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EXHIBIT A

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THE CARMEL VALLEY ALLUVIAL AQUIFER:
Bedrock geometry, hydraulic parameters and storage capacity

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APPENDIX B

AQUIFER CONFINEMENT IN THE LOWER CARMEL VALLEY

This appendix will review the three lines of evidence available in March 1983 relating to confined conditions in the lower Valley.

Nature and continuity of the confining bed

Mount (1980a, 1980b) stressed the continuity of a shallow confining bed from Cal-Am's Schulte well (16s/1e-23E2) to Rancho Canada Well no. 5 (16s/1e-17L4) -- a distance of about 2.8 miles -- and stated that the bed extended to the sea. Permeabilities and depths to the top and the base of the confining bed are presented in Table 2 (of the main report). The permeabilities at the Pearce, Cypress and San Carlos sites are those reported by Jacobs, Haro and Associates (1980), following conversion of units, and certainly the values at the Pearce and Cypress sites are those usually associated with confining beds. The San Carlos value (0.25 gpd/ft^2) is too high to suggest confinement: perhaps semiconfinement would be a better concept.

Jacobs, Haro and Associates (1980) did not present the permeability of 0.81 gpd/ft^2 given in Table 2 for the Rancho Canada well. The measurement may have been made from a sample taken from a shallow monitor located about 300 ft north of 16s/1e-17L5, and about 25 ft. deep (J.R. Mount, personal

communication). Its permeability is much higher than "normal" for a confining bed.

I cannot agree with most of the thicknesses of the confining beds that are given on Table 2:

a) The depths at Schulte are taken from the drillers log of the Schulte observation well (16s/1e-23E3): "12-20´; mud and silt, old lake bottom". But the log of the nearby Schulte production well (-23E2) lists only two ft of impermeable material in the zone 0-42 ft. Mount (1980a) has argued as to the general unreliability of drillers logs. His arguments are quite good and I would hesitate to accept the proposed depths of 12-20 ft, considering that they were obtained from one well log but denied by another.

b) The depths of 49 to 60-plus ft at Pearce are taken from the log of Pearce boring no. 2 presented by Jacobs, Haro and Associates (1980) that notes the occurrence of "silty fine sand" in the interval. That material description was not given by a driller from cuttings but was made by an experienced soils and foundation engineer from auger and split-spoon samples. A "silty fine sand" is certainly not prime aquifer material, but it does not represent a "normal" confining bed either. Further, the log of Jacobs-Haro Pearce boring no. 1 (probably drilled only a few feet from no. 2) lists the occurrence of "sandy gravel" between depths of 54 and 60 ft (no record, 40-54 ft).

c) I do not interpret the Jacobs-Haro log of the Cypress well to indicate confining materials between 38 and 64 ft of depth. The entire interval 40-71 ft is shown as sand, but

with a note of "occasional thin sandy silt lenses" at 51 ft. A ". . . 6" - 12" gray-black silt with some clay binder and peat fibrous . . ." bed is shown at about 39.5 ft but that bed does not suggest 18 ft of confining material as shown on Table 2.

d) Table 2 indicates the presence of confining materials between 40 and 61-plus ft at the Carlos site . Yet the Jacobs-Haro log indicates sand from 40-52 ft (no record is given, 52-61.5 ft), noting only a few inches of fine sandy silts.

e) I have no information for checking the confining layer at the Rancho Canada site, as given in Table 2. However, the three available drillers logs (16s/1e-17L3, -17L4, -17L5) each list confining materials at shallow depths.

Thus the available evidence does not compel me to accept the presence of a shallow confining bed in the Schulte-San Carlos sector.

Although I generally share Mount's (1980a) thoughts on the value of most logs prepared by drillers -- particularly of standard rotary-drilled wells -- I do believe that one can often draw valuable conclusions from them if available in large number. Should there be a persistent confining bed from the Schulte well to the ocean, it should have been recognized by enough (but perhaps not all) drillers to be reflected in specific yield as estimated by the well-log method. To test that possibility, the specific yield estimates in the depth interval 10-50 ft were combined into groups divided at the Schulte well with the following results:

Below Scarlett Narrows

	n	S	Std. dev.
Schulte and below	67	0.1987	0.0531
Above Schulte	58	.2210	.0340

This difference is highly significant ("t" = 2.7256; 0.5 percent level). It certainly forces the conclusion that fine materials are more common in the 10-50 depth zone in the lower Valley than in mid-Valley. But it does not necessarily substantiate the existence of confinement. For such substantiation, continuity must be demonstrated.

