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RESULTS OF DRILLING
TEST WELLS 3 & 4
AT THE
DALE #4 STRIP PIT

June, 1986

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Introduction

In February 1985 two test wells were drilled near the pit and piezometers were installed for monitoring. Additional drilling has now been done to increase the monitoring capability with the installation of Test Wells 3 and 4. Figure 1 shows the location of the new wells. Both of the new wells have piezometer pipes set at three levels.

Test Well Drilling

Test Wells 3 and 4 were drilled about 240 feet deep using a Speedstar air rotary drilling machine. A down-hole hammer with a button bit was used to drill the 6-inch holes. Each well was started with the installation of 6-inch casing placed 10 to 17 feet below ground surface. Below the casing, a 6-inch nominal open borehole was drilled to depth.

Test Well 3 was drilled 150 feet north west of the pit. The location was selected so that the hole might penetrate the Dale tunnel which runs from the workings to the portal. Drilling began in fill material and quickly penetrated a redish-orange sandstone at 4 feet which is the silica sand that is mined to the west of the pit. At 11

feet a gray to lavender claystone was penetrated to 133 feet. The drill cuttings were damp after 64 feet and the air rotary discharge was definitely less dusty. After 100 feet the discharge was wet with a flow of 2 to 5 gpm. The discharge water was dark brown to lavender with a reddish-brown, oil-like slick which is often seen in coal-rich formations. The formations below 133 feet produced water and were all layered with coal to the total depth of 244 feet. The Dale tunnel was not penetrated during the drilling of test Well 3. No loss of air pressure or lack of return of the drill cuttings were experienced. (These losses did occur at TW-2 which is completed in the old mine workings.)

Test Well 4 was drilled 440 feet south of TW 3. The drill site at this location is about 70 feet from the edge of the pit. Drilling began on April 23, 1986. The strata at this location dips to the west at an angle of 60 to 80 degrees. The formations penetrated at this site are similar to TW 3 but due to the reduced dip they have a reduced apparent vertical thickness. The geologic log and construction details are shown in Figure 3. During the drilling of TW 4 some moisture was evidenced by a low discharge flow during drilling and some filling of the borehole with water when the drill rods were changed. After drilling below 110 feet the cuttings and discharge were dry and dusty. Water and a foam additive was added to assist drilling to the final depth of 235 feet. The Dale tunnel or mine workings were not penetrated by TW 4.

Three plastic piezometers tubes were installed in the boreholes as depicted in Figures 2 and 3. Each well has a deep, mid-level, and shallow piezometer setting. Each piezometer screen section was packed with washed silica sand from the mine. Pea gravel was used to backfill the hole and bentonite pellets were used to seal each level. The well head consists of a 6-inch casing with locking cap. The piezometers are sealed at the surface with bentonite.

Development and Testing

The piezometer tubes in each well were measured with a sounding line to ensure that they were clear. Each tube was then cleaned and pumped out with air from a 100 psi compressor. The results for each well and piezometer were recorded and give additional insight to the nature of the materials penetrated.

Test Well 3 water levels are relatively close to the surface and have been so since completion. Depths to water have been 12 to 16 feet with the actual daily measurements of each piezometer within 0.5 feet of each other. Prior to air development the water levels in all piezometers were close to 13 feet. The deep piezometer was observed to produce about 1 gpm with the air development. The discharge water quickly cleared and after 53 minutes the air was turned off and the recovery water level in the deep piezometer was 200.6 feet after 6 minutes. The mid level piezometer in TW 3 was observed to have a water level 1.5 feet

lower than it had prior to air development in the deep piezometer. The measurement was taken 13 minutes after the air was turned off in the deep piezometer indicating some interference between these completion depths. The mid level piezometer was then cleaned and pumped out with air and was observed to clear slowly. Considerable silt and dirty water was produced by cycling the air on then off again. The piezometer was pumped until it cleared and it produced about ½ gpm. After 4 hours of development and pumping, the air was stopped and after 5 minutes the water level had recovered to 51.8 feet. During the cleanout of the mid level piezometer the water level in the shallow piezometer fell below the bottom of the tube which is 43 feet. The water level in the deep piezometer was 44.2 feet, 18 minutes after the air development stopped in the mid piezometer. Additional air development was done in the deep piezometer for 33 minutes. By this time water levels in the shallow piezometer had recovered sufficiently for cleanout and pumping. The shallow piezometer was then developed and pumped with air for one hour. The pumping rate increased to about 1 gpm and the discharge water became almost clear.

Test Well 4 water levels, in the three piezometers, prior to development were 24.6 feet in the shallow, 28.4 feet in the middle and 46.7 feet in the deep. After completion the deep piezometer water level was 185 feet and slowly rose to the present level after several days. The air development produced brown silty water which did not clear at a pumping rate of .05 gpm. After one hour the air

was turned off and the water level was observed to recover very slowly to 214.5 feet after 9 minutes. The mid level piezometer was then pumped and developed with air. The flow rate was .05 gpm. After one hour the water was clearing and the air was turned off. The water level recovered to 83 feet after 10 minutes. The shallow piezometer was air developed for 52 minutes. The discharge was very dirty and did not clear. After the air was turned off the water level rose to 29 feet in 10 minutes.

Geohydrology

The recovery from air lift pumping is shown on Figures 4 and 5 for the TW 3 and 4 deep piezometers. Based on this recovery information an aquifer transmissivity value was calculated for each well of 2 to 3 gpd/foot. This value of transmissivity is useful for purposes of comparison only. The conditions for testing the aquifer are not valid in that the strata are steeply dipping, casing and borehole storage effects are relatively large, and the recovery data cannot be correctly plotted for non equilibrium conditions. Nevertheless, the transmissivity and permeability for the two new wells is similar to or less than Test Wells 1 and 2. Recovery measurements taken in the upper piezometers of TW 3 and 4 were not used for transmissivity calculations, because the water levels were depressed and recovering from the pumping of the lower piezometers.

The relationship of the recently completed wells to

the dipping strata is represented in Figures 6 and 7 as a schematic cross section. The depths and locations of both test wells were selected so as to drill as close as possible to the Dale tunnel. There was no indication that the tunnel was penetrated in either well. Test Wells 3 and 4 are both completed in formations that are stratigraphically above Test Wells 1 and 2.

