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Hydrogeologic Investigation of
Alluvial Ground-Water System
U.S. Radium Corporation
Bloomsburg, Pa.

April 9, 1979

Edgar W. Meiser, Jr.

Edgar W. Meiser, Jr. Ph.D.

MEISER & EARL



hydrogeologists

Table of Contents

	<u>Page</u>
Introduction.	1
Location of Test Holes.	1
Supervision of Drilling	1
Subsurface Geologic Conditions	32
Water Table Configuration	34
Pumping Tests	39
Ground-Water Flow Rates	44
Water Quality Samples	50
Pollution Abatement Techniques	51

Introduction

This report will summarize our investigation of the hydrogeologic conditions at the Bloomsburg plant of U.S. Radium Corporation. The purpose of our work was to outline and supervise a drilling program to determine the depths to ground water, water-table gradients and flow directions, existing water quality, extent of any radioactive contamination from abandoned disposal areas, and to propose appropriate pollution abatement techniques. Work on this project commenced on January 29, 1979.

Location of Test Holes

A total of 13 approximate locations for test drilling on the plant property were selected by Terry Brown and Tom Earl of this firm to allow for maximum definition of ground-water conditions, emphasizing the area of the abandoned canal, lagoons, and disposal pits, with a few sites (14, 15, and 16) chosen for background definition (see Plate 1). Borings No. 1, 2 and 3 were drilled in October 1978 in a position directly below the disposal pits, the main area of concern. After the holes were drilled and cased, U.S. Radium surveyed the locations for position on the ground and elevation relative to an arbitrary datum (See Table 1).

Supervision of Drilling

Meiser and Earl coordinated and directed installation of the test borings with two objectives: 1) collect interval soil samples for textural classification and radioactivity analysis and 2) construct screened or cased wells from which water samples could be collected. Our original approach, based on the previous drilling by Giles Drilling Corp. in October 1978, (see logs for holes 1, 2, 3, Table 2A and 2B), was to advance a hollow-stem

Table 1. U.S. Radium Corporation - Bloomsburg, Pa.
Locations and Elevations of Test Borings

Boring/Well No.	Distance From Center of Burial Pit (ft)	Bearing ¹ from Center of Burial Pit	Ground Elevation ² (ft)	Height of Casing above Ground (ft)
1	25	146°	- 3.0	1.0
2	77	159°	- 9.0	1.0
3	137	159°	-16.0	0.5
4	83	206°	- 7.5	3.0
5	218	227°	-15.5	2.5
6	185	208°	-16.4	3.0
7	319	226°	-16.8	1.8
8	307	237°	-16.0	2.5
9	243	266°	+ 3.6	1.7
10	359	241°	-18.1	0.8
11	115	292°	+ 3.0	1.8
12	35	350°	+ 1.8	1.8
13	67	44°	+ 1.1	1.5
14	365	51°	+ 4.0	1.8
15	414	329°	+13.0	1.9
16	474	294°	+12.6	1.8
17	73	304°	+ 2.5	1.1
18	389	92°	- 7.6	1.5
19	190	103°	- 8.1	1.3

¹Directions are relative to magnetic north = 0°

²0 elevation is center of burial pit

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Table 2A
U.S. Radium Corp.
Drillers Logs of Test Borings

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1512 W. COLLEGE AVENUE, STATE COLLEGE, PENNSYLVANIA 16801 814 234-0813

△

40.

Project BLOOMSBURG, PA

Rt.

Sec.

Sta.

Offset

Lt.
 R.

Date Started 10-10-78 Completed 10-10-78

tion, Change if any:

Inside Dia. of Casing	2 1/2
" " " Spoon	1 3/4
Weight of Hammer on Casing	300 LBS
" " " " Spoon	140 LBS
Drop of Hammer on Casing	24"
" " " " Spoon	30"

DRY SAMPLE DATA			
Sample No.	Elevation bottom of Spoon	Total Penetration	Length of Sample
S 1	0 To 2'	24"	9"
S 2	2 To 4'	24"	9"
S 3	4 To 6'	24"	N.P.
S 3	6 To 8'	24"	8"
S 4	8 To 10'	24"	12"
S 5	10 To 12'	24"	16"
S 6	12 To 14'	24"	15"
S 7	14 To 16'	24"	16"
S 8	16 To 18'	24"	16"
S 9	18 To 20'	24"	17"
S 10	20 To 22'	24"	7"
S 11	22 To 24'	24"	19"

C — COARSE	AND 35-50%
M — MEDIUM	SOME 20-35%
F — FINE	LITTLE 10-20%
	TRACE 0-10%

Bottom of Hole 24'

Rock Drilled and Size _____

Date	Time	Depth Water	Casing At
------	------	-------------	-----------

10-10-78	11-6"	NO CAS
10-11-78	10-10"	24' C.F. PLASTIC

THE GILE DRILLING CORPORATION

SUBSURFACE INFORMATION

5

10.

Hole No. B-2

U.S. RADIUM CORP.

Project BLOOMSBURG, PA.

ure

Rt.

Sec.

Sta.

Offset

Li
Rt

gs made by: T. LAUSSO
K. FRISBIE Inspector

Date Started 10-11-78 Completed 10-11-78

ion, Change if any:

Ground Line Elevation

Blows on Spoon
0 6 12 18

2	Materials Encountered 0 TO 4'	1	2	3	4
6	BRN F/SAND & SILT				7
7	TR. ROOTS TR. GRAVEL	2	6	8	8
10					8
12	4' TO 12-6"	3	6	5	7
14	GRAY-BRN CLAYEY				6
15	SILT TR. F/SAND	4	2	2	3
19					3
19		5	3	5	6
23					7
15		6	2	5	6
20					8
27		7	8	25	24
49	12-6' TO 24'				29
94	GRAY, BRN C/F SAND	8	23	86	73
83	& C/F GRAVEL				32
60	TR. SILT	9	22	28	32
56					27
30	TR. COBBLES	10	24	31	29
43					36
39		10	16	17	15
41					19
41		11	16	21	23
47					27

Blows Per Foot of Casing Penetration

Sample Number

NOTE

INSTALLED 24' OF
2" PLASTIC PIPE
IN HOLE - B-2

Inside Dia. of Casing	3"
" " " Spoon	1 1/2
Weight of Hammer on Casing	300 LBS
" " " " Spoon	140 LBS
Drop of Hammer on Casing	24"
" " " " Spoon	30"

DRY SAMPLE DATA

Sample No.	Elevation bottom of Spoon	Total Penetration	Length of Sample
S1	0 TO 2'	24"	19"
S2	2 TO 4'	24"	10"
S3	4 TO 6'	24"	18"
S4	6 TO 8'	24"	10"
S5	8 TO 10'	24"	20"
S6	10 TO 12'	24"	14"
S7	12 TO 14'	24"	12"
S8	14 TO 16'	24"	11"
S9	16 TO 18'	24"	N.R.
S10	18 TO 20'	24"	7'
S11	20 TO 22'	24"	8'
	22 TO 24'	24"	15"

CLASSIFICATION OF MATERIALS

C — COARSE AND 35-50%
M — MEDIUM SOME 20-35%
F — FINE LITTLE 10-20%
TRACE 0-10%

Bottom of Hole 24'

Rock Drilled and Size _____

GROUND WATER OBSERVATIONS

Date	Time	Depn Water	Casing At
10-11-78		5-5"	MUCAS
10-11-78		10-4"	24" OF PLASTIC PIPE

6

Q.

Project BLOOMSBURG, PA

Offset

L1
R

Date Started 10-12-78 Completed 10-12-78

on, Change if any:

Inside Dia. of Casing	24
" " " Spoon	13
Weight of Hammer on Casing	300 LBS
" " " " Spoon	140 LBS
Drop of Hammer on Casing	24"
" " " " Spoon	30"

DRY SAMPLE DATA			
Sample No.	Elevation bottom of Spoon	Total Penetration	Length of Sample
S1	0 To 2'	24"	13"
S2	2 To 4'	24"	12"
S3	4 To 6'	24"	12"
S4	6 To 8'	24"	16"
S5	8 To 10'	24"	14"
S6	10 To 12'	24"	12"
S7	12 To 14'	24"	10"
S8	14 To 16'	24"	10"
S9	16 To 18'	24"	13"
S10	18 To 19'	12"	9"

C — COARSE	AND 35-50%
M — MEDIUM	SOME 20-35%
F — FINE	LITTLE 10-20%
	TRACE 0-10%

Bottom of Hole 24

Rock Drilled and Size *B*

GROUND WATER OBSERVATIONS

Date	Time	Depth Water	Casing At
10-12-78		4-4	No CAS
10-13-78		3	24" C.F./PLASTIC P.P.T.B.

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1234 E. COLLEGE AVE.

814-238-8223

STATE COLLEGE, PA., 16801

TEST BORING LOG

FILE NO. 79007

Name <u>United States Radium Corp.</u>		Date <u>2/22/79</u>	
Location <u>4150 Old Berwick Road</u> <u>Bloomsburg, Pa.</u>		Boring No. <u>4</u>	
Insp. or Eng. <u>Ed Meiser</u>		Station _____	
Driller <u>V. Dye, D. Ritchey</u>		Offset _____	
Gnd. Elev. _____		Sheet <u>1</u> of <u>1</u>	
Depth to Water Ft. <u>4.5</u>		After <u>1</u> Hrs.	

Rig No. <u>M-1</u>	Casing Size <u>8"HSA</u>	Spoon Size <u>2"</u>
Depth of Soil <u>20.0</u>	Hammer Wt. <u>N/A</u>	Hammer Wt. <u>140#</u>
Depth of Rock <u>0.0</u>	Hammer Drop <u>N/A</u>	Hammer Drop <u>30"</u>
Total Depth <u>20.0</u>	Core Bit Size <u>N/A</u>	Bit No. <u>N/A</u>

BORING LOG		SPOON SAMPLE & ROCK CORE DATA										REMARKS	Casing blows	
Depth from to	Material Description	Sample Blows on Spoon						Run No.	Depth of Run	Core Rec.	% Core Rec.			
		No.	Depth	0	6	12	18							
0.0	Fine Silt w/Trace Gray Clay	1	2.0	1	3	5	6						1'	
2.0													2'	
2.0	Red to Gray Clay and Silt	2	2.0	3	3	4	5						3'	
4.0													4'	
4.0	Fine Sand, Wet Gray Silt	3	2.0	3	4	5	5					Water at 4.5'	5'	
6.0													6'	
6.0	Fine Sand w/wet Gray Silt and Sandstone Cobbles	4	2.0	2	2	4	6						7'	
8.0													8'	
8.0	Fine Sandy Gray Silt, Very Wet	5	2.0	6	6	9	14						9'	
10.0													10'	
10.0	Fine Sand, Gray, Silt, V.Wet w/Sandstone Cobbles	6	2.0	6	11	11	15						11'	
12.0													12'	
12.0	Same	7	2.0	18	33	25	14						13'	
14.0													14'	
14.0	Same	8	2.0	7	16	17	19						15'	
16.0													16'	
16.0	Very wet Brn. Sandstone Boulders w/sand	9	2.0	8	16	19	37						17'	
18.0													18'	
18.0	Same	10	2.0	19	22	24	19					Set monitoring Well 15' slotted, 7' solid	19'	
20.0													20'	
													21'	
													22'	
													23'	
													24'	
													25'	
													26'	

SOIL DESCRIPTION:

1. Kind - Clay, Silt, Sand, Etc.
2. Color - Light, Medium, Dark, Etc.
3. Moisture - Dry, Moist, Wet, Etc.
4. Compaction - Loose, Compact, Etc.

ROCK DESCRIPTION:

1. Kind - Sandstone, Shale, Etc.
2. Condition - Solid, Broken, Etc.
3. Hardness - Soft, Medium, Hard Very Hard, Etc.

LEGEND

- T - Trace, LT - Light, MD - Medium, DK - Dark, D - Dry
M - Moist, W - Wet, VW - Very Wet, H - Hard, S - Soft
L - Loose, C - Compact, SLD - Solid, B - Broken
BB - Badly Broken, W/- With, MS - Mud Seams, Rec. - Recovered

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TEST BORING LOG

FILE NO. 79007

Name <u>United States Radium Corp.</u>	Gnd. Elev. _____	Date <u>5/20/79</u>
Location <u>4150 Old Berwick Road</u>	Depth to Water _____	Boring No. <u>5</u>
<u>Bloomsburg, Pa.</u>	Ft. <u>6.8</u>	Station _____
Insp. or Eng. <u>Ed Meiser</u>	After <u>1</u> Hrs.	Offset _____
Driller <u>V. Dye, D. Ritchey</u>		Sheet <u>1</u> of <u>1</u>

Rig No. <u>M-1</u>	Casing Size <u>8" HSA</u>	Spoon Size <u>2"</u>
Depth of Soil <u>20.0</u>	Hammer Wt. <u>N/A</u>	Hammer Wt. <u>140#</u>
Depth of Rock <u>0.0</u>	Hammer Drop <u>N/A</u>	Hammer Drop <u>30"</u>
Total Depth <u>20.0</u>	Core Bit Size <u>N/A</u>	Bit No. <u>N/A</u>

BORING LOG		SPOON SAMPLE & ROCK CORE DATA							REMARKS	Casing blows	
Depth from to	Material Description	Sample No.	Blows on Spoon	Run No.	Depth of Run	Core Rec.	% Core Rec.			1'	
			0 6 12 18 24							2'	
0.0	Brown Coarse Sandy Silt	1	2.0	1	1	1	2			3'	
2.0	Very Soft Silt w/Fine to Coarse Brown Sand	2	2.0	1	1	1	1			4'	
4.0	Same	Weight of Hammer								5'	
6.0	Same	Weight of Hammer							Water at 6.8'	6'	
8.0	Dark Brown Fine Sand/Trace of Clay	3	2.0	1	3	6	12			7'	
10.0	Dark Brn. Fine Sand w/Sandstone Cobbles, Very Wet	4	2.0	4	18	22	18			8'	
12.0	Same	5	2.0	13	10	6	6			9'	
14.0	Dark Brn. fine Sand w/Trace of Clay	6	2.0	3	4	5	9			10'	
16.0	Wet Sandstone Cobbles w/Sandy Silt	7	2.0	11	22	20	21			11'	
18.0	Silty Sand w/Sandstone Cobbles	8	2.0	16	19	40	21			12'	
20.0										13'	
									Set monitoring well	14'	
									15' slotted	15'	
									7' solid	16'	
										17'	
										18'	
										19'	
										20'	
										21'	
										22'	
										23'	
										24'	
										25'	
										26'	

SOIL DESCRIPTION:

1. Kind - Clay, Silt, Sand, Etc.
2. Color - Light, Medium, Dark, Etc.
3. Moisture - Dry, Moist, Wet, Etc.
4. Compaction - Loose, Compact, Etc.

