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9 December 1981
81C217-4

ENCLOSURE 3

Consumers Power Company
1945 West Parnall Road
Jackson, Michigan 49201

Attention: Dr. T. R. Thiruvengadam
Section Head - Civil Engineering
Mail Code P-14-400

Subject: Additional Test Results
Foundation Till - Perimeter Dike
Soil Boring and Testing Program
Midland Plant - Units 1 and 2

Gentlemen:

On 1 July 1981, we issued a report presenting test results for fill and foundation materials from the Perimeter and Baffle Dike Areas. Results of both index property and strength testing of the foundation till deposit were included. On 12 October 1981, Mr. Ramanujam verbally authorized the processing of the remaining tube and core samples of foundation till from the dike borings for the purpose of performing additional index property tests. Such testing was recently completed and the results are presented herein. These test results supersede a similar presentation of results given in our draft report of 20 November 1981 entitled "Preliminary Additional Test Results, Foundation Till - Perimeter Dike, Soil Boring and Testing Program, Midland Plant - Units 1 and 2."

Recent index property testing included processing of 9 tube and 5 core samples and determinations of density, water content, consistency (pocket penetrometer), liquid and plastic limits, and particle-size distribution. Results of the recently completed index property testing of foundation till samples from Perimeter Dike borings COE-2 through COE-5 are listed in Tables 1 through 4, respectively.

Consulting Engineers, Geologists
and Environmental Scientists

Offices in Other Principal Cities

8205130251 820503
PDR ADOCK 05000329
A PDR



To aid in correlating these additional data, the index property test results for foundation till previously tabulated in Appendix B of our 1 July report are also listed in the tables. Similar data for sample S-17B from Baffle Dike boring COE-7 are presented in Table 5. This sample had been previously included with the foundation till summary based on similarities of the index and strength properties of the test specimen with those of other specimens of foundation till.

The tube densities reported in these tables were calculated assuming the sample diameter was that of the inside diameter of the sampling tube. Where two densities are reported, the larger value was calculated assuming the sample diameter was that of the inside diameter of the cutting edge of the tube. Section densities were based on measurements of the sample. A list of abbreviations and symbols applicable to the laboratory testing data was previously included as Table B-0 in our 1 July report.

Foundation till samples that have been tested for strength properties are noted in Tables 1 through 5. The results of these strength tests were previously presented in Appendices D and E of our 1 July report.

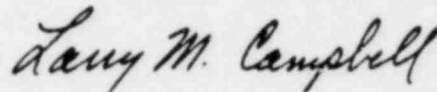
Particle-size distribution data for selected sieve sizes are summarized in Tables 1 through 5; complete particle-size distribution curves and descriptions for 15 recently tested specimens of foundation till are presented in boring-number order on Figs. 1 through 5. For completeness, particle-size distribution curves for the 12 specimens of foundation till that were previously presented in Appendix C of our 1 July report are also included on the figures.

All index property test results of the foundation till from the Dike Areas are therefore presented in this report. Ranges and averages of these data are summarized in Table 6. Ranges in gradation are similarly presented on Fig. 6. For comparison, the ranges and averages that were previously presented for foundation till in Table 3 and Fig. 3 in our 1 July report are also included in Table 6 and Fig. 6 of this report.

As shown, the ranges and averages of the index properties previously presented for the foundation till are consistent with those based on more extensive testing and further confirm the judgment in our 1 July report that strength tests on foundation till "... have been performed on test specimens considered to be representative of the range of ... material properties encountered in the dike borings."

If you have any questions regarding these additional test results, please call.

Very truly yours,



Larry M. Campbell
Project Manager

LMC:snmc

Enclosure

cc: Mr. N. Ramanujam (2 copies)
Mr. T.C. Cooke/D.E. Sibbald
Dr. S.S. Afifi, Bechtel
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81C217

Prepared by JWS

Reviewed by JML

Checked by BAH 11/19/81

Boring No. COE-2 Ground Surface Elevation (ft) 631.8

Sheet 1 of 1

Sample No	Section No	Depth (ft)	Tube			Section				Ave. PP t/ft	W %	W _L %	PI %	% Passing Sieve				Gs	Typ Eng Prop Test
			Type	Rec ft	σ_t lb/ft ²	USCS	W %	σ_t lb/ft ²	σ_d lb/ft ²					# 4	# 10	# 40	# 200		
S-14		31.3 - 33.8	PS	0.92	141.7 145.5														*
		31.5								>4.5									*
	A	31.6					10.2												*
	B	32.0				SC-SM	9.6	144.3	131.7	>4.5		18	6	97	94	86	49		*
S-15		33.8 - 35.3	PS	1.01	145.0														
	A	34.1					10.6			>4.5									
	B	34.6				CL	9.2			>4.5		22	10	96	93	86	58		
S-16		35.3 - 37.9	PS	1.47	146.3														*
	A	35.6					9.4			>4.5									*
	B	35.9					8.3			>4.5									*
	C	36.2				CL-ML	7.5			>4.5		17	6	99	97	89	51		*
	D	36.9					7.7			>4.5									*
S-17		37.8 - 40.3	PS	2.02	136.1 128.8														
	A	38.0					9.1			>4.5									
	B	38.6				SC-SM	8.7			>4.5		17	7	95	93	85	50		
	C	39.0					9.0			>4.5									
	D	39.6					8.1			>4.5									

* Data previously presented in Table B-2 of Perimeter and Baffle Dike report of 1 July 81.

MIDLAND PLANT UNITS 1 and 2 - CONSUMERS POWER CO.
LAB TESTING SUMMARY: PERIMETER and Baffle DIKES
FOUNDATION TILL
Table 1 (1/1)

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Prepared by JWS Reviewed by JMM Checked by JMM 11/19/81

Boring No. COE-3 Ground Surface Elevation (ft) 631.4

Sheet 1 of 1

MIDLAND PLANT UNITS 1 and 2 - CONSUMERS POWER CO
LAB TESTING SUMMARY: PERIMETER and BAFFLE DIKES
FOUNDATION TILL
Table 2 (1/1)

Sample ID	Section No	Depth (ft)	Tube			Section			Ave. PP t/ft	W %	W _L %	PI %	% Passing Sieve				Gs	Typ Eng Prop Test
			Type	Rec ft	σ_t lb/ft ²	USCS SYMB	W %	σ_t lb/ft ²	σ_d lb/ft ²				# 4	# 10	# 40	# 200		
S-17		35.9 - 32.4	PS	2.19	146.1 147.6													
	A	36.2					7.4			>4.5								
	B	36.6					7.2			>4.5								
	C	37.2					7.4			>4.5								
	D	37.6				ML	9.1			>4.5	15	3	100	98	93	58		
	E	38.0					8.4			>4.5								
S-18		38.4 - 32.9	PS	1.40	150.8 149.5													
	A	38.6					7.2			>4.5								
	B	39.2				CL- ML	7.2			>4.5	17	5	98	97	92	58		
	C	39.7					7.6			>4.5								
S-19		40.9 - 33.4	PS	0.92	159.6													*
	A	41.2				CL-ML	6.7	150.1	140.6		16	4	98	97	93	67	UU	*
	B	41.6					6.6											*

* Data previously reported in Table B-3 of Perimeter and Baffle Dike report of July 1981

810217

Prepared by JWS Reviewed by JML Checked by JAH 11/11/91

Boring No. COE-4 Ground Surface Elevation (ft) 632.0

Sheet 1 of 2

Sample No	Section No	Depth (ft)	Tube		Section				Ave PP t/ft	W %	W _L %	PI %	% Passing Sieve				G _s	Typ Eng Prop Test
			Type	R _{max} ft	σ _t lb/ft ²	USCS Symbol	w %	σ _t lb/ft ²					σ _d lb/ft ²	# 4	# 10	# 40		
S-17		34.5 - 35.2	PS	1.02	151.1 151.3													
	A	34.8				CL	9.4		>4.5		21	8	97	94	85	56		
	B	35.2					7.0		>4.5									
	C	35.4					5.8											
S-18		36.0 - 36.8	PS	0.67	150.8													
	A	36.2				CL-ML	4.9		>4.5		18	7						
	B	36.6				(C-SM)	5.3						90	87	78	45		
S-19		37.0 - 37.5	PS	0.65	152.3													
	A	37.2				SC-SM	5.5		>4.5		17	7	93	90	82	48		
	B	37.5					5.6		>4.5									
S-20		39.6 - 42.0	PS	0.45	143.2													
	A	39.6					6.5											
	B	39.8				CL-ML	5.2		>4.5		17	7	98	94	86	50 ⁺		
S-21		42.0 - 42.5	HR	0.5	—													Cove Sample in bag - No tests run
S-22		42.5 - 43.9	HR	1.4	—													
	A	43.4				SC-SM	7.6	150.0	139.4	>4.5	16	5	97	93	85	49		

MIDLAND PLANT UNITS 1 and 2 - CONSUMERS POWER CO.
LAB TESTING SUMMARY: PERIMETER and BAFFLE DIKES
FOUNDATION TILL
Table 3 (1/2)

Sample No	Section No	Depth (ft)	Tube			Section				Ave PP	W %	W _L %	PI %	% Passing Sieve					Typ Eng App Test
			Type	Roc ft	σ _e lb/ft ²	σ ₁ lb/ft ²	σ ₂ lb/ft ²	σ ₃ lb/ft ²	W %	σ _e lb/ft ²	σ ₁ lb/ft ²	σ ₂ lb/ft ²	σ ₃ lb/ft ²	#	#	#	#	#	
S-23		43.9-45.0	HR	1.1	—														
	A	44.4						SL-SM	7.1	150.2	140.3			96	92	84	48		
S-24		45.0-49.8	HR	4.7	—														
	B	47.6						SL-SM	7.2					97	94	85	48		
	C	48.0						(SL-SM)	7.4	150.8	140.4			97	94	86	49		
	D	49.0							7.7										
S-25		49.8-51.8	HR	1.3	—														
	A	50.4						SL-SM	9.0					96	93	85	49		

8/10/217

Prepared by JWS

Reviewed by JMC

Checked by ZH 11/19/01

Boring No. COE-5 Ground Surface Elevation (ft) 631.6

Sheet 1 of 1

Sample No	Section No	Depth (ft)	Tube			Section			Ave. FP L/ft	W %	W _L %	PI %	% Passing Sieve				G _s	Typ Eng Prop Test
			Type	R _q ft	σ_t lb/ft ²	USCS Symbol	W %	σ_t lb/ft ²	σ_d lb/ft ²				# 4	# 10	# 40	# 200		
S-14		33.0 - 32.5	PS	1.47	42.3 140.3													
	A	33.2					11.6			>4.5								
	B	33.8				CL	10.1			>4.5	23	10	99	97	89	57		
	C	34.2				ML	11.5				15	3						
S-15A		35.5 - 40.5	PQ3	5.0	-													
	B	36.2				CL-ML	6.6	150.7	141.4		18	6	97	95	89	57	2.73	CTU *
	C	37.0				CL-ML	6.5	149.6	140.5		18	6	99	95	92	58	2.74	CTU *
	F	40.0				CL-ML	6.8	150.3	140.7		17	6	98	96	90	57	2.74	CTU *
S-16		40.5 - 45.5	PQ3	5.0	-													
	A	40.8				CL-ML	7.1	150.3	140.3		18 17	6 6	94	92	87	54	2.73	CTU *
	B	41.4				CL-ML	7.5	149.6	139.1		17	5	97	96	91	57		UU *
	C	42.0				CL-ML	7.4	151.0	140.6		18	6	98	97	92	58		UU *
	D	42.9				CL-ML	7.1	149.8	139.9		17	5	99	98	93	59		UU *
	E	43.6				CL-ML	7.2	150.1	140.0		16	5	98	96	91	58		UU *
S-17		45.5 - 50.5	PQ3	4.3	-													
	B	45.1				CL-ML	7.4	148.4	138.1		16	5	98	96	91	59		Bottom 2.5 ft of sample processed upper 1.8 ft resealed
	C	48.6					7.9	152.7	141.5	>4.5								
	D	49.0				CL-ML				>4.5	15	4						
	E	49.5					7.7			>4.5								

* Data previously reported in Table B-5 of Perimeter and Baffle Dike report of 1 July 1981

MIDLAND PLANT UNITS 1 and 2 - CONSUMERS POWER CO.
LAB TESTING SUMMARY: PERIMETER and Baffle Dikes
Table 4 (1/1)
FOUNDATION TILL

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Sheet 1 of 1

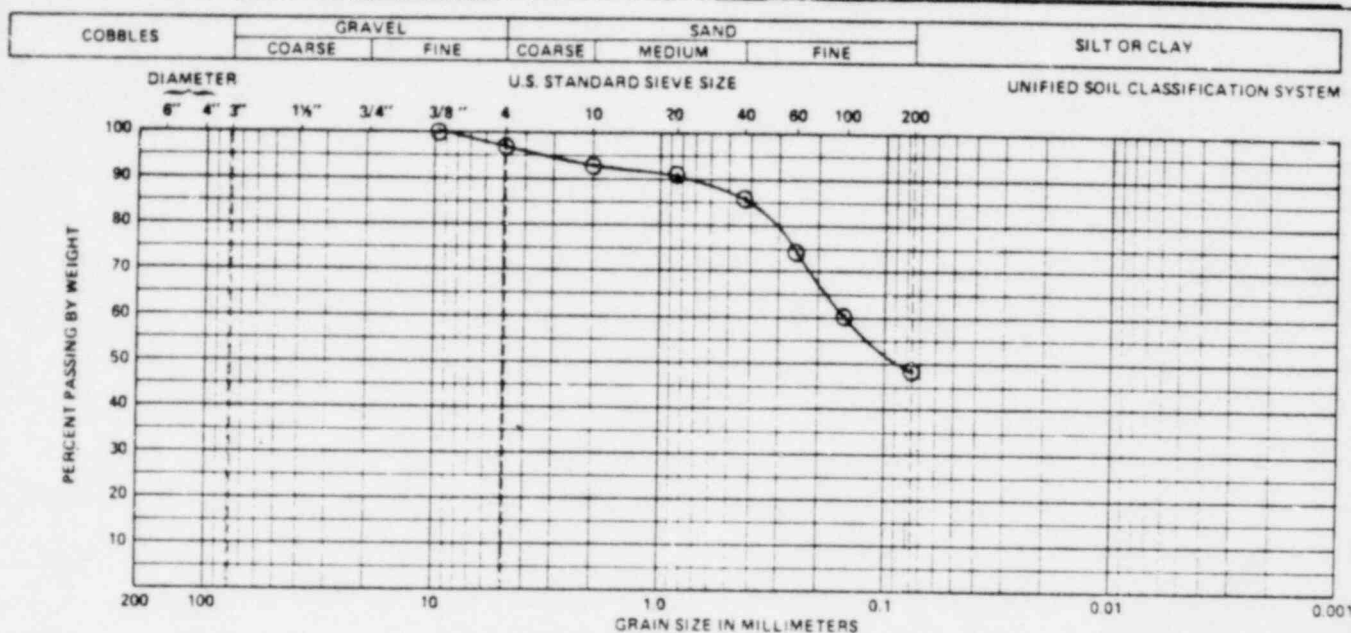
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* Data previously reported in Table B-7 of Perimeter and Baffle Dike report of 1 July 1981

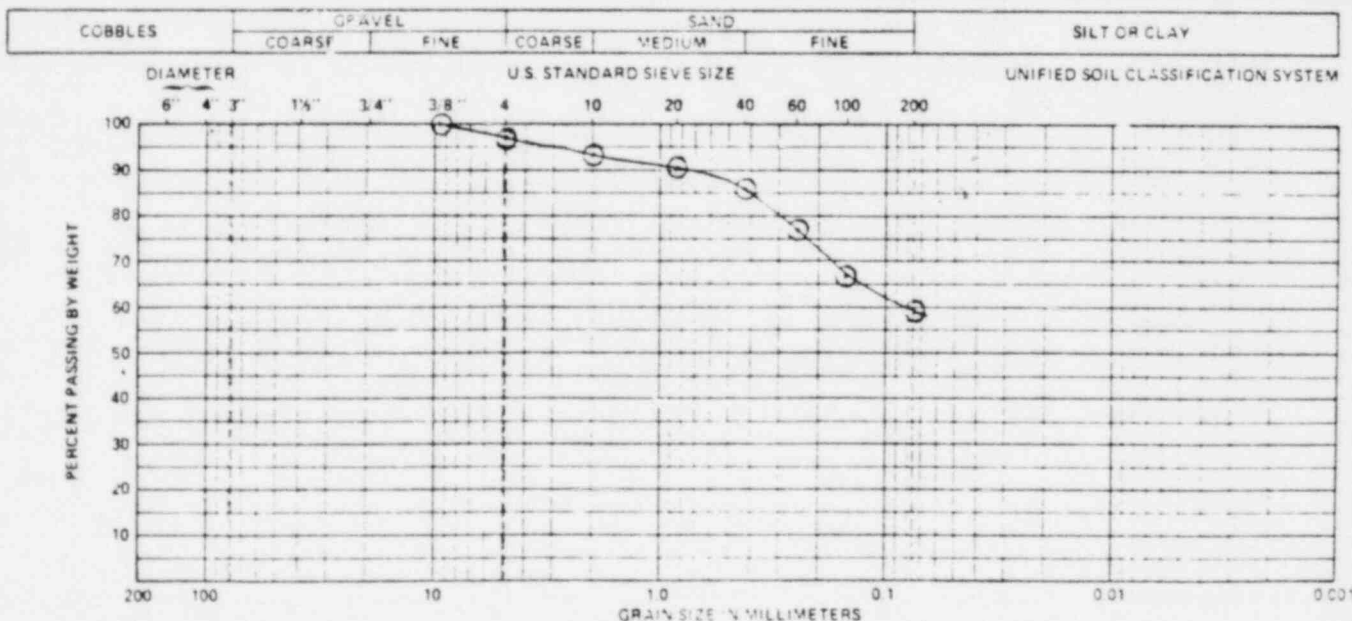
MIDLAND PLANT UNITS 1 and 2 - CONSUMERS POWER CO
LAB TESTING SUMMARY: EERIMETER and BAFFLE DIKES
FOUNDATIONS TILL
Table 5 (1/1)

REVIEWED BY WCC LR-101 (8/90) *June* *Discussed by: S-SHP 29 JUNE '91*

PARTICLE-SIZE DISTRIBUTION



BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)
COE-2	S-14-B	32.0	⊙	SC-SM, mottled gray and brown, s.p. clayey silty f. SAND, some f. gravel to m. sand	9.6	18	12