The relationship of all of the well completion depths and water levels is shown on Figure 8. The decline in water levels from TW 3 to TW 2 is better illustrated by the potentiometeric contour map on Figure 9. The presence of the abandoned mine workings in and near the Dale 4 strip acts as sink or collector of ground water in the adjacent strata. The lowest water levels are reflected in TW 2 east of the pit because it penetrates the workings that are drained by the Dale Tunnel. The contours depicting depression of the potentiometric surface around TW 2 in Figure 9 are most probably an anomoly on the regional gradient that is presumed to be northwest in this area. The pit does not have visible water standing in it and was not used to determine gradient.

Water Quality

On May 1, 1986 initial water quality samples were taken from all of the test wells. Analysis was not done on Test Well 3 shallow and medium piezometers because the water was too dirty from development. The results from subsequent samples are attached. Additional water quality monitoring will be done on a regular basis.

The water quality results that are available appear to be close to the results obtained for Test Wells 1 and 2. Of the constituents measured from samples taken on May 1, 1986 the new monitoring wells have similar or lower concentrations than Test Wells 1 and 2. The exception to this is the high concentrations of Sodium found in the shallow piezometer of Test Well 4. It is possible that some of the sodium may come from a binding agent in the bentonite pellets that were used to seal between piezometer settings. Continued monitoring should show a reduced level of sodium if it is related to the bentonite seal.

Conclusions

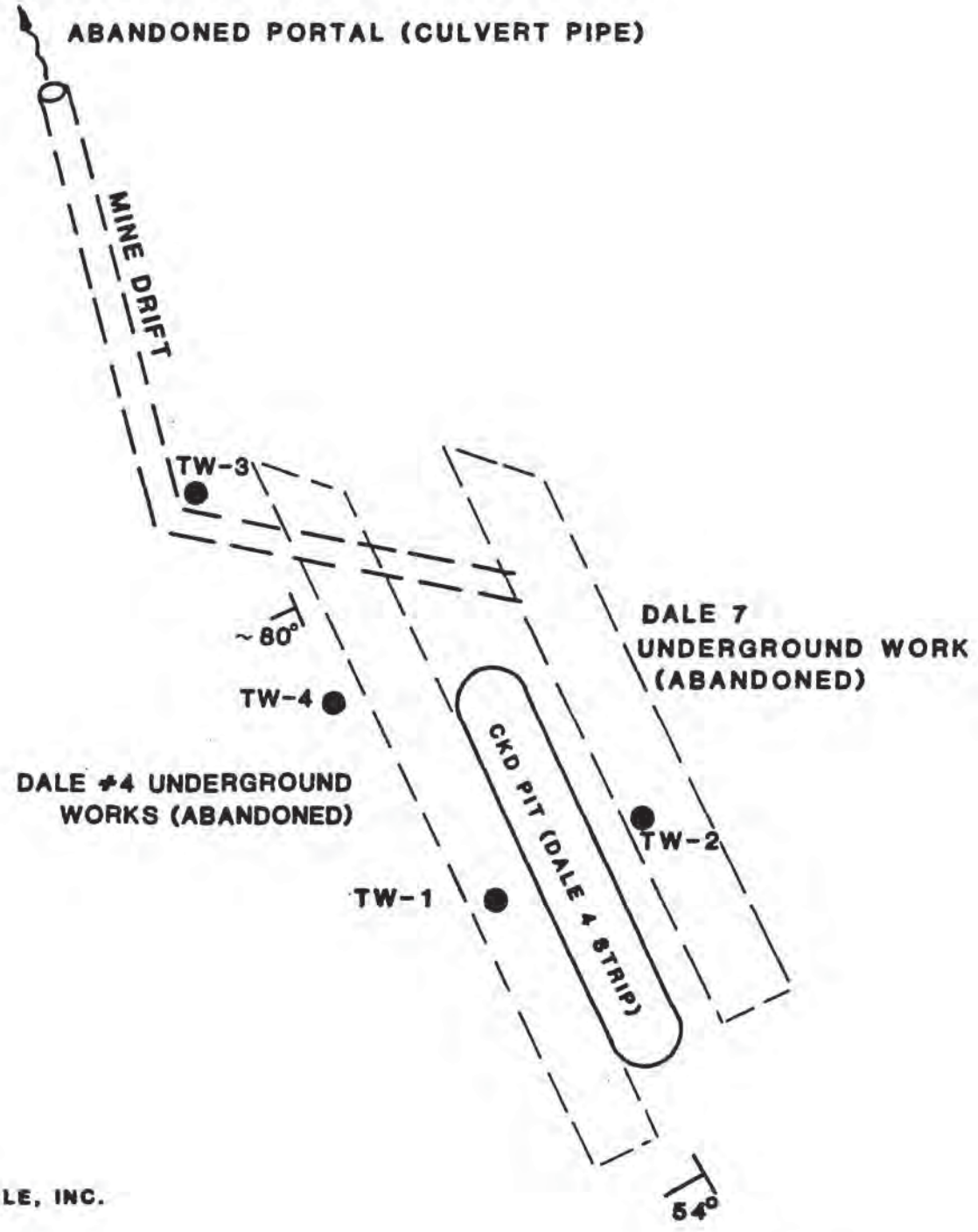
The completion of Test Wells 3 and 4 further indicates that the permeability and transmissivity near the Dale 4 pit is very low for aquifer standards. Water that discharges from the portal of the Dale Tunnel is the most likely to be affected by the CKD placed in the pit. Therefore the portal water will always be the first to indicate changes in water quality caused by the contents of the pit. The low water levels in TW 2 are related to the draining effect of the old workings. The water levels in TW 3 are probaby "normal" or what would be expected if the pit and tunnel did not exist. A water level gradient and natural downgradient flow is presumed to still be to the northwest.

Respectfully submitted,

ROBINSON & NOBLE, INC.

