarasota County	1	Hawthorn (intermediate)
Tropical River Grove, northeast De Soto County	3	Hawthorn, Tampa, Suwannee, Ocala, Avon Park (intermediate and Floridan)
Venice well field, southwest Sarasota County	1	Hawthorn, Tampa[2/], Suwannee (intermediate and upper Floridan)
Fort Ogden, southwest De Soto County	1	Hawthorn, Tampa[2/], Suwannee, Ocala, Avon Park (intermediate and upper Floridan)
Tropical River Grove, northeast Charlotte County	1	Tamiami, Hawthorn, Tampa (intermediate)

results--Continued

Thickness of aquifer penetrated by pumping well (feet)	Aquifer characteristics			Test number	Test date
	Transmissivity (T) (ft^2/d)	Storage coefficient (S)	Leakance (K'/b/) [(ft/d)/ft]		
561	56,000	$1.2x10^{-3}$	$1.2x10^{-3}$	6d	7-18-73
387	106,000	$8x10^{-4}$	5.0 to $8.7x10^{-3}$	7	3-18-75
740	37,100	$1.5x10^{-3}$	$<3.2x10^{-4}$	8	10-19-70
55	86,000[1/]	$9x10^{-4}$	$8x10^{-4}$	9	5-10-72
50	120,000[1/]	$1.1x10^{-3}$	$8.6x10^{-3}$	10	3-30-72
475	67,000	$1.1x10^{-3}$	$7.8x10^{-5}$	11	8-22-56
350	1,900	$1.4x10^{-3}$		12a	4-16-64
6	740	$1.5x10^{-4}$		12b	10-04-71
920	920,000			13	11-02-70
450	17,900	$1.3x10^{-4}$	$1.0x10^{-4}$	14	3-26-75
930	13,400	$2x10^{-4}$	$8x10^{-5}$	15	8-28-73
530	3,000	$1.3x10^{-4}$		16	10-02-69

Table 3.--Aquifer test

Location	Number of observation wells	Formations penetrated (aquifer)
Englewood well field, southwest Sarasota County	1	Tamiami (intermediate)
Englewood well field, southwest Sarasota County	1	Tamiami (intermediate)
Englewood well field, southwest Sarasota County	1	Tamiami (intermediate)

surficial aquifer is usually fine grained and stratified, and gravity drainage of water is delayed. If the test is not long enough, the water-table storage coefficient may not be accurately computed. However, the range of storage coefficients obtained from tests of the surficial aquifer is probably due more to physical variations in the surficial aquifer than factors associated with the test. Values of storage coefficients obtained from aquifer tests range from $1.3x10^{-4}$ to $1.5x10^{-3}$ for the Floridan aquifer, $5x10^{-5}$ to $1.7x10^{-4}$ for the intermediate aquifer, and $4x10^{-3}$ to $2.0x10^{-1}$ for the surficial aquifer.

Leakance

As with transmissivity and storage coefficient, leakance is affected by heterogeneity and anisotropy of the aquifer and confining bed and boundary conditions. Sources of recharge, such as sinkholes, streams, and canals that breach the confining bed, are interpreted from the tests as leakance because, by the method of analysis used, they cannot be readily separated from leakage through the confining beds.

Physical variation of the confining beds is probably the main cause of leakance variation. Aquifer tests using wells that partially penetrate an aquifer, particularly wells that do not penetrate the highly permeable stratum of the Floridan aquifer, probably have a higher computed leakance than they would have had if the wells penetrated the permeable stratum.

The values of leakance obtained from aquifer tests range from $5x10^{-5}$ to $9x10^{-3}$ (ft/d)/ft for the Floridan aquifer and $2x10^{-4}$ to $7x10^{-4}$ (ft/d)/ft for the intermediate aquifers.

results--Continued

Thickness of aquifer penetrated by pumping well (feet)	Aquifer characteristics			Test number	Test date
	Transmissivity (T) (ft^2/d)	Storage coefficient (S)	Leakance (K'/b') [(ft/d)/ft]		
6	5,500	$1.1x10^{-4}$	$7x10^{-4}$	17a	2-25-69
15	7,800	$5x10^{-5}$		17b	3-27-69
28	3,800	$1.7x10^{-4}$	$2.4x10^{-4}$	17c	2-05-76

CONCLUSIONS

Ground water in west-central Florida occurs under confined and unconfined conditions. The surficial aquifer, where present, generally consists of clastic deposits that may be as much as 100 feet thick. Transmissivity values, determined from aquifer tests in the surficial aquifer, range from 240 to 600 ft^2/d, and storage coefficient (specific yield) values range from $4x10^{-3}$ to $2x10^{-1}$.

The intermediate aquifer system is composed of units of the Caloosahatchee Marl, Tamiami and Hawthorn Formations, and Tampa Limestone. The limestone of the aquifer is commonly clayey, which results in generally low hydraulic conductivity. However, in local areas, solution channeling greatly increases the hydraulic conductivity of the aquifer. Transmissivity values determined from aquifer tests range from 740 to 7,800 ft^2/d, storage coefficient from $5x10^{-5}$ to $1.7x10^{-4}$, and leakance from $2x10^{-4}$ to $7x10^{-4}$ (ft/d)/ft.

The Floridan aquifer occurs in all of west-central Florida and is the principal source of water in the area. It is a confined aquifer (except in northern portions) composed of persistent limestone and dolomite units of the Tampa, Suwannee, Ocala, Avon Park, and Lake City Limestones. The major producing layer or zone in most of the area is fractured dolomite and calcitic dolomite beds of the Avon Park Limestone. This zone is about 50 to 100 feet thick and usually occurs near the middle of the Avon Park Limestone. Although the Floridan aquifer has multiple layers, aquifer tests indicate that the layers generally respond to pumping as a unit. Transmissivity values determined from aquifer tests in the Floridan range from 1,900 to 920,000 ft^2/d, storage coefficient from $1.3x10^{-4}$ to $1.5x10^{-3}$, and leakance from $5x10^{-5}$ to $9x10^{-3}$ (ft/d)/ft.

The methods of analyses used in this report are the simplest available for transient well-test data. More detailed analyses of these data could provide additional information about the aquifer coefficients in some areas. However, computed values of transmissivity, storage coefficient, and leakance should be within the above ranges.

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SUMMARY DATA

General Test Information

Following are data from 30 aquifer pumping tests. Data include a general description of each test and the following information: (1) name and general location; (2) test period; (3) aquifer tested; (4) data corrections applied; (5) test problems; and (6) test reliability. Also included for each test is a figure that shows well locations, aquifer data, and a graph that shows drawdown versus t/r^2 and detailed information on location, wells used, and test data.

Following is an explanation of data presented in the graph in each of the 30 tests.

Latitude and longitude of wells were determined from locations on U.S. Geological Survey 7-1/2-minute topographic maps.

Township, range, section, and position within the section were also determined from U.S. Geological Survey 7-1/2-minute topographic maps.

Well number is the local well number assigned by the owner.

Depth of well is the bottom-hole depth, in feet, at the time the test was run.

Depth of casing is the depth cased, in feet, or depth to first perforations.

Diameter of well, in inches, is the inside diameter of the innermost casing.

Altitude of water level is the elevation of the water level, in feet, above sea level.

Date is the date the test was started.

Aquifer is the name of the geologic or hydrologic units from which the well produces water.

Radius is the distance, in feet, from pumping well to observation wells or the radius of the pumping well.

Q is the average rate of discharge, in cubic feet per minute (ft^3/min), of the pumped well for the length of the test.

"X" after drawdown or recovery denotes whether the graph shows drawdown or recovery.

Specific capacity is a measure of well performance expressed as the rate of yield per unit drawdown in cubic feet per minute per foot [(ft^3/min)/ft].

Type of analysis indicates the analytical method used to determine the aquifer characteristics.

Data corrections denotes whether data were corrected for barometric effects with barograph record or for regional trends with control well record.

The following items are defined in the text under the section heading "Hydraulic Properties of Aquifers":

Transmissivity (T)

Storage coefficient (S), and

Leakance (K'/b').

The types of well logs that are available (geophysical, lithologic, drillers') are listed after the item "logs".

Chemical analyses denotes the water-quality data available.

"Remarks" gives other information about the test.

Additional information on wells tested may be found in county or area publications of the Florida Bureau of Geology, the U.S. Geological Survey, and consultants' reports prepared for municipal agencies and companies.

Pasco Well Field (Test 1a), Southwest Pasco County

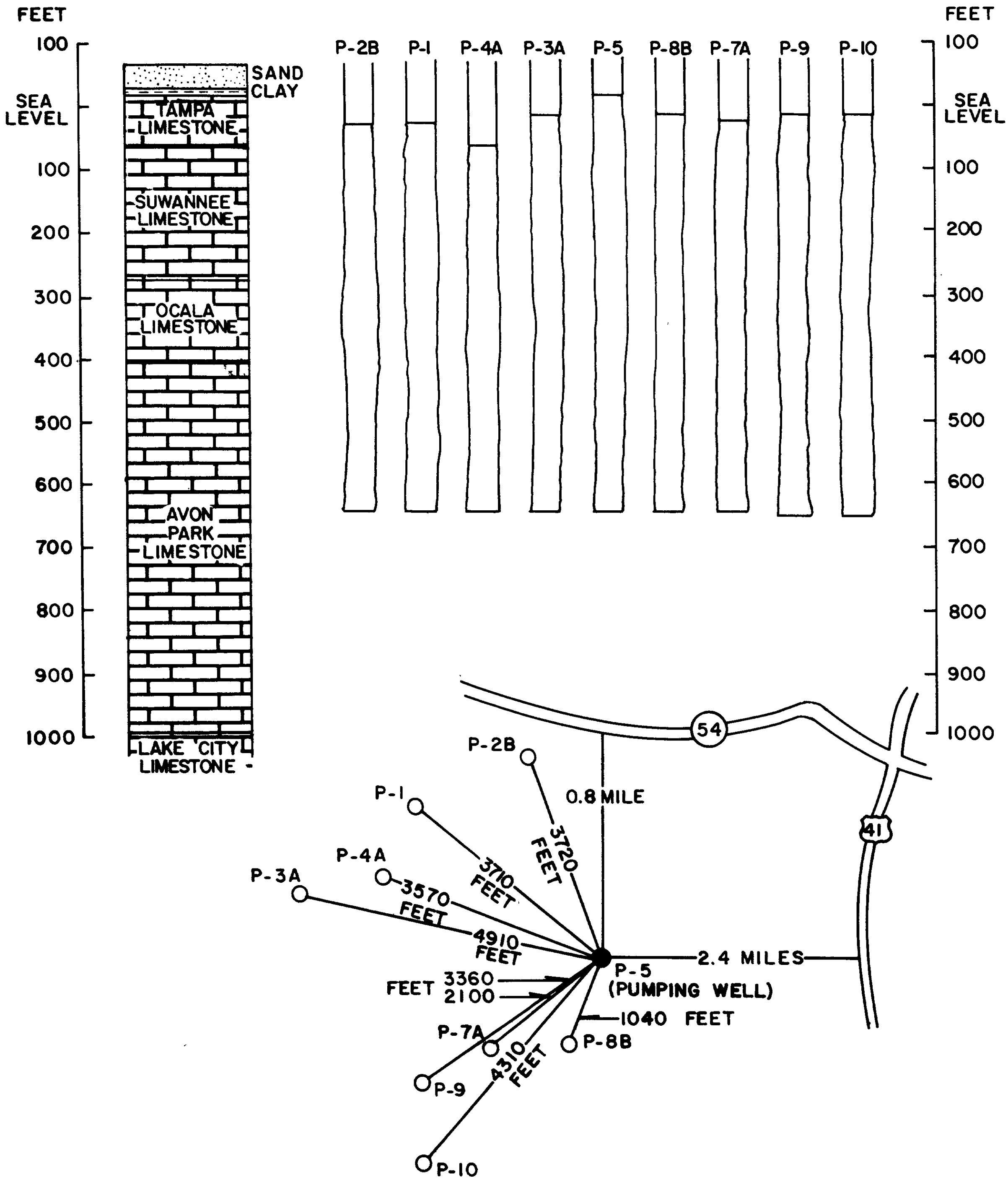
Test period (drawdown and recovery): 1000, 6-19-71 to 1000, 6-21-71.

Aquifer tested: Floridan.

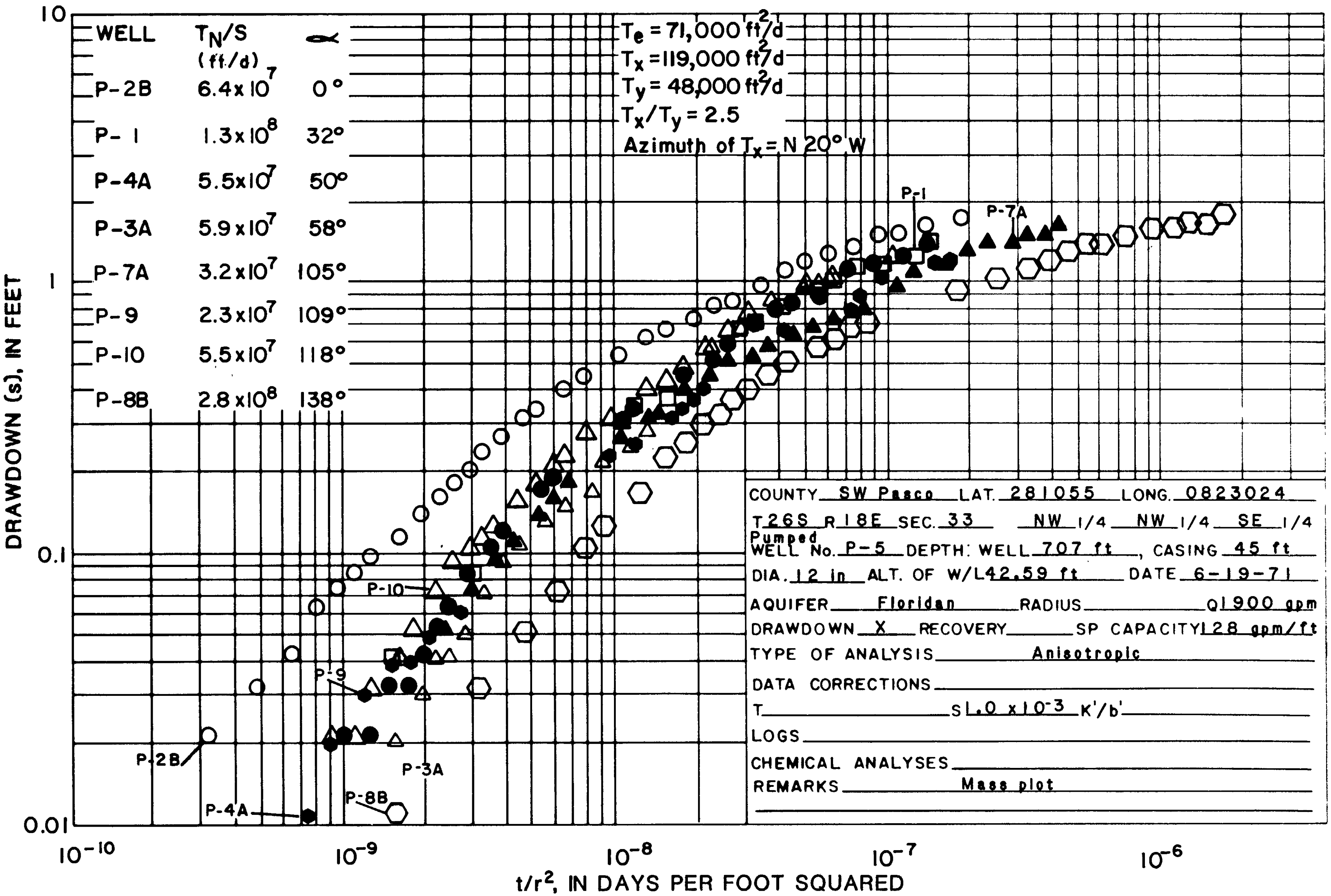
Data corrections applied: Because of absence of control wells in the area, no data corrections were applied.

Test problems: Variation of observation-well drawdown is primarily due to aquifer anisotropy.

Test reliability: The Floridan aquifer in the Pasco well field is anisotropic in the horizontal plane. The anisotropy of the aquifer is indicated by the lines of equal drawdown around the pumped well that form elliptical circles rather than concentric circles formed in an isotropic aquifer. Consequently, an anisotropic analytical method was used to determine aquifer characteristics. The principal directions of anisotropy, determined from the test analysis, generally correspond to directions determined from a hydrogeologic evaluation of the area. The principal directional and effective transmissivity and storage coefficient determined from the test are representative of the aquifer in the area. The test was not of long enough duration to determine leakance.



Pasco well-field location map and well characteristics: 06-19-71 aquifer test (test site 1a).


WELL T_N/S (ft/d) α
P-2B 6.4x10^7 0°
P-1 1.3x10^8 32°
P-4A 5.5x10^7 50°
P-3A 5.9x10^7 58°
P-7A 3.2x10^7 105°
P-9 2.3x10^7 109°
P-10 5.5x10^7 118°
P-8B 2.8x10^8 138°
Te = 71,000 ft²/d
Tx = 119,000 ft²/d
Ty = 48,000 ft²/d
Tx/Ty = 2.5
Azimuth of Tx = N 20° W
P-1
P-7A
P-10
P-9
P-2B
P-4A
P-3A
P-8B
COUNTY SW Pasco LAT. 281055 LONG. 0823024
T26S R18E SEC. 33 NW 1/4 NW 1/4 SE 1/4
Pumped WELL No. P-5 DEPTH: WELL 707 ft, CASING 45 ft
DIA. 12 in ALT. OF W/L 42.59 ft DATE 6-19-71
AQUIFER Floridan RADIUS Q 1900 gpm
DRAWDOWN X RECOVERY SP CAPACITY 128 gpm/ft
TYPE OF ANALYSIS Anisotropic
DATA CORRECTIONS
T S 1.0 x10-3 K'/b'
LOGS
CHEMICAL ANALYSES
REMARKS Mass plot
DRAWDOWN (s), IN FEET
10
1
0.1
0.01
10^-10
10^-9
10^-8
10^-7
10^-6
t/r², IN DAYS PER FOOT SQUARED

Pasco Well Field (Test 1b), Southwest Pasco County

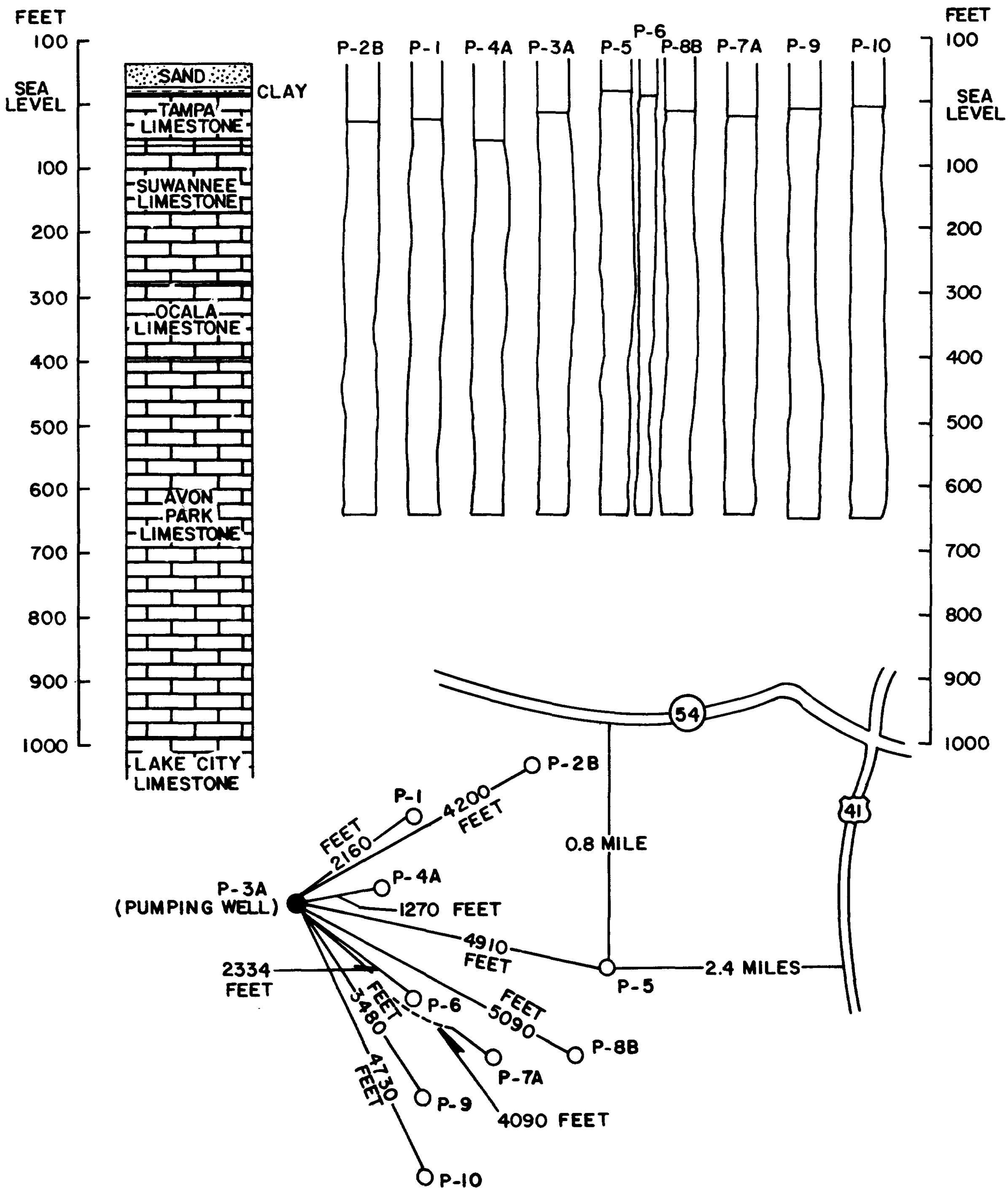
Test period (drawdown and recovery): 1100, 6-28-71 to 1100, 6-30-71.

Aquifer tested: Floridan.

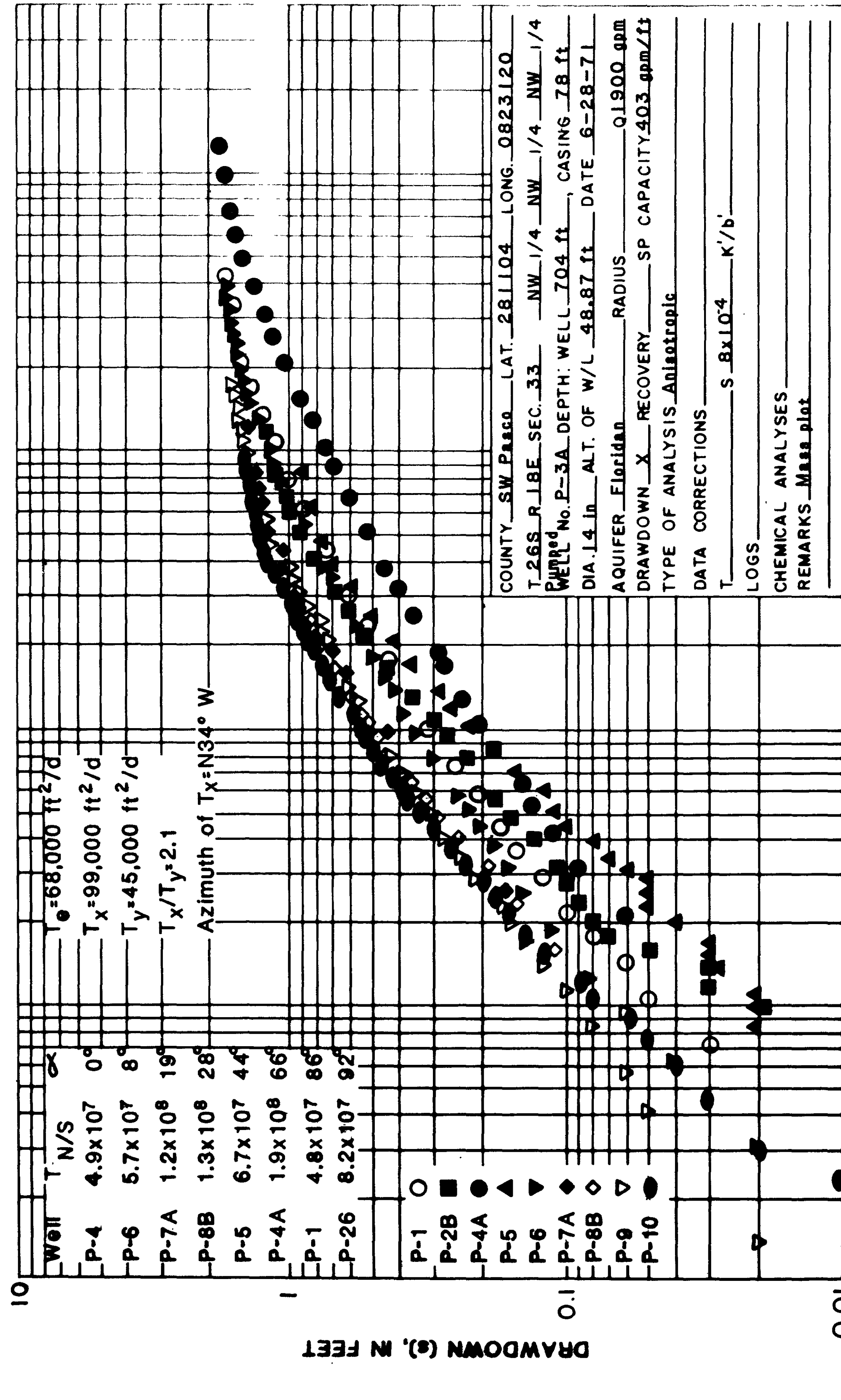
Data corrections applied: Because of absence of control wells in area, no data corrections were applied.

Test problems: Variation of observation-well drawdown is primarily due to aquifer anisotropy.

Test reliability: As with test 1a, an anisotropic analysis was necessary to determine aquifer characteristics. The principal directions of transmissivity and aquifer characteristics determined from the analysis are reasonably similar to test 1a. Because the pumping well from test 1a is about 1 mile west of the test 1b pumping well, the similarity of results are plausible. The test was not of long enough duration to determine leakance.



Pasco well-field location map and well characteristics: 06-28-71 aquifer test (test site 1b).



Well T N/S α
P-4 4.9x10^7 0°
P-6 5.7x10^7 8°
P-7A 1.2x10^8 19°
P-8B 1.3x10^8 28°
P-5 6.7x10^7 44°
P-4A 1.9x10^8 66°
P-1 4.8x10^7 86°
P-26 8.2x10^7 92°
Te=68,000 ft²/d
Tx=99,000 ft²/d
Ty=45,000 ft²/d
Tx/Ty=2.1
Azimuth of Tx=N34° W
P-1
P-2B
P-4A
P-5
P-6
P-7A
P-8B
P-9
P-10
COUNTY SW Pasco LAT. 281104 LONG. 0823120
T 26S R 18E SEC. 33 NW 1/4 NW 1/4 NW 1/4
Pumped WELL No. P-3A DEPTH: WELL 704 ft, CASING 78 ft
DIA. 14 in ALT. OF W/L 48.87 ft DATE 6-28-71
AQUIFER Floridan RADIUS Q 1900 gpm
DRAWDOWN X RECOVERY SP CAPACITY 403 gpm/ft
TYPE OF ANALYSIS Anisotropic
DATA CORRECTIONS
T S 8x10^-4 K'/b'
LOGS
CHEMICAL ANALYSES
REMARKS Mass plot
DRAWDOWN (s), IN FEET
10
1
0.1
0.01
10^-10
10^-9
10^-8
10^-7
10^-6
t/r² IN DAYS PER FOOT SQUARED

Pasco Well Field (Test 1c), Southwest Pasco County

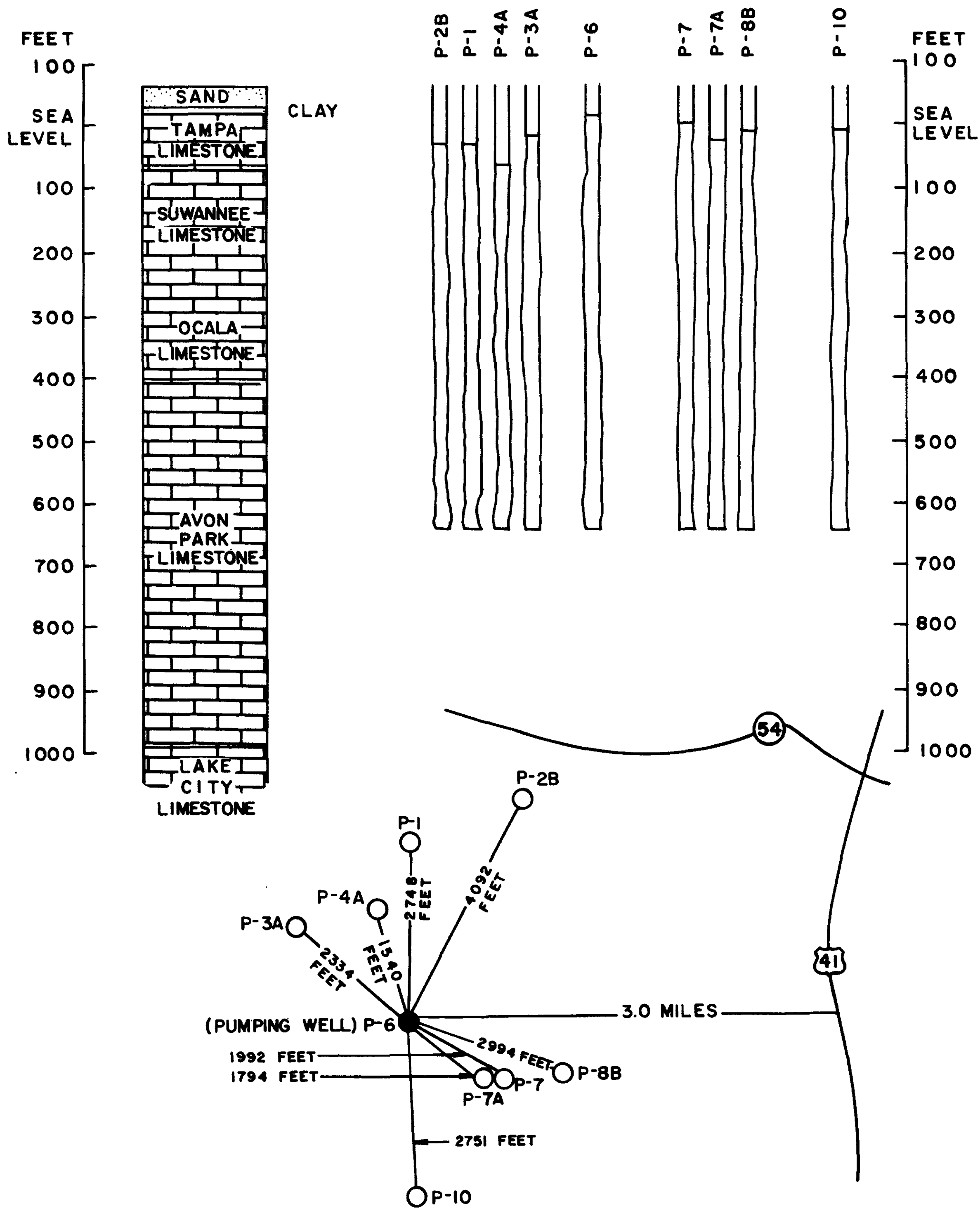
Test period (drawdown and recovery): 1030, 3-5-73 to 1500, 3-21-73.

Aquifer tested: Floridan.

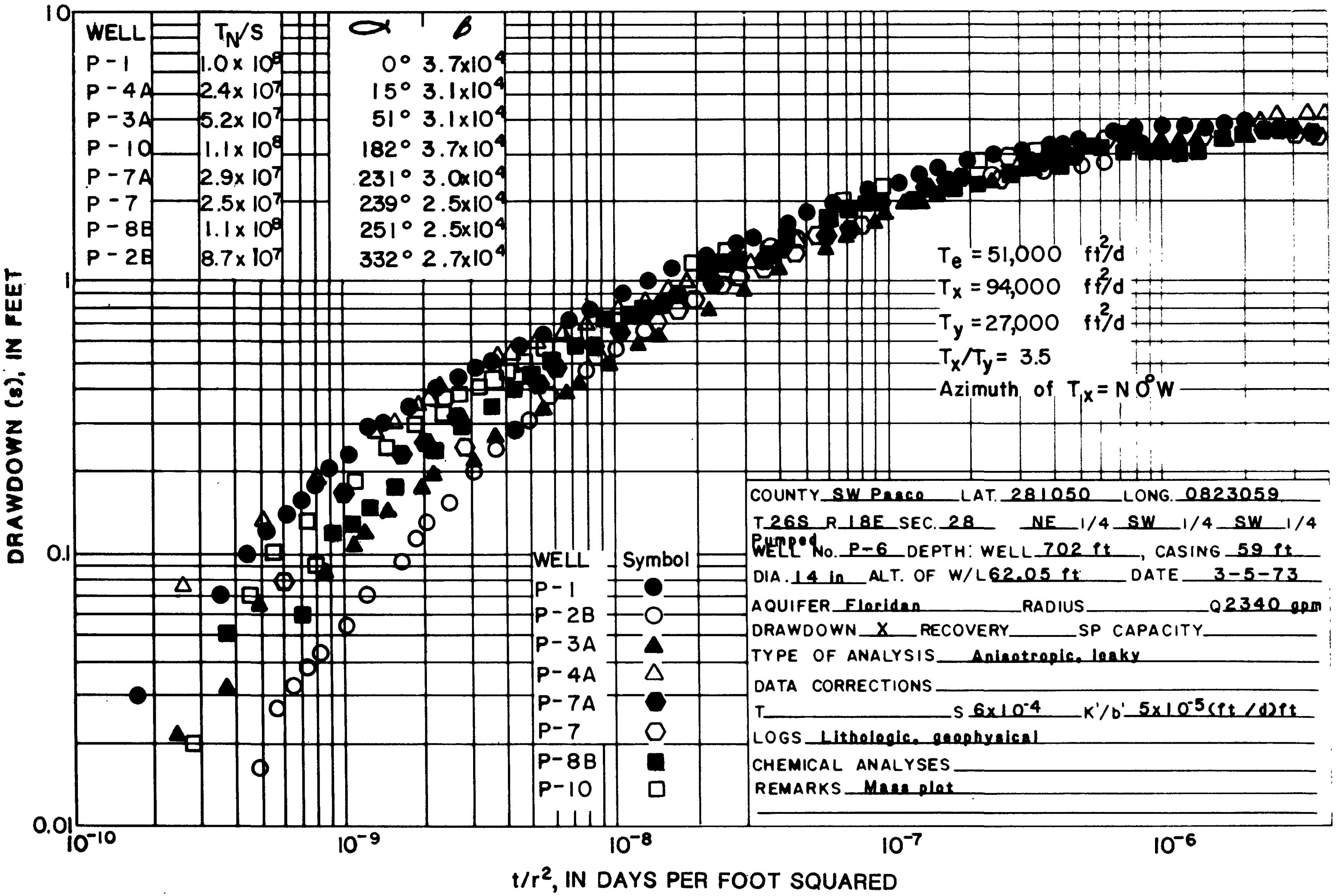
Data corrections applied: Because of absence of control wells in the area, no data corrections were applied.

