PRELIMINARY REPORT
Aquifer Analysis
LUZ Solar Energy Generating Station
Harper Valley, California

December 19, 1989
89-03409.18

THE MARK GROUP
ENGINEERS & GEOLOGISTS, INC.

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LUZ Development and Finance Corporation
924 Westwood Blvd., Suite 1000
Los Angeles, California 90024

Attention: Mr. Paul Limburg

Subject: PRELIMINARY REPORT - Aquifer Analysis
LUZ Solar Energy Generating Systems
Harper Valley, California

Gentlemen:

This letter transmits a preliminary report by The MARK Group, Engineers and Geologists, Inc. (MARK) describing aquifer testing and analysis performed during December 1989 for LUZ Development and Finance. The aquifer test was performed at LUZ Solar Energy Generating Station, in Harper Valley, San Bernardino County, California to support our earlier Hydrogeologic Assessment Report for the site dated April 7, 1989.

Due to time constraints, the analysis was not fully completed. However, all the raw data and enough analysis is included in this report to adequately support the results shown in the report. Generally, the data compiled and analysis completed thus far support the conclusions in our earlier report that there is adequate water supply for the proposed development. Water Quality analysis was not a part of this project.

Sincerely,

The MARK Group,
Engineers & Geologists, Inc.

Raymond L. Moresco
Director of Operations

RLM/GJH:nrc

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PROFESSIONAL CERTIFICATION
REPORT
for
LUZ Development and Finance Corporation
924 Westwood Blvd., Suite 1000
Los Angeles, California 90024

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This report has been prepared by the staff of The MARK Group, Engineers & Geologists, Inc. under the professional supervision of the principal whose seal and signature appear hereon.

The findings, recommendations, specifications or professional opinions are presented, within the limits prescribed by the client, after being prepared in accordance with generally accepted professional engineering and geologic practice. There is no other warranty, either express or implied.

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1.0 INTRODUCTION

1.1 General

This letter is to report the results of aquifer testing and analysis performed by The MARK Group, Engineers & Geologists, Inc. (MARK) for LUZ Development and Finance Corporation (LUZ) at LUZ Solar Energy Generating Station (SEGS) in Harper Valley, California (Vicinity Map, Drawing 1). MARK was authorized by LUZ to perform an aquifer analysis to evaluate the availability of groundwater resources based on current water level measurements and a four-day aquifer test in comparison to conclusions from previous studies as described in a MARK report dated April 7, 1989.

1.2 Objectives

The overall objective of this analysis is to approximate the effects of projected groundwater pumping required to meet the water supply demands of The Harper Valley SEGS operation over a 30-year period. Water supply demands are estimated to be approximately 4800 acre-feet per year (AFY) upon completion of five 80 megawatt SEGS to be constructed over the next four years. For comparison, and to allow for the possibility of other developments increasing water supply demands in the SEGS area, analyses included scenarios of 6000 and 8000 AFY groundwater extraction projected over 15 and 30 years. This analysis is also intended to estimate the effects of projected groundwater pumping on water levels beneath a certain LaMont property located approximately 2 miles west of the SEGS in Section 22 of Township 11 North, Range 5 West, San Bernardino Meridian (Drawing 1).

Analysis of water quality was not a part of this project.

1.3 Executive Summary

Based on the results of a 72 hour aquifer test, calculations using the Theis nonequilibrium equation, and a computer simulated model, projected groundwater use to meet the demands of the Harper Valley SEGS appear to impact groundwater levels no more than the historic result of previous years of groundwater pumping for agricultural purposes in the SEGS area. The historic extraction of an estimated 380,000 total acre feet from 1953 to 1986 (MARK, 1989), or an average of 11,515 acre feet per year (AFY), lowered the water table of the main aquifer as much as 80 feet to an elevation of approximately 1850 feet in 1986 in the SEGS area (formerly the Lockhart and Most Ranches). A digital model of aquifer drawdown was prepared using aquifer characteristics calculated from our recent aquifer test, December 1989 water levels in the immediate SEGS area (approximately 1880 feet elevation), and using the following conservative assumptions for conditions outside the site area:

- No water recharge occurring to the basin during the projected 30 year period;
- Water available only from the "main aquifer" estimated to be 300 feet thick in the Harper Lake area; and
- A "flat" water table at about the current elevation of groundwater beneath the SEGS/Harper Lake vicinity, thereby ignoring water in storage at higher elevations away from the central basin area.

Computer model analysis indicated a maximum drawdown of approximately 30 feet in the SEGS area (a general elevation of about 1850 feet) using 4800 AFY withdrawal, as is currently anticipated. Drawdown effects (lowering of the water table) estimated for the LaMont property were calculated to be 17 feet using the same analytical criteria and an interpreted current aquifer thickness of 100 feet beneath the LaMont property. Actual groundwater conditions at the LaMont property are currently unknown. Less refined Theis time-drawdown calculations indicated a drawdown on the order of 5 to 10 feet at the LaMont property using the same projected pumping rate and similar aquifer characteristics.

Finally, based on the historic effects of decreased agricultural pumping over the past 3 years, wherein the deepest portion of the 1986 "depression cone" has recovered approximately 30 feet, the projected water use for the SEGS alone may not actually lower the water table any more than current conditions.

2.0 SCOPE OF WORK

2.1 General

The following general tasks were completed by MARK for this project:

1. Well inventory in the immediate site vicinity.

2. Preparation for an aquifer test.

3a. Interim aquifer test at a well currently in use for SEGS construction activities.

3b. Four-day aquifer test using a test-pump subcontractor.

4. Analysis of the aquifer test results to calculate projected effects of SEGS water supply demands.

5. Report preparation.

2.2 Task 1 - Well Inventory

Obtaining accurate current well information was essential to achieve the objectives of this project. To select the best site for the aquifer test the location and status of any wells that could be used as pumping or water level observation wells were first established. It was desirable to have several observation wells near the pumping well to properly analyze the pumping test and evaluate possible interference by other actively pumping wells in the area. This required locating pumping wells (high yield irrigation rather than relatively insignificant domestic wells) and monitoring water pumping rates.

Information was obtained from three sources:

1. LUZ Construction Management office at Harper Lake, primarily Mr. Matthew Harris,

2. Don Most, proprietor of remaining agricultural operations on the Lockhart/Most Ranch properties, and

3. Physical inspection of potential well locations based on field observations.

Data obtained from this task are summarized on Table 1, "1989 Well Inventory Table" and corresponding well locations are shown on Drawing 2, "Well Inventory Map and 1989 Water Levels". Several wells previously on record in the area have been destroyed. Several wells not previously recorded were located and measured.

Most domestic wells outside of Sections 19, 24, and 30 on Drawing 2 were not inventoried because they will probably not be impacted by the aquifer test. Certain wells on private property were not accessible.

2.3 Task 2 - Preparation for Pumping Test

Based on our well inventory, a location for an aquifer test was selected using the following criteria:

- locations and possible effects of active pumping wells that could not be shut down during the test,
- location of potential pumping wells and examination of well condition by downhole video,
- locations of potential water level observation wells within range of pumping effects of the test well, and
- control of water discharge from the aquifer test.

An inactive irrigation well in tract "F" of Section 19 (11N4W) was selected for the test well (Well 13 on Drawing 2).

Howard Pump, Inc., Yermo, California was contracted by MARK to pull the existing pump equipment, conduct a downhole video survey, and install test pumping equipment.

2.4 Task 3 - Aquifer Tests (Interim and 4-Day)

2.4.1 Interim Test

Any validated aquifer test data in the Harper Valley basin that could be obtained was considered valuable to the objectives of this project.

During the course of our well inventory, it was noted that a well approximately 1/2 mile southeast of the LUZ Construction Management (LCM) main gate (MARK Well No. 7 on Drawing 2, State well location 11N 4W 19Q) was being operated as a water supply well by the earthwork subcontractor at the site. Three potential observation wells were also located (No's. 6, 12, and 27 on Drawing 2). The construction supply well is fairly close to the selected test pumping well (about 1/2 mile to the south); therefore it was important to know the effects of pumping this well on nearby wells.

The construction supply well is pumped at a steady rate of 700 gallons per minute (gpm) during working days and shut off during evenings and, sometimes, shut down over the weekend.

Authorization was granted to conduct a groundwater recovery test at this well over the weekend of December 2 and 3 (while the pump was scheduled to be turned off) and perform a continuous discharge aquifer test starting Monday, December 4 lasting until a convenient stopping time. MARK well Nos. 6, 12, and 27 were monitored as observation wells.

This information was useful when analyzing the four-day aquifer test because it provided additional and supplemental data on aquifer parameters and static water levels, as well as allowing consideration of the effects of pumping a well so near the longer 4 day test. Well No. 7 continued pumping at 700 gpm from December 5 throughout the duration of the Four-Day Test in well No. 13 and subsequent recovery monitoring. Drawdown effects from pumping at well No. 7 had stabilized by the time the Four-Day Test commenced.

2.4.2 Four-Day Test

On Wednesday, December 6, 1989 at 9:15 a.m., pumping began at the test well (No. 13 on Drawing 2) at a constant pumping rate of 1400 gpm. The test was run continuously for over 72 hours until the following Saturday morning. Water levels in the pumping well and eight observation wells (MARK well No.'s 6, 12, 14, 16, 17, 25, 27, and 28 on Drawing 2) were monitored by MARK personnel throughout the test. An automatic data recorder that measures water level changes and barometric pressure at programmed time intervals was installed in wells 14, 28, and 25 and used throughout the test. Water levels were monitored in most of the same wells for approximately 48 hours after the pump was turned off to analyze recovery effects.

Besides well No. 7, the only other wells known to be pumping within one mile of the test well No. 13 were Nos. 10 and 11 located about 1/2 mile west of No. 13. These two wells are small diameter and assumed to produce quantities of water and related drawdown levels which would not significantly affect test results.

Also, a Most Ranch irrigation well just south of the test pumping area (No. 38 on Drawing 2, 11N4W30B) had been pumping continuously at about 1000 gpm for more than one week prior to either pumping test; the well was coincidentally shut off at the beginning of the 4-day test on December 6.

2.5 Task 4 - Analysis and Calculation

2.5.1 Transmissivity and Storativity

Water level monitoring data taken during the interim test at MARK well No. 7 and corresponding aquifer transmissivity analyses are in Appendix A. Transmissivity is the rate at which water is transmitted through a unit width of the aquifer under a unit hydraulic gradient. Data and transmissivity analysis for the 72 hour test at MARK well No. 13 are in Appendix B. Data has been analyzed for transmissivity and storativity using the Cooper-Jacob straight-line method. Results of transmissivity calculations are summarized in Table 2.

Storativity is the volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head. A common storage coefficient of 0.10 was used for all subsequent projections of pumping effects for reasons described in detail in Appendix B.

2.5.2 Projected Average Water Level Decline

The method of average water level declines is a first cut approach which assumes that the drawdown induced by pumping is spread evenly across the entire acquifer area being considered with no recharge allowed to replenish the aquifer. It estimates the average thickness of aquifer which must be dewatered to account for the volume of water to be produced over 30 years. The result of this analysis is a single number that represents the average water level change.

A 12 x 12 mile area (indicated in Drawing 3) was used in the following formula:

$$s = V_w/SA_a$$

where s = average drawdown in feet

S = storativity (0.10 was used)

A_a = total area of the aquifer, (144 square miles)

Vw = total volume of the projected water in storage to be pumped (4800 AFY x 30 years = 144,000 AF)

An average drawdown of 19.9 feet was calculated for the entire aquifer area. Actually, water level declines will be greatest in the vicinity of pumping wells and least in areas far from pumping. For example, drawdown could be 50 feet within 1000 feet of the pumping area and less than 20 feet four miles away.

2.5.3 Theis Nonequilibrium Analysis

The Theis non-equilibrium analysis allows for some consideration of the distribution of drawdown induced by pumping. For this analysis, projected pumping was concentrated at one point and the predicted water level decline was calculated at various times and distances from the pumping point.

The following Theis equation and assumptions were utilized:

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

where:

- s = drawdown
- r = radius from pumping well
- t = time since pumping started
- Q = pumping rate
- T = transmissivity (from pumping tests)
- $W_{(u)}$ = well function (an exponential integral)

assumptions:

- transmissivity does not change with a change in head;
- aquifer is homogeneous and isotropic, uniform in thickness, and infinite in areal extent;
- no recharge from any source;
- the pumped well penetrates, and receives water from, the full thickness of the aquifer;
- water removed from storage is discharged instantaneously when the head is lowered;
- the pumping well is 100% efficient;
- all water removed from the well comes from aquifer storage;
- laminar flow exists throughout the well;
- the water table has no initial slope.

The effects of pumping for various scenarios were calculated and are summarized on Table 3 and drawings 5 and 6.

2.5.4 Computer Simulated Digital Model

For more sophisticated analysis of the effects of projected groundwater pumping for SEGS, a portion of the Harper Valley basin was simulated with the PLASM (Prickett and Lonnquist, 1971) digital model.

PLASM allows for needed flexibility in considering distribution of pumping and variability in hydraulic parameters of the aquifer. Time constraints required that hydraulic parameters be generalized. Calibration of hydraulic parameters with historical pumping data was not performed. The model results are an estimate of future water levels.

The area modeled is a 144-square-mile, rectangular grid (12 x 12 miles) with Harper Dry Lake centrally located as shown on Drawing 3. The northern and western boundaries of the model area are near the limits of the basin defined by bedrock of low transmissivity. Bedrock outcrops have been described in previous geologic reports of the area (see references). Potential recharge sources (saturated alluvium) exist at the southern and eastern boundaries of the model. In particular the eastern model boundary extends through the portion of the basin that is in hydrologic continuity with, and downgradient from, the higher potentiometric heads associated with the Mojave River/Hinkley portion of the Middle-Mojave basin.

The model area is divided into 576, 1/2 x 1/2-mile areas. The individual nodes are not shown on Drawing 3, but the 1-square-mile survey grid sections from the USGS 15 minute quadrangle base map on Drawing 3 each include 4 nodes.

The parameters that can be varied at each individual node are as follows:

- Transmissivity (entered as a function of aquifer thickness and hydraulic conductivity),

- Storativity,
- Potentiometric head elevation ("water table" surface elevation),
- Elevation of aquifer bottom, and
- Recharge conditions (if any).

For this initial stage of modeling, certain parameters were simplified to be conservative. They are:

- "No-flow" recharge conditions were used along the outer boundaries of the model, thereby nullifying any argument concerning the currently unknown actual groundwater recharge conditions. However, it should be pointed out that historic conditions support the conclusion in our April 1989 report that there could be recharge to Harper Valley groundwater basin in volumes ranging from 2000 to 6000 AFY.

- A constant initial potentiometric head was used. This was done because of data and time constraints involved in setting up the model to represent actual dynamic equilibrium flow conditions at the start of projected pumping iterations.

- Groundwater storage was considered within the "main aquifer" only, estimated to lie between elevations of approximately 1900 and 1600 feet (above mean sea level), thereby ignoring the so-called "deep aquifer" and the poorer-quality, "perched" groundwater zone known to exist within the general Harper Dry Lake area.

- The Lockhart Fault Zone was considered (refer to MARK April 7 report) to be a significant impedance to groundwater flow from higher elevations in the southern portion of the model, even though there is no observed evidence that the fault does cause significant impedance to groundwater flow.

Also, a constant storativity of 0.10 was used in all nodes for reasons explained in Appendix C.

The effective transmissivity was varied by using different aquifer thicknesses and hydraulic conductivities according to the grid shown on Drawing 3 based on the following factors:

- Transmissivities of 300,000 gpd/ft were used for a 300-foot-thick aquifer in the SEGS site area as a conservative average of pumping test analysis results and geologic well logs.

- Transmissivities of 100,000 gpd/ft were used for most of the remaining central basin based on geologic logs and certain well-yield data from Sections 2 and 4 of T.11N/R.4W.

- Other transmissivities (including 2500 gpd/ft in the Lockhart Fault Zone) were based on a combination of geologic interpretations from the present investigation combined with transmissivity interpretations made in U.S.G.S. Open File Report 72-157, Hydrologic Analysis of Mojave River Basin, California, (Hardt, 1971).

3.0 RESULTS

3.1 Groundwater Elevations

A generalized groundwater contour map of the "main aquifer" is shown on Drawing 4 using MARK December 1989 water level measurements (described in detail on Drawing 2 and Table 1) for the SEGS area, and 1986 measurements (Crandall 1986) for most of the outlying wells surrounding Harper Lake. (Perched groundwater is known at depths on the order of 10 to 20 feet in the general SEGS area, but analysis of the perched groundwater zone was not a part of this study.) We are assuming that the groundwater elevations in the outlying wells have not changed significantly since the 1986 measurements. The groundwater elevations within the SEGS area are considered accurate to within approximately ± 2 feet based on ground surface elevations at the measuring points interpolated from USGS 7.5 minute quadrangles for Lockhart and Twelve Gauge Lake, California. Therefore, the approximate elevations have been averaged to represent a general elevation of approximately 1880 feet above sea level throughout the immediate SEGS area. In comparison to 1986 well elevations measured by Leroy Crandall and Associates, current data indicates a general recovery of water levels in the main aquifer in the agricultural irrigation area (Drawing 2) of 20 to 30 feet over the past three years, probably due to decreased irrigation pumping. There are no reliable measuring points for the main aquifer in the basin area west and north of the SEGS property but it is reasonable to assume that the main aquifer water table roughly corresponds to elevations similar to the easterly and southerly contours shown on Drawing 4, and that the main aquifer water table lies approximately 100 to 200 feet beneath ground surface.

3.2 Aquifer Characteristics

3.2.1 Transmissivity

Table 2 summarizes transmissivity calculations made from 1989 aquifer test data (Appendices A and B) that were available for this report. Some of the data were not plotted, calculated, and checked in time for this report and will be provided in an addendum.

Transmissivities shown in Table 2 were calculated using the Cooper-Jacob straight line method. The remaining data will be analyzed using the Theis curve-fitting technique. The results on Table 2 combined with preliminary results from Theis-method analyses of the remaining wells indicate an approximate transmissivity of 300,000 gallons per day per foot (gpd/ft) can be used for the aquifer area tested. The final results of transmissivity calculations will be included as an addendum later.

3.2.2 Storativity

Storativity values were also calculated as shown in Appendices A and B. However, because the aquifer appears to be unconfined, a storativity value of 0.10 has been used in drawdown calculations and the PLASM model. The rationale for using 0.10 for storativity is described in detail in Appendix C.

3.2.3 Aquifer Thickness

Based on a study of the well logs in Harper Valley Basin, the "bottom" of the main aquifer is conservatively interpreted to be at an average elevation of approximately 1600 feet. This translates into an average aquifer thickness of about 300 feet. This is considered conservative because the so-called "deeper" aquifer is ignored. Water in storage and leakage from perched groundwater (known to exist at depths of 5 to 20 feet in the western Harper Dry Lake and SEGS area) are also ignored.

3.3 Projected Drawdowns at SEGS

3.3.1 Theis Time - Drawdown Projections

Table 3 summarizes the results of Theis time-drawdown calculations for various scenarios. Groundwater extractions range from the anticipated SEGS demand of approximately 4800 AFY to quantities of 6000 and 8000 AFY for comparison and to evaluate the possibility of other developments in the area. These scenarios were projected over 15 and 30 year periods using transmissivity variables of 70,000, 100,000 and 300,000 and 630,000 gpd/ft.

The first four calculations on Table 1, using 4800 AFY extraction effects at 1/2 to 1 mile from the theoretical single well, showing drawdowns of 15 to 20 feet, are the most realistic representations calculated for Table 2 of possible drawdowns in the SEGS area. The same 30 year scenario is shown in plan view on Drawing 6. It is important to note that several wells spaced several hundred or a few thousand feet apart will actually be used for the well field to avoid drawdown concentrated at a single point.

3.3.2 PLASM Projections for SEGS area

Table 4 summarizes the results of PLASM calculations of water level declines for 8 scenarios including total annual extractions of 4800, 6000 and 8000 AFY projected over approximately 15 and 30 years using a conservative "no recharge" assumption. The most realistic projection calculated, of 4800 AFY over 15 and 30 years, resulted in calculated maximum drawdowns of 20 and 31 feet in the SEGS well field. Estimated water level declines predicted by the PLASM for the 8 scenarios on Table 4 are shown as generalized contour maps of the model area on Drawings 7 through 14.

3.4 Projected Drawdowns at LaMont Property

3.4.1 Theis Time - Drawdown Projections

The 4-mile radius represents the distance from the proposed SEGS groundwater extraction well field area, centered at the northwest corner of Section 32 of 11N/4W (Drawing No. 1), to the LaMont property in Section 22 of 11N/5W. Using an annual volume of 4800 AFY discharge, values for transmissivity of 100,000 and 300,000 gpd/ft, and a storage coefficient of 0.10, we calculate projected drawdowns at 4 miles distance of 2.8 to 5.2 feet over 15 years and 3.6 to 7.1 feet over 30 years (Table 3 and Drawing 6).

3.4.2 PLASM projections at LaMont Property

Table 4 includes a summary of projected water level declines at the LaMont property for the various scenarios calculated by the PLASM model. For the most realist groundwater extraction discharge of 4800 AFY, and using a conservative "no recharge" scenario, the model calculated water level declines of approximately 7 and 17 feet for 15 and 30 years, respectively, in Section 22. Again, generalized water level decline contours calculated by PLASM are shown on Drawings 7 through 14.

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TABLE 1: 1989 WELL INVENTORY

MARK	WELL NUMBER STATE	MOST	DATE MEASURED	DEPTH TO WATER (FT)	SURFACE ELEVATION (FT)	WATER ELEVATION (FT)	USE	REMARKS
1	11N/4W-30N	14	11/28/89	224.08	2104	1880	Irrigation	Not pumping 11-28-89
2	11N/4W-30N	28			2104		Irrigation	Cascading water falling into well. Unable to obtain measurement. Not pumping 11-28-89.
3	11N/4W-30M	21	11/28/89	207	2098	1891	Irrigation	No access port. Drillers moved pump to allow for later access. Not pumping 11-28-89.
4	11N/4W-30E	15	11/28/89	215	2087	1872	Irrigation	TD = 534 Drillers removed pump. Well no longer efficient for irrigation purposes.
5	11N/4W-30D	22	12/05/89	207.71	2082	1874	Irrigation	Drillers raised pump to allow measurement access. Not pumping 12-5-89.
6	11N/4W-19Q		12/04/89	185.75	2058	1872	Monitor	Casing covered with cap. Easy measuring access. No pump.
7	11N/4W-19Q	5			2058		Construction	Pumping well (Q = 700 gpm). Provides water for construction site.
8	11N/4W-30K	33	11/28/89	203.35	2080	1877	Irrigation	Not pumping 11-28-89
9	11N/4W-30P	6			2083		Irrigation	Unable to measure; Pump attatched; Not pumping 11-28-89.
10	11N/4W-19E	34			2058		Irrigation	Submersible pump. Pumping at 14:30 11-28-89 = 4,777,222 gallons.

TABLE 1: 1989 WELL INVENTORY

MARK	WELL NUMBER STATE	MOST	DATE MEASURED	DEPTH TO WATER (FT)	SURFACE ELEVATION (FT)	WATER ELEVATION (FT)	USE	REMARKS
11	11N/4W-19E	16			2058		Irrigation	Has submersible pump. No access for measurement.
12	11N/4W-19K	8	12/04/89	180.79	2059	1878	Irrigation	Not pumping 12-04-89.
13	11N/4W-19F	17	11/29/89	172.36	2049	1877	Irrigation	Used for pumping test 12/06/89 - 12/09/89.
14	11N/4W-19G		11/29/89	161.37	2048	1887	Monitor	TD = 475' - Volcanics/Schist below middle aquifer. Perforated in lower aquifer - upward vertical gradient (FOX - 1989).
15	11N/4W-18H		11/28/89	137.75	2023	1885	Monitor	No pump, casing covered by railroad ties.
16	11N/4W-19A		11/28/89	151.24	2034	1883	Monitor	No pump.
17	11N/5W-24K		12/05/89	210.63	2085	1874	Irrigation	Located within LUZ Construction site. Submersible pump (FOX 1989) removed 12/05/89. TD = 430'.
18	11N/5W-24Q				2087		Irrigation	Well or booster station? No access for measurement.
19	11N/5W-24P				2098		Irrigation (Construction)	New pump. Not pumping as of 12/05/89. No access for measurement.
20	11N/4W-33Q		11/29/89	213.05	2095	1882	Domestic	Domestic well. No pump.
21	11N/4W-30H		11/29/89	170	2052	1882	Domestic	Domestic well. Not pumping.

TABLE 1: 1989 WELL INVENTORY

MARK	WELL NUMBER STATE	MOST	DATE MEASURED	DEPTH TO WATER (FT)	SURFACE ELEVATION (FT)	WATER ELEVATION (FT)	USE	REMARKS
22	11N/4W-29D				2050			
23	11N/4W-19R		11/29/89	11.43	2044	2033	Monitor	Shallow aquifer (perched) monitoring well.
24	11N/4W-19J		11/29/89	158.67	2039	1880	Monitor	No pump. 6' casing welded to bottom of cover.
25	11N/4W-19H		11/29/89	159.45	2040	1881	Monitor	No pump. Open hole in concrete pad.
26	11N/4W-19L		11/29/89		2056		Monitor	Dry to 128'.
27	11N/4W-19L		12/04/89	182.1	2056	1874	Monitor	Open casing, no pump.
28	11N/4W-19H		12/05/89	162.55	2045	1882	Monitor	Pump removed, 12/89.
29	11N/4W-33C	1			2040		Irrigation	Pumping 11/29/89, flow meter non-functioning.
30	11N/4W-33B	2			2040		Irrigation	Not pumping 11/29/89. Attempted measurement. Survey chain obstructed 100'.
31	11N/4W-33G	3			2060		Irrigation	Pumping 11/29/89. Q = 1000 gpm.
32	11N/4W-33H	4			2059		Irrigation	Not pumping 11/29/89. Has airline in access port. Survey chain obstructed 166'.
33	11N/4W-32D	11			2075		Irrigation	Not pumping 11/29/89. No access port.

TABLE 1: 1989 WELL INVENTORY

MARK	WELL NUMBER STATE	MOST	DATE MEASURED	DEPTH TO WATER (FT)	SURFACE ELEVATION (FT)	WATER ELEVATION (FT)	USE	REMARKS
34	11N/4W-29Q	19			2050		Irrigation	Not pumping 11/29/89. No access port.
35	11N/4W-32A				2044		Irrigation	Pumping 11/29/89. USGS observation well. No flow meter.
36	11N/4W-29N		11/29/89	167	2067	1899	Monitor	TD = 698′ Screened to deep aquifer (FOX, 1989).
37	11N/4W-28M	29			2040		Irrigation	Pumping 11/29/89. Q = 1000 gpm.
38	11N/4W-30A	7	11/29/89		2045		Irrigation	Pumping 11/29/89. Q = 1000 gpm.

