

GEOTECHNICAL ENGINEERING SERVICES  
ZIMMER NUCLEAR POWER STATION  
MOSCOW, OHIO

**INFORMATION ONLY**



*G. J. Thelen & Associates, Inc.*

☐ 516 Enterprise Drive/Covington, Kentucky 41017/606-341-1322  
☐ 1008 Marshall Ave./Cincinnati, Ohio 45225/513-559-9089

8304190425 830414  
PDR ADOCK 05000358  
A PDR



CIVIL ENGINEERS

*G. J. Thelen & Associates, Inc.*

☒ 516 Enterprise Drive/Covington, Kentucky 41017/606-341-1322  
☐ 1008 Marshall Ave /Cincinnati, Ohio 45225/513-559-9089

February 21, 1983

H. J. Kaiser, Inc.  
P. O. Box 201  
Moscow, Ohio 45153

Attn: Mr. B. A. Gott

Re: Geotechnical Engineering Services  
Zimmer Nuclear Power Station  
Moscow, Ohio

Gentlemen:

Submitted herewith are the results of the drilling, testing and engineering services performed by our firm. The scope of this work was developed in a meeting on February 14, 1983. Those in attendance were representatives of the H. J. Kaiser, Inc., Cincinnati Gas & Electric Company, Sargent & Lundy, Dames & Moore, and G. J. Thelen & Associates, Inc. This work was performed in accordance with our proposal-agreement dated February 17, 1983 and authorized by Mr. B. A. Gott in the meeting on February 13, 1983.

Six (6) test borings were made located as shown by the coordinate system referenced on each test boring log. We have also included in the Appendix to this report a test boring plan which shows the approximate location of the test borings relative to the nuclear reactor building. The ground surface elevation at each test boring location was estimated from elevations determined by the project surveyors. The test borings were made in accordance with

ASTM D1586 and were made with a truck mounted drill rig advancing continuous flight hollow stem augers and sampling ahead of the augers with a 2-inch O.D. split spoon driven with a 140-pound weight falling 30 inches. This procedure is described as the standard drive sample method and results in the standard penetration test. Representative portions of each sample obtained were placed in glass jars, the jars sealed and marked for proper identification. Two sets of samples were made up, one set was left at the site, the other set was returned to our Soil Mechanics Laboratory.

As the Drilling Technician advanced each test boring, a field log was kept noting soil type, soil stratification, standard penetration test results, ground water and other pertinent data.

Upon completion of the test borings all samples obtained therein were returned to our Soil Mechanics Laboratory where they were examined and visually classified by the Project Geotechnical Engineer. On the basis of this visual examination, the field log kept by the Drilling Technician and the results of the laboratory tests, final test boring logs were prepared. Copies of these logs are included in the Appendix to this report together with a Soil Classification Sheet which describes the terms and symbols used on the test boring logs.

In the immediate areas of the test borings field density tests were run by our Senior Technician, Mr. Thomas Litteral, C.E.T. These tests were run in accordance with ASTM D1556. The soil excavated during the running of each of the field density tests, by the sand cone method, was placed in a quart jar, the jar sealed and properly labeled. When each field density test was completed our Senior Technician obtained a bag sample in the immediate area

of the field density test. This bag sample was labeled for proper identification.

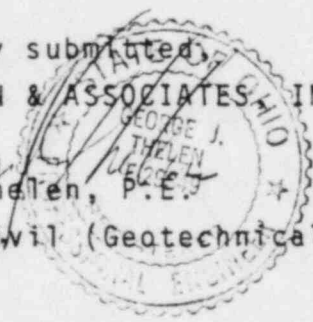
Upon completion of the field density tests, the samples obtained therein were returned to our Soil Mechanics Laboratory. A washed sieve analyses, ASTM D422, was run on each quart jar sample. The results of these tests have been tabulated and the tabulation is included in the Appendix to this report together with the appropriate test forms.

Relative density tests, ASTM D2049, were run on each of the large bag samples. These relative density tests were run wet and dry. Initially, the tests were repeated for the first few samples to check our ability to duplicate the test results. Once the test data verified the accuracy of the testing only one relative density test was run on each of the remaining samples. We have tabulated the results of the relative density tests and the tabulation is included in the Appendix to this report. In addition to the results of the relative density tests we have also shown on the tabulation the results of the field density tests and the computed relative density values.

If you have any questions concerning the information contained herein, please do not hesitate to contact us.

Respectfully submitted,  
G. J. THELEN & ASSOCIATES, INC.

George J. Thelen, P.E.  
Principal Civil (Geotechnical) Engineer



GJT:mg

83034E

Copies submitted: 10

APPENDIX

Test Boring Plan

Test Boring Logs

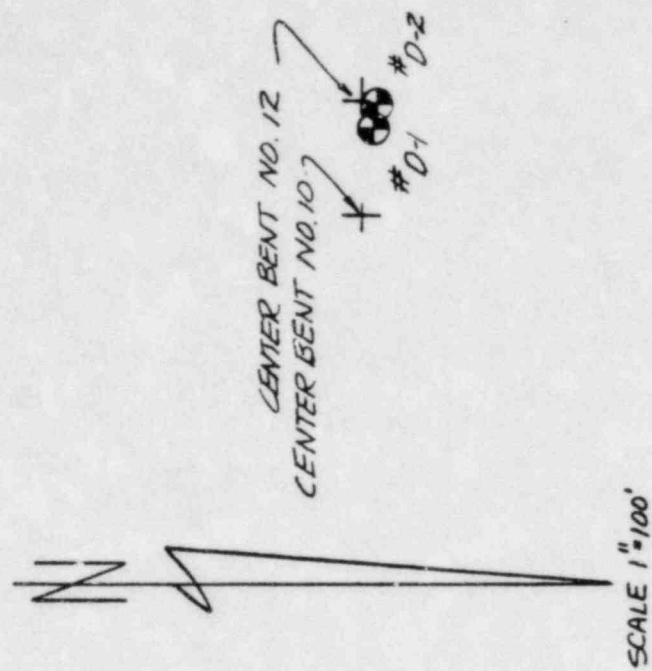
Soil Classification Sheet

Tabulation of Gradation Analyses

Laboratory Test Forms

Tabulation of Field and Laboratory Tests





NUCLEAR REACTOR BUILDING

#D-3  
#D-4  
#D-5  
#D-6

CENTER BENT NO. 12  
CENTER BENT NO. 10-7  
#D-1  
#D-2

SCALE 1"=100'

● INDICATES TEST BORING LOCATION

SUBSURFACE EXPLORATION  
ZIMMER N.P.S.  
MOSCOW, OHIO 83034E

TEST BORING PLAN

G. J. THELEN & ASSOCIATES, INC.  
516 ENTERPRISE DRIVE  
COVINGTON, KENTUCKY 41017



G. J. Thelen & Associates, Inc.

☐ 516 Enterprise Drive/Covington, Kentucky 41017/606-341-1322  
☐ 1008 Marshall Ave./Cincinnati, Ohio 45225/513-559-9089

## LOG OF TEST BORING

CLIENT H.J. Kaiser, Inc. BORING # D-1  
 PROJECT Subsurface Exploration, Zimmer N.P.S., Moscow, Ohio JOB # 83034E  
 LOCATION OF BORING Coordinates, North 1773.50, West 1202.50

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRA. DEPTH	DEPTH SCALE	SAMPLE			
				Cond	Blows/6"	No.	Type Rec.
498.2	<b>SURFACE</b>	0.2					
498.0	Mixed brown moist soft FILL, silty clay with grass and hairlike roots, thawing.	2.9	I	2/10/12	1A	DS	16"
					1B		
495.3	Mixed brown moist stiff to very stiff FILL, sandy silty clay with hairlike roots, trace fine to coarse gravel.	4.5	D	8/9/12	2A	DS	18"
					2B		
493.7	Mixed dark brown moist medium dense FILL, fine to medium silty sand, some fine to coarse gravel.	8.0	D	4/3/3	3	DS	6"
		9.5	D	3/2/2	4	DS	6"
490.2	Mixed dark brown moist loose FILL, silty fine to medium sand, little fine to coarse gravel. (SP-SM) & SW-SM)	12.0	D	12/14/16	5	DS	12"
488.7	Mixed dark brown very moist very loose FILL, fine to medium sand, some fine to coarse gravel.	14.5	I	5/5/6	6	DS	13"
486.2	Mixed brown moist medium dense FILL, fine to medium sand, little fine to coarse gravel.	16.5	I	5/3/4	7	DS	18"
483.7	Mottled brown and gray moist stiff SILTY CLAY.						
481.7	Brown moist to very moist soft to medium stiff SILTY CLAY with iron oxide stains and thin wet fine sand seams.						
	Bottom of test boring at 16.5 feet.						