Test problems: Variation of observation-well drawdown is primarily due to aquifer anisotropy.

Test reliability: Test 1c utilized a pumping well located approximately midway between pumping wells from tests 1a and 1b. An anisotropic analysis yielded aquifer characteristics reasonably similar to tests 1a and 1b. Because test 1c was of longer duration than tests 1a and 1b, a value for leakance was determined.



Pasco well-field location map and well characteristics: 03-05-73 aquifer test (test site 1c).


WELL
P - 1
P - 4A
P - 3A
P - 10
P - 7A
P - 7
P - 8B
P - 2B
T_N/S
1.0 x 10^8
2.4 x 10^7
5.2 x 10^7
1.1 x 10^8
2.9 x 10^7
2.5 x 10^7
1.1 x 10^8
8.7 x 10^7
α
β
0° 3.7x10^4
15° 3.1x10^4
51° 3.1x10^4
182° 3.7x10^4
231° 3.0x10^4
239° 2.5x10^4
251° 2.5x10^4
332° 2.7x10^4
T_e = 51,000 ft²/d
T_x = 94,000 ft²/d
T_y = 27,000 ft²/d
T_x/T_y = 3.5
Azimuth of T_x = N 0° W
WELL Symbol
P - 1
P - 2B
P - 3A
P - 4A
P - 7A
P - 7
P - 8B
P - 10
COUNTY SW Pasco LAT. 281050 LONG. 0823059
T 26S R 18E SEC. 28 NE 1/4 SW 1/4 SW 1/4
Pumped WELL No. P-6 DEPTH: WELL 702 ft, CASING 59 ft
DIA. 14 in ALT. OF W/L 62.05 ft DATE 3-5-73
AQUIFER Floridan RADIUS Q 2340 gpm
DRAWDOWN X RECOVERY SP CAPACITY
TYPE OF ANALYSIS Anisotropic, leaky
DATA CORRECTIONS
T S 6x10^-4 K'/b' 5x10^-5 (ft /d)ft
LOGS Lithologic, geophysical
CHEMICAL ANALYSES
REMARKS Mass plot
10
1
0.1
0.01
10^-10
10^-9
10^-8
10^-7
10^-6
DRAWDOWN (s), IN FEET
t/r², IN DAYS PER FOOT SQUARED

Eldridge-Wilde Well Field (Test 2a), Northeast Pinellas County

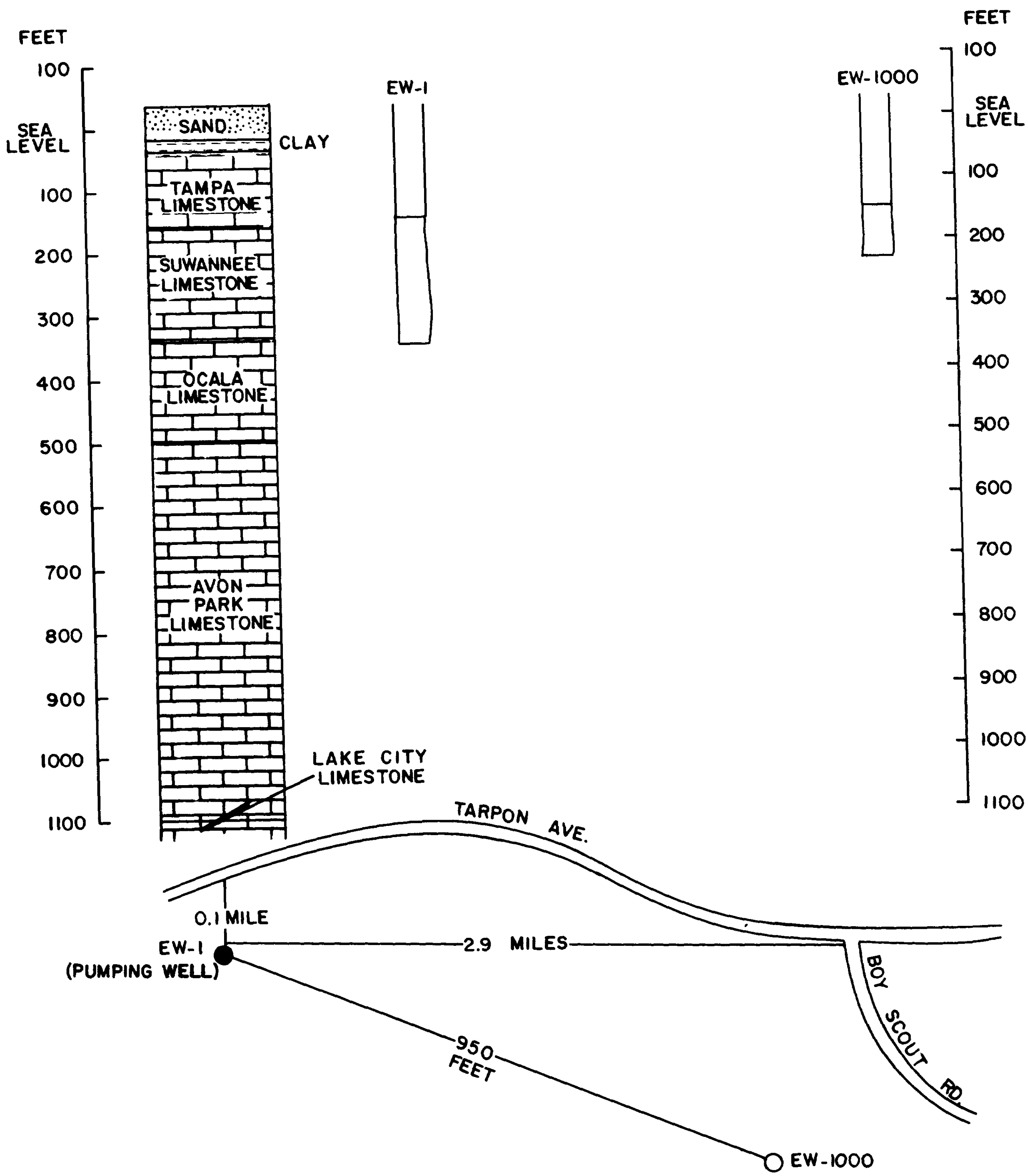
Test period (drawdown and recovery): 1030, 1-8-52 to 1535, 1-9-52.

Aquifer tested: Upper Floridan.

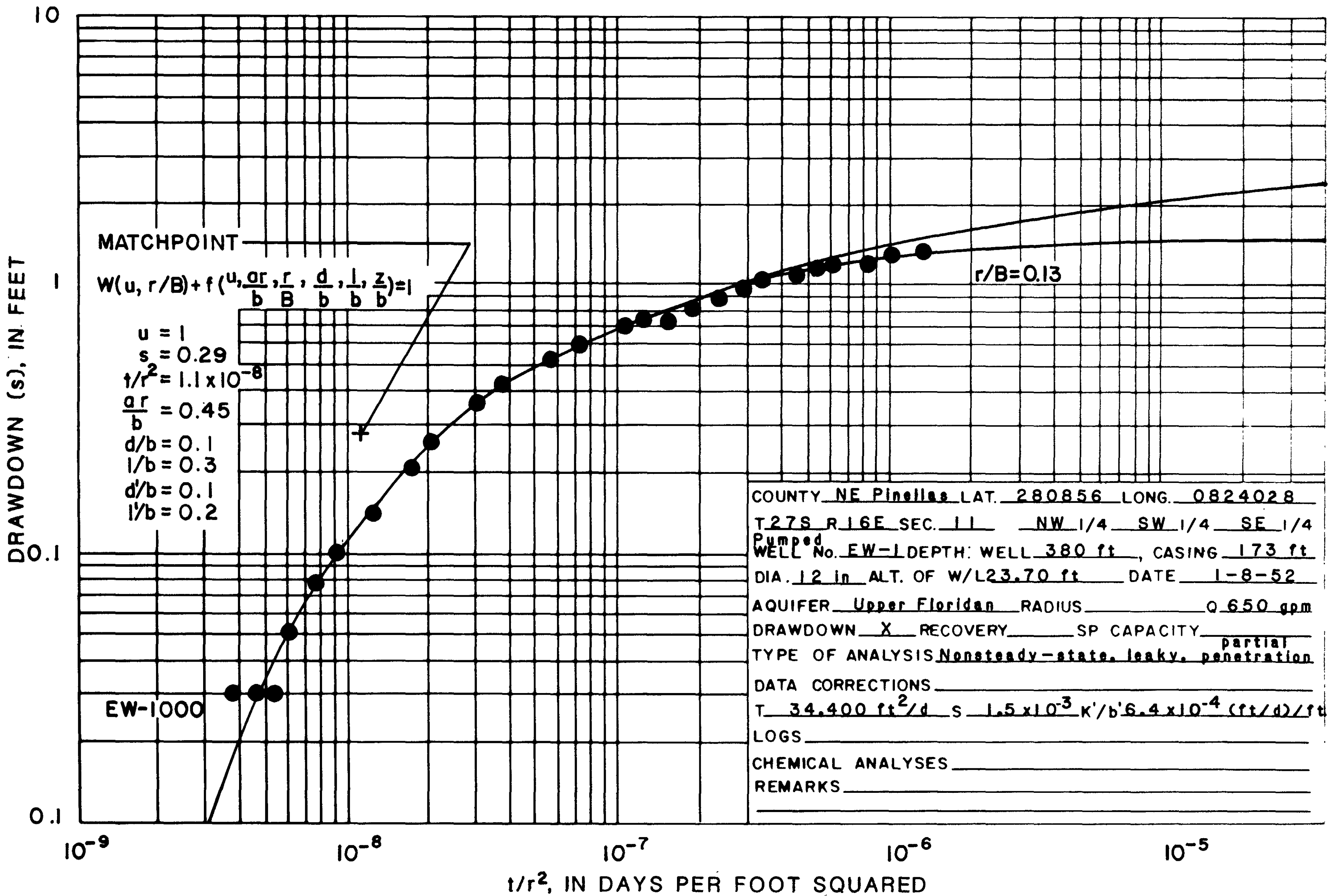
Data corrections applied: Information was not available to correct test data for water-level changes; nevertheless, uncorrected drawdowns were probably not greatly affected by the moderate changes during the test.

Test problems: The pumping and observation wells penetrate less than one half the aquifer thickness and the wells are not the same depth.

Test reliability: The pumping and observation wells partially penetrate a leaky aquifer. Therefore, an analytical method that accounts for the vertical flow in the aquifer due to partially penetrating a leaky aquifer was used to determine aquifer characteristics. The transmissivity, storage coefficient, and leakance are representative of the aquifer in the area.



Eldridge-Wilde well-field location map and well characteristics: 01-08-52 aquifer test (test site 2a).



MATCHPOINT
W(u, r/B) + f(u, ar/b, r/B, d/b, l/b, z/b) = 1
u = 1
s = 0.29
t/r² = 1.1 x 10⁻⁸
ar/b = 0.45
d/b = 0.1
l/b = 0.3
d'/b = 0.1
l'/b = 0.2
EW-1000
r/B = 0.13
COUNTY NE Pinellas LAT. 280856 LONG. 0824028
T 27S R 16E SEC. 11 NW 1/4 SW 1/4 SE 1/4
Pumped WELL No. EW-1 DEPTH: WELL 380 ft , CASING 173 ft
DIA. 12 in ALT. OF W/L 23.70 ft DATE 1-8-52
AQUIFER Upper Floridan RADIUS Q 650 gpm
DRAWDOWN X RECOVERY SP CAPACITY
TYPE OF ANALYSIS Nonsteady-state, leaky, partial penetration
DATA CORRECTIONS
T 34,400 ft²/d S 1.5 x 10⁻³ K'/b' 6.4 x 10⁻⁴ (ft/d)/ft
LOGS
CHEMICAL ANALYSES
REMARKS
DRAWDOWN (s), IN FEET
10
1
0.1
0.1
10⁻⁹
10⁻⁸
10⁻⁷
10⁻⁶
10⁻⁵
t/r², IN DAYS PER FOOT SQUARED

Eldridge-Wilde Well Field (Test 2b), Northeast Pinellas County

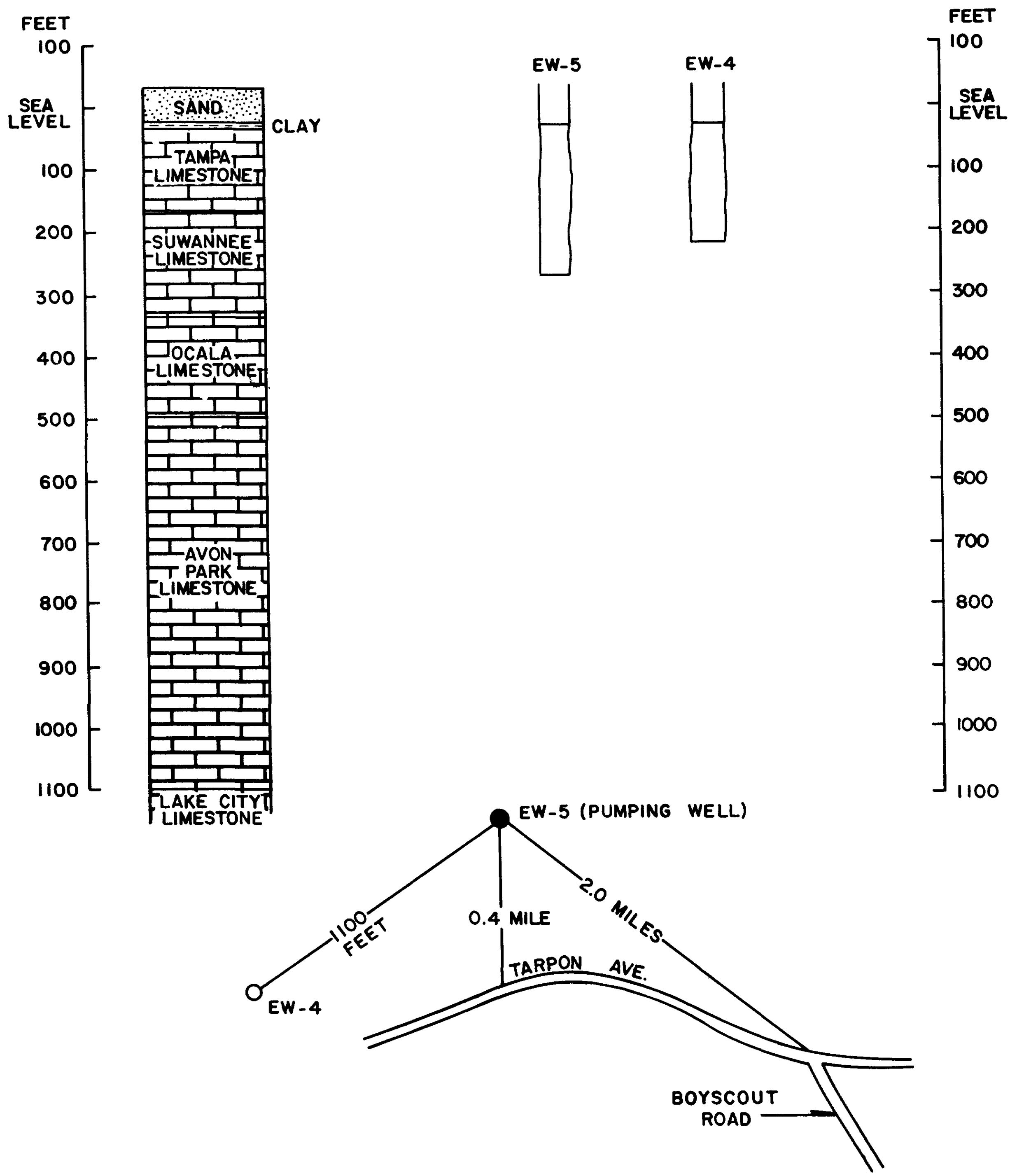
Test period (drawdown and recovery): 1000, 8-25-54 to 1300, 8-28-54.

Aquifer tested: Upper Floridan.

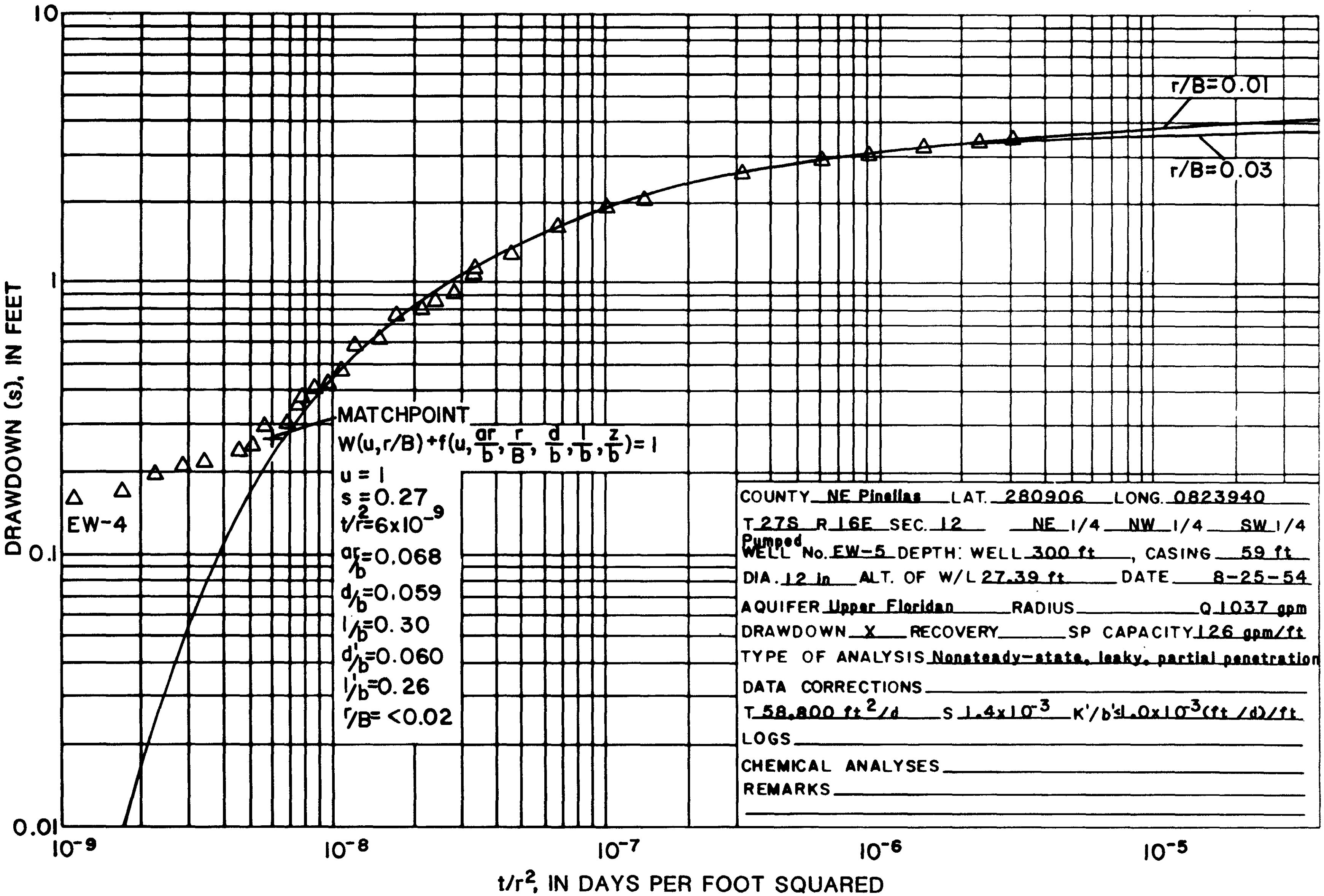
Data corrections applied: Due to the moderate water-level changes during the test period and the short duration of the test, no data corrections were applied.

Test problems: Pumping and observation wells penetrate less than one half the aquifer thickness, and they are not the same depth.

Test reliability: The pumping and observation wells partially penetrate a leaky aquifer. Therefore, an analytical method that accounts for the vertical flow in the aquifer due to partially penetrating a leaky aquifer was used to determine aquifer characteristics. The transmissivity, storage coefficient, and leakance are representative of the aquifer in the area.



Eldridge-Wilde well-field location map and well characteristics: 08-25-54 aquifer test (test site 2b).


DRAWDOWN (s), IN FEET
10
1
0.1
0.01
10⁻⁹
10⁻⁸
10⁻⁷
10⁻⁶
10⁻⁵
t/r², IN DAYS PER FOOT SQUARED
r/B=0.01
r/B=0.03
EW-4
MATCHPOINT
W(u,r/B)+f(u, ar/b, r/B, d/b, l/b, z/b)=1
u = 1
s = 0.27
t/r² = 6x10⁻⁹
ar/b = 0.068
d/b = 0.059
l/b = 0.30
d'/b = 0.060
l'/b = 0.26
r/B = <0.02
COUNTY NE Pinellas LAT. 280906 LONG. 0823940
T 27S R 16E SEC. 12 NE 1/4 NW 1/4 SW 1/4
Pumped WELL No. EW-5 DEPTH: WELL 300 ft , CASING 59 ft
DIA. 12 in ALT. OF W/L 27.39 ft DATE 8-25-54
AQUIFER Upper Floridan RADIUS Q 1037 gpm
DRAWDOWN X RECOVERY SP CAPACITY 126 gpm/ft
TYPE OF ANALYSIS Nonsteady-state, leaky, partial penetration
DATA CORRECTIONS
T 58,800 ft²/d S 1.4x10⁻³ K'/b' 1.0x10⁻³ (ft/d)/ft
LOGS
CHEMICAL ANALYSES
REMARKS

Dundee Ranch Test Site (Test 3a), Northwest Hillsborough County

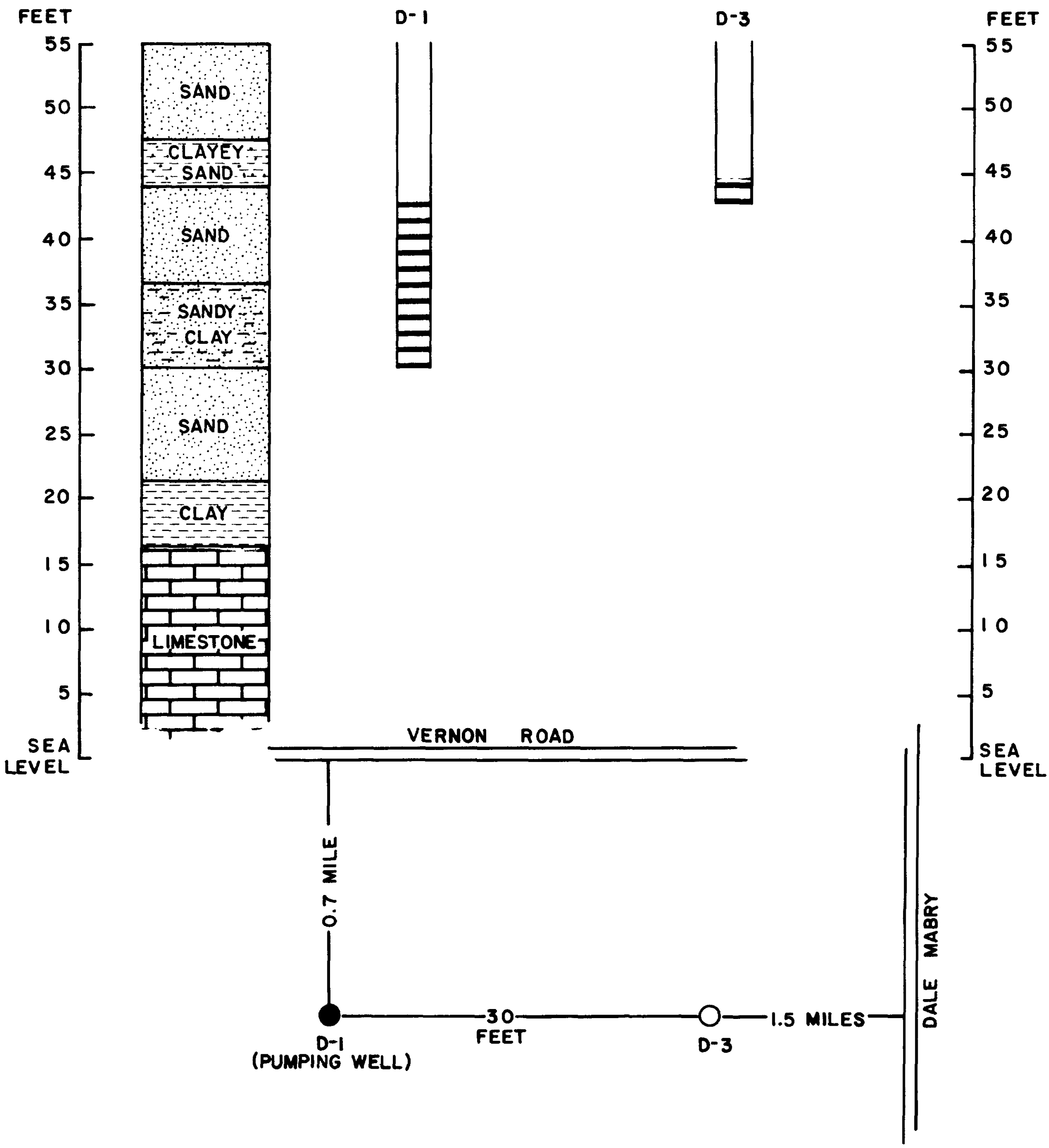
Test period (drawdown and recovery): 1120, 4-21-72 to 0630, 4-22-72.

Aquifer tested: Surficial.

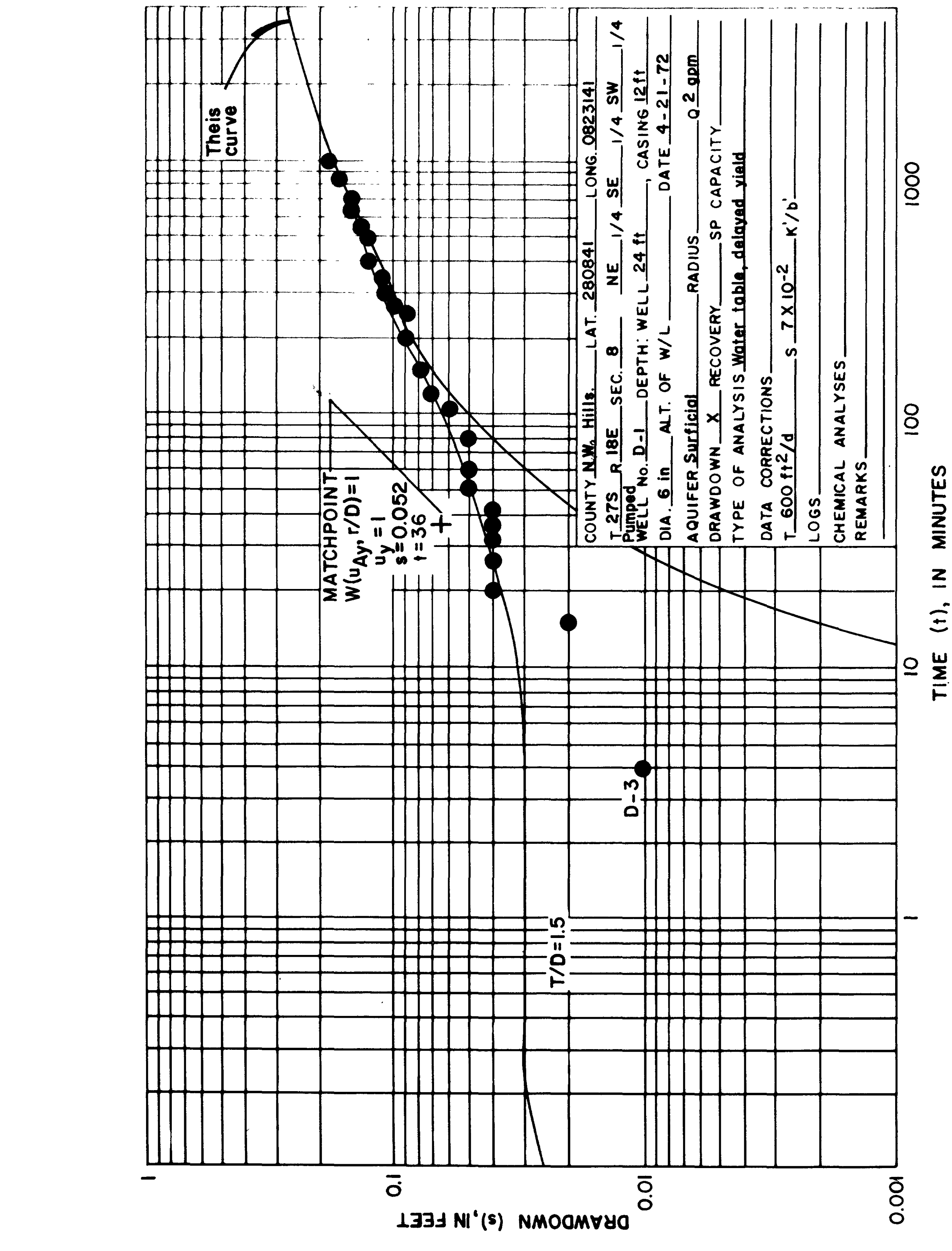
Data corrections applied: None applied. However, because of the moderate water-level changes and the short duration of the test, the test data are probably reliable.

Test problems: Low pumping rate produced small drawdowns. Aquifer response shows delayed yield from storage due to gravity drainage.

Test reliability: Although the drawdown is erratic during the early part of the aquifer test, the transmissivity and storage coefficient determined from the late part of the test are representative of the lithology tested.



Dundee Ranch well-field location map and well characteristics: 04-21-72 aquifer test (test site 3a).


Theis curve
MATCHPOINT
W(u_Ay, r/D)=1
u_y = 1
s = 0.052
t = 36
T/D=1.5
D-3
COUNTY N.W. Hills. LAT. 280841 LONG. 0823141
T 27S R 18E SEC. 8 NE 1/4 SE 1/4 SW 1/4
Pumped WELL No. D-1 DEPTH: WELL 24 ft , CASING 12 ft
DIA. 6 in ALT. OF W/L DATE 4-21-72
AQUIFER Surficial RADIUS Q 2 gpm
DRAWDOWN X RECOVERY SP CAPACITY
TYPE OF ANALYSIS Water table, delayed yield
DATA CORRECTIONS
T 600 ft²/d S 7 X 10-2 K'/b'
LOGS
CHEMICAL ANALYSES
REMARKS
1
0.1
0.01
0.001
DRAWDOWN (s), IN FEET
1
10
100
1000
TIME (t), IN MINUTES

Dundee Ranch Test Site (Test 3b), Northwest Hillsborough County

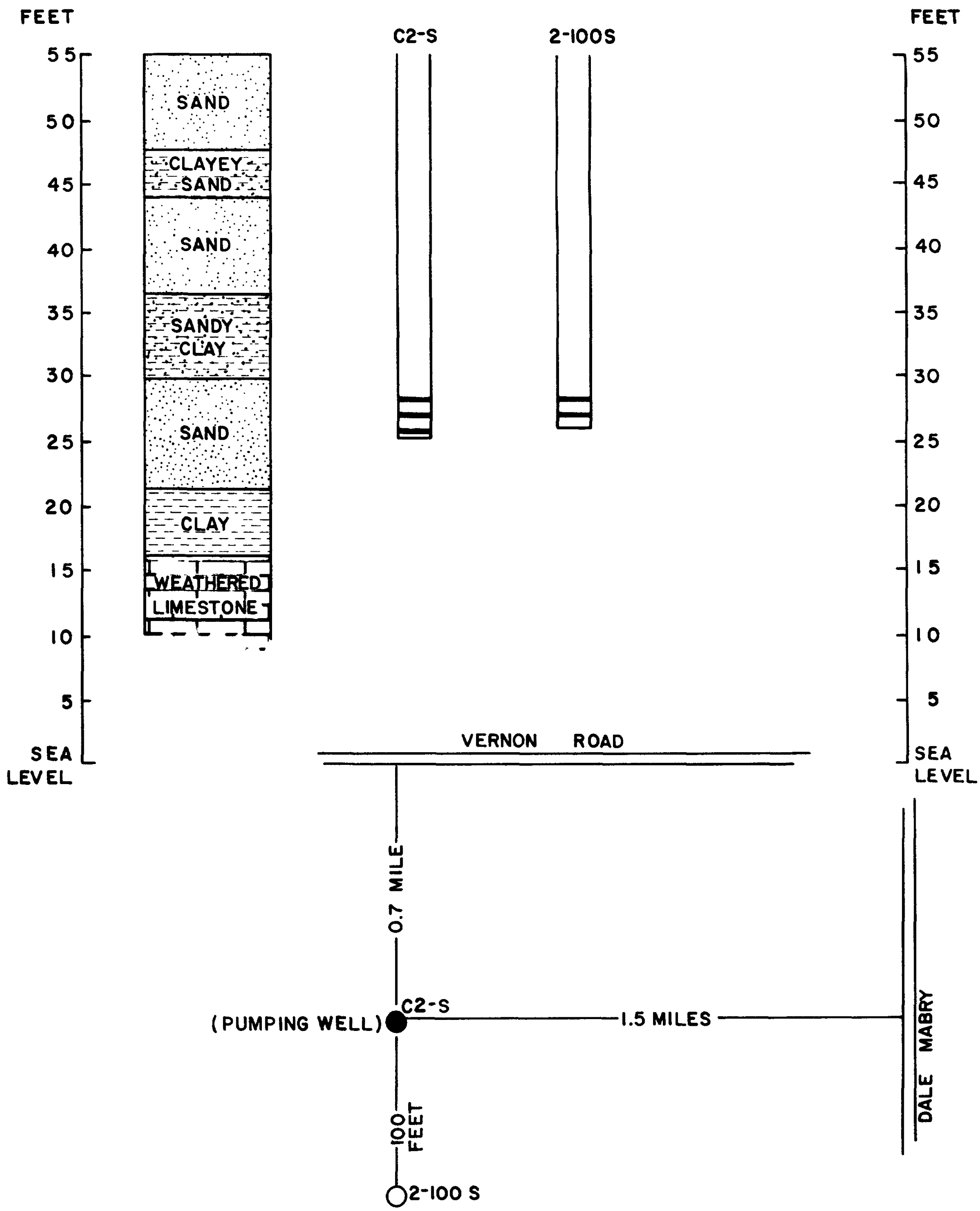
Test period (drawdown and recovery): 0945, 3-15-73 to 1645, 3-18-73.

Aquifer tested: Surficial.