TABLE 2: Summary of Transmissivity Calculations

WELL NO. 7

Observation Well Number	r Distance from Pumping Well (ft)	Total Drawdown During Test (ft)	Transmissivity (T) gpd/ft Pumping	Transmissivity (T) gpd/ft Recovery
6	80	3.7	70,000	82,000
12	1120	1.1	297,000	420,000
27	1850	0.8	260,000	267,000

WELL NO. 13

Observation Well Number	r Distance from Pumping Well (ft)	Total Drawdown During Test (ft)	Transmissivity (T) gpd/ft Pumping	Transmissivity (T) gpd/ft Recovery
12	1630	2.8	199,000	215,000
13	pumping well	77		30,000
27	1150	7.2	127,000	89,000
28	1860	1.7	369,000	420,000

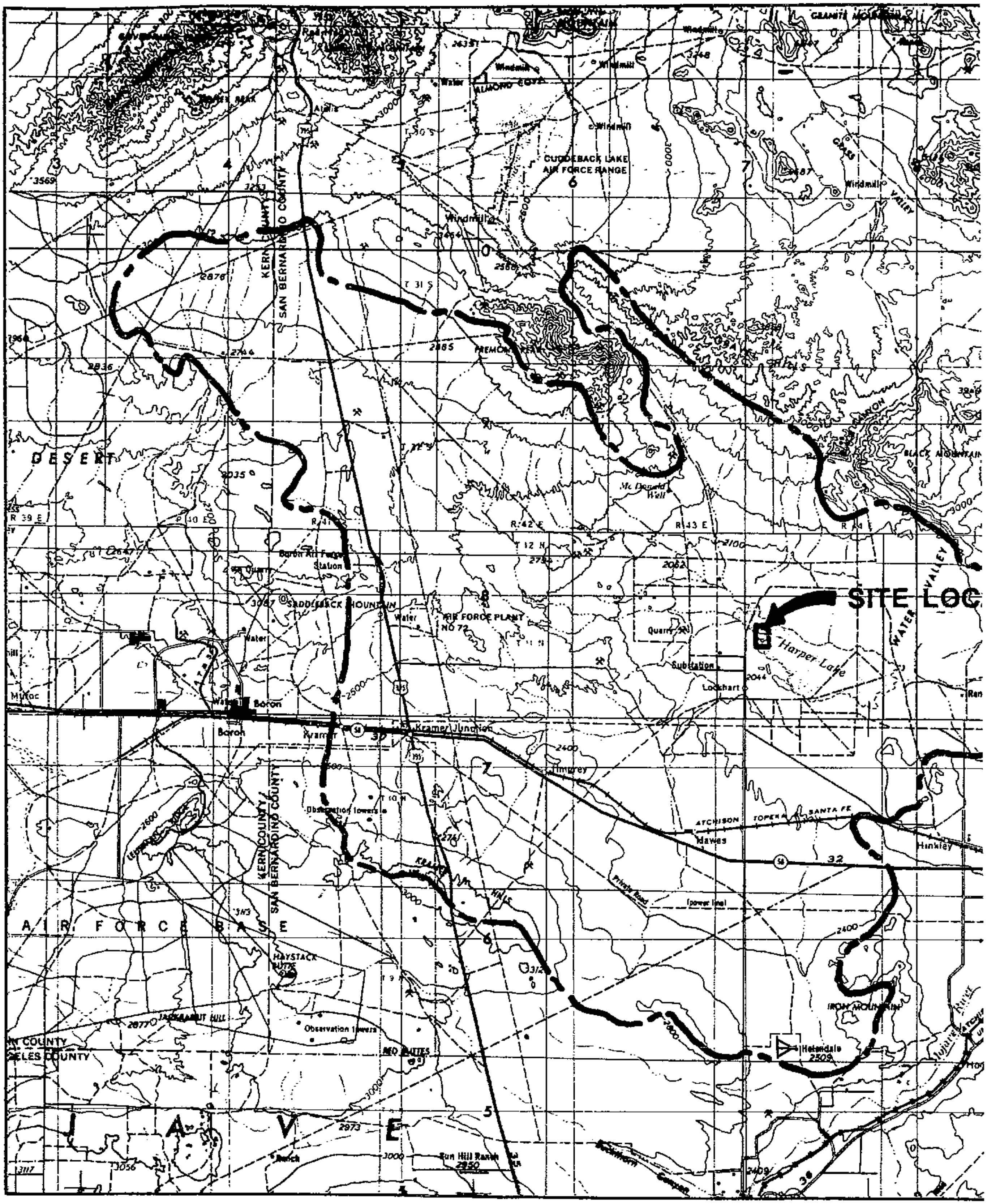
TABLE 3: Results of Time-Drawdown Analyses

Q Discharge acre-ft/year	r Distance from pumping well (miles)	time (yrs)	Transmissivity (gpd/ft)	Storage Coefficient	Predicted Drawdown (ft)
4800	.5	15	100,000	.10	18.3
4800	.5	30	100,000	.10	21.0
4800	1	15	100,000	.10	14.0
4800	1	30	100,000	.10	16.3
4800	2	15	100,000	.10	9.3
4800	2	30	100,000	.10	11.6
4800	4	15	100,000	.10	5.2
4800	4	30	100,000	.10	7.1
4800	.5	15	300,000	.10	7.5
4800	.5	30	300,000	.10	8.3
4800	1	15	300,000	.10	5.7
4800	1	30	300,000	.10	6.7
4800	2	15	300,000	.10	4.4
4800	2	30	300,000	.10	5.1
4800	4	15	300,000	.10	2.8
4800	4	30	300,000	.10	3.6
8000	4	1	70,000	.10	0.9
8000	4	10	70,000	.10	6.9
8000	4	20	70,000	.10	11.3
8000	4	30	70,000	.10	13.9
8000	4	1	630,000	.10	0.7
8000	4	10	630,000	.10	2.5
8000	4	20	630,000	.10	3.1
8000	4	30	630,000	.10	3.5

TABLE 4: SUMMARY OF COMPUTER SIMULATIONS

Q Discharge (acre-ft/yr)	Maximum Transmissivity (gpd/ft)	Time (years)	Predicted Drawdown (ft) SEGS Well Field*	Predicted Drawdown (ft) Section 22
8,000	100,000	15	44	10
8,000	100,000	30	65	27
8,000	300,000	15	33	11
8,000	300,000	30	53	28
6,000	300,000	15	25	9
6,000	300,000	30	39	21
4,800	300,000	15	20	7
4,800	300,000	30	31	17

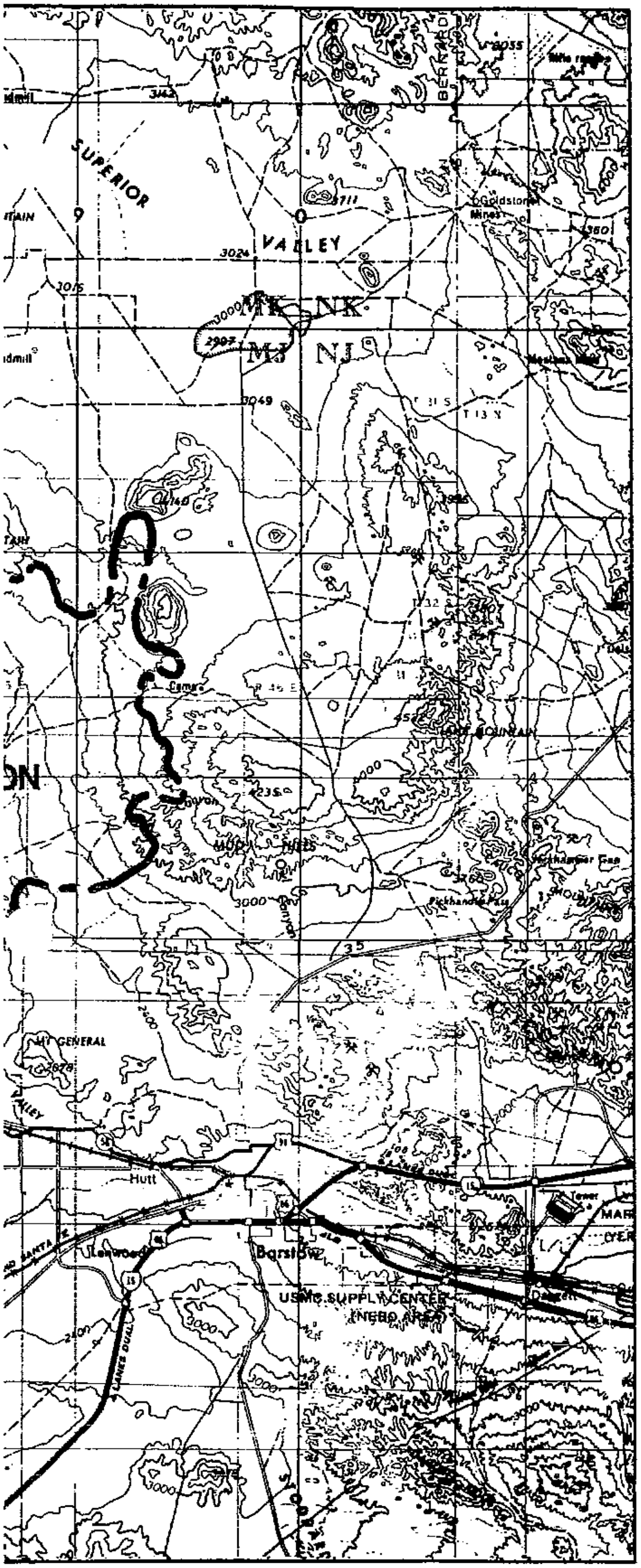
* 4 wells distributed within sections 28, 32, and 33 of TIIN/4W (Drawing No. 3)



Prepared By

Approved By

Date 12/11/89



EXPLANATION

HARPER LAKE GROUNDWATER BASIN BOUNDARY

☐ STUDY AREA

NORTH

0 5 10 MILES

SCALE

SOURCES:

USGS SAN BERNARDINO AND TRONA 1:250,000 SHEETS.

DWR BULLETIN 84.

DWR BULLETIN 106-1.

THE MARK GROUP
ENGINEERS & GEOLOGISTS, INC.

SITE VICINITY MAP
Aquifer Study

LUZ Development and Finance Corporation
Harper Valley, California

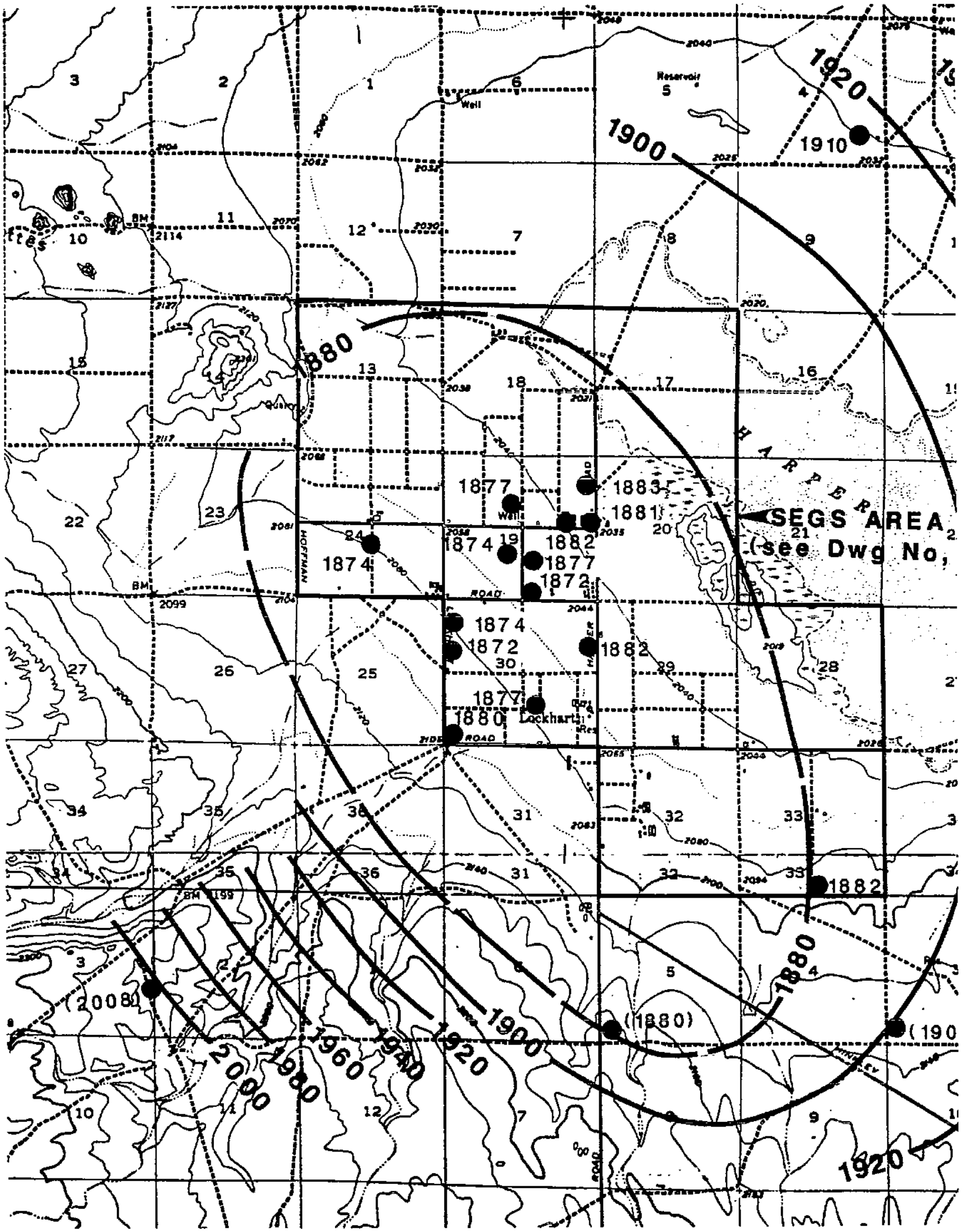
PROJECT NO.
89-03409.18

DRAWING NO.
1

Date 12-19-89

Approved By

Prepared By



EXPLANATION

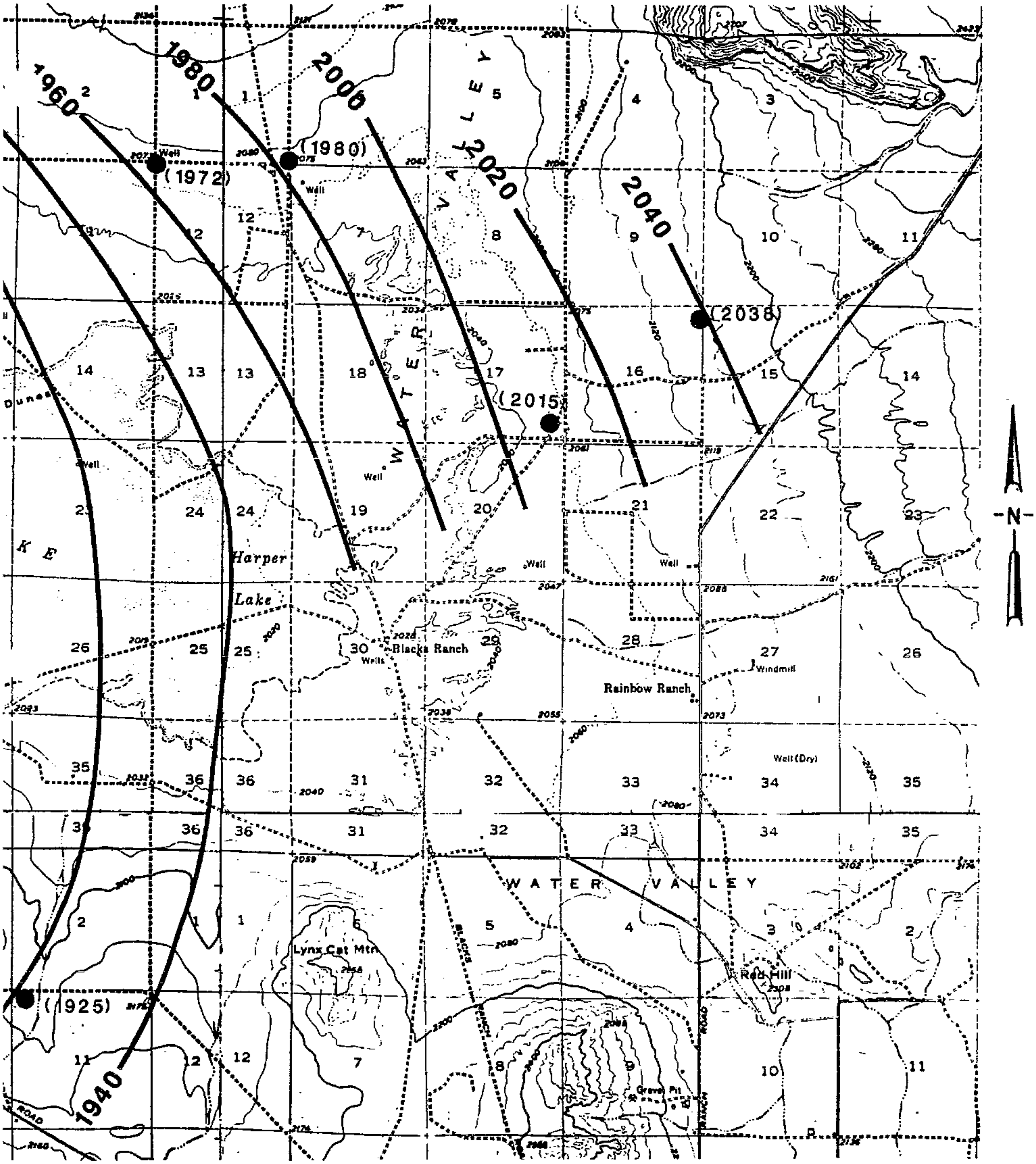
2000 Elevation contour in feet of main aquifer

● 1880 Measuring point with 12/89 groundwater elevation (feet) (see drawing No. 2 for details)

● (2000) Measuring point with 1986 groundwater elevation (from Leroy Crandall and Associates, 8-1-86)

0 1

Scale-mile



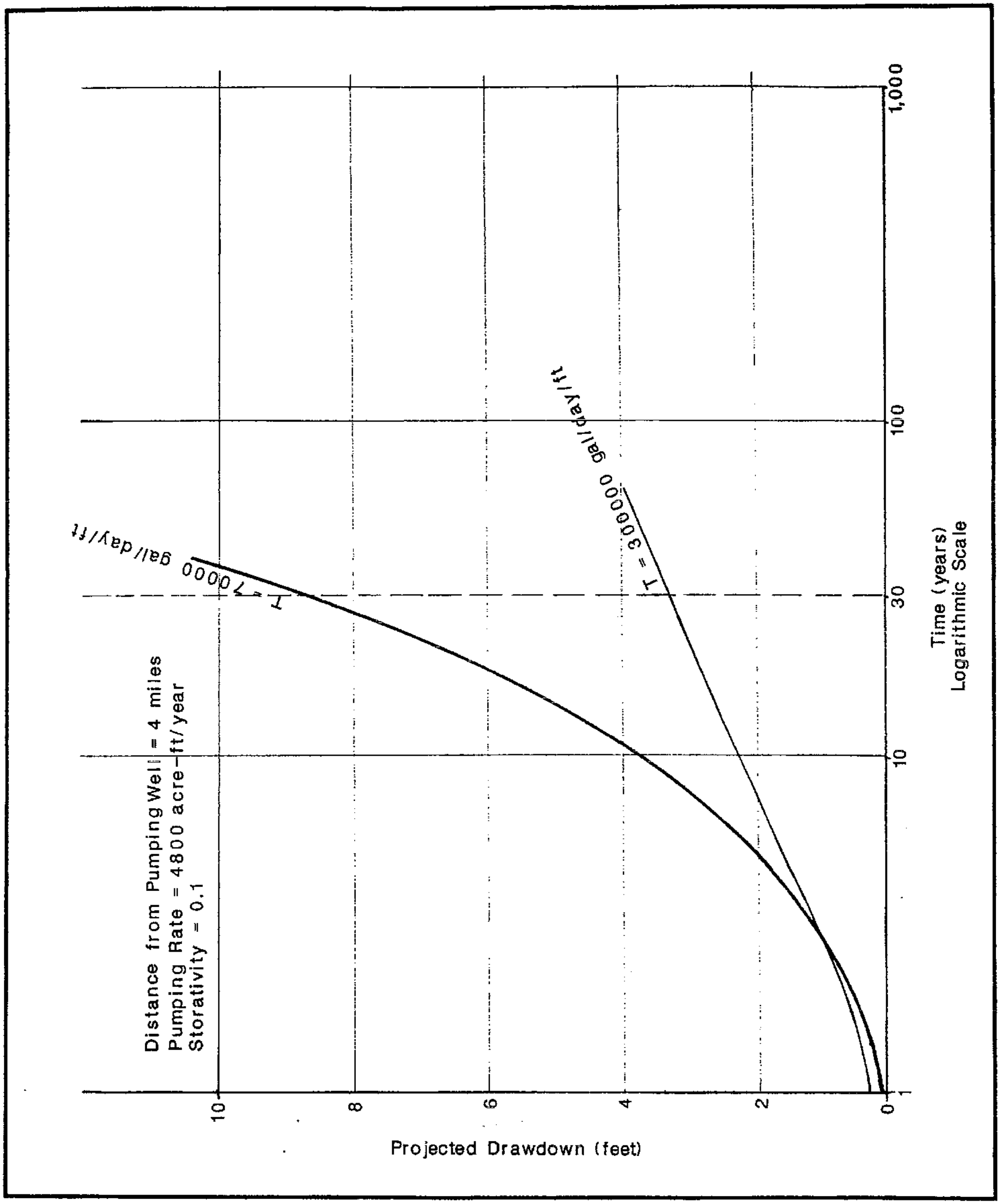
GROUNDWATER CONTOUR MAP
MAIN AQUIFER

LUZ Development and Finance Corporation
Harper Valley, California

PROJECT NO.
89-03409.18

DRAWING NO.
4

THE MARK GROUP
ENGINEERS & GEOLOGISTS, INC.

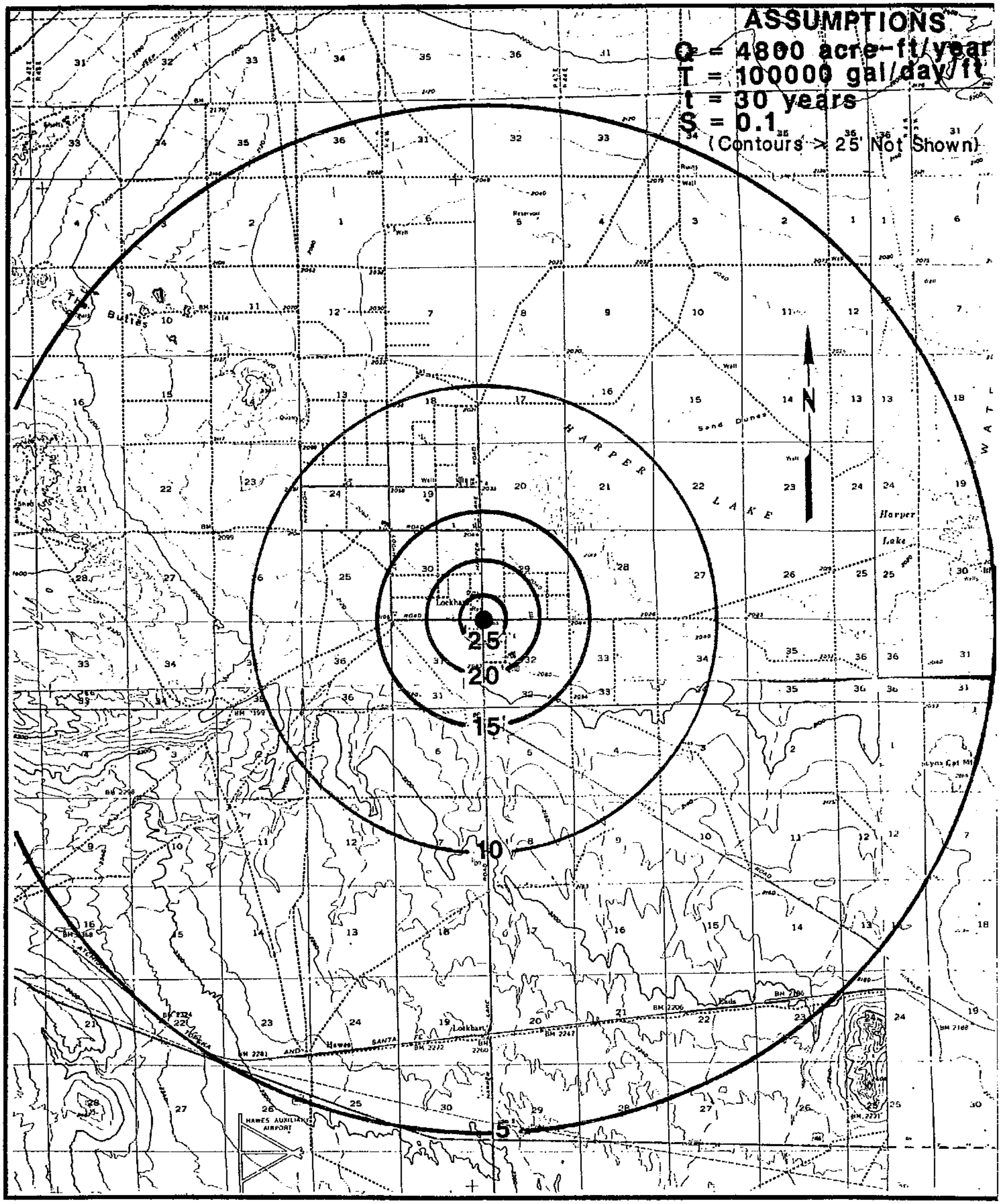


THE MARK GROUP
ENGINEERS & GEOLOGISTS, INC.