Datum USGS Hammer Wt. 140 Lbs. Hole Diameter 8" Foreman JM  
 Surf. Elev. 498.2 Ft. Hammer Drop 30 In. Rock Core Dia.  Engineer GJT  
 Date Started 2/16/83 Pipe Size 0.D.2 In. Boring Method HSA Date Completed 2/16/83

### SAMPLE CONDITIONS

D - DISINTEGRATED  
 I - INTACT  
 U - UNDISTURBED  
 L - LOST

### SAMPLER TYPE

DS - DRIVEN SPLIT SPOON  
 PT - PRESSED SHELBY TUBE  
 CA - CONTINUOUS FLIGHT AUGER  
 RC - ROCK CORE

### GROUND WATER DEPTH

FIRST NOTED 8.0 FT.  
 AT COMPLETION Dry FT.  
 AFTER HRS. FT.  
 BACKFILLED Immed. HRS.

### BORING METHOD

HSA - Hollow Stem Augers  
 CFA - Continuous Flight Augers  
 DC - Driving Casing  
 MD - Mud Drilling

\*STANDARD PENETRATION TEST - DRIVING 2" OD SAMPLER 1' WITH 140 # HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS



G. J. Thelen & Associates, Inc.

516 Enterprise Drive/Covington, Kentucky 41017/606-341-1322  
1008 Marshall Ave./Cincinnati, Ohio 45225/513-559-9089

## LOG OF TEST BORING

CLIENT H. J. Kaiser, Inc. BORING # D-2  
PROJECT Subsurface Exploration, Zimmer N.P.S., Moscow, Ohio JOB # 83034E  
LOCATION OF BORING Coordinates, North 1774.00, West 1218.20

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRA. DEPTH	DEPTH SCALE	SAMPLE				
				Cond	Blows/6"	No.	Type	Rec.
498.2	<b>SURFACE</b>	0.6		I	4/6/8	1A	DS	13'
497.6	Mixed dark brownish gray moist medium stiff to stiff FILL, very silty clay with hairlike roots, trace fine gravel.	3.5		D	5/6/9	2	DS	16'
494.7	Mixed dark brown moist stiff FILL, sandy clay, some fine to coarse gravel.	5.0	5	D	4/3/5	3	DS	18'
493.2	Mixed dark brown, trace brown moist medium dense FILL, silty fine to medium sand, little fine to coarse gravel.	9.5	10	D	3/3/3	4	DS	11'
488.7	Mixed dark brown moist loose FILL, silty fine to medium sand, little fine to coarse gravel with clay lumps. (SP-SM)	12.0		D	7/8/9	5	DS	13'
486.2	Mixed brown very moist medium dense FILL, fine to medium sand, some fine to coarse gravel.	14.5	15	I	4/5/6	6	DS	18'
483.7	Mottled brown and gray moist very stiff SILTY CLAY.	16.5		I	4/5/5	7	DS	18'
481.7	Brown, trace gray moist medium stiff SILTY CLAY with iron oxide stains.		20					
	Bottom of test boring at 16.5 feet.							

Datum USGS Hammer Wt. 140 Lbs. Hole Diameter 8" Foreman JM  
Surf. Elev. 498.2 Ft. Hammer Drop 30 In. Rock Core Dia. - Engineer GJT  
Date Started 2/16/83 Pipe Size 0.D.2 In. Boring Method HSA Date Completed 2/16/83

### SAMPLE CONDITIONS

D - DISINTEGRATED  
I - INTACT  
U - UNDISTURBED  
L - LOST

### SAMPLER TYPE

DS - DRIVEN SPLIT SPOON  
PT - PRESSED SHELBY TUBE  
CA - CONTINUOUS FLIGHT AUGER  
RC - ROCK CORE

### GROUND WATER DEPTH

FIRST NOTED 9.5 FT.  
AT COMPLETION Dry FT.  
AFTER HRS. FT.  
BACKFILLED Immed. HRS.

### BORING METHOD

HSA - Hollow Stem Augers  
CFA - Continuous Flight Augers  
DC - Driving Casing  
MD - Mud Drilling

\*STANDARD PENETRATION TEST - DRIVING 2" OD SAMPLER 1' WITH 140 # HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS





CIVIL ENGINEERS

G. J. Thelen &amp; Associates, Inc.

□ 516 Enterprise Drive/Covington, Kentucky 41017/606-341-1322  
 □ 1008 Marshall Ave./Cincinnati, Ohio 45225/513-559-9089

## LOG OF TEST BORING

CLIENT H. J. Kaiser, Inc. BORING # D-3  
 PROJECT Subsurface Exploration, Zimmer N.P.S., Moscow, Ohio JOB # 83034E  
 LOCATION OF BORING Coordinates, North 1802.20 West 382.80

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRA DEPTH	DEPTH SCALE	SAMPLE				
				Cond	Blows/6"	No.	Type	Rec.
505.0	<b>SURFACE</b>	0.6						
504.4	Mixed brown moist medium stiff FILL, silty clay.			I	6/5/5	1A	DS	16"
500.5	Mixed brown moist loose silty fine to medium SAND, some fine gravel with clay lumps.			I	3/5/4	2A	DS	14"
498.0	Mottled brown and gray moist stiff FILL, silty clay with seams of fine to medium sand, little fine to coarse gravel.	4.5	5	I	3/2/2	3A	DS	5'
497.0	Mixed dark brown and brown moist medium dense FILL, silty fine to medium sand, little fine to coarse gravel. (SP-SM)	7.0		D	6/13/16	4A 4B	DS	16'
490.5	Mixed dark brown moist medium dense FILL, fine to medium sand, trace fine to coarse gravel. (SP)	8.0	10	D	8/10/16	5A	DS	17'
489.5	Mixed brown moist very dense FILL, fine to medium sand and fine to coarse gravel.	14.5		D	11/13/18	6A	DS	18'
488.0	Mixed dark brown moist very dense FILL, fine to medium sand, some fine to coarse gravel.	15.5	15	D	29/45/50 /5"	7A 7B	DS	16'
483.0	Mixed brown moist very dense FILL, fine to medium sand and fine to coarse gravel.	17.0		D	29/25/50 /4"	8A	DS	15'
480.5	Mixed dark brown and brown moist very dense FILL, fine to medium sand, trace fine to coarse gravel.	22.0	20	D	34/82	9A	DS	10'
478.9	Mixed dark brown moist very dense FILL, fine to medium sand, some fine to coarse gravel.	24.5		D	15/30/46	10A	DS	1'
478.0	Mixed brown and dark brown moist very dense FILL, fine sand, trace fine gravel.	26.1	25	D	32/58/74	11A	DS	1'
476.0	Mixed dark brown moist to very moist very dense FILL, fine to medium sand, little fine to coarse gravel.	27.0 29.0	30	D	24/38/45	11B 12	DS	18'
Bottom of test boring at 29.0 feet.								

Datum USGS Hammer Wt. 140 Lbs. Hole Diameter 8" Foreman JM  
 Surf. Elev. 505.0 Ft. Hammer Drop 30 In. Rock Core Dia. - Engineer GJT  
 Date Started 2/15/83 Pipe Size 0.D.2 In. Boring Method HSA Date Completed 2/16/83

## SAMPLE CONDITIONS

D - DISINTEGRATED  
 I - INTACT  
 U - UNDISTURBED  
 L - LOST

## SAMPLER TYPE

DS - DRIVEN SPLIT SPOON  
 PT - PRESSED SHELBY TUBE  
 CA - CONTINUOUS FLIGHT AUGER  
 RC - ROCK CORE

## GROUND WATER DEPTH

FIRST NOTED None FT.  
 AT COMPLETION Dry FT.  
 AFTER        HRS. FT.  
 BACKFILLED Immed. HRS.

## BORING METHOD

HSA - Hollow Stem Augers  
 CFA - Continuous Flight Augers  
 DC - Driving Casing  
 MD - Mud Drilling

\*STANDARD PENETRATION TEST - DRIVING 2" OD SAMPLER 1' WITH 140 # HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS



G. J. Thelen & Associates, Inc.

516 Enterprise Drive/Covington, Kentucky 41017/606-341-1322  
1008 Marshall Ave./Cincinnati, Ohio 45225/513-559-9089

## LOG OF TEST BORING

CLIENT H.J. Kaiser, Inc. BORING # D-4  
PROJECT Subsurface Exploration, Zimmer N.P.S., Moscow, Ohio JOB # 83034E  
LOCATION OF BORING Coordinates, North 1805.85, West 416.80