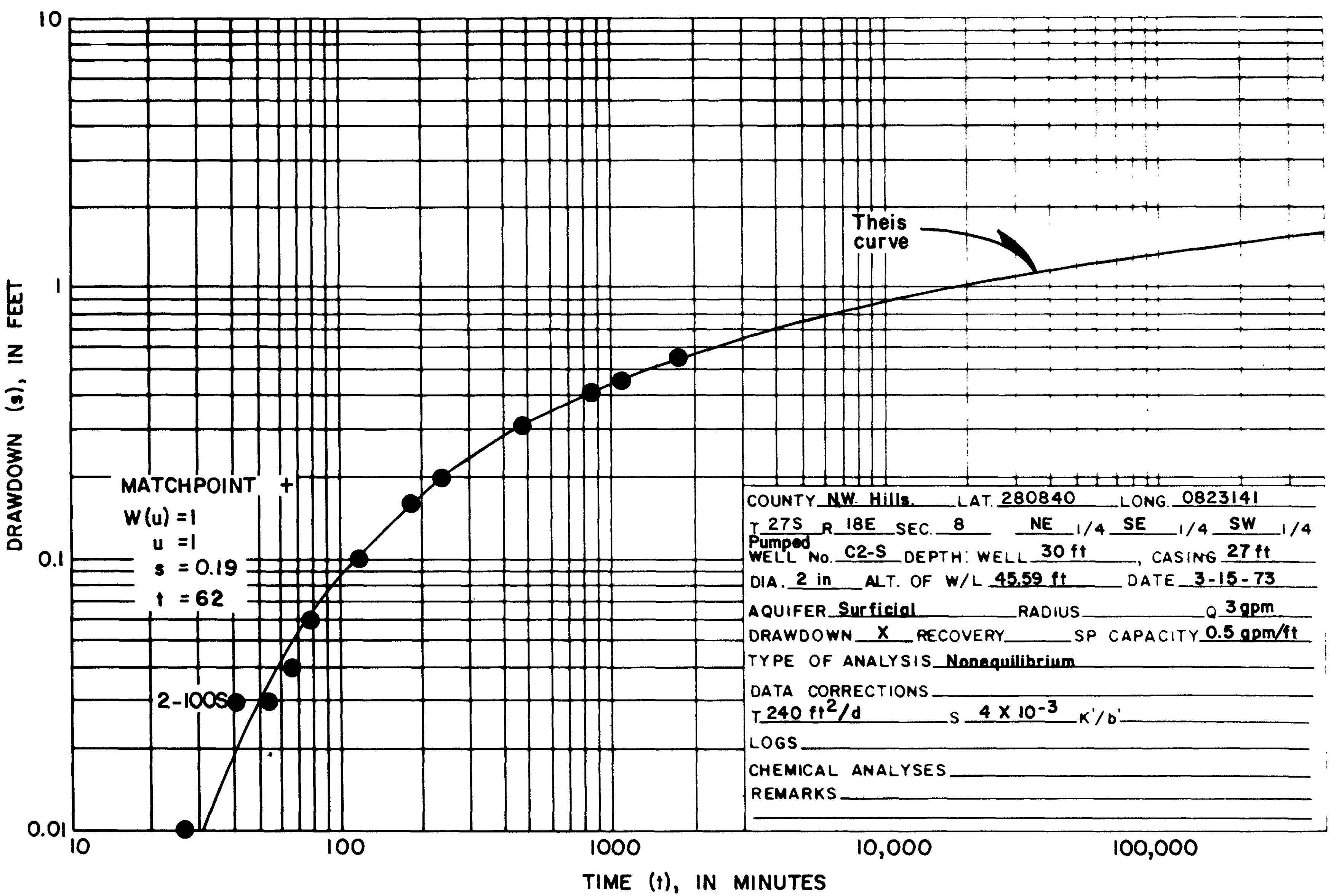
Data corrections applied: None applied. However, water-level changes were moderate during the test period.

Test problems: Test wells partially penetrate the lower part of a stratified aquifer. The sand layer that the pumping well is open to is locally confined.

Test reliability: Transmissivity and storage coefficient determined from the nonequilibrium method are representative of the aquifer considering its lithology and thickness. Although the storage coefficient is not within the common probable range of confined aquifers, it is still considered to be reasonable because the specific storage of unconsolidated sand and clay is approximately 1×10^{-4} per foot. With aquifer thickness of about 30 feet, the storage coefficient determined by multiplying the aquifer thickness by the specific storage is approximately 3×10^{-3}, which compares favorably to the value of 4×10^{-3} determined from the aquifer test.



Dundee Ranch well-field location map and well characteristics: 03-15-73 aquifer test (test site 3b).


10
1
0.1
0.01
DRAWDOWN (s), IN FEET
10
100
1000
10,000
100,000
TIME (t), IN MINUTES
Theis curve
MATCHPOINT +
W(u) = 1
u = 1
s = 0.19
t = 62
2-100S
COUNTY NW. Hills. LAT. 280840 LONG. 0823141
T 27S R 18E SEC. 8 NE 1/4 SE 1/4 SW 1/4
Pumped WELL No. C2-S DEPTH: WELL 30 ft, CASING 27 ft
DIA. 2 in ALT. OF W/L 45.59 ft DATE 3-15-73
AQUIFER Surficial RADIUS Q 3 gpm
DRAWDOWN X RECOVERY SP CAPACITY 0.5 gpm/ft
TYPE OF ANALYSIS Nonequilibrium
DATA CORRECTIONS
T 240 ft2/d S 4 X 10-3 K'/b'
LOGS
CHEMICAL ANALYSES
REMARKS

Dundee Ranch Test Site (Test 3c), Northwest Hillsborough County

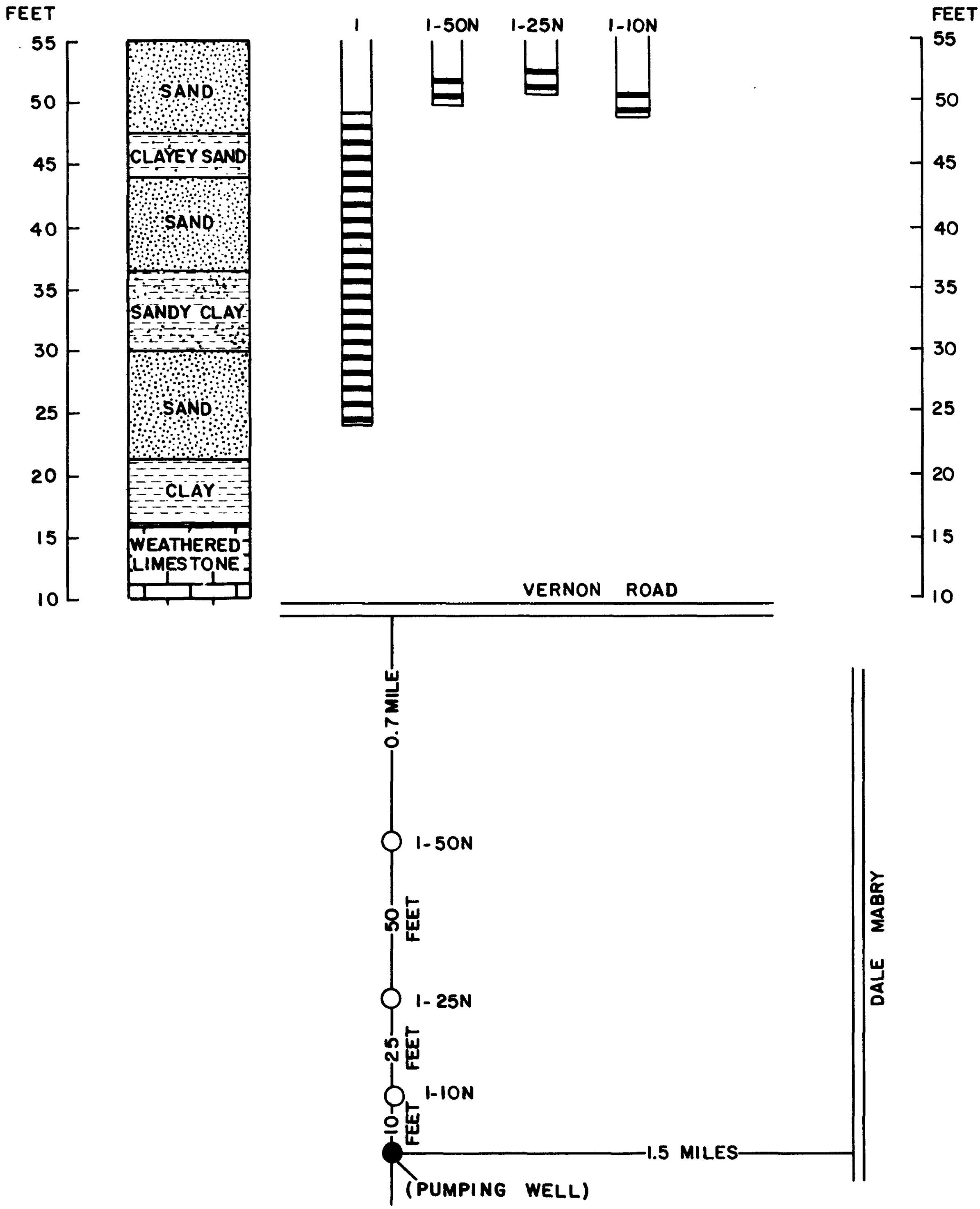
Test period (drawdown and recovery): 1200, 4-22-74 to 1600, 5-6-74.

Aquifer tested: Surficial.

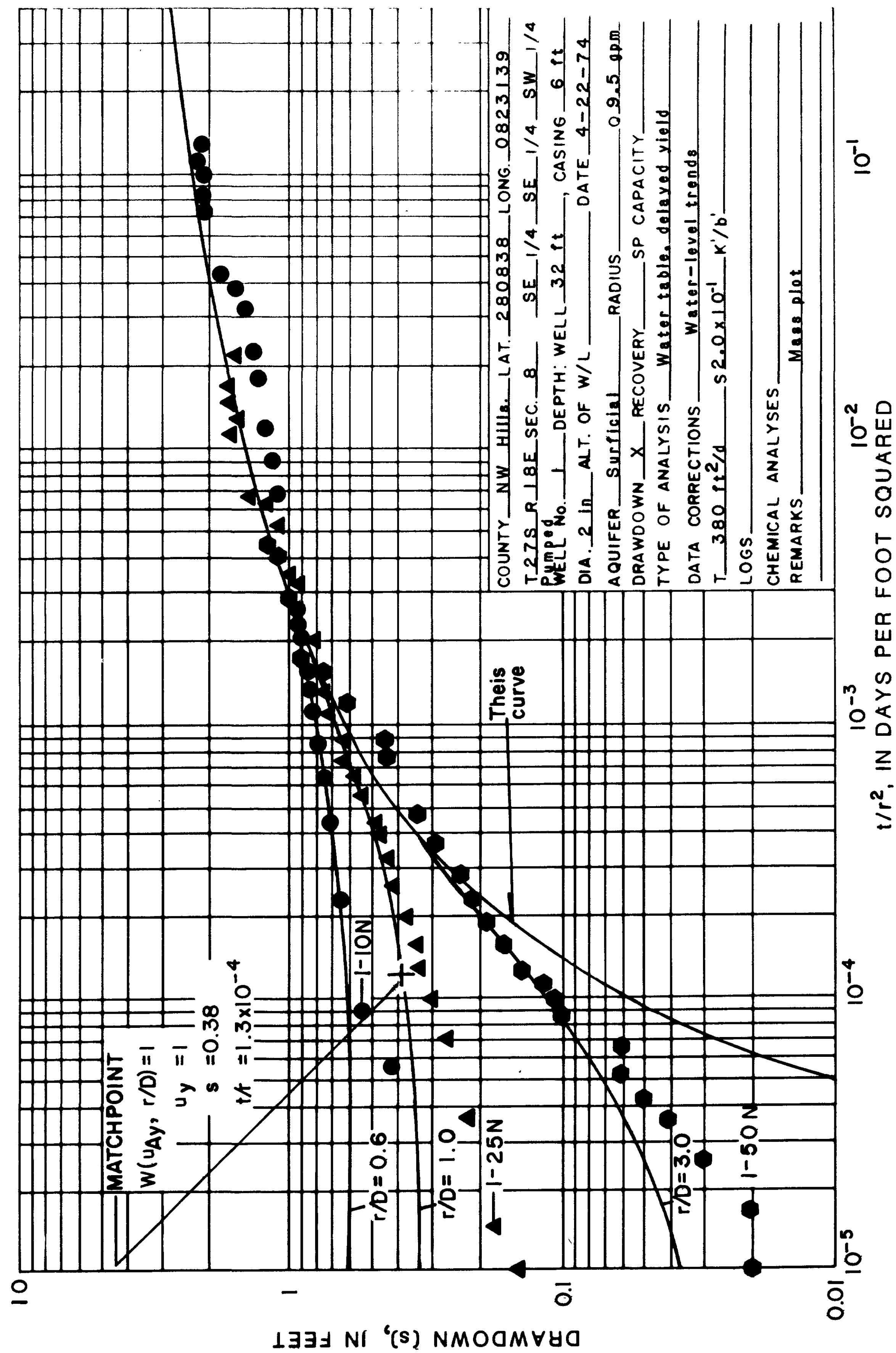
Data corrections applied: Observed data were corrected for water-level changes with available information from area wells.

Test problems: Observation wells were not open to the same zones of the surficial aquifer as the pumping well. Aquifer is highly stratified, and aquifer response shows delayed yield from storage due to gravity drainage.

Test reliability: Aquifer characteristics determined from the test are representative of the lithology tested.



Dundee Ranch well-field location map and well characteristics: 04-22-74 aquifer test (test site 3c).


MATCHPOINT
W(u_Ay, r/D)=1
u_y = 1
s = 0.38
t/r² = 1.3x10^-4
r/D=0.6
r/D=1.0
r/D=3.0
1-10N
1-25N
1-50N
Theis curve
10
1
0.1
0.01
10^-5
10^-4
10^-3
10^-2
10^-1
DRAWDOWN (s), IN FEET
t/r², IN DAYS PER FOOT SQUARED
COUNTY NW Hills. LAT. 280838 LONG. 0823139
T 27S R 18E SEC. 8 SE 1/4 SE 1/4 SW 1/4
Pumped WELL No. 1 DEPTH: WELL 32 ft, CASING 6 ft
DIA. 2 in ALT. OF W/L DATE 4-22-74
AQUIFER Surficial RADIUS Q 9.5 gpm
DRAWDOWN X RECOVERY SP CAPACITY
TYPE OF ANALYSIS Water table, delayed yield
DATA CORRECTIONS Water-level trends
T 380 ft²/d S 2.0x10^-1 K'/b'
LOGS
CHEMICAL ANALYSES
REMARKS Mass plot

Section 21 Well Field (Test 4a), Northwest Hillsborough County

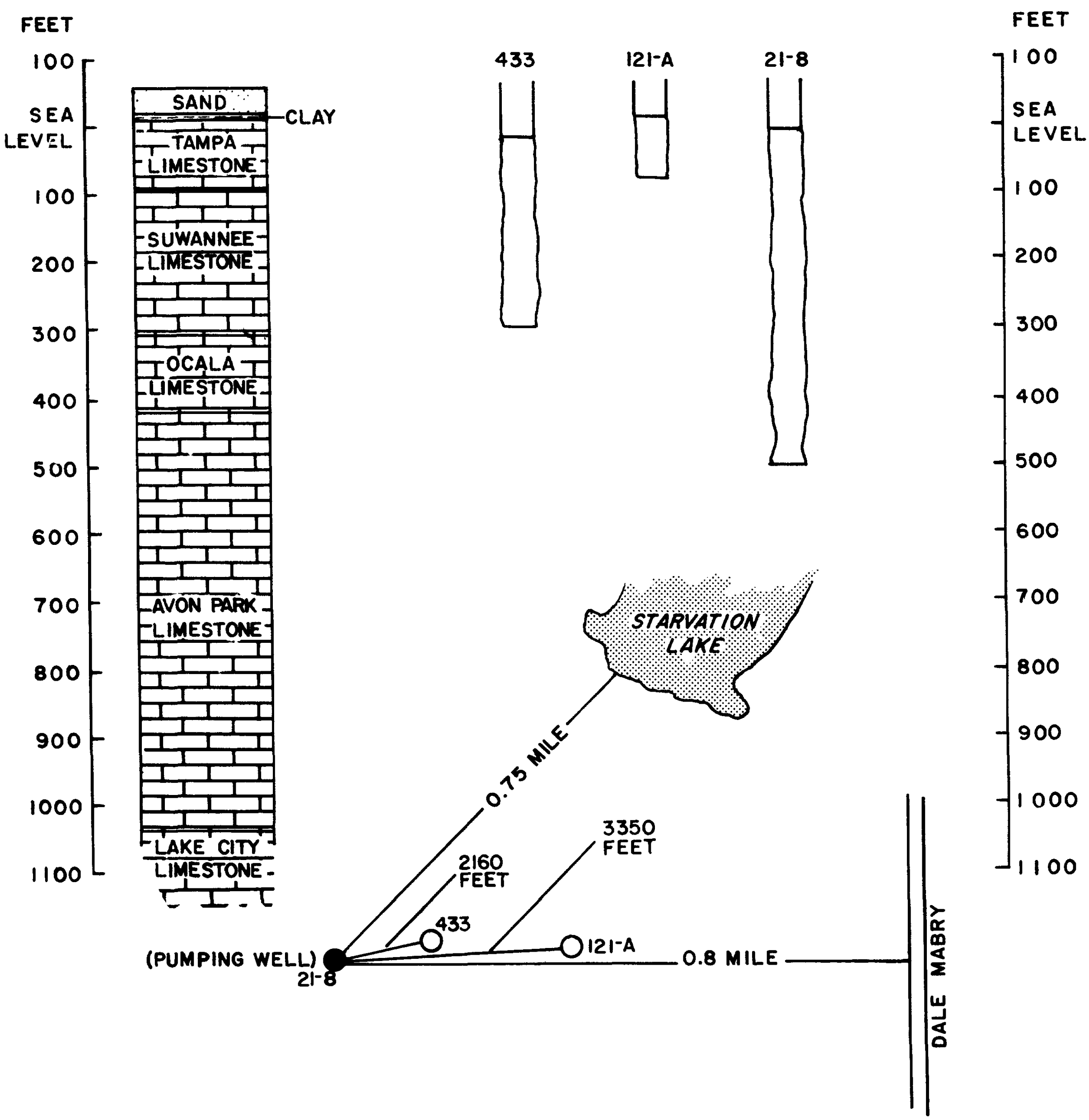
Test period (drawdown and recovery): 1145, 3-15-65 to 2400, 3-28-65.

Aquifer tested: Floridan.

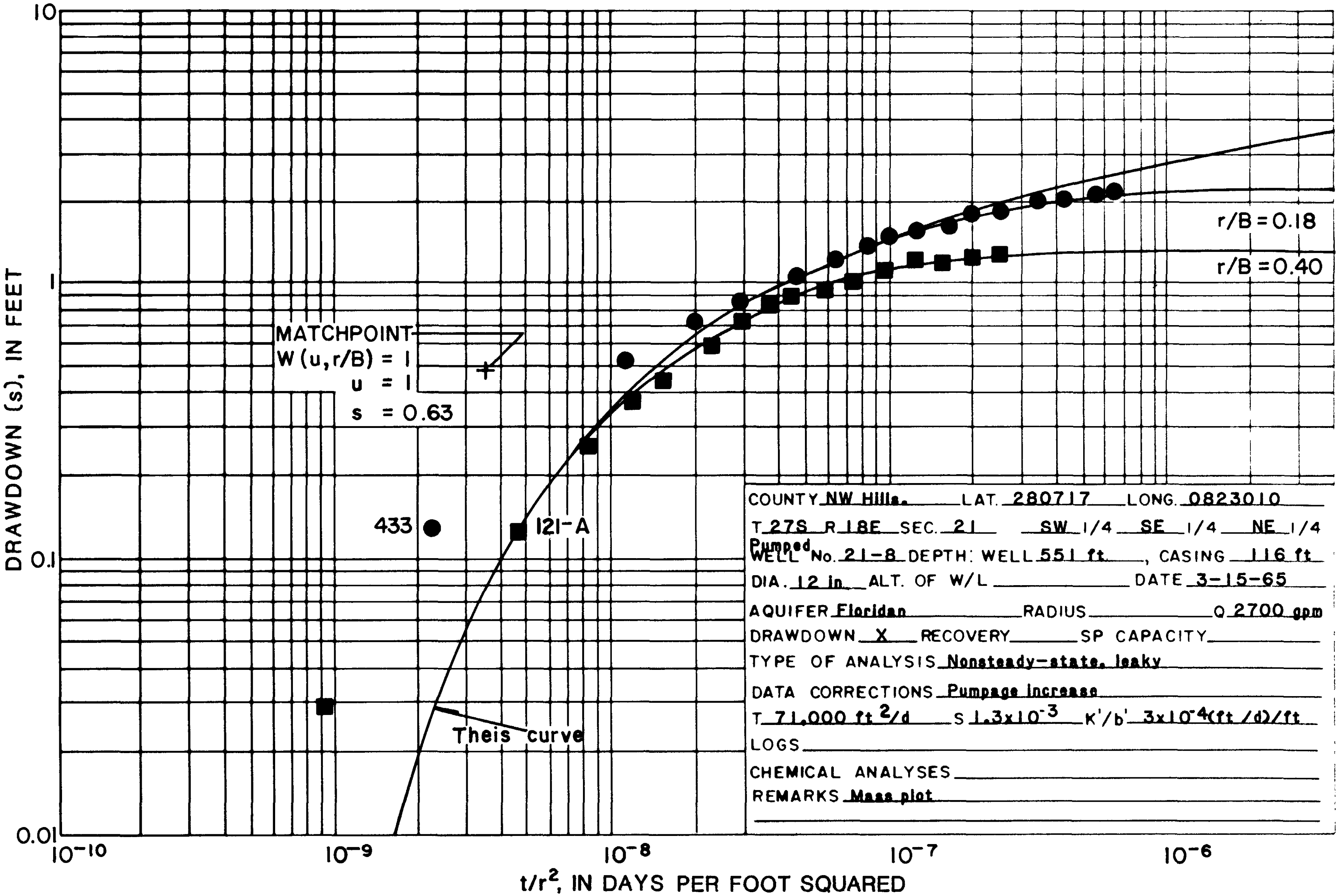
Data corrections applied: None applied. However, water-level changes were slight during the test.

Test problems: Some observation wells were not open to the same formations of the aquifer as the pumping well. Pumping rate increased from 2,700 to 5,400 gal/min after 3 days of pumping and was erratic for the test period.

Test reliability: Aquifer characteristics are within the plausible range for the Floridan aquifer in the test area.



Section 21 well-field location map and well characteristics: 03-15-65 aquifer test (test site 4a).


10
1
0.1
0.01
DRAWDOWN (s), IN FEET
10^-10
10^-9
10^-8
10^-7
10^-6
t/r², IN DAYS PER FOOT SQUARED
MATCHPOINT
W (u, r/B) = 1
u = 1
s = 0.63
433
121-A
Theis curve
r/B = 0.18
r/B = 0.40
COUNTY NW Hills. LAT. 280717 LONG. 0823010
T 27S R 18E SEC. 21 SW 1/4 SE 1/4 NE 1/4
Pumped WELL No. 21-8 DEPTH: WELL 551 ft, CASING 116 ft
DIA. 12 in. ALT. OF W/L DATE 3-15-65
AQUIFER Floridan RADIUS Q 2700 gpm
DRAWDOWN X RECOVERY SP CAPACITY
TYPE OF ANALYSIS Nonsteady-state, leaky
DATA CORRECTIONS Pumpage increase
T 71,000 ft²/d S 1.3x10⁻³ K'/b' 3x10⁻⁴(ft/d)/ft
LOGS
CHEMICAL ANALYSES
REMARKS Mass plot

Section 21 Well Field (Test 4b), Northwest Hillsborough County

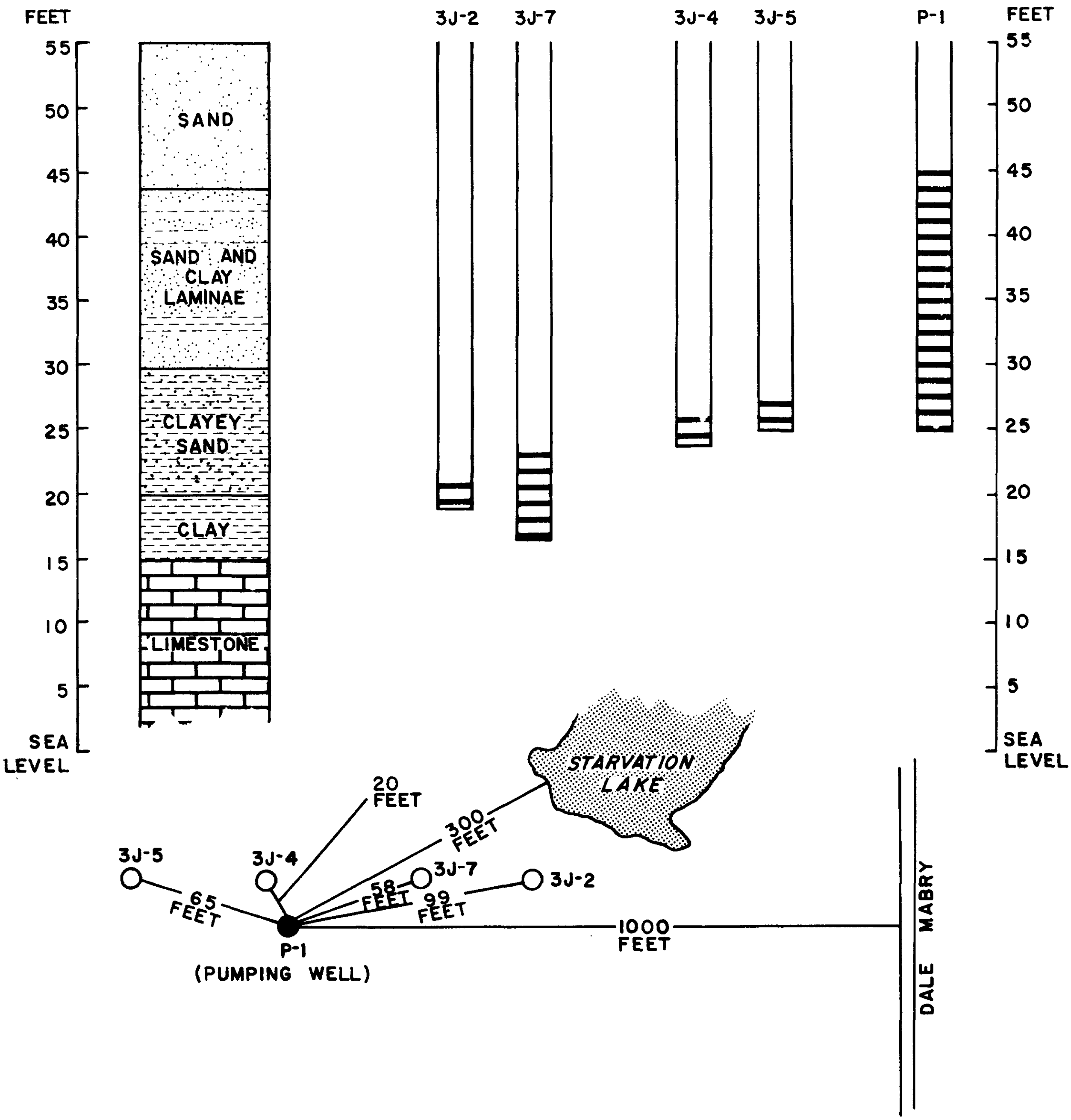
Test period (drawdown and recovery): 1400, 5-24-70 to 1030, 6-4-70.

Aquifer tested: Surficial.

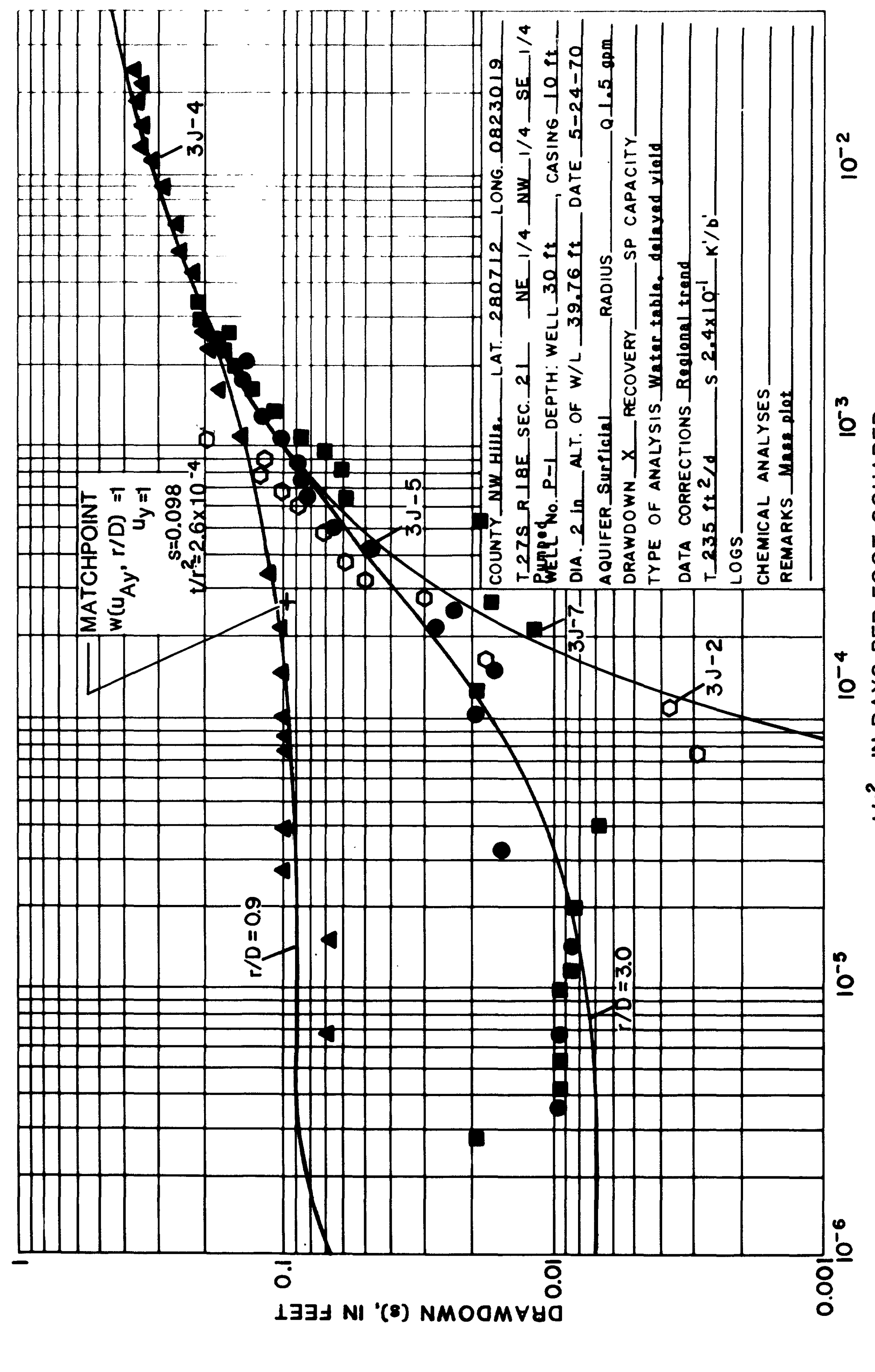
Data corrections applied: Observed data were corrected for water-level changes with available information from area wells.

Test problems: Observation wells were not open to the same zones of the surficial aquifer as the pumping well. Aquifer response shows delayed yield from storage due to gravity drainage.

Test reliability: Aquifer characteristics are within a plausible range for the surficial aquifer in the test area.



Section 21 well-field location map and well characteristics: 05-24-70 aquifer test (test site 4b).


DRAWDOWN (s), IN FEET
1
0.1
0.01
0.001
t/r², IN DAYS PER FOOT SQUARED
10⁻⁶
10⁻⁵
10⁻⁴
10⁻³
10⁻²
MATCHPOINT
W(u_Ay, r/D) =1
u_y =1
s=0.098
t/r²=2.6x10⁻⁴
r/D=0.9
r/D=3.0
3J-4
3J-5
3J-7
3J-2
COUNTY NW Hills. LAT. 280712 LONG. 0823019
T 27S R 18E SEC. 21 NE 1/4 NW 1/4 SE 1/4
Pumped WELL No. P-1 DEPTH: WELL 30 ft, CASING 10 ft
DIA. 2 in ALT. OF W/L 39.76 ft DATE 5-24-70
AQUIFER Surficial RADIUS Q 1.5 gpm
DRAWDOWN X RECOVERY SP CAPACITY
TYPE OF ANALYSIS Water table, delayed yield
DATA CORRECTIONS Regional trend
T 235 ft²/d S 2.4x10⁻¹ K'/b'
LOGS
CHEMICAL ANALYSES
REMARKS Mass plot

Sunset Lake Test Site (Test 5), Northwest Hillsborough County

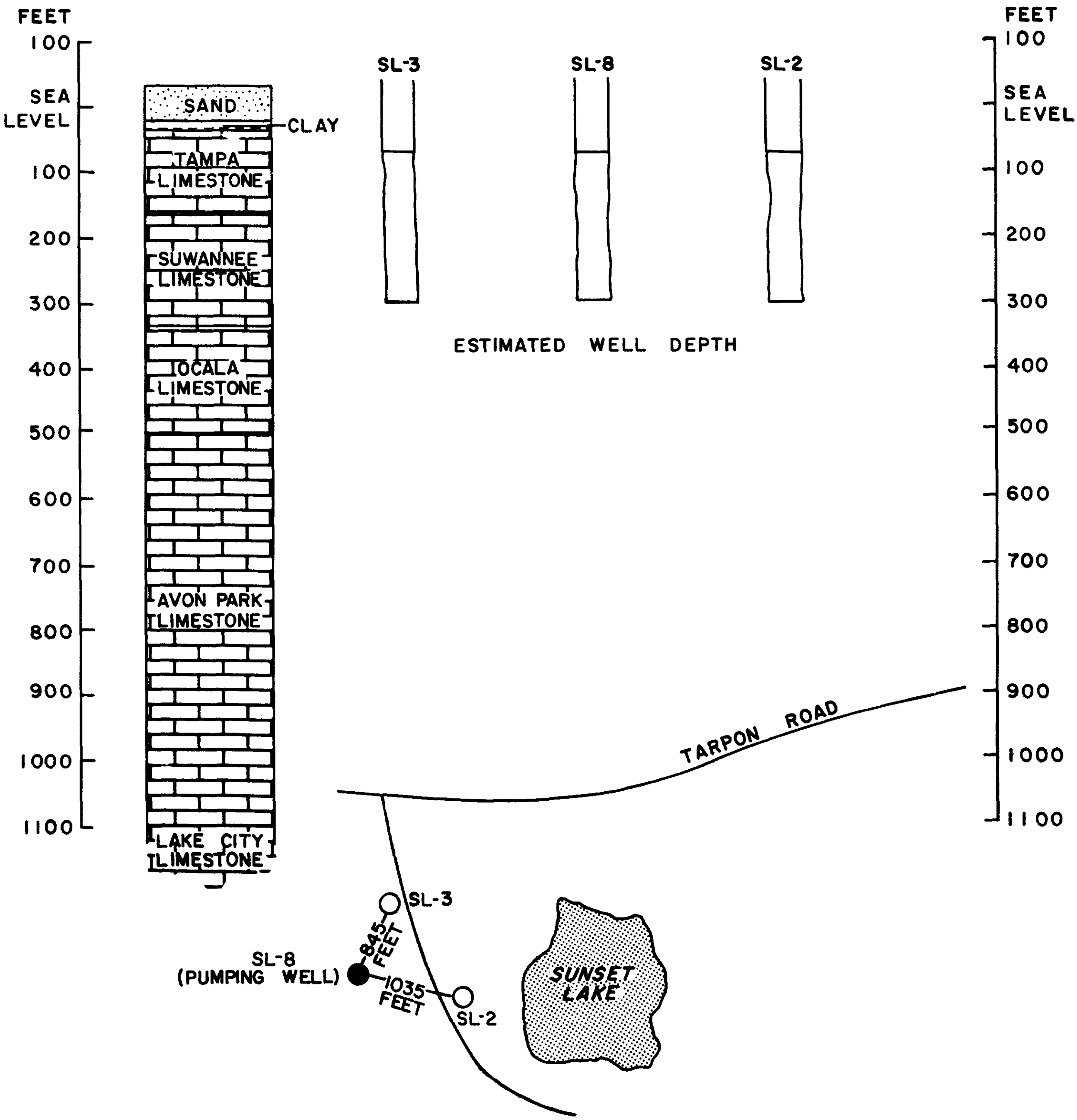
Test period (drawdown and recovery): 1000, 4-12-74 to 1240, 4-13-74.

