APT site: STL_W
Station name: ↙
C-3_SLW
OW-1_SLW
OW-2_SLW
PSTL_OBSD1

B-2
B-4
D-2
D-4

ST. LUCIE WEST
St. Lucie County, Florida

(Surficial Only)

Prepared for
Thos. J. White Development Corporation

May 1985

POST, BUCKLEY, SCHUH & JERNIGAN, INC.
Engineering • Planning • Architecture

14-081.35A

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SUMMARY

Thos. J. White Development Corporation is planning to develop a 4,614-acre tract of land in St. Lucie County as a full service community called St. Lucie West. This community will consist of residential areas, commercial areas, industrial parks, stadiums and golf courses, schools, and open parks. Construction and development of St. Lucie West are to be carried out in six phases spanning 30 years. The final average water demand for St. Lucie West is expected to be 18.68 million gallons per day. For reasons of economy, the water supply for St. Lucie West will be met by available on-site resources.

Post, Buckley, Schuh & Jernigan, Inc. was retained by the Thos. J. White Development Corporation to carry out a hydrologic investigation of St. Lucie West with the dual purpose of answering questions in the Application for Development Approval of a Development of Regional Impact for St. Lucie West and of developing a water resources management plan. As part of this hydrologic investigation, Post, Buckley, Schuh & Jernigan, Inc. carried out field tests, including an aquifer pump test, a series of borings, water quality samplings, and other hydrologic testing.

This report presents the results of the pump test and other testing and boring work at St. Lucie West. The surficial hydrologic characteristics of the area are described, the major soils identified, and area rainfall patterns evaluated. The geological strata and aquifers underlying the site are also described and the capacity of those aquifers to provide sufficient volumes of water to meet the projected demands is evaluated. The two primary aquifers are discussed with particular reference to their current use in the area.

The 24-hour pump test of the surficial aquifer system was conducted at a discharge of 156 gallons per minute. The pump test analysis shows that the surficial aquifer system has a transmissivity of 20,000 gallons per day per foot, a storage coefficient of 1.5×10^{-4} and a leakage coefficient of 4.0×10^{-3}. These data are similar to values determined from previous pump tests in St. Lucie County; although there appears to be a general trend of increasing transmissivity towards the southeast of the county. Research of the available

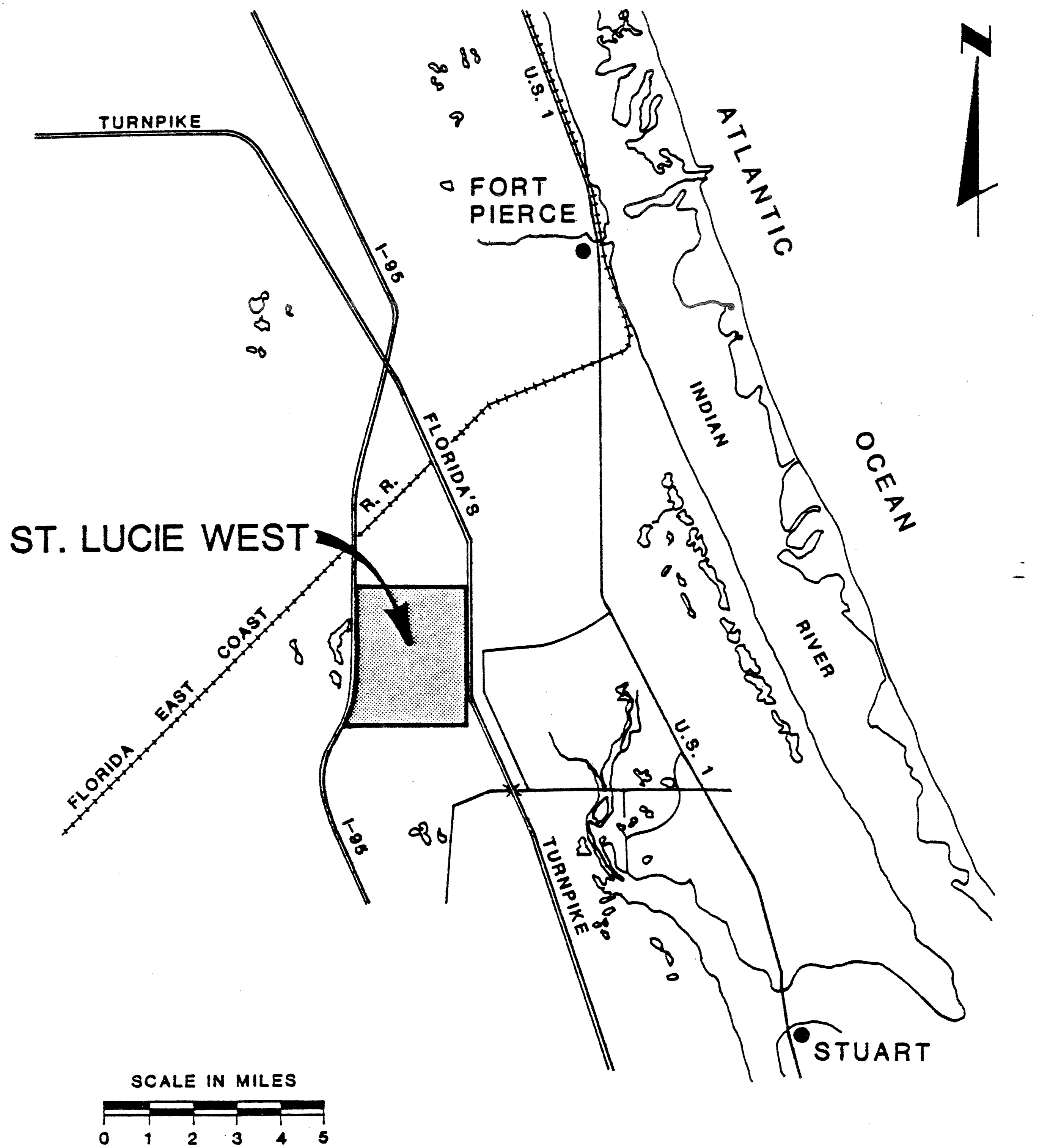
4×10^{-3} ft³/ft²/min × 7.48 gal/ft³ = 0.030 GPD/FT³ literature shows that the Floridan Aquifer has a transmissivity of 50,000 gallons per day per foot.

Water quality in the surface water bodies and in the surficial aquifer system is quite variable. Water quality in the Floridan Aquifer is poor and the water requires membrane process treatment.

The surficial aquifer system is capable of meeting the projected final demand for the site, but will experience serious depletion and large drawdowns which are deleterious. The estimated safe yield of the surficial aquifer system is 8 million gallons per day. To help alleviate the demands from the surficial aquifer system, it is recommended that a membrane process be used in the water treatment plant (e.g., ultrafiltration or reverse osmosis membranes), and that the water from the Floridan Aquifer be used as feedwater.

It is also recommended that a separate water supply system be installed to provide the non-potable demand of the area. This system could use wastewater effluent. The use of a separate water supply system in conjunction with the prohibition of private wells will ensure the careful management of the surficial aquifer system. It is further recommended that a deep injection well system be used as a backup for a spray effluent disposal system. The deep injection well system is also required to dispose of the reverse osmosis reject water from the water treatment plant.

Scenarios using different combinations of deep and shallow wells were evaluated for the phased development of the site. The phasing of the deep and shallow wells presented in Scenario 5 is recommended. The shallow wells will be used to make up the deficit in the non-potable demand, after the inclusion of the wastewater effluent. Eight-inch shallow wells are recommended, with a discharge of 170 gallons per minute and a spacing of 750 feet between wells. The 10-inch deep wells shall have a discharge of 800 gallons per minute and a spacing of 800 feet. By the end of Phase VI, including standby requirements, 19 deep wells are recommended to meet the potable demand at St. Lucie West, and 21 shallow wells are recommended to meet the non-potable demand deficit not satisfied by wastewater effluent.



ST. LUCIE WEST SITE

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FIGURE 1-2

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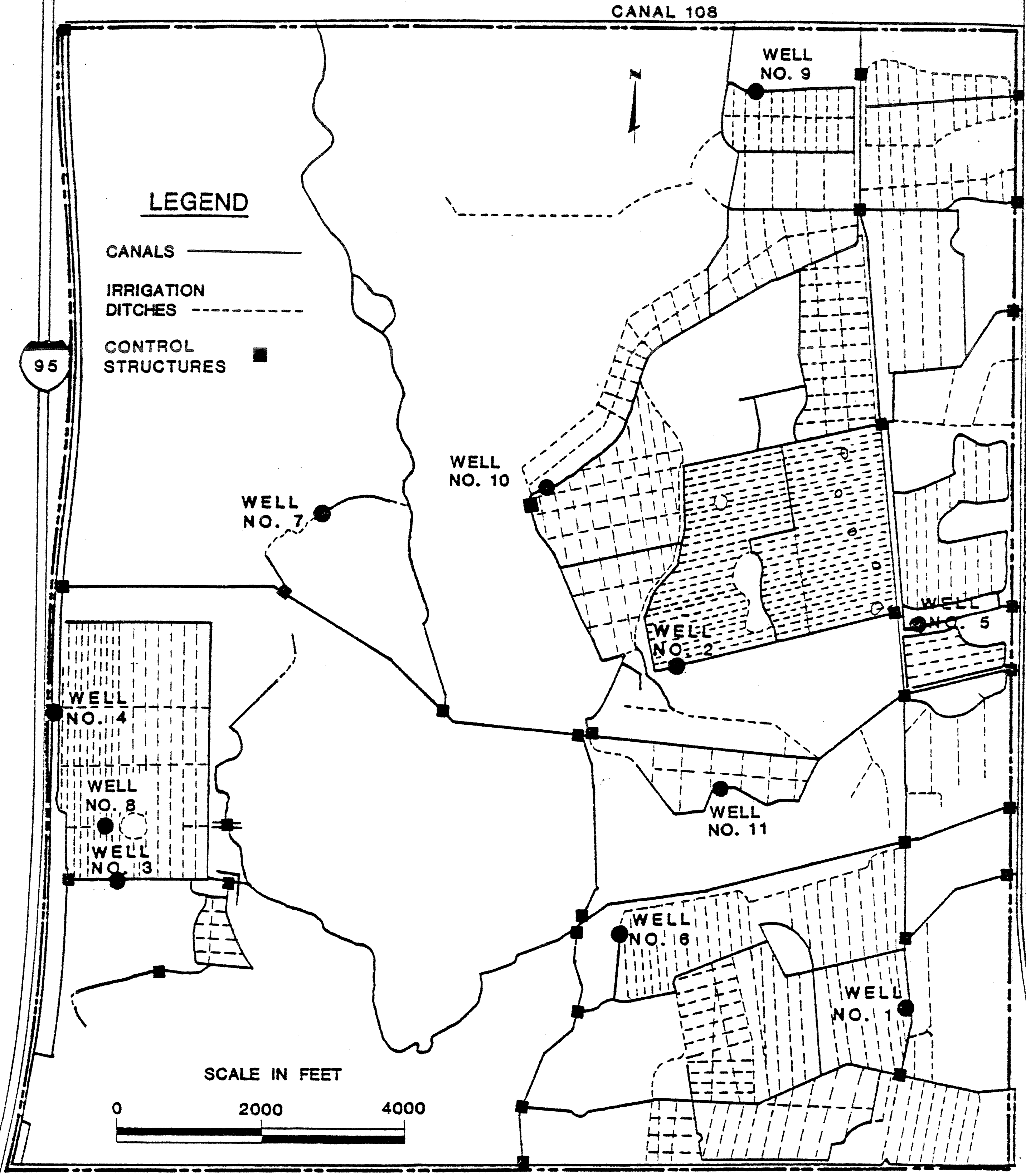

SURFACE HYDROLOGY OF PROJECT SITE

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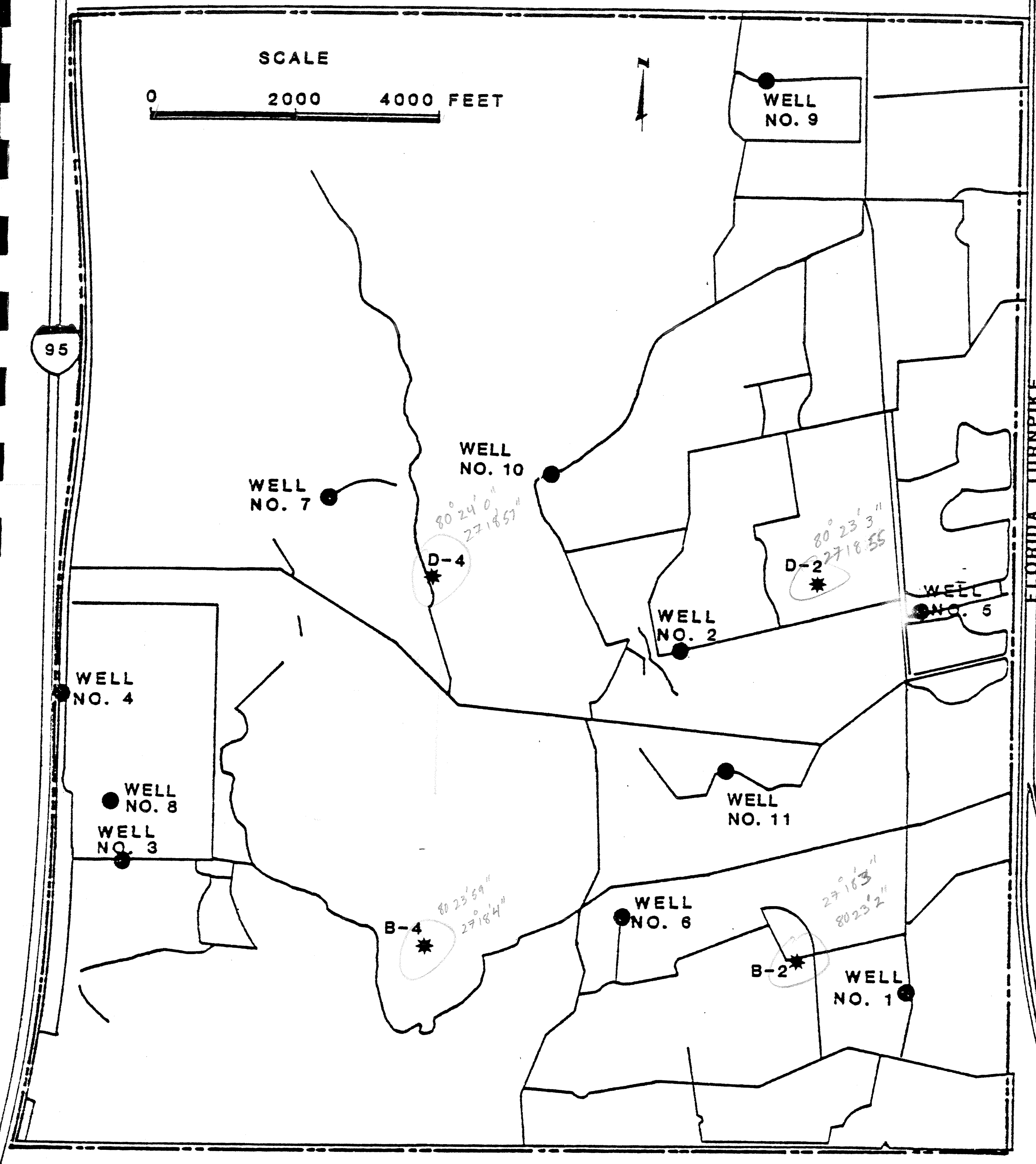
FIGURE 2-3



DEEP BORINGS (130')

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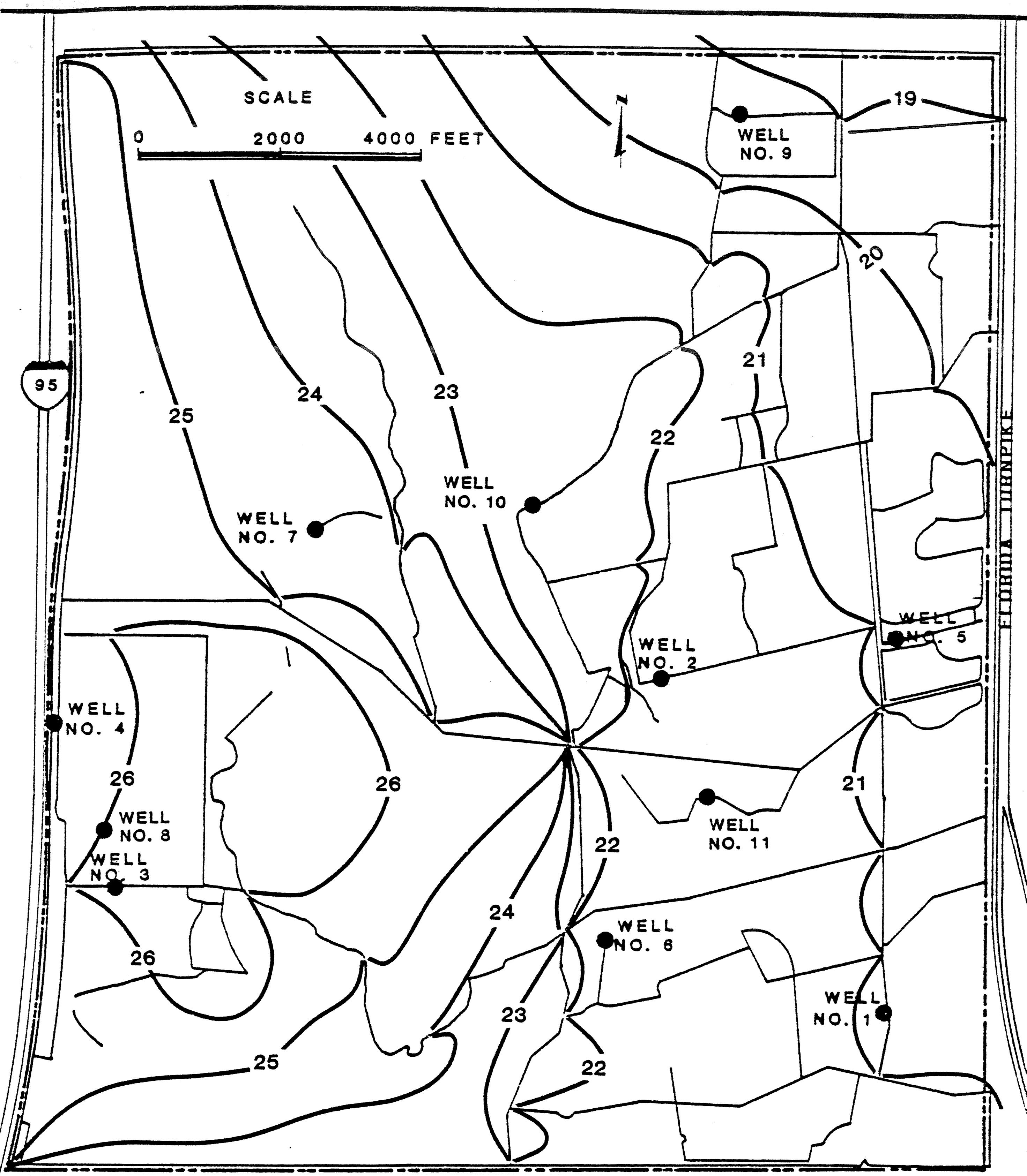
FIGURE 2-7



WATER TABLE MAP

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FIGURE 2-9

Section 3
AQUIFER TEST AND ANALYSIS

3.1 BACKGROUND

The last step of the testing program for the St. Lucie West site was carried out following the completion of the boring program by Jammal and Associates. This step consisted of a pump test within the optimum water-producing formations of the surficial aquifer system as identified from the soil borings (see Section 2.4.2). The pump test site is shown in Figure 3-1, and the testing configuration is shown in Figure 3-2.