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRA. DEPTH	DEPTH SCALE	SAMPLE			
				Cond	Blows/6"	No.	Type Rec
505.0	<b>SURFACE</b>	0.0					
503.0	Mixed dark brown, trace gray moist stiff FILL, silty clay, little fine to coarse gravel.	2.0		I	4/7/7	1	DS 15'
500.5	Mixed brown, trace gray moist stiff FILL, silty clay, little fine to coarse gravel.	4.5		I	5/5/6	2	DS 18
498.0	Mixed dark brown and gray moist stiff FILL, silty clay, little fine to coarse gravel.	7.0	5	I	4/5/6	3	DS 16
495.5	Mixed dark brown moist medium dense FILL, silty fine to coarse sand, some fine to coarse gravel with silty clay lumps. (SW-SM)	9.5		D	8/12/11	4	DS 18
491.5	Mixed dark brown moist loose FILL, silty fine to medium sand, little fine to coarse gravel. Split spoon penetrated plastic barrier. (SP-SM)	13.5	10	D	4/3/3	5	DS 15
490.5	Mixed brown and dark brown moist medium dense FILL, fine to medium sand, little fine to coarse gravel.	14.5		D	5/4/14	6	DS 17
488.0	Mixed brown moist very dense FILL, fine to medium sand, little fine to coarse gravel with silty clay lumps.	17.0	15	I	15/25/49	7	DS 16
485.5	Mixed dark brown and brown moist very dense FILL, fine to coarse sand and gravel.	19.5		I	21/35/50	8	DS 18
483.0	Mixed dark brown moist very dense FILL, fine sand and fine to coarse gravel.	22.0	20	D	Note: Scale Change 27/53/61	9	DS 16
478.0	Mixed dark brown moist very dense FILL, fine to medium sand, little fine to coarse gravel.	27.0	25	D	28/45/85	10	DS 16
476.0	Mixed dark brown and brown moist very dense fine to medium sand, trace fine to coarse gravel.	29.0	30	D	35/60/85 30/43/56	11 12	DS 18 DS 18
	Bottom of test boring at 29.0 feet.		35				

Datum USGS Hammer Wt. 140 Lbs. Hole Diameter 8" Foreman JM  
Surf. Elev. 505.0 Ft. Hammer Drop 30 In. Rock Core Dia. - Engineer GJT  
Date Started 2/15/83 Pipe Size 0.0.2 In. Boring Method HSA Date Completed 2/15/83

### SAMPLE CONDITIONS

D - DISINTEGRATED  
I - INTACT  
U - UNDISTURBED  
L - LOST

### SAMPLER TYPE

DS - DRIVEN SPLIT SPOON  
PT - PRESSED SHELBY TUBE  
CA - CONTINUOUS FLIGHT AUGER  
RC - ROCK CORE

### GROUND WATER DEPTH

FIRST NOTED None FT.  
AT COMPLETION Dry FT.  
AFTER HRS. FT.  
BACKFILLED Immed. HRS.

### BORING METHOD

HSA - Hollow Stem Augers  
CFA - Continuous Flight Augers  
DC - Driving Casing  
MD - Mud Drilling

\*STANDARD PENETRATION TEST - DRIVING 2" OD SAMPLER 1' WITH 140 # HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS



CIVIL ENGINEERS

G. J. Thelen &amp; Associates, Inc.

☐ 516 Enterprise Drive/Covington, Kentucky 41017/606-341-1322  
☐ 1008 Marshall Ave./Cincinnati, Ohio 45225/513-559-9089

## LOG OF TEST BORING

CLIENT H. J. Kaiser, Inc. BORING # D-5  
 PROJECT Subsurface Exploration, Zimmer N.P.S., Moscow, Ohio JOB # 83034E  
 LOCATION OF BORING Coordinates, North 1806.30, West 430.80

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRA. DEPTH	DEPTH SCALE	SAMPLE				
				Cond	Blows/6"	No.	Type	Rec
505.0	<b>SURFACE</b>	0.0						
	Mixed dark brown and gray moist very stiff to stiff FILL, sandy clay, little fine to coarse gravel with thin fine sand layers.		I		6/7/7	1	DS	15
500.5		4.5	I		7/7/9	2	DS	18
	Mixed grayish brown and brown moist stiff FILL, silty clay with pieces of grass, trace fine gravel.		I		4/5/7	3	DS	18
497.2		7.8						
	Mixed dark brown moist medium dense FILL, silty fine to medium sand, little fine to coarse gravel. Split spoon penetrated plastic barrier.		D		7/9/17	4	DS	16
493.0		12.0	D		5/6/8	5	DS	6
	Mixed brown and dark brown moist medium dense FILL, fine to medium sand, some fine to coarse gravel.		D		6/11/19	6	DS	18
490.5		14.5						
	Mixed dark brown moist very dense FILL, fine to coarse sand and gravel.		D		23/37/64	7	DS	18
488.0		17.0						
	Mixed brown moist very dense FILL, fine sand, some fine to coarse gravel.		D		26/58/75	8	DS	18
486.0		19.0						
	Bottom of test boring at 19.0 feet.							

Datum USGS Hammer Wt. 140 Lbs. Hole Diameter 8" Foreman JM  
 Surf. Elev. 505.0 Ft. Hammer Drop 30 in. Rock Core Dia. - Engineer GJT  
 Date Started 2/17/83 Pipe Size 0.D.2 in. Boring Method CFA Date Completed 2/17/83

## SAMPLE CONDITIONS

D - DISINTEGRATED  
 I - INTACT  
 U - UNDISTURBED  
 L - LOST

## SAMPLER TYPE

DS - DRIVEN SPLIT SPOON  
 PT - PRESSED SHELBY TUBE  
 CA - CONTINUOUS FLIGHT AUGER  
 RC - ROCK CORE

## GROUND WATER DEPTH

FIRST NOTED None FT.  
 AT COMPLETION Dry FT.  
 AFTER HRS. FT.  
 BACKFILLED immed. HRS.

## BORING METHOD

HSA - Hollow Stem Augers  
 CFA - Continuous Flight Augers  
 DC - Driving Casing  
 MD - Mud Drilling

\*STANDARD PENETRATION TEST - DRIVING 2" OD SAMPLER 1' WITH 140 # HAMMER FALLING 30"; COUNT MADE AT 6" INTERVALS





G. J. Thelen & Associates, Inc.

516 Enterprise Drive/Covington, Kentucky 41017/606-341-1322  
1008 Marshall Ave./Cincinnati, Ohio 45225/513-559-9089

## LOG OF TEST BORING

CLIENT H. J. Kaiser, Inc. BORING # D-6  
PROJECT Subsurface Exploration, Zimmer N.P.S., Moscow, Ohio JOB # 83034E  
LOCATION OF BORING Coordinates, North 1815.50, West 417.80

ELEV.	SOIL DESCRIPTION COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS	STRA. DEPTH	DEPTH SCALE	SAMPLE			
				Cond	Blows/6"	No.	Type Re
505.0	<b>SURFACE</b>	0.0					
	Mixed dark brown, brown and gray moist very stiff FILL, sandy clay, some fine to coarse gravel.	2.0		I	4/6/8	1	DS 18
503.0							
	Mixed brown moist stiff to very stiff FILL, silty clay, little fine to coarse gravel.	4.5		I	8/8/9	2	DS 17
500.5							
	Dark brownish gray moist very stiff FILL, silty clay, trace fine gravel.	7.0		I	4/5/7	3	DS 15
498.0		7.9					
	Mixed brown moist stiff FILL, silty clay, trace fine gravel.	9.5		D	10/14/22	4	DS 15
497.1							
	Mixed dark brown moist dense FILL, fine sand, little fine to coarse gravel.	12.0		D	16/18/22	5	DS 15
495.5							
	Mixed brown and dark brown moist dense FILL, fine sand, little fine to coarse gravel.	14.5		D	15/19/28	6	DS 18
493.0							
	Mixed brown moist dense FILL, fine to medium sand, little fine to coarse gravel.	19.0		D	24/40/56	7	DS 16
490.5							
	Mixed brown moist very dense FILL, fine to medium sand, little fine to coarse gravel.			D	20/40/60	8	DS 18
486.0							
	Bottom of test boring at 19.0 feet						

Datum USGS Hammer Wt. 140 Lbs. Hole Diameter 8" Foreman JM  
Surf. Elev. 505.0 Ft. Hammer Drop 30 In. Rock Core Dia. - Engineer GJT  
Date Started 2/17/83 Pipe Size 0.0.2 In. Boring Method CFA Date Completed 2/17/83

### SAMPLE CONDITIONS

D - DISINTEGRATED  
I - INTACT  
U - UNDISTURBED  
L - LOST

### SAMPLER TYPE

DS - DRIVEN SPLIT SPOON  
PT - PRESSED SHELBY TUBE  
CA - CONTINUOUS FLIGHT AUGER  
RC - ROCK CORE

### GROUND WATER DEPTH

FIRST NOTED 15.5 FT.  
AT COMPLETION Dry FT.  
AFTER - HRS. FT.  
BACKFILLED Immed. HRS.