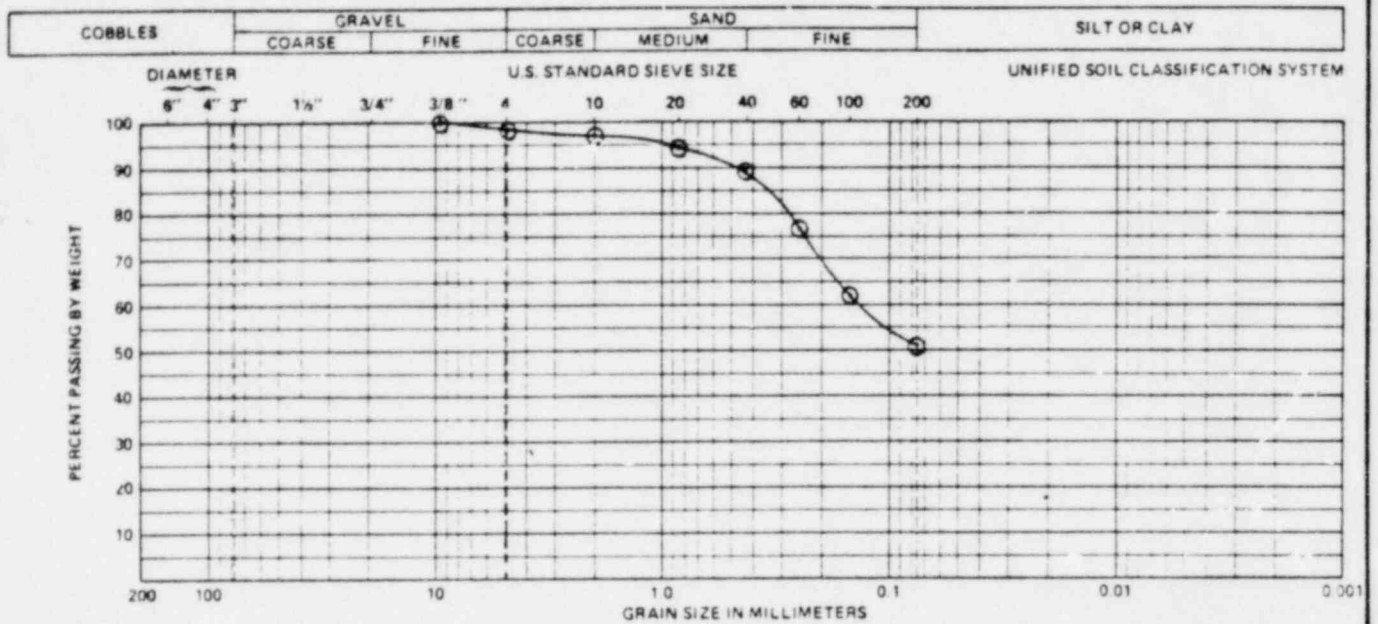


BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)
COE-2	S-15-B	34.6	⊙	CL, brown, f. sandy, sp. to m.p., silty CLAY, trace f. gravel, trace c. to m. sand	9.2	22	12

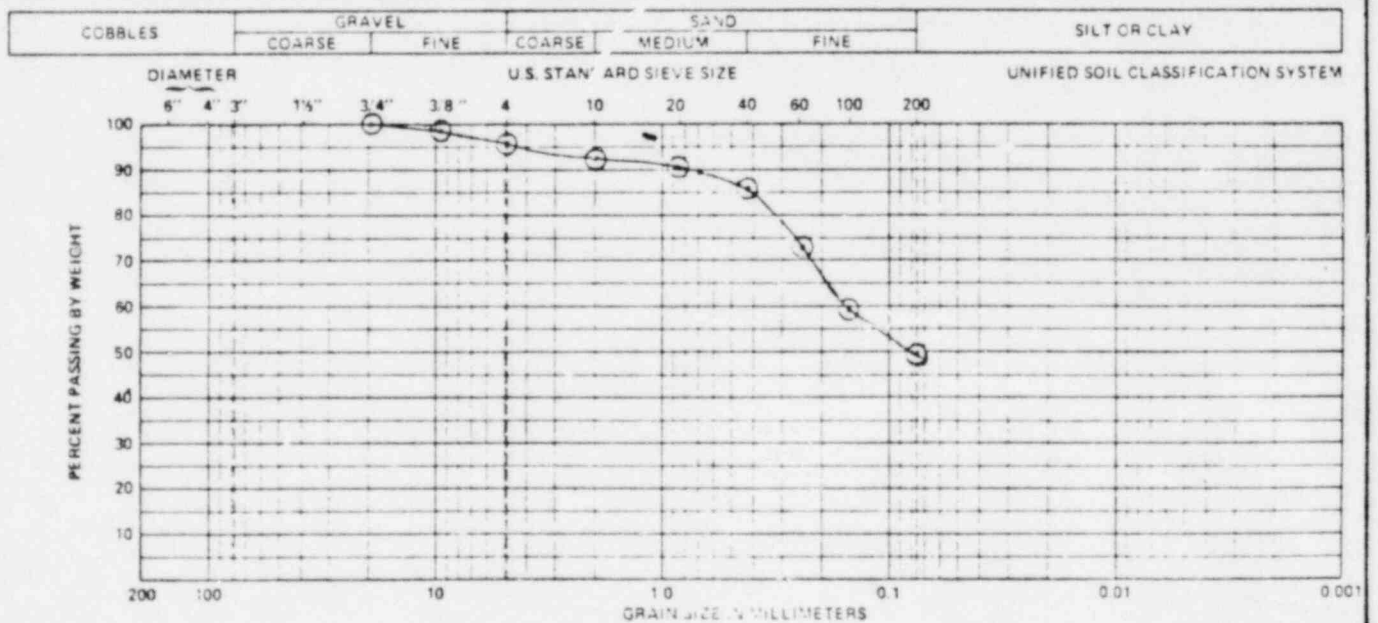
F31 (1/2)

REVIEWED BY WCC LR-101 (8/90) *JWS*

PARTICLE-SIZE DISTRIBUTION



BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)
COE-2	S-16-C	36.2	○	CL-MH, mottled gray and brown, f. sandy, s.p. silty CLAY, tr. c. to fine sand, acc. f. gravel	7.5	17	11



BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)
COE-2	S-17-B	38.6	○	SC-SM, gray, s.p. clayey, silty f. SAND, trace f. gravel, trace c. to m. sand	8.7	17	10

CHECKED BY M.D. 15 JUNE 81

REVIEWED BY WCC LR 101 (JUN 81)

IAH

PROJECT NO. C-217 DRAWN BY:

Thus

REVIEWED BY WCC (A-101) (9/90)



PROJECT NO. 210 217 DRAWN BY:

Grain size distribution curve for a soil sample. The graph plots Percent Passing by Weight (0-100) against Grain Size in Millimeters (200 to 0.075) on a semi-logarithmic scale. The curve shows a soil that is mostly sand and fine gravel, with a significant portion passing the No. 20 sieve (95% passing) and a smaller portion passing the No. 100 sieve (70% passing).

Grain Size (mm)	U.S. Standard Sieve Size	Percent Passing (%)
200	No. 10	100
100	No. 20	100
75	No. 20	100
60	No. 25	100
42.5	No. 40	95
30	No. 60	82
25	No. 60	70
150	No. 100	60

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Fig. 2 (1/2)

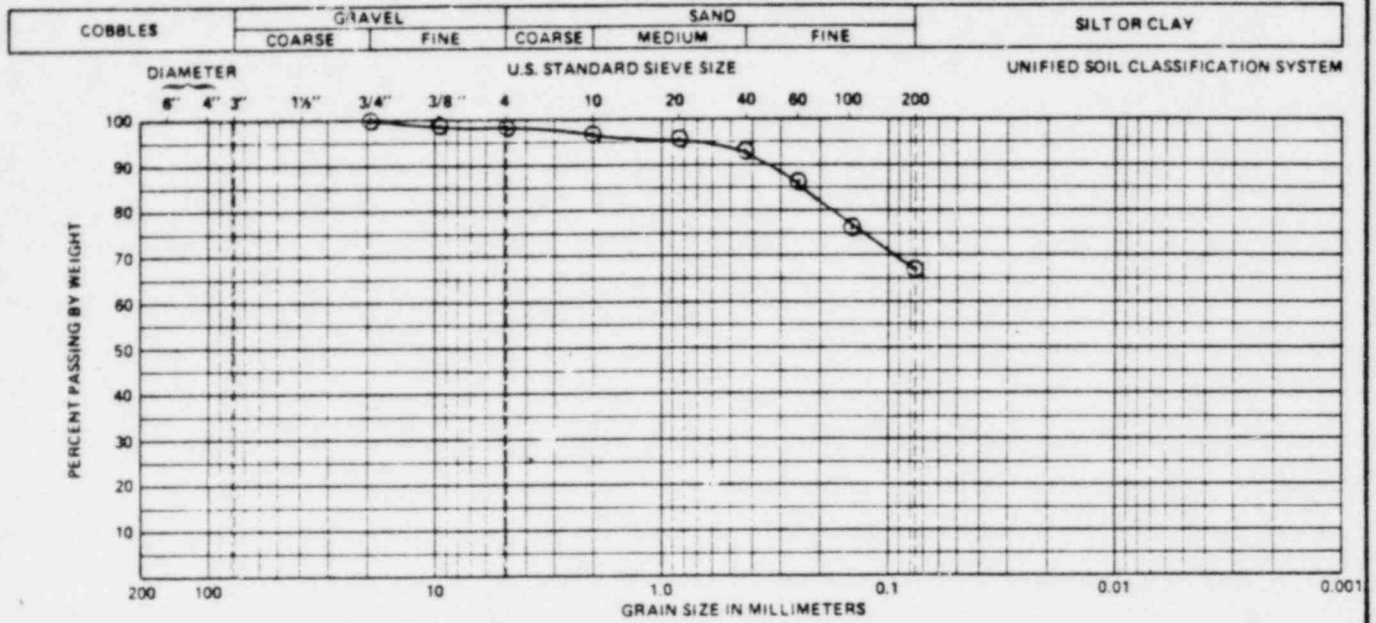
Prepared by JWS Rvw: *luc* Checked by *GAH* 11/20/81

	Testing of 6 Samples ^①			Testing of 20 samples		
TYPICAL MATERIAL DESCRIPTION	CL-ML, gray, f. sandy, slightly plastic, silty CLAY, trace f. gravel, trace c. to m. sand, occ. c. gravel					
TEST TYPE	NUMBER OF TESTS	DATA RANGE	DATA AVERAGE	NUMBER OF TESTS	DATA RANGE	DATA AVERAGE
Tube Density γ_T in lb/ft ³	4	141.7 - 159.6	148.2	13	136.1 - 159.6	147.2
Saction Total Density γ_T in lb/ft ³	11	144.3 - 151.0	149.2	16	144.3 - 152.7	149.6
Section Dry Density γ_d in lb/ft ³	11	131.7 - 141.4	138.9	16	131.7 - 141.5	139.2
Water Content w in %	19	6.5 - 10.2	8.0	54	4.9 - 11.6	7.9
Pocket Penetrometer PP in ton/ft ²	4	all >4.5	>4.5	39	all >4.5	>4.5
Liquid Limit w_L in %	13	16 - 22	18	29	15 - 23	17
Plasticity Index PI in %	13	4 - 8	6	29	3 - 10	6
% Passing #4 Sieve	12	94 - 99	97.8	27	90 - 99	97.0
% Passing #10 Sieve	12	92 - 98	95.8	27	87 - 98	94.6
% Passing #40 Sieve	12	86 - 93	90.1	27	78 - 93	87.9
% Passing #200 Sieve	12	49 - 67	56.8	27	45 - 67	54.2

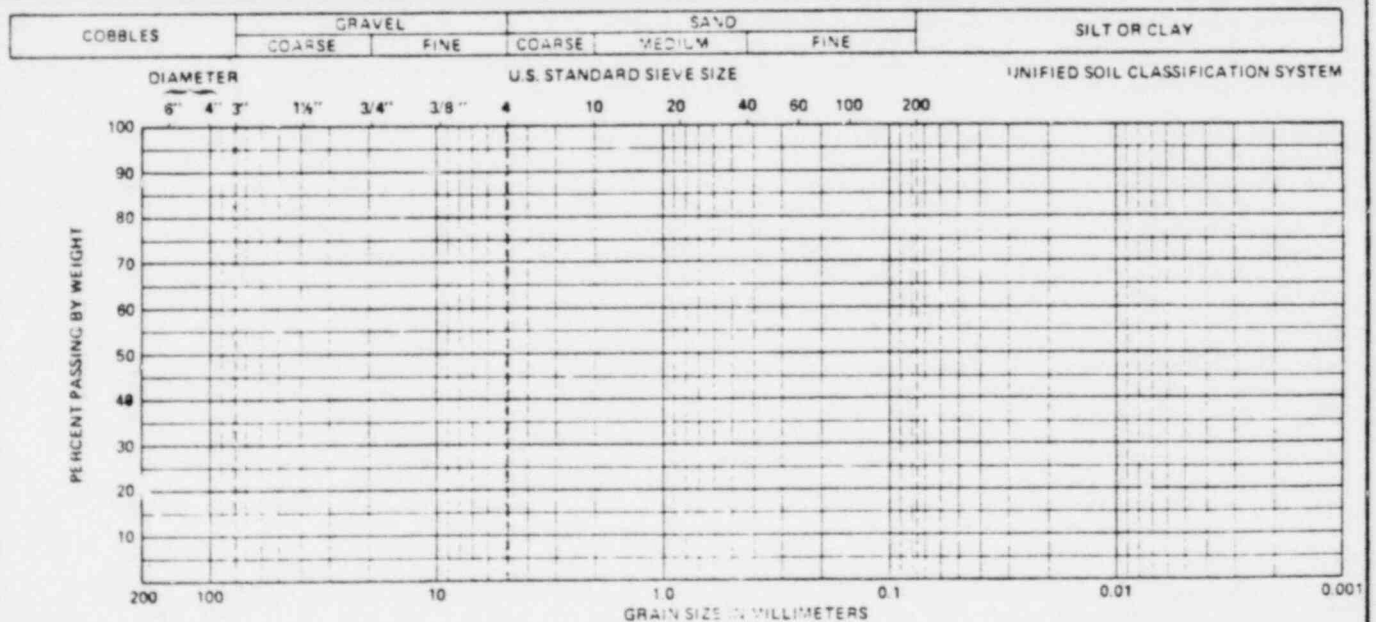
① Data previously presented in Table 3 of Perimeter and Baffle Dike report of 1 July 1981.

MIDLAND PLANT UNITS 1 and 2 - CONSUMERS POWER CO.
INDEX PROPERTY SUMMARY - PERIMETER and BAFFLE DIKES
FOUNDATION TILL
TABLE 6

PARTICLE-SIZE DISTRIBUTION



BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)
COE-3	S-19-A	41.2	⊙	CL-MI, gray, f.p. silty CLAY, some f. sand tr. f. gravel to m. sand - UH spec	6.7	16	12



BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)

Fig 2 (2/2)

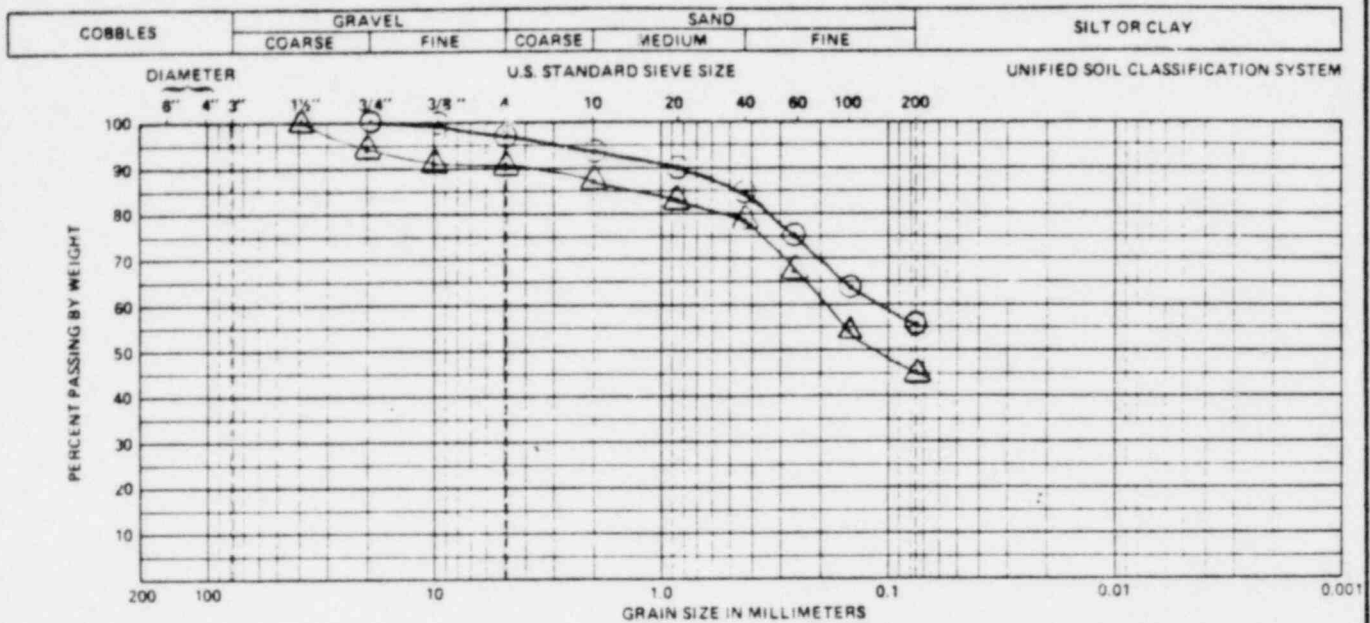
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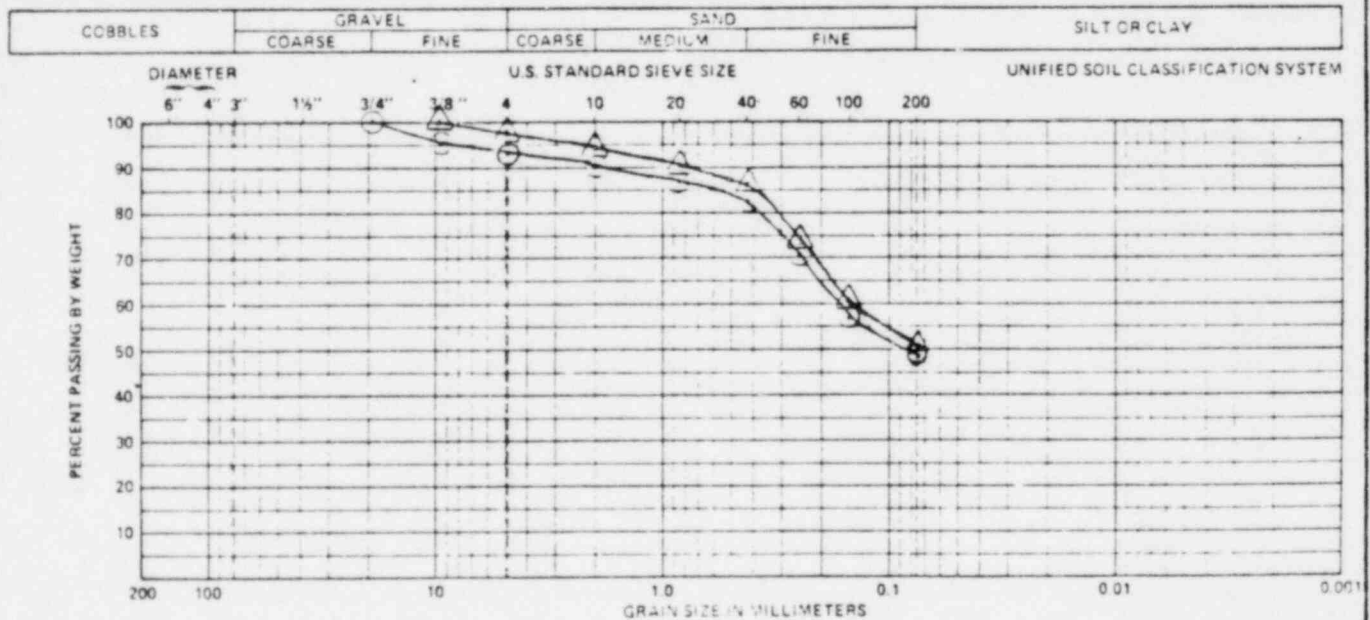
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PARTICLE-SIZE DISTRIBUTION



BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)
COE-4	S-17-A	34.8	⊙	CL, brown, f. sandy, s.p., silty CLAY, trace f. gravel, trace f. to m. sand	9.4	21	13
COE-4	S-18-B	36.6	Δ	SC-SM, gray-brown, s.p., clayey, silty fine SAND, trace gravel, trace c. to m. sand	5.3	(18)	(11)



BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)
COE-4	S-19-A	37.2	⊙	SC-SM, mottled brown and gray, s.p., clayey, silty fine SAND, trace f. gravel, trace c. to m. sand	5.5	17	10
COE-4	S-20-B	39.8	Δ	CL-ML, gray-brown, f. sandy, s.p., silty CLAY, trace f. gravel, trace c. to m. sand	5.2	17	10

Fig. 3 (1/3)

JWS

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WCC

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PARTICLE-SIZE DISTRIBUTION

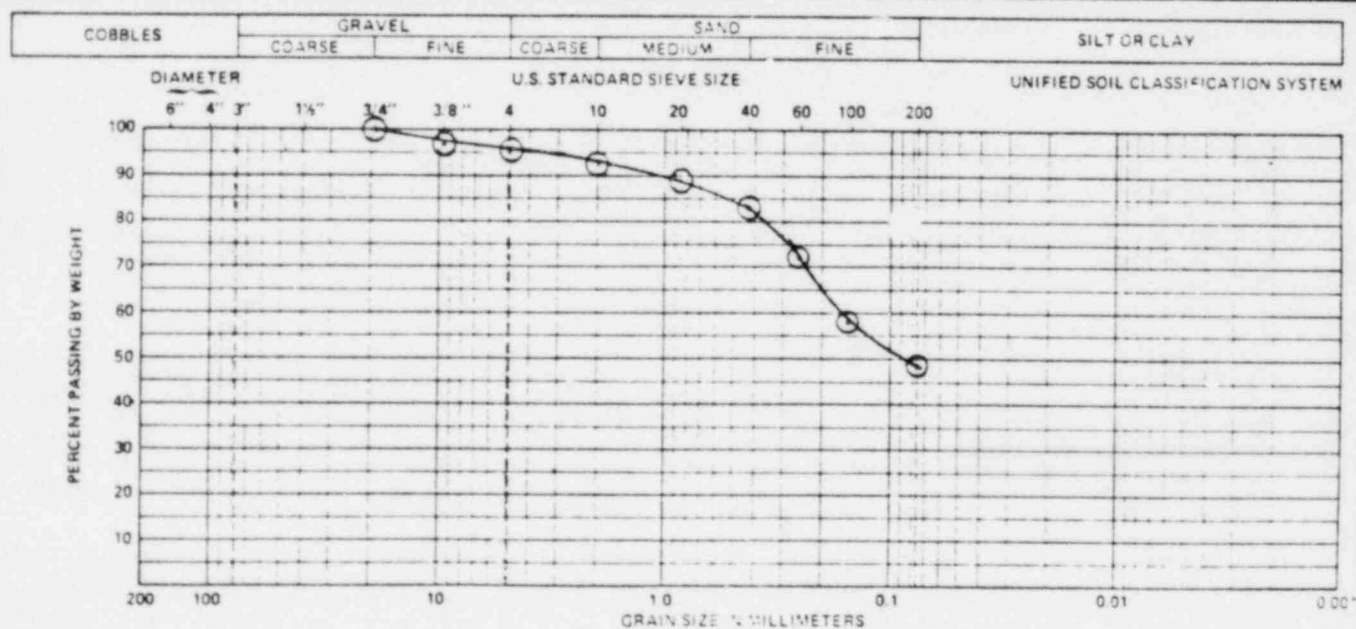
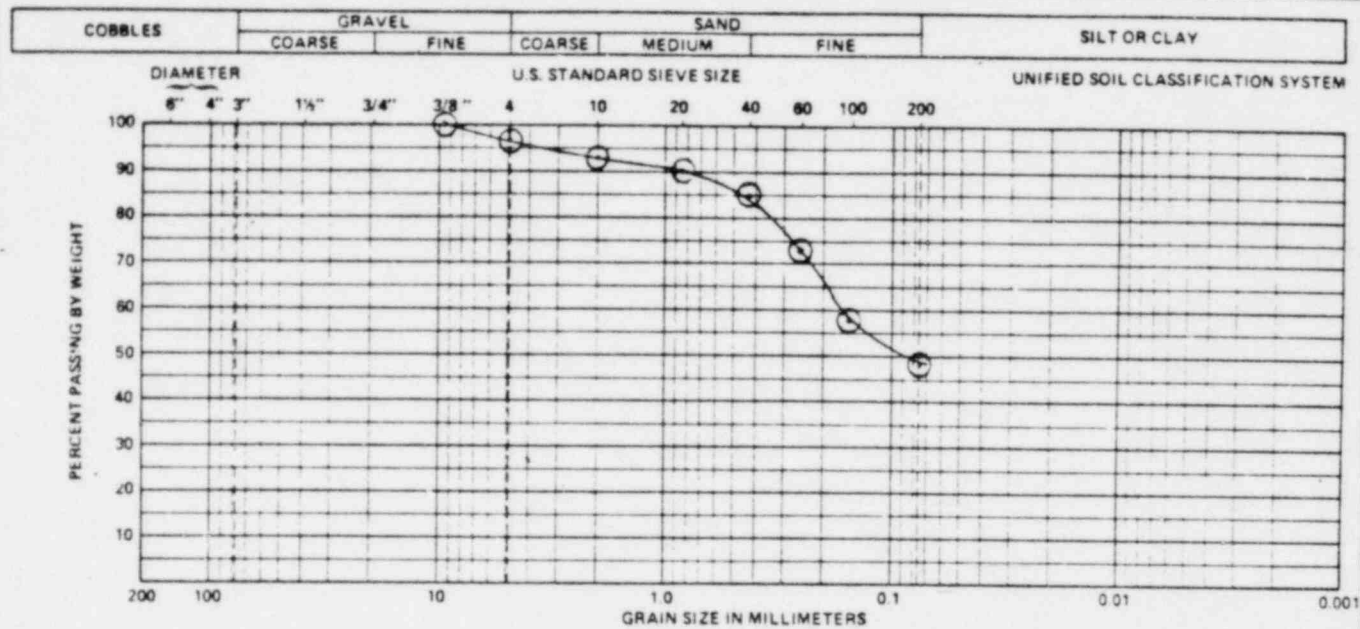


Fig. 3 (2/3)

REVIEWED BY WCC LR-101 (8/80) 8/11/11-17-81

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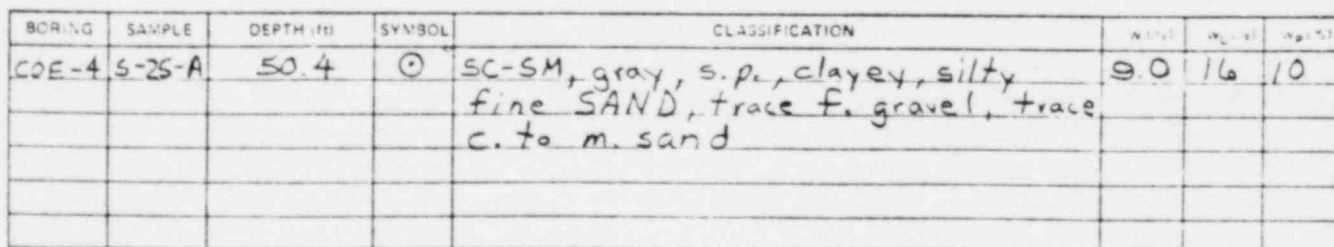
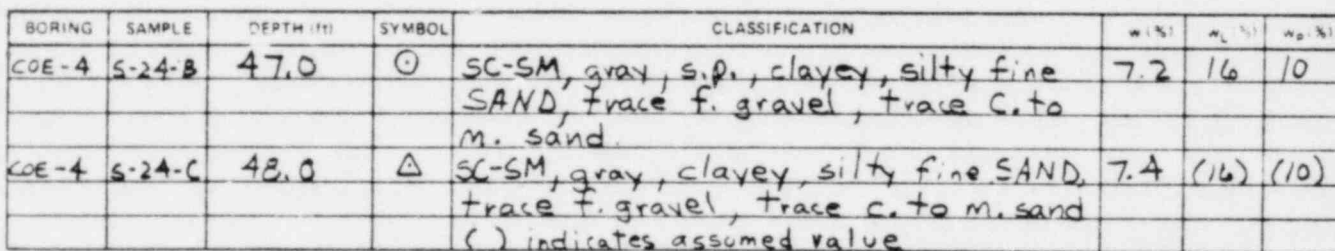
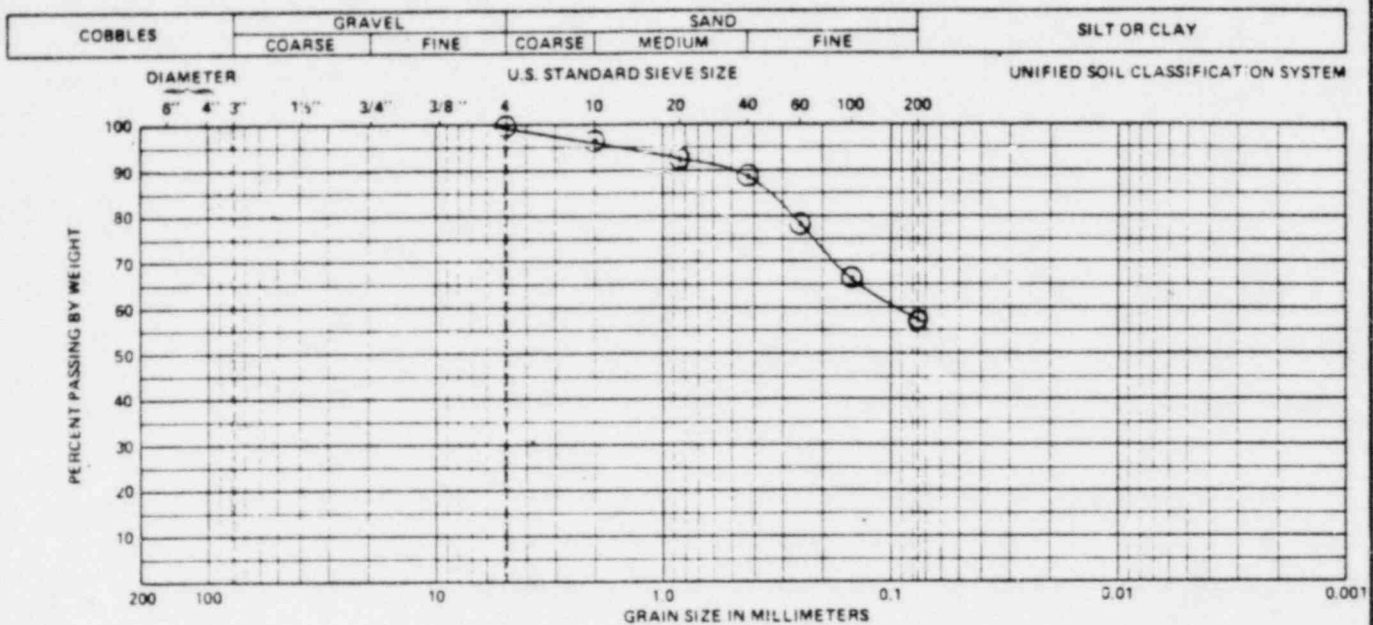
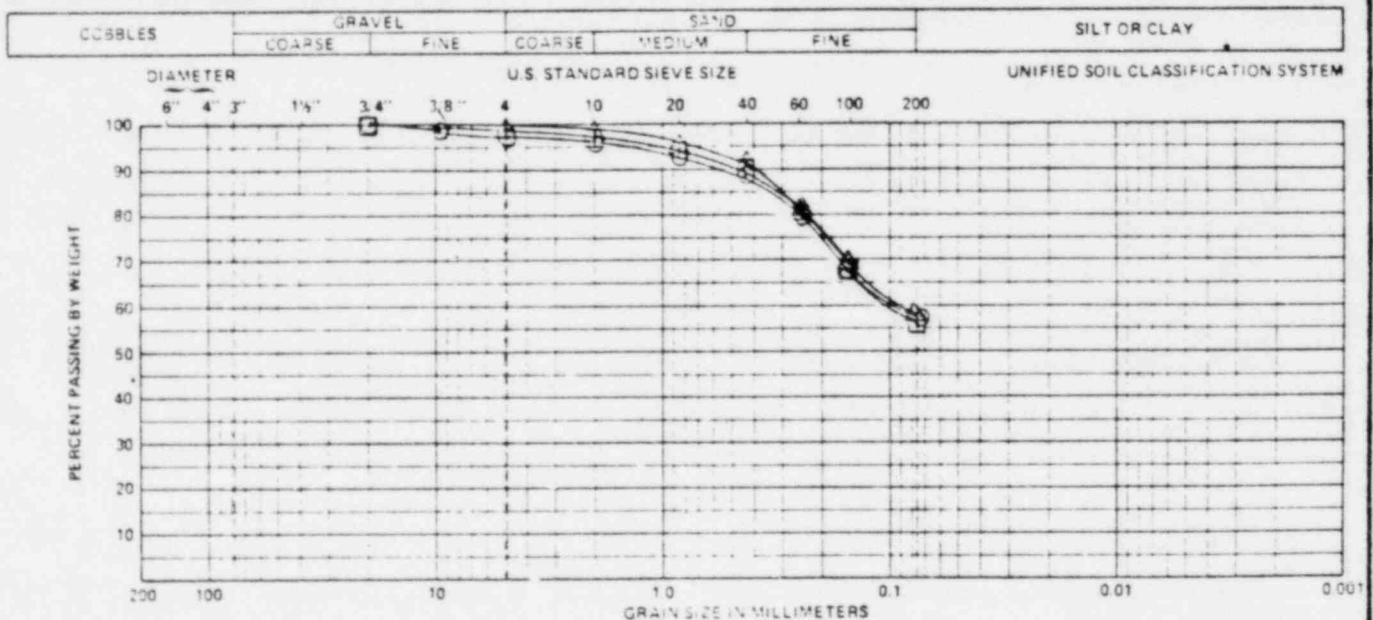


Fig. 3 (3/3)

PARTICLE-SIZE DISTRIBUTION

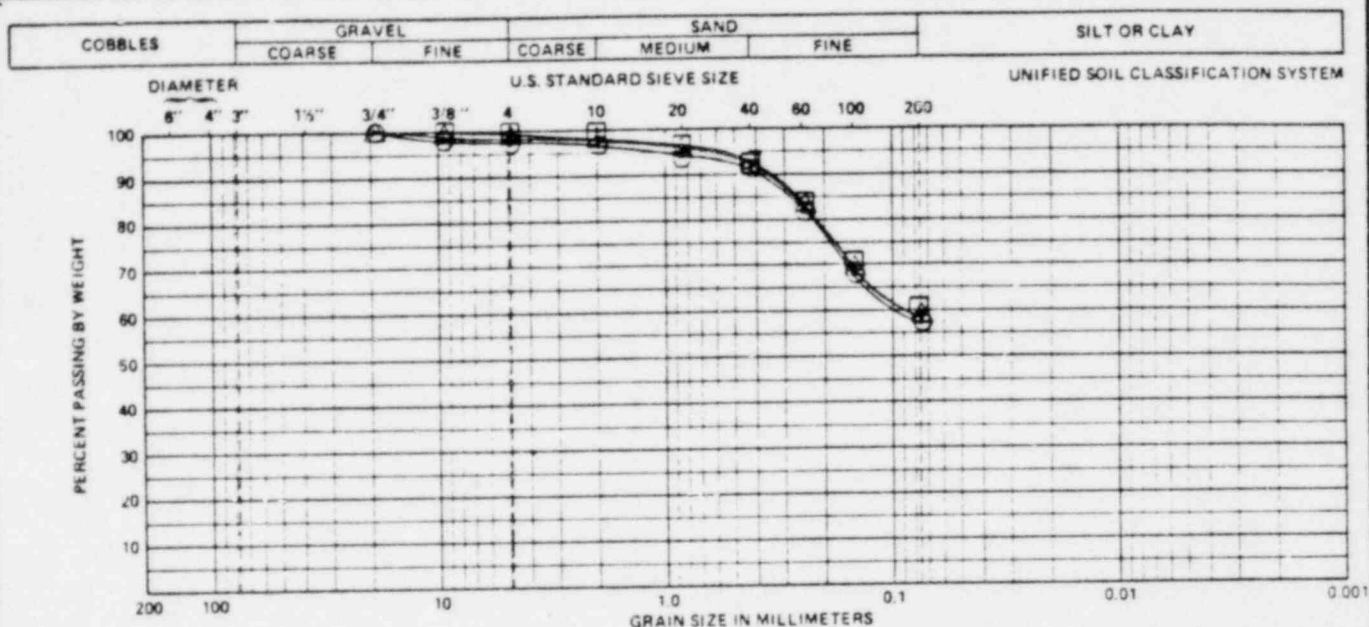


BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)
COE-5	S-14-B	33.8	○	CL, brown, f. sandy, sp. to m.p. silty CLAY, trace f. gravel to m. sand.	10.1	23	13

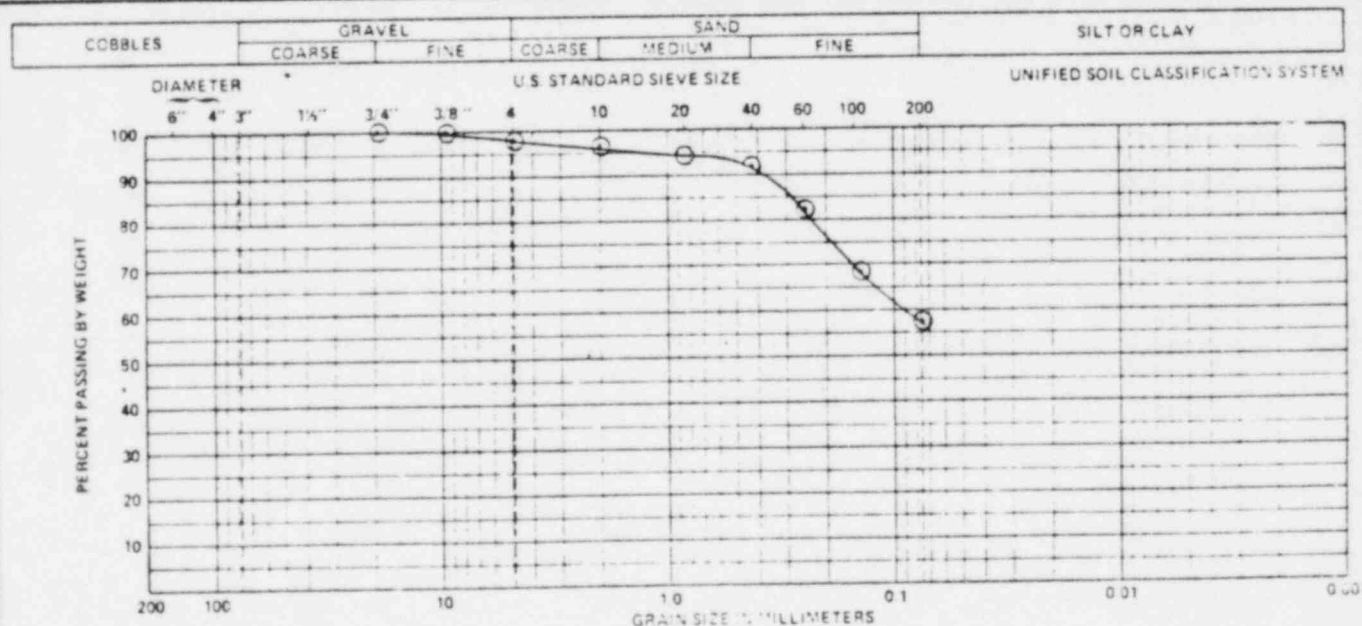


BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)
COE-5	S15A-B	36.2	○	CL-MI, mottled brown and gray, f. sandy, sp. silty CLAY, tr. m. sand - CH spec.	6.6	18	12
COE-5	S15A-C	37.0	△	CL-MI, brown, f. sandy, sp. silty CLAY, tr. f. gravel to m. sand - CH spec.	6.5	18	12
COE-5	S15A-F	40.0	□	CL-MI, mottled brown and gray, f. sandy, sp. silty CLAY, tr. m. sand - CH spec.	6.8	17	11