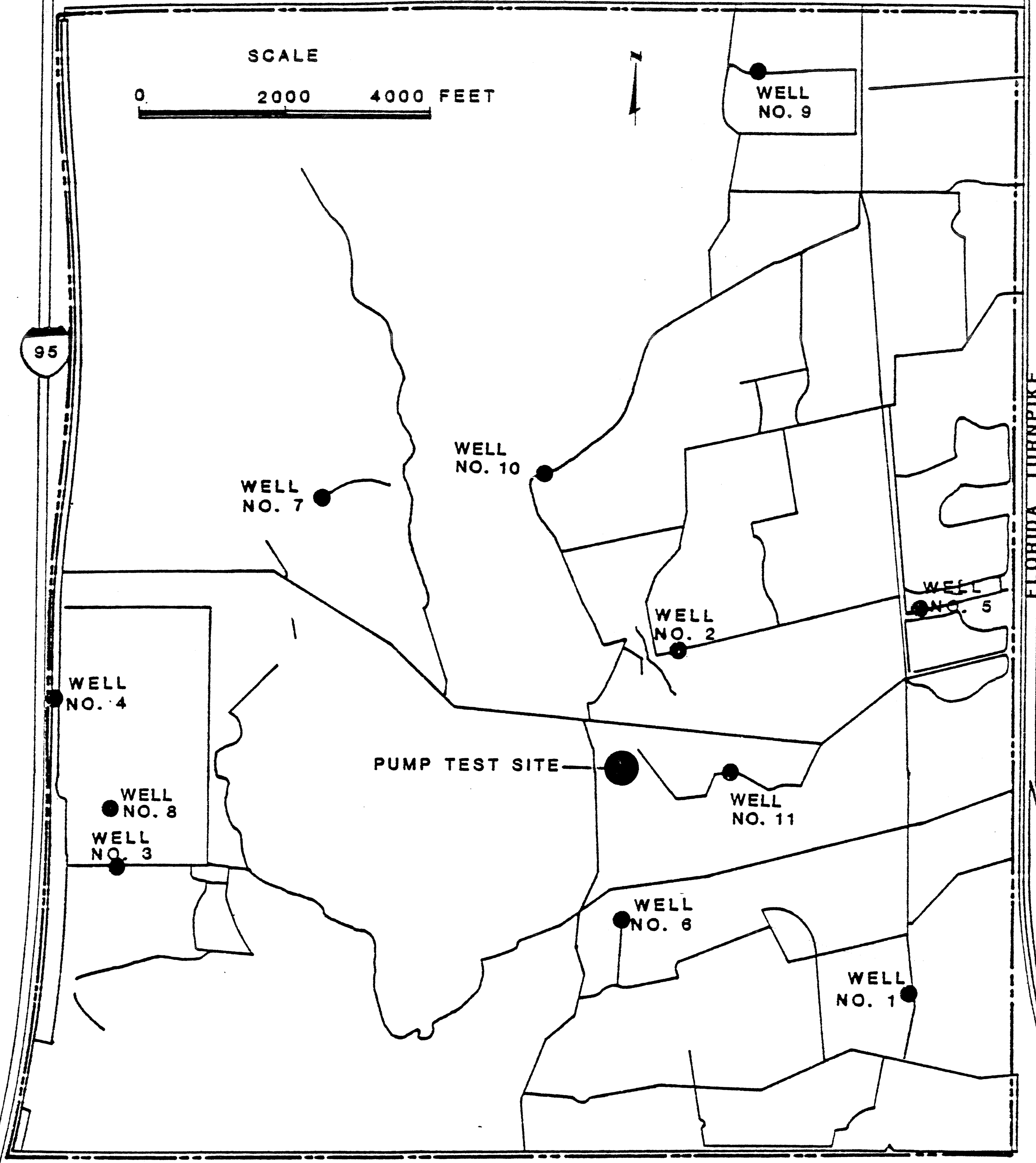
In January 1985, Meridith Corporation was engaged to construct one 6-inch test well and two 2-inch observation wells at the pump test site. The two observation wells were sited 50 (Well 1) and 200 (Well 2) feet north of the test well. The test well itself is located at C-3 on the grid network used by Jammal and Associates to locate the borings shown in Figure 2-6. The three wells were oriented along a north-south axis, approximately perpendicular to the direction of groundwater flow in the area. Both observation wells were located on the north side of the test well. The construction permit obtained by Meridith Corporation from the SFWMD is contained in Appendix B.

All of the wells were drilled to 60 feet below land surface. Each well was constructed with 30 feet of PVC well screen and 30 feet of PVC casing. The PVC screens were gravel packed and the casings were grouted in place.

The purpose of these three wells was to assess the potential capacity of a wellfield tapping the surficial aquifer system. In addition to determining the available water capacity of the surficial aquifer system, it was also necessary to ascertain the water quality of the discharge stream and how this water quality changes with time.

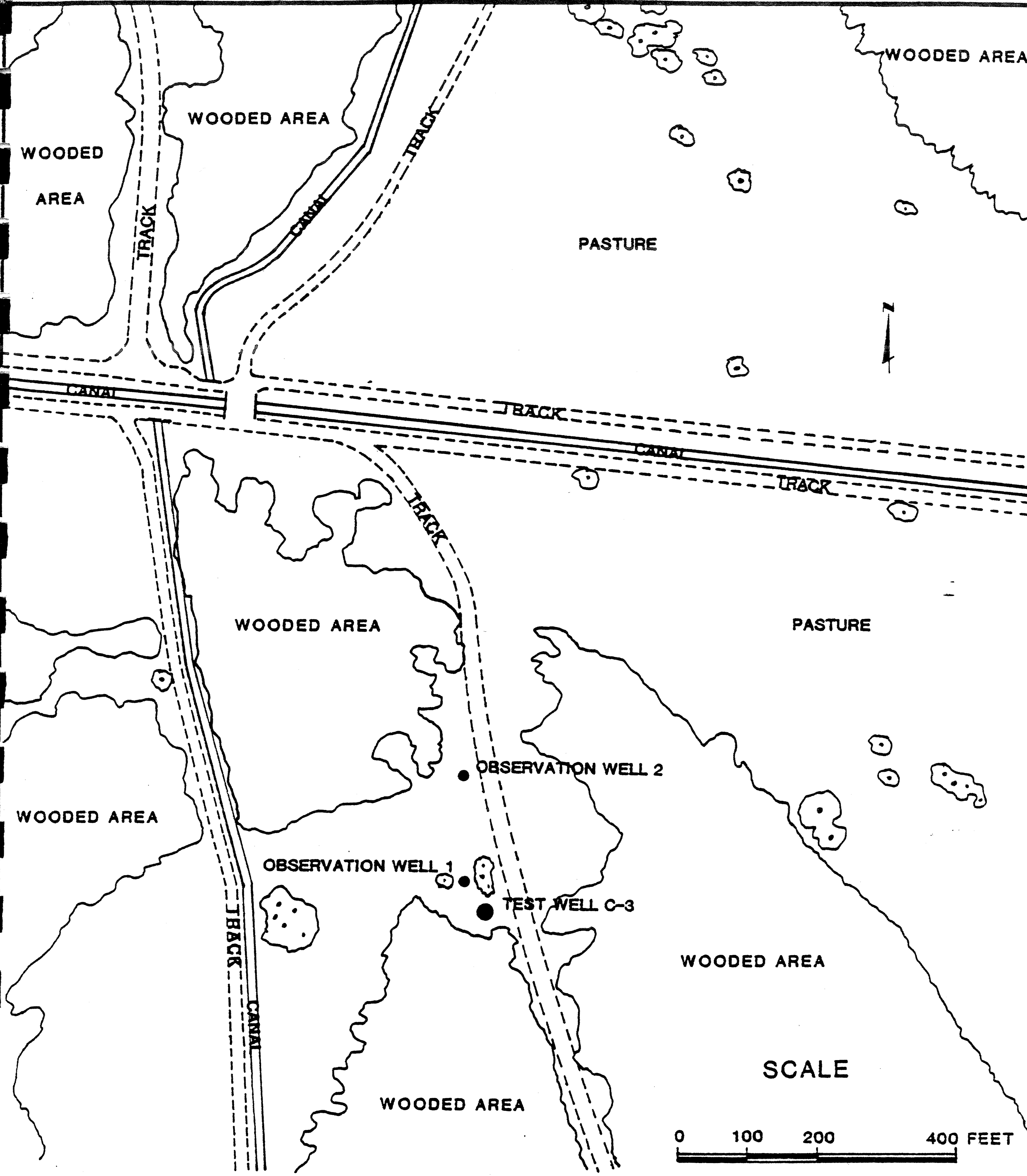
3.2 PUMP TEST

Meridith Corporation completed the construction of the three wells by February 6, 1985. The orifice manometer and the discharge pipeline were assembled and



PUMP TEST SITE

Post, Buckley, Schuh & Jernigan, Inc. CONSULTING ENGINEERS and PLANNERS	FIGURE 3-1



PUMP TEST – WELL LAYOUT

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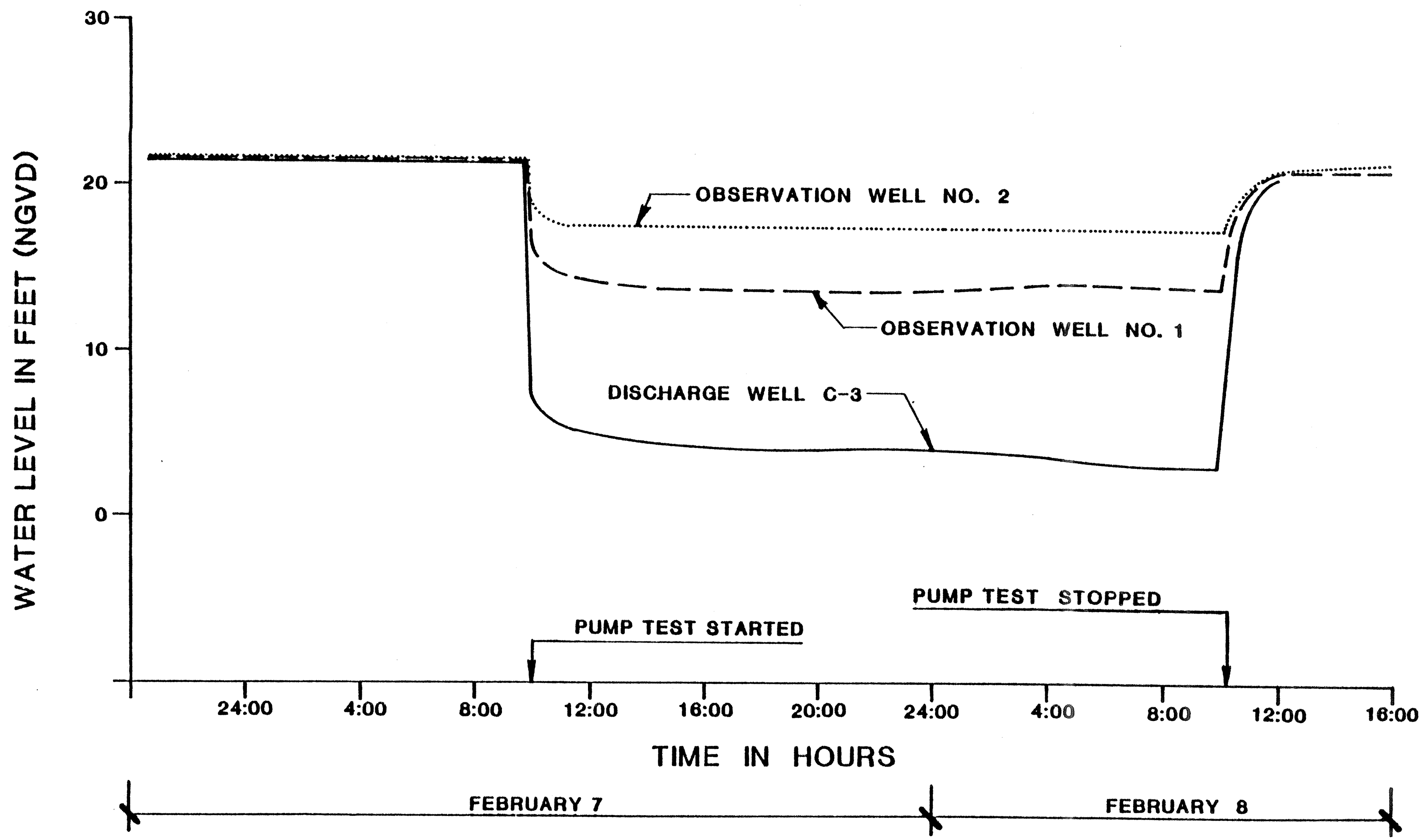
FIGURE 3-2

the pump test was ready to start on February 7, 1985. The flow measurements were made using a water manometer and a 2½-inch orifice plate in a 4-inch diameter discharge pipe. A 4-inch diameter three-stage submersible pump was used in the test well. The discharge leaving the orifice was piped through irrigation pipes to a final discharge point about 200 feet south of the test well.

The pump test was started at 10:00 hours on February 7, 1985 and was carried out at a constant discharge rate of 156 gpm. The pumping phase of the test was carried out for a period of 1,469 minutes (i.e., 24 hours, 29 minutes). The water levels in the test well dropped 16 feet within the first hour of the test. The response in Observation Well 1 was also very rapid, with a drop of 6.5 feet within the first hour of the test. The water levels in Observation Well 2 declined at a slower pace and, after an hour of pumping, the drawdown was just over 3 feet.

Figure 3-3 shows the relationships between the drawdown and the lapsed time from the start of the pump test. The maximum recorded drawdown in the test well was 17.85 feet below the static water level recorded prior to the start of the test. In Observation Well 1, the maximum recorded drawdown was 7.49 feet below the static water level recorded prior to the start of the pump test, though the water level in this well did experience a slight recovery towards the end of the test. The maximum recorded drawdown in Observation Well 2 was 3.99 feet below the static water level recorded prior to the start of the test. As with Observation Well 1, Observation Well 2 also experienced a slight recovery towards the end of the pump test. The cause of the slight recovery in both observation wells may be a delayed yield in the surficial aquifer system.

The initial water levels in all three wells, shown in Table 3-1 and Figure 3-3, were fairly close to each other (i.e., only 0.05 feet apart). The final water levels in the two observation wells, also shown in Figure 3-2, were 0.02 feet apart, with both wells having water levels 0.01 feet below their initial water levels prior to the start of the pump test. Therefore, by the end of the recovery phase of the test, both observation wells had fully recovered from the effects of the test.



WATER LEVELS IN THE TEST AND OBSERVATION WELLS

FIGURE 3-3

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Table 3-1

DESCRIPTION OF PUMP TEST WELLS
(All data in feet referred to NGVD)

	Test Well C-3	Observation Well 1	Observation Well 2
Elevation of Top of Casing	24.97	26.55	26.45
Bottom of Casing (i.e., Top of PVC Screen)	-6.0	-6.1	-6.1
Bottom of Well	-36.0	-36.1	-36.1
Static Water Level	21.44	21.39	21.41

The pump test was conducted without any interruptions and the drawdown curves for all three wells were smooth. The only interruption occurred in the test well during the recovery phase, when the drillers had to remove the submersible pump from the well casing. The volume displacement affected the head readings and, therefore, piezometric readings were discontinued at this well for the remainder of the recovery phase of the pump test.

The pump test was finished at 10:29 hours on February 8, 1985, after a continuous 24-hour discharge of 156 gpm. The recovery was fairly rapid for all three wells and the water levels had fully recovered their initial starting levels by 15:00 hours on February 8, 1985, only four and one-half hours later. All of the field data collected during the pump test are shown in Appendix C.

3.3 HYDRAULIC CHARACTERISTICS

The hydraulic characteristics of the surficial aquifer system were evaluated from the pump test data described in Section 3.2 and contained in Appendix C, using several different methods. The effects upon the piezometric levels of changes in the barometric pressure and of tidal fluctuations were ignored, as they are usually small with respect to the net changes recorded during the pump test. In addition, the short period over which the test was conducted (i.e., 24 hours) did not warrant the inclusion of the effects of barometric pressure and tidal fluctuations.

