APT REANALYSIS

SITE: Palm Springs, Forest Hill Village Wellfield
Section [illegible], Township 44S, Range 42E

REPORT: CH2M-Hill, Hydrogeologic Report, Evaluation of Wellfield Facilities, Village of Palm Springs, Palm Beach County, Florida, June 1983.

GEOLOGIC DATA: pp. 5-10

Well #5 - Drilling logs for pilot hole to 260' below grade showing:

0-33 sand
33-46 sandstone/clay
46-71 sandstone
71-83 shell
83-108 sand
108-132 sandstone
132-139 sand
139-166 sandstone
166-234 limestone
234-260 clay/limestone

Geophysical, electric and gamma ray logs to 260' below grade

Wells #1-4 - gamma logs

Based on drilling log and gamma logs, aquifer thickness estimated at 234'.

The lithologic and geophysical logs show a good producing zone, probably the Turnpike aquifer, from 120' to 165' BG.

Site elevation is approximately __ NGVD.

WELL DESCRIPTIONS:

Well	Diam. (in)	Total Depth	Cased Depth	Screen /Open	r	State Plane Coords. X	Y
5	8	170	123 133-140	scr	pump		
2	8	115	145	scr	300		
1	8	100	135	scr	372		
3	8	110	135	scr	570		
4	8	96	94	open	600		

Depth to water: 5'

INFLUENCING FACTORS:

1) Lake Worth Drainage District canals E-3 and E-8, 350' and 600' from the pumping well, respectively. Both canals are about 6' deep.

APT:

Started: 4/13/83 at 0917
Duration: 48 hours
Discharge: 1600 GPM to E-3 (308,021 FT3/DAY)
Recovery:

Comments:

1) Stevens recorders on wells 2, 3, and 4. Chalked steel tape on wells 1, 5, and canal.

2) Variation in Q at t = 8 hours, "quickly" corrected.

3) At 40 hours a 6" irrigation well located 3,000' from well #5 was pumped for three hours at about 300 GPM.

CONSULTANT'S ANALYSIS:

Method: Jacob - distance drawdown, time drawdown

→ Results (average): ________

Comments:

1) Pg. 6-7 Consultant corrected drawdown data for declining water level trend based on eight hours of background data. The decline was obvious only for the last two hours, 0600-0800. The decline was attributed to evapotranspiration and barometric pressure change. The arguments are not convincing.

2) Poor results for well #4.

3) Jacob analysis gave higher T's.

4) Analysis of recharge from canals made using Walton's method. This analysis seems inappropriate given that the method assumes a fully penetrating boundary and the canals penetrate only 3% of the aquifer.

REANALYSIS:

Method: Neuman, 1975, Analysis of Pumping Test Data from Anisotropic Unconfined Aquifers Considering Delayed Gravity Response.

Results:

Well	T Ft2/Day	S	K_D
1	166,763	.0132	.0038
2	375,217	.0221	.0006
3	372,764	.0086	.0002
*Avg.	374,000	.015	.0004

Comments:

1) Drawdown data was used as measured.

2)* Wells 2 and 3 had good type curve matches, fairly smooth drawdown curves and similar results. The drawdown curve for well 1 was more erratic, the type curve match was not as good, and the results did not agree well with results from wells 2 and 3. Since well 1 was measured with chalked tape while wells 2 and 3 were measured with Stevens recorders, it is possible that the time-drawdown measurements were not as accurate in well 1. Therefore, the results from well 1 were not used in calculating the average aquifer characteristics.

3) There was not sufficient late time data to calculate specific yield at these sites.

4) Using the assumed thickness of the aquifer, 230', and the average T, 374,000 FT2/DAY, the horizontal conductivity of the aquifer is 1,626 FT/DAY. This k is completely unrealistic for the sand and unsolutioned rock sections. caps

5) Given the high K computed from this method and the likely presence of the Turnpike aquifer, the Neuman method assuming a homogeneous unconfined system is inappropriate.

Method: Modified Hantush

Results:

Well	T Ft2/Day	S	Beta
1	204,400	.000023	.02
2	169,100	.00014	.02
3	176,600	.00012	.02
*Avg.	172,800	.00013	.02

Comments:

1) There are two possibilities for semi-confined aquifer behavior at the site. First, if the Turnpike aquifer at the site is sufficiently more permeable than the non-solutioned zones above and below it, it would act as a semi-confined aquifer. Second, the sandstone/clay layer from 33-46 ft. at the site could act as a semi-confining layer for the aquifer below it. In either case, a semi-confined analysis is appropriate.

2) as 1) from above.

3)* as 2) from above.

4) The modified Hantush method assumes: 1) there is negligible drawdown in the source bed above the semi-confined production zone and 2) water release from storage in the semi-confining layer is appreciable. Since thre is no data on the upper aquifer zones during the pump test, it is not possible to check these assumptions.

5) If the effective producing zone at the site is the Turnpike aquifer with a thickness of 45', the hydraulic conductivity of the zone, based on the above results, is 3,840 FT/DAY.

6) If the effective producing zone is the aquifer below the sandstone/clay layer, with a thickness of 188', the hydraulic conductivity of the zone is 920 FT/DAY. based on the above results

Method: Hantush-Jacob

Results:

Well	T Ft2/Day	S	V
2	188,600	.00015	.01
3	213,400	.00016	.02
*Avg.	201,000	.000155	.015

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Comments:

1) through 3)* as above.

4) The Hantush-Jacob method assumes:

5) as above except K = 4,470 FT/DAY.

6) as above except K = 1,070 FT/DAY.

Method: Numerical Analysis using radial finite element method.

RECOMMENDED VALUES:

Comments:

REFERENCES:

Water Use Permit 50-00036, Staff Report

Palm Springs Pump Test Reanalysis

Constant Flux Nodes - Actual Prod. Well Partially Penetrating

Well from 140-170 Nodes 5, 6, 7
Q = 1600 GPM = 214 FT^3/MIN = 308,000 FT^3/DAY
Axisymetric ÷ Q by 2π Q_A = 49,048 FT^3/DAY
Nodes 5 & 7 get half shares because at top & bottom of well

Node 5 = 7 = 12,262 FT^3/DAY
Node 6 = 24,524 FT^3/DAY

Hydraulic Conductivity -

From PB135, Hantush-Jacob analysis, $\bar{T}$ = 156,000 FT^2/DAY
Assuming aquifer thickness of 235', $\bar{K} = \bar{T}/b$ = 662 FT/DAY
(based on litho logs, model setup)
Rough cut since used entire thickness & analysis semi confined,
using K = 600 FT/DAY K_H/K_V = 10 (assumed, no basis)

Drawdowns seem quite small. Double checking model by running fully penetrating well to compare to Theis

Q = 308,000 FT^3/DAY $\bar{b}$ = 235'

$Q/\bar{b}$ = 1311 FT^2/day
$Q/\bar{b}2\pi$ = 209 FT^2/day

Node	Ft. cov.	Q
1	10	2090
2	20	4180
3	17.5	3658
4	15	3135
5	15	3135
6	15	3135
7	12.5	2613
8	10	2090
9	12.5	2613
10	15	3135
11	15	3135
12	15	3135
13	15	3135
14	15	3135
15	12.5	2613
16	12.5	2613
17	7.5	1568

Palm Springs APT Reanalysis w/ MODFLOW

A 3-dimensional model was chosen to reflect the aquifer layering and the partially penetrating pumping well. The model was given 16 layers as show in figure 1. The pumping well, which was open to the aquifer from 123-133, and 140-170 feet BG, was represented as open to the aquifer from 120 to 170 feet in the model. This makes nodes 9, 10, 11 and 12 pumping nodes. The model represented 1/4 of the aquifer area with the well in 1 corner and no flow boundaries on all sides.

Dischage : APT Q = 1600 GPM

1) ÷ 4 for 1/4 area in model = 400 GPM

= 77000 FT^3/DAY

2) Divide proportionally among pumping nodes

Nodes 9 & 10 10' thick
Nodes 11 & 12 15' thick

Σ 50' 77000/50 = 1540 $FT^3/DAY-FT$

Nodes 9 & 10 10' (1540) = 15,400 FT^3/DAY
Nodes 11 & 12 15' (1540) = 23,100 FT^3/DAY

Time : 2 Days

Supporting Data : There is a continuous record of water levels at a monitoring well in the Palm Springs wellfield. The data reflect primarily when the pumps are on & off. Data is in strip chart form and data reduction would be extremely tedious. Not worth the effort. Monitor well is completed in the production zone. No shallow monitoring wells.

Aquifer Characteristics:

Neuman analysis of Palm Springs Obs Wells 1, 2, and 3 showed the following:

Well	T (FT^2/DAY)	S	K_D
1	166,800	.013	.0038
2	375200	.022	.0006
3	372,764	.0086	.0002

The lithologic and geophysical logs show a good producing zone from 120' BG to 165' BG.

Results from Well 1 were considered questionable (see APT reanalysis sheet). Average characteristics based on wells 2 and 3 are:

T = 374,000 FT^2/DAY
S = .015
K_D = .0004

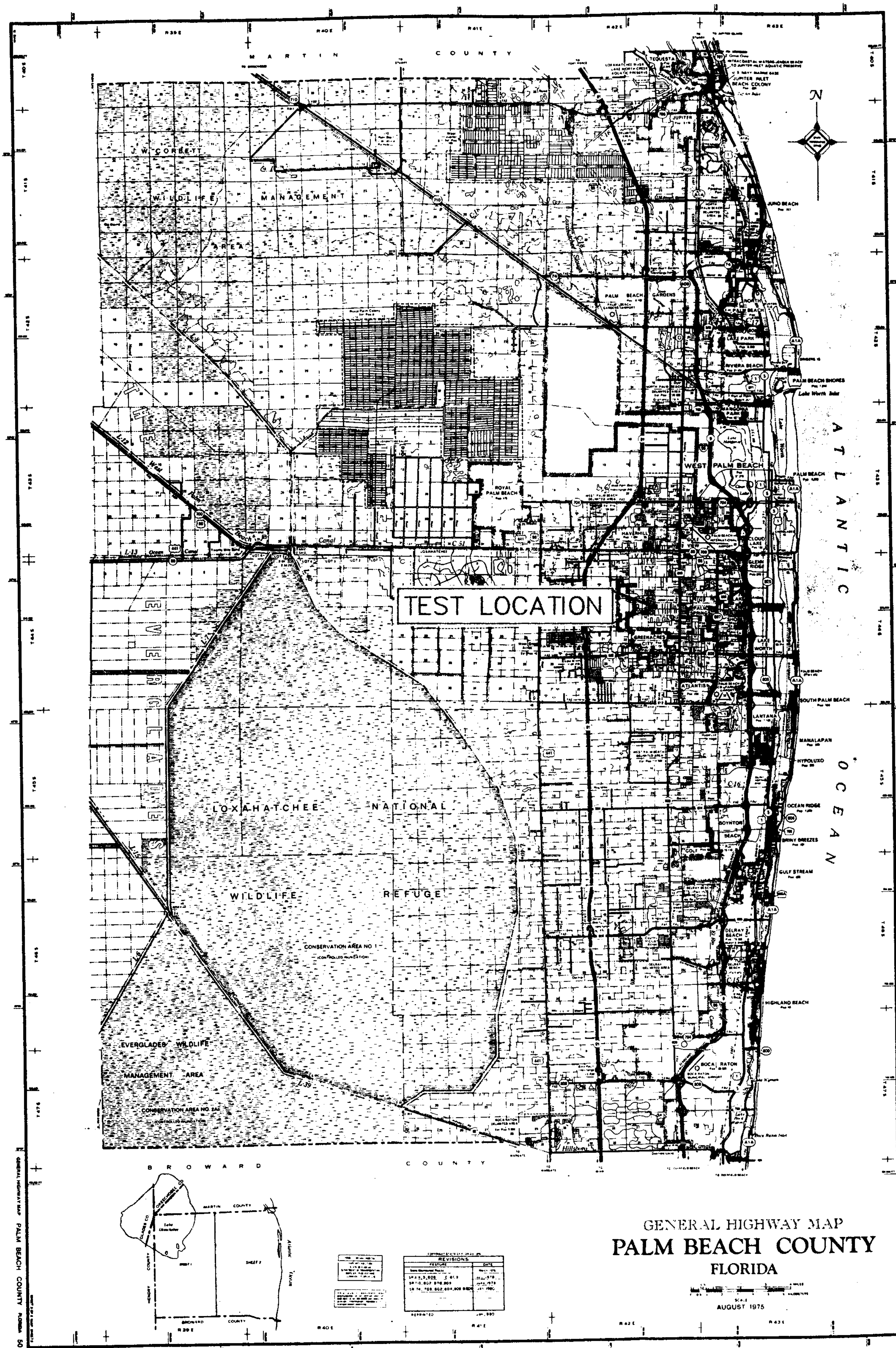
Using the assumed thickness of the aquifer, 230', K = 1626 FT/DAY, which is clearly ridiculous.

Modified Hantush Method

Well	T	S	β
1	204,366	.000023	.02
2	245,240	.00020	.02
3	176,570	.00012	.02
*Avg	210,900	.00016	.02

Assume b of producing zone is 45' (estimated Turnpike thickness at site). Then K of producing zone is T/b = 4690 FT/DAY.

Assume b of producing zone is 188' (thickness of aquifer below sandstone / clay layer). Then K of producing zone is T/b = 1120 FT/DAY.


MARTIN COUNTY
BROWARD COUNTY
J. W. CORBETT WILDLIFE MANAGEMENT AREA
TEST LOCATION
LOXAHATCHEE NATIONAL WILDLIFE REFUGE
CONSERVATION AREA NO. 1
EVERGLADES WILDLIFE MANAGEMENT AREA
CONSERVATION AREA NO. 2A
ATLANTIC OCEAN
TEQUESTA
JUPITER
JUNO BEACH
PALM BEACH GARDENS
NORTH PALM BEACH
RIVIERA BEACH
PALM BEACH SHORES
WEST PALM BEACH
ROYAL PALM BEACH
HAVERHILL
PALM BEACH
GREENACRES CITY
LAKE WORTH
ATLANTIS
LANTANA
SOUTH PALM BEACH
MANALAPAN
HYPOLUXO
OCEAN RIDGE
BOYNTON BEACH
BRINY BREEZES
GULF STREAM
DELRAY BEACH
HIGHLAND BEACH
BOCA RATON
Lake Worth Inlet
R 39 E
R 40 E
R 41 E
R 42 E
R 43 E
GENERAL HIGHWAY MAP
PALM BEACH COUNTY
FLORIDA
AUGUST 1975
GENERAL HIGHWAY MAP PALM BEACH COUNTY FLORIDA 50

FC50100.E0

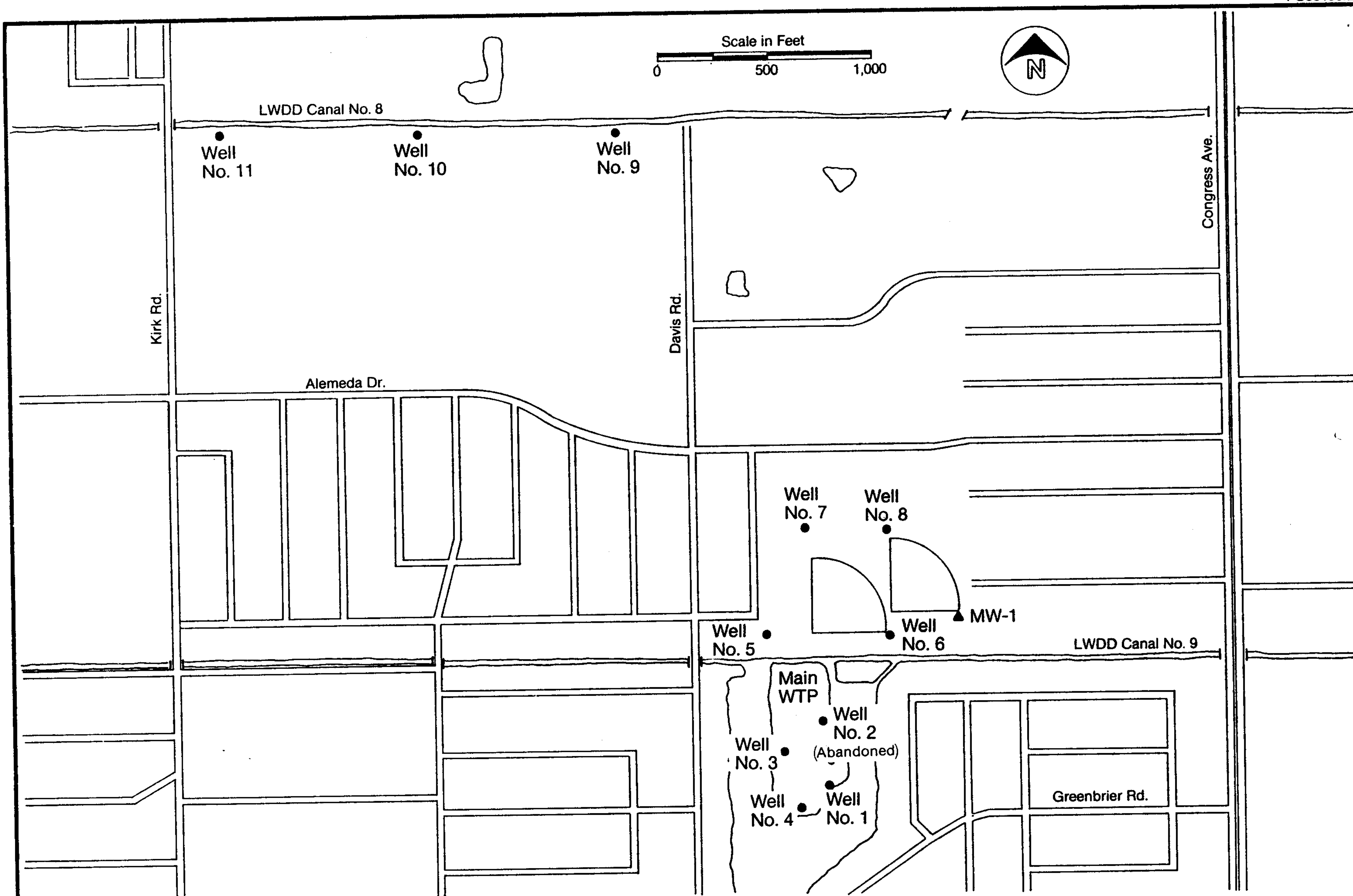


FIGURE 2-1.
Main Well Field—Well Location Map.

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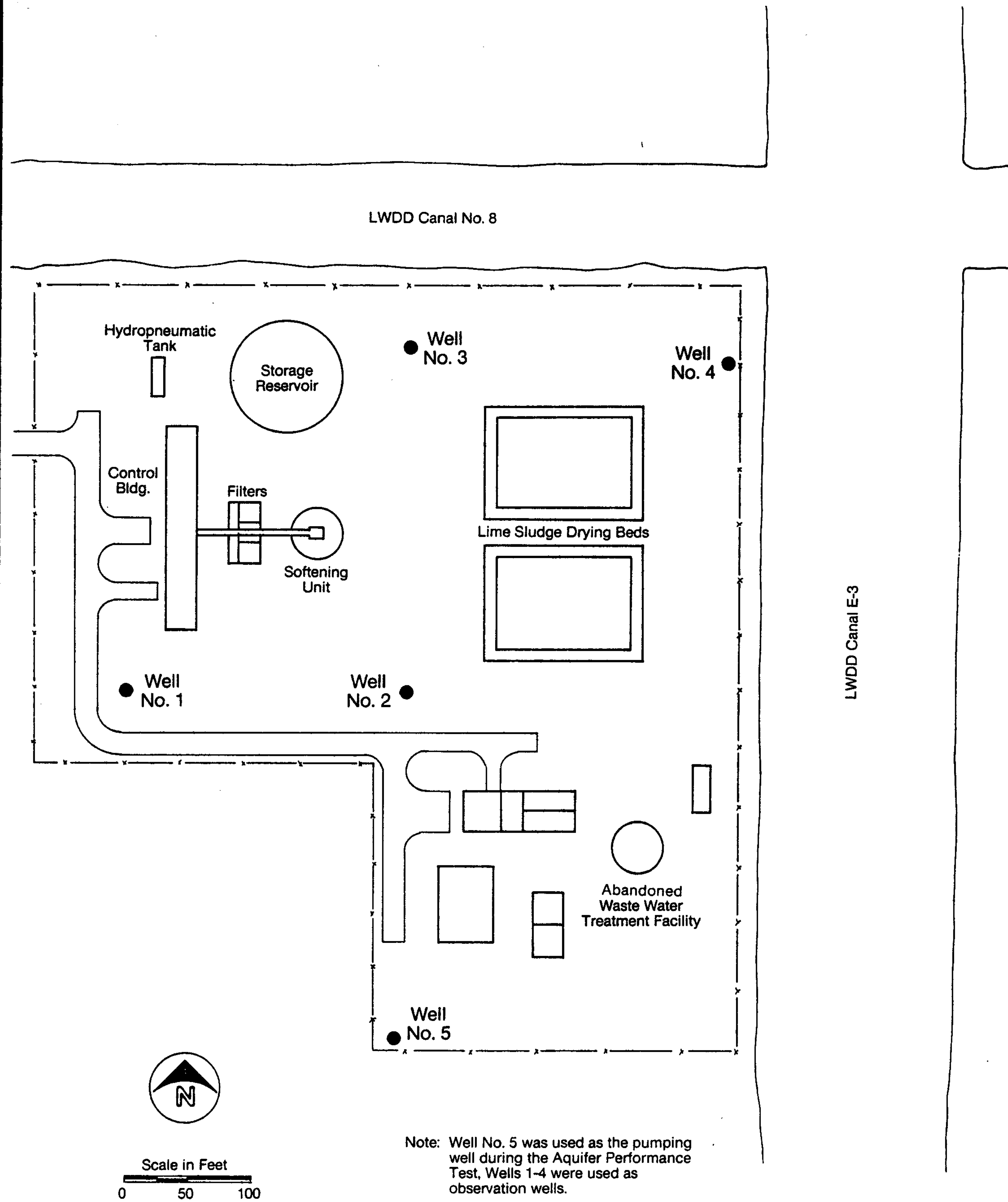

Note: Well No. 5 was used as the pumping well during the Aquifer Performance Test, Wells 1-4 were used as observation wells.

FIGURE 2-2.
Forest Hill Village Well Field—Well Location Map.

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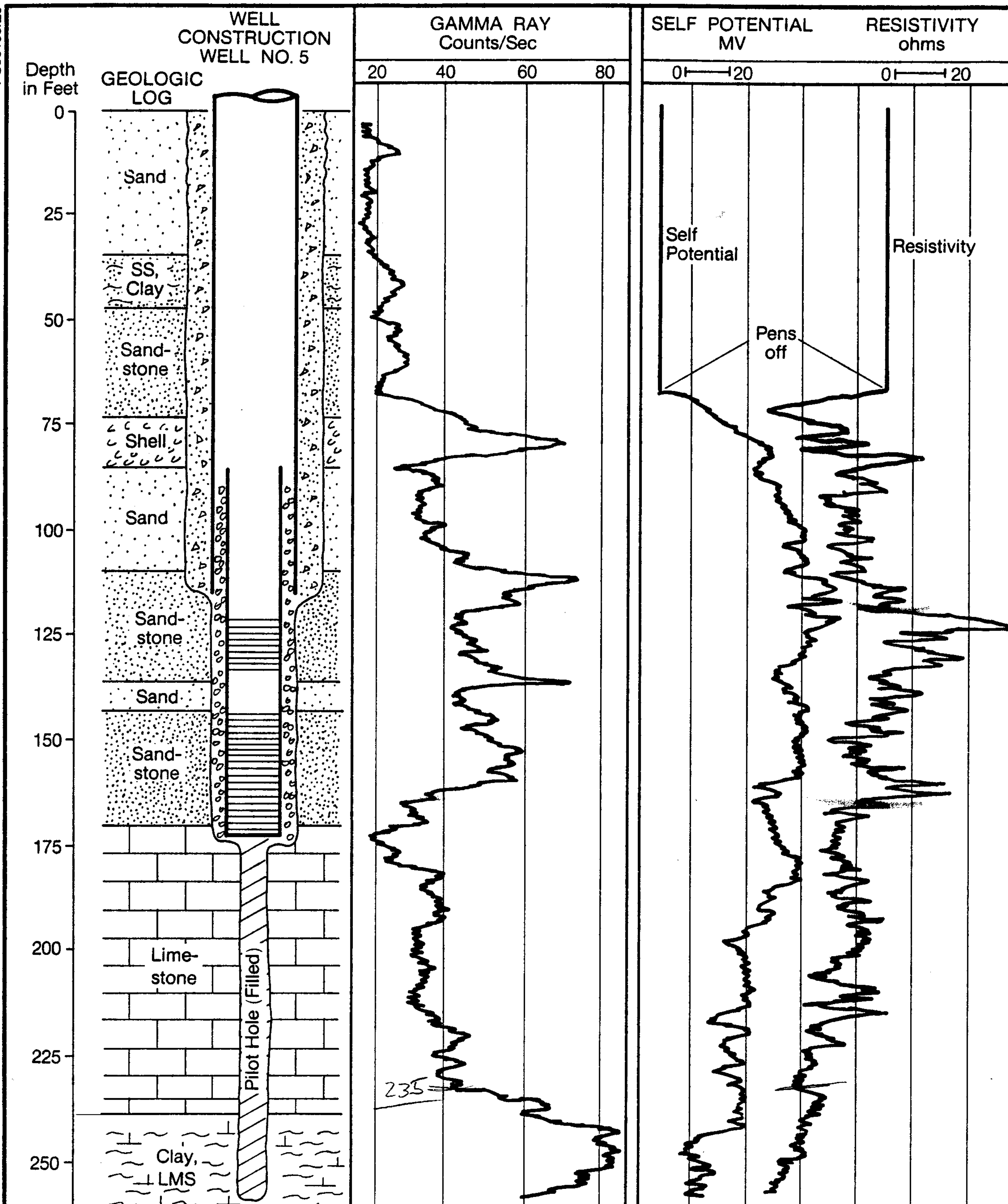
PBC 135

FC50100.E0



Well No. 5
Date Completed 3/25/83
Casing Diameter 14 in
Casing Depth 115 ft
Screen Section 123-133: 140-170

Screen Diameter 8 in TS
Screen Slot Size 80
Gravel Pack Size ⅛ in x ¼ in
Final Pumping Test 4/13 to 4/15, 1983
Duration 48 hr

Pumping Rate 1,600 gpm
Static Water Level 5.05 ft
Maximum Drawdown 11.92 ft
→ Specific Capacity 134 gpm/ft

Note: SS is Sandstone.

FIGURE 5-6.
Well Completion Report—Well No. 5 (Forest Hill)

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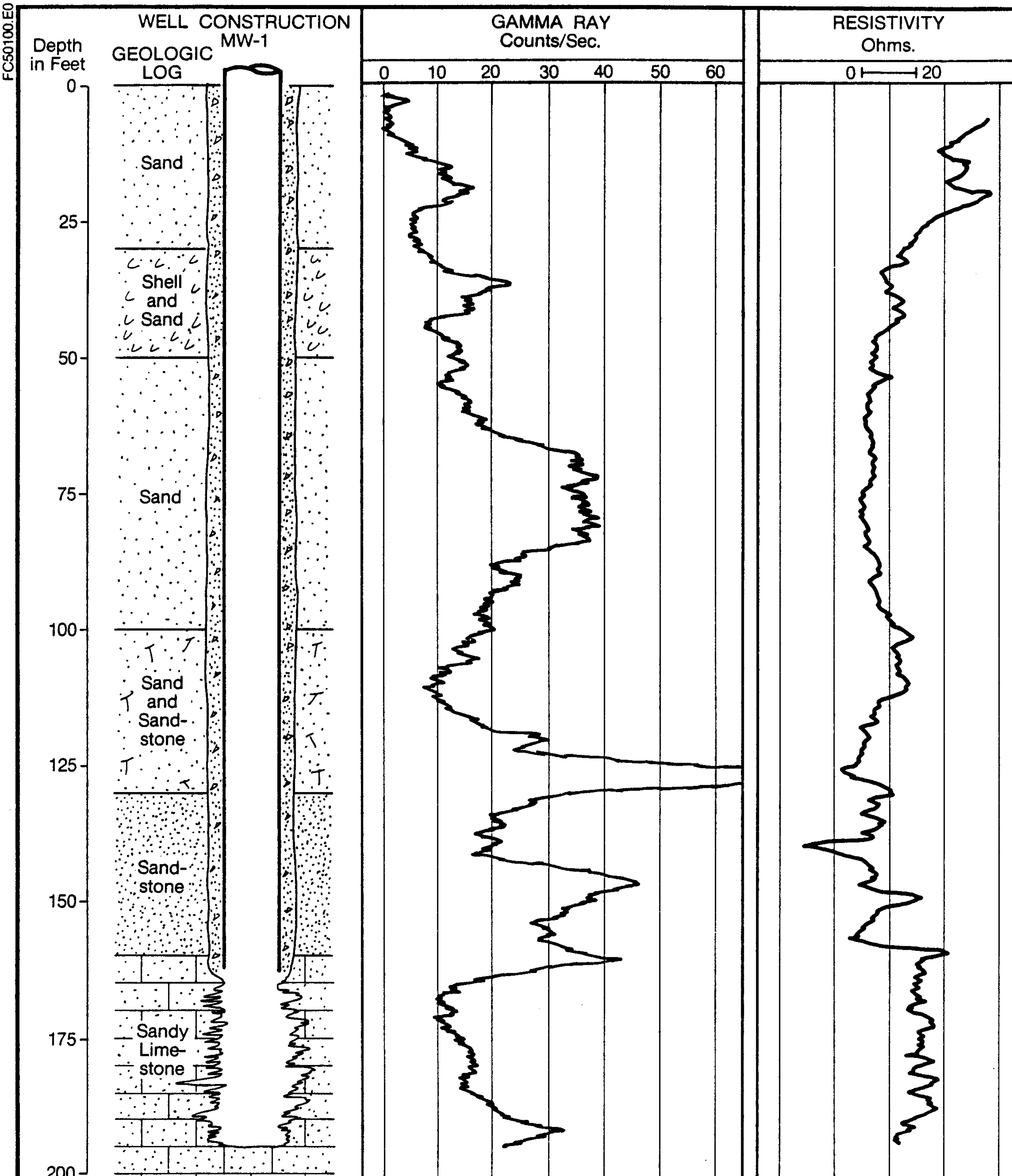

Well No. MW-1
Date Completed 12/20/82
Casing Diameter 6 in.
Casing Depth 162 ft.
Open Hole 162-195 ft.

Final Pumping Test 12/20/82
Duration 2 hr
Pumping Rate 75 gpm
Static Water Level 15.75 ft
Maximum Drawdown 6.35 ft
→Specific Capacity 12 gpm/ft

FIGURE 5-5.
Well Completion Report—MW-1.