PARTICLE-SIZE DISTRIBUTION



BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)
COE 5	S-16-B	41.4	⊙	CL-ML, gray, f. sandy, s.p. silty CLAY, tr f. gravel to m. sand - UU spec	7.5	17	12
COE 5	S-16-C	42.0	△	CL-ML, gray, f. sandy, s.p. silty CLAY, tr f. gravel to m. sand, occ. g. gravel - UU spec	7.4	18	12
COE 5	S-16-D	42.9	□	CL-ML, gray, f. sandy, s.p. silty CLAY, tr f. gravel to m. sand - UU spec	7.1	17	12



BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)
COE 5	S-16-E	43.6	⊙	CL-ML, gray, f. sandy, s.p. silty CLAY, tr f. gravel to m. sand - UU spec	7.2	16	11

Fig 4 (2/3)

CHECKED BY DTB 19 JUNE 81

REVIEWED BY WCC LR-101 (8/80)

PROJECT NO BIC 405573 DRAWN BY PRF

PARTICLE-SIZE DISTRIBUTION

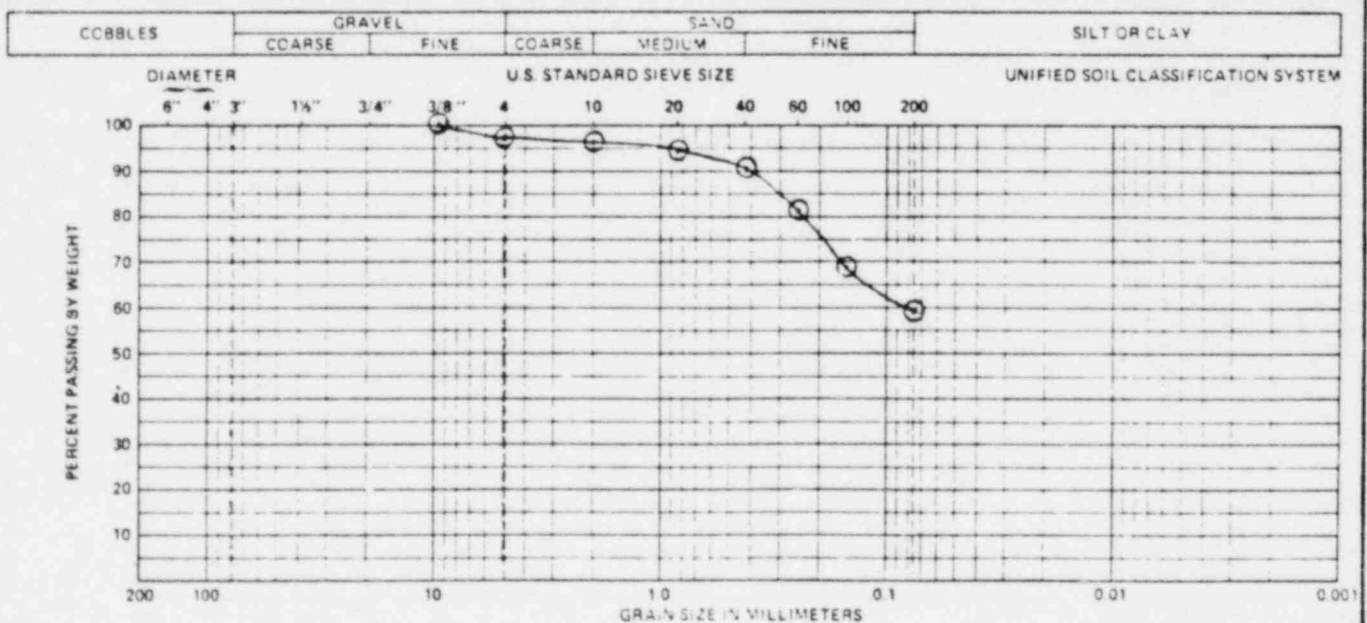
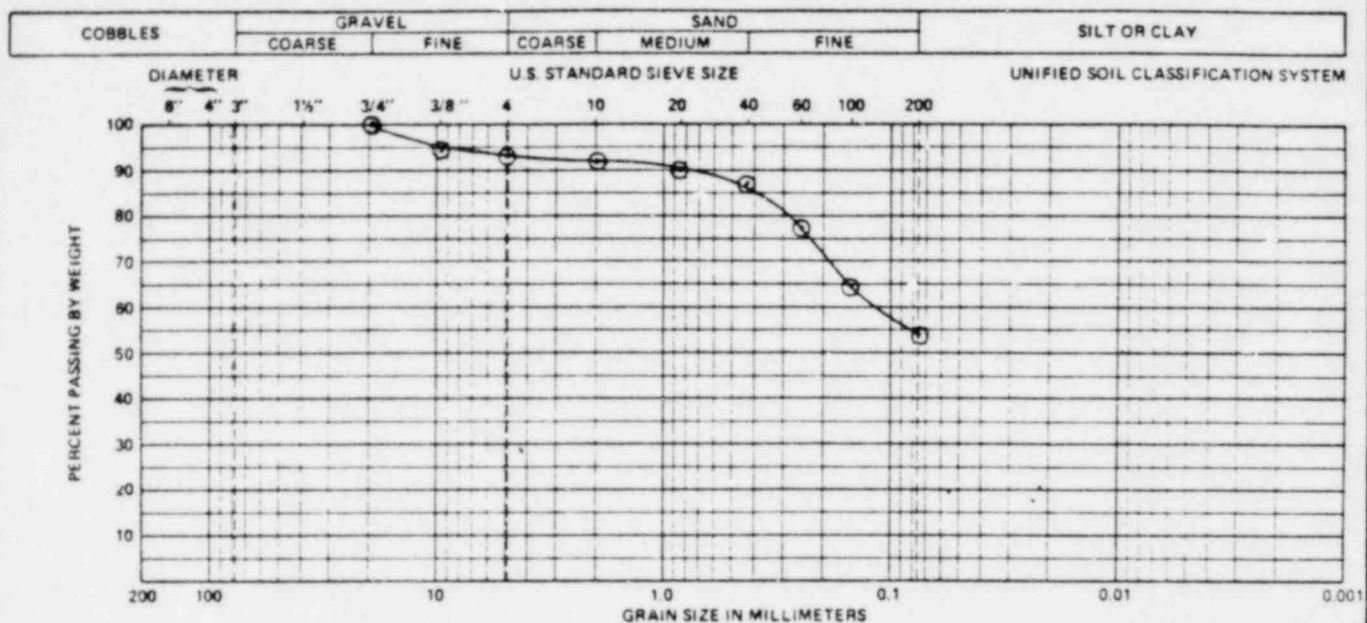


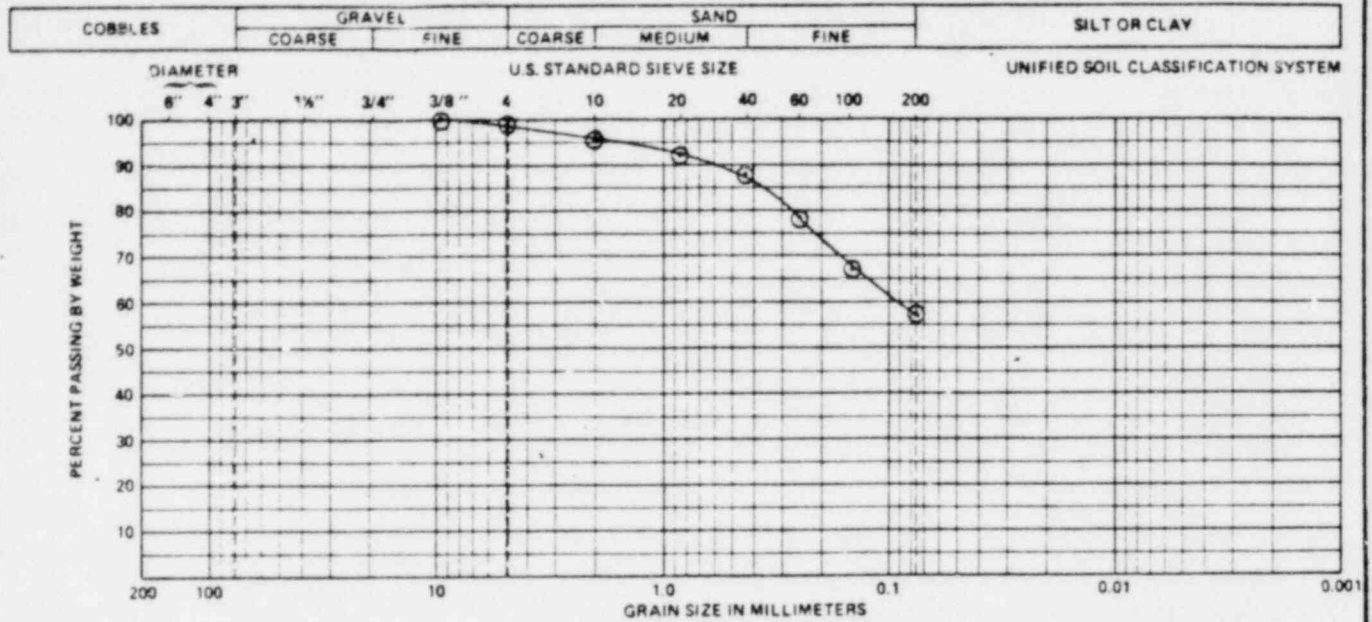
Fig 4 (3/3)

CHECKED BY JTB 10 JUNE 81

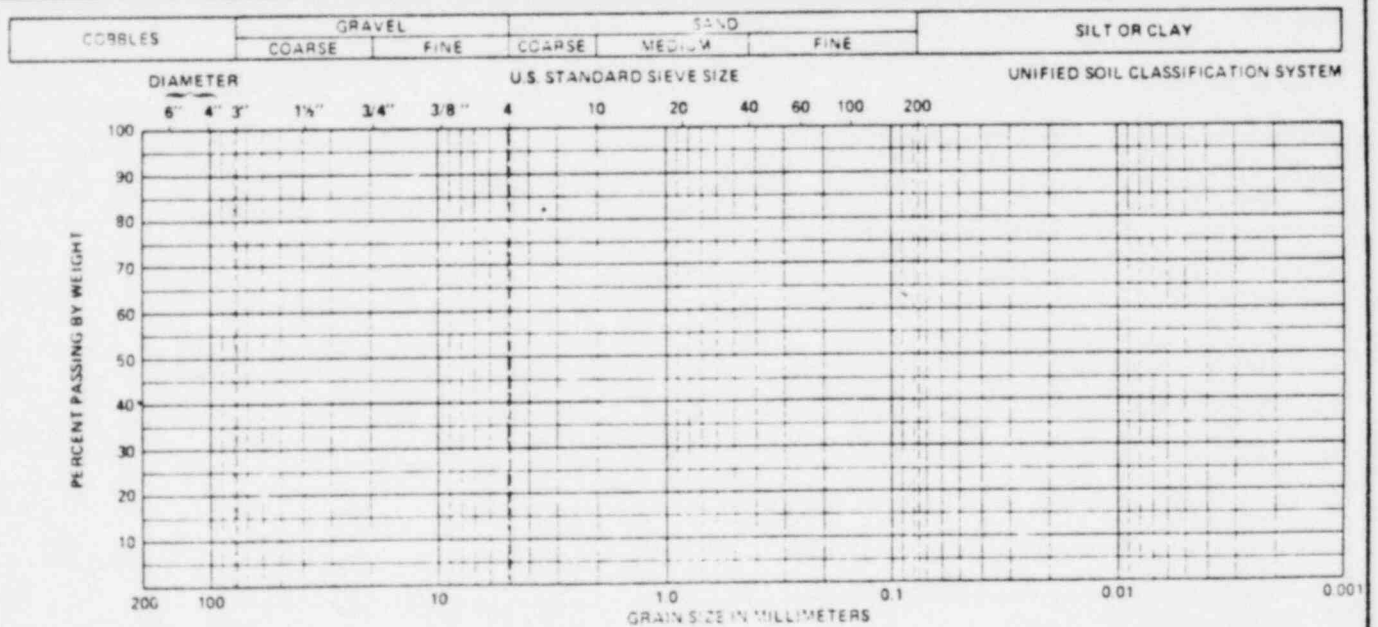
REVIEWED BY WCC LR-101 (8/80) June

PROJECT NO BIC217 DRAWN BY JTB

PARTICLE-SIZE DISTRIBUTION



BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)
COE 7	S-17-B	31.2	⊙	CL, brown f. sandy, s.p. silty CLAY, fr. f. gravel to m. sand - ULL spec.	9.7	22	14



BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)

Fig. 5 (1/1)

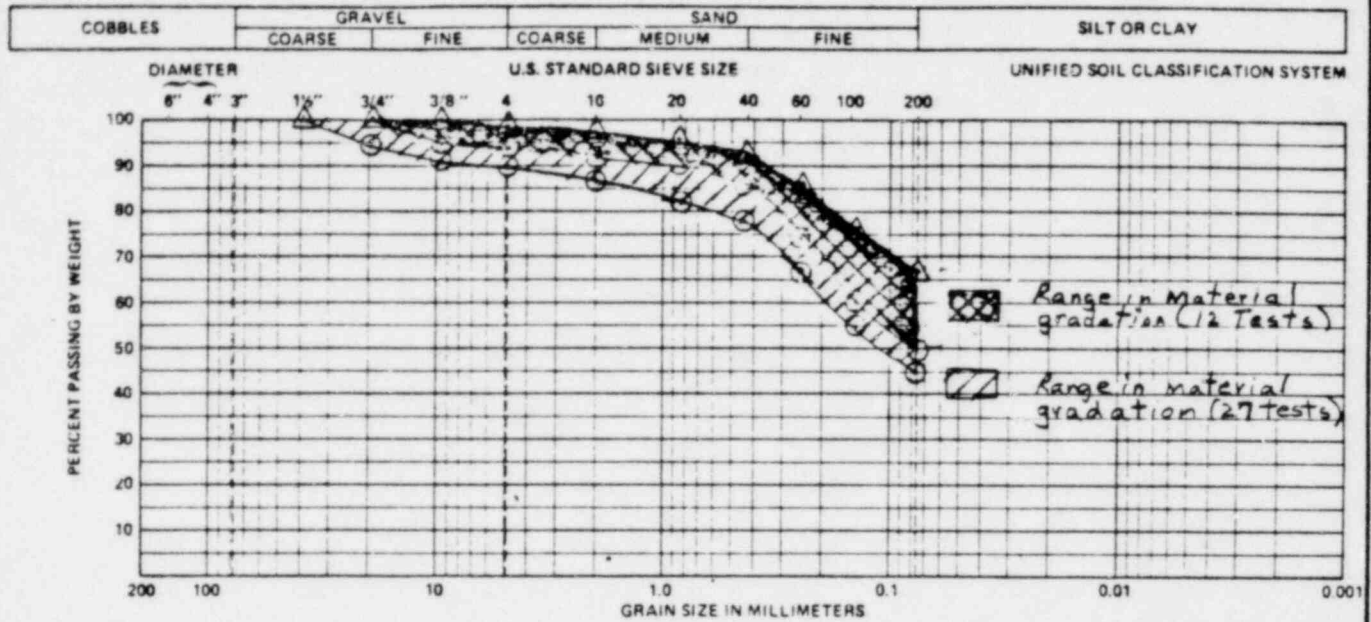
CHECKED BY 22 JUN 81

REVIEWED BY 10/11/81

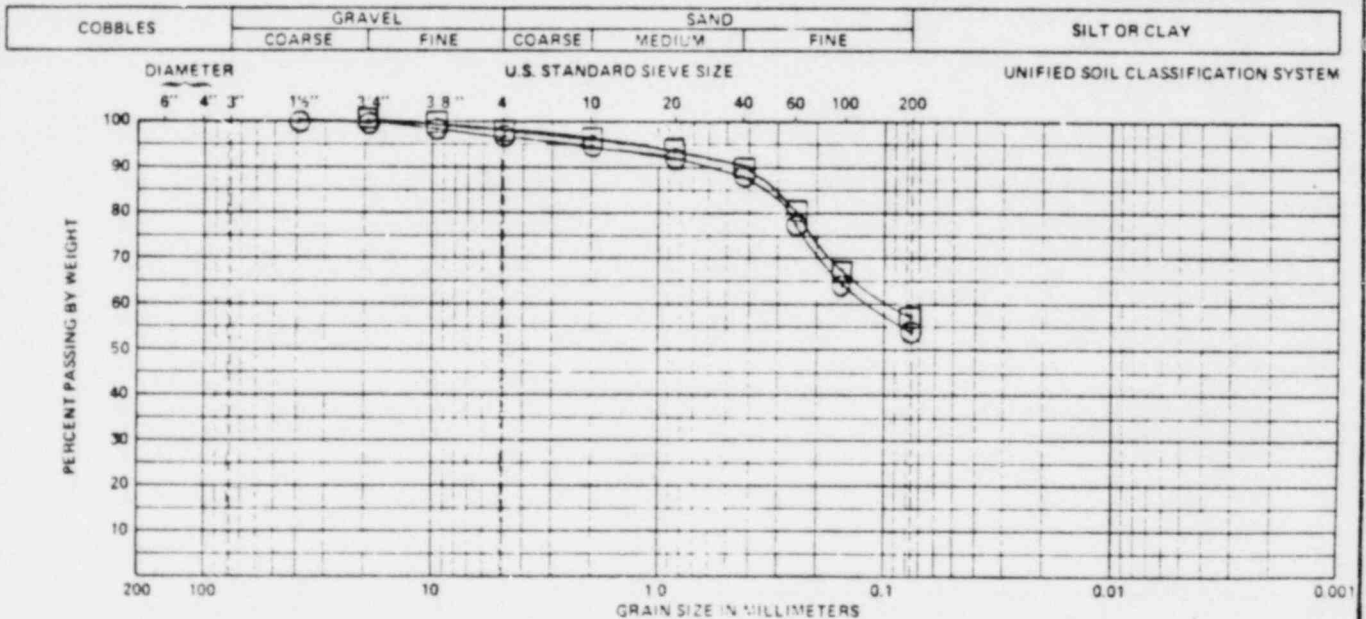
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PROJECT NO

PARTICLE-SIZE DISTRIBUTION



BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)
				CL-ML; gray, f. sandy, slightly plastic, silty CLAY, trace f. gravel trace c. to m. sand, occ. c. gravel			
				FOUNDATION TILL			
			△	} Range of test results			
			○				
				Max % passing sieve			
				Min % passing sieve			



BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)
				Same as above - FOUNDATION TILL			
			□	Average of 12 tests (data previously reported)			
			○	Average of 27 tests			

GRADATION RANGES and AVERAGES - FOUNDATION TILL
PERIMETER and BAFFLE DIKES

Fig 6

REVIEWED BY WCC LR-101 (8/80) Lmc

PROJECT NO 816217 DRAWN BY JWS

11 East Adams Street
Suite 1500
Chicago, Illinois 60603
312-939-1000
Telex 253875 (WOODWARD CIO)

Woodward-Clyde Consultants

9 December 1981
81C217-4

Consumers Power Company
1945 West Parnall Road
Jackson, Michigan 49201

Attention: Dr. T. R. Thiruvengadam
Section Head - Civil Engineering
Mail Code P-14-400

Subject: Additional Test Results
Foundation Till - Perimeter Dike
Soil Boring and Testing Program
Midland Plant - Units 1 and 2

Gentlemen:

On 1 July 1981, we issued a report presenting test results for fill and foundation materials from the Perimeter and Baffle Dike Areas. Results of both index property and strength testing of the foundation till deposit were included. On 12 October 1981, Mr. Ramanujam verbally authorized the processing of the remaining tube and core samples of foundation till from the dike borings for the purpose of performing additional index property tests. Such testing was recently completed and the results are presented herein. These test results supersede a similar presentation of results given in our draft report of 20 November 1981 entitled "Preliminary Additional Test Results, Foundation Till - Perimeter Dike, Soil Boring and Testing Program, Midland Plant - Units 1 and 2."