3.3.1 Drawdown Analysis

The drawdown phase of the surficial aquifer system pump test was carried out for a 24-hour period, starting at 10:00 hours on February 7, 1985. Three methods were chosen to analyze the pump test data: the Hantush-Jacob method, the straight line method (otherwise known as Jacob's modification and the constant t method. The first two methods relate the dependent variable (drawdown) to the independent variable (time). The third relates the dependent variable to the second independent variable, distance from point of discharge.

The Hantush-Jacob method (Lohman, 1972) uses a type curve matching technique to obtain match point coordinates. This method, which is appropriate for leaky confined or semi-confined aquifers, may be used to analyze data from each separate well. The straight line method is essentially an approximation of the well function W(u) incorporated within the type curve solution. This method utilizes the data used in the type curve analysis, but only if they lie within the limits of the approximation incorporated within the equations governing the method. The constant t method is similar to the straight line method in that it incorporates the same approximations in the derivation of the same basic equation. The main difference is in the independent variable: where the straight line method uses time, this method uses distance from point of discharge.

3.3.1.1 Type Curve Solution

Type curves are standard curves that represent the relationship between the well function W(u) and u, where u is defined as follows:

$$u = \frac{r^2 S}{4Tt} \qquad (1)$$

where r is distance from point of discharge to observation well (feet)
S is storage coefficient
T is aquifer transmissivity (gal/day/ft)
t is time of observation and discharge (days)

For each set of data from the observation wells, a log-log plot was developed with s, the drawdown in feet, and t, in minutes, on the vertical and horizontal axes, respectively. The curve represented by the data points was matched to the standard type curves. Once the curves were matched, the values of s and t were read from the data plot at the point where both u and W(u) were equal to unity or powers of ten (e.g., 10^2 etc). This point, which is called the match point, was marked on the data plot for future reference. The values of s and t obtained from the match point were used in conjunction with the following equations to obtain the aquifer transmissivity and the storage coefficient:

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

where Q is discharge for duration of time t in the pump test

s is drawdown obtained from the match point

W(u) is the well function at match point, and

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

where u is as defined in Equation 1 and evaluated for the match point

t is the value from the plot obtained from the match point.

The pump test data were set up in a tabular form suitable for plotting the curves required for matching with the type curves for the monitor well. The data for the drawdown at all three wells (Table D-1) are tabulated in Appendix D-1 along with the curves plotted for both observation wells from the tabulated data (see Figure D-1 and D-2). The results of the type curve analysis for the surficial aquifer system are shown in Table 3-2.

3.3.1.2 Straight Line Method

The straight line method is an approximation of the Hantush-Jacob method described above. The advantage of this method is that the well function, W(u), is reduced to a linear equation, which allows the data to approximate a straight line within the limits established by the acceptable level of percentage errors, rather than matching a set of type curves. The well function W(u) can be written as follows:

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

This may be approximated to the following equation:

$$W(u) = -0.577216 - \ln(u) \qquad (5)$$

* Equation 3 is a rearrangement of Equation 1.

Table 3-2

SUMMARY OF SURFICIAL AQUIFER SYSTEM CHARACTERISTICS AT ST. LUCIE WEST

Well	Method of Analysis	Transmissivity T (gpd/ft)	Storage Coefficient S	Leakage Coefficient L $(days)^{-1}$
		DRAWDOWN		
Discharge Well C-3	Straight Line Method	21,680	-	-
Observation Well 1	Type Curve Solution	22,350	4.7×10^{-5}	8.9×10^{-4}
	Straight Line Method	18,750	9.5×10^{-5}	-
Observation Well 2	Type Curve Solution	23,650	1.5×10^{-4}	3.8×10^{-3}
	Straight Line Method	21,120	1.6×10^{-4}	-
All Three Wells	Constant t Method	17,500	2.0×10^{-4}	-
	Constant t Method	17,880	1.1×10^{-3}	-
		RECOVERY		
Discharge Well C-3	Straight Line Method	18,720	-	-
Observation Well 1	Type Curve Solution	18,060	1.9×10^{-4}	6.5×10^{-3}
	Recovery Test Method	17,160	-	-
	Straight Line Method	16,540	2.0×10^{-4}	-
Observation Well 2	Type Curve Solution	19,860	2.1×10^{-4}	5.0×10^{-3}
	Recovery Test Method	21,010	-	-
	Straight Line Method	21,450	1.8×10^{-4}	-
		SUMMARY		
	Average[a]	20,000	1.5×10^{-4}	4.0×10^{-3}

[a] Rounded value

Equation 5 assumes that all terms to the right of the natural logarithm in Equation 4 are negligible, but this is true only when u is less than 0.01. When u is equal to 0.01, the error inherent in Equation 5 is 0.2 percent; when u is equal to 0.05, the error in the evaluation of W(u) is only 2.0 percent. The latter error is quite acceptable for analyzing the pump test data from the surficial aquifer system. Therefore, Equation 5 is considered to be true for values of u less than 0.05 in the analyses contained in Appendix D and reported in Section 3.3.3. Whenever this limiting criterion was applied to the analysis, the location of the ordinate where u is equal to 0.05 is shown in the figures.

If the first term in Equation 5 is reduced to a logarithmic value and u in the second term is inverted to delete the negative signs and then replaced by Equation 1, Equation 5 can be substituted into Equation 2 to obtain the following rearranged equation:

$$s = \frac{2.30 \times Q}{4\pi T} \left(\log \frac{2.25 \times T}{r^2 S} + \log t \right) \qquad (6)$$

where s is drawdown in the well (feet)

A plot of s against log t will give a straight line with the following slope:

$$\text{slope} = \frac{2.30 \times Q}{4\pi T} \qquad (7)$$

$$\text{and intercept} = \frac{2.30 \times Q}{4\pi T} \log \frac{2.25\,T}{r^2 S} \qquad (8)$$

The aquifer transmissivity can then be calculated from the slope, as defined in Equation 7, and the storage coefficient can be calculated from the intercept and the slope, as shown in Equation 8.

The pump test data were set up in tabular form suitable for plotting the straight lines required to evaluate the slope and intercepts and thus the aquifer transmissivity and storage coefficient for the monitor well. The data for the drawdown at the test and observation wells (Table D-1) are tabulated in Appendix D-1 along with the graphs plotted for these wells from the tabulated data (see Figures D-3 through D-5). The results of the straight line method are shown in Table 3-2 for the surficial aquifer system.

3.3.1.3 Constant t Method

The constant t method is similar to the straight line method and the same assumptions apply in the derivation of the equations for this method. The basic equation for this method is Equation 6. After Equation 6 is rearranged to show r as the dependent variable and t as a constant in the first term within the brackets, the following equation is obtained:

$$s = \frac{2.30xQ}{4\pi T} \left(\log \frac{2.25xtT}{S} - 2 \log r\right) \tag{9}$$

A plot of s against r will give a straight line with the slope given in Equation 7 and the following intercept:

$$s = \frac{2.30xQ}{4\pi T} \log \frac{2.25\ tT}{S} \tag{10}$$

when $r = 1$

The aquifer transmissivity can then be calculated from the slope, as defined in Equation 7, and the storage coefficient can be calculated from the intercept and the slope, as shown in Equation 10.

Since the pump test was conducted with one test (or discharge) well and two observation wells, only three points can be expected to define the curve. These three points represent the bare minimum needed to define a straight line on the graphs shown in Appendix D. As a result, the values for the transmissivity and storage coefficient should be treated carefully without applying too much weight to the results. The tabulated data used for the previous two solution methods (see Appendix D-1) were used for this method. The graphs plotted for all three wells at two chosen points in time are also included in Appendix D-1 (see Figures D-6 and D-7). The results of the constant t method for the surficial aquifer system are shown in Table 3-2.

3.3.2.2 Straight Line Method

A full description of the straight line method is given in Section 3.3.1.2. The data for the residual drawdowns at all three wells (Table D-2) are tabulated in Appendix D-2, along with the graphs plotted from the tabulated data (see Figures D-10 through D-12). The results of the straight line method for the surficial aquifer system are shown in Table 3-2.

3.3.2.3 Recovery Method

The recovery method represents the difference between two well functions, one for the discharge and the other for a hypothetical recharge; therefore, the net effect upon the well is a zero discharge. The difference between the two well functions, reached by approximations, can be written as follows:

$$s' = \frac{2.30\,Q}{4\pi\,T} \log \frac{t}{t'} \qquad (11)$$

where s' is the residual drawdown (feet)

t is time since start of pump test

t' is time since start of recovery

The use of this method is valid only if u is less than 0.05 for the data set. As discussed in Section 3.3.1.2, the ordinates where u is equal to 0.05 are shown in the figures included in Appendix D-2.

The recovery method was used for both observation wells in the pump test. The tabulated data required for this method are shown in Table D-3. The data were tabulated for s' and the time ratio of t/t' and these two variables were plotted on semi-logarithmic paper to obtain a best fit straight line for the valid data points. The plots for the recovery method for both observation wells are shown in Appendix D-2 (see Figures D-13 and D-14).

If there are no interference effects (i.e., impermeable barriers, recharging or discharging boundaries) within the aquifer, the best fit straight line intersects the point where residual drawdown is zero and t/t' is unity. If recharging is occurring within the aquifer, the plotted line should intersect t/t' at a point that is greater than unity for zero residual drawdown. The reverse of this holds true for those aquifers in which withdrawals or losses are occurring, or where there is an impermeable boundary. The results from the use of the recovery method are shown in Table 3-2.

3.3.3 Results

The results of the complete data analysis for the pump test conducted on the surficial aquifer system from February 7 to 8, 1985 are shown in Table 3-2. Only the straight line method results are shown for the test well (C-3) for both the drawdown and recovery phases of the test because the results for this well obtained by any of the other methods were inconclusive. In addition, because of the difficulty in evaluating the radius from the center of pumpage in the test well, the determination of the storage coefficient by the straight line method for the test well was also found to be inconclusive.

The results obtained from the constant t method have similar problems, in that a value for the radius from the center point of discharge in the test well is difficult to evaluate or estimate. The transmissivity values shown in Table 3-2 are fairly close to those obtained from other methods; therefore, they have been included. Similarly, the values for the storage coefficient from the constant t method are quite variable. Though not inconclusive, the second value of the storage coefficient shown for the constant t method in Table 3-2 is somewhat higher than the other values shown, hence care must be taken in interpreting these data in context with all of the other data shown in that table.

The greatest variation in the transmissivities, as determined by the different methods for any one well shown in Table 3-2, was 5,800 gpd/ft (i.e., Observation Well 1). This variation represents 29 percent of the average transmissivity. The results varied about the average transmissivity from +11 percent to -18 percent. One cause of such a variation in the tabulated results from the same well may be the methods used to analyze the results.

The above difference in transmissivity values for the same well probably occurred because the type curve solution accounts for variations from the Theis curve (as defined by W(u) and u) caused by leakage, whereas the other two methods only approximate the Theis curve and do not take into account any variations from it that may result from leakage. Leakage appears to be appreciable in the surficial aquifer system.

The values for the leakage coefficient shown in Table 3-2 range from 8.9 x 10^{-4} to 65 x 10^{-4}, for Observation Well 1. On the other hand, the leakage coefficients calculated for Observation Well 2 exhibit a greater stability between the pumping and recovery phases of the aquifer test.

The most significant feature of the results shown in Table 3-2 is that the transmissivity values for Observation Well 1 obtained by the various solution methods are consistently lower than those obtained for Observation Well 2 using the same methods. On the average, the transmissivities for Observation Well 2 are 16 percent higher than those for Observation Well 1.

The limited transmissivity data for the test well tend to indicate that the transmissivity for this well lies between the values calculated for each observation well site, but is closer to that for Observation Well 2. The average transmissivity for the surficial aquifer system at Observation Well 1 is 18,600 gpd/ft; at Observation Well 2, it is 21,400 gpd/ft. The transmissivity for the surficial aquifer system at the discharge well is about 20,200 gpd/ft. These results highlight the variable nature of the formations found within the surficial aquifer system from one location to the next. The average transmissivity for the surficial aquifer system at the pump test site is 20,000 gpd/ft. The average storage coefficient is 1.5 x 10^{-4}, which is fairly typical of a semi-confined aquifer, rather than of an unconfined aquifer. This value indicates that the surficial aquifer system might be much more confined than originally expected.

The two curves developed as part of the recovery method (see Section 3.3.2.3 and Figures D-13 and D-14) intersect the zero drawdown axis at the t/t' value of about 10. The implication of this intersection point is that the section of the surficial aquifer system that was pumped during the pump test was experiencing significant recharge, probably from the upper portions of the surficial aquifer system. Therefore, the hypothesis is that the 40- to 60-foot depth range of the surficial aquifer system does receive recharge from adjacent layers, most probably above this depth range. The relatively large leakage coefficients shown in Table 3-2 tend to bear out this hypothesis. The average leakage coefficient for the pumped zone of the surficial aquifer system at the test site was 4.0×10^{-3} $days^{-1}$. This value of the leakage coefficient is at least one order of magnitude greater than that for the better confined Floridan Aquifer.

3.4 COMPARISON WITH PREVIOUS RESEARCH

Previous work conducted in the Fort Pierce area included an assessment of the aquifer characteristics in that area. Bearden (1972) reported transmissivities in the 22,600- to 41,800-gpd/ft range from work conducted by Black, Crow and Eidsness in 1962. Lichtler (1960) conducted tests in the northern half of Martin County, some of them at Stuart, and reported transmissivities in the 16,000- to 27,000-gpd/ft range. The storage coefficients obtained by Lichtler ranged from 1.0×10^{-4} to 25×10^{-4}, with an average value of 6.2×10^{-4}. Anomalies in varying well depths at another well site invalidated results Lichtler obtained further west of Stuart.

Bearden (1972) also conducted pump tests in St. Lucie County at two sites 12 miles northwest of St. Lucie West, one site 7 miles southwest of St. Lucie West, and two sites east and southeast by 3 and 6 miles, respectively, from St. Lucie West. These sites are shown in Figure 3-4, in addition to a site recently tested by G&M in 1984 (Site F on Figure 3-4). The averages of the transmissivity and storage coefficient data collected at each of these sites are shown in Table 3-3. These data tend to support the contention that transmissivities are highest towards the southeast (SFWMD, 1980). They also exhibit the variable nature of the aquifer. In addition, the storage coefficient data do not lie within the typical range of 0.01 to 0.35 that is usually expected with water table aquifers. Therefore, there appears to be a general semi-confining layer lying above the primary production zone of the surficial aquifer system.

BORING LOG FOR B-2

DEPTH RANGE (feet)	DESCRIPTION OF FORMATION
0-1	Black silty organic fine sand with roots.
1-11	Grey to tan fine to medium sand, occasionally iron-stained.
11-22	Grey to brown slightly silty fine to medium sand, with thin clayey lenses.
22-42	Brown to grey slightly sandy to sandy shell with trace of silt.
42-53	Grey to brown slightly silty fine to medium sand, with thin clayey lenses.
53-57	Brown to grey slightly sandy to sandy shell with trace of silt.
57-62	Grey to brown slightly silty fine to medium sand, with thin clayey lenses.
62-68	Brown to grey slightly sandy to sandy shell with trace of silt.
68-87	Grey to brown slightly silty fine to medium sand, with thin clayey lenses.
87-94	Light grey to grey sandy to very sandy silty clay, scattered shell fragments and occasional limerock.
94-102	Grey to green-grey to brown to green-brown clayey to silty fine to medium sand with scattered shell fragments.
102-107	Brown to grey slightly sandy to sandy shell with a trace of silt.
107-116	Light grey to grey sandy to very sandy silty clay, scattered shell fragments and occasional limerock lenses.
116-122	Brown to grey to dark grey slightly silty to very silty fine sand with small shells and shell fragments.
122-130	Grey to green-grey to brown to green-brown clayey to silty fine to medium sand with scattered shell fragments and lenses of limerock.

BORING LOG FOR B-4

DEPTH RANGE (feet)	DESCRIPTION OF FORMATION
0-1	Black silty, organic fine sand with roots.
1-3	Grey to brown to tan, occasionally iron-stained, fine to medium sand.
3-6	Dark brown to dark reddish-brown slightly silty fine sand, organic stained and slightly cemented.
6-28	Grey to brown slightly silty fine to medium sand with thin clayey lenses.
28-30	Brown to grey to dark grey slightly silty to very silty fine sand with small shells and shell fragments.
30-48	Brown to grey slightly sandy to sandy shell with a trace of silt.
48-91	Brown to grey to dark grey slightly silty to very silty fine sand with small shells and shell fragments.
91-98	Light grey to grey sandy to very sandy silty clay, scattered shell fragments and occasional limerock lenses.
98-102	Brown to grey to dark grey slightly silty to very silty fine sand with small shells and shell fragments.
102-108	Light grey to grey sandy to very sandy silty clay, scattered shell fragments and occasional limerock lenses.
108-111	Brown to grey to dark grey slightly silty to very silty fine sand with small shells and shell fragments.
111-126	Light grey to grey sandy to very sandy silty clay, scattered shell fragments and occasional limerock lenses.

BORING LOG FOR D-2

DEPTH RANGE (feet)	DESCRIPTION OF FORMATION
0-1	Black silty, organic fine sand with roots.
1-3	Grey to brown to tan, occasionally iron-stained, fine to medium sand with small roots near land surface.
3-8	Dark brown to dark reddish-brown slightly silty fine sand, organic stained and slightly cemented.
8-24	Grey to brown slightly silty fine to medium sand with thin clayey lenses.
24-55	Brown to grey to dark grey slightly silty to very silty fine sand with small shells and shell fragments.
55-69	Brown to grey slightly sandy to sandy shell with a trace of silt.
69-72	Brown to grey to dark grey slightly silty to very silty fine sand with small shells and shell fragments.
72-78	Light grey to grey sandy to very sandy silty clay, scattered shell fragments and occasional limerock lenses.
78-88	Grey to green-grey to brown to green-brown clayey to silty fine to medium sand with scattered shell fragments and lenses of limerock in deeper depths.
88-130	Brown to grey to dark grey slightly silty to very silty fine sand with small shells and shell fragments.

