The Light company Houston Lighting & Power P.O. Box 1700 Houston, Texas 77001 (713) 228-9211

October 12, 1982
ST-HL-AE-890
File Number: G9.15

Thomas M. Novak
Assistant Director of Licensing
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Novak:

South Texas Project
Units 1 & 2
Docket Nos. STN 50-498, STN 50-499
Geotechnical Engineering Information

On July 22, 1982, members of my staff met with Messrs. L. Heller and D. Gupta of the NRC Hydrological and Geotechnical Engineering Branch and Mr. D. Sells of your staff to discuss the licensing review of the South Texas Project geotechnical design. Attached is the geotechnical information on Essential Cooling Water (ECW) Pipeline soil profiles, the boundaries of the four low density backfill areas, contaminated backfill, settlement and nonconforming backfill beneath the ECW intake and discharge that was requested by the NRC staff during the above meeting.

If you should have any questions concerning this matter, please contact Mr. Michael E. Powell at (713) 877-3281.

Very truly yours,

J. H. Goldberg

J. H. Goldberg
Vice President
Nuclear Engineering & Construction

McB/mg

Attachment

B001

8210200075 A

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Woodward-Clyde Consultants

January 8, 1979
ST-WC-BR-5427
SFN: D-0540/P-0087

Brown & Root, Inc.
P. O. Box 3
Houston, Texas 77001

Attention: Mr. L. E. Hayden, Jr.
Engineering Project Manager

Subject: Contaminated Backfill
Mechanical-Electrical Auxiliary Building -
Unit 2

Gentlemen:

This letter transmits our conclusions regarding extent and compressibility of contaminated backfill in the Mechanical-Electrical Auxiliary Building area of Unit 2. This letter and the attached calculation package supercedes WCC's letter ST-WC-BR-5414. The calculation package presents calculations of differential settlement between Diesel Generator Building and northern end of the Mechanical-Electrical Auxiliary Building, results of Standard Penetration Tests, logs of soil borings and results of laboratory tests all made to define the extent and compressibility of contaminated backfill.

Fifteen borings were drilled from 23 to 28 October 1978 for the purposes of determining extent of contaminated backfill. Boring locations are given in Table 1 and Figure 1. Contaminated backfill was encountered in eight of the borings. Two additional borings were drilled adjacent to previously drilled borings for the purpose of obtaining undisturbed samples.

Elevations of the limits of backfill, contaminated backfill and top of the D layer in each boring are listed on Table 2. The contaminated backfill was encountered in thicknesses ranging from 1/4 to 4 ft. Because borings BF-17 and BF-18 contained no more than 3 in. of contaminated backfill we believe that the lateral extent of contaminated backfill does not exceed limits defined by borings BF-4, -7, -12, -21, -17, -15, -16 and -18. The contaminated backfill in all eight borings except

boring BF-18 consisted of a mixture of medium to coarse sand, and yellowish-brown and reddish-brown clay with a trace of rounded gravel. In many instances the sand and clay were so thoroughly mixed that the soil was visually classified as a yellowish-brown and reddish-brown clayey sand. Borings BF-6 and BF-13 differed slightly from the other borings in that in boring BF-6 a lime treated layer of sand and gravel was encountered between El -13 to -14.5 ft (MSL) and in boring BF-13 limestone gravel was encountered between El -16 and -16.25. The contaminated backfill in boring BF-18 consisted of an approximately 3 in. thick layer of lime-treated clay with limestone gravel.

Using the results of consolidation tests and Standard Penetration Tests we conclude that the compressibility of the contaminated backfill is very low. It is our opinion that the contaminated backfill will not lead to differential settlements in excess of criteria.

If you have any questions concerning our findings or the conclusions presented in this letter please call me.

Very truly yours,

WOODWARD-CLYDE CONSULTANTS

Charles S. Hedges
Project Manager

Y310XP (12)

Distribution:
Technical

CSH/dn

Project South Texas Project

Phase IV

Subject Contaminated Backfill

ASSIGNMENT OF CALCULATIONS

Calculation No.: WCC- 6000-H

Document Title: Contaminated Backfill, Mechanical-Electrical Auxiliary Bldg.-Unit 2

Assigned by: [signature] Date: 1 Nov 1978

Checked by: [signature] Date: 8 Jan 1979

Performed by: [signature] Date: 8 Jan 1979

Verified by: Charles S Hedges Date: Jan 10, 1979

Purpose: To determine the extent and compressibility of contaminated backfill in the Mechanical-Electrical Auxiliary Building area of Unit 2.

Procedure: Examine soil boring logs and the results of Foundation Verification and determine the extent of the contaminated backfill.

Use the results of standard penetration tests and consolidation tests to determine the compressibility of the contaminated backfill.

Results Used for: To support the conjecture that if the contaminated backfill is left in place that it will not lead to differential settlements in excess of criteria.

Revisions:

Determine the compressibility of the contaminated backfill if left in place

- Limits

The limits of the contaminated backfill as defined by WCC field investigation and foundation verification programs are shown in Figure 1. The limits of the contaminated backfill are defined by borings B7-7, -12 and -21 on the east, B7-17 and -15 on the south, and B7-16, -18 and -4 on the west. Of these 8 borings, contaminated backfill was encountered in borings B7-18 and -17; however, the thickness of contaminated backfill was less than 3 in. at these two borings so they are considered to define the lateral extent at their specific location. The northern extent of the contaminated backfill is defined by concrete placed on design verified D layer soil in zones 224 and 230 on 28 September 1978 (see Figure 1). The locations of borings drilled to define the extent of and sample contaminated backfill are listed on Table 1. The limits of the concrete pours in zones 224 and 230 are shown on Form 518-WCC-4000-2 of the foundation verification package for the respective zones. The logs of soil borings drilled to define the extent of contaminated backfill are presented in Appendix A of this calculation package.

FOR South Texas Project

- Thickness
Elevations of the vertical limits of structural backfill, contaminated backfill and top of D layer in each boring are listed on Table 2. The thickness of the contaminated backfill ranged from 1/4 to 4 ft. The nature of the contaminated backfill is discussed in WCC's letter ST-WC-BR-5427 dated 8 January 1979. For computational purposes assume that the maximum thickness of contaminated backfill underlies the plant area to the horizontal limits shown in Figure 1.

- Compressibility using Consolidation Test Results
To determine the amount of compression that will occur in a 4-ft-thick layer use the equation:

$$\Delta H = \frac{H \Delta e}{1+e_i} \quad \text{where}$$

H = thickness of soil layer, ft

Δe = change in void ratio over the stress excursion that the soil layer is subjected to

e_i = initial void ratio

ΔH = compression of contaminated backfill layer

The consolidation test, liquid and plastic limits determinations, and specific gravity test results are included in Appendix B of this calculation package.

WOODWARD-CLYDE CONSULTANTS

Sheet No. 3 Of 6

File 7377306 (Rev. 04)

Made by M. Perez Date 11 Nov 1978

Checked by [illegible] Date 8 Jan 1979

FOR South Texas Project

Initial Conditions:

The overburden stresses for the contaminated backfill samples at the time of piping connections are:

Boring	Sample No.	Elevation ft	Average Depth ft	γ pcf	σ_o ksf	u(2) ksf	σ_o' ksf
B19U	T-3	-11.5 to -13.5	16	118	1.89	0.22	1.67
B19U	T-4	-13.5 to -14	17.25	118	2.04	0.30	1.74
B20U	T-2	-12.5 to -13.5	16.5	118	1.95	0.25	1.70

(1) Assume Ground Surface Elev = +3.5
(2) Assume water table Elev = -9.0

For computional purposes use 1.70 ksf as the effective overburden stress (σ_o').

Final Conditions

Boring	Sample No.	Contact Stress ksf (3) DGB	Contact Stress ksf (3) MEA	σ_o ksf	Final Total Stress ksf (1) DGB	Final Total Stress ksf (1) MEA	u(2) ksf	Final Effective Stress ksf DGB	Final Effective Stress ksf MEA
19U	T-3	3.04	3.51	1.89	4.93	5.40	1.90	3.03	3.50
19U	T-4	"	"	2.04	5.08	5.55	1.98	3.10	3.57
20U	T-2	"	"	1.95	4.99	5.46	1.93	3.06	3.53
								3.1	3.6 Use

(1) Assume no stress distribution w/ depth
(2) Assume water table Elev. +18.0
(3) Contact stresses from B&R T.R.D. 3Y100SQ003-B

Using the initial and final stress conditions determine the change in void ratio and hence the compression of the contaminated backfill using the equation:

$$\Delta H = \frac{\Delta e \, H}{1+e_i} \quad \text{with:}$$

H = 48 in.

e_o = void ratio at initial stress or effective overburd stress, 1.70 ksf

Structure	Boring No.	Sample No.	σ'_{oi} ksf	σ'_{of} ksf	e_i	e_f	Δe	$\Delta e/(1+e_i)$ $\times 10^{-3}$	ΔH in.
DGB	19U	T-3	1.70	3.1	0.3177	0.3127	0.0050	3.8	0.18
	19U	T-4	"	"	0.2698	0.2650	0.0048	3.8	0.18
	20U	T-2	"	"	0.3169	0.3107	0.0062	4.7	0.23
MEA	19U	T-3	"	3.6	0.3177	0.3113	0.0064	4.9	0.23
	19U	T-4	"	"	0.2698	0.2637	0.0061	4.8	0.23
	20U	T-2	"	"	0.3169	0.3090	0.0079	6.0	0.29

The maximum differential settlement is 0.06 in. between the Deisel Generator and Mechanical-Electrical Auxiliary Bldgs.

WOODWARD-CLYDE CONSULTANTS

Sheet No. 5 of 6

File 75-3005 (UC:OH)

Made by [illegible] Date 27 DEC 1978

Checked by [illegible] Date 8 Jan 1979

FOR South Texas Project

- Compressibility Using Standard Penetration Test Results

Using the results of standard penetration tests the consistency of the contaminated backfill has been compared to the D layer clay. The standard penetration test results for backfill sand, contaminated backfill and D layer clay are listed in Table 3. Figure 2 presents the frequency of occurrence of standard penetration resistance for the D layer and the contaminated backfill. At all values of frequency of occurrence standard penetration resistances in the contaminated backfill are greater than that for the D layer.

WOODWARD-CLYDE CONSULTANTS

Sheet No. 6 of 6

File 75-3050 (6-004)

FOR South Texas Project

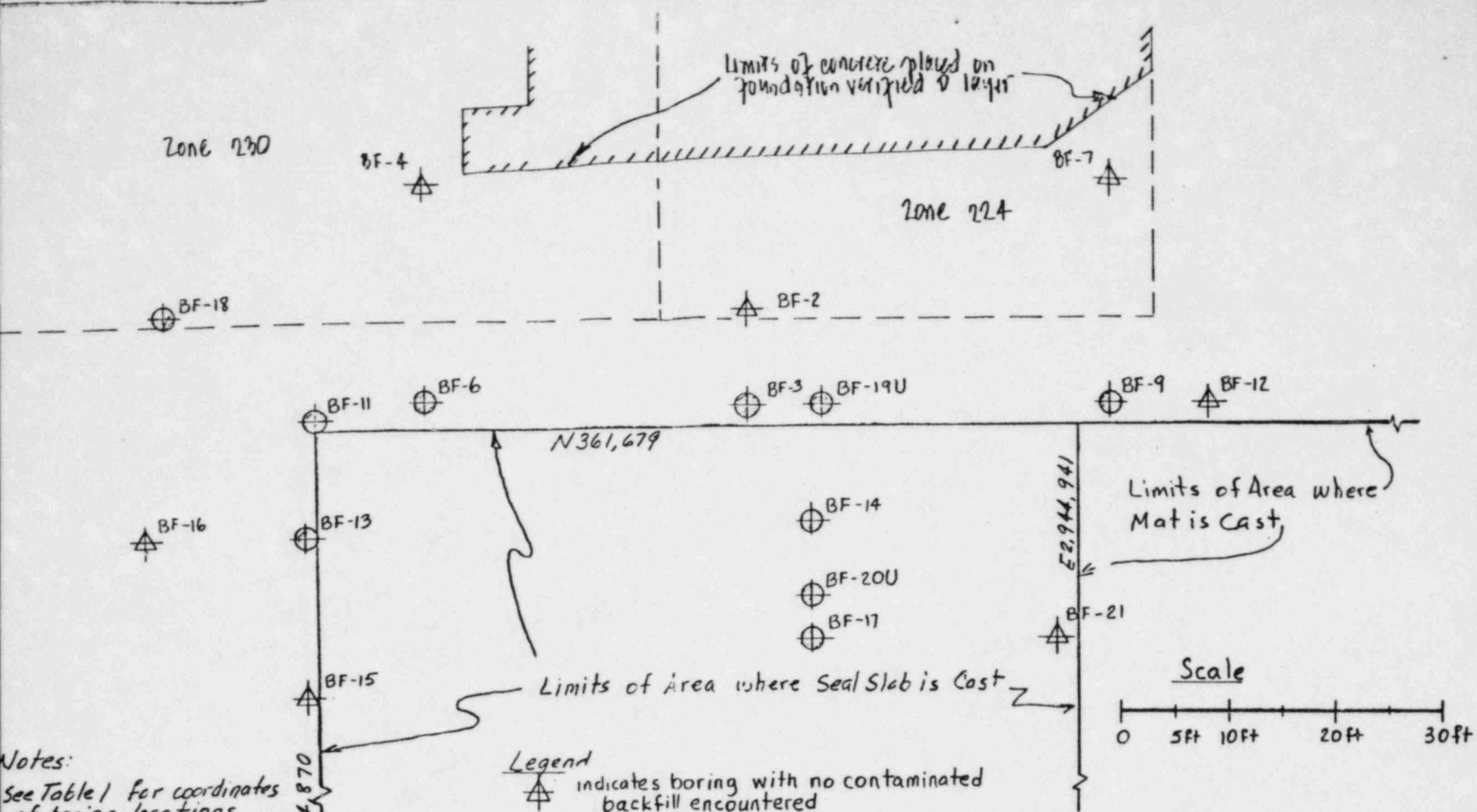
Made by [illegible] Date 19 Dec 1978

Checked by [illegible] Date 8 Jan 1979

Conclusions

The maximum calculated differential movement between the Diesel Generator Building and the northern end of the MEAB is 0.06 in. In fact, some compression of the contaminated backfill has more than likely already occurred. As shown in Figure 2 at all values of frequency of occurrence standard penetration resistances in the contaminated backfill are greater than that for the D layer.

We conclude that the compressibility of the contaminated backfill is very small. It is our opinion that the contaminated backfill will not lead to differential settlements in excess of criteria.



Notes:

See Table 1 for coordinates of boring locations

See Table 2 for elevations of boundaries of backfill sand, contaminated backfill and top of D layer

See Table 3 for Standard Penetration Test Results

Thickness of Contaminated Backfill did not exceed 3 in. in borings BF-17 and BF-18

Legend

△ indicates boring with no contaminated backfill encountered

⊕ indicates boring in which contaminated backfill encountered

BF-20U indicates boring in which undisturbed sample obtained

– – – indicates limits of foundation verification zone

LOCATIONS OF BORINGS

Extent of Contaminated Back fill
M-EA Bldg. Unit 2
SOUTH TEXAS PROJECT

Drawn by: Chk'd by Date: 3Nov.78
Revised by Chk'd by Date 12/12/78

FIG. 1

WOODWARD-CLYDE CONSULTANTS

Sheet No. Of

File 75-30C3, 6000H

Made by MJM Date 1 Nov 1978

Checked by MPA Date 2 Nov 1978

FOR STP-EXTENT OF CONTAMINATED BACKFILL

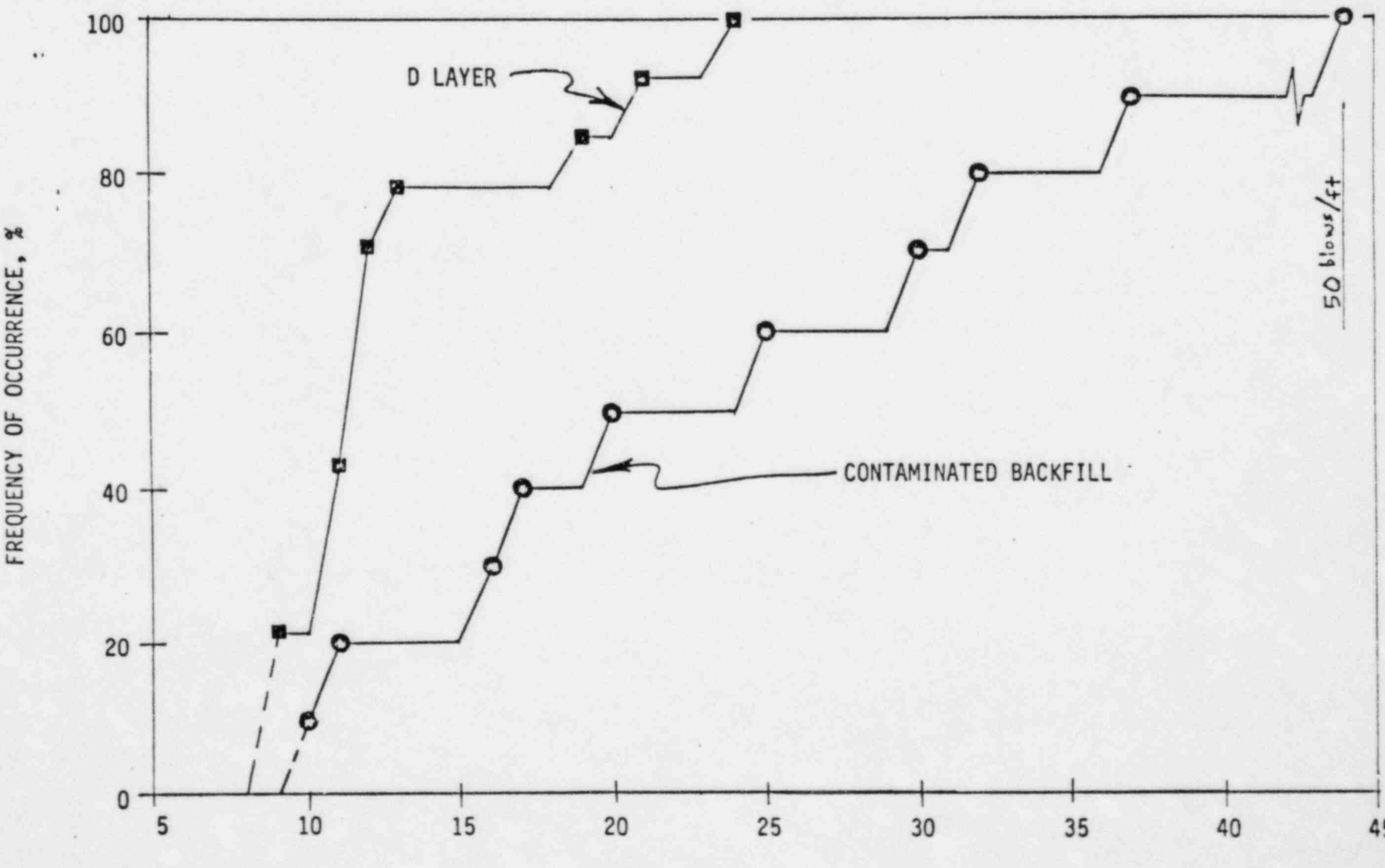


FIGURE 2

South Texas Project
75-3008, Task 6000, Subtask 6000H
Extent of Contaminated Backfill

TABLE 1

LOCATIONS OF BORINGS DRILLED TO DEFINE
EXTENT OF AND SAMPLE CONTAMINATED BACKFILL

BORING NO.	COORDINATES NORTH	EAST
BF-2 [1] (295) [2]	361690	2944910
BF-3 (296)	361681	2944910
BF-4 (297)	361702	2944880
BF-6 (298)	361681.5	2944880
BF-7 (299)	361702	2944944
BF-9 (300)	361681	2944944
BF-11 (301)	361680	2944870
BF-12 (302)	361681	2944953
BF-13 (303)	361669	2944869
BF-14 (304)	361670	2944916
BF-15 (305)	361654	2944869
BF-16 (306)	361669	2944854
BF-17 (307)	361659	2944916
BF-18 (308)	361690	2944856
BF-19U (309)	361681	2944917
BF-20U (310)	361663	2944916
BF-21 (311)	361659	2944939

Notes:
(1) Field assigned boring numbers.
(2) Official South Texas Project boring number designation.
(3) Coordinates of boring locations provided orally by B&R's W. Bray on 28 October 1978.

TABLE 2

THICKNESS OF BACKFILL SAND AND CONTAMINATED BACKFILL, AND TOP OF D LAYER

SOIL STRATIGRAPHY (ELEVATIONS IN FEET FROM MEAN SEA LEVEL)

BORING	BACKFILL SAND	CONTAMINATED BACKFILL	TOP OF D-LAYER
BF-2	+2.75(2) to -14.85	NP(1)	-14.85
BF-3	+3 to -11	-11 to -15	-15
BF-4	+3 to -15.4	NP	-15.4
BF-5	Not drilled		
BF-6	+3 to -12	-12 to -15.8	-15.8
BF-7	+3 to -15.5	NP	-15.5
BF-8	Not drilled		
BF-9	+3.5 to -10 and -12 to -14.3	-10 to -12	-14.3
BF-10	Not drilled		
BF-11	+3.5 to -14.7 and -15.2 to -15.7	-14.7 to -15.2	-15.7(3)
BF-12	+3.5 to -14.5	NP	-14.5
BF-13	+3.5 to -14.5 & -16.3 to -16.7	-14.5 to -16.3	-16.7(3)
BF-14	+3(5) to -12.7 and -14.8 to -15.5	-12.7 to -14.8	-15.5
BF-15	+3.5 to -17.5	NP	-17.5
BF-16	+3.5 to -18.5	NP	-18.5
BF-17	+3(5) to -13.3 and -13.5 to -15	-13.3 to -13.5	-15
BF-18	+3.5 to -15.8 & -16.1 to -17.2	-15.8 to -16.1	-17.2(3)
BF-19U	ND(6)	-11 to -14(4)	-15
BF-20U	ND	-11.5 to -13.5(4)	ND
BF-21	+3(5) to -15.1	NP	-15.1(3)

(1) NP indicates that contaminated backfill was not encountered at this boring location.

(2) Elevations are approximate only.

(3) Reddish brown clayey sand identifies interface between D layer and backfill sand.

(4) Indicates that boring drilled for undisturbed sampling only. Limits of contaminated backfill are approximate.

(5) Estimated based on 1-ft-thick seal slab.

(6) Indicates thickness of backfill sand and top D layer not determined.

TABLE 3

STANDARD PENETRATION TEST RESISTANCES FOR
BACKFILL SAND, CONTAMINATED BACKFILL AND D LAYER

BORING	SPT VALUES(1) IN BACKFILL SAND blows/ft	SPT VALUES IN CONTAMINATED BACKFILL blows/ft	SPT VALUES IN D LAYER blows/ft
BF-2	44, 36		9
BF-3	--	20, 48 (16)(3), 11(2)	7/6 in.
BF-4	50/9 in., 49, 50 50/10 in.		13
BF-6	64,50	50, 10	19
BF-7	14, 14, 15, 28		11
BF-9	79, 48, 28(2)	30(2)	7/6 in., 12
BF-11	50/9 in., 20, 23, 50/8 in.	37(2)	21
BF-12	50/5 in., 50/6 in., 50/7 in., 51/9 in.		9
BF-13	80/9 in., 58/10 in., 50/9 in., 76/9 in.	17	12
BF-14	63/9 in., 130/9 in., 55	32, 25(2)	9
BF-15	76/9 in., 64/9 in., 72/9 in., 64, 78/9 in., 35		12
BF-16	54/9 in., 54/9 in., 65/9 in., 64/9 in., 70/6 in., 56/6 in., 89(2)		11
BF-17	68/10 in., 101/9 in., 71/7 in., 87, 65		12
BF-18	55, 70, 85/9 in., 68/9 in., 74/10 in., 33		24
BF-21	70/6 in., 74/6 in., 79 61/9 in., 35(2)		11

(1) Values of penetration resistance are for the last 12 in. of an 18 in. drive unless so noted.

(2) Penetration resistance value is for first 12 in. of drive.

(3) Gravel wedged in split-spoon orifice may have resulted in artificially high blow counts. The 48 blows/ft was recorded for the last 12 in. of an 18 in. drive and 16 blows/ft was recorded for the first 12 in. of an 18 in. drive.

APPENDIX A

LOGS OF SOIL BORINGS

BORING NO. 295*

SOUTH TEXAS PROJECT

LOCATION COORDINATES E 2944910 - N 361,v0

LOCATION AREA Mechanical-Electrical Auxiliary Bldg., Unit 2

SURFACE ELEV. +2.75 m.s.l. TOTAL DEPTH 19.5 feet

DATE COMPLETED 23 Oct 1978 DATE E-LOGGED - - -

NOTES: * Field prepared boring log designated BF-2. Boring made for contaminated backfill study.

BLOW COUNT	SAMPLE	DEPTH (FEET)	DESCRIPTION	LAYER I.D.
		0	MEDIUM TO COARSE SAND (SW): yellowish brown "Structural Backfill Sand"	
46	S1	5	dense	
36	S2			
		10		
		15		
9	S3		SILTY CLAY (CH): stiff, reddish brown	D
		20	Bottom of Hole @ 19.5'	

BLOW COUNT	SAMPLE	DEPTH (FEET)	BORING NO. ____ (CONT'D.) DESCRIPTION	LAYER I.D.

SOUTH TEXAS PROJECT UNITS 1 & 2

BORING LOG NO. 295

FIGURE 11.6-191

BORING NO. 296*

SOUTH TEXAS PROJECT

LOCATION COORDINATES E 2944910 - N 361681

LOCATION AREA Mechanical-Electrical Auxiliary Bldg., Unit 2

SURFACE ELEV. +3 m.s.l. TOTAL DEPTH 18.5 feet

DATE COMPLETED 23 Oct 1978 DATE E-LOGGED - - -

NOTES: *Field prepared boring log designated BF-3. Boring made for contaminated backfill study.

BLOW COUNT	SAMPLE	DEPTH (FEET)	DESCRIPTION	LAYER I.D.
		0	MEDIUM TO COARSE SAND (SW): yellowish brown "Structural Backfill Sand"	
20	S1	14	Mixture of MEDIUM TO COARSE SAND (SW) and SILTY CLAY (CH): yellowish brown w/rounded gravel	
48	S2			
13	S3			
		18	SILTY CLAY (CH): stiff, reddish brown	D
		18.5	Bottom of Hole @ 18.5'	

BORING NO. ____ (CONT'D.)

BLOW COUNT	SAMPLE	DEPTH (FEET)	DESCRIPTION	LAYER I.D.

SOUTH TEXAS PROJECT UNITS 1 & 2

BORING LOG NO. 296

FIGURE 11.6-192

BORING NO. 297*

SOUTH TEXAS PROJECT

LOCATION COORDINATES E 2944880 - N 361702

LOCATION AREA Mechanical-Electrical Auxiliary Bldg., Unit 2

SURFACE ELEV +3 m.s.l. TOTAL DEPTH 19.5 feet

DATE COMPLETED 24 Oct 1978 DATE E-LOGGED - - -

NOTES: * Field prepared boring log designated BF-4. Boring made for contaminated backfill study.

BLOW COUNT	SAMPLE	DEPTH (FEET)	DESCRIPTION	LAYER I.D.
		0	MEDIUM TO COARSE SAND (SW): yellowish brown "Structural Backfill Sand"	
		5		
		10		
50/9 in.	S1		dense to very dense	
49	S2			
		15		
50	S3			
50/10 in.	S4			
13	S5		CLAY (CH): stiff, reddish brown	D
		20	Bottom of Hole @ 19.5'	
		25		

BLOW COUNT	SAMPLE	DEPTH (FEET)	BORING NO. ____ (CONT'D.) DESCRIPTION	LAYER I.D.

SOUTH TEXAS PROJECT UNITS 1 & 2

BORING LOG NO. 297

FIGURE 11.6-193

BORING NO. 298*

SOUTH TEXAS PROJECT

LOCATION COORDINATES E 2944880 - N 361691.5

LOCATION AREA Mechanical-Electrical Auxiliary Bldg., Unit 2

SURFACE ELEV. 43 m.s.l. TOTAL DEPTH 20.5 feet

DATE COMPLETED 23 Oct 1978 DATE E-LOGGED - - -

NOTES: * Field prepared boring log designated BF-6. Boring made for contaminated backfill study.

BLOW COUNT	SAMPLE	DEPTH (FEET)	DESCRIPTION	LAYER I.D.
			MEDIUM TO COARSE SAND (SW): yellowish brown	
		5		
			"Structural Backfill Sand"	
		10		
64	S1		very dense	
50	S2	15	MEDIUM TO COARSE SAND (SW): gray and yellowish brown w/trace rounded gravel and clay	
50	S3		MEDIUM TO COARSE SAND AND GRAVEL (SM-GP): very dense, gray and white, appears lime treated	
10	S4		medium dense	
19	S5		SILTY CLAY (CH): very stiff, reddish brown w/ silt lenses	D
		20		
			Bottom of Hole @ 20.5'	
		25		

BLOW COUNT	SAMPLE	DEPTH (FEET)	BORING NO. ____ (CONT'D.) DESCRIPTION	LAYER I.D.

SOUTH TEXAS PROJECT
UNITS 1 & 2

BORING LOG NO. 298

FIGURE 11.6-194

BORING NO. 299*

SOUTH TEXAS PROJECT

LOCATION COORDINATES E 2944941 - N 361702

LOCATION AREA Mechanical-Electrical Auxiliary Bldg., Unit 2

SURFACE ELEV. +3.5 m.s.l. TOTAL DEPTH 20.5 ft

DATE COMPLETED 24 Oct 1978 DATE E-LOGGED ---

NOTES: * Field prepared boring log designated BF-7. Boring made for contaminated backfill study.

BLOW COUNT	SAMPLE	DEPTH (FEET)	DESCRIPTION	LAYER I.D.
			MEDIUM TO COARSE SAND (SW): yellowish brown	
			"Structural Backfill Sand"	
		5		
		10		
14	S1		medium dense	
14	S2	15	light grown	
15	S3			
			1/2 in. thick silty clay seam	
28	S4			
11	S5	20	SILTY CLAY (CH): stiff, reddish brown	D
			Bottom of Hole @ 20.5'	
		25		

BORING NO. ____ (CONT'D.)

BLOW COUNT	SAMPLE	DEPTH (FEET)	DESCRIPTION	LAYER I.D.

SOUTH TEXAS PROJECT UNITS 1 & 2

BORING LOG NO. 299

FIGURE 11.6 - 195

BORING NO. 300*

SOUTH TEXAS PROJECT

LOCATION COORDINATES E 2944942 - N ,61681

LOCATION AREA Mechanical-Electrical Auxiliary Bldg., Unit 2

SURFACE ELEV +3.5 m.s.l. TOTAL DEPTH 20 feet

DATE COMPLETED 24 Oct 1978 DATE E-LOGGED ---

NOTES: * Field prepared boring log designated BF-9. Boring drilled for contaminated backfill study.

BLOW COUNT	SAMPLE	DEPTH (FEET)	DESCRIPTION	LAYER I.D.
			MEDIUM TO COARSE SAND (SW): yellowish brown	
			"Structural Backfill Sand"	
		5		
		10		
79	S1		very dense	
			CLAYEY SAND (SC): dense, gray and yellowish brown — alternating layers of clayey sand and structural backfill sand	
45	S2 S3	15		
48	S4		MEDIUM TO COARSE SAND (SW): dense, yellowish brown	
			"Structural Backfill Sand"	
23	S5			
			SILTY CLAY (CH): stiff, reddish brown	D
12	S6			
		20	Bottom of Hole @ 20'	
		25		

BLOW COUNT	SAMPLE	DEPTH (FEET)	BORING NO. ____ (CONT'D.) DESCRIPTION	LAYER I.D.

SOUTH TEXAS PROJECT
UNITS 1 & 2

BORING LOG NO. 300

FIGURE 11.6 - 196

BORING NO. 301*

SOUTH TEXAS PROJECT

LOCATION COORDINATES E 2944670 - N 361660

LOCATION AREA Mechanical-Electrical Auxiliary Bldg., Unit 2

SURFACE ELEV +3.5 m.s.l. TOTAL DEPTH 21 feet

DATE COMPLETED 25 Oct 1976 DATE E-LOGGED - - -

NOTES: * Field prepared boring log designated BF-11. Boring drilled for contaminated backfill study.

BLOW COUNT	SAMPLE	DEPTH (FEET)	DESCRIPTION	LAYER I.D.
			MEDIUM TO COARSE SAND (SW): yellowish brown	
			"Structural Backfill Sand"	
		5		
		10		
50 / 5 in	S1		very dense	
20	S2			
		15	medium dense	
23	S3			
50 / 6 in	S4		very dense	
			CLAYEY SAND (SC): medium dense, reddish brown	
	S5		MEDIUM TO COARSE SAND (SW): yellowish brown "Structural Backfill Sand"	
25	S6			
	S7		SILTY CLAY (CH): very stiff, reddish brown w/silt lenses	D
		20		
21	S8			
			Bottom of Hole @ 21'	
		25		

BLOW COUNT	SAMPLE	DEPTH (FEET)	BORING NO ____ (CONT'D) DESCRIPTION	LAYER I.D.

SOUTH TEXAS PROJECT UNITS 1 & 2

BORING LOG NO. 301

FIGURE 11.6 - 197

BORING NO. 302*

SOUTH TEXAS PROJECT

LOCATION COORDINATES E2944953 - N 361681

LOCATION AREA Mechanical-Electrical Auxiliary Bldg., Unit 2

SURFACE ELEV. +3.5 m.s.l. TOTAL DEPTH 19.5 feet

DATE COMPLETED 25 Oct 1978 DATE E-LOGGED - - -

NOTES: * Field prepared boring log designated BF-12. Boring drilled for contaminated backfill study.

BLOW COUNT	SAMPLE	DEPTH (FEET)	DESCRIPTION	LAYER I.D.
			MEDIUM TO COARSE SAND (SW): yellowish brown	
			"Structural Backfill Sand"	
		5		
		10		
50/5 in	S1		very dense	
50/6 in	S2			
50/7 in	S3	15		
50/5 in	S4			
9	S5		SILTY CLAY (CH): stiff, reddish brown	D
		20	Bottom of Hole @ 19.5'	
		25		

BLOW COUNT	SAMPLE	DEPTH (FEET)	BORING NO. ____ (CONT'D.) DESCRIPTION	LAYER I.D.

SOUTH TEXAS PROJECT UNITS 1 & 2

BORING LOG NO. 302

FIGURE 11.6 - 198

BORING NO. 303*

SOUTH TEXAS PROJECT

LOCATION COORDINATES E 2944869 - N 351669

LOCATION AREA Mechanical-Electrical Auxiliary Bldg., Unit 2

SURFACE ELEV. +2.5 m.s.l. TOTAL DEPTH 21 feet

DATE COMPLETED 25 Oct 1978 DATE E-LOGGED . . .

NOTES: *Field prepared boring log designated BF-13. Boring drilled for contaminated backfill study.

BLOW COUNT	SAMPLE	DEPTH (FEET)	DESCRIPTION	LAYER I.D.
			MEDIUM TO COARSE SAND (SW): yellowish brown	
			"Structural Backfill Sand"	
		5		
		10		
80/9 in.	S1		very dense	
58/10 in.	S2			
50/9 in.	S3	15		
76/9 in.	S4			
	S5		CLAYEY SAND (SC): medium dense, reddish brown	
17	S6		Mixture of structural backfill sand and clay with a little limestone gravel	
	S7			
	S8	20	"Structural Backfill Sand"	
12	S9		SILTY CLAY (CH): stiff, reddish brown w/silt lenses	D
	S10			
			Bottom of Hole @ 21'	
		25		

BLOW COUNT	SAMPLE	DEPTH (FEET)	BORING NO. ____ (CONT'D.) DESCRIPTION	LAYER I.D.

SOUTH TEXAS PROJECT UNITS 1 & 2

BORING LOG NO. 303

FIGURE 11.6 - 199

BORING NO. 304*

SOUTH TEXAS PROJECT

LOCATION COORDINATES E 2944916 - N 361670

LOCATION AREA Mechanical-Electrical Auxiliary Bldg., Unit 2

SURFACE ELEV. 4.5 m.s.l. TOTAL DEPTH 21.5 feet

DATE COMPLETED 26 Oct 1978 DATE E-LOGGED - - -

NOTES: * Field prepared boring log designated BF-14. Boring drilled for contaminated backfill study.

BLOW COUNT	SAMPLE	DEPTH (FEET)	DESCRIPTION	LAYER I.D.
			Mechanical-Electrical Auxiliary Bldg., Reinforcing steel and seal slab	
			MEDIUM TO COARSE SAND (SW): yellowish brown "Structural Backfill Sand"	
		5		
		10		
63/9 in	S1 S2		very dense -- ½ in. seam SANDY CLAY (CL)	
130/9 in	S3	15		
55	S4			
32	S5		CLAYEY SAND (SC): medium dense to dense, yellowish and reddish brown	
	S6		w/trace rounded gravel	
29	S7		MEDIUM TO COARSE SAND (SW): yellowish brown "Structural Backfill Sand"	
9	S8	20	SILTY CLAY (CH): stiff, reddish brown	D
			Bottom of Hole @ 21.5'	
		25		

BLOW COUNT	SAMPLE	DEPTH (FEET)	BORING NO. ____ (CONT'D.) DESCRIPTION	LAYER I.D.

SOUTH TEXAS PROJECT UNITS 1 & 2

BORING LOG NO. 304

FIGURE 11.6 - 200

BORING NO. 305*

SOUTH TEXAS PROJECT

LOCATION COORDINATES E 2944869 - N 361654

LOCATION AREA Mechanical-Electrical Auxiliary Bldg., Unit 2

SURFACE ELEV. +3.5 m.s.l. TOTAL DEPTH 22.5 feet

DATE COMPLETED 26 Oct 1978 DATE E-LOGGED - - -

NOTES: * Field prepared boring log designated BF-15. Boring drilled for contaminated backfill study.

BLOW COUNT	SAMPLE	DEPTH (FEET)	DESCRIPTION	LAYER I.D.
			MEDIUM TO COARSE SAND (SW): yellowish brown	
			"Structural Backfill Sand"	
		5		
		10		
76/5 in	S1		very dense	
64/5 in	S2			
72/5 in	S3	15		
64	S4			
78/5 in	S5			
35	S6	20	dense	
12	S7		SILTY CLAY (CH): stiff, reddish brown w/silt lenses	D
			Bottom of boring @ 22.5'	
		25		

BLOW COUNT	SAMPLE	DEPTH (FEET)	BORING NO. ____ (CONT'D.) DESCRIPTION	LAYER I.D.

SOUTH TEXAS PROJECT UNITS 1 & 2

BORING LOG NO. 305

FIGURE 11.6 - 201

BORING NO. 306*

SOUTH TEXAS PROJECT

LOCATION COORDINATES E 2944854 - N 361669

LOCATION AREA Mechanical-Electrical Auxiliary Bldg., Unit 2

SURFACE ELEV. +1.5 m.s.l. TOTAL DEPTH 24 feet

DATE COMPLETED 26 Oct 1978 DATE E-LOGGED - -

NOTES: * Field Prepared boring log designated BF-16. Boring drilled for contaminated backfill study.

BLOW COUNT	SAMPLE	DEPTH (FEET)	DESCRIPTION	LAYER I.D.
		0	MEDIUM TO COARSE SAND (SW): yellowish brown	
			"Structural Backfill Sand"	
		5		
		10		
54/5 in.	S1		very dense	
54/5 in.	S2			
65/9 in.	S3	15		
64/5 in.	S4			
70/6 in.	S5			
56/6 in.	S6	20		
63	S7			
11	S8		SILTY CLAY (CH): stiff, reddish brown w/silt lenses	D
		25	Bottom of Hole @ 24'	

BLOW COUNT	SAMPLE	DEPTH (FEET)	BORING NO. ____ (CONT'D.) DESCRIPTION	LAYER I.D.

SOUTH TEXAS PROJECT UNITS 1 & 2

BORING NO. 306

FIGURE 11.6 - 202

BORING NO. 3'7*

SOUTH TEXAS PROJECT

LOCATION COORDINATES E 2944916 - N 361659

LOCATION AREA Mechanical-Electrical Auxiliary Bldg., Unit 2

SURFACE ELEV. +4.5 m.s.l. TOTAL DEPTH 21 feet

DATE COMPLETED 27 Oct 1978 DATE E-LOGGED - - -

NOTES: * Field prepared boring log designated BF-17. Boring drilled for contaminated backfill study.

BLOW COUNT	SAMPLE	DEPTH (FEET)	DESCRIPTION	LAYER I.D.
			Mechanical-Electrical Auxiliary Bldg. Reinforcing Steel and Seal Slab	
			MEDIUM TO COARSE SAND (SW): yellowish brown	
		5	"Structural Backfill Sand"	
		10		
68/10 in.	S1		very dense	
101/9 in.	S2			
71/7 in.	S3	15		
87	S4 S5			
			— 2½ in. seam of CLAYEY SAND (SC)	
65	S6			
12	S7	20	SILTY CLAY (CH): stiff, reddish brown	D
			Bottom of Hole @ 21'	
		25		

BLOW COUNT	SAMPLE	DEPTH (FEET)	BORING NO ____ (CONT'D) DESCRIPTION	LAYER I.D.

SOUTH TEXAS PROJECT UNITS 1 & 2

BORING LOG NO. 307

FIGURE 11.6 - 203

BORING NO. 308*

SOUTH TEXAS PROJECT

LOCATION COORDINATES E 2944856 - N 361650

LOCATION AREA Mechanical-Electrical Auxiliary Bldg., Unit 2

SURFACE ELEV. +3.5 m.s.l. TOTAL DEPTH 22.5 feet

DATE COMPLETED 27 Oct 1978 DATE E-LOGGED - - -

NOTES: * Field prepared boring log designated BF-18. Boring drilled for contaminated backfill study.

BLOW COUNT	SAMPLE	DEPTH (FEET)	DESCRIPTION	LAYER I.D.
		0	MEDIUM TO COARSE SAND (SW): yellowish brown "Structural Backfill Sand"	
		5		
		10		
55	S1		very dense	
70	S2			
85/9 in.	S3	15		
68/9 in.	S4			
74/10 in.	S5 S6		3 in. seam of lime treated clay and sand w/limestone gravel	
33	S7 S8	20	MEDIUM TO COARSE SAND (SW): Medium dense, yellowish brown. "Structural Backfill Sand"	
24	S9		SILTY CLAY (CH): very stiff, reddish brown w/ silt partings	D
			Bottom of Hole @ 22.5'	
		25		

BLOW COUNT	SAMPLE	DEPTH (FEET)	BORING NO. ____ (CONT'D.) DESCRIPTION	LAYER I.D.

SOUTH TEXAS PROJECT UNITS 1 & 2

BORING LOG NO. 308

FIGURE 11.6 - 204

BORING NO. 309*

SOUTH TEXAS PROJECT

LOCATION COORDINATES E 2944917 - N 361681

LOCATION AREA Mechanical-Electrical Auxiliary Bldg., Unit 2

SURFACE ELEV. +4.5 m.s.l. TOTAL DEPTH 20.5 feet

DATE COMPLETED 28 Oct 1978 DATE E-LOGGED - - -

NOTES: * Field prepared boring log designated BF-19U. Boring drilled for contaminated backfill study for explicit purpose of obtaining an undisturbed sample of the contaminated backfill.

BLOW COUNT	SAMPLE	DEPTH (FEET)	DESCRIPTION	LAYER I.D.
		0	MEDIUM TO COARSE SAND (SW): yellowish brown "Structural Backfill Sand"	
		5		
		10		
			Field engineer's interpretation of lower limit of structural backfill sand based on wash samples	
			* (See Notes)	
		15	**(See Notes)	
	T-3		CLAYEY SAND (SC): hard, reddish brown	
	T-4			
			MEDIUM TO COARSE SAND (SW): yellowish brown -"Structural Backfill Sand".	
	T-5	20	SILTY CLAY (CH): stiff, reddish brown	D
			Bottom of Hole @ 20.5'	
		25		

Notes:

* Attempted to push sampling tube but could not penetrate soil.

** Attempted to push sampling tube but could not penetrate soil. Powdered lime on end of sampling tube.

BLOW COUNT	SAMPLE	DEPTH (FEET)	BORING NO. ____ (CONT'D.) DESCRIPTION	LAYER I.D.

SOUTH TEXAS PROJECT UNITS 1 & 2

BORING LOG NO. 309

FIGURE 11.6 - 205

BORING NO. 310*

SOUTH TEXAS PROJECT

LOCATION COORDINATES E 2944516 - N 361663

LOCATION AREA Mechanical-Electrical Auxiliary Bldg., Unit 2

SURFACE ELEV. +4.5 m.s.l. TOTAL DEPTH 18 feet

DATE COMPLETED 27 Oct 1978 DATE E-LOGGED - - -

NOTES: *Field prepared boring log designated BF-20U. Boring drilled for contaminated backfill study for explicit purpose of obtaining an undisturbed sample of the contaminated backfill.

BLOW COUNT	SAMPLE	DEPTH (FEET)	DESCRIPTION	LAYER I.D.
			Mechanical-Electrical Auxiliary Bldg. Reinforcing Steel and Seal Slab	
			MEDIUM TO COARSE SAND (SW): yellowish brown	
		5	"Structural Backfill Sand"	
		10		
		15	Field engineers interpretation of lower limit of structural backfill sand based on wash samples	
			*	
	T-2		SANDY CLAY (CL): hard, reddish brown	
			**	
			Bottom of Hole @ 18'	
		20		
			Notes:	
			* Attempted to push sampling tube but could not penetrate soil. Powdered lime on end of sampling tube.	
			** Attempted to push sampling tube but could not penetrate soil.	
		25		

BLOW COUNT	SAMPLE	DEPTH (FEET)	BORING NO. ____ (CONT'D.) DESCRIPTION	LAYER I.D.

SOUTH TEXAS PROJECT UNITS 1 & 2

BORING LOG NO. 310

FIGURE 11.6 - 206

BORING NO. 311*

SOUTH TEXAS PROJECT

LOCATION COORDINATES E 2944939 - N 361659

LOCATION AREA Mechanical-Electrical Auxiliary Bldg., Unit 2

SURFACE ELEV. +4 m.s.l. TOTAL DEPTH 21 feet

DATE COMPLETED 28 Oct 1978 DATE E-LOGGED - - -

NOTES: * Field prepared boring log designated BF-21. Boring drilled for contaminated backfill study.

BLOW COUNT	SAMPLE	DEPTH (FEET)	DESCRIPTION	LAYER I.D.
			Mechanical-Electrical Auxiliary Bldg. Seal Slab	
			MEDIUM TO COARSE SAND (SW): yellowish brown	
		5	"Structural Backfill Sand"	
		10		
70/6 in.	S1		very dense	
74/6 in.	S2			
79	S3	15		
61/5 in.	S4			
16	S5		dense	
			SILTY CLAY (CH): stiff, reddish brown	D
11	S6	20		
			Bottom of Hole @ 21'	
		25		

BLOW COUNT	SAMPLE	DEPTH (FEET)	BORING NO. ____ (CONT'D.) DESCRIPTION	LAYER I.D.

SOUTH TEXAS PROJECT UNITS 1 & 2

BORING LOG NO. 311

FIGURE 11.6 - 207

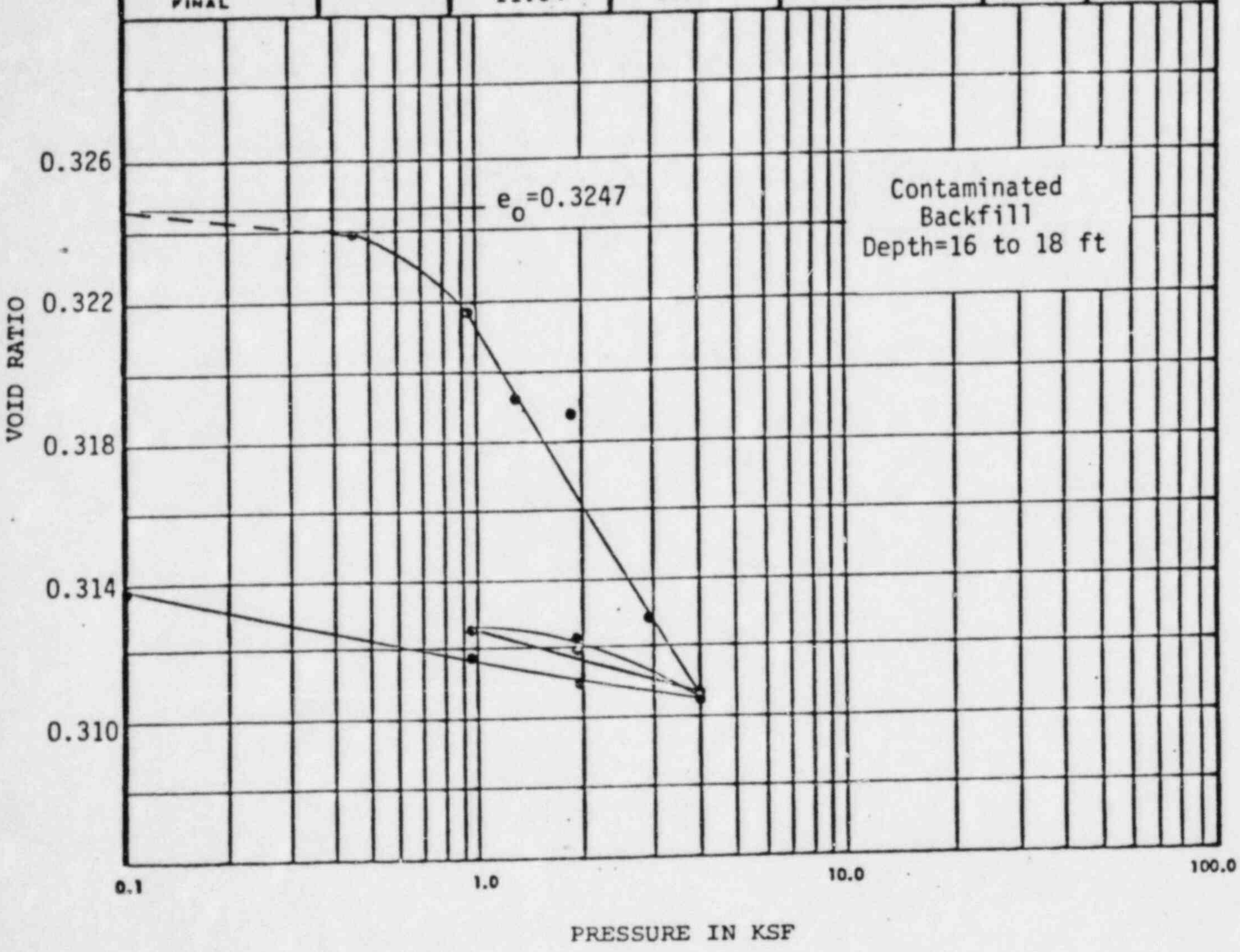
APPENDIX B

LABORATORY TEST RESULTS

South Texas Project
75-3008, Task 6000, Subtask 6000H
Extent of Contaminated Backfill

Woodward-Clyde Consultants

SAMPLE NO.	SUMMARY OF TEST RESULTS					
BF-19U, T-3	SPECIFIC GRAVITY	MOISTURE CONTENT, (%)	DRY DENSITY, (PCF)	PERCENT OF SATURATION, (%)	HEIGHT (IN.)	DIAMETER (IN.)
INITIAL	2.66	10.90	125.3	89.3	0.9504	2.80
FINAL		11.64	126.3	98.7	0.9425	



CONSOLIDATION TEST

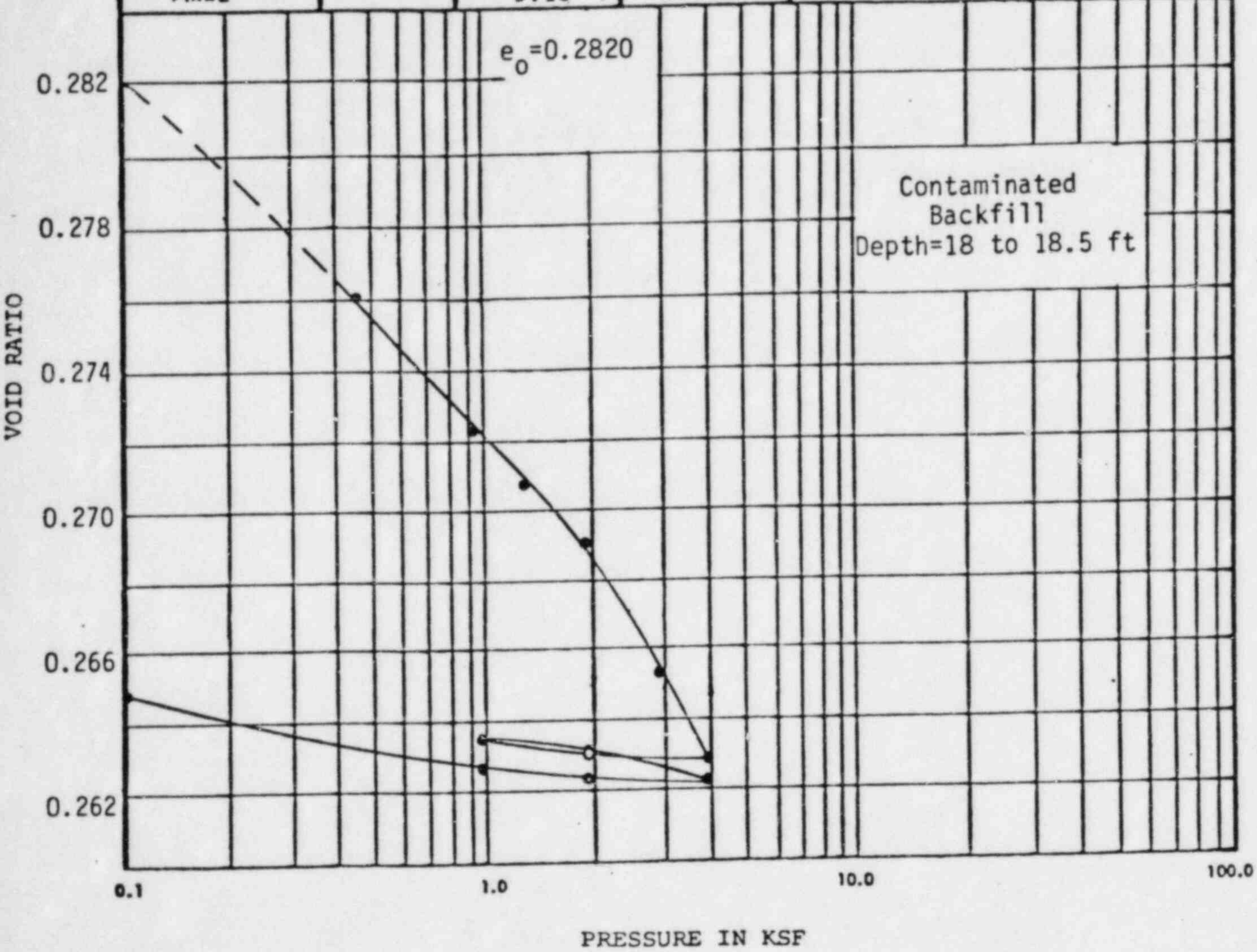
LL = 31

PL = 10

PI = 21

FIGURE B1

SAMPLE NO.	SUMMARY OF TEST RESULTS					
BF-19U, T-4	SPECIFIC GRAVITY	MOISTURE CONTENT, (%)	DRY DENSITY, (PCF)	PERCENT OF SATURATION, (%)	HEIGHT (IN.)	DIAMETER (IN.)
INITIAL	2.66	8.79	129.5	82.9	0.9832	2.81
FINAL		9.15	131.2	91.9	0.9701	



CONSOLIDATION TEST

LL = 25

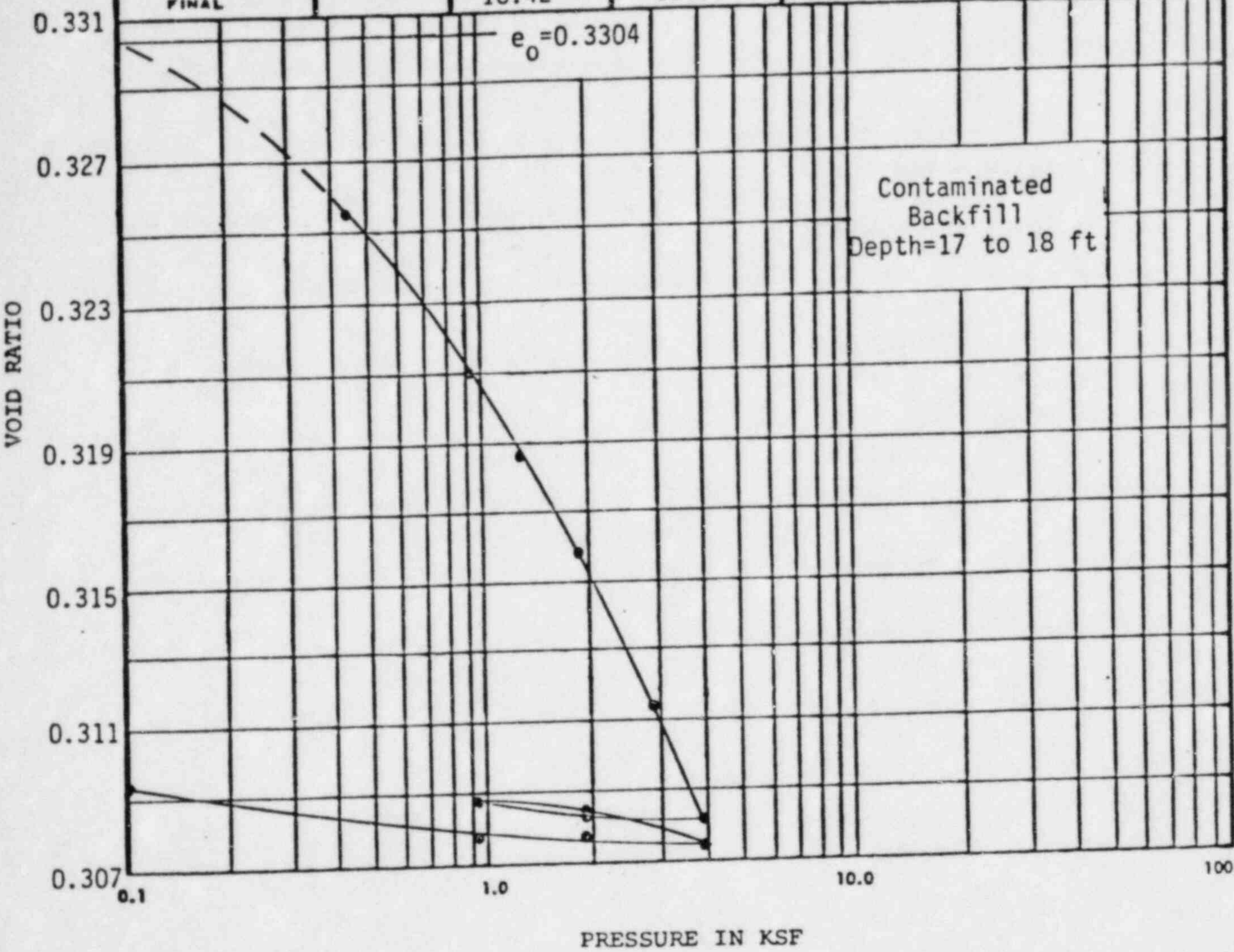
PL = 10

PI = 15

South Texas Project
75-3008, Task 6000, Subtask 6000H
Extent of Contaminated Backfill

Woodward-Clyde Consultants

SAMPLE NO.	SUMMARY OF TEST RESULTS					
BF-20U, T-2	SPECIFIC GRAVITY	MOISTURE CONTENT, (%)	DRY DENSITY, (PCF)	PERCENT OF SATURATION, (%)	HEIGHT (IN.)	DIAMETER (IN.)
INITIAL	2.66	9.27	124.8	74.6	0.9846	2.81
FINAL		10.42	126.8	89.5	0.9691	



CONSOLIDATION TEST

LL = 22

PL = 10

PI = 12

FIGURE B3

75-3008 (6000H)

GEOTECHNICAL DESIGN VERIFICATION FORM SOUTH TEXAS PROJECT

Calculation No.: WCC- 6000H

Document Title: Contaminated Backfill, Mech-Elec. Aux. Bldg - Unit 2
(include revision number and date) JAN/8/79

Document Author(s) M. Zinn

Design Verifier(s) CSHEDGES Title: PM

Design Verifier(s) Signature Charles S. Hedges Date: Jan 10, 1979

Document Type (check one)

- [x] Engineering Report & Calculation Package
- [ ] Construction Specification
- [ ] Other (specify) ______

Type of Verification (check one)

- [ ] "Expert" verification
- [x] "Peer" verification

Method of Verification (check one or more)

- [x] Detailed review of document statements and backup files
- [ ] Spot checking
- [ ] Alternate calculation
- [ ] Other (specify) ______

Results of Verification (check one)

- [ ] Approved with minor comments noted on Form DV-2.
- [ ] Approved with major comments noted on Form DV-2.
- [ ] Not approved because of major analytical errors.

VERIFICATION CHECKLIST

A. DESIGN INPUT

1. Soil data: Is the stratigraphy used in analyses consistent with the pertinent (including the most recent) borings, test-pits,

trenches, etc.? Are the soil properties cited in the document consistent with laboratory test data? Is the laboratory test program consistent with the various methods of analyses? If data are referenced from another document, are the data still current?

(This checklist item verified on pages pg. 2; Table 2; logs).

2. Physical Structural Data: Are pertinent structural data such as building loads, building size, foundation elevations, correct and based upon current drawings? The document itself or its backup data should contain reference to structural drawing numbers and their dates.

(This checklist item verified on page pg. 3 + B&R T.R.D.).

3. Performance and Functional Requirements of Structures: Are performance requirements of structures (e.g., maximum allowable differential settlement) correct and based upon current, documented information? Is the function(s) of a structure clearly described (e.g., a foundation supporting vibrating machinery should be identified so correct analyses procedures can be used)? Have special performance criteria for Category I structures been identified?

(This checklist item verified on pages pg. 5+6).

4. Environmental Data: If ground-water table data are pertinent, have they been correctly interpreted from measured values? Have during-and-after-construction ground-water effects been considered? Are extreme climatic effects (e.g., floods, extreme rainfall or drought) provided for in the analyses? Does the water table elevation (or other environmental data) have an appropriate degress of conservatism?

(This checklist item verified on pages pg. 3).

5. Assumptions: Assumptions are those input data not supported by drawings and specifications, laboratory data, or field measurements; often, assumptions are referred to as "engineering judgements". All assumptions should be clearly identified in

the document itself together with their bases. The bases of the assumptions shall be reassessed by the verifier to ensure that they are reasonable and consistent with other project documents.
(This checklist item verified on page pg. 2).

6. Standard or Codes: Are any standards or codes (i.e., ASTM laboratory testing procedures) appropriate and correctly referenced when used in the document? All codes or standards used for the office analyses, laboratory test procedures, or field specifications shall be referenced.
(This checklist item verified on pages N/A).

B. ANALYSES AND RECOMMENDATIONS

1. Methods of Analyses: Is each analytical problem clearly identified? Does the analysis procedure fit the problem? Are the analyses procedures at least briefly mentioned in the document and fully detailed with the backup calculations? If feasible, a good (if not the best) validation of a complicated analytical procedure is a calculations based upon several simplifying assumptions.
(This checklist item verified on pages pg. 2).

2. Interpretation of Laboratory Results: As geotechnical analyses are often dependent on detailed appraisals of laboratory test results, interpretations of the more complicated laboratory tests (e.g., consolidation and consolidated-undrained triaxial) shall be carefully checked by referring to graphical results of all applicable tests. Have a large collection of similar test results been reasonably and correctly interpreted?
(This checklist item verified on pages pg. 4).

3. Engineering Experience: Just as engineering judgement is used in the determination of some design input (refer to item A.5, above), engineering experience is sometimes used as a part of

an analysis procedure. Engineering judgement might be used, for instance, where no closed-form mathematic solution or computer-aided analysis of a problem exists. Any engineering experience or judgement used in an analysis shall be clearly noted in the document or its supporting material. The verifier shall validate that all such instances are reasonable in their context and the reasons for choosing a particular experience-based analysis method are clearly stated; for instance, if experience is deduced from similar analyses reported in the literature, the pertinent literature sources shall be explicitly documented and interpreted.

(This checklist item verified on pages pg. 1, 2, 5).

4. Design Recommendations: Do the recommendations clearly follow from the analysis procedures? Are recommendations presented in a distinct manner not likely to be misinterpreted by subsequent plant designers? Are the recommendations reasonable with respect to input and engineering experience from other jobs? If specific construction materials are required to satisfy design assumptions, are material specifications cited in the document text?

(This checklist item verified on pages pg 6).

5. Field Monitoring of Design: Because of the empirical nature of some geotechnical design procedures, field data collecting during and after construction is necessary. Field data may also be required to establish precise control over a construction process (e.g., the ground-water level, which is drawn down during construction, may be raised or lowered slightly depending upon the results of field settlement or heave measurements). If field measurements are described in the document, are they needed and practical to obtain? The criteria for analyzing the field data shall be presented in the document together with the reasons for requiring field instrumentation. Does the instrumentation monitor the parameters most critical to successful structure performance? Is additional field instrumentation necessary?

(This checklist item verified on pages N/A).

C. DOCUMENT PRESENTATION

1. Organization: Make any comments about the overall report organization that improve its clarity. Are the tables and figures readily understood and correctly referenced? Is the logic flow from input data to design recommendations clear to the reader? (This checklist item verified on pages all pages).

2. Editorial Comments: Editorial/typographical mistakes will generally be handled by the document author. Any that are noticed, however, should be noted on Form DV-1. (This Checklist item verified on pages N/A).

D. OTHER REMARKS

Letter report & calculations verified; Form DV-2 not used.
[illegible initials]

Item 1: ECW Pipeline Soil Profiles

HL&P was requested to provide the following information related to the Essential Cooling Water (ECW) pipeline soil profiles:

a) The South Texas Project (STP) position on the boring spacing requirements of Regulatory Guide 1.132,

b) An evaluation of the Standard Penetration Test (SPT) results with blow counts less than 10 (N values) in the subgrade below the ECW pipeline, and

c) A drawing depicting the location of the borings identified in ST-HL-AE-855 relative to the ECW pipeline.

RESPONSE

Item 1a: Regulatory Guide 1.132

Based on the numerous borings drilled at the STP site and as evidenced by the regional and site geologic studies presented in the Final Safety Analysis Report (FSAR), the geology is uniform within the STP site and only minor local variations exist within the individual strata. Therefore the intent of the Regulatory Guide 1.132 Appendix C requirement is met. The requirement states:

> "Principal borings: This (spacing) may vary depending on how well site conditions are understood from other plant site borings. For variable conditions, one per 100 linear feet (30 linear meters) for buried pipelines...."

As stated, the subsurface conditions are uniform (not variable); therefore, one boring per 100 linear feet would not be the requirement and a greater spacing is permitted. A lesser frequency of borings, as defined in Regulatory Guide 1.132 for uniform conditions, would accordingly be appropriate. Note that in addition to the borings obtained a continuous geologic mapping trench was excavated between Unit 1 and the Essential Cooling Pond, approximately following the ECWS piping alignment (PSAR Figure 2.5.1-45, attached).

The design phase subsurface investigation program was supplemented by geologic mapping and geotechnical engineering foundation verification performed on the piping trenches during construction. The basic intent of the verification program is to determine and document that the foundation is of the quality evaluated in the design work and meets the design criteria. Heave/settlement monitoring field instrumentation was also installed during construction of the piping to allow observation of the soil behavior.

The geologic mapping and foundation verification programs (Reference: FSAR Appendices 2.5.A and 2.5.B) provide documented assurance that the soil stratigraphy and parameters satisfy the design basis, at all locations. As of this date (August 1982), the mapping and verification has not shown any anomalous conditions. The results of these construction phase field studies will be presented in the appendices to FSAR Section 2.5 as part of future amendments.

The overall geotechnical program for STP provides sufficient information for evaluation of subsurface conditions along the ECW piping alignment and conforms to the intent of Regulatory Guide 1.132. Furthermore, Regulatory Guide 1.132 "Site Investigations for Foundations of Nuclear Power Plants" (Rev. 0) was applicable only to construction permit applications docketed after June 1, 1978, or for evaluations of foundation investigation results obtained after that date. The corresponding date for the current revision (Rev. 1) is March 30, 1979. Because subsurface investigations for STP were conducted in 1973 and 1974 and the construction permit application was docketed on July 5, 1974, Regulatory Guide 1.132 did not govern the STP subsurface investigation program.

Item 1b: Evaluation of SPT Results Underneath the ECW Pipeline

The NRC requested an evaluation of the SPTs with blow counts (N values) less than 10 blows per foot found in subgrade materials below the ECW pipeline. The subsurface conditions in the pipeline area were reviewed to the top of the D layer. A copy of the subsurface profile developed along the ECW pipeline is presented in the Figures 1-1, 1-2 and 1-3. The soil conditions illustrated by the soil profile are summarized and presented in Table 1-1.

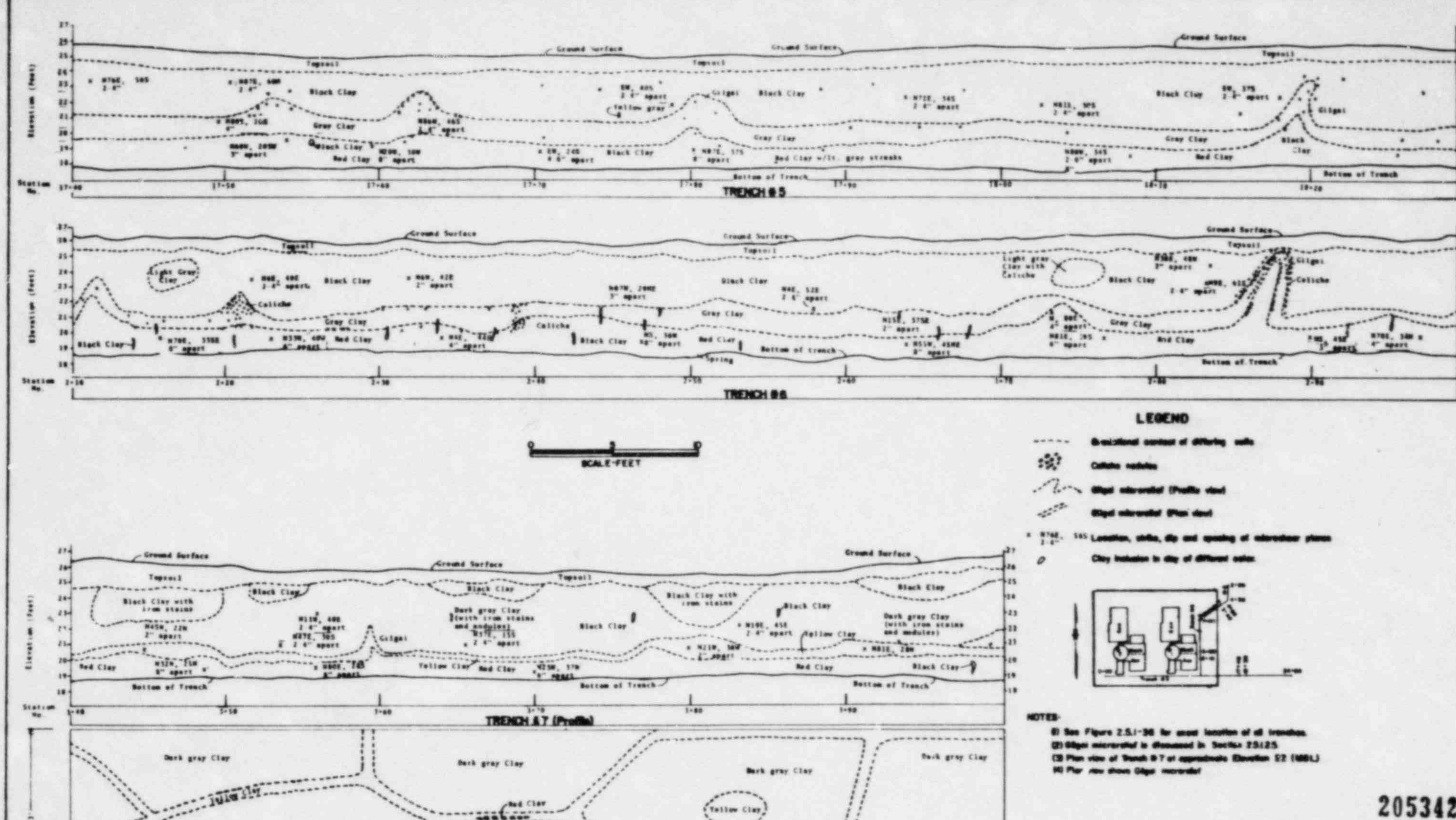
A total of 240 SPTs were made in layers A1, A2, B and C. The ECW Pipeline is founded in the A2 layer. The A2 layer is cohesive therefore the resultant blow counts are not of major concern in this layer. Of the 80 SPTs conducted in the B layer, 21 had blow counts of 10 or less. A review of the 21 low SPT results (10 blows or less) reveals that 19 SPTs were performed on cohesive materials which are medium stiff to stiff and therefore are no major concern to the stability of ECW pipeline foundation. All of the SPT results for the C layer, silty sandy, were 12 blows per foot or greater.

The two low blow counts in Boring 121 are identified in the B layer as sandy silt. The 4 blow count test is immediately beneath the A2 layer, silty clay, and above an 18 blow count test, sandy and clayey silt. The 9 blow count test is between the 18 blow count, sandy silt and clayey silt, and a silty clay layer. Laboratory test results show that the 18 blow count test material is cohesive. Further, the low blow count materials occur in isolated zones and not in continuous layers. The zones of low blow counts will be inspected in the field during foundation verification. Should layers of loose sandy silt or soft clay be encountered within 2 feet below the ECW subgrade, then these layers will be over excavated and replaced with compacted granular fill as specified in the specification for structural excavation and backfill (Bechtel, TPNS No. 3Y069YS043).

Because the low blow counts are isolated, the stress developed by the weight of the pipe and the backfill will not create an engineering concern regarding differential settlement.

Item 1c: ECW Pipeline Boring Plan

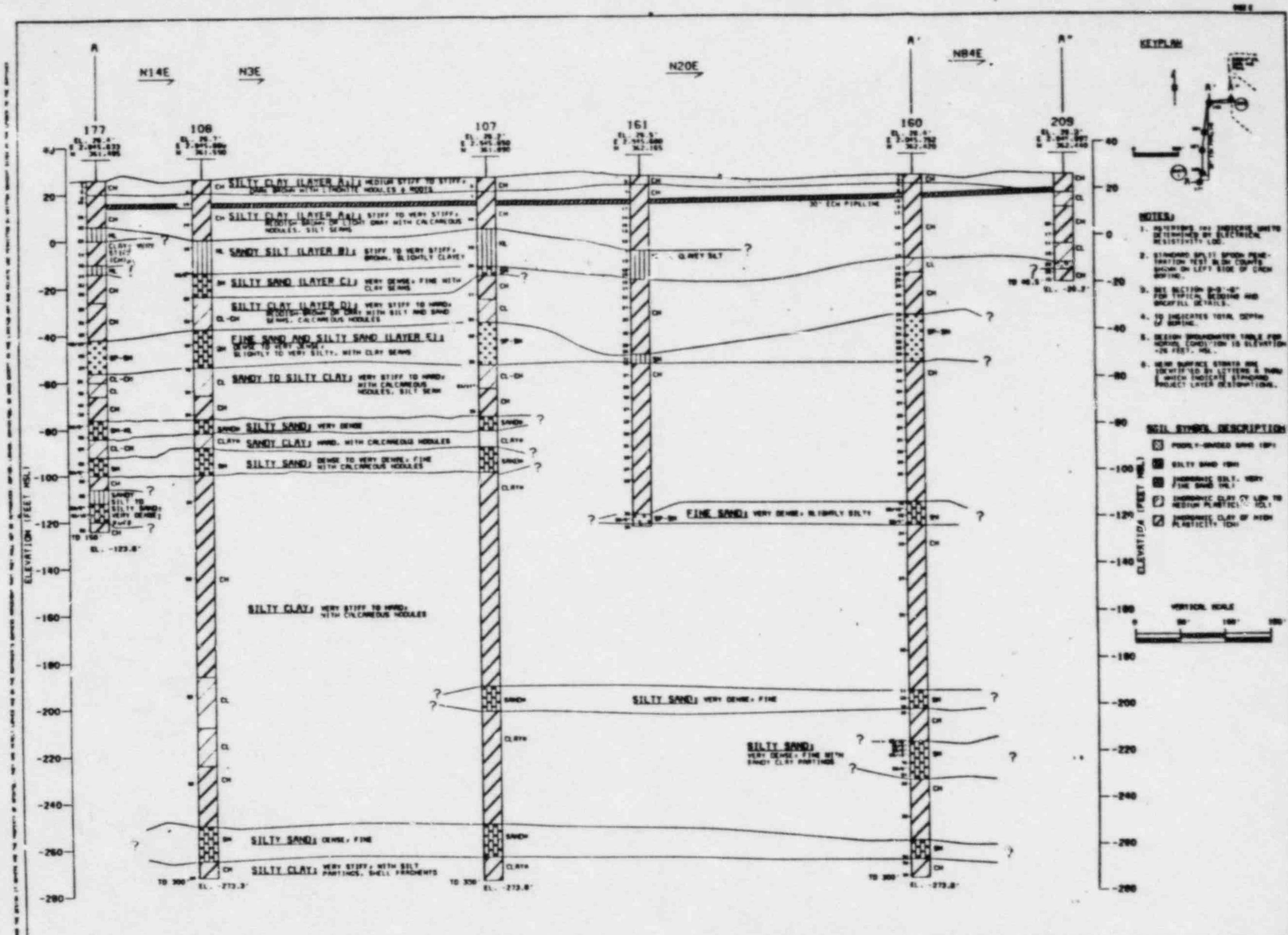
The ECW Pipeline Boring Plan is shown in Figure 1-4.



205342

SOUTH TEXAS PROJECT
UNITS 1 & 2

GEOLOGIC LOGS
TRENCHES 5, 6, AND 7
FIGURE 2.5.1-45



BECHTEL POWER CORPORATION

HOUSTON LIGHTING & POWER CO.
SOUTH TEXAS PROJECT

Figure 1-1

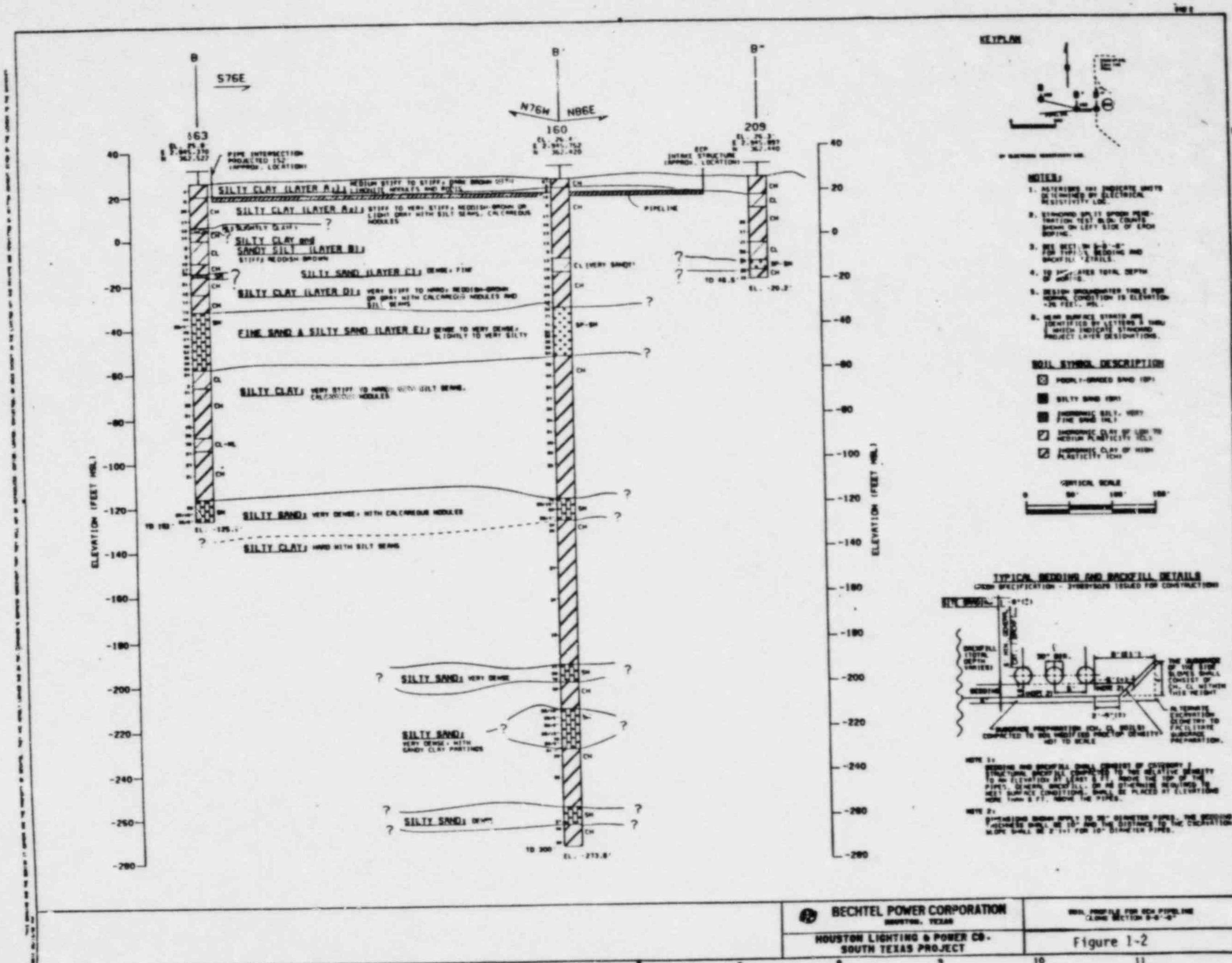

B
B'
B"
S76E
N76W
N86E
163
160
209
KEYPLAN
SILTY CLAY (LAYER A1)
SILTY CLAY (LAYER A2)
SILTY CLAY and
SANDY SILT (LAYER B)
SILTY SAND (LAYER C)
SILTY CLAY (LAYER D)
FINE SAND & SILTY SAND (LAYER E)
SILTY CLAY
SILTY SAND
SILTY CLAY
SILTY SAND
SILTY SAND
SILTY SAND
PIPELINE
ELEVATION (FEET MSL)
NOTES:
SOIL SYMBOL DESCRIPTION
TYPICAL BEDDING AND BACKFILL DETAILS
BECHTEL POWER CORPORATION
HOUSTON LIGHTING & POWER CO.
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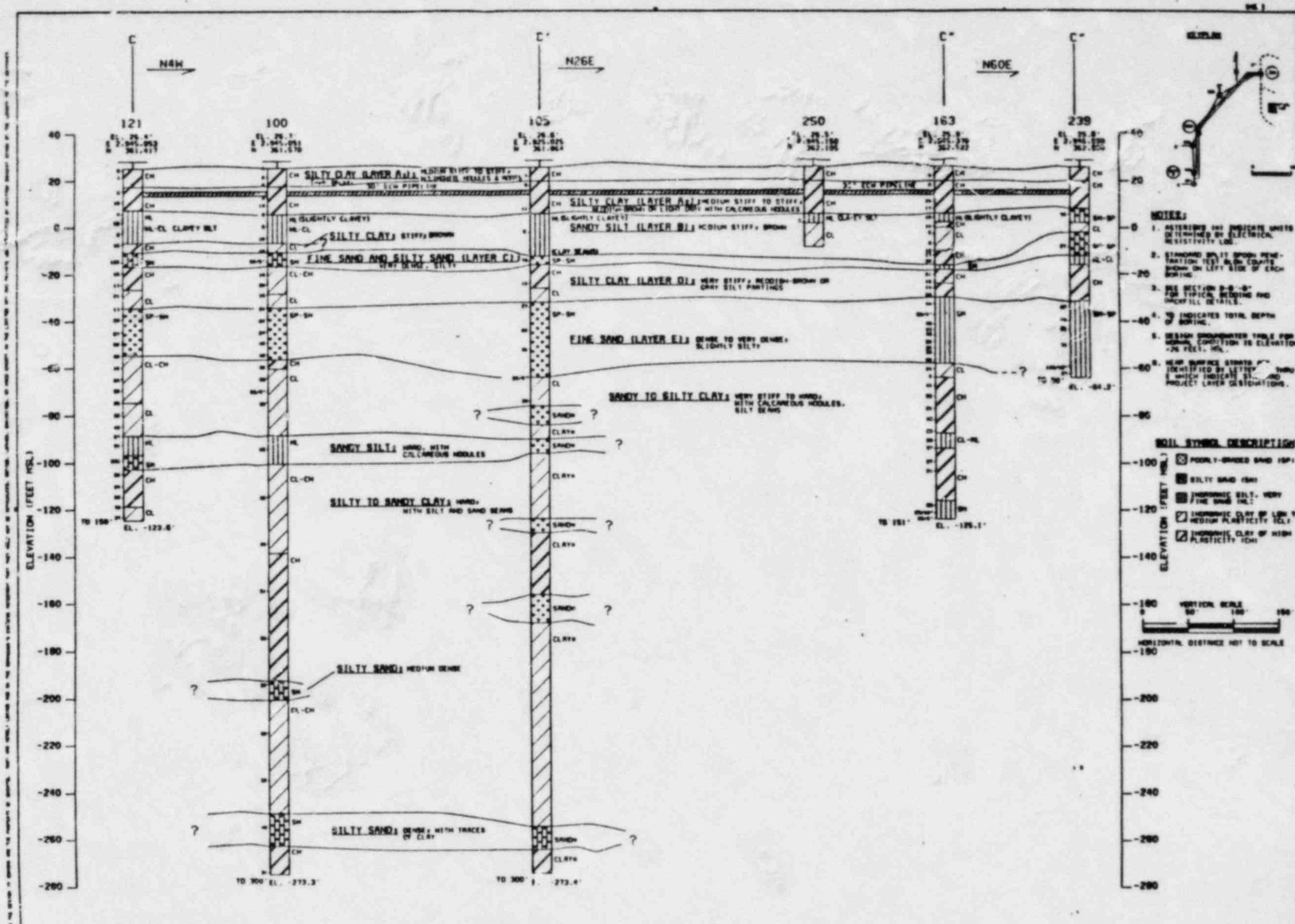
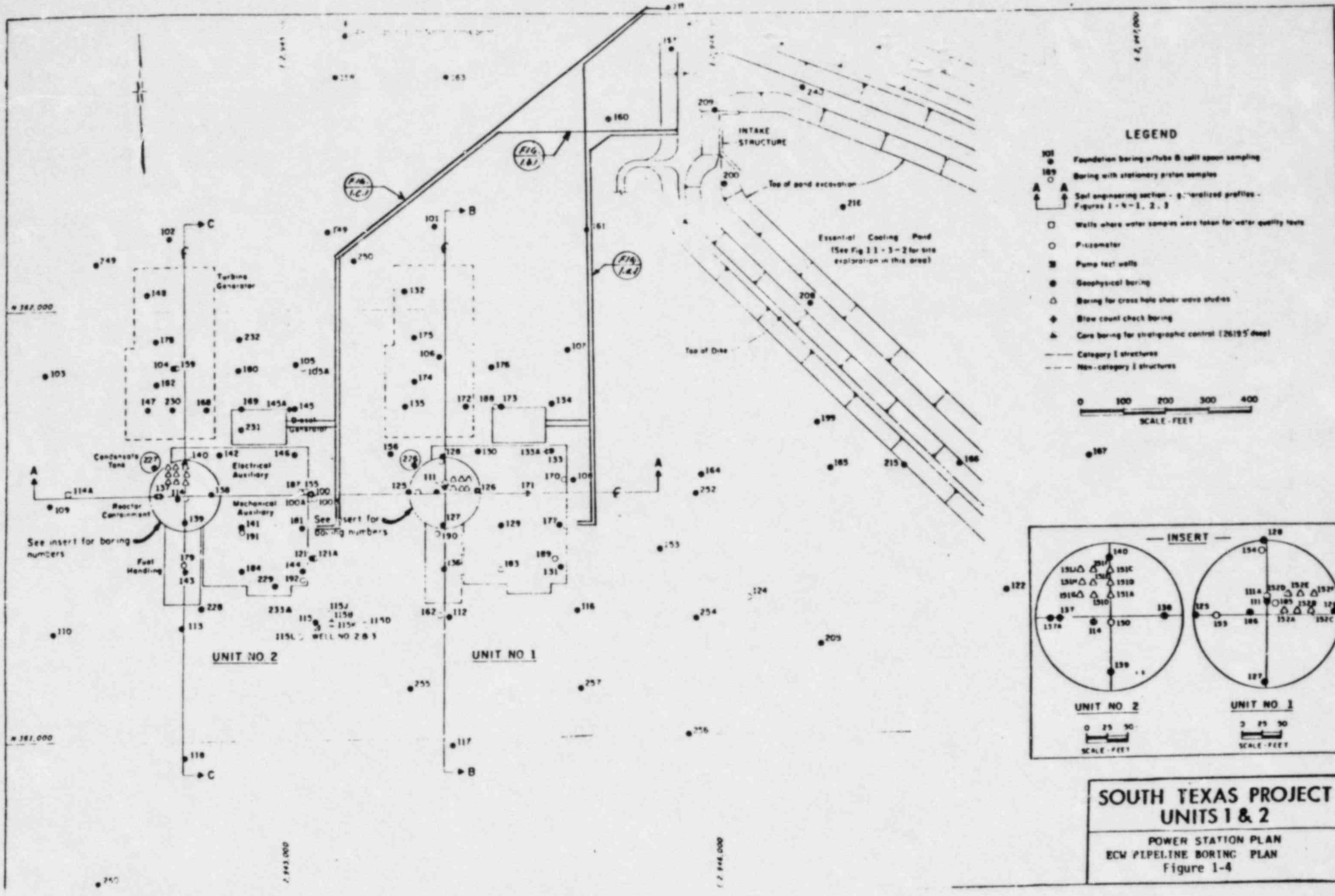
Figure 1-2



BECHTEL POWER CORPORATION
HOUSTON, TEXAS

HOUSTON LIGHTING & POWER CO.
SOUTH TEXAS PROJECT

Figure 1-3



SOUTH TEXAS PROJECT
UNITS 1 & 2

POWER STATION PLAN
ECW PIPELINE BORING PLAN
Figure 1-4

TABLE 1-1

GENERAL FOUNDATION CONDITION - ECW PIPELINE

Layer	Soil Type	Approximate Depth Range (ft) From-to	SPT-Blow Counts Range Low[1]	High	Average Value	Unified Classification (Field)	Percent Clay (Laboratory)
A_1	Silty clay	0-8	4	7	5	CH	73
A_2	Silty clay	8-25	7	26	12	CH	49-59
B.	Sandy Silt Clayey Silt Silty Clay	25-35	4[2]	39	14	ML ML-CL CL	9-16
C.	Silty sand	35-45	12[3]	125	60	SP-SM	2-6

Notes:

1. Low blow counts in isolated zones.
2. Encountered in isolated condition in Boring 101 only.
3. Encountered in isolated cohesive zones within Layer C sand. (See Boring 160).

Item 2: Boundaries of the Four Low Density Backfill Areas

NRC requested that HL&P provide a discussion of the actual backfill construction sequence to explain how the boundaries of the four identified low density areas were established.

RESPONSE

A special investigation including a two-phase boring program was conducted in 1980 to verify the backfill compaction adequacy and the measurement and mapping of compacted lift thicknesses in open excavations at the site.

The fifteen original boring locations (part of Phase I) are shown on Figure 2-1. These borings were designated as 101 through 106 (Unit 1), and 201 through 209 (Unit 2). To gain additional information or samples, other borings were drilled for both phases in the vicinity of those shown. They were given the same base numbers, but with various suffixes (e.g., 205A, 205B, 205-V1, etc).

Phase I Borings

Twenty-one borings were drilled and 288 Standard Penetration Tests (SPT) were performed in the structural backfill during the period of January 28 to February 8, 1980. Out of the 288 SPTs conducted, only eight indicated relative density less than the 80 percent minimum construction control criteria (as determined using the Gibbs and Holtz correlation of SPT N-values versus relative density). These eight tests showed four potential problem areas with relative densities less than the construction quality control criteria.

Phase II Borings

Twenty-eight additional borings were made during the period of March 24 to April 11, 1980, to better define the horizontal and vertical extent of those areas and zones identified in Phase I with densities less than the construction quality control criteria.

Unit 1-Results from Boring Program

Within the Unit 1 area, results of the SPTs indicate that the structural backfill equals or exceeds the construction quality control criteria of 80 percent relative density, as determined using the Gibbs and Holtz correlation.

Unit 2-Four Potential Problem Areas

Four small areas within the Unit 2 area have relative densities (based on the Gibbs and Holtz correlation) less than the construction quality control criteria. The relative locations of these areas are generally situated as follows (refer to Figure 2-1):

1) Area 1. West of Unit 2 Reactor Containment Building , adjacent to Tendon Gallery Access (Boring 204 area)

2) Area 2. Northwest of Unit 2 Reactor Containment Building (Boring 205 area)

3) <u>Area 3</u>. East of Unit 2 Mechanical-Electrical Auxiliary Building (Area of borings 208 and 209)

4) <u>Area 4</u>. West of Unit 2 Fuel Handling Building (Boring 203 area)

For each of the potential low density areas, a comparative evaluation of the boring logs and the backfill construction documents was made to compare the in-situ density test results with the SPT data at similar depths. The construction documents were researched for evidence of any anomalous fill conditions or construction practices which locally might have affected backfill density at the point of the low SPT blow count. Boring logs were reviewed and discussed with cognizant on-site personnel to ascertain whether blow counts might have been affected by drilling practices or anomalies at the test boring locations (i.e. SPTs taken adjacent to subgrade cut slopes).

Evaluation of Test Data in Areas of Potential Low Densities

Area 1.

Area 1 has an extent somewhat larger than any of the other areas and has several isolated zones and pockets with indicated densities less than the construction quality control criteria. The locations of the zones within Area 1 with low densities are shown on Figure 2-2. The area is within the local excavation for the Reactor Containment Building at a depth of approximately 70 feet. Test Boring No. 321 (WCBV-204) showed low blow counts in two of the lowermost three lifts above subgrade.

From construction records, it appears that lengthy exposure and consequent sloughing of excavation slopes during inclement weather and relaxation of the foundation subgrade resulted in an irregular subgrade surface. The subgrade and the slopes had to be repeatedly reworked. Trimming of the slopes created near vertical slopes of varying height. Static compaction was performed to avoid further sloughing. In the southern portion of the area between the RCB Tendon Gallery Access shaft and the local excavation slopes, the required rework and over excavation of the natural subgrade lead to placement of the first lift to a maximum thickness of 2.5 feet in the southern portion; while, in the northern portion of this area, the first lift was only one foot thick. The lift was not tested where the construction difficulties occurred. This lift was also static-rolled, because of concern over possible subgrade pumping through the fill and slope sloughing. Lift No. 2 and three subsequent lifts were placed atop Lift No. 1. Backfilling was then halted for some three months, and fill material already placed was removed down to Lift No. 2 before placement of Lift No. 4. Possibly, Lift No. 2 was disturbed by removal of the overlying backfill. No density test is recorded for Lift No.4; it appears that no test was required based upon the area of that placement on that day.

Additional test borings in this area showed a few scattered low blow counts higher in the fill (up to Elevation -27.8). These generally occurred adjacent to vertical subgrade cut slopes where compactive effort may have been low in isolated areas of small extent.

The densities as indicated by the SPTs are rather variable within the area of concern and can predominately be contributed to two causes: first, the too thick and statically rolled first lift; and second, the difficulties experienced adjacent to the near vertical, sloughing slopes. HL&P believes that the combination of difficult construction conditions experienced in this area are unique and should be treated separately from the overall evaluation of the backfill conditions. The Expert Committee also concluded that the area 1 conditions are unique (Expert Committee Report, Page 28).

The boundaries of Area 1 are well defined by the excavation slope, the structure, and the borings, and the conditions within the area were defined by the extensive boring program as shown in Figure 2-2.

Area 2.

Area 2 lies northwest of the reactor containment building, where 1 low blow count was recorded for Boring No. 322 (WCBV-205) in Lift Nos. 25 and 26 (Figure 2-3). Subsequent borings show that the possible low density area is limited to these lifts and is only some 6 feet by 10 feet in extent. The 6 foot width was assumed based on the dimensions of the vibratory roller, while the 10 foot length was estimated simply based on the assumed limits midway between borings. Construction records indicate that structural backfill was halted and temporary backfill was placed atop Lift No. 26 in June of 1978; the temporary backfill was removed about two weeks later and permanent backfill placement resumed. Possibly some disturbance of these upper two lifts occurred with removal of the temporary backfill.

Area 3.

Area 3 is east of the machanical electrical auxiliary building, where borings showed low blow counts in two small isolated areas within Lift No. 11 (Borings 325 (WCBV-208) and 326 (WCBV-209), Figure 2-4). From the boring logs, it appears that these two test holes penetrated lift No. 11 immediately adjacent to the subgrade cut slope where compactive effort may have been locally low. Although these two borings are only about 65 feet apart, standard penetration resistances in the two subsequent adjacent holes indicate relative densities exceeding the quality control criterion; the areas with low blow counts thus appear to be isolated and a few feet in extent. The verification borings were laid out parallel with the subgrade benches and placement/compaction orientation.

Area 4.

In Area 4, southwest of the fuel handling building, Boring No. 320 (WCBV-203) showed low blow counts in two widely separated lifts (Figure 2-5). The deeper of these penetrated Lift No. 1 immediately above subgrade. This lift varied from approximately 12 to 18 inches thick at the boring location, and was static-rolled due to concern over possible subgrade pumping through the fill. The relative density was approximately 78 percent. The shallower of the two low blow counts occurred within Lift No. 16. The approximate relative density was also 78 percent. The limits for the lower zone were controlled to the south and west by the excavation slope and to the east by the adjoining restricted area placements against the Fuel Handling Building.

The northern limit was assumed midway between borings. The low density in the upper zone was not verified by the two adjacent borings. The length of the zone, following the building and excavation geometry, was assumed midway between the borings. The width was, as in the other cases, assumed to be approximately 6 feet based on the roller size.

Table 2-1 gives the field boring and corresponding FSAR boring number, elevations, and coordinates.

Summary

Backfill with indicated density less than the construction quality criteria has been encountered in two generalized groups, namely adjacent to cut slopes or the subgrade and in isolated pockets within the backfill.

Area 1 and the lower zone of Area 4 exemplify cases in which the subgrade or excavation slope probably contributed to the backfill conditions. These areas are well defined by the excavations, structure locations, and borings. It is unlikely that similar areas would be found within the interior portions of the backfill.

Area 2 and the upper zone of Area 4 exemplify small isolated pockets of material in the interior of the backfill with densities less than the construction quality control criteria. Area 3, with two separate isolated pockets, is similar but influence from the subgrade cannot be precluded as the indications occurred within the first lift. It is important to note that the initial low density indications in these areas were only repeated in one instance (Area 2), which provides further evidence of the very limited extent of these pockets. The probability of occurrence of pockets of backfill with densities less than the construction quality control criteria is further discussed in the following.

Because the low density backfill occurs only in isolated pockets, settlement due to compression of the backfill is not a problem.

Overall Backfill Relative Density Evaluation

Statistical analyses show that the probability of low density material within the structural backfill mass is very low. The probability of backfill with a relative density less than 70 percent is 1×10^{-3}, and the probability of backfill with a relative density less than 60 percent is 1×10^{-5} to 1×10^{-7}.

The review of the placement data and information showed that finite layers were placed thus large zones do not exist. The liquefaction evaluation (Expert Committee Report, Page 45) shows that small areas or small masses with relative densities of 60 percent to 45 percent will not liquefy and affect the safety and operation of the plant.

The evaluation of the backfill adequacy was based on judgement as well as the statistical postulated likelihood of existing random pockets of backfill with relative densities less than 80 percent.

Two statistical analyses were made on the field density test data obtained during construction of the structural backfill. One analysis was made on all of the Category I backfill placed within the plant area. The other analysis was made on density test results for fill placements penetrated by the initial boring program compared to all Category I backfill in order to evaluate the representativeness of the initial boring program.

The purpose of the first statistical analysis was to determine the probability distribution of in-place relative density of Category I structural backfill materials for the different building areas of Units 1 and 2. The probability distribution of relative density was to be used in evaluating the likelihood that the relative density at some locations could be below certain values.

The data base for the statistical analysis was the final in-place density test results used for acceptance of the backfill, expressed in percent Relative Density. The data pertained to backfill placements made through July 1980, subdivided according to units and building areas as follows:

1. Containment Area
2. Pedestal Area
3. Fuel Handling Building Area
4. Mechanical-Electrical Auxiliary Building Area
5. Diesel Generator Building Area

The pedestal area is the backfill soil beneath the Containment Building surrounded by the tendon gallery. Each data set was analyzed separately so that individual buildings could be evaluated.

The field quality control specification criteria required at least one field density test per 20,000 ft.^{2} (which corresponds to one test per approximately 1,100 cubic yards of fill when placed in layers not more than 18 inch loose thickness) of each lift in unrestricted areas. In restricted areas, at least one field density test was required for each 200 cubic yards. All building Category I backfill had an acceptance criteria of a minimum relative density of 80 percent. If upon testing, the fill did not meet this requirement, the entire work area or placement area was recompacted until repeat tests showed a passing result.

The number of field density tests used in the first statistical analyses was 2813. This is approximately one test per 250 cubic yards of structural backfill placed (as of July 1980).

The analysis showed that a shifted lognormal model would fit the test data reasonably well. The best estimate is that 93.4 to 98.7 percent of the volume of the structural backfill in the various building areas is expected to have relative densities of 80 percent or greater. The best estimate for the entire plant area is the 96.4 percent of the structural backfill volume is expected to have a relative density of 80 percent or greater.

Correspondingly, the expected probability of random portions of the fill having a relative density less than 80 percent ranged from 1.3 percent to 6.6 percent for the different building areas in Units 1 and 2. The overall weighted average probability was found to be between 3.2 percent and 4.0 percent, indicating that the variance of this probability is very small.

The statistical probabilities are very low that random portions or pockets of backfill may have relative densities less than 70 or 60 percent. The weighted average probability is less than 0.1 percent that random pockets of backfill could have relative density less than 70 percent, and the probability of relative density less than 60 percent is extremely low (1×10^{-5} to 1×10^{-7}). The results are shown by the probability distribution curves of Figure 2-6.

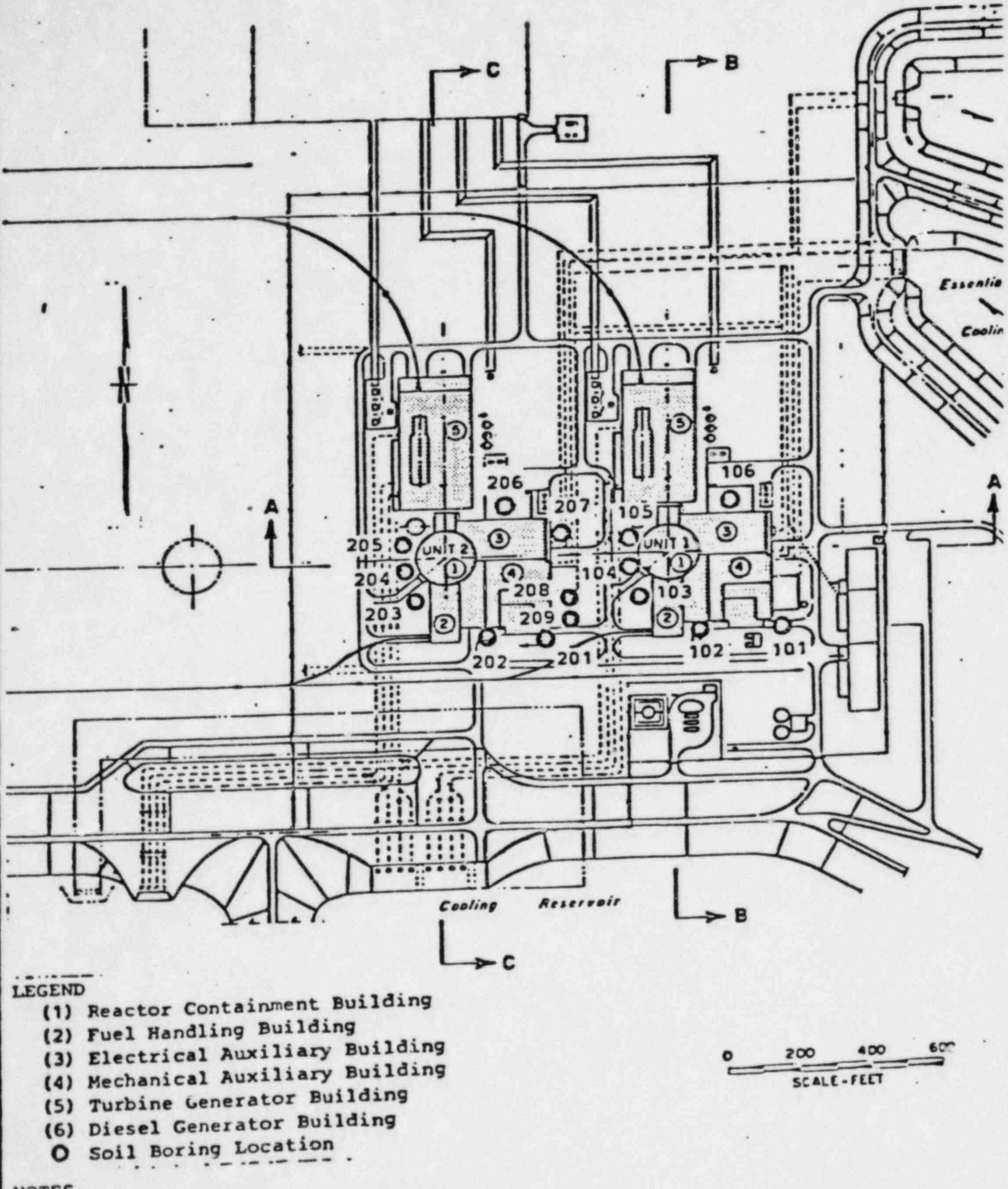
The second statistical analysis included two sets of data to evaluate the representativeness of the backfill conditions at the original fifteen Phase I boring locations. The data sets were:

a) Relative density data from in-place density tests for all backfill placements penetrated by the borings, including placements in which no SPT was taken due to the sampling interval (called the large data set).

b) Relative density data from in-place density tests involving only backfill placements penetrated by SPT (called the small data set). This data set is a subset of the large data set.

Statistically, the two sets of SPT related data (large data set and small data set) both have essentially the same distribution as the distribution obtained from the first analysis based on all final in-place density acceptance tests. The results are shown by the probability distribution curves of Figure 2-7. This close similarity demonstrates that the 288 SPT results obtained at the original 15 boring locations are representative for the conditions of the entire plant area backfill.

Note that based on the statistical analysis of the in place density tests approximately 3.2 percent to 4.0 percent of the in place backfill could be expected to be below 80 percent relative density. Thus, out of the 288 SPTs performed in Phase 1 of the boring program, between nine and eleven SPTs could be expected to show results below 80 percent relative density. This is consistent with the results of the Phase 1 boring program in which eight of the 288 SPTs showed results below 80 percent relative density.



LEGEND

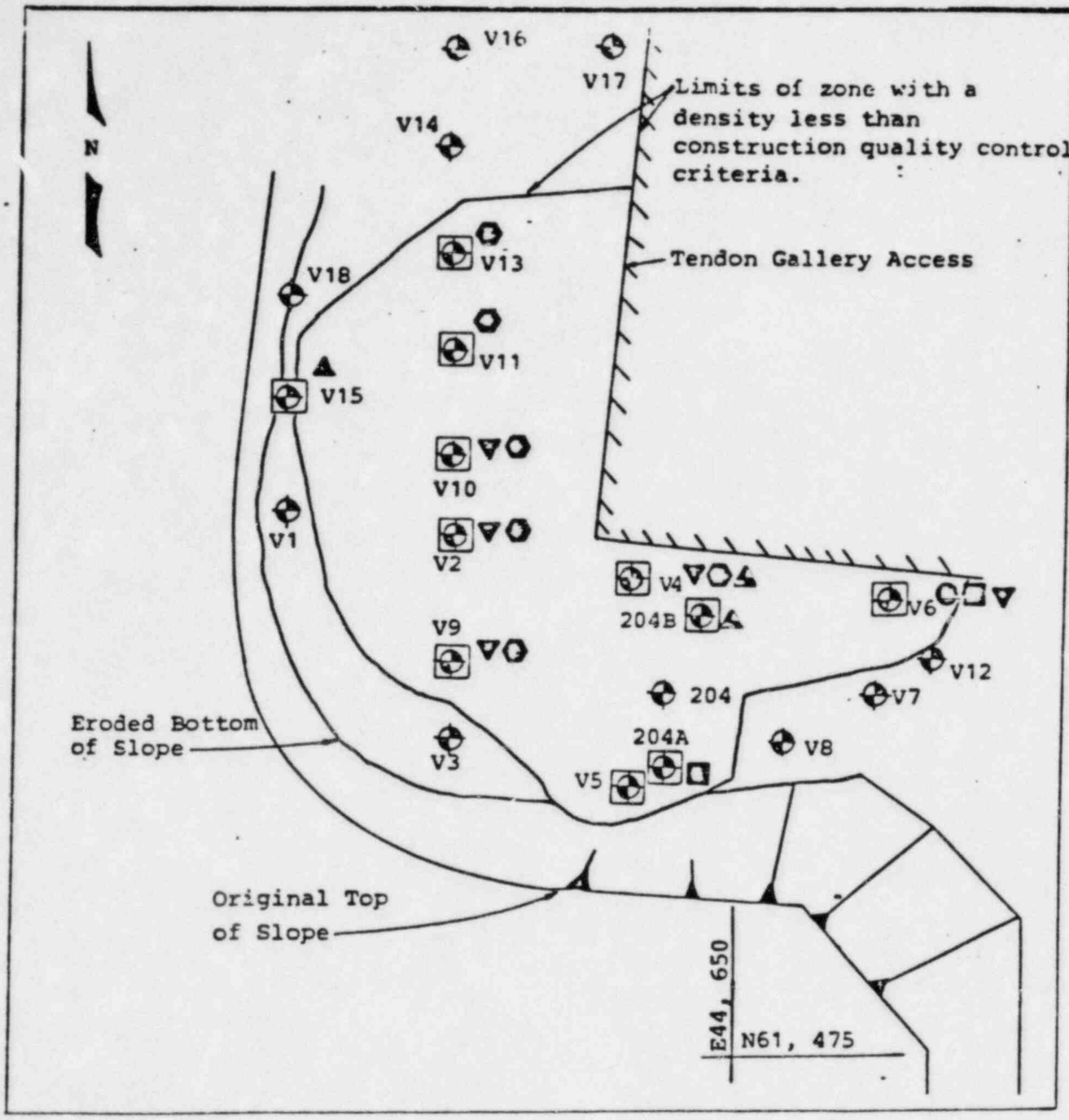
- (1) Reactor Containment Building
- (2) Fuel Handling Building
- (3) Electrical Auxiliary Building
- (4) Mechanical Auxiliary Building
- (5) Turbine Generator Building
- (6) Diesel Generator Building
- O Soil Boring Location

NOTES

(1) Borings with A, B and V suffixes drilled in vicinity of other boring with same boring number, eg., 205, 205A, 205B and 205V1. See Figures 2, 3, 4 and 5 for detailed boring location plan in Unit 2.

SOIL BORING LOCATION PLAN

FIGURE 2-1



LEGEND

- ▲ El -27.8 to -30.8 ft
- ● El -31.8 to -32.8 ft
- ◘ El -36.7 to -37.8 ft
- ▼ El -38.8 to -39.9 ft
- ⬡ El -40.8 to -41.9 ft
- ◬ El -41.4 to -42.4 ft and El -42.8 to -43.8 ft

SCALE

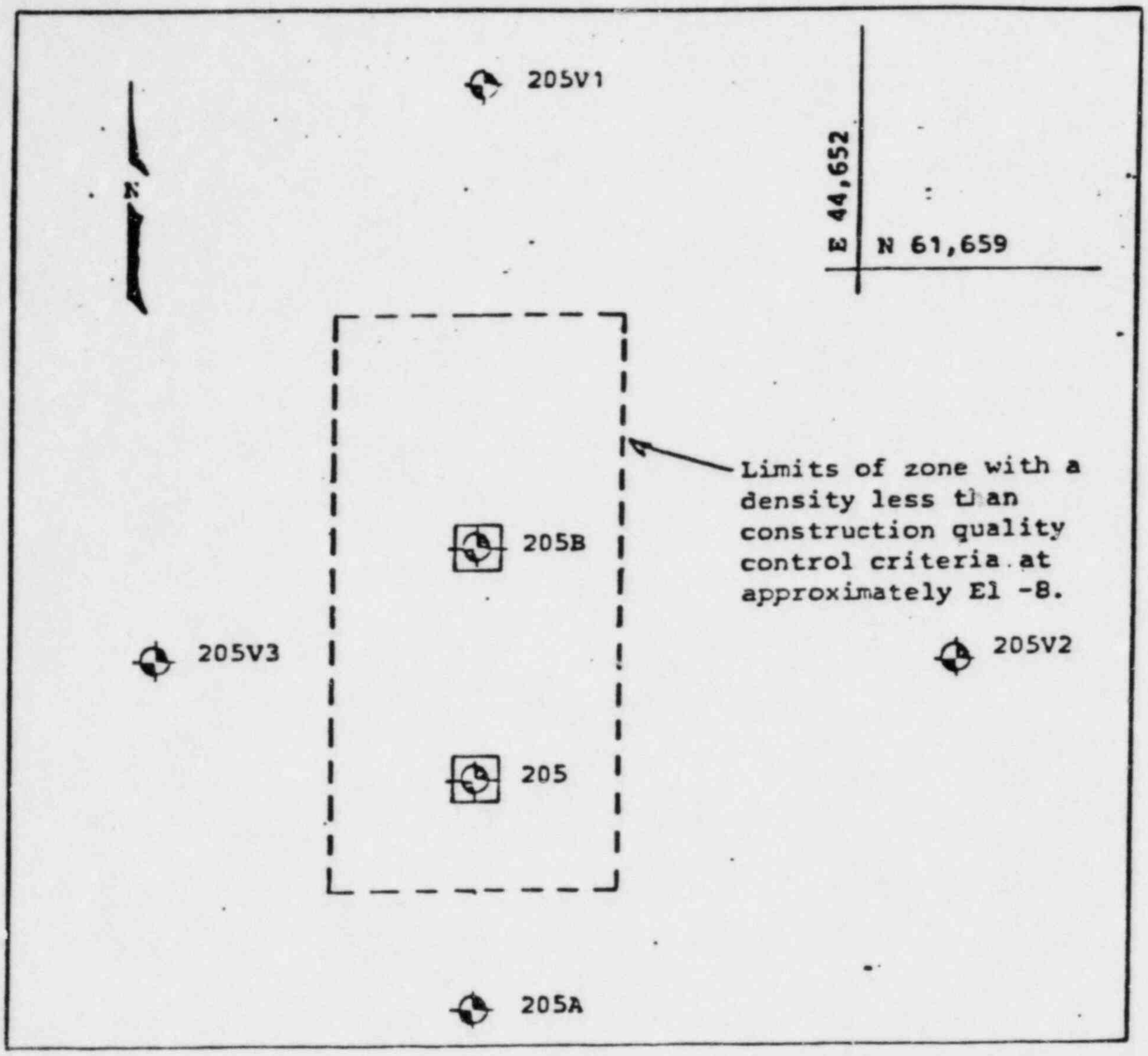
0 20 40 feet

Boring Location

Indicates standard penetration test performed in structural backfill had a standard penetration resistance less than 80% relative density.

LOCATIONS OF ZONES WITHIN AREA 1 WITH
A DENSITY LESS THAN CONSTRUCTION QUALITY CONTROL CRITERIA

FIGURE 2-2



Boring Location

Indicates standard penetration test performed in boring had a standard penetration resistance less than 80% relative density in structural backfill.

0 2 4 6 feet

NOTE: 1.) Borings 205, 205A and 205B were drilled as part of the initial structural backfill study.

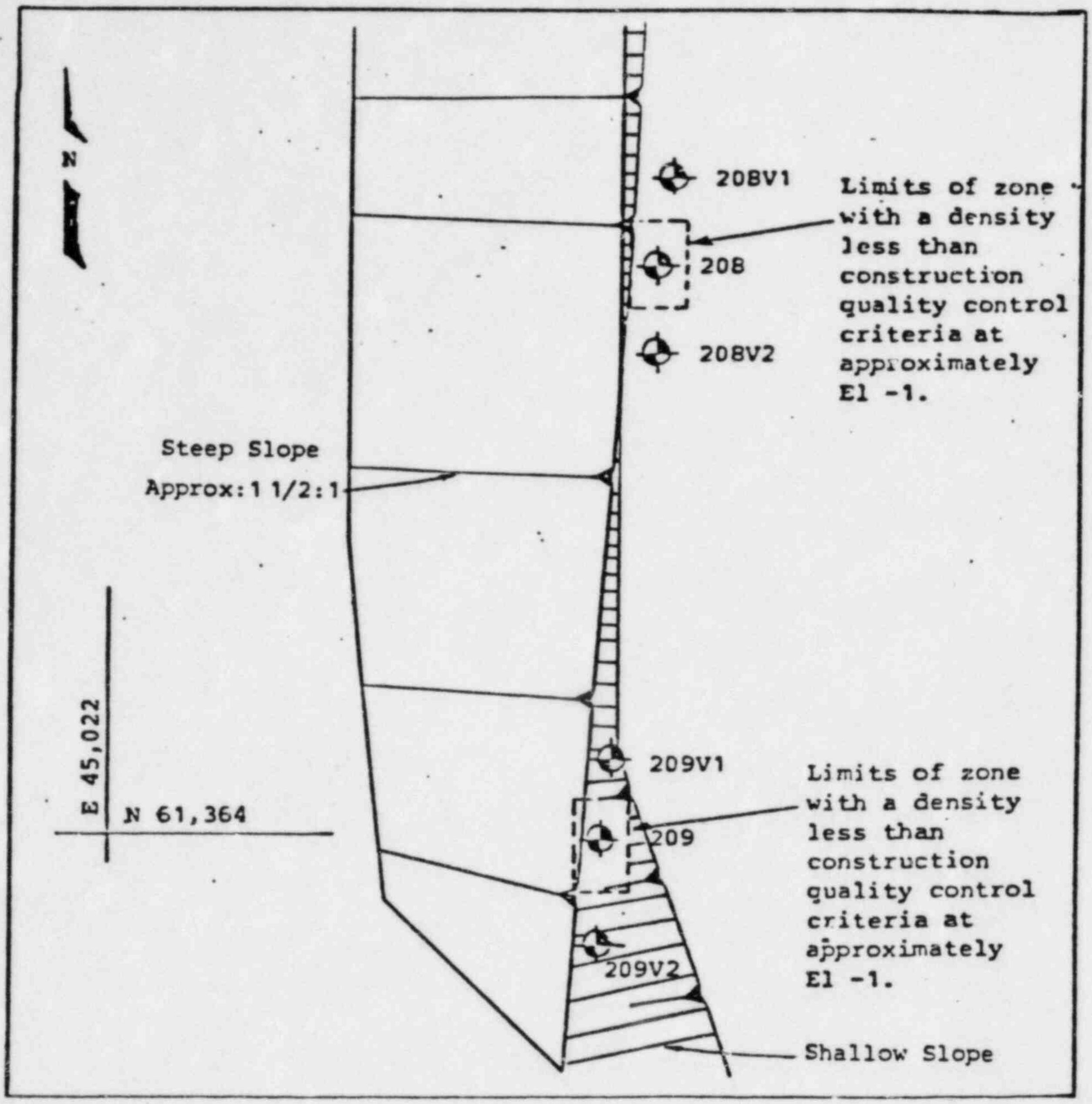
2.) See Page 3/5 for discussion.

3.) Limits of zone approximately midway between borings or to structural boundary.

BORING LOCATION PLAN

AREA 2

FIGURE 2-3



Boring Location

Indicates standard penetration test performed in boring had a standard penetration resistance less than 80% relative density in structural backfill.

0 10 20 30 40 feet

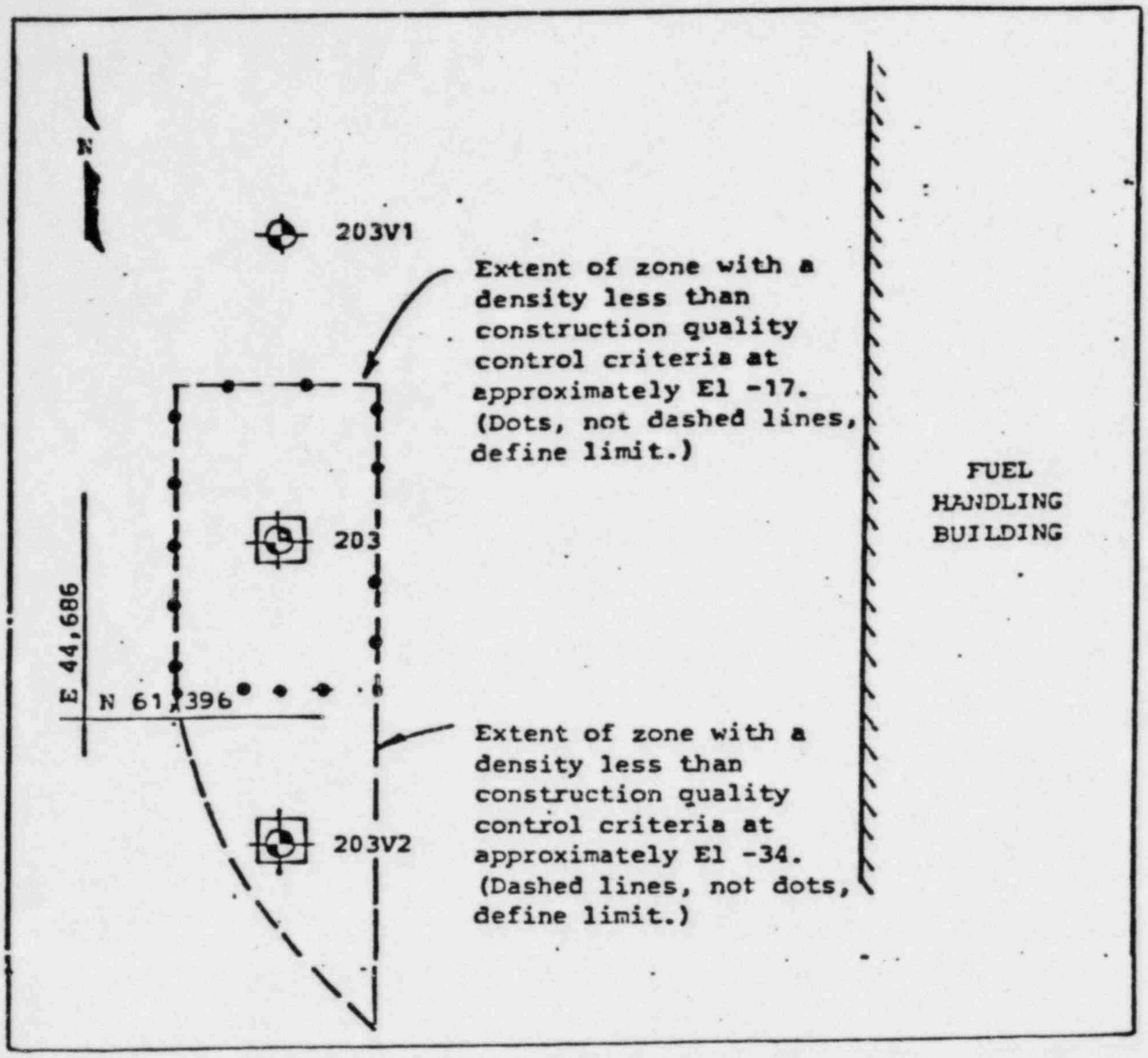
NOTE: 1.) Borings 208 and 209 were drilled as part of the initial structural backfill study.

2.) See page 3/5 for discussion.

3.) Limits of zone approximately midway between borings or to structural boundary.

BORING LOCATION PLAN
AREA 3

FIGURE 2-4



Boring Location

Indicates standard penetration test performed in boring had a standard penetration resistance less than 80% relative density in structural backfill.

0 5 10 feet

NOTE: 1.) Boring 203 was drilled as part of the initial structural backfill study.

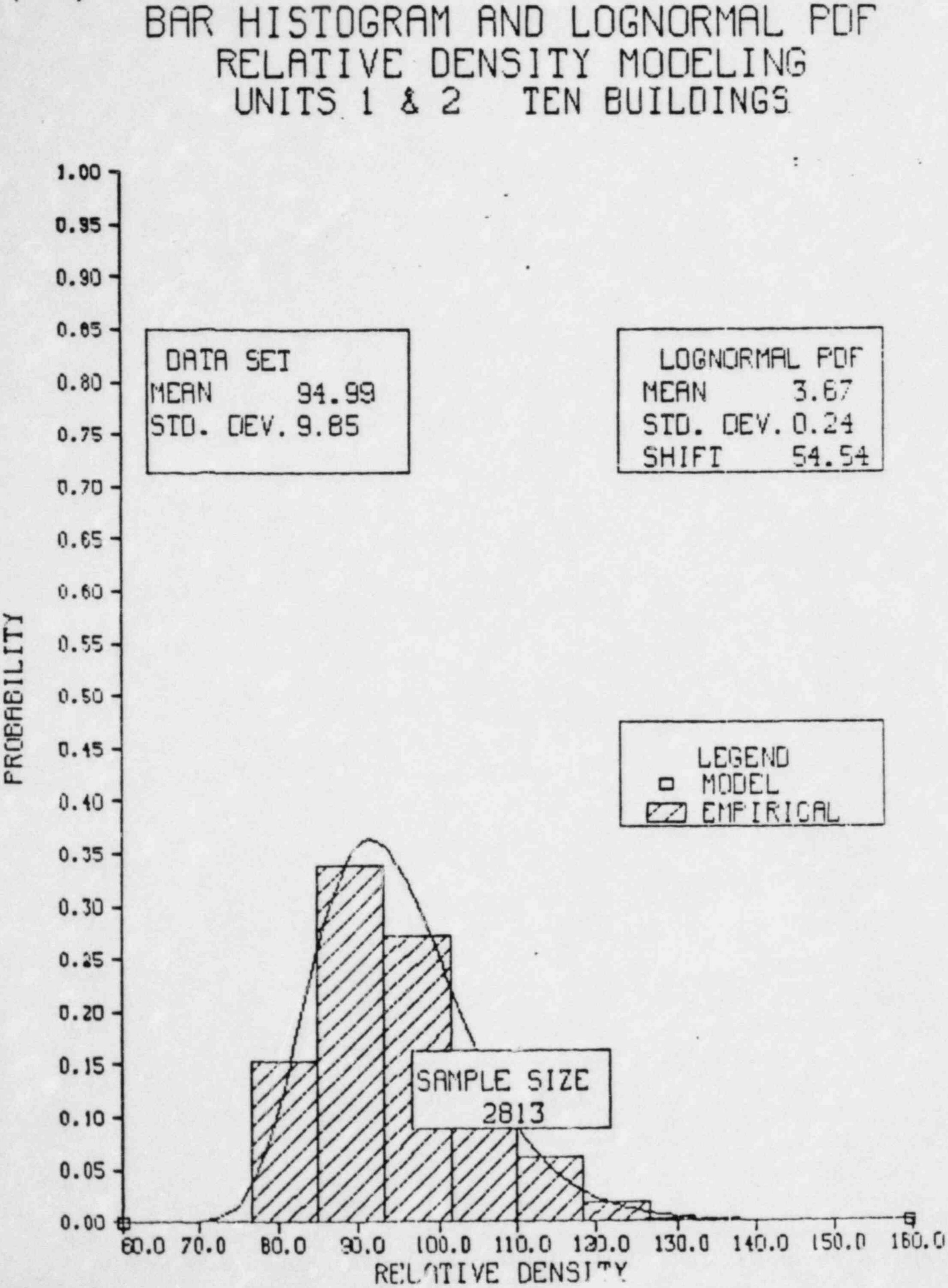
2.) See Page 3/5 for discussion.

3.) Limits of zones approximately midway between borings or to structural boundary.

BORING LOCATION PLAN

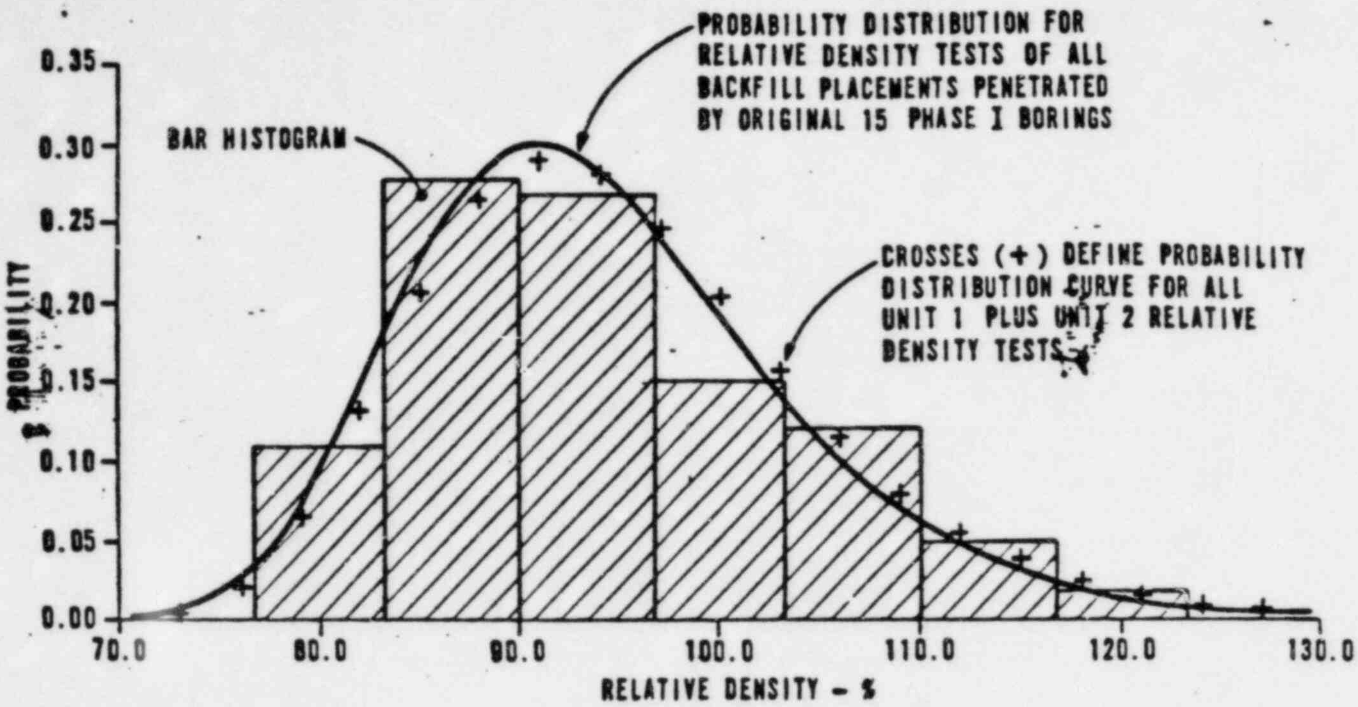
AREA 4

FIGURE 2-5

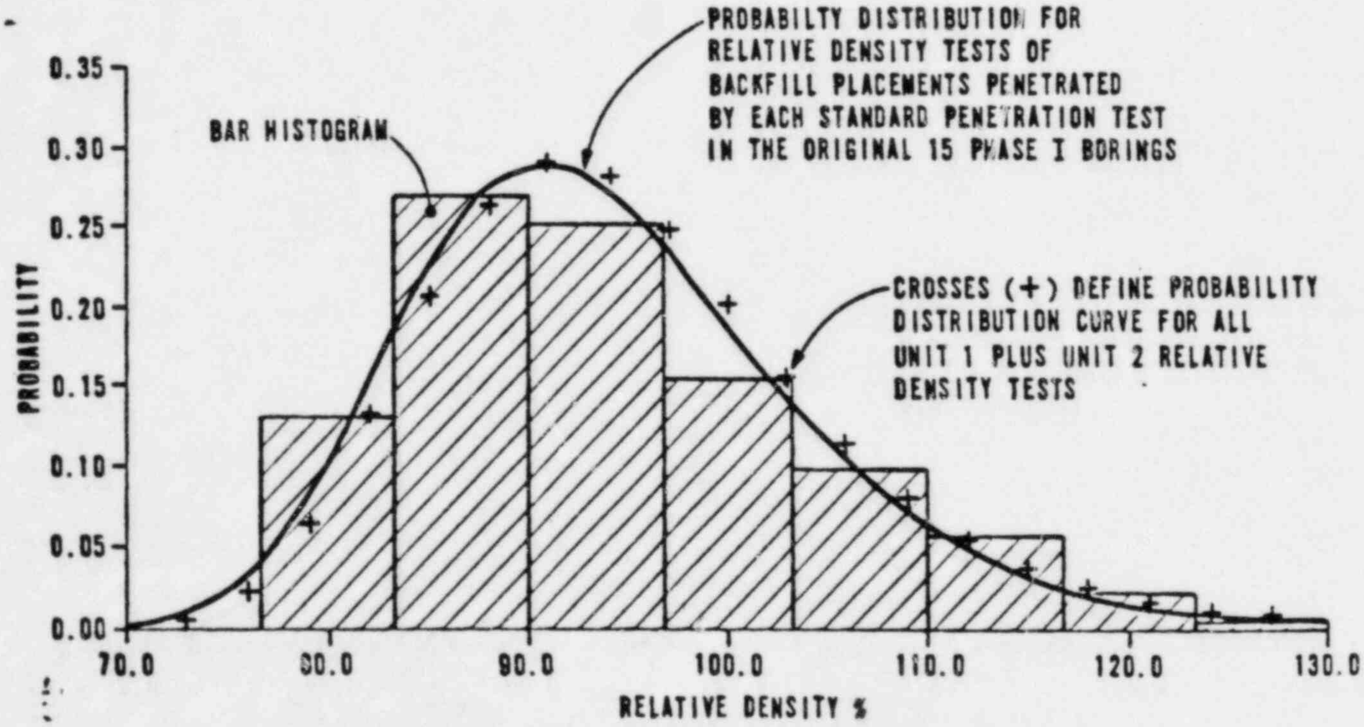


BAR HISTOGRAM AND LOGNORMAL PDF
RELATIVE DENSITY MODELING
UNITS 1 & 2 TEN BUILDINGS
PROBABILITY
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
DATA SET
MEAN 94.99
STD. DEV. 9.85
LOGNORMAL PDF
MEAN 3.67
STD. DEV. 0.24
SHIFT 54.54
LEGEND
MODEL
EMPIRICAL
SAMPLE SIZE
2813
60.0 70.0 80.0 90.0 100.0 110.0 120.0 130.0 140.0 150.0 160.0
RELATIVE DENSITY

FIGURE 2-6



A. ALL PLACEMENTS (LARGE DATA SET)



B. PLACEMENTS WITH SPT VALUES (SMALL DATA SET)

NOTES

1. THE UNIT 1 PLUS UNIT 2 DATA INCLUDE ALL TESTS THROUGH JULY 31, 1980 FOR CATEGORY I BACKFILL AS ACCEPTED.
2. REFER TO TABLE 5 FOR STATISTICAL SUMMARY OF ABOVE DATA.
3. DATA ON THIS FIGURE TAKEN FROM REFERENCE 28.

SOUTH TEXAS PROJECT

STATISTICAL COMPARISON
BORINGS VS. TOTAL PLANT

FIGURE 2-7

FIELD BORING NO.	FSAR BORING NO.	ELEVATION M.S.L. FT	COORDINATES N	E
WCBV-101	312	28.06	361,326	2,945,660
WCBV-102	313	29.93	361,327	2,945,419
WCBV-103	314	31.33	361,444	2,945,280
WCBV-104	315	31.51	361,530	2,945,253
WCBV-105	316	31.31	361,614	2,945,255
WCBV-106	317	22.10	361,789	2,945,628
WCBV-201	318	19.10	361,331	2,945,024
WCBV-201A	318A	19.0	361,444	2,945,285
WCBV-202	319	21.24	361,332	2,944,849
WCBV-203	320	26.72	361,402	2,944,692
203-V1	320A	26.7	361,412	2,944,690
203-V1A	320B	26.65	361,412	2,944,697
203-V2	320C	26.53	361,392	2,944,692
WCBV-204	321	27.25	361,520	2,944,644
WCBV-204A	321A	27.25	361,510	2,944,644
WCBV-204B	321B	27.25	361,529	2,944,648
204-V1	321C	29.43	361,543	2,944,600
204-V2	321D	29.61	361,540	2,944,619
204-V3	321E	29.36	361,514	2,944,619
204-V4	321F	27.32	361,534	2,944,640
204-V5	321G	29.4	361,508	2,944,640
204-V6	321H	27.25	361,531	2,944,671
204-V7	321I	29.58	361,516	2,944,666
204-V8	321J	29.5	361,513	2,944,657
204-V9	321K	29.61	361,524	2,944,619
204-V10	321L	28.18	361,550	2,944,619
204-V11	321M	28.28	361,563	2,944,619
204-V12	321N	27.4	361,523	2,944,676
204-V13	321O	29.37	361,576	2,944,619
204-V14	321P	28.9	361,589	2,944,619
204-V15	321Q	29.8	361,557	2,944,600

BORING ELEVATIONS AND COORDINATES

TABLE 2-1

FIELD BORING NO.	FSAR BORING NO.	ELEVATION M.S.L. FT	COORDINATES N	E
204-V16	321R	29.4	361,601	2,944,619
204 V17	321S	29.0	361,601	2,944,637
204-V18	321T	29.6	361,570	2,944,600
WCBV-205	322	25.67	361,648	2,944,644
WCBV-205A	322A	25.67	361,640	2,944,644
WCBV-205B	322B	25.67	361,653	2,944,644
205-V1	322C	27.23	361,663	2,944,644
205-V2	322D	26.84	361,650	2,944,654
205-V3	322E	27.6	361,650	2,944,640
WCBV-206	323	9.50	361,749	2,944,952
WCBV-207	324	15.91	361,641	2,944,072
WCBV-208	325	27.97	361,429	2,945,082
WCBV-208X	325A	28.0	361,394	2,945,076
208-V1	325B	28.0	361,439	2,945,084
208-V2	325C	28.2	361,419	2,945,082
WCBV-209	326	28.37	361,364	2,945,076
209-V1	326A	28.31	361,374	2,945,078
209-V2	326B	28.38	361,354	2,945,076

BORING ELEVATIONS AND COORDINATES

TABLE 2-1

Item 3: Contaminated Backfill

NRC requested that HL&P docket the Woodward Clyde Consultants' (WCC) report on the contaminated backfill underneath the Unit 2 Mechanical-Electrical Auxiliary Building.

RESPONSE

The subject WCC report (ST-WC-BR-5427) is attached.

Item 4a: Settlement

NRC requested that HL&P provide an evaluation of the observed settlement at STP to date.

RESPONSE

The evaluation and analyses of plant unit ground movement (settlement) has been an ongoing engineering work item since the design phase (1973) work began and will continue to be an engineering work item. To date the match between predicted and measured movements are good after the maximum heave occurred.

FSAR Appendix 2.5.C Subsections 2.5.C.4.5 and 2.5.C.4.6 and the responses to NRC Questions 241.1 and 241.2 will be updated in the first half of 1983 to incorporate the settlement monitoring data through December 1982.

The differential movements experienced between buildings are shown on Table 4-1 and Figure 4-1 and Figure 4-2 for Unit 1 and Unit 2, respectively. On these Figures six individual data graphs are shown. These graphs show differential movement of one point relative to another point. Figures 4-1 and 4-2 are updated through February 1982. To date, predicted and measured movements are good and within design criteria.

The differential movements within individual buildings are shown on plots for representative dates on the attached Figures 4-3 and 4-4 for Unit 1 and on Figures 4-5 and 4-6 for Unit 2. The locations of the data points for Figures 4-3, 4-4, 4-5, and 4-6 are shown on Figure 4-7. The Figures 4-3, 4-4, 4-5, and 4-6 are updated through February 1982. Table 4-1 shows a tabulation of the measured end to end tilt of the buildings. To date, the match between predicted and measured movements are good after the maximum heave occurred as evidenced by Figures 4-8 through 4-15.

No Category I piping has been connected between structures as of August 1982. Recording of differential movements between buildings started when adjacent portions of two building foundations had been completed. Category I piping systems were only partially installed within the Unit 1 Mechanical-Electrical Auxiliary Building (MEAB) as of 1979, and no piping installations had been made in Unit 2 MEAB as of 1980. Any effects of differential movements on the piping will be evaluated upon complete installations.

The tilt criteria, FSAR Section 2.4.5.11, applies to piping after final installation and connections. The tilt is also considered for the structural design. Table 4-2 shows a tabulation of end to end tilt of the buildings. The end to end tilt is also seen on Figures 4-3, 4-4, 4-5, and 4-6.

The ground movement (heave, recompression of heave and settlement) analyses and the ground movement observation made to date (August 1982) show results that were anticipated in the design phase of the STP. The ground movements have been predicted and considered in design and construction and will not detrimentally affect the plant construction or operation. The ground movement is caused by heave due to excavation unloading, the recompression due to construction loads, and the new or net settlement due to loads greater than the excavation unloading.

The critical connections, none of which have been made to date (August 1982), will be constructed at such a time that the remaining differential settlement and ground movement will be accommodated without adversely affecting safety or operation.

Item 4b: Tilt

NRC requested that HL&P address tilt reported in the Unit 2 Mechanical-Electrical Auxiliary Building (MEAB) in 1980.

RESPONSE

For the MEAB, the design criteria is 1.0 inch tilt in the East-West direction and 0.5 inch tilt in the North-South direction (FSAR section 2.5.5.11). The observed tilt and differential settlement of the Unit 2 MEAB is presented in Table 4-3.

Differential Settlement

The differential settlement and curvature of the mat for the Unit 2 MEAB were anticipated and factored into the design. Although the design criteria were exceeded during one segment of construction, the corrective action taken during a subsequent segment of construction brought the differential settlement and curvature to within the design criteria tolerances. The structural design effects of the differential movements experienced by the Unit 2 MEAB mat were evaluated and it was determined by Brown & Root that temporary differential settlement resulting in bending of the mat during the construction period could exceed the original design criteria by 50 percent without any adverse effects.

The maximum design tilt in the MEAB is defined in FSAR Section 2.5.4.11 and is specified as 0.5 inches tilt in the North-South direction. This differential settlement criteria is to be applied at the time of penetration connections or pipe installations for Category I piping. The North end local curvature criteria is defined as 0.25 inches. The values for maximum design tilt and North local curvature were exceeded by 0.2 inches and 0.05 inches respectively.

The tilt and curvature experienced by the Unit 2 MEAB foundation mat resulted from the deviation from the planned construction loading sequence. The major contributor to the situation was the lack of placement of backfill around the North end of the MEAB. The actions taken to correct this situation involved the removal of approximately 11,143 tons of backfill from around the South and Southeast end of the MEAB and the scheduling of concrete placements such that the North portion of the building would be loaded first. The efforts to correct this situation were successful. Corrective action by load modification was described in a letter to NRC dated February 3, 1981 (ST-HL-AE-616). Piping installation had not begun in Unit 2 MEAB in 1980.

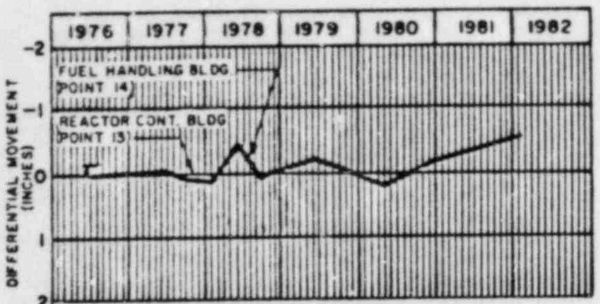
The design criteria are not applicable in the early part of the building construction and before installation of interconnected systems. It is desirable to minimize deviations throughout the construction period in order to avoid adverse trends which would affect the structure or piping systems at a later date. The differential movements were found not to have any detrimental effect on the Unit 2 MEAB.

Compression

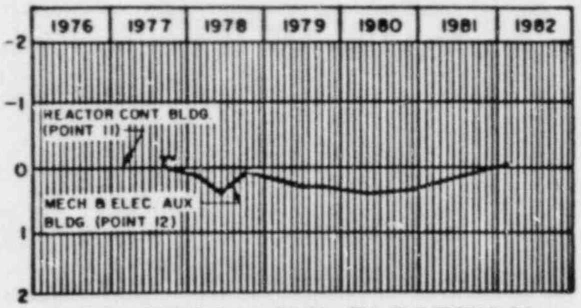
A special study was undertaken to examine the possible relation between observed tilting of the Unit 2 MEAB and compression of the structural backfill.

A method of evaluation used to determine if the tilting could be associated with compression of the structural backfill was to compare vertical movement histories of structural bench marks (SBM) located along the profile in question with vertical movement histories of nearby bore hole heave points (BHP) and Sondex rings located in D-layer clays.

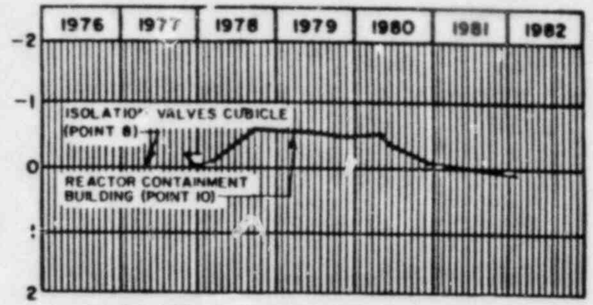
The only materials between the SBMs and the geotechnical instruments are the concrete mat and seal slab, structural backfill sand and a few feet of D-layer clay (above the geotechnical instruments and below the backfill sand). Because there is very little relative movement between the SBM curves and the geotechnical instruments, it is concluded that there is very little compression of the structural backfill sand below the Unit 2 MEAB Building. The Expert Committee also concluded that the condition of the fill is entirely adequate for the design requirement of the project. "For the Unit 1 Auxiliary Building, a compression of about 3/8-inch is indicated, which is approximately equal to the amount of compression calculated using the imposed building pressure and the soil modulus value E for very dense structural backfill material as determined from References 3 and 4. Thus, a very dense structural backfill is indicated."



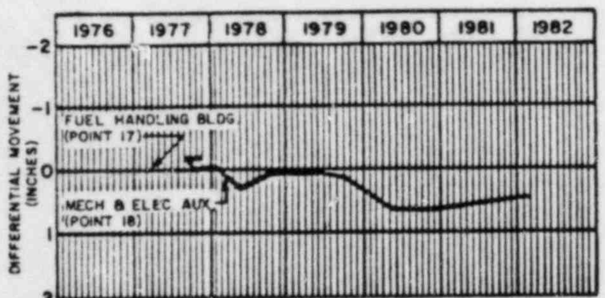
FUEL HANDLING BUILDING
VERSUS
REACTOR CONTAINMENT BUILDING



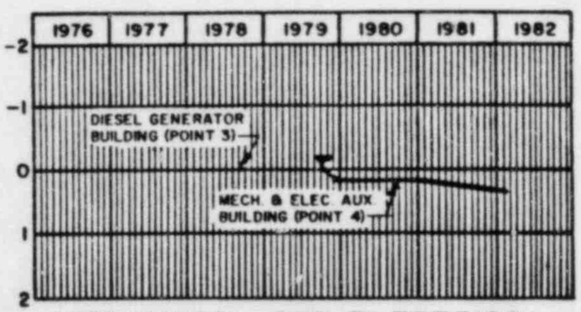
MECHANICAL AND ELECTRICAL
AUXILIARY BUILDING
VERSUS
REACTOR CONTAINMENT BUILDING



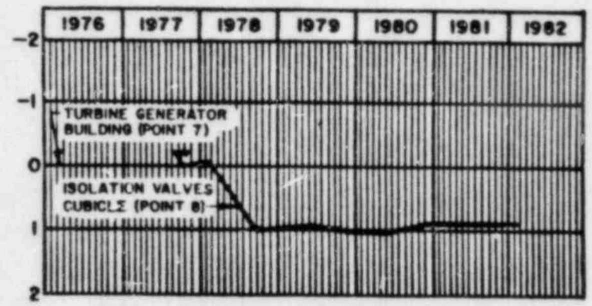
ISOLATION VALVES CUBICLE
VERSUS
REACTOR CONTAINMENT BUILDING



MECHANICAL AND ELECTRICAL
AUXILIARY BUILDING
VERSUS
FUEL HANDLING BUILDING



MECHANICAL AND ELECTRICAL
AUXILIARY BUILDING
VERSUS
DIESEL GENERATOR BUILDING



ISOLATION VALVES CUBICLE
VERSUS
TURBINE GENERATOR BUILDING

CONTROL POINTS	3	4	7	8	9	10	11	12	13	14	17	18
HEAVE (INCHES) SEE NOTE 2	-0.1	0.3	-0.4	-2.8		-2.5	-2.5	-2.6	-4.3	-4.1	-2.8	-2.4

LEGEND:

▼ INDICATES START OF DIFFERENTIAL MOVEMENT COMPARISON

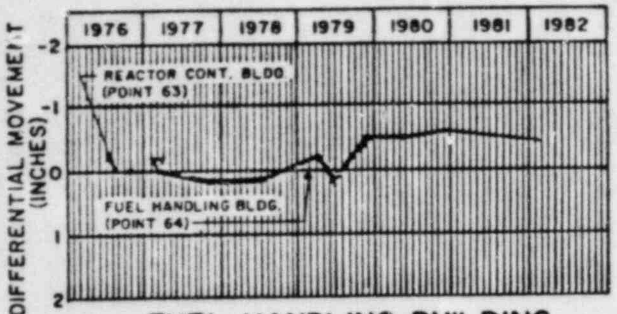
NOTES:

1. SEE FIGURE 7 FOR LOCATION OF ANALYSIS CONTROL POINTS.
2. POSITIVE NUMBER INDICATES SETTLEMENT.

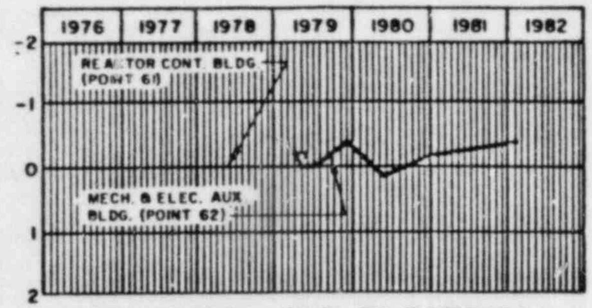
SOUTH TEXAS PROJECT
UNITS 1&2

DIFFERENTIAL MOVEMENTS
BETWEEN BUILDINGS
UNIT I

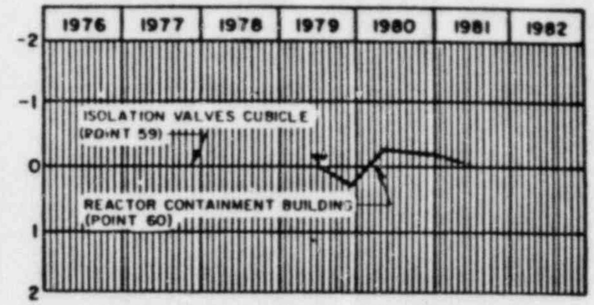
FIGURE 4-1



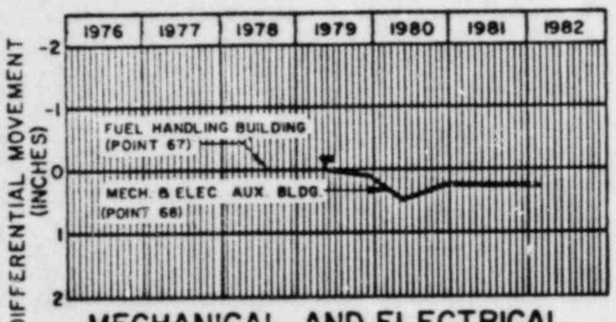
FUEL HANDLING BUILDING
VERSUS
REACTOR CONTAINMENT BUILDING
(REACTOR CONT. BLDG. FIXED REFERENCE)



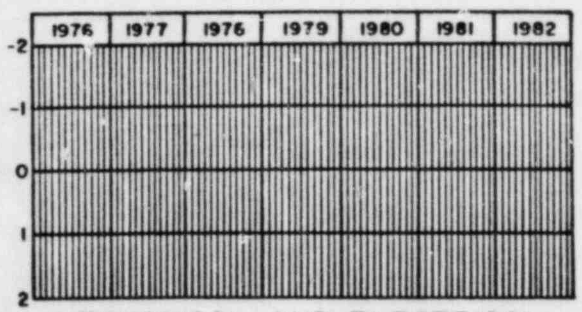
MECHANICAL AND ELECTRICAL
AUXILIARY BUILDING
VERSUS
REACTOR CONTAINMENT BUILDING
(REACTOR CONT. BLDG. FIXED REFERENCE)



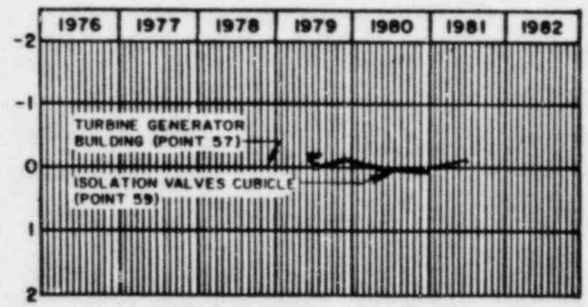
ISOLATION VALVES CUBICLE
VERSUS
REACTOR CONTAINMENT BUILDING



MECHANICAL AND ELECTRICAL
AUXILIARY BUILDING
VERSUS
FUEL HANDLING BUILDING



MECHANICAL AND ELECTRICAL
AUXILIARY BUILDING
VERSUS
DIESEL GENERATOR BUILDING



ISOLATION VALVES CUBICLE
VERSUS
TURBINE GENERATOR BUILDING

CONTROL POINTS	53	54	57	58	59	60	61	62	63	64	67	68
HEAVE (INCHES) SEE NOTE 2			0.5		-2.3	-2.3	-2.1	-2.1	-5.1	-5.0	-2.3	-2.3

LEGEND:

▼ INDICATES START OF DIFFERENTIAL MOVEMENT COMPARISON

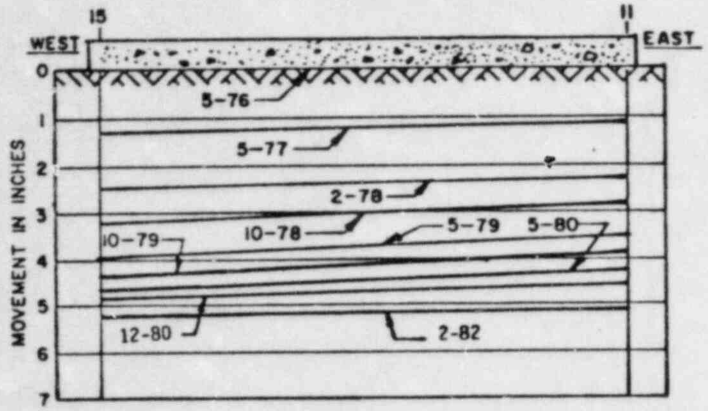
NOTES:

1. SEE FIGURE 7 FOR LOCATION OF ANALYSIS CONTROL POINTS.
2. POSITIVE NUMBER INDICATES SETTLEMENT

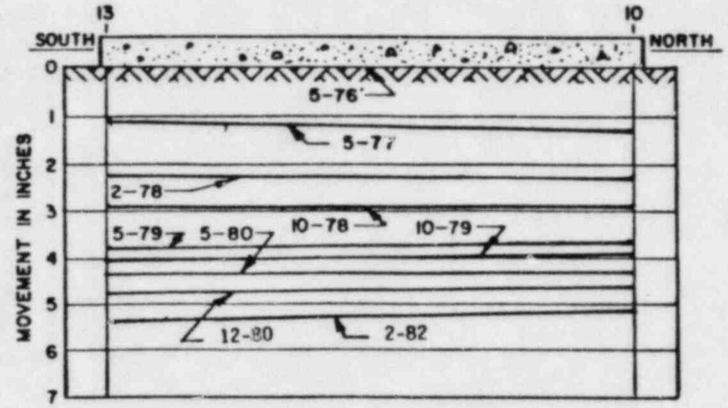
SOUTH TEXAS PROJECT
UNITS 1 & 2

DIFFERENTIAL MOVEMENTS
BETWEEN BUILDINGS
UNIT 2

FIGURE 4-2



SECTION A_1–A_1



SECTION C_1–C_1

REACTOR CONTAINMENT BUILDING

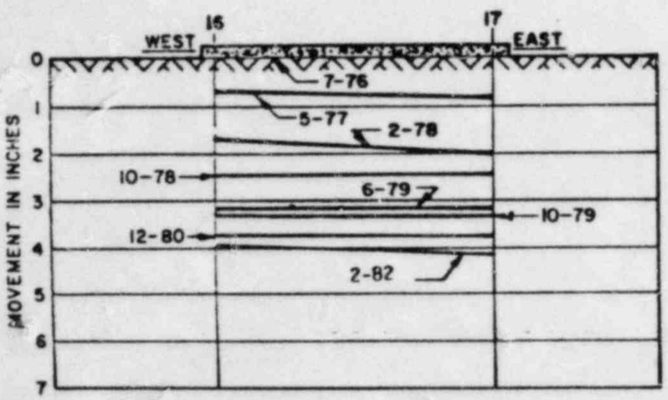
NOTES

1. SEE FIGURE 7 FOR LOCATIONS OF ANALYSIS CONTROL POINTS.
2. SUBSCRIPT NUMBER INDICATES BUILDING CODE AS SHOWN IN FIGURE 7 LEGEND (A_1–A_1).
3. MOVEMENT SHOWN HEREIN INDICATES SETTLEMENT OF INDIVIDUAL ANALYSIS CONTROL POINT SINCE MAT CONSTRUCTION. THE TOTAL MOVEMENT WILL INCLUDE RECOMPRESSION OF HEAVE (AVERAGE 4 INCHES) PLUS A NET SETTLEMENT.
4. STRUCTURAL BENCHMARK AT ANALYSIS CONTROL POINT 19 WAS INSTALLED IN OCTOBER, 1978.

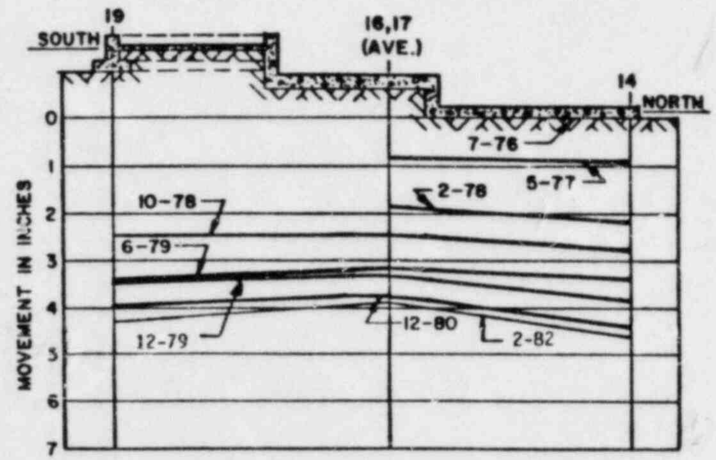
LEGEND

13 ANALYSIS CONTROL POINT

2-78 DATE READINGS WERE TAKEN



SECTION B_2–B_2



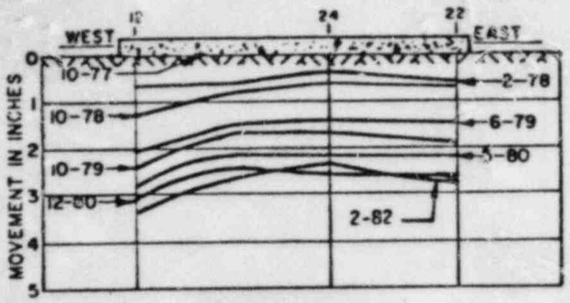
SECTION C_2–C_2

FUEL HANDLING BUILDING

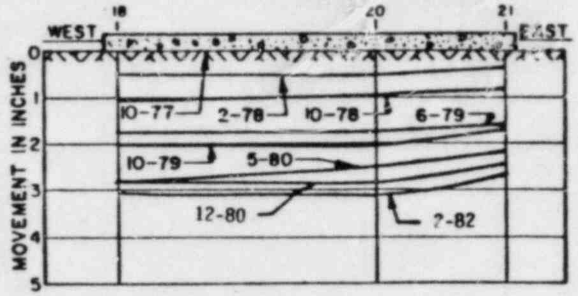
SOUTH TEXAS PROJECT
UNITS 1 & 2

DIFFERENTIAL MOVEMENT PROFILE
WITHIN BUILDINGS
UNIT 1

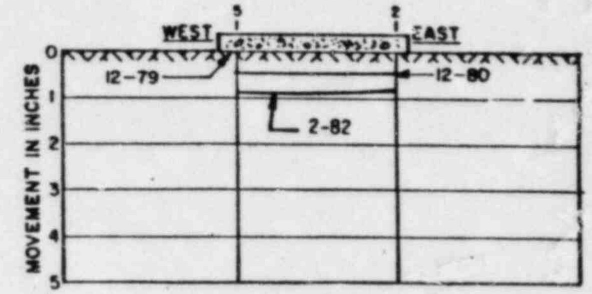
FIGURE 4-3



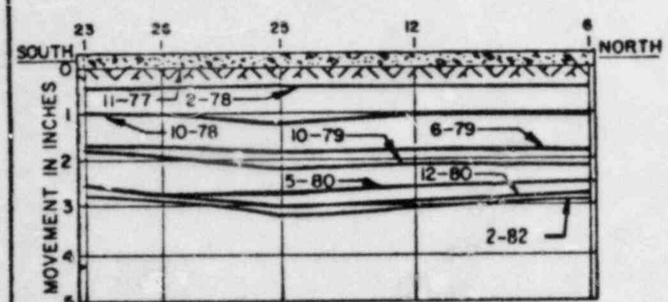
SECTION A_3–A_3



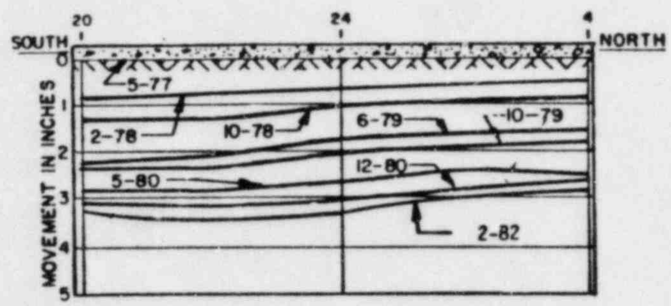
SECTION B_3–B_3



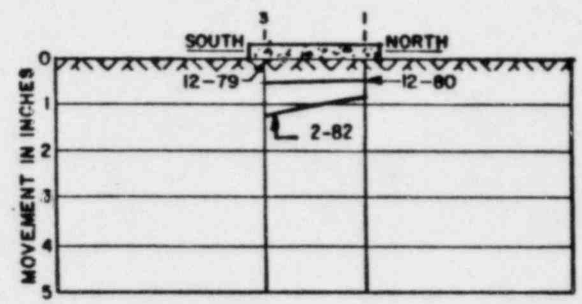
SECTION F_4–F_4



SECTION D_3–D_3



SECTION E_3–E_3



SECTION G_4–G_4

MECHANICAL & ELECTRICAL AUXILIARY BUILDING

DIESEL GENERATOR BUILDING

NOTES

1. FOR NOTES AND LEGEND SEE FIGURE 3
2. MOVEMENT SHOWN HEREIN INDICATES SETTLEMENT OF EACH INDIVIDUAL ANALYSIS CONTROL POINT SINCE MAT CONSTRUCTION. THE TOTAL MOVEMENT WILL INCLUDE RECOMPRESSION OF HEAVE (AVERAGE 3 INCHES) PLUS A NET SETTLEMENT.

20 0 20 40 60 80

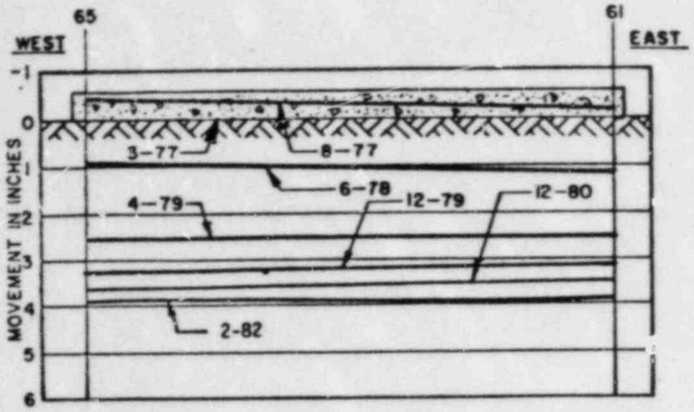
HORIZONTAL SCALE IN FEET

3. THE SAME POINT IN DIFFERENT SECTIONS MAY SHOW DIFFERENT MOVEMENTS ON THE SAME DATE, BECAUSE THEY ARE MEASURED FROM DIFFERENT STARTING DATES.

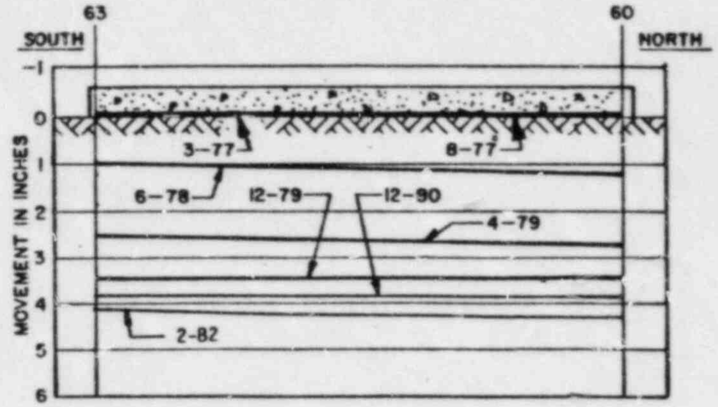
SOUTH TEXAS PROJECT
UNITS 1 & 2

DIFFERENTIAL MOVEMENT PROFILE
WITHIN BUILDINGS
UNIT 1

FIGURE 4-4



SECTION M_1—M_1



SECTION O_1—O_1

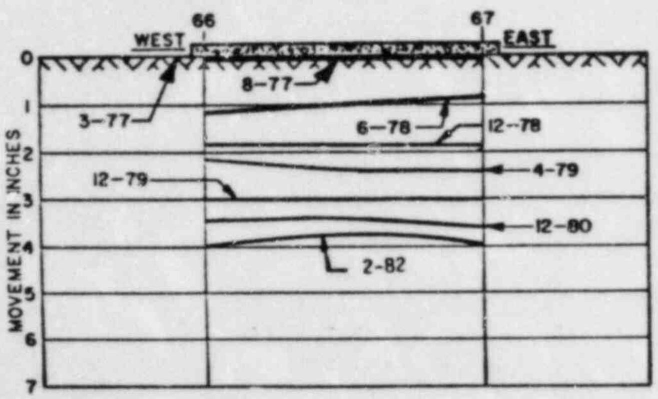
REACTOR CONTAINMENT BUILDING

NOTES

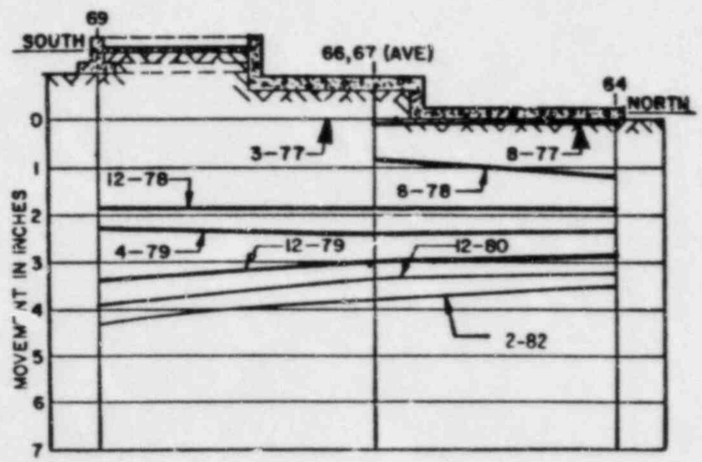
1. SEE FIGURE 7 FOR LOCATIONS OF ANALYSIS CONTROL POINTS.
2. SUBSCRIPT NUMBER INDICATES BUILDING CODE AS SHOWN IN FIGURE 7 LEGEND (O_1—O_1).
3. POSITIVE MOVEMENT SHOWN HEREIN INDICATES SETTLEMENT OF INDIVIDUAL ANALYSIS CONTROL POINT SINCE MAT CONSTRUCTION. THE TOTAL MOVEMENT WILL INCLUDE RECOMPRESSION OF HEAVE (AVERAGE 5 INCHES) PLUS A NET SETTLEMENT.

LEGEND

63 ANALYSIS CONTROL POINT
12-79 DATE READINGS WERE TAKEN



SECTION N_2—N_2



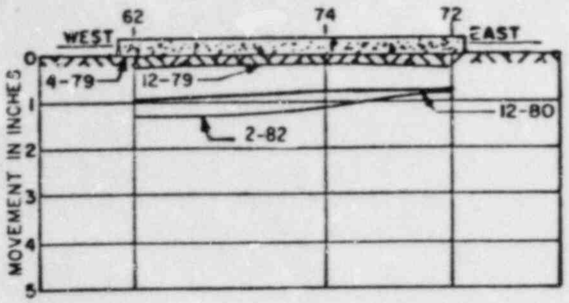
SECTION O_2—O_2

FUEL HANDLING BUILDING

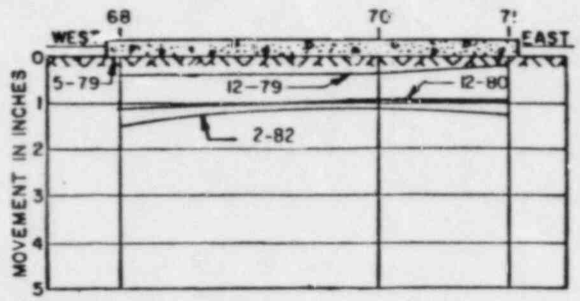
SOUTH TEXAS PROJECT UNITS 1 & 2

DIFFERENTIAL MOVEMENT PROFILE WITHIN BUILDINGS UNIT 2

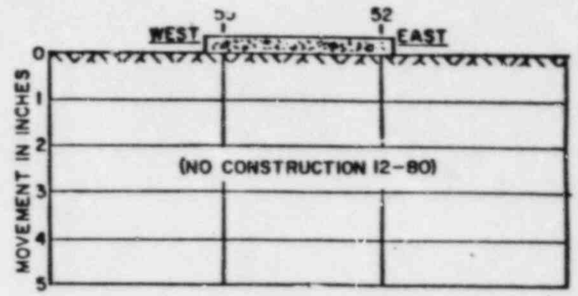
FIGURE 4-5



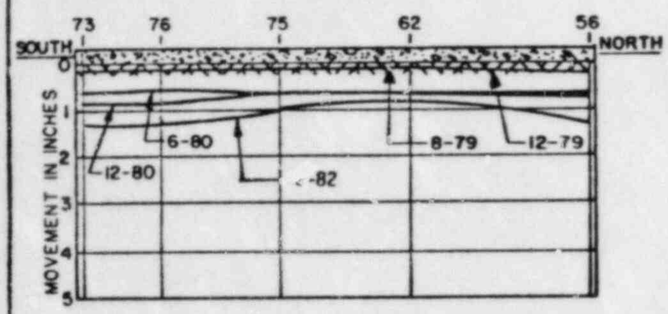
SECTION M_3—M_3



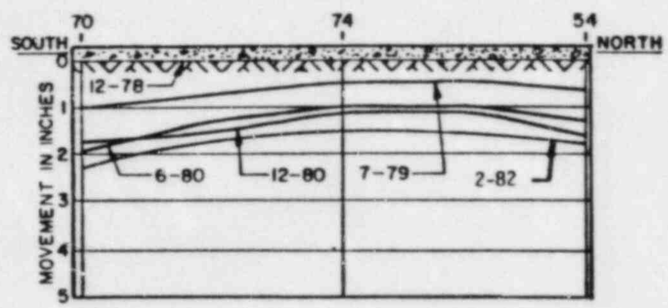
SECTION N_3—N_3



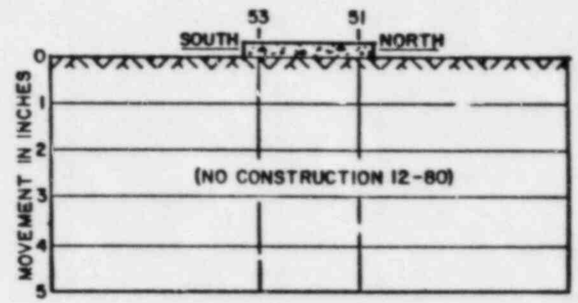
SECTION R_4—R_4



SECTION P_3—P_3



SECTION Q_3—Q_3



SECTION S_4—S_4

MECHANICAL & ELECTRICAL AUXILIARY BUILDING

DIESEL GENERATOR BUILDING

NOTES

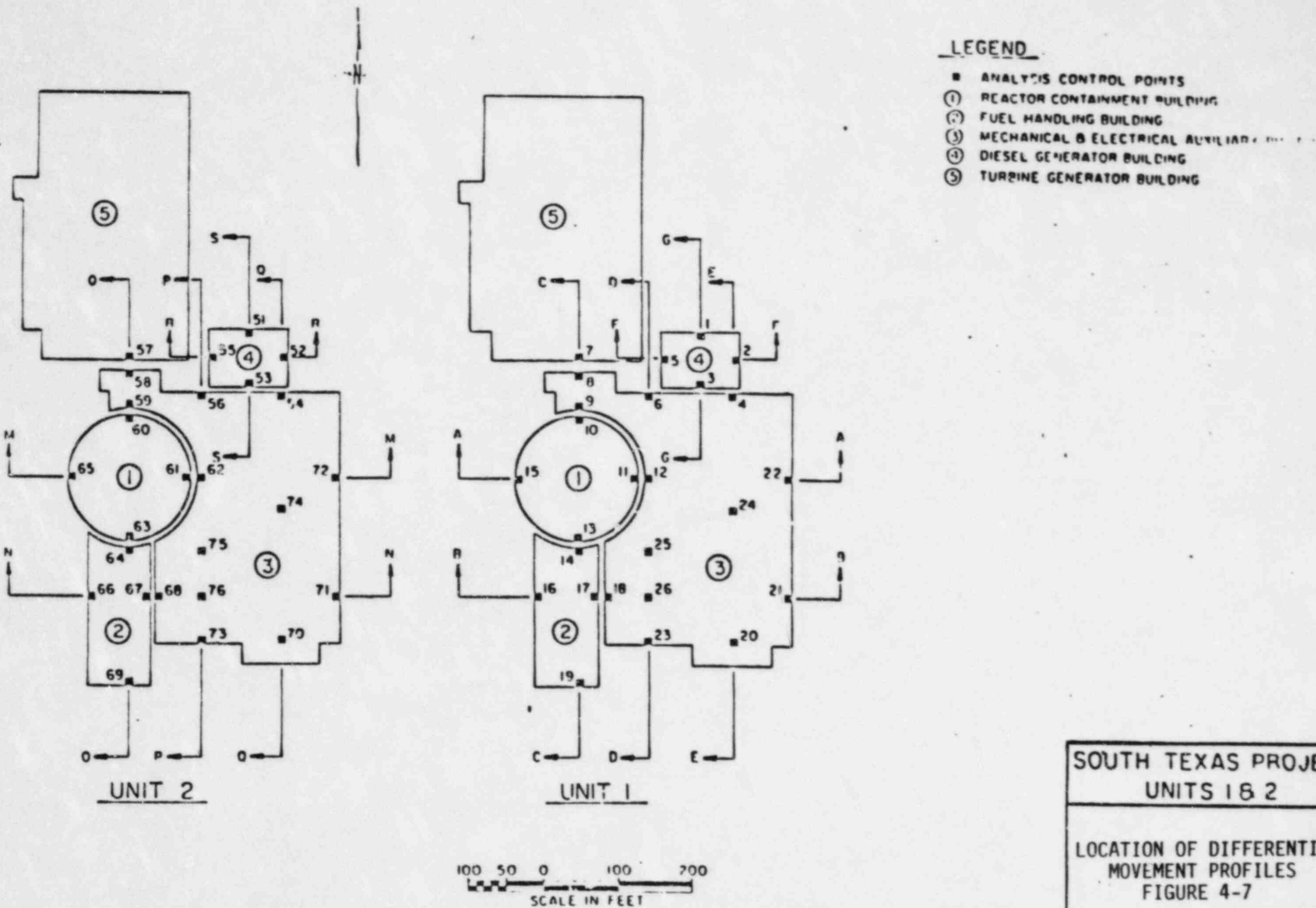
1. FOR NOTES AND LEGEND SEE FIGURE 5
2. MOVEMENT SHOWN HEREIN INDICATES SETTLEMENT OF INDIVIDUAL ANALYSIS CONTROL POINT SINCE MAT CONSTRUCTION. THE TOTAL MOVEMENT WILL INCLUDE RECOMPRESSION OF HEAVE (AVERAGE 2 INCHES) PLUS A NET SETTLEMENT.

3. THE SAME POINT IN DIFFERENT SECTIONS MAY SHOW DIFFERENT MOVEMENTS AT THE SAME DATE, BECAUSE THEY ARE MEASURED FROM DIFFERENT STARTING DATES.

SOUTH TEXAS PROJECT
UNITS 1 & 2

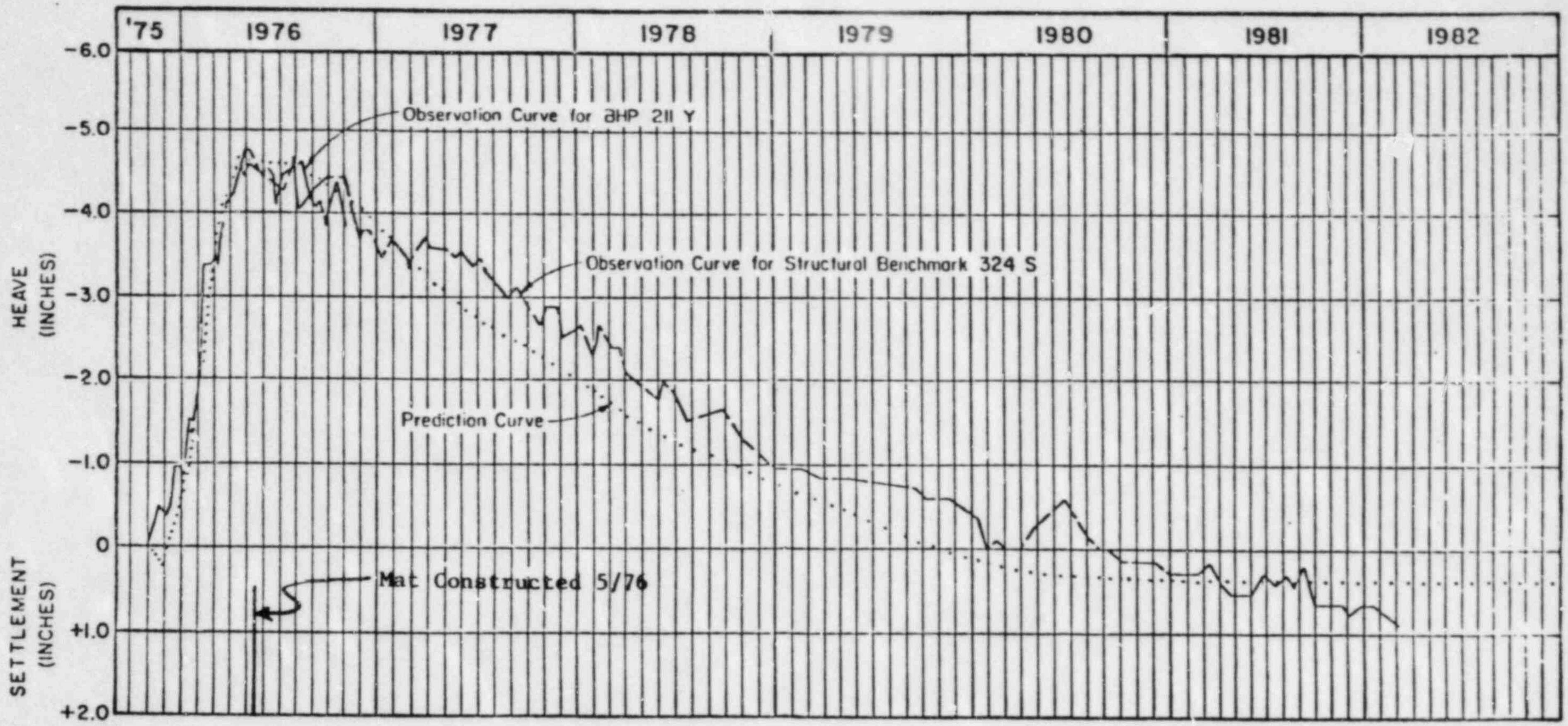
DIFFERENTIAL MOVEMENT PROFILE
WITHIN BUILDINGS
UNIT 2

FIGURE 4-6



SOUTH TEXAS PROJECT
UNITS 1 & 2

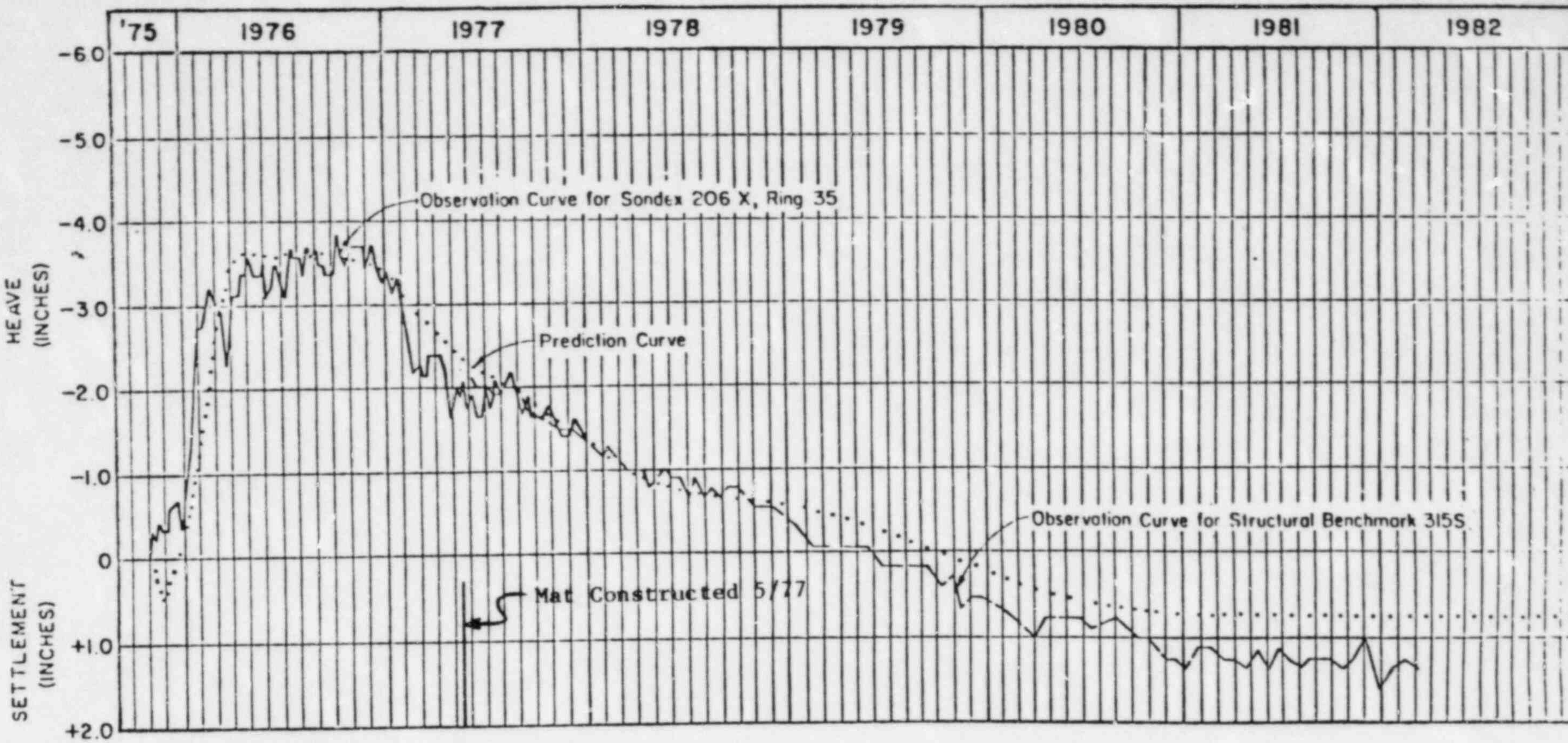
LOCATION OF DIFFERENTIAL
MOVEMENT PROFILES
FIGURE 4-7



REACTOR CONTAINMENT BUILDING

UNIT I

NOTE: Maximum predicted long term settlement of buildings after 1/2 complete = + 2.0 inches



MECHANICAL AND ELECTRICAL

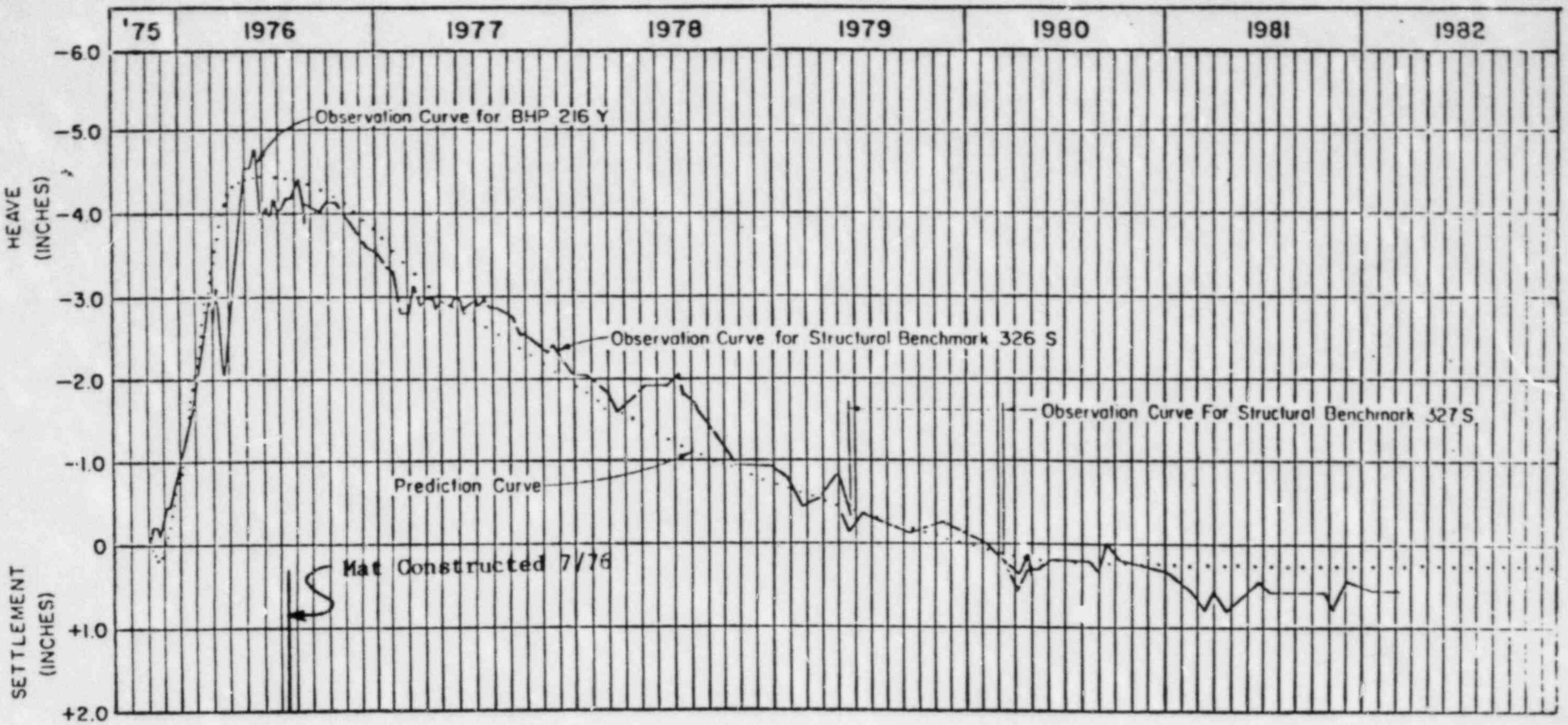
AUXILIARY BUILDING

UNIT I

NOTE: Maximum predicted long term settlement after building is 1/2 complete = + 2.1 inches

Geotechnical Instrumentation
Heave/Settlement Movement
Unit 1

FIGURE 4-9



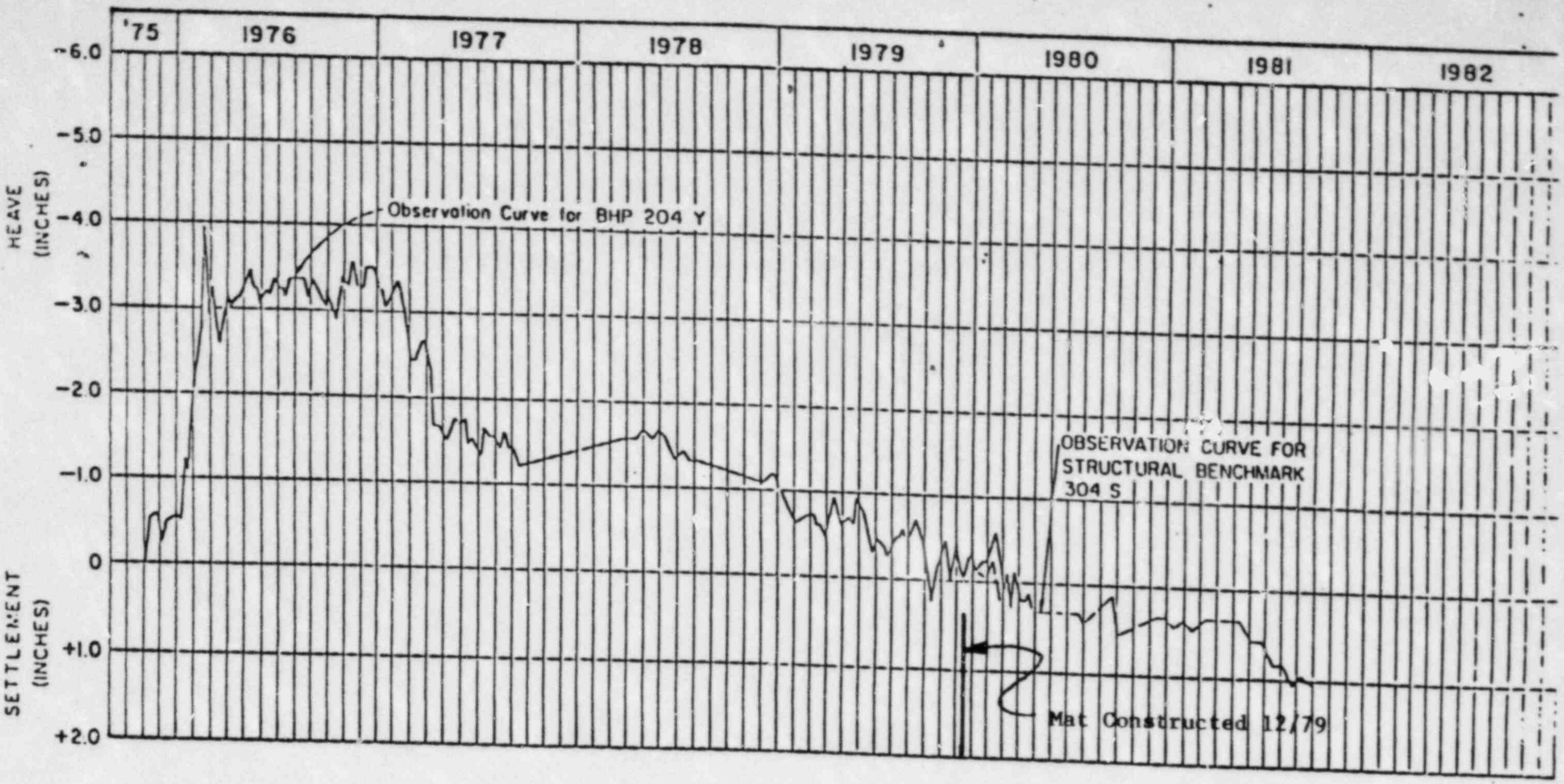
FUEL HANDLING BUILDING

NOTE: Maximum predicted long term settlement after building is 1/2 complete = + 4.8 inches

UNIT I

Geotechnical Instrumentation
Heave/Settlement Movement
Unit 1

FIGURE 4-10



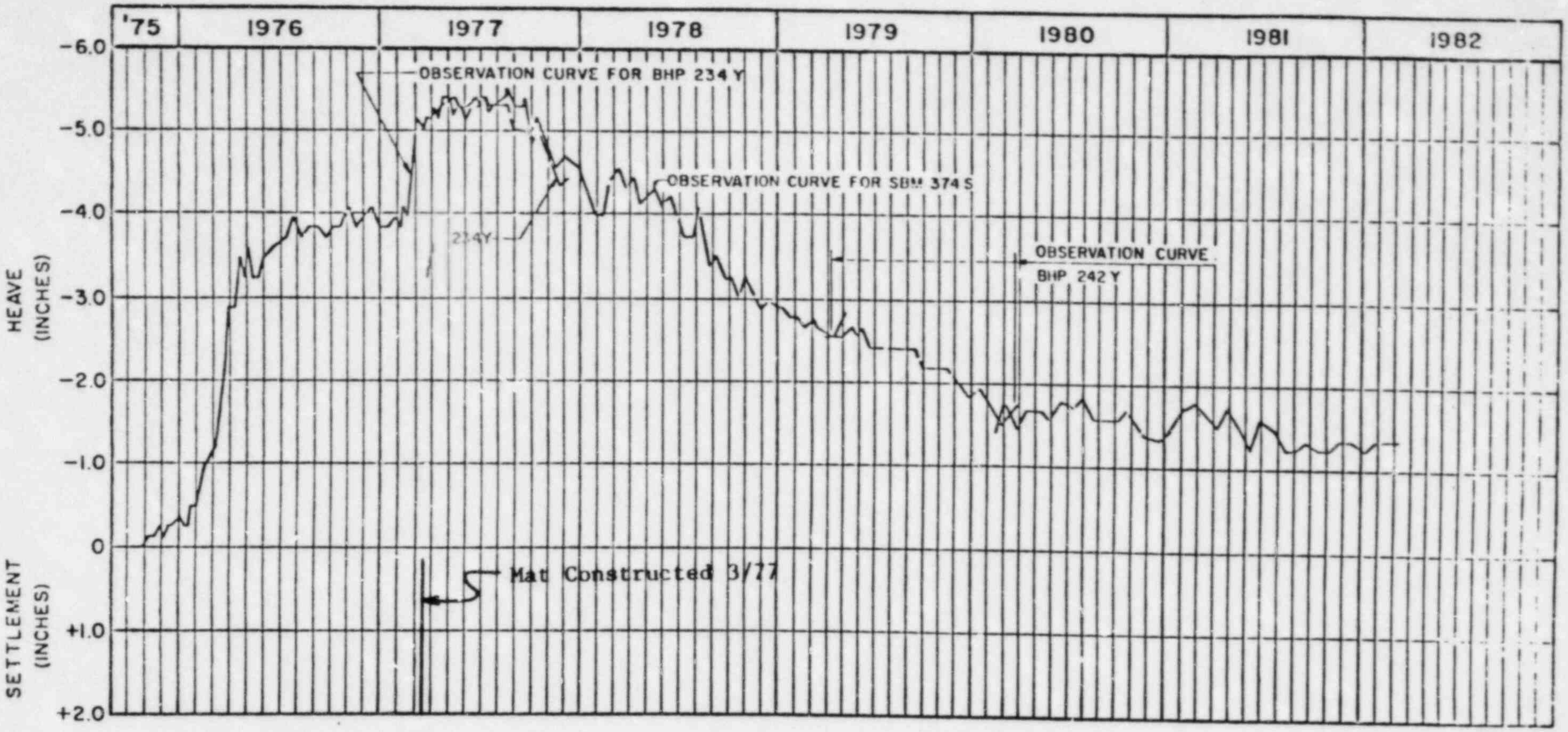
DIESEL GENERATOR BUILDING

UNIT I

NOTE: Maximum predicted long term settlement after building is 1/2 complete = + 1.6 inches

GEOTECHNICAL INSTRUMENTATION
HEAVE/SETTLEMENT MOVEMENT

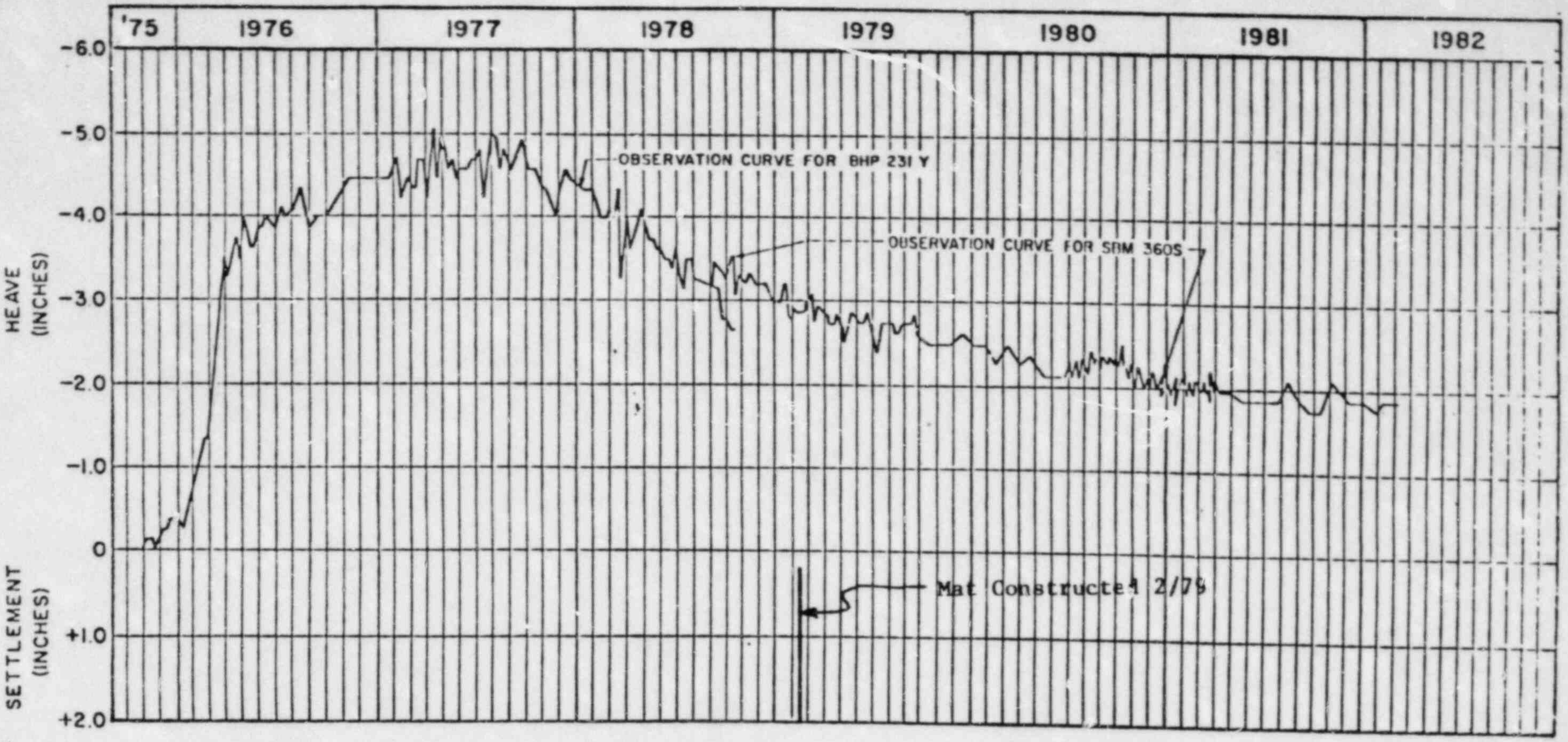
FIGURE 4-11



REACTOR CONTAINMENT BUILDING

UNIT 2

NOTE: Maximum predicted long term settlement after building is 1/2 complete = + 2.6 inches



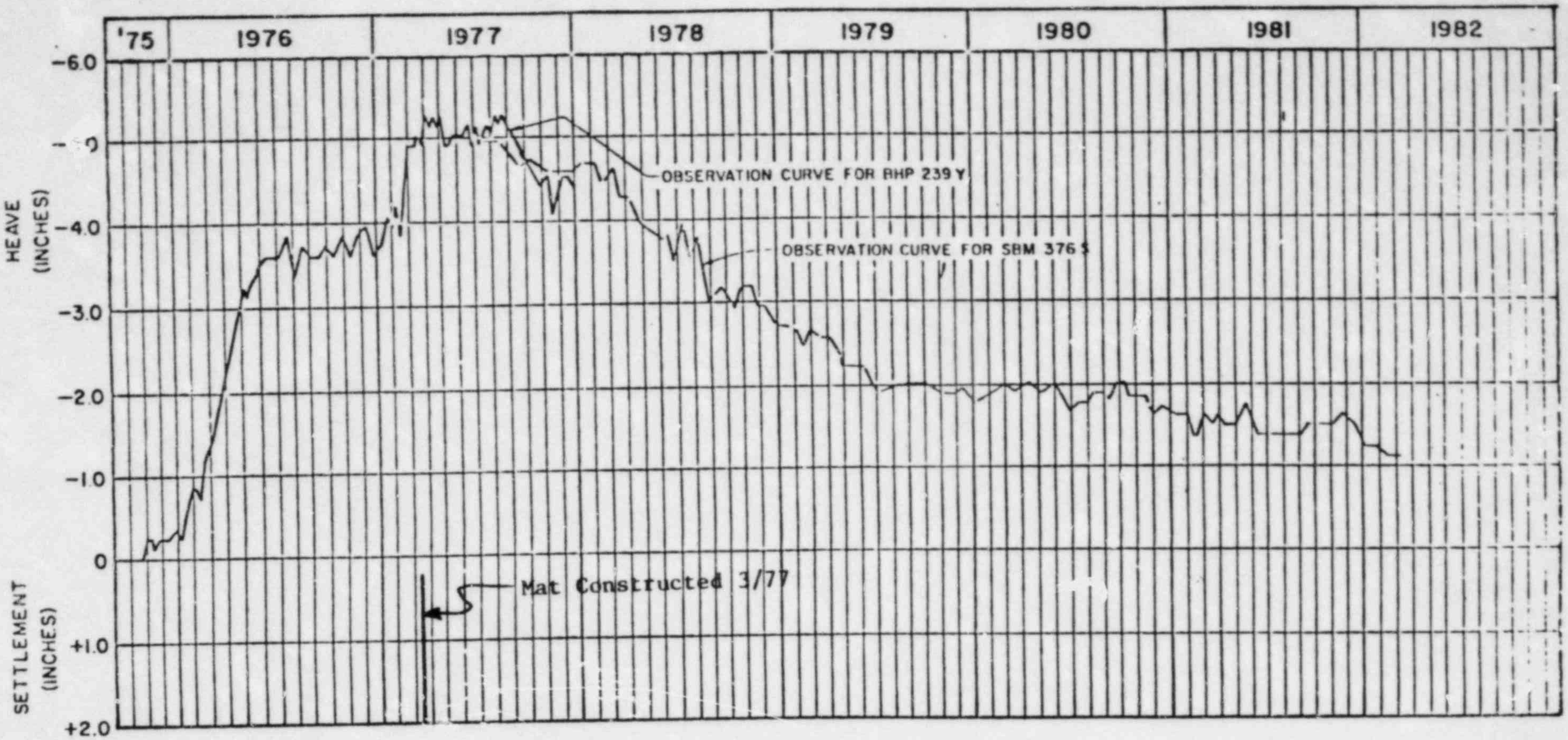
MECHANICAL AND ELECTRICAL AUXILIARY BUILDING

UNIT 2

NOTE: Maximum predicted long term settlement after building is 1/2 complete = + 1.7 inches

Geotechnical Instrumentation
Heave/Settlement Movement
Unit 2

FIGURE 4-13



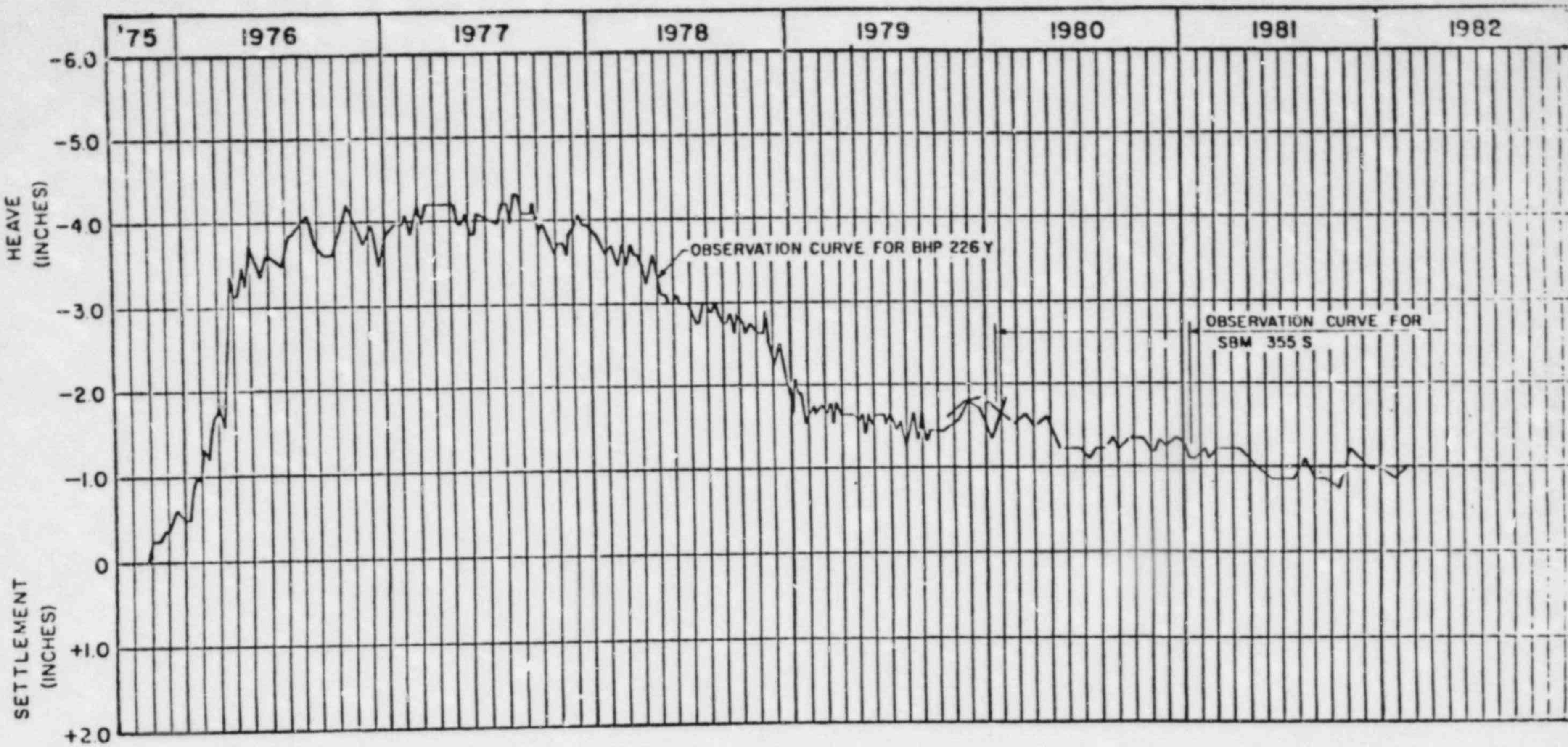
FUEL HANDLING BUILDING

UNIT 2

NOTE: Maximum predicted long term settlement after building is 1/2 complete = + 4.4 inches

Geotechnical Instrumentation
Heave/Settlement Movement
Unit 2

FIGURE 4-14



DIESEL GENERATOR BUILDING

UNIT 2

NOTE 1: Maximum predicted long term settlement after building is 1/2 complete = + 1.6 inches

NOTE 2: DGB 2 mat not poured as of 9/17/82

Geotechnical Instrumentation
Heave/Settlement Movement
Unit 2

FIGURE 4-15

TABLE 4-1

MEASURED DIFFERENTIAL SETTLEMENT

UNIT 1

BETWEEN BUILDINGS	DATE STARTED	MEASURED DIFFERENTIAL SETTLEMENT (in.) OCT. 1978	JUNE 1979	DECEMBER 1980	JUNE 1981	FEBRUARY 1982
FHB vs. RCB	July 1976	0	0.2	0.1	0.3	0.5
MEAB vs. RCB	Oct. 1977	0.1	0.3	0.3	0.0	0.1
MEAB vs. FHB	Oct. 1977	0.1	0.1	0.6	0.6	0.4
MEAB vs. DGB	Dec. 1979	-	-	0.2	0.0	0.3
IVC vs. RCB	Dec. 1977	0.6	0.6	0.1	0.2	0.1

UNIT 2

BETWEEN BUILDINGS	DATE STARTED	MEASURED DIFFERENTIAL SETTLEMENT (in.) DECEMBER 1979	DECEMBER 1980	JUNE 1981	FEBRUARY 1982
FHB vs. RCB	March 1977	0.3	0.6	0.6	0.5
MEAB vs. RCB	April 1979	0.4	0.1	0.3	0.4
MEAB vs. FHB	May 1979	0.1	0.2	0.2	0.3
MEAB vs. DGB	(1)	-	-	-	-
IVC vs. RCB	July 1979	0.3	0.2	0	(5)

NOTES: (1) No construction of DGB-2 as of February 1982.

(2) See Figure 1. for Unit 1 differential movement plots.

(3) See Figure 2. for Unit 2 differential movement plots.

(4) No Category I pipe connection has been made between buildings as of August 1982.

(5) Insufficient data for evaluation from 7/81 to 2/82.

TABLE 4-2

MEASURED END-TO-END TILT

UNIT 1

BUILDING	DIRECTION	MEASURED END-TO-END TILT (in.) OCT. 1978	JUNE 1979	DEC. 1980	JUNE 1981	FEBRUARY 1982
RCB	E-W	0.3	0.4	0.3	0.1	0.1
RCB	N-S	0	0.1	0.2	0.2	0.3
FHB	E-W	0	0	0	0	0.2
FHB	N-S	0.3	0	0.4	0.3	0.4
MEAB	E-W N Portion	0.6	0.6	0.5	0.5	0.6
MEAB	E-W S Portion	0.3	0.2	0.4	0.3	0.3
	N-S E Portion	0.4	0.7	0.5	0.5	0.4
MEAB	N-S W Portion	0	0.1	0.1	0	0.1
DGB	E-W	(1)	(1)	0	0	0
DGB	N-S	(1)	(1)	0	0	0.3

UNIT 2

BUILDING	DIRECTION	MEASURED END-TO-END TILT (in.) OCT. 1978	JUNE 1979	DEC. 1980	JUNE 1981	FEBRUARY 1982
RCB	E-W	0.2	0.3	0.2	0	0
RCB	N-S	0	0	0	0	0
FHB	E-W	0	0.1	0.2	0.2	0
FHB	N-S	0.2	0.7	0.7	0.9	0.7
MEAB	E-W N Portion	0.1	0.2	0.2	0.1	0.4
MEAB	E-W S Portion	0.2	0.2	0.7	0.3	0.3
MEAB	N-S E Portion	0.7	0.7	0.1	0.3	0.4
MEAB	N-S W Portion	0.1	0.1	0.1	0.2	0.3
DGB	E-W	(2)	(2)	(2)	(2)	(2)
DGB	N-S	(2)	(2)	(2)	(2)	(2)

. . . cont'd.

NOTES:

(1) DGB, Unit 1, construction started in December 1979.

(2) No construction of DGB, Unit 2, as of February 1982.

(3) See Figures 3 and 4 for differential movement profile within Unit 1 Buildings.

(4) See Figures 5 and 6 for differential movement profile within Unit 2 Buildings.

(5) No Category I pipe connections has been made between buildings as of August 1982.

TABLE 4-3

OVERALL TILT AND DIFFERENTIAL SETTLEMENT
MEAB-2 BUILDING

Date	Load Modification	Overall Tilt	Peak Differential Settlement	Curvature Ordinate Overall	Curvature Ordinate North Local
6/04/80	Prior to Load modification	0.7"	1"	0.65"	0.2"
8/07/80	6/30/80 8-ft excavation	0.3"	0.8"	0.6"	0.3"
9/11/80	1,533 tons add'l loads	0.22"	0.65"	0.5"	0.25"
11/25/80	2,985 tons add'l loads	0.15"	0.55"	0.45"	0.25"
2/20/81	3,878 tons add'l loads	0.15"	0.5"	0.45"	0.2"
3/30/81	4,378 tons add'l loads	0.1"	0.5"	0.45"	0.2"

Ref.: B&R Technical Reference Document, "Load Modification Surcharge Monitoring Data" 5Y310SR156-B, 1/27/82.

Item 5: Nonconforming Backfill Beneath the ECW Intake and Discharge Structure

The NRC told HL&P that they had seen a document during their site visit in April 1982 that indicated the existence of backfill below 80 percent relative density beneath the ECW intake and discharge structure. HL&P was requested to review available documentation and explain the existence of any such conditions.

RESPONSE

Nonconformance reports have been reviewed to determine whether any nonconforming conditions exist within the backfill beneath the ECW intake and discharge structures. No nonconforming conditions have been reported within the backfill beneath either the ECW intake or discharge structure foundations.

NCR S-C-7957A identified those tests within the overall backfill areas of the ECW intake and discharge structures which had relative densities below 80 percent. This is the required degree of compaction for Category I backfill for structures (70 percent relative density is required for the ECW piping). Three tests were listed, and justification for the less than 80 percent relative density was provided in the NCR for each case. According to the NCR, in one case the material in question was removed and replaced. In the second case, 70 percent relative density was required because the test was adjacent to the ECW pipeline. In the third case, a nonconforming condition identified beneath the concrete apron east of the intake structure was accepted based on an evaluation of the overall backfill condition in the area, including consideration of areas with limited access for compaction. The backfill conditions under the apron are scheduled to be reevaluated by Bechtel to ensure that all pertinent design criteria have been satisfied by the as-built backfill.