Recent index property testing included processing of 9 tube and 5 core samples and determinations of density, water content, consistency (pocket penetrometer), liquid and plastic limits, and particle-size distribution. Results of the recently completed index property testing of foundation till samples from Perimeter Dike borings COE-2 through COE-5 are listed in Tables 1 through 4, respectively.



To aid in correlating these additional data, the index property test results for foundation till previously tabulated in Appendix B of our 1 July report are also listed in the tables. Similar data for sample S-17B from Baffle Dike boring COE-7 are presented in Table 5. This sample had been previously included with the foundation till summary based on similarities of the index and strength properties of the test specimen with those of other specimens of foundation till.

The tube densities reported in these tables were calculated assuming the sample diameter was that of the inside diameter of the sampling tube. Where two densities are reported, the larger value was calculated assuming the sample diameter was that of the inside diameter of the cutting edge of the tube. Section densities were based on measurements of the sample. A list of abbreviations and symbols applicable to the laboratory testing data was previously included as Table B-0 in our 1 July report.

Foundation till samples that have been tested for strength properties are noted in Tables 1 through 5. The results of these strength tests were previously presented in Appendices D and E of our 1 July report.

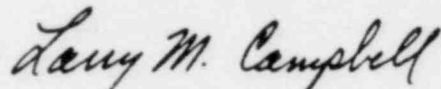
Particle-size distribution data for selected sieve sizes are summarized in Tables 1 through 5; complete particle-size distribution curves and descriptions for 15 recently tested specimens of foundation till are presented in boring-number order on Figs. 1 through 5. For completeness, particle-size distribution curves for the 14 specimens of foundation till that were previously presented in Appendix C of our 1 July report are also included on the figures.

All index property test results of the foundation till from the Dike Areas are therefore presented in this report. Ranges and averages of these data are summarized in Table 6. Ranges in gradation are similarly presented on Fig. 6. For comparison, the ranges and averages that were previously presented for foundation till in Table 3 and Fig. 3 in our 1 July report are also included in Table 6 and Fig. 6 of this report.

As shown, the ranges and averages of the index properties previously presented for the foundation till are consistent with those based on more extensive testing and further confirm the judgment in our 1 July report that strength tests on foundation till "... have been performed on test specimens considered to be representative of the range of ... material properties encountered in the dike borings."

If you have any questions regarding these additional test results, please call.

Very truly yours,



Larry M. Campbell
Project Manager

LMC:snmc

Enclosure

cc: Mr. N. Ramanujam (2 copies)
Mr. T.C. Cooke/D.E. Sibbald
Dr. S.S. Afifi, Bechtel
Mr. A.J. Boos, Bechtel
Dr. R.B. Peck
Dr. A.J. Hendron, Jr.
Dr. J.P. Gould, MRJD
Dr. H.M. Horn, WCC
Mr. D.M. Hendron, WCC
Mr. R.S. Ladd, WCC

BIC217 Prepared by JWS Reviewed by JMW Checked by SAH 11/19/81

Boring No. COE-2 Ground Surface Elevation (ft) 631.8 Sheet 1 of 1

MIDLAND PLANT UNITS 1 and 2. CONSUMERS POWER CO.
LAB. TESTING SUMMARY: PERIMETER and BAFFLE DIKES
FOUNDATION TILL
Table 1 (1/1)

Sample No	Section No	Depth (ft)	Tube		Section			Ave PP t/ft	W %	W _L %	PI %	% Passing Sieve				G _s	Typ Eng Prop Test
			Type	Re ft	σ_c lb/ft ²	SO BWS	w %	σ_c lb/ft ²	σ_d lb/ft ²			# 4	# 10	# 40	# 200		
S-14		31.3 - 33.8	PS	0.92	141.7 145.5												*
		31.5								>4.5							*
	A	31.6					10.2										*
	B	32.0				SC-SM	9.6	144.3	131.7	>4.5	18	6	97	94	86	49	*
S-15		33.8 - 35.3	PS	1.01	145.0												
	A	34.1					10.6			>4.5							
	B	34.6				CL	9.2			>4.5	22	10	96	93	86	58	
S-16		35.3 - 37.9	PS	1.47	146.3												*
	A	35.6					9.4			>4.5							*
	B	35.9					8.3			>4.5							*
	C	36.2				CL-ML	7.5			>4.5	17	6	99	97	89	51	*
	D	36.9					7.7			>4.5							*
S-17		37.8 - 40.3	PS	2.02	136.1 138.0												
	A	38.0					9.1			>4.5							
	B	38.6				SC-SM	8.7			>4.5	17	7	95	93	85	50	
	C	39.0					9.0			>4.5							
	D	39.6					8.1			>4.5							

* Data previously presented in Table B-2 of Perimeter and Baffle Dike report of 1 July 81.

Prepared by JWS Reviewed by JWS Checked by LJA 11/19/01

Prepared by JWS Reviewed by JWS Checked by LJA 11/19/01

Sheet 1 of 1

MIDLAND PLANT UNITS 1 and 2- CONSUMERS POWER CO
LAB. TESTING SUMMARY: PERIMETER and BAFFLE DIKES
FOUNDATION TILL
Table 2 (1/1)

[illegible]

* Data previously reported in Table B-3 of Perimeter and Baffle Dike report of 1 July 1981

81C217

Prepared by JWS Reviewed by JML Checked by JWH 11/19/81

Boring No COE-4 Ground Surface Elevation (ft) 632.0Sheet 1 of 2

Sample No	Section No	Depth (ft)	Tube		Section			Ave FP t/ft ³	W %	W _L %	PI %	% Passing Sieve				Gs	Typ Eng Prop Test
			Type	Roc ft	σ_t lb/ft ³	USCS SYMB	w %	σ_t lb/ft ³	σ_d lb/ft ³			# 4	# 10	# 40	# 200		
S-17		34.5 - 35.2	PS	1.02	151.1 151.3												
	A	34.8				CL	9.4			>4.5		21	8	97	94	85	56
	B	35.2					7.0			>4.5							
	C	35.4					5.8										
S-18		36.0 - 36.8	PS	0.67	150.8												
	A	36.2				CL-ML	4.9			>4.5		18	7				
	B	36.6				(C-SM)	5.3					90	87	78	45		
S-19		37.0 - 37.5	PS	0.65	152.3												
	A	37.2				SC-SM	5.5			>4.5		17	7	93	90	82	48
	B	37.5					5.6			>4.5							
S-20		39.6 - 42.0	PS	0.45	143.2												
	A	39.6					6.5										
	B	39.8				CL-ML	5.2			>4.5		17	7	98	94	86	50 ⁺
S-21		42.0 - 42.5	HR	0.5	—												
																	Cove Sample in bag - No tests run
S-22		42.5 - 43.9	HR	1.4	—												
	A	43.4				SC-SM	7.6	150.0	139.4	>4.5		16	5	97	93	85	49

MIDLAND PLANT UNITS 1 and 2 - CONSUMERS POWER CO.
LAB. TESTING SUMMARY: PERIMETER and BAFFLE DIKES
FOUNDATION TILL
Table 3 (1/2)

Boring No. COE-A Ground Surface Elevation (ft) 632.0 Sheet 2 of 3

Sample No	Section No	Depth (ft)	Tube		Section							Avg. FP	W %	W _L %	PI %	% Passing Sieve					Type Eng App Test																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
			Type	Refr ft	σ_c lb/ft ²	σ_c lb/ft ²	σ_c lb/ft ²	W %	σ_c lb/ft ²	σ_c lb/ft ²	PI %					#	#	#	#																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
S-23		43.9-45.0	HR	1.1	—																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									

810217

Prepared by JWS

Reviewed by JWC

Checked by JWN 11/15/81

Boring No. COE-5 Ground Surface Elevation (ft) 631.6

Sheet 1 of 1

Sample No.	Section No.	Depth (ft)	Tube			Section				Ave. FP	W %	W _L %	PI %	% Passing Sieve				G _s	Typ. Eng. Prop. Test
			Type	Roc ft	σ_c lb/ft ²	USCS	W %	σ_c lb/ft ²	σ_d lb/ft ²					# 4	# 10	# 40	# 200		
S-14		33.0 - 39.5	PS	1.47	42.5 140.3														
	A	33.2					11.6			>4.5									
	B	33.8				CL	10.1			>4.5		23	10	99	97	89	57		
	C	34.2				ML	11.5					15	3						
S-15A		36.5 - 40.5	PQ3	5.0	-														
	B	36.2				CL-ML	6.6	150.7	141.4			18	6	97	95	89	57	2.73	CTU *
	C	37.0				CL-ML	6.5	149.6	140.5			18	6	99	95	92	58	2.74	CTU *
	F	40.0				CL-ML	6.8	150.3	140.7			17	6	98	96	90	57	2.74	CTU *
S-16		40.5 - 46.5	PQ3	5.0	-														
	A	40.8				CL-ML	7.1	150.3	140.3			18 17	6 6	94	92	87	54	2.73	CTU *
	B	41.4				CL-ML	7.5	149.6	139.1			17	5	97	96	91	57		UU *
	C	42.0				CL-ML	7.4	151.0	140.6			18	6	98	97	92	58		UU *
	D	42.9				CL-ML	7.1	149.8	139.9			17	5	99	98	93	59		UU *
	E	43.6				CL-ML	7.2	150.1	140.0			16	5	98	96	91	58		UU *
S-17		48.5 - 49.5	PQ3	4.3	-														
	B	48.1				CL-ML	7.4	148.4	138.1			16	5	98	96	91	59		Bottom 2.5 ft of sample processed upper 1.8 ft resieved
	C	48.6					7.9	152.7	141.5	>4.5									
	D	49.0				CL-ML				>4.5		15	4						
	E	49.5					7.7			>4.5									

* Data previously reported in Table B-5 of Perimeter and Baffle Dike report of 1 July 1981

MIDLAND PLANT UNITS 1 and 2 - CONSUMERS POWER CO.
LAB TESTING SUMMARY: PERIMETER and Baffle Dikes
Table 4 (1/1)
FOUNDATION TILL

Prepared by JWS Reviewed by JWC Checked by JWC 11/19/01

Sheet 1 of 1

$$T_{q,b/a} \quad \underline{5(111)}$$

Sample No.	Section No	Depth (ft)	Tube		Section				Ave. PP t/ft	W %	W _L %	PI %	% Passing Sieve				G _s	Typ Eng Prop Test
			Type	Rec. ft	σ_t lb/ft ²	USCS SYMBOL	W %	σ_t lb/ft ²					σ_d lb/ft ²	# 4	# 10	# 40		
5-17		30.7 - 33.2	PS	0.91	147.9													*
	A	30.9						>45	9.7									*
	B	31.2				CL	9.7	145.7	132.8		22	8	99	96	88	57	UU	*
		31.4								>45	9.6							*

* Data previously reported in Table B-7 of Perimeter and Baffle Dike report of 1 July 1981

Prepared by JWS Rvw: LMC Checked by JAH 11/20/81

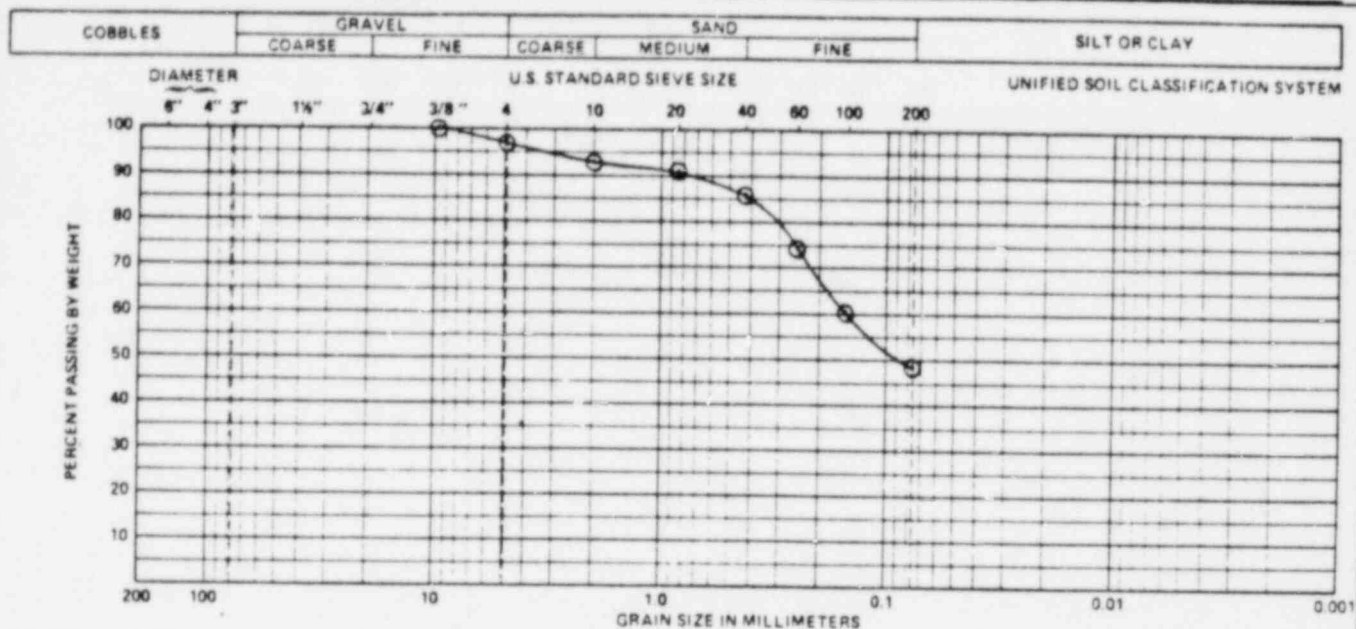
	Testing of 6 samples ^①			Testing of 20 samples		
TYPICAL MATERIAL DESCRIPTION	CL-ML, gray, f. sandy, slightly plastic, silty CLAY, trace f. gravel, trace c. to m. sand, occ. c. gravel					
TEST TYPE	NUMBER OF TESTS	DATA RANGE	DATA AVERAGE	NUMBER OF TESTS	DATA RANGE	DATA AVERAGE
Tube Density γ_T " lb/ft ³	4	141.7 - 159.6	148.2	13	136.1 - 159.6	147.2
Section Total Density γ_T in lb/ft ³	11	144.3 - 151.0	149.2	16	144.3 - 152.7	149.6
Section Dry Density γ_d in lb/ft ³	11	131.7 - 141.4	138.9	16	131.7 - 141.5	139.2
Water Content w in %	19	6.5 - 10.2	8.0	54	4.9 - 11.6	7.9
Pocket Penetrometer PP in ton/ft ²	4	all > 4.5	> 4.5	39	all > 4.5	> 4.5
Liquid Limit w_L in %	13	16 - 22	18	29	15 - 23	17
Plasticity Index PI in %	13	4 - 8	6	29	3 - 10	6
% Passing #4 Sieve	12	94 - 99	97.8	27	90 - 99	97.0
% Passing #10 Sieve	12	92 - 98	95.8	27	87 - 98	94.6
% Passing #40 Sieve	12	86 - 93	90.1	27	78 - 93	87.9
% Passing #200 Sieve	12	49 - 67	56.8	27	45 - 67	54.2

① Data previously presented in Table 3 of Perimeter and Baffle Dike report of 1 July 1981.

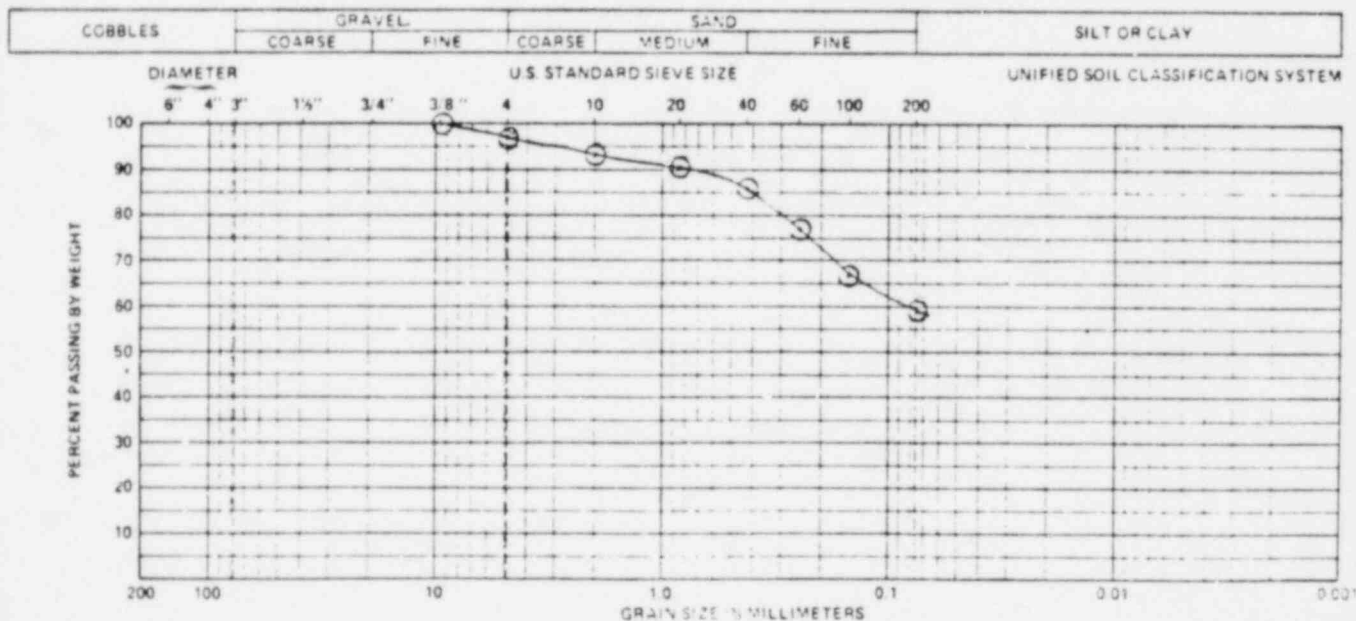
MIDLAND PLANT UNITS 1 and 2 - CONSUMERS POWER CO.
INDEX PROPERTY SUMMARY - PERIMETER and BAFFLE DIKES
FOUNDATION TILL
TABLE 6

REVIEWED BY WCC LR 101 (8-90) *file* *Reviewed by: JWS 29 JUNE '81*

PARTICLE-SIZE DISTRIBUTION



BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)
COE-2	S-14-B	32.0	⊙	SC-5M, mottled gray and brown, s.p. clayey silty f. SAND, some f. gravel to m. sand	9.6	18	12

