ELECTRICAL RESISTIVITY STUDIES RELATED TO THE PROPOSED LOW-LEVEL RADIOACTIVE WASTE REPOSITORY, HUDSPETH COUNTY, TEXAS

by

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Final Contract Report

Prepared for

Texas Low-Level Radioactive Waste Disposal Authority

by

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As part of the site characterization effort for the proposed low-level nuclear waste disposal site north of Fort Hancock, Texas, the University of Texas at El Paso conducted an electrical resistivity survey of the area. This survey was contracted by the Texas Low-Level Radioactive Waste Authority. The intent is to repeat this survey annually if the site is licensed in order to monitor leachate migration.

A series of soundings were made and profile readings were made around the entire perimeter of the proposed site. The locations of these measurements are shown in Figure 1. The procedures outlined in Draft Regulatory Guide 6.7 of the Texas Department of Health were followed. A Price array configuration was used to make the measurements and the Barnes layer method (Barnes, 1953) was used to calculate apparent subsurface resistivities. The voltage readings were generally the average of 4 measurements but in a few cases 16 measurements were averaged. Repeatability was excellent (1 or 2%) for a specific placement of the electrodes. However, movement of any electrode by 1 m created variations in readings of up to 100% and variations of 50% were common. These results are to be expected considering the near surface variability in terms of soil composition and water saturation, but they must be kept in mind if the survey is repeated in the future.

For the soundings, the outer current electrodes (I_1 and I_2) were spaced 210 m apart. The first voltage electrode (V_1) was placed in the center of the array, and the second (V_2) was first placed 35 m from V_1 and moved in increments (5 m, 2 m, or 1 m; see attached data sheets) toward I_2. After some experimentation in the field, it was clear that one-sided soundings would be adequate.

The field data sheets are attached in the Appendix of this report, and the apparent resistivities obtained are plotted versus depth in Figures 2-6. In each case, the resistivity generally decreases with depth. Higher resistivities were encountered at electrode spacings in

the range of 30-40 m. These probably reflect the presence of gravels. The lacustrine sediments of the Fort Hancock Formation should have low resistivities, and we interpret values of 5-7 ohm-meters encountered at spacings of 60-65 m to reflect penetration of this formation. Drill holes in area place the top of this formation at 30 m or less.

The profile measurements were intended to evaluate lithologic variability in the site area and were made with the two current electrodes (I_1 and I_2) spaced 98 m apart. The first voltage electrode (V_1) was placed at the middle of the array and the second (V_2) was placed first at a distance of 16 m from V_1 and then at a distance of 32 m. Thus, two depth intervals were sampled. The resistivity values obtained are plotted on three profiles which appear in Figures 7-9. The correlation with the soundings is good, and the field data sheets are included in the appendix. The first profile (Fig. 7) extends along the west side of the site. The major feature evident on this profile is the northward dip as stratigraphic units deepen as they approach the center of the small basin in the area. The second profile (Fig. 8) extends across the north side and short east side of the almost triangular site. Caliche outcrops along the western end of this profile, and it strongly effects stations 17-20. The consistently high values at stations 24-26 probably indicates the presence of a gravel-filled channel. On the southern profile (Fig. 9), high resistivity values also indicate channels at stations 38-42 and 51-55. The dip to the northeast is consistent with profile 1 and the seismic results. With the possible exception of the caliche outcrop area, the resistivity values produced consistent patterns which should make it possible to detect leachate migration with confidence in the future. A major variable would be recent rainfall and care should be taken that future surveys be undertaken under the same dry conditions encountered during this survey. This normally would be easy considering the climate if the late summer months are avoided.

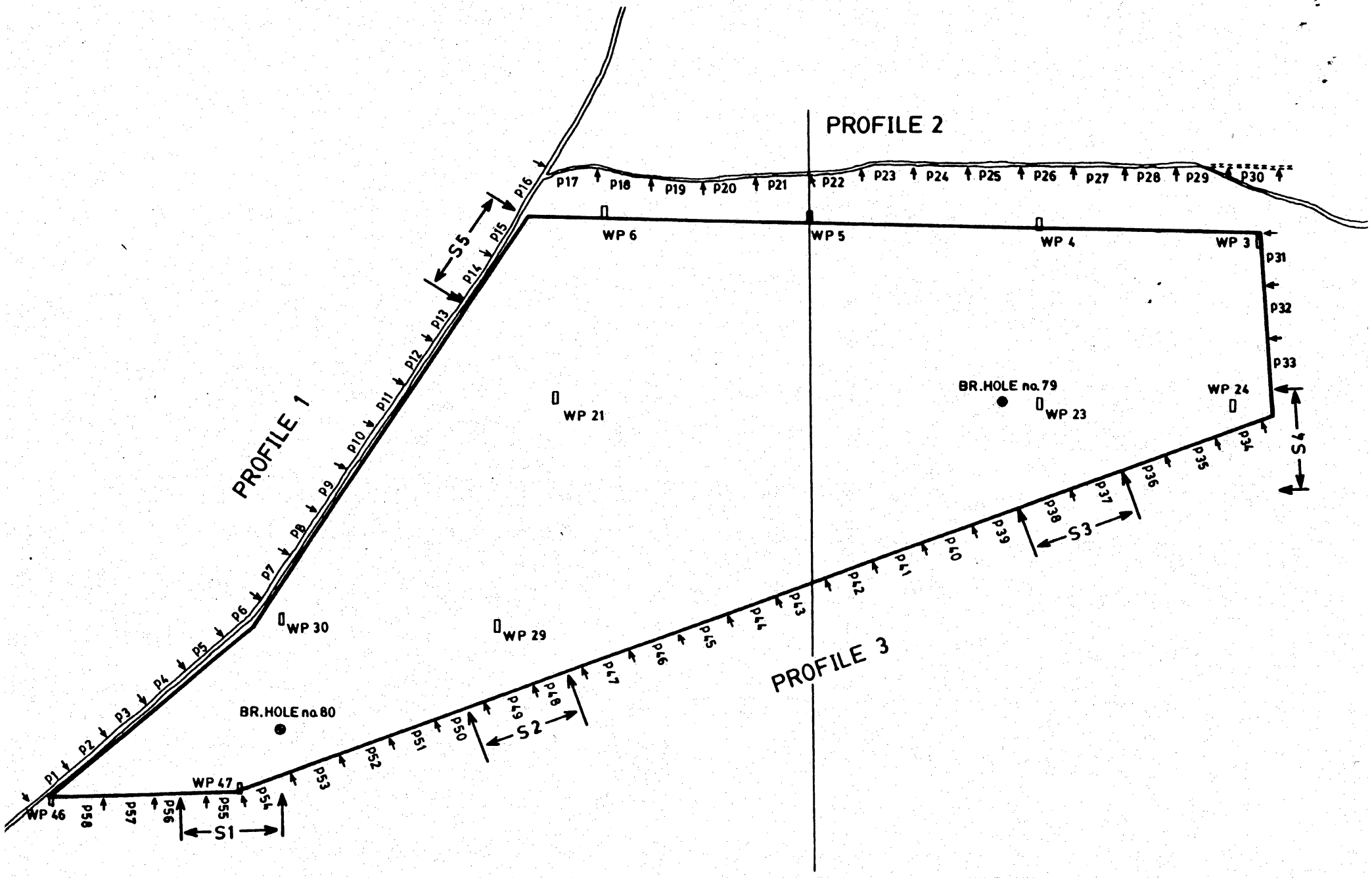


Figure 1: Index map of the proposed site showing locations for the soundings and profiles.

