GROUND WATER IN SPEARFISH VALLEY

Prepared for:

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and

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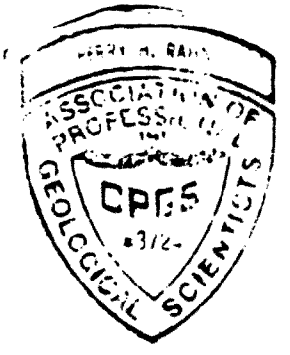


INTRODUCTION

There has been concern that septic tanks are polluting ground water in the developing areas adjoining Spearfish, S. D. Of particular interest is the possibility that septic tanks do not have a required 4 ft of unsaturated zone below the septic tank, as required by S. D. law. The U. S. Environmental Protection Agency (EPA), the S. D. Department of Environmental Protection, the Lawrence County Commissioners, and officials from the cities of Spearfish and Belle Fourche have been studying the problem.

On April 27, 1979, the U. S. EPA agreed to extend their study of the ground-water conditions in Spearfish Valley, just north and west of Spearfish. A contract was arranged for this study through the City of Spearfish and Scott Engineering.

GEOLOGY

The area of interest for this study is the lowland north and west of the City of Spearfish in Sections 28, 29, 32, 33, T. 7 N., R. 2 E., and Sections 4, 5 8, and 9, T. 6 N., R. 2 E.

The geology of the area is shown in Figure 1. The area of shallow water table is in the lowland, which consists of alluvium underlying the flood plain (Qal) and, in some places, the young terrace deposits (Qty). The alluvium typically consists of sandy gravel (Figure 2), which grades into coarse boulder (alluvial fan) deposits at the mouth of Higgins Gulch and other canyons to the south. The alluvium is about 10 to 30 ft thick.

OBSERVATION WELLS

On April 18 and 19, 1979, ten observation wells (EPA-1 to EPA-10) were drilled by Francis-Meador-Gellhaus, Incorporated (Figure 3). The wells are located so as to optimize information concerning the water table. All wells were logged and flushed to ensure hydraulic connection with ground water. The location of the ten wells is shown in Figure 4.

Forty-three additional wells were also monitored for this study. Some of these wells are unused water wells and some are observation wells drilled by the City of Belle Fourche for earlier studies. Several of these wells were always dry during this study and no information other than their location (Figure 4) is noted.

Water levels in the 53 monitoring wells were measured approximately every week during the period April 18 to July 14. A water level indicator was used to measure the static level (Figure 5). Table 1 shows the raw data. The depth to the water table was plotted as a function of time (Figure 6). Graphs are not included for those wells which were nearly always dry (e.g. EPA-1, 64, 81-84, etc.). For each well shown in Figure 6, the highest water-table position was determined.

WATER-TABLE CONDITIONS

Figure 7 shows a contour map of the seasonal high water table. This map is based on data from 46 observation wells, springs, seeps, and perennial streams, in conjunction with topographic maps and aerial photographs.

The water-table contours indicate that ground water in the alluvial aquifer moves north-northeasterly from the Higgins Gulch area and thence

northerly in Spearfish Valley.

Water coming down Higgins Gulch from the Black Hills disappears in the SE 1/4 of SE 1/4 of Sec. 6. Down-valley, springs occur in Higgins Gulch, in the SE 1/4 of SW 1/4 of Sec. 28. It is believed there is a good exchange between surface water and ground water in alluvium throughout the valley.

Figure 8 is an isopach map of the unsaturated zone. This map shows that the water table is near the surface (less than 10 ft) in the lower reaches of the flood plain near the Belle Fourche infiltration gallery, but is generally more than 20 ft deep in the southwestern half of the study area.

DISCUSSION

The direction of flow of ground water (Figure 7) in the surficial alluvial aquifer indicates that contamination of the Belle Fourche gallery could occur from sources in the Higgins Gulch area. It would appear, however, that houses in this area (i.e. south of I-90) are not in violation of septic tank codes because the water table is over 15 ft deep. The water table is quite shallow, however, in the Hope Weiss property and adjoining areas near the Belle Fourche gallery (Figure 9).

Another source of contamination is at the mouth of Higgins Gulch (Figure 10), in NE 1/4 of NE 1/4 of Section 7. At this point water flows out of the Black Hills and sinks into coarse (alluvial fan) boulder gravel. Manure from a barn and corral can be seen in the water where it sinks into the alluvium.

It should be pointed out that in 1979 the spring and early summer were unusually dry (Table 2). Therefore under normal conditions the

seasonal high water table may be higher than the 1979 data indicate. It is believed that under normal precipitation the water table may be about 5 to 10 ft higher in the Higgins Gulch area than indicated in Figure 7.

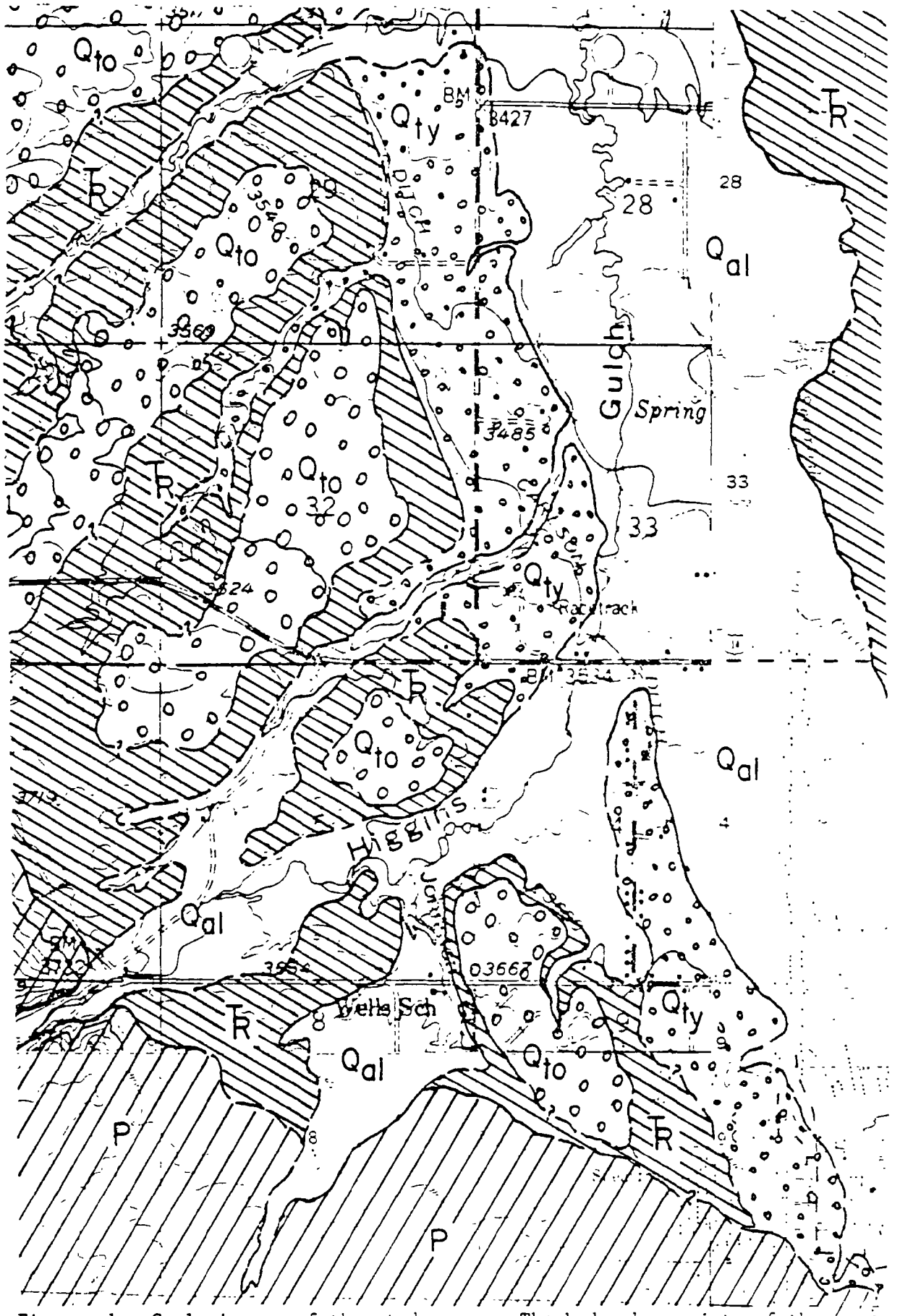


Figure 1. Geologic map of the study area. The bedrock consists of the Permian Minnekahta Limestone and older sedimentary rocks (P) and the Triassic Spearfish Formation (TR). The surficial deposits consist of Quaternary alluvium (Qal), a young Quaternary terrace deposit (Qty), and an old Quaternary terrace deposit (Qto). Mapped by P. H. Rahn, July, 1979.

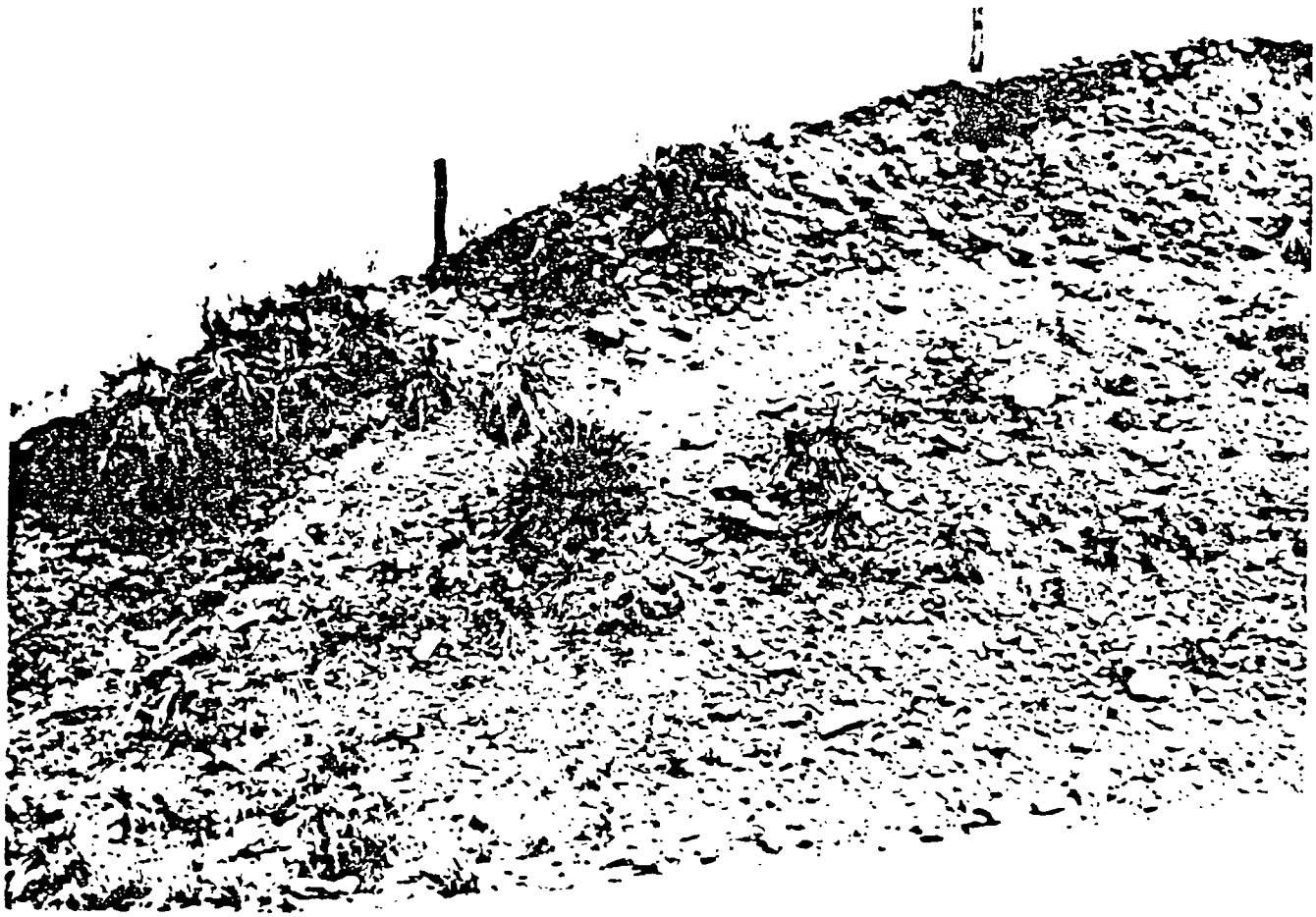


Figure 2. Alluvium exposed in a road cut in a terrace deposit in SE 1/4 of SE 1/4 of Section 5.