ROCK DESCRIPTION:

1. Kind - Sandstone, Shale, Etc.
2. Condition - Solid, Broken, Etc.
3. Hardness - Soft, Medium, Hard, Very Hard, Etc.

LEGEND

- T - Trace, LT - Light, MD - Medium, DK - Dark, D - Dry
M - Moist, W - Wet, VW - Very Wet, H - Hard, S - Soft
L - Loose, C - Compact, SLD - Solid, B - Broken
BB - Badly Broken, W/- With, MS - Mud Seams, Rec. - Recovered

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TEST BORING LOG

FILE NO. 79007

Name <u>United States Radium Corp.</u>	Gnd. Elev. _____	Date <u>2/21/79</u>
Location <u>4150 Old Berwick Road</u> <u>Bloomsburg, Pa.</u>	Depth to Water Ft. <u>3.6</u>	Boring No. <u>6</u>
Insp. or Eng. <u>Ed Meiser</u>	After <u>1</u> Hrs.	Station _____
Driller <u>V. Dye, D. Ritchey</u>		Offset _____
		Sheet <u>1</u> of <u>1</u>

Rig No. <u>M-1</u>	Casing Size <u>8" HSA</u>	Spoon Size <u>2"</u>
Depth of Soil <u>20.0</u>	Hammer Wt. <u>N/A</u>	Hammer Wt. <u>140#</u>
Depth of Rock <u>0.0</u>	Hammer Drop <u>N/A</u>	Hammer Drop <u>30"</u>
Total Depth <u>20.0</u>	Core Bit Size <u>N/A</u>	Bit No. <u>N/A</u>

BORING LOG		SPOON SAMPLE & ROCK CORE DATA							REMARKS		Casing blows				
Depth from to	Material Description	Sample		Blows on Spoon				Run No.	Depth of Run	Core Rec.	% Core Rec.		1'		
		No.	Depth	0	6	12	18								24
0.0 / 2.0	Light Brown Silty Sandy Soil	1	2.0	2	1	1	1							3'	
2.0 / 4.0	Same	Weight of Hammer										Water at 3.6		5'	
4.0 / 6.0	Same	Weight of Hammer												7'	
6.0 / 8.0	Brown Sandy Silt, Moist	2	2.0	1	1	2	3							9'	
8.0 / 10.0	Moist Brn. Fine Sand, Trace of Clay, Trace of Sandstone	3	2.0	3	2	6	18							11'	
10.0 / 12.0	Fine Brn. Sand w/Silty Moist	4	2.0											12'	
12.0 / 14.0	Fine to Coarse Black Sand Moist Brown Sand	5	2.0											13'	
14.0 / 16.0	Brown Sand w/Small River Rock	6	2.0	3	3	3	12							14'	
16.0 / 18.0	Same	7	2.0	10	17	17	22							15'	
18.0 / 20.0	Brn. Sand River Rock Weather Shale	8	2.0	8	15	19	21							16'	
		9	2.0	15	33	22	50							17'	
														18'	
														19'	
														20'	
														21'	
														22'	
														23'	
														24'	
														25'	
														26'	

SOIL DESCRIPTION:

1. Kind - Clay, Silt, Sand, Etc.
2. Color - Light, Medium, Dark, Etc.
3. Moisture - Dry, Moist, Wet, Etc.
4. Compaction - Loose, Compact, Etc.

ROCK DESCRIPTION:

1. Kind - Sandstone, Shale, Etc.
2. Condition - Solid, Broken, Etc.
3. Hardness - Soft, Medium, Hard, Very Hard, Etc.

LEGEND

- T - Trace, LT - Light, MD - Medium, DK - Dark, D - Dry
M - Moist, W - Wet, VW - Very Wet, H - Hard, S - Soft
L - Loose, C - Compact, SLD - Solid, B - Broken
BB - Badly Broken, W/- With, MS - Mud Seams, Rec. - Recover

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TEST BORING LOG

FILE NO. 79007

Name <u>United States Radium Corp.</u>	Gnd. Elev. _____	Date <u>2/14/79</u>
Location <u>4150 Old Berwick Road</u>	Depth to Water _____	Boring No. <u>7</u>
<u>Bloomburg, Pa.</u>	Ft. <u>8.5</u>	Station _____
Insp. or Eng. <u>Ed Meiser</u>	After <u>1.0</u> Hrs.	Offset _____
Driller <u>V. Dye, D. Ritchey</u>		Sheet <u>1</u> of <u>1</u>

Rig No. _____	M-1	Casing Size _____	8" HSA	Spoon Size _____	2"
Depth of Soil _____	20.0	Hammer Wt. _____	N/A	Hammer Wt. _____	140#
Depth of Rock _____	0.0	Hammer Drop _____	N/A	Hammer Drop _____	30"
Total Depth _____	20.0	Core Bit Size _____	N/A	Bit No. _____	N/A

[illegible]

SOIL DESCRIPTION:

1. Kind - Clay, Silt, Sand, Etc.
2. Color - Light, Medium, Dark, Etc.
3. Moisture - Dry, Moist, Wet, Etc.
4. Compaction - Loose, Compact, Etc.

ROCK DESCRIPTION:

1. Kind - Sandstone, Shale, Etc.
2. Condition - Solid, Broken, Etc.
3. Hardness - Soft, Medium, Hard
Very Hard, Etc.

LEGEND

- T- Trace, LT- Light, MD- Medium, DK- Dark, D- Dry
M- Moist, W- Wet, VW- Very Wet, H- Hard, S- Soft
L- Loose, C- Compact, SLD- Solid, B- Broken
BB- Badly Broken, W/- With, MS- Mud Seams, Rec.- Recovered

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TEST BORING LOG

FILE NO. 79007

Name <u>United States Radium Corp.</u>		Gnd. Elev. _____ Depth to Water Ft. <u>6.7</u> After <u>1.0</u> Hrs.	Date <u>2/20/79</u>
Location <u>4150 Old Berwick Road</u> <u>Bloomsburg, Pa.</u>			Boring No. <u>8</u>
Insp. or Eng. <u>Ed Meiser</u>			Station _____
Driller <u>V. Dye, D. Ritchey</u>			Offset _____
			Sheet <u>1</u> of <u>1</u>

Rig No. <u>M-1</u>	Casing Size <u>8" HSA</u>	Spoon Size <u>2"</u>
Depth of Soil <u>20.0</u>	Hammer Wt. <u>N/A</u>	Hammer Wt. <u>140#</u>
Depth of Rock <u>0.0</u>	Hammer Drop <u>N/A</u>	Hammer Drop <u>30"</u>
Total Depth <u>20.0</u>	Core Bit Size <u>N/A</u>	Bit No. <u>N/A</u>

BORING LOG		SPOON SAMPLE & ROCK CORE DATA								REMARKS	Casing blows							
Depth from to	Material Description	Sample		Blows on Spoon						Run No.	Depth of Run	Core Rec.	% Core Rec.		1'			
		No.	Depth	0	6	12	18	24										
0.0	Brown Silty Clay	1	2.0	4	6	1	1									1'		
2.0																2'		
2.0	Dark Brown Sandy Silt	2	2.0	2	2	3	3									3'		
4.0																4'		
4.0	Same	3	2.0	2	1	1	2									5'		
6.0																6'		
6.0	Light Brn. Fine Sandy	4	2.0	2	5	11	11							Water at 6.7		7'		
8.0																8'		
8.0	Light Brown Fine Sand	5	2.0	10	11	13	12									9'		
10.0																10'		
10.0	Light Brown Sand, Wet	6	2.0	5	9	7	14									11'		
12.0																12'		
12.0	Dark Brown Sand w/ Sandstone Boulders	7	2.0	16	29	27	34									13'		
14.0																14'		
14.0	Same	8	2.0	18	23	33	35									15'		
16.0																16'		
16.0	Same	9	2.0	15	26	32	25									17'		
18.0																18'		
18.0	Same	10	2.0	13	21	31	56							Set monitoring well 15' slotted		19'		
20.0																20'		
														7' solid		21'		
																22'		
																23'		
																24'		
																25'		
																26'		

SOIL DESCRIPTION:

1. Kind - Clay, Silt, Sand, Etc.
2. Color - Light, Medium, Dark, Etc.
3. Moisture - Dry, Moist, Wet, Etc.
4. Compaction - Loose, Compact, Etc.

ROCK DESCRIPTION:

1. Kind - Sandstone, Shale, Etc.
2. Condition - Solid, Broken, Etc.
3. Hardness - Soft, Medium, Hard Very Hard, Etc.

LEGEND

- T - Trace, LT - Light, MD - Medium, DK - Dark, D - Dry
M - Moist, W - Wet, VW - Very Wet, H - Hard, S - Soft
L - Loose, C - Compact, SLD - Solid, B - Broken
BB - Badly Broken, W/- With, MS - Mud Seams, Rec. - Recovered

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1234 E. COLLEGE AVE.

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STATE COLLEGE, PA., 16801

TEST BORING LOG

FILE NO. 79007

Name <u>United States Radium Corp.</u>		Gnd. Elev. _____	Date <u>2/20 & 2/21/79</u>
Location <u>4150 Old Berwick Road</u>			Boring No. <u>9</u>
<u>Bloomsburg, Pa.</u>		Depth to Water	Station _____
Insp. or Eng. <u>Ed Maier</u>		Ft. <u>19.0</u>	Offset _____
Driller <u>Gene Wieand</u>		After <u>1.0</u> Hrs.	Sheet <u>1</u> of <u>1</u>

Rig No. _____	Casing Size <u>6"</u>	Spoon Size <u>N/A</u>
Depth of Soil <u>30.0</u>	Hammer Wt. <u>N/A</u>	Hammer Wt. <u>N/A</u>
Depth of Rock <u>0.0</u>	Hammer Drop <u>N/A</u>	Hammer Drop <u>N/A</u>
Total Depth <u>30.0</u>	Core Bit Size <u>N/A</u>	Bit No. <u>N/A</u>

BORING LOG		SPOON SAMPLE & ROCK CORE DATA							REMARKS	Casing blows				
Depth from to	Material Description	Sample		Blows on Spoon					Run No.	Depth of Run	Core Rec.	% Core Rec.		
		No.	Depth	0	6	12	18	24						
0.0	Light Brown Sand and Sandstone Boulders													1'
19.0														2'
														3'
														4'
19.0	Light Brown Sand and Gravel													5'
30.0														6'
														7'
														8'
														9'
														10'
														11'
														12'
														13'
														14'
														15'
														16'
														17'
														18'
														19'
														20'
														21'
														22'
														23'
														24'
														25'
														26'

SOIL DESCRIPTION:

1. Kind - Clay, Silt, Sand, Etc.
2. Color - Light, Medium, Dark, Etc.
3. Moisture - Dry, Moist, Wet, Etc.
4. Compaction - Loose, Compact, Etc.

ROCK DESCRIPTION:

1. Kind - Sandstone, Shale, Etc.
2. Condition - Solid, Broken, Etc.
3. Hardness - Soft, Medium, Hard Very Hard, Etc.

LEGEND

- T - Trace, LT - Light, MD - Medium, DK - Dark, D - Dry
M - Moist, W - Wet, VW - Very Wet, H - Hard, S - Soft
L - Loose, C - Compact, SLD - Solid, B - Broken
BB - Badly Broken, W/- With, MS - Mud Seams, Rec. - Recovered

UNI-TEC

1234 E. COLLEGE AVE.

814-238-8223

STATE COLLEGE, PA., 16801

TEST BORING LOG

FILE NO. 79007

Name <u>United States Radium Corp.</u>		Date <u>2/13/79</u>	
Location <u>4150 Old Berwick Road</u> <u>Bloomsburg, Pa.</u>		Boring No. <u>10</u>	
Insp. or Eng. <u>Ed Meiser</u>		Station _____	
Driller <u>V. Dye, D. Ritchey</u>		Offset _____	
Gnd. Elev. _____		Sheet <u>1</u> of <u>1</u>	
Depth to Water <u>7.5</u>			
After <u>24</u> Hrs.			

Rig No. <u>M-1</u>	Casing Size <u>8" HSA</u>	Spoon Size <u>2"</u>
Depth of Soil <u>20.0</u>	Hammer Wt. <u>N/A</u>	Hammer Wt. <u>140#</u>
Depth of Rock <u>0.0</u>	Hammer Drop <u>N/A</u>	Hammer Drop <u>30"</u>
Total Depth <u>20.0</u>	Core Bit Size <u>N/A</u>	Bit No. <u>N/A</u>

BORING LOG		SPOON SAMPLE & ROCK CORE DATA							REMARKS		Casing blows			
Depth from to	Material Description	Sample		Blows on Spoon				Run No.	Depth of Run	Core Rec.	% Core Rec.		1'	
		No.	Depth	0	6	12	18						24	2'
0.0 2.0	Dark Brown Silt	1	2.0	13	10	2	5						3'	
													4'	
2.0 4.0	Dark Brown Silty Sand	2	2.0	1	2	2	2						5'	
													6'	
4.0 6.0	Brown Silt, Trace of Sand, Moist	3	2.0	2	3	5	15						7'	
													8'	
6.0 8.0	Brown Silt, Trace of Sand Small River Rock	4	2.0	10	19	18	20					Water at 7.5'	9'	
													10'	
8.0 10.0	Same	5	2.0	9	15	16	18					No recovery	11'	
													12'	
10.0 12.0	Same	6	2.0	27	28	33	48						13'	
													14'	
12.0 14.0	Coarse Sand, River Rock	7	2.0	48	38	21	44						15'	
													16'	
14.0 16.0	Coarse Sand, River Rock	8	2.0	15	22	29	34						17'	
													18'	
16.0 18.0	Brown Sand, River Rock	9	2.0	18	30	36	43						19'	
													20'	
18.0 20.0	Brown Sand, Rover Rock	10	2.0	21	27	33	52						21'	
													22'	
												bet monitoring well	23'	
												15' slotted	24'	
												7' solid	25'	
													26'	

SOIL DESCRIPTION:

1. Kind - Clay, Silt, Sand, Etc.
2. Color - Light, Medium, Dark, Etc.
3. Moisture - Dry, Moist, Wet, Etc.
4. Compaction - Loose, Compact, Etc.

ROCK DESCRIPTION:

1. Kind - Sandstone, Shale, Etc.
2. Condition - Solid, Broken, Etc.
3. Hardness - Soft, Medium, Hard Very Hard, Etc.

LEGEND

- T - Trace, LT - Light, MD - Medium, DK - Dark, D - Dry
M - Moist, W - Wet, VW - Very Wet, H - Hard, S - Soft
L - Loose, C - Compact, SLD - Solid, B - Broken
BB - Badly Broken, W/- With, MS - Mud Seams, Rec. - Recovery

1234 E. COLLEGE AVE.

814-238-8223

STATE COLLEGE, PA., 16801

TEST BORING LOG

FILE NO. 79007

Name <u>United States Radium Corp.</u>	Gnd. Elev. _____ Depth to Water _____ Ft. _____ After _____ Hrs.	Date <u>3/2/79</u>
Location <u>4150 Old Berwick Road</u> <u>Bloomsburg, Pa.</u>		Boring No. <u>11</u>
Insp. or Eng. <u>Ed Meiser</u>		Station _____
Driller <u>Gene Wieand</u>		Offset _____ Sheet <u>1</u> of <u>1</u>

Rig No.	M-1	Casing Size	6"	Spoon Size	N/A
Depth of Soil	30.0	Hammer Wt.	N/A	Hammer Wt.	N/A
Depth of Rock	0.0	Hammer Drop	N/A	Hammer Drop	N/A
Total Depth	30.0	Core Bit Size	N/A	Bit No.	N/A

[illegible]

SOIL DESCRIPTION:

1. Kind - Clay, Silt, Sand, Etc.
2. Color - Light, Medium, Dark, Etc.
3. Moisture - Dry, Moist, Wet, Etc.
4. Compaction - Loose, Compact, Etc.