### BORING METHOD

HSA - Hollow Stem Augers  
CFA - Continuous Flight Augers  
DC - Driving Casing  
MD - Mud Drilling

\*STANDARD PENETRATION TEST - DRIVING 2" OD SAMPLER 1" WITH 140 # HAMMER FALLING 30" COUNT MADE AT 2" INTERVALS



CIVIL ENGINEERS

G. J. Thelen, PSC

□ 516 Enterprise Drive/Covington, Kentucky 41011/606-341-1322  
 □ 1008 Marshall Ave./Cincinnati, Ohio 45225/513-559-9089

## FIELD CLASSIFICATION SYSTEM FOR SOIL EXPLORATION

### NON COHESIVE SOILS

(Silt, Sand, Gravel and Combinations)

#### Density

Very Loose	- 5 blows/ft. or less
Loose	- 6 to 10 blows/ft.
Medium Dense	-11 to 30 blows/ft.
Dense	-31 to 50 blows/ft.
Very Dense	-51 blows/ft. or more

#### Relative Proportions

Descriptive Term	Percent
Trace	1 - 10
Little	11 - 20
Some	21 - 35
And	36 - 50

#### Particle Size Identification

Boulders	-8 inch diameter or more
Cobbles	-3 to 8 inch diameter
Gravel	-Coarse - $\frac{3}{4}$ to 3 inches Fine - $\frac{3}{16}$ to $\frac{3}{4}$ inches
Sand	-Coarse -2mm to 5mm (dia. of pencil lead) Medium -0.45mm to 2mm (dia. of broom straw) Fine -0.075mm to 0.45mm (dia. of human hair)
Silt	-0.005mm to 0.075mm Cannot see particles)

### COHESIVE SOILS

(Clay, Silt and Combinations)

#### Consistency

#### Field Identification

#### Unconfined Compressive Strength (tons/sq. ft.)

Very soft	Easily penetrated several inches by fist	Less than 0.25
Soft	Easily penetrated several inches by thumb	0.25 - 0.5
Medium	Can be penetrated several inches by thumb with moderate effort	0.5 - 1.0
Stiff	Readily indented by thumb but penetrated only with great effort	1.0 - 2.0
Very Stiff	Readily indented by thumbnail	2.0 - 4.0
Hard	Indented with difficulty by thumbnail	Over 4.0

Classification on logs are made by visual inspection.

Standard Penetration Test—Driving a 2.0" O. D., 1 $\frac{3}{8}$ " I. D., sampler a distance of 1.0 foot into undisturbed soil with a 140 pound hammer free falling a distance of 30.0 inches. It is customary for GJT to drive the spoon 6.0 inches to seat into undisturbed soil, then perform the test. The number of hammer blows for seating the spoon and making the tests are recorded for each 6.0 inches of penetration on the drill log (Example—6/8/9). The standard penetration test results can be obtained by adding the last two figures (i.e. 8 + 9 = 17 blows/ft.). Refusal is defined as greater than 50 blows for 6 inches or less penetration.

Strata Changes—In the column "Soil Descriptions" on the drill log the horizontal lines represent strata changes. A solid line (—) represents an actually observed change, a dashed line (---) represents an estimated change.

Ground Water observations were made at the times indicated. Porosity of soil strata, weather conditions, site topography, etc., may cause changes in the water levels indicated on the logs.



G. J. THELEN & ASSOCIATES, INC.  
516 ENTERPRISE DRIVE  
COVINGTON, KENTUCKY 41017

SUBSURFACE EXPLORATION  
ZIMMER NUCLEAR POWER PLANT  
MOSCOW, OHIO

83034E

TABULATION OF GRADATION ANALYSES

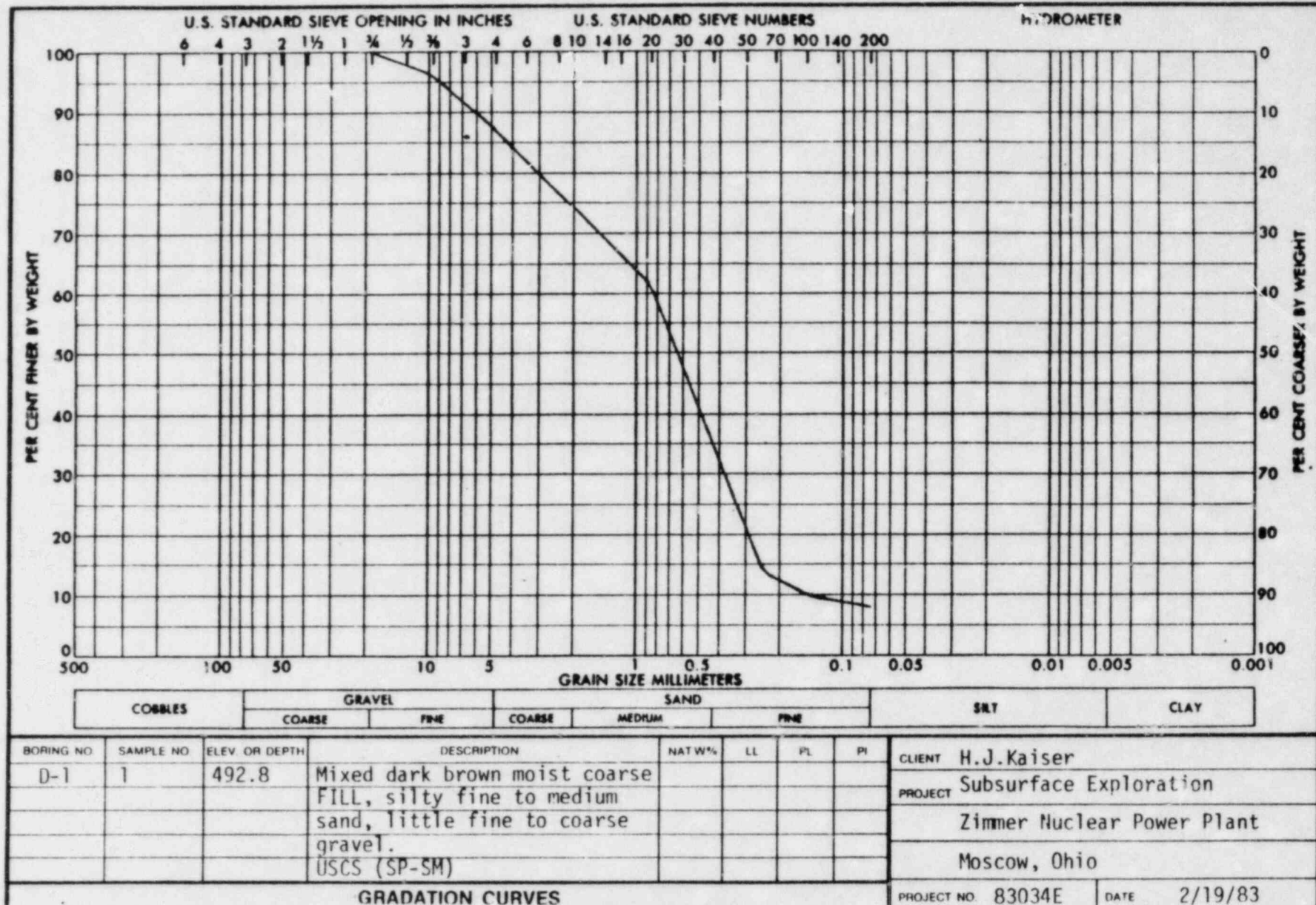
<u>Boring Number</u>	<u>Sample Number</u>	<u>Elevation</u>	<u>Gradation Analysis</u>				<u>USCS Classification</u>
			<u>Gravel</u>	<u>Sand</u>	<u>Silt</u>	<u>Clay</u>	
D-1	1	492.8	13	79	- 8 -		SP-SM
	2	490.0	14	77	- 9 -		SW-SM
D-2	1	492.8	12	80	- 8 -		SP-SM
	2	490.8	11	81	- 8 -		SP-SM
D-3	1	498.0	14	78	- 8 -		SP-SM
	2	495.0	5	92	- 3 -		SP
	3	492.0	2	94	- 4 -		SP
D-4	1	498.0	24	66	- 10 -		SW-SM
	2	495.0	10	84	- 6 -		SP-SM
	3	492.0	7	85	- 8 -		SP-SM



G. J. Thelen, PSC

□ 516 Enterprise Drive/Covington, Kentucky 41017/606-341-1322  
□ 1008 Marshall Ave./Cincinnati, Ohio 45225/513-559-9089