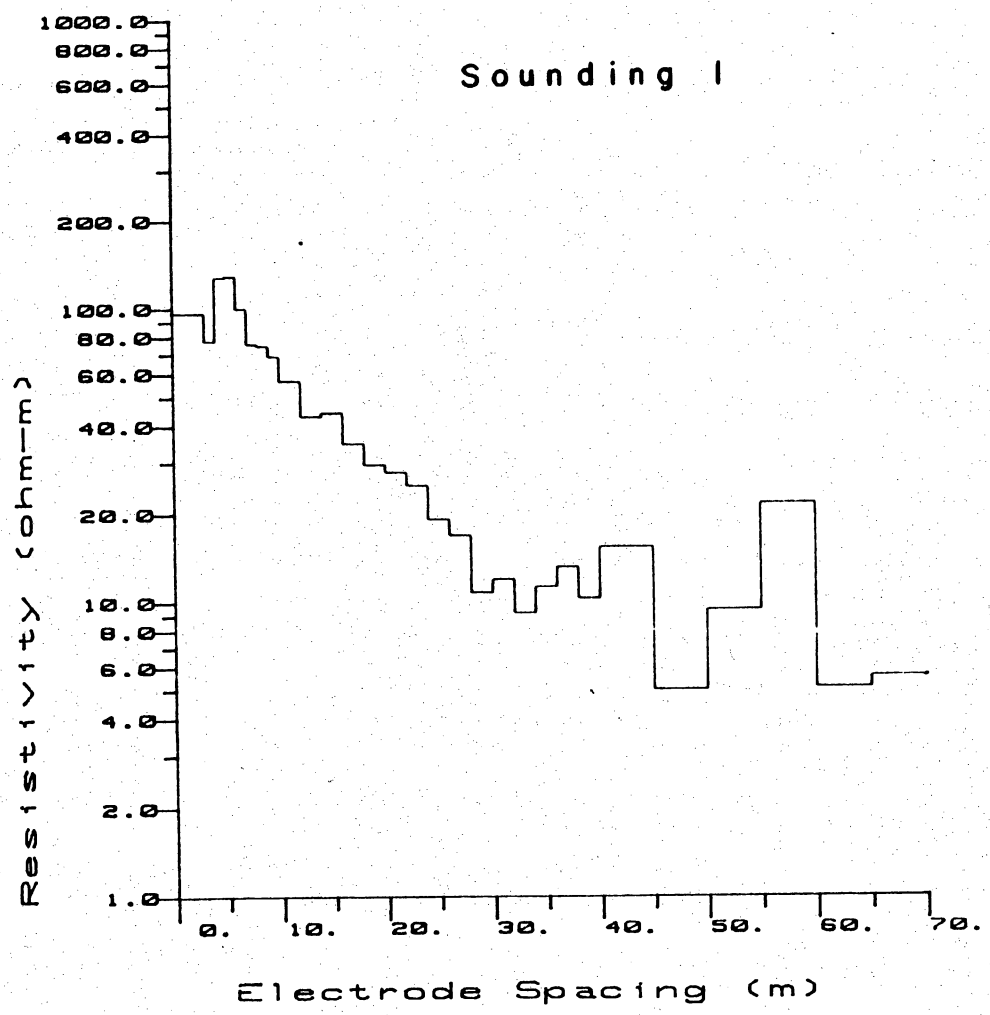


Figure 2: Resistivity profile for sounding 1

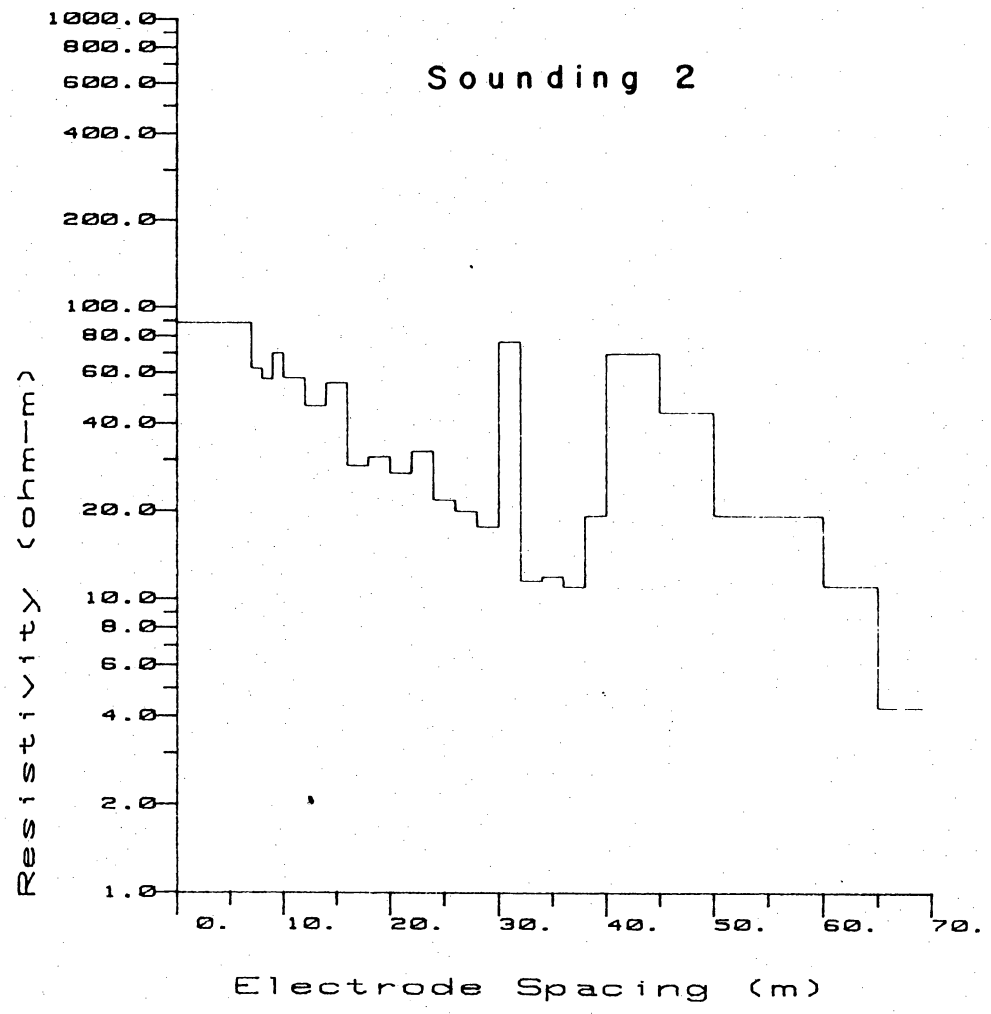


Figure 3: Resistivity profile for sounding 2

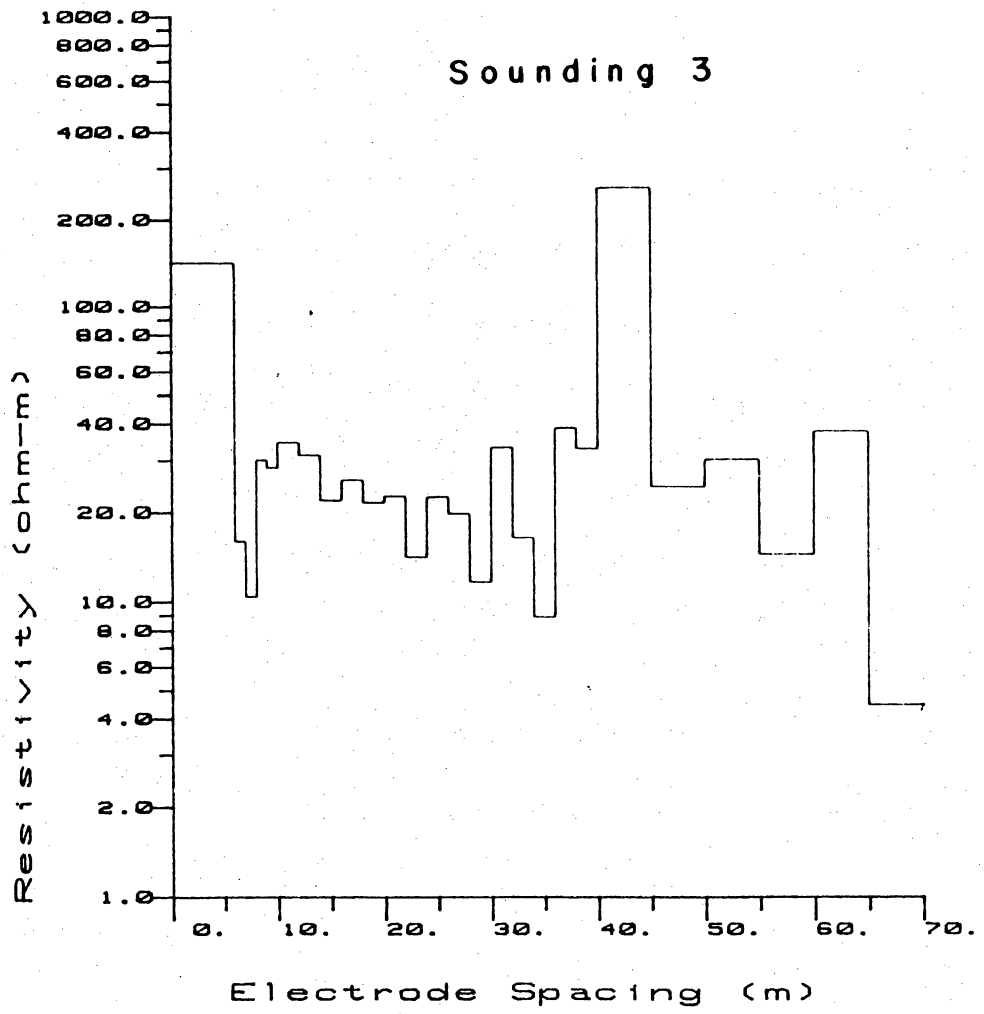


Figure 4: Resistivity profile for sounding 3

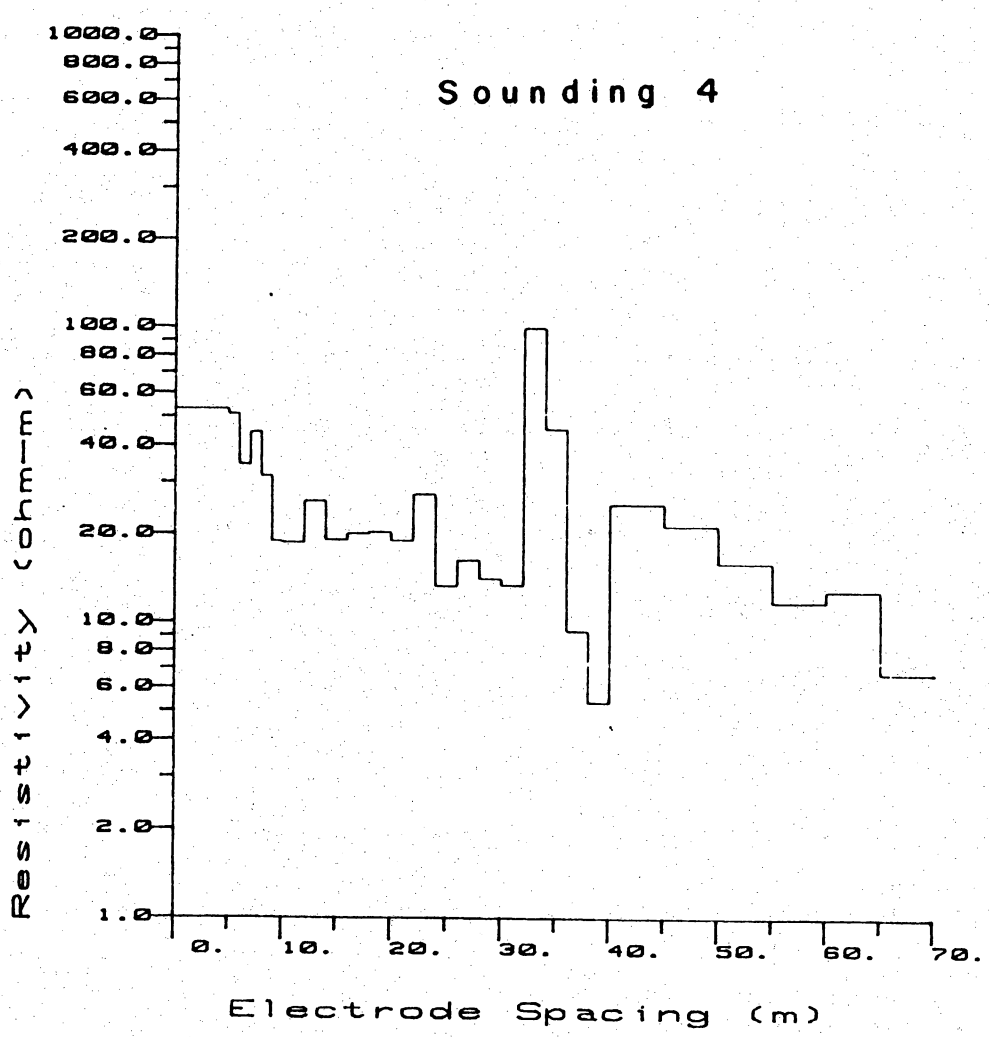


Figure 5: Resistivity profile for sounding 4

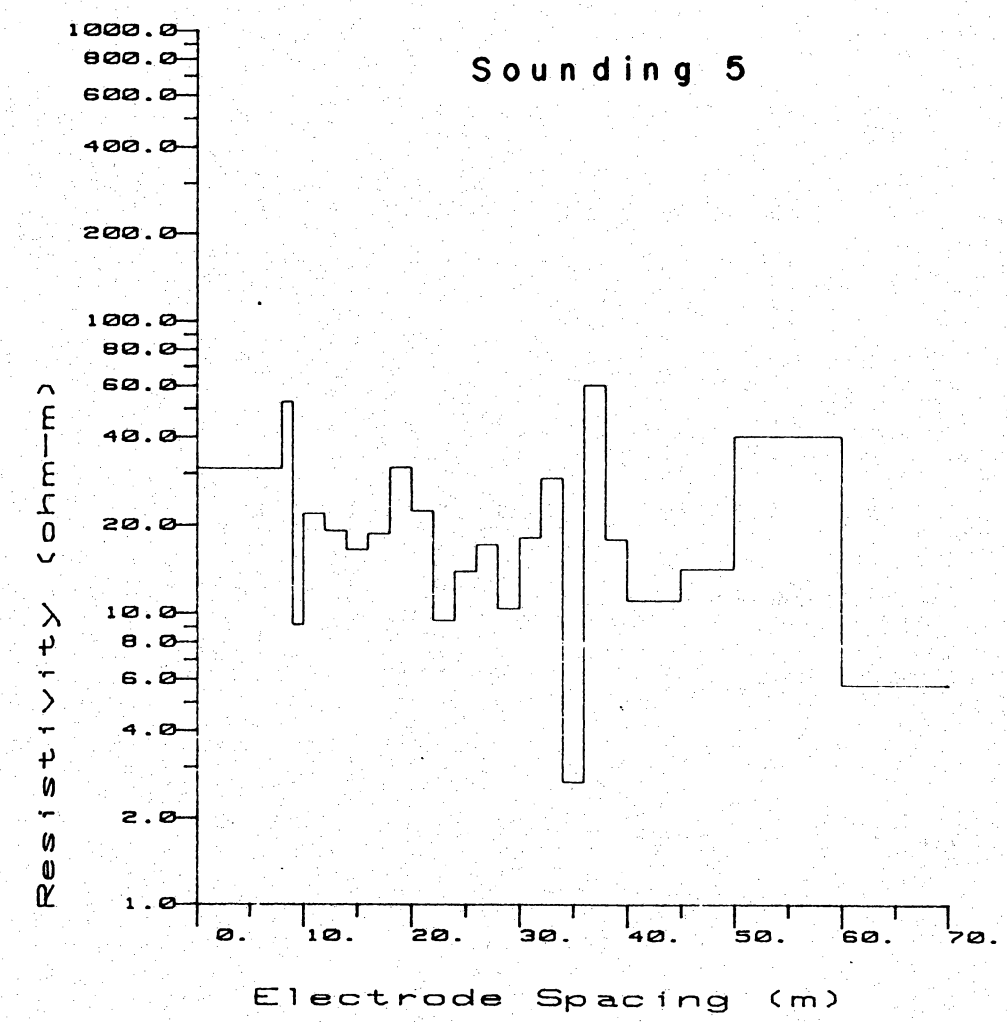


Figure 6: Resistivity profile for sounding 5

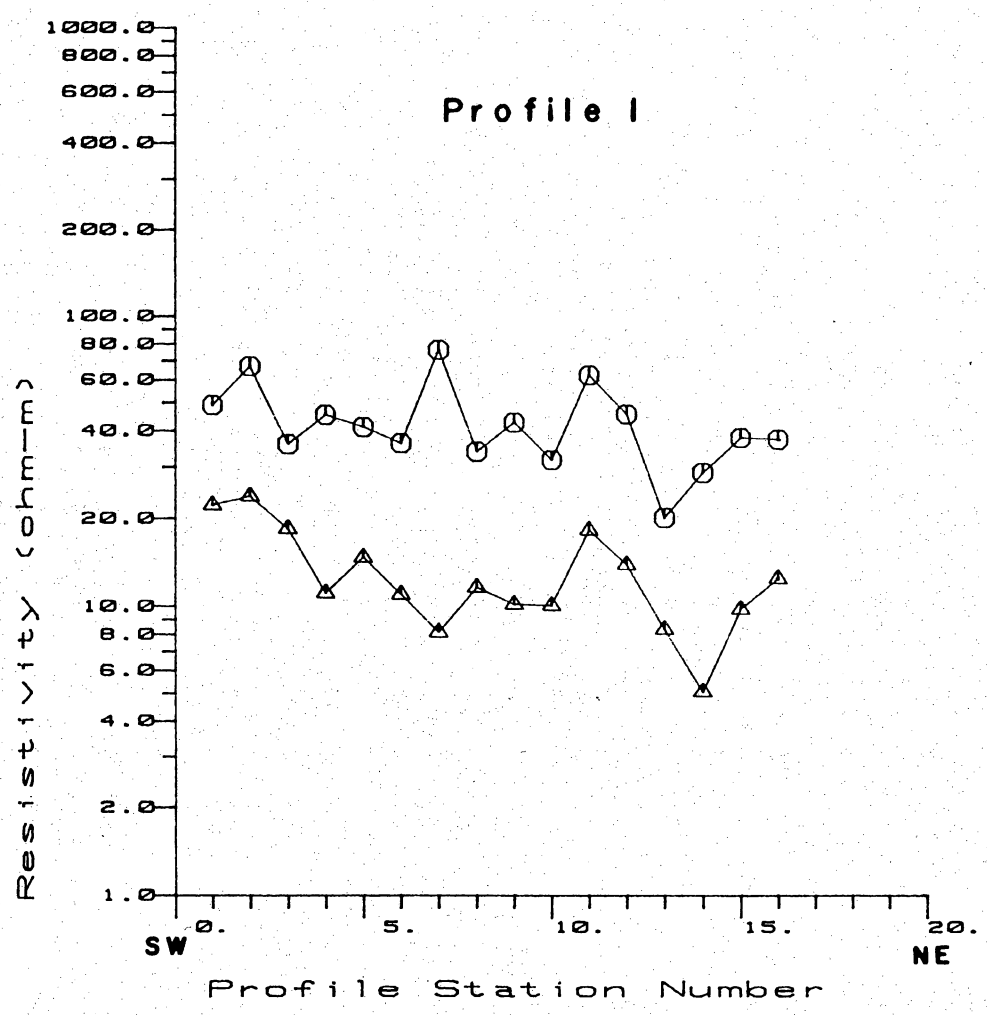


Figure 7: Resistivity values along profile 1

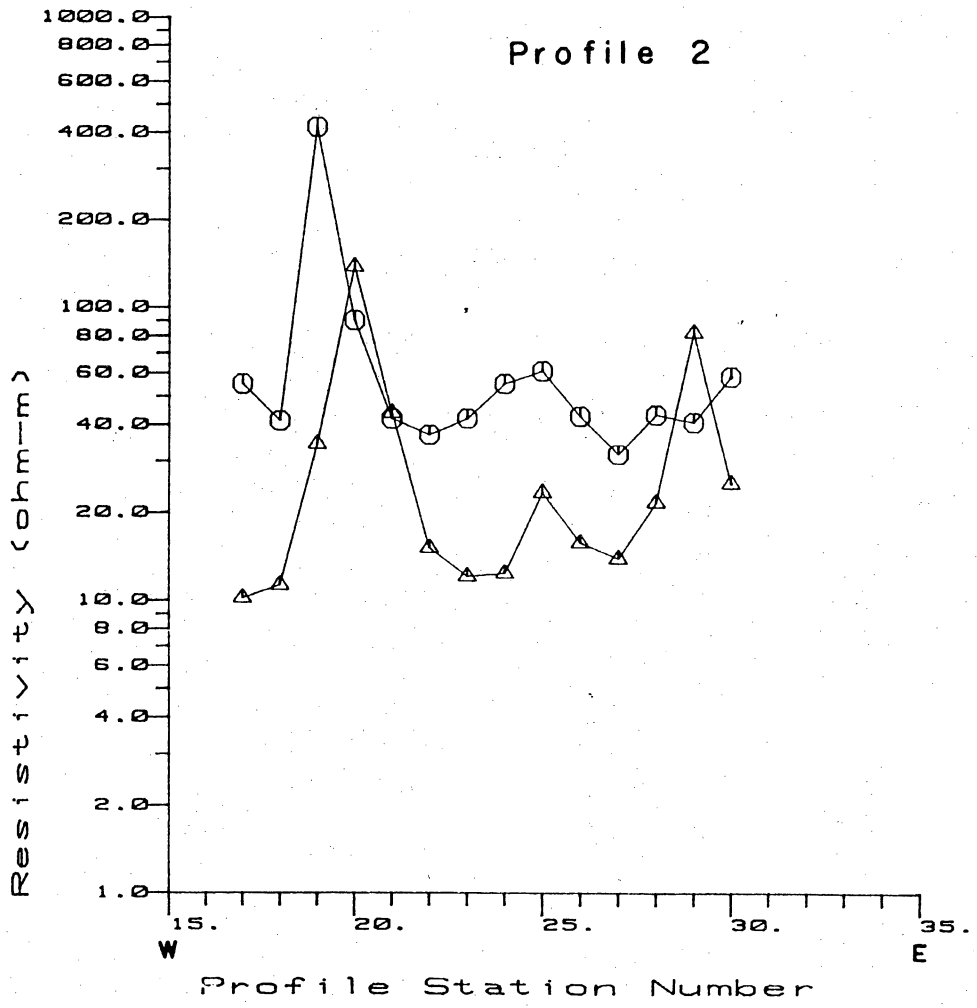


Figure 8: Resistivity values along profile 2

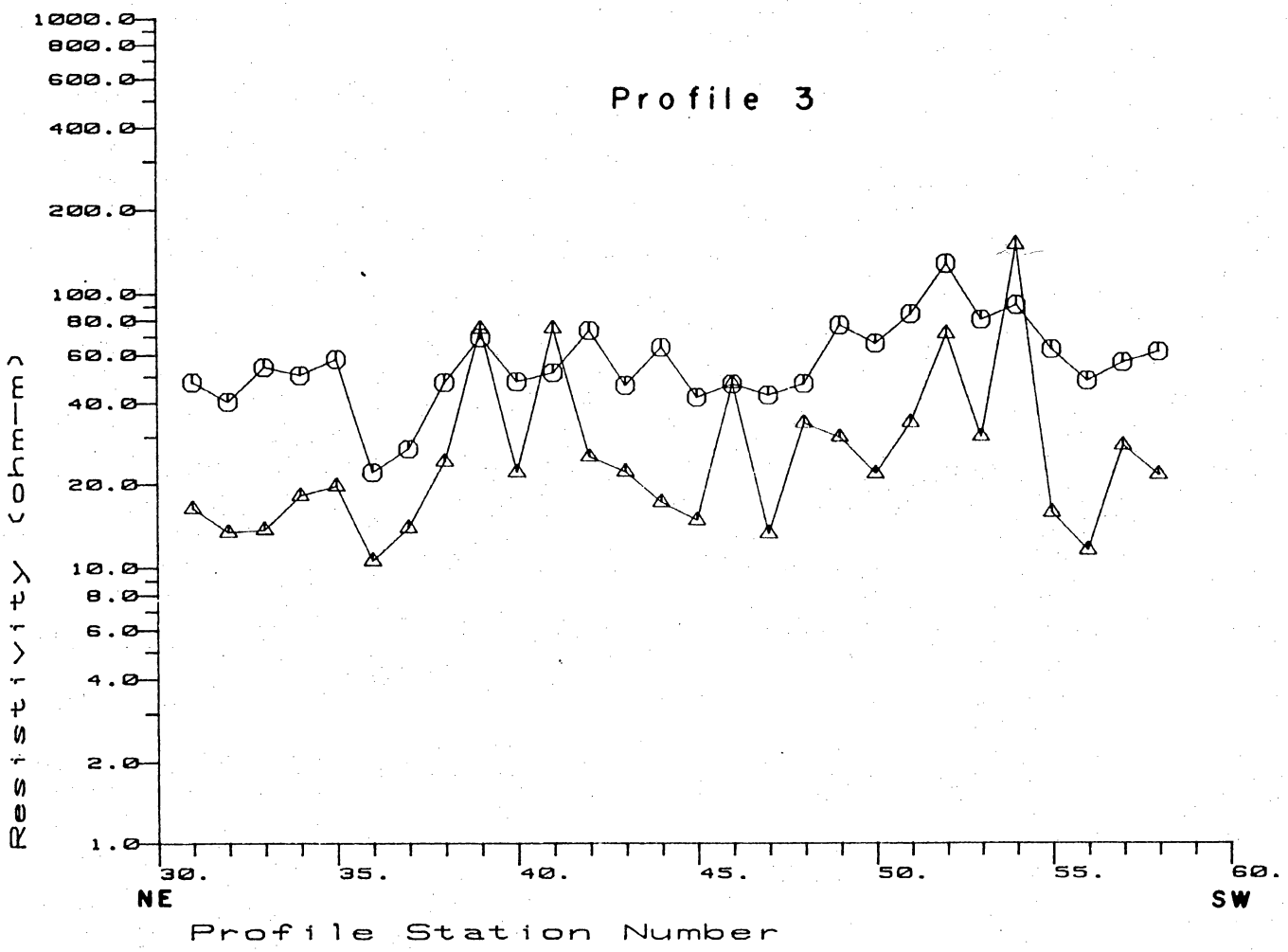


Figure 9: Resistivity values along profile 3

PROJECT Fort Hancock

PROFILE NO. 1 ARRAY Price

DATE 6/8/90

RESISTIVITY DATA SHEET
PROFILE

UNIT ABEM

CALIBRATION OK

OPERATOR ACOUNNAR, Baker

Station No.	A Electrode Spacing (Depth) In ~~Feet~~ meters	B Electrode Placement From Center In ~~Feet~~ meters V	B I	M Meter Reading 1. ~~2π V/I~~ 2. V/I 3. V	I Current	S Scale	M x S	Q Warp Factor For Price Array	D Dial Value In Ohms Wenner Array 1. MS 2. 2x MS 3. 2x MS/I Price Array 1. 2 MS Q 2. 4x MS Q 3. 4x MS Q/I	R Resistivity In Ohm-~~Cm~~m Barnes Layer Method Layer 1 AD 30.5 Layer 2 $A_2 - A_1 \frac{(D_1 \times D_2)}{(D_1 - D_2)} 30.5$	Sketch 40 meters from WP46 stake 363 Soil Condition/Elevation
P1	32	16		0.0759	20	1	0.0759	1.0	0.954	22.2	
	16	32		0.301	20	1	0.301	0.51	3.064	49.0	I_2
P2	32	16		0.0873	20	1	0.0873	1.0	1.097	25.8	
	16	32		0.411	20	1	0.411	0.81	4.18	66.9	