ROCK DESCRIPTION:

1. Kind - Sandstone, Shale, Etc.
2. Condition - Solid, Broken, Etc.
3. Hardness - Soft, Medium, Hard
Very Hard, Etc.

LEGEND

- T- Trace , LT- Light , MD- Medium , DK- Dark , D- Dry
M- Moist , W- Wet , VW- Very Wet , H- Hard , S- Soft
L- Loose , C- Compact , SLD- Solid , B- Broken
BB- Badly Broken , W/- With , MS- Mud Seams, Rec.- Recovery

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15

1234 E. COLLEGE AVE.

814-238-8223

STATE COLLEGE, PA., 16801

TEST BORING LOG

FILE NO. 79007

Name <u>United States Radium Corp.</u>	Gnd. Elev. _____ Depth to Water _____ Ft. _____ After _____ Hrs.	Date <u>3/1/79</u>
Location <u>4150 Old Berwick Road</u> <u>Bloomsburg, Pa.</u>		Boring No. <u>12</u>
Insp. or Eng. <u>Ed Meiser</u>		Station _____
Driller <u>Gene Wieand</u>		Offset _____
		Sheet <u>1</u> of <u>1</u>

Rig No. <u>M-1</u>	Casing Size <u>6"</u>	Spoon Size <u>N/A</u>
Depth of Soil <u>37.0</u>	Hammer Wt. <u>N/A</u>	Hammer Wt. <u>N/A</u>
Depth of Rock <u>0.0</u>	Hammer Drop <u>N/A</u>	Hammer Drop <u>N/A</u>
Total Depth <u>37.0</u>	Core Bit Size <u>N/A</u>	Bit No. <u>N/A</u>

BORING LOG		SPOON SAMPLE & ROCK CORE DATA								REMARKS	Casing blows		
Depth from to	Material Description	Sample		Blows on Spoon				Run No.	Depth of Run	Core Rec.	% Core Rec.		
		No.	Depth	0	6	12	18						
0.0	Light Brown Sand and Boulders												1'
16.0													2'
16.0	Sand and Gravel												3'
35.5													4'
35.5	Gray Rock												5'
37.0													6'
													7'
													8'
													9'
													10'
													11'
													12'
													13'
													14'
													15'
													16'
													17'
													18'
													19'
													20'
													21'
													22'
													23'
													24'
													25'
													26'

SOIL DESCRIPTION:

1. Kind - Clay, Silt, Sand, Etc.
2. Color - Light, Medium, Dark, Etc.
3. Moisture - Dry, Moist, Wet, Etc.
4. Compaction - Loose, Compact, Etc.

ROCK DESCRIPTION:

1. Kind - Sandstone, Shale, Etc.
2. Condition - Solid, Broken, Etc.
3. Hardness - Soft, Medium, Hard Very Hard, Etc.

LEGEND

T - Trace, LT - Light, MD - Medium, DK - Dark, D - Dry
M - Moist, W - Wet, VW - Very Wet, H - Hard, S - Soft
L - Loose, C - Compact, SLD - Solid, B - Broken
BB - Badly Broken, W/- With, MS - Mud Seams, Rec. - Recovery

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814-238-8223

STATE COLLEGE, PA., 16801

TEST BORING LOG

FILE NO. 79007

Name <u>United States Radium Corp.</u>		Gnd. Elev. _____ Depth to Water _____ Ft. <u>None</u> After _____ Hrs.	Date <u>2/22/79</u>
Location <u>4150 Old Berwick Road</u> <u>Bloomsburg, Pa.</u>			Boring No. <u>12</u>
Insp. or Eng. <u>Ed Meiser</u>			Station _____
Driller <u>V. Dye, D. Ritchey</u>			Offset _____
			Sheet <u>1</u> of <u>1</u>

Rig No. <u>M-1</u>	Casing Size <u>8" HSA</u>	Spoon Size <u>2"</u>
Depth of Soil <u>5.0</u>	Hammer Wt. <u>N/A</u>	Hammer Wt. <u>140#</u>
Depth of Rock <u>0.0</u>	Hammer Drop <u>N/A</u>	Hammer Drop <u>30"</u>
Total Depth <u>5.0</u>	Core Bit Size <u>N/A</u>	Bit No. <u>N/A</u>

BORING LOG		SPOON SAMPLE & ROCK CORE DATA								REMARKS	Casing blows				
Depth from to	Material Description	Sample		Blows on Spoon					Run No.	Depth of Run	Core Rec.	% Core Rec.		1'	2'
		No.	Depth	0	6	12	18	24							
0.0 2.0	Light to Dark Brown Silt w/Gravel	1	2.0	6	6	4								3'	4'
2.0 4.0	Light Brown Sandy Silt, Moist, w/River Rock	2	2.0	10	12	17	35							5'	6'
4.0 5.0	Coarse Gravel w/Sand-stone Boulder	3	0.9	38	61								Spoon & Auger refusal	7'	8'
														9'	10'
														11'	12'
														13'	14'
														15'	16'
														17'	18'
														19'	20'
														21'	22'
														23'	24'
														25'	26'

SOIL DESCRIPTION:

1. Kind - Clay, Silt, Sand, Etc.
2. Color - Light, Medium, Dark, Etc.
3. Moisture - Dry, Moist, Wet, Etc.
4. Compaction - Loose, Compact, Etc.

ROCK DESCRIPTION:

1. Kind - Sandstone, Shale, Etc.
2. Condition - Solid, Broken, Etc.
3. Hardness - Soft, Medium, Hard Very Hard, Etc.

LEGEND

T- Trace, LT- Light, MD- Medium, DK- Dark, D- Dry
M- Moist, W- Wet, VW- Very Wet, H- Hard, S- Soft
L- Loose, C- Compact, SLD- Solid, B- Broken
BB- Badly Broken, W/- With, MS- Mud Seams, Rec.- Recovered

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1234 E. COLLEGE AVE.

814-238-8223

STATE COLLEGE, PA., 16801

TEST BORING LOG

FILE NO. 79007

Name <u>United States Radium Corp.</u>	Gnd. Elev. _____	Date <u>2/20/79</u>
Location <u>4150 Old Berwick Road</u>	Depth to Water _____	Boring No. <u>13</u>
<u>Bloomsburg, Pa.</u>	Ft. <u>32.0</u>	Station _____
Insp. or Eng. <u>Ed Meiser</u>	After <u>1.0</u> Hrs.	Offset _____
Driller <u>Gene Wieand</u>		Sheet <u>1</u> of <u>1</u>

Rig No. _____	Casing Size <u>6"</u>	Spoon Size <u>N/A</u>
Depth of Soil <u>30.0</u>	Hammer Wt. <u>N/A</u>	Hammer Wt. <u>N/A</u>
Depth of Rock <u>0.0</u>	Hammer Drop <u>N/A</u>	Hammer Drop <u>N/A</u>
Total Depth <u>30.0</u>	Core Bit Size <u>N/A</u>	Bit No. <u>N/A</u>

BORING LOG		SPOON SAMPLE & ROCK CORE DATA								REMARKS		Casing blows			
Depth from to	Material Description	Sample		Blows on Spoon					Run No.	Depth of Run	Core Rec.	% Core Rec.		1'	
		No.	Depth	0	6	12	18	24							
0.0 16.0	Light Brown Sand w/Sandstone Boulders												Water @ 14.0'	3'	
16.0 30.0	Light Brown Sand w/Gravel												Set 32.0 Ft. of 6" Casing	5'	
														6'	
														7'	
														8'	
														9'	
														10'	
														11'	
														12'	
														13'	
														14'	
														15'	
														16'	
														17'	
														18'	
														19'	
														20'	
														21'	
														22'	
														23'	
														24'	
														25'	
														26'	

SOIL DESCRIPTION:

1. Kind - Clay, Silt, Sand, Etc.
2. Color - Light, Medium, Dark, Etc.
3. Moisture - Dry, Moist, Wet, Etc.
4. Compaction - Loose, Compact, Etc.

ROCK DESCRIPTION:

1. Kind - Sandstone, Shale, Etc.
2. Condition - Solid, Broken, Etc.
3. Hardness - Soft, Medium, Hard Very Hard, Etc.

LEGEND

- T - Trace, LT - Light, MD - Medium, DK - Dark, D - Dry
M - Moist, W - Wet, VW - Very Wet, H - Hard, S - Soft
L - Loose, C - Compact, SLD - Solid, B - Broken
BB - Badly Broken, W/- With, MS - Mud Seams, Rec. - Recovered

UNI-TEC

1234 E. COLLEGE AVE.

814-238-8223

STATE COLLEGE, PA., 16801

TEST BORING LOG

FILE NO. 79007

Name <u>United States Radium Corp.</u>	Gnd. Elev. _____	Date <u>2/22/79</u>
Location <u>4150 Old Berwick Road</u>	Depth to Water _____	Boring No. <u>13</u>
<u>Bloomsburg, Pa.</u>	Fl. <u>None</u>	Station _____
Insp. or Eng. <u>Ed Meiser</u>	After <u>1</u> Hrs.	Offset _____
Driller <u>V. Dye, D. Ritchey</u>		Sheet <u>1</u> of <u>1</u>

Rig No. <u>M-1</u>	Casing Size <u>8" HSA</u>	Spoon Size <u>2"</u>
Depth of Soil <u>8.0</u>	Hammer Wt. <u>N/A</u>	Hammer Wt. <u>140#</u>
Depth of Rock <u>0.0</u>	Hammer Drop <u>N/A</u>	Hammer Drop <u>30"</u>
Total Depth <u>8.0</u>	Core Bit Size <u>N/A</u>	Bit No. <u>N/A</u>

BORING LOG		SPOON SAMPLE & ROCK CORE DATA								REMARKS	Casing blows			
Depth from to	Material Description	Sample		Blows on Spoon				Run No.	Depth of Run	Core Rec.	% Core Rec.		1'	2'
		No.	Depth	0	6	12	18							
0.0 / 2.0	Silt River Rock Gravel	1	2.0	3	14	8	7						3'	
2.0 / 4.0	Silt, River Rock w/Sandstone Boulders	2	2.0	8	13	21	26						5'	
4.0 / 6.0	Same	3	2.0	22	28	39	40						7'	
6.0 / 8.0	Same	4	2.0	34	32	28	52					Spoon & Auger refusal	9'	
													10'	
													11'	
													12'	
													13'	
													14'	
													15'	
													16'	
													17'	
													18'	
													19'	
													20'	
													21'	
													22'	
													23'	
													24'	
													25'	
													26'	

SOIL DESCRIPTION:

1. Kind - Clay, Silt, Sand, Etc.
2. Color - Light, Medium, Dark, Etc.
3. Moisture - Dry, Moist, Wet, Etc.
4. Compaction - Loose, Compact, Etc.

ROCK DESCRIPTION:

1. Kind - Sandstone, Shale, Etc.
2. Condition - Solid, Broken, Etc.
3. Hardness - Soft, Medium, Hard Very Hard, Etc.

LEGEND

- T - Trace, LT - Light, MD - Medium, DK - Dark, D - Dry
M - Moist, W - Wet, VW - Very Wet, H - Hard, S - Soft
L - Loose, C - Compact, SLD - Solid, B - Broken
BB - Badly Broken, W/- With, MS - Mud Seams, Rec. - Recovered

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1234 E. COLLEGE AVE.

814-238-8223

STATE COLLEGE, PA., 16801

TEST BORING LOG

FILE NO. 79007

Name <u>United States Radium Corp.</u>		Date <u>2/14 & 2/15/79</u>	
Location <u>4150 Old Berwick Road</u>		Boring No. <u>14</u>	
<u>Bloomsburg, Pa.</u>		Station <u></u>	
Insp. or Eng. <u>Ed Meiser</u>		Offset <u></u>	
Driller <u>Gene Wieand</u>		Sheet <u>1</u> of <u>1</u>	
Gnd. Elev. <u></u>		Depth to Water <u>18.0</u>	
Ft. <u>18.0</u>		After <u>1.0</u> Hrs.	

Rig No. <u></u>	Casing Size <u>6"</u>	Spoon Size <u>N/A</u>
Depth of Soil <u>30.0</u>	Hammer Wt. <u>N/A</u>	Hammer Wt. <u>N/A</u>
Depth of Rock <u>0.0</u>	Hammer Drop <u>N/A</u>	Hammer Drop <u>N/A</u>
Total Depth <u>30.0</u>	Core Bit Size <u>N/A</u>	Bit No. <u>N/A</u>

BORING LOG		SPOON SAMPLE & ROCK CORE DATA								REMARKS	Casing blows		
Depth from to	Material Description	Sample		Blows on Spoon				Run No.	Depth of Run	Core Rec.	% Core Rec.		
		No.	Depth	0	6	12	18						
0.0	Light Brown Sand w/ Sandstone Boulders											Water @ 18.0'	1'
18.0													2'
18.0	Light Brown Sand w/Gravel											Set 32.0 Ft. of 6" Casing	3'
30.0													4'
													5'
													6'
													7'
													8'
													9'
													10'
													11'
													12'
													13'
													14'
													15'
													16'
													17'
													18'
													19'
													20'
													21'
													22'
													23'
													24'
													25'
													26'

SOIL DESCRIPTION:

1. Kind - Clay, Silt, Sand, Etc.
2. Color - Light, Medium, Dark, Etc.
3. Moisture - Dry, Moist, Wet, Etc.
4. Compaction - Loose, Compact, Etc.

ROCK DESCRIPTION:

1. Kind - Sandstone, Shale, Etc.
2. Condition - Solid, Broken, Etc.
3. Hardness - Soft, Medium, Hard Very Hard, Etc.

LEGEND

- T - Trace, LT - Light, MD - Medium, DK - Dark, D - Dry
M - Moist, W - Wet, VW - Very Wet, H - Hard, S - Soft
L - Loose, C - Compact, SLD - Solid, B - Broken
BB - Badly Broken, W/- With, MS - Mud Seams, Rec. - Recovered

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814-238-8223

STATE COLLEGE, PA., 16801

TEST BORING LOG

FILE NO. 79007

Name <u>United States Radium Corp.</u>	Gnd. Elev. _____	Date <u>1/31/79</u>
Location <u>4150 Old Berwick Road</u>	Depth to Water _____	Boring No. <u>I.B. #14</u>
<u>Bloomsburg, Pa.</u>	Ft. <u>None</u>	Station _____
Insp. or Eng. <u>Ed Meiser</u>	After _____ Hrs.	Offset _____
Driller <u>V. Dye, D. Ritchey</u>		Sheet <u>1</u> of <u>1</u>

Rig No. <u>M-1</u>	Casing Size <u>8" HSA</u>	Spoon Size <u>2"</u>
Depth of Soil <u>7.0</u>	Hammer Wt. <u>N/A</u>	Hammer Wt. <u>140#</u>
Depth of Rock <u>0.0</u>	Hammer Drop <u>N/A</u>	Hammer Drop <u>30"</u>
Total Depth <u>7.0</u>	Core Bit Size <u>N/A</u>	Bit No. <u>N/A</u>

BORING LOG		SPOON SAMPLE & ROCK CORE DATA								REMARKS	Casing blows				
Depth from to	Material Description	Sample		Blows on Spoon						Run No.	Depth of Run	Core Rec.	% Core Rec.		
		No.	Depth	0	6	12	18	24							
0.0	Moist Dark Brown Silt to Moist Brown Silty Clay	1	2.0	2	3	3	10							1'	
2.0														2'	
2.0	Moist Brown Silty Clay w/Sandstone & Pebbles	2	2.0	11	16	21	27							3'	
4.0														4'	
4.0	Same												Tri-cone Refusal	7'	
7.0														8'	
														9'	
														10'	
														11'	
														12'	
														13'	
														14'	
														15'	
														16'	
														17'	
														18'	
														19'	
														20'	
														21'	
														22'	
														23'	
														24'	
														25'	
														26'	

SOIL DESCRIPTION:

1. Kind - Clay, Silt, Sand, Etc.
2. Color - Light, Medium, Dark, Etc.
3. Moisture - Dry, Moist, Wet, Etc.
4. Compaction - Loose, Compact, Etc.