### GRADATION ANALYSIS

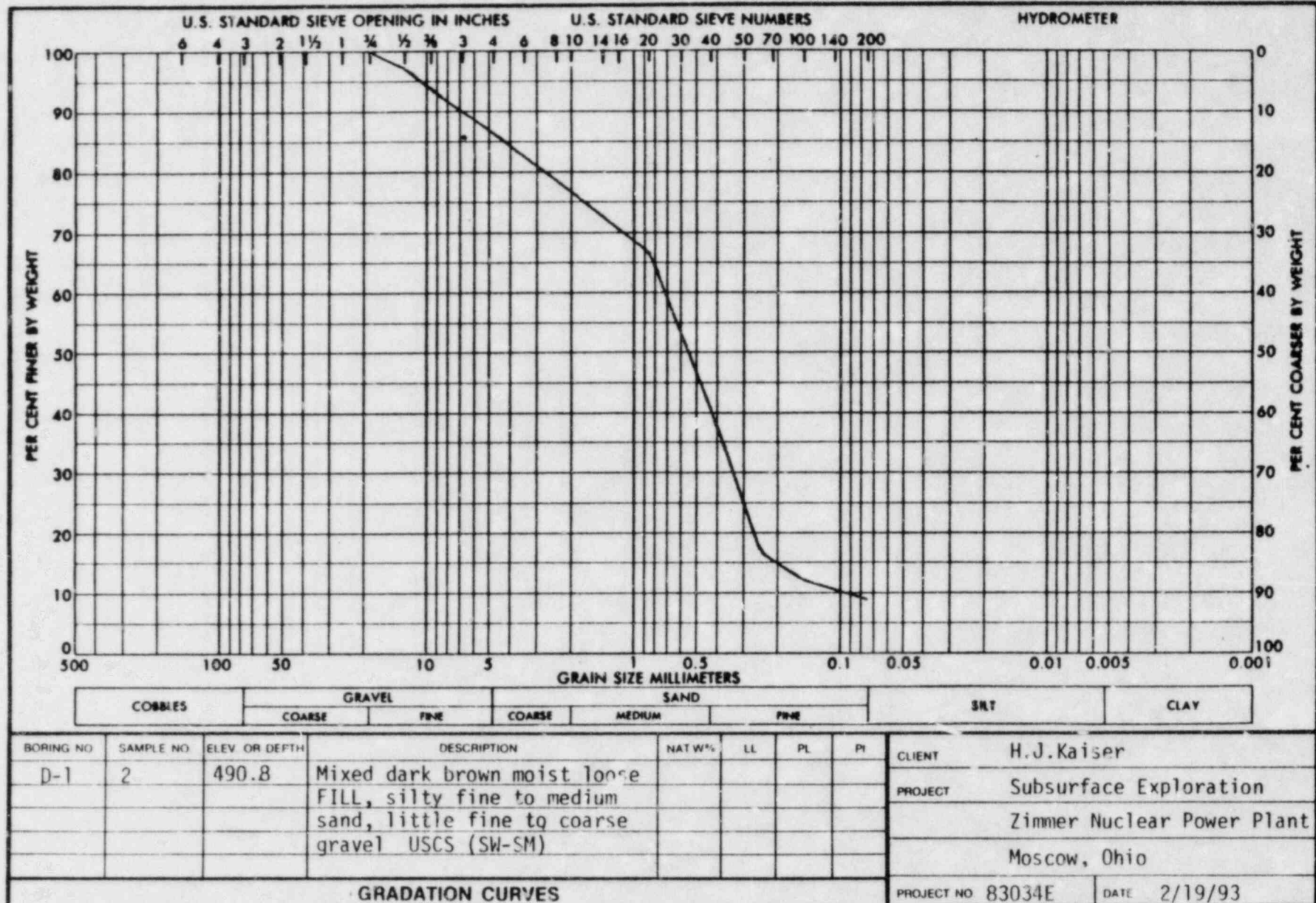




G. J. Thelen, PSC

□ 516 Enterprise Drive / Covington, Kentucky 41017/606-341-1322  
□ 1008 Marshall Ave. / Cincinnati, Ohio 45225/513-559-9029

### GRADATION ANALYSIS

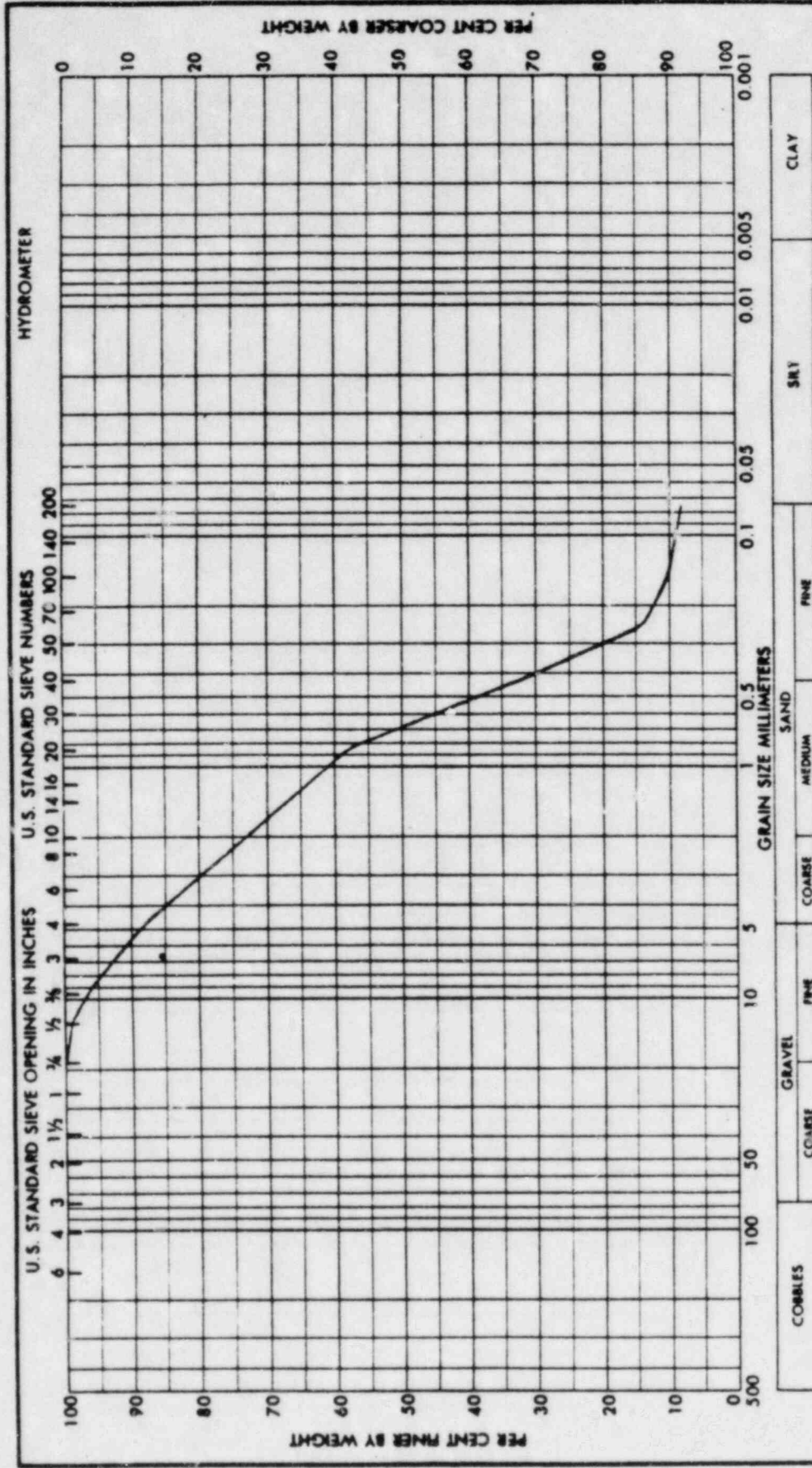




G. J. Thelen, PSC

516 Enterprise Drive/Covington, Kentucky 41017/606-341-1322  
1008 Marshall Ave /Cincinnati, Ohio 45225/513-559-9089

GRADATION ANALYSIS



BOHRING NO.	SAMPLE NO.	ELEV. OR DEPTH	DESCRIPTION	NAT W%	LL	PL	PH	CLIENT	PROJECT	DATE
D-2	1	492.8	Mixed dark brown moist loose FILL, silty fine to medium sand, little fine to coarse gravel.					H. J. Kaiser	Subsurface Exploration	2/19/83
			USCS (SP-SM)						Zimmer Nuclear Power Plant	
									Moscow, Ohio	
								PROJECT NO	83034E	