P3	32	16		0.0606	10	1	0.0606	1.0	0.761	18.4	
	16	32		0.221	10	1	0.221	0.81	2.249	35.9	
P4	32	16		0.0445	20	1	?0.0445	1.0	0.559	11.1	
	16	32		0.279	20	1	0.279	0.81	2.84	45.4	
P5	32	16		0539	20	1	0.0539	1.0	0.677	14.7	
	16	32		0.253	20	1	0.253	0.81	2.575	41.2	
P6	32	16		0.0419	20	1	0.0419	1.0	0.526	10.97	I_1 is due west at 100 meter flow
	16	32		0.222	20	1	0.222	0.81	2.26	36.2	WP30
P7	32	16		0.0366	10	1	0.0366	1.0	0.460	8.14	
	16	32		0.469	10	1	0.469	0.81	4.77	76.3	
P8	32	16		0.0431	10	1	0.0431	1.0	0.542	11.6	
	16	32		0.208	10	1	0.208	0.81	2.117	33.9	

PROJECT Fort Hancock

PROFILE NO. 1 ARRAY Pole

DATE 6-8-1990

RESISTIVITY DATA SHEET
PROFILE

UNIT ABEM

CALIBRATION OK

OPERATOR ACWINNER

Station No.	A Electrode Spacing (Depth) in ~~Feet~~ meters	B Electrode Placement From Center in ~~Feet~~ meters V	B I	M Meter Reading 1. 2πV/I 2. V/I 3. V	I Current	S Scale	M x S	Q Warp Factor For Price Array	D Dial Value in Ohms Wenner Array 1. MS 2. 2x MS 3. 2x MSA Price Array 1. 2 MS Q 2. 4x MS Q 3. 4x MS QA	R Resistivity in Ohm-~~Cm~~ m Barnes Layer Method Layer 1 AD 30.5 Layer 2 $A_2 - A_1 \frac{(D_1 \times D_2)}{(D_1 - D_2)} 30.5$	Sketch Soil Condition/Elevation
P9	32	16		0.0410	20	1	0.0410	1.0	0.512	10.14	
	16	32		0.262	20	1	0.262	0.81	2.667	42.7	
P10	32	16		0.380	20	1	0.0380	1.0	0.477	10.05	I_1 is due East (50 meters) from WP 20
	16	32		0.1944	20	1	0.1944	0.81	1.978	31.65	
P11	32	16		0.0700	10	1	0.0700	1.0	0.879	13.19	
	16	32		0.382	10	1	0.382	0.81	3.89	62.2	
P12	32	16		0.0529	5	1	0.0529	1.0	0.665	13.87	
	16	32		0.280	5	1	0.280	0.81	2.85	45.6	