Aquifer tested: Upper Floridan.

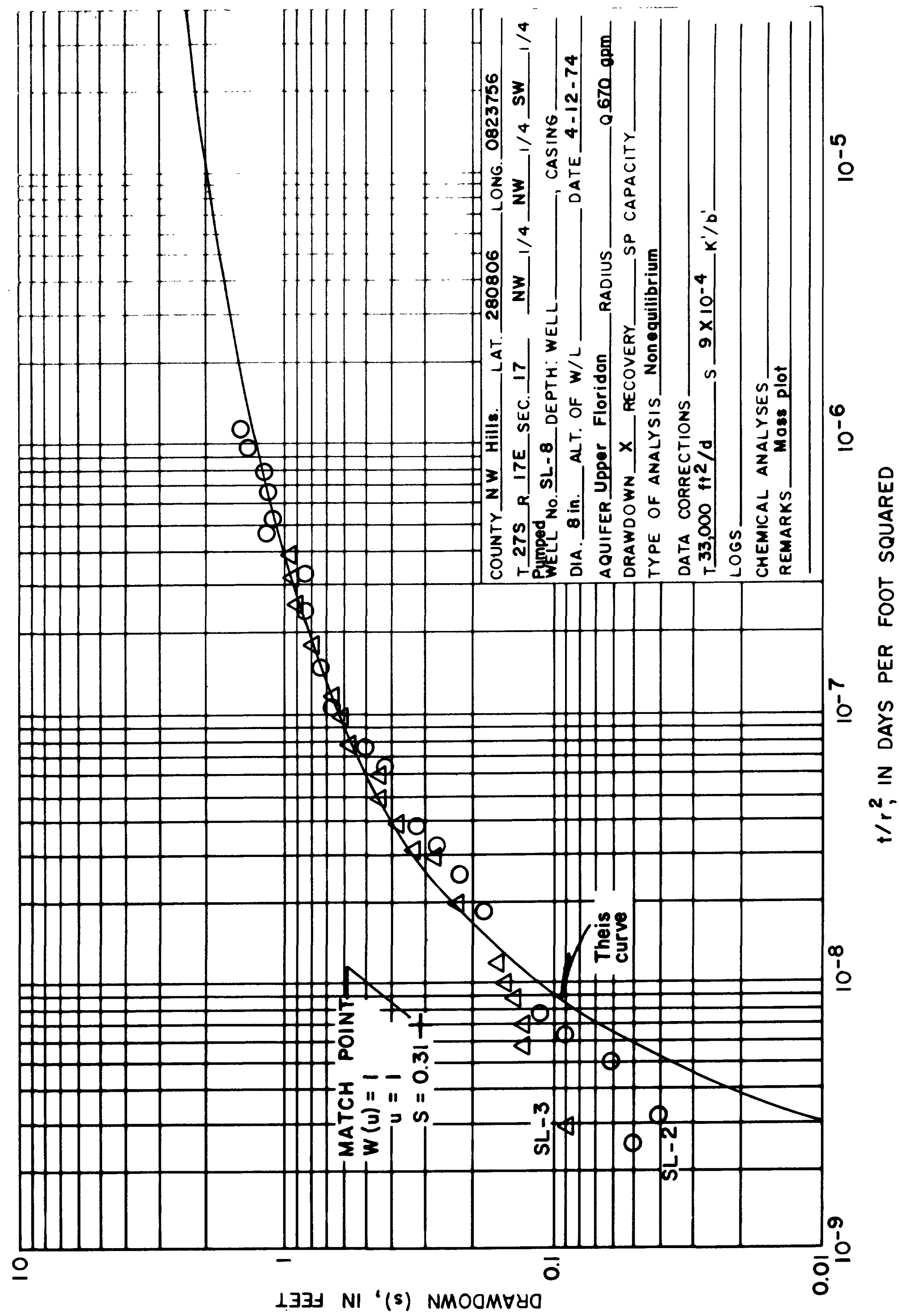
Data corrections applied: None applied. However, due to the short duration of the test, water-level changes caused by trends were probably not significant.

Test problems: The pumping well penetrated only the upper half of the Floridan aquifer; however, the effects of partial penetration are probably insignificant and can be ignored at the distance the observation well is from the pumping well.

Test reliability: Because of partially penetrating wells and aquifer stratification, transmissivity is for that part of the aquifer penetrated. Storage is within the plausible range for the Floridan aquifer. Test was not of long enough duration to determine leakance.



Sunset Lake test site location map and well characteristics: 04-12-74 aquifer test (test site 5).


COUNTY NW Hills. LAT. 280806 LONG. 0823756
T 27S R 17E SEC. 17 NW 1/4 NW 1/4 SW 1/4
Pumped WELL No. SL-8 DEPTH: WELL , CASING
DIA. 8 in. ALT. OF W/L DATE 4-12-74
AQUIFER Upper Floridan RADIUS Q 670 gpm
DRAWDOWN X RECOVERY SP CAPACITY
TYPE OF ANALYSIS Nonequilibrium
DATA CORRECTIONS
T 33,000 ft2/d S 9 X 10-4 K'/b'
LOGS
CHEMICAL ANALYSES
REMARKS Mass plot
MATCH POINT
W(u) = 1
u = 1
S = 0.31
SL-3
SL-2
Theis curve
DRAWDOWN (s), IN FEET
10
1
0.1
0.01
10-9
10-8
10-7
10-6
10-5
t/r2, IN DAYS PER FOOT SQUARED

Morris Bridge Well Field (Test 6a), Northeast Hillsborough County

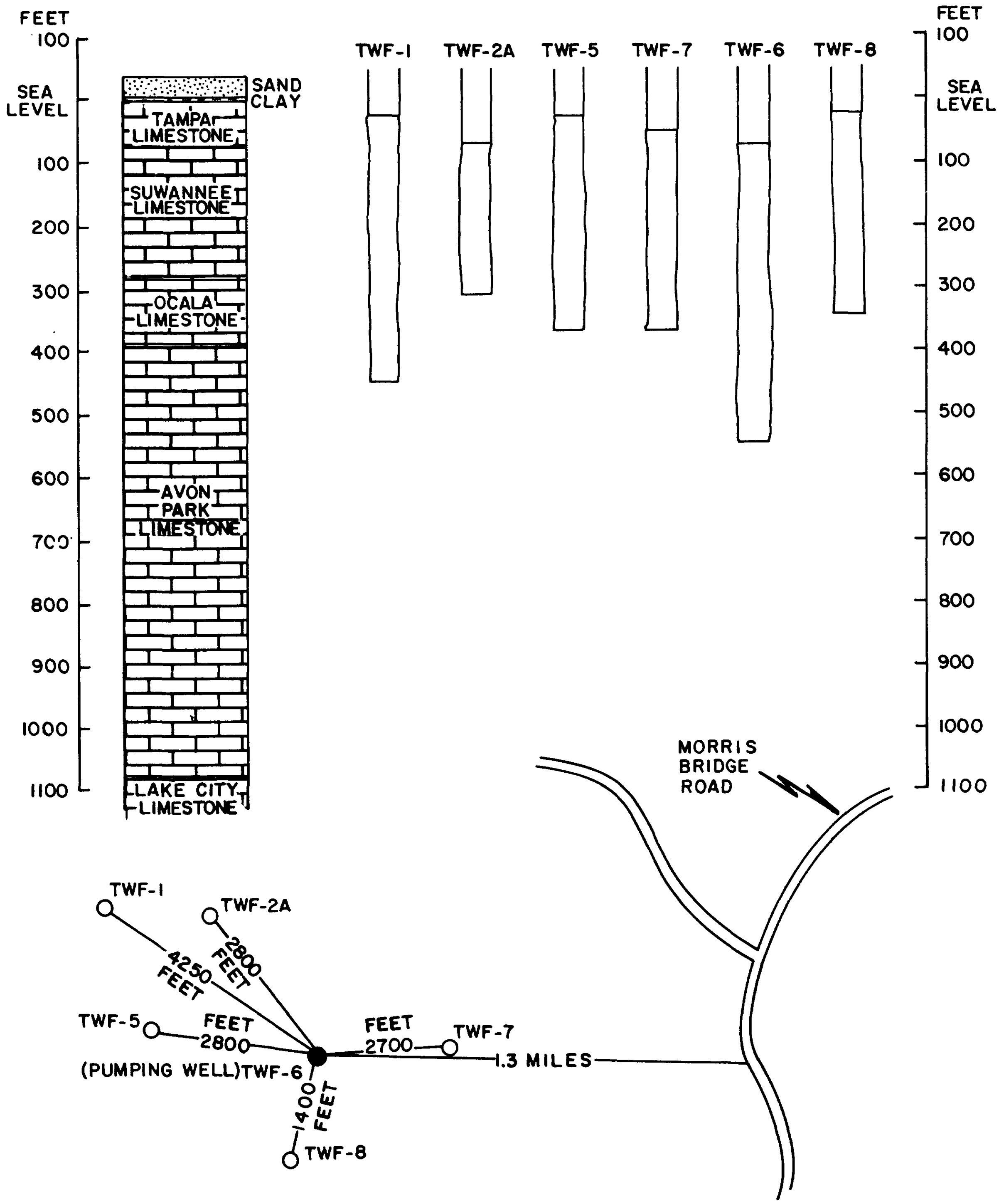
Test period (drawdown and recovery): 1030, 9-21-70 to 2400, 9-26-70.

Aquifer tested: Floridan.

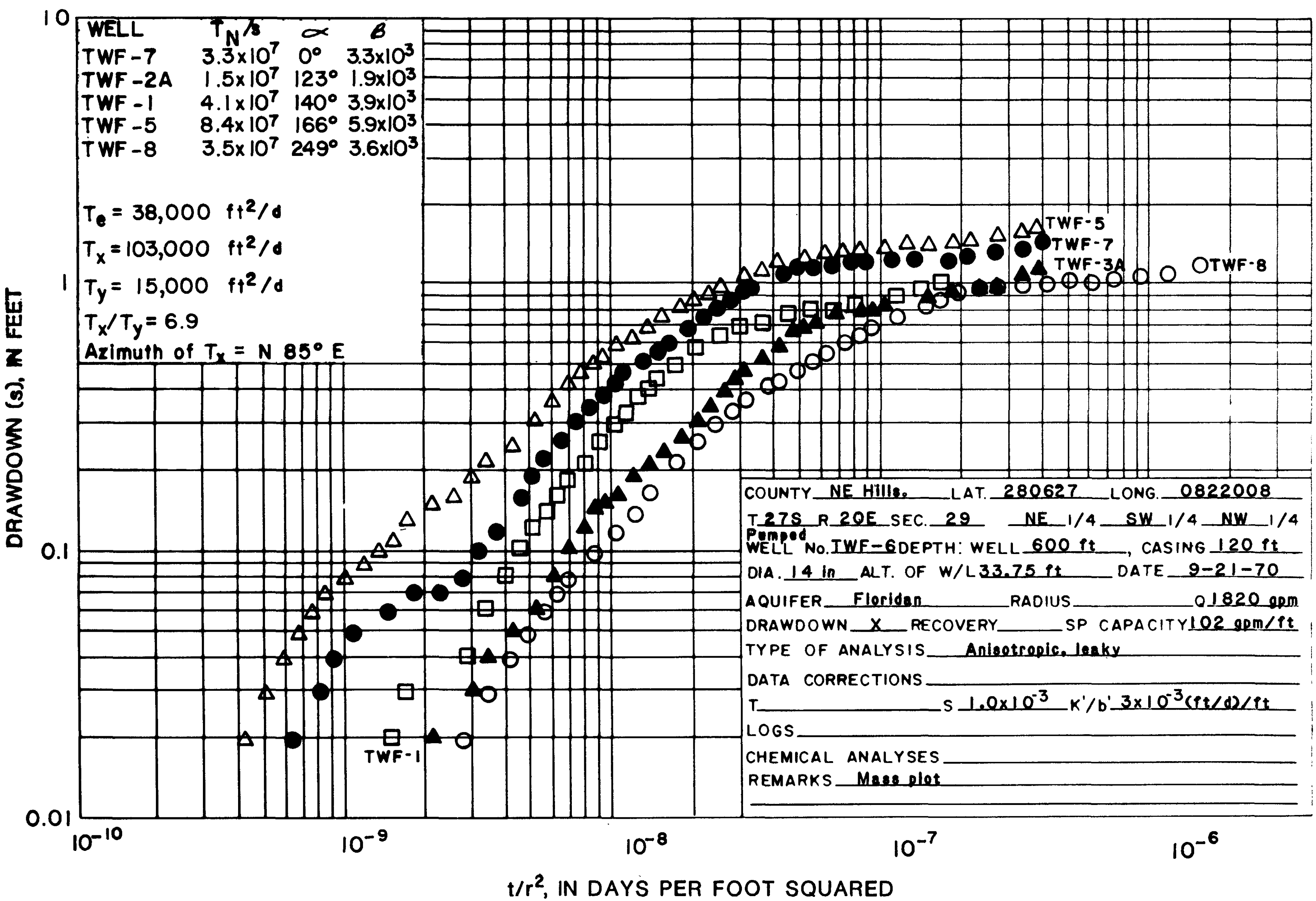
Data corrections applied: None applied. However, water-level changes were slight during the test.

Test problems: Test wells were not at the same depth. Variation of observation-well response is primarily due to aquifer anisotropy.

Test reliability: The Floridan aquifer in the Morris Bridge well field is anisotropic in the horizontal plane. The anisotropy of the aquifer is indicated by the lines of equal drawdown around the pumped well that form elliptical circles rather than concentric circles formed in an isotropic aquifer. Consequently, an anisotropic analytical method was used to determine aquifer characteristics. The principal directions of anisotropy, determined from the test analysis, generally correspond to directions determined from a hydrogeologic evaluation of the area. The principal directional and effective transmissivity, storage coefficient, and leakance determined from the test are representative of the aquifer in the area.



Morris Bridge well-field location map and well characteristics: 09-21-70 aquifer test (test site 6a).



WELL T_N/s α β
TWF-7 3.3×10^7 0° 3.3×10^3
TWF-2A 1.5×10^7 123° 1.9×10^3
TWF-1 4.1×10^7 140° 3.9×10^3
TWF-5 8.4×10^7 166° 5.9×10^3
TWF-8 3.5×10^7 249° 3.6×10^3
T_e = 38,000 ft^2/d
T_x = 103,000 ft^2/d
T_y = 15,000 ft^2/d
T_x/T_y = 6.9
Azimuth of T_x = N 85° E
TWF-5
TWF-7
TWF-3A
TWF-8
TWF-1
COUNTY NE Hills. LAT. 280627 LONG. 0822008
T 27S R 20E SEC. 29 NE 1/4 SW 1/4 NW 1/4
Pumped WELL No. TWF-6 DEPTH: WELL 600 ft, CASING 120 ft
DIA. 14 in ALT. OF W/L 33.75 ft DATE 9-21-70
AQUIFER Floridan RADIUS Q 1820 gpm
DRAWDOWN X RECOVERY SP CAPACITY 102 gpm/ft
TYPE OF ANALYSIS Anisotropic, leaky
DATA CORRECTIONS
T S 1.0×10^{-3} K'/b' 3×10^{-3} (ft/d)/ft
LOGS
CHEMICAL ANALYSES
REMARKS Mass plot
DRAWDOWN (s), IN FEET
10
1
0.1
0.01
10^{-10}
10^{-9}
10^{-8}
10^{-7}
10^{-6}
t/r^2, IN DAYS PER FOOT SQUARED

Morris Bridge Well Field (Test 6b), Northeast Hillsborough County

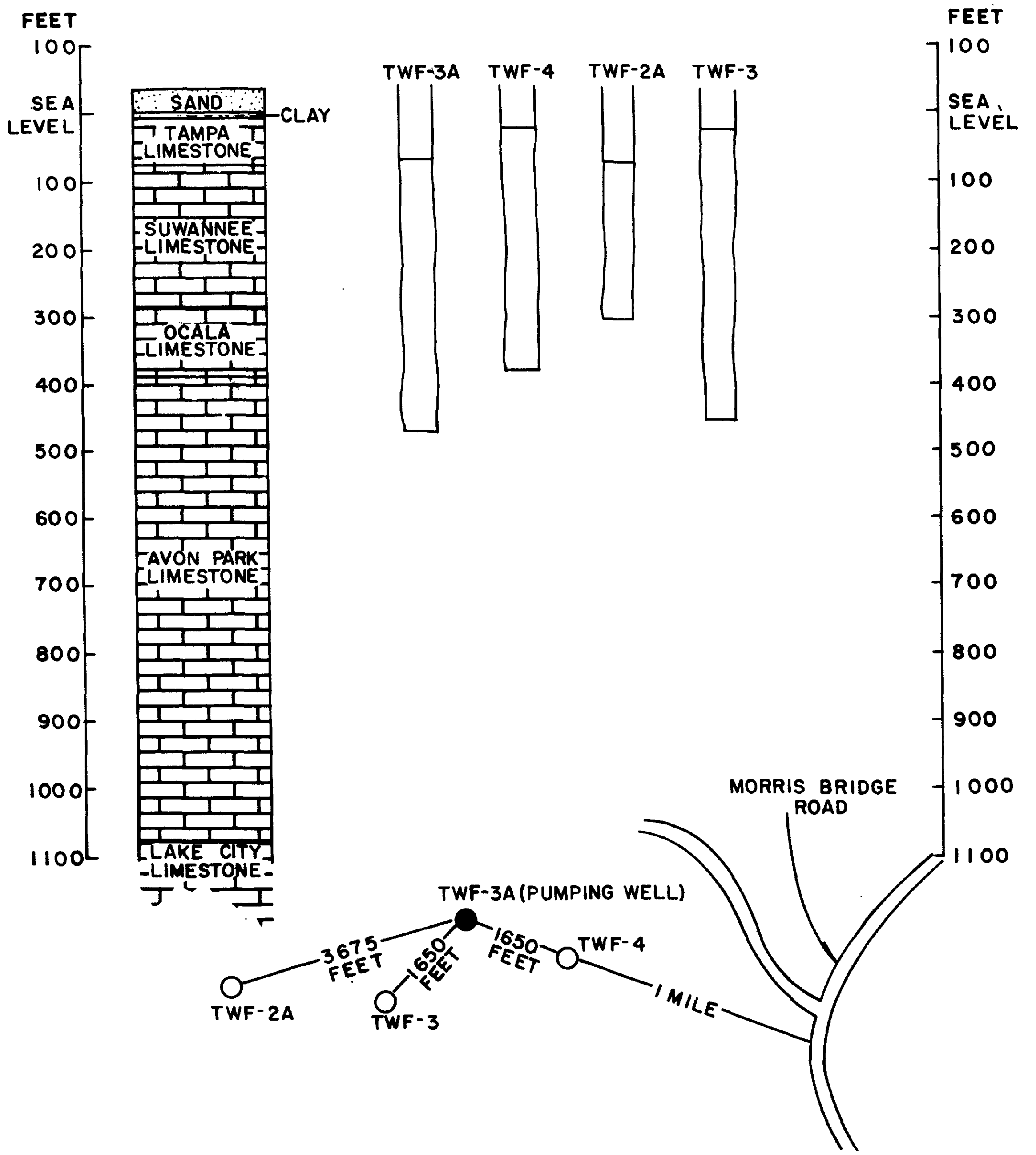
Test period (drawdown and recovery): 1100, 12-14-70 to 1100, 12-17-70.

Aquifer tested: Floridan.

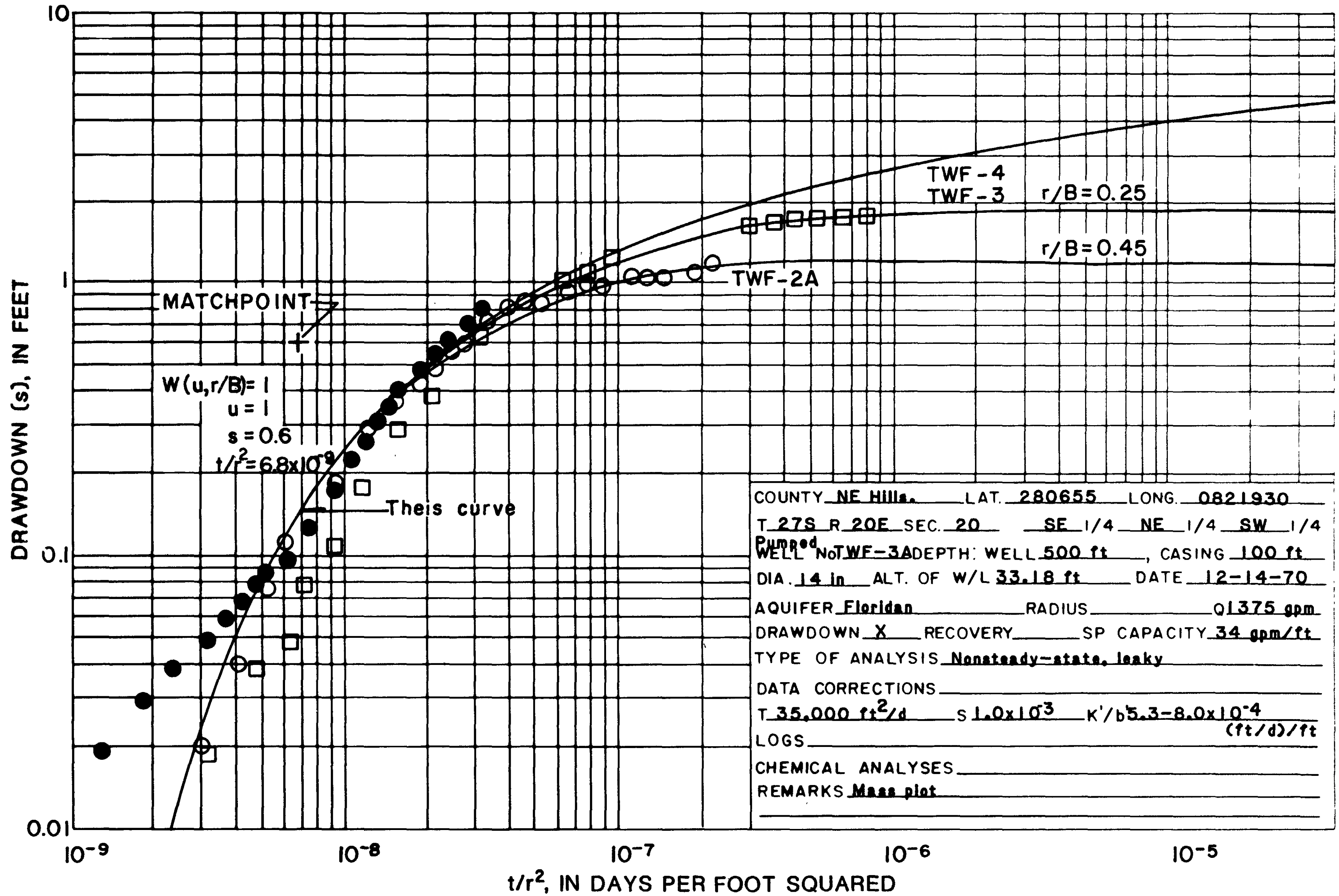
Data corrections applied: None applied. However, water-level changes were slight during the test.

Test problems: Test wells are not at the same depth and do not penetrate the most permeable stratum of the Floridan aquifer.

Test reliability: As the pumping well does not penetrate the most highly permeable stratum, the transmissivity depicts only that section of the aquifer tested. Both leakance and storage are within the plausible range for the Floridan aquifer; however, leakance would probably decrease if the pumping well was open to the most permeable stratum.



Morris Bridge well-field location map and well characteristics: 12-14-70 aquifer test (test site 6b).


DRAWDOWN (s), IN FEET
10
1
0.1
0.01
10^{-9}
10^{-8}
10^{-7}
10^{-6}
10^{-5}
t/r^2, IN DAYS PER FOOT SQUARED
TWF-4
TWF-3
r/B=0.25
r/B=0.45
TWF-2A
MATCHPOINT
W(u,r/B)=1
u=1
s=0.6
$t/r^2=6.8x10^{-9}$
Theis curve
COUNTY NE Hills. LAT. 280655 LONG. 0821930
T 27S R 20E SEC. 20 SE 1/4 NE 1/4 SW 1/4
Pumped WELL No TWF-3A DEPTH: WELL 500 ft, CASING 100 ft
DIA. 14 in ALT. OF W/L 33.18 ft DATE 12-14-70
AQUIFER Floridan RADIUS Q 1375 gpm
DRAWDOWN X RECOVERY SP CAPACITY 34 gpm/ft
TYPE OF ANALYSIS Nonsteady-state, leaky
DATA CORRECTIONS
T 35,000 ft^2/d S $1.0x10^{-3}$ K'/b' $5.3-8.0x10^{-4}$ (ft/d)/ft
LOGS
CHEMICAL ANALYSES
REMARKS Mass plot

Morris Bridge Well Field (Test 6c), Northeast Hillsborough County

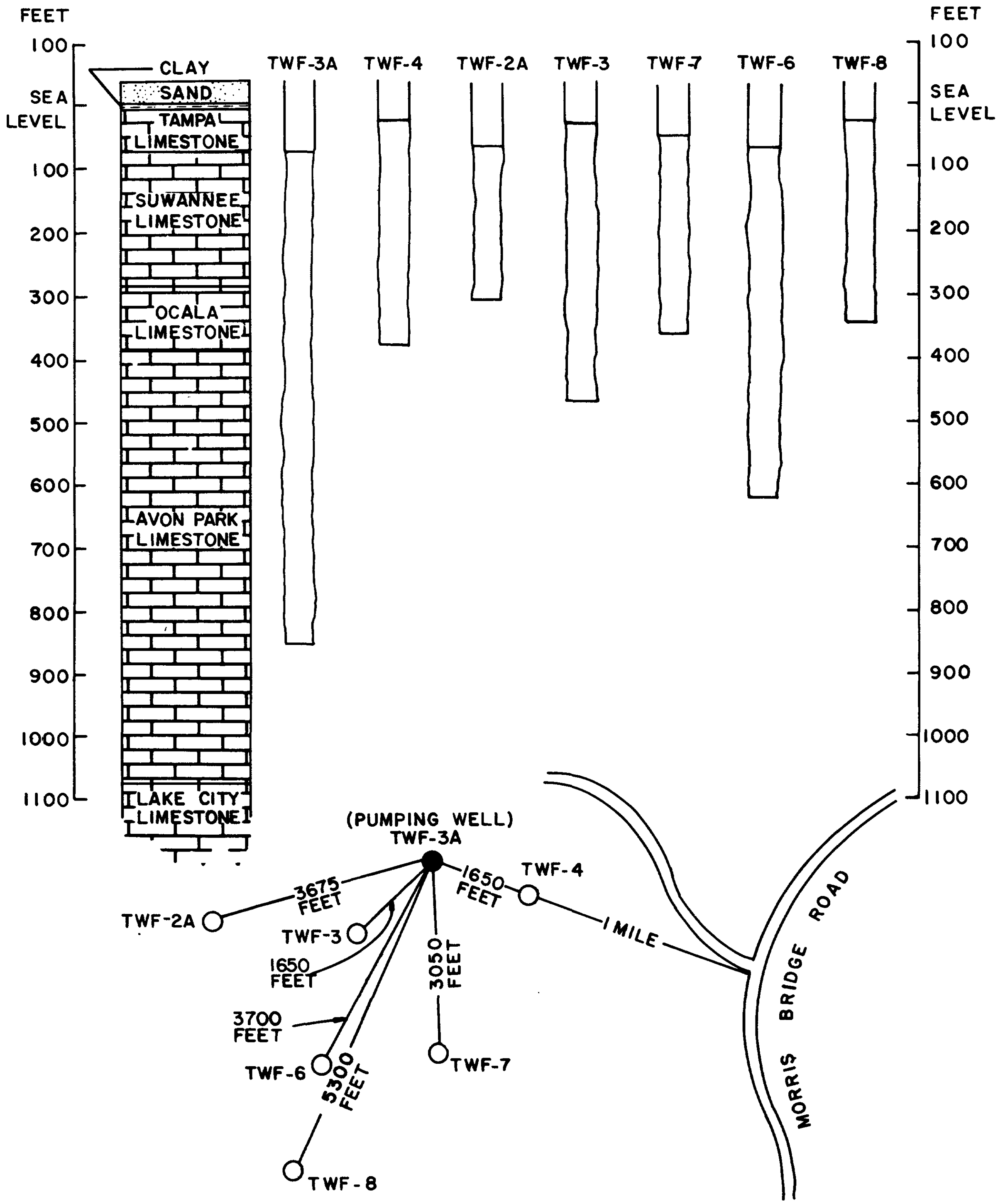
Test period (drawdown and recovery): 1000, 3-2-71 to 1000, 3-5-71.

Aquifer tested: Floridan.

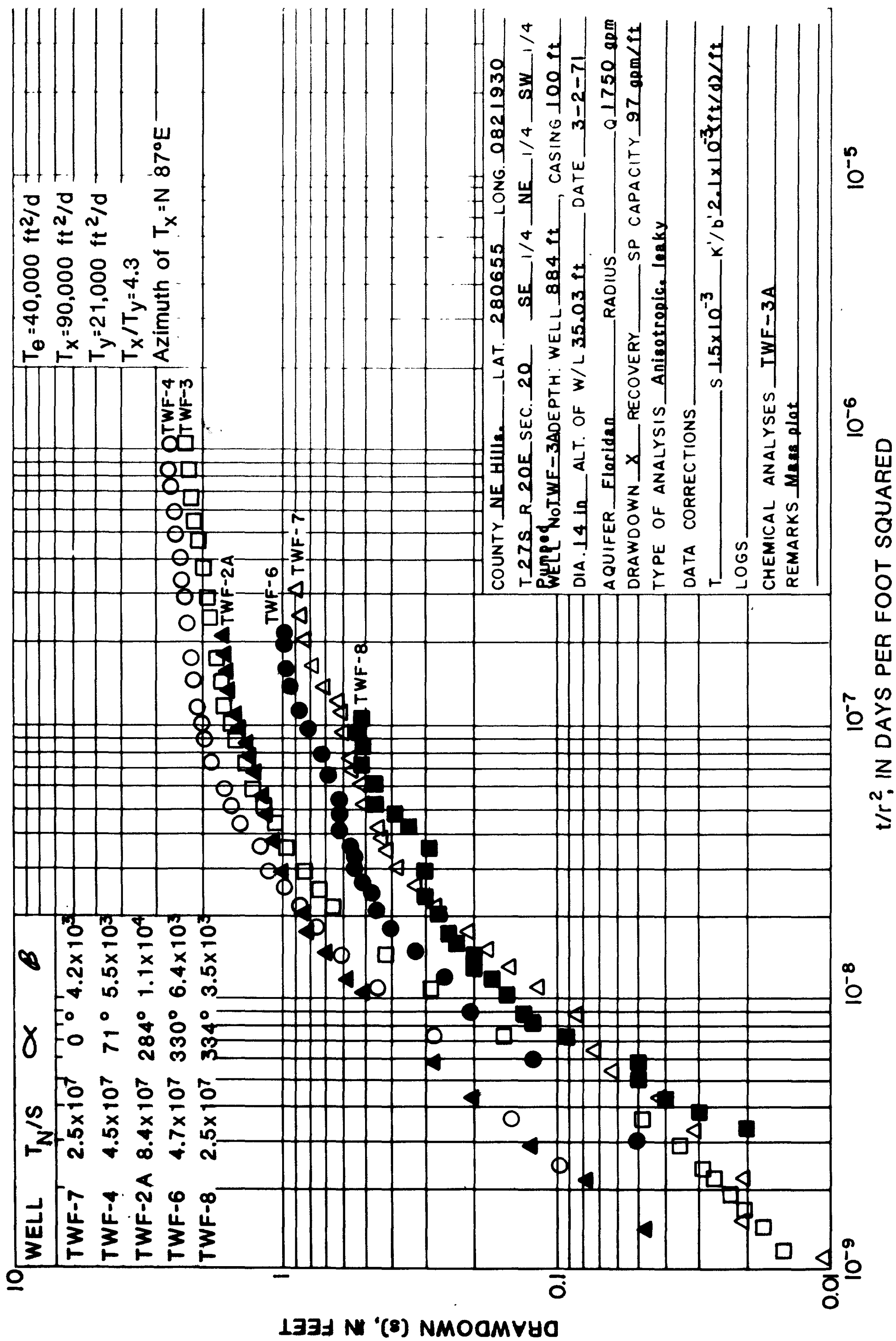
Data corrections applied: None applied. However, water-level changes were moderate during the test.

Test problems: Test 6c has the same test well plan as 6b except that pumping well 3a has been deepened from 500 feet to 834 feet and now penetrates the most permeable stratum. Variation of observation-well response is primarily due to aquifer anisotropy.

Test reliability: As with test 6a, the Floridan aquifer in the Morris Bridge well field is anisotropic in the horizontal plane. Consequently, an anisotropic analytical method was used to determine aquifer characteristics. The principal directions of anisotropy determined from the test analysis generally correspond to directions determined from a hydrogeologic evaluation of the area. The principal directional and effective transmissivity and storage coefficient determined from the test are representative of the aquifer in the area.



Morris Bridge well-field location map and well characteristics: 03-02-71 aquifer test (test site 6c).