A number of geological sections were drawn to search for continuity of possible confining beds: all failed. Silty and clayey horizons commonly appear in the well logs but cannot be correlated for any appreciable distance, even with the best of control. Although Mount's position regarding the value of drillers logs is correct, the available logs do not support continuity of fine materials at any depth. The silts and clays appear to be lenses of limited lateral extent. Even the seven electric logs acquired during this study do not support continuity: the wells are too far apart and the top 50-80 ft cannot be interpreted.

Differences in water levels

Table 2 presents differences in water levels between deep and shallow wells of 12.5, 12.5 and 7 ft at the Pearce, Cypress and San Carlos sites, respectively. Such differences can be powerful suggestors of confinement or semiconfinement but, alone, they are not enough. This writer was engaged by the WMD to observe the pumping tests of Sept. - Oct. 1982 of those three

wells. Although very few of the many measurements collected during the tests are now available to me and I am necessarily drawing on my memory, I was concentrating on searching for evidences of confinement at the time. I do not recall any appreciable differences in water levels between deep and shallow wells at any of the three sites. At Cypress and San Carlos, there is a positive record (n.b.: not from memory but from measurements by the District staff and myself) of a very rapid decline of shallow water levels to pumping. The latter fact and the former recall of memory (if correct) support unconfined rather than confined conditions.

At the start of the testing of Cal-Am's Rancho Canada well (16s/1e-17L5) in Oct. 1982, I do not recall any appreciable difference in water levels between deep and shallow wells. I made a number of measurements of water level in the prime shallow monitor: although I have not made an "analytical solution" (for only a part of the total record is available), those measurements suggest semiconfined, not confined conditions.

<u>The Schulte test of September 1974</u>

The Schulte well was tested in September 1974: the results are summarized by Dames and Moore (1974) although no basic data are presented. The reported value of 0.004 for storativity was a major evidence leading to the conclusion of confinement.

Because of the unavailability of basic data for the Schulte test, it was not possible to verify the reported storativity. However, the District recently obtained copies of six of J.R. Mount's original hand-drawn graphic solutions of aquifer parameters. They are summarized as follows (n.b.: the Noto well

was a obervation well 380 ft distant from the Schulte well):

Well	Type of Analysis	Reported Solutions T(gpd/ft)	S
1. Schulte	Recovery;straight line;t/t´	190,000	-
2. Schulte	" " " "	276,000	-
3. Noto	Drawdown;straight line	141,000	0.049
4. Noto	" ;type curve	145,000	0.013
5. Noto	Recovery;straight line;t/t´	220,000	-
6. Noto	" ;type curve;t´	446,000	0.0044

Although no. 6 is out of line numerically, the variations between nos. 1-5 are not surprising: they are in the range commonly obtained in such analyses. The surprising thing is found in the rejection of no. 6 above in the selection of transmissivity of 180,000 gpd/ft and the acceptance of only no. 6 in the selection of 0.004 for storativity (see Table 1 of Dames and Moore, 1974).

Storativity can only be derived from solutions 3, 4, and 6 above. Because of their importance to the discussion that follows, Mount´s graphic analyses corresponding to numbers 3, 4, and 6 above are presented, attached, as Figures B-1, B-2 and B-3, respectively. For each figure, the abscissa represents time, in hours. The ordinates of Figures B-2 and B-3 are clearly drawdown or recovery, in feet. On the copy of Fig. B-1 available to us, only the decimal values of the ordinate are reproduced: the scale on the figure has been added by myself, with the guide of the identical data that appear on Fig. B-2. When the straight line of Fig. B-1 is projected to zero drawdown, t_o is found to be 2.7 hours rather than 10 hours as indicated on the figure.

Storativity is calculated on the figures according to the following formulae:

$$S = t_o T/200 r^2 \quad \text{(Fig. B-1)}$$
$$S = u t T/112.2 r^2 \quad \text{(Figs. B-2, B-3)}$$

The coefficients in those formulae are not correct, being exactly 2.5 times too large, and the values of S have been miscalculated on each figure. To avoid any confusion that may arise from coefficients, S is recalculated with the use of "standard" formulae as given by Walton (1962), with time being expressed in minutes:

$$S = t_o\, T/4790\, r^2 \quad \text{(Fig. B-1)}$$
$$S = u\, t\, T/2693\, r^2 \quad \text{(Figs. B-2, B-3)}$$

With that change and with the use of the correct value of t_o (Fig. B-1), the recalculation is as follows:

<u>Fig. B-1</u>

$$S = (2.7)(60)(141000)/(4790)(380^2) = 0.033$$

<u>Fig. B-2</u>

$$S = (.01)(150)(60)(145000)/(2693)(380^2) = 0.034$$

<u>Fig. B-3</u>

$$S = (.01)(16)(60)(446000)(2693)(380^2) = 0.011$$

Such values indicate that the aquifer is not confined. Indeed, there is nothing on any of Mount's six graphs of the Schulte test that even indicates semiconfinement. Clearly such interpretations would be more firm if based on actual measurements rather than graphing, but I find no evidence in Mount's graphs to support the occurrence of confinement at Schulte.