THEIS TIME - DRAWDOWN PROJECTIONS
LUZ Development and Finance Corporation
Harper Valley, California

PROJECT NO.
89-03409.18

DRAWING NO
5



Reference: USGS 15' Quadrangles – Fremont Peak & Twelve Gauge Lake, 1986

Predicted Water Level Declines

After 30 Years Using Theis Assumptions

LUZ Development and Finance Corporation

Harper Valley, California

PROJECT NO. 89-03409.18

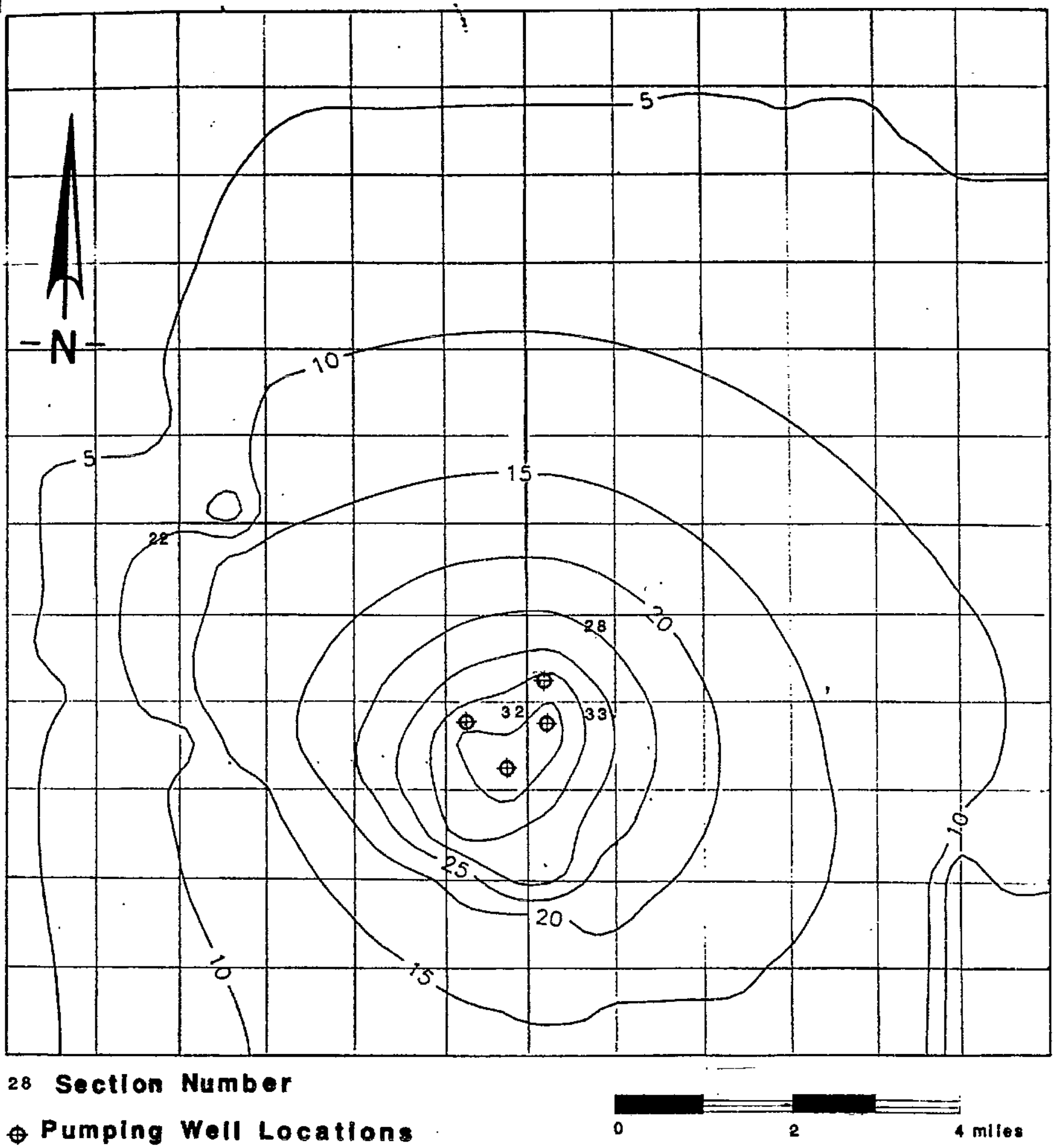
DRAWING NO. 6

THE MARK GROUP
ENGINEERS & GEOLOGISTS, INC.

Prepared By JAW Approved By [signature] Date 12-17-87

CALC-1 3/3/86

LUZ – 15 year (8000 AFY, Tmax = 100,000 gpd/ft)



28 **Section Number**

⊕ **Pumping Well Locations**

-20- **Estimated Water Level Decline in Feet**

Prepared By J.S. Approved By WJH Date 12-19-89

Water Level Decline
Estimated by PLASM Model

LUZ Finance and Development
Harper Valley, California

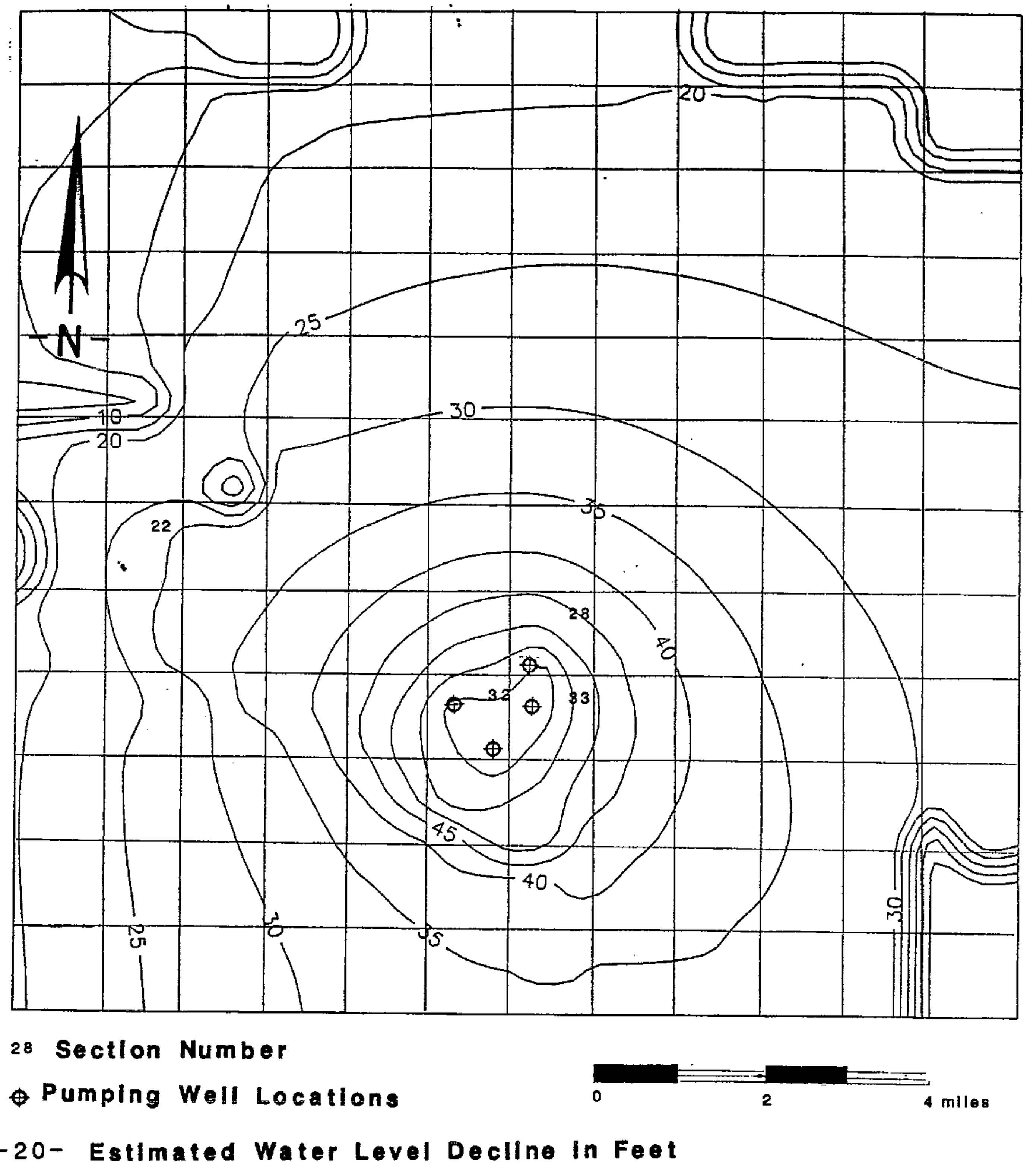
THE MARK GROUP
ENGINEERS & GEOLOGISTS, INC.

PROJECT NO. 8903409.18

SHEET NO. 7

CALC-1 3/3/88

LUZ – 30 year (8000 AFY, Tmax = 100,000 gpd/ft)



Prepared By____ Approved By ____ Date 12-19-89

Water Level Decline
Estimated by PLASM Model

LUZ Finance and Development
Harper Valley, California

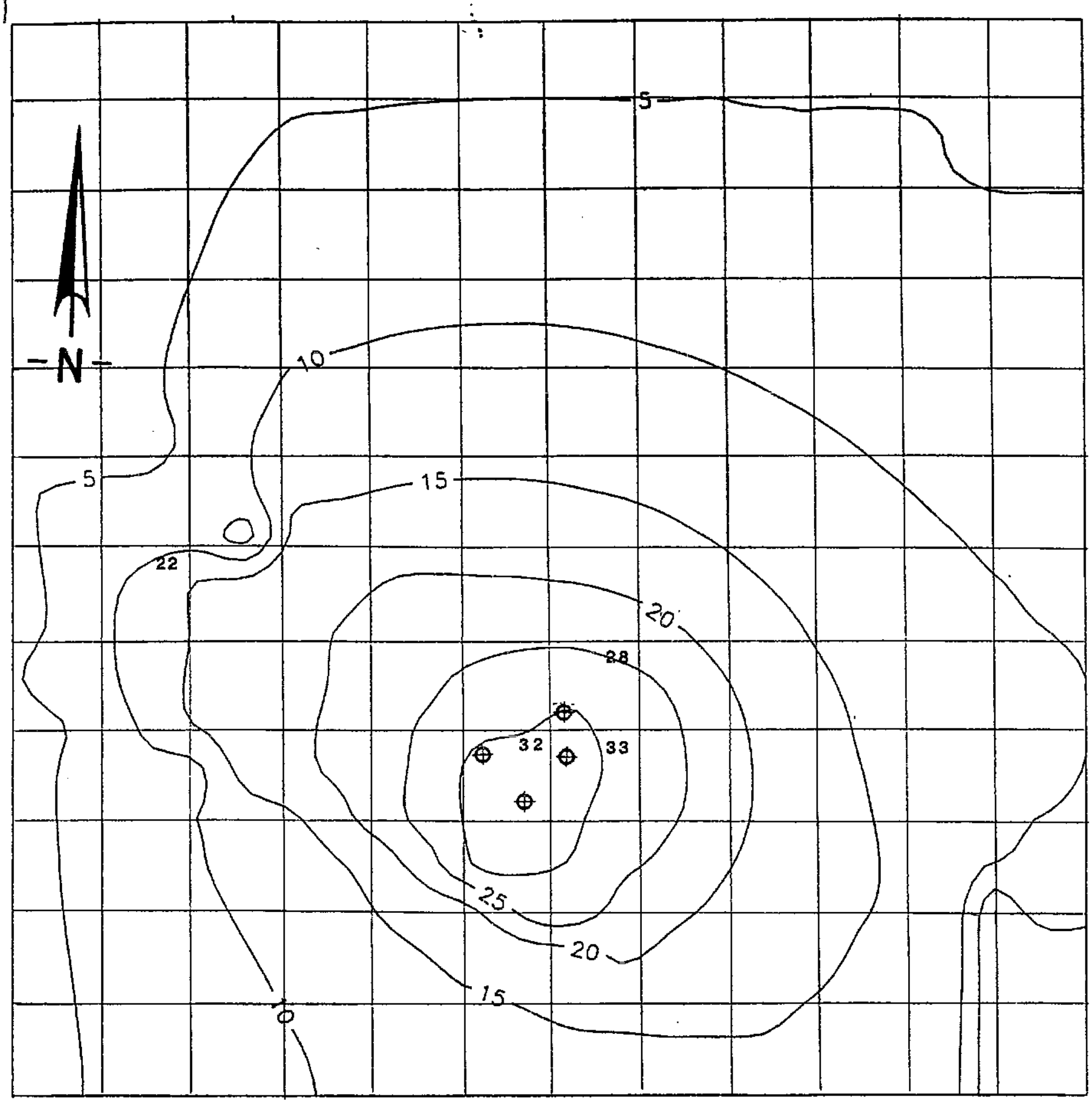
THE MARK GROUP
ENGINEERS & GEOLOGISTS, INC.

PROJECT NO. 8903409.18

SHEET NO. 8

CALC-1 3/3/88

LUZ – 15 year (8000 AFY, Tmax = 300,000 gpd/ft)



28 **Section Number**

⊕ **Pumping Well Locations**

0 2 4 miles

-20- **Estimated Water Level Decline in Feet**

Prepared By_____ Approved By MJH Date 12-19-89

Water Level Decline Estimated by PLASM Model

LUZ Finance and Development Harper Valley, California

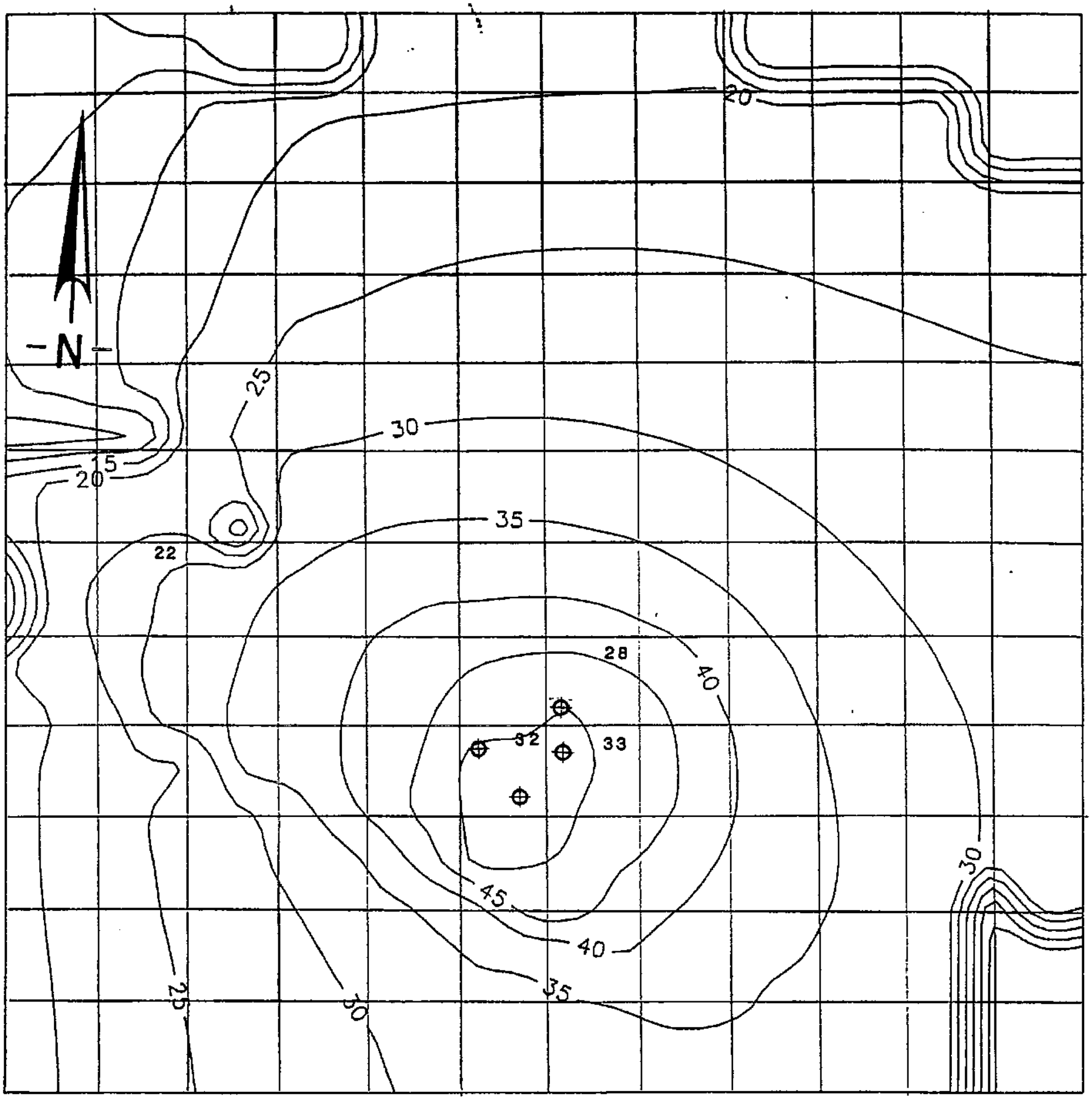
THE MARK GROUP ENGINEERS & GEOLOGISTS, INC.

PROJECT NO. 8903409.18

SHEET NO. 9

CALC-1 3/3/88

LUZ – 30 year (8000 AFY, Tmax = 300,000 gpd/ft)



28 **Section Number**

⊕ **Pumping Well Locations**

0 2 4 miles

-20- **Estimated Water Level Decline in Feet**

Prepared By____ Approved By [signature] Date 12-19-89

Water Level Decline Estimated by PLASM Model

LUZ Finance and Development Harper Valley, California

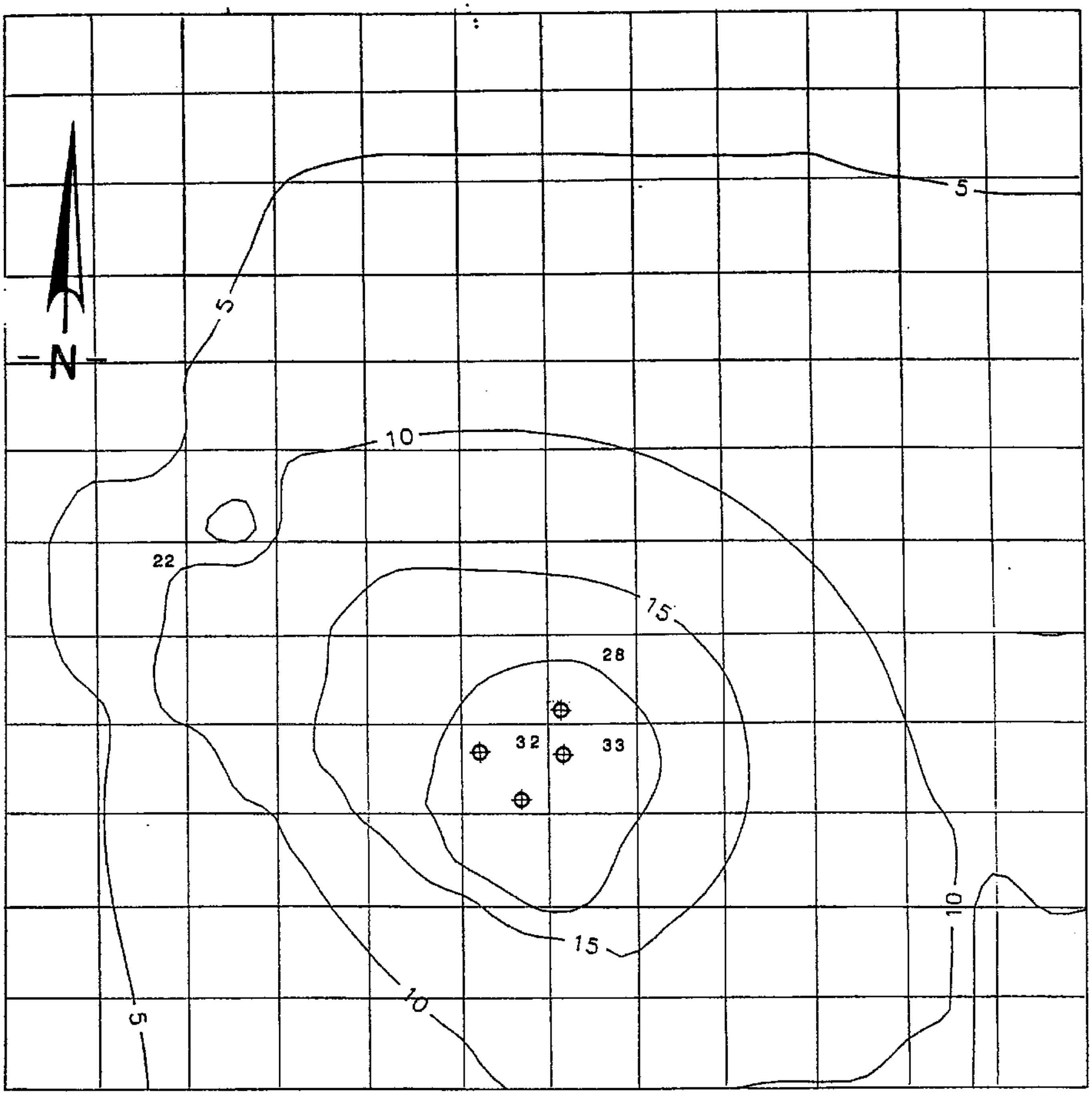
THE MARK GROUP
ENGINEERS & GEOLOGISTS, INC.

PROJECT NO. 8903409.18

SHEET NO. 10

CALC-1 3/3/86

LUZ — 15 year (6000 AFY, Tmax = 300,000 gpd/ft)



28 **Section Number**

⊕ **Pumping Well Locations**

-20- **Estimated Water Level Decline in Feet**

Prepared By

Approved By

Date 12-15-89

THE MARK GROUP

ENGINEERS & GEOLOGISTS, INC.

Water Level Decline Estimated by PLASM Model

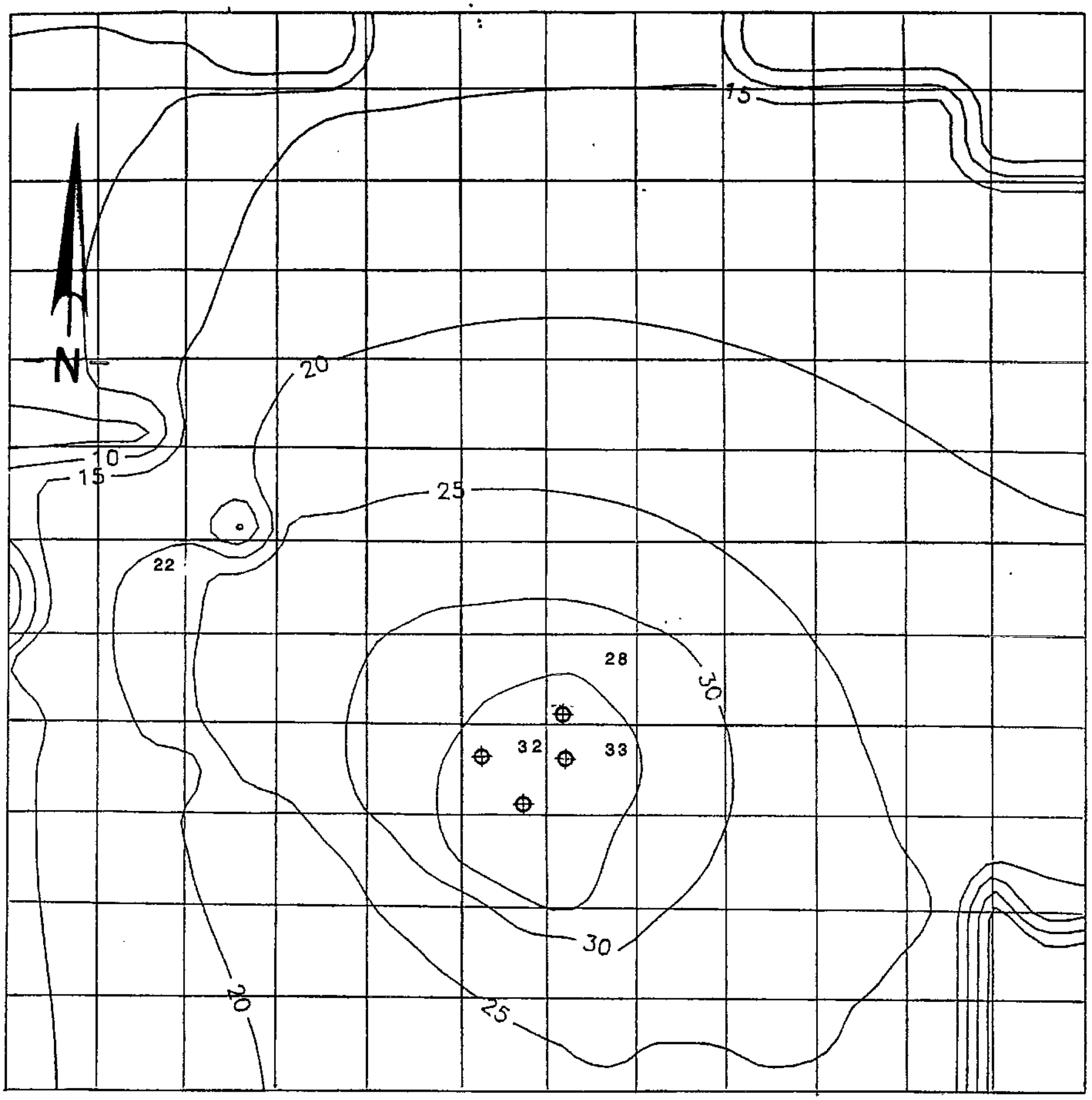
LUZ Finance and Development Harper Valley, California

PROJECT NO. 8903409.18

SHEET NO. 11

CALC-1 3/3/88

LUZ – 30 year (6000 AFY, Tmax = 300,000 gpd/ft)



28 **Section Number**

⊕ **Pumping Well Locations**

0 2 4 miles

–20– **Estimated Water Level Decline in Feet**

Date 12-19-89

Approved By

Prepared By

Water Level Decline
Estimated by PLASM Model

LUZ Finance and Development
Harper Valley, California

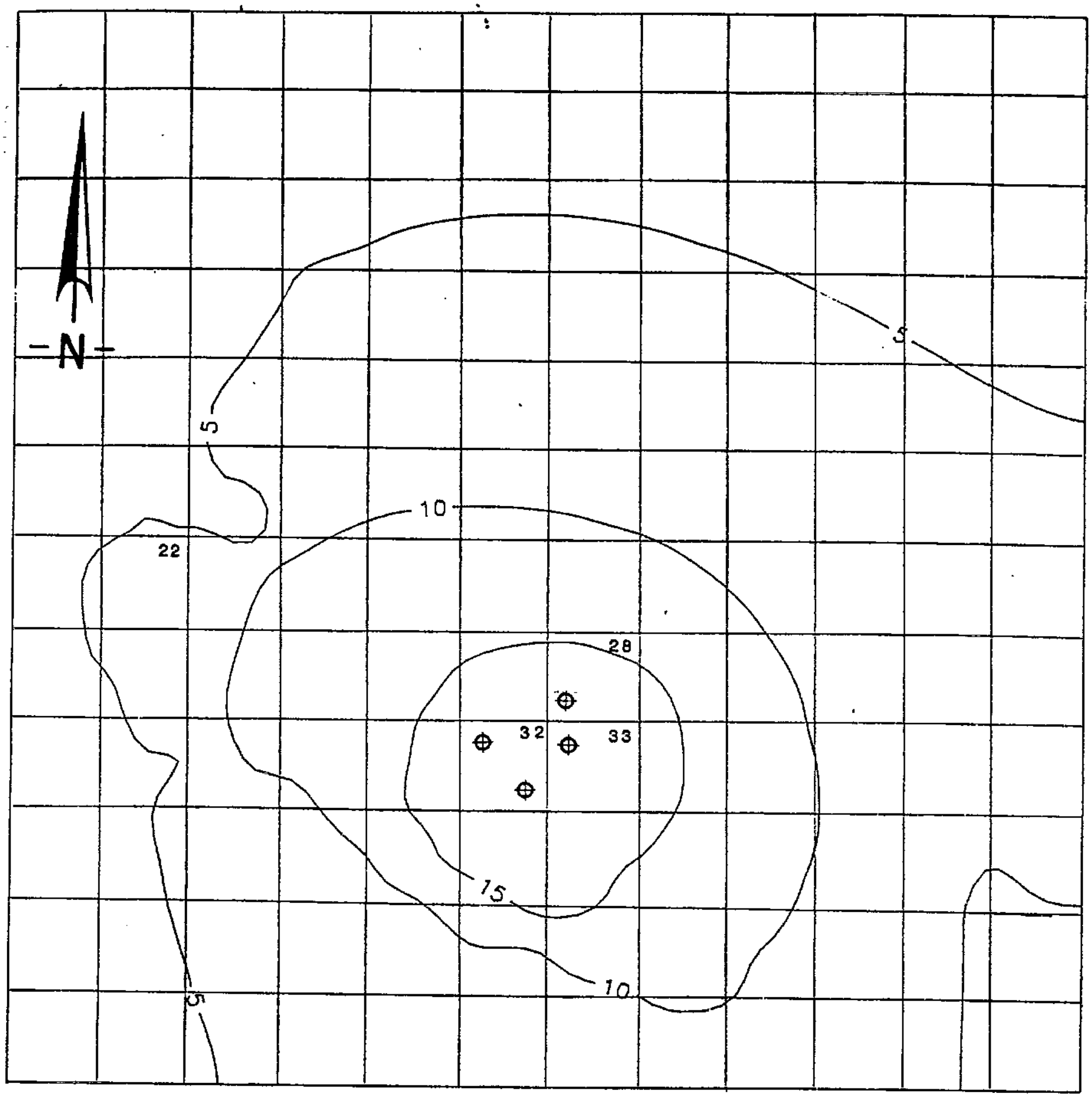
THE MARK GROUP
ENGINEERS & GEOLOGISTS, INC.