WELL T_N/S α β
TWF-7 2.5x10^7 0° 4.2x10^3
TWF-4 4.5x10^7 71° 5.5x10^3
TWF-2A 8.4x10^7 284° 1.1x10^4
TWF-6 4.7x10^7 330° 6.4x10^3
TWF-8 2.5x10^7 334° 3.5x10^3
Te = 40,000 ft²/d
Tx = 90,000 ft²/d
Ty = 21,000 ft²/d
Tx/Ty = 4.3
Azimuth of Tx = N 87°E
TWF-4
TWF-3
TWF-2A
TWF-6
TWF-7
TWF-8
COUNTY NE Hills. LAT. 280655 LONG. 0821930
T 27S R 20E SEC. 20 SE 1/4 NE 1/4 SW 1/4
Pumped WELL No. TWF-3A DEPTH: WELL 884 ft, CASING 100 ft
DIA. 14 in ALT. OF W/L 35.03 ft DATE 3-2-71
AQUIFER Floridan RADIUS Q 1750 gpm
DRAWDOWN X RECOVERY SP CAPACITY 97 gpm/ft
TYPE OF ANALYSIS Anisotropic, leaky
DATA CORRECTIONS
T S 1.5x10^-3 K'/b' 2.1x10^-3 (ft/d)/ft
LOGS
CHEMICAL ANALYSES TWF-3A
REMARKS Mass plot
10
1
0.1
0.01
DRAWDOWN (s), IN FEET
10^-9
10^-8
10^-7
10^-6
10^-5
t/r², IN DAYS PER FOOT SQUARED

Morris Bridge Well Field (Test 6d), Northeast Hillsborough County

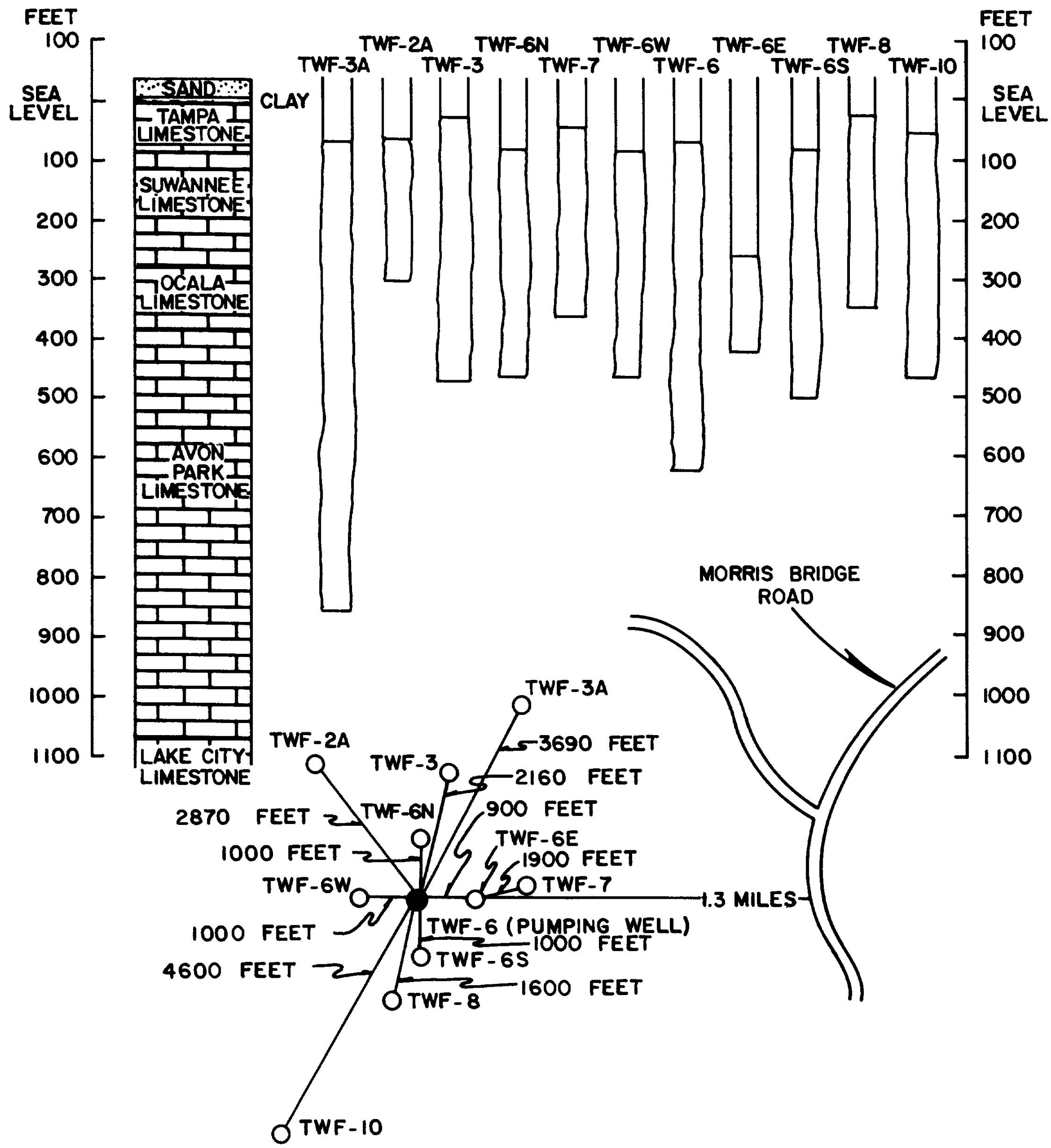
Test period (drawdown and recovery): 1000, 7-18-73 to 1000, 7-21-73.

Aquifer tested: Floridan.

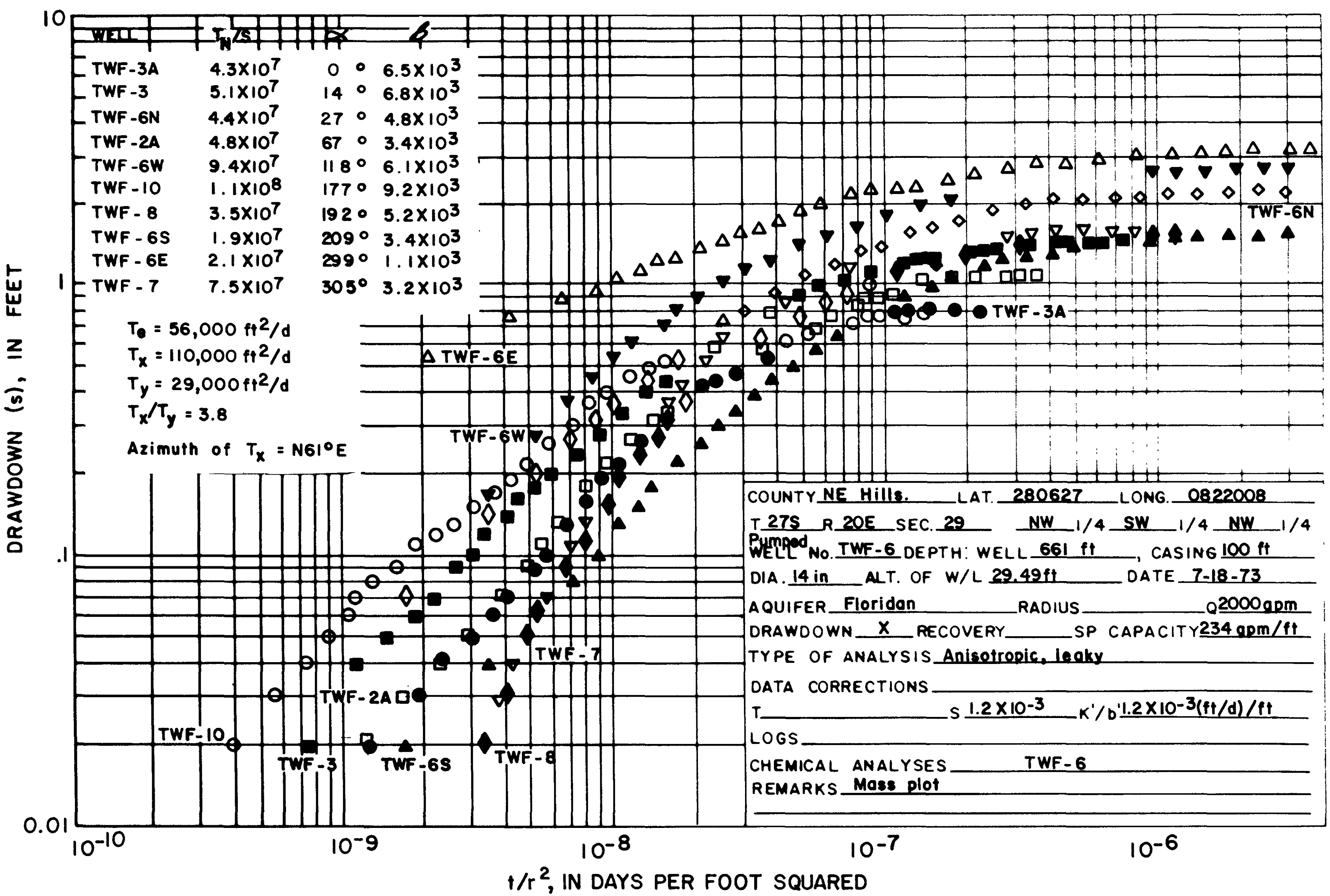
Data corrections applied: None applied. However, water-level changes were moderate during the test.

Test problems: Test 6d has the same test well plan as test 6a except for four additional wells that were drilled 1,000 feet north, south, east, and west of the pumping well. Variation of observation-well response is primarily due to aquifer anisotropy.

Test reliability: As with tests 6a and 6c, the Morris Bridge well field is anisotropic in the horizontal plane. Consequently, an anisotropic analytical method was used to determine aquifer characteristics. The principal directions of anisotropy determined from the test analysis generally correspond to directions determined from a hydrogeologic evaluation of the area. The principal directional and effective transmissivity and storage coefficient determined from the test are representative of the aquifer in the area.



Morris Bridge well-field location map and well characteristics: 07-18-73 aquifer test (test site 6d).


WELL
T_N/S
α
β
TWF-3A 4.3X10^7 0° 6.5X10^3
TWF-3 5.1X10^7 14° 6.8X10^3
TWF-6N 4.4X10^7 27° 4.8X10^3
TWF-2A 4.8X10^7 67° 3.4X10^3
TWF-6W 9.4X10^7 118° 6.1X10^3
TWF-10 1.1X10^8 177° 9.2X10^3
TWF-8 3.5X10^7 192° 5.2X10^3
TWF-6S 1.9X10^7 209° 3.4X10^3
TWF-6E 2.1X10^7 299° 1.1X10^3
TWF-7 7.5X10^7 305° 3.2X10^3
T_e = 56,000 ft²/d
T_x = 110,000 ft²/d
T_y = 29,000 ft²/d
T_x/T_y = 3.8
Azimuth of T_x = N61°E
TWF-6N
TWF-3A
TWF-6E
TWF-6W
TWF-7
TWF-2A
TWF-10
TWF-3
TWF-6S
TWF-8
COUNTY NE Hills. LAT. 280627 LONG. 0822008
T 27S R 20E SEC. 29 NW 1/4 SW 1/4 NW 1/4
Pumped WELL No. TWF-6 DEPTH: WELL 661 ft, CASING 100 ft
DIA. 14 in ALT. OF W/L 29.49ft DATE 7-18-73
AQUIFER Floridan RADIUS Q 2000 gpm
DRAWDOWN X RECOVERY SP CAPACITY 234 gpm/ft
TYPE OF ANALYSIS Anisotropic, leaky
DATA CORRECTIONS
T S 1.2X10-3 K'/b' 1.2X10-3(ft/d)/ft
LOGS
CHEMICAL ANALYSES TWF-6
REMARKS Mass plot
10
1
.1
0.01
DRAWDOWN (s), IN FEET
10-10
10-9
10-8
10-7
10-6
t/r², IN DAYS PER FOOT SQUARED

Temple Terrace Well Field (Test 7), Northwest Hillsborough County

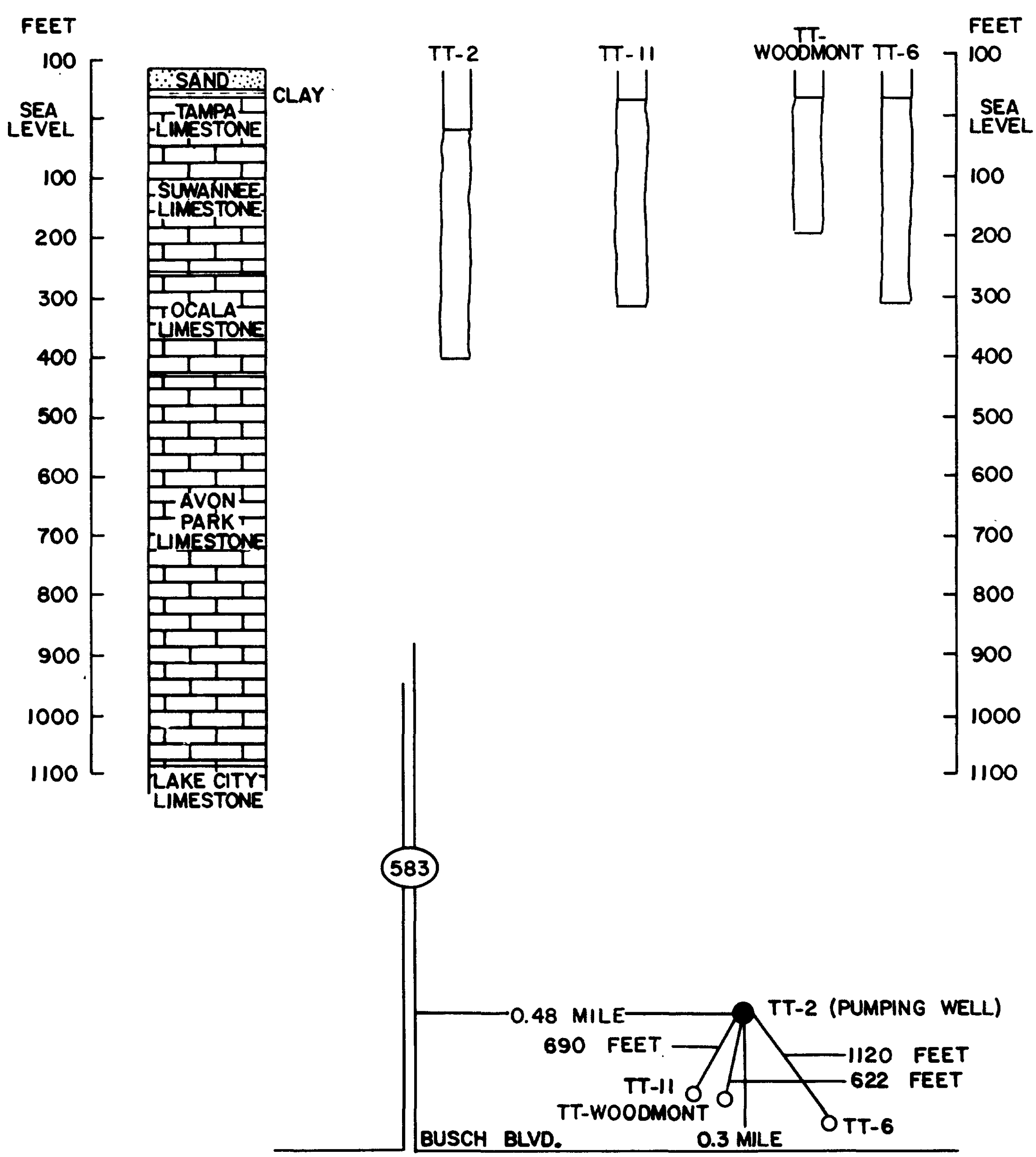
Test period (drawdown and recovery): 1100, 3-18-75 to 2030, 3-19-75.

Aquifer tested: Upper Floridan.

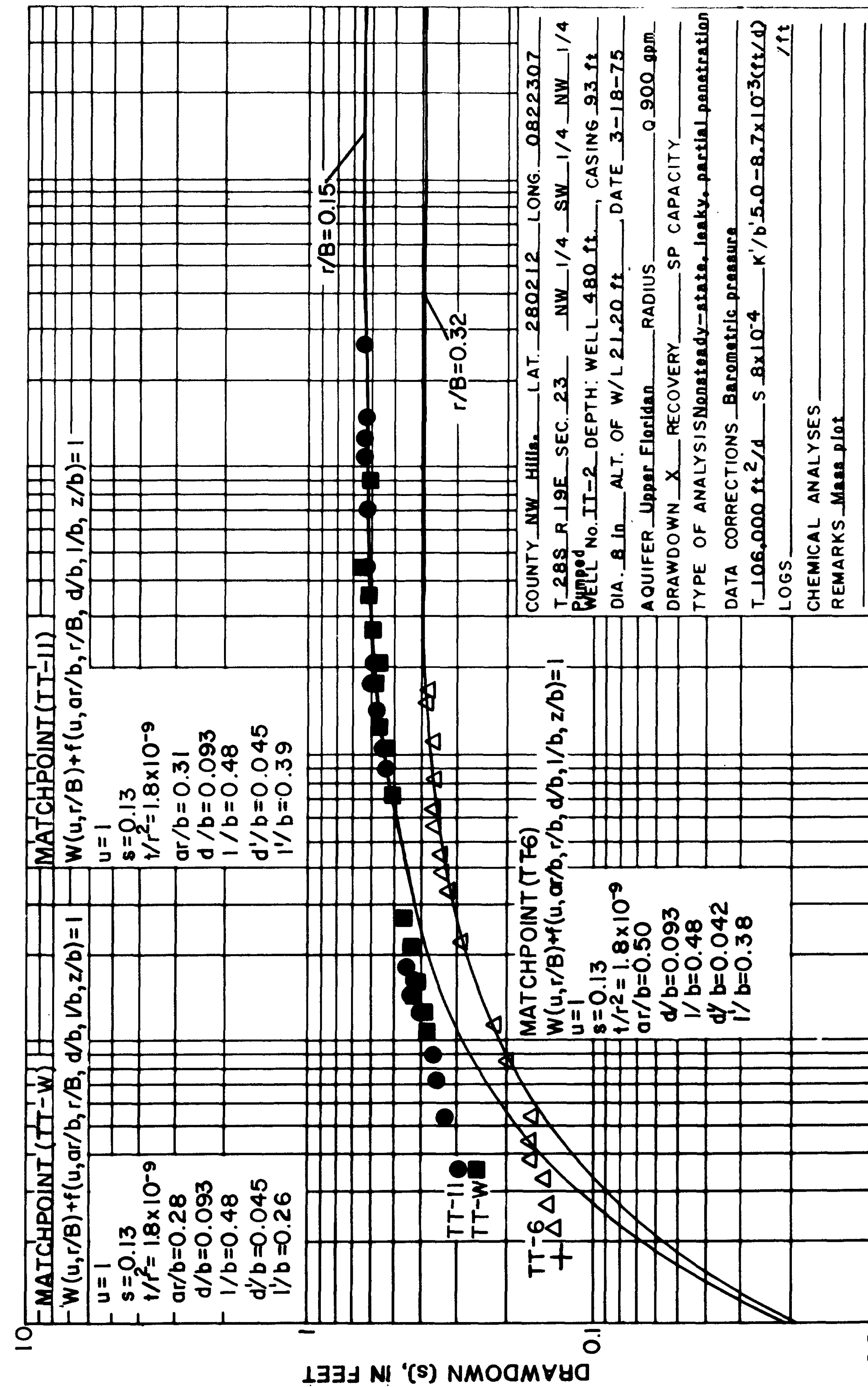
Data corrections applied: Data were corrected for changes in barometric pressure.

Test problems: Test wells are not at the same depth and penetrate less than one half the Floridan aquifer. Response of observation wells close to pumping well are probably distorted due to partial penetration. The pumping well does not penetrate the most permeable zone of the Floridan aquifer. However, a locally occurring permeable zone near the top of the aquifer is open to the pumping well. Variation of observation-well response from theory is probably due to partial penetration.

Test reliability: The pumping and observation wells partially penetrate a leaky aquifer. Therefore, an analytical method that accounts for the vertical flow in the aquifer due to partially penetrating a leaky aquifer was used to determine aquifer characteristics. The transmissivity, storage coefficient, and leakance are representative of the aquifer in the area.



Temple Terrace well-field location map and well characteristics: 03-18-75 aquifer test (test site 7).



MATCHPOINT (TT-W)
W(u,r/B)+f(u,ar/b,r/B, d/b, l/b, z/b)=1
u=1
s=0.13
t/r²= 1.8x10⁻⁹
ar/b=0.28
d/b=0.093
l/b=0.48
d'/b=0.045
l'/b=0.26
MATCHPOINT (TT-11)
W(u,r/B)+f(u,ar/b,r/B, d/b,l/b, z/b)=1
u=1
s=0.13
t/r²=1.8x10⁻⁹
ar/b=0.31
d/b=0.093
l/b=0.48
d'/b=0.045
l'/b=0.39
MATCHPOINT (TT-6)
W(u,r/B)+f(u,ar/b,r/b,d/b,l/b,z/b)=1
u=1
s=0.13
t/r²=1.8x10⁻⁹
ar/b=0.50
d/b=0.093
l/b=0.48
d'/b=0.042
l'/b=0.38
TT-6
TT-11
TT-W
r/B=0.15
r/B=0.32
COUNTY NW Hills. LAT. 280212 LONG. 0822307
T 28S R 19E SEC. 23 NW 1/4 SW 1/4 NW 1/4
Pumped WELL No. TT-2 DEPTH: WELL 480 ft., CASING 93 ft
DIA. 8 in ALT. OF W/L 21.20 ft DATE 3-18-75
AQUIFER Upper Floridan RADIUS Q 900 gpm
DRAWDOWN X RECOVERY SP CAPACITY
TYPE OF ANALYSIS Nonsteady-state, leaky, partial penetration
DATA CORRECTIONS Barometric pressure
T 106,000 ft²/d S 8x10⁻⁴ K'/b' 5.0-8.7x10⁻³(ft/d)/ft
LOGS
CHEMICAL ANALYSES
REMARKS Mass plot
10
1
0.1
0.01
DRAWDOWN (s), IN FEET
10⁻⁹
10⁻⁸
10⁻⁷
10⁻⁶
10⁻⁵
t/r², IN DAYS PER FOOT SQUARED

Plant City Well Field (Test 8), Southeast Hillsborough County

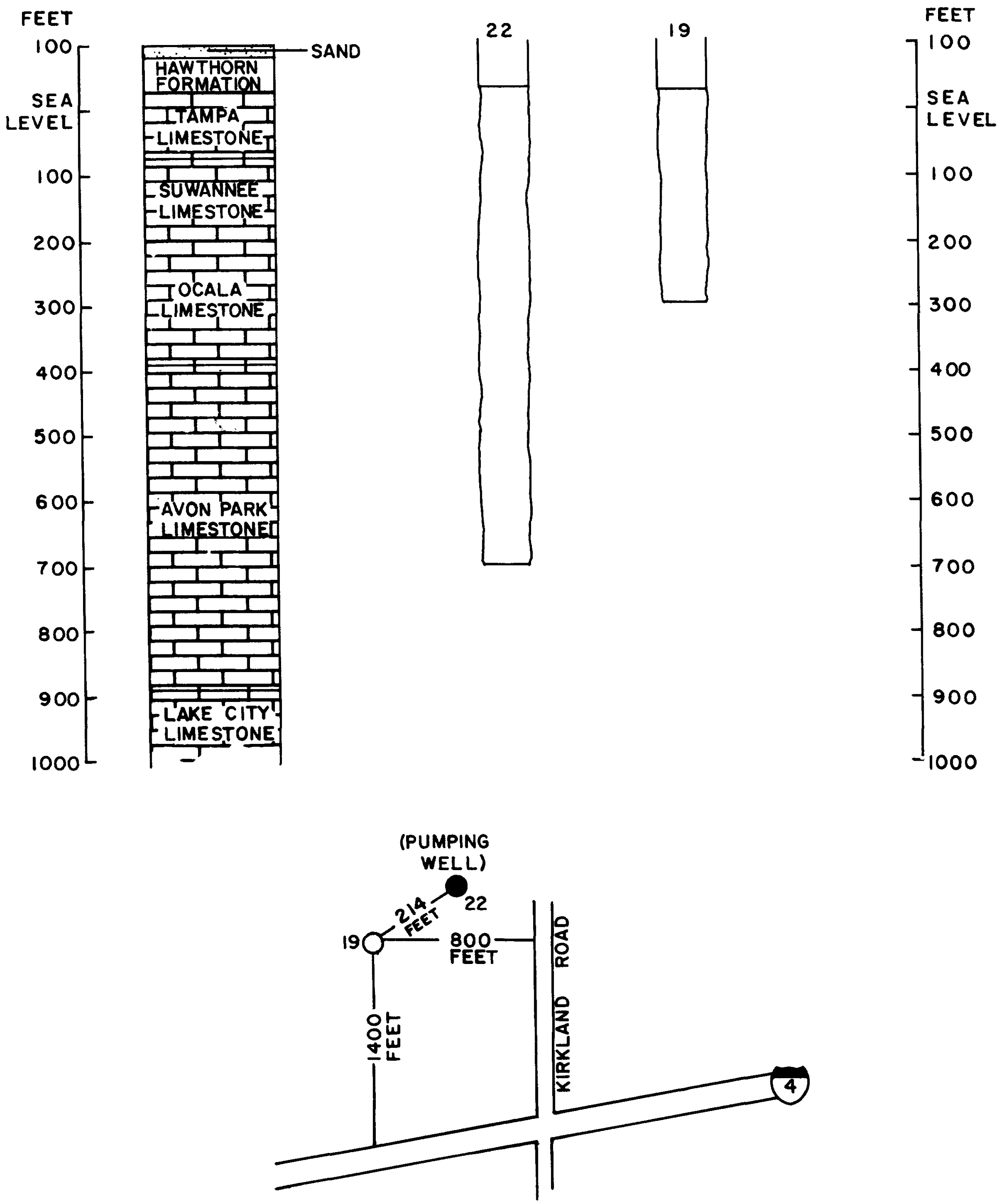
Test period (drawdown and recovery): 1115, 10-19-70 to 1115, 10-20-70.

Aquifer tested: Floridan.

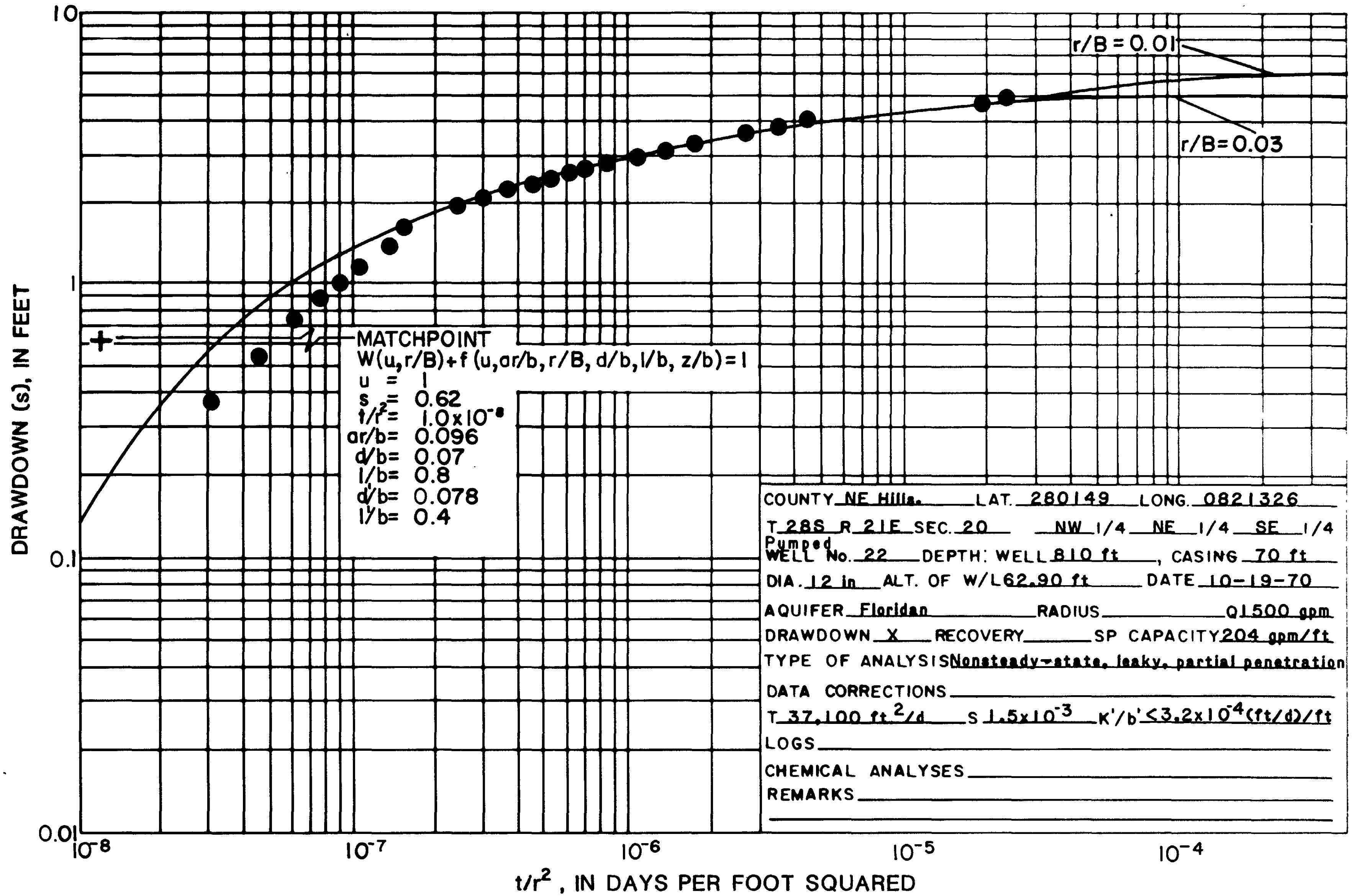
Data corrections applied: None applied. However, water-level changes were moderate during the test.

Test problems: Test data are available from only one observation well. Observation well is not at the same depth as the pumping well and is very close to the pumping well. Both the pumping and observation wells partially penetrate the aquifer and the observation-well response is probably distorted due to partial penetration.

Test reliability: The pumping well partially penetrates a leaky aquifer. Therefore, an analytical method that accounts for the vertical flow in the aquifer due to partially penetrating a leaky aquifer was used to determine aquifer characteristics. The transmissivity and storage coefficient are representative of the aquifer in the area. The test was not of long enough duration to determine the leakage coefficient; however, the largest value that it could be is reported.



Plant City well-field location map and well characteristics: 10-19-70 aquifer test (test site 8).


r/B = 0.01
r/B = 0.03
MATCHPOINT
W(u, r/B) + f (u, ar/b, r/B, d/b, l/b, z/b) = 1
u = 1
s = 0.62
t/r² = 1.0x10⁻⁸
ar/b = 0.096
d/b = 0.07
l/b = 0.8
d'/b = 0.078
l'/b = 0.4
COUNTY NE Hills. LAT. 280149 LONG. 0821326
T 28S R 21E SEC. 20 NW 1/4 NE 1/4 SE 1/4
Pumped WELL No. 22 DEPTH: WELL 810 ft, CASING 70 ft
DIA. 12 in ALT. OF W/L 62.90 ft DATE 10-19-70
AQUIFER Floridan RADIUS Q 1500 gpm
DRAWDOWN X RECOVERY SP CAPACITY 204 gpm/ft
TYPE OF ANALYSIS Nonsteady-state, leaky, partial penetration
DATA CORRECTIONS
T 37,100 ft²/d S 1.5x10⁻³ K'/b' <3.2x10⁻⁴(ft/d)/ft
LOGS
CHEMICAL ANALYSES
REMARKS
DRAWDOWN (s), IN FEET
10
1
0.1
0.01
10⁻⁸
10⁻⁷
10⁻⁶
10⁻⁵
10⁻⁴
t/r², IN DAYS PER FOOT SQUARED

Sixmile Creek Test Site (Test 9), Northeast Hillsborough County

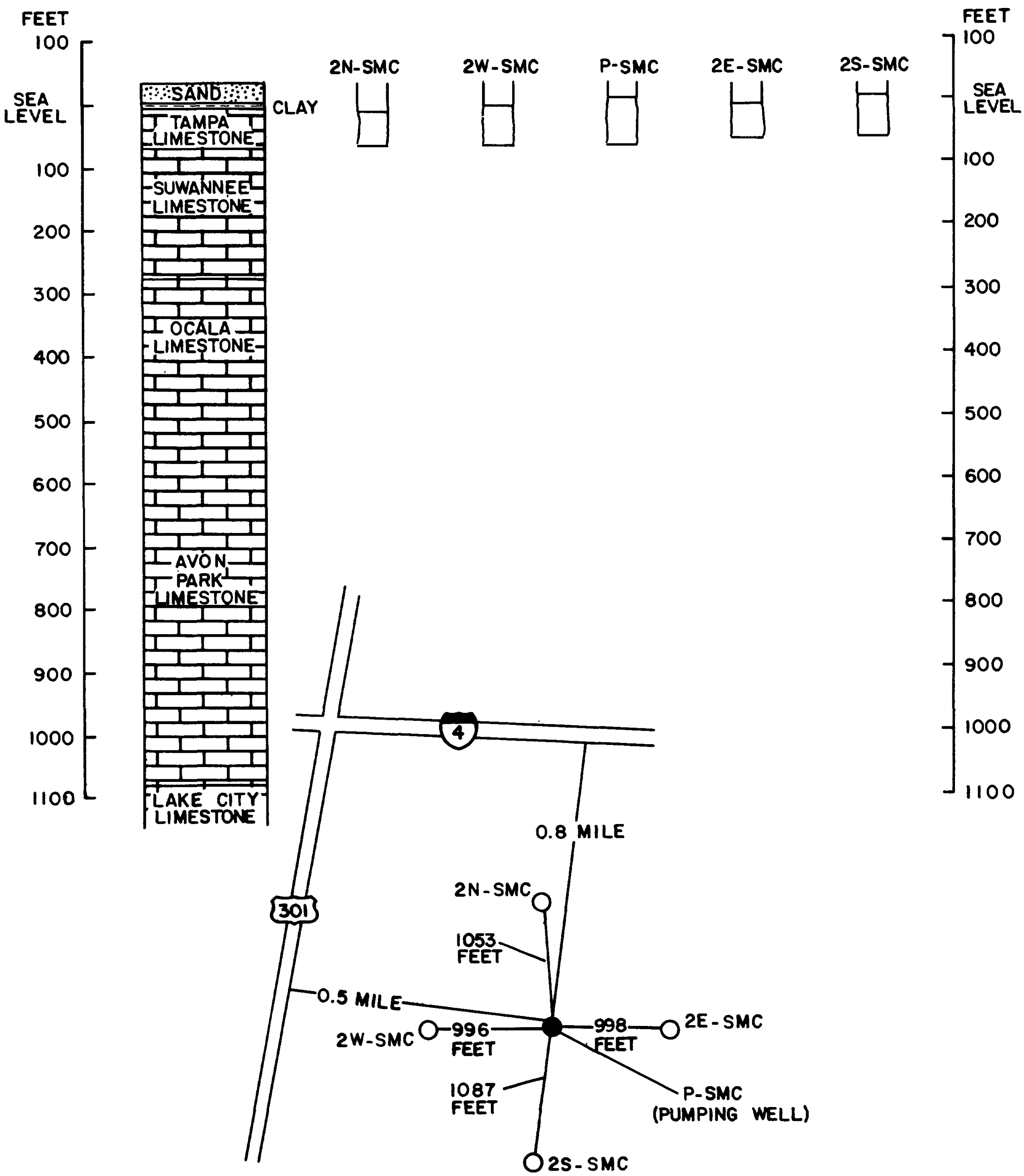
Test period (drawdown and recovery): 1000, 5-10-72 to 1000, 5-14-72.

Aquifer tested: Upper Floridan.