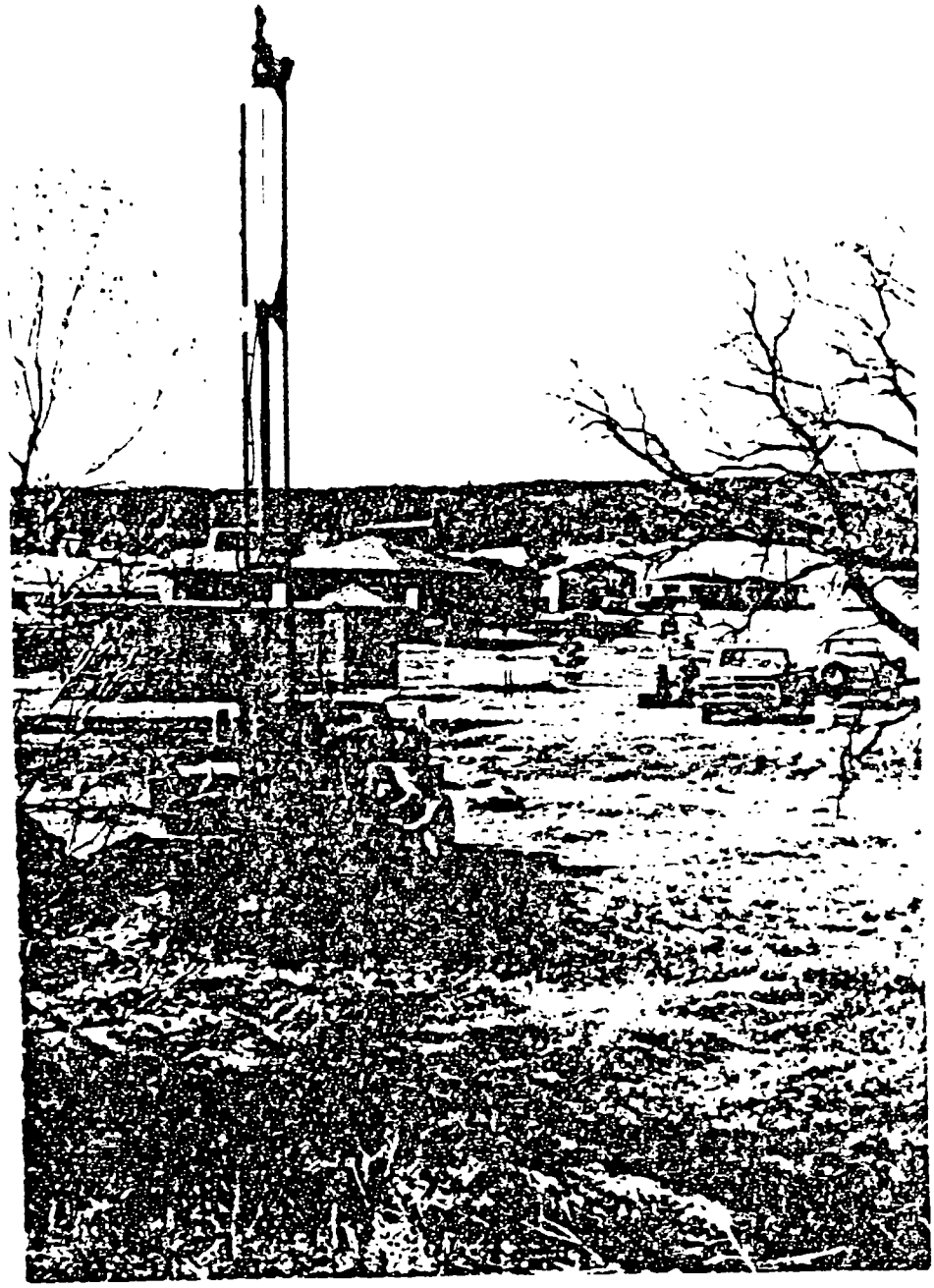


Figure 3. Drilling observation well EPA-1.

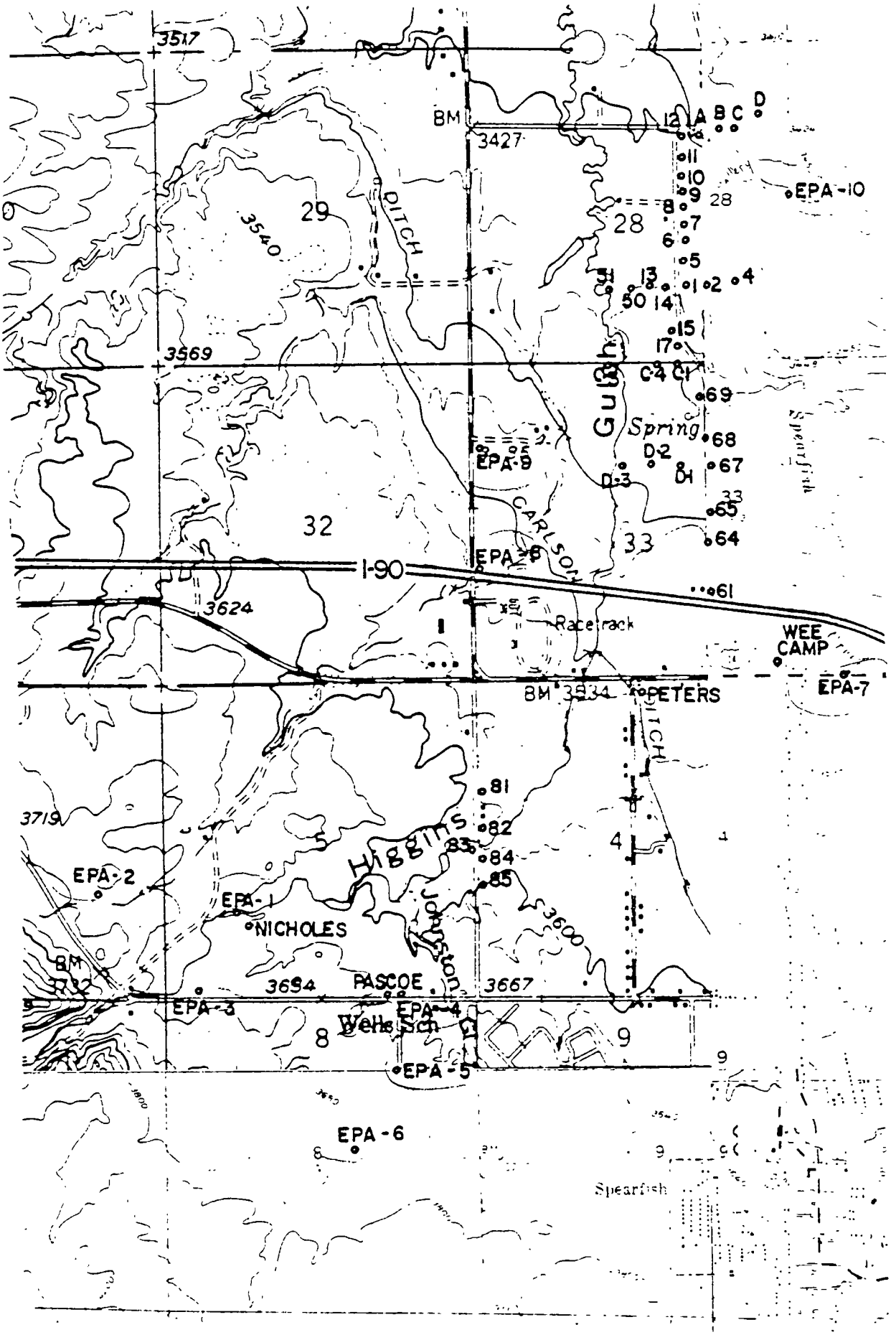


Figure 4. Map of Spearfish Valley showing location of observation wells.

Figure 5. Measuring the static level in observation well EPA-5. The 2" PVC casing and the Soiltest water level indicator probe can be seen.