ROCK DESCRIPTION:

1. Kind - Sandstone, Shale, Etc.
2. Condition - Solid, Broken, Etc.
3. Hardness - Soft, Medium, Hard Very Hard, Etc.

LEGEND

- T - Trace, LT - Light, MD - Medium, DK - Dark, D - Dry
M - Moist, W - Wet, VW - Very Wet, H - Hard, S - Soft
L - Loose, C - Compact, SLD - Solid, B - Broken
BB - Badly Broken, W/- With, MS - Mud Seams, Rec. - Recover

UNI-TEC

1234 E. COLLEGE AVE.

814-238-8223

STATE COLLEGE, PA., 16801

TEST BORING LOG

FILE NO. 79007

Name <u>United States Radium Corp.</u>	Gnd. Elev. _____	Date <u>2/15/79</u>
Location <u>4150 Old Berwick Road</u>	Depth to Water _____	Boring No. <u>15</u>
<u>Bloomsburg, Pa.</u>	Ft. <u>26.0</u>	Station _____
Insp. or Eng. <u>Ed Meiser</u>	After <u>1.0</u> Hrs.	Offset _____
Driller <u>Gene Wieand</u>		Sheet <u>1</u> of <u>1</u>

Rig No. _____	Casing Size <u>6"</u>	Spoon Size <u>N/A</u>
Depth of Soil <u>35.0</u>	Hammer Wt. <u>N/A</u>	Hammer Wt. <u>N/A</u>
Depth of Rock <u>0.0</u>	Hammer Drop <u>N/A</u>	Hammer Drop <u>N/A</u>
Total Depth <u>35.0</u>	Core Bit Size <u>N/A</u>	Bit No. <u>N/A</u>

BORING LOG		SPOON SAMPLE & ROCK CORE DATA								REMARKS	Casing blows				
Depth from to	Material Description	Sample		Blows on Spoon					Run No.	Depth of Run	Core Rec.	% Core Rec.		1'	
		No.	Depth	0	6	12	18	24						2'	
0.0	Light Brown Sand w/ Sandstone Boulders													3'	
25.0														4'	
25.0	Light Brown Sand w/Gravel												Water @ 26.0'	5'	
35.0														6'	
													Set 37.0' of 6" Casing Pipe	7'	
														8'	
														9'	
														10'	
														11'	
														12'	
														13'	
														14'	
														15'	
														16'	
														17'	
														18'	
														19'	
														20'	
														21'	
														22'	
														23'	
														24'	
														25'	
														26'	

SOIL DESCRIPTION:

1. Kind - Clay, Silt, Sand, Etc.
2. Color - Light, Medium, Dark, Etc.
3. Moisture - Dry, Moist, Wet, Etc.
4. Compaction - Loose, Compact, Etc.

ROCK DESCRIPTION:

1. Kind - Sandstone, Shale, Etc.
2. Condition - Solid, Broken, Etc.
3. Hardness - Soft, Medium, Hard Very Hard, Etc.

LEGEND

- T - Trace, LT - Light, MD - Medium, DK - Dark, D - Dry
M - Moist, W - Wet, VW - Very Wet, H - Hard, S - Soft
L - Loose, C - Compact, SLD - Solid, B - Broken
BB - Badly Broken, W/- With, MS - Mud Seams, Rec. - Recov

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1234 E. COLLEGE AVE.

814-238-8223

STATE COLLEGE, PA., 16801

TEST BORING LOG

FILE NO. 79007

Name <u>United States Radium Corp.</u>		Date <u>1/30/79</u>	
Location <u>4150 Old Berwick Road</u>		Boring No. <u>15</u>	
<u>Bloomsburg, Pa.</u>		Station <u></u>	
Insp. or Eng. <u>Ed Meiser</u>		Offset <u></u>	
Driller <u>V. Dye, D. Ritchey</u>		Sheet <u>1</u> of <u>1</u>	
Gnd. Elev. <u></u>		Depth to Water <u>None</u>	
Ft. <u></u>		After <u></u> Hrs. <u></u>	

Rig No. <u>M-1</u>	Casing Size <u>8" HSA</u>	Spoon Size <u>2"</u>
Depth of Soil <u>6.0</u>	Hammer Wt. <u>N/A</u>	Hammer Wt. <u>140#</u>
Depth of Rock <u>0.0</u>	Hammer Drop <u>N/A</u>	Hammer Drop <u>30"</u>
Total Depth <u>6.0</u>	Core Bit Size <u>N/A</u>	Bit No. <u>N/A</u>

BORING LOG		SPOON SAMPLE & ROCK CORE DATA								REMARKS	Casing blows			
Depth from to	Material Description	Sample		Blows on Spoon				Run No.	Depth of Run	Core Rec.	% Core Rec.		1'	
		No.	Depth	0	6	12	18							
0.0	Moist Dark Brown Silt to	1	2.0	2	5	5	10						3'	
2.0	Moist Brown Silty Clay w/												4'	
4.0	Moist Brown Sandy Silt w/	2	2.0	10	12	17	23						5'	
6.0	Shale & Sandstone Frag. & Pebbles												6'	
8.0	Moist Brown Silty Clay to	3	2.0	17	21	29	34						7'	
10.0	Dry Gray Silt w/Lime-stone & River Rock Fragments												8'	
												Auger Tricone & Refusal	9'	
													10'	
													11'	
													12'	
													13'	
													14'	
													15'	
													16'	
													17'	
													18'	
													19'	
													20'	
													21'	
													22'	
													23'	
													24'	
													25'	
													26'	

SOIL DESCRIPTION:

1. Kind - Clay, Silt, Sand, Etc.
2. Color - Light, Medium, Dark, Etc.
3. Moisture - Dry, Moist, Wet, Etc.
4. Compaction - Loose, Compact, Etc.

ROCK DESCRIPTION:

1. Kind - Sandstone, Shale, Etc.
2. Condition - Solid, Broken, Etc.
3. Hardness - Soft, Medium, Hard Very Hard, Etc.

LEGEND

- T - Trace, LT - Light, MD - Medium, DK - Dark, D - Dry
M - Moist, W - Wet, VW - Very Wet, H - Hard, S - Soft
L - Loose, C - Compact, SLD - Solid, B - Broken
BB - Badly Broken, W/- With, MS - Mud Seams, Rec. - Recycled

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STATE COLLEGE, PA., 16801

TEST BORING LOG

FILE NO. 79007

Name <u>United States Radium Corp.</u>	Gnd. Elev. _____	Date <u>2/8 & 2/14/79</u>
Location <u>4150 Old Berwick Road</u>	Depth to Water _____	Boring No. <u>16</u>
<u>Bloomsburg, Pa.</u>	Ft. <u>26.0</u>	Station _____
Insp. or Eng. <u>Ed Meiser</u>	After <u>1.0</u> Hrs.	Offset _____
Driller <u>Gene Wieand</u>		Sheet <u>1</u> of <u>1</u>

Rig No. _____	Casing Size <u>6"</u>	Spoon Size <u>N/A</u>
Depth of Soil <u>35.0</u>	Hammer Wt. <u>N/A</u>	Hammer Wt. <u>N/A</u>
Depth of Rock <u>0.0</u>	Hammer Drop <u>N/A</u>	Hammer Drop <u>N/A</u>
Total Depth <u>35.0</u>	Core Bit Size <u>N/A</u>	Bit No. <u>N/A</u>

BORING LOG		SPOON SAMPLE & ROCK CORE DATA								REMARKS	Casing blows							
Depth from to	Material Description	Sample		Blows on Spoon						Run No.	Depth of Run	Core Rec.	% Core Rec.		1'		2'	
		No.	Depth	0	6	12	18	24										
0.0	Light Brown Sand w/ Sandstone Boulders																	
25.0																		
26.0		Light Brown Sand w/Gravel												Water @ 26.0'				
35.0																		
														Set 37.0' of 6"				
														steel casing, 20.0'				
													of 2" PVC slotted					
													11.0' of 2" PVC					
													solid.					

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TEST BORING LOG

FILE NO. 79007

Name <u>United States Radium Corp.</u>	Gnd. Elev. _____	Date <u>1/29/79</u>
Location <u>4150 Old Berwick Road</u>	Depth to Water _____	Boring No. <u>16</u>
<u>Bloomsburg, Pa.</u>	Ft. <u>None</u>	Station _____
Insp. or Eng. <u>Ed Meiser</u>	After _____ Hrs.	Offset _____
Driller <u>V. Dye, D. Ritchey</u>		Sheet <u>1</u> of <u>1</u>

Rig No. <u>M-1</u>	Casing Size <u>8" HSA</u>	Spoon Size <u>2"</u>
Depth of Soil <u>15.0</u>	Hammer Wt. <u>N/A</u>	Hammer Wt. <u>140#</u>
Depth of Rock <u>0.0</u>	Hammer Drop <u>N/A</u>	Hammer Drop <u>30"</u>
Total Depth <u>15.0</u>	Core Bit Size <u>N/A</u>	Bit No. <u>N/A</u>

BORING LOG		SPOON SAMPLE & ROCK CORE DATA								REMARKS		Casing blows		
Depth from to	Material Description	Sample Blows on Spoon						Run No.	Depth of Run	Core Rec.	% Core Rec.		1'	
		No.	Depth	0	6	12	18						24	2'
0.0 / 2.0	Dark Brn. Silt w/organic material & River Rock	1	2.0	3	5	7	11						3'	
2.0 / 4.0	Moist Brn. Silty Clay w/ Sandstone Pebbles	2	2.0	5	8	10	12						4'	
4.0 / 6.0	Same	3	2.0	8	17	24	30						5'	
6.0 / 8.0	Moist Brown Sandy Silt w/Multi-colored River Rock	4	2.0	15	19	23	25						6'	
8.0 / 10.0	No Recovery	5	2.0	18	21	25	31						7'	
10.0 / 12.0	No Recovery	6	2.0	21	26	36	43						8'	
12.0 / 15.0	Moist Light Brown Sand & River Rock											Tri-cone Refusal	9'	
													10'	
													11'	
													12'	
													13'	
													14'	
													15'	
													16'	
													17'	
													18'	
													19'	
													20'	
													21'	
													22'	
													23'	
													24'	
													25'	
													26'	

SOIL DESCRIPTION:

1. Kind - Clay, Silt, Sand, Etc.
2. Color - Light, Medium, Dark, Etc.
3. Moisture - Dry, Moist, Wet, Etc.
4. Compaction - Loose, Compact, Etc.

ROCK DESCRIPTION:

1. Kind - Sandstone, Shale, Etc.
2. Condition - Solid, Broken, Etc.
3. Hardness - Soft, Medium, Hard Very Hard, Etc.

LEGEND

- T - Trace, LT - Light, MD - Medium, DK - Dark, D - Dry
M - Moist, W - Wet, VW - Very Wet, H - Hard, S - Soft
L - Loose, C - Compact, SLD - Solid, B - Broken
BB - Badly Broken, W/- With, MS - Mud Seams, Rec. - Recovered

TEST BORING LOG

FILE NO. 79007

UNI-TEC

UNIVERSAL TECHNICAL, INC.

Name United States Radium Corp.		Location 4150 Old Berwick Road Bloombsburg, Pa.		Insp. or Eng. Ed Meiser		Driller V. Dye, D. Ritchey	
Date 2/28/79		Boring No. 18		Station Offset		Sheet 1 of 1	
Gnd Elev Depth to Water Ft. After 1.0 Hrs.							

Rig No.	M-1	Casing Size	8" HSA	Spoon Size	2"
Depth of Soil	20.0	Hammer Wt.	N/A	Hammer Wt.	140#
Depth of Rock	0.0	Hammer Drop	N/A	Hammer Drop	30"
Total Depth	20.0	Core Bit Size	N/A	Bit No.	N/A

BORING LOG		SPOON SAMPLE & ROCK CORE DATA										REMARKS			
Depth from to	Material Description	Sample					No. Depth	Blows on Spoon				Run of Depth	Core Rec	% Core Rec	
		1	2.0	5	6	12		18	24	Run No.	Run of Depth				Core Rec
0.0	Loose Topsoil	1	2.0	5	5	1	1								
2.0	Light Brown Silt, Fine Sand w/River Rock	2	2.0	4	4	4	4								
4.0	Light Brown Silt, Fine Sand, River Rock, Some Clay	3	2.0	3	6	21	21								
6.0	Light Brown Silt, Fine Sand, River Rock, Very Wet	4	2.0	13	13	31	28								
8.0	Same	5	2.0	12	46	15	27								
10.0	Light Brown Silt, Some Sand, River Rock, Very Wet w/Shale	6	2.0	7	13	14	17								
12.0	River Rock w/Sand	7	2.0	8	14	18	7								
14.0	Same	8	2.0	7	10	3	5								
16.0	Running Sand, River Rock	9	2.0	2	2	3	2								
18.0	Same														
20.0	Same														
21'	Set monitoring well, 15' slotted, 7 feet solid														
22'															
23'															
24'															
25'															
26'															

SOIL DESCRIPTION:

1. Kind - Clay, Silt, Sand, Etc.
 2. Color - Light, Medium, Dark, Etc.
 3. Moisture - Dry, Moist, Wet, Etc.
 4. Compaction - Loose, Compact, Etc.

ROCK DESCRIPTION:

1. Kind - Sandstone, Shale, Etc.
 2. Condition - Solid, Broken, Etc.
 3. Hardness - Soft, Medium, Hard
 Very Hard, Etc.

T - Trace, LT - Light, MD - Medium, DK - Dark, D - Dry
 M - Moist, W - Wet, VW - Very Wet, H - Hard, S - Soft
 L - Loose, C - Compact, SLD - Solid, B - Broken
 BB - Badly Broken, W/- With, MS - Mud Seams, Rec - Recovers

UNI-TEC

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814-238-8223

STATE COLLEGE, PA., 16801

TEST BORING LOG

FILE NO. 79007

Name <u>United States Radium Corp.</u>	Gnd. Elev. _____	Date <u>2/26/79</u>
Location <u>4150 Old Berwick Road</u>	Depth to Water _____	Boring No. <u>19</u>
<u>Bloomsburg, Pa.</u>	Ft. <u>5.2</u>	Station _____
Insp. or Eng. <u>Ed Meiser</u>	After <u>1.0</u> Hrs.	Offset _____
Driller <u>V. Dye, D. Ritchey</u>		Sheet <u>1 of 1</u>

Rig No. <u>M-1</u>	Casing Size <u>8" HSA</u>	Spoon Size <u>2"</u>
Depth of Soil <u>20.0</u>	Hammer Wt. <u>N/A</u>	Hammer Wt. <u>140#</u>
Depth of Rock <u>0.0</u>	Hammer Drop <u>N/A</u>	Hammer Drop <u>30"</u>
Total Depth <u>20.0</u>	Core Bit Size <u>N/A</u>	Bit No. <u>N/A</u>

BORING LOG		SPOON SAMPLE & ROCK CORE DATA								REMARKS	Casing blows				
Depth from to	Material Description	Sample		Blows on Spoon					Run No.	Depth of Run	Core Rec.	% Core Rec.		1'	
		No.	Depth	0	6	12	18	24						2'	
0.0 / 2.0	Light Brown Sandy Silt	1	2.0	1	2	5	6							3'	
														4'	
2.0 / 4.0	Same	2	2.0	1	3	5	7							5'	
														6'	
4.0 / 6.0	Same	3	2.0	13	12	14	10						Water @ 5.2	7'	
														8'	
6.0 / 8.0	Light Brown Sandy Silt, Wet	4	2.0	8	7	18	8							9'	
														10'	
8.0 / 10.0	Same	5	2.0	3	2	4	6						Very Loose Soft No recovery	11'	
														12'	
10.0 / 12.0	Dark Gray Sandy Silt, River Rock	6	2.0	8	32	12	17							13'	
														14'	
12.0 / 14.0	Same	7	2.0	5	8	36	22							15'	
														16'	
14.0 / 16.0	Same	8	2.0	12	30	31	15							17'	
														18'	
16.0 / 18.0	Same	9	2.0	7	7	7	7						Mostly water	19'	
														20'	
18.0 / 20.0	Same	10	2.0	12	17	14	22						No recovery	21'	
														22'	
													Set monitoring well, 15' slotted	23'	
													7' solid	24'	
														25'	
														26'	

SOIL DESCRIPTION:

1. Kind - Clay, Silt, Sand, Etc.
2. Color - Light, Medium, Dark, Etc.
3. Moisture - Dry, Moist, Wet, Etc.
4. Compaction - Loose, Compact, Etc.

