ATTACHMENT 13

Alluvial Cross Sections Determined Using

Seismic Refraction Techniques

Explanation

Alluvium, undivided

Alluvium, saturated

Bedrock, undivided

Contact, dashed where inferred. Note: lower contact represents bedrock-alluvium contact; upper contact represents level of water table. All other contacts are described where shown.

6785.2
WELL 100R

Alluvial monitoring well, giving elevation of wellhead (feet above mean sea level) and well #. Dashed where casing is perforated.

25,697

Drill hole, giving Peabody log #.

Vertical Scale: 1 inch = 16.4-31 feet

Horizontal Scale: 1 inch = 82-153 feet

Elevation given in feet above mean sea level

Profile distance given in feet along line of section (vertical profile)

Line of Section given in degrees east or west of geographic north

Sources of data for cross-sections

Seismic Refraction Traverses

Alluvial Monitoring Well Lithologic Logs

USGS Topographic Maps

Aerial Photographs (black and white)

Drill hole and core hole data, PCC files

Hydrologic Data, 1985, Volume I, Black Mesa and Kayenta Mines, Peabody Coal Company, Arizona Division, pp. 38-39

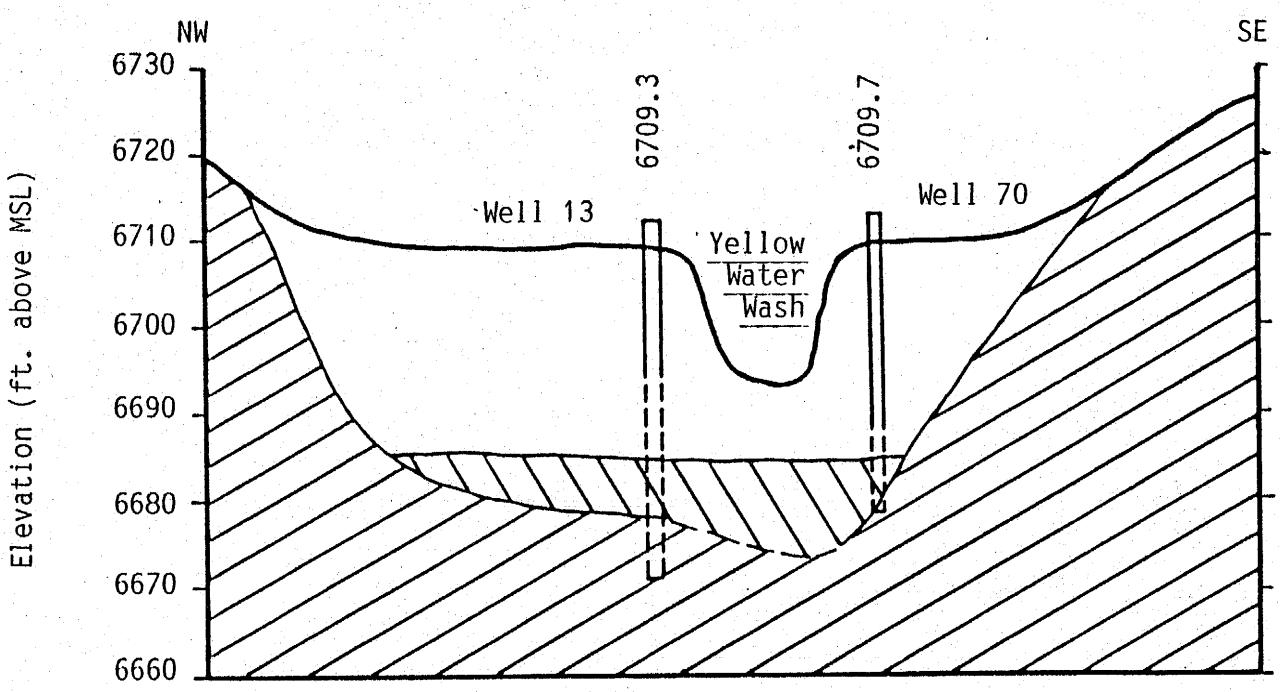
Wepo Aquifer Water Level Contour Map, Drawing 85610

Alluvial Aquifer Water Level Contour Map, Drawing 85620

Revised 12/01/86

Site: 70
Location: Upper Yellow Water Wash
Line of Section: N38W

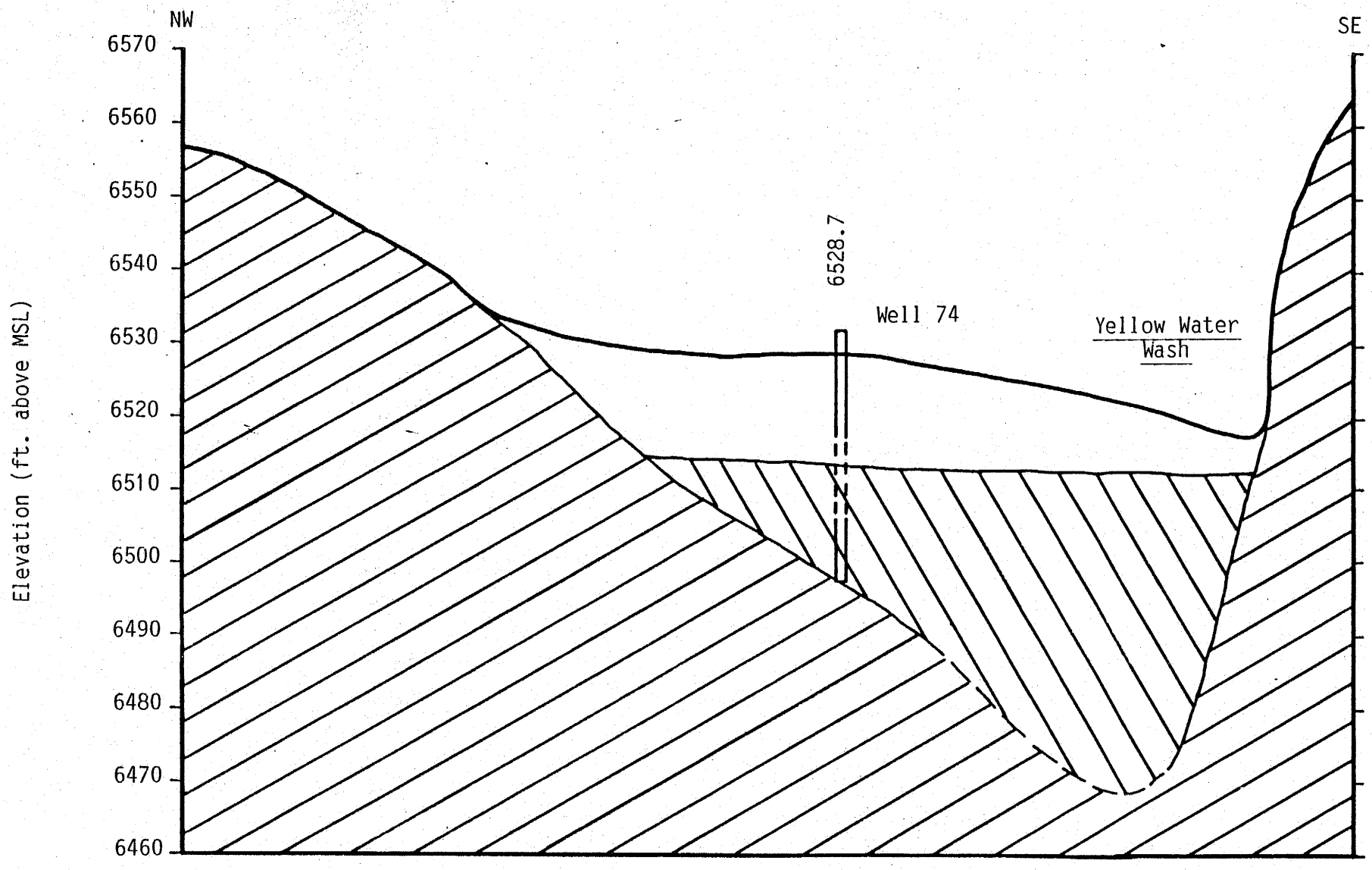
Vertical Scale 1" = 22'
Horizontal Scale 1" = 110'



Revised 12/01/86

Site: 74
Location: Lower Yellow Water Wash
Line of Section: N58W

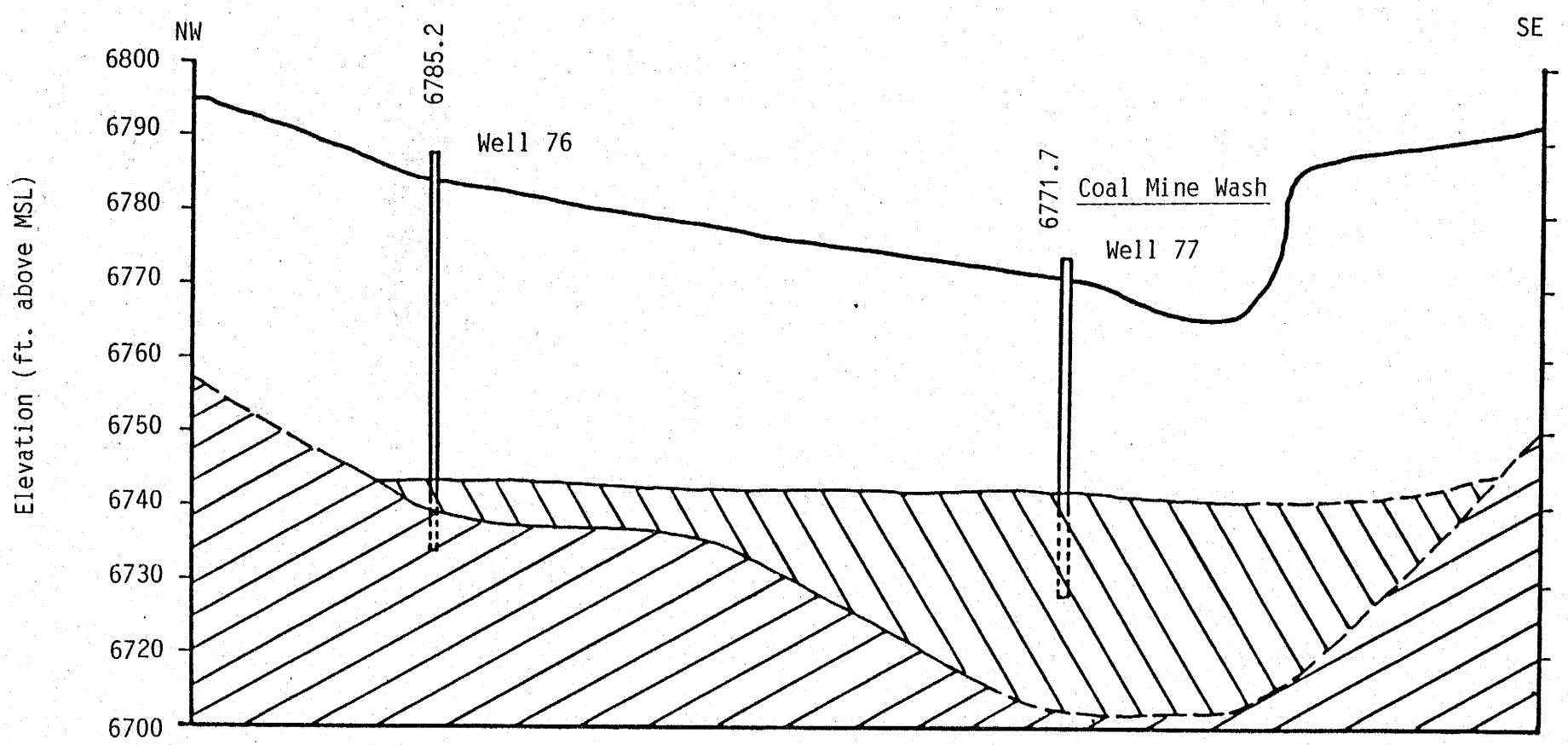
Vertical Scale 1" = 20'
Horizontal Scale 1" = 100'



Revised 12/01/86

Site: 77
Location: Upper Coal Mine Wash
Line of Section: N42W

Vertical Scale 1" = 24.7'
Horizontal Scale 1" = 110'



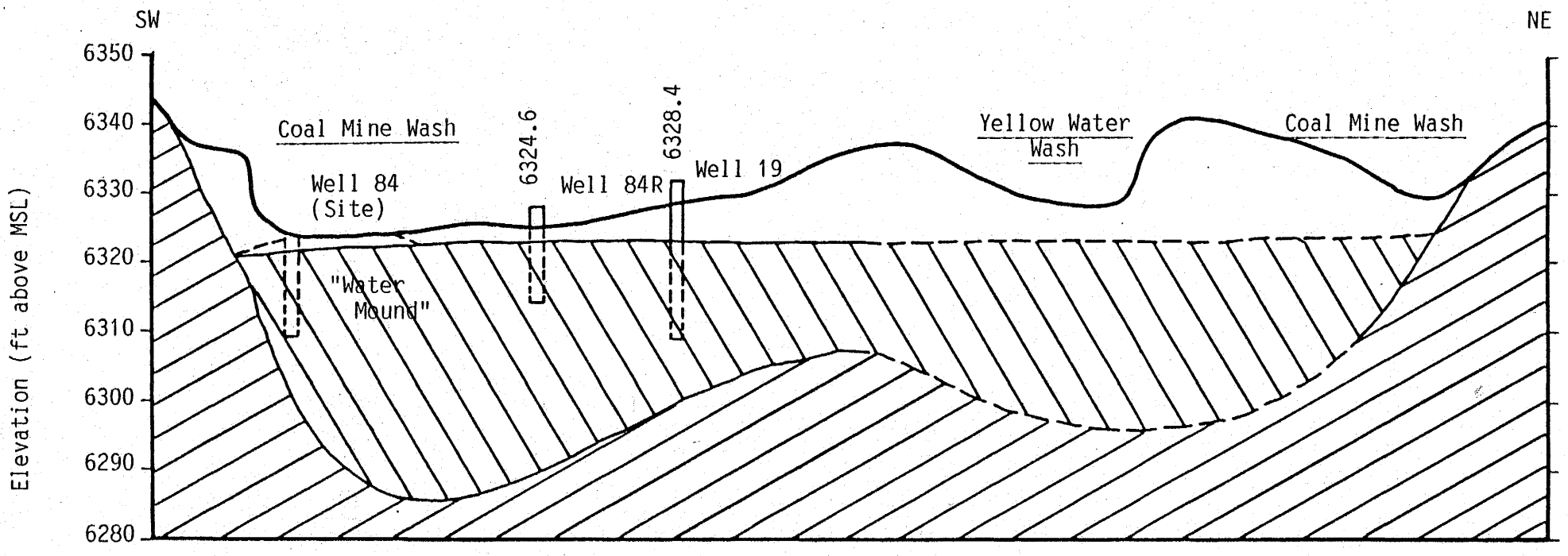
Revised 12/01/86

Site: 84R
Location: Lower Coal Mine Wash
Line of Section: N32E

Vertical Scale 1" = 22'
Horizontal Scale 1" = 110'

Notes:

1. Well 84 washed away by flood of 7/29/84.
2. Well 84R located approximately 15 ft. west of profile.



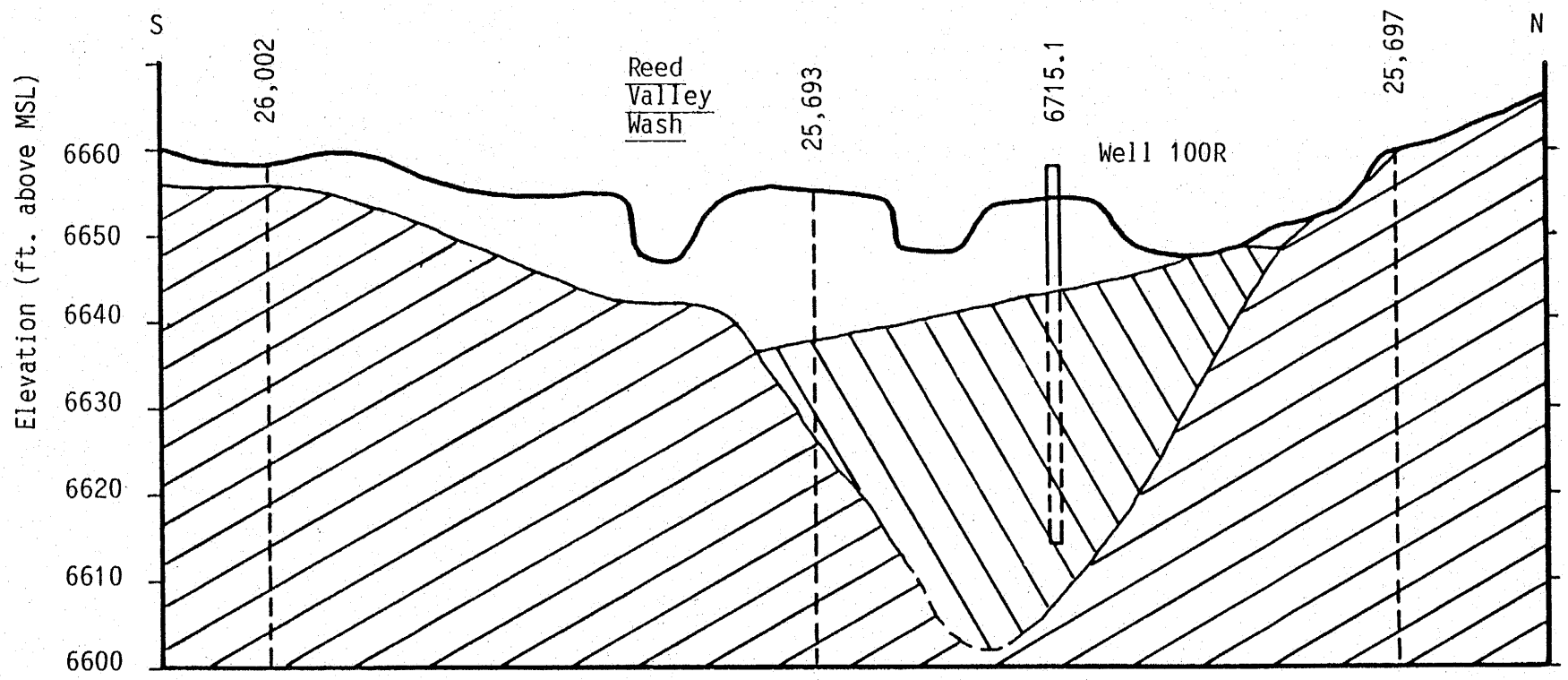
Revised 12/01/86

Site: 100R
Location: Middle Reed Valley Wash
Line of Section: N-S

Vertical Scale 1" = 20'
Horizontal Scale 1" =100'

Notes:

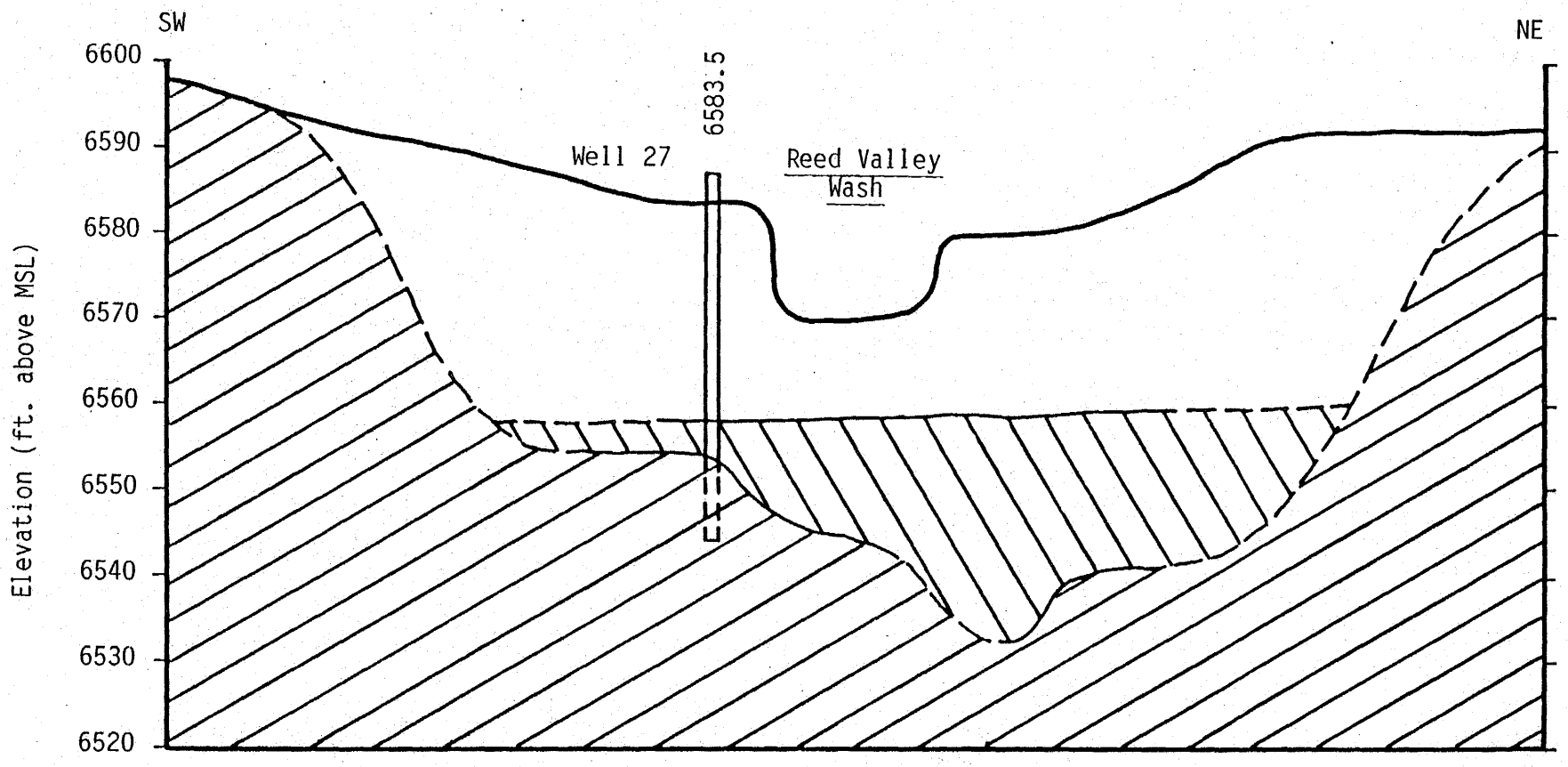
1. Drill Hole #26,002 is located 10 ft. east of section.
2. Drill Hole #25,693 is located 40 ft. east of section.
3. Drill Hole #25,694 is located 10 ft. west of section.



Revised 12/01/86

Site: 27
Location: Lower Reed Valley Wash
Line of Section: N70E

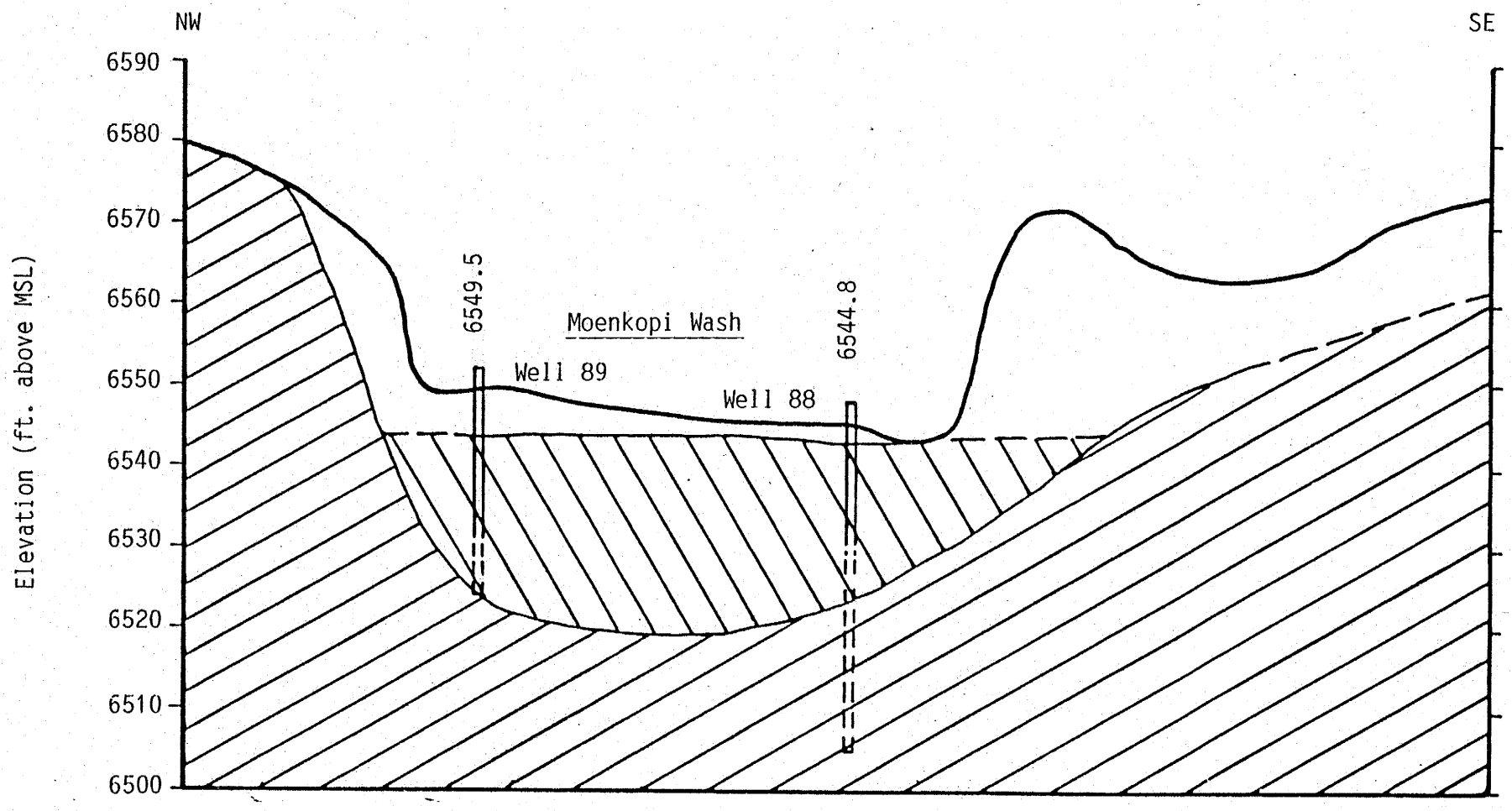
Vertical Scale 1" = 20'
Horizontal Scale 1" = 100'



Revised 12/01/86

Site: 88
Location: Middle Moenkopi Wash
Line of Section: N35W

Vertical Scale 1" = 20'
Horizontal Scale 1" =100'

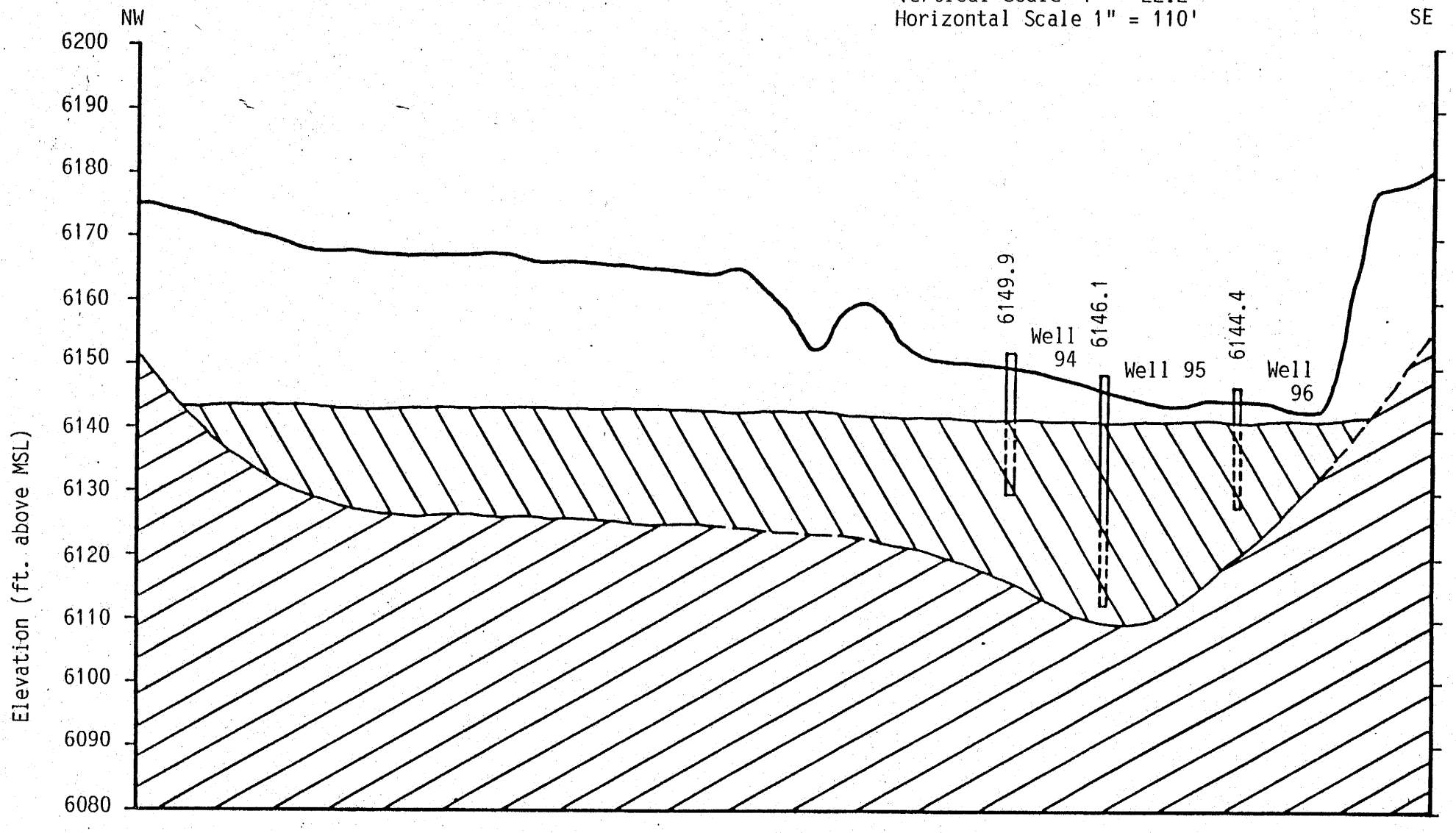


Revised 12/01/86

Site: 95
Location: Lower Moenkopi Wash
Line of Section: N57W

Note:
Well 95 is located approximately 4 ft. south of cross section.

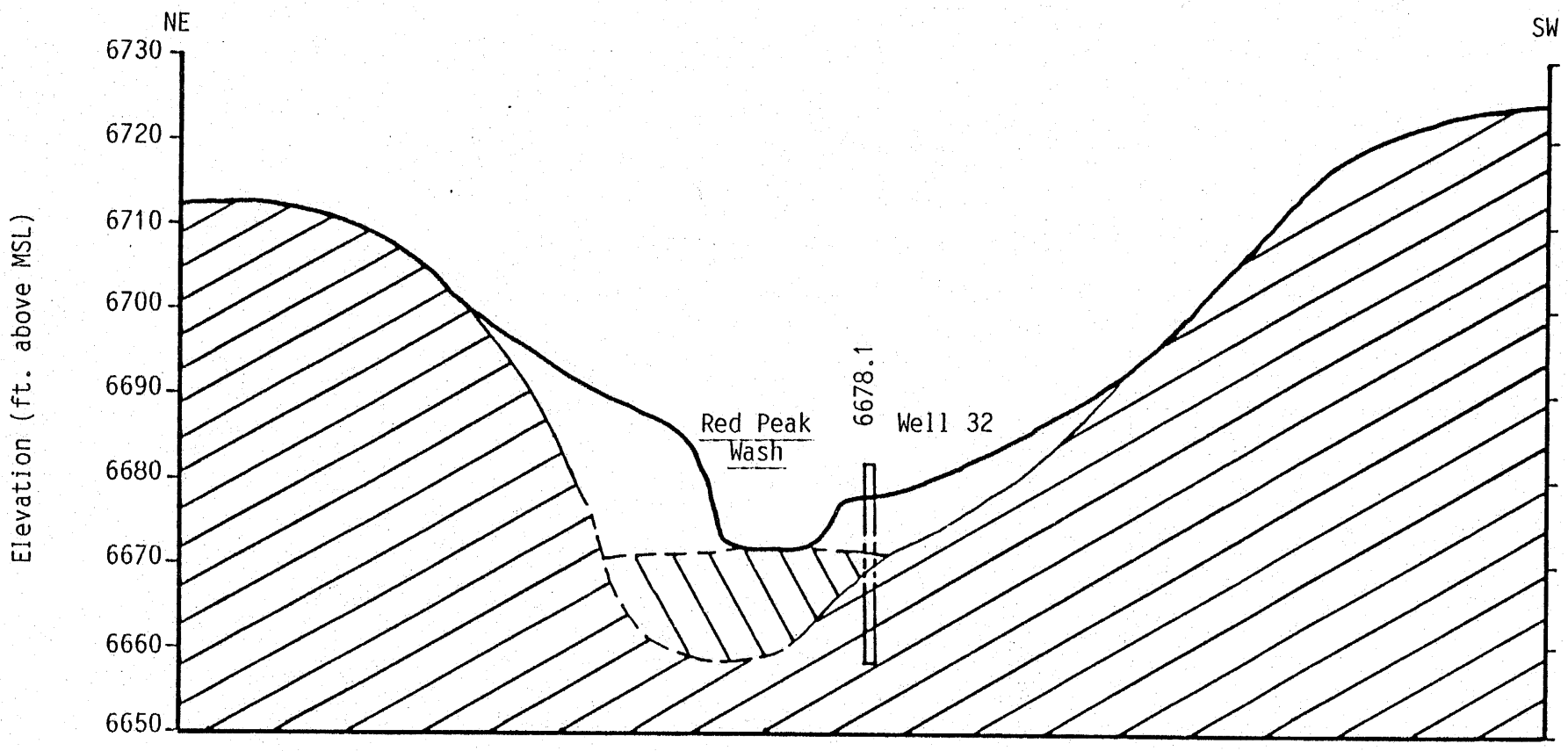
Vertical Scale 1" = 22.2'
Horizontal Scale 1" = 110'



Revised 12/01/86

Site: 32
Location: Upper Red Peak Wash
Line of Section: N12E

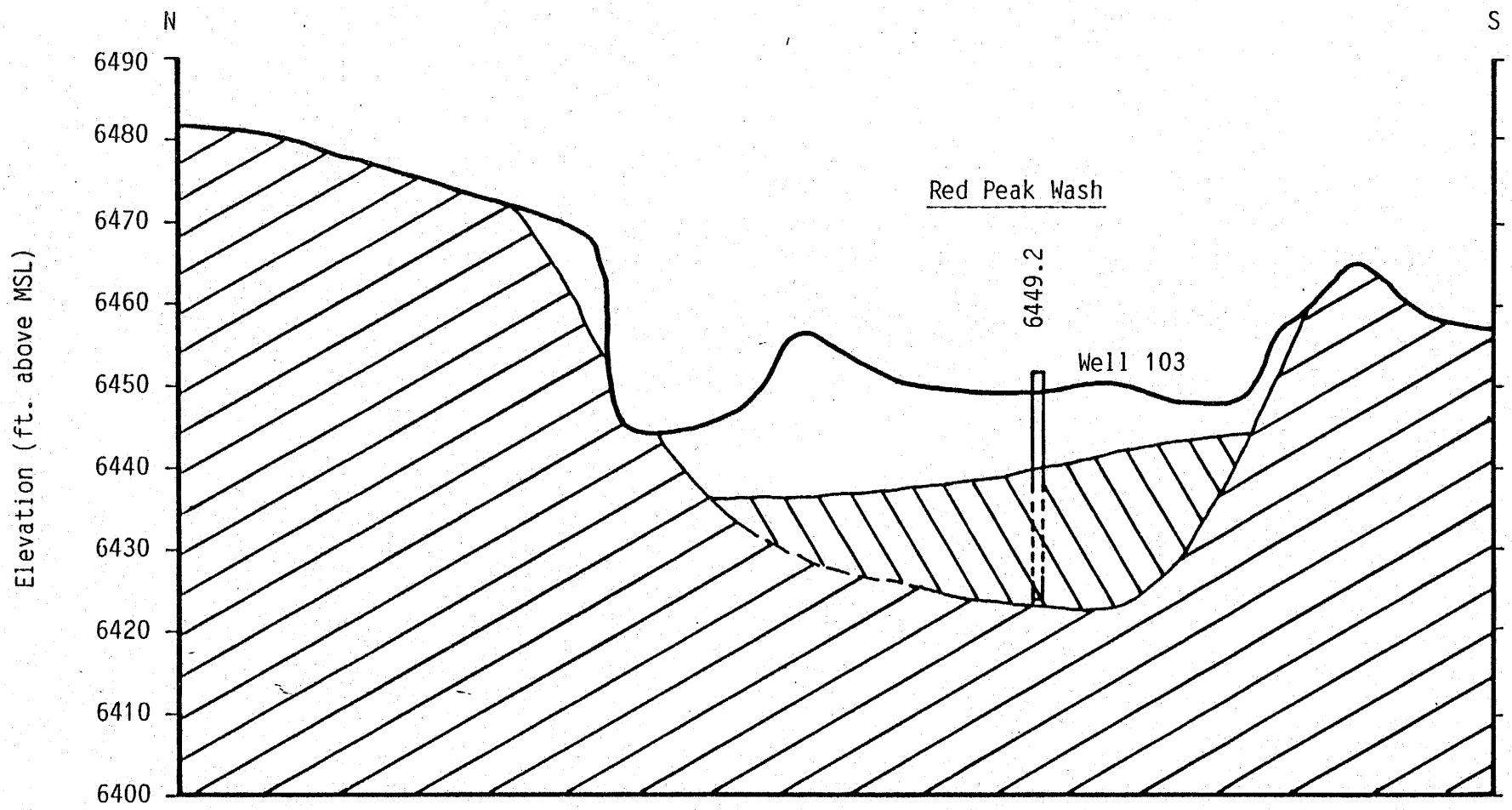
Vertical Scale 1" = 20'
Horizontal Scale 1" = 98.8'



Revised 12/01/86

Site: 103
Location: Middle Red Peak Wash
Line of Section: N4W

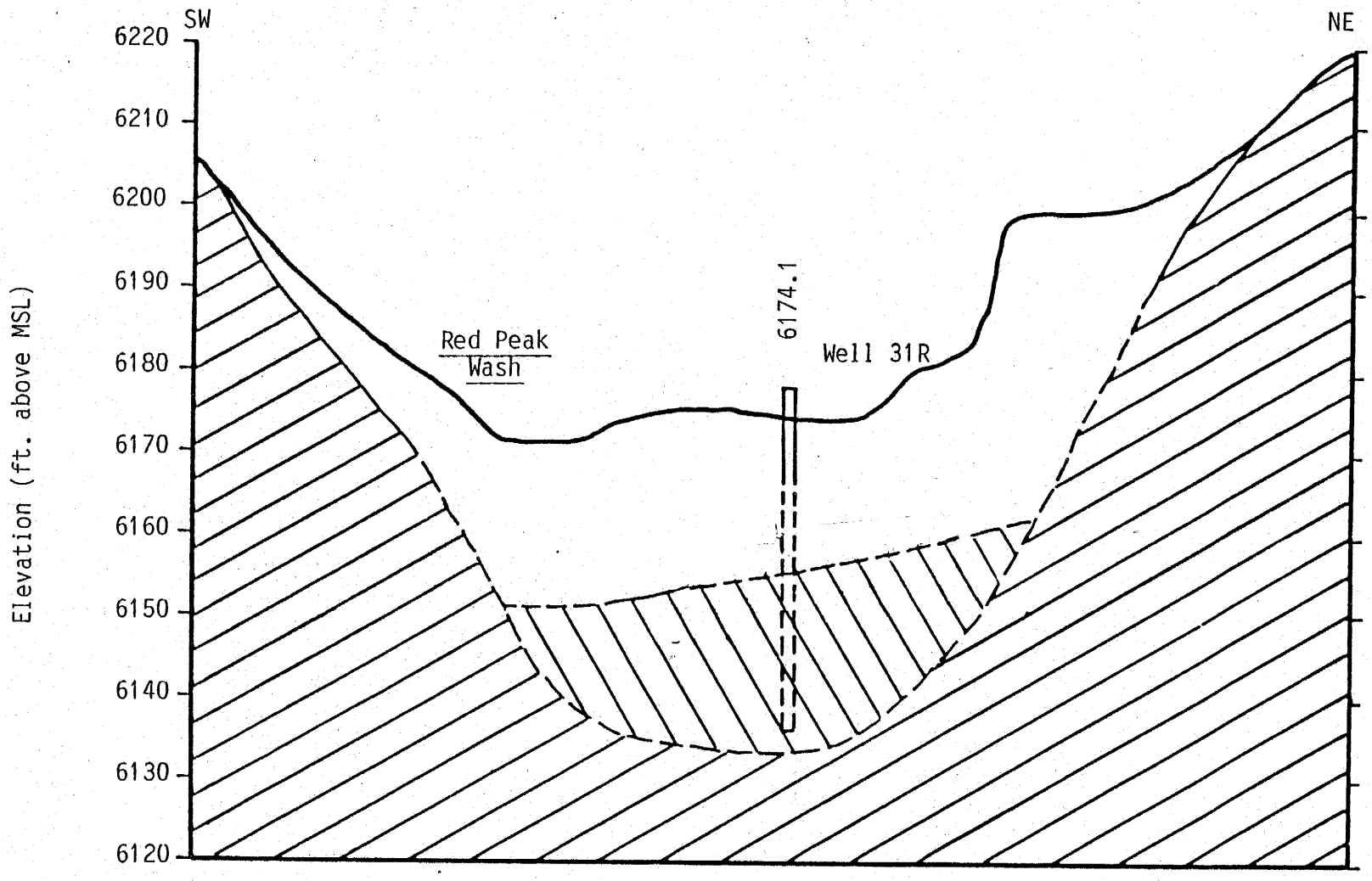
Vertical Scale 1" = 20'
Horizontal Scale 1" = 87.5'



Revised 12/01/86

Site: 31R
Location: Lower Red Peak Wash
Line of Section: N33E

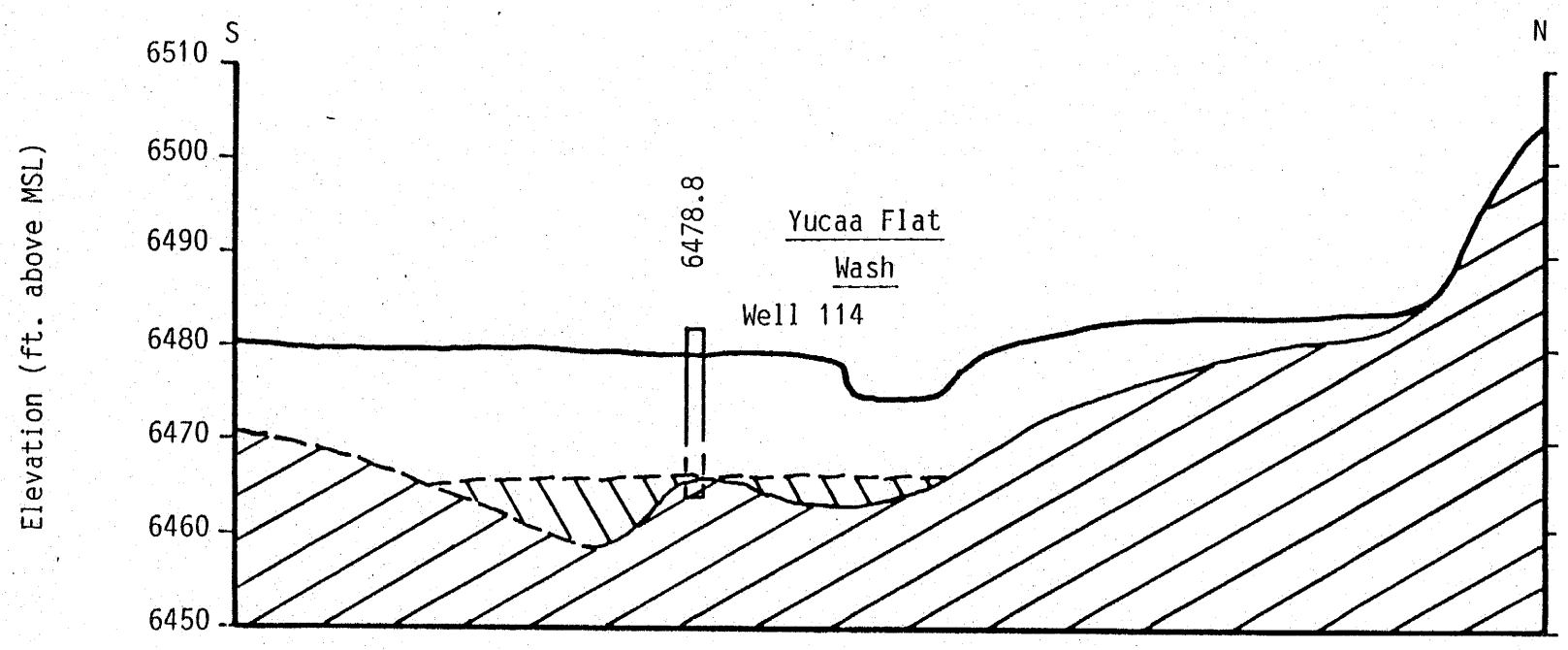
Vertical Scale 1" = 20'
Horizontal Scale 1" = 98.6'



Revised 12/01/86

Site: 114
Location: Upper Yucca Flat Wash
Line of Section: N8E

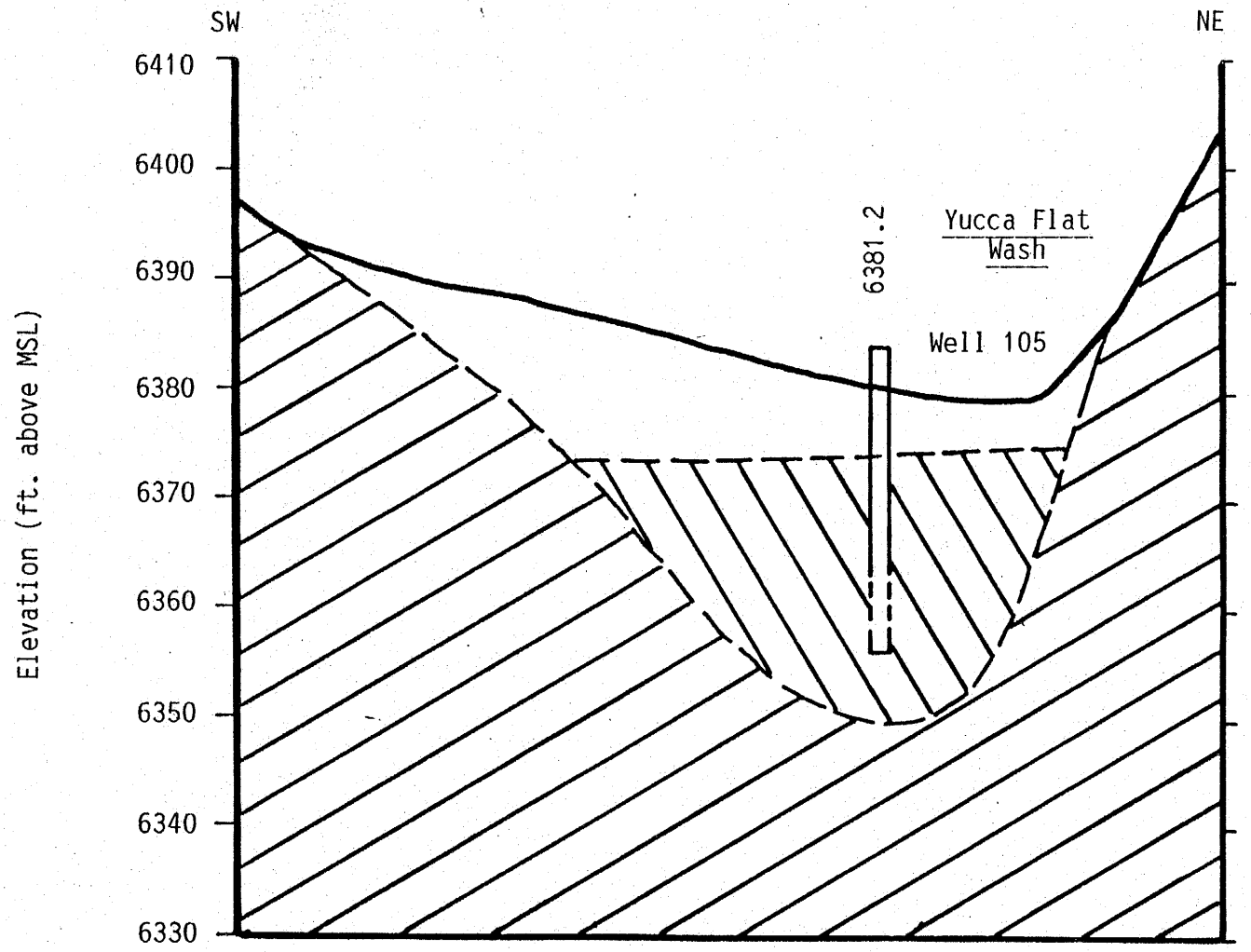
Vertical Scale 1" = 20'
Horizontal Scale 1" = 100'



Revised 12/01/86

Site: 105
Location: Middle Yucca Flat Wash
Line of Section: N52E

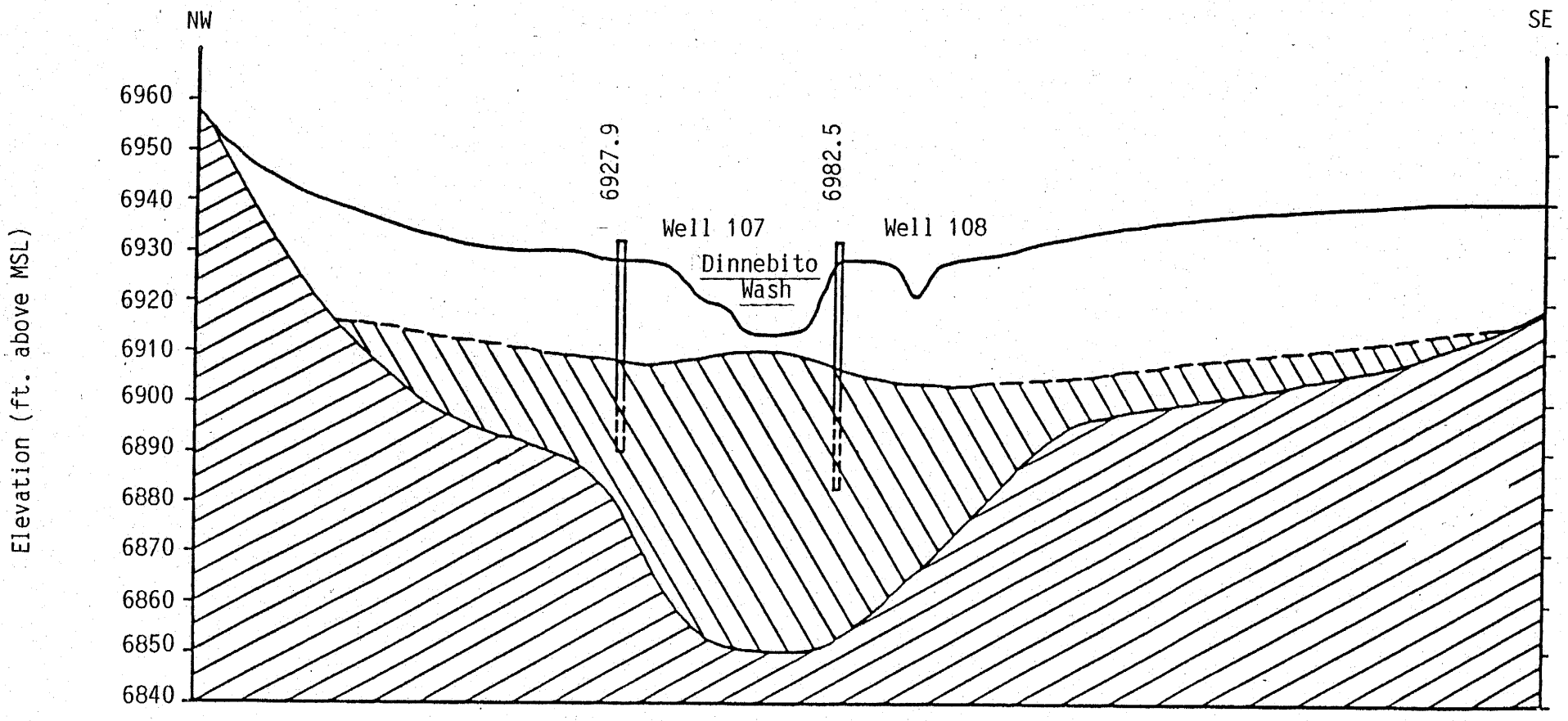
Vertical Scale 1" = 16.4'
Horizontal Scale 1" = 82'



Revised 12/01/86

Site: 107
Location: Upper Dinnebito Wash
Line of Section: N43W

Vertical Scale 1" = 31'
Horizontal Scale 1" = 153'



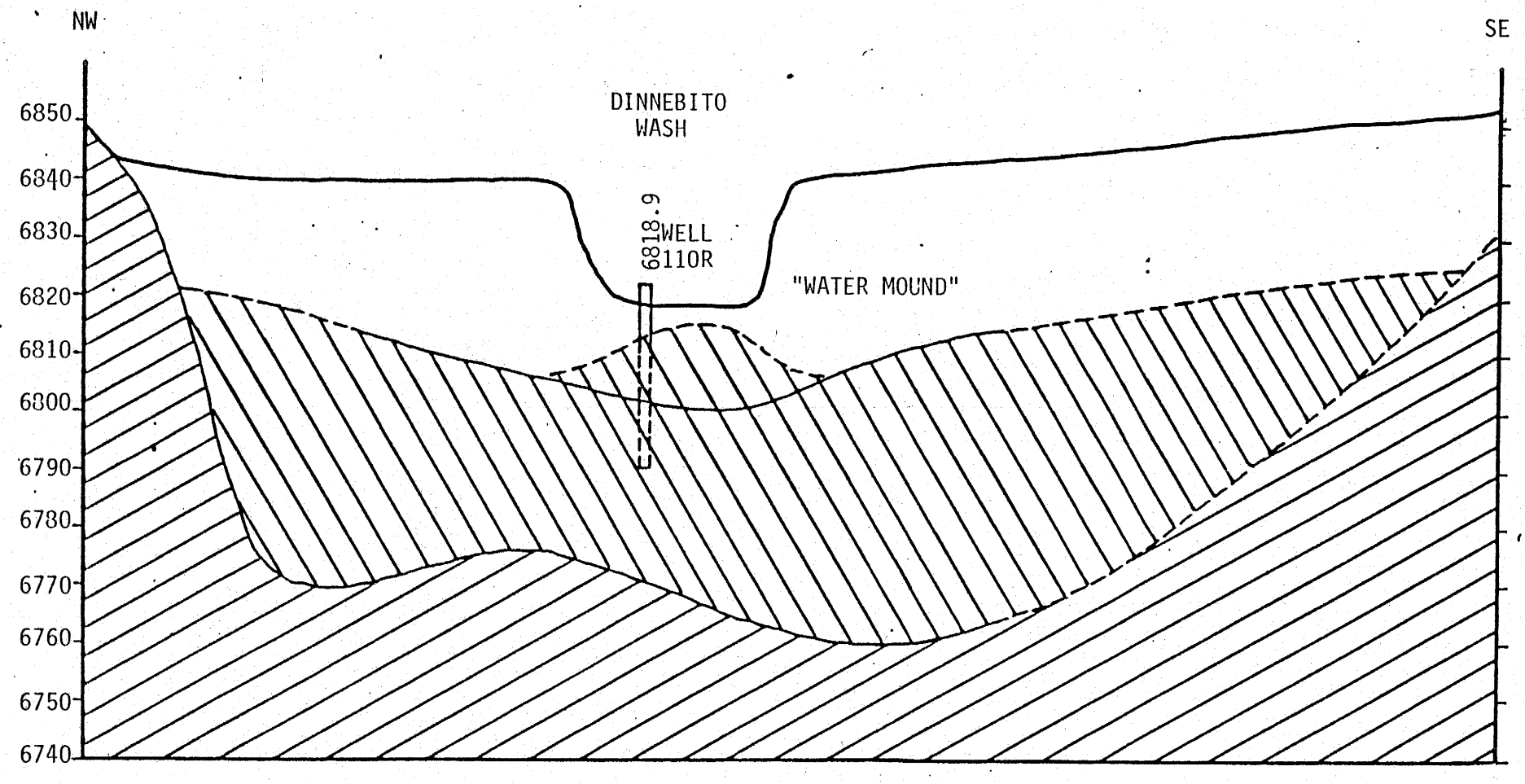
Revised 12/01/86

SITE: 110R

LOCATION: LOWER DINNEBITO WASH

LINE OF SECTION: N60W

Vertical Scale 1" = 27'
Horizontal Scale 1" = 133'



Revised 12/01/86

ATTACHMENT 14

Alluvial Aquifer Test Data and Results

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 36 N. S., R. 18 E. W., Sec. 11 WELL NO. 17

Personnel Smith & Freund Driller Sergent, Hauskins & Beckwith

Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specify) slug injection

Total Well Depth 16.6 ft. Well diameter 6½ in. Casing diameter 2 in.

Casing type PVC Type of screen or perforation saw s:pt

Interval of screen or perforation 2'6" to 12'6" Pump hp. & type

Pump depth ____ ft. Aquifer alluvial Aquifer lithology alluvial material

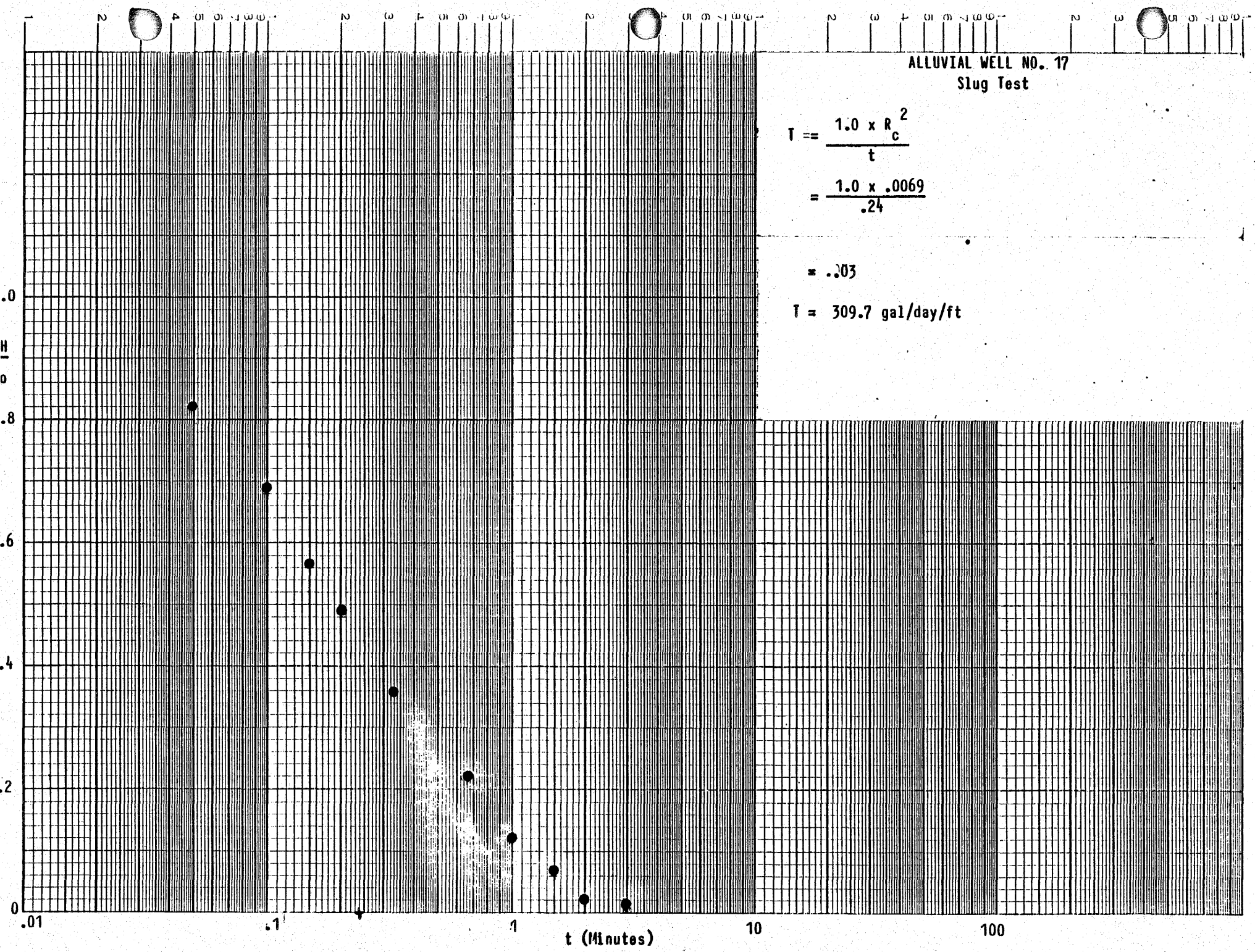
Altitude of land surface ____ How determined surveyed

MP Above Below LSD ____ Altitude MP ____

SWL from MP ____ How measured ____

Static Transducer Reading =-2.97

DATE	TIME (MINS)	TRANSDUCER READINGS	Ho (ft)	H/Ho
9-14-85	0	-1.29	1.68	1.00
	.05	-1.60		.82
	.10	-1.81		.69
	.15	-2.01		.57
	.20	-2.14		.49
	.33	-2.37		.36
	.67	-2.60		.22
	1.0	-2.77		.12
	1.5	-2.86		.07
	2.0	-2.93		.02
	3.0	-2.94		.01



ALLUVIAL WELL NO. 17
Slug Test

$$T = \frac{1.0 \times R_c^2}{t}$$

$$= \frac{1.0 \times .0069}{.24}$$

$$= .03$$

T = 309.7 gal/day/ft

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 36 N. S., R. 19 E. W., Sec. 32 WELL NO. 27

Personnel Smith & Freund Driller Sergent, Hauskins & Beckwith

Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specify) slug injection

Total Well Depth 40 ft. Well diameter 6½ in. Casing diameter 2 in.

Casing type PVC Type of screen or perforation saw slot

Interval of screen or perforation 32' to 39' Pump hp. & type

Pump depth ft. Aquifer alluvial Aquifer lithology alluvial material

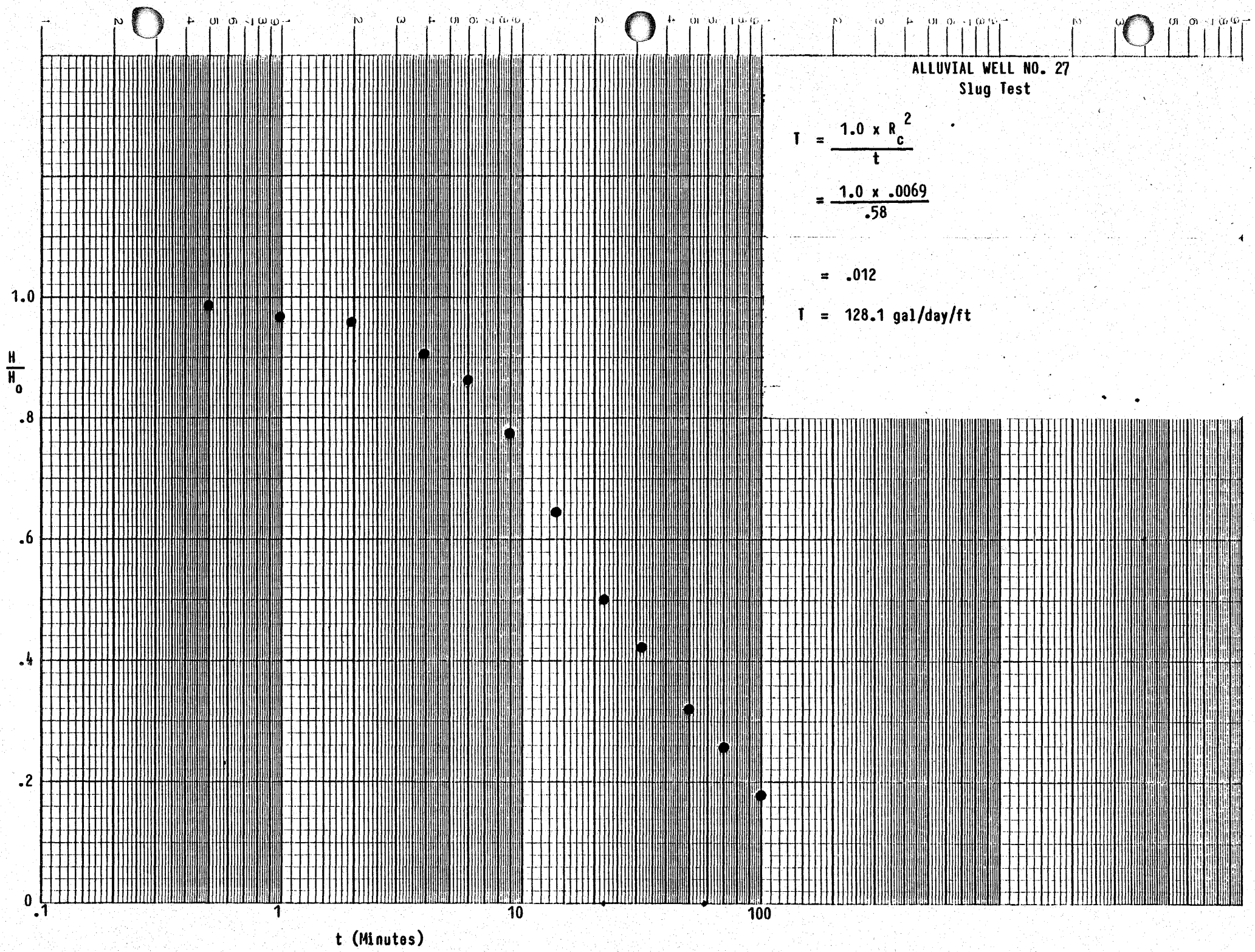
Altitude of land surface How determined surveyed

MP Above Below LSD Altitude MP

SWL from MP How measured

Static Transducer Reading = 1.12

DATE	TIME (MINS)	TRANSDUCER READINGS	Ho (ft)	H/Ho
9-6-85	0	4.61	3.49	1.0
	.5	4.57		.99
	1.0	4.53		.97
	2.0	4.46		.96
	4.0	4.30		.91
	6.0	4.12		.86
	9.0	3.80		.77
	14.0	3.34		.64
	22.0	2.88		.50
	32.0	2.57		.42
	50.0	2.23		.32
	70.0	2.01		.26
	100.0	1.75		.18


ALLUVIAL WELL NO. 27
Slug Test
T = 1.0 x R_c^2 / t
= 1.0 x .0069 / .58
= .012
T = 128.1 gal/day/ft
H/H_o
1.0
.8
.6
.4
.2
0
.1
1
10
100
t (Minutes)

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 35 N. S., R. 18 E. W., Sec. 20 WELL NO. 31R

Personnel Smith & Freund Driller Sergent, Hauskins & Beckwith

Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specify) slug injection

Total Well Depth 38 ft. Well diameter 12 in. Casing diameter 3 in.

Casing type PVC Type of screen or perforation saw slot

Interval of screen or perforation 8' to 38' Pump hp. & type

Pump depth ft. Aquifer Alluvial Aquifer lithology Alluvial Material

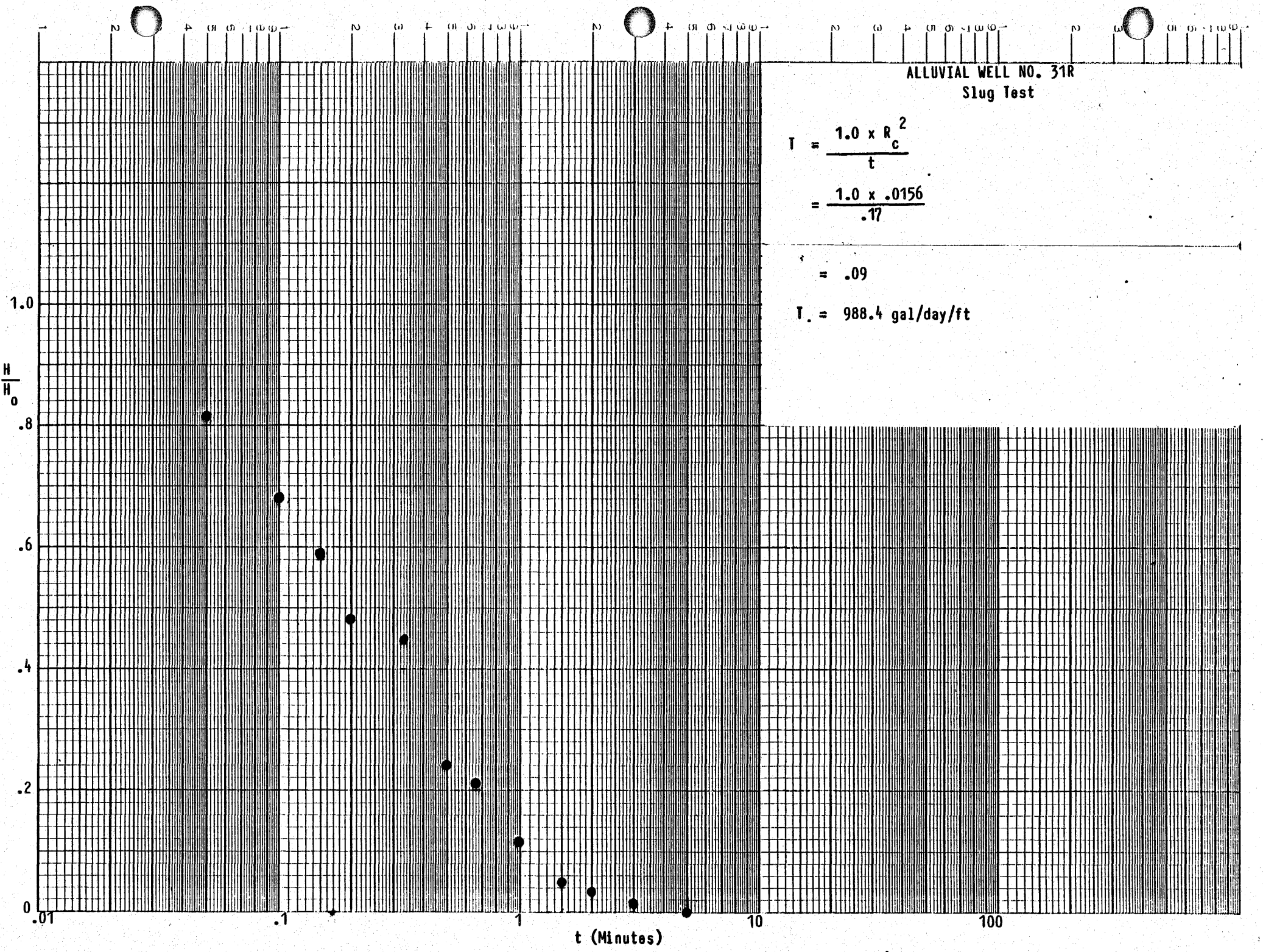
Altitude of land surface How determined surveyed

MP Above Below LSD Altitude MP

SWL from MP How measured

Static Transducer Reading = 11.43

DATE	TIME (MINS)	TRANSDUCER READINGS	Ho (ft)	H/Ho
9-14-85	0	13.70	2.27	1.00
	.05	13.28		.81
	.10	12.98		.68
	.15	12.77		.59
	.20	12.61		.48
	.33	12.45		.45
	.50	11.97		.24
	.67	11.90		.21
	1.0	11.69		.11
	1.5	11.55		.05
	2.0	11.50		.03
	3.0	11.46		.013
	5.0	11.43		.000


ALLUVIAL WELL NO. 31R
Slug Test
$T = \frac{1.0 \times R_c^2}{t}$
$= \frac{1.0 \times .0156}{.17}$
$= .09$
T = 988.4 gal/day/ft
$\frac{H}{H_o}$
1.0
.8
.6
.4
.2
0
.01
.1
1
10
100
t (Minutes)

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 37 N. S., R. 18 E. W., Sec. 34 WELL NO. 69

Personnel Smith & Freund Driller Sergent, Hauskins & Beckwith

Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specify) slug injection

Total Well Depth 20 ft. Well diameter 6½ in. Casing diameter 2 in.

Casing type PVC Type of screen or perforation saw slot

Interval of screen or perforation 7' to 17' Pump hp. & type

Pump depth ft. Aquifer alluvial Aquifer lithology alluvial material

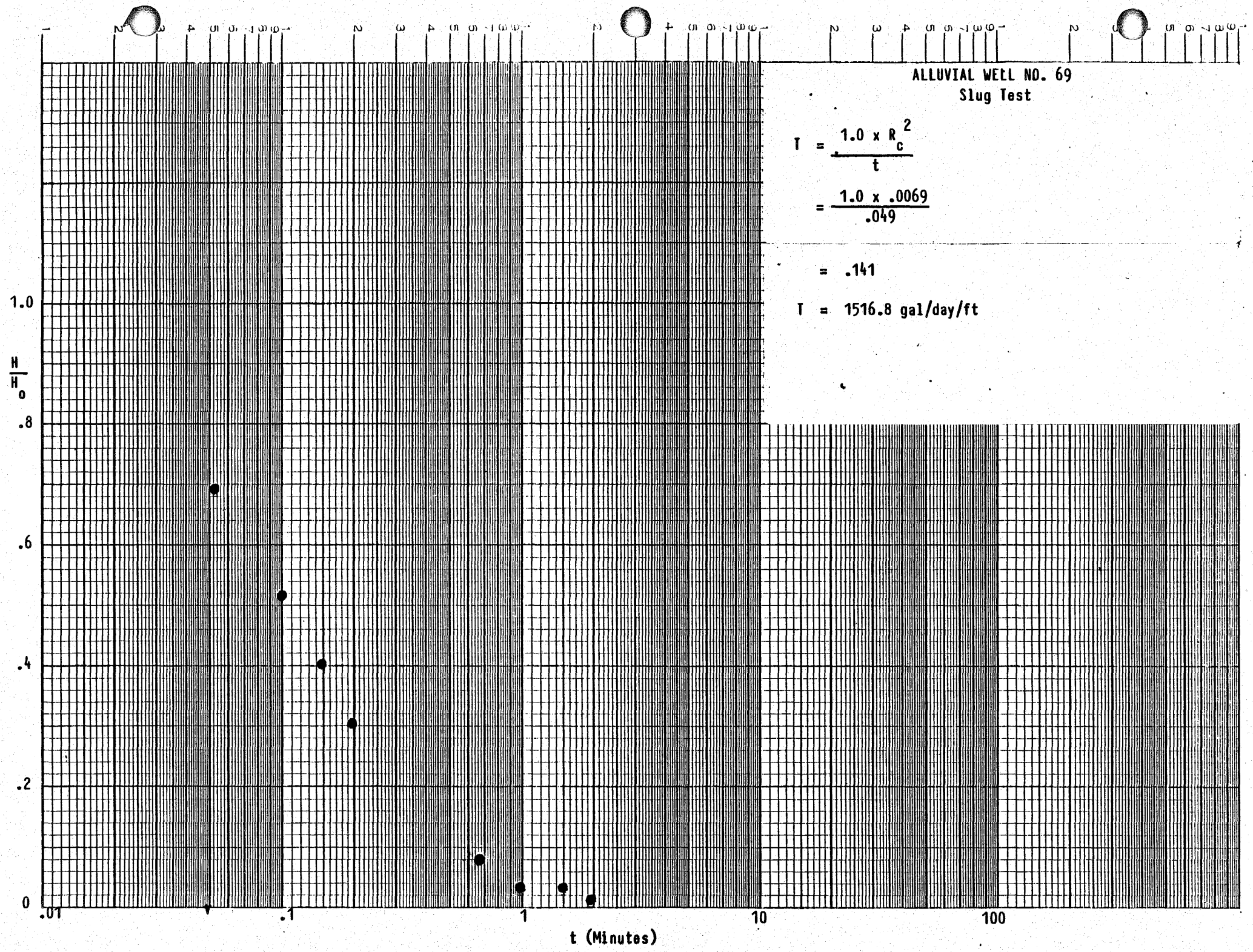
Altitude of land surface How determined surveyed

MP Above Below LSD Altitude MP

SWL from MP How measured

Static Transducer Reading = -3.22

DATE	TIME (MINS)	TRANSDUCER READINGS	Ho (ft)	H/Ho
9-26-85	0	-2.45	.77	1.0
	.05	-2.69		.69
	.10	-2.83		.51
	.15	-2.91		.40
	.20	-2.99		.30
	.67	-3.16		.08
	1.0	-3.20		.03
	1.5	-3.20		.03
	2.0	-3.21		.01


ALLUVIAL WELL NO. 69
Slug Test
T = 1.0 x R_c^2 / t
= 1.0 x .0069 / .049
= .141
T = 1516.8 gal/day/ft
H/H_o
1.0
.8
.6
.4
.2
0
.01
.1
1
10
100
t (Minutes)

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 36 N. S., R. 18 E. W., Sec. 8 WELL NO. 72

Personnel Smith & Freund Driller Sergent, Hauskins & Beckwith

Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specify) Slug Injection

Total Well Depth 25 ft. Well diameter 6 1/2 in. Casing diameter 2 in.

Casing type PVC Type of screen or perforation Saw Slot

Interval of screen or perforation 14' to 24' Pump hp. & type

Pump depth ft. Aquifer Alluvial Aquifer lithology Alluvial Material

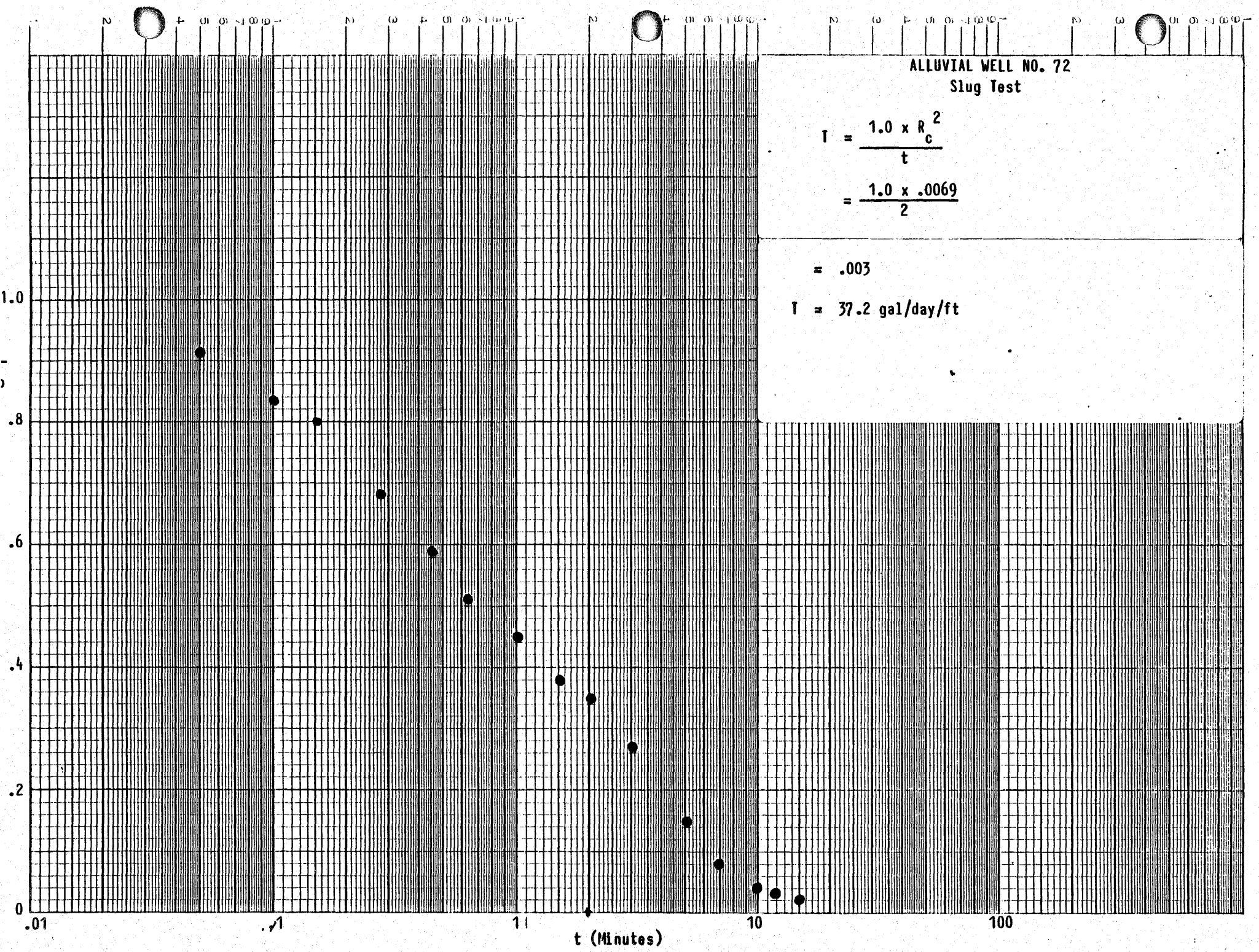
Altitude of land surface How determined Surveyed

MP Above Below LSD Altitude MP

SWL from MP How measured

Static Transducer Reading = -4.83

DATE	TIME (MINS)	TRANSDUCER READINGS	Ho (ft)	H/Ho
9/14/85	0	-3.11	1.72	1.00
	.05	-3.27		.91
	.1	-3.40		.83
	.15	-3.46		.80
	.28	-3.66		.68
	.45	-3.82		.59
	.62	-3.95		.51
	1.00	-4.05		.45
	1.5	-4.18		.38
	2.0	-4.23		.35
	3.0	-4.37		.27
	5.0	-4.58		.15
	7.0	-4.69		.08
	10.0	-4.76		.04
	12.0	-4.78		.03
	15.0	-4.80		.02


ALLUVIAL WELL NO. 72
Slug Test
$T = \frac{1.0 \times R_c^2}{t}$
$= \frac{1.0 \times .0069}{2}$
= .003
T = 37.2 gal/day/ft
1.0
.8
.6
.4
.2
0
.01
.1
1
10
100
t (Minutes)

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 36 N. S., R. 18 E. W., Sec. 8 WELL NO. 75

Personnel Cochran, Dee Driller Sergent, Hauskins, & Beckwith

Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specify) Drawdown in an excavated pit

Total well depth 28 ft. Well diameter 12 in. Casing diameter 4 in.

Casing type pvc Type of screen or perforation saw slots

Interval of screen or perforation 18-28 Pump hp. & type 1/3 hp. Fairbanks Morse

Pump depth 3 ft. Aquifer Alluvium Aquifer lithology gravel, sand, silt & clay

Altitude of land surface 6565 How determined surveyed

MP Above/Below LSD Altitude MP

SWL from MP 1.62 How measured calibrated staff gage

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
7-27-82	8:05	pump on	0			
	8:06	.02	1.0			
	8:06:30	.03	1.5			
	8:07	.04	2.0			
	8:08	.05	3.0			
	8:08:30	.06	3.5			
	8:09	.07	4.0			
	8:09:30	.08	4.5			
	8:10	.09	5.0			
	8:11	.09	6.0			
	8:12	.10	7.0			
	8:13	.11	8.0			
	8:14:30	.12	9.5			
	8:15	.12	10.0			
	8:15:30	.13	10.5			
	8:16:30	.14	11.5			
	8:17:30	.15	12.5			
	8:19	.16	14.0			
	8:20:30	.17	15.5			
	8:22	.18	17			
	8:23	.19	18			
	8:24:30	.20	19.5			
	8:26	.21	21			
	8:27:30	.22	22.5			
	8:30	.23	25.0			
	8:33	.24	28.0			
	8:36	.25	31.0			
	8:39	.26	34.0			

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 36 (N) S., R. 18 (E) W., Sec. 8 WELL NO. 75

Personnel Cochran, Dee Driller Sergent, Hauskins & Beckwith

Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well (5.) Other (specify) Drawdown in an excavated pit

Total well depth 28 ft. Well diameter 12 in. Casing diameter 4 in.

Casing type pvc Type of screen or perforation saw slots

Interval of screen or perforation 18-28 Pump hp. & type 1/3 hp. Fairbanks Morse

Pump depth 3 ft. Aquifer Alluvium Aquifer lithology gravel, sand, silt & clay

Altitude of land surface 6565 How determined surveyed

MP Above/Below LSD Altitude MP

SWL from MP 1.62 How measured calibrated staff gage

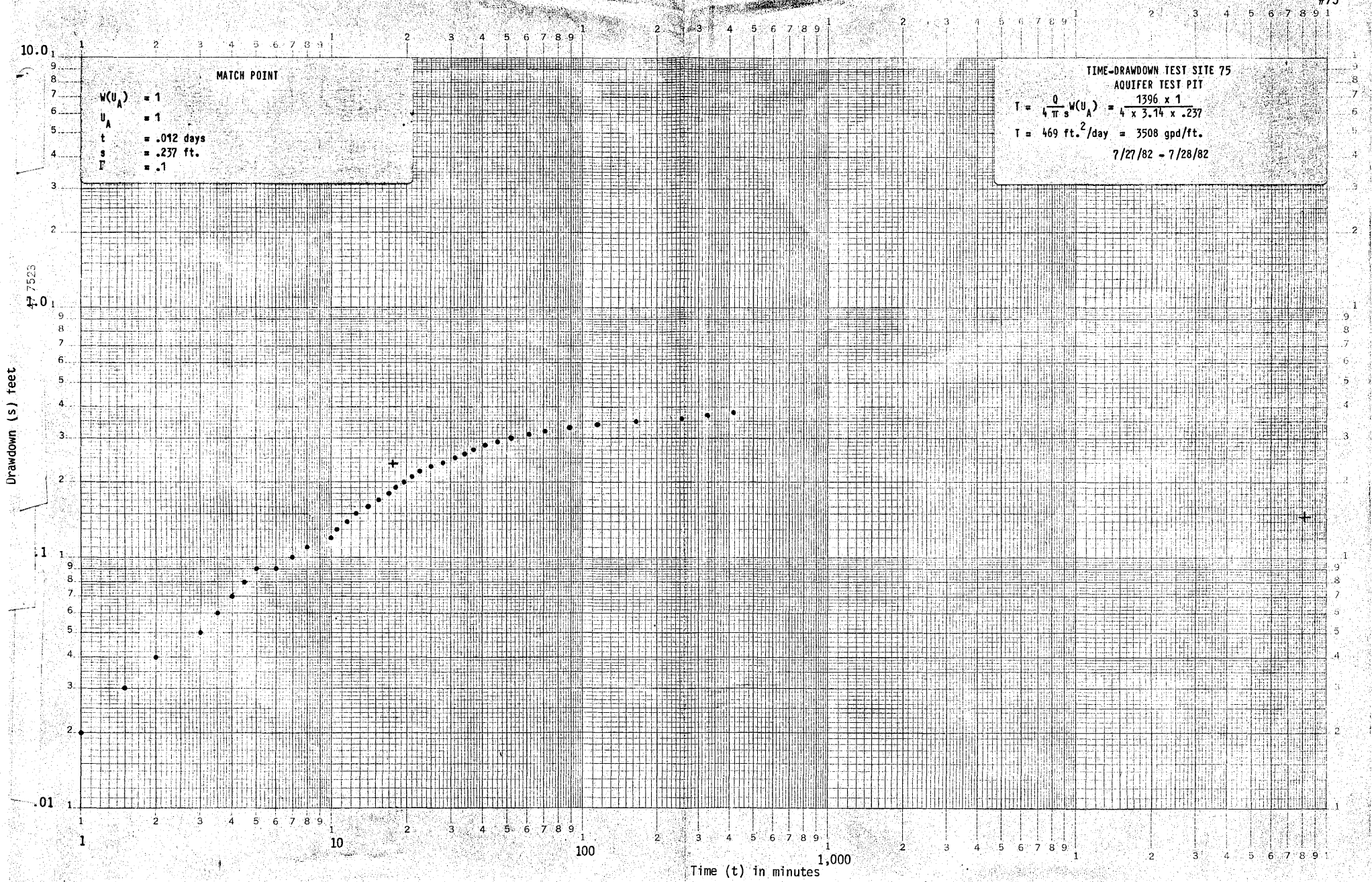
DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
7-27-82	8:42	.27	37.0			
	8:46	.28	41.0			
	8:51	.29	46.0			
	8:57	.30	52.0			
	9:07	.31	62.0			
	9:17	.32	72.0			
	9:35	.33	90.0			
	10:00	.34	115.0			
	10:51	.35	166.0			
7-28-82	12:21	.36	256.0			
	1:31	.37	326.0			
	3:00	.38	415.0			
	3:00	pump off				

WATER WELL 75

PUMPING RATE DATA

DATE	TIME TEST TAKEN	TEST DURATION SEC.	TEST DURATIONS PER MIN.	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
7/27/82	8:05	pump on				
	8:08	29.3		3.0	.0096	.0590
	8:10	23.7		3.0	.0060	.0456
	8:13	23.7		3.0	.0060	.0456
	8:15	23.8		3.0	.0084	.0635
	8:20	23.8		3.0	.0120	.0907
	8:25	23.8		3.0	.0120	.0907
	8:30	23.7		3.0	.0120	.0911
	8:35	23.8		3.0	.0180	.1361
	8:45	23.6		3.0	.0241	.1838
	8:55	23.8		3.0	.0180	.1361
	9:00	23.7		3.0	.0180	.1368
	9:10	23.9		3.0	.0241	.1815
	9:20	23.2		3.0	.0241	.1869
	9:30	23.1		3.0	.0241	.1878
	9:40	23.6		3.0	.0241	.1838
	9:50	23.8		3.0	.0241	.1823
	10:00	23.8		3.0	.0241	.1823
	10:10	23.5		3.0	.0241	.1846
	10:20	23.9		3.0	.0361	.2718
	10:40	24.0		3.0	.0482	.3615
	11:00	23.5		3.0	.0602	.4611
	11:30	23.8		3.0	.0723	.5468
7/28/82	12:00	24.5		3.0	.0723	.5312
	12:30	23.8		3.0	.0723	.5468
	1:00	24.2		3.0	.0723	.5377
	1:30	24.1		3.0	.0723	.5401
	2:00	24.2		3.0	.0723	.5377
	2:30	24.1		3.0	.0723	.5401
	3:00	pump off				
			TOTAL WEIGHTED AVERAGE DISCHARGE			7.25 gpm

#75


MATCH POINT
W(U_A) = 1
U_A = 1
t = .012 days
s = .237 ft.
F = .1
TIME-DRAWDOWN TEST SITE 75
AQUIFER TEST PIT
T = Q/(4πs) W(U_A) = 1396 x 1 / (4 x 3.14 x .237)
T = 469 ft.²/day = 3508 gpd/ft.
7/27/82 - 7/28/82
Drawdown (s) feet
10.0
1.0
.1
.01
Time (t) in minutes
1
10
100
1,000

F 7523

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 19 N. S., R. 19 E. W., Sec. 31 WELL NO. 76

Personnel Smith & Freund Driller Sergent, Hauskins & Beckwith

Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specify) Slug Injection

Total Well Depth 50' ft. Well diameter 6 1/2 in. Casing diameter 2 in.

Casing type PVC Type of screen or perforation Saw Slot

Interval of screen or perforation 44' to 49' Pump hp. & type

Pump depth ft. Aquifer Alluvial Aquifer lithology Alluvial Material

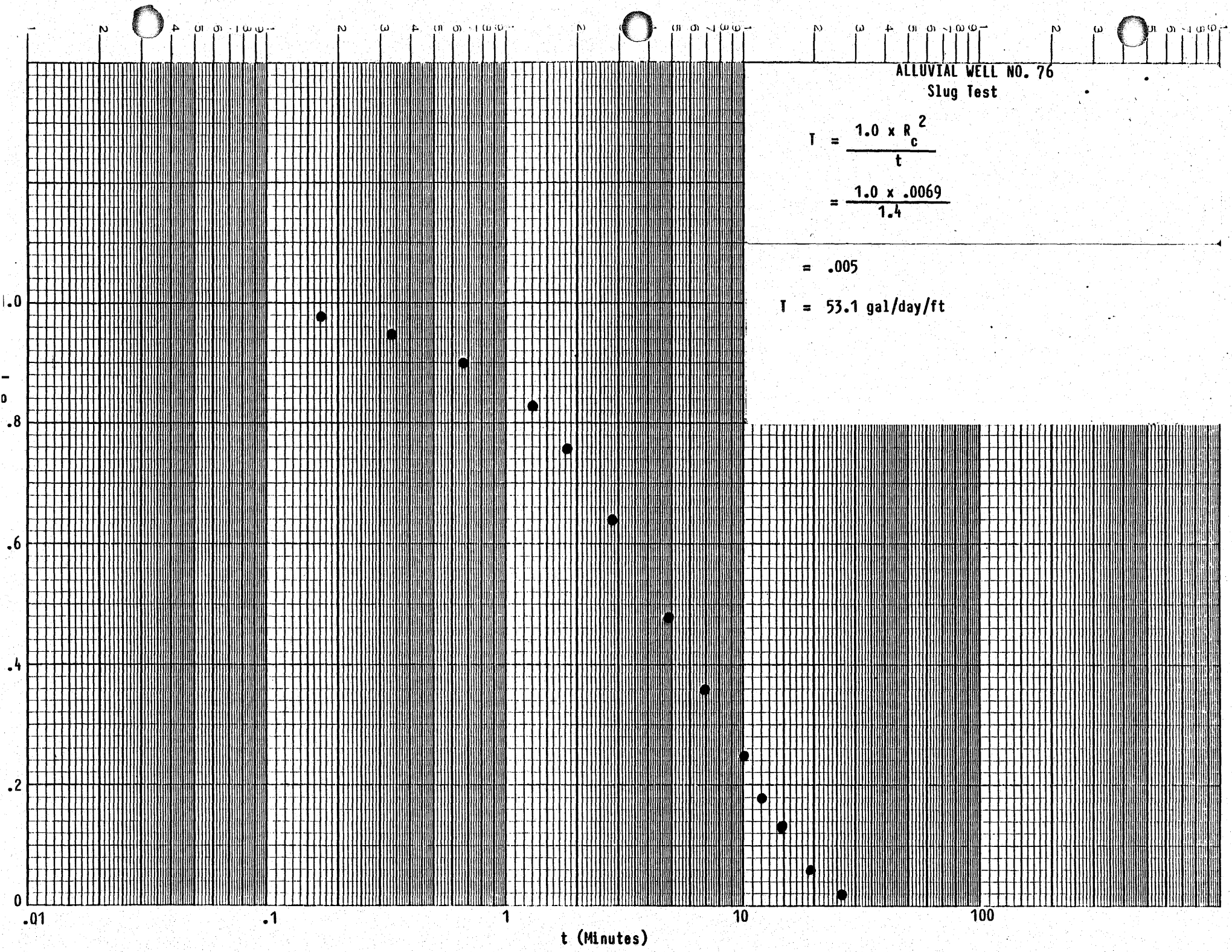
Altitude of land surface How determined Surveyed

MP Above Below LSD Altitude MP

SWL from MP How measured

Static Transducer Reading = -2.31

DATE	TIME (MINS)	TRANSDUCER READINGS	Ho (ft)	H/Ho
9/14/85	0	-.25	2.06	1.0
	.17	-.29		.98
	.33	-.36		.95
	.67	-.45		.90
	1.33	-.61		.83
	1.83	-.74		.76
	2.83	-.99		.64
	4.83	-1.32		.48
	6.83	-1.57		.36
	9.83	-1.81		.25
	11.83	-1.93		.18
	14.83	-2.05		.13
	19.83	-2.19		.06
	25.83	-2.28		.01


ALLUVIAL WELL NO. 76
Slug Test
$T = \frac{1.0 \times R_c^2}{t}$
$= \frac{1.0 \times .0069}{1.4}$
= .005
T = 53.1 gal/day/ft
1.0
.8
.6
.4
.2
0
.01
.1
1
10
100
t (Minutes)

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 36 N. S., R. 18 E. W., Sec. 20 WELL NO. 82

Personnel Smith & Freund Driller Sergent, Hauskins & Beckwith

Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specify) slug injection

Total Well Depth 16 ft. Well diameter 6½ in. Casing diameter 2 in.

Casing type PVC Type of screen or perforation saw slot

Interval of screen or perforation 7' to 14' Pump hp. & type

Pump depth ft. Aquifer alluvial Aquifer lithology alluvial material

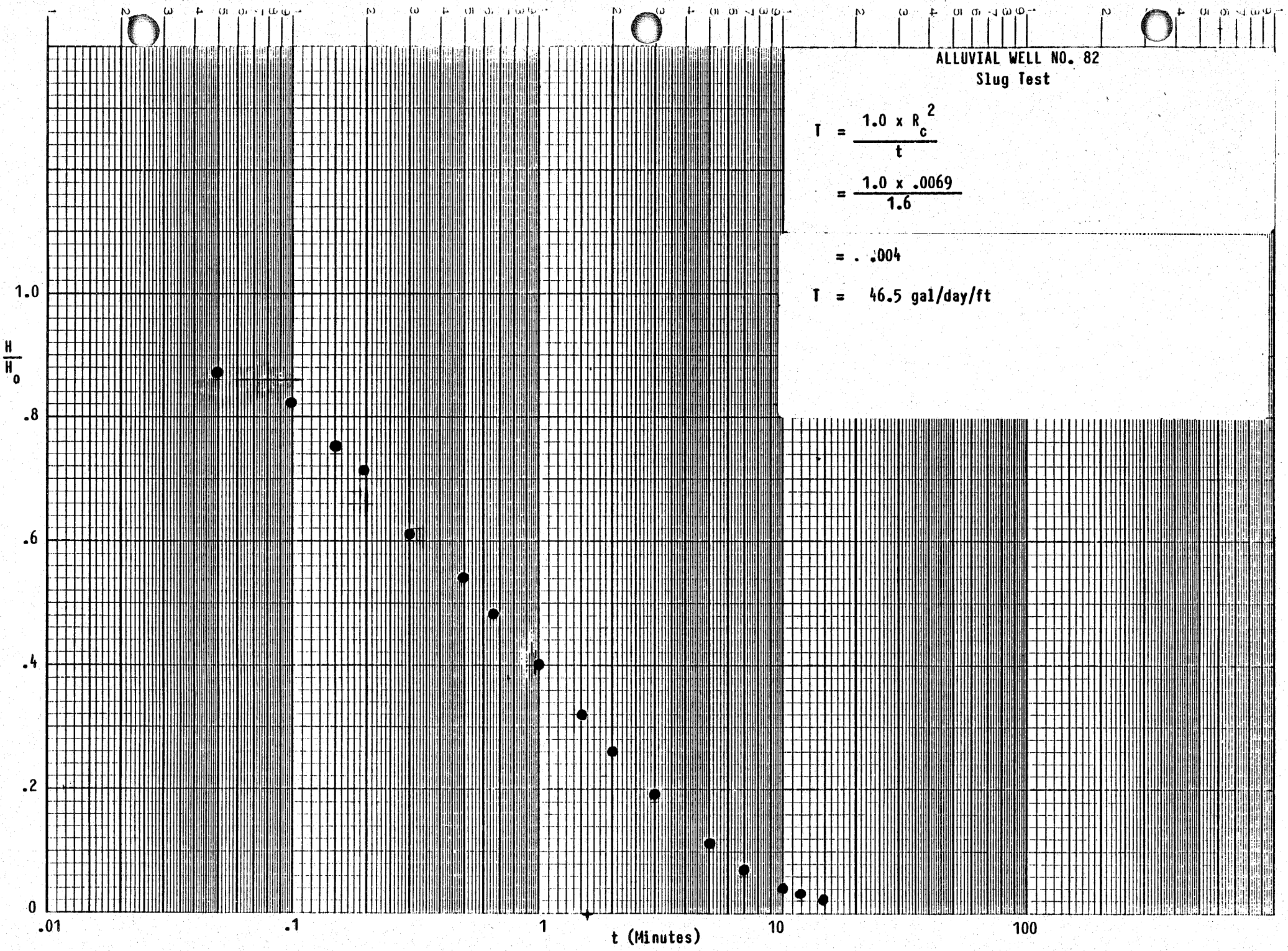
Altitude of land surface How determined surveyed

MP Above Below LSD Altitude MP

SWL from MP How measured

Static Transducer Reading = -1.77

DATE	TIME (MINS)	TRANSDUCER READINGS	Ho (ft)	H/Ho
9-14-85	0	.34	2.11	1.00
	.05	.06		.87
	.10	-.05		.82
	.15	-.19		.75
	.20	-.28		.71
	.30	-.48		.61
	.50	-.64		.54
	.67	-.75		.48
	1.0	-.92		.40
	1.5	-1.09		.32
	2.0	-1.22		.26
	3.0	-1.37		.19
	5.0	-1.53		.11
	7.0	-1.62		.07
	10.0	-1.68		.04
	12.0	-1.70		.03
	15.0	-1.73		.02


ALLUVIAL WELL NO. 82
Slug Test
T = 1.0 x R_c^2 / t
= 1.0 x .0069 / 1.6
= . .004
T = 46.5 gal/day/ft
H/H_o
1.0
.8
.6
.4
.2
0
.01
.1
1
10
100
t (Minutes)

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T.36 N., R. 18 E., Sec. 29 WELL NO. 84

Personnel Roznovak Driller Sergent, Hauskins & Beckwith

Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specify) Aquifer Pit Test

Total well depth 22'6"ft. Well diameter 12 in. Casing diameter 4 in.

Casing type PVC Type of screen or perforation Saw Slots

Interval of screen or perforation 12'6" - 22'6" Pump hp. & type 1/2 h.p. Berkeley

Pump depth 3.0 ft. Aquifer Alluvium Aquifer lithology Silt, Sand and Gravel

Altitude of land surface _____ How determined _____

MP Above/Below LSD _____ Altitude MP _____

SWL from MP 2.38 How measured Stevens staff gage

DATE	TIME	DEPTH TO WATER LEVEL	STAFF GAGE READING		TIME SINCE PUMP ON t, mins.	RESIDUAL DRAWDOWN feet
10-26-83 (P.M.)	04:06	0.00	2.38	Pump On	-	0.00
	04:07	0.00	2.38		1	0.00
	04:08	0.00	2.38		2	0.00
	04:09	0.00	2.38		3	0.00
	04:10	0.00	2.38		4	0.00
	04:11	0.01	2.37		5	0.01
	04:12	0.02	2.36		6	0.02
	04:13	0.02	2.36		7	0.02
	04:14	0.03	2.35		8	0.03
	04:16	0.03	2.35		10	0.03
	04:18	0.04	2.34		12	0.04
	04:21	0.06	2.32		15	0.06
	04:24	0.07	2.31		18	0.07
	04:26	0.08	2.30		20	0.08
	04:31	0.10	2.28		25	0.10
	04:36	0.12	2.26		30	0.12
	04:41	0.14	2.24		35	0.14
	04:46	0.15	2.23		40	0.15
	04:51	0.16	2.22		45	0.16
	04:56	0.18	2.20		50	0.18
	05:01	0.20	2.18		55	0.20
	05:06	0.21	2.17		60	0.21
	05:16	0.23	2.15		70	0.23
	05:26	0.25	2.13		80	0.25
	05:36	0.28	2.10		90	0.28
	05:46	0.30	2.08		100	0.30
	06:06	0.33	2.05		120	0.33
	06:26	0.35	2.03		140	0.35

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 36 (N.) S., R. 18 (E.) W., Sec. 29 WELL NO. 84

Personnel Roznovak Driller Sergent, Hauskins & Beckwith

Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well (5.) Other (specify) Aquifer Pit Test

Total well depth 22'6" ft. Well diameter 12 in. Casing diameter 4 in.

Casing type PVC Type of screen or perforation Saw Slots

Interval of screen or perforation 12'6" - 22'6" Pump hp. & type 1/2 h.p. Berkeley

Pump depth 3.0 ft. Aquifer Alluvium Aquifer lithology Silt, Sand and Gravel

Altitude of land surface _____ How determined _____

MP Above/Below LSD _____ Altitude MP _____

SWL from MP 2.38 How measured Stevens staff gage

DATE	TIME	DEPTH TO WATER LEVEL	STAFF GAGE READING		TIME SINCE PUMP ON t, mins.	RESIDUAL DRAWDOWN feet
10-26-83	06:46	0.38	2.00		160	0.38
(P.M.)	07:06	0.40	1.98		180	0.40
	07:26	0.42	1.96		200	0.42
	07:46	0.43	1.95		220	0.43
	08:16	0.45	1.93		250	0.45
	08:46	0.46	1.92		280	0.46
	09:16	0.48	1.90		310	0.48
	09:46	0.48	1.90		340	0.48
	10:16	0.49	1.89		370	0.49
	10:46	0.50	1.88		400	0.50
	11:36	0.50	1.88		450	0.50
10-27-83	12:26	0.51	1.87		500	0.51
(A.M.)	01:16	0.52	1.86		550	0.52
	02:06	0.52	1.86		600	0.52
	02:56	0.52	1.86		650	0.52
	03:46	0.52	1.86		700	0.52
	04:36	0.52	1.86		750	0.52
	05:26	0.52	1.86		800	0.52
	07:06	0.52	1.86		900	0.52
	08:46	0.52	1.86		1,000	0.52
	10:26	0.52	1.86		1,100	0.52
(P.M.)	12:06	0.52	1.86		1,200	0.52
	13:46	0.52	1.86		1,300	0.52
	15:26	0.52	1.86		1,400	0.52
	17:06	0.52	1.86		1,500	0.52
	20:26	0.52	1.86		1,700	0.52
	23:46	0.53	1.85		1,900	0.53
10-28-83 (A.M.)	03:06	0.53	1.85		2,100	0.53

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 36 (N.) S., R. 18 (E.) W., Sec. 29 WELL NO. 84

Personnel Roznovak Driller Sergent, Hauskins & Beckwith

Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well (5.) Other (specify) Aquifer Pit Test

Total well depth 22'6" ft. Well diameter 12 in. Casing diameter 4 in.

Casing type PVC Type of screen or perforation Saw Slots

Interval of screen or perforation 12'6" - 22'6" Pump hp. & type 1/2 h.p. Berkeley

Pump depth 3.0 ft. Aquifer Alluvium Aquifer lithology Silt, Sand and Gravel

Altitude of land surface _____ How determined _____

MP Above/Below LSD _____ Altitude MP _____

SWL from MP 2.38 How measured Stevens staff gage

DATE	TIME	DEPTH TO WATER LEVEL	STAFF GAGE READING		TIME SINCE PUMP ON t, mins.	RESIDUAL DRAWDOWN feet
10-28-83	06.26	0.53	1.85		2300	0.53
(A.M.)	09:46	0.54	1.84		2500	0.54
(P.M.)	02:46	0.53	1.85		2800	0.53
	04:26	0.53	1.85		2900	0.53
	04:46			Pump Off		

WATER WELL 84

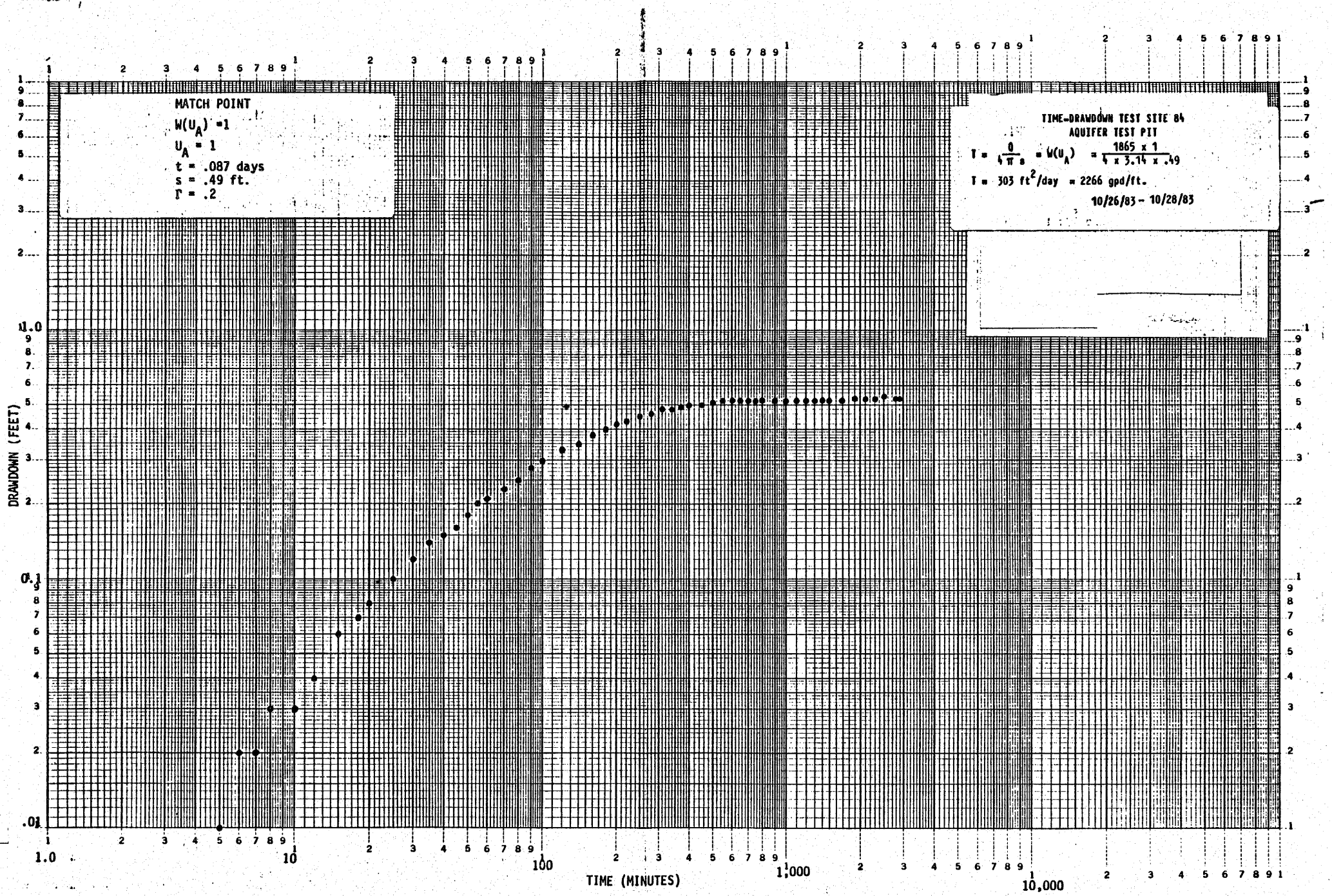
PUMPING RATE DATA

DATE	TIME TEST TAKEN	TEST DURATION SEC.	TEST DURATIONS PER MIN.	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
10-26-83	04:06	PUMP ON				
(P.M.)	04:07	99.1	.6054	16.12	.0015	.0146
	04:12	98.7	.6079	16.12	.0015	.0147
	04:16	99.0	.6060	16.12	.0014	.0137
	04:20	98.6	.6085	16.12	.0015	.0147
	04:25	98.2	.6110	16.12	.0017	.0167
	04:30	98.5	.6091	16.12	.0017	.0167
	04:35	98.0	.6122	16.12	.0017	.0168
	04:40	98.6	.6085	16.12	.0017	.0167
	04:45	98.2	.6110	16.12	.0060	.0591
	05:15	98.2	.6110	16.12	.0103	.1014
	05:45	98.2	.6110	16.12	.0103	.1014
	06:15	99.0	.6060	16.12	.0103	.1006
	06:45	98.4	.6100	16.12	.0103	.1013
	07:15	98.2	.6110	16.12	.0103	.1014
	07:45	98.1	.6116	16.12	.0103	.1015
	08:15	98.2	.6110	16.12	.0103	.1014
	08:45	98.2	.6110	16.12	.0103	.1014
	09:15	98.3	.6104	16.12	.0103	.1013
	09:45	97.9	.6129	16.12	.0103	.1018
	10:15	98.1	.6116	16.12	.0103	.1015
	10:45	98.2	.6110	16.12	.0103	.1014
	11:15	98.3	.6104	16.12	.0103	.1013
	11:45	98.4	.6100	16.12	.0103	.1013
10-27-83	00:15	98.6	.6085	16.12	.0103	.1010
(A.M.)	00:45	98.9	.6067	16.12	.0103	.1007
	01:15	99.2	.6048	16.12	.0103	.1004
	01:45	99.3	.6042	16.12	.0154	.1500
	02:45	98.7	.6079	16.12	.0205	.2009
	03:45	98.4	.6100	16.12	.0205	.2016
	04:45	98.6	.6085	16.12	.0205	.2011
	05:45	98.4	.6100	16.12	.0205	.2016

WATER WELL 84

PUMPING RATE DATA

DATE	TIME TEST TAKEN	TEST DURATION SEC.	TEST DURATIONS PER MIN.	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
10-27-83	06:45	98.4	.6100	16.12	.0205	.2016
(A.M.)	07:45	98.2	.6110	16.12	.0205	.2019
	08:45	98.6	.6085	16.12	.0283	.2776
	10:30	98.9	.6067	16.12	.0385	.3765
10-27-83	12:30	99.0	.6060	16.12	.0308	.3009
(P.M.)	01:30	99.4	.6036	16.12	.0308	.2997
	03:30	100.0	.6000	16.12	.0411	.3975
	05:30	100.0	.6000	16.12	.0411	.3975
	07:30	102.0	.5882	16.12	.0308	.2920
	08:30	101.0	.5941	16.12	.0462	.4425
10-28-83	00:00	101.0	.5941	16.12	.0565	.5411
(A.M.)	02:00	101.0	.5941	16.12	.0411	.3936
	04:00	101.0	.5941	16.12	.0411	.3936
	06:00	101.0	.5941	16.12	.0616	.5899
	10:00	101.0	.5941	16.12	.0925	.8859
10-28-83	03:00	101.0	.5941	16.12	.0877	.8399
(P.M.)	04:46	PUMP OFF				
			Wt. Avg. Q =	9.69 G.P.M.		


MATCH POINT
W(U_A) = 1
U_A = 1
t = .087 days
s = .49 ft.
Γ = .2
TIME-DRAWDOWN TEST SITE 84
AQUIFER TEST PIT
T = Q/(4πs) = W(U_A) = 1865 x 1 / (4 x 3.14 x .49)
T = 303 ft²/day = 2266 gpd/ft.
10/26/83 - 10/28/83
DRAWDOWN (FEET)
TIME (MINUTES)
1.0
10
100
1,000
10,000
.01
0.1
1.0

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 36 (N) S., R. 18 (E) W., Sec. 29 WELL NO. 84

Personnel Roznovak Driller Sergent, Hauskins, Beckwith

Test type: 1. Single well drawdown 2. Single well recovery (3) Drawdown with obs. well 1
4. Recovery with obs. well 5. Other (specify)

Total well depth 22'6" ft. Well diameter 12.0 in. Casing diameter 4.0 in.

Casing type pvc Type of screen or perforation saw slots

Interval of screen or perforation 12'6" - 22'6" Pump hp. & type ½ h.p. Berkeley

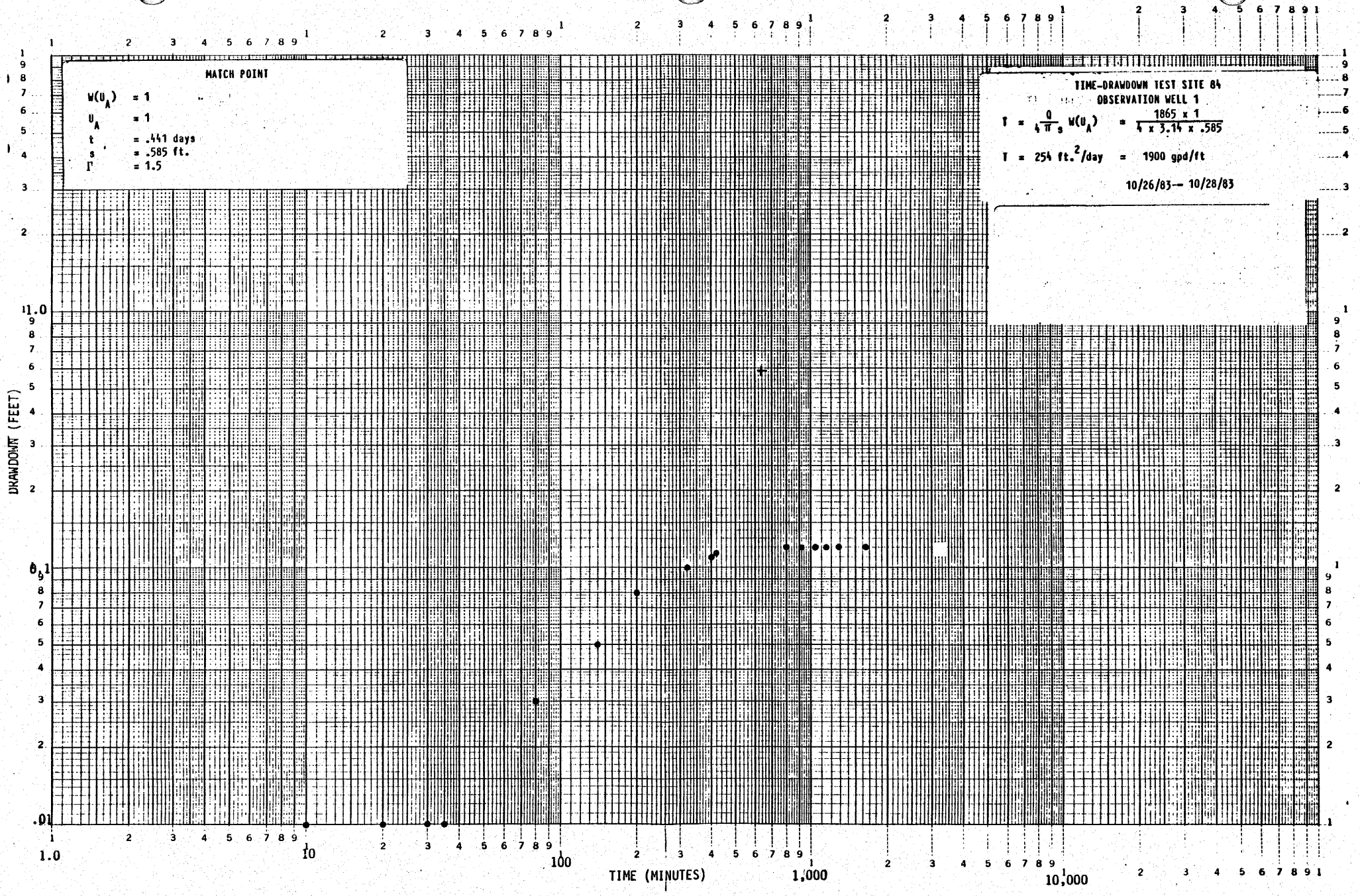
Pump depth 3.0 ft. Aquifer Alluvium Aquifer lithology Silt, Sand and Gravel

Altitude of land surface _____ How determined _____

MP Above/Below LSD _____ Altitude MP _____

SWL from MP _____ How measured Stevens type-F recorder

DATE	TIME	DEPTH TO WATER LEVEL	STAFF GAGE READING		TIME SINCE PUMP ON t, mins.	RESIDUAL DRAWDOWN feet
10-26-83	04:06	0.00	Pump on		-	0.00
(P.M.)	04:16	0.01			10	0.01
	04:26	0.01			20	0.01
	04:36	0.01			30	0.01
	04:41	0.01			35	0.01
	05:26	0.03			80	0.03
	06:26	0.05			140	0.05
	07:26	0.08			200	0.08
	09:26	0.10			320	0.10
	10:46	0.11			400	0.11
	11:06	0.113			420	0.113
10-27-83	05:26	0.12			800	0.12
(A.M.)	07:26	0.12			920	0.12
	09:16	0.12			1,030	0.12
	11:16	0.12			1,150	0.12
(P.M.)	01:36	0.12			1,290	0.12
	07:36	0.12			1,650	0.12
10-28-83	04:46		Pump off			
(P.M.)						


MATCH POINT
W(U_A) = 1
U_A = 1
t = .441 days
s = .585 ft.
Γ = 1.5
TIME-DRAWDOWN TEST SITE 84
OBSERVATION WELL 1
T = Q/(4πs) W(U_A) = 1865 x 1 / (4 x 3.14 x .585)
T = 254 ft.²/day = 1900 gpd/ft
10/26/83-- 10/28/83
DRAWDOWN (FEET)
TIME (MINUTES)
1.0
10
100
1,000
10,000
.01
.1
1.0

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 36 (N.) S., R. 18 (E.) W., Sec. 29 WELL NO. 84

Personnel Roznovak Driller Sergent, Hauskins, Beckwith

Test type: 1. Single well drawdown 2. Single well recovery (3) Drawdown with obs. well 2
4. Recovery with obs. well 5. Other (specify)

Total well depth 22'6" ft. Well diameter 12.0 in. Casing diameter 4.0 in.

Casing type pvc Type of screen or perforation saw slots

Interval of screen or perforation 12'6" - 22'6" Pump hp. & type 1/2 h.p. Berkeley

Pump depth 3.0 ft. Aquifer Alluvium Aquifer lithology Silt, Sand and Gravel

Altitude of land surface How determined

MP Above/Below LSD Altitude MP

SWL from MP 0.73 How measured Sinco water level indicator

DATE	TIME	DEPTH TO WATER LEVEL			TIME SINCE PUMP ON t, mins.	RESIDUAL DRAWDOWN feet
10-26-83	04:06	0.730	-	-	Pump On	0.000
(P.M.)	04:07	0.730			1	0.000
	04:08	0.730			2	0.000
	04:09	0.730			3	0.000
	04:10	0.735			4	0.005
	04:11	0.735			5	0.005
	04:12	0.740			6	0.010
	04:13	0.740			7	0.010
	04:14	0.740			8	0.010
	04:16	0.745			10	0.015
	04:21	0.745			15	0.015
	04:26	0.745			20	0.015
	04:31	0.750			25	0.020
	04:36	0.750			30	0.020
	04:41	0.755			35	0.025
	04:46	0.760			40	0.030
	04:51	0.765			45	0.035
	04:56	0.770			50	0.040
	05:01	0.770			55	0.040
	05:06	0.775			60	0.045
	05:16	0.780			70	0.050
	05:26	0.790			80	0.060
	05:36	0.795			90	0.065
	05:46	0.805			100	0.075
	06:06	0.820			120	0.090
	06:26	0.840			140	0.110
	06:46	0.880			160	0.150
	07:06	0.840			180	0.110

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 36 (N.) S., R. 18 (E.) W., Sec. 29 WELL NO. 84

Personnel Roznovak Driller Sergent, Hauskins, Beckwith

Test type: 1. Single well drawdown 2. Single well recovery (3.) Drawdown with obs. well 2
4. Recovery with obs. well 5. Other (specify)

Total well depth 22'6" ft. Well diameter 12.0 in. Casing diameter 4.0 in.

Casing type pvc Type of screen or perforation saw slots

Interval of screen or perforation 12'6" - 22'6" Pump hp. & type 1/2 h.p. Berkeley

Pump depth 3.0 ft. Aquifer Alluvium Aquifer lithology Silt, Sand and Gravel

Altitude of land surface _____ How determined _____

MP Above/Below LSD _____ Altitude MP _____

SWL from MP 0.73 How measured Sinco water level indicator

DATE	TIME	DEPTH TO WATER LEVEL			TIME SINCE PUMP ON t, mins.	RESIDUAL DRAWDOWN feet
10-26-83	07:26	0.860			200	0.130
(P.M.)	07:46	0.870			220	0.140
	08:16	0.880			250	0.150
	08:46	0.890			280	0.160
	09:16	0.895			310	0.165
	09:46	0.900			340	0.170
	10:16	0.905			370	0.175
	10:46	0.910			400	0.180
	11:36	0.920			450	0.190
10-27-83	12:26	0.930			500	0.200
(A.M.)	01:16	0.935			550	0.205
	02:06	0.935			600	0.205
	02:56	0.935			650	0.205
	03:46	0.940			700	0.210
	04:36	0.940			750	0.210
	05:26	0.940			800	0.210
	07:06	0.940			900	0.210
	08:46	0.945			1,000	0.215
	10:26	0.945			1,100	0.215
10-27-83	12:06	0.945			1,200	0.215
(P.M.)	01:46	0.945			1,300	0.215
	03:26	0.945			1,400	0.215
	05:06	0.945			1,500	0.215
	08:26	0.945			1,700	0.215
	11:46	0.950			1,900	0.220
10-28-83	03:06	0.950			2,100	0.220
(A.M.)	06:26	0.950			2,300	0.220
	09:46	0.950			2,500	0.220

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 36 N. S., R. 18 E. W., Sec. 29 WELL NO. 84

Personnel Roznovak Driller Sergent, Hauskins, Beckwith

Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 2
4. Recovery with obs. well 5. Other (specify)

Total well depth 22'6" ft. Well diameter 12.0 in. Casing diameter 4.0 in.

Casing type pvc Type of screen or perforation saw slots

Interval of screen or perforation 12'6" - 22'6" Pump hp. & type 1/2 h.p. Berkeley

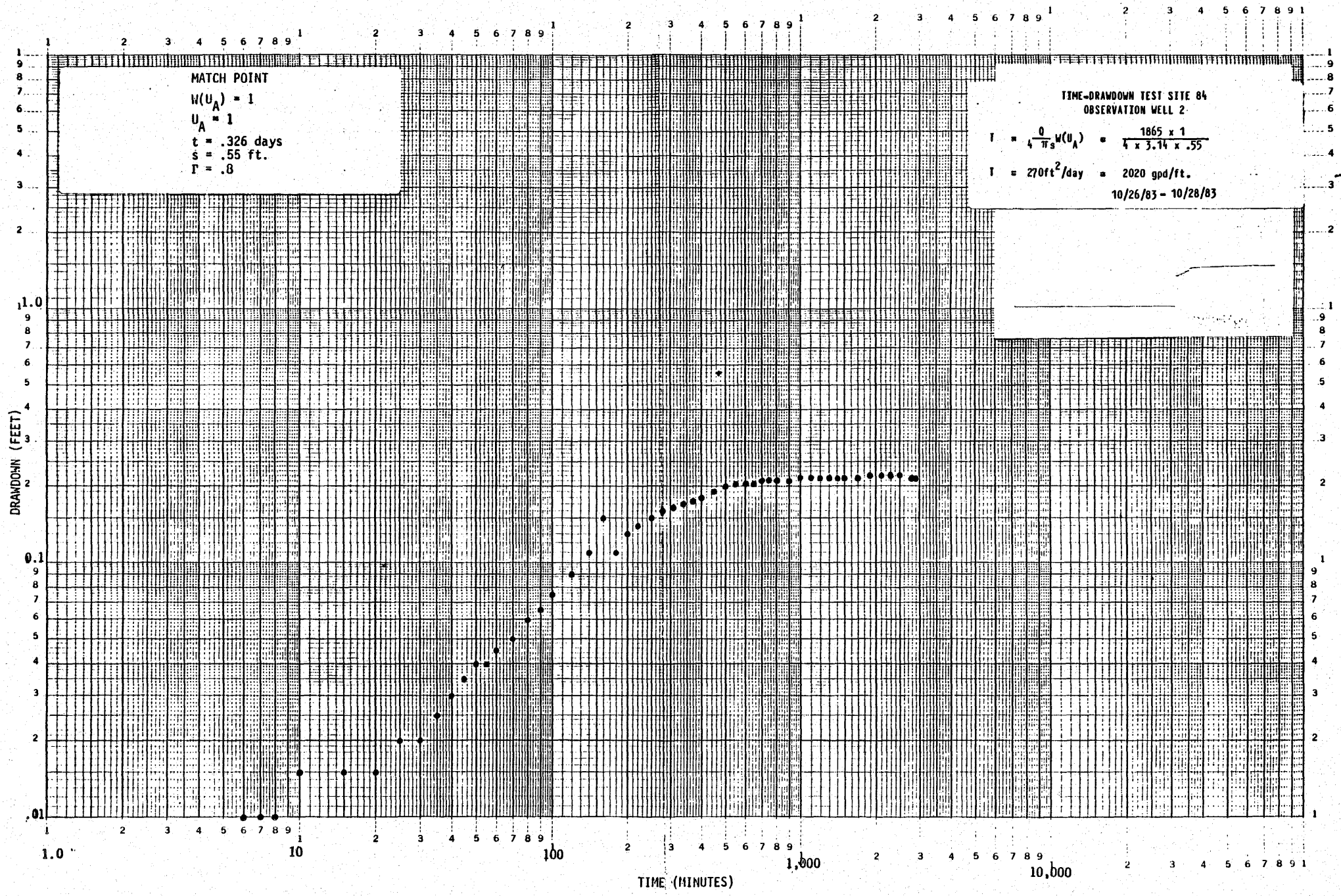
Pump depth 3.0 ft. Aquifer Alluvium Aquifer lithology Silt, Sand and Gravel

Altitude of land surface _____ How determined _____

MP Above/Below LSD _____ Altitude MP _____

SWL from MP 0.73 How measured Sinco water level indicator

DATE	TIME	DEPTH TO WATER LEVEL			TIME SINCE PUMP ON t, mins.	RESIDUAL DRAWDOWN feet
10-28-83	02:46	0.945			2,800	0.215
(P.M.)	04:26	0.945			2,900	0.215
	04:46		Pump Off			


MATCH POINT
W(U_A) = 1
U_A = 1
t = .326 days
s = .55 ft.
Γ = .8
TIME-DRAWDOWN TEST SITE 84
OBSERVATION WELL 2
T = Q/(4πs) W(U_A) = 1865 x 1 / (4 x 3.14 x .55)
T = 270ft²/day = 2020 gpd/ft.
10/26/83 - 10/28/83
DRAWDOWN (FEET)
TIME (MINUTES)
1.0
10
100
1,000
10,000
.01
0.1
1.0

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 36 N. S., R. 19 E. W., Sec. 15 WELL NO. 87

Personnel Smith & Freund Driller Sergent, Hauskins & Beckwith

Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specify) slug injection

Total Well Depth 39 ft. Well diameter 6½ in. Casing diameter 2 in.

Casing type PVC Type of screen or perforation saw slot

Interval of screen or perforation 25' to 39' Pump hp. & type

Pump depth ft. Aquifer alluvial Aquifer lithology alluvial material

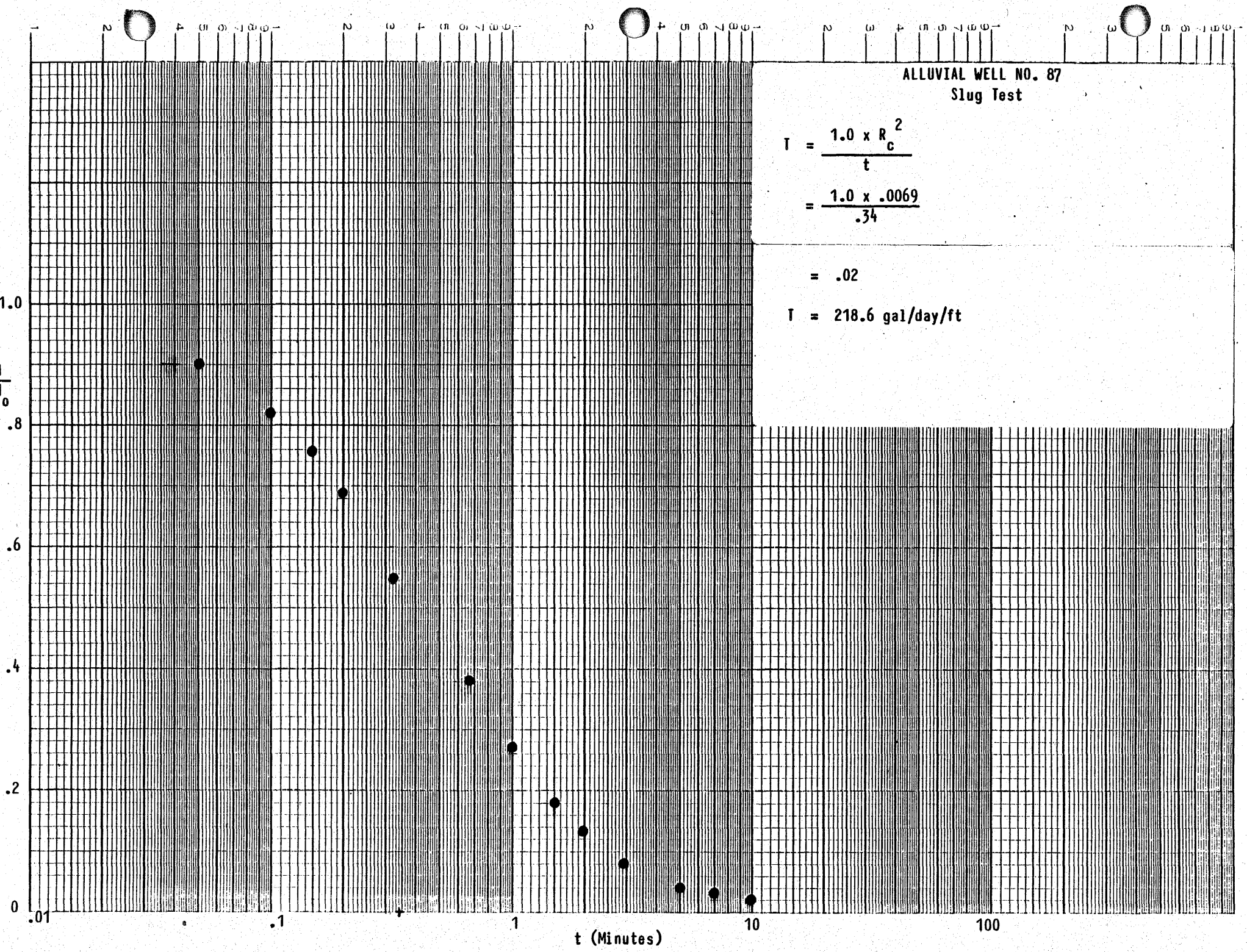
Altitude of land surface How determined surveyed

MP Above Below LSD Altitude MP

SWL from MP How measured

Static Transducer Reading = 6.47

DATE	TIME (MINS)	TRANSDUCER READINGS	Ho (ft)	H/Ho
9-26-85	0	9.32	2.85	1.00
	.05	9.04		.90
	.10	8.82		.82
	.15	8.65		.76
	.20	8.43		.69
	.33	8.04		.55
	.67	7.54		.38
	1.0	7.24		.27
	1.5	6.99		.18
	2.0	6.85		.13
	3.0	6.69		.08
	5.0	6.58		.04
	7.0	6.56		.03
	10.0	6.54		.02


ALLUVIAL WELL NO. 87
Slug Test
T = 1.0 x R_c^2 / t
= 1.0 x .0069 / .34
= .02
T = 218.6 gal/day/ft
1.0
.8
.6
.4
.2
0
.01
.1
1
10
100
t (Minutes)

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 36 N. ~~S.~~, R. 19 E. ~~W.~~, Sec. 29 WELL NO. 88

Personnel Hamilton, Miller, LaRue Driller Sergent, Hauskins & Beckwith

Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specify) Drawdown in an excavated pit

Total well depth 40' ft. Well diameter 12 in. Casing diameter 4 in.