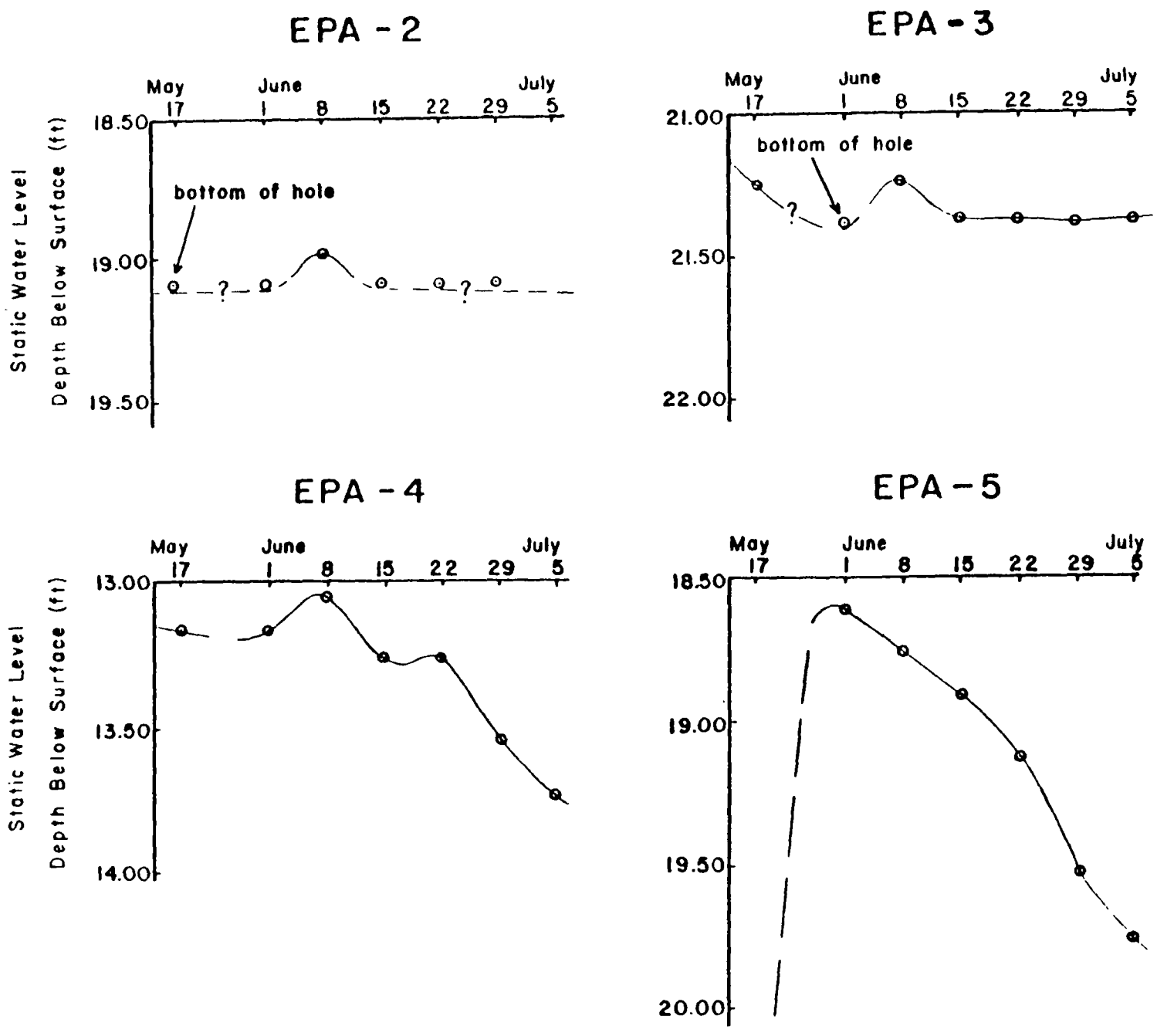
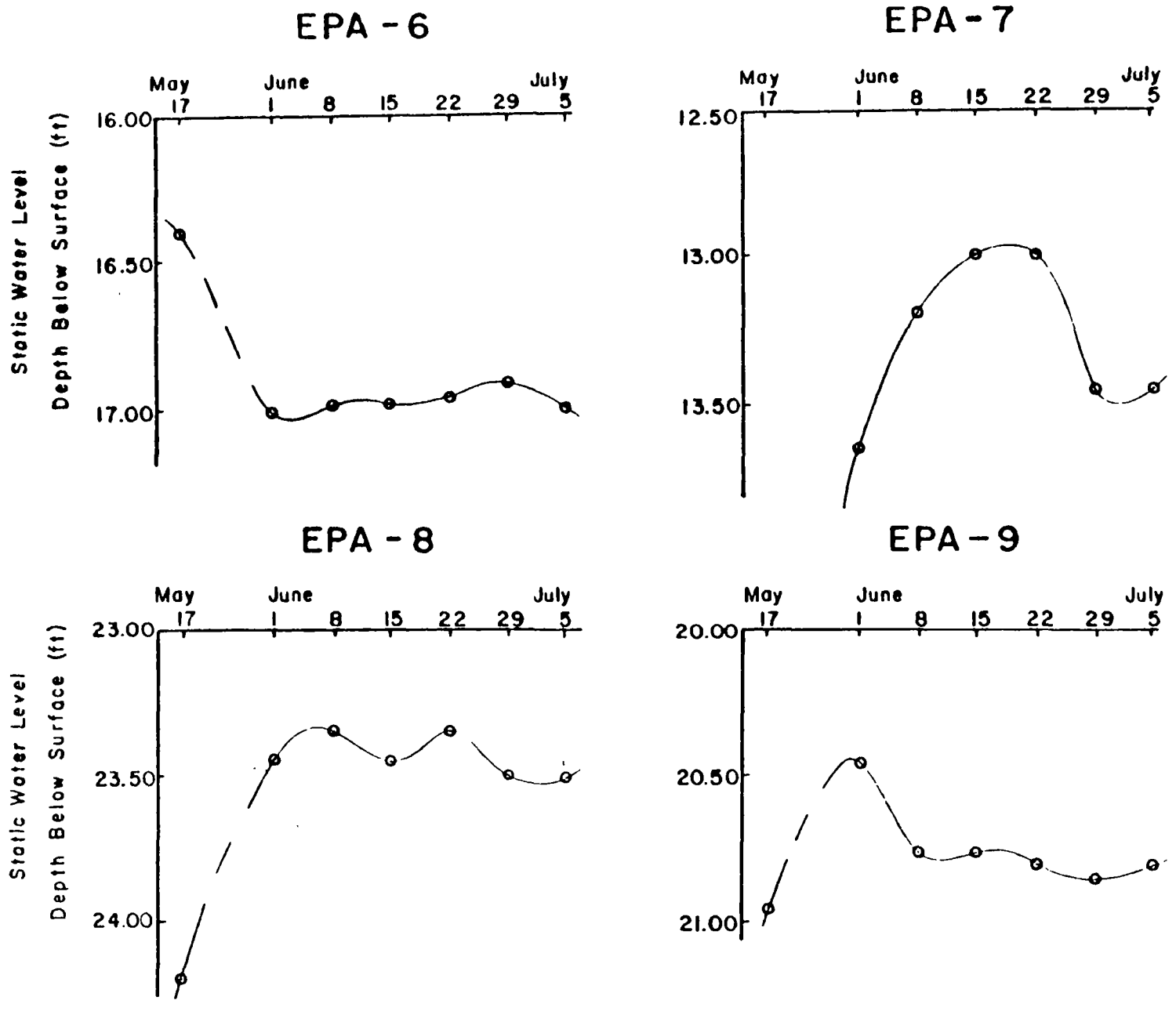
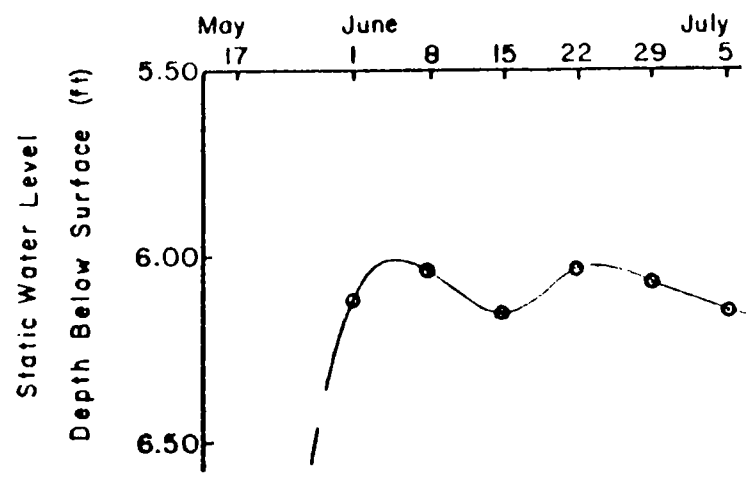


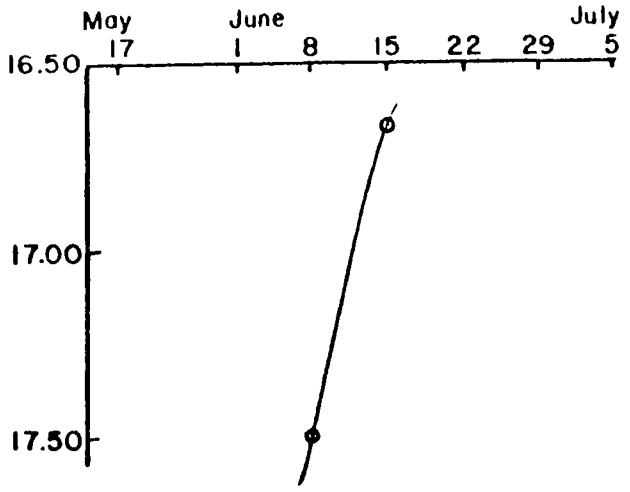
Figure 6. Plots of water-table depth (ft below ground surface) vs. time for 44 observation wells.


EPA - 6
Static Water Level
Depth Below Surface (ft)
May
June
July
17
1
8
15
22
29
5
16.00
16.50
17.00
EPA - 7
12.50
13.00
13.50
EPA - 8
23.00
23.50
24.00
EPA - 9
20.00
20.50
21.00