ROCK DESCRIPTION:

1. Kind - Sandstone, Shale, Etc.
2. Condition - Solid, Broken, Etc.
3. Hardness - Soft, Medium, Hard Very Hard, Etc.

LEGEND

- T - Trace, LT - Light, MD - Medium, DK - Dark, D - Dry
M - Moist, W - Wet, VW - Very Wet, H - Hard, S - Soft
L - Loose, C - Compact, SLD - Solid, B - Broken
BB - Badly Broken, W/- With, MS - Mud Seams, Rec. - Recover

Table 2B. U.S. Radium Corporation - Bloomsburg, Pa.
Meiser & Earl Logs of Selected Borings

Boring No. 1 - 10 Oct 78 - Giles Drilling Corp.

0-7 Brown silt
7-15 Brown sand and gravel
15-24 Gray brown sand and gravel

Boring No. 2 - 11 Oct 78 - Giles Drilling Corp.

0-8 Brown silt
8-12 Light brown and light gray silt and clay
12-20 Fine-medium sand and gravel; broken pebbles $\frac{1}{2}$ "-1 $\frac{1}{2}$ "
20-24 Medium-coarse sand and fine, rounded gravel, pebbles $\frac{1}{4}$ "-1"

Boring No. 3 - 12 Oct 78 - Giles Drilling Corp.

0-4 Dark brown silt, fine sand and black coal silt
4-8 Gray-brown and gray silt, trace fine sand
8-10 Brown silt and fine sand, trace gravel
10-14 Fine-medium sand and gravel, some broken chips, $\frac{1}{2}$ "-1 $\frac{1}{2}$ "
14-19 Sand and gravel, pebbles $\frac{1}{2}$ "-3/4"
19-24 Gray shale bedrock

Boring No. 4 - 22 Feb 79 - Universal Technical, Inc.

0-10 Brown silt
10-12 Brown silt, gravel, rounded pebbles
12-16 Fine sand and gravel, most pebbles $\frac{1}{2}$ "
16-20 Sand and coarse gravel, rounded pebbles to 1 $\frac{1}{2}$ "

Boring No. 5 - 20 Feb 79 - Universal Technical, Inc.

0-4 Dark brown silt and black coal silt
4-8 No sample
8-12 Coal silt and fine sand
12-16 Dark gray silty fine sand
16-20 Brown sand and gravel, pebbles avg. $\frac{1}{2}$ "-1"

Boring No. 6 - 21 Feb 79 - Universal Technical, Inc.

6-14 Gray silt
14-20 Sand and gravel, shale bedrock at bottom

Boring No. 7 - 14 Feb 79 - Universal Technical, Inc.

0-2 Brown silt
2-10 Black coal silt and fine sand, some brown silt
10-12 No sample
12-14 Brown clayey silt
14-16 Brown fine sand, silt and gravel, rounded pebbles $\frac{1}{4}$ "-1"
16-20 Fine sand and gravel, most pebbles $\frac{1}{2}$ ", up to 1 $\frac{1}{2}$ "

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 hydrogeologists

Table 2B Continued

Boring No. 8 - 20 Feb 79 - Universal Technical, Inc.

0-2 Brown silt
 2-8 Black coal silt, some brown silt and fine sand
8-12 Light brown silty fine sand, some coal silt
 12-14 Gray fine-medium sand and gravel, pebbles <1"
 14-20 Sand and gravel, pebbles up to 1½"

Well No. 9 - 21 Feb 79 - Wieand Bros. Drilling

5-15 Brown sand and gravel, many broken fragments of larger cobbles and boulders
 15-20 Sand and gravel, abundant fine gravel (pebbles ¼")
 20-25 Brown silty sand and gravel
 25-30 Brown sand and gravel, most pebbles ¼"-½"

Boring No. 10 - 13 Feb 79 - Universal Technical, Inc.

0-2 Brown silt
 2-4 Brown silt and black coal silt
4-6 Brown silty clay
 12-14 Sand and gravel, rounded pebbles to 1½"
 14-20 Sand and gravel, rounded pebbles ½"-1"

Well No. 11 - 2 Mar 79 - Wieand Bros. Drilling

0-10 Brown sand and gravel, large pebbles 2"-3" and broken fragments of boulders
 10-15 Sand and finer gravel, but abundant broken fragments of broken pebbles
 15-20 Brown silty sand and gravel, large fragments from broken cobbles and boulders
 20-30 Brown sand and gravel, finer pebbles, ¼"-½", better sorting than above materials

Well No. 12 - 1 Mar 79 - Wieand Bros. Drilling

0-10 Light brown sand and gravel, with broken fragments of cobbles and boulders
 10-15 Gray brown sand and gravel, angular fragments
 15-20 Gray brown silty sand and gravel, rounded pebbles ½"-1"
 20-30 Brown sand and gravel, most pebbles ¼"-1", abundant sand in lower 5 feet

Well No. 13 - 20 Feb 79 - Wieand Bros. Drilling

0-15 Light brown sand and gravel, with large fragments of broken cobbles and boulders
 15-25 Brown silty sand and gravel, pebbles rounded, mostly ¼"-½"
 25-30 Brown sand and fine gravel, well rounded pebbles ¼"-½", high percentage of sand, fairly well sorted

Well No. 14 - 15 Feb 74 - Wieand Bros. Drilling

0-15 Light brown sand and gravel, broken pebbles and chips of coarser cobbles
 15-20 Gray brown very silty sand and finer gravel
 20-25 Dark brown gravelly coarse sand, few small rounded pebbles ½"
 25-30 Light brown sand and fine gravel, most pebbles <¼"

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Well No. 15 - 15 Feb 79 - Wieand Bros. Drilling

0-25 Light brown sand and gravel, numerous broken fragments of cobbles and boulders, many pebbles $1\frac{1}{2}$ "

25-35 Gray brown silty sands and fine gravel, most pebbles $1/8$ "- $3/8$ "

Well No. 16 - 14 Feb 79 - Wieand Bros. Drilling

0-20 Brown sand and gravel, rounded pebbles $1/2$ "- $1\frac{1}{2}$ " plus fragments of broken larger cobbles

20-25 Brown sand with fine gravel, most pebbles $1/8$ "- $3/8$ "

25-35 Brown silty sand and fine gravel, angular pebbles

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hydrogeologists

auger or to drive casing, sample the soil inside with a split spoon every 2 feet, then set 2-inch schedule 80 PVC pipe and screen (.015" slot) in the hole for a permanent well. However, attempts at augering and/or driving casing by Universal Technical, Inc. at locations 12, 13, 14, 15 and 16 proved to be unsuccessful because of the presence of an upper layer of sand and gravel with sandstone boulders approximately 15-25 feet thick (see logs for these holes, Tables 2A and 2B). Consequently, we worked out a technique, employing an air rotary well drill (Wieand Bros. Well Drilling, Inc.) of drilling and setting 5-foot increments of 6-inch steel casing with welded joints, slotted to about 5 feet above the water table. This proved to be the only practical method for drilling and sampling this coarse, bouldery material.

The borings located down over the canal bank at the lower elevations in the active flood plain of the Susquehanna River experienced no difficulty with the bouldery gravels because this layer is not present there stratigraphically; it is replaced by silts and fine sand and silts, overlying sand and fine gravel as will be discussed in the next section (see Figure 1). The drillers did have considerable difficulty in this area in keeping the auger holes open to set the 2-inch pipe because of "running sand" or quick sand conditions in the silt and fine sand and silt. These holes are screened to within 5 feet of the surface, and have a collar of concrete grout at the surface to minimize direct infiltration of surface runoff and river flooding.

Construction details are described for each well in the drillers test boring logs (Table 2A).

Subsurface Geologic Conditions

Based on the material descriptions from the drilling logs, correction of drilling depths to actual elevations, our own inspection of the samples, and a cross section taken through the site (Figure 1), the subsurface geologic conditions are relatively straightforward. The site lies about 5 miles downstream (west) from the edge of the most recent glacial ice advance during Late Wisconsin time, 10,000 years BP. The site is clearly within the outwash plain produced by torrential flooding of ice meltwater down the Susquehanna River valley. The nearly level elevation of the shale bedrock seen in holes 3, 6, and 12 show the bedrock floor beneath the site area to be relatively horizontal, as might be expected by the area's history of glaciation and outwash flooding. Overlying the bedrock is a deposit of poorly sorted sands and gravels, the outwash plain from the melting Wisconsin glacier, approximately 35-45 feet thick under most of the plant site (see Figure 1). These materials are described in detail in the drillers logs and our own logs in Table 2A and 2B. The gravelly deposits can be subdivided into two units: a coarser, sand and gravel with large sandstone boulders, approximately 15-25 feet thick overlying sands and finer gravels above the bedrock.

In the development of the present day flood plain, of the Susquehanna, the river has cut a fairly steep bank against the sand and gravel outwash plain and deposited a blanket of silts, fine sandy silts, clayey silts, and coal silts, as seen in the geologic cross section (Figure 1).

An abandoned canal follows the upper edge of the gravel bank and has been filled in over most of the site. The two lagoons are actually remnants of the old canal (Plate 1). The canal was dug primarily in the silts and appears to have little influence on the hydrologic system. One of the backhoe test pits (No. 1) we dug encountered wood and radioactive debris filled in the old canal (see Table 3).

Table 3. U.S. Radium Corporation - Bloomsburg, Pa.
Backhoe Pit Logs

Test Pit No. 1 (50 feet toward river from SE corner of Laquer Storage building)

0-3" Dark brown silt loam topsoil, roots.

3-17" Brown and yellow-brown silt with cobbles
5"-16" <25%; some sand and silty sand.

17"-7' Dark gray sand matrix in gravel; water @ about 5' flowing 15 gpm; old fill - boards and logs, strong oily smell; evidence of radioactive materials in dump.

Test Pit No. 2 (125 feet toward river from SE corner of Laquer Storage building)

0-14" Dark brown silt, roots.

14" - 6' Brown silt, some gray vertical mottling.

6'-6½' Large cobbles - river bottom gravel.

Pits logged on March 14, 1979 by R. M. Hershey

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The compositional, textural and hydrologic-behavior contrast between the silts and the sands and gravels is striking. Furthermore, the dense shale bedrock floor defines a lower boundary to the hydrologic system of the overlying sedimentary deposits. From our inspection of the drilling samples, we estimated the permeabilities of the deposits to allow calculation of the rates of ground-water flow. Expressed in terms of flow rate through a unit area of aquifer under a hydraulic gradient of unity (i.e. slope on the water table is 1:1), we estimated the "textbook" permeability of the sands and gravels to be on the order of 1000-3000 gal/day per square foot (gpd/ft^2). For the silts, we estimated permeabilities of about 0.1 gpd/ft^2 .

As another approach to estimating permeabilities, we ran several laboratory tests on sands and gravels from wells 9 and 13, using a falling-head permeameter. The results are summarized in Table 4, and show excellent replication within any one test, but considerable variability among all samples. Our conclusion concerning these data is that the permeability of the gravels varies with increased silt content but is at least 200 gpd/ft^2 , somewhat lower than our "textbook" estimates.

Water Table Configurations

On February 21, 1979, we measured static water levels in all available wells and borings. We corrected these levels to elevations with respect to an assumed datum of elevation 0 at the center of the burial pit (Table 5). The Water Table - February 21, 1979 overlay (Plate 2) shows our interpretation of these data points as a water-table contour map; this interpretation is straightforward and justifiable for the given set of data. Basically, the water table is nearly flat in the front of the plant property; gradients

Table 4.

U.S. Radium Corporation - Bloomsburg, Pa.

Falling Head Permeameter Tests

Well	Depth Interval (ft)	$\frac{d^2}{D^2}$	l (cm)	h_o (ft)	h (ft)	t (sec)	P (cm/sec)	Avg. P (gal/day) ft ²
13	15-20	.0544	9.4	2.42	2.06	192	4.2×10^{-4}	8.5
					2.06	311	2.6×10^{-4}	
					2.12	169	4.0×10^{-4}	
13	10-15	.0544	9.1	2.46	2.03	15	6.3×10^{-3}	150
					1.71	25	7.2×10^{-3}	
					1.70	30	6.1×10^{-3}	
					1.47	32	8.0×10^{-3}	
13	25-30	.0544	7.16	2.47	1.41	27	8.0×10^{-3}	180
					1.24	31	8.6×10^{-3}	
					1.22	32	8.6×10^{-3}	
9	15-20	.0544	6.7	2.43	1.43	16	1.2×10^{-2}	230
					1.33	19	1.1×10^{-2}	
					1.23	22	1.1×10^{-2}	
9	20-25	.0544	9.45	2.48	2.365	110	2.2×10^{-4}	4.2
					2.33	155	2.0×10^{-4}	
					2.29	240	1.7×10^{-4}	

$$p = 2.30 \frac{d^2}{D^2} \frac{1}{t} \log_{10} \frac{h_o}{h}$$

Testing performed on February 23, 1977 by

T. A. Earl

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Table 5.

U.S. Radium Corporation - Bloomsburg, Pa.