<u>Conclusion</u>

The concept of confinement does not stand up to any of these examinations. Until contrary evidence appears, the alluvial aquifer of the lower Carmel Valley should be regarded as an unconfined ground-water body, recognizing that there may be semiconfinement at Rancho Canada.

FIGURE B-1

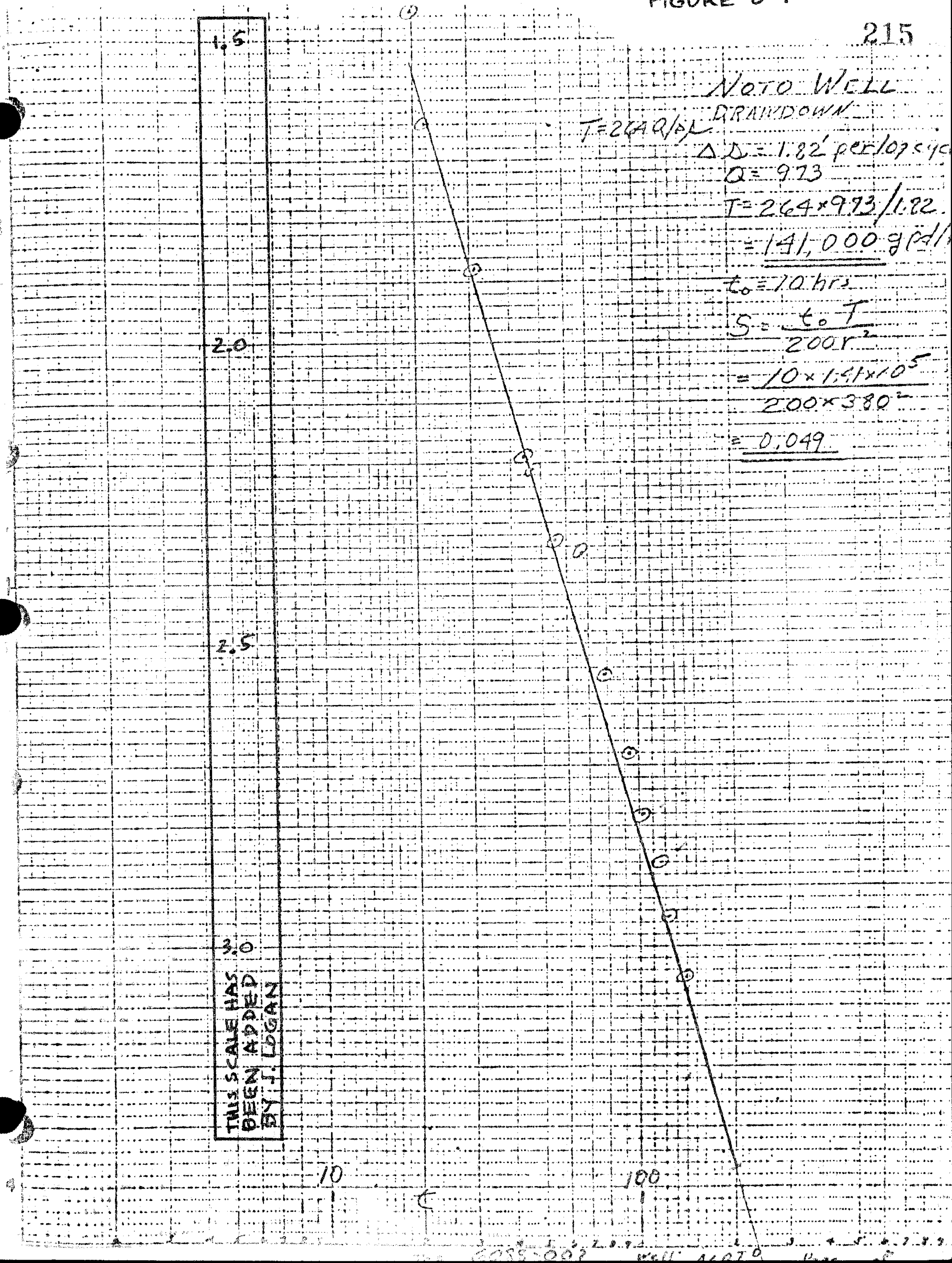
NOTO WELL
DRAWDOWN
T=264Q/ΔD
ΔD = 1.82' per log cyc
Q = 973
T = 264×973/1.82
= 141,000 gpd/
t₀ = 10 hrs
S = t₀ T / 200r²
= 10×1.41×10⁵ / 200×380²
= 0.049
1.5
2.0
2.5
3.0
THIS SCALE HAS BEEN ADDED BY J. LOGAN
10
100
t

