IDAHO DEPARTMENT OF WATER RESOURCES

OPEN-FILE REPORT

RESULTS OF
WALKER – LEE – TWO-PLUS WELL TEST
ELMORE COUNTY, IDAHO

April 1978

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The purpose of this well test was to determine whether the newly drilled Two-Plus well is withdrawing water from the aquifer subject to the Walker-Lee Decree (Decree number 61-C). The Walker-Lee system is located in Elmore County, Idaho in the Bennett Creek area. This system has been the subject of previous studies by Keith E. Anderson, a consultant geologist/engineer. Included with this report are copies of previous reports completed by Mr. Anderson. Anderson's studies were used as the basis for a court decree issued in November 1967 which controls the operation of the Walker and Lee wells.

There are several other hot, flowing wells in the same area, as shown in figure 1. The Blackwell well is used for stockwater only and since the water use is very small, the potential effects of this well on other water uses is probably negligible. The Ross well was drilled about the time that the Walker-Lee litigation was concluding and since this water use is not particularly large, no effort was made to include this water right in the decree. The Ross well is used for stockwater, space heating, household hot water, and irrigation. This water right is evidenced by permit number 61-2208 for which proof of beneficial use has been submitted and a field examination of the water use has been made. Another small well was drilled at the Lee Springs,

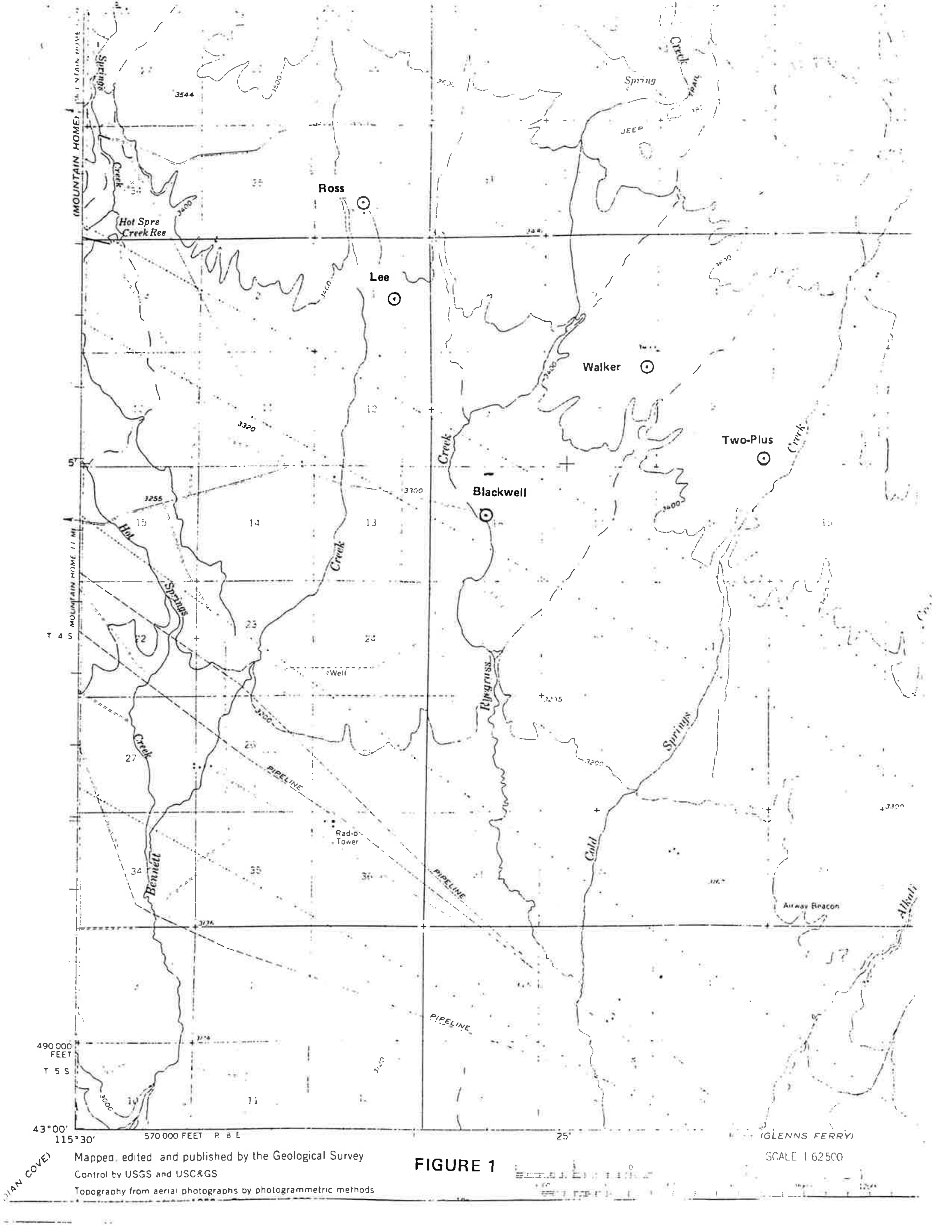

Ross
Lee
Walker
Two-Plus
Blackwell
Hot Sprs Creek Res
Spring
Creek
JEEP
Hot
Springs
Bennett
Creek
Rypgrass
Cold
Springs
Alkali
PIPELINE
Radio Tower
Well
Airway Beacon
(MOUNTAIN HOME)
MOUNTAIN HOME 11 MI
T 4 S
T 5 S
490 000 FEET
43°00'
115°30'
570 000 FEET R 8 E
(GLENNS FERRY)
SCALE 1:62500
Mapped, edited and published by the Geological Survey
Control by USGS and USC&GS
Topography from aerial photographs by photogrammetric methods

FIGURE 1

located within the SW¼SW¼ of Sec. 16 and NE¼NE¼ of Sec. 20, Twp. 3S, Rge. 8E, B.M. This well was drilled in an attempt to recover the flow of the hot springs and was never put into production since it does not flow.

The Walker well, the Lee well, and the Two-Plus well are large irrigation wells. The Two-Plus well is the newest well in this area and has caused water right concerns by the earlier water users since it is also a hot, flowing well. The Two-Plus water right is evidenced by permit number 61-7288. This well test to determine whether mutual interference exists between the Lee, Walker, and Two-Plus wells is the Department's initial response to these concerns.

The test consisted of two basic parts: 1) measurements of recovery since the previous irrigation season were made during the period from December 1977 until April 1978, and 2) the flow test which was completed during the week of April 3, 1978. Although most concern was centered on the Two-Plus water use, it was decided to include the Ross well in the test to make the interference study as complete as possible. Recovery data was taken at the Lee Springs well since it is a demonstrated observation point for the Walker-Lee system, but due to the travel distance involved no measurements were made during the flow test. No measurements were made at the Blackwell well.