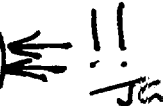
Water Table Measurements

Well No.	Ground Elevation ¹ (inches)	Measuring Point above Ground (inches)	Measuring Point Elevation (inches)	Measuring Point Elevation (feet)	21 Feb 79 Water Level (feet)	21 Feb 79 Water Table Elevation (feet)	14 Mar 79 Water Level (feet)	14 Mar 79 Water Table Elevation (feet)
1	- 36	+12	- 24	- 2.0	- 9.0	-11.0	-8.6	-10.6
2	-108	+12	- 96	- 8.0	- 4.8	-12.8	-10.0	- 9.0
3	-192	+ 6	-186	-15.5	- 2.4	-17.9	-0.5	-16.0
4	- 90	+36	- 54	- 4.5	---	-----	-4.5	- 9.0
5	-186½	+30	-157	-13.1	- 7.0	-20.1	-5.2	-18.3
6	-197	+36	-161	-13.4	- 9.5	-22.9	-2.6	-16.0
7	-202	+22	-180	-15.0	-10.4	-25.4	-3.2	-18.2
8	-192	+30	-162	-13.5	- 4.2	-17.7	-1.8	-15.3
9	+ 43½	+20	+ 64	+ 5.3	-16.0	-10.7	-13.6	- 8.3
10	-217	+ 9	-208	-17.3	- 2.9	-20.2	- 1.4	-18.7
11	+ 36	+22	+ 58	+ 4.8	-----	-----	-13.2	- 8.4
12	+ 22	+22	+ 44	+ 3.7	-----	-----	-13.2	- 9.5
13	+13½	+18	+ 32	+ 2.7	-13.3	-10.6	-11.0	- 8.3
14	+48½	+22	+ 71	+ 5.9	-16.6	-10.7	-14.4	- 8.5
15	+156	+23	+178	+14.9	-25.0	-10.1	-22.5	- 7.6
16	+151 3/4	+22	+174	+14.5	-24.3	- 9.8	-22.0	- 7.5
17	+ 29½	+13	+ 43	+ 3.6	-----	-----	-----	-----
18	- 91½	+17½	- 74	- 6.1	-----	-----	- 1.9	- 8.0
19	- 97½	+16	- 82	- 6.8	-----	-----	- 2.9	- 9.7

¹All elevations relative to center of burial pit = elevation 0

here are on the order of 0.3% (Table 6). But as the gravel aquifer is pinched between the overlying river flood plain silts and the underlying shale bedrock, the water table steepens dramatically. Grade on the water table through the burial pit is about 0.7%. Beneath the canal bank, the gradient steepens to 5%, then to 10% in the flood plain area.

Weather conditions preceding the late February water table were fairly wet, but ground frost was still present, and appeared to have blocked or delayed significant regional ground-water recharge.

Concerning ground-water flow direction, particularly in the areas of the disposal pit and old dumps, flow appears to be heading toward the river. 

From the February 21, 1979 water table map, the direction of ground-water flow through the burial pits is 180° (where magnetic north = 0°).

By the time of our second round of water level measurements on March 14, 1979, the water table had reached its seasonal maximum following very heavy rains, snowmelt, and flooding of the river over all the borings on the flood plain. Contouring the water-table configuration for this mid-March period (Plate 3) was considerably more difficult than the first construction for February levels. At the risk of stretching the limits of our "artistic license" in interpreting the water-table elevations (Table 5), there appears to be an elongated, subdued ground-water mound paralleling the edge of the active flood plain. This is caused by the flooding of the river which had receded only a few days before our measurements, and had saturated the entire flood plain area to the ground surface. This high-water configuration is therefore a temporary situation, reflecting bank storage in the silts.

Gradients on the seasonal high water table map do not show any change from the earlier (February) configuration (Table 6) in the front of the property, which has the same 0.3% grade. The flood plain area shows some variation, but averages about the same 10% as the earlier gradients.

Table 6. U.S. Radium Corporation - Bloomsburg, Pa.
Water-Table Gradients

Location	Date	From-To	Δ Elev/Distance	Gradient	Average Gradient
Front of Property	21 Feb 79	No. 15-No. 9	0.6/360	0.17%	0.3%
		No. 16-No. 9	0.9/285	0.32%	
Through Burial Pits	21 Feb 79	No. 13-No. 1	0.4/75	0.53%	0.7%
		-10.5 Contour-No. 1	0.5/70	0.71%	
Canal Bank	21 Feb 79	No. 1-No. 2	1.8/53	3.4%	4.0%
		-11.0- -13.0 contours	2.0/50	4.0%	
Floodplain	21 Feb 79	No. 7-No. 8	7.7/60	13%	10%
		No. 2-No. 3	5.1/60	8.5%	
Front of property	14 Mar 79	-7.5- -8.5 contours	1.0/320	0.31%	0.3%
			1.0/400	0.25%	
Floodplain	14 Mar 79	No. 7-No. 8	2.9/60	4.8%	10%
		No. 2-No. 3	7.0/60	12%	

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However, in the disposal pits area under these ephemeral conditions there would be essentially little or no definable lateral flow as the shallow trough (through Well No. 1) fills, and the narrow ground-water mound through Well No. 2 dissipates. In other words flow toward the river is temporarily "blocked" by the mound, and actually would reverse for a short distance toward the trough (Well No. 1).

Pumping Tests

The most realistic and representative determination of the field permeabilities of the sand and gravel aquifer and the silt aquitard (slowly permeable unit) can only come from conducting pumping tests on wells in these formations, and measuring drawdown and recovery water levels. We pumped four wells, Nos. 6, 9, 12 and 14 to get this information.

Boring No. 6 is drilled primarily through the flood plain silts (14 feet of silt of total 20-foot depth). Figure 2 shows a plot of recovery water levels in Boring 6 following pumping the well down at a rate of about 1/3 gallon per minute (gpm). Table 7 shows the data from the pumping tests used in the calculation of permeability. The silts in No. 6 have a field permeability of 0.28 gpd/ft^2 , very close to our earlier "textbook" estimate of 0.1 gpd/ft^2 .

Figure 3 is a plot of drawdown levels measured during pumping Well No. 14. From the drawdown data we calculated a permeability of 2600 gpd/ft^2 for the sand and gravels penetrated by this well. Well No. 9 is also drilled in the sands and gravel aquifer. Based on the recovery water levels measured after pumping this well for 40 minutes at 13 gpm (Figure 4), the permeability of the sands and gravel aquifer near the western property line is 560 gpd/ft^2 .

Table 7. U.S. Radium Corporation - Bloomsburg, Pa.
Pumping Test Calculations

Well No.	Types of Test Data	Slope of Water Level Trend ΔS ft	Pumping Rate Q gpm	Transmissivity		Permeability P gpd/ft ²
				T gpd/ft	Saturated Thickness m ft	
6	Recovery	16	0.33	5.3	19	0.28
14	Drawdown	0.10	14	37,000	16	2300
9	Recovery	0.41	13	8,400	17	500
12	Drawdown	0.25	15	16,000	23	700
12	Recovery	0.21	15	19,000	23	830
13	Drawdown (Obs. well for No. 12)	0.06	15	66,000	23	2700
1	Drawdown (Obs. well for No. 12)	0.06	15	66,000	23	2900

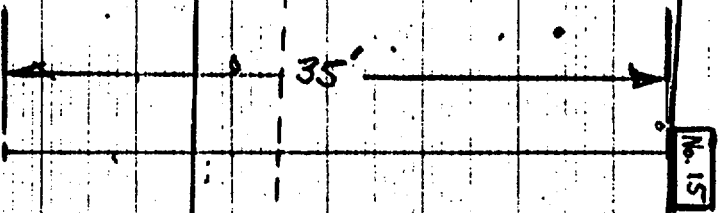
$$T = \frac{264 Q}{\Delta S}$$

$$P = \frac{T}{M}$$

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1512 W. COLLEGE AVENUE, STATE COLLEGE, PENNSYLVANIA 16801 814 234-0813

A
Property
line



U.S. Radium Corporation - Bloomsburg, Pa.

Geologic Cross Section

HORIZONTAL SCALE: 1" = 40'

VERTICAL SCALE: 1"=10'

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1512 W. COLLEGE AVE.,

STATE COLLEGE, PA. 16801

"D" Folder
#40
C-00

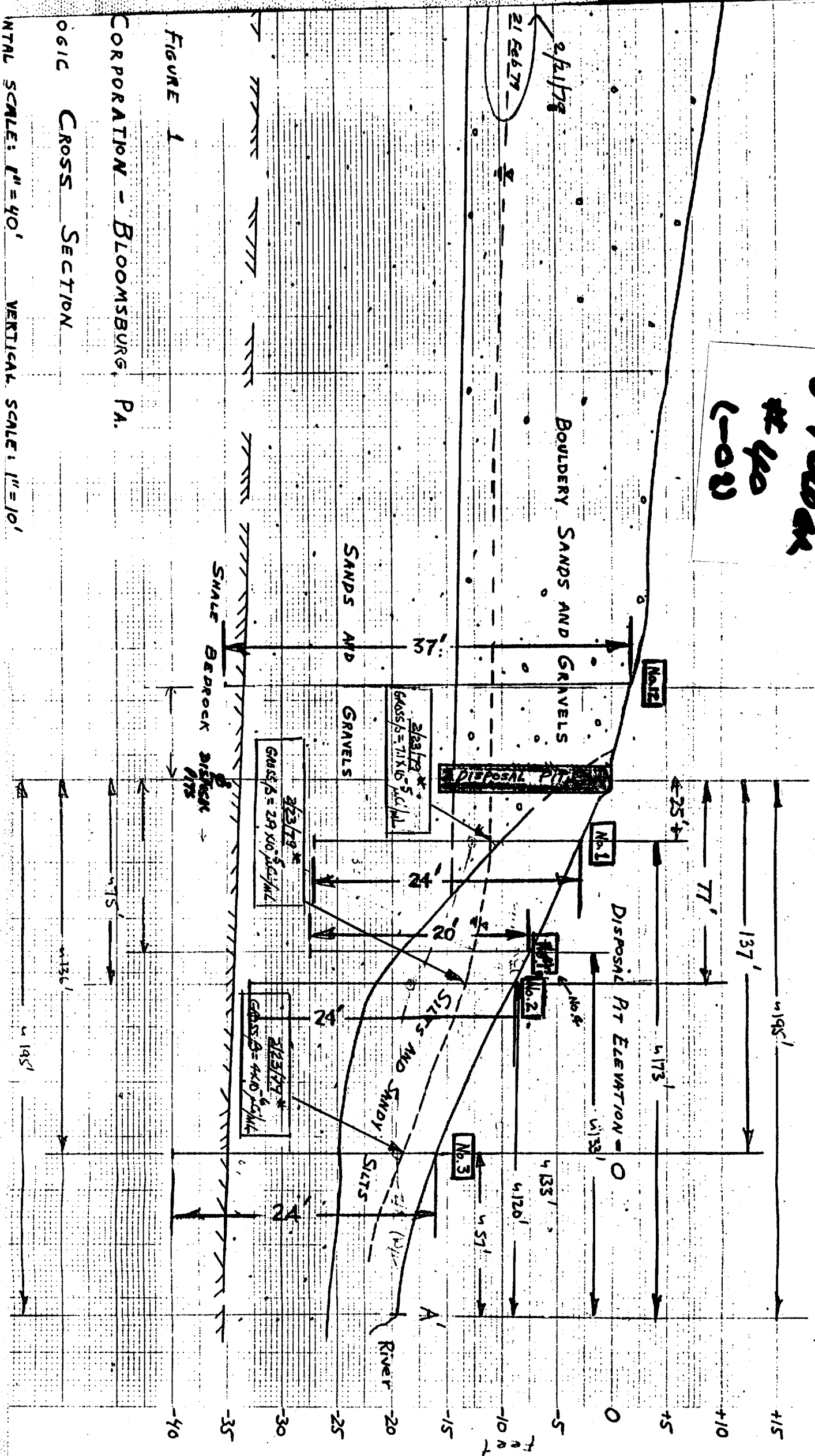


FIGURE 1

CORPORATION - BLOOMSBURG, PA.

CROSS SECTION

VERTICAL SCALE: 1" = 40' HORIZONTAL SCALE: 1" = 10'