Chandler Ellis

FIGURE 1

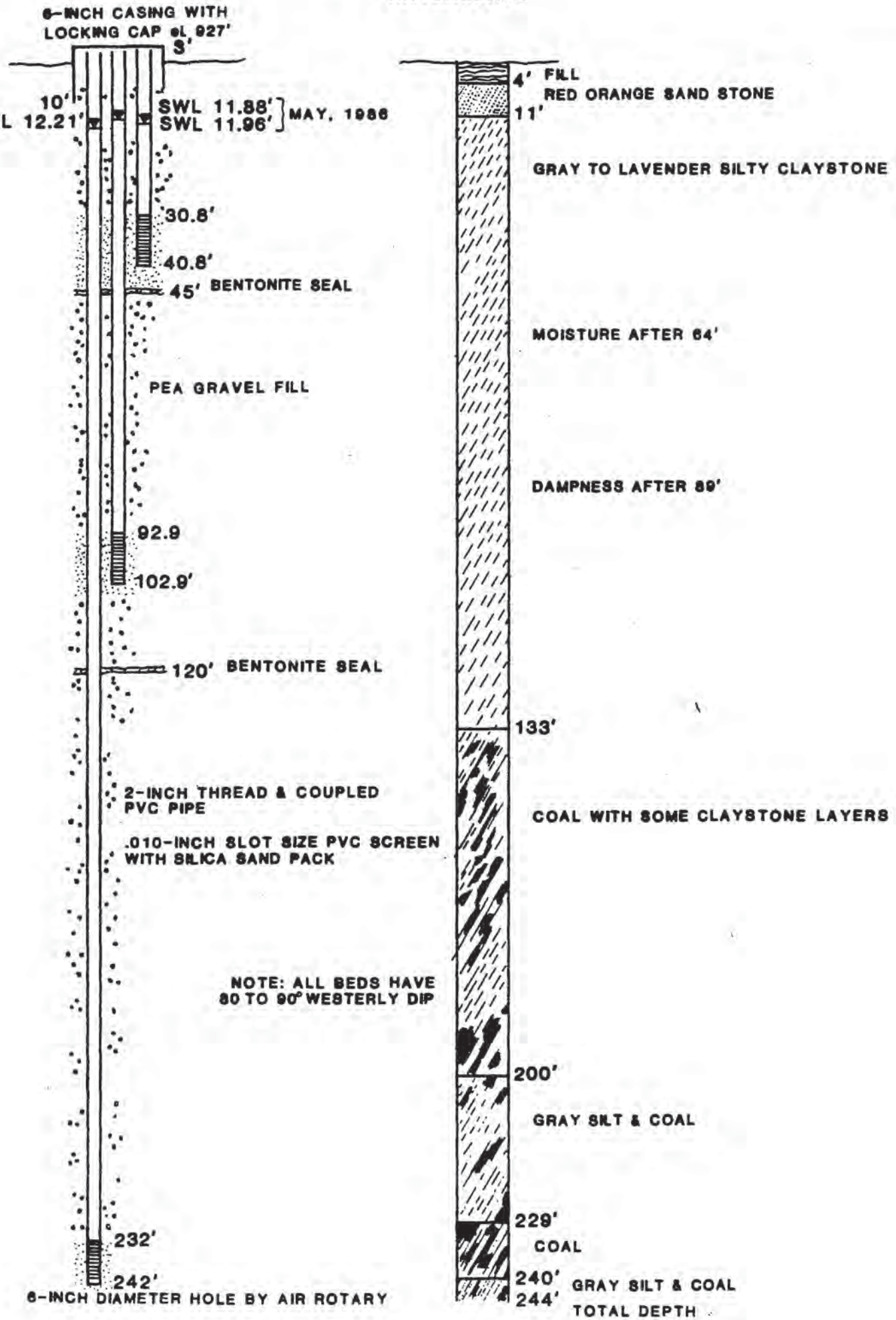


NO SCALE

SCHEMATIC OF PIT, UNDERGROUND MINES AND PROBABLE DRAINAGE ROUTE

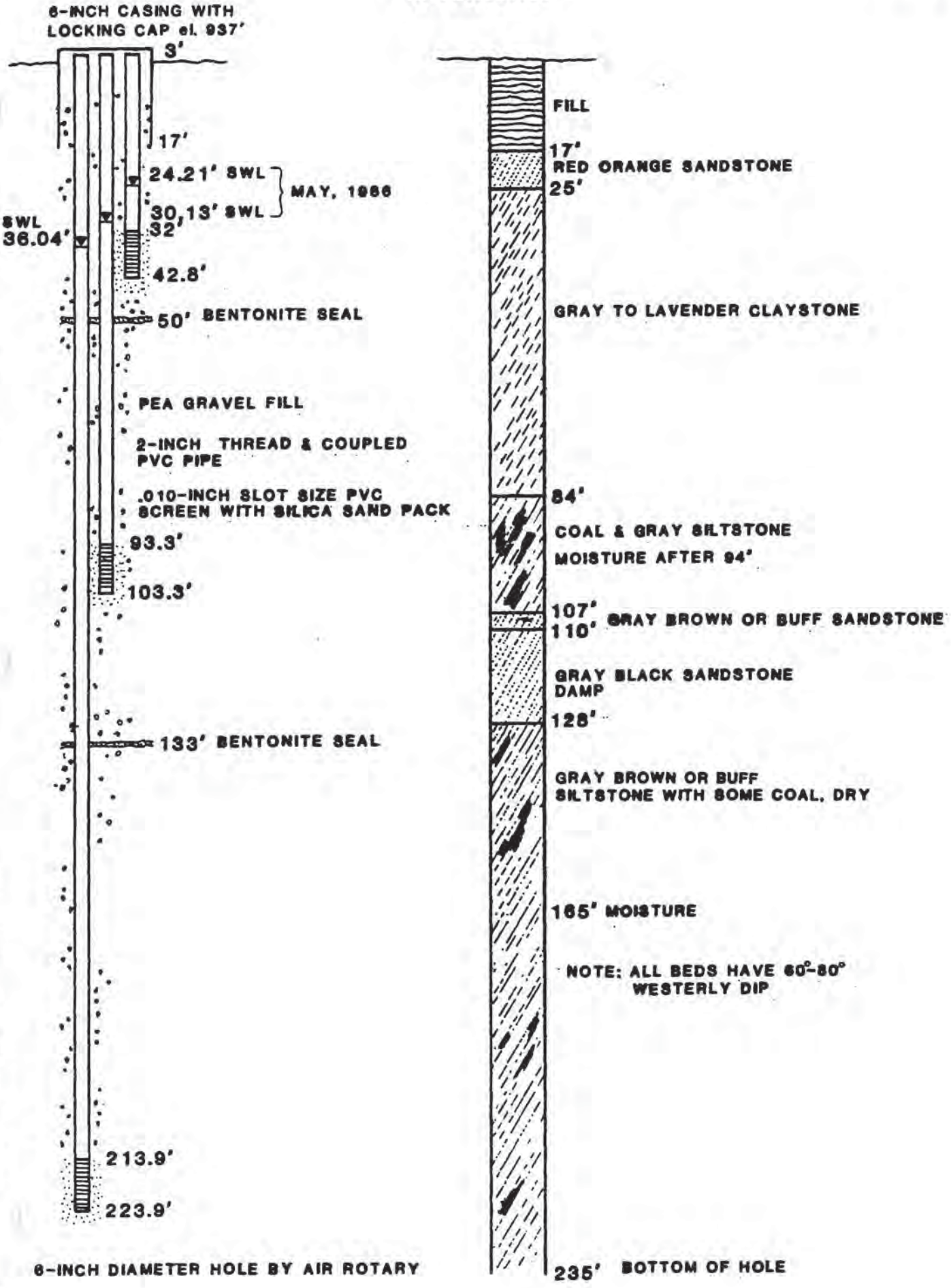
TEST WELL 3
RAVENSDALE

FIGURE 2



TEST WELL 4
RAVENSDALE

FIGURE 3