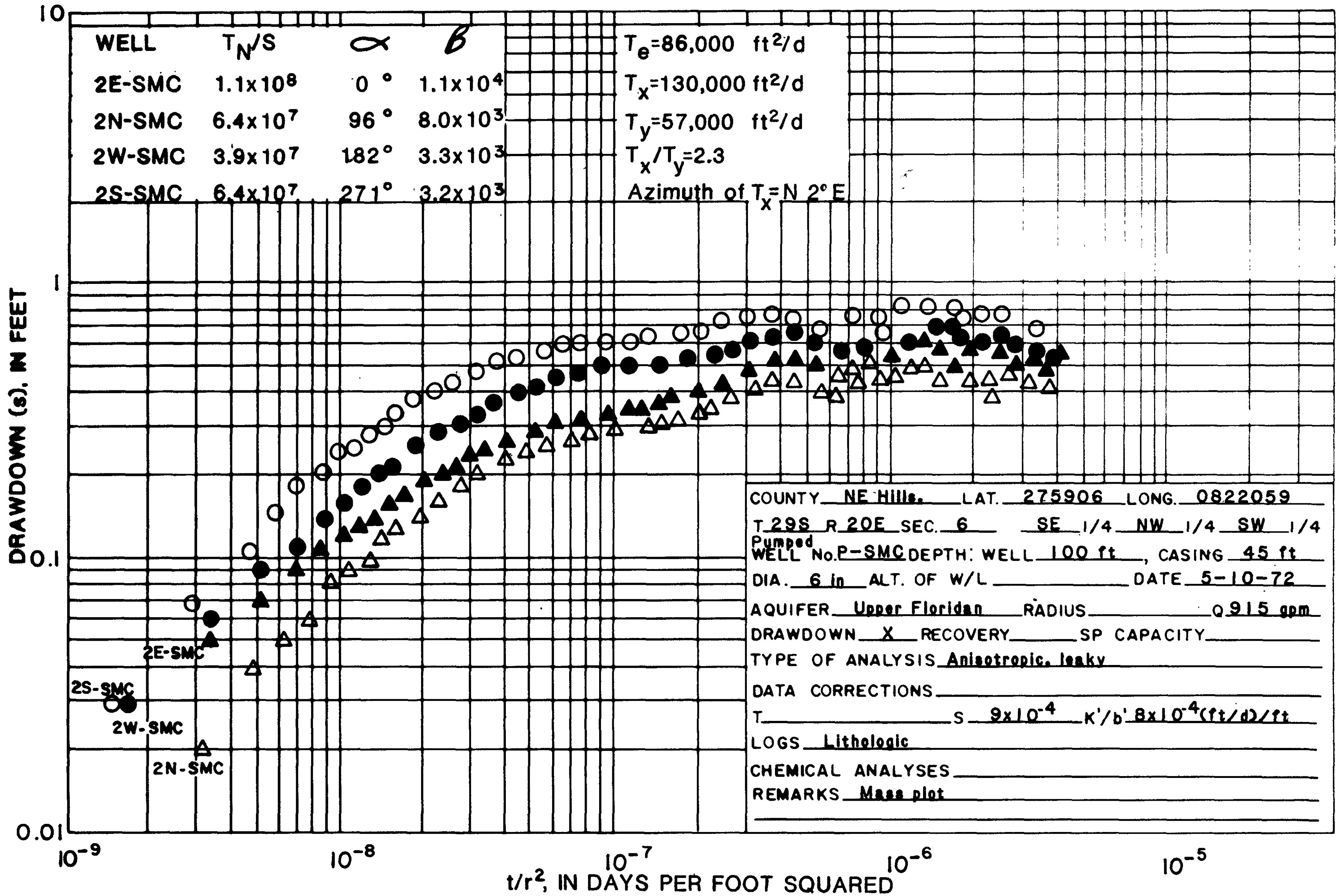
Data corrections applied: None applied.

Test problems: Test wells penetrate less than one fourth of the Floridan aquifer. The pumping well does not penetrate the most permeable stratum of the Floridan aquifer, but a locally occurring permeable zone near the top of the aquifer is open to the pumping well. Both the pumping and observation wells partially penetrate the aquifer; however, the effects of partial penetration are probably insignificant and can be ignored at the distance the observation wells are from the pumping wells. Variation of observation-well drawdown is primarily due to aquifer anisotropy.

Test reliability: Aquifer characteristics were determined utilizing an anisotropic analytical method. The principal directions of anisotropy determined from the test analysis are similar to directions determined from a hydrogeologic evaluation of the area. Due to partial penetration and stratification, transmissivity is probably for only that part of the aquifer penetrated. The storage coefficient and leakance reported are plausible for the aquifer in the area tested.



Sixmile Creek test site location map and well characteristics: 05-10-72 aquifer test (test site 9).


WELL T_N/S α β
2E-SMC 1.1x10^8 0° 1.1x10^4
2N-SMC 6.4x10^7 96° 8.0x10^3
2W-SMC 3.9x10^7 182° 3.3x10^3
2S-SMC 6.4x10^7 271° 3.2x10^3
Te=86,000 ft²/d
Tx=130,000 ft²/d
Ty=57,000 ft²/d
Tx/Ty=2.3
Azimuth of Tx=N 2° E
COUNTY NE Hills. LAT. 275906 LONG. 0822059
T 29S R 20E SEC. 6 SE 1/4 NW 1/4 SW 1/4
Pumped WELL No. P-SMC DEPTH: WELL 100 ft, CASING 45 ft
DIA. 6 in ALT. OF W/L DATE 5-10-72
AQUIFER Upper Floridan RADIUS Q 915 gpm
DRAWDOWN X RECOVERY SP CAPACITY
TYPE OF ANALYSIS Anisotropic, leaky
DATA CORRECTIONS
T S 9x10^-4 K'/b' 8x10^-4 (ft/d)/ft
LOGS Lithologic
CHEMICAL ANALYSES
REMARKS Mass plot
2E-SMC
2S-SMC
2W-SMC
2N-SMC
DRAWDOWN (s), IN FEET
10
1
0.1
0.01
10^-9
10^-8
10^-7
10^-6
10^-5
t/r², IN DAYS PER FOOT SQUARED

Eureka Springs Test Site (Test 10), Northeast Hillsborough County

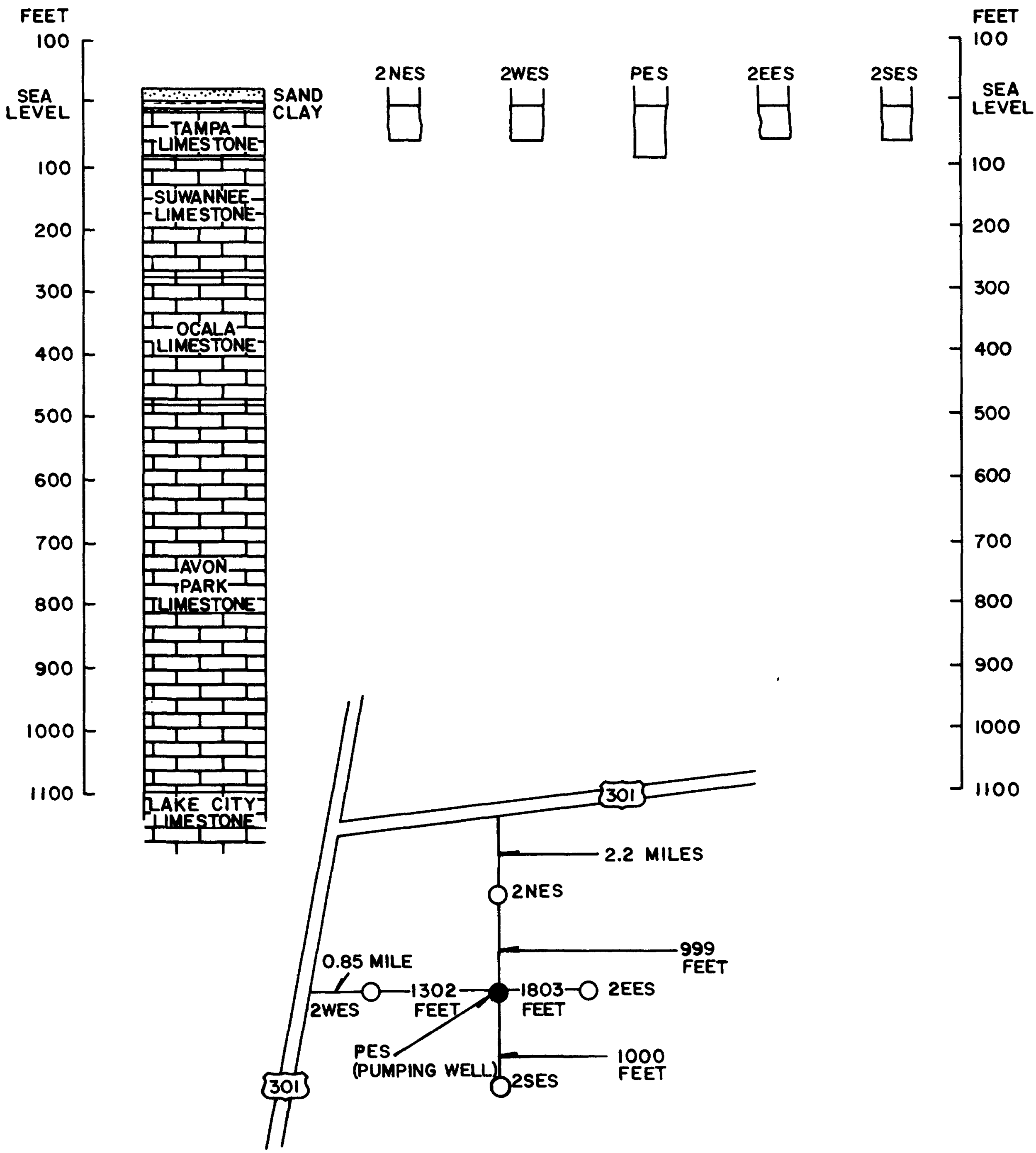
Test period (drawdown and recovery): 0900, 3-30-72 to 0900, 3-31-72.

Aquifer tested: Upper Floridan.

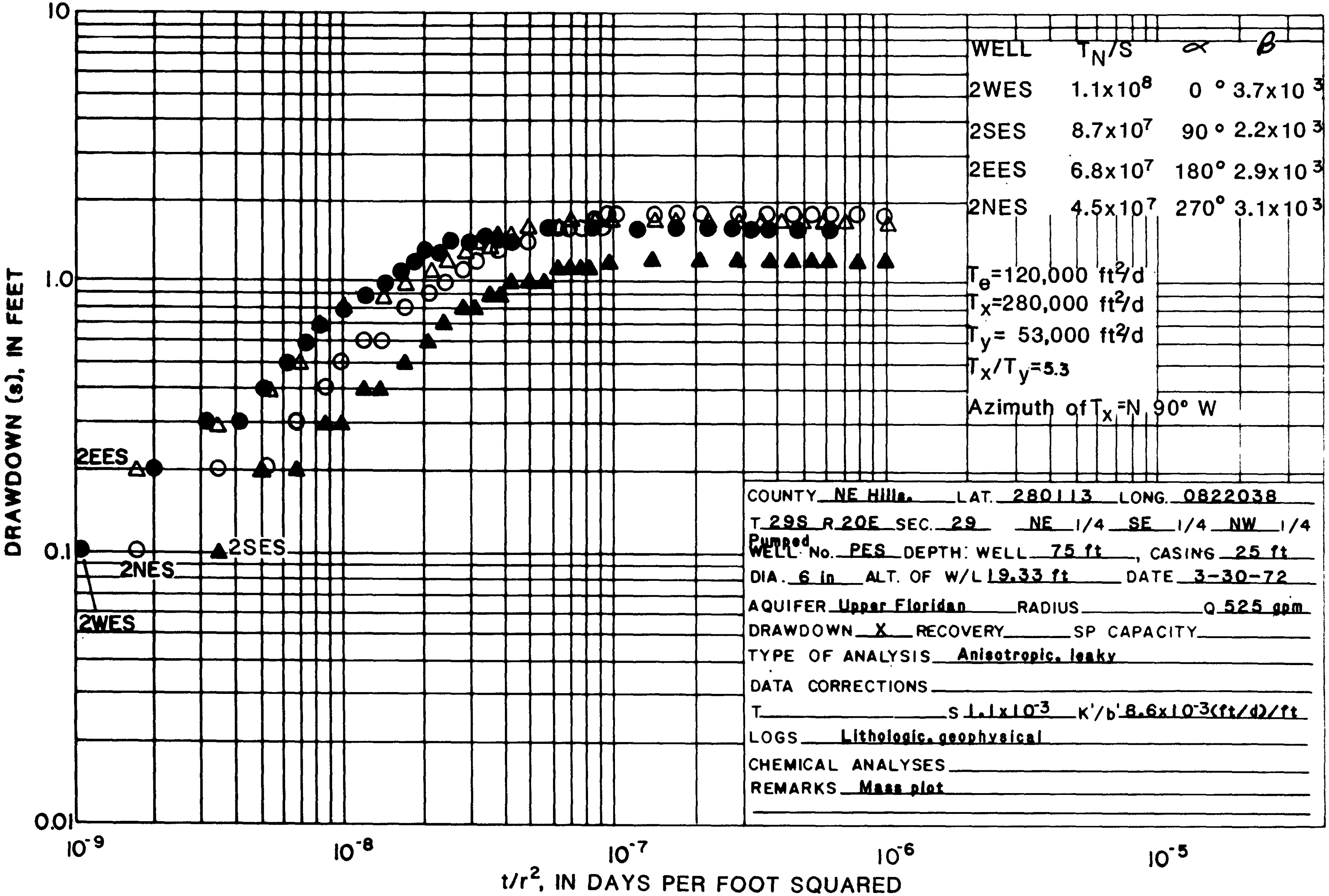
Data corrections applied: None applied. However, water-level changes were moderate during the test, and the test was of short duration.

Test problems: The pumping well does not penetrate the most permeable stratum of the Floridan aquifer, but it does penetrate a local permeable stratum found at the test site. Both the pumping and observation wells partially penetrate the aquifer; however, the effects of partial penetration are probably insignificant and can be ignored at the distance the observation wells are from the pumping wells. Variation of observation-well drawdown is primarily due to aquifer anisotropy.

Test reliability: Aquifer characteristics were determined utilizing an anisotropic analytical method. The principal directions of anisotropy determined from the test analysis are similar to directions determined from a hydrogeologic evaluation of the area. Due to partial penetration and stratification, transmissivity is probably for only that part of the aquifer penetrated. The storage coefficient and leakance reported are plausible for the aquifer in the area tested.



Eureka Springs test site location map and well characteristics: 03-30-72 aquifer test (test site 10).


WELL T_N/S α β
2WES 1.1x10^8 0° 3.7x10^3
2SES 8.7x10^7 90° 2.2x10^3
2EES 6.8x10^7 180° 2.9x10^3
2NES 4.5x10^7 270° 3.1x10^3
Te=120,000 ft²/d
Tx=280,000 ft²/d
Ty= 53,000 ft²/d
Tx/Ty=5.3
Azimuth of Tx=N 90° W
COUNTY NE Hills. LAT. 280113 LONG. 0822038
T 29S R 20E SEC. 29 NE 1/4 SE 1/4 NW 1/4
Pumped WELL No. PES DEPTH: WELL 75 ft, CASING 25 ft
DIA. 6 in ALT. OF W/L 19.33 ft DATE 3-30-72
AQUIFER Upper Floridan RADIUS Q 525 gpm
DRAWDOWN X RECOVERY SP CAPACITY
TYPE OF ANALYSIS Anisotropic, leaky
DATA CORRECTIONS
T S 1.1x10^-3 K'/b' 8.6x10^-3(ft/d)/ft
LOGS Lithologic, geophysical
CHEMICAL ANALYSES
REMARKS Mass plot
2EES
2NES
2WES
2SES
DRAWDOWN (s), IN FEET
10
1.0
0.1
0.01
10^-9
10^-8
10^-7
10^-6
10^-5
t/r², IN DAYS PER FOOT SQUARED

Peaks Test Site (Test 11), Northwest Manatee County

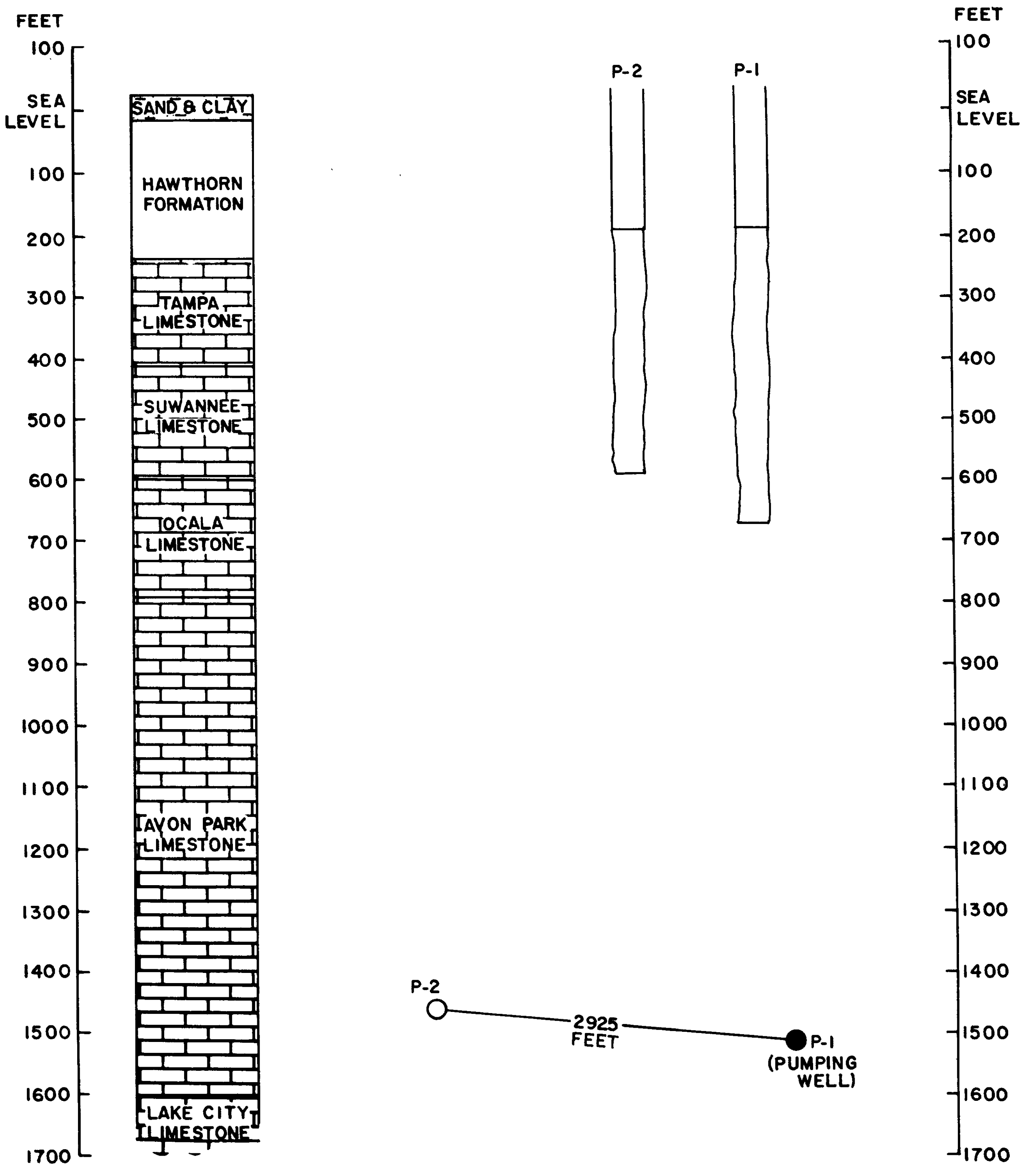
Test period (drawdown and recovery): 1100, 8-22-56 to 1430, 8-27-56.

Aquifer tested: Intermediate and upper Floridan.

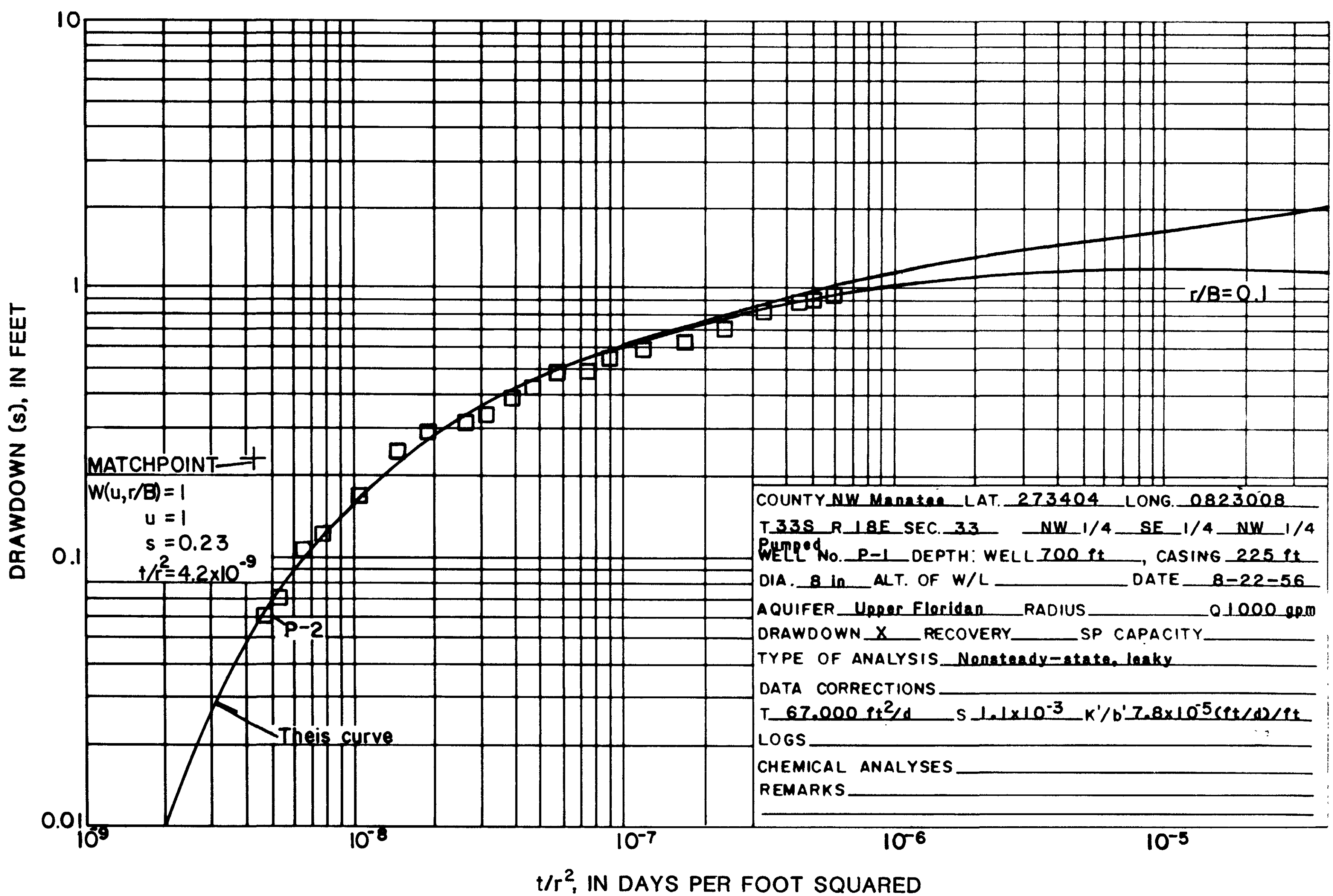
Data corrections applied: None applied. However, water-level changes were moderate during the test.

Test problems: Test wells penetrate less than one half the Floridan aquifer and are not open to the most permeable stratum of the aquifer. However, the observation well is at great enough distance from the pumping well that the effects of partial penetration are insignificant.

Test reliability: Aquifer characteristics determined are plausible for the aquifer in the area tested. Due to partial penetration and stratification, transmissivity is probably for only that part of the aquifer penetrated.



Peaks test site location map and well characteristics: 08-22-56 aquifer test (test site 11).



DRAWDOWN (s), IN FEET
10
1
0.1
0.01
10-9
10-8
10-7
10-6
10-5
t/r2, IN DAYS PER FOOT SQUARED
MATCHPOINT
W(u,r/B)=1
u=1
s=0.23
t/r2=4.2x10-9
P-2
Theis curve
r/B=0.1
COUNTY NW Manatee LAT. 273404 LONG. 0823008
T 33S R 18E SEC. 33 NW 1/4 SE 1/4 NW 1/4
Pumped WELL No. P-1 DEPTH: WELL 700 ft, CASING 225 ft
DIA. 8 in ALT. OF W/L DATE 8-22-56
AQUIFER Upper Floridan RADIUS Q 1000 gpm
DRAWDOWN X RECOVERY SP CAPACITY
TYPE OF ANALYSIS Nonsteady-state, leaky
DATA CORRECTIONS
T 67,000 ft2/d S 1.1x10-3 K'/b' 7.8x10-5(ft/d)/ft
LOGS
CHEMICAL ANALYSES
REMARKS

Verna Well Field (Test 12a), Northeast Sarasota County

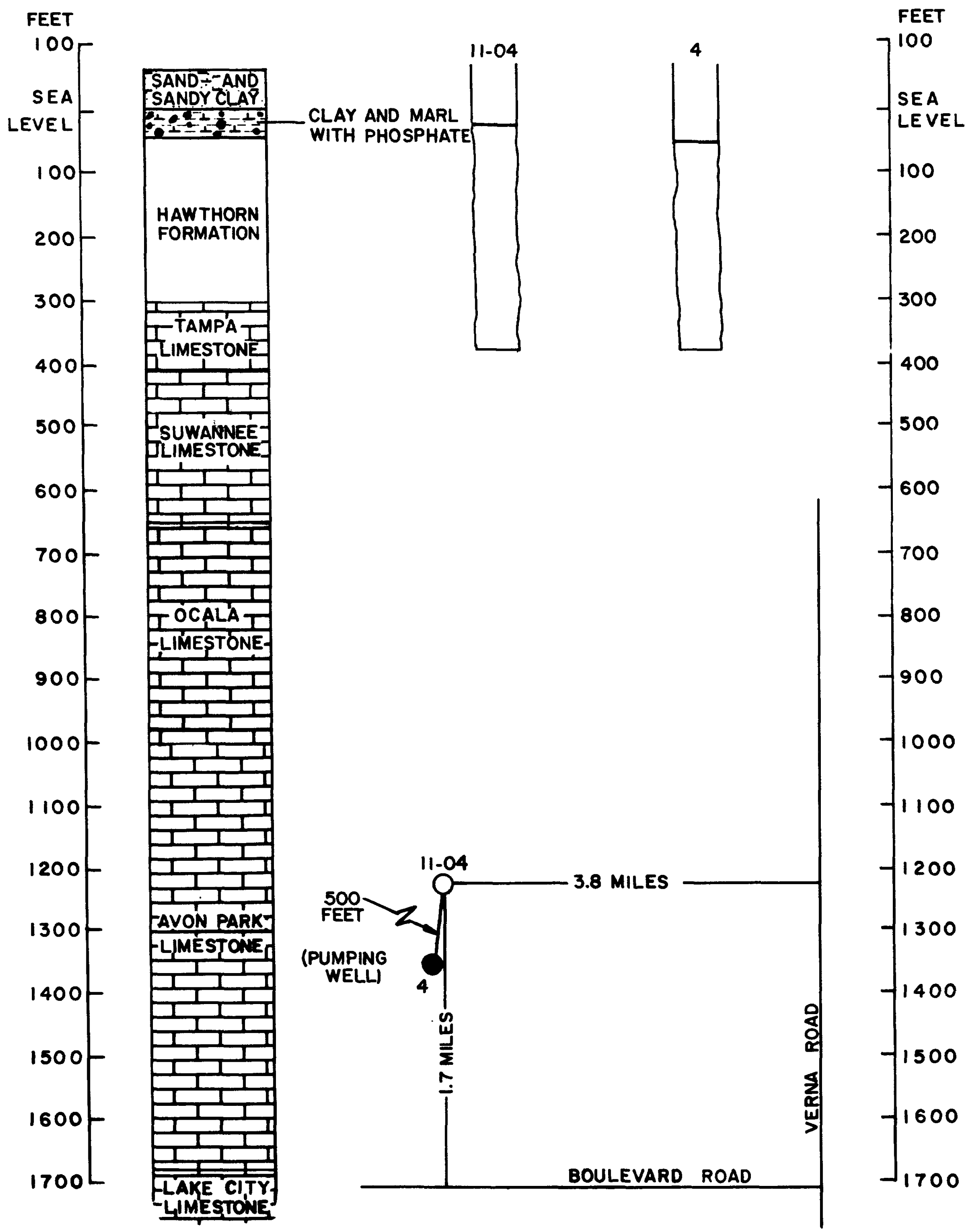
Test period (drawdown and recovery): 1200, 4-16-64 to 1300, 5-14-64.

Aquifer tested: Intermediate and upper Floridan.

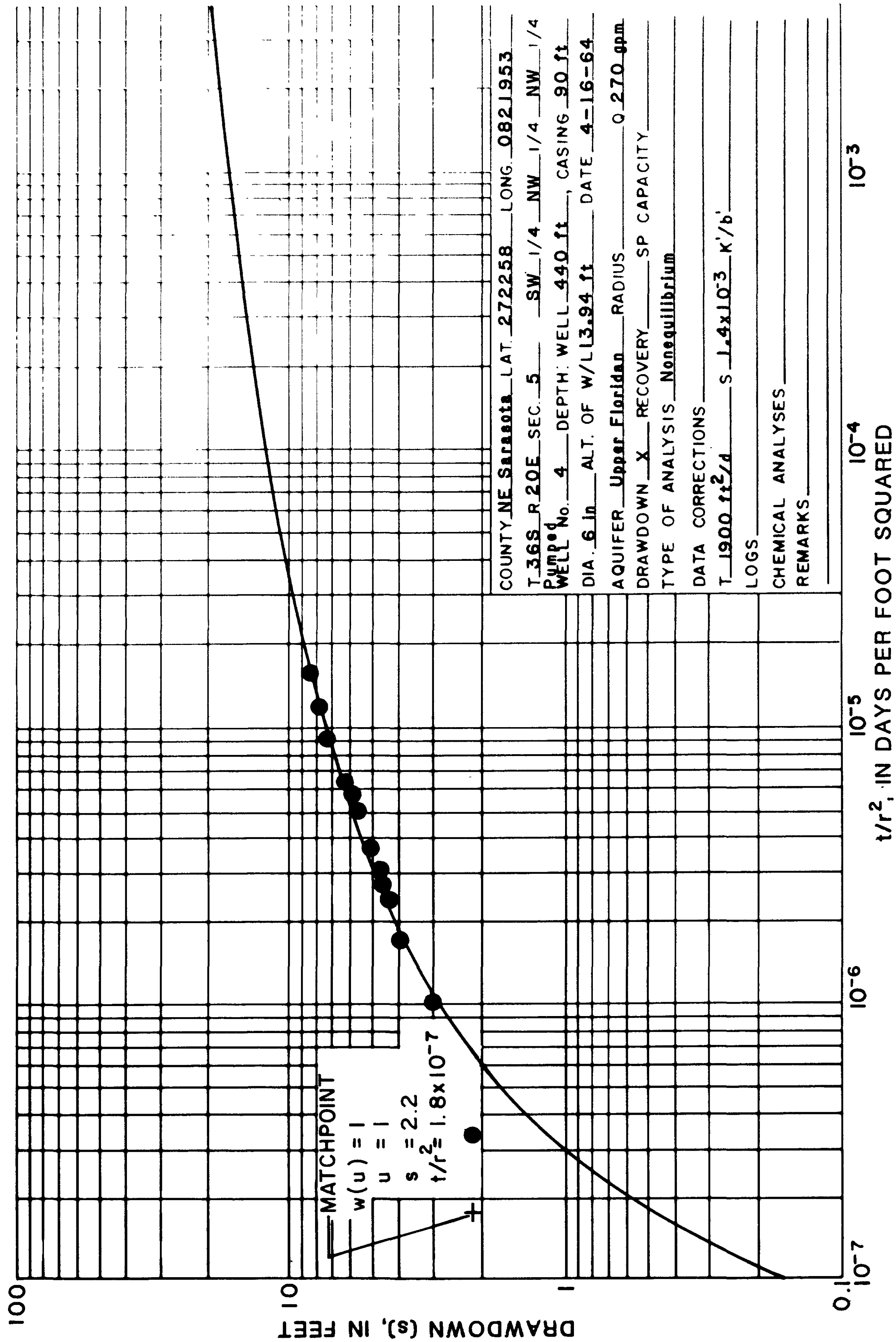
Data corrections applied: None applied. However, water-level changes were moderate during the test.

Test problems: Data from only one observation well were available. Pumping well probably is open to the top of the Floridan aquifer in addition to the intermediate aquifer.

Test reliability: The transmissivity is for the intermediate aquifer and the upper part of the Floridan aquifer. The storage coefficient is the summation of the intermediate and Floridan aquifer storage coefficient. The test was not of long enough duration to determine leakance.



Verna well-field location map and well characteristics: 04-16-64 aquifer test (test site 12a).


COUNTY NE Sarasota LAT. 272258 LONG. 0821953
T 36S R 20E SEC. 5 SW 1/4 NW 1/4 NW 1/4
Pumped WELL No. 4 DEPTH: WELL 440 ft, CASING 90 ft
DIA. 6 in ALT. OF W/L 13.94 ft DATE 4-16-64
AQUIFER Upper Floridan RADIUS Q 270 gpm
DRAWDOWN X RECOVERY SP CAPACITY
TYPE OF ANALYSIS Nonequilibrium
DATA CORRECTIONS
T 1900 ft²/d S 1.4x10⁻³ K'/b'
LOGS
CHEMICAL ANALYSES
REMARKS
MATCHPOINT
w(u) = 1
u = 1
s = 2.2
t/r² = 1.8x10⁻⁷
DRAWDOWN (s), IN FEET
100
10
1
0.1
10⁻⁷
10⁻⁶
10⁻⁵
10⁻⁴
10⁻³
t/r², IN DAYS PER FOOT SQUARED

Verna Well Field (Test 12b), Northeast Sarasota County

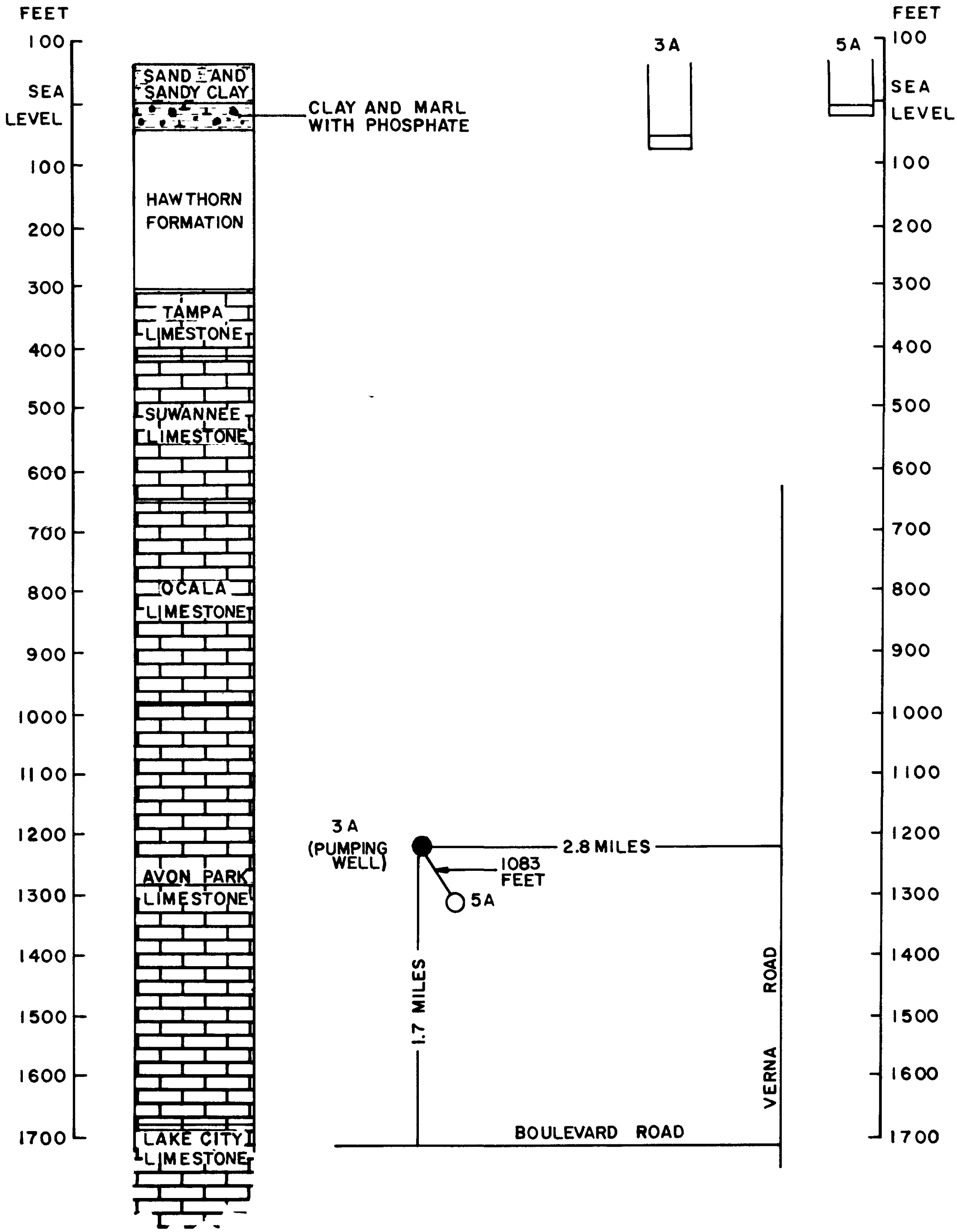
Test period (drawdown and recovery): 1215, 10-4-71 to 1215, 10-6-71.