Figure 2

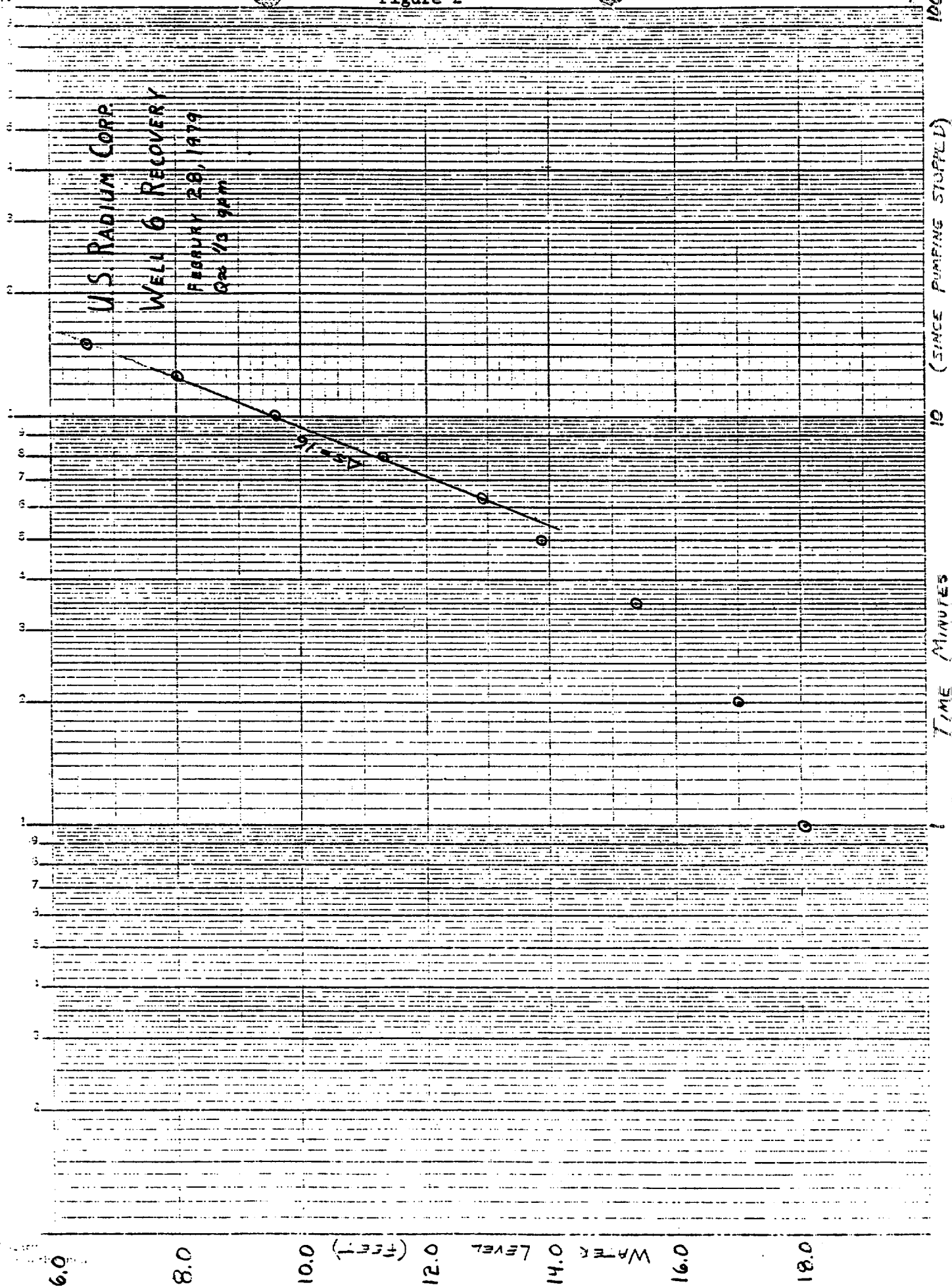


Figure 3

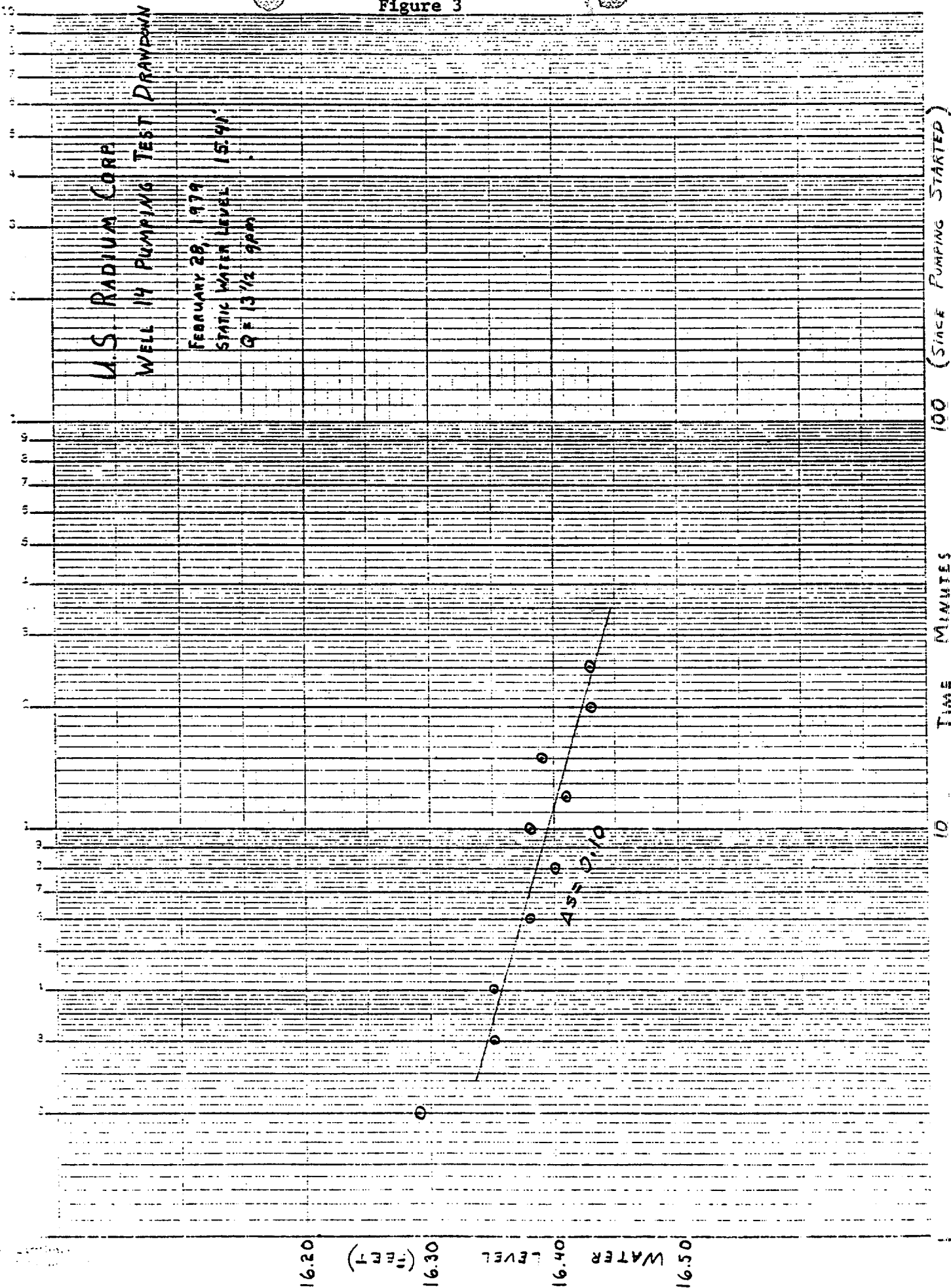


Figure 4

U.S. RADIUM CORP.

WELL 9 RECOVERY

FEBRUARY 28, 1979

QT 13 gpm

STATIC WATER LEVEL 14.78'

14.70

14.80

14.90

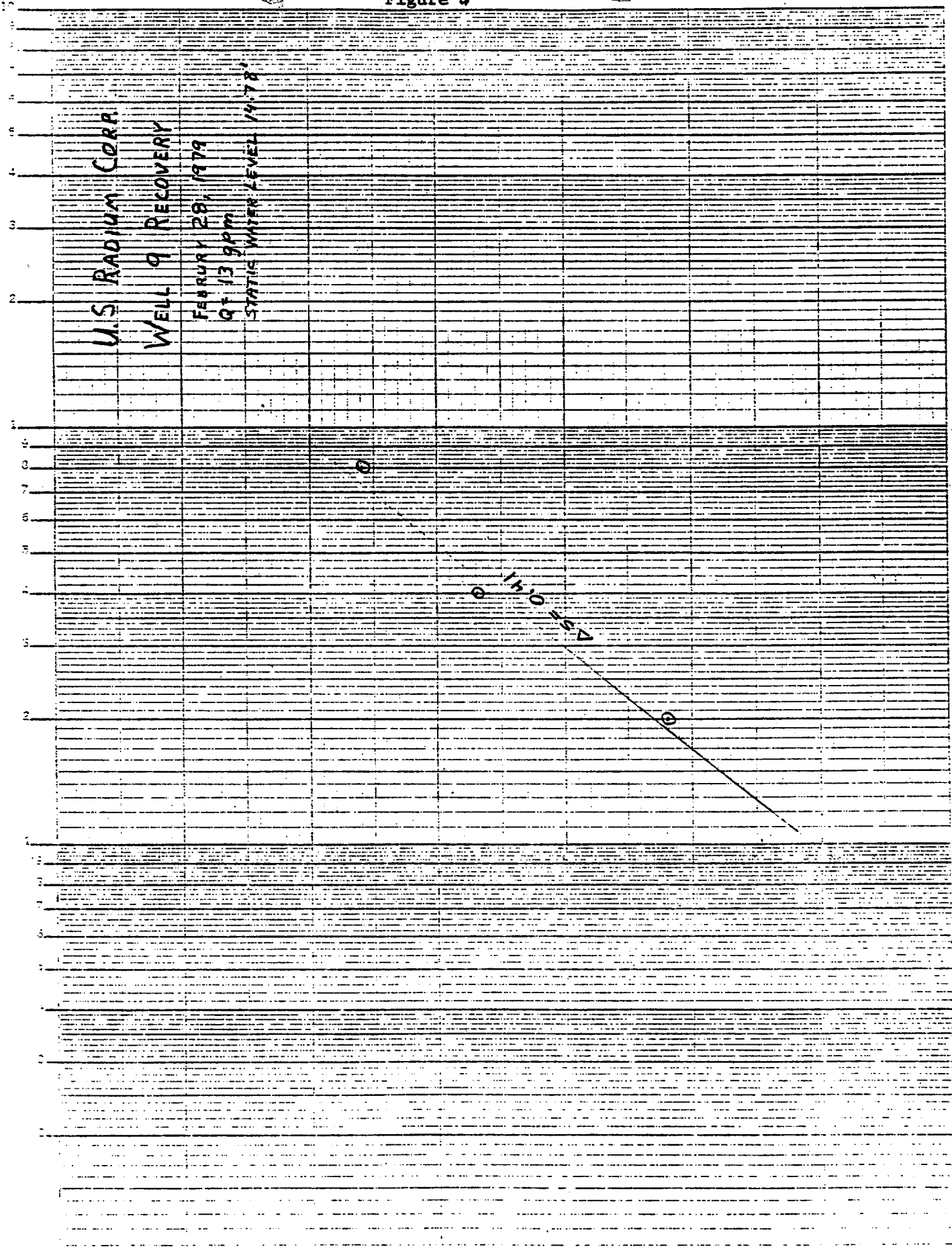
15.00

15.10

15.20

15.30

MINUTES
10 (SINCE PUMPING STOPPED)



The pumping test on Well No. 12 is the most significant, since it involved the sand and gravel aquifer directly where the burial pits are excavated. During pumping of Well No. 12 for one hour and forty minutes, drawdown levels in two observation wells were recorded: in No. 13, and in No. 1 located on the opposite side of the burial pit from the pumped well, No. 12. Drawdown and recovery data in Well No. 12 (Figures 5 and 6, respectively) yielded nearly the same values of permeability: 700 gpd/ft^2 and 830 gpd/ft^2 . The drawdown data in observation Well No. 13 (Figure 7) allowed us to calculate a permeability of 3100 gpd/ft^2 , which is nearly the same value we calculated from the drawdown data in observation Well No. 1 (Figure 8).

In summary, the permeabilities calculated from actual field pumping tests in the sand and gravel aquifer ranged from 560 to 2900 gpd/ft^2 , which is remarkably close to our original "textbook" estimates of 1000-3000 gpd/ft^2 .

Ground-Water Flow Rates

Permeability has been expressed in this report as gallons per day per square foot. By dividing permeability by 7.48 gallons per cubic foot, the permeability values can also be expressed as velocities in feet/day. Multiplying permeability expressed as velocity by the actual gradient on the water table, a unitless percentage, yields ground-water flow velocity along that gradient.

We have summarized several possible flow velocities at different locations in the sand and gravel aquifer, assuming a low and a high value of permeability, and using the water-table gradients measured from the maps of water-table configurations (Table 8). The flow rates through the

(cont'd p. 50)