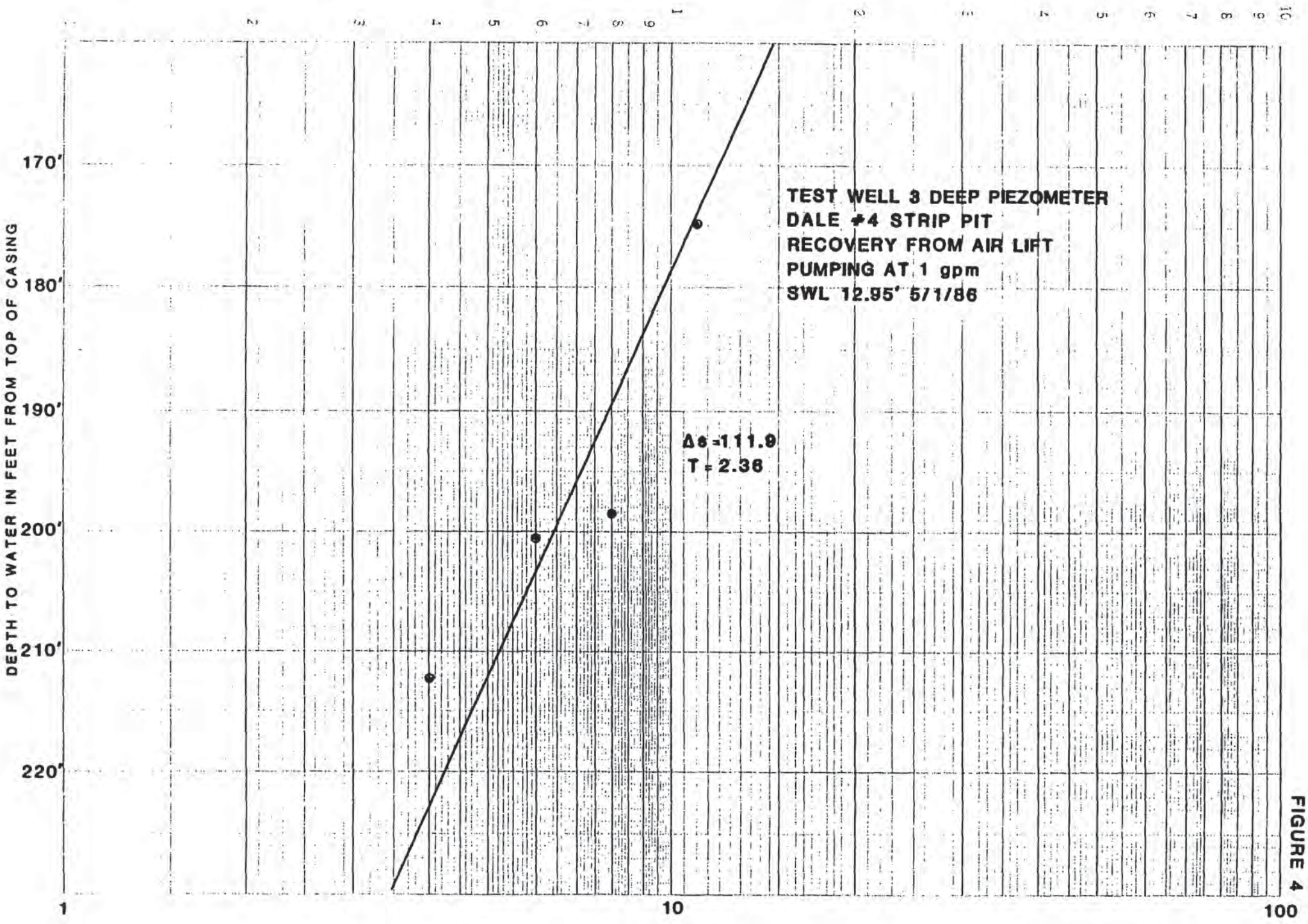

SEMI-LOGARITHMIC
KEUFFEL & ESSER CO.
DEPTH TO WATER IN FEET FROM TOP OF CASING
170'
180'
190'
200'
210'
220'
1
10
100
TEST WELL 3 DEEP PIEZOMETER
DALE #4 STRIP PIT
RECOVERY FROM AIR LIFT
PUMPING AT 1 gpm
SWL 12.95' 5/1/86
Δs=11.9
T = 2.36