P13	32	16		0.0362	10	1	0.0362	1.0	0.368	8.32	Center due west of the trench
	16	32		0.1234	10	1	0.1234	0.81	1.256	20.1	
P14	32	16		0.0214	20	1	0.0214	1.0	0.269	5.06	
	16	32		0.1763	20	1	0.1763	0.81	1.794	28.7	
P15	32	16		0.0386	10	1	0.0386	1.0	0.485	9.77	
	16	32		0.232	10	1	0.232	0.81	2.361	37.8	
P16	32	16		0.0464	10	1	0.0464	1.0	0.583	12.44	Center is ~ due west ~~from the East~~ West
	16	32		0.229	10	1	0.229	0.81	2.331	37.3	Road for the next line

PROJECT Fort Hancock

PROFILE NO. 2 ARRAY Pride

DATE 6-8-1990

RESISTIVITY DATA SHEET
PROFILE

UNIT ARCM

CALIBRATION OK

OPERATOR ARGUNNAR / BAKER

Station No.	A Electrode Spacing (Depth) In Feet m	B Electrode Placement From Center In Feet m V	B I	M Meter Reading ~~1. 2π V/I~~ 2. V/I ~~3. V~~	I Current	S Scale	M x S	Q Warp Factor For Price Array	D Dial Value In Ohms Wenner Array 1. MS 2. 2π MS 3. 2π MS/I Price Array ~~1. 2 MS Q~~ 2. 4π MS Q ~~3. 4π MS Q/I~~	R Resistivity In Ohm-Cm Barnes Layer Method Layer 1 AD 30.5 Layer 2 $A_2 - A_1 \frac{(D_1 \times D_2)\,30.5}{(D_1 - D_2)}$	Sketch Soil Condition/Elevation
P17	32	16		0.0429	20	1	0.0429	1.0	3.539	10.2	the start of the
	16	32		0.339	20	1	0.339	.81	3.45	55.2	East-west line.
P18	32	16		0.0441	10	1	0.0441	1.0	0.554	11.3	center due east
	16	32		0.254	5	1	0.254	.81	2.585	41.3	16.25 meter from gate
6/16/90											
P18	32	16		0.0380	10	1	0.0380	1.0	0.478	10.7	Duplicate at start
	16	32		0.164	10	1	0.164	0.81	1.669	26.7	
P19	32	16		0.158	2	1	0.158	1.0	1.98	34.4	
	16	32		2.58	2	1	2.580	0.81	26.26	420.	
P20	32	16		0.273	2	1	0.273	1.0	3.43	138.6	
	16	32		0.558	2	1	0.558	0.81	5.68	90.8	
P21	32	16		0.107	2	1	0.107	1.0	1.34	44.1	
	16	32		0.258	2	1	0.258	0.81	2.63	42.1	
P22	32	16		0.0536	16	1	0.0536	1.0	0.674	15.18	
	16	32		0.228	10	1	0.228	.0.81	2.32	37.1	

PROJECT Ft Hancock

PROFILE NO. 2 ARRAY Price

DATE 6/16/90

RESISTIVITY DATA SHEET
PROFILE

UNIT ABEM

CALIBRATION OK

OPERATOR BAKER

Station No.	A Electrode Spacing (Depth) In Feet m	B Electrode Placement From Center In Feet m V	B I	M Meter Reading 1. 2π V/I 2. V/I 3. V	I Current	S Scale	M x S	Q Warp Factor For Price Array	D Dial Value In Ohms Wenner Array 1. MS 2. 2π MS 3. 2π MSA Price Array 1. 2 MS Q 2. 4π MS Q 3. 4π MS QA	R Resistivity In Ohm-Cm Barnes Layer Method Layer 1 AD 30.5 Layer 2 $A_2 = A_1 \frac{(D_1 \times D_2)}{(D_1 - D_2)} 30.5$	Sketch Soil Condition/Elevation
P23	32	16		0.0469	10	1	0.0469	1.0	0.589	12.14	RP
	16	32		0.259	10	1	0.259	0.81	2.64	42.2	to South side of Rd
P24	32	16		0.0505	10	1	0.0505	1.0	0.635	12.42	
	16	32		0.341	10	1	0.341	0.81	3.47	55.5	
P25	32	16		0.0844	10	1	0.0844	1.0	1.061	23.5	
	16	32		0.376	10	1	0.376	0.81	3.83	61.3	
P26	32	16		0.0574	10	1	0.0574	1.0	0.721	15.8	Center V2 line WP4
	16	32		0.264	10	1	0.264	0.81	2.687	43.0	
P27	32	16		0.0482	10	1	0.0482	1.0	0.606	13.95	
	16	32		0.1950	10	1	0.195	0.81	1.985	31.8	
P28	32	16		0.0721	10	1	0.0721	1.0	0.906	21.75	
	16	32		0.267	10	1	0.267	0.81	2.718	43.5	
P29	32	16		0.1365	10	1	0.1365	1.0	1.715	32.8	
	16	32		0.252	10	1	0.252	0.81	2.56	41.0	
P30	32	16		0.0881	5	1	0.0881	1.0	1.107	25.3	
	16	32		0.361	5	1	0.361	0.81	3.67	58.7	

PROJECT Ft Hancock

PROFILE NO. 3 ARRAY Price

DATE 6/18/90

RESISTIVITY DATA SHEET
PROFILE

UNIT ABEM

CALIBRATION OK

OPERATOR Keller

Station No.	A Electrode Spacing (Depth) in ~~Feet~~ Meters	B Electrode Placement From Center in ~~Feet~~ Meters V	B I	M Meter Reading 1. 2π V/I 2. V/I 3. V	I Current	S Scale	M x S	Q Warp Factor For Price Array	D Dial Value in Ohms Wenner Array 1. MS 2. 2x MS 3. 2x MS/I Price Array 1. 2 MS Q 2. 4x MS Q 3. 4x MS QI	R Resistivity in Ohm-Cm Barnes Layer Method Layer 1 AD 30.5 Layer 2 $A_2 = A_1 \frac{(D_1 \times D_2)}{(D_1 - D_2)} 30.5$	Sketch SW 96 NE I_2 I_1 Soil Condition/Elevation
P38	32	16		0.0798	10	1	0.0798	1.0	1.003	24.2	
	16	32		0.292	10	1	0.292	0.81	2.972	47.6	
P37	32	16		0.0458	10	1	0.0458	1.0	0.575	13.9	
	16	32		0.166	10	1	0.166	0.81	1.689	27.0	
P36	32	16		0.0356	10	1	0.0356	1.0	0.447	10.6	
	16	32		0.1358	10	1	0.1358	0.81	1.382	22.1	
P35	32	16		0.0733	10	1	0.0733	1.0	0.921	19.7	
	16	32		0.356	10	1	0.356	0.81	3.62	57.9	
P34	32	16		0.0665	10	1	0.0665	1.0	0.836	18.2	
	16	32		0.311	10	1	0.311	0.81	3.166	50.6	

PROJECT Ft Hancock

PROFILE NO. 3 ARRAY Price

DATE 6/16/90

RESISTIVITY DATA SHEET
PROFILE

UNIT ABEM

CALIBRATION OK

OPERATOR Baker

Station No.	A Electrode Spacing (Depth) In Feet meters	B Electrode Placement From Center In Feet meters V	B I	M Meter Reading 1. 2π V/I 2. V/I 3. V	I Current	S Scale	M x S	Q Warp Factor For Price Array	D Dial Value In Ohms Wenner Array 1. MS 2. 2x MS 3. 2x MS/4 Price Array 1. 2 MS Q 2. 4x MS Q 3. 4x MS Q4	R Resistivity In Ohm-Cm Barnes Layer Method Layer 1 AD 30.5 Layer 2 $A_2 = A_1 \frac{(D_1 \times D_2)}{(D_1 - D_2)} 30.5$	Sketch Soil Condition/Elevation
P46	32	16		0.1169	10	1	0.1169	1.0	1.469	47.1	
	16	32		0.288	10	1	0.288	0.81	2.93	46.9	
P45	32	16		0.0544	10	1	0.0544	1.0	0.684	14.8	
	16	32		0.258	10	1	0.253	0.81	2.626	42.0	
P44	32	16		0.0674	10	1	0.0674	1.0	0.847	17.2	
	16	32		0.393	10	1	0.393	0.81	4.00	64.0	
P43	32	16		0.0747	10	1	0.0747	1.0	0.939	22.2	
	16	32		0.285	10	1	0.285	0.81	2.901	46.4	
P42	32	16		0.0935	10	1	0.0935	1.0	1.175	25.2	
	16	32		0.453	10	1	0.453	0.81	4.61	73.7	
P41	32	16		0.152	10	1	0.152	1.0	1.910	74.9	
	16	32		0.317	10	1	0.317	0.81	3.227	51.6	
P40	32	16		0.0753	10	1	0.0753	1.0	0.946	22.1	
	16	32		0.294	10	1	0.294	0.81	2.992	47.9	
P39	32	16		0.179	10	1	0.179	1.0	2.249	74.8	
				0.426	10	1	0.426	0.81	4.34	69.4	

PROJECT Ft Hancock

PROFILE NO. 3 ARRAY Price

DATE 6/16/90

RESISTIVITY DATA SHEET
PROFILE

UNIT ABEM

CALIBRATION OK

OPERATOR Barker

Station No.	A Electrode Spacing (Depth) in ~~Feet~~ Meters	B Electrode Placement From Center in ~~Feet~~ Meters V	B I	M Meter Reading 1. 2πV/I 2. V/I 3. V	I Current	S Scale	M x S	Q Warp Factor For Price Array	D Dial Value in Ohms Wenner Array 1. MS 2. 2π MS 3. 2π MS/I Price Array 1. 2 MS Q 2. 4π MS Q 3. 4π MS Q/I	R Resistivity in Ohm-~~Cm~~ m Barnes Layer Method Layer 1 AD 30.5 Layer 2 $A_2 - A_1 \frac{(D_1 \times D_2)}{(D_1 - D_2)} 30.5$	Sketch Soil Condition/Elevation
P54	32	16		0.280	5	1	0.280	1.0	3.52	149.	WP47
	16	32		0.556	5	1	0.556	0.81	5.66	90.6	
P53	32	16		0.1083	10	1	0.1083	1.0	1.36	29.9	I_2 V_2 V_1 I_1
	16	32		0.493	10	1	0.493	0.81	5.018	80.28	
P52	32	16		0.228	5	1	0.228	1.0	2.86	71.3	
	16	32		0.784	5	1	0.784	0.81	7.98	127.7	
P51	32	16		0.1201	5	1	0.1201	1.0	1.509	33.8	
	16	32		0.517	5	1	0.517	0.81	5.26	84.2	
P50	32	16		0.0813	10	1	0.0813	1.0	1.022	21.75	V_2 at intersection
	16	32		0.404	10	1	0.404	0.81	4.112	65.8	of seismic lines
P49	32	16		0.1068	10	1	0.1068	1.0	1.342	29.8	
	16	32		0.472	10	1	0.472	0.81	4.804	76.8	
P48	32	16		0.0977	10	1	0.0977	1.0	1.23	33.7	
	16	32		0.289	10	1	0.289	0.81	2.94	47.0	
P47	32	16		0.0503	10	1	0.0503	1.0	0.632	13.25	
	16	32		0.262	10	1	0.262	0.81	2.67	42.7	

PROJECT Fort Hancock

PROFILE NO. 31 ARRAY Pride

DATE 6/6/90

RESISTIVITY DATA SHEET
PROFILE

UNIT ABEM

CALIBRATION OK

OPERATOR Baker

Station No.	A Electrode Spacing (Depth) in ~~Feet~~ meter	B Electrode Placement From Center in ~~Feet~~ meter V	B I	M Meter Reading 1. 2π V/I 2. V/I 3. V	I Current	S Scale	M x S	Q Warp Factor For Price Array	D Dial Value in Ohms Wenner Array 1. MS 2. 2x MS 3. 2x MS/I Price Array 1. 2 MS Q 2. 4x MS Q 3. 4x MS Q/I	R Resistivity in Ohm-~~Cm~~ m Barnes Layer Method Layer 1 AD 30.5 Layer 2 $A_2 - A_1 \frac{(D_1 \times D_2)\ 30.5}{(D_1 - D_2)}$	Sketch Road WP46 Soil Condition/Elevation
P58	32	16		0.079	20	1	0.079	1.0	0.993	21.5	I_2
	16	32		0.375	20	1	0.375	0.81	3.317	61.0	
P57	32	16		0.0894	10	1	0.0894	1.0	1.123	27.6	
	16	32		0.343	10	1	0.343	0.81	3.491	55.8.	
P56	32	16		0.0461	20	1	0.0461	1.0	0.579	11.5	
	16	32		0.294	20	1	0.294	0.81	2.992	47.9	W WP47 E
P55	32	16		0.0623	20	1	0.0623	1.0	0.783	15.7	I_2 V_2
	16	32		0.384	20	1	0.384	0.81	3.908	62.5	WP3 25
P31	32	16		0.0606	10	1	0.0606	1.0	0.761	16.34	V_2 I_1
	16	32		0.293	10	1	0.293	0.81	2.982	47.7	I_2^N 5
P32	32	16		0.0502	10	1	0.0502	1.0	0.631	13.4	
	16	32		0.249			0.249	0.81	2.534	40.5	
P33	32	16		0.0544	10	1	0.0544	1.0	0.684	13.7	
	16	32		0.332	10	1	0.332	0.81	3.379	54.1	

End of Profile 2

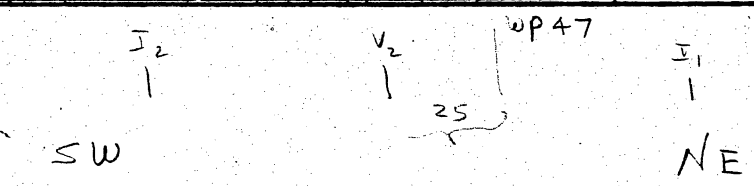
Texas LLRWDS Sounding

	A	B	C	D	E	F	G	H
1	Electrod	Price Array	Meter	Current	Scale	Price	Price Array	Resistivity
2	Spacing	Center to V	Reading			Array	4π C E F	Barnes Layer
3						Warp		
4	METERS	METERS	V/I	ma		Factor	Ohms	Ohm-~~cm~~ m
5	1	104				0.491		
6	2	103				0.505		
7	3	102	4.92	10	1	0.519	32.1	96.3
8	4	101	3.40	10	1	0.531	22.7	77.5
9	5	100	2.83	10	1	0.544	19.3	128
10	6	99	2.40	10	1	0.556	16.8	129
11	7	98	2.02	10	1	0.568	14.4	100
12	8	97	1.658	10	1	0.580	12.1	75.7
13	9	96	1.414	10	1	0.591	10.5	74.7
14	10	95	1.205	10	1	0.602	9.11	65.8
15	11	94				0.613		
16	12	93	0.881	10	1	0.623	6.90	56.8
17	13	92				0.633		
18	14	91	0.647	10	1	0.643	5.23	43.2
19	15	90				0.653		
20	16	89	0.509	10	1	0.663	4.24	44.3
21	17	88				0.672		
22	18	87	0.398	10	1	0.681	3.41	34.8
23	19	86				0.690		
24	20	85	0.315	10	1	0.699	2.77	29.5
25	22	83	0.257	10	1	0.716	2.31	27.8
26	24	81	0.212	10	1	0.732	1.95	25.0
27	26	79	0.172	10	1	0.748	1.62	19.1
28	28	77	0.142	10	1	0.763	1.36	16.9
29	30	75	0.112	10	1	0.778	1.095	10.8
30	32	73	0.093	10	1	0.792	0.926	12.0
31	34	71	0.083	10	1	0.806	0.841	9.16
32	36	69	0.071	10	1	0.820	0.732	11.3
33	38	67	0.063	10	1	0.833	0.659	13.2
34	40	65	0.055	10	1	0.845	0.584	10.3
35	42	63				0.857		
36	44	61				0.869		
37	46	59				0.881		
38	45 ~~48~~	60 ~~57~~	0.0447	10	1	~~0.892~~	0.875 0.491	15.4
39	50	55	0.029	10	1	0.903	0.329	5.00
40	55	50	0.024	10	1	0.929	0.280	9.40
41	60	45	0.022	10	1	0.954	0.263	21.6
42	65	40	0.017	10	1	0.978	0.209	5.09
43	70	35	0.014	10	1	1.000	0.176	5.57

SKETCH, SOIL CONDITION/ELEVATION

Location of P 34 Center electrode

Sandy soil dry



SOUNDING RESISTIVITY DATA SHEET

DATE 6/6/90 CALIBRATION OK UNIT ABEM

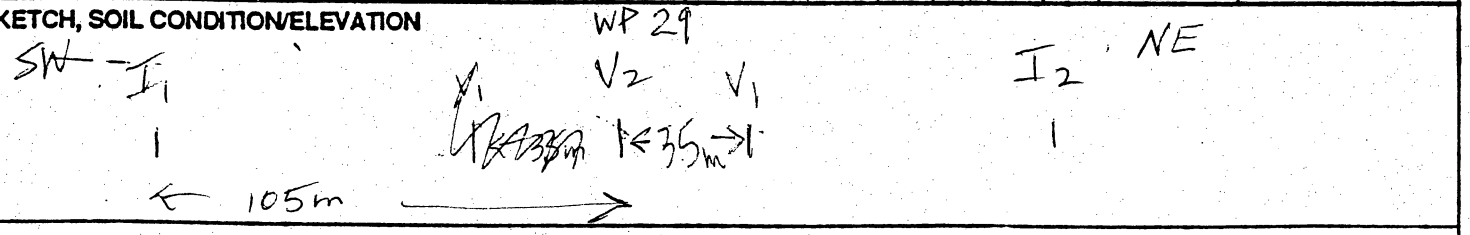
PROJECT Ft Hancock OPERATOR Baker ARRAY Price

SOUNDING NO. 1

Texas LLRWDS Sounding

	A	B	C	D	E	F	G	H
1	Electrod	Price Array	Meter	Current	Scale	Price	Price Array	Resistivity
2	Spacing	Center to V	Reading			Array	4π C E F	Barnes Layer
3						Warp		
4	METERS	METERS	V/I	ma		Factor	Ohms	Ohm-~~cm~~ m
5	1	104				0.491		
6	2	103				0.505		
7	3	102				0.519		
8	4	101				0.531		
9	5	-100				0.544		
10	6	99				0.556		
11	7	98	1.780	10		0.568	12.70	88.9
12	8	97	1.447	10		0.580	10.54	62.1
13	9	96	1.198	10		0.591	8.89	57.1
14	10	-95	1.043	10		0.602	7.89	70.2
15	11	94				0.613		
16	12	-93	0.791	10		0.623	6.19	57.6
17	13	92				0.633		
18	14	-91	0.604	10		0.643	4.88	46.1
19	15	90				0.653		
20	16	-89	0.498	10		0.663	4.15	55.4
21	17	88				0.672		
22	18	-87	0.376	10		0.681	3.22	28.6
23	19	86	~~0.340~~	~~10~~		0.690		
24	20	-85	0.303	10		0.699	2.66	30.7
25	22	83	0.247	10		0.716	2.22	27.0
26	24	81	0.212	10		0.732	1.950	32.1
27	26	79	0.176	10		0.748	1.654	21.8
28	28	77	0.148	10		0.763	1.419	19.97
29	30	75	0.125	10		0.778	1.222	17.6
30	32	73	0.119	10		0.792	1.184	76.9
31	34	71	0.0970	10		0.806	0.932	11.5
32	36	69	0.0813	10		0.820	0.843	11.9
33	38	67	0.0698	10		0.833	0.731	11.0
34	40	-65	0.0640	10		0.845	0.679	19.3
35	42	63				0.857		
36	44	61				0.869		
37	-46	59				0.881		
38	45 ~~48~~	60 ~~57~~	0.0589	10		~~0.892~~ 0.875	0.647	70.1
39	50	-55	0.0531	10		0.903	0.602	43.8
40	55	-50	0.0520	10		0.929	0.607	
41	-60	-45	0.0386	10		0.954	0.462	19.3
42	65	-40	0.0311	10	1	0.978	0.382	11.1
43	70	-35	0.0211	10	1	1.000	0.265	4.3

SKETCH, SOIL CONDITION/ELEVATION



SOUNDING RESISTIVITY DATA SHEET

DATE 6/18/90 CALIBRATION OK UNIT ABEM

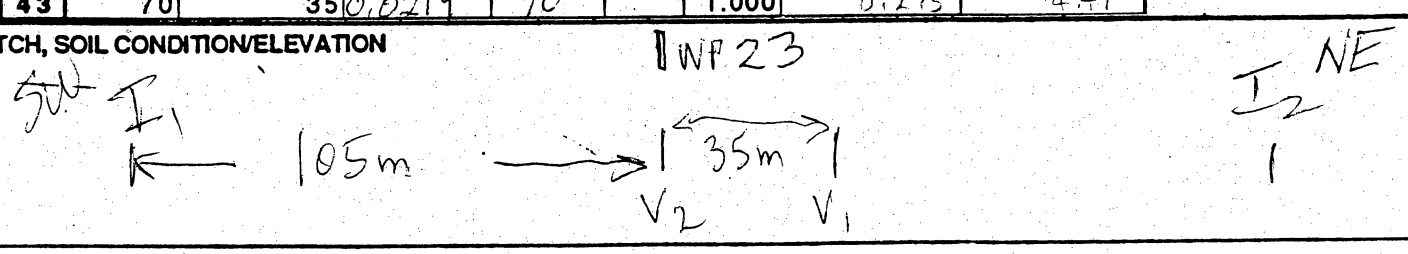
PROJECT Ft. Hancock OPERATOR Keller ARRAY Price