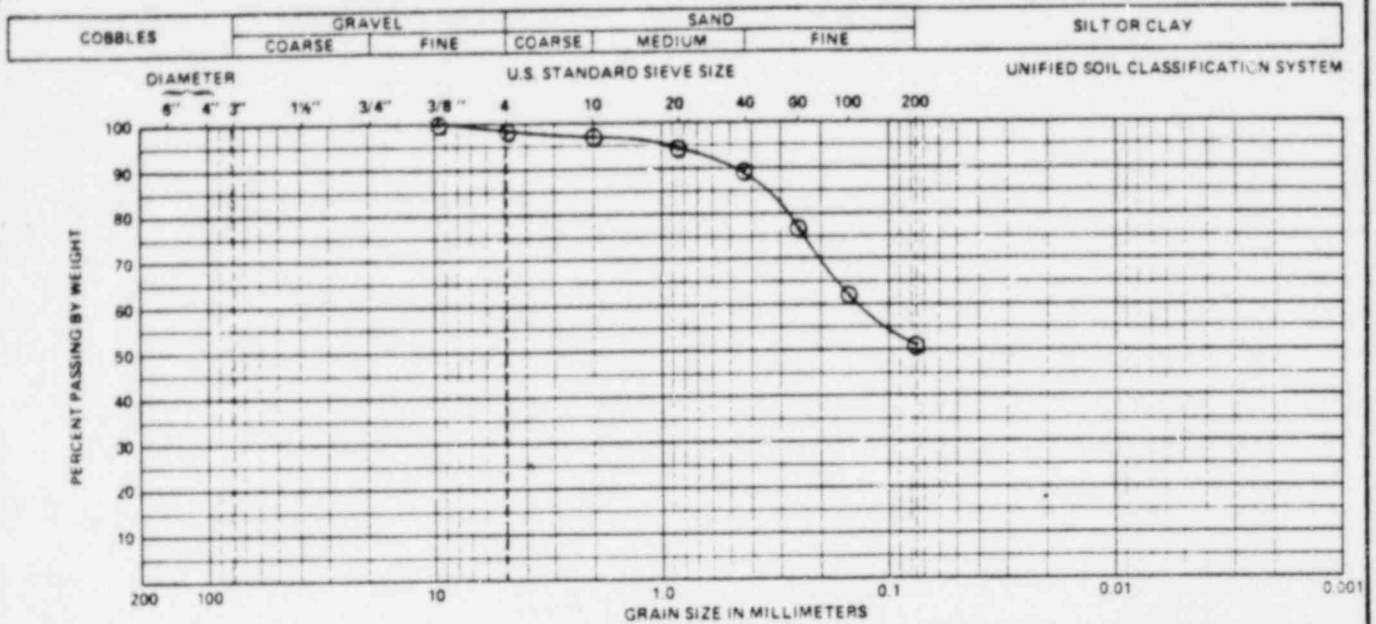


BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)
COE-2	S-15-B	34.6	⊙	CL, brown, f. sandy, sp. to m.p., silty CLAY, trace f. gravel, trace c. to m. sand	9.2	22	12

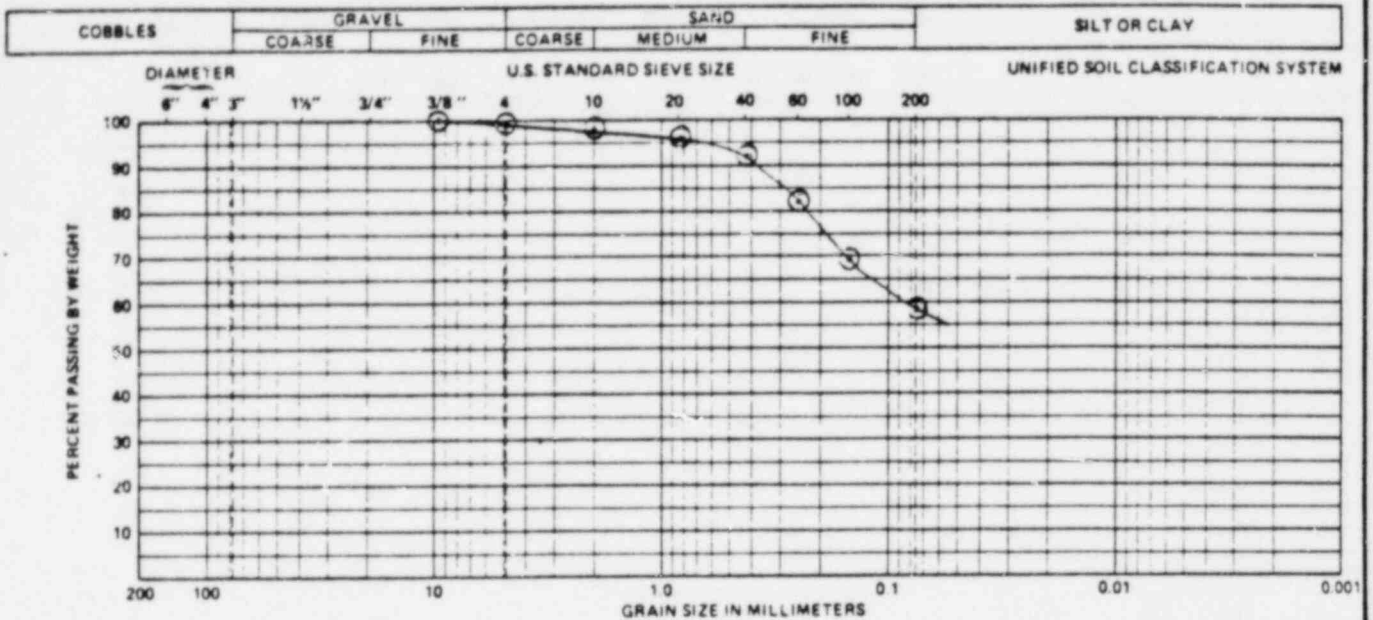
F31 (1/2)

REVIEWED BY WCC LR 101 (8-90) *JWS*

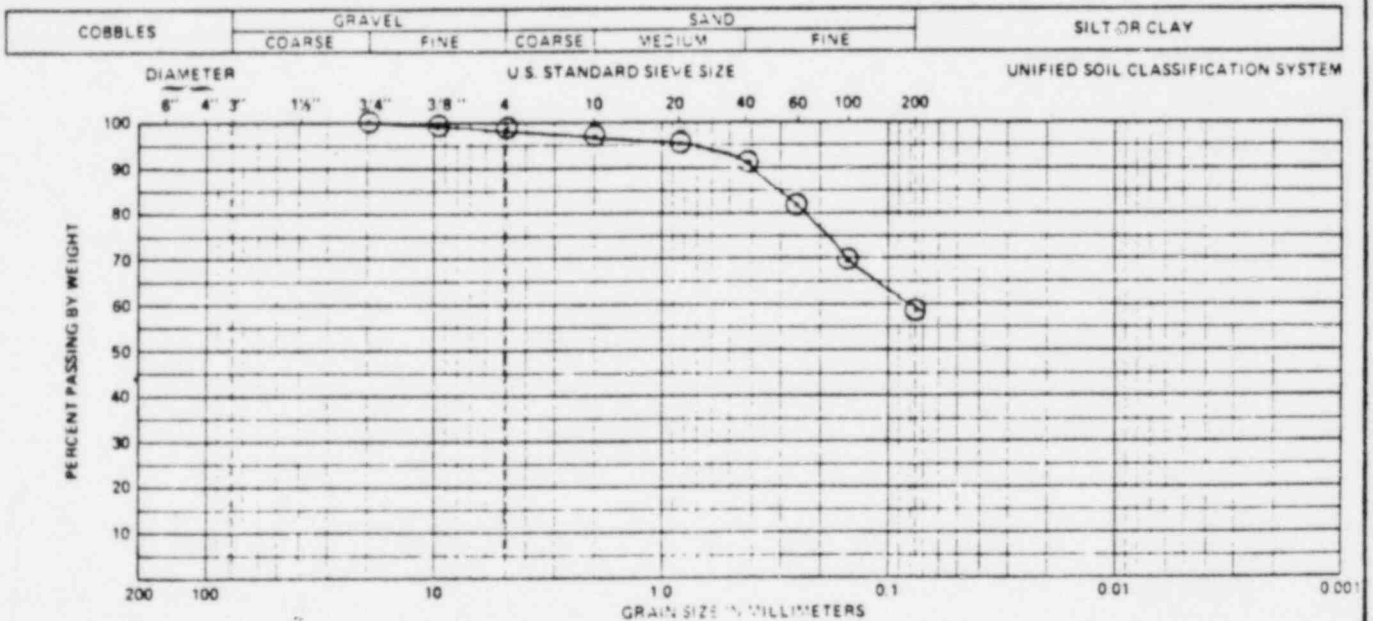
PARTICLE-SIZE DISTRIBUTION



PARTICLE-SIZE DISTRIBUTION



BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)
COE-3	S-17-D	37.6	⊙	ML, gray-brown, f. sandy, s.p., clayey SILT, trace f. gravel to m. sand.	9.1	15	12



BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)
COE-3	S-18-B	39.0	⊙	CL-ML, gray-brown, f. sandy, s.p., silty CLAY, trace f. gravel to m. sand.	7.2	17	12

Fig. 2 (1/2)

REVIEWED BY WCC LR-101 (B-90) JWS

PROJECT NO B1C217 DRAWN BY JWH

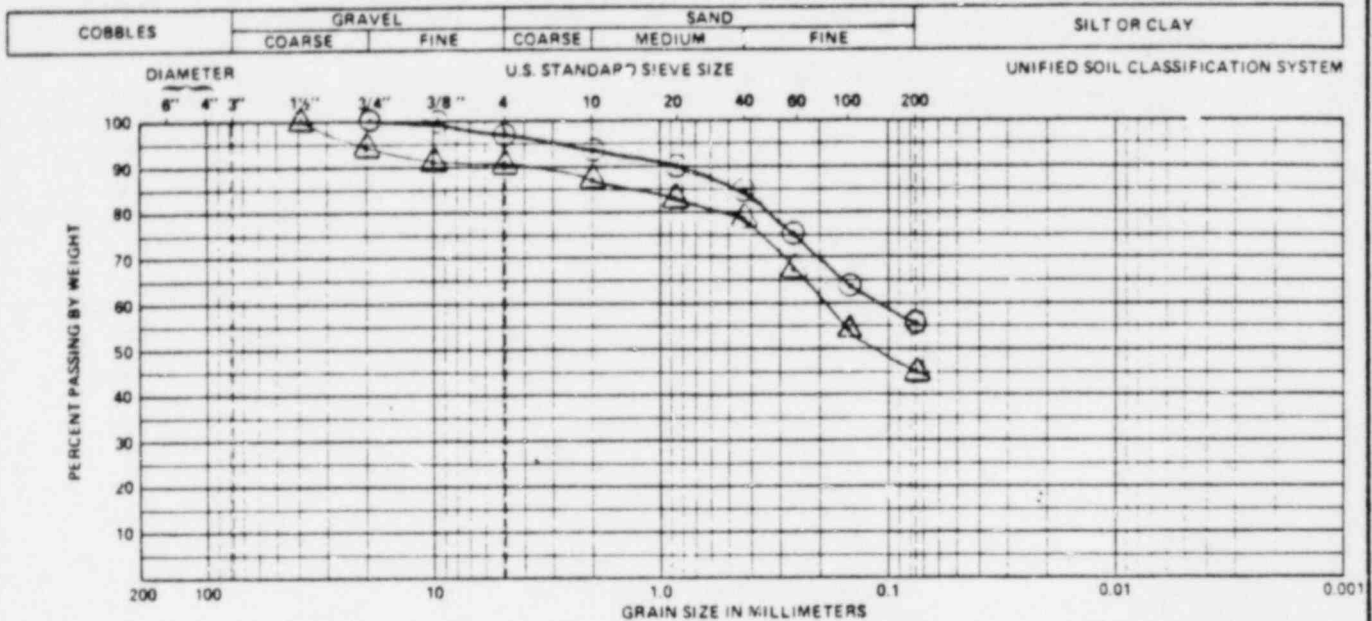
PROJECT NO. 81C4055 T3 DRAWN BY: P6



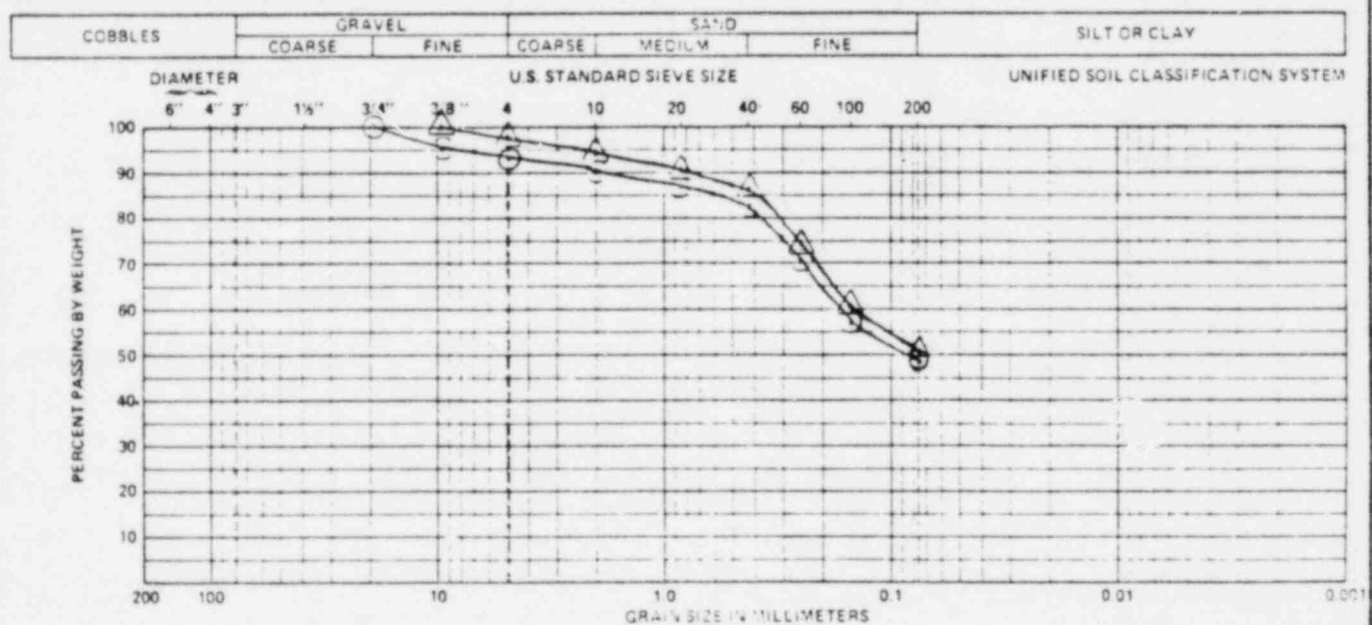
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PARTICLE-SIZE DISTRIBUTION



BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)
COE-4	3-17-A	34.8	⊙	CL, brown, f. sandy, s.p., silty CLAY, trace f. gravel, trace f. to m. sand	94	21	13
COE-4	5-18-B	36.6	Δ	SC-SM, gray-brown, s.p., clayey, silty fine SAND, trace gravel, trace c. to m. sand	53	(18)	(11)



BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)
COE-4	5-19-A	37.2	⊙	SC-SM, mottled brown and gray, s.p., clayey, silty fine SAND, trace f. gravel, trace c. to m. sand	55	17	10
COE-4	5-20-B	39.8	Δ	CL-ML, gray-brown, f. sandy, s.p., silty CLAY, trace f. gravel, trace c. to m. sand	52	17	10

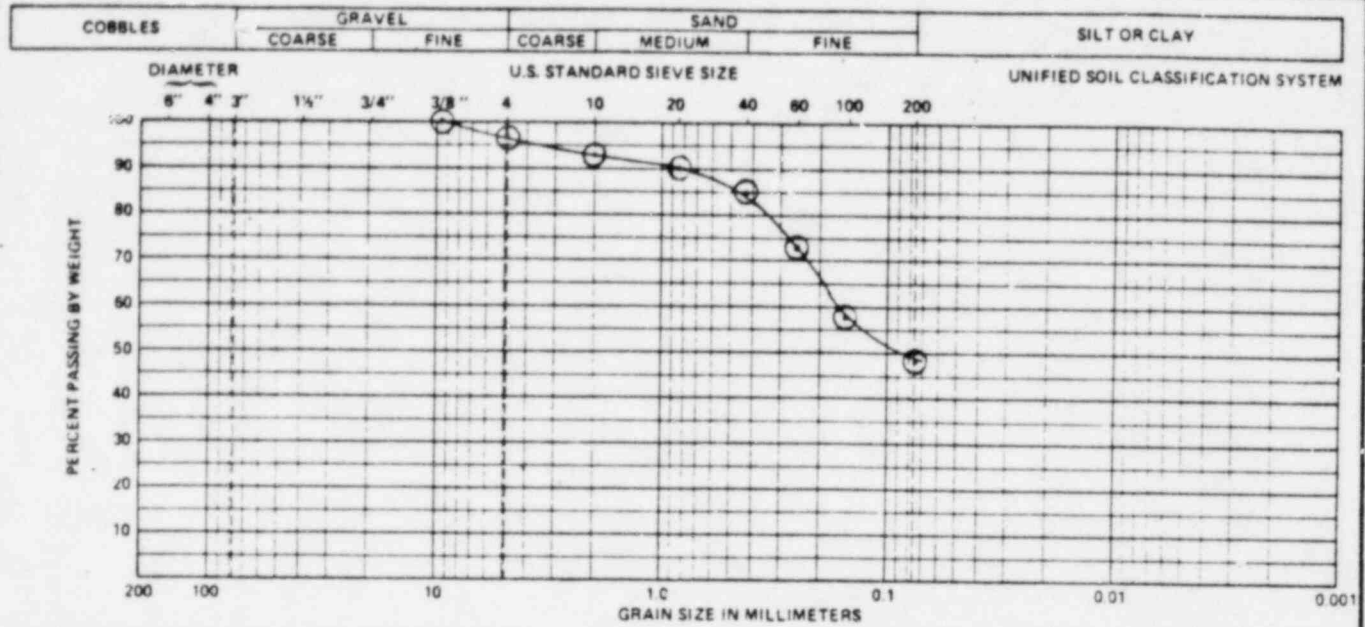
Fig. 3 (113)

JWS

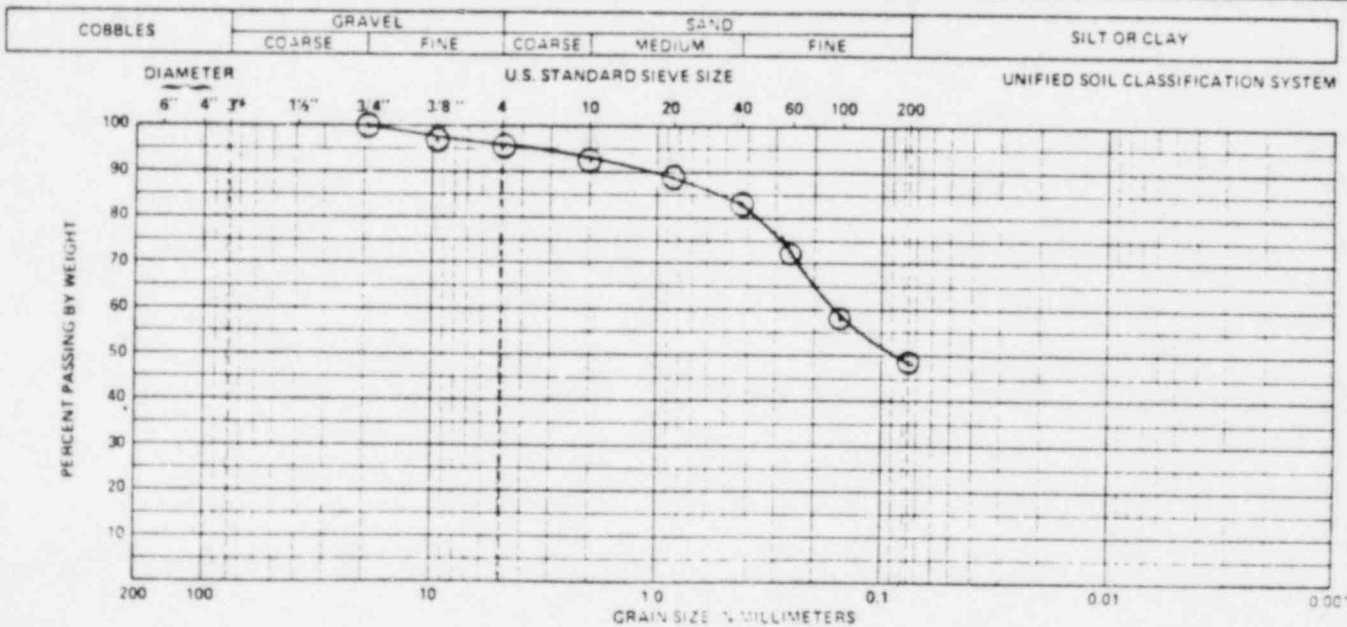
REVIEWED BY WCC (R-101) (B-2)