Aquifer tested: Intermediate.

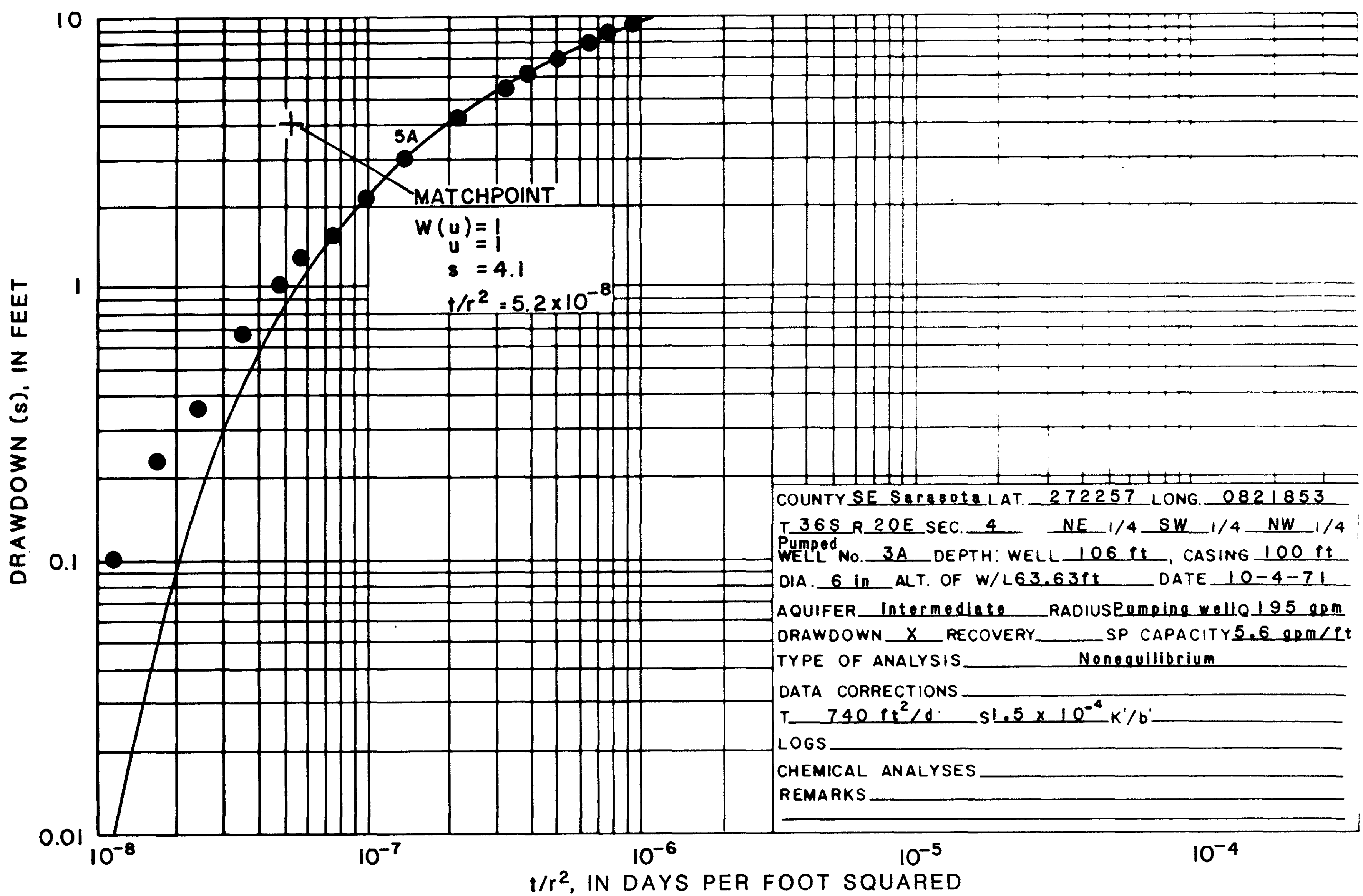
Data corrections applied: None applied. However, water-level changes were moderate during the test.

Test problems: Both the pumping and observation wells partially penetrate the aquifer; however, the effects of partial penetration are insignificant and can be ignored at the distance the observation well is from the pumping well.

Test reliability: Transmissivity is for only that part of the aquifer tested. The storage coefficient is plausible for the aquifer in the area tested. Leakance was not determined because the test was not of long enough duration.



Verna well-field location map and well characteristics: 10-04-71 aquifer test (test site 12b).


10
1
0.1
0.01
DRAWDOWN (s), IN FEET
10^{-8}
10^{-7}
10^{-6}
10^{-5}
10^{-4}
t/r², IN DAYS PER FOOT SQUARED
5A
MATCHPOINT
W(u) = 1
u = 1
s = 4.1
t/r² = 5.2 x 10⁻⁸
COUNTY SE Sarasota LAT. 272257 LONG. 0821853
T 36S R 20E SEC. 4 NE 1/4 SW 1/4 NW 1/4
Pumped WELL No. 3A DEPTH: WELL 106 ft, CASING 100 ft
DIA. 6 in ALT. OF W/L 63.63ft DATE 10-4-71
AQUIFER Intermediate RADIUS Pumping well Q 195 gpm
DRAWDOWN X RECOVERY SP CAPACITY 5.6 gpm/ft
TYPE OF ANALYSIS Nonequilibrium
DATA CORRECTIONS
T 740 ft²/d S 1.5 x 10⁻⁴ K'/b'
LOGS
CHEMICAL ANALYSES
REMARKS

Tropical River Grove Test Site (Test 13), Northeast De Soto County

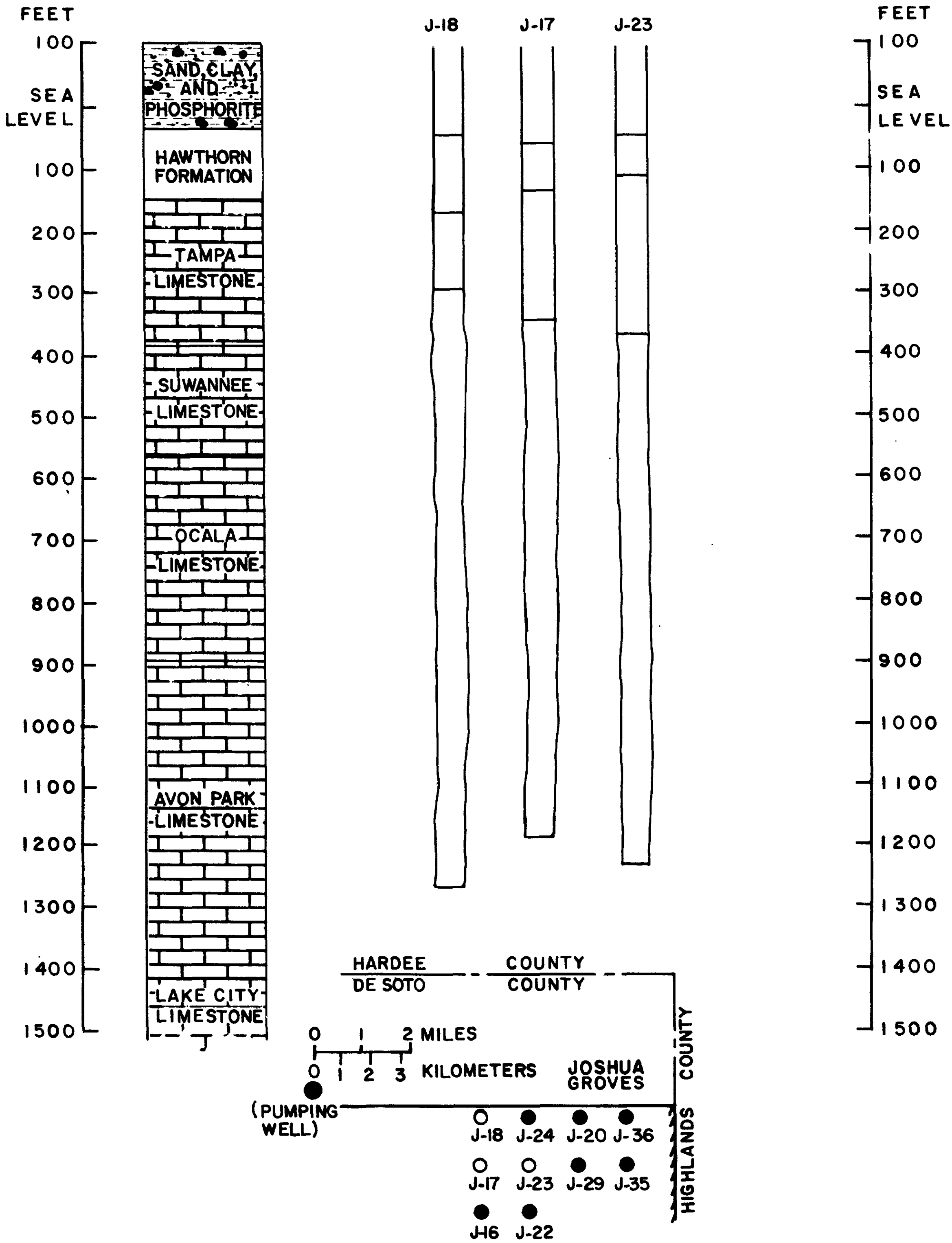
Test period (drawdown and recovery): 0900, 11-2-70 to 0940, 11-6-70.

Aquifer tested: Intermediate and Floridan.

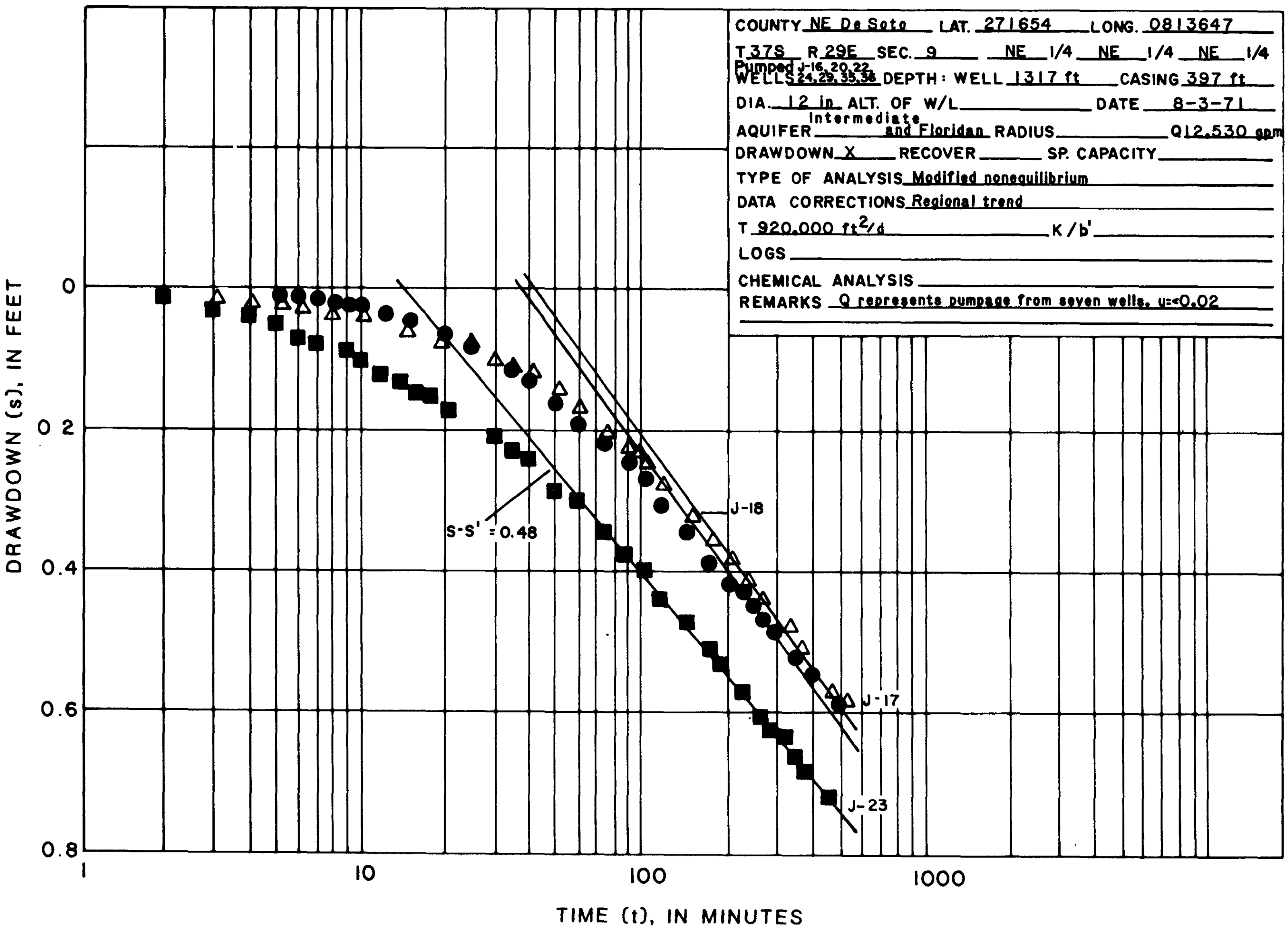
Data corrections applied: Observed data were corrected for water-level changes with available background information from area wells.

Test problems: Test was of short duration. Test wells were open to the intermediate and Floridan aquifers.

Test reliability: Analytical techniques that require the plotting of drawdown versus time divided by the square of the effective distances of the observation wells cannot be used because the center of pumping and also the effective distance of the observation wells from the pumping center are unknown. However, transmissivity was determined by the modified nonequilibrium method from the slope of the straight-line segment of observation-well drawdown versus the log of time. Drawdowns for all three observation wells follow the same trend with time and yield the same values for transmissivity.



Tropical River Grove test site location map and well characteristics: 11-02-70 aquifer test (test site 13).



COUNTY NE De Soto LAT. 271654 LONG. 0813647
T 37S R 29E SEC. 9 NE 1/4 NE 1/4 NE 1/4
Pumped WELLS J-16, 20, 22, 24, 29, 35, 36 DEPTH: WELL 1317 ft CASING 397 ft
DIA. 12 in. ALT. OF W/L DATE 8-3-71
AQUIFER Intermediate and Floridan RADIUS Q 12,530 gpm
DRAWDOWN X RECOVER SP. CAPACITY
TYPE OF ANALYSIS Modified nonequilibrium
DATA CORRECTIONS Regional trend
T 920,000 ft2/d K/b'
LOGS
CHEMICAL ANALYSIS
REMARKS Q represents pumpage from seven wells, u<0.02
J-18
J-17
J-23
S-S' = 0.48
DRAWDOWN (s), IN FEET
0
0.2
0.4
0.6
0.8
1
10
100
1000
TIME (t), IN MINUTES

Venice Well Field (Test 14), Southwest Sarasota County

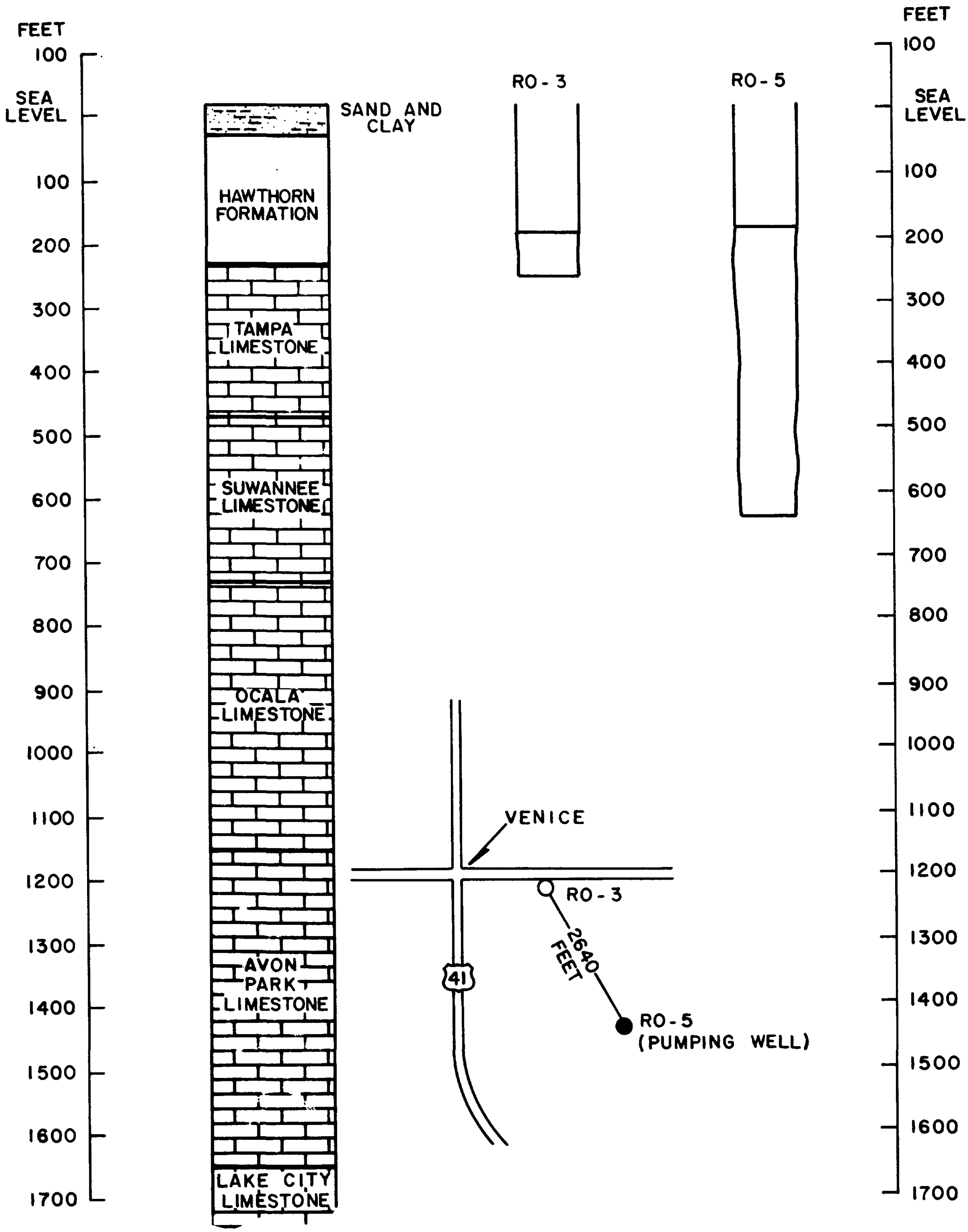
Test period (drawdown and recovery): 0845, 3-26-75 to 1845, 3-26-75.

Aquifer tested: Intermediate and upper Floridan.

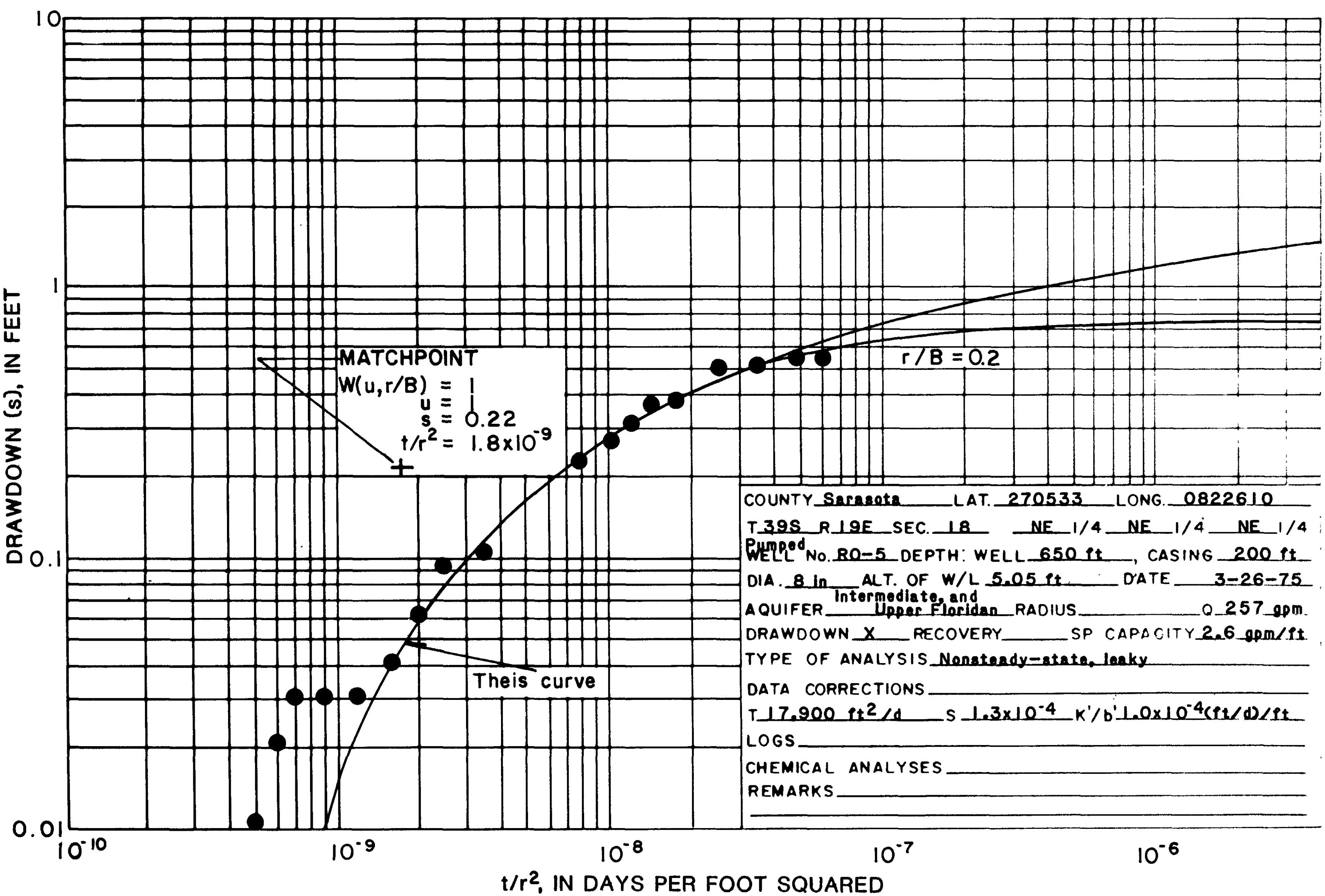
Data corrections applied: None applied. However, test was of short duration.

Test problems: Data from only one observation well were available. Floridan aquifer is severely stratified in test area.

Test reliability: Transmissivity, storage coefficient, and leakance are plausible for the combined lower intermediate aquifer and upper section of the Floridan aquifer open to the pumping well.



Venice well-field location map and well characteristics: 03-26-75 aquifer test (test site 14).


MATCHPOINT
W(u,r/B) = 1
u = 1
s = 0.22
t/r2 = 1.8x10-9
r/B = 0.2
Theis curve
COUNTY Sarasota LAT. 270533 LONG. 0822610
T 39S R 19E SEC. 18 NE 1/4 NE 1/4 NE 1/4
Pumped WELL No. RO-5 DEPTH: WELL 650 ft, CASING 200 ft
DIA. 8 in ALT. OF W/L 5.05 ft DATE 3-26-75
AQUIFER Intermediate, and Upper Floridan RADIUS Q 257 gpm
DRAWDOWN X RECOVERY SP CAPACITY 2.6 gpm/ft
TYPE OF ANALYSIS Nonsteady-state, leaky
DATA CORRECTIONS
T 17,900 ft2/d S 1.3x10-4 K'/b' 1.0x10-4(ft/d)/ft
LOGS
CHEMICAL ANALYSES
REMARKS
DRAWDOWN (s), IN FEET
10
1
0.1
0.01
10-10
10-9
10-8
10-7
10-6
t/r2, IN DAYS PER FOOT SQUARED

Fort Ogden Test Site (Test 15), Southwest De Soto County

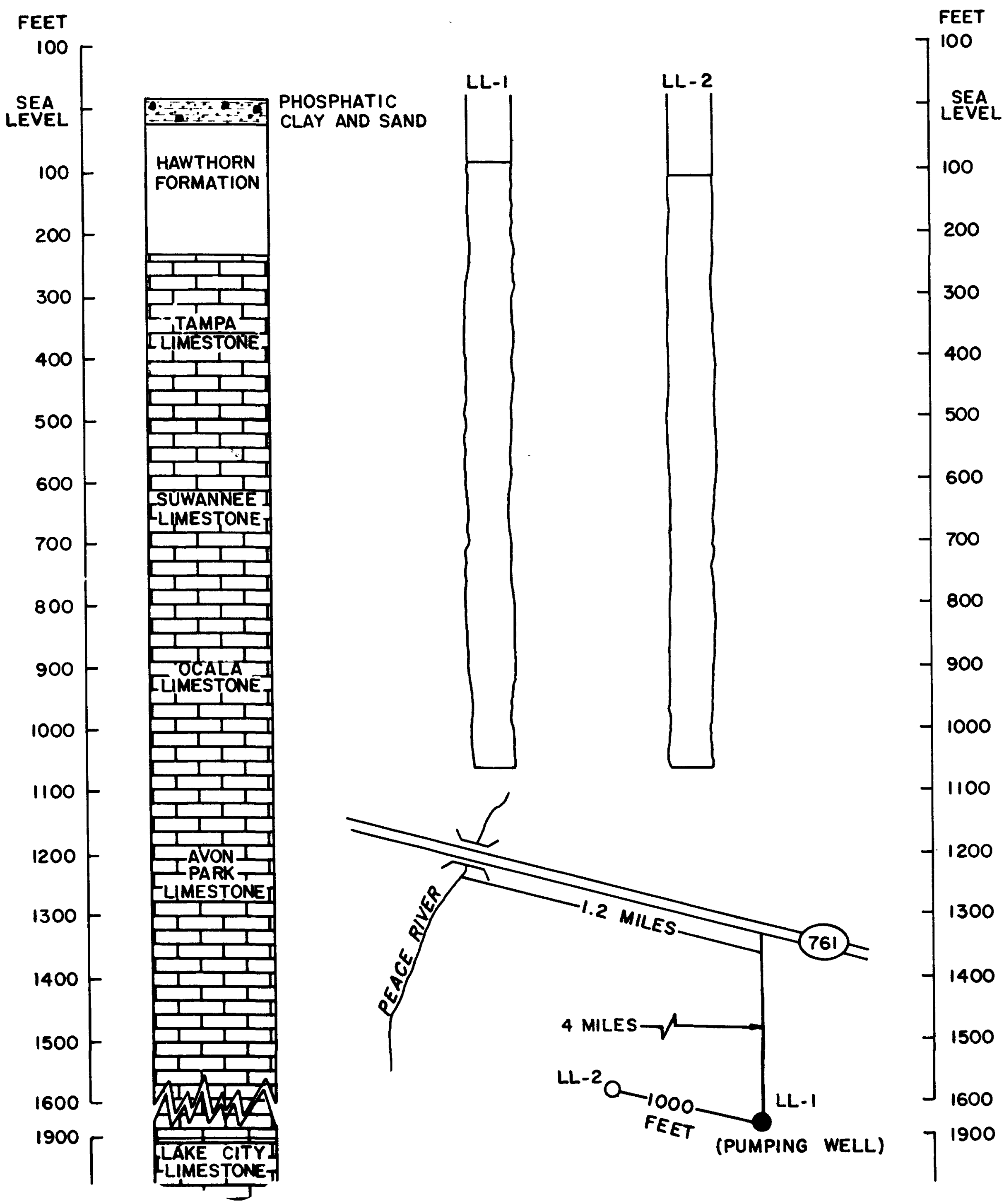
Test period (drawdown and recovery): 1200, 8-28-73 to 1530, 8-29-73.

Aquifer tested: Intermediate and upper Floridan.

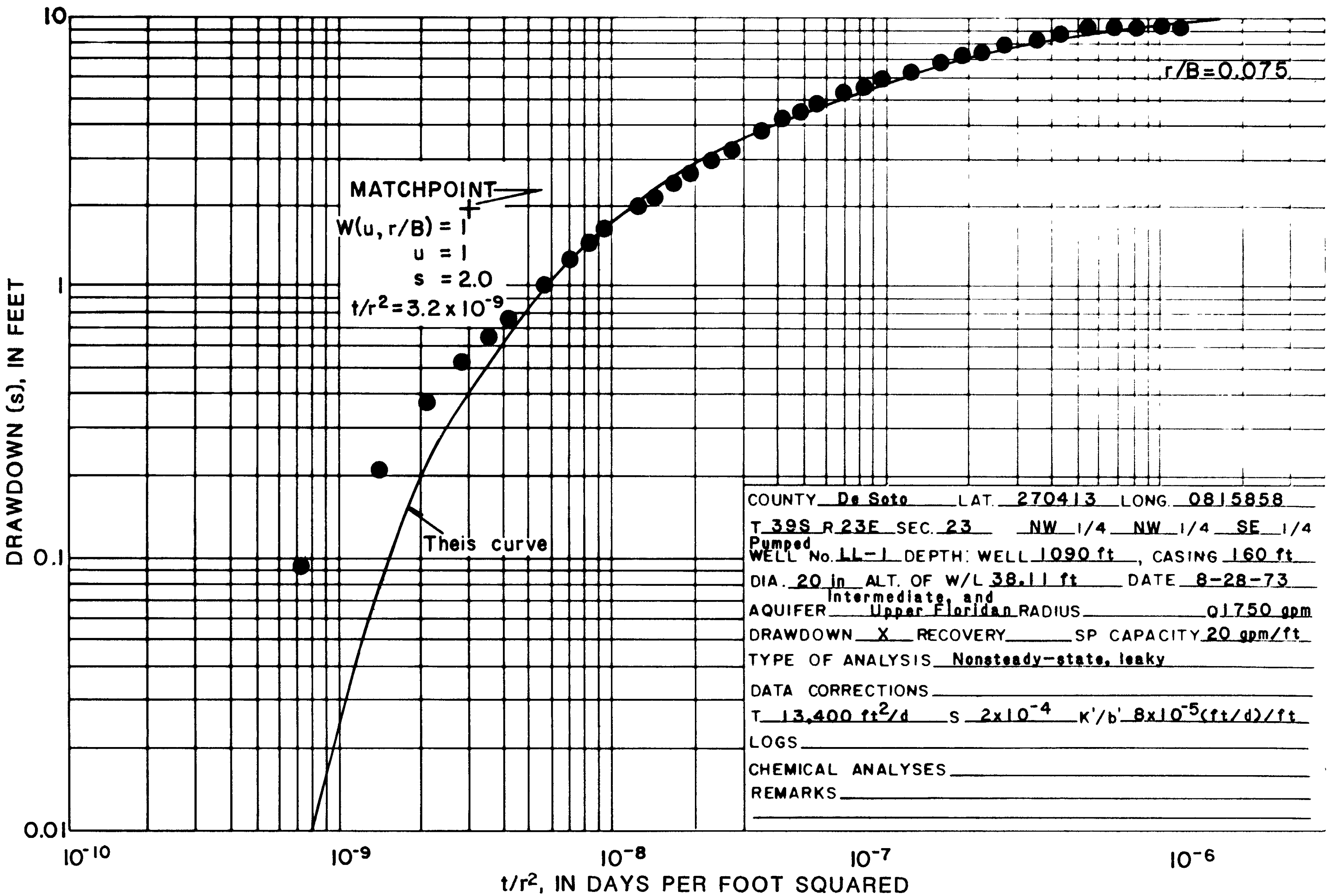
Data corrections applied: None applied. However, test was of short duration.

Test problems: Data from only one observation well were available. Test wells do not penetrate the most permeable stratum of the Floridan aquifer and are open to the lower part of the intermediate aquifer.

Test reliability: Transmissivity is plausible for section of Floridan aquifer open to the pumping well. Storage coefficient is plausible considering the severe stratification in the test area. The leakance coefficient computed probably reflects flow into the zone penetrated by the well through both overlying confining materials and the untapped lower part of the Floridan.



Fort Ogden test site location map and well characteristics: 08-28-73 aquifer test (test site 15).