SOUNDING NO. ~~6~~ 2

Texas LLRWDS Sounding

	A	B	C	D	E	F	G	H
1	Electrod	Price Array	Meter	Current	Scale	Price	Price Array	Resistivity
2	Spacing	Center to V	Reading			Array	4π C E F	Barnes Layer
3						Warp		
4	METERS	METERS	V/I	ma		Factor	Ohms	Ohm-~~cm~~ m
5	1	104				0.491		
6	2	103				0.505		
7	3	102				0.519		
8	4	101				0.531		
9	5	100				0.544		
10	6	99	3.39			0.556	23.68	142
11	7	98	2.24			0.568	15.99	16.02
12	8	97	1.417	10		0.580	10.33	10.4
13	9	-96	1.037	10		0.591	7.70	30.24
14	10	-95	0.801	10		0.602	6.06	28.4
15	11	94				0.613		
16	12	-93	0.573	10		0.623	4.49	34.66
17	13	92				0.633		
18	14	-91	0.432	10		0.643	3.49	31.34
19	15	90				0.653		
20	16	-89	0.318	10		0.663	2.65	22.0
21	17	88				0.672		
22	18	-87	0.257	10		0.681	2.199	25.8
23	19	86				0.690		
24	20	-85	0.208	10		0.699	1.827	21.6
25	22	83	0.195	10		0.716	1.574	22.7
26	24	81	0.140	10		0.732	1.288	14.17
27	26	79	0.123	10		0.748	1.156	22.6
28	28	77	0.108	10		0.763	1.035	19.7
29	30	75	0.0900	10		0.778	0.880	11.7
30	32	73	0.0840	10		0.792	0.836	33.4
31	34	71	0.0750	10		0.806	0.759	16.5
32	36	69	0.0630	10		0.820	0.649	8.9
33	38	67	0.0600	10		0.833	0.628	38.8
34	40	-65	0.0570	10		0.845	0.605	33.0
35	42	63				0.857		
36	44	61				0.869		
37	46	59				0.881		
38	45 ~~48~~	60 ~~57~~	0.0544	10		~~0.892~~ 0.875	0.598	258.4
39	50	55	0.0470	10		0.903	0.533	24.5
40	55	50	0.0420	10		0.929	0.490	30.3
41	60	45	0.0350	10		0.954	0.419	14.5
42	65	40	0.0323	10		0.978	0.397	37.2
43	70	35	0.0219	10		1.000	0.275	4.47

SKETCH, SOIL CONDITION/ELEVATION



SOUNDING RESISTIVITY DATA SHEET

DATE 6/18/90 CALIBRATION OK UNIT ABEM

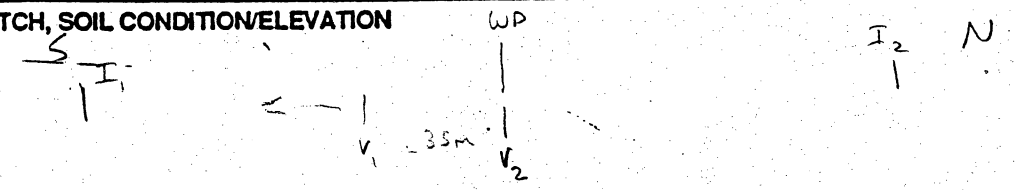
PROJECT Ft. Hancock OPERATOR Keller ARRAY Price

SOUNDING NO. ~~4~~ 3

Texas LLRWDS Sounding

	A	B	C	D	E	F	G	H
1	Electrod	Price Array	Meter	Current	Scale	Price	Price Array	Resistivity
2	Spacing	Center to V	Reading			Array	4π C E F	Barnes Layer
3						Warp		
4	METERS	METERS	V/I	ma		Factor	Ohms	Ohm-~~cm~~ m
5	1	104				0.491		
6	2	103				0.505		
7	3	102				0.519		
8	4	101				0.531		
9	5	100	1.545			0.544	10.6	53.0
10	6	99	1.264	10	1	0.556	8.83	51.1
11	7	98	0.985	10	1	0.568	7.03	34.5
12	8	97	0.833	10	1	0.580	6.07	44.4
13	9	96	0.685	10	1	0.591	5.09	31.5
14	10	95	0.530	10	1	0.602	4.01	18.9
15	11	94				0.613		
16	12	93	0.359	10	1	0.623	2.81	18.7
17	13	92				0.633		
18	14	91	0.286	10	1	0.643	2.37	25.9
19	15	90				0.653		
20	16	89	0.223	10	1	0.663	1.86	19.1
21	17	88				0.672		
22	18	87	0.184	10	1	0.681	1.57	20.1
23	19	86				0.690		
24	20	85	0.155	10	1	0.699	1.36	20.3
25	22	83	0.132	10	1	0.716	1.19	19.0
26	24	81	0.119	10	1	0.732	1.095	27.4
27	26	79	0.100	10	1	0.748	0.940	13.3
28	28	77	0.082	10	1	0.763	0.843	16.3
29	30	75	0.077	10	1	0.778	0.753	14.1
30	32	73	0.068	10	1	0.792	0.677	13.4
31	34	71	0.066	10	1	0.806	0.668	100
32	36	69	0.063	10	1	0.820	0.649	45.6
33	38	67	0.058	10	1	0.833	0.607	9.38
34	40	65	0.0466	10	1	0.845	0.495	5.36
35	42	63				0.857		
36	44	61				0.869		
37	46	59				0.881		
38	45 ~~48~~	60 ~~57~~	0.041	10	1	~~0.892~~ 0.875	0.451	25.4
39	50	55	0.036	10	1	0.903	0.408	21.4
40	55	50	0.031	10	1	0.929	0.362	16.0
41	60	45	0.0263	10	1	0.954	0.314	11.8
42	65	40	0.0228	10	1	0.978	0.290	12.9
43	70	35	0.0185	10	1	1.000	0.232	6.76

SKETCH, SOIL CONDITION/ELEVATION



SOUNDING RESISTIVITY DATA SHEET

DATE 6/6/90 CALIBRATION OK UNIT ABEM

PROJECT Ft Hancock OPERATOR Baker ARRAY Price

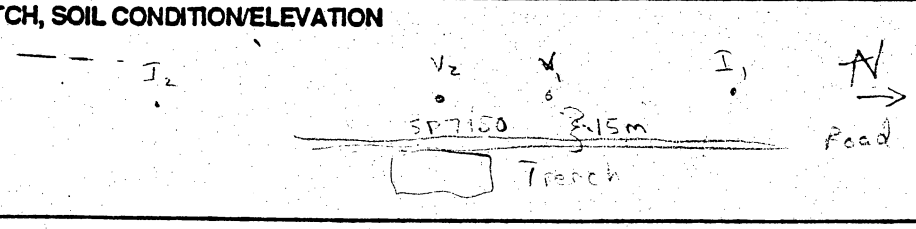
SOUNDING NO. 4

Texas LLRWDS Sounding

	A	B	C	D	E	F	G	H
1	Electrod	Price Array	Meter	Current	Scale	Price	Price Array	Resistivity
2	Spacing	Center to V	Reading			Array	4π C E F	Barnes Layer
3						Warp		
4	METERS	METERS	V/I	ma		Factor	Ohms	Ohm-~~cm~~ m
5	1	104				0.491		
6	2	103				0.505		
7	3	102				0.519		
8	4	101				0.531		
9	5	100				0.544		
10	6	99				0.556		
11	7	98				0.568		
12	8	97	0.539	10	1	0.580	3.92	31.7
13	9	96	0.492	10	1	0.591	3.65	53.0
14	10	95	0.345	10	1	0.602	2.61	9.16
15	11	94				0.613		
16	12	93	0.269	10	1	0.623	2.11	22.0
17	13	92				0.633		
18	14	91	0.214	10	1	0.643	1.73	19.2
19	15	90				0.653		
20	16	89	0.172	10	1	0.663	1.43	16.5
21	17	88				0.672		
22	18	87	0.145	10	1	0.681	1.24	18.7
23	19	86				0.690		
24	20	85	0.131	10	1	0.699	1.15	31.6
25	22	83	0.116	10	1	0.716	1.044	22.45
26	24	81	0.093	10	1	0.732	0.855	9.47
27	26	79	0.081	10	1	0.748	0.761	13.9
28	28	77	0.073	10	1	0.763	0.699 ~~0.761~~	17.2
29	30	75	0.063	10	1	0.778	0.616	10.37
30	32	73	0.058	10	1	0.792	0.577	18.2
31	34	71	0.0548	10	1	0.806	0.555	29.1
32	36	69	0.038	10	1	0.820	0.392	2.67
33	38	67	0.037	10	1	0.833	0.387	60.7
34	40	65	0.035	10	1	0.845	0.371	179.
35	42	63				0.857		
36	44	61				0.869		
37	46	59				0.881		
38	45 ~~48~~	60 ~~57~~	0.029	10	1	~~0.892~~ 0.875	0.318	11.1
39	50	55	0.026	10	1	0.903	0.295	14.2
40	55	50	0.026	10	1	0.929	0.303	—
41	60	45	0.023	2	1	0.954	0.275	40.5
42	65	40	0.0252	20	1	0.978	0.309	—
43	70	35	0.0148	20	1	1.000	0.186	5.75

← Show original or fixed (fixed)

SKETCH, SOIL CONDITION/ELEVATION



Watering Electrodes every 4 reading

SOUNDING RESISTIVITY DATA SHEET

DATE 6/6/90 CALIBRATION _____ UNIT ABEM

PROJECT Ft Hancock OPERATOR _____ ARRAY Price

SOUNDING NO. 5 Reoccat Bad Sounding