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Palm Springs

Table 2-1
SUMMARY OF WELL DATA

Parameters	Main Well Field: Well Field No. 1			Well Field No. 2				Well Field No. 3			Forest Hill Well Field				
Well No.	1	3[a]	4	5	6	7	8	9	10	11	1	2	3	4	5[b]
Construction Date	1957	1964	1967	1969	1969	1971	1974	1977	1977	1977	1959	1959	1959	1959	1983
Total Depth, ft	150	222	150	222	205	200	200	210	210	210	135	141	135	93[e]	170
Casing: Diameter, in	8	10	10	12	12	12	12	12	12	12	8	8	8	8	14
Depth, ft	140	182	110	183	165	161	160	104	102	104	100	113	109	90	115
Screen: Material	None	Everdur	Everdur	Everdur	Stainless	Stainless	Stainless	Open Hole	Open Hole	Stainless	Unk	Unk	Unk	Unk	Stainless
Size, Slot	--	--	40	--	--	35	40	--	--	40	Unk	Unk	Unk	Unk	80
Depth, ft	--	182	110	182	165	161	160	170	170	170	100-135	113-141	109-135	--	
Pump: Manufacturer	Peerless	Peerless	Peerless	Deming	Deming	Johnston	Courbin	Johnston	Johnston	Johnston	None	None	None	None	None
Model	8MA	10L8	10MA	15M8E1	20M8E1	GD3620	20M8E1	10DS	10DS	10DS	--	--	--	--	--
Well Yield, gpm	400	400	500	500	500	500	600	700	700	700	500	500	400	--	1,400
Static Water Level/ Date	8.4/1-83	10.0/1-83	7.3/1-83	14.5/1-83	5.3/1-83	7.2/1-83	6.2/1-83	8.0/1-83[c]	10.3/1-83	8.7/1-83	5.35/1-83	6.92/12-82	8.65/12-82	--	5.05/4-83
Pumped Water Level/ Date	27.2/1-83	40.0/1-83	34.6/1-83	41.3/1-83	22.7/1-83	42.1/1-83	28.2/1-83	10.6/1-83	17.9/1-83	18.2/1-83	14.15/1-83	10.67/12-82	11.58/12-82	--	16.96/4-83
Maximum Drawdown, ft	18.8	30.0	27.3	26.8	17.4	34.9	22.1	2.6	7.6	9.5	8.80	3.75	2.93	--	11.91
Flow Rate, gpm	325	360	480	675	585	75	715	700	700	700	620	500	400	--	1,600
Specific Capacity, gpm/ft	17	12	18(20)[d]	25(16)[d]	34(42)[d]	2	32(42)[d]	269	92(110)[d]	74	70	133	137	--	134

[a] Well No. 2, drilled in 1964, was abandoned in 1974, used as monitoring well with recorder 1980 to 1983.

[b] Well No. 5 is recently constructed Test Production Well, TPW-1.

[c] Static water level above the base of below-grade pump pit.

[d] Number in parenthesis is original specific capacity given where data available.

[e] Well logged to 93 feet, however, postulated to be deeper (see Figure 5-4). This well will be abandoned.

GNR61

PB135

The Forest Hill WF, located approximately 2 miles west of WF No. 3, clearly develops water from the Turnpike aquifer. This highly permeable section of the Anastasia Formation probably extends from WF No. 3 westward through the Forest Hill Village site, terminating in the vicinity of the Florida Turnpike.

Aquifer Performance Test

During the rehabilitation of Forest Hill Village Wells No. 1, 2, and 3, it became clear that the well yields at this site were quite high (70 to 137 gpm/ft). Following the rehabilitation of these existing wells, a new well was constructed to complete the well field facility. This well, identified as Well No. 5, was used as the pumping well during a 48-hour APT conducted April 13 to April 15, 1983.

In order to conduct the test, a 12-inch vertical turbine pump with diesel engine was installed in Well No. 5. A total of 350 feet of 10-inch PVC pipe was laid from the well eastward to LWDD Canal E-3 (see Figure 2-2).

False Start

A Stevens Type F continuous water level recorder was installed at Well No. 2 one day prior to the planned start of the test to collect background water level data. However, the pen malfunctioned and no record was produced. On April 12, 1983, Stevens recorders were installed at Wells No. 2, 3, and 4 and gear ratios were set to run 4 hours at full time scale using a 1:1 gauge scale ratio. Static water levels in Wells No. 1 through 5 were measured, as was the "static" water level in Canal E-3 adjacent to Well No. 4. The test was officially started at 1446 hours at a withdrawal rate of 1,800 gpm. Approximately 30 minutes into the test, a "familiar" pattern was observed on the water level recorder charts. This pattern indicated that the pump was cavitating and the resulting water level response was a series of rapid, cyclic fluctuations. The test was terminated and rescheduled for the next day after determining a more suitable withdrawal rate (1,600 gpm).

The APT was restarted on April 13, 1983, at 0917 at the rate of 1,600 gpm. Figure 6-1 illustrates the background water level response at Well No. 2 (300 feet north of Well No. 5) just prior to the start of the test.

Data collection during the test was accomplished with Stevens recorders (Wells No. 2, 3, and 4) and chalked, steel tape (Wells No. 1, 5 and the canal). At the start of the test each well, the flow measuring device, and the engine were manned. The start of the test was signaled at the pumped well just after static water levels were measured (all wells and canal). Simultaneously, stop watches were started at all wells. The pumping rate quickly stabilized at 1,600 gpm. Flow was measured by an 8-inch orifice plate attached to 10-inch pipe and piezometer.

Water levels in Wells No. 1 and 5 were measured using a chalked, steel tape at regular (logarithmic) intervals. Appendix C lists time-drawdown values obtained during the test. At Wells No. 2, 3, and 4, equipped with Stevens recorders, a different technique was used. Here, at time, t = 0, the recorder pen was lifted off the chart. The pen was subsequently dropped and lifted at t = 15, 30, 45, and 60 seconds. As the test proceeded, the pen was dropped at 1½, 2, 2½, 3, 4, etc., minutes for every minute until 10 minutes into the test. After marking 12, 15, and 17 minutes, the pen was dropped and raised every 5 minutes until 40 minutes into the test, at which time the pen was dropped and allowed to track a continuous record. At approximately 4 hours into the test, recorder charts were replaced and time scales changed to 24-hour, full scale. Figure 6-2 illustrates the type of data this method produces. During the initial portion of the test, when water levels are dropping (or recovering) rapidly, a single point at a known time is made. The drawdown can be accurately scaled from the 1:1 chart, and the method results in very accurate early time-drawdown/recovery data. Later in the test, as water levels change less rapidly, the pen can be dropped to produce a continuous record requiring only periodic checking rather than continuous staffing. For recovery, the reverse procedure is used, i.e., 24-hour recorder gears are replaced with 4-hour gears, and the pen dropping maneuver is employed at the cessation of pumping.

Throughout the test, recorders were checked at regular intervals and the water levels in the pumped well, Well No. 1, and the canal were measured. Also, flow rate from the pumped well was checked periodically. The withdrawal portion of the APT lasted approximately 48 hours, and recovery was tracked for 4 hours. Appendix C also includes time-recovery data from the pumped well and observation wells.

There are several pertinent observations that can be made regarding the APT based on a review of the continuous water level record at Well No. 3 (see Figure 6-2). These are as follows:

1. The initial segment of the water level record (just prior to the start of the test) traces a slow, steady decline. This decline represents the aquifer response to evapotranspiration. Although no rainfall occurred during the test, approximately 2 inches fell the previous week. Since the shallow aquifer in eastern Palm Beach County is recharged directly by rainfall, continuous water level records plot the rise of

the aquifer water levels after rainfall (and the decline when no rain falls).

Extending the pre-test water level decline to the end of the test results in the projection of a 0.5-foot decline in water level over 24 hours, using the same slope as the initial segment. This would be valid except that the water level decline is influenced by other factors including barometric pressure. Changes in barometric pressure cause a water level response in aquifers. Increases in pressure result in water level decline. The amount of water level decline attributed to barometric pressure changes can be estimated by comparing the static water level at the beginning and end of the test. Since the test was started and stopped at approximately the same time, it can be assumed that the daily barometric cycles were approximately equal at the beginning and end of the test. Then, comparing the static water levels at the beginning and end of the test, there is approximately a 0.25-foot difference in water level. Comparing this number to the projected slope of the plot on the initial segment suggests that half of the decline is therefore attributable to daily cyclic barometric pressure change and that the other half is attributable to aquifer response due to lack of rainfall.

.25 feet due to cyclic barometer variations seems excessive ??

No

2. At a point approximately 8 hours into the test, the piezometer attached to the orifice which was used to measure flow slipped down approximately 2 inches. This resulted in the appearance that the flow rate had increased by approximately 100 gpm and therefore the engine was throttled back. This error was quickly discovered and the piezometer and flow rate subsequently adjusted to the proper position. The result can be seen on the continuous water level plot. There is a slight recovery of the water level as the engine (and therefore pumping rate) was throttled back and a return to a steady-state drawdown condition as the situation was corrected.

Q variation

3. Approximately midway through the test, water levels began to stabilize and even recover slightly. This is due to the fact that at this point, the cone of depression had stabilized and discharge was balanced by recharge and inflow in the production zone. Therefore, the plot represents a "static" water level response although at a lower elevation (approximately 1 foot lower). During this time segment, the

Possibly delayed yield

water level decline due to evapotranspiration is balanced by the effects of cyclic barometer pressure changes. bs

4. The water level plot has two "peaks," one at the approximate midpoint of the graph, the other approximately 24 hours later. If a line is drawn connecting the crest of these two "peaks," the scope of that line has the same slope as the initial segment of the plot just prior to starting the test. Again this suggests that pumping has been balanced by recharge and inflow and that the plot represents aquifer "static" response.

5. At approximately 40 hours into the test, a water level decline was observed at all observation wells. After checking the flow rate, it was determined that another well must have been turned on. A thorough search of the area was made and a 6-inch irrigation well used to water grass and shrubs was located. The well was pumping at approximately 300 gpm and was located more than 3,000 feet from Well No. 5. This well caused approximately 0.12 foot of drawdown at Well No. 5. The irrigation well discharged for approximately 3 hours, after which water levels at the Forest Hill Village site recovered.

Addition well turned on for 3 hrs. 300 GPM

This drawdown-recovery due to the irrigation well affected all of the observation wells, and therefore all subsequent data plots of time vs. water level will depict this response. This can be seen clearly at the end of the data plots illustrated in this report.

Figure 2-2 illustrates the areal relationships among the pumped well, the four observation wells, and canals at the APT site. Figure 6-3 illustrates the vertical relationship of the wells and canal at the site.

DATA ANALYSIS

Time vs. water level data from the pumped well and observation wells were tabulated (Appendix C) and plotted on 3x5 cycle log/log and 5 cycle semi-log graph paper. Both time/drawdown and time/recovery data were plotted. In addition, distance/drawdown data at specific times were also plotted on 5 cycle semi-log graph paper.

Figure 6-4 illustrates the plot of drawdown versus distance from the pumped well at times of 100, 200, and 400 minutes after the start of the test.

Only the observation wells were plotted at this scale and aquifer transmissivity was calculated using the non-equilibrium formula developed by Jacob. Transmissivity was determined using Equation No. 1:

$$T = \frac{528\ Q}{\Delta s} \qquad (1)$$

where

T = Transmissivity (gpd/ft)

Q = Pumping rate (gpm)

Δs = Slope of the distance-drawdown graph expressed as the change in drawdown per log cycle (ft)

Jacob Analysis

From Figure 6-4, transmissivity was calculated as follows:

$$T = \frac{528\ (1,600\ gpm)}{0.79\ ft}$$

T = 1,070,000 gpd/ft or ~~227,270 ft²/day~~ 143,048 ft²/day

143,048 ft²/day

Therefore, from the slope of the distance-drawdown graph, transmissivity is calculated to be ~~227,270 ft²~~/day. 143,040 ft²/day

In reviewing the distance-drawdown plots on Figure 6-4 two major facts should be noted: first, drawdown at Well No. 4 was considerably less than would be expected based on the plotted curves using Wells No. 1, 2, and 3. This could be due to its proximity to the canal (~50 feet) and distance from the pumping well (600 feet). However, it is more likely a function of well construction. Recalling Figure 5-4, Well No. 4 apparently has no screen and what appears to be 1 or 2 feet of open hole. This results in a very poor, inefficient hydraulic connection to the aquifer which in turn results in a poor transmission of aquifer water level change to the well. Due to this fact, distance and time drawdown data obtained from Well No. 4 were not used to formulate conclusions regarding aquifer characteristics.

The second observation made from review of Figure 6-4 is that distance from the canals, a line source of recharge, was found to have no greater effect on those wells in close proximity than on those located farther away. Wells No. 2 and 3 were parallel to Canal E-3 but perpendicular to Canal No. 8 (see Figure 2-2). Well No. 1 was located the furthest from either canal.

Since the hydraulic gradient observed from drawdown measurements made at Wells No. 1, 2, and 3 were approximately equal in all directions, time versus drawdown plots were prepared for the pumped well and observation wells (including Well No. 4). Data were plotted on both log/log and semi-log graph paper and used to calculate aquifer characteristics using two different methods.

Semi-log graphical plots were used to calculate transmissivity and aquifer storage using non-equilibrium equations derived by Jacob. Equation No. 2 was used to calculate transmissivity and Equation No. 3 was used to calculate storage, as follows:

$$T = \frac{264\ Q}{\Delta s} \qquad (2)$$

where

T = Transmissivity (gpd/ft)

Q = Pumping rate (gpm)

Δs = Slope of the distance-drawdown graph expressed as the change in drawdown per log cycle (ft)

Jacob Analysis

and

$$S = \frac{0.3\ T\ t_o}{r^2} \qquad (3)$$

where

S = Storage coefficient (dimensionless)

T = Transmissivity (gpd/ft)

t_o = Intercept of the straight line at zero drawdown (days)

r = Distance from pumped well to the observation well where drawdown measurements were made (ft)

Log/log plots were used to calculate aquifer characteristics using graphical methods described by Hantush, Jacob, and others. Equation 4 was used to calculate transmissivity, Hantush-Jacob (see Lohman 1972 plate 3A) assume semi-conf.

Equation 5 to calculate storage, and Equation 6 to calculate leakance, as follows:

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

where

T = Transmissivity (ft^2/day)

Q = Pumping rate (gpm)

s = Drawdown at match point (ft)

L(u,v) = Leakance function of u,v; values obtained from match point on the type curve (dimensionless)

and

$$S = 4T \frac{t/r^2}{1/u} \qquad (5)$$

where

S = Storage coefficient (dimensionless)

T = Transmissivity (ft^2/day)

t = Time from match point (days)

r = Distance from pumped well to the observation well where drawdown measurements were made (feet)

1/u = Values obtained from match point on the type curve (dimensionless)

and

$$k'/b' = 4T \frac{v^2}{r^2} \qquad (6)$$

where

k'/b' = Leakance (day^{-1})

T = Transmissivity (ft^2/day)

v = Values obtained from curve matrix to type curve (dimensionless)

r = Distance from pumped well to the observation well where drawdown measurements were made (feet)

Figure 6-5 illustrates the time-drawdown plot from data collected at the pumped well (No. 5). Although the pumped well data is not the most appropriate application for the above formulas, transmissivity can be calculated using Equation No. 1. From this plot, there appear to be two distinct trends to the points plotted. A best-fit line has been drawn approximating the trend of both sets of points and the slope per log cycle measured. The general shape of the data points and the best-fit lines seems to indicate that a recharge boundary has been reached by the expanding cone of depression. This data plot, or at least the best-fit lines through the points, resemble a typical recharge boundary condition. That is, during the early time (0 to 12 minutes) water is derived from the production zone only, and the slope of this portion of the curve reflects aquifer hydraulic characteristics accurately. After approximately 12 minutes, the cone of depression created by the pumping well begins to become distorted, expanding at a much slower rate due to recharge. This recharge, either from a line source (canal) or from induced infiltration, results in the drawdown being less than it would otherwise be and thus the later time sections of the curve have a much flatter slope than the earlier segments. Since the later time segment does not accurately reflect aquifer hydraulic conditions alone, only the early time segment can be used to determine aquifer characteristics. Table 6-1 lists aquifer characteristics calculated from the data plot of time/drawdown for Well No. 5 (Figure 6-5).

Figure 6-6 illustrates the time/drawdown plot from data collected at Well No. 2. Again, aquifer characteristics were calculated using Equation 1. The storage coefficient can also be calculated from observation well data, whereas it cannot be calculated from pumped well data. Equation 2 was used to determine storage, and the results are listed in Table 6-1.

Figure 6-7 illustrates the time/recovery plot for Well No. 2. In comparing the two curves, the time/drawdown curve again results in a change in slope at approximately 12 minutes into the test, indicating a recharge boundary condition. The time/recovery curve appears to be a smooth plot, with the best-fit line having the same slope throughout.

Figure 6-8 illustrates the time/drawdown data plotted on a log/log scale water level response collected at Well No. 2. These data, when matched to the type curves developed by

Table 6-1
SUMMARY OF AQUIFER CHARACTERISTICS

Pumped Well No.	Observation Well No.	Distance[a] (ft)	ΔS/Log Cycle[b]	t_o[c] (days)	Match Point Values[d] s, t, 1/u, L(u,v), v	Method	Transmissivity ft^2/day	Storage	Leakance day^{-1}
5	5	0.6	$\Delta s_1 = 0.75$ $\Delta s_2 = 0.33$	--	--	Jacob, DD	75,300 171,100	--	--
5	1	372	$\Delta s_1 = 0.24$ $\Delta s_2 = 0.10$	5×10^{-6}	--	Jacob, DD	235,300 564,700	2×10^{-5}	--
5	1	372	--	--	1.9, 12, 10, 10, 0.8	→ Jacob-Hantush, DD	129,000	3×10^{-3}	2.3×10[illegible]
5	1	372	$\Delta s' = 0.22$	9.7×10^{-6}	--	Jacob, Recov	265,700	6×10^{-6}	--
5	1	372	--	--	1.0, 0.16, 10, 10, 0.02	Jacob-Hantush, Recov	245,100	7.9×10^{-5}	2.8×10^{-3}
5	2	300	$\Delta s_1 = 0.30$ $\Delta s_2 = 0.16$	3.3×10^{-5}	--	Jacob, DD	188,200 352,900	2×10^{-4}	--
5	2	300	--	--	1.5, 0.43, 10, 10, 0.02	→ Jacob-Hantush, DD	163,400	2×10^{-4}	3×10^{-3}
5	2	300	$\Delta s' = 0.2$	2.0×10^{-6}	--	Jacob, Recov	282,400	1×10^{-5}	--
5	2	300	--	--	1.04, 0.44, 100, 10, 0.005	Jacob-Hantush, Recov	176,300	2.4×10^{-5}	--
5	3	300	$\Delta s'_1 = 0.27$ $\Delta s'_2 = 0.18$	1×10^{-4}	--	Jacob, DD	209,200 313,700	5×10^{-5}	--
5	3	570	--	--	1.05,0.70, 10, 10, 0.02	→ Jacob-Hantush, DD	174,600	1×10^{-4}	9×10^{-4}
5	3	570	$\Delta s'_1 = 0.22$ $\Delta s'_2 = 0.18$	4×10^{-5}	--	Jacob, DD	256,700 313,700	7×10^{-5}	--
5	3	570	--	--	1.2, 0.70, 10, 10, 0.02	Jacob-Hantush, Recov	152,800	9×10^{-5}	9×10^{-4}
5	4	600	$\Delta s_1 = 0.22$ $\Delta s_2 = 0.13$	4×10^{-4}	--	Jacob, DD	256,700 434,400	6×10^{-4}	--
5	4	600	--	--	0.13, 0.33, 1, 1, 0.05	→ Jacob-Hantush, DD	188,600	5×10^{-4}	5×10^{-3}

[a]Distance from pumped well to the observation well where drawdown measurements were made.

[b]Slope of the time-drawdown graph expressed as change in drawdown per log cycle.

[c]Intercept of the straight line at zero drawdown.

[d]Values obtained from matching the log/log time/drawdown-recovery data to the type curve.

Hantush-Jacob has best assumptions.

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Cooper, were used to calculate aquifer characteristics using Equations 3, 4, and 5.

Similarly, time/recovery data were also plotted on a log/log scale and matched to the type curve; aquifer characteristics were then calculated (see Figure 6-9). Table 6-1 lists the results of these calculations.

Using this methodology, aquifer characteristics were determined based on data collected from all the observation wells used during the APT. Data plots for Wells No. 1, 3, and 4 are included in Appendix D.

Table 6-1 summarizes the results of these time/drawdown recovery calculations.

Aquifer characteristics determined from time/drawdown-recovery calculations were averaged, resulting in the following approximation:

$$T = 215{,}000 \text{ ft}^2/\text{day}$$

$$S = 1.5 \times 10^{-4}$$

$$k'/b' = 2 \times 10^{-3} \text{ day}^{-1}$$

Values obtained from distance/drawdown plots were:

$$T = 143{,}000 \text{ ft}^2/\text{day}$$

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

The results using the average values calculated from time/drawdown recovery rate do not compare well with distance/drawdown values.

Comparing the average values for transmissivity for each observation well regardless of the method used results in the following:

$$T_{ave} \text{ @ Well No. 1} = 218{,}775 \text{ ft}^2/\text{day}$$

$$T_{ave} \text{ @ Well No. 2} = 202{,}575 \text{ ft}^2/\text{day}$$

$$T_{ave} \text{ @ Well No. 3} = 198{,}325 \text{ ft}^2/\text{day}$$

Comparing the average values for transmissivity for each observation well for both log/log and semi-log methods results in the following:

T_{ave} @ Well No. 1 = 250,500 ft²/day (semi-log)

T_{ave} @ Well No. 1 = 245,100 ft²/day (log/log)

T_{ave} @ Well No. 2 = 235,400 ft²/day (semi-log)

T_{ave} @ Well No. 2 = 169,850 ft²/day (log/log)

T_{ave} @ Well No. 3 = 232,950 ft²/day (semi-log)

T_{ave} @ Well No. 3 = 163,700 ft²/day (log/log)

Some observations can be made from these comparisons. In general, a higher transmissivity is obtained using the semi-log data plots and Jacob non-equilibrium equations. Also, there appears to be little difference in transmissivity when calculated from data taken at Wells No. 2 and 3. Distance versus drawdown calculated transmissivity (143,000 ft²/day) appears to compare well to the log/log calculated values from data at Wells No. 2 and 3 (average = 166,800 ft²/day).

Comparing time-drawdown to distance-drawdown observations, it appears that the transmissivity obtained from the average value of log/log data plots is a reasonably good approximation. However, the storage coefficient determination using this method is not accurate because of the effects of recharge. Walton describes a procedure for calculating the effect of a recharge boundary groundwater withdrawal. Walton's method assumes that no drawdown occurs along an effective line of recharge. Under this boundary condition, water levels will drawdown at an initial rate under the influence of the pumping well only. When the recharge boundary begins to affect the production well, the time rate of drawdown will change, continually decreasing until equilibrium is reached. The APT site is bounded by two partially penetrating recharge boundaries, and therefore Walton's method may be somewhat inappropriate for this site. To apply this method to the Forest Hill Village site, these two partially penetrating recharge boundaries (Canal E-3 and 8 are approximately 6 feet deep) are theoretically replaced by one single, fully penetrating boundary which would produce the same effect on the site.

Applying Walton's method, a determination of storage coefficient can be made and the results checked by trial and error against actual data. For this analysis, observed drawdown (stabilized) data for Wells No. 1, 2, and 3 were substituted into Equation No. 7 to calculate a value for the distance (a) from the pumped well to the effective recharge boundary as follows:

$$s = \frac{528\ Q\ \text{Log}\ \frac{\sqrt{4a^2 + r^2}}{r}}{T} \qquad (7)$$

where

a = Distance to effective recharge boundary (ft)

r = Distance from observation well to pumped well (ft)

Q = Pumping rate (gpm)

T = Transmissivity (gpd/ft)

The results of these calculations were as follows:

Well No.	Distance (ft)	Drawdown (ft)	a (ft)
1	372	1.14	8,975
2	300	1.21	9,184
3	570	0.96	7,453
		Average a =	8,537

Once a value is known for the distance to the effective recharge boundary (a), the storage coefficient can be determined by substitution using Equations No. 8, 9, 10, 11, and 12.

$$s_r = s - s_i = \frac{114.6\ Q}{T}\ [W(u) - W(u_i)] \qquad (8)$$

where

$$u = \frac{1.87\ r^2\ S}{Tt} \qquad (9)$$

and

$$u_i = \frac{1.87\ ri^2\ S}{Tt} \qquad (10)$$

and

$$W(u) = -0.5772 - \ln u \tag{11}$$

and

$$W(u_i) = -0.5772 - \ln u_i \tag{12}$$

where

S_r = Drawdown in observation well (ft)

s = Drawdown due to pumped well (ft)

S_i = Build-up to image well (ft)

Q = Pumping rate (gpm)

T = Transmissivity (gpd/ft)

S = Storage coefficient

r = Distance from observation well to pumped well (ft)

r_i = Distance from observation well to image well (ft)

Using this method, a storage coefficient of 1×10^{-3} was calculated using Wells 1, 2, and 3 (see Table 6-2).

Once aquifer characteristics are known, the percentage of water being diverted from a source of recharge can be calculated using Equation No. 13 together with Figure 6-10 as follows:

$$F_f = \frac{1.87\ a^2\ S}{Tt} \tag{13}$$

where

a = Distance to effective recharge boundary (ft)

S = Storage coefficient

T = Transmissivity (gpd/ft)

t = Time (days)

Table 6-2
SUMMARY OF STORAGE COEFFICIENT DETERMINATIONS

Well No.	r (ft)	u	ui	w(u)	w(ui)	Drawdown (Calculated) (ft)	Drawdown (Actual) (ft)
1	370	7.4×10^{-4}	1.5	6.62	0.10	0.96	0.95
2	300	4.85×10^{-4}	1.5	7.08	0.10	1.02	1.00
3	570	1.75×10^{-3}	1.5	5.783	0.10	0.83	0.78

Note: r_i = 17,074 feet

$S = 1 \times 10^{-3}$

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therefore

$$F_f = \frac{1.87\ (8{,}537)^2\ 1 \times 10^{-3}}{1{,}247{,}664\ (0.278)}$$

$$= 0.39$$

From Figure 6-10:

$$P_r = 40\%$$

where

P_r = % of water diverted from a source of recharge

The sources of recharge are induced infiltration from the overlying permeable sediments and leakance from the canal. Since the canal is not fully penetrating, it recharges the upper water table, which in turn recharges the production zone.

No attempt was made to rigorously determine the actual amount of recharge contributed by the canal. In other parts of the County where transmissivity of the Anastasia Formation is much lower, a pumping well (or well field) will cause a greater head differential between the canal and the producing zone than was experienced at the Forest Hill Village site. The head differential caused by the pumping well (Well No. 5) during the APT at the closest canal was less than 1 foot (see Figure 6-11). The reason for this is that the producing zone at this site has much higher transmissivity than is common for the Anastasia Formation.

A very rough approximation can be made regarding how much water is obtained from canal recharge at the Forest Hill Village. If we assume a very simple model, the site can be replaced by a square having a discharge point at the center to simulate the well field center of pumping. The square is bounded on two adjacent sides by a line source of recharge (LWDD canals 8 and E-3) which are considered fully penetrating for this discussion. Then, if 40 percent of the water produced at the center comes from a recharge source, approximately half would come from the canal. Since the model described above does not exactly fit conditions at the site, a reasonable assumption as to amount of water recharged by both canals is 15 to 25 percent.

Having established a value for aquifer transmissivity, storage, and leakance, a series of theoretical distance-drawdown curves were constructed using steady-state leaky artesian formulas. Figure 6-11 illustrates this series of curves for various pumping rates including the rate used during the APT.

Values used to calculate theoretical distance-drawdown curves were:

$$T = 166,800 \text{ ft}^2/\text{day}$$

$$S = 1 \times 10^{-3}$$

$$k'/b' = 2 \times 10^{-3}\text{day}^{-1}$$

Theoretical curves, if based on appropriate aquifer characteristics, should predict aquifer response to pumping. A comparison of theoretical versus actual distance-drawdown relationships was made to determine if the aquifer characteristics arrived at were reasonable. Figure 6-12 illustrates the plot of the actual, stabilized distance-drawdown relationship observed during the APT (the solid line). The theoretical distance-drawdown curve (the dashed line), calculated from the steady-state leaky artesian formula at 1,600 gpm, plots almost directly over the actual curve constructed after 48 hours of pumping.

It appears, therefore, that the aquifer characteristics established for the Forest Hill Village site are reasonable and that theoretical curves can be used to predict aquifer response to pumping. Having developed these curves, it is now possible to design a well field for the site. Had wells not already been constructed on the site, the design would focus on well spacing (location) and withdrawal rates which would efficiently develop groundwater within the site boundaries. However, since production wells have already been located, well field design efforts will be directed toward the establishment of withdrawal rates for the wells.

In selecting the pumping rate for a particular well, several factors must be considered, including:

- Aquifer characteristics
- Available drawdown
- Casing size
- Screen conditions
- Proximity to recharge boundary
- Well efficiency/specific capacity
- Need for water

Aquifer characteristics determine the interference effects among wells in the well field, which in turn affect well spacing. Since well spacing has already been established, interference effects can be mitigated only by adjustments to the individual well pumping rate.

Available drawdown limits the water level to which individual wells can be reduced by pumping. In screened wells, the maximum design pumping level including interference effects is 10 to 15 feet above the top of the screen.

Casing size limits the size pump which can be installed in a particular well, which therefore limits the pumping rate.

Screen condition, which depends primarily upon the age, type, and installation method, may limit the rate of withdrawal. The higher the pumping rate, the higher the likelihood that the well will pump sand if the screen is in poor condition, improperly designed, etc.

Proximity to a recharge boundary might result in a well being rated higher than wells remote from the boundary, because induced recharge from a recharge source would reduce the effects of pumping.

Well efficiency/specific capacity, which is a measure of individual well performance, is a function of construction and development rather than aquifer characteristics. Therefore, a well having a low efficiency and/or specific capacity would be rated lower than perhaps might be possible given the aquifer characteristics.

Finally, after considering all of the above factors, the actual water needed from a particular site must be considered.

As discussed above, aquifer characteristics determined for this site are:

Transmissivity	=	166,800 ft^2/day
Storage	=	1×10^{-3}
Leakance	=	2×10^{-3} day^{-1}

Again referring to the theoretical distance-drawdown curves constructed on the basis of aquifer characteristics (Figure 6-11), interference effects can be determined for various pumping rates. Recalling that well spacing has already been established, the determination of recommended withdrawal rates then becomes an iterative process of assigning pumping rates to each well and evaluating interference effects using the theoretical distance-drawdown curves. As an example, if Well No. 5 is assigned a rate of 1,600 gpm, then theoretically (from Figure 6-11) the drawdown at that well would be approximately 2-1/2 feet, assuming that no other wells were in use and that Well No. 5 were 100 percent efficient.