FIGURE 4

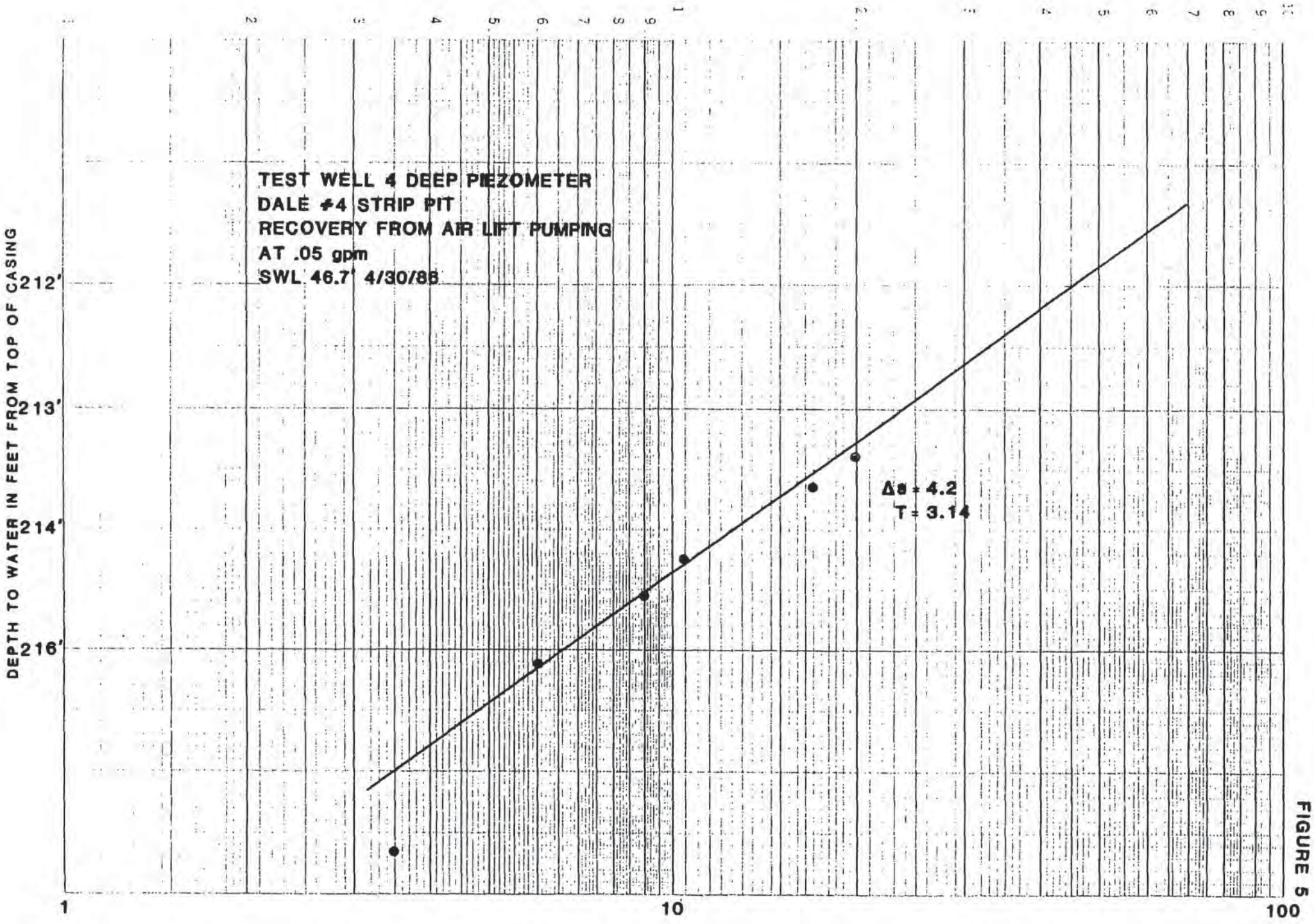
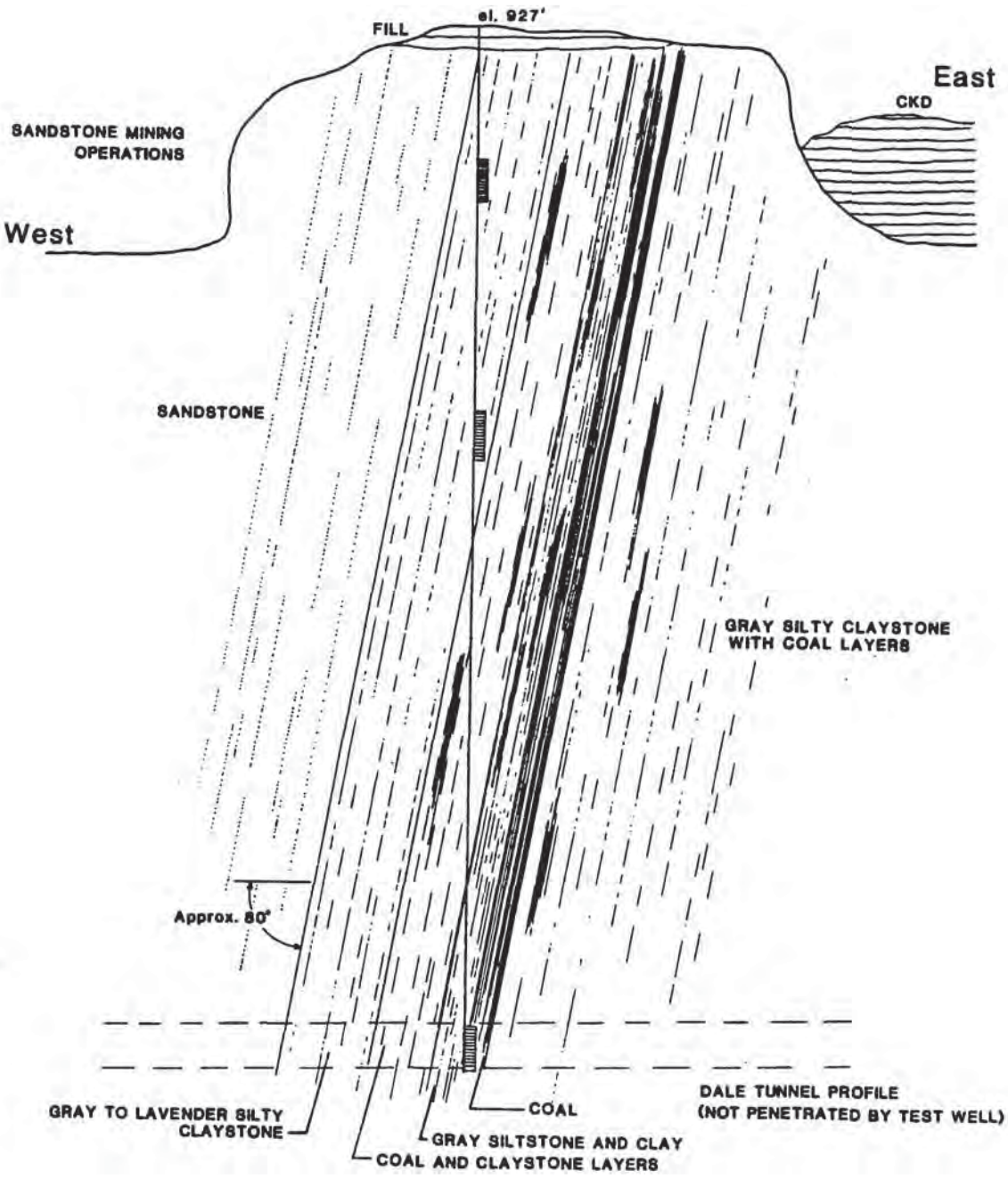