BORING LOG FOR D-4

DEPTH RANGE (feet)	DESCRIPTION OF FORMATION
0-1	Black silty, organic fine sand with roots.
1-2	Grey to brown slightly silty fine to medium sand with thin clayey lenses.
2-4	Grey to green-grey to brown to green-brown clayey to silty fine to medium sand with scattered shell fragments.
4-13	Grey to brown slightly silty fine to medium sand with thin clayey lenses.
13-77	Brown to grey to dark grey slightly silty to very silty fine sand with shells and shell fragments.
77-84	Grey to green-grey to brown to green-brown clayey to silty fine to medium sand with scattered shell fragments and lenses of limerock in deeper depths.
84-130	Brown to grey to dark grey slightly silty to very silty fine sand with small shells and shell fragments.

m.H16.a

APPENDIX C

PUMP TEST DATA

Table C-1

PUMP TEST RECORDS

Date	Time (Hr:Min:Sec)	Discharge Well C-3: Depth to Water from ToC (feet)	Discharge Well C-3: Manometer Tube Reading (inches)	Discharge Well C-3: Calculated Flow (gpm)	Observation Well 1: Depth to Water from ToC (feet)	Observation Well 2: Depth to Water from (ToC (feet)	Remarks
2/6/85	17:45:00	3.54	-	-	5.16	-	
2/7/85	9:16:00	-	-	-	5.16	-	
	9:17:00	-	-	-	-	5.04	
	9:20:00	3.53	-	-		-	
	9:56:00	-	-	-	5.20	-	
	10:00:00	3.53	0.0	0.0	-	5.04	Started Pumping
	10:00:18	-	-	-	6.90	-	
	10:00:44	-	-	-	-	5.37	
	10:00:45	-	-	-	7.90	-	
	10:01:10	-	-	-	8.05	-	
	10:01:20	-	-	-	-	5.58	
	10:01:38	-	-	-	8.38	-	
	10:01:58	-	-	-	-	5.70	
	10:02:10	-	-	-	8.58	-	
	10:02:40	-	-	-	8.77	-	
	10:02:49	-	-	-	-	5.89	
	10:03:06	-	-	-	8.88	-	
	10:03:30	-	-	-	-	6.00	
	10:03:35	-	-	-	9.04	-	
	10:04:00	17.50	39.0	157	9.15	-	
	10:04:10	-	-	-	-	6.08	
	10:04:25	-	-	-	9.22	-	
	10:04:45	-	-	-	9.38	-	
	10:04:55	-	-	-	-	6.20	
	10:05:00	17.65	39.0	157	-	-	
	10:05:15	-	-	-	9.41	-	

Table C-1 (Continued)

Date	Time (Hr:Min:Sec)	Discharge Well C-3 Depth to Water from ToC (feet)	Discharge Well C-3 Manometer Tube Reading (inches)	Discharge Well C-3 Calculated Flow (gpm)	Observation Well 1 Depth to Water from ToC (feet)	Observation Well 2 Depth to Water from (ToC (feet)	Remarks
2/7/85	10:05:35	-	-	-	9.48	-	
	10:05:48	-	-	-	-	6.29	
	10:06:00	17.72	39.0	157	9.54	-	
	10:06:22	-	-	-	9.62	-	
	10:06:30	17.75	38.5	156	-	6.37	
	10:06:45	-	-	-	9.68	-	
	10:07:00	17.94	39.0	157	-	-	
	10:07:10	-	-	-	9.72	-	
	10:07:24	-	-	-	9.78	-	
	10:07:46	-	-	-	-	6.42	
	10:07:50	-	-	-	9.82	-	
	10:08:00	18.00	39.0	157	-	-	
	10:08:15	-	-	-	9.88	-	
	10:08:45	-	-	-	-	6.55	
	10:09:00	18.21	39.0	157	-	-	
	10:09:10	-	-	-	10.00	-	
	10:09:40	-	-	-	10.07	-	
	10:09:51	-	-	-	-	6.63	
	10:10:00	18.25	38.5	156	-	-	
	10:10:10	-	-	-	10.11	-	
	10:10:33	-	-	-	10.15	-	
	10:10:45	-	-	-	-	6.70	
	10:11:00	18.42	38.5	156	-	-	
	10:11:30	-	-	-	10.23	-	
	10:11:34	-	-	-	-	6.78	
	10:12:00	18.42	-	-	-	-	
	10:12:30	-	-	-	10.34	-	
	10:13:00	-	-	-	-	6.89	
	10:13:30	-	-	-	10.42	-	
	10:14:00	18.75	-	-	-	6.95	W/Q Sample
	10:14:30	-	-	-	10.49	-	
	10:14:53	-	-	-	-	7.01	

Table C-1 (Continued)

Date	Time (Hr:Min:Sec)	Discharge Well C-3 Depth to Water from ToC (feet)	Discharge Well C-3 Manometer Tube Reading (inches)	Discharge Well C-3 Calculated Flow (gpm)	Observation Well 1 Depth to Water from ToC (feet)	Observation Well 2 Depth to Water from (ToC (feet)	Remarks
	10:15:30	-	-	-	10.56	-	
	10:15:51	-	-	-	-	7.06	
	10:16:00	-	-	-	-	-	
	10:16:30	-	-	-	10.62	-	
	10:16:40	-	-	-	-	7.12	
	10:17:30	-	-	-	10.68	-	
	10:17:35	-	-	-	-	7.17	
	10:18:00	18.79	38.5	156	-	-	
	10:18:28	-	-	-	-	7.20	
	10:18:30	-	-	-	10.72	-	
	10:19:20	-	-	-	-	7.23	
	10:20:00	18.92	38.5	156	10.79	7.22	
	10:20:45	-	-	-	-	7.28	
	10:21:00	18.96	38.3	155	-	-	
	10:21:51	-	-	-	-	7.32	
	10:22:00	-	-	-	10.88	-	
	10:22:45	-	-	-	-	7.35	
	10:23:28	-	-	-	-	7.39	
	10:24:00	-	-	-	10.97	-	
	10:24:16	-	-	-	-	7.44	
	10:25:16	-	-	-	-	7.45	
	10:26:00	19.17	38.4	156	-	-	
	10:26:51	-	-	-	-	7.51	
	10:27:00	-	-	-	11.08	-	
	10:27:51	-	-	-	-	7.54	
	10:28:56	-	-	-	-	7.58	
	10:29:58	-	-	-	-	7.60	
	10:30:00	-	-	-	11.16	-	
	10:32:10	-	-	-	-	7.66	
	10:33:00	19.25	38.0	155	11.23	-	
	10:33:08	-	-	-	-	7.68	
	10:35:10	-	-	-	-	7.74	
	10:36:00	19.50	38.0	155	-	-	

Table C-1 (Continued)

Date	Time (Hr:Min:Sec)	Discharge Well C-3 Depth to Water from ToC (feet)	Discharge Well C-3 Manometer Tube Reading (inches)	Discharge Well C-3 Calculated Flow (gpm)	Observation Well 1 Depth to Water from ToC (feet)	Observation Well 2 Depth to Water from (ToC (feet)	Remarks
2/7/85	10:37:00	-	-	-	11.33	-	
	10:37:55	-	-	-	-	7.79	
	10:39:50	-	-	-	-	7.82	
	10:41:00	19.50	38.2	155	11.43	-	
	10:44:52	-	-	-	-	7.99	
	10:45:10	-	-	-	11.51	-	
	10:50:00	19.42	38.0	155	11.57	-	
	10:50:20	-	-	-	-	8.01	
	10:55:00		-	-	11.62	-	
	10:55:32	-	-	-	-	8.09	
	10:58:00	19.50	38.0	155	-	-	
	11:00:00	-	-	-	11.67	-	
	11:00:30	-	-	-	-	8.20	
	11:06	-	-	-	11.74	8.20	
	11:10	19.58	37.5	154	-	-	
	11:12	-	-	-	11.78	-	
	11:15	-	-	-	-	8.28	
	11:20	-	-	-	11.86	-	
	11:28	-	-	-	-	8.37	
	11:30	19.77	37.5	154	-	-	
	11:32	-	-	-	11.95	-	
	11:41	-	-	-	-	8.46	
	11:45	-	-	-	12:00	-	
	11:46	19.85	37.5	154	-	-	
	12:00	-	-	-	-	8.56	
	12:01	19.88	37.5	154	-	-	
	12:02	-	-	-	12.12	-	
	12:30	19.96	37.5	154	-	-	
	12:32	-	-	-	12.22	-	
	12:34	-	-	-	-	8.66	
	13:00	20.00	37.5	154	12.26	8.77	W/Q Sample
	13:20	-	38.0	155	-	-	Opened Valve
	13:30	20.33	38.0	155	-	-	

Table C-1 (Continued)

Date	Time	Discharge Well C-3			Observation Well 1	Observation Well 2	Remarks
	(Hr:Min:Sec)	Depth to Water from ToC (feet)	Manometer Tube Reading (inches)	Calculated Flow (gpm)	Depth to Water from ToC (feet)	Depth to Water from (ToC (feet)	
	13:34	-	-	-	12.35	-	
	13:36	-	-	-	-	8.81	
	14:00	20.58	38.5	156	-	-	
	14:02	-	-	-	12.45	-	
	14:03	-	-	-	-	8.88	
	14:30	20.58	39.0	157	-	-	
2/7/85	14:31	-	-	-	12.50	-	
	14:32	-	-	-	-	8.90	
	14:59	20.58	39.0	157	12.55	-	
	15:01	-	-	-	-	8.93	
	16:00	-	-	-	-	8.97	
	16:02	-	-	-	12.64	-	
	16:04	20.60	39.0	157	-	-	W/Q Sample
	17:14	-	-	-	-	9.01	
	17:16	-	-	-	12.64	-	
	17:19	20.63	39.0	157	-	-	
	18:11	-	-	-	-	9.01	
	18:13	-	-	-	12.64	-	
	18:17	20.63	38.5	156	-	-	
	19:21	20.68	38.5	156	-	-	W/Q Sample
	19:30	-	-	-	12.62	-	
	19:33	-	-	-	-	9.02	
	20:28	20.63	39.0	157	-	-	
	20.34	-	-	-	12.64	-	
	20:37	-	-	-	-	9.02	
	21:47	20.67	39.0	157	-	-	W/Q Sample
	21:56	-	-	-	12.65	-	
	21:59	-	-	-	-	9.03	
	22:59	20.69	39.0	157	-	-	
	23:05	-	-	-	12.64	-	
	23:09	-	-	-	-	9.02	
	23:56	20.73	39.0	157	-	-	

Table C-1 (Continued)

Date	Time (Hr:Min:Sec)	Discharge Well C-3: Depth to Water from ToC (feet)	Discharge Well C-3: Manometer Tube Reading (inches)	Discharge Well C-3: Calculated Flow (gpm)	Observation Well 1: Depth to Water from ToC (feet)	Observation Well 2: Depth to Water from (ToC (feet)	Remarks
2/8/85	00:02	-	-	-	12.63	-	
	00:05	-	-	-	-	9.02	
	00:56	20.79	39.0	157	-	-	
	01:04	-	-	-	12.65	-	W/Q Sample
	01:09	-	-	-	-	9.03	
	02:40	20.96	39.0	157	-	-	
	02:55	-	-	-	12.61	-	
	03:05	-	-	-	-	9.02	
	04:00	-	-	-	-	9.00	
	04:05	-	-	-	12.50	-	
	04:10	21.13	39.0	157	-	-	W/Q Sample
	06:10	-	-	-	-	8.92	
	06:20	-	-	-	12.54	-	
	06:25	21.25	39.0	157	-	-	W/Q Sample
	08:02	-	-	-	-	8.98	
	08:05	-	-	-	12.52	-	
	08:08	21.38	39.0	157	-	-	
	10:20	21.33	38.5	156	12.52	8.98	W/Q Sample Started Recovery
	10:29	-	-	-	-	-	
	10:29:08	-	-	-	11.89	-	
	10:29:35	-	-	-	10.80	-	
	10:29:55	-	-	-	10.32	-	
	10:30:28	-	-	-	9.87	-	
	10:31:00	8.00	-	-	-	-	
	10:31:06	-	-	-	9.48	-	
	10:31:30	7.75	-	-	-	-	
2/8/85	10:31:45	-	-	-	9.26	-	
	10:31:50	-	-	-	-	8.37	
	10:32:00	7.33	-	-	-	-	
	10:32:18	-	-	-	9.04	-	
	10:32:30	7.13	-	-	-	-	

Table C-1 (Continued)

Date	Time	Discharge Well C-3			Observation Well 1	Observation Well 2	Remarks
	(Hr:Min:Sec)	Depth to Water from ToC (feet)	Manometer Tube Reading (inches)	Calculated Flow (gpm)	Depth to Water from ToC (feet)	Depth to Water from (ToC (feet)	
	10:32:55	-	-	-	8.89	-	
	10:33:20	-	-	-	8.78	8.11	
	10:33:30	6.79	-	-	-	-	
	10:33:53	-	-	-	8.65	-	
	10:34:00	6.75	-	-	-	-	
	10:34:30	-	-	-	8.55	-	
	10:35:00	6.58	-	-	-	-	
	10:35:10	-	-	-	-	7.83	
	10:35:12	-	-	-	8.42	-	
	10:35:30	6.50	-	-	-	-	
	10:35:42	-	-	-	8.33	-	
	10:36:20	-	-	-	8.24	-	
	10:36:30	6.33	-	-	-	-	
	10:36:47	-	-	-	-	7.64	
	10:37:00	-	-	-	8.14	-	
	10:37:30	6.25	-	-	8.08	-	
	10:38:00	-	-	-	8.04	-	
	10:38:15	-	-	-	-	7.52	
	10:38:30	6.13	-	-	7.98	-	
	10:39:00	6.08	-	-	7.90	-	
	10:39:41	-	-	-	-	7.40	
2/8/85	10:40:00	6.04	-	-	7.82	-	
	10:41:00	5.88	-	-	7.72	-	
	10:41:32	-	-	-	-	7.25	
	10:42:00	5.83	-	-	7.63	-	
	10:43:00	5.71	-	-	7.55	-	
	10:43:10	-	-	-	-	7.17	
	10:44:00	5.69	-	-	7.49	-	
	10:44:15	-	-	-	-	7.09	
	10:45:00	5.58	-	-	7.43	-	
	10:45:24	-	-	-	-	7.00	

Table C-1 (Continued)

Date	Time (Hr:Min:Sec)	Discharge Well C-3: Depth to Water from ToC (feet)	Discharge Well C-3: Manometer Tube Reading (inches)	Discharge Well C-3: Calculated Flow (gpm)	Observation Well 1: Depth to Water from ToC (feet)	Observation Well 2: Depth to Water from (ToC (feet)	Remarks
	10:46:00	5.54	-	-	7.37	-	
	10:46:25	-	-	-	-	6.98	
	10:47:00	5.50	-	-	7.28	-	
	10:47:22	---	-	-	-	6.91	
	10:48:00	5.46	-	-	7.25	-	
	10:48:21	-	-	-	-	6.88	
	10:49:00	5.42	-	-	7.11	-	
	10:49:16	-	-	-	-	6.84	
	10:50:10	5.33	-	-	-	-	
	10:50:20	-	-	-	-	6.80	
	10:51:00	-	-	-	7.03	-	
	10:51:40	-	-	-	-	6.74	
	10:52:00	5.25	-	-	-	-	
	10:52:45	-	-	-	-	6.70	
	10:53:00	-	-	-	6.93	-	
	10:53:30	5.13	-	-	-	-	
	10:53:57	-	-	-	-	6.66	
	10:55:00	5.13	-	-	6.87	-	
	10:55:18	-	-	-	-	6.61	
	10:56:00	5.00	-	-	-	-	
	10:56:22	-	-	-	-	6.56	
	10:57:00	-	-	-	6.79	-	
	10:57:27	-	-	-	-	6.54	
	10:59:00	-	-	-	6.73	-	
	11:01:00	-	-	-	6.69	-	
	11:01:15	-	-	-	-	6.42	
	11:02:53	-	-	-	-	6.39	
	11:03:00	4.88	-	-	6.62	-	
	11:05:00	-	-	-	6.55	-	
	11:06:00	4.79	-	-	-	6.31	
	11:07:00	-	-	-	6.51	-	
	11:08:30	4.71	-	-	-	-	
	11:09:00	-	-	-	6.45	-	

Table C-1 (Continued)

Date	Time (Hr:Min:Sec)	Discharge Well C-3: Depth to Water from ToC (feet)	Discharge Well C-3: Manometer Tube Reading (inches)	Discharge Well C-3: Calculated Flow (gpm)	Observation Well 1: Depth to Water from ToC (feet)	Observation Well 2: Depth to Water from (ToC (feet)	Remarks
	11:09:10	-	-	-	-	6.25	
	11:11:00	4.67	-	-	-	-	
	11:12:00	-	-	-	6.37	-	
	11:12:40	-	-	-	-	6.17	
	11:13:30	4.63	-	-	-	-	
	11:15:00	-	-	-	6.33	-	
	11:18:00	-	-	-	6.30	-	
	11:20:00	4.50	-	-	-	-	
	11:21:00	-	-	-	6.22	-	
2/8/85	11:21:10	-	-	-	-	6.02	
	11:25:00	-	-	-	6.15	-	
	11:26:00	4.42	-	-	-	-	
	11:27:00	-	-	-	-	5.93	
	11:32:00	4.29	-	-	-	-	
	11:33:00	-	-	-	6.05	5.86	
	11:38:00	-	-	-	5.98	-	
	11:40:30	-	-	-	-	5.78	
	11:41:00	4.21	-	-	-	-	
	11:44:00	-	-	-	5.94	-	
	11:46:00	4.17	-	-	-	-	
	11:48:30	-	-	-	-	5.70	
	11:50	-	-	-	5.88	-	
	11:56	-	-	-	5.79	-	
	12:00	4.04	-	-	-	-	
	12:01	-	-	-	-	5.59	
	12:06	-	-	-	5.72	-	
	12:10	4.00	-	-	-	-	
	12:18	-	-	-	-	5.46	Pump Removal
	12:22	-	-	-	5.61	-	
	12:31	-	-	-	-	5.40	
	12:34	-	-	-	5.56	-	
	12:51	-	-	-	-	5.33	