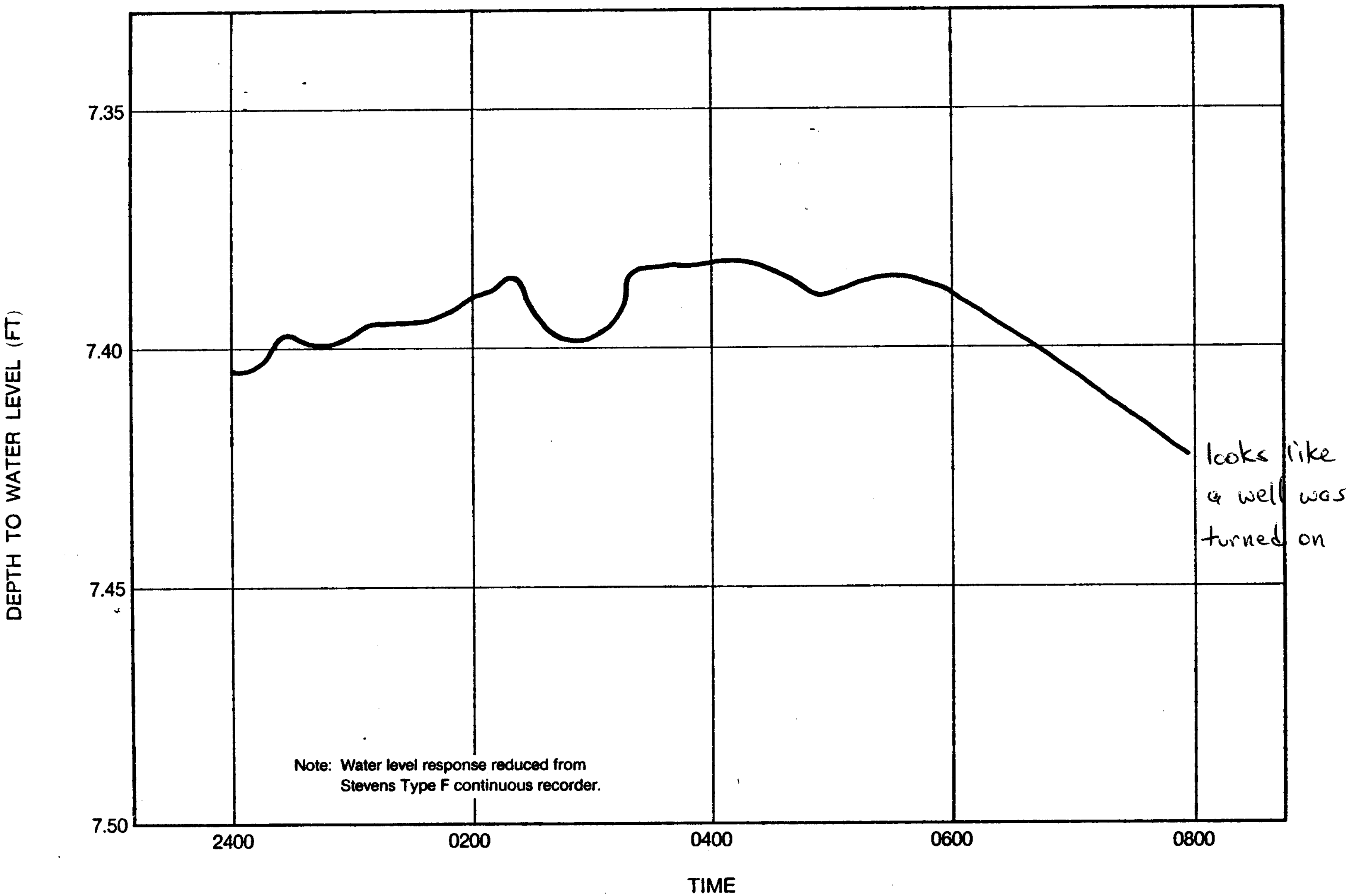

FIGURE 6-1.
Background Water Level Response at Well No. 2 (4/12/83).

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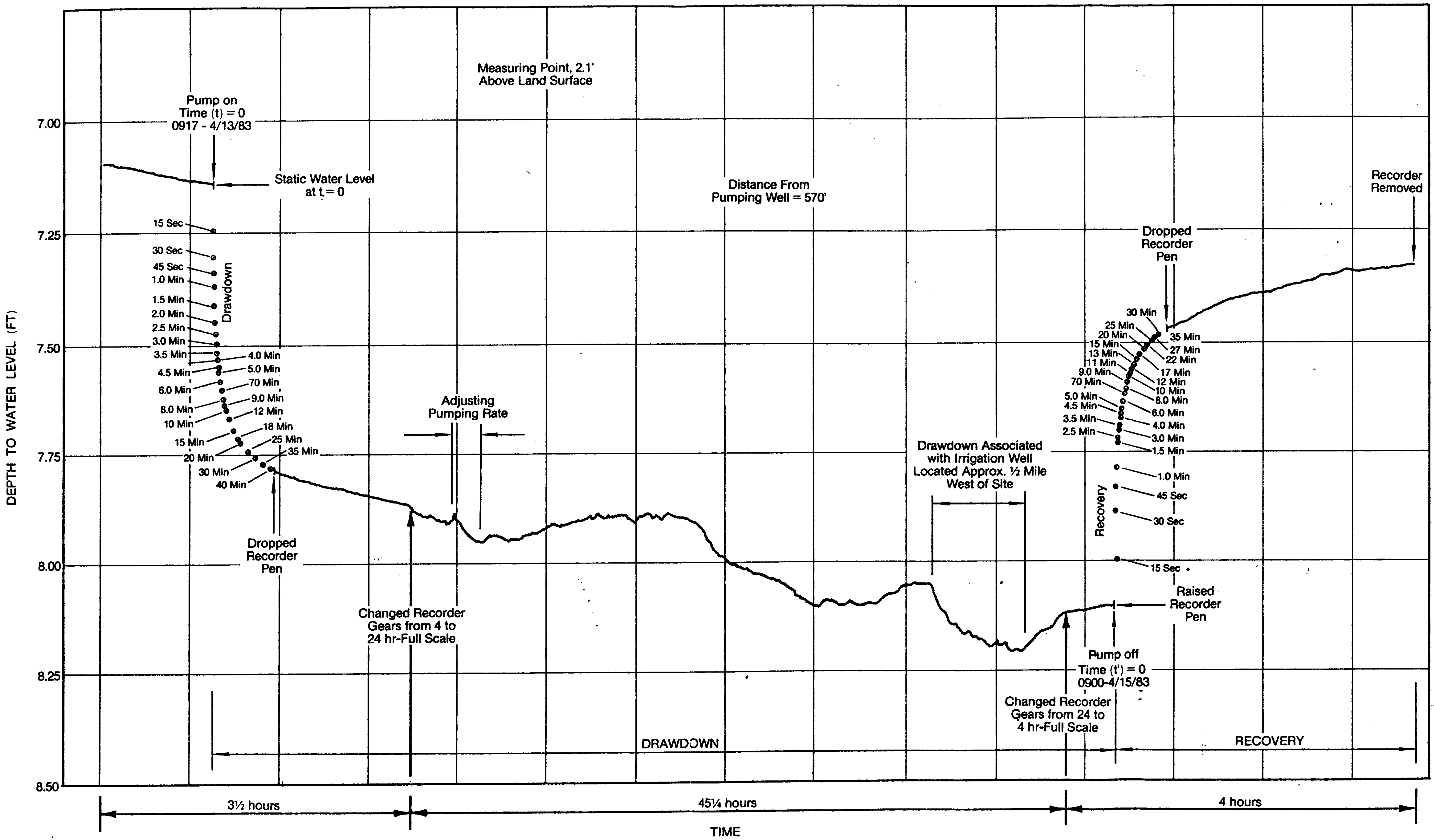

Note: This illustration was copied from a photographic reduction of the Stevens Recorder Charts used during the test.

FIGURE 6-2.
Typical Water Level Record from Observation Well (Well No. 3).

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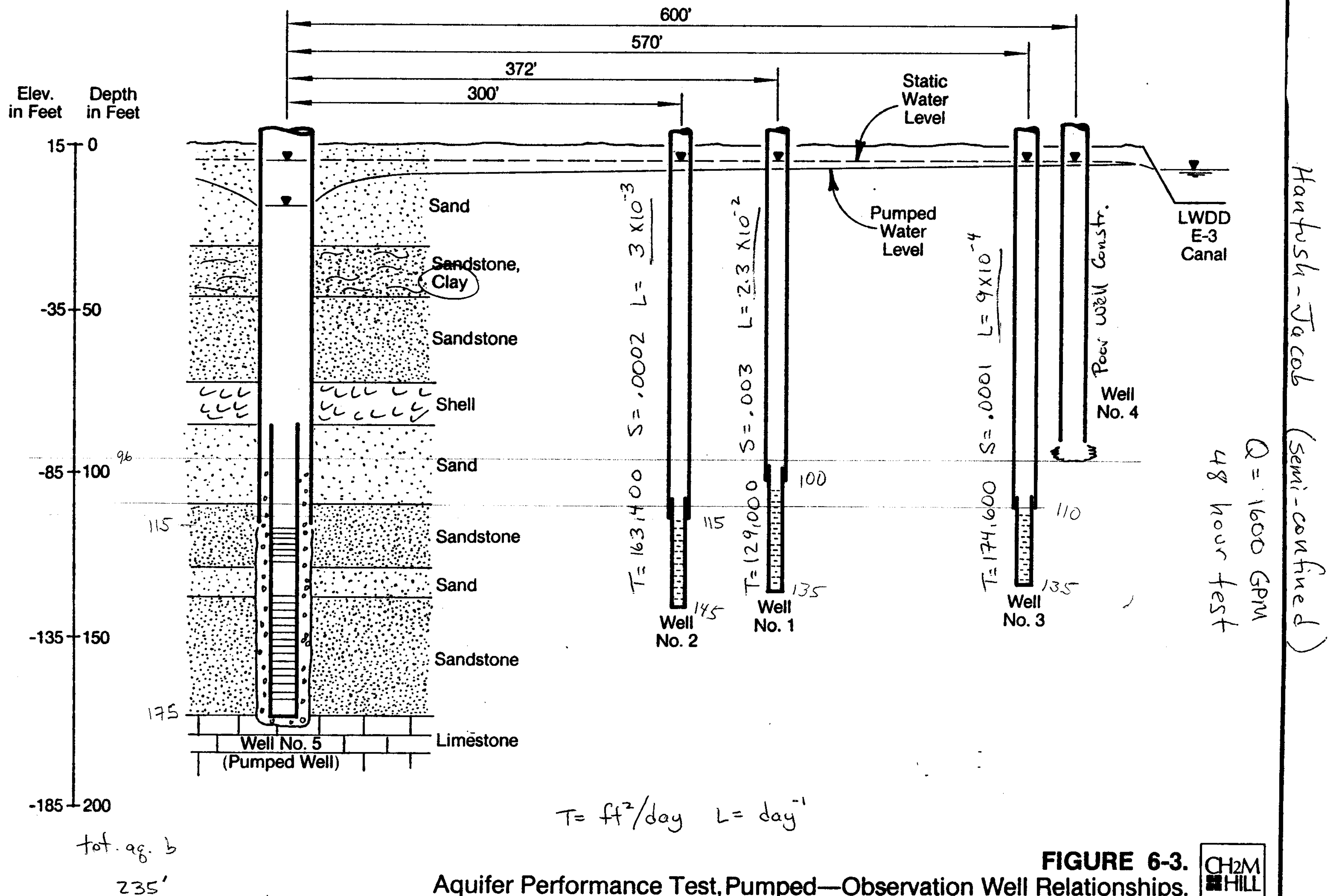

FIGURE 6-3.
Aquifer Performance Test, Pumped—Observation Well Relationships.

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Well No.	Distance (ft)	Drawdown @ 100 Min. (ft)	Drawdown @ 200 Min. (ft)	Drawdown @ 400 Min. (ft)
1	372	0.83	0.92	0.93
2	300	0.90	0.95	1.00
3	570	0.68	0.75	0.78
4	600	0.46	0.50	0.54

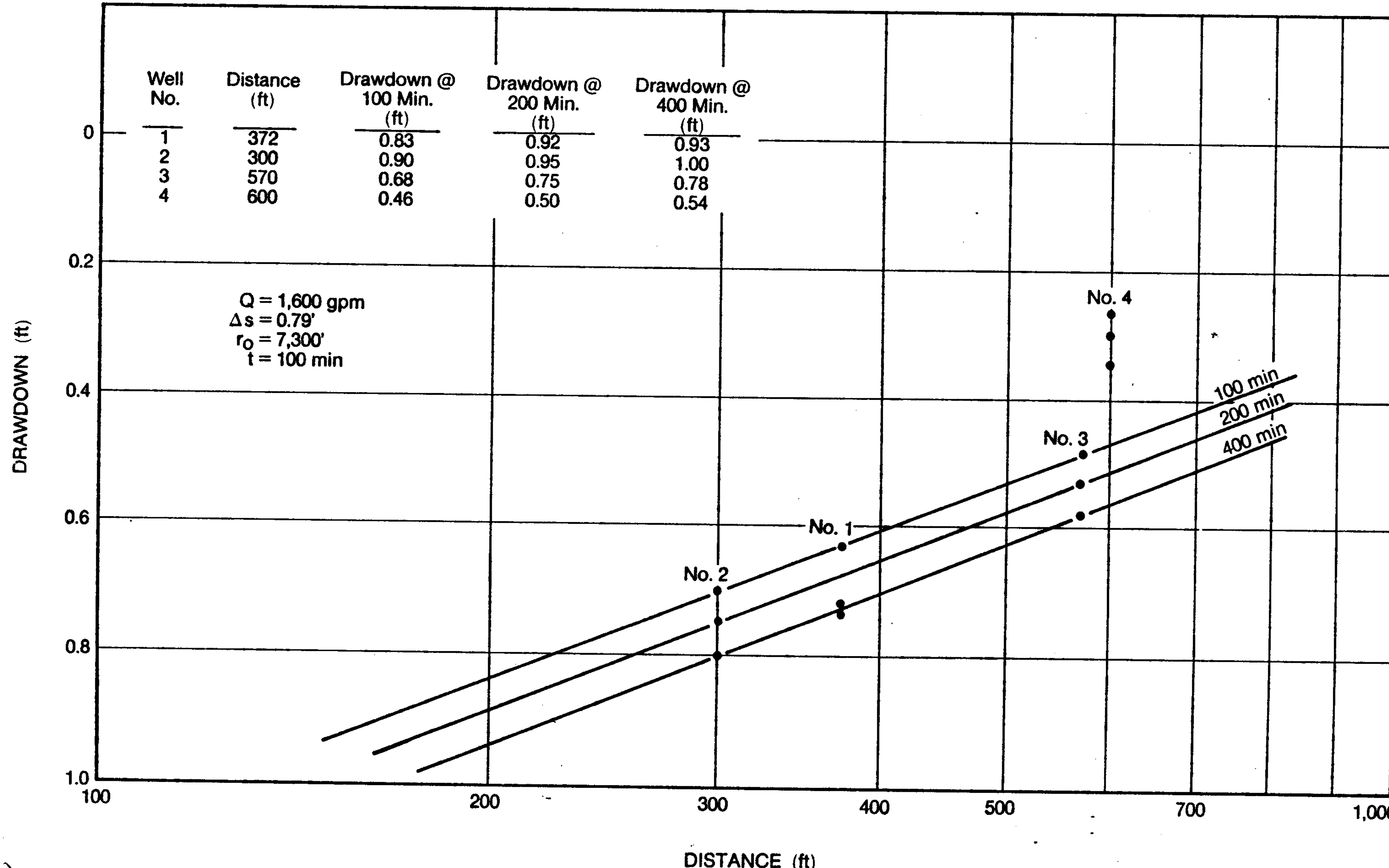

FIGURE 6-4.
Distance-Drawdown Graphs.

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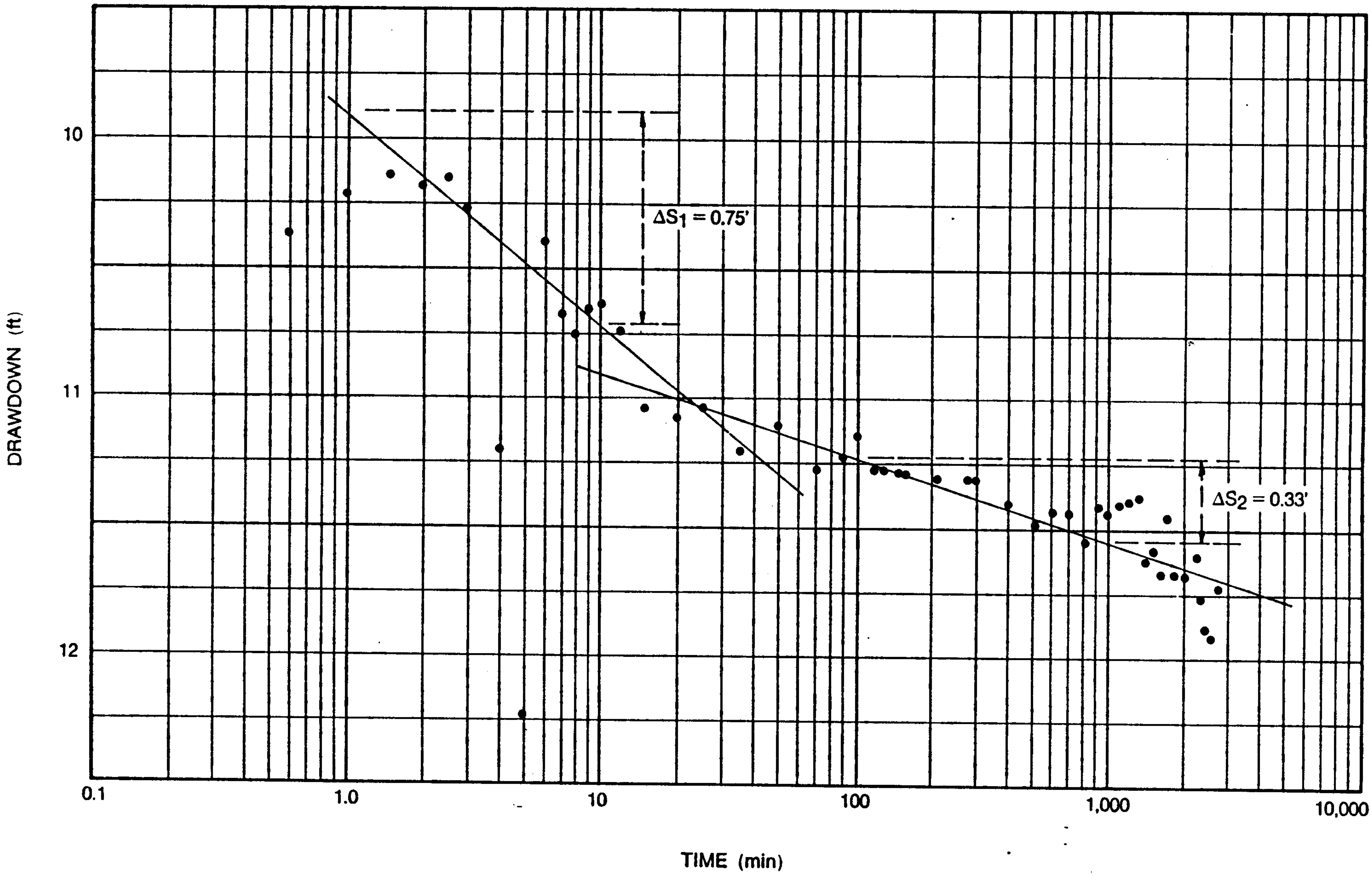

FIGURE 6-5.
Drawdown at the Pumped Well, Well No. 5.

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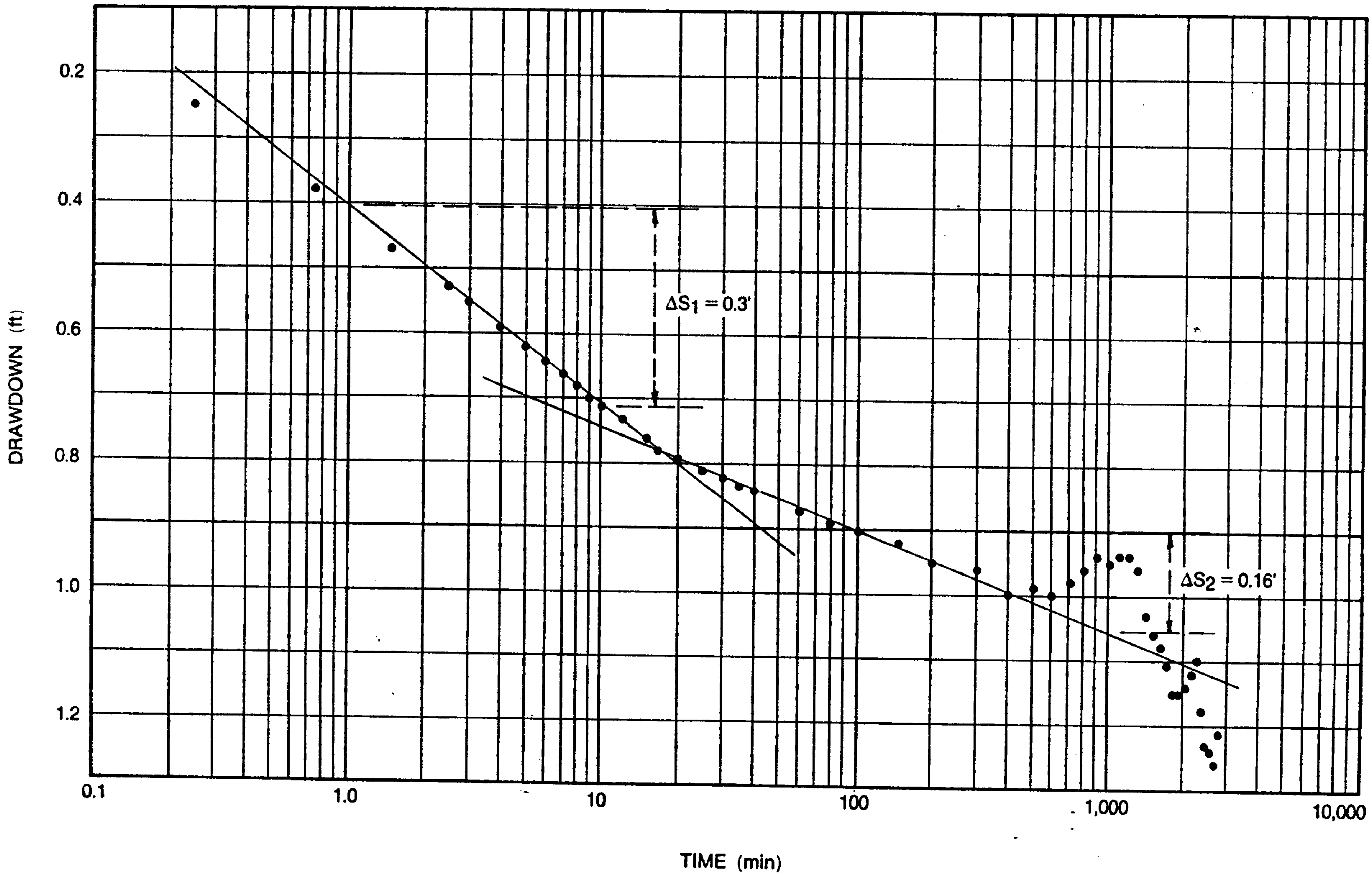

FIGURE 6-6.
Pumping Test at Well No. 5, Drawdown at Well No. 2.

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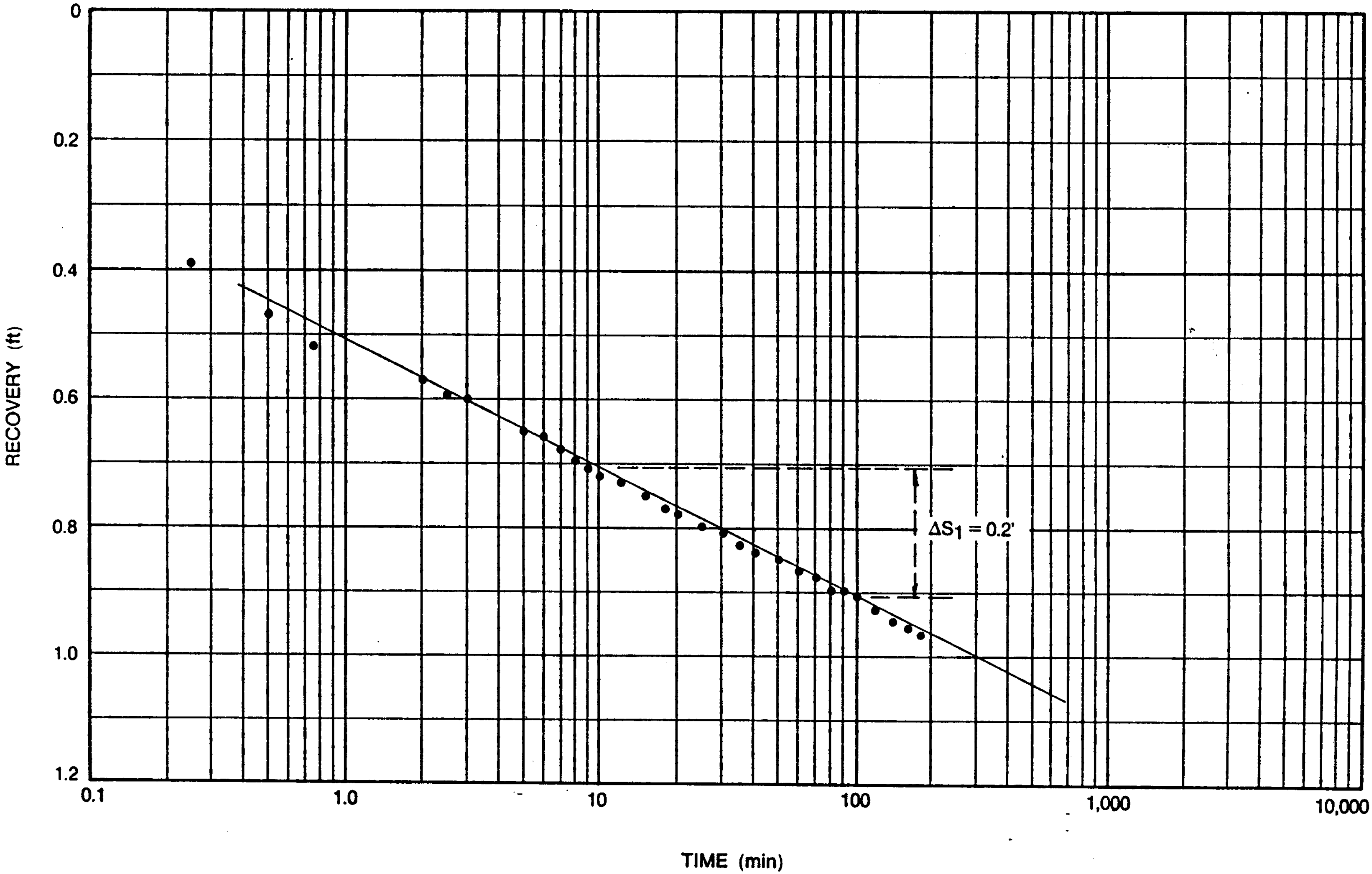

FIGURE 6-7.
Pumping Test at Well No. 5, Recovery at Well No. 2.

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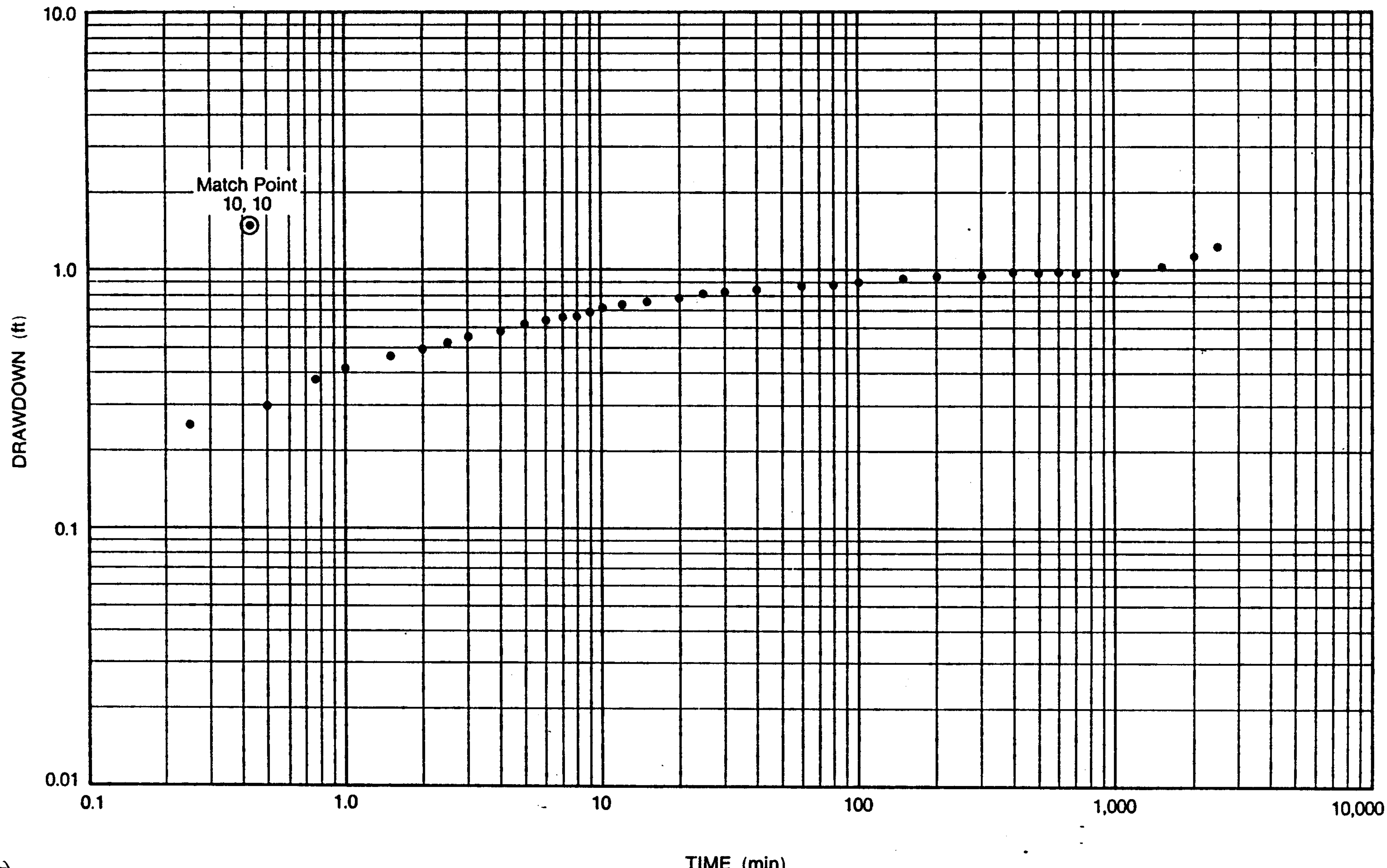

FIGURE 6-8.
Pumping Test at Well No. 5, Drawdown at Well No. 2.