PROJECT NO.
8903409.18

SHEET NO.
12

CALC-1 3/3/86

LUZ – 15 year (4800 AFY, Tmax = 300,000 gpd/ft)



28 **Section Number**

⊕ **Pumping Well Locations**

-20- **Estimated Water Level Decline in Feet**

Prepared By______ Approved By [signature] Date 12-19-89

Water Level Decline
Estimated by PLASM Model

LUZ Finance and Development
Harper Valley, California

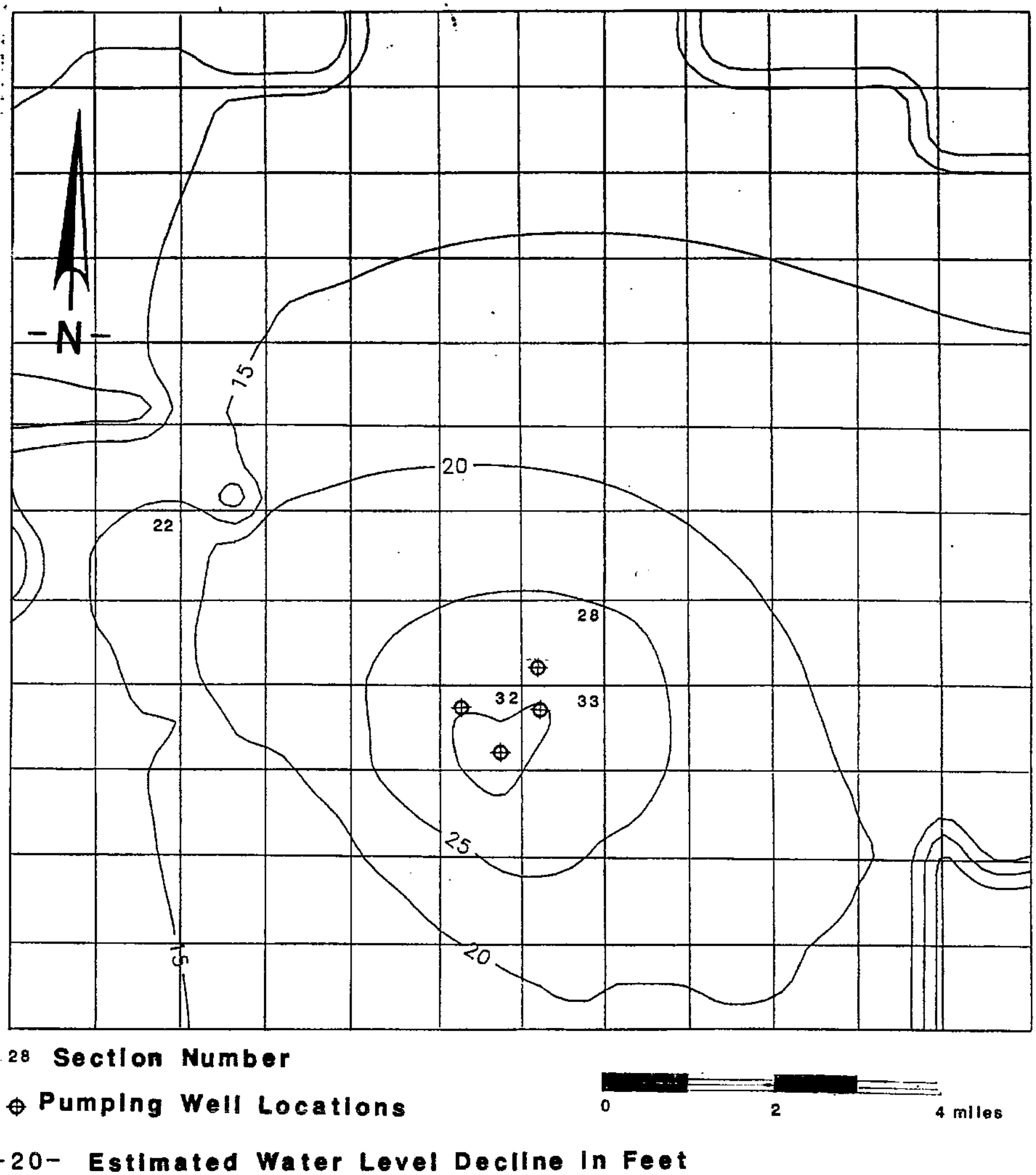
THE MARK GROUP
ENGINEERS & GEOLOGISTS, INC.

PROJECT NO.
8903409.18

SHEET NO.
13

CALC-1 3/3/86

LUZ – 30 year (4800 AFY, Tmax = 300,000 gpd/ft)



Date 12-19-89

Approved By [signature]

Prepared By

THE MARK GROUP
ENGINEERS & GEOLOGISTS, INC.

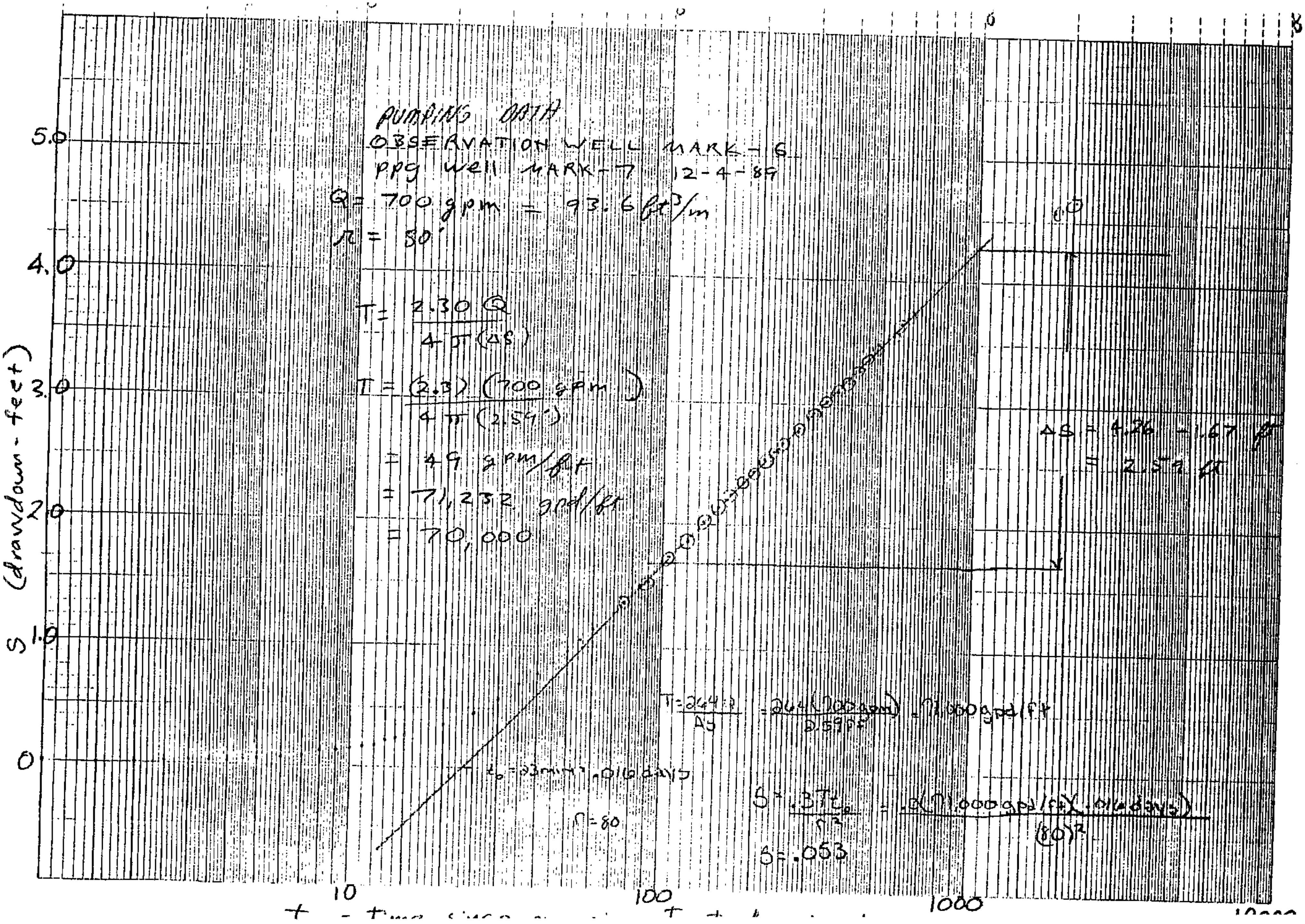
Water Level Decline
Estimated by PLASM Model

LUZ Finance and Development
Harper Valley, California

PROJECT NO.
8903409.18

SHEET NO.
14

CALC-1 3/3/86



PUMPING DATA
OBSERVATION WELL MARK-6
ppg well MARK-7 12-4-89
Q = 700 gpm = 93.6 ft³/m
r = 80'
T = 2.30 Q / 4π(Δs)
T = (2.3)(700 gpm) / 4π(2.59')
= 49 gpm/ft
= 71,232 gpd/ft
= 70,000
Δs = 4.26 - 1.67 ft
= 2.59 ft
T = 264 Q / Δs = 264(700 gpm) / 2.59 ft = 71,000 gpd/ft
t₀ = 23 min = .016 days
r = 80
S = .3 T t₀ / r² = .3(71,000 gpd/ft)(.016 days) / (80)²
S = .053
5.0
4.0
3.0
2.0
1.0
0
s (drawdown - feet)
10
100
1000
t - time since ...

AQUIFER TEST DATA

______ Address ______ County SAN BERNADINO State CA

4 Dec 89 Company performing test THE MARK GROUP Measured by J. S.

6 (MARK) Distance from pumping well ~80' Type of test PUMPING Test No. INTER

4W-19Q

ng equipment SOLINST   Q = 700 gpm

Time Data	Water Level Data 07:15	Discharge Data	Comments on factors affecting test data
n: Date 12-4 Time ____ (t_0) ff: Date ____ Time ____ (t_0') of aquifer test: ing ✓ Recovery ____	Static water level 185.74 Measuring point ____ Elevation of measuring point 2058	How Q measured FLOW METER Depth of pump/air line ____ Previous pumping? Yes ____ No ____ Duration ____ End ____	

Clock time	Time since pump started t	Time since pump stopped t'	t/t'		DTW (ft) Water level measurement	Correction or Conversion	Water level	Water level change s or s'	Cumulative change	Discharge measurement	Rate		Comments
	.5				185.74			–	-				
	1				185.74			0	0				
	1.5				185.74			0	0				
	2				185.74			0	0				
	2.5				185.75			.01	.01				
	3				185.76			.01	.02				
	3.5				185.77			.01	.03				
	4				185.77			0	.03				
	4.5				185.78			.01	.04				
	5				185.79			.01	.05				
	6				185.81			.02	.07				
	7				185.83			.02	.09				
	8				185.86			.03	.12				
	9				185.87			.01	.13				
	10				185.89			.02	.15				
	11				185.92			.03	.18				
	12				185.93			.01	.19				
	13				185.95			.02	.21				
	14				185.97			.02	.23				
	15				186.0			.03	.26				
	20				186.12			.12	.38				
	25				186.22			.10	.48				
	30				186.33			.11	.59				
	35				186.44			.11	.70				
	40				186.53			.09	.79				
	45				186.62			.09	.88				
	50				186.71			.09	.97				
	55				186.79			.08	1.05				
15	60				186.88			.09	1.14				

AQUIFER TEST DATA

Address ______ County SAN BERNARDINO State CA

4 Dec 89 Company performing test THE MARK GROUP Measured by J.S.

6 Distance from pumping well ~80' Type of test PUMPING Test No. INTERI

N/4W-19Q

ng equipment SOLINST Q = 700 gpm

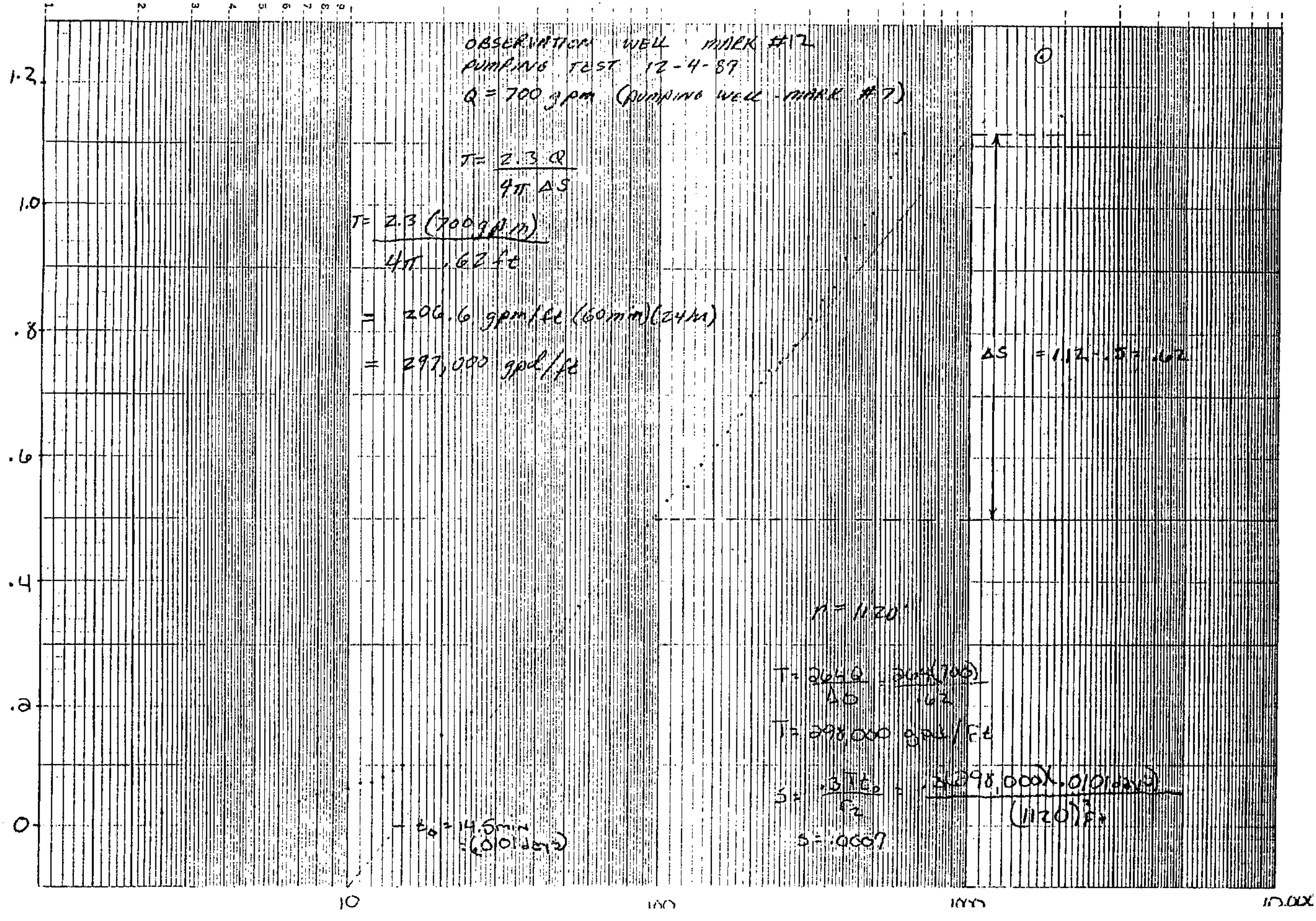
Time Data
n: Date 12-4 Time ______ (t_0)
f: Date ______ Time ______ (t_0')
of aquifer test:
ng ✓ Recovery ______

Water Level Data
Static water level 185.74
Measuring point ______
Elevation of measuring point 2058

Discharge Data
How Q measured FLOW METER
Depth of pump/air line ______
Previous pumping? Yes ______ No ______
Duration ______ End ______

Comments on factors affecting test data

Clock time	Time since pump started t	Time since pump stopped t'	t/t'		OTW (24) Water level measurement	Correction or Conversion	Water level	Water level change s or s'	Cumulative change	Discharge measurement	Rate		Comments on factors affecting test data
	75				187.10			.22	1.36				
	90				187.30			.20	1.56				
	105				187.46			.16	1.72				
15	120				187.61			.15	1.87				
	135				187.75			.14	2.01				
	150				187.87			.12	2.13				
	165				187.98			.11	2.24				
15	180				188.08			.10	2.34				
	195				188.17			.09	2.43				
	210				188.26			.09	2.52				
	225				188.34			.08	2.60				
15	240				188.41			.07	2.67				
	270				188.53			.12	2.79				
15	300				188.65			.12	2.91				
	330				188.75			.10	3.01				
15	360				188.84			.09	3.10				
	390				188.93			.09	3.19				
15	420				189.02			.09	3.28				
	450				189.11			.09	3.37				
15	480				189.17			.06	3.43				
15	540				189.31			.14	3.57				
	570				189.38			.07	3.64				
15	600				189.44			.06	3.70				


OBSERVATION WELL MARK #12
PUMPING TEST 12-4-87
Q = 700 gpm (pumping well - mark #7)
T = 2.3 Q / 4π ΔS
T = 2.3 (700 gpm) / 4π .62 ft
= 206.6 gpm/ft (60 min)(24 hr)
= 297,000 gpd/ft
ΔS = 1.12 - .5 = .62
r = 1120'
T = 264 Q / Δs = 264(700) / .62
T = 298,000 gpd/ft
S = .3 T t0 / r² = .3(298,000)(.0101 days) / (1120)² ft²
S = .0007
t0 = 14.6 min = (.0101 days)
1.2
1.0
.8
.6
.4
.2
0
10
100
1000
10,000

AQUIFER TEST DATA

Luz _____ Address _____ County SAN BERNARDINO State CA

+Dec 89 Company performing test THE MARK GROUP Measured by C.H.

12 Distance from pumping well ~1120' Type of test Pumping Test No. INTER

1N/4W-19K

ng equipment Solinst Q = 200 gpm

Time Data	Water Level Data	Discharge Data	Comments on factors affecting test data
Date 4 Aug 89 Time 7:29 (t_0) Date _____ Time _____ (t_0') of aquifer test: ng X Recovery _____	Static water level 180.9 Measuring point Portion turbine Elevation of measuring point 2059	How Q measured FLOW METER Depth of pump/air line _____ Previous pumping? Yes _____ No _____ Duration _____ End _____	

Clock time	Time since pump started t	Time since pump stopped t'	t/t'		Water level measurement	Correction or Conversion	Water level	Water level change s or s'	Cumulative change	Discharge measurement	Rate		Comments
	.5												
	1												
	1.5												
	2												
	2.5				180.92			.02	.02				
	3				180.92			0	.02				
	3.5				180.92			0	.02				
	4												
	4.5												
	5				180.93			.01	.03				
	6				180.93			0	.03				
	7				180.94			.01	.04				
	8				180.95			.01	.05				
	9				180.95			0	.05				
	10				180.96			.01	.06				
	11				180.97			.01	.07				
	12				180.97			0	.07				
	13				180.98			.01	.08				
	14				180.99			.01	.09				
	15				181.00			.01	.10				
	20				181.05			.05	.15				
	25				181.09			.04	.19				
	30				181.13			.04	.23				
	35				181.16			.03	.26				
	40				181.19			.03	.29				
	45				181.22			.03	.32				
	50				181.24			.02	.34				
	55				181.26			.02	.36				
	60				181.28			.02	.38				

AQUIFER TEST DATA

Address ______ County SAN BERNADINO State CA

Dec 89 Company performing test THE MARK GROUP Measured by J.S.

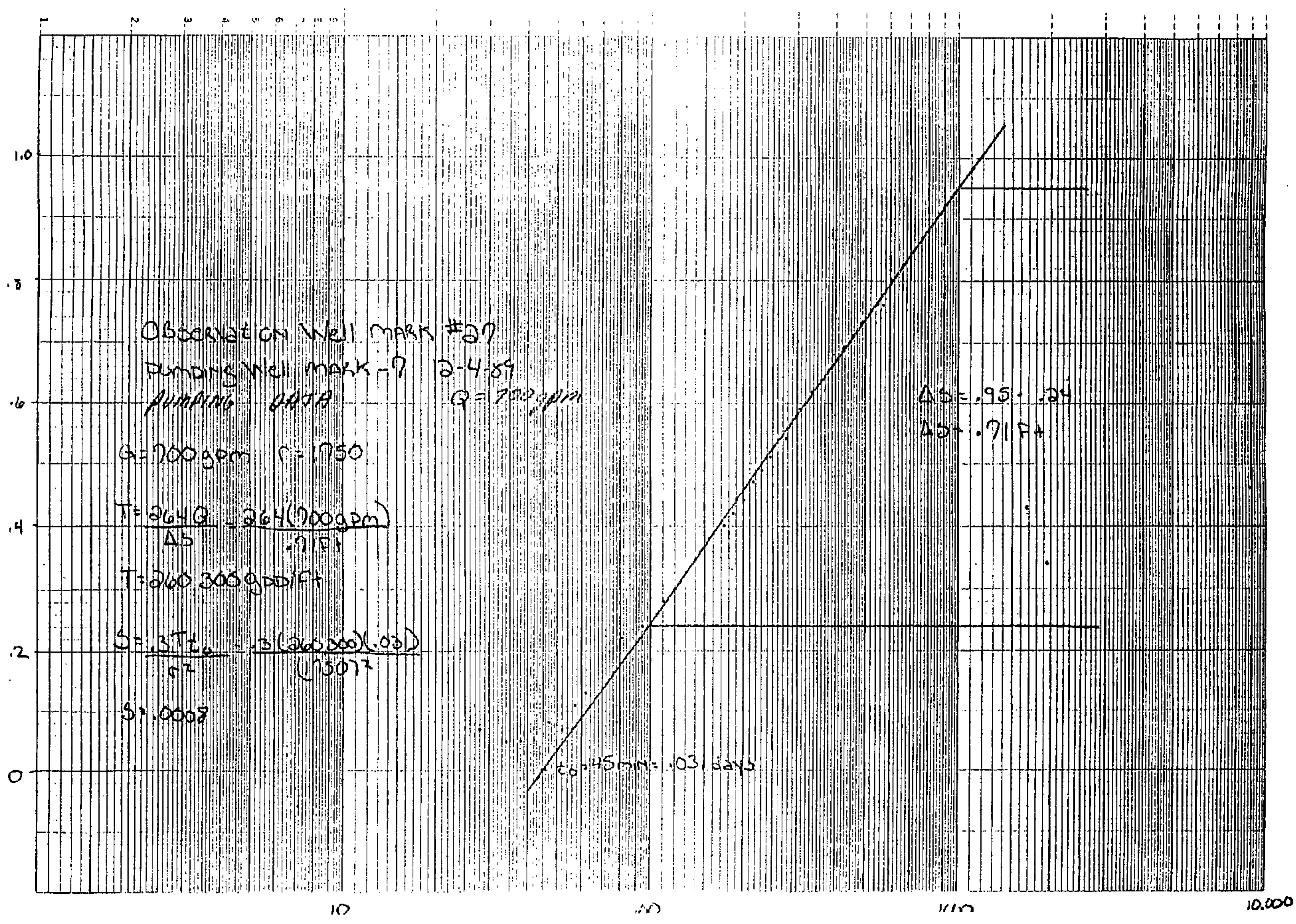
12 Distance from pumping well 1120' Type of test AUMPING Test No. INTER

11N/4W-19K

ng equipment SOLINST Q = 200gpm

Time Data	Water Level Data	Discharge Data	Comments on factors affecting test data
n: Date ___ Time ___ (t_0) ff: Date ___ Time ___ (t_0') of aquifer test: ing ✓ Recovery ___	Static water level 150.7 Measuring point ___ Elevation of measuring point 2059	How Q measured FLOW METER Depth of pump/air line ___ Previous pumping? Yes ___ No ___ Duration ___ End ___	

Clock time	Time since pump started t	Time since pump stopped t'	t/t'		Water level measurement	Correction or Conversion	Water level	Water level change s or s'	cumulative change	Discharge measurement	Rate		Comments
	78				181.34			.06	.44				
	92				181.39			.05	.49				
	108				181.43			.04	.53				
	123				181.45			.02	.55				
	138				181.47			.04	.59				
	153				181.52			.03	.62				
	168				181.54			.02	.64				
	183				181.57			.03	.67				
	198				151.60			.03	.70				
	213				181.62			.02	.72				
	228				181.64			.02	.74				
	243				181.65			.01	.75				
	273				181.67			.03	.78				
	303				151.72			.04	.82				
	373				181.75			.03	.85				
	363				181.77			.02	.87				
	395				181.82			.05	.92				
	423				181.85			.03	.95				
	453				181.87			.02	.97				
	483				181.89			.02	.99				
	543				181.95			.06	1.05				181.99' @ 573 min
	693				182.02			.07	1.12				



Observation Well Mark #27
Pumping Well Mark -7 2-4-89
Pumping Data Q = 700 gpm
Q = 700 gpm r = 1750
T = 264Q / Δs = 264(700gpm) / .71 ft
T = 260,300 gpd/ft
S = .3Tt₀ / r² = .3(260,300)(.031) / (1750)²
S = .0008
Δs = .95 - .24
Δs = .71 ft
t₀ = 45 min = .031 days
1.0
.8
.6
.4
.2
0
10
100
1000
10,000