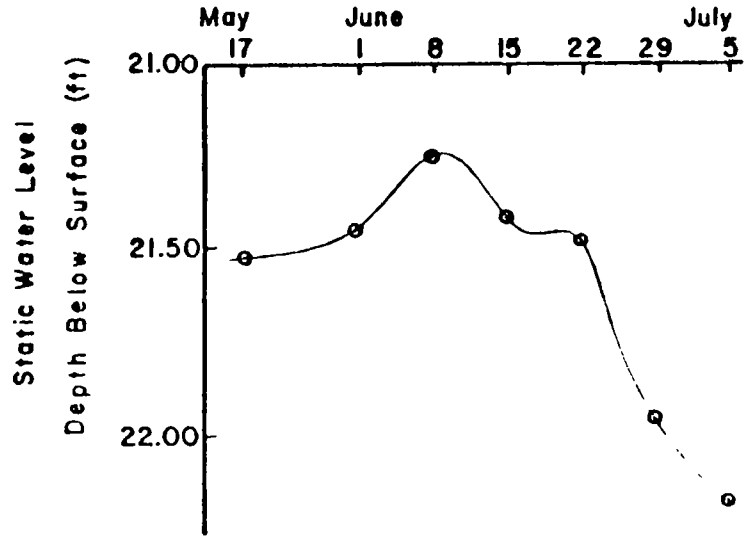
EPA -10



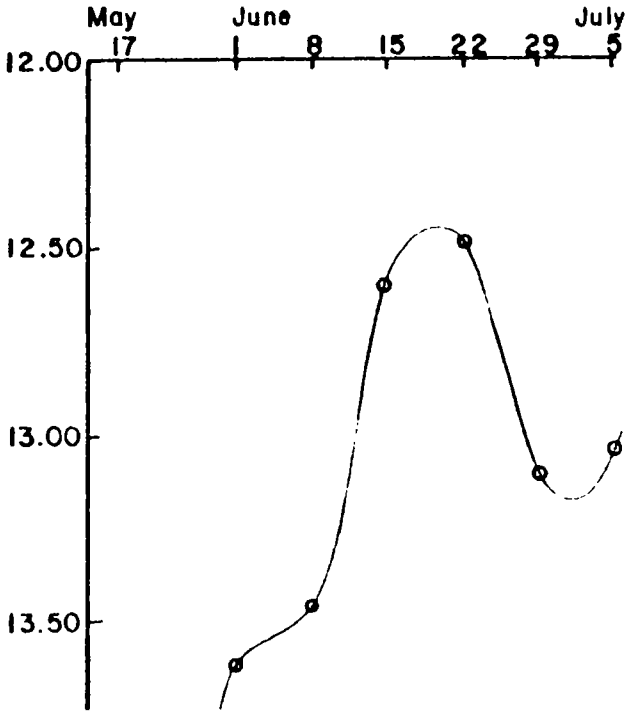
Peters I

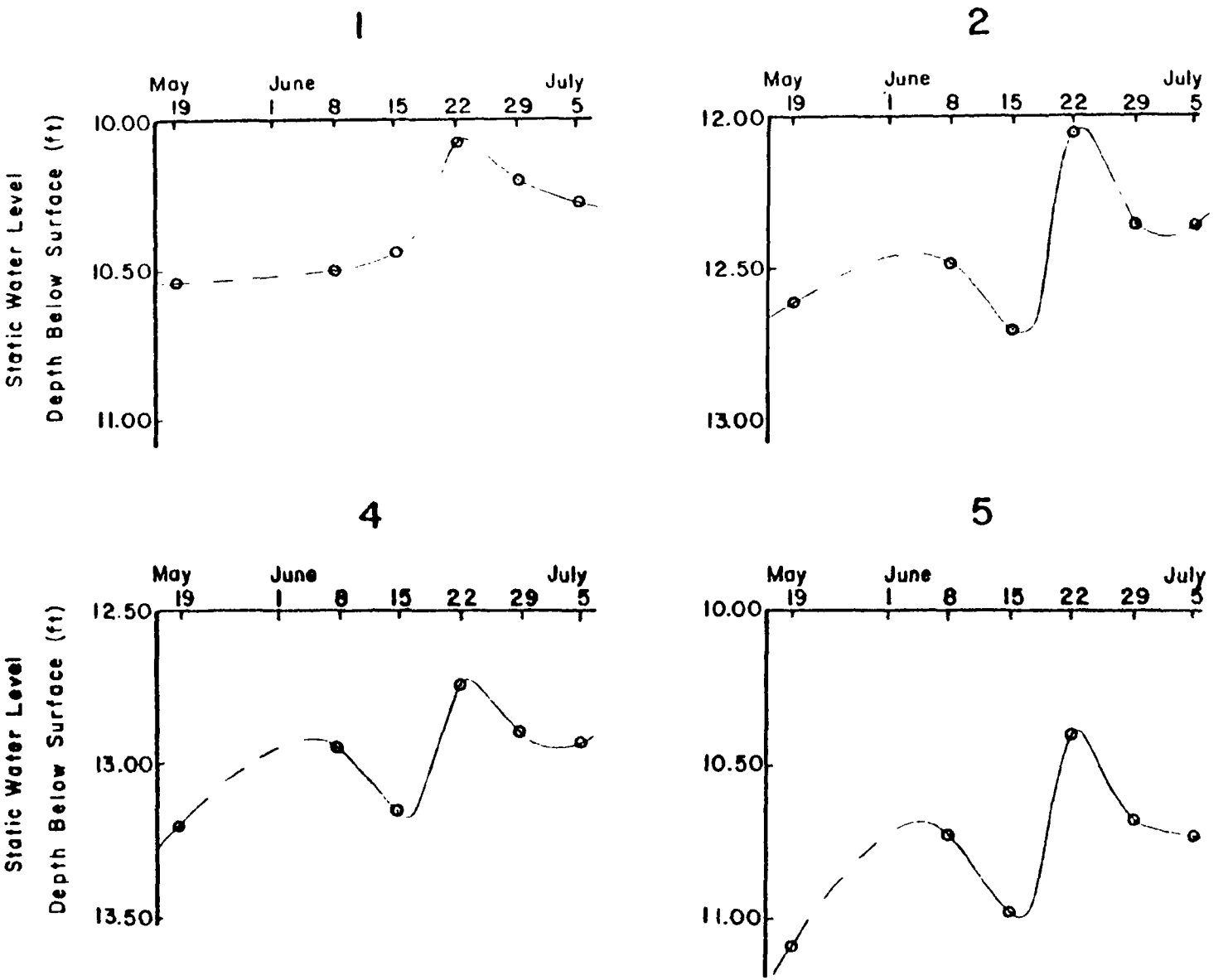


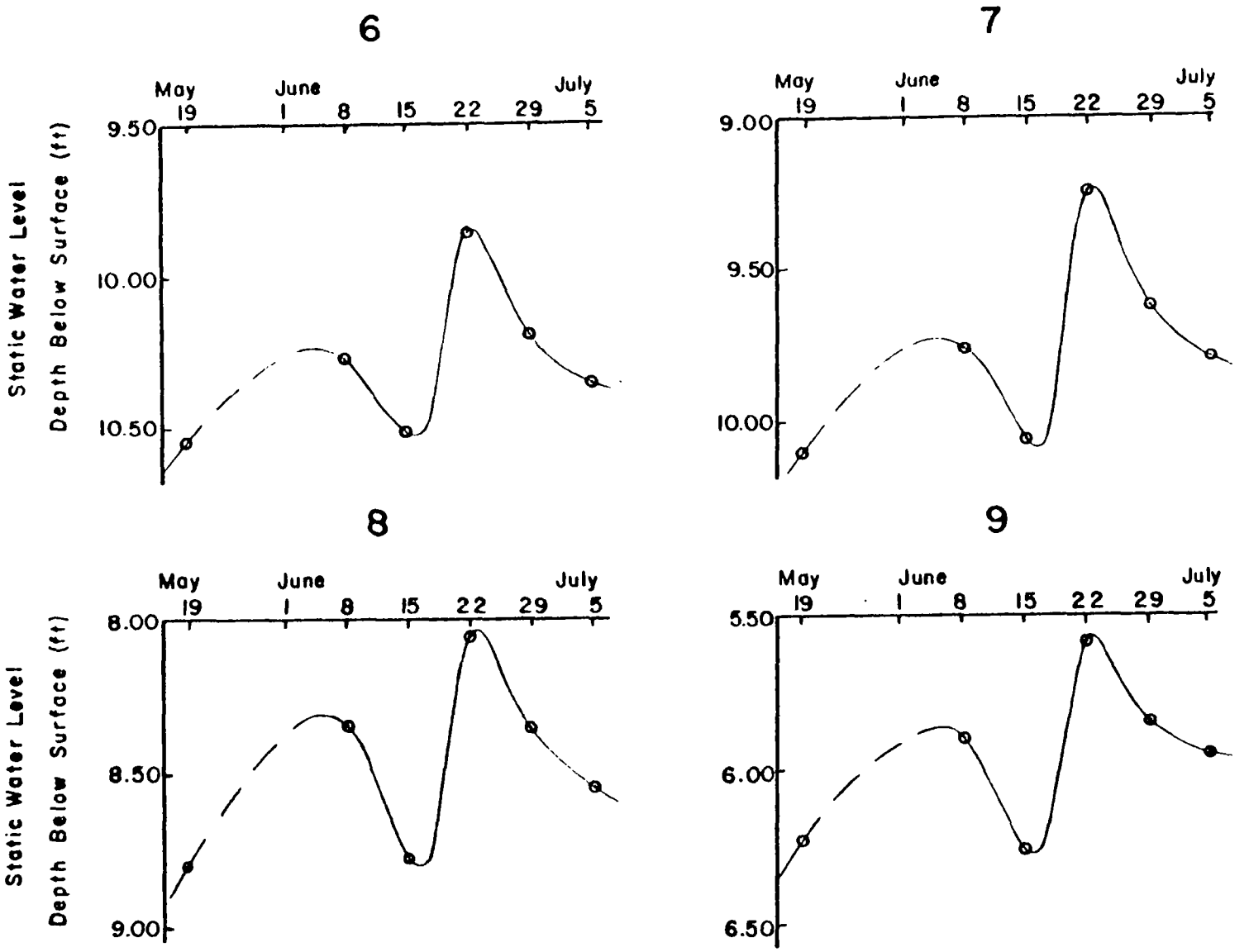
Pascoe

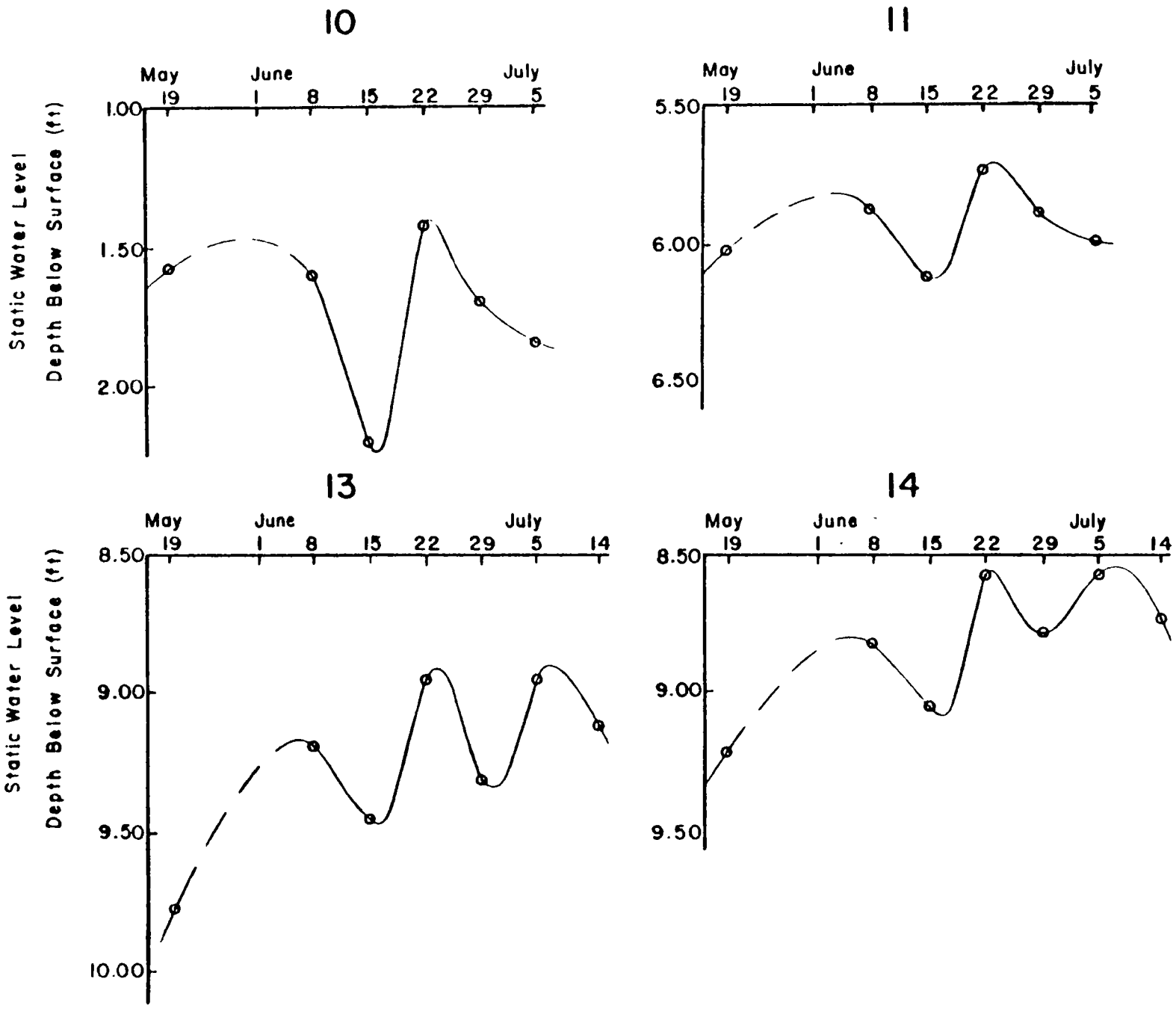


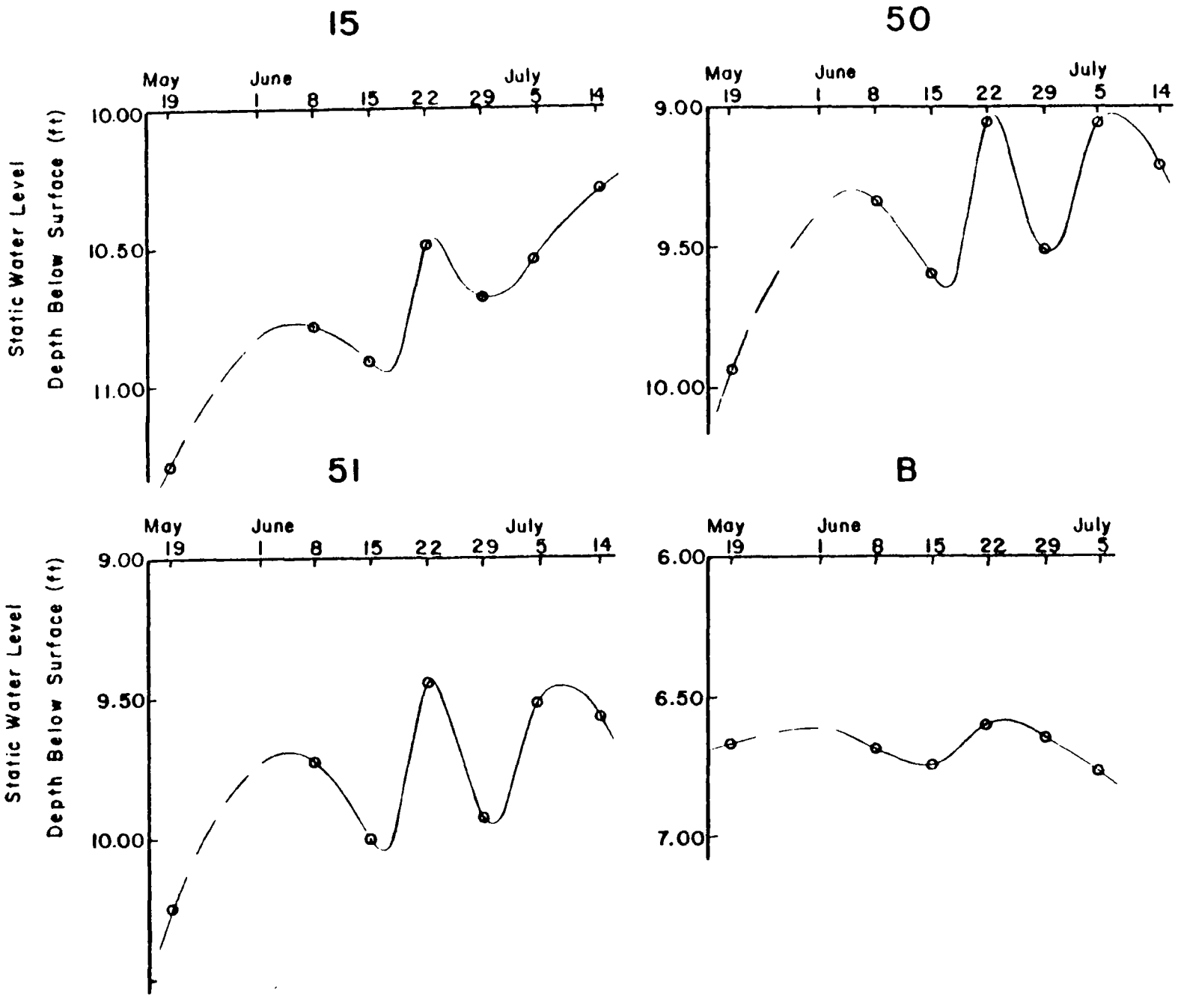
Wee C. G.

