

SECOND LONG TERM PUMP TEST
FOR
KERR-McGEE NUCLEAR CORPORATION
Q SAND IN SITU PILOT PROJECT
CONVERSE COUNTY, WYOMING

NRC DOCKET NO. 40-8768

APRIL 27, 1981

THIS DOCUMENT CONTAINS
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LONG TERM PUMP TEST
Q SAND IN SITU R&D PROJECT
CONVERSE COUNTY, WYOMING

NRC DOCKET NO. 40-8768

A second long term pump test was initiated at the in-situ leach pilot site beginning at 9:38 a.m. on April 10, 1981 with pumping continuing until 9:23 a.m. on April 13, 1981. During the three day period, the pumping was maintained at a near constant rate of 16.7 gallons per minute. The rate was measured by a instantaneous rate (turbine) meter and flow was adjusted as necessary with a throttle type control valve. During the 4305 minute pump period, a total of 71,995 gallons of water were produced. All produced water was routed to the Bill Smith mine water treatment ponds for radium removal.

The three wells selected for monitoring the Q sand aquifer properties, QI-2, QI-7, and QI-11, are all located about 158 feet from the pumped well, QP-3 (see Figure 1). The overlying and underlying aquifers were observed by monitoring fluid levels in well QMS-1 and QMO-1, respectively. Each of these wells are located about 112 feet from the pumped well.

During the four day period prior to and for the four day period following the pump test, fluid levels in wells QMS-1, QMO-1, and QI-2 were recorded and this data is included in Table 1. The overlying and underlying aquifer fluid level data are also presented in graphical form in Figure 2. There was no indication of significant communication between the overlying or the underlying aquifer and Q sand aquifer.

Drawdown and recovery data for the three Q sand monitor wells and the pumped well are presented in Tables 2 and 3. This data is presented for the individual wells in graphical form in Figures 3 through 11. A common characteristic in all four graphical plots of the drawdown data is the increased slope during the latter time frame, 1000 minute to 4000 minute area. This change in the rate

of drawdown is believed to be caused by the definite thinning of the Q sand to the southwest of the pilot area. The Q sand in well QM-8 (see Figure 1) is only about 11 feet thick whereas in most of the pilot area, it averages about 30 feet thick.

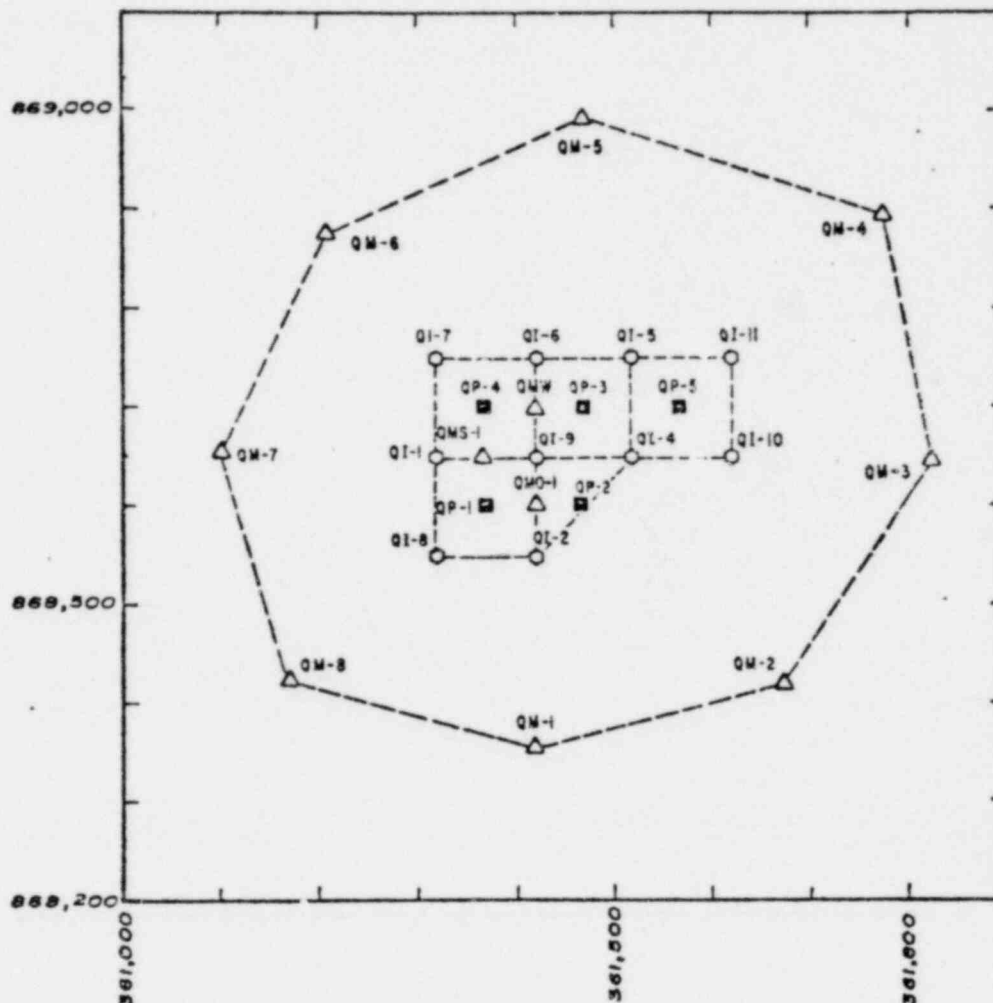
Based on interpretation of the Q sand aquifer drawdown data, as indicated on the individual graphs, there is no major difference in transmissivities in the test area. The transmissivity and storativity data average 1017 gpd/ft and 4.4×10^{-5} respectively. These data are summarized in Table 4. Although the average coefficient of transmissivity calculated from this test is about 30 percent greater than the 780 gpd/ft calculated in the original test, it should be noted that the average sand thickness for the wells in this test, about 33 feet, is significantly greater than the average for wells in the initial pump test, about 25 feet.

It is believed that this test confirms the conclusions drawn from the original pump test i.e.

1. The Q sand is a confined aquifer.
2. Relatively uniform hydrological communication exists in the Q sand within the pilot area.
3. There is no evidence of significant vertical leakage between the Q sand and the overlying and/or underlying aquifers.
4. There is no indication of faults or other subsurface features that would disrupt the local groundwater flow; however, the change in slope of the drawdown curves in the latter time frame does indicate some aquifer limitation in the larger areal extent. This limitation is believed to be the geological thinning of the Q sand unit to the southwest and west as is illustrated in the east-west geological cross-section previously provided.
5. The Q sand aquifer in the pilot area has all the hydrological controls needed and is well suited for the in-situ R&D program.