Figure 5

45

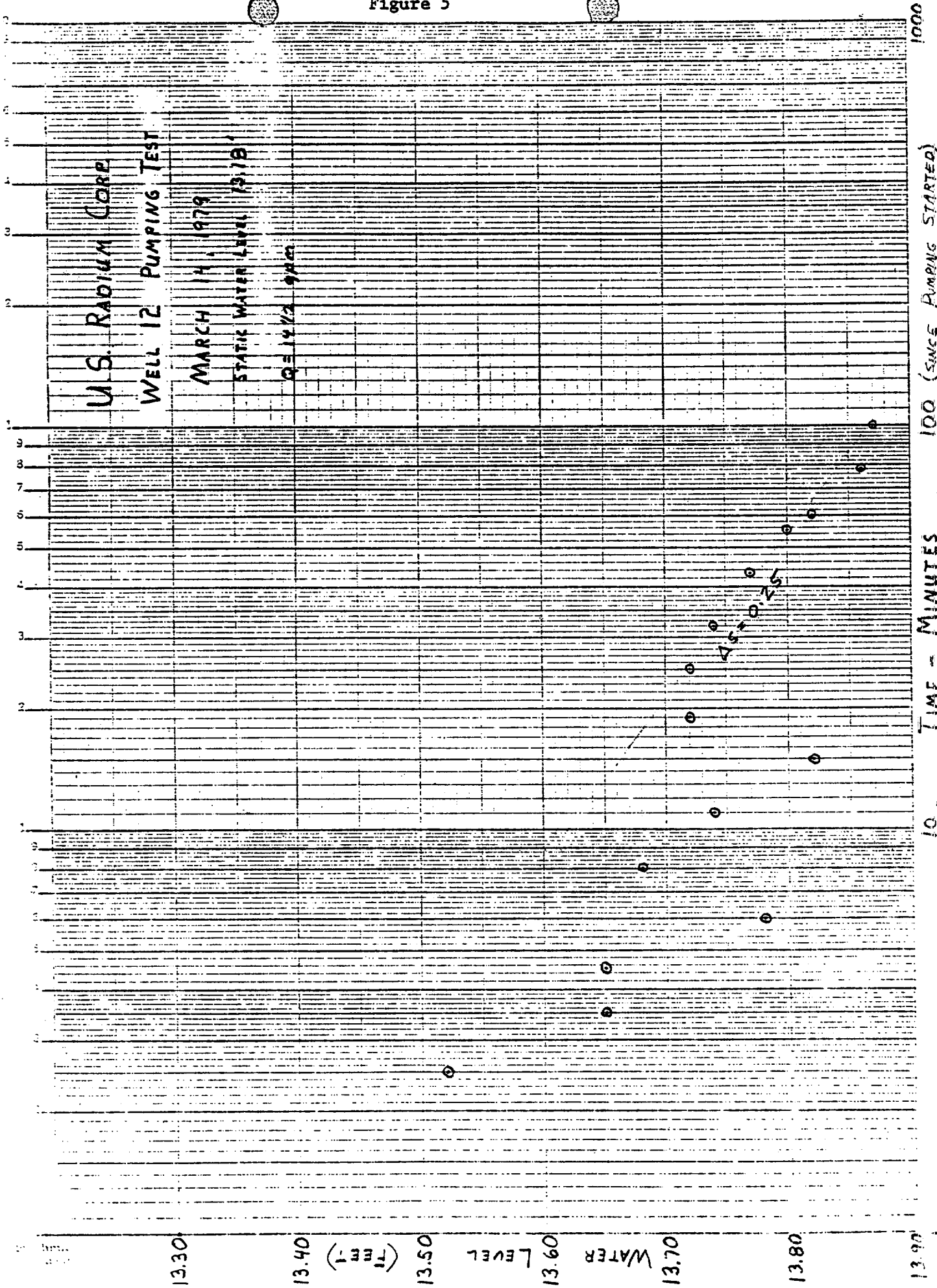


Figure 6

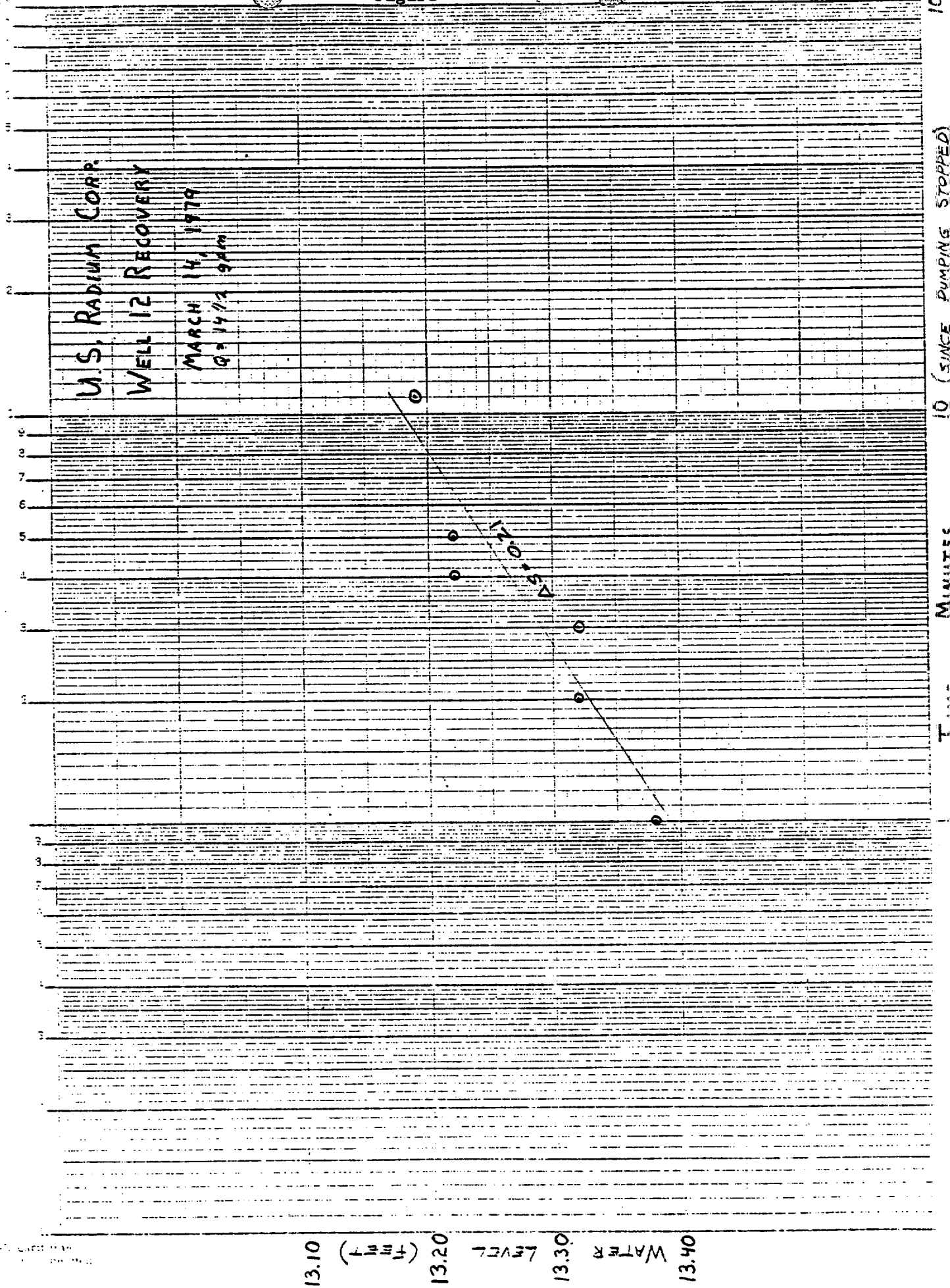


Figure 7

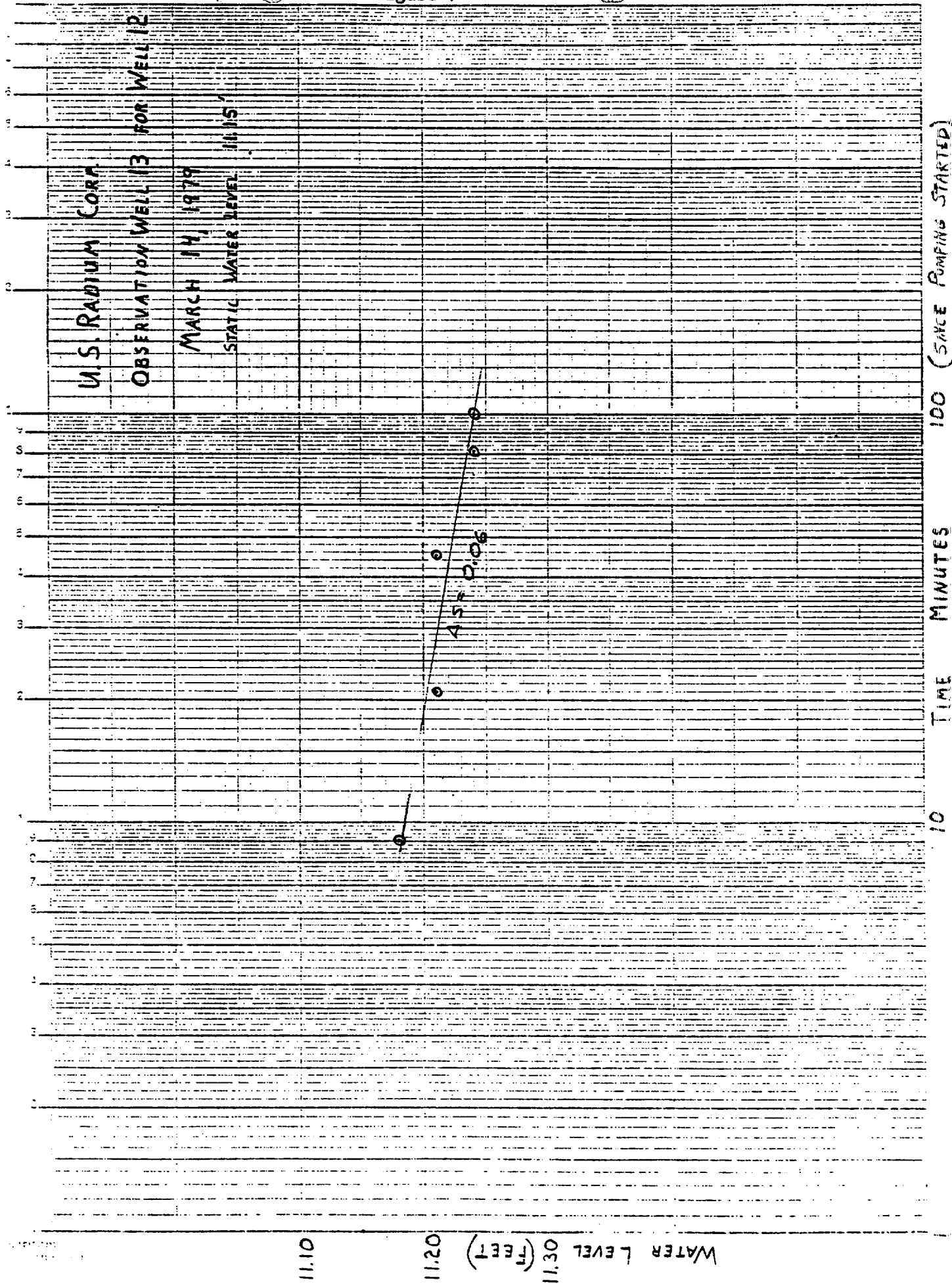


Figure 8

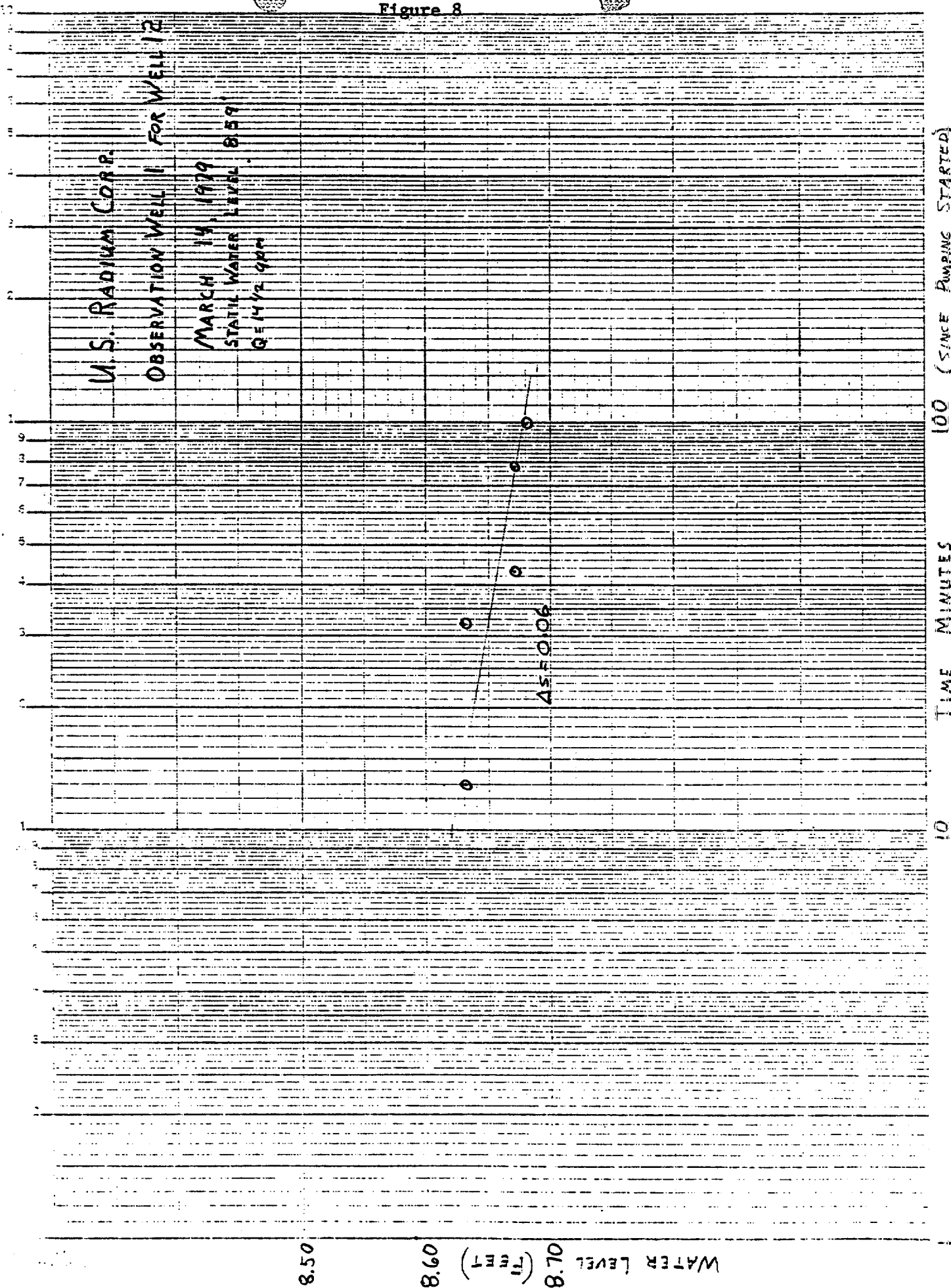


Table 8.

U.S. Radium Corporation - Bloomsburg, Pa.

Ground-Water Flow Rates

Location	Permeability P gpd/ft ²	Permeability P ft/day	Gradient I	Velocity ¹ V ft/day
Through Burial Pit (Well No. 12 to Boring No. 1	500 3000	67 400	0.7% 0.7%	0.47 2.8
Front of Plant	500 3000	67 400	0.3% 0.3%	0.20 1.2
Floodplain	500 3000	67 400	10% 10%	6.7 40

¹ V = PI

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burial pit range from 0.47 to 2.8 ft/day over the range of permeabilities.
The most rapid flow rates are in the flood plain, where the aquifer thins between bedrock and silt, and velocities increase to a few tens of feet per day. The area in front of the plant shows ground-water flow rates of little more than 1 ft/day due to extremely flat gradients.

Another consideration is the total volume of ground water moving through the aquifer. To calculate the daily flow in gallons through a one-foot wide 'window' of the aquifer extending vertically from the bedrock base to the top of the aquifer, we use this expression of Darcy's Law:

$$Q = PIA,$$

where Q is flow in gallons per day, P is permeability, I is gradient, and A is cross-sectional area through which flow occurs. Since our best definition of aquifer conditions and gradients is in the vicinity of the burial pits (Well No. 12), and this is also an area of special concern, we assumed an average permeability of 2000 gpd/ft² (see Table 7). The aquifer is 23 feet thick there from bedrock to water table; the area A is therefore 23 square feet. If we use the gradient (from February 21, 1979) of 0.7%, our calculation becomes:

$$Q = 2000 \text{ gpd/ft}^2 (0.007) 23 \text{ ft}^2$$

$$Q = \underline{\underline{320 \text{ gallons/day.}}}$$

This appears to be a realistic estimate of daily flow toward the river, through a one-foot wide 'window' of the sand and gravel aquifer.

Water Quality Samples

We bailed half-gallon water samples on February 21, 1979 from all completed test wells (except 1, 2, 3) and submitted them to U.S. Radium for

preliminary analysis of radioactivity levels. Again on March 14, 1979 we bailed water samples, two gallons from each of the nineteen total wells and borings, and submitted these to U.S. Radium for radioactivity analysis. In addition to these samples, we collected 250 ml from each point for our own analyses of basic water chemistry. Of chief importance to Radiation Management Corp. were the values of pH and Calcium. We also measured conductivity (as a means of comparing total dissolved solids), alkalinity and sulfate (Table 9).

The least variable parameter of those tested was pH, averaging 7.1. Conductivity is probably the single most diagnostic measurement for quickly distinguishing or characterizing ground waters; the two highest values are associated with Well No. 11 (which was heavily polluted by an oily, solvent type material) and with Well No. 5, adjacent to a waste discharge stream from the plant to the river. Well No. 5 also had the highest Ca, SO_4 , and alkalinity values. Wells No. 1, 2, 12 and 13 are within about 120 feet of each other and had reasonably similar chemistries, which appears to reflect some pollution from reported surface dumping in the past in that general area. The remaining wells as a group show insignificant amounts of variation in their chemical nature.

Pollution Abatement Techniques

If certain zones of previous dumping are identified as contributing unacceptable levels of radioactive contamination to the ground water on the basis of the soil and/or water samples, there are several possible techniques for correction to consider.

Table 9. U.S. Radium Corporation - Bloomsburg, Pa.
 Chemical Analyses of Water Samples
 Collected 14 Mar 79

Well No.	Conductivity μ mhos	Ca mg/l	pH	Alkalinity mg/l as CaCO_3	SO_4 mg/l
1	390	48	7.0	120	43
2	300	34	7.2	70	35
3	240	27	7.1	40	30
4	270	20	7.75	80	77
5	540	75	7.4	100	110
6	230	34	7.3	30	30
7	350	48	7.2	60	37
8	160	7	6.55	30	33
9	270	27	6.6	30	69
10	200	14	6.6	25	47
11	570	69	6.95	140	72
12	330	48	7.1	110	24
13	340	55	7.2	110	22
14	82	14	6.6	30	20
15	170	27	7.0	50	22
16	200	27	6.75	25	49
17	200	34	7.3	40	13
18	280	41	7.15	50	52
19	270	34	7.15	80	40

Analyses by Meiser & Earl

pH - Beckman pH Meter

Conductivity - Hach Meter

Ca Hardness - Hach test kit titration

Alkalinity and SO_4 - Filter photometer (Hydrodyne)

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The brute force approach would be physical removal of all contaminated soil and waste material. Aside from the potentially large volume of material and difficulties in handling and containing it for transportation, we are not familiar with any sites in Pennsylvania which are designed or permitted for disposal of radioactive wastes.

The concept of dewatering an area around the contaminated zone by pumping down ground-water levels and thereby eliminating ground-water flow through the radioactive material does not appear feasible for two reasons. First, the sands and gravels around the old disposal areas are high permeability and would require wells pumping at a large discharge rate to lower the water table effectively around the contaminated areas. Second, pumping would produce a large sustained flow which would have to be acceptable for stream discharge under Pa. D.E.R. regulations, and we suspect that such a permit would be extremely difficult or likely impossible to obtain.

We considered a slurry trench as a possible solution, where a deep ditch would be excavated around the contaminated zone, then filled with a concrete grout or impermeable clay slurry to form a wall enclosing the radioactive waste. However, under the conditions we have described, it is our opinion that it would be impossible to excavate a trench in 35 feet of gravel to bedrock with the lower 20-25 feet being below the water table.

Another method for constructing a grout "wall" around the waste zone would be to drill closely-spaced holes to bedrock then inject grout under pressure to form a coalesced grout curtain. This technique has been developed and applied extensively by Halliburton, Inc. On the basis of their advertising literature and a lengthy discussion with a technical representative, we estimated the costs of grouting 100 lineal feet of perimeter at roughly \$75-100,000.

However, the company representative would not quote a price without the specific details of the site, so our estimate could be wrong, but we did consider well costs, material costs, and installation time.

One other possibility might be an injection well from which chemicals could be introduced into the ground water upgradient from the radioactive waste. According to Scott Murray of Radiation Management Corporation, controlling the pH and/or calcium levels in the water might control the radioactivity levels in ground water moving through the waste.

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