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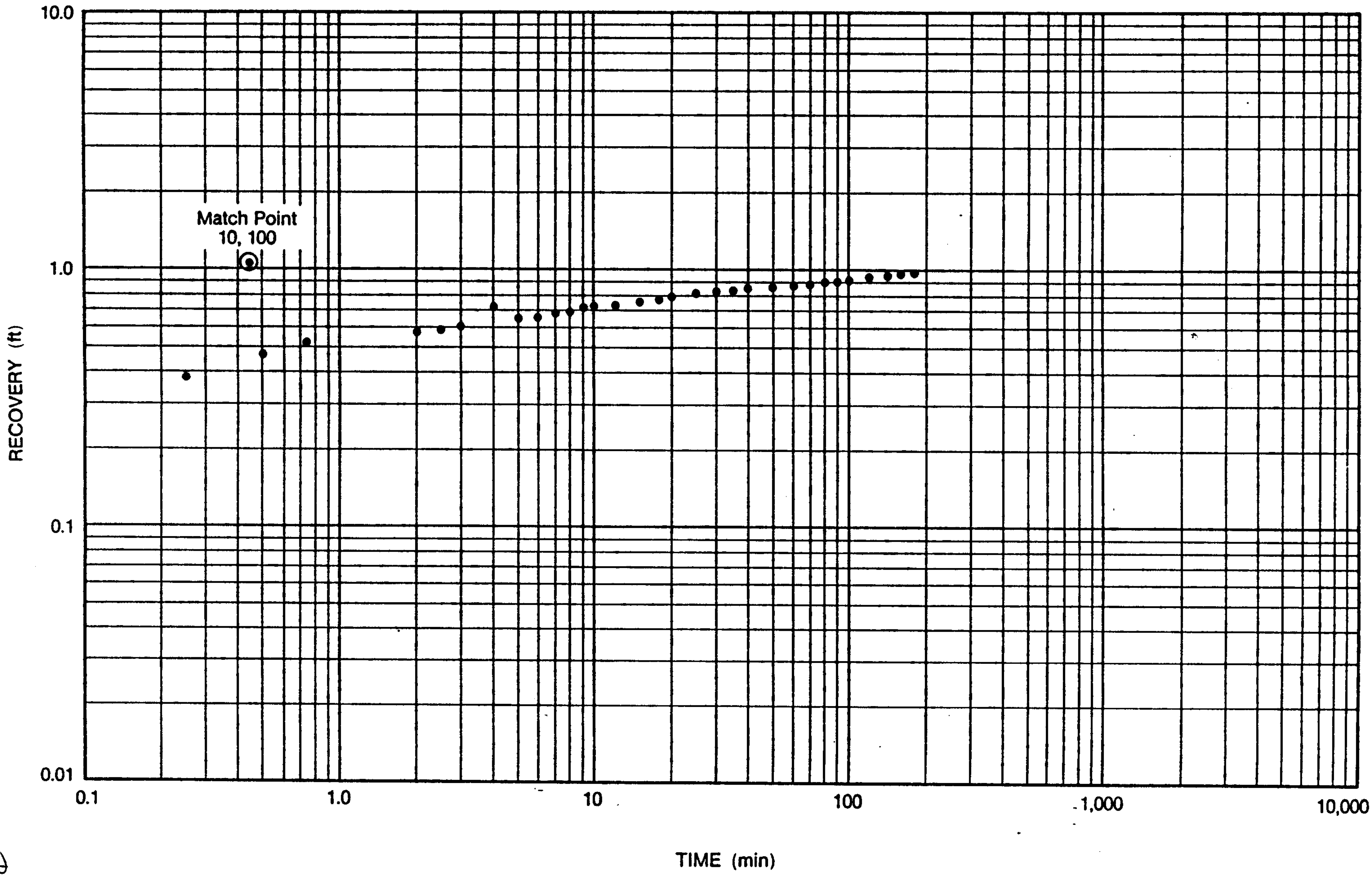

FIGURE 6-9.
Pumping Test at Well No. 5, Recovery at Well No. 2.

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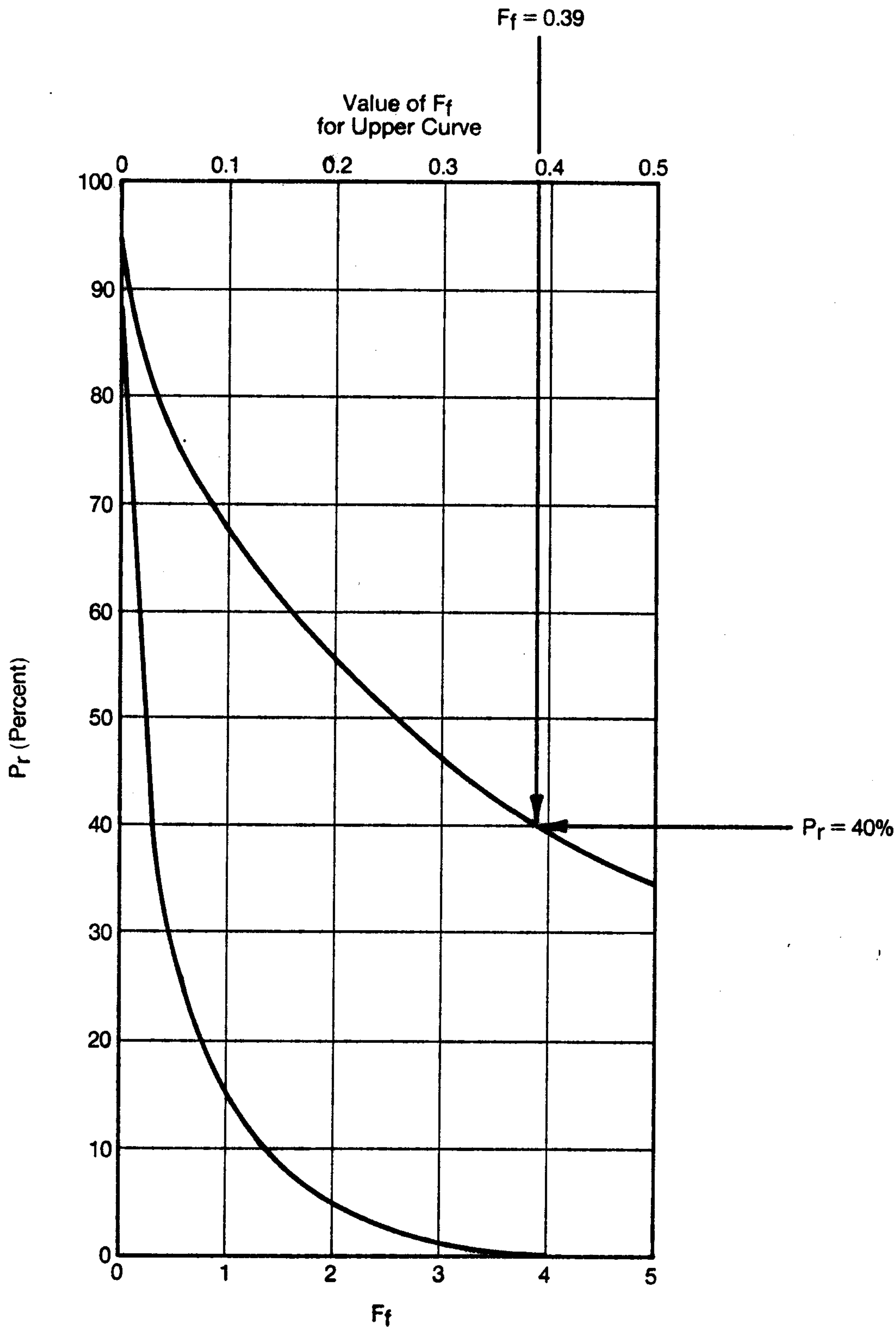

Note: Graph for determination of percentage of pumped water being diverted from a source of recharge. (From Theis, 1941.)

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FIGURE 6-10.
Percentage of Pumped Water Derived from Recharge.

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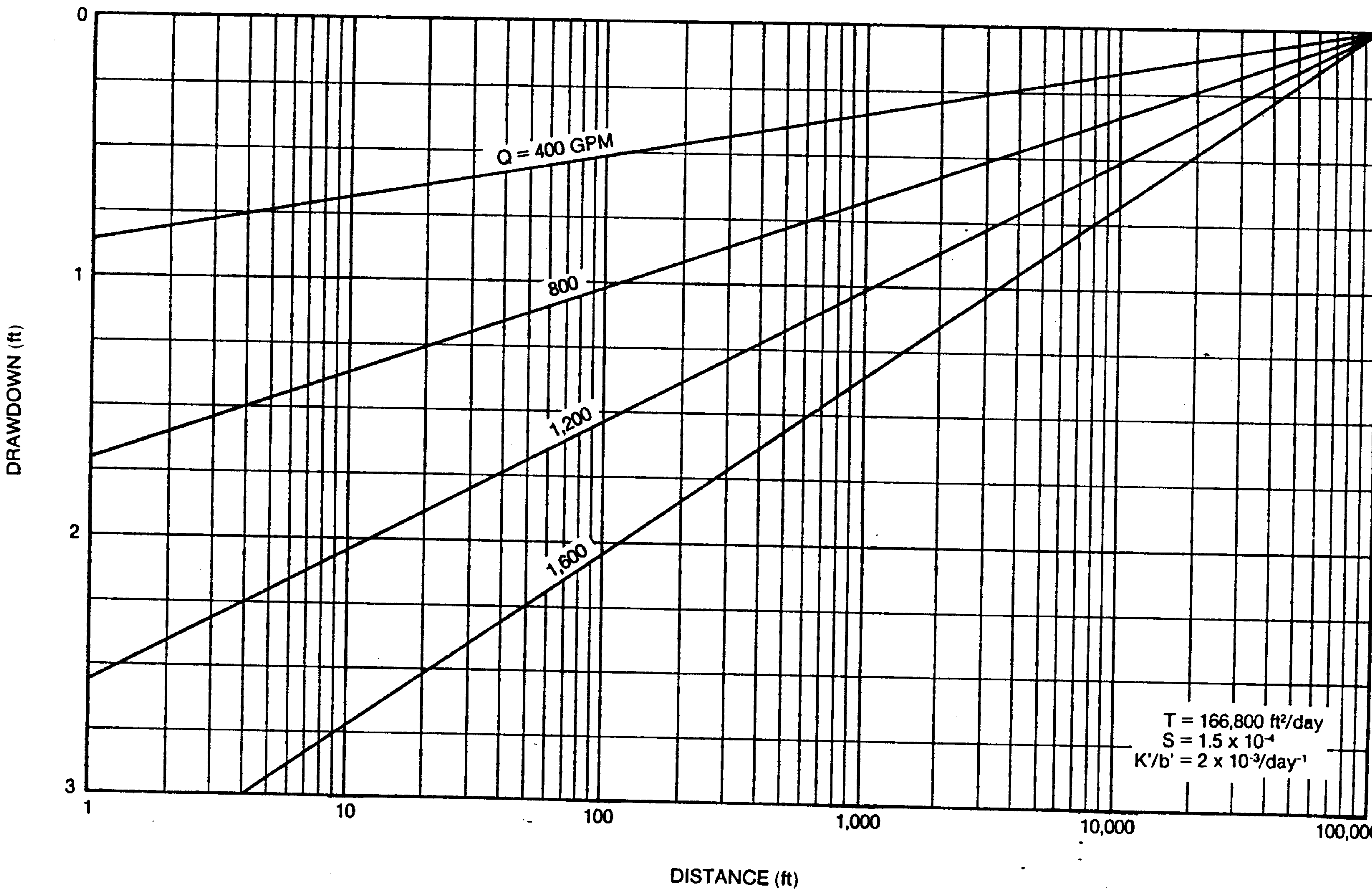

FIGURE 6-11.
Theoretical Distance-Drawdown Curves.

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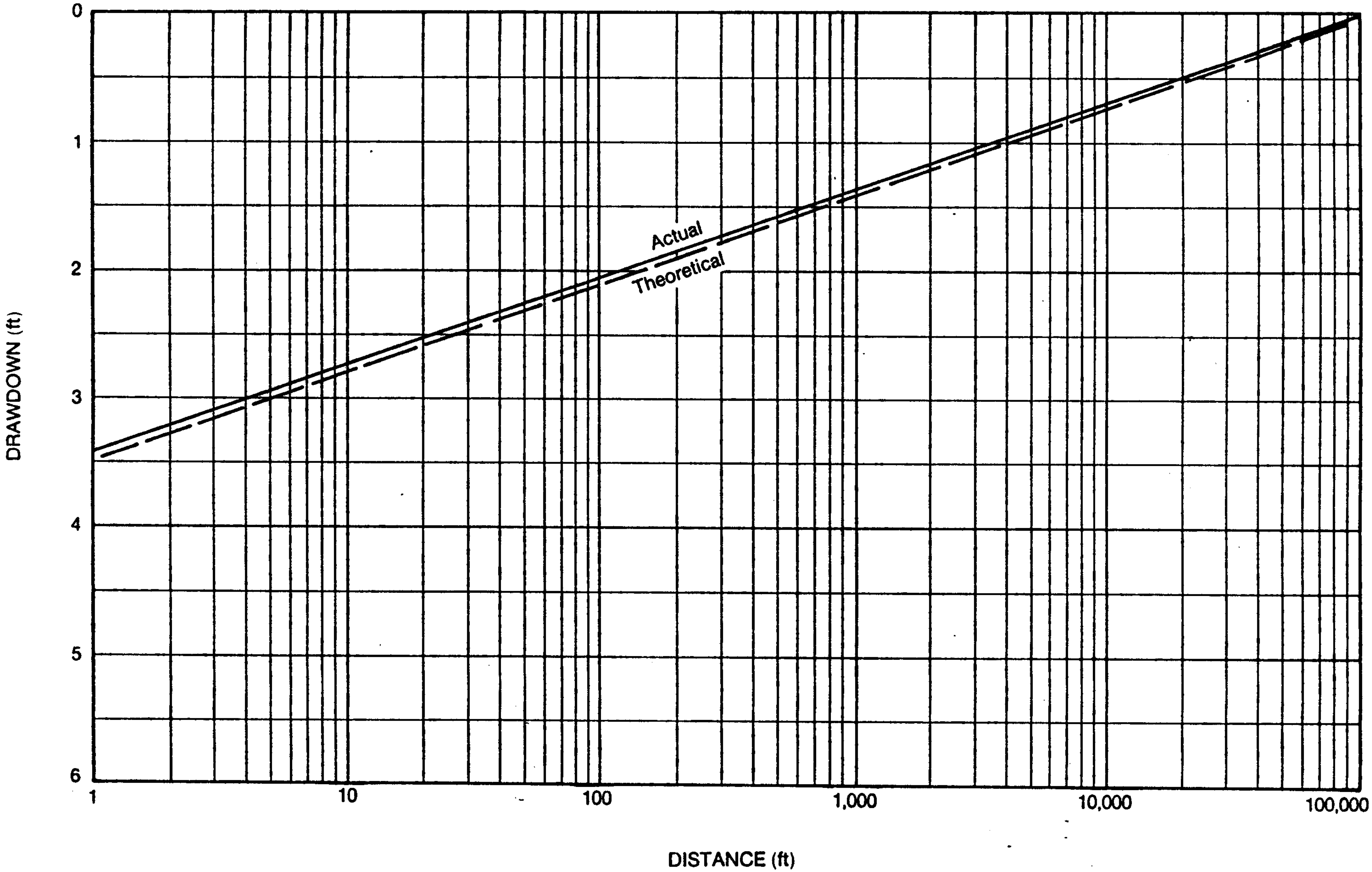

FIGURE 6-12.
Distance-Drawdown Relationship at 1,600 GPM—Actual Versus Theoretical.

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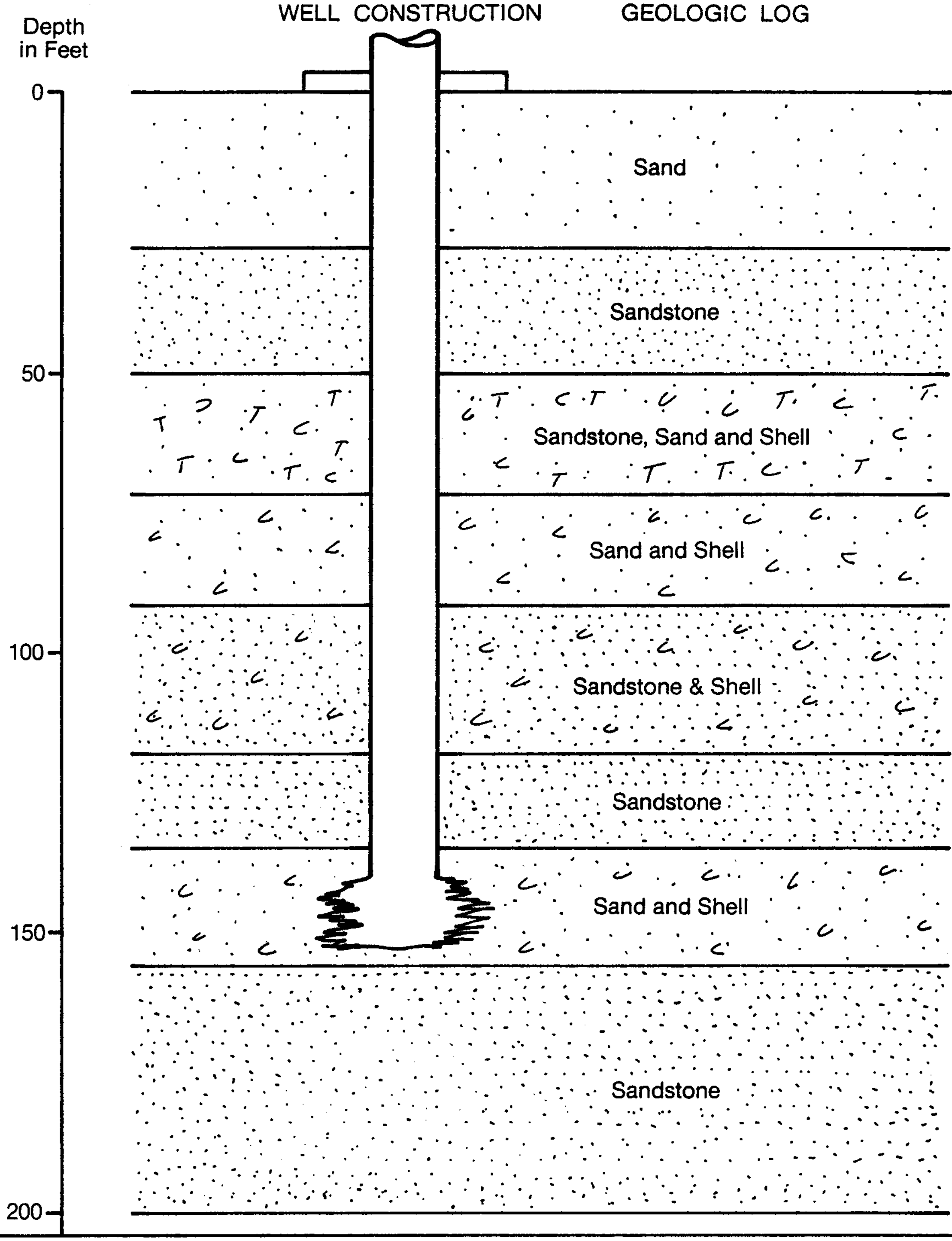

Well No. 1
Date Completed 1957
Casing Diameter 8 in.
Casing Depth 140 ft.
Open Hole Section 140-150 ft.

Screen Diameter N/A
Screen Slot Size N/A
Gravel Pack Size None
Pumping Test 1/83
Duration 3 hr.

Pumping Rate 325 gpm
Static Water Level 8.4 ft.
Maximum Drawdown 18.8 ft.
→Specific Capacity 17 gpm/ft.

Note: Geologic Log Developed from Nearby Wells.

FIGURE E-1.
Well Completion Report—Well No. 1.

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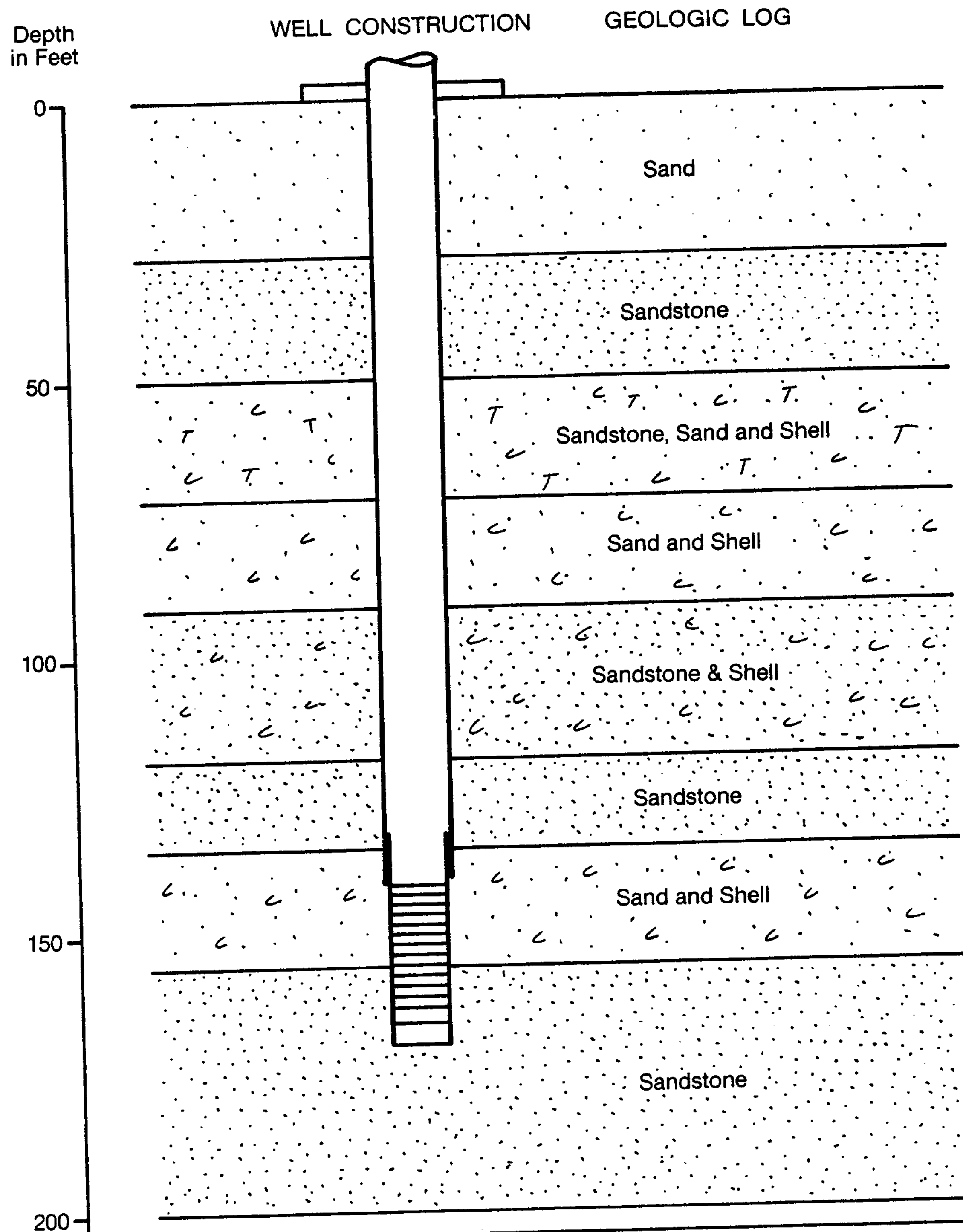

Well No. 2
Date Completed 1957
Casing Diameter 8 in.
Casing Depth 140 ft.
Screen Section 140-170 ft.

Screen Diameter 8 in.
Screen Slot Size —
Gravel Pack Size None
Pumping Test —
Duration — hr.

Pumping Rate — gpm
Static Water Level — ft.
Maximum Drawdown — ft.
Specific Capacity — gpm/ft.

Note: Geologic Log Developed from Nearby Wells. This Well is Abandoned.

FIGURE E-2. CH2M HILL
Well Completion Report—Well No. 2.

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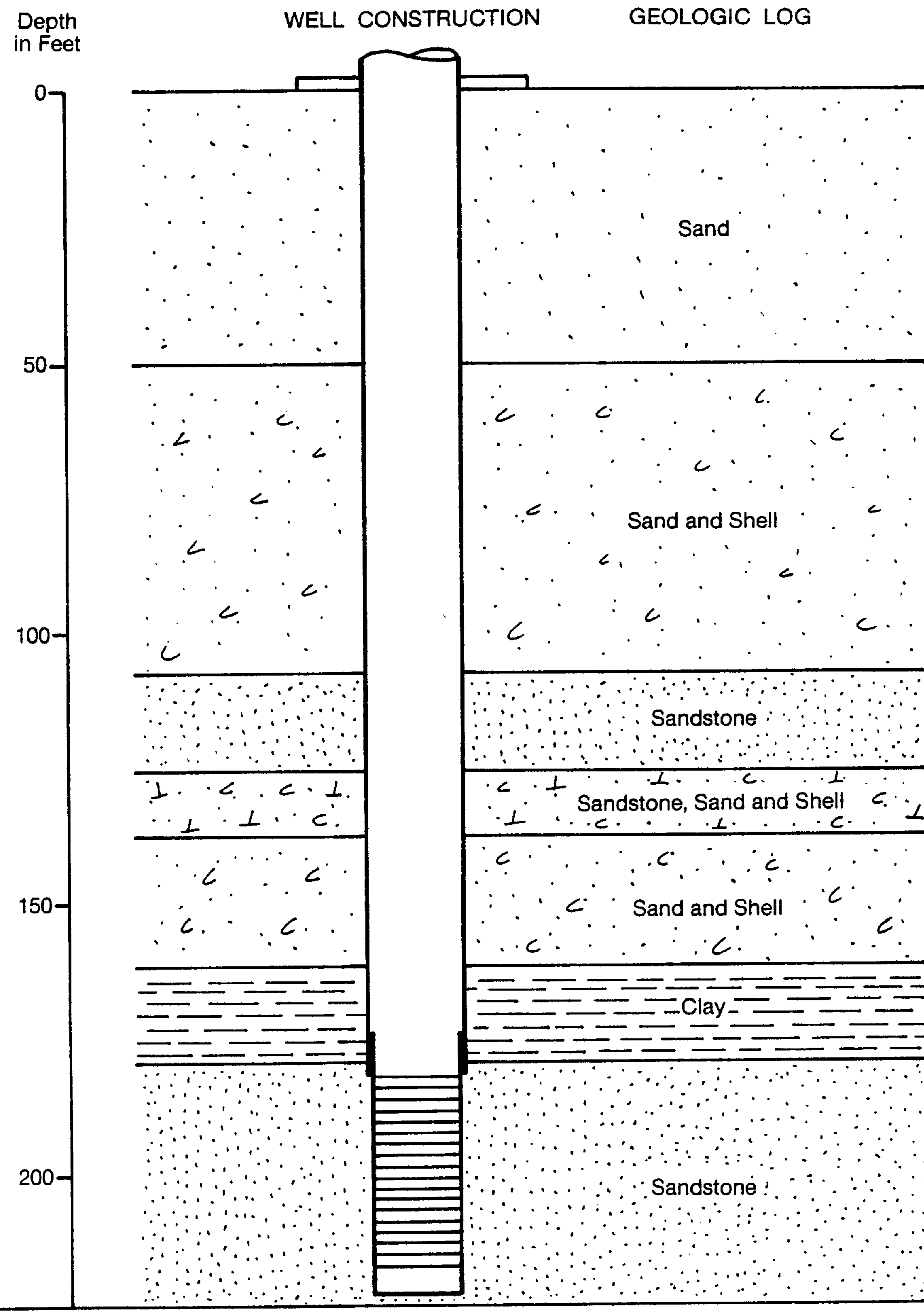

Well No. 3
Date Completed 1964
Casing Diameter 10 in.
Casing Depth 182 ft.
Screen Section 182-222 ft.

Screen Diameter 10 in.
Screen Slot Size —
Gravel Pack Size None
Pumping Test 1/83
Duration 3 hr.

Pumping Rate 360 gpm
Static Water Level 10.0 ft.
Maximum Drawdown 30.0 ft.
→ Specific Capacity 12 gpm/ft.

Note: Geologic Log Developed from Nearby Wells.

FIGURE E-3.
Well Completion Report—Well No. 3.

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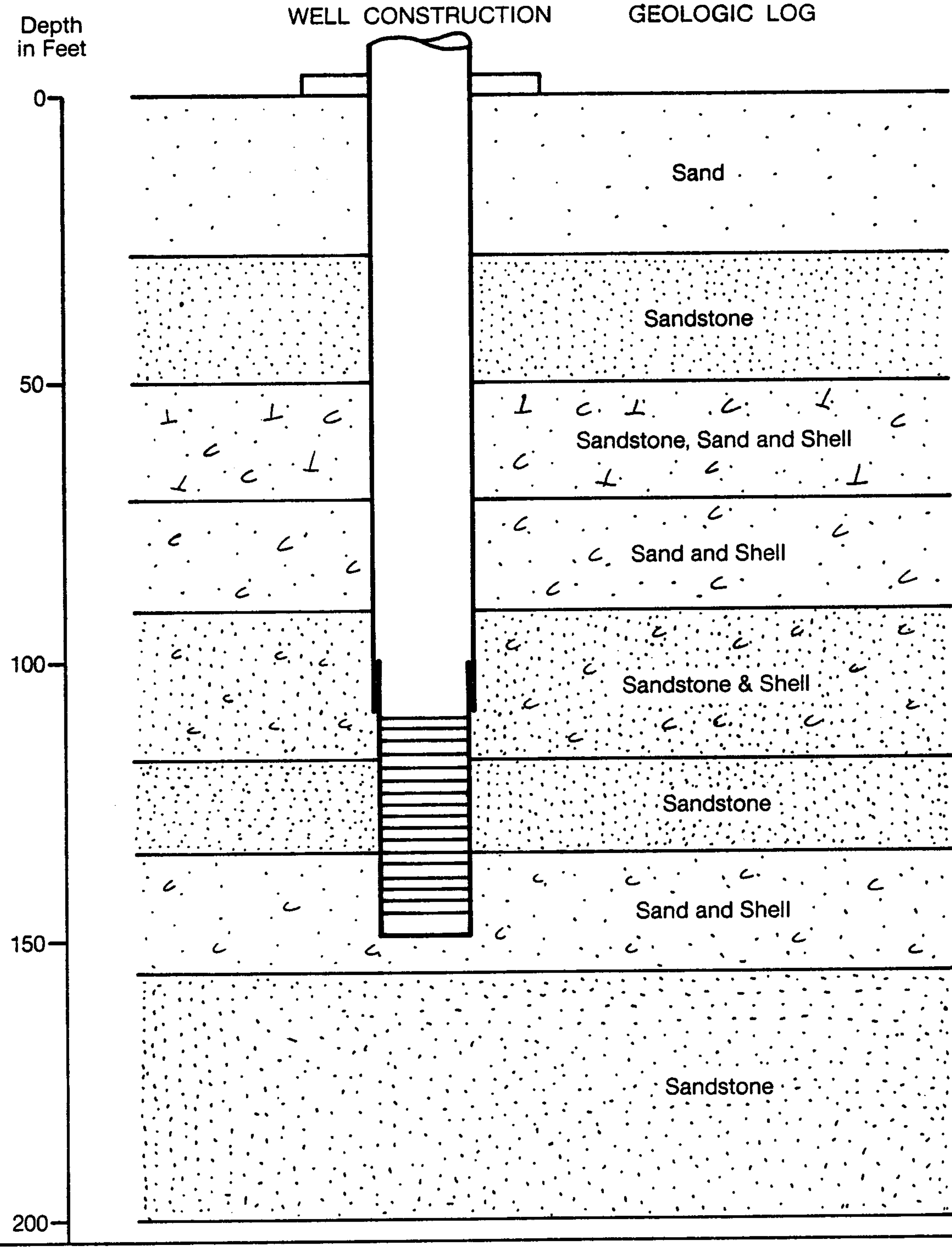

Well No. 4
Date Completed 1967
Casing Diameter 10 in.
Casing Depth 110 ft.
Screen Section 110-150 ft.