DRAWDOWN (s), IN FEET
10
1
0.1
0.01
t/r², IN DAYS PER FOOT SQUARED
10⁻¹⁰
10⁻⁹
10⁻⁸
10⁻⁷
10⁻⁶
MATCHPOINT
W(u, r/B) = 1
u = 1
s = 2.0
t/r² = 3.2 x 10⁻⁹
Theis curve
r/B=0.075
COUNTY De Soto LAT. 270413 LONG. 0815858
T 39S R 23E SEC. 23 NW 1/4 NW 1/4 SE 1/4
Pumped WELL No. LL-1 DEPTH: WELL 1090 ft, CASING 160 ft
DIA. 20 in ALT. OF W/L 38.11 ft DATE 8-28-73
AQUIFER Intermediate and Upper Floridan RADIUS Q 1750 gpm
DRAWDOWN X RECOVERY SP CAPACITY 20 gpm/ft
TYPE OF ANALYSIS Nonsteady-state, leaky
DATA CORRECTIONS
T 13,400 ft²/d S 2x10⁻⁴ K'/b' 8x10⁻⁵(ft/d)/ft
LOGS
CHEMICAL ANALYSES
REMARKS

Tropical River Grove Test Site (Test 16),
Northeast Charlotte County

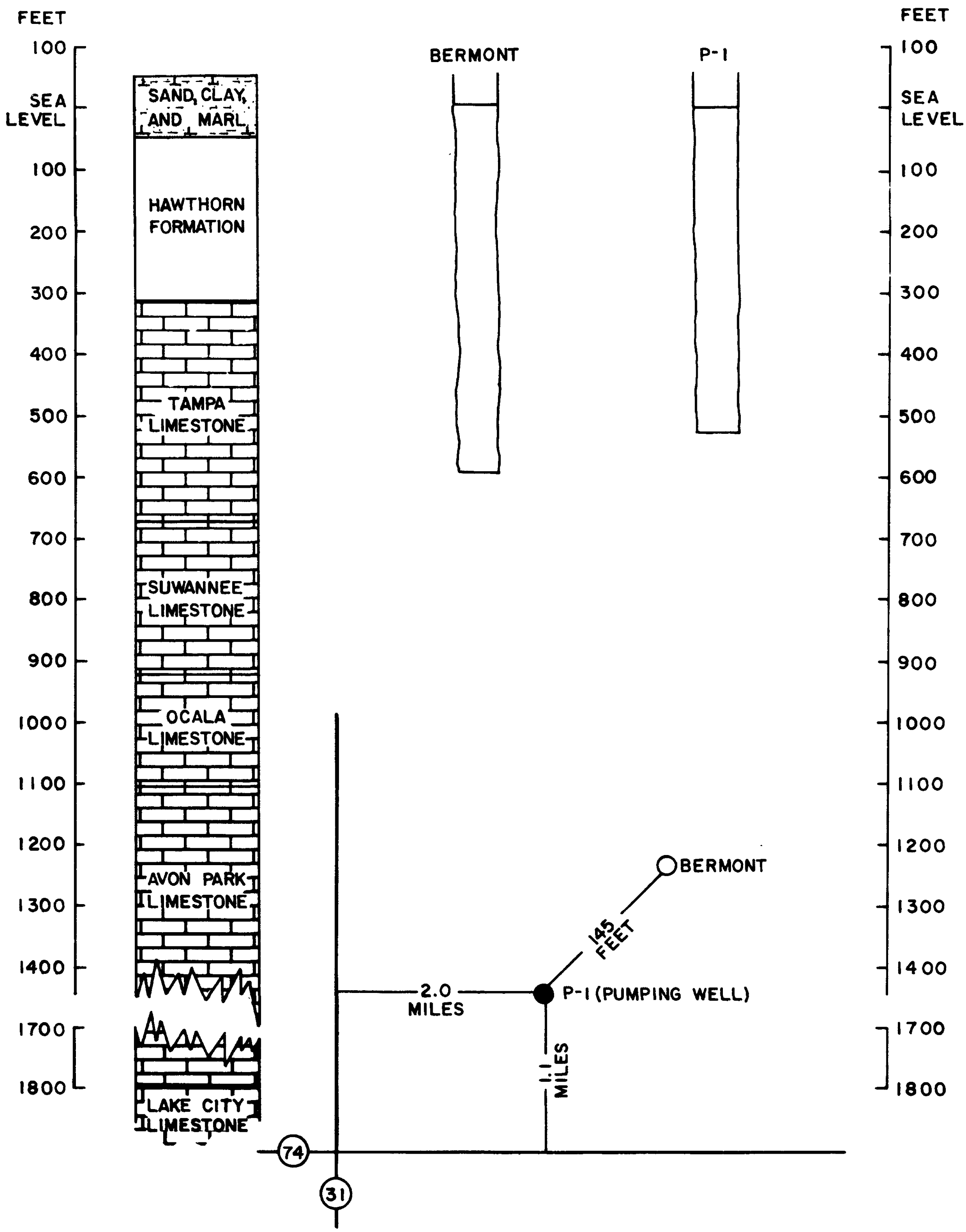
Test period (drawdown and recovery): 1200, 10-2-69 to 1500, 10-2-69.

Aquifer tested: Intermediate.

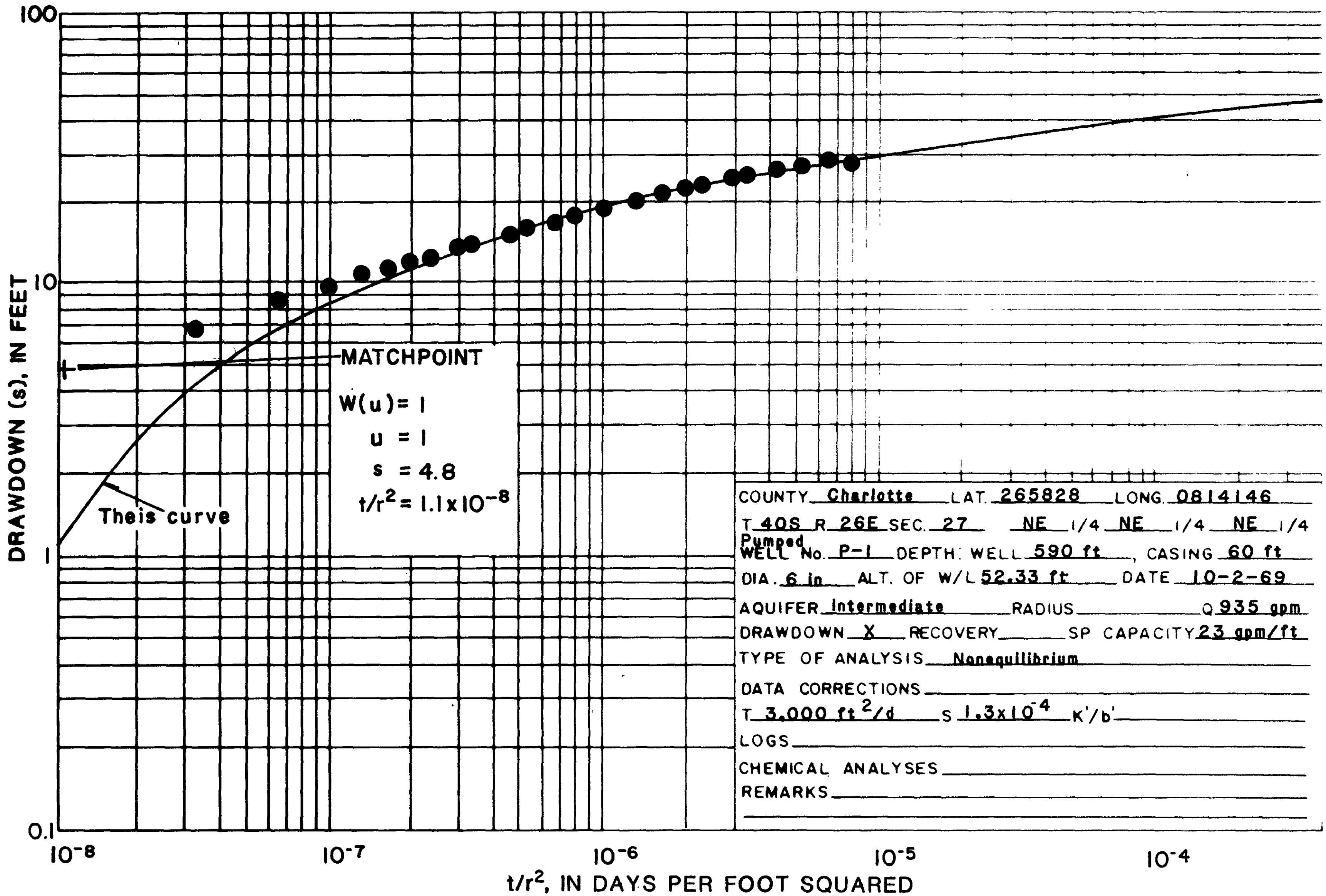
Data corrections applied: None applied. However, test was of very short duration.

Test problems: Data from only one observation well were available, and the test was of short duration.

Test reliability: Transmissivity and storage coefficient are plausible for the intermediate aquifer. Leakance was not determined as the test was not of long enough duration.



Tropical River Grove test site location map and well characteristics: 10-02-69 aquifer test (test site 16).


DRAWDOWN (s), IN FEET
100
10
1
0.1
10^{-8}
10^{-7}
10^{-6}
10^{-5}
10^{-4}
t/r^2, IN DAYS PER FOOT SQUARED
MATCHPOINT
W(u) = 1
u = 1
s = 4.8
$t/r^2 = 1.1 \times 10^{-8}$
Theis curve
COUNTY Charlotte LAT. 265828 LONG. 0814146
T 40S R 26E SEC. 27 NE 1/4 NE 1/4 NE 1/4
Pumped WELL No. P-1 DEPTH: WELL 590 ft, CASING 60 ft
DIA. 6 in ALT. OF W/L 52.33 ft DATE 10-2-69
AQUIFER Intermediate RADIUS Q 935 gpm
DRAWDOWN X RECOVERY SP CAPACITY 23 gpm/ft
TYPE OF ANALYSIS Nonequilibrium
DATA CORRECTIONS
T 3,000 ft^2/d S 1.3×10^{-4} K'/b'
LOGS
CHEMICAL ANALYSES
REMARKS

Englewood Well Field (Test 17a), Southwest Sarasota County

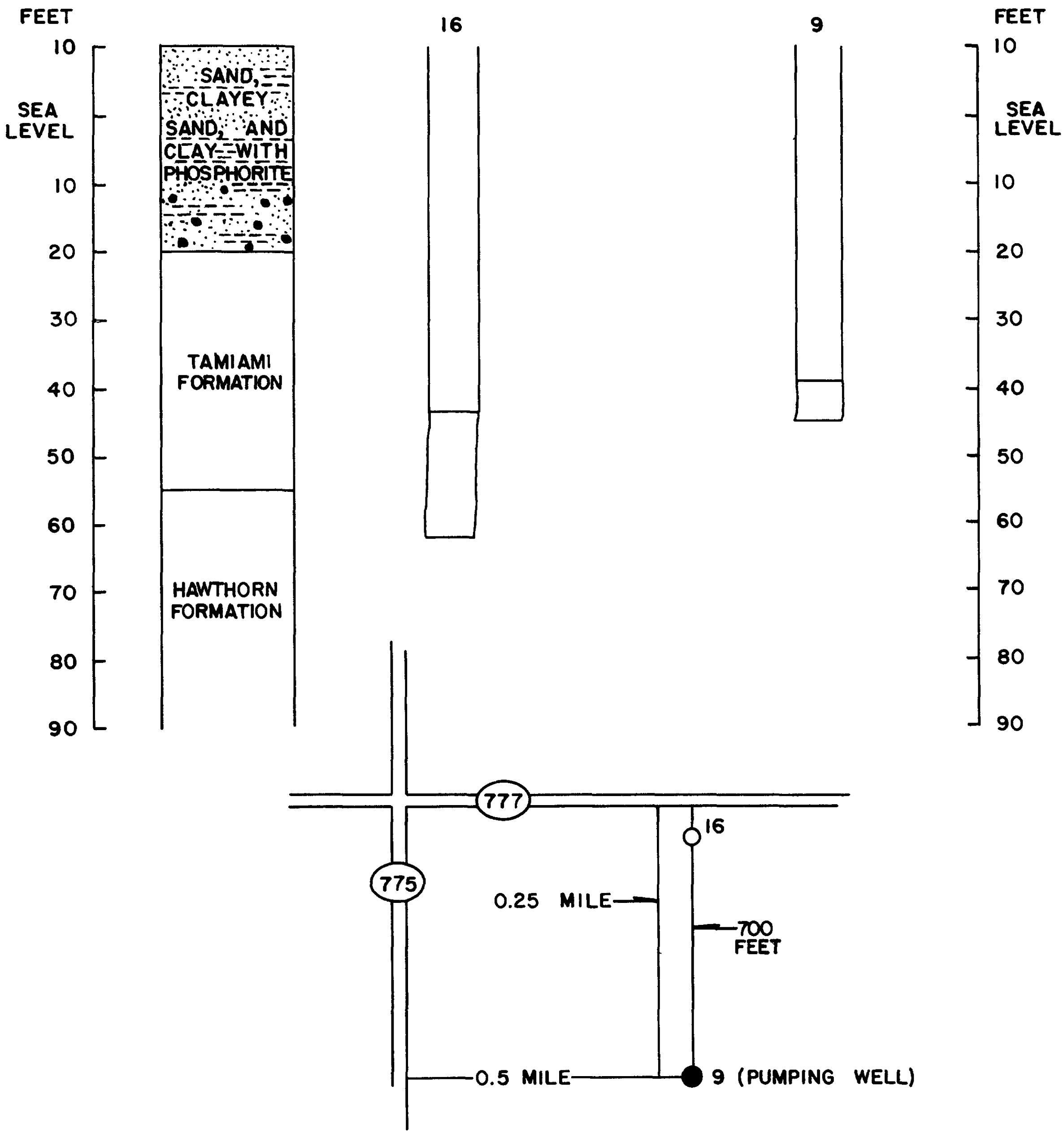
Test period (drawdown and recovery): 1000, 2-25-69 to 1330, 2-25-69.

Aquifer tested: Intermediate.

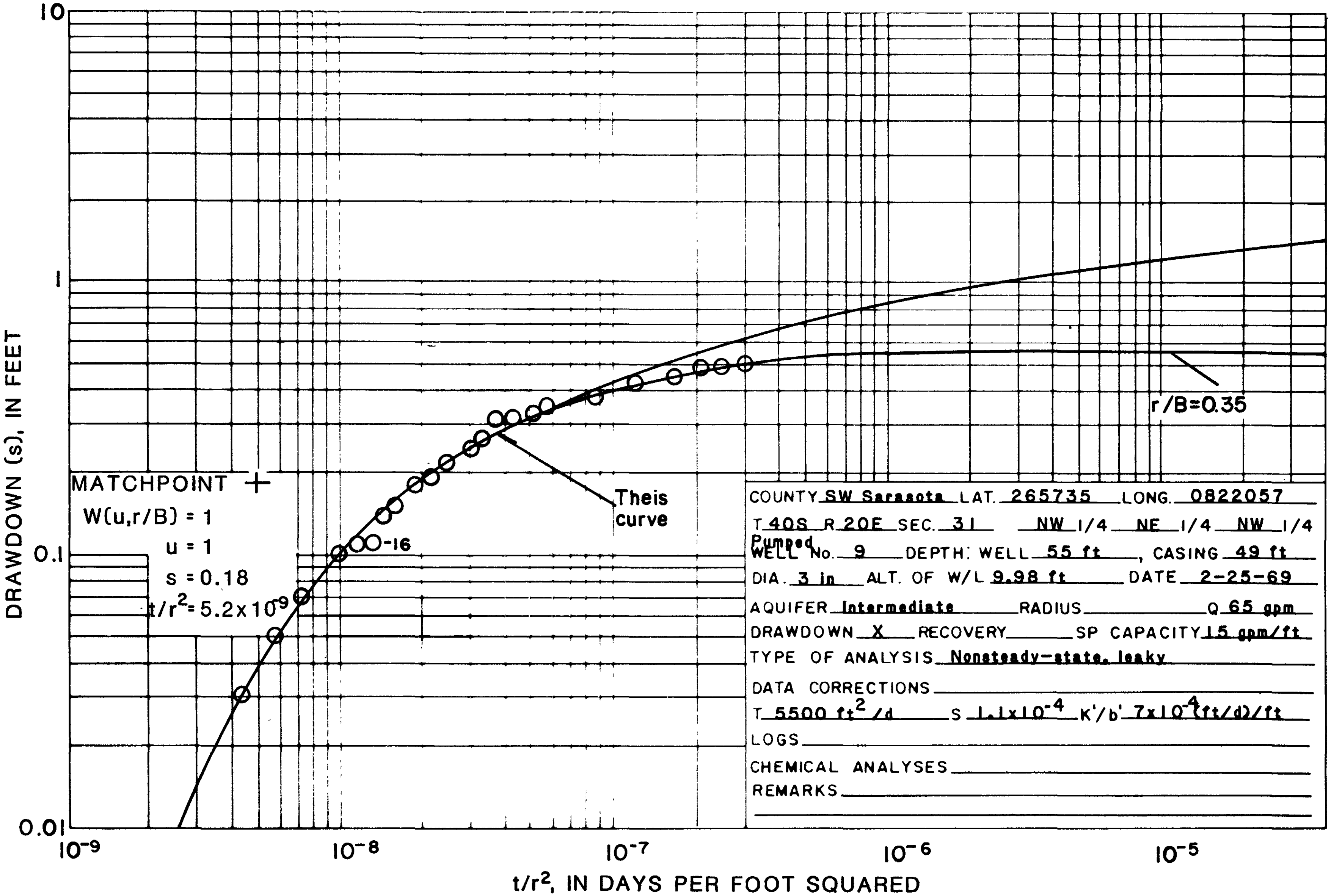
Data corrections applied: None applied. However, test was of short duration.

Test problems: Test wells are not at the same depth, and the test was of short duration.

Test reliability: Transmissivity and storage coefficient are plausible for the intermediate aquifer in the test area. Leakance is relatively high; however, it probably represents leakage from above and below.



Englewood well-field location map and well characteristics: 02-25-69 aquifer test (test site 17a).


DRAWDOWN (s), IN FEET
10
1
0.1
0.01
10^{-9}
10^{-8}
10^{-7}
10^{-6}
10^{-5}
t/r^2, IN DAYS PER FOOT SQUARED
MATCHPOINT +
W(u,r/B) = 1
u = 1
s = 0.18
$t/r^2 = 5.2 \times 10^{-9}$
-16
Theis curve
r/B=0.35
COUNTY SW Sarasota LAT. 265735 LONG. 0822057
T 40S R 20E SEC. 31 NW 1/4 NE 1/4 NW 1/4
Pumped WELL No. 9 DEPTH: WELL 55 ft , CASING 49 ft
DIA. 3 in ALT. OF W/L 9.98 ft DATE 2-25-69
AQUIFER Intermediate RADIUS Q 65 gpm
DRAWDOWN X RECOVERY SP CAPACITY 15 gpm/ft
TYPE OF ANALYSIS Nonsteady-state, leaky
DATA CORRECTIONS
T 5500 ft^2/d S 1.1×10^{-4} K'/b' 7×10^{-4} (ft/d)/ft
LOGS
CHEMICAL ANALYSES
REMARKS

Englewood Well Field (Test 17b), Southwest Sarasota County

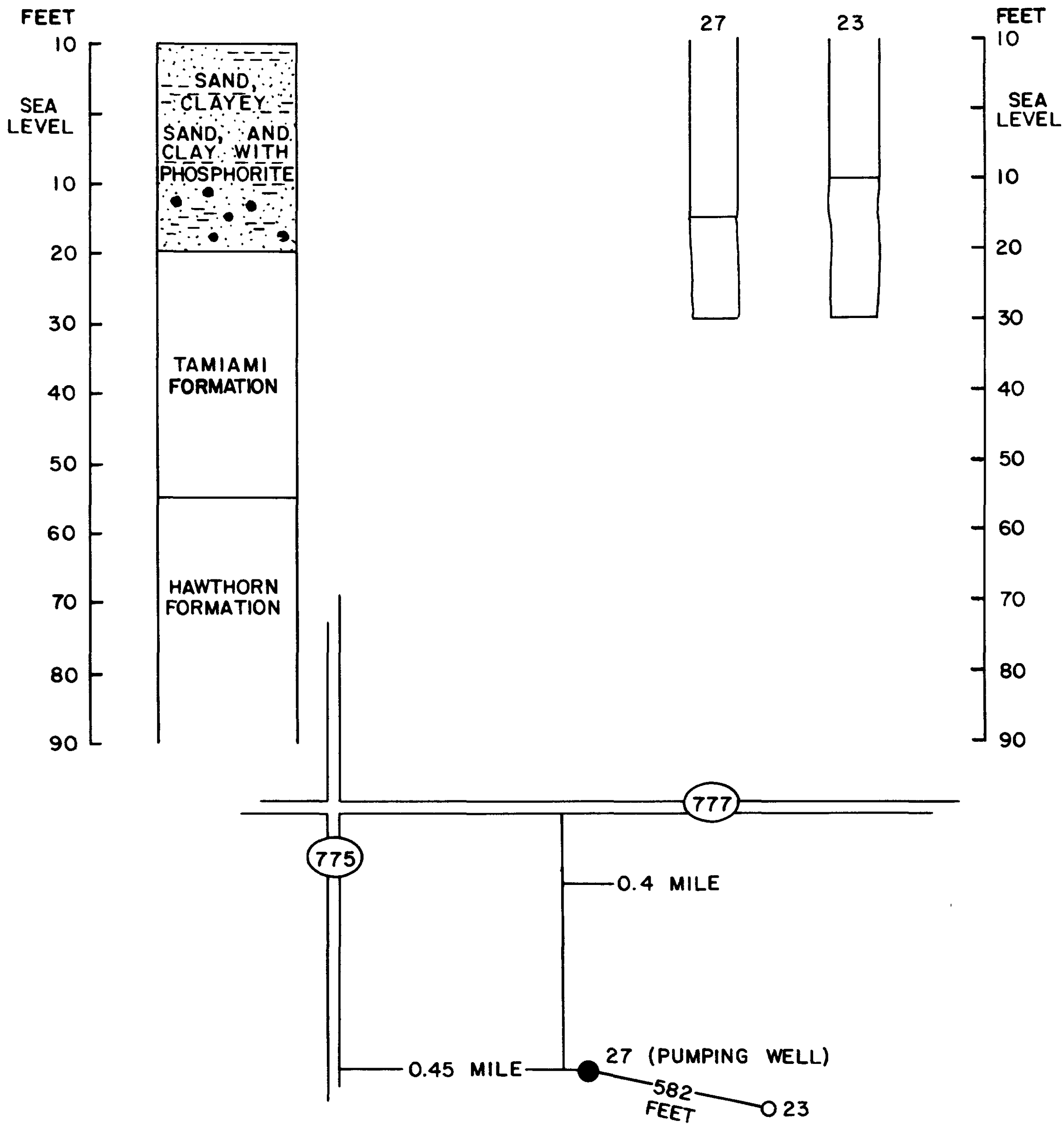
Test period (drawdown and recovery): 1200, 3-27-69 to 1520, 3-27-69.

Aquifer tested: Intermediate.

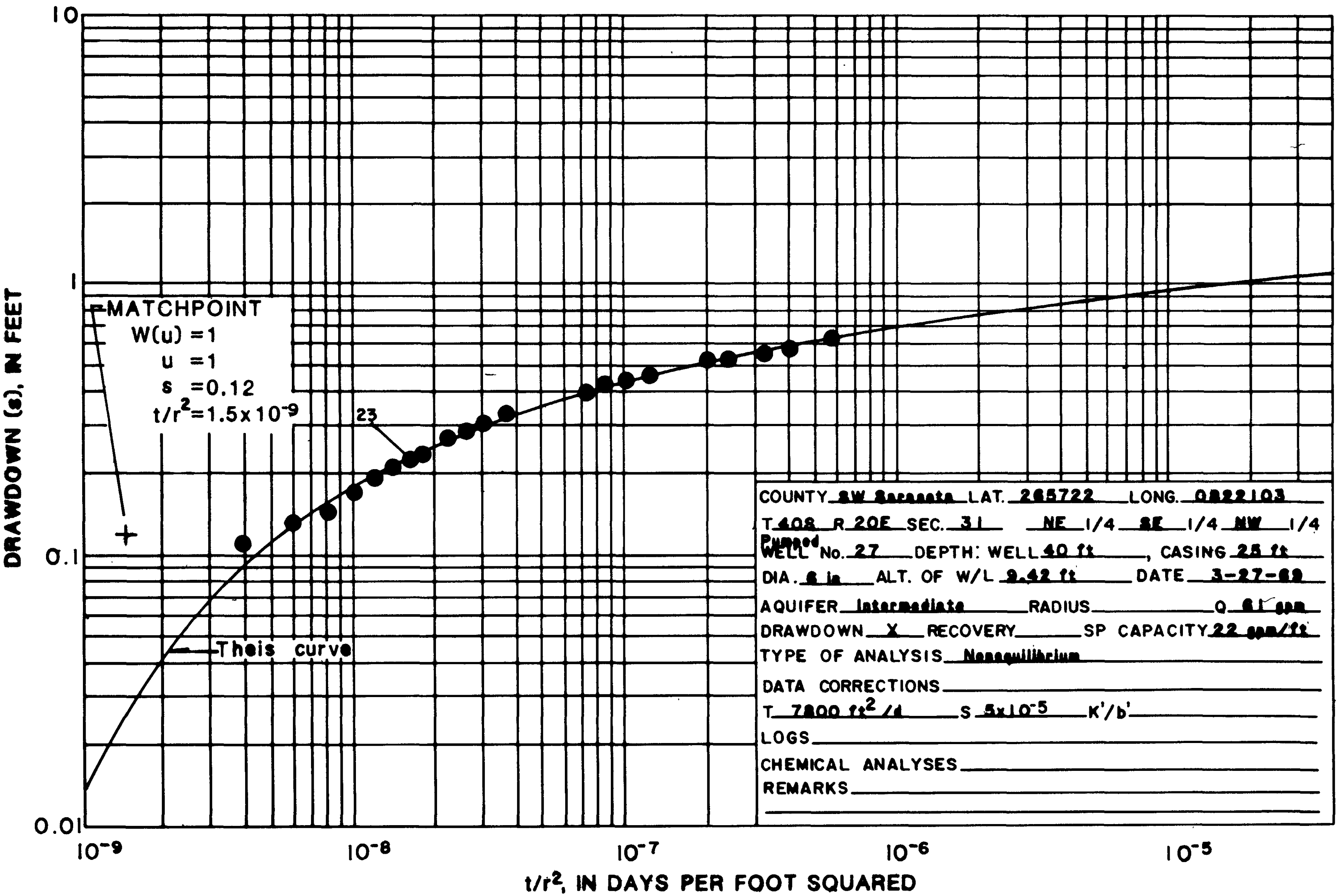
Data corrections applied: None applied. However, test was of short duration.

Test problems: Data from only one observation well were available, and the test was of short duration.

Test reliability: Transmissivity and storage coefficient are in the probable range for the upper intermediate aquifer. Leakance was not determined as the test was not of long enough duration.



Englewood well-field location map and well characteristics: 03-27-69 aquifer test (test site 17b).


10
1
0.1
0.01
DRAWDOWN (s), IN FEET
10⁻⁹
10⁻⁸
10⁻⁷
10⁻⁶
10⁻⁵
t/r², IN DAYS PER FOOT SQUARED
MATCHPOINT
W(u) = 1
u = 1
s = 0.12
t/r² = 1.5 x 10⁻⁹
23
Theis curve
COUNTY SW Sarasota LAT. 265722 LONG. 0822103
T 40S R 20E SEC. 31 NE 1/4 SE 1/4 NW 1/4
Pumped WELL No. 27 DEPTH: WELL 40 ft, CASING 25 ft
DIA. 6 in ALT. OF W/L 9.42 ft DATE 3-27-69
AQUIFER Intermediate RADIUS Q 61 gpm
DRAWDOWN X RECOVERY SP CAPACITY 22 gpm/ft
TYPE OF ANALYSIS Nonequilibrium
DATA CORRECTIONS
T 7800 ft²/d S 5x10⁻⁵ K'/b'
LOGS
CHEMICAL ANALYSES
REMARKS

Englewood Well Field (Test 17c), Southwest Sarasota County

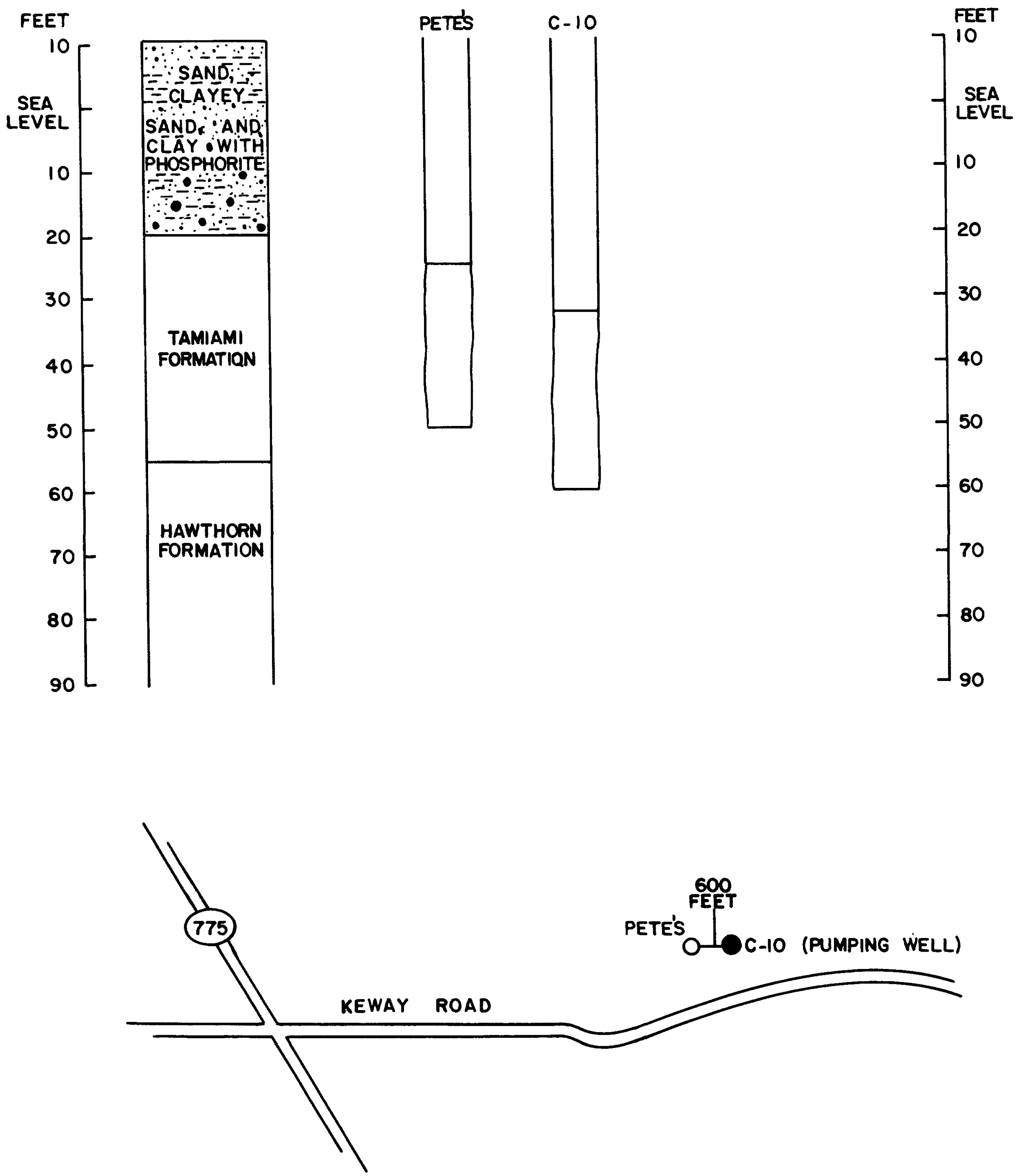
Test period (drawdown and recovery): 0900, 2-5-76 to 1000, 2-6-76.

Aquifer tested: Intermediate.

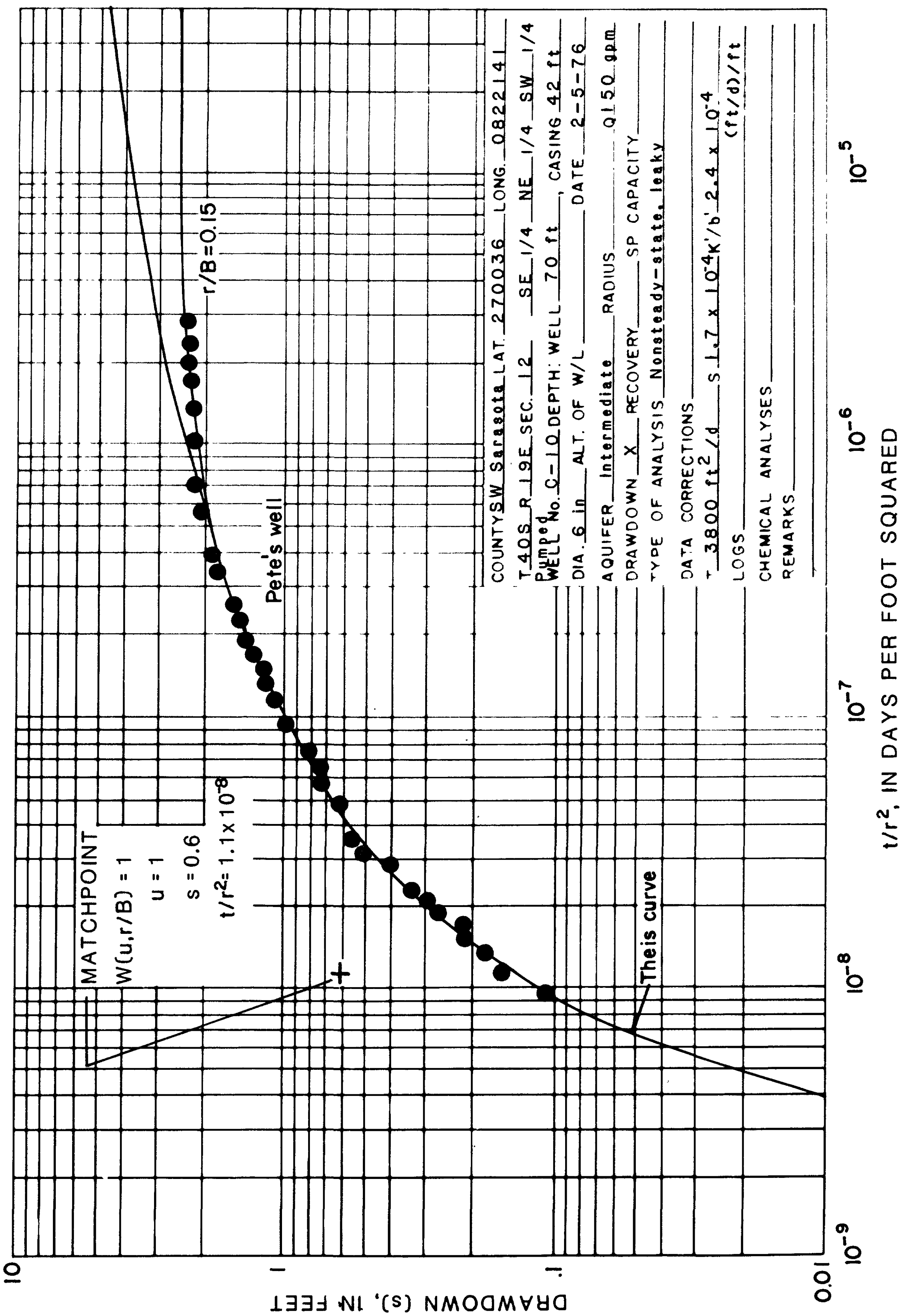
Data corrections applied: None applied. However, test was of short duration.

Test problems: Test wells are not at the same depth.

Test reliability: Aquifer characteristics determined are plausible for the aquifer in the test area.



Englewood well-field location map and well characteristics: 02-05-76 aquifer test (test site 17c).



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