Casing type pvc Type of screen or perforation saw slots

Interval of screen or perforation 24-34 Pump hp. & type 1/3 hp. Fairbanks Morse

Pump depth 7 ft. Aquifer Alluvium Aquifer lithology gravel, sand, silt & clay

Altitude of land surface 6545 How determined surveyed

MP Above/Below LSD Altitude MP

SWL from MP 3.82 How measured calibrated staff gage

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
7/28/82	3:11	pump on	0			
	3:12	0	1			
	3:13	.01	2			
	3:14	.01	3			
	3:16	.02	5			
	3:17	.03	6			
	3:18	.03	7			
	3:19	.04	8			
	3:20	.04	9			
	3:21	.04	10			
	3:22	.05	11			
	3:24	.06	13			
	3:26	.06	15			
	3:28	.07	17			
	3:30	.08	19			
	3:32	.09	21			
	3:34	.09	23			
	3:36	.10	25			
	3:38	.11	27			
	3:40	.11	29			
	3:42	.12	31			
	3:44	.13	33			
	3:46	.13	35			
	3:48	.14	37			
	3:50	.14	39			
	3:55	.16	44			
	4:00	.16	49			
	4:15	.18	64			

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 36 (N.) S., R. 19 (E.) W., Sec. 29 WELL NO. 88

Personnel Hamilton, Miller LaRue Driller Sergent, Hauskins & Beckwith

Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well (5.) Other (specify) Drawdown in an excavated pit

Total well depth 40' ft. Well diameter 12 in. Casing diameter 4 in.

Casing type pvc Type of screen or perforation saw slots

Interval of screen or perforation 24-34 Pump hp. & type 1/3 hp. Fairbanks Morse

Pump depth 7 ft. Aquifer Alluvium Aquifer lithology gravel, sand, silt & clay

Altitude of land surface 6545 How determined surveyed

MP Above Below LSD Altitude MP

SWL from MP 3.82 How measured calibrated staff gage

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
7/28/82	4:30	.20	79			
	4:45	.21	94			
	5:00	.23	109			
	5:15	.24	124			
	5:30	.24	139			
	5:45	.25	154			
	6:00	.26	169			
	6:30	.26	199			
	7:00	.27	229			
	7:30	.27	259			
	8:00	.27	289			
	8:30	.28	319			
	9:00	.28	349			
	10:00	.28	409			
	11:40	.29	509			
7/29/82	1:20	.30	609			
	1:20	pump off				

WATER WELL 88

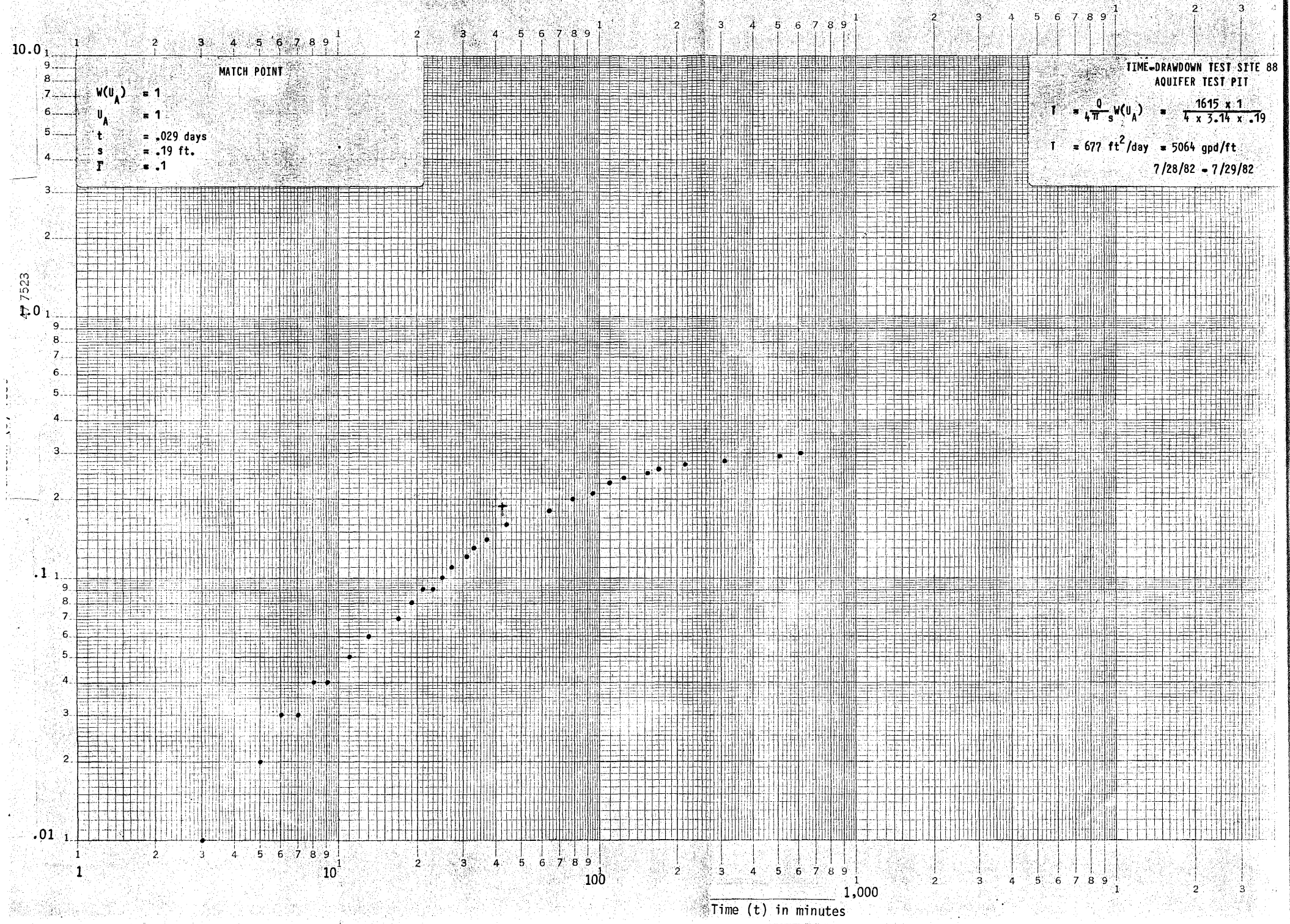
PUMPING RATE DATA

DATE	TIME TEST TAKEN	TEST DURATION SEC.	TEST DURATIONS PER MIN.	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
7/28/82	3:11	pump on				
	3:12	29	2.069	3.0	.0041	.0254
	3:15	20.8	2.885	3.0	.0049	.0424
	3:18	20.8	2.885	3.0	.0049	.0424
	3:21	19.8	3.030	3.0	.0049	.0445
	3:24	22.1	2.715	3.0	.0049	.0399
	3:27	20.4	2.941	3.0	.0049	.0432
	3:30	21.7	2.765	3.0	.0049	.0406
	3:33	22.5	2.667	3.0	.0049	.0392
	3:36	22.0	2.728	3.0	.0049	.0401
	3:39	20.8	2.885	3.0	.0049	.0424
	3:42	22.2	2.703	3.0	.0049	.0397
	3:45	21.4	2.804	3.0	.0049	.0412
	3:48	22.0	2.728	3.0	.0049	.0401
	3:51	21.0	2.857	3.0	.0049	.0420
	3:55	21.5	2.791	3.0	.0074	.0620
	4:00	20.6	2.913	3.0	.0082	.0716
	4:05	21.4	2.804	3.0	.0082	.0690
	4:10	21.9	2.740	3.0	.0082	.0674
	4:15	24.1	2.490	3.0	.0082	.0613
	4:20	20.2	2.970	3.0	.0082	.0731
	4:25	20.4	2.941	3.0	.0082	.0723
	4:30	20.3	2.955	3.0	.0082	.0727
	4:35	22.0	2.728	3.0	.0082	.0671
	4:40	20.8	2.885	3.0	.0082	.0709
	4:45	21.5	2.791	3.0	.0082	.0686
	4:50	22.0	2.728	3.0	.0082	.0671
	4:55	20.5	2.927	3.0	.0082	.0720
	5:00	20.7	2.898	3.0	.0082	.0713
	5:05	22.4	2.678	3.0	.0082	.0658
	5:10	22.5	2.667	3.0	.0082	.0656
	5:15	21.7	2.765	3.0	.0082	.0680

WATER WELL 88

PUMPING RATE DATA

DATE	TIME TEST TAKEN	TEST DURATION SEC.	TEST DURATIONS PER MIN.	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
7/28/82	5:20	23.4	2.564	3.0	.0123	.0946
	5:30	23.5	2.55	3.0	.021	.161
	5:45	23.0	2.60	3.0	.025	.195
	6:00	23.4	2.56	3.0	.037	.284
	6:30	23.2	2.59	3.0	.049	.381
	7:00	24.0	2.50	3.0	.049	.368
	7:30	22.3	2.69	3.0	.049	.395
	8:00	20.7	2.90	3.0	.049	.426
	8:30	21.0	2.86	3.0	.049	.420
	9:00	20.8	2.88	3.0	.074	.639
	10:00	20.4	2.94	3.0	.164	1.45
	11:40	20.2	2.97	3.0	.148	1.32
7/29/83	1:20	22.4	2.68	3.0	.066	.531
	1:20	pump off				
					TOTAL	
					WEIGHTED	
					AVERAGE	
					DISCHARGE	8.39 gpm


MATCH POINT
W(U_A) = 1
U_A = 1
t = .029 days
s = .19 ft.
Γ = .1
TIME-DRAWDOWN TEST SITE 88
AQUIFER TEST PIT
T = Q/4πs W(U_A) = 1615 x 1 / 4 x 3.14 x .19
T = 677 ft²/day = 5064 gpd/ft
7/28/82 - 7/29/82
10.0
1.0
.1
.01
1
10
100
1,000
Time (t) in minutes

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 36 (N) S., R. 19 (E) W., Sec. 29 WELL NO. 88

Personnel Cochran Driller Sergent, Hauskins & Beckwith

Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well (5) Other (specify) Aquifer Pit Test

Total well depth 40 ft. Well diameter 12 in. Casing diameter 4 in.

Casing type PVC Type of screen or perforation saw slots

Interval of screen or perforation 24-34 Pump hp. & type 1/3 h.p. Berkeley

Pump depth 3.0 ft. Aquifer Alluvium Aquifer lithology Silt, Sand and Gravel

Altitude of land surface _____ How determined _____

MP Above/Below LSD _____ Altitude MP _____

SWL from MP _____ How measured Stevens staff gage

DATE	TIME	DEPTH TO WATER LEVEL			TIME SINCE PUMP ON t, mins.	RESIDUAL DRAWDOWN feet
6-6-83	09:25	0.00	Pump On		-	0.00
(A.M.)	09:26	0.00			1	0.00
	09:27	0.01			2	0.01
	09:28	0.01			3	0.01
	09:29	0.02			4	0.02
	09:30	0.02			5	0.02
	09:31	0.03			6	0.03
	09:32	0.04			7	0.04
	09:33	0.05			8	0.05
	09:34	0.06			9	0.06
	09:35	0.06			10	0.06
	09:37	0.07			12	0.07
	09:40	0.08			15	0.08
	09:43	0.10			18	0.10
	09:45	0.11			20	0.11
	09:50	0.12			25	0.12
	09:55	0.14			30	0.14
	10:00	0.16			35	0.16
	10:05	0.17			40	0.17
	10:15	0.19			50	0.19
	10:25	0.21			60	0.21
	10:35	0.22			70	0.22
	10:45	0.23			80	0.23
	10:55	0.25			90	0.25
	11:05	0.25			100	0.25
	11:25	0.25			120	0.25
	11:45	0.28			140	0.28

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 36 (N.) S., R. 19 (E.) W., Sec. 29 WELL NO. 88

Personnel Cochran Driller Sergent, Haukins & Beckwith

Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well (5.) Other (specify) Aquifer Pit Test

Total well depth 40 ft. Well diameter 12" in. Casing diameter 4 in.

Casing type PVC Type of screen or perforation saw slots

Interval of screen or perforation 24-34 Pump hp. & type 1/3 h.p. Berkeley

Pump depth 3.0 ft. Aquifer Alluvium Aquifer lithology Silt, Sand and Gravel

Altitude of land surface _____ How determined _____

MP Above/Below LSD _____ Altitude MP _____

SWL from MP _____ How measured Stevens staff gage

DATE	TIME	DEPTH TO WATER LEVEL			TIME SINCE PUMP ON t, mins.	RESIDUAL DRAWDOWN feet
6-6-83	12:05	0.29			160	0.29
(P.M.)	12:25	0.29			180	0.29
	12:45	0.30			200	0.30
	01:05	0.30			220	0.30
	01:25	0.30			240	0.30
	01:45	0.31			260	0.31
	02:05	0.31			280	0.31
	02:25	0.31			300	0.31
	03:15	0.32			350	0.32
	04:05	0.32			400	0.32
	04:55	0.33			450	0.33
	05:45	0.33			500	0.33
	06:35	0.33			550	0.33
	07:25	0.33			600	0.33
	09:05	0.34			700	0.34
	10:45	0.35			800	0.35
6-7-83	12:25	0.35			900	0.35
(A.M.)	02:05	0.34			1,000	0.34
	03:45	0.34			1,100	0.34
	05:25	0.33			1,200	0.33
	07:05	0.33			1,300	0.33
	08:45	0.33			1,400	0.33
	10:25	0.32			1,500	0.32
(P.M.)	12:05	0.32			1,600	0.32
	01:45	0.33			1,700	0.33
	03:25	0.33			1,800	0.33
	05:05	0.34			1,900	0.34

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 36 N. S., R. 19 E. W., Sec. 29 WELL NO. 88

Personnel Cochran Driller Sergent, Haukins & Beckwith

Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specify) Aquifer Pit Test

Total well depth 40 ft. Well diameter 12 in. Casing diameter 4 in.

Casing type PVC Type of screen or perforation saw slots

Interval of screen or perforation 24-34 Pump hp. & type 1/3 h.p. Berkeley

Pump depth 3.0 ft. Aquifer Alluvium Aquifer lithology Silt, Sand and Gravel

Altitude of land surface _____ How determined _____

MP Above/Below LSD _____ Altitude MP _____

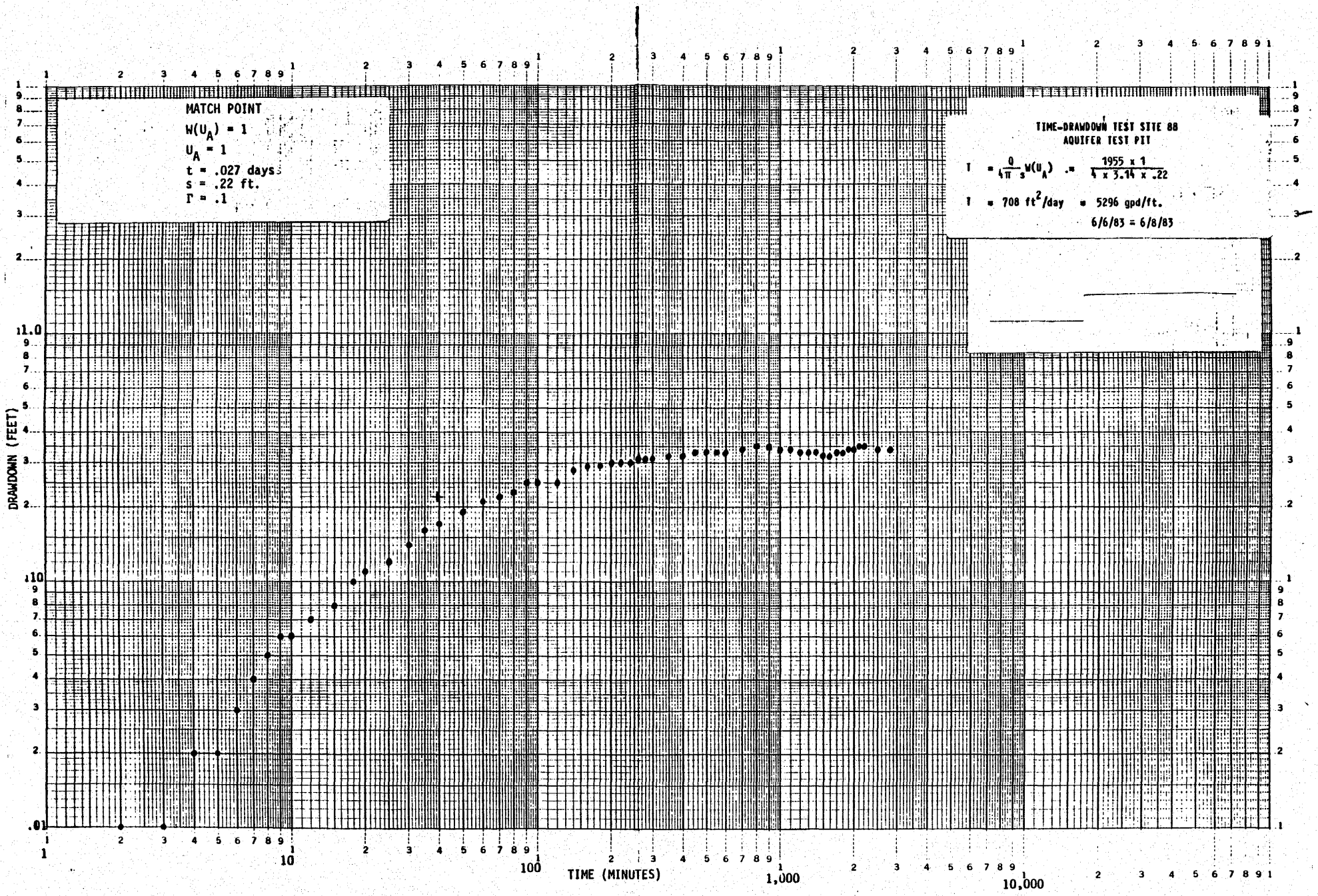
SWL from MP _____ How measured Stevens staff gage

DATE	TIME	DEPTH TO WATER LEVEL			TIME SINCE PUMP ON t, mins.	RESIDUAL DRAWDOWN feet
6-7-83	06:45	0.34			2,000	0.34
(P.M.)	08:25	0.35			2,100	0.35
	10:05	0.35			2,200	0.35
6-8-83	03:05	0.34			2,500	0.34
(A.M.)	08:05	0.34	Pump Off		2,800	0.34

WATER WELL 88

PUMPING RATE DATA

DATE	TIME TEST TAKEN	TEST DURATION SEC.	TEST DURATIONS PER MIN.	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
6-6-83	09:25	PUMP ON				
(A.M.)	09:30	96.0	0.625	16.12	0.0027	0.0273
	09:35	97.0	0.619	16.12	0.0018	0.0180
	09:40	97.0	0.619	16.12	0.0059	0.0589
	10:08	96.0	0.625	16.12	0.0157	0.1582
	11:08	95.0	0.632	16.12	0.0254	0.2588
(P.M.)	12:30	95.5	0.628	16.12	0.0468	0.4738
	03:30	96.0	0.625	16.12	0.0429	0.4322
	04:30	95.0	0.632	16.12	0.0214	0.2180
	05:30	95.0	0.632	16.12	0.0214	0.2180
	06:30	95.0	0.632	16.12	0.0214	0.2180
	07:30	95.0	0.632	16.12	0.0214	0.2180
	08:30	95.0	0.632	16.12	0.0321	0.3270
	10:30	94.6	0.634	16.12	0.0429	0.4384
6-7-83	12:30	94.5	0.635	16.12	0.0429	0.4391
(A.M.)	02:30	95.2	0.630	16.12	0.0429	0.4357
	04:30	94.6	0.634	16.12	0.0429	0.4384
	06:30	95.0	0.632	16.12	0.0429	0.4371
	08:30	96.0	0.625	16.12	0.0429	0.4322
	10:30	96.0	0.625	16.12	0.0429	0.4322
(P.M.)	12:30	95.0	0.632	16.12	0.0429	0.4371
	02:30	95.0	0.632	16.12	0.0429	0.4371
	04:30	95.0	0.632	16.12	0.0429	0.4371
	06:30	96.0	0.625	16.12	0.0429	0.4322
	08:30	96.0	0.625	16.12	0.0429	0.4322
	10:30	96.0	0.625	16.12	0.0429	0.4322
6-8-83	12:30	96.0	0.625	16.12	0.0491	0.4947
(A.M.)	03:05	95.0	0.632	16.12	0.1348	1.3733
	08:05	PUMP OFF	TOTAL PUMPING TIME = 2,800 min			
				Weighted Average Q = 10.155 G.P.M.		


MATCH POINT
W(U_A) = 1
U_A = 1
t = .027 days
s = .22 ft.
Γ = .1
TIME-DRAWDOWN TEST SITE 88
AQUIFER TEST PIT
T = Q/(4π s) W(U_A) = 1955 x 1 / (4 x 3.14 x .22)
T = 708 ft²/day = 5296 gpd/ft.
6/6/83 = 6/8/83
DRAWDOWN (FEET)
TIME (MINUTES)
1
10
100
1,000
10,000
.01
1.0
10

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 36 (N.) S., R. 19 (E.) W., Sec. 29 WELL NO. 88

Personnel Cochran Driller Sergent, Hauskins & Beckwith

Test type: 1. Single well drawdown 2. Single well recovery (3) Drawdown with obs. well 1
4. Recovery with obs. well 5. Other (specify)

Total well depth 40 ft. Well diameter 12 in. Casing diameter 4 in.

Casing type PVC Type of screen or perforation saw slots

Interval of screen or perforation 24-34 Pump hp. & type 1/3 h.p Berkeley

Pump depth 3.0 ft. Aquifer Alluvium Aquifer lithology Silt, Sand and Gravel

Altitude of land surface _____ How determined _____

MP Above/Below LSD _____ Altitude MP _____

SWL from MP _____ How measured Stevens digital recorder

DATE	TIME	DEPTH TO WATER LEVEL			TIME SINCE PUMP ON t, mins.	RESIDUAL DRAWDOWN feet
6-6-83	09:25	0.00	Pump On		-	0.00
(A.M.)	09:26	0.01			1	0.01
	09:27	0.02			2	0.02
	09:28	0.02			3	0.02
	09:29	0.03			4	0.03
	09:30	0.04			5	0.04
	09:31	0.04			6	0.04
	09:32	0.04			7	0.04
	09:33	0.04			8	0.04
	09:34	0.04			9	0.04
	09:35	0.04			10	0.04
	09:37	0.03			12	0.03
	09:40	0.04			15	0.04
	09:43	0.04			18	0.04
	09:45	0.04			20	0.04
	09:50	0.04			25	0.04
	09:55	0.05			30	0.05
	10:00	0.06			35	0.06
	10:05	0.06			40	0.06
	10:15	0.06			50	0.06
	10:25	0.06			60	0.06
	10:35	0.07			70	0.07
	10:45	0.08			80	0.08
	10:55	0.07			90	0.07
	11:05	0.09			100	0.09
	11:25	0.09			120	0.09
	11:45	0.09			140	0.09

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 36 (N.) S., R. 19 (E.) W., Sec. 29 WELL NO. 88

Personnel Cochran Driller Sergent, Hauskins & Beckwith

Test type: 1. Single well drawdown 2. Single well recovery (3) Drawdown with obs. well 1
4. Recovery with obs. well (5.) Other (specify)

Total well depth 40 ft. Well diameter 12 in. Casing diameter 4 in.

Casing type PVC Type of screen or perforation saw slots

Interval of screen or perforation 24-34 Pump hp. & type 1/3 h.p. Berkeley

Pump depth 3.0 ft. Aquifer Alluvium Aquifer lithology Silt, Sand and Gravel

Altitude of land surface _____ How determined _____

MP Above/Below LSD _____ Altitude MP _____

SWL from MP _____ How measured Stevens digital recorder

DATE	TIME	DEPTH TO WATER LEVEL			TIME SINCE PUMP ON t, mins.	RESIDUAL DRAWDOWN feet
6-6-83	12:05	0.10			160	0.10
(P.M.)	12:25	0.10			180	0.10
	12:45	0.10			200	0.10
	01:05	0.11			220	0.11
	01:25	0.10			240	0.10
	01:45	0.11			260	0.11
	02:05	0.10			280	0.10
	02:25	0.11			300	0.11
	03:15	0.12			350	0.12
	04:05	0.12			400	0.12
	04:55	0.13			450	0.13
	05:45	0.13			500	0.13
	06:35	0.13			550	0.13
	07:25	0.13			600	0.13
	09:05	0.11			700	0.11
	10:45	0.11			800	0.11
6-7-83	12:25	0.11			900	0.11
(A.M.)	02:05	0.12			1,000	0.12
	03:45	0.12			1,100	0.12
	05:25	0.12			1,200	0.12
	07:05	0.11			1,300	0.11
	08:45	0.11			1,400	0.11
	10:25	0.11			1,500	0.11
(P.M.)	12:05	0.11			1,600	0.11
	01:45	0.11			1,700	0.11
	03:25	0.11			1,800	0.11
	05:05	0.12			1,900	0.12

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 36 (N.) S., R. 19 (E.) W., Sec. 29 WELL NO. 88

Personnel Cochran Driller Sergent, Hauskins & Beckwith

Test type: 1. Single well drawdown 2. Single well recovery (3.) Drawdown with obs. well 1
4. Recovery with obs. well (5.) Other (specify)

Total well depth 40 ft. Well diameter 12 in. Casing diameter 4 in.

Casing type PVC Type of screen or perforation saw slots

Interval of screen or perforation 24-34 Pump hp. & type 1/3 h.p. Berkeley

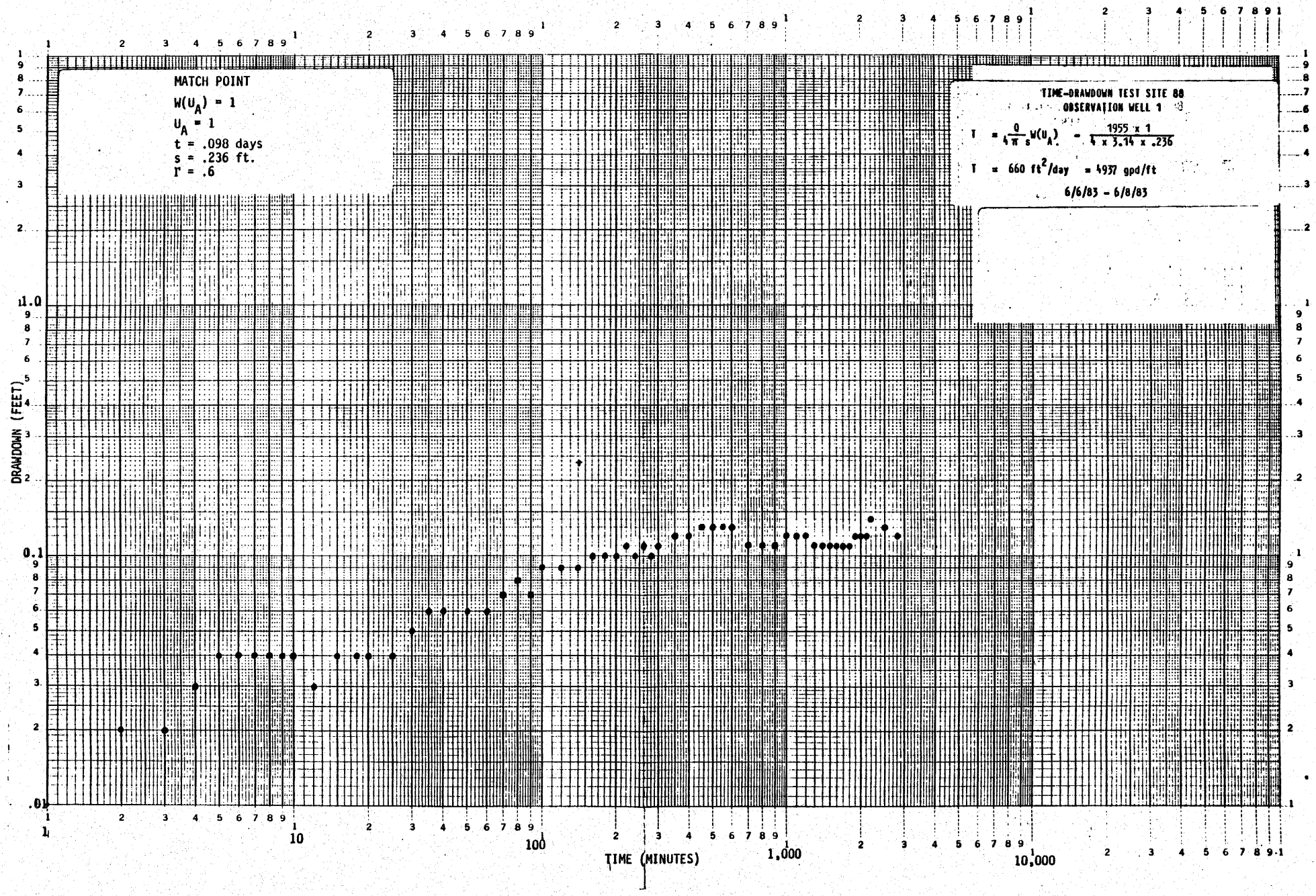
Pump depth 3.0 ft. Aquifer Alluvium Aquifer lithology Silt, Sand and Gravel

Altitude of land surface _____ How determined _____

MP Above/Below LSD _____ Altitude MP _____

SWL from MP _____ How measured Stevens digital recorder

DATE	TIME	DEPTH TO WATER LEVEL			TIME SINCE PUMP ON t, mins.	RESIDUAL DRAWDOWN feet
6-7-83	06:45	0.12			2,000	0.12
(P.M.)	08:25	0.12			2,100	0.12
	10:05	0.14			2,200	0.14
6-8-83	03:05	0.13			2,500	0.13
(A.M.)	08:05	0.12	Pump Off		2,800	0.12


MATCH POINT
W(U_A) = 1
U_A = 1
t = .098 days
s = .236 ft.
Γ = .6
TIME-DRAWDOWN TEST SITE 88
OBSERVATION WELL 1
T = Q/(4πs) W(U_A) = 1955 x 1 / (4 x 3.14 x .236)
T = 660 ft²/day = 4937 gpd/ft
6/6/83 - 6/8/83
DRAWDOWN (FEET)
TIME (MINUTES)
1.0
0.1
.01
1
10
100
1,000
10,000

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 35 (N.) S., R. 18 (E.) W., Sec. 20 WELL NO. 95

Personnel Roznovak Driller Sergent, Hauskins & Beckwith

Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well (5.) Other (specify) Aquifer Pit Test

Total well depth 31 ft. Well diameter 12 in. Casing diameter 4 in.

Casing type PVC Type of screen or perforation saw slots

Interval of screen or perforation 21' - 31' Pump hp. & type 1/2 h.p. Berkeley

Pump depth 4.0 ft. Aquifer Alluvium Aquifer lithology Silt, Sand and Gravel

Altitude of land surface _____ How determined _____

MP Above/Below LSD _____ Altitude MP _____

SWL from MP 2.91 How measured Stevens staff gage

DATE	TIME	DEPTH TO WATER LEVEL	STAFF GAGE READING		TIME SINCE PUMP ON t, mins.	RESIDUAL DRAWDOWN feet
11-28-83	12:25	0.00	2.91	Pump On	-	0.00
(P.M.)	12:26	0.00	2.91		1	0.00
	12:27	0.00	2.91		2	0.00
	12:28	0.01	2.90		3	0.01
	12:29	0.01	2.90		4	0.01
	12:30	0.02	2.89		5	0.02
	12:31	0.02	2.89		6	0.02
	12:32	0.03	2.88		7	0.03
	12:33	0.04	2.87		8	0.04
	12:35	0.05	2.86		10	0.05
	12:37	0.07	2.84		12	0.07
	12:40	0.09	2.82		15	0.09
	12:43	0.11	2.80		18	0.11
	12:45	0.13	2.78		20	0.13
	12:50	0.16	2.75		25	0.16
	12:55	0.20	2.71		30	0.20
	01:00	0.23	2.68		35	0.23
	01:05	0.26	2.65		40	0.26
	01:10	0.29	2.62		45	0.29
	01:15	0.31	2.60		50	0.31
	01:20	0.33	2.58		55	0.33
	01:25	0.36	2.55		60	0.36
	01:35	0.41	2.50		70	0.41
	01:45	0.46	2.45		80	0.46
	01:55	0.50	2.41		90	0.50
	02:05	0.54	2.37		100	0.54
	02:25	0.61	2.30		120	0.61
	02:45	0.67	2.24		140	0.67

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 35 (N.) S., R. 18 (E.) W., Sec. 20 WELL NO. 95

Personnel Roznovak Driller Sergent, Hauskins & Beckwith

Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well (5.) Other (specify) Aquifer Pit Test

Total well depth 31 ft. Well diameter 12 in. Casing diameter 4 in.

Casing type PVC Type of screen or perforation saw slots

Interval of screen or perforation 21' - 31' Pump hp. & type 1/2 h.p. Berkeley

Pump depth 4.0 ft. Aquifer Alluvium Aquifer lithology Silt, Sand and Gravel

Altitude of land surface _____ How determined _____

MP Above/Below LSD _____ Altitude MP _____

SWL from MP 2.91 How measured Stevens staff gage

DATE	TIME	DEPTH TO WATER LEVEL	STAFF GAGE READING		TIME SINCE PUMP ON t, mins.	RESIDUAL DRAWDOWN feet
11-28-83	03:05	0.71	2.20		160	0.71
(P.M.)	03:25	0.76	2.15		180	0.76
	03:45	0.81	2.10		200	0.81
	04:05	0.85	2.06		220	0.85
	04:35	0.88	2.03		250	0.88
	05:05	0.91	2.00		280	0.91
	05:35	0.95	1.96		310	0.95
	06:05	0.94	1.97		340	0.94
	06:35	0.95	1.96		370	0.95
	07:05	0.97	1.94		400	0.97
	07:55	0.99	1.92		450	0.99
	08:45	1.03	1.88		500	1.03
	09:35	1.05	1.86		550	1.05
	10:25	1.07	1.84		600	1.07
	11:15	1.09	1.82		650	1.09
11-29-83	12:05	1.11	1.80		700	1.11
(A.M.)	12:55	1.13	1.78		750	1.13
	01:45	1.15	1.76		800	1.15
	03:25	1.17	1.74		900	1.17
	05:05	1.19	1.72		1,000	1.19
	06:45	1.21	1.70		1,100	1.21
	08:25	1.21	1.70		1,200	1.21
	10:05	1.21	1.70		1,300	1.21
	11:45	1.21	1.70		1,400	1.21
(P.M.)	01:25	1.21	1.70		1,500	1.21
	04:45	1.21	1.70		1,700	1.21
	08:05	1.21	1.70		1,900	1.21
	11:25	1.22	1.69		2,100	1.22

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 35 (N.) S., R. 18 (E.) W., Sec. 20 WELL NO. 95

Personnel Roznovak Driller Sergent, Hauskins & Beckwith

Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well Recovery with obs. well (5) Other (specify) Aquifer Pit Test

Total well depth 31 ft. Well diameter 12 in. Casing diameter 4 in.

Casing type PVC Type of screen or perforation saw slots

Interval of screen or perforation 21' - 31' Pump hp. & type 1/2 h.p. Berkeley

Pump depth 4.0 ft. Aquifer Alluvium Aquifer lithology Silt, Sand and Gravel

Altitude of land surface _____ How determined _____

MP Above/Below LSD _____ Altitude MP _____

SWL from MP 2.91 How measured Stevens staff gage

DATE	TIME	DEPTH TO WATER LEVEL	STAFF GAGE READING		TIME SINCE PUMP ON t, mins.	RESIDUAL DRAWDOWN feet
11-30-83	02:45		1.68		2,300	1.23
(A.M.)	06:05		1.76		2,500	1.15
	11:05		1.74		2,800	1.17
(P.M.)	04:05		1.74		3,100	1.17
	09:05		1.74		3,400	1.17
12-1-83	02:05		1.72		3,700	1.19
(A.M.)	07:05		1.72		4,000	1.19
	08:40			Pump Off		

WATER WELL 95

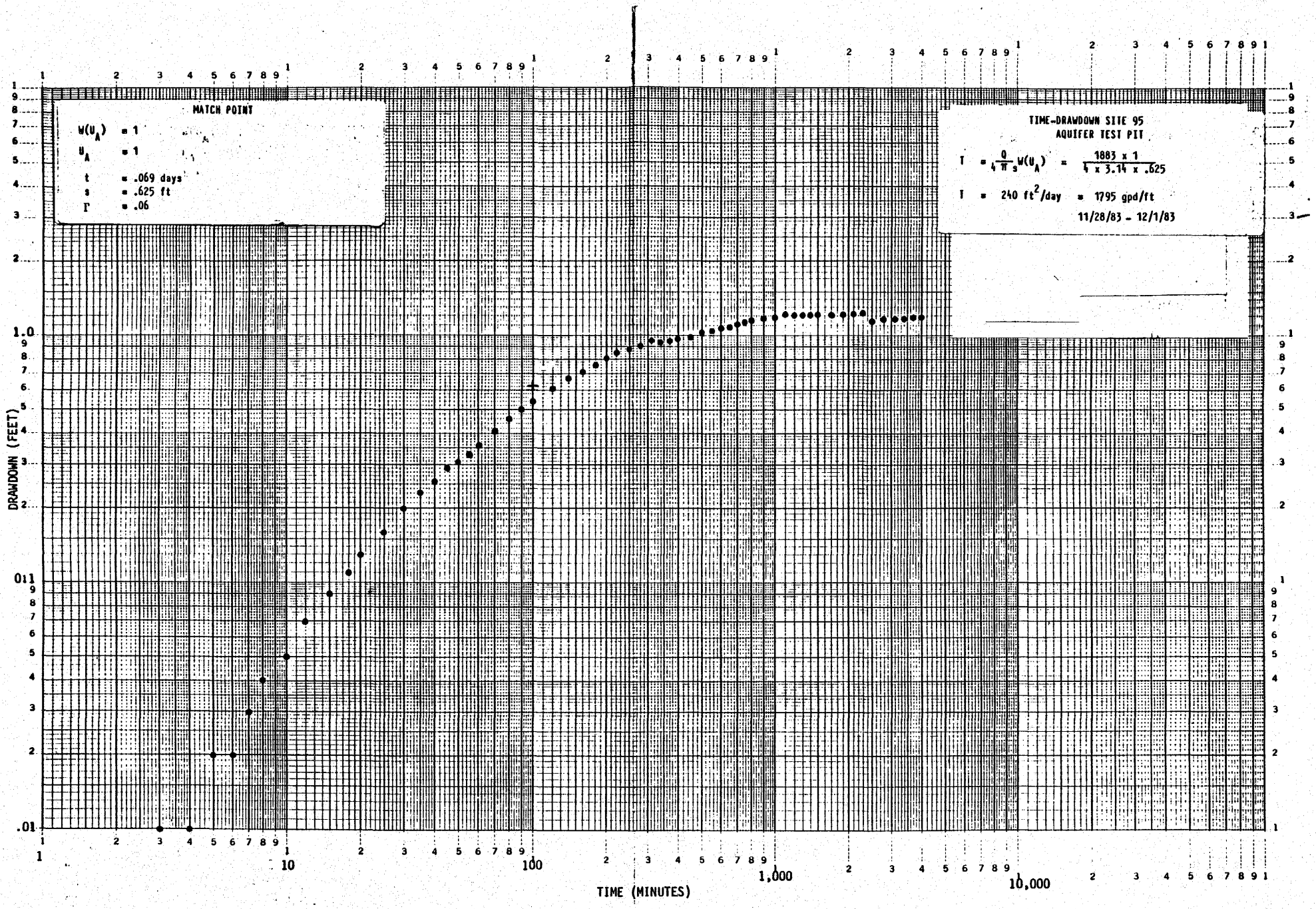
PUMPING RATE DATA

DATE	TIME TEST TAKEN	TEST DURATION SEC.	TEST DURATIONS PER MIN.	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
11-28-83	12:25	Pump On				
(P.M.)	12.42	100	.6000	16.12	.0066	.0638
	01:02	99	.6060	16.12	.0049	.0479
	01:22	100	.6000	16.12	.0046	.0444
	01:40	100	.6000	16.12	.0046	.0444
	02:00	100	.6000	16.12	.0061	.0590
	02:30	100	.6000	16.12	.0073	.0706
	03:00	100	.6000	16.12	.0073	.0706
	03:30	99	.6060	16.12	.0073	.0713
	04:00	100	.6000	16.12	.0073	.0706
	04:30	99	.6060	16.12	.0073	.0713
	05:00	100	.6000	16.12	.0073	.0706
	05:30	97	.6186	16.12	.0073	.0730
	06:00	97	.6186	16.12	.0043	.0429
	06:05	97	.6186	16.12	.0043	.0429
	06:35	98	.6122	16.12	.0073	.0720
	07:05	97	.6186	16.12	.0067	.0670
	07:30	97	.6186	16.12	.0104	.1037
	08:30	98	.6122	16.12	.0147	.1450
	09:30	97	.6186	16.12	.0183	.1825
	11:00	97	.6186	16.12	.0183	.1825
11-29-83	12:00	98	.6122	16.12	.0183	.1806
(A.M.)	01:30	98	.6122	16.12	.0256	.2526
	03:30	98	.6122	16.12	.0256	.2526
	05:00	97	.6186	16.12	.0256	.2553
	07:00	98	.6122	16.12	.0256	.2526
	08:30	97	.6186	16.12	.0219	.2184
	10:00	97	.6186	16.12	.0256	.2553
(P.M.)	12:00	99	.6060	16.12	.0256	.2500
	01:30	99	.6060	16.12	.0293	.2862
	04:30	99	.6060	16.12	.0513	.5011
	08:30	99	.6060	16.12	.0513	.5011

WATER WELL 95

PUMPING RATE DATA

DATE	TIME TEST TAKEN	TEST DURATION SEC.	TEST DURATIONS PER MIN.	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
	11:30	97	.6186	16.12	.0476	.4747
11-30-83	03:00	99	.6060	16.12	.0549	.5363
(A.M.)	07:00	99	.6060	16.12	.0586	.5724
	11:00	100	.6000	16.12	.0586	.5668
(P.M.)	03:00	100	.6000	16.12	.0366	.3540
	04:00	99	.6060	16.12	.0586	.5729
	11:00	100	.6000	16.12	.0806	.7796
12-1-83	03:00	96	.6250	16.12	.0586	.5904
(A.M.)	07:00	98	.6122	16.12	.0537	.5299
	08:40		PUMP OFF			
			WT. AVG. Q =	9.78 G.P.M		


MATCH POINT
W(U_A) = 1
U_A = 1
t = .069 days
s = .625 ft
Γ = .06
TIME-DRAWDOWN SITE 95
AQUIFER TEST PIT
T = Q/(4πs) W(U_A) = 1883 x 1 / (4 x 3.14 x .625)
T = 240 ft²/day = 1795 gpd/ft
11/28/83 - 12/1/83
DRAWDOWN (FEET)
TIME (MINUTES)
1.0
.01
1
10
100
1,000
10,000

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 35 (N.) S., R. 18 (E.) W., Sec. 20 WELL NO. 95

Personnel Roznovak Driller Sergent, Hauskins, Beckwith

Test type: 1. Single well drawdown 2. Single well recovery (3.) Drawdown with obs. well 1
4. Recovery with obs. well 5. Other (specify)

Total well depth 31 ft. Well diameter 12.0 in. Casing diameter 4.0 in.

Casing type pvc Type of screen or perforation saw slots

Interval of screen or perforation 21.0 - 31.0 ft. Pump hp. & type ½ h.p. Berkeley

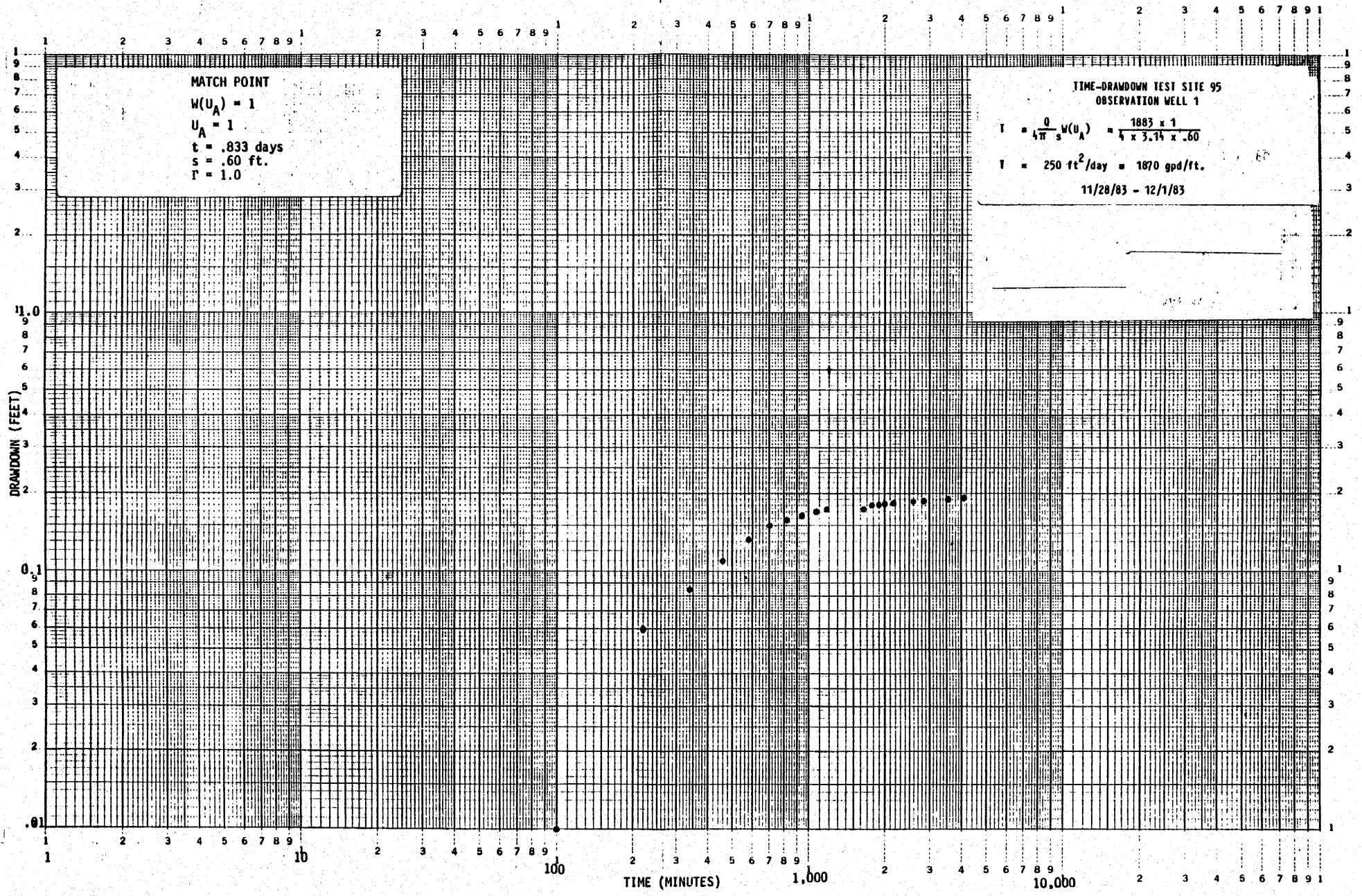
Pump depth 4.0 ft. Aquifer Alluvial Aquifer lithology Silt, Sand and Gravel

Altitude of land surface _____ How determined _____

MP Above/Below LSD _____ Altitude MP _____

SWL from MP _____ How measured Stevens type- F recorder

DATE	TIME	DEPTH TO WATER LEVEL	STAFF GAGE READING		TIME SINCE PUMP ON t, mins.	RESIDUAL DRAWDOWN feet
11-28-83	12:25	0.00	Pump on		-	0.00
(P.M.)	2:05	0.01			100	0.01
	4:05	0.06			220	0.06
	6:05	0.085			340	0.085
	8:05	0.11			460	0.11
	10:05	0.132			580	0.132
11-29-83	12:05	0.15			700	0.15
(A.M.)	2:05	0.158			820	0.158
	3:45	0.163			920	0.163
	6:25	0.17			1,080	0.17
	8:05	0.173			1,180	0.173
(P.M.)	3:55	0.173			1,650	0.173
	6:05	0.18			1,780	0.18
	8:05	0.181			1,900	0.181
	9:45	0.182			2,000	0.182
11-30-83	12:25	0.184			2,160	0.184
(A.M.)	7:45	0.186			2,600	0.186
	11:55	0.188			2,850	0.188
(P.M.)	11:35	0.19			3,550	0.19
12-1-83	8:40	0.192	Pump off		4,095	0.192
(A.M.)						


MATCH POINT
W(U_A) = 1
U_A = 1
t = .833 days
s = .60 ft.
Γ = 1.0
TIME-DRAWDOWN TEST SITE 95
OBSERVATION WELL 1
T = Q/(4π s) W(U_A) = 1883 x 1 / (4 x 3.14 x .60)
T = 250 ft²/day = 1870 gpd/ft.
11/28/83 - 12/1/83
DRAWDOWN (FEET)
TIME (MINUTES)
1.0
0.1
.01
1
10
100
1,000
10,000

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 35 N. S., R. 18 E. W., Sec. 20 WELL NO. 95

Personnel Roznovak Driller Sergent, Hauskins, Beckwith

Test type: 1. Single well drawdown 2. Single well recovery (3) Drawdown with obs. well 2
4. Recovery with obs. well 5. Other (specify)

Total well depth 31 ft. Well diameter 12 in. Casing diameter 4 in.

Casing type pvc Type of screen or perforation saw slots

Interval of screen or perforation 21' - 31' Pump hp. & type 1/2 h.p. Berkeley

Pump depth 4.0 ft. Aquifer Alluvium Aquifer lithology Silt, Sand and Gravel

Altitude of land surface _____ How determined _____

MP Above Below LSD _____ Altitude MP _____

SWL from MP 10.87 How measured Sinco water level indicator

DATE	TIME	DEPTH TO WATER LEVEL	STAFF GAGE READING		TIME SINCE PUMP ON t, mins.	RESIDUAL DRAWDOWN feet
11-28-83	12:25	10.87		Pump On	-	0.00
(P.M.)	12:26	10.87			1	0.00
	12:27	10.87			2	0.00
	12:28	10.87			3	0.00
	12:29	10.87			4	0.00
	12:30	10.87			5	0.00
	12:31	10.87			6	0.00
	12:32	10.87			7	0.00
	12:33	10.87			8	0.00
	12:35	10.87			10	0.00
	12:37	10.87			12	0.00
	12:40	10.88			15	0.01
	12:43	10.88			18	0.01
	12:45	10.88			20	0.01
	12:50	10.88			25	0.01
	12:55	10.88			30	0.01
	01:00	10.89			35	0.02
	01:05	10.89			40	0.02
	01:10	10.90			45	0.03
	01:15	10.90			50	0.03
	01:20	10.90			55	0.03
	01:25	10.91			60	0.04
	01:35	10.92			70	0.05
	01:45	10.93			80	0.06
	01:55	10.93			90	0.06
	02:05	10.94			100	0.07
	02:25	10.95			120	0.08
	02:45	10.96			140	0.09

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 35 (N.) S., R. 18 (E.) W., Sec. 20 WELL NO. 95

Personnel Roznovak Driller Sergent, Hauskins, Beckwith

Test type: 1. Single well drawdown 2. Single well recovery (3.) Drawdown with obs. well 2 4. Recovery with obs. well 5. Other (specify)

Total well depth 31 ft. Well diameter 12 in. Casing diameter 4 in.

Casing type pvc Type of screen or perforation saw slots

Interval of screen or perforation 21' - 31' Pump hp. & type 1/2 h.p. Berkeley

Pump depth 4.0 ft. Aquifer Alluvium Aquifer lithology Silt, Sand and Gravel

Altitude of land surface — How determined —

MP Above/Below LSD — Altitude MP —

SWL from MP 10.87 How measured Sinco water level indicator

DATE	TIME	DEPTH TO WATER LEVEL	STAFF GAGE READING		TIME SINCE PUMP ON t, mins.	RESIDUAL DRAWDOWN feet
11-28-83	03:05	10.97			160	0.10
(P.M.)	03:25	10.99			180	0.12
	03:45	11.00			200	0.13
	04:05	11.01			220	0.14
	04:35	11.05			250	0.18
	05:05	11.06			280	0.19
	05:35	11.03			310	0.16
	06:05	11.04			340	0.17
	06:35	11.07			370	0.20
	07:05	11.08			400	0.21
	07:55	11.10			450	0.23
	08:45	11.12			500	0.25
	09:35	11.12			550	0.25
	10:25	11.11			600	0.24
	11:15	11.11			650	0.24
11-29-83	12:05	11.13			700	0.26
(A.M.)	12:55	11.14			750	0.27
	01:45	11.16			800	0.29
	03:25	11.16			900	0.29
	05:05	11.16			1,000	0.29
	06:45	11.17			1,100	0.30
	08:25	11.17			1,200	0.30
	10:05	11.17			1,300	0.30
	11:45	11.17			1,400	0.30
(P.M.)	01:25	11.17			1,500	0.30
	04:45	11.17			1,700	0.30
	08:05	11.17			1,900	0.30
	11:25	11.18			2,100	0.31

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 35 (N.) S., R. 18 (E.) W., Sec. 20 WELL NO. 95

Personnel Roznovak Driller Sergent, Hauskins, Beckwith

Test type: 1. Single well drawdown 2. Single well recovery (3.) Drawdown with obs. well 2
4. Recovery with obs. well 5. Other (specify)

Total well depth 31 ft. Well diameter 12 in. Casing diameter 4 in.

Casing type pvc Type of screen or perforation saw slots

Interval of screen or perforation 21' - 31' Pump hp. & type 1/2 h.p. Berkeley

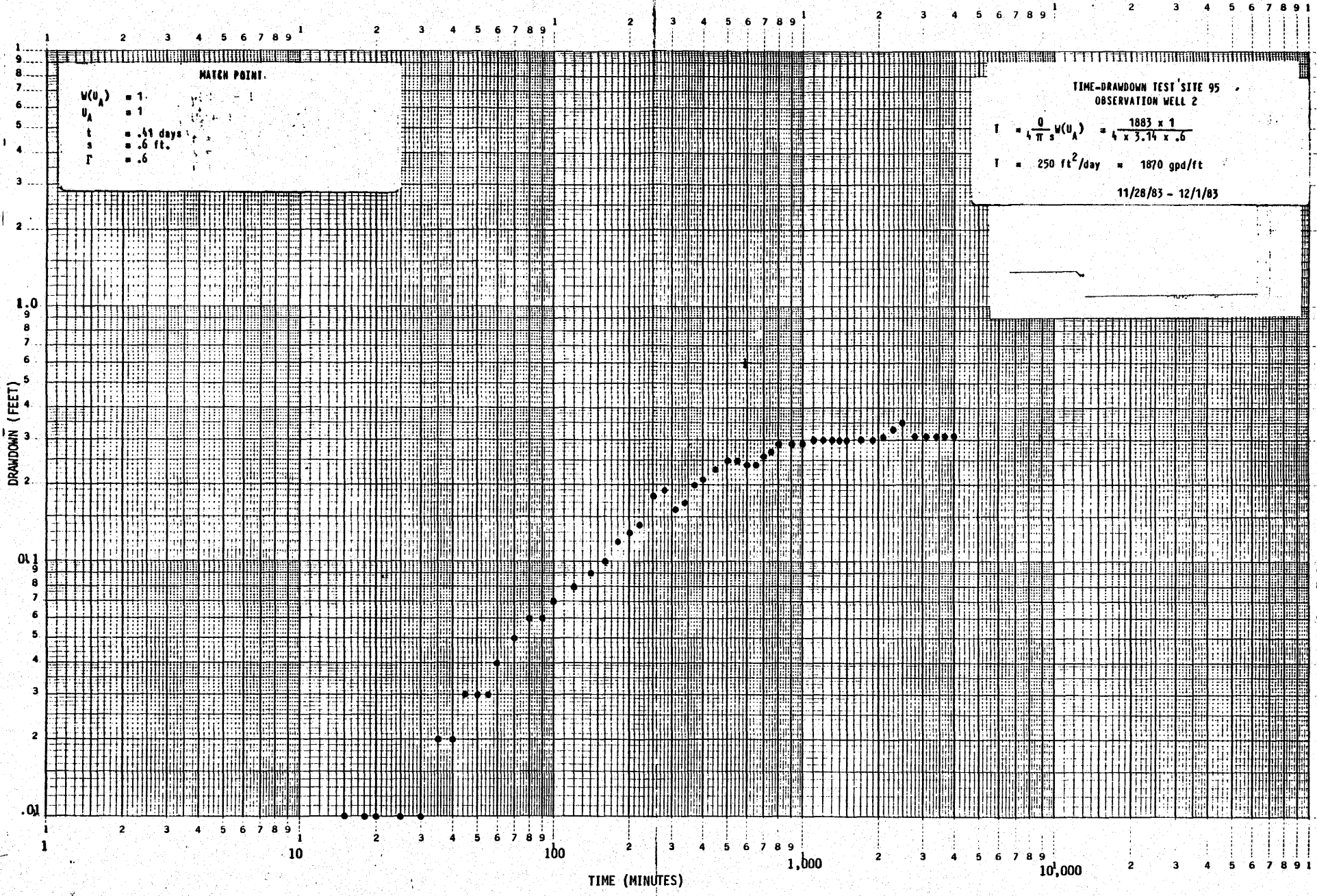
Pump depth 4.0 ft. Aquifer Alluvium Aquifer lithology Silt, Sand and Gravel

Altitude of land surface _____ How determined _____

MP Above/Below LSD _____ Altitude MP _____

SWL from MP 10.87 How measured Sinco water level indicator

DATE	TIME	DEPTH TO WATER LEVEL	STAFF GAGE READING		TIME SINCE PUMP ON t, mins.	RESIDUAL DRAWDOWN feet
11-30-83	02:45	11.20			2,300	0.33
(A.M.)	06:05	11.22			2,500	0.35
	11:05	11.18			2,800	0.31
(P.M.)	04:05	11.18			3,100	0.31
	09:05	11.18			3,400	0.31
12-1-83	02:05	11.18			3,700	0.31
(A.M.)	07:05	11.18			4,000	0.31
	08:40			Pump Off		


MATCH POINT.
W(U_A) = 1
U_A = 1
t = .41 days
s = .6 ft.
Γ = .6
TIME-DRAWDOWN TEST SITE 95
OBSERVATION WELL 2
T = Q/(4πs) W(U_A) = 1883 x 1 / (4 x 3.14 x .6)
T = 250 ft²/day = 1870 gpd/ft
11/28/83 - 12/1/83
DRAWDOWN (FEET)
TIME (MINUTES)
1.0
.01
1
10
100
1,000
10,000

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 35 N. S., R. 19 E. W., Sec. 3 WELL NO. 100R

Personnel Smith & Freund Driller Sergent, Hauskins & Beckwith

Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specify) Slug injection

Total Well Depth 40 ft. Well diameter 6½ in. Casing diameter 2 in.

Casing type PVC Type of screen or perforation saw slot

Interval of screen or perforation 10' to 40' Pump hp. & type

Pump depth ft. Aquifer alluvial Aquifer lithology alluvial material

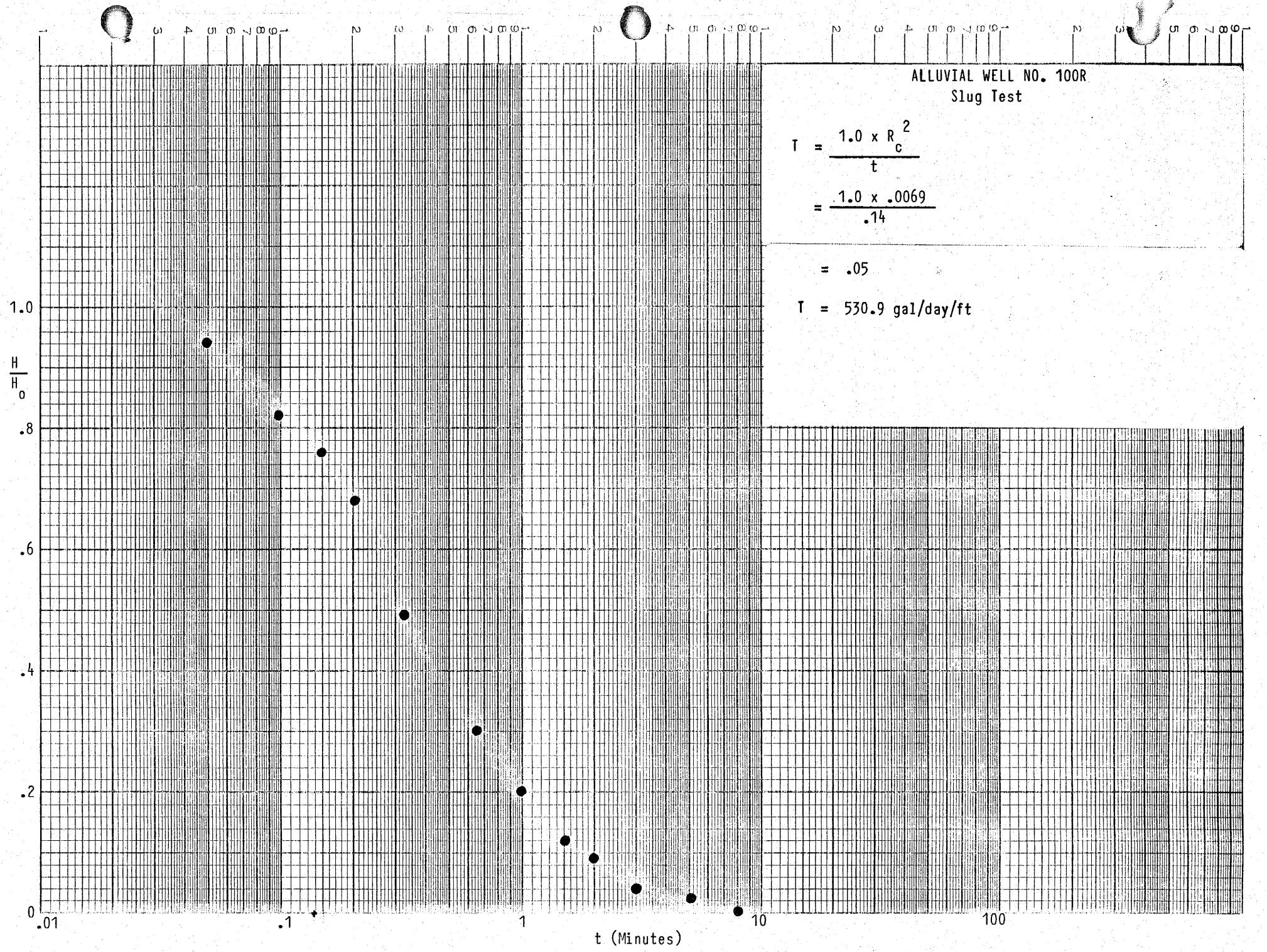
Altitude of land surface How determined surveyed

MP Above Below LSD Altitude MP

SWL from MP How measured

Static Transducer Reading = 7.44

DATE	TIME (MINS)	TRANSDUCER READINGS	Ho (ft)	H/Ho
9-5-85	0	10.08	2.64	1.0
	.05	9.92		.94
	.10	9.61		.82
	.15	9.44		.76
	.20	9.24		.68
	.33	8.74		.49
	.67	8.24		.30
	1.0	7.96		.20
	1.5	7.75		.12
	2.0	7.67		.09
	3.0	7.55		.04
	5.0	7.49		.02
	8.0	7.45		.003


ALLUVIAL WELL NO. 100R
Slug Test
T = 1.0 x R_c^2 / t
= 1.0 x .0069 / .14
= .05
T = 530.9 gal/day/ft
H/H_o
1.0
.8
.6
.4
.2
0
.01
.1
1
10
100
t (Minutes)

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 35 N. S., R. 19 E. W., Sec. 18 WELL NO. 102

Personnel Smith & Freund Driller Sergent, Hauskins & Beckwith

Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specify) slug injection

Total Well Depth 39.6 ft. Well diameter 6½ in. Casing diameter 2 in.

Casing type PVC Type of screen or perforation saw slot

Interval of screen or perforation 15' to 35' Pump hp. & type

Pump depth ft. Aquifer alluvial Aquifer lithology alluvial material

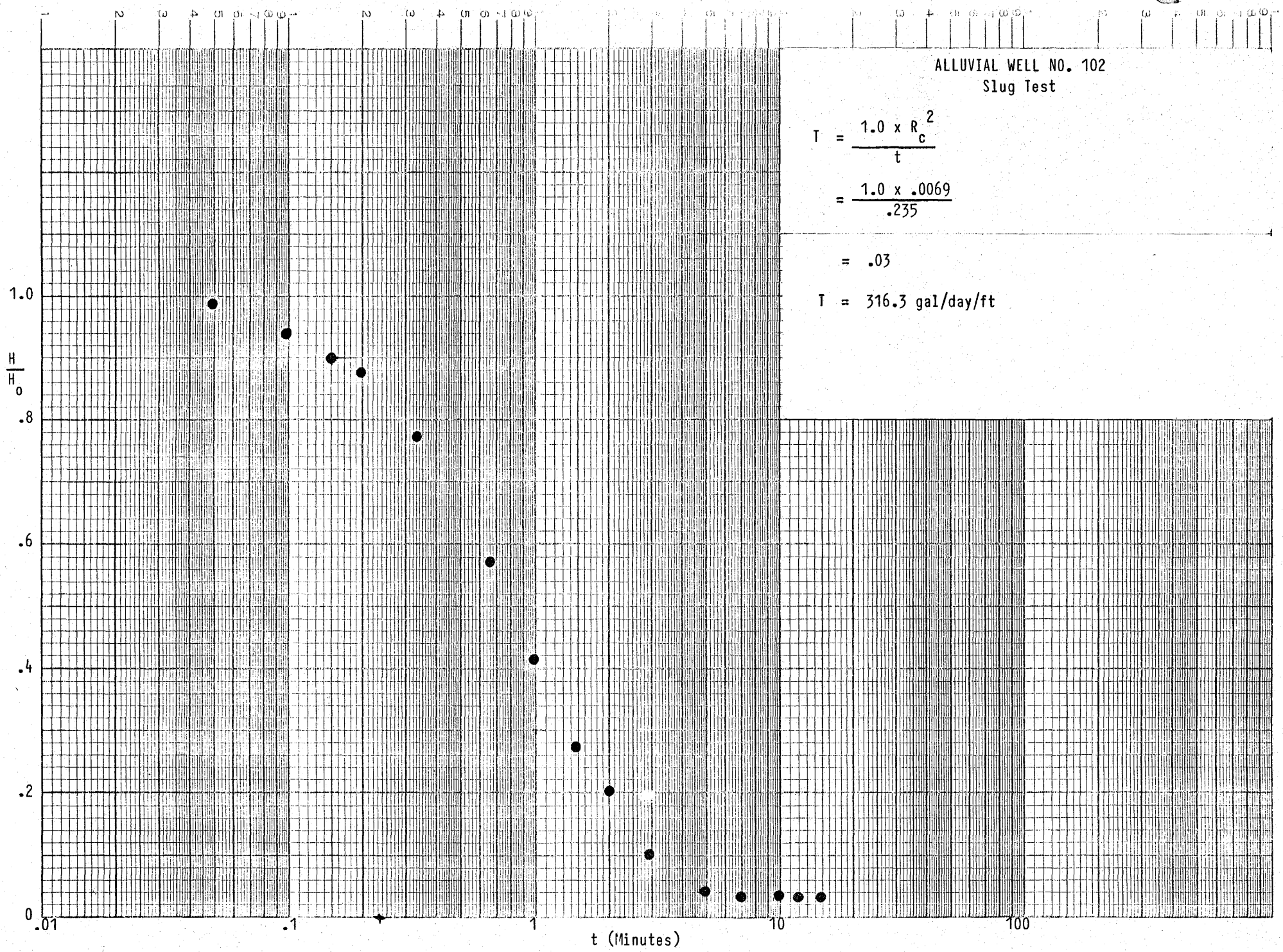
Altitude of land surface How determined surveyed

MP Above Below LSD Altitude MP

SWL from MP How measured

Static Transducer Reading = 12.39

DATE	TIME (MINS)	TRANSDUCE READINGS	Ho (ft)	H/Ho
9-14-85	0	13.09	.70	1.00
	.05	13.08		.99
	.10	13.05		.94
	.15	13.02		.90
	.20	13.00		.87
	.33	12.93		.77
	.67	12.79		.57
	1.0	12.68		.41
	1.5	12.58		.27
	2.0	12.53		.20
	3.0	12.46		.10
	5.0	12.42		.04
	7.0	12.41		.03
	10.0	12.41		.03
	12.0	12.41		.03
	15.0	12.41		.03



ALLUVIAL WELL NO. 102
Slug Test

$$T = \frac{1.0 \times R_c^2}{t}$$

$$= \frac{1.0 \times .0069}{.235}$$

$$= .03$$

$$T = 316.3 \text{ gal/day/ft}$$

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 35 N. S., R. 18 E. W., Sec. 14 WELL NO. 103

Personnel Smith & Freund Driller Sergent, Hauskins & Beckwith

Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specify) slug injection

Total Well Depth 25 ft. Well diameter 6½ in. Casing diameter 2 in.

Casing type PVC Type of screen or perforation saw slot

Interval of screen or perforation 11' to 21' Pump hp. & type

Pump depth ____ ft. Aquifer alluvial Aquifer lithology alluvial material

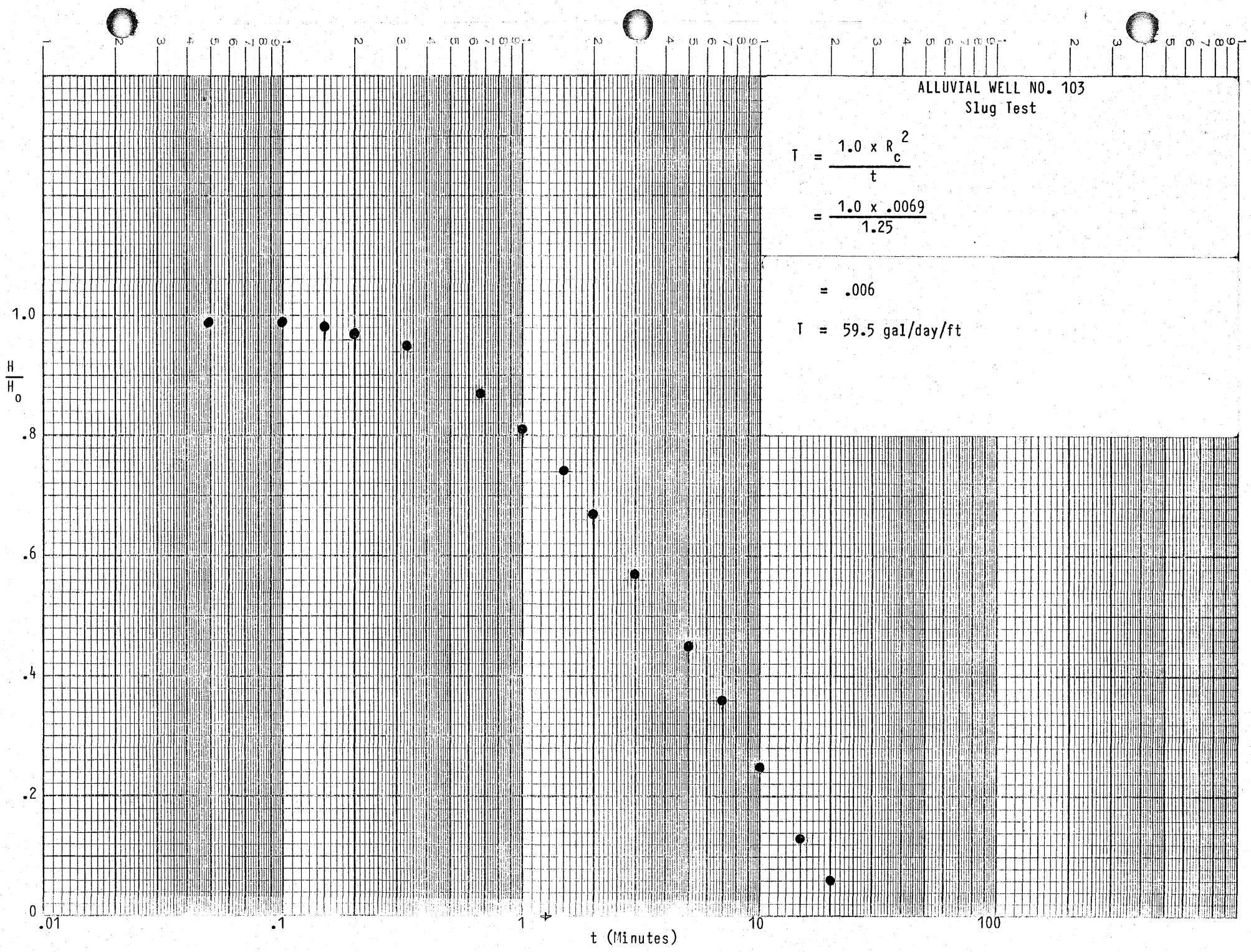
Altitude of land surface ____ How determined surveyed

MP Above Below LSD ____ Altitude MP ____

SWL from MP ____ How measured ____

Static Transducer Reading = .87

DATE	TIME (MINS)	TRANSDUCER READINGS	Ho (ft)	H/Ho
9-14-85	0	1.97	1.10	1.00
	.05	1.96		.99
	.10	1.96		.99
	.15	1.95		.98
	.20	1.94		.97
	.33	1.92		.95
	.67	1.83		.87
	1.0	1.76		.81
	1.5	1.68		.74
	2.0	1.61		.67
	3.0	1.50		.57
	5.0	1.37		.45
	7.0	1.27		.36
	10.0	1.15		.25
	12.0	1.08		.19
	15.0	1.01		.13
	20.0	.93		.06


ALLUVIAL WELL NO. 103
Slug Test
$T = \frac{1.0 \times R_c^2}{t}$
$= \frac{1.0 \times .0069}{1.25}$
$= .006$
T = 59.5 gal/day/ft
$\frac{H}{H_o}$
1.0
.8
.6
.4
.2
0
.01
.1
1
10
100
t (Minutes)

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 35 N. S., R. 18 E. W., Sec. 33 WELL NO. 104

Personnel Smith & Freund Driller Sergent, Hauskins & Beckwith

Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specify) slug injection

Total Well Depth 39 ft. Well diameter 6½ in. Casing diameter 2 in.

Casing type PVC Type of screen or perforation saw slot

Interval of screen or perforation 17' to 32' Pump hp. & type

Pump depth ft. Aquifer Alluvial Aquifer lithology alluvial material

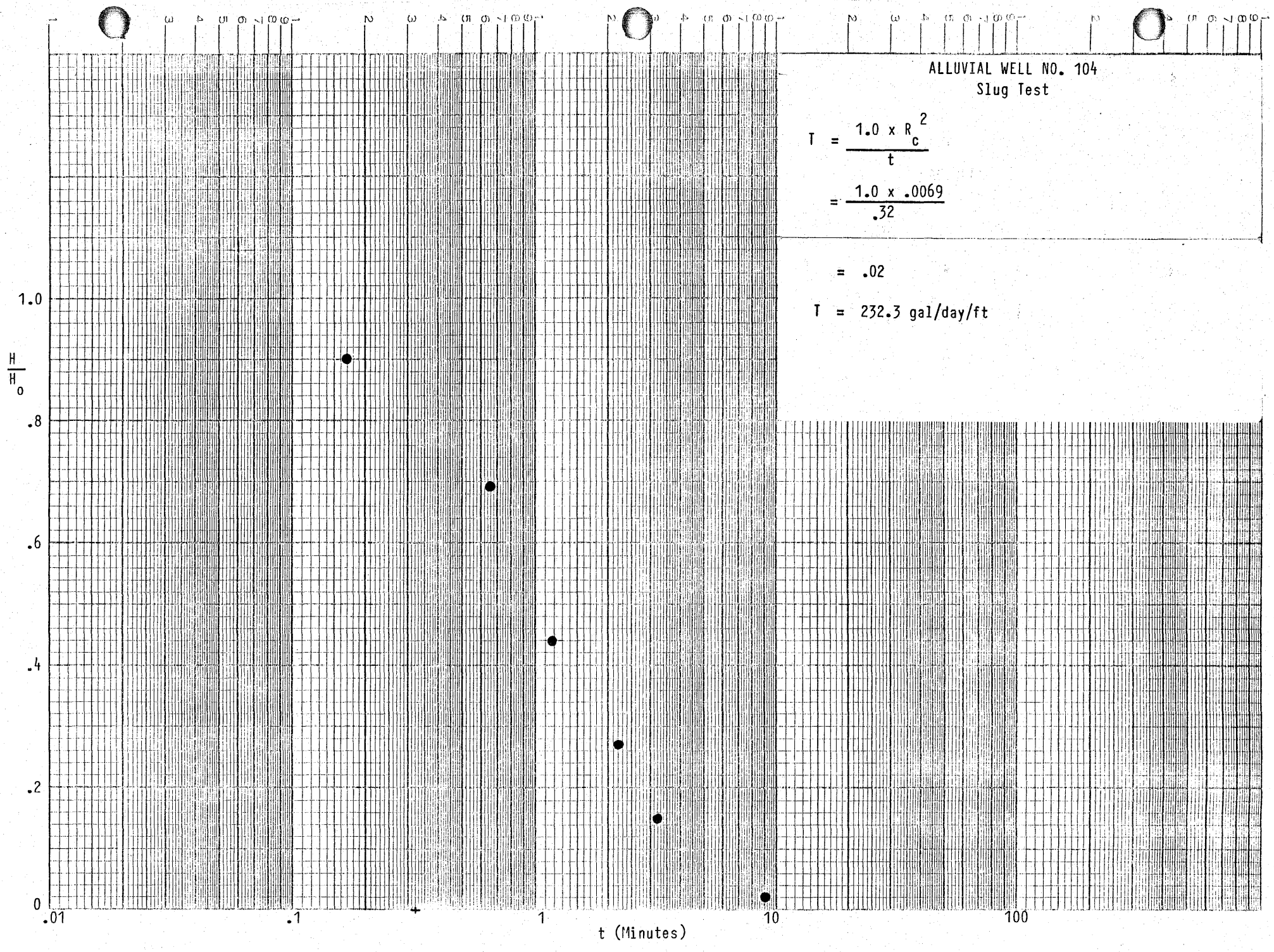
Altitude of land surface How determined surveyed

MP Above Below LSD Altitude MP

SWL from MP How measured

Static Transducer Reading = .44

DATE	TIME (MINS)	TRANSDUCER READINGS	Ho (ft)	H/Ho
9-14-85	.17	.92	.48	.90
	.67	.82		.69
	1.17	.70		.44
	2.17	.62		.27
	3.17	.56		.15
	9.17	.50		.02
	14.17	.49		.001


ALLUVIAL WELL NO. 104
Slug Test
$T = \frac{1.0 \times R_c^2}{t}$
$= \frac{1.0 \times .0069}{.32}$
$= .02$
T = 232.3 gal/day/ft
$\frac{H}{H_o}$
1.0
.8
.6
.4
.2
0
.01
.1
1
10
100
t (Minutes)

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 35 (N) S., R. 18 (E) W., Sec. 34 WELL NO. 105

Personnel Smith & Freund Driller Sergent, Hauskins & Beckwith

Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specify) slug injection

Total Well Depth 25 ft. Well diameter 6½ in. Casing diameter 2 in.

Casing type PVC Type of screen or perforation saw slot

Interval of screen or perforation 18' to 25' Pump hp. & type

Pump depth ft. Aquifer alluvial Aquifer lithology alluvial material

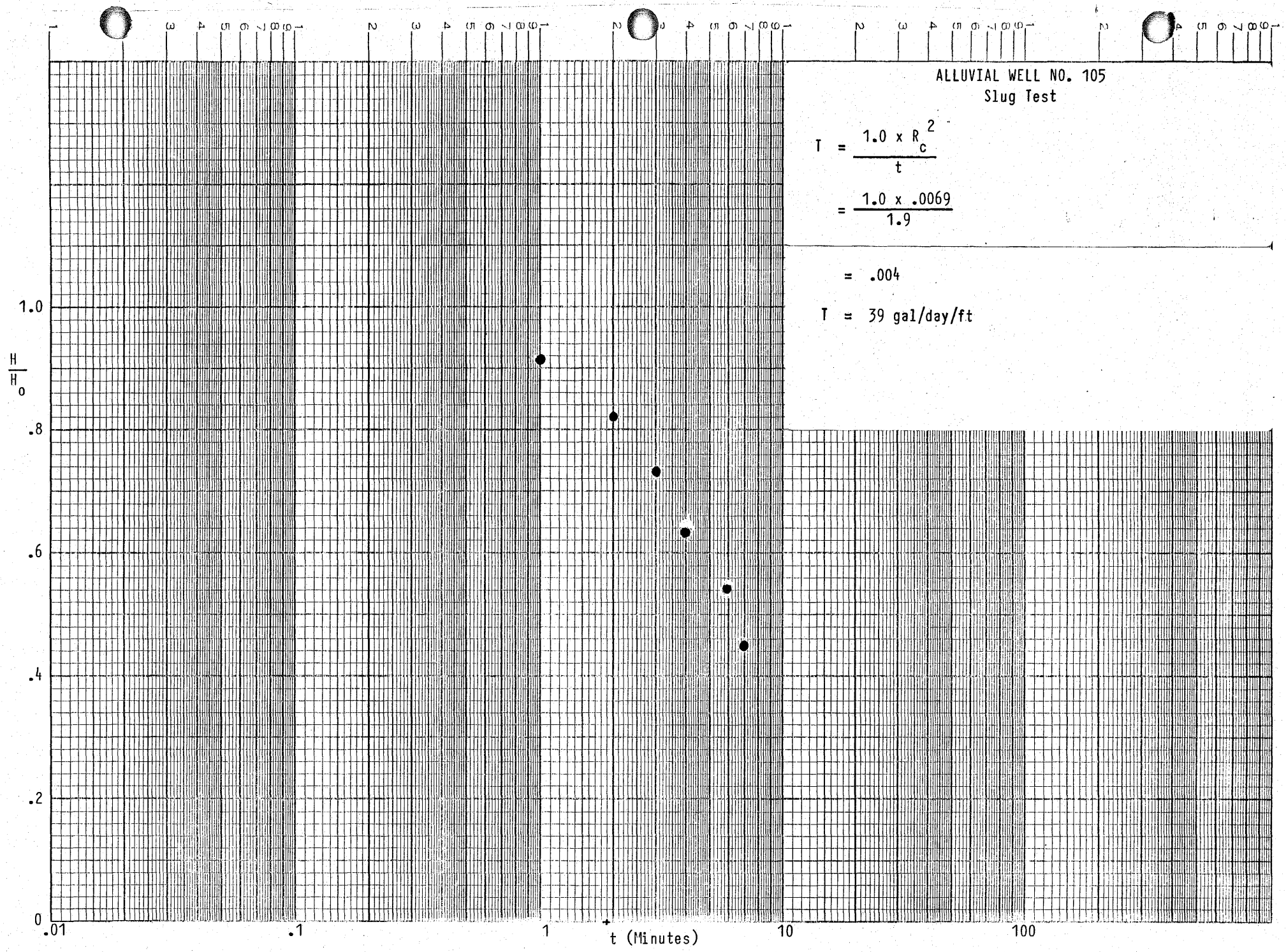
Altitude of land surface How determined surveyed

MP Above Below LSD Altitude MP

SWL from MP How measured

Static Transducer Reading = .44

DATE	TIME (MINS)	TRANSDUCER READINGS	Ho (ft)	H/Ho
9-14-85	1.0	.55	.11	.91
	2.0	.54		.82
	3.0	.53		.73
	4.0	.52		.63
	6.0	.51		.54
	7.0	.50		.45


ALLUVIAL WELL NO. 105
Slug Test
T = 1.0 x R_c^2 / t
= 1.0 x .0069 / 1.9
= .004
T = 39 gal/day/ft
H/H_o
1.0
.8
.6
.4
.2
0
.01
.1
1
10
100
t (Minutes)

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 35 N. S., R. 19 E. W., Sec. 13 WELL NO. 108

Personnel Smith & Freund Driller Sergent, Hauskins & Beckwith

Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specify) slug injection

Total Well Depth 45 ft. Well diameter 6½ in. Casing diameter 2 in.

Casing type PVC Type of screen or perforation saw slot

Interval of screen or perforation 28' to 43' Pump hp. & type

Pump depth ft. Aquifer Alluvial Aquifer lithology alluvial material

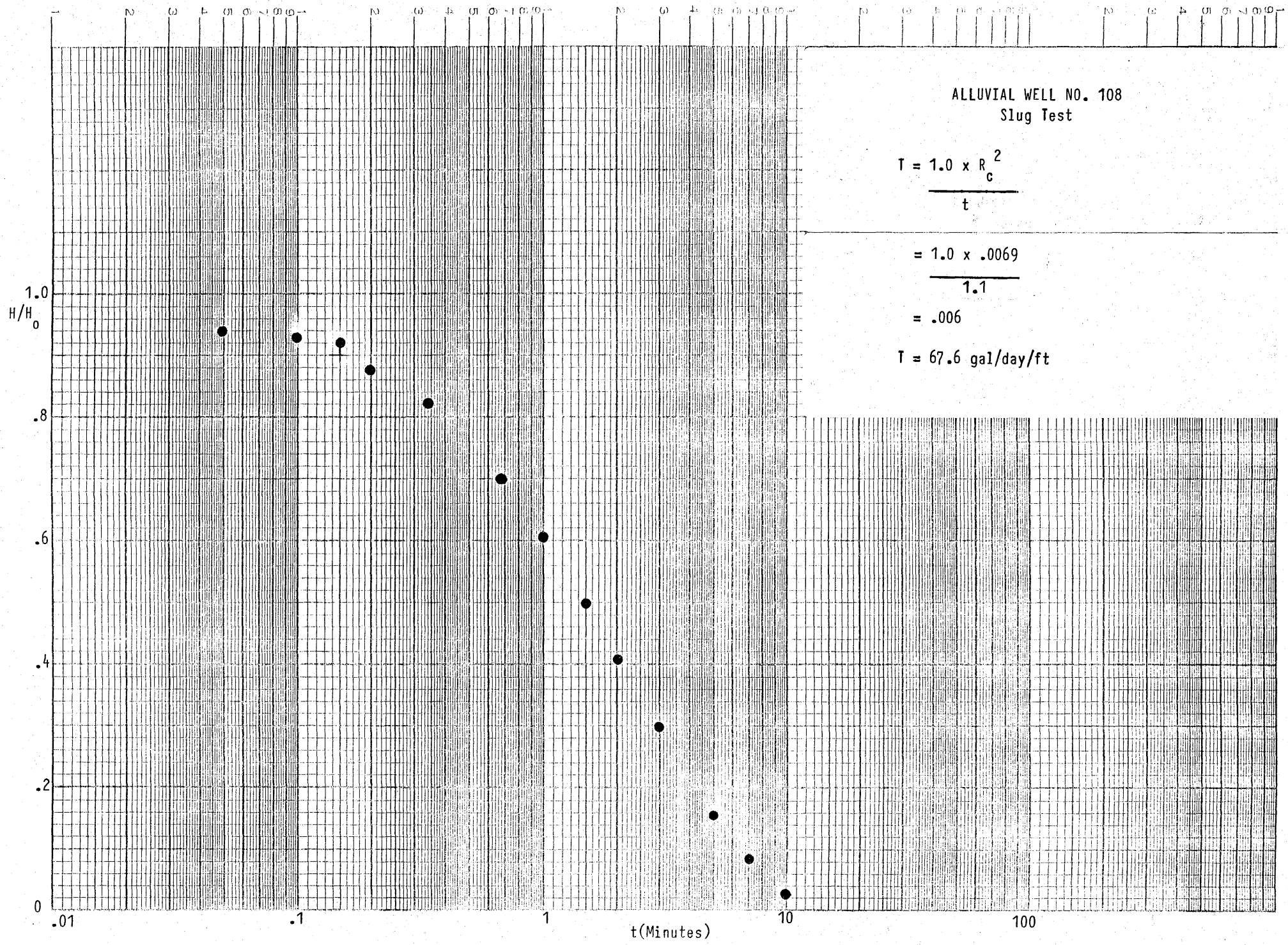
Altitude of land surface How determined surveyed

MP Above Below LSD Altitude MP

SWL from MP How measured

Static Transducer Reading = 2.11

DATE	TIME (MINS)	TRANSDUCER READINGS	Ho (ft)	H/Ho
9-5-85	0	4.44	2.33	1.00
	.05	4.30		.94
	.10	4.28		.93
	.15	4.27		.92
	.20	4.17		.88
	.33	4.02		.82
	.67	3.73		.70
	1.0	3.52		.61
	1.5	3.23		.50
	2.0	3.07		.41
	3.0	2.80		.30
	5.0	2.48		.16
	7.0	2.31		.09
	10.0	2.18		.03



ALLUVIAL WELL NO. 108
Slug Test

$$T = \frac{1.0 \times R_c^2}{t}$$

$$= \frac{1.0 \times .0069}{1.1}$$

$$= .006$$

$$T = 67.6 \text{ gal/day/ft}$$

PEABODY HYDROLOGIC TESTING AQUIFER TEST DATA

State Arizona County Navajo T. 35 N. S., R. 19 E. W., Sec. 26 WELL NO. 110R

Personnel Smith & Freund Driller Sergent, Hauskins & Beckwith

Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specify) Slug injection

Total Well Depth 40 ft. Well diameter 6½ in. Casing diameter 2 in.

Casing type PVC Type of screen or perforation saw slot

Interval of screen or perforation 27' to 37' Pump hp. & type

Pump depth ft. Aquifer Alluvial Aquifer lithology alluvial material

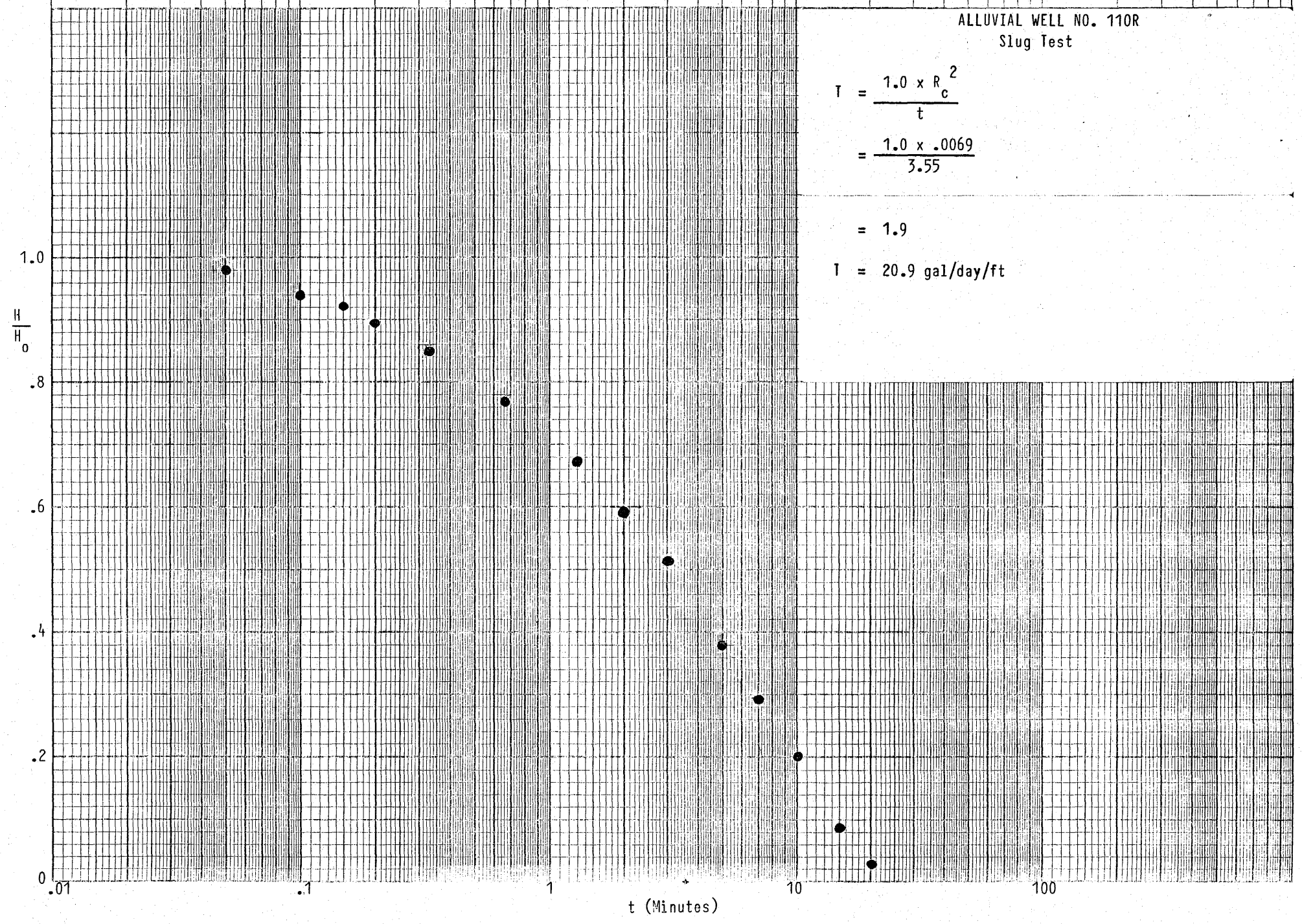
Altitude of land surface How determined surveyed

MP Above Below LSD Altitude MP

SWL from MP How measured

Static Transducer Reading = 3.98

DATE	TIME (MINS)	TRANSDUCER READINGS	Ho (ft)	H/Ho
9-5-85	0	6.48	2.50	1.00
	.05	6.42		.98
	.10	6.33		.94
	.15	6.27		.92
	.20	6.21		.89
	.33	6.10		.85
	.67	5.90		.77
	1.3	5.65		.67
	2.0	5.46		.59
	3.0	5.25		.51
	5.0	4.93		.38
	7.0	4.71		.29
	10.0	4.47		.20
	15.0	4.21		.09
	20.0	4.05		.03



ALLUVIAL WELL NO. 110R
Slug Test

$$T = \frac{1.0 \times R_c^2}{t}$$

$$= \frac{1.0 \times .0069}{3.55}$$

$$= 1.9$$

T = 20.9 gal/day/ft

ATTACHMENT 15

Statistical Summary of Selected Water Quality
Parameters for Alluvial Aquifer Monitoring Sites
(1980 - 1985)

PEABODY COAL COMPANY
ARIZONA DIVISION
WELL WATER QUALITY STATISTICS

VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0252 SAMPPT=0013										
AK4	ALK AS CACO3, PH 4.5	MG_L	16	330.01	82.89	201.00	560.00	20.72	5280.10	6871.26
CD	CADMIUM, DISSOLVED	UG_L	16	22.19	39.83	5.00	160.00	9.96	355.00	1586.30
CA	CALCIUM, DISSOLVED	MG_L	16	423.00	63.32	245.90	515.00	15.83	6768.00	4009.44
CL	CHLORIDE	MG_L	16	51.83	11.69	20.60	68.00	2.92	829.30	136.75
F	FLUORIDE	MG_L	16	0.74	0.15	0.50	1.20	0.04	11.83	0.02
FET	IRON, TOTAL	MG_L	15	16.26	42.65	0.10	154.00	11.01	243.89	1818.99
PB	LEAD, DISSOLVED	UG_L	13	87.69	88.71	20.00	230.00	24.60	1140.00	7869.23
MG	MAGNESIUM, DISSOLVED	MG_L	16	354.82	94.24	135.80	493.00	23.56	5677.20	8880.53
MNT	MANGANESE, TOTAL	MG_L	15	0.57	0.83	0.02	3.13	0.21	8.61	0.69
N_3	NITRATE NITROGEN _N	MG_L	16	5.06	3.65	0.50	13.00	0.91	80.95	13.34
K	POTASSIUM, DISSOLVED	MG_L	16	4.03	1.96	1.50	6.90	0.49	64.50	3.83
SE	SELENIUM, DISSOLVED	UG_L	16	14.69	13.84	5.00	50.00	3.46	235.00	191.56
NA	SODIUM, DISSOLVED	MG_L	16	198.33	62.77	125.00	411.80	15.69	3173.30	3939.46
SD	SOLIDS, DISSOLVED	MG_L	16	3992.44	577.64	2568.00	4510.00	144.41	63879.00	333672.80
SO4	SULFATE	MG_L	16	2446.50	374.53	1566.00	2870.00	93.63	39144.00	140269.60
MINENO=0252 SAMPPT=0017										
AK4	ALK AS CACO3, PH 4.5	MG_L	10	270.26	58.31	132.00	364.60	18.44	2702.60	3400.21
CD	CADMIUM, DISSOLVED	UG_L	10	5.30	0.95	5.00	8.00	0.30	53.00	0.90
CA	CALCIUM, DISSOLVED	MG_L	10	177.70	26.38	136.80	230.70	8.34	1777.00	695.68
CL	CHLORIDE	MG_L	10	9.36	3.23	6.00	14.70	1.02	93.60	10.43
F	FLUORIDE	MG_L	10	0.39	0.07	0.30	0.50	0.02	3.92	0.01
FET	IRON, TOTAL	MG_L	10	19.13	20.94	0.10	64.80	6.62	191.30	438.68
PB	LEAD, DISSOLVED	UG_L	8	22.50	7.07	20.00	40.00	2.50	180.00	50.00
MG	MAGNESIUM, DISSOLVED	MG_L	10	65.60	6.97	56.00	78.10	2.20	656.00	48.54
MNT	MANGANESE, TOTAL	MG_L	10	1.30	1.11	0.02	3.40	0.35	12.97	1.23
N_3	NITRATE NITROGEN _N	MG_L	10	5.35	14.64	0.20	47.00	4.63	53.46	214.31
K	POTASSIUM, DISSOLVED	MG_L	10	5.93	2.19	3.50	11.00	0.69	59.30	4.80
SE	SELENIUM, DISSOLVED	UG_L	10	9.50	1.58	5.00	10.00	0.50	95.00	2.50
NA	SODIUM, DISSOLVED	MG_L	10	26.64	10.16	20.00	55.00	3.21	266.40	103.15
SD	SOLIDS, DISSOLVED	MG_L	10	1233.10	515.07	954.00	2680.00	162.88	12331.00	265296.32
SO4	SULFATE	MG_L	10	470.10	71.96	340.00	550.00	22.76	4701.00	5178.54

PEABODY COAL COMPANY
ARIZONA DIVISION
WELL WATER QUALITY STATISTICS

VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0250 SAMPPT=0019										
AK4	ALK AS CACO3, PH 4.5	MG_L	9	305.56	50.73	258.00	397.40	16.91	2750.00	2573.11
CD	CADMIUM, DISSOLVED	UG_L	9	5.33	1.00	5.00	8.00	0.33	48.00	1.00
CA	CALCIUM, DISSOLVED	MG_L	9	486.71	104.05	333.20	637.00	34.68	4380.40	10826.54
CL	CHLORIDE	MG_L	9	43.20	9.70	35.40	68.00	3.23	388.80	94.07
F	FLUORIDE	MG_L	9	0.44	0.11	0.30	0.70	0.04	3.98	0.01
FET	IRON, TOTAL	MG_L	9	28.89	15.09	4.80	51.50	5.03	260.00	227.82
PB	LEAD, DISSOLVED	UG_L	8	26.25	17.68	20.00	70.00	6.25	210.00	312.50
MG	MAGNESIUM, DISSOLVED	MG_L	9	277.82	53.87	169.00	335.00	17.96	2500.40	2902.30
MNT	MANGANESE, TOTAL	MG_L	9	0.65	0.26	0.29	1.14	0.09	5.84	0.07
N_3	NITRATE NITROGEN _N	MG_L	9	24.72	8.24	12.40	38.80	2.75	222.45	67.95
K	POTASSIUM, DISSOLVED	MG_L	9	8.89	3.63	4.00	14.00	1.21	80.00	13.17
SE	SELENIUM, DISSOLVED	UG_L	9	8.89	2.20	5.00	10.00	0.73	80.00	4.86
NA	SODIUM, DISSOLVED	MG_L	9	286.52	64.10	148.00	380.00	21.37	2578.70	4109.15
SD	SOLIDS, DISSOLVED	MG_L	9	4574.44	1174.44	3314.00	7414.00	391.48	41170.00	1379310.53
SO4	SULFATE	MG_L	9	2436.78	445.49	1670.00	2930.00	148.50	21931.00	198458.44
MINENO=0250 SAMPPT=0029										
AK4	ALK AS CACO3, PH 4.5	MG_L	8	500.20	75.36	352.50	575.00	26.65	4001.60	5679.83
CD	CADMIUM, DISSOLVED	UG_L	8	6.25	3.54	5.00	15.00	1.25	50.00	12.50
CA	CALCIUM, DISSOLVED	MG_L	8	280.30	71.75	124.20	336.00	25.37	2242.40	5148.02
CL	CHLORIDE	MG_L	8	83.10	20.55	49.00	118.00	7.27	664.80	422.37
F	FLUORIDE	MG_L	8	0.44	0.16	0.20	0.70	0.06	3.56	0.03
FET	IRON, TOTAL	MG_L	8	33.15	63.74	2.10	190.00	22.54	265.20	4063.29
PB	LEAD, DISSOLVED	UG_L	7	41.43	56.69	20.00	170.00	21.43	290.00	3214.29
MG	MAGNESIUM, DISSOLVED	MG_L	8	249.27	86.79	98.90	345.00	30.68	1994.20	7531.78
MNT	MANGANESE, TOTAL	MG_L	8	0.48	0.24	0.06	0.75	0.08	3.83	0.06
N_3	NITRATE NITROGEN _N	MG_L	8	11.84	15.03	0.20	42.00	5.31	94.69	225.96
K	POTASSIUM, DISSOLVED	MG_L	8	11.70	2.58	8.10	16.70	0.91	93.60	6.67
SE	SELENIUM, DISSOLVED	UG_L	8	10.63	4.17	5.00	20.00	1.48	85.00	17.41
NA	SODIUM, DISSOLVED	MG_L	8	475.40	116.71	378.00	744.00	41.26	3803.20	13621.79
SD	SOLIDS, DISSOLVED	MG_L	8	3984.63	1331.30	1400.00	5864.00	470.68	31877.00	1772348.27
SO4	SULFATE	MG_L	8	1974.00	236.31	1450.00	2185.00	83.55	15792.00	55843.71

PEABODY COAL COMPANY
ARIZONA DIVISION
WELL WATER QUALITY STATISTICS

VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0252 SAMPPT=0023										
AK4	ALK AS CACO3, PH 4.5	MG_L	8	239.16	68.50	147.00	335.00	24.22	1913.30	4692.21
CD	CADMIUM, DISSOLVED	UG_L	8	5.75	1.39	5.00	8.00	0.49	46.00	1.93
CA	CALCIUM, DISSOLVED	MG_L	8	181.01	30.98	140.00	234.80	10.95	1448.10	959.73
CL	CHLORIDE	MG_L	8	8.79	4.12	1.00	15.10	1.46	70.30	17.00
F	FLUORIDE	MG_L	8	0.36	0.08	0.30	0.50	0.03	2.89	0.01
FET	IRON, TOTAL	MG_L	8	49.27	113.75	0.40	330.00	40.22	394.20	12938.69
PB	LEAD, DISSOLVED	UG_L	7	28.57	22.68	20.00	80.00	8.57	200.00	514.29
MG	MAGNESIUM, DISSOLVED	MG_L	8	64.81	29.96	35.60	133.00	10.59	518.50	897.66
MNT	MANGANESE, TOTAL	MG_L	8	0.52	0.89	0.07	2.70	0.32	4.14	0.80
N_3	NITRATE NITROGEN _N	MG_L	8	1.08	1.20	0.20	3.50	0.42	8.61	1.44
K	POTASSIUM, DISSOLVED	MG_L	8	6.55	1.66	4.90	10.00	0.59	52.40	2.77
SE	SELENIUM, DISSOLVED	UG_L	8	9.38	1.77	5.00	10.00	0.63	75.00	3.13
NA	SODIUM, DISSOLVED	MG_L	8	63.24	30.44	29.90	125.00	10.76	505.90	926.88
SD	SOLIDS, DISSOLVED	MG_L	8	1320.63	285.18	976.00	1694.00	100.82	10565.00	81325.41
SO4	SULFATE	MG_L	8	594.13	193.40	390.00	1020.00	68.38	4753.00	37404.13
MINENO=0252 SAMPPT=0027										
AK4	ALK AS CACO3, PH 4.5	MG_L	8	269.22	58.61	182.00	387.90	20.72	2153.80	3435.39
CD	CADMIUM, DISSOLVED	UG_L	8	5.13	0.35	5.00	6.00	0.13	41.00	0.13
CA	CALCIUM, DISSOLVED	MG_L	8	143.20	13.70	120.00	157.80	4.84	1145.60	187.70
CL	CHLORIDE	MG_L	8	19.57	3.51	16.00	24.40	1.24	156.60	12.32
F	FLUORIDE	MG_L	8	0.45	0.07	0.40	0.60	0.03	3.58	0.01
FET	IRON, TOTAL	MG_L	8	6.22	3.50	1.80	13.90	1.24	49.80	12.23
PB	LEAD, DISSOLVED	UG_L	7	24.29	11.34	20.00	50.00	4.29	170.00	128.57
MG	MAGNESIUM, DISSOLVED	MG_L	8	64.52	17.74	47.00	104.00	6.27	516.20	314.68
MNT	MANGANESE, TOTAL	MG_L	8	1.92	0.34	1.50	2.50	0.12	15.39	0.11
N_3	NITRATE NITROGEN _N	MG_L	8	0.55	0.81	0.10	2.50	0.29	4.40	0.65
K	POTASSIUM, DISSOLVED	MG_L	8	9.15	1.55	6.90	12.00	0.55	73.20	2.41
SE	SELENIUM, DISSOLVED	UG_L	8	9.38	1.77	5.00	10.00	0.63	75.00	3.13
NA	SODIUM, DISSOLVED	MG_L	8	193.24	22.56	148.00	229.00	7.98	1545.90	508.91
SD	SOLIDS, DISSOLVED	MG_L	8	1856.25	572.89	1326.00	2960.00	202.55	14850.00	328206.21
SO4	SULFATE	MG_L	8	748.50	70.83	671.00	880.00	25.04	5988.00	5016.86

PEABODY COAL COMPANY
ARIZONA DIVISION
WELL WATER QUALITY STATISTICS

VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0252 SAMPPT=0032										
AK4	ALK AS CACO3, PH 4.5	MG_L	7	992.86	313.91	461.00	1505.00	118.65	6950.00	98537.81
CD	CADMIUM, DISSOLVED	UG_L	7	5.57	1.51	5.00	9.00	0.57	39.00	2.29
CA	CALCIUM, DISSOLVED	MG_L	7	313.11	117.27	89.80	444.00	44.32	2191.80	13751.69
CL	CHLORIDE	MG_L	7	28.43	14.00	16.00	56.70	5.29	199.00	196.00
F	FLUORIDE	MG_L	7	0.24	0.06	0.17	0.30	0.02	1.68	0.00
FET	IRON, TOTAL	MG_L	7	3.34	1.40	1.30	5.10	0.53	23.40	1.97
PB	LEAD, DISSOLVED	UG_L	6	30.00	24.49	20.00	80.00	10.00	180.00	600.00
MG	MAGNESIUM, DISSOLVED	MG_L	7	144.11	46.32	49.80	187.00	17.51	1008.80	2145.42
MNT	MANGANESE, TOTAL	MG_L	7	3.43	2.37	0.53	6.50	0.90	23.98	5.62
N_3	NITRATE NITROGEN _N	MG_L	7	0.68	0.92	0.10	2.70	0.35	4.74	0.84
K	POTASSIUM, DISSOLVED	MG_L	7	16.43	5.62	7.80	25.10	2.13	115.00	31.63
SE	SELENIUM, DISSOLVED	UG_L	7	9.29	1.89	5.00	10.00	0.71	65.00	3.57
NA	SODIUM, DISSOLVED	MG_L	7	344.77	53.04	267.40	410.00	20.05	2413.40	2813.57
SD	SOLIDS, DISSOLVED	MG_L	7	3023.43	817.86	1648.00	4134.00	309.12	21164.00	668896.95
SO4	SULFATE	MG_L	7	1187.00	578.84	590.00	2200.00	218.78	8309.00	335056.33
MINENO=0252 SAMPPT=0068										
AK4	ALK AS CACO3, PH 4.5	MG_L	8	283.47	77.39	144.40	363.40	27.36	2267.80	5988.62
CD	CADMIUM, DISSOLVED	UG_L	8	5.00	0.00	5.00	5.00	0.00	40.00	0.00
CA	CALCIUM, DISSOLVED	MG_L	8	459.87	95.53	352.30	662.00	33.77	3679.00	9125.35
CL	CHLORIDE	MG_L	8	51.26	9.90	45.00	74.00	3.50	410.10	98.05
F	FLUORIDE	MG_L	8	0.75	0.18	0.50	1.00	0.06	5.98	0.03
FET	IRON, TOTAL	MG_L	8	25.75	13.05	3.00	38.90	4.61	206.00	170.19
PB	LEAD, DISSOLVED	UG_L	6	20.00	0.00	20.00	20.00	0.00	120.00	0.00
MG	MAGNESIUM, DISSOLVED	MG_L	8	309.50	45.44	252.00	370.00	16.07	2476.00	2065.14
MNT	MANGANESE, TOTAL	MG_L	8	6.13	3.44	2.00	12.00	1.22	49.03	11.82
N_3	NITRATE NITROGEN _N	MG_L	8	3.79	2.12	0.40	7.50	0.75	30.30	4.51
K	POTASSIUM, DISSOLVED	MG_L	8	4.21	0.84	3.40	6.00	0.30	33.70	0.70
SE	SELENIUM, DISSOLVED	UG_L	8	10.00	0.00	10.00	10.00	0.00	80.00	0.00
NA	SODIUM, DISSOLVED	MG_L	8	251.74	34.65	184.90	299.00	12.25	2013.90	1200.69
SD	SOLIDS, DISSOLVED	MG_L	8	4771.75	1032.88	3800.00	6714.00	365.18	38174.00	1066845.07
SO4	SULFATE	MG_L	8	2502.38	404.07	1870.00	2990.00	142.86	20019.00	163273.98

PEABODY COAL COMPANY
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VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0252 SAMPPT=0069										
AK4	ALK AS CACO3, PH 4.5	MG_L	11	335.41	76.99	219.10	502.00	23.21	3689.50	5928.22
CD	CADMIUM, DISSOLVED	UG_L	11	6.09	3.62	5.00	17.00	1.09	67.00	13.09
CA	CALCIUM, DISSOLVED	MG_L	11	332.55	86.00	104.40	425.00	25.93	3658.10	7396.40
CL	CHLORIDE	MG_L	11	51.39	12.46	16.40	61.40	3.76	565.30	155.25
F	FLUORIDE	MG_L	11	0.78	0.10	0.60	1.00	0.03	8.56	0.01
FET	IRON, TOTAL	MG_L	11	26.44	14.41	2.10	43.40	4.34	290.80	207.60
PB	LEAD, DISSOLVED	UG_L	8	31.25	31.82	20.00	110.00	11.25	250.00	1012.50
MG	MAGNESIUM, DISSOLVED	MG_L	11	356.85	95.29	112.00	490.00	28.73	3925.40	9079.59
MNT	MANGANESE, TOTAL	MG_L	11	0.59	0.28	0.24	1.01	0.08	6.53	0.08
N_3	NITRATE NITROGEN _N	MG_L	11	6.26	4.74	1.30	19.10	1.43	68.83	22.48
K	POTASSIUM, DISSOLVED	MG_L	11	2.95	1.54	0.90	6.50	0.47	32.40	2.38
SE	SELENIUM, DISSOLVED	UG_L	11	9.09	2.02	5.00	10.00	0.61	100.00	4.09
NA	SODIUM, DISSOLVED	MG_L	11	171.08	38.25	129.90	275.20	11.53	1881.90	1462.96
SD	SOLIDS, DISSOLVED	MG_L	11	3875.18	965.89	2198.00	6240.00	291.23	42627.00	932943.36
SO4	SULFATE	MG_L	11	2183.36	490.27	905.00	2800.00	147.82	24017.00	240366.25
MINENO=0252 SAMPPT=0070										
AK4	ALK AS CACO3, PH 4.5	MG_L	5	749.14	192.46	510.00	1018.00	86.07	3745.70	37040.75
CD	CADMIUM, DISSOLVED	UG_L	5	7.20	4.92	5.00	16.00	2.20	36.00	24.20
CA	CALCIUM, DISSOLVED	MG_L	5	486.06	80.60	398.30	605.00	36.05	2430.30	6496.32
CL	CHLORIDE	MG_L	5	183.76	84.72	102.00	280.00	37.89	918.80	7177.19
F	FLUORIDE	MG_L	5	1.09	0.09	1.00	1.20	0.04	5.45	0.01
FET	IRON, TOTAL	MG_L	5	2.49	2.19	0.11	4.80	0.98	12.46	4.80
PB	LEAD, DISSOLVED	UG_L	3	20.00	0.00	20.00	20.00	0.00	60.00	0.00
MG	MAGNESIUM, DISSOLVED	MG_L	5	3015.20	332.57	2500.00	3353.00	148.73	15076.00	110605.70
MNT	MANGANESE, TOTAL	MG_L	5	0.67	0.46	0.31	1.47	0.21	3.36	0.21
N_3	NITRATE NITROGEN _N	MG_L	5	8.04	2.84	4.60	11.20	1.27	40.20	8.04
K	POTASSIUM, DISSOLVED	MG_L	5	10.54	8.78	5.00	26.00	3.93	52.70	77.08
SE	SELENIUM, DISSOLVED	UG_L	5	29.00	40.06	5.00	100.00	17.92	145.00	1605.00
NA	SODIUM, DISSOLVED	MG_L	5	1596.20	811.34	193.00	2200.00	362.84	7981.00	658274.20
SD	SOLIDS, DISSOLVED	MG_L	4	24185.00	2179.51	22112.00	26928.00	1089.76	96740.00	4750276.00
SO4	SULFATE	MG_L	5	15665.00	818.84	14950.00	16700.00	366.20	78325.00	670500.00

PEABODY COAL COMPANY
ARIZONA DIVISION
WELL WATER QUALITY STATISTICS

VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0252 SAMPPT=0071										
AK4	ALK AS CACO3, PH 4.5	MG_L	10	331.57	108.31	174.30	583.70	34.25	3315.70	11731.58
CD	CADMIUM, DISSOLVED	UG_L	10	6.30	4.11	5.00	18.00	1.30	63.00	16.90
CA	CALCIUM, DISSOLVED	MG_L	10	418.33	97.89	277.10	638.00	30.95	4183.30	9581.65
CL	CHLORIDE	MG_L	10	54.09	3.99	48.00	62.00	1.26	540.90	15.94
F	FLUORIDE	MG_L	10	0.95	0.45	0.50	2.10	0.14	9.50	0.20
FET	IRON, TOTAL	MG_L	10	30.17	26.68	4.60	74.30	8.44	301.70	711.96
PB	LEAD, DISSOLVED	UG_L	8	103.75	236.88	20.00	690.00	83.75	830.00	56112.50
MG	MAGNESIUM, DISSOLVED	MG_L	10	400.96	64.57	276.40	514.00	20.42	4009.60	4168.89
MNT	MANGANESE, TOTAL	MG_L	10	0.74	0.98	0.16	3.30	0.31	7.40	0.96
N_3	NITRATE NITROGEN _N	MG_L	10	6.48	6.06	0.60	21.50	1.91	64.78	36.67
K	POTASSIUM, DISSOLVED	MG_L	10	2.50	1.10	0.80	4.00	0.35	25.00	1.21
SE	SELENIUM, DISSOLVED	UG_L	10	9.50	1.58	5.00	10.00	0.50	95.00	2.50
NA	SODIUM, DISSOLVED	MG_L	10	206.93	32.67	140.60	260.00	10.33	2069.30	1067.64
SD	SOLIDS, DISSOLVED	MG_L	10	5119.60	2066.28	3810.00	10798.00	653.41	51196.00	4269510.93
SO4	SULFATE	MG_L	10	2608.20	367.48	1750.00	3000.00	116.21	26082.00	135042.40
MINENO=0252 SAMPPT=0072										
AK4	ALK AS CACO3, PH 4.5	MG_L	9	355.58	94.87	239.00	528.60	31.62	3200.20	9000.62
CD	CADMIUM, DISSOLVED	UG_L	9	5.89	2.67	5.00	13.00	0.89	53.00	7.11
CA	CALCIUM, DISSOLVED	MG_L	9	501.27	75.81	392.70	640.60	25.27	4511.40	5746.45
CL	CHLORIDE	MG_L	9	73.48	6.02	64.40	81.60	2.01	661.30	36.28
F	FLUORIDE	MG_L	9	0.57	0.12	0.31	0.70	0.04	5.16	0.02
FET	IRON, TOTAL	MG_L	9	24.43	15.61	5.50	43.00	5.20	219.90	243.76
PB	LEAD, DISSOLVED	UG_L	8	236.25	611.65	20.00	1750.00	216.25	1890.00	374112.50
MG	MAGNESIUM, DISSOLVED	MG_L	9	446.43	72.55	330.00	586.00	24.18	4017.90	5263.04
MNT	MANGANESE, TOTAL	MG_L	9	2.33	1.65	0.92	6.40	0.55	20.94	2.73
N_3	NITRATE NITROGEN _N	MG_L	9	3.34	2.61	0.20	7.20	0.87	30.09	6.83
K	POTASSIUM, DISSOLVED	MG_L	9	8.92	5.94	2.00	19.00	1.98	80.30	35.24
SE	SELENIUM, DISSOLVED	UG_L	9	9.44	1.67	5.00	10.00	0.56	85.00	2.78
NA	SODIUM, DISSOLVED	MG_L	9	299.54	41.44	221.10	379.00	13.81	2695.90	1716.90
SD	SOLIDS, DISSOLVED	MG_L	9	5775.22	1045.07	4210.00	8004.00	348.36	51977.00	1092181.44
SO4	SULFATE	MG_L	9	3053.67	424.67	2520.00	3820.00	141.56	27483.00	180343.50

PEABODY COAL COMPANY
ARIZONA DIVISION
WELL WATER QUALITY STATISTICS

VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0252 SAMPPT=0073										
AK4	ALK AS CACO3, PH 4.5	MG_L	9	335.10	112.25	189.20	543.50	37.42	3015.90	12599.83
CD	CADMIUM, DISSOLVED	UG_L	9	6.00	3.00	5.00	14.00	1.00	54.00	9.00
CA	CALCIUM, DISSOLVED	MG_L	9	532.24	102.25	380.00	693.00	34.08	4790.20	10454.99
CL	CHLORIDE	MG_L	9	62.72	11.21	44.00	82.00	3.74	564.50	125.67
F	FLUORIDE	MG_L	9	0.54	0.25	0.20	1.10	0.08	4.88	0.06
FET	IRON, TOTAL	MG_L	9	11.09	15.03	1.60	50.00	5.01	99.80	226.00
PB	LEAD, DISSOLVED	UG_L	7	20.00	0.00	20.00	20.00	0.00	140.00	0.00
MG	MAGNESIUM, DISSOLVED	MG_L	9	413.23	67.65	332.00	571.00	22.55	3719.10	4576.92
MNT	MANGANESE, TOTAL	MG_L	9	0.67	0.33	0.20	1.20	0.11	6.07	0.11
N_3	NITRATE NITROGEN _N	MG_L	9	13.76	9.38	0.20	27.20	3.13	123.84	87.99
K	POTASSIUM, DISSOLVED	MG_L	9	12.64	4.44	4.40	18.00	1.48	113.80	19.73
SE	SELENIUM, DISSOLVED	UG_L	9	9.44	1.67	5.00	10.00	0.56	85.00	2.78
NA	SODIUM, DISSOLVED	MG_L	9	349.60	65.60	282.00	485.00	21.87	3146.40	4303.40
SD	SOLIDS, DISSOLVED	MG_L	9	5452.33	671.97	4706.00	6797.00	223.99	49071.00	451541.50
SO4	SULFATE	MG_L	9	3229.44	487.52	2760.00	4408.00	162.51	29065.00	237675.78
MINENO=0252 SAMPPT=0074										
AK4	ALK AS CACO3, PH 4.5	MG_L	4	331.45	179.87	70.20	465.60	89.94	1325.80	32354.33
CD	CADMIUM, DISSOLVED	UG_L	4	4.25	1.50	2.00	5.00	0.75	17.00	2.25
CA	CALCIUM, DISSOLVED	MG_L	4	485.75	47.38	431.00	537.00	23.69	1943.00	2244.92
CL	CHLORIDE	MG_L	4	58.00	13.02	39.00	68.20	6.51	232.00	169.63
F	FLUORIDE	MG_L	4	0.59	0.07	0.50	0.68	0.04	2.38	0.01
FET	IRON, TOTAL	MG_L	4	8.45	7.64	2.20	19.30	3.82	33.80	58.32
PB	LEAD, DISSOLVED	UG_L	4	20.00	0.00	20.00	20.00	0.00	80.00	0.00
MG	MAGNESIUM, DISSOLVED	MG_L	4	336.50	15.80	314.00	351.00	7.90	1346.00	249.67
MNT	MANGANESE, TOTAL	MG_L	4	1.17	0.82	0.19	1.90	0.41	4.68	0.68
N_3	NITRATE NITROGEN _N	MG_L	4	14.00	25.12	0.20	51.60	12.56	56.00	630.85
K	POTASSIUM, DISSOLVED	MG_L	4	7.15	2.20	4.20	9.40	1.10	28.60	4.84
SE	SELENIUM, DISSOLVED	UG_L	4	14.25	8.50	10.00	27.00	4.25	57.00	72.25
NA	SODIUM, DISSOLVED	MG_L	4	423.00	93.67	325.00	509.00	46.83	1692.00	8773.33
SD	SOLIDS, DISSOLVED	MG_L	4	5986.25	2367.73	4670.00	9534.00	1183.87	23945.00	5606166.92
SO4	SULFATE	MG_L	4	2899.25	177.60	2650.00	3070.00	88.80	11597.00	31542.25

PEABODY COAL COMPANY
ARIZONA DIVISION
WELL WATER QUALITY STATISTICS

VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0252 SAMPPT=0075										
AK4	ALK AS CACO3, PH 4.5	MG_L	13	335.55	113.49	35.00	483.40	31.48	4362.20	12880.20
CD	CADMIUM, DISSOLVED	UG_L	13	11.31	7.72	5.00	27.00	2.14	147.00	59.56
CA	CALCIUM, DISSOLVED	MG_L	13	403.21	75.86	241.00	511.00	21.04	5241.70	5755.01
CL	CHLORIDE	MG_L	13	54.71	12.31	36.60	85.50	3.41	711.20	151.59
F	FLUORIDE	MG_L	13	0.59	0.11	0.37	0.71	0.03	7.61	0.01
FET	IRON, TOTAL	MG_L	12	20.77	42.08	0.20	135.00	12.15	249.25	1771.10
PB	LEAD, DISSOLVED	UG_L	11	109.09	83.00	20.00	220.00	25.03	1200.00	6889.09
MG	MAGNESIUM, DISSOLVED	MG_L	13	291.37	65.12	159.00	370.00	18.06	3787.80	4240.62
MNT	MANGANESE, TOTAL	MG_L	12	0.88	1.10	0.02	2.77	0.32	10.52	1.21
N_3	NITRATE NITROGEN _N	MG_L	13	6.13	3.89	0.77	13.20	1.08	79.65	15.16
K	POTASSIUM, DISSOLVED	MG_L	13	5.40	4.14	1.60	16.40	1.15	70.20	17.12
SE	SELENIUM, DISSOLVED	UG_L	13	16.54	15.19	5.00	50.00	4.21	215.00	230.77
NA	SODIUM, DISSOLVED	MG_L	13	324.58	84.27	177.00	458.00	23.37	4219.50	7101.57
SD	SOLIDS, DISSOLVED	MG_L	13	4318.08	683.15	2670.00	5560.00	189.47	56135.00	466697.58
SO4	SULFATE	MG_L	13	2281.85	704.34	250.00	2858.00	195.35	29664.00	496088.81
MINENO=0252 SAMPPT=0076										
AK4	ALK AS CACO3, PH 4.5	MG_L	9	275.82	83.87	157.00	470.70	27.96	2482.40	7034.09
CD	CADMIUM, DISSOLVED	UG_L	9	5.00	0.00	5.00	5.00	0.00	45.00	0.00
CA	CALCIUM, DISSOLVED	MG_L	9	177.31	24.59	160.00	232.60	8.20	1595.80	604.87
CL	CHLORIDE	MG_L	9	7.51	3.14	2.90	12.70	1.05	67.60	9.88
F	FLUORIDE	MG_L	9	0.44	0.21	0.23	0.90	0.07	3.93	0.04
FET	IRON, TOTAL	MG_L	9	19.54	24.99	0.30	68.00	8.33	175.90	624.62
PB	LEAD, DISSOLVED	UG_L	6	20.00	0.00	20.00	20.00	0.00	120.00	0.00
MG	MAGNESIUM, DISSOLVED	MG_L	9	40.91	6.04	33.00	51.50	2.01	368.20	36.46
MNT	MANGANESE, TOTAL	MG_L	9	0.22	0.19	0.03	0.51	0.06	1.97	0.03
N_3	NITRATE NITROGEN _N	MG_L	9	0.52	0.19	0.20	0.80	0.06	4.64	0.04
K	POTASSIUM, DISSOLVED	MG_L	9	3.77	1.83	1.30	7.00	0.61	33.90	3.34
SE	SELENIUM, DISSOLVED	UG_L	9	10.00	0.00	10.00	10.00	0.00	90.00	0.00
NA	SODIUM, DISSOLVED	MG_L	9	15.92	6.17	12.00	32.10	2.06	143.30	38.09
SD	SOLIDS, DISSOLVED	MG_L	9	1051.78	485.12	794.00	2330.00	161.71	9466.00	235345.44
SO4	SULFATE	MG_L	9	349.44	52.57	268.00	428.00	17.52	3145.00	2763.78

PEABODY COAL COMPANY
ARIZONA DIVISION
WELL WATER QUALITY STATISTICS

VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0252 SAMPPT=0077										
AK4	ALK AS CACO3, PH 4.5	MG_L	15	200.29	49.25	134.50	319.80	12.72	3004.30	2425.78
CD	CADMIUM, DISSOLVED	UG_L	15	5.67	2.47	1.00	10.00	0.64	85.00	6.10
CA	CALCIUM, DISSOLVED	MG_L	15	125.15	22.00	79.00	166.00	5.68	1877.30	484.07
CL	CHLORIDE	MG_L	15	11.24	6.39	3.90	26.80	1.65	168.60	40.89
F	FLUORIDE	MG_L	15	0.46	0.17	0.20	0.90	0.04	6.89	0.03
FET	IRON, TOTAL	MG_L	13	5.57	14.84	0.10	54.60	4.12	72.46	220.21
PB	LEAD, DISSOLVED	UG_L	13	36.92	19.74	20.00	70.00	5.48	480.00	389.74
MG	MAGNESIUM, DISSOLVED	MG_L	15	23.76	2.88	17.50	27.70	0.74	356.40	8.27
MNT	MANGANESE, TOTAL	MG_L	13	0.27	0.35	0.02	1.00	0.10	3.52	0.12
N_3	NITRATE NITROGEN _N	MG_L	15	1.71	1.22	0.07	3.20	0.32	25.67	1.49
K	POTASSIUM, DISSOLVED	MG_L	15	3.46	1.50	1.20	5.40	0.39	51.90	2.26
SE	SELENIUM, DISSOLVED	UG_L	15	15.33	14.07	10.00	50.00	3.63	230.00	198.10
NA	SODIUM, DISSOLVED	MG_L	15	10.91	3.71	7.00	19.00	0.96	163.60	13.73
SD	SOLIDS, DISSOLVED	MG_L	15	628.40	221.04	470.00	1398.00	57.07	9426.00	48859.11
SO4	SULFATE	MG_L	15	213.67	59.47	119.00	320.00	15.36	3205.00	3537.24
MINENO=0252 SAMPPT=0079										
AK4	ALK AS CACO3, PH 4.5	MG_L	16	308.57	89.66	33.00	427.30	22.42	4937.20	8039.36
CD	CADMIUM, DISSOLVED	UG_L	16	6.31	2.12	5.00	10.00	0.53	101.00	4.50
CA	CALCIUM, DISSOLVED	MG_L	16	133.45	25.25	66.50	182.00	6.31	2135.20	637.46
CL	CHLORIDE	MG_L	16	18.21	4.71	12.40	27.10	1.18	291.40	22.14
F	FLUORIDE	MG_L	16	0.32	0.08	0.20	0.50	0.02	5.12	0.01
FET	IRON, TOTAL	MG_L	15	3.29	2.85	0.30	10.30	0.73	49.42	8.10
PB	LEAD, DISSOLVED	UG_L	13	53.08	42.70	20.00	130.00	11.84	690.00	1823.08
MG	MAGNESIUM, DISSOLVED	MG_L	16	53.27	7.62	37.00	68.00	1.90	852.40	58.01
MNT	MANGANESE, TOTAL	MG_L	15	0.12	0.07	0.02	0.29	0.02	1.84	0.00
N_3	NITRATE NITROGEN _N	MG_L	15	0.35	0.36	0.01	1.25	0.09	5.31	0.13
K	POTASSIUM, DISSOLVED	MG_L	16	7.54	2.41	4.00	14.00	0.60	120.60	5.83
SE	SELENIUM, DISSOLVED	UG_L	16	15.63	13.65	10.00	50.00	3.41	250.00	186.25
NA	SODIUM, DISSOLVED	MG_L	16	185.75	11.99	168.00	215.20	3.00	2972.00	143.81
SD	SOLIDS, DISSOLVED	MG_L	15	1335.40	71.31	1234.00	1480.00	18.41	20031.00	5085.40
SO4	SULFATE	MG_L	15	637.60	102.62	465.00	830.00	26.50	9564.00	10531.54

PEABODY COAL COMPANY
ARIZONA DIVISION
WELL WATER QUALITY STATISTICS

VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0250 SAMPPT=0080										
AK4	ALK AS CACO3, PH 4.5	MG_L	8	330.99	39.21	289.00	401.00	13.86	2647.90	1537.04
CD	CADMIUM, DISSOLVED	UG_L	8	16.88	33.59	5.00	100.00	11.88	135.00	1128.13
CA	CALCIUM, DISSOLVED	MG_L	8	455.67	71.06	344.00	514.00	25.12	3645.40	5049.07
CL	CHLORIDE	MG_L	8	47.89	10.42	27.20	61.00	3.68	383.10	108.51
F	FLUORIDE	MG_L	8	0.45	0.11	0.30	0.60	0.04	3.60	0.01
FET	IRON, TOTAL	MG_L	8	38.46	31.61	0.32	99.40	11.17	307.72	999.02
PB	LEAD, DISSOLVED	UG_L	7	25.71	15.12	20.00	60.00	5.71	180.00	228.57
MG	MAGNESIUM, DISSOLVED	MG_L	8	295.31	64.65	173.00	370.00	22.86	2362.50	4179.21
MNT	MANGANESE, TOTAL	MG_L	8	2.10	1.36	0.09	3.80	0.48	16.81	1.85
N_3	NITRATE NITROGEN _N	MG_L	8	5.10	4.39	0.04	11.30	1.55	40.84	19.26
K	POTASSIUM, DISSOLVED	MG_L	8	6.11	2.81	3.50	12.00	0.99	48.90	7.89
SE	SELENIUM, DISSOLVED	UG_L	8	9.38	1.77	5.00	10.00	0.63	75.00	3.13
NA	SODIUM, DISSOLVED	MG_L	8	208.39	41.12	126.00	241.00	14.54	1667.10	1690.49
SD	SOLIDS, DISSOLVED	MG_L	8	4154.50	1229.97	2058.00	6360.00	434.86	33236.00	1512816.57
SO4	SULFATE	MG_L	8	2309.13	352.59	1705.00	2710.00	124.66	18473.00	124321.84
MINENO=0250 SAMPPT=0081										
AK4	ALK AS CACO3, PH 4.5	MG_L	4	236.72	14.90	217.80	254.10	7.45	946.90	221.92
CD	CADMIUM, DISSOLVED	UG_L	4	7.25	3.86	5.00	13.00	1.93	29.00	14.92
CA	CALCIUM, DISSOLVED	MG_L	4	365.42	101.13	275.00	495.30	50.57	1461.70	10227.78
CL	CHLORIDE	MG_L	4	32.32	7.83	25.00	40.90	3.92	129.30	61.38
F	FLUORIDE	MG_L	4	0.50	0.08	0.40	0.60	0.04	2.01	0.01
FET	IRON, TOTAL	MG_L	4	13.27	10.48	0.10	23.20	5.24	53.10	109.80
PB	LEAD, DISSOLVED	UG_L	3	50.00	30.00	20.00	80.00	17.32	150.00	900.00
MG	MAGNESIUM, DISSOLVED	MG_L	4	155.80	37.04	123.60	208.00	18.52	623.20	1372.19
MNT	MANGANESE, TOTAL	MG_L	4	0.66	0.50	0.02	1.20	0.25	2.66	0.25
N_3	NITRATE NITROGEN _N	MG_L	4	3.75	2.47	1.10	6.60	1.24	15.02	6.11
K	POTASSIUM, DISSOLVED	MG_L	4	4.80	1.22	3.70	6.50	0.61	19.20	1.49
SE	SELENIUM, DISSOLVED	UG_L	4	7.50	2.89	5.00	10.00	1.44	30.00	8.33
NA	SODIUM, DISSOLVED	MG_L	4	166.20	33.34	120.00	198.70	16.67	664.80	1111.85
SD	SOLIDS, DISSOLVED	MG_L	4	2967.75	440.13	2541.00	3580.00	220.06	11871.00	193710.92
SO4	SULFATE	MG_L	4	1702.50	324.67	1375.00	2020.00	162.33	6810.00	105408.33