Screen Diameter 10 in.
Screen Slot Size 35
Gravel Pack Size None
Pumping Test 1/83
Duration 3 hr.

Pumping Rate 480 gpm
Static Water Level 7.3 ft.
Maximum Drawdown 27.3 ft.
→ Specific Capacity 18 gpm/ft.

Note: Geologic Log Developed from Nearby Wells.

FIGURE E-4.
Well Completion Report—Well No. 4.

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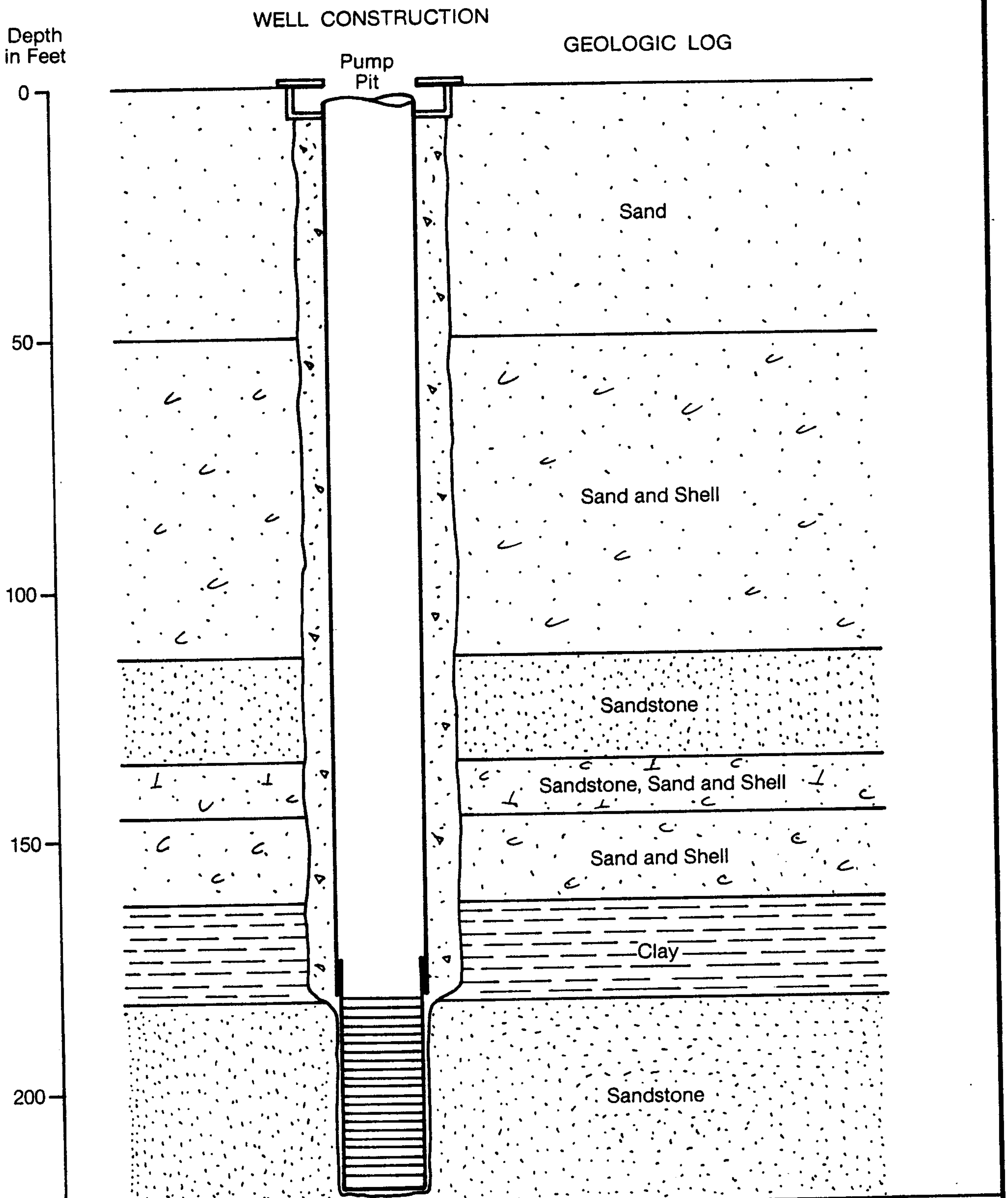


Well No. 5
Date Completed 12/69
Casing Diameter 12 in.
Casing Depth 183 ft.
Screen Section 183-223 ft.

Screen Diameter 12 in.
Screen Slot Size 40
Gravel Pack Size None
Pumping Test 3/70
Duration 2 hr.

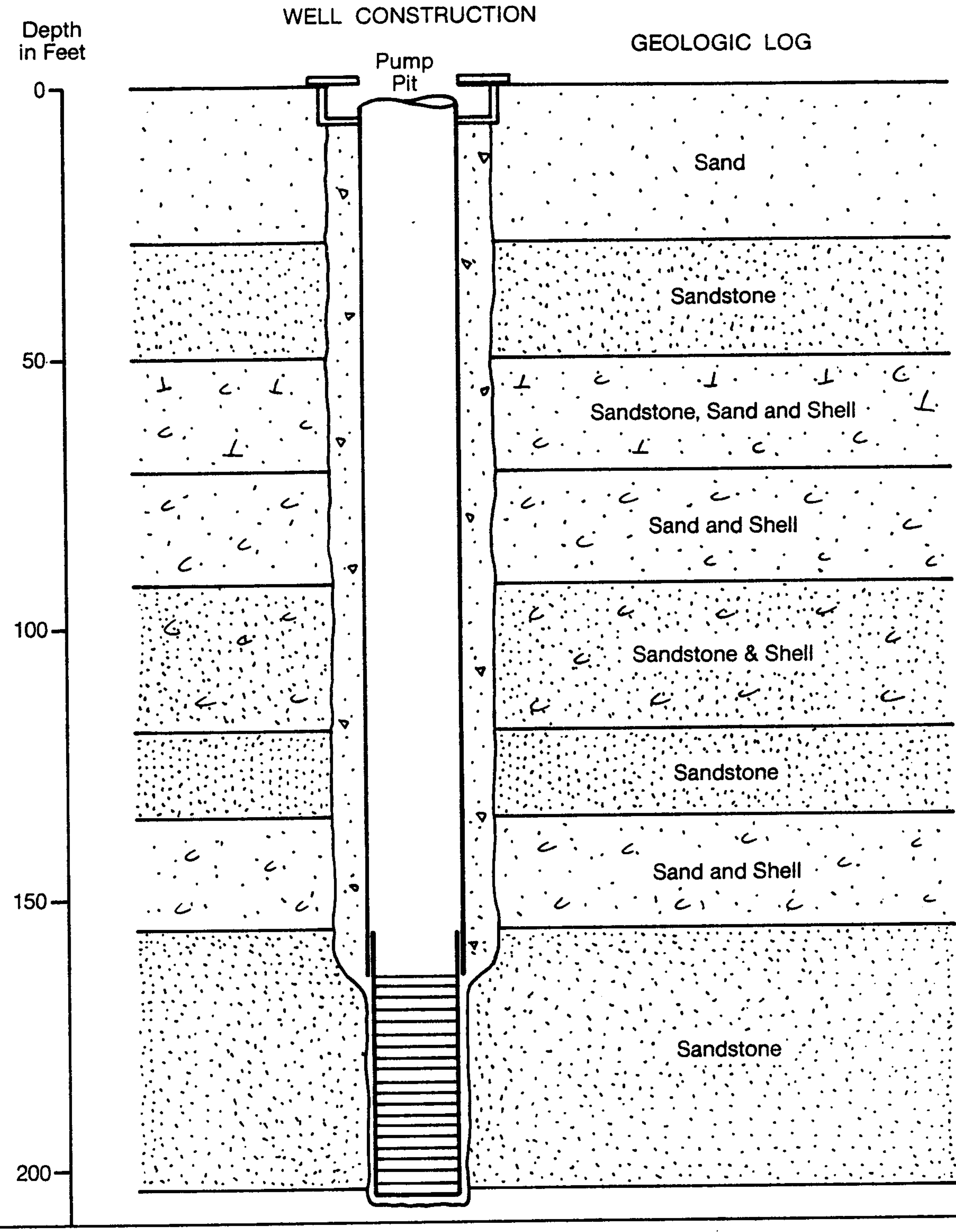
Pumping Rate 900 gpm
Static Water Level 7.8 ft.
Maximum Drawdown 55.6 ft.
→ Specific Capacity 16 gpm/ft.

FIGURE E-5.
Well Completion Report—Well No. 5.

CH2M HILL

PBC 135

FC50100.E0



Well No. 6
Date Completed 12/69
Casing Diameter 12 in.
Casing Depth 165 ft.
Screen Section 165-205 ft.

Screen Diameter 12 in. TS
Screen Slot Size 40
Gravel Pack Size None
Pumping Test 12/69
Duration 3 hr.

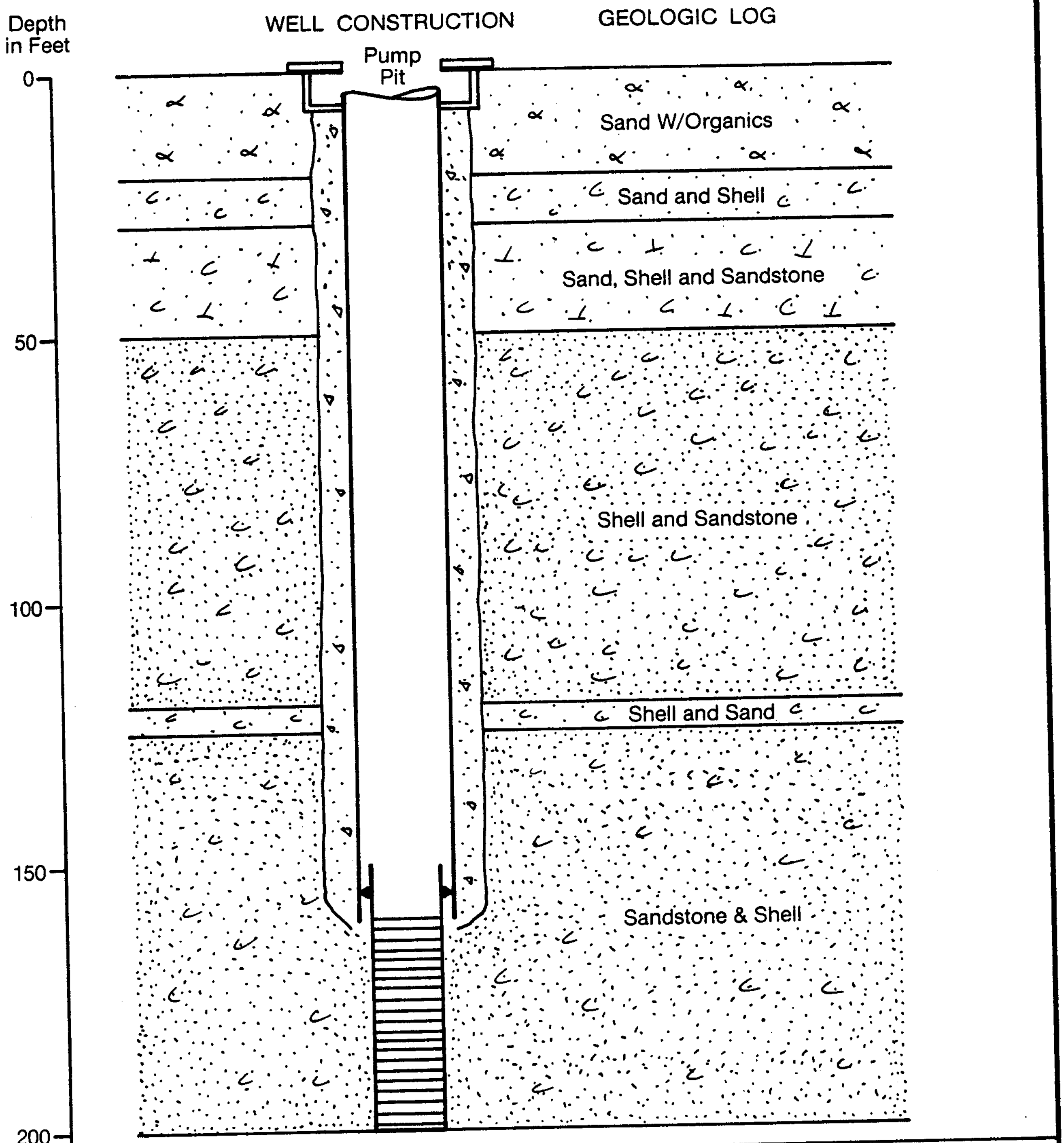
Pumping Rate 1,000 gpm
Static Water Level 7.8 ft.
Maximum Drawdown 23.8 ft.
→ Specific Capacity 42 gpm/ft.

FIGURE E-6.
Well Completion Report—Well No. 6.

CH2M HILL

PBC 135

FC50100.E0



Well No. 7
Date Completed 8/71
Casing Diameter 12 in.
Casing Depth 161 ft.
Screen Section 161-201 ft.

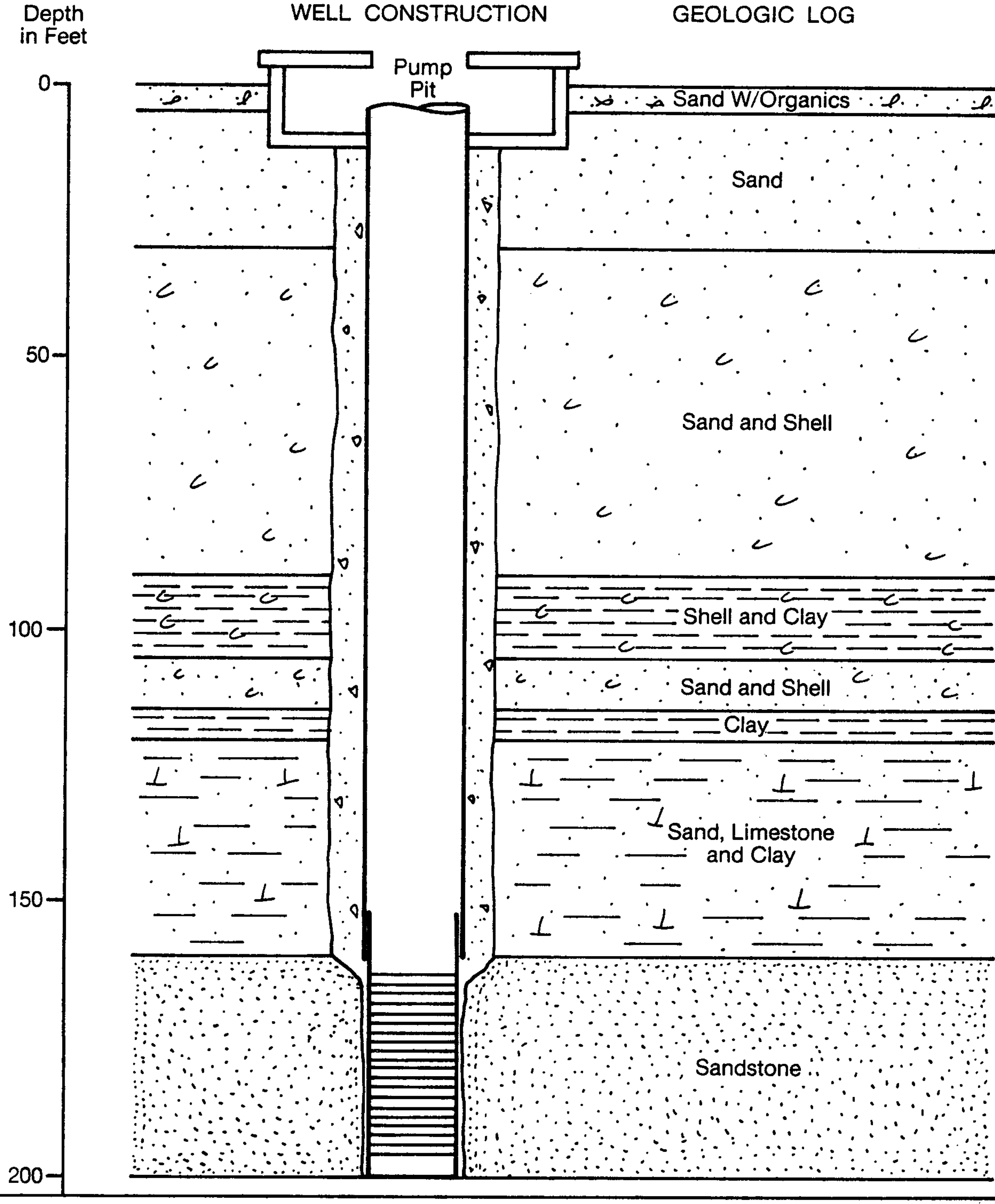
Screen Diameter 10 in. TS
Screen Slot Size 35
Gravel Pack Size None
Pumping Test 1/83
Duration — hr.

Pumping Rate 75 gpm
Static Water Level 7.2 ft.
Maximum Drawdown 34.9 ft.
→Specific Capacity 2 gpm/ft.

FIGURE E-7.
Well Completion Report—Well No. 7.

CH2M HILL

PBC 135



Well No. 8
Date Completed 1974
Casing Diameter 12 in.
Casing Depth 160 ft.
Screen Section 160-200 ft.

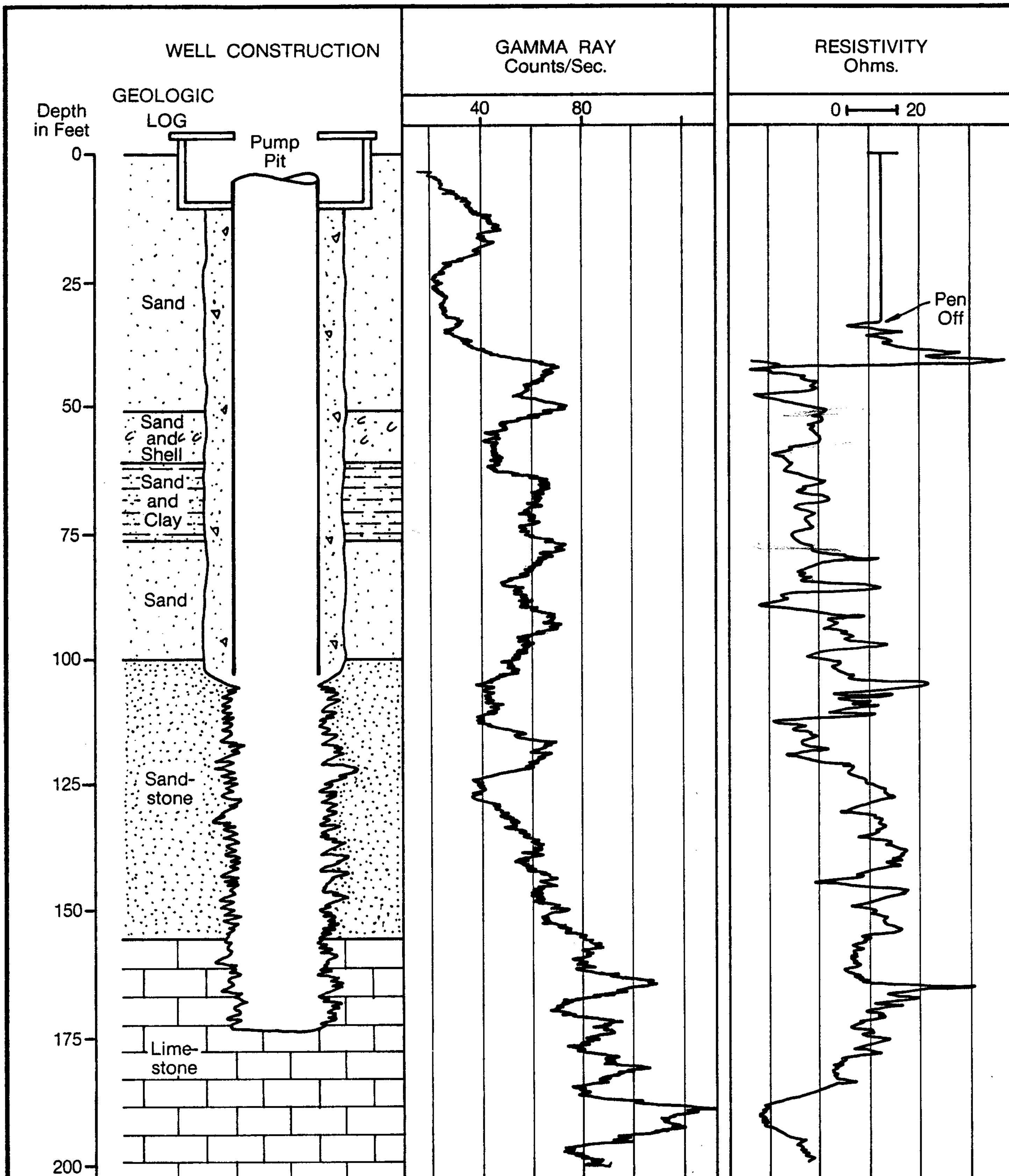
Screen Diameter 12 in. TS
Screen Slot Size 40
Gravel Pack Size None
Pumping Test 1/83
Duration 3 hr.

Pumping Rate 715 gpm
Static Water Level 6.2 ft.
Maximum Drawdown 22.1 ft.
→ Specific Capacity 32 gpm/ft.

FIGURE E-8.
Well Completion Report—Well No. 8.

CH2M HILL

FC50100.E0



Well No. 9
Date Completed 2/77
Casing Diameter 12 in.
Casing Depth 104 ft.
Open Hole Section 104-170 ft.

Screen Diameter N/A
Screen Slot Size N/A
Gravel Pack Size N/A
Pumping Test 3/77
Duration 4 hr.

Pumping Rate 1,200 gpm
Static Water Level 8.1 ft.
Maximum Drawdown 10.9 ft.
→ Specific Capacity 110 gpm/ft.

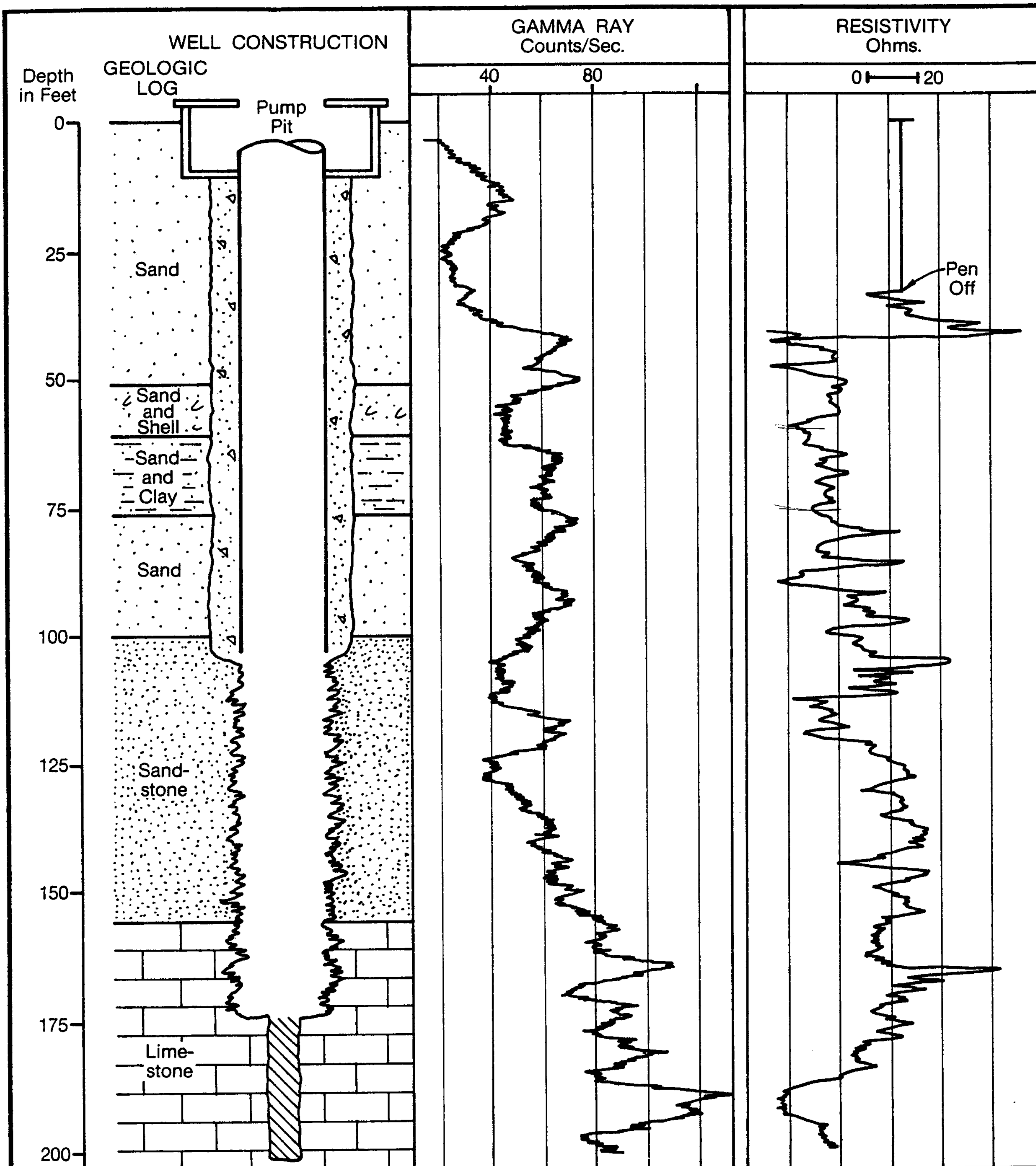
Note: Geophysical Logs from Well 10.

FIGURE E-9.
Well Completion Report—Well No. 9.

CH2M HILL

PBC 135

FC50100.E0



Well No. 10
Date Completed 3/77
Casing Diameter 12 in.
Casing Depth 102 ft.
Open Hole Section 102-170 ft.

Screen Diameter N/A
Screen Slot Size N/A
Gravel Pack Size N/A
Pumping Test 12/76
Duration 23 hr.

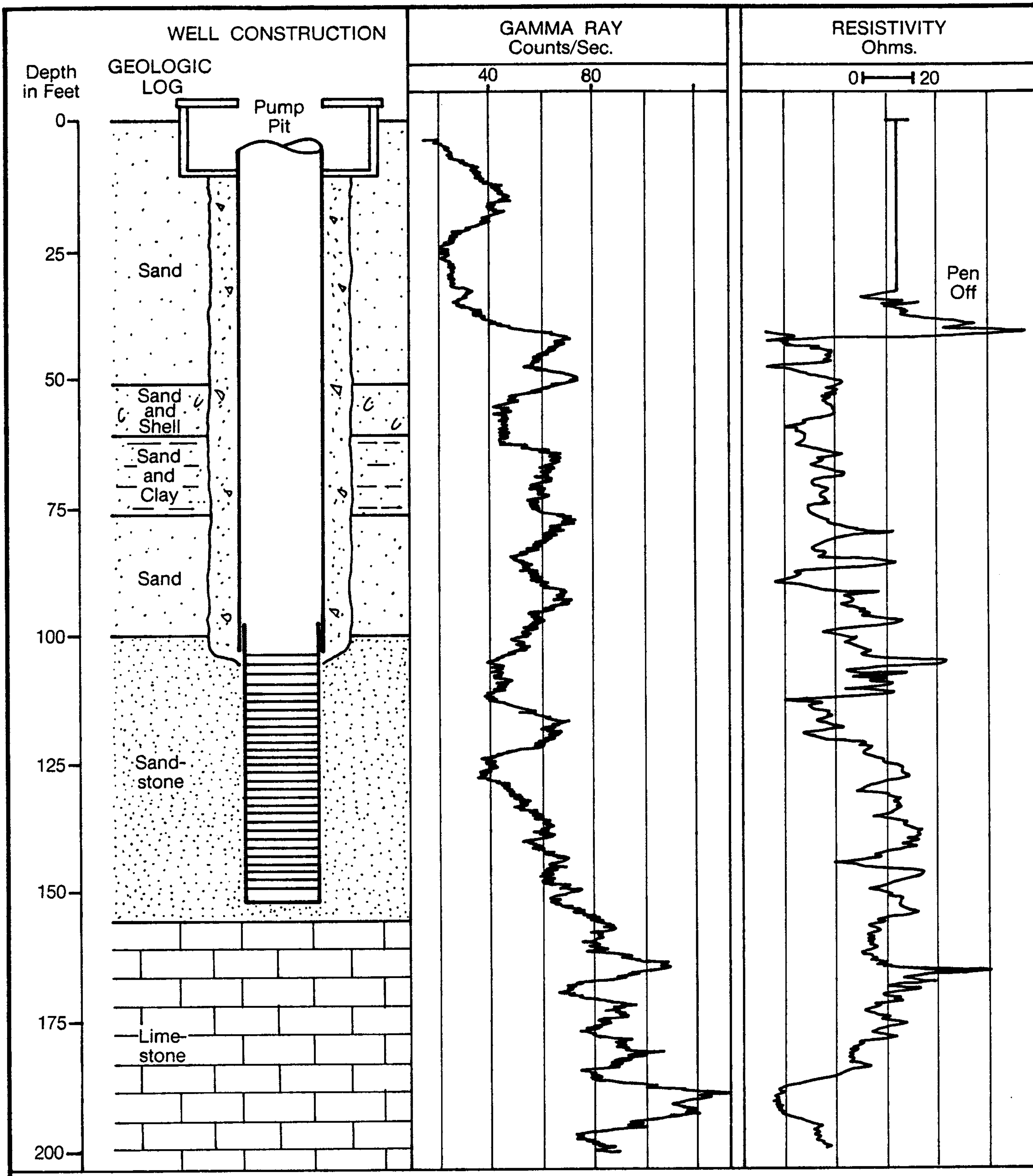
Pumping Rate 1,200 gpm
Static Water Level 8.1 ft.
Maximum Drawdown 10.9 ft.
→ Specific Capacity 110 gpm/ft.

FIGURE E-10.
Well Completion Report—Well No. 10.

CH2M HILL

PBC 135

FC50100.E0



Well No. 11
Date Completed 4/7/77
Casing Diameter 12 in.
Casing Depth 104 ft.
Screen Section 110-150 ft.

Screen Diameter 8 in. TS
Screen Slot Size 40
Gravel Pack Size None
Pumping Test 4/28/77
Duration 12 hr.

Pumping Rate 1000 gpm
Static Water Level 9.8 ft.
Maximum Drawdown 4.6 ft.
→ Specific Capacity 217 gpm/ft.

Note: Geophysical Logs from Well 10.

FIGURE E-11.
Well Completion Report—Well No. 11.

CH2M HILL

PBC 135

FORM 0128
Rev. 7/84

Shane Lacy[illegible]

FORTRAN Coding Form

PROGRAM: Palm Springs APT MODFLOW run

PROGRAMMER: DATE: PUNCHING INSTRUCTIONS: GRAPHIC / PUNCH

PAGE 1 OF   CARD ELECTRO NUMBER*

```
PALM SPRINGS PUMP TEST ANALYSIS
RUN 1
        16        20        20         1         4                PS1
 11 12                   19       22
         0         0                                                 16X {
         0         1
       9.9
         0       0.0                                                 16X {
        2.        10       1.5

         0         0
 1 3 3 3 0 0 0 0 0 0 0 0 0 0 0 0
         0       1.0
        11         0(16F5.1)
  1.5   2.  2.5  3.5  4.5   6.   8.  11.  15.  21.  29.  40.  56.  78. 109. 152.   PS11
 212. 296. 414. 579.
        11         0(16F5.1)
  1.5   2.  2.5  3.5  4.5   6.   8.  11.  15.  21.  29.  40.  56.  78. 109. 152.
 212. 296. 414. 579.
         0        .2                              L1 SY
         0      600.                              L1 KH
         0      -15.                              L1 BOT
         0       48.                              L1 VCONT 600÷12.5
         0     .0001                              L2 S
```

FORM 0128
Rev. 7/84

FORTRAN Coding Form

PROGRAM Palm Springs APT MODFLOW run
PROGRAMMER
DATE
PUNCHING INSTRUCTIONS | GRAPHIC | PUNCH
PAGE 2 OF
CARD ELECTRO NUMBER*

PS11 (Cont.)

0	600.	L2	KH
0	-25.	L2	BOT
0	48.	L2	VCONT 600÷12.5
0	.2	L2	SY
0	-15.	L2	TOP
0	.0001	L3	S
0	600.	L3	KH
0	-40.	L3	BOT
0	40.	L3	VCONT 600÷15
0	.2	L3	SY
0	-25.	L3	TOP
0	.0001	L4	S
0	600.	L4	KH
0	-55.	L4	BOT
0	40.	L4	VCONT 600÷15
0	.2	L4	SY
0	-40.	L4	TOP
0	.0001	L5	S
0	9000.	L5	T 15x600
0	40.	L5	VCONT 600÷15
0	.0001	L6	S
0	9000.	L6	T 15x600
0	40.	L6	VCONT 600÷15
0	.0001	L7	S

FORM 0128
Rev. 7/84

FORTRAN Coding Form

PROGRAM Palm Springs APT MODFLOW run
PROGRAMMER
DATE
PUNCHING INSTRUCTIONS | GRAPHIC | PUNCH

CARD ELECTRO NUMBER*

PS11 (cont.)

Cols 7–10	Cols 16–20	Cols 51–72
0	9000.	L7 T 600X15
0	40.	L7 VCONT 600÷15
0	.0001	L8 S
0	9000.	L8 T 600X15
0	48.	L8 VCONT 600÷12.5
0	.0001	L9 S
0	6000.	L9 T 600X10
0	60.	L9 VCONT 600÷10
0	.0001	L10 S
0	6000.	L10 T 600X10
0	48.	L10 VCONT 600÷12.5
0	.0001	L11 S
0	9000.	L11 T 600X15
0	40.	L11 VCONT 600÷15
0	.0001	L12 S
0	9000.	L12 T 600X15
0	40.	L12 VCONT 600÷15
0	.0001	L13 S
0	9000.	L13 T 600X15
0	40.	L13 VCONT 600÷15
0	.0001	L14 S
0	9000.	L14 T 600X15
0	34.3	L14 VCONT 600÷17.5
0	.0001	L15 S

FORM 0128
Rev. 7/84

FORTRAN Coding Form

PROGRAM | PROGRAMMER | DATE | PUNCHING INSTRUCTIONS | GRAPHIC | PUNCH | PAGE 4 OF | CARD ELECTRO NUMBER*

Group	Cols 1–10	Cols 11–20	Cols 21–30	Cols 31–40	Cols 51–72 (Comments)
PS11 (cont.)	0	12000.			L15 T 600x20
	0	30.			L15 VCONT 600÷20
	0	.0001			L16 S
	0	12000.			L16 T 600x20
PS12	16	0			
	4				
	9	1	1	-15400.	1600 GPM ÷4 PROPORTIONED
	10	1	1	-15400.	TO THICKNESS OF PUMPING
	11	1	1	-23100.	NODES CONVERTED TO FT3/DAY
	12	1	1	-23100.	
PS19	50	5			
	1.0	.001	1		
PS22	4	4	9	10	
	0	1	1	0	
	1	0	1	0	

FORM 0128
Rev. 7/84

FORTRAN Coding Form

PROGRAM: MODFLOW PALM SPRINGS APT (PG 2)

PROGRAMMER:

DATE:

PUNCHING INSTRUCTIONS: GRAPHIC / PUNCH

PAGE OF

CARD ELECTRO NUMBER*

```
    4    4    4    4    6    8    8   12   18   27   40   60   90
         0        .2
         0      150.
         0      -50.
         0        .3
         0    .00014
         0     7500.
         0        .6
         0    .00014
         0   200000.
         0       .18
         0    .00014
         0    24750.
         1         0
         1
         3        15        15   -308000
        50         5
        1.       .01         1
```

PS12

PS19

FORM 0128
Rev. 7/84

FORTRAN Coding Form

PROGRAM: MODFLOW PALM SPRINGS APT

PROGRAMMER:

DATE:

PUNCHING INSTRUCTIONS: GRAPHIC / PUNCH

PAGE OF

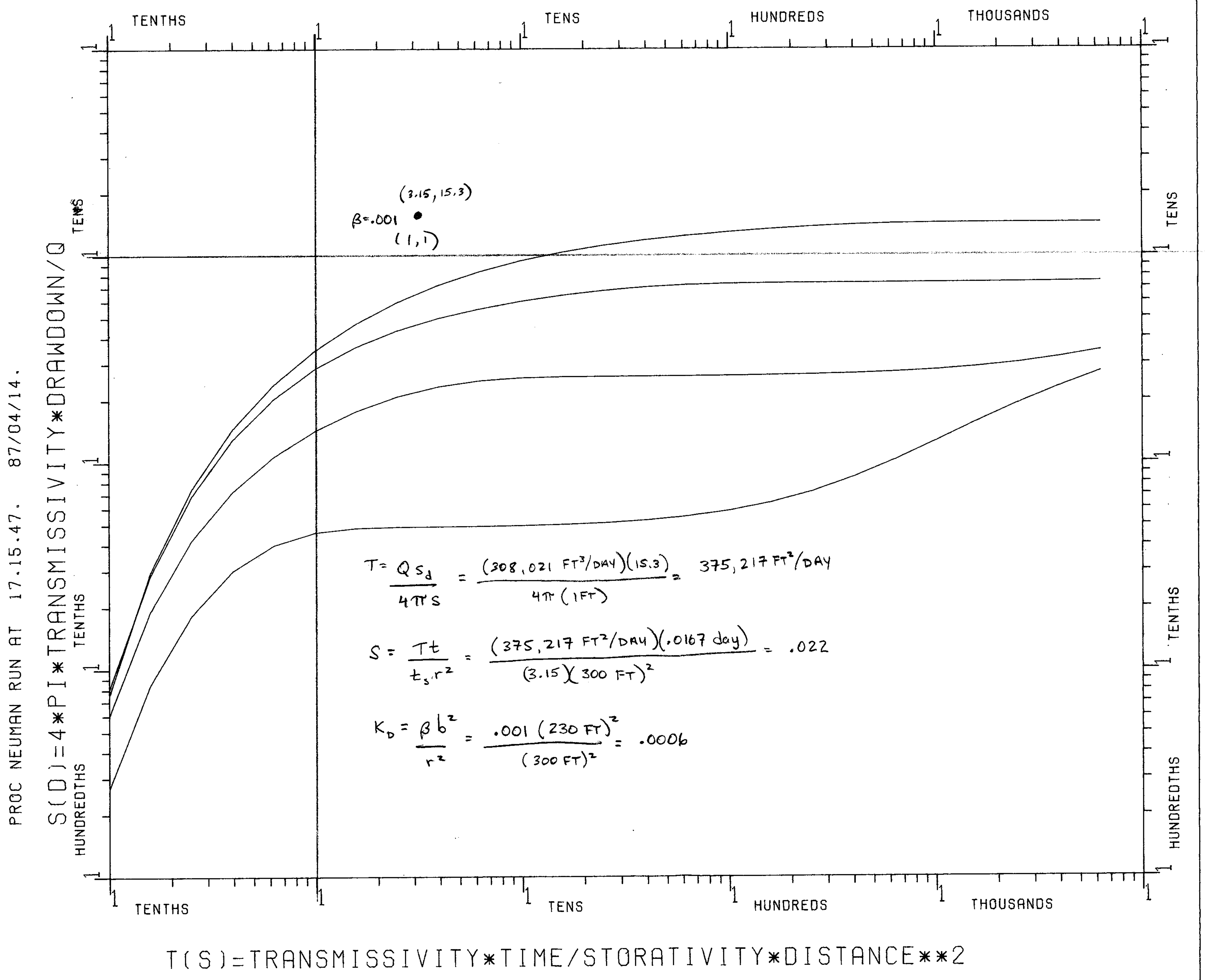
CARD ELECTRO NUMBER*

```
PALM SPRINGS PUMP TEST SIMULATION
RUN 1
         4        29        29         1         4
 11 12    14             19        22
         0         1
         0         1
         0         1
         0         1
         0         1
       9.9
         0      -7.5
         0      -7.5
         0      -7.5
         0      -7.0
      2.08         5       1.5

         1         1
 1 0 0 0
         0        1.
        11        10(16F5.0)                     0
   90   60   40   27   18   12    8    8    6    4    4    4    4    4    4    4
    4    4    4    4    6    8    8   12   18   27   40   60   90
        11        10(16F5.0)                     0
   90   60   40   27   18   12    8    8    6    4    4    4    4    4    4    4
```

PALM SPRINGS WELL NO. 2

NEUMAN PARTIAL PENETRATION SOLUTION
B: 230' PW TD/CD: 165'/120' OW TD/CD: 140'/110'
ZD1=.3913, ZD2=.5217, PD=.7174, DD=.5217
BETA = .001, .01, .1, 1



Hantush - Jacob

$$T = \frac{Q\,L(u,v)}{4\pi s} = \frac{(308021\ FT^3/DAY)(10)}{4\pi\ (1.3)} = 188,646\ FT^2/DAY$$

$$S = \frac{4Tt/r^2}{1/u} = \frac{4(188646\ FT^2/DAY)(.00018\ day)}{10(300\ FT)^2} = .000151$$

Corrected or uncorrected data?

Modified Hantush

Match Point

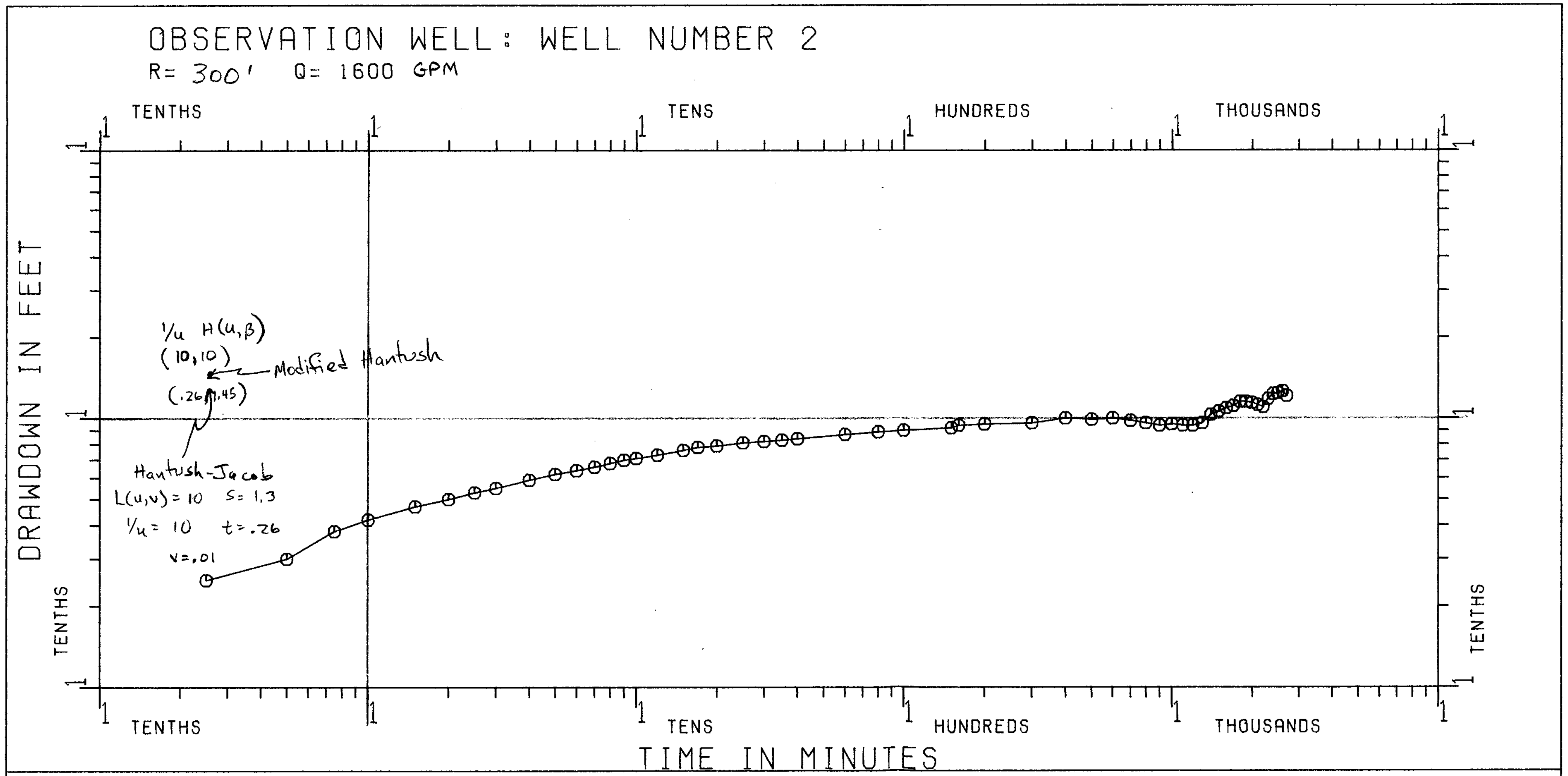
$\frac{1}{u} = 10$, $H(u,\beta) = 10$

$t = .26$ min, $s = 1.45$ FT

$\beta = .02$

$$T = \frac{Q}{4\pi s} H(u,\beta) = \frac{(308021\ FT^3/DAY)(10)}{4\pi\ (1.45)} = 169,131\ FT^2/DAY$$

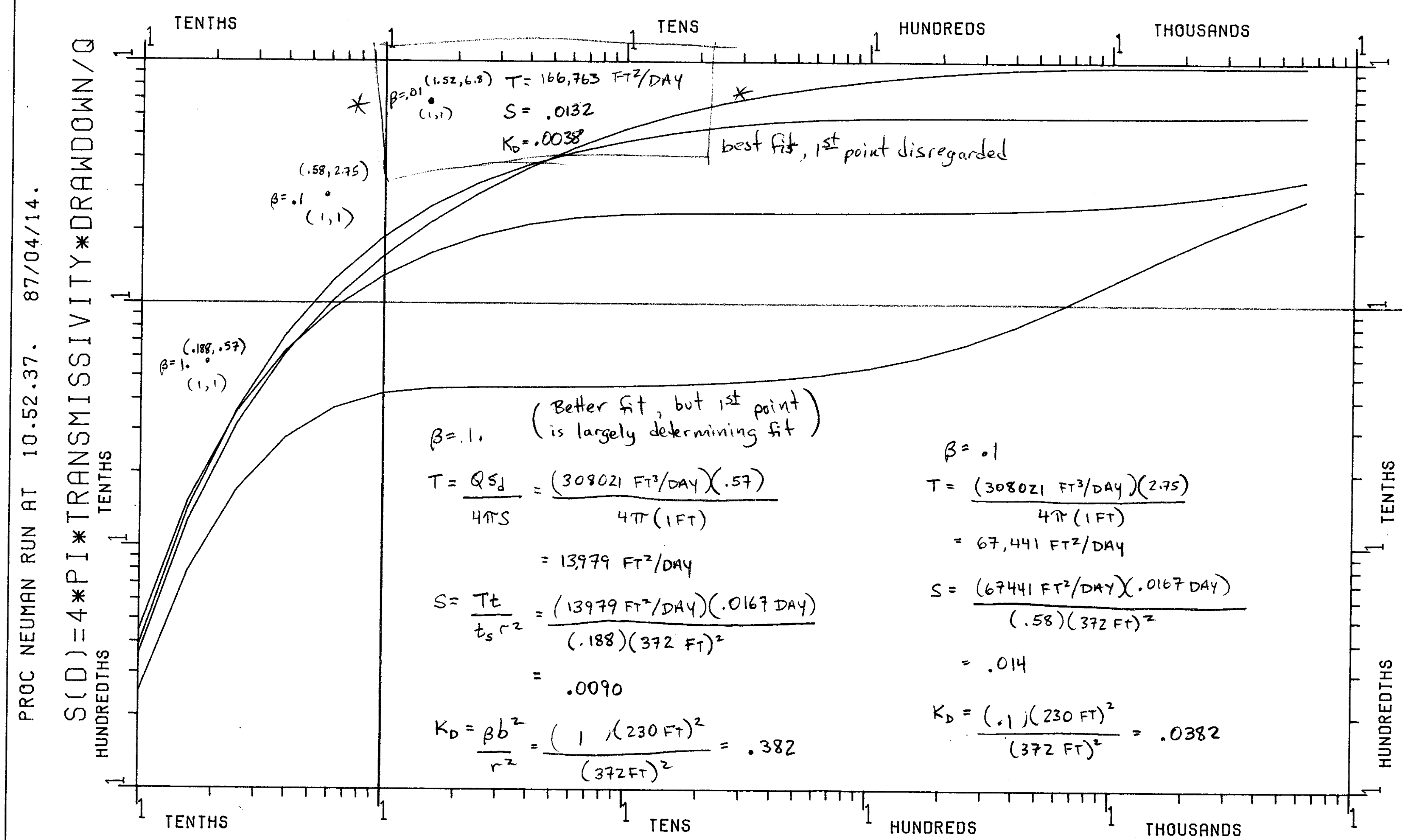
$$S = \frac{4Tt}{\frac{1}{u} r^2} = \frac{4(169,131\ FT^2/DAY)(.00018\ DAY)}{10(300\ FT)^2} = .000135$$



PALM SPRINGS WELLFIELD APT

PALM SPRINGS WELL NO. 1

NEUMAN PARTIAL PENETRATION SOLUTION
B: 230' PW TD/CD: 165'/120' OW TD/CD: 130'/95'
ZD1=.4348, ZD2=.587, PD=.7174, DD=.5217
BETA = .001, .01, .1, 1



T(S)=TRANSMISSIVITY*TIME/STORATIVITY*DISTANCE**2

~~Corrected or~~ Uncorrected data?   Very Flat Match

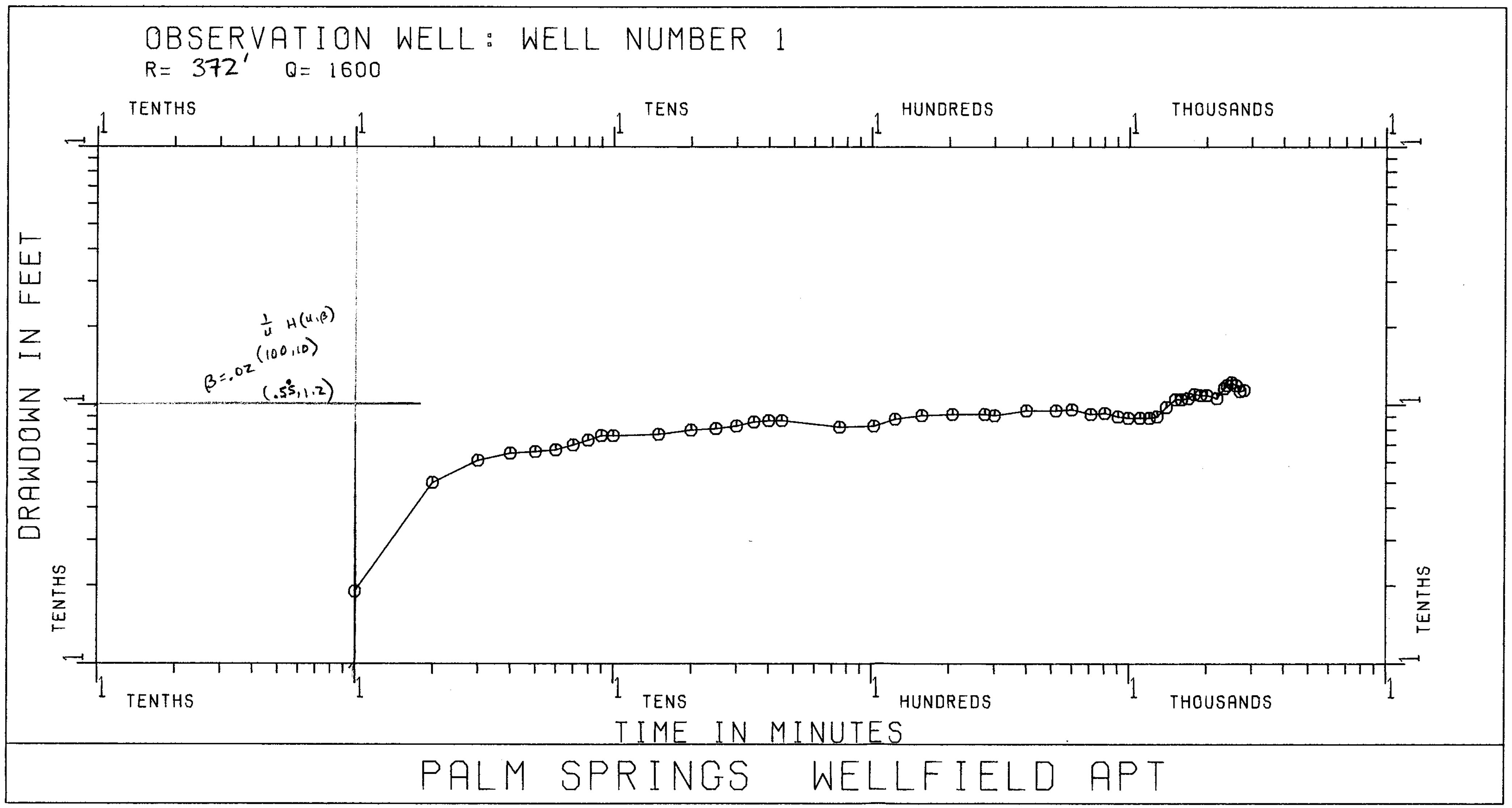
Modified Hantush
Match Point

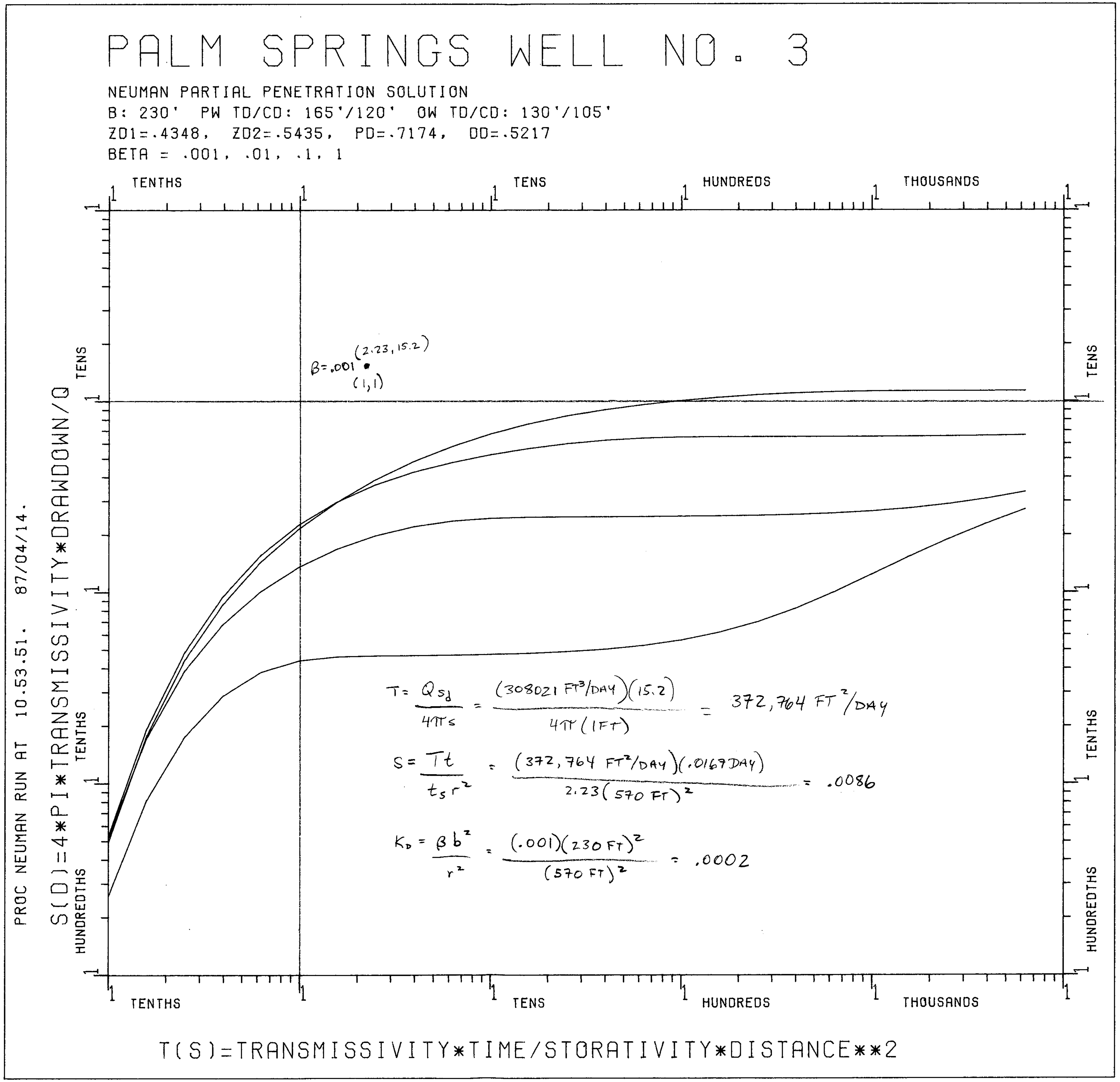
$\frac{1}{u} = 100, \; H(u,\beta) = 10$

$t = .55, \; s = 1.2$

$$T = \frac{QH(u,\beta)}{4\pi s} = \frac{(308021 \text{ FT}^3/\text{DAY})(10)}{4\pi(1.2 \text{ FT})} = 204{,}366 \text{ FT}^2/\text{DAY}$$

$$S = \frac{4Tt}{\frac{1}{u} r^2} = \frac{4(204366 \text{ FT}^2/\text{DAY})(.00038 \text{ DAY})}{100(372 \text{ FT})^2} = .000023$$





TAPENO 6160 PLOT NO 0004 TIME 11:09
USER NO PALM3D DATE 87/04/14

WMD

1/u L(u,v)

(11.8, 8.7) v = .02

Hantush-Jacob

$$T = \frac{Q\,L(u,v)}{4\pi s} = \frac{(308021\ FT^3/DAY)(8.7)}{4\pi\ (1\ FT)} = 21\,3360\ FT^2/DAY$$

$$S = \frac{4T\ t/r^2}{1/u} = \frac{4\,(213360\ FT^2/DAY)(.0007\ day)}{11.8\ (570\ FT)^2} = .00016$$

$$K'/b' = \frac{4\,(21336\ FT^2/DAY)(.02)^2}{(570\ FT)^2} = .000105\ day^{-1}$$

$$r/\sqrt{T/(K'/b')} = .04$$

.04 > .01

Invalid Soln

(walton, 1979, pg. 271)

??

β = .02

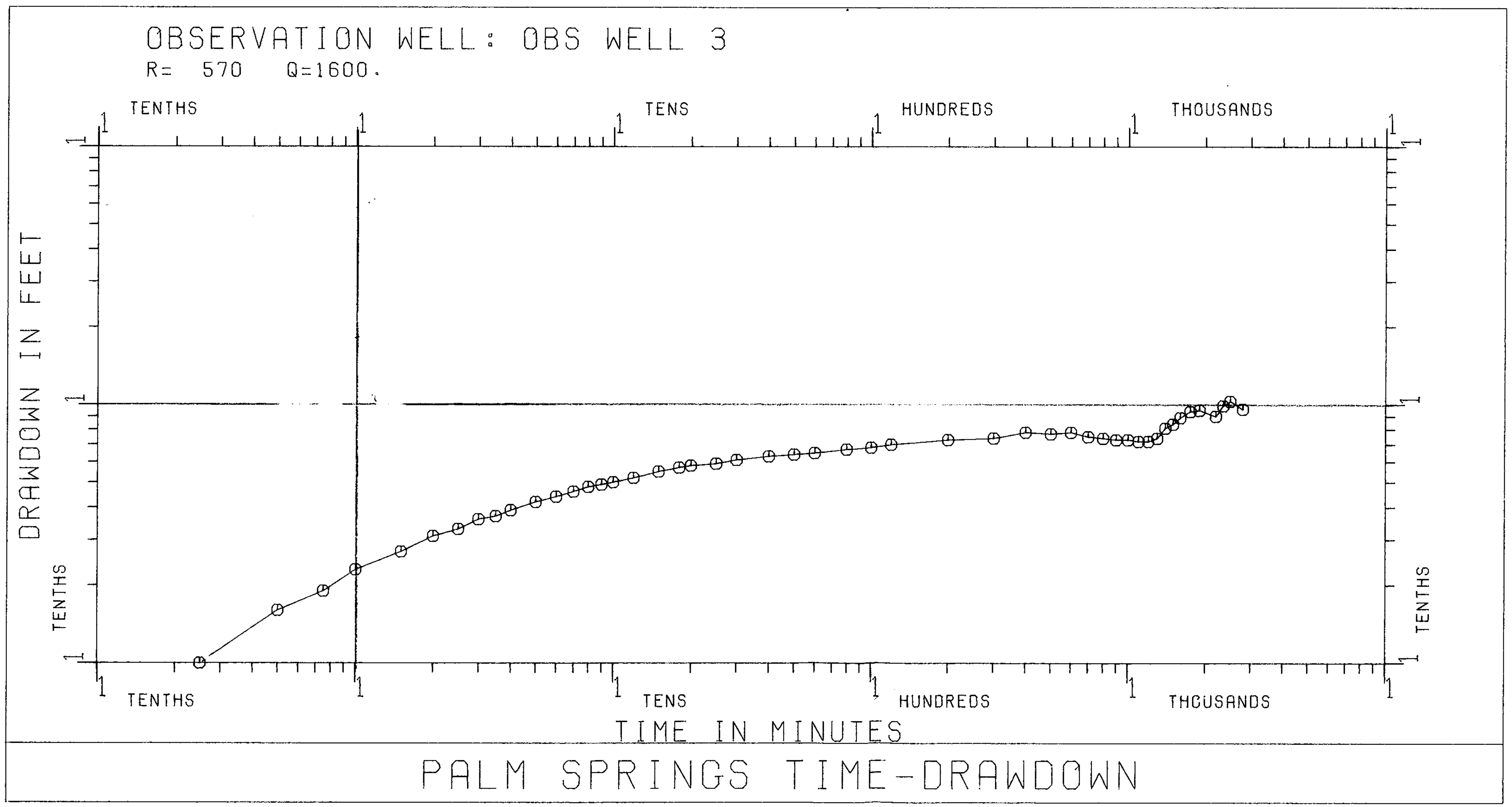
(12.2, 7.2)

1/u H(u,β)

Mod. Hant. Jacob

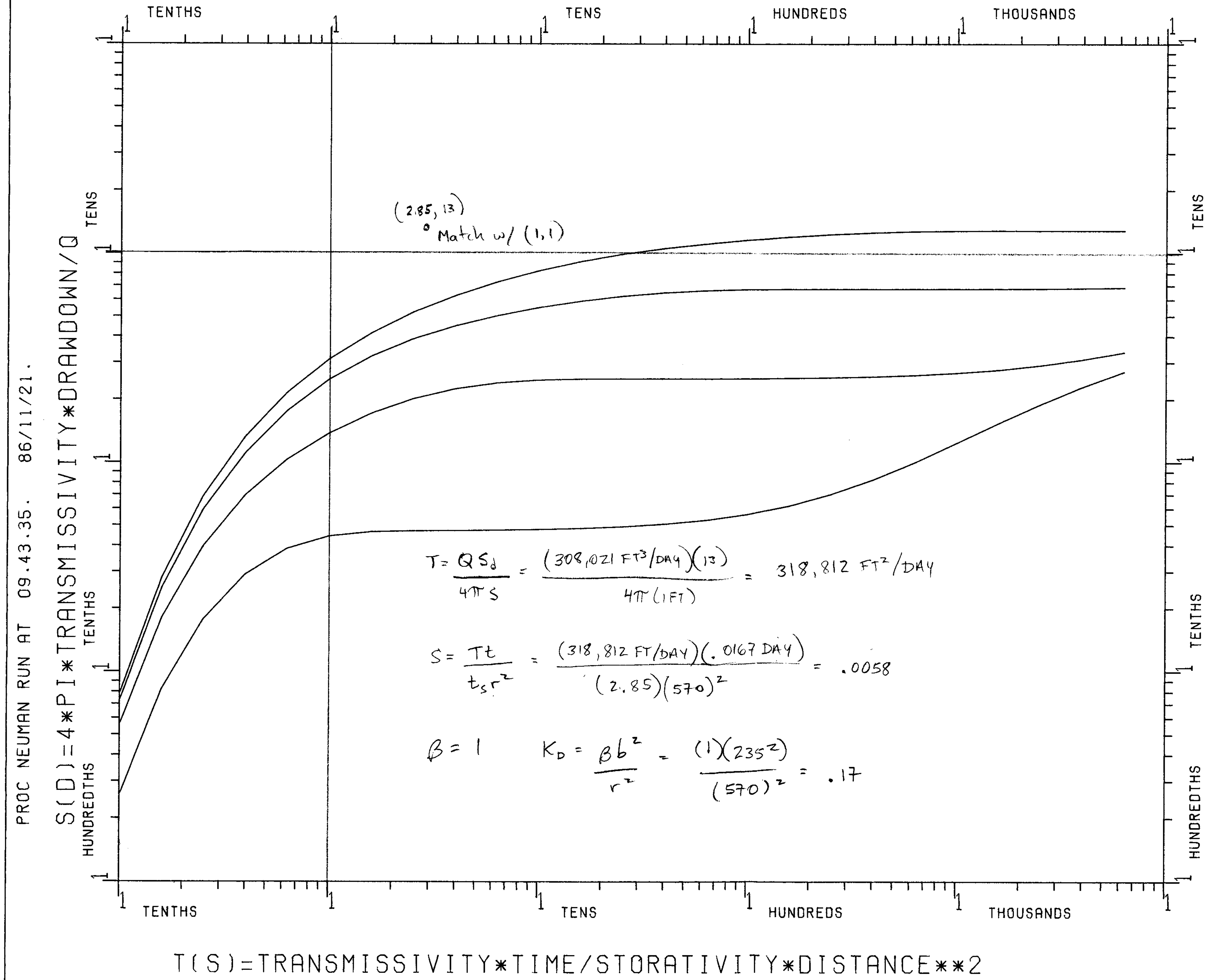
$$T = \frac{Q}{4\pi s} H(u,\beta) = \frac{(308021\ FT^3/DAY)(7.2)}{4\pi\ (1\ FT)} = 176{,}570\ FT^2/DAY$$

$$S = \frac{4Tt}{\frac{1}{u} r^2} = \frac{4\,(176{,}570\ FT^2/DAY)(.0007\ day)}{12.2\ (570\ FT)^2} = .00012$$



PALM SPRINGS WELL NO. 3

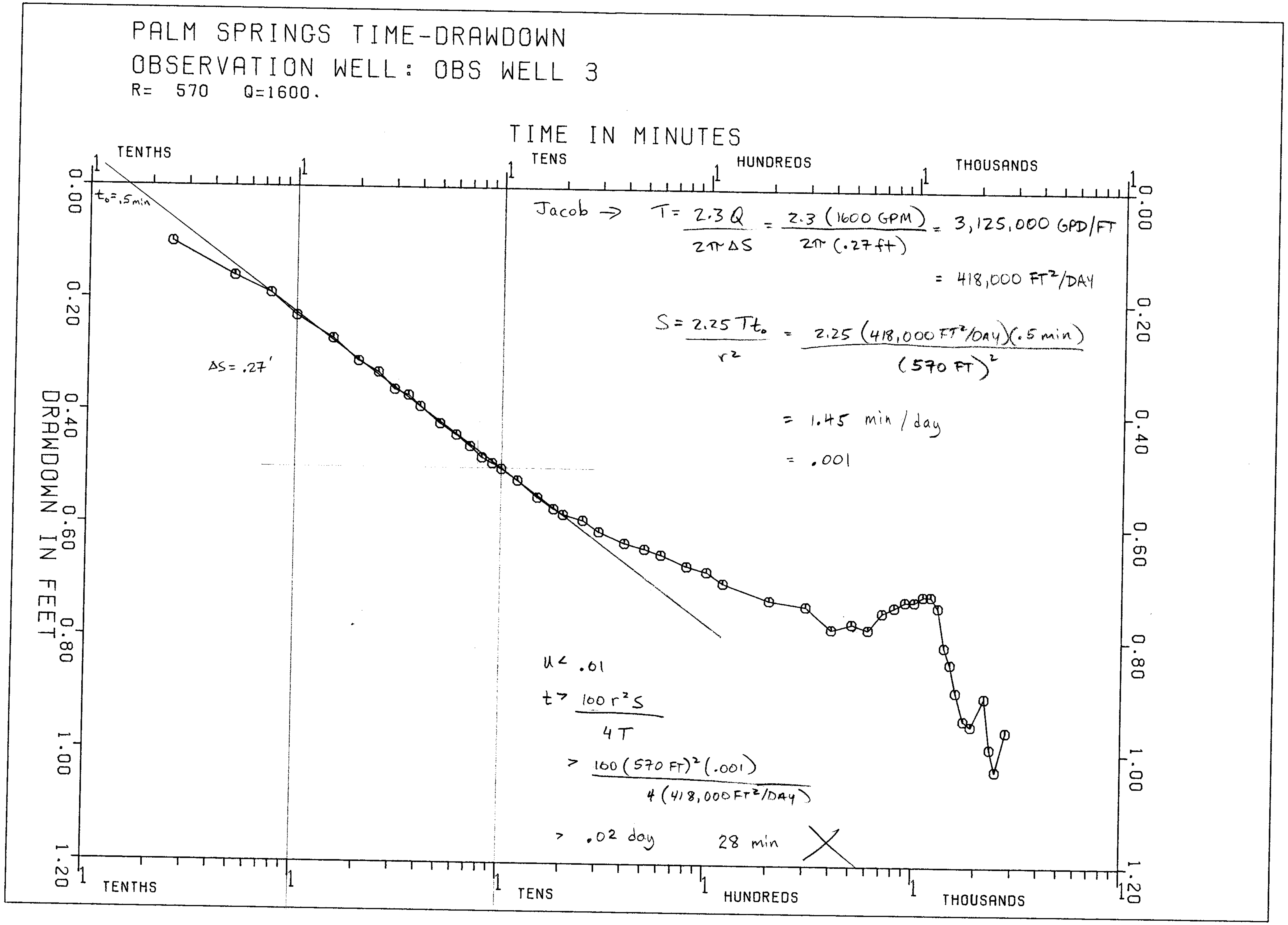
NEUMAN PARTIAL PENETRATION SOLUTION
B: 235' PW TD/CD: 175'/115' OW TD/CD: 135'/110'
ZD1=.4255, ZD2=.5319, PD=.7447, DD=.4894
BETA = .001, .01, .1, 1



WMD

TAPENO 6153 PLOT NO 0019 TIME 09:06

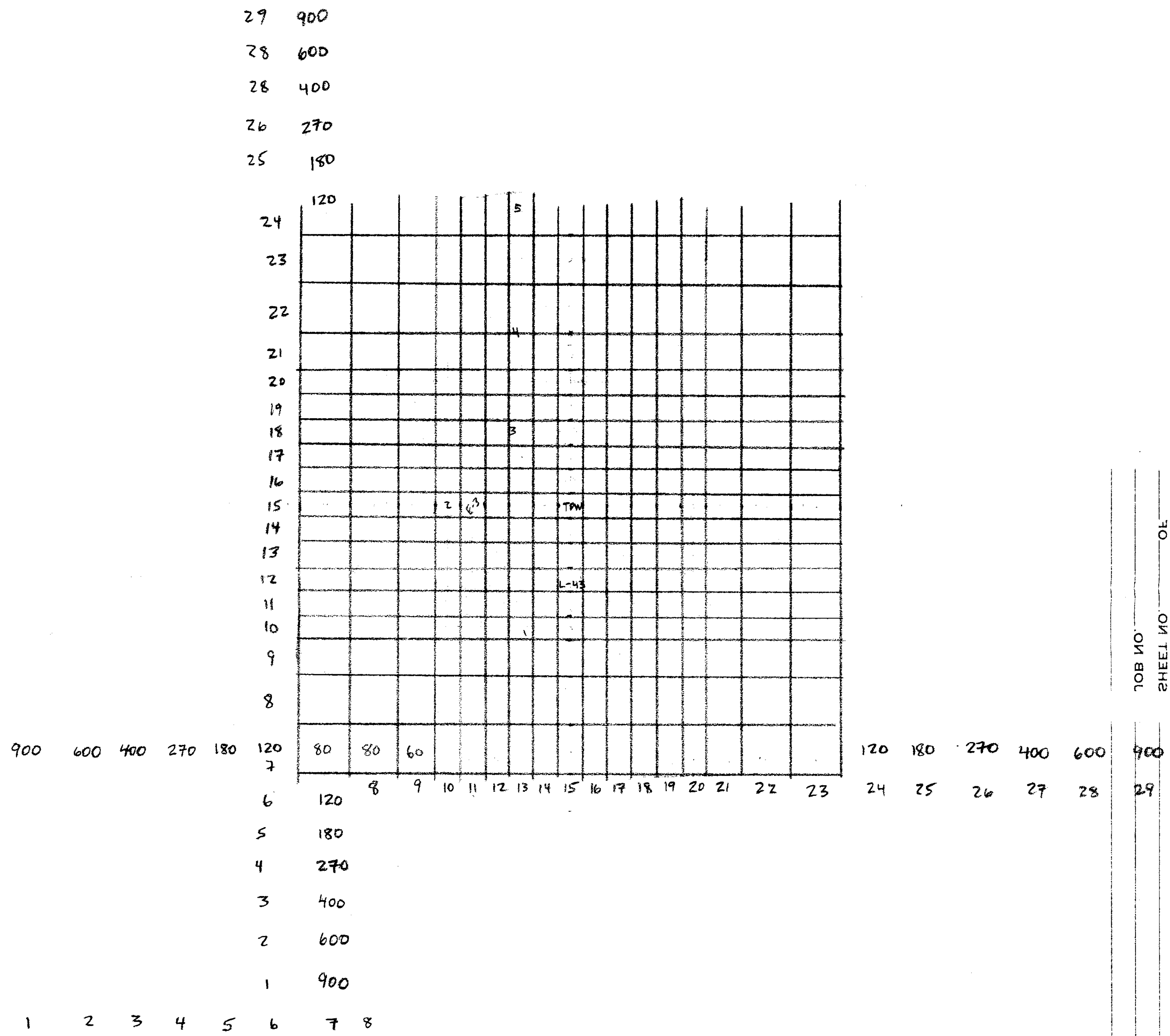
USER NO SHINE DATE 87/07/31



Palm Springs APT Model

4 Layers	K
0-50	150 FT/DAY
50-100	150 FT/DAY
100-150	4000 FT/DAY
150-315	150 FT/DAY

$K_h/K_z = 10/1$



Pumping Node 15,15

Obs Well Nodes

2 → 15,10
5 → 24,13
4 → 22,13 / 21,13
3 → 18,13
1 → 10,13

E-3 Nodes

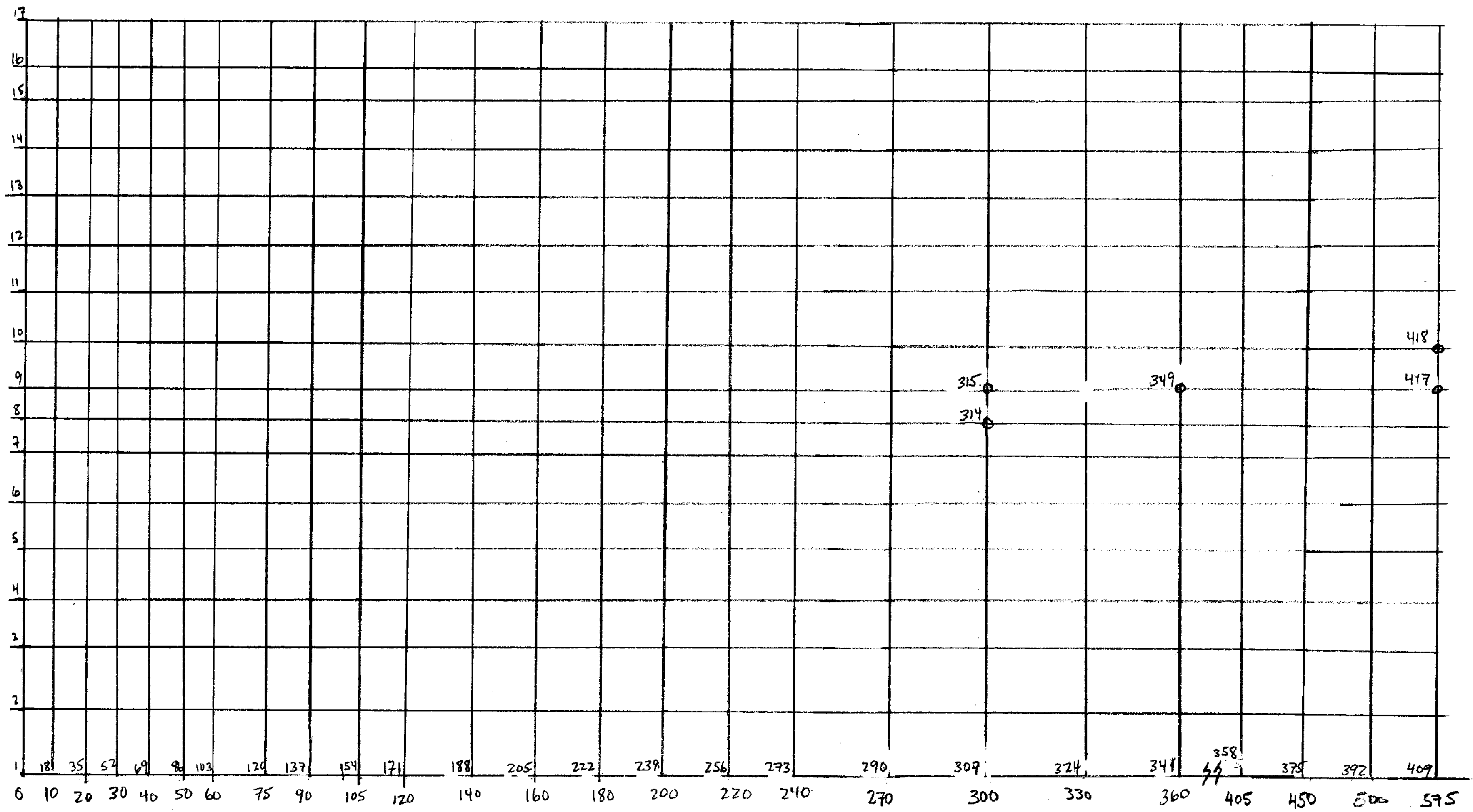
1-29, 11

L-43 Nodes

12, 1-29

JOB NO ___ SHEET NO ___ OF ___
SUBJECT ___
CHKD BY ___ DATE ___
BY ___ DATE ___

Palm Springs APT Analysis SEFTRAN Fine Grid



725 950 1280

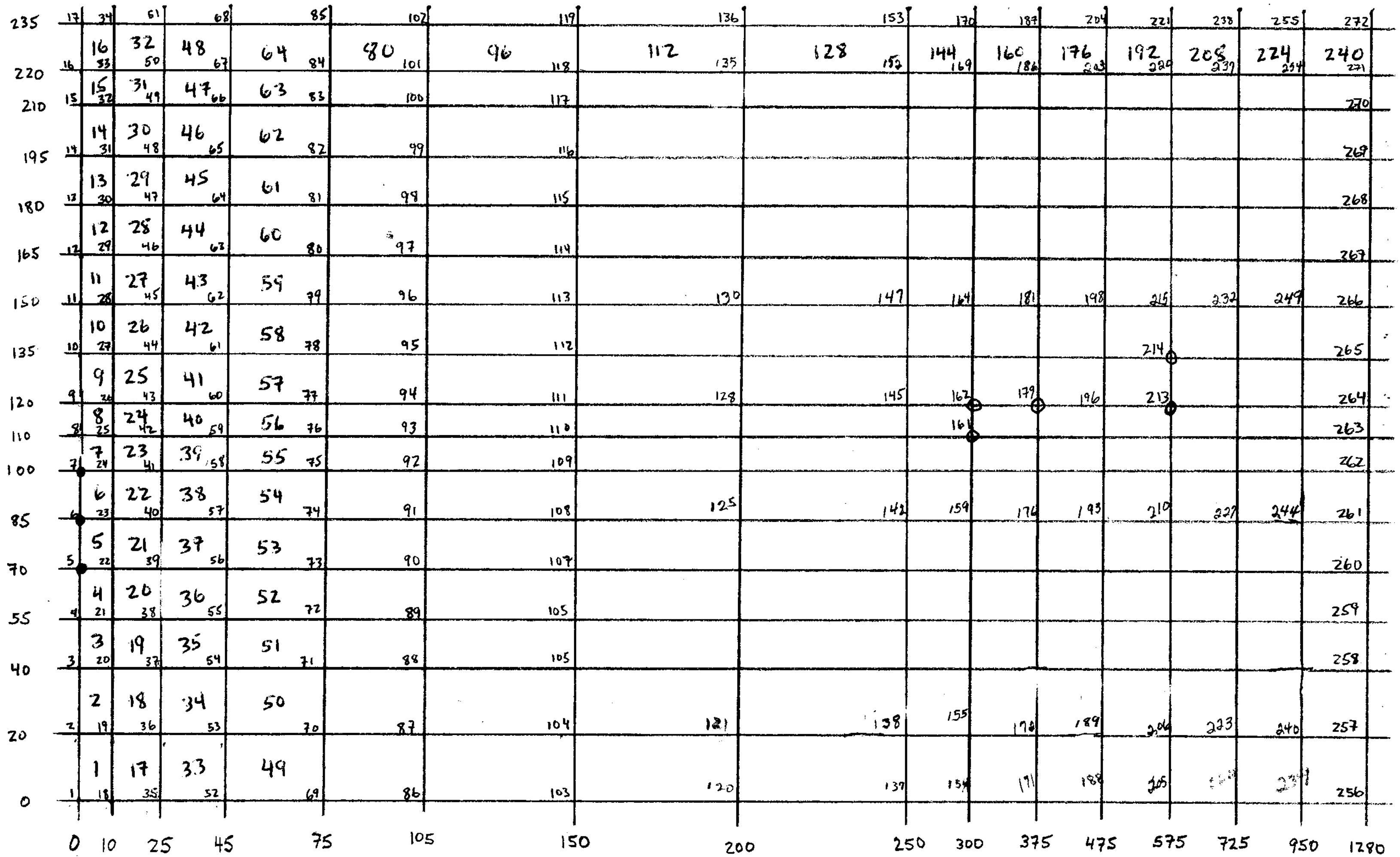
17 28
~~20~~ x ~~25~~

~~500~~ 476
nodes

17 x 25

425 nodes

Palm Springs Pump Test Reanalysis SEFTRAN Grid



type sftps.out SFTPS → Node & Element Data

```
*******************************************************************************
                        S E F T R A N - P C

                            Written by:

                          GeoTrans, Inc.
                    209 Elden Street, Suite 301
                        Herndon, VA  22070

              SEFTRAN: FINITE ELEMENT FLOW AND TRANSPORT
                           VERSION 1.1
               COPYRIGHT 1984 GEOTRANS,INC.,HERNDON,VA

*******************************************************************************
          NUMBER OF PROBLEMS TO BE SOLVED =    1


          PROBLEM NUMBER    1

 ------------------------------------------------------------------------------

 seftran trial palm springs apt

 ------------------------------------------------------------------------------

                         MATERIAL PROPERTY LIST

    MATL.NO.      KXX           KYY           KXY          SS

    1          .600E+03     .600E+03     .000E+00     .200E+00    -.235E+03


          NUMBER OF NODES . . . . . . . . . . . . . .  = 272
          NUMBER OF ELEMENTS. . . . . . . . . . . . .  = 240
          NUMBER OF TIME STEPS. . . . . . . . . . . .  =   5
          NUMBER OF DEPENDENT VARIABLES . . . . . . .  =   1
          NUMBER OF NODES PER ELEMENT . . . . . . . .  =   4
          NUMBER OF DIFFERENT MATERIALS . . . . . . .  =   1
          NUMBER OF PROPERTIES. . . . . . . . . . . .  =   5
          I.C. NONUNIFORMITY INDEX. . . . . . . . . .  =   0


          INITIAL TIME STEP SIZE  . . . . . . . . . .  =   .1500
          INITIAL TIME VALUE  . . . . . . . . . . . .  =   .0000
          TIME MULTIPLIER . . . . . . . . . . . . . .  =   1.500
          MAX. VALUE OF TIME STEP . . . . . . . . . .  =   3.000


          DEFAULT INITIAL VALUES (HEAD OR CONCENTRATION)

                 .0000


          NO. OF NODES FOR WHICH DATA SPECIFIED .  =   0
          CODE FOR GENERATION OF MESH DATA. . . .  =   1
```

NUMBER OF TRIANGULAR ELEMENTS . . . . . = 0

PROBLEM FORMULATION CODE. . . . . = 1
TIME STEPPING INDEX . . . . = 1
NO.OF NODES FOR WHICH I.C.IS TO BE READ = 0
PRINT OUT DELETION CODE . . . . = 0

ELEMENT	NODE NUMBERING			
1	1	18	19	2
2	2	19	20	3
3	3	20	21	4
4	4	21	22	5
5	5	22	23	6
6	6	23	24	7
7	7	24	25	8
8	8	25	26	9
9	9	26	27	10
10	10	27	28	11
11	11	28	29	12
12	12	29	30	13
13	13	30	31	14
14	14	31	32	15
15	15	32	33	16
16	16	33	34	17
17	18	35	36	19
18	19	36	37	20
19	20	37	38	21
20	21	38	39	22
21	22	39	40	23
22	23	40	41	24
23	24	41	42	25
24	25	42	43	26
25	26	43	44	27
26	27	44	45	28
27	28	45	46	29
28	29	46	47	30
29	30	47	48	31
30	31	48	49	32
31	32	49	50	33
32	33	50	51	34
33	35	52	53	36
34	36	53	54	37
35	37	54	55	38
36	38	55	56	39
37	39	56	57	40
38	40	57	58	41
39	41	58	59	42
40	42	59	60	43
41	43	60	61	44
42	44	61	62	45
43	45	62	63	46
44	46	63	64	47
45	47	64	65	48
46	48	65	66	49
47	49	66	67	50
48	50	67	68	51
49	52	69	70	53
50	53	70	71	54

52	55	72	73	56
53	56	73	74	57
54	57	74	75	58
55	58	75	76	59
56	59	76	77	60
57	60	77	78	61
58	61	78	79	62
59	62	79	80	63
60	63	80	81	64
61	64	81	82	65
62	65	82	83	66
63	66	83	84	67
64	67	84	85	68
65	69	86	87	70
66	70	87	88	71
67	71	88	89	72
68	72	89	90	73
69	73	90	91	74
70	74	91	92	75
71	75	92	93	76
72	76	93	94	77
73	77	94	95	78
74	78	95	96	79
75	79	96	97	80
76	80	97	98	81
77	81	98	99	82
78	82	99	100	83
79	83	100	101	84
80	84	101	102	85
81	86	103	104	87
82	87	104	105	88
83	88	105	106	89
84	89	106	107	90
85	90	107	108	91
86	91	108	109	92
87	92	109	110	93
88	93	110	111	94
89	94	111	112	95
90	95	112	113	96
91	96	113	114	97
92	97	114	115	98
93	98	115	116	99
94	99	116	117	100
95	100	117	118	101
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100	106	123	124	107
101	107	124	125	108
102	108	125	126	109
103	109	126	127	110
104	110	127	128	111
105	111	128	129	112
106	112	129	130	113
107	113	130	131	114
108	114	131	132	115
109	115	132	133	116
110	116	133	134	117
111	117	134	135	118
112	118	135	136	119
113	120	137	138	121
114	121	138	139	122
115	122	139	140	123

118	125	142	143	126
119	126	143	144	127
120	127	144	145	128
121	128	145	146	129
122	129	146	147	130
123	130	147	148	131
124	131	148	149	132
125	132	149	150	133
126	133	150	151	134
127	134	151	152	135
128	135	152	153	136
129	137	154	155	138
130	138	155	156	139
131	139	156	157	140
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135	143	160	161	144
136	144	161	162	145
137	145	162	163	146
138	146	163	164	147
139	147	164	165	148
140	148	165	166	149
141	149	166	167	150
142	150	167	168	151
143	151	168	169	152
144	152	169	170	153
145	154	171	172	155
146	155	172	173	156
147	156	173	174	157
148	157	174	175	158
149	158	175	176	159
150	159	176	177	160
151	160	177	178	161
152	161	178	179	162
153	162	179	180	163
154	163	180	181	164
155	164	181	182	165
156	165	182	183	166
157	166	183	184	167
158	167	184	185	168
159	168	185	186	169
160	169	186	187	170
161	171	188	189	172
162	172	189	190	173
163	173	190	191	174
164	174	191	192	175
165	175	192	193	176
166	176	193	194	177
167	177	194	195	178
168	178	195	196	179
169	179	196	197	180
170	180	197	198	181
171	181	198	199	182
172	182	199	200	183
173	183	200	201	184
174	184	201	202	185
175	185	202	203	186
176	186	203	204	187
177	188	205	206	189
178	189	206	207	190
179	190	207	208	191
180	191	208	209	192
181	192	209	210	193
182	193	210	211	194

184	195	212	213	196
185	196	213	214	197
186	197	214	215	198
187	198	215	216	199
188	199	216	217	200
189	200	217	218	201
190	201	218	219	202
191	202	219	220	203
192	203	220	221	204
193	205	222	223	206
194	206	223	224	207
195	207	224	225	208
196	208	225	226	209
197	209	226	227	210
198	210	227	228	211
199	211	228	229	212
200	212	229	230	213
201	213	230	231	214
202	214	231	232	215
203	215	232	233	216
204	216	233	234	217
205	217	234	235	218
206	218	235	236	219
207	219	236	237	220
208	220	237	238	221
209	222	239	240	223
210	223	240	241	224
211	224	241	242	225
212	225	242	243	226
213	226	243	244	227
214	227	244	245	228
215	228	245	246	229
216	229	246	247	230
217	230	247	248	231
218	231	248	249	232
219	232	249	250	233
220	233	250	251	234
221	234	251	252	235
222	235	252	253	236
223	236	253	254	237
224	237	254	255	238
225	239	256	257	240
226	240	257	258	241
227	241	258	259	242
228	242	259	260	243
229	243	260	261	244
230	244	261	262	245
231	245	262	263	246
232	246	263	264	247
233	247	264	265	248
234	248	265	266	249
235	249	266	267	250
236	250	267	268	251
237	251	268	269	252
238	252	269	270	253
239	253	270	271	254
240	254	271	272	255

NODE NUMBER AND X AND Y COORDINATES

1	.00	.00	2	.00	20.00	3	.00	40.00	4	.00	55.00
5	.00	70.00	6	.00	85.00	7	.00	100.00	8	.00	110.00
9	.00	120.00	10	.00	135.00	11	.00	150.00	12	.00	165.00