Table C-1 (Continued)

Date	Time	Discharge Well C-3			Observation Well 1	Observation Well 2	Remarks
	(Hr:Min:Sec)	Depth to Water from ToC (feet)	Manometer Tube Reading (inches)	Calculated Flow (gpm)	Depth to Water from ToC (feet)	Depth to Water from (ToC (feet)	
	12:53	-	-	-	5.48	-	
	13:28	-	-	-	-	5.19	
	13:30	-	-	-	5.33	-	
	13:58	-	-	-	-	5.15	
	13:59	-	-	-	5.28	-	
	14:57	-	-	-	5.17	-	
	15:03	-	-	-	-	5.05	

m.H16.K

APPENDIX D

DATA ANALYSIS AND GRAPHS

Table D-1

DRAWDOWN s (feet)

TIME AFTER PUMP STARTED t (MINS.)	DISCHARGE WELL C-3	OBSERVATION WELL NO. 1 (50' from C-3)	OBSERVATION WELL NO. 2 (200' from C-3)	COMMENTS
0.00	0.00	0.00	0.00	
0.30	-	1.74	-	
0.73	-	-	0.33	
0.75	-	2.74	-	The discharge rate was 156 gpm
1.16	-	2.89	-	
1.33	-	-	0.54	
1.63	-	3.22	-	
1.96	-	-	0.66	
2.16	-	3.38	-	
2.67	-	3.61	-	
2.82	-	-	0.85	
3.10	-	3.72	-	
3.50	-	-	0.96	
3.58	-	3.88	-	
4.00	13.97	3.99	-	
4.16	-	-	1.04	
4.42	-	4.06	-	
4.75	-	4.22	-	
4.92	-	-	1.16	
5.00	14.12	-	-	
5.25	-	4.25	-	
5.58	-	4.32	-	
5.80	-	-	1.25	
6.00	14.19	4.38	-	
6.37	-	4.46	-	
6.50	14.22	-	1.33	
6.75	-	4.52	-	
7.00	14.41	-	-	
7.16	-	4.56	-	
7.40	-	4.62	-	
7.77	-	-	1.38	
7.83	-	4.66	-	
8.00	14.47	-	-	
8.25	-	4.72	-	
8.75	-	-	1.51	
9.00	14.68	-	-	
9.16	-	4.84	-	
9.67	-	4.91	-	
9.85	-	-	1.59	
10.00	14.72	-	-	
10.16	-	4.95	-	
10.55	-	4.99	-	

Table D-1 (Continued)

DRAWDOWN s (feet)

TIME AFTER PUMP STARTED t (MINS.)	DISCHARGE WELL C-3	OBSERVATION WELL NO. 1 (50' from C-3)	OBSERVATION WELL NO. 2 (200' from C-3)	COMMENTS
10.75	-	-	1.66	
11.00	14.89	-	-	
11.50	-	5.07	-	
11.57	-	-	1.74	
12.00	14.89	-	-	
12.50	-	5.18	-	
13.00	-	-	1.85	
13.50	-	5.26	-	
14.00	15.22	-	1.91	
14.50	-	5.33	-	
14.88	-	-	1.97	
15.50	-	5.40	-	
15.85	-	-	2.02	
16.00	-	-	-	
16.50	-	5.46	-	
16.67	-	-	2.08	
17.50	-	5.52	-	The discharge rate was 156 gpm.
17.58	-	-	2.13	
18.00	15.26	-	-	
18.47	-	-	2.16	
18.50	-	5.56	-	
19.33	-	-	2.19	
20.00	15.39	5.63	2.18	
20.75	-	-	2.24	
21.00	15.43	-	-	
21.85	-	-	2.28	
22.00	-	5.72	-	
22.75	-	-	2.31	
23.47	-	-	2.35	
24.00	-	5.81	-	
24.27	-	-	2.40	
25.27	-	-	2.41	
26.00	15.64	-	-	
26.85	-	-	2.47	
27.00	-	5.92	-	
27.85	-	-	2.50	
28.93	-	-	2.54	
29.96	-	-	2.56	
30.00	-	6.00	-	
32.16	-	-	2.62	
33.00	15.72	6.07	-	
33.13	-	-	2.64	

Table D-1 (Continued)

DRAWDOWN s (feet)

TIME AFTER PUMP STARTED t (MINS.)	DISCHARGE WELL C-3	OBSERVATION WELL NO. 1 (50' from C-3)	OBSERVATION WELL NO. 2 (200' from C-3)	COMMENTS
35.16	-	-	2.70	
36.00	15.97	-	-	
37.00	-	6.17	-	
37.92	-	-	2.75	
39.83	-	-	2.78	
41.00	15.97	6.27	-	
44.87	-	-	2.95	
45.16	-	6.35	-	
50.00	15.89	6.41	-	
50.33	-	-	2.97	
55.00	-	6.46	-	
55.53	-	-	3.05	
58.00	15.97	-	-	
60.00	-	6.51	-	
60.50	-	-	3.16	
66.00	-	6.58	3.16	
70.00	16.05	-	-	
72.00	-	6.62	-	
75.00	-	-	3.24	
80.00	-	6.70	-	
88.00	-	-	3.33	
90.00	16.24	-	-	
92.00	-	6.79	-	
101.00	-	-	3.42	
105.00	-	6.84	-	
106.00	16.32	-	-	
120.00	-	-	3.52	The discharge rate was 156 gpm
121.00	16.35	-	-	
122.00	-	6.96	-	
150.00	16.43	-	-	
152.00	-	7.06	-	
154.00	-	-	3.62	
180.00	16.47	7.10	3.73	
200.00	-	-	-	
230.00	16.80	-	-	
234.00	-	7.19	-	
236.00	-	-	3.77	
240.00	17.05	-	-	
242.00	-	7.29	-	
243.00	-	-	3.84	
270.00	17.05	-	-	
271.00	-	7.34	-	
272.00	-	-	3.86	
299.00	17.05	7.39	-	

Table D-1 (Continued)

DRAWDOWN s (feet)

TIME AFTER PUMP STARTED t (MINS.)	DISCHARGE WELL C-3	OBSERVATION WELL NO. 1 (50' from C-3)	OBSERVATION WELL NO. 2 (200' from C-3)	COMMENTS
301.00	-	-	3.89	
360.00	-	-	3.93	
362.00	-	7.48	-	
364.00	17.07	-	-	
434.00	-	-	3.97	
436.00	-	7.48	-	
439.00	17.10	-	-	
491.00	-	-	3.97	The discharge rate was 156 gpm
493.00	-	7.48	-	
497.00	17.10	-	-	
561.00	17.15	-	-	
570.00	-	7.46	-	
573.00	-	-	3.98	
628.00	17.10	-	-	
634.00	-	7.48	-	
637.00	-	-	3.98	
707.00	17.14	-	-	
716.00	-	7.49	-	
719.00	-	-	3.99	
779.00	17.16	-	-	
785.00	-	7.48	-	
789.00	-	-	3.98	
836.00	17.20	-	-	
842.00	-	7.47	-	
847.00	-	-	3.98	
896.00	17.26	-	-	
904.00	-	7.49	-	
909.00	-	-	3.99	
1000.00	17.43	-	-	
1015.00	-	7.45	-	
1025.00	-	-	3.98	
1080.00	-	-	3.96	
1085.00	-	7.34	-	
1090.00	17.60	-	-	
1210.00	-	-	3.88	
1220.00	-	7.38	-	
1225.00	17.72	-	-	
1322.00	-	-	3.94	
1325.00	-	7.36	-	
1328.00	17.85	-	-	
1460.00	17.80	7.36	3.94	
1469.00	-	-	-	Started Recovery

m.H16.M

MATCH POINT DATA

$u = .1$

$L(u,v) = 10$

$v = 0.005$

$s = 8.0$ ft

$t = 0.14$ mins.

① $T = \frac{Q}{4\pi} \cdot \frac{L(u,v)}{s}$

$T = \frac{(156 \times 1440)}{4\pi} \cdot \frac{10}{8.0}$

$T = 22{,}350$ gpd/ft

② $S = \frac{4Tut}{7.48(r^2)}$

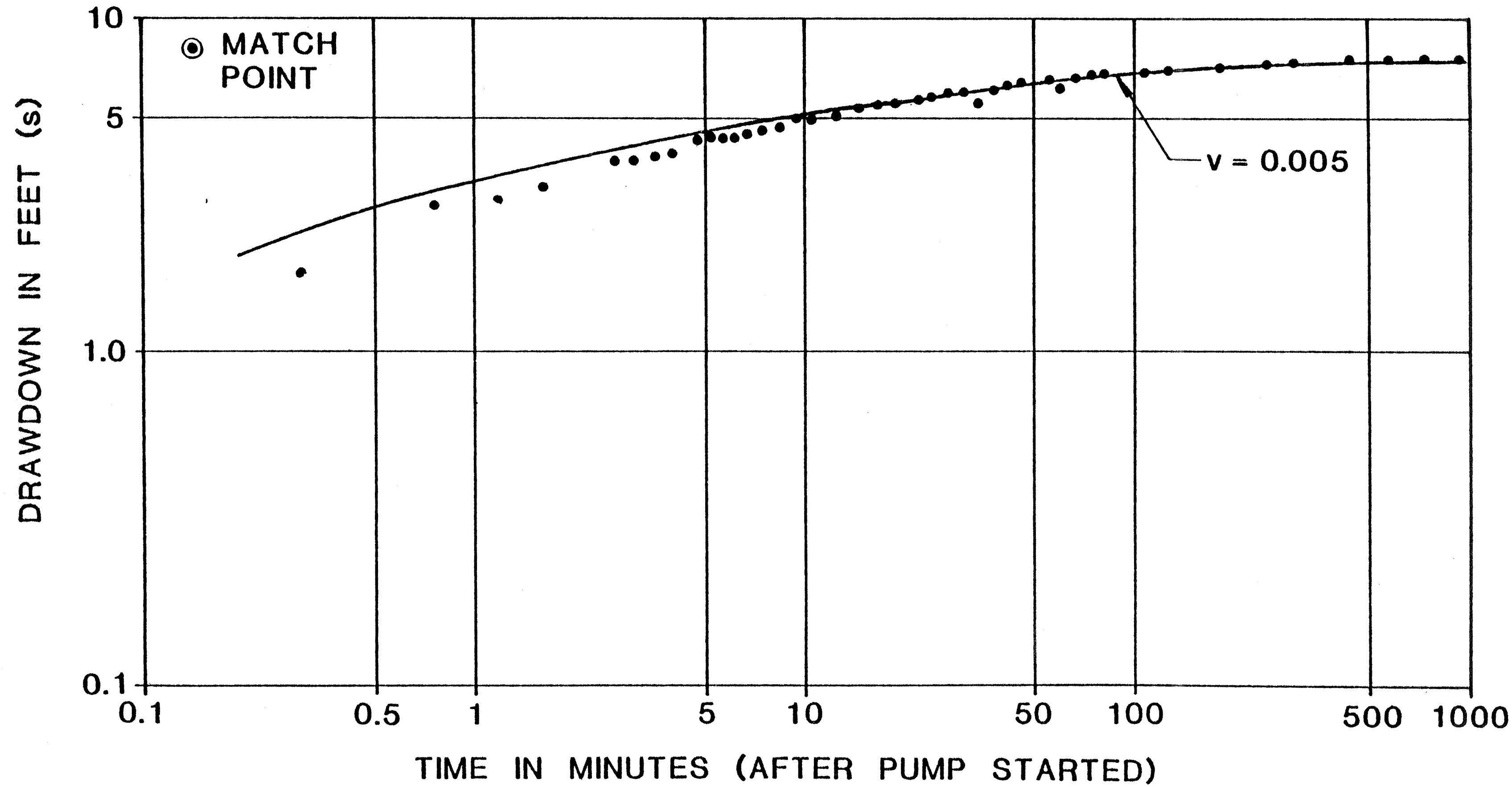
$S = \frac{4(22350)(.1)(.14)}{7.48(50)^2(1440)}$

$S = .0000465$

③ $L = 4T\frac{v^2}{r^2}$

$L = 4(22350)\frac{(.005)^2}{(50)^2}$

$L = .000894$ days^{-1}



TYPE CURVE SOLUTION FOR OBSERVATION WELL No. 1

PBSJ Post, Buckley, Schuh & Jernigan, Inc.
CONSULTING ENGINEERS and PLANNERS

FIGURE D-1

MATCH POINT DATA

$u = 1$
$L(u,v) = 1$
$v = 0.04$
$s = .76$ ft.
$t = .66$ mins

① $T = \frac{Q}{4\pi} \cdot \frac{L(u,v)}{s}$

$T = \frac{(156)(1440)}{4\pi} \cdot \frac{1}{.76}$

$T = 23{,}650$ gpd/ft

② $S = \frac{4Tut}{7.48(r^2)}$

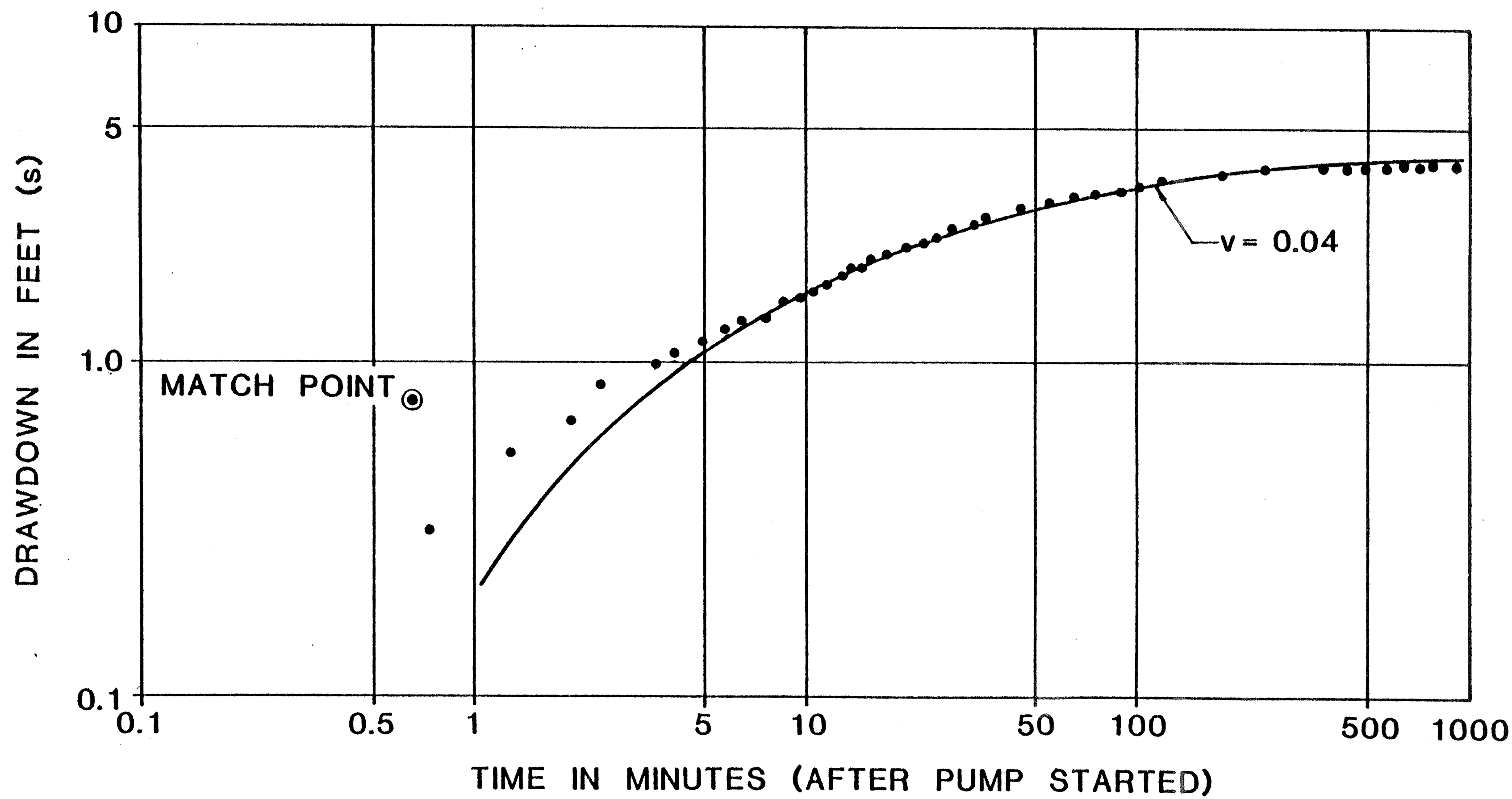
$S = \frac{4(23650)(1)(.66)}{7.48(200)^2(1440)}$