PEABODY COAL COMPANY
ARIZONA DIVISION
WELL WATER QUALITY STATISTICS

VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0250 SAMPPT=0082										
AK4	ALK AS CACO3, PH 4.5	MG_L	9	355.28	73.12	201.70	468.00	24.37	3197.50	5346.40
CD	CADMIUM, DISSOLVED	UG_L	9	6.44	2.88	5.00	12.00	0.96	58.00	8.28
CA	CALCIUM, DISSOLVED	MG_L	9	529.54	120.32	330.50	700.00	40.11	4765.90	14475.76
CL	CHLORIDE	MG_L	9	52.84	9.18	36.80	66.00	3.06	475.60	84.31
F	FLUORIDE	MG_L	9	0.52	0.17	0.30	0.90	0.06	4.71	0.03
FET	IRON, TOTAL	MG_L	9	16.00	9.21	0.10	27.70	3.07	144.00	84.87
PB	LEAD, DISSOLVED	UG_L	8	40.00	37.42	20.00	110.00	13.23	320.00	1400.00
MG	MAGNESIUM, DISSOLVED	MG_L	9	355.32	106.47	222.90	590.00	35.49	3197.90	11335.06
MNT	MANGANESE, TOTAL	MG_L	9	1.13	0.62	0.02	1.75	0.21	10.21	0.38
N_3	NITRATE NITROGEN _N	MG_L	9	26.29	7.85	19.70	43.10	2.62	236.64	61.65
K	POTASSIUM, DISSOLVED	MG_L	9	8.41	3.04	5.40	15.00	1.01	75.70	9.27
SE	SELENIUM, DISSOLVED	UG_L	9	8.89	2.20	5.00	10.00	0.73	80.00	4.86
NA	SODIUM, DISSOLVED	MG_L	9	374.34	80.62	203.70	469.00	26.87	3369.10	6499.87
SD	SOLIDS, DISSOLVED	MG_L	9	4948.56	982.52	3010.00	6090.00	327.51	44537.00	965354.28
SO4	SULFATE	MG_L	9	3009.44	681.40	1625.00	3750.00	227.13	27085.00	464303.78
MINENO=0250 SAMPPT=0083										
AK4	ALK AS CACO3, PH 4.5	MG_L	14	345.40	75.30	249.00	464.00	20.12	4835.60	5670.15
CD	CADMIUM, DISSOLVED	UG_L	14	11.57	7.42	5.00	23.00	1.98	162.00	55.03
CA	CALCIUM, DISSOLVED	MG_L	14	520.95	113.60	307.00	730.00	30.36	7293.30	12905.06
CL	CHLORIDE	MG_L	14	48.26	10.20	24.20	66.00	2.73	675.60	104.02
F	FLUORIDE	MG_L	14	0.53	0.13	0.30	0.80	0.03	7.37	0.02
FET	IRON, TOTAL	MG_L	13	5.46	7.55	0.10	22.80	2.09	70.94	57.00
PB	LEAD, DISSOLVED	UG_L	13	111.54	106.52	20.00	260.00	29.54	1450.00	11347.44
MG	MAGNESIUM, DISSOLVED	MG_L	14	308.95	83.29	180.00	440.00	22.26	4325.30	6937.76
MNT	MANGANESE, TOTAL	MG_L	12	0.53	0.46	0.08	1.65	0.13	6.34	0.21
N_3	NITRATE NITROGEN _N	MG_L	14	16.52	11.16	2.41	35.20	2.98	231.31	124.44
K	POTASSIUM, DISSOLVED	MG_L	14	8.75	2.53	5.70	14.00	0.68	122.50	6.41
SE	SELENIUM, DISSOLVED	UG_L	14	15.36	14.74	5.00	50.00	3.94	215.00	217.17
NA	SODIUM, DISSOLVED	MG_L	14	324.21	85.23	181.20	483.00	22.78	4538.90	7264.50
SD	SOLIDS, DISSOLVED	MG_L	14	4710.71	802.55	3570.00	6150.00	214.49	65950.00	644084.68
SO4	SULFATE	MG_L	14	2832.71	624.06	1575.00	3840.00	166.79	39658.00	389453.60

PEABODY COAL COMPANY
ARIZONA DIVISION
WELL WATER QUALITY STATISTICS

VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0250 SAMPPT=0084										
AK4	ALK AS CACO3, PH 4.5	MG_L	12	230.14	72.43	25.30	301.40	20.91	2761.70	5246.17
CD	CADMIUM, DISSOLVED	UG_L	12	10.50	5.92	5.00	21.00	1.71	126.00	35.00
CA	CALCIUM, DISSOLVED	MG_L	12	503.07	194.16	270.00	861.00	56.05	6036.90	37699.95
CL	CHLORIDE	MG_L	12	34.35	5.56	26.50	43.20	1.61	412.20	30.96
F	FLUORIDE	MG_L	12	0.39	0.11	0.20	0.60	0.03	4.66	0.01
FET	IRON, TOTAL	MG_L	10	14.28	31.06	0.14	101.00	9.82	142.79	964.95
PB	LEAD, DISSOLVED	UG_L	11	106.36	76.19	20.00	220.00	22.97	1170.00	5805.45
MG	MAGNESIUM, DISSOLVED	MG_L	12	210.53	75.40	130.00	347.00	21.77	2526.40	5684.82
MNT	MANGANESE, TOTAL	MG_L	10	0.44	0.54	0.07	1.90	0.17	4.38	0.29
N_3	NITRATE NITROGEN _N	MG_L	12	92.20	160.48	0.10	540.00	46.33	1106.41	25752.98
K	POTASSIUM, DISSOLVED	MG_L	12	10.78	2.30	7.80	14.00	0.66	129.40	5.29
SE	SELENIUM, DISSOLVED	UG_L	12	16.25	16.39	0.00	50.00	4.73	195.00	268.75
NA	SODIUM, DISSOLVED	MG_L	12	221.57	103.25	141.00	433.00	29.81	2658.80	10661.38
SD	SOLIDS, DISSOLVED	MG_L	12	3780.42	1258.78	2457.00	5515.00	363.38	45365.00	1584524.27
SO4	SULFATE	MG_L	12	2245.67	792.98	1410.00	3570.00	228.91	26948.00	628816.42
MINENO=0250 SAMPPT=0093										
AK4	ALK AS CACO3, PH 4.5	MG_L	8	291.85	12.33	275.90	310.60	4.36	2334.80	152.12
CD	CADMIUM, DISSOLVED	UG_L	8	5.75	2.12	5.00	11.00	0.75	46.00	4.50
CA	CALCIUM, DISSOLVED	MG_L	8	456.05	85.63	299.60	540.00	30.27	3648.40	7332.28
CL	CHLORIDE	MG_L	8	44.20	2.37	41.00	47.30	0.84	353.60	5.60
F	FLUORIDE	MG_L	8	0.65	0.09	0.45	0.73	0.03	5.18	0.01
FET	IRON, TOTAL	MG_L	8	14.66	10.09	2.40	28.00	3.57	117.30	101.74
PB	LEAD, DISSOLVED	UG_L	7	45.71	68.03	20.00	200.00	25.71	320.00	4628.57
MG	MAGNESIUM, DISSOLVED	MG_L	8	219.90	58.67	108.50	273.00	20.74	1759.20	3442.12
MNT	MANGANESE, TOTAL	MG_L	8	0.38	0.22	0.06	0.77	0.08	3.04	0.05
N_3	NITRATE NITROGEN _N	MG_L	8	2.75	2.52	0.20	6.60	0.89	22.00	6.37
K	POTASSIUM, DISSOLVED	MG_L	8	8.81	3.53	4.50	15.00	1.25	70.50	12.48
SE	SELENIUM, DISSOLVED	UG_L	8	9.38	1.77	5.00	10.00	0.63	75.00	3.13
NA	SODIUM, DISSOLVED	MG_L	8	247.90	64.22	142.50	322.70	22.70	1983.20	4123.75
SD	SOLIDS, DISSOLVED	MG_L	8	4064.50	968.42	2581.00	5548.00	342.39	32516.00	937840.57
SO4	SULFATE	MG_L	8	2204.00	393.99	1350.00	2502.00	139.30	17632.00	155225.14

PEABODY COAL COMPANY
ARIZONA DIVISION
WELL WATER QUALITY STATISTICS

VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0252 SAMPPT=0087										
AK4	ALK AS CACO3, PH 4.5	MG_L	8	235.36	51.83	188.20	306.00	18.33	1882.90	2686.51
CD	CADMIUM, DISSOLVED	UG_L	8	5.00	0.00	5.00	5.00	0.00	40.00	0.00
CA	CALCIUM, DISSOLVED	MG_L	8	254.64	58.90	197.00	370.00	20.82	2037.10	3468.85
CL	CHLORIDE	MG_L	8	34.91	16.62	19.60	64.70	5.88	279.30	276.39
F	FLUORIDE	MG_L	8	1.55	2.22	0.50	7.00	0.78	12.41	4.91
FET	IRON, TOTAL	MG_L	8	33.46	23.30	4.10	68.60	8.24	267.70	543.11
PB	LEAD, DISSOLVED	UG_L	7	22.86	7.56	20.00	40.00	2.86	160.00	57.14
MG	MAGNESIUM, DISSOLVED	MG_L	8	192.92	142.67	57.00	430.00	50.44	1543.40	20354.51
MNT	MANGANESE, TOTAL	MG_L	8	1.96	1.08	0.13	3.80	0.38	15.68	1.17
N_3	NITRATE NITROGEN _N	MG_L	8	10.05	8.78	2.70	26.00	3.10	80.38	77.13
K	POTASSIUM, DISSOLVED	MG_L	8	2.44	1.93	0.20	6.20	0.68	19.50	3.73
SE	SELENIUM, DISSOLVED	UG_L	8	9.38	1.77	5.00	10.00	0.63	75.00	3.13
NA	SODIUM, DISSOLVED	MG_L	8	167.96	119.29	64.70	379.00	42.18	1343.70	14229.98
SD	SOLIDS, DISSOLVED	MG_L	8	2851.75	1194.17	1478.00	4998.00	422.20	22814.00	1426031.36
SO4	SULFATE	MG_L	8	1490.88	876.18	735.00	2775.00	309.77	11927.00	767682.98
MINENO=0252 SAMPPT=0088										
AK4	ALK AS CACO3, PH 4.5	MG_L	14	293.88	70.56	118.00	389.80	18.86	4114.30	4978.67
CD	CADMIUM, DISSOLVED	UG_L	14	8.71	5.20	5.00	20.00	1.39	122.00	26.99
CA	CALCIUM, DISSOLVED	MG_L	13	358.58	49.44	245.00	434.00	13.71	4661.60	2444.68
CL	CHLORIDE	MG_L	14	41.15	11.56	17.50	56.60	3.09	576.10	133.66
F	FLUORIDE	MG_L	14	0.61	0.17	0.40	1.10	0.05	8.48	0.03
FET	IRON, TOTAL	MG_L	13	2.70	4.39	0.10	16.60	1.22	35.15	19.27
PB	LEAD, DISSOLVED	UG_L	12	108.33	99.16	20.00	290.00	28.63	1300.00	9833.33
MG	MAGNESIUM, DISSOLVED	MG_L	14	310.89	109.47	109.00	441.00	29.26	4352.50	11983.67
MNT	MANGANESE, TOTAL	MG_L	13	18.77	60.48	0.27	220.00	16.77	244.04	3658.03
N_3	NITRATE NITROGEN _N	MG_L	13	1.69	2.29	0.01	6.98	0.63	22.02	5.24
K	POTASSIUM, DISSOLVED	MG_L	14	10.71	4.03	5.00	21.40	1.08	149.90	16.26
SE	SELENIUM, DISSOLVED	UG_L	14	15.71	14.53	10.00	50.00	3.88	220.00	210.99
NA	SODIUM, DISSOLVED	MG_L	14	295.51	83.34	112.50	415.00	22.27	4137.10	6945.80
SD	SOLIDS, DISSOLVED	MG_L	13	4239.54	862.58	2232.00	5090.00	239.24	55114.00	744050.44
SO4	SULFATE	MG_L	13	2476.54	599.78	1290.00	3380.00	166.35	32195.00	359730.77

PEABODY COAL COMPANY
ARIZONA DIVISION
WELL WATER QUALITY STATISTICS

VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0252 SAMPPT=0089										
AK4	ALK AS CACO3, PH 4.5	MG_L	8	295.69	55.96	172.00	352.00	19.78	2365.50	3130.98
CD	CADMIUM, DISSOLVED	UG_L	8	5.13	0.35	5.00	6.00	0.13	41.00	0.13
CA	CALCIUM, DISSOLVED	MG_L	8	211.27	19.09	186.00	238.00	6.75	1690.20	364.38
CL	CHLORIDE	MG_L	8	24.31	12.74	12.00	51.00	4.50	194.50	162.26
F	FLUORIDE	MG_L	8	0.58	0.09	0.40	0.70	0.03	4.62	0.01
FET	IRON, TOTAL	MG_L	8	6.36	7.94	0.58	23.30	2.81	50.88	63.01
PB	LEAD, DISSOLVED	UG_L	7	22.86	7.56	20.00	40.00	2.86	160.00	57.14
MG	MAGNESIUM, DISSOLVED	MG_L	8	144.15	56.74	109.00	281.00	20.06	1153.20	3219.70
MNT	MANGANESE, TOTAL	MG_L	8	0.61	0.48	0.09	1.60	0.17	4.88	0.23
N_3	NITRATE NITROGEN _N	MG_L	8	0.37	0.22	0.20	0.80	0.08	2.96	0.05
K	POTASSIUM, DISSOLVED	MG_L	8	6.10	1.07	4.50	7.90	0.38	48.80	1.15
SE	SELENIUM, DISSOLVED	UG_L	8	9.63	1.06	7.00	10.00	0.38	77.00	1.13
NA	SODIUM, DISSOLVED	MG_L	8	78.74	58.05	45.00	220.00	20.52	629.90	3369.41
SD	SOLIDS, DISSOLVED	MG_L	8	2450.13	1174.00	1590.00	4854.00	415.07	19601.00	1378282.98
SO4	SULFATE	MG_L	8	972.25	411.44	607.00	1930.00	145.47	7778.00	169281.36
MINENO=0252 SAMPPT=0098										
AK4	ALK AS CACO3, PH 4.5	MG_L	7	1723.73	510.69	682.00	2189.10	193.02	12066.10	260802
CD	CADMIUM, DISSOLVED	UG_L	7	5.86	1.86	5.00	10.00	0.70	41.00	3
CA	CALCIUM, DISSOLVED	MG_L	7	445.99	58.88	342.00	536.00	22.26	3121.90	3467
CL	CHLORIDE	MG_L	7	810.80	227.62	450.00	1055.00	86.03	5675.60	51811
F	FLUORIDE	MG_L	7	2.19	0.51	1.60	2.80	0.19	15.30	0
FET	IRON, TOTAL	MG_L	7	16.56	7.14	8.70	27.00	2.70	115.90	51
PB	LEAD, DISSOLVED	UG_L	6	33.33	32.66	20.00	100.00	13.33	200.00	1067
MG	MAGNESIUM, DISSOLVED	MG_L	7	5437.53	3480.33	854.70	9960.00	1315.44	38062.70	12112683
MNT	MANGANESE, TOTAL	MG_L	7	11.31	5.69	6.50	21.00	2.15	79.20	32
N_3	NITRATE NITROGEN _N	MG_L	7	0.60	0.58	0.10	1.80	0.22	4.20	0
K	POTASSIUM, DISSOLVED	MG_L	7	13.73	5.08	6.00	20.50	1.92	96.10	26
SE	SELENIUM, DISSOLVED	UG_L	7	12.86	7.56	10.00	30.00	2.86	90.00	57
NA	SODIUM, DISSOLVED	MG_L	7	7632.86	1342.48	5900.00	10000.00	507.41	53430.00	1802252
SD	SOLIDS, DISSOLVED	MG_L	7	62264.43	28458.12	26950.00	108000.00	10756.16	435851.00	809864775
SO4	SULFATE	MG_L	7	33313.57	15079.22	15550.00	60100.00	5699.41	233195.00	227382973

PEABODY COAL COMPANY
ARIZONA DIVISION
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VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0250 SAMPPT=0094										
AK4	ALK AS CACO3, PH 4.5	MG_L	8	292.02	26.97	250.00	329.60	9.54	2336.20	727.54
CD	CADMIUM, DISSOLVED	UG_L	8	5.50	1.41	5.00	9.00	0.50	44.00	2.00
CA	CALCIUM, DISSOLVED	MG_L	8	447.76	61.82	316.00	501.00	21.85	3582.10	3821.11
CL	CHLORIDE	MG_L	8	40.12	7.26	32.00	55.90	2.57	321.00	52.68
F	FLUORIDE	MG_L	8	0.67	0.10	0.53	0.80	0.03	5.38	0.01
FET	IRON, TOTAL	MG_L	8	26.84	26.90	1.10	87.00	9.51	214.70	723.85
PB	LEAD, DISSOLVED	UG_L	7	28.57	22.68	20.00	80.00	8.57	200.00	514.29
MG	MAGNESIUM, DISSOLVED	MG_L	8	240.22	21.56	217.80	288.00	7.62	1921.80	464.63
MNT	MANGANESE, TOTAL	MG_L	8	0.47	0.44	0.04	1.50	0.16	3.75	0.20
N_3	NITRATE NITROGEN _N	MG_L	8	0.92	0.69	0.10	1.80	0.24	7.37	0.47
K	POTASSIUM, DISSOLVED	MG_L	8	9.57	2.91	6.00	16.00	1.03	76.60	8.49
SE	SELENIUM, DISSOLVED	UG_L	8	9.38	1.77	5.00	10.00	0.63	75.00	3.13
NA	SODIUM, DISSOLVED	MG_L	8	222.09	35.77	154.00	278.00	12.65	1776.70	1279.60
SD	SOLIDS, DISSOLVED	MG_L	8	4028.25	726.73	3356.00	5694.00	256.94	32226.00	528141.07
SO4	SULFATE	MG_L	8	2156.00	202.79	1820.00	2420.00	71.70	17248.00	41124.57
MINENO=0250 SAMPPT=0095										
AK4	ALK AS CACO3, PH 4.5	MG_L	12	257.30	34.00	205.00	318.00	9.82	3087.60	1156.22
CD	CADMIUM, DISSOLVED	UG_L	12	9.42	5.48	5.00	20.00	1.58	113.00	30.08
CA	CALCIUM, DISSOLVED	MG_L	12	389.35	121.67	130.50	509.00	35.12	4672.20	14804.01
CL	CHLORIDE	MG_L	12	34.55	11.71	4.20	56.50	3.38	414.60	137.02
F	FLUORIDE	MG_L	12	0.72	0.11	0.58	0.90	0.03	8.69	0.01
FET	IRON, TOTAL	MG_L	12	2.92	4.90	0.10	17.90	1.42	35.08	24.04
PB	LEAD, DISSOLVED	UG_L	11	100.91	100.25	20.00	280.00	30.23	1110.00	10049.09
MG	MAGNESIUM, DISSOLVED	MG_L	12	214.27	35.90	158.00	261.00	10.36	2571.20	1288.75
MNT	MANGANESE, TOTAL	MG_L	12	0.41	0.34	0.02	1.06	0.10	4.90	0.11
N_3	NITRATE NITROGEN _N	MG_L	12	0.18	0.09	0.00	0.37	0.03	2.19	0.01
K	POTASSIUM, DISSOLVED	MG_L	12	9.97	3.78	6.80	18.00	1.09	119.60	14.29
SE	SELENIUM, DISSOLVED	UG_L	12	13.33	11.55	10.00	50.00	3.33	160.00	133.33
NA	SODIUM, DISSOLVED	MG_L	12	254.48	111.30	132.00	454.00	32.13	3053.80	12387.28
SD	SOLIDS, DISSOLVED	MG_L	12	3503.00	457.38	2597.00	3936.00	132.03	42036.00	209193.27
SO4	SULFATE	MG_L	12	2103.75	285.98	1380.00	2380.00	82.55	25245.00	81782.20

PEABODY COAL COMPANY
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VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0250 SAMPPT=0096										
AK4	ALK AS CACO3, PH 4.5	MG_L	8	321.56	36.57	273.00	382.50	12.93	2572.50	1337.32
CD	CADMIUM, DISSOLVED	UG_L	8	5.88	2.47	5.00	12.00	0.88	47.00	6.13
CA	CALCIUM, DISSOLVED	MG_L	8	480.60	69.76	351.80	572.00	24.66	3844.80	4866.77
CL	CHLORIDE	MG_L	8	60.41	17.98	35.00	93.60	6.36	483.30	323.12
F	FLUORIDE	MG_L	8	0.64	0.10	0.50	0.80	0.04	5.12	0.01
FET	IRON, TOTAL	MG_L	8	31.05	30.93	6.00	100.00	10.94	248.40	956.83
PB	LEAD, DISSOLVED	UG_L	7	34.29	37.80	20.00	120.00	14.29	240.00	1428.57
MG	MAGNESIUM, DISSOLVED	MG_L	8	302.24	63.58	214.90	387.00	22.48	2417.90	4042.99
MNT	MANGANESE, TOTAL	MG_L	8	3.01	2.15	0.28	6.30	0.76	24.08	4.63
N_3	NITRATE NITROGEN _N	MG_L	8	0.36	0.40	0.10	1.30	0.14	2.92	0.16
K	POTASSIUM, DISSOLVED	MG_L	8	12.37	2.54	9.40	16.50	0.90	99.00	6.45
SE	SELENIUM, DISSOLVED	UG_L	8	9.38	1.77	5.00	10.00	0.63	75.00	3.13
NA	SODIUM, DISSOLVED	MG_L	8	308.04	104.90	200.50	472.00	37.09	2464.30	11004.84
SD	SOLIDS, DISSOLVED	MG_L	8	4905.38	1246.88	3300.00	7000.00	440.84	39243.00	1554716.55
SO4	SULFATE	MG_L	8	2635.25	606.08	1870.00	3395.00	214.28	21082.00	367337.64
MINENO=0250 SAMPPT=0103										
AK4	ALK AS CACO3, PH 4.5	MG_L	8	198.45	61.29	128.00	331.00	21.67	1587.60	3755.95
CD	CADMIUM, DISSOLVED	UG_L	8	4.75	0.71	3.00	5.00	0.25	38.00	0.50
CA	CALCIUM, DISSOLVED	MG_L	8	121.44	47.90	61.90	190.00	16.93	971.50	2294.34
CL	CHLORIDE	MG_L	8	14.35	18.04	5.80	58.50	6.38	114.80	325.47
F	FLUORIDE	MG_L	8	0.47	0.05	0.40	0.51	0.02	3.76	0.00
FET	IRON, TOTAL	MG_L	8	7.93	5.63	0.44	14.70	1.99	63.44	31.73
PB	LEAD, DISSOLVED	UG_L	7	22.86	7.56	20.00	40.00	2.86	160.00	57.14
MG	MAGNESIUM, DISSOLVED	MG_L	8	63.82	72.71	19.30	240.00	25.71	510.60	5287.38
MNT	MANGANESE, TOTAL	MG_L	8	0.50	0.41	0.02	1.09	0.15	4.00	0.17
N_3	NITRATE NITROGEN _N	MG_L	8	1.40	1.28	0.10	3.40	0.45	11.19	1.64
K	POTASSIUM, DISSOLVED	MG_L	8	5.07	2.83	3.40	12.00	1.00	40.60	8.03
SE	SELENIUM, DISSOLVED	UG_L	8	9.38	1.77	5.00	10.00	0.63	75.00	3.13
NA	SODIUM, DISSOLVED	MG_L	8	31.21	16.73	16.30	61.40	5.92	249.70	279.98
SD	SOLIDS, DISSOLVED	MG_L	8	1057.75	376.30	567.00	1568.00	133.04	8462.00	141598.21
SO4	SULFATE	MG_L	8	433.50	288.01	158.00	1070.00	101.83	3468.00	82952.00

PEABODY COAL COMPANY
ARIZONA DIVISION
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VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0252 SAMPPT=0099										
AK4	ALK AS CACO3, PH 4.5	MG_L	7	79.36	98.56	0.00	277.00	37.25	555.50	9713.29
CD	CADMIUM, DISSOLVED	UG_L	7	8.14	8.32	5.00	27.00	3.14	57.00	69.14
CA	CALCIUM, DISSOLVED	MG_L	7	336.54	144.11	52.60	460.00	54.47	2355.80	20766.42
CL	CHLORIDE	MG_L	7	144.07	48.63	119.20	254.00	18.38	1008.50	2364.81
F	FLUORIDE	MG_L	7	0.87	0.39	0.51	1.60	0.15	6.06	0.15
FET	IRON, TOTAL	MG_L	7	68.43	66.01	4.80	207.00	24.95	479.00	4356.86
PB	LEAD, DISSOLVED	UG_L	6	70.00	122.47	20.00	320.00	50.00	420.00	15000.00
MG	MAGNESIUM, DISSOLVED	MG_L	7	871.03	193.55	544.20	1060.00	73.15	6097.20	37461.54
MNT	MANGANESE, TOTAL	MG_L	7	5.90	2.89	4.00	12.10	1.09	41.30	8.36
N_3	NITRATE NITROGEN _N	MG_L	7	0.23	0.21	0.00	0.60	0.08	1.60	0.04
K	POTASSIUM, DISSOLVED	MG_L	7	7.13	3.64	4.00	15.00	1.38	49.90	13.27
SE	SELENIUM, DISSOLVED	UG_L	7	10.71	4.50	5.00	20.00	1.70	75.00	20.24
NA	SODIUM, DISSOLVED	MG_L	7	670.63	316.68	84.00	992.00	119.69	4694.40	100287.57
SD	SOLIDS, DISSOLVED	MG_L	5	8834.20	2114.10	5645.00	11150.00	945.45	44171.00	4469423.20
SO4	SULFATE	MG_L	7	5363.71	924.50	3355.00	6030.00	349.43	37546.00	854694.90
MINENO=0252 SAMPPT=0100										
AK4	ALK AS CACO3, PH 4.5	MG_L	5	488.80	150.34	330.00	725.60	67.23	2444.00	22602.7
CD	CADMIUM, DISSOLVED	UG_L	5	6.00	2.24	5.00	10.00	1.00	30.00	5.0
CA	CALCIUM, DISSOLVED	MG_L	5	400.90	137.66	157.10	495.00	61.56	2004.50	18949.8
CL	CHLORIDE	MG_L	5	284.84	14.56	270.30	306.00	6.51	1424.20	212.0
F	FLUORIDE	MG_L	5	1.58	0.16	1.40	1.80	0.07	7.90	0.0
FET	IRON, TOTAL	MG_L	5	14.14	12.77	0.10	31.00	5.71	70.70	163.0
PB	LEAD, DISSOLVED	UG_L	3	80.00	103.92	20.00	200.00	60.00	240.00	10800.0
MG	MAGNESIUM, DISSOLVED	MG_L	5	1922.40	811.99	653.00	2880.00	363.13	9612.00	659320.3
MNT	MANGANESE, TOTAL	MG_L	5	10.80	2.88	8.00	14.00	1.29	54.00	8.3
N_3	NITRATE NITROGEN _N	MG_L	5	8.18	2.74	3.80	10.80	1.22	40.90	7.5
K	POTASSIUM, DISSOLVED	MG_L	5	9.34	2.59	6.30	12.10	1.16	46.70	6.7
SE	SELENIUM, DISSOLVED	UG_L	5	10.00	0.00	10.00	10.00	0.00	50.00	0.0
NA	SODIUM, DISSOLVED	MG_L	5	2118.76	973.44	749.80	3190.00	435.33	10593.80	947582.1
SD	SOLIDS, DISSOLVED	MG_L	4	18826.50	8819.19	5916.00	25044.00	4409.59	75306.00	77778099.7
SO4	SULFATE	MG_L	5	12230.20	5245.49	3500.00	17250.00	2345.85	61151.00	27515150.2

PEABODY COAL COMPANY
ARIZONA DIVISION
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VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0252 SAMPPT=0101										
AK4	ALK AS CACO3, PH 4.5	MG_L	8	519.71	129.88	278.00	750.70	45.92	4157.70	16868.12
CD	CADMIUM, DISSOLVED	UG_L	8	7.50	5.35	5.00	20.00	1.89	60.00	28.57
CA	CALCIUM, DISSOLVED	MG_L	8	419.70	137.55	116.00	537.00	48.63	3357.60	18919.92
CL	CHLORIDE	MG_L	8	150.67	33.12	109.40	206.70	11.71	1205.40	1096.87
F	FLUORIDE	MG_L	8	0.75	0.19	0.56	1.10	0.07	6.03	0.04
FET	IRON, TOTAL	MG_L	8	18.40	27.75	2.40	86.00	9.81	147.20	769.90
PB	LEAD, DISSOLVED	UG_L	7	131.43	294.81	20.00	800.00	111.43	920.00	86914.29
MG	MAGNESIUM, DISSOLVED	MG_L	8	806.90	105.04	622.20	944.00	37.14	6455.20	11032.99
MNT	MANGANESE, TOTAL	MG_L	8	2.16	1.08	1.10	3.70	0.38	17.30	1.16
N_3	NITRATE NITROGEN _N	MG_L	8	0.38	0.25	0.16	0.80	0.09	3.04	0.06
K	POTASSIUM, DISSOLVED	MG_L	8	7.90	1.17	7.00	10.50	0.41	63.20	1.36
SE	SELENIUM, DISSOLVED	UG_L	8	9.38	1.77	5.00	10.00	0.63	75.00	3.13
NA	SODIUM, DISSOLVED	MG_L	8	666.95	269.75	82.00	937.00	95.37	5335.60	72765.11
SD	SOLIDS, DISSOLVED	MG_L	7	8379.14	2014.99	6143.00	11730.00	761.59	58654.00	4060172.81
SO4	SULFATE	MG_L	8	5009.00	819.21	3750.00	6210.00	289.63	40072.00	671098.00
MINENO=0252 SAMPPT=0102										
AK4	ALK AS CACO3, PH 4.5	MG_L	8	416.11	93.38	312.00	614.20	33.01	3328.90	8719.34
CD	CADMIUM, DISSOLVED	UG_L	8	4.88	0.35	4.00	5.00	0.13	39.00	0.13
CA	CALCIUM, DISSOLVED	MG_L	8	314.49	45.32	220.00	380.00	16.02	2515.90	2054.30
CL	CHLORIDE	MG_L	8	17.41	3.51	12.00	21.50	1.24	139.30	12.29
F	FLUORIDE	MG_L	8	0.55	0.17	0.40	0.90	0.06	4.39	0.03
FET	IRON, TOTAL	MG_L	8	58.62	118.02	7.00	349.00	41.73	469.00	13929.40
PB	LEAD, DISSOLVED	UG_L	7	40.00	52.92	20.00	160.00	20.00	280.00	2800.00
MG	MAGNESIUM, DISSOLVED	MG_L	8	89.54	7.46	81.60	100.10	2.64	716.30	55.66
MNT	MANGANESE, TOTAL	MG_L	8	1.47	0.99	0.35	2.80	0.35	11.80	0.99
N_3	NITRATE NITROGEN _N	MG_L	8	0.63	0.64	0.10	2.00	0.23	5.01	0.41
K	POTASSIUM, DISSOLVED	MG_L	8	1.47	0.74	1.00	3.00	0.26	11.80	0.55
SE	SELENIUM, DISSOLVED	UG_L	8	9.38	1.77	5.00	10.00	0.63	75.00	3.13
NA	SODIUM, DISSOLVED	MG_L	8	104.65	17.06	76.00	120.00	6.03	837.20	290.93
SD	SOLIDS, DISSOLVED	MG_L	8	2568.75	1078.88	1860.00	5040.00	381.44	20550.00	1163981.93
SO4	SULFATE	MG_L	8	935.38	96.95	780.00	1060.00	34.28	7483.00	9399.70

PEABODY COAL COMPANY
ARIZONA DIVISION
WELL WATER QUALITY STATISTICS

VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0250 SAMPPT=0104										
AK4	ALK AS CACO3, PH 4.5	MG_L	8	267.64	44.27	212.00	345.00	15.65	2141.10	1959.77
CD	CADMIUM, DISSOLVED	UG_L	8	5.00	0.00	5.00	5.00	0.00	40.00	0.00
CA	CALCIUM, DISSOLVED	MG_L	8	166.35	111.64	90.80	410.00	39.47	1330.80	12463.94
CL	CHLORIDE	MG_L	8	35.05	34.30	7.00	94.10	12.13	280.40	1176.81
F	FLUORIDE	MG_L	8	0.66	0.07	0.60	0.80	0.02	5.28	0.00
FET	IRON, TOTAL	MG_L	8	17.94	14.49	0.40	43.50	5.12	143.50	209.97
PB	LEAD, DISSOLVED	UG_L	7	21.43	3.78	20.00	30.00	1.43	150.00	14.29
MG	MAGNESIUM, DISSOLVED	MG_L	8	69.19	49.84	32.00	150.00	17.62	553.50	2484.09
MNT	MANGANESE, TOTAL	MG_L	8	0.52	0.33	0.10	1.20	0.12	4.15	0.11
N_3	NITRATE NITROGEN _N	MG_L	8	8.01	19.69	0.10	56.70	6.96	64.10	387.66
K	POTASSIUM, DISSOLVED	MG_L	8	2.86	1.17	1.30	4.70	0.41	22.90	1.37
SE	SELENIUM, DISSOLVED	UG_L	8	13.13	7.99	5.00	30.00	2.82	105.00	63.84
NA	SODIUM, DISSOLVED	MG_L	8	153.10	69.53	89.40	280.00	24.58	1224.80	4834.83
SD	SOLIDS, DISSOLVED	MG_L	8	1916.25	1070.01	880.00	3806.00	378.30	15330.00	1144917.36
SO4	SULFATE	MG_L	8	667.75	559.82	282.00	1830.00	197.93	5342.00	313402.50
MINENO=0250 SAMPPT=0105										
AK4	ALK AS CACO3, PH 4.5	MG_L	8	518.80	183.48	312.20	794.00	64.87	4150.40	33665.29
CD	CADMIUM, DISSOLVED	UG_L	8	5.50	1.41	5.00	9.00	0.50	44.00	2.00
CA	CALCIUM, DISSOLVED	MG_L	8	165.05	59.70	104.00	269.60	21.11	1320.40	3564.19
CL	CHLORIDE	MG_L	8	31.92	10.18	19.60	48.00	3.60	255.40	103.66
F	FLUORIDE	MG_L	8	0.64	0.12	0.50	0.86	0.04	5.12	0.01
FET	IRON, TOTAL	MG_L	8	7.04	5.14	1.10	15.00	1.82	56.30	26.37
PB	LEAD, DISSOLVED	UG_L	7	31.43	30.24	20.00	100.00	11.43	220.00	914.29
MG	MAGNESIUM, DISSOLVED	MG_L	8	133.95	81.70	27.00	250.00	28.89	1071.60	6675.66
MNT	MANGANESE, TOTAL	MG_L	8	2.89	2.12	0.70	7.20	0.75	23.14	4.51
N_3	NITRATE NITROGEN _N	MG_L	8	0.41	0.64	0.10	2.00	0.23	3.28	0.41
K	POTASSIUM, DISSOLVED	MG_L	8	8.17	3.78	3.70	15.00	1.34	65.40	14.29
SE	SELENIUM, DISSOLVED	UG_L	8	9.38	1.77	5.00	10.00	0.63	75.00	3.13
NA	SODIUM, DISSOLVED	MG_L	8	559.36	393.85	272.90	1500.00	139.25	4474.90	155120.45
SD	SOLIDS, DISSOLVED	MG_L	8	3189.50	1222.53	1310.00	5562.00	432.23	25516.00	1494571.71
SO4	SULFATE	MG_L	8	1264.00	531.54	524.00	2230.00	187.93	10112.00	282531.43

PEABODY COAL COMPANY
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VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0250 SAMPPT=0106										
AK4	ALK AS CACO3, PH 4.5	MG_L	8	479.10	229.39	225.00	786.00	81.10	3832.80	52619.61
CD	CADMIUM, DISSOLVED	UG_L	8	5.25	0.71	5.00	7.00	0.25	42.00	0.50
CA	CALCIUM, DISSOLVED	MG_L	8	116.52	43.26	76.10	210.00	15.30	932.20	1871.79
CL	CHLORIDE	MG_L	8	31.77	10.13	18.00	51.00	3.58	254.20	102.64
F	FLUORIDE	MG_L	8	0.73	0.11	0.60	0.90	0.04	5.85	0.01
FET	IRON, TOTAL	MG_L	8	11.54	7.77	1.60	23.00	2.75	92.30	60.33
PB	LEAD, DISSOLVED	UG_L	7	25.71	15.12	20.00	60.00	5.71	180.00	228.57
MG	MAGNESIUM, DISSOLVED	MG_L	8	65.80	17.35	46.70	100.00	6.14	526.40	301.11
MNT	MANGANESE, TOTAL	MG_L	8	0.57	0.22	0.34	1.00	0.08	4.57	0.05
N_3	NITRATE NITROGEN _N	MG_L	8	0.53	0.58	0.10	1.80	0.21	4.22	0.34
K	POTASSIUM, DISSOLVED	MG_L	8	6.55	2.61	3.20	10.80	0.92	52.40	6.80
SE	SELENIUM, DISSOLVED	UG_L	8	9.38	1.77	5.00	10.00	0.63	75.00	3.13
NA	SODIUM, DISSOLVED	MG_L	8	291.02	81.53	192.00	419.00	28.83	2328.20	6647.73
SD	SOLIDS, DISSOLVED	MG_L	8	2364.75	1417.42	1386.00	5732.00	501.13	18918.00	2009086.79
SO4	SULFATE	MG_L	8	663.00	232.94	442.00	1140.00	82.36	5304.00	54262.57
MINENO=0250 SAMPPT=031R										
AK4	ALK AS CACO3, PH 4.5	MG_L	2	305.50	24.75	288.00	323.00	17.50	611.00	612.50
CD	CADMIUM, DISSOLVED	UG_L	1	5.00	.	5.00	5.00	.	5.00	.
CA	CALCIUM, DISSOLVED	MG_L	2	165.00	21.21	150.00	180.00	15.00	330.00	450.00
CL	CHLORIDE	MG_L	2	17.55	2.90	15.50	19.60	2.05	35.10	8.41
F	FLUORIDE	MG_L	2	0.65	0.07	0.60	0.70	0.05	1.30	0.01
FET	IRON, TOTAL	MG_L	2	44.50	19.09	31.00	58.00	13.50	89.00	364.50
PB	LEAD, DISSOLVED	UG_L	2	20.00	0.00	20.00	20.00	0.00	40.00	0.00
MG	MAGNESIUM, DISSOLVED	MG_L	2	53.50	2.12	52.00	55.00	1.50	107.00	4.50
MNT	MANGANESE, TOTAL	MG_L	2	0.40	0.52	0.03	0.77	0.37	0.80	0.27
N_3	NITRATE NITROGEN _N	MG_L	2	1.60	1.98	0.20	3.00	1.40	3.20	3.92
K	POTASSIUM, DISSOLVED	MG_L	2	4.50	0.71	4.00	5.00	0.50	9.00	0.50
SE	SELENIUM, DISSOLVED	UG_L	2	10.00	0.00	10.00	10.00	0.00	20.00	0.00
NA	SODIUM, DISSOLVED	MG_L	2	97.50	3.54	95.00	100.00	2.50	195.00	12.50
SD	SOLIDS, DISSOLVED	MG_L	2	1195.00	21.21	1180.00	1210.00	15.00	2390.00	450.00
SO4	SULFATE	MG_L	2	471.00	97.58	402.00	540.00	69.00	942.00	9522.00

PEABODY COAL COMPANY
ARIZONA DIVISION
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VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0252 SAMPPT=0107										
AK4	ALK AS CACO3, PH 4.5	MG_L	15	395.78	82.33	242.00	530.00	21.26	5936.70	6778.86
CD	CADMIUM, DISSOLVED	UG_L	15	12.13	9.24	2.00	30.00	2.39	182.00	85.41
CA	CALCIUM, DISSOLVED	MG_L	15	512.68	71.31	393.80	660.00	18.41	7690.20	5085.15
CL	CHLORIDE	MG_L	15	74.67	13.57	52.00	97.50	3.50	1120.00	184.20
F	FLUORIDE	MG_L	15	0.59	0.10	0.40	0.80	0.03	8.91	0.01
FET	IRON, TOTAL	MG_L	14	3.50	4.54	0.48	18.60	1.21	48.98	20.61
PB	LEAD, DISSOLVED	UG_L	14	107.86	107.36	20.00	300.00	28.69	1510.00	11525.82
MG	MAGNESIUM, DISSOLVED	MG_L	15	371.19	53.91	300.00	502.00	13.92	5567.90	2906.15
MNT	MANGANESE, TOTAL	MG_L	14	2.43	0.91	1.30	4.70	0.24	33.99	0.83
N_3	NITRATE NITROGEN _N	MG_L	15	0.20	0.17	0.00	0.69	0.04	2.95	0.03
K	POTASSIUM, DISSOLVED	MG_L	15	4.93	2.65	1.70	9.40	0.68	74.00	7.03
SE	SELENIUM, DISSOLVED	UG_L	15	14.67	14.45	5.00	50.00	3.73	220.00	208.81
NA	SODIUM, DISSOLVED	MG_L	15	506.59	174.59	321.00	1037.00	45.08	7598.90	30480.08
SD	SOLIDS, DISSOLVED	MG_L	14	5921.14	1128.28	4652.00	8150.00	301.54	82896.00	1273006.13
SO4	SULFATE	MG_L	15	3417.93	573.56	2570.00	4410.00	148.09	51269.00	328973.78
MINENO=0252 SAMPPT=0108										
AK4	ALK AS CACO3, PH 4.5	MG_L	9	289.59	46.85	244.40	389.70	15.62	2606.30	2195.30
CD	CADMIUM, DISSOLVED	UG_L	9	5.22	2.05	2.00	10.00	0.68	47.00	4.19
CA	CALCIUM, DISSOLVED	MG_L	9	497.40	134.97	155.60	622.00	44.99	4476.60	18217.19
CL	CHLORIDE	MG_L	9	75.19	9.85	56.00	93.60	3.28	676.70	96.99
F	FLUORIDE	MG_L	9	0.36	0.04	0.30	0.40	0.01	3.27	0.00
FET	IRON, TOTAL	MG_L	9	16.17	18.63	1.40	49.00	6.21	145.50	346.94
PB	LEAD, DISSOLVED	UG_L	7	25.71	15.12	20.00	60.00	5.71	180.00	228.57
MG	MAGNESIUM, DISSOLVED	MG_L	9	222.14	63.58	75.30	280.00	21.19	1999.30	4042.59
MNT	MANGANESE, TOTAL	MG_L	9	1.69	1.05	0.14	3.50	0.35	15.18	1.10
N_3	NITRATE NITROGEN _N	MG_L	9	0.14	0.08	0.03	0.21	0.03	1.27	0.01
K	POTASSIUM, DISSOLVED	MG_L	9	3.22	2.69	1.80	10.00	0.90	29.00	7.22
SE	SELENIUM, DISSOLVED	UG_L	9	9.56	1.74	5.00	11.00	0.58	86.00	3.03
NA	SODIUM, DISSOLVED	MG_L	9	164.33	42.65	104.00	242.20	14.22	1479.00	1819.41
SD	SOLIDS, DISSOLVED	MG_L	9	3804.22	662.95	2181.00	4624.00	220.98	34238.00	439500.19
SO4	SULFATE	MG_L	9	2035.89	473.89	850.00	2520.00	157.96	18323.00	224570.36

PEABODY COAL COMPANY
ARIZONA DIVISION
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VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0252 SAMPPT=0109										
AK4	ALK AS CACO3, PH 4.5	MG_L	8	298.82	66.72	237.00	427.50	23.59	2390.60	4451.11
CD	CADMIUM, DISSOLVED	UG_L	8	6.25	3.54	5.00	15.00	1.25	50.00	12.50
CA	CALCIUM, DISSOLVED	MG_L	8	470.19	20.62	440.00	502.00	7.29	3761.50	425.00
CL	CHLORIDE	MG_L	8	46.34	7.17	38.10	61.40	2.53	370.70	51.35
F	FLUORIDE	MG_L	8	0.40	0.08	0.30	0.50	0.03	3.21	0.01
FET	IRON, TOTAL	MG_L	8	10.60	8.90	1.20	26.00	3.15	84.80	79.15
PB	LEAD, DISSOLVED	UG_L	6	30.00	24.49	20.00	80.00	10.00	180.00	600.00
MG	MAGNESIUM, DISSOLVED	MG_L	8	305.16	25.75	270.00	353.00	9.10	2441.30	662.90
MNT	MANGANESE, TOTAL	MG_L	8	0.48	0.25	0.05	0.90	0.09	3.88	0.06
N_3	NITRATE NITROGEN _N	MG_L	8	0.26	0.27	0.10	0.90	0.09	2.10	0.07
K	POTASSIUM, DISSOLVED	MG_L	8	2.16	0.94	1.00	4.00	0.33	17.30	0.89
SE	SELENIUM, DISSOLVED	UG_L	8	10.00	2.67	5.00	15.00	0.94	80.00	7.14
NA	SODIUM, DISSOLVED	MG_L	8	254.64	44.36	175.00	313.00	15.68	2037.10	1967.60
SD	SOLIDS, DISSOLVED	MG_L	8	4487.38	761.28	3610.00	5988.00	269.15	35899.00	579551.13
SO4	SULFATE	MG_L	8	2535.00	109.95	2375.00	2707.00	38.87	20280.00	12089.71
MINENO=0252 SAMPPT=033R										
AK4	ALK AS CACO3, PH 4.5	MG_L	2	463.00	16.97	451.00	475.00	12.00	926.00	288.00
CD	CADMIUM, DISSOLVED	UG_L	2	5.00	0.00	5.00	5.00	0.00	10.00	0.00
CA	CALCIUM, DISSOLVED	MG_L	2	430.00	0.00	430.00	430.00	0.00	860.00	0.00
CL	CHLORIDE	MG_L	2	54.75	6.72	50.00	59.50	4.75	109.50	45.13
F	FLUORIDE	MG_L	2	0.50	0.00	0.50	0.50	0.00	1.00	0.00
FET	IRON, TOTAL	MG_L	2	2.05	0.64	1.60	2.50	0.45	4.10	0.41
PB	LEAD, DISSOLVED	UG_L	2	20.00	0.00	20.00	20.00	0.00	40.00	0.00
MG	MAGNESIUM, DISSOLVED	MG_L	2	411.50	82.73	353.00	470.00	58.50	823.00	6844.50
MNT	MANGANESE, TOTAL	MG_L	2	0.34	0.18	0.22	0.47	0.13	0.69	0.03
N_3	NITRATE NITROGEN _N	MG_L	2	10.75	2.47	9.00	12.50	1.75	21.50	6.13
K	POTASSIUM, DISSOLVED	MG_L	2	3.65	0.49	3.30	4.00	0.35	7.30	0.25
SE	SELENIUM, DISSOLVED	UG_L	2	10.00	0.00	10.00	10.00	0.00	20.00	0.00
NA	SODIUM, DISSOLVED	MG_L	2	635.00	21.21	620.00	650.00	15.00	1270.00	450.00
SD	SOLIDS, DISSOLVED	MG_L	2	5625.00	813.17	5050.00	6200.00	575.00	11250.00	661250.00
SO4	SULFATE	MG_L	2	3310.00	551.54	2920.00	3700.00	390.00	6620.00	304200.00

PEABODY COAL COMPANY
ARIZONA DIVISION
WELL WATER QUALITY STATISTICS

VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0252 SAMPPT=074R										
AK4	ALK AS CACO3, PH 4.5	MG_L	1	402.00	.	402.00	402.00	.	402.00	.
CD	CADMIUM, DISSOLVED	UG_L	1	2.00	.	2.00	2.00	.	2.00	.
CA	CALCIUM, DISSOLVED	MG_L	1	348.00	.	348.00	348.00	.	348.00	.
CL	CHLORIDE	MG_L	1	44.00	.	44.00	44.00	.	44.00	.
F	FLUORIDE	MG_L	1	0.73	.	0.73	0.73	.	0.73	.
FET	IRON, TOTAL	MG_L	1	55.50	.	55.50	55.50	.	55.50	.
PB	LEAD, DISSOLVED	UG_L	1	20.00	.	20.00	20.00	.	20.00	.
MG	MAGNESIUM, DISSOLVED	MG_L	1	268.00	.	268.00	268.00	.	268.00	.
MNT	MANGANESE, TOTAL	MG_L	1	5.40	.	5.40	5.40	.	5.40	.
N_3	NITRATE NITROGEN _N	MG_L	1	3.47	.	3.47	3.47	.	3.47	.
K	POTASSIUM, DISSOLVED	MG_L	1	5.40	.	5.40	5.40	.	5.40	.
SE	SELENIUM, DISSOLVED	UG_L	1	6.00	.	6.00	6.00	.	6.00	.
NA	SODIUM, DISSOLVED	MG_L	1	327.00	.	327.00	327.00	.	327.00	.
SD	SOLIDS, DISSOLVED	MG_L	1	3710.00	.	3710.00	3710.00	.	3710.00	.
SO4	SULFATE	MG_L	1	2170.00	.	2170.00	2170.00	.	2170.00	.
MINENO=0252 SAMPPT=084R										
AK4	ALK AS CACO3, PH 4.5	MG_L	2	289.00	25.46	271.00	307.00	18.00	578.00	648.00
CD	CADMIUM, DISSOLVED	UG_L	2	3.50	2.12	2.00	5.00	1.50	7.00	4.50
CA	CALCIUM, DISSOLVED	MG_L	2	523.50	9.19	517.00	530.00	6.50	1047.00	84.50
CL	CHLORIDE	MG_L	2	36.50	3.54	34.00	39.00	2.50	73.00	12.50
F	FLUORIDE	MG_L	2	0.54	0.37	0.28	0.80	0.26	1.08	0.14
FET	IRON, TOTAL	MG_L	2	12.24	15.21	1.49	23.00	10.76	24.49	231.34
PB	LEAD, DISSOLVED	UG_L	2	20.00	0.00	20.00	20.00	0.00	40.00	0.00
MG	MAGNESIUM, DISSOLVED	MG_L	2	235.00	91.92	170.00	300.00	65.00	470.00	8450.00
MNT	MANGANESE, TOTAL	MG_L	2	0.72	0.40	0.44	1.00	0.28	1.44	0.16
N_3	NITRATE NITROGEN _N	MG_L	2	11.57	16.02	0.24	22.90	11.33	23.14	256.74
K	POTASSIUM, DISSOLVED	MG_L	2	8.90	7.21	3.80	14.00	5.10	17.80	52.02
SE	SELENIUM, DISSOLVED	UG_L	2	7.50	3.54	5.00	10.00	2.50	15.00	12.50
NA	SODIUM, DISSOLVED	MG_L	2	256.00	118.79	172.00	340.00	84.00	512.00	14112.00
SD	SOLIDS, DISSOLVED	MG_L	2	3830.00	919.24	3180.00	4480.00	650.00	7660.00	845000.00
SO4	SULFATE	MG_L	2	2360.00	622.25	1920.00	2800.00	440.00	4720.00	387200.00

PEABODY COAL COMPANY
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VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0252 SAMPPT=100R										
AK4	ALK AS CACO3, PH 4.5	MG_L	2	62.00	36.77	36.00	88.00	26.00	124.00	1352.0
CD	CADMIUM, DISSOLVED	UG_L	2	5.00	0.00	5.00	5.00	0.00	10.00	0.0
CA	CALCIUM, DISSOLVED	MG_L	2	312.50	67.18	265.00	360.00	47.50	625.00	4512.5
CL	CHLORIDE	MG_L	2	208.50	120.92	123.00	294.00	85.50	417.00	14620.5
F	FLUORIDE	MG_L	2	1.50	0.28	1.30	1.70	0.20	3.00	0.1
FET	IRON, TOTAL	MG_L	2	164.00	135.76	68.00	260.00	96.00	328.00	18432.0
PB	LEAD, DISSOLVED	UG_L	2	20.00	0.00	20.00	20.00	0.00	40.00	0.0
MG	MAGNESIUM, DISSOLVED	MG_L	2	955.00	487.90	610.00	1300.00	345.00	1910.00	238050.0
MNT	MANGANESE, TOTAL	MG_L	2	22.50	9.19	16.00	29.00	6.50	45.00	84.5
N_3	NITRATE NITROGEN _N	MG_L	2	4.95	6.72	0.20	9.70	4.75	9.90	45.1
K	POTASSIUM, DISSOLVED	MG_L	2	10.00	1.41	9.00	11.00	1.00	20.00	2.0
SE	SELENIUM, DISSOLVED	UG_L	2	10.00	0.00	10.00	10.00	0.00	20.00	0.0
NA	SODIUM, DISSOLVED	MG_L	2	1040.00	650.54	580.00	1500.00	460.00	2080.00	423200.0
SD	SOLIDS, DISSOLVED	MG_L	2	11370.00	4850.75	7940.00	14800.00	3430.00	22740.00	23529800.0
SO4	SULFATE	MG_L	2	5945.00	2722.36	4020.00	7870.00	1925.00	11890.00	7411250.0
MINENO=0252 SAMPPT=107R										
AK4	ALK AS CACO3, PH 4.5	MG_L	2	655.00	50.91	619.00	691.00	36.00	1310.00	2592.00
CD	CADMIUM, DISSOLVED	UG_L	2	5.00	0.00	5.00	5.00	0.00	10.00	0.00
CA	CALCIUM, DISSOLVED	MG_L	2	365.00	91.92	300.00	430.00	65.00	730.00	8450.00
CL	CHLORIDE	MG_L	2	46.90	13.72	37.20	56.60	9.70	93.80	188.18
F	FLUORIDE	MG_L	2	0.40	0.00	0.40	0.40	0.00	0.80	0.00
FET	IRON, TOTAL	MG_L	2	27.00	4.24	24.00	30.00	3.00	54.00	18.00
PB	LEAD, DISSOLVED	UG_L	2	20.00	0.00	20.00	20.00	0.00	40.00	0.00
MG	MAGNESIUM, DISSOLVED	MG_L	2	242.50	31.82	220.00	265.00	22.50	485.00	1012.50
MNT	MANGANESE, TOTAL	MG_L	2	2.35	0.07	2.30	2.40	0.05	4.70	0.01
N_3	NITRATE NITROGEN _N	MG_L	2	0.20	0.00	0.20	0.20	0.00	0.40	0.00
K	POTASSIUM, DISSOLVED	MG_L	2	22.50	2.12	21.00	24.00	1.50	45.00	4.50
SE	SELENIUM, DISSOLVED	UG_L	2	10.00	0.00	10.00	10.00	0.00	20.00	0.00
NA	SODIUM, DISSOLVED	MG_L	2	131.50	167.58	13.00	250.00	118.50	263.00	28084.50
SD	SOLIDS, DISSOLVED	MG_L	2	3030.00	636.40	2580.00	3480.00	450.00	6060.00	405000.00
SO4	SULFATE	MG_L	2	1500.00	367.70	1240.00	1760.00	260.00	3000.00	135200.00

PEABODY COAL COMPANY
ARIZONA DIVISION
WELL WATER QUALITY STATISTICS

MINENO=0252 SAMPPT=110R

VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
AK4	ALK AS CACO3, PH 4.5	MG_L	2	659.00	5.66	655.00	663.00	4.00	1318.00	32.00
CD	CADMIUM, DISSOLVED	UG_L	2	5.00	0.00	5.00	5.00	0.00	10.00	0.00
CA	CALCIUM, DISSOLVED	MG_L	2	560.00	56.57	520.00	600.00	40.00	1120.00	3200.00
CL	CHLORIDE	MG_L	2	74.25	32.88	51.00	97.50	23.25	148.50	1081.13
F	FLUORIDE	MG_L	2	0.40	0.00	0.40	0.40	0.00	0.80	0.00
FET	IRON, TOTAL	MG_L	2	35.00	2.83	33.00	37.00	2.00	70.00	8.00
PB	LEAD, DISSOLVED	UG_L	2	20.00	0.00	20.00	20.00	0.00	40.00	0.00
MG	MAGNESIUM, DISSOLVED	MG_L	2	400.00	42.43	370.00	430.00	30.00	800.00	1800.00
MNT	MANGANESE, TOTAL	MG_L	2	4.65	0.07	4.60	4.70	0.05	9.30	0.00
N_3	NITRATE NITROGEN _N	MG_L	2	0.20	0.00	0.20	0.20	0.00	0.40	0.00
K	POTASSIUM, DISSOLVED	MG_L	2	8.20	1.13	7.40	9.00	0.80	16.40	1.28
SE	SELENIUM, DISSOLVED	UG_L	2	10.00	0.00	10.00	10.00	0.00	20.00	0.00
NA	SODIUM, DISSOLVED	MG_L	2	495.00	21.21	480.00	510.00	15.00	990.00	450.00
SD	SOLIDS, DISSOLVED	MG_L	2	5800.00	212.13	5650.00	5950.00	150.00	11600.00	45000.00
SO4	SULFATE	MG_L	2	3060.00	339.41	2820.00	3300.00	240.00	6120.00	115200.00

PEABODY COAL COMPANY
ARIZONA DIVISION
WELL WATER QUALITY STATISTICS

MINENO=0250 SAMPPT=114R

VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
AK4	ALK AS CACO3, PH 4.5	MG_L	2	1040.00	14.14	1030.00	1050.00	10.00	2080.00	200.00
CD	CADMIUM, DISSOLVED	UG_L	2	5.00	0.00	5.00	5.00	0.00	10.00	0.00
CA	CALCIUM, DISSOLVED	MG_L	2	10.75	6.01	6.50	15.00	4.25	21.50	36.13
CL	CHLORIDE	MG_L	2	80.25	83.09	21.50	139.00	58.75	160.50	6903.13
F	FLUORIDE	MG_L	2	5.20	0.57	4.80	5.60	0.40	10.40	0.32
FET	IRON, TOTAL	MG_L	2	15.50	3.54	13.00	18.00	2.50	31.00	12.50
PB	LEAD, DISSOLVED	UG_L	2	20.00	0.00	20.00	20.00	0.00	40.00	0.00
MG	MAGNESIUM, DISSOLVED	MG_L	2	13.00	14.14	3.00	23.00	10.00	26.00	200.00
MNT	MANGANESE, TOTAL	MG_L	2	0.42	0.03	0.40	0.44	0.02	0.84	0.00
N_3	NITRATE NITROGEN _N	MG_L	2	0.90	0.14	0.80	1.00	0.10	1.80	0.02
K	POTASSIUM, DISSOLVED	MG_L	2	3.05	0.07	3.00	3.10	0.05	6.10	0.00
SE	SELENIUM, DISSOLVED	UG_L	2	10.00	0.00	10.00	10.00	0.00	20.00	0.00
NA	SODIUM, DISSOLVED	MG_L	2	525.00	49.50	490.00	560.00	35.00	1050.00	2450.00
SD	SOLIDS, DISSOLVED	MG_L	2	1490.00	226.27	1330.00	1650.00	160.00	2980.00	51200.00
SO4	SULFATE	MG_L	2	160.00	127.28	70.00	250.00	90.00	320.00	16200.00

ATTACHMENT 16

Statistical Summary of Selected Water Quality

Parameters for Permanent Internal Impoundments

(1980 - 1985)

PEABODY COAL COMPANY
ARIZONA DIVISION
WELL WATER QUALITY STATISTICS

VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0252 SAMPPT=0112										
AK4	ALK AS CACO3, PH 4.5	MG_L	3	156.67	85.49	100.00	255.00	49.36	470.00	7308.33
CD	CADMIUM, DISSOLVED	UG_L	3	9.00	1.73	7.00	10.00	1.00	27.00	3.00
CA	CALCIUM, DISSOLVED	MG_L	3	52.27	1.99	50.10	54.00	1.15	156.80	3.94
CL	CHLORIDE	MG_L	3	29.33	4.24	24.60	32.80	2.45	88.00	18.01
F	FLUORIDE	MG_L	3	1.53	0.52	0.96	1.99	0.30	4.60	0.28
FET	IRON, TOTAL	MG_L	3	1.03	0.33	0.65	1.24	0.19	3.09	0.11
PB	LEAD, DISSOLVED	UG_L	3	86.67	35.12	50.00	120.00	20.28	260.00	1233.33
MG	MAGNESIUM, DISSOLVED	MG_L	3	39.23	23.27	13.50	58.80	13.44	117.70	541.54
MNT	MANGANESE, TOTAL	MG_L	3	0.34	0.43	0.08	0.83	0.25	1.01	0.18
N_3	NITRATE NITROGEN _N	MG_L	3	0.48	0.17	0.34	0.67	0.10	1.45	0.03
K	POTASSIUM, DISSOLVED	MG_L	3	17.50	3.90	13.00	19.80	2.25	52.50	15.19
SE	SELENIUM, DISSOLVED	UG_L	3	10.00	0.00	10.00	10.00	0.00	30.00	0.00
NA	SODIUM, DISSOLVED	MG_L	3	462.00	222.43	212.00	638.00	128.42	1386.00	49476.00
SD	SOLIDS, DISSOLVED	MG_L	2	2627.50	375.47	2362.00	2893.00	265.50	5255.00	140980.50
SO4	SULFATE	MG_L	3	1213.33	644.70	470.00	1620.00	372.22	3640.00	415633.33
MINENO=0252 SAMPPT=0113										
AK4	ALK AS CACO3, PH 4.5	MG_L	8	241.84	95.14	127.00	370.00	33.64	1934.70	9052.3
CD	CADMIUM, DISSOLVED	UG_L	8	15.38	21.90	5.00	68.00	7.74	123.00	479.7
CA	CALCIUM, DISSOLVED	MG_L	8	154.56	136.86	34.00	343.20	48.39	1236.50	18730.9
CL	CHLORIDE	MG_L	8	119.39	113.10	17.00	345.60	39.99	955.10	12792.4
F	FLUORIDE	MG_L	8	2.24	1.26	0.60	4.00	0.45	17.90	1.6
FET	IRON, TOTAL	MG_L	8	0.75	0.33	0.51	1.50	0.12	6.04	0.1
PB	LEAD, DISSOLVED	UG_L	8	355.00	725.38	20.00	2130.00	256.46	2840.00	526171.4
MG	MAGNESIUM, DISSOLVED	MG_L	8	189.32	164.93	15.00	517.00	58.31	1514.60	27203.2
MNT	MANGANESE, TOTAL	MG_L	8	0.11	0.17	0.02	0.53	0.06	0.89	0.0
N_3	NITRATE NITROGEN _N	MG_L	8	1.62	2.49	0.02	6.56	0.88	12.95	6.2
K	POTASSIUM, DISSOLVED	MG_L	8	41.07	18.42	15.00	73.40	6.51	328.60	339.3
SE	SELENIUM, DISSOLVED	UG_L	8	10.00	0.00	10.00	10.00	0.00	80.00	0.0
NA	SODIUM, DISSOLVED	MG_L	8	853.66	747.37	157.00	2038.00	264.24	6829.30	558569.2
SD	SOLIDS, DISSOLVED	MG_L	5	4816.20	4493.16	854.00	10660.00	2009.40	24081.00	20188530.2
SO4	SULFATE	MG_L	8	2589.50	1894.76	382.00	5400.00	669.90	20716.00	3590118.6

PEABODY COAL COMPANY
ARIZONA DIVISION
WELL WATER QUALITY STATISTICS

VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0250 SAMPPT=0116										
AK4	ALK AS CACO3, PH 4.5	MG_L	7	157.79	81.98	75.00	273.00	30.99	1104.50	6720.57
CD	CADMIUM, DISSOLVED	UG_L	7	7.86	2.67	5.00	10.00	1.01	55.00	7.14
CA	CALCIUM, DISSOLVED	MG_L	7	119.40	61.71	46.00	212.80	23.32	835.80	3808.14
CL	CHLORIDE	MG_L	7	35.64	23.26	16.40	84.00	8.79	249.50	541.23
F	FLUORIDE	MG_L	7	0.68	0.19	0.41	1.00	0.07	4.79	0.04
FET	IRON, TOTAL	MG_L	7	2.86	6.15	0.28	16.80	2.33	20.01	37.84
PB	LEAD, DISSOLVED	UG_L	7	38.57	15.74	20.00	60.00	5.95	270.00	247.62
MG	MAGNESIUM, DISSOLVED	MG_L	7	147.79	151.23	22.70	449.00	57.16	1034.50	22869.47
MNT	MANGANESE, TOTAL	MG_L	7	0.23	0.24	0.04	0.72	0.09	1.59	0.06
N_3	NITRATE NITROGEN _N	MG_L	7	1.35	2.54	0.04	6.87	0.96	9.44	6.45
K	POTASSIUM, DISSOLVED	MG_L	7	11.10	4.03	5.80	17.50	1.52	77.70	16.21
SE	SELENIUM, DISSOLVED	UG_L	7	10.00	0.00	10.00	10.00	0.00	70.00	0.00
NA	SODIUM, DISSOLVED	MG_L	7	213.59	214.62	19.00	625.00	81.12	1495.10	46061.13
SD	SOLIDS, DISSOLVED	MG_L	6	2084.50	1762.88	497.00	5018.00	719.69	12507.00	3107760.70
SO4	SULFATE	MG_L	6	1319.83	1024.11	420.00	3050.00	418.09	7919.00	1048792.17
MINENO=0250 SAMPPT=0117										
AK4	ALK AS CACO3, PH 4.5	MG_L	6	135.63	42.52	91.10	214.00	17.36	813.80	1808.18
CD	CADMIUM, DISSOLVED	UG_L	6	7.67	2.58	5.00	10.00	1.05	46.00	6.67
CA	CALCIUM, DISSOLVED	MG_L	6	31.32	7.76	24.60	46.60	3.17	187.90	60.15
CL	CHLORIDE	MG_L	6	9.98	6.24	1.00	19.00	2.55	59.90	38.91
F	FLUORIDE	MG_L	6	0.78	0.35	0.48	1.32	0.14	4.66	0.12
FET	IRON, TOTAL	MG_L	6	1.62	1.27	0.70	3.65	0.52	9.73	1.62
PB	LEAD, DISSOLVED	UG_L	6	35.00	16.43	20.00	50.00	6.71	210.00	270.00
MG	MAGNESIUM, DISSOLVED	MG_L	6	16.28	6.53	11.50	26.10	2.67	97.70	42.63
MNT	MANGANESE, TOTAL	MG_L	6	0.16	0.19	0.02	0.50	0.08	0.99	0.04
N_3	NITRATE NITROGEN _N	MG_L	6	0.08	0.06	0.00	0.15	0.02	0.48	0.00
K	POTASSIUM, DISSOLVED	MG_L	6	13.02	2.81	9.50	16.50	1.15	78.10	7.88
SE	SELENIUM, DISSOLVED	UG_L	6	10.00	0.00	10.00	10.00	0.00	60.00	0.00
NA	SODIUM, DISSOLVED	MG_L	6	10.68	7.49	5.00	24.00	3.06	64.10	56.04
SD	SOLIDS, DISSOLVED	MG_L	6	278.83	64.81	208.00	368.00	26.46	1673.00	4200.97
SO4	SULFATE	MG_L	6	45.83	35.81	15.00	110.00	14.62	275.00	1282.57

PEABODY COAL COMPANY
ARIZONA DIVISION
WELL WATER QUALITY STATISTICS

VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0250 SAMPPT=0118										
AK4	ALK AS CACO3, PH 4.5	MG_L	9	121.29	35.47	62.00	180.00	11.82	1091.60	1258.04
CD	CADMIUM, DISSOLVED	UG_L	9	6.67	2.50	5.00	10.00	0.83	60.00	6.25
CA	CALCIUM, DISSOLVED	MG_L	9	26.13	6.79	14.00	38.30	2.26	235.20	46.10
CL	CHLORIDE	MG_L	9	7.90	5.44	2.00	18.50	1.81	71.10	29.62
F	FLUORIDE	MG_L	9	0.69	0.50	0.20	1.70	0.17	6.18	0.25
FET	IRON, TOTAL	MG_L	9	1.49	1.54	0.10	4.92	0.51	13.37	2.39
PB	LEAD, DISSOLVED	UG_L	9	30.00	15.00	20.00	50.00	5.00	270.00	225.00
MG	MAGNESIUM, DISSOLVED	MG_L	9	12.69	5.14	6.00	21.50	1.71	114.20	26.41
MNT	MANGANESE, TOTAL	MG_L	9	0.16	0.23	0.02	0.61	0.08	1.44	0.06
N_3	NITRATE NITROGEN _N	MG_L	9	0.14	0.07	0.00	0.20	0.02	1.30	0.00
K	POTASSIUM, DISSOLVED	MG_L	9	14.33	4.37	8.00	20.30	1.46	129.00	19.10
SE	SELENIUM, DISSOLVED	UG_L	9	10.00	0.00	10.00	10.00	0.00	90.00	0.00
NA	SODIUM, DISSOLVED	MG_L	9	5.76	5.70	1.00	19.00	1.90	51.80	32.54
SD	SOLIDS, DISSOLVED	MG_L	9	239.11	88.73	130.00	419.00	29.58	2152.00	7872.61
SO4	SULFATE	MG_L	9	19.44	15.58	2.00	48.00	5.19	175.00	242.78
MINENO=0250 SAMPPT=0121										
AK4	ALK AS CACO3, PH 4.5	MG_L	4	78.00	21.36	57.00	104.50	10.68	312.00	456.17
CD	CADMIUM, DISSOLVED	UG_L	4	7.75	2.63	5.00	10.00	1.31	31.00	6.92
CA	CALCIUM, DISSOLVED	MG_L	4	66.00	56.65	26.40	150.00	28.33	264.00	3209.69
CL	CHLORIDE	MG_L	4	17.15	11.30	5.80	32.30	5.65	68.60	127.66
F	FLUORIDE	MG_L	4	0.50	0.22	0.32	0.80	0.11	2.01	0.05
FET	IRON, TOTAL	MG_L	4	0.26	0.22	0.10	0.58	0.11	1.03	0.05
PB	LEAD, DISSOLVED	UG_L	4	42.50	15.00	20.00	50.00	7.50	170.00	225.00
MG	MAGNESIUM, DISSOLVED	MG_L	4	21.45	10.97	13.20	37.40	5.48	85.80	120.31
MNT	MANGANESE, TOTAL	MG_L	4	0.06	0.04	0.02	0.09	0.02	0.24	0.00
N_3	NITRATE NITROGEN _N	MG_L	4	0.08	0.06	0.00	0.13	0.03	0.31	0.00
K	POTASSIUM, DISSOLVED	MG_L	4	14.32	2.77	11.70	17.10	1.38	57.30	7.67
SE	SELENIUM, DISSOLVED	UG_L	4	10.00	0.00	10.00	10.00	0.00	40.00	0.00
NA	SODIUM, DISSOLVED	MG_L	4	19.25	16.05	9.00	43.00	8.02	77.00	257.58
SD	SOLIDS, DISSOLVED	MG_L	4	490.25	323.74	249.00	968.00	161.87	1961.00	104806.92
SO4	SULFATE	MG_L	4	210.25	194.23	88.00	498.00	97.12	841.00	37726.92

PEABODY COAL COMPANY
ARIZONA DIVISION
WELL WATER QUALITY STATISTICS

VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0252 SAMPPT=0119										
AK4	ALK AS CACO3, PH 4.5	MG_L	7	90.71	34.99	45.50	126.00	13.22	635.00	1224.15
CD	CADMIUM, DISSOLVED	UG_L	7	7.14	2.67	5.00	10.00	1.01	50.00	7.14
CA	CALCIUM, DISSOLVED	MG_L	7	37.11	20.38	15.40	73.30	7.70	259.80	415.30
CL	CHLORIDE	MG_L	7	10.87	6.48	2.00	19.40	2.45	76.10	41.98
F	FLUORIDE	MG_L	7	0.77	0.32	0.43	1.32	0.12	5.39	0.10
FET	IRON, TOTAL	MG_L	7	0.64	0.29	0.10	0.93	0.11	4.48	0.09
PB	LEAD, DISSOLVED	UG_L	7	34.29	15.12	20.00	50.00	5.71	240.00	228.57
MG	MAGNESIUM, DISSOLVED	MG_L	7	16.94	13.09	7.50	45.90	4.95	118.60	171.22
MNT	MANGANESE, TOTAL	MG_L	7	0.07	0.05	0.02	0.17	0.02	0.46	0.00
N_3	NITRATE NITROGEN _N	MG_L	7	0.10	0.06	0.02	0.20	0.02	0.73	0.00
K	POTASSIUM, DISSOLVED	MG_L	7	11.39	3.12	8.30	16.10	1.18	79.70	9.71
SE	SELENIUM, DISSOLVED	UG_L	7	10.00	0.00	10.00	10.00	0.00	70.00	0.00
NA	SODIUM, DISSOLVED	MG_L	7	43.09	60.17	7.00	173.00	22.74	301.60	3619.98
SD	SOLIDS, DISSOLVED	MG_L	7	410.57	259.17	160.00	784.00	97.96	2874.00	67167.29
SO4	SULFATE	MG_L	7	187.43	175.46	32.00	490.00	66.32	1312.00	30785.29
MINENO=0252 SAMPPT=0120										
AK4	ALK AS CACO3, PH 4.5	MG_L	7	122.26	29.21	88.00	170.00	11.04	855.80	853.14
CD	CADMIUM, DISSOLVED	UG_L	7	8.19	2.39	5.00	10.00	0.90	57.30	5.71
CA	CALCIUM, DISSOLVED	MG_L	7	80.31	57.40	24.70	175.60	21.69	562.20	3294.57
CL	CHLORIDE	MG_L	7	11.87	5.95	5.00	21.90	2.25	83.10	35.35
F	FLUORIDE	MG_L	7	0.68	0.30	0.30	1.20	0.11	4.77	0.09
FET	IRON, TOTAL	MG_L	7	1.10	1.13	0.13	2.78	0.43	7.71	1.27
PB	LEAD, DISSOLVED	UG_L	7	37.14	16.04	20.00	50.00	6.06	260.00	257.14
MG	MAGNESIUM, DISSOLVED	MG_L	7	34.49	26.12	11.00	74.10	9.87	241.40	682.26
MNT	MANGANESE, TOTAL	MG_L	7	0.06	0.04	0.02	0.10	0.01	0.42	0.00
N_3	NITRATE NITROGEN _N	MG_L	7	0.21	0.29	0.00	0.85	0.11	1.44	0.09
K	POTASSIUM, DISSOLVED	MG_L	7	9.51	4.71	4.00	15.90	1.78	66.60	22.22
SE	SELENIUM, DISSOLVED	UG_L	7	10.71	4.50	5.00	20.00	1.70	75.00	20.24
NA	SODIUM, DISSOLVED	MG_L	7	54.07	48.68	16.00	144.50	18.40	378.50	2370.04
SD	SOLIDS, DISSOLVED	MG_L	6	723.67	580.59	258.00	1618.00	237.03	4342.00	337090.27
SO4	SULFATE	MG_L	7	336.57	371.90	70.00	980.00	140.56	2356.00	138305.95

PEABODY COAL COMPANY
ARIZONA DIVISION
WELL WATER QUALITY STATISTICS

VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0250 SAMPPT=0122										
AK4	ALK AS CACO3, PH 4.5	MG_L	3	116.90	18.27	106.10	138.00	10.55	350.70	333.97
CD	CADMIUM, DISSOLVED	UG_L	3	6.67	2.89	5.00	10.00	1.67	20.00	8.33
CA	CALCIUM, DISSOLVED	MG_L	3	27.23	8.96	17.30	34.70	5.17	81.70	80.25
CL	CHLORIDE	MG_L	3	7.03	4.45	1.90	9.70	2.57	21.10	19.77
F	FLUORIDE	MG_L	3	0.89	0.36	0.62	1.30	0.21	2.66	0.13
FET	IRON, TOTAL	MG_L	3	3.72	2.37	1.20	5.90	1.37	11.15	5.61
PB	LEAD, DISSOLVED	UG_L	3	30.00	17.32	20.00	50.00	10.00	90.00	300.00
MG	MAGNESIUM, DISSOLVED	MG_L	3	11.30	2.82	8.70	14.30	1.63	33.90	7.96
MNT	MANGANESE, TOTAL	MG_L	3	0.08	0.04	0.05	0.12	0.02	0.24	0.00
N_3	NITRATE NITROGEN _N	MG_L	3	0.25	0.20	0.10	0.48	0.12	0.76	0.04
K	POTASSIUM, DISSOLVED	MG_L	3	16.40	2.19	14.80	18.90	1.27	49.20	4.81
SE	SELENIUM, DISSOLVED	UG_L	3	10.00	0.00	10.00	10.00	0.00	30.00	0.00
NA	SODIUM, DISSOLVED	MG_L	3	7.97	2.59	6.00	10.90	1.49	23.90	6.70
SD	SOLIDS, DISSOLVED	MG_L	3	308.33	65.50	248.00	378.00	37.82	925.00	4290.33
SO4	SULFATE	MG_L	3	47.67	40.82	17.00	94.00	23.57	143.00	1666.33
MINENO=0250 SAMPPT=0123										
AK4	ALK AS CACO3, PH 4.5	MG_L	1	229.00	.	229.00	229.00	.	229.00	.
CD	CADMIUM, DISSOLVED	UG_L	1	10.00	.	10.00	10.00	.	10.00	.
CA	CALCIUM, DISSOLVED	MG_L	1	69.10	.	69.10	69.10	.	69.10	.
CL	CHLORIDE	MG_L	1	22.20	.	22.20	22.20	.	22.20	.
F	FLUORIDE	MG_L	1	0.75	.	0.75	0.75	.	0.75	.
FET	IRON, TOTAL	MG_L	1	1.18	.	1.18	1.18	.	1.18	.
PB	LEAD, DISSOLVED	UG_L	1	50.00	.	50.00	50.00	.	50.00	.
MG	MAGNESIUM, DISSOLVED	MG_L	1	23.60	.	23.60	23.60	.	23.60	.
MNT	MANGANESE, TOTAL	MG_L	1	0.11	.	0.11	0.11	.	0.11	.
N_3	NITRATE NITROGEN _N	MG_L	1	0.07	.	0.07	0.07	.	0.07	.
K	POTASSIUM, DISSOLVED	MG_L	1	27.40	.	27.40	27.40	.	27.40	.
SE	SELENIUM, DISSOLVED	UG_L	1	10.00	.	10.00	10.00	.	10.00	.
NA	SODIUM, DISSOLVED	MG_L	1	47.00	.	47.00	47.00	.	47.00	.
SD	SOLIDS, DISSOLVED	MG_L	1	549.00	.	549.00	549.00	.	549.00	.
SO4	SULFATE	MG_L	1	175.00	.	175.00	175.00	.	175.00	.

PEABODY COAL COMPANY
ARIZONA DIVISION
WELL WATER QUALITY STATISTICS

VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0252 SAMPPT=0206										
AK4	ALK AS CACO3, PH 4.5	MG_L	3	76.80	6.61	71.00	84.00	3.82	230.40	43.72
CD	CADMIUM, DISSOLVED	UG_L	2	5.00	0.00	5.00	5.00	0.00	10.00	0.00
CA	CALCIUM, DISSOLVED	MG_L	3	123.33	32.15	100.00	160.00	18.56	370.00	1033.33
CL	CHLORIDE	MG_L	3	11.07	2.28	9.70	13.70	1.32	33.20	5.20
F	FLUORIDE	MG_L	3	0.73	0.21	0.50	0.90	0.12	2.20	0.04
FET	IRON, TOTAL	MG_L	3	0.27	0.15	0.10	0.40	0.09	0.80	0.02
PB	LEAD, DISSOLVED	UG_L	2	20.00	0.00	20.00	20.00	0.00	40.00	0.00
MG	MAGNESIUM, DISSOLVED	MG_L	3	65.67	18.50	47.00	84.00	10.68	197.00	342.33
MNT	MANGANESE, TOTAL	MG_L	3	0.05	0.05	0.02	0.10	0.03	0.14	0.00
N_3	NITRATE NITROGEN _N	MG_L	3	0.20	0.00	0.20	0.20	0.00	0.60	0.00
K	POTASSIUM, DISSOLVED	MG_L	3	11.17	3.55	8.00	15.00	2.05	33.50	12.58
SE	SELENIUM, DISSOLVED	UG_L	3	10.00	0.00	10.00	10.00	0.00	30.00	0.00
NA	SODIUM, DISSOLVED	MG_L	3	22.00	5.00	17.00	27.00	2.89	66.00	25.00
SD	SOLIDS, DISSOLVED	MG_L	3	915.33	191.69	740.00	1120.00	110.67	2746.00	36745.33
SO4	SULFATE	MG_L	3	523.00	116.07	427.00	652.00	67.01	1569.00	13473.00
MINENO=0252 SAMPPT=0212										
AK4	ALK AS CACO3, PH 4.5	MG_L	3	133.33	30.50	103.00	164.00	17.61	400.00	930.33
CD	CADMIUM, DISSOLVED	UG_L	3	5.00	0.00	5.00	5.00	0.00	15.00	0.00
CA	CALCIUM, DISSOLVED	MG_L	3	277.67	212.12	33.00	410.00	122.47	833.00	44996.33
CL	CHLORIDE	MG_L	3	40.70	18.98	20.00	57.30	10.96	122.10	360.43
F	FLUORIDE	MG_L	3	0.80	0.10	0.70	0.90	0.06	2.40	0.01
FET	IRON, TOTAL	MG_L	3	0.21	0.02	0.20	0.23	0.01	0.63	0.00
PB	LEAD, DISSOLVED	UG_L	2	20.00	0.00	20.00	20.00	0.00	40.00	0.00
MG	MAGNESIUM, DISSOLVED	MG_L	3	258.33	62.52	215.00	330.00	36.09	775.00	3908.33
MNT	MANGANESE, TOTAL	MG_L	3	0.03	0.02	0.02	0.05	0.01	0.09	0.00
N_3	NITRATE NITROGEN _N	MG_L	3	1.77	1.37	0.20	2.70	0.79	5.30	1.86
K	POTASSIUM, DISSOLVED	MG_L	3	19.10	7.72	14.30	28.00	4.45	57.30	59.53
SE	SELENIUM, DISSOLVED	UG_L	3	10.00	0.00	10.00	10.00	0.00	30.00	0.00
NA	SODIUM, DISSOLVED	MG_L	3	640.00	96.44	570.00	750.00	55.68	1920.00	9300.00
SD	SOLIDS, DISSOLVED	MG_L	3	4403.33	1235.41	3240.00	5700.00	713.26	13210.00	1526233.33
SO4	SULFATE	MG_L	3	2973.33	825.01	2150.00	3800.00	476.32	8920.00	680633.33

ATTACHMENT 17

Statistical Summary of Selected Water

Quality Parameters for Springs

(1980 - 1985)

PEABODY COAL COMPANY
ARIZONA DIVISION
WELL WATER QUALITY STATISTICS

MINENO=0250 SAMPPT=0092

VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
AK4	ALK AS CACO3, PH 4.5	MG_L	7	387.37	216.14	205.50	790.30	81.69	2711.60	46715.42
CD	CADMIUM, DISSOLVED	UG_L	7	45.71	99.06	5.00	270.00	37.44	320.00	9811.90
CA	CALCIUM, DISSOLVED	MG_L	7	214.13	104.02	86.00	329.90	39.32	1498.90	10820.95
CL	CHLORIDE	MG_L	7	56.07	29.66	17.60	93.50	11.21	392.50	879.74
F	FLUORIDE	MG_L	7	0.83	0.08	0.66	0.90	0.03	5.78	0.01
FET	IRON, TOTAL	MG_L	6	0.91	0.88	0.10	1.98	0.36	5.48	0.78
PB	LEAD, DISSOLVED	UG_L	7	110.00	91.83	20.00	240.00	34.71	770.00	8433.33
MG	MAGNESIUM, DISSOLVED	MG_L	7	208.67	122.20	91.00	395.00	46.19	1460.70	14931.96
MNT	MANGANESE, TOTAL	MG_L	6	0.07	0.08	0.02	0.23	0.03	0.43	0.01
N_3	NITRATE NITROGEN _N	MG_L	7	3.03	3.32	0.19	7.75	1.25	21.21	11.02
K	POTASSIUM, DISSOLVED	MG_L	7	9.44	2.87	5.00	14.00	1.08	66.10	8.21
SE	SELENIUM, DISSOLVED	UG_L	7	15.71	15.12	10.00	50.00	5.71	110.00	228.57
NA	SODIUM, DISSOLVED	MG_L	7	342.43	154.40	189.00	628.00	58.36	2397.00	23838.62
SD	SOLIDS, DISSOLVED	MG_L	6	3206.83	1532.85	1558.00	5643.00	625.78	19241.00	2349638.17
SO4	SULFATE	MG_L	7	1687.57	749.68	788.00	3050.00	283.35	11813.00	562014.62

PEABODY COAL COMPANY
ARIZONA DIVISION
WELL WATER QUALITY STATISTICS

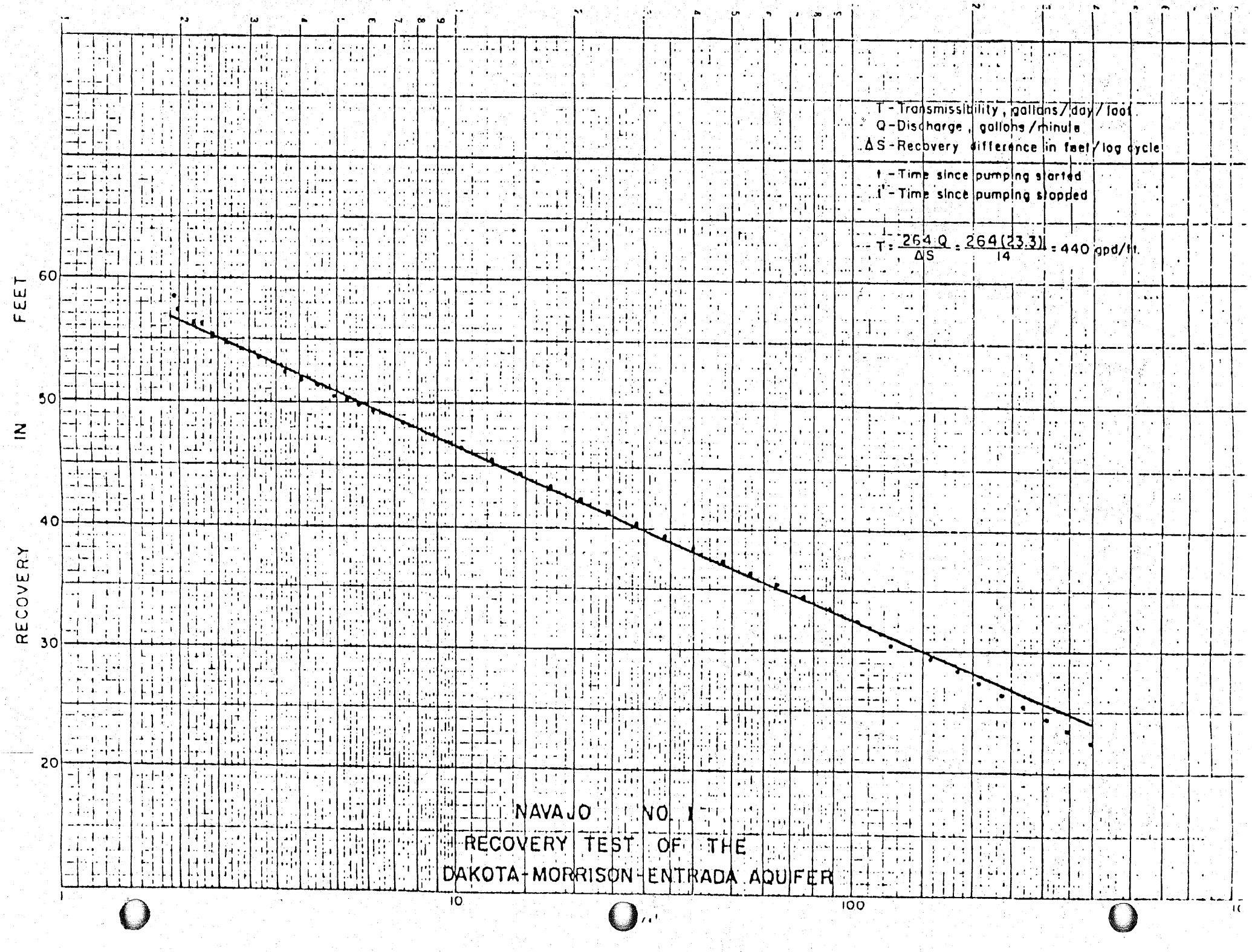
VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0252 SAMPPT=0091										
AK4	ALK AS CACO3, PH 4.5	MG_L	4	336.30	80.27	273.00	453.20	40.13	1345.20	6443.16
CD	CADMIUM, DISSOLVED	UG_L	4	11.25	9.46	5.00	25.00	4.73	45.00	89.58
CA	CALCIUM, DISSOLVED	MG_L	4	203.25	58.77	131.00	260.00	29.38	813.00	3453.58
CL	CHLORIDE	MG_L	4	20.25	18.10	7.80	46.90	9.05	81.00	327.43
F	FLUORIDE	MG_L	4	1.53	0.42	0.96	1.95	0.21	6.11	0.18
FET	IRON, TOTAL	MG_L	3	0.18	0.17	0.06	0.38	0.10	0.54	0.03
PB	LEAD, DISSOLVED	UG_L	4	70.00	62.72	20.00	150.00	31.36	280.00	3933.33
MG	MAGNESIUM, DISSOLVED	MG_L	4	157.75	83.33	98.00	280.00	41.67	631.00	6944.25
MNT	MANGANESE, TOTAL	MG_L	3	0.03	0.02	0.02	0.06	0.01	0.10	0.00
N_3	NITRATE NITROGEN _N	MG_L	4	0.19	0.19	0.02	0.45	0.09	0.78	0.03
K	POTASSIUM, DISSOLVED	MG_L	4	8.70	3.19	4.00	11.00	1.60	34.80	10.19
SE	SELENIUM, DISSOLVED	UG_L	4	22.50	18.93	10.00	50.00	9.46	90.00	358.33
NA	SODIUM, DISSOLVED	MG_L	4	96.00	103.49	34.00	250.00	51.74	384.00	10710.00
SD	SOLIDS, DISSOLVED	MG_L	4	2082.00	1403.33	1087.00	4137.00	701.66	8328.00	1969326.00
SO4	SULFATE	MG_L	4	1127.00	792.50	558.00	2250.00	396.25	4508.00	628049.33
MINENO=0252 SAMPPT=0097										
AK4	ALK AS CACO3, PH 4.5	MG_L	4	405.38	168.87	264.00	645.00	84.44	1621.50	28518.23
CD	CADMIUM, DISSOLVED	UG_L	4	16.50	14.80	5.00	36.00	7.40	66.00	219.00
CA	CALCIUM, DISSOLVED	MG_L	4	443.70	143.76	242.00	579.00	71.88	1774.80	20667.16
CL	CHLORIDE	MG_L	4	78.97	13.16	60.00	89.00	6.58	315.90	173.07
F	FLUORIDE	MG_L	4	2.10	1.35	1.15	4.10	0.67	8.42	1.82
FET	IRON, TOTAL	MG_L	3	0.25	0.20	0.10	0.48	0.12	0.76	0.04
PB	LEAD, DISSOLVED	UG_L	4	167.50	137.93	20.00	290.00	68.97	670.00	19025.00
MG	MAGNESIUM, DISSOLVED	MG_L	4	728.72	97.67	600.00	815.00	48.84	2914.90	9540.37
MNT	MANGANESE, TOTAL	MG_L	3	0.03	0.01	0.02	0.03	0.00	0.08	0.00
N_3	NITRATE NITROGEN _N	MG_L	4	0.10	0.14	0.00	0.30	0.07	0.40	0.02
K	POTASSIUM, DISSOLVED	MG_L	4	7.42	2.37	5.00	10.50	1.18	29.70	5.61
SE	SELENIUM, DISSOLVED	UG_L	4	18.75	20.97	5.00	50.00	10.48	75.00	439.58
NA	SODIUM, DISSOLVED	MG_L	4	274.10	109.00	111.00	338.00	54.50	1096.40	11880.71
SD	SOLIDS, DISSOLVED	MG_L	4	6845.75	163.09	6652.00	7020.00	81.55	27383.00	26598.92
SO4	SULFATE	MG_L	4	4077.25	214.10	3884.00	4375.00	107.05	16309.00	45836.92

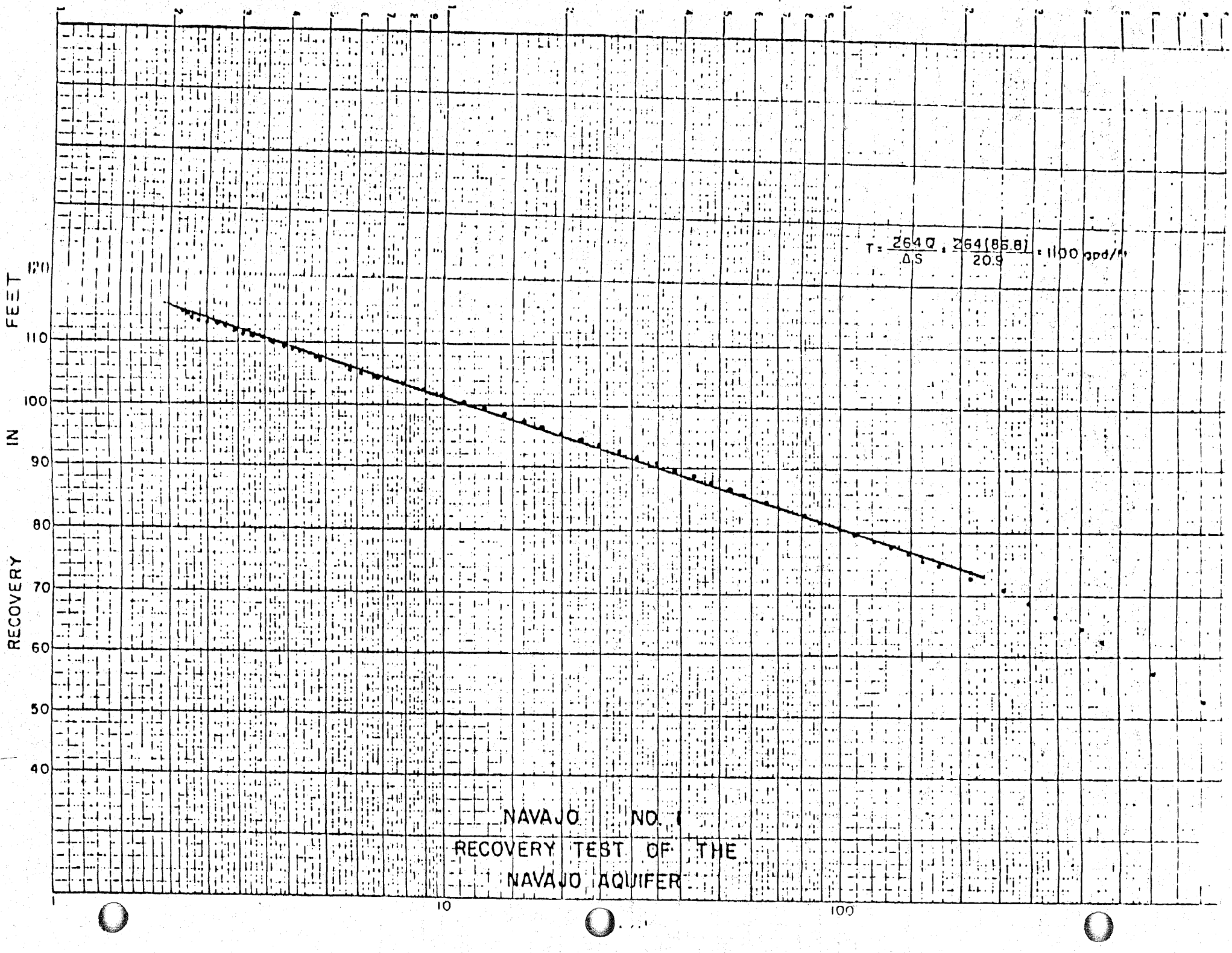
PEABODY COAL COMPANY
ARIZONA DIVISION
WELL WATER QUALITY STATISTICS

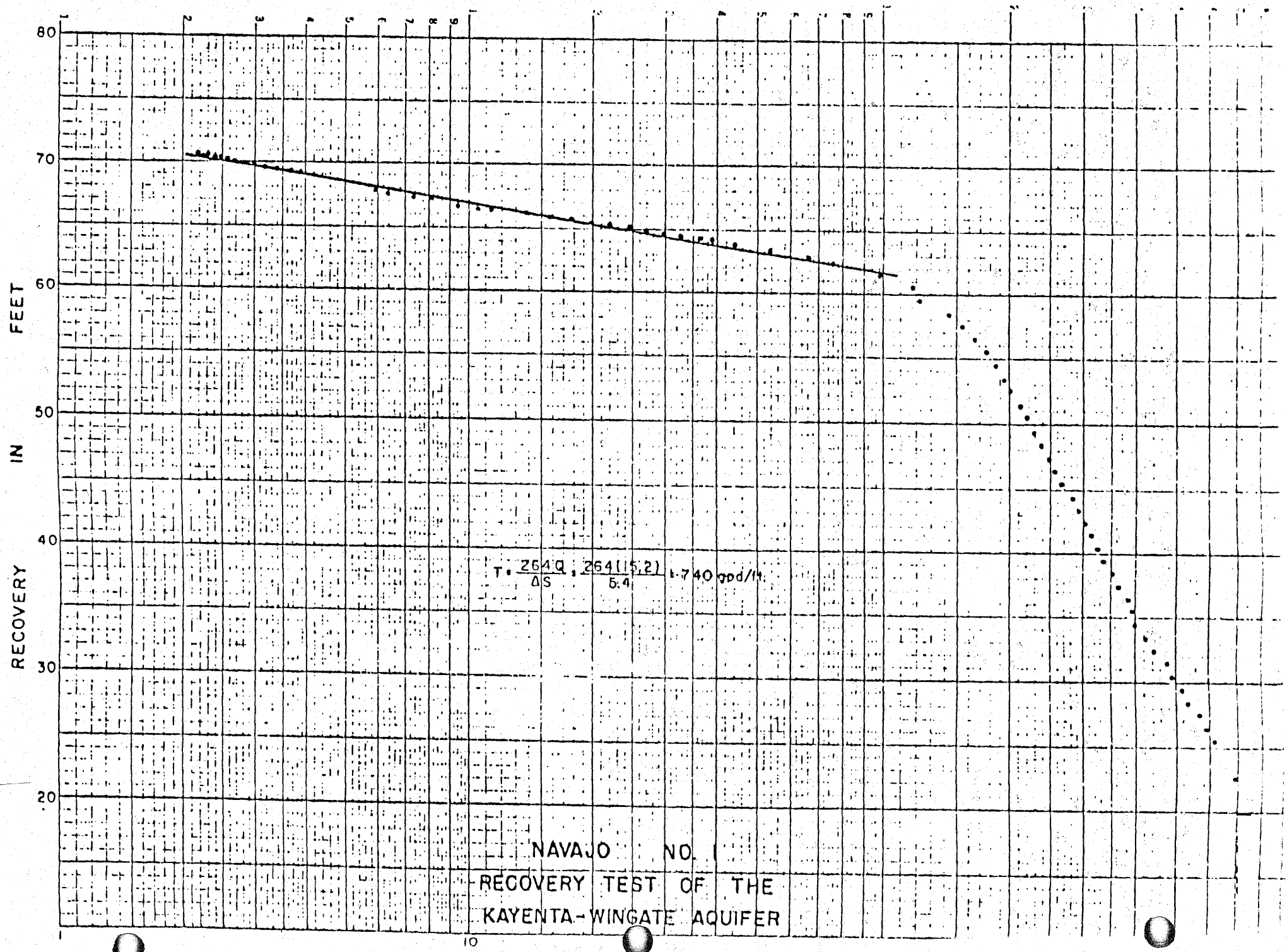
VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0252 SAMPPT=0111										
AK4	ALK AS CACO3, PH 4.5	MG_L	8	291.11	73.20	182.00	431.00	25.88	2328.90	5358.82
CD	CADMIUM, DISSOLVED	UG_L	8	14.38	14.00	5.00	40.00	4.95	115.00	195.98
CA	CALCIUM, DISSOLVED	MG_L	8	445.99	170.60	155.00	620.00	60.32	3567.90	29105.69
CL	CHLORIDE	MG_L	8	91.26	15.00	77.80	114.20	5.30	730.10	224.93
F	FLUORIDE	MG_L	8	4.32	1.26	1.35	5.40	0.44	34.55	1.58
FET	IRON, TOTAL	MG_L	7	2.79	2.85	0.20	8.00	1.08	19.50	8.13
PB	LEAD, DISSOLVED	UG_L	8	142.50	133.39	20.00	330.00	47.16	1140.00	17792.86
MG	MAGNESIUM, DISSOLVED	MG_L	8	860.32	185.96	660.00	1228.00	65.75	6882.60	34579.53
MNT	MANGANESE, TOTAL	MG_L	7	0.68	0.47	0.18	1.40	0.18	4.74	0.22
N_3	NITRATE NITROGEN _N	MG_L	8	0.11	0.07	0.00	0.20	0.03	0.87	0.01
K	POTASSIUM, DISSOLVED	MG_L	8	10.94	3.71	6.00	19.00	1.31	87.50	13.75
SE	SELENIUM, DISSOLVED	UG_L	8	14.38	14.50	5.00	50.00	5.13	115.00	210.27
NA	SODIUM, DISSOLVED	MG_L	8	139.49	78.85	92.00	330.00	27.88	1115.90	6217.53
SD	SOLIDS, DISSOLVED	MG_L	8	7167.75	1185.36	5600.00	8976.00	419.09	57342.00	1405072.79
SO4	SULFATE	MG_L	8	4513.25	836.63	3250.00	5851.00	295.79	36106.00	699945.93
MINENO=0252 SAMPPT=0140										
AK4	ALK AS CACO3, PH 4.5	MG_L	9	167.18	99.52	60.00	352.10	33.17	1504.60	9903.75
CD	CADMIUM, DISSOLVED	UG_L	9	9.33	6.14	5.00	20.00	2.05	84.00	37.75
CA	CALCIUM, DISSOLVED	MG_L	9	323.53	154.16	121.50	523.00	51.39	2911.80	23764.70
CL	CHLORIDE	MG_L	9	49.77	9.80	33.20	58.00	3.27	447.90	96.06
F	FLUORIDE	MG_L	9	0.60	0.14	0.48	0.95	0.05	5.43	0.02
FET	IRON, TOTAL	MG_L	9	0.59	0.73	0.10	2.35	0.24	5.27	0.53
PB	LEAD, DISSOLVED	UG_L	9	64.44	64.25	20.00	180.00	21.42	580.00	4127.78
MG	MAGNESIUM, DISSOLVED	MG_L	9	366.09	108.47	210.00	488.00	36.16	3294.80	11766.07
MNT	MANGANESE, TOTAL	MG_L	9	0.07	0.06	0.02	0.16	0.02	0.63	0.00
N_3	NITRATE NITROGEN _N	MG_L	9	2.04	1.84	0.00	4.85	0.61	18.34	3.40
K	POTASSIUM, DISSOLVED	MG_L	9	7.99	2.35	5.40	12.00	0.78	71.90	5.52
SE	SELENIUM, DISSOLVED	UG_L	9	9.44	1.67	5.00	10.00	0.56	85.00	2.78
NA	SODIUM, DISSOLVED	MG_L	9	355.47	86.60	210.00	454.00	28.87	3199.20	7500.16
SD	SOLIDS, DISSOLVED	MG_L	8	4622.88	1100.94	3139.00	6100.00	389.24	36983.00	1212076.41
SO4	SULFATE	MG_L	9	2817.56	750.59	1710.00	3710.00	250.20	25358.00	563392.53

ATTACHMENT 18

Plots of Single Well Recovery Tests
for Navajo Well Number 1

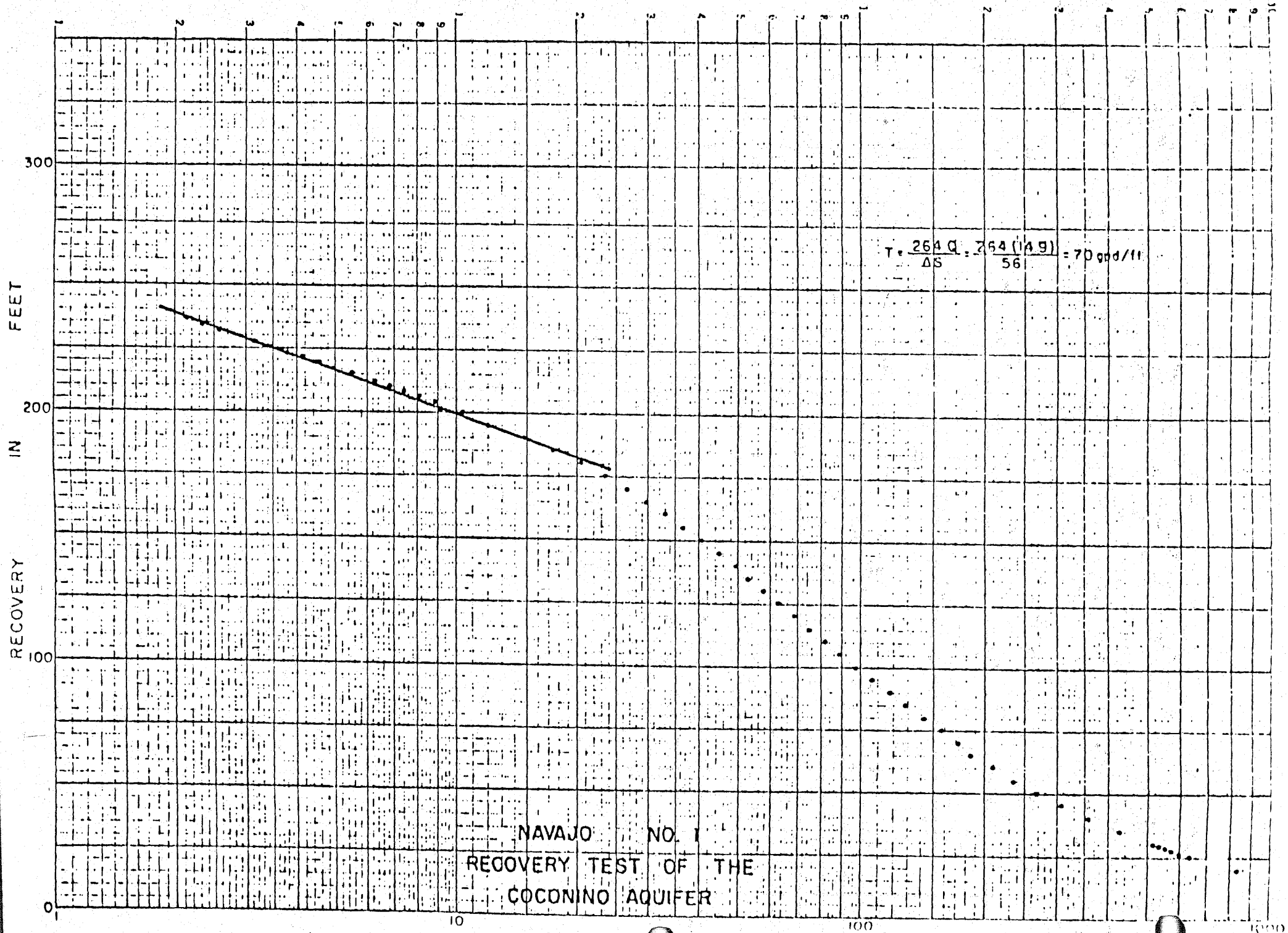

T - Transmissibility, gallons/day/foot
Q - Discharge, gallons/minute
ΔS - Recovery difference in feet/log cycle
t - Time since pumping started
t' - Time since pumping stopped
T = 264 Q / ΔS = 264(23.3) / 14 = 440 gpd/ft.
RECOVERY IN FEET
60
50
40
30
20
1
10
100
NAVAJO NO. 1
RECOVERY TEST OF THE
DAKOTA-MORRISON-ENTRADA AQUIFER


RECOVERY IN FEET
120
110
100
90
80
70
60
50
40
1
10
100
T = 264Q / ΔS = 264(86.8) / 20.9 = 1100 gpd/ft
NAVAJO NO.
RECOVERY TEST OF THE
NAVAJO AQUIFER



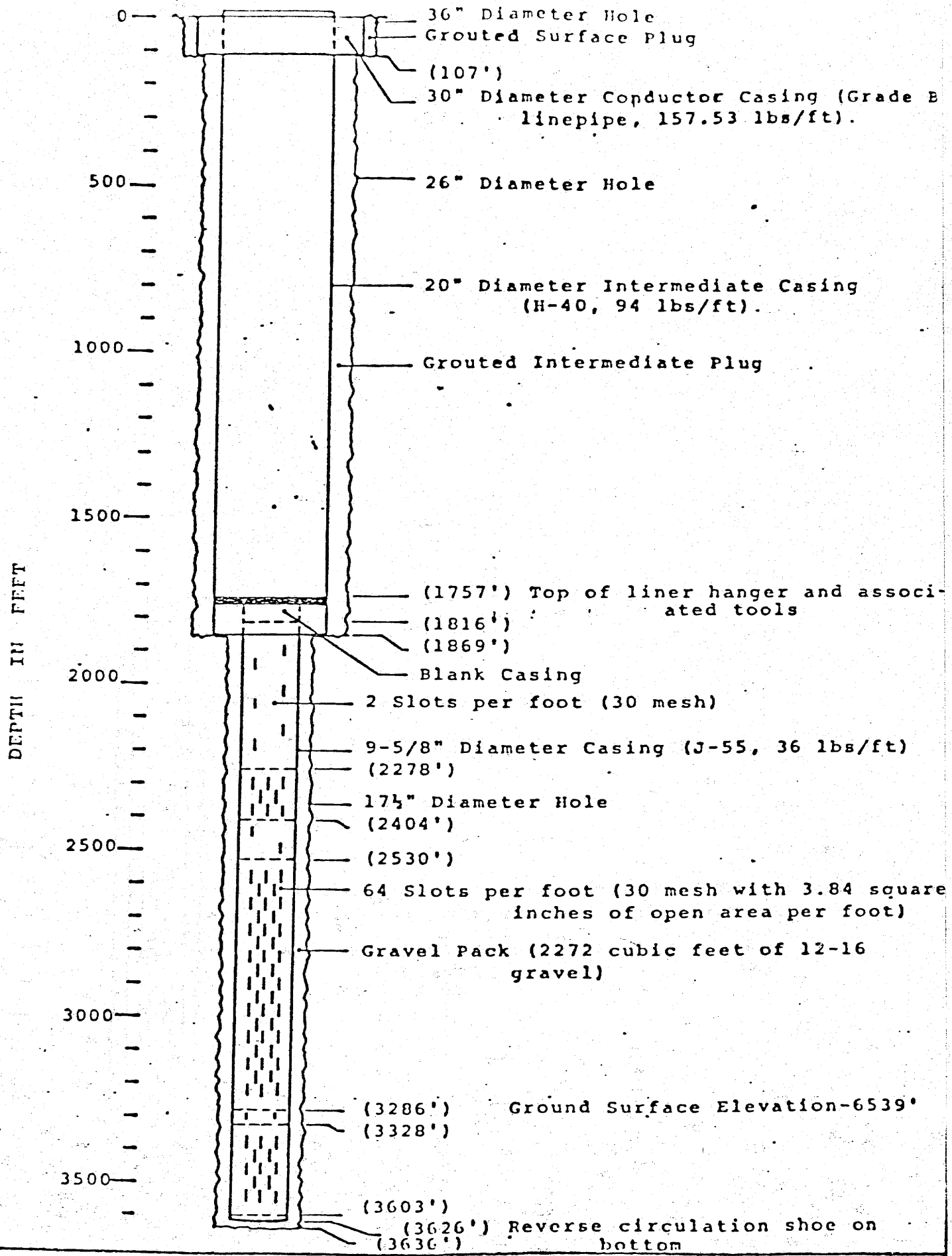
NAVAJO NO.

RECOVERY TEST OF THE
KAYENTA-WINGATE AQUIFER


RECOVERY IN FEET
300
200
100
0
1
10
100
1000
$T = \frac{264\,Q}{\Delta S} = \frac{264\,(14.9)}{56} = 70$ gpd/ft
NAVAJO NO. 1
RECOVERY TEST OF THE
COCONINO AQUIFER

ATTACHMENT 19

Well Construction and Completion Details
Navajo Wellfield



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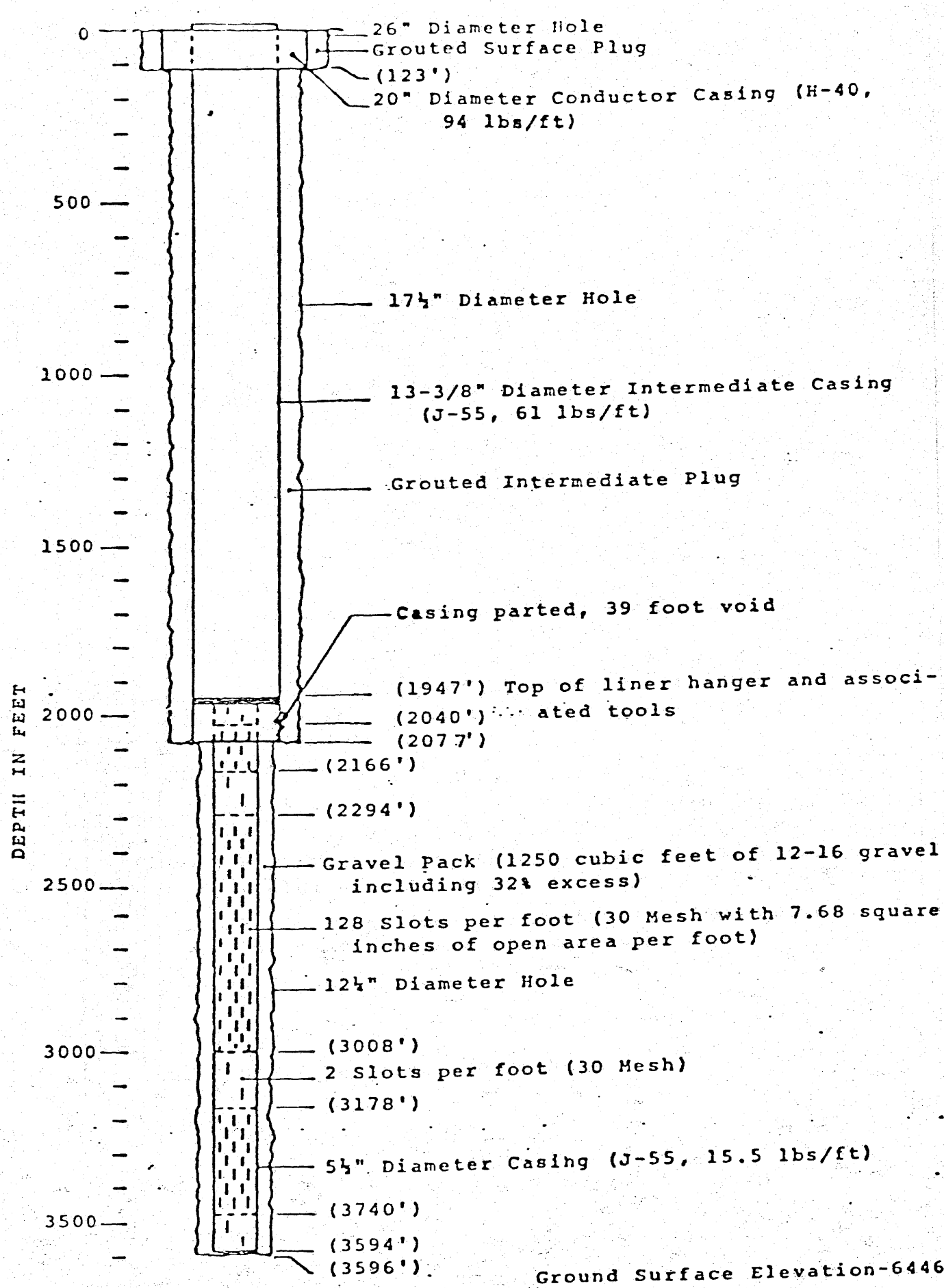
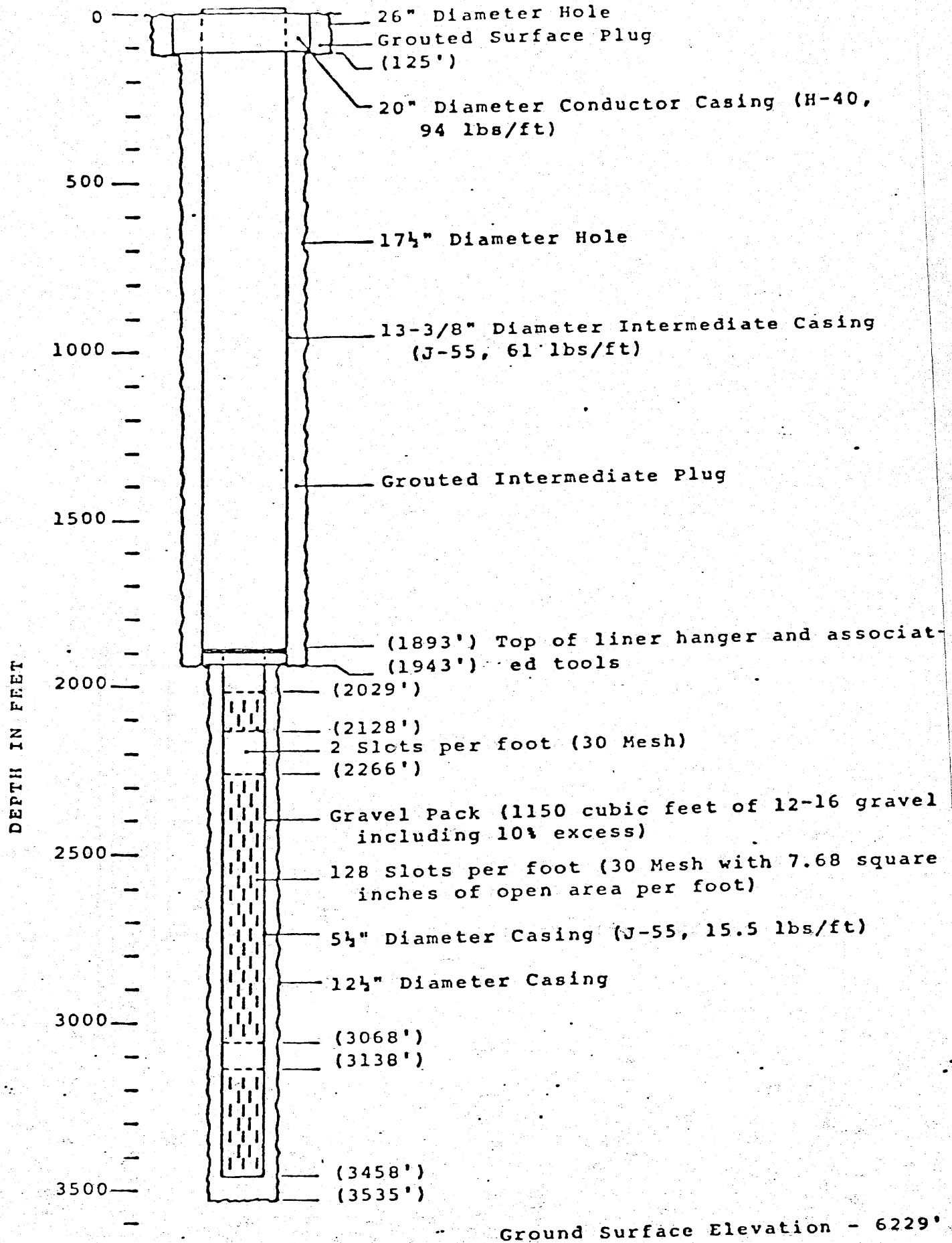
NAVAJO 2 WELL
CONSTRUCTION DIAGRAM



THOMAS M. STETSON CIVIL & CONSULTING ENGINEERS LOS ANGELES - SAN FRANCISCO	NAVAJO 3 WELL CONSTRUCTION DIAGRAM



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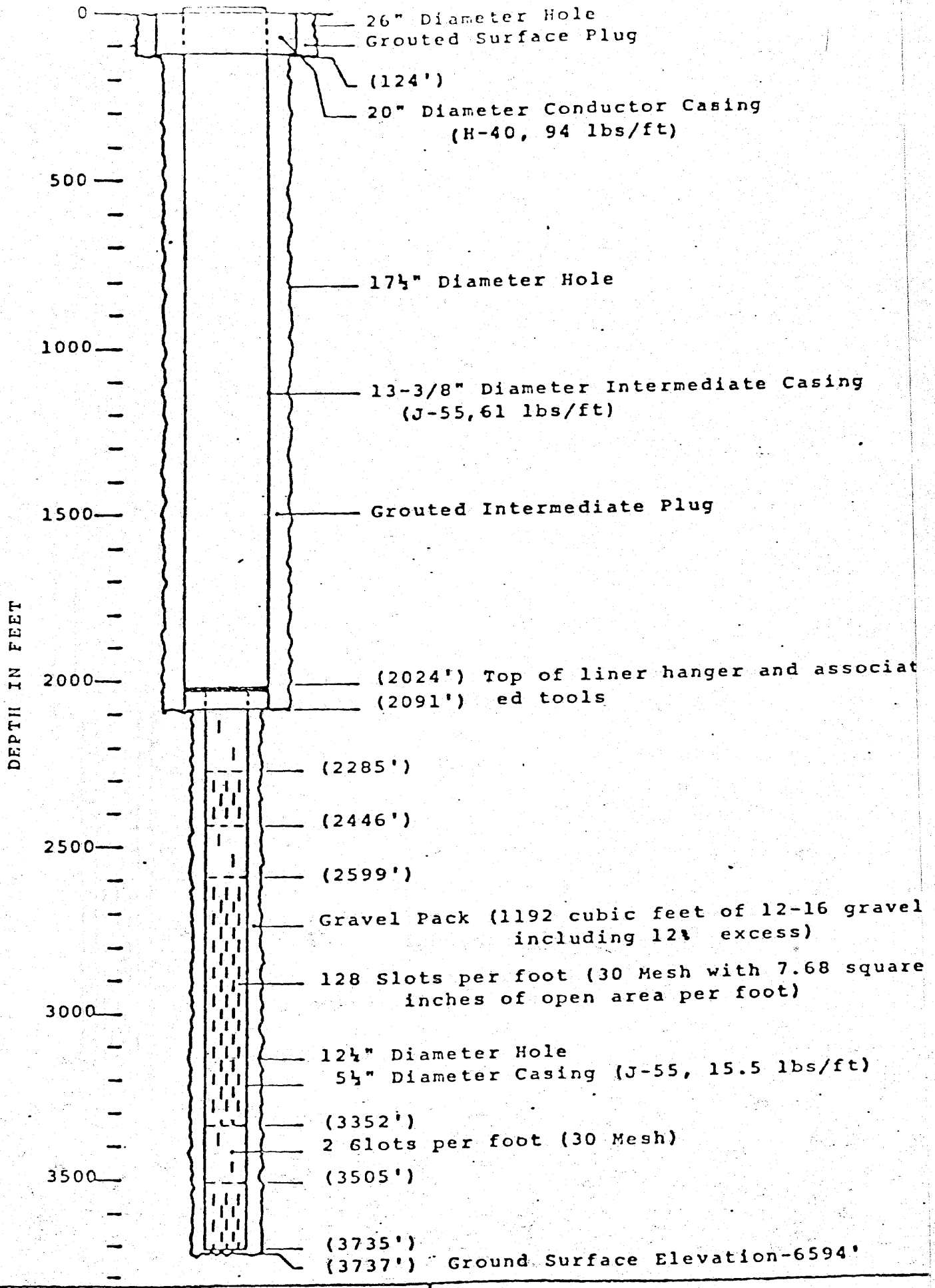
NAVAJO 4 WELL
CONSTRUCTION DIAGRAM



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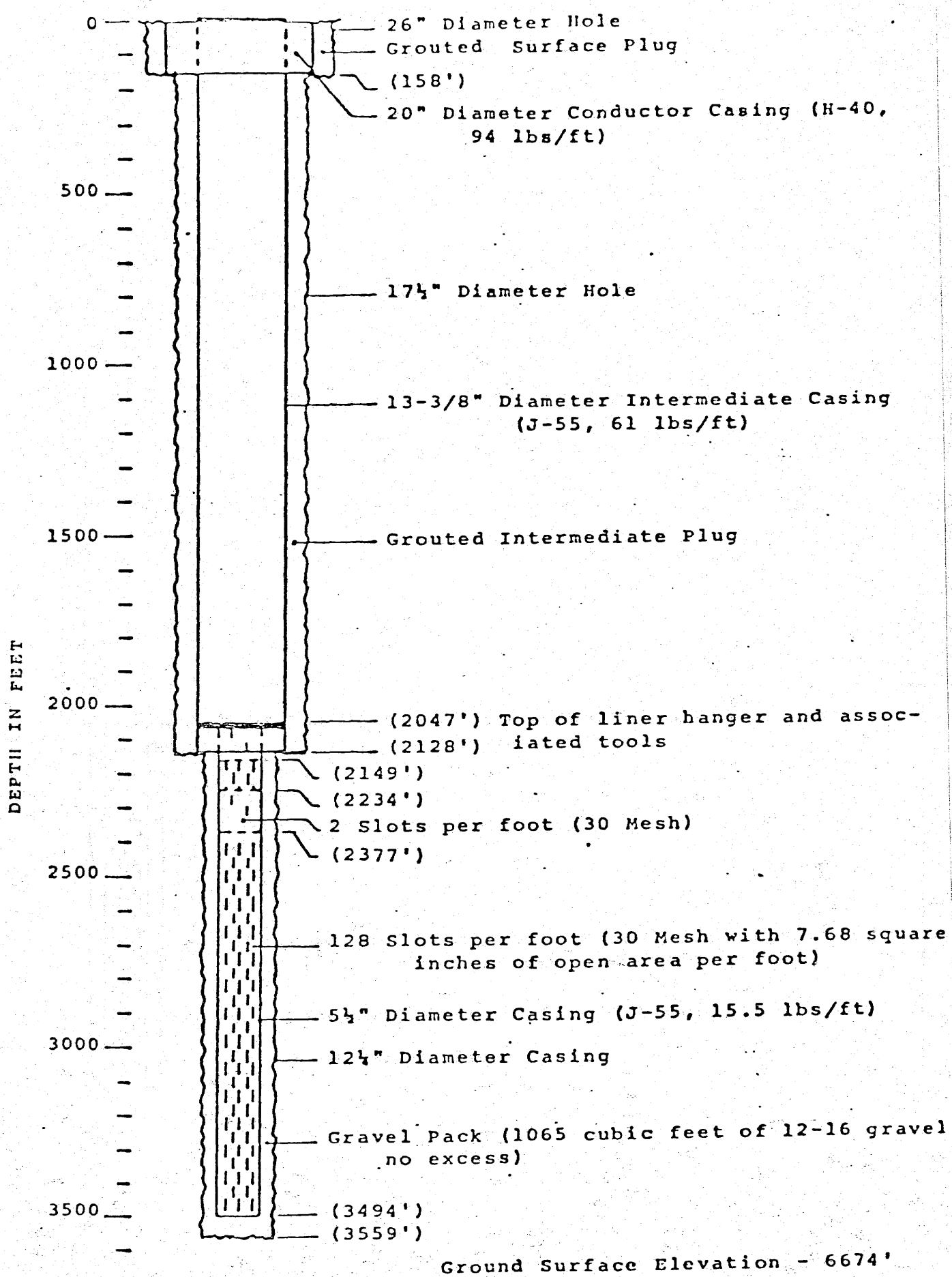
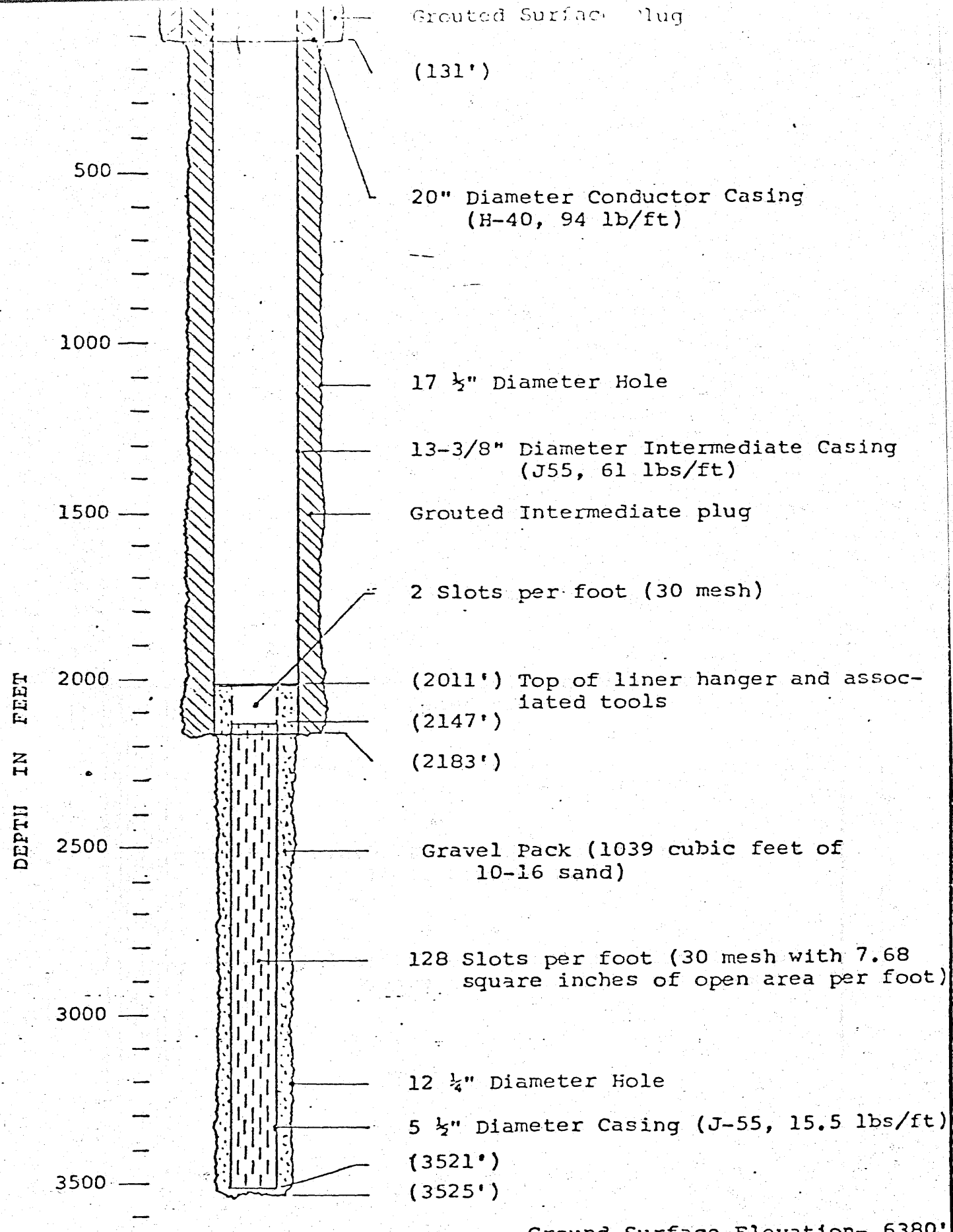
NAVAJO 5 WELL
CONSTRUCTION DIAGRAM

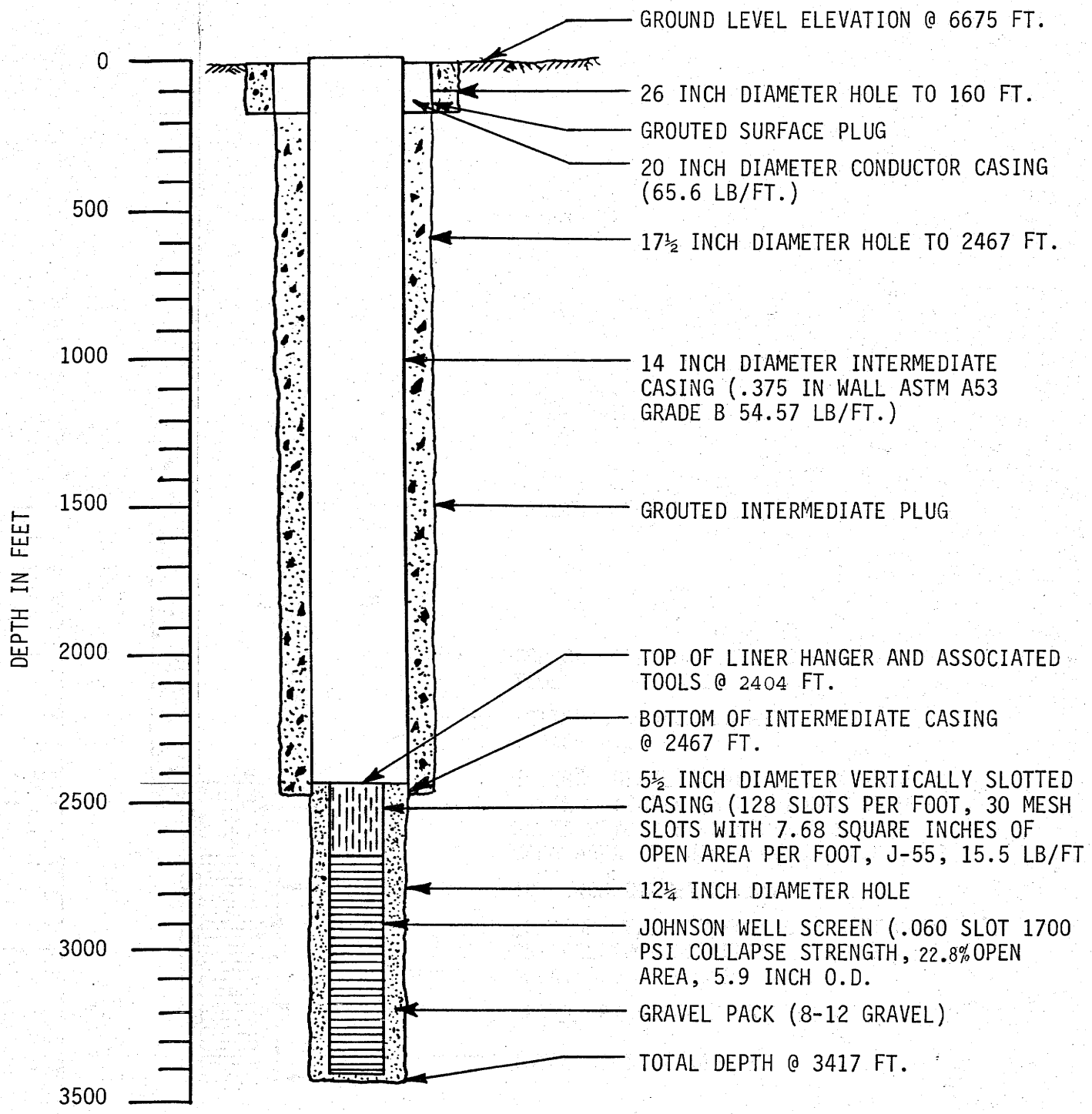


THOMAS M. STETSON CIVIL & CONSULTING ENGINEERS LOS ANGELES - SAN FRANCISCO	NAVAJO 6 WELL CONSTRUCTION DIAGRAM

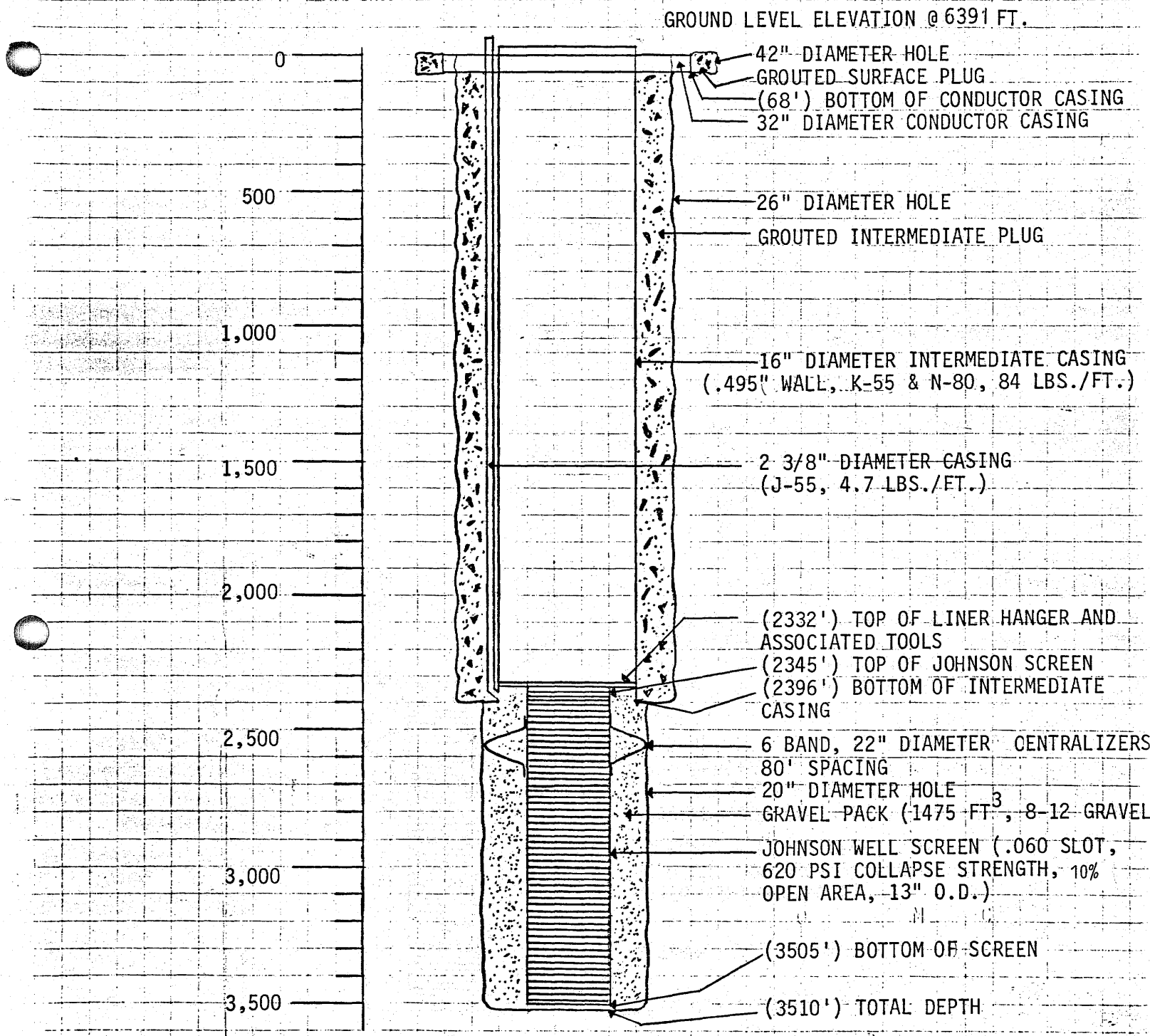


Ground Surface Elevation- 6380'

THOMAS M. STETSON CIVIL & CONSULTING ENGINEERS LOS ANGELES-REDLANDS- SAN FRANCISCO	NAVAJO 7 WELL CONSTRUCTION DIAGRAM



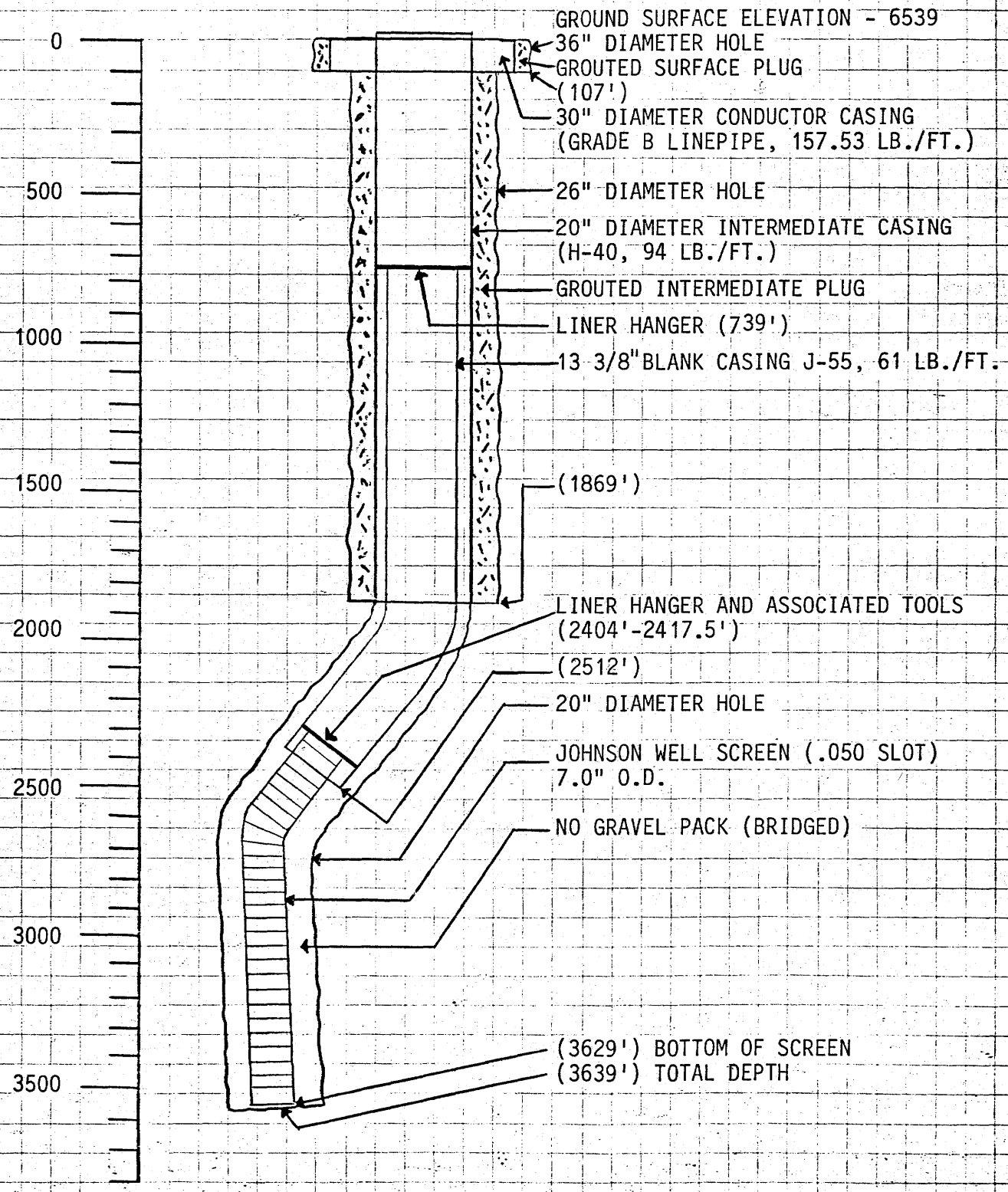
Cross-sectional View of Peabody Navajo Well No. 8.