To summarize, recovery measurements were made at the Lee Springs well, the Ross well, the Lee well, the Walker well, and the Two-Plus well and flow test measurements were made at the Ross well, the Lee well, the Walker well, and the Two-Plus well. The recovery measurements were made by William MacAllister and the flow test measurements were made by Lee Sisco, Ervin Ballou, and William MacAllister. The well test was designed and the preliminary arrangements made by William MacAllister and Paul Castelin.

Flow Test Description

The flow test consisted of flowing the Lee well and taking pressure measurements at the Ross well, the Walker well, and the Two-Plus well. The recovery data and Keith E. Anderson's previous data were used to predict drawdowns, assuming all the observation wells were in the same system. These predictions are included with the data in this report.

From the drawdown predictions, it was decided to run the test for three days. Mercury manometers were used for precise pressure measurements at the Walker well and the Two-Plus well; but due to the high pressure, it was necessary to use a pressure gauge at the Ross well. It was initially planned that Department personnel would be stationed at the Lee well, the Ross well, and the Walker well with the person at the Lee well moving to take measurements at the Two-Plus well after the flow from the Lee well had stabilized. The data and the calculations from these measurements follow.

Recovery Data

For recovery data times, $t_1 = 0$ is chosen as December 12, 1977 since the Two-Plus well was flowed at about 4.5 cubic feet per second for the two-week period prior to this date. All other irrigation uses from wells in this area ended by at least November 1, 1977. Note that the heads listed are in feet above land surface at the respective observation point.

Recovery of
LEE WELL

time (hours)	head (feet)
82	54.3
106	57.8
129	58.9
154	58.9
176	58.9
201	60.1
371	62.4
562	64.7
754	65.8
924	67.0
1090	69.3
1239	67.3
1402	72.0
1577	72.0
1762	74.2
1931	72.0
2101	78.5
2365	78.5
2531	80.7

Recovery Data
LEE SPRINGS

time (hours)	head (feet)
370	-65.59
562	-64.65
753	-63.85
926	-62.77
1089	-62.05
1239	-61.15
1402	-60.15
1576	-59.25
1762	-58.62
1931	-57.37
2100	-56.75
2530	-54.50

Recovery of
ROSS WELL

time (hours)	head (feet)
106	43.9
129	43.9
154	43.9
177	42.7
202	41.6
371	46.2
562	48.5
754	48.5
924	49.7
1090	50.8
1239	52.0
1403	56.6
1577	60.1
1762	57.8
1931	58.9
2100	68.1
2222	72.7
2365	67.6
2532	68.7

Recovery of
WALKER WELL

time (hours)	head (feet)
85	-5.72
107	-5.50
130	-4.65
154	-4.28
177	-4.23
202	-4.00
371	-0.53
563	1.09
754	3.34
925	5.65
1090	2.90
1240	3.80
1403	5.80
1762	8.70
1931	10.20
2102	11.60
2223	12.83
2366	14.14
2532	14.91
2719	16.18

Recovery of
TWO-PLUS WELL

time (hours)	head (feet)
148	14.70
172	13.90
196	13.90
220	13.90
244	13.90
268	13.90
292	12.70
460	13.90
652	16.20
844	18.50
1012	20.80
1180	19.60
1324	20.20
1492	20.80
1684	23.10
1852	23.10
2020	25.40
2188	25.40
2308	27.41
2452	28.77
2620	29.92

If the recovery is assumed to be of the form:

$$\text{head} = m \log(\text{time}) + b \qquad \text{(after Jacob)}$$

where m and b are constants, then linear regression techniques can be used to determine the best straight line fit to the semi-log plots of the recovery data. The results of this analysis are shown in Table 1.

Table 1

Well	m	b	R
Lee Springs	13.19	-101.1	0.96
Ross	18.16	1.72	0.88
Lee	14.64	26.14	0.96
Walker	10.80	- 25.95	0.90
Two-Plus	11.78	14.36	0.93

In Table 1 "R" is the correlation coefficient and from the R values in the table, it appears we have chosen the correct form for the recovery.

The equation that describes the operation of a non-leaky aquifer is:

$$s = \frac{264\ Q}{T} \log \frac{0.3\ T\ t}{r^2 S} \qquad \text{(Jacob formula)}$$

where

Q is in gpm
r is in feet
T is in gpd/ft
t is in days
s is in feet
S is dimensionless

Thus from the recovery data we can calculate the transmissibility as follows:

$$T = \frac{264\ Q}{m}$$

To calculate T use the average of the slopes of the recovery data.

Thus, $T = \frac{264\ Q}{m} = \frac{264\ (20\ 20\ \text{gpm})}{13.71\ \text{ft}} = 3.9 \times 10^4$ gpd/ft

This agrees reasonably well with the transmissibility value calculated by Keith Anderson in his study report dated May 1964. Anderson's transmissibility value was: $T = 2.96 \times 10^4$ gpd/ft.

Calculations of the predicted drawdowns were made using data from the May 1964 Keith Anderson study since this data was the only data available with which to make the calculations. The raw data from this study is given in part in Table 2. Measurements listed are those taken on the Walker well.

Table 2

time (minutes)	head (feet)
1760	47.28
2115	46.88
4375	43.10
5975	42.15

A linear regression was performed using the same form as the recovery data. The results are as follows:

$$Q = 2.5 \text{ cfs}$$
$$r = 10{,}500 \text{ feet}$$
$$b = 80.75$$
$$m = 10.27$$
$$R = 0.9952$$

thus:

$$T = \frac{-264\ Q}{m} = 2.88 \times 10^4 \ \frac{\text{gpd}}{\text{ft}}$$

The t_o value is defined as the t value when the drawdown is zero and t_o was calculated from the linear regression equation. From this:

$$S = \frac{0.3\ T\ t_o}{r^2} = 2.8 \times 10^{-5}$$

where S is the storage coefficient, the amount of water taken into or released from storage per unit area of the aquifer per unit change in head.

These values for S and T were used to predict the expected drawdowns measurements. Since the distances between the wells involved are large, a more exact equation must be used to calculate the drawdown, S:

$$s = \frac{114.6\ Q}{T} W(u) \qquad \text{(Theis equation)}$$

where

$$W(u) = -0.5772 - \ln u + u - \frac{u^2}{2 \cdot 2!} + \frac{u^3}{3.3} - \ldots$$

$$u = \frac{1.87\ r^2 S}{Tt}$$

The results are given in the following tables:

Two-Plus Well r = 20,000 feet

t(days)	t(min)	u	w(u)	s in feet
~~6.94~~ .0694	100	10.41	1.991 X 10^{-5}	0.0002
0.139	200	5.310	7.943 X 10^{-4}	0.0006
0.208	300	3.472	7.226 X 10^{-3}	0.06
0.278	400	2.598	2.194 X 10^{-2}	0.18
0.347	500	2.081	4.375 X 10^{-2}	0.35
0.694	1000	1.041	0.2049	1.64
1.04	1500	6.944 X 10^{-1}	0.3778	3.02
1.39	2000	5.196 X 10^{-1}	0.5367	4.28
1.74	2500	4.151 X 10^{-1}	0.6777	5.41
2.08	3000	3.472 X 10^{-1}	0.7999	6.38
2.43	3500	2.972 X 10^{-1}	0.9126	7.28
2.78	4000	2.598 X 10^{-1}	1.014	8.09
3.00	4320	2.407 X 10^{-1}	1.074	8.57 = 3.7 PSI

Walker Well r = 10,500 feet

t(min)	u	w(u)	s
100	2.866	1.55 X 10^{-2}	0.12
200	1.433	0.1106	0.88
300	0.9555	0.2365	1.89
400	0.7166	0.3623	2.89
500	0.5733	0.4797	3.83
1000	0.2866	0.9398	7.50
1500	0.1911	1.260	10.06
2000	0.1433	1.504	12.00
2500	0.1147	1.700	13.57
3000	9.555 X 10^{-2}	1.864	14.88
3500	8.190 X 10^{-2}	2.005	16.00
4000	7.166 X 10^{-2}	2.129	16.99
4320	6.635 X 10^{-2}	2.201	17.57 = 7.6 PSI

Ross Well

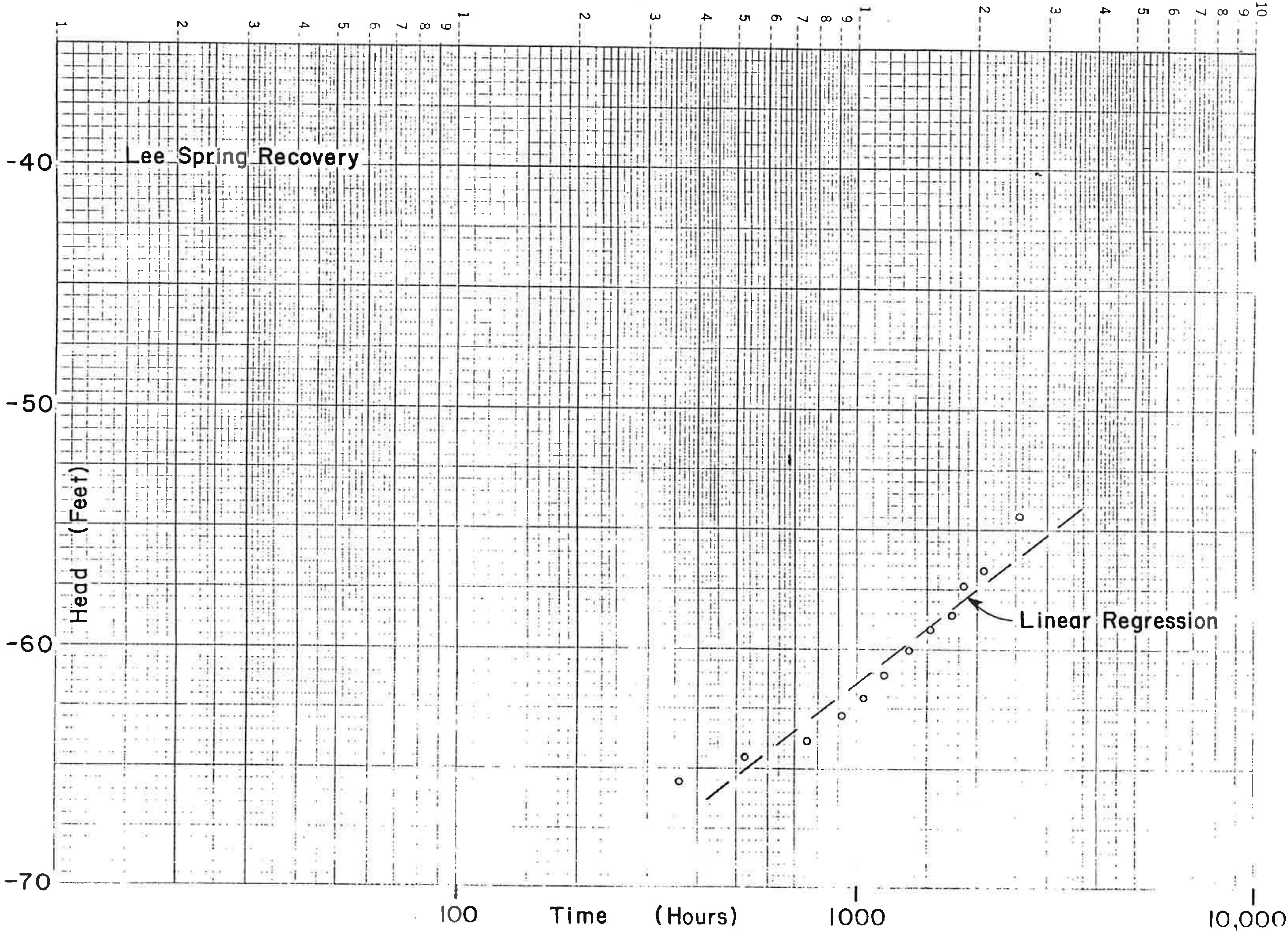
r = 4,000 feet

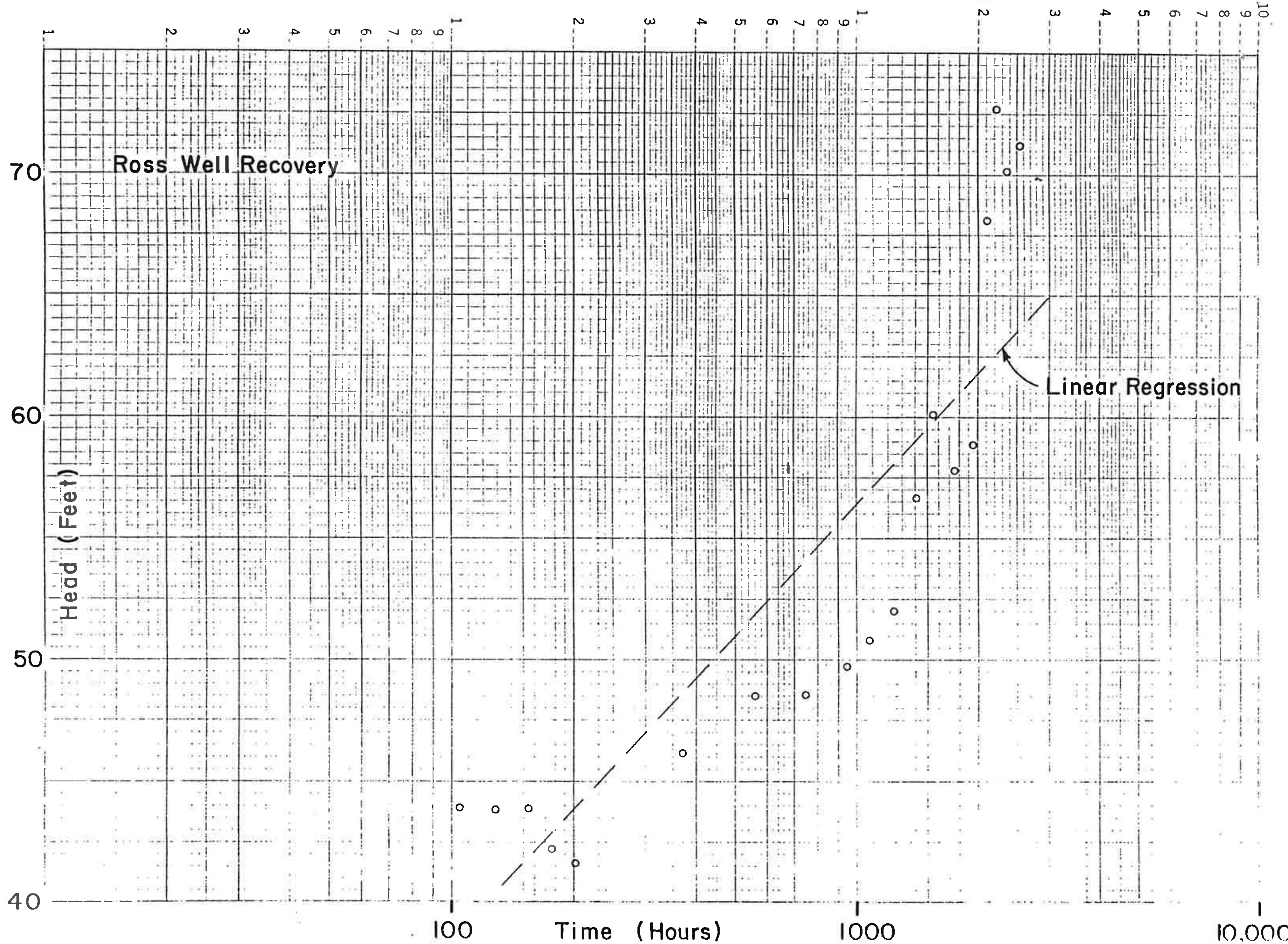
t(min)	u	w(u)	s
100	.4160	0.6763	5.40
200	.2080	1.190	9.50
300	.1387	1.532	12.23
400	.1040	1.788	14.27
500	8.320×10^{-2}	1.991	15.89
1000	4.160×10^{-2}	2.644	21.10
1500	2.773×10^{-2}	3.036	24.23
2000	2.080×10^{-2}	3.316	26.46
2500	1.664×10^{-2}	3.535	28.21
3000	1.387×10^{-2}	3.715	29.65
3500	1.189×10^{-2}	3.867	30.86
4000	1.040×10^{-2}	3.999	31.92
4320	9.629×10^{-3}	4.075	32.52 = 14 PSI

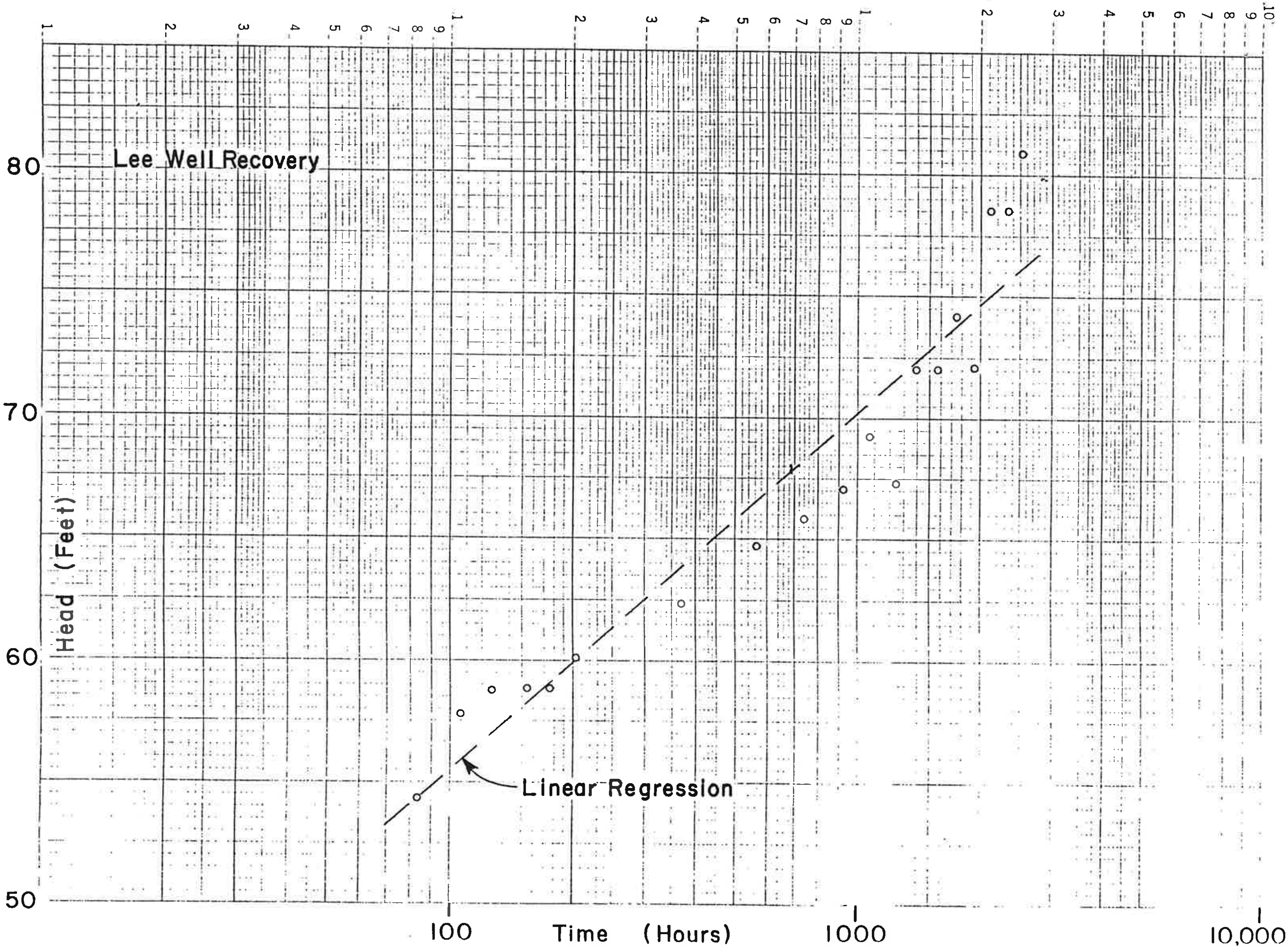
Lee Springs

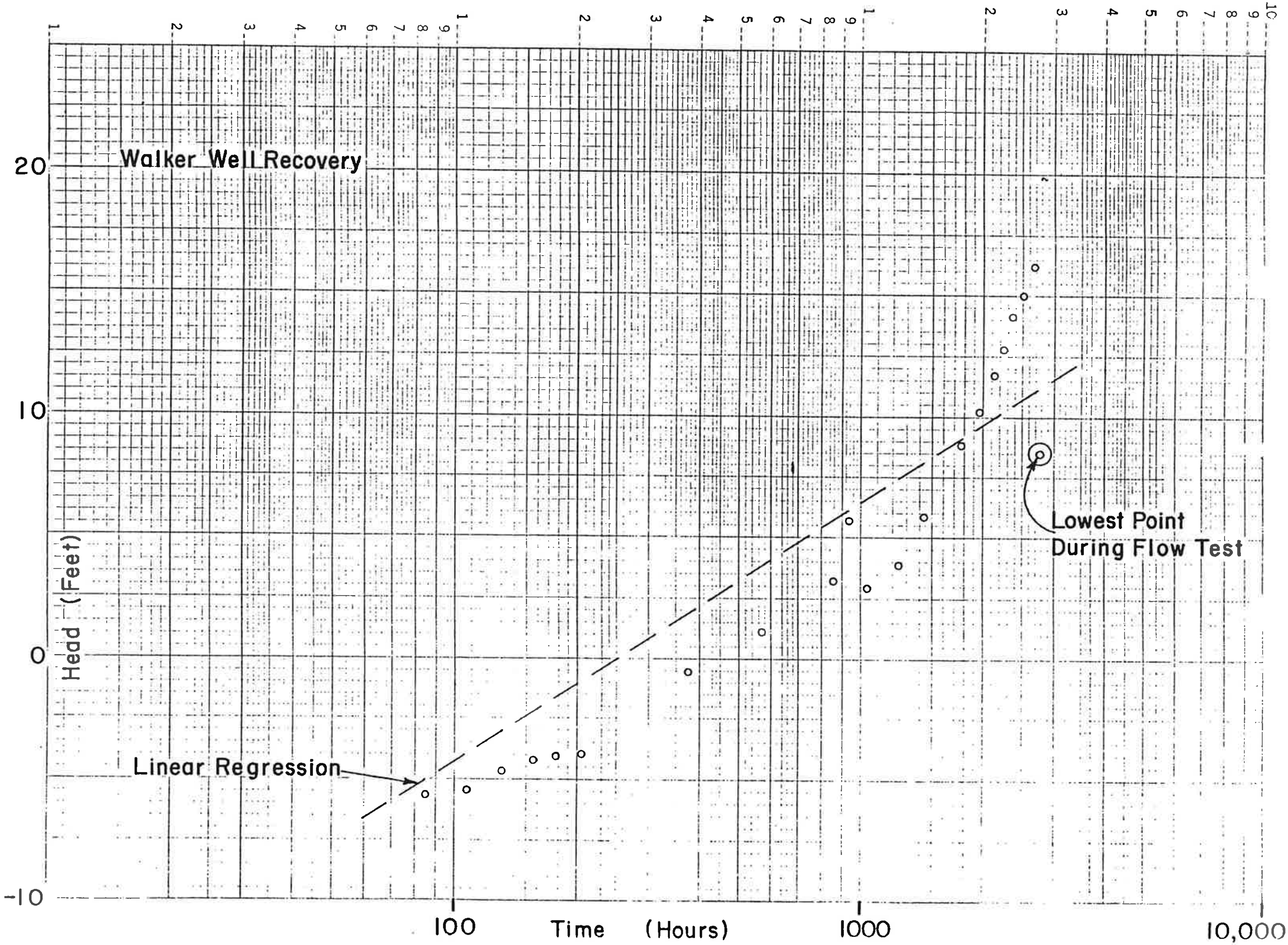
r = 27,000 feet

t(min)	u	w(u)	s
1000	1.885	5.743×10^{-2}	0.46
2000	0.9426	0.2418	1.93
3000	0.6284	0.4294	3.43
4000	0.4713	0.5962	4.76
5320	0.4364	0.6451	5.15


Lee Spring Recovery
Linear Regression
Head (Feet)
-40
-50
-60
-70
Time (Hours)
100
1000
10,000


Ross Well Recovery
Linear Regression
Head (Feet)
Time (Hours)
70
60
50
40
100
1000
10,000


Lee Well Recovery
Linear Regression
Head (Feet)
Time (Hours)
80
70
60
50
100
1000
10,000


Walker Well Recovery
Lowest Point
During Flow Test
Linear Regression
Head (Feet)
20
10
0
-10
Time (Hours)
100
1000
10,000

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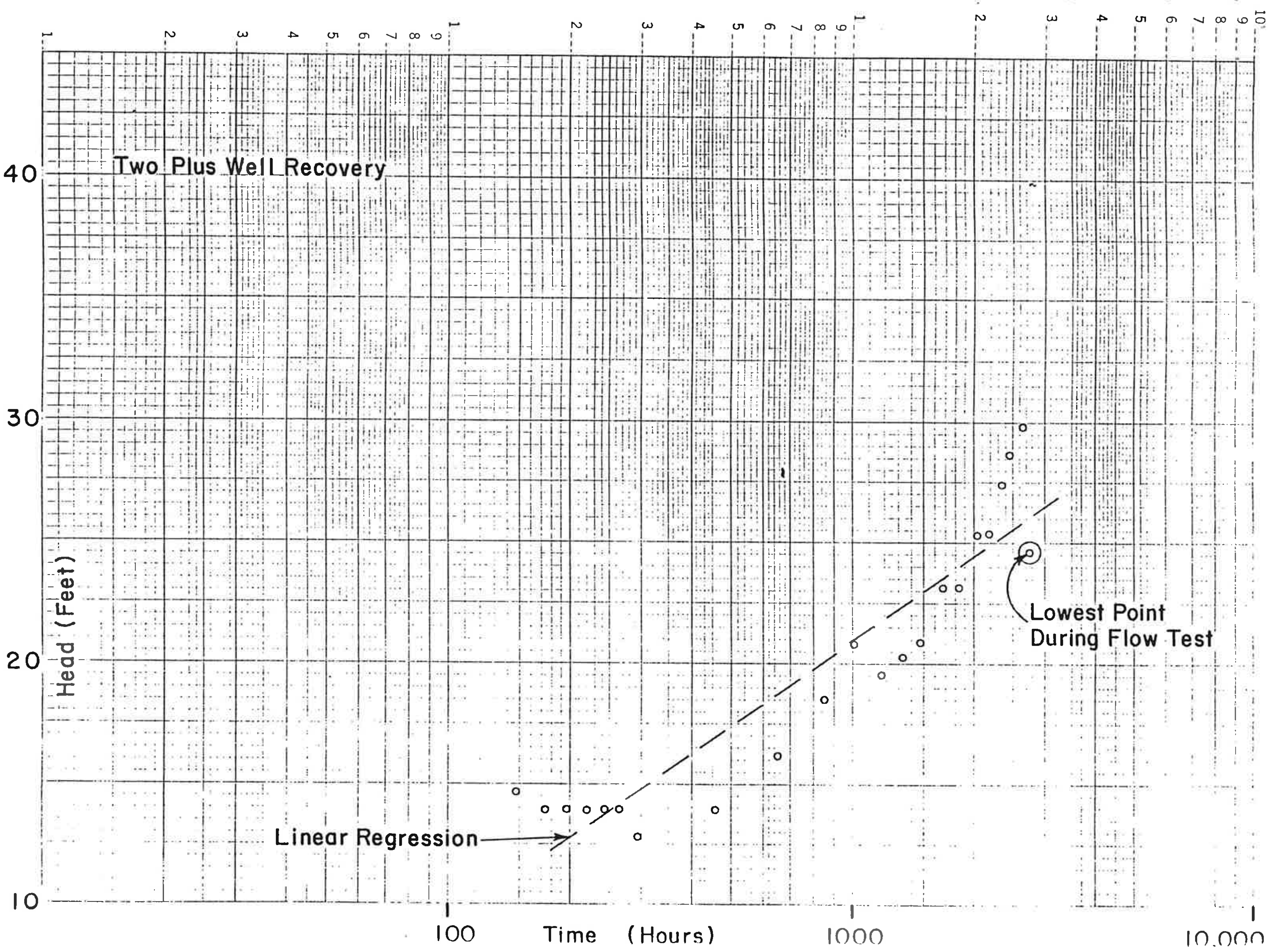


Flow Test

The drawdown listed in the data tables that follow takes into account recharge effects. This was done by assuming that recovery measured before the test continued at the same rate through the test.

The Ross well presented a particular problem since the current owners of the well were using a small amount of water for household uses. Thus, some fluctuations observed are due to the withdrawal of water at the Ross well, some are due to natural recharge, and some are due to withdrawal from the Lee well. Since the predicted effect of flowing the Lee well was so large, no attempt was made initially to have the well completely shut in. When it became apparent that the effect at the Ross well was going to be small if any, the well was completely shut in.

The recharge predictions for the test period were not calculated from the full recharge data. It was assumed that the latter part of the recovery curve would be most applicable to the test period. In the case of the Walker and Two-Plus wells the lowest point that the wells were drawn down to was plotted on the recovery curve to see which section of the curve should be used to predict natural recovery. The last eight recovery points were chosen for the Walker well linear regression.

In the case of the Ross well all but the first five points were used in the linear regression since the first five points probably reflect withdrawals from the system. The results of all linear regressions for recovery prediction are given below:

	m	b	R
Ross	31.10	- 39.31	0.89
Walker	37.11	-111.4	0.996
Two-Plus	37.72	- 99.44	0.97

Recall that these results are for the calculation of head, h, where h is given by:

$$h = m \log t + b$$

These results do not agree exactly with the heads measured at the beginning of the test. To correct for this discrepancy, it is assumed that the slope, m, is correct and that b must be adjusted to give an h equal to the measured head at $t_2 = 0$. The results used to predict the recovery are given below:

	m	b
Ross	31.10	- 42.12
Walker	37.11	-111.48
Two-Plus	37.72	- 98.20

Thus the drawdown, s, is given by:

$$s = m \log t_1 + b - (\text{head})$$

where the head is the head measured.

The data for the flow test is given in the following tables, and graphed in the following graphs. The values for t_1 are for recovery data times since the end of the 1977 irrigation period, t_2 for the time, in minutes from the beginning of the flow test.

Ross Well

Date	Time	t_1(hr)	t_2(min)	Head(ft)	s(ft)
3 Apr. 78	21:50	2710	- 650	71.6	- 7.0
4 Apr. 78	1:17	2713	- 443	68.1	- 3.4
4 Apr. 78	6.12	2718	- 148	67.0	- 2.3
4 Apr. 78	8:40	2721	0	64.7	0
4 Apr. 78	8:41	2721	1	64.7	0
4 Apr. 78	8:42	2721	2	64.7	0
4 Apr. 78	8:43	2721	3	64.7	0
4 Apr. 78	8:44	2721	4	64.7	0
4 Apr. 78	8:45	2721	5	64.7	0
4 Apr. 78	8:46	2721	6	64.7	0
4 Apr. 78	8:47	2721	7	64.7	0
4 Apr. 78	8:48	2721	8	64.7	0
4 Apr. 78	8:49	2721	9	64.7	0
4 Apr. 78	8:50	2721	10	68.1	- 3.4
4 Apr. 78	9.00	2721	20	68.1	- 3.4
4 Apr. 78	9:10	2721	30	68.1	- 3.4
4 Apr. 78	9:20	2721	40	68.1	- 3.4
4 Apr. 78	9:30	2722	50	68.1	- 3.4
4 Apr. 78	9:40	2722	60	68.1	- 3.4
4 Apr. 78	9:50	2722	70	68.1	- 3.4
4 Apr. 78	10:00	2722	80	68.1	- 3.4
4 Apr. 78	10:10	2722	90	68.1	- 3.4
4 Apr. 78	10:20	2722	100	68.1	- 3.4
4 Apr. 78	12:00	2724	200	67.0	- 2.3
4 Apr. 78	13:40	2726	300	73.9	- 9.2
4 Apr. 78	15.20	2727	400	69.3	- 4.6
4 Apr. 78	17:00	2729	500	65.8	- 1.1
4 Apr. 78	18:38	2731	598	67.0	- 2.3
4 Apr. 78	20:20	2732	700	68.1	- 3.3
4 Apr. 78	22:00	2734	800	65.8	- 1.0
4 Apr. 78	23:40	2736	900	67.0	- 2.2
5 Apr. 78	1:20	2737	1000	67.0	- 2.2
5 Apr. 78	9:40	2746	1500	67.0	- 2.2
5 Apr. 78	18:00	2754	2000	67.0	- 2.1
6 Apr. 78	2:40	2763	2520	67.0	- 2.1
6 Apr. 78	*13:00	2773	3140	73.9	- 8.9
6 Apr. 78	13:05	2773	3145	76.2	-11.2
6 Apr. 78	13:10	2773	3150	76.2	-11.2
6 Apr. 78	13:50	2774	3190	77.4	-12.4
6 Apr. 78	14:00	2774	3200	78.0	-13.0
6 Apr. 78	14:10	2774	3210	78.0	-13.0
6 Apr. 78	14:20	2774	3220	78.5	-13.5
6 Apr. 78	14:30	2775	3230	78.5	-13.5
6 Apr. 78	14:40	2775	3240	78.5	-13.5
6 Apr. 78	14:50	2775	3250	78.5	-13.5
6 Apr. 78	15:00	2775	3260	78.5	-13.5
6 Apr. 78	16:22	2776	3342	78.5	-13.5
6 Apr. 78	17:56	2778	3436	78.5	-13.5
7 Apr. 78	8:45	2793	4325	78.5	-13.4
7 Apr. 78	9.25	2793	4365	78.5	-13.4
7 Apr. 78	11:48	2796	4508	78.5	-13.4

* Well shut in completely

Data Reduction Well Test

Walker Well

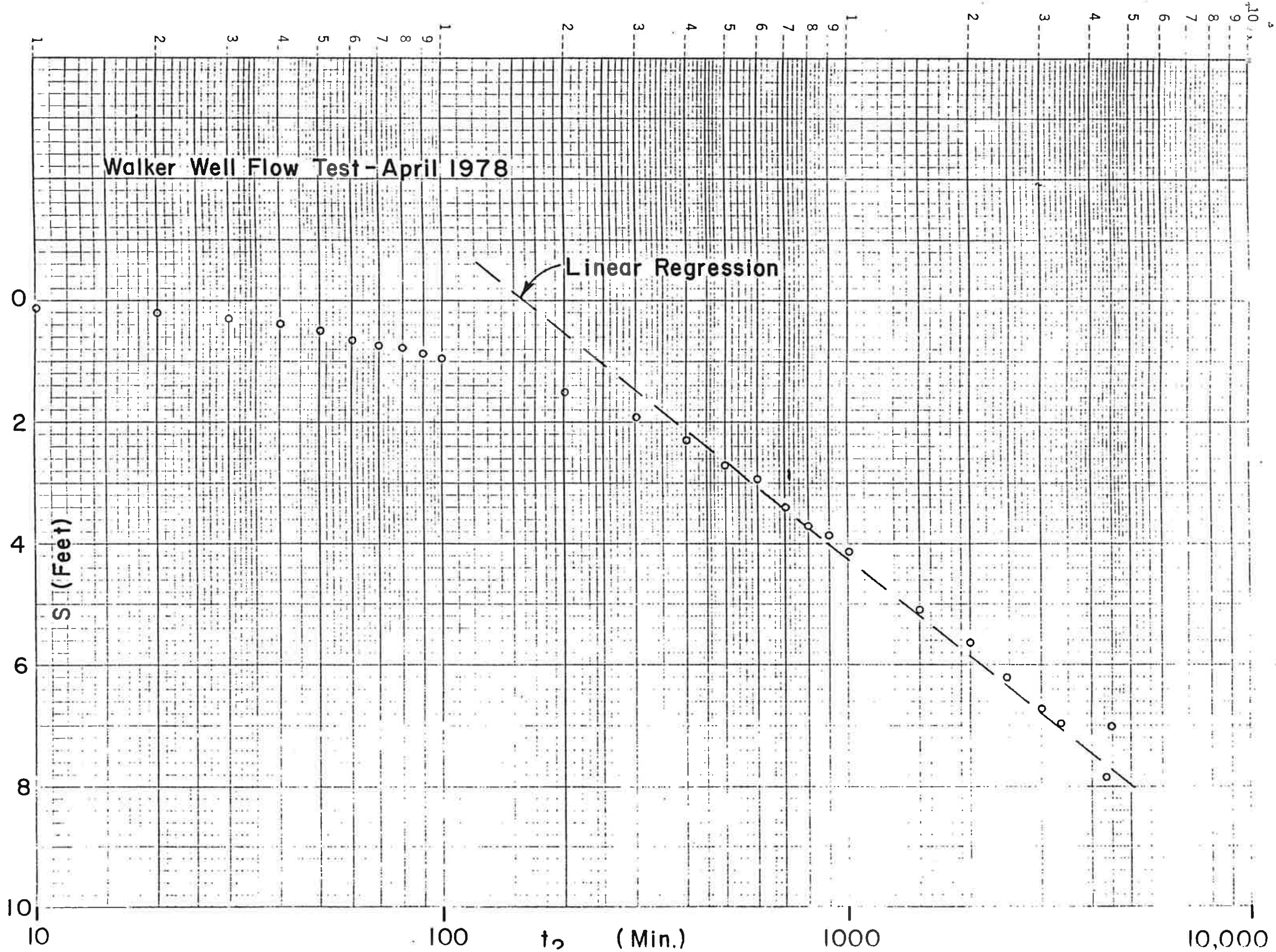
Date	Time	t_1(hr)	t_2(min)	Head(ft)	s(ft)
3 Apr. 78	22:34	2711	- 606	15.90	0.02
4 Apr. 78	1:41	2714	- 419	16.00	-0.06
4 Apr. 78	6:36	2719	- 124	16.18	-0.21
4 Apr. 78	8:40	2721	0	15.98	0.0
4 Apr. 78	8:50	2721	10	15.88	0.10
4 Apr. 78	9:00	2721	20	15.78	0.20
4 Apr. 78	9:10	2721	30	15.68	0.30
4 Apr. 78	9:20	2721	40	15.58	0.40
4 Apr. 78	9:30	2722	50	15.48	0.51
4 Apr. 78	9:40	2722	60	15.36	0.63
4 Apr. 78	9:50	2722	70	15.26	0.73
4 Apr. 78	10:00	2722	80	15.21	0.78
4 Apr. 78	10:10	2722	90	15.16	0.83
4 Apr. 78	10:20	2722	100	15.06	0.93
4 Apr. 78	12:00	2724	200	14.46	1.54
4 Apr. 78	13:40	2726	300	14.06	1.95
4 Apr. 78	15.20	2727	400	13.72	2.30
4 Apr. 78	17:00	2729	500	13.35	2.68
4 Apr. 78	18:40	2731	600	13.05	2.99
4 Ap. 78	20:20	2732	700	12.65	3.40
4 Apr. 78	22:00	2734	800	12.40	3.66
4 Apr. 78	23.40	2736	900	12.20	3.87
5 Apr. 78	1:20	2737	1000	11.90	4.18
5 Apr. 78	9:40	2746	1500	11.00	5.13
5 Apr. 78	18:00	2754	2000	10.55	5.63
6 Apr. 78	2:00	2762	2480	10.00	6.22
6 Apr. 78	10:40	2771	3000	9.50	6.77
6 Apr. 78	16.43	2777	3363	9.35	6.96
7 Apr. 78	8.08	2792	4288	8.50	7.90
7 Apr. 78	10.34	2795	4434	9.40	7.01

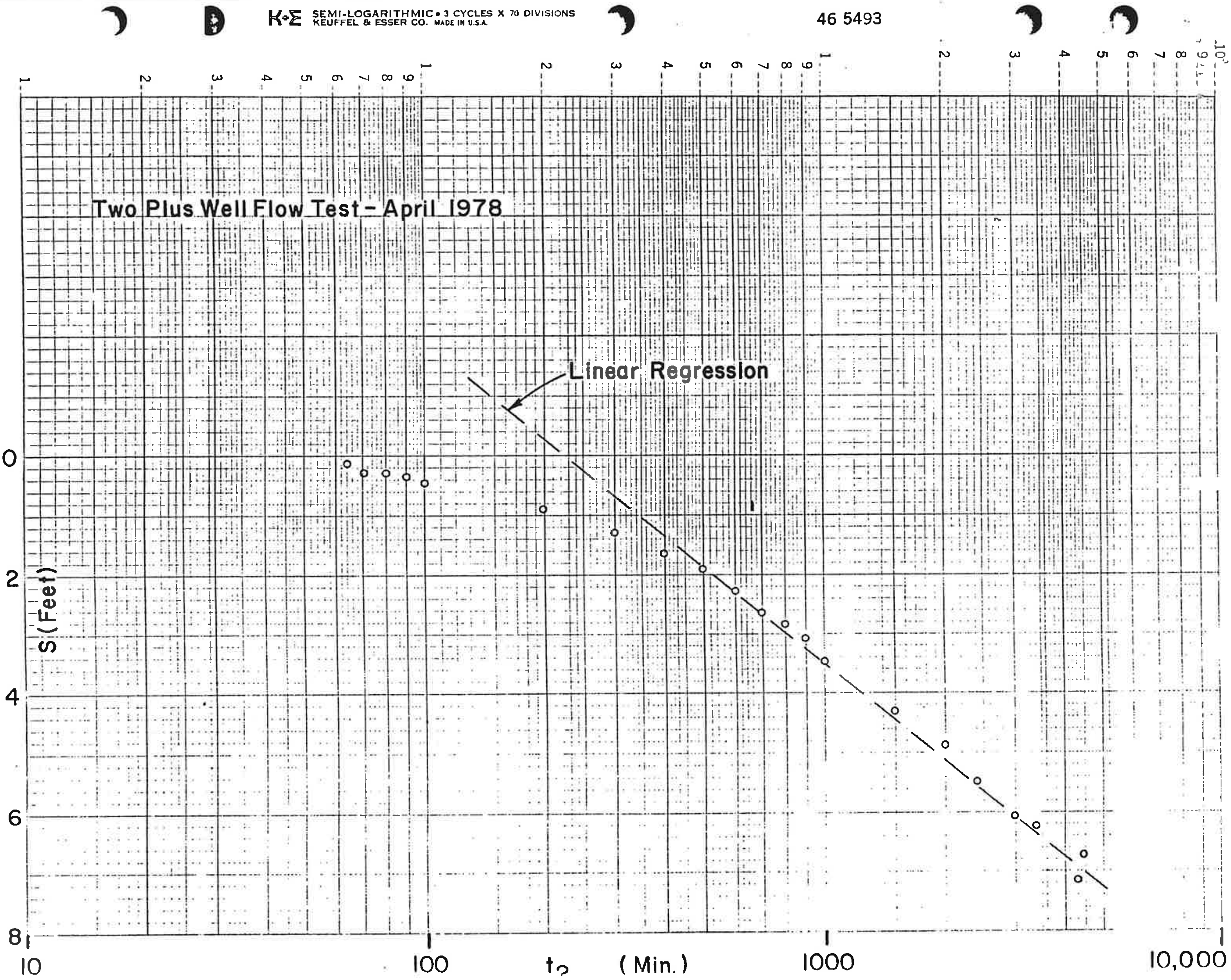
Data Reduction Well Test

Two-Plus Well

Date	Time	t_1(hr)	t_2(hr)	Head(ft)	s(ft)
3 Apr. 78	23:02	2711	- 578	31.91	-0.61
4 Apr. 78	1:59	2714	- 401	31.41	-0.09
4 Apr. 78	6:50	2719	- 110	31.59	-0.25
4 Apr. 78	7:50	2720	- 50	31.49	-0.14
4 Apr. 78	9:44	2722	64	31.19	0.17
4 Apr. 78	9:50	2722	70	31.09	0.27
4 Apr. 78	10:00	2722	80	31.04	0.32
4 Apr. 78	10:10	2722	90	30.99	0.37
4 Apr. 78	10:20	2722	100	30.94	0.43
4 Apr. 78	12:00	2724	200	30.49	0.89
4 Apr. 78	13:40	2726	300	30.09	1.30
4 Apr. 78	15.20	2727	400	29.79	1.61
4 Apr. 78	17:00	2729	500	29.49	1.92
4 Apr. 78	18:40	2731	600	29.14	2.28
4 Apr. 78	20:20	2732	700	28.79	2.64
4 Apr. 78	22:00	2734	800	28.59	2.85
4 Apr. 78	23:40	2736	900	28.29	3.16
5 Apr. 78	1:20	2737	1000	27.99	3.47
5 Apr. 78	9:40	2746	1500	27.19	4.32
5 Apr. 78	18:00	2754	2000	26.69	4.87
6 Apr. 78	2:00	2762	2480	26.09	5.51
6 Apr. 78	10:40	2771	3000	25.64	6.01
6 Apr. 78	16:55	2777	3375	25.49	6.20
7 Apr. 78	8:23	2792	4303	24.59	7.19
7 Apr. 78	11:05	2795	4465	25.04	6.76

K+E SEMI-LOGARITHMIC • 3 CYCLES X 70 DIVISIONS KEUFFEL & ESSER CO. MADE IN U.S.A. 46 5493





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Two Plus Well Flow Test - April 1978
Linear Regression
S (Feet)
0
2
4
6
8
10
100
1000
10,000
t2 (Min.)

No graph was drawn for the Ross well data since no drawdown was observed. From the graphs of the Walker and Two-Plus wells points were chosen for a linear regression assuming, as before, a non-leaky aquifer system, of the form:

$$s = \frac{264\ Q}{T} \log \frac{(0.3\ T\ t)}{r^2 S}$$

For the Walker well points after t_2 = 300 minutes were chosen and for the Two-Plus well points after t_2 = 400 minutes were chosen for the linear regressions in order to use points on the straight-line portion of the curve. The results are:

	m	b	R	t_o(min)	S	T(gpd/ft)
Walker	5.42	-11.81	.997	163	3.03×10^{-5}	1.08×10^{-5}
Two-Plus	5.42	-12.82	.997	232	1.5×10^{-5}	1.06×10^{-5}

Conclusions

The effects measured in the Walker-Lee system are dramatic and immediate. When the Lee well was opened the observer at the Walker well indicated that he could see a pressure change on the mercury manometer within 30 seconds.

From the data collected during this test it is clear that the Two-Plus well is withdrawing water from the same source as the Walker and Lee wells. The transmissibility calculated for the Walker well and the Two-Plus well agree very closely, but the values do not agree with that reported by Keith Anderson in his May 1964 report.

This difference can be explained by noting that Anderson's test was run longer than the current test and if the data taken during the Anderson test is limited to the three-day period, a shallower slope will be obtained. The shallower slope will yield a larger transmissibility more in agreement with the results of this test. What the steeper slope of the longer Anderson study may indicate is that a barrier is encountered in the system and that somewhere past the point where we ended measurements the yield of the aquifer decreases significantly.

Probably the more surprising conclusion of this test is that the Ross well is not in the Walker-Lee system. The effect expected should have been readily measurable even with the small household withdrawal of water, but even with the well completely shut-in no effect was seen.

This test successfully proved mutual well interference to exist and the results clear. The ability of the mercury manometers to indicate small pressure changes accurately was invaluable to produce reliable results from the test.

Date: June 27, 1978 1978 Paul M. Castelli

William H. MacAllister