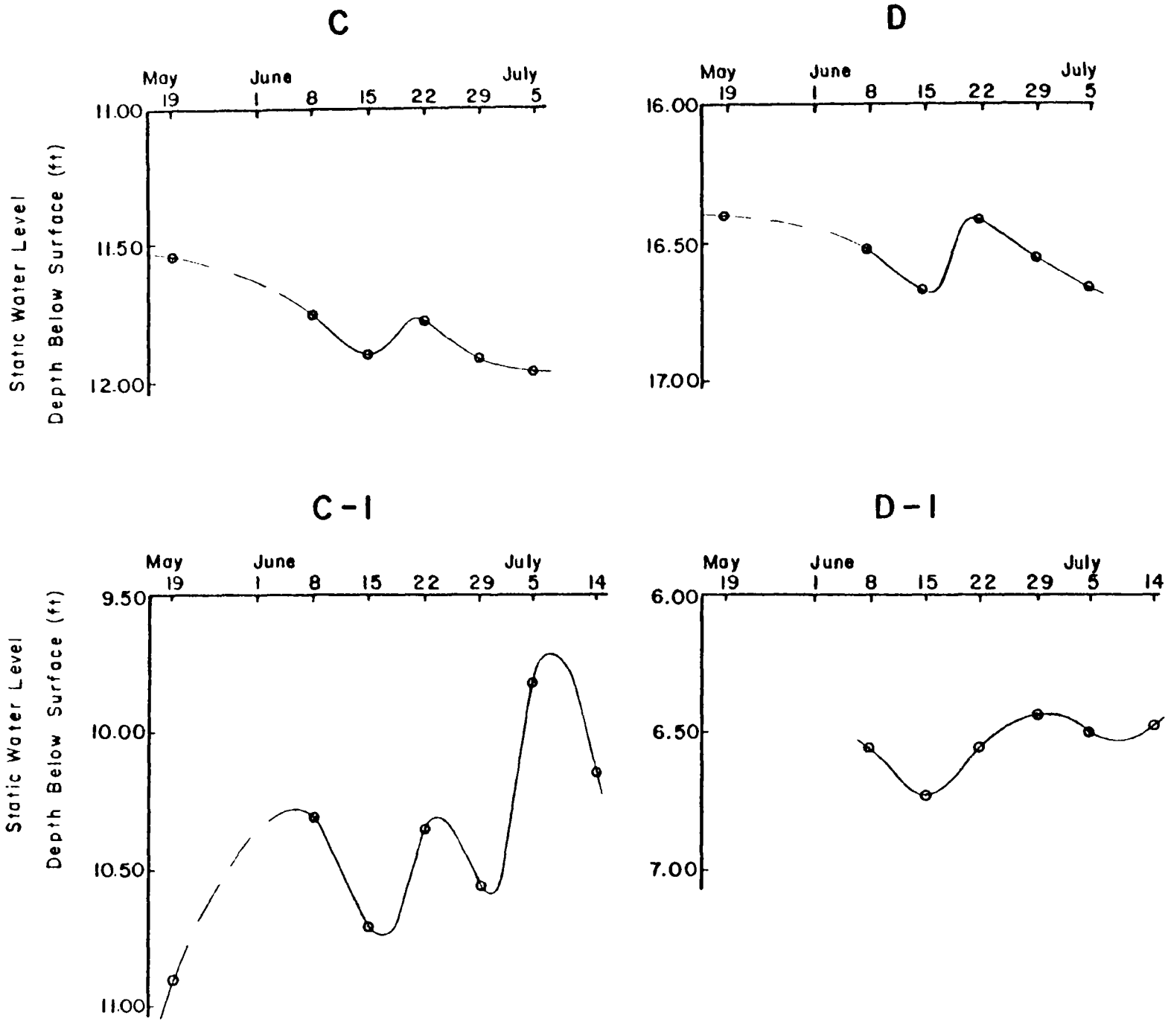


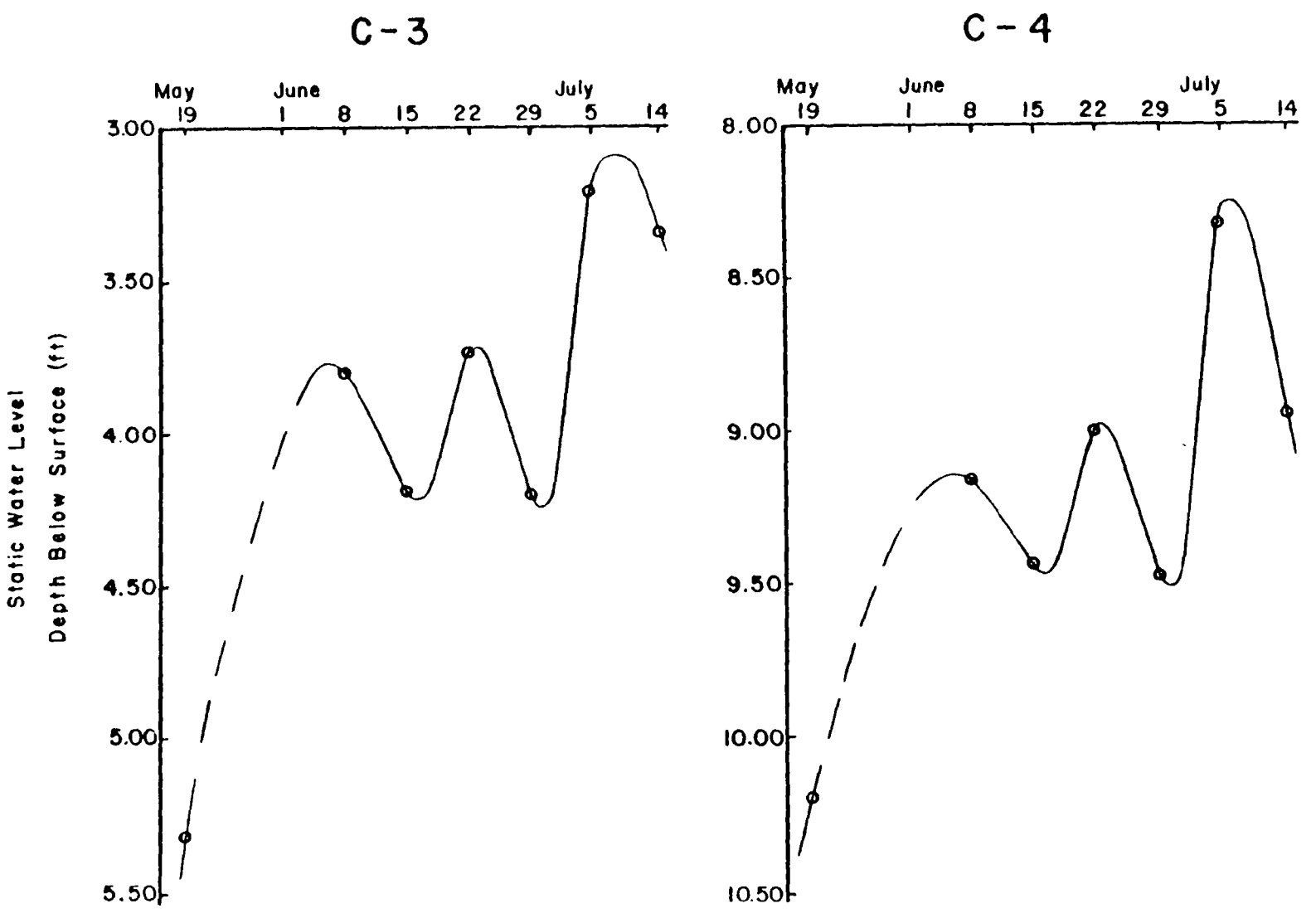

1
2
4
5
May
June
July
19
1
8
15
22
29
5
Static Water Level
Depth Below Surface (ft)
10.00
10.50
11.00
12.00
12.50
13.00
13.50

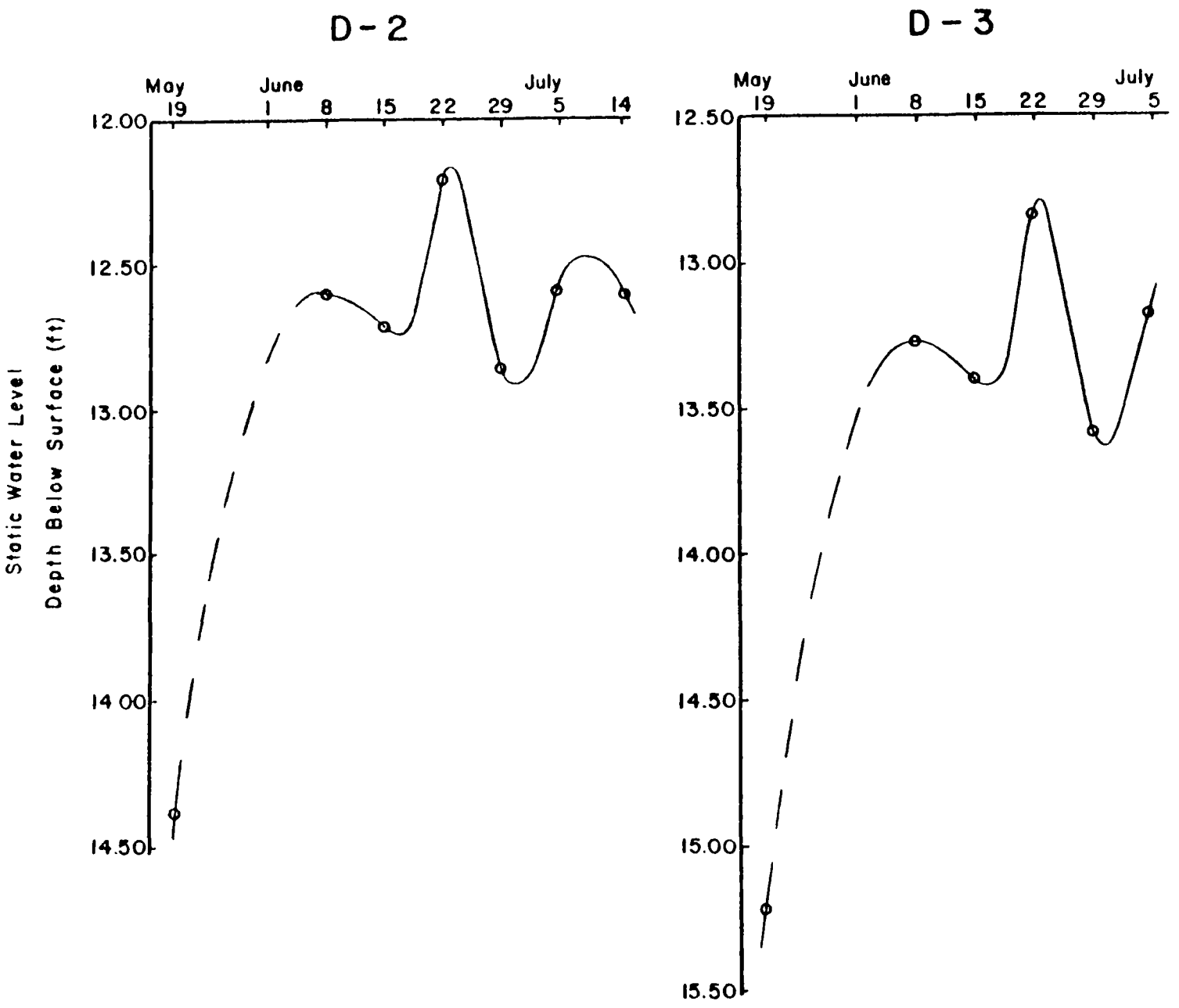

6
7
8
9
Static Water Level
Depth Below Surface (ft)
May
June
July
19
1
8
15
22
29
5
9.50
10.00
10.50
9.00
9.50
10.00
8.00
8.50
9.00
5.50
6.00
6.50