FIGURE B-2

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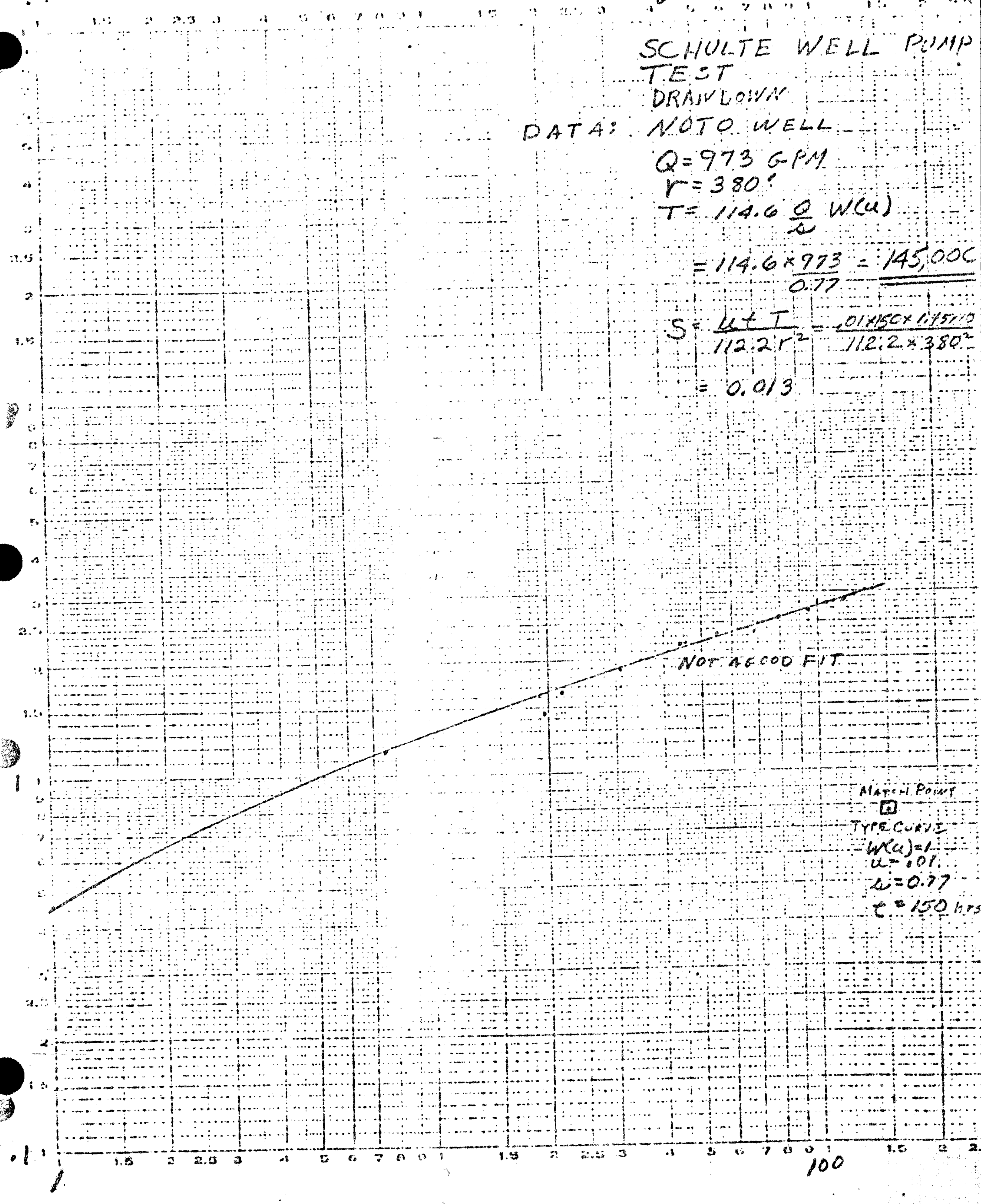
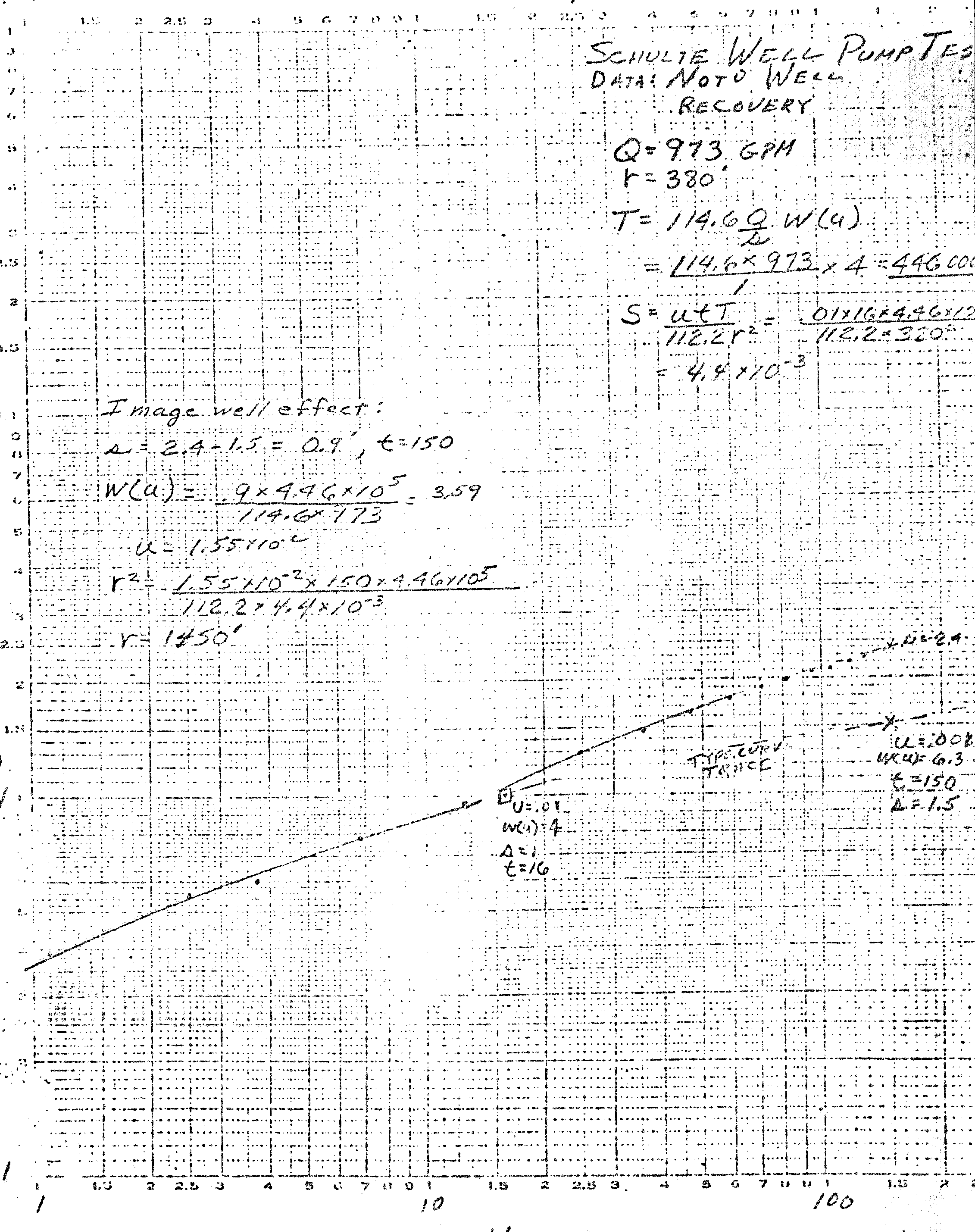


FIGURE B-3

JRM 10-28-74



$Q = 973$ GPM

$r = 380'$

$T = 114.6 \frac{Q}{s} W(u)$

$= \frac{114.6 \times 973}{1} \times 4 = 446,000$

$S = \frac{utT}{112.2 r^2} = \frac{.01 \times 16 \times 4.46 \times 10^5}{112.2 \times 380^2}$

$= 4.4 \times 10^{-3}$

Image well effect:

$s = 2.4 - 1.5 = 0.9'$, $t = 150$

$W(u) = \frac{.9 \times 4.46 \times 10^5}{114.6 \times 973} = 3.59$

$u = 1.55 \times 10^{c}$

$r^2 = \frac{1.55 \times 10^{-2} \times 150 \times 4.46 \times 10^5}{112.2 \times 4.4 \times 10^{-3}}$

$r = 1450'$