FIGURE 1

IN SITU R&D PROJECT WELL PATTERN
"Q" SAND DEPOSIT
SECTION 36-T36N, R74W
CONVERSE COUNTY, WYOMING



LEGEND

- △ MONITOR WELL
- PRODUCTION WELL
- INJECTION WELL



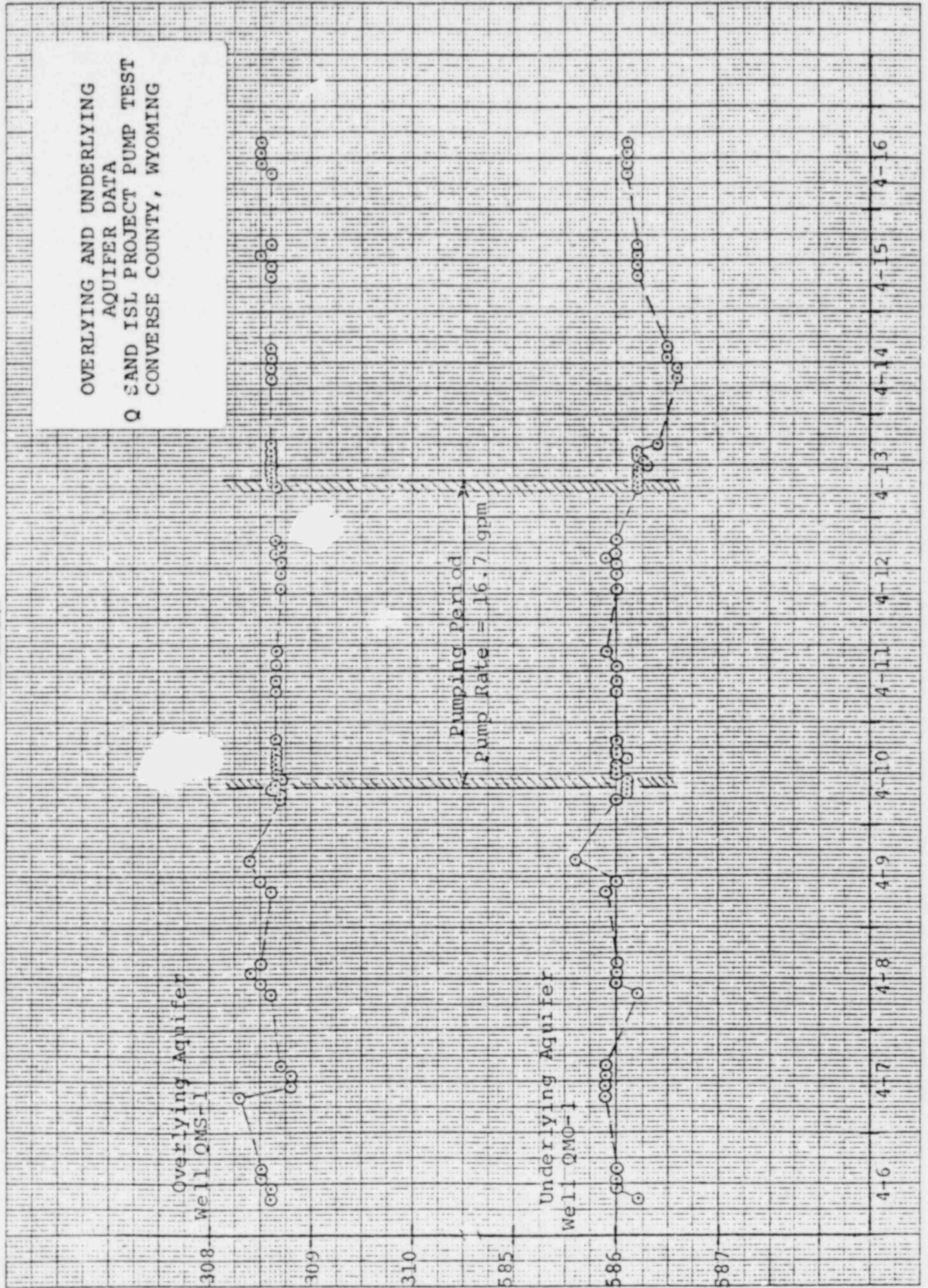
SCALE 1" = 200'

PUMP TEST WELLS

- QP-3 - Pumped Well
- QI-2, QI-7, QI-11 - Q Sand Monitor Well
- QMS-1 - Overlying Aquifer Monitor Well
- QMO-1 - Underlying Aquifer Monitor Well

FEB. 1980
REV. JULY 1980

FIGURE 2



-Depth to Fluid Level - Feet-

FIGURE 3

$t_0 = 6.8$ min.

PUMP TEST DRAWDOWN DATA
 Q SAND ISL PROJECT
 CONVERSE COUNTY, WYOMING
 WELL QI-2
 (158' from pumped well)

$\Delta S = 4.4$

$$T = \frac{264 Q}{\Delta S} = \frac{264(16.7)}{4.4}$$

$$T = 1002 \text{ gpd/ft}$$

$$S = \frac{0.3 T t_0}{r^2}$$

$$= \frac{0.3(1002)(6.8/1440)}{(158)^2}$$

$$S = 5.69 \times 10^{-5}$$

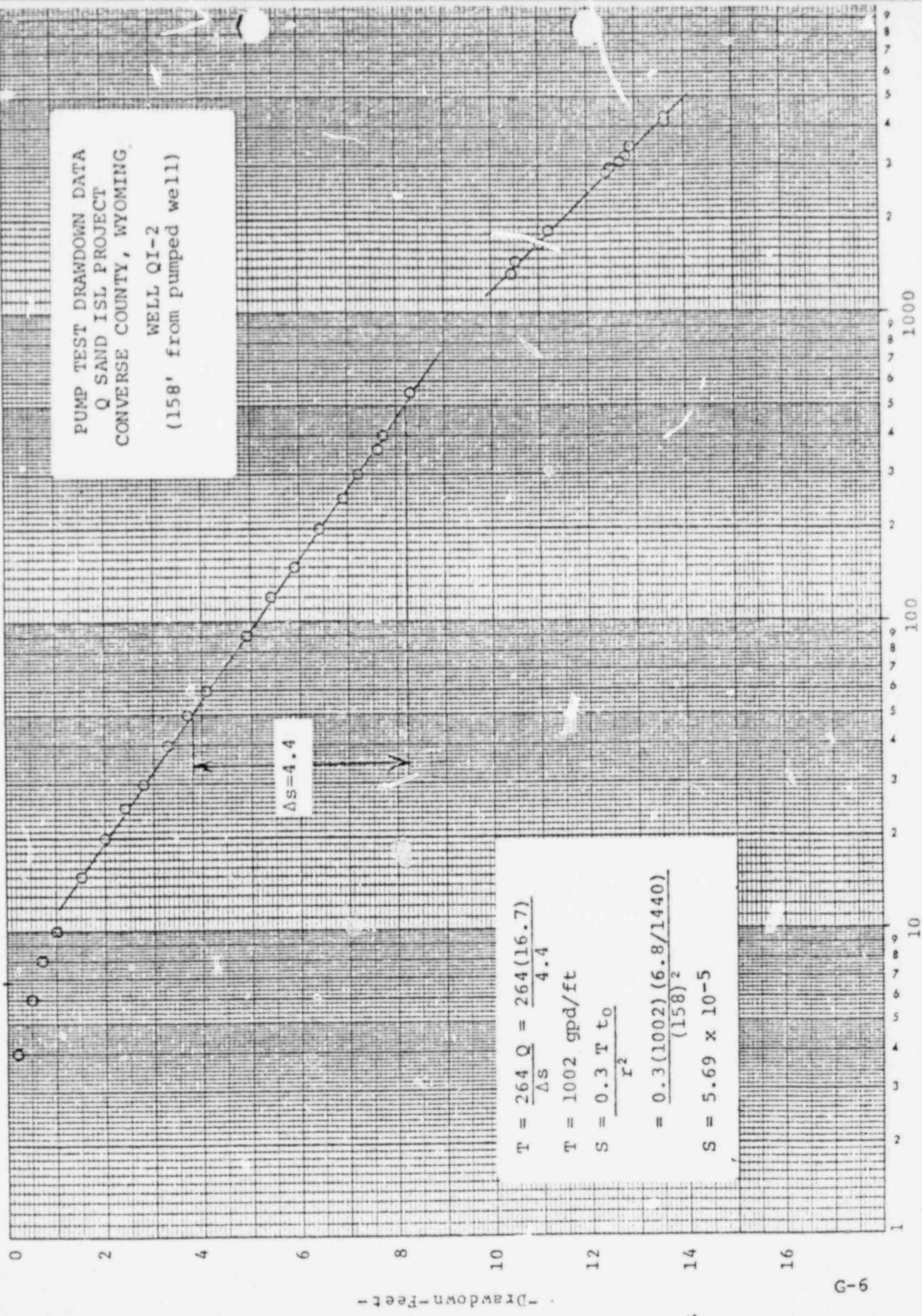
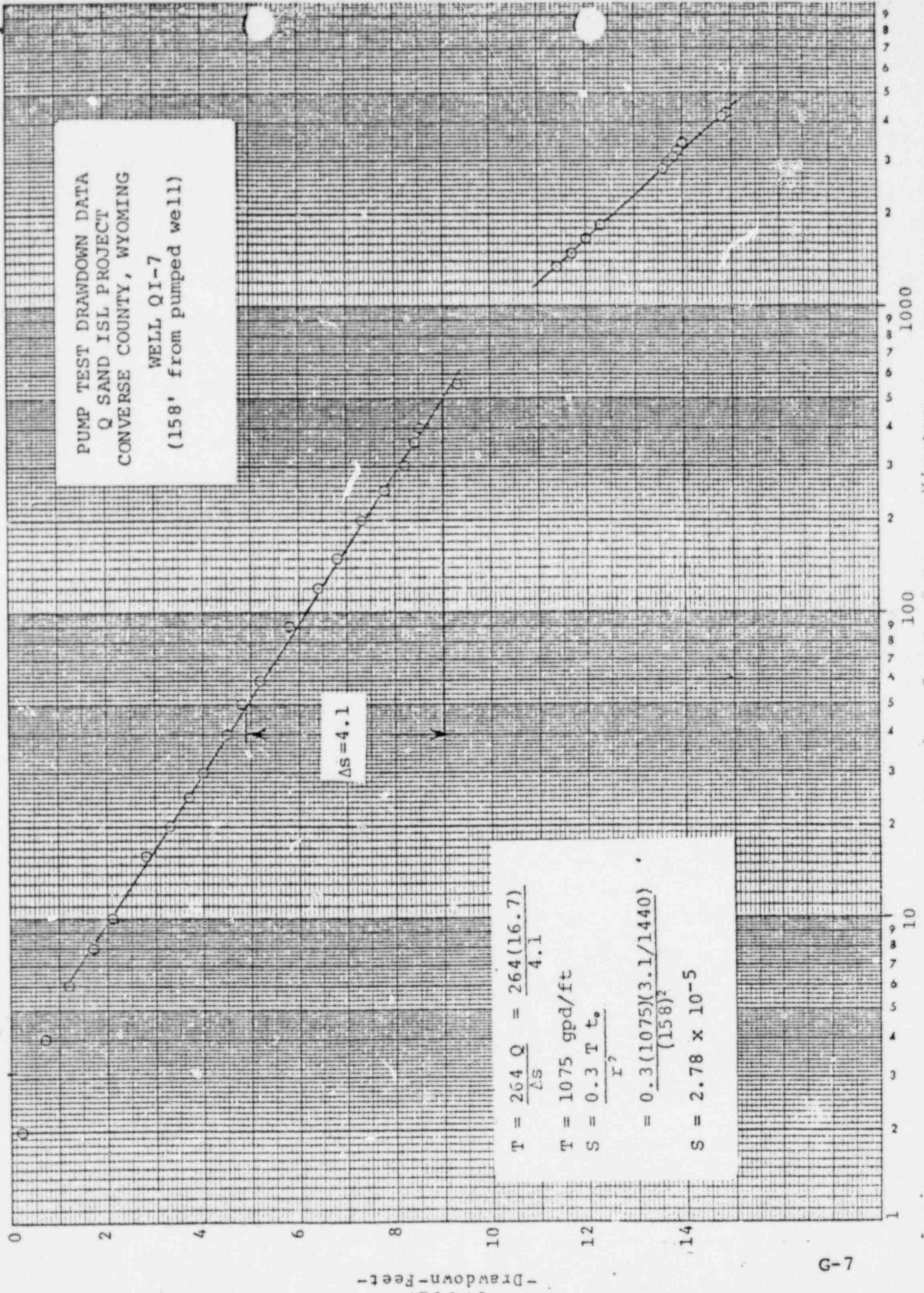


FIGURE # 4

$t_0 = 3.1$ min.

PUMP TEST DRAWDOWN DATA
 Q SAND ISL PROJECT
 CONVERSE COUNTY, WYOMING
 WELL QI-7
 (158' from pumped well)



$\Delta s = 4.1$

$$T = \frac{264 Q}{\Delta s} = \frac{264(16.7)}{4.1}$$

$$T = 1075 \text{ gpd/ft}$$

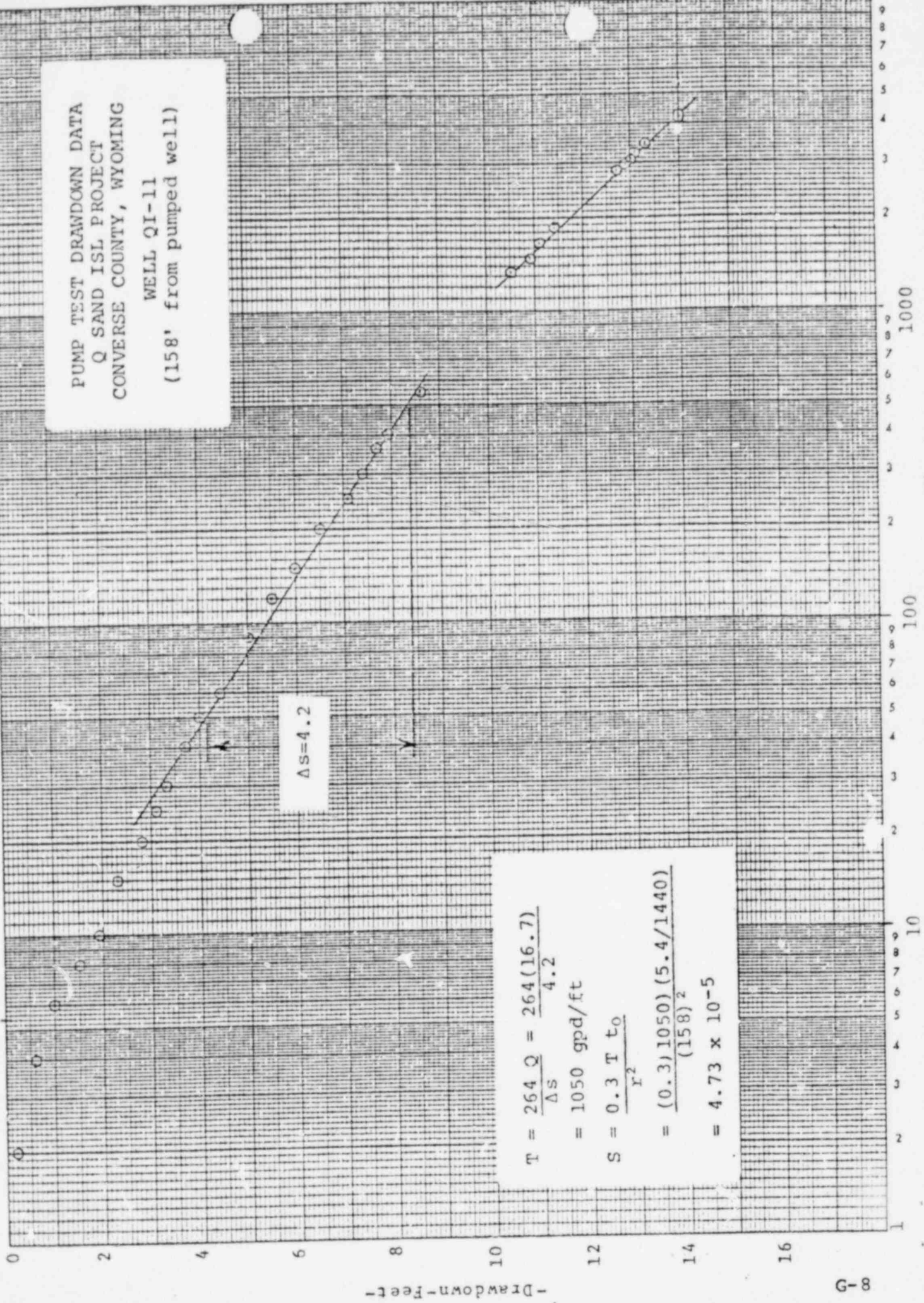
$$S = \frac{0.3 T t_0}{r^2} = \frac{0.3(1075)(3.1/1440)}{(158)^2}$$

$$S = 2.78 \times 10^{-5}$$

FIGURE 5

$t_0 = 5.4$ min.

PUMP TEST DRAWDOWN DATA
 Q SAND ISL PROJECT
 CONVERSE COUNTY, WYOMING
 WELL QI-11
 (158' from pumped well)



$\Delta s = 4.2$

$$T = \frac{264 Q}{\Delta s} = \frac{264(16.7)}{4.2}$$

$$= 1050 \text{ gpd/ft}$$

$$S = \frac{0.3 T t_0}{r^2}$$

$$= \frac{(0.3)(1050)(5.4/1440)}{(158)^2}$$

$$= 4.73 \times 10^{-5}$$

FIGURE 6

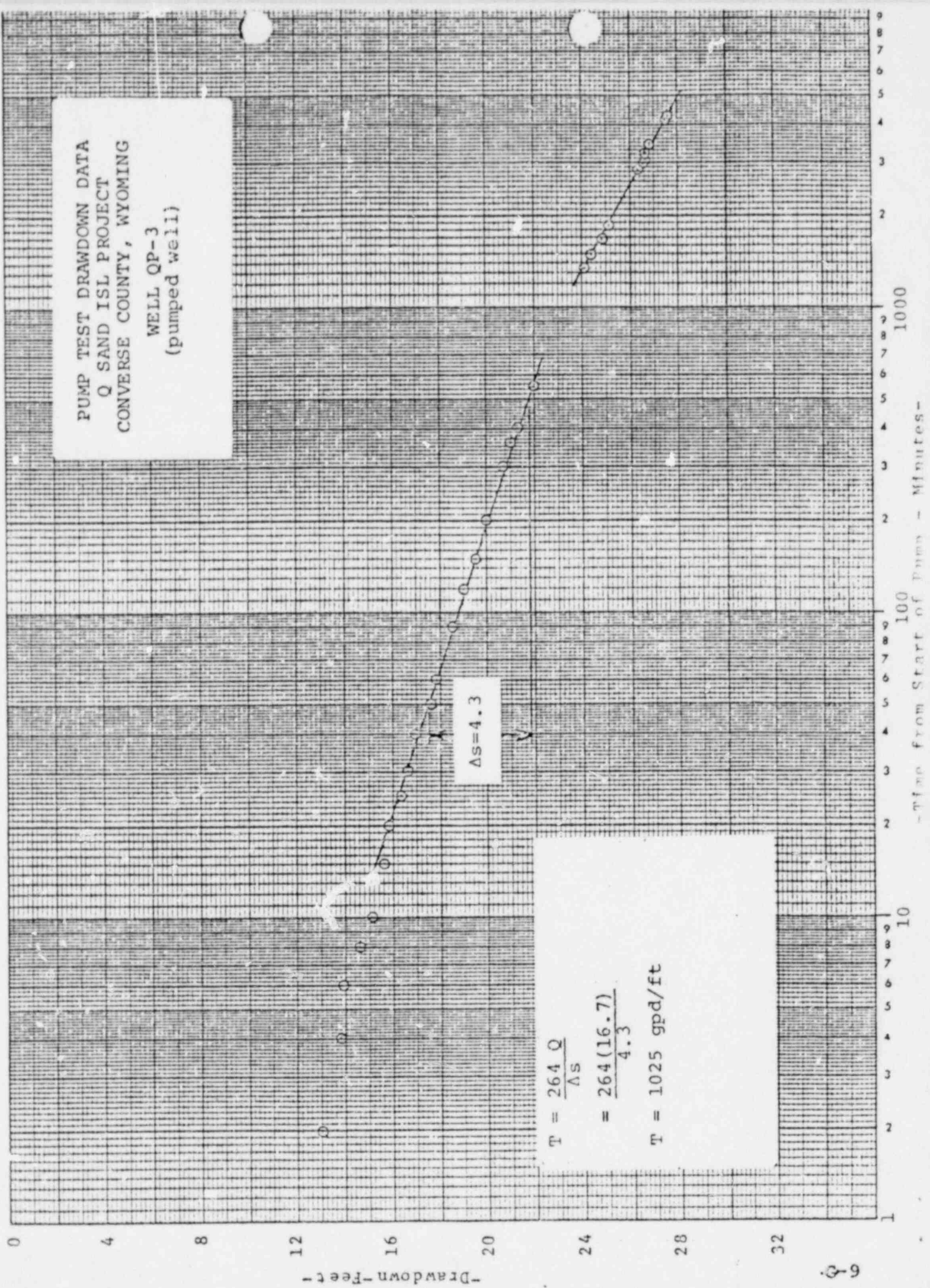


FIGURE 7

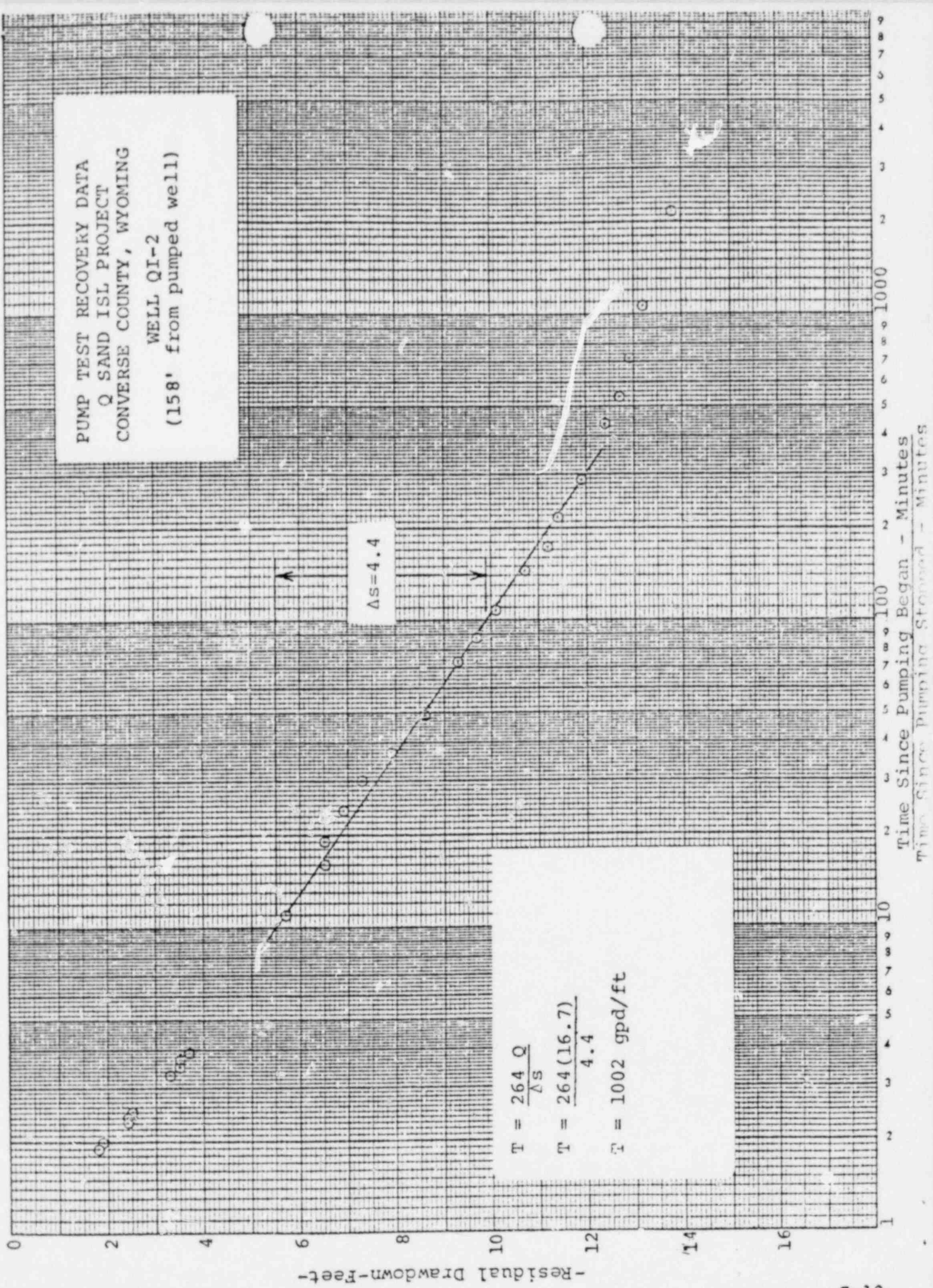


FIGURE 2

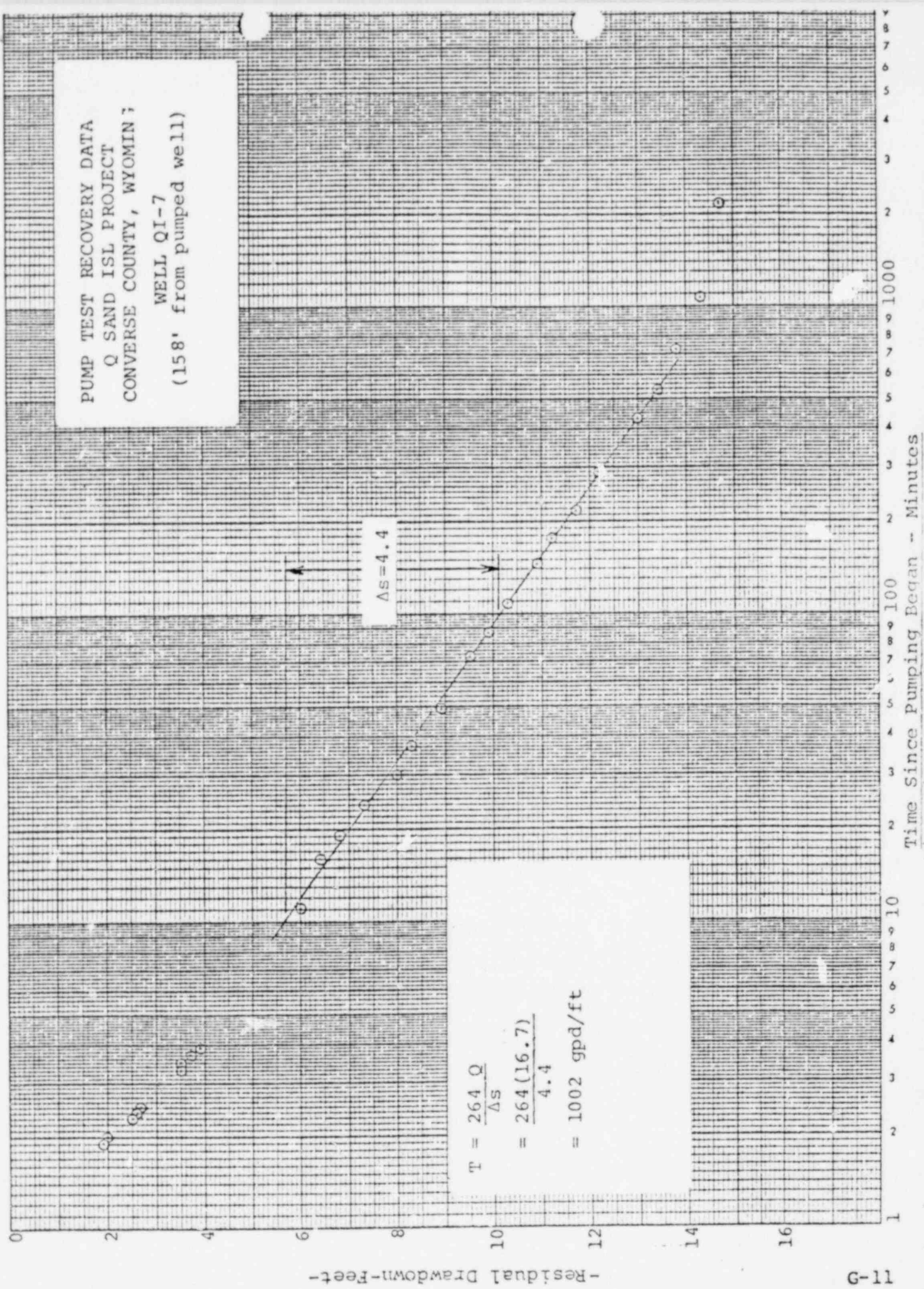


FIGURE 9

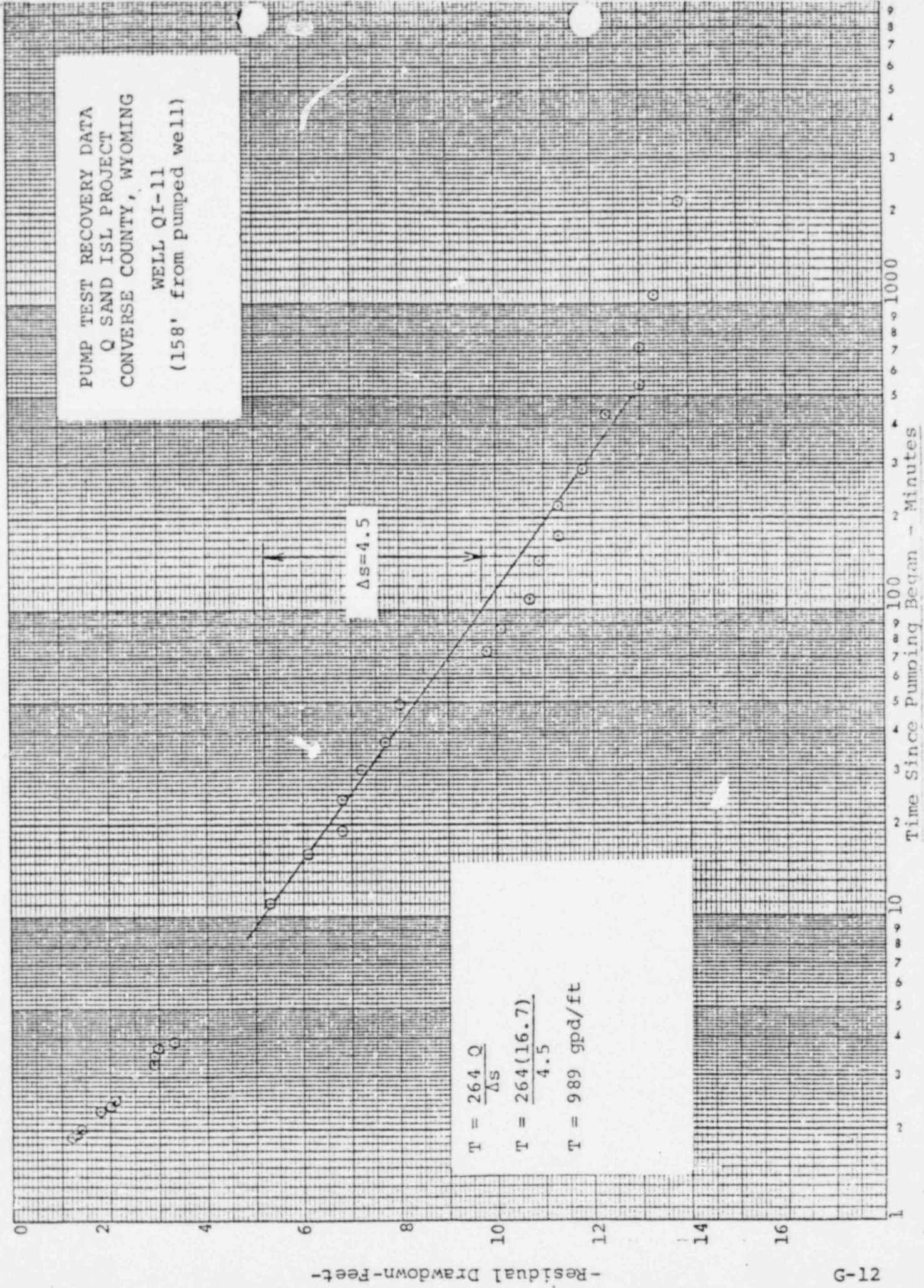


FIGURE 10

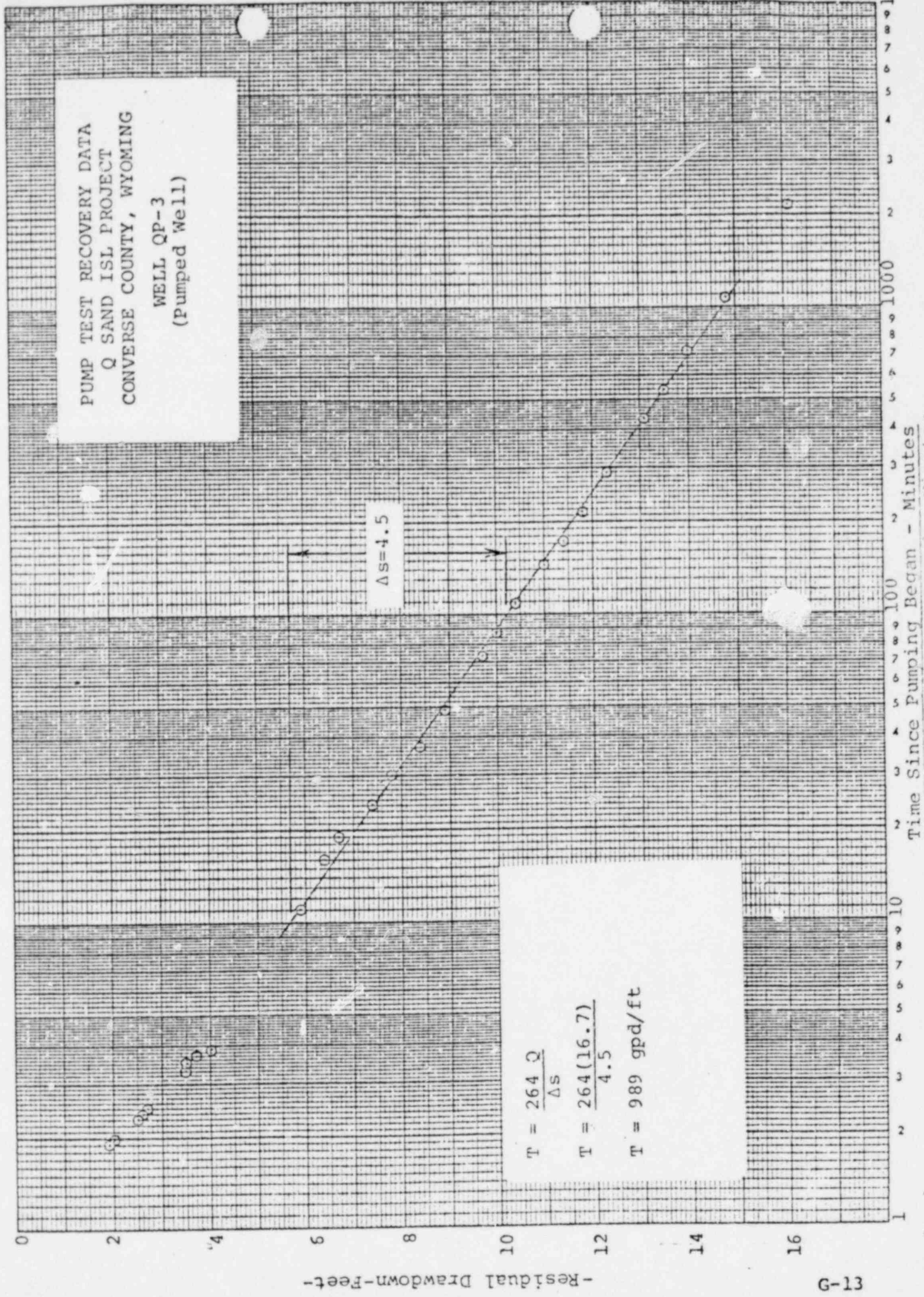


Table 1

OVERLYING AND UNDERLYING AQUIFER DATA
Q SAND ISL PROJECT PUMPT TEST
CONVERSE COUNTY, WYOMING

Date/Time	Depth to Fluid Level - Feet		
	Overlying Aquifer Well QMS-1	Underlying Aquifer Well QM-1	Q Sand Aquifer Well QI-2
4-6-81			
1000	308.6	586.2	
1200	308.6	586.0	376.0
1400	308.5	586.0	375.5
1600	308.5	586.0	375.6
4-7-81			
1000	303.3	585.9	375.5
1200	308.8	585.9	375.3
1400	308.8	585.9	375.5
1600	308.7	585.9	375.4
4-8-81			
1000	308.6	586.2	375.5
1200	308.5	586.0	375.5
1400	308.4	586.0	375.5
1600	308.5	586.0	375.5
4-9-81			
1000	308.6	585.9	375.5
1200	308.5	586.0	375.4
1600	308.4	585.6	375.4
4-10-81			
818	308.7	586.0	-
836	308.7	586.1	-
914	308.6	586.1	375.7
955 ¹	308.65	586.1	377.2 ²