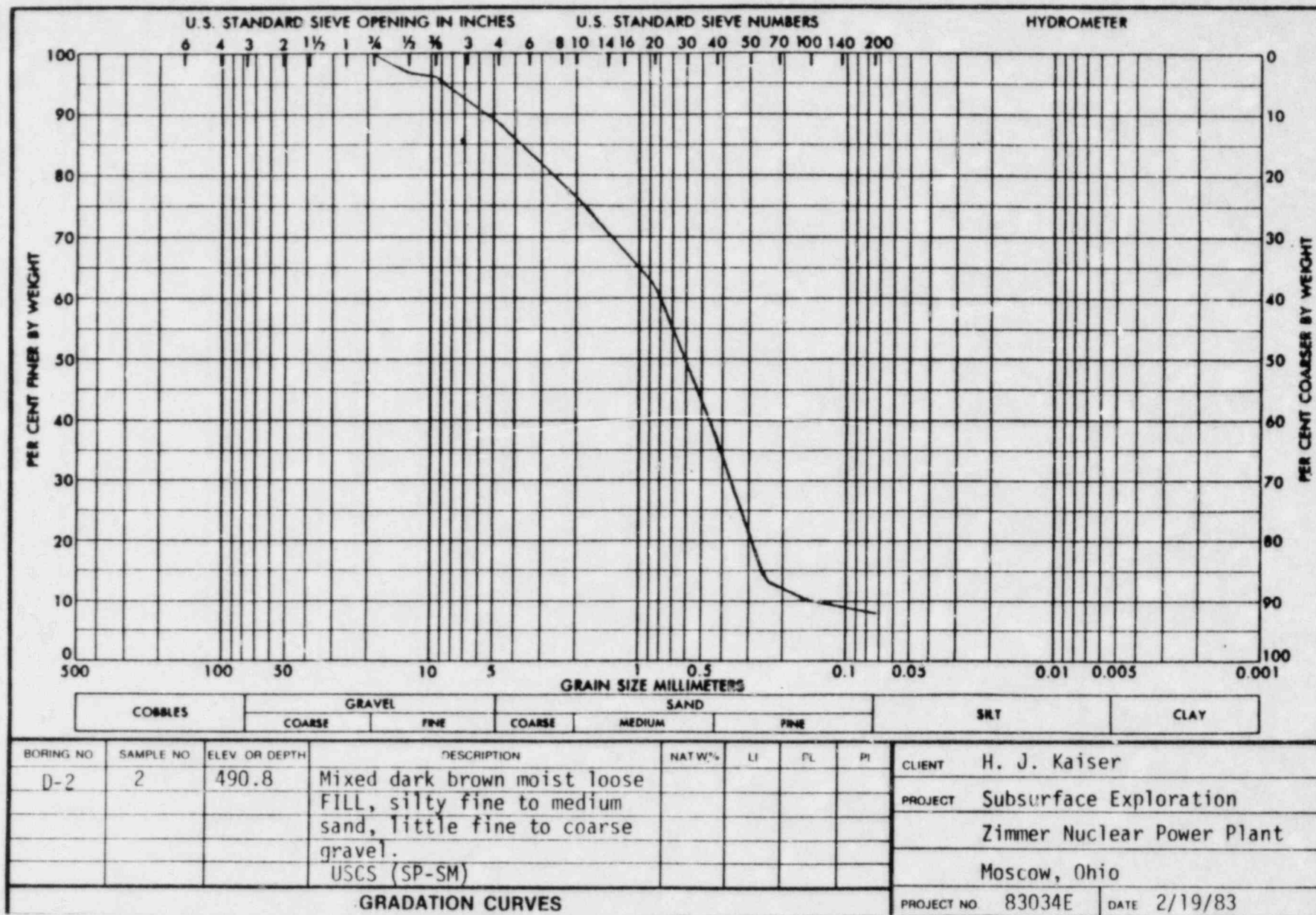




G. J. Thelen, PSC

□ 516 Enterprise Drive/Covington, Kentucky 41017/606-341-1322  
□ 1008 Marshall Ave./Cincinnati, Ohio 45225/513-559-9089

### GRADATION ANALYSIS



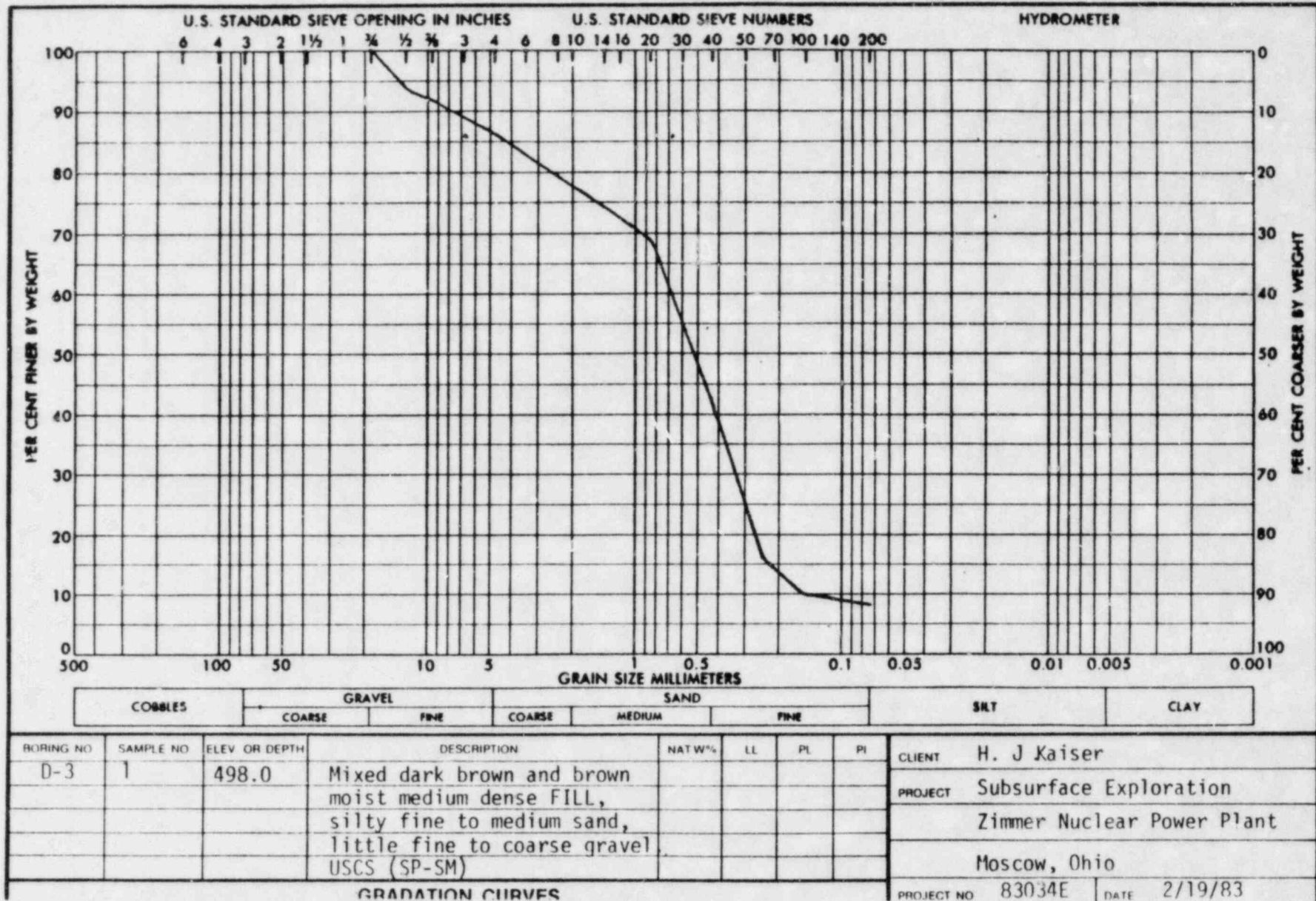




G. J. Thelen, PSC

□ 516 Enterprise Drive/Covington, Kentucky 41017/606-341-1322  
□ 1008 Marshall Ave./Cincinnati, Ohio 45225/513-559-9089