$S = .000145$

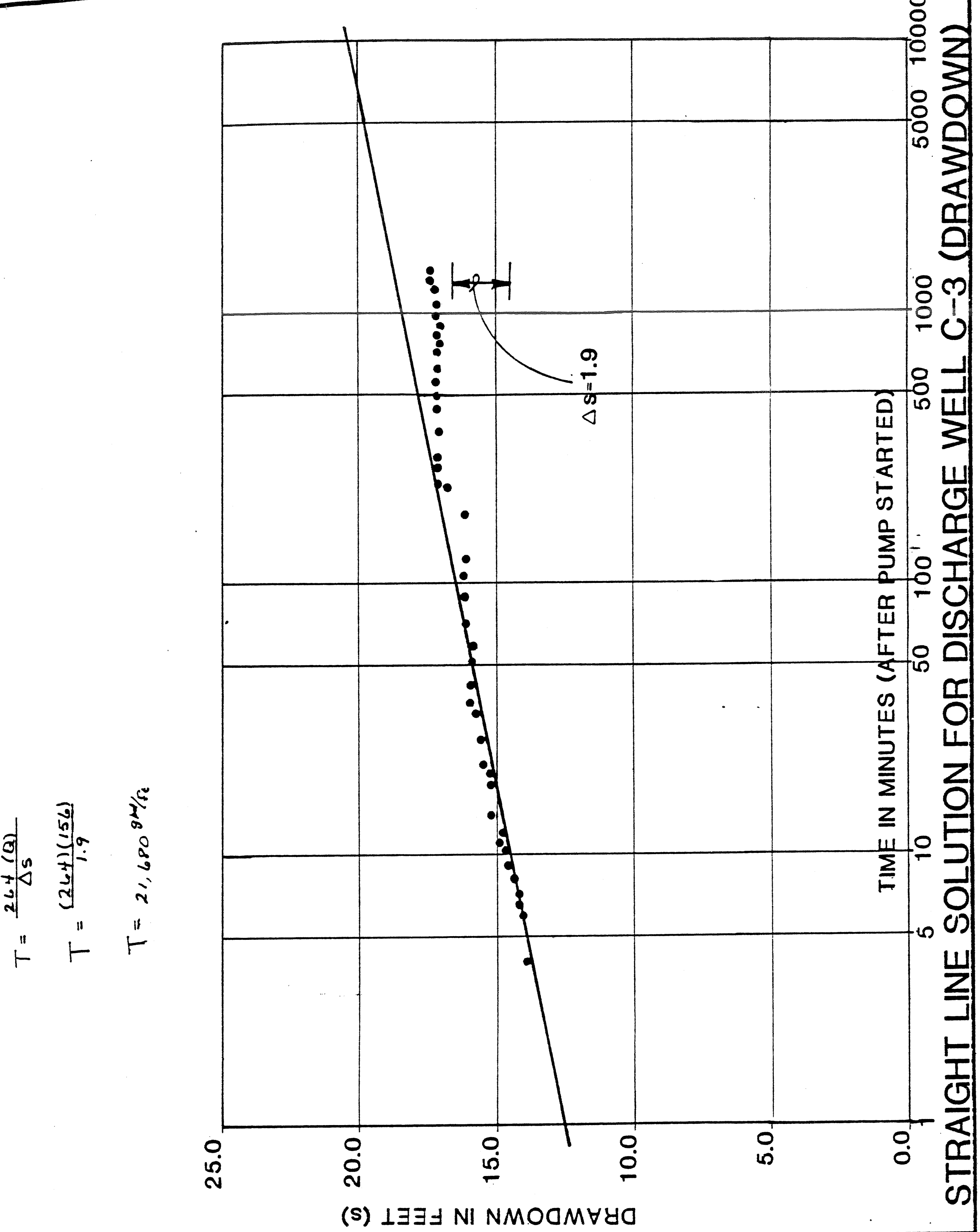
③ $L = 4T\frac{v^2}{r^2}$

$L = 4(23650) \cdot \frac{(.04)^2}{(200)^2}$

$L = .00378$



TYPE CURVE SOLUTION FOR OBSERVATION WELL No. 2



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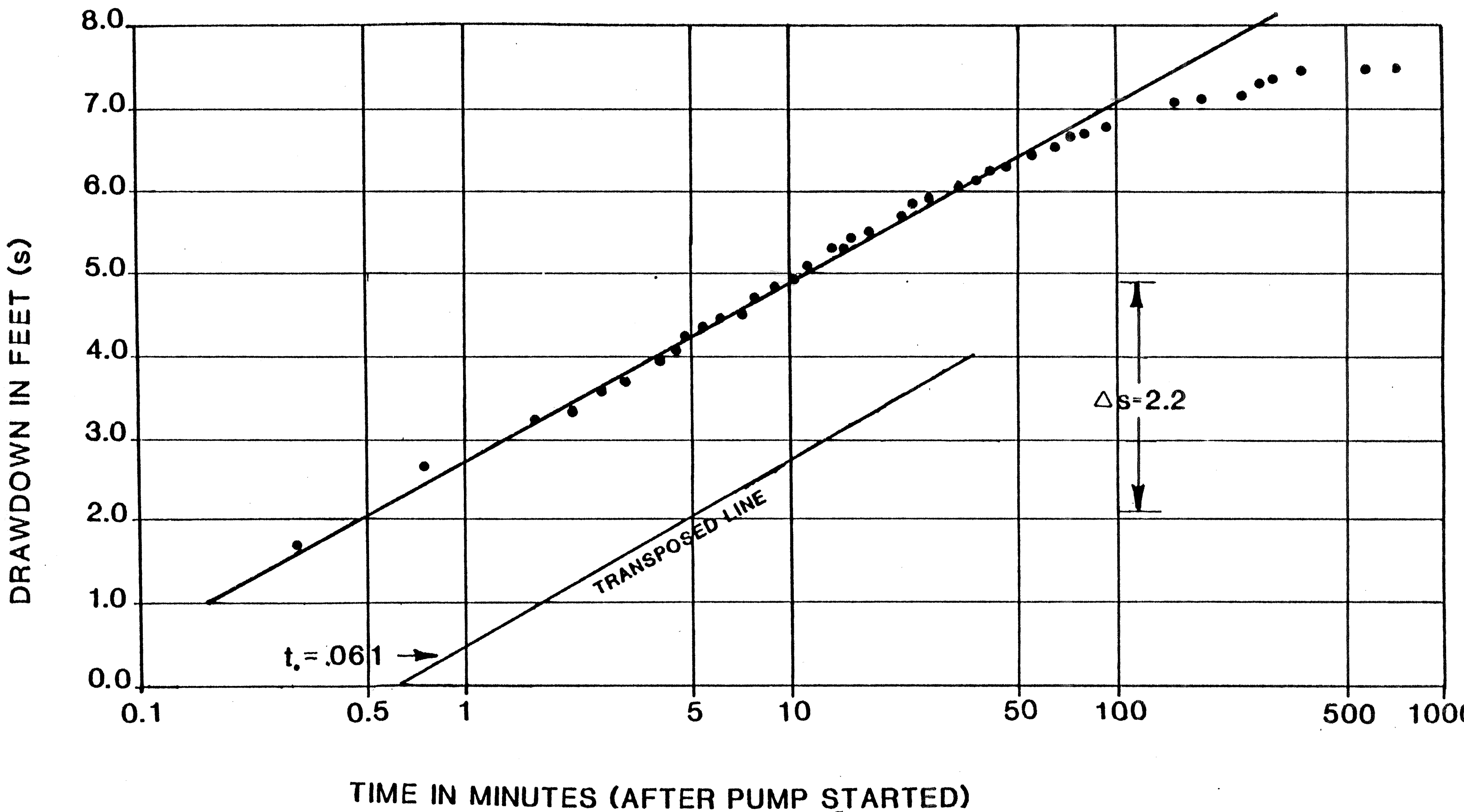
CONSULTING ENGINEERS and PLANNERS

FIGURE D-3

$$T = \frac{264(Q)}{\Delta s} \qquad S = \frac{0.3(T)(t_o)}{r^2}$$

$$T = \frac{(264)(156)}{2.2} \qquad S = \frac{0.3(18750)(0.061)}{(50)^2 \cdot 1440}$$

$$T = 18{,}750 \text{ gpd/ft} \qquad S = .000095$$



STRAIGHT LINE SOLUTION FOR OBSERVATION WELL No.1 (DRAWDOWN)

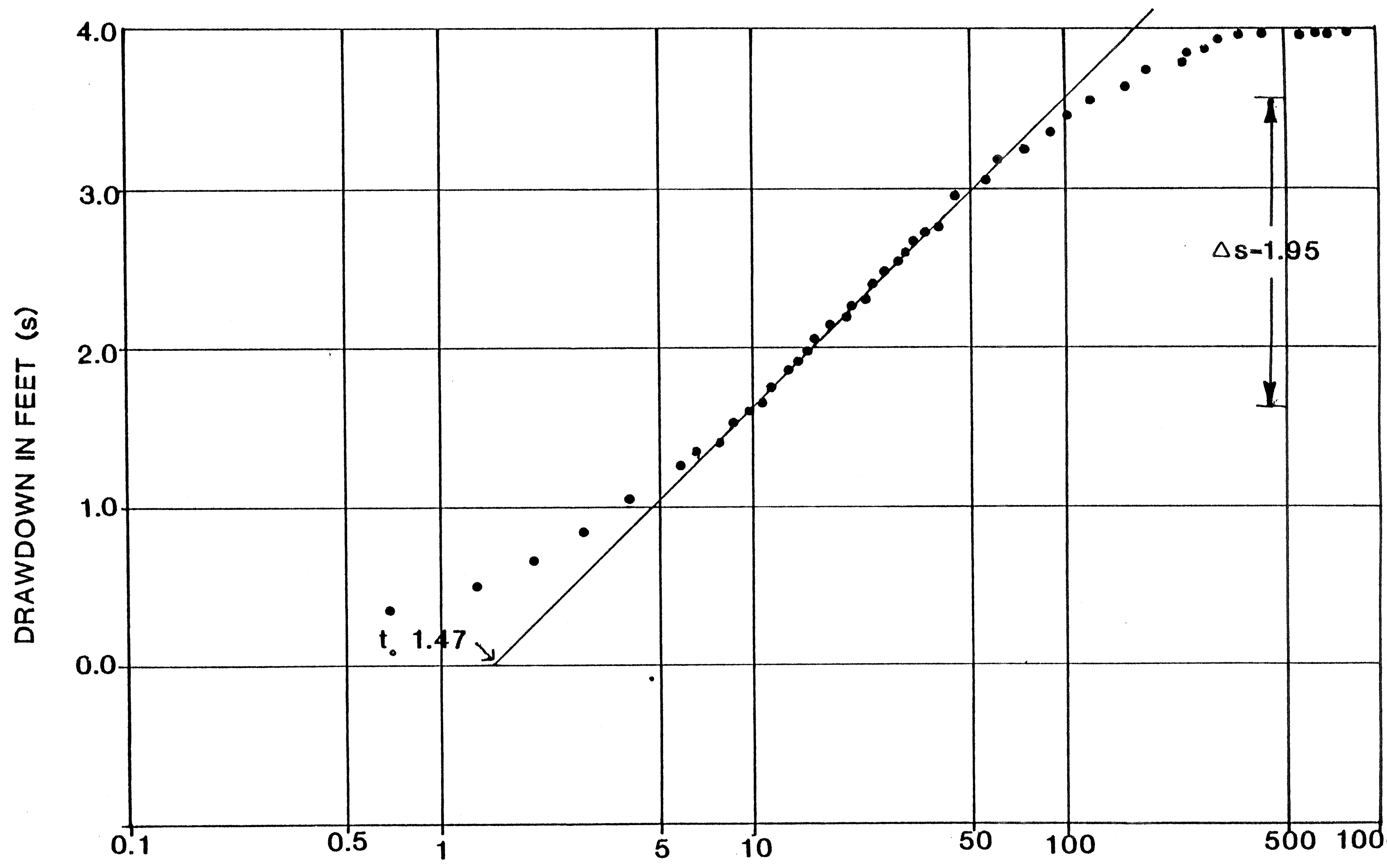
Post, Buckley, Schuh & Jernigan, Inc.
CONSULTING ENGINEERS and PLANNERS

FIGURE D-4

$$T = \frac{264(Q)}{\Delta s} \qquad S = \frac{0.3(T)(t_o)}{r^2}$$

$$T = \frac{(264)(156)}{1.95} \qquad S = \frac{0.3(21{,}120)(1.47)}{(200)^2 \cdot 1440}$$

$$T = 21{,}120 \text{ gpd/ft} \qquad S = .00016$$



STRAIGHT LINE SOLUTION FOR OBSERVATION WELL No.2 (DRAWDOWN)

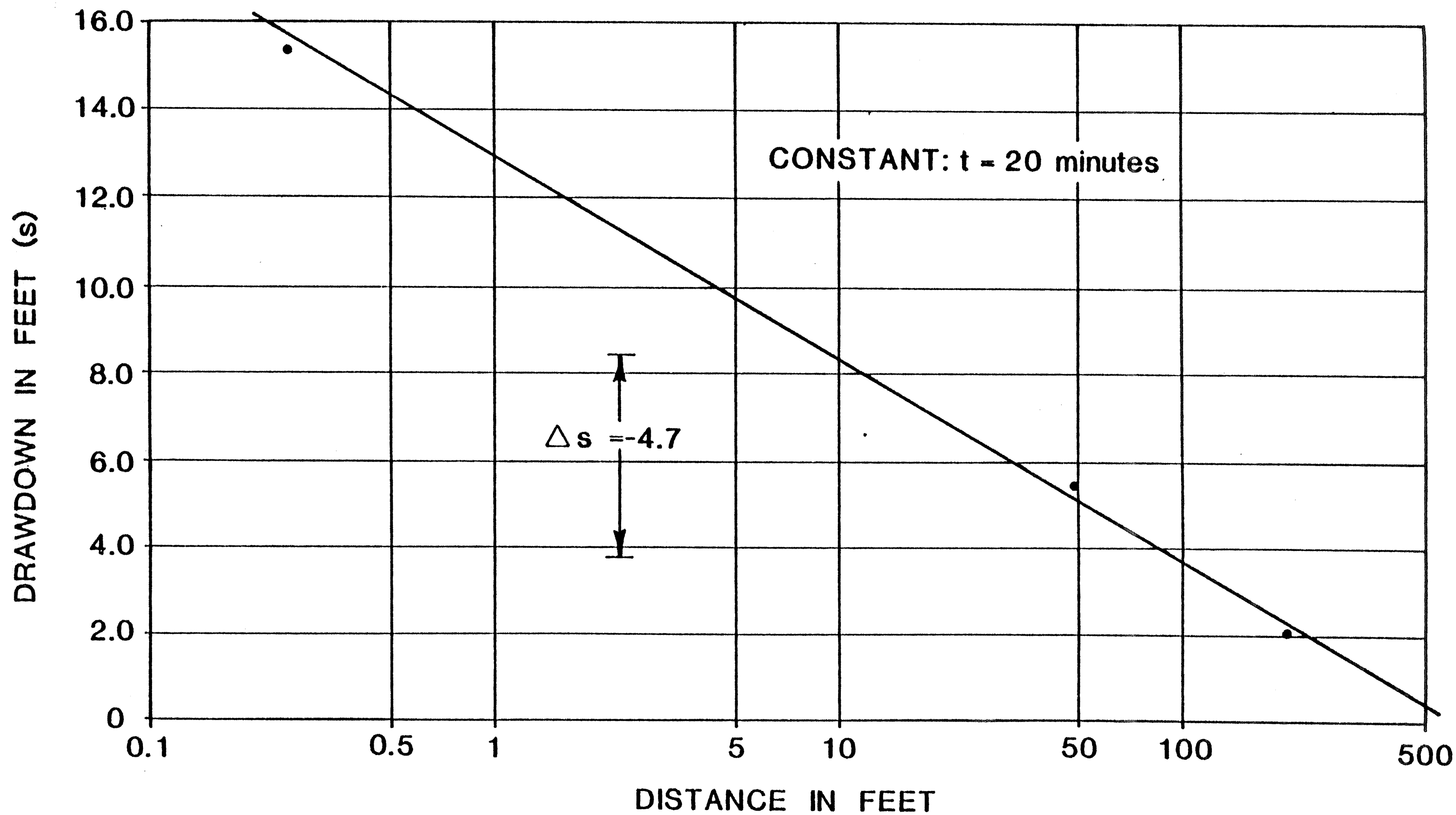
PBSJ **Post, Buckley, Schuh & Jernigan, Inc.**
CONSULTING ENGINEERS and PLANNERS

FIGURE D-5

$$T = \frac{-2.3\,Q}{2\pi \cdot \Delta s}$$

$$T = \frac{-2.3(156) \times 60 \times 24}{2\pi \cdot (-4.7)}$$

$$T = 17{,}500\ gpd/ft$$



CONSTANT t PLOT (DRAWDOWN)