SEMI-LOGARITHMIC
KEUFFEL & ESSER CO.
TEST WELL 4 DEEP PIEZOMETER
DALE #4 STRIP PIT
RECOVERY FROM AIR LIFT PUMPING
AT .05 gpm
SWL 46.7' 4/30/86
Δs = 4.2
T = 3.14
DEPTH TO WATER IN FEET FROM TOP OF CASING
212'
213'
214'
216'
1
10
100

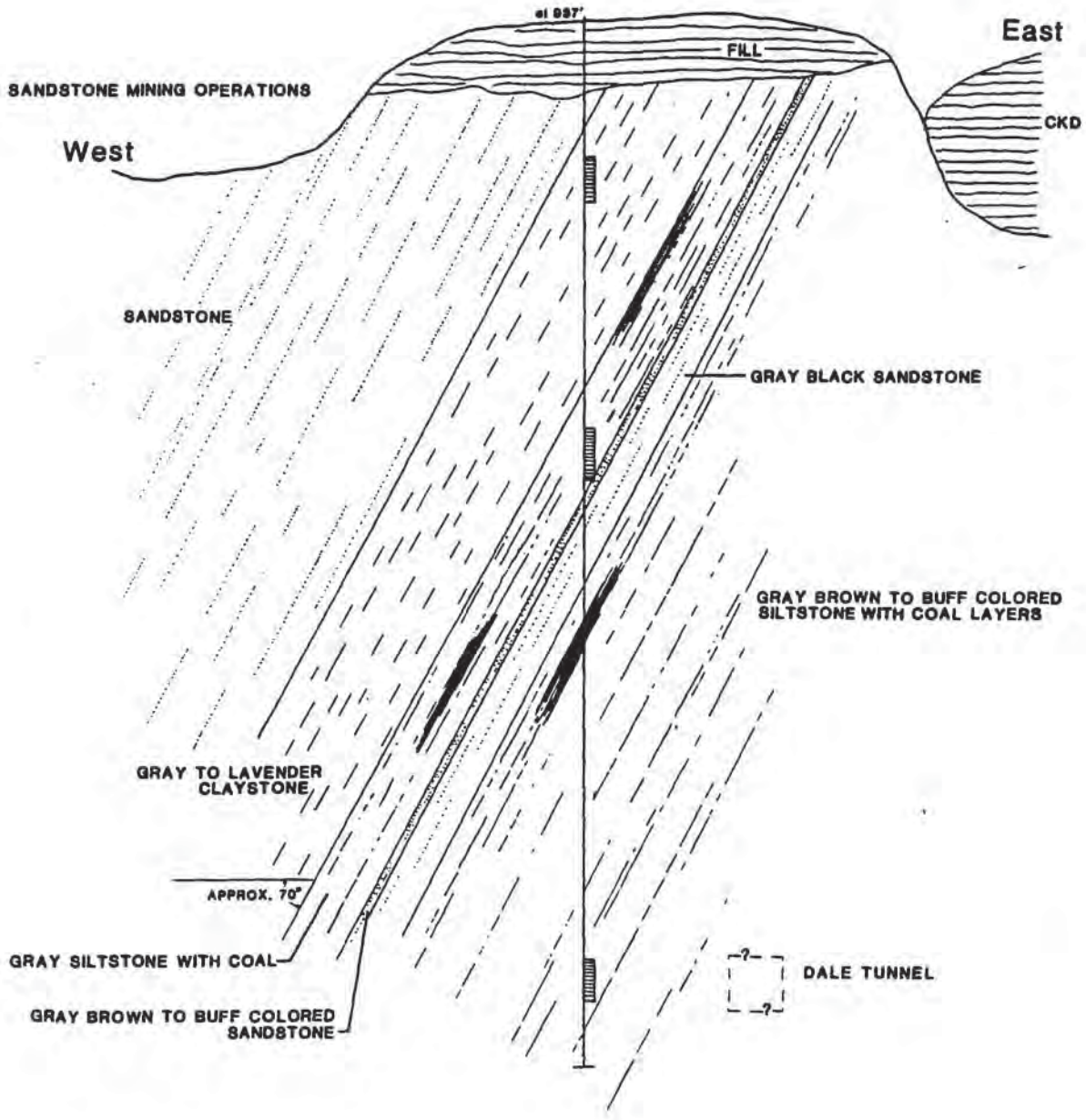
FIGURE 5