PROJECT NO. BIC217 DRAWN BY JSM

PARTICLE-SIZE DISTRIBUTION



BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)
COE-4	S-22-A	43.4	⊙	SC-SM, gray, s.p., clayey, silty fine SAND, trace f. gravel, trace c. to m. sand.	7.6	16	11



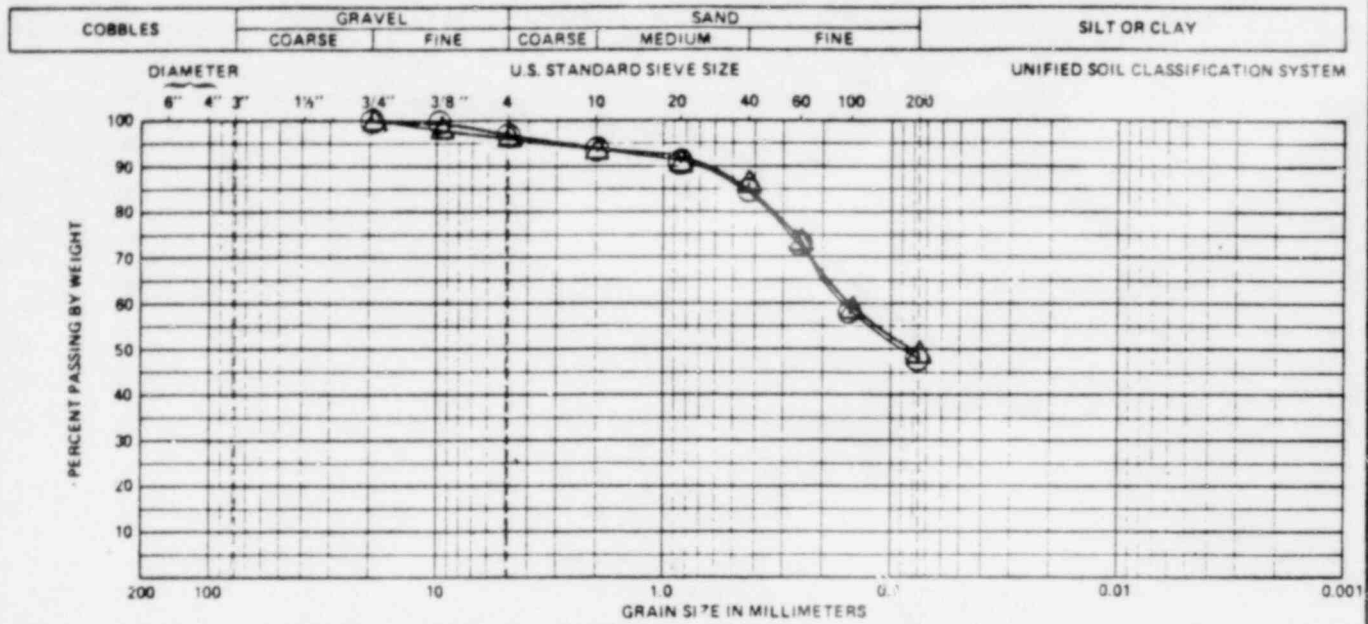
BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)
COE-4	S-23-A	44.4	⊙	SC-SM, gray, s.p., clayey, silty fine SAND, trace f. gravel, trace c. to m. sand.	7.1	16	10

Fig. 3 (2/3)

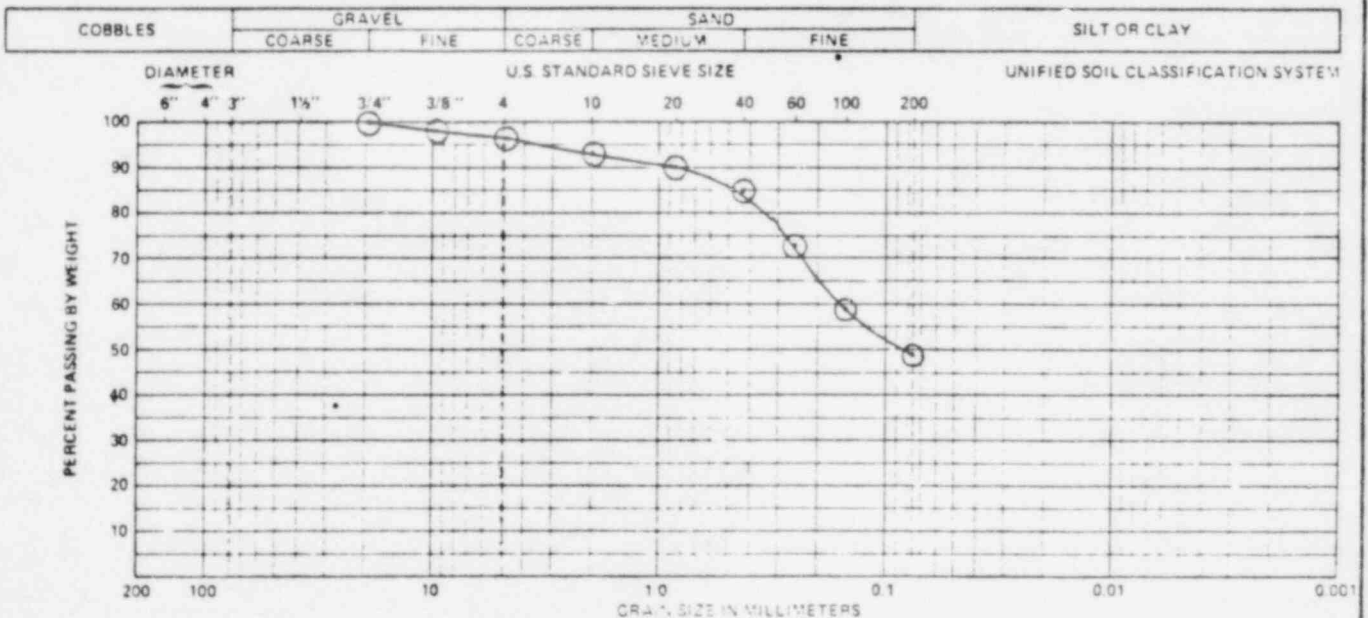
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PROJECT NO 81C217 DRAWN BY: JWS

PARTICLE-SIZE DISTRIBUTION



BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)
COE-4	S-24-B	47.0	⊙	SC-SM, gray, s.p., clayey, silty fine SAND, trace f. gravel, trace c. to m. sand.	7.2	16	10
COE-4	S-24-C	48.0	△	SC-SM, gray, clayey, silty fine SAND, trace f. gravel; trace c. to m. sand () indicates assumed value	7.4	(16)	(10)



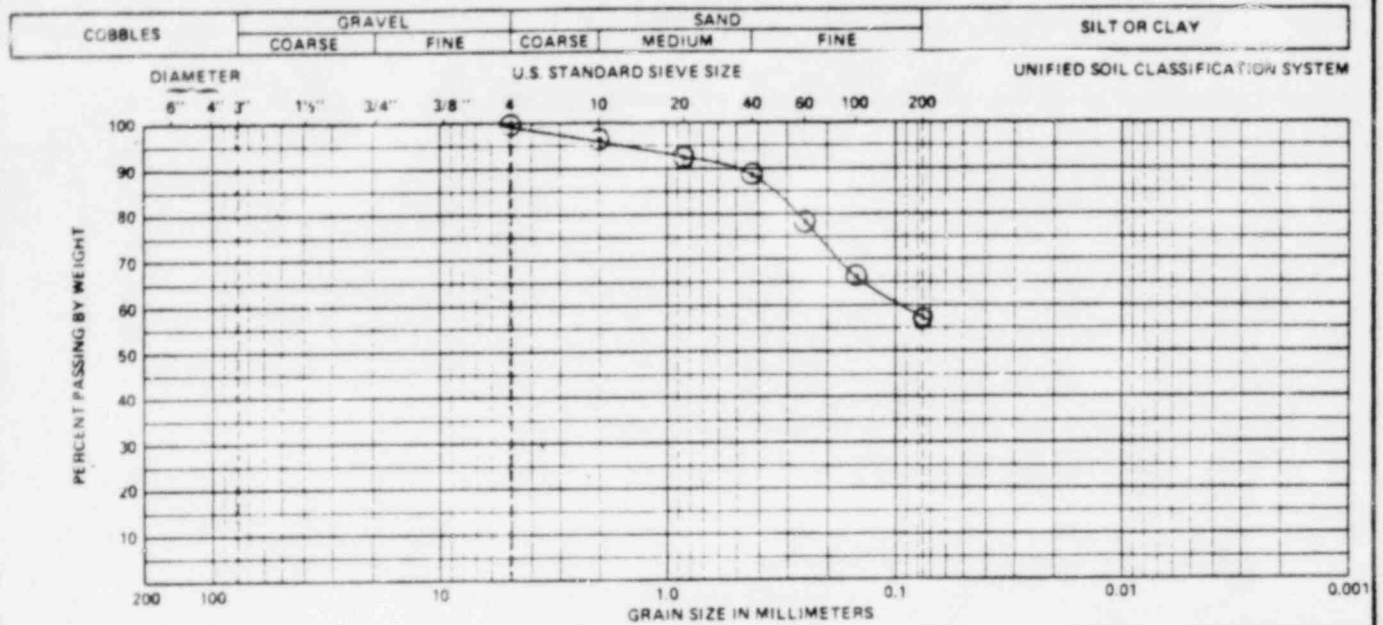
BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)
COE-4	S-25-A	50.4	⊙	SC-SM, gray, s.p., clayey, silty fine SAND, trace f. gravel, trace c. to m. sand	9.0	16	10

Fig. 3 (3/3)

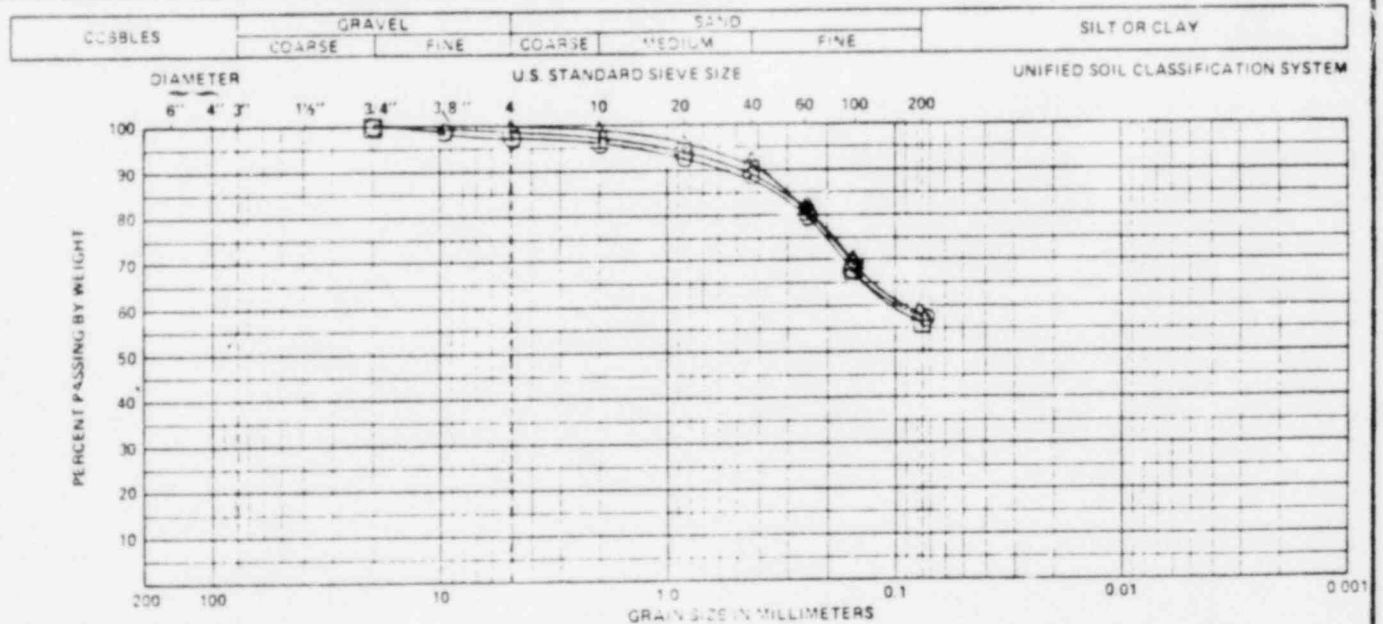
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PARTICLE-SIZE DISTRIBUTION



BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)
COE-5	S-14-B	33.8	○	CL, brown, f sandy, sp. to m.p. silty CLAY, trace f. gravel to m. sand.	10.1	23	13



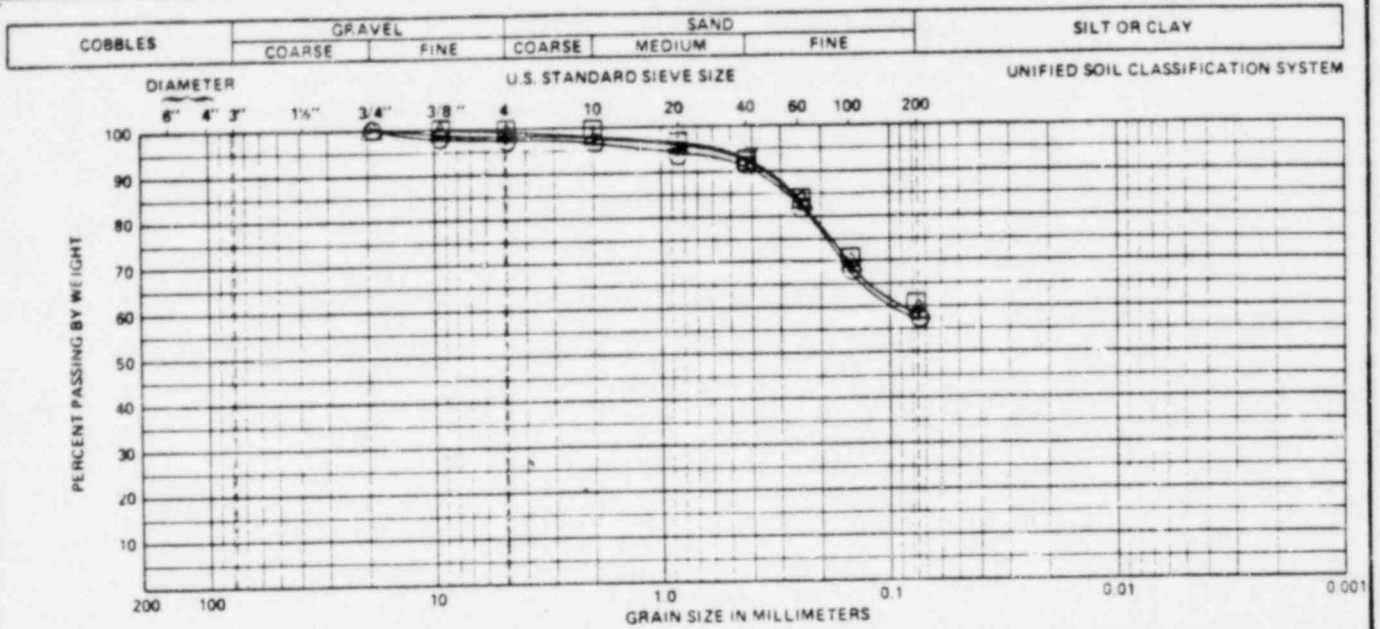
BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)
COE-5	SISA-B	36.2	⊙	CL-MI, mottled brown and gray, f sandy, sp. silty CLAY, tr 2-m sand - CTH spec	6.6	18	12
COE-5	SISA-C	37.0	△	CL-MI, brown, f sandy, sp. silty CLAY, tr f gravel to m. sand - CTH spec	6.5	18	12
COE-5	SISA-E	40.0	□	CL, mottled brown and gray, f sandy, sp. silty CLAY, tr 2-m sand - CTH spec	6.3	17	11

Fig. 4 (1/3)

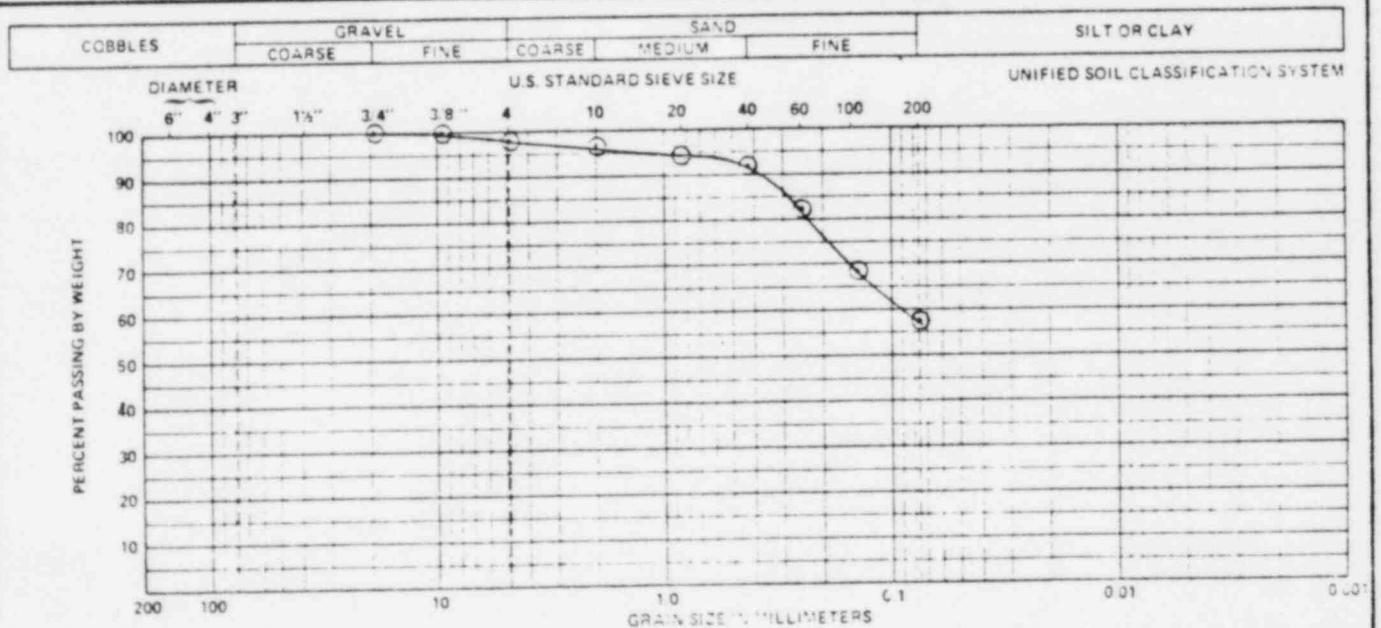
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PROJECT NO 81C-4355 T3 DRAWN BY: MJD