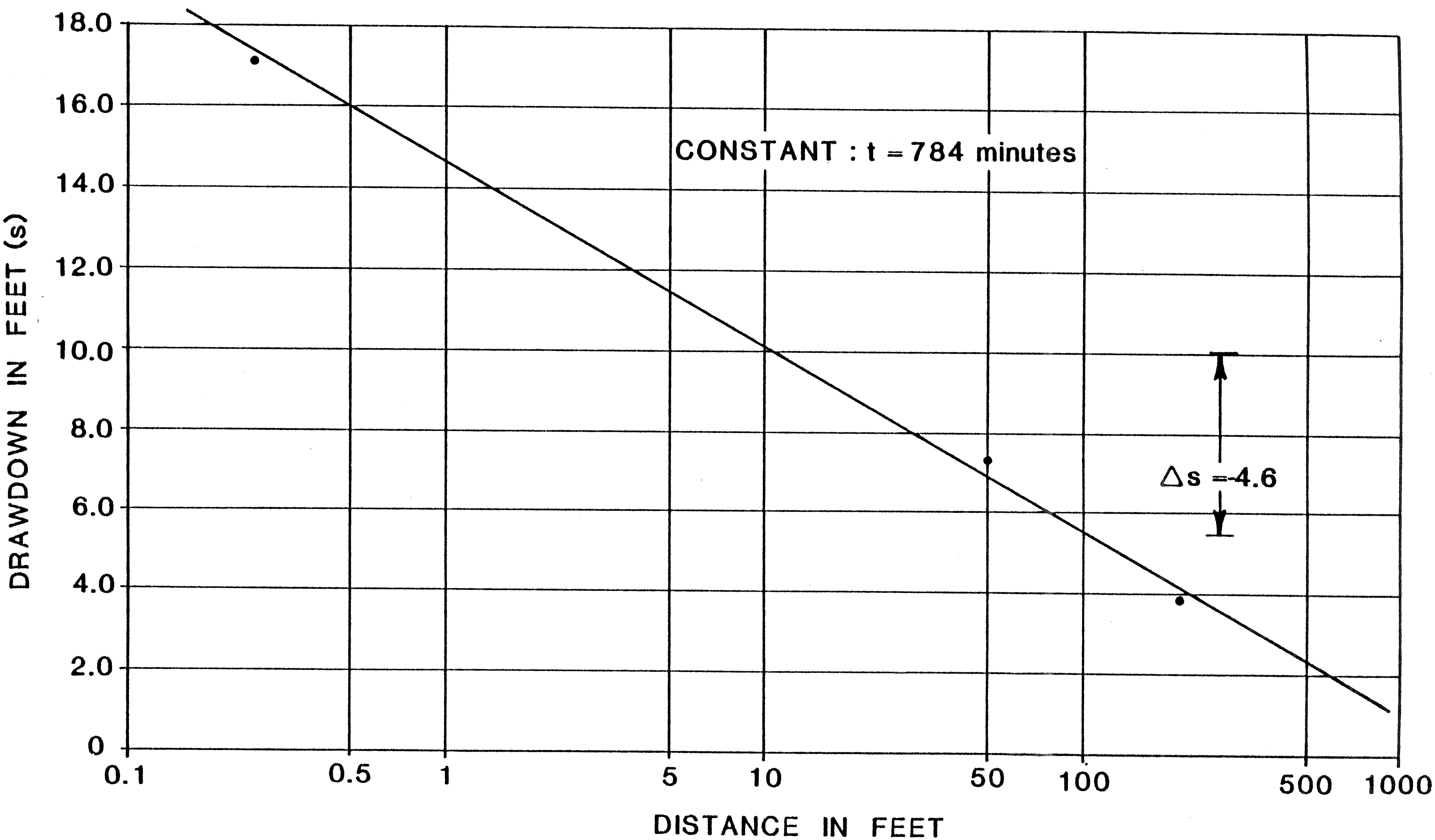
Post, Buckley, Schuh & Jernigan, Inc.
CONSULTING ENGINEERS and PLANNERS

FIGURE D-6

$$T = \frac{-2.3\,Q}{2\pi \cdot \Delta s}$$

$$T = \frac{-2.3\,(156) \times 60 \times 24}{2\pi \cdot (-4.6)}$$

$T = 17,880$ gpd/ft.



CONSTANT t PLOT (DRAWDOWN)

PBSJ Post, Buckley, Schuh & Jernigan, Inc.
CONSULTING ENGINEERS and PLANNERS

FIGURE D-7

APPENDIX D-2

RESIDUAL DRAWDOWNS AND RECOVERY

Table D-2

RESIDUAL DRAWDOWNS s' (feet)

TIME AFTER PUMP STOPPED t (MINS.)	DISCHARGE WELL C-3	OBSERVATION WELL NO. 1 (50' from C-3)	OBSERVATION WELL NO. 2 (200' from C-3)	COMMENTS
0.00	0.00	0.00	0.00	Started Recovery
.13	-	0.63	-	
.58	-	1.72	-	
.92	-	2.20	-	
1.47	-	2.65	-	
2.00	13.33	-	-	
2.10	-	3.04	-	
2.50	13.58	-	-	
2.75	-	3.26	-	
2.83	-	-	0.61	
3.00	14.00	-	-	
3.30	-	3.48	-	
3.50	14.20	-	-	
3.92	-	3.63	-	
4.33	-	3.74	0.87	
4.50	14.54	-	-	
4.88	-	3.87	-	
5.00	14.58	-	-	
5.50	-	3.97	-	
6.00	14.75	-	-	
6.17	-	-	1.15	
6.20	-	4.10	-	
6.50	14.83	-	-	
6.70	-	4.19	-	
7.33	-	4.28	-	
7.50	15.00	-	-	
7.78	-	-	1.34	
8.00	-	4.38	-	
8.50	15.08	4.44	-	
9.00	-	4.48	-	
9.25	-	-	1.46	
9.50	15.20	4.54	-	
10.00	15.25	4.62	-	
10.68	-	-	1.58	
11.00	15.29	4.70	-	
12.00	15.45	4.80	-	
12.53	-	-	1.73	
13.00	15.50	4.89	-	
14.00	15.62	4.97	-	
14.16	-	-	1.81	
15.00	15.64	5.03	-	
15.25	-	-	1.89	
16.00	15.75	5.09	-	
16.40	-	-	1.98	
17.00	15.79	5.15	-	

Table D-2 (Continued)

RESIDUAL DRAWDOWNS s' (feet)

TIME AFTER PUMP STOPPED t (MINS.)	DISCHARGE WELL C-3	OBSERVATION WELL NO. 1 (50' from C-3)	OBSERVATION WELL NO. 2 (200' from C-3)	COMMENTS
17.42	-	-	2.00	
18.00	15.83	5.24	-	
18.37	-	-	2.07	
19.00	15.87	5.27	-	
19.35	-	-	2.10	
20.00	15.91	5.41	-	
20.27	-	-	2.14	
21.16	16.00	-	-	
21.33	-	-	2.18	
22.00	-	5.49	-	
22.67	-	-	2.24	
23.00	16.08	-	-	
23.75	-	-	2.28	
24.00	-	5.59	-	
24.50	16.20	-	-	
24.95	-	-	2.32	
26.00	16.20	5.65	-	
26.30	-	-	2.37	
27.00	16.33	-	-	
27.37	-	-	2.42	
28.00	-	5.73	-	
28.45	-	-	2.44	
30.00	-	5.79	-	
32.00	-	5.83	-	
32.25	-	-	2.56	
33.88	-	-	2.59	
34.00	16.45	5.90	-	
36.00	-	5.97	-	
37.00	16.54	-	2.67	
38.00	-	6.01	-	
39.50	16.62	-	-	
40.00	-	6.07	-	
40.16	-	-	2.73	
42.00	16.66	-	-	
43.00	-	6.15	-	
43.67	-	-	2.81	
44.50	16.70	-	-	
46.00	-	6.19	-	
49.00	-	6.22	-	
51.00	16.83	-	-	
52.00	-	6.30	-	
52.16	-	-	2.96	
56.00	-	6.37	-	
57.00	16.91	-	-	

Table D-2 (Continued)

RESIDUAL DRAWDOWNS s' (feet)

TIME AFTER PUMP STOPPED t (MINS.)	DISCHARGE WELL C-3	OBSERVATION WELL NO. 1 (50' from C-3)	OBSERVATION WELL NO. 2 (200' from C-3)	COMMENTS
58.00	-	-	3.05	
63.00	17.04	-	-	
64.00	-	6.47	3.12	
69.00	-	6.54	-	
71.50	-	-	3.20	
72.00	17.12	-	-	
75.00	-	6.58	-	
77.00	17.16	-	-	
79.50	-	-	3.28	
81.00	-	6.64	-	
87.00	-	6.73	-	
91.00	17.29	-	-	
92.00	-	-	3.39	
97.00	-	6.80	-	
101.00	17.33	-	-	
109.00	-	-	3.52	Pump Removal from C-3
113.00	-	6.91	-	
122.00	-	-	3.58	
125.00	-	6.96	-	
142.00	-	-	3.65	
144.00	-	7.04	-	
179.00	-	-	3.79	
181.00	-	7.19	-	
209.00	-	-	3.83	
210.00	-	7.24	-	
268.00	-	7.35	-	
274.00	-	-	3.93	

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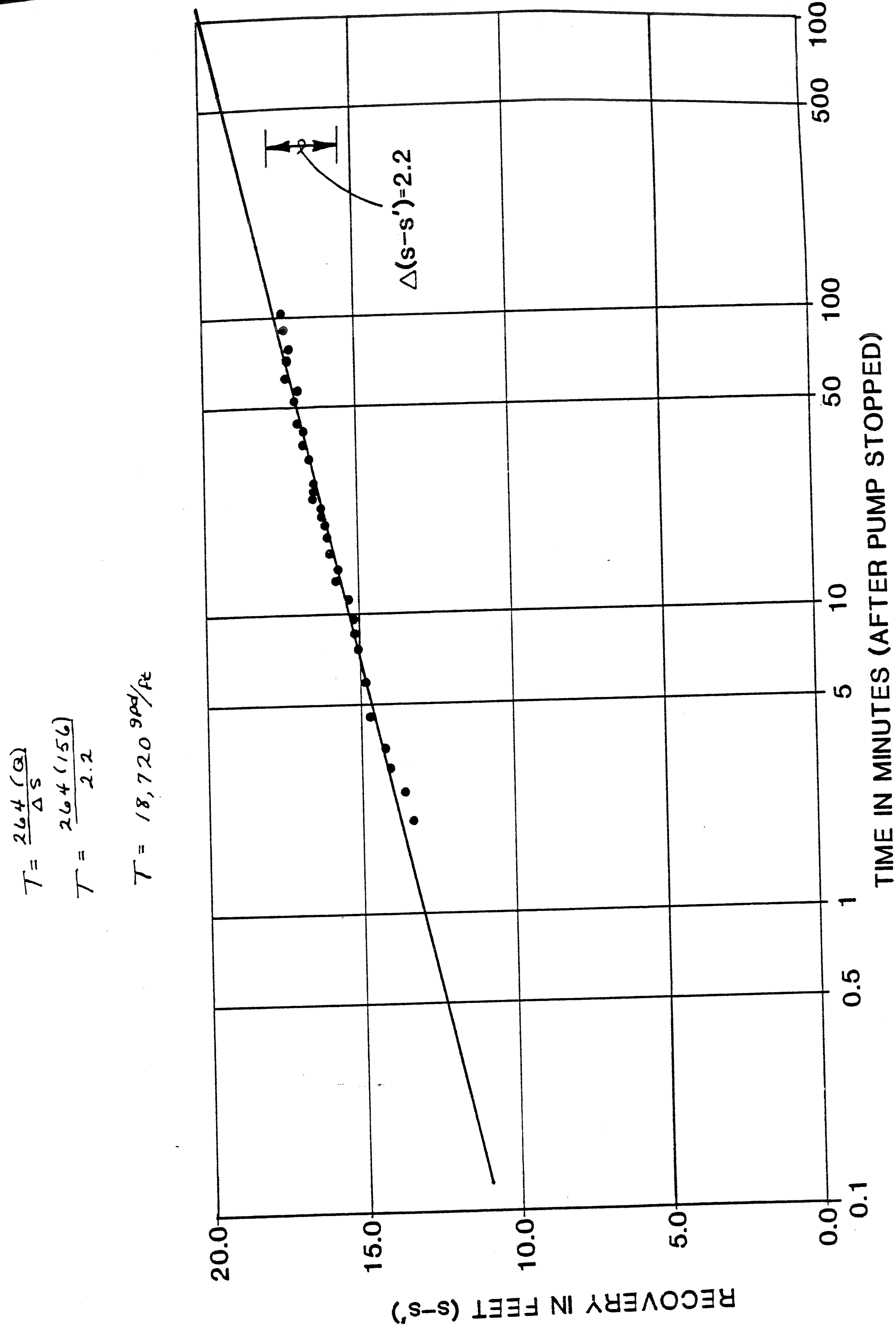


STRAIGHT LINE SOLUTION FOR DISCHARGE WELL C-3 (RECOVERY)

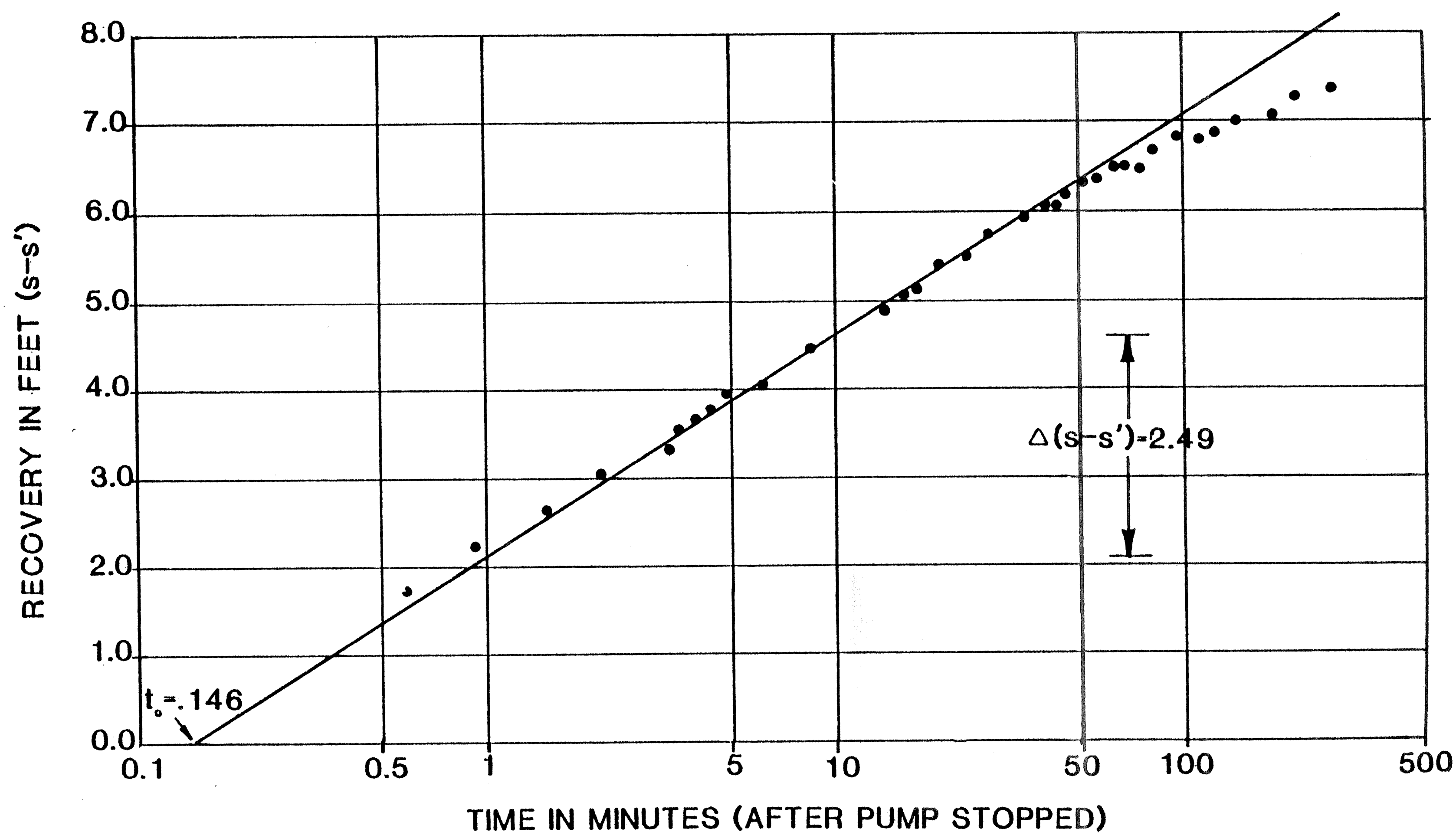
PBSJ **Post, Buckley, Schuh & Jernigan, Inc.**
CONSULTING ENGINEERS and PLANNERS

FIGURE D-10

$$T = \frac{264(Q)}{\Delta s} \qquad S = \frac{0.3(T)(t_o)}{r^2}$$

$$T = \frac{(264)(156)}{2.49} \qquad S = \frac{0.3(16540)(.146)}{(50)^2 \cdot 1440}$$

$$T = 16{,}540 \text{ gpd/ft} \qquad S = .00020$$



STRAIGHT LINE SOLUTION FOR OBSERVATION WELL No.1 (RECOVERY)