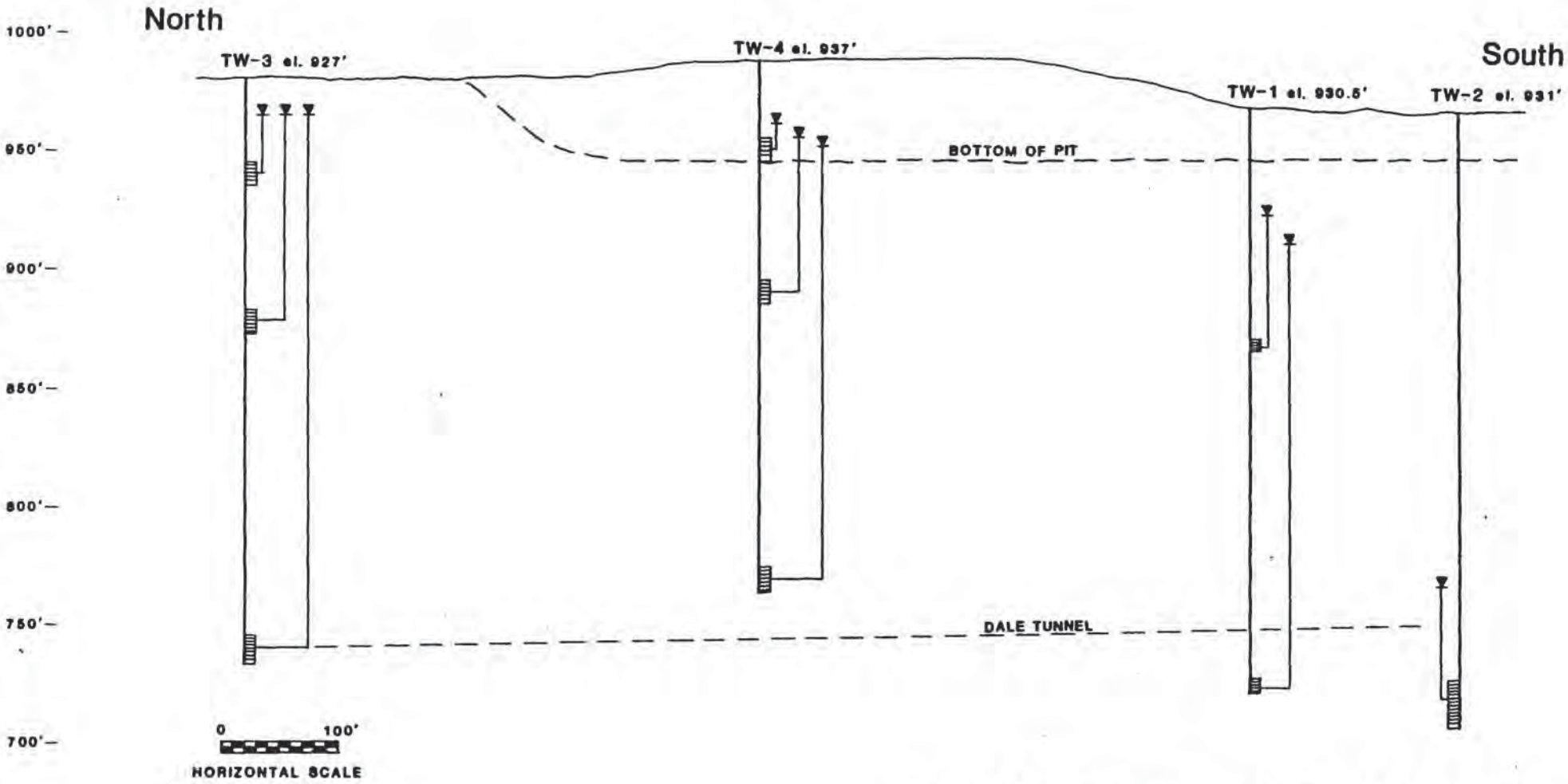
FIGURE 6

SCHEMATIC SECTION OF TW-3
DALE #4 STRIP PIT



SCHEMATIC SECTION OF TW 4
DALE 4 STRIP PIT





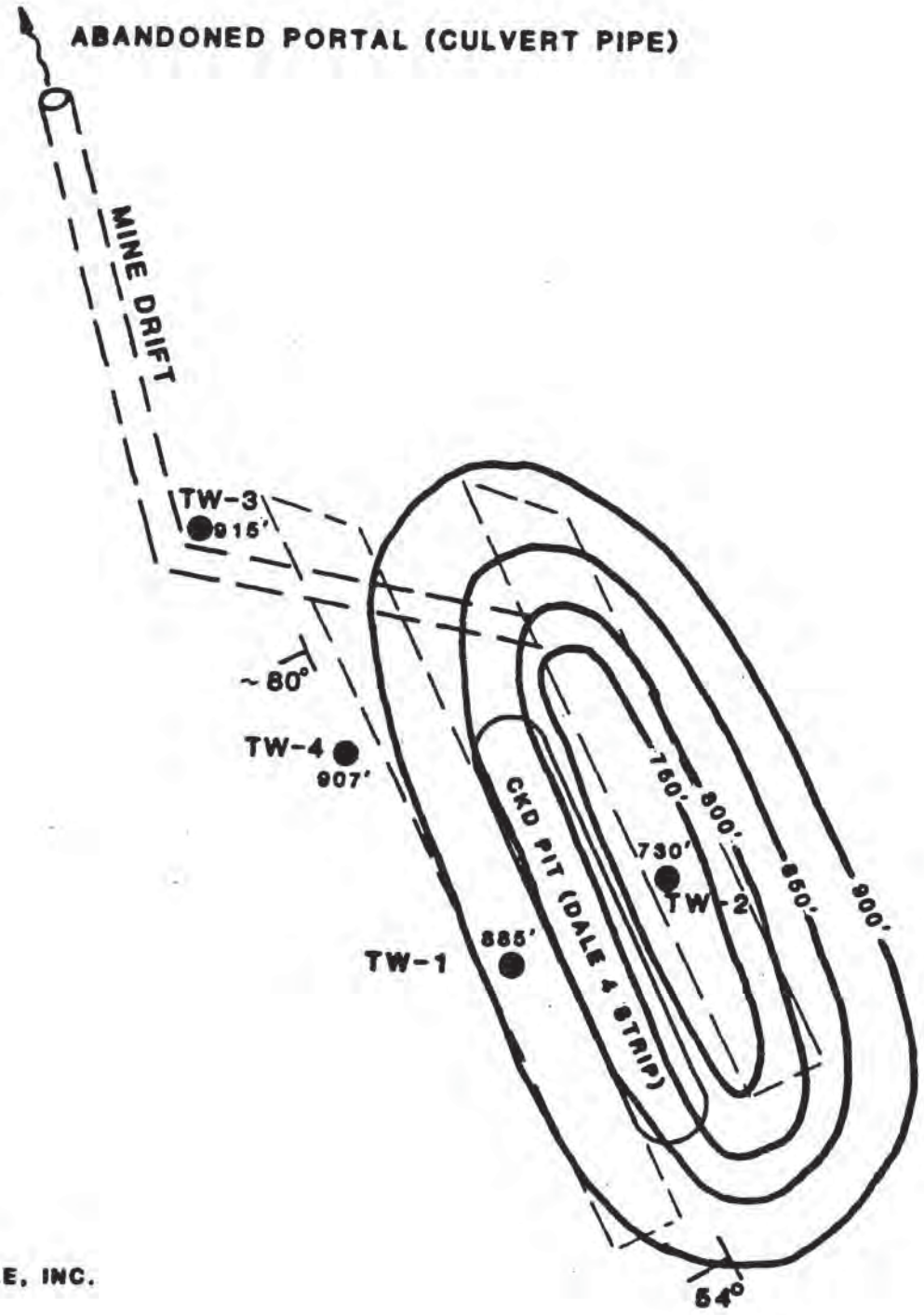
COMPLETION DEPTHS & WATER LEVELS OF TEST WELLS AT THE DALE #4 STRIP PIT

APRIL-MAY, 1986

ROBINSON & NOBLE, INC.