CROSS-SECTIONAL VIEW OF PEABODY NAVAJO WELL NO. 9

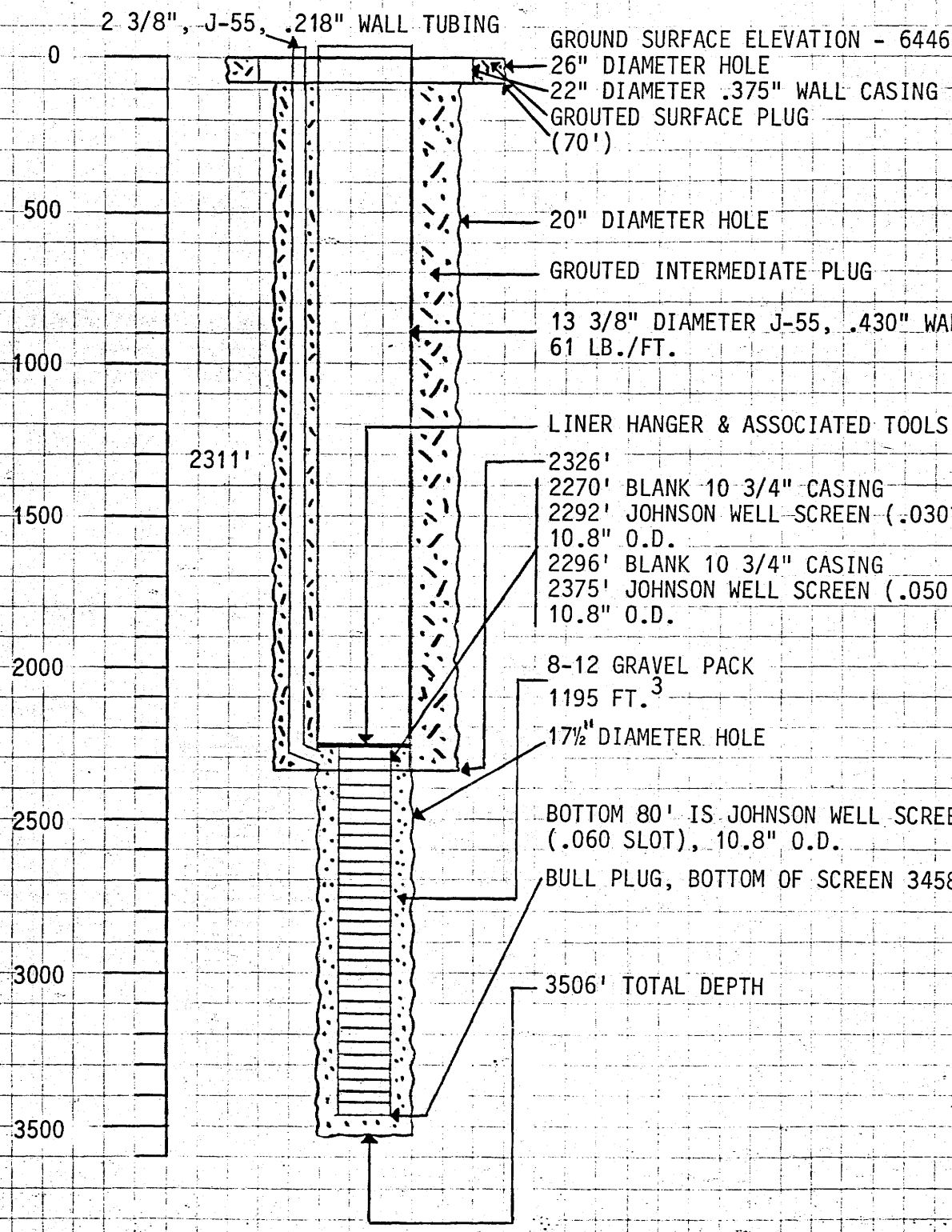
NAVAJO WELL 2

REHABILITATION COMPLETION DIAGRAM



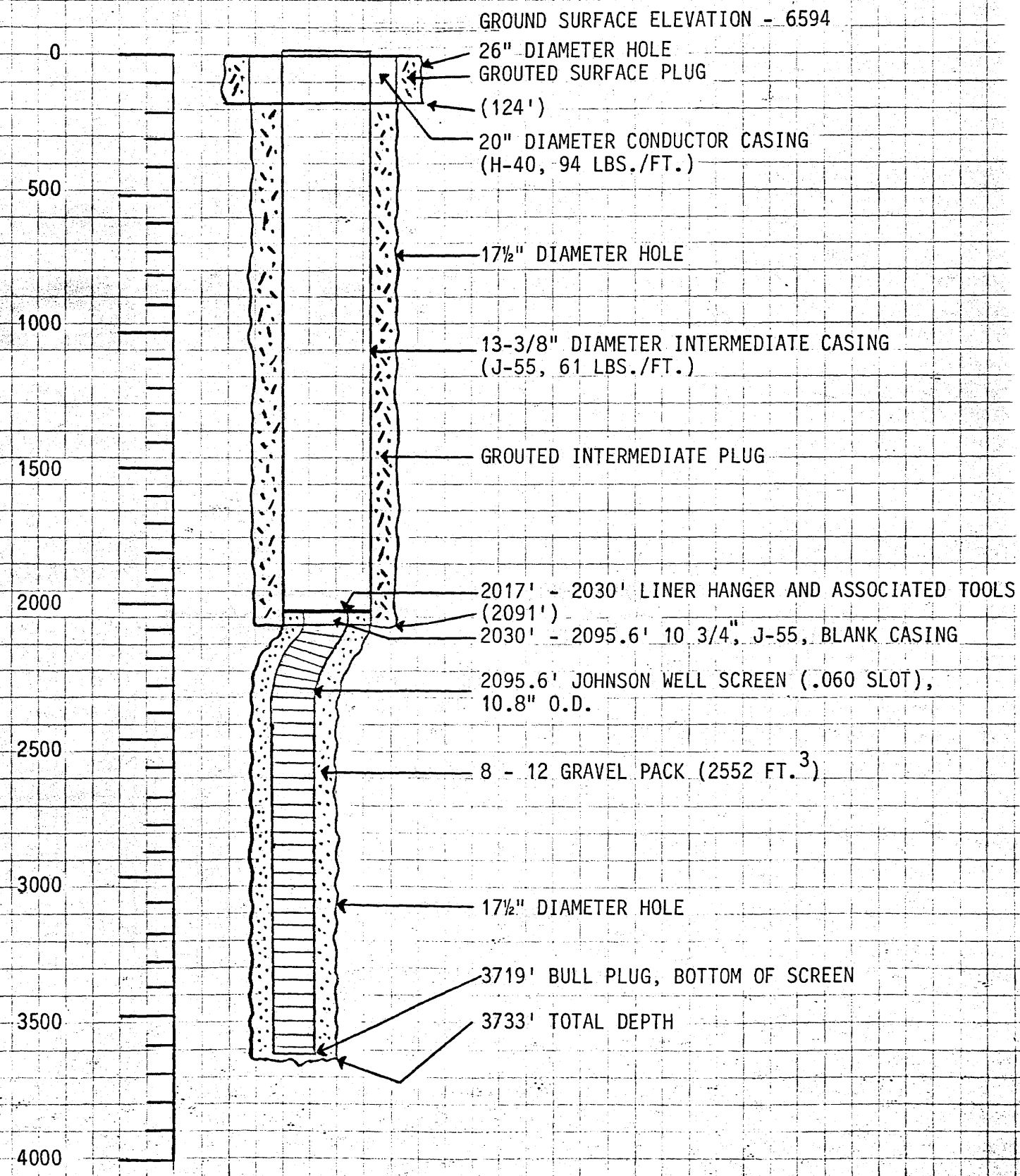
NAVAJO WELL 3

REHABILITATION COMPLETION DIAGRAM



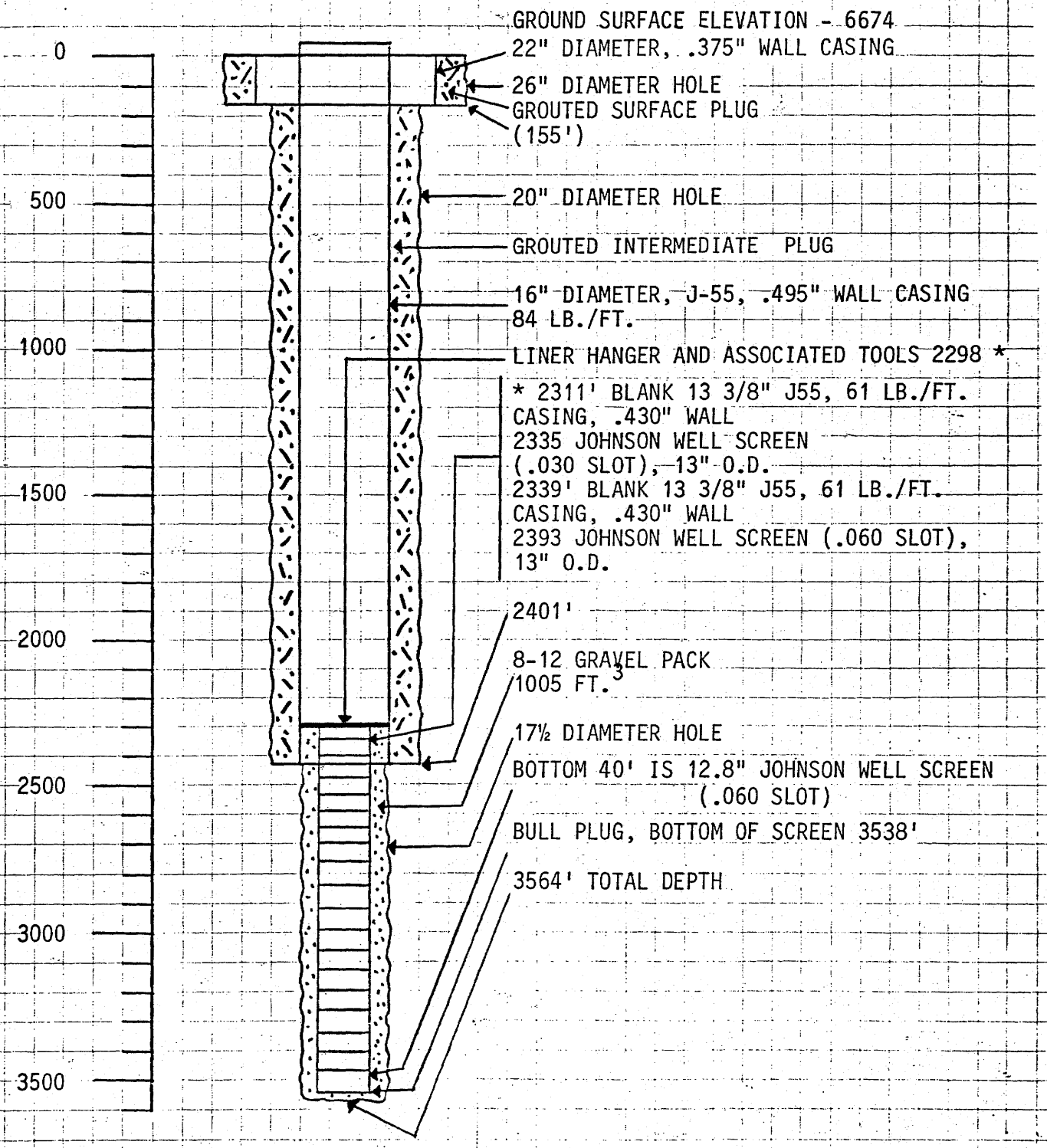
NAVAJO WELL 5

REHABILITATION COMPLETION DIAGRAM



NAVAJO WELL 6

REHABILITATION COMPLETION DIAGRAM



ATTACHMENT 20

Navajo Well Lithologic Logs

NAVAJO No. 2 WELL
LITHOLOGIC SAMPLE LOG

	Depth Interval	Lithologic Description
	150 - 160	Sandstone & shale, reddish brown (surface burn).
	160 - 170	Sandstone (90%) with shale same as above.
	170 - 180	Same as above with reddish brown siltstone.
	180 - 200	Shale, dark gray with coal.
	200 - 210	Sandstone, light gray-white, very fine grained.
	210 - 230	Coal with sandstone & shale as above.
	230 - 240	Coal (95%), silty.
	240 - 250	Siltstone, light gray with very fine grained sandstone.
	250 - 260	Siltstone and coal (70%), good.
	260 - 270	Siltstone (50%), light gray and coal (50%).
	270 - 280	Shale and siltstone, light to dark gray.
	280 - 290	Same as above with good clean coal.
	290 - 360	Shale and siltstone, light gray.
	360 - 370	Sandstone, light gray-white, very fine grained.
	370 - 380	Same as above with a coal stringer.
	380 - 390	Shale-siltstone, light gray (90%) with coal (10%
	390 - 430	Sandstone, white, very fine grained, sugary.
	430 - 470	Shale-siltstone, light gray with sandstone (30%)
Mesa Verde	470 - 490	Sandstone, very fine grained friable with siltstone and shale.
	490 - 500	Siltstone, light to dark gray.
	510 - 550	Sandstone, medium grained subangular, friable with transparent quartz grains.
	550 - 590	Sandstone, very fine grain, white with siltstone and shale, light gray.
	590 - 610	Sandstone (50%) and shale-siltstone (50%).
	610 - 620	Sandstone, white, very fine grained, hard.
	620 - 640	Sandstone as above with dark gray shale-siltstone (50%).
	640 - 650	Sandstone as above, carbonaceous.
	650 - 670	Sandstone, white, very fine to medium grained.
	670 - 690	Sandstone, light gray-white, very fine grained, friable (95%).
	690 - 710	Sandstone, same as above with 5% dark gray shale
	710 - 720	Sandstone, same as above with 10% shale.
	720 - 730 755	Sandstone, same as above with 5% shale.
	730 - 790	Sandstone as above with 5-10% shale.
Mancos	790 - 860	Shale, dark gray.
	860 - 870	Shale, dark gray with sandstone stringer or cave
	870 - 950	Shale, dark gray with occassional burn cave.
	950 - 960	Shale, dark gray with calcite.
	960 - 1020	Shale, dark gray.
	1020 - 1030	Shale, dark gray with massive calcite.
	1030 - 1330	Shale, dark gray with occassional burn cave.

Navajo No. 2 Well (continued)

	Depth Interval	Lithologic Description
	1330 - 1350	Shale as above with 10% light gray-white very fine grained sandstone.
	1350 - 1360 (1355)	Same as above with 20% sandstone.
	1360 - 1370	Same as above with 30% sandstone.
	1370 - 1380	Same as above with 40% sandstone.
	1380 - 1400	Sandstone light gray-white very fine grained (70%) with coal and cave.
Dakota	1410 - 1420	Sandstone as above (60-70%) with cave.
	1420 - 1430	Sandstone as above (50%) with cave.
	1430 - 1440	Sandstone as above (70%) with cave.
	1440 - 1450	Sandstone as above (80-90%).
	1450 - 1470	Sandstone, light gray-white, very fine grain with light green mudstone.
	1470 - 1510	Mudstone-siltstone, reddish brown, very fine grained, white sandstone & bentonitic and mudstone
	1510 - 1560 (1520)	Sandstone, fine to medium grain with mudstone as above and abundant green bentonitic mudstone
	1560 - 1570	Same as above with abundant brown shale.
	1570 - 1600	Same as above with brown bentonitic mudstone.
	1600 - 1630	Same as above with green mudstone.
	1630 - 1660	Sandstone, white fine to medium grained with white and green mudstone.
	1660 - 1700	Same as above with abundant red mudstone.
	1700 - 1720	Mudstone, reddish brown.
Morrison	1720 - 1740	Mudstone, reddish brown, green and brown.
	1740 - 1810	Sandstone, white very fine-medium grain, friable with mudstone as above.
	1810 - 1910	Mudstone, reddish brown and sandstone, mudstone as above.
	1910 - 1990	Sandstone, white-gray green, very fine grained, and mudstone.
	1990 - 2060	Same as above with reddish brown siltstone.
	2060 - 2110	Sandstone, pink-red very fine grained (40%).
	2110 - 2130	Same as above with white bentonitic mudstone.
	2130 - 2160	Same as above with 50% reddish brown mudstone.
	2160 - 2170	Same as above with white bentonitic mudstone.
	2170 - 2210 (2200)	Same as above with transparent calcite.
	2210 - 2130	Same as above with reddish brown siltstone.
Entrada	2230 - 2300	Sandstone, pink-red very fine grained (90%) with 10-20% reddish brown siltstone.
	2310 - 2350	Mudstone, reddish brown and very fine grained sandstone (50%).
	2350 - 2380	Sandstone, pink-red, very fine grained with 50% mudstone.

Navajo No. 2 Well (continued)

	Depth Interval		Lithologic Description
	2380 - 2400	2390	Sandstone, pink, very fine grained (90%) and 10% reddish brown siltstone.
Carmel	2400 - 2440		Same as above with white bentonitic mudstone.
	2440 - 2460		Same as above with 50% white bentonitic mudstone.
	2460 - 2530		Mudstone, red-light pink (90%).
	2530 - 2550	2550	Sandstone, pink-red, very fine grained.
	2550 - 2570		Same as above with light green mudstone.
	2570 - 2580		Sandstone, pink-red, very fine grained with 20% red-brown siltstone. (cave?)
	2580 - 2640		Same as above with 40% siltstone.
	2640 - 2670		Sandstone, pink-reddish brown, very fine grained (80%) and 20% reddish brown siltstone. (cave?)
	2670 - 2770		Same as above; the sand grains are subrounded to rounded.
	2770 - 2970		Sandstone, pink-reddish brown, very fine grained with subrounded grains.
Navajo	2970 - 3100		Same as above with abundant reddish brown siltstone. (cave?)
	3100 - 3150		Sandstone, pink-reddish brown, very fine grained with 30% reddish brown siltstone and shale. (cave?)
	3150 - 3170	3285	Same as above with 40% reddish brown shale. (cav
	3170 - 3290		Same sandstone as above with 10% reddish brown shale.
	3290 - 3310		Sandstone, very fine grained with 30% soft reddish brown shale and a trace of chalk.
	3310 - 3320		Shale, reddish brown, verigated color.
	3320 - 3330		Shale, soft reddish brown with sticky claystone and some very fine grain sandstone.
Kayenta	3330 - 3340		Same as above with some light green shale and claystone.
	3340 - 3370		Same as above with very fine grained sandstone.
	3370 - 3380		Shale, reddish brown and fine grained sandstone with some white sandstone. Free of sticky clay.
	3380 - 3400		Shale-claystone reddish brown, sticky.
	3400 - 3420		Same as above with trace of hard fine grain sandstone.
	3420 - 3440	3435	Same as above with some green shale.
	3440 - 3490		Claystone, reddish brown, sticky with shale and sandstone.
Wingate	3490 - 3500		Sandstone, dark orange, well cemented, fine grain and dark reddish brown shale.
	3500 - 3510		Sandstone, claystone, shale, reddish brown.
	3510 - 3520		Shale and claystone.
	3520 - 3530		Claystone, brick red.
	3530 - 3570		Shale, claystone add sandstone. All reddish bro with a trace of white claystone or $CaCO_3$.

Navajo No. 2 Well (continued)

Depth Interval	Lithologic Description
3570 - 3590	Sandstone, white, fine grained and orange brown shale, cave (?) - claystone.
3590 - 3630	Sandstone, medium grained weakly cemented, well rounded grains and fair sorting.
3630 - 3650	Sandstone, fine grained poor sorting, tight and siltstone.

NAVAJO No. 3 WELL
LITHOLOGIC SAMPLE LOG

	Depth Interval	Lithologic Description
Mesa Verde	150 - 210	Sandstone, light gray, very fine grained with shale.
	210 - 290	Sandstone as above with abundant carbonaceous black shale.
	290 - 360	Sandstone, white medium grained, friable.
	360 - 400	Sandstone as above with abundant dark shale.
	400 - 430	Sandstone, white, fine to medium grained with abundant gray and black shale.
	430 - 440	Same as above with coal.
	440 - 490	Sandstone and shale as above.
	490 - 520	Sandstone, light gray, very fine grained.
	520 - 530	Sandstone as above with abundant coal.
	530 - 550 (540)	Sandstone as above.
Mancos	550 - 560	Shale, gray abundant.
	560 - 570	Clay, light gray.
	570 - 690	Shale, gray.
	690 - 870	Shale, light-dark gray.
	870 - 900	Shale, light gray, fissle.
	900 - 930	Same as above with trace of gypsum.
	930 - 1140 (1135)	Shale, light-dark gray with trace of gypsum.
Dakota	1140 - 1220	Shale, light green and white, very fine grained sandstone.
	1220 - 1250	Shale, reddish brown and light green with white, very fine grained sandstone.
	1250 - 1260	Same as above with white claystone.
	1260 - 1300 (1275)	Sandstone, white, very fine grained, abundant and shale, claystone as above.
Morrison	1300 - 1380	Same as above with reddish brown shale.
	1380 - 1490	Shale, reddish brown with white, transparent and orange, medium coarse sandstone.
	1490 - 1580	Shale, reddish brown and white fine-medium grained sandstone.
	1580 - 1620	Sandstone, transparent-white, fine-medium grained with reddish brown and light green shale.
	1620 - 1660	Same as above with sandstone becoming very fine grained.
	1660 - 1730	Sandstone, white, very fine to fine grained with shale as above.
	1730 - 1820	Sandstone, white, very fine grained, friable (100%) with cave.
	1820 - 1840	Same as above with 3% reddish brown, very fine grained sandstone.
	1840 - 1850	Sandstone, pink-reddish brown, very fine grained (30%)

Navajo No. 3 Well (continued)

	Depth Interval		Lithologic Description
	1850 - 1860		60% sandstone as above.
	1860 - 1890		Cave - poor samples.
	1890 - 1910		Sandstone, pink very fine grained.
	1910 - 1970		Sandstone, pink-reddish brown, very fine grained. (50%)
	1970 - 2000	1990	Sandstone as above with bentonitic clays.
Entrada	2000 - 2020		Sandstone, reddish-brown, very fine grained.
	2020 - 2030		Shale, chocolate brown.
	2030 - 2080		No samples.
	2080 - 2110		Cement.
	2110 - 2120		Sandstone, reddish brown, very fine grained.
	2120 - 2130	2170	Cement.
	2130 - 2200		Cement with reddish-brown shale.
Carmel	2200 - 2250		Shale-mudstone, reddish brown.
	2250 - 2260		Mudstone-shale-reddish-chocolate brown.
	2260 - 2270		Same as above some variated gray, red, brown mudstone.
	2270 - 2300		Same as above with white mudstone.
	2300 - 2330	2330	Same as above with fine to very fine grained sandstone. Quartz grains are transparent.
Navajo	2330 - 2370		Mudstone, reddish to chocolate brown with 10% very fine grained sandstone.
	2370 - 2410		Sandstone, transparent-white-reddish brown, very fine grained.
	2410 - 2530		Sandstone, white-pink, very fine grained, friable.
	2520 - 2530		Same as above with reddish brown cave.
	2530 - 2560		Sandstone as above.
	2560 - 2690		Sandstone as above with 50% reddish brown shale and mudstone (cave?)
	2690 - 2710		Sandstone, pink-white very fine grained with 70% reddish brown shale and mudstone. (cave?)
	2710 - 2820		Sandstone (80%) and shale.
	2820 - 2840		Sandstone, reddish brown, very fine grained with 50% reddish brown shale.
	2840 - 2860		Same as above with white mudstone.
	2860 - 2940		Sandstone, white fine to medium grained with transparent grains.
	2940 - 2990		Sandstone, reddish brown-pink, very fine to medium grained, subrounded to rounded transparent grains.
	2990 - 3020	3020	Sandstone, reddish brown very fine grained, definite grain size change.
Kayenta	3020 - 3030		Sandstone as above with 30% reddish brown shale and siltstone.
	3030 - 3040		Shale, reddish brown.
	3040 - 3050		Same as above with trace of white chalk or mudstone
	3050 - 3060		Shale, reddish brown.

Navajo No. 3 Well (continued)

Depth Interval	Lithologic Description
3060 - 3070	Shale as above with trace of white chalk or mudstone.
3070 - 3210 (3190)	Shale, reddish brown.
3210 - 3290	Shale as above with 30% reddish brown very fine grained sandstone.
3290 - 3310	Sandstone, very fine to fine grained (90%) with rounded to subrounded transparent quartz grains.
3310 - 3480 (3475)	Same as above with grains becoming fine to medium size.
3480 - 3500	Sandstone as above with 30% reddish brown shale. Shale, reddish brown (70%).

Wingate

Chinle

NAVAJO No. 4 WELL
LITHOLOGIC SAMPLE LOG

	Depth Interval	Lithologic Description
	150 - 160	Sandstone-siltstone, gray with carbonaceous material.
	160 - 200	Sandstone, light gray, fine grained.
	200 - 220	Sandstone-siltstone, light gray with carbonaceous material.
	220 - 250	Sandstone, light gray, calcareous, medium grained, well indurated, quartz and mica.
	250 - 270	Coal, silty with 10% sandstone as above.
Mesa Verde	270 - 310	Coal and black carbonaceous siltstone with light gray friable coarse grained sandstone.
	310 - 320	Siltstone-shale, carbonaceous with coal.
	320 - 370	Sandstone, light gray, coarse grained, friable with angular quartz grains; trace of coal.
	370 - 440	Sandstone, light gray, medium to fine grained calcareous with some black carbonaceous shale.
	440 - 470	Sandstone, light gray and shale with calcite crystals.
	470 - 480	Sandstone (90%), light gray and shale (10%) light gray with trace of coal.
	480 - 510 510	Same as above with 80% sandstone and 20% shale.
	510 - 530	Sandstone (60%) and shale (40%) as above.
	530 - 550	Shale (50%), dark gray, and light gray medium grained sandstone. (50%)
	550 - 570	Shale, dark gray.
	570 - 580	Shale (95%) dark gray with 5% gray sandstone.
	580 - 600	Same as above but with only a trace of sandstone.
	600 - 680	Shale, dark gray.
	680 - 690	Same as above with a trace of soft light gray shale.
	690 - 790	Shale, dark gray.
	790 - 800	Same as above, fossils.
	800 - 850	Shale, dark gray.
	850 - 860	Shale, dark gray with trace of light gray, fine grained sandstone with carbonaceous material.
	860 - 880	Shale, dark gray.
Mancos	880 - 890	Shale, dark gray with fossils and light gray sandstone.
	890 - 1000	Shale, dark gray with trace of light gray bentonitic clay.
	1000 - 1020	Shale, dark gray with trace of quartz grains.
	1020 - 1030	Shale, dark gray with trace of gray fine grain sandstone.
	1030 - 1050	Shale, dark gray.
	1050 - 1080	Shale, dark gray with trace of gray fine grain sandstone.
	1080 - 1090	Shale, dark gray with trace of reddish shale and fine grained sandstone.

Navajo No. 4 Well (continued)

	Depth Interval	Lithologic Description
Dakota	1090 - 1120 (1105)	Shale (50%), dark gray and light gray medium grain well indurated sandstone; carbonaceous with mica.
	1120 - 1170	Sandstone (80%) light gray, medium grained, quartz, hard and 20% dark gray shale.
	1170 - 1190	Sandstone (90%) as above with a trace of green-blue shale and black shale cave.
	1190 - 1220	Sandstone, white, medium grained with trace of green and purple shale.
	1220 - 1230 (1230)	Sandstone, white green shale and trace of gray soft shale and purple brown soft shale.
	1230 - 1250	Same as above with trace of reddish brown soft shale.
	1250 - 1260	Shale, reddish brown and green, soft with some white sandstone.
	1260 - 1270	Same as above with 30% sandstone.
	1270 - 1290	Sandstone, white, medium grain and reddish brown shale with minor green shale.
	1290 - 1300	Sandstone (60%) white and 35% reddish brown shale with trace of sticky green shale.
	1300 - 1390	Shale, reddish brown, soft with white sandstone and green shale.
	1390 - 1400	Sandstone, white, medium grain, friable with minor amounts of red and green shale.
	1400 - 1410	Same as above with increase in reddish brown shale.
	1410 - 1480	Sandstone (50%), white and 50% reddish brown shale with trace of tan and green shale.
Morrison	1480 - 1500	Shale, reddish brown with minor amounts of white sandstone.
	1500 - 1510	Sandstone, white, fine-medium grained, friable with some reddish brown shale.
	1510 - 1520	Same as above with trace of reddish brown fine grained sandstone.
	1520 - 1610	Sandstone, white and green, fine grained, soft with reddish brown and green shale.
	1610 - 1640	Sandstone, white, fine grained, fair indurations with gray and green sandstone and reddish brown (cave?) and green shale.
	1640 - 1660	Sandstone, light green and white, fine grained, fair induration and shale cave.
	1660 - 1810	Sandstone, white, very fine grained with light green shale and red burn.
	1810 - 1820	Sandstone, pink-reddish brown, very fine grained 10%.
	1820 - 1850	Same as above but 20%.
	1850 - 1950	Sandstone as above 90%.
Entrada	1950 - 1970 (1980)	Cement.
	1970 - 2030	Sandstone, reddish brown, very fine grained.
	2030 - 2120 (2140)	Same as above with white, very fine grained sandstone. (5%)
Carmel	2120 - 2300 (2290)	Shale, reddish brown and white bentonitic mudstone.
Navajo	2300 - 2880	Sandstone, white and reddish brown, very fine grained.
	2880 - 2900	No record.

Navajo No. 4 Well (continued)

	Depth Interval		Lithologic Description
	2900 - 3000	2990	Sandstone, pink-reddish brown, very fine grained with 10-20 shale, reddish brown cave.
Kayenta	3000 - 3020		Shale (30%)
	3020 - 3030		Shale, reddish brown and mottled blue gray (50%).
	3030 - 3040		Same as above with 80% shale.
	3040 - 3150	3150	Shale.
Wingate	3150 - 3180		Sandstone, reddish brown very fine grained. (10%)
	3180 - 3250		Same as above with 80%.sandstone.
	3250 - 3270		Poor sample.
	3270 - 3340		Sandstone, reddish brown, very fine grained.
	3340 - 3350		Sandstone as above with trace of chocolate brown shale.
	3350 - 3370		Sandstone as above.
	3370 - 3390	3465	Sandstone as above with 5% chocolate brown shale.
Chinle	3390 - 3480		Sandstone as above with claystone and shale.
	3480 - 3490		Sandstone as above with 10% reddish brown shale.
	3490 - 3540		Shale, reddish brown.

NAVAJO No. 5 WELL
LITHOLOGIC SAMPLE LOG

	Depth Interval	Lithologic Description
	10 - 20	Sandstone-shale, burned.
	20 - 30	Same as above with coal.
	30 - 100	Sandstone-shale, burned.
	100 - 140	Sandstone, ash and coal.
	140 - 150	Cement.
	150 - 190	Cement and burn.
	190 - 210	Sandstone, white, very fine grained.
	210 - 230	Abundant coal, dirty.
	230 - 240	Coal, 90%.
	240 - 280	Coal and clay.
	280 - 320	Shale, gray.
	320 - 340	Shale, gray with coal.
	340 - 350	Coal.
Mesa Verde	350 - 370	Shale-sandstone, gray.
	370 - 380	Shale and sandstone as above with 50% coal.
	380 - 400	Sandstone, gray.
	400 - 420	Sandstone, gray with 50% coal.
	420 - 430	Shale, gray.
	430 - 490	Sandstone, gray.
	490 - 510	Shale, gray.
	510 - 520	Sandstone - shale gray.
	520 - 570	Sandstone, gray.
	570 - 610	Sandstone, white, medium-coarse grained.
	610 - 630	Sandstone as above with pyrite.
	630 - 640	Sandstone as above with chert.
	640 - 680	Sandstone, white, coarse grained, frosted grains.
	680 - 710	Sandstone-shale, gray.
	710 - 760	Sandstone, very fine grained with 50% gray shale.
	760 - 790	Same as above with pyrite.
	790 - 1300 (810)	Shale, gray.
	1300 - 1330	Shale, gray with 3% very fine grained sandstone. (Cave?)
Mancos	1330 - 1360	Shale, gray.
	1360 - 1370	Shale, gray with 3% chert.
	1370 - 1390	Shale, gray.
	1390 - 1520 (1440)	Sandstone (60%) gray-white, very fine grained, carbonaceous
Dakota	1520 - 1530	Shale, reddish brown and green.
	1530 - 1550	Shale as above with copper carbonate.
	1550 - 1600 (1595)	Sandstone, white, very fine grained.
	1600 - 1630	Sandstone, white, very fine to medium grained.
	1630 - 1810	Sandstone, very fine grained.

Navajo No. 5 Well (continued)

	Depth Interval	Lithologic Description
	1810 - 1830	Shale, reddish brown.
	1830 - 1850	Sandstone, coarse grained with transparent grains.
	1850 - 1880	Shale, reddish brown.
	1880 - 1950	Sandstone, fine to medium grained.
	1950 - 1960	Sandstone as above with pyrite.
	1960 - 1980	Shale, reddish brown with pyrite.
	1980 - 2000	Shale, reddish brown.
	2000 - 2010	Sandstone, white, very fine grained.
Morrison	2010 - 2060	Sandstone as above with pyrite.
	2060 - 2070	Sandstone as above with abundant pyrite and carbonaceous material.
	2070 - 2100	Sandstone as above.
	2100 - 2140	Sandstone, reddish brown, very fine grained.
	2140 - 2170	Cement.
	2170 - 2250	Sandstone, reddish brown-pink, very fine grained.
	2250 - 2290	Mudstone, red, poor samples.
	2290 - 2300	Poor sample.
Entrada	2300 - 2430 (2305)	Sandstone, reddish brown-white, very fine grained.
	2430 - 2500 (2465)	Mudstone, reddish brown-white, bentonitic.
	2500 - 2540	Shale, reddish brown.
	2540 - 2550	Shale (?) mottled blue green and reddish brown.
Carmel	2550 - 2600	Sandstone, pink-reddish brown, very fine grained, 10%.
	2600 - 3140 (2610)	Sandstone as above, 90%.
	3140 - 3150	Shale, chocolate brown, and mottled blue green. (cave?)
Navajo	3150 - 3200	Sandstone, very fine grained.
	3200 - 3300	Shale, chocolate brown. (cave?)
	3300 - 3310	Sandstone, very fine grained, 50%.
	3310 - 3380 (3335)	Same as above with abundant white chert.
	3380 - 3400	Sandstone, 70-80% very fine grained.
	3400 - 3410	Chert, 50%, white.
Kayenta	3140 - 3420	Sandstone 80% white-reddish brown very fine grained, reddish brown shale and chert.
	3420 - 3430	Shale, barn red.
	3430 - 3450	Shale, reddish brown and chert.
	3450 - 3460	Sandstone, reddish brown, very fine grained, 50%.
	3460 - 3470	Sandstone as above with 30% chert.
	3470 - 3490	Same as above with reddish brown shale.
Wingate	3490 - 3500 (3490)	Same as above with only 10% sandstone.
	3500 - 3520	Sandstone, very fine grained.

NAVAJO No. 6 WELL
LITHOLOGIC SAMPLE LOG

	Depth Interval	Lithologic Description
	48 - 190 (?)	Sandstone, very fine grained and black carbonacerous shale.
	190 - 240	Same as above, dark gray shale contains pyrite.
	240 - 250	Black shale and coal.
	250 - 260	Sandstone, very fine grain, tight.
	260 - 270	Same as above with 30% coal.
	270 - 290	Sandstone as above with pyrite.
	290 - 300	Sandstone, light, fine to medium grain and black shale.
	300 - 320	Sandstone, shale and coal.
Mesa Verde	320 - 420	Sandstone, light, medium to coarse grain.
	420 - 430	Sandstone as above with black shale.
	430 - 450	Coal, dirty.
	450 - 480	Sandstone, light, fine to medium grain and black shale.
	480 - 520	Sandstone, white, very fine grained.
	520 - 530	Sandstone as above with 20% coal.
	530 - 540	Sandstone, white very fine grained and dark gray siltstone.
	540 - 550	Sandstone, white, very fine grained.
	550 - 560	Shale, dark gray.
	560 - 570	Sandstone, white, medium to coarse grained.
	570 - 590	Sandstone white, fine grained.
	590 - 640 615	Sandstone, white very fine grained.
	640 - 670	Sandstone as above with black shale.
Mancos	670 - 740	Shale, black, 90% with calcite (?).
	740 - 1100	Shale, black with red chert and calcite.
	1100 - 1190	Shale, black.
	1190 - 1220 1210	Shale, black with 10% white fine grained sandstone.
	1220 - 1240	Shale, black with 20-30% white fine grained sandstone and pyrite.
	1240 - 1260	Sandstone as above (60%) with black shale.
	1260 - 1280	Sandstone, white, medium to coarse grained (60%) with black shale.
Dakota	1280 - 1290	Sandstone, white, fine to medium grained with pyrite and black shale.
	1290 - 1300	Sandstone as above with chert fragments and pyrite.
	1300 - 1330	Mancos Cave
	1330 - 1340	Sandstone, white, very fine grained with coarse chert fragments and green shale.

Navajo No. 6 Well (continued)

	Depth Interval		Lithologic Description
	1340 - 1350		Sandstone with abundant chert, trace of shale.
	1350 - 1370		Shale, reddish brown and green.
	1370 - 1390	1415	Same as above with pyrite.
	1390 - 1440		Sandstone, white, fine to medium grain, soft.
	1440 - 1450		Siltstone, reddish brown.
	1450 - 1460		Sandstone, white fine to medium grained, soft.
	1460 - 1490		Shale, reddish brown.
	1490 - 1520		Sandstone, reddish brown, very fine grained.
	1520 - 1550		Shale, reddish brown.
	1550 - 1560		Sandstone, medium to coarse grained.
	1560 - 1580		Sandstone as above with chert fragments.
	1580 - 1650		Shale, reddish brown.
	1650 - 1680		Sandstone, medium to coarse grained with chert fragments.
Morrison	1680 - 1710		Shale, red.
	1710 - 1740		Mancos cave.
	1740 - 1770		Sandstone, white, fine grained.
	1770 - 1780		Cave.
	1780 - 1790		Sandstone as above with cave.
	1790 - 1810		Sandstone as above.
	1810 - 1820		Sandstone as above with cave.
	1820 - 1880		Sandstone as above.
	1880 - 1920		Shale, reddish brown.
	1920 - 2000	2060	Sandstone, very fine grained, soft.
Entrada	2000 - 2160		Sandstone, reddish brown, very fine grained.
	2160 - 2200		Cement.
	2200 - 2220		Cement and reddish brown, very fine grained sandstone.
	2220 - 2260	2245	Sandstone as above.
Carmel	2260 - 2270		Cement and sandstone as above.
	2270 - 2280		Shale, chocolate brown.
	2280 - 2290		Shale as above and cement.
	2290 - 2430	2395	Shale, reddish brown.
	2430 - 2450		Sandstone, very fine grained (5%)?
	2450 - 2480		Sandstone (10%)
	2480 - 2500		Sandstone, reddish brown very fine grained, 50%.
	2500 - 2700		Sandstone, reddish brown to white, very fine grained.
Navajo	2700 - 2800		Cement and cave.
	2800 - 2810		Sandstone, pink with 10% cement.
	2810 - 2910		Sandstone, pink.
	2910 - 3010		No description.
	3010 - 3040		Shale, brown, cave.
	3040 - 3070	3085	Sandstone, white-pink, very fine grained.
	3070 - 3090		Cave ??

Navajo No. 6 Well (continued)

	Depth Interval	Lithologic Description
	3090 - 3100	Shale, chocolate brown and mottled green, 50% shale as above (5%) with sandstone.
	3110 - 3120	Shale, 50%.
	3120 - 3130	Shale, 10%.
Kayenta	3130 - 3160	Shale, 20%.
	3160 - 3170	No description.
	3170 - 3180	Shale, 50%.
	3190 - 3240 3245	Shale, reddish brown, 10% cement.
	3240 - 3300	Shale - claystone, bentonitic.
	3300 - 3320	Sandstone, white, very fine grained, 5%.
	3320 - 3410	Sandstone, white-pink, very fine grained, 50%.
Wingate	3410 - 3420	Sandstone, reddish brown-pink, fine medium grained.
	3420 - 3440	Shale, chocolate brown, cave?
	3440 - 3470	Sandstone, 90%.
	3470 - 3510 3520	Sandstone, medium-fine grained.
	3510 - 3530	Shale, chocolate brown 10% cave?
Chinle	3530 - 3550	Shale, chocolate to reddish brown, 60%.
	3550 - 3560	Shale, 80%.

Navajo No. 8 Lithologic Description

Feet	Wepo Formation
0-40	Reddish-Brown Burn
40-50	Carbonaceous Shale (60%); Coal (20%); Burn (10%); Fine to Medium Grained Sandstone and Silty Shale (10%)
50-60	Coal and Carbonaceous Shale (30%); Lt. Reddish Brown Fine to Medium Grained Sandstone (60%); Medium Gray Shale and Slatestone (10%)
60-70	Medium Gray Slatestone; Medium Darkish Gray Silty Shale; Very Fine Grained Sandstone; Carbonaceous Shale; Coal; Burn
70-80	Light Gray Very Fine to Fine Grained Sandstone (60%); Medium Dark Shale (30%); Coal and Minor Carbonate Shale (10%)
80-90	Coal and Minor Carbonate Shale (50%); Slatestone to Very Fine Grained Sandstone (40%); Shale (10%)
90-100	Light Gray, Very Fine Grained Sandstone (65%); Medium Dark Gray Silty Shale (30%); Coal (5%)
100-110	Silty Very Fine to Fine Grained Sandstone (50%); Silty Shale (40%); Burn and Coal (10%)
110-120	Hard Dark Brownish Gray Silty Shale (70%); Light Gray Very Fine to Fine Grained Sandstone (25%); Siderite (5%)
120-130	Medium Dark Gray Silty Shale (50%); Light Gray Very Fine Grained Sandstone (40%); Carbonate to Coaly Shale (10%)
130-140	Shale (60%); Sandstone (40%) As Above
140-150	As Above Except Coal and Carbonate Shale (5%)
150-160	Shale (55%); Sandstone (25%); Coal (20%)
160-170	Medium Dark Brownish Gray Silty Shale (70%); Sandstone (20%); Coal (10%)
170-180	Hard Dark Brownish Gray Shaley Siltstone to Silty Shale (75%); Very Fine to Fine Grained Sandstone (15%); Siderite (10%)
180-190	Soft Light Gray Shale (70%); Harder Darker More Silty Shale (25%); Siderite (5%)
190-200	Interbedded Medium Gray Silty Shale and Light Gray Very Fine Grained Sandstone; Siderite (5-10%)

Navajo No. 8 Lithologic Description

Feet	Wepo Formation
200-210	Coal (50%) Very Light Gray Sandstone (35%) and Interlaminated Medium Dark Brownish Gray Shaley Siltstone to Silty Shale (15%)
210-220	Hard Medium Dark Brownish Gray Shaley Siltstone
220-230	Finely Laminated Very Light Gray Fine Grained Sandstone and Siltstone to Carbonate Shale
230-240	As Above (30%); Coaly to Carbonate Shale and Dark Gray Silty Shale
240-250	Medium Dark Gray Shale (60%); Fine Laminate of Light Grained Very Fine Grained Sandstone and Shale; Some Carbonaceous
250-260	Shale As Above (60%); Coal (30%); Sandstone (10%)
260-270	Medium Gray Shaley Siltstone, Grades to Silty Shale; Siderite (20%); Coal and Sandstone
270-280	Apparently Laminated Dark Brownish Gray Silty Shale and Very Fine Grained Clayey Sandstone; Carbonate Shale (10%)
280-290	Shale and Sandstone; As Above But Higher Amounts of Sandstone; Minor Coal
	Toreva Formation
290-300	Light Gray and Light Brownish Gray Clayey to Silty Fine Grained Sandstone
300-310	Light Gray Sandstone, As Above
310-320	Light Gray Clayey to Fine Grained Sandstone
320-330	Sandstone As Above, Except More Clayey
330-340	Sandstone As Above (35%); Medium Gray Shaley Siltstone to Silty Shale; Subbituminous Coal (10%)
340-350	Shaley to Sandy Siltstone (As Above); Medium Light Gray and Brownish Mudstone
350-360	Light Brown Mudstone (50%); Light Gray Silty to Fine Grained Sandstone; Few Carbonate Shale to Shaley Coal Pieces
360-370	Mudstone and Sandstone, As Above, Except Less Abundant Sandstone
370-380	Silty to Very Fine Sandstone (70%); Soft Mudstone and Hard Siltstone; Minor Coaly Chips

Navajo No. 8 Lithologic Description

Feet	Toreva Formation
380-390	Medium Gray Soft Silty Shale; Soft Gray Sandstone (40%); Minor Coaly Chips
390-400	Light Gray, Fine Grained Sandstone, Some Darker and Finer Grained Interbeds; Siderite Chips Noted
400-410	Sandstone As Above; Coal Chips Noted
410-420	Sandstone As Above
420-430	Dark Brownish Gray Shale (70%); Sandstone As Above (30%)
430-440	Shale As Above; Carbonate to Coaly Shale (25%); Minor Sandstone
440-450	Shale As Above; Coaly Shale (10%); Minor Sandstone Chips
450-460	Shale As Above; Light to Medium Gray Sandstone (25%); Minor Coaly Chips; Darker Sandstone Impurities
460-470	Dark Carbonate to Coaly Shale; Some Coal; Dark Silty Very Fine Grained Sandstone; Some Shale As Above
470-480	Dark Gray Shale; Some Silty; Light Gray Sandstone (10%)
480-490	Dark Gray Shaley Siltstone and Shale; Sandstone (5%); Carbonate to Coaly Shale Fragments (5%)
490-500	Light Gray Silty; Fine Grained Sandstone (90%); Plant Fragments and Some Mica
500-510	Sandstone As Above; Dark Brownish Gray Shale (20%)
510-520	Sandstone Darker Brown Than Above and Some Angular and Coarse Grained; Coaly Fragments (5%)
520-530	Same As Above; Some Soft Sand
530-540	Light Brownish Gray Clayey to Fine Grained Sandstone, Some Medium Grained
540-550	Fine to Medium Grained Sandstone As Above; Some Coarse
550-560	Sandstone As Above; Contains Hard Dark Gray Pebbles
560-570	Sandstone As Above; Lens with Quartz, Some Dark Gray Pebbles
570-580	As Above
580-590	Sandstone As Above; Dark Blackish Gray Mudstone
590-600	Sandstone As Above, Except Little Darker Brownish and Greenish Tint
600-610	Sandstone As Above

Navajo No. 8 Lithologic Description

Feet	Toreva Formation
610-620	Sandstone As Above
620-630	Sandstone Darker, Fine Grained, More Clay Rich Than Above
630-640	Sandstone As Above
640-650	Sandstone As Above
650-660	Sandstone As Above
660-670	Sandstone As Above
670-680	Sandstone As Above, Some Coarser Grains; Two Siderite Chips Noted
680-690	Sandstone As Above, Except No Coarse Grained Components
690-700	Sandstone As Above
700-710	Sandstone As Above
710-720	Sandstone As Above, Except Some 50% Darker
720-730	Sandstone Same As 680-690
730-740	Sandstone Same As 710-720
740-750	Sandstone As Above
	Mancos Formation
750-760	Sandstone As Above, Except Contains Some Weak Brownish Gray Mudstone to Shale
760-770	As Above, Except Shale (60%)
770-780	Relatively Weak, Dark Gray to Brownish Gray Mudstone With Some Very Fine Grained Sandstone
780-790	Silty Mudstone to Shale, Some Fine Grained Sandstone
790-800	Silty Mudstone to Shale As Above, Very Minor Sandstone (5%)
800-810	Silty Mudstone As Above, Some Sandy Components
810-820	Silty Mudstone As Above, Sand (5%); Fossil Fragments Noted
820-830	Silty Mudstone As Above; Dark Gray Shale (10%); Minor Sandstone Contents
830-840	Silty Mudstone As Above, Minor Bentonite
840-850	Silty Mudstone As Above
850-860	Silty Mudstone As Above
860-870	Silty Mudstone As Above

Navajo No. 8 Lithologic Description

Feet	Mancos Formation
870-880	Silty Mudstone As Above
880-890	Silty Mudstone As Above
890-900	Silty Mudstone As Above
900-910	Silty Mudstone As Above
910-920	Silty Mudstone As Above
920-930	Silty Mudstone As Above
930-940	Silty Mudstone As Above; Trace Bentonite
940-950	Silty Mudstone As Above
950-960	Silty Mudstone As Above
960-970	Silty Mudstone As Above
970-980	Silty Mudstone As Above
980-990	Silty Mudstone As Above
990-1000	Silty Mudstone As Above
1000-1010	Silty Mudstone As Above
1010-1020	Silty Mudstone As Above
1020-1030	Silty Mudstone As Above; Trace Bentonite
1030-1040	Silty Mudstone As Above
1040-1050	Silty Mudstone As Above
1050-1060	Silty Mudstone As Above
1060-1070	Silty Mudstone As Above; Two Chips of Brownish Gray Very Fine Grained Sandstone
1070-1080	Silty Mudstone As Above
1080-1090	Silty Mudstone As Above
1090-1100	Silty Mudstone As Above
1110-1120	As Above, Except Dark Gray and Shalier
1120-1130	As Above
1130-1140	As Above
1140-1150	As Above
1150-1160	As Above
1160-1170	As Above; One Piece Bentonite
1170-1180	As Above; Several Small Pieces of Bentonite

Navajo No. 8 Lithologic Description

Feet	Mancos Formation
1180-1190	As Above
1190-1200	As Above; Two Pieces Bentonite
1200-1210	As Above
1210-1220	As Above; Shale Predominate
1220-1230	As Above
1230-1240	As Above; Shale 90%
1240-1250	As Above; Mudstone 30%
1250-1260	As Above; Fossil Fragments Noted
1260-1270	As Above; Mostly Mudstone; Fossil Fragments Noted
1270-1280	As Above; Shale 30%
1280-1290	As Above; Shale 70%
1290-1300	As Above; Shale (50%); Mudstone (50%)
1300-1310	As Above; Shale (50%); Mudstone (50%); One Small Fossil Fragment
1310-1320	As Above
1320-1330	As Above; A Few Small Bentonite Pieces; One Fossil Fragment Noted
1330-1340	As Above; Two Small Bentonite Pieces
1340-1350	As Above; Shale (60%); Mudstone (40%); A Few Small Fragments; One Piece Bentonite
1350-1360	As Above
1360-1370	As Above; Mudstone to Shale; Several Bentonite Pieces; Two Small Bentonite Pieces
1370-1380	As Above; Several Fossil Fragments; Some Bentonite; Some Sandy Shale
1380-1390	As Above; Numerous Fossil Fragments; A Few Sandy Chips
1380-1400	As Above; Slate and Shale; Some Sandy Chips
	Dakota Formation
1400-1410	As Above; Light Gray, Very Fine Grained Sandstone, Often Finely Laminated (30%)
1410-1420	Shale and Mudstone, As Above; Sandstone (40%-50%); Plant Fragments on Laminate
1420-1430	Sandstone As Above; Some Brown Sandstone; Shale and Mudstone (10%-20%)

Navajo No. 8 Lithologic Description

Feet	Dakota Formation
1430-1440	Sandstone As Above; Though Medium Dark Gray and Brown
1440-1450	Medium to Medium Dark Gray and Brown, Very Fine to Medium Grained Sandstone; A Little Betonite
1450-1460	Generally Weak, Medium to Dark Gray Silty Shale; Medium Grained Sandstone (25%)
1460-1470	As Above, Shale, Sandstone, Shell Fragments
1470-1480	Greenish Gray Shale, Very Fine Grained Sandstone (30%); Trace of Carbonate Shale
1480-1490	Medium Dark Gray Shale; Sandstone 20%; Some Plant Fragments in Shale
1490-1500	Light Brownish Gray Silt to Very Fine Grained Sandstone; Some Bentonite; A Few Calcite Pieces
1500-1510	Sandstone As Above; Plant Remains on Laminae; Light Green Claystone; Silty Shale
1510-1520	Light Green Silty Claystone; Whitish Gray Fine Grained Sandstone and Bentonite; Some Shale Chips
1520-1530	As For 1510-1520
1530-1540	As Above with Whitish Gray Fine Grained Sandstone and Reddish Brown Silty Mudstone
	Morrison Formation
1540-1550	Reddish Brown Slightly Silty Claystone
1550-1560	Soft Reddish Brown Claystone, As Above; Light Whitish-Greenish Bentonite
1560-1570	Whitish Gray, Fine to Medium Grained "Sugary" Sandstone; Minor Claystone; Dark Gray Shale
1570-1580	Mixture of Fine to Medium Grained Sandstone, As Above; Light Green Fine Grained Sandstone; Dark Gray Shale
1580-1590	Whitish-Gray Fine to Medium Grained "Sugary" Sanstone (70%); White Clay (20%); Brown Claystone and Dark Gray Shale (10%)
1590-1600	Whitish-Greenish Clayey Very Fine Grained Sandstone

Navajo No. 8 Lithologic Description

Feet	Morrison Formation
1600-1610	Whitish-Greenish Sandstone As Above; Moderately Hard Whitish-Gray to Light Brownish Gray Fine to Medium Grained Sandstone
1610-1620	Whitish-Greenish Clayey Very Fine Grained Sandstone; Some Light Green (Chlorite); Some Moderately Hard Whitish-Gray Fine to Medium Grained Sandstone; Dark Gray Shale; Minor Brownish-Red Mudstone
1620-1630	Whitish-Gray Clayey Fine Grained Sandstone (90%); Light Greenish Sandstone, Dark Gray Shale and Reddish-Brown Mudstone (10%)
1630-1640	Sandstone, Though More Clayey, As Above; Dark Gray Shale and Reddish-Brown Mudstone
1640-1650	Sandstone, As For 1620-1630; Reddish-Brown Mudstone and Dark Gray Shale
1650-1660	Sandstone As Above; A Little More Clayey; Dark Gray Shale; Minor Reddish-Brown Mudstone
1660-1670	Reddish-Brown Mudstone (50%); Sandstone As Above (35%); Dark Gray Shale (15%); Two Pieces of White and Pink Bentonite
1670-1680	Sample As Above
1680-1690	Whitish-Gray Clayey, Very Fined Grained Sandstone (80%); Reddish-Brown Mudstone and Dark Gray Shale (20%)
1690-1700	Sandstone As Above (35%); Reddish-Brown Mudstone (35%); Dark Gray Shale (35%)
1700-1710	Sandstone As Above (80%); Reddish-Brown Mudstone - Dark Gray Shale
1710-1720	Reddish-Brown Mudstone and Light-Whitish Green, Very Clayey, Very Fine Grained Sandstone
1720-1730	Reddish-Brown Mudstone (75%); Whitish-Gray and Whitish-Green Sandstone (25%) As Above
1730-1740	Whitish Gray, Very Fine Grained Sandstone; White Claystone; Reddish-Brown Mudstone
1740-1750	Reddish-Brown Mudstone (70%); Sandstone (30%)
1750-1760	Reddish-Brown Mudstone (50%); Sandstone (30%); Light Green Bentonitic Claystone (20%)

Navajo No. 8 Lithologic Description

Feet	Morrison Formation
1760-1770	Whitish-Gray Very Fine Grained Sandstone (50%); Whitish-Gray Very Clayey, Very Fine Grained Sandstone; Reddish-Brown Mudstone (25%)
1770-1780	Whitish-Gray, Very Fine Grained Sandstone (70%); Reddish-Brown Mudstone (30%)
1780-1790	Reddish-Brown Mudstone (60%); Sandstone (40%); Light Grey Claystone
1790-1800	Reddish-Brown Mudstone (70%); Sandstone (30%)
1800-1810	Whitish-Gray Very Fine Grained Sandstone; Clay and Reddish-Brown Mudstone
1810-1820	Sandstone As Above (65%); Reddish-Brown Mudstone (35%)
1820-1830	Sandstone As Above, Except Generally Clayey (70%); Reddish-Brown Mudstone (30%)
1830-1840	Reddish-Brown Mudstone (60%); Light Green Clayey, Very Fine Grained Sandstone (30%); Whitish-Gray Sandstone (10%)
1840-1850	Whitish-Gray Very Clayey, Very Fine Grained Sandstone to Sandy Claystone (70%); Reddish-Brown Mudstone (25%); Whitish-Gray Very Fine Grained Sandstone (5%)
1850-1860	Sample Fine Grained and As Above
1860-1870	Whitish-Gray Very Fine Grained Sandstone (65%); Light Green Very Fine Grained Sandstone (20%); Clayey Sandstone (20%); Light Green Claystone (5%)
1870-1880	Whitish-Gray Very Fine Grained Sandstone (40%); Light Green Very Fine Grained Sandstone (10%); Clayey Sandstone (20%); Brownish-Red Mudstone (30%)
1880-1890	Whitish-Gray, Very Fine Grained Sandstone (65%); Clayey Sandstone (15%) Reddish-Brown Mudstone (15%); Light Green Claystone (5%)
1890-1900	Sandstone As Above (70%); Clayey Sandstone (15%); Reddish-Brown Mudstone (15%)
1900-1910	Whitish-Gray, Generally Clayey Very Fine Sandstone (85%); Reddish-Brown Mudstone (15%)
1910-1920	As Above, Except Moderately Hard Whitish-Gray Very Fine Grained Sandstone Now Up To 40%; Some Bentonite

Navajo No. 8 Lithologic Description

Feet	Morrison Formation
1920-1930	Sandstone (50% Clayey; 50% Moderately Hard, 50%), (70%); Reddish-Brown Mudstone (30%)
1930-1940	Whitish-Gray, Very Fine Grained Sandstone (60%); Reddish-Brown Mudstone (40%)
1940-1950	Sandstone As Above (45%); Reddish-Brown Mudstone (55%); Minor Light Green Claystone
1950-1960	Reddish-Brown Mudstone (50%); Clayey, Whitish-Gray Sandy Slatestone (30%); Sandstone (20%)
1960-1970	Whitish-Gray, Clayey, Very Fine Grained Sandstone (55%); Reddish-Brown Mudstone (30%); Very Fine Sandstone (15%)
1970-1980	Sample As Above; Minor Light Green Claystone
1980-1990	Soft Whitish-Gray Slatestone (50%); Very Brown Mudstone (40%); Very Fine Sandstone (10%)
1990-2000	Similar to Above, Soft Whitish-Gray Clayey Slatestone (60%); Reddish-Brown Sandy Mudstone and Interbedded Chloritic Sandstone (30%)
2000-2010	Reddish-Brown Mudstone (60%); Chloritic Clayey, Very Fine Grained Sandstone (25%); Light Green Claystone (15%)
2010-2020	Whitish-Gray Bentonitic Silty Mudstone (70%); Chloritic Sandstone (10%); Reddish-Brown Mudstone (20%)
2020-2030	Pinkish-White Bentonite With Very Fine Sand (70%); Reddish-Brown Mudstone (20%); Chloritic Sandstone (10%)
2030-2040	Reddish-Brown Mudstone (60%); Chloritic Sandstone (30%); Bentonite (10%)
2040-2050	Reddish-Brown Mudstone (60%); Interbedded Chloritic Sandstone (25%); Light Green Claystone (5%); Whitish-Gray, Very Fine Grained Sandstone (10%)
2050-2060	Reddish-Brown Mudstone (75%); Chloritic Sandstone (15%); Whitish-Gray, Fine Grained Sandstone (10%); Minor Light Green Claystone
2060-2070	Similar to Above; Reddish-Brown Mudstone Varies in Composition From Claystone to Very Sandy Mudstone; Some White Medium Grained Sandstone

Navajo No. 8 Lithologic Description

Feet	Morrison Formation
2070-2080	Reddish-Brown Sandy Mudstone (80%); Chloritic and Whitish Fine Grained Sandstone (15%); Light Green Claystone (5%); Pinkish Bentonite
2080-2090	Pinkish Bentonite (60%); Sandy Reddish-Brown Mudstone and Chloritic, Very Clayey Sandstone (30%); Whitish Gray, Very Fine Grained Sandstone (10%); Light Green Claystone Trace
2090-2100	Similar to Above, Except Bentonite Less; Mudstone and Chloritic Sandstone with Minor Whitish-Gray, Very Fine Grained Sandstone
2100-2110	Similar to Above, Pinkish-Gray Bentonite Present-Amount Not Determinable; Reddish-Brown Sandy Mudstone with Lesser Amount of Interbedded Chloritic, Very Clayey, Very Fine Grained Sandstone, Plus Some More of a Sandy Claystone
2110-2120	As Above, Bentonite Persists, Minor Light Green Claystone
2120-2130	Bentonite; Reddish-Brown Mudstone; Lesser Amount of Chlorite Sandstone
2130-2140	Sample As Above
2140-2150	Reddish-Brown Sandy Mudstone; Chloritic, Whitish-Gray, Very Clayey Sandstone; Reddish-Brown Mudstone Predominates
2150-2160	Pinkish-Brown Bentonite; Considerably Lesser Amount of Reddish-Brown Mudstone and Chloritic Sandstone
2160-2170	Whitish and Pinkish Bentonite; Brownish-Gray Mudstone and Reddish-Brown Mudstone; Some Light Green Claystone and Very Fine Grained Sandstone
2170-2180	Reddish-Brown Mudstone; Very Fine Clayey Sandstone
	Entrada Formation
2180-2190	Brownish-Red, Very Fine Grained Sandstone; Reddish-Brown Mudstone; Some Whitish-Gray (Some Chloritic Tint); Clayey to Very Fine Grained Sandstone
2190-2200	Sample As Above; Brownish-Red, Very Fine Grained (75%); Pinkish-Brown Bentonite and Reddish-Brown Mudstone and Light Greenish-Gray Claystone; Some Whitish-Gray, Clayey, Very Fine Grained Sandstone

Navajo No. 8 Lithologic Description

Feet	Entrada Formation
2200-2210	Predominately Brownish-Red, Very Fine Grained Sandstone; Bentonite With Reddish-Brown Mudstone With Very Light Gray Clayey Sandstone as Above
2210-2220	Predominately Brownish-Red, Very Fine Grained Sandstone and Bentonite
2220-2230	Brownish-Red, Very Fine Grained Sandstone As Above; Bentonite Lessing
2230-2240	As Above; Minor Whitish-Gray Sandstone Associated With Brownish-Red Sandstone; Some Bentonite
2240-2250	As Above
2250-2260	As Above
2260-2270	As Above; Approximately 30% Reddish-Brown Slatestone
2270-2280	As Above
2280-2290	As Above; Approximately 10% Whitish-Gray Sandstone
2290-2300	As Above
2300-2310	As Above; Slatestone (20%)
2310-2320	As Above
2320-2330	As Above
2330-2340	As Above, Except Considerable Whitish Bentonite
2340-2350	As Above, Except A Little More Reddish-Brown Mudstone and Less Whitish-Gray Sandstone
2350-2360	As Above, Less Mudstone, But White Bentonite Persists
2360-2370	As Above
2370-2380	As Above
2380-2390	As Above; Bentonite Persists; Minor Brown Shale; Fine Quartz Grains
2390-2400	As Above; Brownish-Red, Very Fine Grained Sandstone; Bentonite; Whitish-Gray Fine Grained Sandstone (15%); Chloritic Sandstone (5%)
2400-2410	As Above, Pink and White Bentonite (5%); Brownish-Red, Very Fine Grained Sandstone; Lesser Amounts of Brown Mudstone; Whitish-Gray, Very Fine Grained Sandstone and Chloritic Sandstone
2410-2420	White Bentonite; Some Soft Brown Mudstone; Other Rock Types As Above Though in Minority
2420-2430	White Bentonite; Brownish-Red Sandstone; Other Rock Types As Above

Navajo No. 8 Lithologic Description

Feet	Entrada Formation
2430-2440	As Above
2440-2450	As Above
2450-2460	As Above, Except Much More White, Very Fine Grained Sandstone
	Carmel Formation
2460-2470	Brownish-Red Shale
2470-2480	As Above
2480-2490	As Above
2490-2500	As Above; Minor Bentonite
2500-2510	As Above; White Bentonite and Minor Fine Grained, Whitish-Gray Sandstone
2510-2520	As Above
	Changed to Air and Foam Drilling; No Sample From 2520-2580, but Foam Carrying Only Shale, As Above
2580-2590	As Above
2590-2600	As Above
2600-2610	As Above
2610-2620	As Above
2620-2630	As Above
	Navajo Formation
2630-2640	As Above
2640-2650	As Above; Minor Light Brown, Very Fine Sandstone - Subrounded, Well Sorted, Moderate Cementation
2650-2660	As Above
2660-2670	As Above
2670-2680	As Above
2680-2690	As Above; More Sandstone
2690-2700	As Above
2700-2710	As Above; More Sandstone Than Above

Navajo No. 8 Lithologic Description

Feet	Navajo Formation
2710-2720	Approximately Shale (45%); Sandstone (45%); Approximately 10% Whitish-Gray, Fine Grained Sandstone
2720-2730	As Above
2730-2740	As Above
2740-2750	As Above; More Sandstone Than Shale
2750-2760	As Above
2760-2770	As Above
2770-2780	As Above
2780-2790	As Above
2790-2800	As Above
2800-2810	As Above
2810-2820	As Above
2820-2830	As Above
2830-2840	As Above
2840-2850	As Above
2850-2860	As Above
2860-2870	As Above
2870-2880	As Above; Shale Dominant
2880-3110	As Above
3110-3340	Mostly Sandstone (Light Reddish-Brown) As Above, With Shale (30%)
3340-3365	Shale (60%) and Sandstone (40%)
3365-3385	As Above
3385-3390	Red Shale (70%); Sandstone (30%); Trace White Clay
3390-3395	Shale (Minor Light Green) (60%); Sandstone (40%)
3395-3397	Shale (Minor Light Green and White) (70%); Sandstone (30%)
3397-3402	Shale (80%); Sandstone (20%)
3402-3410	As Above

LITHOLOGIC LOG

WATER WELL NO. 9 RECORDED BY RW

	INTERVAL DEPTH	ROCK TYPES	GSA COLOR	MINERALS	CEMENT MATRIX	GRAIN SIZE	COMMENTS
MESA VERDE FRM	0-60	SS-SH	N7	QTZ,FLD	SIL	FIN	Fe-STAINED
							MNR-ROOTS
	80	SH-CO	N6-N1		SIL		
	100	SH-SS	N2-N7	QTZ,FLD	SIL		MNR-CO
	120	SS	N6	QTZ	SIL	FIN	MNR-CO
							MNR-Fe-STN
	140	SL	N6		SIL		MNR-DRK-SH
	180	SH	N3		SIL		
	200	SS	N7	QTZ	SIL	FIN	
	220	SS	N8	QTZ,FLD	SIL	FIN-MED	SUB-ANG TO
				MNR-BIOT			SUB-RND

LITHOLOGIC LOG

WATER WELL NO. 9 RECORDED BY RW

INTERVAL DEPTH	ROCK TYPES	GSA COLOR	MINERALS	CEMENT MATRIX	GRAIN SIZE	COMMENTS
240	SS	N9	QTZ	SIL	FIN-MED	SUB-ANG TO
			MNR-FLD			SUB-RND
260	SS	A/A	A/A	A/A	A/A	A/A
280	SS	N7	QTZ,FLD	SIL	VRY FIN-FIN	
	SH	5YR6/1		CAL		
300	SS	N6	QTZ,FLD	SIL	FIN	SUB-RND
320	SS	A/A	A/A	A/A	A/A	A/A
340	SS	N7	QTZ,FLD	SIL	FIN	MNR-CO
360	CO-SH	N1-N5		SIL		PYR w/CO
380	SH	N5		SIL		ABN CO w/PYR

LITHOLOGIC LOG

WATER WELL NO. 9 RECORDED BY RW

INTERVAL DEPTH	ROCK TYPES	GSA COLOR	MINERALS	CEMENT MATRIX	GRAIN SIZE	COMMENTS
400	SH	5Y 4/1		SIL		
420	SH	N5		SIL		MNR-SS
440	SH	A/A		A/A		A/A
460	MS	5Y 4/1		SIL		
480	MS	A/A		A/A		
500	MS	N4		SIL		
520	MS	N5		WEK CAL		
540	SS&MS	N5	QTZ, FLD	SIL	FIN-MED	SUB-RND
560	SS	N7	QTZ, FLD	SIL	FIN-MED	SUB-RND

LITHOLOGIC LOG

WATER WELL NO. 9 RECORDED BY RW

	INTERVAL DEPTH	ROCK TYPES	GSA COLOR	MINERALS	CEMENT MATRIX	GRAIN SIZE	COMMENTS
	580	SS	N7	QTZ,BIOT	SIL	FIN-MED	
MANCOS FRM	600	SH	N7		WEK CAL		
	620	SH	A/A		A/A		
	640	SH	A/A		A/A		
	660	SH	N6		CAL		MNR-SS
	680	SH	A/A		A/A		A/A
	700	SH	A/A		A/A		A/A
	720	SH	A/A		A/A		A/A
	740	SH	N3		CAL		

LITHOLOGIC LOG

WATER WELL NO. 9 RECORDED BY RW

INTERVAL DEPTH	ROCK TYPES	GSA COLOR	MINERALS	CEMENT MATRIX	GRAIN SIZE	COMMENTS
760	SH	N3		WEK-CAL		
780	SH	A/A		A/A		
800	SH	A/A		A/A		
820	SH	A/A		A/A		
840	SH	N4		CAL		
860	SH	A/A		A/A		
880	SH	A/A		A/A		
900	SH	A/A		A/A		
920	SH	A/A		A/A		

LITHOLOGIC LOG

WATER WELL NO. 9 RECORDED BY RW

INTERVAL DEPTH	ROCK TYPES	GSA COLOR	MINERALS	CEMENT MATRIX	GRAIN SIZE	COMMENTS
940	SH	N4		CAL		
960	SH	A/A		A/A		
980	SH	A/A		A/A		
1000	SH	N4		CAL		MNR-SS
1020	SH	N4		CAL		
1040	SH	N4		CAL		
	SS	N7	QTZ,BIOT	CAL	VRY FIN	
1060	SH	A/A		A/A		
	SS	A/A	A/A	A/A	A/A	
1080	SH	N4		CAL		

LITHOLOGIC LOG

WATER WELL NO. 9 RECORDED BY RW

INTERVAL DEPTH	ROCK TYPES	GSA COLOR	MINERALS	CEMENT MATRIX	GRAIN SIZE	COMMENTS
1100	SH	N4	GYP	CAL		
1120	SH	N4		CAL		MNR-SS
1140	SH	A/A		A/A		A/A
1160	SH	5YR 4/1	GYP	CAL		
1180	SH	N4	GYP	CAL		
1200	SH	N4		CAL		
	SS	N8	QTZ	CAL	FIN-MED	SUB-RND
1220	SH	N3		CAL		
	SS	5YR 8/1	QTZ		FIN-MED	SUB-RND
1240	SH	A/A		A/A		
	SS	5YR 8/1	QTZ-BIOT	CAL		SUB-RND

LITHOLOGIC LOG

WATER WELL NO. 9 RECORDED BY RW

	INTERVAL DEPTH	ROCK TYPES	GSA COLOR	MINERALS	CEMENT MATRIX	GRAIN SIZE	COMMENTS
DAKOTA FRM	1260	SS	N8	QTZ-BIOT	WEK-CAL	VRY FIN-FIN	SUB-RND
		SL	N6		WEK CAL		
	1280	SS	A/A	A/A	SIL	A/A	A/A
							MNR-SL
	1300	SS	10YR 8/6	QTZ-BIOT	SIL	MED	SUB-RND
							MNR-SL
	1320	SS	10YR 8/6	QTZ-FLD	SIL	FIN-MED	SUB-RND
							MNR-CO
							MNR-DRK-SH
	1340	SS	N7	QTZ-BIOT	WEK CAL	FIN	SUB-RND
	1360	SS	N8	QTZ-BIOT	SIL	FIN	SUB-RND
	1380	SS	5YR 5/2	QTZ	SIL	FIN	SUB ANG -
							SUB RND

LITHOLOGIC LOG

WATER WELL NO. 9 RECORDED BY RW

	INTERVAL DEPTH	ROCK TYPES	GSA COLOR	MINERALS	CEMENT MATRIX	GRAIN SIZE	COMMENTS
MORRISON FRM	1400	SS	N8	QTZ	CAL	FIN	SUB-RND
		SL	10R 4/2		CAL		
	1420	SS	N6	QTZ BIOT	WEK CAL	VRY FIN-FIN	SUB-RND
		SL	5YR 4/1		CAL		
	1440	SS	N7	QTZ-BIOT	SIL	FIN	SUB-RND
		SH	5YR 4/1		CAL		
	1460	SS	5G 5/2	QTZ, BIOT	SIL	FIN	SUB RND
		SH	A/A		A/A		
	1480	SS	A/A	A/A	A/A	A/A	A/A
		SH	A/A		A/A		
	1500	SS	A/A	A/A	A/A	A/A	A/A
		MS	5YR 4/1		CAL		

LITHOLOGIC LOG

WATER WELL NO. 9 RECORDED BY RW

INTERVAL DEPTH	ROCK TYPES	GSA COLOR	MINERALS	CEMENT MATRIX	GRAIN SIZE	COMMENTS
1520	SS	5YR 8/1	QTZ	SIL	FIN	SUB RND
	MS	10R 4/2		CAL		
1540	SS	A/A	A/A	A/A	A/A	A/A
	MS	A/A		A/A		
1560	SS	A/A	A/A	A/A	A/A	A/A
	MS	A/A		A/A		
1580	SS	A/A	A/A	A/A	A/A	A/A
	MS	A/A		A/A		
1600	SS	N8	QTZ BIOT	WEK CAL	MED	SUB RND TO
						WEL RND
1620	SS	A/A	A/A	A/A	A/A	A/A
1640	SS	A/A	A/A	A/A	A/A	A/A

LITHOLOGIC LOG

WATER WELL NO. 9 RECORDED BY RW

INTERVAL DEPTH	ROCK TYPES	GSA COLOR	MINERALS	CEMENT MATRIX	GRAIN SIZE	COMMENTS
1660	SS	N8	QTZ BIOT	WEK CAL	FIN	SUB RND
1680	SS	N8	QTZ BIOT	WEK CAL	FIN	SUB RND
1700	SS	5YR 8/1	QTZ,FLD	CAL	FIN	SUB RND
			MNR BIOT			
	MS	5YR 5/2		SIL		
1720	SS	A/A	A/A	A/A	A/A	A/A
	MS	A/A		A/A		
1740	SS	A/A	A/A	A/A	A/A	A/A
	MS	A/A		A/A		
1760	SS	5G 2/1	QTZ	CAL	FIN	SUB ANG
	MS	5YR 5/2		WEK CAL		
1780	SS	5YR 8/1	QTZ	CAL	VRY FIN-FIN	SUB ANG -
			MNR BIOT			SUB RND

LITHOLOGIC LOG

WATER WELL NO. 9 RECORDED BY RW

INTERVAL DEPTH	ROCK TYPES	GSA COLOR	MINERALS	CEMENT MATRIX	GRAIN SIZE	COMMENTS
1800	SS	5YR 8/1	QTZ, BIOT	CAL	FIN	SUB ANG-
						SUB RND
1820	SS	A/A	A/A	A/A	A/A	A/A
1840	SS	5YR 8/1	QTZ	CAL	VRY FIN-FIN	SUB RND
1860	SS	A/A	A/A	A/A	A/A	A/A
1880	SS	N8	QTZ BIOT	CAL	FIN	SUB ANG-
						SUB RND
	MS	N4	MIC	SIL		
1900	SS	5YR 6/4	QTZ	CAL	VRY FIN_FIN	SUB RND
1920	SS	A/A	A/A	A/A	A/A	A/A
1940	SS	10R 6/2	QTZ BIOT	CAL	VRY FIN	SUB RND

LITHOLOGIC LOG

WATER WELL NO. 9 RECORDED BY RW

INTERVAL DEPTH	ROCK TYPES	GSA COLOR	MINERALS	CEMENT MATRIX	GRAIN SIZE	COMMENTS
1960	SS	10R 6/2	QTZ-BIOT	CAL	VRY FIN	SUB RND
1980	SS	A/A	A/A	A/A	A/A	A/A
	SS	N8	QTZ	CAL	VRY FIN	SUB ANG
2000	SS	10R 6/2	A/A	A/A	A/A	A/A
	SS	N8	A/A	A/A	A/A	A/A
2020	SS	10R 6/2	QTZ BIOT	CAL	FIN	SUB RND
	SS	N8	QTZ	CAL	FIN	SUB ANG
2040	SS	10R 6/2	QTZ BIOT	CAL	FIN	SUB RND
2060	SS	A/A	A/A	A/A	A/A	A/A
2080	SS	A/A	A/A	A/A	A/A	A/A

LITHOLOGIC LOG

WATER WELL NO. 9 RECORDED BY RW

	INTERVAL DEPTH	ROCK TYPES	GSA COLOR	MINERALS	CEMENT MATRIX	GRAIN SIZE	COMMENTS
	2100	SS	10R 6/2	QTZ BIOT	CAL	FIN	SUB RND
ENTRADA FRM	2120	SS	5YR 6/4	QTZ BIOT	CAL	VRY FIN	SUB RND
		SS	5YR 8/1	QTZ	CAL	VRY FIN	SUB RND
	2140	SS	5YR	A/A	A/A	A/A	A/A
		SS	5YR 8/1	A/A	A/A	A/A	A/A
	2160	SS	5YR 6/4	QTZ BIOT	CAL	VRY FIN	SUB ANG-
							SUB RND
		MS	N5		SIL		
	2180	SS	N8	QTZ BIOT	CAL	FIN	SUB RND
		SS	5YR 5/6	QTZ	CAL	VRY FIN	SUB ANG-
							SUB RND
	2200	SS	N8	A/A	A/A	A/A	A/A
		SS	5YR 5/6	A/A	A/A	A/A	A/A

LITHOLOGIC LOG

WATER WELL NO. 9 RECORDED BY RW

	INTERVAL DEPTH	ROCK TYPES	GSA COLOR	MINERALS	CEMENT MATRIX	GRAIN SIZE	COMMENTS
	2220	SS	5R 8/2	QTZ, FLD	SIL	FIN-MED	SUB RND-
				MIC			WEL RND
	2240	SS	A/A	A/A	A/A	A/A	A/A
CARMEL FRM	2260	SLY SH	10YR 5/4		CAL		
		MS	10R 3/4		CAL		
	2280	SL	10R 5/4		CAL		
	2300	SL	A/A		A/A		
	2320	SL	A/A		A/A		
		SS	10R 5/4	QTZ FLD	CAL	FIN	SUB RND
	2340	SS	10R 5/4	QTZ FLD	CAL	FIN	SUB RND

LITHOLOGIC LOG

WATER WELL NO. 9 RECORDED BY RW

INTERVAL DEPTH	ROCK TYPES	GSA COLOR	MINERALS	CEMENT MATRIX	GRAIN SIZE	COMMENTS
2360	SL	10R 5/4		CAL		
2380	SL	10R 5/4		CAL		
	SS	10R 6/6	QTZ BIOT	SIL	FIN	SUB RND
NAVAJO FRM 2400	SS	10R 6/6	QTZ BIOT	SIL	FIN	SUB RND
2420	SS	A/A	A/A	A/A	A/A	A/A
2440	SS	A/A	A/A	A/A	A/A	A/A
2460	SS	10R 6/6	QTZ BIOT	SIL	FIN	SUB RND
2480	SS	A/A	A/A	A/A	A/A	A/A

LITHOLOGIC LOG

WATER WELL NO. 9 RECORDED BY RW

INTERVAL DEPTH	ROCK TYPES	GSA COLOR	MINERALS	CEMENT MATRIX	GRAIN SIZE	COMMENTS
2500	SS	10R 7/4	QTZ BIOT	SIL	FIN	SUB RND -
						WEL STD
2520	SS	10R 6/6	QTZ BIOT	SIL	FIN	SUB RND -
						WEL STD
2540	SS	10R 6/6	QTZ BIOT	SIL	FIN	SUB ANG-
						SUB RND
						WEL STD
2560	SS	A/A	A/A	A/A	A/A	A/A
2580	SS	10R 6/6	QTZ BIOT	SIL	VRY FIN-FIN	SUB RND
						WEL STD
2600	SS	A/A	A/A	A/A	A/A	A/A
2620	SS	A/A	A/A	A/A	A/A	A/A
2640	SS	A/A	A/A	A/A	A/A	A/A

LITHOLOGIC LOG

WATER WELL NO. 9 RECORDED BY RW

INTERVAL DEPTH	ROCK TYPES	GSA COLOR	MINERALS	CEMENT MATRIX	GRAIN SIZE	COMMENTS
2660	SS	10R 6/6	QTZ BIOT	SIL	VRY FIN-FIN	SUB RND
2680	SS	A/A	A/A	A/A	A/A	A/A
2700	SS	10R 6/6	QTZ BIOT	SIL	FIN	SUB RND
						WELL STD
2720	SS	10R 6/6	QTZ BIOT	CAL	FIN	SUB RND
						WEL STD
2740	SS	10R 6/6	QTZ BIOT	CAL	FIN	SUB RND-
						WEL RND
2760	SS	10R 6/6	QTZ BIOT	WEK CAL	VRY FIN-FIN	SUB RND -
						WEL RND
2780	SS	A/A	A/A	A/A	A/A	A/A
2800	SS	A/A	A/A	A/A	A/A	A/A

LITHOLOGIC LOG

WATER WELL NO. 9 RECORDED BY RW

INTERVAL DEPTH	ROCK TYPES	GSA COLOR	MINERALS	CEMENT MATRIX	GRAIN SIZE	COMMENTS
2820	SS	10R 6/6	QTZ BIOT	WEK CAL	VRY FIN-FIN	SUB RND
2840	SS	A/A	A/A	A/A	A/A	A/A
2860	SS	10R 6/6	QTZ BIOT	CAL	VRY FIN-FIN	SUB RND
2880	SS	A/A	A/A	A/A	A/A	A/A
2900	SS	10R 6/6	QTZ BIOT	SIL	VRY FIN-FIN	SUB RND
2920	SS	10R 6/6	QTZ BIOT	WEK CAL	VRY FIN-FIN	SUB RND
2940	SS	10R 6/2	QTZ BIOT	WEK CAL	FIN	SUB ANG-
						SUB RND
2960	SS	A/A	A/A	A/A	A/A	A/A
2980	SS	10R 6/2	QTZ BIOT	SIL	FIN	SUB RND

LITHOLOGIC LOG

WATER WELL NO. 9 RECORDED BY RW

INTERVAL DEPTH	ROCK TYPES	GSA COLOR	MINERALS	CEMENT MATRIX	GRAIN SIZE	COMMENTS
3000	SS	10R 6/2	QTZ	CAL	FIN	SUB RND
			MNR BIOT			
3020	SS	10R 6/6	QTZ BIOT	CAL	FIN	SUB ANG-
						SUB RND
3040	SS	10R 6/6	QTZ BIOT	CAL	VRY FIN-FIN	SUB ANG-
						SUB RND
3060	SS	A/A	A/A	A/A	A/A	A/A
3080	SS	10R 6/6	QTZ BIOT	WEK CAL	VRY FIN-FIN	SUB ANG
						SUB RND
3100	SS	A/A	A/A	A/A	A/A	A/A
KAYTENTA FRM 3120	SS	10R 6/6	QTZ BIOT	CAL	FIN	SUB RND
	SS	10R 6/2	QTZ	CAL	FIN	SUB RND
			ABN BIOT			

LITHOLOGIC LOG

WATER WELL NO. 9 RECORDED BY RW

INTERVAL DEPTH	ROCK TYPES	GSA COLOR	MINERALS	CEMENT MATRIX	GRAIN SIZE	COMMENTS
3140	SS	10R 6/2	QTZ BIOT	CAL	FIN	SUB ANG-
						SUB RND
	MS	5 YR 6/1		CAL		
3160	SS	10R 6/2	QTZ BIOT	CAL	VRY FIN-FIN	SUB ANG-
						SUB RND
3180	SS	10R 6/6	QTZ BIOT	CAL	VRY FIN	SUB ANG-
						SUB RND
3200	SS	A/A	A/A	A/A	A/A	A/A
3220	SS	A/A	A/A	A/A	A/A	A/A
3240	SS	10R 6/6	QTZ BIOT	CAL	VRY FIN	SUB ANG-
						SUB RND
	MS	5YR 3/2		CAL		

LITHOLOGIC LOG

WATER WELL NO. 9 RECORDED BY RW

	INTERVAL DEPTH	ROCK TYPES	GSA COLOR	MINERALS	CEMENT MATRIX	GRAIN SIZE	COMMENTS
WINGATE FRM	3260	SS	10R 6/2	QTZ BIOT	CAL	VRY FIN	SUB RND
		MS	5YR 6/1				
	3280	SS	10R 6/2	QTZ BIOT	CAL	VRY FIN	SUB ANG-
							SUB RND
	3300	SS	10R 6/2	QTZ BIOT	CAL	VRY FIN	SUB ANG-
							SUB RND
		MS	10R 4/6		CAL		
	3320	SS	10R 6/2	QTZ BIOT	CAL	VRY FIN	SUB RND
		MS	5YR 6/1		CAL		
	3340	SS	A/A	A/A	A/A	A/A	A/A
		MS	10R 4/6		CAL		
	3360	SS	A/A	A/A	A/A	A/A	A/A
		MS	A/A		A/A		

LITHOLOGIC LOG

WATER WELL NO. 9 RECORDED BY RW

INTERVAL DEPTH	ROCK TYPES	GSA COLOR	MINERALS	CEMENT MATRIX	GRAIN SIZE	COMMENTS
3380	SS	10R 6/6	QTZ BIOT	CAL	VRY FIN	SUB RND
	MS	10R 4/6		CAL		
3400	SS	A/A	A/A	A/A	A/A	A/A
	MS	A/A		A/A		
3420	SS	10R 6/6	QTZ BIOT	CAL	VRY FIN-FIN	SUB RND
						PRY STD
3440	SS	5YR 5/6	QTZ FLD	WEK CAL	FIN-MED	SUB RND
			MNR BIOT			
3460	SS	5YR 5/6	A/A	A/A	A/A	A/A
	MS	10R 4/6		CAL		
3480	SS	5YR 5/6	QTZ FLD	CAL	VRY FIN-FIN	SUB RND
			BIOT			

LITHOLOGIC LOG

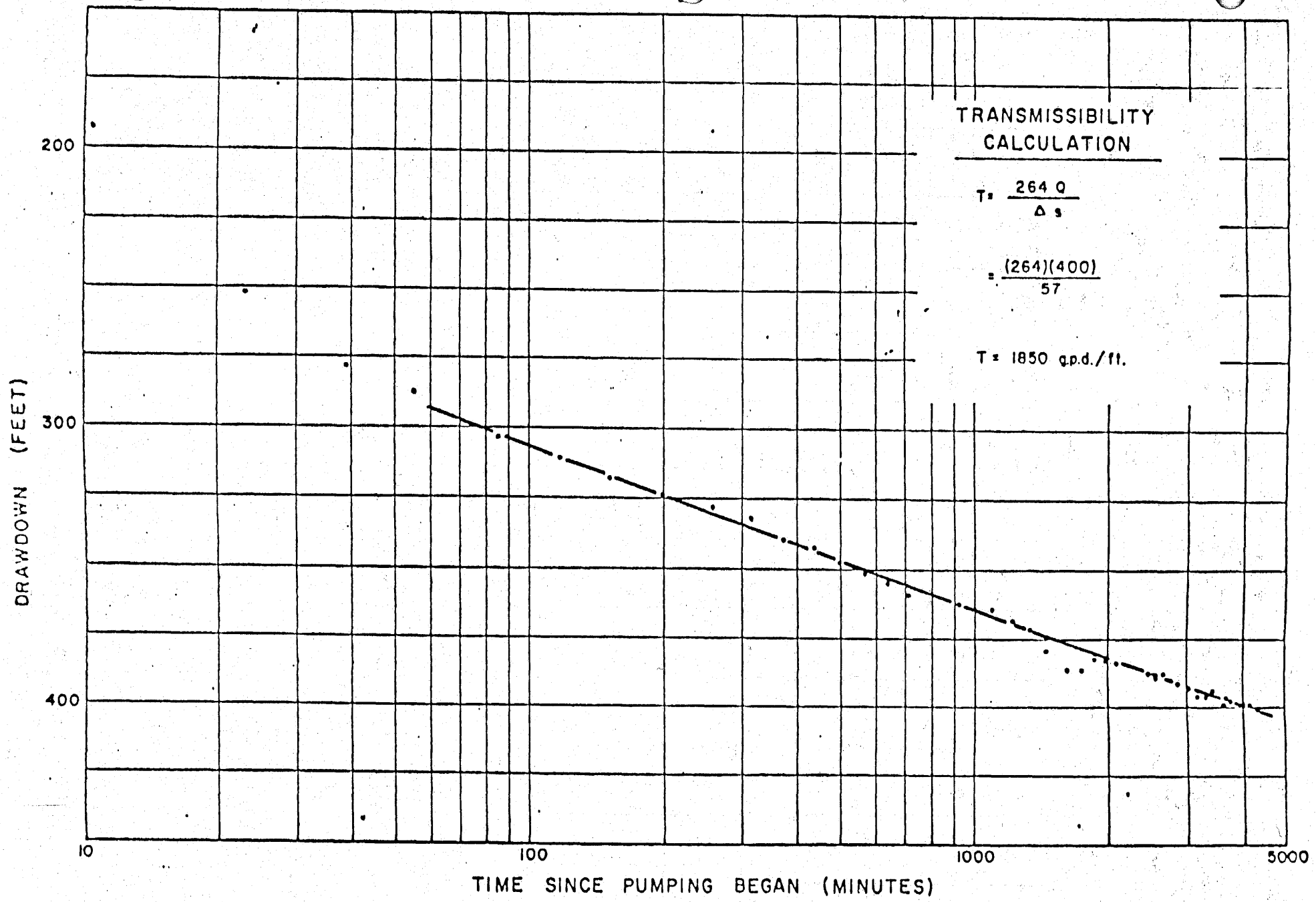
WATER WELL NO. 9 RECORDED BY RW

INTERVAL DEPTH	ROCK TYPES	GSA COLOR	MINERALS	CEMENT MATRIX	GRAIN SIZE	COMMENTS
3500	SS	5YR 5/6	QTZ FLD	CAL	VRY FIN-FIN	SUB RND
			BIOT			

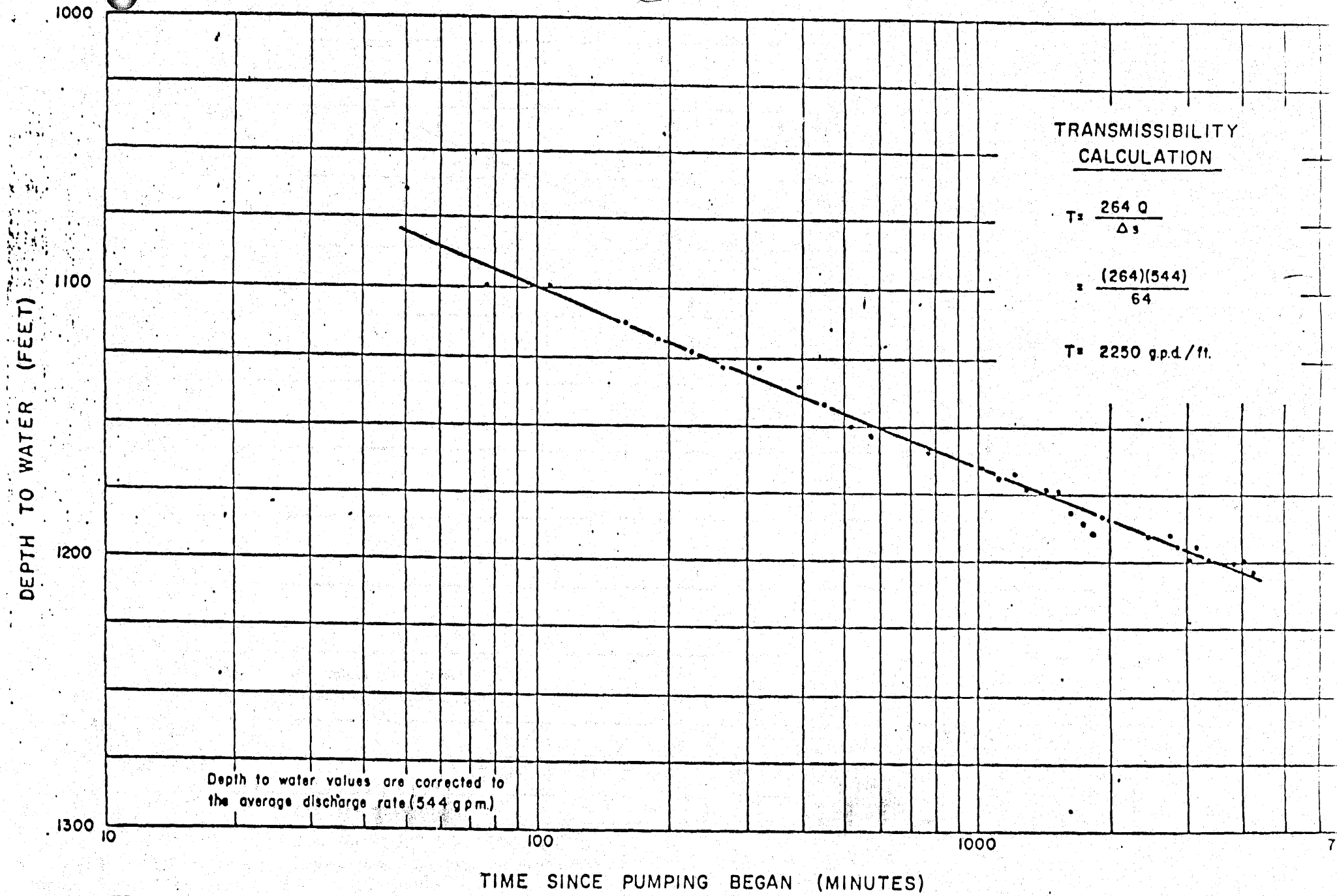
ATTACHMENT 21

Plots of Time-Drawdown Tests for

Navajo Wells 2 through 7

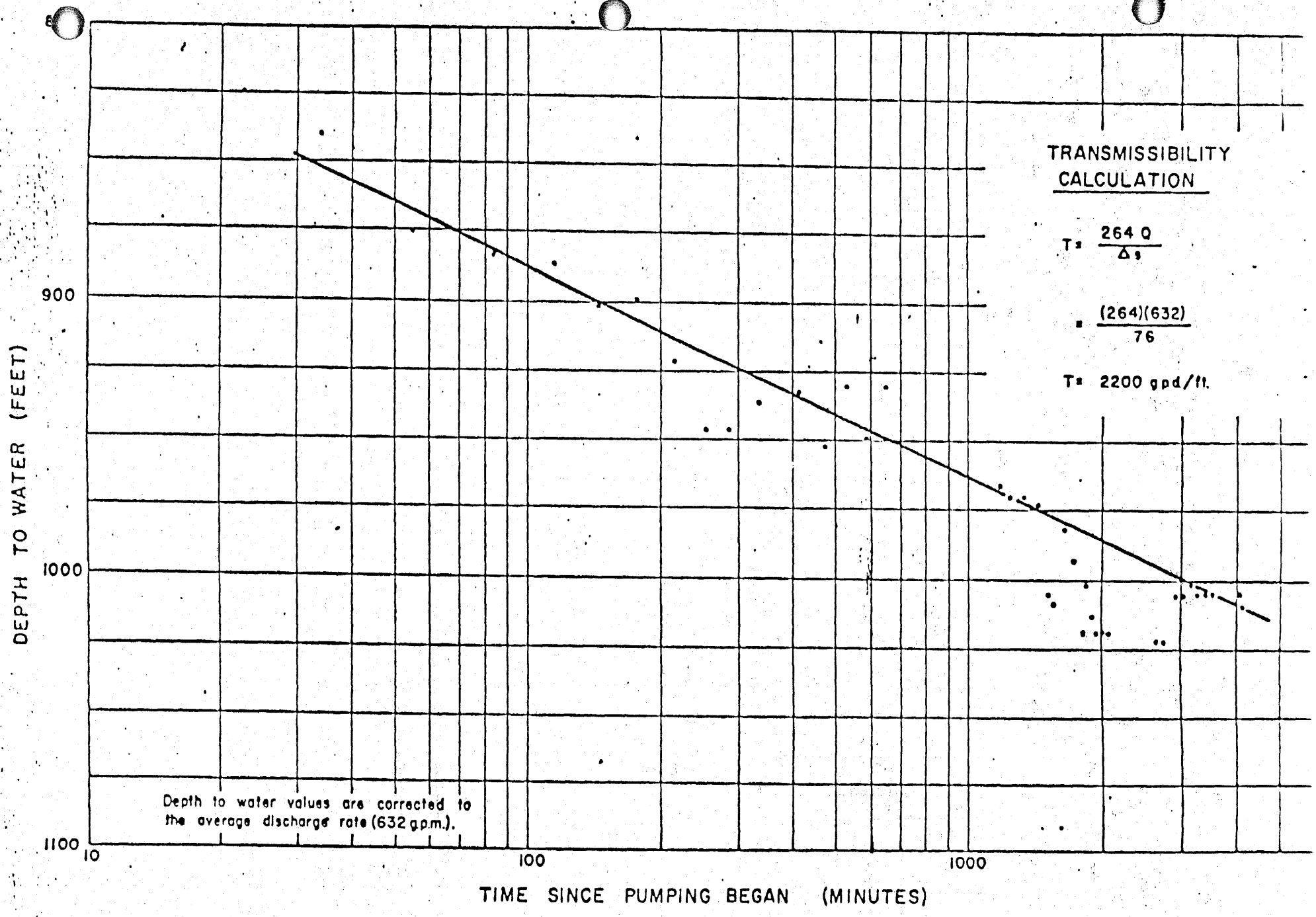


THOMAS M. STETSON CIVIL & CONSULTING ENGINEERS LOS ANGELES - SAN FRANCISCO	NAVAJO 2 WELL TIME-DRAWDOWN CURVE THREE DAY PUMP TEST



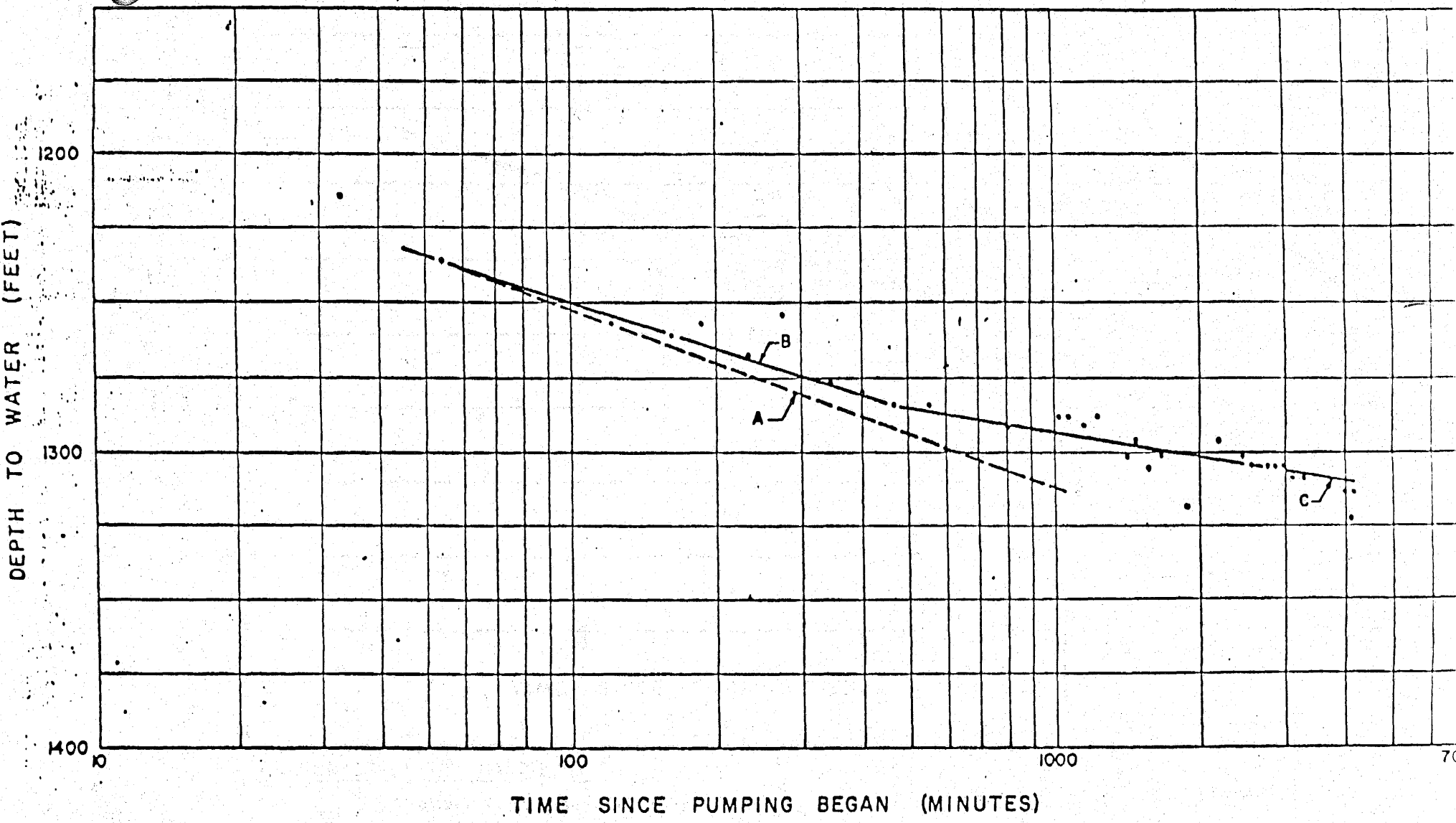
THOMAS M. STETSON
CIVIL & CONSULTING ENGINEERS
LOS ANGELES — SAN FRANCISCO

NAVAJO 3 WELL
TIME-DEPTH TO WATER CURVE



THOMAS M. STETSON
CIVIL & CONSULTING ENGINEERS
LOS ANGELES — SAN FRANCISCO

NAVAJO 4 WELL
TIME-DEPTH TO WATER CURVE
THREE DAY PUMP TEST



TRANSMISSIBILITY CALCULATION

$$T = \frac{264\,Q}{\Delta s}$$

Slope A: $\Delta s = 60$, $T = 2400$ g.p.d./ft.

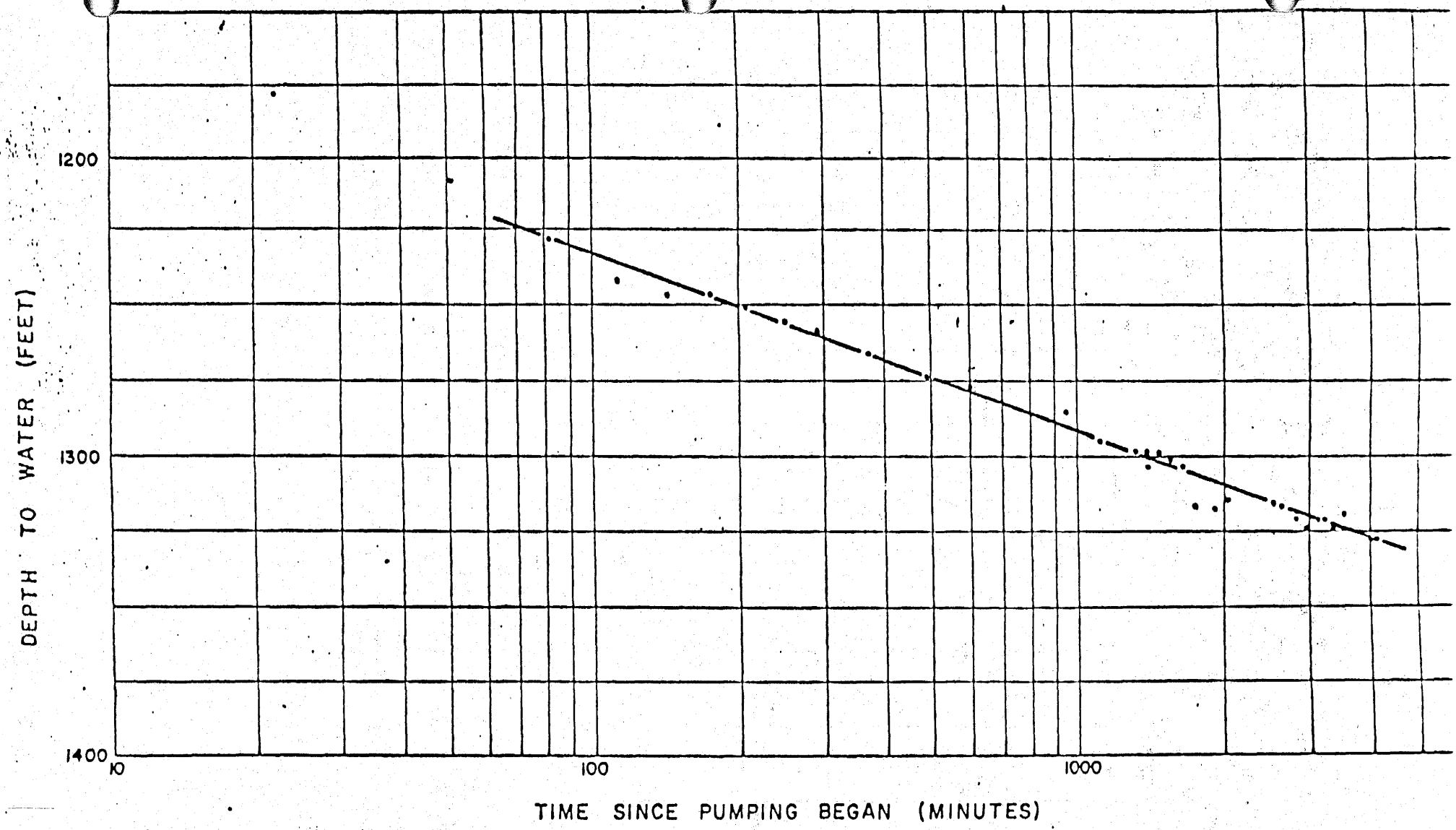
Slope B: $\Delta s = 52$, $T = 2800$ g.p.d./ft.

Slope C: $\Delta s = 27$, $T = 5300$ g.p.d./ft.

Depth to water values are corrected to the average discharge rate (545 g.p.m.).

NAVAJO 5 WELL
TIME-DEPTH TO WATER CURVE
THREE DAY PUMP TEST

THOMAS M. STETSON
CIVIL & CONSULTING ENGINEERS
LOS ANGELES — SAN FRANCISCO



TRANSMISSIBILITY CALCULATION

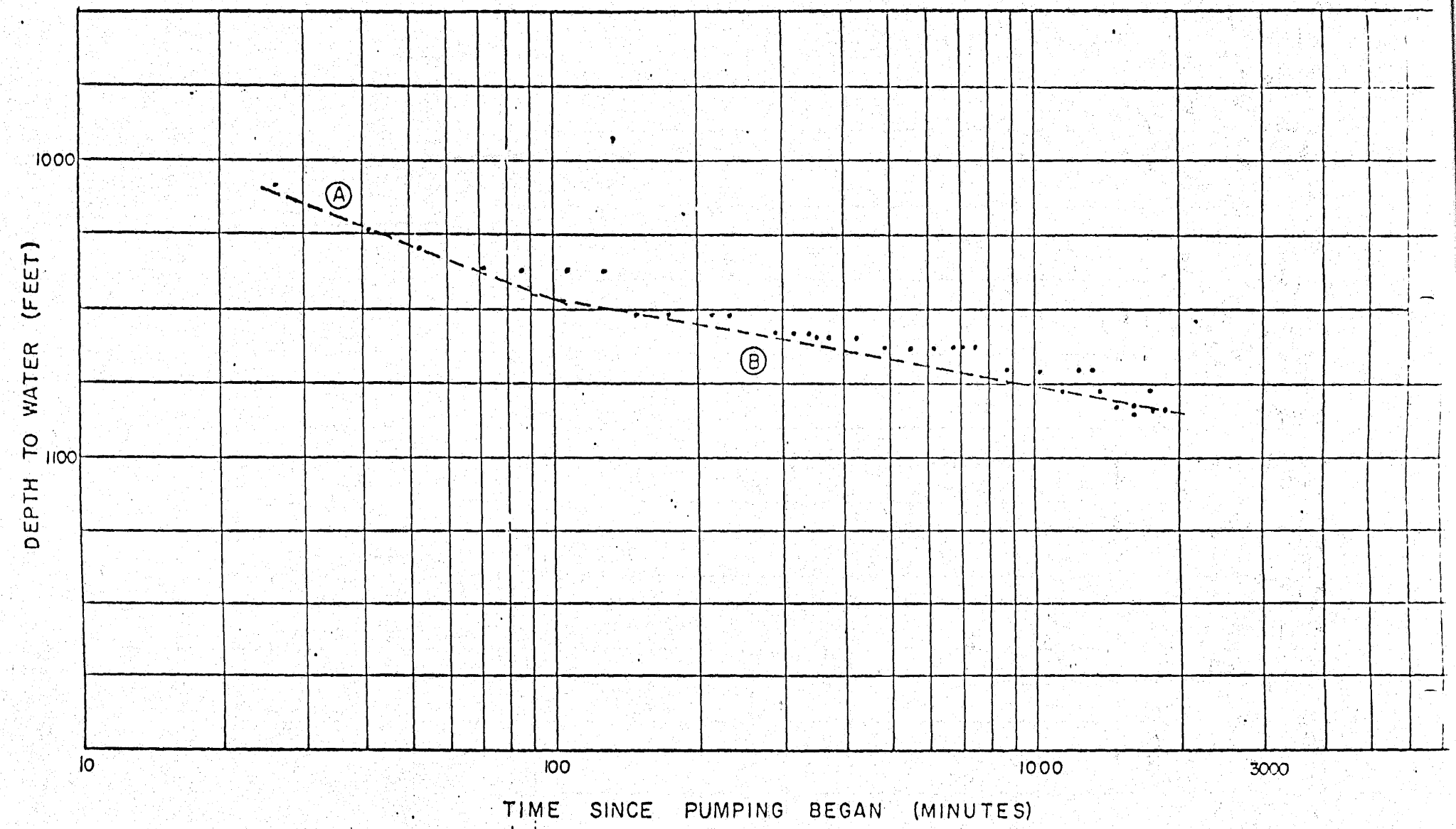
$$T = \frac{264\,Q}{\Delta s} = \frac{(264)(525)}{60}$$

T = 2300 gpd/ft.

Depth to water values are corrected to the average discharge rate (525 gpm).

NAVAJO 6 WELL
TIME-DEPTH TO WATER CURVE
THREE DAY PUMP TEST

THOMAS M. STETSON
CIVIL & CONSULTING ENGINEERS
LOS ANGELES — SAN FRANCISCO



TRANSMISSIBILITY CALCULATION

$T = \frac{264\ Q}{\Delta s}$

Slope A: Q = 561 gpm; Δs = 60; T = 2500 gpd/ft.

Slope B: Q = 557 gpm; Δs = 29; T = 5100 gpd/ft.

Depth to water values were calculated from adjusted pressure Sentry System readings.

NAVAJO 7 WELL

TIME - DEPTH TO WATER CURVE

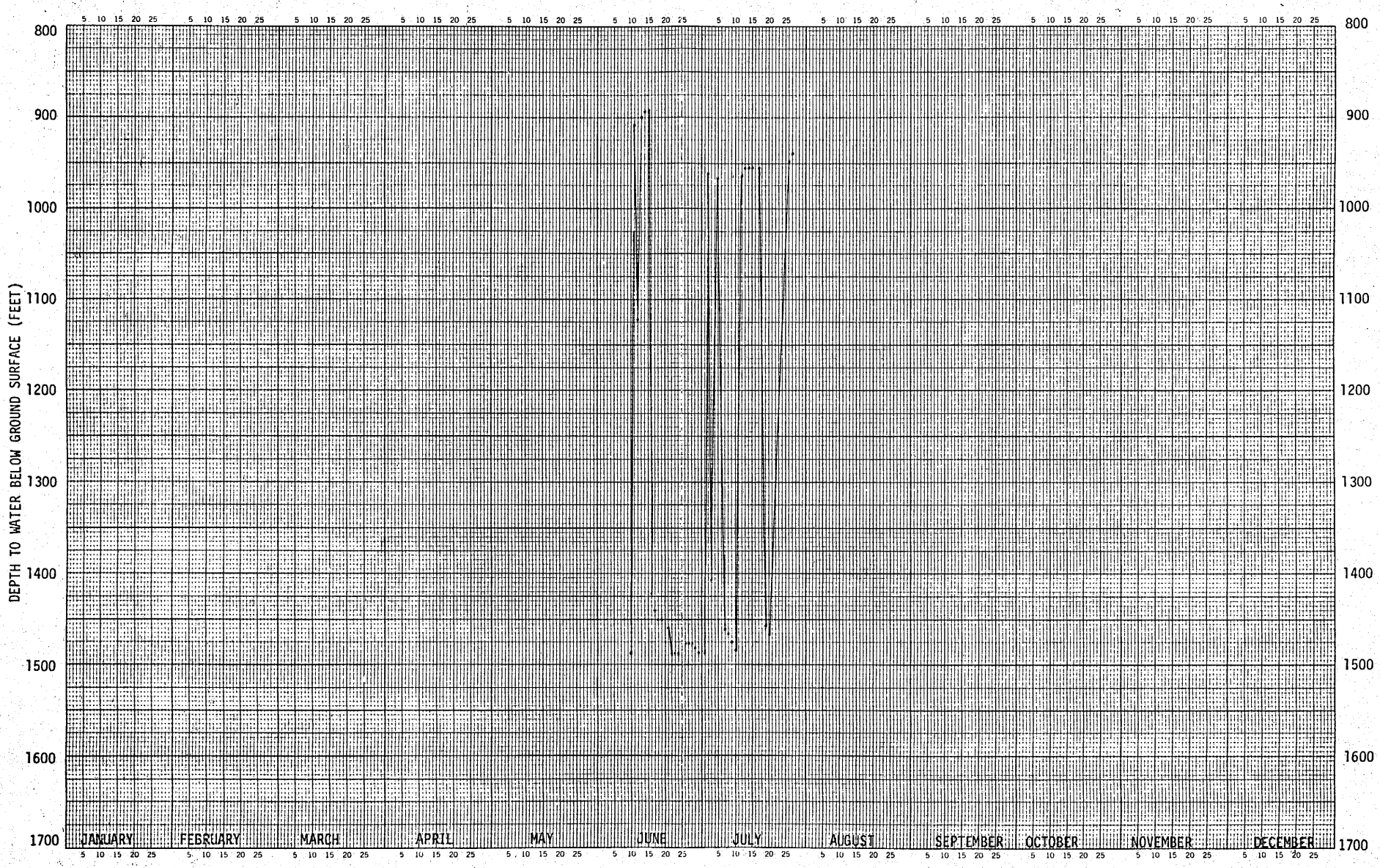
THOMAS M. STETSON

CIVIL & CONSULTING ENGINEERS

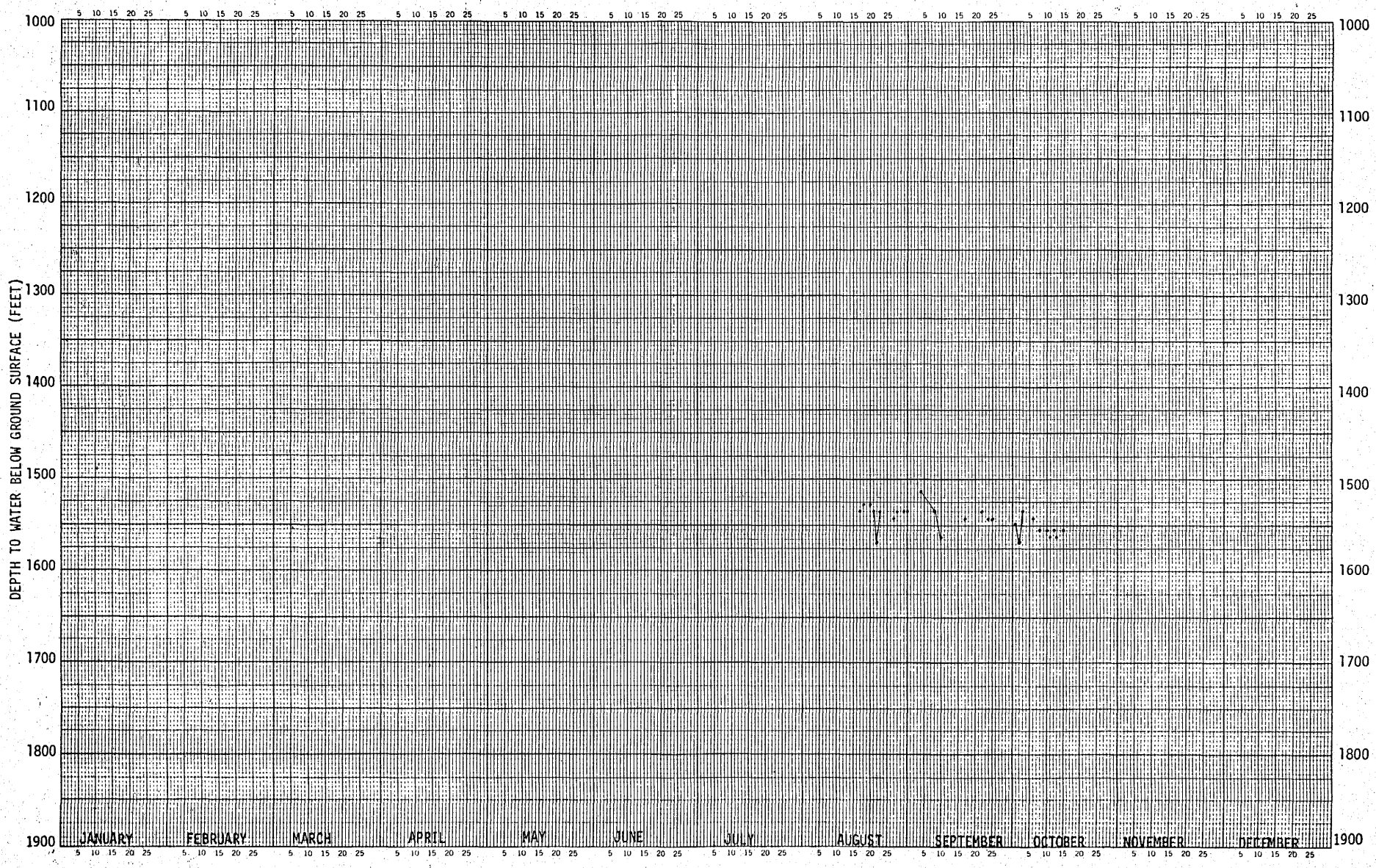
LOS ANGELES REDLANDS SAN FRANCISCO

ATTACHMENT 22

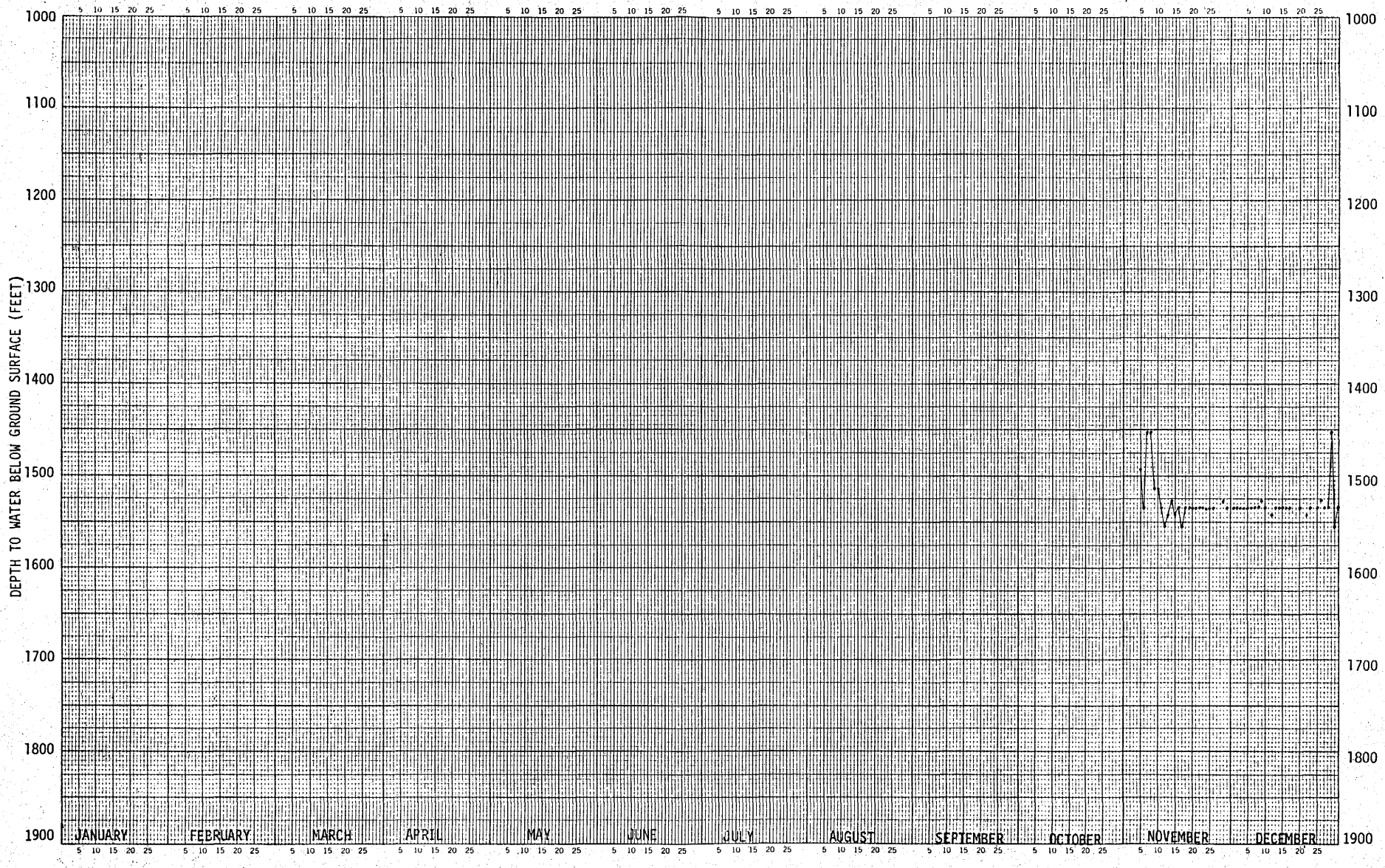
Navajo Well Drawdown History



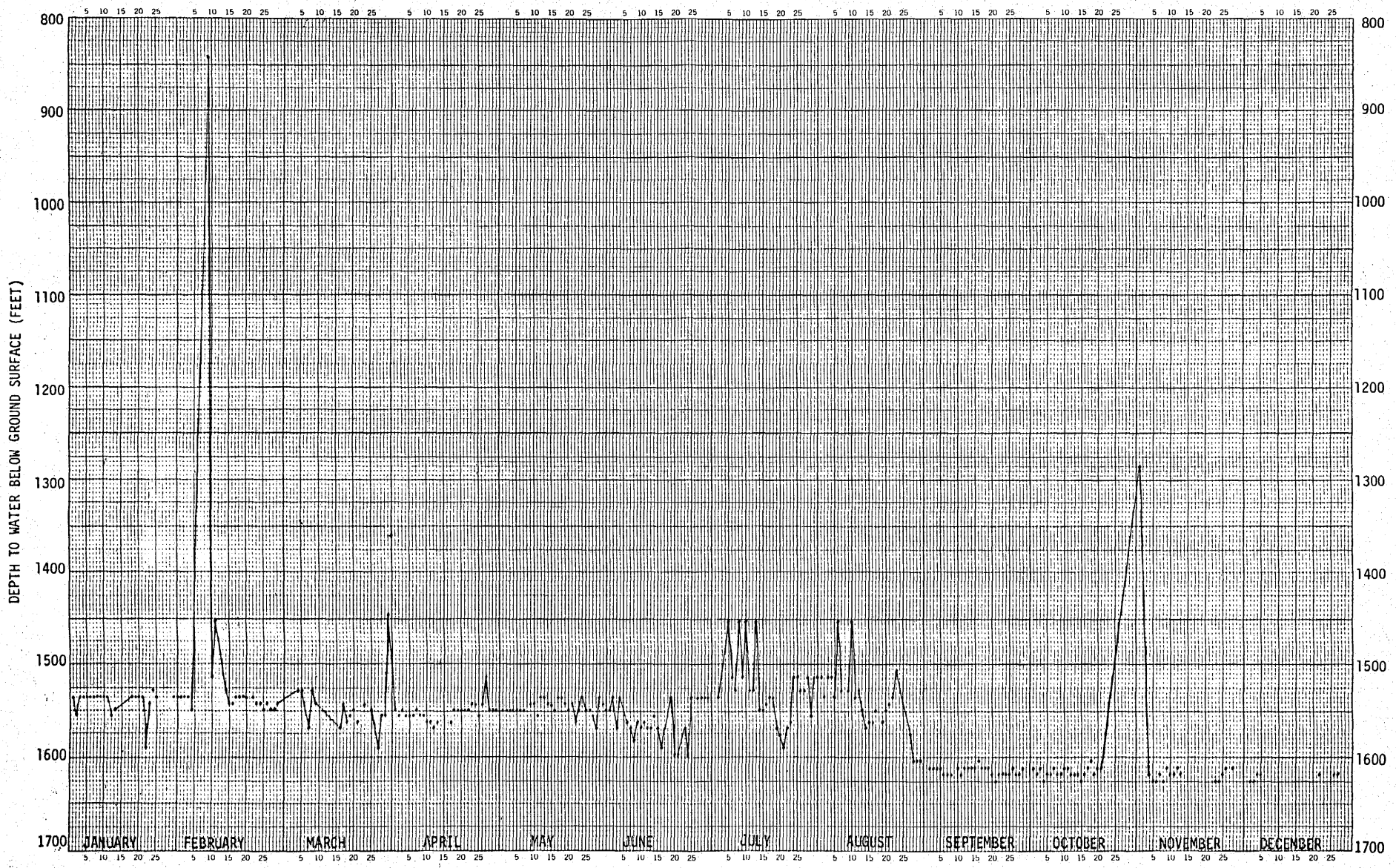
NAVAJO WELL #2, 1971



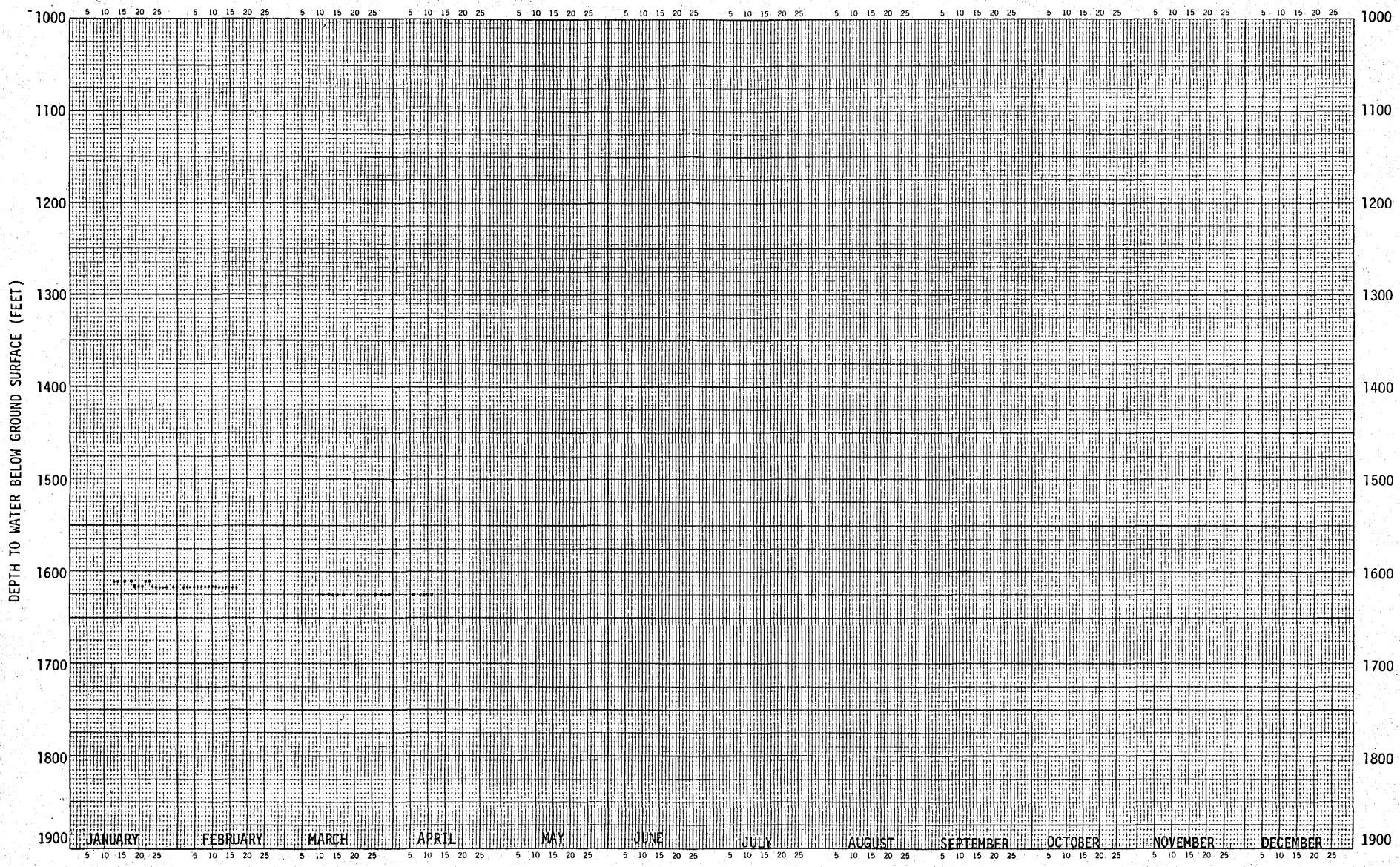
NAVAJO WELL #2, 1973



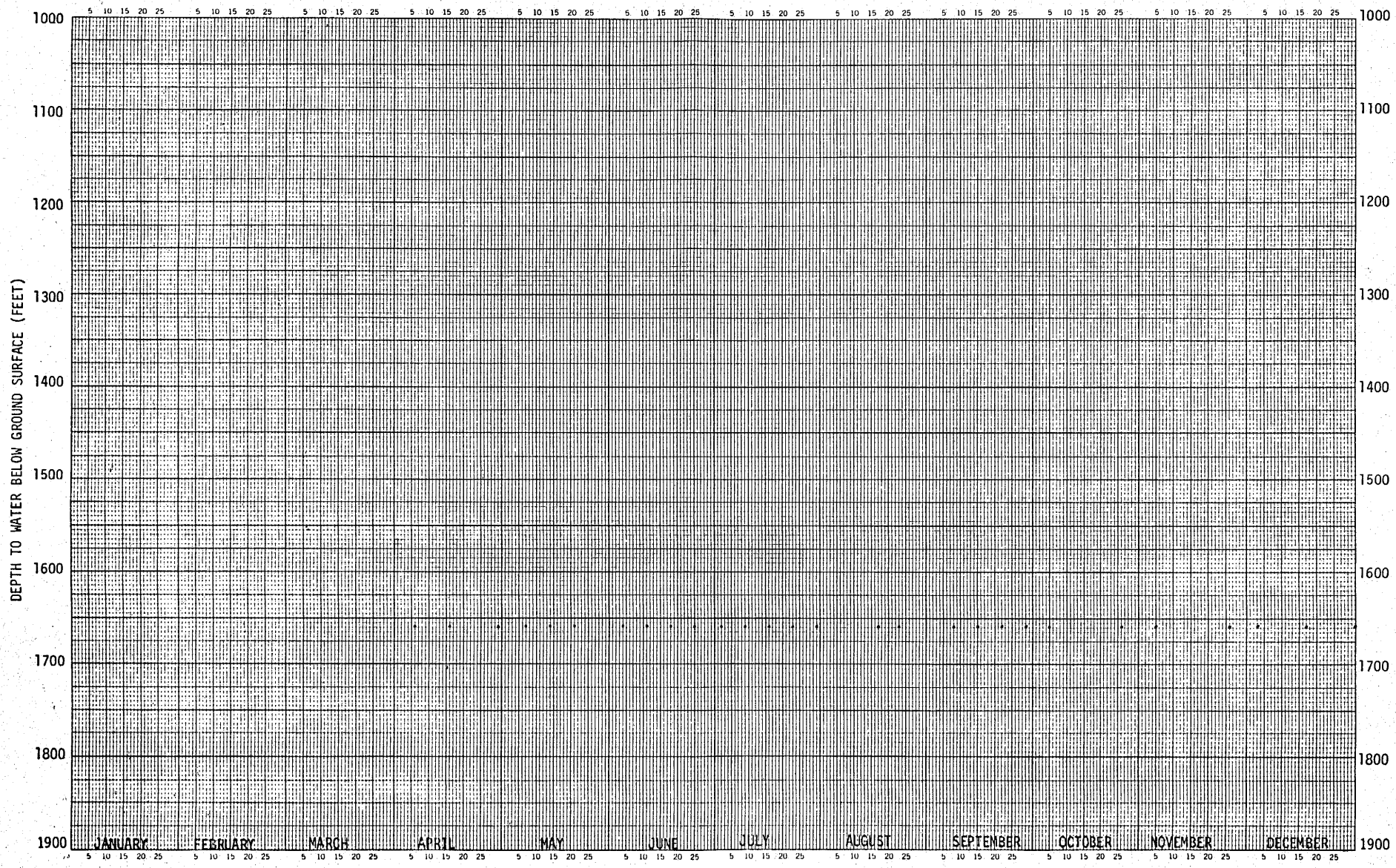
NAVAJO WELL #2, 1975



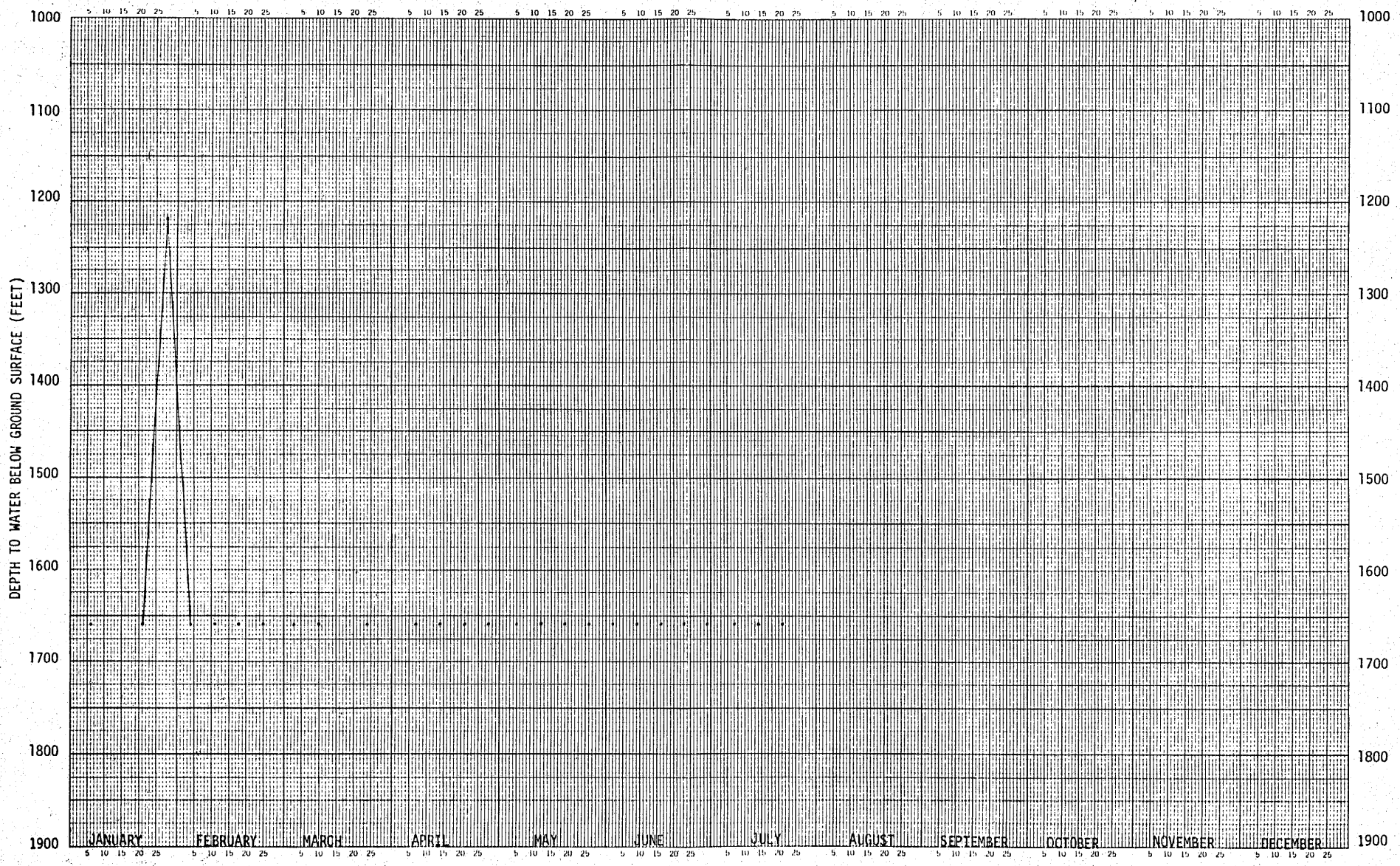
NAVAJO WELL #2, 1976



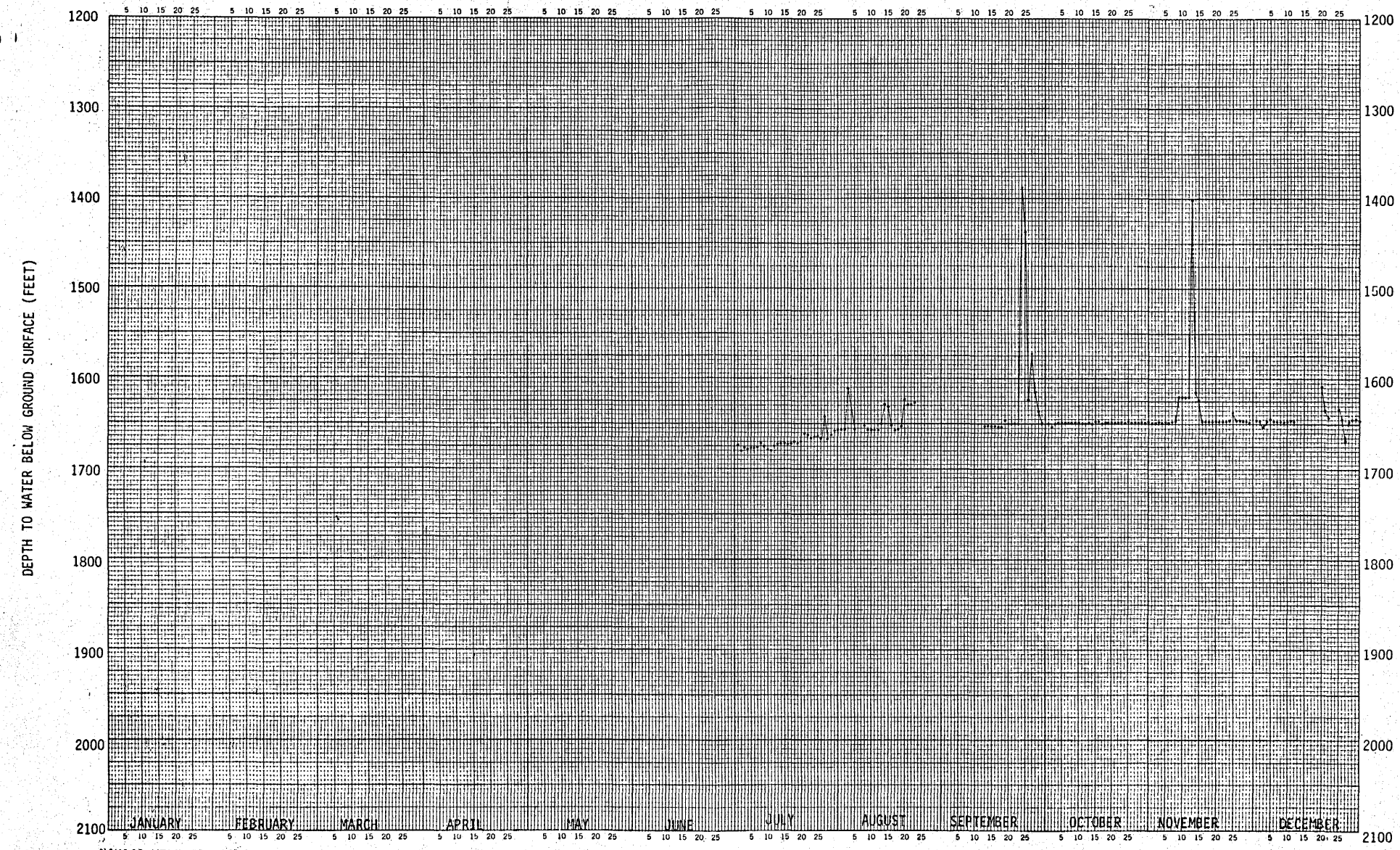
NAVAJO WELL #2, 1977



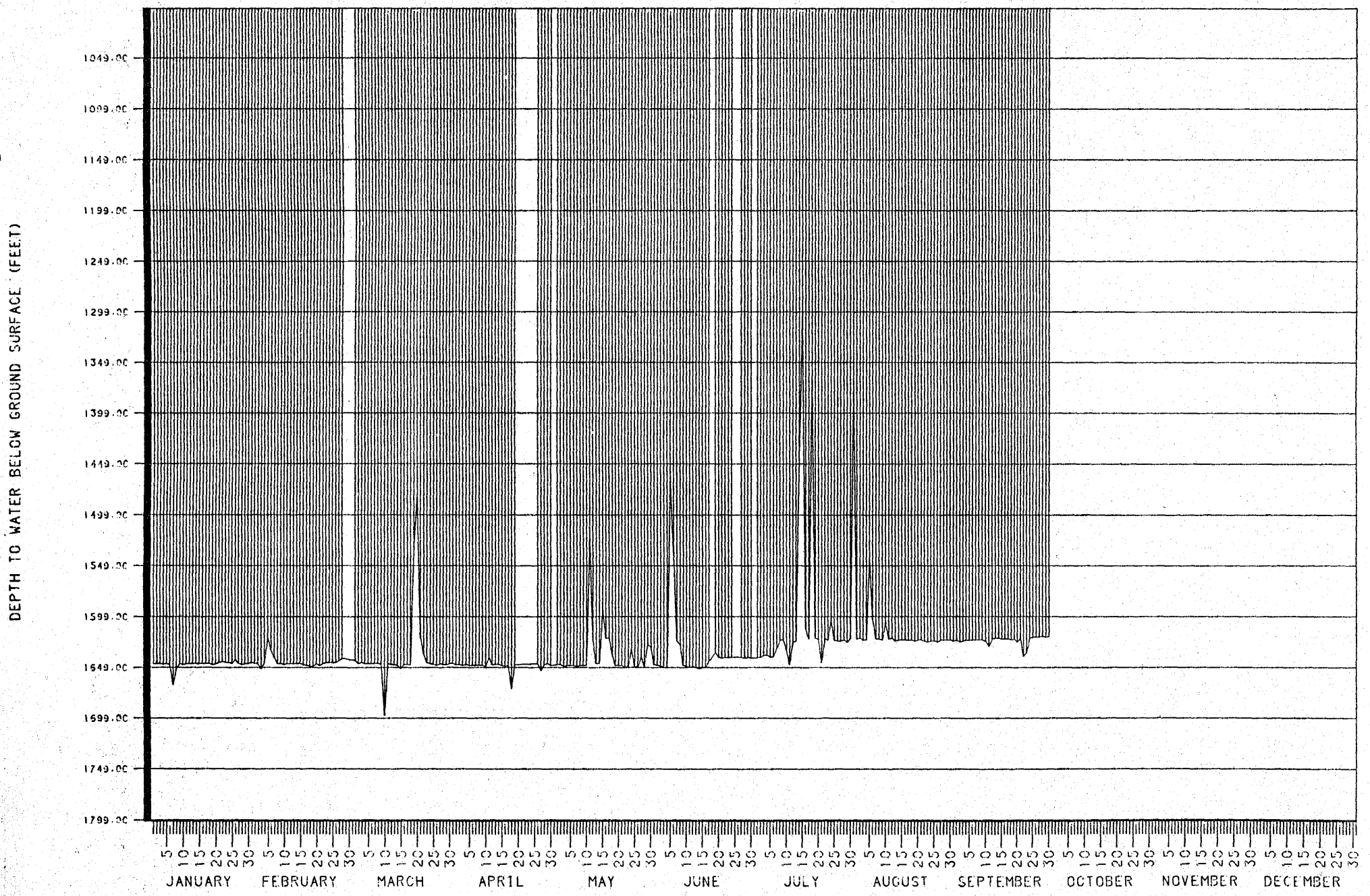
NAVAJO WELL #2, 1979



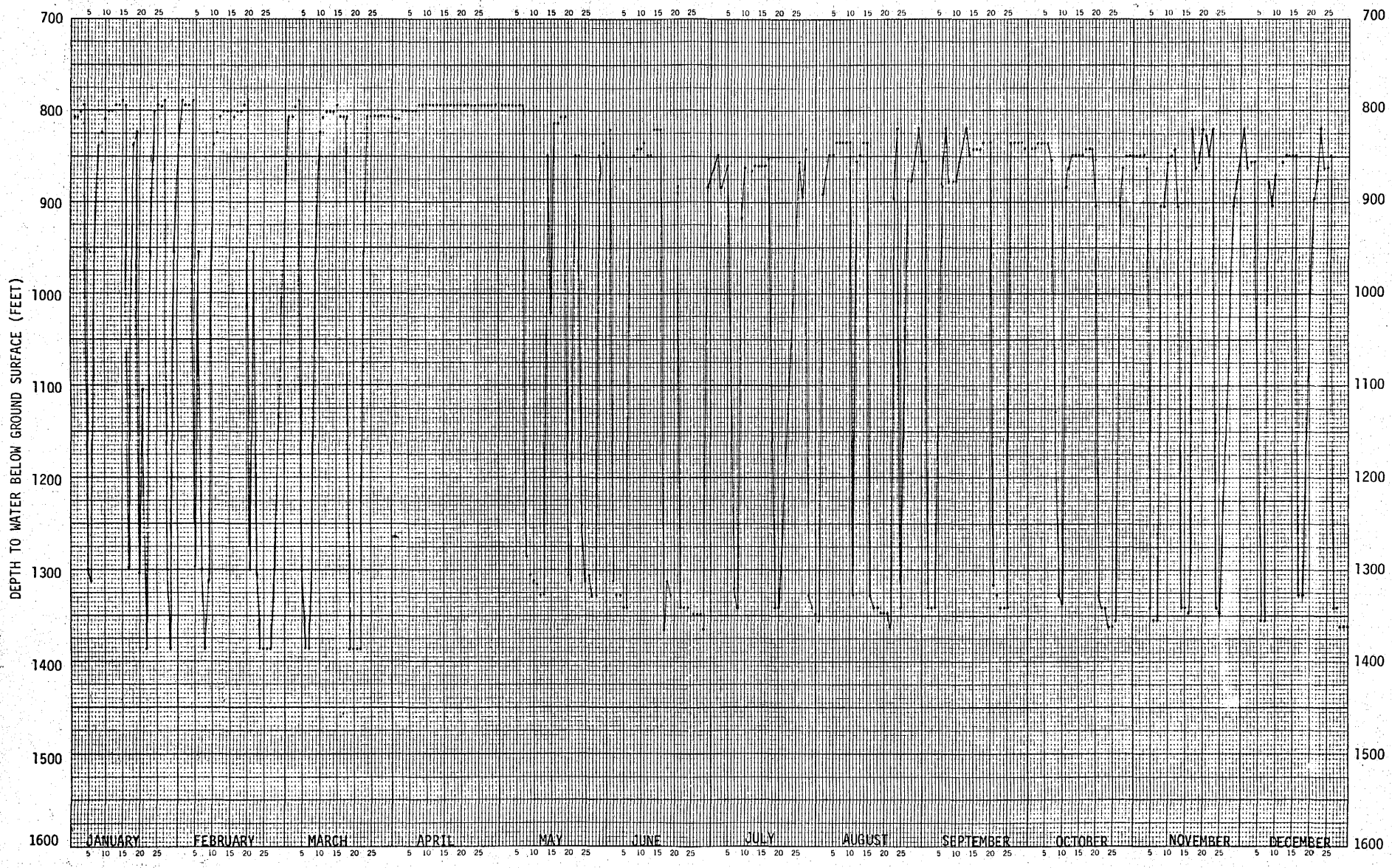
NAVAJO WELL #2, 1980



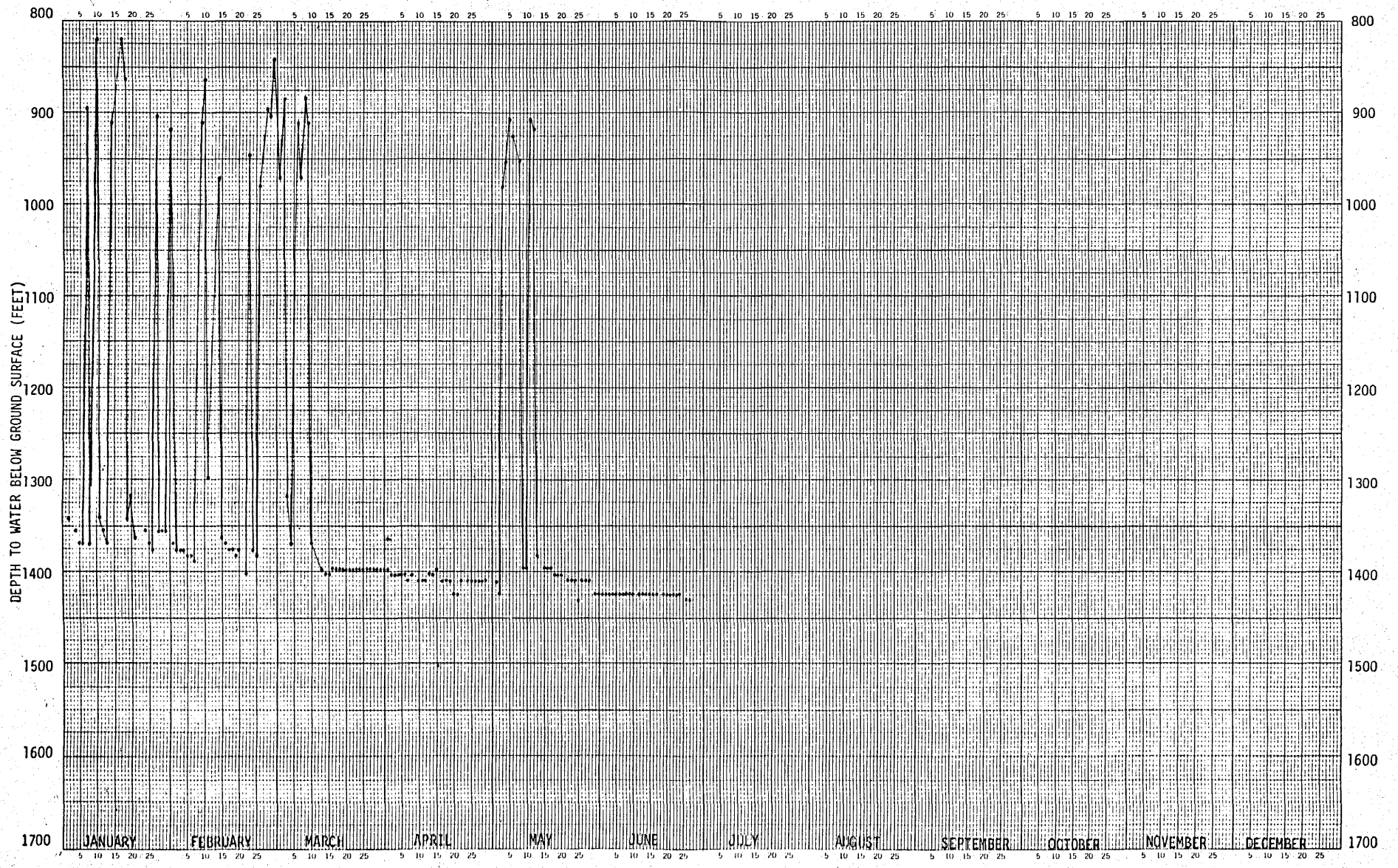
NAVAJO WELL #2, 1984



NAVAJO WELL #2,1985



NAVAJO WELL #3, 1971



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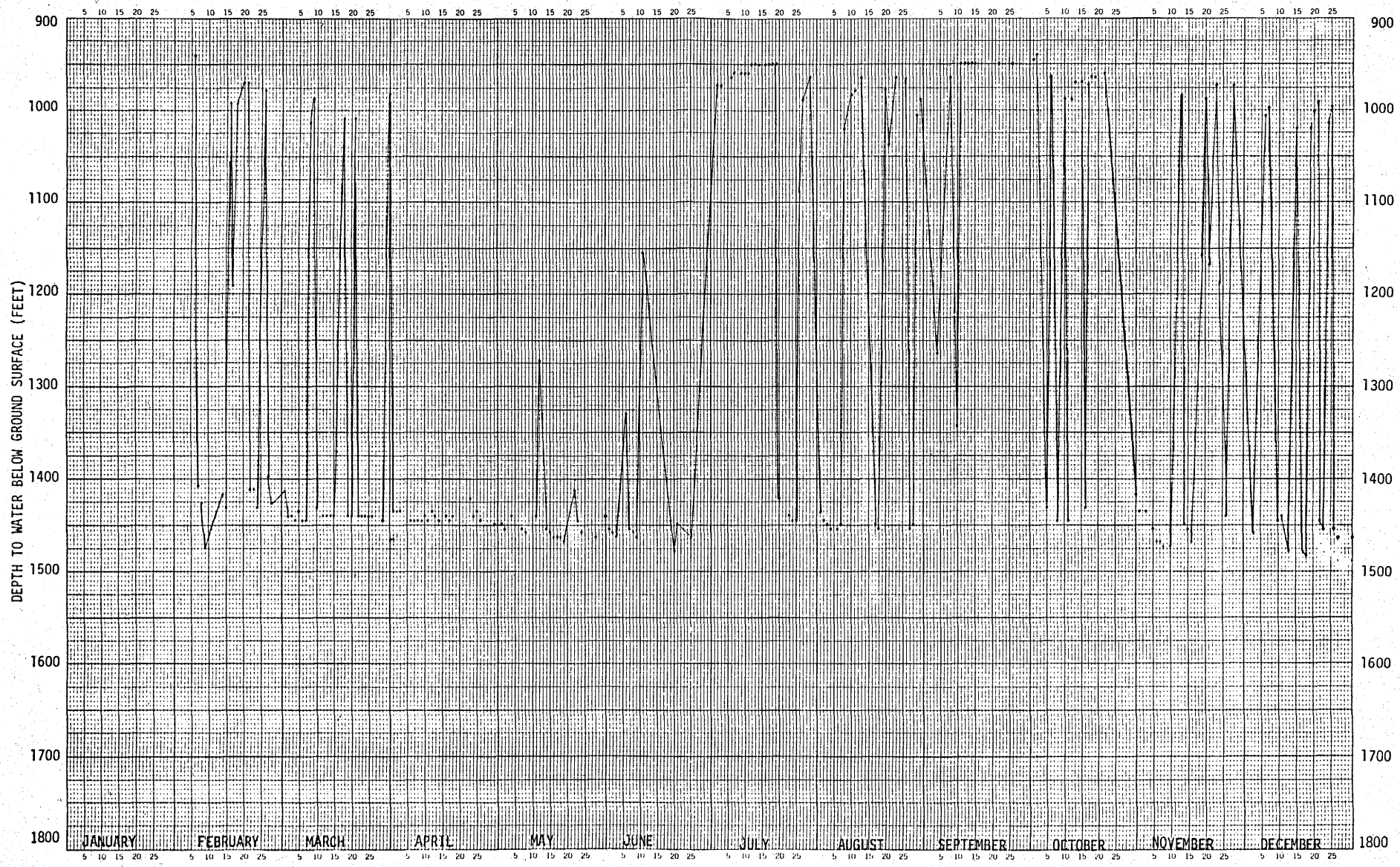
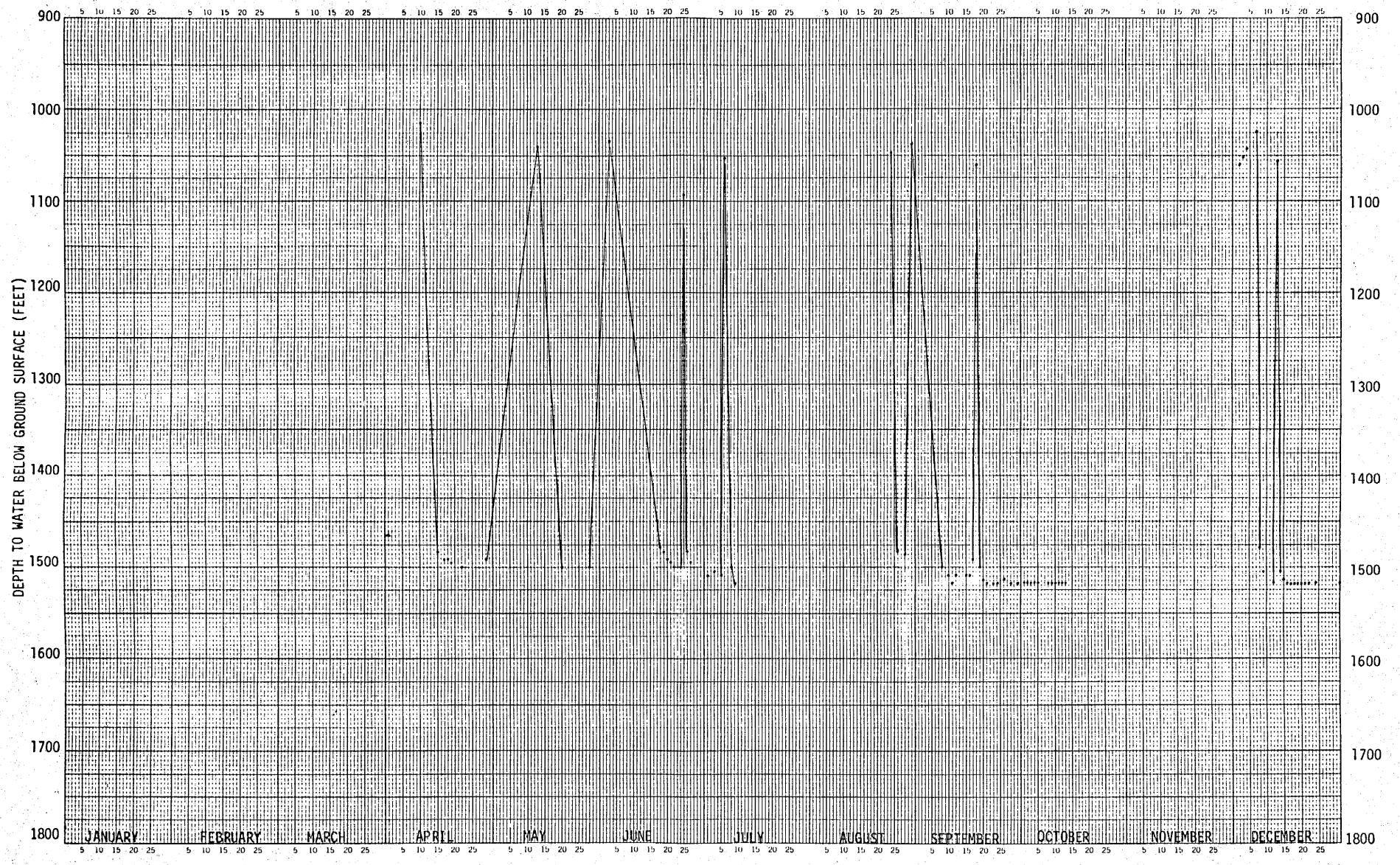
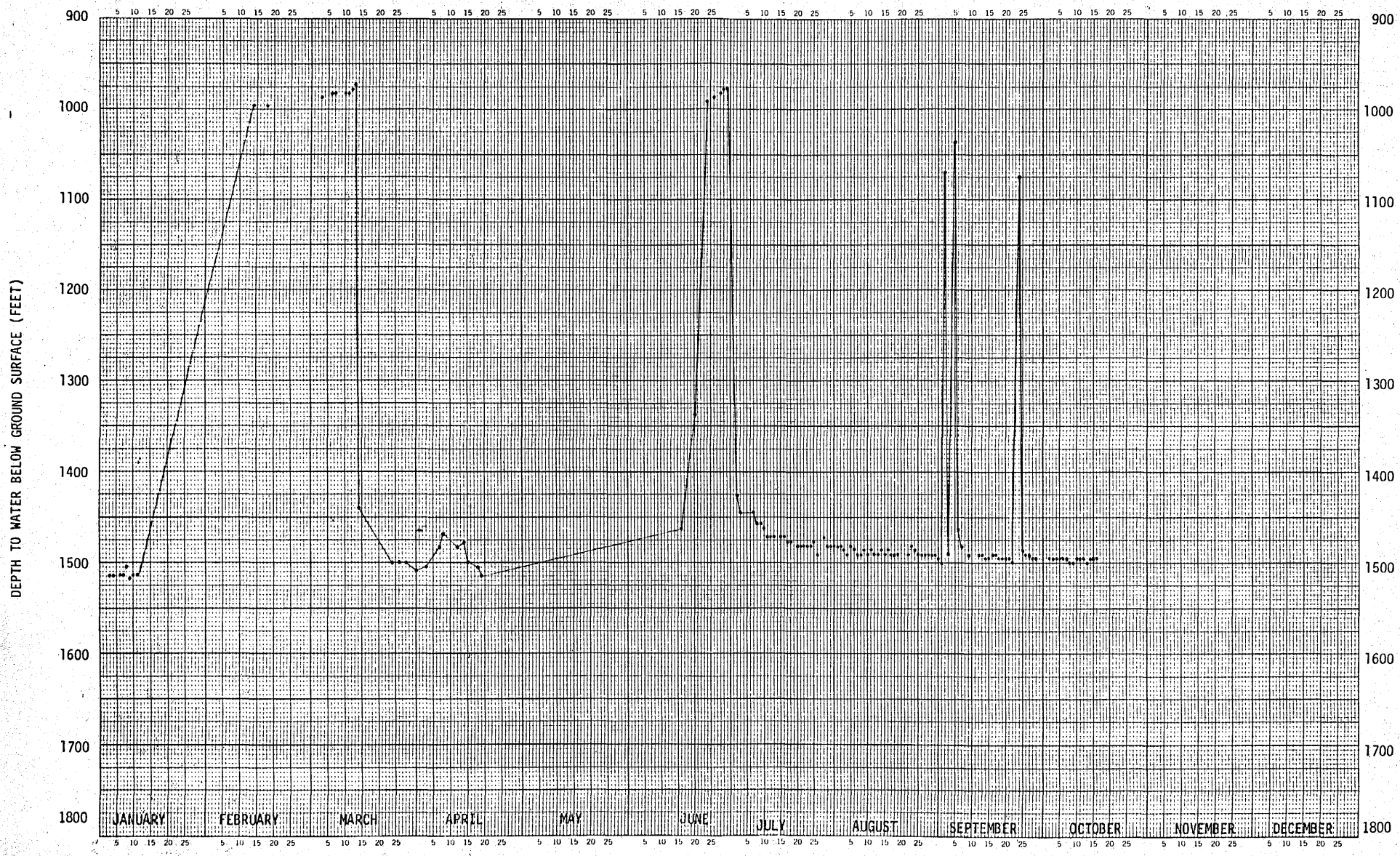


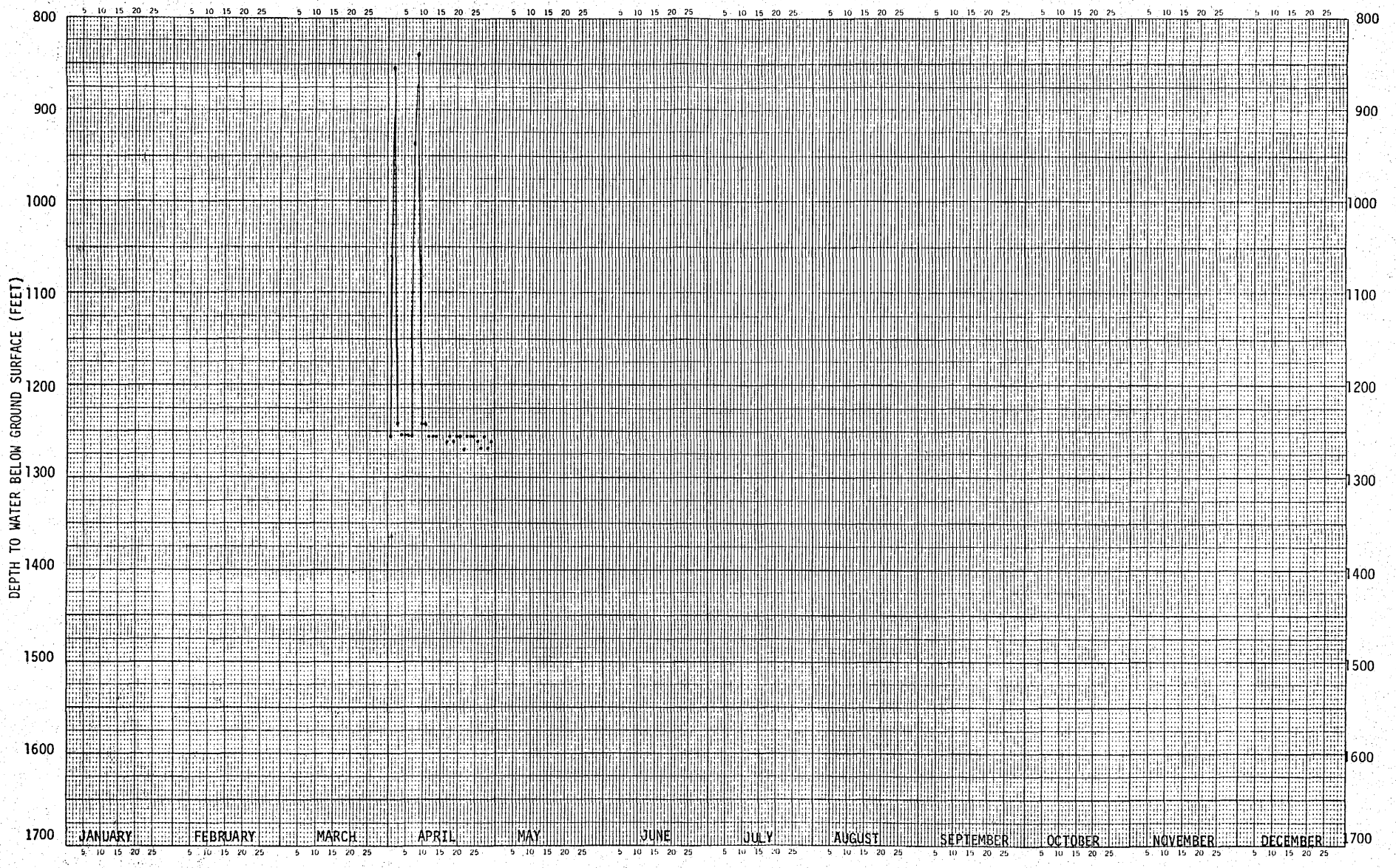
NAVAJO WELL #3, 1973



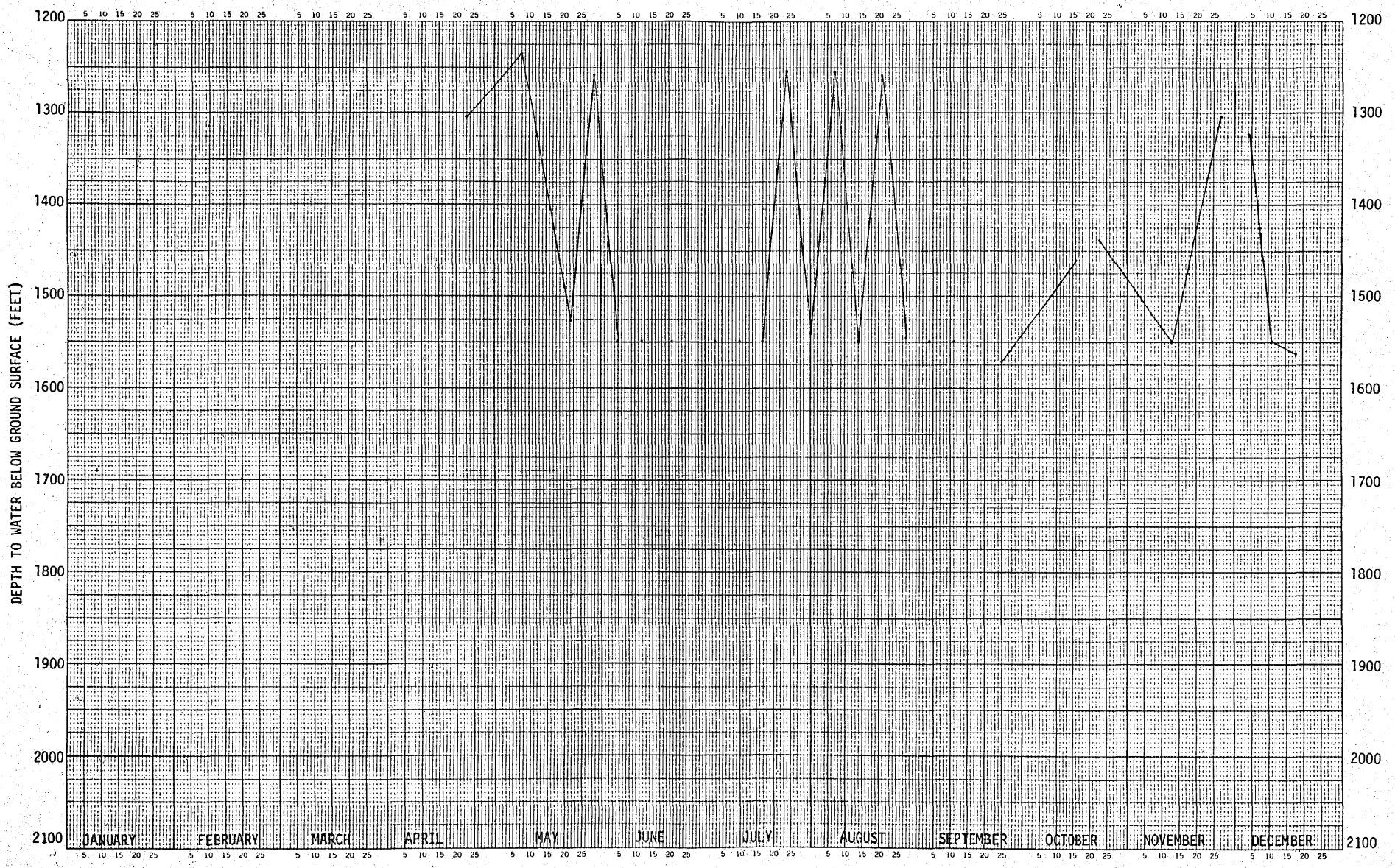
NAVAJO WELL #3, 1974



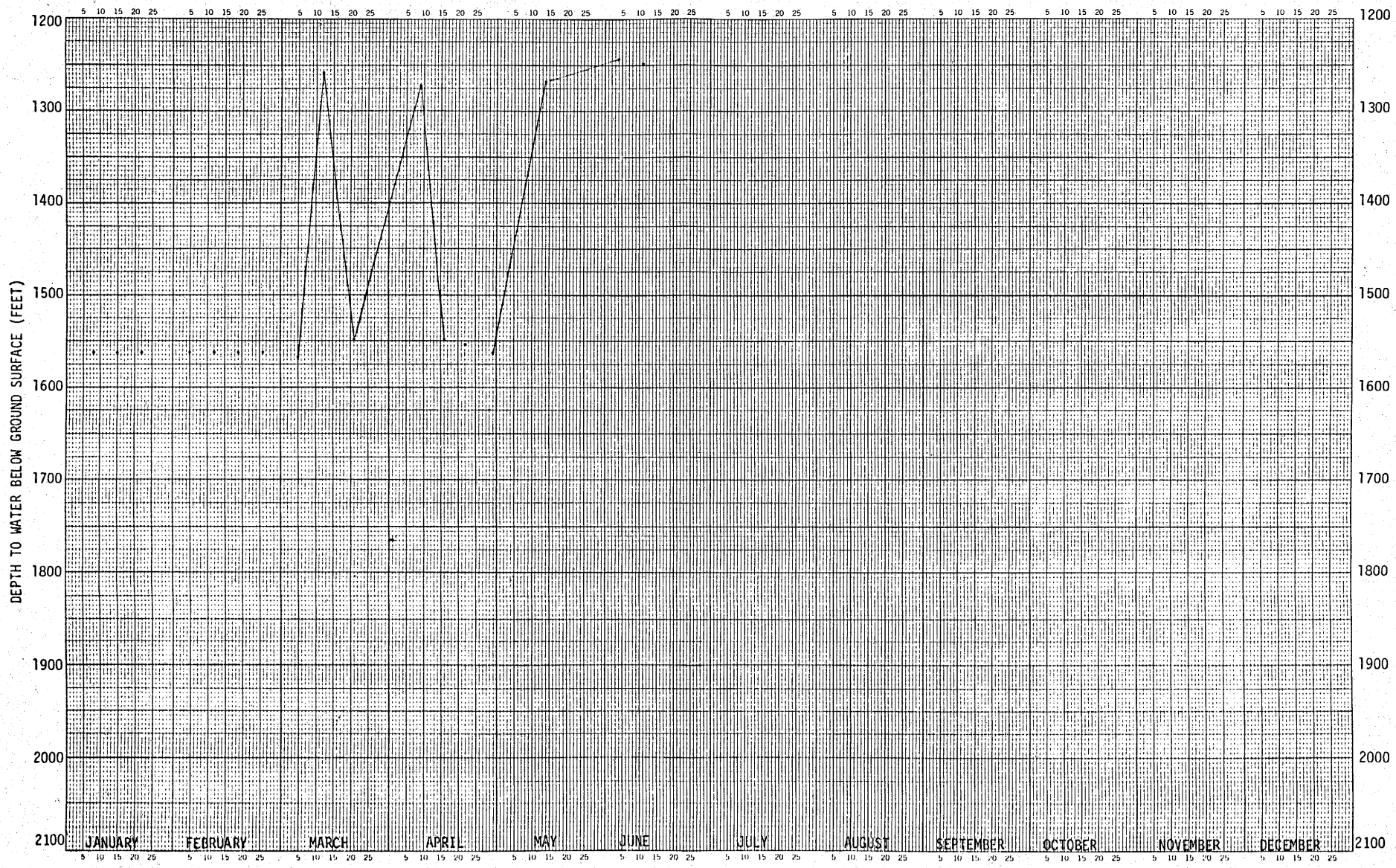
NAVAJO WELL #3, 1975



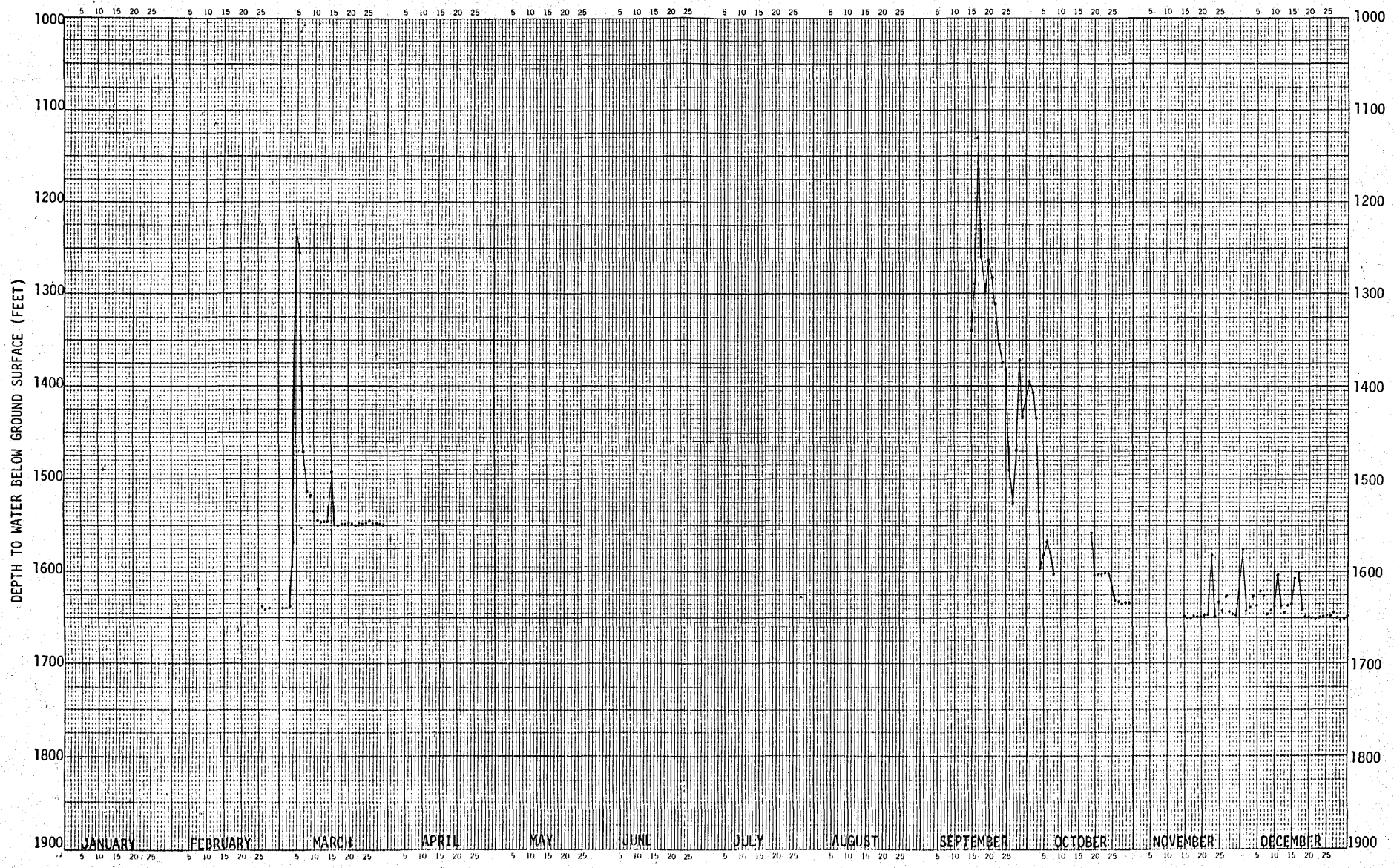
NAVAJO WELL #3, 1976



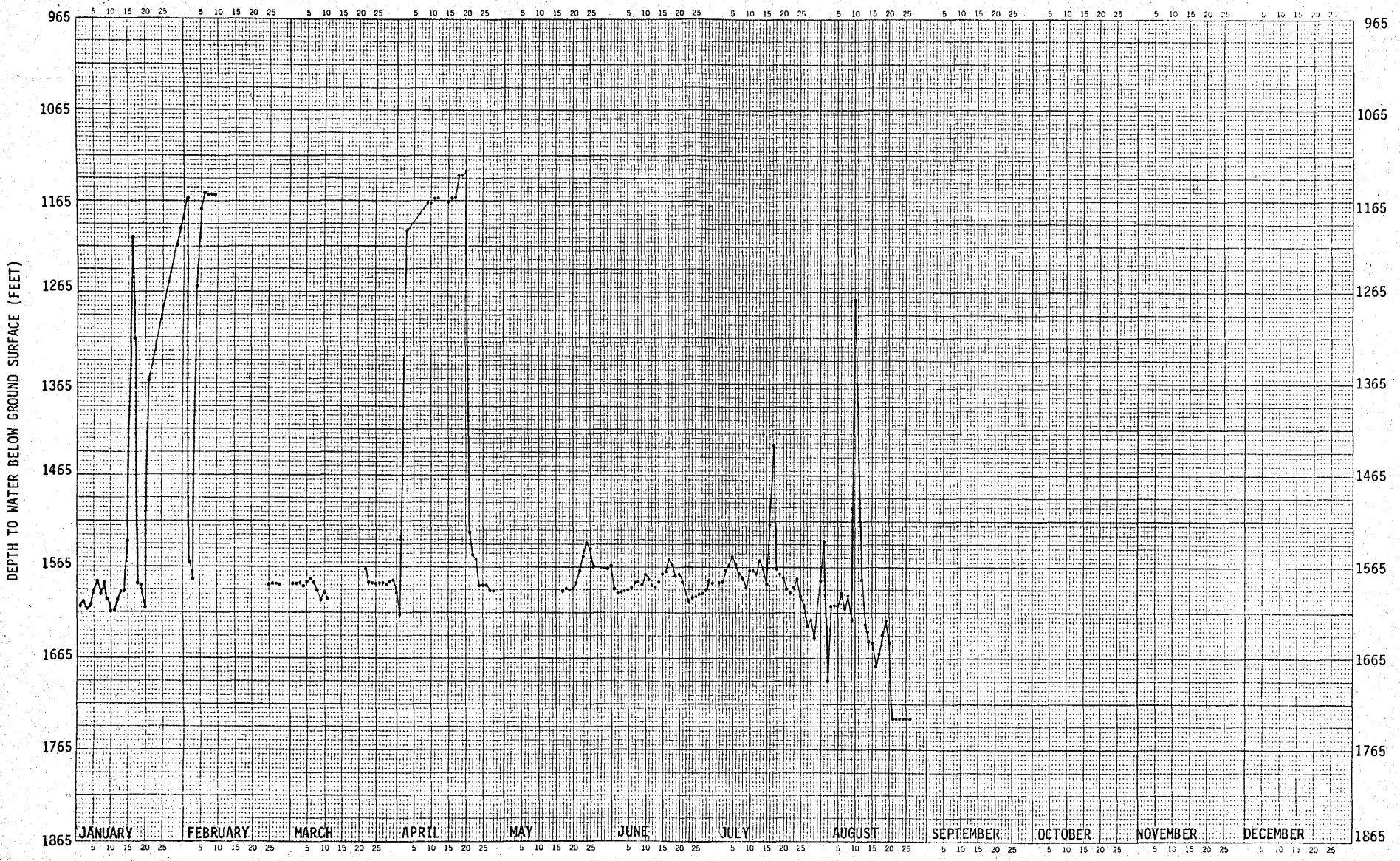
NAVAJO WELL #3, 1978



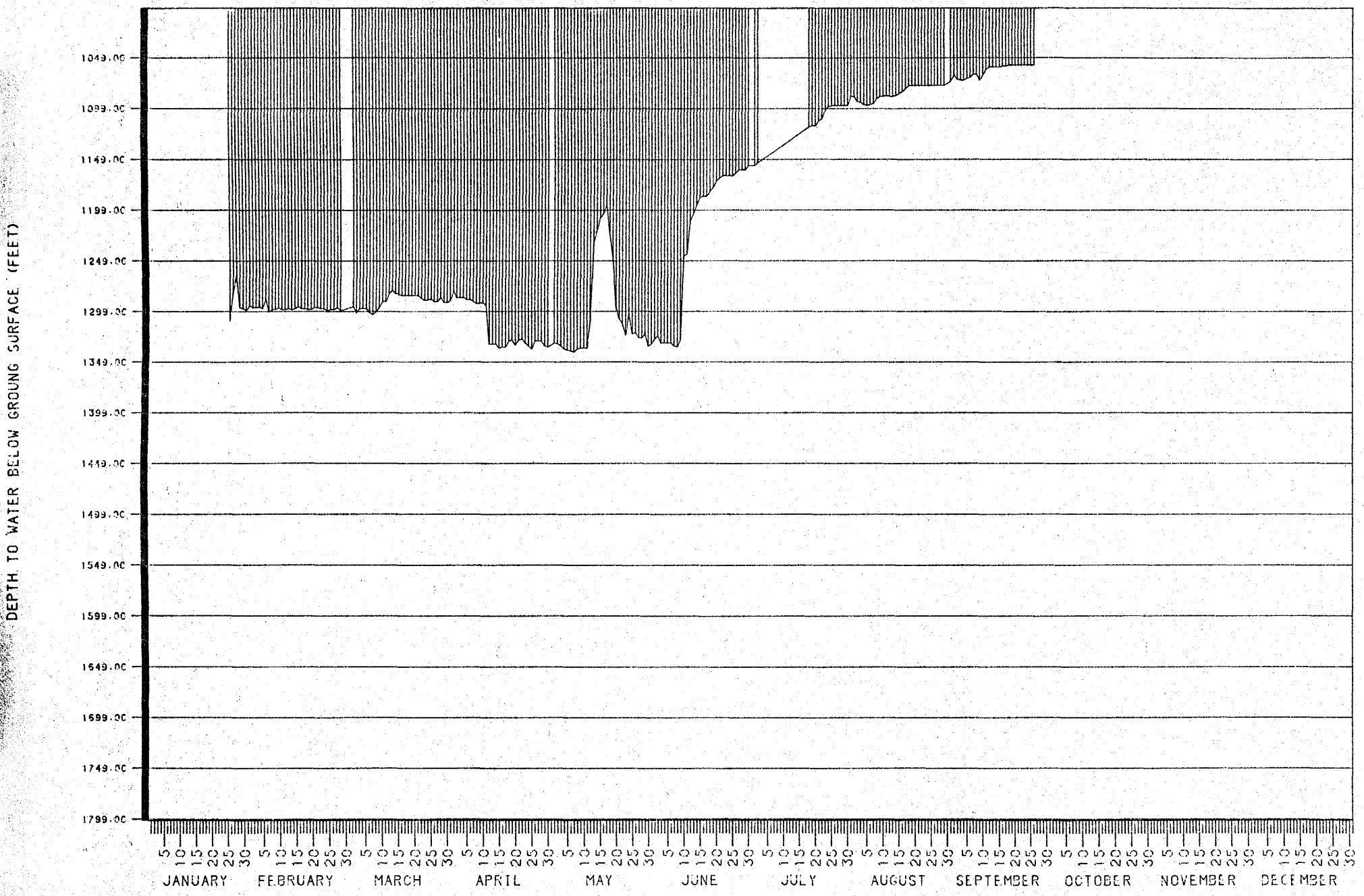
NAVAJO WELL #3, 1979



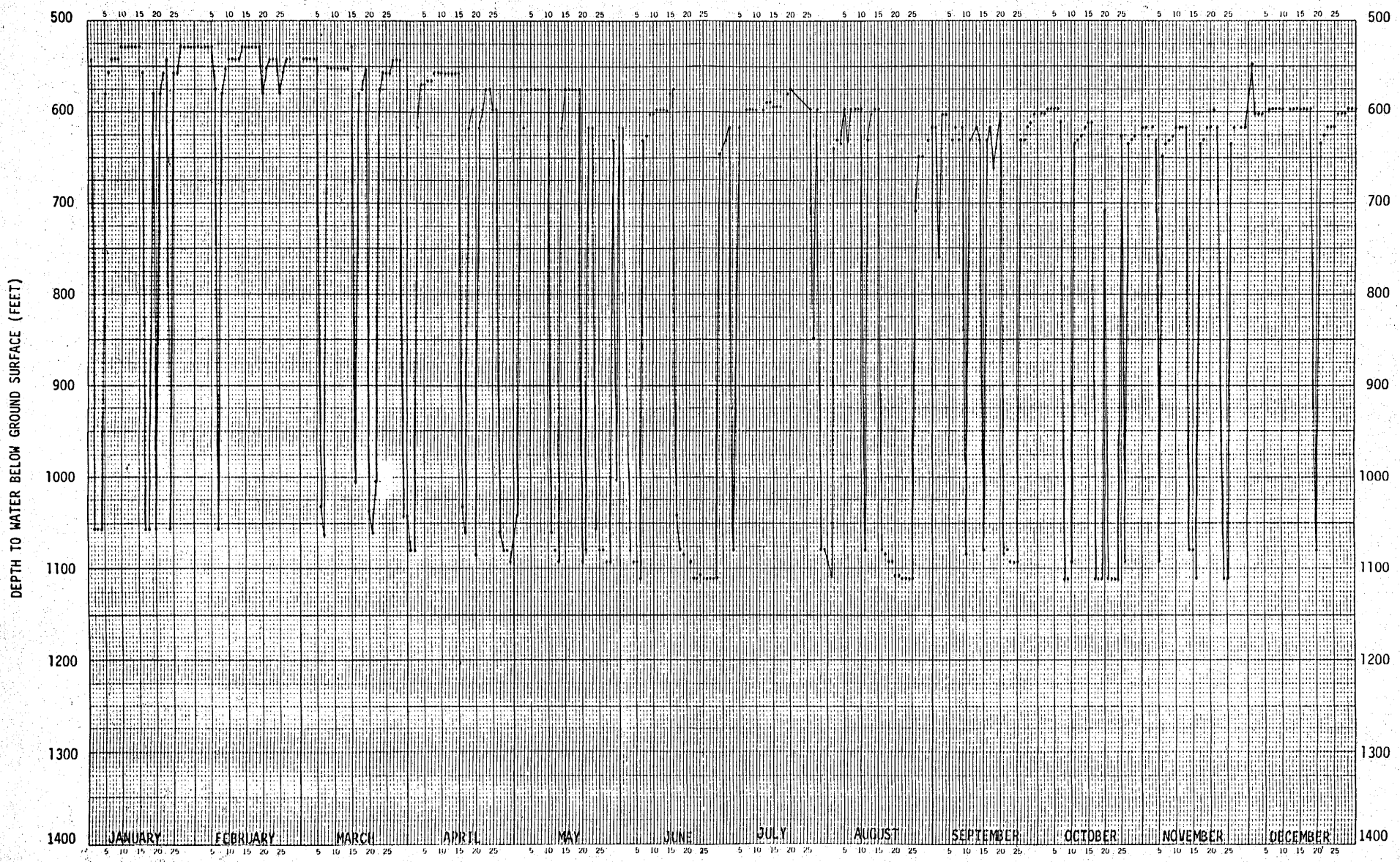
NAVAJO WELL #3, 1982



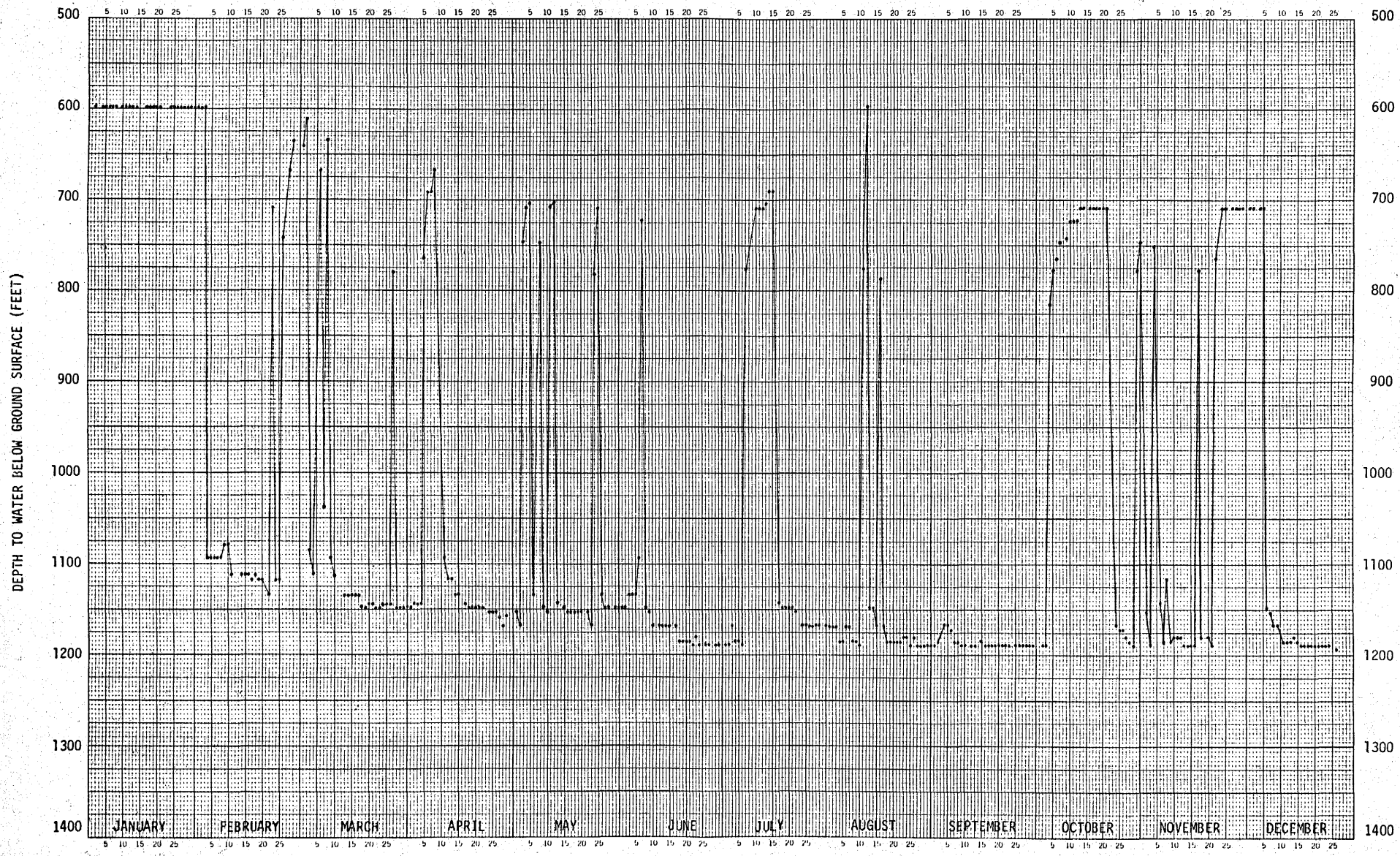
NAVAJO #3, 1983



NAVAJO WELL #3,1985



NAVAJO WELL #4, 1971



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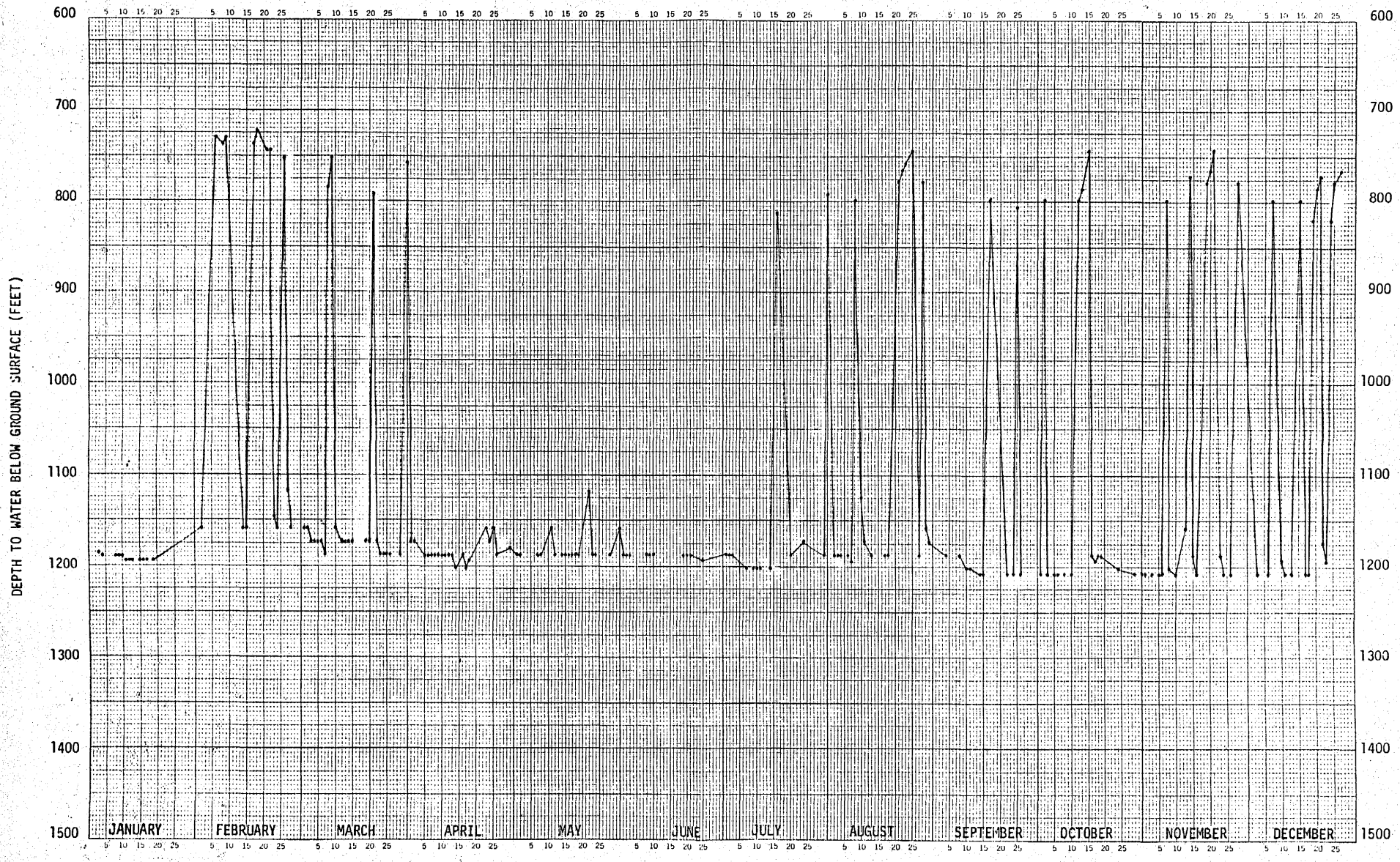

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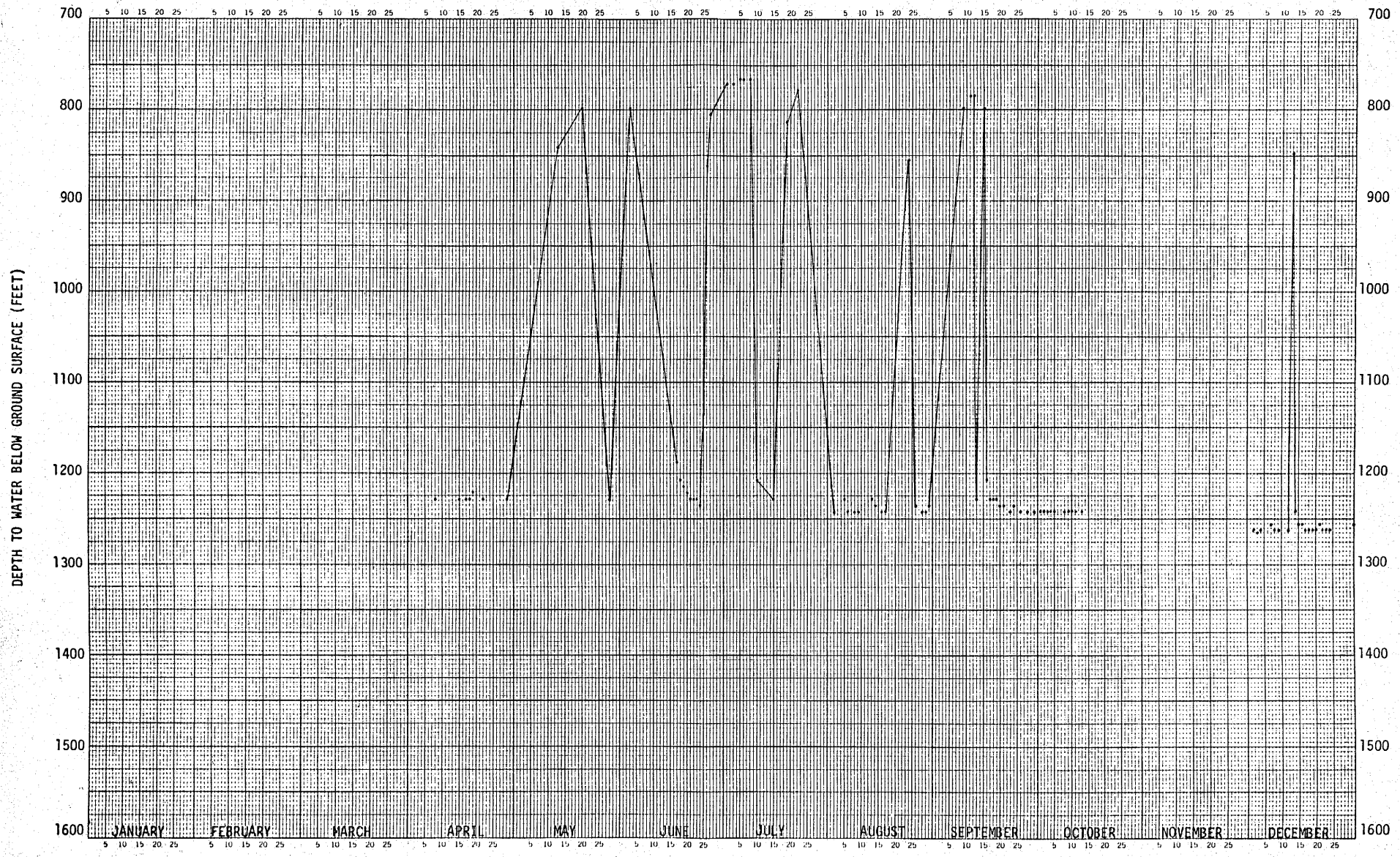
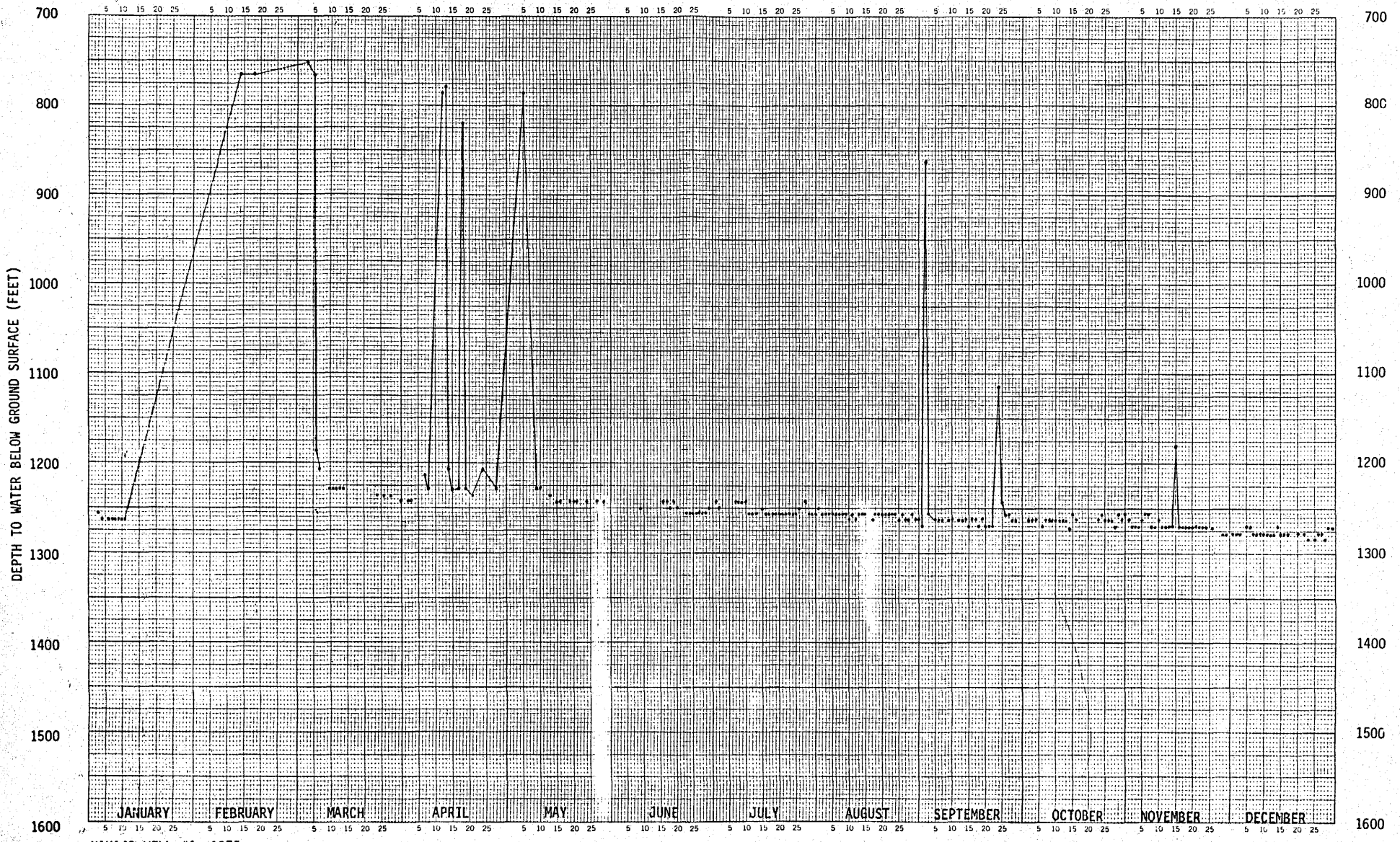


NAVAJO WELL #4, 1974



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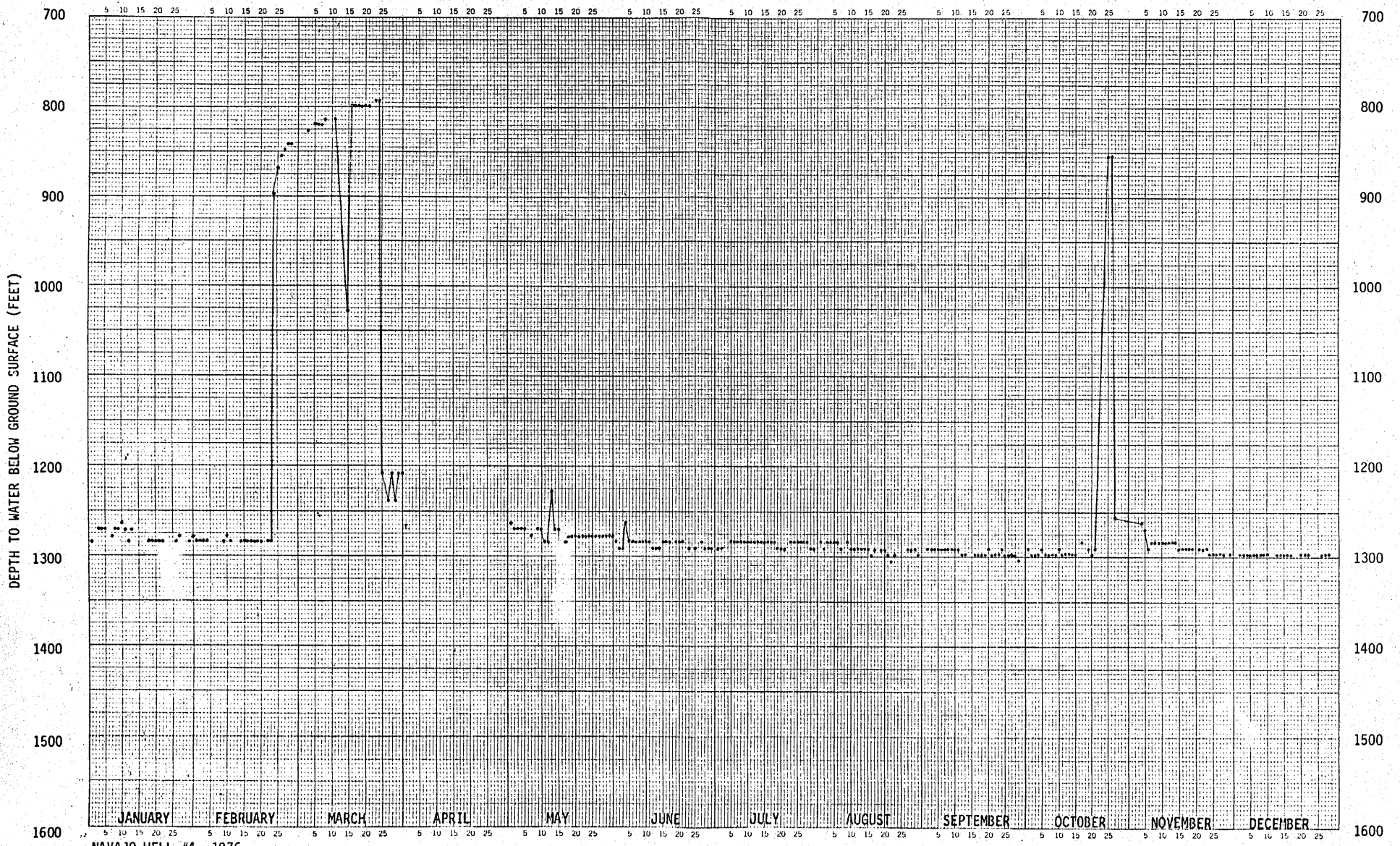
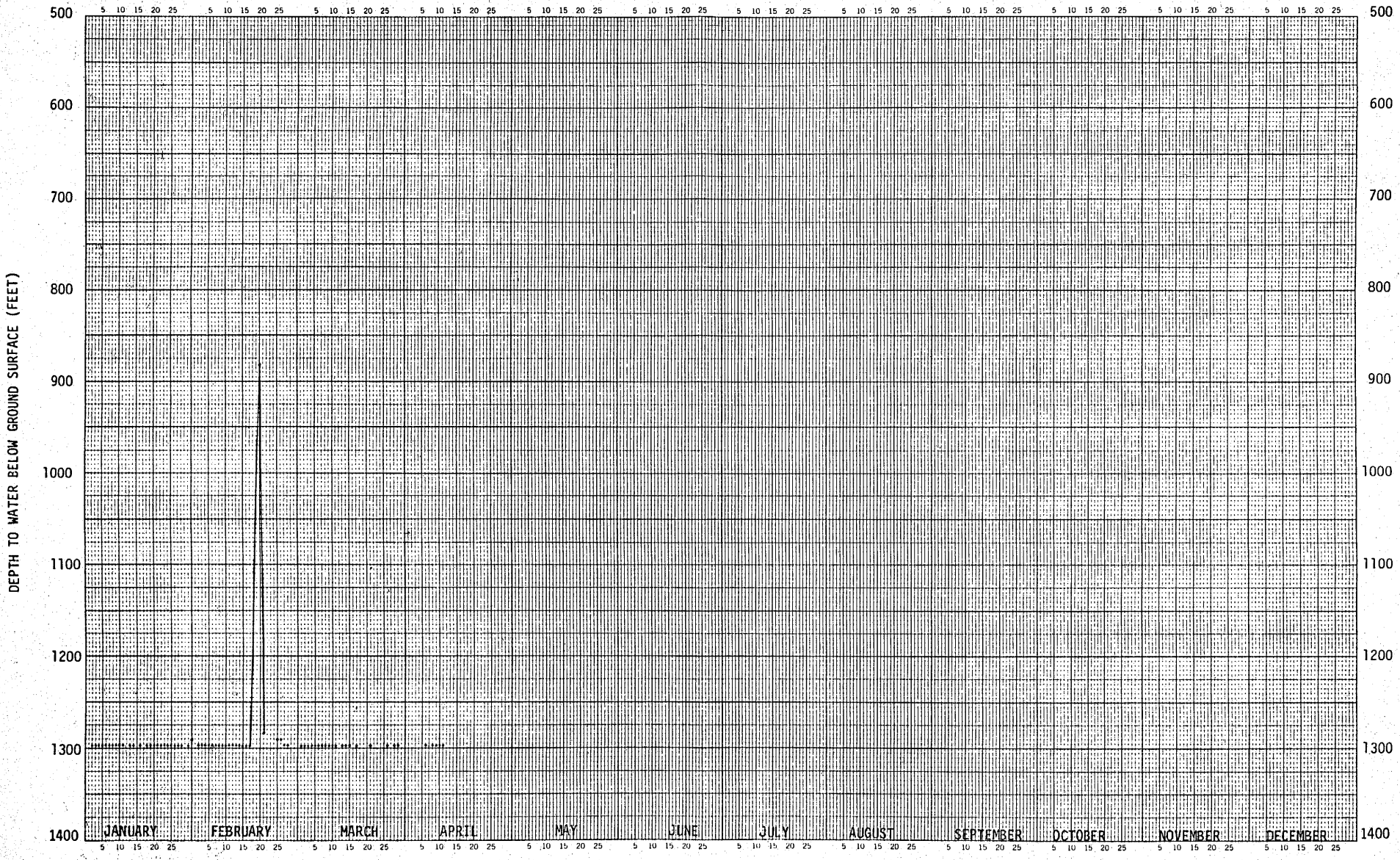
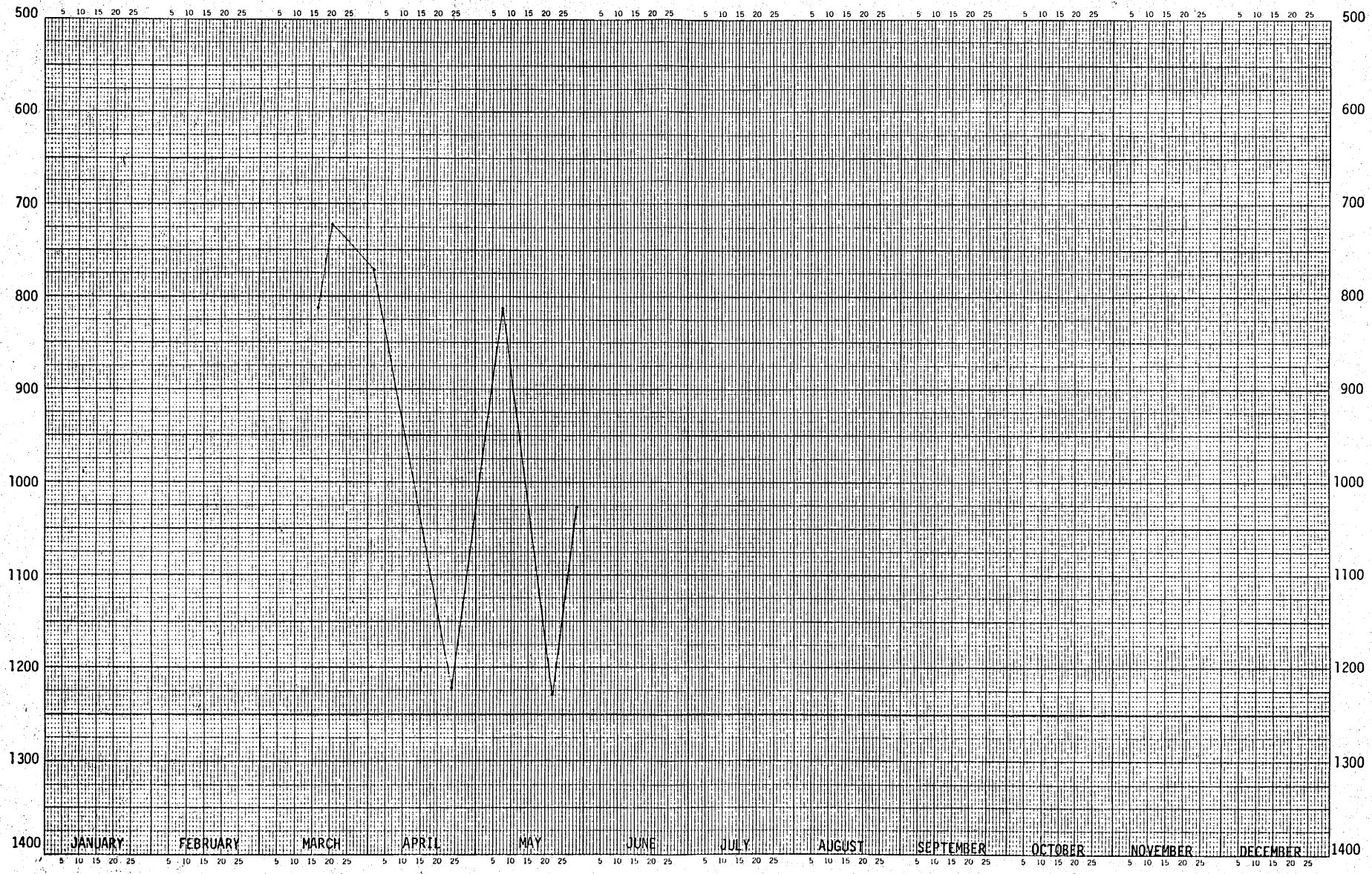


NAVAJO WELL #4, 1976



NAVAJO WELL #4, 1977



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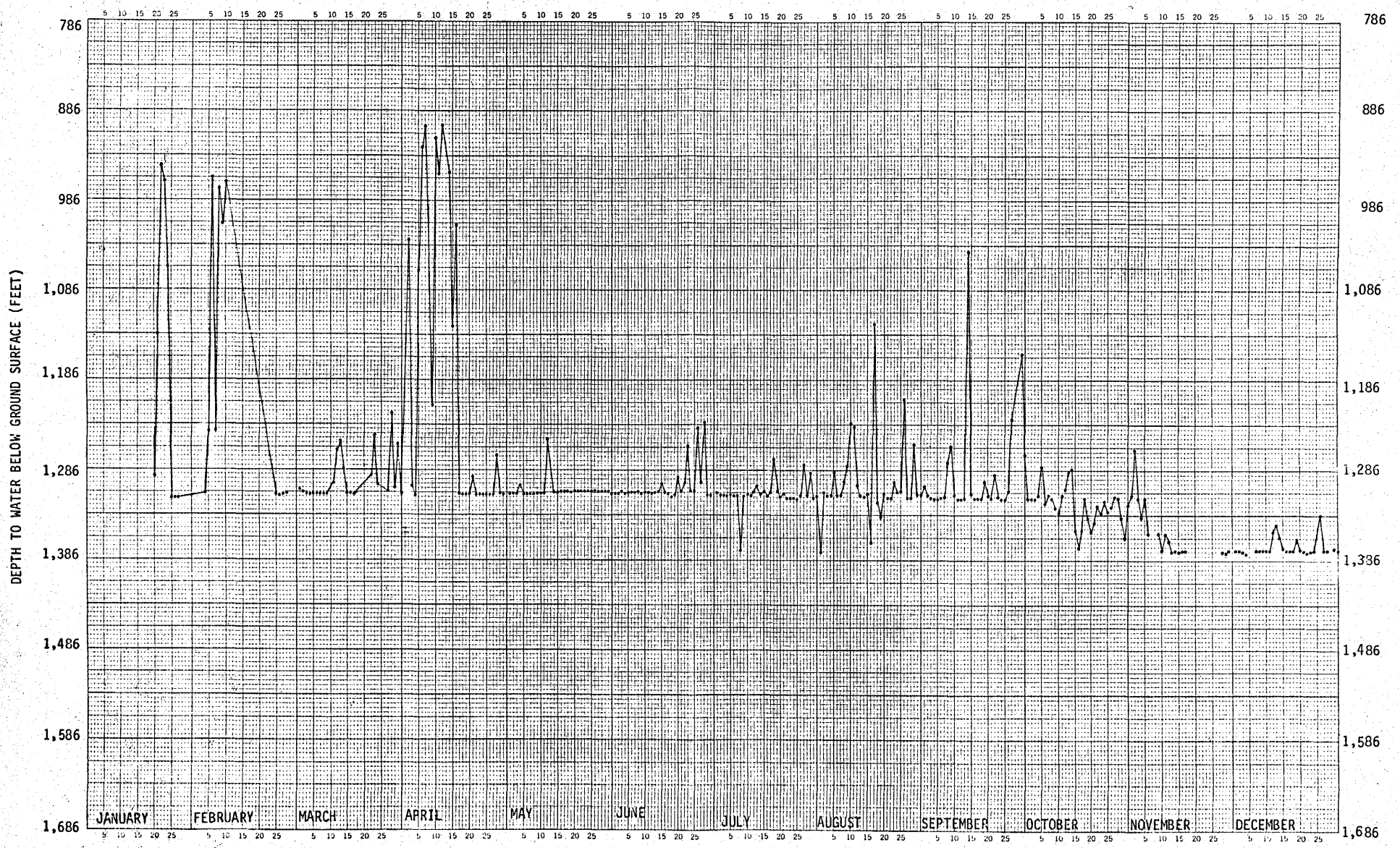
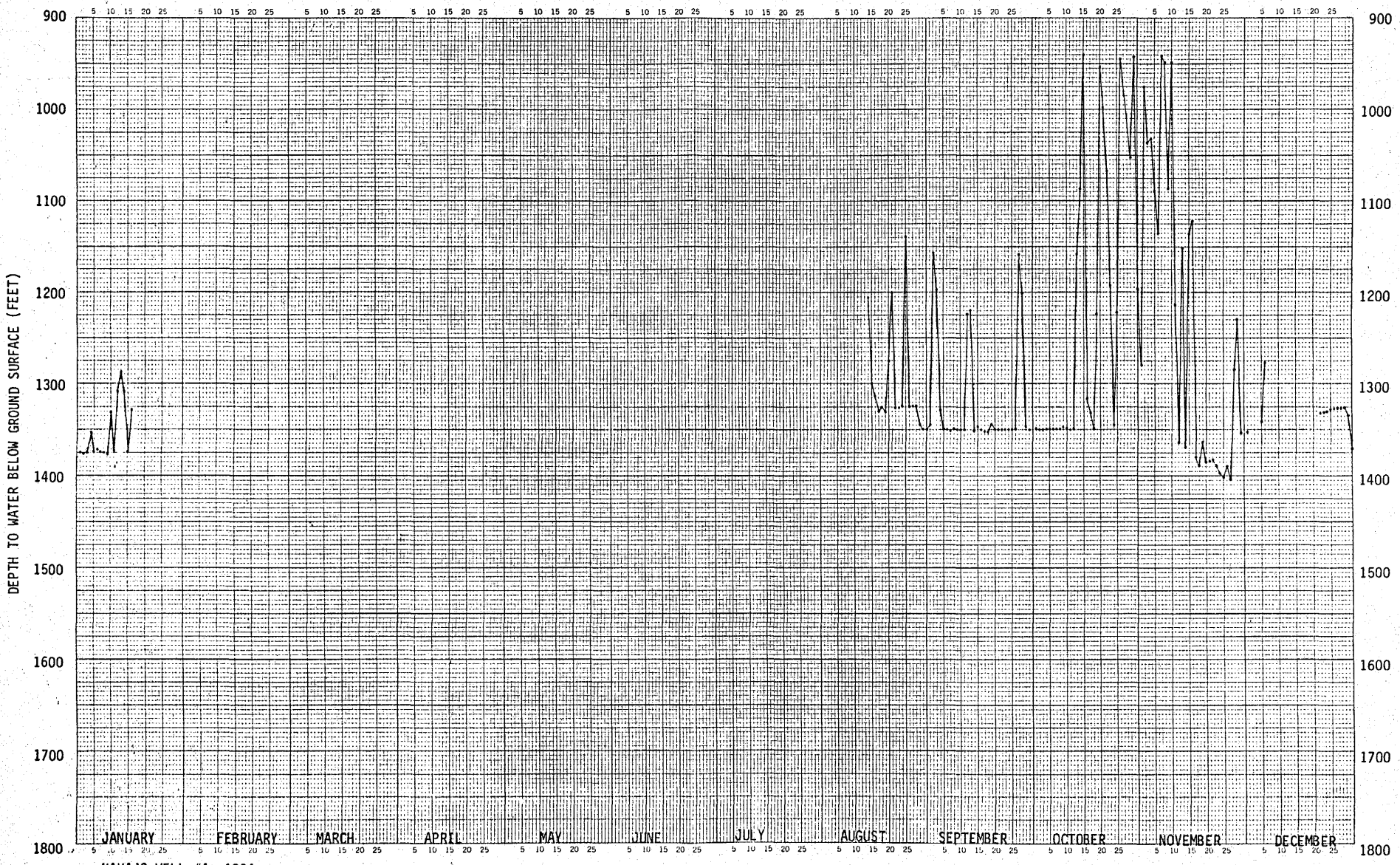
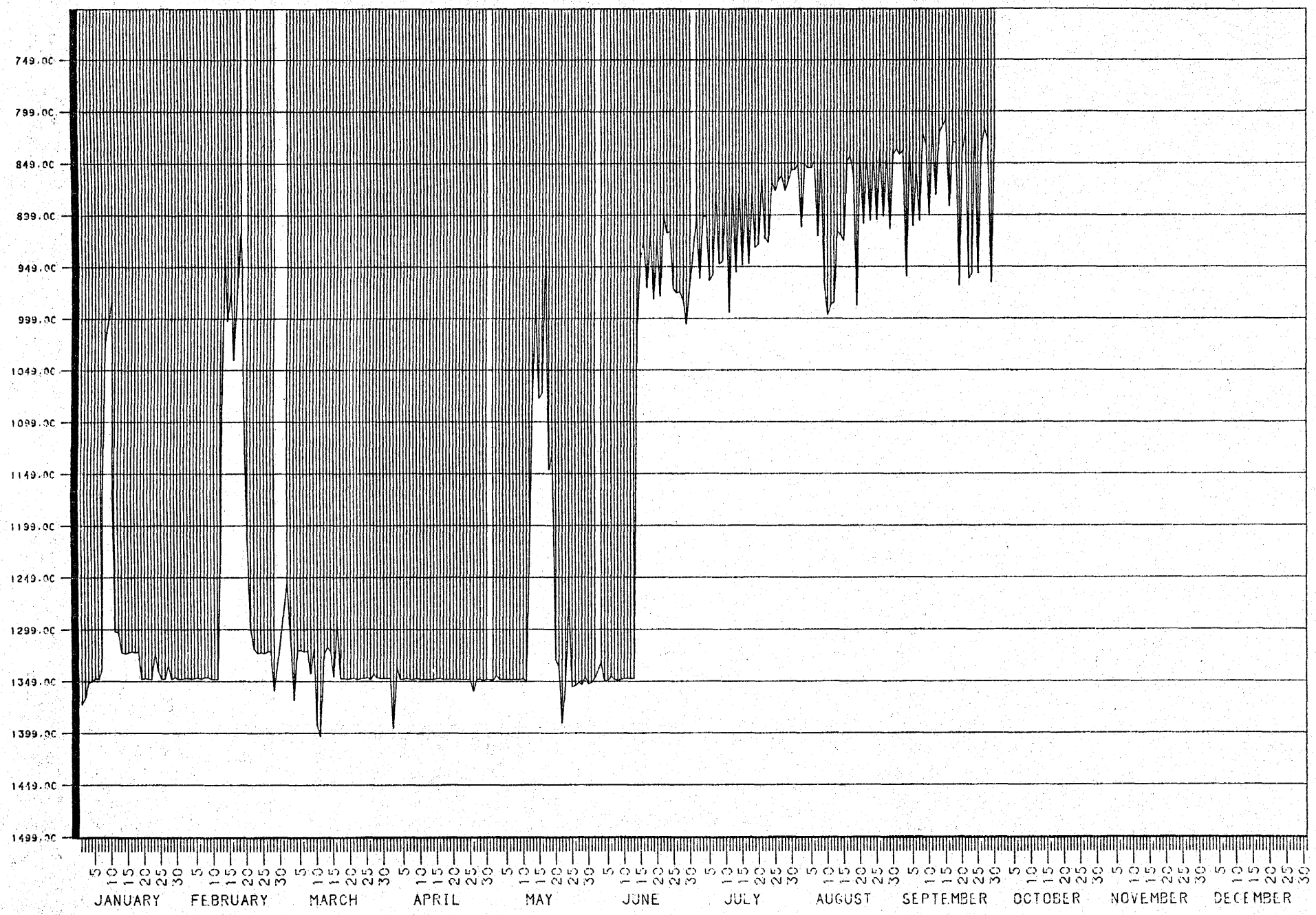


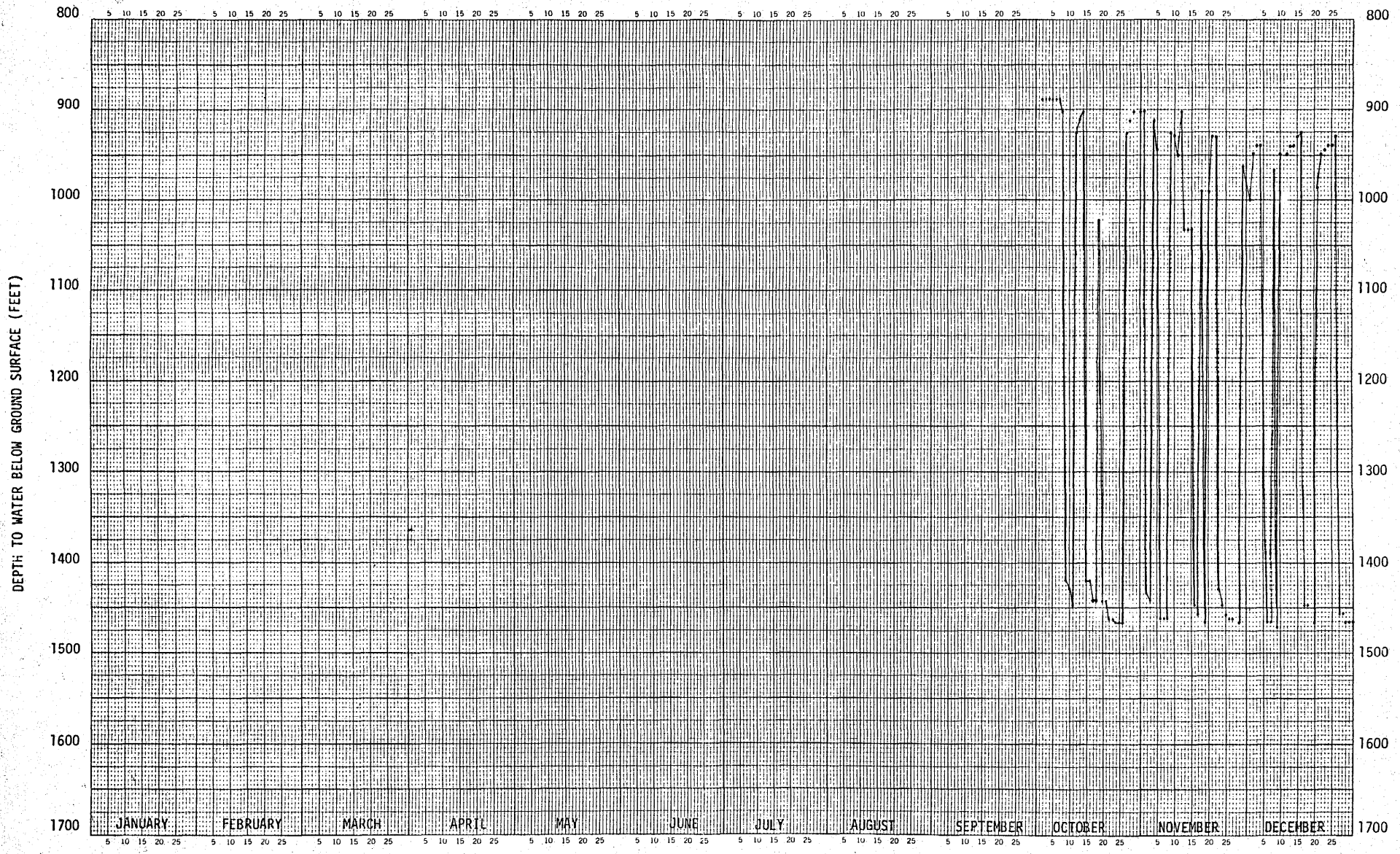
NAVAJO #4, 1983



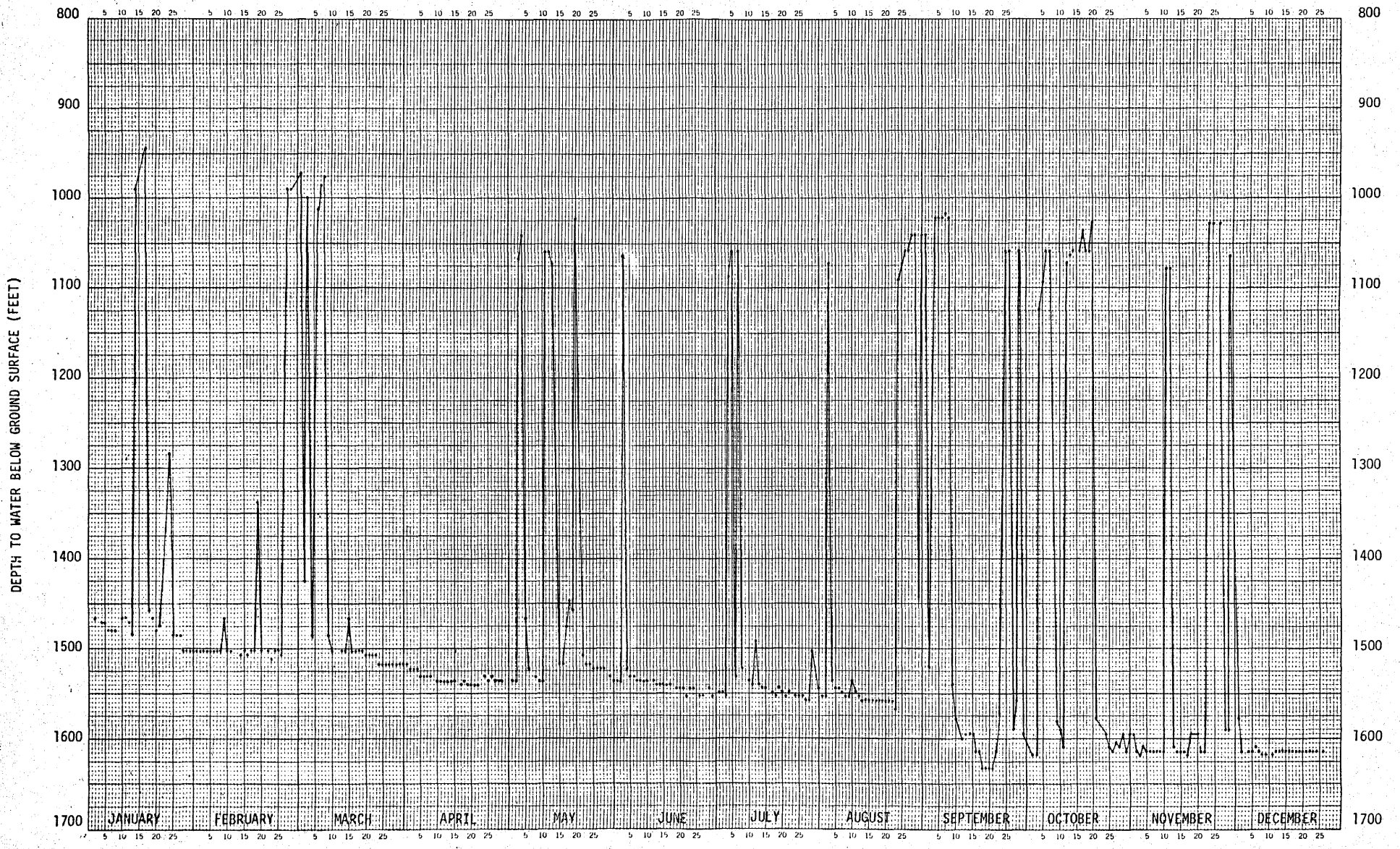
NAVAJO WELL #4, 1984.



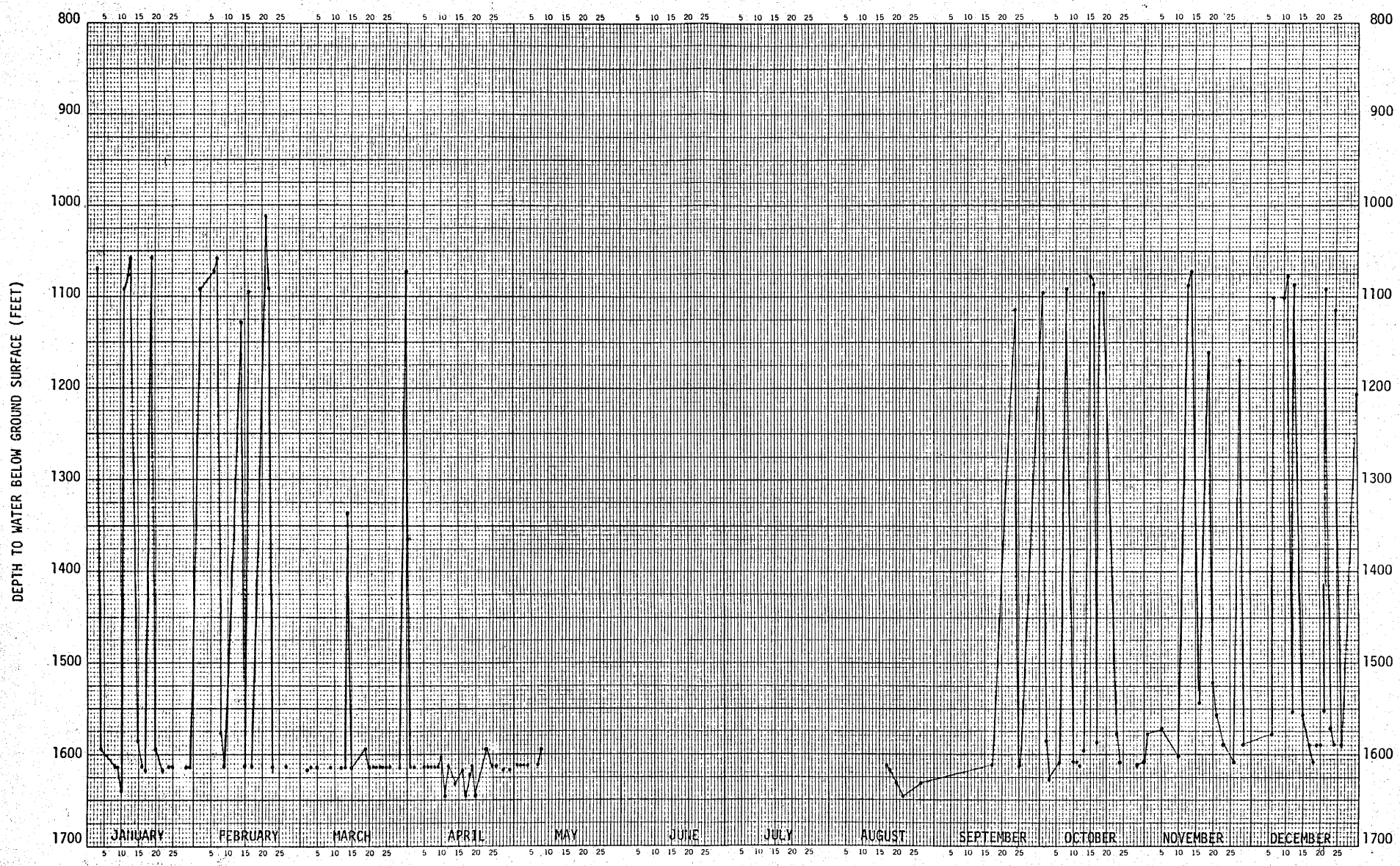
NAVAJO WELL #4, 1985



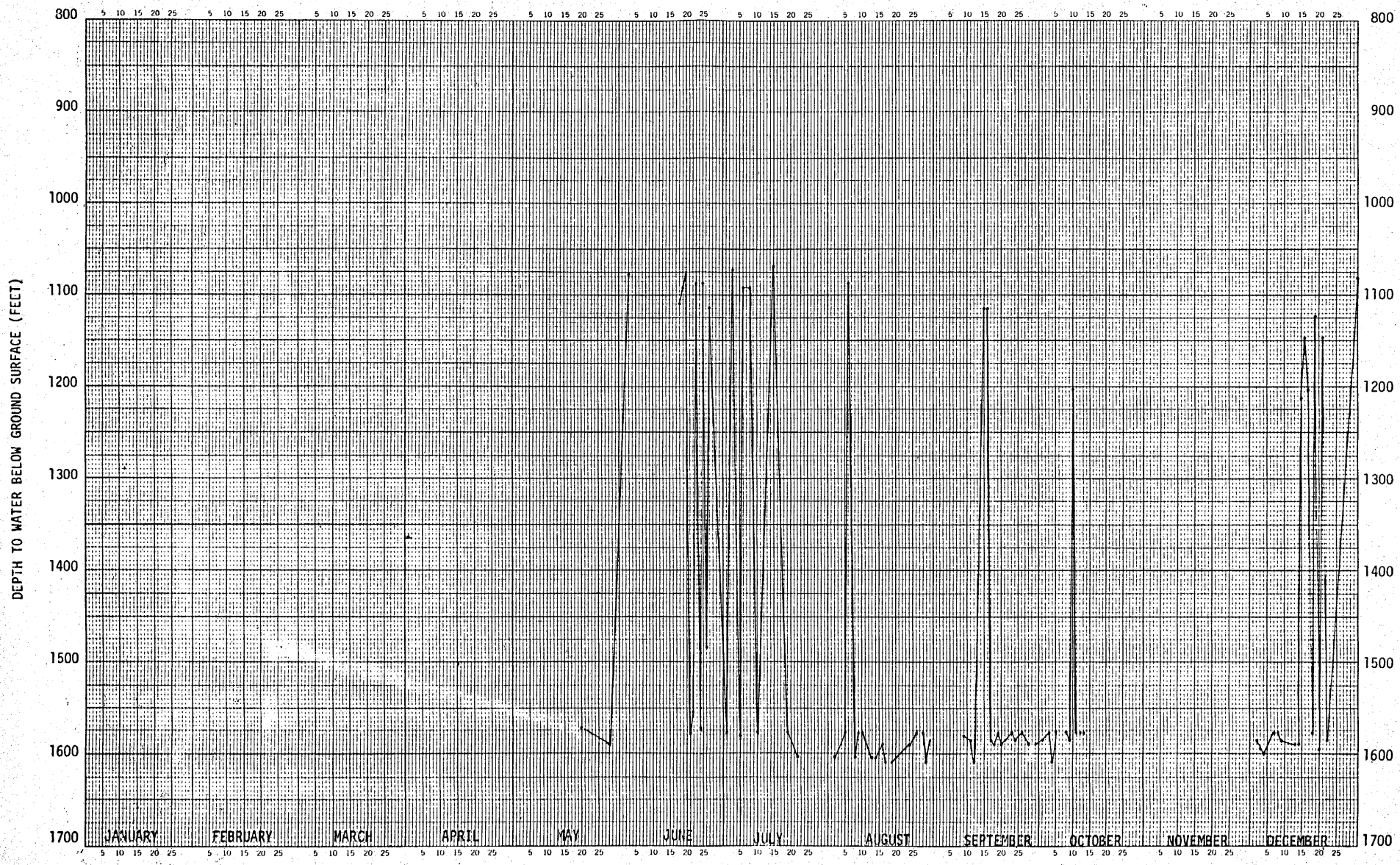
NAVAJO WELL #5, 1971



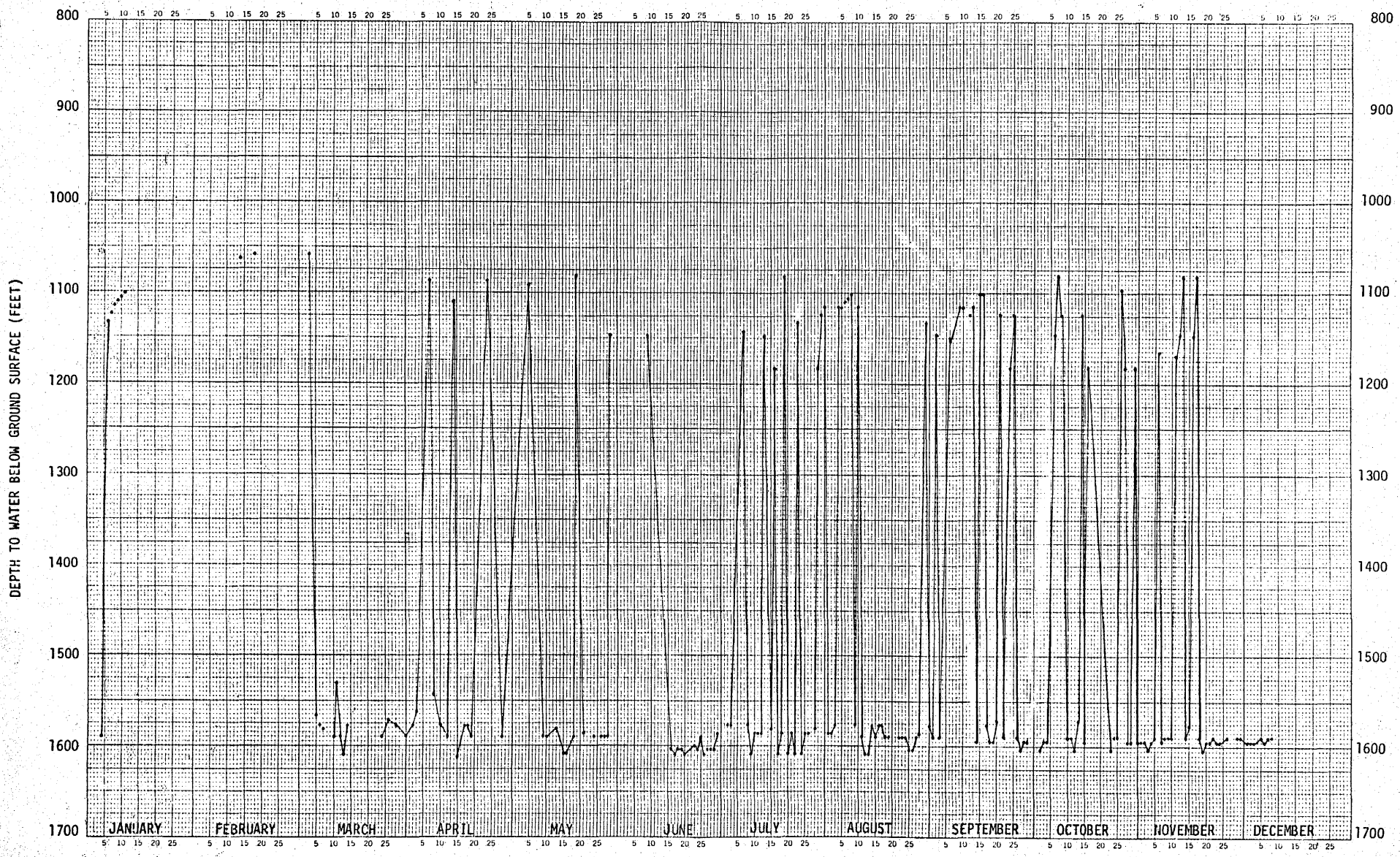
NAVAJO WELL #5, 1972



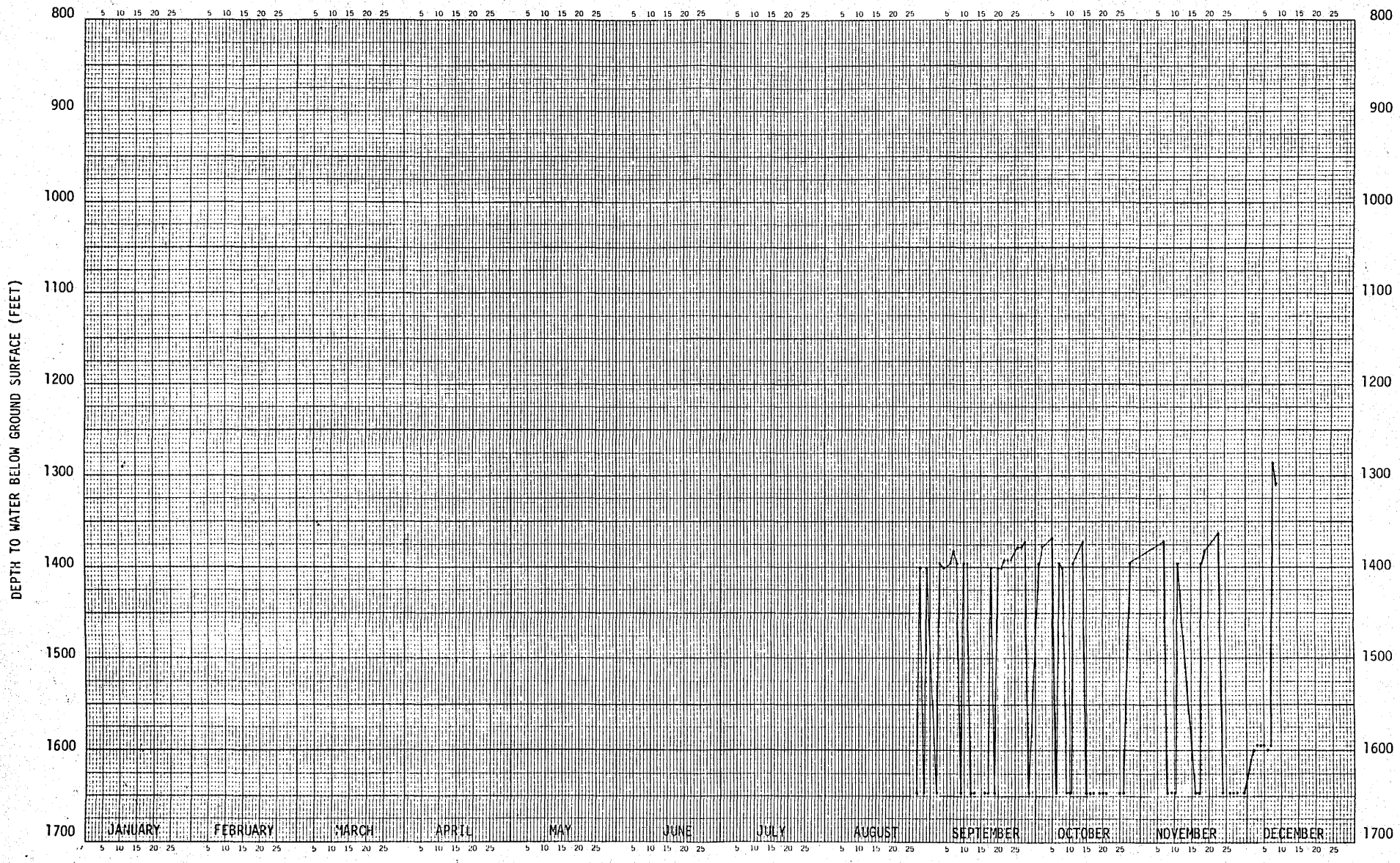
NAVAJO WELL #5, 1973



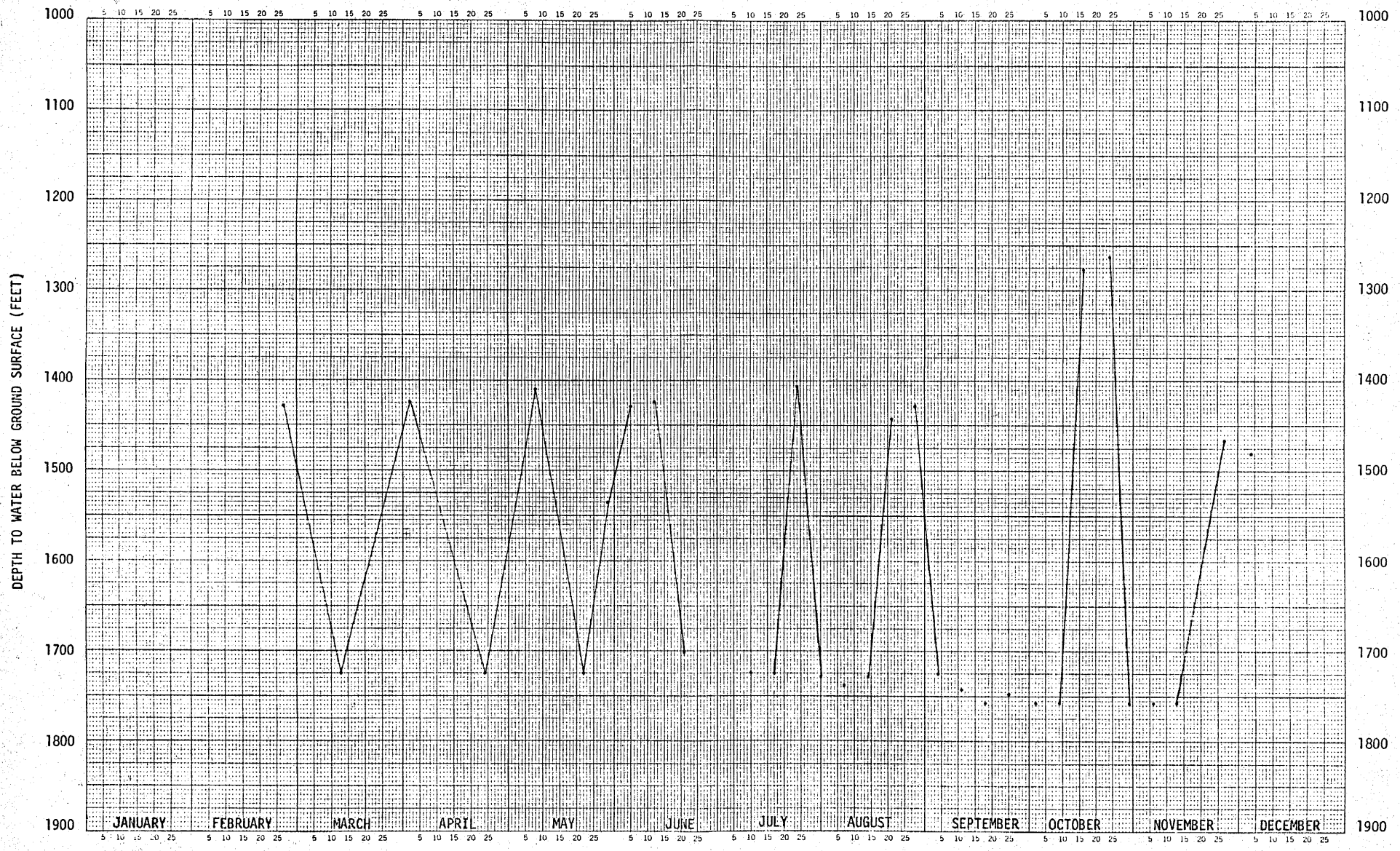
NAVAJO WELL #5, 1974



NAVAJO WELL #5, 1975



NAVAJO WELL #5, 1976



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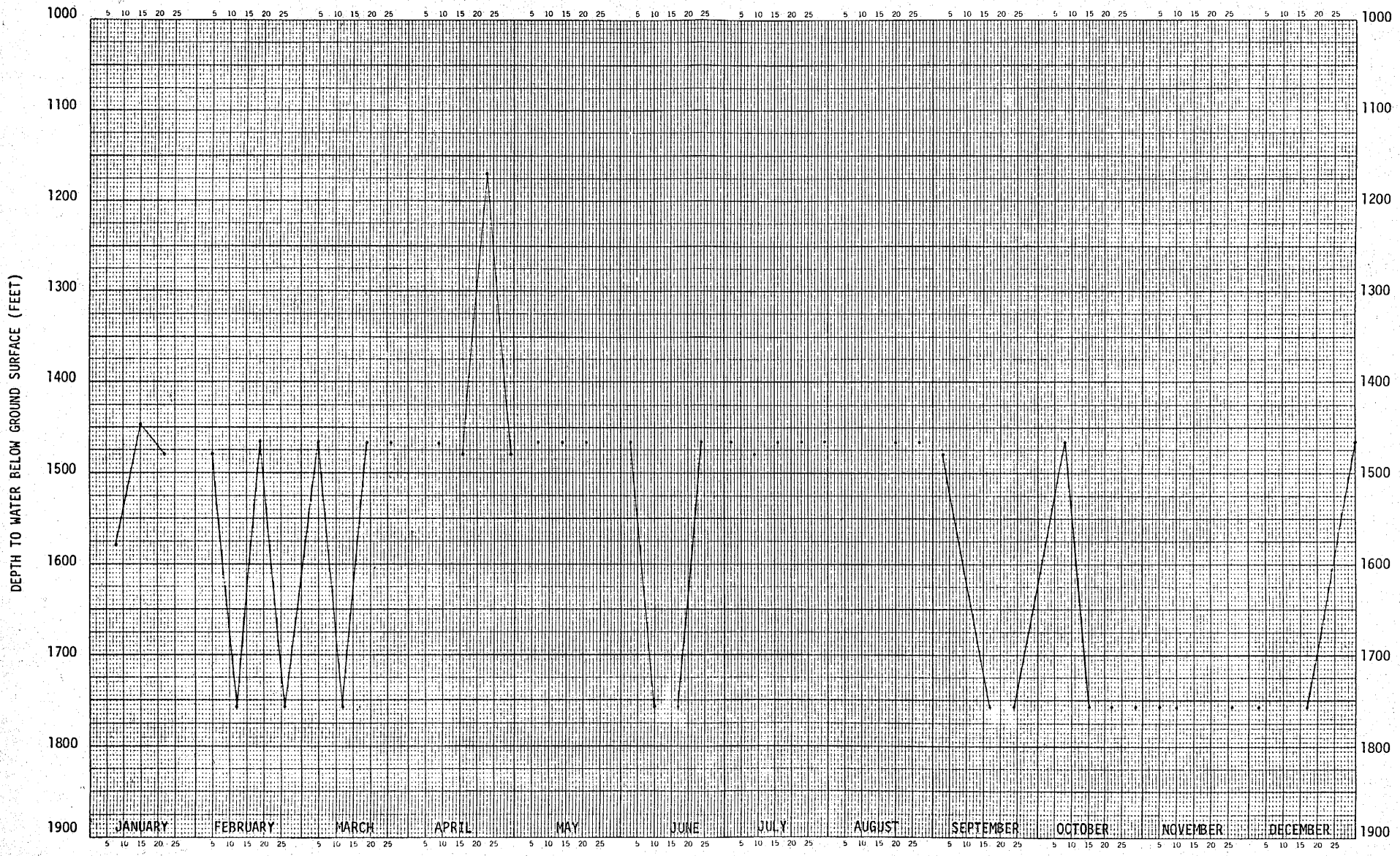

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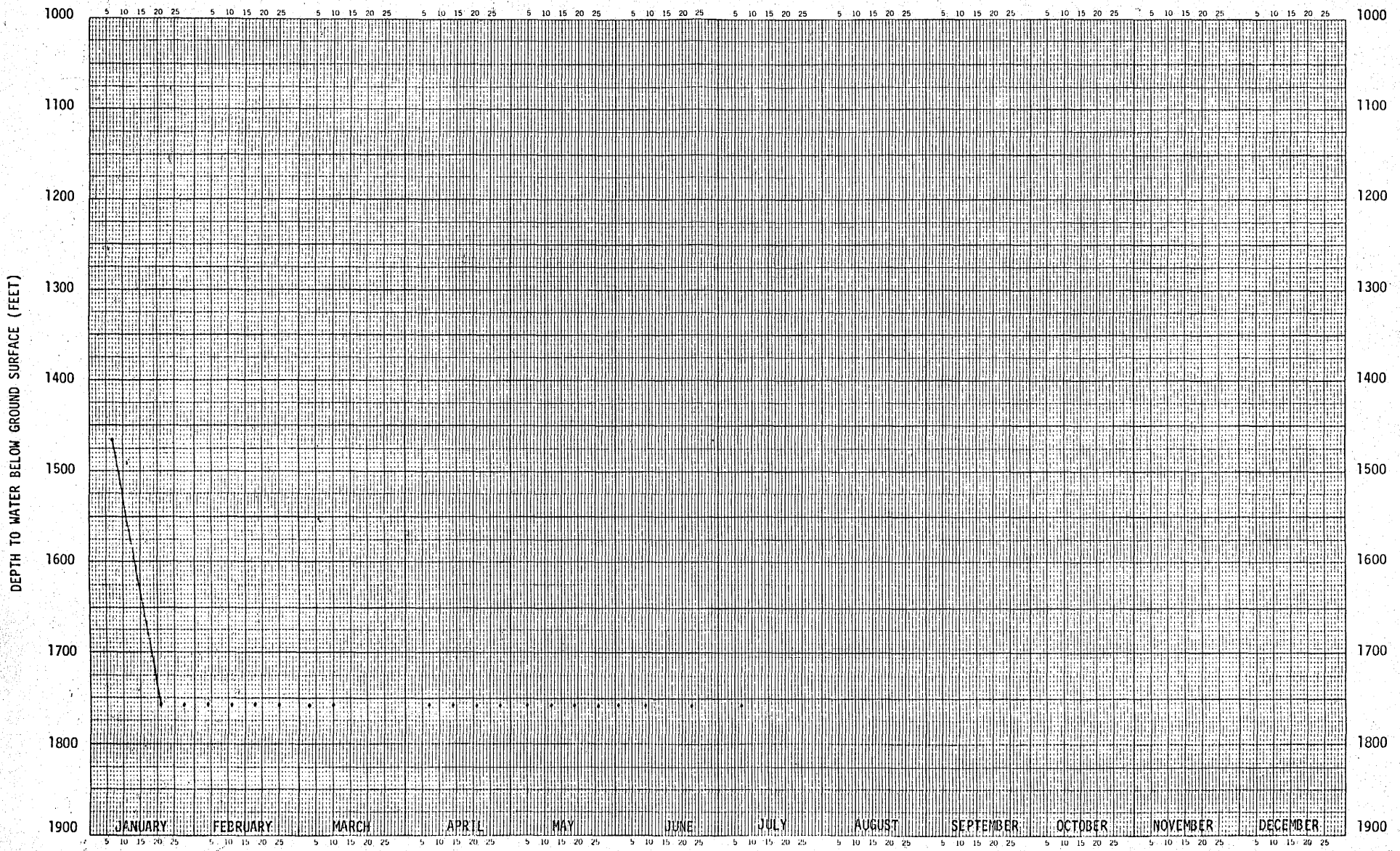
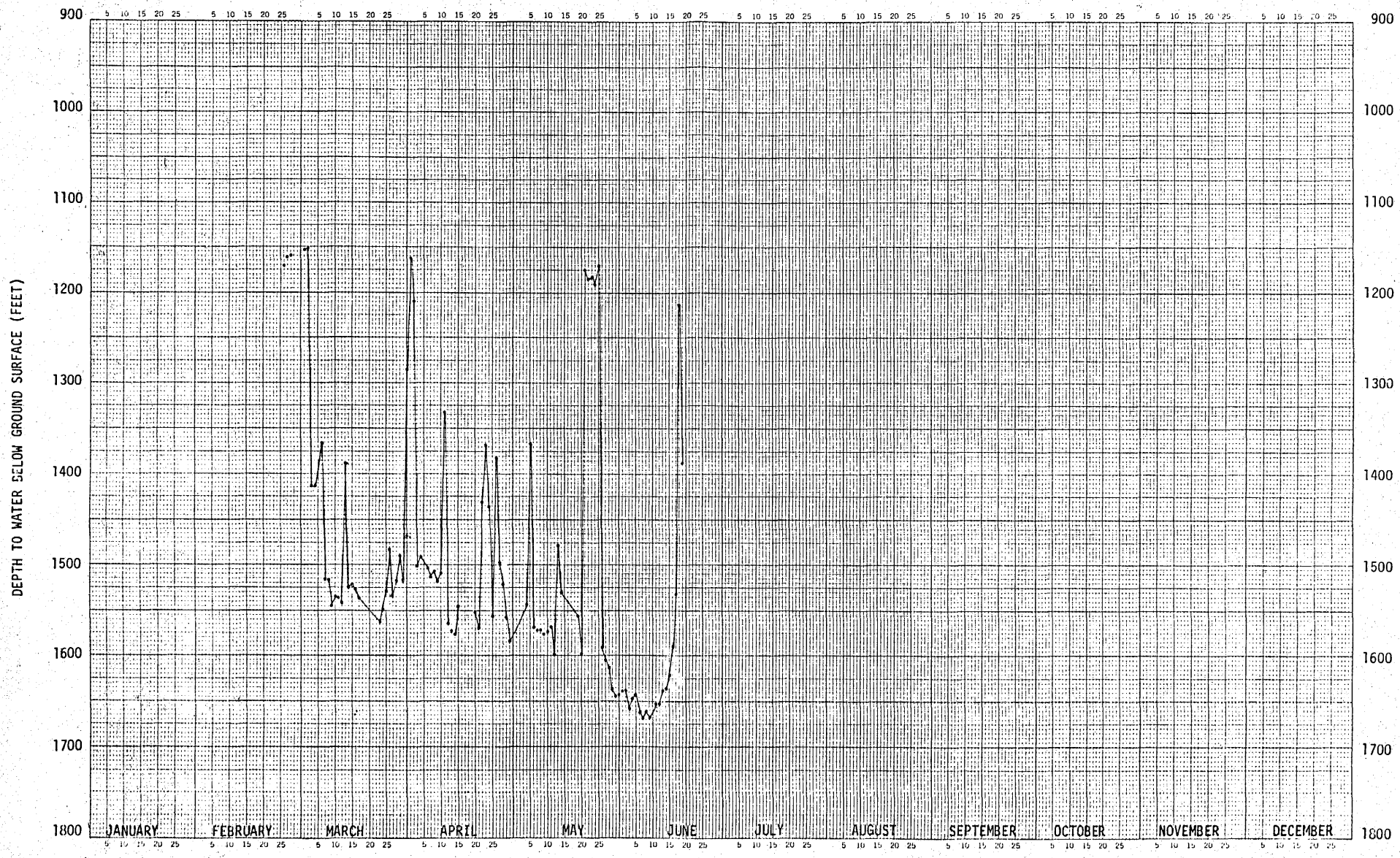
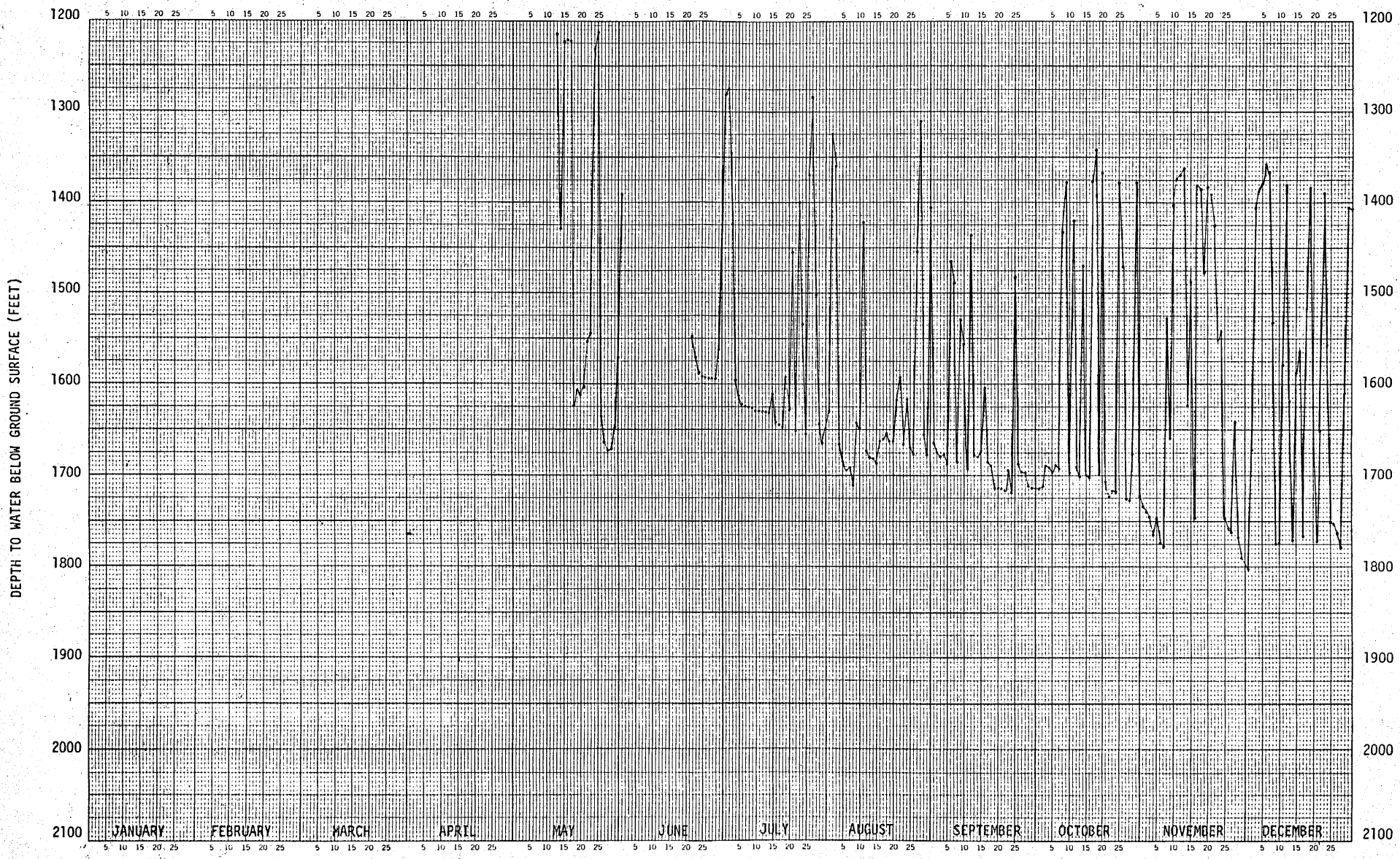


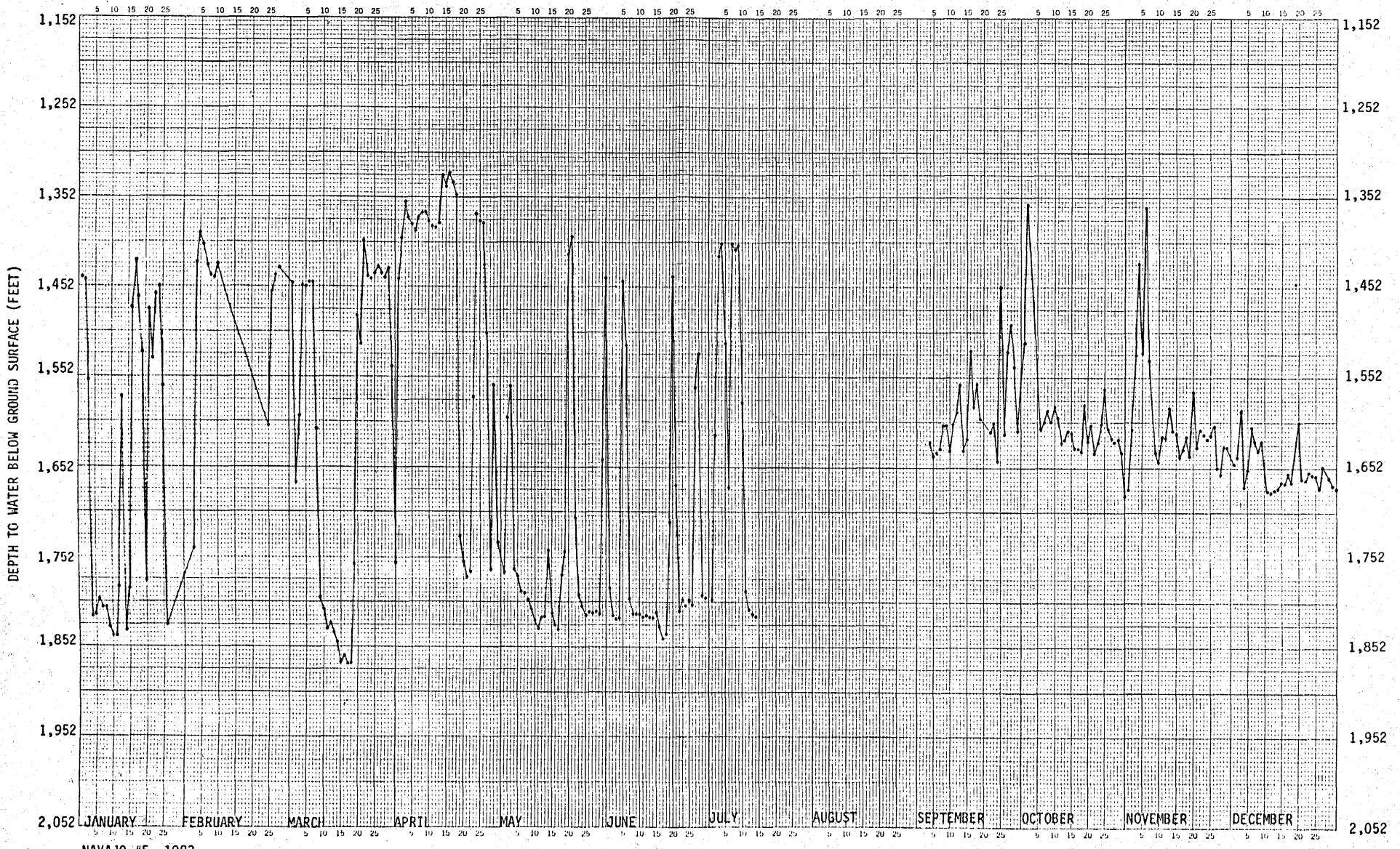
NAVAJO WELL #5, 1980



NAVAJO WELL #5, 1981



NAVAJO WELL #5, 1982



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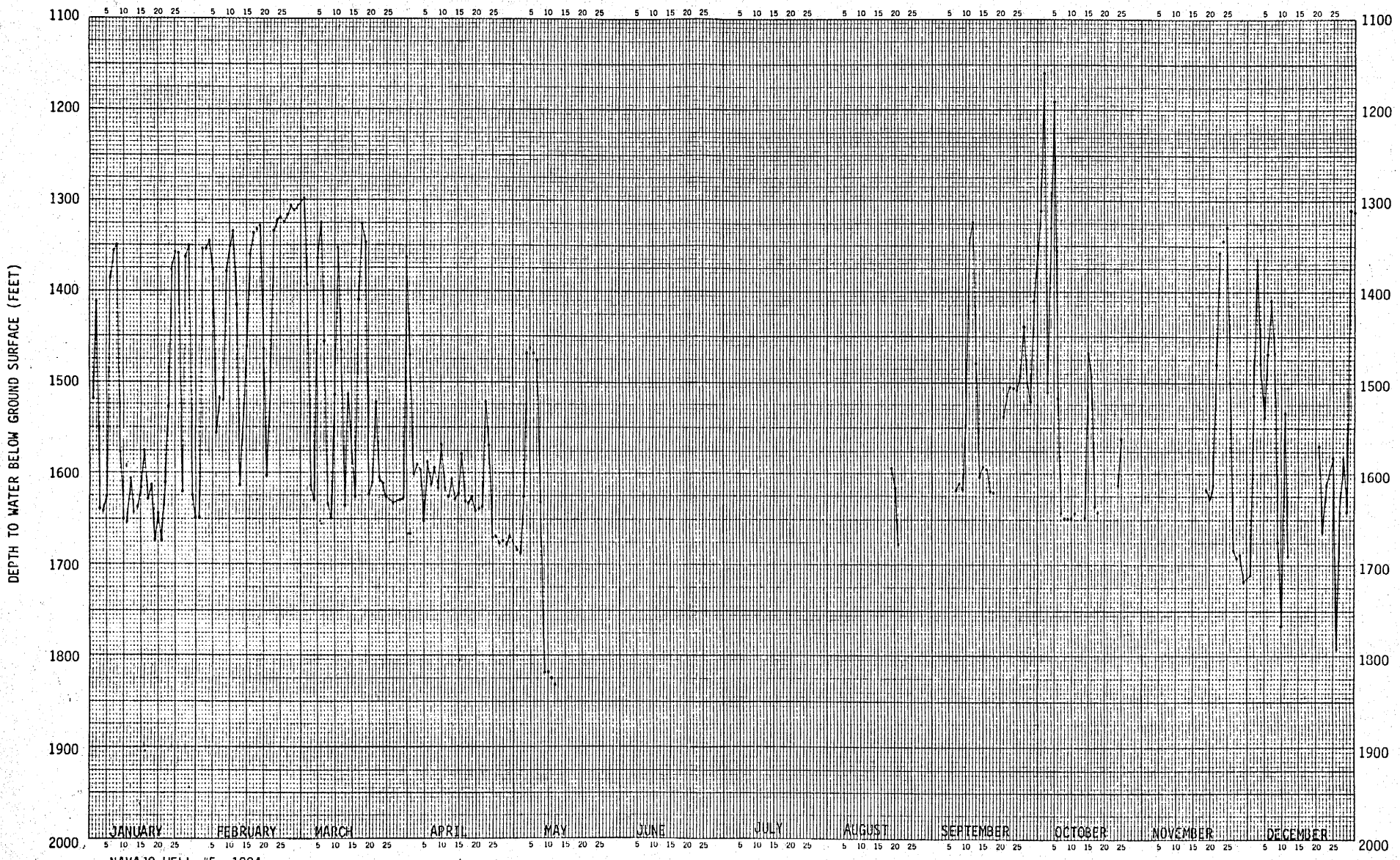
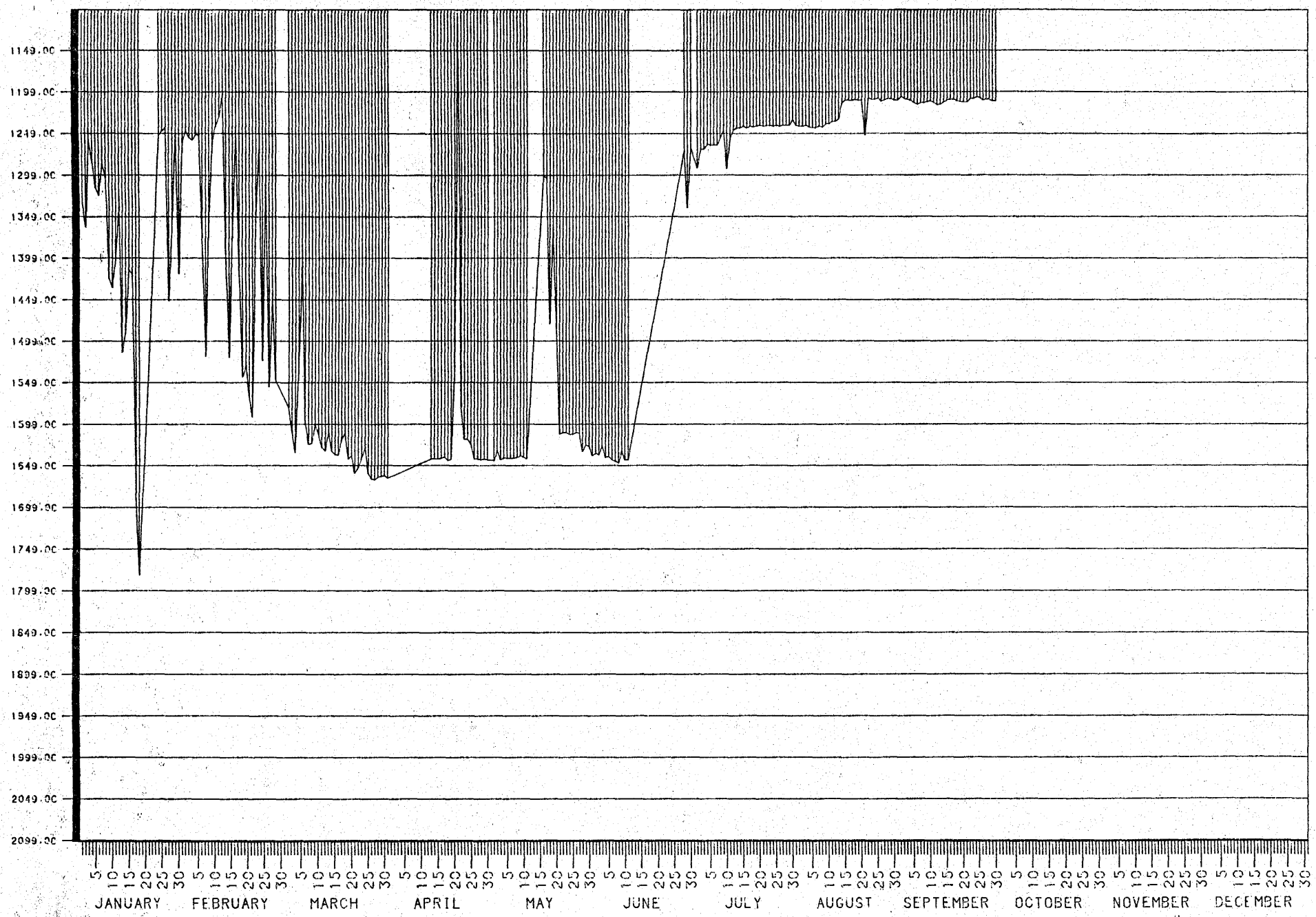
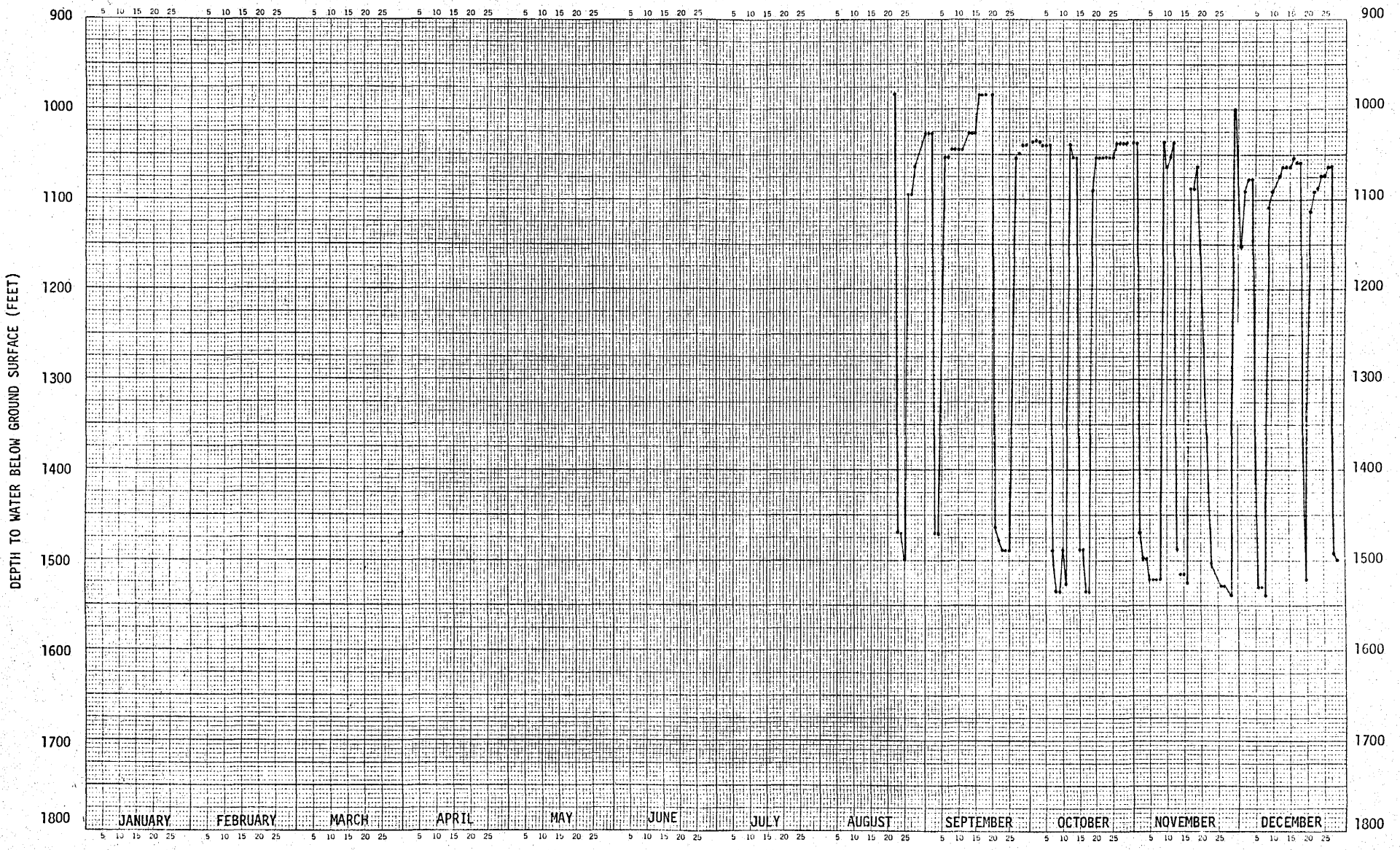


NAVAJO WELL #5, 1984



NAVAJO WELL #5, 1985



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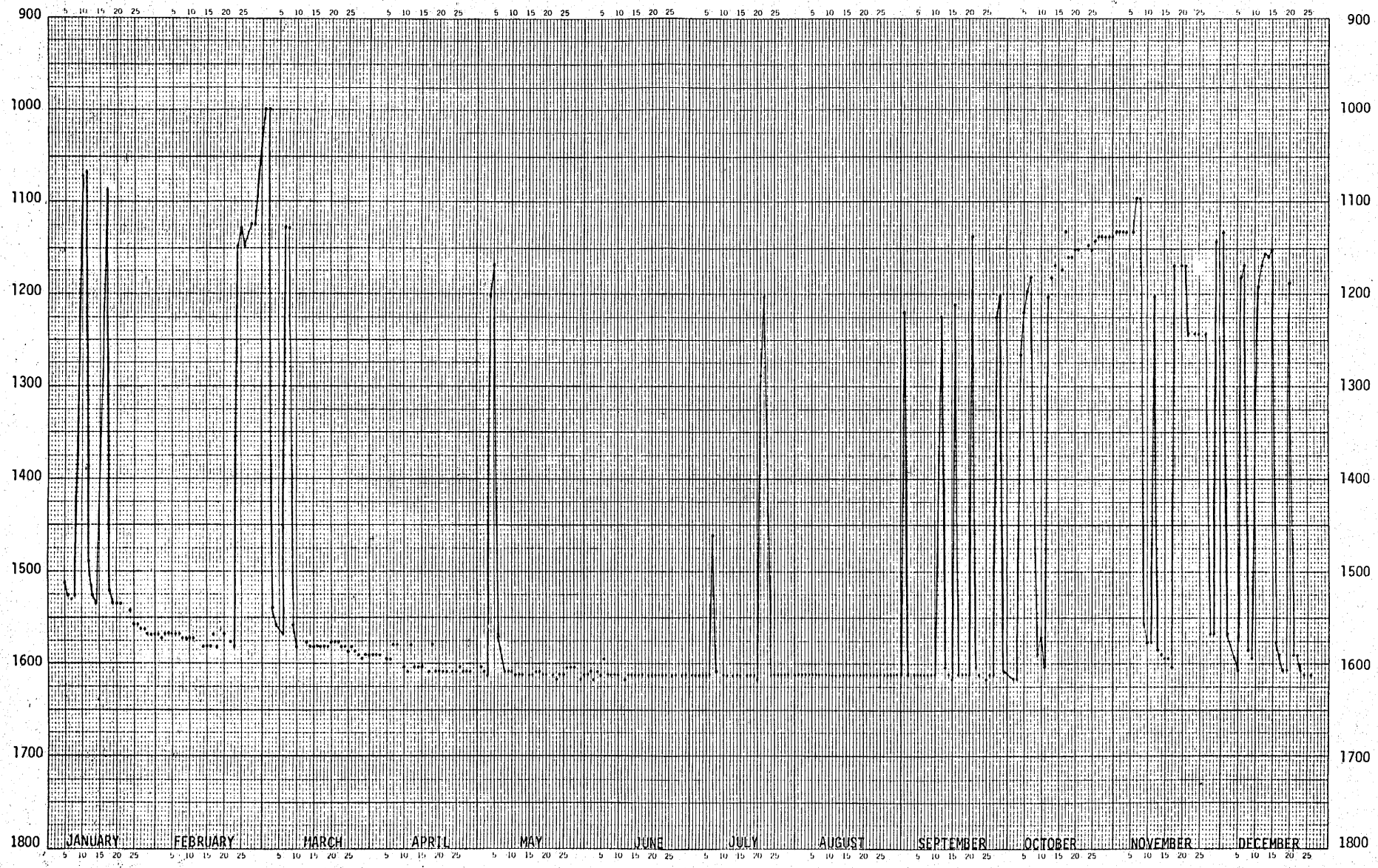

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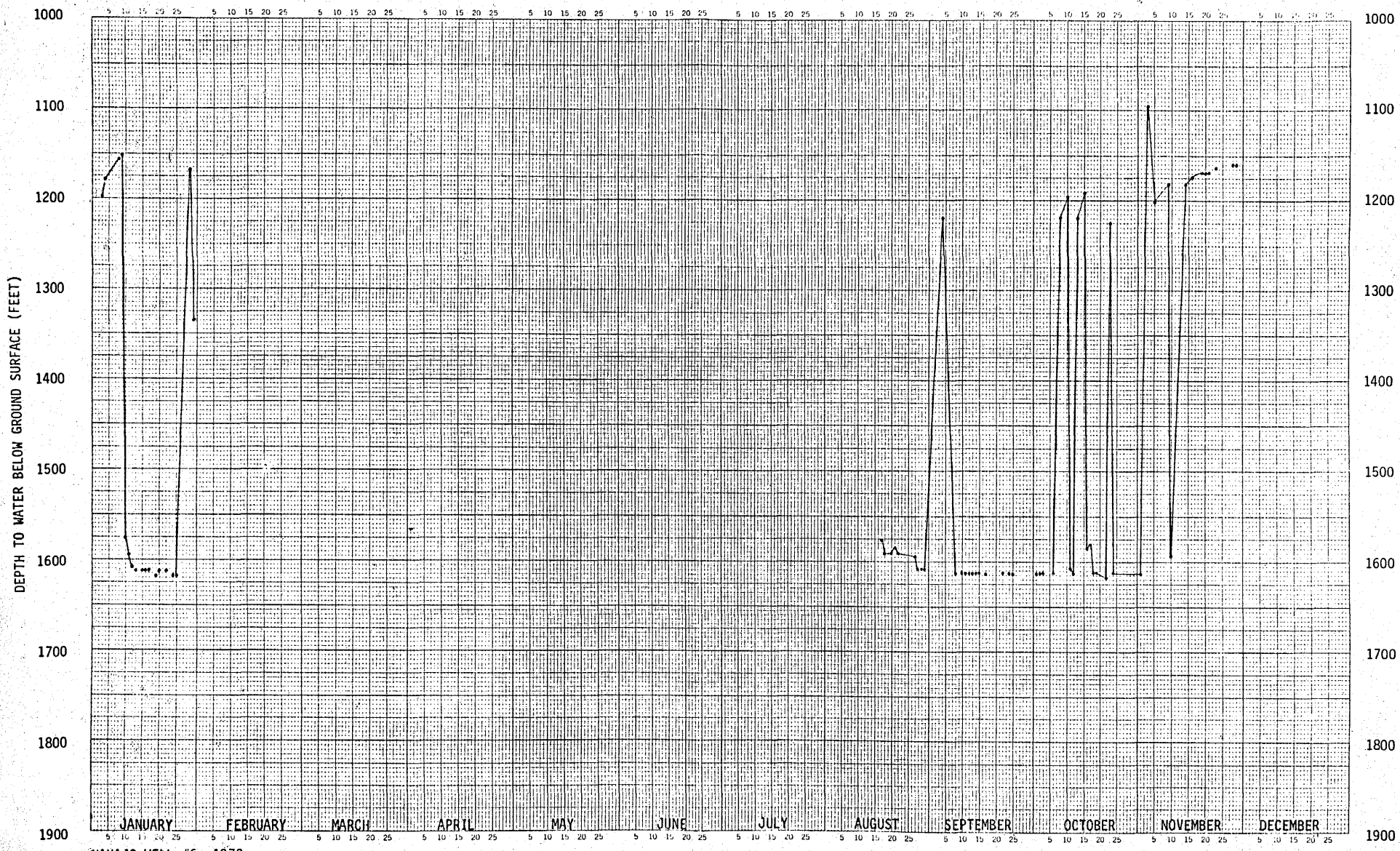

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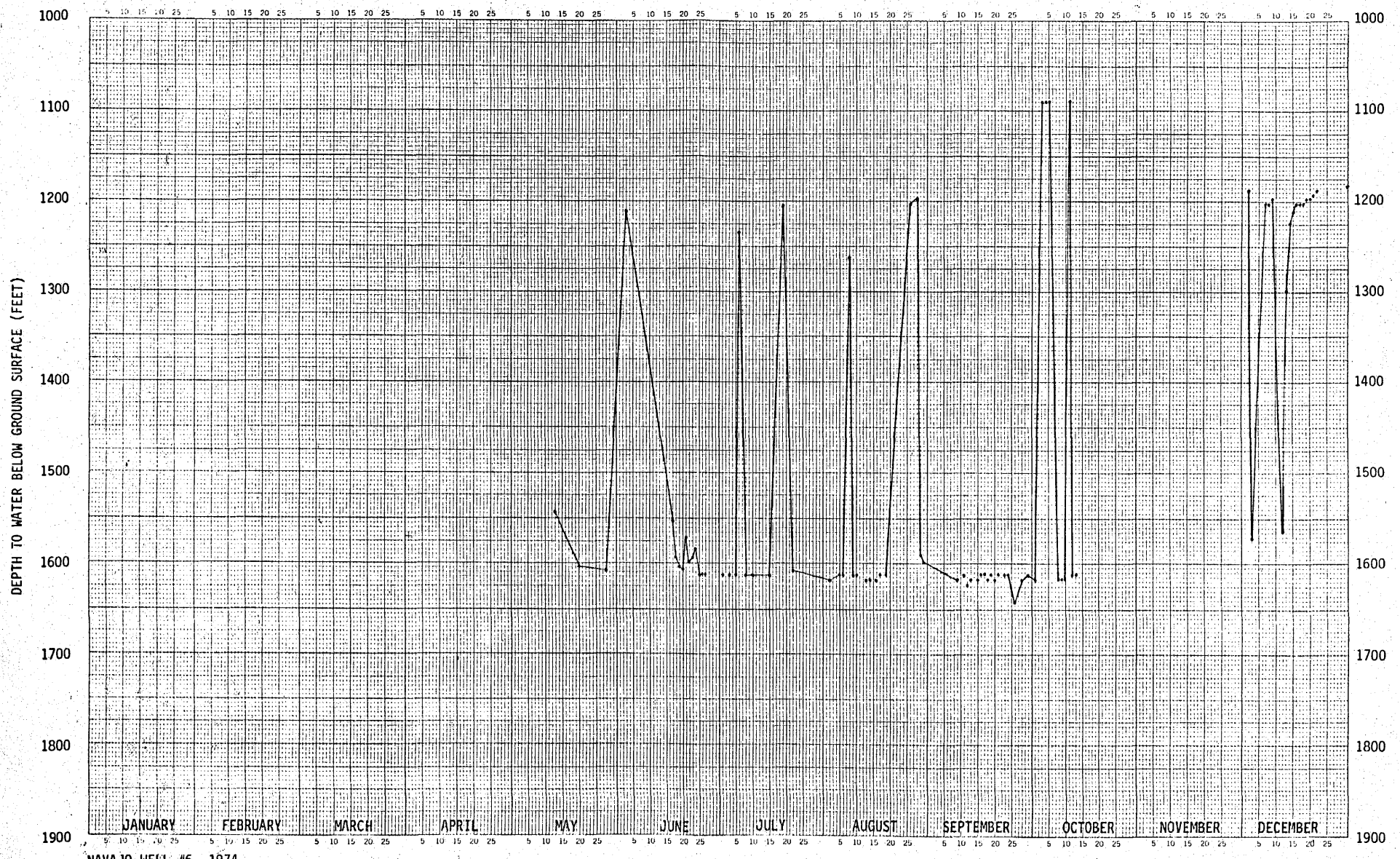

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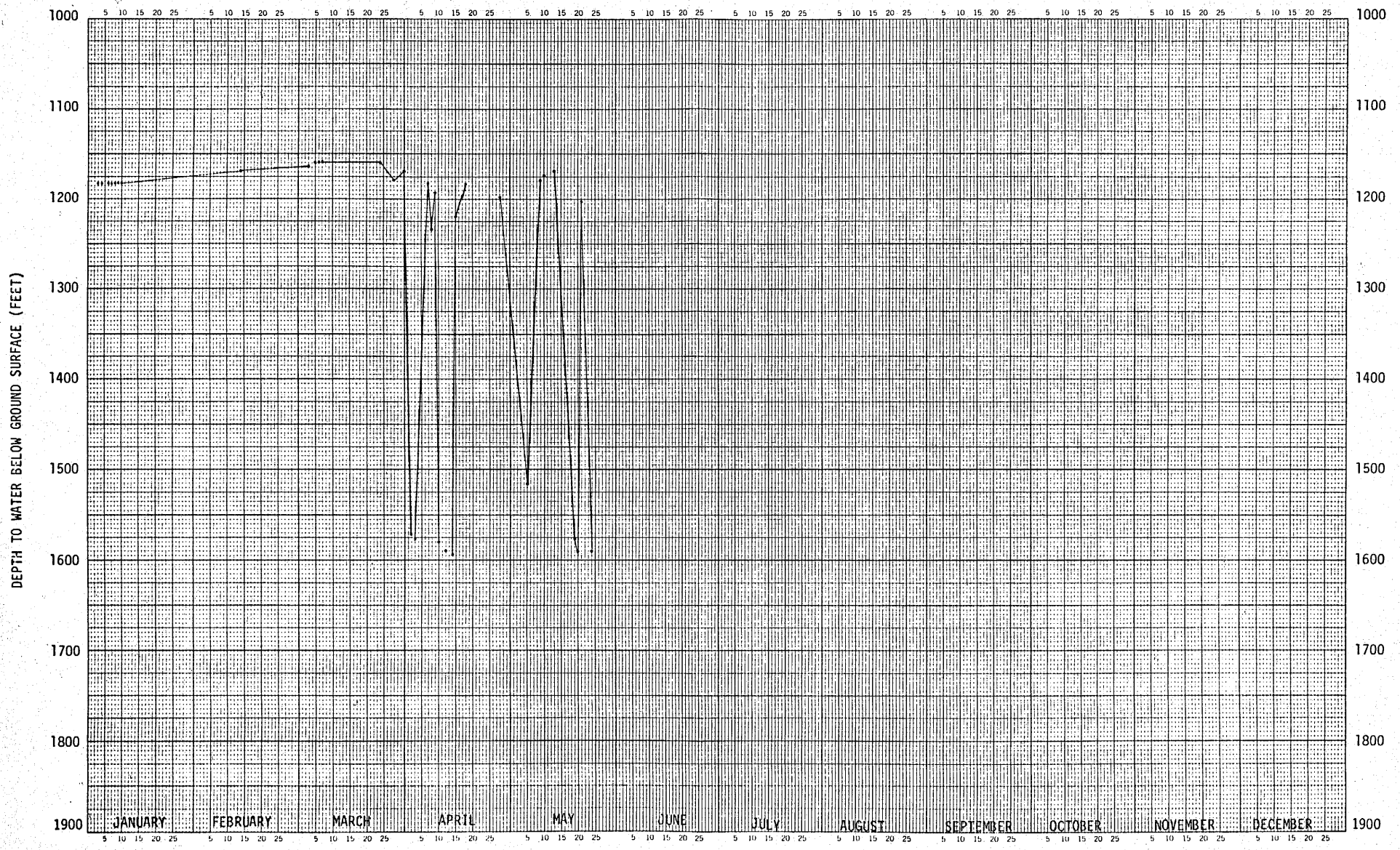
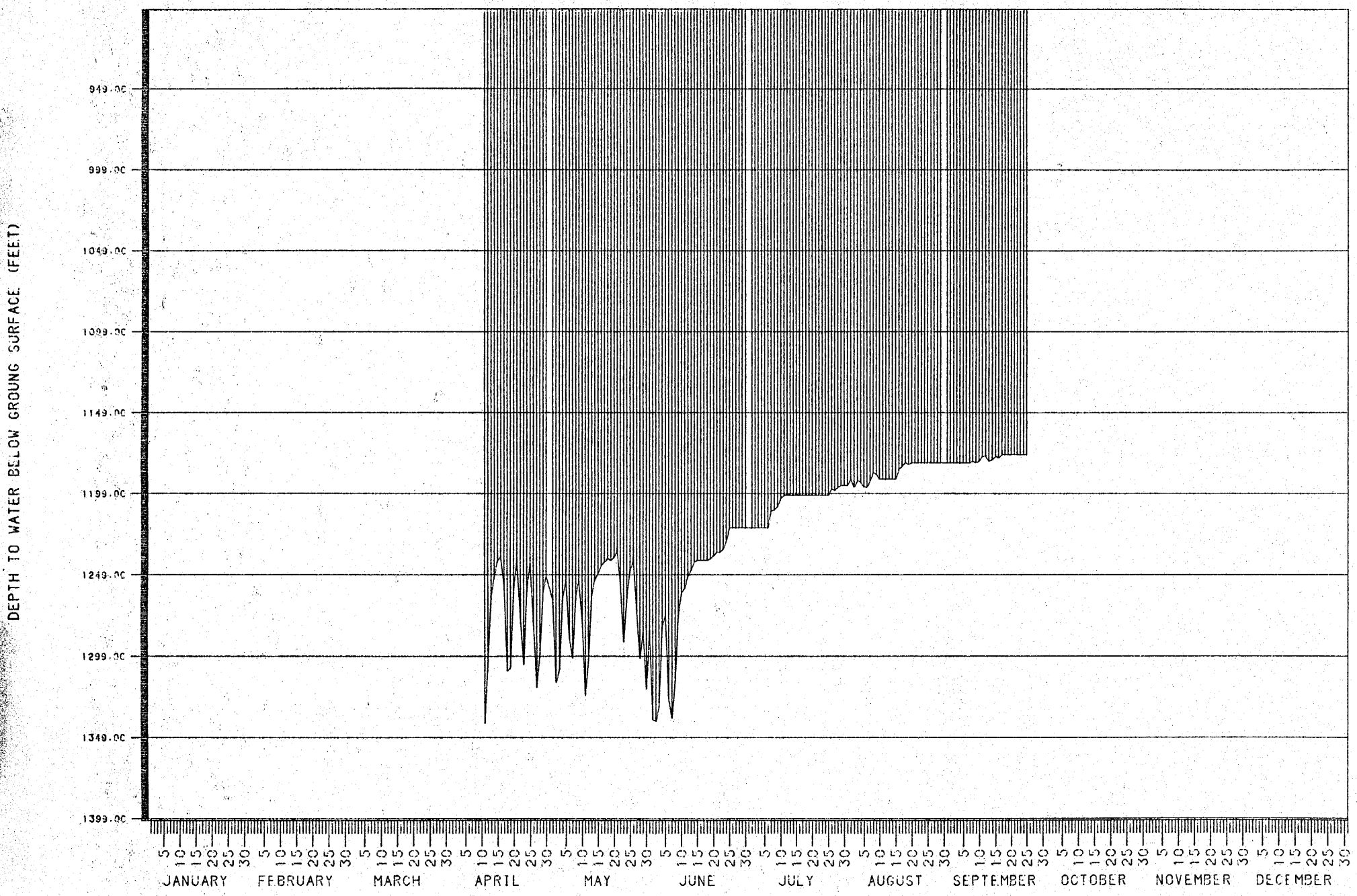


NAVAJO WELL #6, 1975



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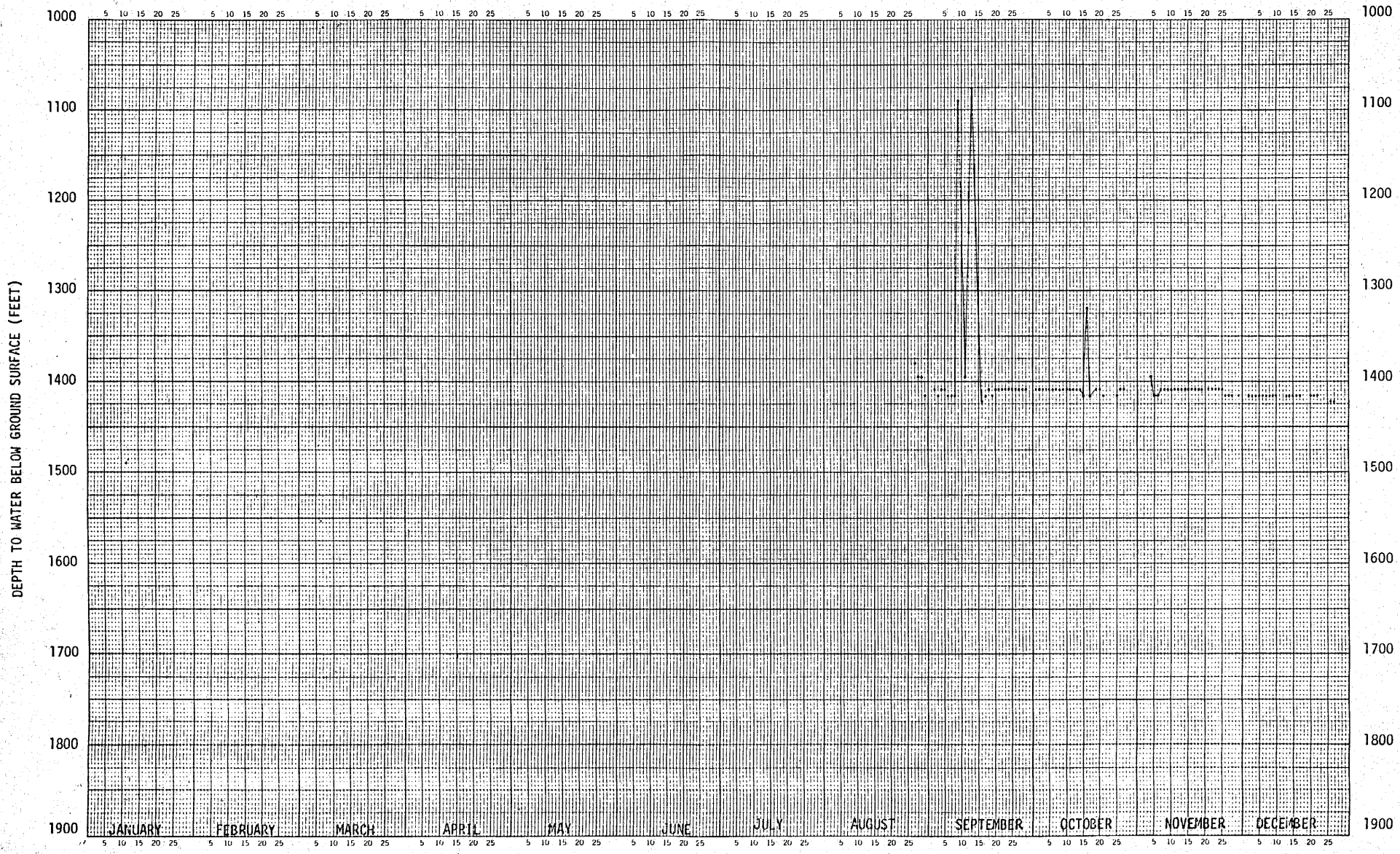

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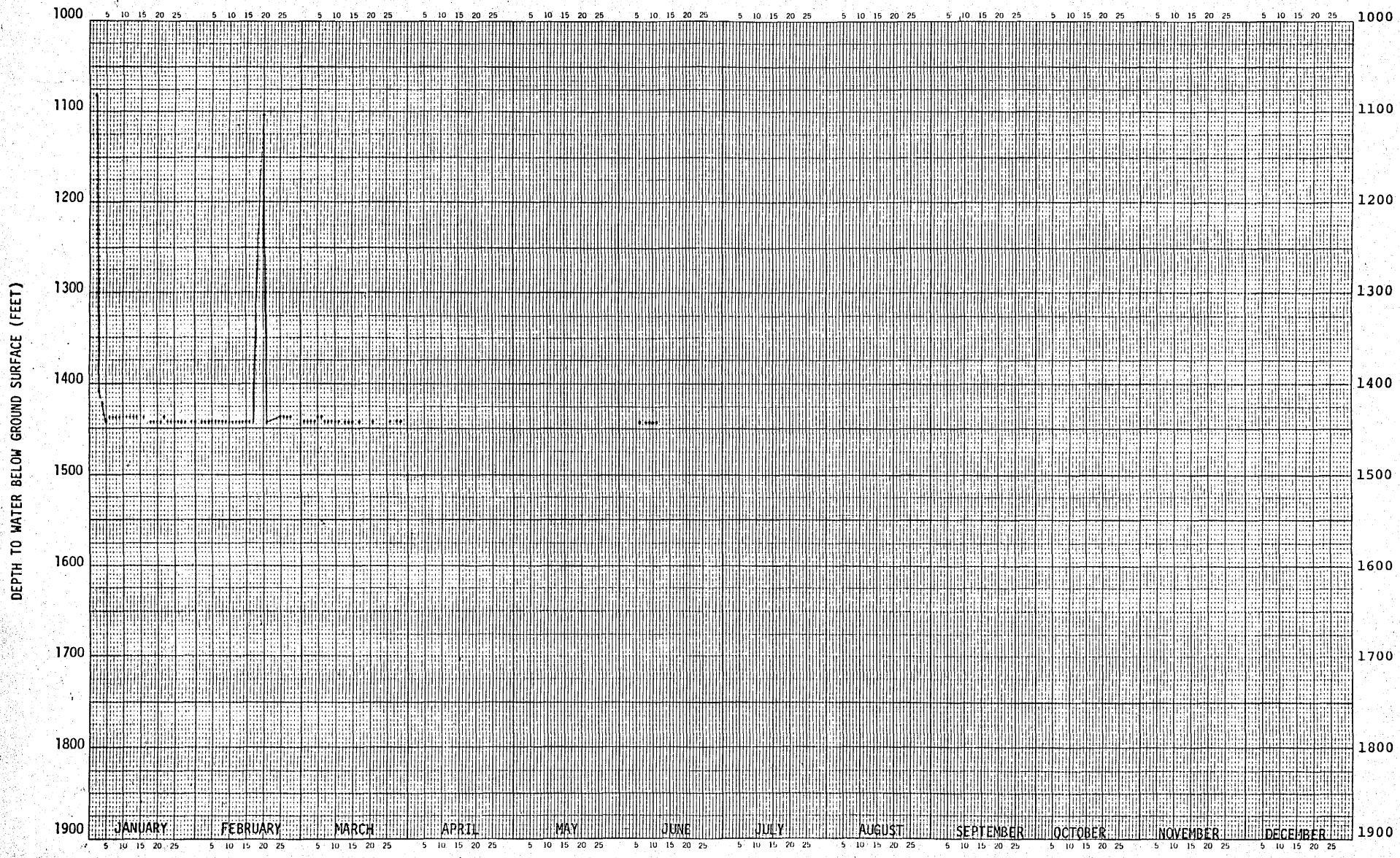

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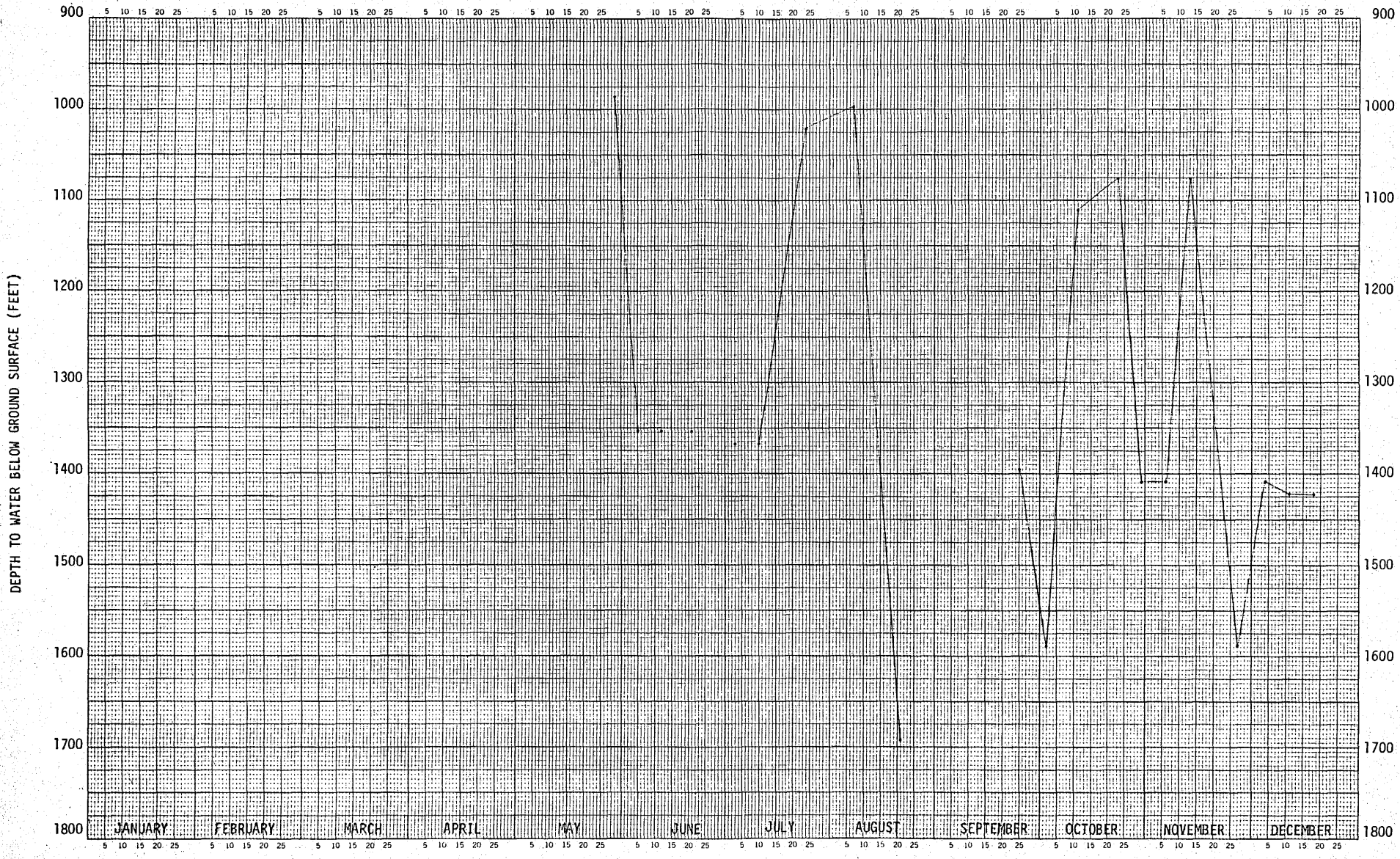

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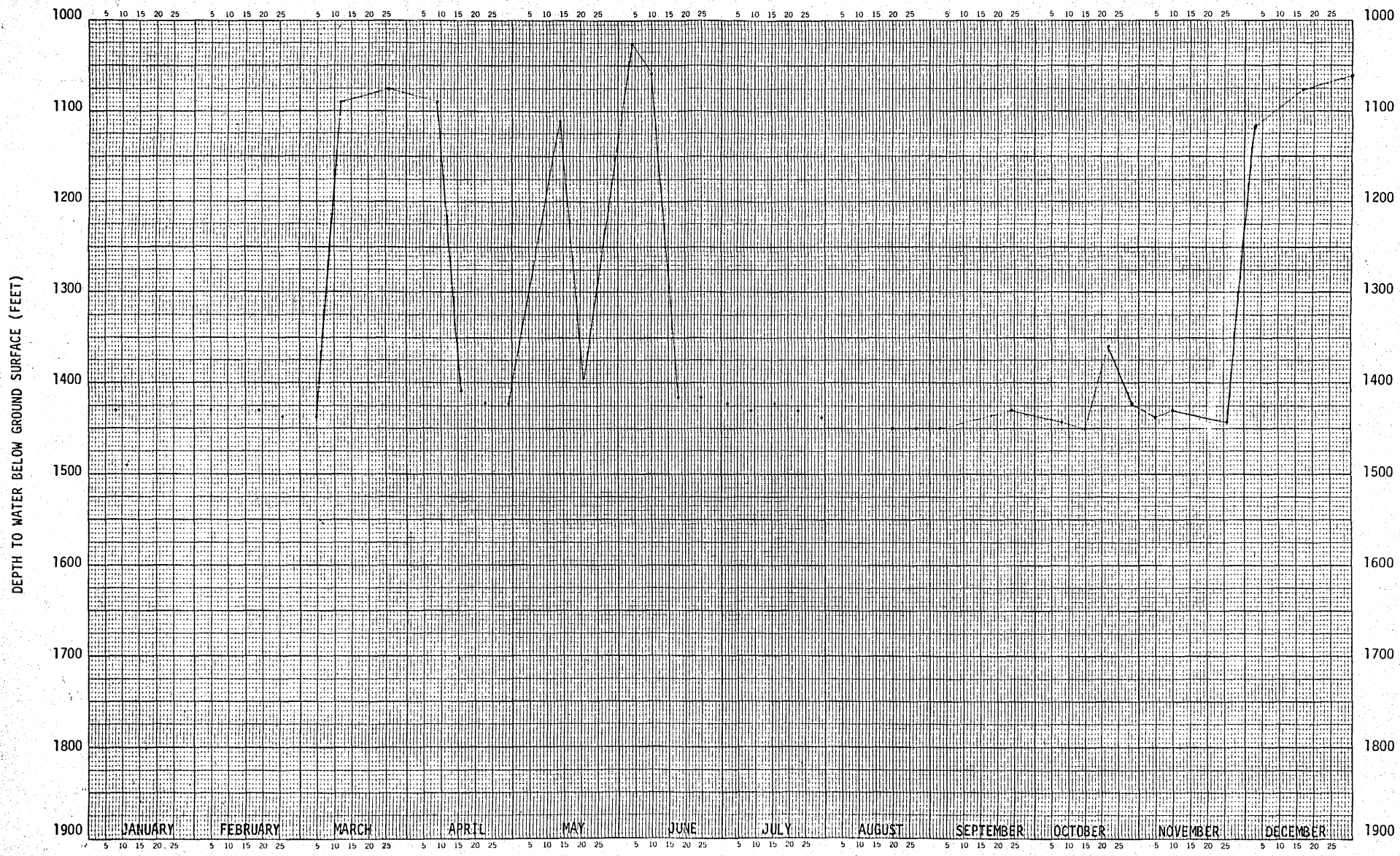

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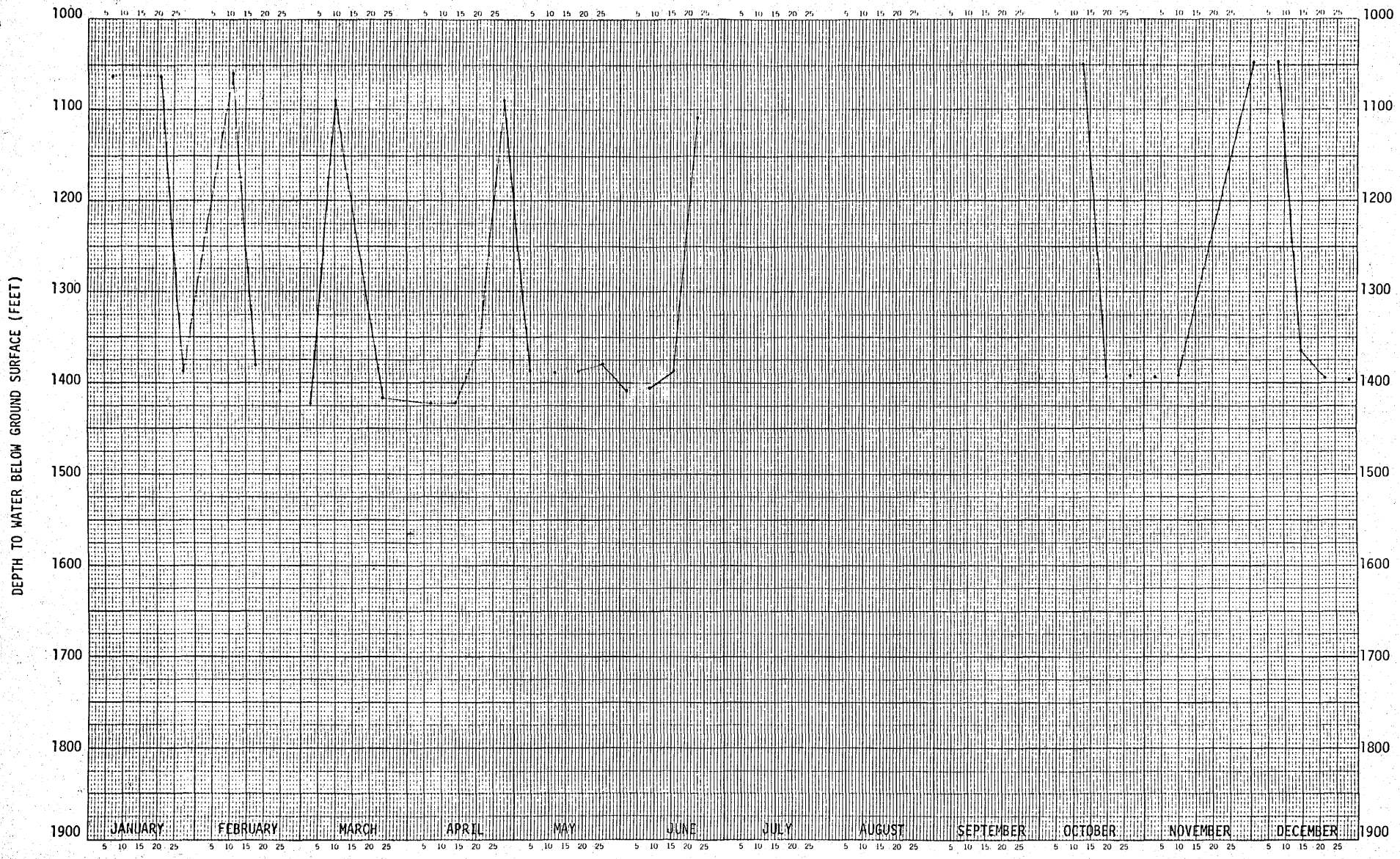

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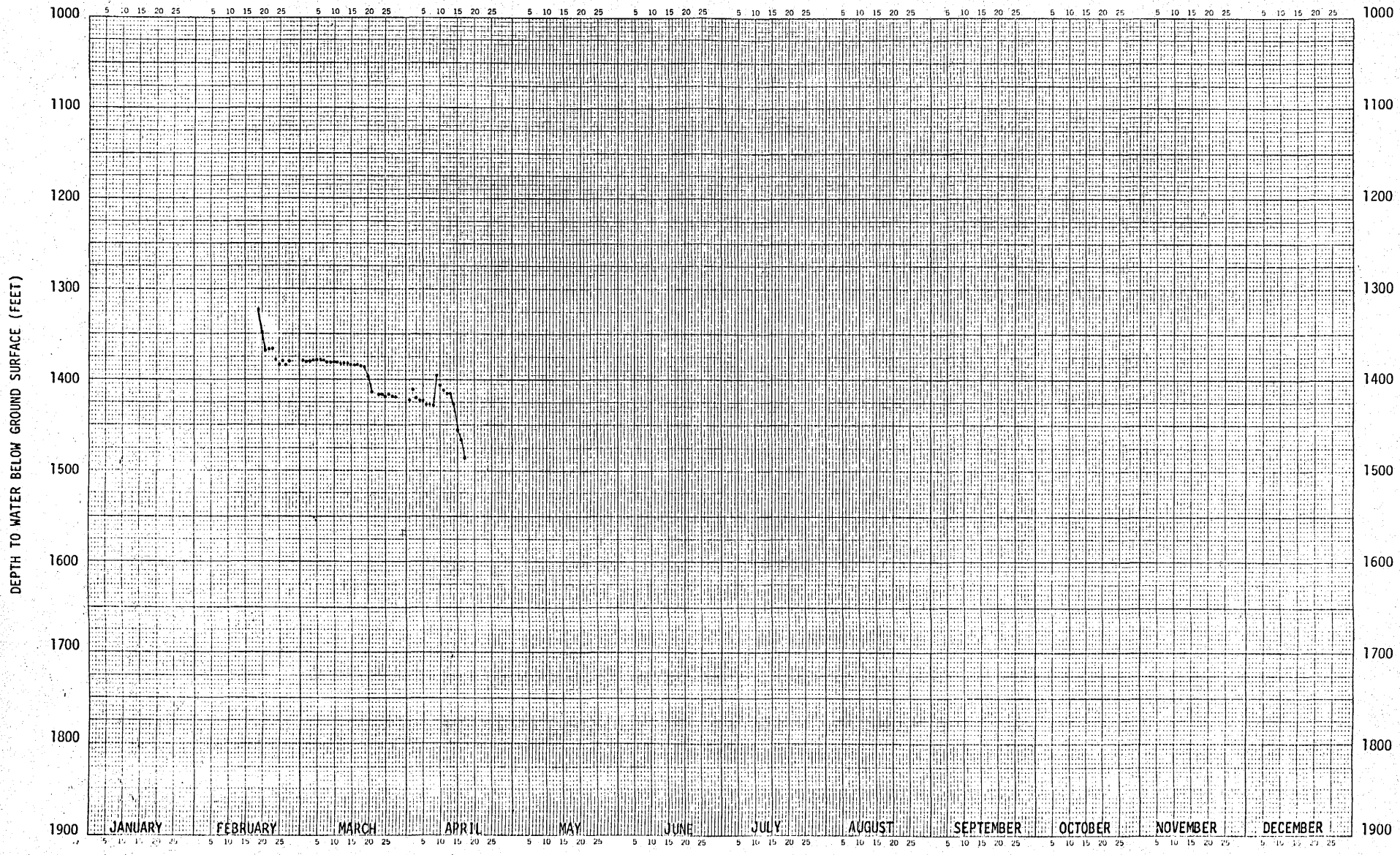

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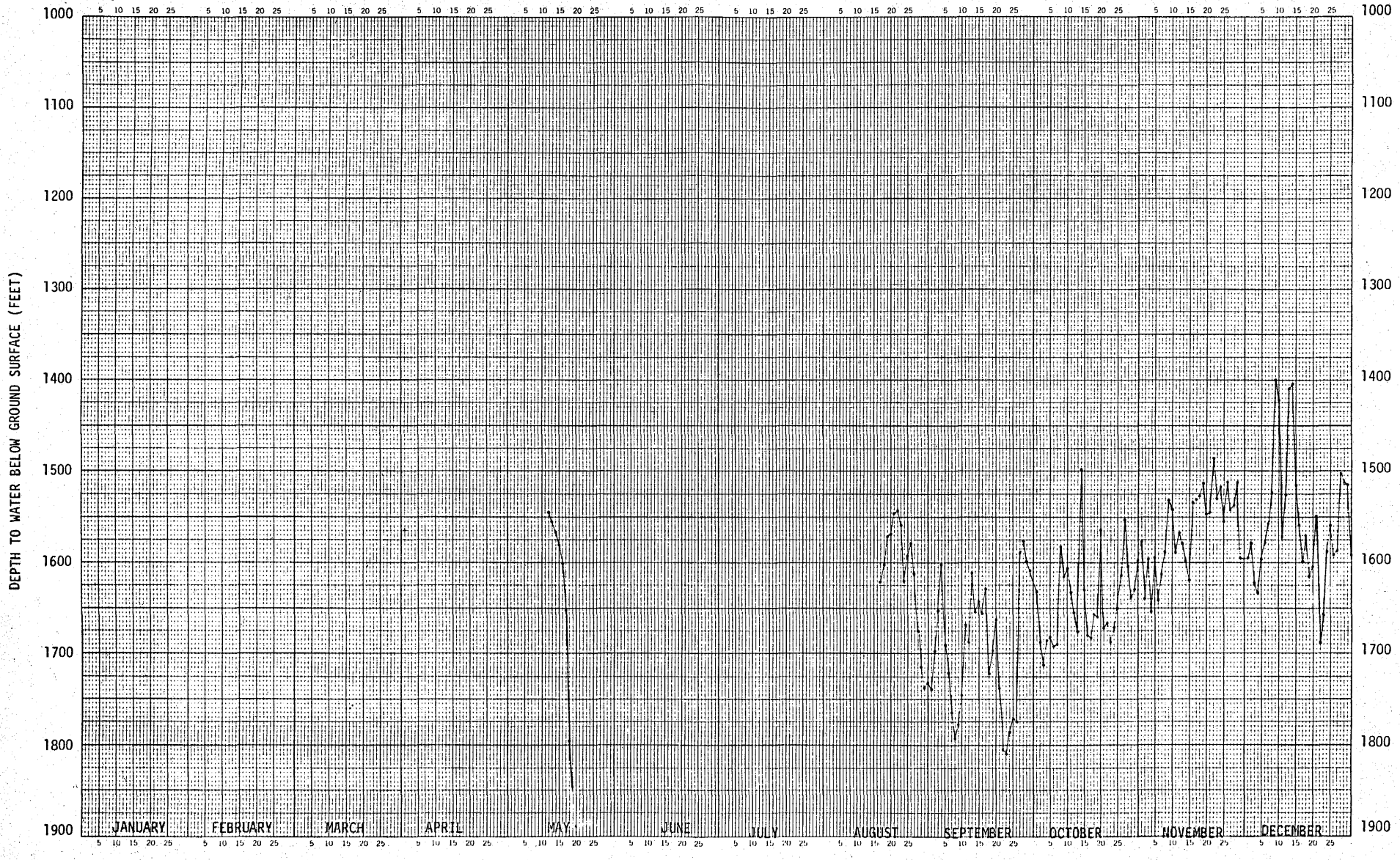

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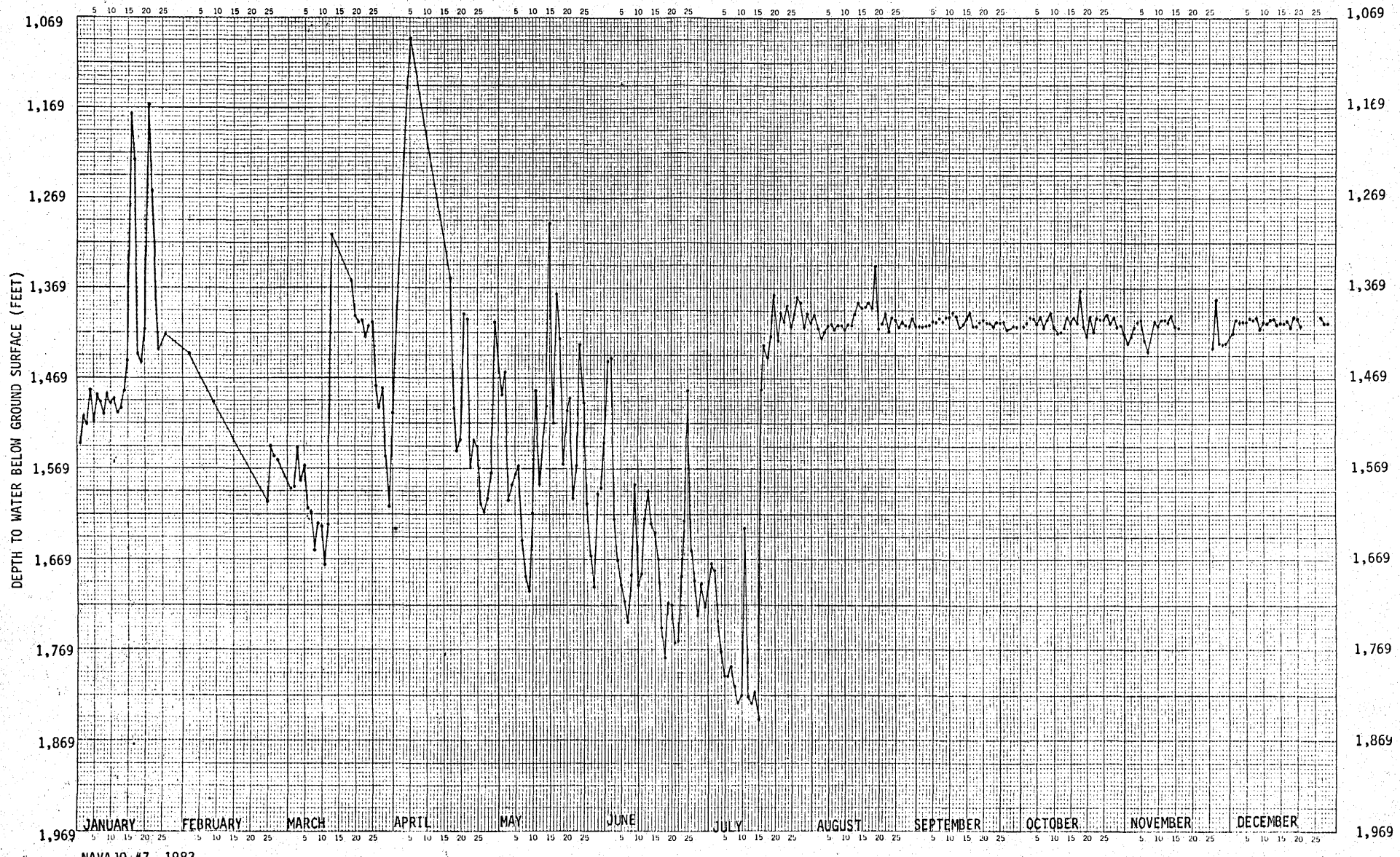

NAVAJO #7, 1983

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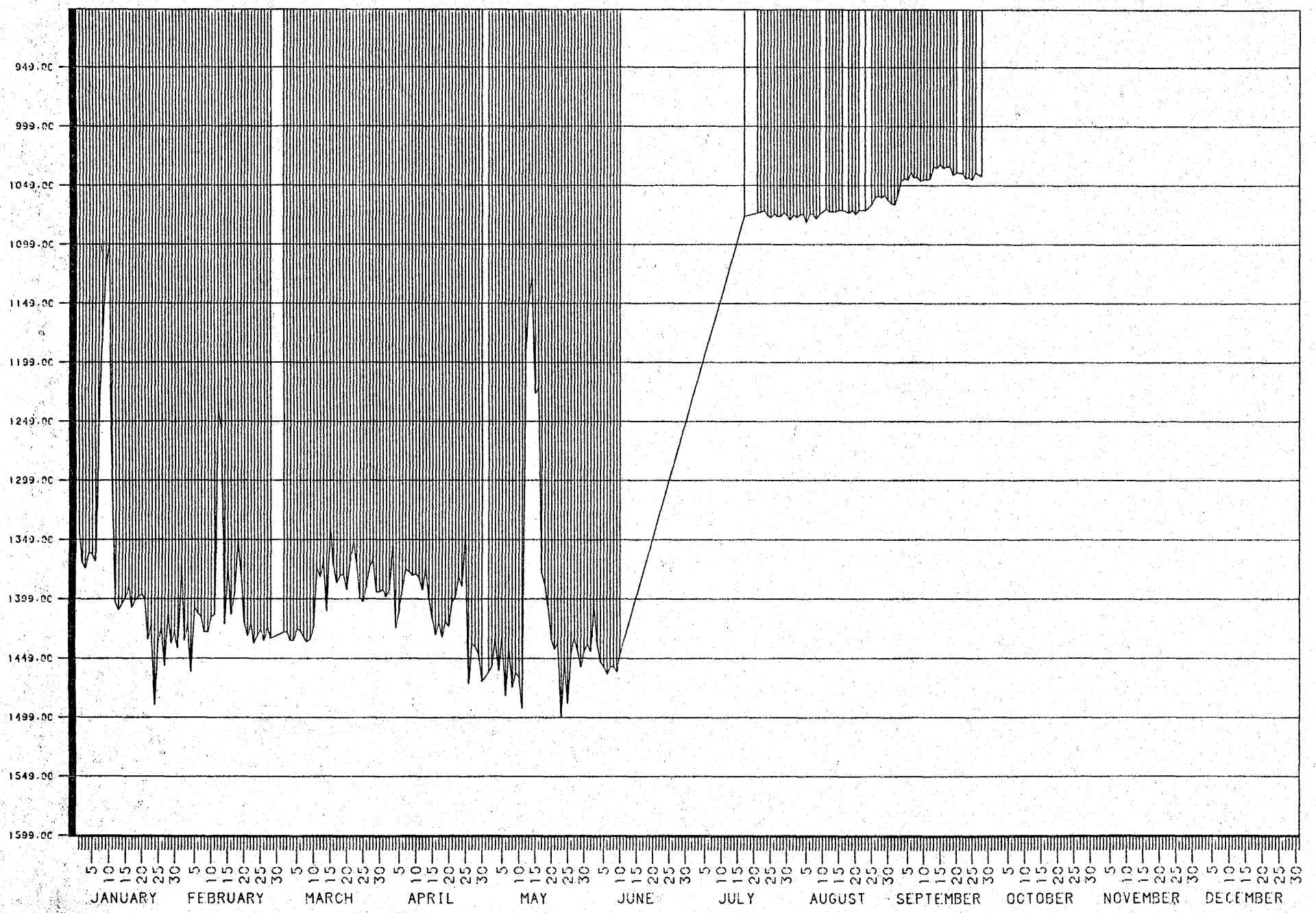

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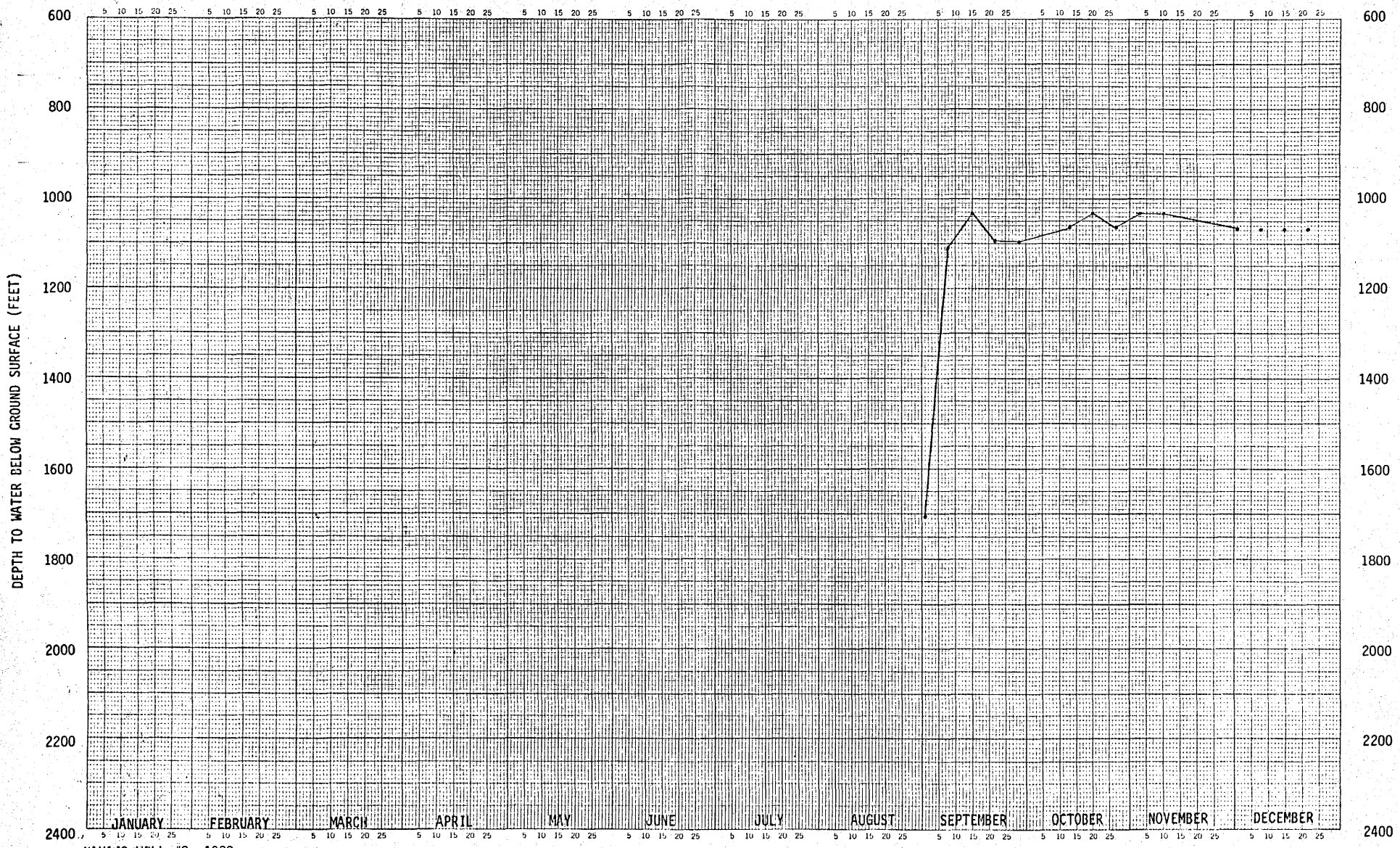
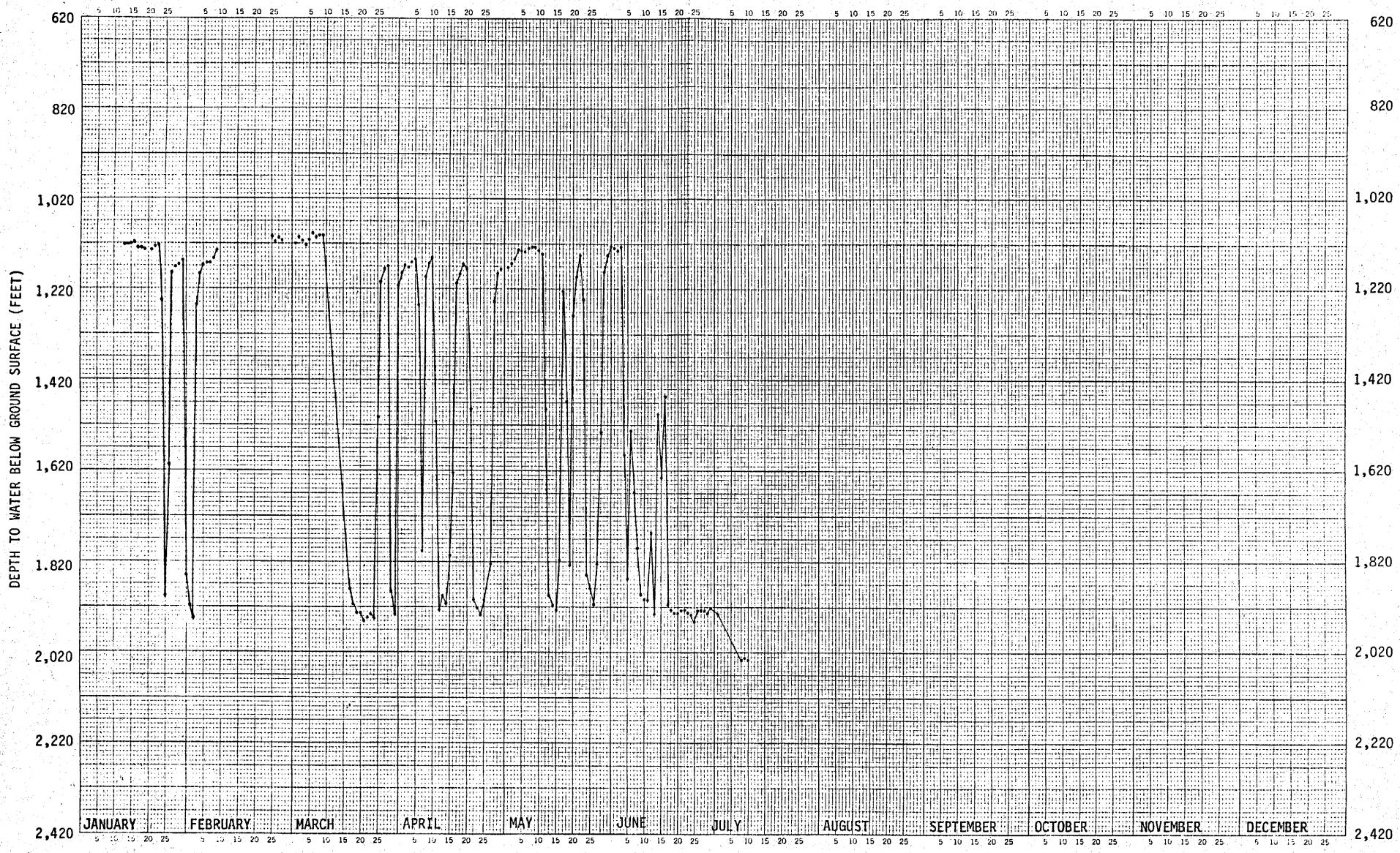


NAVAJO WELL #8, 1980

NAVAJO WELL #8, 1981

NAVAJO WELL #8, 1982



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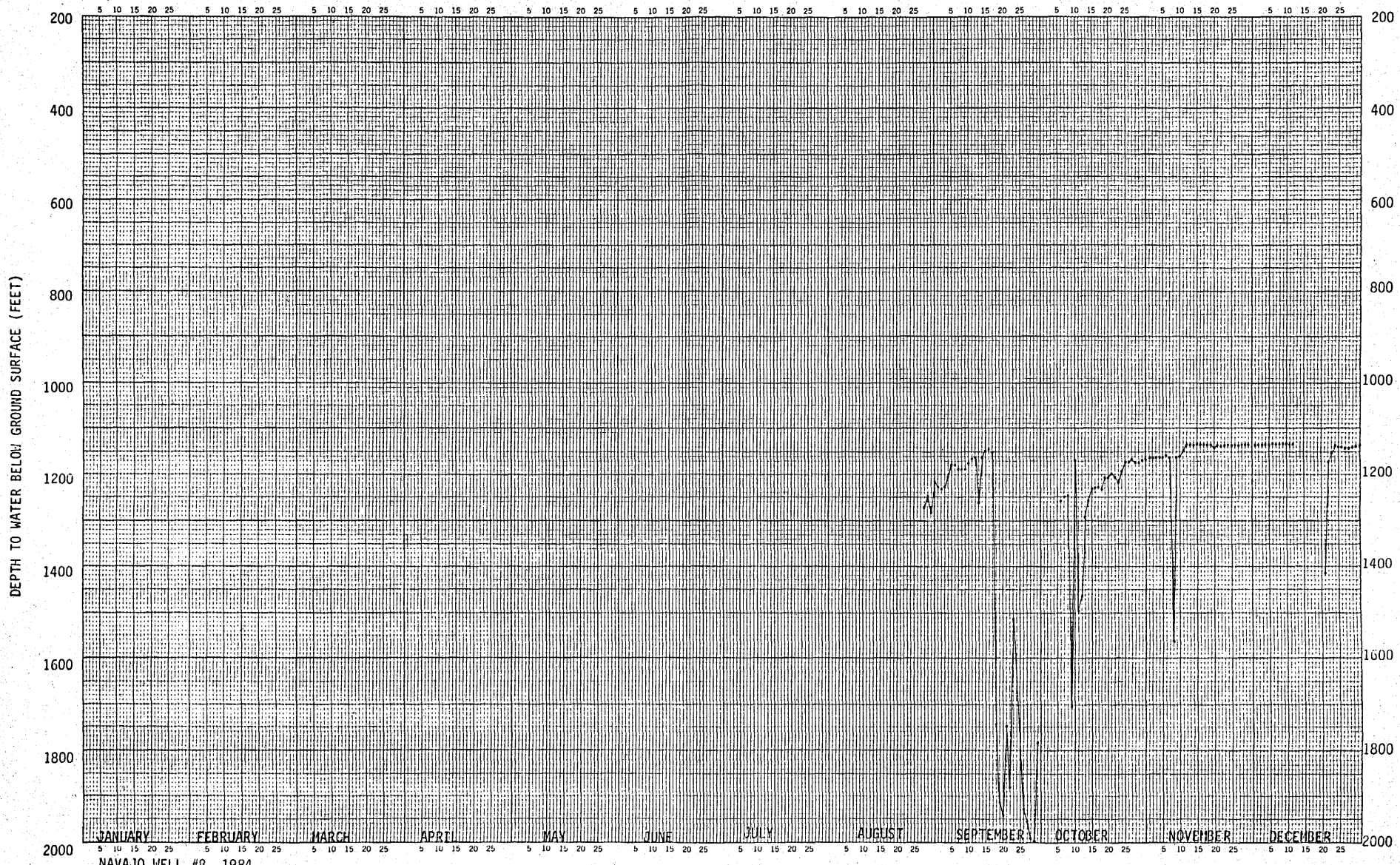

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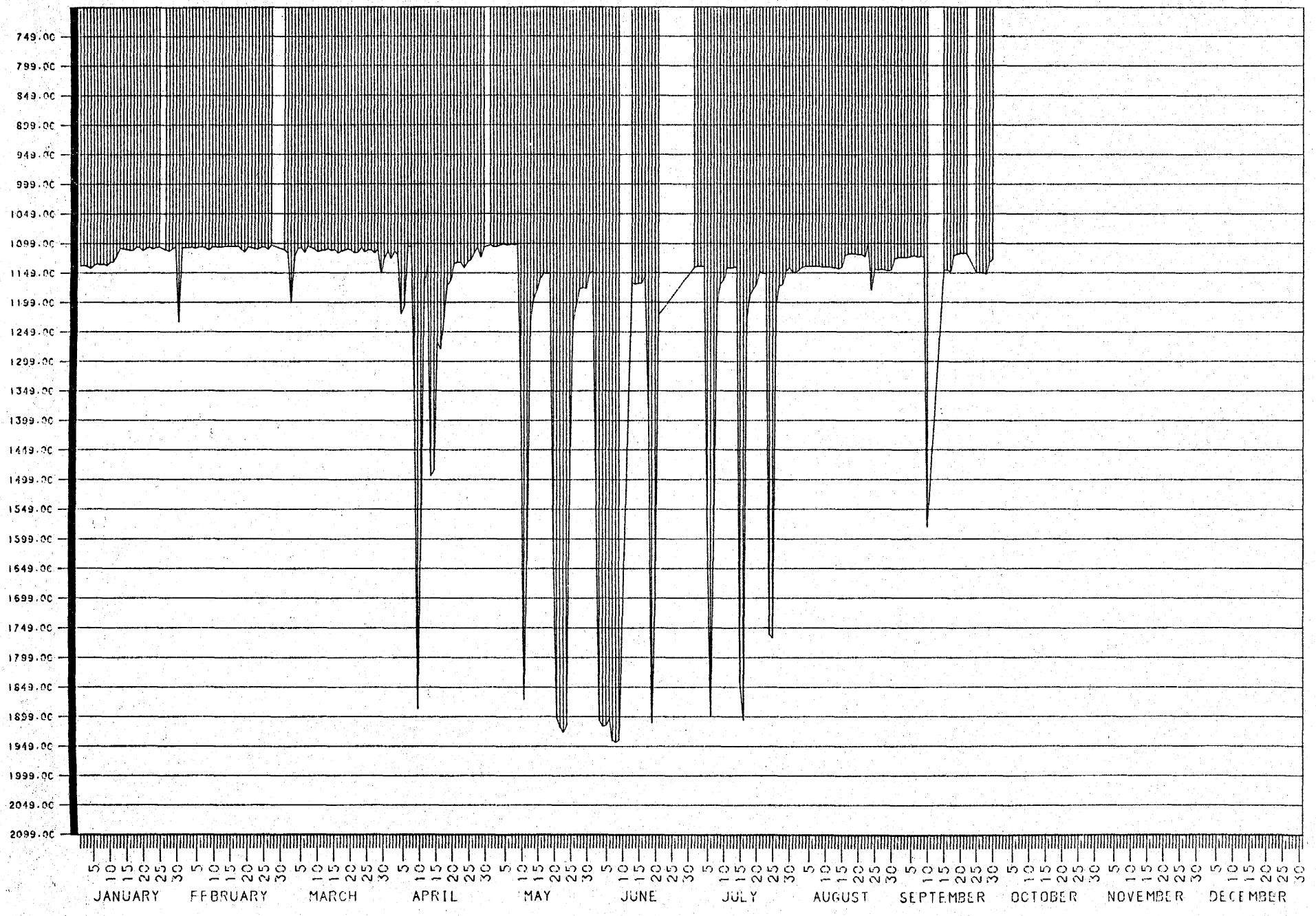

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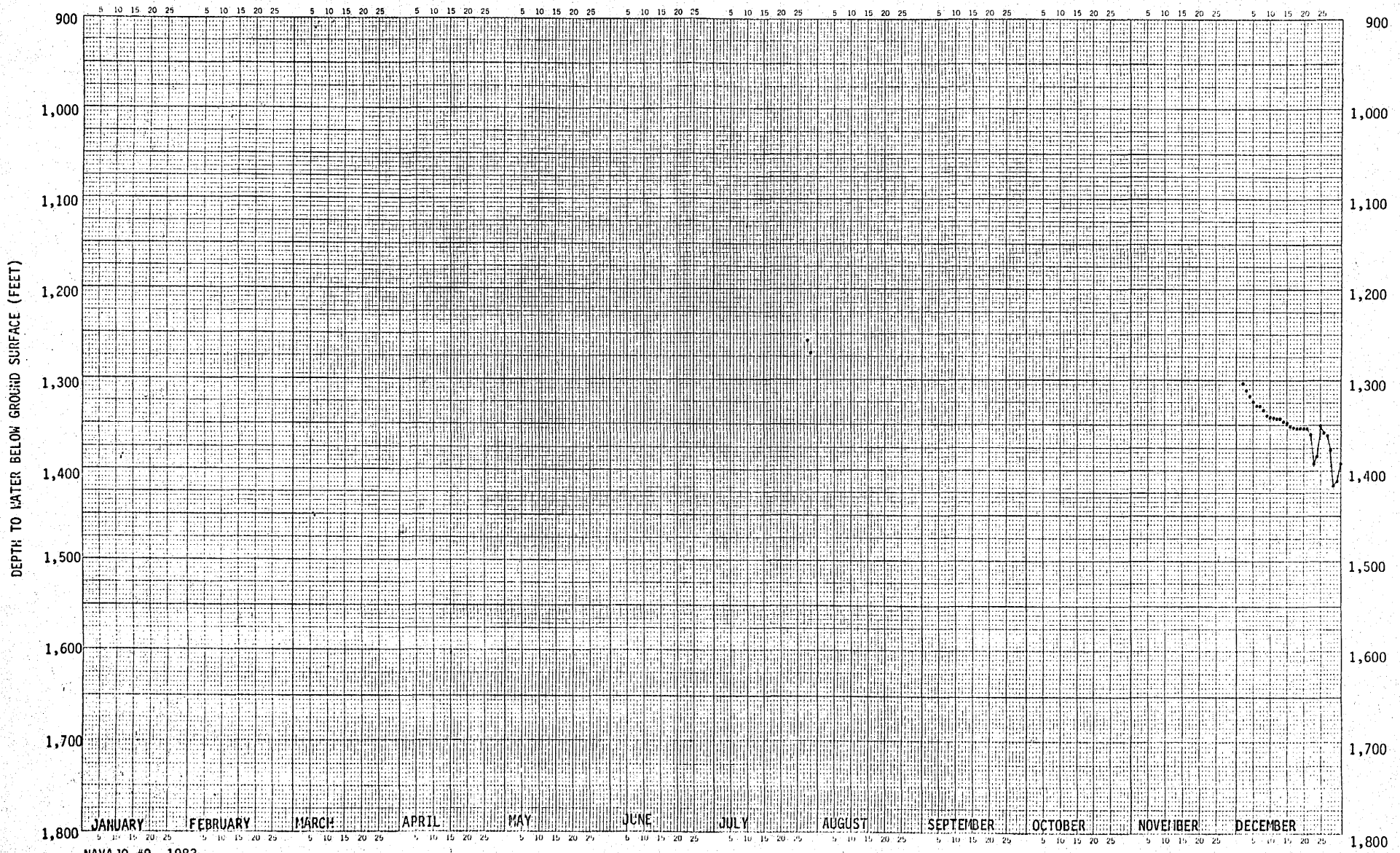
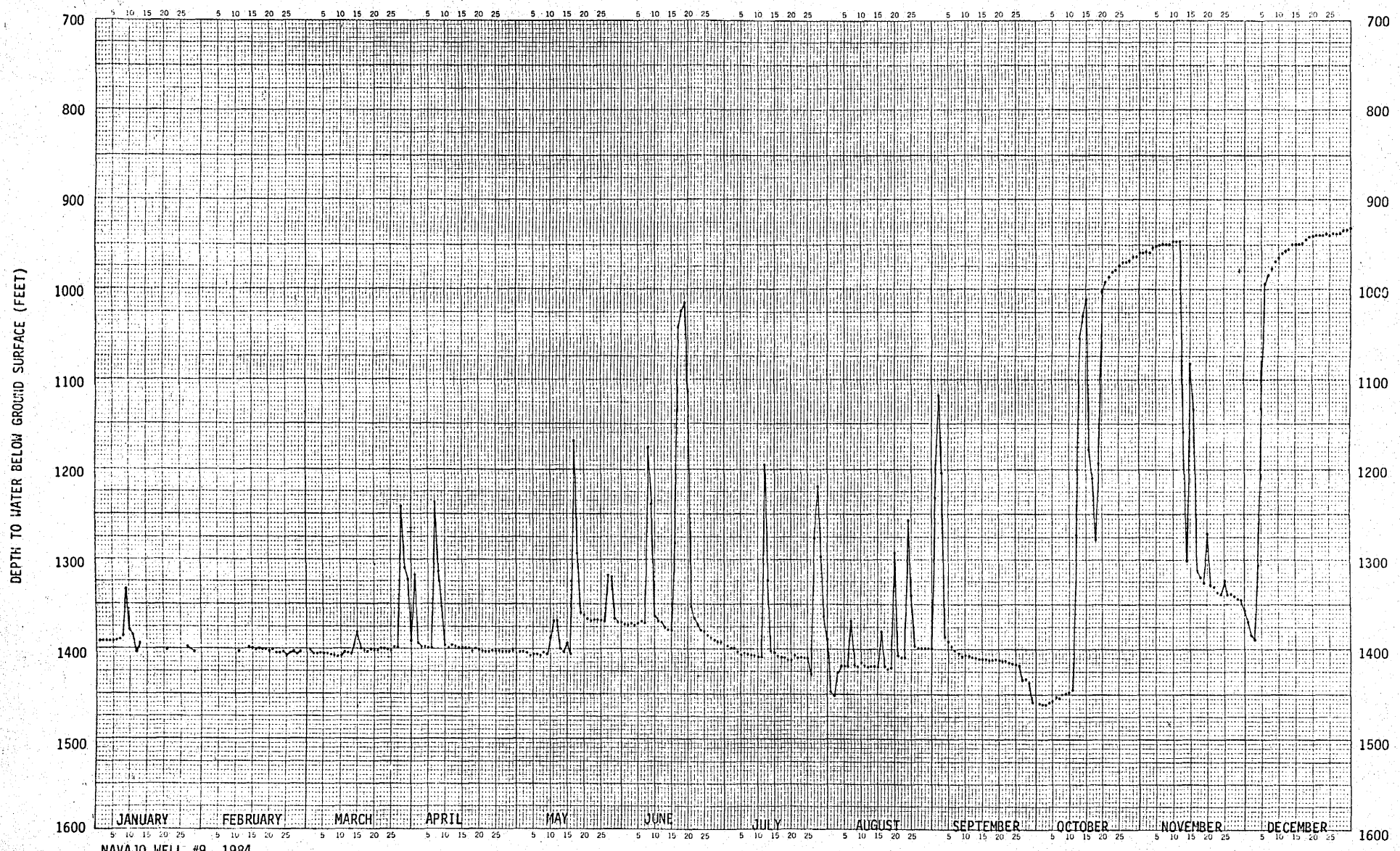


NAVAJO #9, 1983



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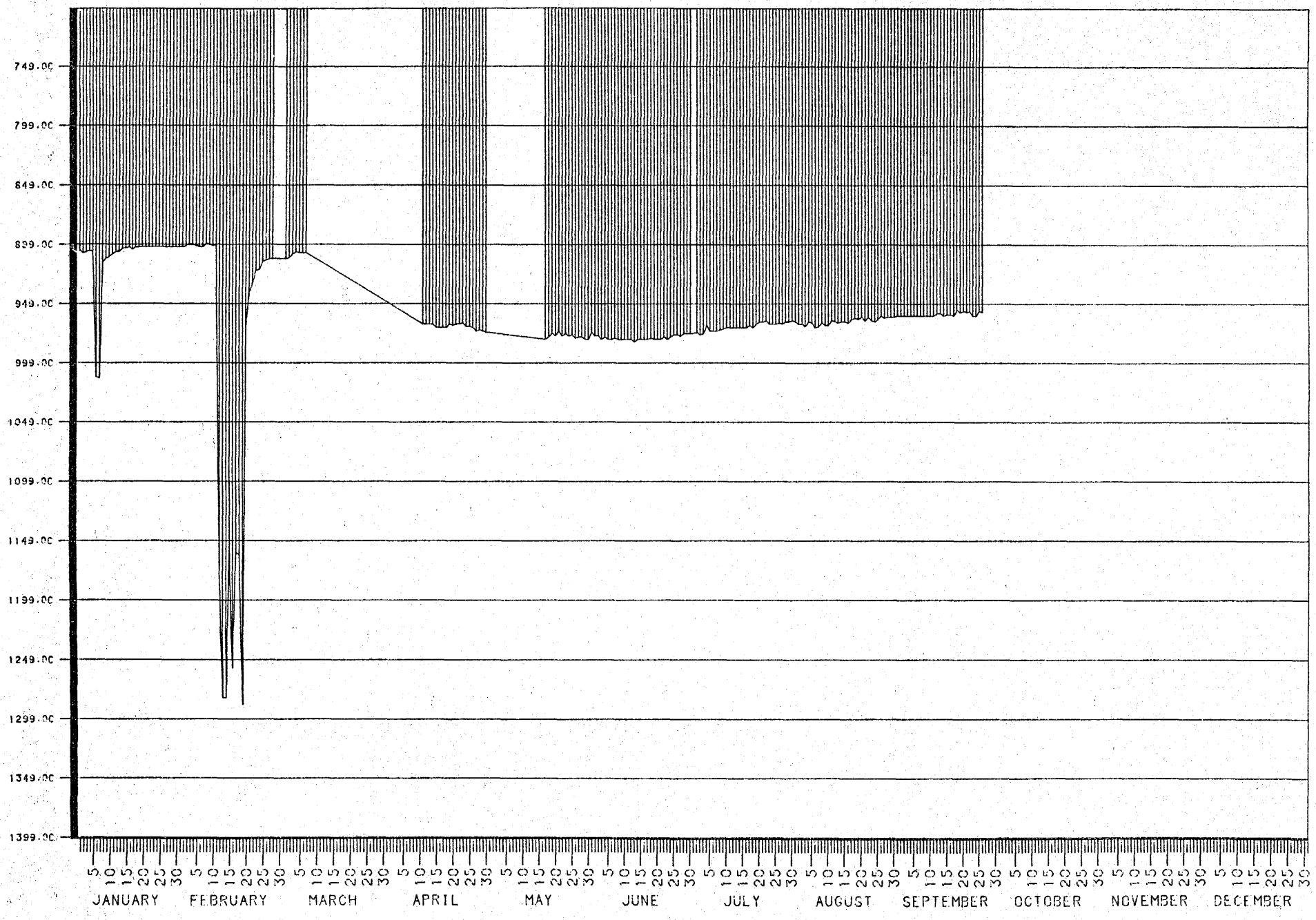

NAVAJO WELL #9,1985

ATTACHMENT 23

Statistical Summary of Selected Water
Quality Parameters for Navajo Wells
(1980 - 1985)

PEABODY COAL COMPANY
ARIZONA DIVISION
WELL WATER QUALITY STATISTICS

VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0250 SAMPPT=0020										
AK4	ALK AS CACO3, PH 4.5	MG_L	14	73.62	8.73	62.60	91.10	2.33	1030.70	76.29
CD	CADMIUM, DISSOLVED	UG_L	14	6.21	2.22	4.00	10.00	0.59	87.00	4.95
CA	CALCIUM, DISSOLVED	MG_L	13	8.69	1.43	7.10	12.00	0.40	113.00	2.03
CL	CHLORIDE	MG_L	14	5.53	3.93	1.00	11.70	1.05	77.40	15.42
F	FLUORIDE	MG_L	14	0.16	0.08	0.10	0.40	0.02	2.18	0.01
FET	IRON, TOTAL	MG_L	13	0.17	0.12	0.04	0.43	0.03	2.27	0.01
PB	LEAD, DISSOLVED	UG_L	14	29.29	13.85	20.00	50.00	3.70	410.00	191.76
MG	MAGNESIUM, DISSOLVED	MG_L	14	0.75	0.43	0.10	1.50	0.11	10.50	0.18
MNT	MANGANESE, TOTAL	MG_L	13	0.03	0.03	0.01	0.10	0.01	0.41	0.00
N_3	NITRATE NITROGEN _N	MG_L	14	0.84	0.76	0.00	3.18	0.20	11.74	0.58
K	POTASSIUM, DISSOLVED	MG_L	14	1.39	0.76	0.70	3.00	0.20	19.50	0.58
SE	SELENIUM, DISSOLVED	UG_L	14	13.21	11.03	5.00	50.00	2.95	185.00	121.57
NA	SODIUM, DISSOLVED	MG_L	14	36.26	9.31	21.00	52.60	2.49	507.60	86.74
SD	SOLIDS, DISSOLVED	MG_L	13	147.85	40.27	78.00	253.00	11.17	1922.00	1621.97
SO4	SULFATE	MG_L	14	14.71	8.70	1.00	29.00	2.32	206.00	75.60
MINENO=0250 SAMPPT=0021										
AK4	ALK AS CACO3, PH 4.5	MG_L	16	88.56	16.46	55.40	113.10	4.12	1416.90	270.99
CD	CADMIUM, DISSOLVED	UG_L	16	6.00	2.50	2.00	10.00	0.63	96.00	6.27
CA	CALCIUM, DISSOLVED	MG_L	16	3.27	0.90	2.00	6.00	0.23	52.40	0.81
CL	CHLORIDE	MG_L	16	5.82	3.20	1.00	12.00	0.80	93.20	10.24
F	FLUORIDE	MG_L	16	0.20	0.07	0.10	0.30	0.02	3.20	0.00
FET	IRON, TOTAL	MG_L	15	0.24	0.24	0.02	0.79	0.06	3.55	0.06
PB	LEAD, DISSOLVED	UG_L	16	30.00	14.14	20.00	50.00	3.54	480.00	200.00
MG	MAGNESIUM, DISSOLVED	MG_L	16	0.61	0.42	0.10	1.00	0.10	9.70	0.17
MNT	MANGANESE, TOTAL	MG_L	15	0.02	0.02	0.01	0.10	0.01	0.37	0.00
N_3	NITRATE NITROGEN _N	MG_L	16	0.83	0.69	0.20	3.18	0.17	13.36	0.47
K	POTASSIUM, DISSOLVED	MG_L	16	1.06	0.52	0.50	2.80	0.13	17.00	0.27
SE	SELENIUM, DISSOLVED	UG_L	16	12.81	10.32	5.00	50.00	2.58	205.00	106.56
NA	SODIUM, DISSOLVED	MG_L	16	50.97	9.27	34.00	69.50	2.32	815.50	85.95
SD	SOLIDS, DISSOLVED	MG_L	16	168.94	45.09	59.00	272.00	11.27	2703.00	2032.73
SO4	SULFATE	MG_L	16	13.25	6.32	1.00	26.00	1.58	212.00	39.93

PEABODY COAL COMPANY
ARIZONA DIVISION
WELL WATER QUALITY STATISTICS

VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0250 SAMPPT=0022										
AK4	ALK AS CACO3, PH 4.5	MG_L	16	89.31	19.27	59.50	130.00	4.82	1428.90	371.36
CD	CADMIUM, DISSOLVED	UG_L	16	6.19	2.46	2.00	10.00	0.61	99.00	6.03
CA	CALCIUM, DISSOLVED	MG_L	16	5.39	3.51	2.10	14.00	0.88	86.30	12.30
CL	CHLORIDE	MG_L	16	7.12	3.50	1.00	14.00	0.88	113.90	12.25
F	FLUORIDE	MG_L	16	0.19	0.08	0.10	0.40	0.02	3.11	0.01
FET	IRON, TOTAL	MG_L	15	0.33	0.40	0.06	1.30	0.10	5.02	0.16
PB	LEAD, DISSOLVED	UG_L	16	30.00	14.14	20.00	50.00	3.54	480.00	200.00
MG	MAGNESIUM, DISSOLVED	MG_L	16	0.76	0.73	0.10	3.00	0.18	12.20	0.53
MNT	MANGANESE, TOTAL	MG_L	15	0.03	0.02	0.01	0.10	0.01	0.40	0.00
N_3	NITRATE NITROGEN _N	MG_L	16	1.47	1.95	0.20	6.80	0.49	23.47	3.80
K	POTASSIUM, DISSOLVED	MG_L	16	1.51	1.37	0.50	5.50	0.34	24.20	1.89
SE	SELENIUM, DISSOLVED	UG_L	16	12.81	10.32	5.00	50.00	2.58	205.00	106.56
NA	SODIUM, DISSOLVED	MG_L	16	48.01	11.58	24.00	72.00	2.90	768.20	134.16
SD	SOLIDS, DISSOLVED	MG_L	16	174.81	39.60	102.00	238.00	9.90	2797.00	1567.90
SO4	SULFATE	MG_L	16	15.81	9.81	1.00	40.00	2.45	253.00	96.30
MINENO=0250 SAMPPT=0024										
AK4	ALK AS CACO3, PH 4.5	MG_L	16	76.69	17.93	41.60	111.00	4.48	1227.00	321.37
CD	CADMIUM, DISSOLVED	UG_L	17	6.30	2.57	2.00	10.00	0.62	107.10	6.58
CA	CALCIUM, DISSOLVED	MG_L	17	5.54	5.16	1.00	25.00	1.25	94.20	26.62
CL	CHLORIDE	MG_L	17	6.98	3.91	1.00	15.80	0.95	118.60	15.26
F	FLUORIDE	MG_L	17	0.17	0.05	0.10	0.30	0.01	2.97	0.00
FET	IRON, TOTAL	MG_L	16	0.48	1.36	0.02	5.57	0.34	7.71	1.85
PB	LEAD, DISSOLVED	UG_L	17	29.41	13.91	20.00	50.00	3.37	500.00	193.38
MG	MAGNESIUM, DISSOLVED	MG_L	17	0.89	0.91	0.10	4.10	0.22	15.20	0.82
MNT	MANGANESE, TOTAL	MG_L	16	0.03	0.03	0.01	0.13	0.01	0.56	0.00
N_3	NITRATE NITROGEN _N	MG_L	17	7.41	19.23	0.10	77.10	4.66	126.04	369.63
K	POTASSIUM, DISSOLVED	MG_L	17	0.96	0.38	0.40	2.10	0.09	16.30	0.14
SE	SELENIUM, DISSOLVED	UG_L	17	13.24	10.15	5.00	50.00	2.46	225.00	102.94
NA	SODIUM, DISSOLVED	MG_L	17	43.20	6.27	39.00	64.00	1.52	734.40	39.28
SD	SOLIDS, DISSOLVED	MG_L	17	157.35	46.30	77.00	266.00	11.23	2675.00	2143.37
SO4	SULFATE	MG_L	17	13.76	6.32	4.00	28.00	1.53	234.00	39.94

PEABODY COAL COMPANY
ARIZONA DIVISION
WELL WATER QUALITY STATISTICS

VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
MINENO=0250 SAMPPT=0028										
AK4	ALK AS CACO3, PH 4.5	MG_L	15	84.87	14.34	55.00	104.30	3.70	1273.00	205.57
CD	CADMIUM, DISSOLVED	UG_L	15	6.27	2.52	2.00	10.00	0.65	94.00	6.35
CA	CALCIUM, DISSOLVED	MG_L	15	3.48	0.66	2.00	5.00	0.17	52.20	0.44
CL	CHLORIDE	MG_L	15	7.13	4.36	1.00	15.10	1.13	107.00	19.02
F	FLUORIDE	MG_L	15	0.33	0.13	0.10	0.50	0.03	4.94	0.02
FET	IRON, TOTAL	MG_L	14	0.23	0.50	0.02	1.95	0.13	3.26	0.25
PB	LEAD, DISSOLVED	UG_L	15	30.00	14.64	20.00	50.00	3.78	450.00	214.29
MG	MAGNESIUM, DISSOLVED	MG_L	15	0.73	0.77	0.10	3.00	0.20	10.90	0.59
MNT	MANGANESE, TOTAL	MG_L	14	0.03	0.02	0.01	0.10	0.01	0.42	0.00
N_3	NITRATE NITROGEN _N	MG_L	15	0.84	0.70	0.20	3.18	0.18	12.57	0.50
K	POTASSIUM, DISSOLVED	MG_L	15	1.07	0.59	0.50	3.00	0.15	16.10	0.35
SE	SELENIUM, DISSOLVED	UG_L	15	13.00	10.66	5.00	50.00	2.75	195.00	113.57
NA	SODIUM, DISSOLVED	MG_L	15	47.29	7.62	31.00	61.00	1.97	709.40	58.03
SD	SOLIDS, DISSOLVED	MG_L	15	152.00	54.97	69.00	290.00	14.19	2280.00	3021.71
SO4	SULFATE	MG_L	15	11.93	6.23	1.00	29.00	1.61	179.00	38.78
MINENO=0250 SAMPPT=0030										
AK4	ALK AS CACO3, PH 4.5	MG_L	16	75.72	9.74	50.60	91.10	2.43	1211.50	94.85
CD	CADMIUM, DISSOLVED	UG_L	16	6.25	2.79	1.00	10.00	0.70	100.00	7.80
CA	CALCIUM, DISSOLVED	MG_L	15	3.82	0.71	2.50	5.50	0.18	57.30	0.51
CL	CHLORIDE	MG_L	16	7.66	5.35	1.00	22.30	1.34	122.50	28.58
F	FLUORIDE	MG_L	16	0.18	0.04	0.10	0.24	0.01	2.93	0.00
FET	IRON, TOTAL	MG_L	15	0.25	0.33	0.01	1.29	0.09	3.71	0.11
PB	LEAD, DISSOLVED	UG_L	16	31.25	15.00	20.00	50.00	3.75	500.00	225.00
MG	MAGNESIUM, DISSOLVED	MG_L	15	0.92	1.09	0.00	4.60	0.28	13.80	1.20
MNT	MANGANESE, TOTAL	MG_L	15	0.07	0.19	0.01	0.74	0.05	1.08	0.03
N_3	NITRATE NITROGEN _N	MG_L	16	3.92	7.71	0.20	29.70	1.93	62.65	59.41
K	POTASSIUM, DISSOLVED	MG_L	16	1.17	0.61	0.60	3.00	0.15	18.80	0.37
SE	SELENIUM, DISSOLVED	UG_L	16	12.81	10.32	5.00	50.00	2.58	205.00	106.56
NA	SODIUM, DISSOLVED	MG_L	14	44.19	4.91	34.00	55.70	1.31	618.70	24.11
SD	SOLIDS, DISSOLVED	MG_L	16	166.50	39.44	113.00	259.00	9.86	2664.00	1555.20
SO4	SULFATE	MG_L	16	13.63	7.26	1.00	24.00	1.81	218.00	52.65

PEABODY COAL COMPANY
ARIZONA DIVISION
WELL WATER QUALITY STATISTICS

MINENO=0252 SAMPPT=0115

VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
AK4	ALK AS CACO3, PH 4.5	MG_L	13	103.73	30.79	56.50	157.00	8.54	1348.50	947.73
CD	CADMIUM, DISSOLVED	UG_L	13	6.00	2.35	3.00	10.00	0.65	78.00	5.50
CA	CALCIUM, DISSOLVED	MG_L	13	23.62	7.86	1.00	30.50	2.18	307.10	61.80
CL	CHLORIDE	MG_L	13	9.18	3.55	3.90	15.80	0.98	119.30	12.60
F	FLUORIDE	MG_L	13	0.19	0.05	0.10	0.30	0.01	2.48	0.00
FET	IRON, TOTAL	MG_L	13	0.92	1.86	0.10	6.81	0.52	11.94	3.47
PB	LEAD, DISSOLVED	UG_L	13	28.46	13.45	20.00	50.00	3.73	370.00	180.77
MG	MAGNESIUM, DISSOLVED	MG_L	13	4.02	1.67	1.00	6.00	0.46	52.30	2.80
MNT	MANGANESE, TOTAL	MG_L	13	0.04	0.03	0.02	0.10	0.01	0.53	0.00
N_3	NITRATE NITROGEN _N	MG_L	13	1.64	1.72	0.30	7.14	0.48	21.36	2.97
K	POTASSIUM, DISSOLVED	MG_L	13	3.55	0.97	2.00	5.00	0.27	46.10	0.95
SE	SELENIUM, DISSOLVED	UG_L	13	10.38	3.20	5.00	20.00	0.89	135.00	10.26
NA	SODIUM, DISSOLVED	MG_L	13	91.74	26.58	61.00	126.00	7.37	1192.60	706.47
SD	SOLIDS, DISSOLVED	MG_L	13	403.92	110.30	268.00	560.00	30.59	5251.00	12165.24
SO4	SULFATE	MG_L	13	151.69	42.22	100.00	210.00	11.71	1972.00	1782.23

PEABODY COAL COMPANY
ARIZONA DIVISION
WELL WATER QUALITY STATISTICS

MINENO=0250 SAMPPT=0156

VARIABLE	LABEL		N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE
AK4	ALK AS CACO3, PH 4.5	MG_L	6	69.30	28.22	44.60	125.10	11.52	415.80	796.57
CD	CADMIUM, DISSOLVED	UG_L	6	5.00	0.00	5.00	5.00	0.00	30.00	0.00
CA	CALCIUM, DISSOLVED	MG_L	6	3.95	1.70	2.00	7.00	0.69	23.70	2.89
CL	CHLORIDE	MG_L	6	2.60	1.92	1.00	6.00	0.78	15.60	3.68
F	FLUORIDE	MG_L	6	0.17	0.05	0.10	0.20	0.02	1.00	0.00
FET	IRON, TOTAL	MG_L	6	0.38	0.48	0.10	1.30	0.20	2.26	0.23
PB	LEAD, DISSOLVED	UG_L	6	20.00	0.00	20.00	20.00	0.00	120.00	0.00
MG	MAGNESIUM, DISSOLVED	MG_L	6	1.02	0.04	1.00	1.10	0.02	6.10	0.00
MNT	MANGANESE, TOTAL	MG_L	6	0.02	0.00	0.02	0.02	0.00	0.12	0.00
N_3	NITRATE NITROGEN _N	MG_L	6	0.57	0.20	0.20	0.71	0.08	3.40	0.04
K	POTASSIUM, DISSOLVED	MG_L	6	1.10	0.24	1.00	1.60	0.10	6.60	0.06
SE	SELENIUM, DISSOLVED	UG_L	6	10.00	0.00	10.00	10.00	0.00	60.00	0.00
NA	SODIUM, DISSOLVED	MG_L	6	39.17	13.89	31.00	67.00	5.67	235.00	192.97
SD	SOLIDS, DISSOLVED	MG_L	6	140.67	55.42	98.00	250.00	22.63	844.00	3071.47
SO4	SULFATE	MG_L	6	3.50	2.59	1.00	8.00	1.06	21.00	6.70

ATTACHMENT 24

U.S. Geological Survey Annual Progress Reports

Black Mesa Monitoring Program

United States
Department of the Interior
Geological Survey

PROGRESS REPORT

ON

BLACK MESA MONITORING PROGRAM

1977

Tucson, Arizona

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Conversion Factors

Factors for converting English units to metric units are shown to four significant figures. In the text, however, the metric equivalents are shown only to the number of significant figures consistent with the values for the English units.

Multiply English unit	By	To obtain metric unit
acres	0.4047	hectares (ha)
acre-feet (acre-ft)	.001233	cubic hectometers (hm^3)
cubic feet per second (ft^3/s)	.02832	cubic meters per second (m^3/s)
feet (ft)	.3048	meters (m)
inches (in)	25.4	millimeters (mm)
miles (mi)	1.609	kilometers (km)
square miles (mi^2)	2.590	square kilometers (km^2)

Introduction

Black Mesa, in northeastern Arizona near the center of the Navajo Indian Reservation, is a prominent topographic high that is from 500 to 1,000 ft (150 to 300 m) above the surrounding area. The Black Mesa contains large deposits of strippable coal and Peabody Coal Company presently operates two strip mines in the area. The present emphasis on coal to meet the nation's energy needs may result in more extensive mining of this area in the future.

Coal from the strip mines is used to fire the Navajo electric generating plant at Page, Arizona and the Mohave electric generating plant near Bullhead City, Arizona. The coal is transported to the Mohave powerplant through a 275-mi (442-km) long coal slurry pipeline. Water for the pipeline operation is withdrawn near the coal mine site from the N aquifer underlying Black Mesa. The N aquifer consists of the Navajo Sandstone, the Kayenta Formation, the Moenave Formation and the Lukachukai member of the Wingate Sandstone. About 3,400 acre-ft (4.2 hm^3) of ground water was pumped from the aquifer annually from 1971 to 1976 for mining and pipeline operation.

Purpose

The Black Mesa monitoring program was initiated in 1971 in an attempt to monitor possible effects of strip-mining activities by Peabody Coal Company on the water resources of the Black Mesa. This ongoing project is funded jointly by the Arizona Water Commission with funds received from the Navajo Tribe, the Hopi Tribe, and Peabody Coal Company, and by the U.S. Geological Survey. In addition, Federal funds for energy-related studies have been available from 1975 to 1977 and have been used for construction purposes to expand the data-collection networks. The project is aimed at monitoring three possible problem areas: (1) increased sediment concentration in surface-water runoff as a result of strip-mining activities, (2) changes in the chemical quality of surface-water runoff as a result of strip-mining activities, and (3) regional decline of the potentiometric surface in the N aquifer as a result of ground-water withdrawals associated with the mining and slurry pipeline operation. In addition, sufficient data must be collected to determine whether the

ground-water pumping for mining operations will cause a lowering of the potentiometric surface at the nearby communities, and if so, to be able to differentiate between the decline resulting from pumping by Peabody Coal Company and that resulting from community pumping. This is required because under the coal-lease agreement, if, in the opinion of the Secretary of the Interior, withdrawals from the Peabody wells are adversely affecting the Navajo-Hopi ground-water supplies, then the coal lessee must obtain its water from other sources or replace the Indian sources with water of equal quality.

Area

lease area ~ 100 mi²

Black Mesa is a topographically high plateau covering about 2,000 mi^2 (5,200 km^2) near the center of the Navajo-Hopi Indian Reservation in northeastern Arizona. The altitude of the land surface on the mesa ranges from about 6,000 ft (1,800 m) to more than 8,000 ft (2,400 m) above mean sea level. The climate of the area is semiarid; rainfall ranges from 9 to 12 inches (230 to 300 mm) per year. Vegetation includes desert shrub, juniper-pinyon woodlands, and ponderosa pine forest at the higher altitudes.

The area leased for strip mining of coal on Black Mesa includes 64,858 acres (26,248 ha) and is near the headwaters of the surface drainage of Moenkopi Wash (fig. 1). The strip-mine area is drained by Coal Mine Wash, Yellow Water Canyon, and several other small washes, all of which flow southwestward and are tributary to Moenkopi Wash, which is the main stem of the drainage network. Some surface-water runoff in Moenkopi Wash is diverted for flood irrigation near the villages of Moenkopi and Tuba City, about 60 miles (97 km) downstream from the strip-mine area. The soil material of the watershed is sand and clay and high sediment concentrations in the surface-water runoff are common.

The water supply for the strip mining and slurry pipeline operations is withdrawn from the N aquifer, which is the principal fresh-water aquifer for the area. Kayenta, Chilchinbito, Rough Rock, and several other communities also derive their water supplies from this aquifer; present withdrawals, excluding those for the coal operations, are about 1,000 acre-ft (1.2 hm^3) annually. Pumpage for mining acti-

vities has averaged 3,400 acre-ft (4.2 hm^3) annually from 1971 to 1976. The N aquifer generally is about 2,400 ft (730 m) below land surface at the strip-mine site. The Mancos Shale, Carmel Formation, and other formations lie between the N aquifer and the land surface; these formations are an effective barrier that limits vertical leakage to or from the N aquifer. Several windmills and small springs derive water sufficient in quantity and quality for stock supply from the Toreva and Wepo Formations at or near the land surface on Black Mesa.

Monitoring Program

Surface Water

The objective of the surface-water activities is to monitor the quantity, sediment concentration, and chemical quality of surface-water runoff from the mined area. The surface-water monitoring is divided into two parts: (1) monitoring the rainfall-runoff characteristics in the immediate vicinity of the strip mine and (2) monitoring the surface-flow conditions and chemical-quality characteristics at a site downstream near the village of Moenkopi where some surface water from Moenkopi Wash is diverted for irrigation. Table 1 lists the streamflow gaging sites being operated as part of the surface-water monitoring program.

Monitoring of surface water in the immediate area of the strip-mine area is being accomplished by studying three intensely instrumented watersheds of about 400 acres (162 ha) each (fig. 2). Two of the watersheds will be disturbed by mining activities and one will remain unmined. Three continuous-record gaging stations with automatic sediment samplers and recording rain gages are in operation in the area. In addition, four peak-flow or crest-stage gages equipped with point sediment samplers are being operated. These are just upstream and just downstream from the strip-mined area on Coal Mine Wash and Yellow Water Canyon; they are designed to indicate whether runoff is originating upstream from or on the strip-mine area.

The three intensively instrumented small watersheds are tributaries to Coal Mine Wash (fig. 2). The gaging stations are near the mouth of each of the three small watersheds and

Table 1. Data from streamflow-gaging stations in the Black Mesa Monitoring Program

Identifying Number on Maps	Station Number	Station Name	Date Record Began	Drainage Area (mi^2)	Water Year	Annual Peak Discharge (ft^3/s)	Date of Occurrence
		Continuous-Record Stations					
1	09401225	Coal Mine Wash tributary No. 3 near Kayenta	May 1975	0.41	1976	0	--
2	09401226	Coal Mine Wash tributary near Kayenta	December 1973	0.62	1974	E 63	08-04-74
					1975	772	07-10-75
					1976	8.4	09-25-76
3	09401229	Coal Mine Wash tributary No. 2 near Kayenta	December 1973	0.62	1974	E 15	07-16-74
					1975	--	--
					1976	0	--
4	09401250	Moenkopi Wash near Moenkopi	October 1973 (Discontinued June 30, 1976)	1,650	1974	E 2,340	07-19-74
					1975	2,380	09-13-75
5	09401260	Moenkopi Wash at Moenkopi	July 1, 1976	1,660	1976	5,400	09-25-76
		Partial-Record Stations					
6	09401224	Coal Mine Wash near Kayenta	November 1973	34.1	1974	E 10	03-02-74
					1975	2,650	07-10-75
					1976	E 30	07-24-76 or 07-25-76
7	09401232	Coal Mine Wash near Shonto	November 1973	44.6	1974	E 12	03-02-74
					1975	1,480	09-08-75
					1976	E 2	09-25-76
8	09401234	Yellow Water Canyon near Kayenta	November 1973	18.6	1974	E 90	07-21-74
					1975	1,500	07-11-75
					1976	E 30	09-25-76
9	09401236	Yellow Water Canyon near Shonto	November 1973	49	1974	--	--
					1975	1,420	07-11-75
					1976	25	09-25-76
Not shown	09401238	Yellow Water Canyon above Coal Mine Wash near Shonto	November 1973 (Discontinued 1975)	--	--	--	--
10	09401240	Moenkopi Wash near Shonto	December 1973	270	1974	E 1,850	08-04-74
					1975	E 900	07-12-75
					1976	E 2,500	07-26-76
11	09401248	Begashibito Wash near Tonalea	August 1973	611	1974	E 280	08-04-74
					1975	E 260	09-13-76
					1976	E 100	09-25-76

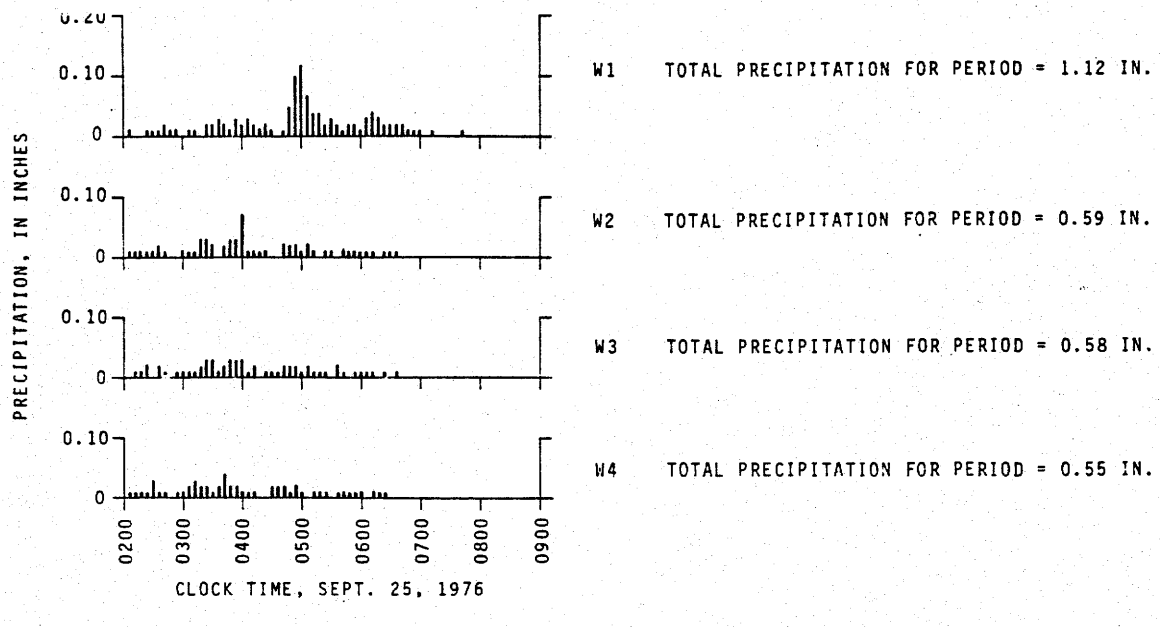
E - estimated

are now equipped with primary and backup systems for collecting stream stage, precipitation data, and water samples for analysis of chemical and sediment characteristics. The installation of backup instrumentation at each site was necessitated by the low number and short duration of runoff events and the generally poor access to the gaging stations during runoff events. An instrumentation failure during one flow event of several hours duration may conceivably result in missing the only flow event of the year. Funds for most of this phase of surface-water monitoring are made available from the Federal government for energy-related research projects.

At each site the primary stage data-collection system is a U.S.G.S. STACOM servo-manometer that senses stream stage using gas pressure. A conventional float-well gage serves as a backup. Both stage-measurement systems are equipped with digital recorders and operate independently. A precipitation gage is part of the instrument package at each gaging site and consists of a propane heated snow gage equipped with a tipping-bucket recorder that registers precipitation in 0.1-inch increments. The precipitation from the tipping bucket gage is spilled into a reservoir where it is measured again by a float gage equipped with a digital recorder. An example of the information collected during a flow event on one of the small watersheds is shown in figure 3.

Ten recording precipitation gages are being operated as part of the monitoring program. Nine of the gages are in the three small watersheds and one is upstream from the mine area on the drainage divide between Yellow Water Canyon and Coal Mine Wash (fig. 2). The precipitation and runoff data from the three small watersheds will be used to develop a rainfall-runoff model which will simulate both pre- and post-mining conditions. Precipitation data collected to date (1977) as part of the monitoring program are shown in table 2.

The precipitation recorder on one of the watersheds is incorporated into a data-collection system in which the data are transmitted via radio to a satellite that relays the data into a computer system. With this system operable, a program can be placed into the computer to obtain a readout from the recorder on almost a current basis. This data-collection system is designed to provide real-time information on rainfall and runoff conditions in the area and will ultimately be used as a guide to determine when the instruments need to be serviced, either because of a malfunction



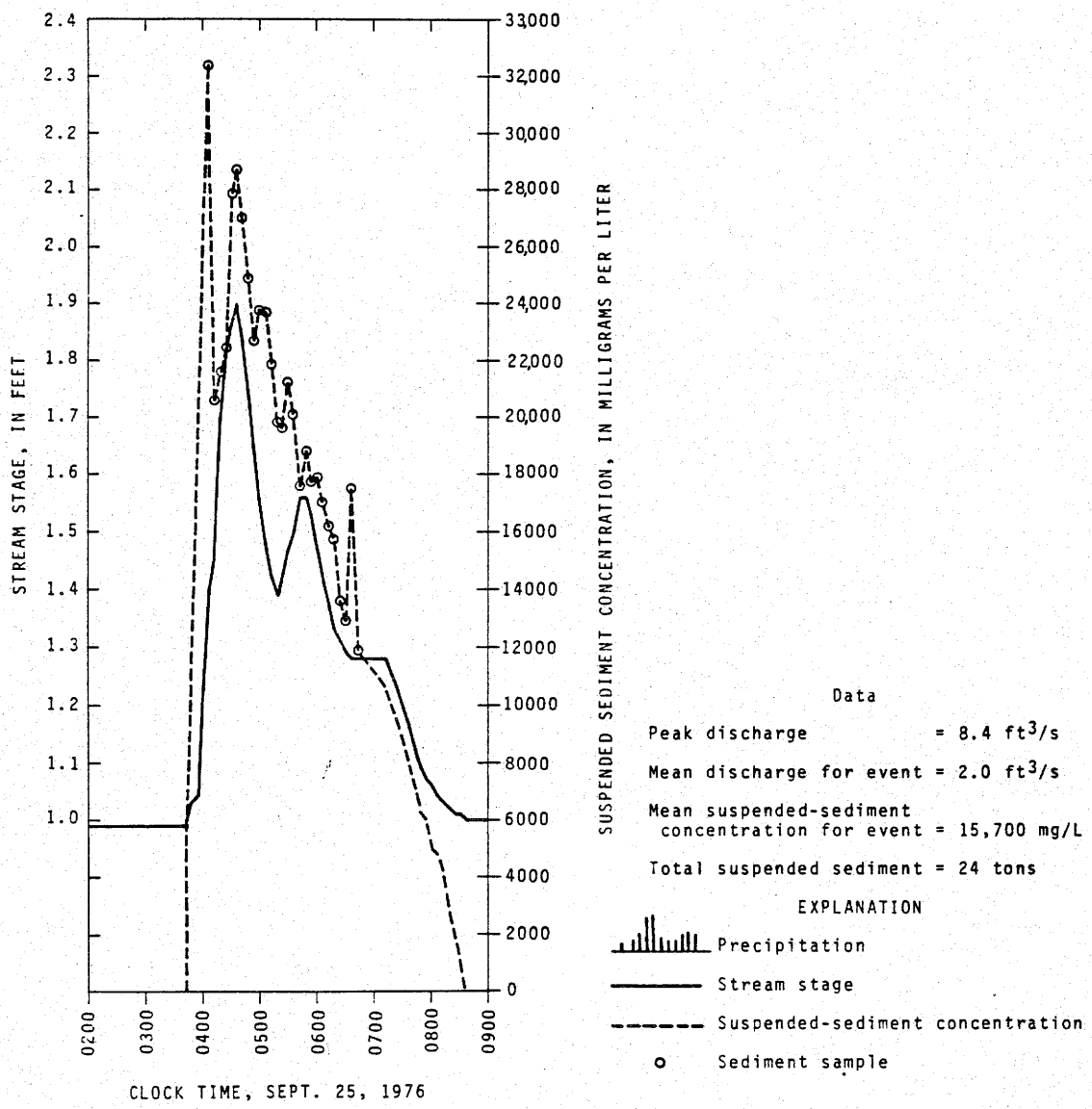


FIGURE 3.--EXAMPLE OF DATA COLLECTED BY INSTRUMENTATION ON THE SMALL WATERSHED STUDY.
[Data are for the peak of September 25, 1976 at station 09401226, Coal Mine Wash tributary near Kayenta, Az.]

Table 2. Monthly and annual precipitation, in inches, for precipitation gages in the Black Mesa Monitoring Program

Station	Water Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Annual	Remarks
L1	1976	0.47	0.77	0.78	0.08	2.51	0.50	0.82	0.92	0.15	1.14	--	2.98[1]	11.12	[1]Total Aug.-Sep. 1976
	1977	0.15													
H1	1976	0.28	0.28	0.16	0.07	1.73	0.20	0.29	--	0.72	0.80	0.22	2.74	7.49	
	1977	0.63	1.43	0.84	0.65	0.64	0.08	0.29							
H2	1976	--	--	--	--	--	--	--	0.71[1]	--	--	1.76[2]	2.02	--	[1]Record started May 3, 1976
	1977	0	0.24	0.11	0.85	0.03	0.03	0.39							[2]Total Jun.-Aug. 1976
H4	1976	--	--	--	--	--	--	--	0.80[1]	0.11	1.10	0.86	2.11	--	[1]Record started May 5, 1976
	1977	0.10	0.25	0.14	0.86	0.06	0.02	0.40							
W1	1975	--	--	--	--	--	--	--	--	--	1.11[1]	--	0.96[2]	--	[1]Record started Jul. 8, 1975
	1976	0.28	0.47	--	0.51[3]	2.31	0	0.79	0.94	0.07	0.99	0.91	2.91	10.18	[2]Total Aug.-Sep. 1975
	1977	0.40	0.99	0.07	0.79	0	0.02	0.43							[3]Total Dec. 1975-Jan. 1976
W2	1974	--	--	--	--	--	--	--	--	--	1.78[1]	0.98	0.31	--	[1]Record started Jul. 10,1974
	1975	1.33	0.60	0.29	0	--	--	--	--	2.48[2]	2.67	0.11	1.41	8.89	[2]Total Feb.-Jun. 1975
	1976	0.24	--	--	--	--	2.85[3]	0.34	0.89	0.04	1.22	0.62	1.99	7.95	[3]Total Nov. 1975-Mar. 1976
	1977	0.14	0.20	0	0.82	0.02	0	0.45							
W3	1976	--	--	--	--	--	--	--	0.78[1]	0	1.27	0.72	2.01	--	[1]Record started May 3, 1976
	1977	0.16	0.21	0.08	0.80	0	0.11	0.35							
W4	1976	--	--	--	--	--	--	--	--	--	0.60[1]	0.43	2.02	--	[1]Record started Jul.15, 1976
	1977	0.10	0.18	0	0.60	0	0	0.47							
P1	1974	--	--	--	--	--	--	--	--	--	2.39[1]	0.34	0.40	--	[1]Record started Jul.10, 1974
	1975	1.72	0.78	0.29	0.47	0	--	--	--	0.14	2.63	0.39	1.62	--	
	1976	--	--	0.19	0.10	1.78	0.32	0.40	0.94	0.07	0.36	0.11	1.93	--	
	1977	--	--	0.04	0.42	1.42	0.58	0.73							
P5	1974	--	--	--	--	--	--	--	--	--	1.57[1]	0.12	0.32	--	[1]Record started Jul.11, 1974
	1975	--	2.73[2]	--	--	1.56[3]	--	--	--	--	0.72	0.44	1.91	7.36	[2]Total Oct. and Nov 1974
	1976	--	0.92[4]	--	0.42[5]	2.35	0.34	0.60	0.97	--	1.63[6]	1.31	2.42	10.96	[3]Total Dec. 1974-Feb. 1975
	1977	0.10	0.41	0.13	0.83	0.07									[4]Total Oct.-Nov. 1975
															[5]Total Dec. 1975 - Jan. 1976
															[6]Total Jun. - Jul. 1976

or because of extreme flow conditions. In the near future, the stream-stage recorders and a counter giving the number of water samples taken by the automatic samplers also will be incorporated into this data-collection system. The transmitting antennas are installed on the other two watersheds and they will be instrumented in a like manner as the equipment becomes available.

Coal Mine Wash and Yellow Water Canyon are each currently instrumented with two crest-stage stations (table 1); each station is in turn equipped with two single-stage point sediment samplers. At this type of station the crest-stage gage records the highest stream stage that is reached between visits to the station, and the point samplers collect a sample at two different stages. The recorded crest stage is then used to compute the peak discharge rate which, along with the concentration of the sediment sampled, can be used to estimate the suspended-sediment load. One station on each stream is upstream from the strip-mine area and the other is downstream from the strip-mine area; the locations are shown on figure 2. One station, which was on Yellow Water Canyon about 0.5 mi (0.8 km) upstream from the confluence with Coal Mine Wash, was discontinued when an evaluation of the data-collection network indicated the site was not necessary. Annual instantaneous peak discharges are being computed for all continuous-record and partial-record gaging sites and the results to date (through 1976) are shown in table 1.

The key station for the monitoring of possible downstream effects of the strip mine is the streamflow and sediment-sampling gaging station, Moenkopi Wash at Moenkopi on Highway 264 (fig. 1, table 1). An observer who lives at Moenkopi collects sediment samples once daily during periods of low flow and more often during high flows. The discharge measured at the station is related to the concentration of suspended sediment in the samples to compute the total suspended-sediment load. Sediment data have been collected at this site since October 1973 and streamflow since July 1976. From October 1, 1973 to June 30, 1976, discharge was measured at a site 3 mi (4.8 km) upstream from the present site (table 1). This station was abandoned when the new station was built. Data collected at these two stations, except for chemical analyses, are presented in tables 3, 4, and 5. The chemical analyses of the surface water at these stations and several others are shown in table 6.

Table 3.--Stream and suspended-sediment discharge, water years 1974-76, for gaging station 09401260, Moenkopi Wash at Moenkopi, Arizona

SUSPENDED-SEDIMENT DISCHARGE (TONS/DAY), WATER YEAR OCTOBER 1973 TO SEPTEMBER 1974

	OCTOBER			NOVEMBER			DECEMBER		
DAY	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)
1	1.0	400	1.1	1.8	363	1.8	2.7	1330	9.7
2	.90	390	.95	1.8	744	3.6	3.0	1370	11
3	.80	364	.79	1.6	288	1.2	2.7	581	4.2
4	.70	400	.76	1.6	315	1.4	2.8	856	6.5
5	.70	599	1.1	1.5	536	2.2	2.7	850	6.2
6	.70	600	1.1	1.5	934	3.8	1.9	825	4.2
7	.80	600	1.3	1.5	295	1.2	2.0	811	4.4
8	.90	600	1.5	1.5	286	1.2	2.5	1440	9.7
9	1.0	600	1.6	1.4	197	.74	2.7	918	6.7
10	1.1	600	1.8	1.4	294	1.1	2.4	1190	7.7
11	1.2	588	1.9	1.5	623	2.5	2.7	889	6.5
12	1.2	370	1.2	1.5	273	1.1	2.5	822	5.5
13	1.1	133	.40	1.5	263	1.1	2.4	1040	6.7
14	1.0	292	.79	1.3	257	.90	2.5	1060	7.2
15	1.0	251	.68	1.2	255	.83	1.5	628	2.5
16	.90	251	.61	1.3	773	2.7	1.6	794	3.4
17	.90	278	.68	1.3	445	1.6	1.9	957	4.9
18	1.0	283	.76	1.3	336	1.2	2.2	928	5.5
19	1.1	263	.78	2.2	1320	7.8	2.0	971	5.2
20	1.2	245	.79	2.2	1740	10	1.1	554	1.6
21	1.3	244	.86	2.0	1040	5.6	1.1	453	1.3
22	1.4	230	.87	1.9	504	2.6	1.6	447	1.9
23	1.4	237	.90	2.7	547	4.0	2.0	623	3.4
24	1.4	228	.86	2.0	1320	7.1	1.5	778	3.2
25	1.3	235	.82	1.9	730	3.7	1.6	450	1.9
26	1.4	278	1.1	1.9	654	3.4	1.5	422	1.7
27	1.4	304	1.1	1.4	544	2.1	1.8	473	2.3
28	1.4	623	2.4	1.3	722	2.5	2.4	967	6.3
29	1.4	283	1.1	1.4	445	1.7	3.5	966	9.1
30	1.8	366	1.8	2.0	1010	5.4	3.9	1850	19
31	1.8	496	2.4	---	---	---	.86	790	1.8
TOTAL	35.20	---	34.80	49.4	---	86.07	67.56	---	171.2

SUSPENDED-SEDIMENT DISCHARGE (TONS/DAY), WATER YEAR OCTOBER 1973 TO SEPTEMBER 1974

	JANUARY			FEBRUARY			MARCH		
DAY	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)
1	1.3	256	.90	3.0	846	6.9	16	30700	2260
2	1.8	482	2.3	3.0	936	7.6	53	81900	12300
3	2.4	506	3.3	2.3	962	6.0	54	58300	7900
4	3.7	518	5.2	2.8	749	5.7	24	25400	1650
5	3.0	363	2.9	3.0	821	6.6	6.9	18000	335
6	2.8	394	3.0	2.4	660	4.3	3.9	5700	60
7	3.9	960	10	2.3	660	4.1	2.2	3420	20
8	3.0	966	7.8	2.4	749	4.8	1.9	1410	7.2
9	3.0	1740	14	2.7	1130	8.2	2.2	1410	8.4
10	3.0	1840	15	3.2	1110	9.6	2.8	1420	11
11	3.0	1820	15	3.7	1900	19	2.7	1860	14
12	3.0	1800	15	3.7	1430	14	2.8	1450	11
13	3.9	823	8.7	3.0	996	8.1	2.8	1310	9.9
14	3.5	820	7.7	3.0	981	7.9	2.8	1260	9.5
15	3.5	863	8.2	3.9	1070	11	2.7	926	6.8
16	3.7	787	7.9	3.9	966	10	2.4	750	4.9
17	4.1	913	10	3.2	770	6.7	2.0	694	3.8
18	3.9	897	9.4	4.1	751	8.3	1.9	554	2.8
19	3.9	902	9.5	3.9	786	8.3	1.8	476	2.3
20	4.1	972	11	2.8	706	5.3	2.0	538	2.9
21	3.7	803	8.0	2.7	571	4.2	2.0	489	2.6
22	2.7	885	6.5	3.5	567	5.4	1.8	548	2.7
23	2.4	775	5.0	2.7	542	4.0	1.8	413	2.0
24	2.4	810	5.2	2.0	719	3.9	1.8	413	2.0
25	3.0	880	7.1	2.2	691	4.1	1.8	360	1.7
26	3.0	1220	9.9	2.8	452	3.4	1.8	378	1.8
27	3.0	858	6.9	2.7	664	4.8	1.8	316	1.5
28	3.0	749	6.1	2.4	460	3.0	1.8	453	2.2
29	2.8	1020	7.7	---	---	---	1.8	382	1.9
30	2.1	953	5.4	---	---	---	1.6	449	1.9
31	3.0	1900	15	---	---	---	1.4	311	1.2
TOTAL	95.6	---	249.60	83.3	---	195.2	210.2	---	24641.0

Table 3.--Stream and suspended-sediment discharge, water years 1974-76, for gaging station 09401260, Moenkopi Wash at Moenkopi, Arizona--Continued

SUSPENDED-SEDIMENT DISCHARGE (TONS/DAY), WATER YEAR OCTOBER 1973 TO SEPTEMBER 1974

	APRIL			MAY			JUNE		
DAY	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)
1	1.4	398	1.5	1.3	226	.79			
2	2.2	1150	6.8	1.3	174	.61			
3	2.5	1460	9.9	1.1	172	.51			
4	2.0	540	2.9	.94	189	.48			
5	1.6	394	1.7	.94	225	.57			
6	1.8	423	2.1	.94	229	.58			
7	1.6	361	1.6	.86	185	.43			
8	1.4	337	1.3	.94	186	.47			
9	1.4	966	3.7	.86	198	.46			
10	1.3	494	1.7	.61	182	.30			
11	1.4	370	1.4	.57	164	.25			
12	1.4	802	3.0	.53	317	.45			
13	1.3	386	1.4	.44	178	.21			
14	1.3	340	1.2	.27	218	.16			
15	1.4	620	2.3	.23	219	.14			
16	1.5	340	1.4	.12	314	.10			
17	1.6	296	1.3	.07	310	.06			
18	1.8	308	1.5	.25	299	.20			
19	1.6	294	1.3	.40	279	.30			
20	1.4	275	1.0	.27	511	.37			
21	1.4	253	.96	.31	472	.40			
22	1.5	271	1.1	.53	403	.58			
23	1.5	250	1.0	.57	262	.40			
24	1.4	256	.97	.61	222	.37			
25	1.5	247	1.0	.53	167	.24			
26	1.5	317	1.3	.40	195	.21			
27	1.3	326	1.1	.31	177	.15			
28	1.3	218	.77	.17	162	.07			
29	1.3	197	.69	0	0	0			
30	1.3	194	.68	0	0	0			
31	---	---	---	0	0	0			
TOTAL	45.9	---	58.57	16.37	---	9.86			

SUSPENDED-SEDIMENT DISCHARGE (TONS/DAY), WATER YEAR OCTOBER 1973 TO SEPTEMBER 1974

	JULY			AUGUST			SEPTEMBER		
DAY	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)
1	0	0	0	.07	34	.01	.17	25	.01
2	0	0	0	.05	31	0	.17	25	.01
3	0	0	0	8.5	40300	3150	.15	20	.01
4	0	0	0	16	91000	4850	.07	10	0
5	0	0	0	22	114000	7210	.17	25	.01
6	0	0	0	4.3	54000	627	10	70800	2860
7	0	0	0	2.3	33000	205	1.5	37500	152
8	0	0	0	1.2	3500	11	.70	858	1.6
9	0	0	0	.57	565	.87	.50	472	.64
10	0	0	0	.27	351	.26	.40	399	.43
11	0	0	0	.19	43	.02	.20	433	.23
12	0	0	0	.21	28	.02	.10	410	.11
13	0	0	0	.04	24	0	0	0	0
14	0	0	0	.01	21	0	.20	450	.24
15	0	0	0	.04	20	0	.40	450	.49
16	0	0	0	.15	40	.02	1.1	450	1.3
17	0	0	0	.11	20	.01	1.2	575	1.9
18	0	0	0	.07	10	0	2.0	700	3.8
19	240	131000	152000.0	.05	10	0	1.2	576	1.9
20	35	85000	8030	.11	20	.01	6.5	52600	1160
21	30	189000	15300	.02	10	0	4.1	33500	371
22	26	66000	4630	0	0	0	3.9	6320	67
23	23	65000	4040	.05	10	0	9.0	39000	948
24	18	85000	4130	.13	20	.01	3.0	23000	186
25	2.7	55000	401	.13	20	.01	1.8	2580	13
26	.94	31000	79	.17	25	.01	1.4	1580	6.0
27	.40	4080	4.4	.09	10	0	1.4	1020	3.9
28	.25	330	.22	.13	20	.01	1.2	741	2.4
29	1.2	307	.99	.13	20	.01	1.3	526	1.8
30	.40	400	.43	.15	25	.01	1.4	697	2.6
31	.17	419	.19	.19	30	.02	---	---	---
TOTAL	378.06	---	188616.2	57.43	---	16054.30	55.23	---	5786.38
YEAR	1094.25		235903.2						

Table 3.--Stream and suspended-sediment discharge, water years 1974-76, for gaging station 09401260, Moenkopi Wash at Moenkopi, Arizona--Continued

SUSPENDED-SEDIMENT DISCHARGE (TONS/DAY), WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

	OCTOBER			NOVEMBER			DECEMBER		
DAY	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)
1	1.0	700	1.9	3.0	10000	81	2.0	455	2.5
2	1.0	670	1.8	2.0	26000	140	2.0	542	2.9
3	1.0	630	1.7	15	44500	1800	2.0	660	3.6
4	.90	540	1.3	5.0	16000	216	2.0	643	3.5
5	1.0	520	1.4	2.0	4000	22	2.0	1130	6.1
6	2.0	625	3.4	2.0	1900	10	2.0	395	2.1
7	2.0	790	4.3	2.0	810	4.4	2.0	381	2.1
8	2.0	980	5.3	1.8	750	3.6	2.0	464	2.5
9	2.0	900	4.9	2.5	1100	7.4	2.0	610	3.3
10	2.0	850	4.6	2.2	1230	7.3	2.0	606	3.3
11	2.0	810	4.4	1.9	720	3.7	2.0	533	2.9
12	2.0	710	3.8	1.9	570	2.9	2.0	428	2.3
13	2.0	920	5.0	1.9	630	3.2	3.0	567	4.6
14	2.0	1340	7.2	1.9	670	3.4	2.0	349	1.9
15	2.0	1030	5.6	1.9	570	2.9	2.0	501	2.7
16	2.0	850	4.6	2.0	560	3.0	3.0	578	4.7
17	2.0	750	4.0	2.0	520	2.8	3.0	542	4.4
18	2.0	670	3.6	2.0	480	2.6	3.0	606	4.9
19	2.0	630	3.4	2.0	470	2.5	3.0	495	4.0
20	2.0	610	3.3	2.0	463	2.5	2.0	615	3.3
21	2.0	890	4.9	2.0	414	2.2	2.0	797	4.3
22	3.0	7000	57	2.0	528	2.9	2.0	740	4.0
23	18	55600	3210	2.0	553	3.0	2.0	513	2.8
24	8.6	40800	996	2.0	435	2.3	2.0	509	2.7
25	3.5	31000	293	2.0	438	2.4	2.0	152	.82
26	1.5	10000	41	2.0	663	3.6	6.0	258	4.2
27	1.9	10700	55	2.0	978	5.3	4.0	154	1.7
28	38	87000	11400	2.0	560	3.0	5.0	240	3.2
29	20	55900	3200	2.0	540	2.9	4.0	263	2.8
30	15	31600	1330	2.0	426	2.3	4.0	309	3.3
31	9.2	22500	559	---	---	---	3.0	292	2.4
TOTAL	155.60	---	21221.3	77.0	---	2351.1	81.0	---	99.82

SUSPENDED-SEDIMENT DISCHARGE (TONS/DAY), WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

	JANUARY			FEBRUARY			MARCH		
DAY	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)
1	3.0	225	1.8	3.0	696	5.6	2.0	380	2.1
2	6.0	228	3.7	2.0	912	4.9	2.0	3110	17
3	4.0	297	3.2	3.0	515	4.2	2.0	2550	14
4	4.0	389	4.2	3.0	494	4.0	2.0	2520	14
5	4.0	286	3.1	3.0	523	4.2	2.0	2400	13
6	3.0	163	1.3	2.0	407	2.2	2.0	1200	6.5
7	3.0	165	1.3	2.0	508	2.7	2.5	900	6.1
8	3.0	320	2.6	2.0	485	2.6	2.5	890	6.0
9	3.0	277	2.2	2.0	455	2.5	2.8	840	6.4
10	3.0	509	4.1	2.0	535	2.9	2.5	790	5.3
11	3.0	331	2.7	2.0	514	2.8	2.5	700	4.7
12	4.0	318	3.4	2.0	337	1.8	3.2	610	5.3
13	3.0	391	3.2	2.0	422	2.3	3.5	850	8.0
14	5.0	306	4.1	2.0	432	2.3	3.5	1020	9.6
15	6.0	344	5.6	2.0	457	2.5	3.7	1100	11
16	6.0	202	3.3	2.0	332	1.8	4.3	2370	28
17	5.0	239	3.2	2.0	339	1.8	4.1	4480	50
18	5.0	364	4.9	2.0	340	1.8	2.8	2410	18
19	3.0	261	2.1	2.0	230	1.2	2.5	1120	7.6
20	2.0	350	1.9	2.0	238	1.3	2.2	900	5.3
21	2.0	352	1.9	2.0	218	1.2	1.8	636	3.1
22	2.0	343	1.9	2.0	214	1.2	1.6	492	2.1
23	2.0	385	2.1	2.0	372	2.0	1.6	509	2.2
24	2.0	460	2.5	2.0	358	1.9	1.5	370	1.5
25	3.0	691	5.6	2.0	261	1.4	1.5	415	1.7
26	4.0	1440	16	2.0	356	1.9	1.8	408	2.0
27	3.0	1200	9.7	2.0	237	1.3	2.2	426	2.5
28	2.0	687	3.7	2.0	393	2.1	2.5	567	3.8
29	2.0	758	4.1	---	---	---	2.8	577	4.4
30	2.0	749	4.0	---	---	---	2.3	578	3.6
31	3.0	796	6.4	---	---	---	2.3	364	2.3
TOTAL	105.0	---	119.8	60.0	---	68.4	76.5	---	267.1

Table 3.--Stream and suspended-sediment discharge, water years 1974-76, for gaging station 09401260, Moenkopi Wash at Moenkopi, Arizona--Continued

SUSPENDED-SEDIMENT DISCHARGE (TONS/DAY), WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

	APRIL			MAY			JUNE		
DAY	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)
1	2.3	399	2.5	1.4	126	.48	1.3	102	.36
2	2.2	362	2.2	1.4	202	.76	2.0	84	.45
3	2.0	444	2.4	1.4	189	.71	1.0	123	.33
4	2.0	374	2.0	1.3	205	.72	1.0	135	.36
5	2.0	366	2.0	1.4	226	.85	1.0	118	.32
6	2.0	333	1.8	1.8	287	1.4	1.0	144	.39
7	2.0	320	1.7	1.5	204	.83	.90	124	.30
8	2.0	317	1.7	1.5	129	.52	.80	139	.30
9	2.0	328	1.8	2.0	114	.62	.70	124	.23
10	2.0	276	1.5	2.0	130	.70	.70	108	.20
11	2.0	304	1.6	2.0	242	1.3	.48	131	.17
12	2.0	438	2.4	2.0	134	.72	.53	124	.18
13	2.0	446	2.4	2.0	134	.72	.53	87	.12
14	2.0	502	2.7	2.0	127	.69	.44	147	.17
15	2.0	293	1.6	2.0	104	.56	.25	95	.06
16	2.0	243	1.3	3.0	148	1.2	.11	136	.04
17	2.0	260	1.4	3.0	150	1.2	0	0	0
18	2.0	268	1.4	3.0	133	1.1	0	0	0
19	2.0	307	1.7	3.0	144	1.2	.07	10	0
20	2.0	315	1.7	2.0	141	.76	.53	85	.12
21	2.0	270	1.5	2.0	193	1.0	.31	50	.04
22	2.0	310	1.7	1.4	304	1.1	.05	10	0
23	2.0	153	.83	1.5	162	.66	0	0	0
24	2.0	172	.93	1.4	157	.59	0	0	0
25	2.0	173	.93	1.3	136	.48	0	0	0
26	1.0	177	.48	1.3	167	.59	0	0	0
27	1.0	156	.42	1.2	110	.36	0	0	0
28	2.0	180	.97	1.3	133	.47	0	0	0
29	2.0	159	.86	1.4	105	.40	0	0	0
30	1.5	260	1.1	1.4	149	.56	0	0	0
31	---	---	---	1.3	185	.65	---	---	---
TOTAL	58.0	---	47.52	55.2	---	23.90	13.70	---	4.14

SUSPENDED-SEDIMENT DISCHARGE (TONS/DAY), WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

	JULY			AUGUST			SEPTEMBER		
DAY	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)
1	0	0	0	3.0	68	.55	.13	10	0
2	0	0	0	2.0	36	.19	.21	20	.01
3	0	0	0	2.0	24	.13	.27	22	.02
4	0	0	0	2.0	132	.71	.53	40	.06
5	.15	50	.02	2.0	66	.36	.53	40	.06
6	3.0	2000	16	1.0	37	.10	.44	50	.06
7	.86	502	1.2	.80	40	.09	.57	188	.29
8	.66	418	.74	.50	52	.07	6.3	11700	788
9	1.0	861	2.3	.50	45	.06	50	93400	12800
10	.44	495	.59	.50	30	.04	46	74900	9270
11	44	61200	12800	.20	10	.01	8.7	66000	1550
12	300	188000	169000.0	2.8	80	.60	35	66300	9430
13	500	179000	242000.0	1.0	102	.28	595	108000	200000.0
14	52	143000	23000	.48	38	.05	179	93000	44900
15	460	130000	161000.0	.31	70	.06	20	55000	2970
16	10	86000	2320	.27	36	.03	6.3	28000	476
17	130	97000	34000	.27	67	.05	2.5	5000	34
18	10	80000	2160	.27	75	.05	102	15400	49000
19	6.0	37000	599	.19	52	.03	260	137000	105000.0
20	4.0	6000	65	.05	20	0	30	89000	7210
21	3.0	1240	10	.43	50	.06	90	105000	25500
22	2.0	100	.54	.96	76	.20	6.0	45000	729
23	2.0	46	.25	.57	50	.08	3.5	14000	132
24	2.0	38	.21	.31	42	.04	1.6	2700	12
25	2.0	118	.64	.17	42	.02	1.4	436	1.6
26	1.0	149	.40	.09	42	.01	1.1	321	.95
27	4.0	153	1.7	.09	40	.01	.86	111	.26
28	3.0	66	.53	.13	30	.01	.86	103	.24
29	150	104000	72000	.09	30	.01	.86	72	.17
30	6.0	31000	502	.07	10	0	.86	22	.05
31	4.0	3910	42	.09	5	0	---	---	---
TOTAL	1701.11	---	719523.1	23.14	---	3.90	1450.52	---	469804.8
YEAR	3856.77		1213535						

Table 3.--Stream and suspended-sediment discharge, water years 1974-76, for gaging station 09401260, Moenkopi Wash at Moenkopi, Arizona--Continued

SUSPENDED-SEDIMENT DISCHARGE (TONS/DAY), WATER YEAR OCTOBER 1975 TO SEPTEMBER 1976

	OCTOBER			NOVEMBER			DECEMBER		
DAY	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)
1	.86	35	.08	2.3	272	1.7	3.0	438	3.5
2	.78	10	.02	2.4	291	1.9	3.0	490	4.0
3	.78	15	.03	2.4	300	1.9	3.0	363	2.9
4	.78	17	.04	2.4	296	1.9	3.0	456	3.7
5	.86	21	.05	2.4	316	2.0	3.0	646	5.2
6	.86	19	.04	2.4	280	1.8	3.0	538	4.4
7	1.0	24	.06	2.3	408	2.5	3.0	558	4.5
8	1.0	124	.33	2.4	330	2.1	3.0	402	3.3
9	1.0	40	.11	2.3	311	1.9	3.0	402	3.3
10	1.0	27	.07	2.3	285	1.8	3.0	388	3.1
11	1.0	50	.14	2.2	250	1.5	3.0	460	3.7
12	1.0	42	.11	1.9	266	1.4	3.0	393	3.2
13	1.0	46	.12	1.8	272	1.3	3.5	289	2.7
14	1.1	60	.18	1.9	399	2.0	3.5	280	2.6
15	.94	55	.14	2.2	389	2.3	1.2	286	.93
16	1.4	369	1.4	2.3	384	2.4	1.3	279	.98
17	1.6	140	.60	2.3	336	2.1	1.6	258	1.1
18	1.8	104	.50	2.3	341	2.1	1.6	284	1.2
19	1.8	106	.51	2.3	363	2.3	1.6	266	1.1
20	1.6	106	.46	2.0	489	2.6	2.0	260	1.4
21	1.8	93	.45	2.2	334	2.0	2.7	229	1.7
22	1.8	106	.52	2.2	339	2.0	4.3	444	5.2
23	1.6	116	.50	2.0	350	1.9	5.0	792	11
24	1.5	87	.35	2.0	476	2.6	2.8	454	3.4
25	1.5	88	.36	2.0	608	3.3	1.8	375	1.8
26	1.8	116	.56	2.0	550	3.0	1.4	365	1.4
27	1.9	141	.72	3.0	470	3.8	1.6	367	1.6
28	2.0	125	.68	4.0	1290	14	2.3	365	2.3
29	1.9	109	.56	4.0	1340	14	1.2	375	1.2
30	1.9	115	.59	3.0	620	5.0	2.5	195	1.3
31	2.2	114	.68	---	---	---	2.2	273	1.6
TOTAL	42.06	---	10.96	71.2	---	91.1	80.1	---	89.31

SUSPENDED-SEDIMENT DISCHARGE (TONS/DAY), WATER YEAR OCTOBER 1975 TO SEPTEMBER 1976

	JANUARY			FEBRUARY			MARCH		
DAY	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)
1	2.4	277	1.8	2.0	390	2.1	2.0	272	1.5
2	1.4	371	1.4	3.0	700	5.7	2.0	292	1.6
3	1.0	246	.66	4.0	942	10	2.0	283	1.5
4	1.0	192	.52	5.0	1450	20	2.0	282	1.5
5	2.0	209	1.1	10	980	26	2.0	342	1.8
6	2.0	248	1.3	6.0	625	10	2.0	376	2.0
7	2.0	253	1.4	4.0	734	7.9	2.0	327	1.8
8	2.0	251	1.4	2.0	383	2.1	2.0	315	1.7
9	2.0	268	1.4	2.0	337	1.8	2.0	287	1.5
10	2.0	316	1.7	2.0	330	1.8	2.0	250	1.4
11	2.0	477	2.6	2.0	315	1.7	2.0	223	1.2
12	2.0	376	2.0	2.0	198	1.1	2.0	208	1.1
13	2.0	381	2.1	2.0	203	1.1	2.0	221	1.2
14	2.0	390	2.1	2.0	191	1.0	2.0	179	.97
15	2.0	479	2.6	2.0	179	.97	2.0	216	1.2
16	2.0	426	2.3	2.0	195	1.1	2.0	228	1.2
17	2.0	552	3.0	2.0	218	1.2	2.0	214	1.2
18	2.0	485	2.6	2.0	258	1.4	2.0	352	1.9
19	2.0	508	2.7	2.0	158	.85	1.9	355	1.8
20	2.0	525	2.8	2.0	134	.72	1.8	310	1.5
21	2.0	456	2.5	2.0	152	.82	2.0	178	.96
22	2.0	510	2.8	2.0	127	.69	2.2	152	.90
23	2.0	498	2.7	2.0	306	1.7	2.2	246	1.5
24	2.0	450	2.4	2.0	251	1.4	1.9	321	1.6
25	2.0	413	2.2	2.0	270	1.5	1.8	266	1.3
26	2.0	351	1.9	2.0	236	1.3	1.5	200	.81
27	2.0	597	3.2	2.0	240	1.3	1.6	300	1.3
28	2.0	424	2.3	2.0	178	.96	1.8	282	1.4
29	2.0	367	2.0	2.0	166	.90	1.9	207	1.1
30	2.0	414	2.2	---	---	---	1.8	182	.88
31	2.0	459	2.5	---	---	---	1.9	191	.98
TOTAL	59.8	---	64.18	78.0	---	109.11	60.3	---	42.30

Table 3.--Stream and suspended-sediment discharge, water years 1974-76, for gaging station 09401260, Moenkopi Wash at Moenkopi, Arizona--Continued

SUSPENDED-SEDIMENT DISCHARGE (TONS/DAY), WATER YEAR OCTOBER 1975 TO SEPTEMBER 1976

	APRIL			MAY			JUNE		
DAY	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)
1	1.9	177	.91	1.3	760	2.7	.48	182	.24
2	1.8	167	.81	1.4	746	2.8	.31	175	.15
3	1.9	168	.86	1.6	197	.85	.25	196	.13
4	2.0	164	.89	1.8	210	1.0	.17	181	.08
5	2.0	184	.99	2.0	218	1.2	.13	180	.06
6	2.3	193	1.2	1.8	166	.81	.11	180	.05
7	2.3	231	1.4	1.9	195	1.0	.05	180	.02
8	2.0	193	1.0	1.9	218	1.1	.05	180	.02
9	1.8	195	.95	2.0	224	1.2	.01	68	.01
10	1.8	254	1.2	2.0	185	1.0	0	0	0
11	1.8	166	.81	2.0	192	1.0	0	0	0
12	1.5	167	.68	1.9	206	1.1	0	0	0
13	1.4	176	.67	1.8	174	.84	0	0	0
14	1.9	214	1.1	1.3	158	.55	0	0	0
15	2.5	262	1.8	1.3	160	.56	0	0	0
16	3.0	269	2.2	1.2	185	.60	0	0	0
17	2.5	258	1.7	1.1	140	.42	0	0	0
18	2.0	185	1.0	1.2	156	.51	0	0	0
19	2.0	178	.96	1.3	186	.65	0	0	0
20	2.0	175	.94	1.4	166	.63	0	0	0
21	1.9	176	.90	5.0	30000	405	0	0	0
22	1.8	187	.91	3.0	6670	54	0	0	0
23	1.7	196	.90	1.5	610	2.5	0	0	0
24	1.6	179	.77	1.4	760	2.9	0	0	0
25	1.5	230	.93	1.3	250	.88	0	0	0
26	1.4	201	.76	1.2	220	.71	0	0	0
27	1.3	185	.65	1.0	204	.55	0	0	0
28	1.4	212	.80	.44	294	.35	0	0	0
29	1.5	198	.80	.40	158	.17	0	0	0
30	1.4	198	.75	.36	164	.16	0	0	0
31	---	---	---	.44	188	.22	---	---	---
TOTAL	55.9	---	30.24	48.24	---	487.96	1.56	---	.76

SUSPENDED-SEDIMENT DISCHARGE (TONS/DAY), WATER YEAR OCTOBER 1975 TO SEPTEMBER 1976

	JULY			AUGUST			SEPTEMBER		
DAY	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)
1	0	0	0	14	88800	3840	0	0	0
2	0	0	0	4.0	39000	421	0	0	0
3	0	0	0	2.8	14500	110	0	0	0
4	0	0	0	1.3	850	3.0	0	0	0
5	0	0	0	.10	193	.05	0	0	0
6	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	3.2	765	6.7
8	0	0	0	20	95300	7720	4.9	811	11
9	0	0	0	7.8	107000	2250	1.8	97	.47
10	0	0	0	2.8	75500	571	1.8	131	.64
11	0	0	0	.90	64000	156	1.5	451	1.8
12	0	0	0	.30	10000	8.1	1.8	380	1.8
13	0	0	0	.10	1000	.27	.90	301	.73
14	0	0	0	0	0	0	.70	136	.26
15	0	0	0	0	0	0	.40	75	.08
16	0	0	0	0	0	0	.20	139	.08
17	0	0	0	0	0	0	.10	101	.03
18	0	0	0	0	0	0	0	585	0
19	0	0	0	0	0	0	0	121	0
20	3.2	32500	527	46	73900	16300	.10	165	.04
21	1.9	5000	26	4.4	41000	487	.60	254	.41
22	0	0	0	1.1	154	.46	3.6	5500	54
23	0	0	0	.30	89	.07	3.6	25800	251
24	0	0	0	.40	276	.30	2.8	108000	816
25	0	0	0	.10	100	.03	1600	262000	1600000
26	66	150000	26700	0	0	0	600	60000	97200
27	52	147000	23300	0	0	0	100	36000	9720
28	27	174000	13200	0	0	0	11	21000	624
29	40	215000	23200	0	0	0	4.0	920	9.9
30	4.0	74000	799	0	0	0	2.8	206	1.6
31	238	208000	252000.0	0	0	0	---	---	---
TOTAL	432.10	---	339152.0	106.40	---	31867.28	2345.80	---	1708701
YEAR	3381.46		2081246						

Table 4.--Specific conductance, water years 1974-76, for gaging station 09401260, Moenkopi Wash at Moenkopi, Arizona

SPECIFIC CONDUCTANCE (MICROMHOS/CM AT 25 DEG. C), WATER YEAR OCTOBER 1973 TO SEPTEMBER 1974
ONCE-DAILY

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	---	1000	990	1010	920	1800	1090	1000		---	3200	---
2	---	1000	990	1180	980	3000	1440	1100		---	3600	---
3	960	1000	900	1200	950	3000	1250	1110		---	3600	---
4	---	1000	900	1250	950	2500	1220	1160		---	2600	---
5	1080	1010	---	1320	950	2500	1200	1150		---	3500	---
6	---	1030	---	1200	950	2000	1050	1100		---	4000	4000
7	---	1050	1000	1090	950	1900	1020	1100		---	2900	3500
8	---	1000	920	1050	980	1600	1000	1100		---	2200	3500
9	---	990	890	1190	1000	1400	1470	1080		---	2300	3200
10	---	990	900	1200	1000	1280	1600	1120		---	2300	3000
11	1070	990	980	1200	910	1220	1400	1180		---	2500	3000
12	1000	990	905	1200	910	1200	1350	2200		---	2500	3500
13	1100	1000	850	1050	960	1450	1250	1540		---	2500	---
14	1000	1000	850	1050	990	1190	1180	1750		---	2900	---
15	1000	1000	860	1020	1000	1120	1050	1750		---	---	---
16	1000	1000	860	1000	1000	1150	1000	2200		---	---	---
17	990	1010	900	1020	1000	1120	990	2200		---	---	---
18	990	1000	880	1020	1010	1120	1000	1900		---	---	---
19	980	2200	950	1020	1000	1100	1100	1900		3760	---	1430
20	980	1600	1070	1050	1000	1100	1100	3900		3170	---	2600
21	980	1100	1120	1110	980	1100	1100	4000		2830	---	2900
22	980	1190	1150	1120	980	1100	1100	2990		2210	---	2300
23	1150	1070	1190	1100	950	1100	1000	2100		2080	---	---
24	1220	1030	1050	1150	950	1100	1020	1650		2600	---	2080
25	1150	1110	1050	1150	950	1070	1020	1400		2500	---	1480
26	1050	1100	1000	1030	950	1070	1200	1450		---	---	1350
27	1000	1100	1050	1150	950	1000	1350	1470		2220	---	1180
28	950	1120	980	1150	900	1050	1220	1550		2250	---	1200
29	920	1180	990	1150	---	1000	1170	---		2200	---	1200
30	1300	1090	900	1150	---	1350	1100	---		2900	---	1060
31	1100	---	1000	950	---	1350	---	---		3200	---	---
MONTH	---	1100	965	1110	945	1450	1170	1720		---	---	---

NOTE: NUMBER OF MISSING DAYS OF RECORD EXCEEDED 20% OF YEAR

SPECIFIC CONDUCTANCE (MICROMHOS/CM AT 25 DEG. C), WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975
ONCE-DAILY

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	1050	1750	1050	1010	1000	1100	1150	990	1000	---	1570	---
2	1000	1550	1010	1000	1000	2500	1180	980	1010	---	1650	---
3	1050	1930	1000	890	1000	2200	1150	1200	1020	---	1790	1200
4	1100	1480	990	1020	1010	2200	1120	1200	1110	---	1800	---
5	1080	1350	990	1050	980	2200	1300	1110	1100	---	1820	---
6	1050	1300	990	1010	1000	1500	1300	1040	1150	---	2000	---
7	1000	1210	990	1040	980	1200	1300	1020	1180	2600	2000	1420
8	1020	1200	1000	950	990	1250	1300	990	1190	2800	2050	1210
9	1000	1180	980	890	980	1240	1380	980	1080	2350	2150	1900
10	1000	1190	1150	1000	1020	1240	1200	940	1100	3200	---	2600
11	980	1290	1190	1070	1000	1310	1190	960	1150	2320	---	2600
12	1000	1100	1180	1150	1010	1210	1200	960	1190	3930	1950	2800
13	1000	1100	1050	1100	1010	1150	1190	980	1190	2690	2100	1340
14	1020	1080	1190	1180	1010	1650	1190	1020	1150	4070	2000	1350
15	1150	1080	1180	1140	1000	1800	1270	980	1220	2080	2000	1780
16	1150	1090	1200	1000	1010	1590	1320	1070	1400	2130	2050	1800
17	980	1080	1010	990	1070	2100	1320	1070	1580	1480	2000	1750
18	950	1050	1000	990	1070	2500	1320	1070	---	1850	2050	1650
19	950	1100	1000	890	1100	2100	1140	980	---	1950	2100	2400
20	950	1100	990	890	1050	1960	1200	950	---	1950	---	1480
21	960	1080	950	900	1010	1700	1160	1150	---	1900	---	1980
22	1700	1040	910	900	1020	1450	1160	1100	---	1900	1570	1400
23	2100	1080	1090	920	1190	1400	1160	1000	---	1900	---	1650
24	2250	1070	1090	920	1150	1300	1180	970	---	1900	1950	1600
25	2450	1100	1200	870	1010	1300	1180	970	---	1900	1950	1770
26	1650	1020	1300	830	1000	1300	1500	1010	---	2000	1970	1500
27	1460	1020	1250	810	1070	1280	1350	1010	---	1850	---	1420
28	2930	1020	1250	890	1130	1210	1220	1010	---	1600	---	1390
29	2070	1020	1100	890	---	1210	1200	1010	---	1980	---	1300
30	1800	1150	1100	940	---	1210	1150	1050	---	1770	---	1250
31	1600	---	1010	950	---	1200	---	1010	---	1600	---	---
MONTH	1340	1190	1080	970	1030	1570	1230	1030	---	2230	---	1780
YEAR	MAX	4070	MIN	810	MEAN	1350						

SPECIFIC CONDUCTANCE (MICROMHOS/CM AT 25 DEG. C), WATER YEAR OCTOBER 1975 TO SEPTEMBER 1976
ONCE-DAILY

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	1390	860	1300	860	870	940	1030	1040	1150	---	2550	---
2	1380	870	1300	1060	---	950	1070	1040	1180	---	2400	---
3	---	850	960	1090	970	1040	955	1040	1200	---	2400	---
4	1300	830	810	990	975	1040	1140	1080	1200	---	2300	1480
5	1220	790	850	1010	980	1000	1140	1040	---	---	2300	1180
6	1210	810	800	890	975	1020	1120	1070	---	---	2400	1460
7	1210	830	800	885	965	940	980	1090	---	---	---	1450
8	1250	800	800	870	990	925	1000	1070	---	---	2000	982
9	1250	800	800	860	1010	940	980	1060	---	---	2600	1740
10	1250	820	780	820	1090	950	965	1030	---	---	2500	1760
11	1210	800	850	840	1070	935	1100	1020	---	---	2400	1500
12	1210	880	800	770	1040	990	1030	1010	---	---	---	1280
13	1210	890	700	820	1010	965	1080	1080	---	---	---	1150
14	1200	920	890	855	1060	1000	1110	1090	---	---	---	1290
15	1200	880	900	875	1040	920	1140	1100	---	---	---	1550
16	1180	880	1050	790	975	935	1360	1070	---	---	---	1550
17	1220	820	1150	780	1060	940	1120	1040	---	---	---	1450
18	1100	820	1150	815	925	980	1100	1060	---	---	---	1410
19	1070	850	770	830	1050	960	970	1040	---	---	---	1370
20	1070	920	860	815	1050	1010	970	1060	---	---	1690	1180
21	1150	900	950	855	1090	975	930	1320	---	---	1600	1160
22	1150	910	750	770	1050	950	915	1100	---	---	1520	1310
23	1120	890	730	790	1030	925	915	1120	---	---	1410	1170
24	1120	950	740	710	980	1110	940	1060	---	---	1440	2600
25	1100	890	780	805	1030	1130	975	1040	---	---	1460	2090
26	1090	900	820	800	1010	1080	930	1070	---	---	---	1360
27	1050	900	820	800	965	1010	955	1060	---	3000	---	1400
28	1060	920	900	920	990	1030	930	1040	---	2700	885	1320
29	1040	930	880	870	940	950	930	1100	---	2700	---	1210
30	1020	1220	900	850	---	990	965	1160	---	3000	1990	1260
31	1020	---	880	890	---	---	---	1240	---	2600	2400	---
MONTH	1170	878	886	858	1010	984	1020	1080	---	---	---	1430
YEAR	MAX	3000	MIN	700	MEAN	1130						

Table 5.--Water temperature, water years 1974-76, for gaging station 09401260, Moenkopi Wash at Moenkopi, Arizona

TEMPERATURE (DEG. C) OF WATER, WATER YEAR OCTOBER 1973 TO SEPTEMBER 1974
ONCE-DAILY

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	---	12.0	5.0	0.0.	---	---	12.0	27.0		---	22.0	---
2	---	14.0	4.0	0.0	---	---	15.0	22.0		---	21.0	---
3	11.0	10.0	4.0	0.0	---	---	14.0	26.0		---	25.0	---
4	---	11.0	3.0	0.0	---	---	14.0	29.0		---	21.0	---
5	---	3.5	---	0.0	---	---	16.0	29.0		---	22.5	---
6	---	3.5	---	0.0	---	---	19.0	18.5		---	20.0	24.0
7	---	15.0	7.0	0.0	---	---	11.0	30.0		---	18.0	18.0
8	---	15.0	2.0	0.0	---	---	8.0	31.0		---	19.0	21.0
9	---	14.0	8.0	0.0	---	---	9.0	14.0		---	18.0	25.0
10	---	15.0	1.0	1.0	---	---	11.0	12.0		---	19.0	25.0
11	19.5	15.0	2.0	1.0	---	17.0	11.0	13.0		---	18.0	22.0
12	11.0	14.0	4.0	2.0	---	---	15.0	17.0		---	16.0	13.0
13	15.0	---	4.0	0.0	---	---	5.0	12.0		---	17.0	---
14	16.0	---	5.0	---	---	10.0	9.0	14.0		---	16.0	---
15	14.0	---	1.0	---	---	13.0	18.0	14.0		---	---	---
16	18.0	---	1.0	---	---	13.0	19.0	12.0		---	---	---
17	18.0	---	4.0	---	---	14.0	9.0	19.0		---	---	---
18	12.0	---	4.0	---	---	9.0	---	16.0		---	---	---
19	17.0	---	0.0	---	---	10.0	14.0	16.0		22.0	---	22.0
20	18.0	---	0.0	---	9.5	13.0	7.0	14.0		25.0	---	24.0
21	8.0	2.0	0.0	---	---	19.0	19.0	---		23.0	---	20.0
22	10.0	3.0	0.0	---	---	14.5	11.0	13.0		26.0	---	19.0
23	16.0	8.0	0.0	---	---	9.0	14.0	15.0		26.0	---	---
24	17.0	8.0	0.0	---	---	20.0	14.0	11.0		20.0	---	18.0
25	18.0	4.0	0.0	---	---	19.0	12.0	12.0		22.0	---	15.0
26	13.0	4.0	0.0	---	---	10.0	20.0	20.0		---	---	13.0
27	10.0	3.0	0.0	---	---	20.0	13.0	19.0		29.5	---	17.0
28	12.0	3.0	0.0	---	---	16.0	21.0	18.0		22.0	---	7.0
29	11.0	4.0	0.0	---	---	21.0	25.0	---		26.0	---	8.0
30	13.0	4.0	4.0	---	---	16.0	16.0	---		25.0	---	8.0
31	15.0	---	0.0	---	---	16.0	---	---		21.0	---	---
MONTH	---	---	2.0	---	---	---	14.0	18.5		---	---	---

NOTE: NUMBER OF MISSING DAYS OF RECORD EXCEEDED 20% OF YEAR

TEMPERATURE (DEG. C) OF WATER, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975
ONCE-DAILY

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	10.0	9.5	5.0	2.0	4.0	14.0	5.0	18.0	30.0	---	21.0	---
2	10.0	6.0	5.0	2.0	6.0	10.0	2.0	25.0	14.0	---	23.0	---
3	13.0	8.5	5.0	1.0	4.0	4.0	7.0	12.0	12.0	---	18.0	11.0
4	9.0	7.5	7.0	2.0	5.0	10.0	12.0	16.0	12.0	---	19.0	---
5	11.0	7.0	8.0	2.0	6.0	11.0	6.0	8.0	14.0	---	20.0	---
6	10.0	3.0	6.0	3.0	6.0	11.0	10.0	12.5	14.0	---	21.0	---
7	13.0	10.0	6.0	3.0	7.0	13.0	11.0	7.0	15.0	28.0	20.0	22.0
8	13.0	11.0	6.0	3.0	8.0	11.0	7.0	26.0	25.0	19.0	20.0	22.0
9	12.0	5.0	5.0	3.0	7.0	11.0	9.0	24.0	28.0	33.0	20.0	18.0
10	12.0	9.0	5.0	1.0	9.0	10.0	20.0	10.0	18.0	27.0	---	20.0
11	17.0	5.0	7.0	1.0	10.0	10.0	19.0	22.0	26.0	24.5	---	18.0
12	13.0	11.0	4.0	2.0	9.0	11.0	16.0	26.0	24.0	23.5	21.0	16.0
13	11.0	5.0	3.0	2.0	8.0	13.0	19.0	29.0	28.0	23.0	19.0	12.0
14	9.0	5.0	1.0	3.0	10.0	10.0	21.0	11.0	29.0	24.0	20.0	15.0
15	7.0	6.0	3.0	2.0	8.0	15.0	20.0	14.0	19.0	22.5	19.0	16.0
16	7.0	4.0	4.0	3.0	10.0	6.0	18.0	22.0	14.0	22.5	28.0	17.0
17	8.0	8.0	3.0	2.0	8.0	14.0	10.0	12.0	14.0	23.0	17.0	10.0
18	9.0	4.0	3.0	2.0	8.0	17.0	7.0	30.0	---	19.0	16.0	17.0
19	9.0	5.0	3.0	2.0	10.0	12.0	20.0	14.0	---	19.0	16.0	17.0
20	12.0	3.0	3.0	2.0	6.0	16.0	19.0	11.0	---	20.0	---	18.0
21	11.0	4.0	3.0	2.0	6.0	17.0	26.0	8.0	---	20.0	---	14.0
22	12.0	12.0	4.0	2.0	7.0	7.0	20.0	8.0	---	28.0	33.0	12.0
23	11.5	5.0	4.0	3.0	8.0	15.0	18.0	10.0	---	29.0	---	12.0
24	12.5	2.0	3.0	4.0	7.0	15.0	22.0	29.0	---	22.0	16.0	13.0
25	13.0	6.5	1.0	2.0	10.0	11.0	10.0	19.0	---	22.0	15.0	12.0
26	12.5	8.0	2.0	4.0	12.0	12.0	18.0	14.0	---	25.0	15.0	12.0
27	12.5	7.0	2.0	2.0	12.0	7.0	19.0	22.0	---	20.0	---	13.0
28	11.5	6.0	2.0	3.0	11.0	6.0	22.0	24.0	---	28.0	---	14.0
29	9.0	5.0	2.0	4.0	---	6.0	19.0	12.0	---	21.5	---	14.0
30	8.5	1.0	2.0	3.0	---	2.0	11.0	18.0	---	19.0	---	23.0
31	10.0	---	1.0	3.0	---	6.0	---	16.0	---	21.0	---	---
MONTH	11.0	6.5	4.0	2.5	8.0	10.5	18.5	17.0	---	23.5	---	16.0
YEAR	MAX	33.0	MIN	1.0	MEAN	12.0						

TEMPERATURE (DEG. C) OF WATER, WATER YEAR OCTOBER 1975 TO SEPTEMBER 1976
ONCE-DAILY

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	11.0	9.0	4.0	2.0	8.0	10.0	14.0	20.0	26.0	---	20.0	---
2	12.0	5.0	4.0	4.0	---	8.0	15.0	22.0	28.0	---	22.0	---
3	---	6.0	2.0	1.0	8.0	6.0	19.0	12.0	26.0	---	22.0	---
4	13.0	5.0	4.0	1.0	7.0	---	19.0	18.0	14.0	---	19.0	17.0
5	14.0	5.0	4.0	2.0	6.0	9.0	11.0	19.0	---	---	24.0	24.0
6	11.0	7.5	4.0	3.0	5.0	10.0	16.0	16.0	---	---	22.0	19.0
7	13.0	12.0	4.0	2.0	8.0	5.0	6.0	17.0	---	---	---	18.0
8	9.0	6.0	6.0	2.0	9.0	10.0	6.0	18.0	---	---	18.0	19.0
9	8.0	5.0	7.0	2.0	10.0	12.0	6.0	12.0	---	---	14.0	22.0
10	10.0	5.0	7.0	3.0	8.0	10.0	18.0	24.0	---	---	16.0	26.0
11	13.0	11.0	6.0	2.0	6.0	10.0	16.0	26.0	---	---	14.0	22.0
12	12.0	2.0	5.0	3.0	12.0	9.0	15.0	24.0	---	---	---	20.0
13	10.0	10.0	5.0	4.0	10.0	6.0	15.0	26.0	---	---	---	18.0
14	9.0	3.0	3.0	3.0	10.0	12.0	17.0	28.0	---	---	---	12.0
15	12.0	3.0	2.0	1.0	9.0	14.0	11.0	14.0	---	---	---	17.0
16	7.0	4.0	4.0	4.0	11.0	10.0	10.0	24.0	---	---	---	15.0
17	8.0	2.0	4.0	4.0	10.0	14.0	15.0	26.0	---	---	---	15.0
18	9.0	8.0	2.0	2.0	12.0	12.0	12.0	16.0	---	---	---	13.0
19	10.0	2.0	3.0	4.0	12.0	6.0	6.0	19.0	---	---	---	12.0
20	10.0	3.0	3.0	4.0	10.0	4.0	7.0	22.0	---	---	24.0	11.0
21	10.0	1.0	4.0	4.0	10.0	13.0	18.0	18.0	---	---	19.0	15.0
22	9.0	6.0	3.0	4.0	10.0	12.0	11.0	19.0	---	---	22.0	18.0
23	8.0	5.0	2.0	3.0	9.0	14.0	12.0	24.0	---	---	19.0	16.0
24	4.0	6.0	5.0	1.0	9.0	15.0	10.0	17.0	---	---	20.0	16.0
25	3.0	3.0	4.0	4.0	10.0	16.0	8.0	19.0	---	---	26.0	14.0
26	4.0	5.0	2.0	3.0	12.0	15.0	6.0	22.0	---	---	---	15.0
27	9.0	3.0	3.0	3.0	10.0	12.0	5.0	25.0	---	24.0	---	19.0
28	6.0	2.0	3.0	5.0	12.0	7.0	8.0	24.0	---	24.0	24.0	15.0
29	16.0	3.0	3.0	10.0	10.0	---	10.0	22.0	---	27.0	---	15.0
30	6.0	3.0	3.0	10.0	---	---	12.0	23.0	---	33.0	24.0	19.0
31	8.0	---	2.0	5.0	---	---	---	15.0	---	21.0	12.0	---
MONTH	9.5	5.0	4.0	3.5	9.5	10.5	11.5	20.5	---	---	---	17.0
YEAR	MAX	33.0	MIN	1.0	MEAN	11.0						

Table 6.--Chemical analyses of surface waters sampled as a part of the Black Mesa monitoring program

If the name of the site is preceeded by an 8-digit number starting with 09, the site is one where systematic observations are being or have been made. The 8-digit number is called a downstream order number. If the name of the site is preceeded by a 15-digit number of which the first 13 digits are identical to the latitude and longitude of the site, then the site is a miscellaneous site where only random observations are made.

Code for agency analyzing sample: 1028 is U. S. G. S.

DATE	TIME	INSTANTANEOUS DISCHARGE (CFS)	DISSOLVED SILICA (SIO2) (MG/L)	DISSOLVED IRON (FE) (UG/L)	DISSOLVED MAGNESIUM (MG) (MG/L)	DISSOLVED SODIUM (NA) (MG/L)	DISSOLVED POTASSIUM (K) (MG/L)	BICARBONATE (HCO3) (MG/L)	CARBONATE (CO3) (MG/L)	DISSOLVED SULFATE (SO4) (MG/L)	DISSOLVED CHLORIDE (CL) (MG/L)	DISSOLVED FLUORIDE (F) (MG/L)
09401236 - YELLOW WATER CANYON NR SHONTO (LAT 36 30 33 LONG 110 26 20)												
JUL , 1975												
15...	0800	.50	15	60	39	39	10	159	0	380	13	.9
09401240 - MOENKOPI WASH NR SHONTO (LAT 36 24 51 LONG 110 27 28)												
DEC , 1973												
13...	1100	1.5	15	20	170	220	8.3	295	0	1700	26	.5
MAR , 1974												
13...	1220	1.2	15	170	170	220	11	284	0	1700	26	.5
MAY												
08...	1200	.08	15	80	170	260	14	244	0	1700	26	.6
JUL												
25...	1200	E1.0	20	40	160	220	12	265	0	1700	26	.5
SEP												
18...	1100	.91	11	50	140	170	10	223	--	1400	22	.8
FEB , 1975												
27...	0950	.27	11	40	150	190	7.7	250	--	1500	24	.6
JUN												
11...	1100	.10	16	50	170	240	12	274	0	1700	29	.7
MAR , 1977												
17...	0815	--	13	50	150	240	9.2	345	0	1400	28	.4
09401248 - BEGASHIBITO WASH NEAR TONALEA ARIZ (LAT 36 12 58 LONG 110 58 36)												
JAN , 1975												
21...	1400	--	11	10	34	110	3.2	257	--	450	25	.5
JUN												
09...	1330	.05	10	30	34	120	4.5	158	0	480	31	.8
DEC												
11...	1430	E.10	7.5	20	32	110	4.7	256	0	410	28	.4
DEC , 1976												
10...	0930	.02	9.3	30	31	97	2.7	263	0	390	25	.5

DATE	DISSOLVED NITRITE PLUS NITRATE (N) (MG/L)	DISSOLVED ORTHO. PHOSPHORUS (P) (MG/L)	DISSOLVED SOLIDS (RESIDUE AT 180 C) (MG/L)	DISSOLVED SOLIDS (TONS PER AC-FT)	HARDNESS (CA,MG) (MG/L)	NONCARBONATE HARDNESS (MG/L)	SODIUM ADSORPTION RATIO	SPECIFIC CONDUCTANCE (MICROMHOS)	PH (UNITS)	TEMPERATURE (DEG C)	DISSOLVED BORON (B) (UG/L)	CODE FOR AGENCY ANALYZING SAMPLE
09401236 - YELLOW WATER CANYON NR SHONTO (LAT 36 30 33 LONG 110 26 20)												
JUL , 1975												
15...	.96	.00	729	.99	460	330	.8	940	7.8	21.0	120	1028
09401240 - MOENKOPI WASH NR SHONTO (LAT 36 24 51 LONG 110 27 28)												
DEC , 1973												
13...	1.8	.04	2810	3.82	1500	1300	2.5	3032	7.9	.0	130	1028
MAR , 1974												
13...	2.4	.02	2840	3.86	1600	1300	2.4	3090	7.9	17.0	120	1028
MAY												
08...	.05	.01	2820	3.84	1400	1200	3.0	3050	8.1	25.0	160	1028
JUL												
25...	1.3	.01	2840	3.86	1500	1300	2.5	3010	7.9	--	200	1028
SEP												
18...	2.7	.04	2360	3.21	1300	1100	2.1	2500	7.7	20.0	140	1028
FEB , 1975												
27...	3.1	.01	2500	3.40	1400	1200	2.2	2750	8.0	--	120	1028
JUN												
11...	.11	.01	2710	3.69	1400	1200	2.8	3000	8.1	27.5	170	1028
MAR , 1977												
17...	.80	.01	2650	3.60	1300	1000	2.9	2800	8.0	.0	110	1028
09401248 - BEGASHIBITO WASH NEAR TONALEA ARIZ (LAT 36 12 58 LONG 110 58 36)												
JAN , 1975												
21...	.14	.01	907	1.23	460	250	2.2	1120	8.0	1.0	120	1028
JUN												
09...	.00	.00	922	1.25	380	250	2.7	1240	8.5	29.0	190	1028
DEC												
11...	.02	.00	881	1.20	430	220	2.3	1100	8.4	12.0	130	1028
DEC , 1976												
10...	.01	.02	854	1.16	430	210	2.0	1100	7.8	.5	130	1028

Table 6.--Chemical analyses of surface waters sampled as a part of the Black Mesa monitoring program--Continued

09401250 - MOENKOPI WASH NR MOENKOPI, ARIZ. (LAT 36 06 36 LONG 111 09 19)

DATE	TIME	INSTANTANEOUS DISCHARGE (CFS)	DISSOLVED SILICA (SIO2) (MG/L)	DISSOLVED IRON (FE) (UG/L)	DISSOLVED MAGNESIUM (MG) (MG/L)	DISSOLVED SODIUM (NA) (MG/L)	DISSOLVED POTASSIUM (K) (MG/L)	BICARBONATE (HCO3) (MG/L)	CARBONATE (CO3) (MG/L)	DISSOLVED SULFATE (SO4) (MG/L)	DISSOLVED CHLORIDE (CL) (MG/L)	DISSOLVED FLUORIDE (F) (MG/L)
JUN , 1972												
22...	1330	E200	14	70	79	200	15	196	0	1500	25	.7
SEP												
26...	--	E2.5	10	30	23	100	5.5	243	0	320	10	.7
OCT												
26...	1430	E400	6.3	60	32	64	5.4	78	0	650	8.0	.7
JUL , 1973												
20...	1325	E15	8.3	60	170	630	15	248	0	2700	64	1.2
SEP												
12...	1030	3.7	8.9	100	73	160	9.6	137	0	1100	20	.9
OCT												
03...	0930	1.1	7.9	50	24	140	4.7	231	7	380	14	.8
DEC												
12...	1145	1.7	7.9	30	21	110	4.0	230	0	290	12	.5
MAR , 1974												
11...	1400	3.0	8.6	50	32	110	5.7	219	0	440	12	.7
JUL												
19...	1315	270	15	50	150	240	15	248	0	2300	24	.5
22...	1300	47	14	50	72	120	10	168	0	1100	13	.6
23...	1330	5.8	13	30	66	110	9.6	153	0	1000	13	.6
SEP												
03...	1040	.14	8.3	50	46	190	6.9	208	--	680	22	.8
19...	1030	1.2	8.4	50	36	150	7.6	187	--	580	14	.7
OCT												
31...	1300	8.5	6.8	10	34	120	7.7	136	--	660	9.9	.5
NOV												
25...	1330	2.0	8.2	40	19	110	4.1	245	--	290	10	.5
JAN , 1975												
15...	1215	1.2	13	10	24	120	4.3	314	--	310	15	.5
FEB												
28...	1430	2.3	7.0	30	18	100	3.5	218	--	260	11	.5
MAR												
20...	1330	2.1	9.1	20	53	150	6.3	228	0	610	15	.5
MAY												
06...	1305	2.4	6.7	20	26	130	4.7	247	--	350	19	.6
JUN												
09...	1220	.78	4.1	10	22	140	6.2	216	0	310	17	.7

09401250 - MOENKOPI WASH NR MOENKOPI, ARIZ. (LAT 36 06 36 LONG 111 09 19)

DATE	DISSOLVED NITRITE PLUS NITRATE (N) (MG/L)	DISSOLVED ORTHO. PHOSPHORUS (P) (MG/L)	DISSOLVED SOLIDS (RESIDUE AT 180 C) (MG/L)	DISSOLVED SOLIDS (TONS PER AC-FT)	HARDNESS (CA,MG) (MG/L)	NONCARBONATE HARDNESS (MG/L)	SODIUM ADSORPTION RATIO	SPECIFIC CONDUCTANCE (MICROMHOS)	PH (UNITS)	TEMPERATURE (DEG C)	DISSOLVED BORON (B) (UG/L)	CODE FOR AGENCY ANALYZING SAMPLE
JUN , 1972												
22...	2.4	.01	--	3.20	1300	1200	2.4	2780	7.9	22.0	--	1028
SEP												
26...	.03	--	--	.92	320	120	2.4	950	8.2	21.0	130	1028
OCT												
26...	1.7	.01	1090	1.48	630	570	1.1	1350	7.4	12.0	70	1028
JUL , 1973												
20...	.24	.02	4300	5.85	1600	1400	6.8	4860	7.7	32.0	460	1028
SEP												
12...	3.4	.07	1910	2.60	930	810	2.3	2130	7.4	19.5	60	1028
OCT												
03...	.03	.02	824	1.12	280	80	3.6	1130	8.4	11.0	120	1028
DEC												
12...	.23	.02	640	.87	270	85	2.9	943	8.3	4.0	90	1028
MAR , 1974												
11...	.38	.01	865	1.18	410	230	2.4	1200	8.2	17.0	80	1028
JUL												
19...	.65	.02	3640	4.95	1900	1700	2.4	2250	7.1	25.5	230	1028
22...	1.7	.02	1850	2.52	1000	910	1.6	1900	7.3	28.8	160	1028
23...	.62	.01	1760	2.39	950	820	1.6	1600	7.4	31.0	160	1028
SEP												
03...	.10	.01	1330	1.63	540	370	3.6	1600	8.1	22.5	200	1028
19...	.15	.00	1080	1.47	450	290	3.1	1400	8.1	19.0	130	1028
OCT												
31...	1.7	.02	1140	1.55	510	400	2.3	1490	7.8	11.0	40	1028
NOV												
25...	.03	.00	667	.91	290	90	2.8	950	8.3	9.0	100	1028
JAN , 1975												
15...	.43	.00	747	1.02	330	76	2.9	1100	8.1	1.0	80	1028
FEB												
28...	.04	.01	614	.84	250	70	2.8	901	8.5	18.0	80	1028
MAR												
20...	.39	.01	1190	1.62	570	380	2.7	1580	8.8	17.0	90	1028
MAY												
06...	.00	.00	749	1.02	280	82	3.4	950	--	17.0	130	1028
JUN												
09...	.03	.01	679	.92	220	38	4.2	900	8.7	31.0	120	1028

Table 6.--Chemical analyses of surface waters sampled as a part of the Black Mesa monitoring program--Continued

09401250 - MOENKOPI WASH NR MOENKOPI, ARIZ. (LAT 36 06 36 LONG 111 09 19)

DATE	TIME	INSTANTANEOUS DISCHARGE (CFS)	DISSOLVED SILICA (SIO2) (MG/L)	DISSOLVED IRON (FE) (UG/L)	DISSOLVED MAGNESIUM (MG) (MG/L)	DISSOLVED SODIUM (NA) (MG/L)	DISSOLVED POTASSIUM (K) (MG/L)	BICARBONATE (HCO3) (MG/L)	CARBONATE (CO3) (MC/L)	DISSOLVED SULFATE (SO4) (MG/L)	DISSOLVED CHLORIDE (CL) (MG/L)	DISSOLVED FLUORIDE (F) (MG/L)
JUL , 1975												
09...	1330	.86	12	10	50	300	15	163	0	1100	22	.9
11...	1230	86	13	10	59	150	15	222	0	910	22	.7
13...	1215	205	13	10	72	130	12	194	0	1100	14	.6
AUG												
11...	1130	.21	7.8	10	49	190	11	146	0	880	22	.7
12...	1415	4.3	9.3	20	44	190	11	183	0	820	14	.8
22...	1415	1.2	7.8	0	29	170	8.0	195	0	590	15	.7
SEP												
23...	1130	3.9	8.3	30	51	85	9.3	103	0	880	21	.6
OCT												
07...	1030	.86	8.6	40	26	110	8.6	165	0	510	9.7	.5
NOV												
06...	1100	2.4	9.2	10	19	110	4.8	247	0	340	10	.5
DEC												
11...	1300	3.3	8.3	10	19	110	3.9	235	0	320	12	.5
FEB , 1976												
18...	1345	2.5	7.3	10	18	110	3.6	226	5	300	12	.5
MAR												
18...	1650	2.3	7.9	0	19	120	4.6	228	6	300	12	.7
APR												
23...	1250	1.8	6.3	370	21	130	4.9	234	0	300	18	.6
MAY												
28...	1530	.50	4.7	10	18	150	6.8	194	12	310	17	.8

09401250 - MOENKOPI WASH NR MOENKOPI, ARIZ. (LAT 36 06 36 LONG 111 09 19)

DATE	DISSOLVED NITRITE PLUS NITRATE (N) (MG/L)	DISSOLVED ORTHO. PHOSPHORUS (P) (MG/L)	DISSOLVED SOLIDS (RESIDUE AT 180 C) (MG/L)	DISSOLVED SOLIDS (TONS PER AC-FT)	HARDNESS (CA,MG) (MG/L)	NONCARBONATE HARDNESS (MG/L)	SODIUM ADSORPTION RATIO	SPECIFIC CONDUCTANCE (MICROMHOS)	PH (UNITS)	TEMPERATURE (DEG C)	DISSOLVED BORON (B) (UG/L)	CODE FOR AGENCY ANALYZING SAMPLE
JUL , 1975												
09...	4.5	.00	1940	2.64	680	550	5.0	2420	8.2	34.0	180	1028
11...	.68	.00	1670	2.27	870	690	2.2	1700	7.3	29.0	190	1028
13...	.42	.00	1900	2.58	1100	910	1.7	2120	7.3	22.5	160	1028
AUG												
11...	.04	.00	1490	2.03	630	510	3.3	1800	7.9	28.0	190	1028
12...	.31	.01	1420	1.93	630	480	3.3	1650	7.9	29.0	150	1028
22...	.05	.00	1090	1.48	390	230	3.7	1400	8.0	33.0	130	1028
SEP												
23...	1.5	.01	1510	2.05	810	720	1.3	1625	7.2	18.0	90	1028
OCT												
07...	.00	.00	861	1.17	410	270	2.4	1200	8.4	15.0	100	1028
NOV												
06...	.27	.00	694	.94	310	110	2.7	1000	8.3	9.0	70	1028
DEC												
11...	.18	.01	677	.92	300	110	2.8	984	8.3	7.0	30	1028
FEB , 1976												
18...	.15	.00	668	.91	270	78	2.9	960	8.4	13.0	70	1028
MAR												
18...	.00	.00	652	.89	260	64	3.2	940	9.0	17.0	160	1028
APR												
23...	.06	.00	669	.91	300	100	3.3	1200	8.4	26.0	100	1028
MAY												
28...	.03	.00	657	.89	200	25	4.6	980	8.7	26.0	130	1028

Table 6.--Chemical analyses of surface waters sampled as a part of the Black Mesa monitoring program--Continued

DATE	TIME	INSTANTANEOUS DISCHARGE (CFS)	DISSOLVED SILICA (SIO2) (MG/L)	DISSOLVED IRON (FE) (UG/L)	DISSOLVED MAGNESIUM (MG) (MG/L)	DISSOLVED SODIUM (NA) (MG/L)	DISSOLVED POTASSIUM (K) (MG/L)	BICARBONATE (HCO3) (MG/L)	CARBONATE (CO3) (MG/L)	DISSOLVED SULFATE (SO4) (MG/L)	DISSOLVED CHLORIDE (CL) (MG/L)	DISSOLVED FLUORIDE (F) (MG/L)
09401260 - MOENKOPI WASH AT MOENKOPI (LAT 36 06 18 LONG 111 12 04)												
JAN , 1976												
24...	1000	E2.0	--	--	--	--	--	--	--	--	--	--
FEB												
10...	1600	E2.0	--	--	--	--	--	--	--	--	--	--
MAY												
21...	1900	E5.0	--	--	--	--	--	--	--	--	--	--
JUL												
27...	1515	139	13	30	160	330	19	234	0	2300	31	.6
30...	1500	2.4	11	30	86	230	19	87	0	1800	12	.7
31...	1000	640	--	--	--	--	--	--	--	--	--	--
AUG												
08...	0800	45	--	--	--	--	--	--	--	--	--	--
20...	1430	26	--	--	--	--	--	--	--	--	--	--
NOV												
11...	1320	2.5	7.8	10	20	110	4.5	217	0	350	12	.5
DEC												
10...	1240	4.6	8.7	30	20	110	3.8	226	0	320	15	.5
JAN , 1977												
19...	1300	3.3	8.8	80	16	99	3.3	217	0	260	16	.4
MAR												
15...	1430	1.5	6.3	20	19	120	4.4	220	2	310	18	.6
360849111015801 - LOWER COAL MINE WASH AT MOENKOPI (LAT 36 08 49 LONG 111 01 58.01)												
DEC , 1973												
12...	1415	.20	11	40	27	380	6.0	516	0	700	19	1.0
JAN , 1975												
21...	1130	.10	13	10	30	500	6.8	588	--	930	24	2.9

DATE	DISSOLVED NITRITE PLUS NITRATE (N) (MG/L)	DISSOLVED ORTHO. PHOSPHORUS (P) (MG/L)	DISSOLVED SOLIDS (RESIDUE AT 180 C) (MG/L)	DISSOLVED SOLIDS (TONS PER AC-FT)	HARDNESS (CA,MG) (MG/L)	NONCARBONATE HARDNESS (MG/L)	SODIUM ADSORPTION RATIO	SPECIFIC CONDUCTANCE (MICROMHOS)	PH (UNITS)	TEMPERATURE (DEG C)	DISSOLVED BORON (B) (UG/L)	CODE FOR AGENCY ANALYZING SAMPLE
09401260 - MOENKOPI WASH AT MOENKOPI (LAT 36 06 18 LONG 111 12 04)												
JAN , 1976												
24...	--	--	--	--	--	--	--	--	--	1.0	--	--
FEB												
10...	--	--	--	--	--	--	--	--	--	8.0	--	--
MAY												
21...	--	--	--	--	--	--	--	--	--	18.0	--	--
JUL												
27...	.77	.03	3790	5.15	2000	1800	3.2	3100	7.1	26.0	260	1028
30...	11	.03	2750	3.74	1500	1400	2.6	2700	7.7	33.0	140	1028
31...	--	--	--	--	--	--	--	--	--	20.0	--	--
AUG												
08...	--	--	--	--	--	--	--	--	--	14.0	--	--
20...	--	--	--	--	--	--	--	--	--	26.0	--	--
NOV												
11...	.11	.00	682	.93	320	140	2.7	760	8.0	10.0	80	1028
DEC												
10...	.33	.02	707	.96	300	120	2.8	820	8.1	1.5	70	1028
JAN , 1977												
19...	.53	.02	619	.84	250	75	2.7	720	8.3	--	70	1028
MAR												
15...	.05	.09	668	.91	260	79	3.2	920	8.4	8.5	80	1028
360849111015801 - LOWER COAL MINE WASH AT MOENKOPI (LAT 36 08 49 LONG 111 01 58.01)												
DEC , 1973												
12...	.16	.02	1460	1.99	320	0	9.3	2112	8.1	4.0	180	1028
JAN , 1975												
21...	.12	.01	1880	2.56	340	0	12	2500	8.0	1.0	180	1028

Table 6.--Chemical analyses of surface waters sampled as a part of the Black Mesa monitoring program--Continued

DATE	TIME	INSTANTANEOUS DISCHARGE (CFS)	DISSOLVED SILICA (SIO2) (MG/L)	DISSOLVED IRON (FE) (UG/L)	DISSOLVED MAGNESIUM (MG) (MG/L)	DISSOLVED SODIUM (NA) (MG/L)	DISSOLVED POTASSIUM (K) (MG/L)	BICARBONATE (HCO3) (MG/L)	CARBONATE (CO3) (MG/L)	DISSOLVED SULFATE (SO4) (MG/L)	DISSOLVED CHLORIDE (CL) (MG/L)	DISSOLVED FLUORIDE (F) (MG/L)
360907110593600 - BEGASHIBITO WASH AT MOUTH NR TONALEA AZ (LAT 36 09 07 LONG 110 59 36)												
DEC , 1973												
12...	1515	.50	9.3	80	18	56	3.0	270	0	130	15	.4
JAN , 1975												
21...	1300	--	11	40	16	53	3.3	267	--	130	12	.0
362541110233000 - PEABODY RESERVOIR ON BLACK MESA (LAT 36 25 41 LONG 110 23 30)												
JAN , 1975												
22...	1530	--	8.9	10	27	53	6.9	217	--	270	13	.6
NOV												
06...	0930	--	.0	0	41	85	8.3	115	8	390	18	.6
MAR , 1977												
17...	1035	--	.6	30	26	56	6.4	148	0	270	14	.7
362622110233300 - BLACK MESA PUMPING STATION RESERVOIR (LAT 36 26 22 LONG 110 23 33)												
NOV , 1971												
10...	--	--	20	--	3.6	87	1.5	182	0	58	7.5	1.2
362728110234200 - MOENKOPI WASH AT HAUL ROAD (LAT 36 27 28 LONG 110 23 42)												
NOV , 1971												
10...	--	--	7.8	--	160	180	7.7	144	0	1600	24	1.8
362738110250000 - BLACK MESA MINE, STRIP J-3 (LAT 36 27 38 LONG 110 25 00)												
NOV , 1971												
10...	--	--	3.8	--	7.8	160	2.0	218	8	190	16	1.2

DATE	DISSOLVED NITRITE PLUS NITRATE (N) (MG/L)	DISSOLVED ORTHO. PHOSPHORUS (P) (MG/L)	DISSOLVED SOLIDS (RESIDUE AT 180 C) (MG/L)	DISSOLVED SOLIDS (TONS PER AC-FT)	HARDNESS (CA,MG) (MG/L)	NONCARBONATE HARDNESS (MG/L)	SODIUM ADSORPTION RATIO	SPECIFIC CONDUCTANCE (MICROMHOS)	PH (UNITS)	TEMPERATURE (DEG C)	DISSOLVED BORON (B) (UG/L)	CODE FOR AGENCY ANALYZING SAMPLE
360907110593600 - BEGASHIBITO WASH AT MOUTH NR TONALEA AZ (LAT 36 09 07 LONG 110 59 36)												
DEC , 1973												
12...	.12	.02	432	.59	240	20	1.6	675	8.3	1.5	80	1028
JAN , 1975												
21...	.31	.00	431	.59	240	22	1.5	640	8.2	1.0	70	1028
362541110233000 - PEABODY RESERVOIR ON BLACK MESA (LAT 36 25 41 LONG 110 23 30)												
JAN , 1975												
22...	.12	.00	622	.85	360	180	1.2	876	8.2	.0	50	1028
NOV												
06...	.01	.00	765	1.04	330	220	2.0	1060	8.8	9.0	120	1028
MAR , 1977												
17...	.01	.00	546	.74	290	170	1.4	560	8.3	5.0	100	1028
362622110233300 - BLACK MESA PUMPING STATION RESERVOIR (LAT 36 26 22 LONG 110 23 33)												
NOV , 1971												
10...	--	--	--	.38	40	0	6.0	445	7.9	--	--	1028
362728110234200 - MOENKOPI WASH AT HAUL ROAD (LAT 36 27 28 LONG 110 23 42)												
NOV , 1971												
10...	--	--	--	3.25	1500	1400	2.0	2650	8.1	--	--	1028
362738110250000 - BLACK MESA MINE, STRIP J-3 (LAT 36 27 38 LONG 110 25 00)												
NOV , 1971												
10...	--	--	--	--	42	0	8.2	846	8.5	--	--	1028

Table 6.--Chemical analyses of surface waters sampled as a part of the Black Mesa monitoring program--Continued

DATE	TIME	INSTANTANEOUS DISCHARGE (CFS)	DISSOLVED SILICA (SIO2) (MG/L)	DISSOLVED IRON (FE) (UG/L)	DISSOLVED MAGNESIUM (MG) (MG/L)	DISSOLVED SODIUM (NA) (MG/L)	DISSOLVED POTASSIUM (K) (MG/L)	BICARBONATE (HCO3) (MG/L)	CARBONATE (CO3) (MG/L)	DISSOLVED SULFATE (SO4) (MG/L)	DISSOLVED CHLORIDE (CL) (MG/L)	DISSOLVED FLUORIDE (F) (MG/L)
363040110252501 - SITE 3, COAL MINE WASH ON BLACK MESA (LAT 36 30 40 LONG 110 25 25.01)												
APR , 1973												
12...	1145	1.0	12	30	150	130	5.0	236	0	1300	23	.7
363142110243200 - COAL MINE WASH NEAR 09401229 (LAT 36 31 42 LONG 110 24 32)												
JAN , 1975												
21...	1700	--	16	10	160	93	2.7	216	--	1400	21	.5
NOV												
06...	1100	--	11	0	190	110	4.8	148	0	1800	27	.5
363213110242800 - COAL MINE WASH TRIB NO.2 AB 09401229 (LAT 36 32 13 LONG 110 24 28)												
JAN , 1975												
21...	1620	--	9.4	80	660	770	5.7	248	--	4100	100	.5
363223110242700 - COAL MINE WASH TRIB 2, SITE A-4 (LAT 36 32 23 LONG 110 24 27)												
MAY , 1973												
17...	1030	<.01	20	40	480	410	4.0	287	0	3100	84	1.5
NOV , 1975												
06...	1145	--	15	0	540	630	5.2	256	0	3900	85	1.8
363237110250000 - PROSPECT PIT NO. 1 (LAT 36 32 37 LONG 110 25 00)												
SEP , 1973												
25...	1130	--	3.0	80	350	120	22	229	0	2000	120	.8

DATE	DISSOLVED NITRITE PLUS NITRATE (N) (MG/L)	DISSOLVED ORTHO. PHOSPHORUS (P) (MG/L)	DISSOLVED SOLIDS (RESIDUE AT 180 C) (MG/L)	DISSOLVED SOLIDS (TONS PER AC-FT)	HARDNESS (CA,MG) (MG/L)	NONCARBONATE HARDNESS (MG/L)	SODIUM ADSORPTION RATIO	SPECIFIC CONDUCTANCE (MICROMHOS)	PH (UNITS)	TEMPERATURE (DEG C)	DISSOLVED BORON (B) (UG/L)	CODE FOR AGENCY ANALYZING SAMPLE
363040110252501 - SITE 3, COAL MINE WASH ON BLACK MESA (LAT 36 30 40 LONG 110 25 25.01)												
APR , 1973												
12...	10	.01	2200	2.99	1300	1100	1.6	1900	8.1	11.5	130	1028
363142110243200 - COAL MINE WASH NEAR 09401229 (LAT 36 31 42 LONG 110 24 32)												
JAN , 1975												
21...	6.0	.01	2320	3.16	1400	1300	1.1	2520	8.1	--	120	1028
NOV												
06...	5.0	.00	2870	3.90	1800	1600	1.1	2690	8.6	10.0	150	1028
363213110242800 - COAL MINE WASH TRIB NO.2 AB 09401229 (LAT 36 32 13 LONG 110 24 28)												
JAN , 1975												
21...	270	.01	7990	10.9	3900	3700	5.4	8000	7.0	--	900	1028
363223110242700 - COAL MINE WASH TRIB 2, SITE A-4 (LAT 36 32 23 LONG 110 24 27)												
MAY , 1973												
17...	300	.03	6630	9.02	3800	3600	2.9	5500	6.7	11.0	760	1028
NOV , 1975												
06...	220	.00	7290	9.91	3800	3600	4.4	6910	8.4	12.0	670	1028
363237110250000 - PROSPECT PIT NO. 1 (LAT 36 32 37 LONG 110 25 00)												
SEP , 1973												
25...	1.2	.02	3430	4.66	2200	2100	1.1	3650	7.9	13.0	220	1028

Table 6.--Chemical analyses of surface waters sampled as a part of the Black Mesa monitoring program--Continued

DATE	TIME	INSTANTANEOUS DISCHARGE (CFS)	DISSOLVED SILICA (SIO2) (MG/L)	DISSOLVED IRON (FE) (UG/L)	DISSOLVED MAGNESIUM (MG) (MG/L)	DISSOLVED SODIUM (NA) (MG/L)	DISSOLVED POTASSIUM (K) (MG/L)	BICARBONATE (HCO3) (MG/L)	CARBONATE (CO3) (MG/L)	DISSOLVED SULFATE (SO4) (MG/L)	DISSOLVED CHLORIDE (CL) (MG/L)	DISSOLVED FLUORIDE (F) (MG/L)
363243110252200 - YELLOW WATER CANYON AT ROAD CROSSING (LAT 36 32 43 LONG 110 25 22)												
JAN , 1975												
22...	1700	--	2.2	10	45	37	2.6	45	--	570	5.0	.3
JUL												
29...	1730	E30	11	310	12	9.6	7.6	176	0	110	7.6	.6

DATE	DISSOLVED NITRITE PLUS NITRATE (N) (MG/L)	DISSOLVED ORTHO. PHOSPHORUS (P) (MG/L)	DISSOLVED SOLIDS (RESIDUE AT 180 C) (MG/L)	DISSOLVED SOLIDS (TONS PER AC-FT)	HARDNESS (CA,MG) (MG/L)	NONCARBONATE HARDNESS (MG/L)	SODIUM ADSORPTION RATIO	SPECIFIC CONDUCTANCE (MICROMHOS)	PH (UNITS)	TEMPERATURE (DEG C)	DISSOLVED BORON (B) (UG/L)	CODE FOR AGENCY ANALYZING SAMPLE
363243110252200 - YELLOW WATER CANYON AT ROAD CROSSING (LAT 36 32 43 LONG 110 25 22)												
JAN , 1975												
22...	1.7	.01	874	1.19	540	500	.7	1120	7.2	--	30	1028
JUL												
29...	.01	.00	379	.52	230	90	.3	400	7.7	17.5	130	1028

The area leased for strip mining on Black Mesa is about 100 mi^2 (259 km^2) whereas, the drainage area for the station Moenkopi Wash at Moenkopi is 1,660 mi^2 (430 km^2). Therefore, because most of the surface flow at the Moenkopi gaging station could originate in areas other than the strip mine, two additional gaging stations were installed. One station--Moenkopi Wash near Shonto--is about 1.2 mi (1.9 km) downstream from the mouth of Coal Mine Wash. The drainage area for this station is 270 mi^2 (700 km^2) including the mined area. The other station is on Begashibito Wash near Tonalea, 5.7 mi (9.2 km) upstream from its confluence with Moenkopi Wash. The drainage area for this station is 611 mi^2 (1,580 km^2), which is west of the mined area.

Ground Water

The objective of the ground-water activities is to monitor the effects of ground-water withdrawals on the regional potentiometric surface in the N aquifer. In order to accomplish this a network of 14 observation wells was established in 1972; six of these wells were equipped with continuous recorders and eight were measured annually. One of the sites measured annually has since been discontinued because of an obstruction in the well. Recorders were installed on five wells in late 1972, four drilled by the Geological Survey (BM1, BM2, BM4, and BM5) and an existing well belonging to the Navajo Tribe (BM3); the locations of the wells are shown in figure 1. In the fall of 1973 a recorder was installed on the well P1, which was the original Peabody test hole drilled on the mesa.

Six windmills that penetrate the N aquifer, along the northeast and northwest edge of Black Mesa, are measured annually; these have been designated W1, W2, W3, W4, W5, and W6 and also are shown in figure 1. Data from these wells represent the only predevelopment water-level data available in the N aquifer in the area. Data from several wells were collected as early as 1967.

Two windmills that penetrate the Wepo and Toreva Formations are in the strip-mined area; W7 (fig. 1) has been measured periodically since 1973 and W8 (not shown in fig. 1) was measured during 1974 until it became inoperative and water-level measurements could no longer be made. The Wepo

and Toreva Formations locally yield water for stock supplies and lie above the N aquifer. Water levels in the Wepo and Toreva Formations will not be affected by pumping from the N aquifer. The object of monitoring the water level in these wells is to detect the effects, if any, of the mine operation on the shallow aquifers.

A new well--BM6--was completed in January 1977. The well is about 18 mi (29 km) south of the Peabody well field (fig. 1). This well was added to the monitoring network in an attempt to improve the network and to enhance the possibility of differentiating the amount of lowering of the potentiometric surface attributable to either mine or community withdrawals. The well is 2,506 ft (764 m) deep and is now open only to the N aquifer from 1,954 to 2,506 ft (596 to 764 m) below land surface. Water levels monitored in this well will reflect only the fluctuations of the potentiometric surface in the N aquifer. The formations penetrated during drilling, their depths, and the physical dimensions of the well are shown in figure 4.

Ground-water samples from the Peabody production wells are being collected and analyzed annually to detect any changes in quality that may be attributed to leakage of poorer quality water from the overlying formations into the N aquifer. To date (1977), no changes have been observed. The chemical analyses of the water samples from the Peabody wells are shown in table 7.

Total withdrawals from the N aquifer are monitored on a continuing basis. Pumpage records for Peabody production wells are obtained from Peabody Coal Company on a quarterly basis; records of the amount of ground water pumped from the Navajo Tribal Utility Authority wells in Kayenta are obtained on a yearly basis. In order to determine pumpage for the Bureau of Indian Affairs' wells at the schools in Kayenta, Chilchinbito, and Rough Rock, water meters have been installed on six wells. The Indian Health Service also meters the amount of water pumped from a well at Chilchinbito and one at Rough Rock. Annual pumpage for 1974-76 for the communities of Kayenta, Chilchinbito, and Rough Rock are summarized in table 8.

BLACK MESA OBSERVATION WELL NUMBER 6 (BM6)

Location: District 4, Quadrangle 74, 08.95 x 02.95

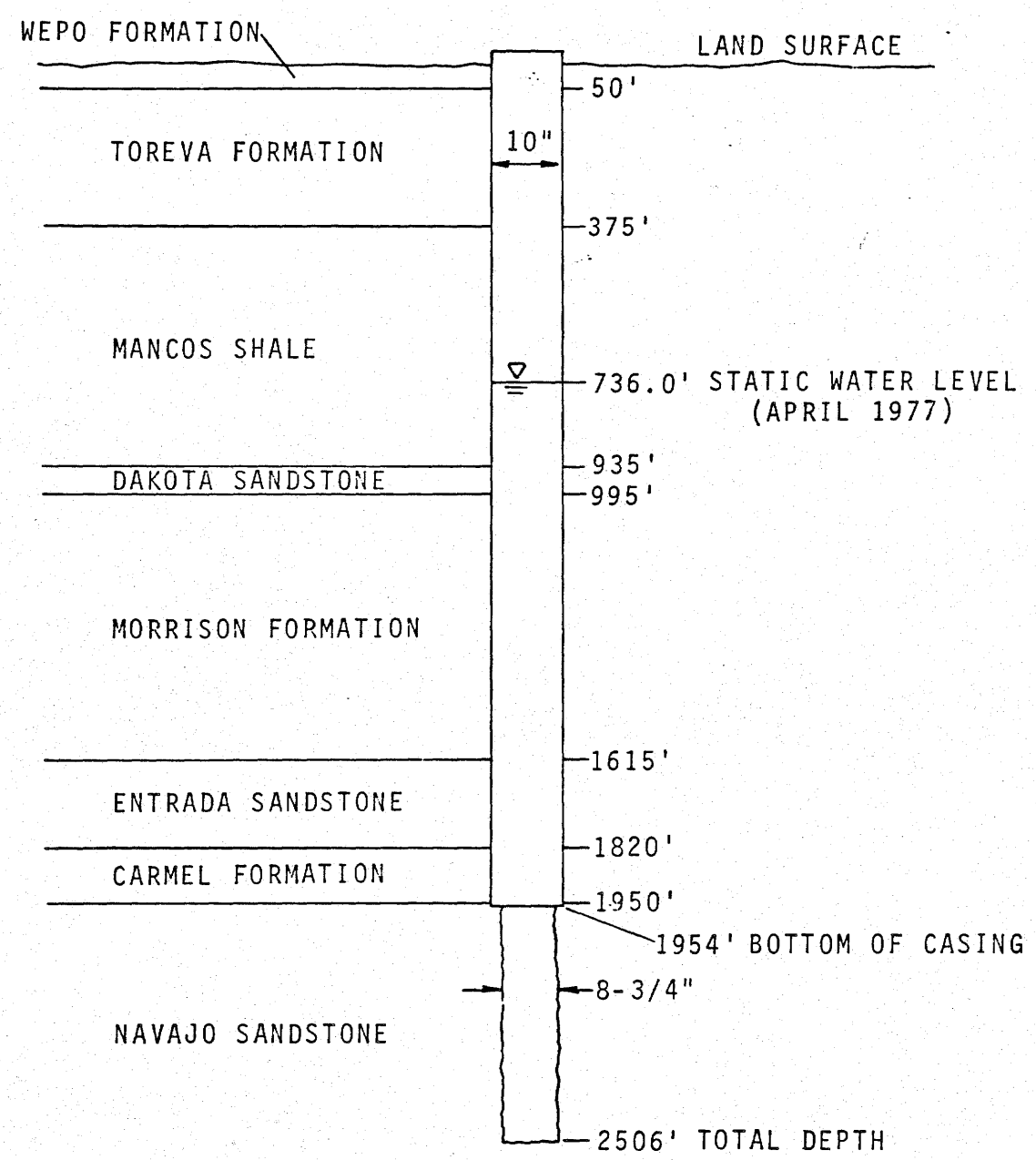


FIGURE 4.--DEPTHS OF FORMATIONS PENETRATED AND PHYSICAL DIMENSIONS OF WELL BM6.

Table 7.--Chemical analyses of water from the Peabody wells

Local Identifier: Includes well number and location. The first two numbers of the location are the district, the next three numbers are the quadrangle, the next four numbers are the distance in miles west from the northeast corner of the quadrangle, and the last four numbers are the distance south from the northeast corner of the quadrangle.

Code for agency analyzing sample: 9801 is private laboratory, 1028 is U. S. G. S.

	LOCAL IDENT-I-FIER	LAT-I-TUDE	LONG-I-TUDE	SEQ. NO.	DATE OF SAMPLE	GEO-LOGIC UNIT	TEMPER-ATURE (DEG C)	CODE FOR AGENCY ANA-LYZING SAMPLE	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	PH (UNITS)	CARBON DIOXIDE (CO2) (MG/L)
PEABODY 1	0803909741675	36 30 26	110 25 28	01	65-10-12	231KYNT	30.0	--	436	9.1	.1
					65-12-15	220NVJO	30.0	--	204	8.1	1.2
					65-12-19	211DKOT	26.0	--	1400	7.9	6.0
PEABODY 2	0803909441718	36 30 05	110 25 09	01	67-08-17	--	29.0	9801	221	8.8	1.0
					71-10-19	--	--	1028	211	8.7	.3
					74-11-13	--	30.0	--	210	--	--
					75-09-10	220NVJO	31.0	--	230	8.2	1.0
					76-11-17	--	30.0	1028	260	8.6	.4
PEABODY 3	0405607110413	36 26 25	110 22 37	01	68-04-29	--	31.0	9801	236	8.2	1.3
					71-10-19	--	--	1028	247	9.2	.1
					73-08-23	--	--	9801	--	8.2	--
					74-11-13	--	33.0	--	230	--	--
					75-09-10	220NVJO	31.0	--	240	8.5	.6
					76-11-18	--	32.0	1028	250	9.2	.1
PEABODY 4	0405609000373	36 26 47	110 24 35	01	73-08-23	--	--	9801	--	8.3	--
					74-11-13	--	33.0	--	200	--	--
					75-09-10	220NVJO	34.0	--	220	8.4	.7
					76-11-17	--	32.0	1028	240	9.1	.1
PEABODY 5	0405608110115	36 29 01	110 23 41	01	68-06-12	--	31.5	9801	224	9.2	.1
					71-08-18	--	--	1028	226	9.0	.2
					73-08-22	--	--	9801	--	9.0	--
					74-11-13	--	33.0	--	210	--	--
					75-09-10	220NVJO	34.0	--	240	8.5	.6
					77-01-18	--	32.0	1028	220	9.2	.1
PEABODY 6	0803906681711	36 30 07	110 22 12	01	68-06-29	--	34.0	9801	201	9.0	.2
					74-11-13	--	33.0	--	500	--	--
PEABODY 7	0405608800585	36 24 56	110 24 23	01	72-06-30	--	31.0	9801	222	9.0	.2
					73-08-22	--	--	9801	--	9.1	--
					74-11-13	--	33.0	--	210	--	--
					75-09-10	220NVJO	33.0	--	220	8.5	.5
					76-11-18	--	32.0	1028	240	9.2	.1

Table 7.--Chemical analyses of water from the Peabody wells--Continued

LOCAL IDENT-I-FIER	DATE OF SAMPLE	ALKA-LINITY AS CACO3 (MG/L)	BICAR-BONATE (HCO3) (MG/L)	CAR-BONATE (CO3) (MG/L)	DIS-SOLVED NITRITE PLUS NITRATE (N) (MG/L)	PHOS-PHATE (PO4) (MG/L)	DIS-SOLVED ORTHO PHOS-PHATE (PO4) (MG/L)	DIS-SOLVED ORTHO. PHOS-PHORUS (P) (MG/L)	HARD-NESS (CA,MG) (MG/L)	NON-CAR-BONATE HARD-NESS (MG/L)	DIS-SOLVED CAL-CIUM (CA) (MG/L)	DIS-SOLVED MAG-NE-SIUM (MG) (MG/L)	DIS-SOLVED SODIUM (NA) (MG/L)
PEABODY 1 0803909741675	65-10-12	96	117	18	--	--	--	--	28	0	10	.7	--
	65-12-15	80	97	0	--	--	--	--	31	0	12	.2	--
	65-12-19	244	298	0	--	--	--	--	94	0	22	9.5	--
PEABODY 2 0803909441718	67-08-17	99	76	22	--	--	--	--	22	0	7.0	1.0	42
	71-10-19	81	84	7	--	--	--	--	19	0	7.5	.1	40
	74-11-13	89	96	6	.95	--	.03	.01	22	0	8.2	.3	40
	75-09-10	84	102	0	.86	--	.00	.00	20	0	7.8	.2	41
	76-11-17	79	78	9	1.2	--	.03	.01	12	0	4.9	.0	41
PEABODY 3 0405607110413	68-04-29	104	127	0	--	--	--	--	11	0	2.4	1.2	55
	71-10-19	99	88	16	--	--	--	--	7	0	3.0	.0	53
	73-08-23	--	--	--	--	--	--	--	--	--	--	--	--
	74-11-13	101	99	12	.79	--	.03	.01	14	0	5.5	.1	51
	75-09-10	99	88	16	.74	--	.00	.00	9	0	3.3	.2	52
	76-11-18	101	38	42	1.6	--	.03	.01	9	0	3.5	.0	50
PEABODY 4 0405609000373	73-08-23	--	--	--	--	--	--	--	--	--	--	--	--
	74-11-13	86	91	7	1.1	--	.03	.01	15	0	5.8	.2	42
	75-09-10	84	70	16	.95	--	.00	.00	13	0	4.9	.2	41
	76-11-17	76	78	7	1.2	--	.03	.01	18	0	7.0	.1	40
PEABODY 5 0405608110115	68-06-12	103	81	22	--	--	--	--	11	0	2.8	1.0	51
	71-08-18	94	90	12	--	--	--	--	10	0	3.9	.0	45
	73-08-22	--	--	--	--	--	--	--	--	--	--	--	--
	74-11-13	104	103	12	.80	--	.03	.01	11	0	4.0	.2	49
	75-09-10	99	100	10	.88	--	.00	.00	9	0	3.5	.1	52
	77-01-18	95	87	14	3.2	--	.09	.03	10	0	3.5	.4	45
PEABODY 6 0803906681711	68-06-29	108	81	25	--	.50	--	--	9	0	2.8	.5	52
	74-11-13	213	201	29	1.4	--	.09	.03	4	0	1.3	.1	120
	72-06-30	89	70	19	--	--	--	--	14	0	4.4	.7	54
PEABODY 7 0405608800585	73-08-22	--	--	--	--	--	--	--	--	--	--	--	--
	74-11-13	87	92	7	.80	--	.06	.02	11	0	4.2	.1	44
	75-09-10	88	85	11	.77	--	.00	.00	11	0	3.8	.3	46
	76-11-18	86	14	45	1.4	--	.03	.01	11	0	4.2	.1	45

Table 7.--Chemical analyses of water from the Peabody wells--Continued

LOCAL IDENT-I-FIER	DATE OF SAMPLE	SODIUM AD-SORP-TION RATIO	PERCENT SODIUM	DIS-SOLVED SODIUM PLUS POTAS-SIUM (MG/L)	DIS-SOLVED PO-TAS-SIUM (K) (MG/L)	DIS-SOLVED CHLO-RIDE (CL) (MG/L)	DIS-SOLVED SULFATE (SO4) (MG/L)	DIS-SOLVED FLUO-RIDE (F) (MG/L)	DIS-SOLVED SILICA (SIO2) (MG/L)	DIS-SOLVED ARSENIC (AS) (UG/L)	DIS-SOLVED BORON (B) (UG/L)	DIS-SOLVED CAD-MIUM (CD) (UG/L)	HEXA-VALENT CHRO-MIUM (CR6) (UG/L)
PEABODY 1 0803909741675	65-10-12	--	--	90	--	6.0	85	.6	--	--	--	--	--
	65-12-15	--	--	35	--	3.5	17	.2	--	--	--	--	--
	65-12-19	--	--	290	--	19	430	.3	--	--	--	--	--
PEABODY 2 0803909441718	67-08-17	3.9	80	--	1.2	5.0	21	.1	18	--	--	--	--
	71-10-19	4.0	81	--	1.1	2.8	18	.2	20	--	--	--	--
	74-11-13	3.7	79	--	1.2	2.8	17	.1	21	--	40	--	--
	75-09-10	4.0	81	--	.8	5.0	20	.2	20	--	30	--	--
	76-11-17	5.1	87	--	.7	3.6	16	.2	22	3	30	0	0
PEABODY 3 0405607110413	68-04-29	7.2	91	--	.9	4.0	17	.6	30	--	--	--	--
	71-10-19	8.4	93	--	.8	3.5	17	.2	19	--	--	--	--
	73-08-23	--	--	--	--	--	--	--	--	--	--	--	--
	74-11-13	5.9	88	--	1.1	3.2	13	.4	20	--	70	--	--
	75-09-10	7.5	92	--	.7	2.8	14	.5	19	--	50	--	--
	76-11-18	7.4	92	--	.7	3.0	11	.4	17	--	50	--	--
PEABODY 4 0405609000373	73-08-23	--	--	--	--	--	--	--	--	--	--	--	--
	74-11-13	4.7	85	--	1.1	3.8	13	.1	22	--	50	--	--
	75-09-10	4.9	86	--	.7	3.4	13	.2	21	--	30	--	--
	76-11-17	4.1	82	--	.8	2.9	19	.2	21	3	30	0	0
PEABODY 5 0405608110115	68-06-12	6.7	90	--	.9	3.5	16	--	--	--	--	--	--
	71-08-18	6.3	89	--	1.8	2.1	12	.2	21	--	--	--	--
	73-08-22	--	--	--	--	--	--	--	--	--	--	--	--
	74-11-13	6.5	89	--	1.4	2.7	12	.2	21	--	50	--	--
	75-09-10	7.5	92	--	.7	4.0	18	.2	20	--	30	--	--
	77-01-18	6.1	90	--	.6	3.0	13	.2	21	--	30	--	--
PEABODY 6 0803906681711	68-06-29	7.5	92	--	.9	3.0	13	.4	34	--	300	--	--
	74-11-13	27	98	--	1.3	11	40	.2	22	--	100	--	--
PEABODY 7 0405608800585	72-06-30	6.3	88	--	1.2	2.5	20	.3	30	--	--	--	--
	73-08-22	--	--	--	--	--	--	--	--	--	--	--	--
	74-11-13	5.8	89	--	.9	3.3	14	.2	21	--	30	--	--
	75-09-10	6.1	90	--	.7	3.0	15	.2	20	--	30	--	--
	76-11-18	5.9	89	--	.7	3.2	13	.2	21	--	30	--	--

Table 7.--Chemical analyses of water from the Peabody wells--Continued

LOCAL IDENT-I-FIER	DATE OF SAMPLE	DIS-SOLVED COBALT (CO) (UG/L)	DIS-SOLVED COPPER (CU) (UG/L)	DIS-SOLVED IRON (FE) (UG/L)	DIS-SOLVED LEAD (PB) (UG/L)	TOTAL MAN-GANESE (MN) (UG/L)	DIS-SOLVED MAN-GANESE (MN) (UG/L)	DIS-SOLVED MOLYB-DENUM (MO) (UG/L)	DIS-SOLVED ZINC (ZN) (UG/L)	DIS-SOLVED SELE-NIUM (SE) (UG/L)	DIS-SOLVED SOLIDS (RESI-DUE AT 180 C) (MG/L)	DIS-SOLVED SOLIDS (SUM OF CONSTI-TUENTS) (MG/L)	DIS-SOLVED SOLIDS (TONS PER AC-FT)	TOTAL NITRATE (NO3) (MG/L)	DIS-SOLVED MERCURY (HG) (UG/L)	TOTAL DEPTH OF WELL (FT)
PEABODY 1 0803909741675	65-10-12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5735
	65-12-15	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5735
	65-12-19	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5735
PEABODY 2 0803909441718	67-08-17	--	--	50	--	--	40	--	--	--	--	147	--	1.0	--	3636
	71-10-19	--	--	20	--	M0	0	--	--	--	--	141	--	3.4	--	3636
	74-11-13	--	--	10	--	--	--	--	--	--	144	148	.20	--	--	3636
	75-09-10	--	--	10	--	--	--	--	--	--	163	149	.22	--	--	3636
	76-11-17	1	1	60	6	--	--	0	20	1	133	141	.18	--	.0	3636
PEABODY 3 0405607110413	68-04-29	--	--	20	--	--	M0	--	--	--	--	171	--	4.0	--	3596
	71-10-19	--	--	10	--	--	M0	--	--	--	--	159	--	3.0	--	3596
	73-08-23	--	--	--	--	--	--	--	--	--	--	213	--	--	--	3596
	74-11-13	--	--	10	--	--	--	--	--	--	154	159	.21	--	--	3596
	75-09-10	--	--	10	--	--	--	--	--	--	157	155	.21	--	--	3596
	76-11-18	--	--	30	--	--	--	--	--	--	145	154	.20	--	--	3596
PEABODY 4 0405609000373	73-08-23	--	--	--	--	--	--	--	--	--	--	157	--	--	--	3535
	74-11-13	--	--	20	--	--	--	--	--	--	140	145	.19	--	--	3535
	75-09-10	--	--	30	--	--	--	--	--	--	144	139	.20	--	--	3535
	76-11-17	1	2	30	12	--	--	0	20	1	138	142	.19	--	.0	3535
PEABODY 5 0405608110115	68-06-12	--	--	20	--	--	M0	--	--	--	--	168	--	--	--	3737
	71-08-18	--	--	0	--	--	10	--	--	--	--	145	--	2.9	--	3737
	73-08-22	--	--	--	--	--	--	--	--	--	--	162	--	--	--	3737
	74-11-13	--	--	10	--	--	--	--	--	--	149	157	.20	--	--	3737
	75-09-10	--	--	30	--	--	--	--	--	--	161	162	.22	--	--	3737
	77-01-18	--	--	20	--	--	0	--	--	--	--	158	.21	--	--	3737
PEABODY 6 0803906681711	68-06-29	--	--	70	--	--	<20	--	--	--	--	170	--	2.6	--	3559
	74-11-13	--	--	40	--	--	--	--	--	--	333	330	.45	--	--	3559
PEABODY 7 0405608800585	72-06-30	--	--	160	--	--	20	--	--	--	--	157	--	.84	--	3538
	73-08-22	--	--	--	--	--	--	--	--	--	--	151	--	--	--	3538
	74-11-13	--	--	10	--	--	--	--	--	--	141	144	.19	--	--	3538
	75-09-10	--	--	20	--	--	--	--	--	--	146	145	.20	--	--	3538
	76-11-18	--	--	10	--	--	--	--	--	--	140	146	.19	--	--	3538

Table 8. Annual ground-water pumpage for communities of Kayenta, Chilchinbito, and Rough Rock

A. Pumpage, in acre-feet, in individual wells, 1974-76.

	1974	1975	1976
Kayenta P.M. 2	-	46.9*	137.7
Kayenta P.M. 3	-	20.5*	47.3
Rough Rock P.M. 5	28	10 Est.	10.4
Rough Rock P.M. 6	9	29	28.1
Rough Rock P.M. 7	-	0.5	0.5
Rough Rock Community Well	8	7.3	5.8
Chilchinbito P.M. 3	21	20	14.6 Est.
Chilchinbito P.H.S. (8T-540)	-	-	6

B. Pumpage, in acre-feet, in three N.T.U.A. wells at Kayenta, 1965-76.

1965 - 44	1971 - 195.9
1966 - 98.5	1972 - 171.9
1967 - 99.7	1973 - 298.2
1968 - 127.5	1974 - 300.7
1969 - 145	1975 - 281
1970 - 169.8	1976 - 303.4

*Meters installed May 1975

Results of Monitoring Program to Date

Ten streamflow-gaging sites (fig. 1, table 1) and ten recording rain gages (fig. 2, table 2) are currently in operation; two of the original streamflow stations have been discontinued (table 1). Few samples for sediment concentration and chemical analysis have been collected except at the stations Moenkopi Wash near Moenkopi and Moenkopi Wash at Moenkopi owing to a relative lack of precipitation during the period of record. Available data are insufficient at this time (1977) to make any statement regarding the effects of strip mining on the quantity, sediment concentration, or chemical quality of surface-water runoff.

Water-level declines of about 7 ft (2.1 m) have occurred in wells BM2 and BM5; water levels have not declined in wells BM1 and BM4 (fig. 5). The water level in well BM3 fluctuates as much as 10 ft (3 m) in response to the seasonal pumping of the nearby community and school wells at Kayenta (fig. 5). The water level in this well has declined 45 ft (14 m) since 1959. The static water level in well P1 has risen about 15 ft (4.6 m) since the recorder was installed in the fall of 1973. The water level in the well is not affected by pumping of the nearby Peabody production wells and it is very doubtful that it represents the static water level in the N aquifer; the water level in this well may reflect conditions in the shallow aquifer. To date (1977) the water levels in the seven wells that are measured annually have not shown any significant long-term declines. Graphs showing the depth to water in the 13 observation wells for the period of record are given in figure 5.

Future Plans

The plans for future work on the monitoring program include the continuation of all the present activities, a pumping test on BM6 to obtain additional data on the characteristics of the N aquifer, and the development of a model of the N aquifer to be used in predicting aquifer response to pumping stresses applied to the system. Expanded use of the satellite relay telemetry system is planned for the three small watersheds currently under study. Eventually a data transmitter with the ability to relay rainfall, stage, and

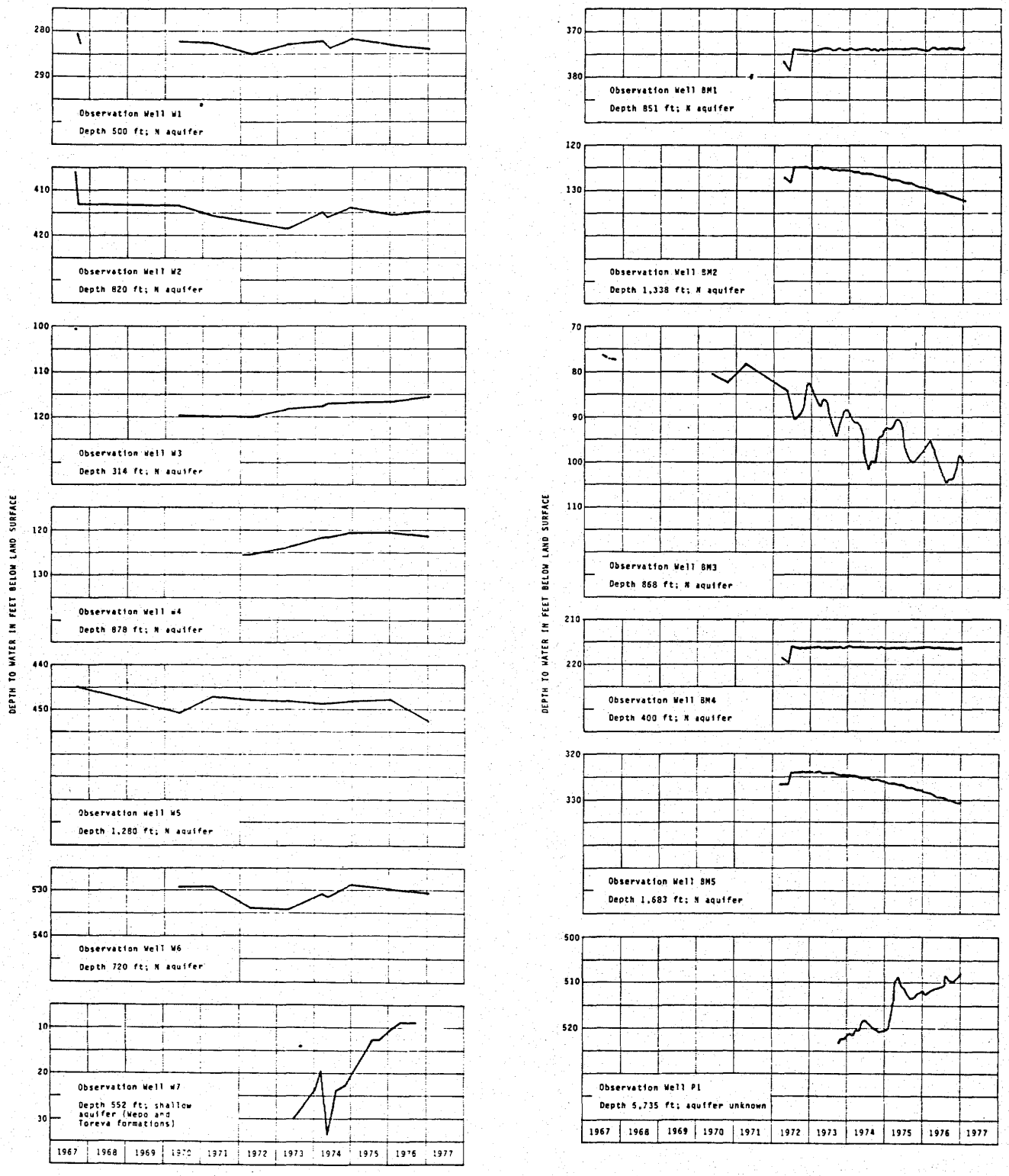


FIGURE 5.--DEPTH TO WATER IN OBSERVATION WELLS

sample frequency data will be installed at each of the three gaging stations at the mouths of the small watersheds. The data relay system hopefully will provide a means of alerting project personnel in Flagstaff, Arizona to equipment malfunctions and extreme hydrologic events.

United States
Department of the Interior
Geological Survey

Progress Report on Black Mesa Monitoring Program—1982

By

George W. Hill

Prepared in cooperation with the
Arizona Department of Water Resources

Basic-Data Report

Tucson, Arizona
December 1982

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CONVERSION FACTORS

For readers who prefer to use the International System of Units (SI) rather than inch-pound units, the conversion factors for the terms used in this report are listed below:

Multiply inch-pound unit	By	To obtain SI unit
foot (ft)	0.3048	meter (m)
square mile (mi^2)	2.590	square kilometer (km^2)
acre-foot (acre-ft)	0.001233	cubic hectometer (hm^3)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
ton (short)	0.9072	ton (metric)

PROGRESS REPORT ON BLACK MESA MONITORING PROGRAM—1982

By

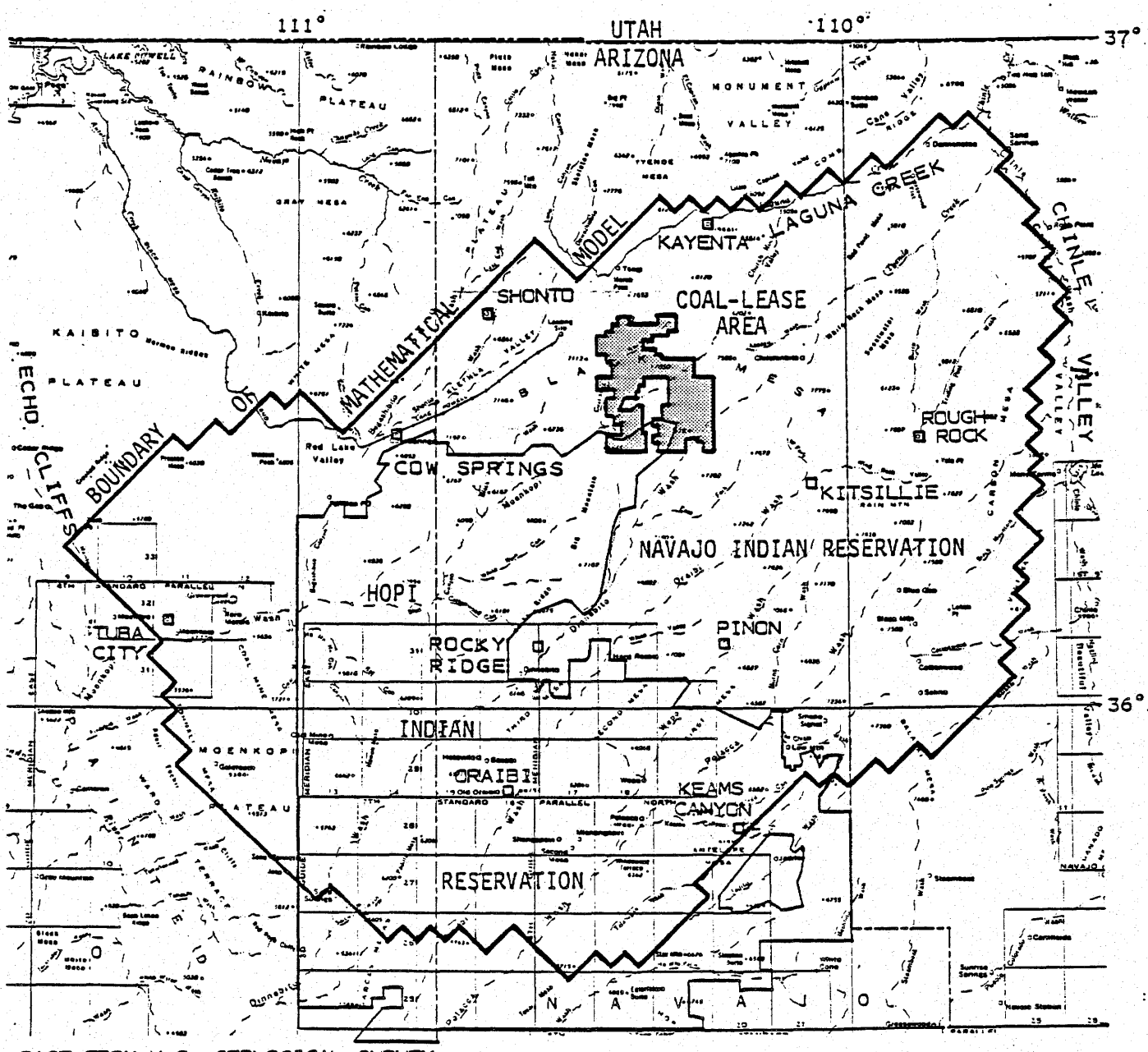
George W. Hill

INTRODUCTION

The N aquifer is an important source of water in the 5,400 mi^2 Black Mesa area on the Navajo and Hopi Indian Reservations in northeastern Arizona (fig. 1). On the northern part of the mesa, Peabody Coal Co. operates a strip mine in a lease area of about 100 mi^2. When operation of the mine began in 1968, the company pumped about 95 acre-ft of ground water from the N aquifer. In 1981 slightly more than 4,000 acre-ft was pumped. Withdrawals from the N aquifer for municipal use increased from an estimated 70 acre-ft in 1965 to 2,000 acre-ft in 1981. The Navajo and Hopi Tribes became concerned about the long-term effects of withdrawals from the N aquifer on supplies for domestic and municipal purposes. These and other concerns about the effects of strip mining led to the Black Mesa water-resources investigation by the U.S. Geological Survey in cooperation with the Arizona Department of Water Resources. The cooperation and assistance of the Navajo and Hopi Tribes, U.S. Bureau of Indian Affairs, and Peabody Coal Co. are gratefully acknowledged.

Purpose and Scope of the Report

The report covers the progress of the Black Mesa Monitoring Program from 1977 to 1982. Many of the data collected during this period have been published in the U.S. Geological Survey Water Resources Data for Arizona (U.S. Geological Survey, issued annually). Except for earlier



BASE FROM U.S. GEOLOGICAL SURVEY
STATE BASE MAP, 1:1,000,000

0 25 50 MILES

0 25 50 KILOMETERS

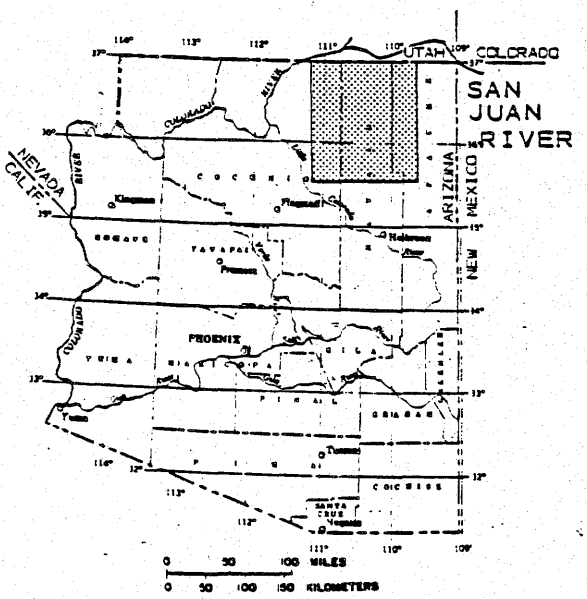


Figure 1.--Area of report.

data that are used for comparison, only data that have not been published will appear in this report. An earlier report covered the progress of the Black Mesa Monitoring Program from 1971 to 1977 (U.S. Geological Survey, 1978).

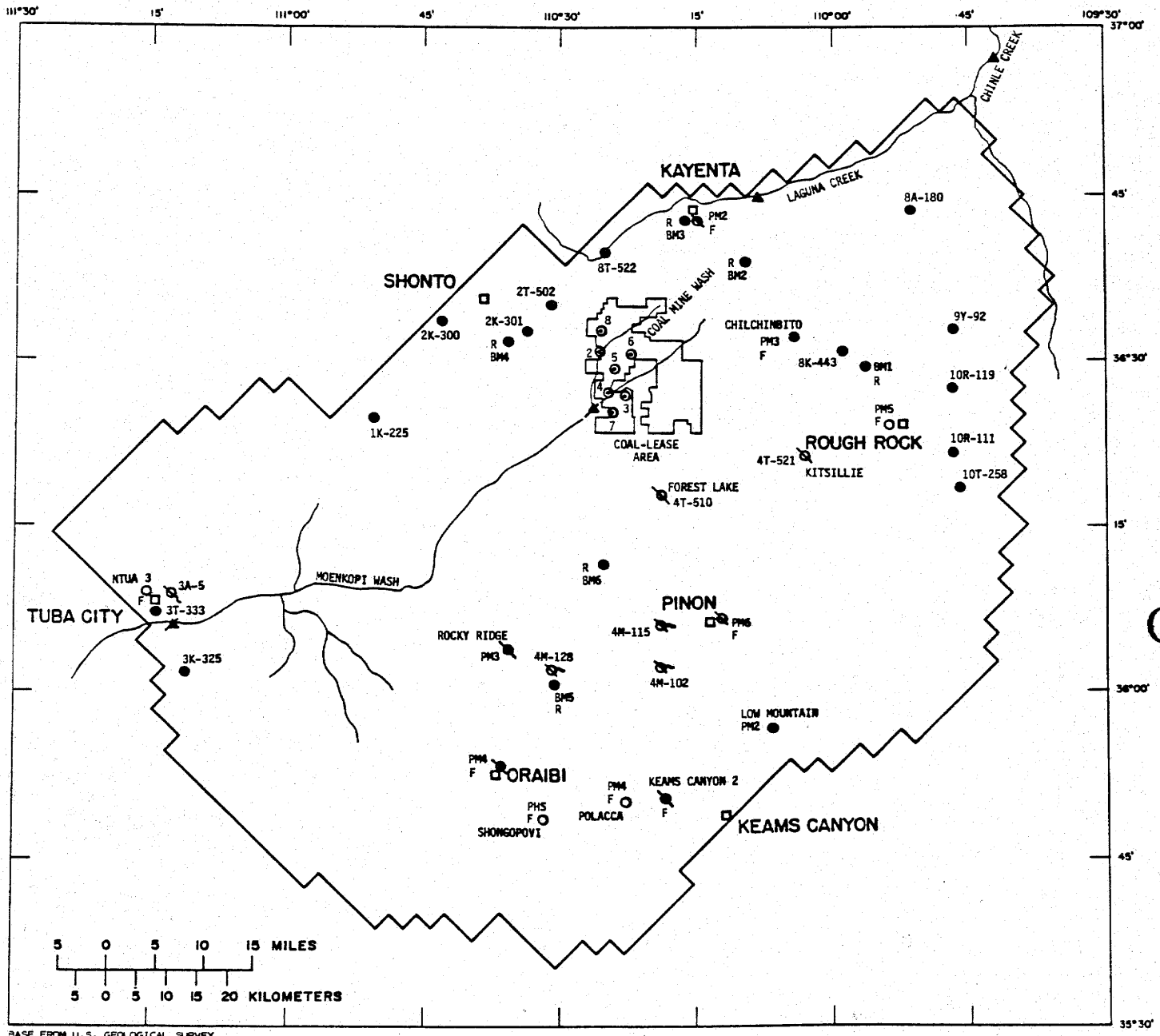
HYDROLOGIC-DATA COLLECTION, 1977-82

In accordance with the objectives of the program, monitoring activities have been continued by periodic measurements of (1) ground-water levels in the confined and unconfined areas of the N aquifer; (2) major withdrawals from the N aquifer by industrial and nonindustrial pumping from the confined and unconfined areas; (3) ground-water quality of the N aquifer in the coal-lease area and other areas of the mesa; (4) discharge and chemical quality of selected springs that discharge from the Wepo Formation[1] and N aquifer; and (5) surface-water discharge, sediment discharge, and chemical quality of streams related to the mining operation and function of the N aquifer.

Ground-Water Levels

Six continuous-record observation wells that penetrate the N aquifer—five installed in 1972 and one in 1977—have been continued in operation to the present (1982). The wells are referred to as Black Mesa observation wells 1-6 (BM1-6) and are shown in figure 2. In 1979 well BM1 was vandalized, plugged with debris, and put out of operation. Several efforts to open the well have been unsuccessful; further efforts are planned for 1983. During 1979-82, water levels in a network of wells in the confined and unconfined areas of the N aquifer were measured.

[1]This report has not been reviewed for conformity with U.S. Geological Survey nomenclature.



BASE FROM U.S. GEOLOGICAL SURVEY
FLAGSTAFF 1:250,000, 1954-70,
GALLUP 1:250,000, 1950-70,
MARBLE CANYON 1:250,000, 1956-70,
AND SHIPROCK 1:250,000, 1954-69

Figure 2.--Data-collection sites.

EXPLANATION

R BM2 F — WELL THAT TAPS THE N AQUIFER IN WHICH WATER LEVEL WAS MEASURED—BM2, is well identifier. R, indicates well equipped with a recorder; \, indicates water-quality sample was collected; F, indicates one or more wells in the area equipped with a flowmeter

F PM6 — WELL THAT TAPS THE N AQUIFER—PM6, is well identifier. \, indicates water-quality sample was collected; F, indicates one or more wells in the area equipped with a flowmeter

8 — PEABODY COAL CO. PRODUCTION WELL—Water-quality sample was collected. 8, is well number

SPRING AT WHICH DISCHARGE WAS MEASURED AND WATER-QUALITY SAMPLE WAS COLLECTED

GAGING STATION OPERATED BY THE U.S. GEOLOGICAL SURVEY—/, indicates water-quality and sediment samples were collected

BOUNDARY OF MATHEMATICAL MODEL—From Eychaner (1981)

Figure 2

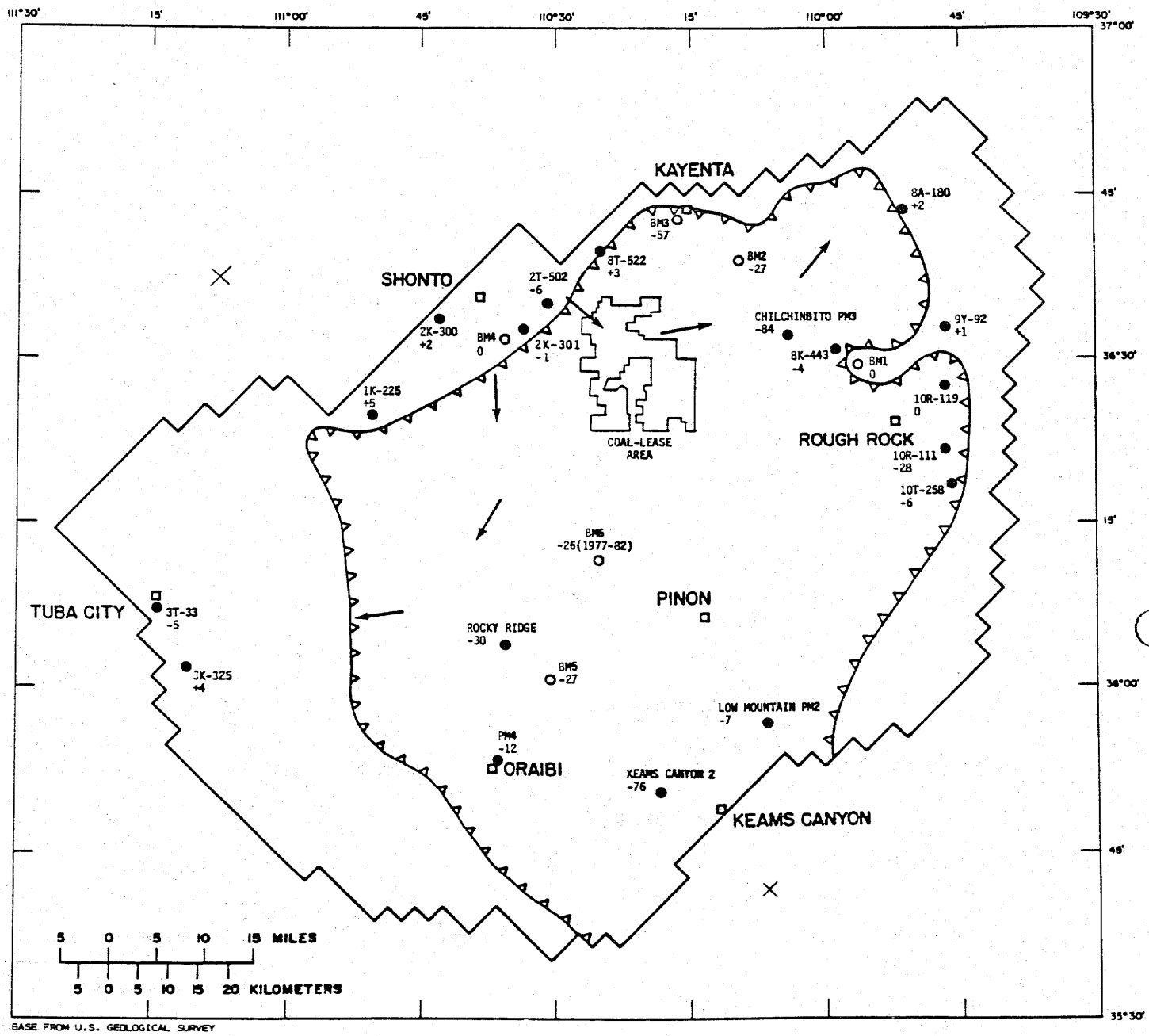
Most of the wells were measured prior to 1965 before the system was stressed by appreciable pumping (fig. 2).

The data indicate that water levels in the confined area of the N aquifer continue to decline as predicted by a mathematical model constructed by Eychaner (1981). The data also indicate that water levels in the unconfined area of the N aquifer have not declined. Figure 3 shows the net change of water levels in selected wells in the N aquifer over the Black Mesa area since prestress times. The value shown for wells BM2-5 is the difference, in feet, between water-level measurements during assumed local equilibrium 1965-72 and 1982. For BM1, the water-level differential is between 1972 and 1979; for BM6 the differential is from 1977 to 1982. For the remainder of the wells in figure 3, the difference is between assumed local equilibrium 1953-72 and 1982. Figure 4 shows a comparison between measured and simulated water levels in the six continuous-record observation wells, BM1-6, for 1959-82.

The two largest measured water-level declines are at Keams Canyon and Chilchinbito (fig. 3). Wells near these communities are pumped for public water supply. The water levels may be affected by the local pumping as well as by industrial withdrawals. In 1982, the water level in a well at Tuba City, which is outside the area of confined conditions, showed a decline of 5 ft (fig. 3). Declines in this area probably are caused by local pumping (Eychaner, 1981).

Withdrawals from the N Aquifer

The three categories of withdrawals from the N aquifer are industrial (Peabody Coal Co.) from the confined area, nonindustrial from



BASE FROM U.S. GEOLOGICAL SURVEY
FLAGSTAFF 1:250,000, 1954-70,
GALLUP 1:250,000, 1950-70,
MARBLE CANYON 1:250,000, 1956-70,
AND SHIPROCK 1:250,000, 1954-69

Figure 3.--Difference in water levels in selected wells that tap the N aquifer, 1953-82.

E X P L A N A T I O N

● 3T-333
-5

WELL IN WHICH DEPTH TO WATER WAS MEASURED INTERMITTENTLY—First entry, 3T-333, is Bureau of Indian Affairs site identification; second entry, -5, is difference, in feet, between water-level measurements during assumed local equilibrium 1953-72 and 1982

○ BM2
-27

CONTINUOUS-RECORD OBSERVATION WELL—First entry, BM2, is well identifier. Second entry, -27, is difference, in feet, between water-level measurements during assumed local equilibrium 1965-72 and 1982

CONFINED
△△△△△
UNCONFINED

APPROXIMATE BOUNDARY BETWEEN CONFINED AND UNCONFINED CONDITIONS—From Eychaner (1981)

→

GENERALIZED DIRECTION OF GROUND-WATER MOVEMENT

———

BOUNDARY OF MATHEMATICAL MODEL—From Eychaner (1981)

Figure 3

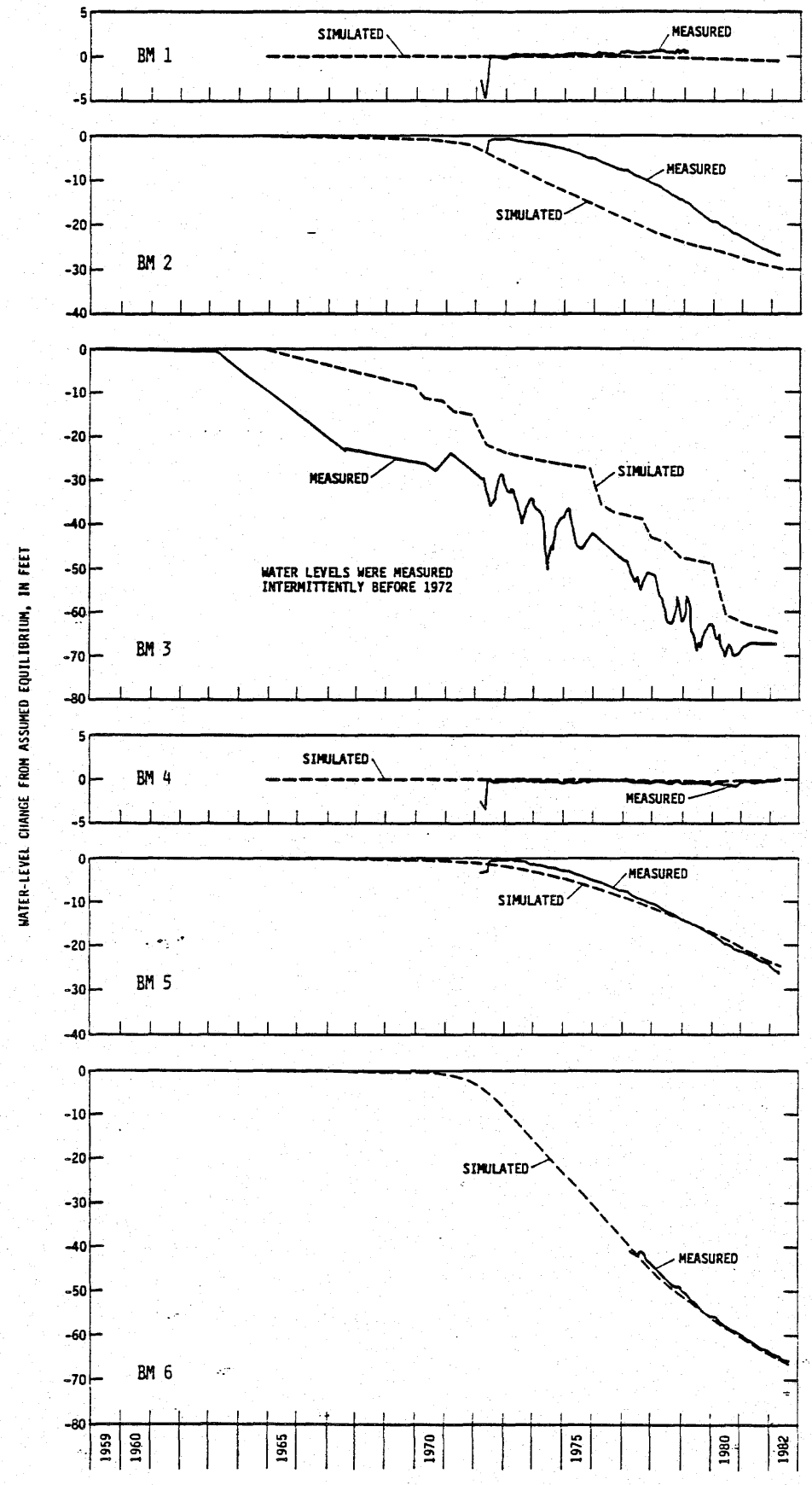


Figure 4.--Measured and simulated water-level changes for observation wells, 1959-82.

the confined area, and nonindustrial from the unconfined area. Nonindustrial withdrawals include municipal and domestic supplies. At present (1982), the primary interest is in withdrawals related to the mining operation and nonindustrial pumpage of significant amounts. Pumpage data have not been collected from wells equipped with windmills.

Until 1980, Peabody Coal Co. was pumping from six wells in the N aquifer; in 1980, an additional well was added (fig. 2). Peabody collects and maintains its own pumpage data and makes the data available to the U.S. Geological Survey. Pumpage data for 1965-81 are given in table 1.

In 1982 the U.S. Geological Survey conducted a reconnaissance of major municipal-supply wells to determine which were metered. All supply wells at Kayenta, Chilchinbito, Pinon, Rough Rock, Keams Canyon, Oraibi, Shongopovi and Polacca are now metered. In 1982 the U.S. Geological Survey installed two flowmeters at Oraibi, one flowmeter at Shongopovi, and one large flowmeter to measure the pumpage from the entire well field (four wells) at Polacca. Sites where pumpage data are collected are shown in figure 2; about 20 wells are represented in this group. A representative well at each community is identified in figure 2.

Chemical Quality of Water from Wells That Tap the N Aquifer

Water samples from all Peabody Coal Co. wells (fig. 2) have been collected and analyzed for major ions and fluoride for 1976-82 (table 2).

In 1982 seven nonindustrial wells in the confined area of the N aquifer were selected for collection of water-quality data. Water from each well was analyzed for major ions and fluoride (table 3). The wells at

Table 1.--Withdrawals from the N aquifer, 1965-81

[Measurements are in acre-feet. Data for 1965-79 are from Eychaner, 1981]

Year	[1]Industrial	[2]Nonindustrial	
		[3]Confined	[4]Unconfined
1965	0	50	20
1966	0	110	30
1967	0	120	50
1968	95	150	100
1969	43	200	100
1970	740	280	150
1971	1,900	340	150
1972	3,680	370	250
1973	3,520	530	300
1974	3,830	580	362
1975	3,550	600	508
1976	4,180	690	645
1977	4,090	750	726
1978	3,000	830	930
1979	3,500	860	930
1980	3,540	910	880
1981	4,010	960	1,000

[1]Metered pumpage by Peabody Coal Co. at their mine on Black Mesa, which is in the area of confined conditions.

[2]Does not include withdrawals by wells equipped with windmills.

[3]Includes metered pumpage at Kayenta and estimated pumpage at Chilchinbito, Rough Rock, Pinon, Keams Canyon, and Oraibi.

[4]Includes estimated pumpage at Tuba City, 1965-73, and metered pumpage, 1974-81.

Table 2.--Chemical analyses of Peabody Coal Co. supply wells, 1976-82

	LOCAL IDENT-I-FIER	LAT-I-TUDE	LONG-I-TUDE	SEQ. NO.	DATE OF SAMPLE	GEO-LOGIC UNIT	SAMPLE NUMBER	TEMPER-ATURE (DEG C)	AGENCY ANA-LYZING SAMPLE (CODE NUMBER)	STREAM-FLOW, INSTAN-TANEOUS (CFS)	SPE-CIFIC CON-DUCT-ANCE (UMHOS)
PEABODY 2	0803909441718	36 30 05	110 25 09	01	76-11-17	220NVJU	--	30.0	1028	--	260
					79-08-09	220NVJU	1080	31.0	80020	--	220
					80-08-19	220NVJU	1080	30.5	80020	--	225
PEABODY 3	0405607110413	36 26 25	110 22 37	01	76-11-18	220NVJU	1085	32.0	1028	--	250
					77-08-23	220NVJU	1085	32.0	1028	--	230
					79-08-09	220NVJU	1080	32.0	80020	--	240
					80-08-19	220NVJU	1080	32.0	80020	--	230
PEABODY 4	0405609000373	36 26 47	110 24 35	01	76-11-17	220NVJU	1085	32.0	1028	--	240
					79-08-09	220NVJU	1080	32.0	80020	--	220
					80-08-19	220NVJU	1080	32.0	80020	--	230
PEABODY 5	0405608110115	36 29 01	110 23 41	01	77-01-18	220NVJU	1085	32.0	1028	--	220
					77-08-23	220NVJU	1085	33.0	1028	--	220
					79-08-09	220NVJU	1080	31.0	80020	--	220
					80-08-19	220NVJU	1080	32.0	80020	--	210
PEABODY 6	0803906681711	36 30 07	110 22 12	01	77-08-23	220NVJU	1085	34.0	1028	--	240
					79-08-09	220NVJU	1080	33.5	80020	--	260
					80-08-19	220NVJU	1080	32.0	80020	--	260
PEABODY 7	0405608800585	36 24 56	110 24 23	01	76-11-18	220NVJU	1085	32.0	1028	--	240
					79-08-09	220NVJU	1080	32.0	80020	--	225
					80-08-19	220NVJU	1080	33.5	80020	--	210
PEABODY 8	0803909261434	36 31 30	110 25 45	01	80-08-19	220NVJU	1080	30.0	80020	--	420
					82-06-10	220NVJU	--	30.0	80020	1.3	385

Table 2.--Chemical analyses of Peabody Coal Co. supply wells, 1976-82—Continued

	LOCAL IDENT-I-FIER	DATE OF SAMPLE	PH (UNITS)	PH LAB (UNITS)	CARBON DIOXIDE DIS-SOLVED (MG/L AS CO2)	ALKA-LINITY FIELD (MG/L AS CACO3)	BICAR-BONATE FET-FLD (MG/L AS HCO3)	CAR-BONATE FET-FLD (MG/L AS CO3)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)	PHOS-PHATE, ORTHO, DIS-SOLVED (MG/L AS PO4)	PHOS-PHORUS, ORTHO, DIS-SOLVED (MG/L AS P)
PEABODY 2	0803909441718	76-11-17	8.6	--	.4	79	78	9	1.2	.03	.010
		79-08-09	8.5	--	.5	82	100	0	.93	--	--
		80-08-19	7.7	--	--	67	--	--	.90	.28	.090
PEABODY 3	0405607110413	76-11-18	9.2	--	.1	101	38	42	1.6	.03	.010
		77-08-23	9.3	--	.1	110	100	16	.88	.06	.020
		79-08-09	8.5	--	.7	110	110	14	.83	--	--
		80-08-19	9.1	--	--	90	--	--	.77	.00	.000
PEABODY 4	0405609000373	76-11-17	9.1	--	.1	76	78	7	1.2	.03	.010
		79-08-09	8.8	--	.3	85	96	4	.94	--	--
		80-08-19	9.1	--	--	84	--	--	.95	.00	.000
PEABODY 5	0405608110115	77-01-18	9.2	--	.1	95	87	14	3.2	.09	.030
		77-08-23	9.3	--	.1	110	98	15	.90	.06	.020
		79-08-09	8.7	--	.3	85	100	2	.82	--	--
		80-08-19	9.1	--	--	84	--	--	.80	.00	.000
PEABODY 6	0803906681711	77-08-23	9.3	--	.1	98	120	0	.85	.06	.020
		79-08-09	8.5	--	.7	120	120	13	.75	--	--
		80-08-19	8.9	--	--	100	--	--	.72	.12	.040
PEABODY 7	0405608800585	76-11-18	9.2	--	.1	86	14	45	1.4	.03	.010
		79-08-09	8.7	--	.4	95	95	10	.80	--	--
		80-08-19	9.1	--	--	75	--	--	.78	.12	.040
PEABODY 8	0803909261434	80-08-19	7.9	--	--	84	--	--	1.5	.00	.000
		82-06-10	8.0	8.2	--	130	--	--	1.6	--	<.010

Table 2.--Chemical analyses of Peabody Coal Co. supply wells, 1976-82—Continued

	LOCAL IDENT-I-FIER	DATE OF SAMPLE	HARD-NESS (MG/L AS CACO3)	HARD-NESS, NONCAR-BONATE (MG/L CACO3)	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)	SODIUM, DIS-SOLVED (MG/L AS NA)	SODIUM AD-SORP-TION RATIO	PERCENT SODIUM	SODIUM+ POTAS-SIUM DIS-SOLVED (MG/L AS NA)	POTAS-SIUM, DIS-SOLVED (MG/L AS K)
PEABODY 2	0803909441718	76-11-17	12	0	4.9	<.1	41	5.1	87	--	.7
		79-08-09	21	0	8.2	.2	43	4.1	81	44	.8
		80-08-19	23	0	8.5	.5	39	3.5	78	--	.7
PEABODY 3	0405607110413	76-11-18	9	0	3.5	<.1	50	7.4	92	--	.7
		77-08-23	10	0	3.9	<.1	49	6.8	91	--	.7
		79-08-09	8	0	3.1	.1	53	8.1	93	54	.7
		80-08-19	9	0	3.4	.1	50	7.3	92	--	.7
PEABODY 4	0405609000373	76-11-17	18	0	7.0	.1	40	4.1	82	--	.8
		79-08-09	13	0	5.1	.1	45	5.4	87	46	.7
		80-08-19	12	0	4.6	.1	44	5.6	88	--	.7
PEABODY 5	0405608110115	77-01-18	10	0	3.5	.4	45	6.1	90	--	.6
		77-08-23	10	0	3.8	<.1	47	6.6	91	--	.7
		79-08-09	11	0	4.3	.1	43	5.6	89	44	.7
		80-08-19	12	0	4.5	.1	42	5.4	88	--	.8
PEABODY 6	0803906681711	77-08-23	10	0	4.0	.1	51	6.9	91	--	.8
		79-08-09	8	0	3.1	.1	52	7.9	93	53	.7
		80-08-19	10	0	4.0	.0	50	6.9	91	--	.8
PEABODY 7	0405608800585	76-11-18	11	0	4.2	.1	45	5.9	89	--	.7
		79-08-09	11	0	4.3	.1	48	6.3	90	49	.7
		80-08-19	10	0	4.0	.0	38	5.2	88	--	.7
PEABODY 8	0803909261434	80-08-19	66	0	22	2.8	61	3.3	65	--	2.8
		82-06-10	73	0	24	3.1	64	3.4	65	--	2.7

Table 2.--Chemical analyses of Peabody Coal Co. supply wells, 1976-82—Continued

	LOCAL IDENT-I-FIER	DATE OF SAMPLE	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	SULFATE DIS-SOLVED (MG/L AS SO4)	FLUO-RIDE, DIS-SOLVED (MG/L AS F)	SILICA, DIS-SOLVED (MG/L AS SIO2)	ARSENIC DIS-SOLVED (UG/L AS AS)	BORON, DIS-SOLVED (UG/L AS B)	CADMIUM DIS-SOLVED (UG/L AS CD)	CHRO-MIUM, HEXA-VALENT, DIS. (UG/L AS CR)	COBALT, DIS-SOLVED (UG/L AS CO)
PEABODY 2	0803909441718	76-11-17	3.6	16	.2	22	3	30	ND	0	<2
		79-08-09	3.4	24	.1	22	--	30	--	--	--
		80-08-19	11	20	.2	21	--	30	--	--	--
PEABODY 3	0405607110413	76-11-18	3.0	11	.4	17	--	50	--	--	--
		77-08-23	3.2	12	.5	20	--	50	--	--	--
		79-08-09	3.3	17	.4	21	--	60	--	--	--
		80-08-19	3.5	14	.4	20	--	70	--	--	--
PEABODY 4	0405609000373	76-11-17	2.9	19	.2	21	3	30	ND	0	<2
		79-08-09	3.9	19	.2	23	--	<20	--	--	--
		80-08-19	4.3	13	.2	21	--	50	--	--	--
PEABODY 5	0405608110115	77-01-18	3.0	13	.2	21	--	30	--	--	--
		77-08-23	3.0	12	.2	21	--	40	--	--	--
		79-08-09	2.9	15	.2	21	--	40	--	--	--
		80-08-19	2.9	9.5	.2	21	--	60	--	--	--
PEABODY 6	0803906681711	77-08-23	3.2	13	.2	22	--	40	--	--	--
		79-08-09	3.2	19	.3	22	--	40	--	--	--
		80-08-19	3.5	15	.3	20	--	70	--	--	--
PEABODY 7	0405608800585	76-11-18	3.2	13	.2	21	--	30	--	--	--
		79-08-09	3.4	20	.2	22	--	30	--	--	--
		80-08-19	3.7	11	.2	20	--	60	--	--	--
PEABODY 8	0803909261434	80-08-19	4.8	100	.2	19	--	70	--	--	--
		82-06-10	4.7	100	.2	20	--	40	--	--	--

Table 2.--Chemical analyses of Peabody Coal Co. supply wells, 1976-82—Continued

	LOCAL IDENT-I-FIER	DATE OF SAMPLE	COPPER, DIS-SOLVED (UG/L AS CU)	IRON, DIS-SOLVED (UG/L AS FE)	LEAD, DIS-SOLVED (UG/L AS PB)	MANGA-NESE, DIS-SOLVED (UG/L AS MN)	MOLYB-DENUM, DIS-SOLVED (UG/L AS MO)	ZINC, DIS-SOLVED (UG/L AS ZN)	SELE-NIUM, DIS-SOLVED (UG/L AS SE)	SOLIDS, RESIDUE AT 180 DEG. C DIS-SOLVED (MG/L)	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L)
PEABODY 2	0803909441718	76-11-17	<2	60	6	--	<1	20	1	133	141
		79-08-09	--	<10	--	<1	--	--	--	--	155
		80-08-19	--	250	--	--	--	--	--	145	145
PEABODY 3	0405607110413	76-11-18	--	30	--	--	--	--	--	145	154
		77-08-23	--	<10	--	<10	--	--	--	--	159
		79-08-09	--	<10	--	<1	--	--	--	--	171
		80-08-19	--	<10	--	--	--	--	--	151	150
PEABODY 4	0405609000373	76-11-17	2	30	12	--	<1	20	1	138	142
		79-08-09	--	<10	--	<1	--	--	--	--	153
		80-08-19	--	<10	--	--	--	--	--	139	143
PEABODY 5	0405608110115	77-01-18	--	20	--	<10	--	--	--	--	158
		77-08-23	--	<10	--	<10	--	--	--	--	155
		79-08-09	--	<10	--	<1	--	--	--	--	142
		80-08-19	--	<10	--	--	--	--	--	134	135
PEABODY 6	0803906681711	77-08-23	--	20	--	20	--	--	--	--	157
		79-08-09	--	<10	--	<1	--	--	--	--	176
		80-08-19	--	80	--	--	--	--	--	160	157
PEABODY 7	0405608800585	76-11-18	--	<10	--	--	--	--	--	140	146
		79-08-09	--	<10	--	<1	--	--	--	--	159
		80-08-19	--	10	--	--	--	--	--	136	126
PEABODY 8	0803909261434	80-08-19	--	<10	--	--	--	--	--	283	270
		82-06-10	--	10	--	3	--	--	--	--	282

Table 2.--Chemical analyses of Peabody Coal Co. supply wells, 1976-82—Continued

	LOCAL IDENT-I-FIER	DATE OF SAMPLE	SOLIDS, DIS-SOLVED (TONS PER AC-FT)	MERCURY DIS-SOLVED (UG/L AS HG)	SPE-CIFIC CON-DUCT-ANCE LAB (UMHOS)	ALKA-LINITY LAB (MG/L AS CACO3)	HARD-NESS NONCAR-BONATE (MG/L AS CACO3)
PEABODY 2	0803909441718	76-11-17	.18	<.5	--	--	--
		79-08-09	.21	--	--	--	--
		80-08-19	.20	--	--	--	--
PEABODY 3	0405607110413	76-11-18	.20	--	--	--	--
		77-08-23	.22	--	--	--	--
		79-08-09	.23	--	--	--	--
		80-08-19	.21	--	--	--	--
PEABODY 4	0405609000373	76-11-17	.19	<.5	--	--	--
		79-08-09	.21	--	--	--	--
		80-08-19	.19	--	--	--	--
PEABODY 5	0405608110115	77-01-18	.21	--	--	--	--
		77-08-23	.21	--	--	--	--
		79-08-09	.19	--	--	--	--
		80-08-19	.18	--	--	--	--
PEABODY 6	0803906681711	77-08-23	.21	--	--	--	--
		79-08-09	.24	--	--	--	--
		80-08-19	.22	--	--	--	--
PEABODY 7	0405608800585	76-11-18	.19	--	--	--	--
		79-08-09	.22	--	--	--	--
		80-08-19	.19	--	--	--	--
PEABODY 8	0803909261434	80-08-19	.38	--	--	--	--
		82-06-10	--	--	446	94	.00

Table 3.--Chemical analyses of selected nonindustrial wells and springs, Black Mesa area, 1948-54 and 1982

Site name	Identification number	Date of sample	Temperature (°C)	Specific conductance (µmhos)	pH (units)	Alkalinity (mg/L as $CaCO_3$)	Nitrogen, NO_2+NO_3 dissolved (mg/L as N)
			Wells				
Keams Canyon 2	355023110182701	09-01-82	19.0	1,010	9.0	348	0.10
Rocky Ridge PM 3	360422110353501	09-02-82	26.0	255	9.2	114	1.2
New Oraibi PM 4	355236110364501	07-29-82	22.0	385	9.5	167	.55
Kayenta PM 2	364347110145901	09-28-82	17.5	360	7.8	120	.80
Forest Lake	361737110180301	06-09-82	29.0	470	9.4	160	.56
Kitsillie	362035110032201	08-31-82	20.0	580	7.6	-----	1.0
Pinon PM 6	360614110130801	10-30-82	25.5	485	9.6	228	1.4
			Springs				
Pasture Canyon	361021111115901	02-27-48	15.5	199	----	77	16
Do.	Do.	09-18-82	19.0	240	7.6	98	5.2
Pigeon	360559110190201	10-26-54	16.0	468	----	121	5.9
Do.	Do.	09-02-82	20.0	350	7.2	-----	.10
Hard Rocks	360209110303301	08-01-52	21.0	541	----	112	22
Do.	Do.	06-10-82	13.0	525	7.3	140	4.2
Crooked Finger	360145110190101	09-01-82	21.0	305	7.9	-----	.46

Table 3.--Chemical analyses of selected nonindustrial wells and springs, Black Mesa area, 1948-54 and 1982—Continued

Site name	Identification number	Date of sample	Phosphorus ortho, dissolved (mg/L as P)	Hardness (mg/L as $CaCO_3$)	Hardness, noncarbonate (mg/L as ($CaCO_3$)	Calcium, dissolved (mg/L as Ca)
			Wells			
Keams Canyon 2	355023110182701	09-01-82	0.01	3	0	0.82
Rocky Ridge PM 3	360422110353501	09-02-82	.02	----	----	.52
New Oraibi PM 4	355236110364501	07-29-82	.01	1	0	.43
Kayenta PM 2	364347110145901	09-28-82	.01	120	0	35
Forest Lake	361737110180301	06-09-82	.05	4	0	1.4
Kitsillie	362035110032201	08-31-82	.01	35	0	7.8
Pinon PM 6	360614110130801	10-30-82	.03	----	0	.58
			Springs			
Pasture Canyon	361021111115901	02-27-48	-----	85	8	26
Do.	Do.	09-18-82	0.01	95	12	30
Pigeon	360559110190201	10-26-54	-----	189	0	28
Do.	Do.	09-02-82	.01	130	0	38
Hard Rocks	360209110303301	08-01-52	-----	160	48	46
Do.	Do.	06-10-82	.07	160	58	45
Crooked Finger	360145110190101	09-01-82	.01	110	6	31

Table 3.--Chemical analyses of selected nonindustrial wells and springs, Black Mesa area, 1948-54 and 1982—Continued

Site name	Identification number	Date of sample	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Sodium adsorption ratio	Percent sodium	Sodium+ potassium, dissolved (mg/L as Na)
			Wells				
Keams Canyon 2	355023110182701	09-01-82	0.25	240	64	99	-----
Rocky Ridge PM 3	360422110353501	09-02-82	<.01	56	2	-----	-----
New Oraibi PM 4	355236110364501	07-29-82	.04	85	34	99	-----
Kayenta PM 2	364347110145901	09-28-82	7.5	29	1.2	34	-----
Forest Lake	361737110180301	06-09-82	.07	95	22	98	-----
Kitsillie	362035110032201	08-31-82	3.7	120	9.7	88	-----
Pinon PM 6	360614110130801	10-30-82	<.01	110	-----	-----	-----
			Springs				
Pasture Canyon	361021111115901	02-27-48	4.9	-----	0.6	23	12
Do.	Do.	09-18-82	4.8	11	.5	20	-----
Pigeon	360559110190201	10-26-54	9.5	-----	.9	24	20
Do.	Do.	09-02-82	9.7	17	.7	21	-----
Hard Rocks	360209110303301	08-01-52	11	-----	1.7	41	51
Do.	Do.	06-10-82	12	56	2.0	43	-----
Crooked Finger	360145110190101	09-01-82	8.0	17	.8	25	-----

Table 3.--Chemical analyses of selected nonindustrial wells and springs, Black Mesa area, 1948-54 and 1982—Continued

Site name	Identification number	Date of sample	Potassium, dissolved (mg/L as K)	Chloride, dissolved (mg/L as Cl)	Sulfate, dissolved (mg/L as SO_4)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)
			Wells				
Keams Canyon 2	355023110182701	09-01-82	0.8	94	35	1.4	13
Rocky Ridge PM 3	360422110353501	09-02-82	.5	1.4	6	.1	20
New Oraibi PM 4	355236110364501	07-29-82	.4	4.0	10	.2	23
Kayenta PM 2	364347110145901	09-28-82	1.3	4.5	58	.2	17
Forest Lake	361737110180301	06-09-82	.9	11	67	.4	23
Kitsillie	362035110032201	08-31-82	1.9	5.4	84	17	30
Pinon PM 6	360614110130801	10-30-82	.5	3.7	5	.2	27
			Springs				
Pasture Canyon	361021111115901	02-27-48	-----	5	13	.2	-----
Do.	Do.	09-18-82	1.2	5.1	18	.2	9.7
Pigeon	360559110190201	10-26-54	-----	12	11	.4	23
Do.	Do.	09-02-82	2.4	9.7	17	.4	15
Hard Rocks	360209110303301	08-01-52	-----	32	91	.4	17
Do.	Do.	06-10-82	2.2	37	110	.2	14
Crooked Finger	360145110190101	09-01-82	1.4	9.7	26	.4	18

Table 3.--Chemical analyses of selected nonindustrial wells and springs, Black Mesa area, 1948-54 and 1982—Continued

Site name	Identification number	Date of sample	Boron, dissolved (µg/L as B)	Iron, dissolved (µg/L as Fe)	Manganese, dissolved (µg/L as Mn)	Dissolved solids	
						Residue at 180°C (mg/L)	Sum of constit-uents (mg/L)
			Wells				
Keams Canyon 2	355023110182701	09-01-82	850	3	1	-----	592
Rocky Ridge PM 3	360422110353501	09-02-82	150	28	3	-----	-----
New Oraibi PM 4	355236110364501	07-29-82	40	16	1	-----	228
Kayenta PM 2	364347110145901	09-28-82	30	27	1	-----	228
Forest Lake	361737110180301	06-09-82	100	8	6	-----	281
Kitsillie	362035110032201	08-31-82	160	16	35	-----	365
Pinon PM 6	360614110130801	10-30-82	100	5	1	-----	-----
			Springs				
Pasture Canyon	361021111115901	02-27-48	-----	----	-----	123	-----
Do.	Do.	09-18-82	30	3	1	-----	153
Pigeon	360559110190201	10-26-54	-----	----	-----	279	-----
Do.	Do.	09-02-82	140	3	2	-----	200
Hard Rocks	360209110303301	08-01-52	-----	----	-----	337	-----
Do.	Do.	06-10-82	60	3	2	-----	358
Crooked Finger	360145110190101	09-01-82	140	3	1	-----	176

Kayenta, Kitsillie, and Forest Lake are near the coal-lease area; the wells at Keams Canyon, New Oraibi, Rocky Ridge, and Pinon are farther away (fig. 2).

Discharge and Chemical Quality of Springs

Some members of the Navajo and Hopi Tribes are concerned that springs being used for domestic purposes could be affected by coal-lease withdrawals. Many springs on the Black Mesa discharge from the Wepo Formation, which lies close to land surface and in places is exposed. Springs are present also on the southwest perimeter of the study area where the N aquifer is exposed.

In 1982 three springs that discharge from the Wepo Formation in the area south of the coal-lease area and one spring from the N aquifer were selected for measurement of discharge and water-quality sampling. Springs from the Wepo Formation were Pigeon (4M-115) and Crooked Finger (4M-102) near Pinon and Hard Rocks (4M-128) near Hotevilla (fig. 2). The spring from the N aquifer was Pasture Canyon (3A-5) near Tuba City. Pigeon, Hard Rocks, and Pasture Canyon Springs were sampled as early as 1954, 1952, and 1948, respectively (Kister and Hatchett, 1963). Samples collected in 1982 were analyzed for major ions and fluoride (table 3). For comparison, analyses of earlier data also are shown.

The amounts of discharge from springs sampled in 1982 were small. In September 1982 the discharge of Pasture Canyon Spring was 0.3 ft^3/s, which is equivalent to about 220 acre-ft/yr. Pigeon, Crooked Finger, and Hard Rocks Springs were barely flowing.

Surface-Water Data

From the beginning of strip-mining operations in the coal-lease area, there was concern about the effects on sediment discharge and water quality of Moenkopi Wash, especially near Moenkopi and Tuba City where water is diverted for irrigation of crops and other domestic uses. For 1977-82, collection of streamflow and water-quality data for Moenkopi Wash was continued at a gaging station at Highway 264, a short distance from Moenkopi (fig. 2). From 1973 to 1976, the gage was at a site 2.5 mi upstream from the present site. Data collected at these sites included discharge, sediment discharge, daily water temperature, daily specific conductance, and periodic water-quality samples (major ions and fluoride). Collection of daily water temperature and specific conductance was discontinued September 30, 1978. Collection of periodic water-quality samples and sediment-discharge data was discontinued September 30, 1980. Since 1980, only continuous-discharge data have been collected at this site.

The base-flow of Moenkopi Wash during winter months when evapotranspiration is at a minimum is maintained by discharge from the N aquifer. All base-flow discharge measurements made during November-February for 1976-81 averaged 3.2 ft^3/s, which is equivalent to about 2,320 acre-ft/yr.

Chinle Creek, which is along the northeast perimeter of the study area (fig. 2), receives water from the N aquifer. The water is principally from Laguna Creek, which flows along the north boundary of the study area and empties into Chinle Creek about 5 mi above the gaging station near Mexican Water (fig. 2). This station has been in operation

since 1964, and discharge data have been published in Water Resources Data for Arizona (U.S. Geological Survey, issued annually). The amount of base flow in Chinle Creek that is attributable to Laguna Creek is unknown. The average discharge of all low-flow measurements made during November-February for 1976-81 was 5.46 ft^3/s, which is equivalent to 3,950 acre-ft/yr.

In 1981 a low-flow measuring site was established on Laguna Creek (fig. 2). This station consists of a permanent reference mark and low flows are measured intermittently in winter months. Four measurements were made in the winter of 1982. The average of these measurements was 3.9 ft^3/s, which is equivalent to 2,820 acre-ft/yr.

Coal Mine Wash near mouth near Shonto, a continuous-record gaging station (fig. 2), was established in 1978 as a part of the Federally funded Black Mesa Small Watershed Study. The original purpose of the station was to determine discharge and suspended-sediment discharge from a site in the mined area and compare findings with a similar site that would be undisturbed. The undisturbed site, however, was never established. The station was also to be used to compare discharge data with that collected from small watersheds in the coal-lease area by Peabody Coal Co. Because of the remoteness of the station and the flashiness of peaks, mainly from local thunderstorms, a fully satisfactory stage-discharge curve has not been established during the 4 years of operation. On the basis of a recommendation by the U.S. Geological Survey to the cooperators, Coal Mine Wash gaging station was discontinued on September 30, 1982.

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United States
Department of the Interior
Geological Survey

Progress Report on Black Mesa Monitoring Program—1983

By

George W. Hill

Prepared in cooperation with the
Arizona Department of Water Resources

Basic-Data Report

Tucson, Arizona
December 1983

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CONVERSION FACTORS

For readers who use metric units, conversion factors for terms used in this report are listed below:

Multiply inch-pound unit	By	To obtain SI unit
foot (ft)	0.3048	meter (m)
square mile (mi^2)	2.590	square kilometer (km^2)
acre-foot (acre-ft)	0.001233	cubic hectometer (hm^3)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
gallon per minute (gal/min)	0.06309	liter per second (L/s)

PROGRESS REPORT ON BLACK MESA MONITORING PROGRAM—1983

By

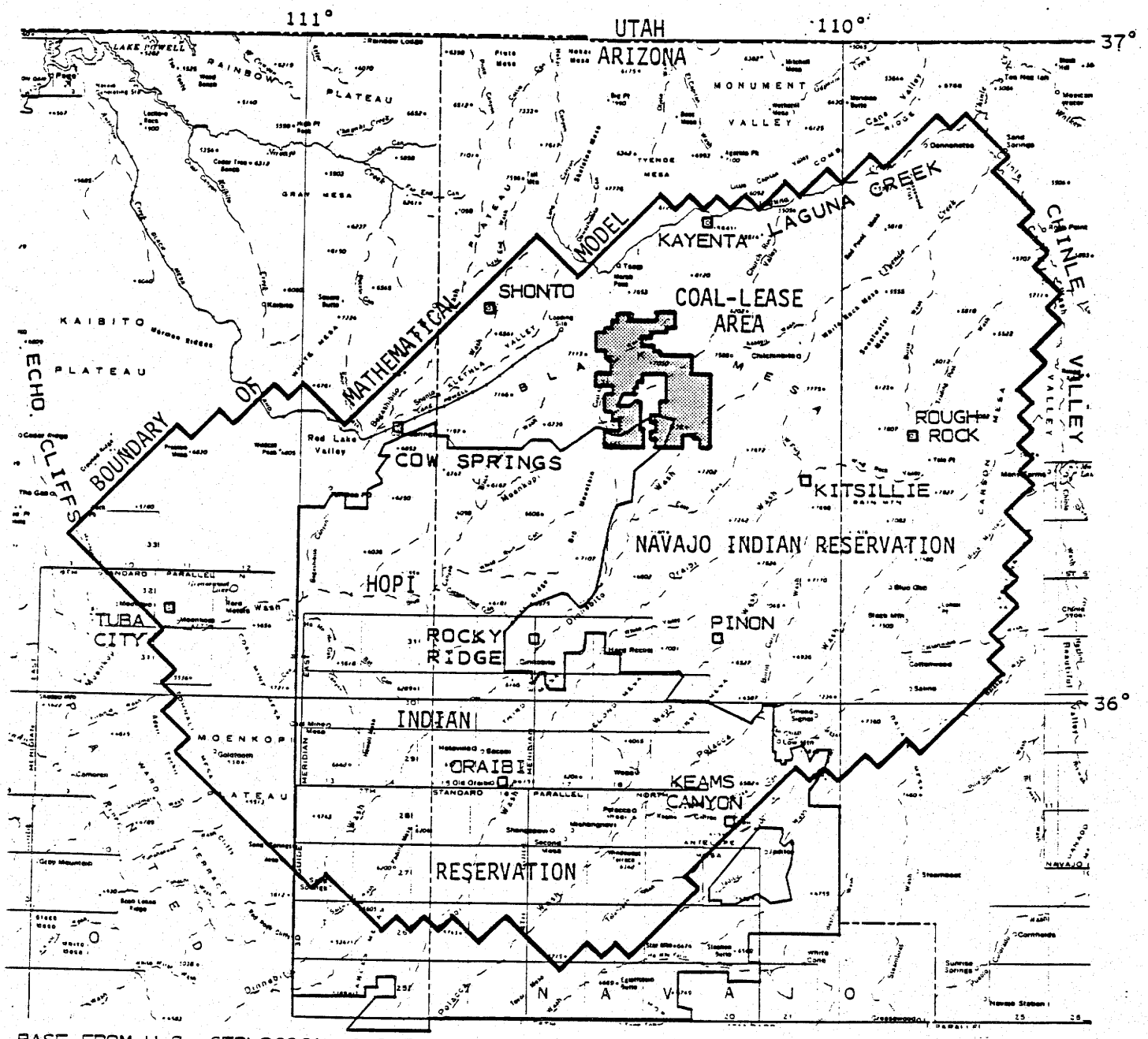
George W. Hill

INTRODUCTION

The N aquifer is an important source of water in the 5,400 mi^2 Black Mesa area on the Navajo and Hopi Indian Reservations in northeastern Arizona (fig. 1). On the northern part of the mesa, Peabody Coal Co. operates a strip mine in a lease area of about 100 mi^2. When operation of the mine began in 1968, the company pumped about 95 acre-ft of ground water from the N aquifer. In 1982 slightly more than 4,000 acre-ft was pumped. Withdrawals from the N aquifer for municipal use increased from an estimated 70 acre-ft in 1965 to about 2,000 acre-ft in 1982. The Navajo and Hopi Tribes became concerned about the long-term effects of withdrawals from the N aquifer on supplies for domestic and municipal purposes. These and other concerns about the effects of strip mining led to the Black Mesa water-resources investigation by the U.S. Geological Survey in cooperation with the Arizona Department of Water Resources. The cooperation and assistance of the Navajo and Hopi Tribes, U.S. Bureau of Indian Affairs, and Peabody Coal Co. are gratefully acknowledged.

Purpose and Scope of the Report

The report covers the progress of the Black Mesa Monitoring Program from October 1, 1982, to September 30, 1983, and discusses data collected throughout the monitoring program from its beginning in 1972.



BASE FROM U.S. GEOLOGICAL SURVEY
STATE BASE MAP, 1:1,000,000

0 25 50 MILES

0 25 50 KILOMETERS

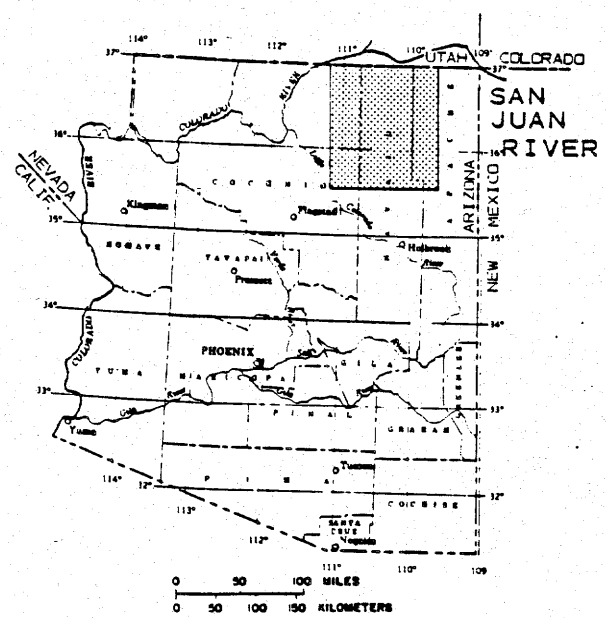


Figure 1.--Area of report.

Except for some earlier data that are used for comparison, only new data will appear in this report.

Previous Reports on the Project

Two progress reports by the U.S. Geological Survey on the monitoring phase of the program have been published (U.S. Geological Survey, 1978; Hill, 1982). Most of the basic data are contained in these reports except for stream-discharge and sediment-discharge data from Moenkopi Wash, which have been published in Water Resources Data for Arizona (U.S. Geological Survey, issued annually). Eychaner (1983) showed the results of a mathematical model that was developed to simulate the flow of ground water in the N aquifer. The model is used to predict the effects of withdrawals through the year 2014, which is 13 years after the existing coal lease expires. The present monitoring program is essential for checking the model simulations and water quality of the N aquifer as water levels decline.

HYDROLOGIC-DATA COLLECTION, 1983

In accordance with the objectives of the program, monitoring activities have been continued by continuous or periodic measurements of (1) ground-water levels in the confined and unconfined areas of the N aquifer; (2) major withdrawals from the N aquifer by industrial and nonindustrial pumping from the confined and unconfined areas; (3) ground-water quality of the N aquifer in the coal-lease area and other areas of the mesa; (4) discharge and chemical quality of selected springs

that discharge from the various formations, including the N aquifer; and (5) surface-water discharge, which reflects the conditions of the N aquifer. The data-collection network is shown in figure 2.

Ground-Water Levels

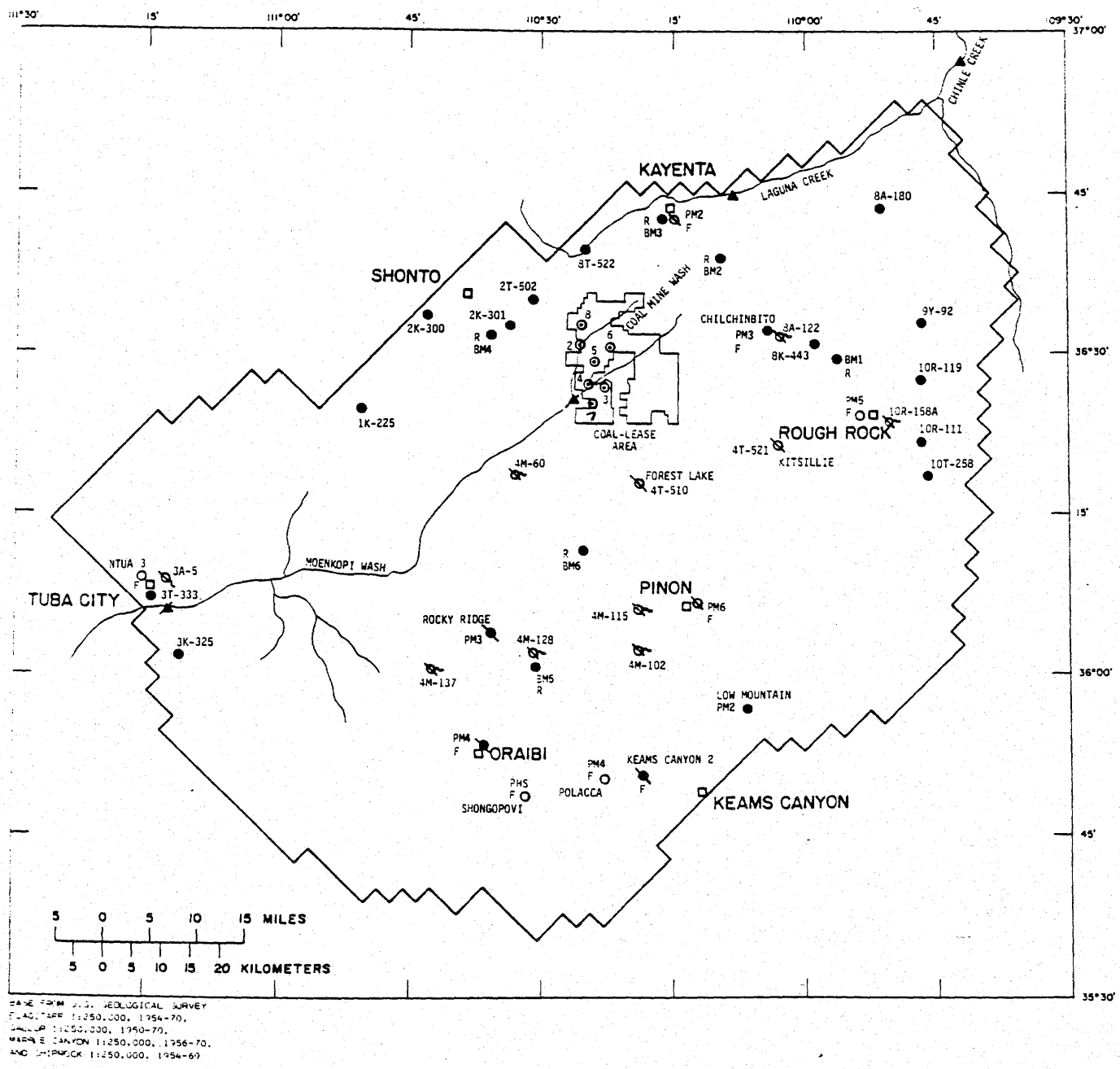
Ground-water levels continue to decline in wells penetrating the confined area of the N aquifer. Observation wells in the unconfined area of the N aquifer indicate no decline in water levels. The net change of water levels in selected wells in the N aquifer within the Black Mesa area since prestress times, which is prior to 1965, is shown in figure 3.

The three largest measured water-level declines outside the coal-lease area are at Kayenta, Keams Canyon, and Chilchinbito (fig. 3). Wells in or near these communities are pumped for public supply, and the water levels may be affected by local pumping as well as by industrial withdrawals.

In the construction of the mathematical model of the N aquifer system, water-level changes were simulated for several continuous-record observation and nonindustrial wells penetrating the N aquifer (Eychaner, 1983). A comparison between measured and simulated water levels in the six continuous-record observation wells—BM1-6—for 1959-83 is shown in figure 4.

Withdrawals from the N Aquifer

The three categories of withdrawals from the N aquifer are industrial (Peabody Coal Co.) from the confined area, nonindustrial from the confined area, and nonindustrial from the unconfined area. The



BASE FROM U.S. GEOLOGICAL SURVEY
FLAGSTAFF 1:250,000, 1954-70,
GALLUP 1:250,000, 1950-70,
MARBLE CANYON 1:250,000, 1956-70,
AND SHIPROCK 1:250,000, 1954-69

Figure 2.--Data-collection sites.

EXPLANATION

R F
BM2

WELL THAT TAPS THE N AQUIFER IN WHICH WATER LEVEL WAS MEASURED—BM2, is well identifier. R, indicates well equipped with a recorder; \ , indicates water-quality sample was collected; F, indicates one or more wells in the area equipped with a flowmeter

F
PM6

WELL THAT TAPS THE N AQUIFER—PM6, is well identifier. \ , indicates water-quality sample was collected; F, indicates one or more wells in the area equipped with a flowmeter

8

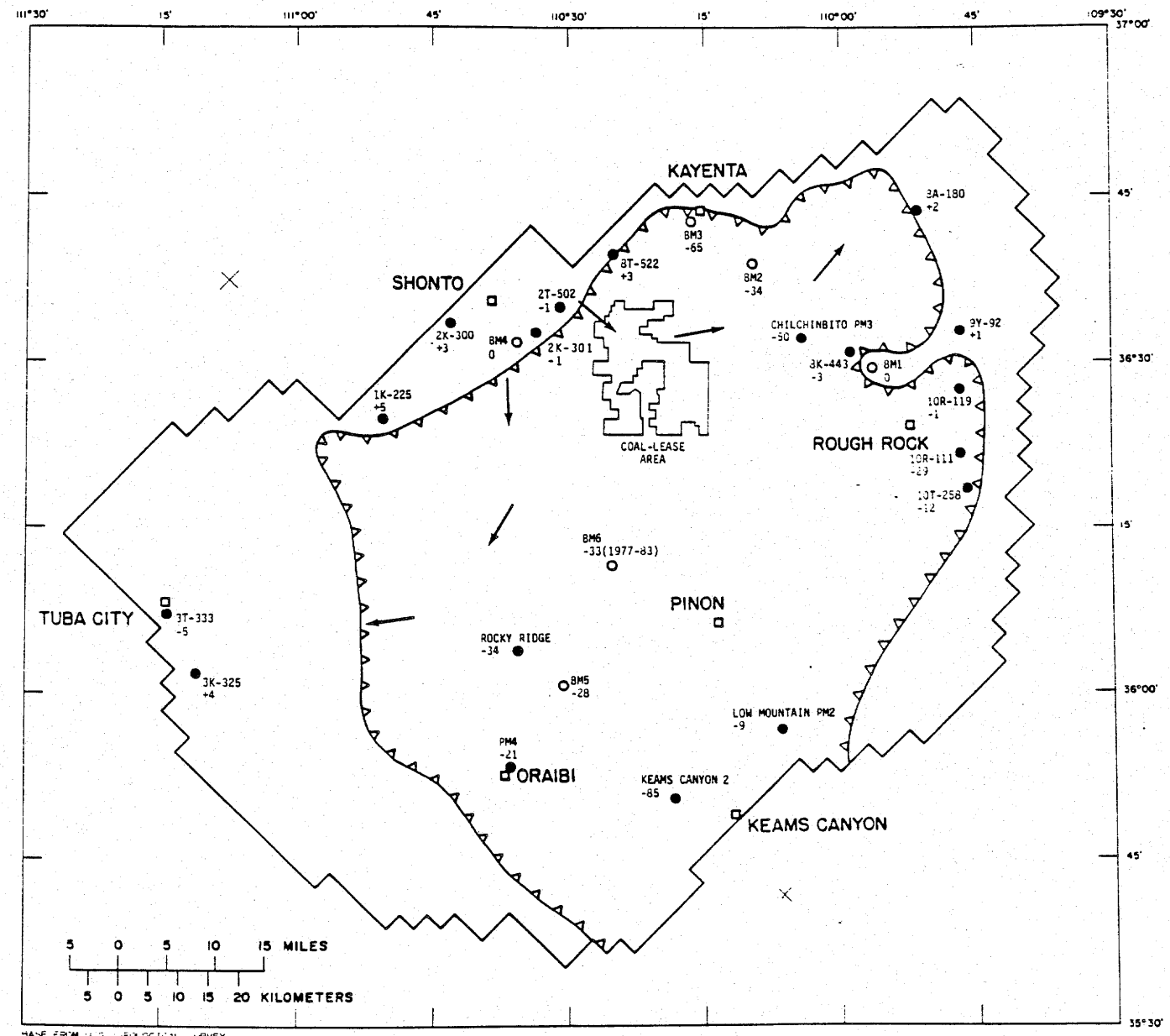
PEABODY COAL CO. PRODUCTION WELL— Water-quality sample was collected. 8, is well number

SPRING AT WHICH DISCHARGE WAS MEASURED AND WATER-QUALITY SAMPLE WAS COLLECTED

GAGING STATION OPERATED BY THE U.S. GEOLOGICAL SURVEY— / , indicates water-quality and sediment samples were collected

BOUNDARY OF MATHEMATICAL MODEL—From Eychaner (1983)

Figure 2



BASE FROM U.S. GEOLOGICAL SURVEY
FLAGSTAFF 1:250,000, 1954-70,
GALLUP 1:250,000, 1960-70,
MARBLE CANYON 1:250,000, 1956-70,
AND SHIPROCK 1:250,000, 1954-69

Figure 3.--Water-level changes in wells that tap the N aquifer, 1953-83.

EXPLANATION

● 3T-333 -5	WELL IN WHICH DEPTH TO WATER WAS MEASURED INTERMITTENTLY—First entry, 3T-333, is Bureau of Indian Affairs site identification; second entry, -5, is difference, in feet, between water-level measurements during assumed local equilibrium 1953-72 and 1983
○ BM2 -34	CONTINUOUS-RECORD OBSERVATION WELL—First entry, BM2, is well identifier. Second entry, -34, is difference, in feet, between water-level measurements during assumed local equilibrium 1965-72 and 1983
CONFINED △△△△△△△△ UNCONFINED	APPROXIMATE BOUNDARY BETWEEN CONFINED AND UNCONFINED CONDITIONS—From Eychaner (1983)
→	GENERALIZED DIRECTION OF GROUND-WATER MOVEMENT
———	BOUNDARY OF MATHEMATICAL MODEL—From Eychaner (1983)

Figure 3

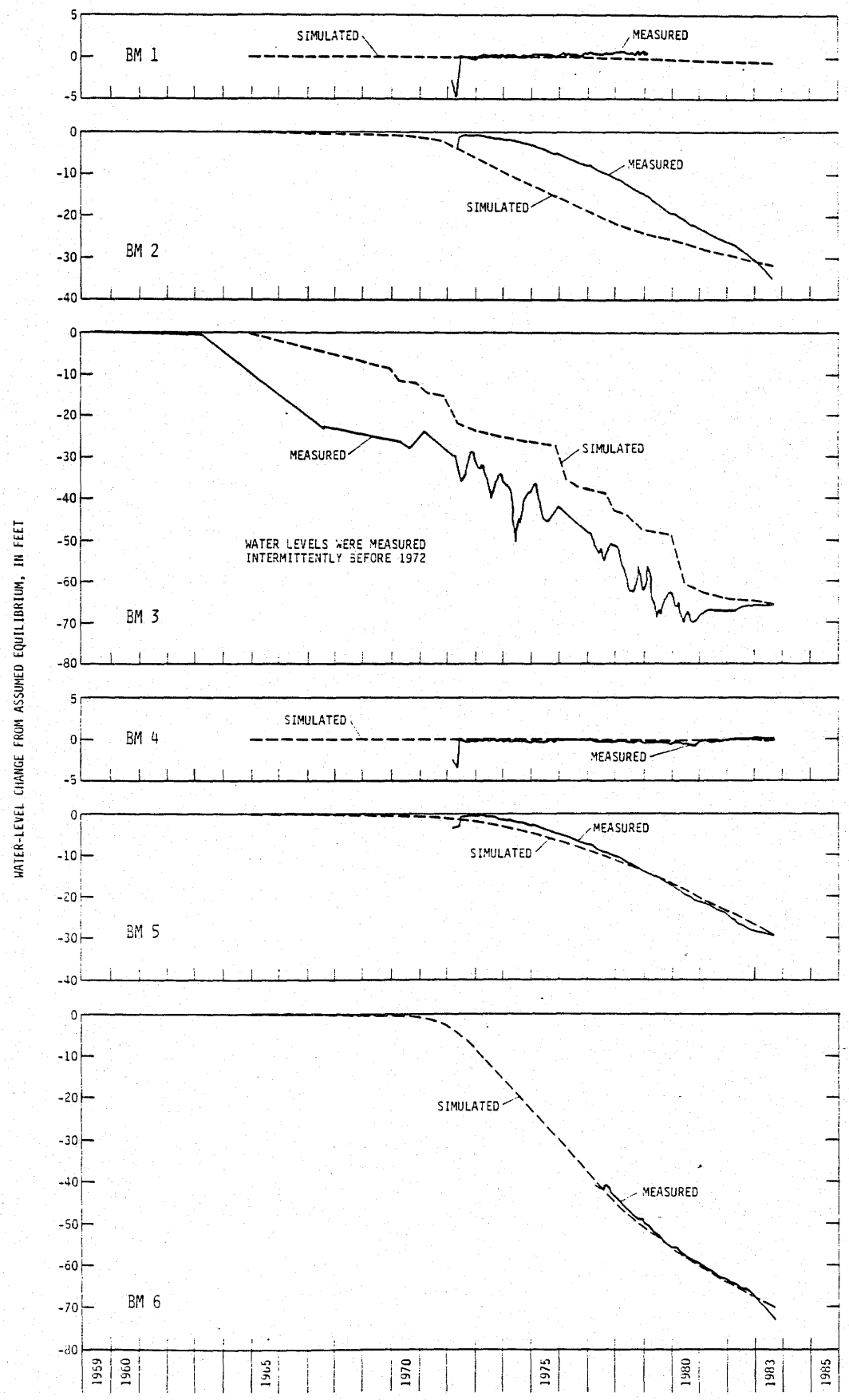


Figure 4.--Measured and simulated water-level changes for observation wells, 1959-83.

primary interest is in withdrawals related to the mining operation and nonindustrial pumpage of significant amounts. Pumpage data have not been collected from wells equipped with windmills.

A concerted effort has been made by the U.S. Geological Survey in the past 2 years to inventory nonindustrial supply wells that have flowmeters as well as to install flowmeters on wells that have significant pumpage. In 1982-83 five additional flowmeters were installed (fig. 2). About 20 wells are represented, and a representative well at each community is identified in figure 2. Annual pumpage for all three categories of withdrawals from the N aquifer for the period 1965-82 is shown in table 1.

Chemical Quality of Water from Wells That Tap the N Aquifer

One major concern on the part of some residents of the Black Mesa area has been the effect of withdrawals on the chemical quality of water from the N aquifer. Eychaner (1983) stated that some water may enter the N aquifer from the upper confining beds. He also stated that the driving force for such flow is present because the head in the overlying D aquifer in 1964 averaged about 300 ft higher than that in the N aquifer. Differences in the chemical composition of the waters of the two aquifers, D and N, indicate that the amount of downward leakage must be small (Eychaner, 1983). On the average, the concentration of dissolved solids in water from the D aquifer is about 7 times greater than that from the N aquifer, the concentration of chloride ions is 11 times greater, and the concentration of sulfate ions is 30 times greater (Eychaner, 1983).

Table 1.--Withdrawals from the N aquifer, 1965-82
[Measurements are in acre-feet. Data for 1965-79 from Eychaner, 1983]

Year	Industrial[1]	Nonindustrial[2] year	
		Confined[3]	Unconfined[4]
1965	0	50	20
1966	0	110	30
1967	0	120	50
1968	95	150	100
1969	43	200	100
1970	740	280	150
1971	1,900	340	150
1972	3,680	370	250
1973	3,520	530	300
1974	3,830	580	362
1975	3,550	600	508
1976	4,180	690	645
1977	4,090	750	726
1978	3,000	830	930
1979	3,500	860	930
1980	3,540	910	880
1981	4,010	960	1,000
1982	4,740	870	965

[1]Metered pumpage by Peabody Coal Co. at their mine on Black Mesa, which is in the area of confined conditions.

[2]Does not include withdrawals from wells equipped with windmills.

[3]Includes metered pumpage at Kayenta, 1982; and estimated pumpage at Chilchinbito, Rough Rock Pinon, Keams Canyon and Oraibi. Estimated pumpage was prior to 1982.

[4]Includes estimated pumpage, 1965-73, and metered pumpage, 1974-82, at Tuba City; and metered pumpage at Moenkopi, 1982.

Any increase in the leakage rate due to pumping from the N aquifer should appear first as an increase in the dissolved-solids concentration in the water from Peabody wells (Eychaner, 1983). Concentrations of dissolved solids, sulfate ions, or chloride ions of waters have not increased in the Peabody wells 2-8 from 1967 to 1983 (table 2).

In 1983, seven wells in the confined area of the N aquifer were sampled for major ions and fluoride—Peabody Well 8, Keams Canyon 2, New

Oraibi PM 3, Kayenta PM 2, Kitsillie, Pinon PM 6, and Rough Rock PM 5 (fig. 2, table 3). Peabody Well 8, Keams Canyon 2, Rocky Ridge PM 3, New Oraibi PM 4, Kayenta PM 2, Forest Lake, Kitsillie, and Pinon PM 6 were sampled in 1982 (Hill, 1982). Selected parameters from chemical analyses of water from all nonindustrial wells sampled during 1982-83 are shown in table 4.

A marked difference has been noted between the chemical composition of water from the Rough Rock PM 5 and Keams Canyon 2 wells and that of the other nonindustrial wells in the N aquifer that were sampled in 1982-83 (table 4). Chemical analyses of samples taken from Rough Rock PM 5 in 1964 and Keams Canyon 2 in 1972, however, indicate

Table 2.--Selected parameters from chemical analysis of water from wells of the Peabody Coal Co., Black Mesa, 1967-74 and 1980-83.

Well number	Year	Specific conductance (umhos)	Dissolved solids / Residue at 180°C (mg/L)	Chloride, dissolved (mg/L as Cl)	Sulfate, dissolved (mg/L as SO_4)
2	1967	221	144 (1974)	5.0	21
	1980	225	144	11	20
3	1968	236	154 (1974)	4.0	17
	1980	230	151	3.5	14
4	1974	200	140	3.8	13
	1980	230	139	4.3	13
5	1968	224	149 (1974)	3.5	16
	1980	210	134	2.9	9.5
6	1968	201	333 (1974)	3.0	13
	1980	260	160	3.5	15
7	197?	222	141 (1974)	2.5	20
	1980	210	136	3.7	11
8	1980	420	283	4.8	100
	1983	440	278	4.8	100

Table 3.--Chemical analyses of selected industrial and nonindustrial wells, Black Mesa area, 1983

Site name	Identification number	Date of sample	Temperature (°C)	Specific conductance (µmhos)	pH (units)	Alkalinity (mg/L as $CaCO_3$)	Nitrogen, NO_2+NO_3 dissolved (mg/L as N)
Peabody Well 8	363130110254501	07-19-83	30	440	8.2	93	1.5
Keams Canyon 2	355023110182701	08-23-83	19.0	1,120	9.1	330	<.10
Rough Rock PM 5	362418109514601	07-20-83	21.5	1,090	8.7	210	1.1
New Oraibi PM 3	355236110364501	08-15-83	22.0	400	9.6	180	1.2
Kayenta PM 2	364347110145901	07-19-83	18.0	375	7.9	110	.81
Kitsillie	362035110032201	08-16-83	27.5	505	9.3	180	1.1
Pinon PM 6	360614110130801	08-16-83	24.5	505	9.7	210	1.4

Site name	Identification number	Date of sample	Phosphorus ortho, dissolved (mg/L as P)	Hardness (mg/L as $CaCO_3$)	Hardness, noncarbonate (mg/L as ($CaCO_3$)	Calcium, dissolved (mg/L as Ca)
Peabody Well 8	363130110254501	07-19-83	<0.01	67	0	22
Keams Canyon 2	355023110182701	08-23-83	.02	0	0	.99
Rough Rock PM 5	362418109514601	07-20-83	<.01	6	0	2.0
New Oraibi PM 3	355236110364501	08-15-83	.02	2	0	.50
Kayenta PM 2	364347110145901	07-19-83	<.01	120	1	36
Kitsillie	362035110032201	08-16-83	<.01	15	0	3.8
Pinon PM 6	360614110130801	08-16-83	<.01	2	0	.56

Site name	Identification number	Date of sample	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Sodium adsorption ratio	Percent sodium
Peabody Well 8	363130110254501	07-19-83	3.0	61	3.5	65
Keams Canyon 2	355023110182701	08-23-83	.14	250	65	99
Rough Rock PM 5	362418109514601	07-20-83	.29	230	42	98
New Oraibi PM 3	355236110364501	08-15-83	.16	87	30	99
Kayenta PM 2	364347110145901	07-19-83	7.4	28	1.2	33
Kitsillie	362035110032201	08-16-83	1.4	100	12	93
Pinon PM 6	360614110130801	08-16-83	.07	110	38	99

Site name	Identification number	Date of sample	Potassium, dissolved (mg/L as K)	Chloride, dissolved (mg/L as Cl)	Sulfate, dissolved (mg/L as SO_4)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)
Peabody Well 8	363130110254501	07-19-83	2.6	4.8	100	0.2	19
Keams Canyon 2	355023110182701	08-23-83	1.0	120	42	1.5	12
Rough Rock PM 5	362418109514601	07-20-83	1.4	130	110	2.1	12
New Oraibi PM 4	355236110364501	08-15-83	.5	4.1	9.8	.2	23
Kayenta PM 2	364347110145901	07-19-83	1.5	5.9	60	.3	16
Kitsillie	362035110032201	08-16-83	1.2	4.4	37	.2	20
Pinon PM 6	360614110130801	08-16-83	.5	3.6	5.3	.2	27

Site name	Identification number	Date of sample	Boron, dissolved (µg/L as B)	Iron, dissolved (µg/L as Fe)	Manganese, dissolved (µg/L as Mn)	Dissolved solids: Sum of constituents (mg/L)
Peabody Well 8	363130110254501	07-19-83	40	16	2	278
Keams Canyon 2	355023110182701	08-23-83	730	37	<1	636
Rough Rock PM 5	362418109514601	07-20-83	420	44	<1	628
New Oraibi PM 4	355236110364501	08-15-83	49	41	2	235
Kayenta PM 2	364347110145901	07-19-83	30	17	2	230
Kitsillie	362035110032201	08-16-83	60	37	7	291
Pinon PM 6	360614110130801	08-16-83	50	32	1	293

no significant change in composition. In 1964, for example, water from Rough Rock PM 5 showed specific conductance as 1,120 micromhos, dissolved solids (sum of constituents) as 638 mg/L, and dissolved chloride as 100 mg/L. Analysis of water from Keams Canyon 2 in 1972 indicates specific conductance as 937 micromhos, dissolved solids (sum of constituents) as 597 mg/L, and dissolved chloride as 91 mg/L. The values are in the same general range as those reported in 1982-83 (table 4). Analyses from Keams Canyon 2, however, show an increase in these parameters from 1982 to 1983.

One possibility for the differences in chemical composition between Rough Rock PM5 and Keams Canyon 2 and other nonindustrial wells is that the Rough Rock PM 5 and Keams Canyon 2 are finished below the

Table 4.--Selected parameters from chemical analysis of water from nonindustrial wells in the N aquifer, Black Mesa area, 1982-83

Site name	Year	Specific conductance (umhos)	Dissolved solids, Residue at 180°C (mg/L)	Chloride, dissolved (mg/L as Cl)	Sulfate, dissolved (mg/L as SO_4)
Keams Canyon 2	1982	1,010	592	94	35
	1983	1,120	636	42	120
Rough Rock PM 5	1983	1,090	628	130	110
Rocky Ridge PM 3	1982	255	---	1.4	6.0
New Oraibi PM 4	1982	385	228	4.0	10
New Oraibi PM 3	1983	400	235	4.1	9.8
Kayenta PM 2	1982	360	228	4.5	58
	1983	375	230	-----	60
Forest Lake	1982	470	281	11	67
Kitsillie	1982	580	365	5.4	84
	1983	505	291	4.4	37
Pinon PM 6	1982	485	---	3.7	5.0
	1983	505	293	3.6	5.3

Navajo Sandstone and the other wells are finished in the Navajo Sandstone. Well construction and withdrawal stress may also affect the chemical composition.

Discharge and Chemical Quality of Springs

The effects of withdrawals from the N aquifer on the quality of spring water used for domestic purposes are a major concern of some residents of the reservations. Many springs on Black Mesa discharge from several stratigraphic units including the Navajo Sandstone where the units are exposed. Discharge from springs sampled in 1983 was as follows:

Spring	Discharge, in gallons per minute
Chilchinbito	0.68
Rough Rock	.15
Red Willow	<1.0
Cottonwood	<.5

In 1982-83, water-quality samples were analyzed for eight springs representing the Navajo Sandstone, Morrison Formation, Dakota Sandstone, Toreva and Wepo Formations, and alluvium[1] (fig. 2). All but one of the springs selected were sampled from 1948 to 1954 (Kister and Hatchett, 1963). Chemical analyses of four selected springs in the Black Mesa area for 1949, 1954, and 1983 are shown in table 5. Chemical analyses of four selected springs sampled in 1982 have been published (Hill, 1982). Selected parameters from chemical analyses from all springs sampled in 1948-54 and 1982-83 are shown in table 6.

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[1]This report has not been reviewed for conformity with U.S. Geological Survey nomenclature.

Table 5.--Chemical analysis of selected springs, Black Mesa area, 1949, 1954, and 1983

Site name	Bureau of Indian Affairs field number	Identification number	Date of sample	Formation	Temperature (°C)	Specific conductance (µmhos)	pH (units)	Alkalinity (mg/L as $CaCO_3$)	Nitrogen, NO_2+NO_3 dissolved (mg/L as N)
Chilchinbito	8A-122	363109110025700	06-12-54	Morrison	----	2,750	----	----	-----
Do.	Do.	Do.	07-20-83	Do.	22.0	1,980	7.7	190	0.19
Red Willow	4M-60	361907110324800	10-28-54	Toreva	----	530	----	----	11
Do.	Do.	Do.	08-17-83	Do.	14.5	580	6.5	99	3.0
Cottonwood	4M-137	36093411043140	10-28-54	Alluvium	15.0	560	----	----	-----
Do.	Do.	Do.	08-23-83	Do.	17.0	550	7.7	200	.10
Rough Rock	10R-158A	36242210952120	07-28-49	Dakota	16.0	362	----	----	-----
Do.	Do.	Do.	07-20-83	Do.	15.0	290	7.9	108	.98

Site name	Bureau of Indian Affairs field number	Identification number	Date of sample	Formation	Phosphorus ortho, dissolved (mg/L as P)	Hardness (mg/L as $CaCO_3$)	Hardness, noncarbonate (mg/L as ($CaCO_3$)	Calcium, dissolved (mg/L as Ca)
Chilchinbito	8A-122	363109110025700	06-12-54	Morrison	----	1,490	1,310	286
Do.	Do.	Do.	07-20-83	Do.	<0.01	940	750	180
Red Willow	4M-60	361907110324800	10-28-54	Toreva	----	208	102	59
Do.	Do.	Do.	08-17-83	Do.	<.01	230	130	64
Cottonwood	4M-137	36093411043140	10-28-54	Alluvium	----	52	0	12
Do.	Do.	Do.	08-23-83	Do.	.01	31	0	8.4
Rough Rock	10R-158A	36242210952120	07-28-49	Dakota	----	176	70	49
Do.	Do.	Do.	07-20-83	Do.	<.01	120	24	37

Site name	Bureau of Indian Affairs field number	Identification number	Date of sample	Formation	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Sodium adsorption ratio	Percent sodium	Sodium+ potassium, dissolved (mg/L as Na)
Chilchinbito	8A-122	363109110025700	06-12-54	Morrison	188	-----	1.6	18	146
Do.	Do.	Do.	07-20-83	Do.	120	110	1.7	20	-----
Red Willow	4M-60	361907110324800	10-28-54	Toreva	15	-----	1.0	25	32
Do.	Do.	Do.	08-17-83	Do.	17	24	.7	18	-----
Cottonwood	4M-137	36093411043140	10-28-54	Alluvium	5.3	-----	6.6	82	110
Do.	Do.	Do.	08-23-83	Do.	2.5	110	9.2	88	-----
Rough Rock	10R-158A	36242210952120	07-28-49	Dakota	13	-----	.2	7	5.8
Do.	Do.	Do.	07-20-83	Do.	7.7	6.4	.3	10	-----

Site name	Bureau of Indian Affairs field number	Identification number	Date of sample	Formation	Potassium, dissolved (mg/L as K)	Chloride, dissolved (mg/L as CL)	Sulfate, dissolved (mg/L as SO_4)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)
Chilchinbito	8A-122	363109110025700	06-12-54	Morrison	-----	30	1,520	-----	-----
Do.	Do.	Do.	07-20-83	Do.	15	31	990	0.5	11
Red Willow	4M-60	361907110324800	10-28-54	Toreva	-----	21	126	.6	21
Do.	Do.	Do.	08-17-83	Do.	5.1	19	140	<.1	20
Cottonwood	4M-137	36093411043140	10-28-54	Alluvium	-----	10	62	.6	14
Do.	Do.	Do.	08-23-83	Do.	2.2	7.1	60	.3	12
Rough Rock	10R-158A	36242210952120	07-28-49	Dakota	-----	27	39	.2	-----
Do.	Do.	Do.	07-20-83	Do.	3.7	6.0	25	.4	7.9

Site name	Bureau of Indian Affairs field number	Identification number	Date of sample	Formation	Boron, dissolved (µg/L as B)	Iron, dissolved (µg/L as Fe)	Manganse, dissolved (µg/L as Mn)	Dissolved solids: Residue at 180°C (mg/L)	Dissolved solids: Sum of constituents (mg/L)
Chilchinbito	8A-122	363109110025700	06-12-54	Morrison	-----	-----	-----	2,280	-----
Do.	Do.	Do.	07-20-83	Do.	90	30	13	-----	1,580
Red Willow	4M-60	361907110324800	10-28-54	Toreva	-----	-----	-----	350	-----
Do.	Do.	Do.	08-17-83	Do.	40	4	1	-----	364
Cottonwood	4M-137	36093411043140	10-28-54	Alluvium	-----	-----	-----	341	-----
Do.	Do.	Do.	08-23-83	Do.	70	59	60	-----	328
Rough Rock	10R-158A	36242210952120	07-28-49	Dakota	-----	-----	-----	202	-----
Do.	Do.	Do.	07-20-83	Do.	30	28	1	-----	163

Table 6.--Selected parameters from chemical analyses of water sampled from springs in the Black Mesa area, 1948-54 and 1982-83

Spring name	Bureau of Indian Affairs number	Date sampled	Formation	Specific conductance (umhos)	Chloride, dissolved (mg/L as Cl)	Sulfate, dissolved (mg/L as SO_4)
Pasture Canyon...	3A-5	02-27-48	Navajo SS	199	5.0	13
Do.	Do.	09-18-82	Do.	240	5.1	18
Pigeon.....	4M-115	10-26-54	Wepo	287	12	11
Do.	Do.	09-02-82	Do.	350	9.7	17
Hard Rocks.....	4M-128	08-01-52	Toreva	541	32	91
Do.	Do.	06-10-82	Do.	525	37	110
Crooked Finger...	4M-102	09-01-82	Wepo	305	9.7	26
Chilchinbito.....	8A-122	06-12-54	Morrison	2,750	30	1,520
Do.	Do.	07-20-83	Do.	1,980	31	990
Red Willow.....	4M-60	10-28-54	Toreva	530	21	126
Do.	Do.	08-17-83	Do.	580	19	140
Cottonwood.....	4M-137	10-28-54	Alluvium	560	10	62
Do.	Do.	08-23-83	Do.	550	7.1	60
Near Rough Rock..	10R-158A	07-28-49	Dakota	362	27	39
Do.	Do.	07-20-83	Do.	290	6.0	25

Surface-Water Data

The continuous-record streamflow stations on Moenkopi Wash at Moenkopi and Chinle Wash near Mexican Water and the partial-record streamflow station on Laguna Creek near Church Rock were continued to 1983. The base flow of Moenkopi Wash during winter months when evapotranspiration is at a minimum is maintained by discharge from the N aquifer. All base-flow discharge measurements made during November-February from 1976-83 averaged 3.3 ft^3/s, which is equivalent to about 2,390 acre-ft/yr. Unpublished streamflow data for Moenkopi Wash from October 1, 1981, to September 30, 1982, are shown in table 7, and in Water Resources Data for Arizona, water year 1982 (U.S. Geological Survey, issued annually.

Chinle Wash, which is along the northeast perimeter of the study area, received water from the N aquifer (fig. 2). The water attributable to flow from the N aquifer is principally from Laguna Creek, which flows along the north boundary of the study area and empties into Chinle Wash about 5 mi above the gaging station near Mexican Water (fig. 2). The average discharge of low-flow measurements made during November through February for 1976-83 was 5.45 ft^3/s, which is equivalent to 3,950 acre-ft/yr. Unpublished streamflow data from October 1, 1983, to September 30, 1982, are shown in table 8 and will be published in Water Resources Data for Arizona, water year 1983 (U.S. Geological Survey, issued annually). The average of all low-flow measurements made on Laguna Creek during winter months since the station was established in 1981 was 3.9 ft^3/s, which is equivalent to 2,820 acre-ft/yr, and no continuous streamflow data are available for this station.

Table 7.--Discharge data, Moenkopi Wash at Moenkopi, 1982 water year

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	1.5	1.5	8.0	1.0	3.8	6.0	2.0	2.0	.10	.00	.20	1.5
2	2110	1.0	8.0	1.0	3.6	6.0	2.0	2.0	.10	.00	.00	1.5
3	331	1.0	7.0	.80	3.6	5.5	1.8	22	.10	.00	.10	1.5
4	8.4	1.0	7.0	.80	3.4	5.0	1.8	9.0	.10	.00	.60	1.5
5	8.0	1.0	6.0	.60	3.0	4.5	1.6	160	.10	.00	.20	1.5
6	7.0	1.0	6.0	2.0	2.5	4.0	1.6	23	.10	.00	.00	15
7	6.0	1.5	5.0	1.0	2.5	4.0	1.6	13	.00	.00	.00	17
8	5.0	1.0	4.0	1.0	2.5	4.5	1.4	9.0	.00	.00	.00	3.0
9	4.0	.80	3.0	1.0	2.5	4.5	1.4	8.4	.00	.00	4.8	2.0
10	4.0	.80	3.0	1.0	2.5	4.5	1.4	6.5	.00	.00	4.0	2.0
11	3.5	.80	3.0	1.0	2.5	6.5	1.2	6.5	.00	.00	.50	200
12	3.5	.80	3.0	1.0	2.5	6.0	1.4	5.0	.00	.00	9.9	50
13	3.5	.80	3.0	1.0	2.8	6.0	1.2	13	.00	.00	34	25
14	3.0	.60	3.0	1.0	3.0	5.5	1.2	9.0	.00	.00	9.0	10
15	3.5	.60	2.5	1.0	3.0	5.5	1.2	9.0	.00	.00	1.5	6.0
16	3.0	.60	2.5	1.0	3.2	5.5	1.2	6.0	.00	.00	62	3.0
17	2.5	.60	2.5	1.0	3.4	5.0	1.0	4.0	.00	4.2	12	2.0
18	2.5	.40	2.5	1.0	3.4	4.5	1.0	3.5	.00	1.0	5.4	2.0
19	2.5	.40	2.5	1.0	5.0	4.0	1.0	3.0	.00	.00	1.3	2.0
20	2.5	.40	2.5	2.0	6.0	3.5	1.0	2.5	.00	.00	5.4	1.5
21	2.0	.40	3.0	2.0	7.2	3.5	1.0	2.0	.00	.00	35	1.5
22	2.0	.40	2.5	2.0	15	3.5	1.5	1.5	.00	18	227	1.5
23	2.0	.40	2.0	2.5	12	3.0	7.8	1.0	.00	8.9	40	1.5
24	2.0	.40	2.0	3.0	11	3.0	6.0	1.0	.00	8.3	15	1.5
25	2.0	.40	2.0	4.0	8.5	3.0	4.0	.80	.00	1.5	600	1.5
26	1.7	.40	1.8	5.0	6.5	5.0	3.0	.70	.00	10	60	1.5
27	1.5	1.0	1.6	4.6	6.0	4.5	2.0	.60	.00	.50	30	350
28	2.0	3.0	1.4	4.5	6.0	4.0	1.8	.50	.00	.50	15	65
29	2.0	10	1.2	4.5	---	3.0	1.8	.40	.00	7.9	7.0	15
30	1.5	9.0	1.0	4.0	---	2.1	2.0	.30	.00	1.6	3.0	7.0
31	1.5	---	1.0	4.0	---	2.0	---	.20	---	.60	2.0	---
TOTAL	2535.1	42.00	103.5	61.30	136.9	137.1	58.9	325.40	.60	63.00	1184.90	794.0
MEAN	81.8	1.40	3.34	1.98	4.89	4.42	1.96	10.5	.020	2.03	38.2	26.5
MAX	2110	10	8.0	5.0	15	6.5	7.8	160	.10	18	600	350
MIN	1.5	.40	1.0	.60	2.5	2.0	1.0	.20	.00	.00	.00	1.5
AC-FT	5030	83	205	122	272	272	117	645	1.2	125	2350	1570

TR YR 1982 TOTAL 5442.70 MEAN 14.9 MAX 2110 MIN .00 AC-FT 10800

Table 8.--Discharge data, Chinle Creek near Mexican Water, 1982 water year

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1981 TO SEPTEMBER 1982
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	10	3.0	30	3.0	8.4	19	13	140	.00	.00	22	75
2	120	3.0	17	4.0	4.0	12	7.7	151	.00	.00	147	70
3	405	3.0	7.0	4.0	4.0	9.2	4.0	150	.00	.00	402	65
4	437	3.0	5.0	4.0	5.0	9.6	2.6	166	.00	.00	278	60
5	79	3.5	4.0	5.0	5.0	10	3.3	832	.00	.00	72	50
6	27	4.0	4.0	5.0	5.0	8.8	4.8	850	.00	.00	28	40
7	21	4.3	4.0	5.0	5.0	7.7	2.1	260	.00	.00	13	40
8	7.7	4.0	4.0	6.0	5.0	7.3	1.5	160	.00	.00	32	40
9	5.9	4.0	4.0	6.0	5.0	13	1.5	100	.00	.00	66	40
10	3.5	4.5	4.0	6.0	7.0	15	1.5	80	.00	.00	52	40
11	2.1	4.3	4.0	7.0	7.0	8.8	1.8	70	.00	.00	46	40
12	1.6	4.3	4.0	7.0	7.0	7.3	3.3	80	.00	.00	34	40
13	1.0	4.0	4.0	7.0	7.0	153	2.2	70	.00	.00	27	40
14	.70	4.3	4.0	8.0	7.0	202	1.5	60	.00	.00	23	40
15	3.0	4.0	4.0	8.0	7.0	182	1.4	50	.00	.00	20	40
16	3.5	3.7	4.0	8.0	7.0	164	1.5	40	.00	.00	17	35
17	5.9	3.7	5.5	9.0	7.0	103	1.4	40	.00	.20	143	35
18	3.3	3.7	2.7	9.0	7.0	76	28	40	.00	.10	194	35
19	3.5	3.7	3.3	9.0	7.0	62	25	30	.00	.00	38	35
20	3.0	3.3	4.3	10	9.0	57	68	30	.00	.00	34	35
21	2.7	3.3	4.0	10	9.0	23	62	30	.00	.00	82	35
22	3.0	3.3	9.2	11	10	14	50	30	.00	.00	4000	35
23	3.3	3.3	7.3	11	15	9.6	19	20	.00	.00	12000	35
24	3.3	4.3	3.3	12	18	6.6	56	20	.00	.00	5000	35
25	3.0	5.2	4.3	12	23	4.5	40	15	.00	.00	3000	30
26	3.0	4.0	3.3	13	128	3.3	35	10	.00	.00	1000	30
27	3.0	3.7	3.3	12	68	23	78	5.0	.00	.00	750	30
28	3.0	3.5	3.3	15	37	71	90	2.0	.00	13	200	30
29	3.0	6.2	3.0	14	---	63	126	1.0	.00	85	140	30
30	3.0	27	3.0	18	---	56	134	.00	.00	83	100	30
31	3.3	---	3.0	10	---	38	---	.00	---	58	80	---
TOTAL	1177.30	139.1	169.8	268.0	433.4	1438.7	866.1	3532.00	.00	239.30	28040	1215
MEAN	38.0	4.64	5.48	8.65	15.5	46.4	28.9	114	.000	7.72	905	40.5
MAX	437	27	30	18	128	202	134	850	.00	85	12000	75
MIN	.70	3.0	2.7	3.0	4.0	3.3	1.4	.00	.00	.00	13	30
AC-FT	2340	276	337	532	860	2850	1720	7010	.00	475	55620	2410

WTR YR 1982 TOTAL 37518.70 MEAN 103 MAX 12000 MIN .00 AC-FT 74420

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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PROGRESS REPORT ON BLACK MESA MONITORING PROGRAM—1984

By George W. Hill

Open-File Report 85-483

Prepared in cooperation with the

ARIZONA DEPARTMENT OF WATER RESOURCES

and the U.S. BUREAU OF INDIAN AFFAIRS

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CONVERSION FACTORS

For readers who use metric units, conversion factors for terms used in this report are listed below:

Multiply inch-pound unit	By	To obtain SI unit
foot (ft)	0.3048	meter (m)
square mile (mi^2)	2.590	square kilometer (km^2)
acre-foot (acre-ft)	0.001233	cubic hectometer (hm^3)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
gallon per minute (gal/min)	0.06309	liter per second (L/s)

PROGRESS REPORT ON BLACK MESA MONITORING PROGRAM—1984

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ABSTRACT

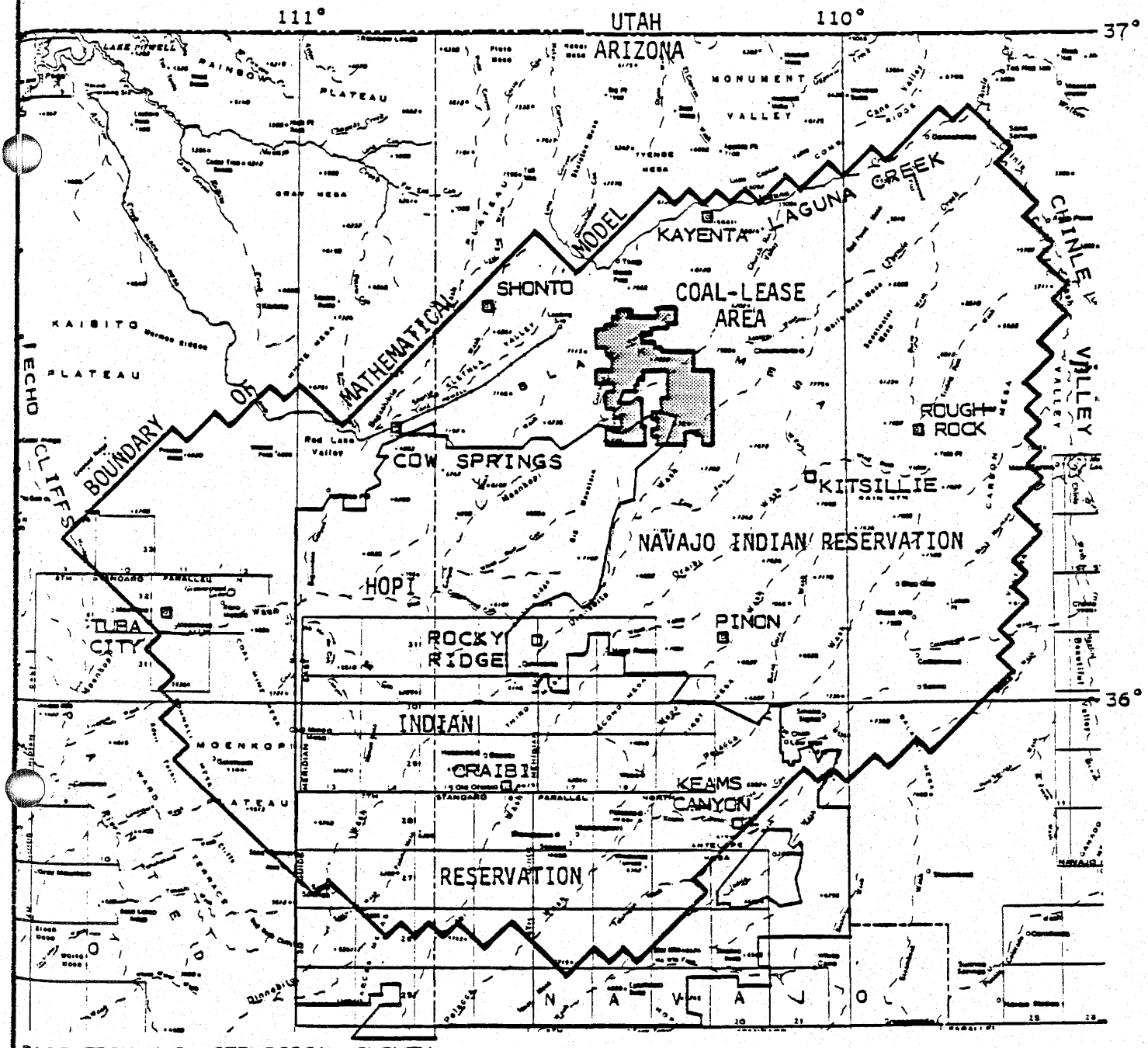
The N aquifer is an important source of water in the 5,400 square-mile Black Mesa area on the Navajo and Hopi Indian Reservations. The project is designed to monitor long-term effects on the ground-water resources of the mesa as a result of withdrawals from the aquifer by the strip-mining operation of Peabody Coal Co. Withdrawals from the N aquifer by the mine have increased from 95 acre-ft in 1968 to more than 4,000 acre-ft in 1984.

Water levels in the confined area of the aquifer have declined as much as 75 feet in some municipal and observation wells within about a 15-mile radius of the mine well field. Part of the drawdown in municipal wells is due to local pumpage. Water levels have not declined in wells tapping the unconfined area of the aquifer. Chemical analyses indicate no significant changes in the quality of water from wells that tap the N aquifer or from springs that discharge from several stratigraphic units, including the N aquifer, since pumping began at the mine.

INTRODUCTION

The N aquifer is an important source of water in the 5,400 mi^2 Black Mesa area on the Navajo and Hopi Indian Reservations in northeastern Arizona (fig. 1). On the northern part of the mesa, Peabody Coal Co. operates a strip mine in a lease area of about 100 mi^2. When operation of the mine began in 1968, the company pumped about 95 acre-ft of ground water from the N aquifer; in 1984 more than 4,000 acre-ft was pumped. Withdrawals from the N aquifer for municipal use increased from an estimated 70 acre-ft in 1965 to about 2,500 acre-ft in 1984. The Navajo and Hopi Tribes became concerned about the long-term effects of withdrawals from the N aquifer on supplies for domestic and municipal purposes. These and other concerns about the effects of strip mining led to the Black Mesa water-resources investigation by the U.S. Geological Survey in cooperation with the Arizona Department of Water Resources. In 1983, the U.S. Bureau of Indian Affairs joined the cooperative effort.

The cooperation and assistance of the Navajo and Hopi Tribes and Peabody Coal Co. are gratefully acknowledged. The assistance in the collection of pumpage data by the Western Navajo Agency, Chinle Agency, and Hopi Agency of the U.S. Bureau of Indian Affairs and by the Navajo Tribal Utility Authority is also gratefully acknowledged.



BASE FROM U.S. GEOLOGICAL SURVEY
STATE BASE MAP, 1:1,000,000

0 25 50 MILES

0 25 50 KILOMETERS

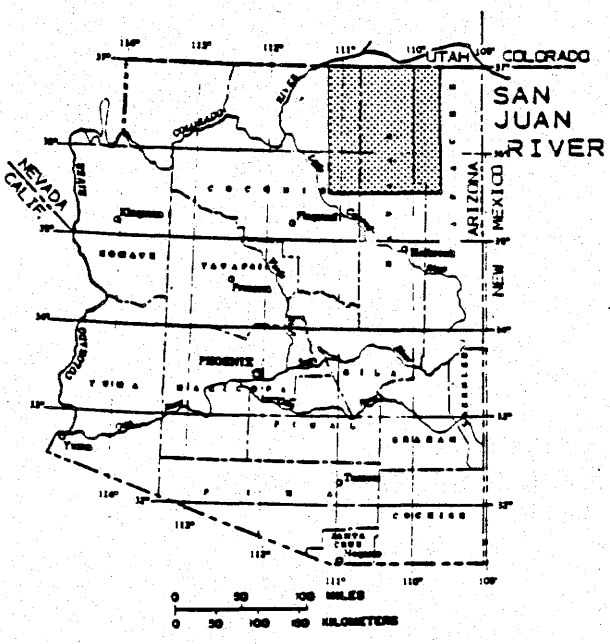


Figure 1.--Area of report.

Purpose and Scope of the Report

The report covers the progress of the Black Mesa Monitoring Program from October 1, 1983, to September 30, 1984, and discusses data collected throughout the monitoring program from its beginning in 1972. Except for some earlier data that are used for comparison, only new data will appear in this report.

Previous Reports on the Project

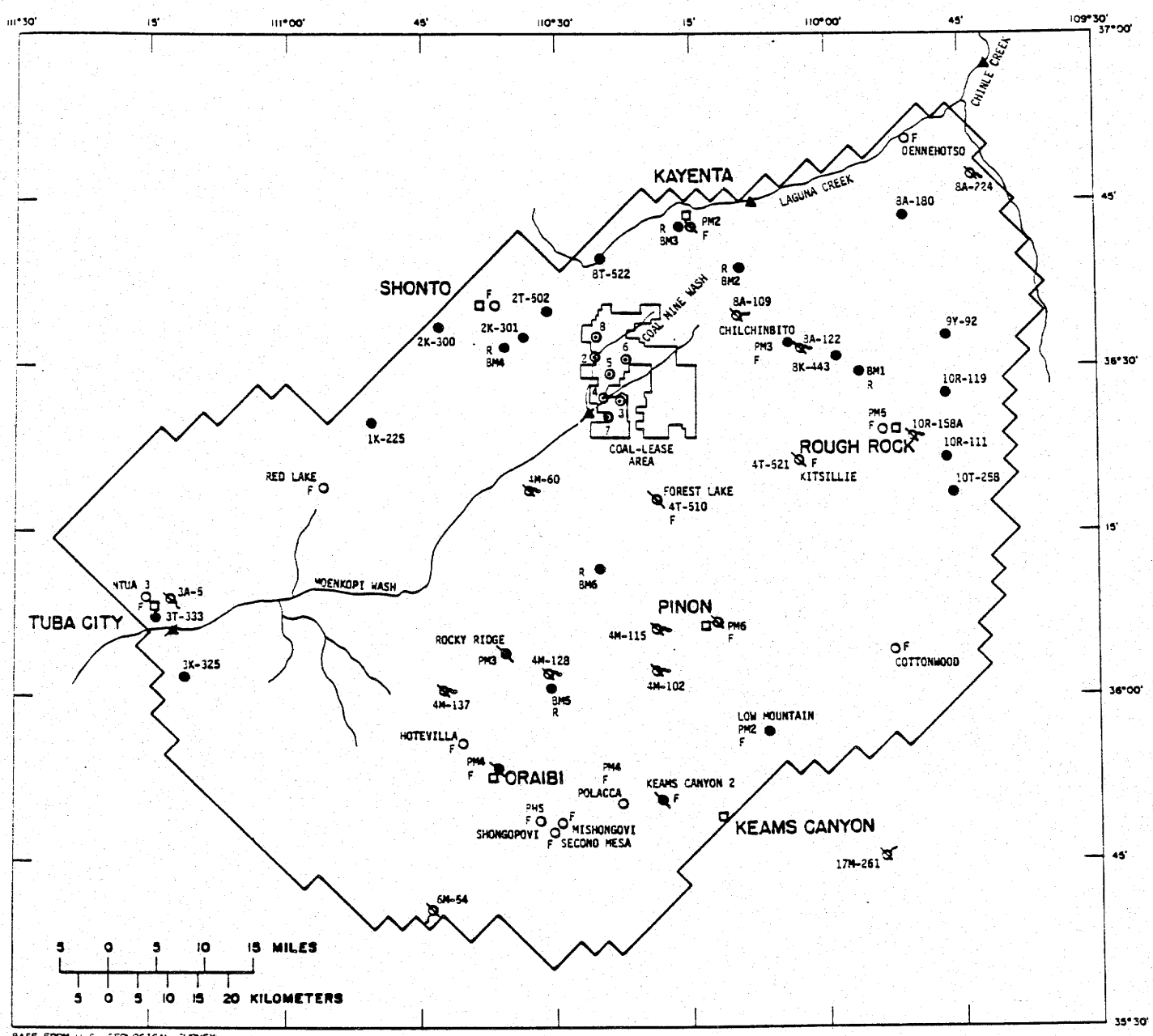
Three progress reports by the U.S. Geological Survey on the monitoring phase of the program have been done (U.S. Geological Survey, 1978; G. W. Hill, U.S. Geological Survey, written commun., 1982, 1983). Most of the basic data are contained in these reports except for stream-discharge and sediment-discharge data from Moenkopi Wash, which have been published in Water Resources Data for Arizona (U.S. Geological Survey, 1976-84). Eychaner (1983) showed the results of a mathematical model that was developed to simulate the flow of ground water in the N aquifer. The model is used to predict the effects of withdrawals through the year 2014, which is 13 years after the existing coal lease expires. The present monitoring program is essential for checking the model simulations and water quality of the N aquifer as water levels decline.

HYDROLOGIC-DATA COLLECTION, 1984

In accordance with the objectives of the program, monitoring activities have been continued by continuous or periodic measurements of (1) ground-water levels in the confined and unconfined areas of the N aquifer; (2) major withdrawals from the N aquifer by industrial and nonindustrial pumping from the confined and unconfined areas; (3) ground-water quality of the N aquifer in the coal-lease area and other areas of the mesa; (4) discharge and chemical quality of selected springs that discharge from the various formations, including the N aquifer; and (5) surface-water discharge, which reflects the conditions of the N aquifer. The data-collection network is shown in figure 2.

Ground-Water Levels

Ground-water levels continue to decline in wells that penetrate the confined area of the N aquifer. Observation wells in the unconfined area of the N aquifer indicate no decline in water levels. The net change of water levels in selected wells in the N aquifer within the Black Mesa area since prestress times, which is prior to 1965, is shown in figure 3.



BASE FROM U.S. GEOLOGICAL SURVEY
FLAGSTAFF 1:250,000, 1954-70,
GALLUP 1:250,000, 1950-70,
MARBLE CANYON 1:250,000, 1956-70,
AND SHIPROCK 1:250,000, 1954-69

Figure 2.--Data-collection sites, 1984.

EXPLANATION

R F
BM2

WELL THAT TAPS THE N AQUIFER IN WHICH WATER LEVEL WAS MEASURED—BM2, is well identifier. R, indicates well equipped with a recorder; \ , indicates water-quality sample was collected; F, indicates one or more wells in the area equipped with a flowmeter

F
PM6

WELL THAT TAPS THE N AQUIFER—PM6, is well identifier. \ , indicates water-quality sample was collected; F, indicates one or more wells in the area equipped with a flowmeter

8

PEABODY COAL CO. PRODUCTION WELL— Water-quality sample was collected. 8, is well number

SPRING AT WHICH DISCHARGE WAS MEASURED AND WATER-QUALITY SAMPLE WAS COLLECTED

GAGING STATION OPERATED BY THE U.S. GEOLOGICAL SURVEY— / , indicates water-quality and sediment samples were collected

BOUNDARY OF MATHEMATICAL MODEL—From Eychaner (1983)

Figure 2

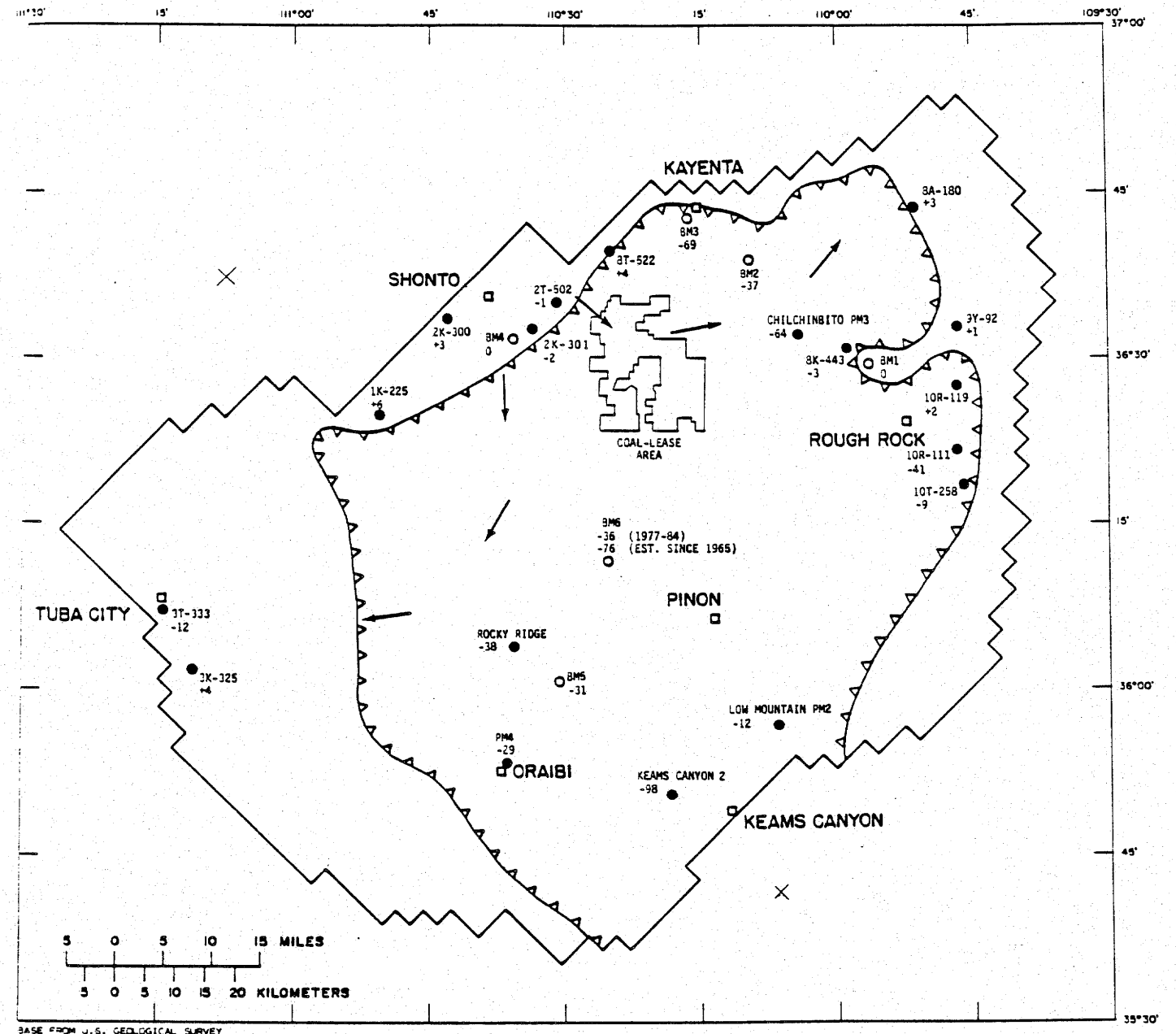


Figure 3.--Water-level changes in wells that tap the N aquifer, 1953-84.

EXPLANATION

● 3T-333 -5	WELL IN WHICH DEPTH TO WATER WAS MEASURED INTERMITTENTLY—First entry, 3T-333, is Bureau of Indian Affairs site identification; second entry, -5, is difference, in feet, between water-level measurements during assumed local equilibrium 1953-72 and 1983
○ BM2 -34	CONTINUOUS-RECORD OBSERVATION WELL—First entry, BM2, is well identifier. Second entry, -34, is difference, in feet, between water-level measurements during assumed local equilibrium 1965-72 and 1983
CONFINED △△△△△△△△△ UNCONFINED	APPROXIMATE BOUNDARY BETWEEN CONFINED AND UNCONFINED CONDITIONS—From Eychaner (1983)
→	GENERALIZED DIRECTION OF GROUND-WATER MOVEMENT
———	BOUNDARY OF MATHEMATICAL MODEL—From Eychaner (1983)

Figure 3

The three largest measured water-level declines in municipal wells outside the coal-lease area are at Kayenta, Keams Canyon, and Chilchinbito (fig. 3). Wells in or near these communities are pumped for public supply, and the water levels may be affected by local pumping as well as by industrial withdrawals.

In the construction of the mathematical model of the N-aquifer system, water-level changes were simulated for several continuous-record observation and nonindustrial wells that penetrate the N aquifer (Eychaner, 1983). A comparison between measured and simulated water levels in the six continuous-record observation wells—BM1 through BM6—for 1959-84 is shown in figure 4.

Withdrawals from the N Aquifer

The three categories of withdrawals from the N aquifer are industrial (Peabody Coal Co.) from the confined area, nonindustrial from the confined area, and nonindustrial from the unconfined area. The primary interest is in withdrawals related to the mining operation and nonindustrial pumpage of significant amounts. Pumpage data have not been collected from wells equipped with windmills.

A concerted effort has been continued by the U.S. Geological Survey to inventory withdrawals from nonindustrial supply wells that penetrate the N aquifer and to determine where additional flowmeters are needed. Thirty distribution systems, which included about 55 nonindustrial wells, serve the Hopi and Navajo Tribes in the project area. Most of the wells have meters, but function and accuracy of meters have not been checked. Communities that have metered wells are identified by a representative well in figure 2. Annual pumpage for the three categories of withdrawals from the N aquifer for 1965-84 is given in table 1. Withdrawals for the 1984 calendar year from nonindustrial and industrial well systems that pump from the N aquifer are given in table 2.

Chemical Quality of Water from Wells That Tap the N Aquifer

One major concern on the part of some residents of the Black Mesa area has been the effect of withdrawals on the chemical quality of water from the N aquifer. Eychaner (1983) stated that some water may enter the N aquifer from the upper confining beds. He also stated that the driving force for such flow is present because the head in the overlying D aquifer in 1964 averaged about 300 ft higher than that in the N aquifer. Differences in the chemical composition of the waters of the two aquifers, D and N, indicate that the amount of downward leakage must be small (Eychaner, 1983). On the average, the concentration of dissolved solids in water from the D aquifer is about 7 times greater than that from the N aquifer, the concentration of chloride ions is 11 times greater, and the concentration of sulfate ions is 30 times greater (Eychaner, 1983).

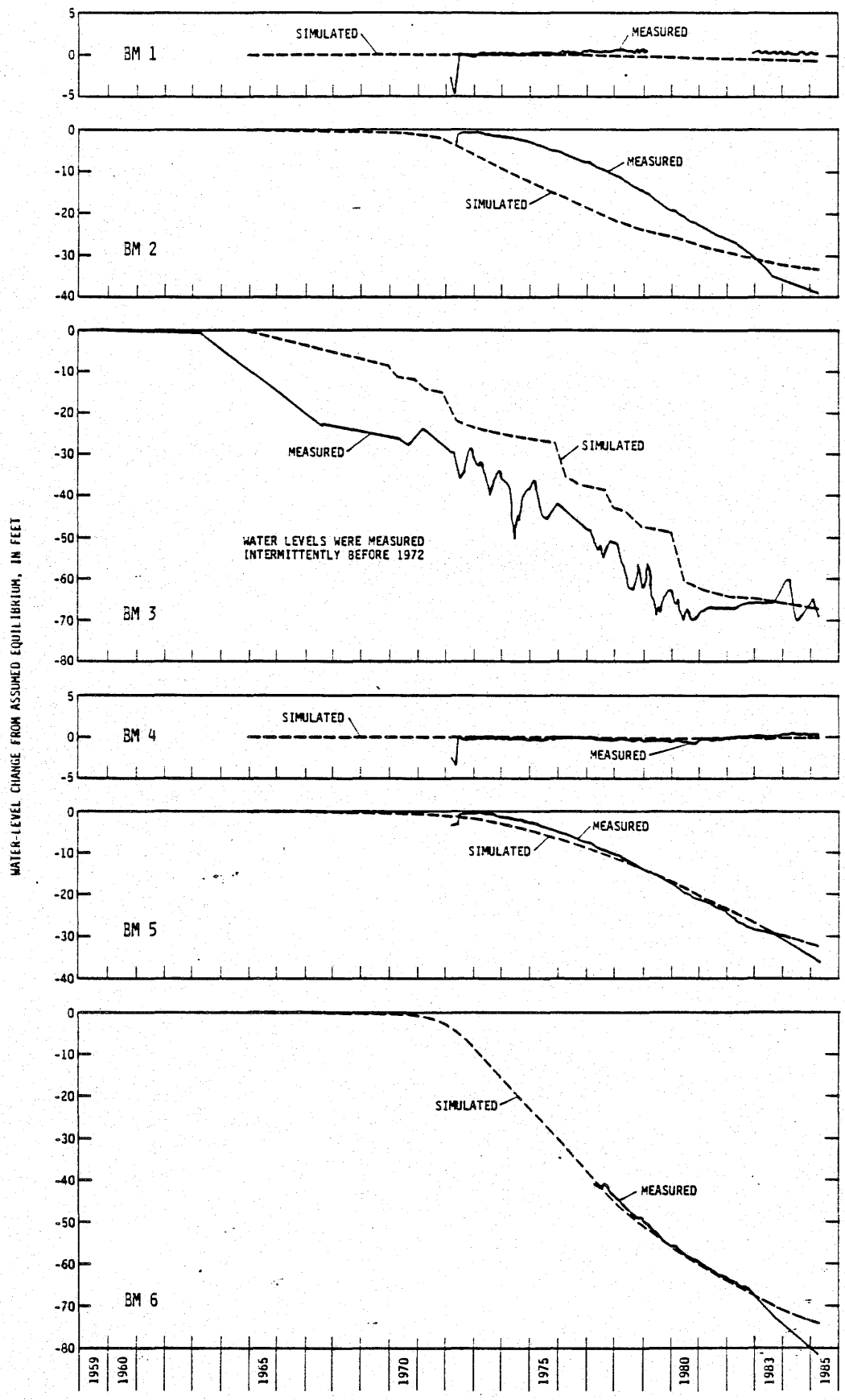


Figure 4.--Measured and simulated water-level changes for observation wells, 1959-84

Table 1.--Withdrawals from the N aquifer, 1965-84
[Measurements are in acre-feet. Data for 1965-79 from Eychaner, 1983]

Year	Industrial[1]	Nonindustrial[2] year	
		Confined[3]	Unconfined[4]
1965	0	50	20
1966	0	110	30
1967	0	120	50
1968	95	150	100
1969	43	200	100
1970	740	280	150
1971	1,900	340	150
1972	3,680	370	250
1973	3,520	530	300
1974	3,830	580	362
1975	3,550	600	508
1976	4,180	690	645
1977	4,090	750	726
1978	3,000	830	930
1979	3,500	860	930
1980	3,540	910	880
1981	4,010	960	1,000
1982	4,740	870	965
1983	4,460	1,360	1,280
1984	4,170	1,070	1,400

[1]Metered pumpage by Peabody Coal Co. at their mine on Black Mesa.

[2]Does not include withdrawals from wells equipped with windmills.

[3]Includes metered pumpage at Kayenta and estimated pumpage at Chilchinbito, Rough Rock, Pinon, Keams Canyon, and Oraibi prior to 1980; metered and estimated pumpage furnished by the Navajo Tribal Utility Authority and the U.S. Bureau of Indian Affairs and collected by the U.S. Geological Survey, 1980-84.

[4]Includes estimated pumpage, 1965-73, and metered pumpage, 1974-79, at Tuba City; metered and estimated data furnished by the Navajo Tribal Utility Authority and the U.S. Bureau of Indian Affairs, 1980-84.

Table 2.--Withdrawals from the N aquifer, Black Mesa area, in acre-feet, 1984

Locations	Confined	Unconfined
Bureau of Indian Affairs[1]		
Tuba City[2]		316
Chilchinbeto[2]	13.2	
Dinnehotso[2]		38.6
Kayenta[2]	75.8	
Red Lake[2]		27.7
Rocky Ridge[2]	19.7	
Shonto		140
Cottonwood		13.2
Low Mountain	11.6	
Pinon	123	
Rough Rock	40.5	
Hotevilla	25.6	
Second Mesa	8.9	
Navajo Tribal Utility Authority[1]		
Kayenta	451	
Chilchinbeto	27.9	
Dinnehotso		29.7
Shonto		16.1
Forest Lake	2.3	
Shonto Junction		3.2
Tuba City		780
Red Lake		20.4
Rough Rock	9.1	
Cottonwood		11.0
Pinon	68.1	
Kitsillie	3.3	
Peabody Coal Company[1]		
Mine well field	4,174	
U.S. Geological Survey[1]		
Keams Canyon	45.1	
Polacca[3]	85	
Oraibi	48.7	
Shungopovi[3]	12.0	
Shipaulovi-Mishongovi	2.1	

[1]Reporting agency.

[2]Pumpage computed on the basis of the U.S. Bureau of Indian Affairs' compound population figures allowing an average consumption of 110 gallons per day per person.

[3]Estimated.

Any increase in the leakage rate due to pumping from the N aquifer should appear first as an increase in the dissolved-solids concentrations in the water from Peabody wells (Eychaner, 1983). Concentrations of dissolved solids, sulfate ions, or chloride ions did not increase in Peabody Wells 2 through 7 from 1967 to 1980 or in Peabody Well 8 for 1980-84 (table 3). Chemical analyses of water from all Peabody wells will be done in 1986.

The same wells sampled in 1983 were sampled in 1984 for major ions and fluoride. The wells were Peabody Well 8, Keams Canyon 2, New Oraibi PM 3, Kayenta PM 2, Kitsillie, Pinon PM 6, and Rough Rock PM 5 (fig. 2, table 4). Wells sampled in 1982 were Peabody Well 8, Keams Canyon 2, Rocky Ridge PM 3, New Oraibi PM 4, Kayenta PM 2, Forest Lake, Kitsillie, and Pinon PM 6 (G. W. Hill, written commun., 1982). Selected parameters from chemical analyses of water from all nonindustrial wells sampled in 1982-84 are shown in table 5. Of the nonindustrial wells sampled since 1983, Kayenta PM 2 is nearest the Peabody Coal Co. well field and no significant changes have occurred in specific conductance, dissolved solids, dissolved chloride ions, and dissolved sulfate ions. The same is true of all other nonindustrial wells sampled since 1982.

The marked difference noted between the chemical composition of water from the Rough Rock PM 5 and Keams Canyon 2 wells and that of the other nonindustrial wells sampled in 1982-84 still exists (table 5). Comparison of chemical analyses of samples taken from Rough Rock PM 5 in 1964 and Keams Canyon 2 in 1972 and those taken in 1984 indicate no significant change in chemical composition. In 1964, water from Rough Rock PM 5 had a specific conductance of 1,120 micromhos compared to 1,090 micromhos in 1984, dissolved solids (sum of constituents) of 638 mg/L (milligrams per liter) compared to 613 mg/L in 1984, and dissolved chloride of 100 mg/L compared to 130 mg/L in 1984. Analysis of water from Keams Canyon 2 in 1972 showed specific conductance of 937 micromhos compared to 1,040 micromhos in 1984, dissolved solids of 597 mg/L compared to 578 mg/L in 1984, and dissolved chloride of 91 mg/L compared to 96 mg/L in 1984.

As discussed by G. W. Hill (written commun., 1983), one possibility for the differences in chemical composition between Rough Rock PM5 and Keams Canyon 2 and other nonindustrial wells is that Rough Rock PM 5 and Keams Canyon 2 are finished below the Navajo Sandstone and the other wells are finished in the Navajo Sandstone. Well construction and withdrawal stress also may affect the chemical composition.

Discharge and Chemical Quality of Springs

The effect of withdrawals from the N aquifer on the quality of spring water used for domestic purposes is a major concern of some residents of the reservations. Many springs on Black Mesa discharge from several stratigraphic units including the Navajo Sandstone where the

Table 3.--Selected parameters from chemical analysis of water from wells of the Peabody Coal Co., Black Mesa area, 1967-74 and 1980-84

Well number	Year	Specific conductance (umhos)	Dissolved solids Residue at 180°C (mg/L)	Chloride, dissolved (mg/L as Cl)	Sulfate, dissolved (mg/L as SO_4)
2	1967	221	144[1]	5.0	21
	1980	225	144	11	20
3	1968	236	154[1]	4.0	17
	1980	230	151	3.5	14
4	1974	200	140	3.8	13
	1980	230	139	4.3	13
5	1968	224	149[1]	3.5	16
	1980	210	134	2.9	9.5
6	1968	201	333[1]	3.0	13
	1980	260	160	3.5	15
7	1972	222	141[1]	2.5	20
	1980	210	136	3.7	11
8	1980	420	283	4.8	100
	1983	440	278	4.8	100
	1984	436	264	4.7	100

[1]Dissolved-solids data from 1974.

Table 4.--Chemical analyses of selected industrial and nonindustrial wells, Black Mesa area, 1984

Site name	Identification number	Date of sample	Temperature (°C)	Specific conductance (µmhos)	pH (units)	Alkalinity (mg/L as $CaCO_3$)	Nitrogen, NO_2+NO_3 dissolved (mg/L as N)
Peabody Well 8	363130110254501	08-16-84	29.5	445	8.8	104	1.5
Keams Canyon 2	355023110182701	08-13-84	19.0	1,060	9.3	336	<.10
Rough Rock PM 5	362418109514601	08-15-84	21.0	1,100	9.0	210	1.1
New Oraibi PM 3	355236110364501	08-14-84	21.0	385	9.9	174	1.2
Kayenta PM 2	364347110145901	08-16-84	16.0	370	8.0	122	.79
Kitsillie	362035110032201	08-15-84	26.5	460	9.9	204	1.2
Pinon PM 6	360614110130801	08-14-84	27.0	490	10.0	220	1.4

Site name	Identification number	Date of sample	Phosphorus, ortho, dissolved (mg/L as P)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)
Peabody Well 8	363130110254501	08-16-84	<0.01	24	3.2	63
Keams Canyon 2	355023110182701	08-13-84	<.01	.90	.20	240
Rough Rock PM 5	362418109514601	08-15-84	<.01	2.1	.29	230
New Oraibi PM 3	355236110364501	08-14-84	.03	.43	.02	86
Kayenta PM 2	364347110145901	08-16-84	<.01	39	8.0	28
Kitsillie	362035110032201	08-15-84	<.01	1.9	.60	100
Pinon PM 6	360614110130801	08-14-84	<.01	.50	.01	110

Table 4.--Chemical analyses of selected industrial and nonindustrial wells, Black Mesa area, 1984--Continued

Site name	Identification number	Date of sample	Potassium, dissolved (mg/L as K)	Chloride, dissolved (mg/L as Cl)	Sulfate, dissolved (mg/L as SO_4)	Fluoride, dissolved (mg/L as F)
Peabody Well 8	363130110254501	08-16-84	2.4	4.7	100	.01
Keams Canyon 2	355023110182701	08-13-84	.70	96	36	1.3
Rough Rock PM 5	362418109514601	08-15-84	1.3	130	99	1.7
New Oraibi PM 4	355236110364501	08-14-84	.40	4.0	9.9	.20
Kayenta PM 2	364347110145901	08-16-84	1.3	4.2	51	.20
Kitsillie	362035110032201	08-15-84	.90	5.2	20	.20
Pinon PM 6	360614110130801	08-14-84	.40	3.7	5.4	.20

Site name	Identification number	Date of sample	Silica, dissolved (mg/L as SiO_2)	Boron, dissolved (µg/L as B)	Iron, dissolved (µg/L as Fe)	Dissolved solids: Sum of constituents (mg/L)
Peabody Well 8	363130110254501	08-16-84	19	60	11	264
Keams Canyon 2	355023110182701	08-13-84	12	680	8	578
Rough Rock PM 5	362418109514601	08-15-84	12	430	20	613
New Oraibi PM 4	355236110364501	08-14-84	22	50	11	216
Kayenta PM 2	364347110145901	08-16-84	16	50	6	209
Kitsillie	362035110032201	08-15-84	21	70	14	258
Pinon PM 6	360614110130801	08-14-84	26	60	6	273

Table 5.--Selected parameters from chemical analysis of water from nonindustrial wells that tap the N aquifer, Black Mesa area, 1982-84

Site name	Year	Specific conductance (umhos)	Dissolved solids, Residue at 180°C (mg/L)	Chloride, dissolved (mg/L as Cl)	Sulfate, dissolved (mg/L as SO_4)
Keams Canyon 2	1982	1,010	592	94	35
	1983	1,120	636	120	42
	1984	1,040	578	96	36
Rough Rock PM 5	1983	1,090	628	130	110
	1984	1,090	613	130	99
Rocky Ridge PM 3	1982	255	---	1.4	6.0
New Oraibi PM 4	1982	385	228	4.0	10
New Oraibi PM 3	1983	400	235	4.1	9.8
	1984	395	216	4.0	9.9
Kayenta PM 2	1982	360	228	4.5	58
	1983	375	230	-----	60
	1984	365	209	4.2	51
Forest Lake	1982	470	281	11	67
Kitsillie	1982	580	365	5.4	84
	1983	505	291	4.4	37
	1984	460	258	5.2	20
Pinon PM 6	1982	485	---	3.7	5.0
	1983	505	293	3.6	5.3
	1984	495	273	3.7	5.4

units are exposed. Discharge from springs sampled in 1984 are as follows:

Spring	Discharge, in gallons per minute
Near Steamboat	seeping (discharge unobtainable)
Nasjo Toh	1.0 (estimate)
Shonto	.67
Near Dinnehotso	2.0

In 1982-84, water-quality samples were analyzed for 12 springs representing the Navajo Sandstone, Morrison Formation, Dakota Sandstone, Toreva and Wepo Formations, and alluvium[1] (fig. 2). Nine of the springs were sampled from 1948 to 1954 (Kister and Hatchett, 1963). Chemical analyses of four selected springs in the Black Mesa area for 1949, 1952, and 1984 are shown in table 6. Chemical analyses of eight selected springs sampled in 1982 have been presented (G. W. Hill, written commun., 1982, 1983). Selected parameters from chemical analyses from all springs sampled in 1948-54 and 1982-84 are shown in table 7. In general, these data indicate that no significant changes in specific conductance, chloride, and sulfate have occurred since 1948-54. In most cases, the analyses show decreases in these constituents. The changes indicated are not considered major and could be due, in part, to differences between analytical procedures in 1948-54 and 1984.

Surface-Water Data

The continuous-record streamflow stations on Moenkopi Wash at Moenkopi and Chinle Wash near Mexican Water and the partial-record streamflow station on Laguna Creek near Church Rock were continued (fig. 2). The base flow of Moenkopi Wash during winter months when evapotranspiration is at a minimum is maintained by discharge from the N aquifer. The average of base-flow discharge measurements made during November-February in the 1984 water year was 3.0 ft^3/s, which is equivalent to about 2,170 acre-ft/yr. The average of all base-flow discharge measurements during November-February from 1976 to 1984 was 3.2 ft^3/s, which is equivalent to about 2,320 acre-ft/yr. Mean daily discharges during the 1983 water year are shown in table 8. Data for previous water years have been published in Water Resources Data for Arizona (U.S. Geological Survey, 1976-84).

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[1]This report has not been reviewed for conformity with U.S. Geological Survey nomenclature.

Table 6.--Chemical analysis of selected springs, Black Mesa area, 1949, 1952, and 1984

Site name	Bureau of Indian Affairs field number	Identification number	Date of sample	Formation	Temperature (°C)	Specific conductance (µmhos)	pH (units)	Alkalinity (mg/L as $CaCO_3$)	Nitrogen, NO_2+NO_3 dissolved (mg/L as N)
Near Steamboat	17M-261	354523109504300	07-10-49	Dakota	18.0	222	---	---	----
Do.	Do.	Do.	06-26-84	Do.	18.0	280	7.6	112	.47
Nasjo Toh	8A-109	363504110093701	08-15-84	Dakota	----	480	8.4	134	.68
Shonto	6M-54	354032110443900	07-09-52	Navajo	22.0	1,080	---	---	----
Do.	Do.	Do.	06-26-84	Do.	20.5	990	7.3	133	3.8
Near Dinnehotso	8A-224	364656109425400	06-27-84	Navajo	18.0	195	8.1	51	1.6

Site name	Bureau of Indian Affairs field number	Identification number	Date of sample	Formation	Phosphorus, otho, dissolved (mg/L as P)	Hardness (mg/L as $CaCO_3$)	Hardness, noncarbonate (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)
Near Steamboat	17M-261	354523109504300	07-10-49	Dakota	----	112	14	34
Do.	Do.	Do.	06-26-84	Do.	.03	---	--	44
Nasjo Toh	8A-109	363504110093701	08-15-84	Dakota	<.01	---	--	49
Shonto	6M-54	354032110443900	07-09-52	Navajo	----	328	192	105
Do.	Do.	Do.	06-26-84	Do.	.02	---	---	94
Near Dinnehotso	8A-224	364656109425400	06-27-84	Navajo	.03	---	---	27

Table 6.--Chemical analysis of selected springs, Black Mesa area, 1949, 1952, and 1984--Continued

Site name	Bureau of Indian Affairs field number	Identification number	Date of sample	Formation	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Sodium absorption ratio	Percent sodium
Near Steamboat	17M-261	354523109504300	07-10-49	Dakota	6.7	----	3	.1
Do.	Do.	Do.	06-26-84	Do.	5.2	5.9	---	--
Nasjo Toh	8A-109	363504110093701	08-15-84	Dakota	24	13	---	--
Shonto	6M-54	354032110443900	07-09-52	Navajo	16	----	2.6	42
Do.	Do.	Do.	06-26-84	Do.	13	100	---	--
Near Dinnehotso	8A-224	364656109425400	06-27-84	Navajo	3.9	4.8	---	--

Site name	Bureau of Indian Affairs field number	Identification number	Date of sample	Formation	Sodium+ Potassium, dissolved (mg/L as Na+K)	Potassium, dissolved (mg/L as K)	Chloride, dissolved (mg/L as Cl)
Near Steamboat	17M-261	354523109504300	07-10-49	Dakota	1.8	---	3.0
Do.	Do.	Do.	06-26-84	Do.	---	1.3	4.0
Nasjo Toh	8A-109	363504110093701	08-15-84	Dakota	---	2.3	10
Shonto	6M-54	354032110443900	07-09-52	Navajo	109	---	82
Do.	Do.	Do.	06-26-84	Do.	---	1.8	64
Near Dinnehotso	8A-224	364656109425400	06-27-84	Navajo	---	1.1	2.8

Table 6.--Chemical analysis of selected springs, Black Mesa area, 1949, 1952, and 1984--Continued

Site name	Bureau of Indian Affairs field number	Identification number	Date of sample	Formation	Sulfate, dissolved (mg/L as SO_4)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)
Near Steamboat	17M-261	354523109504300	07-10-49	Dakota	11	.4	18
Do.	Do.	Do.	06-26-84	Do.	15	.3	15
Nasjo Toh	8A-109	363504110093701	08-15-84	Dakota	100	.6	11
Shonto	6M-54	354032110443900	07-09-52	Navajo	281	.5	17
Do.	Do.	Do.	06-26-84	Do.	260	.6	15
Near Dinnehotso	8A-224	364656109425400	06-27-84	Navajo	7.1	.3	13

Site name	Bureau of Indian Affairs field number	Identification number	Date of sample	Formation	Boron, dissolved (µg/L as B)	Iron, dissolved (µg/L as Fe)	Dissolved solids	
							Residue at 180°C (mg/L)	Sum of constituents (mg/L)
Near Steamboat	17M-261	354523109504300	07-10-49	Dakota	---	--	136	---
Do.	Do.	Do.	06-26-84	Do.	20	6	159	161
Nasjo Toh	8A-109	363504110093701	08-15-84	Dakota	60	4	276	280
Shonto	6M-54	354032110443900	07-09-52	Navajo	---	--	716	---
Do.	Do.	Do.	06-26-84	Do.	120	20	643	649
Near Dinnehotso	8A-224	364656109425400	06-27-84	Navajo	20	5	112	112

Table 7.--Selected parameters from chemical analyses of water sampled from springs in the Black Mesa area, 1948-54 and 1982-84

Spring name	Bureau of Indian Affairs number	Date sampled	Formation	Specific conductance (umhos)	Chloride, dissolved (mg/L as Cl)	Sulfate, dissolved (mg/L as SO_4)
Pasture Canyon	3A-5	02-27-48	Navajo SS	199	5.0	13
Do.	Do.	09-18-82	Do.	240	5.1	18
Pigeon	4M-115	10-26-54	Wepo	287	12	11
Do.	Do.	09-02-82	Do.	350	9.7	17
Hard Rocks	4M-128	08-01-52	Toreva	541	32	91
Do.	Do.	06-10-82	Do.	525	37	110
Crooked Finger	4M-102	09-01-82	Wepo	305	9.7	26
Chilchinbito	8A-122	06-12-54	Morrison	2,750	30	1,520
Do.	Do.	07-20-83	Do.	1,980	31	990
Red Willow	4M-60	10-28-54	Toreva	530	21	126
Do.	Do.	08-17-83	Do.	580	19	140
Cottonwood	4M-137	10-28-54	Alluvium	560	10	62
Do.	Do.	08-23-83	Do.	550	7.1	60
Near Rough Rock	10R-158A	07-28-49	Dakota	362	27	39
Do.	Do.	07-20-83	Do.	290	6.0	25
Near Steamboat	17M-261	07-10-49	Dakota	222	3.0	11
Do.	Do.	06-26-84	Do.	280	4.0	15
Nasjo Toh	8A-109	08-15-84	Dakota	470	10	100
Shonto	6M-54	07-09-52	Navajo	1,080	82	281
Do.	Do.	06-26-84	Do.	989	64	260
Near Dinnehotso	8A-224	06-27-84	Navajo	187	2.8	7.1

Table 8.--Discharge data, Moenkopi Wash at Moenkopi, 1983 water year

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1982 TO SEPTEMBER 1983
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	7.0	3.5	4.8	3.0	3.0	3.5	1.1	1.6	.10	.00	70	.00
2	6.0	3.1	4.4	3.0	3.0	3.5	.95	1.6	.10	.00	50	.00
3	6.0	2.3	1.6	3.0	3.0	3.5	.95	1.6	.00	.00	20	.00
4	5.0	2.3	2.3	3.0	3.0	3.5	.80	1.1	.00	.00	250	.00
5	5.0	3.5	1.6	3.0	3.0	6.4	.95	.95	.00	.00	50	.00
6	5.0	4.0	1.6	3.0	3.0	5.6	1.1	.95	.00	.00	80	.00
7	4.0	4.0	2.0	3.0	3.0	3.5	2.0	1.3	.00	.00	100	.00
8	4.0	4.4	2.0	3.0	3.0	3.1	2.0	1.6	.00	.00	160	.00
9	4.0	4.8	1.6	3.0	3.0	1.6	1.3	1.1	.00	.00	100	.00
10	3.0	5.2	3.1	3.0	3.0	1.1	.80	1.3	.00	.00	50	.00
11	3.0	5.2	2.3	3.0	3.0	1.1	.95	1.6	.00	.00	20	.00
12	3.0	4.8	2.0	3.0	3.0	1.1	.95	2.3	.00	.00	400	.00
13	2.0	4.4	2.0	3.0	3.0	1.1	.95	2.0	.00	.00	50	.00
14	2.0	4.0	1.6	3.0	3.0	1.3	2.0	1.3	.00	.00	20	.00
15	2.0	4.0	1.6	3.0	3.0	2.7	2.0	1.1	.00	.00	7.0	.00
16	2.0	4.0	1.6	3.0	3.0	2.3	1.6	1.1	.00	.00	2.0	.00
17	2.0	4.4	2.7	3.0	3.0	1.3	1.3	2.0	.00	.00	.00	.00
18	2.0	4.8	2.7	3.0	3.0	2.3	1.1	1.3	.00	.00	.00	.00
19	2.3	4.4	2.0	3.0	3.0	2.7	1.3	1.1	.00	.00	20	.00
20	2.3	4.4	2.0	3.0	3.0	2.3	1.3	1.3	.00	.00	5.0	.00
21	2.3	4.0	2.0	3.0	3.0	2.3	1.6	1.3	.00	.00	.00	.00
22	2.3	4.0	2.0	3.0	3.0	3.1	2.7	.80	.00	.00	.00	.00
23	2.3	3.1	2.0	3.0	3.5	3.5	2.3	.80	.00	.00	.00	50
24	2.7	2.3	2.0	3.0	3.5	2.7	1.6	.70	.00	46	.00	20
25	2.7	2.0	2.0	3.0	3.5	2.0	1.1	.60	.00	500	.00	5.0
26	2.3	1.6	2.0	3.0	3.5	2.3	1.3	.52	.00	50	.00	2.0
27	2.3	1.6	2.0	3.0	3.5	2.7	1.3	.52	.00	20	.00	20
28	2.3	1.6	2.0	3.0	3.5	1.3	1.3	.10	.00	10	.00	10
29	2.3	2.0	2.0	3.0	---	1.3	1.1	.10	.00	10	.00	400
30	2.3	4.4	2.0	3.0	---	2.0	1.3	.20	.00	10	.00	3500
31	3.1	---	2.0	3.0	---	4.4	---	.20	---	20	.00	---
TOTAL	98.5	108.1	67.5	93.0	87.0	81.1	41.00	34.04	.20	666.00	1454.00	4007.00
MEAN	3.18	3.60	2.18	3.00	3.11	2.62	1.37	1.10	.01	21.5	46.9	134
MAX	7.0	5.2	4.8	3.0	3.5	6.4	2.7	2.3	.10	500	400	3500
MIN	2.0	1.6	1.6	3.0	3.0	1.1	.80	.10	.00	.00	.00	.00
AC-FT	195	214	134	184	173	161	81	68	.4	1320	2880	7950

CAL YR 1982	TOTAL	3036.20	MEAN	8.32	MAX	600	MIN	.00	AC-FT	6020
WTR YR 1983	TOTAL	6737.44	MEAN	18.5	MAX	3500	MIN	.00	AC-FT	13360

Chinle Creek, which is along the northeast perimeter of the study area, receives water from the N aquifer principally from Laguna Creek. Laguna Creek flows along the north boundary of the study area and empties into Chinle Wash about 5 mi above the gaging station near Mexican Water (fig. 2). Low-flow measurements made from November through February in the 1984 water year were 13.0, 7.2, and 7.1 ft^3/s. These measurements are somewhat higher than the average discharge of all low-flow measurements made during the winter months from 1976 to 1983, which was 5.5 ft^3/s (about 3,950 acre-ft/yr). The daily mean discharges for the 1983 water year are shown in table 9. All previous data have been published in Water Resources Data for Arizona (U.S. Geological Survey, 1976-84).

The average discharge of all low-flow measurements made on Laguna Creek from November through February since the station was established in 1981 was 3.3 ft^3/s, which is equivalent to 2,410 acre-ft/yr. Continuous streamflow data are not available for this station.

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Table 9.--Discharge data, Chinle Creek near Mexican Water, 1983 water year

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1982 TO SEPTEMBER 1983
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	100	3.0	8.0	8.0	76	217	367	360	112	.35	20	.00
2	80	3.0	30	4.8	56	236	356	307	46	.30	8.0	.00
3	40	3.0	12	5.3	32	211	257	263	33	.20	4.0	.00
4	20	3.0	8.0	5.7	28	198	254	251	26	.10	2.0	.00
5	10	3.0	4.0	5.7	46	284	185	338	23	.10	1.0	.00
6	8.0	3.0	4.0	4.4	127	254	133	413	21	.10	.40	.00
7	8.0	4.0	4.0	4.4	190	188	121	453	18	.38	.20	.00
8	8.0	4.0	4.0	5.3	198	168	96	397	18	.71	.10	.00
9	8.0	4.0	6.0	2.5	193	190	82	413	15	87	.00	.00
10	6.0	6.0	12	4.1	148	254	76	496	12	150	.00	.00
11	6.0	4.0	30	6.2	77	288	93	492	8.4	200	.00	.00
12	6.0	4.0	25	8.0	52	297	137	462	6.2	180	.00	.00
13	6.0	4.0	20	20	41	317	137	331	4.4	80	.00	.00
14	6.0	4.0	18	17	41	307	137	248	1.4	40	.00	.00
15	6.0	4.0	16	17	55	314	133	231	1.4	30	.00	.00
16	6.0	4.0	14	18	62	324	119	201	1.0	20	.00	.00
17	6.0	4.0	14	4.0	71	245	127	222	.36	10	.00	.00
18	6.0	4.0	12	43	74	173	198	240	.20	9.0	.00	.00
19	6.0	8.0	12	160	69	159	212	200	.10	9.0	.00	.00
20	6.0	16	10	160	60	166	225	220	.10	4.0	.00	.00
21	6.0	12	10	140	65	157	214	280	.00	2.0	.00	1.0
22	5.0	10	11	140	69	173	203	240	.00	1.0	.00	.40
23	4.0	18	26	120	69	173	242	200	.00	60	.00	.20
24	4.0	26	166	120	72	157	195	180	.38	10	.00	.10
25	4.0	20	95	150	138	159	164	180	1.2	3.0	.00	.00
26	3.0	12	25	150	193	157	228	171	.60	1.0	.00	.00
27	3.0	8.0	8.0	124	211	155	304	171	.30	50	.00	.00
28	3.0	6.0	5.7	166	180	139	304	173	.30	1500	.00	.00
29	3.0	4.0	8.8	288	---	142	352	164	1.0	200	.00	.00
30	3.0	4.0	12	171	---	166	352	166	1.5	60	.00	70
31	3.0	---	8.0	125	---	291	---	148	---	30	.00	---
TOTAL	389.0	212.0	638.5	2197.4	2693	6659	6003	8611	352.84	2738.24	35.70	71.70
MEAN	12.5	7.07	20.6	70.9	96.2	215	200	278	11.8	88.3	1.15	2.39
MAX	100	26	166	288	211	324	367	496	112	1500	20	70
MIN	3.0	3.0	4.0	2.5	28	139	76	148	.00	.10	.00	.00
AC-FT	772	421	1270	4360	5340	13210	11910	17080	700	5430	71	142

CAL YR 1982	TOTAL	34139.60	MEAN	93.5	MAX	6000	MIN	.00	AC-FT	67720
WTR YR 1983	TOTAL	30601.38	MEAN	83.8	MAX	1500	MIN	.00	AC-FT	60700