AQUIFER TEST DATA

_______________ Address _______________ County SAN BERNARDINO State CA

4 DEC 89 Company performing test THE MARK GROUP Measured by JL

27 Distance from pumping well ~1850' Type of test Pumping Test No. INTER

1/4W-19L

ng equipment Powers Sounder Q = 700 gpm

Time Data
n: Date 4 Dec 89 Time 729 (t_0)
: Date ______ Time ______ (t_0')
of aquifer test:
ing X Recovery ______

Water Level Data
Static water level 182.10
Measuring point ______
Elevation of measuring point 2056

Discharge Data
How Q measured FLOW METER
Depth of pump/air line ______
Previous pumping? Yes ____ No ____
Duration ______ End ______

Comments on factors affecting test data

Clock time	Time since pump started t	Time since pump stopped t'	t/t'		Water level measurement	Correction or Conversion	Water level	Water level change s or s'	Cumulative change	Discharge measurement	Rate		Comments
	28				182.17			.07	.07				
	34				182.15			-.02	.05				
	38				182.15			0	.05				
	42				182.15			0	.05				
	47				182.18			.03	.08				
	52				182.17			-.01	.07				
	57				182.21			.04	.11				
	62				182.25			.02	.13				
	81				182.32			.09	.22				
	94				182.34			.02	.24				
	110				182.38			.04	.28				
	125				[illegible]			.03	.31				
	140				182.45			.04	.35				
	155				182.48			.03	.38				
	171				182.50			.02	.40				
	185				182.52			.02	.42				
	200				182.54			.02	.44				
	215				182.57			.03	.47				
	230				182.59			.02	.49				
	245				182.61			.02	.51				
	275				[illegible]			.03	.54				
	305				182.69			.05	.59				
	335				182.72			.03	.62				
	365				182.74			.02	.64				
	393				182.78			.04	.68				
	425				182.79			.01	.69				
	455				182.81			.02	.71				
	485				182.83			.02	.73				
	545				182.86			.03	.76				

AQUIFER TEST DATA

Address ______ County SAN BERNARDINO State CA

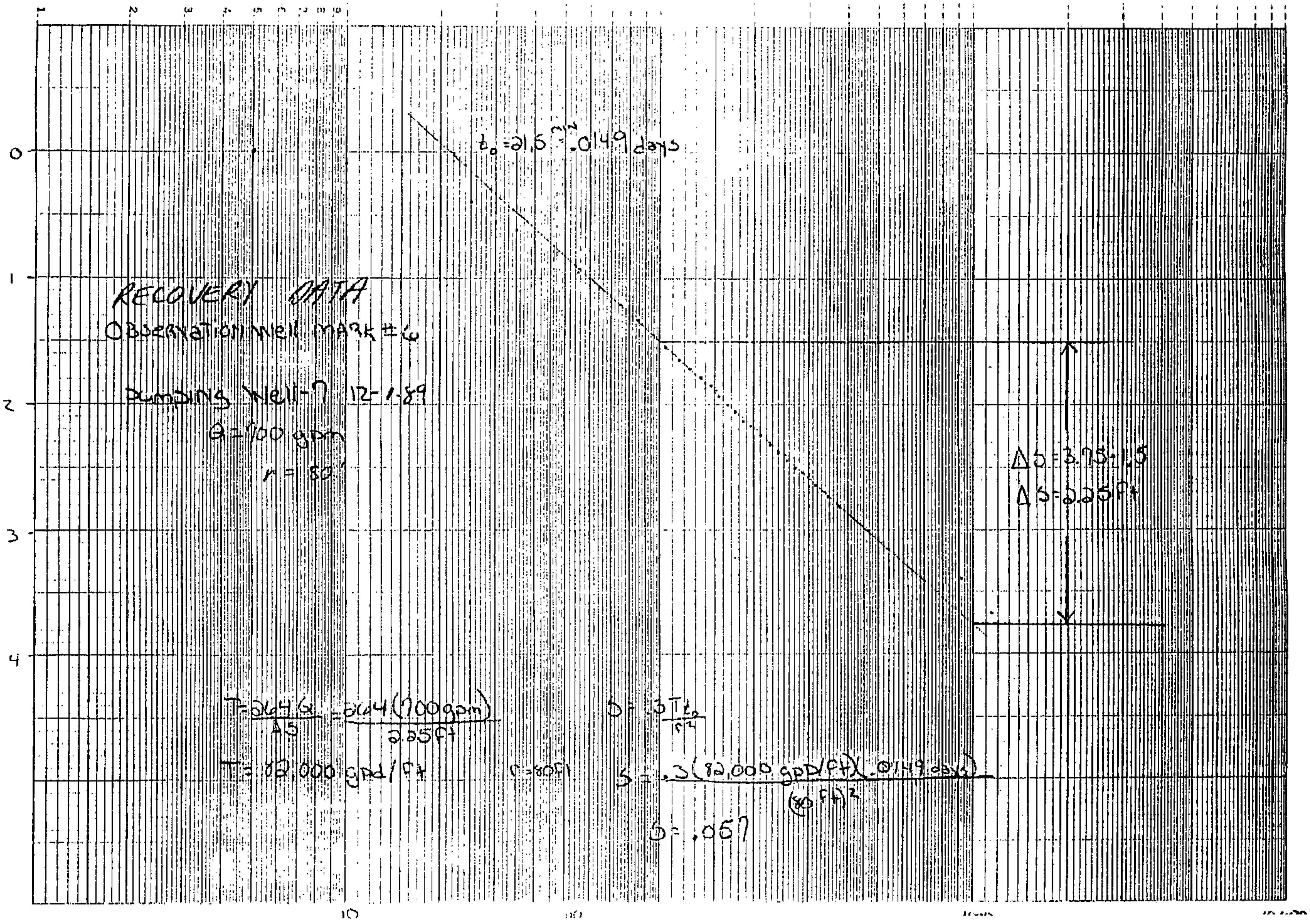
Rec Company performing test THE MARK GROUP Measured by JL

27 11N/4W-19C Distance from pumping well ~1850' Type of test PUMPING Test No. INTERF.

ng equipment Powers Sounder Q = 7000gpm

Time Data	Water Level Data	Discharge Data	Comments on factors affecting test data
: Date ___ Time ___ (t_0) : Date ___ Time ___ (t_0') of aquifer test: ng ✓ Recovery ___	Static water level 182.10 Measuring point ___ Elevation of measuring point 2056	How Q measured FLOW METER Depth of pump/air line ___ Previous pumping? Yes ___ No ___ Duration ___ End ___	

Clock time	Time since pump started t	Time since pump stopped t'	t/t'		Water level measurement	Correction or Conversion	Water level	Water level change s or s'	Cummulative change	Discharge measurement	Rate		
725 / 7:05	576				182.86			0	.76				
25					182.90			.04	.80				


RECOVERY DATA
Observation well MARK #6
Pumping Well-7 12-1-89
Q=700 gpm
r = 80'
t₀ = 21.5 min = .0149 days
ΔS = 3.75-1.5
ΔS = 2.25 ft
T = 264 Q / ΔS = 264 (700 gpm) / 2.25 ft
T = 82,000 gpd/ft
r = 80 ft
S = .3 T t₀ / r²
S = .3 (82,000 gpd/ft)(.0149 days) / (80 ft)²
S = .057
0
1
2
3
4
10
100

AQUIFER TEST DATA

Address ______ County SAN BERNARDINO State CA

12-1-89 Company performing test THE MARK GROUP Measured by JP

MARK #10 Distance from pumping well ~80' Type of test RECOVERY Test No. INTER

N/4W-19Q

g equipment SOLINST Q = 700 gpm

Time Data
. Date ____ Time ____ (t_0)
: Date 12-1 Time 12:07 (t_0')
of aquifer test:
ng ____ Recovery ✓

Water Level Data
Static water level 189.98
Measuring point ____
Elevation of measuring point 2058

Discharge Data
How Q measured FLOW METER
Depth of pump/air line ____
Previous pumping? Yes ____ No ____
Duration ____ End ____

Comments on factors affecting test data

Clock time	Time since pump started t	Time since pump stopped t'	t/t'		DTW Water level measurement	Correction or Conversion	Water level	Water level change s or s'	Cummulative level	Discharge measurement	Rate		Comments on factors affecting test data
		min 0			189.98			—					5 min interval
		5			189.89			0	0				↓
		10			189.78			.10'	.1				
		15			189.69			.09'	.19				
		25			189.49			.21'	.40				10 min interval
		35			189.27			.21'	.61				↓
		47			189.08			.19	.80				
		55			188.94			.14	.94				
		65			188.79			.15	1.09				
		75			188.67			.12	1.21				
		85			188.55			.12	1.33				
		95			188.45			.10	1.43				
		105			188.35			.10	1.53				
		115			188.26			.09	1.62				
		125			188.17			.09	1.71				
		135			188.09			.08	1.79				
		145			188.02			.07	1.86				
		155			187.94			.08	1.94				
		165			187.87			.07	2.01				
		175			187.82			.05	2.06				
		185			187.75			.07	2.13				
		195			187.71			.04	2.17				15 min interval
		210			187.63			.08	2.25				↓
		225			187.56			.07	2.32				
		240			187.49			.07	2.39				
		255			187.43			.06	2.45				
		270			187.37			.06	2.51				
		285			187.33			.04	2.55				30 min interval
		315			187.23			.10	2.65				

AQUIFER TEST DATA

______ Address ______ County SAN BERNARDINO State CA

______ Company performing test THE MARK GROUP Measured by [illegible]

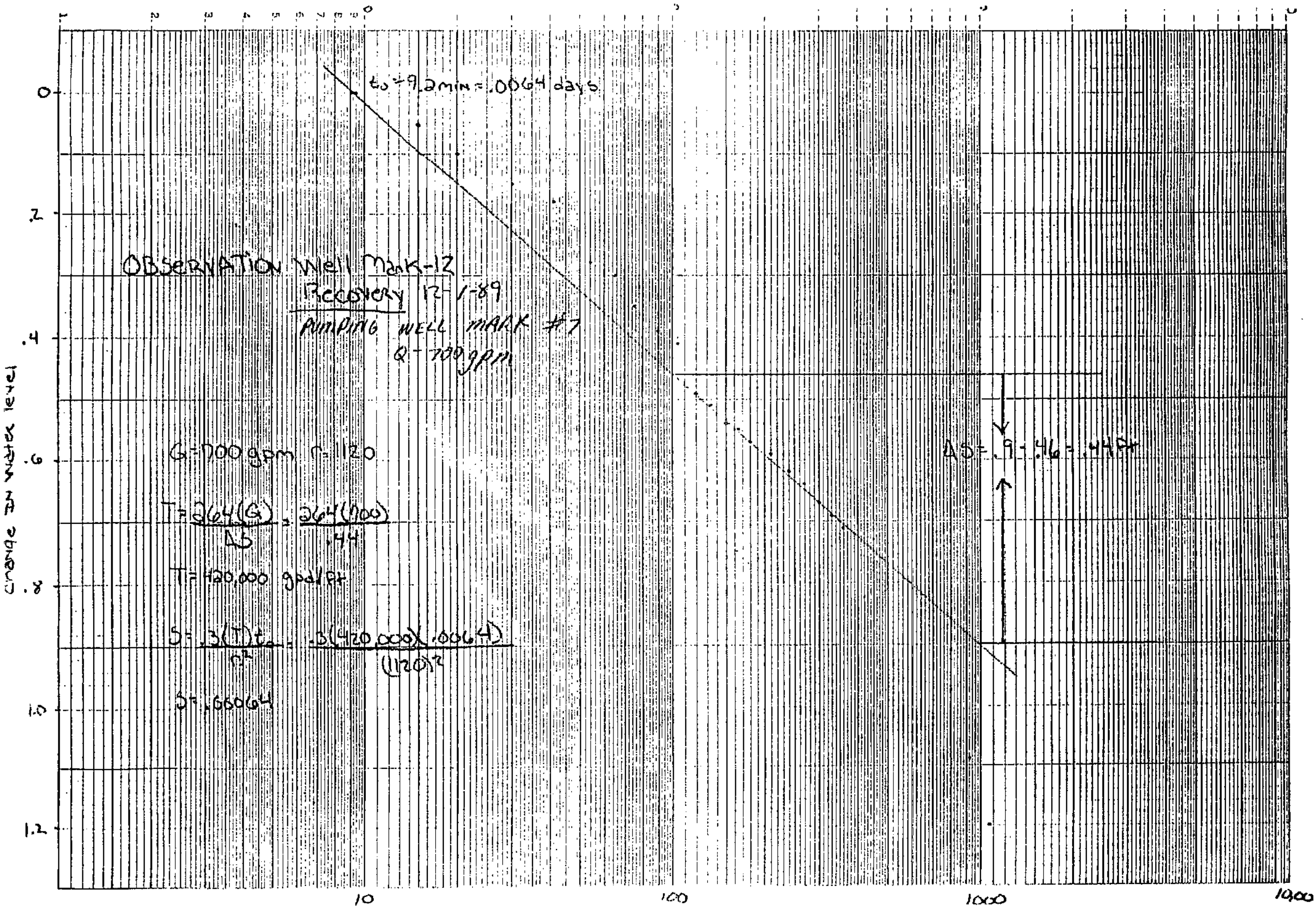
NEAR #6 Distance from pumping well ~80' Type of test RECOVERY Test No. INTER.

11N/4W-19Q

g equipment SOLINST Q = 700 gpm

Time Data	Water Level Data	Discharge Data	Comments on factors affecting test data
Date ____ Time ____ (t_0) Date ____ Time ____ (t_0') of aquifer test: ng ____ Recovery ✓	Static water level 189.88 Measuring point ____ Elevation of measuring point 2058	How Q measured FLOW METER Depth of pump/air line ____ Previous pumping? Yes ____ No ____ Duration ____ End ____	

lock time	Time since pump started t	Time since pump stopped t'	t/t'		OTW Water level measurement	Correction or Conversion	Water level	Water level change s or s'		Discharge measurement	Rate		Comments
45					157.15			.08	2.73				
75					157.07			.08	2.81				
3					156.48			.59	3.40				
57					18[illegible].21			.27	3.67				



t₀ = 9.2 min = .0064 days
OBSERVATION Well Mark-12
Recovery 12-1-89
PUMPING WELL MARK #7
Q = 700 gpm
ΔS = .9 - .46 = .44 ft
G = 700 gpm r = 120
T = 264(G)/ΔS = 264(700)/.44
T = 420,000 gpd/ft
S = .3(T)t₀/r² = .3(420,000)(.0064)/(120)²
S = .00064
change in water level
0
.2
.4
.6
.8
1.0
1.2
10
100
1000
10,000

AQUIFER TEST DATA

LUZ Address Harper Lake County San Bernardino State CA

Dec 89 Company performing test THE MARK GROUP Measured by C.H.

ARK 12 Distance from pumping well ~1120' Type of test Recovery Test No. INTERI.

9K

g equipment Schlmbt

Q = 700 gpm

Time Data

: Date ___ Time ___ (t_0)
: Date 10Dec89 Time 17:07 (t_0')
of aquifer test:
ng ___ Recovery X

Water Level Data

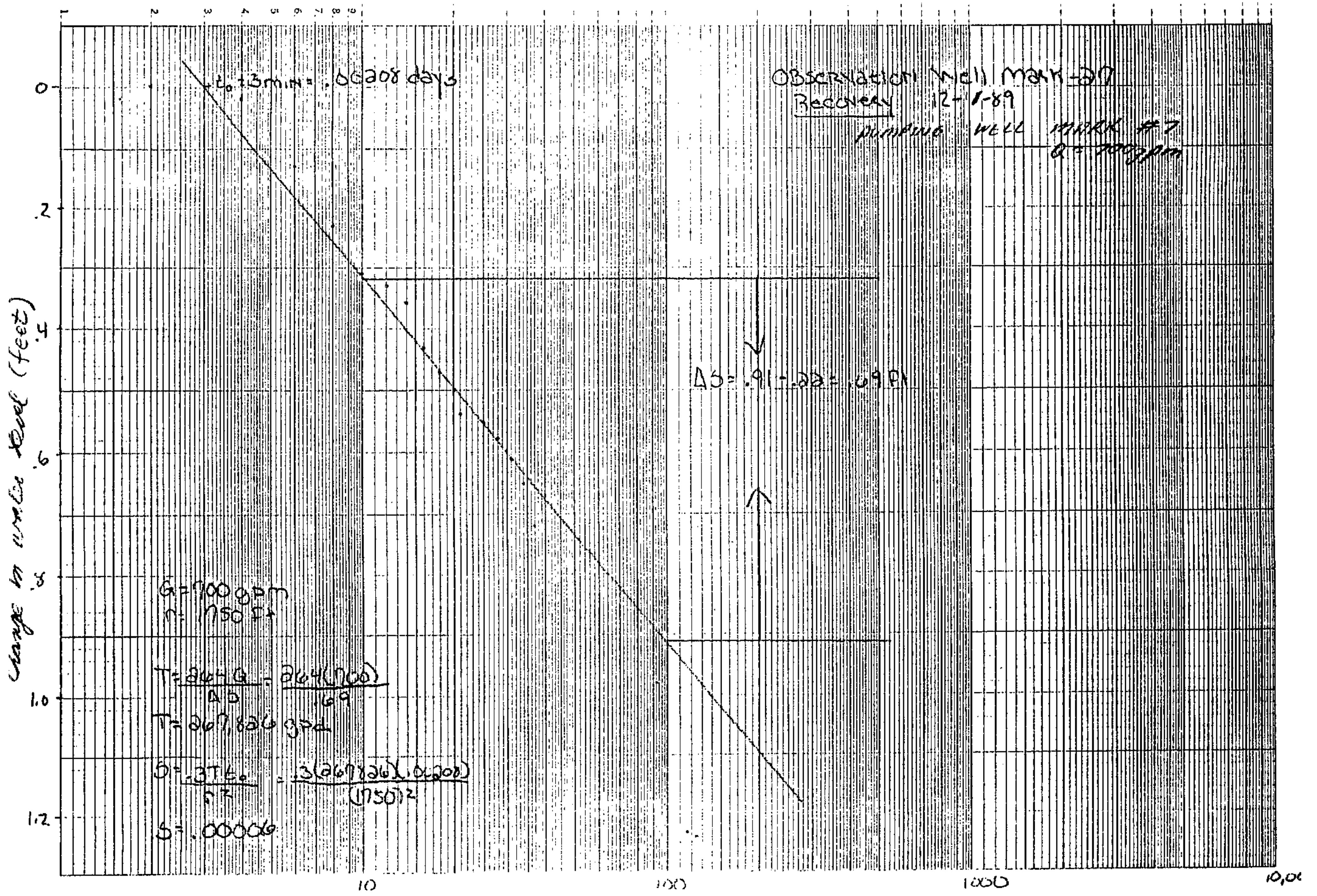
Static water level 182.15'
Measuring point Bottom of port
Elevation of measuring point 2059

Discharge Data

How Q measured FLOW METER
Depth of pump/air line ___
Previous pumping? Yes ___ No ___
Duration ___ End ___

Comments on factors affecting test data

Clock time	Time since pump started t	Time since pump stopped (minute) t'	t/t'		Water level measurement	Correction or Conversion	Water level	Water level change s or s'	Cummulative change	Discharge measurement	Rate		Comments
7:22		15			182.10			.05	.05				
7:27		20			182.05			.05	.10				
7:37		30			182.00			.05	.15				
7:48		41			181.97			.03	.18				
		54			181.87			.10	.28				Cleaned wet sand from sc
		65			181.85			.02	.30				Prior to reading.
		75			181.80			.05	.35				
		90			181.76			.04	.39				
8:51		104			181.74			.02	.41				
		120			181.66			.08	.49				
9:21		133			181.64			.02	.51				
		150			181.61			.03	.54				
		167			181.60			.01	.55				
0:07		180			181.58			.02	.57				
0:37		210			181.56			.02	.59				30 min. interval
		240			181.53			.03	.62				
		270			181.51			.02	.64				
		300			181.48			.03	.67				
		330			181.46			.02	.69				
		360			181.44			.02	.71				
		920			181.06			.38	1.09				
		1183			180.95			.11	1.20				



t_0 = 3 min = .00208 days
Observation Well Mark-20
Recovery 12-1-89
pumping well Mark #7
Q = 700 gpm
ΔS = .91 - .22 = .69 ft
Q = 700 gpm
r = 1750 ft
T = 264 Q / ΔS = 264(700) / .69
T = 267,826 gpd
S = .3 T t_0 / r^2 = .3(267826)(.00208) / $(1750)^2$
S = .00006
Change in water level (feet)
0
.2
.4
.6
.8
1.0
1.2
10
100
1000
10,000

AQUIFER TEST DATA

Address ______ County SAN BERNARDINO State CA

17-189 Company performing test THE MARX GROUP Measured by JJ

MARX # 27 Distance from pumping well ~1850' Type of test RECOVERY Test No. INTER.
MW-19L

…ing equipment POWERS WELL SOUNDER Q ~ 700 gpm

Time Data
…n: Date ______ Time ______ (t_0)
…ff: Date 12-1 Time 1707 (t_0')
… of aquifer test:
…ing ______ Recovery ✓

Water Level Data
Static water level 182.65
Measuring point ______
Elevation of measuring point 2056

Discharge Data
How Q measured FLOW METER
Depth of pump/air line ______
Previous pumping? Yes ____ No ____
Duration ______ End ______

Comments on factors affecting test data

Clock time	Time since pump started t	Time since pump stopped t'	t/t'		Water level measurement	Correction or Conversion	Water level	Water level change s or s'	Cumulative change	Discharge measurement	Rate		Comments
min 0					182.65			–					20 min interval
20					182.65			0	0				
40					182.63			.02	.02				
[illegible]					182.52			.11	.13				
[illegible]					182.42			.10	.23				
[illegible]					182.34			.08	.31				
[illegible]					182.32			.02	.33				
[illegible]					182.29			.03	.36				
[illegible]					182.22			.07	.43				
[illegible]					182.18			.04	.47				
[illegible]					182.15			.03	.50				
20					182.11			.04	.54				
50					182.10			.01	.55				30
50					182.07			.03	.58				
310					182.04			.03	.61				
340					182.00			.04	.65				
370					181.93			.07	.72				
[illegible]					181.67			.26	.98				
75					181.[illegible]			.25	1.23				
38					181.[illegible]			.01	1.24				

Appendix E

THE MARK GROUP
ENGINEERS & GEOLOGISTS

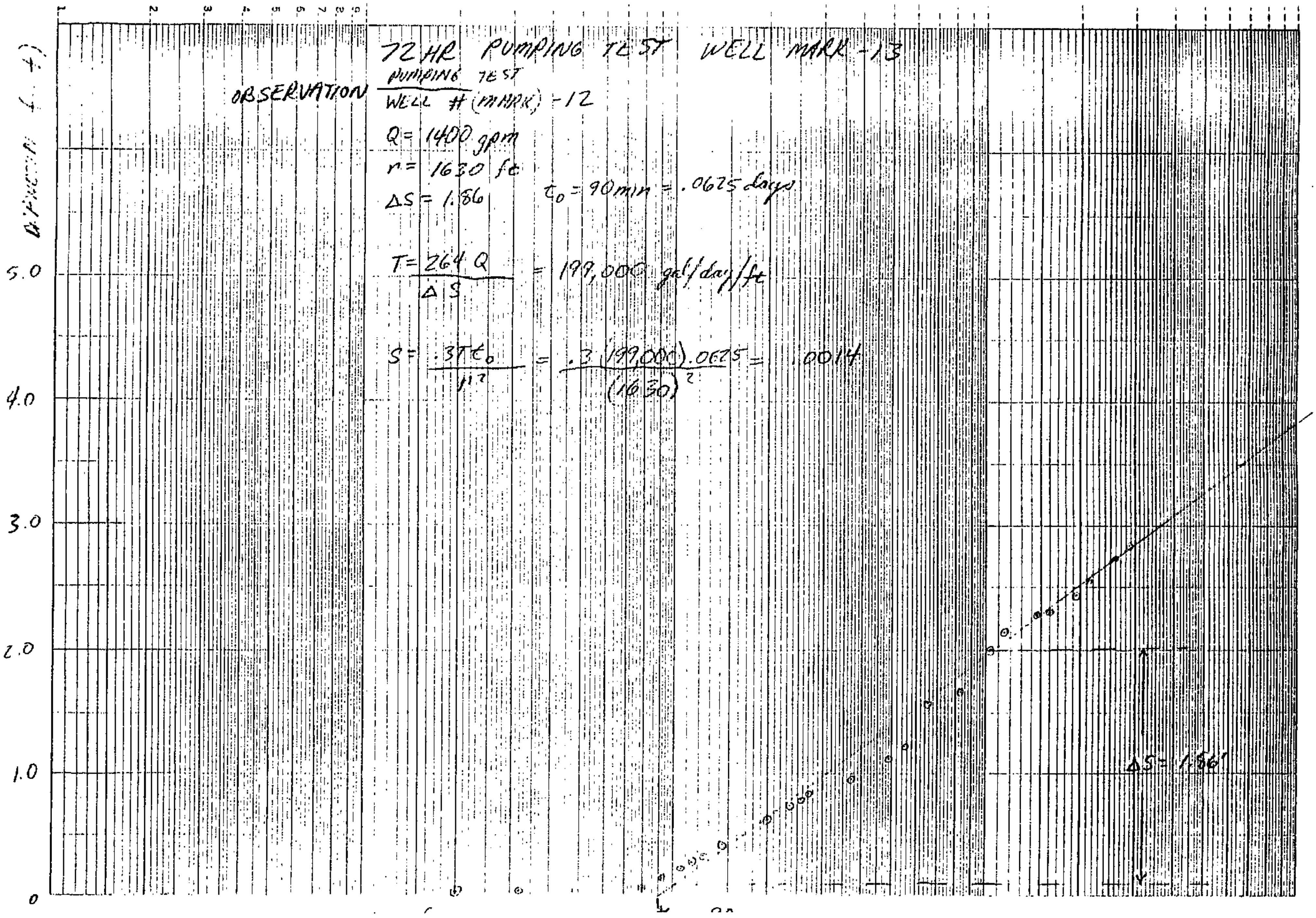
PUMPING TEST DATA

WELL MARK No. 6
PUMPING / OBSERVATION WELL
PUMPING / RECOVERY DATA
PAGE 1 OF 1

TYPE of PUMPING TEST Turbine
HOW Q MEASURED Flow Meter
M.P. for WL's Top of Casing elev. 2058
HOW WL's MEASURED Slinst or Powers 500 W.L.M.
DEPTH of PUMP/AIRLINE N.A. wrt
PUMPED WELL NO. 2 wells; #7 (nearest), #12 (½ mile)
% SUBMERGENCE: initial — ; pumping
RADIUS of PUMPED WELL
PUMP ON: date 12-6-89 time 09:15
DISTANCE from PUMPED WELL 2950'
PUMP OFF: date time

STATIC WATER LEVEL 185.74

CLOCK TIME	ELAPSED TIME mins/hrs	t	t'	t/t'	READING	CONVERSIONS or CORRECTIONS	WATER LEVEL	S or S'		WATER PRODUCT.	Q	COMMENTS (NOTE ANY CHANGES IN OBSERVERS)
:55	0	—	—	—	190.40							pumping water
												level when #7
												avg 700 gpm
:50		155			190.2 – 190.5							
:37		262			190.65							
:48		513			190.68	190.68						
0:00		595			190.85							
33:00		765			190.85							
7:50		1775			190.97							12/7/89
0:35		2120			191.10							
410	55/47	2775			191.26							12/8/89