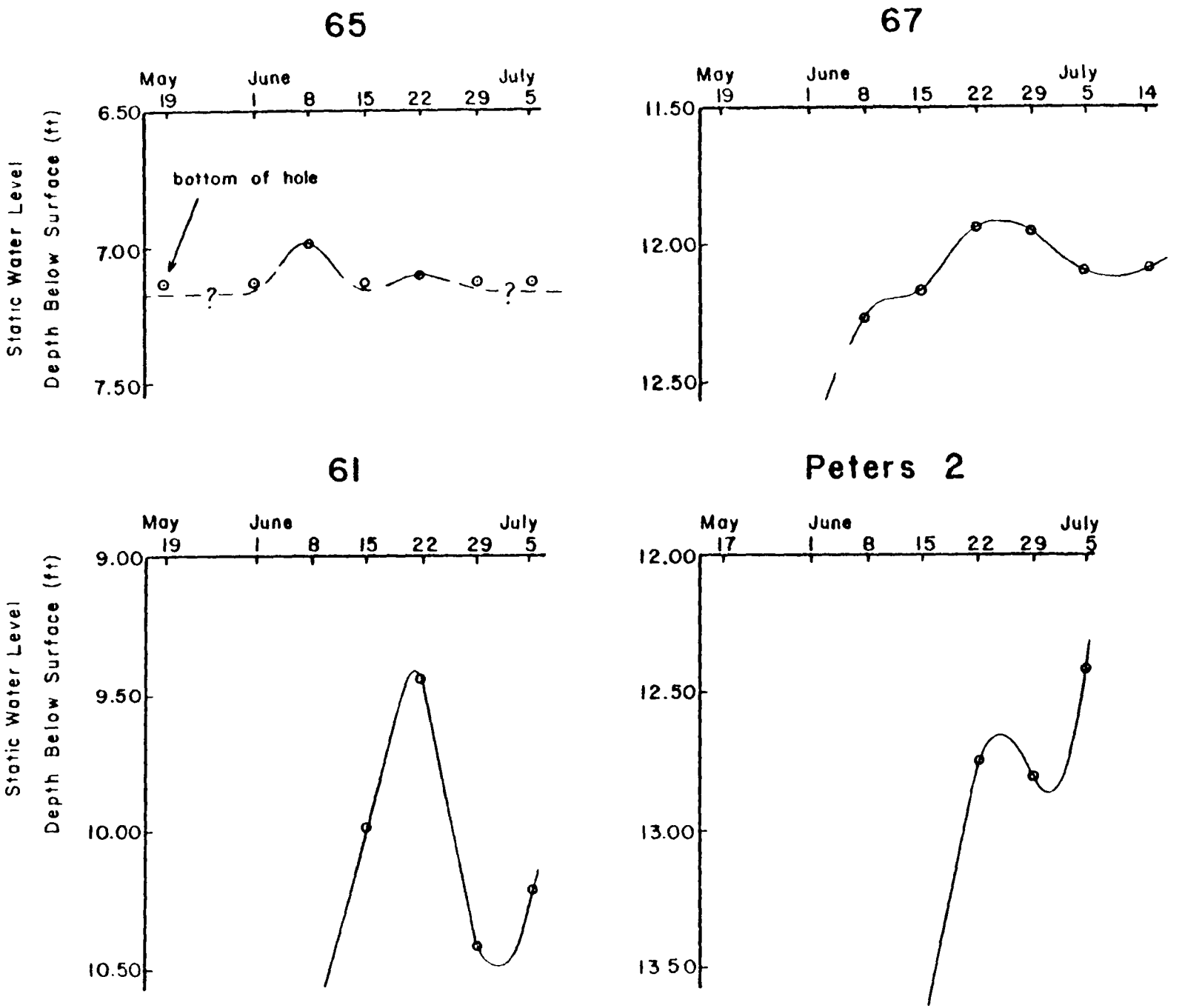

10
11
13
14
May
June
July
19
1
8
15
22
29
5
14
Static Water Level
Depth Below Surface (ft)
1.00
1.50
2.00
5.50
6.00
6.50
8.50
9.00
9.50
10.00

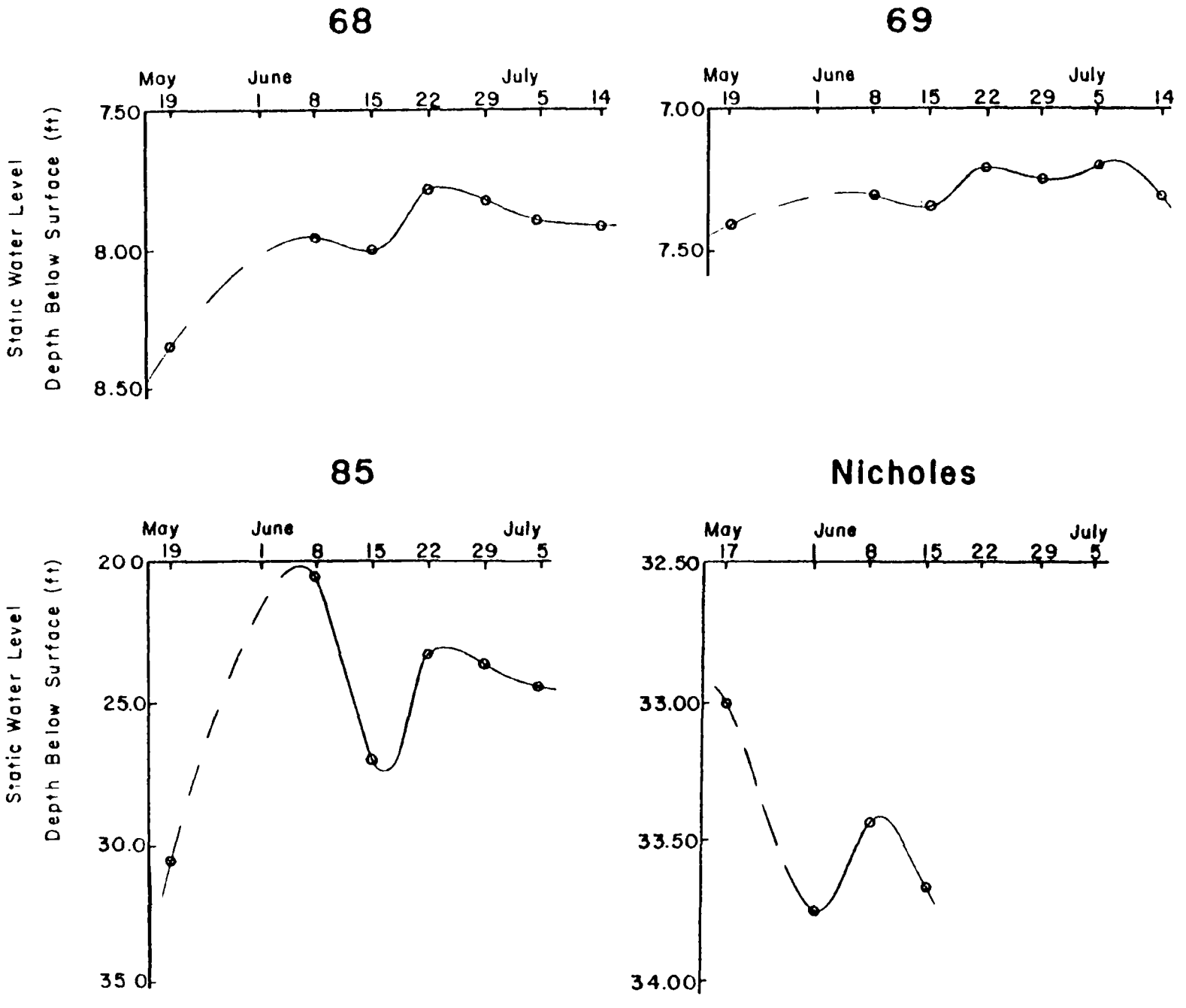

15
50
51
B
Static Water Level
Depth Below Surface (ft)
May
June
July
19
1
8
15
22
29
5
14
10.00
10.50
11.00
9.00
9.50
10.00
9.00
9.50
10.00
6.00
6.50
7.00


C
D
C-1
D-1
Static Water Level
Depth Below Surface (ft)
May
June
July
19
1
8
15
22
29
5
14
11.00
11.50
12.00
16.00
16.50
17.00
9.50
10.00
10.50
11.00
6.00
6.50
7.00


C-3
C-4
May
June
July
19
1
8
15
22
29
5
14
3.00
3.50
4.00
4.50
5.00
5.50
8.00
8.50
9.00
9.50
10.00
10.50
Static Water Level
Depth Below Surface (ft)


D-2
D-3
May
June
July
19
1
8
15
22
29
5
14
12.00
12.50
13.00
13.50
14.00
14.50
15.00
15.50
Static Water Level
Depth Below Surface (ft)


65
Static Water Level
Depth Below Surface (ft)
May
June
July
19
1
8
15
22
29
5
6.50
7.00
7.50
bottom of hole
67
May
June
July
19
1
8
15
22
29
5
14
11.50
12.00
12.50
61
May
June
July
19
1
8
15
22
29
5
9.00
9.50
10.00
10.50
Peters 2
May
June
July
17
1
8
15
22
29
5
12.00
12.50
13.00
13 50


68
69
85
Nicholes
Static Water Level
Depth Below Surface (ft)
May
June
July
19
1
8
15
22
29
5
14
17
7.50
8.00
8.50
7.00
7.50
20.0
25.0
30.0
35.0
32.50
33.00
33.50
34.00