1033	308.7	586.1	379.6
1103	308.7	586.0	380.5
1134	308.65	586.0	380.0
1206	308.65	586.0	381.5
1300	308.65	586.0	382.1
1354	308.65	586.0	382.6
1450	308.65	586.1	382.9
1540	308.65	586.0	383.3
1625	308.65	586.0	383.5
1845	308.65	586.0	384.0
4-11-81			
745	308.65	586.0	386.1
1030	308.65	586.0	386.2
1330	308.65	586.0	386.7
1620	308.65	585.9	386.9
4-12-81			
830	308.7	586.0	388.1
1050	308.7	586.0	388.2
1300	308.7	586.0	388.4
1400	308.65	585.9	388.6
1525	308.7	586.0	388.5
1830	308.65	586.0	388.6
4-13-81			
810	308.65	586.2	389.3
915	308.6	586.2	389.3
940 ³	308.6	586.2	387.4 ³
958	308.6	586.2	386.1
1015	308.6	586.2	385.3
1040	308.6	586.2	384.6
1120	308.6	586.2	383.6
1200	308.6	586.3	383.1
1255	308.6	586.25	382.4
1320	308.6	586.2	382.2
1420	308.6	586.2	382.0
1620	308.6	586.4	381.4
4-14-81			
1000	308.6	586.6	379.4
1200	308.6	586.6	379.2
1400	308.6	586.5	379.2
1600	308.6	586.5	379.0
4-15-81			
1000	308.6	586.2	378.2
1200	308.6	586.2	378.1
1400	308.5	586.2	378.1
1600	308.6	586.2	378.1
4-16-81			
1000	308.6	586.1	377.6
1200	308.5	586.1	377.6
1400	308.5	586.1	377.5
1600	308.5	586.1	377.5

¹Pump started on 4-10-81 at 9:38 am

²Level data during test interpolated

³Pump shutdown on 4-13-81 at 9:23 am

TABLE 2

Q SAND AQUIFER DRAWDOWN DATA
 Q SAND ISL PROJECT PUMP TEST
CONVERSE COUNTY, WYOMING

Drawdown in Monitor Wells - Feet