72 HR PUMPING TEST WELL MARK-13
OBSERVATION PUMPING TEST WELL # (MARK) -12
Q = 1400 gpm
r = 1630 ft
ΔS = 1.86
t₀ = 90 min = .0625 days
T = 264 Q / ΔS = 199,000 gal/day/ft
S = .3 T t₀ / r² = .3 (199,000) .0625 / (1630)² = .0014
ΔS = 1.86'
DRAWDOWN (ft)
5.0
4.0
3.0
2.0
1.0
0

THE MARK GROUP
ENGINEERS & GEOLOGISTS

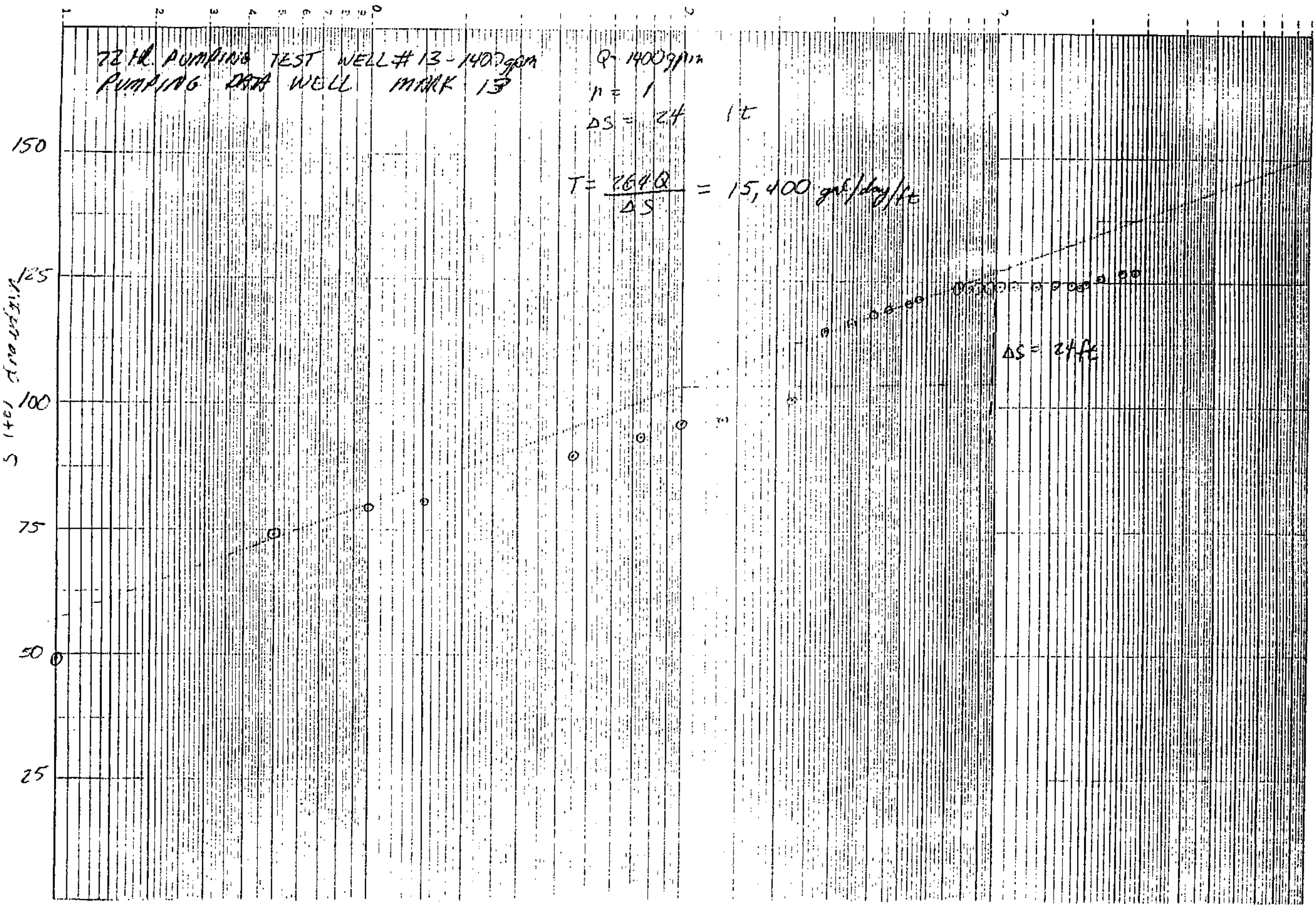
PUMPING TEST DATA

WELL MARK-12
~~PUMPING~~ / (OBSERVATION WELL)
(PUMPING) / ~~RECOVERY~~ DATA
PAGE 1 OF 1

TYPE of PUMPING TEST 100 hr
HOW Q MEASURED Flow meter
HOW WL's MEASURED Solinst 300' [illegible] (dipper)
PUMPED WELL NO. 13 (also #6 pg @ 700 gpm)
RADIUS of PUMPED WELL
DISTANCE from PUMPED WELL 1630
M.P. for WL's ______ elev. 2059
DEPTH of PUMP/AIRLINE ______ wrt ______
% SUBMERGENCE : initial ______ ; pumping ______
PUMP ON : date 12-6-89 time 9:15
PUMP OFF : date ______ time ______

TIME t = ____ at t' = 0
WATER LEVEL DATA — STATIC WATER LEVEL 180.9 (12-4-89)

CLOCK TIME	ELAPSED TIME min / hrs	t	t'	t/t'	READING	CONVERSIONS or CORRECTIONS	WATER LEVEL	s or s'		WATER PRODUCT.	Q	COMMENTS (NOTE ANY CHANGES IN OBSERVERS)
06:50	0				182.40							
9:20	5 / 0	5			182.48							
9:22	7 / 0	7			182.48							
9:28	13 / 0	13			182.48							
9:35	20 / 0	20			182.50							
9:47	32 / 0	32			182.51			0.01				9:50 - Well #7
10:03	48 / 0	48			.51			0.01				Turned off for maint.
10:35	20 / 1	80			.54			.04				ON @ 10:20
10:47	32 / 1	92			.63			.13				
11 02	47 / 1	107			.70			.20				
11 10	55 / 1	115			.75			.25				
11 20	5 / 2	125			.80			.30				
11 28	13 / 2	133			.82			.32				
11 40	25 / 2	145			.90			.40				
1235	20 / 3	200			183.10			.60				
1310	55 / 3	235			183.20			.70				
1330	15 / 4	255			183.27			.77				
1345	30 / 4	270			183.31			.81				
15:30	15 / 6	375			183.43			.93				
17:31	16 / 8	496			183.60			1.10				
18:23	8 / 9	548			183.70			1.20				
20:10	55 / 10	655			184.07			1.57				
22:50	35 / 13	815			184.15			1.65				
0235	20 / 17	1040			184.38			~~1.85~~ 1.88				12/7/89
0445	30 / 19	1170			184.64			2.14				
0955	40 / 24	1480			184.75			2.25				
1150	35 / 26	1595			184.78			2.28				
1443	28 / 29	1678			184.82			2.32				
1725	10 / 32	~~1925~~	1930		184.93			~~2.37~~	2.43			
2030	5 / 35	2115			185.05			~~2.49~~	2.55			12/8/89
0425	0 / 43	2580			185.23			2.73				
0855	40 / 47	2860			185.34			2.84				


72 Hr. PUMPING TEST WELL # 13 - 1400 gpm
PUMPING DATA WELL MARK 13
Q - 1400 gpm
n = 1
ΔS = 24 ft
T = 264Q / ΔS = 15,400 gal/day/ft
ΔS = 24 ft
150
125
100
75
50
25
S (ft) drawdown

WELL NUMBER AND LOCATION: #13 HARPER DRY LAKE - LUZ TEST PUMP SETTING: 360 AIRLINE: 352.0

DATE: Dec 6, 89 PERSON(S) TESTING WELL: M. RAFFERTY TOTAL HOURS THIS SHEET: 14hr 45min SHEET 1 OF

TOTALIZER START: 6024000 TOTALIZER FINISH: WATER TEMPERATURE:

	TIME	PUMPING RATE GPM	PUMPING LEVEL	DRAW-DOWN	SPECIFIC CAPACITY	SAND CONTENT	REMARKS
[illegible]	0915	1395					PUMP ON. CLOUDY, GREY. LOT OF AIR.
	0916	1350	221.8	49.6	27.21		
	0920	1300	245.5	73.7	17.63		
	0925	1300	251.0	79.2	16.41		
	0930	1400	252.6	80.8	17.32		Adjust ~~Flow~~ Q ↑
45	1000	1300	261.4	89.6	14.50		
75	1030	1300	266.2	94.4	13.77		
105	1100	1300	267.9	96.1	13.52		
135	1130	1300	269.0	97.2	13.37		
165	1200	1300	271.3	99.5	13.06		
225	1300	1300	273.4	101.6	12.79		Ad JUST Q ↑
285	1400	1395	286.1	114.3	12.20	1ppm	Adjust Q ↑
345	1500	1402	288.4	116.6	12.02		
405	1600	1397	289.6	117.8	11.85		
465	1700	1400	290.7	118.9	11.77		
525	1800	1398	292.1	120.3	11.68		AIR ↓
585	1900	1402	293.3	121.5	11.53		
645	2000	1398	294.0	122.2	11.44		
705	2100	1403	294.2	122.4	11.46		
765	2200	1400	295.4	123.6	11.32		
825	2300	1404	295.4	123.6	11.53		
885	2400	1405	295.4	123.6	11.36		

CUSTOMER: MARK GROUP WELL DIAMETER: [illegible] DEPTH OF WELL: [illegible]

WELL NUMBER AND LOCATION: #13 HARPER DRY LAKE - LUZ TEST PUMP SETTING: 360 AIRLINE: 352

DATE: Dec 7/8 PERSON(S) TESTING WELL: M. RAFFERTY TOTAL HOURS THIS SHEET: ______ SHEET 2 OF ____

TOTALIZER START: ______ TOTALIZER FINISH: ______ WATER TEMPERATURE: ______

TIME	PUMPING RATE GPM	PUMPING LEVEL	DRAW-DOWN	SPECIFIC CAPACITY	SAND CONTENT	REMARKS
0100	1402	295.3	123.6	11.34		
0300	1400	295.4	123.6	11.32		
0500	1398	295.4	123.6	11.31		
0800	1395	295.4	123.6	11.28		
1100	1392	295.4	123.6	11.26		
1400	1390	295.4	123.6	11.26	1 PPM	
1600	1387	295.1	123.3	11.24		ADJUST Q ↑
1700	1399	296.5	124.7	11.21		
2100	1400	297.9	126.1	11.10		
0600	1405	298.8	127.0	11.06		
1000	1407	298.8	127.0	11.07		

THE MARK GROUP
ENGINEERS & GEOLOGISTS

PUMPING TEST DATA

WELL MAKK 14
PUMPING/OBSERVATION WELL (circled: OBSERVATION WELL)
PUMPING/RECOVERY DATA (circled: PUMPING)
PAGE 1 OF 1

TYPE of PUMPING TEST: 72 HR
HOW Q MEASURED: FLOW METER
HOW WL's MEASURED:
PUMPED WELL NO.: 13
RADIUS of PUMPED WELL:
DISTANCE from PUMPED WELL: 510

M.P. for WL's: Bottom of Port — elev. 2048
DEPTH of PUMP/AIRLINE: — wrt:
% SUBMERGENCE: initial: ; pumping:
PUMP ON: date 6 Dec 89 time:
PUMP OFF: date: time:

TIME: t = 9:15 at t' = 0
WATER LEVEL DATA — STATIC WATER LEVEL 162.65'

CLOCK TIME	ELAPSED TIME mins	hrs	t	t'	t/t'	READING	CONVERSIONS or CORRECTIONS	WATER LEVEL	S or S'		WATER PRODUCT.	Q	COMMENTS (NOTE ANY CHANGES IN OBSERVERS)
9:16						150	-.35	149.65					Start Test @ 9:15
9:25						150	+.70	150.7					
9:26						150	+1.50	151.50					[illegible]
9:29						150	+2.70	152.70					
9:30						155	-.85	154.15					Water levels from
9:32						155	+.30	155.30					9:10 through 9:48
9:35						155	+.30	155.30					may be erroneous.
9:37						155	+.45	155.45					
9:39						155	+1.7	156.70					[illegible]
9:42						155	+2.9	157.90					[illegible]
9:48						160	2.7	162.7					[illegible]
10:06	51	0	51					162.10	+.55				Each # - 162.65
10:08	53		53					162.00	+.65				
10:10	55		55					161.90	+.75				
10:16	1	1	61					161.75	+.90				
10:20	5	1	65					161.60	+1.05				
10:22	12	1	72					161.55	+1.10				
10:27	17	1	77					161.45	+1.20				
10:34	19	1	79					161.30	+1.35				
11:29	14	2	134					161.80	+0.85				
11:41	26	2	146					161.75	+0.90				
12:36	21	3	201					160.57	+2.08				
14:22	12	5	312					160.67	+1.95				
14:58	43	5	343					160.77	+1.88				
16:32	17	7	437					162.60	+0.05				- Beginning to fall
17:17	2	8	482					162.95	-.30				
18:32	17	9	557					163.03	-.38				
22:00	45	12	765					161.55	+1.10				[illegible]
1:18	3	16	1023					161.85	+.80				12/7/89
0750	35	19	1085				Water &	Sediment	@ 131?				+ Collapse of
1055	40	25	1540					164.54	-1.89				Casing?
1412	57	29	1797					163.83	-1.18				
1627	[illegible]	31	1872					164.10	-1.45				
1837	22	33	2014					164.00	-1.35				
0400			2565					165.67	-3.02				12/8/89
0740	25	46	2785					165.80	-3.15				
1310			3115					165.73	-3.08				

THE MARK GROUP
ENGINEERS & GEOLOGISTS

PUMPING TEST DATA

WELL 16
PUMPING / OBSERVATION WELL (circled)
PUMPING / RECOVERY DATA
PAGE 1 OF 1

TYPE of PUMPING TEST 72 HR
HOW Q MEASURED FLOW METER
HOW WL's MEASURED
PUMPED-WELL NO. 13
RADIUS of PUMPED WELL
DISTANCE from PUMPED WELL 3200'

M.P. for WL's TOC elev. 2034
DEPTH of PUMP/AIRLINE wrt
% SUBMERGENCE : initial ; pumping
PUMP ON : date 6Dec89 time
PUMP OFF : date time

TIME t = 9:15 at t' = 0

WATER LEVEL DATA — STATIC WATER LEVEL 151.02'

CLOCK TIME	ELAPSED TIME mins/hrs	t	t'	t/t'	READING	CONVERSIONS or CORRECTIONS	WATER LEVEL	s or s'		WATER PRODUCT.	Q	COMMENTS (NOTE ANY CHANGES IN OBSERVERS)
1:56	41 / 2	161			151.07			0.05				
3:02	13 / 3	193			151.07			0.05				
1:49	34 / 4	274			151.10			0.08				Rust falls down
7:01	46 / 5	346			151.15			0.13				the well. Rolldown
9:10	50 / 9	590			151.34			0.33				[illegible] slowly
23.26	11 / 13	791			151.35			0.33				
:27		1032			151.47			0.45				12/7/89
:35		1280			151.55			0.53				
:50	15 / 55	1575			151.53			0.51				
:28	13 / 27	1693			151.50			0.48				
1:00		1965			151.53			0.51				
1:38		2085			151.57			0.55				
330		2535			151.67			0.65				↑ Meunhaw
715		2760			151.70			0.68				12/8/89

THE MARK GROUP
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PUMPING TEST DATA

WELL: MARK-17 (illegible)
PUMPING / OBSERVATION WELL
PUMPING / RECOVERY DATA
PAGE 1 OF 1

TYPE of PUMPING TEST: 72 HR
HOW Q MEASURED: FLOW METER
HOW WL's MEASURED:
PUMPED WELL NO.: -13
RADIUS of PUMPED WELL:
DISTANCE from PUMPED WELL: 5100

M.P. for WL's: Top of Casing Elev. 208.80
DEPTH of PUMP/AIRLINE: ______ wrt ______
% SUBMERGENCE: initial ______ ; pumping ______
PUMP ON: date 12-6-89 time ______
PUMP OFF: date ______ time ______

TIME (t = ___ at t' = 0)					WATER LEVEL DATA (STATIC WATER LEVEL 208.3 (?))					WATER PRODUCT.		COMMENTS
CLOCK TIME	ELAPSED TIME mins/hrs	t	t'	t/t'	READING	CONVERSIONS or CORRECTIONS	WATER LEVEL	s or s'			Q	(NOTE ANY CHANGES IN OBSERVERS)
7:23		—	—		208.37	12-5-89	SWL					Previously meas
												swl was 210.6
												on 12-5-89
												after pump pull
1257					208.35	.08						
16:03					208.45	.18						
21:46					209.00	.73						
0300	45/17	1055			209.02	.75						
1015	0/25	1500			209.30	1.03						
1205	50/26	1610			209.31	1.04						
17:13	58/28	1740			209.40	1.13						
0445	30/43	2610			210.14	1.87						Well Cover
1920	5/48	2885			210.41	2.14						Installed

PERSONNEL

THE MARK GROUP
ENGINEERS & GEOLOGISTS

PUMPING TEST DATA

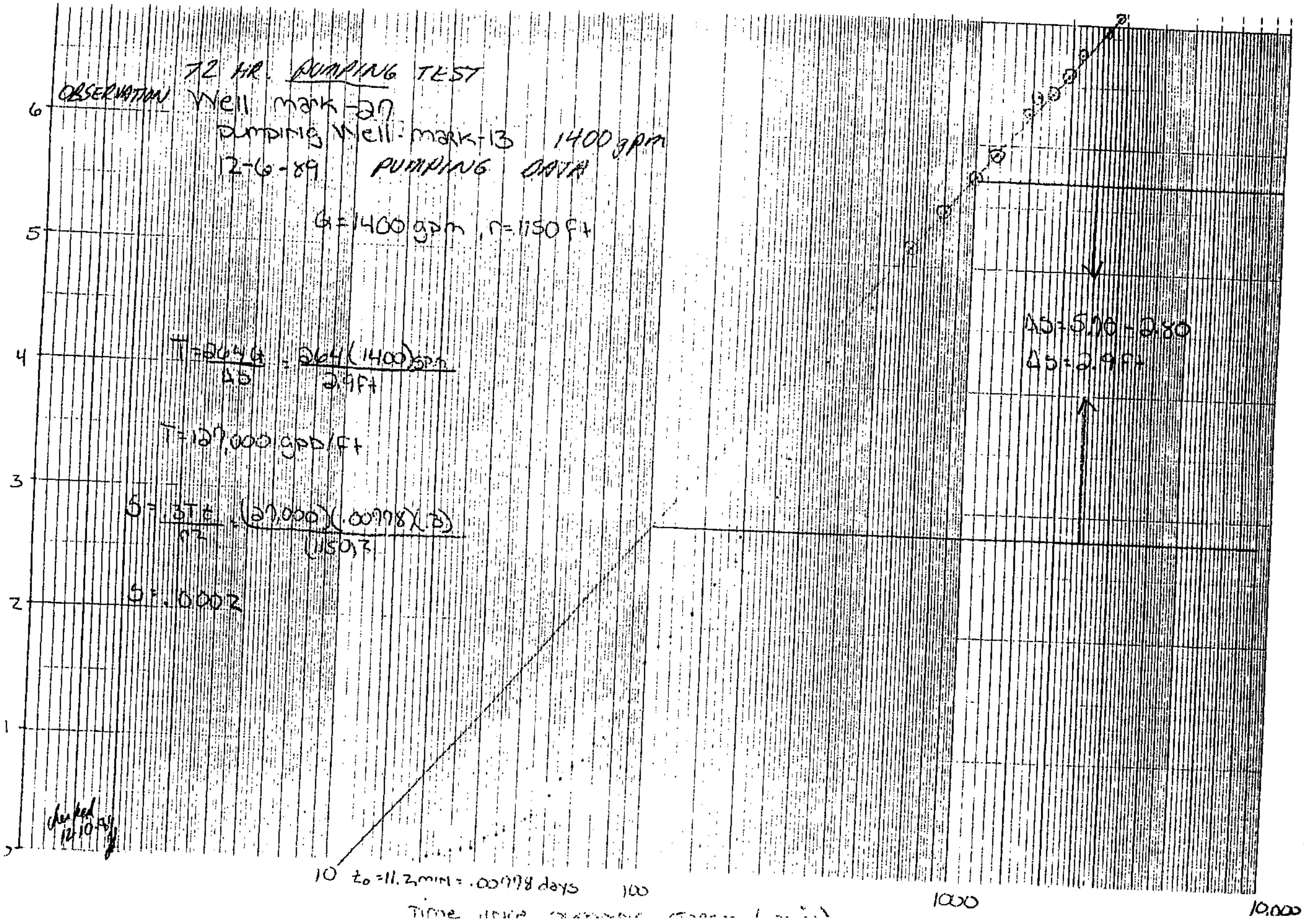
WELL 25
PUMPING / OBSERVATION WELL (circled: OBSERVATION WELL)
PUMPING / RECOVERY DATA (circled: PUMPING)
PAGE 1 OF 1

TYPE of PUMPING TEST: 72 HR
HOW Q MEASURED: FLOW METER
HOW WL's MEASURED: Solinst & Data logger
PUMPED WELL NO. 25 (MARK #)
RADIUS of PUMPED WELL:
DISTANCE from PUMPED WELL: ≈500

M.P. for WL's: TOC elev. 2040
DEPTH of PUMP/AIRLINE: wrl
% SUBMERGENCE: initial ; pumping
PUMP ON: date 6 Dec 89 time 9:15
PUMP OFF: date time

TIME: t = 9:15 at t' = 0
WATER LEVEL DATA — STATIC WATER LEVEL 156.48

CLOCK TIME	ELAPSED TIME mins/hrs	t	t'	t/t'	READING	CONVERSIONS or CORRECTIONS	WATER LEVEL	S or S'		WATER PRODUCT.	Q	COMMENTS (NOTE ANY CHANGES IN OBSERVERS)
9:00												Test started
11:48		153			160.90							
13:40		265			159.55							
14:41		326			159.60							
17:10		475			159.65							
19:08		585			159.35							
2234		799			159.85							
1:34		1039			160.00							12/7/89
0520		1265			160.08							
1040	25 / 25	1590			160.05							
1247		1712			160.00							
1710		1975			160.07							
1926		2111			160.12							
2340		2545			160.20							K. Moynihan
0725		2770			160.26							12/8/89
1330		3135			160.17							



72 HR. PUMPING TEST
OBSERVATION Well mark-27
Pumping Well: mark-13 1400 gpm
12-6-89 PUMPING DATA
Q = 1400 gpm, r = 1150 ft
T = 264 Q / Δs = 264 (1400) gpm / 2.9 ft
T = 127,000 gpd/ft
S = .3Tt / r² = (127,000)(.00778)(.3) / (1150)²
S = .0002
Δs = 5.70 - 2.80
Δs = 2.9 ft
t₀ = 11.2 min = .00778 days
6
5
4
3
2
1
0
10
100
1000
10,000
checked 12-10-89

THE MARK GROUP
ENGINEERS & GEOLOGISTS

PUMPING TEST DATA

WELL MARK-27
PUMPING/OBSERVATION WELL
PUMPING/RECOVERY DATA
PAGE 1 OF 2

TYPE of PUMPING TEST Turbine
HOW Q MEASURED Flow Meter
HOW WL's MEASURED
PUMPED WELL NO. MARK-13 | MARK-7
RADIUS of PUMPED WELL
DISTANCE from PUMPED WELL 1150'

M.P. for WL's Top of Casing elev. 2056
DEPTH of PUMP/AIRLINE open well wrt
% SUBMERGENCE : initial ; pumping
PUMP ON : date 12-6-89 time 0915
PUMP OFF : date time

TIME 1= at t'=0						WATER LEVEL DATA STATIC WATER LEVEL 182.10 (12-4-89)					WATER PRODUCT.		COMMENTS
CLOCK TIME	ELAPSED TIME mins	hrs	t	t'	t/t'	READING	CONVERSIONS or CORRECTIONS	WATER LEVEL	s or s'		CR 13	O	(NOTE ANY CHANGES IN OBSERVERS)
7:02	0		—	—	—	182.70	Measured w/ Solinst—						Preliminary measur
9:15	0	0				182'6.5"	measured w/ Powers						
920	5	0				182'6.5"	182.54'						
921	6	0				182'6.75"	182.56'						1st Reserve
924	9					182'6.75"	182.56'						w/ lossing tape
926	11					182'6.75"	182.56'						strech
928	13					~~182'7.0"~~	182'7.25	182.60'					Not Correction
93130	16	30				182.595							New Tape; use two
93230	17	30				182.61			0.01				
934	19	0				182.625			0.03				
936	21	0				182.660			0.06				
938:30	23	30				182.69			0.09				
940	25	0				182.705			0.11				
942	27	0				182.72			0.12				
944	29	0				182.75			0.15				
947	32	0				182.82			0.22				#7
950	35	0				182.87			0.27				Pump ~~#7~~ shut
952	37	1				182.895			0.30				off @ 0950
957	42	0				~~182.5~~ 183.00			0.40				for Maint
1000	45	0				183.03			0.43				
1006	51	0				183.2			0.60				
1010	55	0				183.35			0.75				
1015	0	1	60			183.44			0.84				
1020	5	1	65			183.50			0.90				
1025	10	1	70			183.65			1.05				
1030	15	1	75			183.70			1.10				Pump #7 back
1037	22	1	82			183.78			1.28				on @ 1020
1045	30	1	90			184.00			1.40				700 GPM
1055	40	1	100			184.31			1.71				
1105	50	1	110			184.45			1.85				
1115	0	2	120			184.57			1.91				
1135	20	2	140			184.70			2.10				
1200	45	2	165			184.95			2.35				
1230	15	3	195			185.35			2.75				
1326	11	4	251			185.76			3.12				
1350	35	4	275			186.02			3.42				
15:11	56	5	356			186.60			4.20				
17:23	8	8	488			187.05			4.65				
19:48	33	10	633			187.45			5.15				
22:40	22	13	802			187.44			5.45				