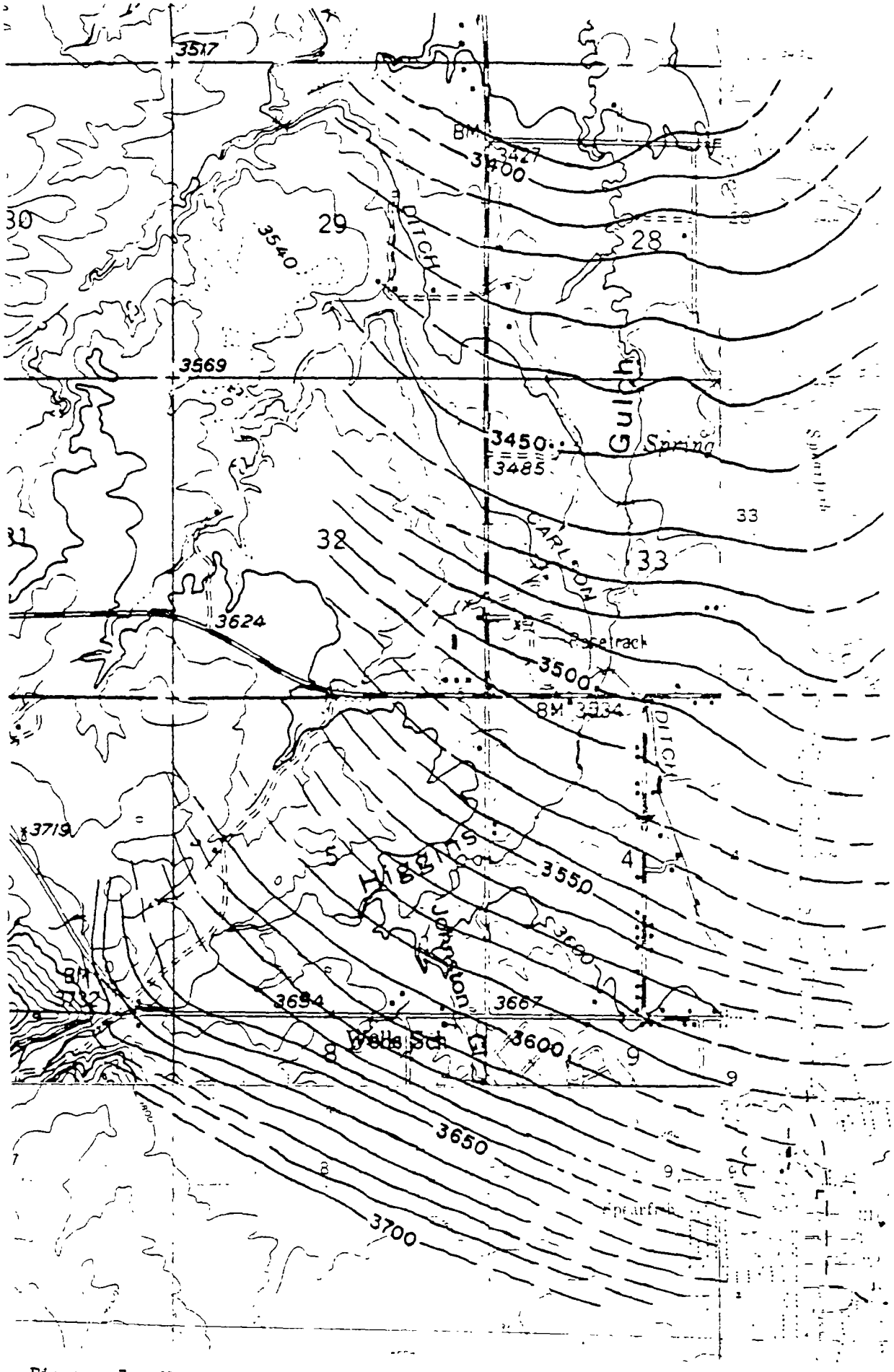


Figure 7. Water-table contour map. Contour interval is 10 ft. All elevations are feet above sea level. Ground water would flow perpendicular to the contours.

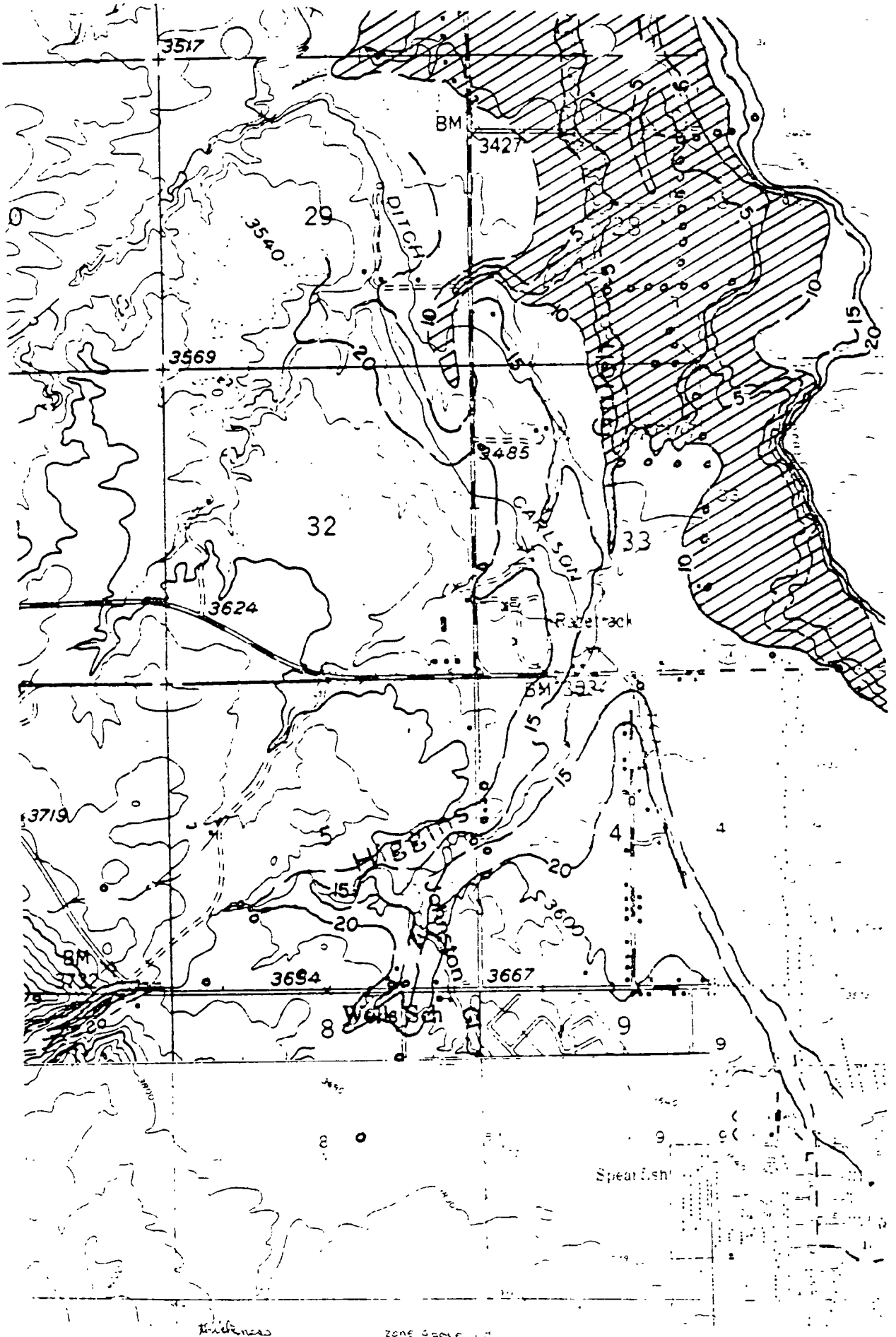


Figure 8. Isopach map of the unsaturated zone. The contour level is 10 ft. Areas where the water table is less than 10 ft deep are shown with diagonal shading.

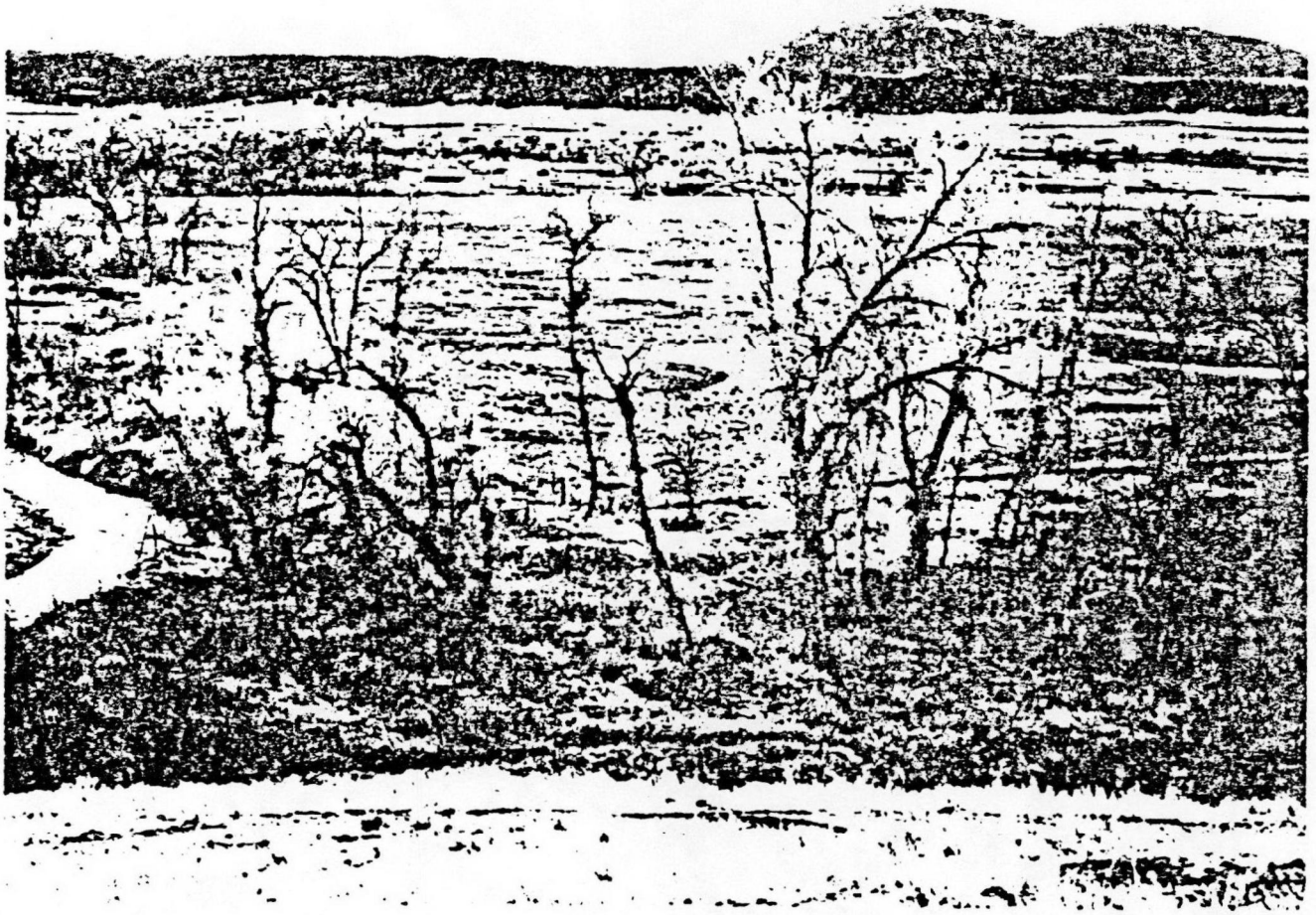


Figure 9. View of the Belle Fourche Infiltration gallery area, looking southwest. Spearfish Creek is on the left. Hope Weiss property adjoins the gallery area to the south. Crow Peak is in the background.