PARTICLE-SIZE DISTRIBUTION



BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)
COE 5	S-16-B	41.4	⊙	CL-ML, gray, f. sandy, s.p. silty CLAY, tr. f. gravel to m. sand - U.U. spec.	7.5	17	12
COE 5	S-16-C	42.0	△	CL-ML, gray, f. sandy, s.p. silty CLAY, tr. f. gravel to m. sand, occ. c. gravel - U.U. spec.	7.4	13	12
COE 5	S-16-D	42.9	□	CL-ML, gray, f. sandy, s.p. silty CLAY, tr. f. gravel to m. sand - U.U. spec.	7.1	17	12



BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)
COE 5	S-16-E	43.6	⊙	CL-ML, gray, f. sandy s.p. silty CLAY tr. f. gravel to m. sand - U.U. spec.	7.2	16	11

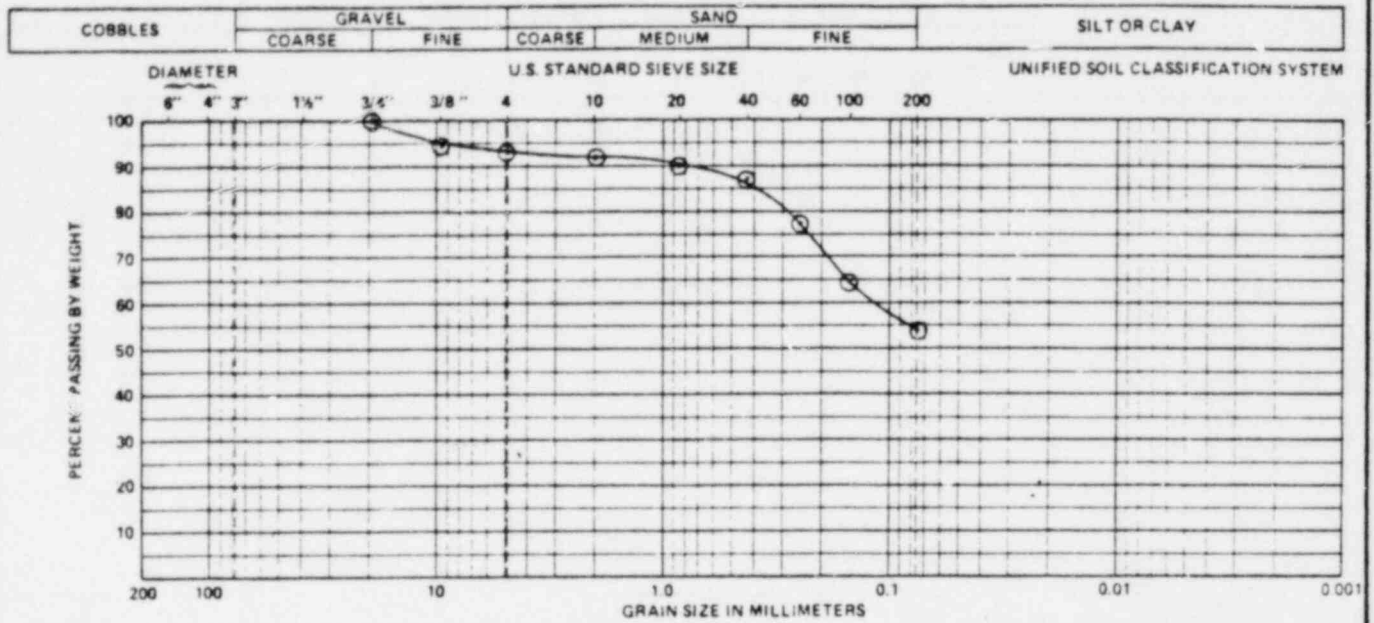
Fig 4 (2/3)

CHECKED BY 770 19 JUNE 81

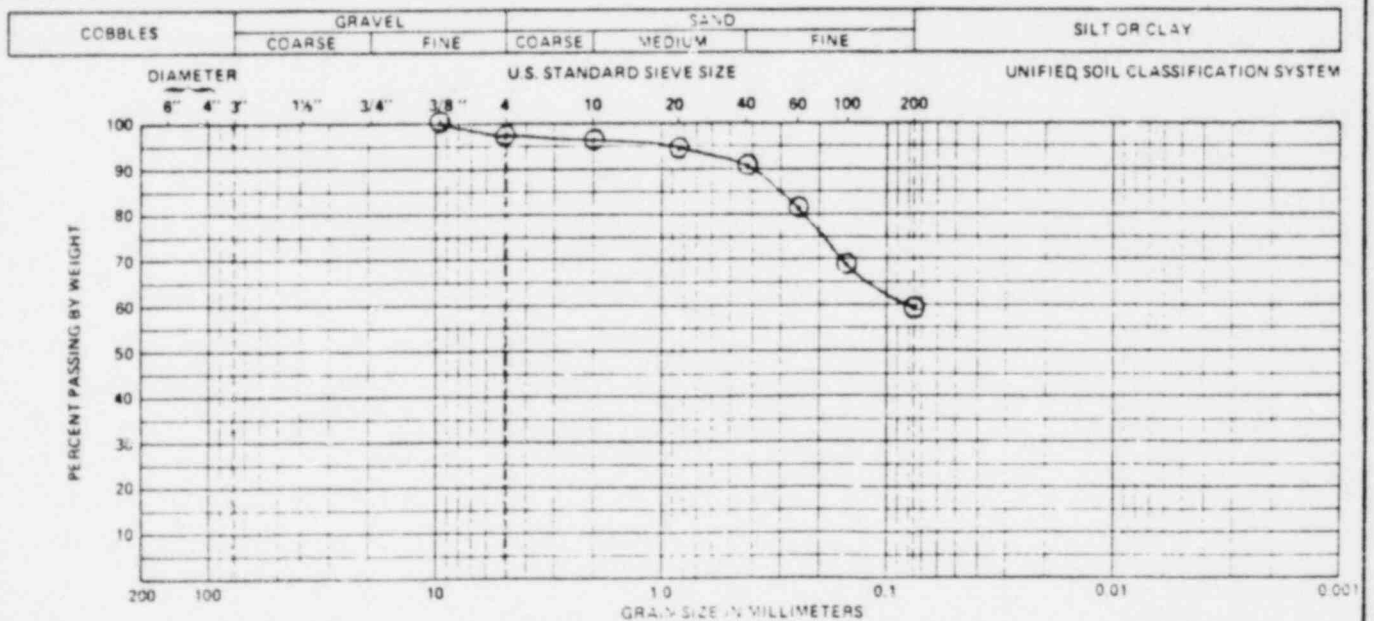
REVIEWED BY MCC/LR 101 (R/80)

PROJECT NO. B12405513 DRAWN BY PRF

PARTICLE-SIZE DISTRIBUTION



BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)
COE-5	16A	40.8	①	CL-ML, gray, f. sandy, s.p. silty CLAY, some f. gravel to m. sand - old spec	7.1	17	11
						18	12



BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)
COE-5	S-17-B	48.1	①	CL-ML, gray, f. sandy, s.p., silty CLAY, trace f. gravel to m. sand	7.4	16	11

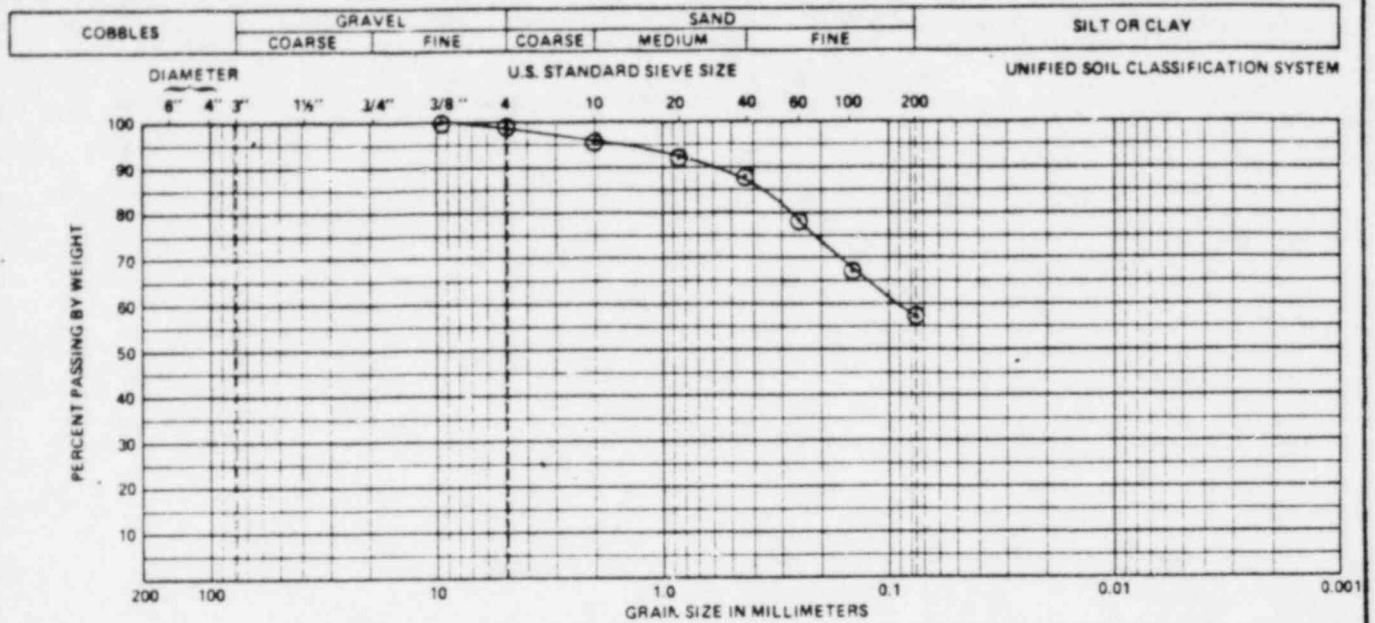
Fig 4 (3/3)

CHECKED BY 2788 19 JUNE 81

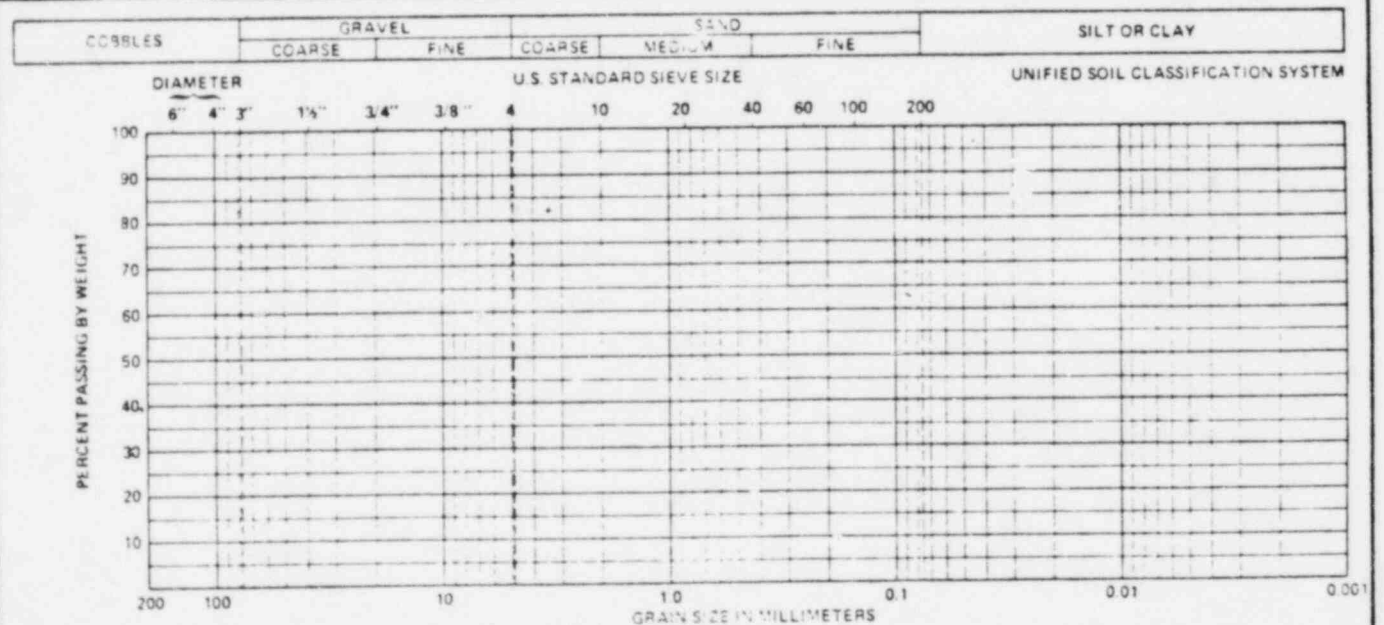
REVIEWED BY WCC/LR 101 (8/80)

PROJECT NO BIC217 DRAWN BY: JWH

PARTICLE-SIZE DISTRIBUTION



BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)
COE 7	5-17-B	31.2	⊙	CL, brown f. sandy, s.p. silty CLAY, H. f. gravel to m. sand - Ull spec.	9.7	22	14



BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)

Fig. 5 (1/1)

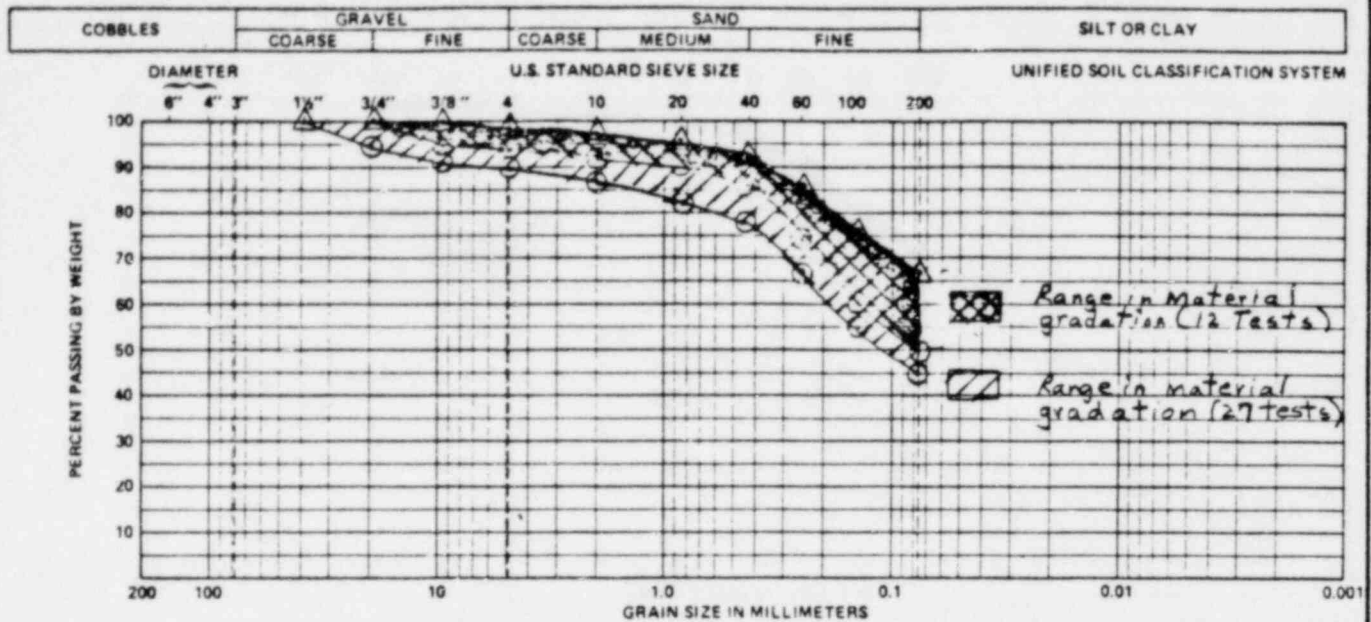
CHECKED BY *W.C. L. 101 (9-80)* 22 JUN 81

REVIEWED BY *W.C. L. 101 (9-80)*

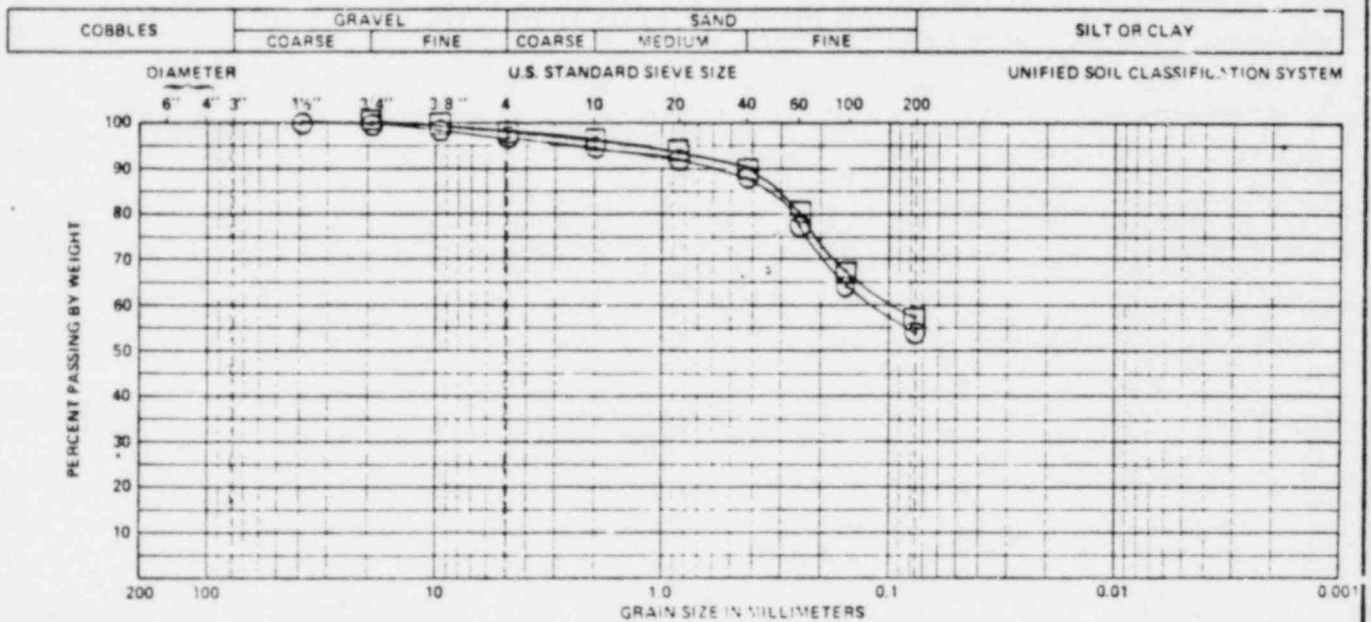
DRAWN BY

PROJECT NO.

PARTICLE-SIZE DISTRIBUTION



BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)
				CL-ML, gray, f. sandy, slightly plastic, silty CLAY, trace f. gravel			
				trace c. to m. sand, occ. c. gravel			
				FOUNDATION TILL			
			△	} Range of test results			
			○				
				Max % passing sieve			
				Min % passing sieve			



BORING	SAMPLE	DEPTH (ft)	SYMBOL	CLASSIFICATION	w (%)	w _L (%)	w _p (%)
				Same as above - FOUNDATION TILL			
			□	Average of 12 tests (data previously reported)			
			○	Average of 27 tests			

GRADATION RANGES and AVERAGES - FOUNDATION TILL
PERIMETER and BAFFLE DIKES

Fig 6

REVIEWED BY WCC LR-101 (8/80) Lmc

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