<u>Time From Start of Pump Minutes</u>	<u>Pumped Well QP-3</u>	<u>Monitor Well QI-2</u>	<u>Monitor Well QI-7</u>	<u>Monitor Well QI-11</u>
2	13.0	-	0.2	0.2
4	13.8	0.2	0.7	0.6
6	13.9	0.5	1.2	1.0
8	14.6	0.7	1.7	1.5
10	15.1	1.0	2.1	1.9
15	15.6	1.5	2.8	2.3
20	15.8	2.0	3.3	2.8
25	16.3	2.4	3.7	3.1
30	16.6	2.8	4.0	3.3
40	16.9	3.3	4.5	3.7
50	17.6	3.7	4.8	4.0
60	17.8	4.1	5.2	4.4
90	18.5	4.9	5.8	5.0
120	19.0	5.4	6.4	5.5
150	19.5	5.9	6.8	6.0
200	20.0	6.4	7.3	6.5
250	-	6.9	7.8	7.1
300	20.7	7.2	8.2	7.4
360	21.0	7.6	8.4	7.7
400	21.3	7.7	8.5	7.9
550	22.0	8.3	9.3	8.6
1330	24.1	10.4	11.4	10.5
1490	24.4	10.5	11.7	10.9
1670	24.8	11.0	12.0	11.1
1840	25.1	11.2	12.3	11.4
2810	26.3	12.4	13.6	12.7
2960	26.5	12.5	13.7	12.9
3090	26.6	12.7	13.8	13.0
3240	26.6	12.8	13.9	13.1
3430	26.8	12.9	14.0	13.3
4180	27.5	13.6	14.8	14.0
4300	27.6	13.6	14.9	14.0
4305		-Pump Shut Off-		

TABLE 3

Q SAND AQUIFER RECOVERY DATA
 Q SAND ISL PROJECT PUMP TEST
CONVERSE COUNTY, WYOMING

Residual Drawdown in Monitor Wells - Feet

<u>Time From Start of Pump Minutes</u>	<u>Time Since Pumping Stopped Minutes</u>	<u>Pumped Well QP-3</u>	<u>Monitor Well QI-2</u>	<u>Monitor Well QI-7</u>	<u>Monitor Well QI-11</u>
4307	2	16.1	13.8	14.7	13.8
4309	4	14.8	13.2	14.3	13.3
4311	6	14.0	12.9	13.8	13.0
4313	8	13.5	12.7	13.4	13.0
4315	10	13.1	12.4	13.0	12.3
4320	15	12.3	11.9	12.2	11.8
4325	20	11.8	11.4	11.7	11.3
4330	25	11.4	11.2	11.2	11.3
4335	30	11.0	10.7	10.9	10.9
4345	40	10.4	10.1	10.3	10.7
4355	50	10.0	9.7	9.9	10.1
4365	60	9.7	9.3	9.5	9.8
4395	90	8.9	8.6	8.9	8.0
4425	120	8.4	7.9	8.3	7.7
4455	150	7.8	7.3	8.0	7.2
4520	215	7.4	6.9	7.3	6.8
4540	235	6.7	6.5	6.8	6.8
4600	295	6.4	6.5	6.4	6.1
4720	415	5.9	5.7	6.0	5.3
5780	1475	4.0	3.7	3.9	3.3
5900	1595	3.7	3.5	3.7	3.0
6020	1715	3.5	3.5	3.5	2.9
6140	1835	3.5	3.3	3.5	2.9
7220	2915	2.7	2.5	2.7	2.1
7340	3035	2.6	2.4	2.6	2.0
7460	3155	2.5	2.4	2.6	1.8
7580	3275	2.5	2.4	2.5	1.8
8660	4355	2.0	1.9	2.0	1.4
8780	4475	2.0	1.9	2.0	1.3
8900	4595	1.9	1.8	1.9	1.3
9020	4715	1.9	1.8	1.9	1.2

TABLE 4

SUMMARY OF AQUIFER PROPERTIES
Q SAND ISL R&D PROJECT
CONVERSE COUNTY, WYOMING

Well Number	Transmissivity - gpd/ft			Storativity (dimensionless)
	Drawdown	Recovery	Average	
QP-3	1025	989	1007	-
QI-2	1002	1002	1002	5.69×10^{-5}
QI-7	1075	1002	1039	2.78×10^{-5}
QI-11	1050	989	1020	4.73×10^{-5}
Average	1038	996	1017	4.4×10^{-5}

BAROMETRIC PRESSURE DATA
 Q SAND PUMP TEST
CONVERSE COUNTY, WYOMING

The following data was taken from a barometric pressure monitoring station located about 8 miles east of the test site. A calibration indicated the recorder was reading 0.68 inches too high; however, if corrected, all data would be adjusted accordingly.

<u>Date</u>	<u>Time</u>	<u>Pressure</u> <u>in. Hg.</u>	<u>Date</u>	<u>Time</u>	<u>Pressure</u> <u>in. Hg.</u>
4/6	8 am	25.5	4/11	8 am	25.5
	12 N	25.5		12 N	25.5
	4 pm	25.4		4 pm	25.4
4/7	8 am	25.4	4/12	8 am	25.6
	12 N	25.3		12 N	25.5
	4 pm	25.3		4 pm	25.5
4/8	8 am	25.5	4/13	8 am	25.9
	12 N	25.5		12 N	25.9
	4 pm	25.5		4 pm	26.0
4/9	8 am	25.4	4/14	8 am	26.2
	12 N	25.3		12 N	26.1
	4 pm	25.3		4 pm	26.1
4/10	8 am	25.6			
	12 N	25.5			
	4 pm	25.4			

The higher barometric pressure in 4/13-4/14 time is the probable cause of the lower fluid level in well QMO-1 during that time. The O-sand is believed to be more sensitive to barometric pressure than the S-sand due to the Bill Smith mine workings in the O-sands.

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WELL COMPLETION DATA

ISL WELLS

KERR-McGEE Q SAND PROJECT
CONVERSE COUNTY, WYOMING

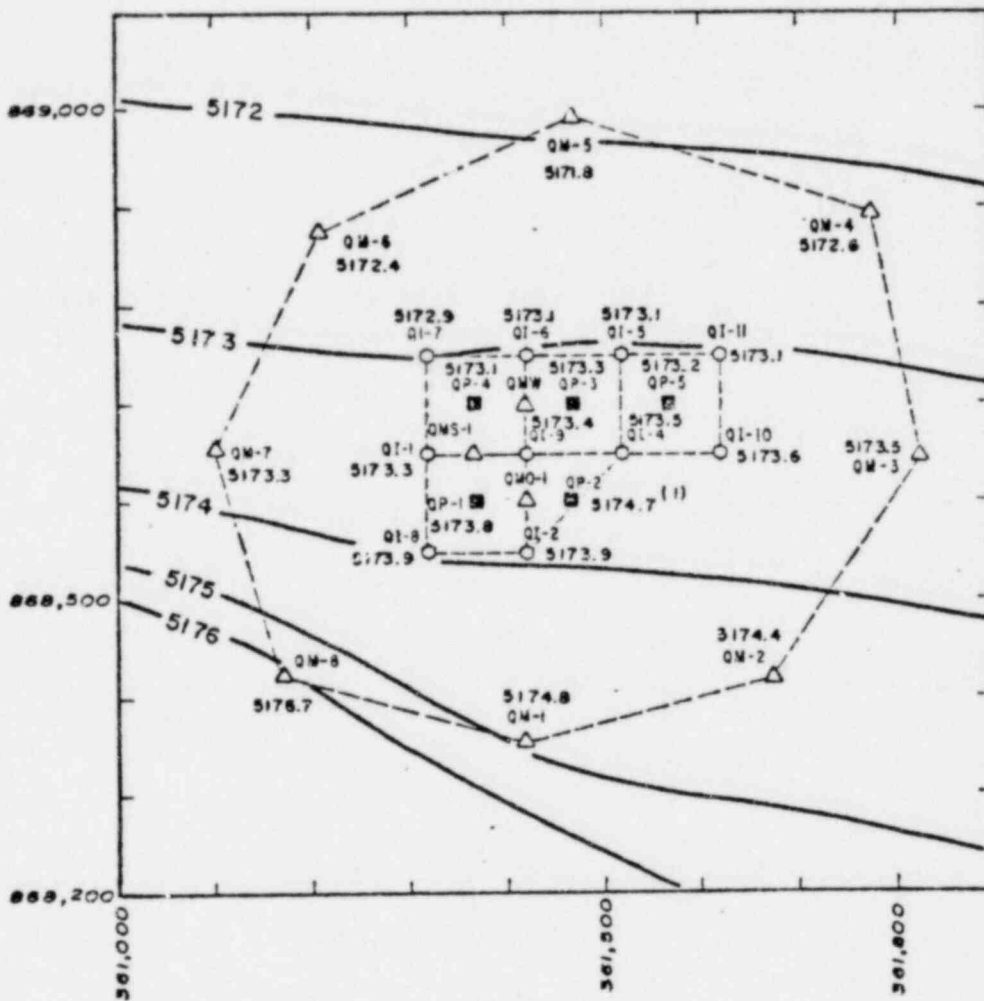
Kerr-McGee Well Number	Elevation at Top of casing (feet above MSL)	Depth of well (feet)	Water Level		Completion Internal (T.D. -up)
			Depth from Casing Top 9/11/80	MSL Elevation	
QP-1*	5549.65	497	375.80	5173.85	497'-475'
QP-2	5544.06	495	369.40	5174.66	495'-470'
QP-3	5557.24	512	383.97	5173.27	512'-480'
QP-4	5559.96	515	386.83	5173.13	515'-490'
QP-5	5552.11	517	378.88	5173.23	517'-465'
QI-1*	5556.17	509	382.86	5173.31	509'-492'
QI-2	5546.38	496	372.45	5173.93	496'-475'
QI-4	5548.68	513	375.22	5173.46	513'-475'
QI-5	5560.62	513	387.55	5173.07	513'-490'
QI-6	5565.42	520	392.35	5173.07	520'-495'
QI-7	5567.82	522	394.88	5172.94	522'-495'
QI-8	5553.52	503	379.59	5173.94	503'-480'
QI-9	5552.04	505	378.66	5173.38	505'-480'
QI-10	5543.38	514	369.80	5173.58	514'-465'
QI-11	5554.35	525	381.28	5173.07	525'-475'
QMW-1**	5558.71	350	188.48	5370.23	350'-170'
QMS-1**	5553.63	421	315.35	5235.28	421'-393'
QMO-1**	5545.47	612	579.34	4966.13	612'-558'
QM-1	5550.53	505	375.75	5174.78	505'-475'
QM-2	5535.80	505	361.35	5174.45	505'-460'
QM-3	5528.17	505	354.65	5173.52	505'-455'
QM-4	5550.72	539	378.10	5172.62	539'-475'
QM-5	5582.73	537	410.9	5171.83	537'-513'
QM-6	5562.61	520	390.16	5172.45	520'-495'
QM-7	5562.15	514	369.91	5173.34	514'-460'
QM-8	5556.75	508	360.08	5176.67	508'-494'

*6" I.D. steel casing, all other holes cased with 4.33 I.D. fiberglass

**Monitor well completed in another aquifer unit.

Well QMS-1 is completed in the Wasatch formation, all other wells are completed in the Fort Union formation.

"Q" SAND PIEZOMETRIC CONTOUR MAP
 "Q" SAND R & D PROJECT AREA
 SECTION 36-T36N, R74W
 CONVERSE COUNTY, WYOMING



LEGEND

- △ MONITOR WELL
- PRODUCTION WELL
- INJECTION WELL

— 5172—WATER LEVEL ELEVATION ABOVE MSL

(1) NOT USED FOR CONTROL, DATA POINT APPEARS TO BE OFF BY ONE FOOT.



SCALE 1" = 200'

OCT. 1980

INJECTION WELL CASING INTEGRITY TESTS
KERR-McGEE "Q" SAND PROJECT
CONVERSE COUNTY, WYOMING

NRC DOCKET NO. 40-8768

Casing integrity tests were conducted on the injection wells by setting an inflatable packer in the casing opposite the shale zone directly above the injection interval and pressuring the well casing to approximately 100 psi, the authorized injection pressure. The results of the tests were as follow:

<u>Well Designation</u>	<u>Initial Test Pressure PSIG</u>	<u>Pressure After 10 Min. PSIG</u>
QI-1	100	99
QI-2	101	101
QI-4	101	101
QI-5	93	93
QI-6	102	101
QI-7	100	99
QI-8	101	101
QI-9	100	99
QI-10	102	102
QI-11	100	98

All injection wells are cased with either steel or fiberglass casing.