21	10.00	55.00	22	10.00	70.00	23	10.00	85.00	24	10.00	100.00
25	10.00	110.00	26	10.00	120.00	27	10.00	135.00	28	10.00	150.00
29	10.00	165.00	30	10.00	180.00	31	10.00	195.00	32	10.00	210.00
33	10.00	220.00	34	10.00	235.00	35	25.00	.00	36	25.00	20.00
37	25.00	40.00	38	25.00	55.00	39	25.00	70.00	40	25.00	85.00
41	25.00	100.00	42	25.00	110.00	43	25.00	120.00	44	25.00	135.00
45	25.00	150.00	46	25.00	165.00	47	25.00	180.00	48	25.00	195.00
49	25.00	210.00	50	25.00	220.00	51	25.00	235.00	52	45.00	.00
53	45.00	20.00	54	45.00	40.00	55	45.00	55.00	56	45.00	70.00
57	45.00	85.00	58	45.00	100.00	59	45.00	110.00	60	45.00	120.00
61	45.00	135.00	62	45.00	150.00	63	45.00	165.00	64	45.00	180.00
65	45.00	195.00	66	45.00	210.00	67	45.00	220.00	68	45.00	235.00
69	75.00	.00	70	75.00	20.00	71	75.00	40.00	72	75.00	55.00
73	75.00	70.00	74	75.00	85.00	75	75.00	100.00	76	75.00	110.00
77	75.00	120.00	78	75.00	135.00	79	75.00	150.00	80	75.00	165.00
81	75.00	180.00	82	75.00	195.00	83	75.00	210.00	84	75.00	220.00
85	75.00	235.00	86	105.00	.00	87	105.00	20.00	88	105.00	40.00
89	105.00	55.00	90	105.00	70.00	91	105.00	85.00	92	105.00	100.00
93	105.00	110.00	94	105.00	120.00	95	105.00	135.00	96	105.00	150.00
97	105.00	165.00	98	105.00	180.00	99	105.00	195.00	100	105.00	210.00
101	105.00	220.00	102	105.00	235.00	103	150.00	.00	104	150.00	20.00
105	150.00	40.00	106	150.00	55.00	107	150.00	70.00	108	150.00	85.00
109	150.00	100.00	110	150.00	110.00	111	150.00	120.00	112	150.00	135.00
113	150.00	150.00	114	150.00	165.00	115	150.00	180.00	116	150.00	195.00
117	150.00	210.00	118	150.00	220.00	119	150.00	235.00	120	200.00	.00
121	200.00	20.00	122	200.00	40.00	123	200.00	55.00	124	200.00	70.00
125	200.00	85.00	126	200.00	100.00	127	200.00	110.00	128	200.00	120.00
129	200.00	135.00	130	200.00	150.00	131	200.00	165.00	132	200.00	180.00
133	200.00	195.00	134	200.00	210.00	135	200.00	220.00	136	200.00	235.00
137	250.00	.00	138	250.00	20.00	139	250.00	40.00	140	250.00	55.00
141	250.00	70.00	142	250.00	85.00	143	250.00	100.00	144	250.00	110.00
145	250.00	120.00	146	250.00	135.00	147	250.00	150.00	148	250.00	165.00
149	250.00	180.00	150	250.00	195.00	151	250.00	210.00	152	250.00	220.00
153	250.00	235.00	154	300.00	.00	155	300.00	20.00	156	300.00	40.00
157	300.00	55.00	158	300.00	70.00	159	300.00	85.00	160	300.00	100.00
161	300.00	110.00	162	300.00	120.00	163	300.00	135.00	164	300.00	150.00
165	300.00	165.00	166	300.00	180.00	167	300.00	195.00	168	300.00	210.00
169	300.00	220.00	170	300.00	235.00	171	375.00	.00	172	375.00	20.00
173	375.00	40.00	174	375.00	55.00	175	375.00	70.00	176	375.00	85.00
177	375.00	100.00	178	375.00	110.00	179	375.00	120.00	180	375.00	135.00
181	375.00	150.00	182	375.00	165.00	183	375.00	180.00	184	375.00	195.00
185	375.00	210.00	186	375.00	220.00	187	375.00	235.00	188	475.00	.00
189	475.00	20.00	190	475.00	40.00	191	475.00	55.00	192	475.00	70.00
193	475.00	85.00	194	475.00	100.00	195	475.00	110.00	196	475.00	120.00
197	475.00	135.00	198	475.00	150.00	199	475.00	165.00	200	475.00	180.00
201	475.00	195.00	202	475.00	210.00	203	475.00	220.00	204	475.00	235.00
205	575.00	.00	206	575.00	20.00	207	575.00	40.00	208	575.00	55.00
209	575.00	70.00	210	575.00	85.00	211	575.00	100.00	212	575.00	110.00
213	575.00	120.00	214	575.00	135.00	215	575.00	150.00	216	575.00	165.00
217	575.00	180.00	218	575.00	195.00	219	575.00	210.00	220	575.00	220.00
221	575.00	235.00	222	725.00	.00	223	725.00	20.00	224	725.00	40.00
225	725.00	55.00	226	725.00	70.00	227	725.00	85.00	228	725.00	100.00
229	725.00	110.00	230	725.00	120.00	231	725.00	135.00	232	725.00	150.00
233	725.00	165.00	234	725.00	180.00	235	725.00	195.00	236	725.00	210.00
237	725.00	220.00	238	725.00	235.00	239	950.00	.00	240	950.00	20.00
241	950.00	40.00	242	950.00	55.00	243	950.00	70.00	244	950.00	85.00
245	950.00	100.00	246	950.00	110.00	247	950.00	120.00	248	950.00	135.00
249	950.00	150.00	250	950.00	165.00	251	950.00	180.00	252	950.00	195.00
253	950.00	210.00	254	950.00	220.00	255	950.00	235.00	256	1280.00	.00
257	1280.00	20.00	258	1280.00	40.00	259	1280.00	55.00	260	1280.00	70.00
261	1280.00	85.00	262	1280.00	100.00	263	1280.00	110.00	264	1280.00	120.00
265	1280.00	135.00	266	1280.00	150.00	267	1280.00	165.00	268	1280.00	180.00
269	1280.00	195.00	270	1280.00	210.00	271	1280.00	220.00	272	1280.00	235.00

NUMBER OF DIRICHLET BOUNDARY CONDITIONS = 0

NUMBER OF FLUX BOUNDARY CONDITIONS. . . = 17

FLUX BOUNDARY CONDITION DATA

```
  NODE #     D.O.F. #     B.C. CODE       FLUID FLUX

      1          1           0          -.2090E+04        .0000E+00
  1   1     0 -.209E+04
      2          1           0          -.4180E+04        .0000E+00
  2   1     0 -.418E+04
      3          1           0          -.3660E+04        .0000E+00
  3   1     0 -.366E+04
      4          1           0          -.3140E+04        .0000E+00
  4   1     0 -.314E+04
-----------------------------------------------------------------------
      5          1           0          -.3140E+04        .0000E+00
  5   1     0 -.314E+04
      6          1           0          -.3140E+04        .0000E+00
  6   1     0 -.314E+04
      7          1           0          -.2610E+04        .0000E+00
  7   1     0 -.261E+04
      8          1           0          -.2090E+04        .0000E+00
  8   1     0 -.209E+04
      9          1           0          -.2610E+04        .0000E+00
  9   1     0 -.261E+04
-----------------------------------------------------------------------
     10          1           0          -.3140E+04        .0000E+00
 10   1     0 -.314E+04
     11          1           0          -.3140E+04        .0000E+00
 11   1     0 -.314E+04
     12          1           0          -.3140E+04        .0000E+00
 12   1     0 -.314E+04
     13          1           0          -.3140E+04        .0000E+00
 13   1     0 -.314E+04
     14          1           0          -.3140E+04        .0000E+00
 14   1     0 -.314E+04
-----------------------------------------------------------------------
     15          1           0          -.2610E+04        .0000E+00
 15   1     0 -.261E+04
     16          1           0          -.2610E+04        .0000E+00
 16   1     0 -.261E+04
     17          1           0          -.1570E+04        .0000E+00
 17   1     0 -.157E+04
```

MAXIMUM FULL BANDWIDTH = 37

ELEMENT NUMBERS AND CENTROIDAL COORDINATES

1	5.00	10.00	2	5.00	30.00	3	5.00	47.50	4	5.00	62.50
5	5.00	77.50	6	5.00	92.50	7	5.00	105.00	8	5.00	115.00
9	5.00	127.50	10	5.00	142.50	11	5.00	157.50	12	5.00	172.50
13	5.00	187.50	14	5.00	202.50	15	5.00	215.00	16	5.00	227.50
17	17.50	10.00	18	17.50	30.00	19	17.50	47.50	20	17.50	62.50
21	17.50	77.50	22	17.50	92.50	23	17.50	105.00	24	17.50	115.00
25	17.50	127.50	26	17.50	142.50	27	17.50	157.50	28	17.50	172.50
29	17.50	187.50	30	17.50	202.50	31	17.50	215.00	32	17.50	227.50
33	35.00	10.00	34	35.00	30.00	35	35.00	47.50	36	35.00	62.50
37	35.00	77.50	38	35.00	92.50	39	35.00	105.00	40	35.00	115.00
41	35.00	127.50	42	35.00	142.50	43	35.00	157.50	44	35.00	172.50
45	35.00	187.50	46	35.00	202.50	47	35.00	215.00	48	35.00	227.50
49	60.00	10.00	50	60.00	30.00	51	60.00	47.50	52	60.00	62.50
53	60.00	77.50	54	60.00	92.50	55	60.00	105.00	56	60.00	115.00
57	60.00	127.50	58	60.00	142.50	59	60.00	157.50	60	60.00	172.50

65	90.00	10.00	66	90.00	30.00	67	90.00	47.50	68	90.00	62.50
69	90.00	77.50	70	90.00	92.50	71	90.00	105.00	72	90.00	115.00
73	90.00	127.50	74	90.00	142.50	75	90.00	157.50	76	90.00	172.50
77	90.00	187.50	78	90.00	202.50	79	90.00	215.00	80	90.00	227.50
81	127.50	10.00	82	127.50	30.00	83	127.50	47.50	84	127.50	62.50
85	127.50	77.50	86	127.50	92.50	87	127.50	105.00	88	127.50	115.00
89	127.50	127.50	90	127.50	142.50	91	127.50	157.50	92	127.50	172.50
93	127.50	187.50	94	127.50	202.50	95	127.50	215.00	96	127.50	227.50
97	175.00	10.00	98	175.00	30.00	99	175.00	47.50	100	175.00	62.50
101	175.00	77.50	102	175.00	92.50	103	175.00	105.00	104	175.00	115.00
105	175.00	127.50	106	175.00	142.50	107	175.00	157.50	108	175.00	172.50
109	175.00	187.50	110	175.00	202.50	111	175.00	215.00	112	175.00	227.50
113	225.00	10.00	114	225.00	30.00	115	225.00	47.50	116	225.00	62.50
117	225.00	77.50	118	225.00	92.50	119	225.00	105.00	120	225.00	115.00
121	225.00	127.50	122	225.00	142.50	123	225.00	157.50	124	225.00	172.50
125	225.00	187.50	126	225.00	202.50	127	225.00	215.00	128	225.00	227.50
129	275.00	10.00	130	275.00	30.00	131	275.00	47.50	132	275.00	62.50
133	275.00	77.50	134	275.00	92.50	135	275.00	105.00	136	275.00	115.00
137	275.00	127.50	138	275.00	142.50	139	275.00	157.50	140	275.00	172.50
141	275.00	187.50	142	275.00	202.50	143	275.00	215.00	144	275.00	227.50
145	337.50	10.00	146	337.50	30.00	147	337.50	47.50	148	337.50	62.50
149	337.50	77.50	150	337.50	92.50	151	337.50	105.00	152	337.50	115.00
153	337.50	127.50	154	337.50	142.50	155	337.50	157.50	156	337.50	172.50
157	337.50	187.50	158	337.50	202.50	159	337.50	215.00	160	337.50	227.50
161	425.00	10.00	162	425.00	30.00	163	425.00	47.50	164	425.00	62.50
165	425.00	77.50	166	425.00	92.50	167	425.00	105.00	168	425.00	115.00
169	425.00	127.50	170	425.00	142.50	171	425.00	157.50	172	425.00	172.50
173	425.00	187.50	174	425.00	202.50	175	425.00	215.00	176	425.00	227.50
177	525.00	10.00	178	525.00	30.00	179	525.00	47.50	180	525.00	62.50
181	525.00	77.50	182	525.00	92.50	183	525.00	105.00	184	525.00	115.00
185	525.00	127.50	186	525.00	142.50	187	525.00	157.50	188	525.00	172.50
189	525.00	187.50	190	525.00	202.50	191	525.00	215.00	192	525.00	227.50
193	650.00	10.00	194	650.00	30.00	195	650.00	47.50	196	650.00	62.50
197	650.00	77.50	198	650.00	92.50	199	650.00	105.00	200	650.00	115.00
201	650.00	127.50	202	650.00	142.50	203	650.00	157.50	204	650.00	172.50
205	650.00	187.50	206	650.00	202.50	207	650.00	215.00	208	650.00	227.50
209	837.50	10.00	210	837.50	30.00	211	837.50	47.50	212	837.50	62.50
213	837.50	77.50	214	837.50	92.50	215	837.50	105.00	216	837.50	115.00
217	837.50	127.50	218	837.50	142.50	219	837.50	157.50	220	837.50	172.50
221	837.50	187.50	222	837.50	202.50	223	837.50	215.00	224	837.50	227.50
225	1115.00	10.00	226	1115.00	30.00	227	1115.00	47.50	228	1115.00	62.50
229	1115.00	77.50	230	1115.00	92.50	231	1115.00	105.00	232	1115.00	115.00
233	1115.00	127.50	234	1115.00	142.50	235	1115.00	157.50	236	1115.00	172.50
237	1115.00	187.50	238	1115.00	202.50	239	1115.00	215.00	240	1115.00	227.50

TIME STEP NUMBER = 1

PRINT CHECK FOR ELEMENT NO. 1

PMXXA = .6000E+04 PMYYA = .1500E+04 PMXYA = .0000E+00

SSA = .3704E+02 THETA = .1000E+01

ELEMENT MATRIX: AA - CC - AI1 - EI1

.2648E+04	-.1676E+04	-.1213E+04	.5741E+03
-.1676E+04	.2648E+04	.5741E+03	-.1213E+04
-.1213E+04	.5741E+03	.2648E+04	-.1676E+04

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      .1481E+03        .7407E+02        .3704E+02        .7407E+02
      .7407E+02        .1481E+03        .7407E+02        .3704E+02
      .3704E+02        .7407E+02        .1481E+03        .7407E+02
      .7407E+02        .3704E+02        .7407E+02        .1481E+03

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      .0000E+00        .0000E+00        .0000E+00        .0000E+00

         SOLVING FOR DEPENDENT VARIABLE 1

         PRINT CHECK NDFLX-FVAL-QVAL

             1    -.2090E+04      .0000E+00    2    -.4180E+04      .0000E+00    3    -.3660E+04      .0000E+00
   4    -.3140E+04      .0000E+00    5    -.3140E+04      .0000E+00    6    -.3140E+04      .0000E+00
   7    -.2610E+04      .0000E+00    8    -.2090E+04      .0000E+00    9    -.2610E+04      .0000E+00
  10    -.3140E+04      .0000E+00   11    -.3140E+04      .0000E+00   12    -.3140E+04      .0000E+00
  13    -.3140E+04      .0000E+00   14    -.3140E+04      .0000E+00   15    -.2610E+04      .0000E+00
  16    -.2610E+04      .0000E+00   17    -.1570E+04      .0000E+00

         TIME VALUE  =   .1500E+00


         TIME STEP NO.    1  COMPLETED


-----------------------------------------------------------------------------
         TIME STEP NUMBER =    2
-----------------------------------------------------------------------------

         SOLVING FOR DEPENDENT VARIABLE 1

         PRINT CHECK NDFLX-FVAL-QVAL

             1    -.2090E+04      .0000E+00    2    -.4180E+04      .0000E+00    3    -.3660E+04      .0000E+00
   4    -.3140E+04      .0000E+00    5    -.3140E+04      .0000E+00    6    -.3140E+04      .0000E+00
   7    -.2610E+04      .0000E+00    8    -.2090E+04      .0000E+00    9    -.2610E+04      .0000E+00
  10    -.3140E+04      .0000E+00   11    -.3140E+04      .0000E+00   12    -.3140E+04      .0000E+00
  13    -.3140E+04      .0000E+00   14    -.3140E+04      .0000E+00   15    -.2610E+04      .0000E+00
  16    -.2610E+04      .0000E+00   17    -.1570E+04      .0000E+00

         TIME VALUE  =   .3750E+00


         TIME STEP NO.    2  COMPLETED


-----------------------------------------------------------------------------
         TIME STEP NUMBER =    3
-----------------------------------------------------------------------------

         SOLVING FOR DEPENDENT VARIABLE 1

         PRINT CHECK NDFLX-FVAL-QVAL
```

4	-.3140E+04	.0000E+00	5	-.3140E+04	.0000E+00	6	-.3140E+04	.0000E+00
7	-.2610E+04	.0000E+00	8	-.2090E+04	.0000E+00	9	-.2610E+04	.0000E+00
10	-.3140E+04	.0000E+00	11	-.3140E+04	.0000E+00	12	-.3140E+04	.0000E+00
13	-.3140E+04	.0000E+00	14	-.3140E+04	.0000E+00	15	-.2610E+04	.0000E+00
16	-.2610E+04	.0000E+00	17	-.1570E+04	.0000E+00			

TIME VALUE = .7125E+00

TIME STEP NO. 3 COMPLETED

TIME STEP NUMBER = 4

SOLVING FOR DEPENDENT VARIABLE 1

PRINT CHECK NDFLX-FVAL-QVAL

1	-.2090E+04	.0000E+00	2	-.4180E+04	.0000E+00	3	-.3660E+04	.0000E+00
4	-.3140E+04	.0000E+00	5	-.3140E+04	.0000E+00	6	-.3140E+04	.0000E+00
7	-.2610E+04	.0000E+00	8	-.2090E+04	.0000E+00	9	-.2610E+04	.0000E+00
10	-.3140E+04	.0000E+00	11	-.3140E+04	.0000E+00	12	-.3140E+04	.0000E+00
13	-.3140E+04	.0000E+00	14	-.3140E+04	.0000E+00	15	-.2610E+04	.0000E+00
16	-.2610E+04	.0000E+00	17	-.1570E+04	.0000E+00			

TIME VALUE = .1219E+01

TIME STEP NO. 4 COMPLETED

TIME STEP NUMBER = 5

SOLVING FOR DEPENDENT VARIABLE 1

PRINT CHECK NDFLX-FVAL-QVAL

1	-.2090E+04	.0000E+00	2	-.4180E+04	.0000E+00	3	-.3660E+04	.0000E+00
4	-.3140E+04	.0000E+00	5	-.3140E+04	.0000E+00	6	-.3140E+04	.0000E+00
7	-.2610E+04	.0000E+00	8	-.2090E+04	.0000E+00	9	-.2610E+04	.0000E+00
10	-.3140E+04	.0000E+00	11	-.3140E+04	.0000E+00	12	-.3140E+04	.0000E+00
13	-.3140E+04	.0000E+00	14	-.3140E+04	.0000E+00	15	-.2610E+04	.0000E+00
16	-.2610E+04	.0000E+00	17	-.1570E+04	.0000E+00			

TIME VALUE = .1979E+01

```
type sftps1.out

***************************************************************************
                         S  E  F  T  R  A  N  -  P C

                                 Written by:

                               GeoTrans, Inc.
                         209 Elden Street, Suite 301
                             Herndon, VA  22070

                    SEFTRAN: FINITE ELEMENT FLOW AND TRANSPORT
                                 VERSION 1.1
                     COPYRIGHT 1984 GEOTRANS,INC.,HERNDON,VA

***************************************************************************
         NUMBER OF PROBLEMS TO BE SOLVED =    1


         PROBLEM NUMBER    1

 --------------------------------------------------------------------------

 seftran trial palm springs apt

 --------------------------------------------------------------------------

                           MATERIAL PROPERTY LIST

    MATL.NO.      KXX          KYY          KXY          SS

    1          .600E+03     .600E+03     .000E+00     .200E+00     -.235E+03


         NUMBER OF NODES . . . . . . . . . . . .  = 272
         NUMBER OF ELEMENTS. . . . . . . . . . .  = 240
         NUMBER OF TIME STEPS. . . . . . . . . .  =   5
         NUMBER OF DEPENDENT VARIABLES . . . . .  =   1
         NUMBER OF NODES PER ELEMENT . . . . . .  =   4
         NUMBER OF DIFFERENT MATERIALS . . . . .  =   1
         NUMBER OF PROPERTIES. . . . . . . . . .  =   5
         I.C. NONUNIFORMITY INDEX. . . . . . . .  =   0


         INITIAL TIME STEP SIZE  . . . . . . . .  =   .1500
         INITIAL TIME VALUE  . . . . . . . . . .  =   .0000
         TIME MULTIPLIER . . . . . . . . . . . .  =   1.500
         MAX. VALUE OF TIME STEP . . . . . . . .  =   3.000



         DEFAULT INITIAL VALUES (HEAD OR CONCENTRATION)

                .0000


         NO. OF NODES FOR WHICH DATA SPECIFIED .  =   0
         CODE FOR GENERATION OF MESH DATA. . . .  =   1
         PRINTOUT CONTROL PARAMETER  . . . . . .  =   5
```

```
     NUMBER OF TRIANGULAR ELEMENTS . . . . . =    0


     PROBLEM FORMULATION CODE. . . . . . . . =    1
     TIME STEPPING INDEX . . . . . . . . . . =    1
     NO.OF NODES FOR WHICH I.C.IS TO BE READ =    0
     PRINT OUT DELETION CODE . . . . . . . . =    3


     NUMBER OF DIRICHLET BOUNDARY CONDITIONS =    0

     NUMBER OF FLUX BOUNDARY CONDITIONS. . . =    3


     FLUX BOUNDARY CONDITION DATA

  NODE #     D.O.F. #    B.C. CODE      FLUID FLUX

     5          1          0           -.1230E+05       .0000E+00
 5    1     0 -.123E+05
     6          1          0           -.2550E+05       .0000E+00
 6    1     0 -.255E+05
     7          1          0           -.1230E+05       .0000E+00
 7    1     0 -.123E+05

     MAXIMUM FULL BANDWIDTH =   37

--------------------------------------------------------------------------------
     TIME STEP NUMBER =     1
--------------------------------------------------------------------------------

     PRINT CHECK FOR ELEMENT NO.     1


  PMXXA =   .6000E+04  PMYYA =   .1500E+04  PMXYA =   .0000E+00

    SSA =   .3704E+02  THETA =   .1000E+01

     ELEMENT MATRIX: AA - CC  - AI1 - EI1

    .2648E+04      -.1676E+04      -.1213E+04       .5741E+03
   -.1676E+04       .2648E+04       .5741E+03      -.1213E+04
   -.1213E+04       .5741E+03       .2648E+04      -.1676E+04
    .5741E+03      -.1213E+04      -.1676E+04       .2648E+04
--------------------------------------------------------------------------------

    .1481E+03       .7407E+02       .3704E+02       .7407E+02
    .7407E+02       .1481E+03       .7407E+02       .3704E+02
    .3704E+02       .7407E+02       .1481E+03       .7407E+02
    .7407E+02       .3704E+02       .7407E+02       .1481E+03
--------------------------------------------------------------------------------

    .0000E+00       .0000E+00       .0000E+00       .0000E+00

     SOLVING FOR DEPENDENT VARIABLE 1

     PRINT CHECK NDFLX-FVAL-QVAL
```

```
    5    -.1230E+05    .0000E+00    6    -.2550E+05    .0000E+00    7    -.1230E+05    .0000E+00
TIME VALUE  =   .1500E+00


TIME STEP NO.     1  COMPLETED


------------------------------------------------------------------------------
TIME STEP NUMBER =     2
------------------------------------------------------------------------------

SOLVING FOR DEPENDENT VARIABLE 1

PRINT CHECK NDFLX-FVAL-QVAL

    5    -.1230E+05    .0000E+00    6    -.2550E+05    .0000E+00    7    -.1230E+05    .0000E+00
TIME VALUE  =   .3750E+00


TIME STEP NO.     2  COMPLETED


------------------------------------------------------------------------------
TIME STEP NUMBER =     3
------------------------------------------------------------------------------

SOLVING FOR DEPENDENT VARIABLE 1

PRINT CHECK NDFLX-FVAL-QVAL

    5    -.1230E+05    .0000E+00    6    -.2550E+05    .0000E+00    7    -.1230E+05    .0000E+00
TIME VALUE  =   .7125E+00


TIME STEP NO.     3  COMPLETED


------------------------------------------------------------------------------
TIME STEP NUMBER =     4
------------------------------------------------------------------------------

SOLVING FOR DEPENDENT VARIABLE 1

PRINT CHECK NDFLX-FVAL-QVAL

    5    -.1230E+05    .0000E+00    6    -.2550E+05    .0000E+00    7    -.1230E+05    .0000E+00
TIME VALUE  =   .1219E+01


TIME STEP NO.     4  COMPLETED
```

TIME STEP NUMBER = 5

SOLVING FOR DEPENDENT VARIABLE 1

PRINT CHECK NDFLX-FVAL-QVAL

5	-.1230E+05	.0000E+00	6	-.2550E+05	.0000E+00	7	-.1230E+05	.0000E+00

TIME VALUE = .1978E+01

Partial

NODE NUMBERS AND CORRESPONDING HEAD VALUES

1	-.4153E+00	2	-.4798E+00	3	-.7595E+00	4	-.1217E+01	5	-.4698E+01	6	-.8099E+01
7	-.4824E+01	8	-.1825E+01	9	-.1059E+01	10	-.5883E+00	11	-.3738E+00	12	-.2536E+00
13	-.1808E+00	14	-.1356E+00	15	-.1088E+00	16	-.9866E-01	17	-.9313E-01	18	-.4029E+00
19	-.4645E+00	20	-.6978E+00	21	-.1185E+01	22	-.2051E+01	23	-.2565E+01	24	-.2026E+01
25	-.1414E+01	26	-.9278E+00	27	-.5506E+00	28	-.3580E+00	29	-.2458E+00	30	-.1764E+00
31	-.1329E+00	32	-.1070E+00	33	-.9713E-01	34	-.9175E-01	35	-.3700E+00	36	-.4171E+00
37	-.5826E+00	38	-.8021E+00	39	-.1032E+01	40	-.1127E+01	41	-.1011E+01	42	-.8506E+00
43	-.6762E+00	44	-.4595E+00	45	-.3163E+00	46	-.2241E+00	47	-.1640E+00	48	-.1252E+00
49	-.1016E+00	50	-.9261E-01	51	-.8767E-01	52	-.3049E+00	53	-.3314E+00	54	-.4058E+00
55	-.4769E+00	56	-.5345E+00	57	-.5523E+00	58	-.5187E+00	59	-.4722E+00	60	-.4143E+00
61	-.3233E+00	62	-.2438E+00	63	-.1828E+00	64	-.1390E+00	65	-.1090E+00	66	-.9013E-01
67	-.8277E-01	68	-.7872E-01	69	-.1993E+00	70	-.2068E+00	71	-.2252E+00	72	-.2398E+00
73	-.2491E+00	74	-.2491E+00	75	-.2378E+00	76	-.2244E+00	77	-.2073E+00	78	-.1775E+00
79	-.1468E+00	80	-.1190E+00	81	-.9632E-01	82	-.7933E-01	83	-.6800E-01	84	-.6343E-01
85	-.6088E-01	86	-.1179E+00	87	-.1195E+00	88	-.1230E+00	89	-.1253E+00	90	-.1260E+00
91	-.1239E+00	92	-.1185E+00	93	-.1132E+00	94	-.1066E+00	95	-.9526E-01	96	-.8309E-01
97	-.7132E-01	98	-.6094E-01	99	-.5264E-01	100	-.4681E-01	101	-.4439E-01	102	-.4303E-01
103	-.4948E-01	104	-.4946E-01	105	-.4927E-01	106	-.4883E-01	107	-.4798E-01	108	-.4659E-01
109	-.4459E-01	110	-.4292E-01	111	-.4103E-01	112	-.3786E-01	113	-.3448E-01	114	-.3114E-01
115	-.2808E-01	116	-.2553E-01	117	-.2368E-01	118	-.2289E-01	119	-.2244E-01	120	-.1754E-01
121	-.1746E-01	122	-.1721E-01	123	-.1691E-01	124	-.1649E-01	125	-.1596E-01	126	-.1530E-01
127	-.1481E-01	128	-.1428E-01	129	-.1343E-01	130	-.1256E-01	131	-.1172E-01	132	-.1095E-01
133	-.1031E-01	134	-.9847E-02	135	-.9648E-02	136	-.9535E-02	137	-.5914E-02	138	-.5883E-02
139	-.5792E-02	140	-.5684E-02	141	-.5543E-02	142	-.5373E-02	143	-.5176E-02	144	-.5034E-02
145	-.4885E-02	146	-.4655E-02	147	-.4426E-02	148	-.4210E-02	149	-.4018E-02	150	-.3859E-02
151	-.3743E-02	152	-.3696E-02	153	-.3669E-02	154	-.1881E-02	155	-.1872E-02	156	-.1845E-02
157	-.1813E-02	158	-.1772E-02	159	-.1724E-02	160	-.1670E-02	161	-.1632E-02	162	-.1592E-02
163	-.1531E-02	164	-.1472E-02	165	-.1416E-02	166	-.1368E-02	167	-.1332E-02	168	-.1313E-02
169	-.1294E-02	170	-.1283E-02	171	-.2927E-03	172	-.2915E-03	173	-.2878E-03	174	-.2836E-03
175	-.2781E-03	176	-.2714E-03	177	-.2636E-03	178	-.2576E-03	179	-.2510E-03	180	-.2397E-03
181	-.2260E-03	182	-.2089E-03	183	-.1864E-03	184	-.1549E-03	185	-.1087E-03	186	-.1253E-03
187	-.1341E-03	188	-.1453E-04	189	-.1442E-04	190	-.1406E-04	191	-.1358E-04	192	-.1288E-04
193	-.1188E-04	194	-.1047E-04	195	-.9224E-05	196	-.7680E-05	197	-.4646E-05	198	-.4936E-06
199	.5124E-05	200	.1259E-04	201	.2225E-04	202	.3417E-04	203	.3177E-04	204	.3032E-04
205	-.2769E-06	206	-.2531E-06	207	-.1805E-06	208	-.9256E-07	209	.2486E-07	210	.1710E-06
211	.3413E-06	212	.4634E-06	213	.5859E-06	214	.7494E-06	215	.8429E-06	216	.7863E-06
217	.4585E-06	218	-.3085E-06	219	-.1716E-05	220	-.9601E-06	221	-.5351E-06	222	.3580E-07
223	.3365E-07	224	.2684E-07	225	.1805E-07	226	.5465E-08	227	-.1153E-07	228	-.3318E-07
229	-.5002E-07	230	-.6821E-07	231	-.9557E-07	232	-.1166E-06	233	-.1184E-06	234	-.7929E-07
235	.3451E-07	236	.2692E-06	237	.1248E-06	238	.4508E-07	239	-.5953E-08	240	-.5663E-08
241	-.4712E-08	242	-.3430E-08	243	-.1505E-08	244	.1221E-08	245	.4867E-08	246	.7820E-08
247	.1112E-07	248	.1635E-07	249	.2077E-07	250	.2196E-07	251	.1560E-07	252	-.5380E-08
253	-.5117E-07	254	-.2144E-07	255	-.5192E-08	256	.2722E-08	257	.2603E-08	258	.2205E-08
259	.1655E-08	260	.8097E-09	261	-.4170E-09	262	-.2096E-08	263	-.3481E-08	264	-.5054E-08
265	-.7594E-08	266	-.9822E-08	267	-.1057E-07	268	-.7690E-08	269	.2383E-08	270	.2492E-07
271	.9976E-08	272	.1842E-08								

TIME STEP NO. 5 COMPLETED

```
------------------------------------------------------------------------
        REQUIRED INFORMATION AT OBSERVATION NODES
------------------------------------------------------------------------

        OBSERVED NODE NUMBER =  162

        TIME VERSUS NODAL VALUE OF DEPENDENT VARIABLE (HEAD OR CONCENTRATION)

  .1500E+00    .8000E-09     .3750E+00  -.3390E-06     .7125E+00  -.1884E-04     .1219E+01  -.2551E-03
  .1978E+01   -.1592E-02

        OBSERVED NODE NUMBER =  161

        TIME VERSUS NODAL VALUE OF DEPENDENT VARIABLE (HEAD OR CONCENTRATION)

  .1500E+00   -.9223E-09     .3750E+00  -.3494E-06     .7125E+00  -.1945E-04     .1219E+01  -.2627E-03
  .1978E+01   -.1632E-02

        OBSERVED NODE NUMBER =  179

        TIME VERSUS NODAL VALUE OF DEPENDENT VARIABLE (HEAD OR CONCENTRATION)

  .1500E+00   -.1366E-09     .3750E+00   .1418E-07     .7125E+00  -.2339E-06     .1219E+01  -.2081E-04
  .1978E+01   -.2510E-03

        OBSERVED NODE NUMBER =  213

        TIME VERSUS NODAL VALUE OF DEPENDENT VARIABLE (HEAD OR CONCENTRATION)

  .1500E+00   -.5013E-11     .3750E+00   .1490E-09     .7125E+00  -.1061E-08     .1219E+01  -.9448E-09
  .1978E+01    .5859E-06

        OBSERVED NODE NUMBER =  214

        TIME VERSUS NODAL VALUE OF DEPENDENT VARIABLE (HEAD OR CONCENTRATION)

  .1500E+00   -.4919E-11     .3750E+00   .1425E-09     .7125E+00  -.1131E-08     .1219E+01   .2774E-10
  .1978E+01    .7494E-06

C:\JAMES>
```