### GRADATION ANALYSIS



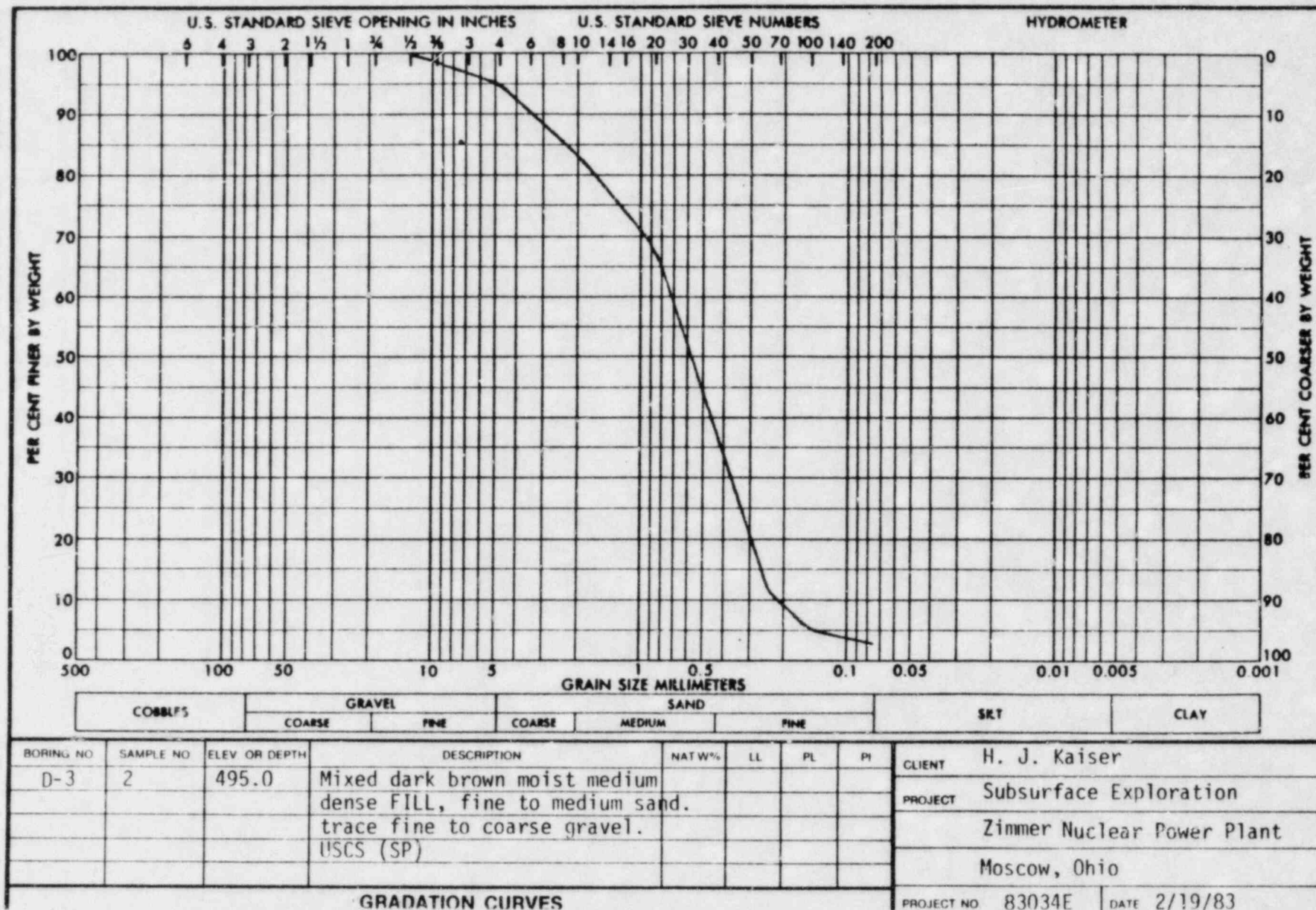
GRADATION CURVES



G. J. Thelen, PSC

516 Enterprise Drive/Covington, Kentucky 41017/606-341-1322  
1008 Marshall Ave./Cincinnati, Ohio 45225/513-559-9089

### GRADATION ANALYSIS

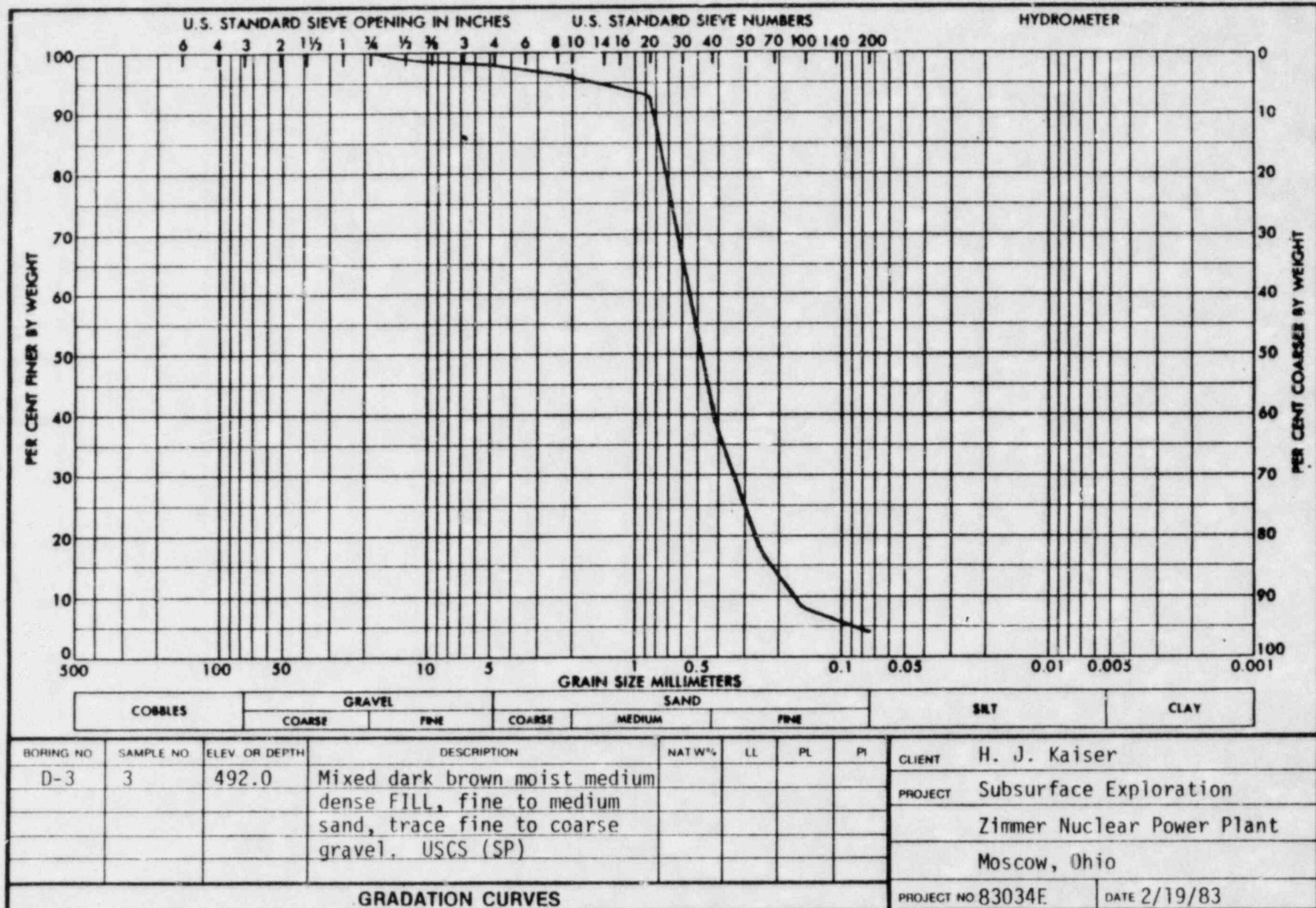




G. J. Thelen, PSC

□ 516 Enterprise Drive/Covington, Kentucky 41017/606-341-1322  
□ 1008 Marshall Ave./Cincinnati, Ohio 45225/513-559-9089