THE MARK GROUP
ENGINEERS & GEOLOGISTS

PUMPING TEST DATA

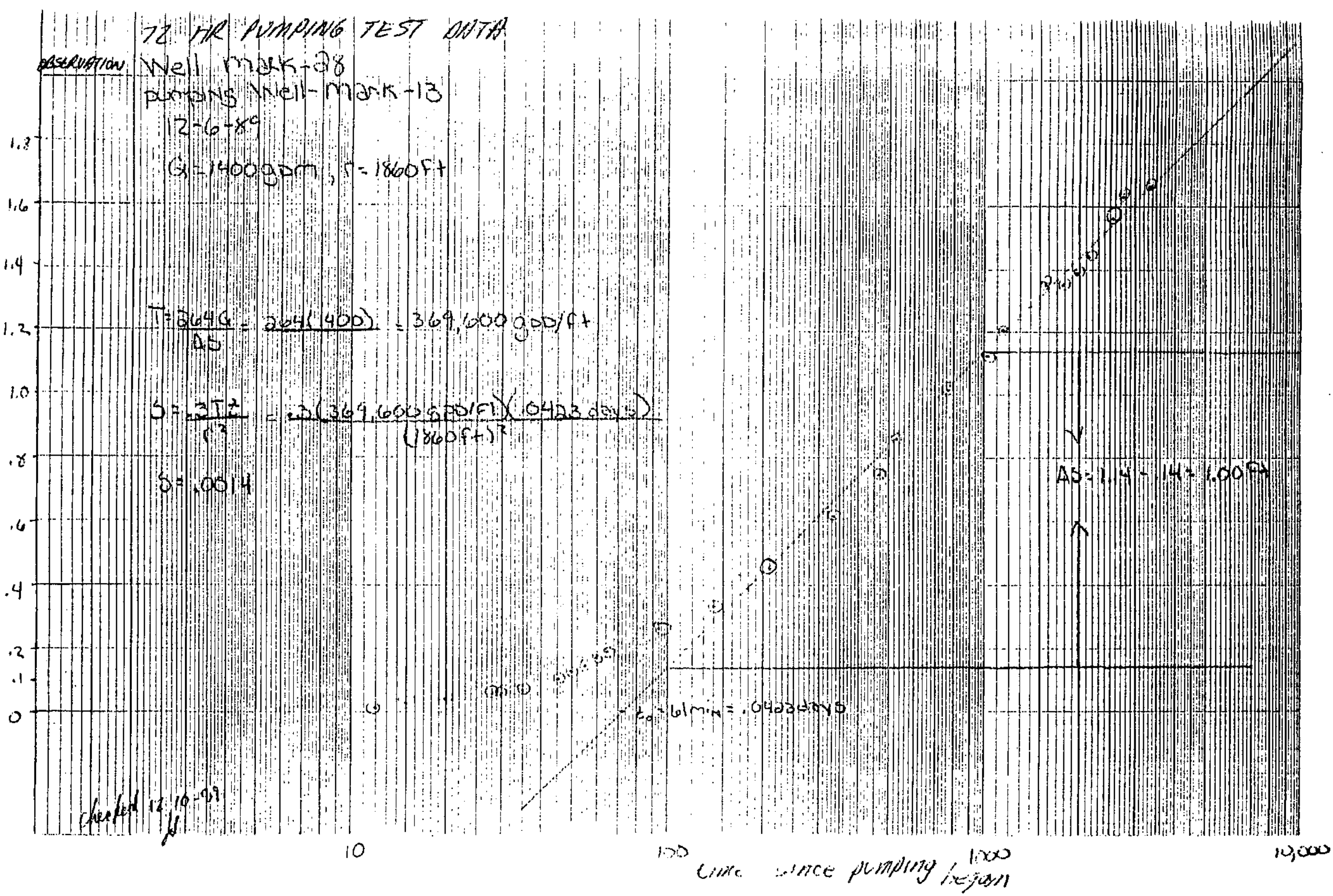
WELL Mark-27
PUMPING/OBSERVATION WELL
PUMPING/RECOVERY DATA
PAGE 1 OF 2

TYPE of PUMPING TEST Turbine
HOW Q MEASURED Flow meter
HOW WL's MEASURED
PUMPED WELL NO. Mark 13/Mark 7
RADIUS of PUMPED WELL
DISTANCE from PUMPED WELL 1150'

M.P. for WL's TOC elev.
DEPTH of PUMP/AIRLINE open well wrt 2056
% SUBMERGENCE : initial ; pumping
PUMP ON : date 12-6-89 time 0915
PUMP OFF : date time

TIME: t = ___ at t' = 0
WATER LEVEL DATA — STATIC WATER LEVEL 182.60 (12-6)

CLOCK TIME	ELAPSED TIME mins/hrs	t	t'	t/t'	READING	CONVERSIONS or CORRECTIONS	WATER LEVEL	S or S'		WATER PRODUCT.	Q	COMMENTS (NOTE ANY CHANGES IN OBSERVERS)
2220	5/17	1025			188.33			5.73				12/7/89
2435	20/19	1160			188.51			5.91				
0945	30/24	1470			188.86			6.26				
1130	15/26	1575			189.00			6.40				3
1439	33/29	1763			189.00			6.40				Steve (Umbd)
1716	01/32	1921			189.20			6.60				
2021	6/35	2106			189.35			6.75				
2420	5/43	2585			189.53			6.93				12/8/89
2840	25/47	2845			189.60			7.06				
337					189.79			7.19				


72 HR PUMPING TEST DATA
OBSERVATION Well Mark-28
pumping Well-Mark-13
12-6-89
Q=1400gpm, r=1860ft
T=264Q/ΔS = 264(400)/... = 369,600 gpd/ft
S=.3Tt/r² = .3(369,600 gpd/ft)(.0423 days)/(1860ft)²
S=.0014
ΔS=1.14-.14=1.00ft
t₀=61min=.0423days
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
.1
0
10
100
1000
10,000
time since pumping began
checked 12-10-89

THE MARK GROUP
ENGINEERS & GEOLOGISTS

PUMPING TEST DATA

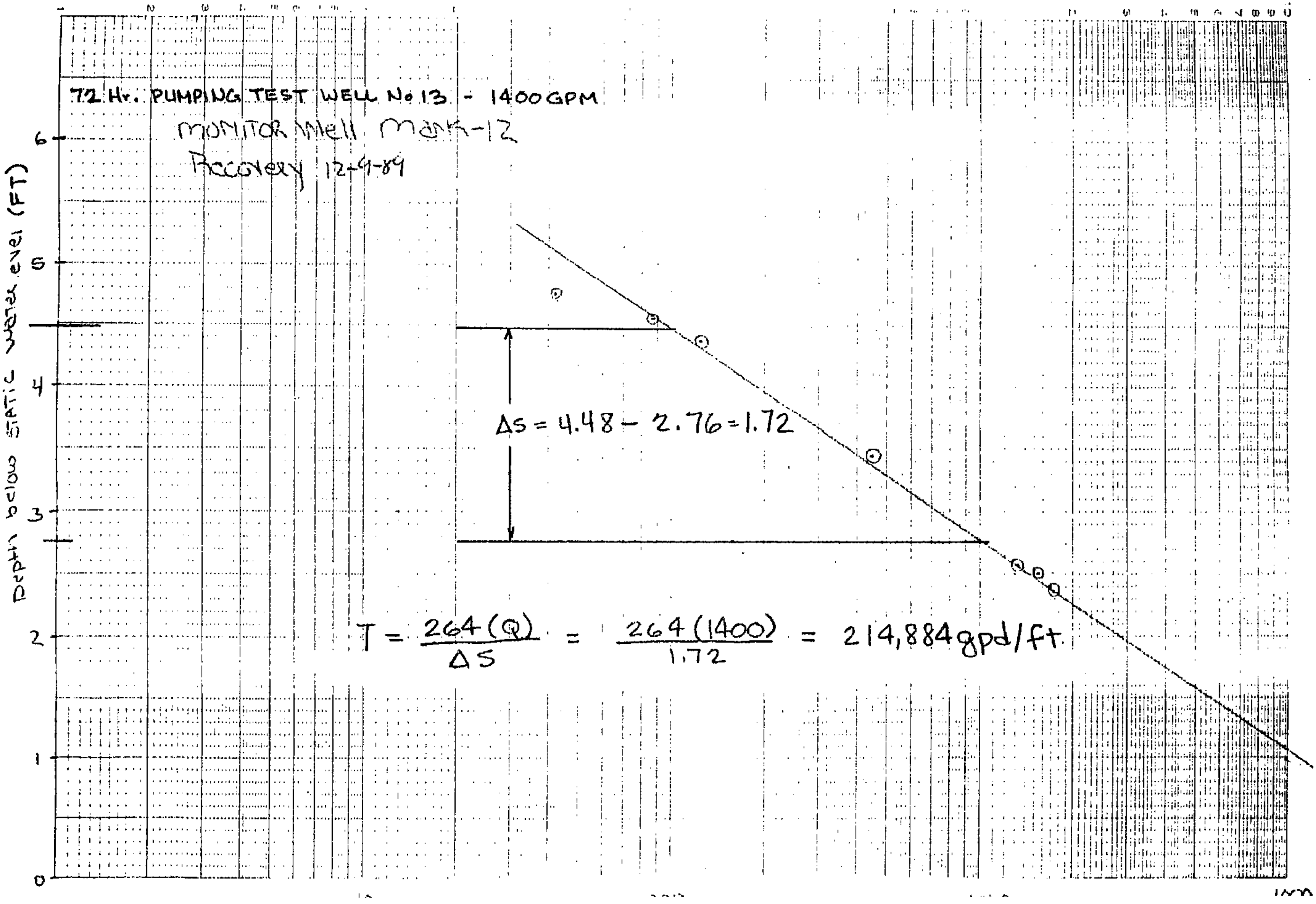
WELL 28
~~PUMPING~~/OBSERVATION WELL
PUMPING/~~RECOVERY~~ DATA
PAGE 1 OF 1

TYPE of PUMPING TEST: 72 HR
HOW Q MEASURED: FLOW METER
HOW WL's MEASURED: Solinst 500' (MARK)
PUMPED WELL NO.: 13
RADIUS of PUMPED WELL:
DISTANCE from PUMPED WELL: 1960

M.P. for WL's: TOC elev. 2045
DEPTH of PUMP/AIRLINE: wrt
% SUBMERGENCE: initial ; pumping
PUMP ON: date 6Dec89 time 09:15
PUMP OFF: date time

TIME: t = 09:15 at t' = 0
WATER LEVEL DATA — STATIC WATER LEVEL 162.74'

CLOCK TIME	ELAPSED TIME hrs	t min	t'	t/t'	READING	CONVERSIONS or CORRECTIONS	WATER LEVEL	S or S'	Cumm	WATER PRODUCT.	Q	COMMENTS (NOTE ANY CHANGES IN OBSERVERS)
09:27		12			162.75			.01	.01			CWH
09:30		15			162.77			.02	.03			
09:35		20			162.78			.01	.04			
09:43		28			162.80			.02	.06			
09:45		30			162.80			0	.06			
09:50		35			162.81			.01	.07			
10:00		45			162.85			.04	.11			Switched to ACTAT
10:05		50			162.87			.02	.13			[illegible]
10:10		55			162.89			.02	.15			
10:15		60			162.91			.02	[illegible]			
10:20		65			162.91			.02	[illegible]			
10:44		94			162.99			[illegible]	.29			Steve Turnbull
11:20		140			163.05			.06	.33			
12:30		210			163.17			.12	.45			
14:32		332			163.33			.16	.61			
16:48		468			163.46			.13	[illegible]			
17:43		523			163.58			.12	.86			
22:10		770			163.73			.15	1.01			
1:38		1043			163.84			[illegible]	1.12			12-7-89
0510		1255			163.93			.09	1.21			Bill Morrison
1045	30 / 25	1590			164.07			[illegible]	1.35			
14:05		1790			164.07			0	1.35			Steve Turnbull
16:52		1957			164.11			.04	1.39			
19:15		2100			164.16			.05	1.44			
2350	35 / 42	2555			164.28			.12	1.56			12-8-89
0730	15 / 46	2775			164.35			.07	1.63			
1320					164.32			.03	1.66			



72 Hr. PUMPING TEST WELL No 13 - 1400 GPM
MONITOR Well Mark-12
Recovery 12-9-89
Depth below STATIC water level (FT)
6
5
4
3
2
1
0
ΔS = 4.48 − 2.76 = 1.72
T = 264 (Q) / ΔS = 264 (1400) / 1.72 = 214,884 gpd/ft

THE MARK GROUP ENGINEERS & GEOLOGISTS

PUMPING TEST DATA

WELL *MARK-12*
PUMPING/~~OBSERVATION~~ WELL
PUMPING/~~RECOVERY~~ DATA
PAGE *1* OF *2*

TYPE of PUMPING TEST *100 hr*
HOW Q MEASURED *Flow meter*
HOW WL's MEASURED *Solinst 300' - (w/o damper)*
PUMPED WELL NO. *13 (also #6 ppg @ 700 gpm)*
RADIUS of PUMPED WELL
DISTANCE from PUMPED WELL *1550'*

M.P. for WL's ______ elev. *2059*
DEPTH of PUMP/AIRLINE ______ wrt ______
% SUBMERGENCE: initial ______ ; pumping ______
PUMP ON: date *12-6-89* time *9:15*
PUMP OFF: date ______ time ______

TIME: t = ______ at t' = 0
WATER LEVEL DATA — STATIC WATER LEVEL *180.9 (12-4-89)*

CLOCK TIME	ELAPSED TIME mins/hrs	t	t'	t/t'	READING	CONVERSIONS or CORRECTIONS	WATER LEVEL	S or S'		WATER PRODUCT	Q	COMMENTS (NOTE ANY CHANGES IN OBSERVERS)
6:50	0				182.40							
7:20	5 / 0				182.48							
7:22	7 / 0				182.48							
7:28	13 / 0				182.48							
9:35	20 / 0				182.50							PPG
9:47	32 / 0				182.51			0.01				7:50 - Well #7
10:03	48 / 0				.51			0.01				Turned off for [illegible] min.
10:35	20 / 1	80			.54			.04				ON @ 10:20
10:47	32 / 1	92			.63			.13				
11 02	47 / 1	107			.70			.20				
11 10	55 / 1	115			.75			.25				
1120	5 / 2	125			.80			.30				
1128	13 / 2	133			.82			.32				
1140	25 / 2	145			.90			.40				
1235	20 / 3	200			183.10			.60				
1310	55 / 3	235			183.20			.70				
1330	15 / 4	255			183.27			.77				
1345	30 / 4	270			183.31			.81				
15:30	15 / 6	375			183.43			.93				
17:31	16 / 8	496			183.60			1.10				
18:23	8 / 9	548			183.70			1.20				
20:10	55 / 10	655			184.07			1.57				
22.50	35 / 13	815			184.15			1.65				
0235	20 / 17	1040			184.38			1.85 1.88				12/7/89
0445	30 / 19	1170			184.64			2.14				
0955	40 / 24	1480			184.75			2.25				
1150	35 / 26	1595			184.78			2.28				
1443	28 / 29	1678			184.82			2.32				
1725	[illegible] / 32	~~1725~~ 1930			184.93			~~2.37~~	2.43			
1028	[illegible] / 49	[illegible]			185.05			~~2.49~~	2.55			12/8/89
0425	[illegible] / 73	[illegible]			185.23			2.73				
0835	[illegible]	[illegible]			185.34			2.84				
1555					185.38			2.92				
[illegible]					185.10							12/9/89
[illegible]					185.76							Pump off @ [illegible]
1027		-2			185.66			4.76				
1113		-7			185.45			4.55				
1149		24			185.27			4.37				
1221					18[illegible]			3.95				

THE MARK GROUP
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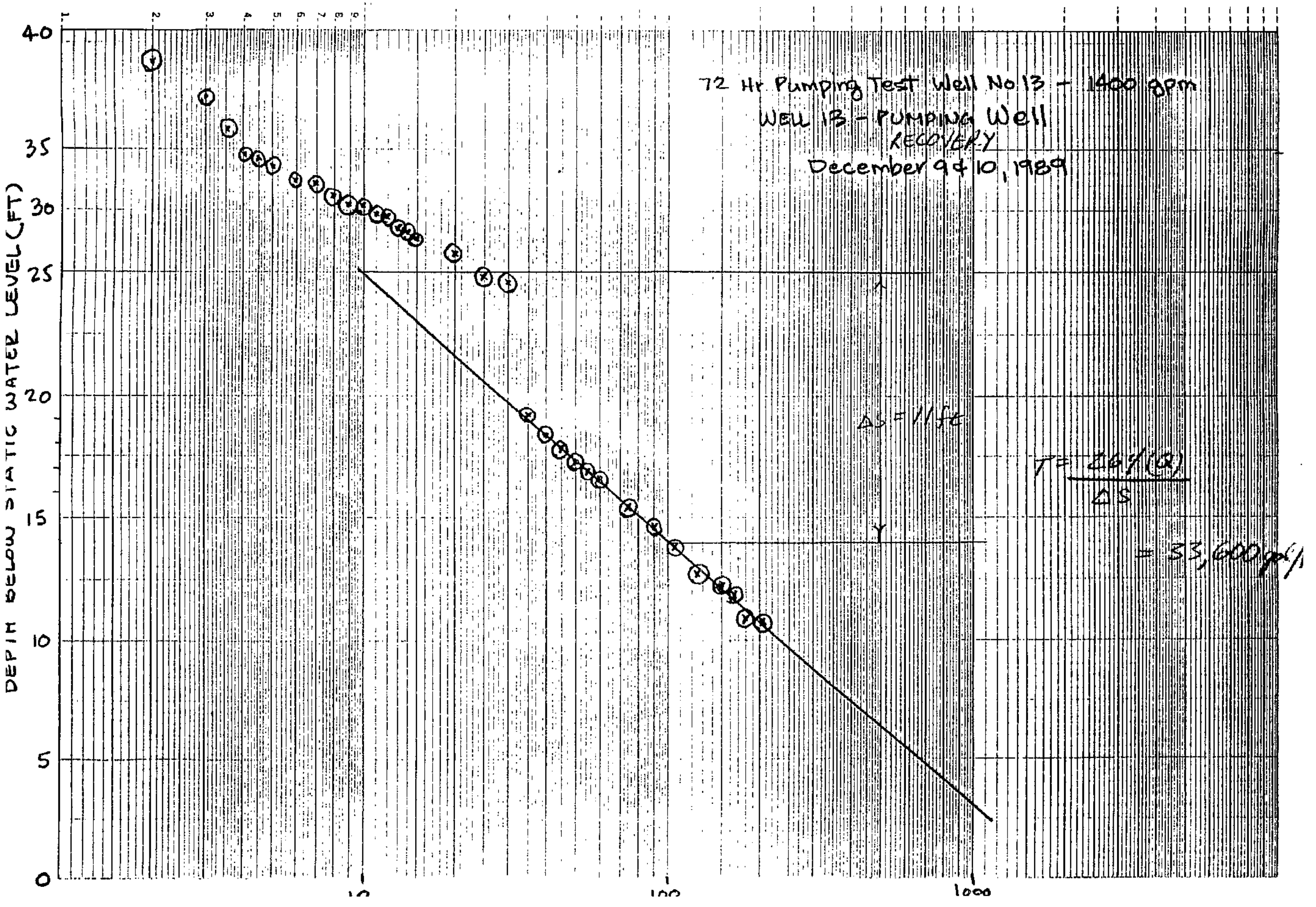
PUMPING TEST DATA

WELL NGKR-12
PUMPING / OBSERVATION WELL
PUMPING / RECOVERY DATA
PAGE 2 OF 2

TYPE of PUMPING TEST [illegible]
HOW Q MEASURED FLOW METER
HOW WL's MEASURED
PUMPED WELL NO. 13
RADIUS of PUMPED WELL
DISTANCE from PUMPED WELL 1635

M.P. for WL's ______ elev. 2059
DEPTH of PUMP/AIRLINE ______ w/l ______
% SUBMERGENCE : initial ______ ; pumping ______
PUMP ON : date 12-7-99 time 9:15
PUMP OFF : date 12-9-99 time 9:41

TIME (t = ___ at t' = 0)					WATER LEVEL DATA (STATIC WATER LEVEL ___)					WATER PRODUCT.		COMMENTS
CLOCK TIME	ELAPSED TIME mins/hrs	t	t'	t/t'	READING	CONVERSIONS or CORRECTIONS	WATER LEVEL	S or S'			Q	(NOTE ANY CHANGES IN OBSERVERS)
1220		[illegible]55			184.32			3.43				
859		[illegible]			183.48			2.58				12/10/89
1108		[illegible]			183.40			[illegible]				
1507		[illegible]			183.25			[illegible]				



72 Hr Pumping Test Well No 13 - 1400 gpm
WELL 13 - PUMPING Well
RECOVERY
December 9 & 10, 1989
Δs = 11 ft
T = 264(Q) / Δs
= 33,600
DEPTH BELOW STATIC WATER LEVEL (FT)
40
35
30
25
20
15
10
5
0
10
100
1000

THE MARK GROUP
ENGINEERS & GEOLOGISTS

PUMPING TEST DATA

WELL 13
PUMPING/OBSERVATION WELL
PUMPING/RECOVERY DATA
PAGE 1 OF 2

TYPE of PUMPING TEST 72 HR
HOW Q MEASURED
HOW WL's MEASURED Airline, Solinst (?)
PUMPED WELL NO. 13
RADIUS of PUMPED WELL
DISTANCE from PUMPED WELL 0

M.P. for WL's GL elev. 2049
DEPTH of PUMP/AIRLINE 352 wrt
% SUBMERGENCE initial ; pumping
PUMP ON: date time
PUMP OFF: date 9Dec89 time 9:45

t = 9:45 or t' = 0
STATIC WATER LEVEL

CLOCK TIME	ELAPSED TIME t	t'	t/t'	READING	CONVERSIONS OR CORRECTIONS	WATER LEVEL	s or s'		WATER PRODUCT	Q	COMMENTS (NOTE ANY CHANGES IN OBSERVERS)
[illegible]	0			21.7	(2131 ... 521	[illegible]	132.2[illegible]				12066 (?) Totalizer at shut down
10 sec	10 sec			28.0		287.17					
	.5			31.0		250.39	110.59				
9:46	1			[illegible]		280.39	110.88				
	1.5			[illegible]5		212.25	42.74				
9:47	2.0			62.3		208.09	38.58				
	3.[illegible]			62.9		206.70	37.19				
	3.5			63.5		205.32	35.81				
	4.0			63.9		[illegible]4.39	3[illegible].88				
	4.5			64.[illegible]		2[illegible]16	34.65				
9:50	5			64.5		2[illegible]9.00	[illegible]				
	6			65.0		201.85	[illegible]				
	7			65.1		2[illegible].62	32.11				
	8			65.5		200.[illegible]9	31.1[illegible]				
	9			65.8		200.00	[illegible]				
	10			65.8		200.00	[illegible]				
	11			66.[illegible]		19[illegible].31	[illegible]				
	12			[illegible]		199.08	[illegible]				
	13			[illegible]		198.39	[illegible]				
	14			[illegible]		197.69	[illegible]				
10:00	15			66.7		197.46	[illegible]				
	20			67.5		196.08	[illegible]				
	25			68.0		194.92	[illegible]				
	30			68.5		193.53	[illegible]				
	35					188.52	19.01				Solinst, Airline disconnected
	40					187.94	[illegible]				
	45					187.38	[illegible]				
	50					186.86	[illegible]				
	55					186.46	[illegible]				
10:45	60					186.04	16.53				
11:00	75					184.98	15.47				
[illegible]	92					184.11	14.60				
[illegible]	115					183.37	13.86				
[illegible]	124					182.66	[illegible]				
[illegible]	151					181.77	12.26				
[illegible]	165					181.45	11.94				
12:45	180					181.10	11.59				
[illegible]	[illegible]					180.40	10.92				
14:00						177.83	10.32				
14:[illegible]						179.20	9.69				

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PUMPING TEST DATA

WELL 13
PUMPING/OBSERVATION WELL
PUMPING/RECOVERY DATA
PAGE 2 OF 2

TYPE of PUMPING TEST 72 hr
HOW Q MEASURED flow meter
HOW WL's MEASURED Solinist (300')
PUMPED WELL NO. 13
RADIUS of PUMPED WELL
DISTANCE from PUMPED WELL [illegible]

M.P. for WL's ______ elev. 2049
DEPTH of PUMP/AIRLINE ______ wt ______
% SUBMERGENCE : initial ______ ; pumping ______
PUMP ON : date ______ time ______
PUMP OFF : date ______ time ______

TIME: t = ______ at t' = 0
WATER LEVEL DATA: STATIC WATER LEVEL ______

CLOCK TIME	ELAPSED TIME min.	t	t'	t/t'	READING	CONVERSIONS or CORRECTIONS	WATER LEVEL	S or S'		WATER PRODUCT.	Q	COMMENTS (NOTE ANY CHANGES IN OBSERVERS)
1610					178.40			8.66				
006					178.10			8.59				
1746					177.85			8.34				
332					174.80			5.29				12/10/89
926					174.70			5.19				
1136					174.51			5.00				
1456					174.15			4.64				

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PUMPING TEST DATA

WELL 16
PUMPING / OBSERVATION WELL (circled)
PUMPING / RECOVERY DATA
PAGE 1 OF 1

TYPE of PUMPING TEST 72 HR
HOW Q MEASURED Flow meter
HOW WL's MEASURED
PUMPED WELL NO. 13
RADIUS of PUMPED WELL
DISTANCE from PUMPED WELL 3000

M.P. for WL's TOC elev. 2034
DEPTH of PUMP/AIRLINE ______ wrt ______
% SUBMERGENCE : initial ______ ; pumping ______
PUMP ON : date 6Dec89 time ______
PUMP OFF : date ______ time ______

TIME t = 9:15 at t' = 0
STATIC WATER LEVEL 151.02'

CLOCK TIME	ELAPSED TIME min	hrs	t	t'	t/t'	READING	CONVERSIONS or CORRECTIONS	WATER LEVEL	s or s'	WATER PRODUCT	Q	COMMENTS (NOTE ANY CHANGES IN OBSERVERS)
11:56	41	2	161			151.07			0.05			
13:22	13	3	193			151.07			0.05			
14:49	34	4	274			151.10			0.08			Rust falls down
17:01	46	5	346			151.15			0.13			the well, Roll down
19:10	50	9	590			151.35			0.33			Sounder slowly
22:30	11	13	791			151.35			0.33			
1:27			1032			151.47			0.45			12/7/89
535			1280			151.55			0.53			
[illegible]	15	25	1575			151.53			0.51			
1129	13	[illegible]	1693			151.50			0.48			
1700			1965			151.53			0.51			
1938			2085			151.57			0.55			
0335			2555			151.67			0.65			Maynihan
0715			2760			151.70			0.68			12/9/89
1623						151.59						
[illegible]						151.65						
1009			24			151.67			.65			Pump off @ 9:45
1059			1[illegible]			151.51			.49			
1443			[illegible]			151.45			.43			
1804			[illegible]			151.40			.38			
849			1394			151.33			.31			12/10/89
1054			1499			151.33			.31			
1442			1731			151.25			.23			

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PUMPING TEST DATA

WELL MARK - 17 (Church)
PUMPING/OBSERVATION WELL
PUMPING/RECOVERY DATA
PAGE 1 OF 1

TYPE of PUMPING TEST 72 HR
HOW Q MEASURED Flow Meter
HOW WL's MEASURED
PUMPED WELL NO. 13
RADIUS of PUMPED WELL
DISTANCE from PUMPED WELL 5100

M.P. for WL's Top of Casing elev 218.80 208
DEPTH of PUMP/AIRLINE ______ wrt ______
% SUBMERGENCE : initial ______ ; pumping ______
PUMP ON : date 12-6-89 time ______
PUMP OFF : date ______ time ______