Post, Buckley, Schuh & Jernigan, Inc.
CONSULTING ENGINEERS and PLANNERS

FIGURE D–11

$$T = \frac{264\,(Q)}{\Delta s}$$

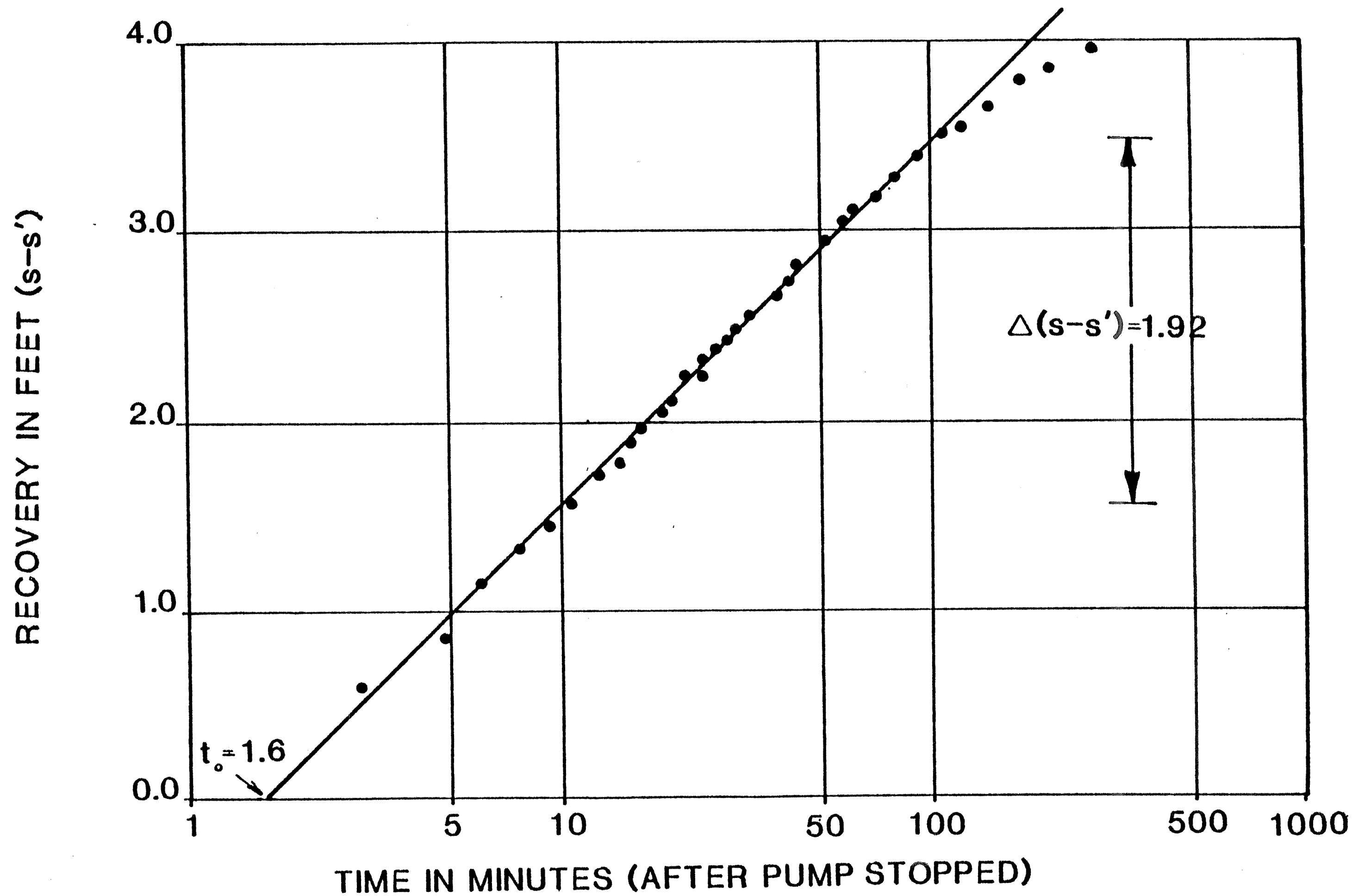
$$T = \frac{(264)(156)}{1.92}$$

$$T = 21{,}450 \text{ gpd/ft}$$

$$S = \frac{0.3\,(T)(t_o)}{r^2}$$

$$S = \frac{0.3\,(21450)(1.6)}{(200)^2 \cdot 1440}$$

$$S = .00018$$



STRAIGHT LINE SOLUTION FOR OBSERVATION WELL No.2 (RECOVERY)

PBSJ Post, Buckley, Schuh & Jernigan, Inc.
CONSULTING ENGINEERS and PLANNERS

FIGURE D-12

Table D-3

RECOVERY TEST METHOD TABULATION

TIME SINCE PUMP STARTED t (MINS.)	TIME SINCE PUMP STOPPED t' (MINS.)	RATIO t/t'	RECOVERY s-s' (FEET) (50' from C-3) OBSERVATION WELL #1	RECOVERY s-s' (FEET) (200' from C-3) OBSERVATION WELL #2	COMMENTS
0.00	0.00	0.0	0.00	0.00	Started Recovery
1469.13	.13	11,301.0	6.73	-	
1469.58	.58	2,533.8	5.64	-	
1469.92	.92	1,597.7	5.16	-	
1470.47	1.47	1,000.3	4.71	-	
1471.00	2.00	735.5	-	-	
1471.10	2.10	700.5	4.32	-	
1471.50	2.50	588.6	-	-	
1471.75	2.75	535.2	4.10	-	
1471.83	2.83	520.1	-	3.33	
1472.00	3.00	490.7	-	-	
1472.30	3.30	446.2	3.88	-	
1472.50	3.50	420.7	-	-	
1472.92	3.92	375.7	3.73	-	
1473.33	4.33	340.3	3.62	3.07	
1473.50	4.50	327.4	-	-	
1473.88	4.88	302.0	3.49	-	
1474.00	5.00	294.8	-	-	
1474.50	5.50	268.1	3.39	-	
1475.00	6.00	245.8	-	-	
1475.17	6.17	239.1	-	2.79	
1475.20	6.20	237.9	3.26	-	
1475.50	6.50	227.0	-	-	
1475.70	6.70	220.3	3.17	-	
1476.33	7.33	201.4	3.08	-	
1476.50	7.50	196.9	-	-	
1476.78	7.78	189.8	-	2.6	
1477.00	8.00	184.6	2.98	-	
1477.50	8.50	173.8	2.92	-	
1478.00	9.00	164.2	2.88	-	
1478.25	9.25	159.8	-	2.48	
1478.50	9.50	155.6	2.82	-	
1479.00	10.00	147.9	2.74	-	
1479.68	10.68	138.5	-	2.36	
1480.00	11.00	134.5	2.66	-	
1481.00	12.00	123.4	2.56	-	
1481.53	12.53	118.2	-	2.21	
1482.00	13.00	114.0	2.47	-	
1483.00	14.00	105.9	2.39	-	
1483.16	14.16	104.7	-	2.13	
1484.00	15.00	98.9	2.33	-	

Table D-3 (Continued)

RECOVERY TEST METHOD TABULATION

TIME SINCE PUMP STARTED t (MINS.)	TIME SINCE PUMP STOPPED t' (MINS.)	RATIO t/t'	RECOVERY s-s' (FEET) (50' from C-3) OBSERVATION WELL #1	RECOVERY s-s' (FEET) (200' from C-3) OBSERVATION WELL #2	COMMENTS
1484.25	15.25	97.30	-	2.05	
1485.00	16.00	92.80	2.27	-	
1485.40	16.40	90.60	-	1.96	
1486.00	17.00	87.40	2.21	-	
1486.42	17.42	85.30	-	1.94	
1487.00	18.00	82.60	2.12	-	
1487.37	18.37	81.00	-	1.87	
1488.00	19.00	78.30	2.09	-	
1488.35	19.35	76.90	-	1.84	
1489.00	20.00	74.50	1.95	-	
1489.27	20.27	73.50	-	1.8	
1490.16	21.16	70.40	-	-	
1490.33	21.33	69.90	-	1.76	
1491.00	22.00	67.80	1.87	-	
1491.67	22.67	65.80	-	1.7	
1492.00	23.00	64.90	-	-	
1492.75	23.75	62.90	-	1.66	
1493.00	24.00	62.20	1.77	-	
1493.50	24.50	61.00	-	-	
1493.95	24.95	59.90	-	1.62	
1495.00	26.00	57.50	1.71	-	
1495.30	26.30	56.90	-	1.57	
1496.00	27.00	55.40	-	-	
1496.37	27.37	54.70	-	1.52	
1497.00	28.00	53.50	1.63	-	
1497.45	28.45	52.60	-	1.5	
1499.00	30.00	50.00	1.57	-	
1501.00	32.00	46.90	1.53	-	
1501.25	32.25	46.60	-	1.38	
1502.88	33.88	44.40	-	1.35	
1503.00	34.00	44.20	1.46	-	
1505.00	36.00	41.80	1.39	-	
1506.00	37.00	40.70	-	1.27	
1507.00	38.00	39.70	1.35	-	
1508.50	39.50	38.20	-	-	
1509.00	40.00	37.73	1.29	-	
1509.16	40.16	37.60	-	1.21	
1511.00	42.00	36.00	-	-	
1512.00	43.00	35.20	1.21	-	
1512.67	43.67	34.60	-	1.13	
1513.50	44.50	34.00	-	-	
1515.00	46.00	32.90	1.17	-	
1518.00	49.00	31.00	1.14	-	
1520.00	51.00	29.80	-	-	
1521.00	52.00	29.30	1.06	-	
1521.16	52.16	29.20	-	0.98	

Table D-3 (Continued)

RECOVERY TEST METHOD TABULATION

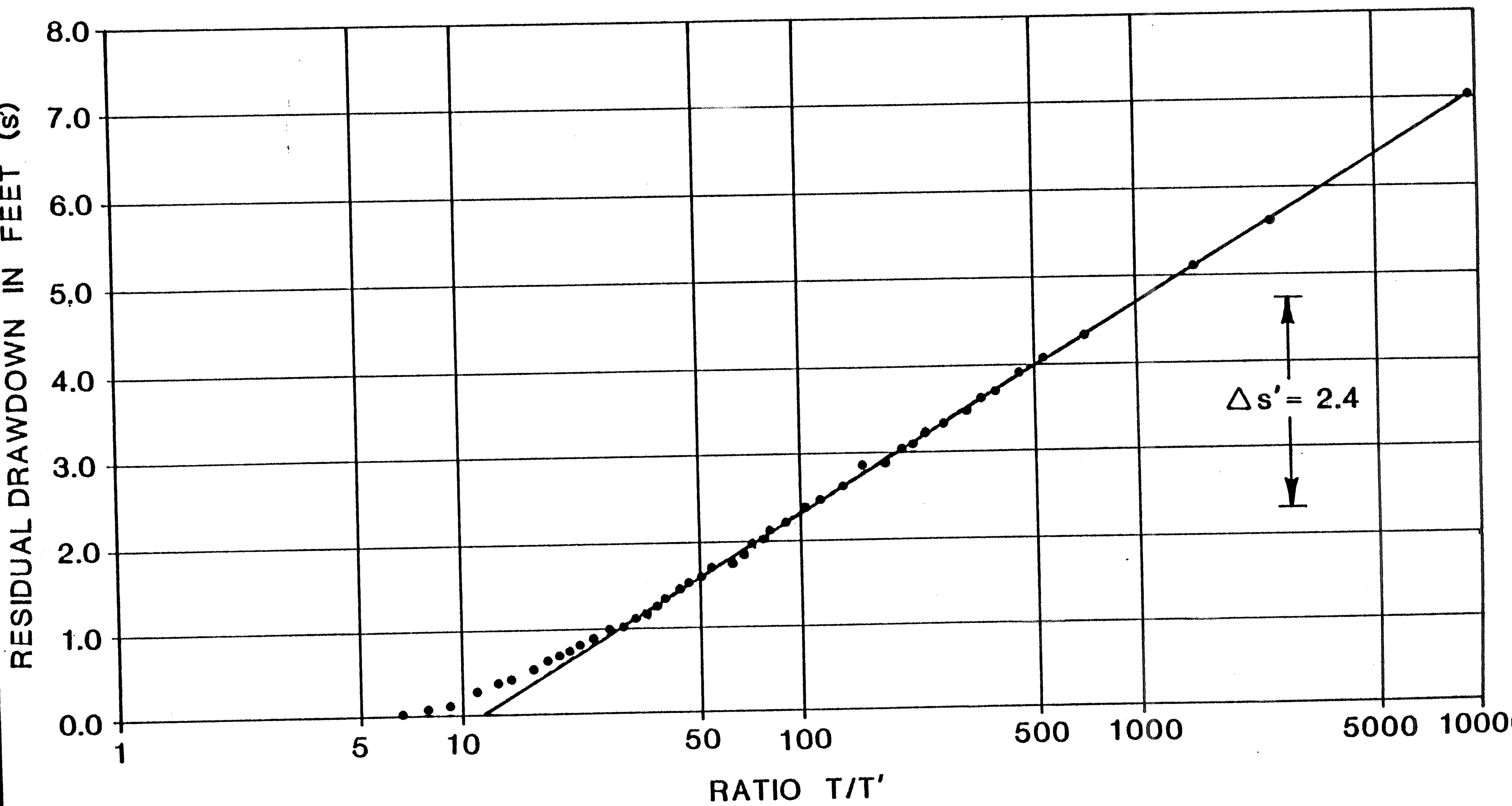
TIME SINCE PUMP STARTED t (MINS.)	TIME SINCE PUMP STOPPED t' (MINS.)	RATIO t/t'	RECOVERY s-s' (FEET) (50' from C-3) OBSERVATION WELL #1	RECOVERY s-s' (FEET) (200' from C-3) OBSERVATION WELL #2	COMMENTS
1525.0	56.0	27.2	0.99	-	
1526.0	57.0	26.8	-	-	
1527.0	58.0	26.3	-	0.89	
1532.0	63.0	24.3	-	-	
1533.0	64.0	24.0	0.89	0.82	
1538.0	69.0	22.3	0.82	-	
1540.5	71.5	21.5	-	0.74	
1541.0	72.0	21.4	-	-	
1544.0	75.0	20.6	0.78	-	
1546.0	77.0	20.1	-	-	
1548.5	79.5	19.5	-	0.66	
1550.0	81.0	19.1	0.72	-	
1556.0	87.0	17.9	0.63	-	
1560.0	91.0	17.1	-	-	
1561.0	92.0	17.0	-	0.55	
1566.0	97.0	16.1	0.56	-	
1570.0	101.0	15.5	-	-	
1578.0	109.0	14.5	-	0.42	Pump Removed from C-3
1582.0	113.0	14.0	0.45	-	
1591.0	122.0	13.0	-	0.36	
1594.0	125.0	12.8	0.40	-	
1611.0	142.0	11.3	-	0.29	
1613.0	144.0	11.2	0.32	-	
1648.0	179.0	9.2	-	0.15	
1650.0	181.0	9.1	0.17	-	
1678.0	209.0	8.0	-	0.11	
1679.0	210.0	7.9	0.12	-	
1737.0	268.0	6.5	0.01	-	
1743.0	274.0	6.4	-	0.01	

m.H16.0

$$T = \frac{264\,Q}{\Delta s'}$$

$$T = \frac{(264)(156)}{2.4}$$

$$T = 17{,}160\ \text{gpd/ft}$$

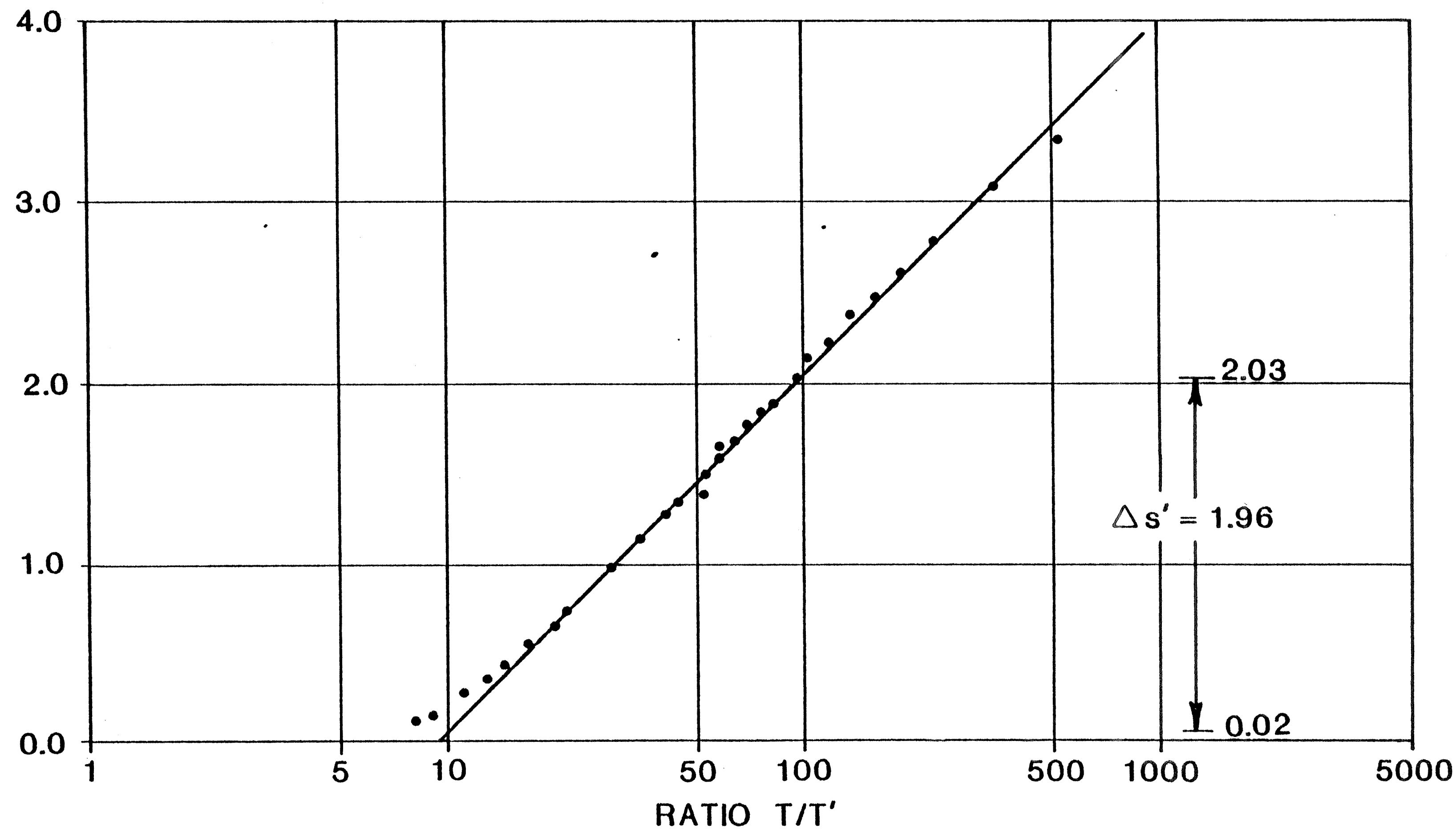


RECOVERY TEST METHOD FOR OBSERVATION WELL No. 1

$$T = \frac{264(Q)}{\Delta s'}$$

$$T = \frac{264(156)}{1.96}$$

$$T = 21{,}010 \text{ gpd/ft}$$



RECOVERY TEST METHOD FOR OBSERVATION WELL No. 2

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CONSULTING ENGINEERS and PLANNERS

FIGURE D-14