### GRADATION ANALYSIS



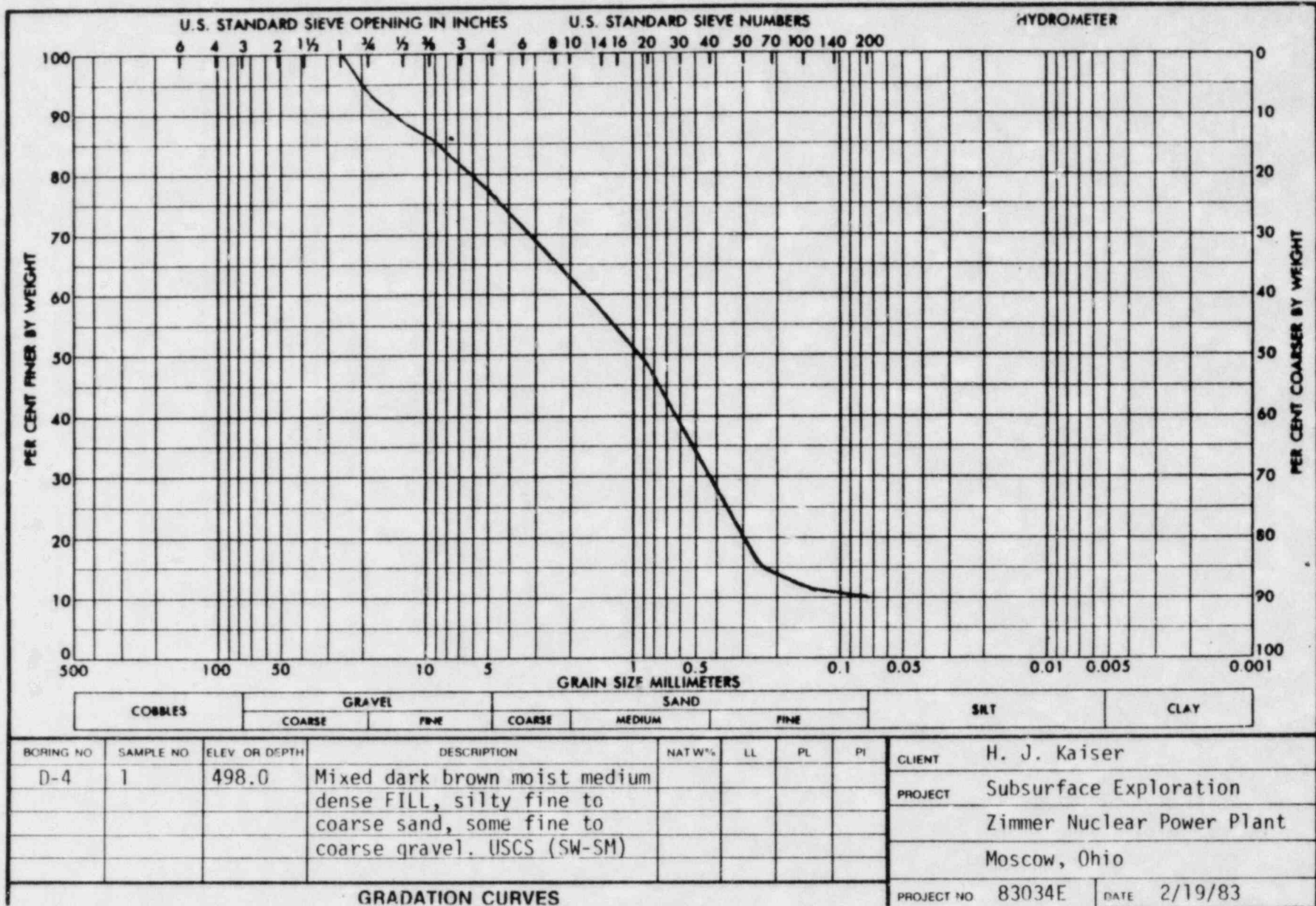




G. J. Thelen, PSC

516 Enterprise Drive/Covington, Kentucky 41017/606-341-1322  
1008 Marshall Ave./Cincinnati, Ohio 45225/513-559-9089

# GRADATION ANALYSIS

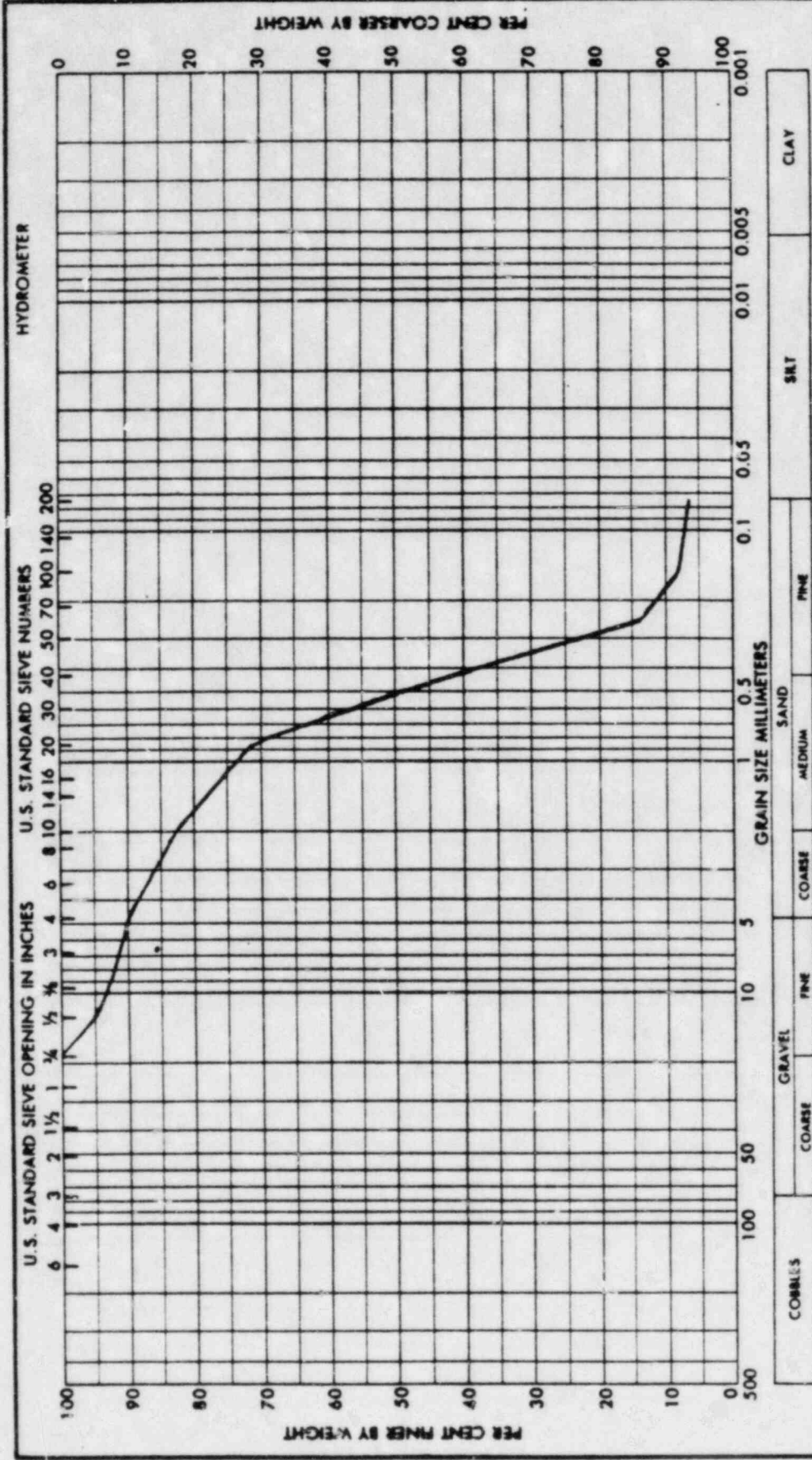




516 Enterprise Drive / Covington, Kentucky 41017 / 606-341-1322  
1008 Marshall Ave. / Cincinnati, Ohio 45225 / 513-559-9089

C. J. Thelen, PSC

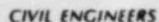
### GRADATION ANALYSIS



BORING NO	SAMPLE NO	ELEV OR DEPTH	DESCRIPTION	NAT W%				PI				CLIENT	PROJECT	DATE
				LL	PL	PI		LL	PL	PI				
D-4	2	495.0	Mixed dark brown moist loose FILL, silty fine to medium sand, little fine to coarse gravel. USCS (SP-SM)									H. J. Kaiser	Subsurface Exploration	2/19/83
													Zimmer Nuclear Power Plant	
													Moscow, Ohio	

GRADATION CURVES





☐ 516 Enterprise Drive/Covington, Kentucky 41017/606-341-1322  
☐ 1008 Marshall Ave./Cincinnati, Ohio 45225/513-559-9089

U.S. STANDARD SIEVE OPENING IN INCHES		U.S. STANDARD SIEVE NUMBERS		HYDROMETER																				
6	4	3	2	1½	1	¾	½	⅜	⅓	5	6	8	10	14	16	20	30	40	50	70	100	140	200	
COBBLES		GRAVEL		SAND		SILT		CLAY																
		COARSE	FINE	COARSE	MEDIUM	FINE																		

BORING NO.	SAMPLE NO.	ELEV. OR DEPTH	DESCRIPTION	NAT W%	LL	PL	PI	CLIENT
D-4	3	492.0	Mixed dark brown moist loose FILL, silty fine to medium sand, trace fine to coarse gravel, USCS (SP-SM)					H. J. Kaiser
								PROJECT Subsurface Exploration
								Zimmer Nuclear Power Plant
								Moscow, Ohio
GRADATION CURVES								PROJECT NO 83034E
								DATE 2/19/83

G. J. THELEN & ASSOCIATES, INC.  
516 ENTERPRISE DRIVE  
COVINGTON, KENTUCKY 41017

SUBSURFACE EXPLORATION  
ZIMMER NUCLEAR POWER PLANT  
MOSCOW, OHIO

83034E

TABULATION OF FIELD AND LABORATORY TESTS

Test Area	Sample No.	USGS Elev.	In-place Density, pcf (1)	In-place Moisture, % (field/oven)	Minimum Density, pcf (2)	Maximum Density, pcf, (Dry/Wet) (3)	Relative Density, % (4)
D-1	1	492.8 <sup>±</sup>	115.4	7.6 / 8.0	96.3	114.7 / 113.1	103.2
	2	490.8 <sup>±</sup>	111.2	13.6 / 13.1	96.0	117.2 / 117.6	74.3
D-2	1	492.8 <sup>±</sup>	117.6	7.6 / 7.4	99.7	120.1 / 115.1	89.6
	2	490.8 <sup>±</sup>	110.8	8.0 / 8.3	100.2	118.5 / 114.1	61.9
D-3	1	498.0 <sup>±</sup>	117.3	6.7 / 6.8	98.5	115.4 / 115.1	109.4
	1A				98.3	115.0 / 115.3	
	2	495.0 <sup>±</sup>	112.6	5.4 / 6.1	98.8	116.4 / 106.2	81.0
	3	492.0 <sup>±</sup>	110.3	8.2 / 8.3	90.9	108.7 / 107.0	107.4
D-4	1	498.0 <sup>±</sup>	118.0	4.5 / 5.1	102.0	119.8 / 116.5	
	1A				102.7	120.7 / 116.5	86.9
	2	495.0 <sup>±</sup>	116.2	4.4 / 4.8	97.3	114.5 / 104.4	108.3
	2A				98.3	113.6 / 104.4	
	3	492.0 <sup>±</sup>	109.9	5.7 / 6.1	97.5	112.9 / 107.3	
	3A				97.5	114.3 / 107.3	76.8

(1) In-place dry density calculated using the oven dry moisture content and field sand cone method.

(2) Minimum density determined using a scoop.

(3) Mold size used was 0.1 cubic feet.

(4) Relative density calculated using the highest maximum density number.