TIME: CLOCK TIME	ELAPSED TIME: min/hrs	t	t'	t/t'	WATER LEVEL DATA (STATIC WATER LEVEL 208.3 (?)): READING	CONVERSIONS or CORRECTIONS	WATER LEVEL	S or S'		WATER PRODUCT.	Q	COMMENTS (NOTE ANY CHANGES IN OBSERVERS)
7:23			-		208.27	12-6-89	SWL					[illegible] MEASU
												swl was 210.6
												on 12-5-89
												after pump pulle
1257					208.35							
16,03					208.45							12/6/89
21:46					209.00							
03:00	45/17	1055			209.02							12/7/89
1015	2/25	1500			209.30							
1205	50/26	1610			209.31							
17:13	58/28	1740			209.40							
04:45	30/45	2610			210.14							Well Cover 12/[illegible]
09:20	5/48	2885			210.11							Installed
1500					210.75	-0.40	210.35					
[illegible]					211.16	-0.40	210.76					12/9/89
1051		60			211.33	-0.40	210.93	[illegible]				Pump off @ 9:45
1530		101			211.06	-0.40	210.66	[illegible]				
1737		[illegible]			210.78	-0.40	210.59	[illegible]				
920		201			209.68	-0.40	209.28	[illegible]				12/10/89
1122		393			209.58	-0.40	209.18	.88				
[illegible]		[illegible]			209.46	-0.40	209.06	.70				

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PUMPING TEST DATA

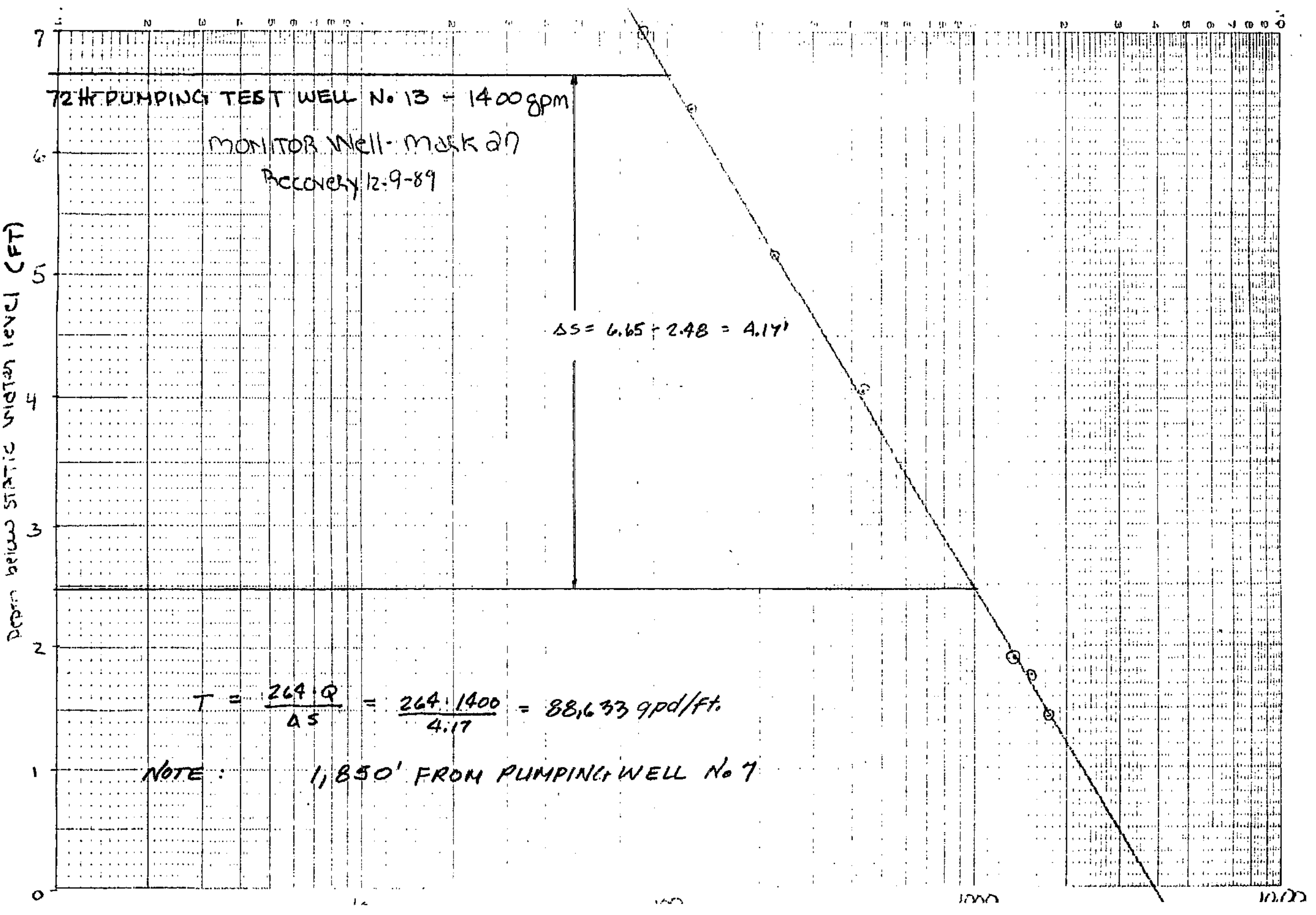
WELL 25
PUMPING/OBSERVATION WELL
PUMPING/RECOVERY DATA
PAGE 2 OF ___

TYPE of PUMPING TEST 72 HR
HOW Q MEASURED [illegible]
HOW WL's MEASURED [illegible]
~~PUMPED WELL~~ NO. 25 (MARK #)
RADIUS of PUMPED WELL ___
DISTANCE from PUMPED WELL 2500

M.P. for WL's TOC elev. [illegible]
DEPTH of PUMP/AIRLINE ___ wrt ___
% SUBMERGENCE : initial ___ ; pumping ___
PUMP ON : date 6 Dec 89 time ___
PUMP OFF : date ___ time ___

TIME: t = 9:15 at t' = 0
STATIC WATER LEVEL 156.48

CLOCK TIME	ELAPSED TIME min/hrs	t	t'	t/t'	READING	CONVERSIONS or CORRECTIONS	WATER LEVEL	S or S'		WATER PRODUCT.	Q	COMMENTS (NOTE ANY CHANGES IN OBSERVERS)
												[illegible]
7.00												
11:49					160.90							
13:19					159.55							
14:41					159.60							
17:10					159.65							
1900					159.35							
2234					159.93							
134		1039			160.00							12/7/89
0520		1265			160.00							
1047	25	1590			160.05							
1247		1712			160.00							
1710		1975			160.07							
1926		2111			160.12							[illegible]
0340		2545			160.20							Killingham
0725		2770			160.26							12/8/89
1330					160.17							
1619					160.14							
126					160.21							12/9/89
1002		17			160.24			3.76				[illegible] @ 9:45
1133		105			160.17			3.69				
1203		135			160.14			3.[illegible]				
1438		293			160.05			3.5[illegible]				
1800		[illegible]			160.03			[illegible]				
541		[illegible]			160.00			[illegible]				12/10/89
1049		[illegible]			160.07			3.52				
1347		[illegible]			159.92			3.44				



72 Hr PUMPING TEST WELL No 13 = 1400 gpm
MONITOR Well - Mark 27
Recovery 12-9-89
ΔS = 6.65 - 2.48 = 4.17'
T = 264·Q / ΔS = 264·1400 / 4.17 = 88,633 gpd/ft.
NOTE : 1,850' FROM PUMPING WELL No 7
Depth below static water level (FT)
7
6
5
4
3
2
1
0
10
100
1000
10,000

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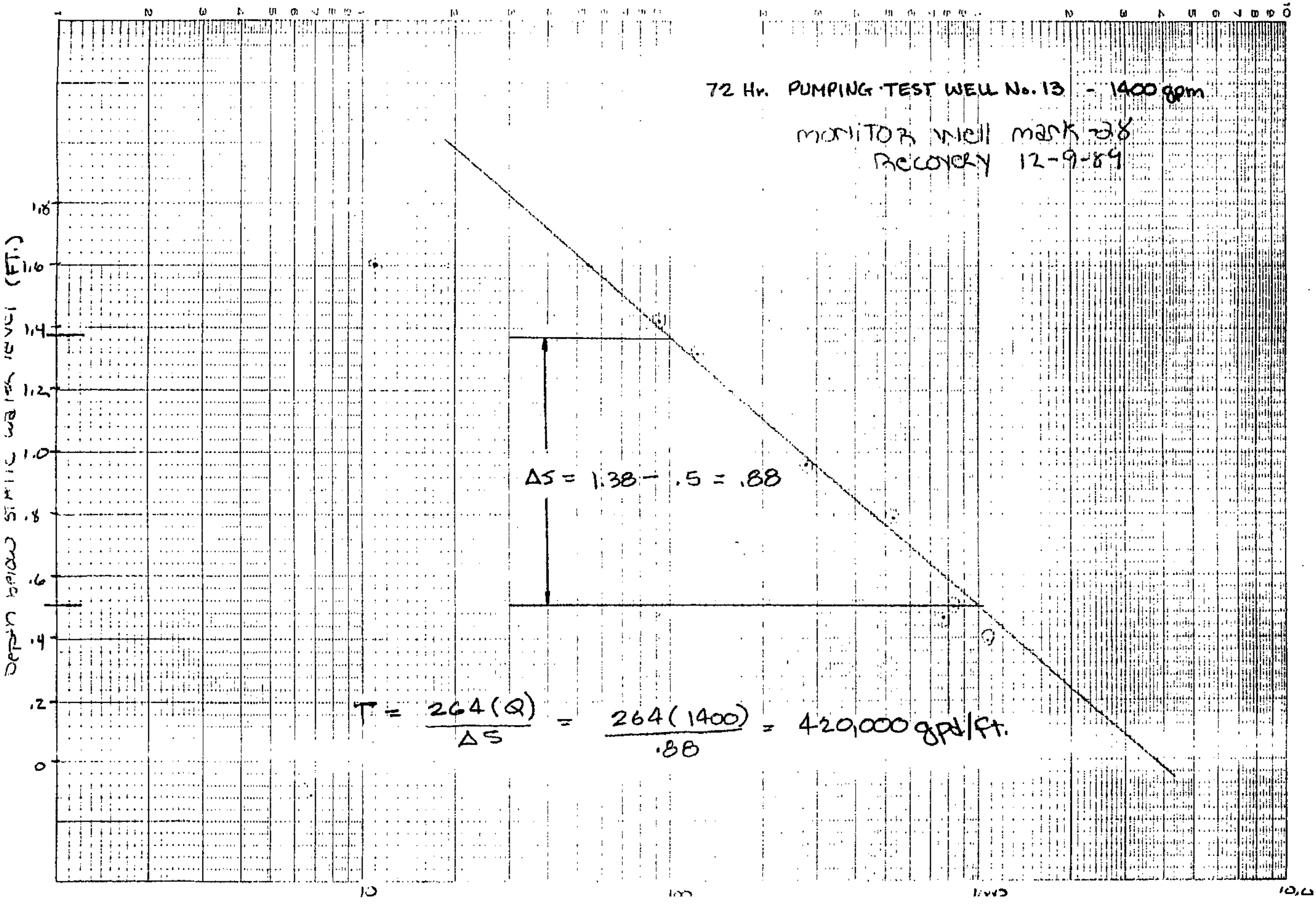
PUMPING TEST DATA

WELL Mai-27
PUMPING/OBSERVATION WELL
PUMPING/RECOVERY DATA
PAGE 2 OF 2

TYPE of PUMPING TEST [illegible]
HOW Q MEASURED [illegible]
HOW WL's MEASURED
PUMPED WELL NO. [illegible] 13/[illegible] 7
RADIUS of PUMPED WELL
DISTANCE from PUMPED WELL 1150

M.P. for WL's TOC elev. 2056
DEPTH of PUMP/AIRLINE [illegible] wrt
% SUBMERGENCE : initial ; pumping
PUMP ON : date 12-[illegible] time 0915
PUMP OFF : date time

TIME t = ___ of t' = 0					WATER LEVEL DATA STATIC WATER LEVEL 182.60 ([illegible])					WATER PRODUCT.		COMMENTS
CLOCK TIME	ELAPSED TIME min/hrs	t	t'	t/t'	READING	CONVERSIONS or CORRECTIONS	WATER LEVEL	s or s'			O	(NOTE ANY CHANGES IN OBSERVERS)
[illegible]	5/17	1025			188.33			5.73				12/7/89
[illegible]	[illegible]/16	[illegible]			188.5			5.91				
2245	[illegible]/24	[illegible]			188.86			6.26				
1130	[illegible]/26	[illegible]			189.00			6.40				5
1438	[illegible]/28	[illegible]			189.00			6.40				Same (umbl)
1716	[illegible]/32	[illegible]			189.20			6.60				
2021	6/35	2176			189.35			6.75				
0426	[illegible]/43	2585			189.53			6.93				12/8/89
0840	[illegible]/47	2845			189.60			7.06				
1337					189.79			7.19				
1529					189.94			7.[illegible]				
[illegible]					190.00			~~[illegible]~~	7.40			12/9/89
[illegible]		0			190.36			~~[illegible]~~	7.76			Pump off @ 9:45
1502		10			190.17			7.57				
1102		[illegible]			189.56			6.96				
1145		[illegible]			188.99			6.39				
1337		[illegible]			187.77			5.17				
1713		[illegible]			186.65			~~6.29~~	4.05			
854		1379			184.50			~~8.44~~	1.90			12/10/89
1102		1507			184.37				1.77			
1516		[illegible]			~~184.02~~	184.02			1.[illegible]			


72 Hr. PUMPING TEST WELL No. 13 - 1400 gpm
MONITOR Well mark 38
Recovery 12-9-89
ΔS = 1.38 - .5 = .88
T = 264(Q)/ΔS = 264(1400)/.88 = 420,000 gpd/ft.
Depth below static water level (FT.)
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
0
10
100
1000
10,000

ON3

THE MARK GROUP ENGINEERS & GEOLOGISTS

PUMPING TEST DATA

WELL 28

PUMPING / OBSERVATION WELL

PUMPING / RECOVERY DATA

PAGE 1 OF 1

TYPE of PUMPING TEST 72 HR

HOW Q MEASURED FLOW METER

HOW WL's MEASURED Solinst 500' (MARK)

PUMPED WELL NO. 13

RADIUS of PUMPED WELL

DISTANCE from PUMPED WELL 1860

M.P. for WL's TOC elev. 2045

DEPTH of PUMP/AIRLINE ______ wrl ______

% SUBMERGENCE: initial ______ ; pumping ______

PUMP ON: date 6Dec89 time 09:15

PUMP OFF: date ______ time ______

TIME: t = 09:15 at t' = 0

STATIC WATER LEVEL 162.74'

CLOCK TIME	ELAPSED TIME min/hrs	t min	t'	t/t'	READING WL	CONVERSIONS or CORRECTIONS	WATER LEVEL	s or s'		WATER PRODUCT.	Q	COMMENTS (NOTE ANY CHANGES IN OBSERVERS)
												CWH
09:27		12			162.75							
09:30		15			162.77							
09:35		20			162.78							
09:43		28			162.80							
09:45		30			162.80							
09:50		35			162.81							
10:00		45			162.85							Switched to ACTAT
10:05		50			162.87							Compared checkoff w/ Solinst Readings by
10:10		55			162.89							
10:15		60			162.91							
10:20		65			162.91							
10:44		94			162.99							Steve Turnbull
11:30		140			163.05							
12:30		210			163.17							
14:32		332			163.33							
16:48		468			163.46							
17:43		523			163.58							
22:10		770			163.73							
1:38		1043			163.84							12-7-89
0510		1255			163.93							Bill Mornin
1045	32	1590			164.07							
14:05		1790			164.07							Steve Turnbull
16:5?		1957			164.11							
19:15		2100			164.16							
1350	35 / 42	2555			164.28							12-8-89
2730	15 / 46	2775			164.35							
1330					164.32							
1115					164.31							
12??					164.33							12/9/89
956					164.34			[illegible]				Pump off @ 945
10:??		54			164.34			[illegible]				
1120		92			164.16			1.42				
1151		121			164.06			1.32				
1337		2??			163.??			.9?				
1748		532			163.52			.??				
335		9??			163.20			.46				12/10/89
1044		?84			163.23			.49				
[illegible]		1?92			163.13			.39				

Appendix C

APPENDIX C

Storativity Values in Harper Valley,
San Bernardino County, California

Introduction

For the "main" aquifer within the Harper Valley basin, a long-term average storativity on the order of 0.1 is anticipated for the reasons described in the subsequent paragraphs. Groundwater in the main aquifer is first encountered at depths usually greater than 100 feet and excludes the perched groundwater which lies at depths of about 10 feet in the Harper Dry Lake area.

Theis Assumptions

It is common practice to use the Theis equation (Theis, 1935, pp. 519-524) or appropriate simplifications to calculate storativity. A number of assumptions are inherent in the Theis equation. Storativity values determined via the Theis equation are valid only to the extent that Theis assumptions approximate actual aquifer conditions. As will be detailed in the paragraphs below, the following Theis assumptions do <u>not</u> appear to be valid for the main aquifer of Harper Valley:

- The aquifer is confined;
- Hydraulic conductivity is isotropic and homogeneous; and
- All water is released from storage instantaneously with decline in head.

Confined Versus Water Table Conditions

Under confined conditions, the only water available during pumping of a well is released from storage via expansion of the water and compression of the aquifer. Under such conditions, storativity would range between .005 and .00005 (Freeze and Cherry, 1979, p. 60). In a water table aquifer, the available volume of water which can be pumped from a well equals the entire volume which can flow from the pore space of the rock. This is the same as the effective porosity and could range from 0.01 to 0.30 (Freeze and Cherry, 1979, p. 61). Confined conditions can arise when an extensive layer of lower permeability lies over an aquifer. A continuous layer of very fine-grained lithology could cause confinement in alluvium.

Within the alluvium in Harper Valley, numerous well driller's logs show a heterogeneous stratigraphy of poorly-sorted clay through sand and gravel sized particles. Variation between wells indicates highly lenticular deposits. Such deposits are typical of sediment deposited under desert alluvial conditions (Friedman and Sanders, 1978, pp. 202-209). The lithologic data give no indication of a regionally extensive impermeable layer. For this reason it is expected that the aquifer will behave as a water table aquifer in the context of Harper Valley as a whole.

Delayed Yield Effects

In a water table aquifer, the Theis assumption that water is instantaneously discharged from storage with a decline in head is rarely valid (U.S. Department of the Interior, 1981, p. 101). Any time the vertical hydraulic conductivity is significantly less than the horizontal hydraulic conductivity, release of water from storage will be delayed (S.P. Neuman, June 1988, personal communication). Such a directional dependence in hydraulic conductivity is typical of stratified (including lenticular) deposits. Using short duration aquifer tests under such conditions as were encountered in Harper Valley, the calculated storativities can be several orders of magnitude less than the true long-term storativity of the aquifer. This effect is widely considered to be typical of alluvial basins of the southwestern United States (see list of contacts).

When delayed yield effects are present, a longer than usual pump test must be run to obtain a realistic, long-term storativity. Walton (1987, pp. 2-4) presents an equation to determine the length of pumping test required, given the approximate hydraulic parameters of an aquifer. Applying this equation and considering the other hydraulic parameters observed at the SEGS well field in Harper Valley indicates a month-long aquifer pumping test would be required to obtain a valid long-term storativity.

Standard Practice for Approximating Storativity

Aquifer test of several weeks or more are not usually economically justified and judgement of known or inferred aquifer conditions should be used in analysis (U.S. Department of the Interior, 1981, p. 129). Standard practice is exemplified by Harrill and Moore (1970, p. 24), who write:

> "No storage coefficients were calculated for deposits in either Paradise Valley or Eden Valley; however, the lenticular nature of the deposits suggests that the horizontal permeability of the valley fill is greater than the vertical permeability and that the flow system, for short periods, will respond to pumping stress as an artesian system. Artesian storage coefficients typically have values of less than 0.001. Over the long term, however, all deposits will drain slowly in response to pumping, and the storage coefficient will be nearly equal to the specific yield. Thus, in analyzing long-term cause and effect relations, the valley-fill reservoir must be considered as a water-table system. Storage coefficients in water-table aquifers are effectively equal to the specific yield values..."

It is stated in Ground Water and Wells (Johnson Division, 1972, p. 144) that if storativity cannot be reliably calculated, it is reasonable to employ a storage coefficient of 0.1 if geologic data indicate water table conditions will exist over the long term.

Conclusions and Recommendations

References Cited

Freeze, R.A. and Cherry, J.A., 1979. Groundwater. Prentice Hall, pp. 60- 61.

Friedman, G.M. and Sanders, J.E., 1978. Principles of Sedimentology, John Wiley & Sons, pp. 202-209.

Harrill, J.R. and D.O. Moore, 1970. Effects of Ground Water Development on the Water Regimen of Paradise Valley, Humboldt County, Nevada: 1948-1968, and Hydrologic Reconnaissance of Tributary Areas: Water Resources Bulletin 39, Nevada Division of Water Resources, p. 24.

Johnson Division, Universal Oil Products, 1972. Ground Water and Wells. Edward E. Johnson, Inc., p. 144.

Theis, C.V., 1935. The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using ground water storage. Trans. Amer. Geophysical Union, 2, pp. 519-524.

U.S. Department of the Interior, Water and Power Resources Service, 1981. Ground Water Manual. United States Government Printing Office, ppg. 101,129.

Walton, W.C., 1987. Groundwater Pumping Tests: Design and Analysis, Lewis Publishers, Chelsea, MI. p. 2-4.

Contacts

The following individuals all have verified that short (24-72 hours) aquifer pump tests of alluvial aquifers often give storativity values which are 2-3 orders of magnitude low:

Mr. Thomas Anderson, Water Resources Division, U.S.G.S., Tucson

Mr. Jim Harrill, District Chief, Water Resources Division, U.S.G.S., Carson City

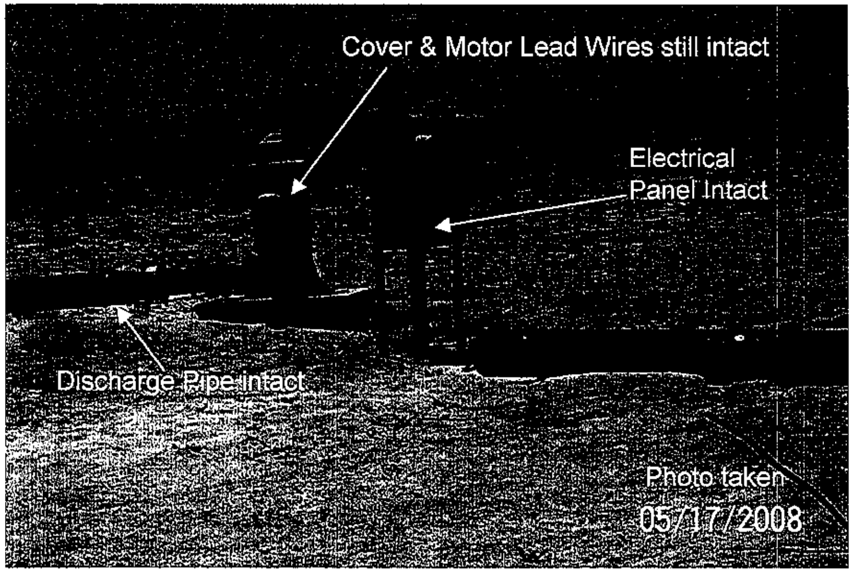
Dr. Terry Katzer, Director of Conservation and Research, Las Vegas Valley Water District

Dr. Shlomo P. Neuman, Professor of Hydrology, University of Arizona

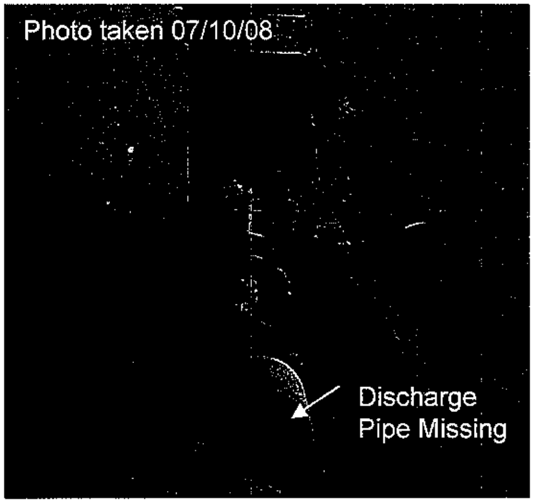
Mr. Frank Putman, Arizona Division of Water Resources

Dr. Kenneth Schmidt, Consultant (Phoenix, Fresno)

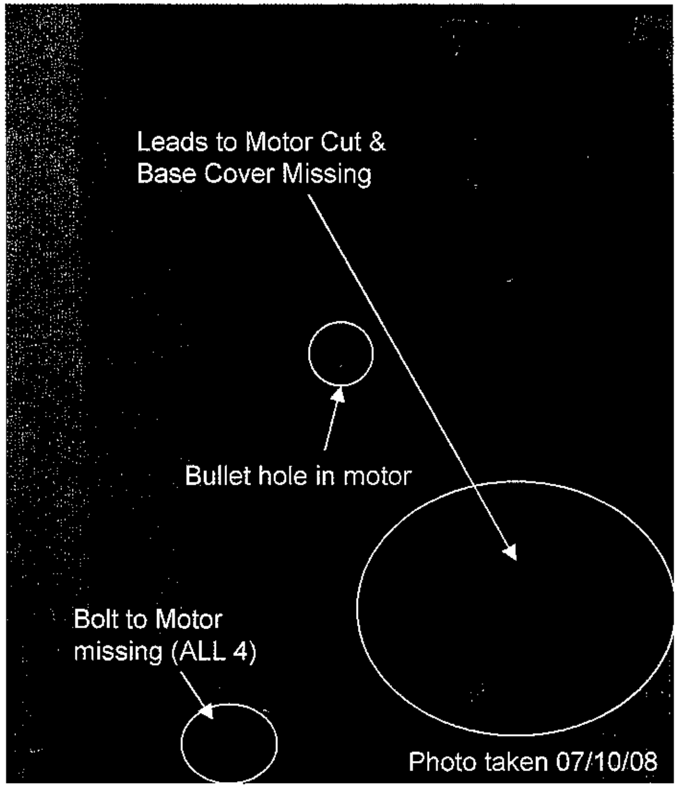
Mr. Herbert Schuman, U.S.G.S., Phoenix



Electrical Panel Vandalized



Discharge Pipe Vandalized



Site Visit 07/10/2008 by Victor Jackowich (Layne Geosciences) and Bob Porter (Barstow Pump Technician)

Assessed vandalism to Harper Lake Wetlands Supply Well, South on Lockhart Rd.

The following items need to be replaced based on visual assessment:

1. Replacement of motor (75 hp).
2. Replacement of electrical wiring and components
3. Replacement of Well Discharge Pipe (~12')