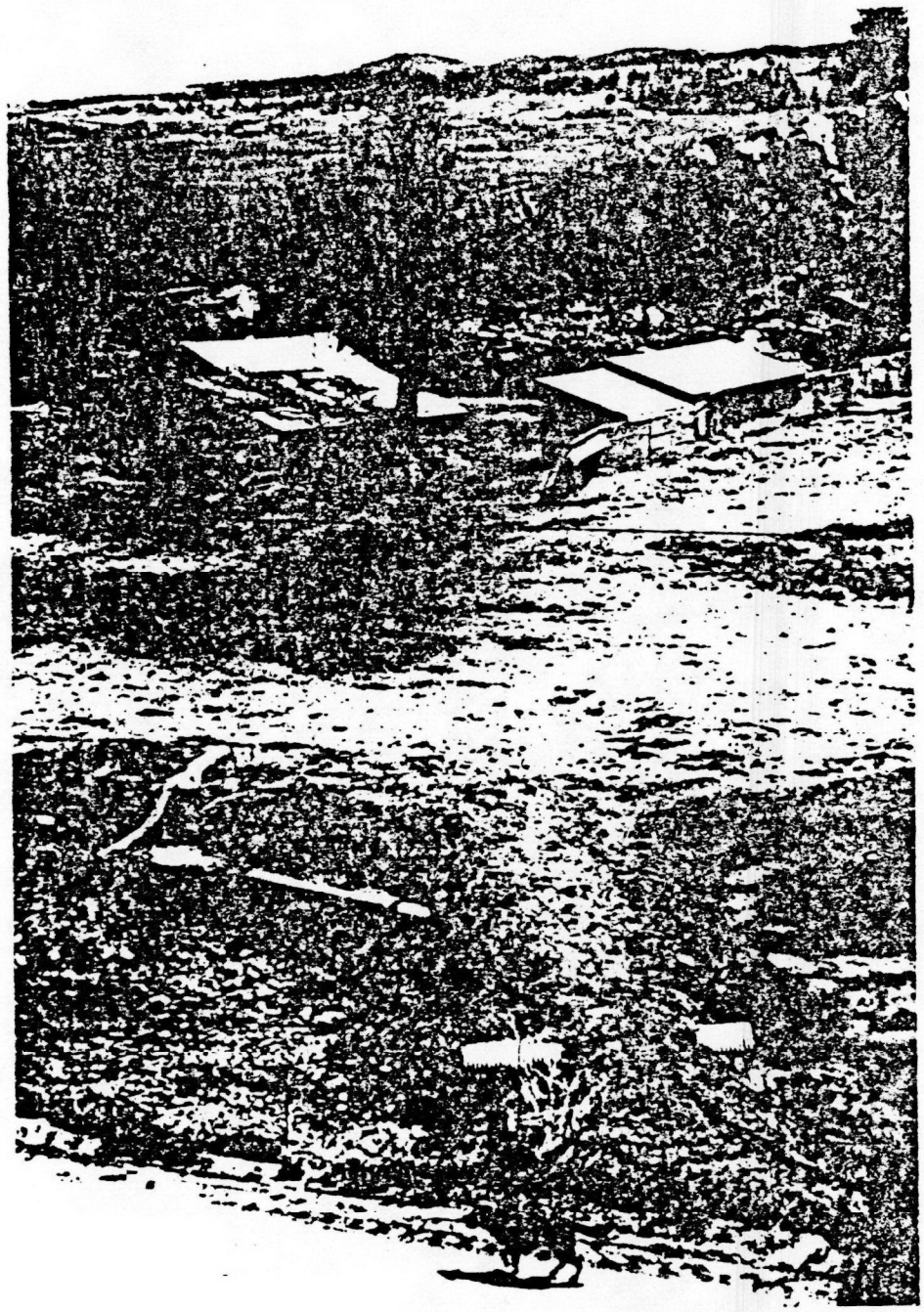


Figure 10. Contaminated water at mouth of Higgins Gulch. Manure lies in the water at this point.

Table 1. Data for 44 monitoring wells.

WATER LEVELS - SPEARFISH VALLEY PROJECT

Well Number	Ground Elev.	Elev. - Top of Casing	Ht. of Casing	Static Water Level (ft below ground) May 5, '79
EPA-1	3638.20	3640.69	2.49	
EPA-2	3703.01	3703.38	.37	
EPA-3	3664.65	3668.10	3.45	
EPA-4	3612.39	3612.47	.08	
EPA-5	3665.23	3665.73	.50	
EPA-6	3706.14	3707.17	1.03	
EPA-7	3478?	3478?	0	
EPA-8	3516	3516	0	
EPA-9	3471	3471	0	
EPA-10	3418.57	3419.02	.45	
Wee C. G.				14.95
Peters #1				
Peters #2				20.42
Pascoe	3622.79	3623.43		21.68
Nicholes				
1	3432.10	3432.87	.77	
2	3433.20	3434.12	.92	
4	3431.62	3432.52	.90	
5	3429.27	3430.27	1.00	
6	3426.77	3427.73	.96	
7	3423.49	3424.55	1.06	
8	3420.34	3421.25	.91	
9	3415.66	3416.41	.75	
10	3407.13	3408.15	1.02	
11	3405.95	3406.85	.90	
B	3399.07	3400.36	1.29	
C	3407.27	3408.69	1.42	
D	3414.27	3415.37	1.10	
13	3433.10	3433.50	.40	
14	3432.36	3433.19	.83	
15	3436.91	3436.91	0	
17	3441.53	3441.53	0	
50	3432.27	3433.35	1.08	
51	3431.49	3432.51	1.02	
C-1	3446.59	3446.59	0	
C-3	3441.86	3441.86	0	
C-4	3446.45	3451.83	5.38	
D-1	3460.55	3467.32	6.77	
D-2	3466.37	3469.50	3.13	
D-3	3467.65	3468.75	1.10	
61	3486.11	3488.30	2.19	
65	3469.54	3469.54	0	
67	3458.75	3458.75	0	
68	3453.35	3453.35	0	
69	3447.80	3450.46	2.66	
85	3580	3580	0	

WATER LEVELS - SPEARFISH VALLEY PROJECT

Static Water Level (ft below ground)

Well Number	May 17-19, '79	June 1, '79	June 8, '79	June 15, '79
EPA-1	>21.81	dry	dry	dry
EPA-2	19.09	"	18.98	"
EPA-3	21.25	"	21.24	21.38
EPA-4	13.17	13.17	13.05	13.27
EPA-5	20.51	18.62	18.77	18.92
EPA-6	16.40	17.02	dry	16.99
EPA-7	16.83	13.65	13.19	13.00
EPA-8	24.20	23.45	23.35	23.46
EPA-9	20.95	20.46	20.77	20.77
EPA-10	7.97	6.11	6.03	6.15
Wee C. G.	13.15	13.62	13.46	12.60
Peters #1	19.20		17.50	16.67
Peters #2	17.68	15.85	14.88	13.81
Pascoe	21.53	21.45	21.25	21.42
Nicholes	33.01	33.75	33.44	33.67
1	10.54		10.50	10.44
2	12.62		12.48	12.71
4	13.20		12.95	13.16
5	11.10		10.73	10.98
6	10.54		10.27	10.52
7	10.09		9.75	10.05
8	8.80		8.36	8.78
9	6.23		5.90	6.27
10	1.58		1.61	2.21
11	6.02		5.87	6.12
B	6.67		6.69	6.75
C	11.53		11.75	11.89
D	16.40		16.53	16.67
13	9.77		9.18	9.45
14	9.21		8.82	9.05
15	11.29		10.79	10.92
17	10.46		>9.90	dry
50	9.94		9.34	9.61
51	10.25		9.73	10.00
C-1	10.90		10.31	10.71
C-3	5.31		3.81	4.19
C-4	10.18		9.16	9.43
D-1	dry		6.56	6.73
D-2	14.39		12.60	12.72
D-3	15.23		13.28	13.40
61	14.16		10.79	9.98
65	dry		6.98	7.13
67	13.44		12.27	12.17
68	8.35		7.96	8.00
69	7.42		7.31	7.35
85	30.60		20.54	27.10

WATER LEVELS - SPEARFISH VALLEY PROJECT

Static Water Level (ft below ground)

Well Number	June 22, '79	June 29, '79	July 5, '79	July 14, '79
EPA-1	dry	dry	dry	
EPA-2	"	"	"	
EPA-3	21.38	21.40	21.38	
EPA-4	13.27	13.55	13.74	
EPA-5	19.13	19.52	19.75	
EPA-6	16.97	16.92	17.01	
EPA-7	13.00	13.46	13.46	
EPA-8	23.35	23.50	23.51	
EPA-9	20.80	20.84	20.80	
EPA-10	6.03	6.06	6.14	
Wee C. G.	12.48	13.11	13.04	
Peters #1				
Peters #2	12.75	12.81	12.42	
Pascoe	21.48	21.96	22.17	
Nicholes				
1	10.08	10.21	10.28	10.40
2	12.06	12.37	12.37	
4	12.74	12.90	12.93	
5	10.40	10.68	10.73	
6	9.86	10.19	10.34	
7	9.24	9.61	9.78	
8	8.07	8.37	8.56	
9	5.59	5.85	5.96	
10	1.43	1.71	1.86	
11	5.73	5.88	5.98	
B	6.61	6.65	6.77	
C	11.77	11.91	11.96	
D	16.42	16.56	16.67	
13	8.95	9.30	8.95	9.12
14	8.57	8.78	8.57	8.73
15	10.50	10.69	10.54	10.31
17	dry	dry	>9.38	dry
50	9.06	9.52	9.07	9.23
51	9.45	9.93	9.52	9.58
C-1	10.35	10.56	9.82	10.15
C-3	3.74	4.21	3.22	3.36
C-4	9.00	9.47	8.33	8.95
D-1	6.56	6.44	6.50	6.48
D-2	12.22	12.86	12.58	12.60
D-3	12.84	13.59	13.18	
61	9.44	10.41	10.21	
65	7.10	dry	dry	
67	11.94	11.96	12.10	12.09
68	7.79	7.83	7.90	7.92
69	7.22	7.25	7.21	7.32
85	23.33	23.77	24.46	

WATER LEVELS - SPEARFISH VALLEY PROJECT

Well Number	Distance (below ground) to Highest Water Level	Elevation of Highest Water Level
EPA-1	> 21.81	< 3616.39
EPA-2	18.98	3684.03
EPA-3	21.23	3643.42
EPA-4	13.04	3599.35
EPA-5	18.60	3646.63
EPA-6	16.33	3689.81
EPA-7	12.96	3465.04 ?
EPA-8	23.33	3492.67
EPA-9	20.44	3450.56
EPA-10	6.00	3412.57
Wee C. G.	12.44	
Peters #1	16.55	
Peters #2	12.35	
Pascoe	21.24	3601.55
Nicholes	32.94	
1	10.06	3422.04
2	12.04	3421.16
4	12.72	3418.90
5	10.38	3418.89
6	9.84	3416.93
7	9.23	3414.26
8	8.04	3412.30
9	5.56	3410.10
10	1.41	3405.72
11	5.70	3400.25
B	6.59	3392.48
C	11.52	3395.75
D	16.39	3397.88
13	8.91	3424.19
14	8.54	3423.82
15	10.25	3426.66
17	> 9.38	< 3432.15
50	9.03	3423.24
51	9.43	3422.06
C-1	9.72	3436.87
C-3	3.10	3438.76
C-4	8.25	3438.20
D-1	6.42	3434.13
D-2	12.17	3434.20
D-3	12.80	3434.85
61	9.42	3476.69
65	6.94	3462.60
67	11.92	3446.83
68	7.78	3445.57
69	7.19	3440.61
85	20.2	3560

1979			May	June	July
January	0.79	1	0.04	0.04	0
		2	0	0	0
February	1.02	3	0	0	0
		4	0	0	0.16
March	0.81	5	0	0	0
		6	0	0	0
April	1.31	7	0	0.24	0
		8	0.02	0.12	0
May	1.85	9	0.27	0.06	0.14
	ave annual precip. Jan-June 11.55	10	0.31	0.05	0
June	2.91 11 total thru June 8.69	11	0	0	0
		12	0.03	0	0
July	2.85 (ave. 2.94)	13	0.02	0	0.23
		14	0	0	0.08
Total	11.54	15	0	0	0
		16	0	0.70	0.72
		17	0	0.72	0.13
1889-1977 ave. precip. Jan-July 14.49		18	0.19	0.09	0
		19	0.22	0.05	0
		20	0	0.03	0
All data are inches.		21	0	0	0
		22	0	0.08	0
		23	0	0	0
		24	0	0	0
		25	0	0.03	0.64
		26	0	0	0.26
So 1st part of 1979		27	0	0.09	0.04
was drier than average		28	0.06	0.10	0
		29	T	0.01	0.45
		30	0.67	0	0
		31	0.02	--	0?
		Total	1.85	2.91	2.85

Table 2. Precipitation data. Supplied by Stuart Reed of Homestake Sawmill and the U. S. Weather Bureau.