FIGURE 8

FIGURE 9



NO SCALE

WATER LEVEL ELEVATIONS AND POTENTIOMETRIC CONTOURS AT THE DALE STRIP PIT

Chandler — I'll get more info on Well #3 Shallow + med. Piezometers when I go it. The water was too dirty to sample on the day I drew them

L-BAR PRODUCTS, INCORPORATED
P.O. BOX 95
RAVENSDALE, WA 98051
(206) 432-1286

LABORATORY TEST RESULTS

Customer: L-Bar
Report To:
Sample I.D.:
Date Reported: 5/8/86
Sample Description: Well water

Test Requested:
Results:

TEST, CONCENTRATION / SAMPLE	Well #1 Shallow	Well #1 Deep	Well #2	Well #3 deep	Well #4 Shallow	Well #4 Medium	Well #4 deep
pH	6.50	6.68	6.29	7.22	6.01	6.54	6.29
Cl, ppm	2.9	5.8	2.9	1.9	39	2.4	4.8
Na, ppm	14.95	26.67	19.26	13.02	37.50	25.98	19.08
K, ppm	3.30	15.23	3.00	3.02	3.99	3.43	4.91
Ca, ppm	89.64	75.44	86.10	59.17	55.02	72.06	81.61
Mg, ppm	47.54	38.21	34.09	32.19	27.42	33.56	27.75
DISS. SOLIDS, ppm	386	426	308	166	414	420	264

5/1/86

Pointed Culvert 45 gpm
Well #1 Shallow SWL 43.7'
Deep SWL 53.9
Well #2 SWL 201.2'

Comments:

Analyst:

Chandler -
I collected more samples today (6/3/86) + will send them when I get the analysis.

The analysis here are for samples I collected on 5/1/86
Glenn

L-BAR PRODUCTS, INCORPORATED
P.O. BOX 95
RAVENSDALE, WA 98051
(206) 432-1286

LABORATORY TEST RESULTS

Customer: L-bar Report To:
Sample I.D.: Hole 3, shallow, medium, deep, Hole 4 shallow, medium, deep Date Reported: 5/29/86
Sample Description: well water

Test Requested:
Results:

SAMPLE / TEST, CONCENTRATION	Hole 3 Shallow	Hole 3 Medium	Hole 3 Deep	Hole 4 Shallow	Hole 4 Medium	Hole 4 Deep	
pH	6.53	6.40	6.53	6.19	6.69	6.64	
Cl, ppm	2.44	2.9	2.4	3.4	1.9	2.9	
Na, ppm	17.55	1.07	4.21	58.63	0.81	13.42	
K, ppm	2.96	1.55	2.36	4.53	2.96	3.69	
Ca, ppm	52.90	63.73	58.06	56.51	72.50	72.61	
Mg, ppm	22.54	28.98	33.81	32.20	35.10	24.05	
DISS. SOLIDS, ppm	238	330	322	436	388	392	

6/3/86 Monitoring wells SWL.

Well 1 Shallow 41.75'
Deep 53.75'

Well 2 200.5'

Portal Culvert flow 30 gpm

Well 3 Shallow 13.7'
medium 13.5'
Deep 13.8'

Well 4 Shallow 24.6'
medium 26.95'
Deep 32.1'

Comments:

Analyst: GA

Chandler - the one sample results collected on 6/2/86

L-BAR PRODUCTS, INCORPORATED
P.O. BOX 95
RAVENSDALE, WA 98051
(206) 432-1286

LABORATORY TEST RESULTS

Customer: L-bar
Sample I.D.:
Sample Description: well water

Report To:
Date Reported: 6/9/86

Test Requested: # Ph, K, Na, Ca, Mg, Cl, Cd, Pb, Zn, Cu, As, Cr, Hg, Ni, Se, Ag, Ti, diss. solids
Results:

Samp # / Detn	well #1 shallow	well #1 Deep	well #2	well #3 Shallow	well #3 Medium	well #3 Deep	well #4 Shallow	well #4 Medium	well #4 Deep	Point Exhaust
Ph	6.68	6.76	6.33	6.66	6.53	6.51	5.98	6.67	6.60	6.60
K ppm	4.21	14.47	3.01	2.58	1.89	2.40	4.47	2.92	3.67	4.72
Na ppm	16.50	23.01	8.97	17.87	10.79	7.60	91.48	3.15	14.79	50.74
Ca ppm	96.36	75.38	86.37	59.40	71.38	62.40	61.40	80.37	71.38	67.39
Mg ppm	48.30	38.20	34.20	21.56	27.76	31.68	34.51	36.37	25.53	49.02
Cl ppm	2.9	6.3	2.9	2.9	2.9	2.4	3.9	1.9	2.9	7.2
Cd ppm	0	0	0	0	0	0	0	0	0	0
Pb ppm	0.41	0	0	0.73	0.41	0.10	0.26	0.10	0	0.10
Zn ppm	0	0	0	0	0	0	0	0	0	0
Cu ppm	0	0	0	0	0	0	0	0	0	0
As ppm	0.9	0	0	0.8	0	0.7	1.2	1.0	0	0
Sb ppm										
Ba ppm										
Be ppm										
Cr ppm	0	0	0	0	0	0	0	0	0	0
Hg ppm	0	0	0	0	0	0	0	0	0	0
Ni ppm	0	0	0	0	0	0	0	0	0	0
Se ppm	1.1	0.4	1.0	1.6	1.3	0.6	1.2	1.1	0.4	0.0
Ag ppm	0	0	0	0	0	0	0	0	0	0
Ti ppm	0	0	0	0	0	0	0	0	0	0
Diss solids	464	434	240	292	316	304	464	282	338	556

Comments: Ba, Be, Sb ... not run. due to technical difficulties

Analyst: